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EDDY CURRENT SCANNING AND VISUAL INSPECTION REPORT OF 94 SQUARES FOR 5 ILC CAVITIES TO BE PRODUCED AT AES

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TD-05-050
November 16, 2005

1 INTRODUCTION

As part of the quality control of the material used for the production of SRF cavities, at Fermilab, we perform eddy current scanning on each side of the received material. Out of 240 10.5" squares delivered by Wah-Chang, 94 were visually inspected and eddy current scanned. The squares are part of the first batch of material to be used for ILC cavities production. The material has been scanned before cutting it into disks since the production of the cavities will be entirely performed by AES. This report summarizes the results of the inspection and scanning and describes the additional measurements performed on samples showing new or unusual defects.

The eddy current scanner (ECS) setup, as described in TD-05-032, TD-05-016 and TM-2313, had to be modified to accommodate the larger parts by eliminating the 3rd Harmonic disks fixture and by fabricating additional brackets to hold the samples. Figure 1 shows how the squares were mounted into the sample-holder. The squares were more or less centered in the holder, leaving a small gap between the square and the holder which did not interfere with the measurements. Since the ECS operates only on circular areas and some distance must be kept between the floating probe and the edge of the sample, the scanned area had a diameter of 9.64" as measured from the center of the probe. The probe itself has a diameter of ~3/4" leaving only a small part of the outside rim not scanned as shown in figure 2.

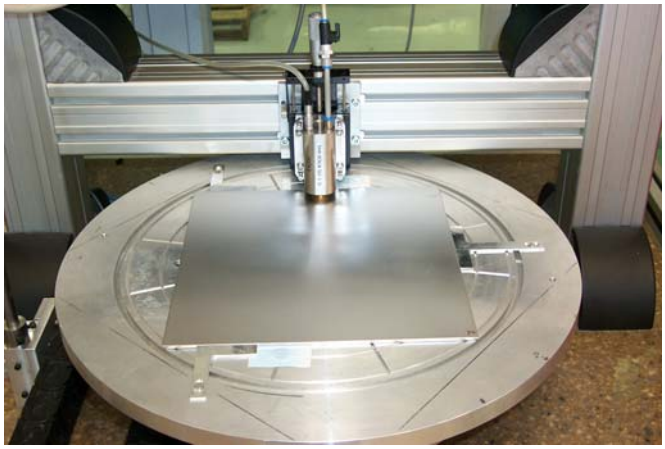


Figure 1 Setup for scanning square samples.

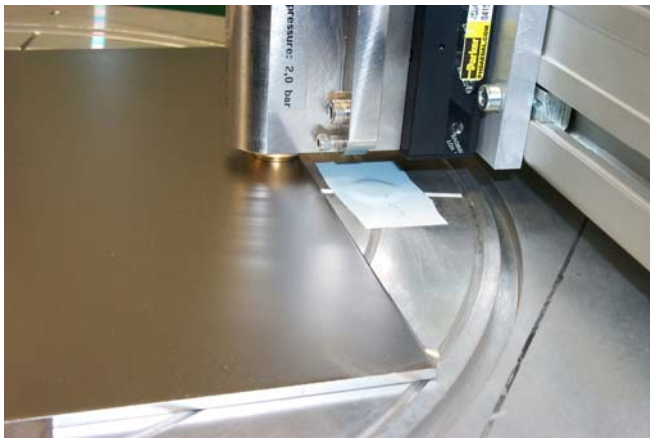


Figure 2 Distance of the probe from the sample edge.

The table below lists the operational parameters of the eddy current scanner.

Parameter	Channel 1 – SNS/FNAL
Frequency	190 kHz
Probe Adjust	50 Ohm
Probe Current	333 mA
Phase	205 deg
Pre-amplifier	30 dB
Total gain (x/y)	46/66dB
X/Y spread	0/20 dB
Highpass filter	static
Lowpass filter	0.5-2 kHz
BW limit	off
Track spacing	100 ◎m
Point spacing	0.225°
Turntable speed	105 rpm

Table 1 Scanning parameters

2 Q. C. PROCEDURE

The following procedure was applied to each sample:

2.1 VISUAL INSPECTION

1. The samples were handled using nitrile gloves all the time during visual inspection
2. The samples have been optically inspected, using a magnifying glass when necessary, looking for scratches, pits, dings, discolorations, large surface imperfections
3. The results were written in the **VISUAL INSPECTION LOG BOOK**

2.2 SCANNING

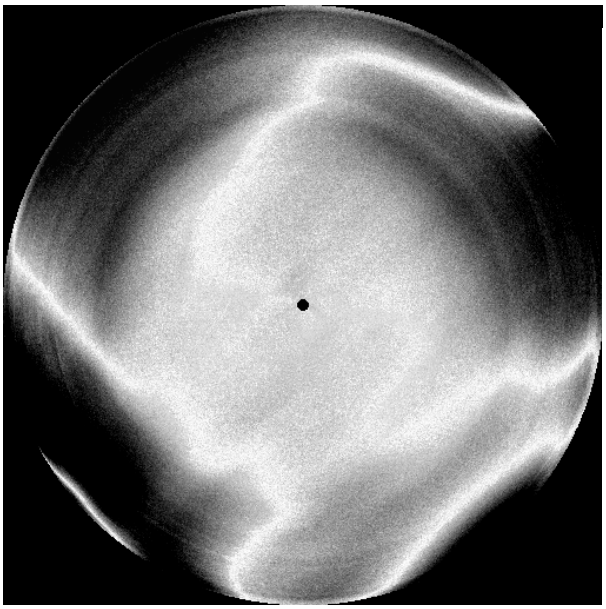
1. The system was switched on at least one hour before testing. The probe height was adjusted for the first sample to be scanned and kept fixed for all the samples of the batch.
2. Each sample was centered between the holding brackets.
3. The phase was set at the center of each sample
4. The calibration of the probe signal was automatically performed on the outermost radius of each disk
5. Each side of the samples was marked at the top-right corner in correspondence of the 0 angle of the scanner rotating plate with a 1 for the first side scanned and a 2 for the second side scanned
6. The scanning information were reported in the **ECS LOG BOOK**
7. The scan results were saved in NSD, NSX and BMP formats using the following convention: **ILC_disc#_disc-side_run#** where disk# follows the vendor numbering as reported in each sample package
8. The scan results were filtered using FIONDA and a image of the results was saved in JPG format using the same naming convention as in point 7
9. Printouts of the BMP and JPG files were archived in a folder

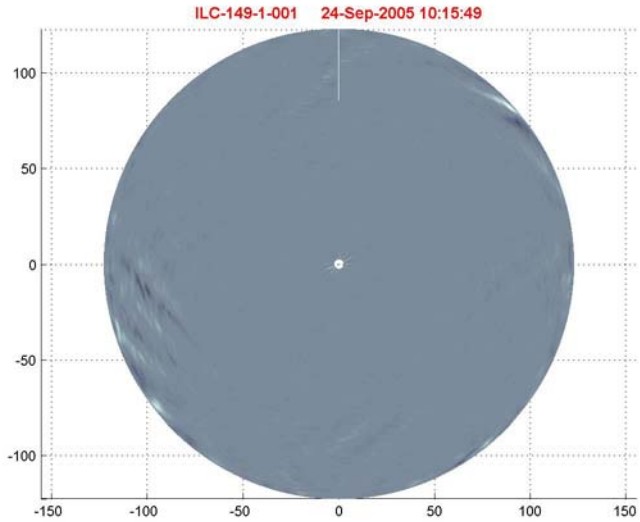
2.3 POST PROCESSING

1. The visual inspection and the scanning results were compared
2. Samples needing additional measurements were selected
3. Anodization, etching, degreasing, microscopy, ultrasound thickness measurements and profile measurements where used as additional diagnostic techniques.

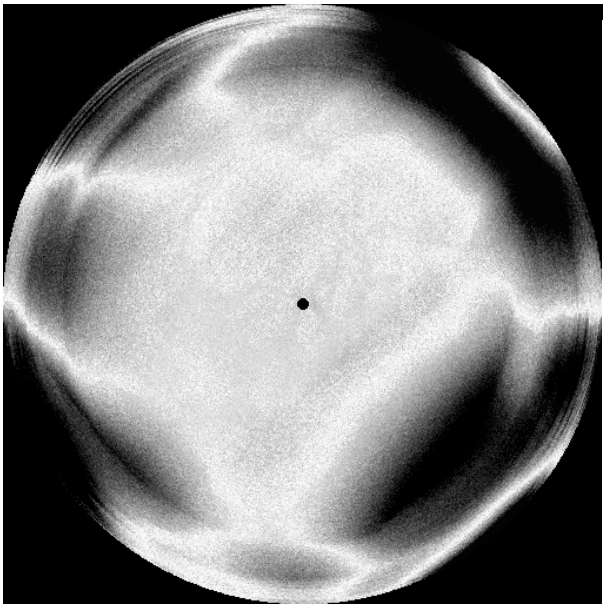
3 EDDY CURRENT SCANS

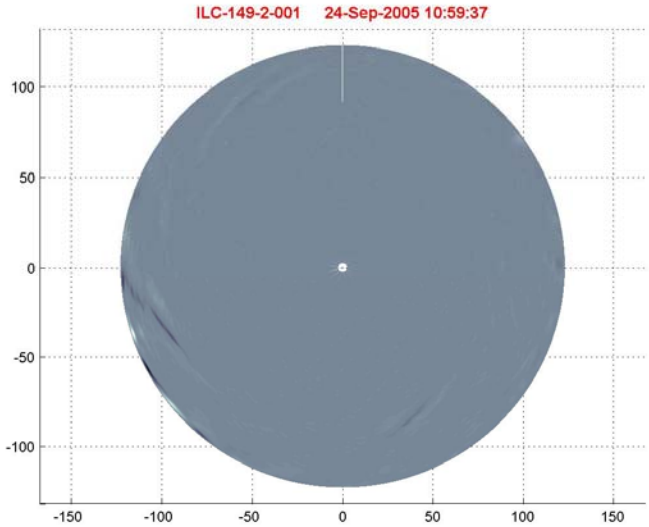
The following presents the results of scans performed on 94 squares. In some instances multiple scans needed to be performed to achieve satisfactory results. For each side of the disks are available two pictures: one as computed by NiobScan and one resulting form the filtering process.





Square 149 side 1 scan left, Filter right





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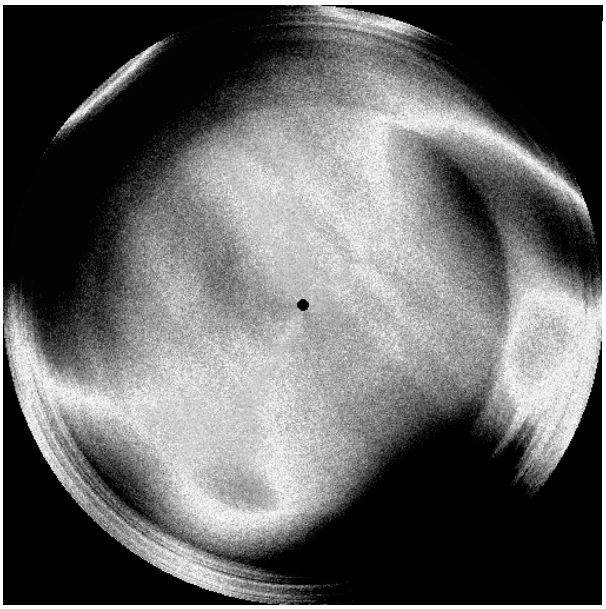

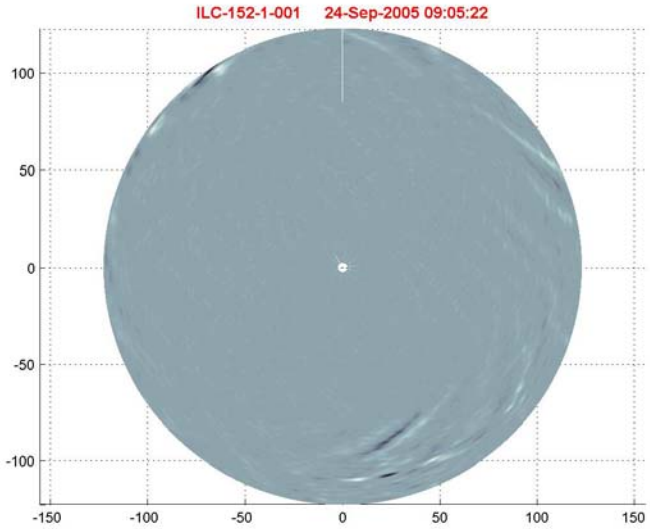

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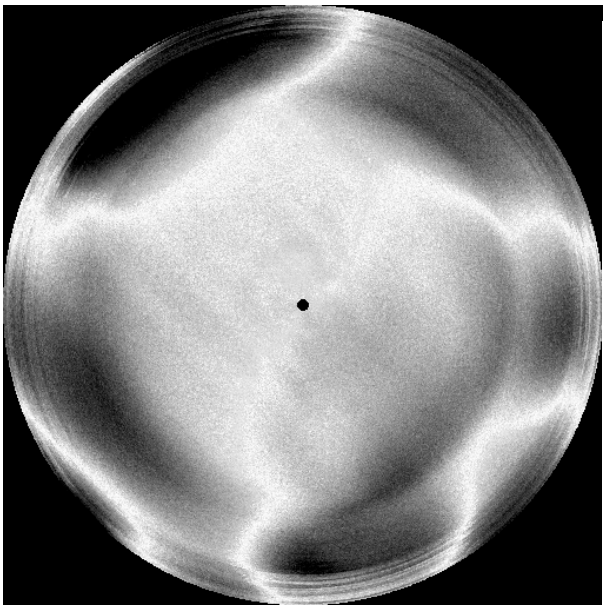

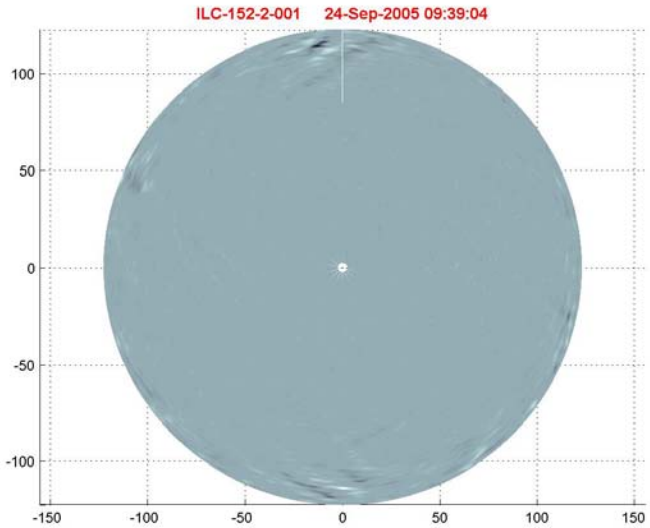

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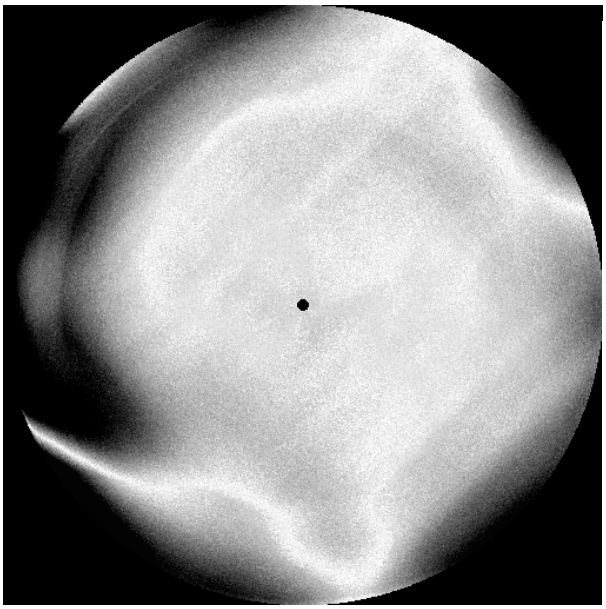

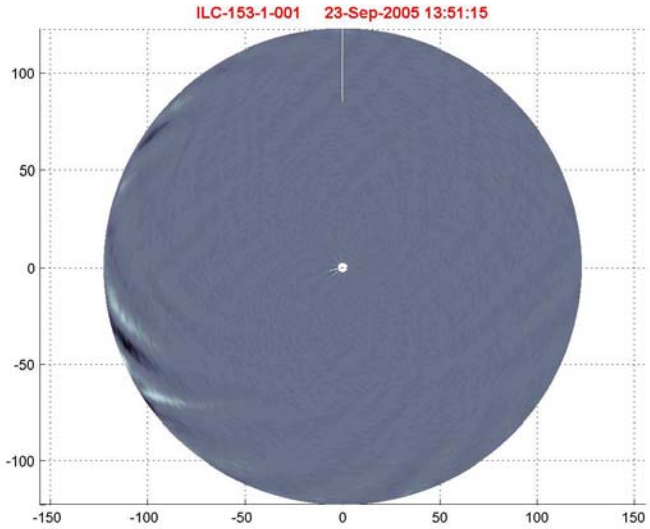

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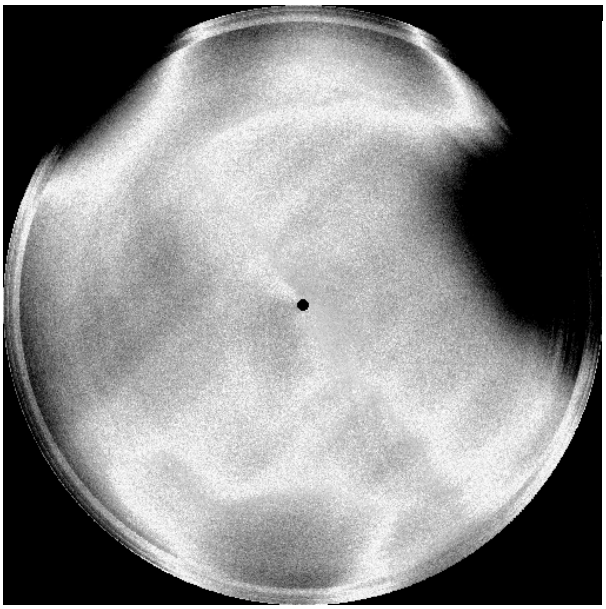

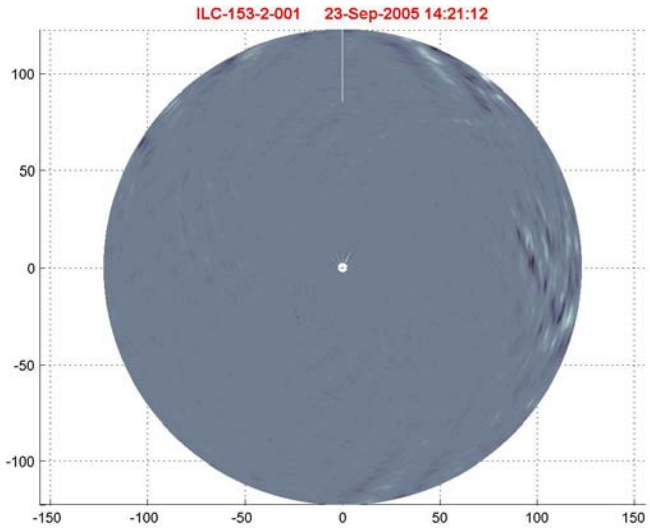

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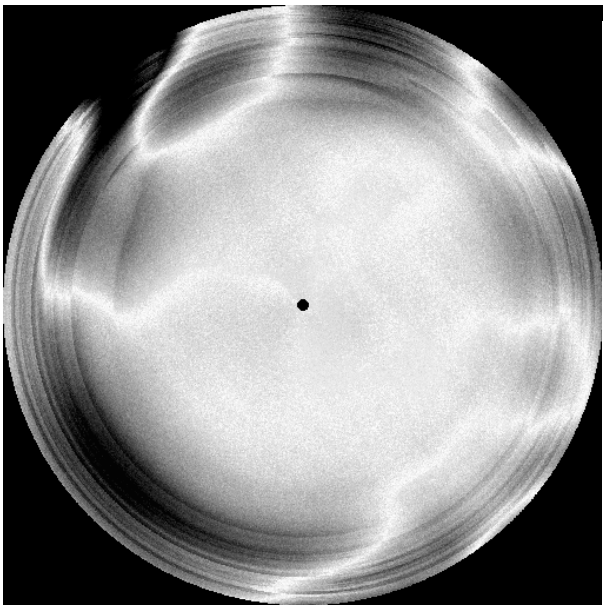

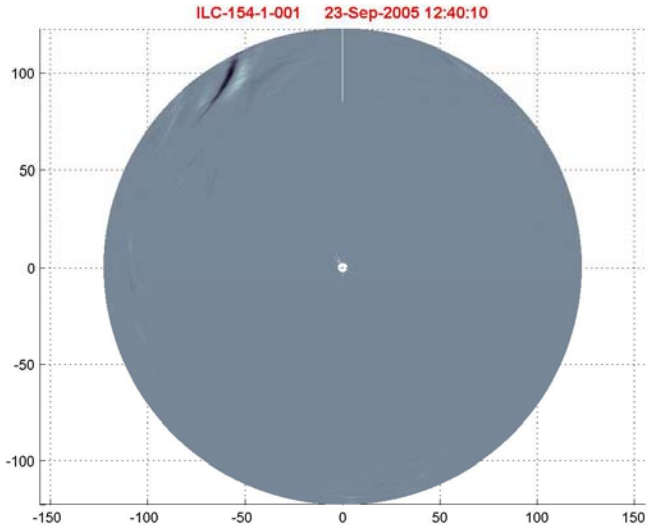

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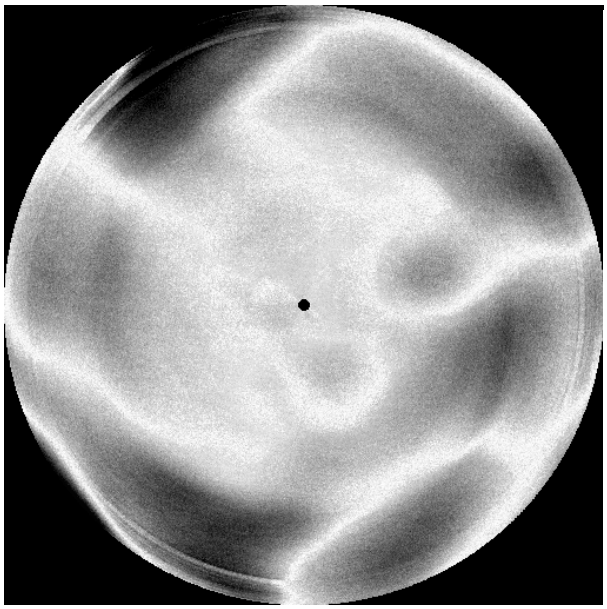

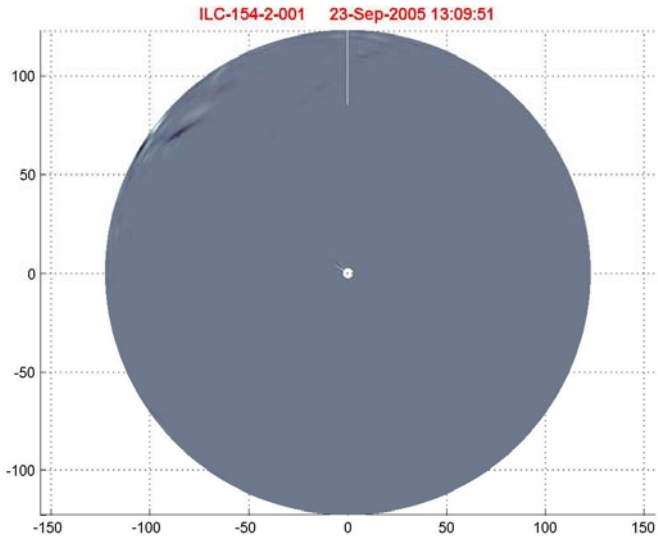

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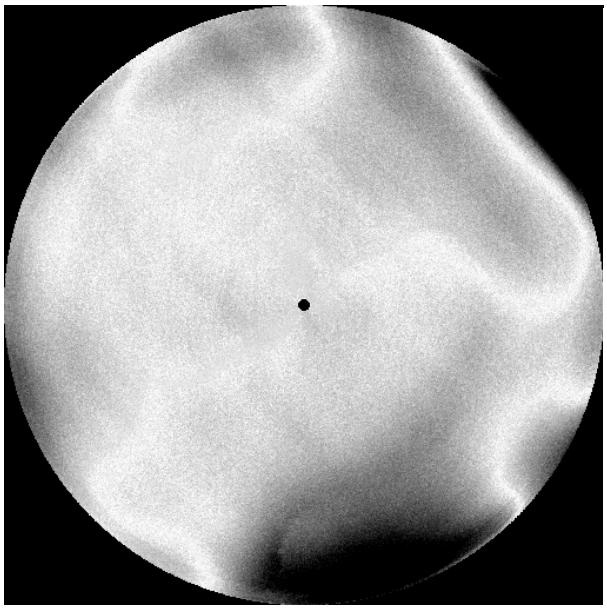

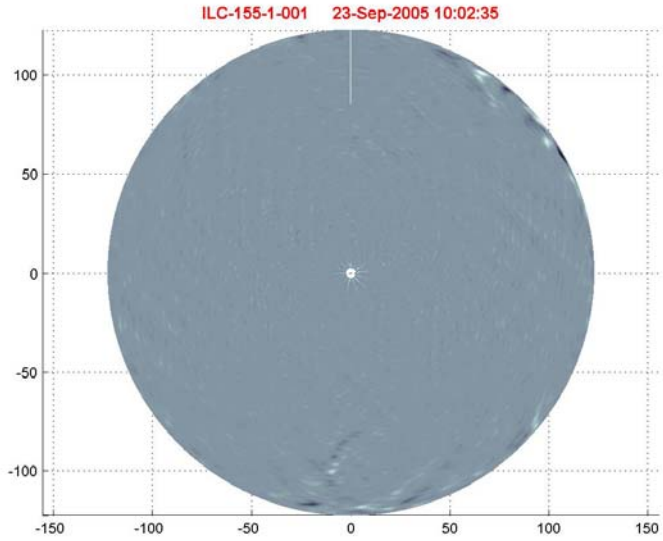

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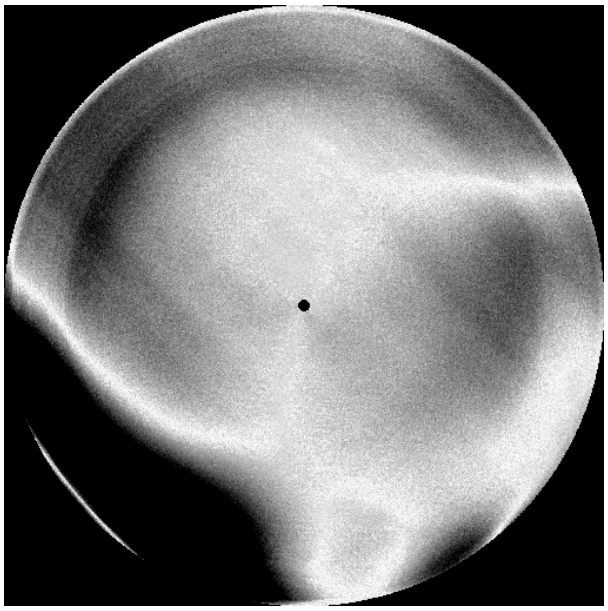

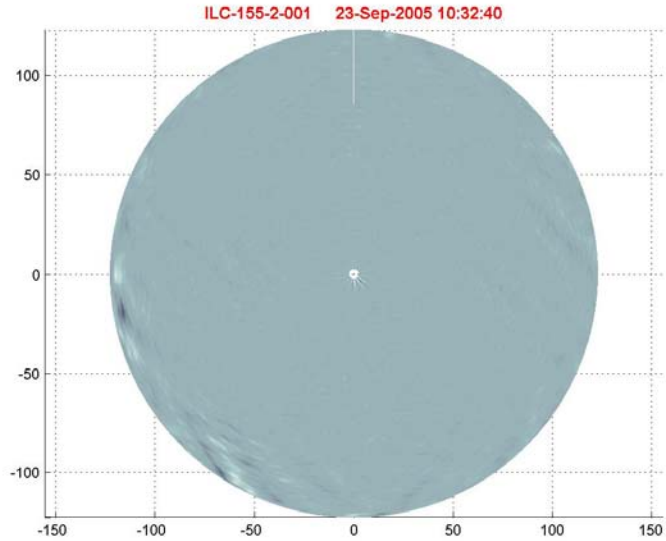

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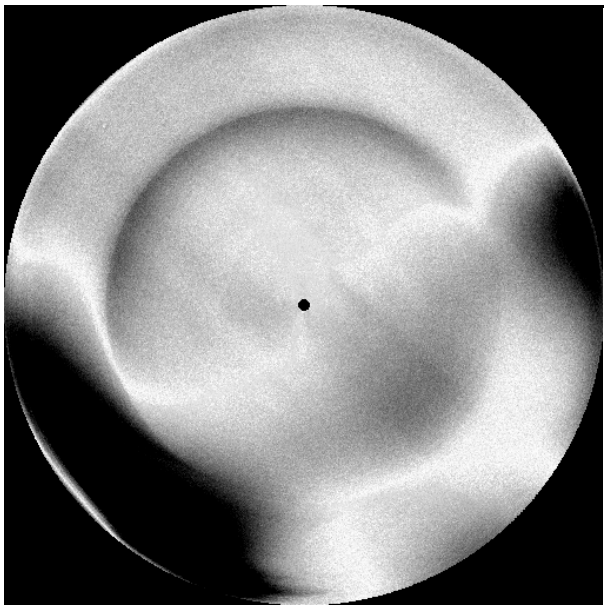

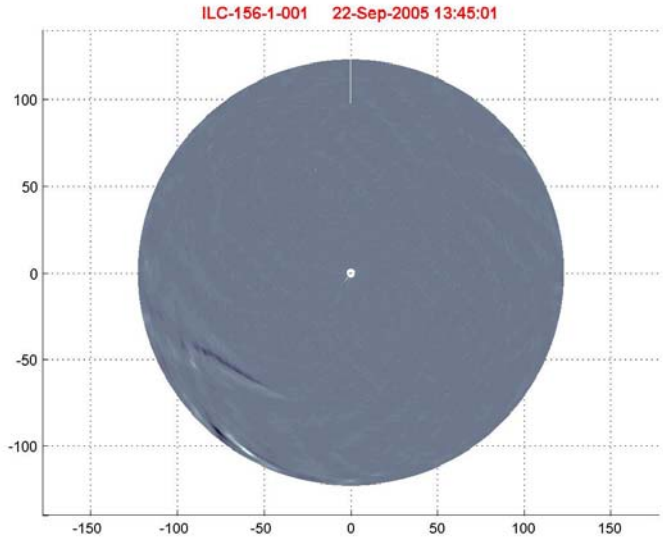

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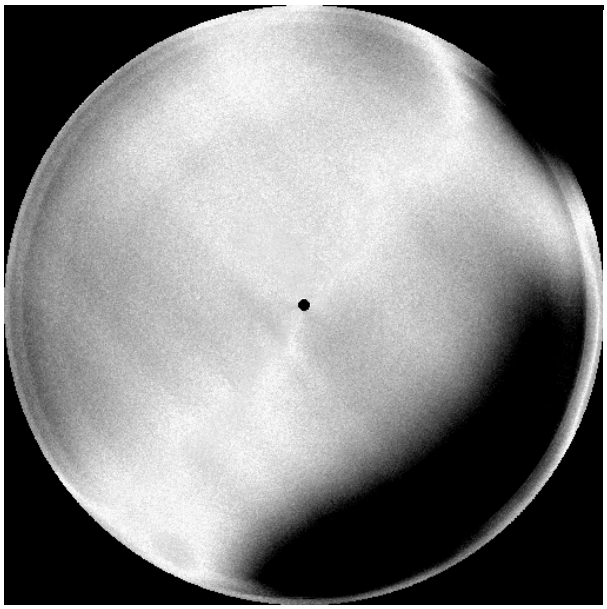

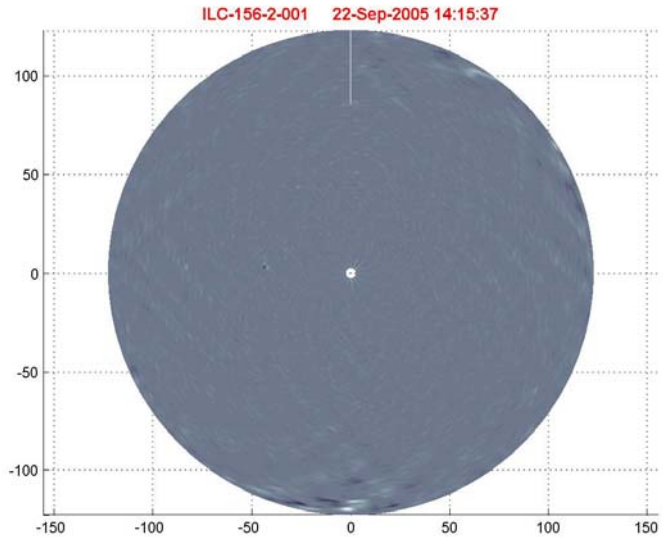

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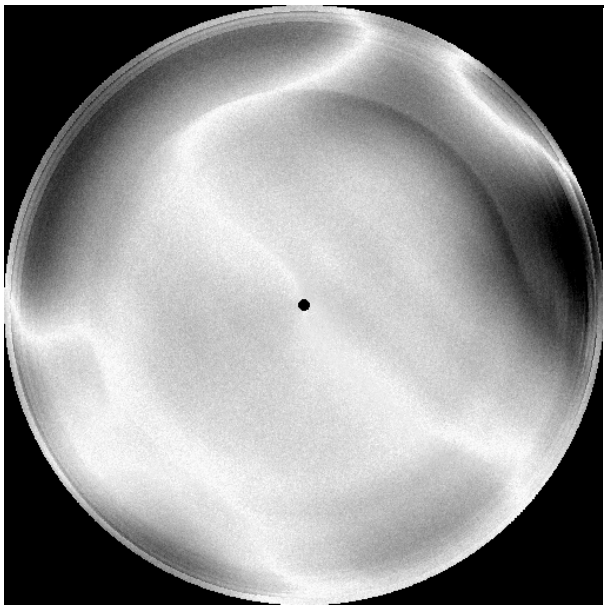

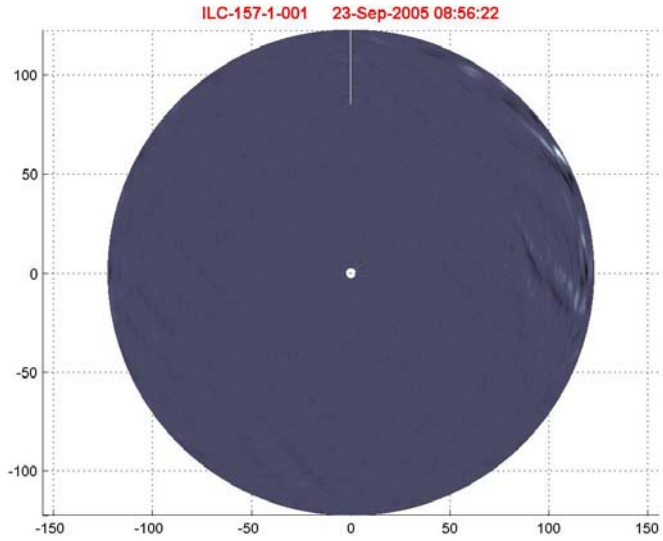

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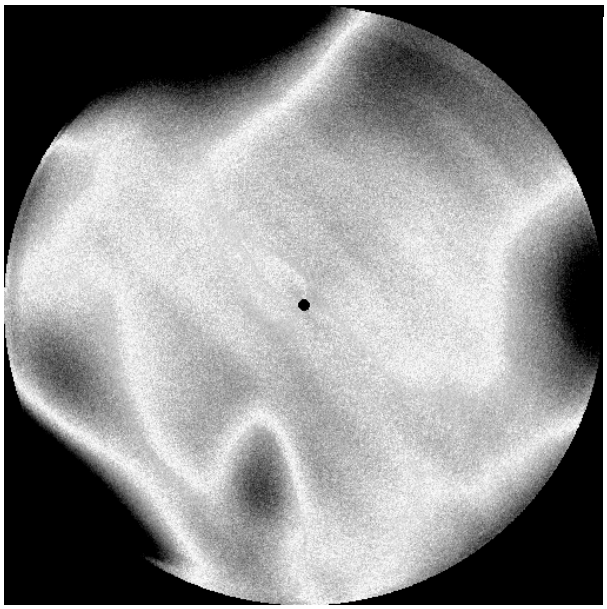

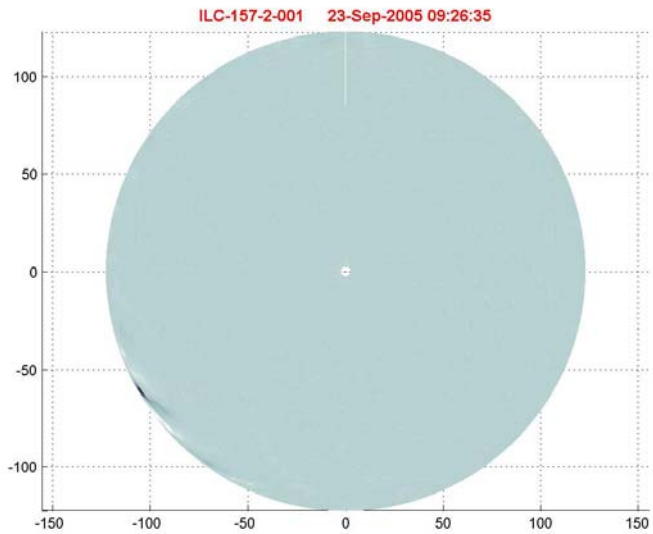

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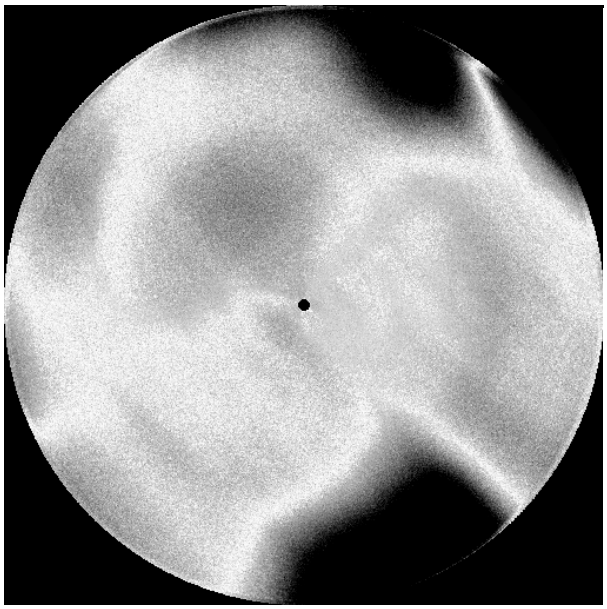

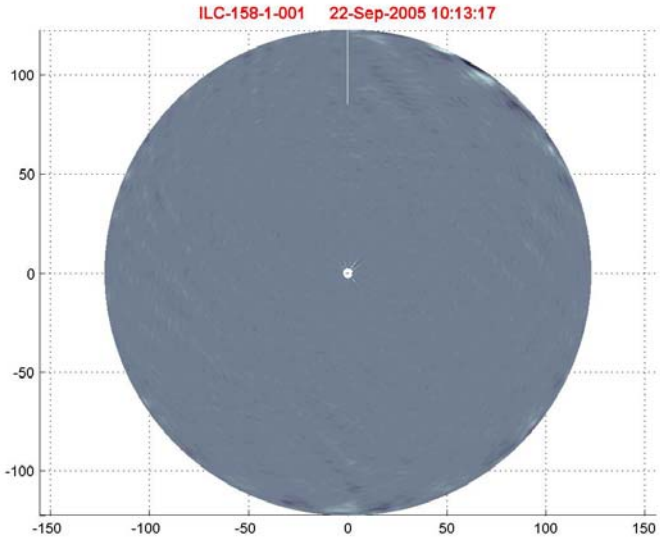

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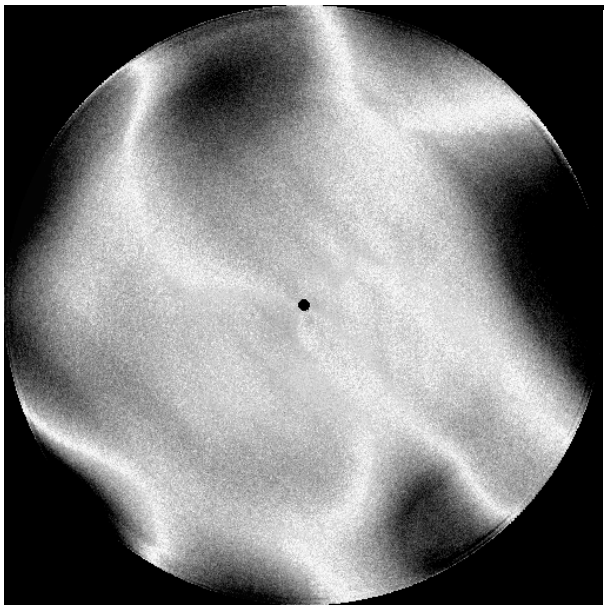

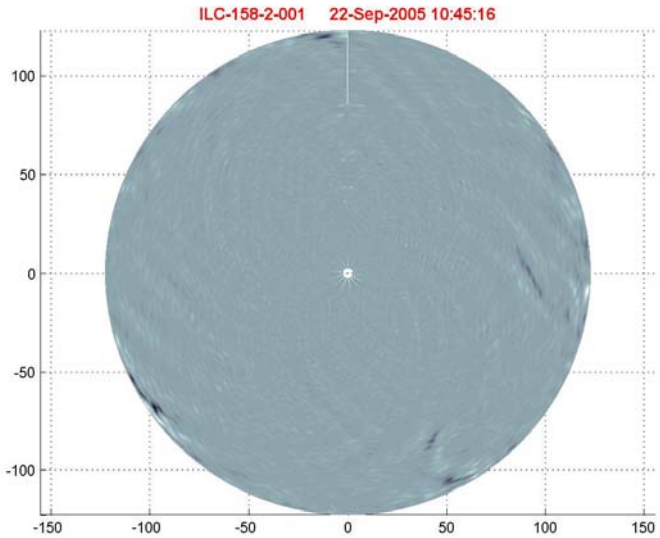

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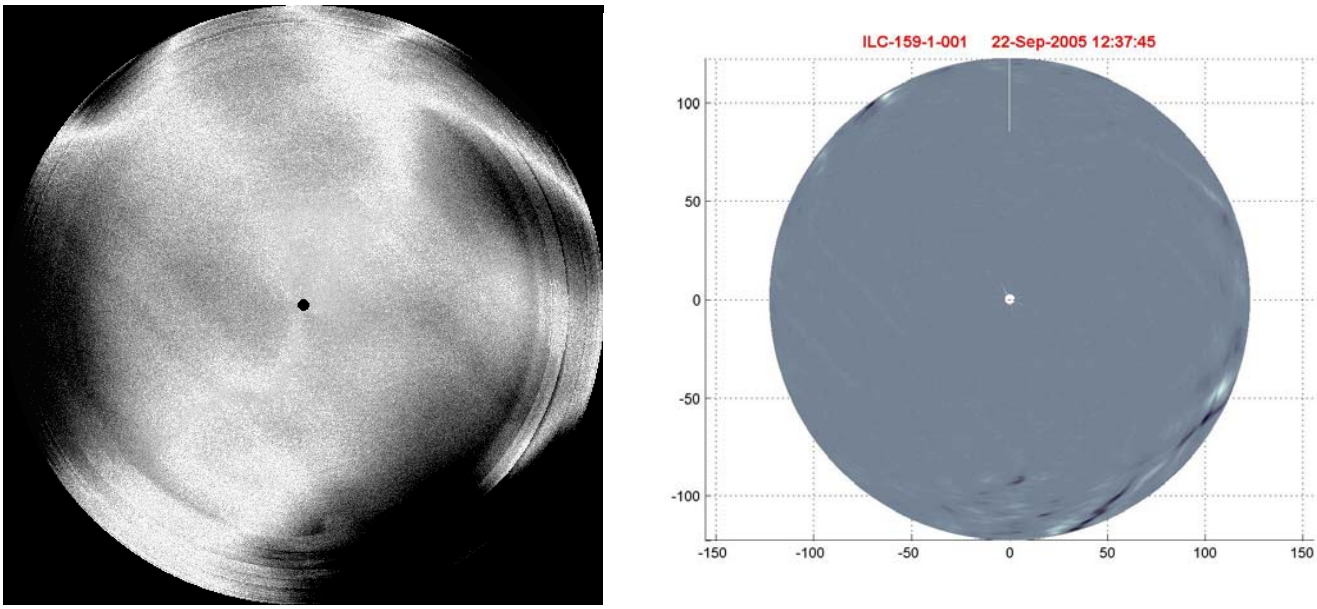

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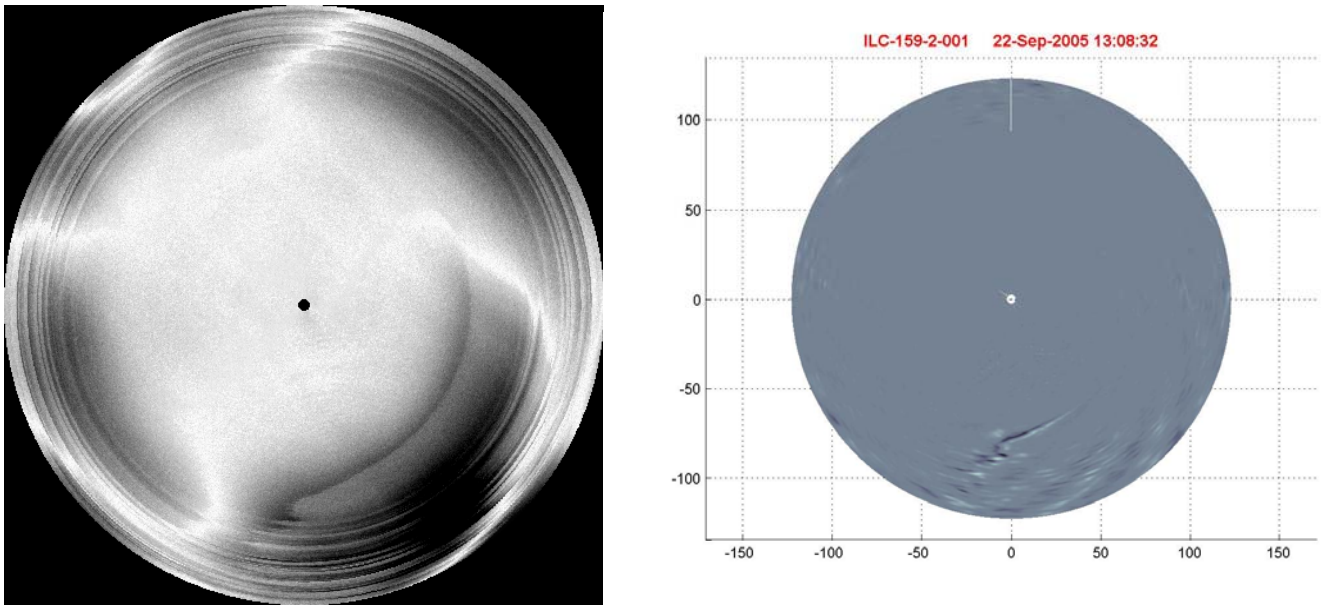

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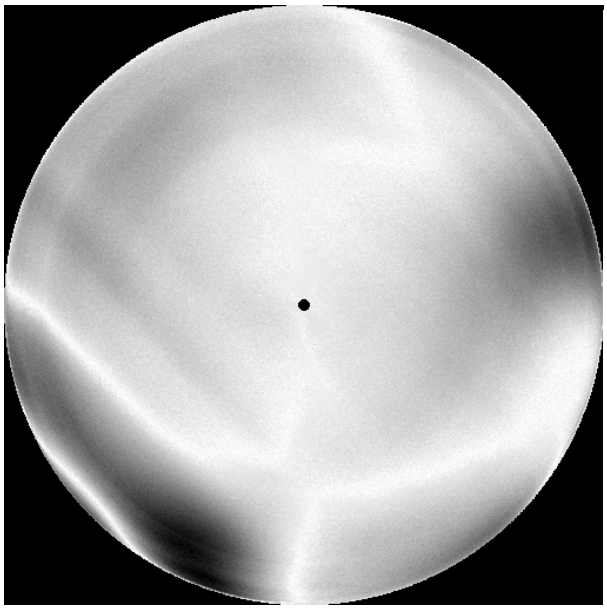

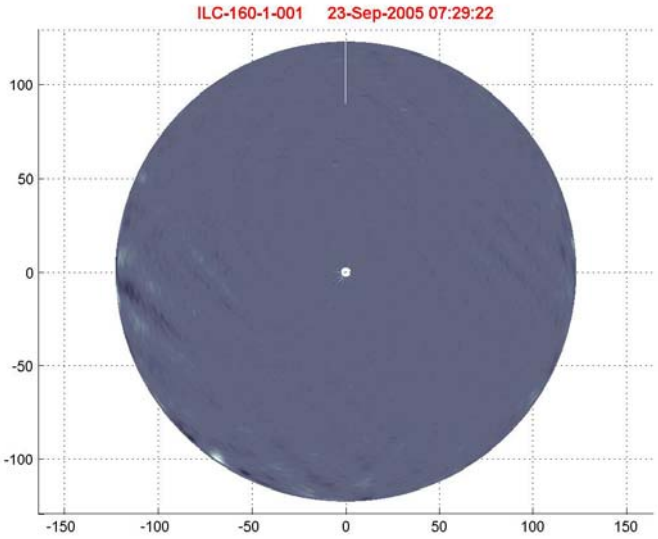

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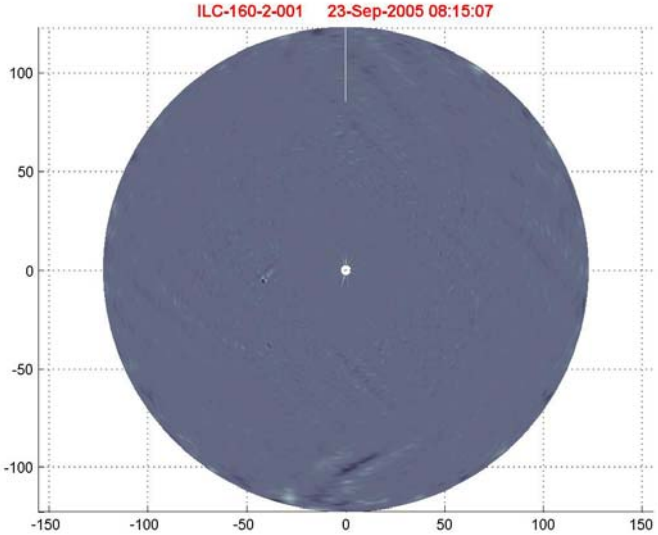

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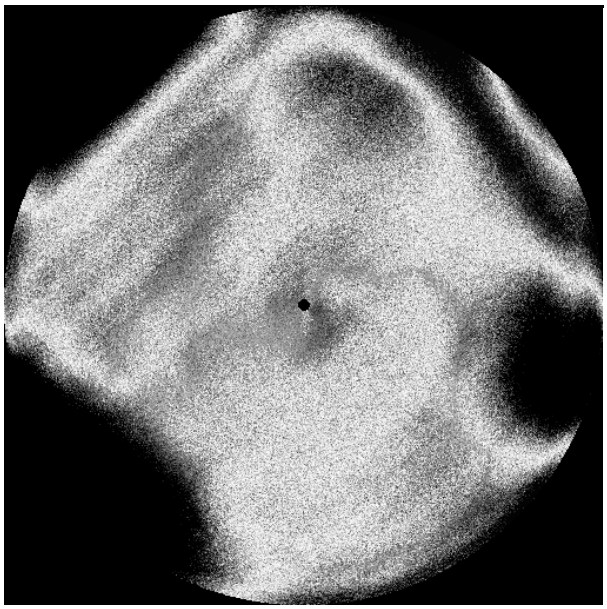

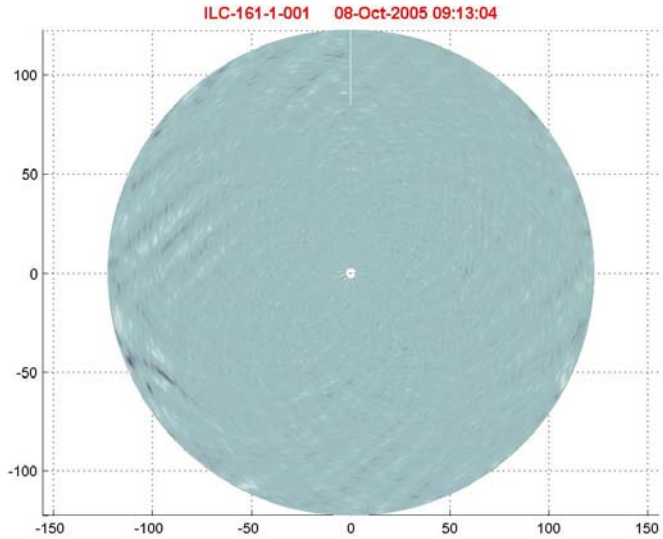

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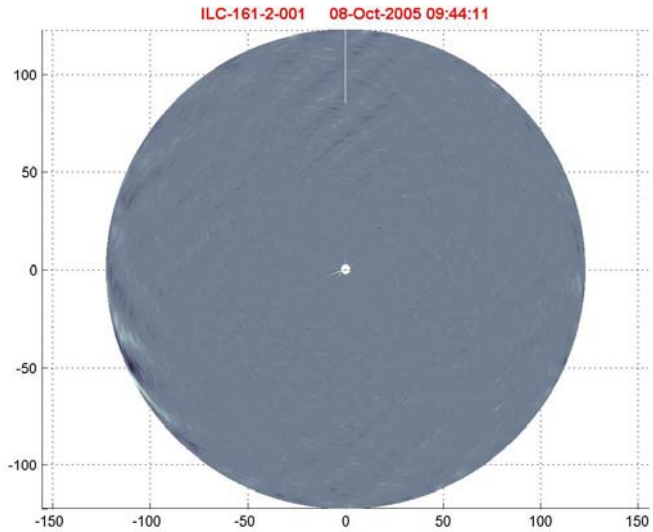

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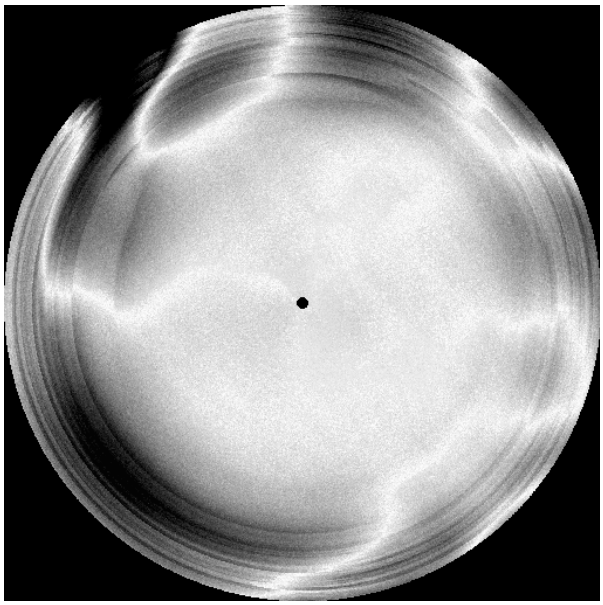

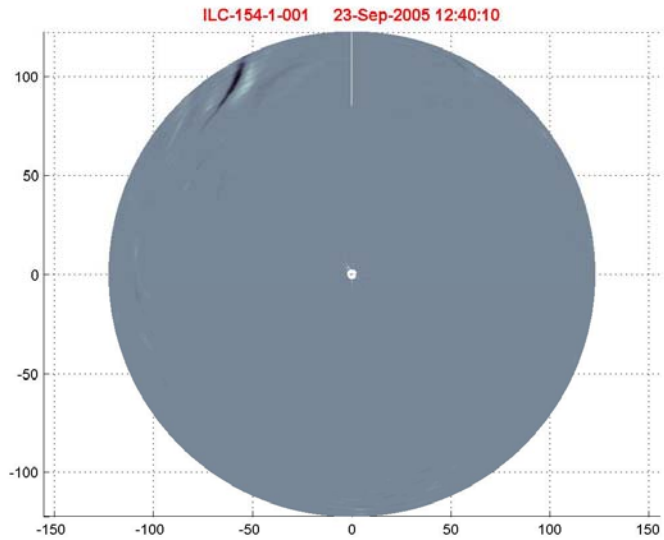

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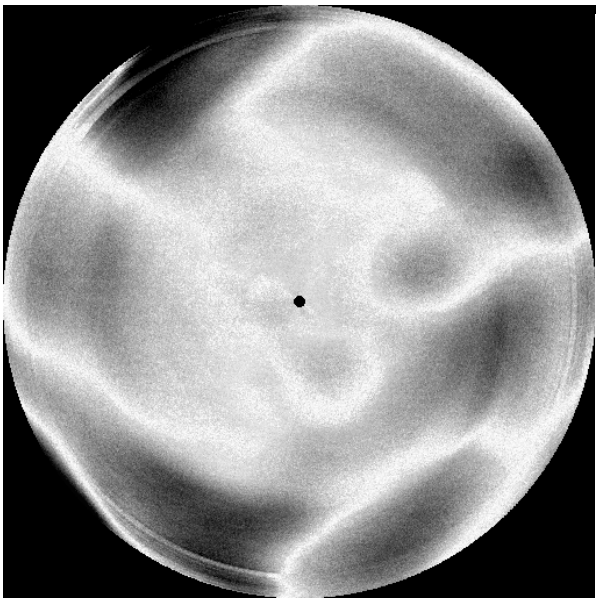

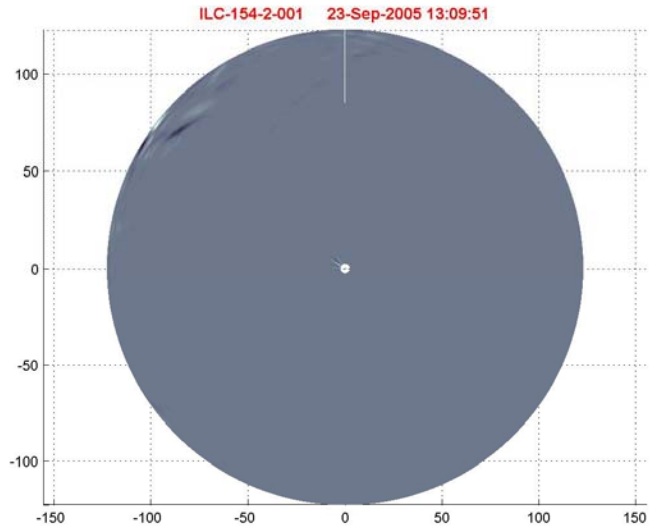

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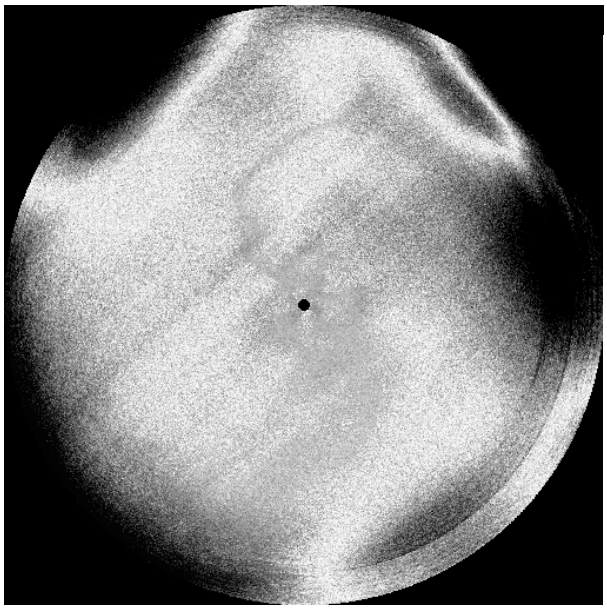

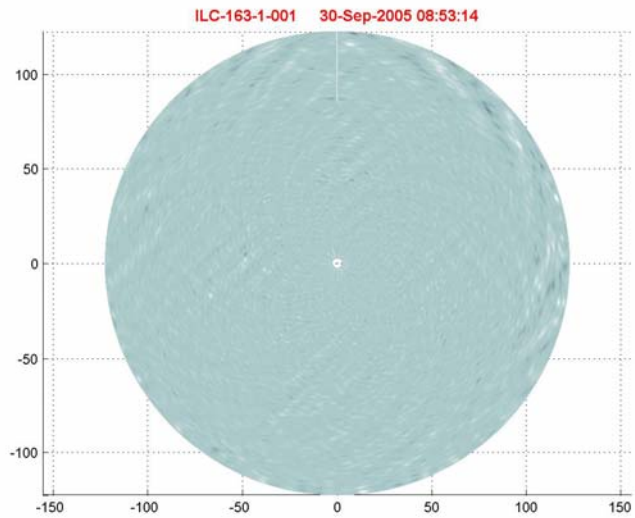

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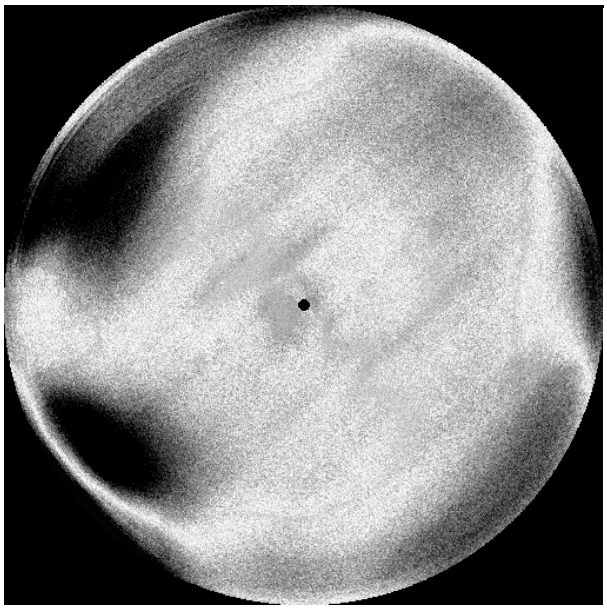

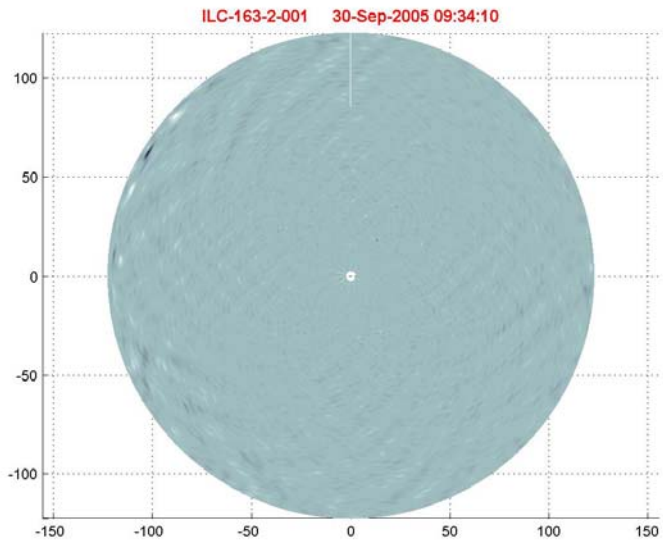

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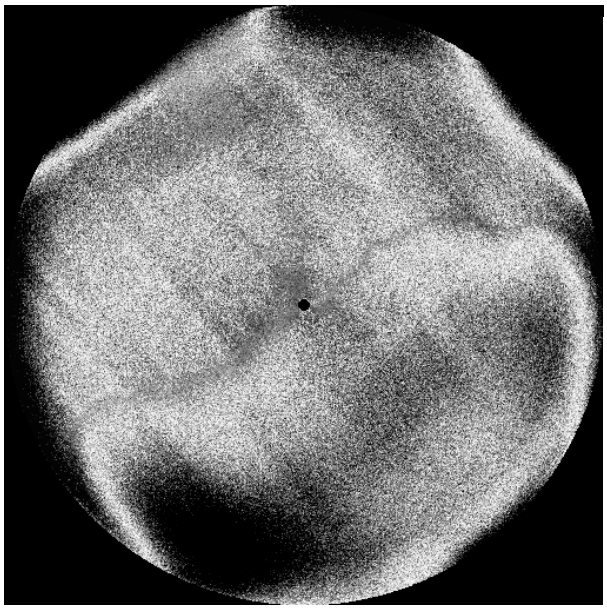

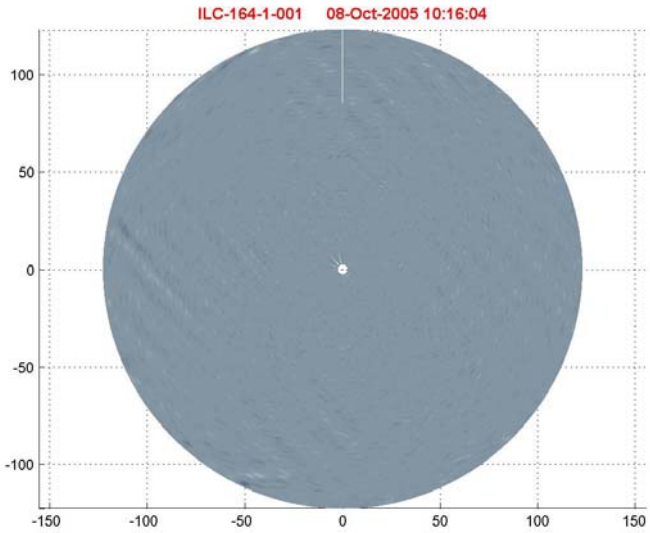

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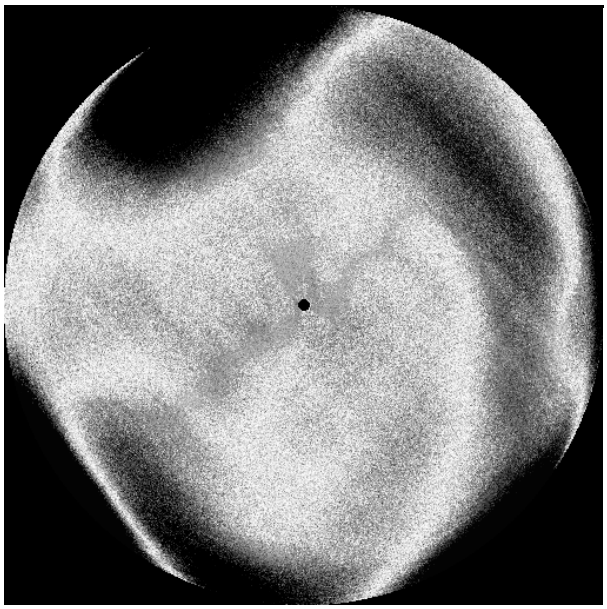

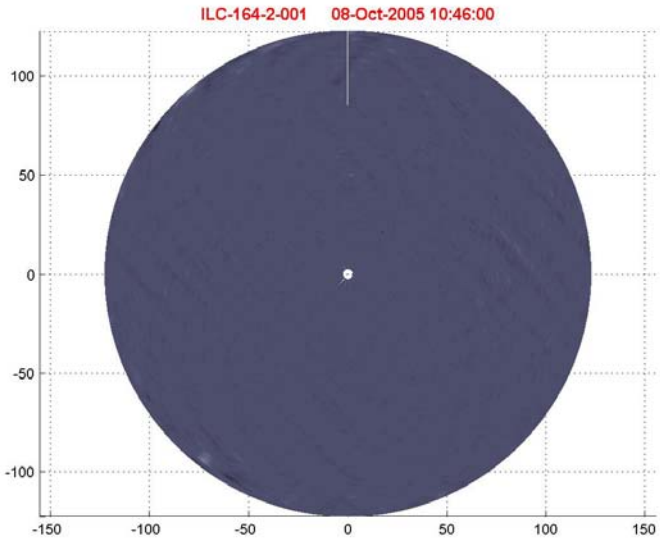

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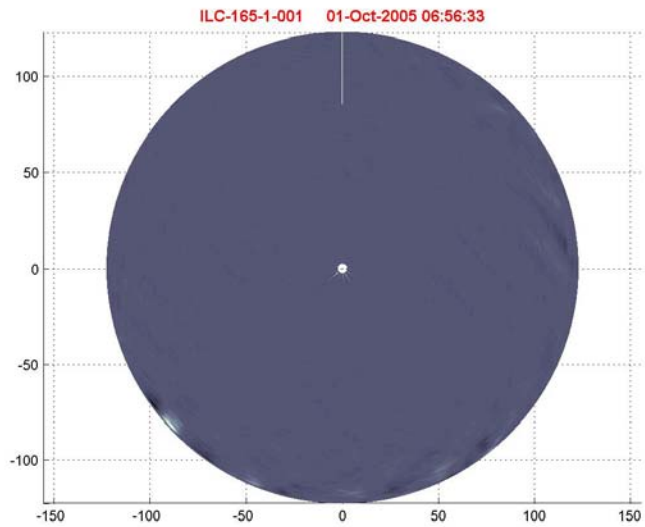

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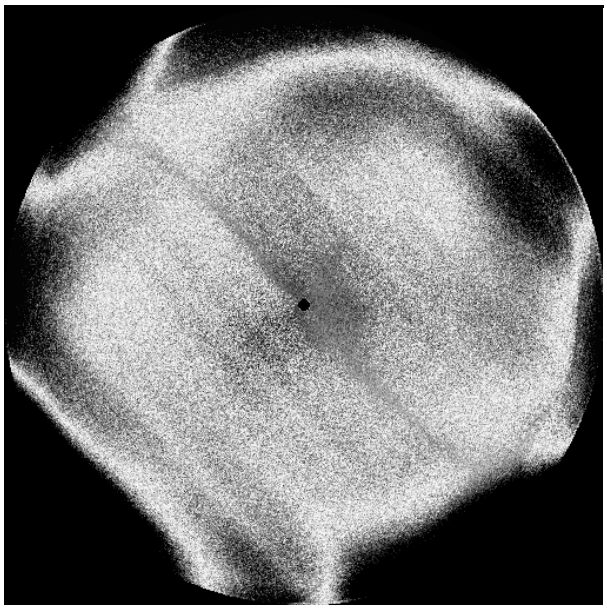

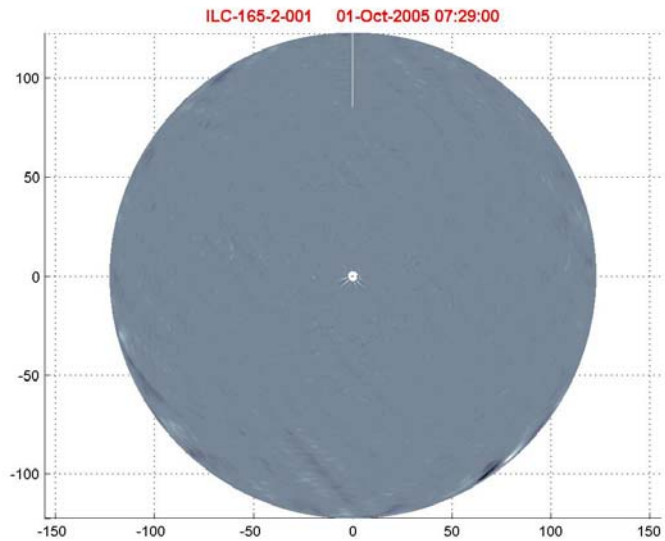

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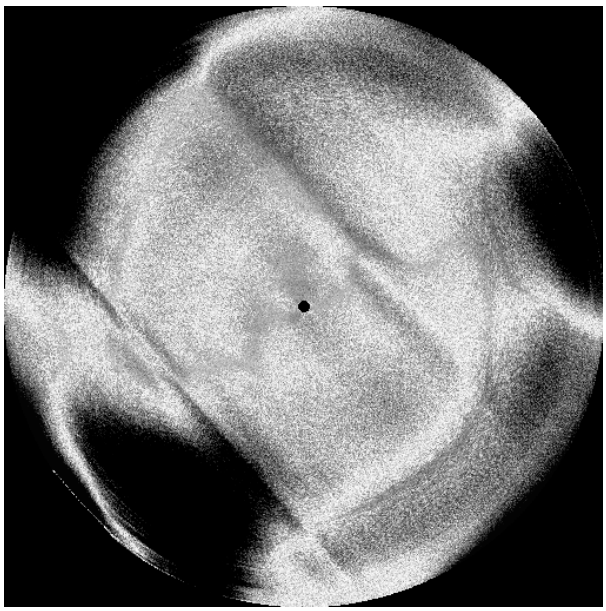

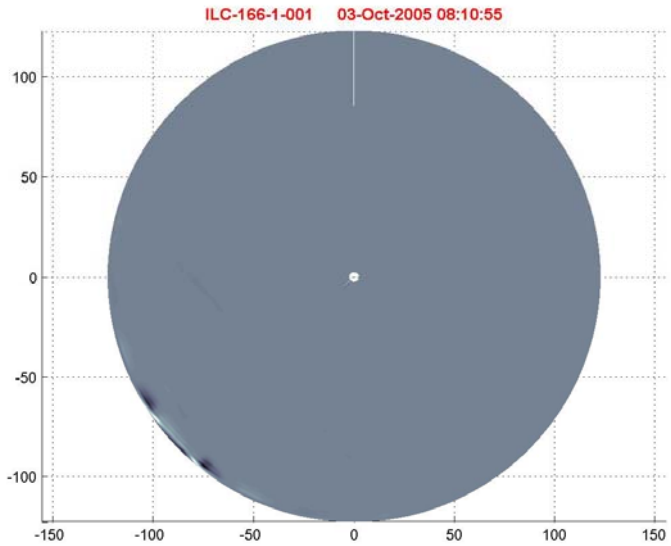

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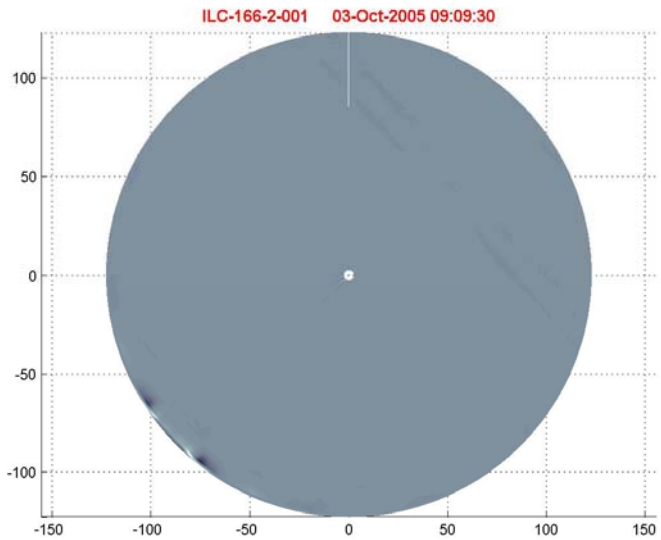

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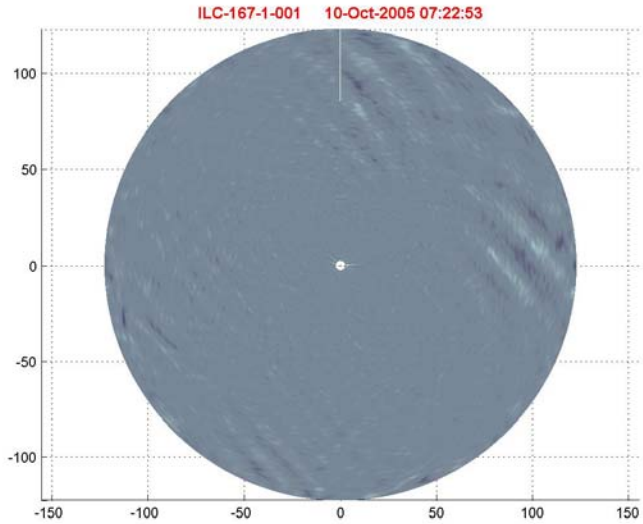

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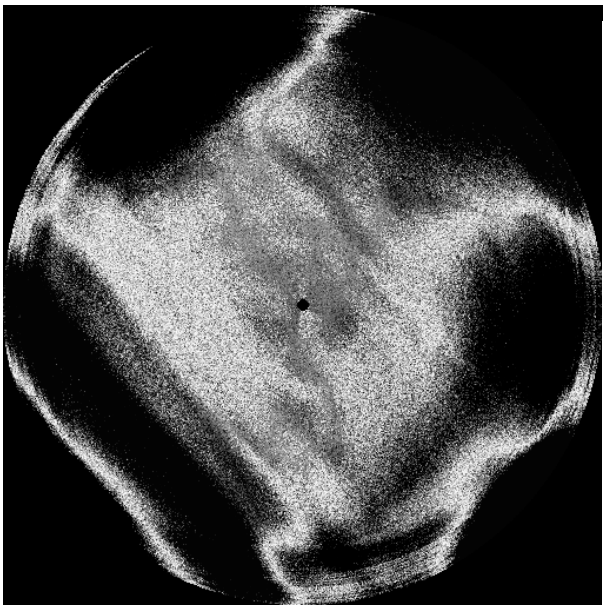

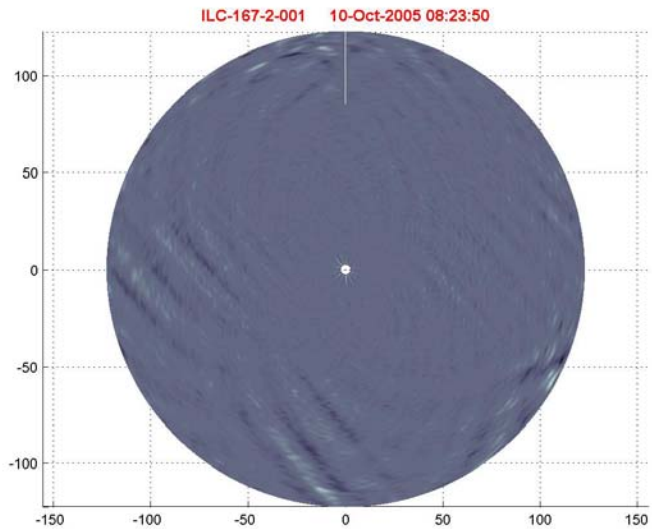

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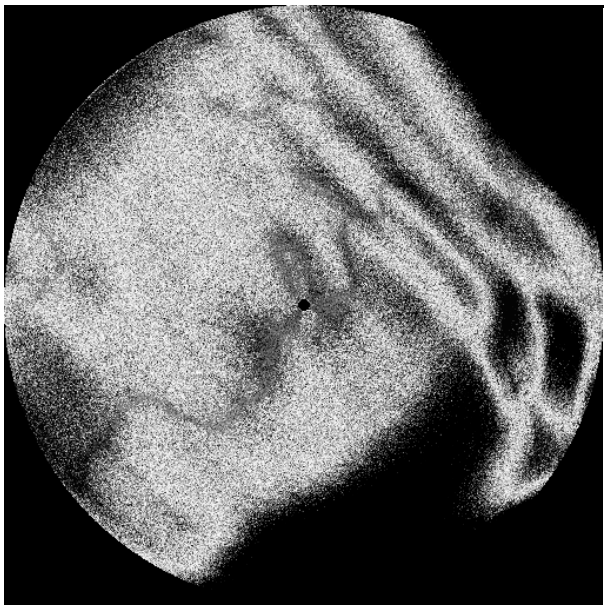

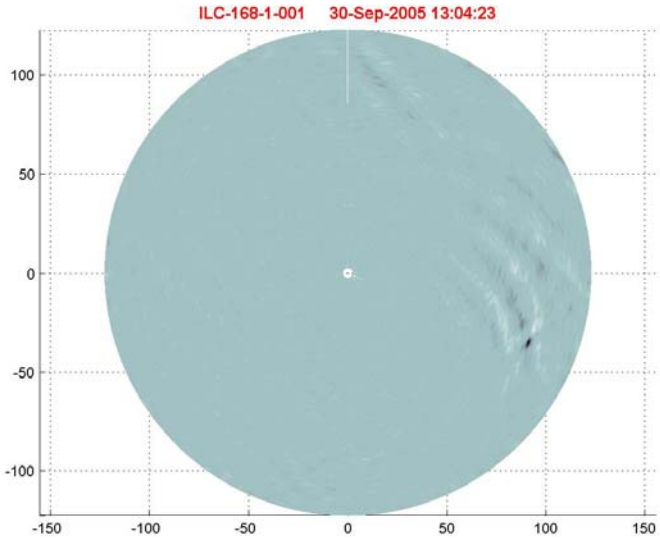

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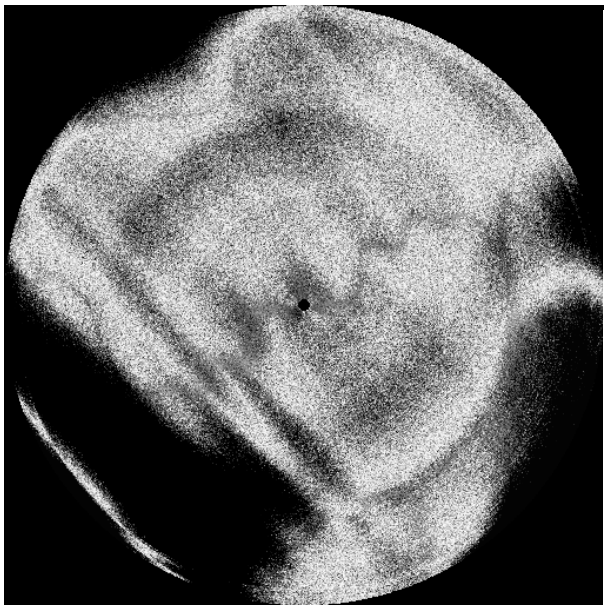

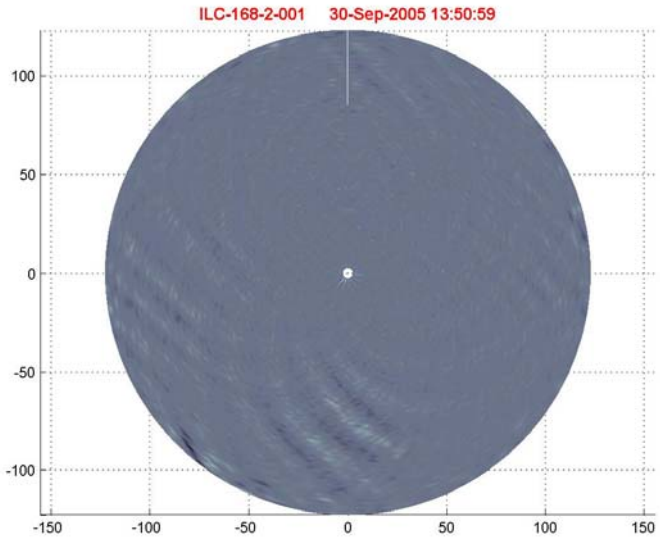

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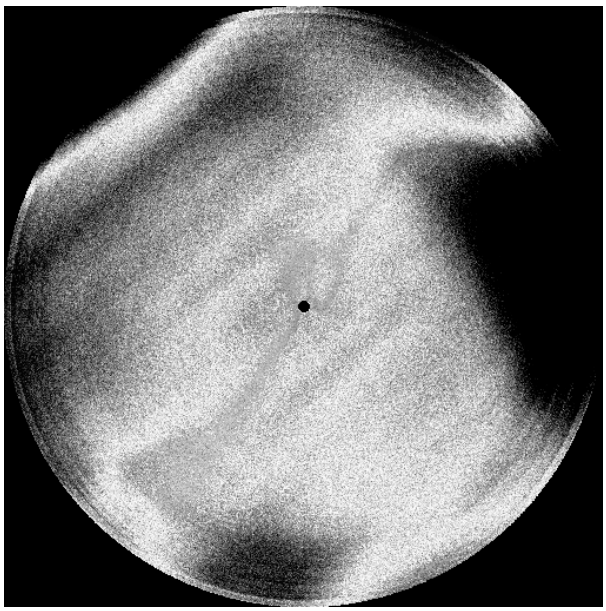

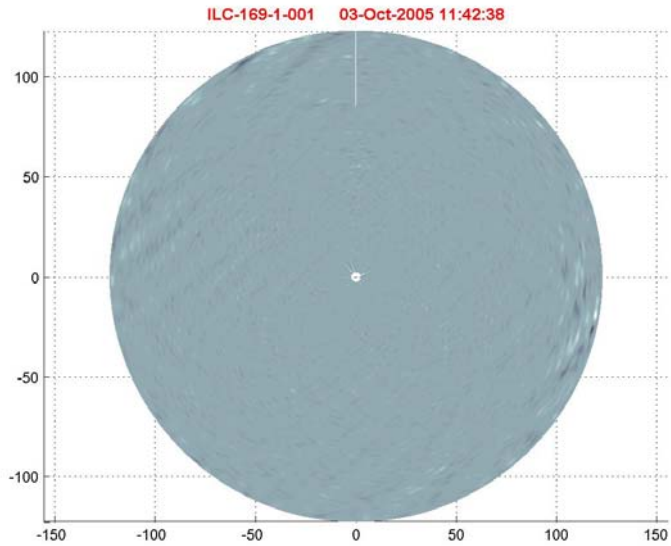

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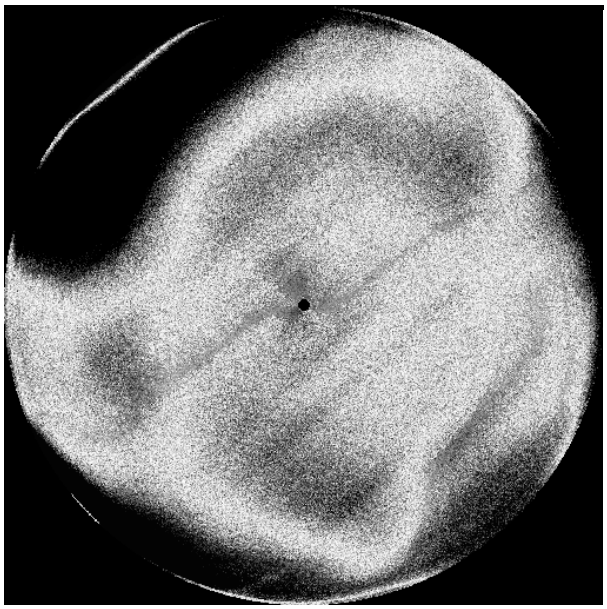

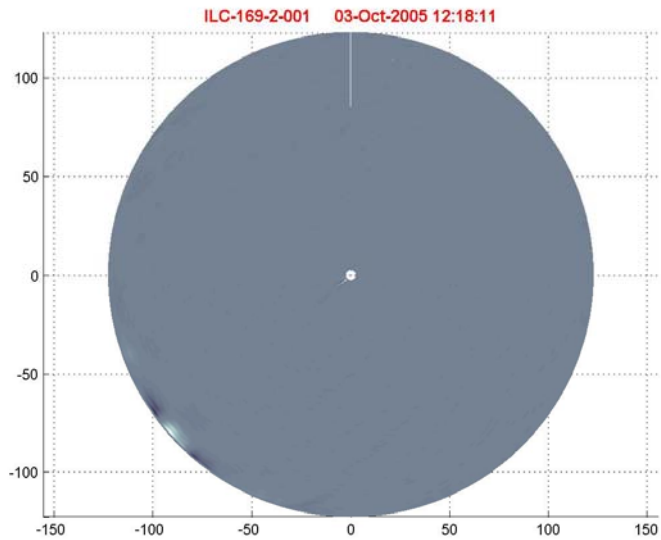

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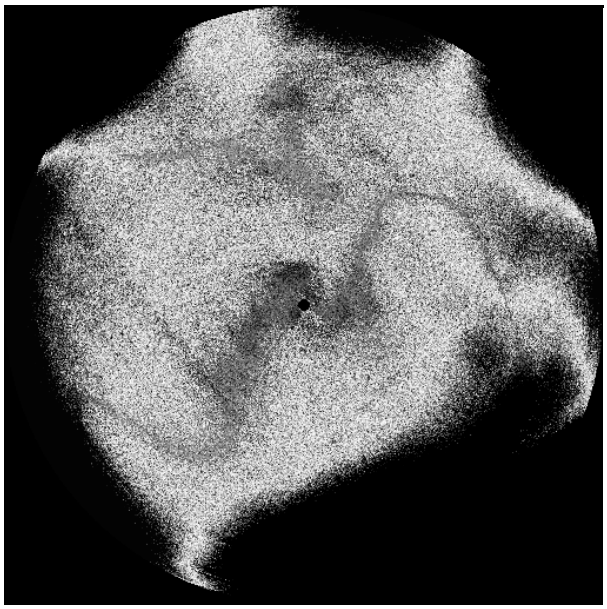

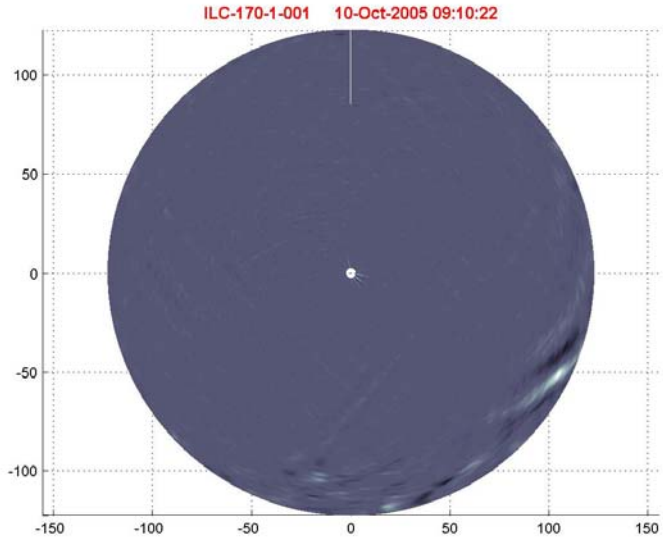

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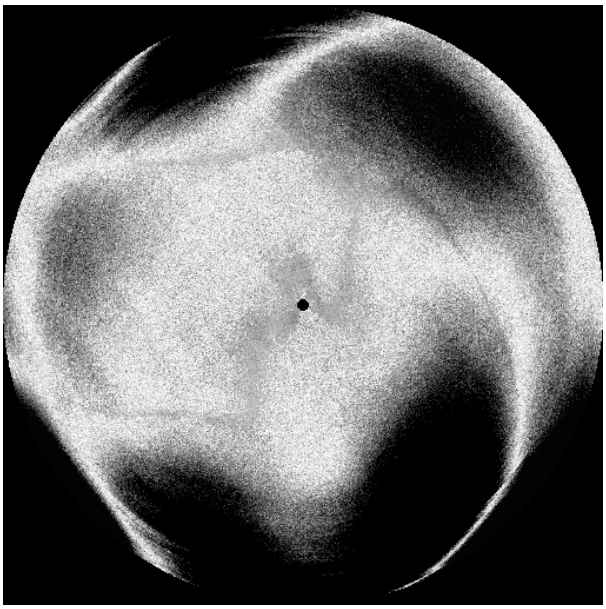

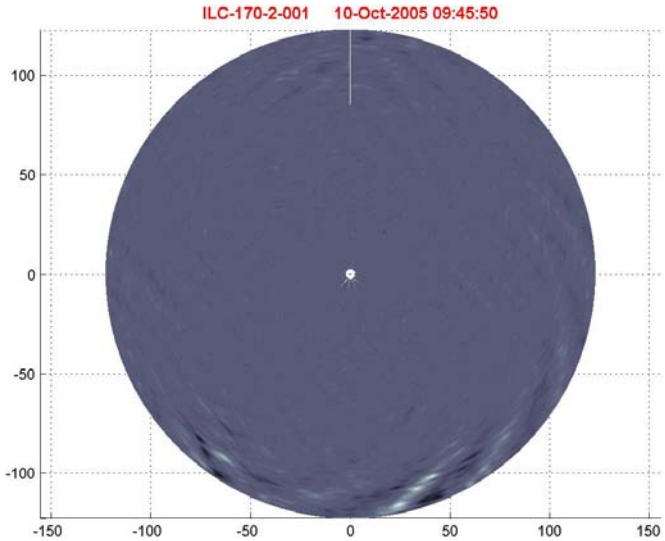

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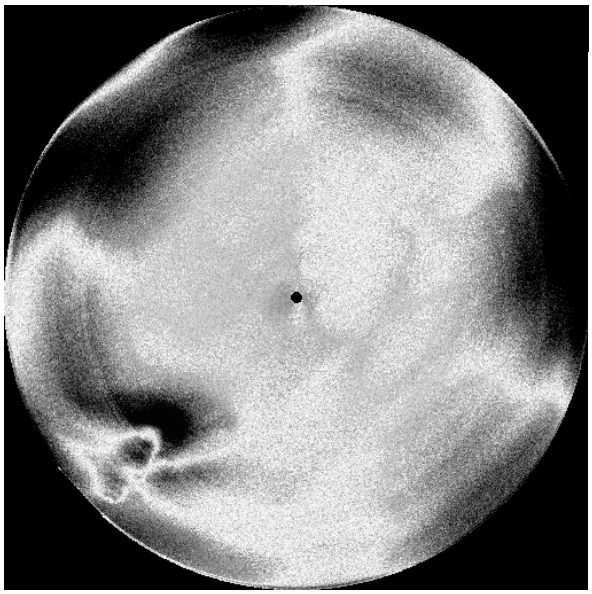

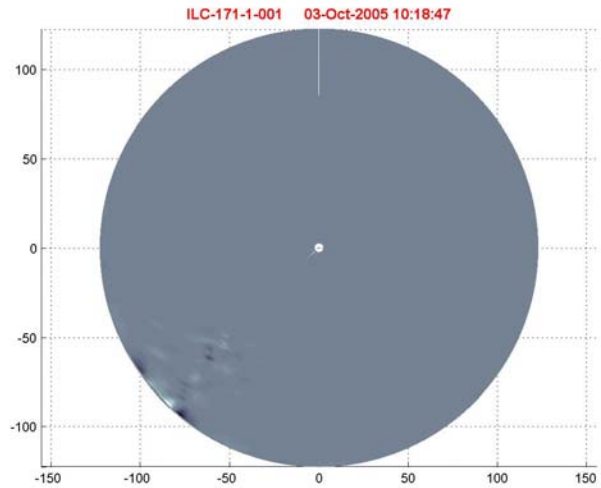

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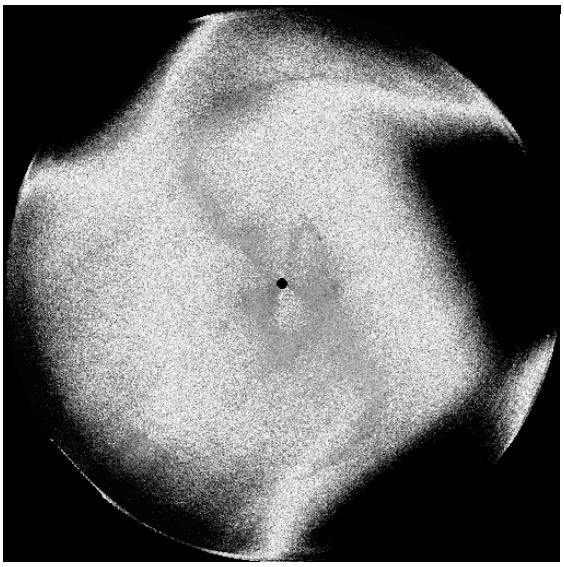

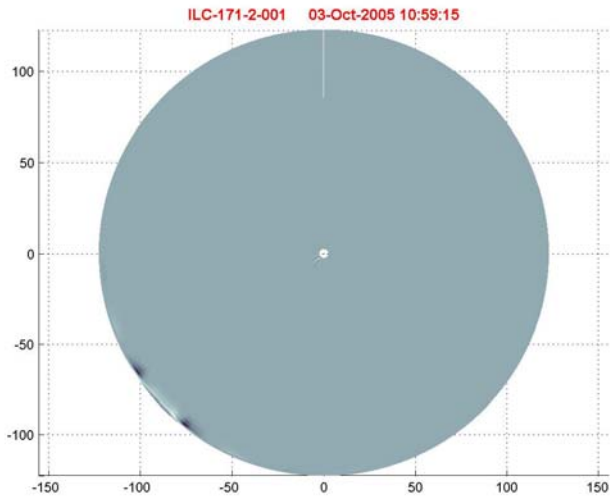

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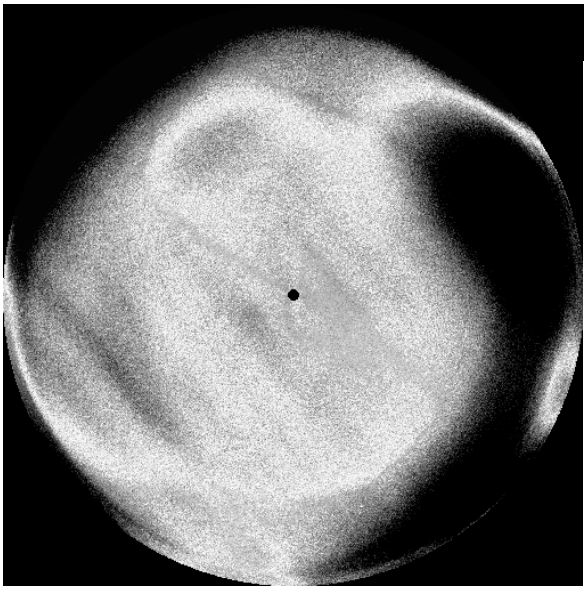

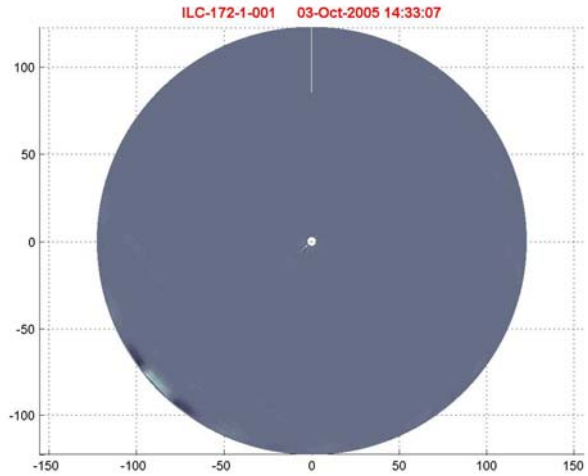

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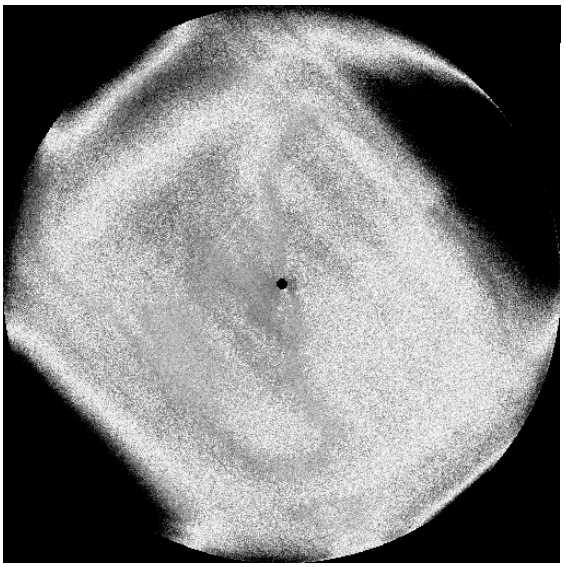

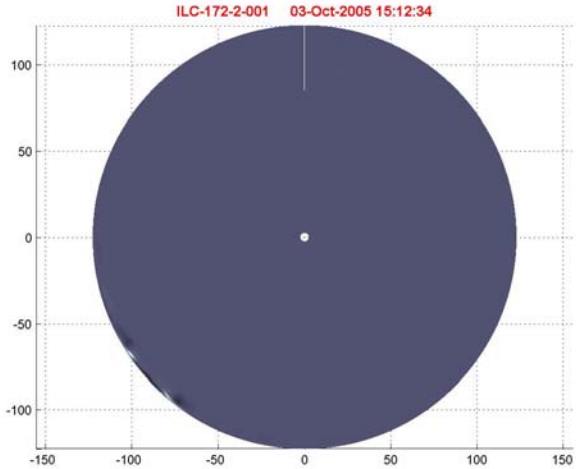

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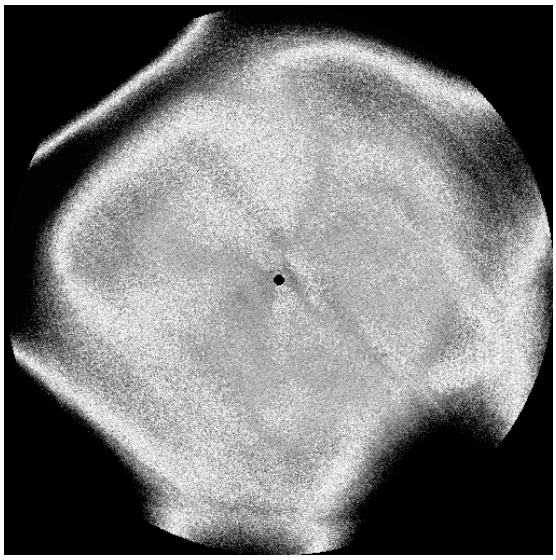

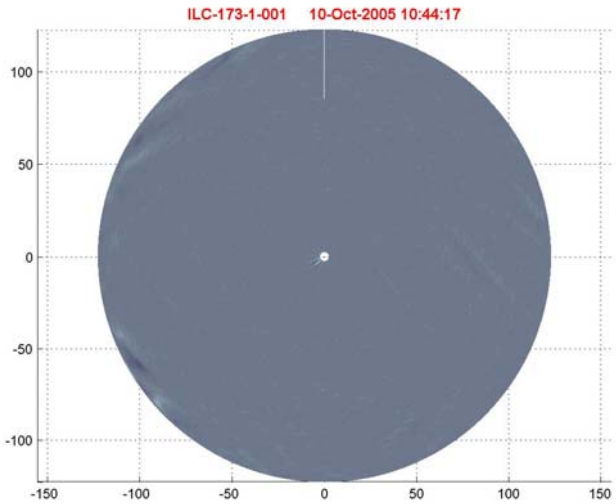

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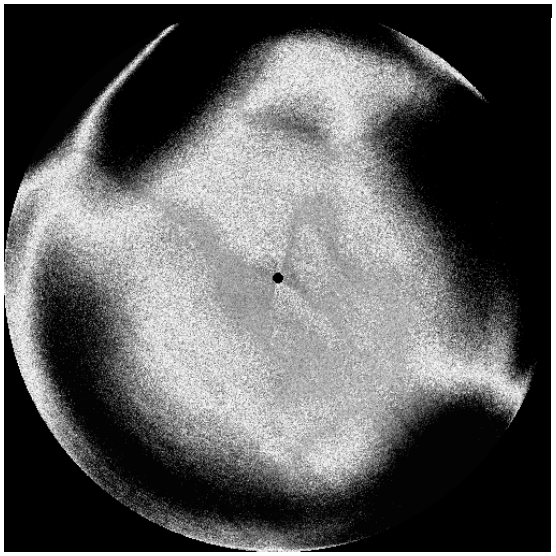

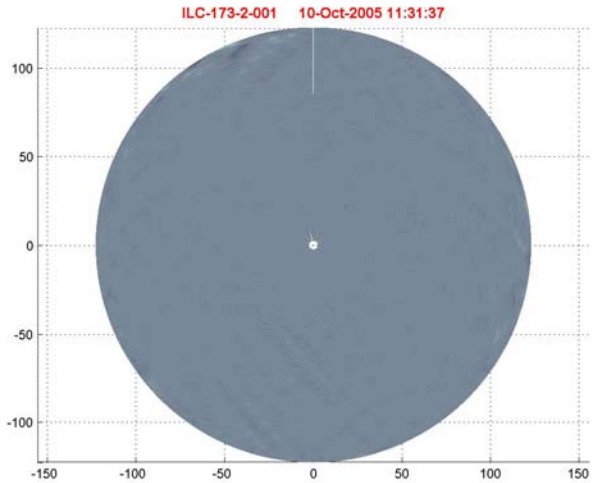

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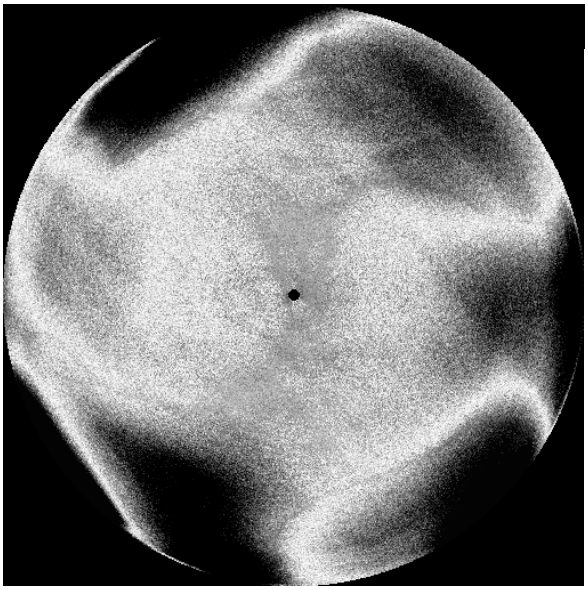

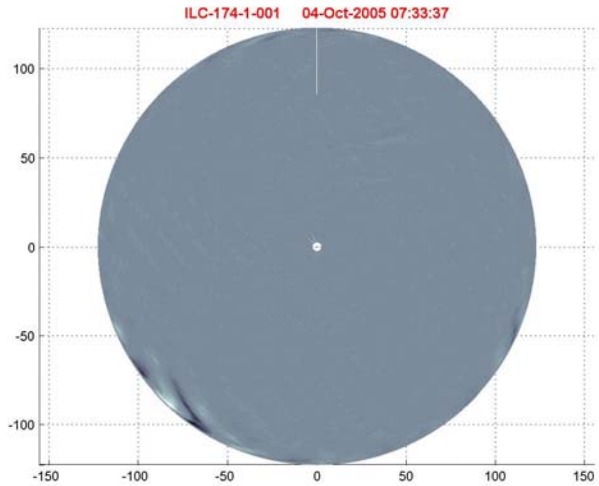

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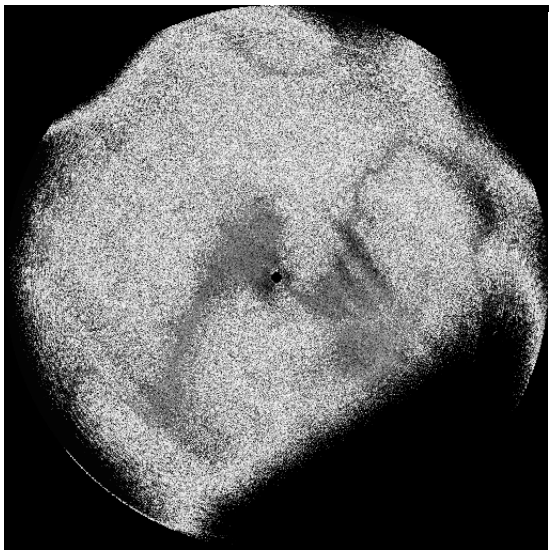

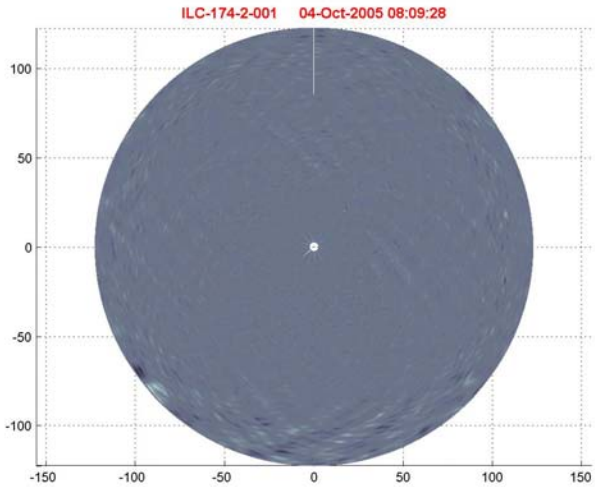

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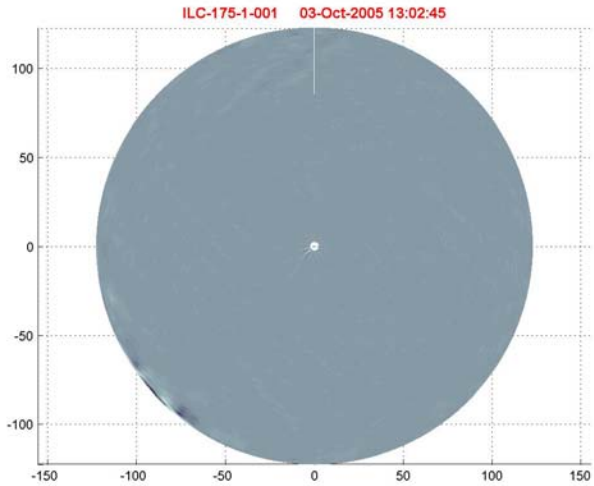

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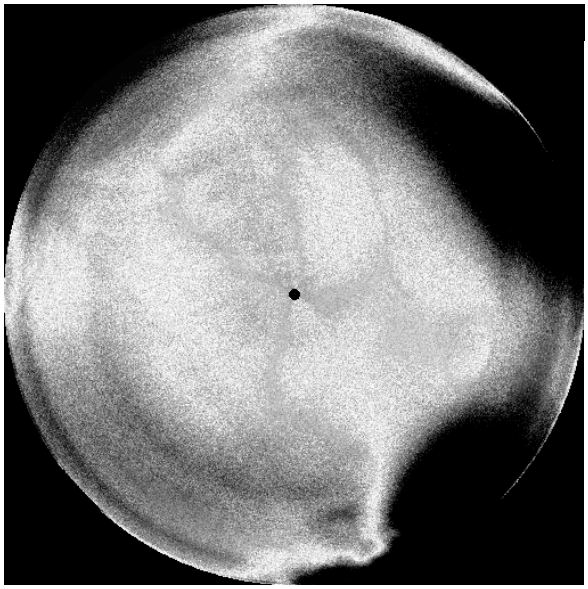

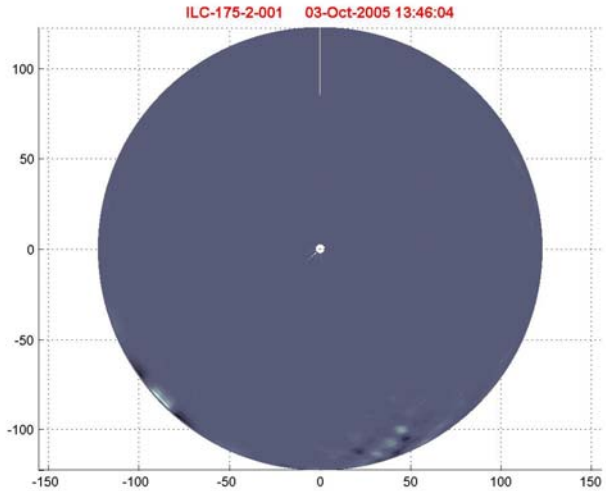

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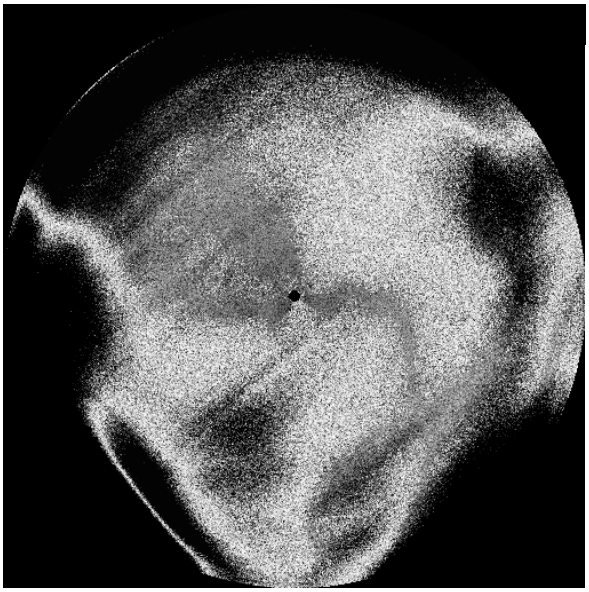

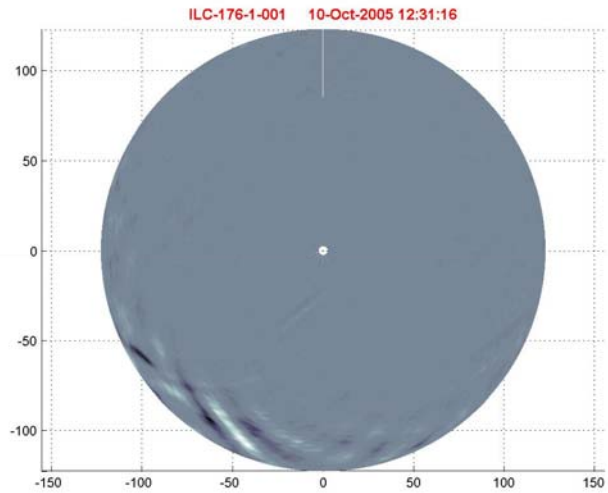

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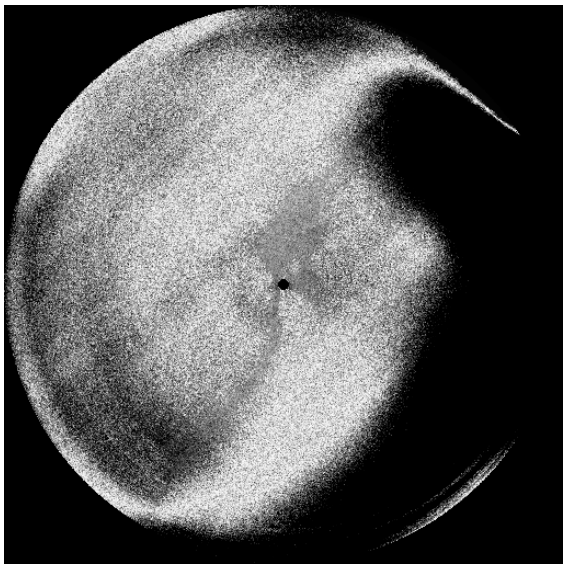

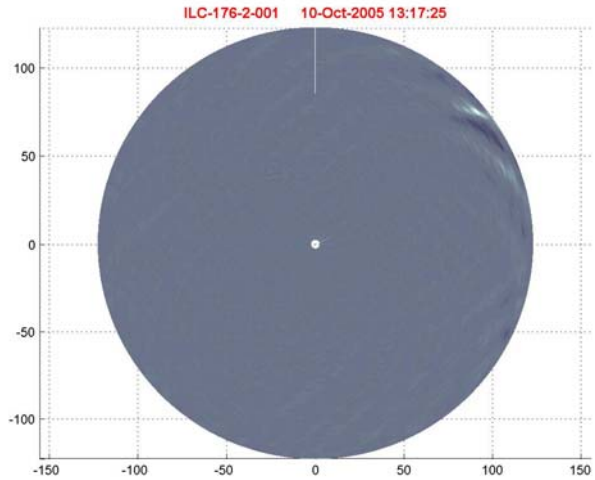

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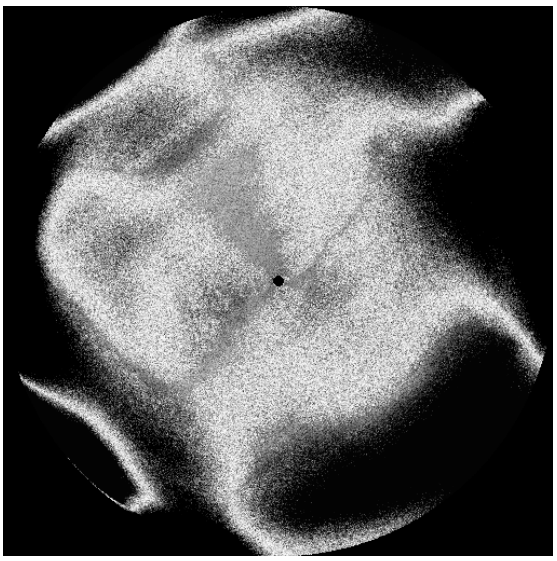

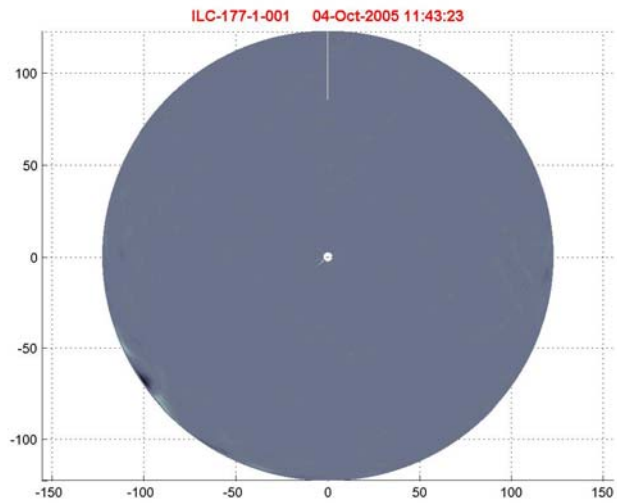

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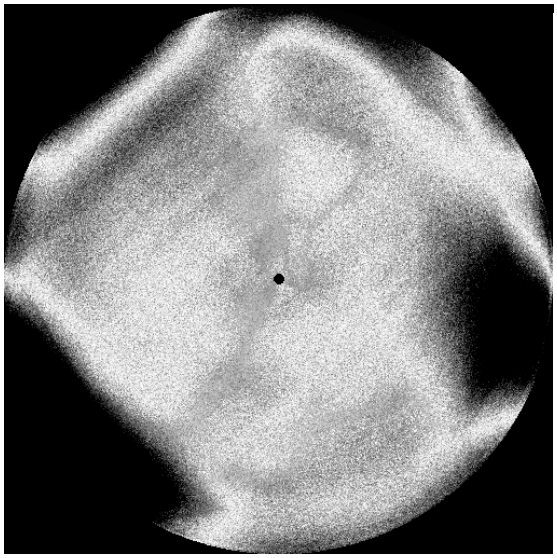

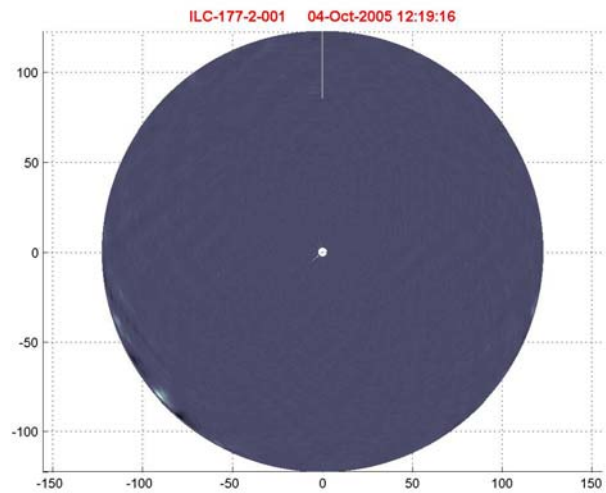

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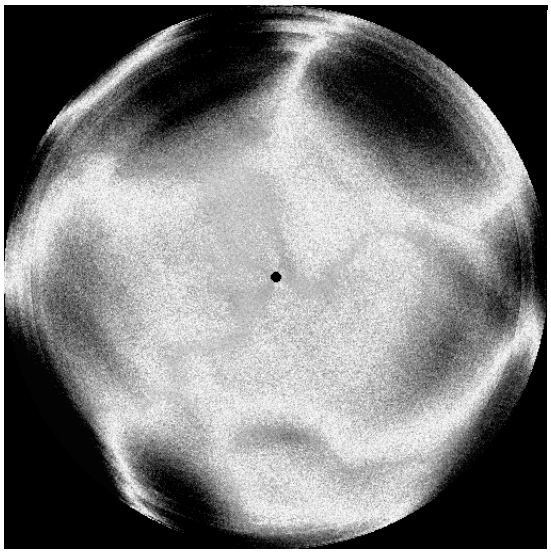

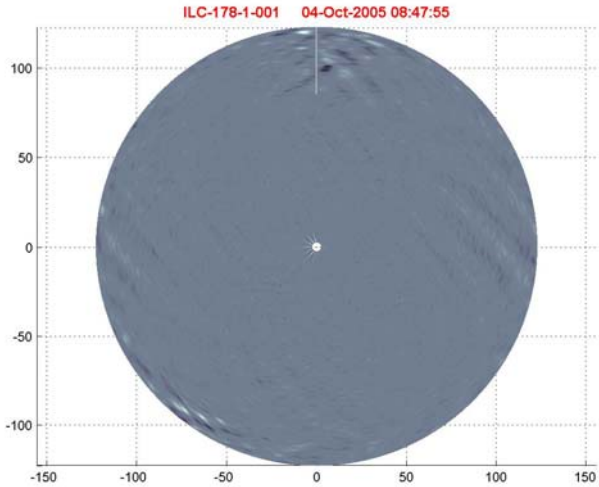

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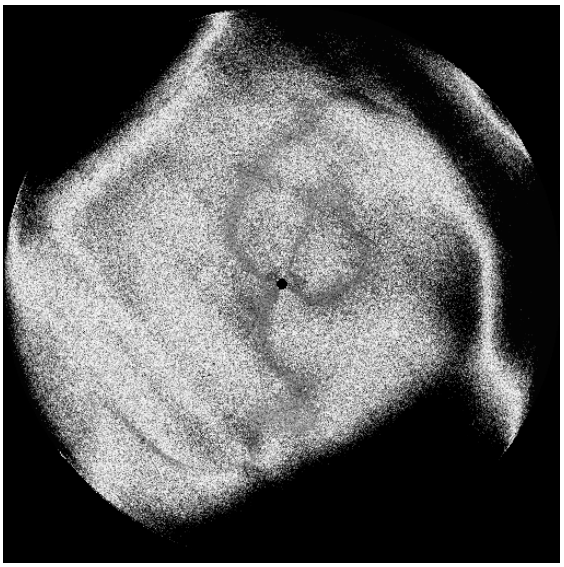

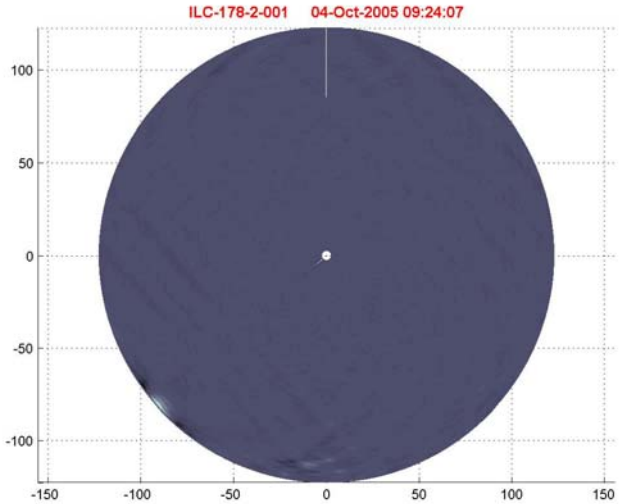

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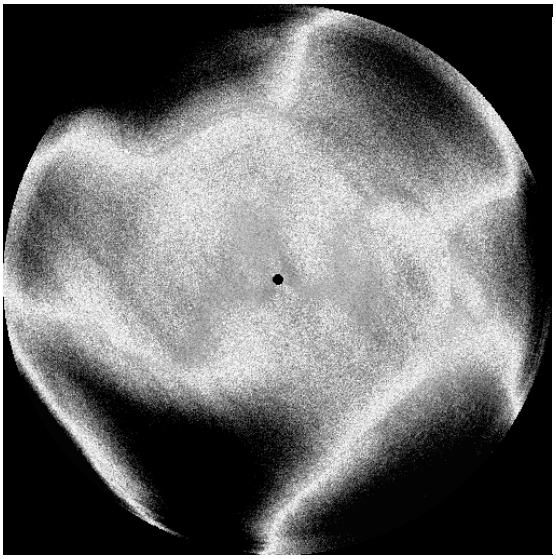

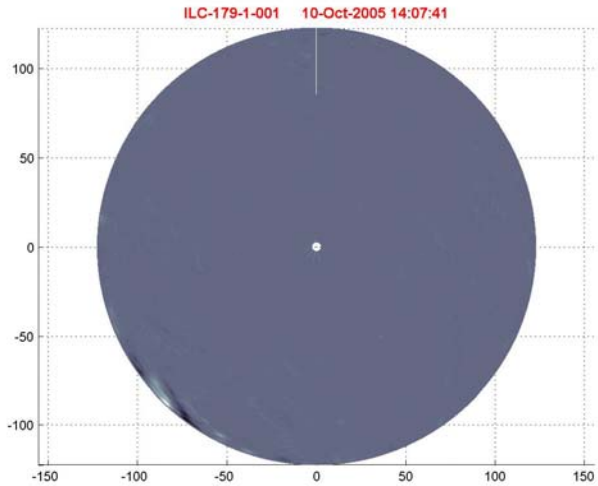

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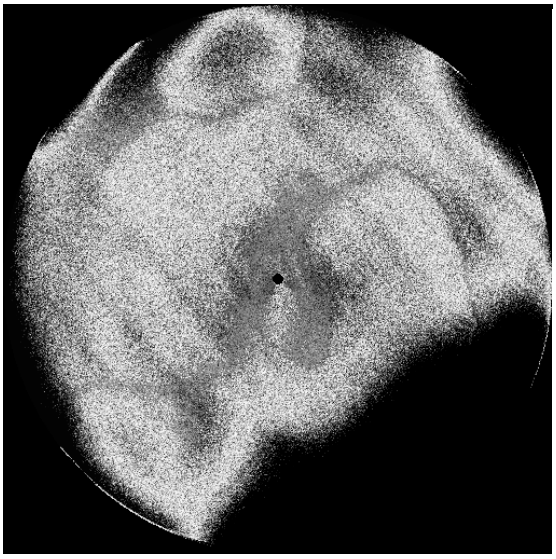

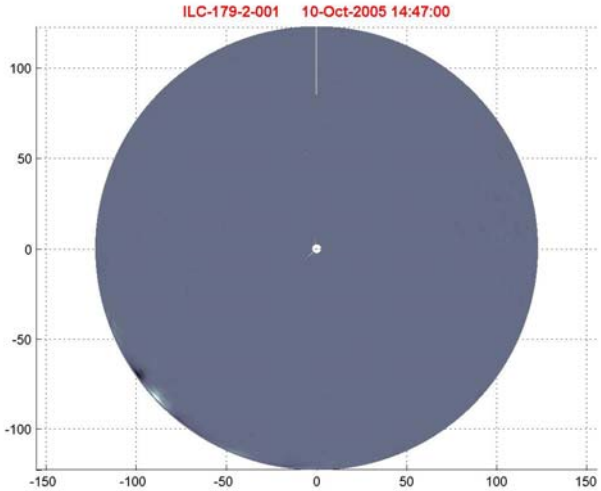

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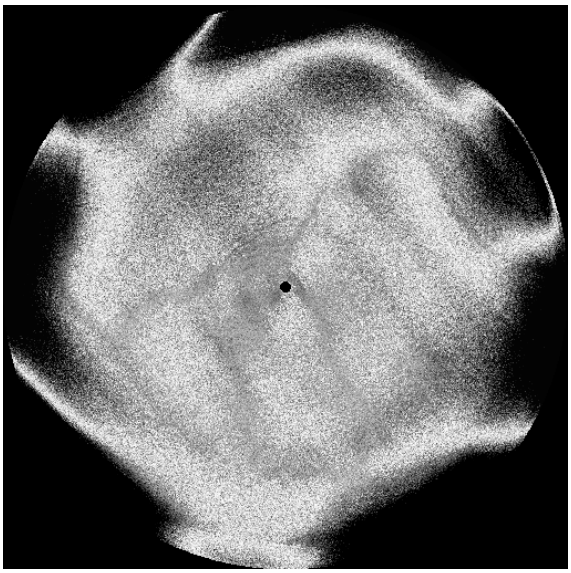

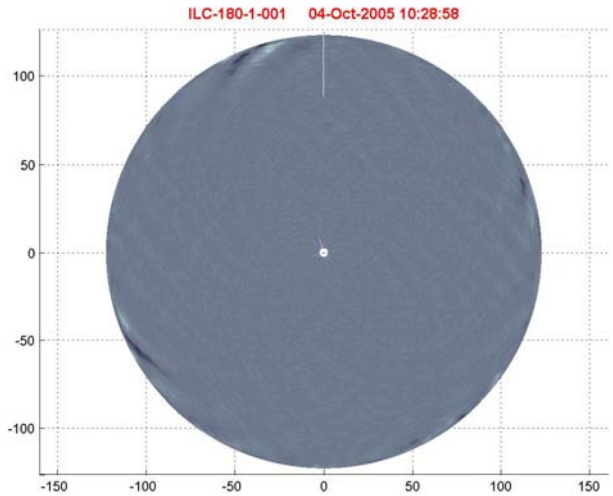

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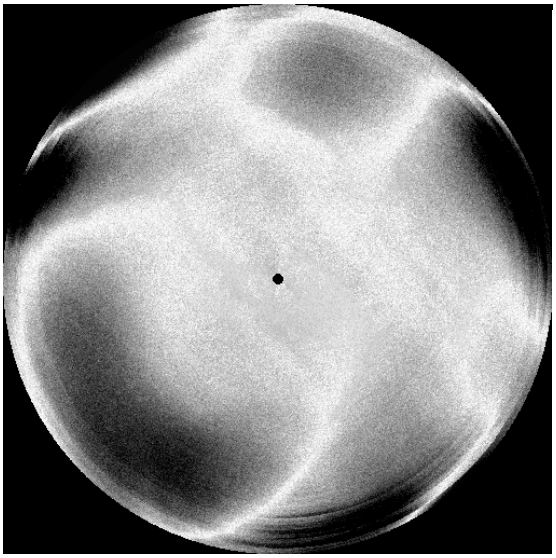

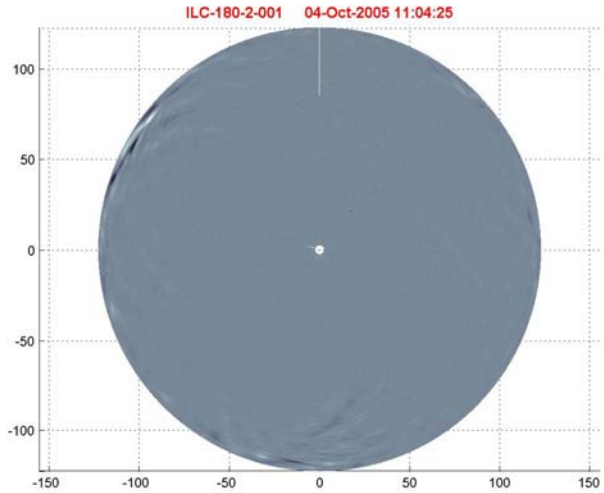

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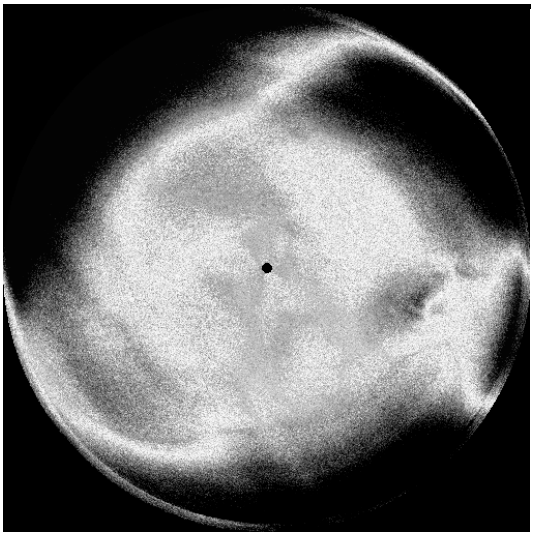

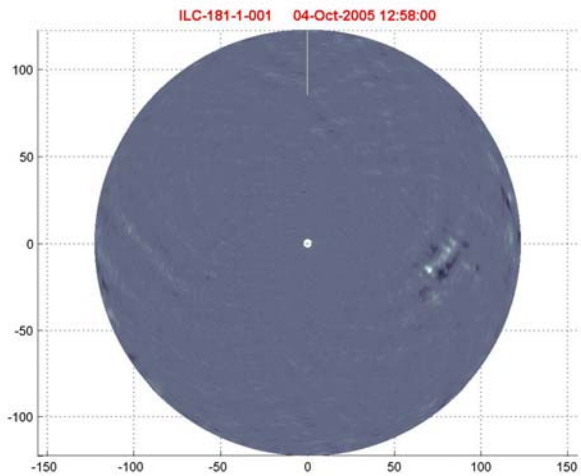

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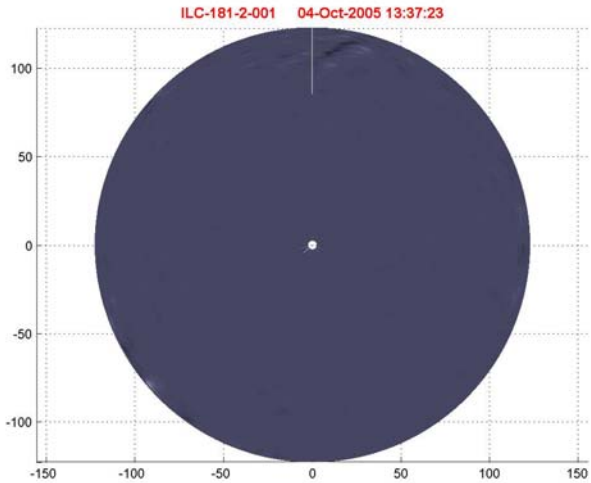

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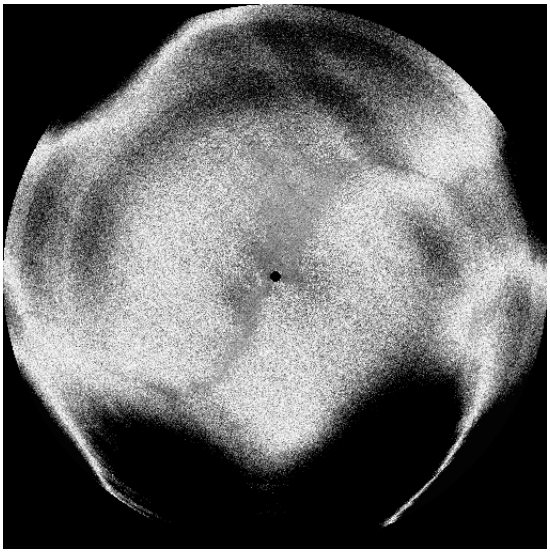

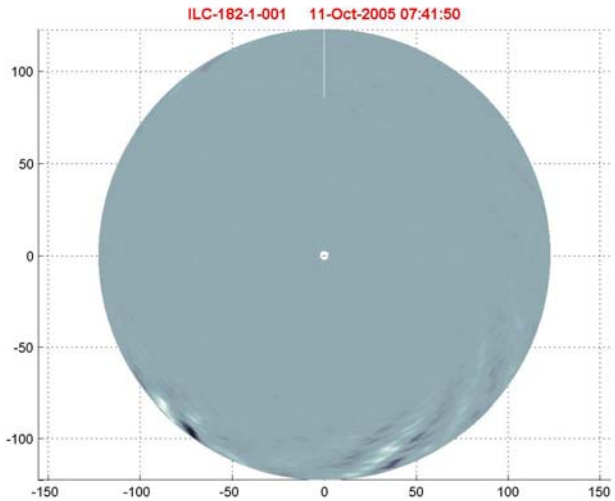

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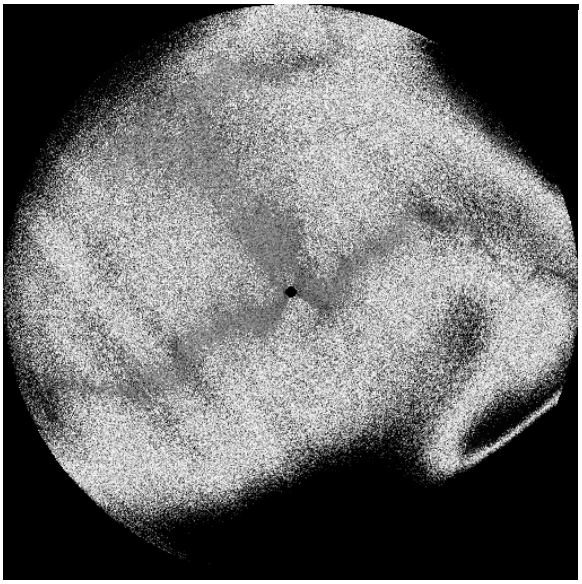

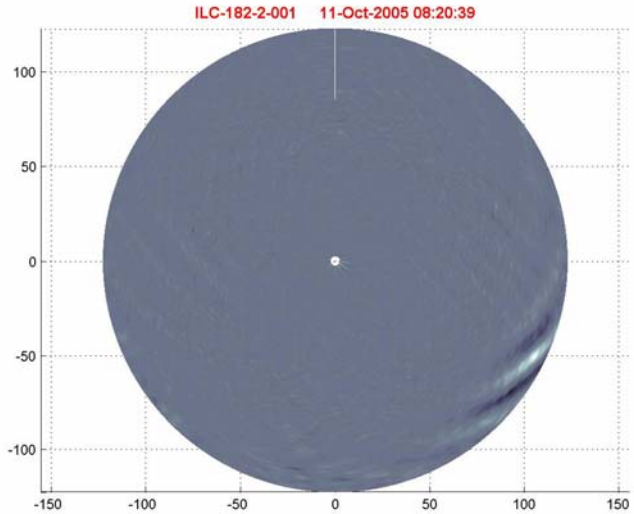

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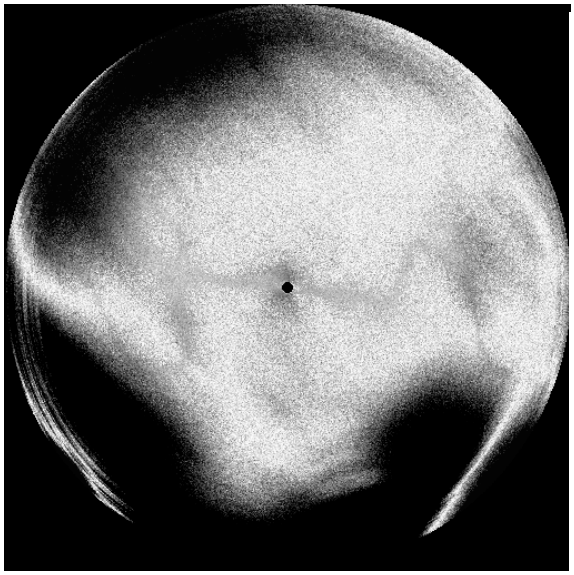

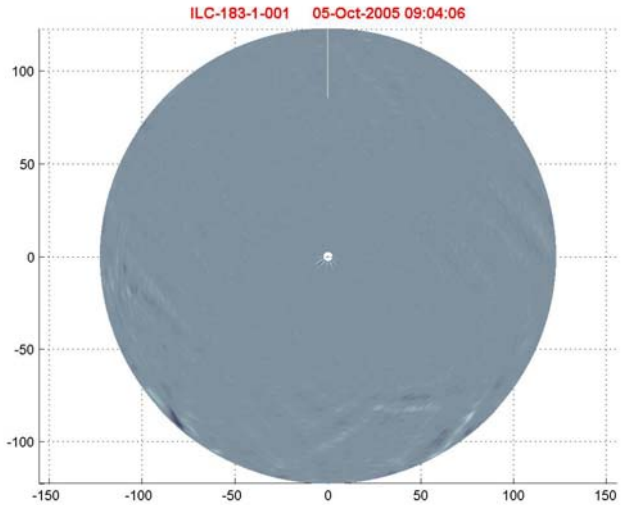

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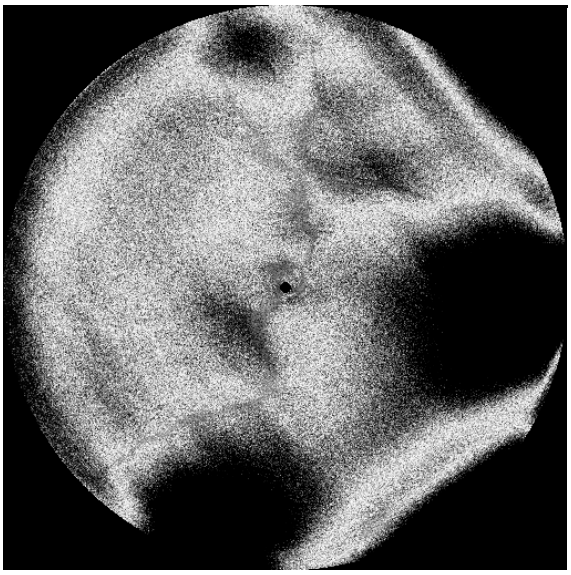

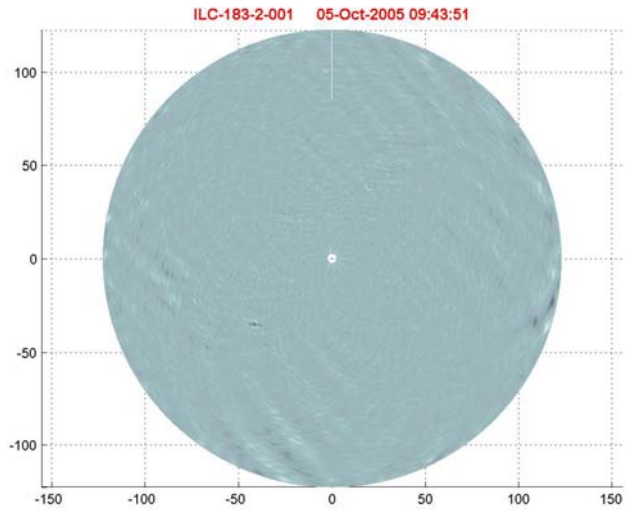

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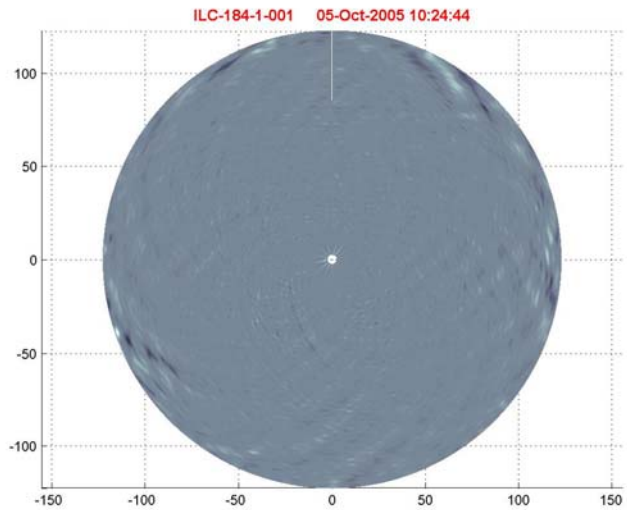

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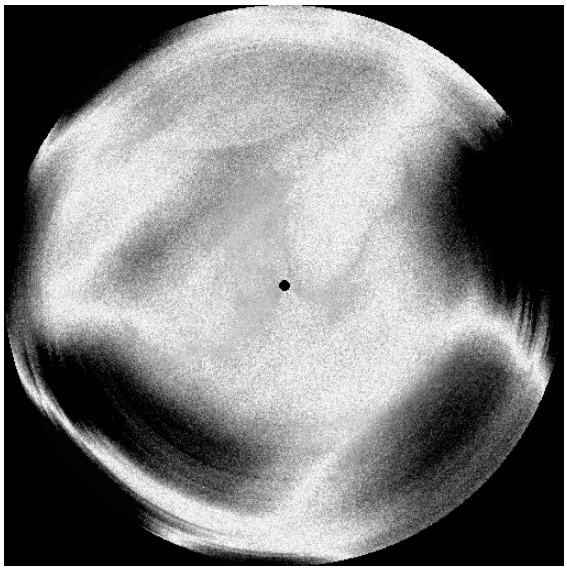

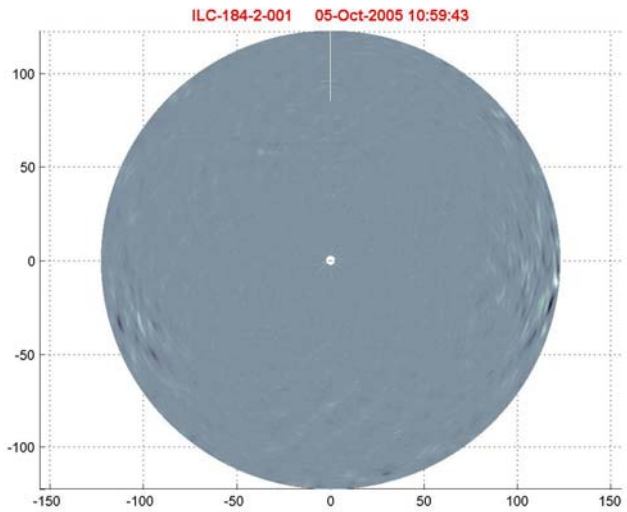

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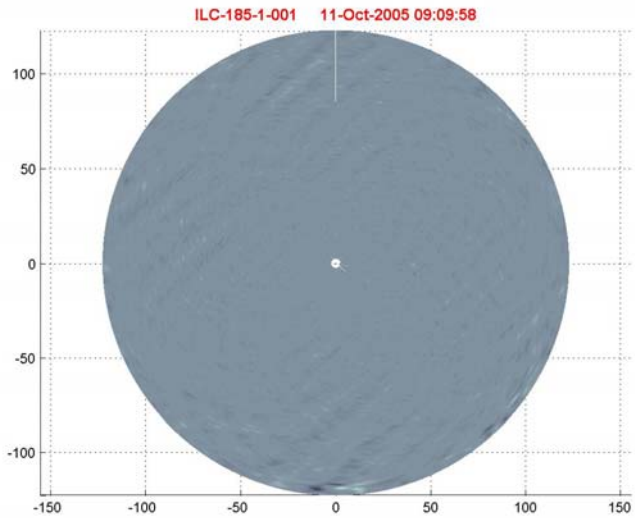

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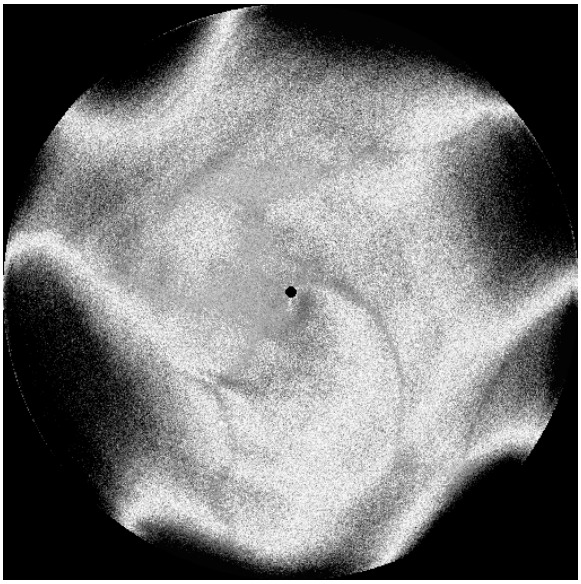

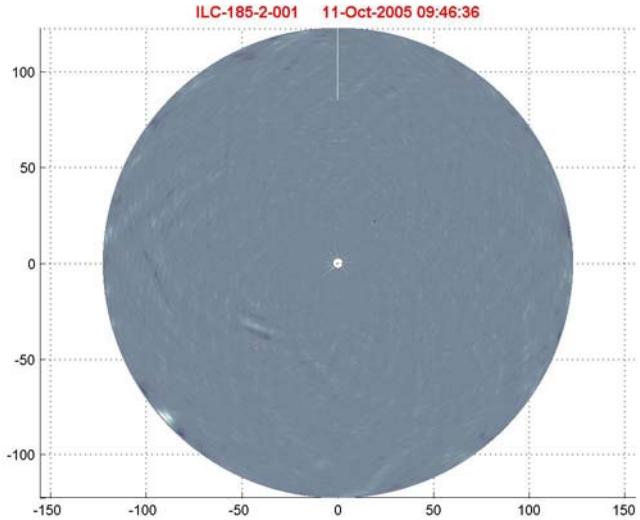

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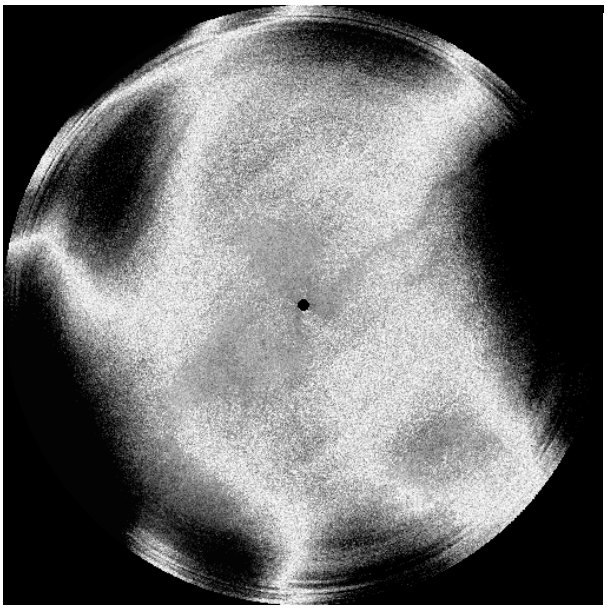

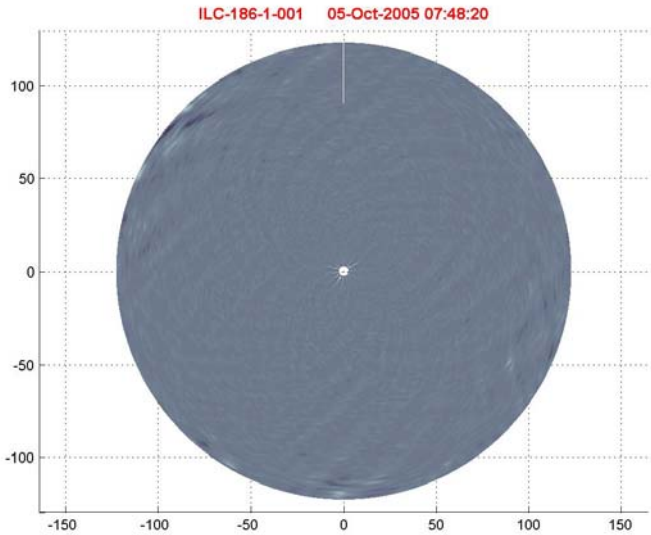

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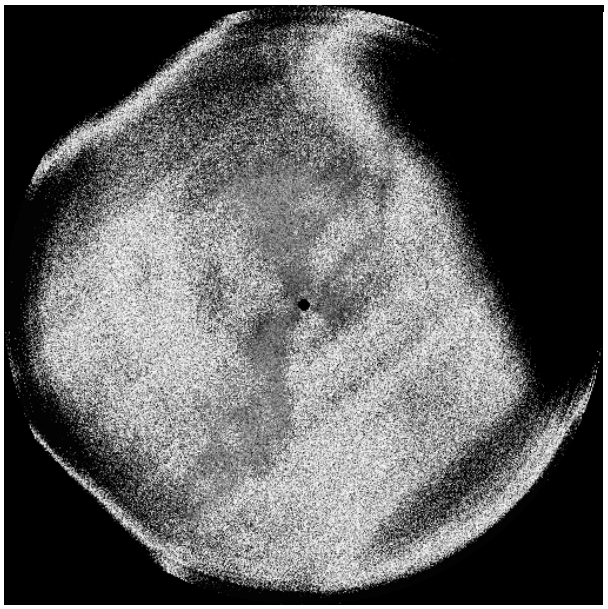

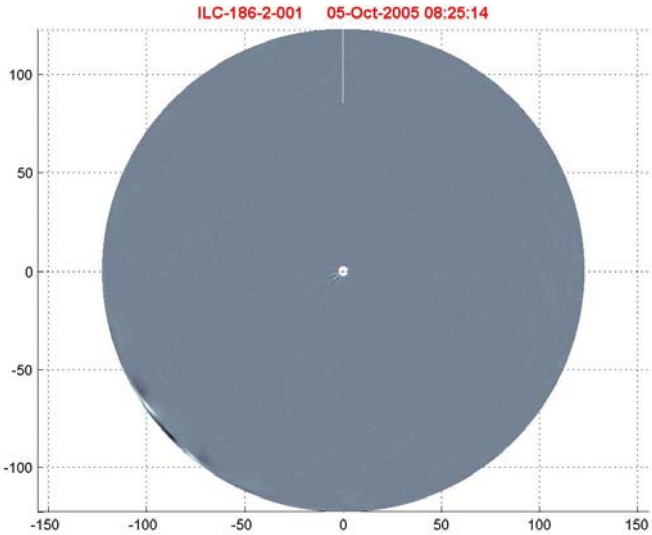

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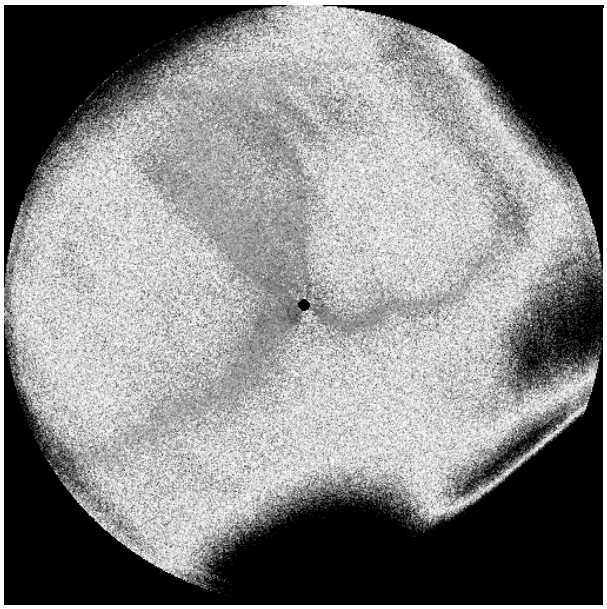

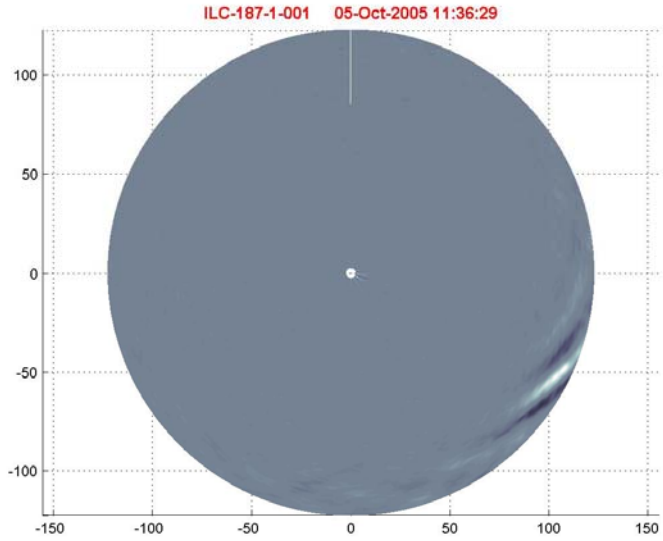

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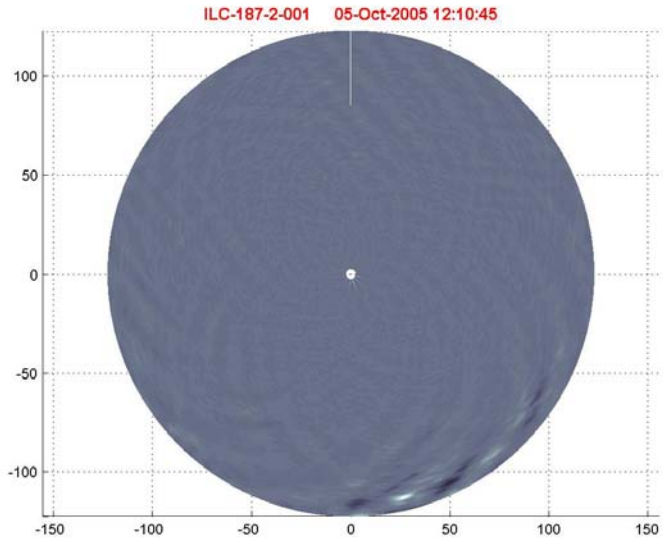

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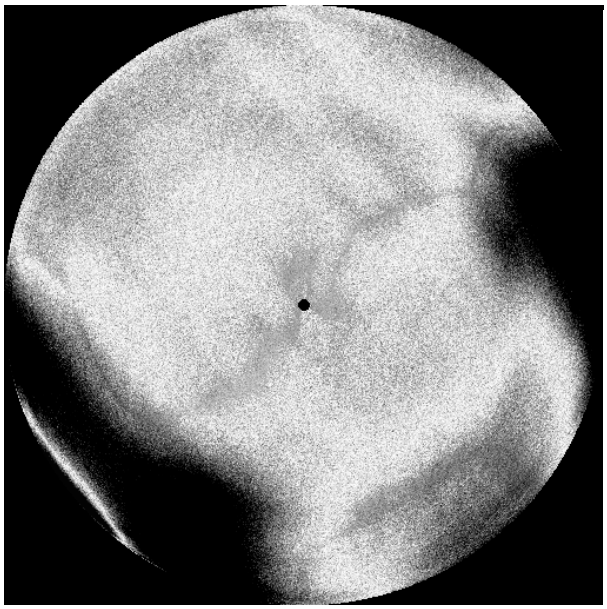

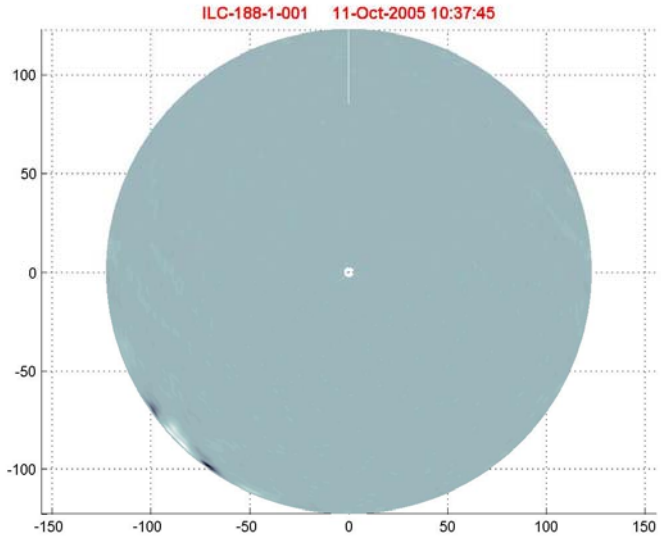

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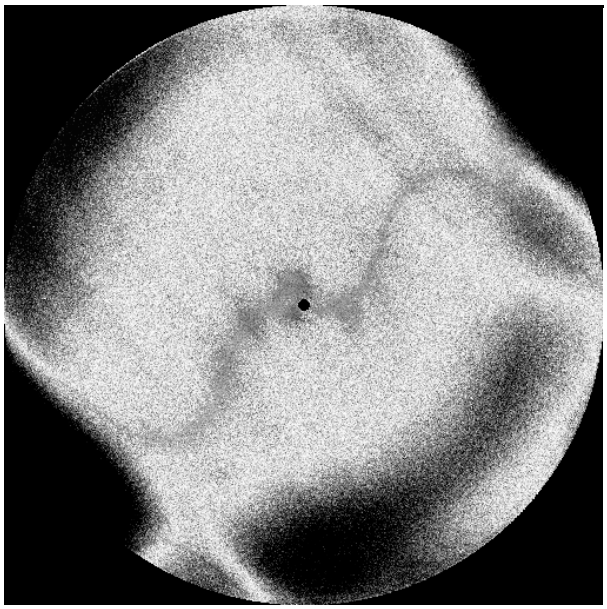

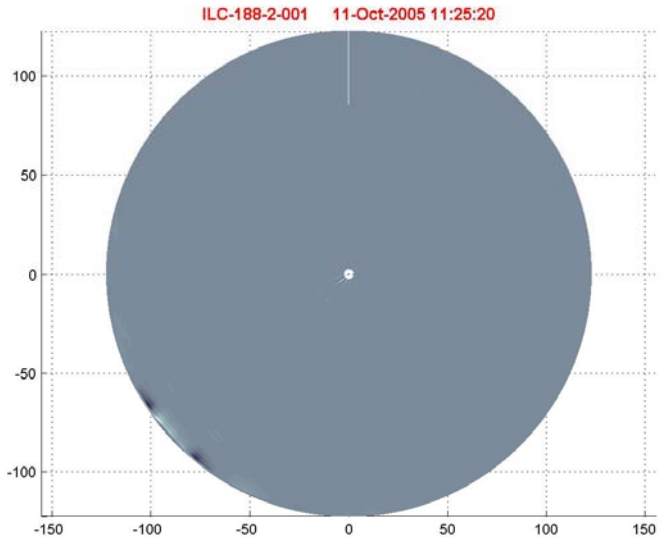

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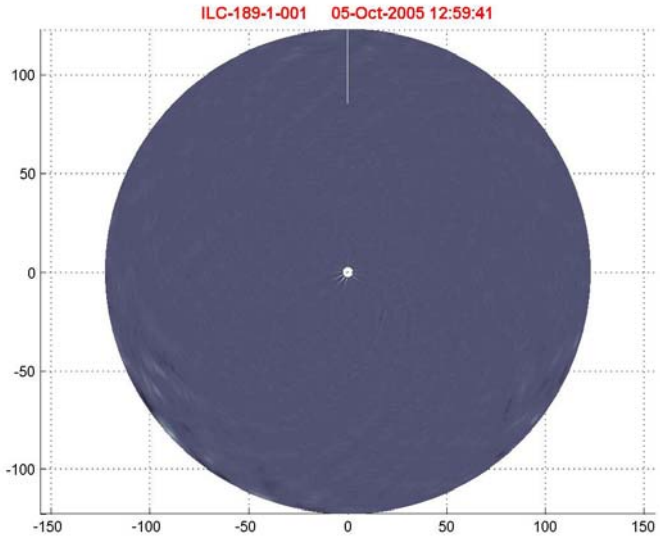

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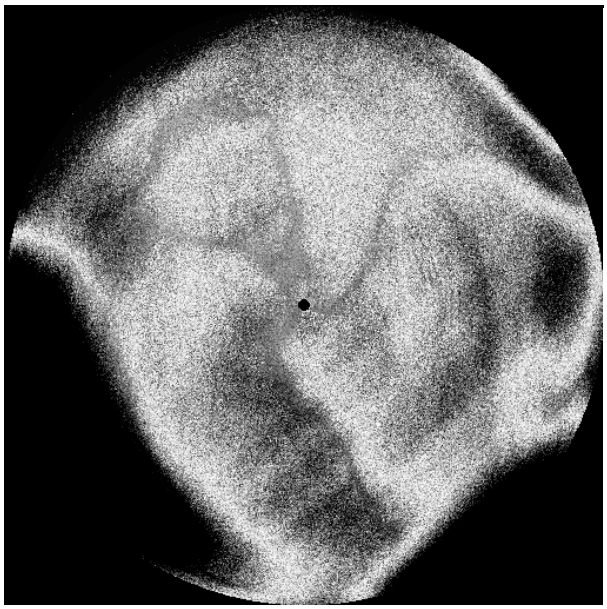

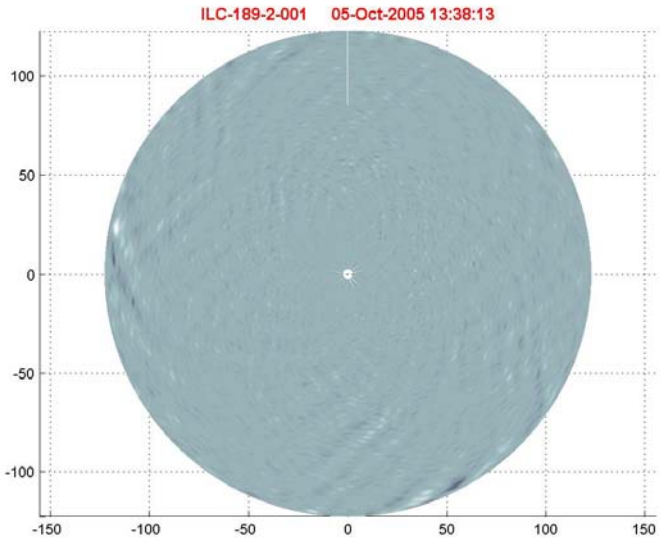

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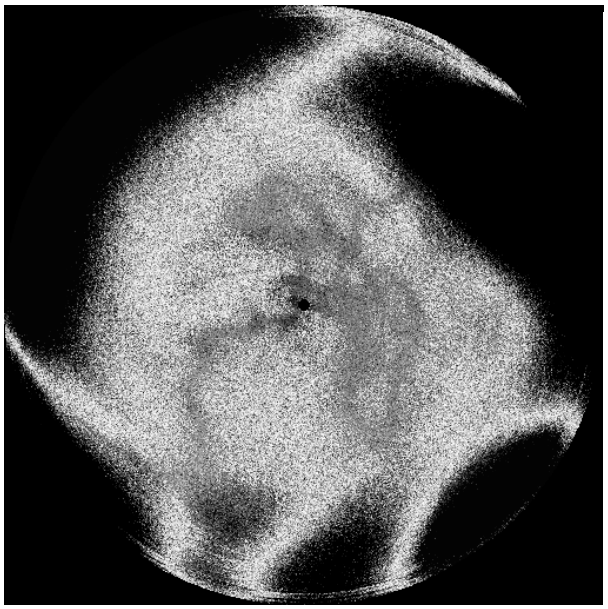

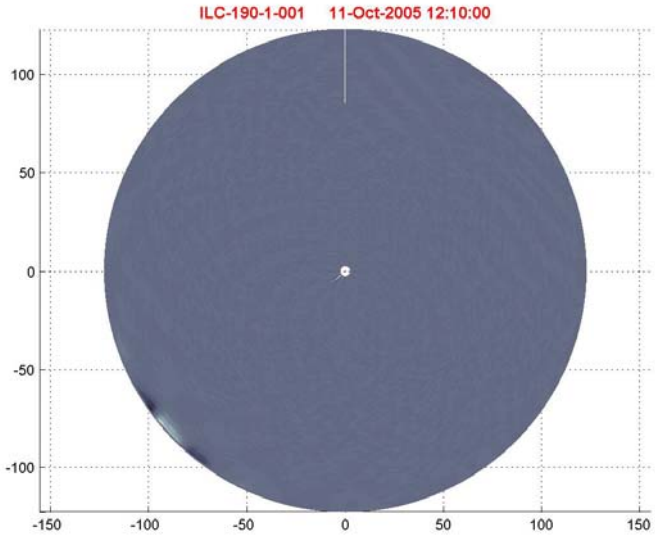

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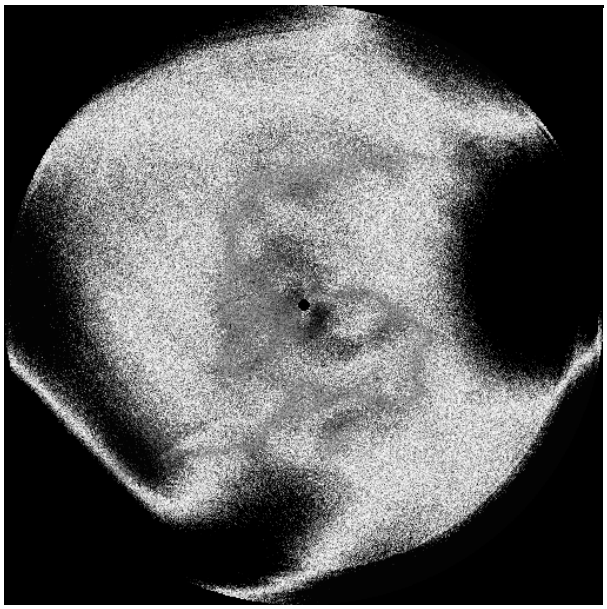

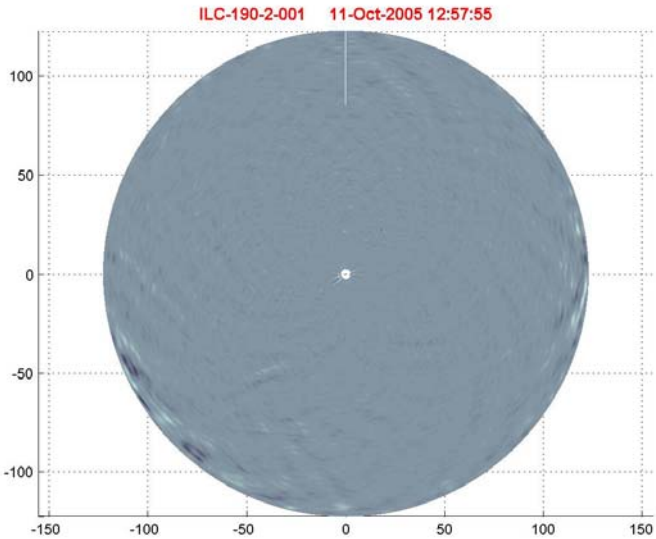

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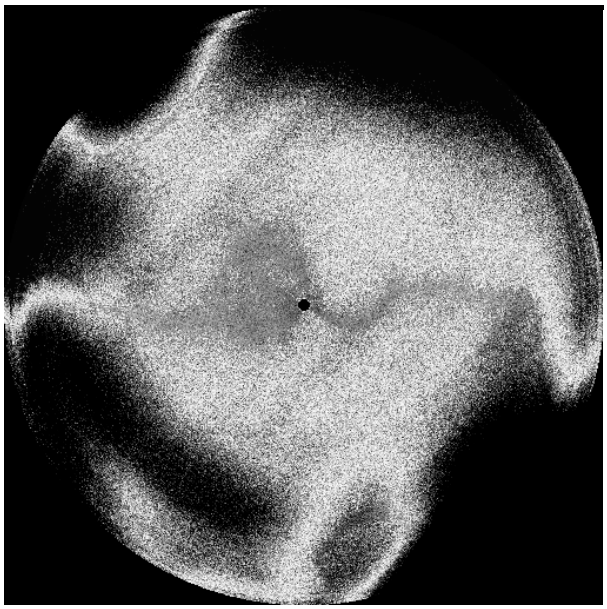

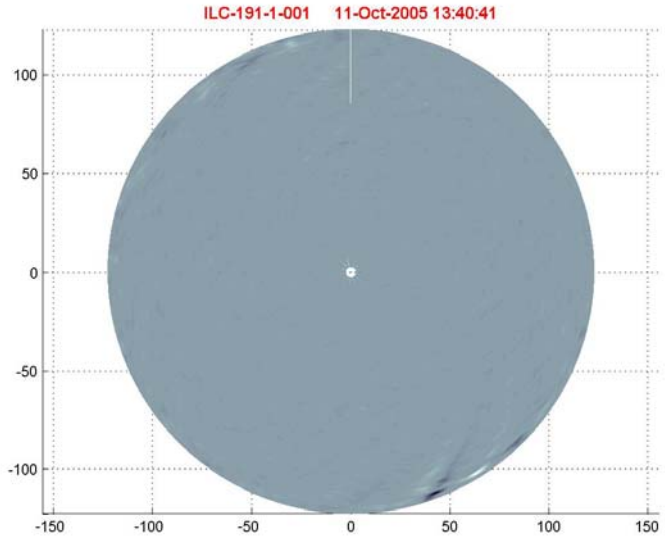

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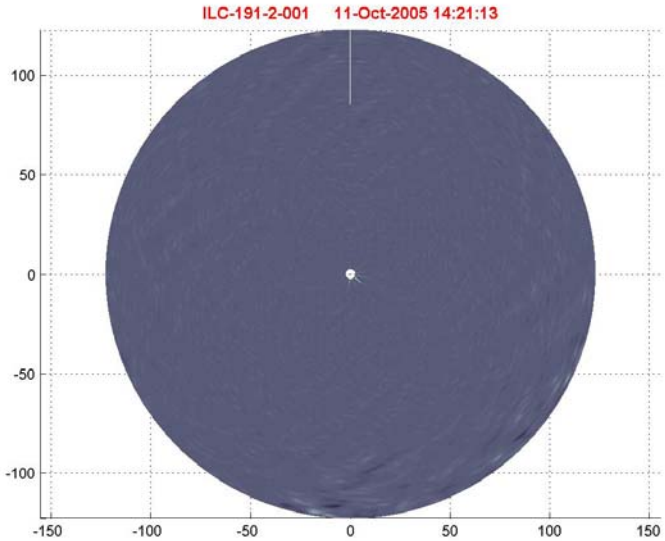

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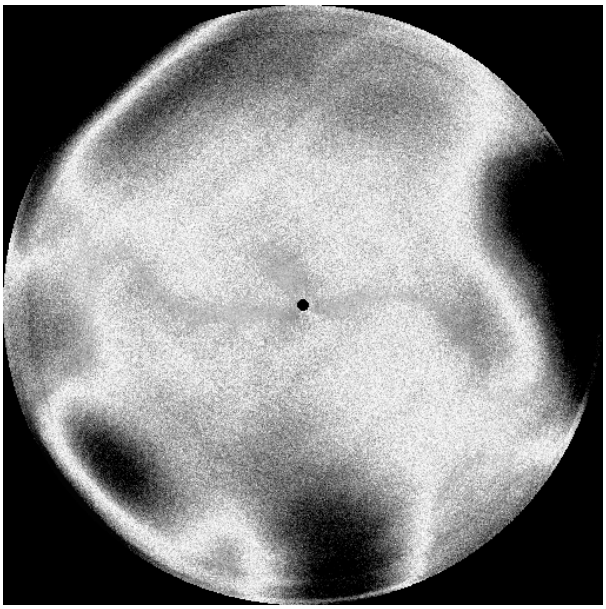

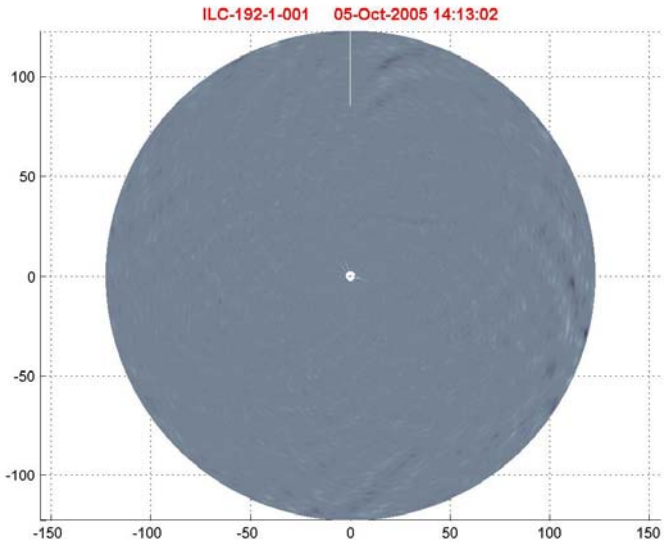

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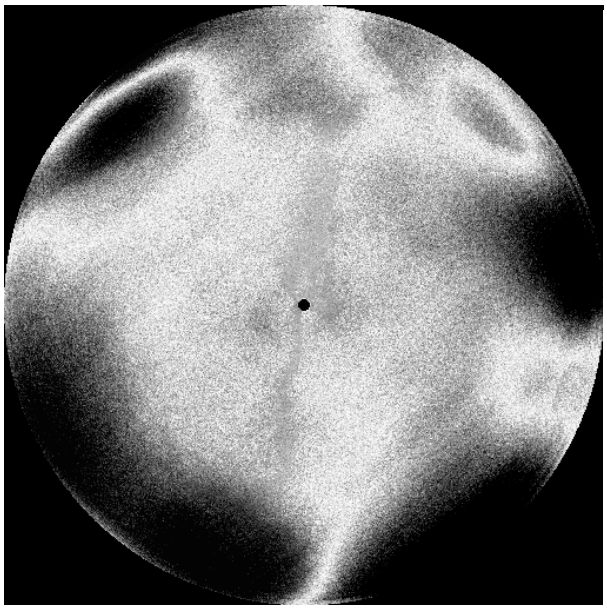

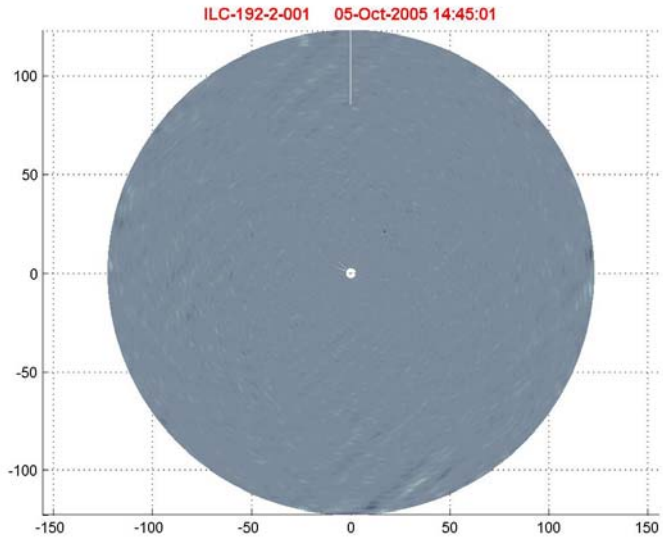

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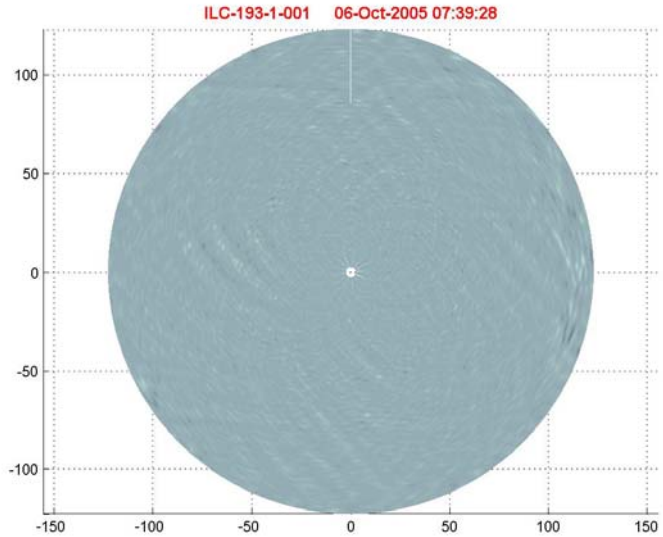

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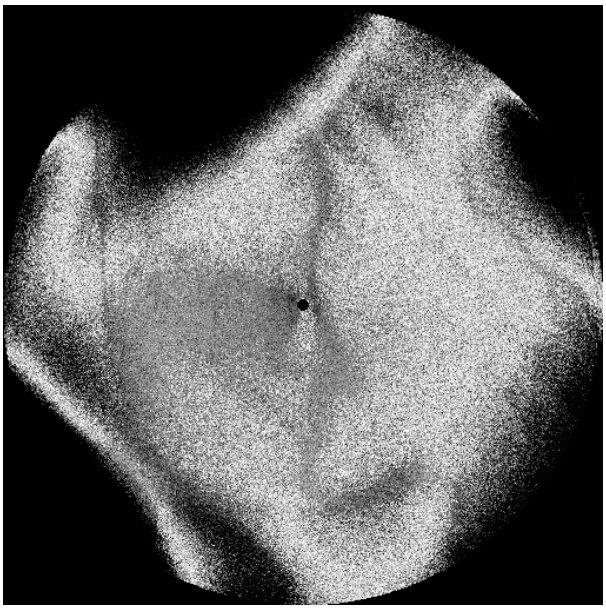

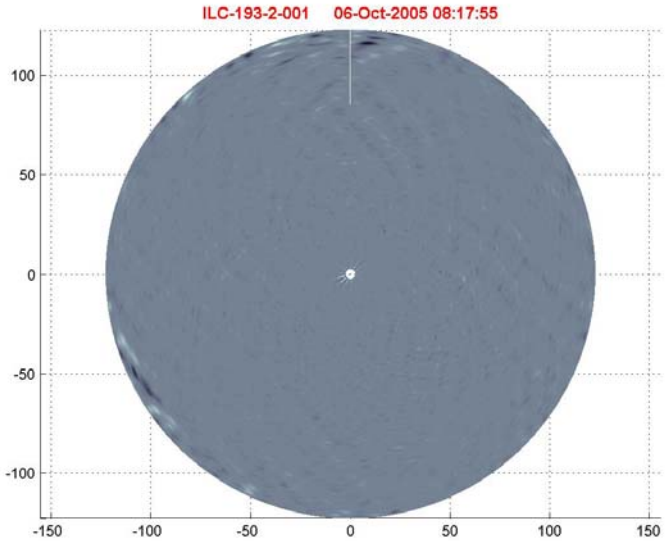

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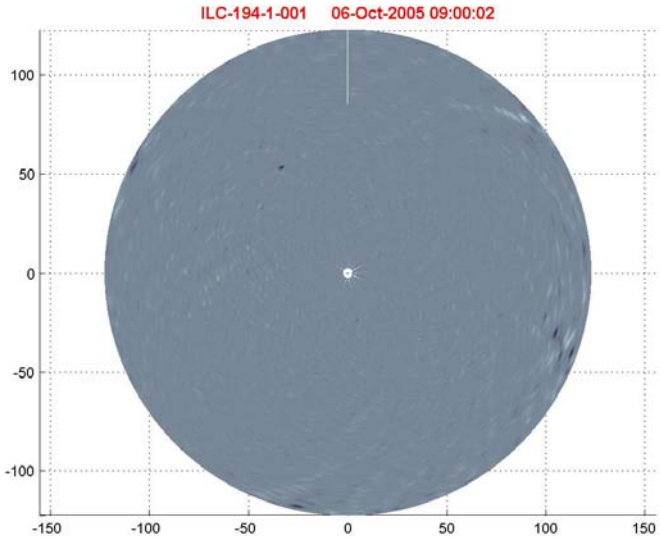

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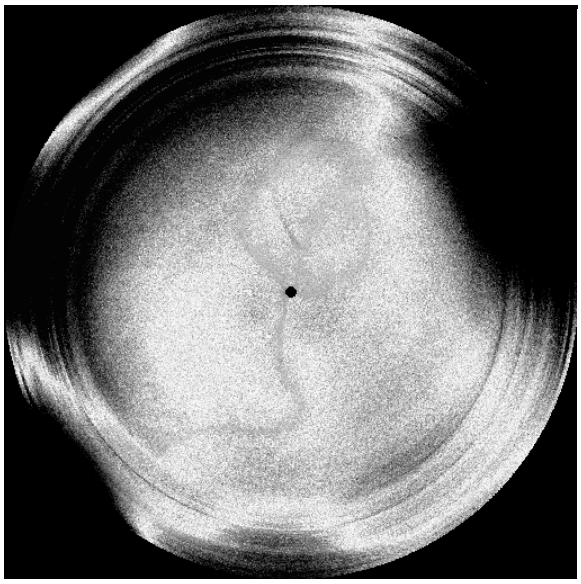

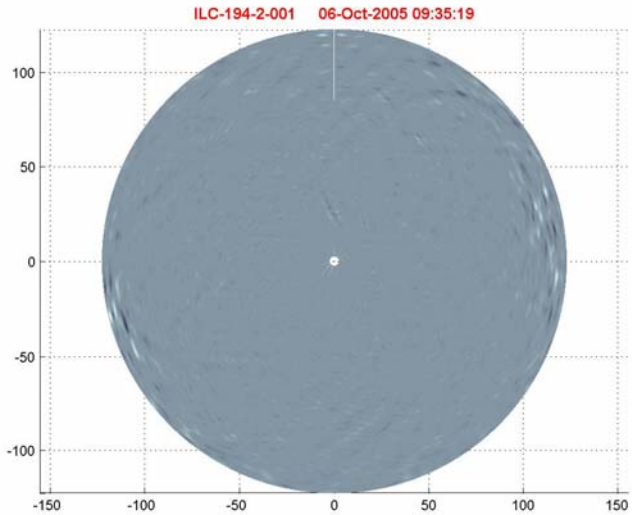

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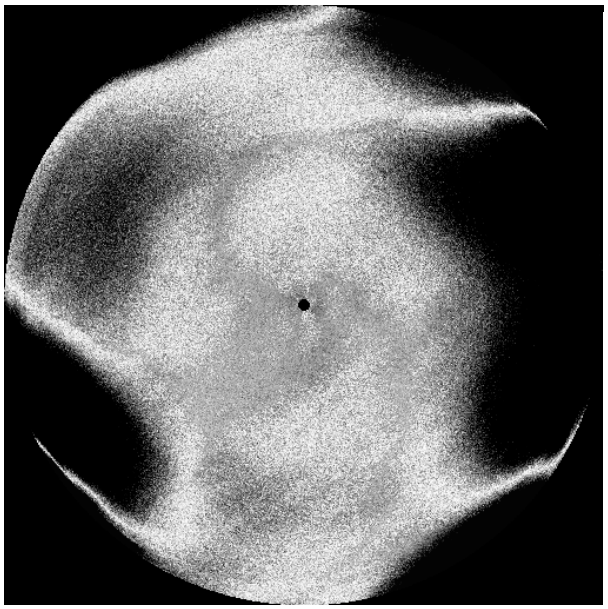

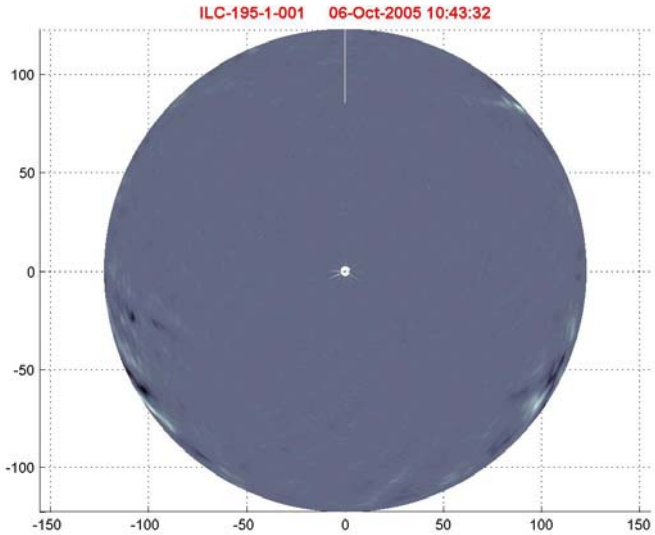

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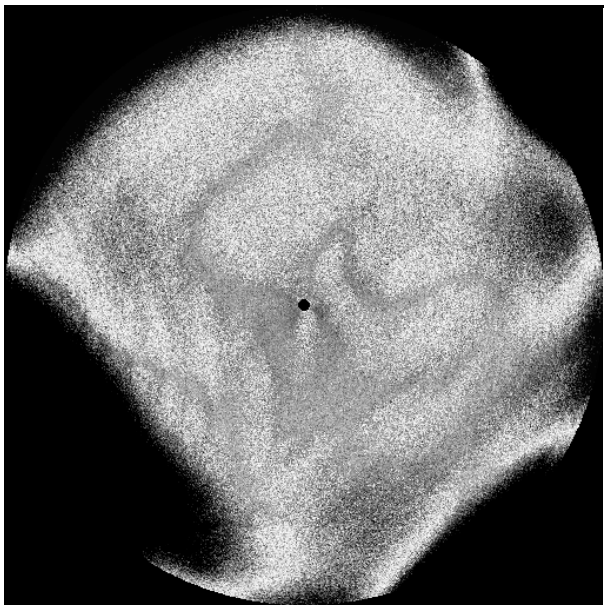

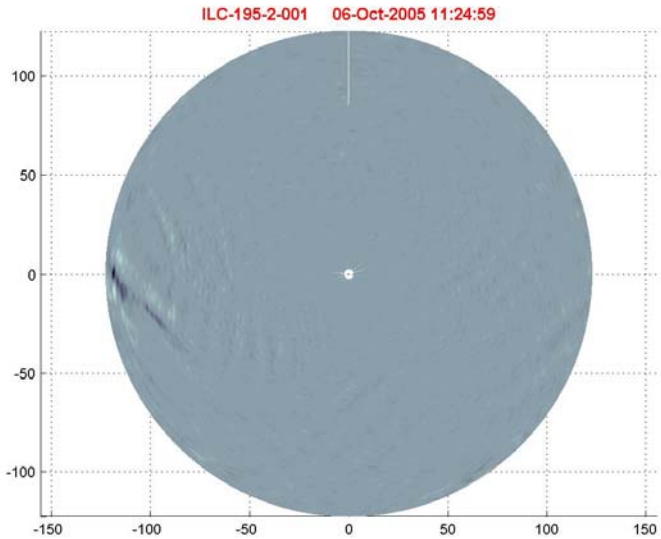

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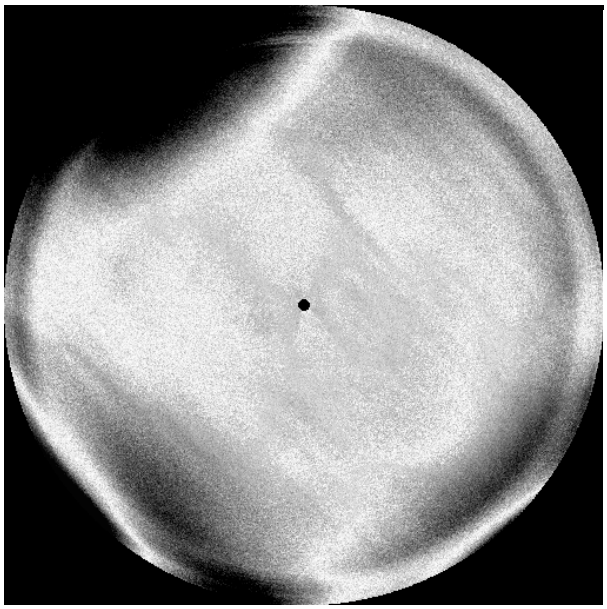

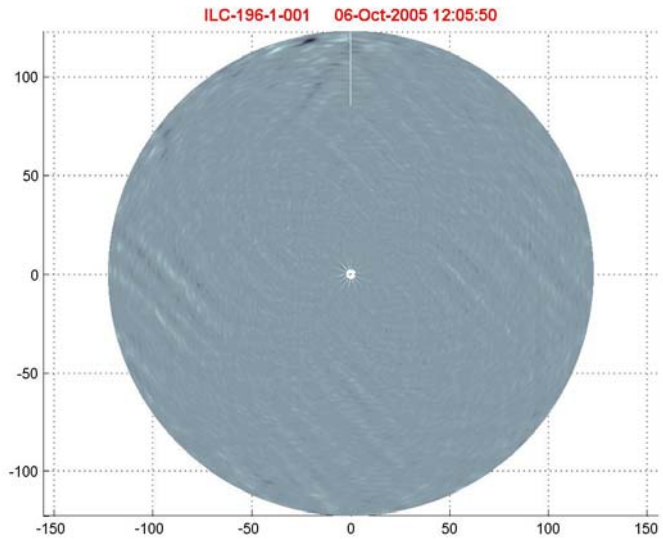

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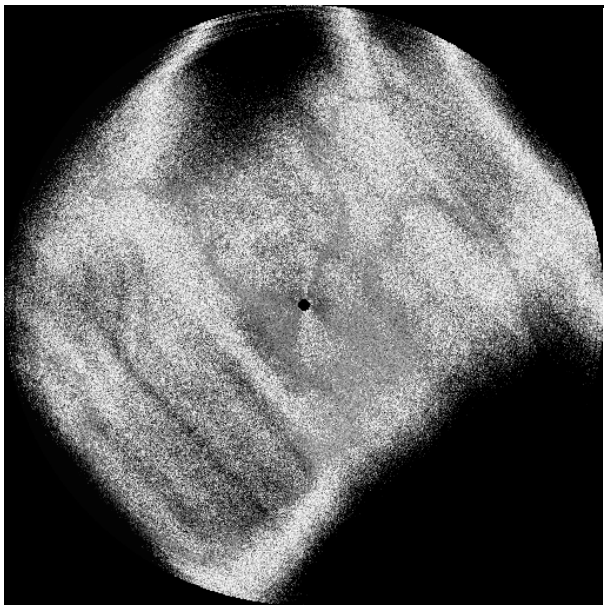

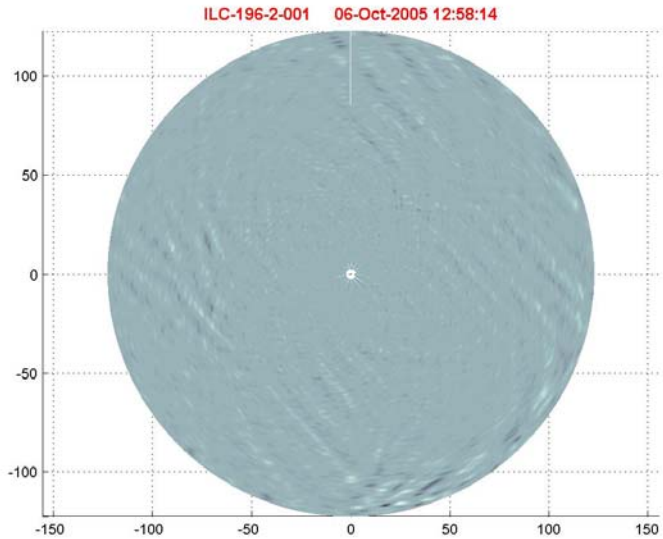

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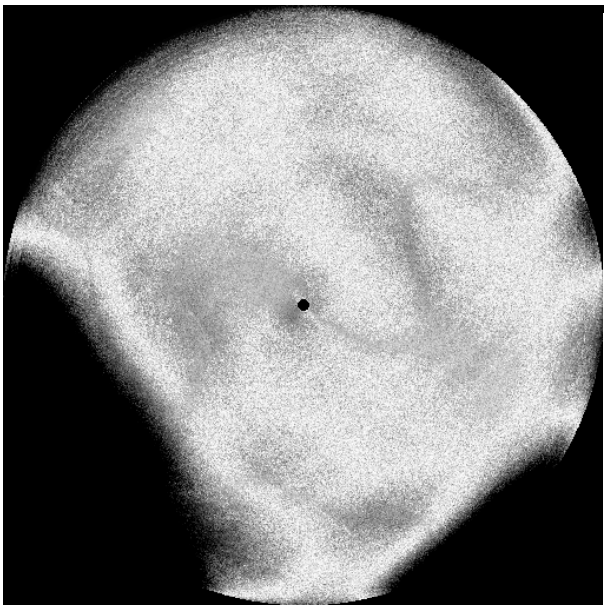

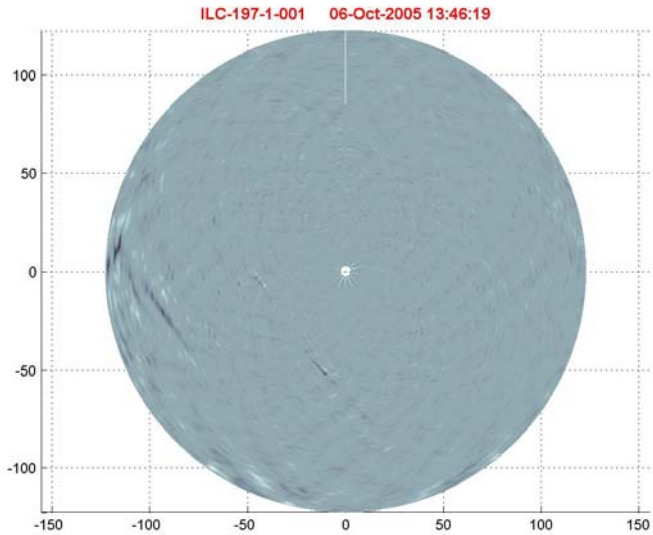

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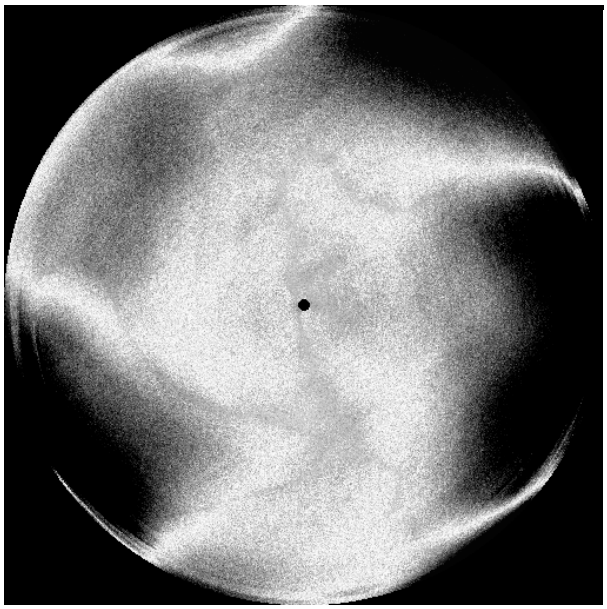

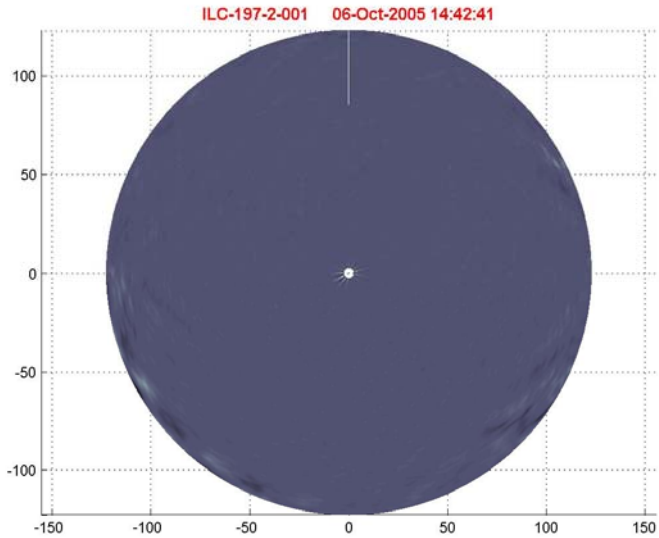

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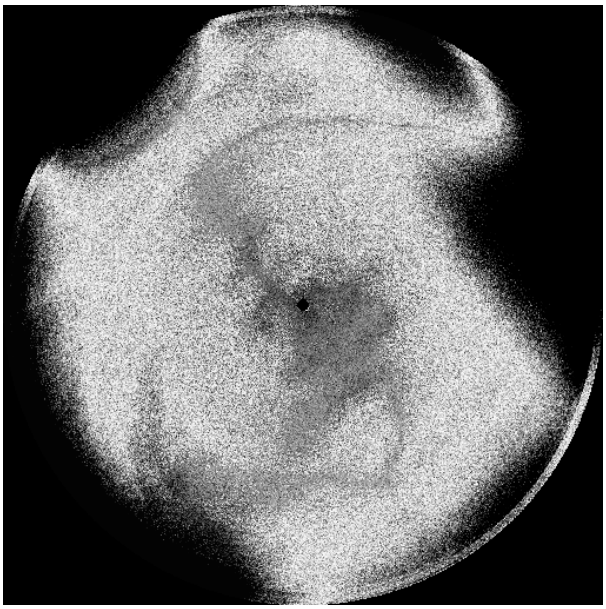

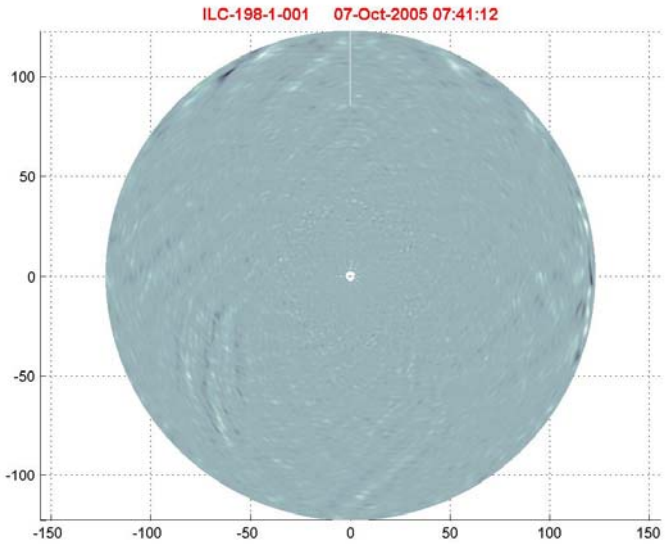

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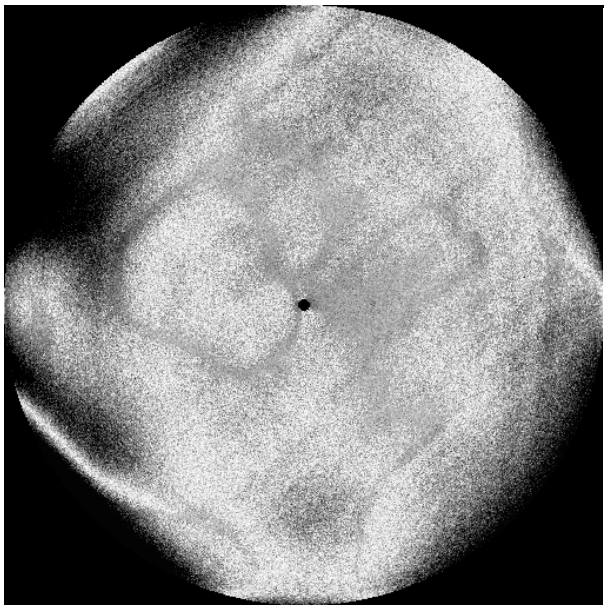

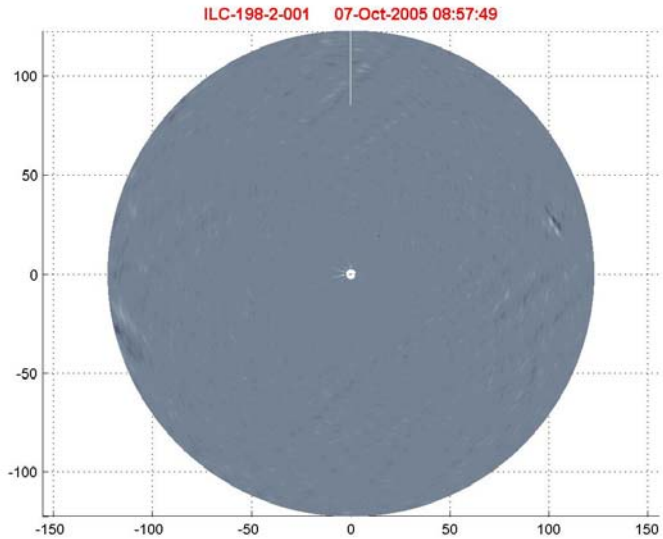

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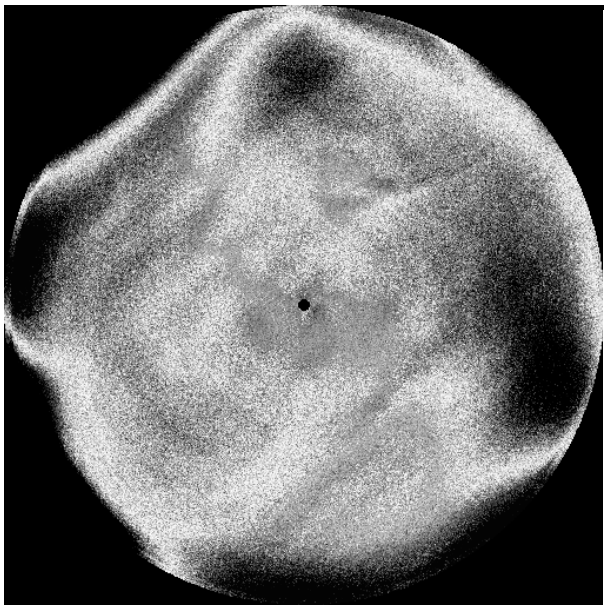

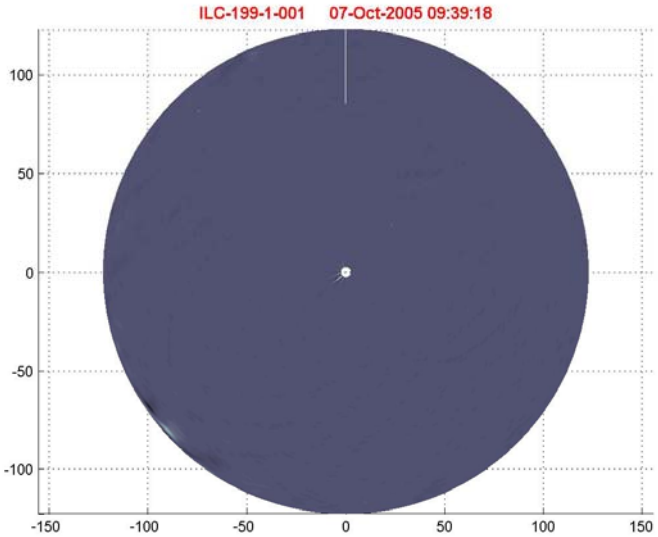

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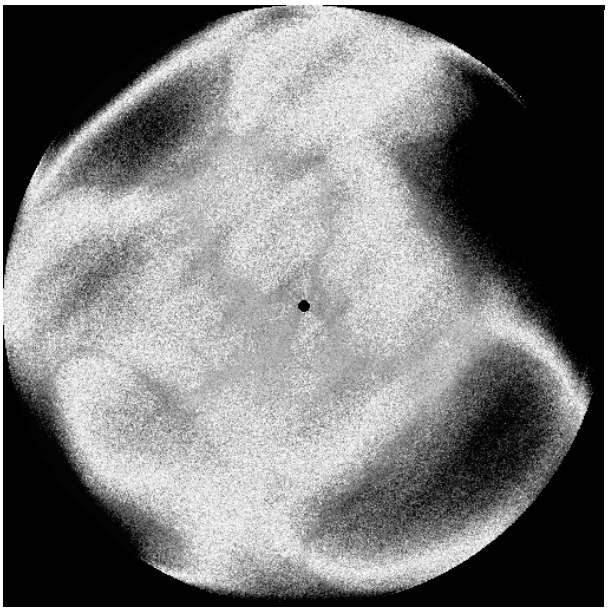

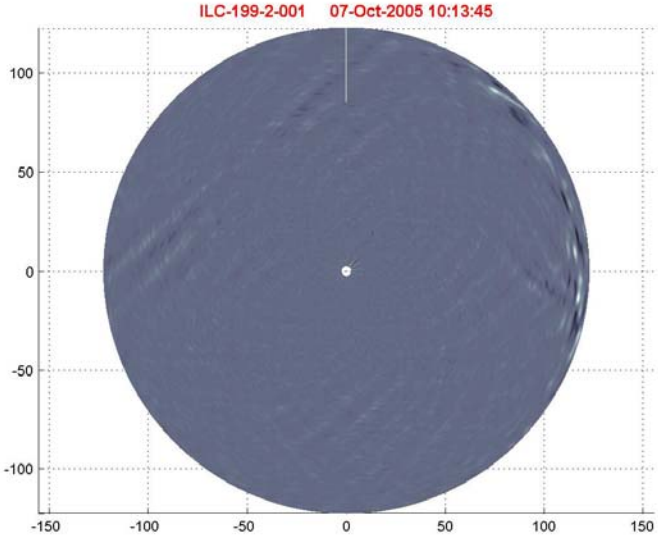

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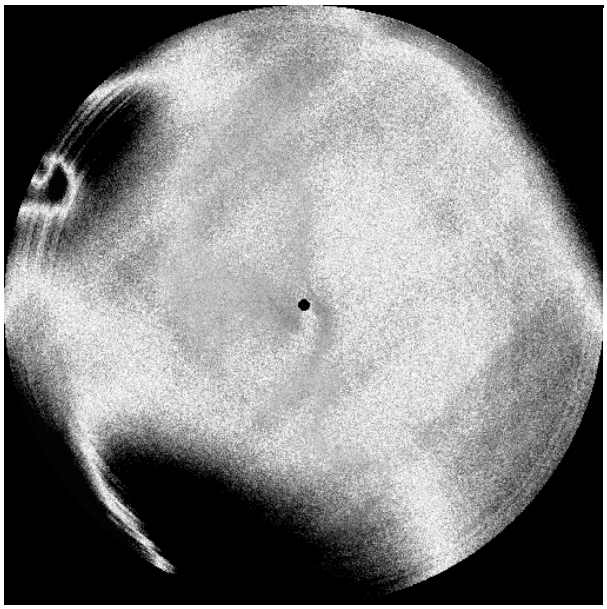

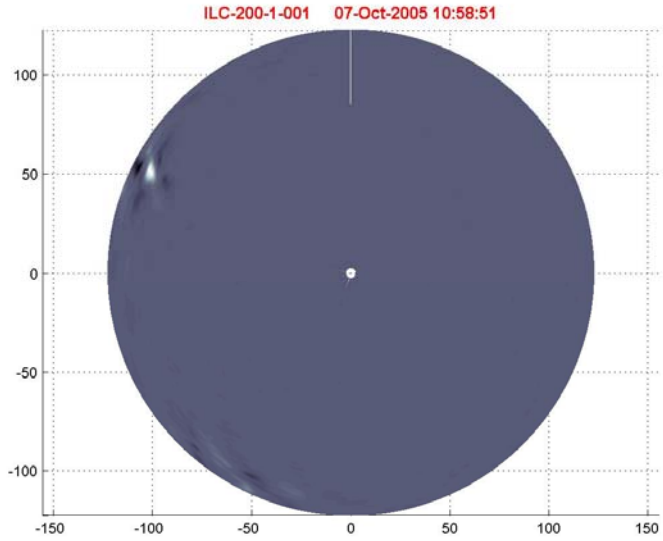

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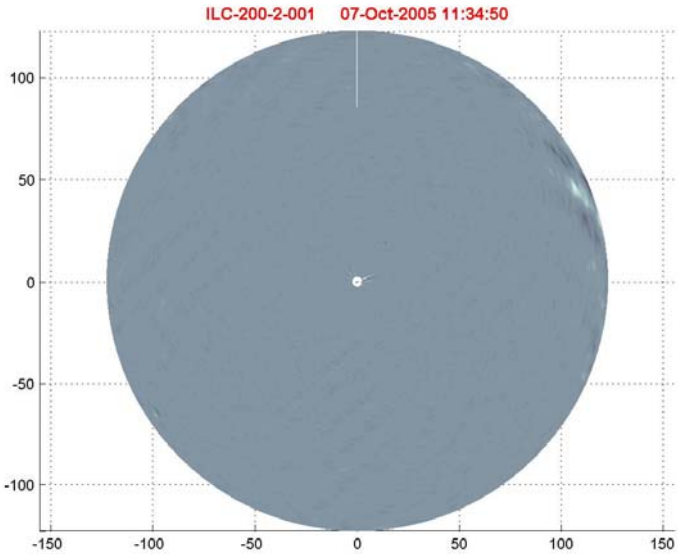

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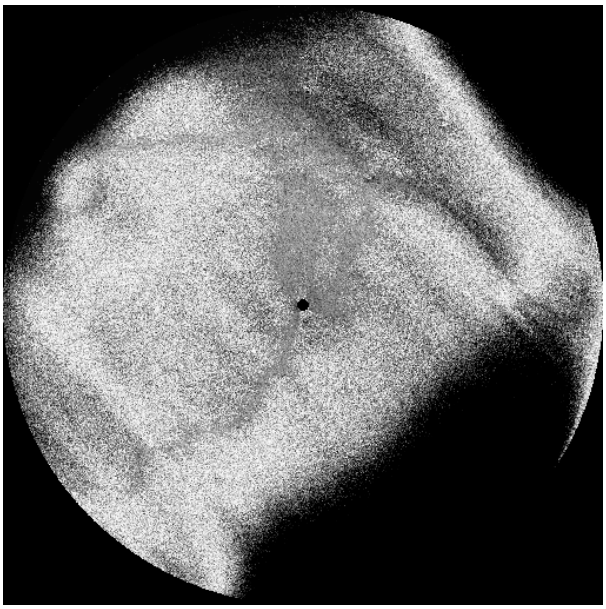

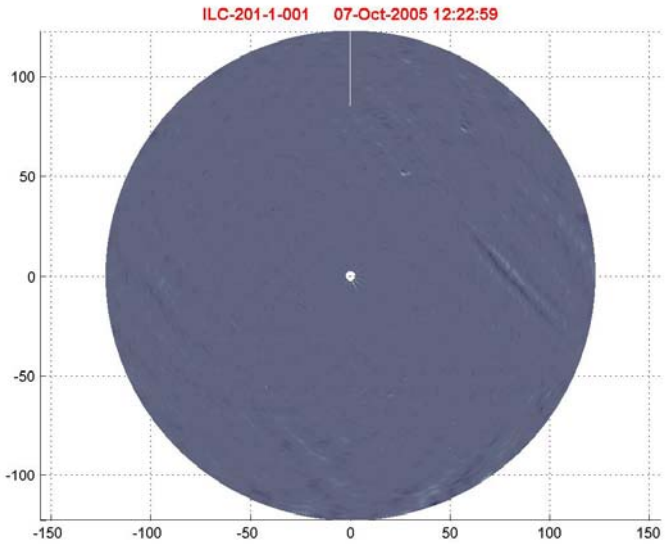

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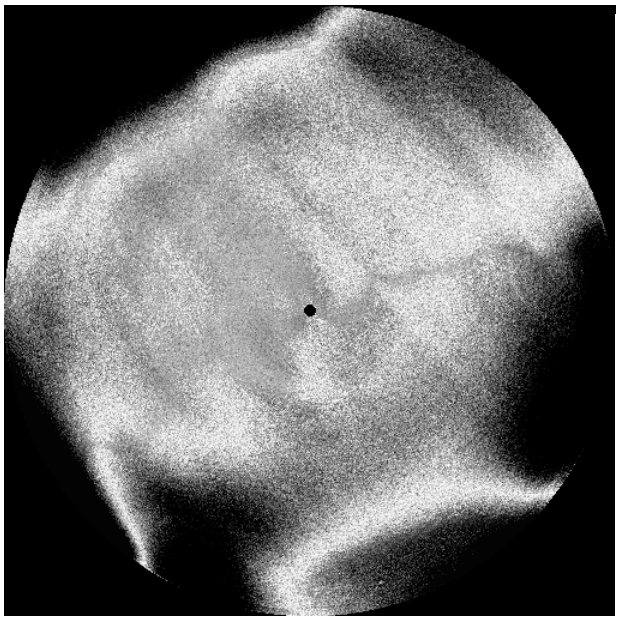

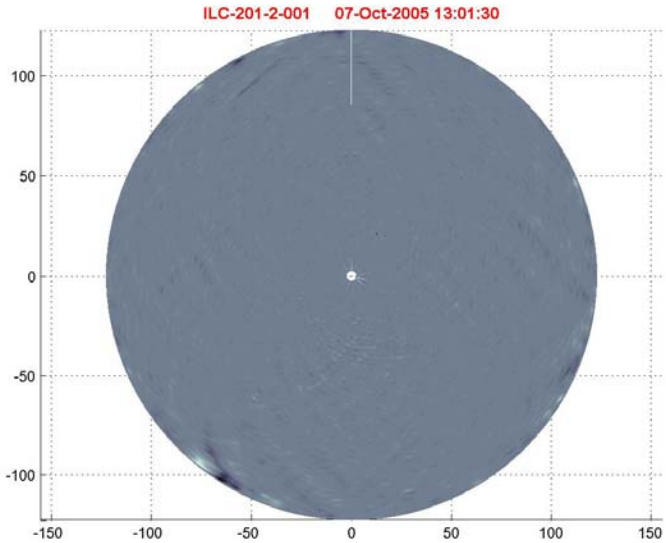

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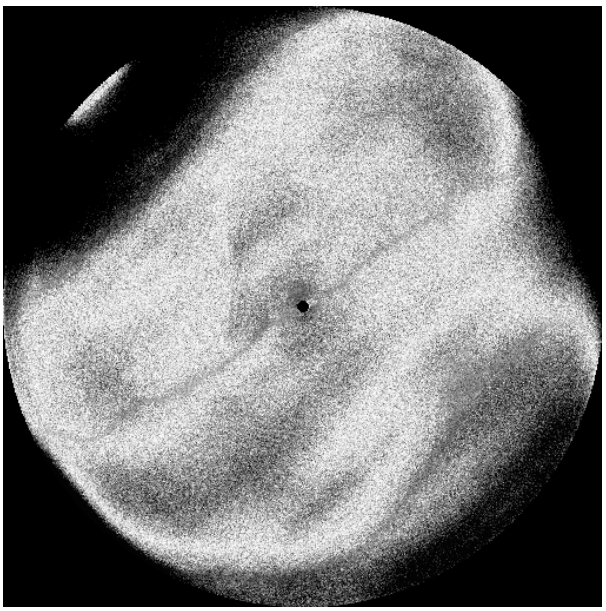

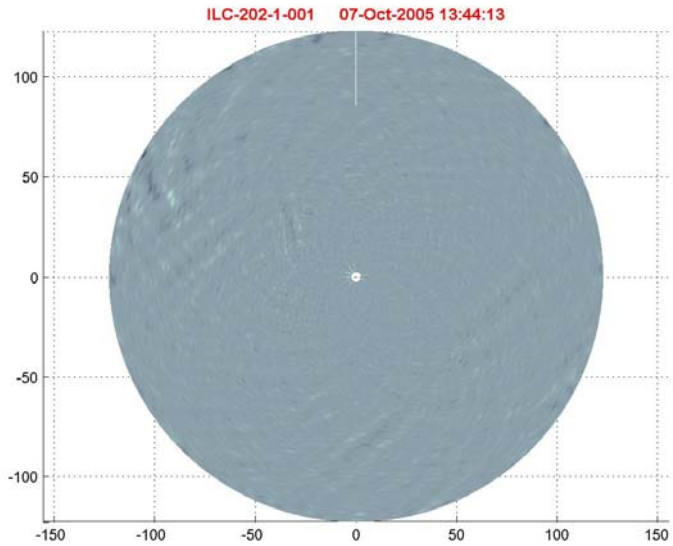

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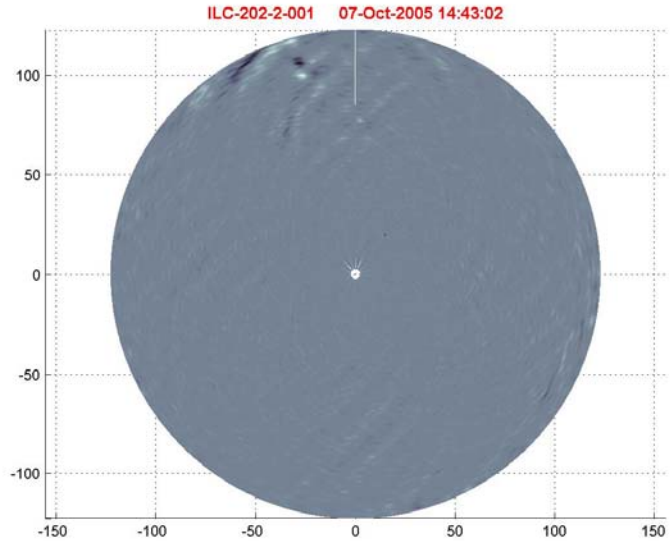

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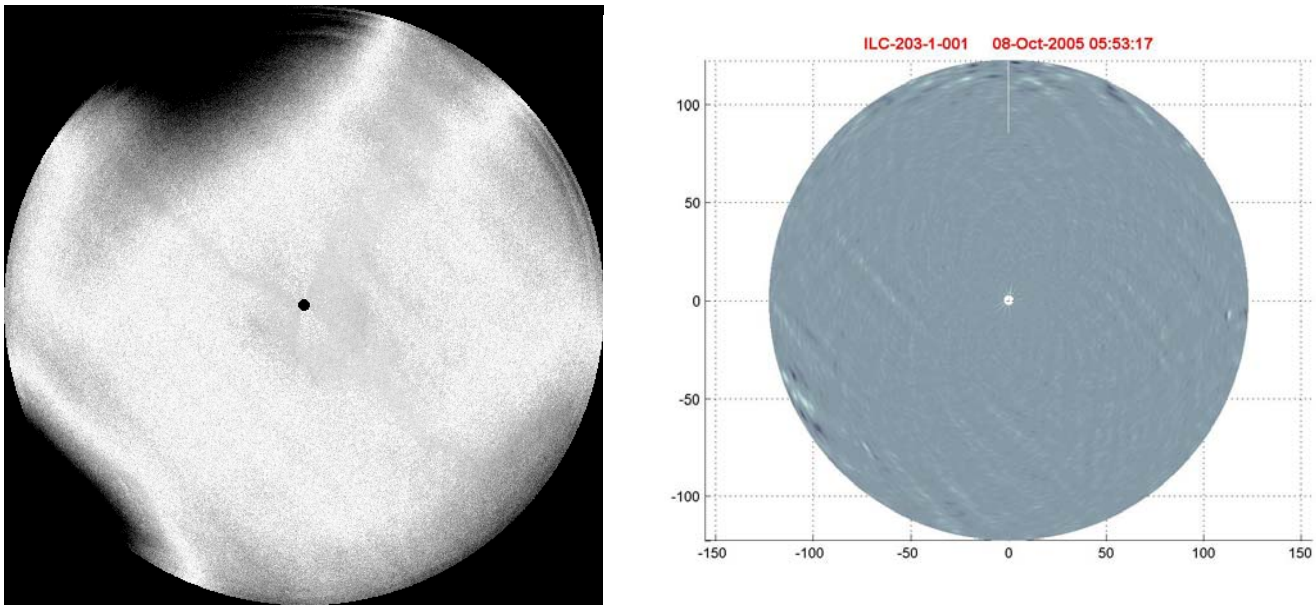

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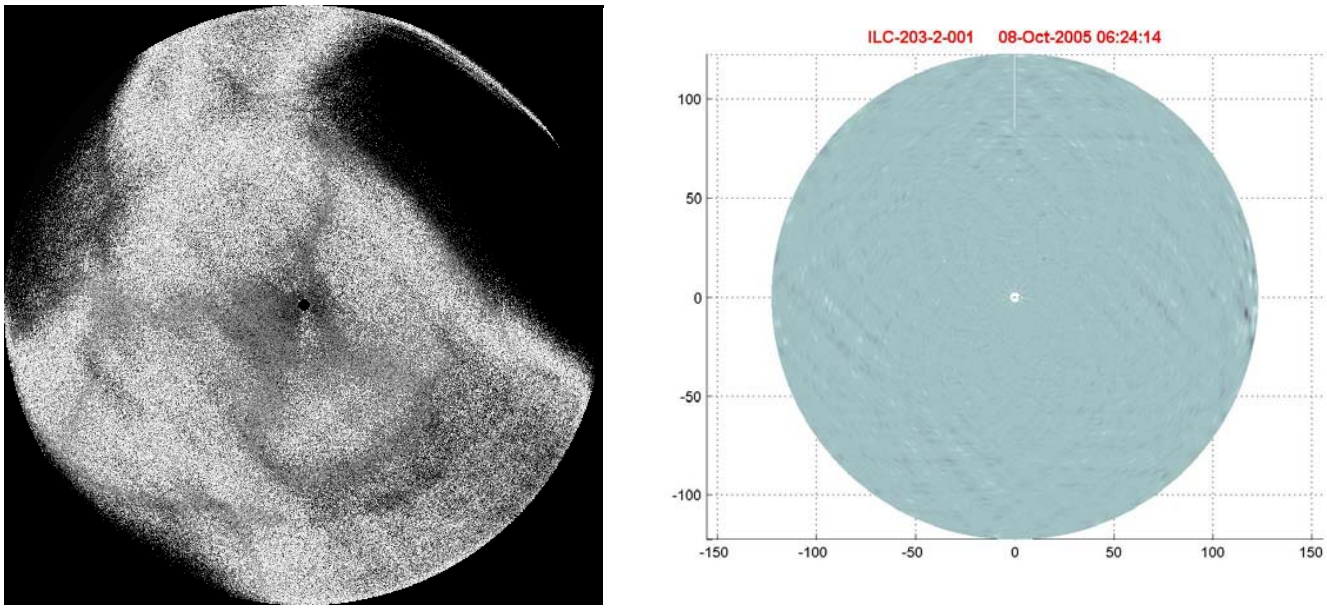

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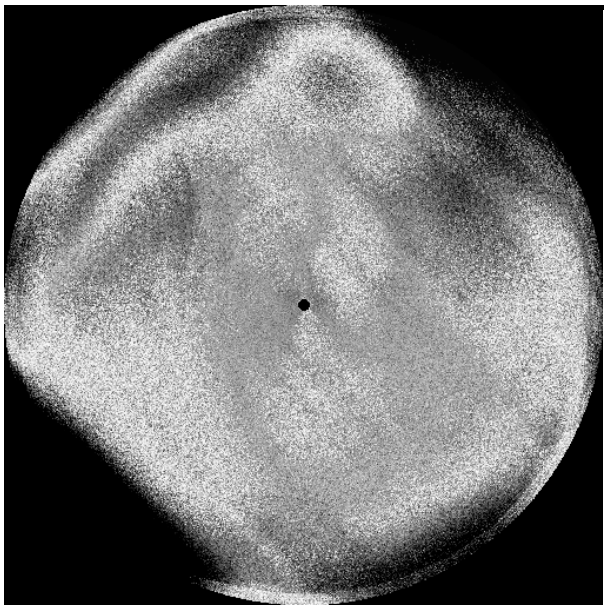

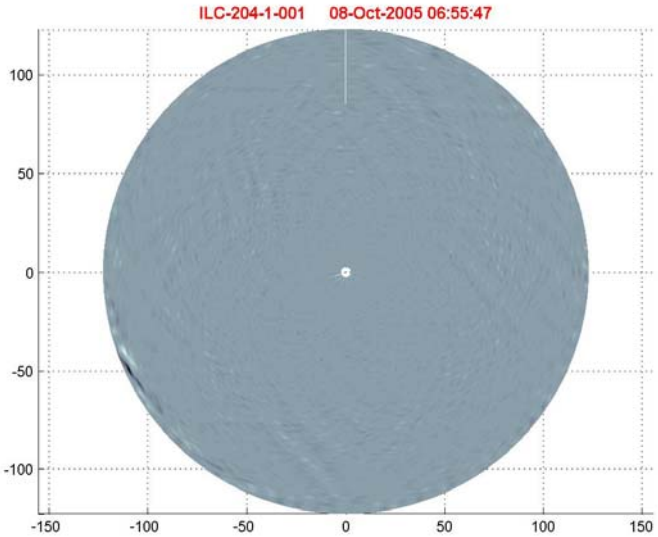

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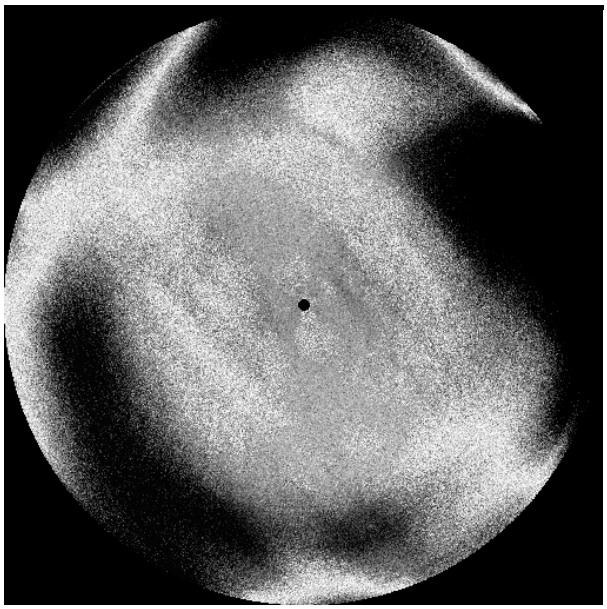

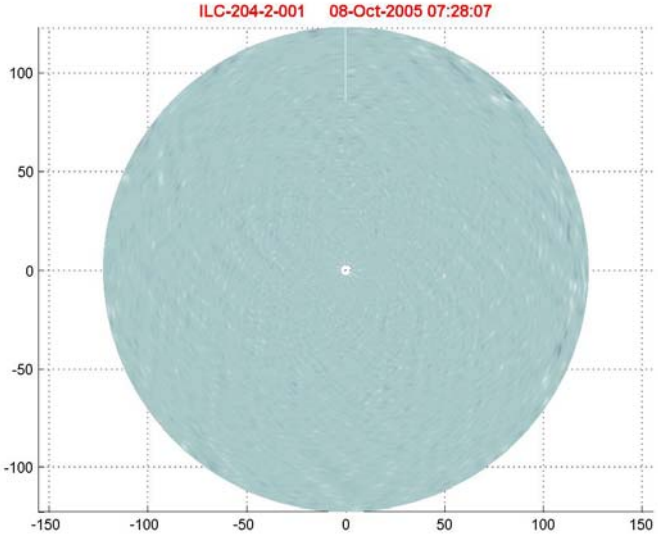

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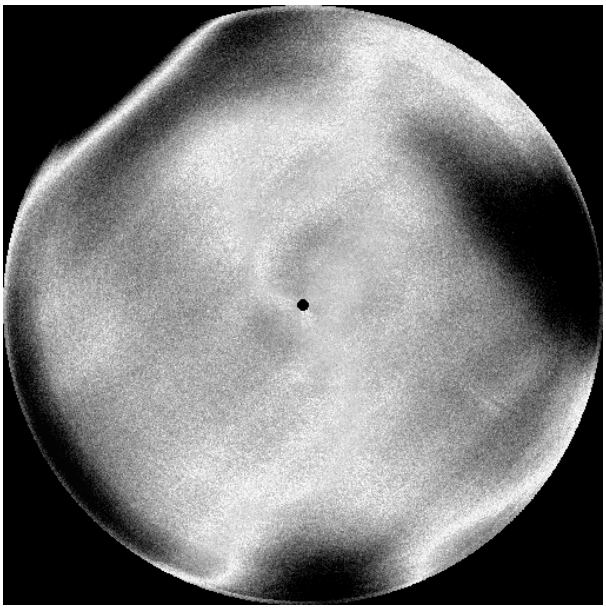

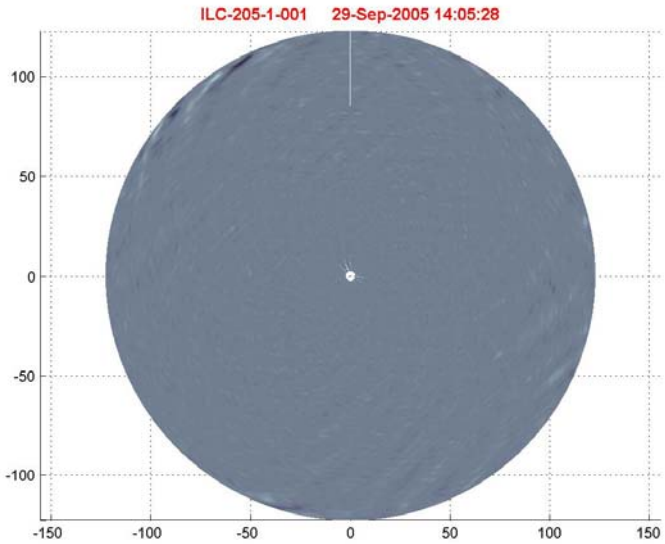

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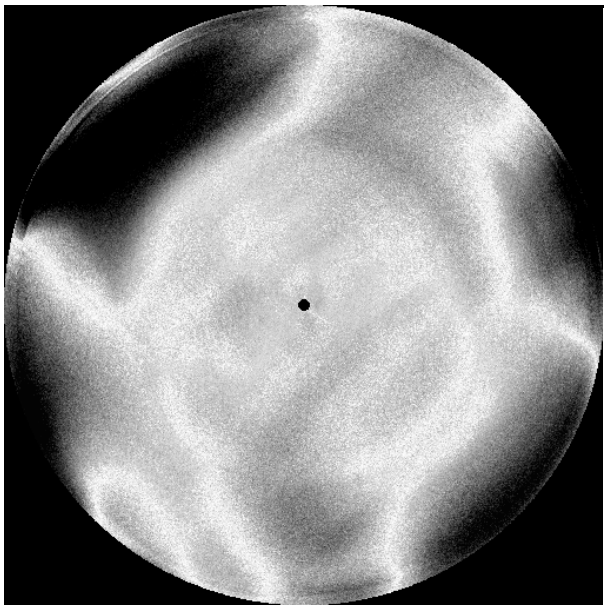

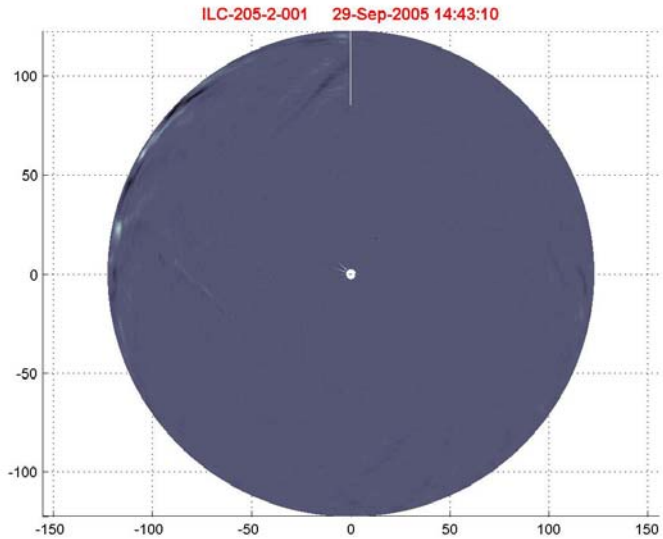

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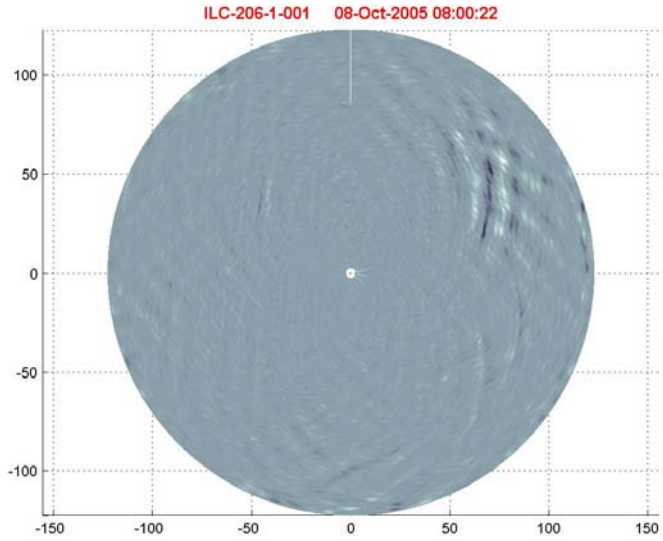

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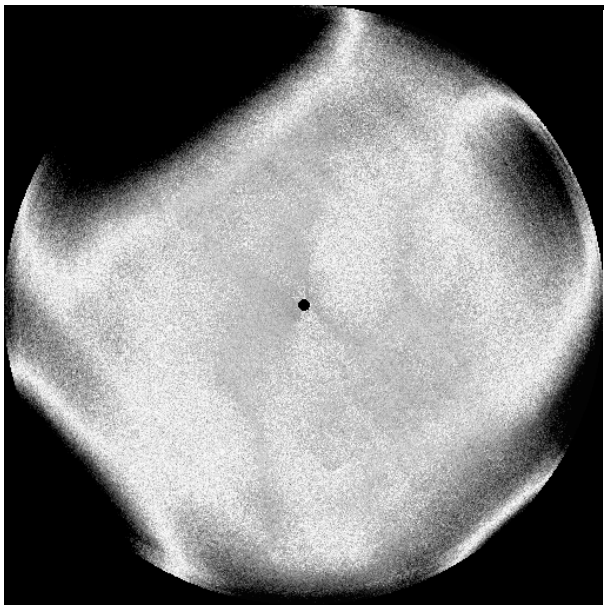

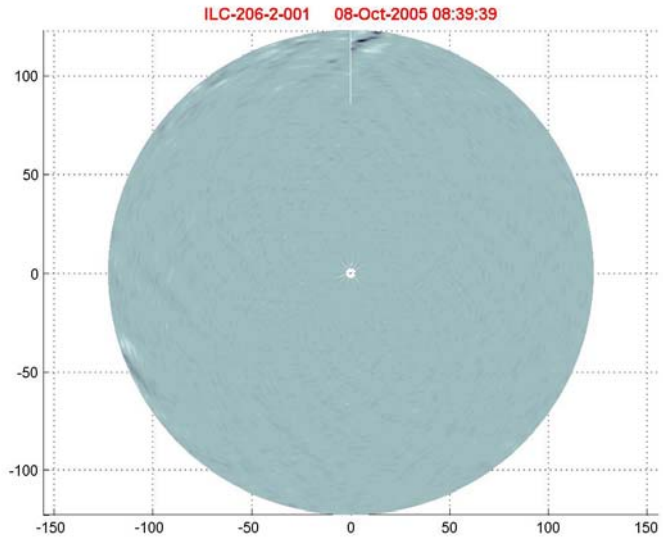

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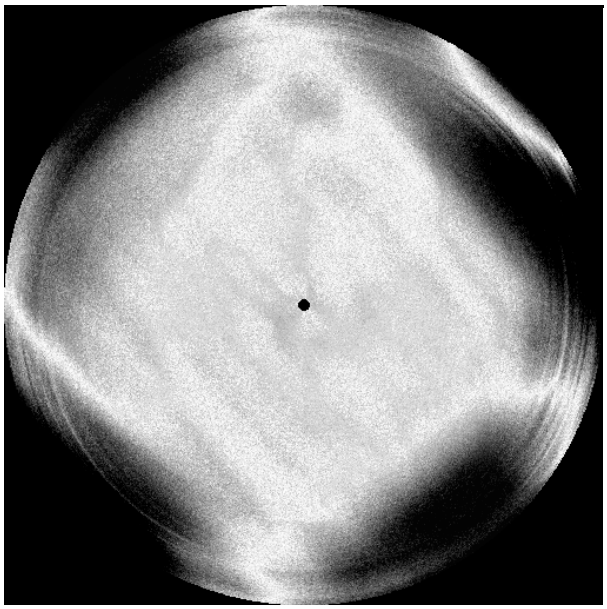

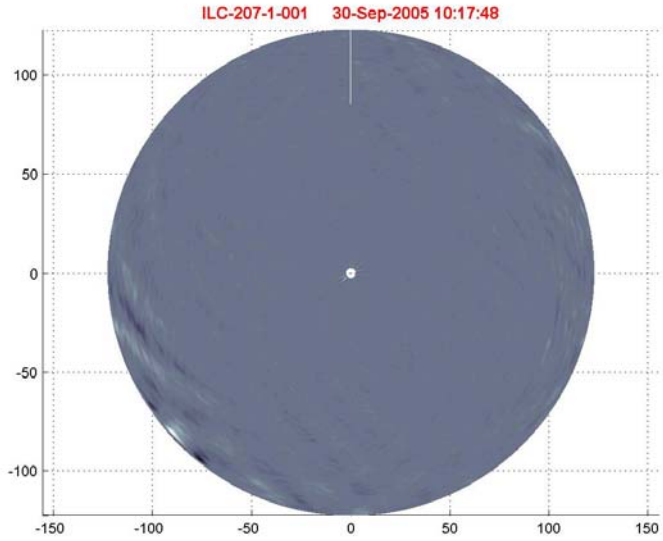

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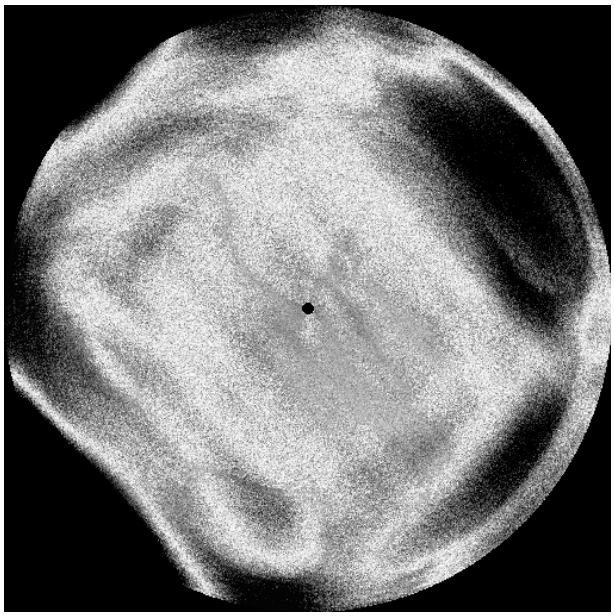

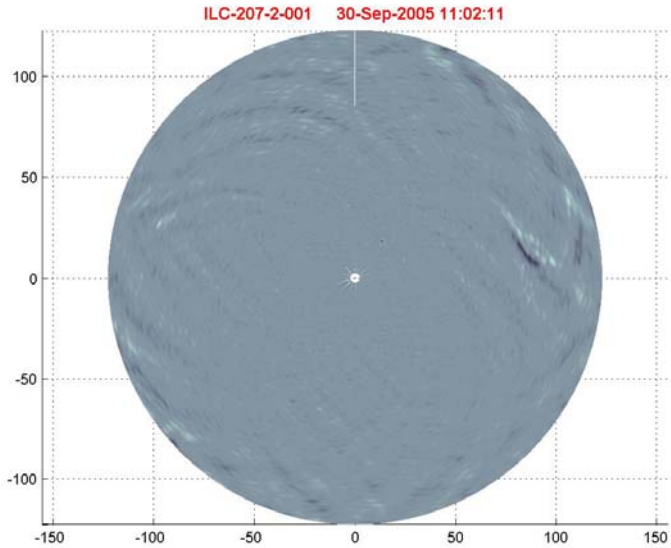

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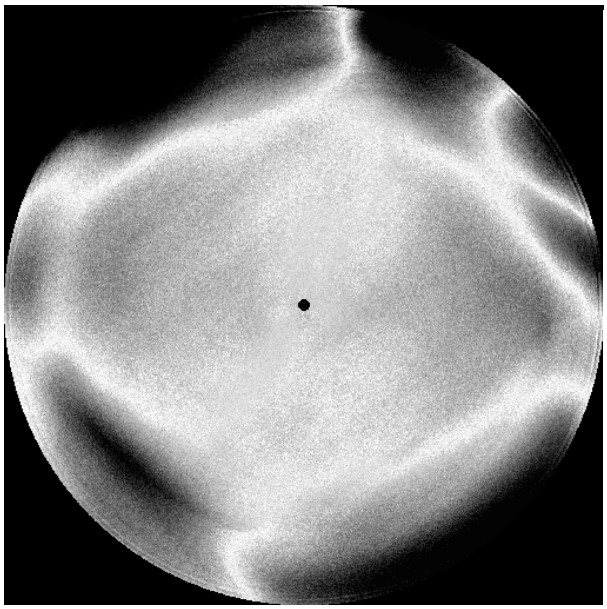

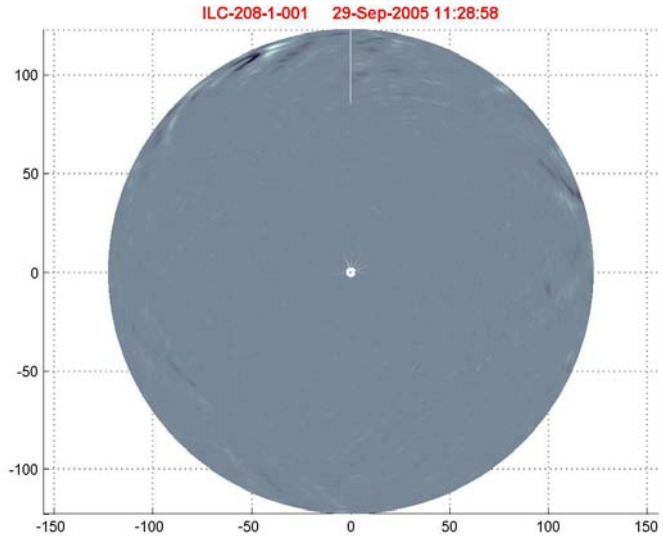

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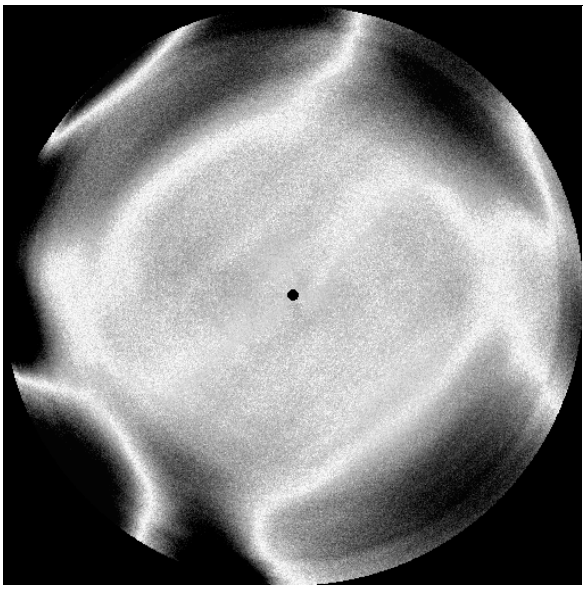

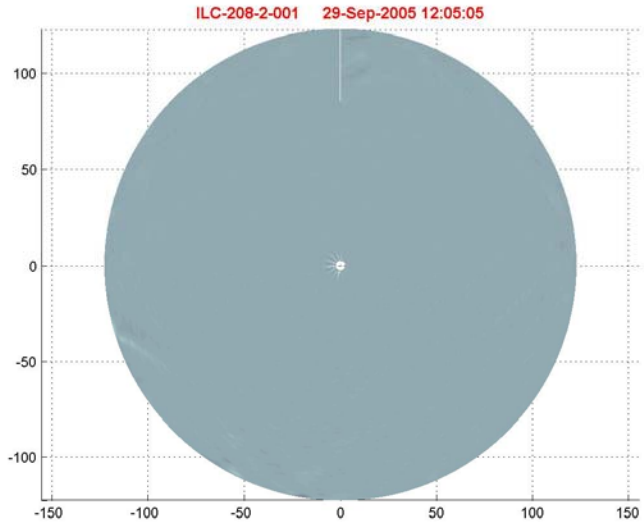

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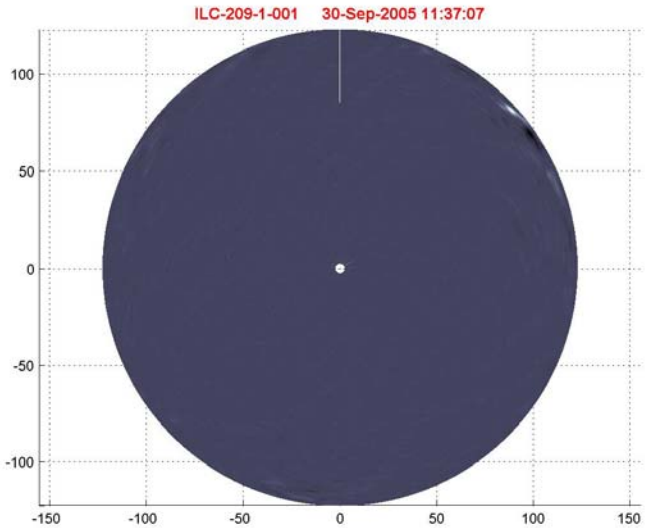

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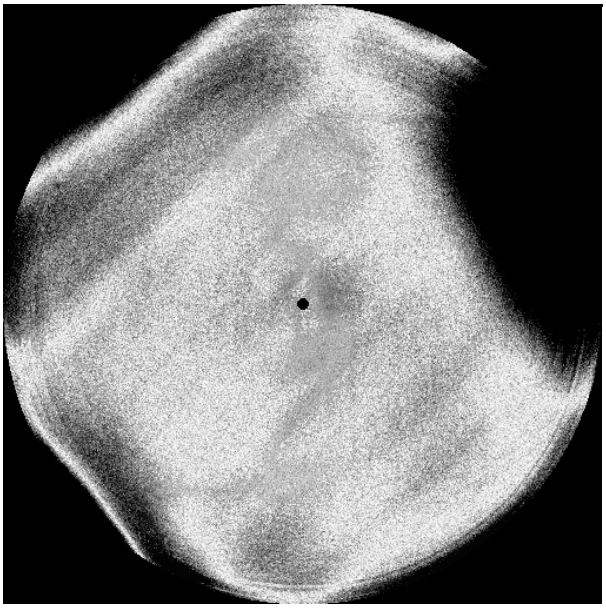

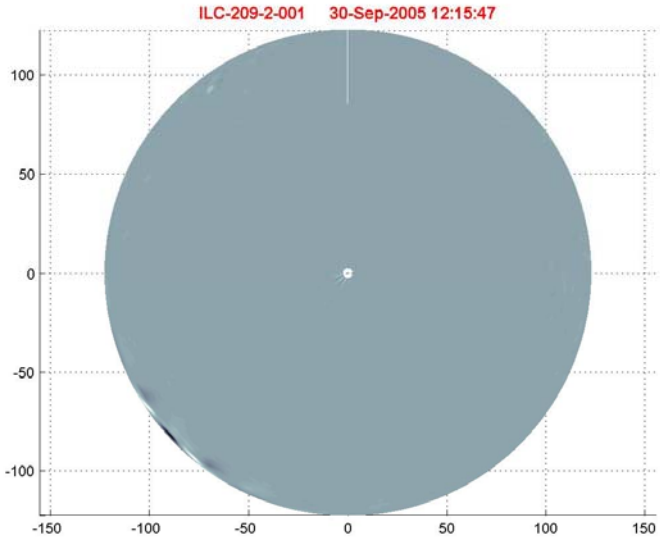

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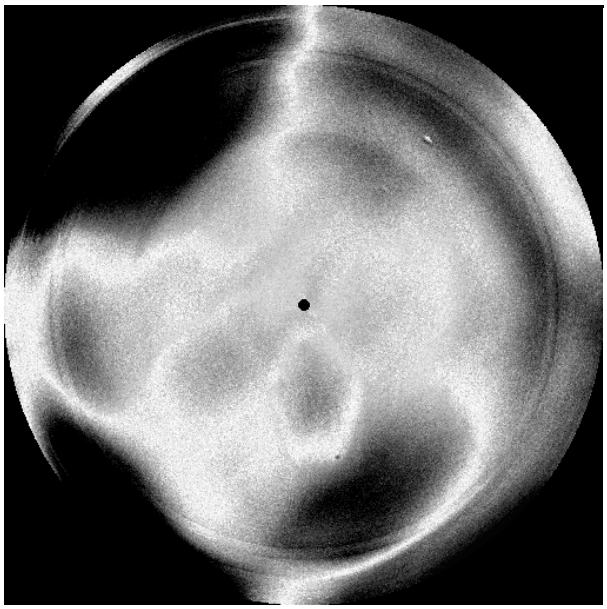

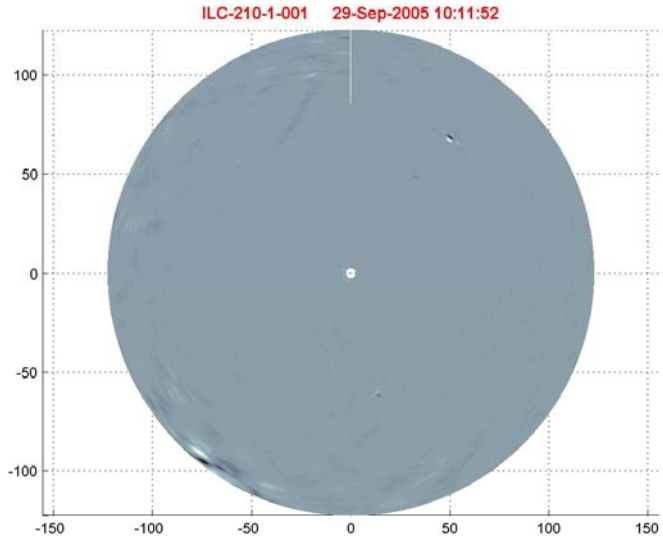

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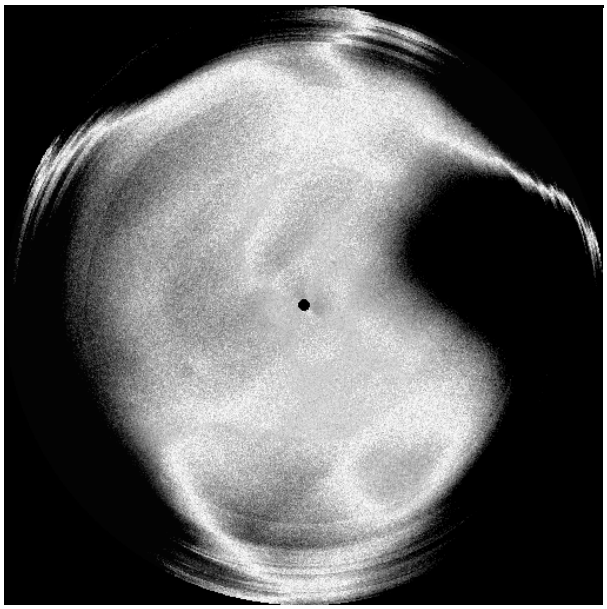

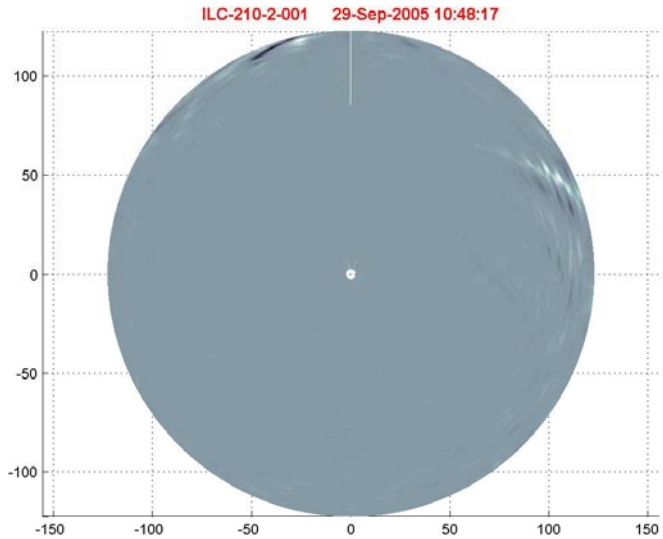

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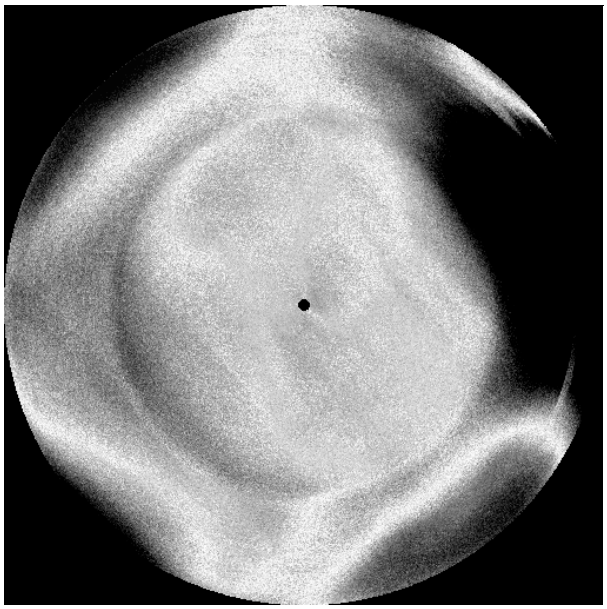

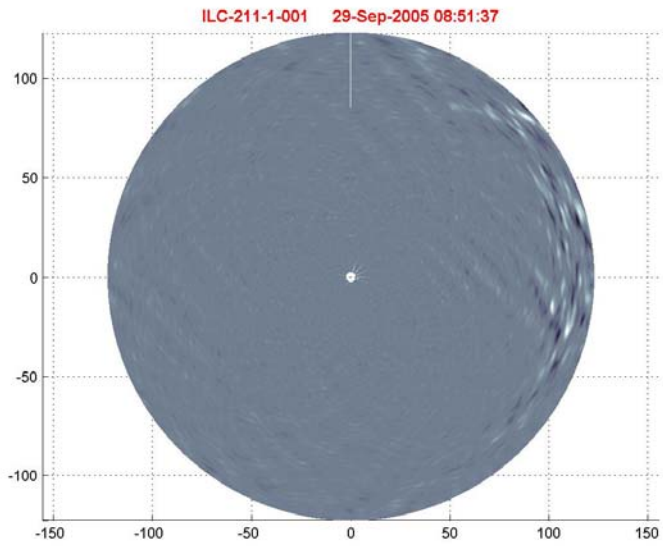

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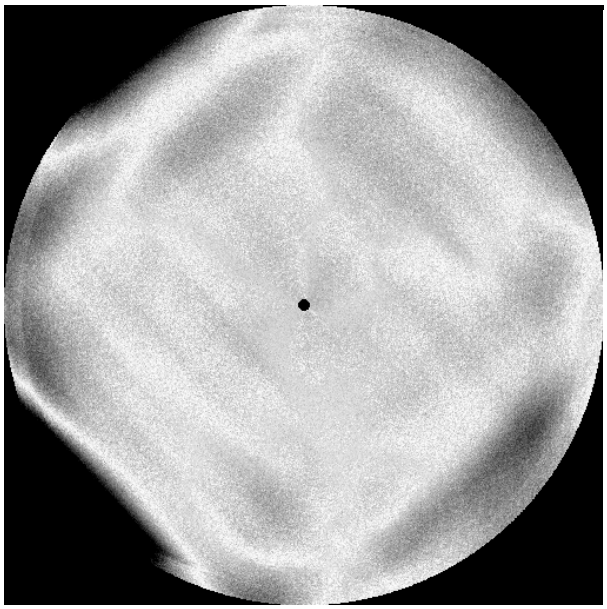

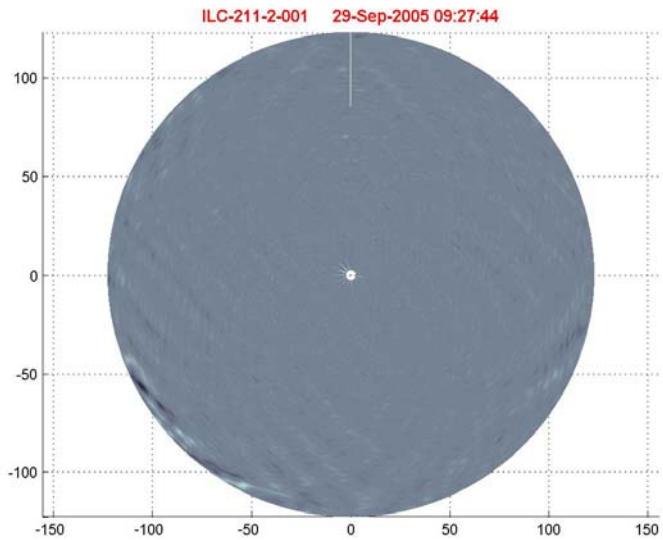

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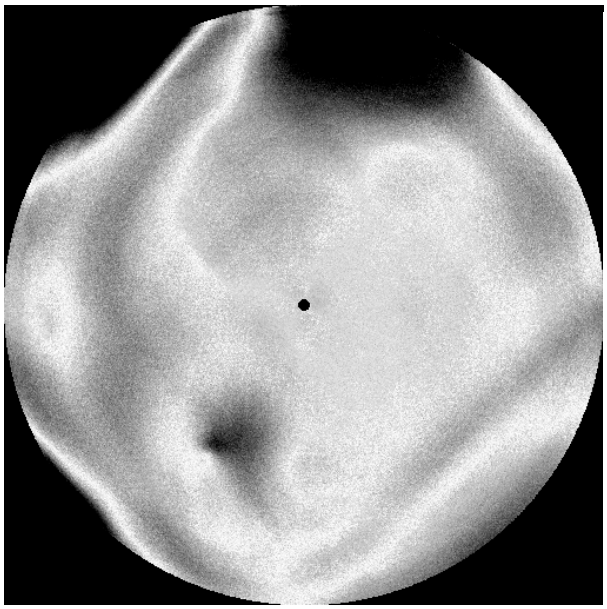

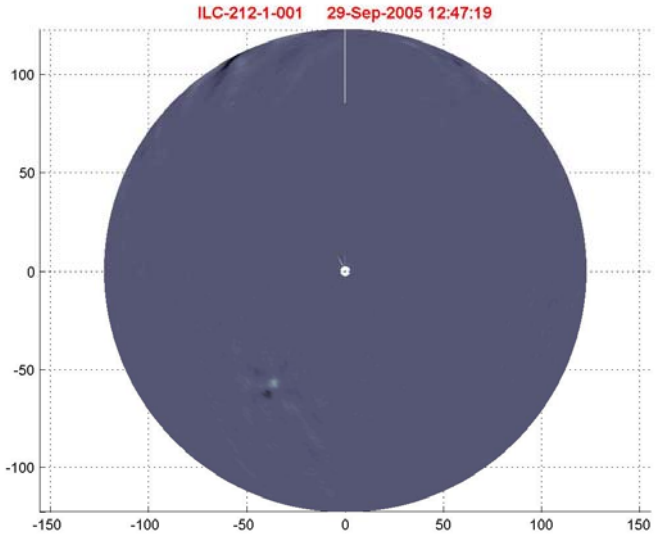

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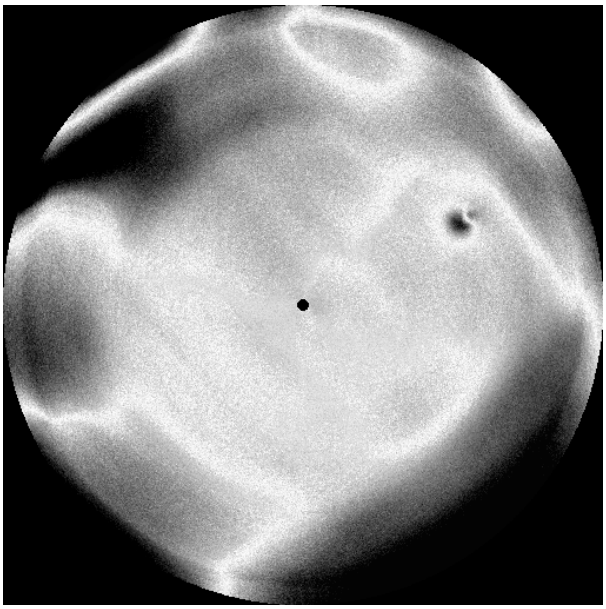

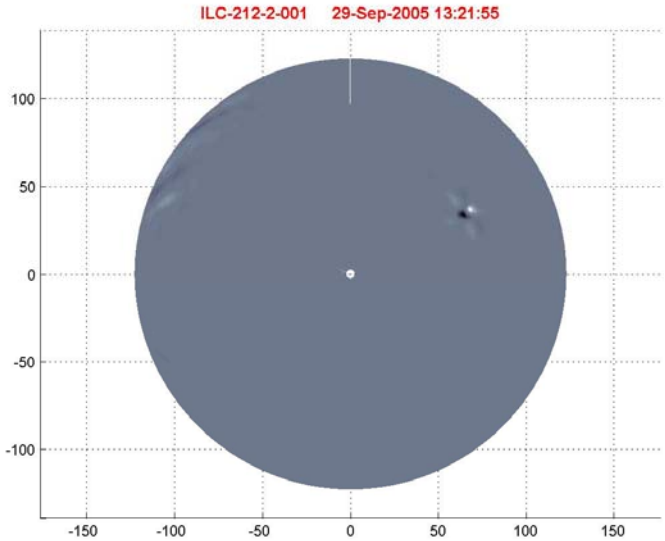

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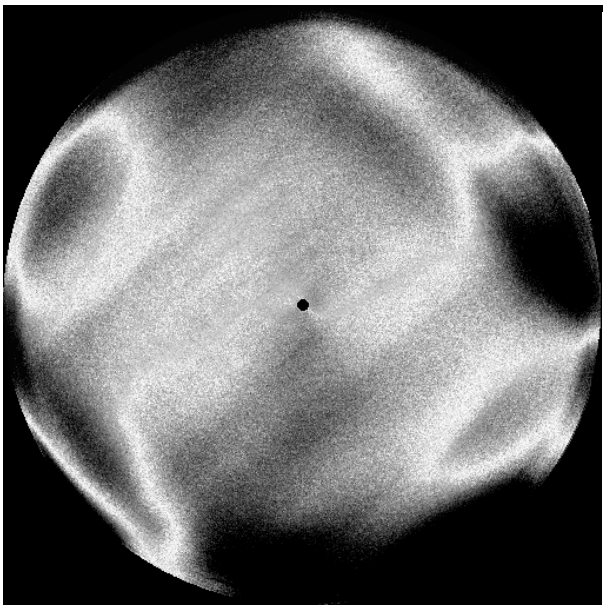

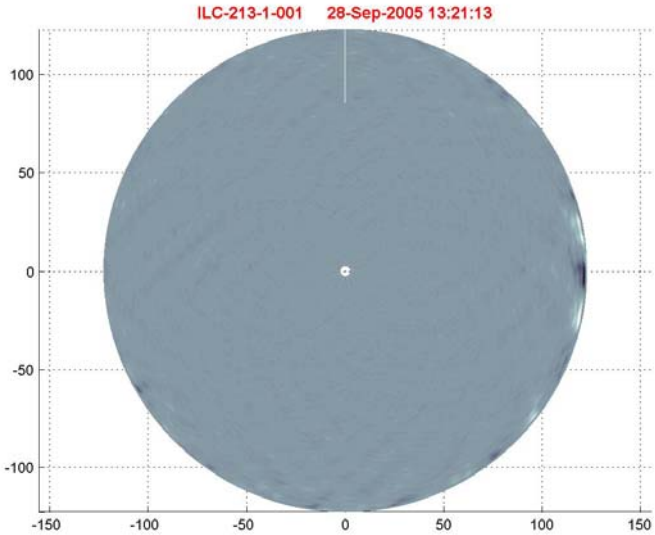

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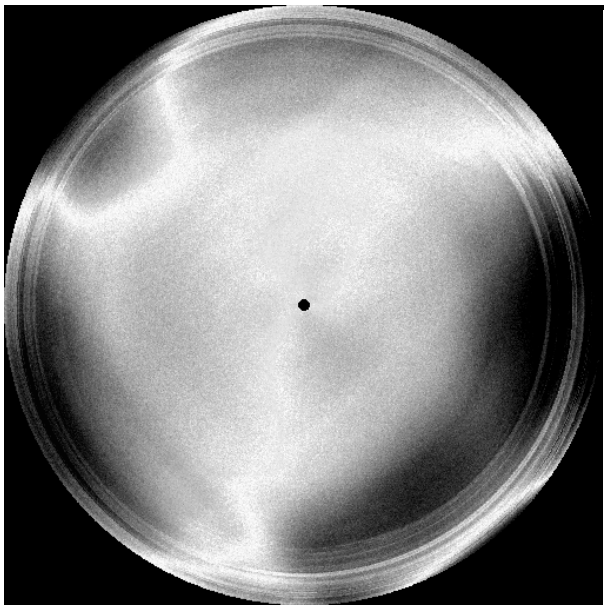

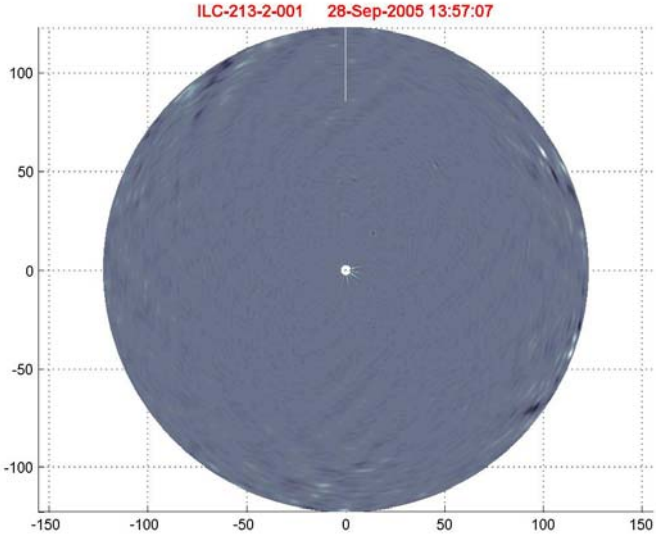

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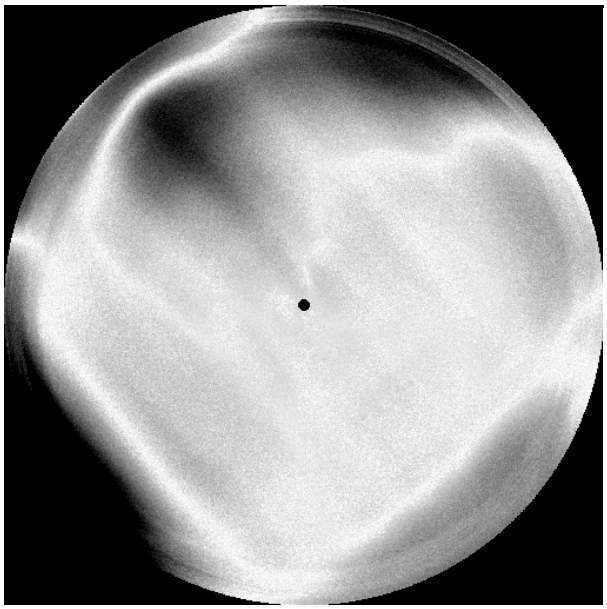

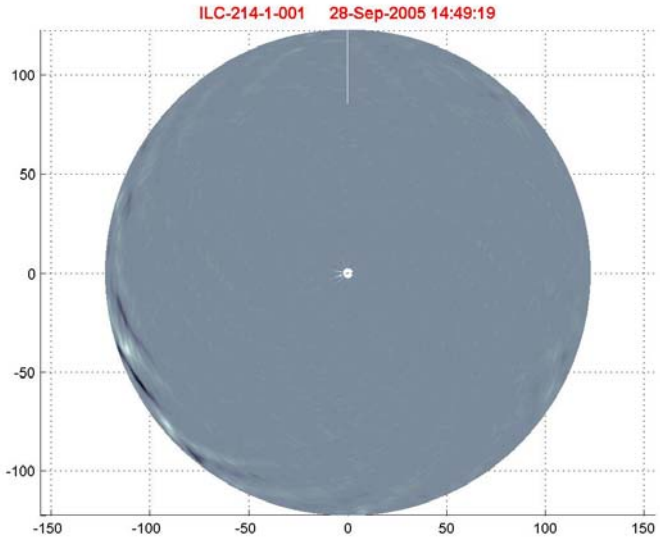

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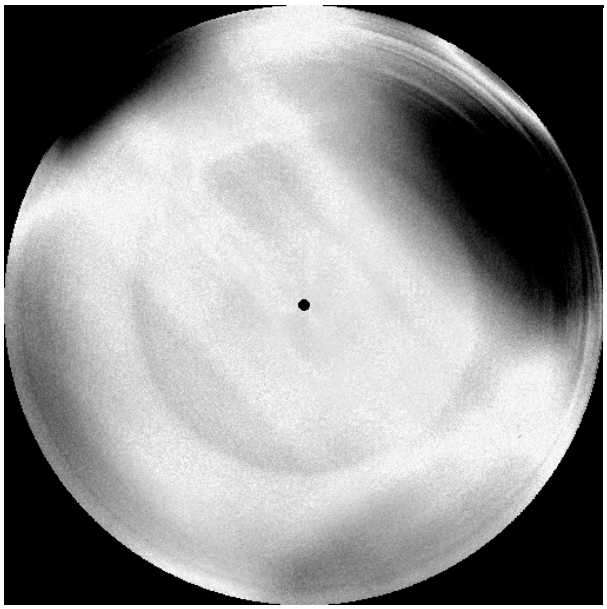

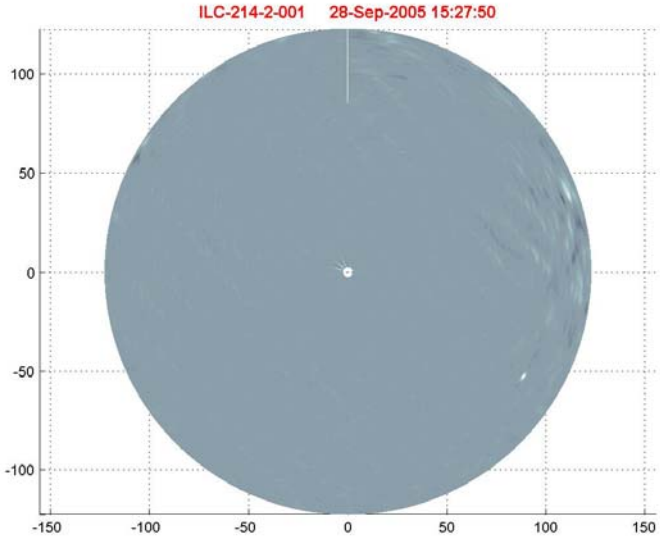

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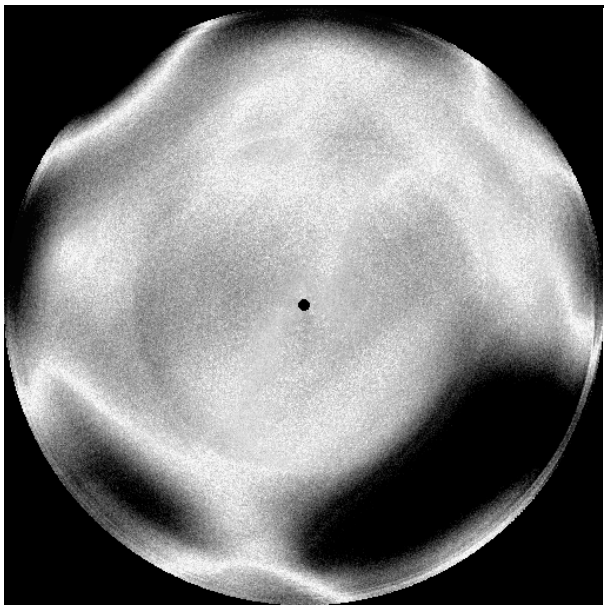

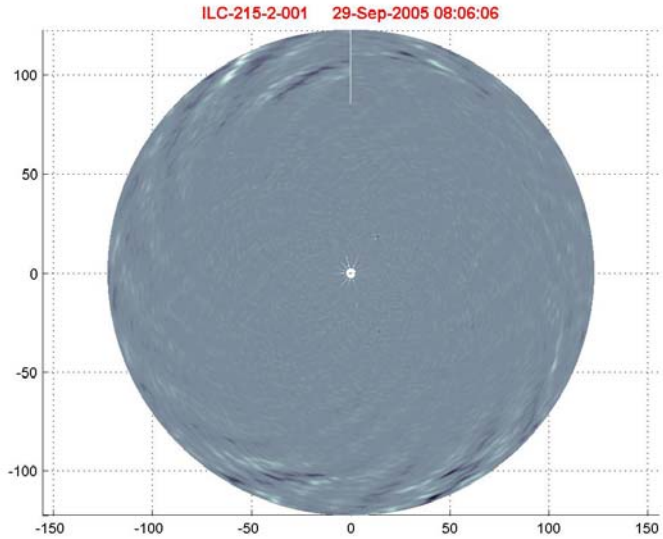

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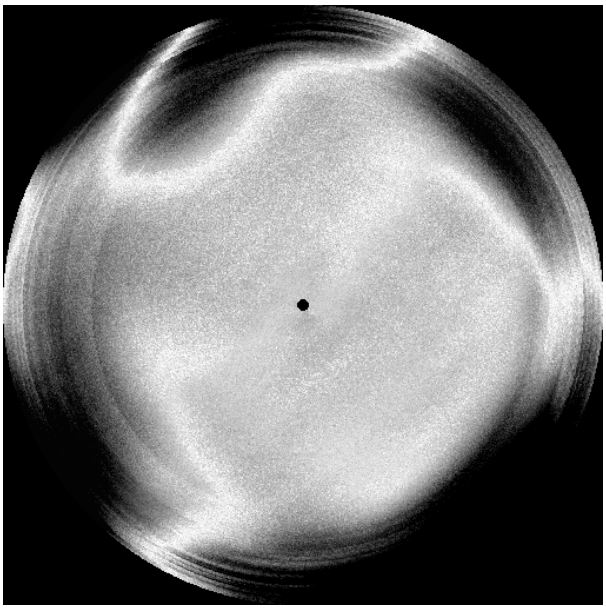

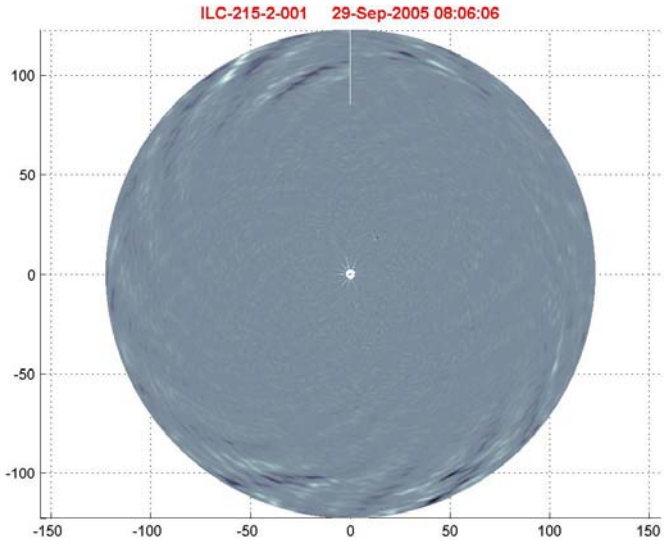

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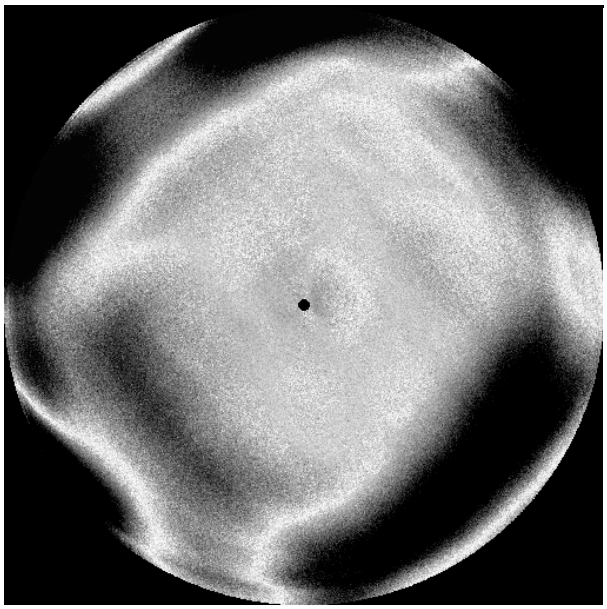

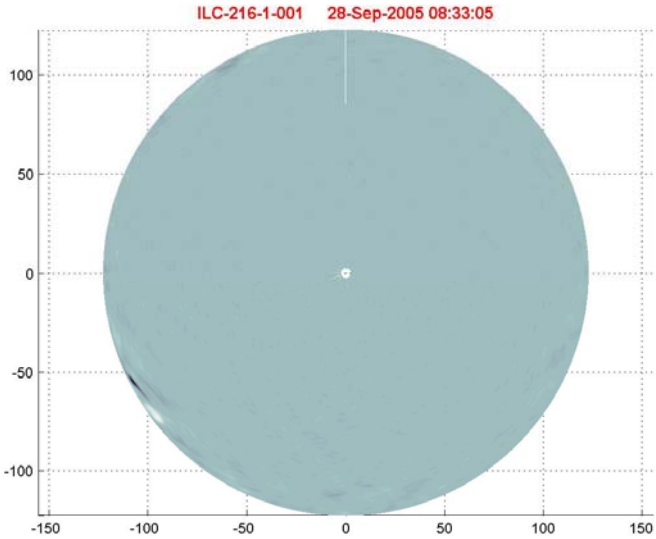

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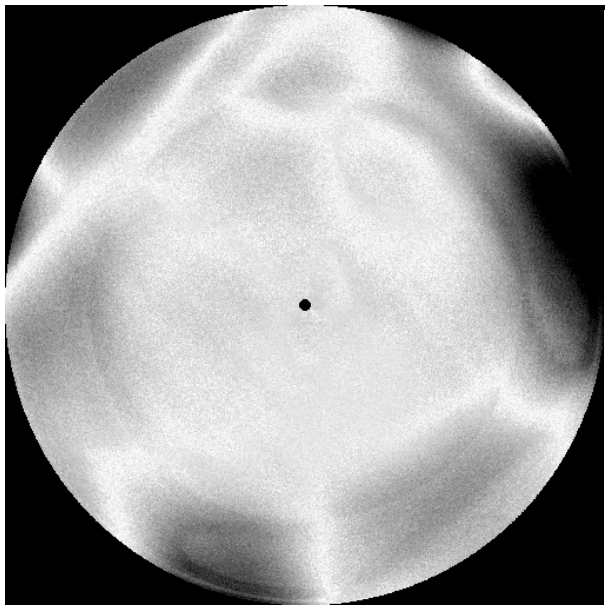

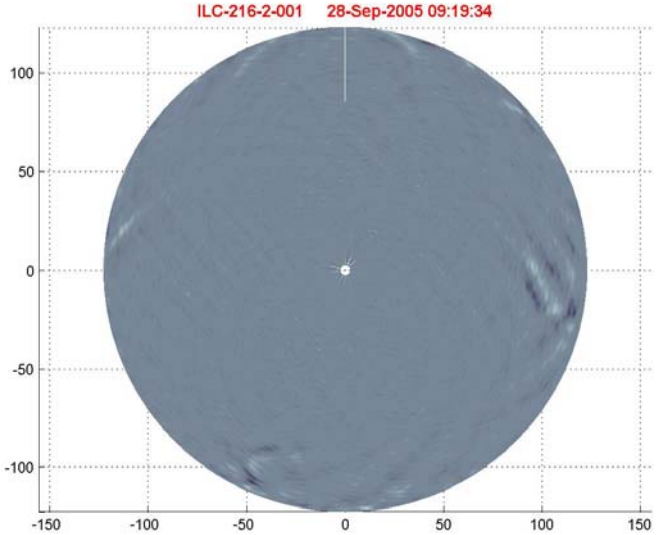

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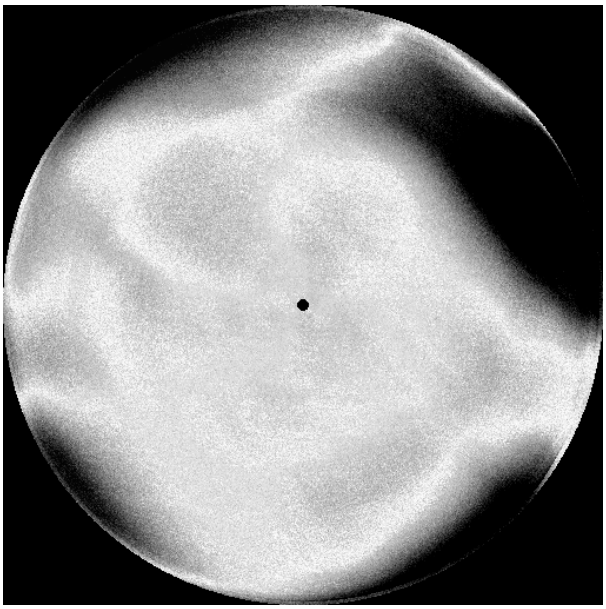

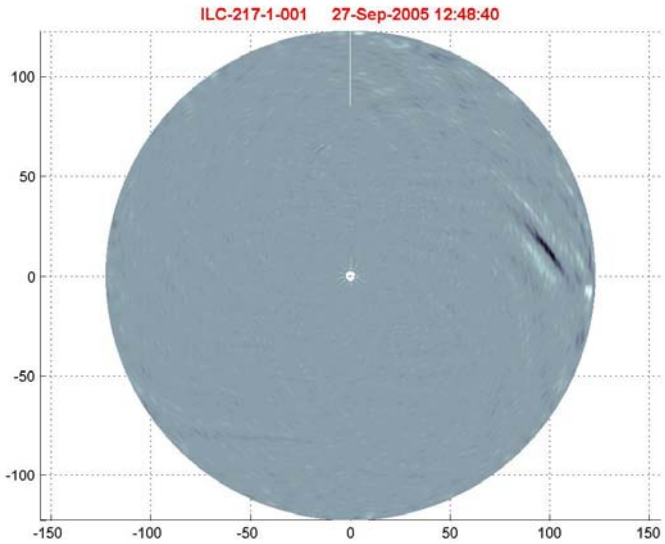

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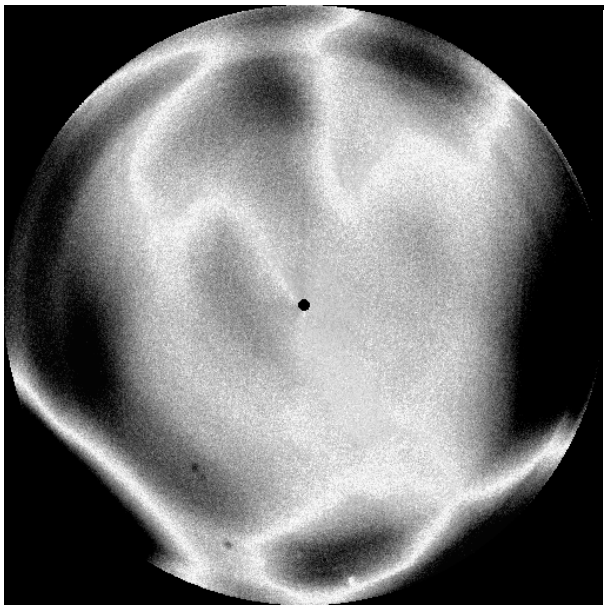

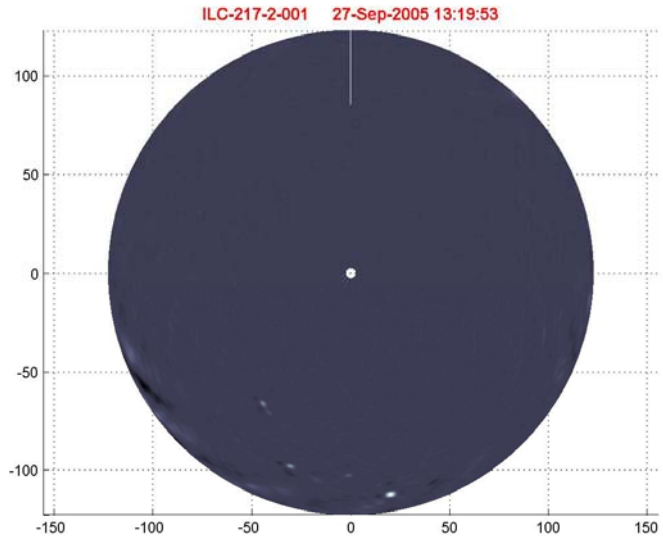

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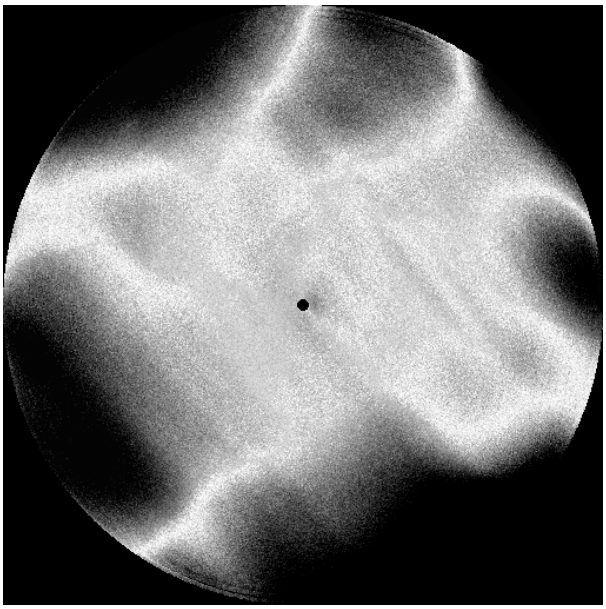

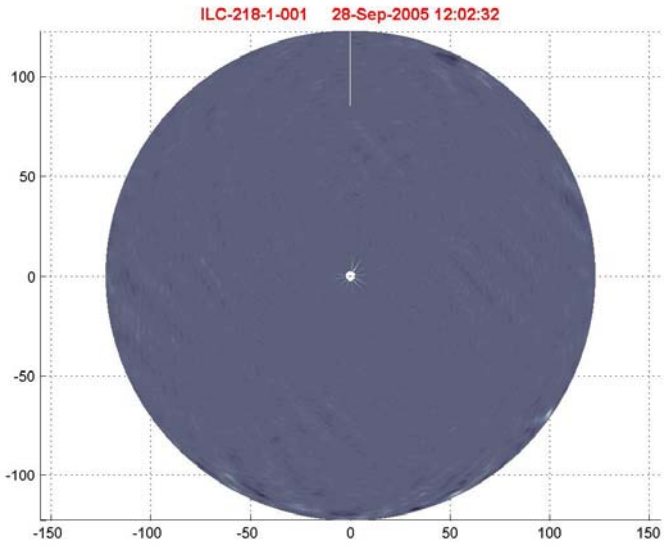

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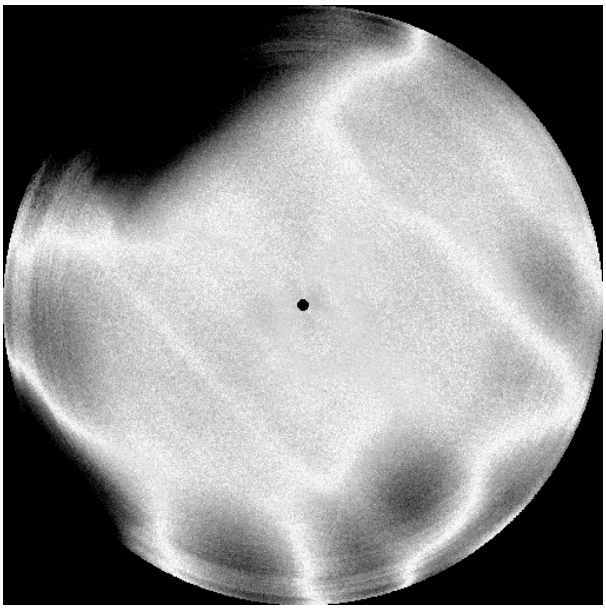

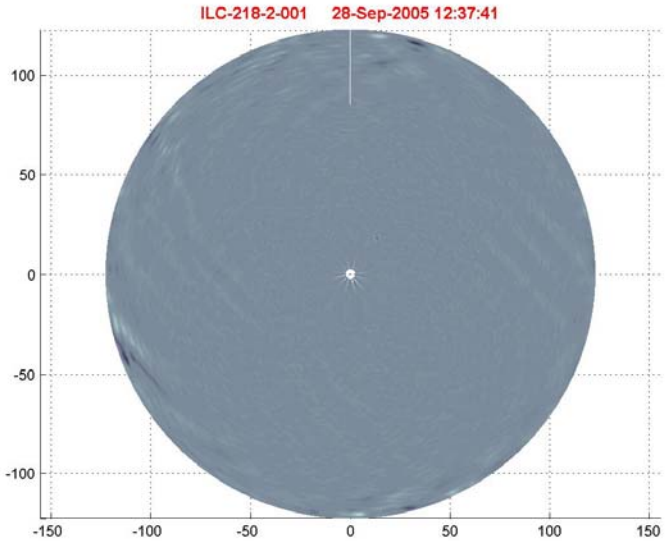

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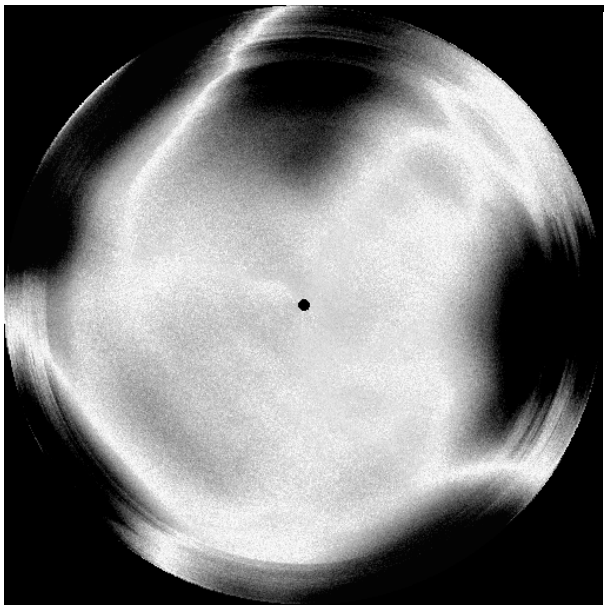

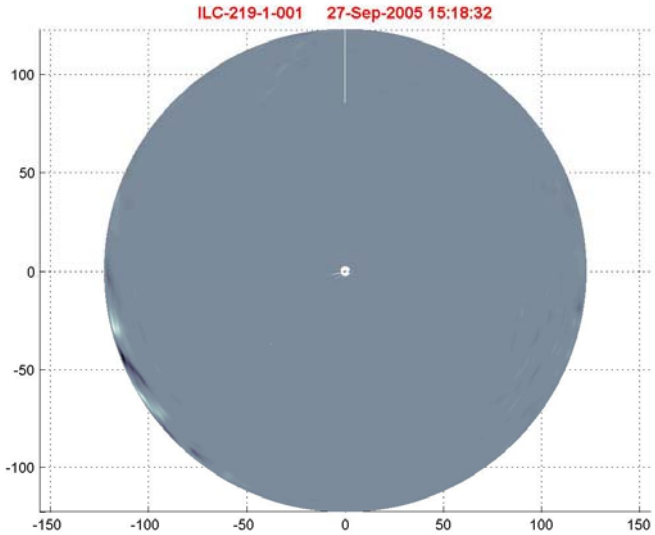

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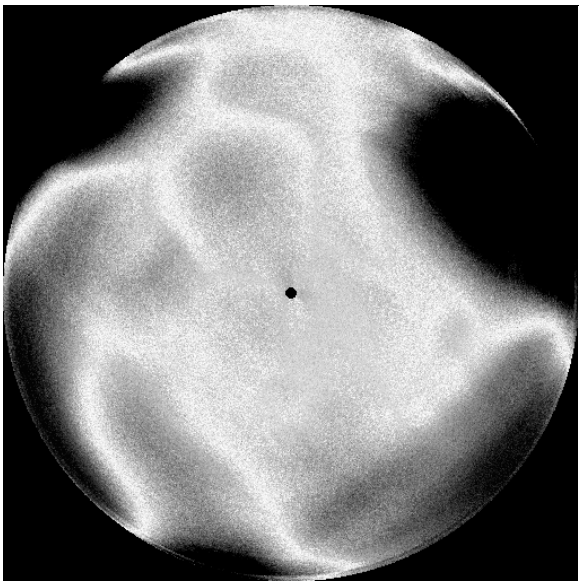

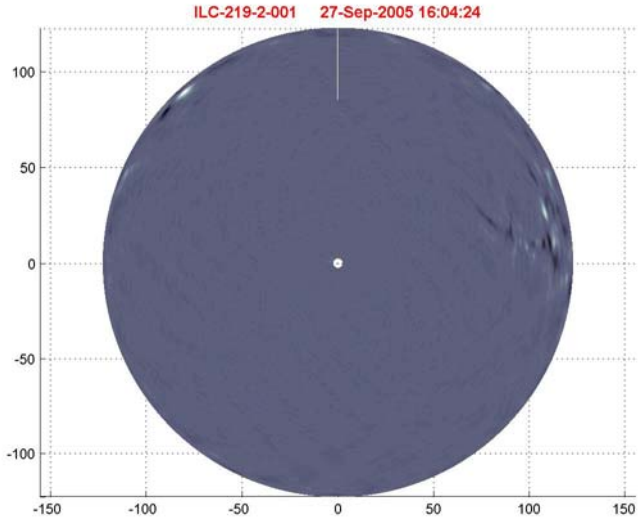

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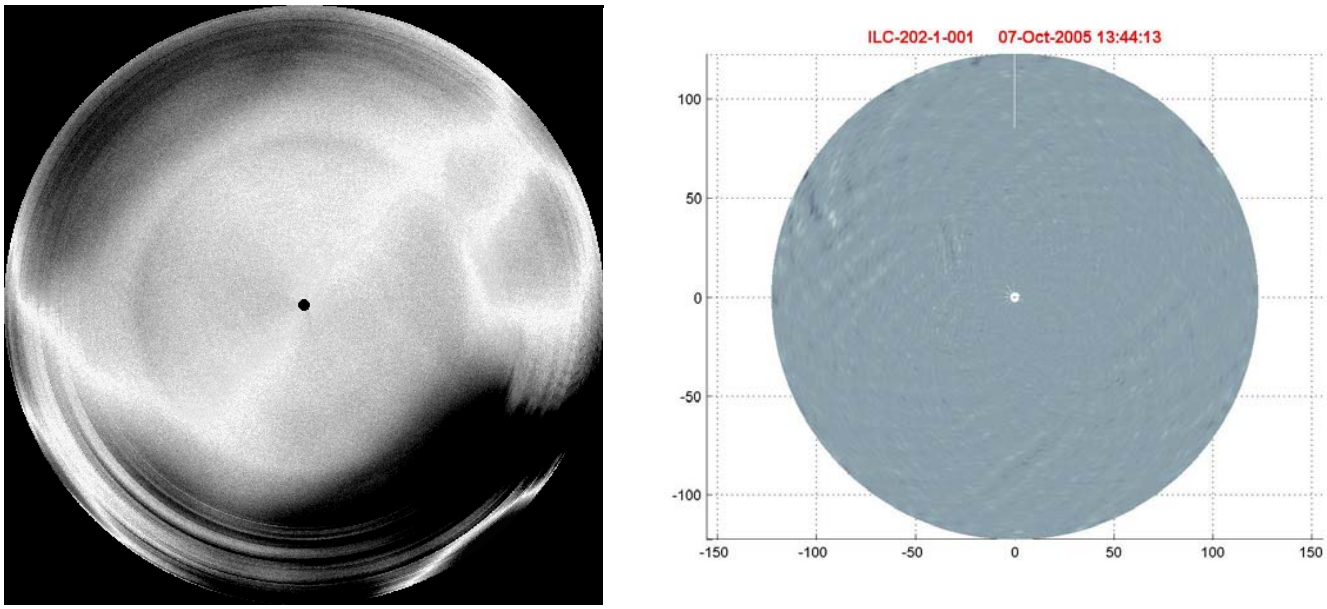

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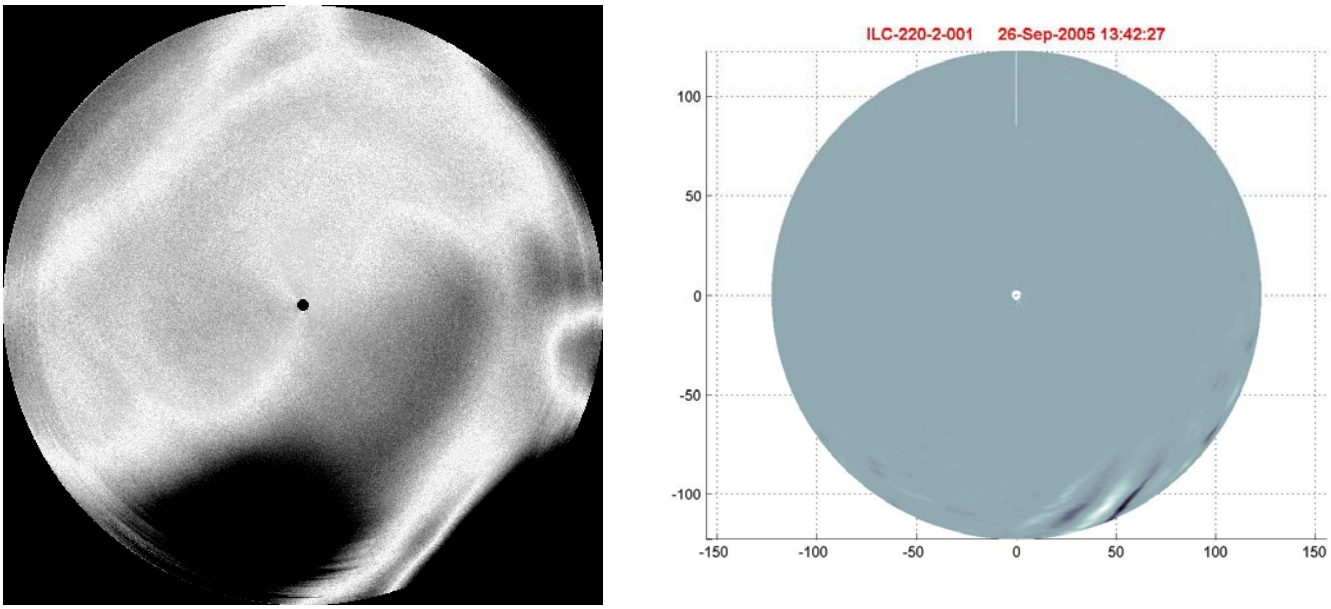

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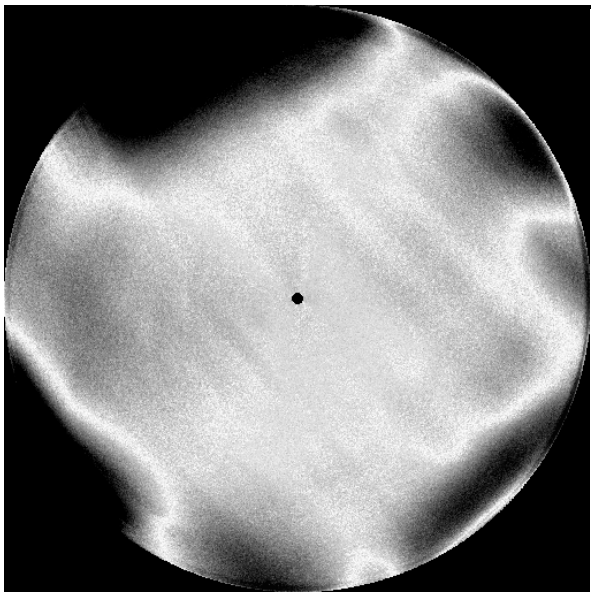

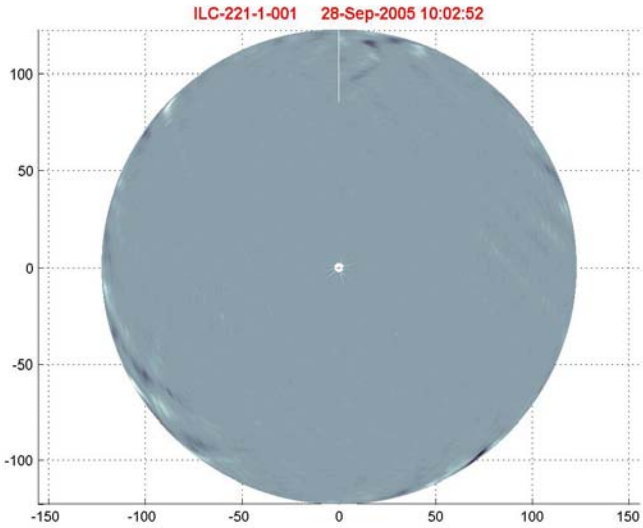

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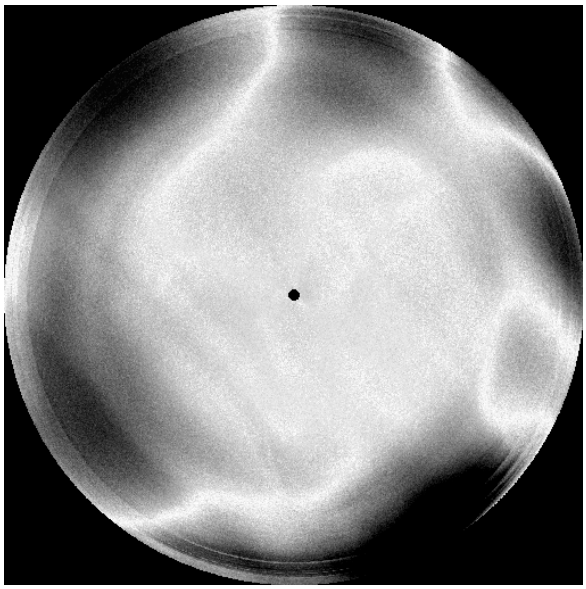

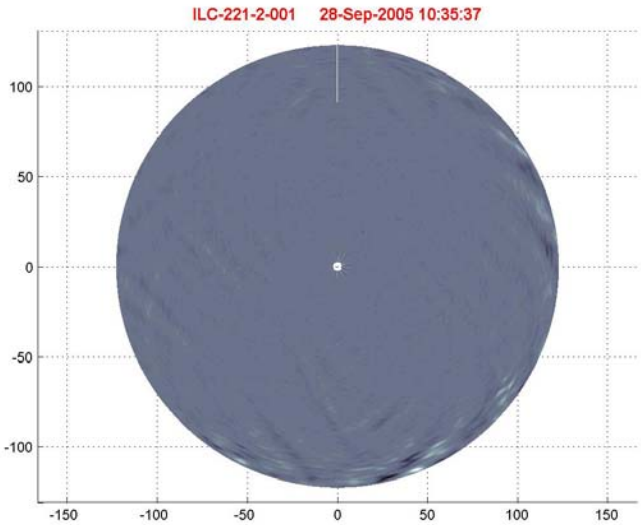

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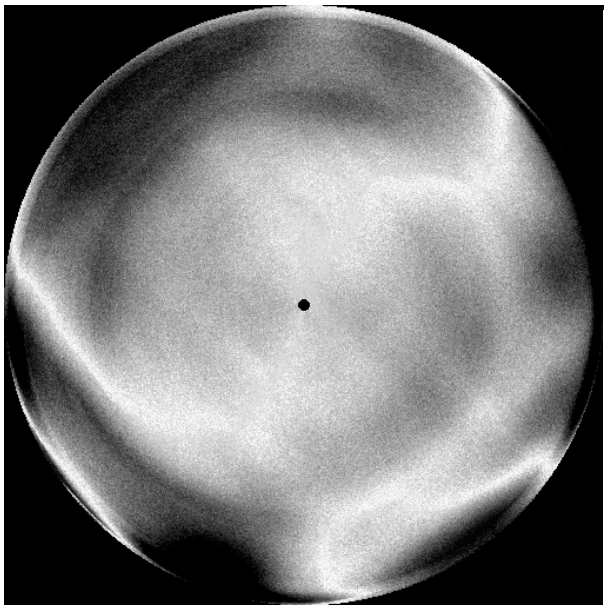

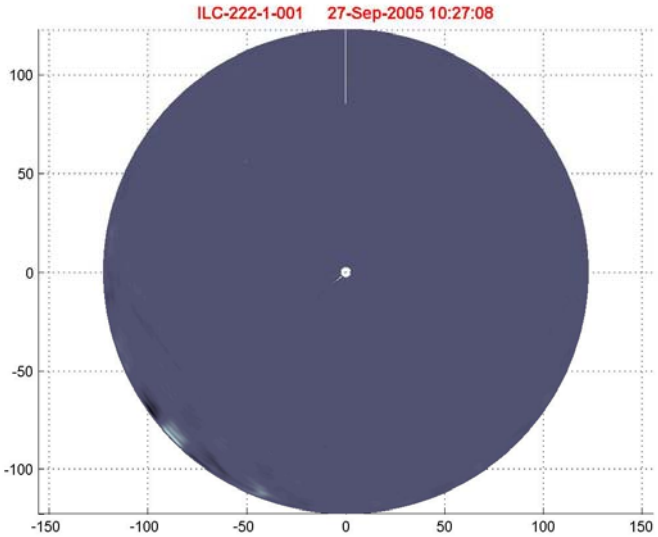

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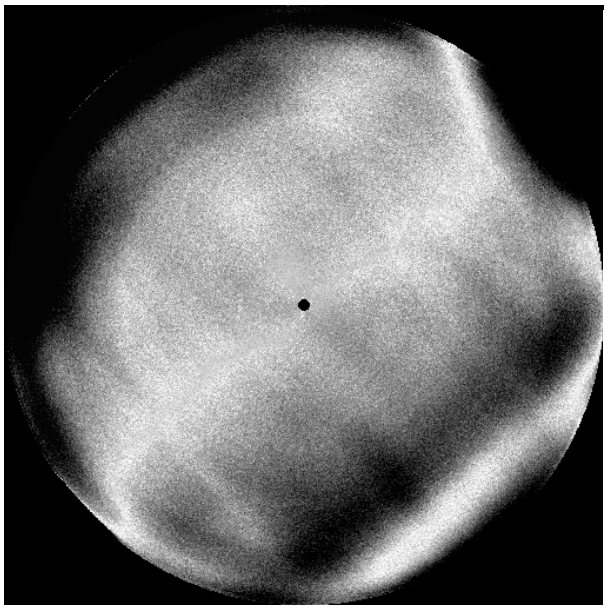

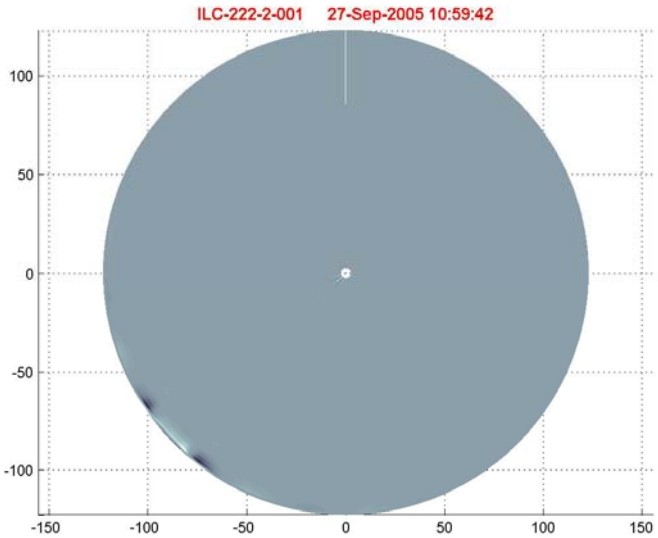

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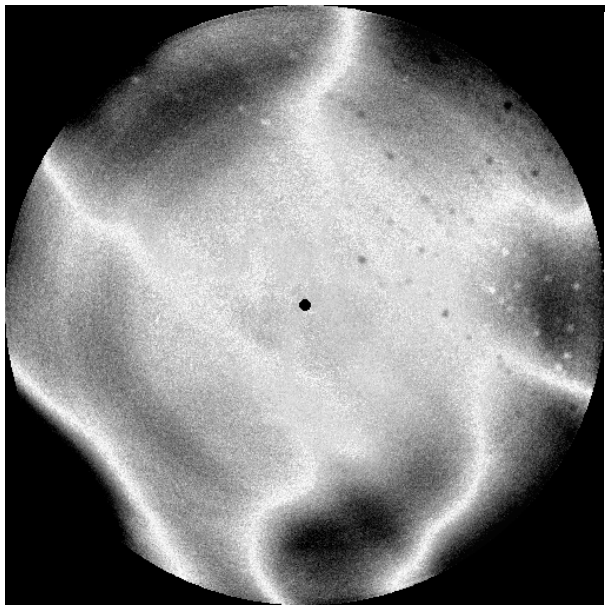

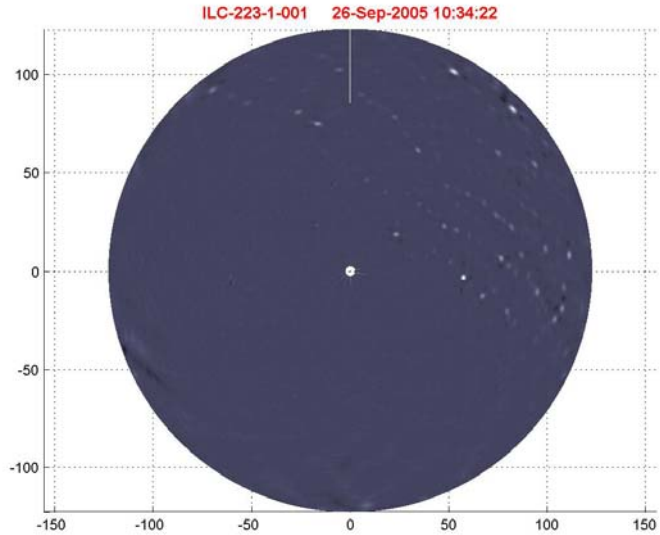

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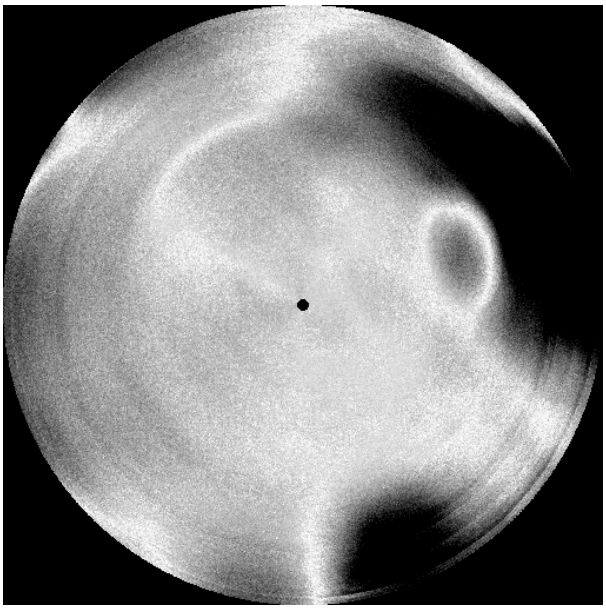

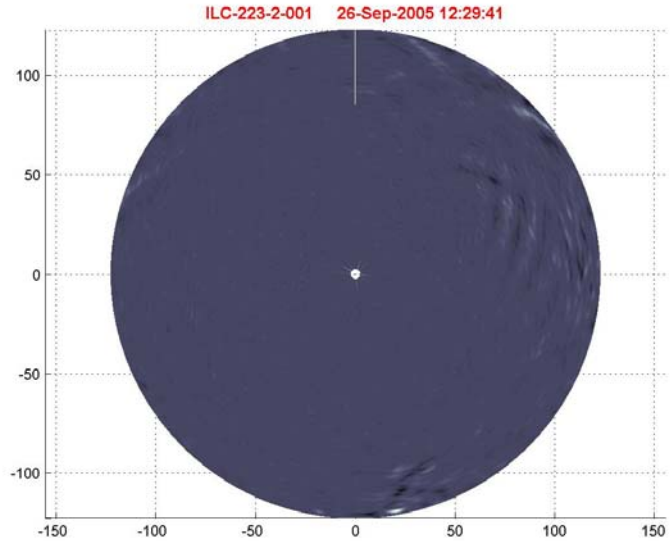

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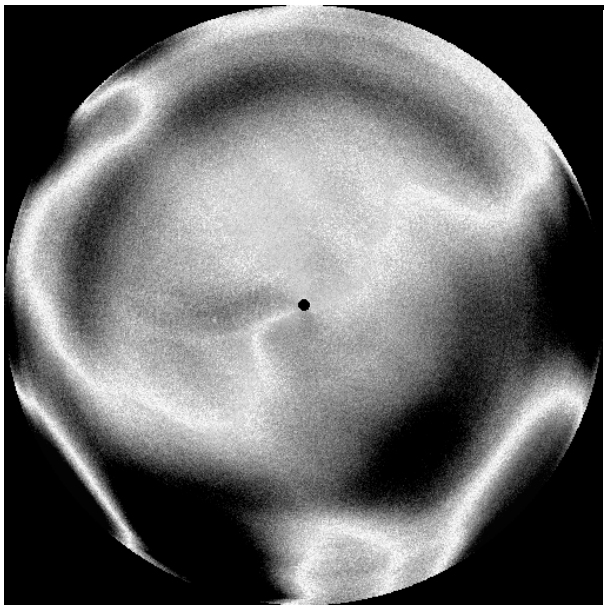

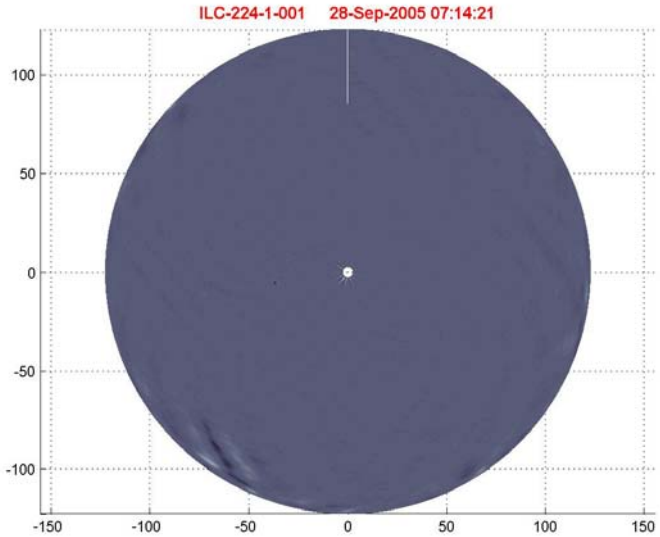

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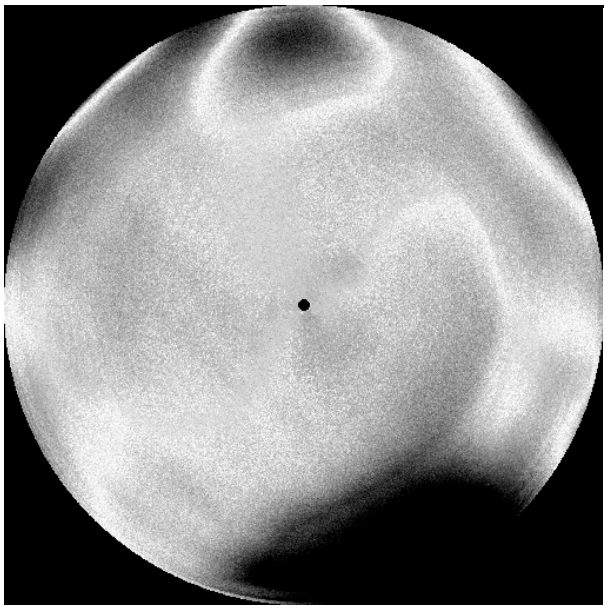

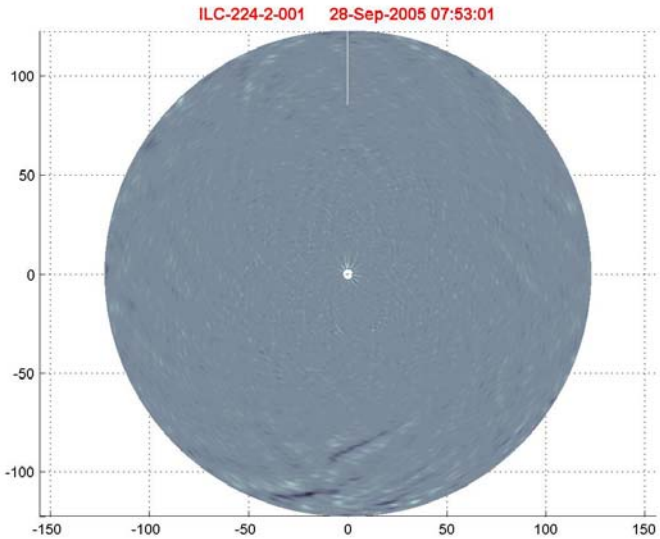

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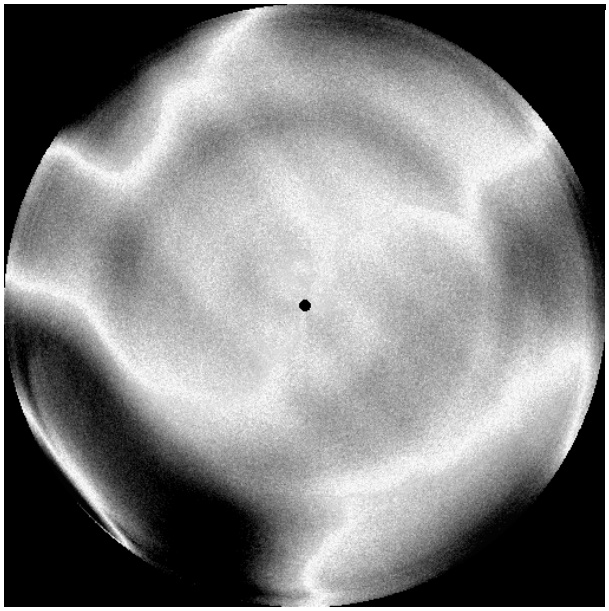

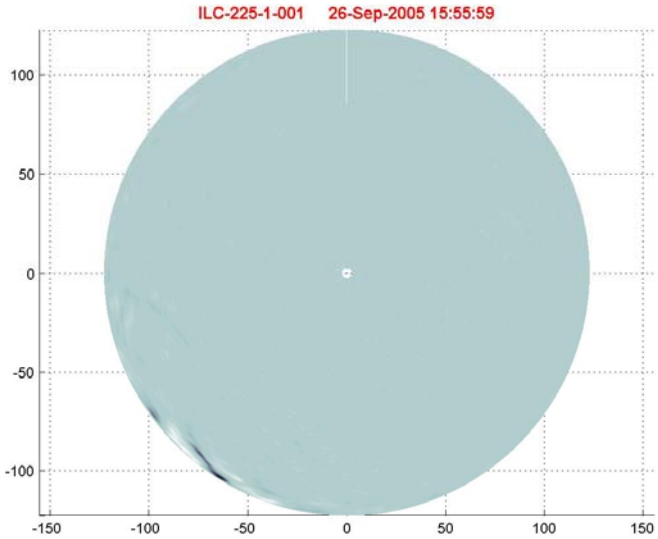

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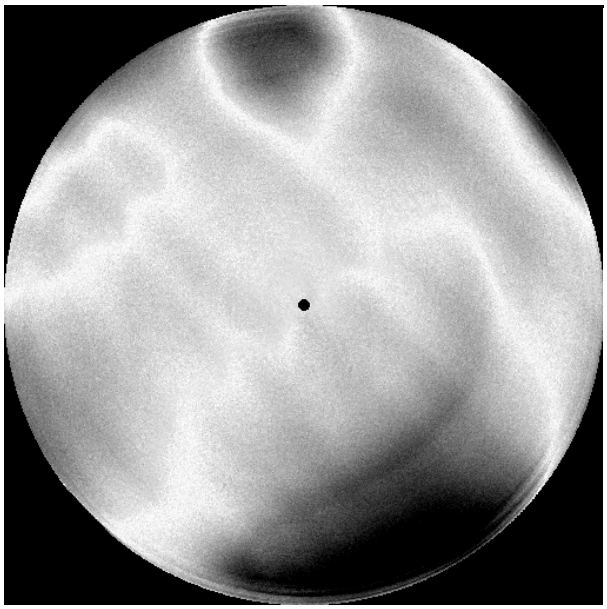

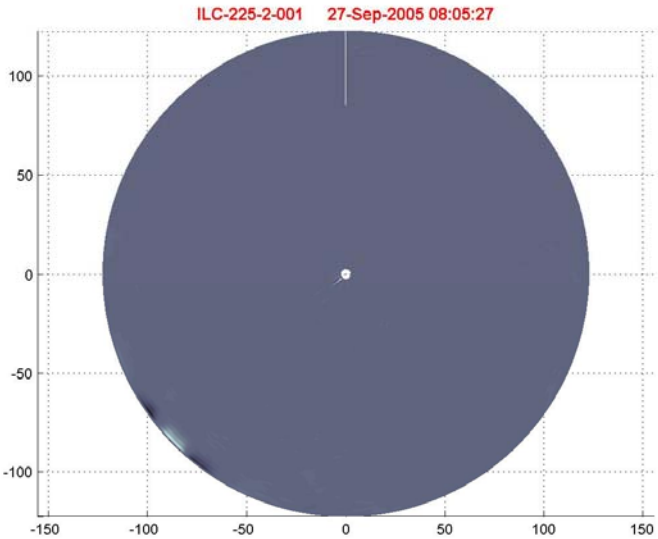

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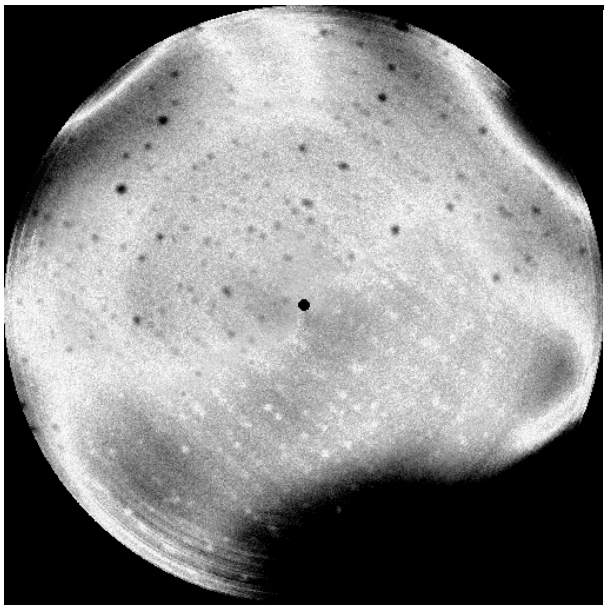

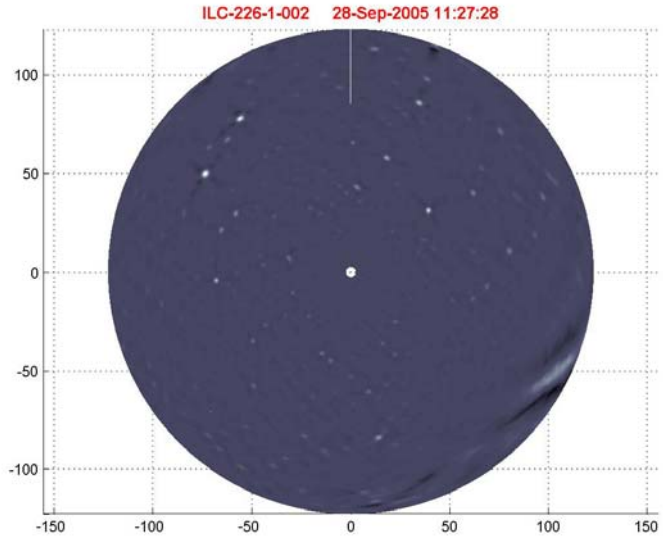

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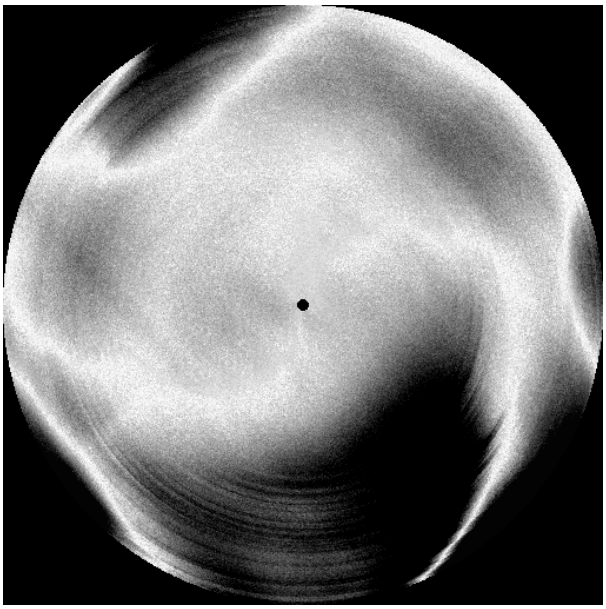

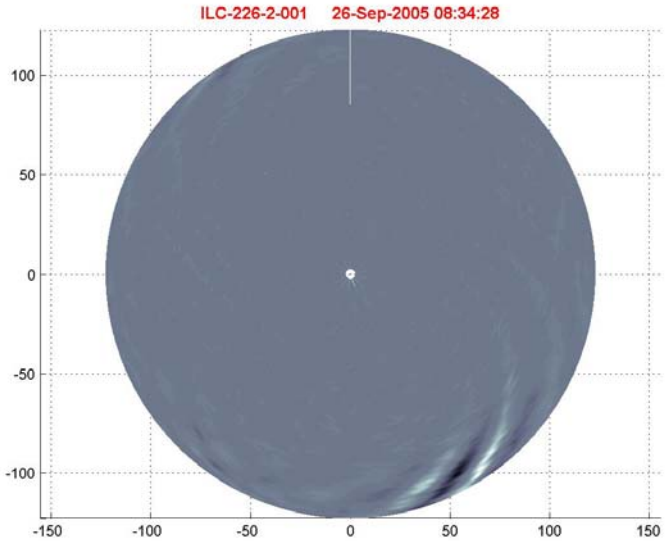

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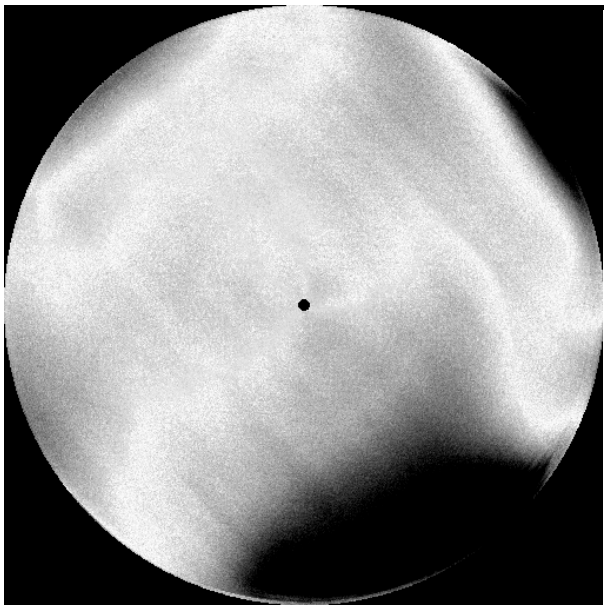

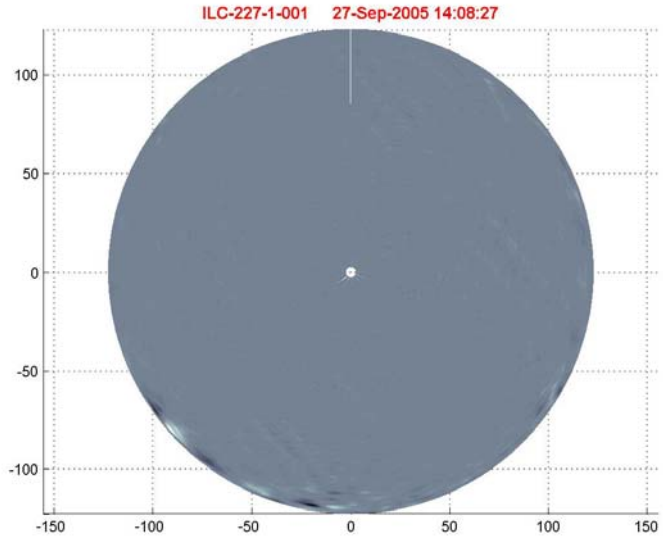

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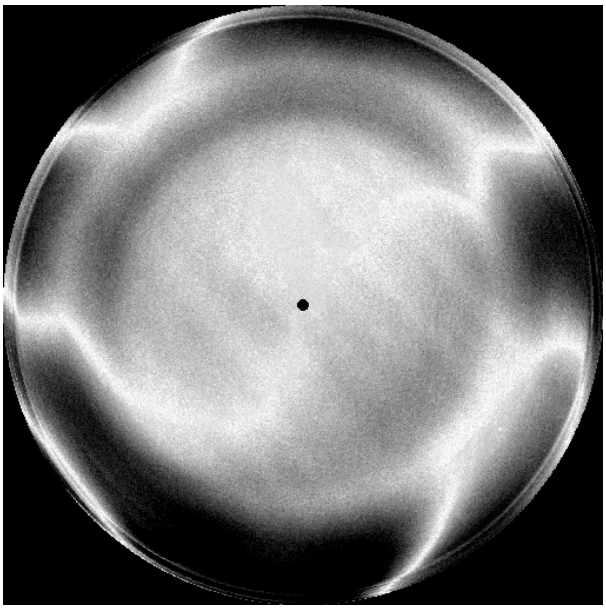

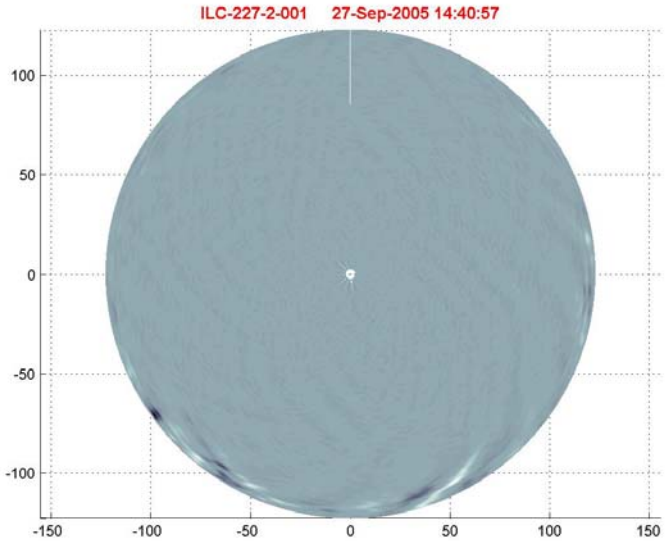

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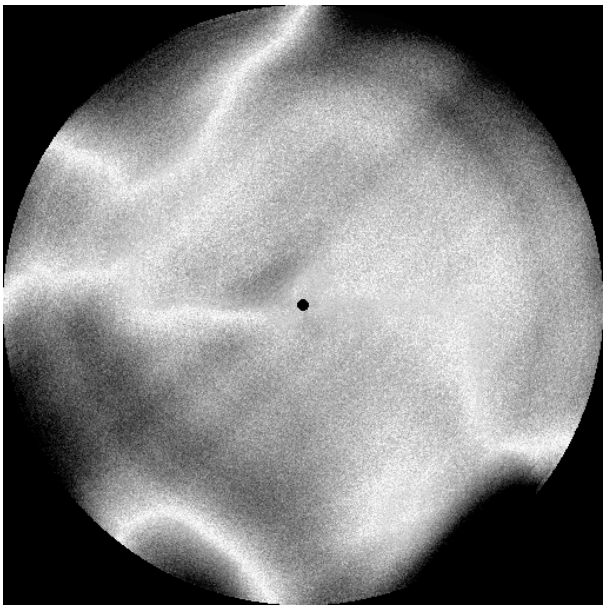

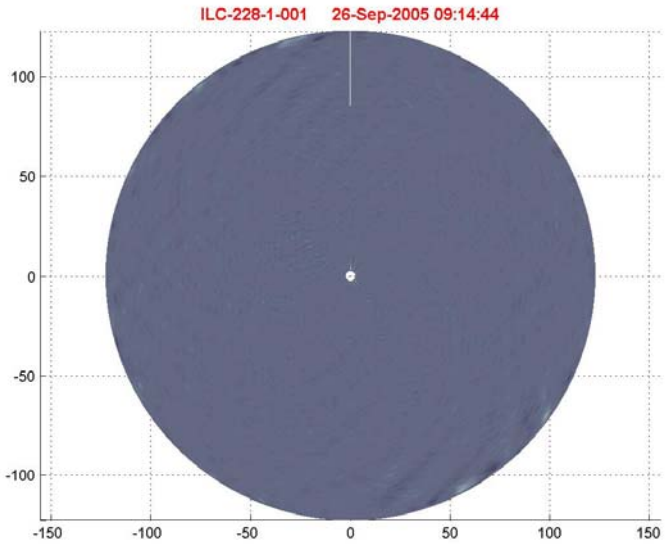

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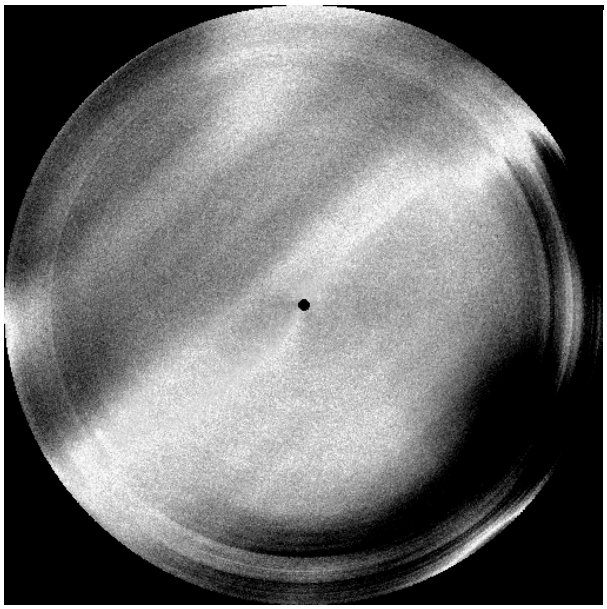

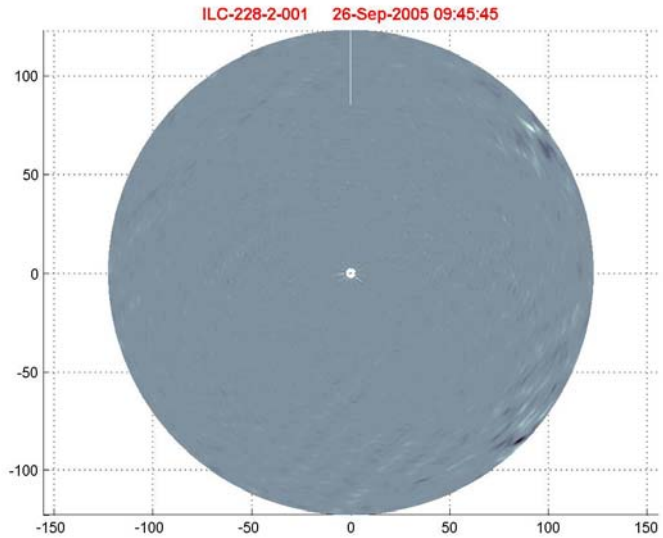

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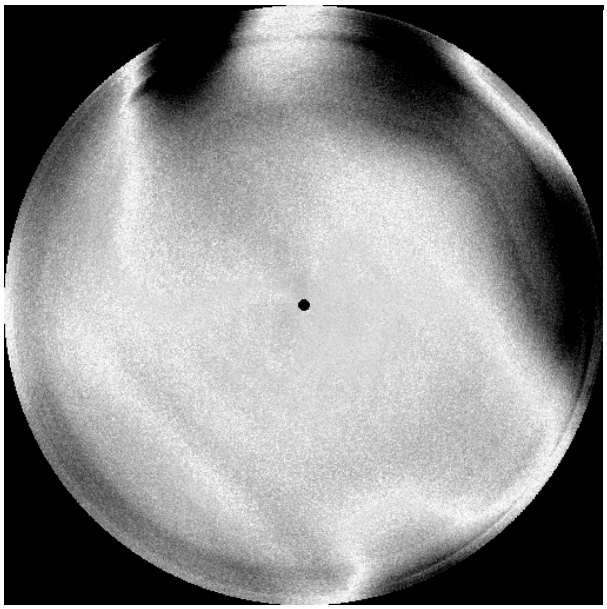

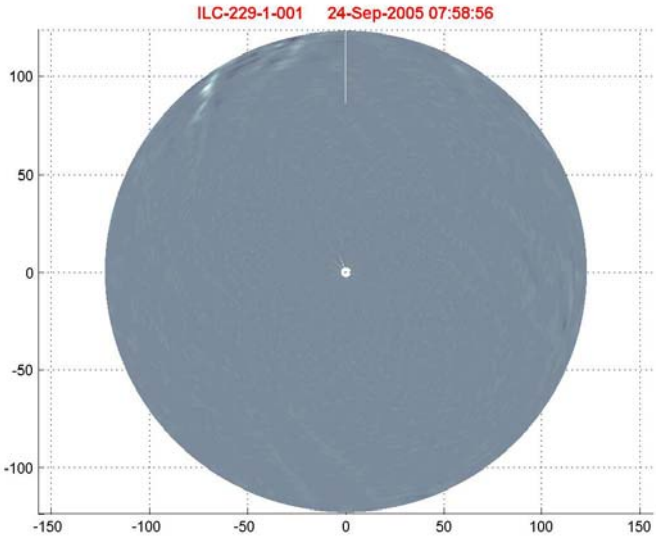

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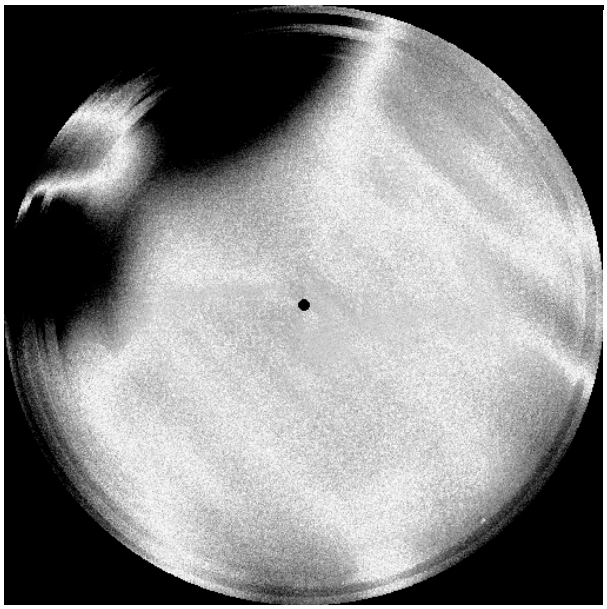

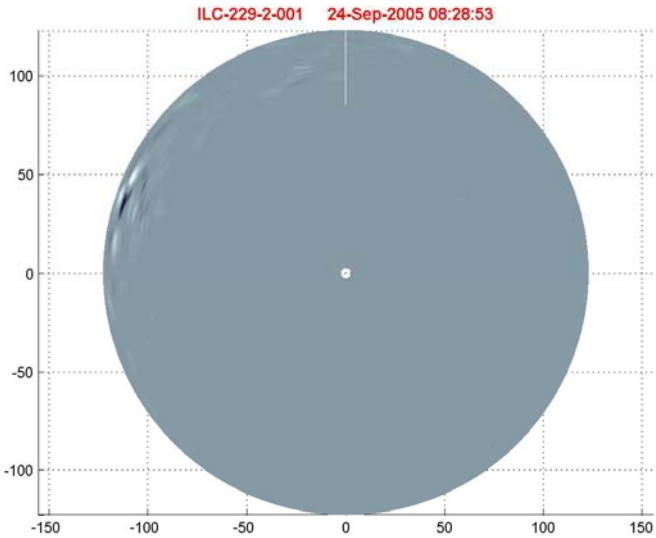

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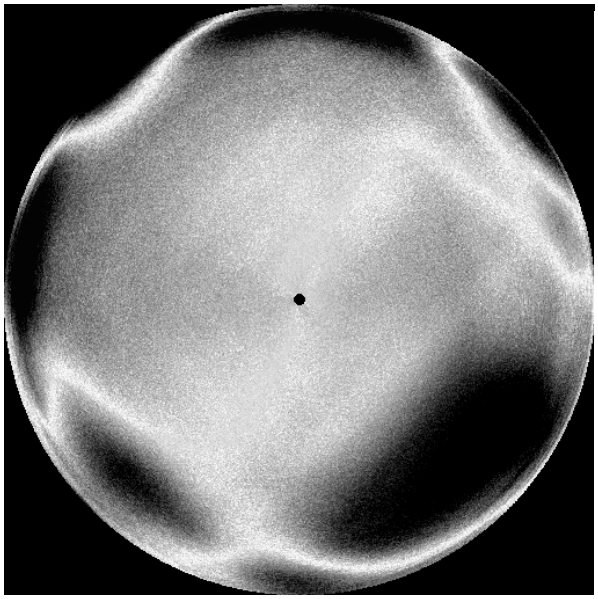

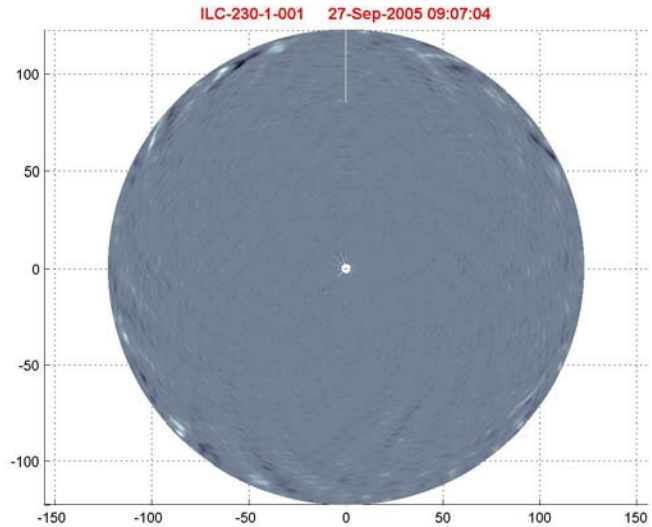

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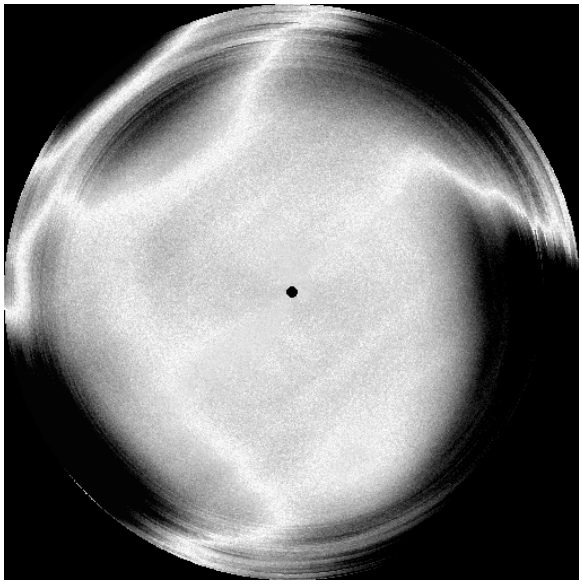

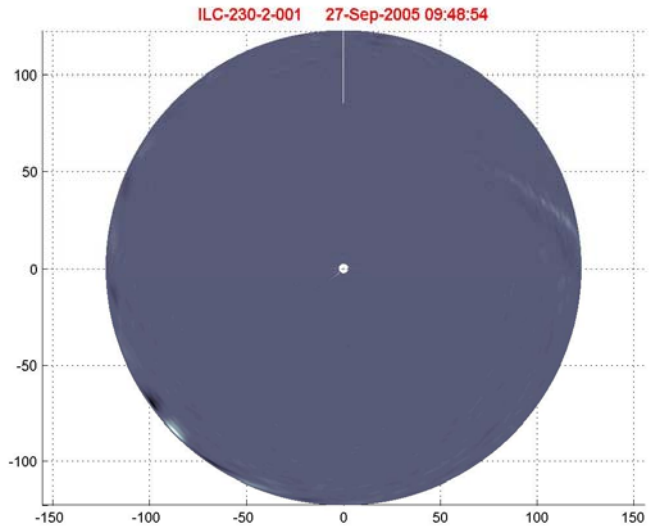

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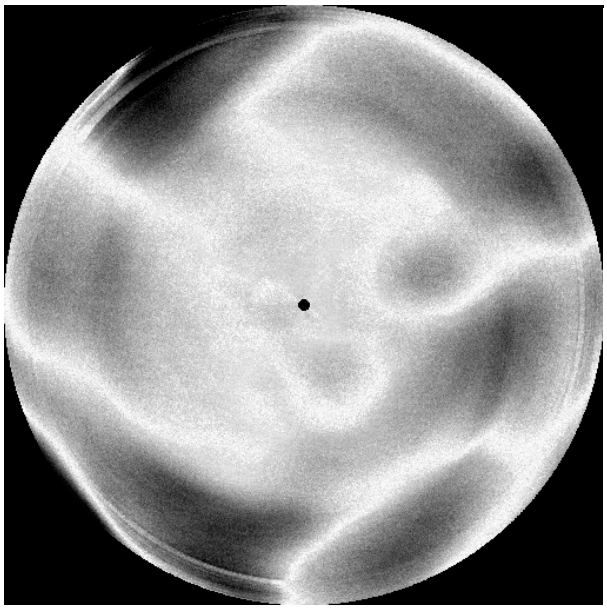

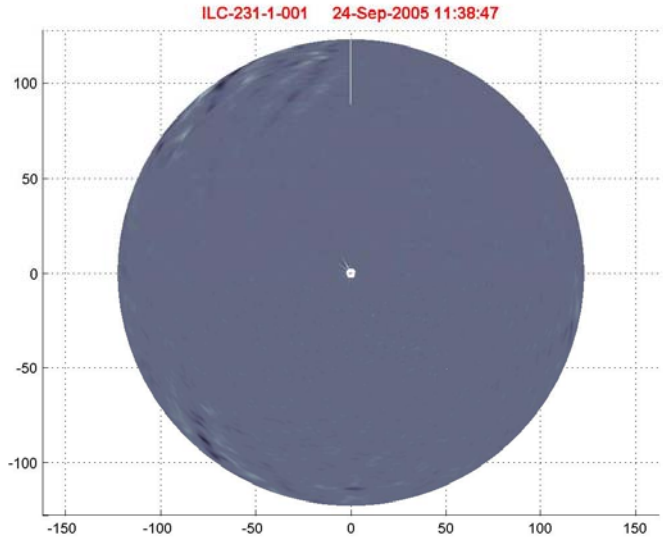

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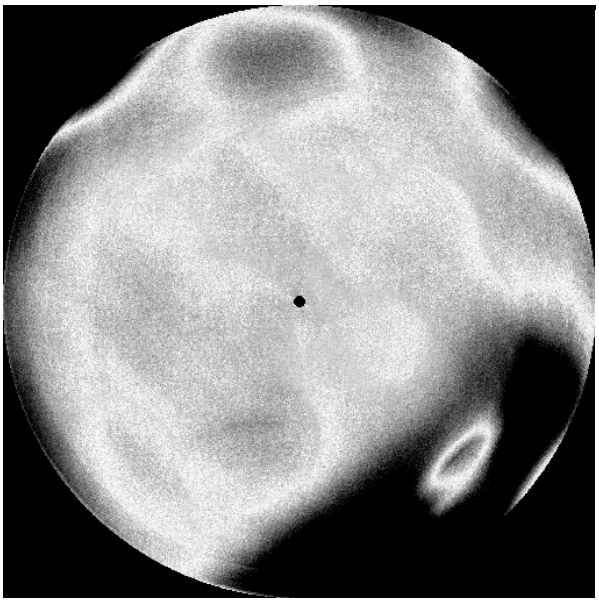

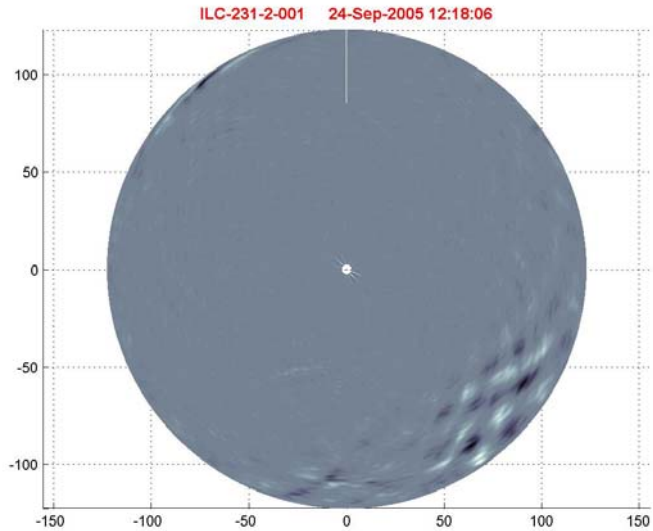

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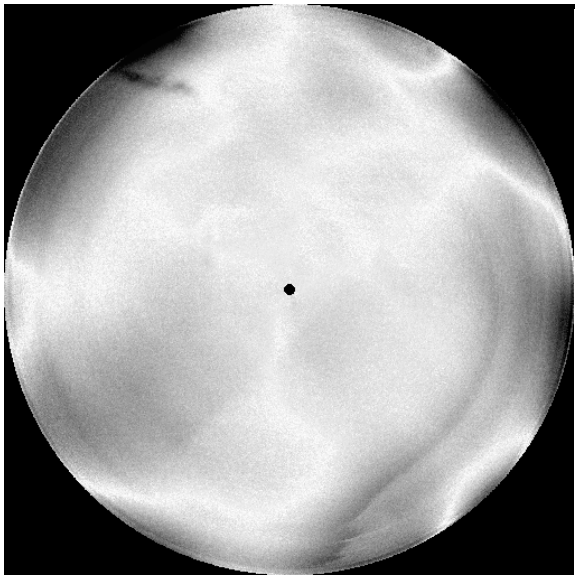

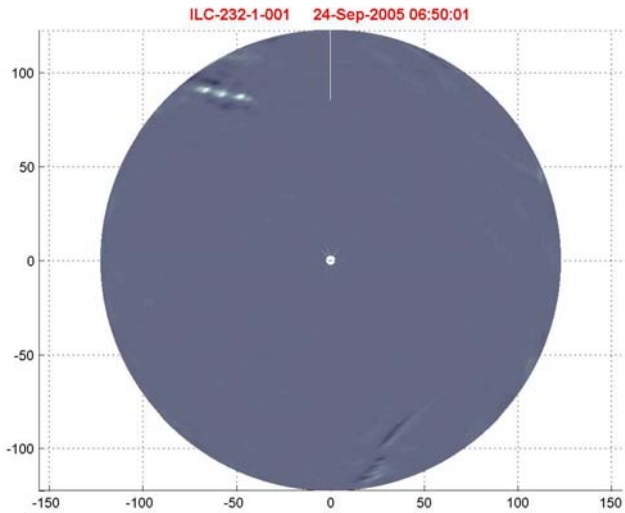

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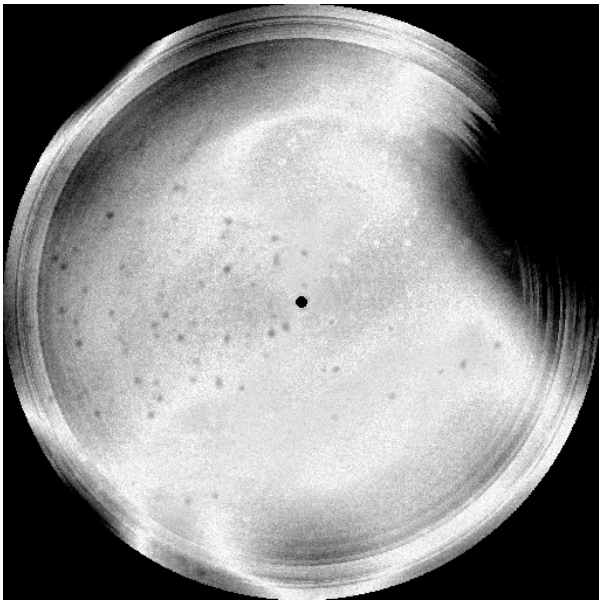

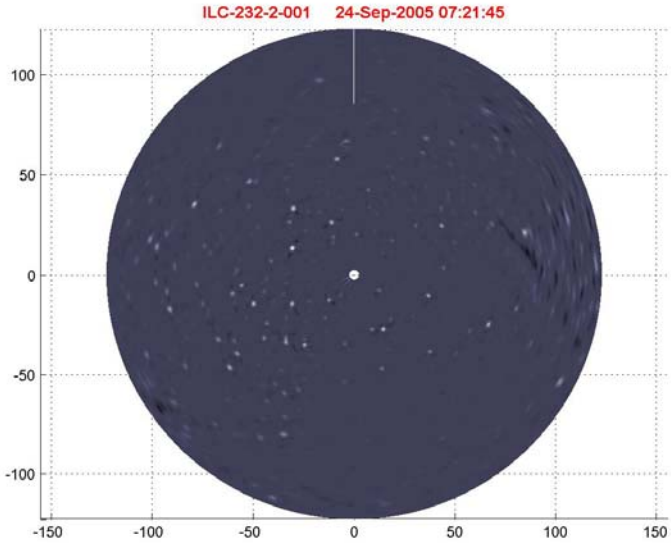

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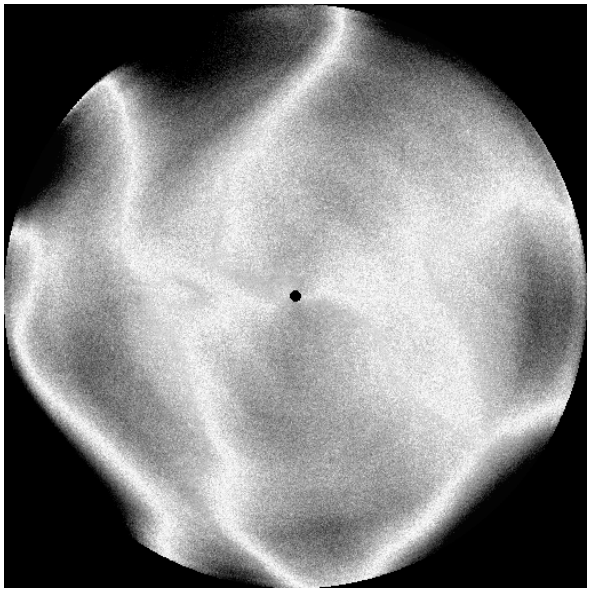

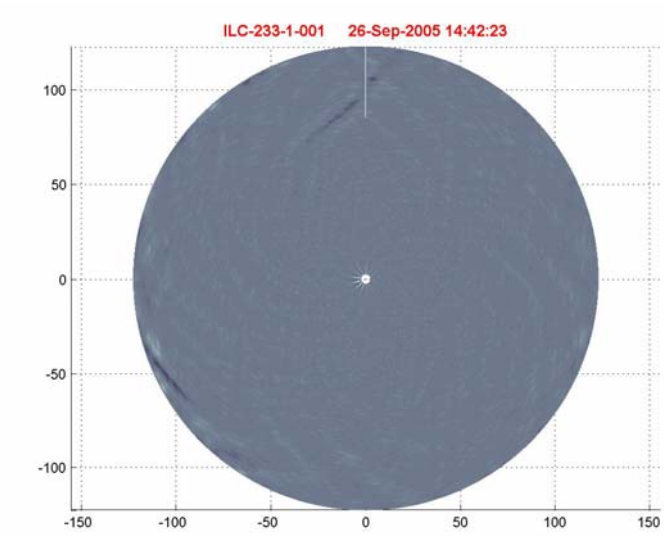

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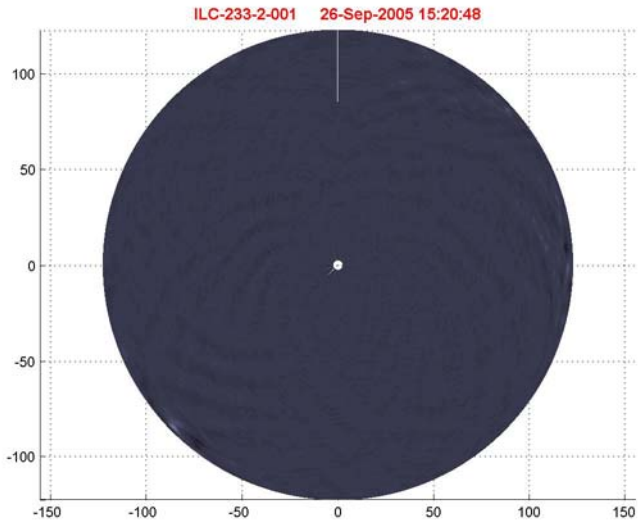

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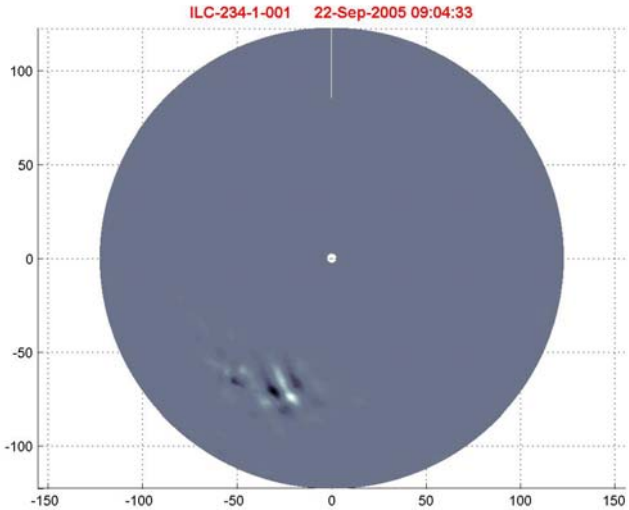

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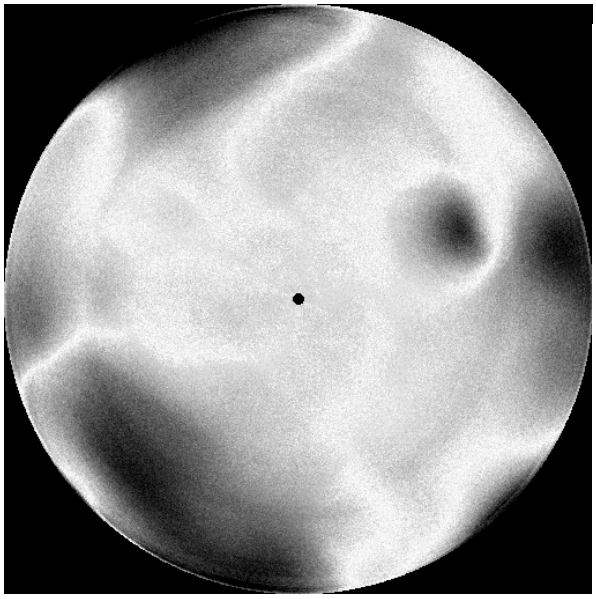

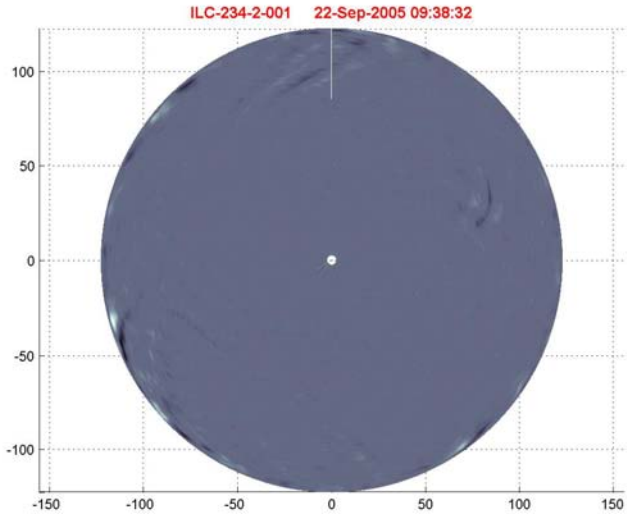

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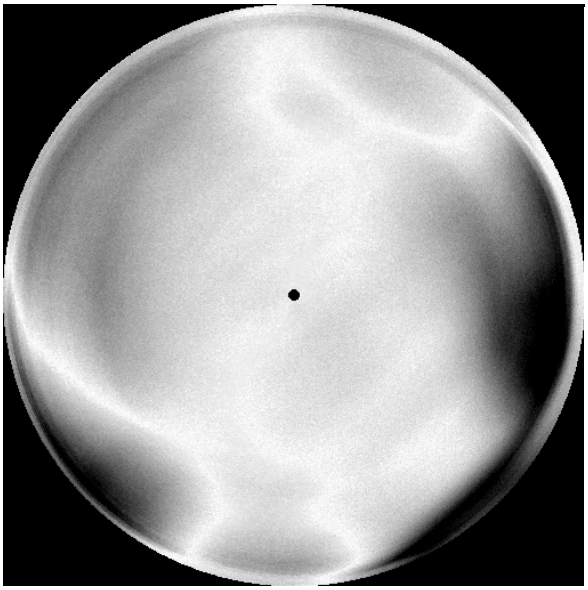

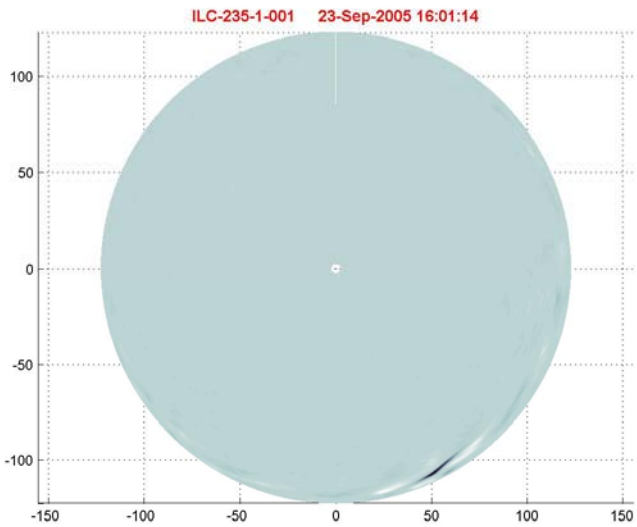

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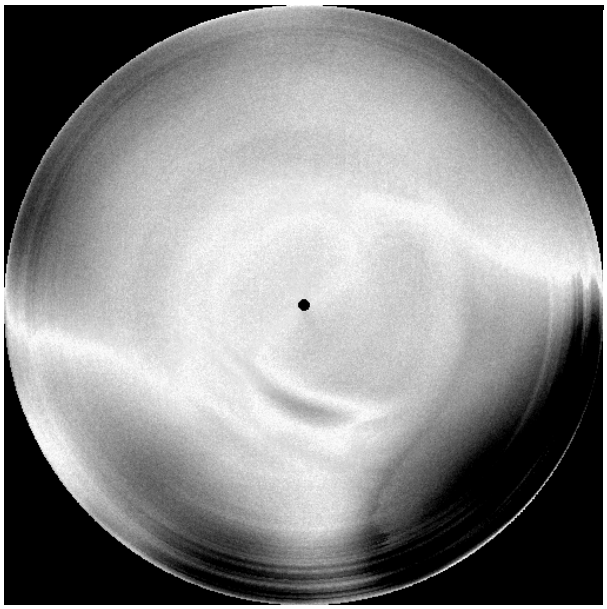

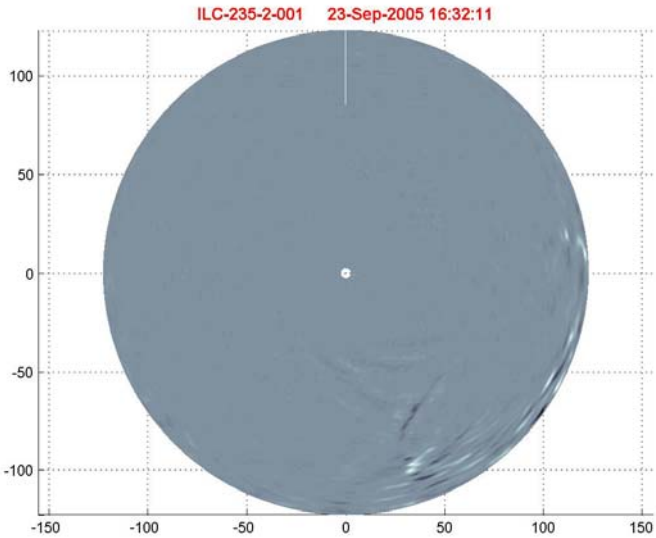

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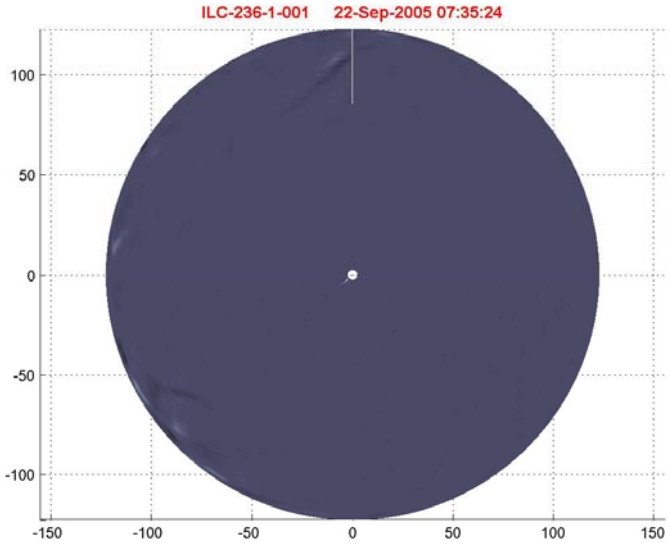

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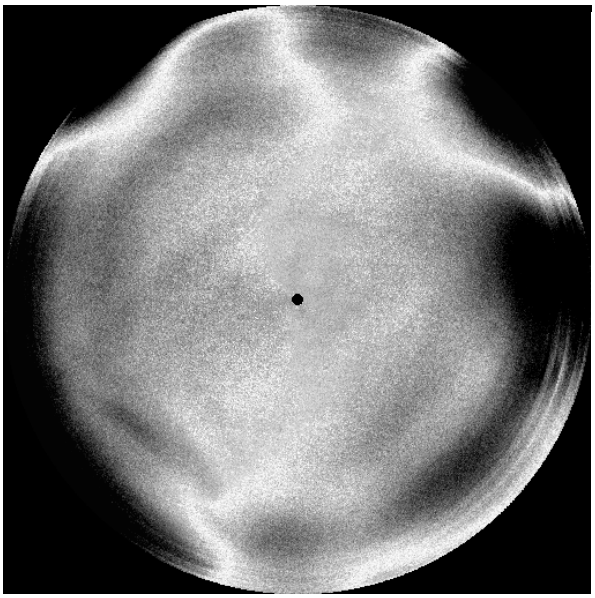

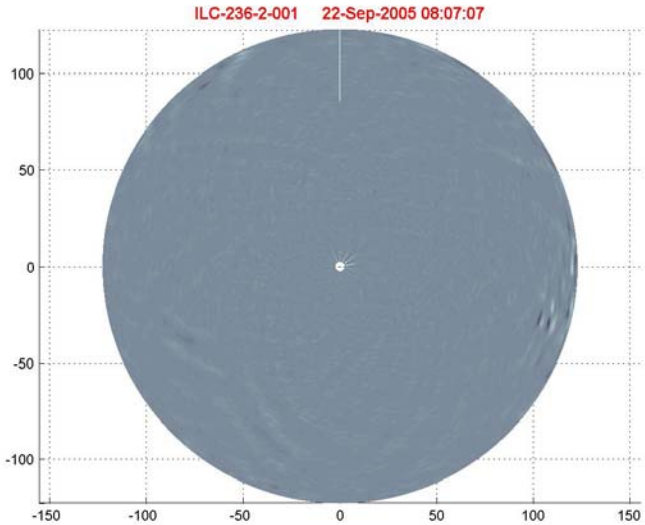

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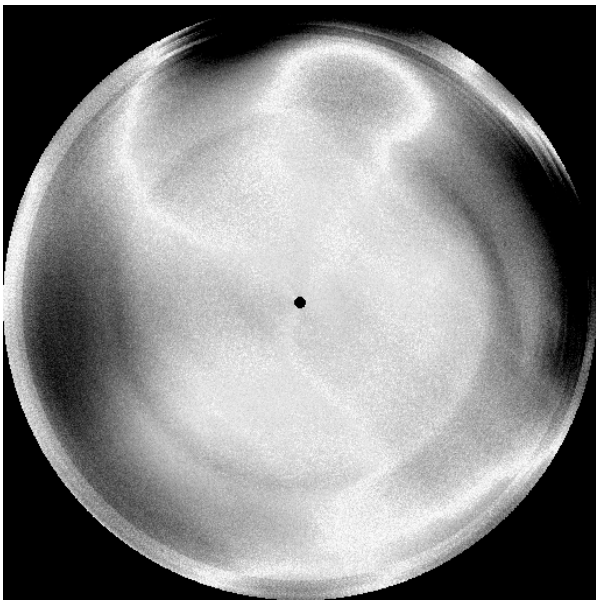

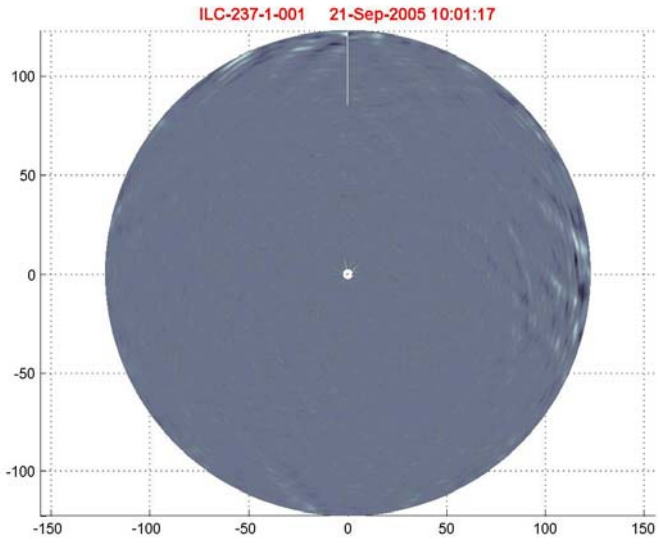

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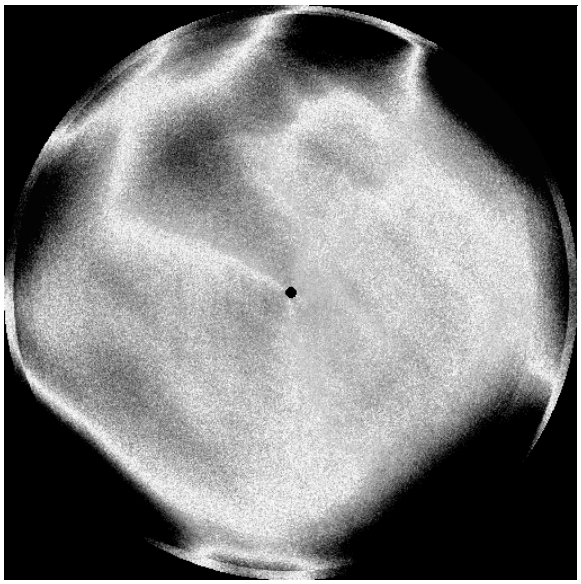

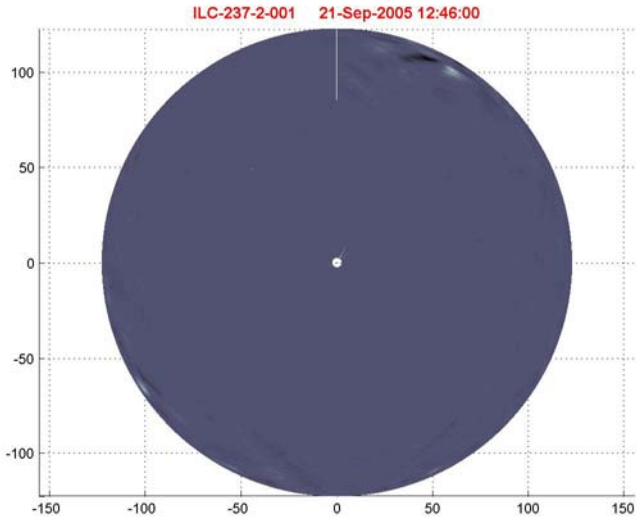

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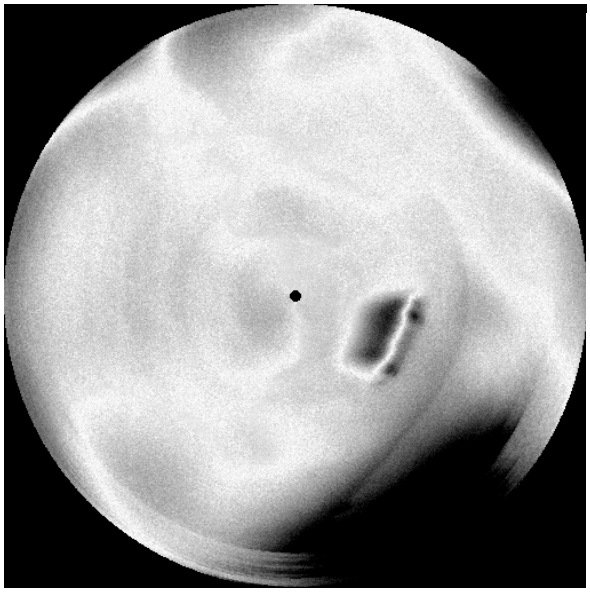

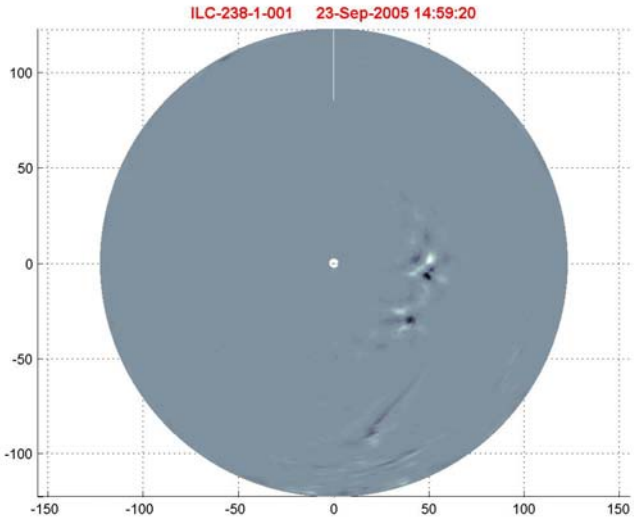

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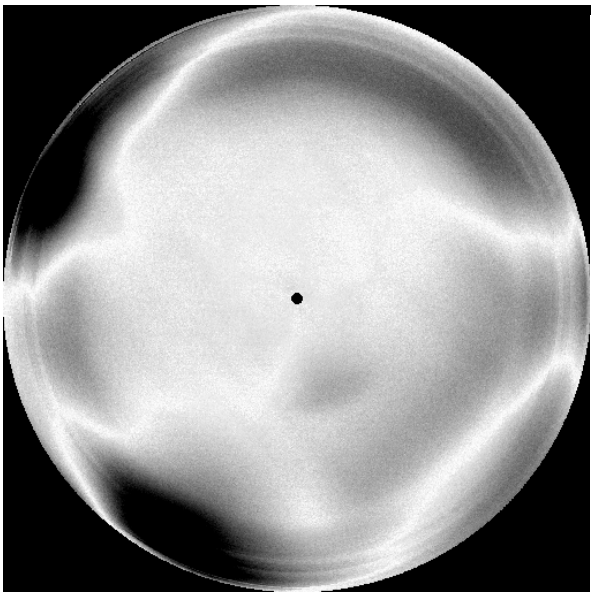

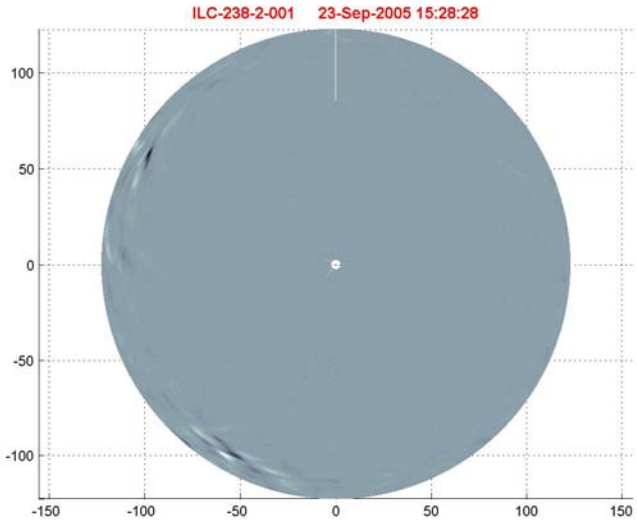

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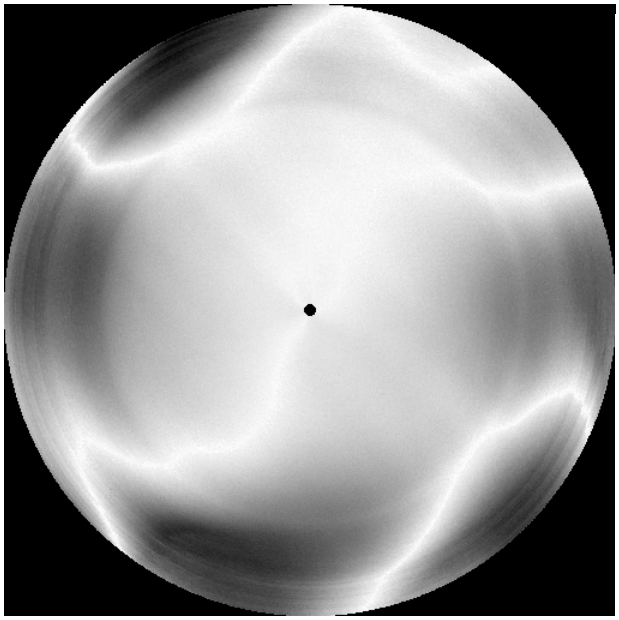

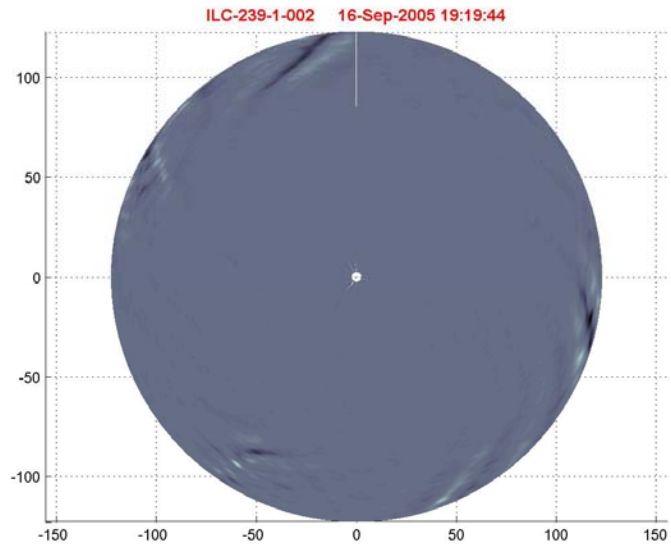

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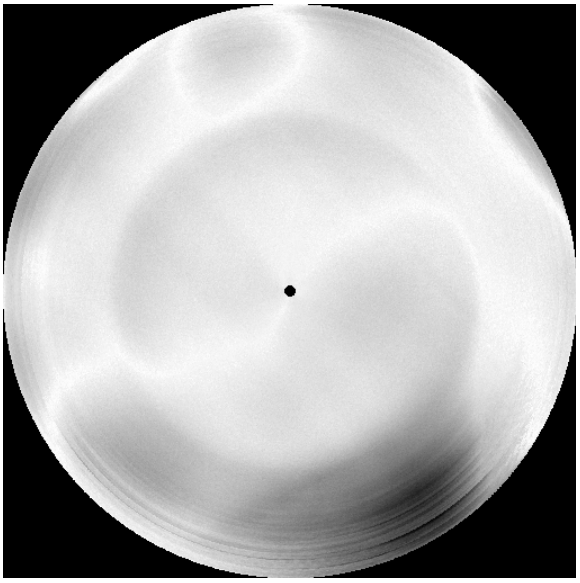

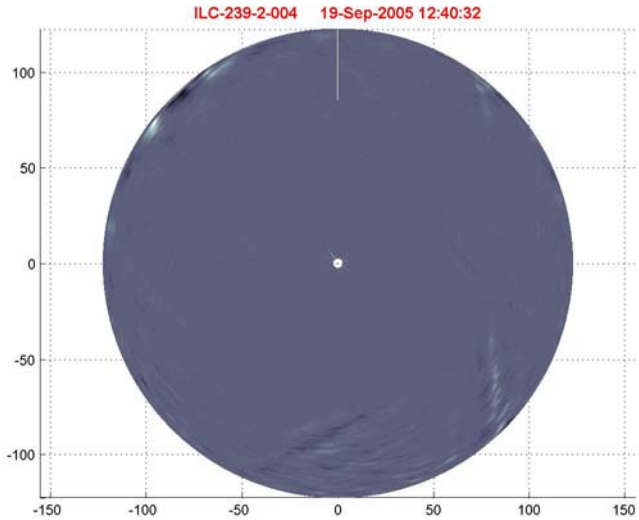

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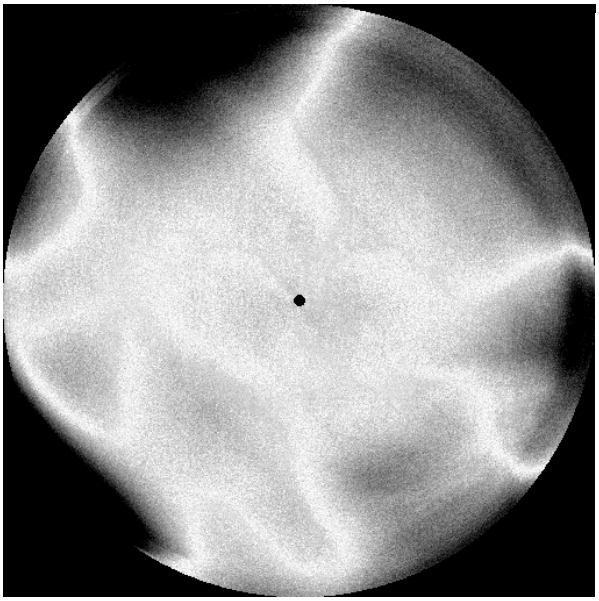

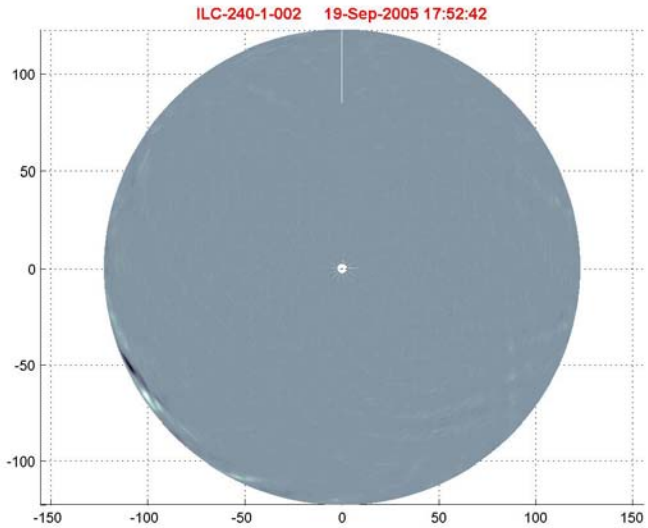

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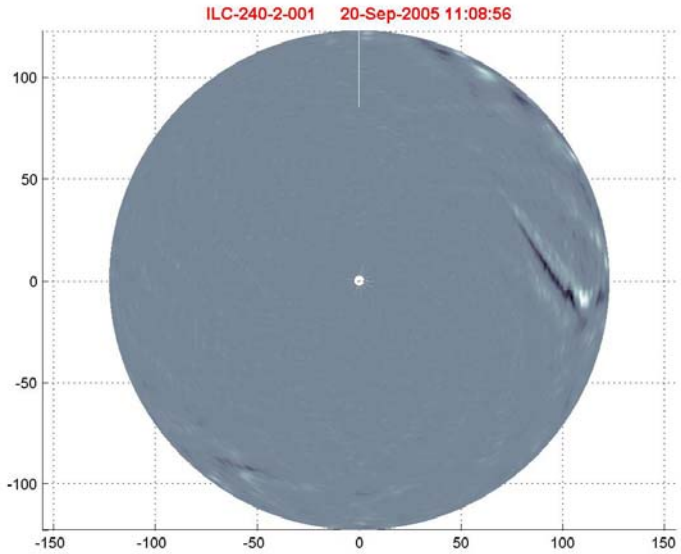

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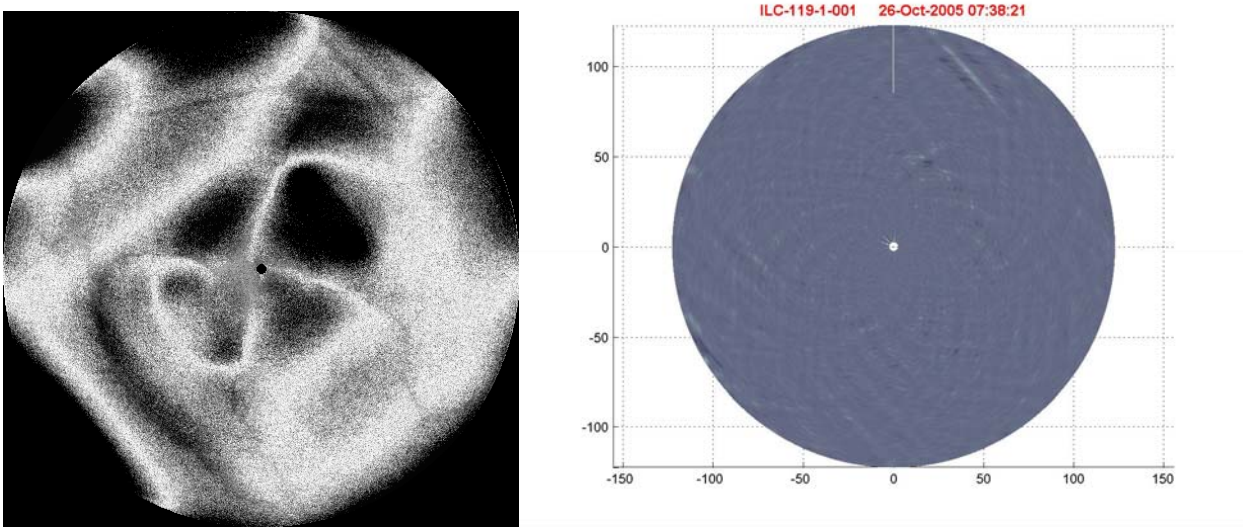

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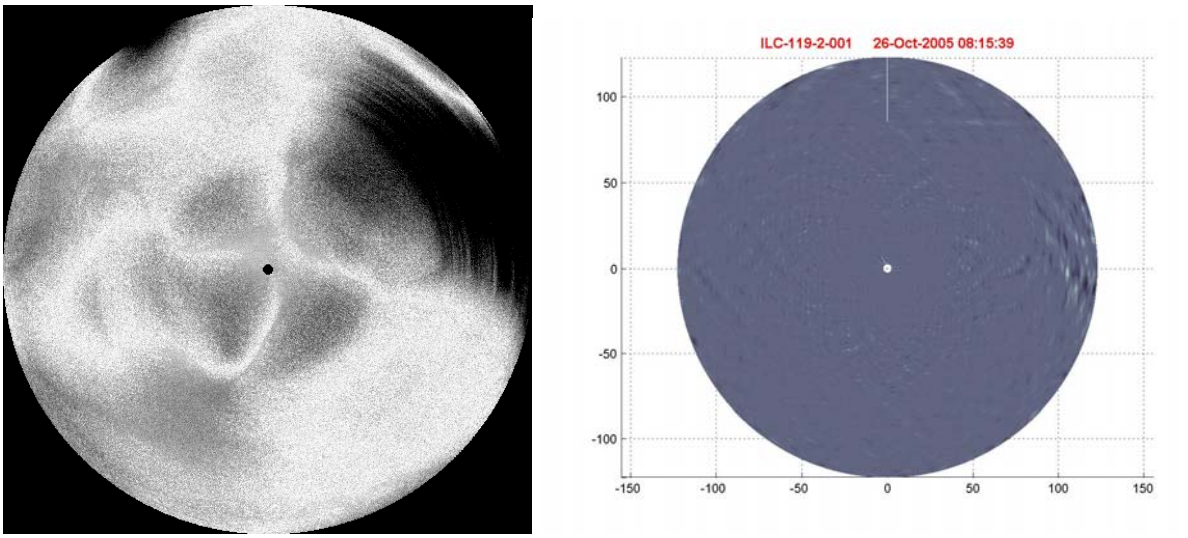

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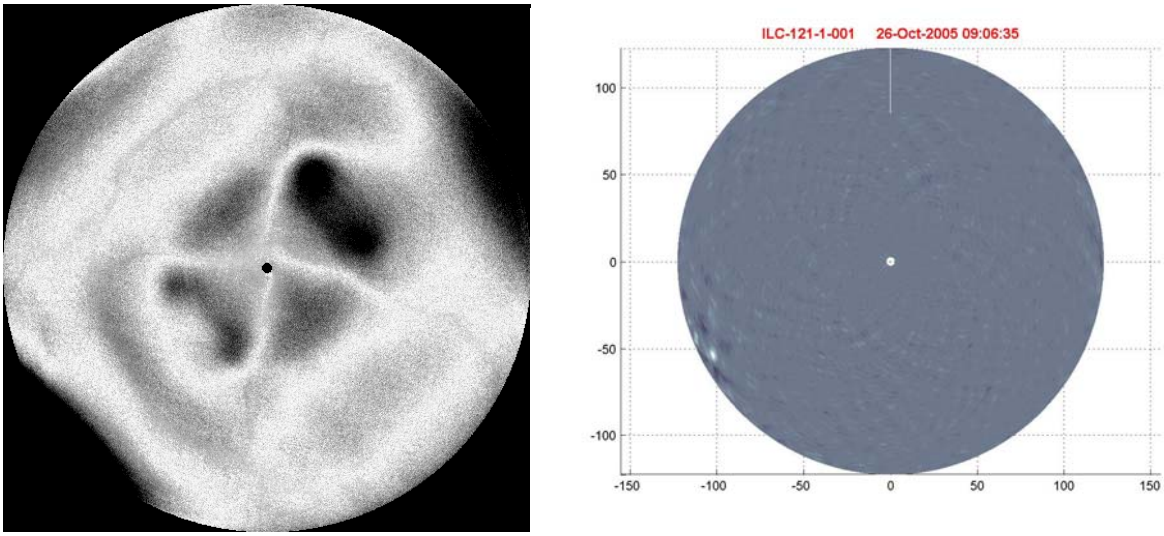

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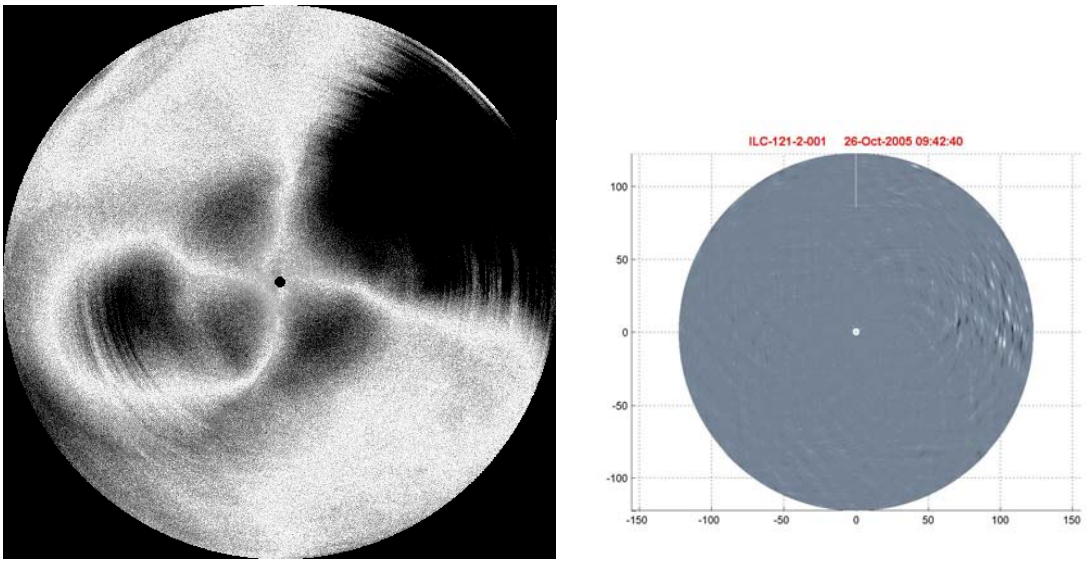

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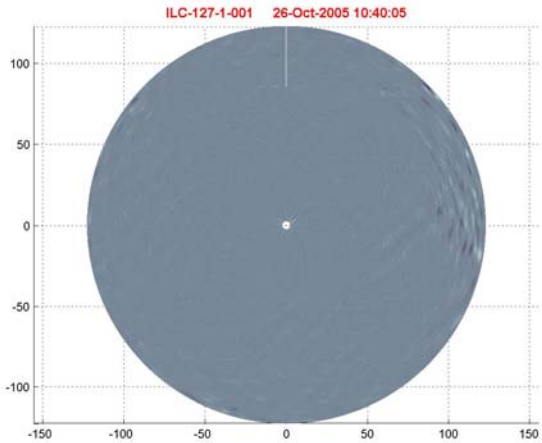

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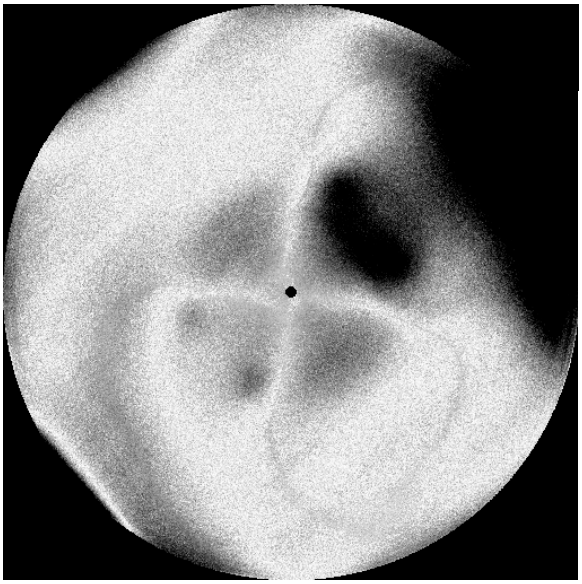

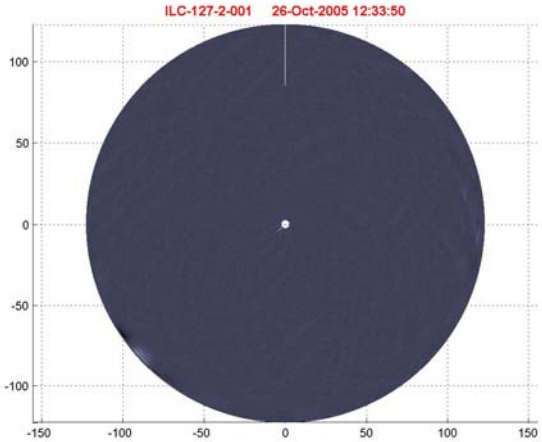

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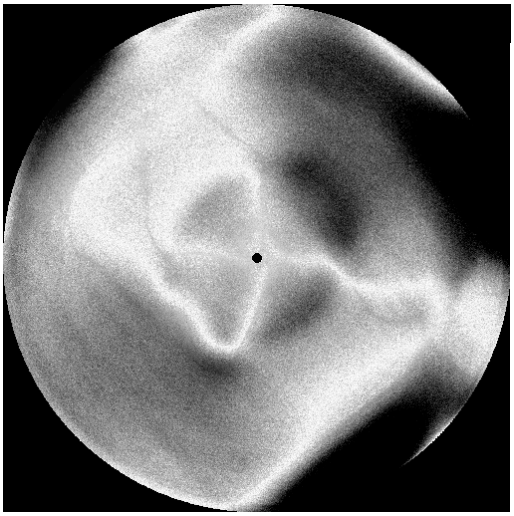

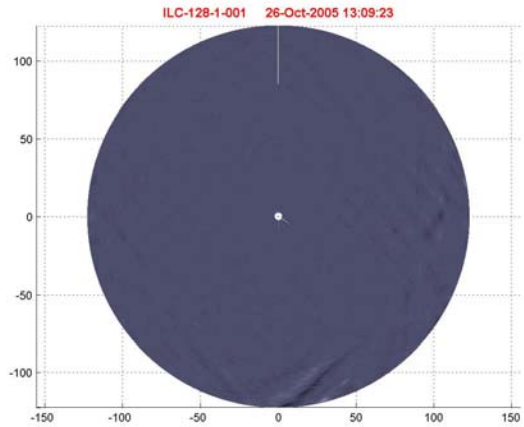

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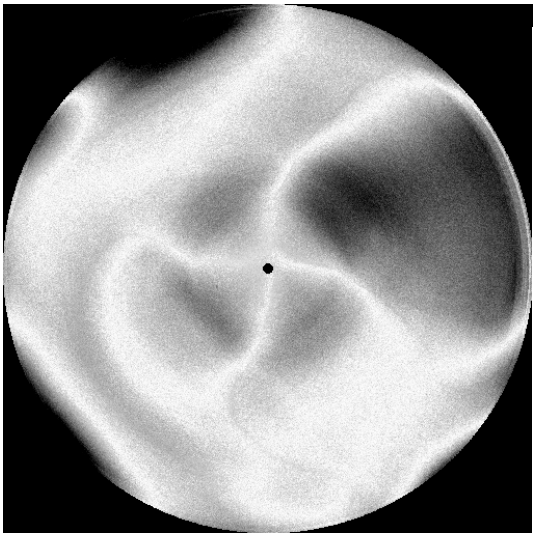
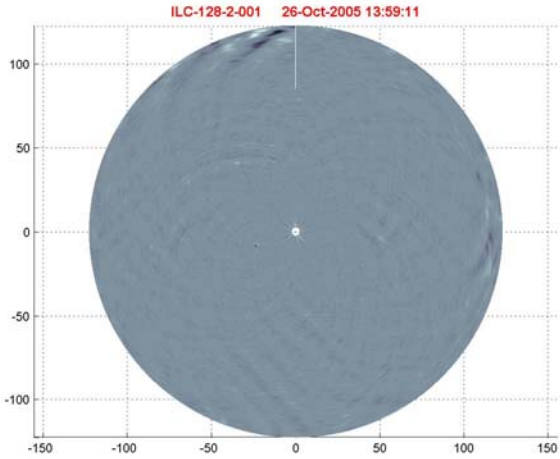




Square 128 side 2 scan left, Filter right

4 SUMMARY TABLES

The table below contains the results of the eddy current inspection of the 94 squares. The results of a visual inspection using a simple magnifying glass are also reported. The indicated numbers are approximate angle coordinates on the square, where the angle is counted clockwise from the middle point of the top edge when the side number is positioned on the top right corner. OR stands for "outer rim", that is the ~5 mm band at the outer rim of the disc. It is to be assumed that this area will be removed during subsequent production steps. MR stands for the ring in the middle, which will also be stamped out. HR stands for "half radius" and scratches, dents and pits in this area are more serious because this area will be used in the cavities. Most of the squares have a bevel along the edge as a result of the stamping or shearing process. Moreover most of the scans on side two show a pit in the MR which is related to an imperfection of the rotating table. These features have not been mentioned explicitly in the table below. All the 94 squares present markings as shown in Figure 3. Probably they are indentations left from a clamp used during the cutting process.

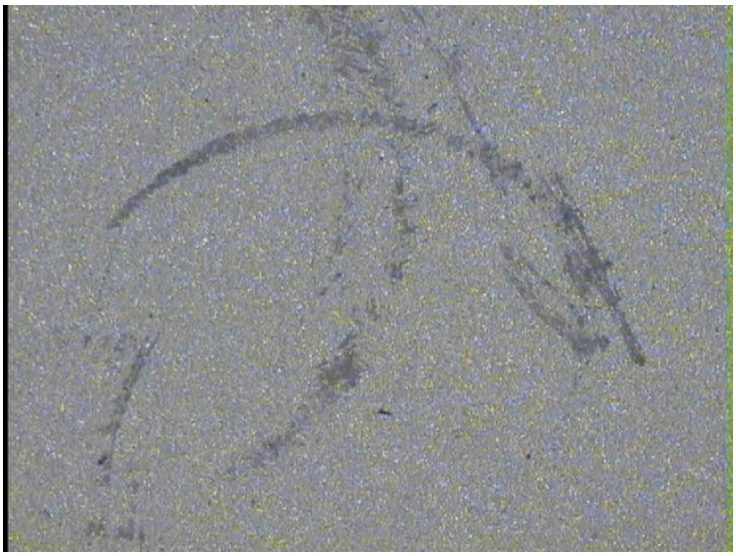


Figure 3 Clamp marks present in 2 or 4 spots in each side of the squares

The first column of the table indicates the recommendation to use the square or not. The square number is **RED** when both sides are NO from a combined optical and ECS inspection as shown in the last column. Furthermore each side is qualified with **NO** label in the last column when clear signals appear in the ECS scan. In most of the cases the signals visible in the ECS images show surface features deep enough to generate concern. In some cases the signal shown in the scans does not find a corresponding feature on the surface of the square which may call for sub surface inclusions in the material. Since the effective influence on the cavity performances of most of the signals reported is not clearly correlated, the NO marks should not be considered a categorical exclusion. Instead they are a suggestion to avoid the use that side of the square. Additional studies, reported in section 5, have been performed in order to better understand the nature of the signals in the ECS and the surface features discovered through the visual inspection.

Square	comment	Recc.
119	S1: Light Surface Scratches ,Tiny Pits Throughout , Pit on scanner S2: Light Surface Scratches ,Tiny Pits Throughout , Black Spec at 330 deg. O	S1: NO S2: OK
121	S1: OK S2: OK	S1: OK S2: OK
127	S1: Light Surface Scratches ,Tiny Pits Throughout , Ding at 45 deg. MR S2: Light Surface Scratches ,Tiny Pits Throughout , Scratch at 45 deg MR , C	S1: NO S2: OK
128	S1: Light Surface Scratches ,Tiny Pits Throughout , OK S2:Pits and scratches	S1: OK S2: NO
149	S1: OK S2: Light Surface Scratches , OK	S1: OK S2: OK
152	S1: Pits Throughout , Ding at 45 deg. MR and 75 deg. MR S2: Tiny Pits Throughout, Light Surface Scratches , OK	S1: NO S2: OK
153	S1: Scratch at 0 deg. MR , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
154	S1: OK S2: Scratch at 300 deg. MR , OK	S1: OK S2: OK
155	S1: Tiny Pits Throughout, Light Surface Scratches , OK S2: Tiny Pits Throughout, Light Surface Scratches , Scratch at 270 deg. MR , OK	S1: OK S2: OK
156	S1: Tiny Pits , OK S2: Tiny Pits , Ding at 95 deg. OR	S1: OK S2: NO
157	S1: Tiny Pits Throughout, Light Surface Scratches , OK S2: Tiny Pits Throughout, Light Surface Scratches , Dings at 20 deg. MR , 200 deg. OR , OK	S1: OK S2: OK
158	S1: Light Surface Scratches , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
159	S1: OK S2: OK	S1: OK S2: OK
160	S1: Tiny Pits Throughout, Light Surface Scratches , OK S2: Tiny Pits Throughout, Scratches at 320 deg. OR , deep scratches	S1: OK S2: NO
161	S1: Light Surface Scratches ,Tiny Pits Throughout , OK S2: Light Surface Scratches ,Tiny Pits Throughout , OK	S1: OK S2: OK
162	S1: Light Surface Scratches , Tiny Pits Throughout , Scratch at 45 deg. MR , Pit at 60 deg. MR S2: Light Surface Scratches , Tiny Pits Throughout	S1: **NO** S2: **NO**
163	S1: Tiny Pits Throughout, Light Surface Scratches , Scratch at 225-250 deg. MR , OK S2: Tiny Pits Throughout, Light Surface Scratches , OK	S1: OK S2: OK

164	S1: Dirty , Light Surface Scratches ,Tiny Pits Throughout , Scratches through center and MR S2: Light Surface Scratches ,Tiny Pits Throughout , OK	S1: NO S2: OK
165	S1: Light Surface Scratches , Tiny Pits Throughout , Black Spots at 20 deg. MR S2: Light Surface Scratches , Tiny Pits Throughout , Deeper Pits at 160 deg. MR	S1: NO S2: NO
166	S1: Light Surface Scratches , Tiny Pits Throughout , OK S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: OK S2: OK
167	S1: Dirty, Light Surface Scratches ,Tiny Pits Throughout , OK S2: Light Surface Scratches ,Tiny Pits Throughout , OK	S1: OK S2: OK
168	S1: Tiny Pits Throughout, Light Surface Scratches , Deep scratch scanner S2: Light Surface Scratches , Tiny Pits Throughout , Dings at 60 deg. MR , 120 deg. MR	S1: NO S2: OK
169	S1: Light Surface Scratches , Tiny Pits Throughout , OK S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: OK S2: OK
170	S1: Light Surface Scratches , Scratch at 250 deg. MR , Black mark at 300 deg. MR S2: Light Surface Scratches ,Tiny Pits Throughout , Nick at 90 deg. MR , OK	S1: NO S2: OK
171	S1: Light Surface Scratches , Tiny Pits Throughout , valley S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: NO S2: OK
172	S1: Light Surface Scratches , Tiny Pits Throughout , Pits at 0 deg. MR and 320 deg. MR/OR S2: Light Surface Scratches , Tiny Pits Throughout , Scratches through Center	S1: OK S2: NO
173	S1: Dirty, Light Surface Scratches ,Tiny Pits Throughout , OK S2: Dirty , Light Surface Scratches ,Tiny Pits Throughout , Scratch and Pits at 270 and 0 deg. MR , OK	S1: OK S2: OK
174	S1: Light Surface Scratches , Tiny Pits Throughout , Black Specs through square S2: Light Surface Scratches , Tiny Pits Throughout , Scratch Center/MR 45 deg. , Nicks at 180 deg MR	S1: OK S2: NO
175	S1: Light Surface Scratches , Tiny Pits Throughout , Scratch in Center , Dings at 200 deg. MR and 340 deg. OR S2: Light Surface Scratches , Tiny Pits Throughout , roller mark	S1: OK S2: NO
176	S1: Light Surface Scratches ,Tiny Pits Throughout , Black spot at 250 deg. MR S2: Tiny Pits Throughout , Scratch at 310-340 deg. MR , Black spot at 250 deg. MR	S1: OK S2: NO
177	S1: OK S2: Tiny Pits Throughout , OK	S1: OK S2: OK
178	S1: Light Surface Scratches , Tiny Pits Throughout , Scratch at 180 deg.-240 deg. MR S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: NO S2: OK

179	S1: Pits and Black specs through square S2: Light Surface Scratches ,Tiny Pits Throughout , Dings at 240 deg. OR and MR	S1: NO S2: NO
180	S1: Tiny Pits Throughout , OK S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: OK S2: OK
181	S1: Light Surface Scratches , Tiny Pits Throughout , pit on scanner S2: Light Surface Scratches , Tiny Pits Throughout slightly deeper than normal (probe hit square misaligned)	S1: NO S2: OK
182	S1: Light Surface Scratches , OK S2: Tiny Pits Throughout , Scratch at 300 deg. MR-Center	S1: OK S2: NO
183	S1: Light Surface Scratches , Scratch at 20 deg. OR , 180 deg. OR-MR , Black spot at 30 deg. MR S2: Light Surface Scratches , Ding at 0 deg. MR	S1: OK S2: NO
184	S1: Light Surface Scratches , Tiny Pits Throughout , Ding at 200 deg. MR S1: Light Surface Scratches , Tiny Pits Throughout , OK	S1: NO S2: OK
185	S1: Light Surface Scratches , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
186	S1: Light Surface Scratches , Tiny Pits Throughout , Scratch at 100 deg. OR-MR , 170 deg. OR-MR , Ding at 175 deg. MR S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: NO S2: OK
187	S1: Light Surface Scratches , Black marks at 180 deg. MR S1: Light Surface Scratches , OK	S1: NO S2: OK
188	S1: Light Surface Scratches ,Tiny Pits Throughout , OK S2: Light Surface Scratches ,Tiny Pits Throughout , Deeper Pits at 30 deg. MR	S1: OK S2: NO
189	S1: Light Surface Scratches , Tiny Pits Throughout , OK S1: Light Surface Scratches , Black Specs Through square , Ding at 340 deg. MR	S1: OK S2: NO
190	S1: Light Surface Scratches , Nick at 350 deg. OR/MR , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
191	S1: Light Surface Scratches ,Tiny Pits Throughout , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
192	S1: Light Surface Scratches , Tiny Pits Throughout , Nick at 45 deg. MR , Scratch at 90-180 deg. OR , Nicks at 125 deg. MR S2: Scratch 90-180 deg. OR , Scratch at 340 deg. OR-MR	S1: NO S2: OK
193	S1: Light Surface Scratches , Pits 80 deg. MR and 290 deg. MR S2: Light Surface Scratches , Dirty , OK	S1: OK S2: OK
194	S1: Ding at 95 deg. MR , Pit at 100 deg. MR , Ding at 120 deg. MR , Scratch at 270-360 deg. MR S2: Light Surface Scratches , Tiny Pits Throughout , Bad scratches at 0-90 deg. MR and 270-360 deg. MR	S1: NO S2: NO
195	S1: Tiny Pits Throughout , Black specs throughout disk S2: Light Surface Scratches , Tiny Pits Throughout , A few Black specs , OK	S1: NO S2: OK

196	S1: Light Surface Scratches , Tiny Pits Throughout , OK S2: Light Surface Scratches , Tiny Pits Throughout , Scratch at 160 deg. OR-MR , Black spot at 300 deg. MR	S1: OK S2: OK
197	S1: Light Surface Scratches , Tiny Pits Throughout , Black Specs throughout disk S2: Light Surface Scratches , OK	S1: NO S2: OK
198	S1: Light Surface Scratches , Nick at 255 deg. MR S2: Light Surface Scratches , OK	S1: NO S2: OK
199	S1: Light Surface Scratches , Tiny Pits Throughout , OK S2: OK	S1: OK S2: OK
200	S1: Light Surface Scratches , Tiny Pits Throughout , Black Spec at 110 deg. MR , Dings at 300 deg. OR-MR S2: Dirty , Light Surface Scratches , Tiny Pits Throughout , A few Black spots at 180 deg. MR	S1: NO S2: NO
201	S1: Nick at 45 deg. MR Scratch Center, 340 deg. , 300 deg. MR Black specs at 180 deg. MR S2: Bad Pits Through Square	S1: NO S2: OK
202	S1: Light Surface Scratches , Tiny Pits Throughout , OK S2: Light Surface Scratches , Tiny Pits Throughout , Nick at 255 deg. MR , Black spot at 290 deg. MR	S1: OK S2: NO
203	S1: Light Surface Scratches ,Tiny Pits Throughout , deep scratch scanner S2: Tiny Pits Throughout , Pit at 220 deg. MR	S1: NO S2: NO
204	S1: Dirty , Light Surface Scratches ,Tiny Pits Throughout , OK S1: Light Surface Scratches ,Tiny Pits Throughout , Scratch at 160 deg. OR/MR , 300 deg. MR	S1: OK S2: NO
205	S1: Light Surface Scratches , Tiny Pits Throughout , OK S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: OK S2: OK
206	S1: Light Surface Scratches ,Tiny Pits at 180 deg. OR-MR , OK S2:Ding at 60 , 140 , 220 , 250 , 290, 310, 340 deg. MR	S1: OK S2: NO
207	S1: Light Surface Scratches , Tiny Pits Throughout , Pits Mostly Through MR Very Noticeable S2: Light Surface Scratches , Tiny Pits Throughout slightly , Pit at 180 deg. MR	S1: NO S2: OK
208	S1: Light Surface Scratches , Ding at 75 deg. MR S2: Light Surface Scratches , Pits at 20,180,290 deg. MR , Scratch at 110 deg. OR-MR deep	S1: OK S2: NO
209	S1: Light Surface Scratches , Tiny Pits Throughout , Black Spot at 125 deg. OR/MR S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: NO S2: OK
210	S1: Ding at 45 deg. MR and 150 deg. MR , Light surface scratches S2: Larger Nicks or Dings that Usual Throughout Square	S1: NO S2: OK
211	S1: Light Surface Scratches , Tiny Pits Throughout , OK S1: Light Surface Scratches , Scratch at 110 deg. OR-MR, OK	S1: OK S2: OK
212	S1: Scratch at 110 deg. OR , Pit at 250 deg. MR S1: Pits Throughout Square Deeper than Normal	S1: NO S2: NO

213	S1: Light Surface Scratches , Scratch at 180 deg. MR , OK S1: Light Surface Scratches , OK	S1: OK S2: OK
214	S1: Pits , Scratches , Black Specs at 350 and 80 deg. MR S1: Light Surface Scratches , Tiny Pits Throughout , deep scratch scanner	S1: NO S2: NO
215	S1: Light Surface Scratches , Tiny Pits Throughout , OK S2: Light Surface Scratches , Tiny Pits Throughout , A few Deeper Pits at 180 deg. MR	S1: OK S2: NO
216	S1: Light Surface Scratches , OK S2: Light Surface Scratches , Black Spot at 90 deg. C/MR , OK	S1: OK S2: OK
217	S1: Light Surface Scratches , OK S2: Light Surface Scratches , Scratch at 70 deg. MR , inclusion?	S1: OK S2: NO
218	S1: Light Surface Scratches , OK S2: Light Surface Scratches , Tiny Pits Throughout , OK	S1: OK S2: OK
219	S1: Light Surface Scratches , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
220	S1: Light Surface Scratches , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
221	S1: Light Surface Scratches , Scratches at 190 deg. OR , OK S2: Light Surface Scratches , Scratch at 45 deg. MR/C , OK	S1: OK S2: OK
222	S1: Light Surface Scratches , Tiny Pits Throughout , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
223	S1: Light Surface Scratches , pits scanner S2: Light Surface Scratches , OK	S1: NO S2: OK
224	S1: Light Surface Scratches , deep scratch scanner S2: Light Surface Scratches , OK	S1: NO S2: OK
225	S1: Light Surface Scratches ,Tiny Pits Throughout , OK S2: Light Surface Scratches , OK	S1: OK S2: OK
226	S1: Several pits scanner S1: Light Surface Scratches ,Tiny Pits Throughout , OK	S1: NO S2: OK
227	S1: Light Surface Scratches , OK S2: Light Surface Scratches ,Tiny Pits Throughout , OK	S1: OK S2: OK
228	S1: OK S2: Light Surface Scratches ,Tiny Pits Throughout , OK	S1: OK S2: OK
229	S1: Light Surface Scratches , Pits S2: Light Surface Scratches , Dings in Center	S1: NO S2: NO
230	S1: Light Surface Scratches , OK S2: Light Surface Scratches , Dings at 90 deg. OR , 200 deg. MR , 210 deg. MR/OR	S1: OK S2: NO
231	S1: OK S2: OK	S1: OK S2: OK
232	S1:Tiny Pits Throughout , Dings at 30 deg. MR , inclusions? S2: Inclusions?	S1: NO S2: NO
233	S1: Light Surface Scratches , OK S2: Light Surface Scratches , OK	S1: OK S2: OK

234	S1: Cris was a little low on the probe and touched square ,valley S2: Valley	S1: **NO** S2: **NO**
235	S2: S1: Light Surface Scratches at 45 deg. MR , OK S2: Tiny Black Specs Throughout (Grease??) , OK	S1: **OK** S2: **OK**
236	S1: OK S2: OK	S1: **OK** S2: **OK**
237	S1: OK S2: OK	S1: **OK** S2: **OK**
238	S1: Valley S2: OK	S1: **NO** S2: **OK**
239	S1:Tiny Pits Throughout , OK S2:Tiny Pits Throughout , OK	S1: **OK** S2: **OK**
240	S1:Tiny Pits Throughout , OK S2:Tiny Pits Throughout , OK	S1: **OK** S2: **OK**

The above table can be summarized as follows: out of the 94 squares, 43 (46%) have no signal (**OK**), 40 (43%) give signals on one side only and 7 (7%) give a signal on both sides (**NO** or **NO**). In terms of signals: 111 sides show no signal, 30 sides show signals on the scans, 30 show surface features through the visual inspection only and 17 show some surface irregularities.

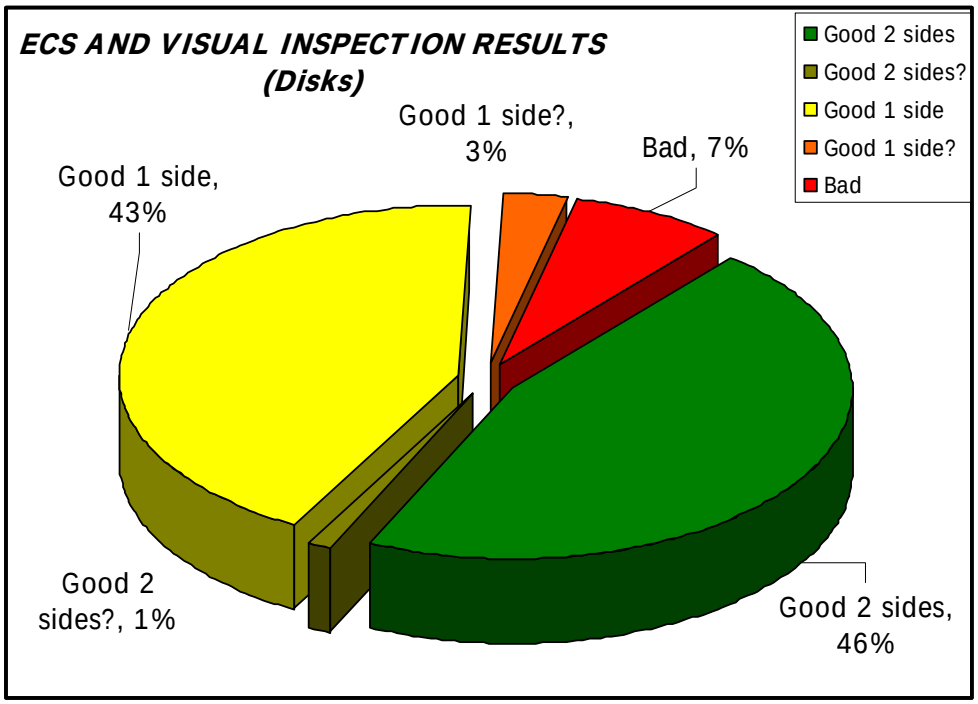


Figure 4 ECS and Visual inspection results on disks

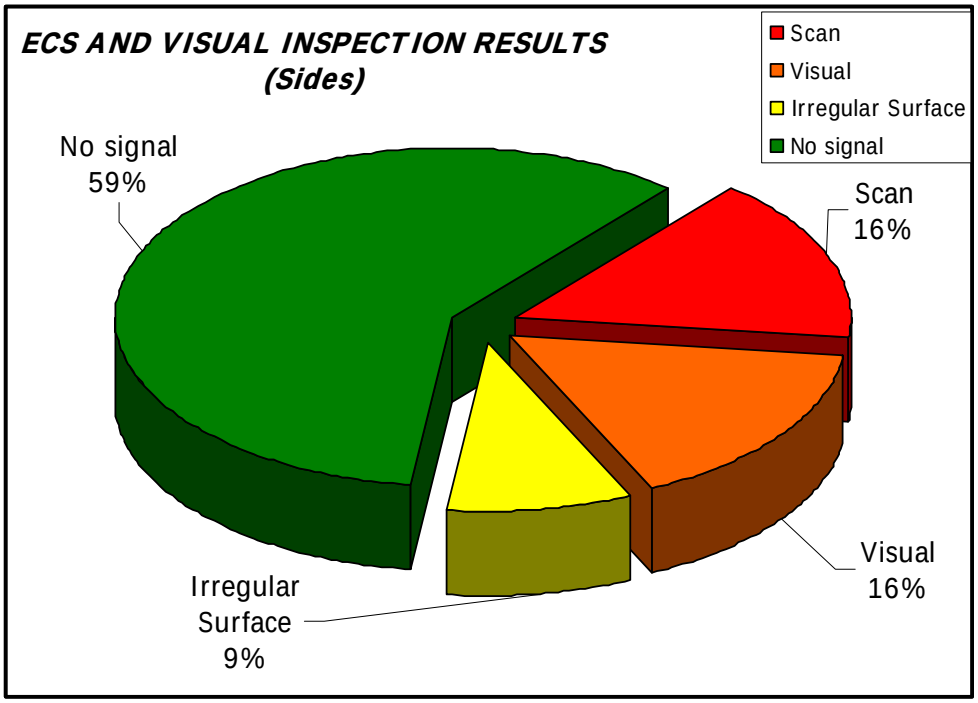


Figure 5 ECS and Visual inspection results on sides of disks

5 ADDITIONAL INVESTIGATIONS

In order to better understand the nature of the defects seen on the scanner results and during visual inspection, we started a campaign of additional measurements including: anodization, step by step etching, ultrasound thickness measurement, profile measurement and microscopy.

5.1 ANODIZATION

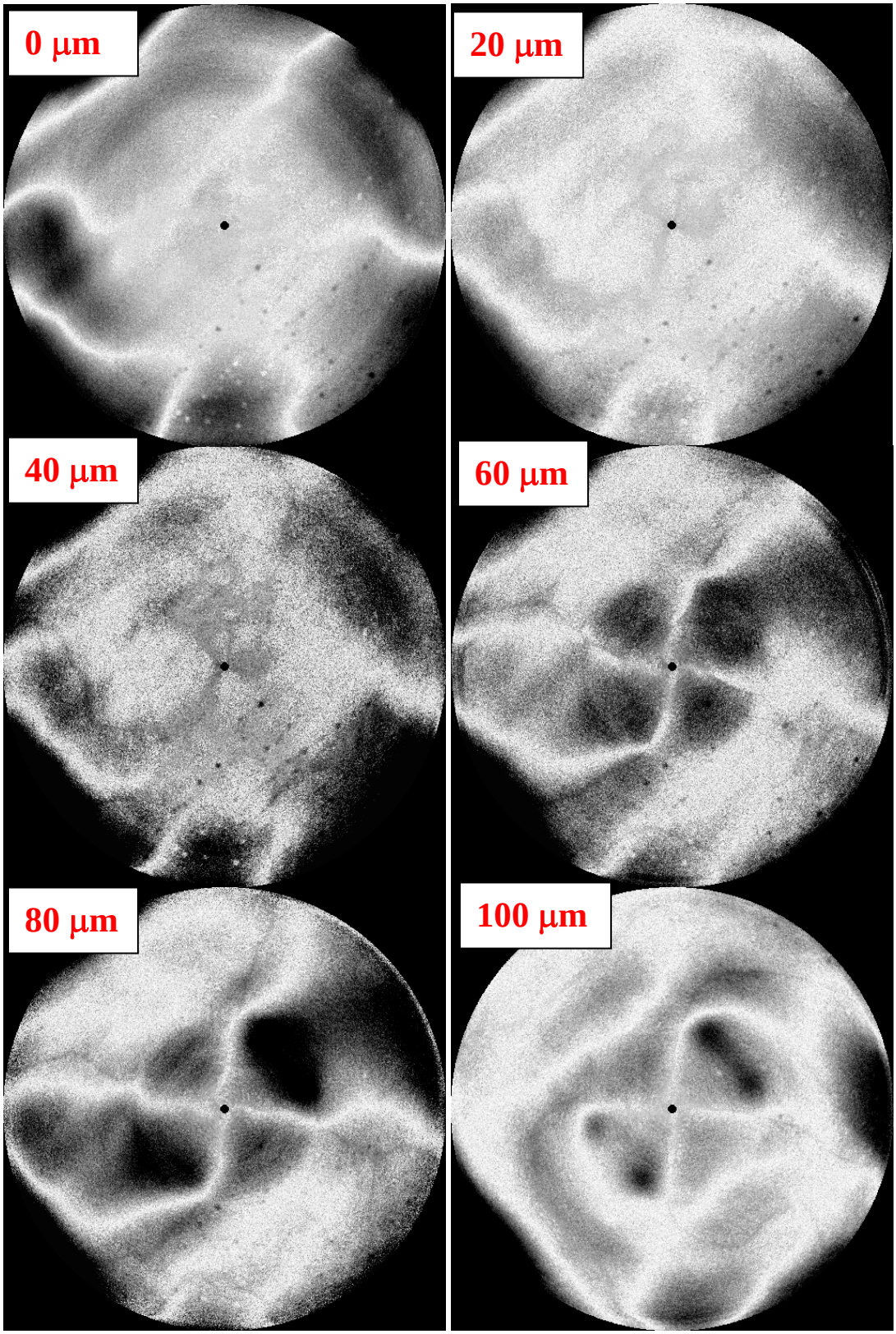
Anodization is the deposition of a fixed thickness oxide layer on the material surface giving to it a characteristic color. For Niobium the better contrast of the colored surface allows to better detect inclusions or defects. The procedure is explained in detail in the "DESY Specification of the welded 1.3 GHz SRF resonators for the TTF-FEL". By applying 20V to an electrolytic cell composed by a Nb anode and the Nb sample as s cathode in a 5:1 H_2O:HNO_3 solution, the niobium surface becomes dark blue. Materials like brass and stainless steel maintain their original color, aluminum changes completely color while titanium becomes almost like niobium.

Two samples: 198 and 226 showing many pits on the surface were anodized. The surface inspection after anodization did not show any particular sign of defects or inclusions. Figure 6 shows an anodized square. The color was removed later by dipping the squares in a BCP solution.

Figure 6 Square 226 anodized

5.2 ETCHING

Square 223 showed strong signals on the scan results and the visual inspection confirmed the presence of many deep pits. Usually when pits show up in the scan results there are concerns that the material processing will not recover them. Studies have been performed in the past to understand this issue and are reported in TD-05-032. Square 223 was etched 120 um at 20 um steps and between the etching steps it was scanned to check for changes in the surface features. Figure 7 shows the ECS results for each step.


0 μm
20 μm
40 μm
60 μm
80 μm
100 μm

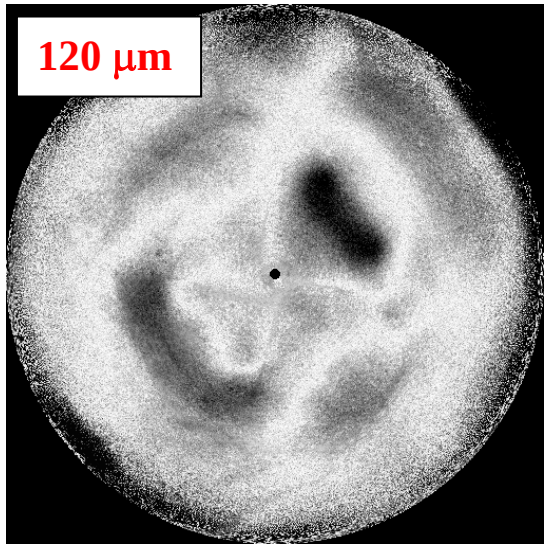


Figure 7 Square 223 step by step etching 0 to 120 um

After the 120 um removal some pits are still present in the scan results confirming, as in the previous results, that even a deep BCP etch may not remove completely pits that are visible in the ECS images.

A 20 um light etch test was also performed on square 168 to check if the "buffing" marks on the surface of the material are removed. This test confirmed that such surface features can be eliminated by the light etch.

5.3 ULTRASOUND THICKNESS MEASUREMENT

Square 162 was very difficult to scan due to flatness irregularity. This sample did not look flat and did not adhere perfectly to the vacuum clamping system. In order to understand better additional thickness related effects, the square was measures using an ultrasound thickness measurement device. One quarter of the square was marked with points distant 1/2" and a measurement was taken at each point.

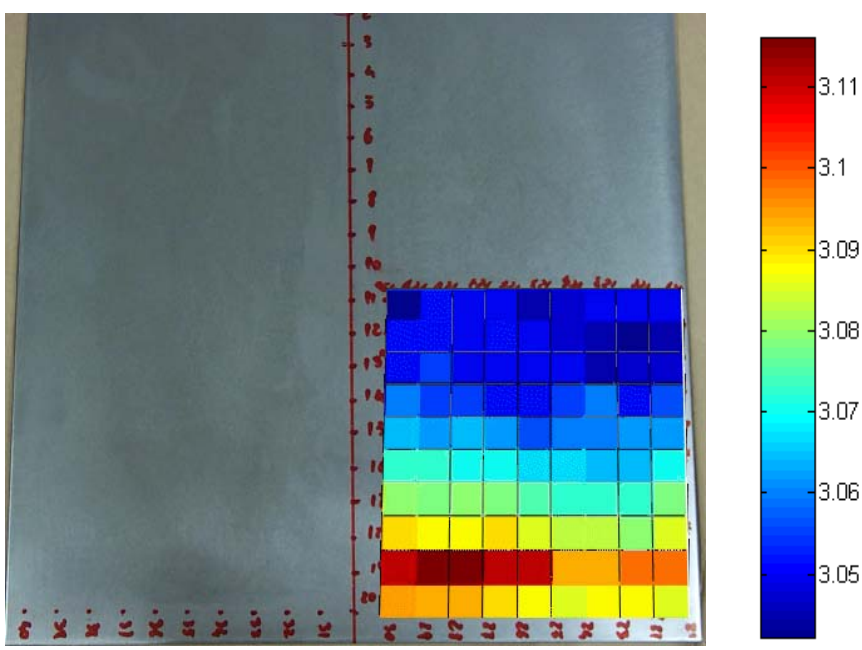
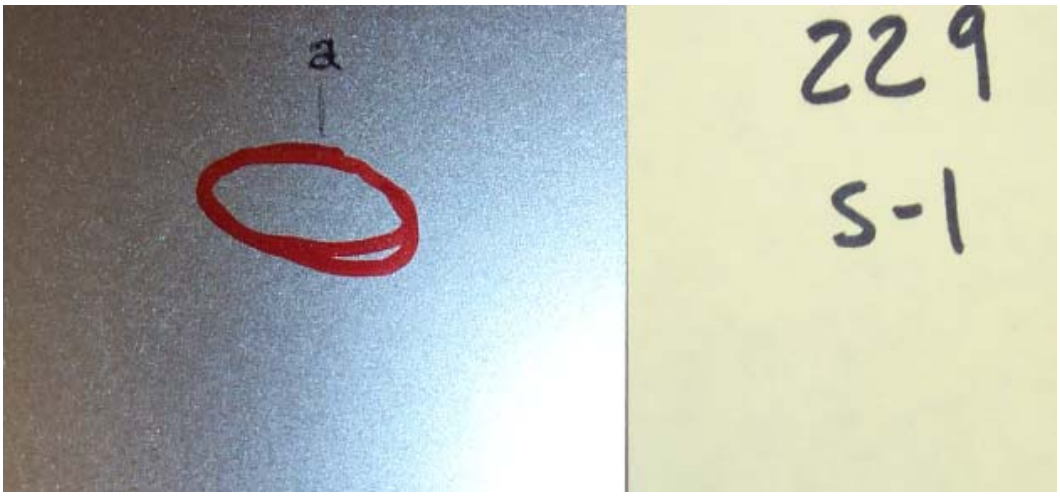


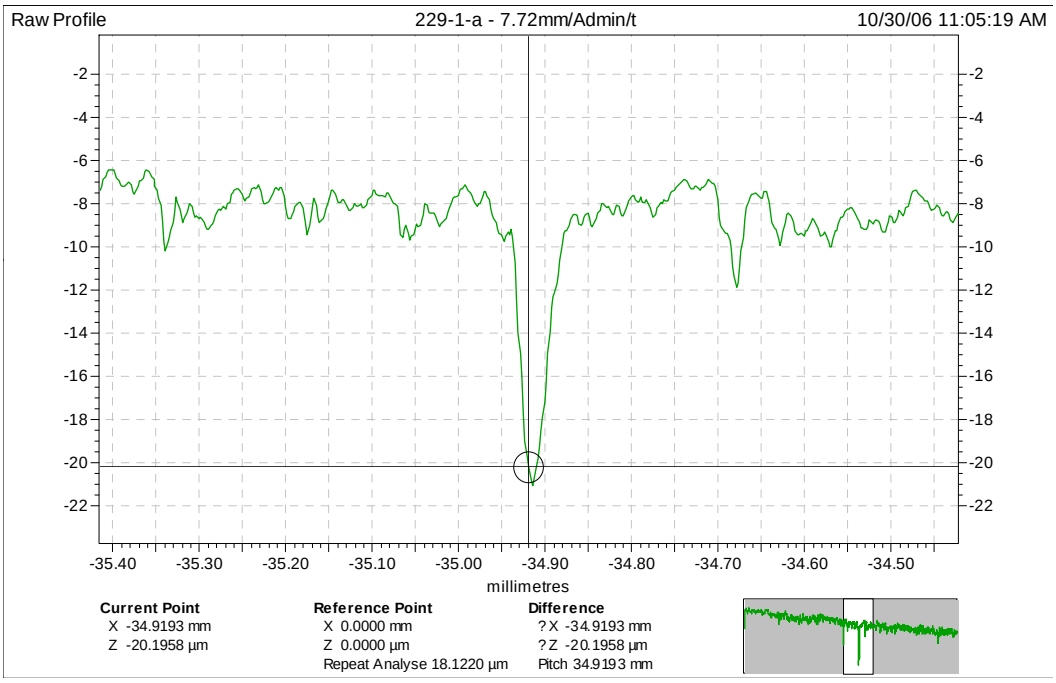
Figure 8 Square 162 color map of the thickness over one quarter of the surface

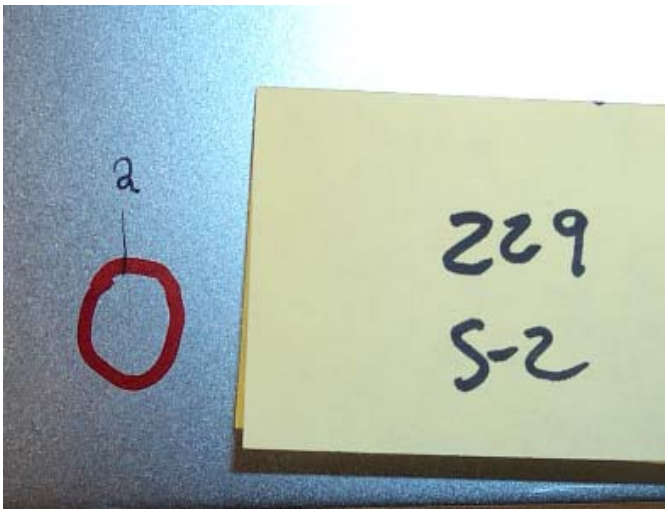
Results of the measurements are shown in Fig. 8. The square had an average thickness of 3.068 mm over 130 points with a standard deviation of 0.019 mm, the highest point was 3.116 mm and the lowest 3.042 mm. This measurement confirms that the squares are within the expected tolerance of 0.1 mm for the material thickness, but also that the material is thicker than expected.

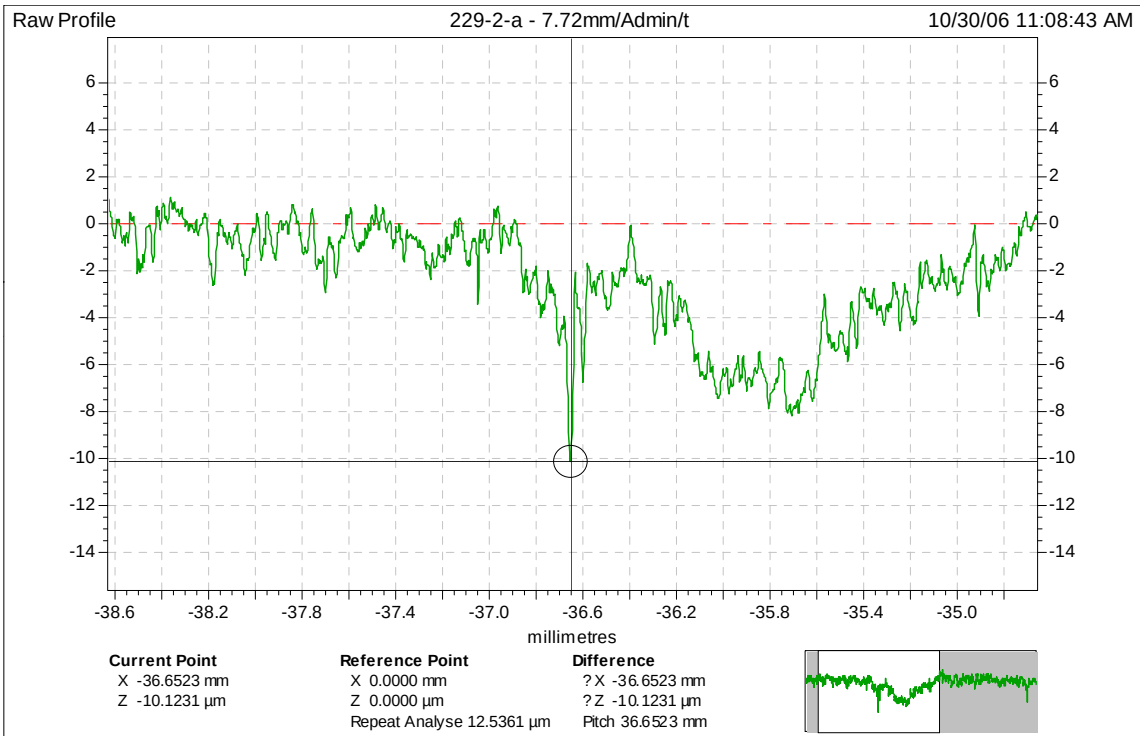
5.4 PROFILE MEASUREMENT

In the effort to better understand the relevance of scratches and pits on the Nb surface, squares 214 and 229 were measured with a Taylor-Hobsen profilometer. This technique allows detecting the deepness of pits and scratches. The scratches are more extended with respect to pits and most of the times do not show up in the scan results. The measurements shown below confirm that the scratches are less deep than the pits and will probably be removed during the material processing.






a
229
S-2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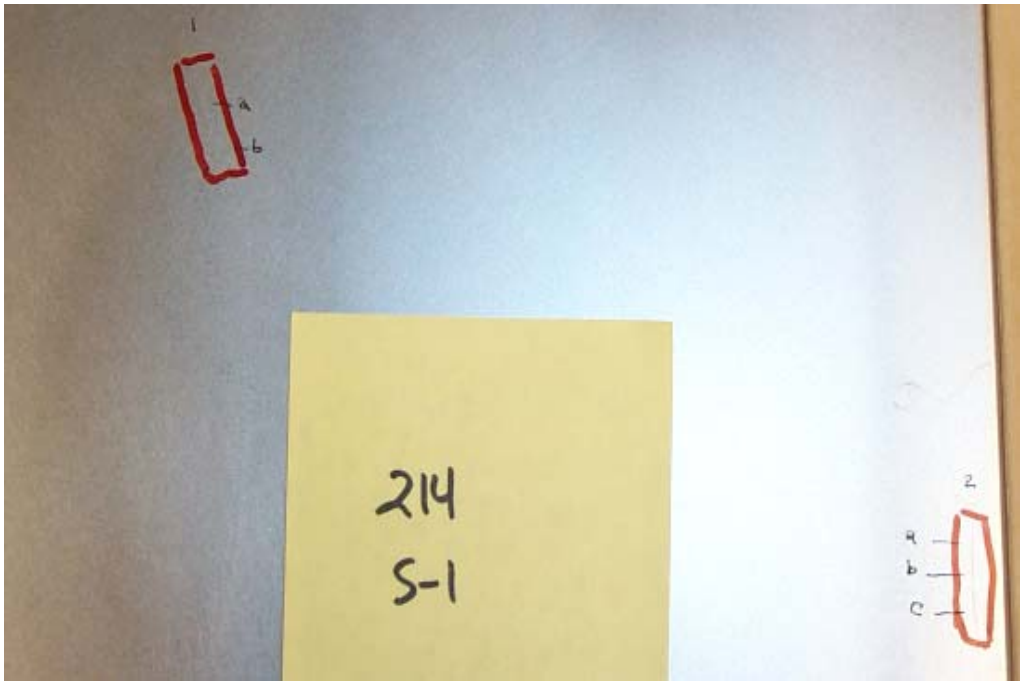
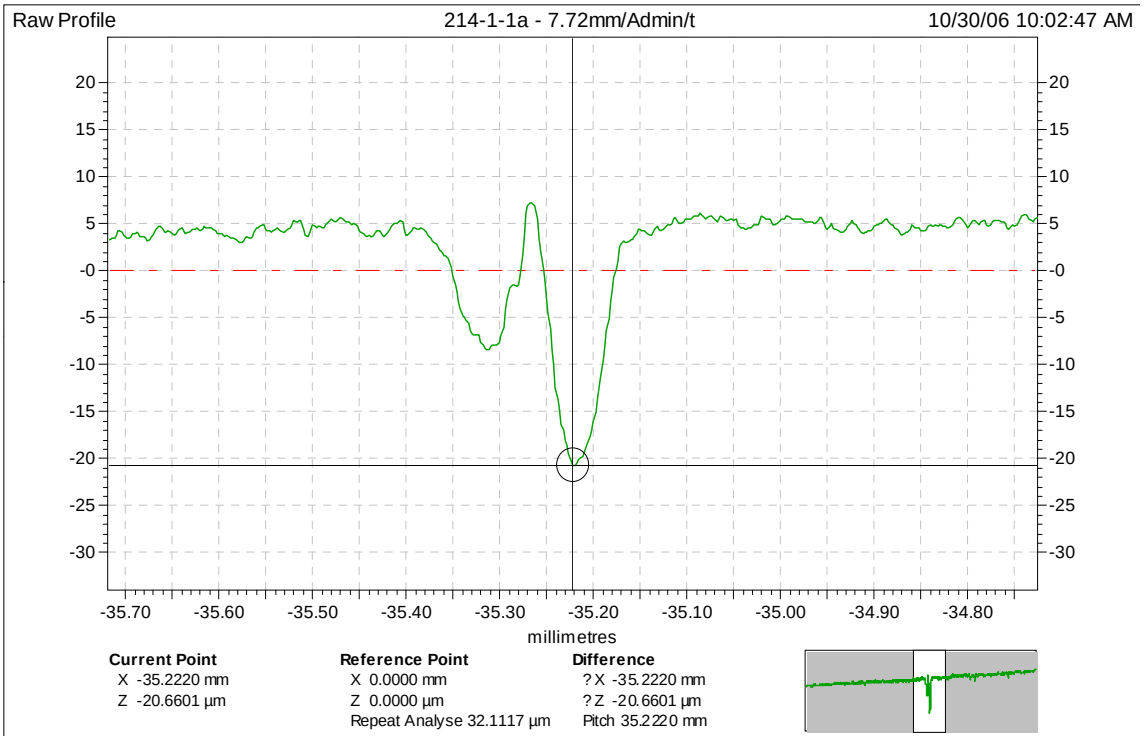
4
2
0
-2
-4
-6
-8
-10
-12
-14
-38.6
-38.2
-37.8
-37.4
-37.0
-36.6
-36.2
-35.8
-35.4
-35.0
millimetres
Current Point
X -36.6523 mm
Z -10.1231 µm
Reference Point
X 0.0000 mm
Z 0.0000 µm
Repeat Analyse 12.5361 µm
Difference
?X -36.6523 mm
?Z -10.1231 µm
Pitch 36.6523 mm


1
a
b
214
S-1
2
a
b
c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-20
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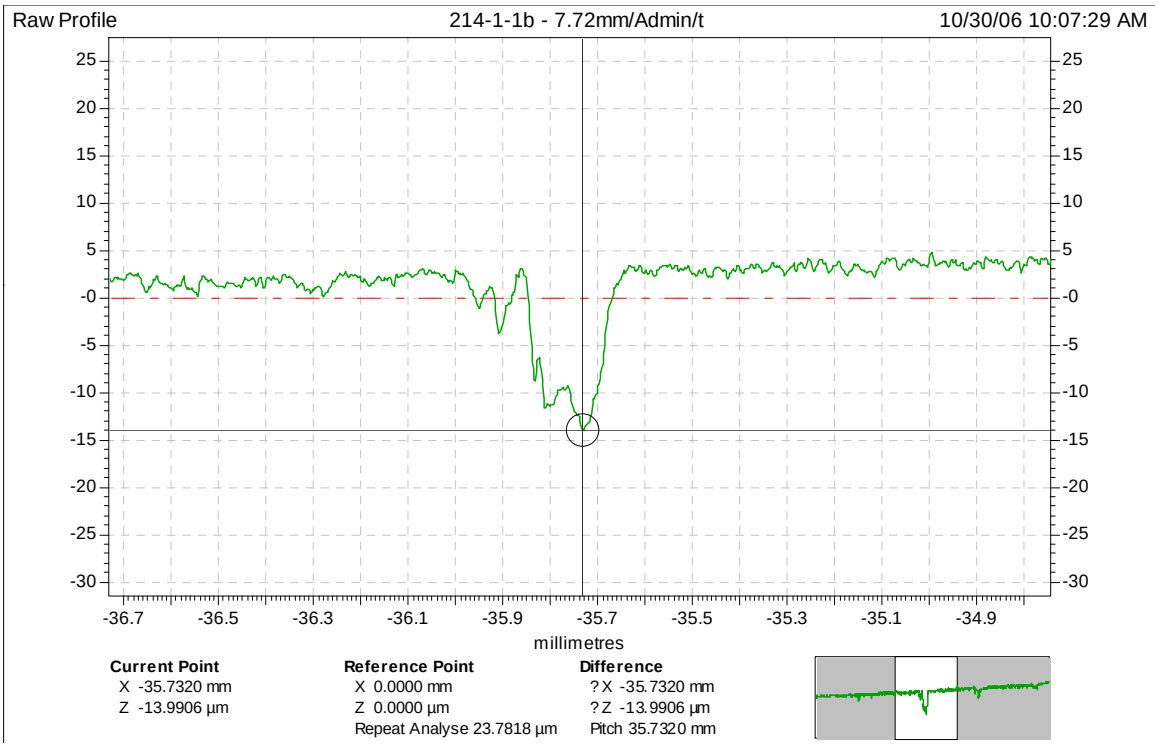
-30
-35.70
-35.60
-35.50
-35.40
-35.30
-35.20
-35.10
-35.00
-34.90
-34.80
millimetres
Current Point
X -35.2220 mm
Z -20.6601 µm
Reference Point
X 0.0000 mm
Z 0.0000 µm
Repeat Analyse 32.1117 µm
Difference
?X -35.2220 mm
?Z -20.6601 µm
Pitch 35.2220 mm


Raw Profile
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20
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10
5
-0
-5
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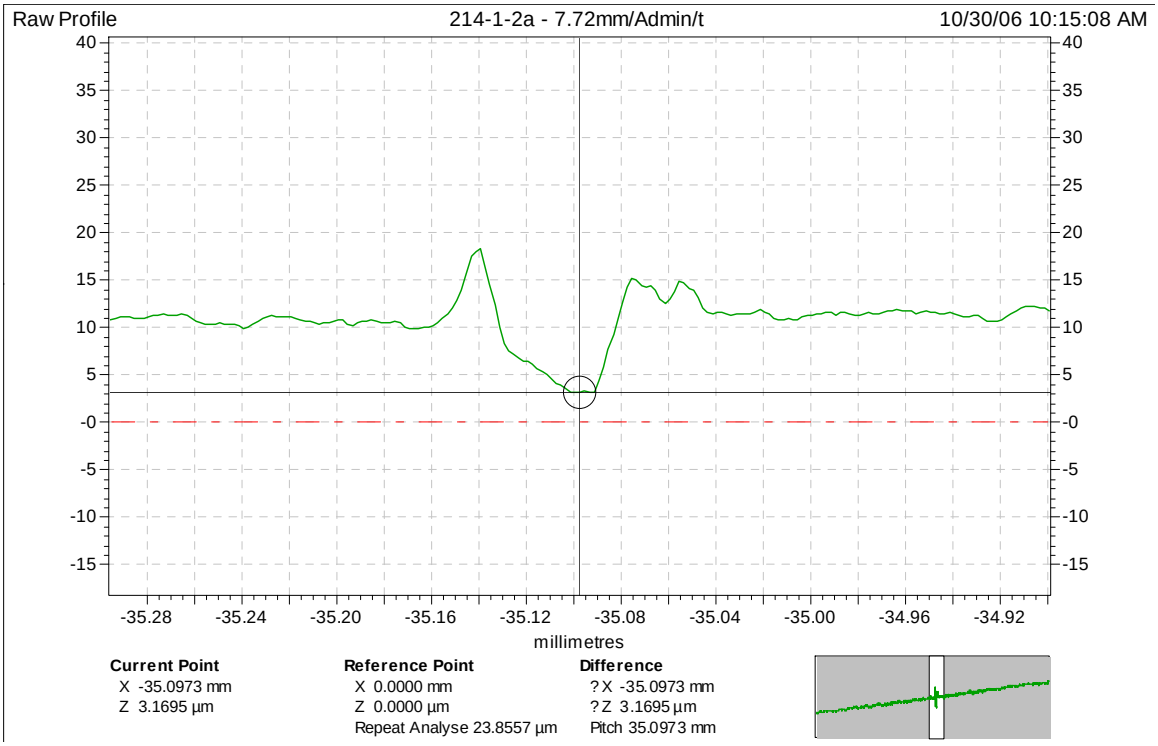
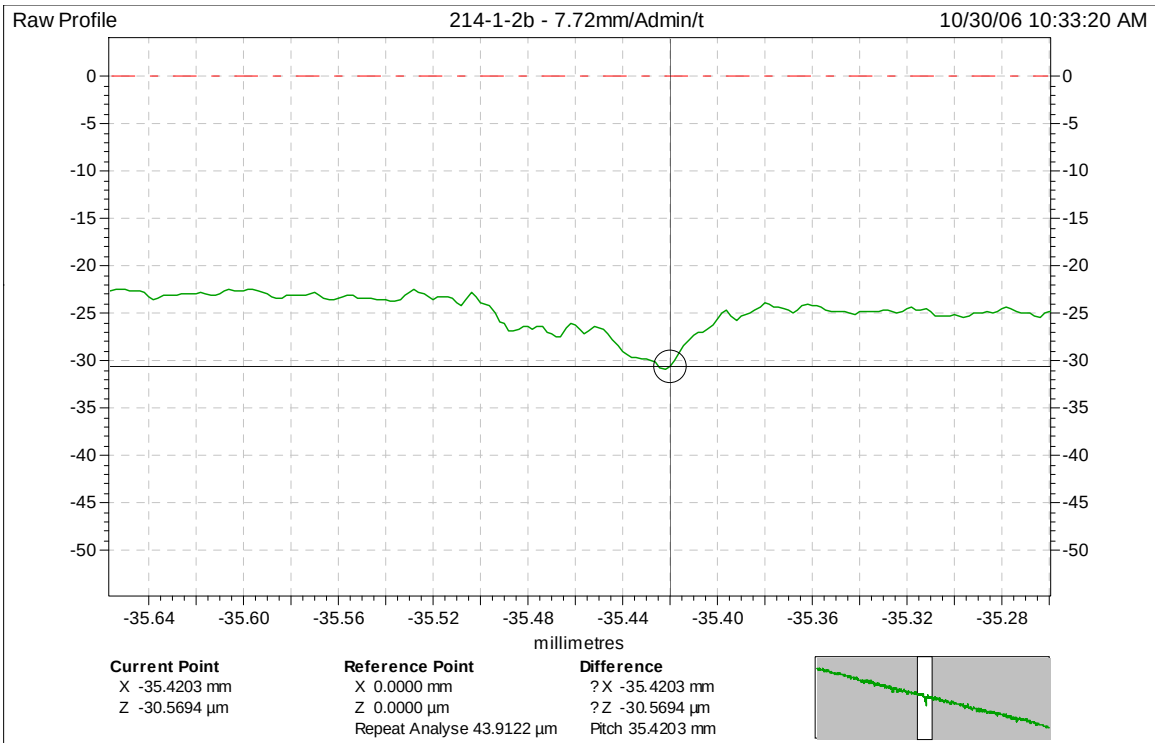
-36.3
-36.1
-35.9
-35.7
-35.5
-35.3
-35.1
-34.9
millimetres
Current Point
X -35.7320 mm
Z -13.9906 µm
Reference Point
X 0.0000 mm
Z 0.0000 µm
Repeat Analyse 23.7818 µm
Difference
?X -35.7320 mm
?Z -13.9906 µm
Pitch 35.7320 mm


Raw Profile
214-1-2a - 7.72mm/Admin/t
10/30/06 10:15:08 AM
40
35
30
25
20
15
10
5
-0
-5
-10
-15
-35.28
-35.24
-35.20
-35.16
-35.12
-35.08
-35.04
-35.00
-34.96
-34.92
millimetres
Current Point
X -35.0973 mm
Z 3.1695 µm
Reference Point
X 0.0000 mm
Z 0.0000 µm
Repeat Analyse 23.8557 µm
Difference
?X -35.0973 mm
?Z 3.1695 µm
Pitch 35.0973 mm


Raw Profile
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-15
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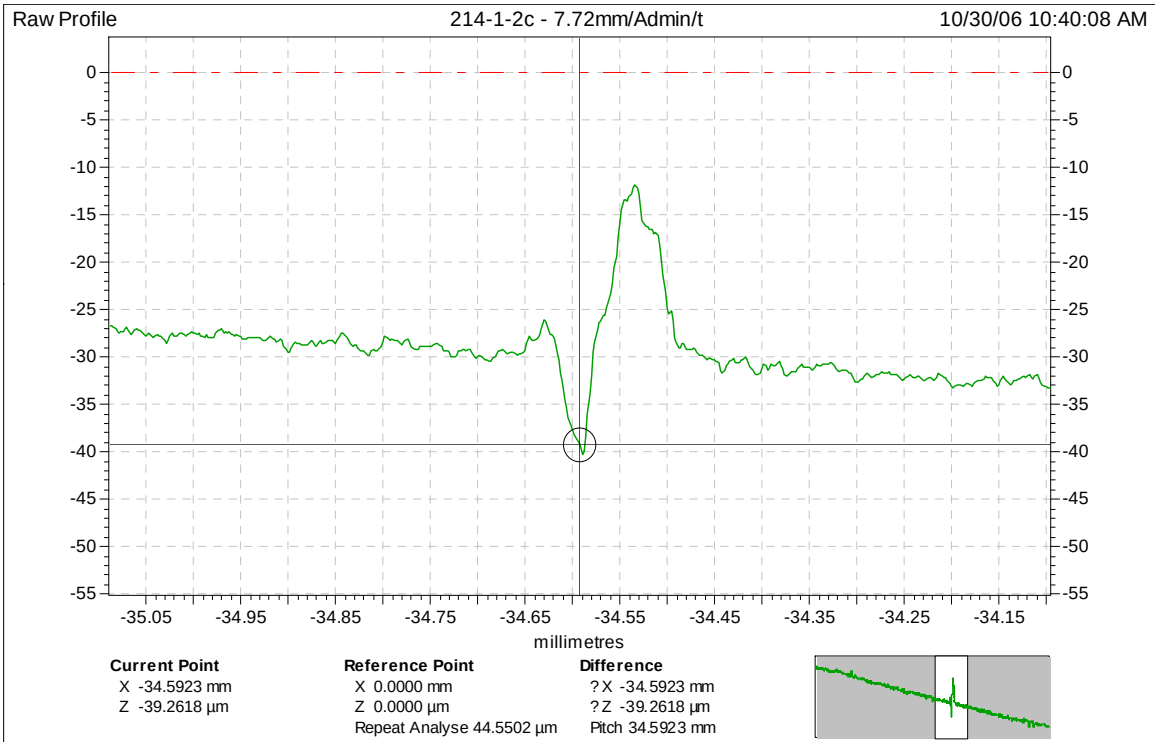
-50
-35.64
-35.60
-35.56
-35.52
-35.48
-35.44
-35.40
-35.36
-35.32
-35.28
millimetres
Current Point
X -35.4203 mm
Z -30.5694 µm
Reference Point
X 0.0000 mm
Z 0.0000 µm
Repeat Analyse 43.9122 µm
Difference
?X -35.4203 mm
?Z -30.5694 µm
Pitch 35.4203 mm


Raw Profile
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-5
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-15
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-50
-55
-35.05
-34.95
-34.85
-34.75
-34.65
-34.55
-34.45
-34.35
-34.25
-34.15
millimetres
Current Point
X -34.5923 mm
Z -39.2618 µm
Reference Point
X 0.0000 mm
Z 0.0000 µm
Repeat Analyse 44.5502 µm
Difference
?X -34.5923 mm
?Z -39.2618 µm
Pitch 34.5923 mm

5.5 MICROSCOPY

Squares 170, 194, 217 and 232 showed strong signals on the scan results but no correlation with surface features. This is the first case we observe this type of defect at FNAL. In order to obtain more information on this issue, the four samples were sent to outside microscopy labs for further investigations.

6 SUMMARY

A total of 94 square blanks, to be used for the production of 4 ILC cavities plus test samples, underwent the optical inspection and the eddy current scanning quality control. All the material typically showed what we believe are C clamp marks in 4 for spots on each side and the edges presented a bevel due to the cutting process.

Out of the 94 total, 43 (46%) blanks had no signal (**OK**), 40 (43%) gave signals on one side only and 7 (7%) gave a signal on both sides (**NO** or **NO**). Most of the signals are the result of the visual inspection an only a smaller portion is visible on the scan result. Never the less in four cases the scanner revealed signals not corresponding to any surface feature. In order to better understand these cases, the correspondent blanks have been sent out to microscopy labs for additional investigations. We also discovered that an indentation on the scanner rotating plate generated pits on each side of the blanks. Fortunately these pits are in the area that will be cut out during the fabrication process. The indentation has been eliminated and covered with tape. In order to avoid these problems and in general to keep the material surface cleaner and scratch free, a sample was scanned when protected by a clear vinyl coating. The presence of the coating did not affect the scan results opening for the possibility to apply this technique during all future scanning processes.

In terms of diagnostic tools, the mechanical profilometry measurements, performed in IB4 QC, are now a routine technique. In addition we also applied the rust check technique, used to identify possible iron inclusions on the surface of the material as a result of the rolling process. The rust check consists on dipping the material in a light nitric acid solution for a couple of minutes to eliminate the oxide layer and, immediately after rinsing, drop it in a container filled with UPW for 24 hours. If any iron is present on the surface, rust will be visible. Anodization was also used for the first time to check surface inclusions.

Finally we confirmed previous tests showing that when pits are visible in the scan results, they might not be removed during the cavity fabrication process.