

# Minutes of the 40<sup>th</sup> SOHO SWT Meeting

Toulouse, France

14 October 2008

## Agenda

- 1) Welcome and actions revision
- 2) Spacecraft status and prospects
  - Power
  - Thermal
  - Experiment LCL monitoring
  - Bogart phase overview
- 3) Ground system status + status of automation
- 4) DSN: changes after the loss of the 26 m stations
- 5) Instrument status
- 6) Operations during the Bogart Mission
  - Changes to operations
  - EOF  $\Rightarrow$  BOF (Bogart Operations Facility)
  - Remote teams' IT infrastructure
- 7) SOHO archive status
- 8) Future meetings
- 9) Final SOHO archive
- 10) AOB

## Participants

F. Auchère (EIT), H. Benefield (FOT), P. Boumier (GOLF), M. Charra (GOLF), V. Domingo (Univ. Valencia), B. Fleck (ESA), C. Fröhlich (VIRGO), A. Gabriel (GOLF), D. Germerott (SUMER), G. Grec (GOLF), J. Gurman (EIT, NASA), R. Howard (LASCO), B. Klecker (CELIAS), R. Müller-Mellin (COSTEP), G. Noci (UVCS), J.-P. Olive (EADS Astrium), C. Renaud (GOLF), P. Scherrer (MDI), U. Schühle (SUMER), H. Schweitzer (ESA), S. Turck-Chièze (GOLF), E. Valtonen (ERNE), T. van Overbeek (ESA)

## Actions

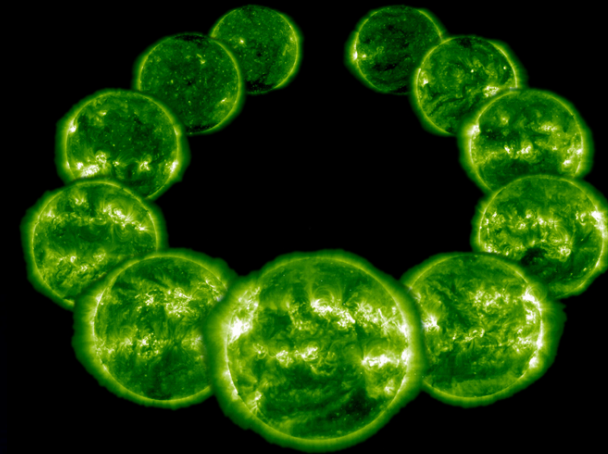
**40-1: on remote teams:** verify bootability and patchability of current duneon systems by 30 November 2008. If systems cannot be booted or patched, they should be replaced before 31 May 2009.

## Summary

- Need to follow up power issues, in particular wrt peak power consumption.
- Need to follow up thermal issues, in particular for those instruments that use substitution heaters when ON (GOLF, SUMER, UVCS).
- It seems possible to continue the MDI structure program at no extra cost, but there may be issues during keyholes as LASCO will have priority.
- Endorsed John Kohl's proposal for SOHO-23 "Understanding a Peculiar Solar Minimum", to be held from 22 to 25 September 2009 in Northeast Harbor, Maine.
- Next SWT meeting tentatively planned for end of September 2009 in conjunction with SOHO-23 in Maine.



# SOHO SWT-40

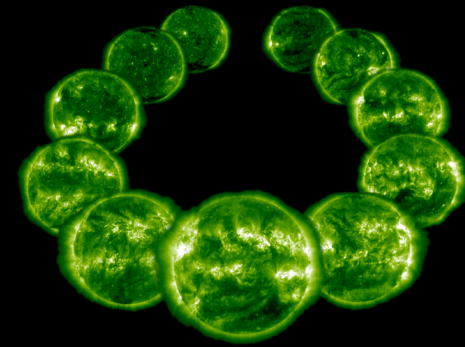


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# *Actions Revision*

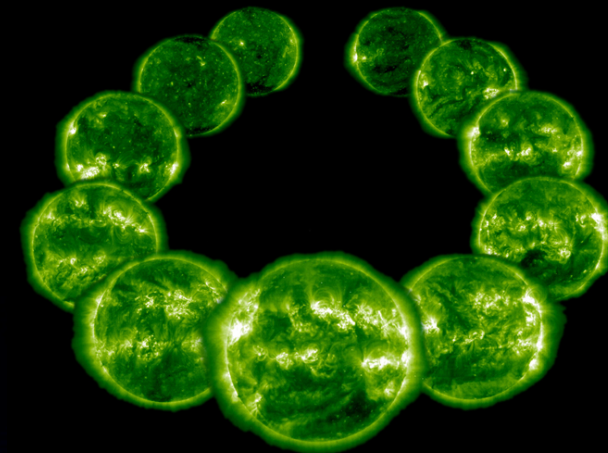


- **Action 39-1: on remote teams:**  
verify bootability and patchability of current  
dungeon systems before 30 November 2008. If  
systems cannot be booted or patched, they should  
be replaced before 31 May 2009.





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# Spacecraft status: overall



- ❑ **Power:**
  - Solar Arrays degradation of 20% since launch
  - Margin: section 1 has never been on the bus but margin is decreasing
- ❑ **Remaining fuel: 116kg**
- ❑ **Equipments: all on A-side**
  
- ❑ **Thermal: stable temperatures, FPSS Head warmer than its qualification level (>40C).**
  
- ❑ **Spacecraft HW failures:**
  - Loss fast lock loop of Receiver 1 (1997 Apr)
  - Loss of all 3 gyros (1998 Sep and Dec)
  - Loss of battery 1 (2002 Mar)
  - HGA antenna Z axis stuck (2003 May)
  - Loss of FSPAAD (2004 Apr)
  
- ❑ **CDMU memory: single-bit errors corrected by EDAC (since Sept 2008)**



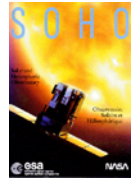
# Power Budget: introduction



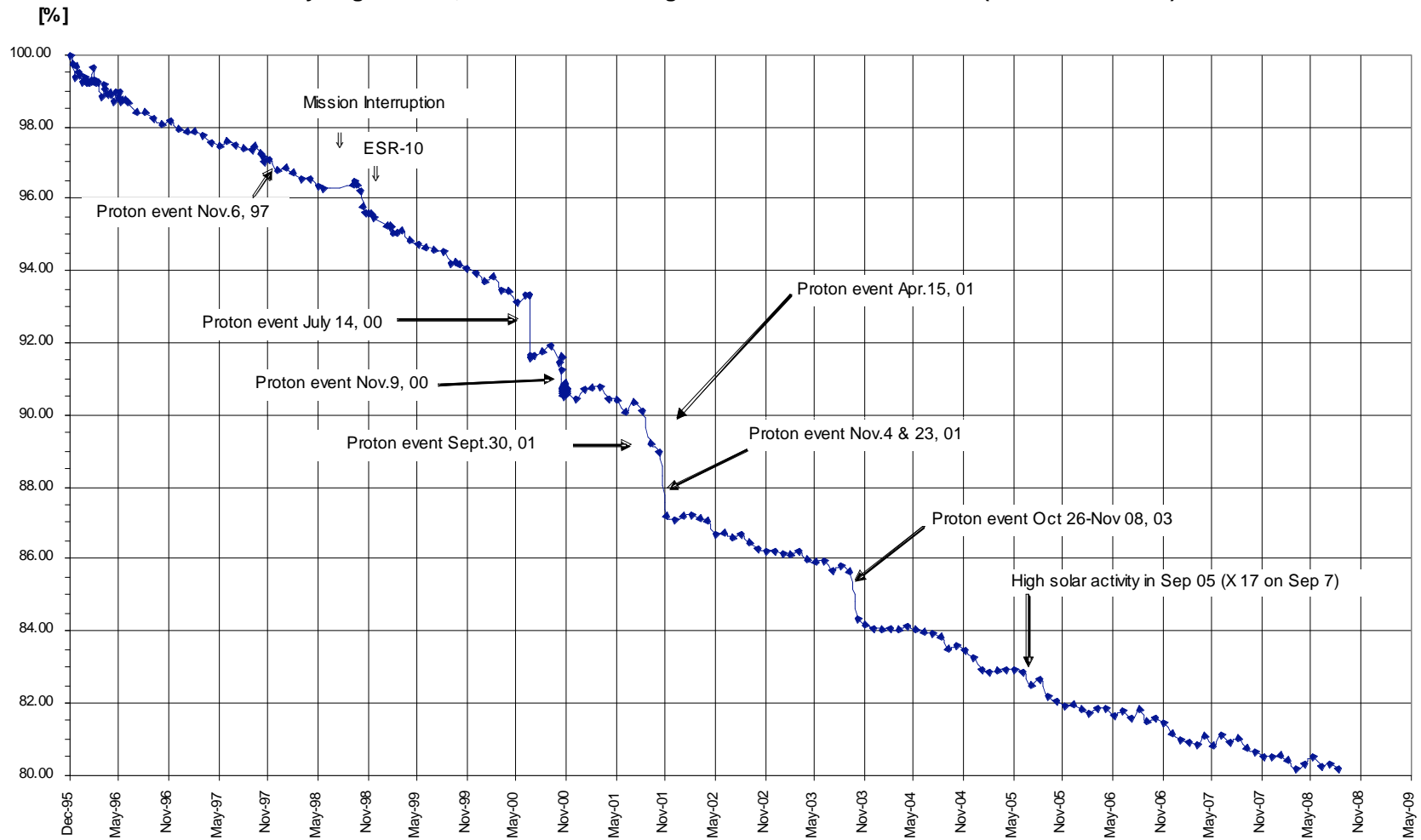
- ❑ **Solar arrays degradation: average of 1.6% per year**
  - Which corresponds to roughly a total of 1A per year
  
- ❑ **Power consumption fluctuates (average 33A, peaks at 41A) due to**
  - Seasonal effect
  - Extra power for experiments (move mechanism, special observations, ...)
  - SVM heaters cycling (in mode 1: over several hours to several days)
  - Extra consumption cases
    - Key Holes (UVCS substitution heater, EIT bake out, ...)
    - Maneuvers (specially ROLL maneuvers)
  
- ❑ **Battery 1 is dead (Dec 2001)**
- ❑ **Battery 2 status: in trickle charge but not used since 1998-Sep**



# Solar arrays degradation



SOHO Solar Array Degradation, based on the average of the two section currents (PISW1 and PISW2)

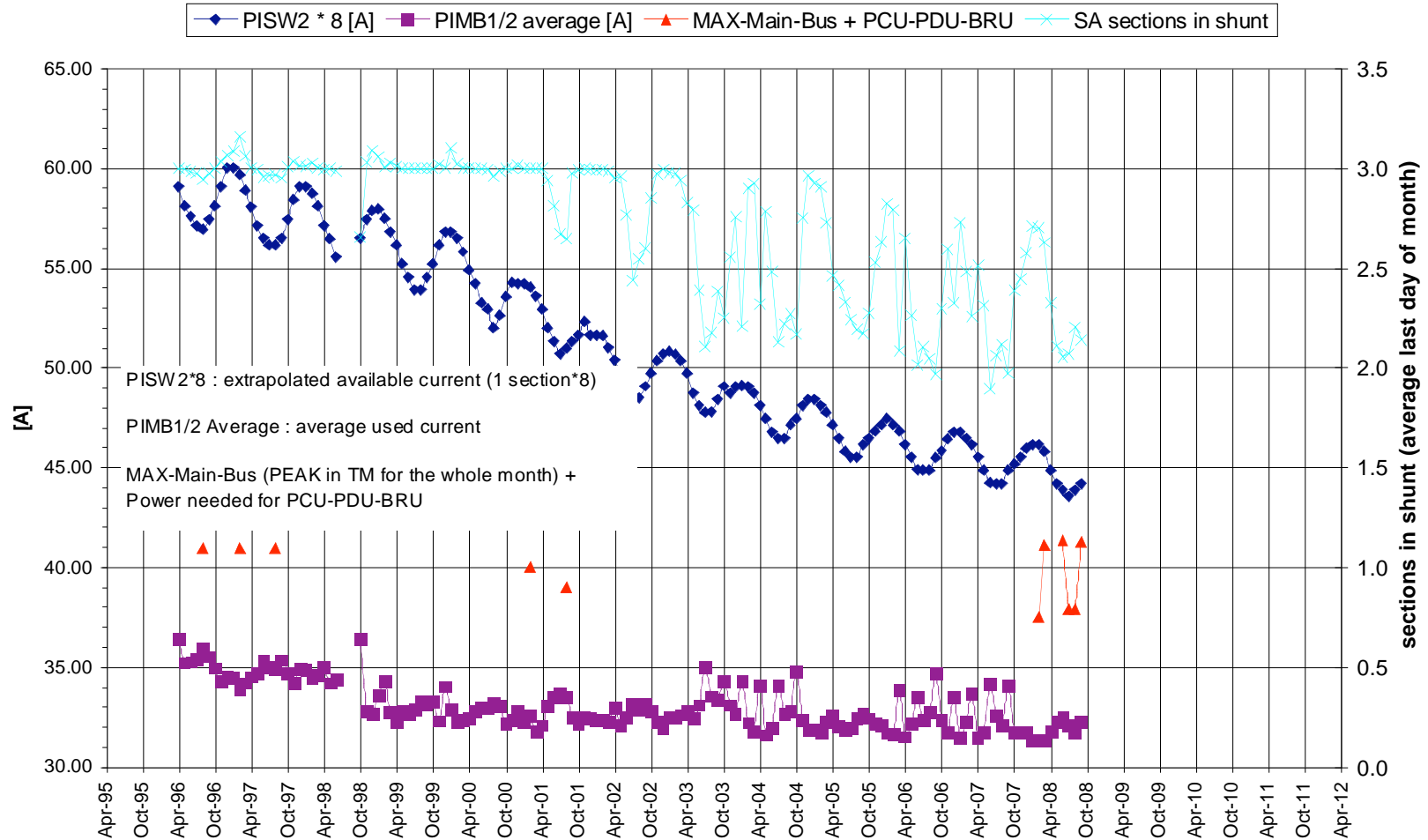






# Power budget margin

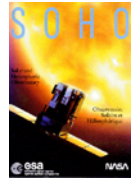
## SOHO Power Generation Margin





# Power budget: conclusion

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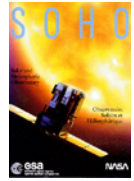
- ❑ Power budget margin is still OK (specially for average consumption at 33A)
- ❑ Peak consumption sometimes 8A above average (during last Keyhole only one section was still in shunt)
- ❑ Note for Mission Extension for Bogart:
  - Summer Keyhole occurring closer and closer to aphelion (worst case predicted for 2012)
- ❑ Recommendations
  - Reduce power consumption at aphelion (specially for keyhole)
  - Switch OFF or reduce heaters
  - Overall coordinate planned spacecraft activities to ensure staying within power available from Solar Arrays

# Thermal: use of substitution heaters 1/5



- ❑ **Some substitution heaters are ON, at a reduced power level, when instrument is still ON:**
  - **GOLF: to compensate for a reduced power mode (since April 2005)**
  - **SUMER: when door is closed and detectors switched OFF**
  - **UVCS: during key Hole to keep warm the aft of the instrument when the shutter is closed and detectors switched OFF**
  
- ❑ **Duty cycles have been changed for both nominal and redundant substitution heaters.**

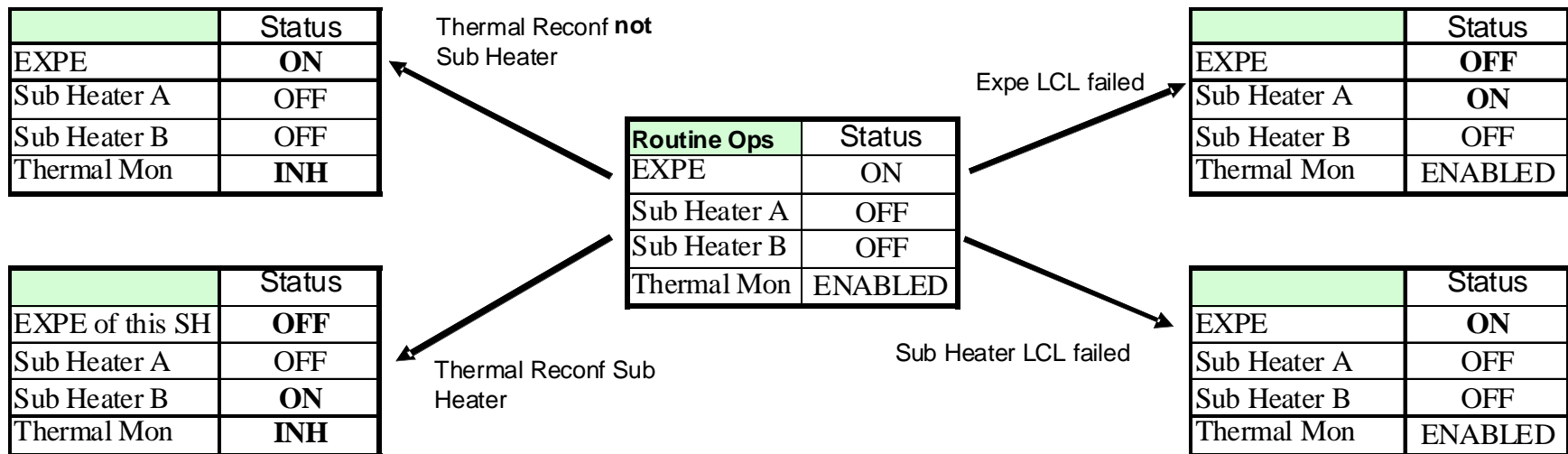
|  |            |                               |
|--|------------|-------------------------------|
| ➤ <b>GOLF sensor (circ 68)</b>   | <b>30%</b> | <b>vs 80% when GOLF OFF</b>   |
| ➤ <b>GOLF electronics (circ 69)</b>                                    | <b>30%</b> | <b>vs 100% when GOLF OFF</b>  |
| ➤ <b>SUMER sensor (circ 82)</b>  | <b>30%</b> | <b>vs 100% when SUMER OFF</b> |
| ➤ <b>UVCS sensor (circ 84)</b><br><b>(limited difference for UVCS)</b> | <b>50%</b> | <b>vs 60% when UVCS OFF</b>   |



# Thermal: use of substitution heaters 2/5

- ❑ SOHO design is based on substitution heater OFF as soon as instrument is switched ON (and reciprocally).
- ❑ Thermal reconfiguration with substitution heater OFF when instrument is ON: note that after a first failure experiment is thermally safe

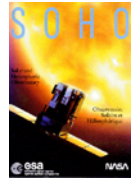
Thermal reconf => switch over to redundant heaters



Sub heater failed => switch over to redundant heater



# Thermal: use of substitution heaters 3/5



- ❑ Thermal reconfiguration with substitution heater ON (with reduced level for BOTH nominal and redundant heaters as it is now for GOLF and SUMER) when instrument is ON
  - There are 2 cases when instrument is switched OFF and could become too cold (it happened in January 2007 and was solved by the FOT turning ON the instruments)

Thermal reconf => switch over to redundant heaters

Expe LCL failed => switch ON nominal substitution heater

|              | Status    |
|--------------|-----------|
| EXPE         | ON        |
| Sub Heater A | OFF lower |
| Sub Heater B | ON lower  |
| Thermal Mon  | INH       |

Thermal Reconf  
not Sub Heater

| Routine Ops  | Status    |
|--------------|-----------|
| EXPE         | ON        |
| Sub Heater A | ON lower  |
| Sub Heater B | OFF lower |
| Thermal Mon  | ENABLED   |

Expe LCL failed

| Expe OFF too cold | Status    |
|-------------------|-----------|
| EXPE              | OFF       |
| Sub Heater A      | ON lower  |
| Sub Heater B      | OFF lower |
| Thermal Mon       | ENABLED   |

Thermal Reconf Sub Heater

| Expe OFF too cold | Status    |
|-------------------|-----------|
| EXPE              | OFF       |
| Sub Heater A      | OFF lower |
| Sub Heater B      | ON lower  |
| Thermal Mon       | INH       |

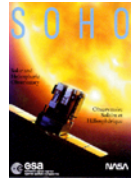
| Expe OFF too cold | Status    |
|-------------------|-----------|
| EXPE of this SH   | OFF       |
| Sub Heater A      | OFF lower |
| Sub Heater B      | ON lower  |
| Thermal Mon       | INH       |

Thermal Reconf Sub

Sub Heater LCL failed

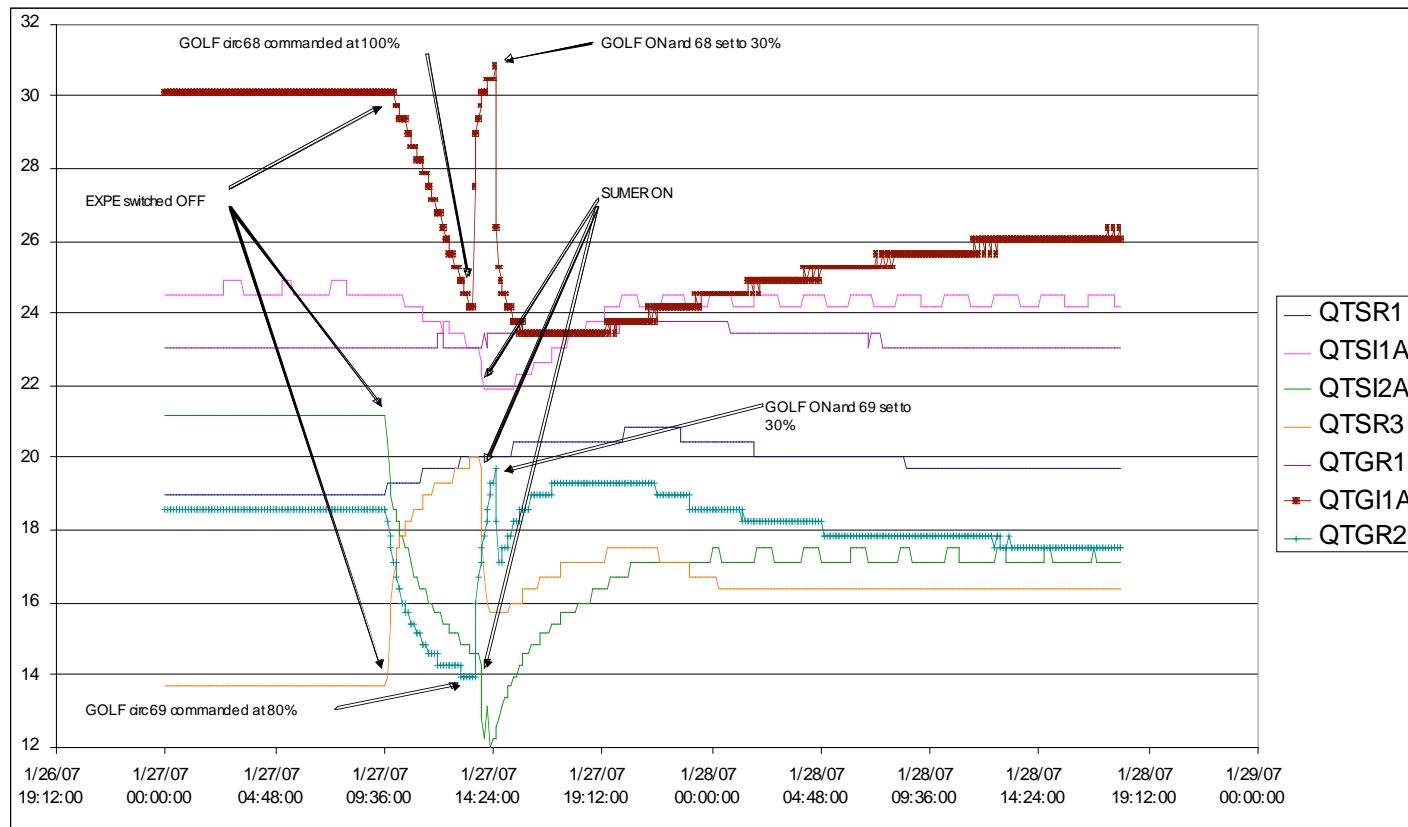
Not applicable since SH is already ON

|                     | Status    |
|---------------------|-----------|
| EXPE not of this SH | ON        |
| Sub Heater A        | OFF lower |
| Sub Heater B        | ON lower  |
| Thermal Mon         | INH       |



# Thermal: use of substitution heaters 4/5

- ❑ In Jan 2007, all experiments were switched OFF (due to spurious ON of SUMER redundant LCL)
  - GOLF and SUMER temperatures decreased quickly and the FOT had to command (switch ON SUMER and increase GOLF non op heaters)



# Thermal: use of substitution heaters 5/5



- ❑ **Current situation may be acceptable for UVCS**
  - Non op heater duty cycle settings are of the same order: 60% when UVCS OFF; 50% for UVCS safing during Key Hole
  
- ❑ **For SUMER and GOLF it is worth looking at ways to avoid switching ON Substitution Heater when experiment is ON**
  - Experiment internal heaters could be used (if any)
  
  - SUMER could keep detectors ON when not observing (To Be Assessed by SUMER team)
  
  - GOLF: with the PLM warming year after year, it may be that having non op heaters is not necessary (To Be Discussed with GOLF team)
    - GOLF substitution heaters were switched ON in April 2005



# COBS experiment LCL monitoring

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- ❑ **Four spurious ON/OFF of LCL happened (two OFF and two ON) since 2005**
  - In January 2007, due to SUMER redundant LCL unexpectedly ON, COBS Expe monitoring function switched OFF all instruments
  - However some instruments can afford to have their redundant LCL ON:  
CDS, CELIAS, CEPAC, SWAN, SUMER, VIRGO
  
- ❑ **To limit the effect on PLM of spurious LCL ON of instruments, it is suggested to limit COBS experiment LCL monitoring to the following instruments:  
GOLF, LASCO (TBC), MDI (TBC) and UVCS**

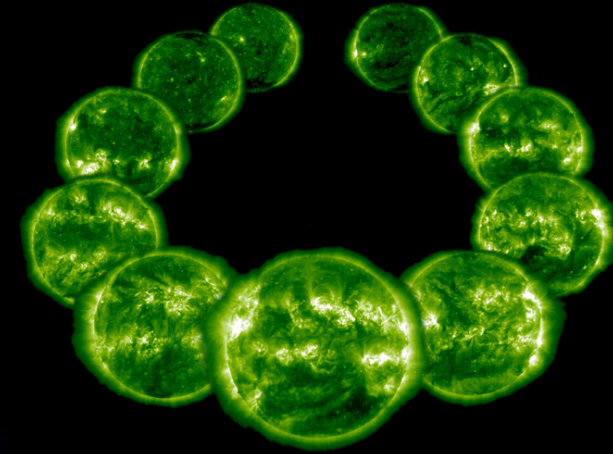
# Bogart phase presentation



- ❑ **SOHO Bogart phase will start when MDI is switched OFF**
  - After a period of cross calibration with SDO to be launched early 2010 (TBC) with a nominal mission of 5 years
- ❑ **Without MDI, pointing requirements are loosened**
  - Roll: Roll angle can be always at 0 or 180 degrees
  - Stars will stay within SSU field of view between 2 key Holes
  - RSL table still needed to follow stars
  - RSL table can be extended (from 6.33 days to 93 days) in order to cover the whole period between 2 Key Holes
- ❑ **Without MDI operations are easier**
  - No more VC2 and VC3



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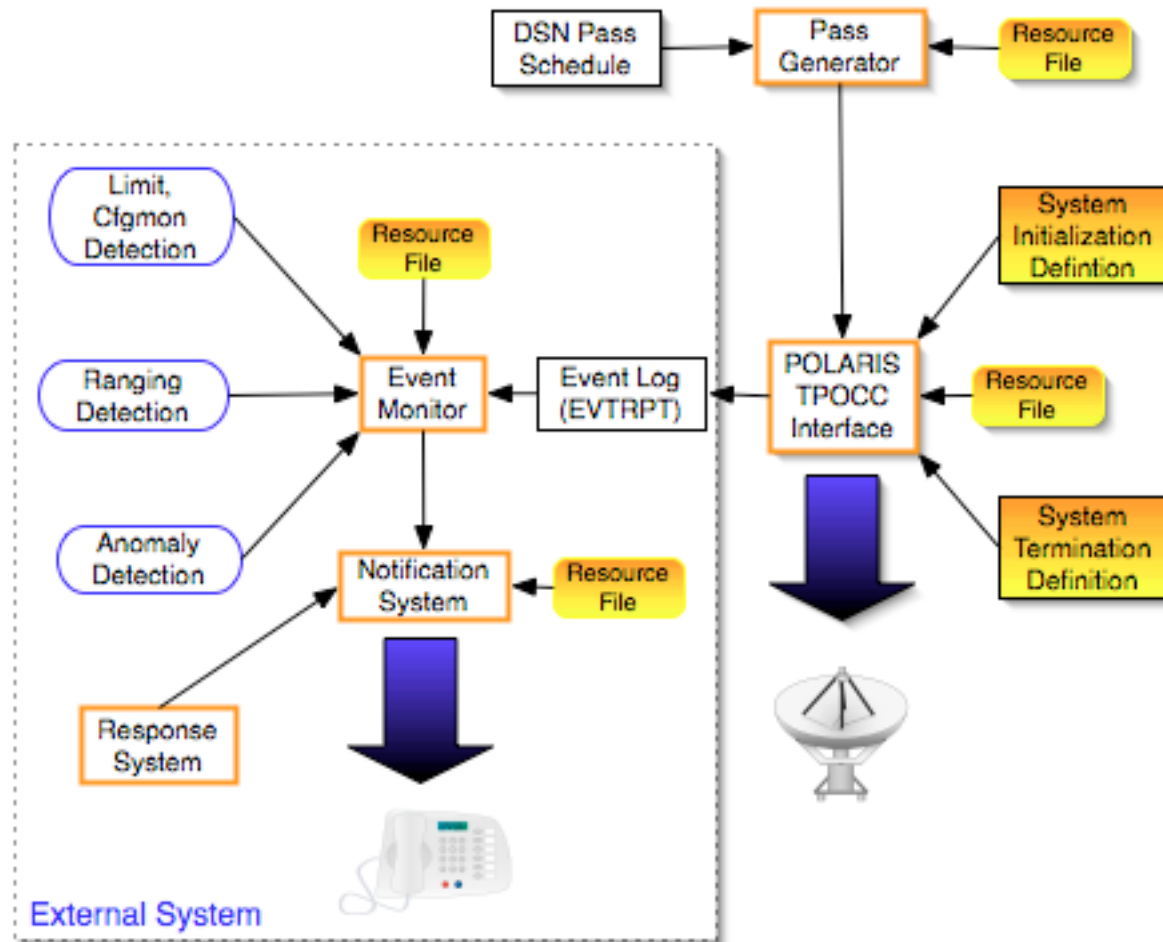
# SOHO Ground System and Automation Overview



Harold Benefield  
Lead Engineer  
October 14, 2008

**Honeywell**

# Design Overview



# Interfaces

- EOF
  - No change to interface
  - Provide projected NRT times as part of input to daily meeting
  - NRT enabled during unattended operations
  - Instrument teams can page on-call OE through Attention!





# Anomaly Notification

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- TPOCC generates
  - Limit violations
  - Configuration monitor violations
  - Software anomaly messages
- No changes made to TPOCC for automation
- ALL events from TPOCC sent to Attention! Server
- Attention! software processes all event messages for anomaly indications
- Notifications made based on FOT defined alarm status
- On-call OE paged/emailed based on calendar and schedule in Attention! Database
- Instrument teams emailed for all instrument limit violations



# DSN Interface Changes

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Honeywell

- Develop specific Sequence of Events (SOEs) for different pass conditions
- Change station handover criteria for unattended operations
- Monitor ground station taking unattended passes



# Operations Automation

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Honeywell

- Modified nominal operations procedures to run without user input
- Created new ground procedures to handle pass conditions
- Commanding for ranging operations moved onboard
- Emergency record moved onboard
- Automation now handles RSL upload and star acquisitions



# Spacecraft On-board Changes

Honeywell

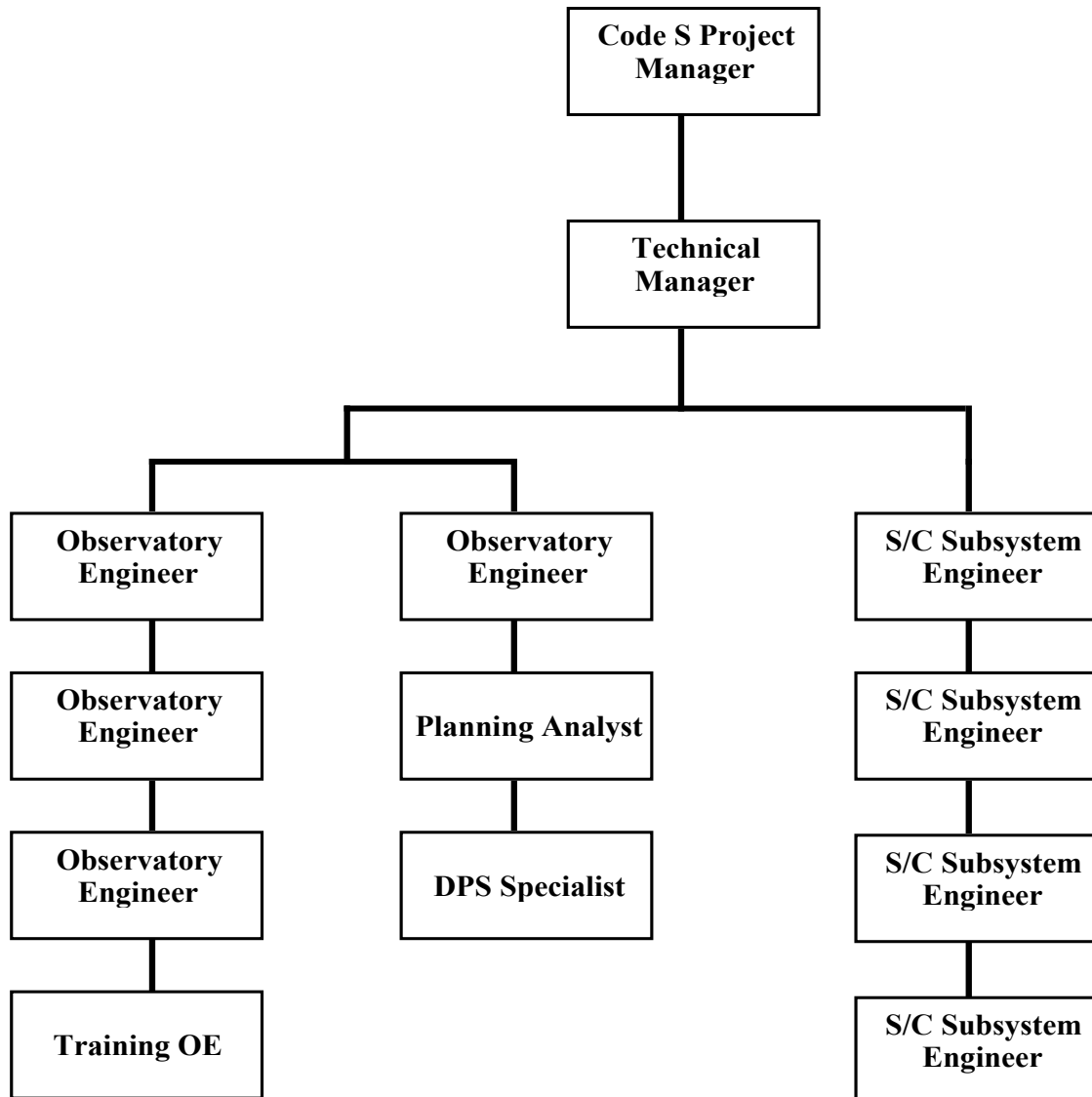
- Transition daily reaction wheel speed monitoring commanding to on-board function
  - COBS RW Speed Limits Update patch
    - Automate daily update of reaction wheel speed (uplinked 17 Apr 07)
    - New function enabled since patch uplink
- Add capability to use more “complex” commands to onboard macros.
  - COBS TCM in Macros patch
    - Ability to put software/OBDH commands in macros (uplinked 17 Apr 07)
    - New standard monitoring channels and macros uplinked 15 May 07
      - Used for 2-4 days before May 07 keyhole
      - In use since 4 June 07





# Authorized Automation Profile

Honeywell

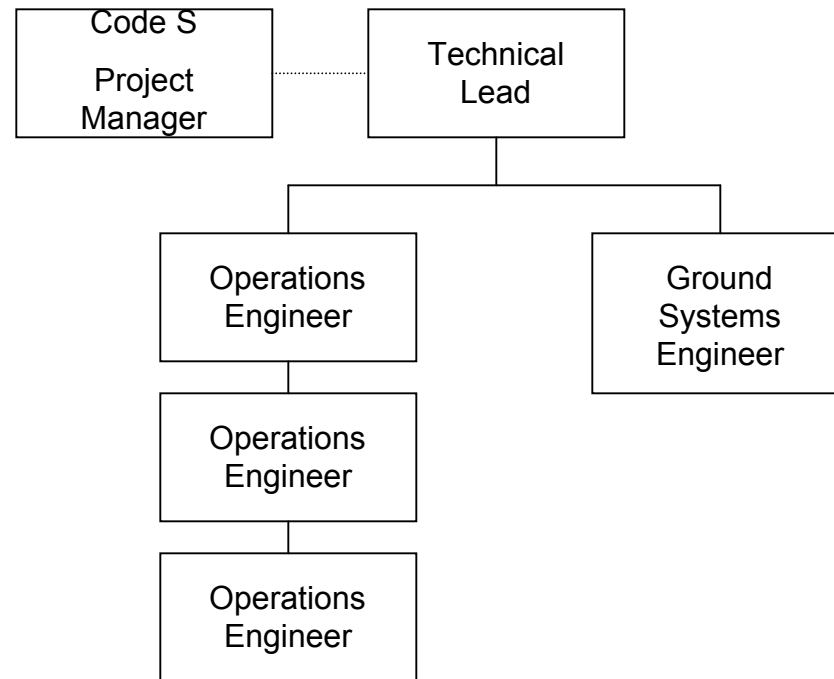


# Bogart Mission

- MDI switched OFF
- 3 passes/day to dump recorder
- LASCO prime instrument for space weather



# Bogart Mission Profile



# Current Status

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**Honeywell**

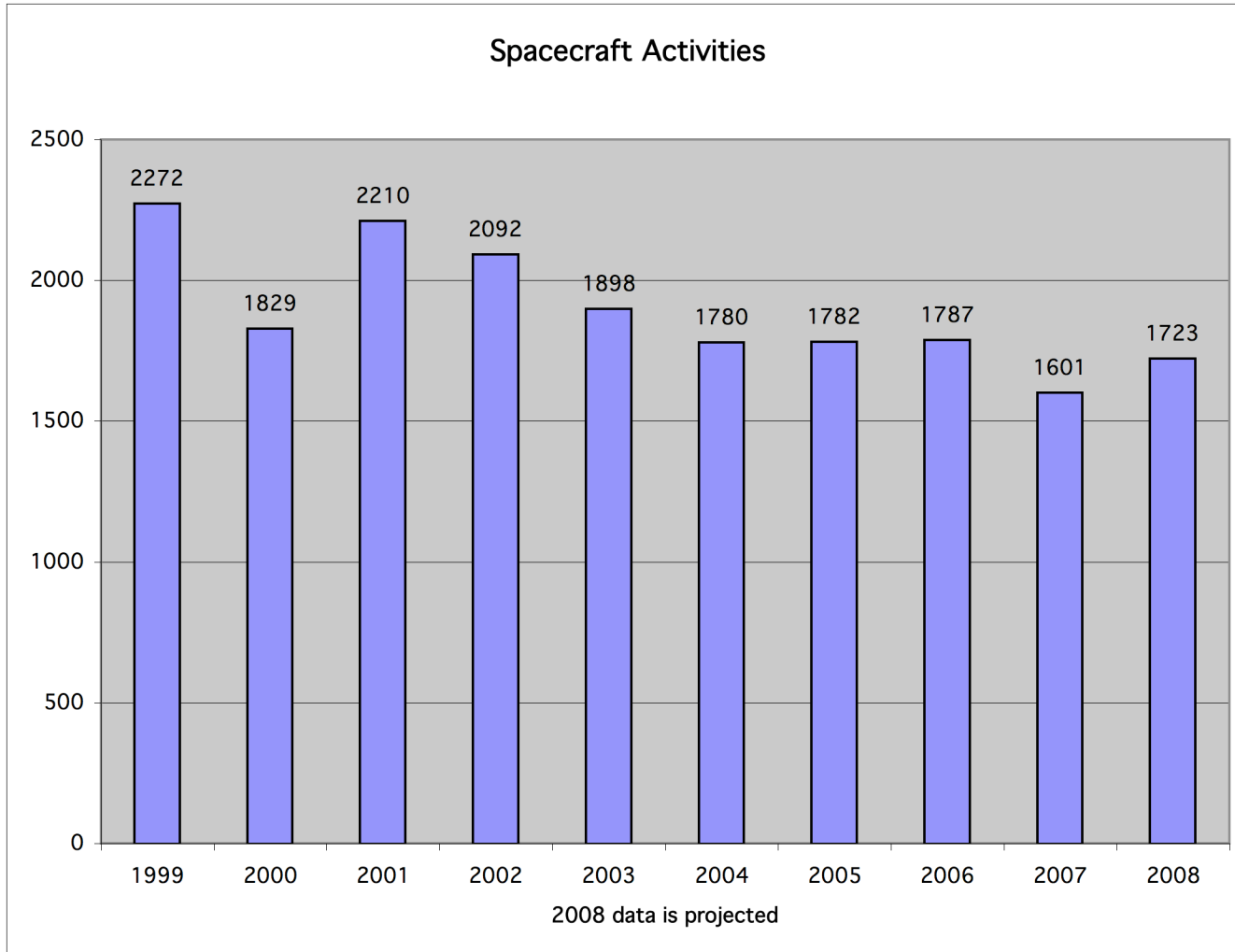
- Automation implemented
- Staffing reduction for automation
- Lights-out implementation being tested

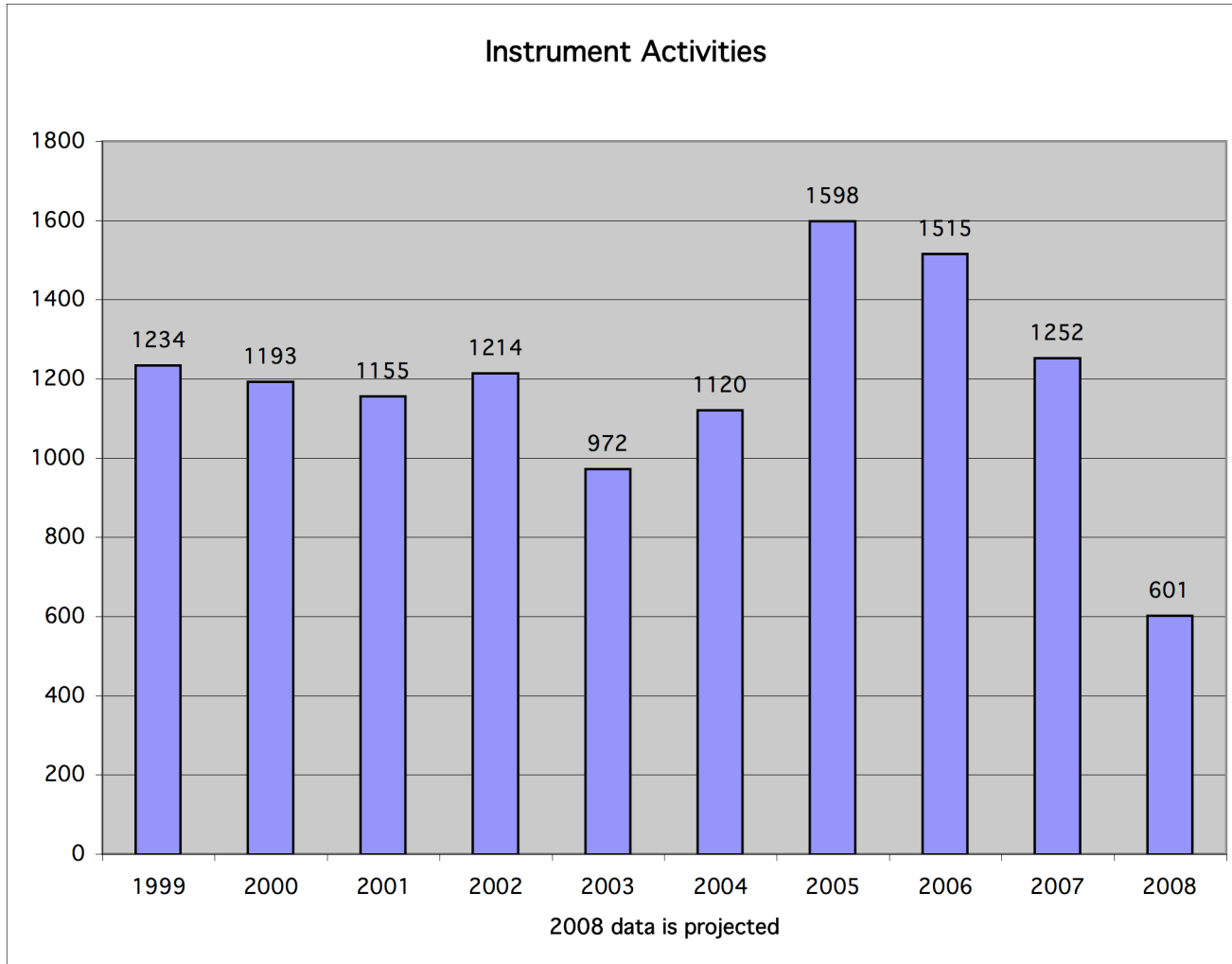


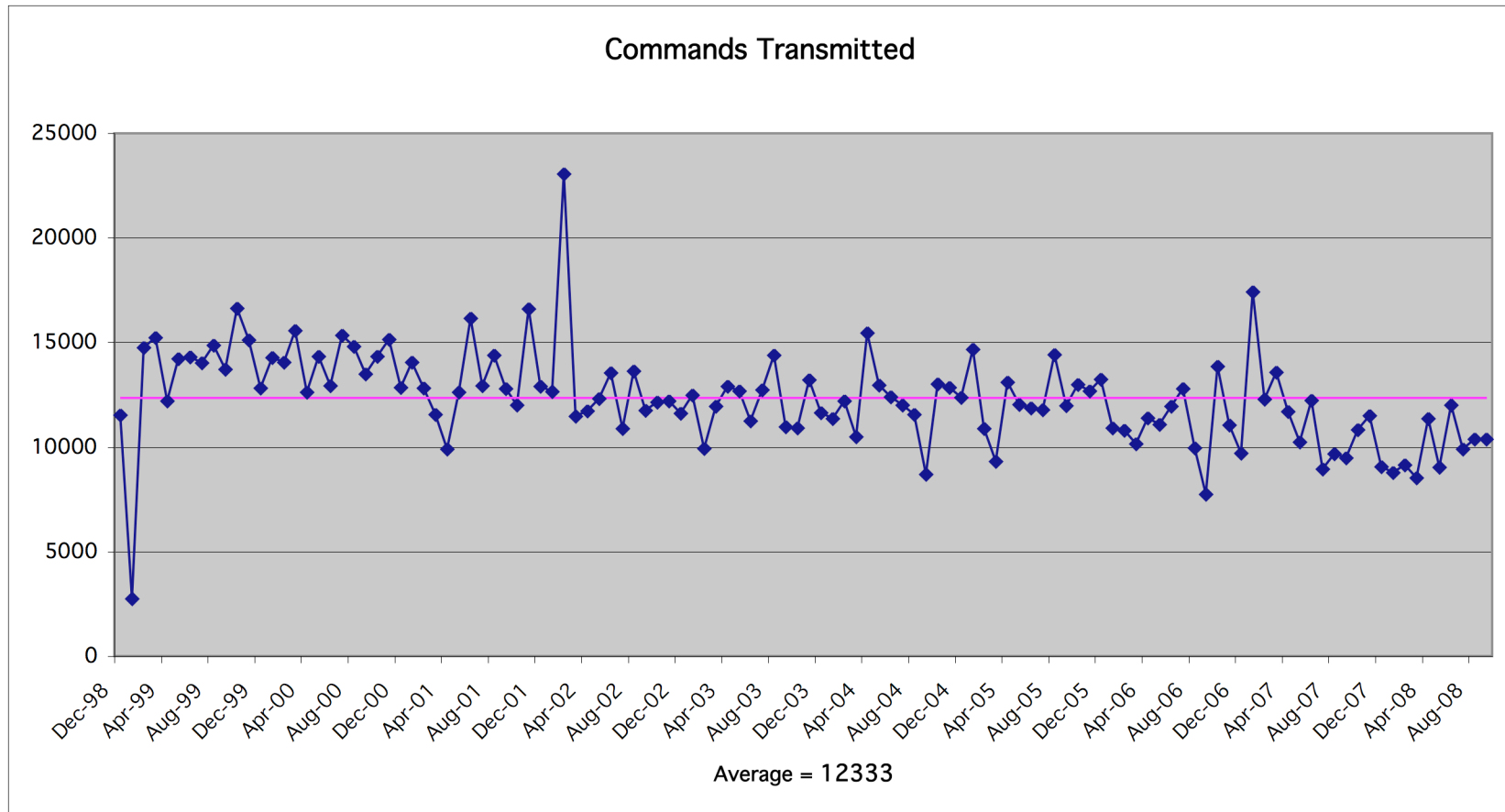


# Metrics

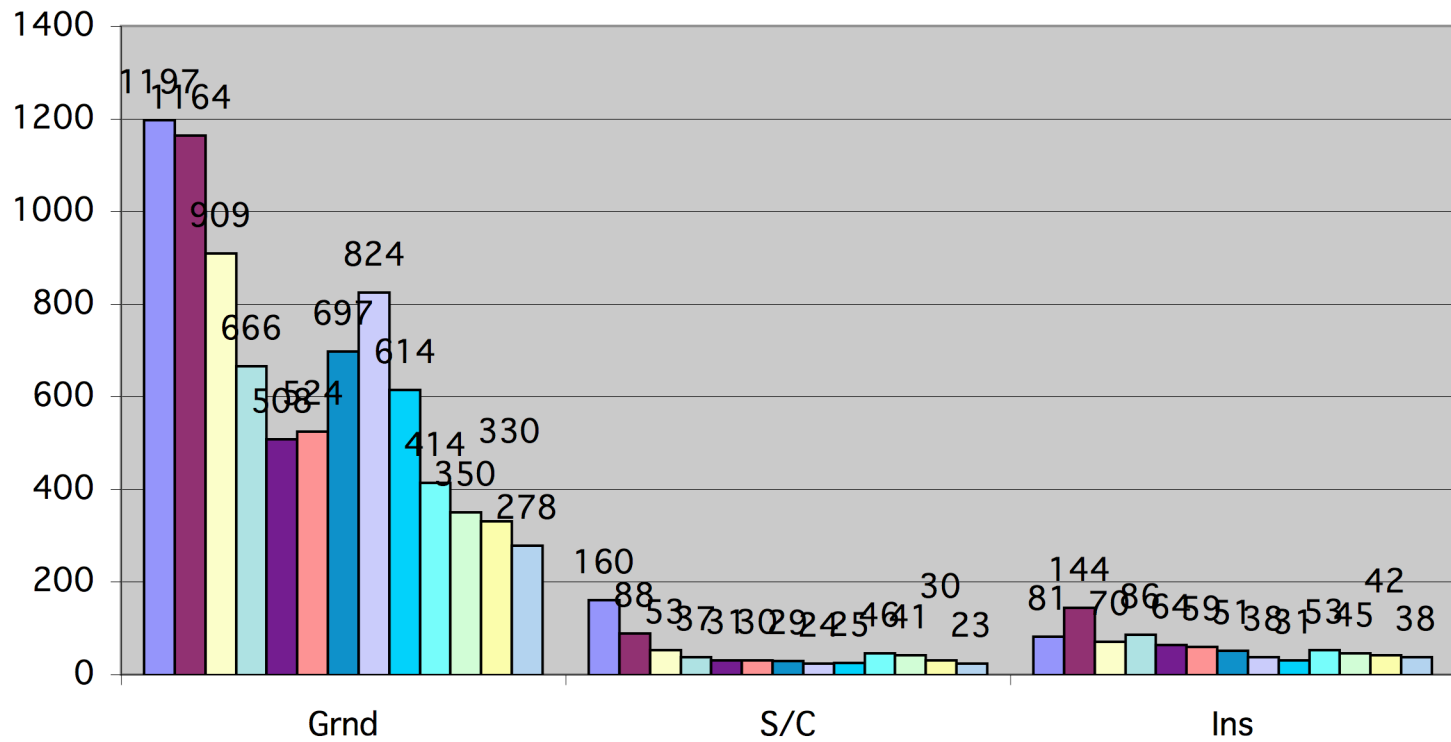
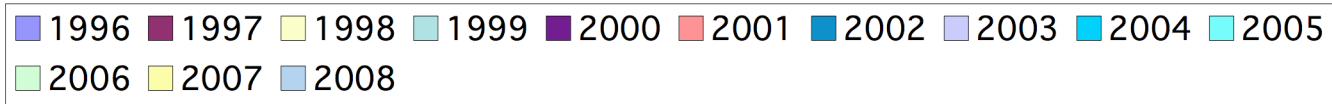








### Anomalies

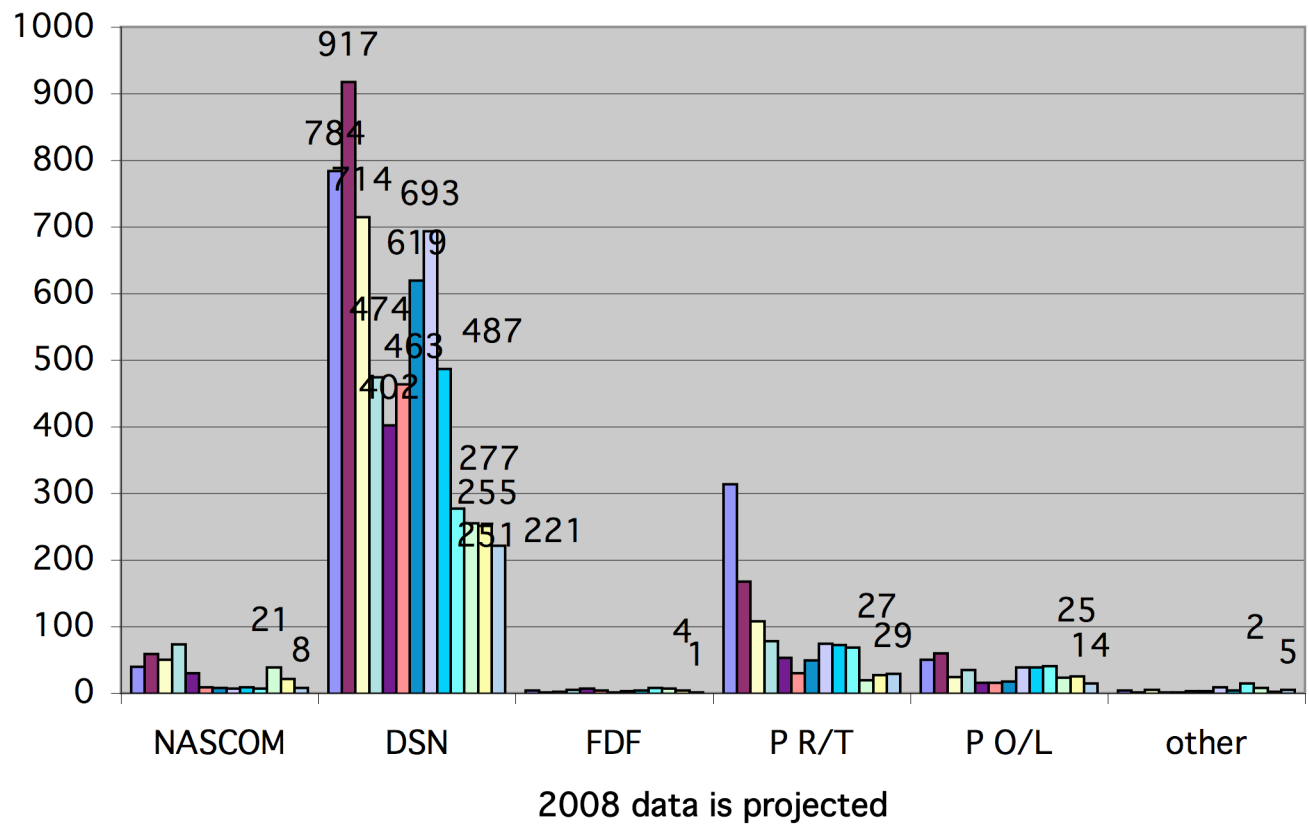
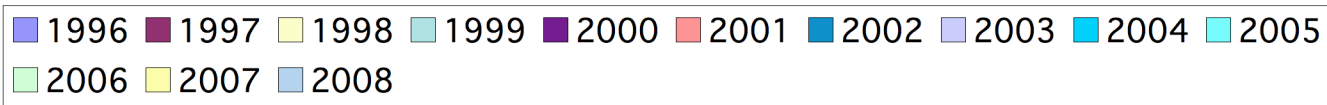


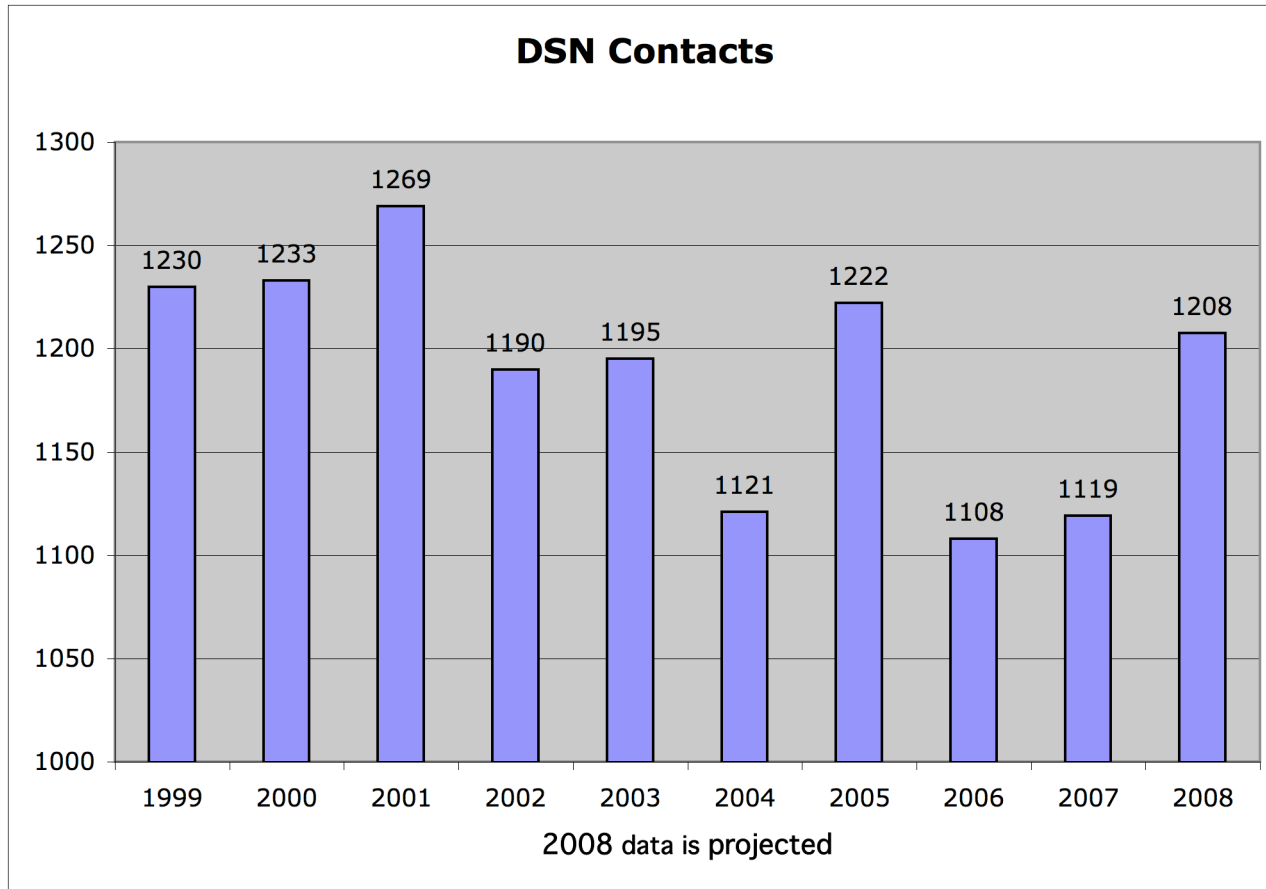
2008 data is projected



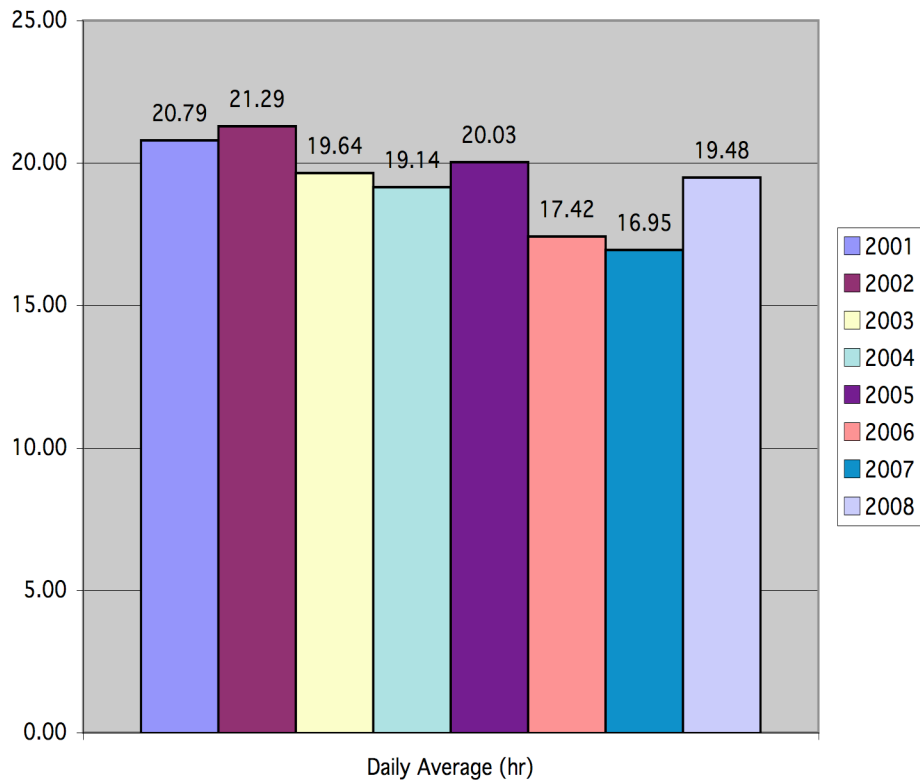


### Ground Anomalies

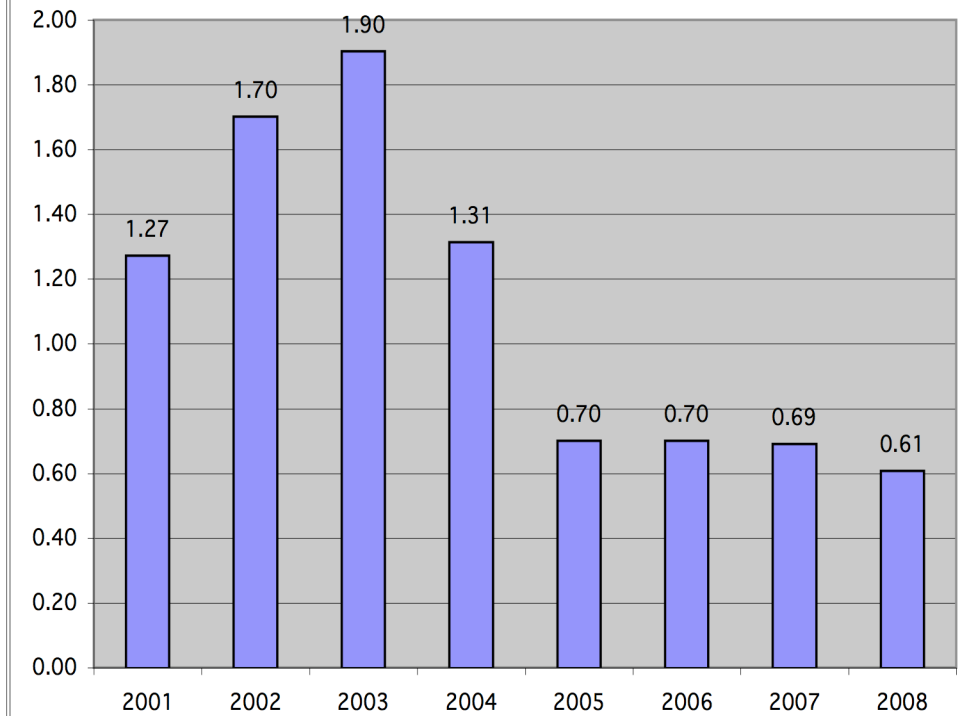




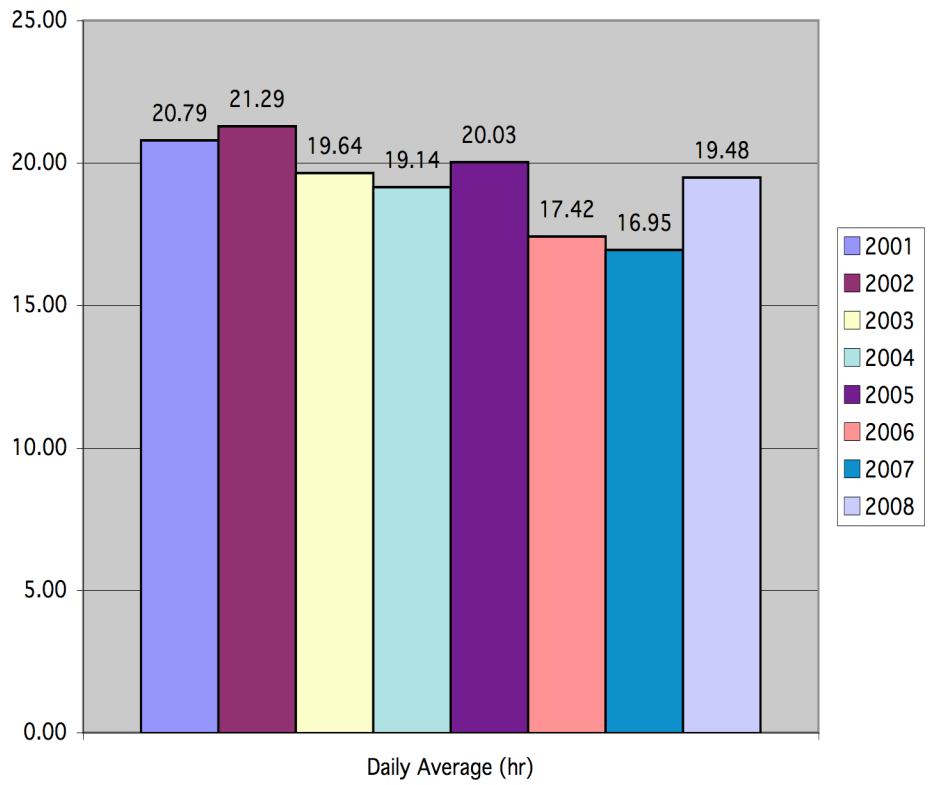
DSN Contact Time



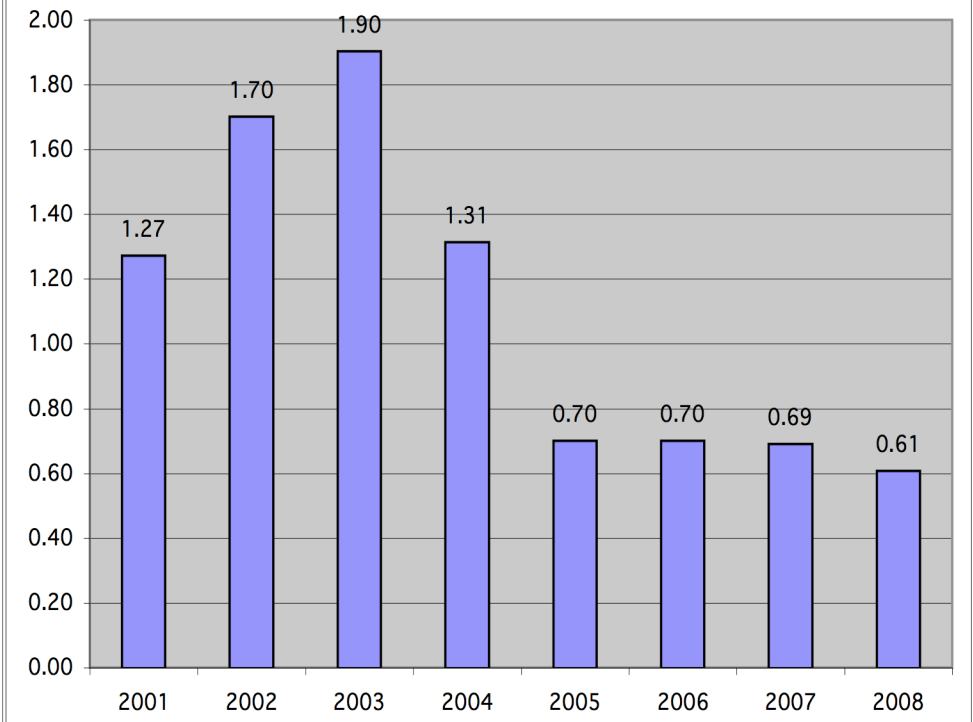
DSN Anomalies/Day



DSN Contact Time

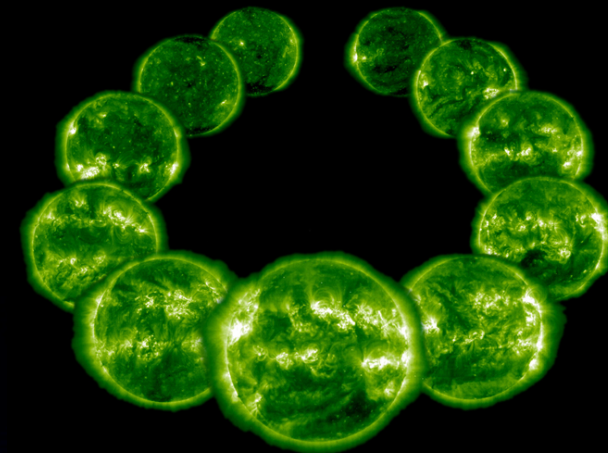


DSN Anomalies/Day





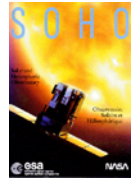
# SOHO SWT-40



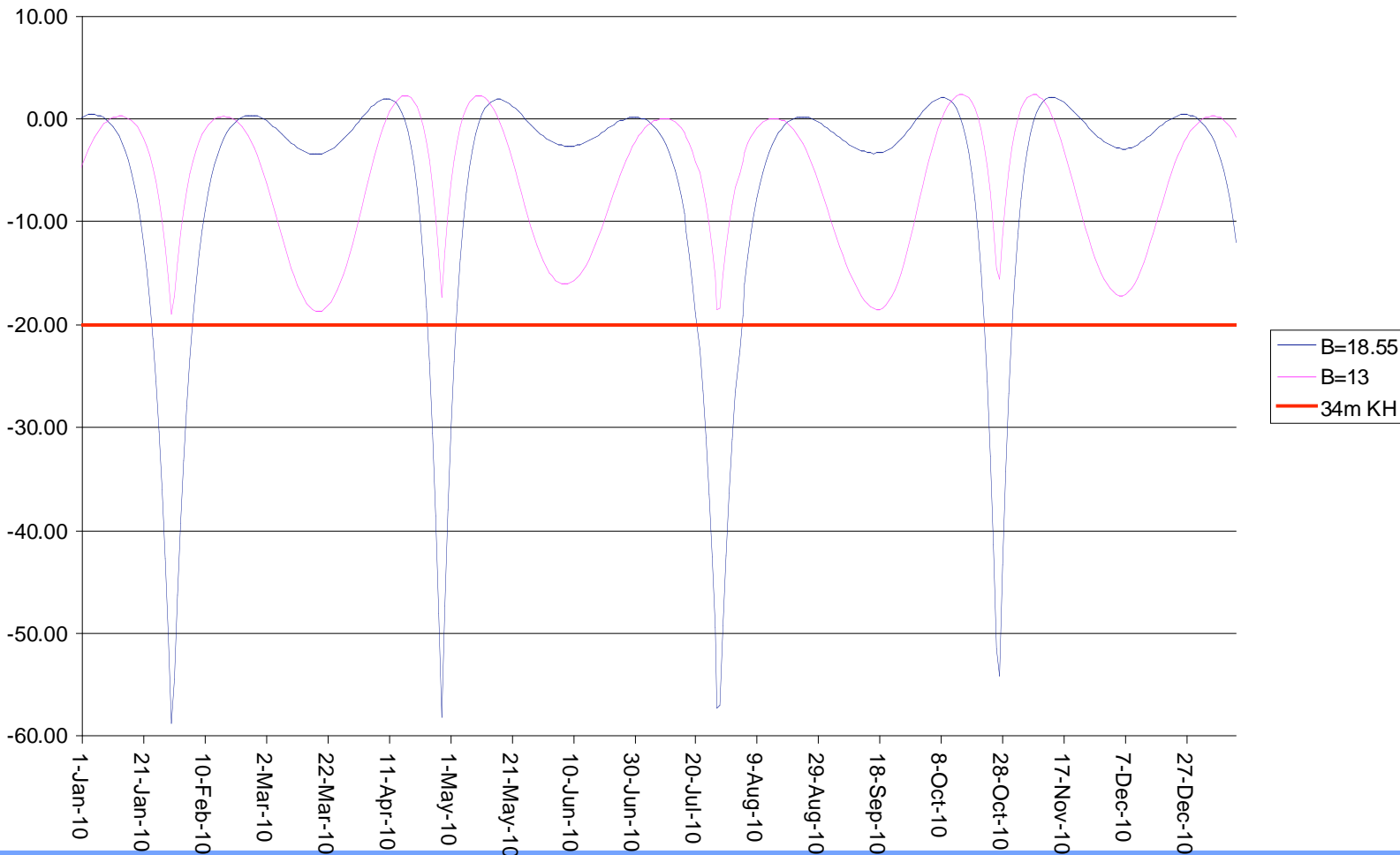
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# With only 34m and HGA moved at 13 deg: NO Keyhole



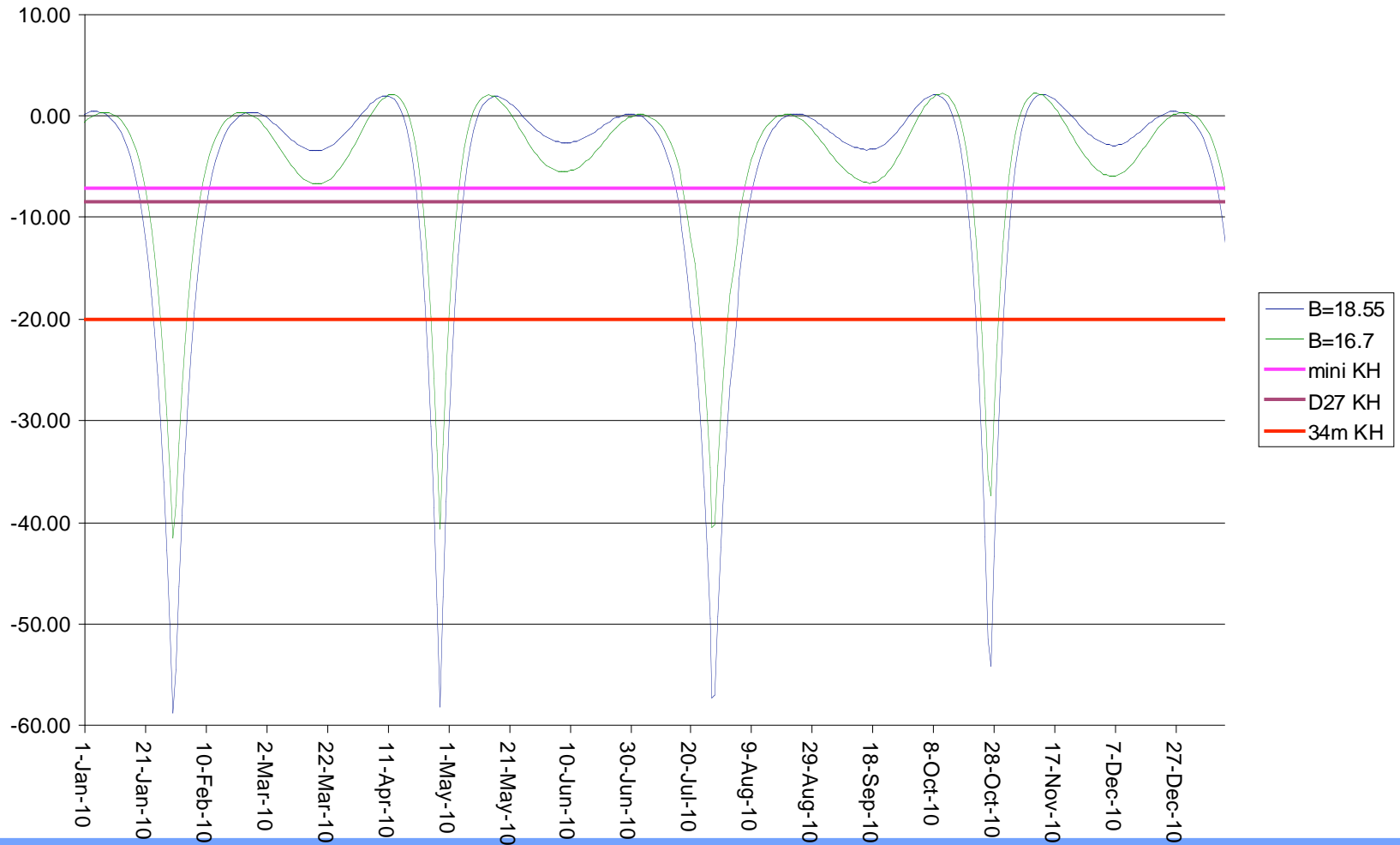
No 26m (TM loss in dB)



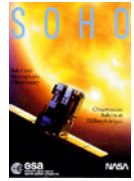
# With D27



D27 (TM loss in dB)



# Sum UP of Keyhole optimization



|      | Key Hole duration per year (days) |     |     |     |                      |               |             |                   |     |     |
|------|-----------------------------------|-----|-----|-----|----------------------|---------------|-------------|-------------------|-----|-----|
|      | NOW (B=-18.55 deg)                |     |     |     | Only 34m (B=-13 deg) |               |             | D27 (B=-16.7 deg) |     |     |
|      | mini                              | 26m | D27 | 34m | 26m                  | D27 (if used) | 34m         | D27 mini KH       | D27 | 34m |
| 2008 | 0                                 | 99  | 84  | 53  | NA                   | 172           | No Key Hole | 0                 | 67  | 37  |
| 2009 | 0                                 | 99  | 83  | 53  | NA                   | 155           | No Key Hole | 0                 | 67  | 38  |
| 2010 | 0                                 | 100 | 83  | 53  | NA                   | 154           | No Key Hole | 0                 | 65  | 38  |

**❑ Case with only 34m: NO Keyhole**

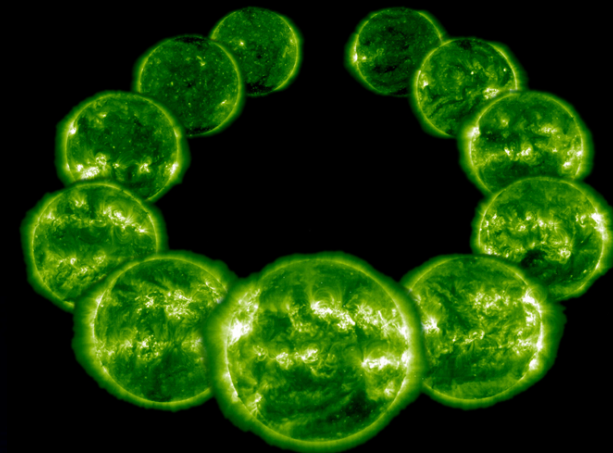
- However Key Hole would be twice longer for D27 if it had to be used

**❑ Case with D27, for a typical Keyhole season (4 per year):**

- D27 Keyhole reduced by 3 to 4 days
- 34m KH shorter by 4 days



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GOLF



## GOLF STATUS - SWT Toulouse 14.10.08 (A. Gabriel)

No new instrument risk factors discovered in the last 3 years.

No known reasons why GOLF cannot continue in operation for further 5 years

Progressive decrease in sensitivity (counting rate) with time, due to unidentified cause  
possible reasons

detector fatigue

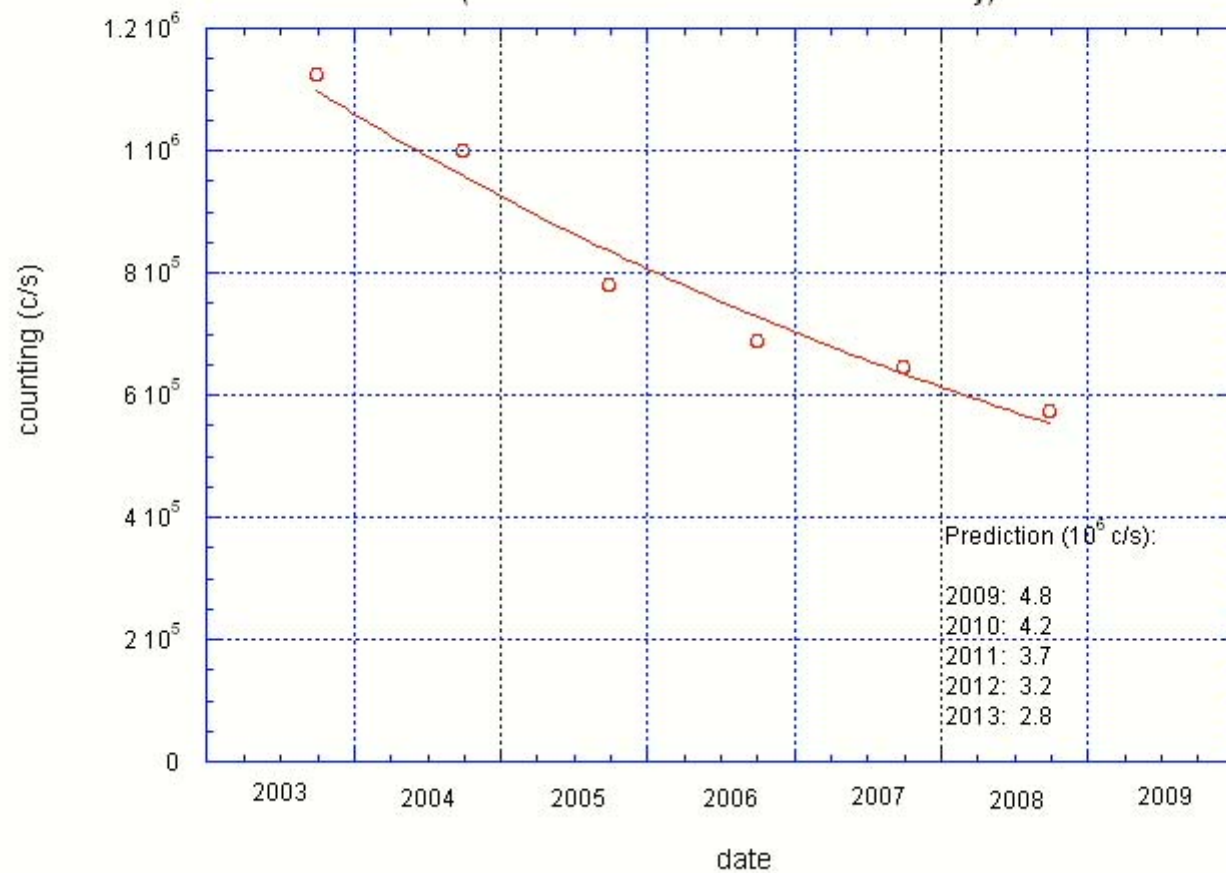
cell fatigue

cell window transmission

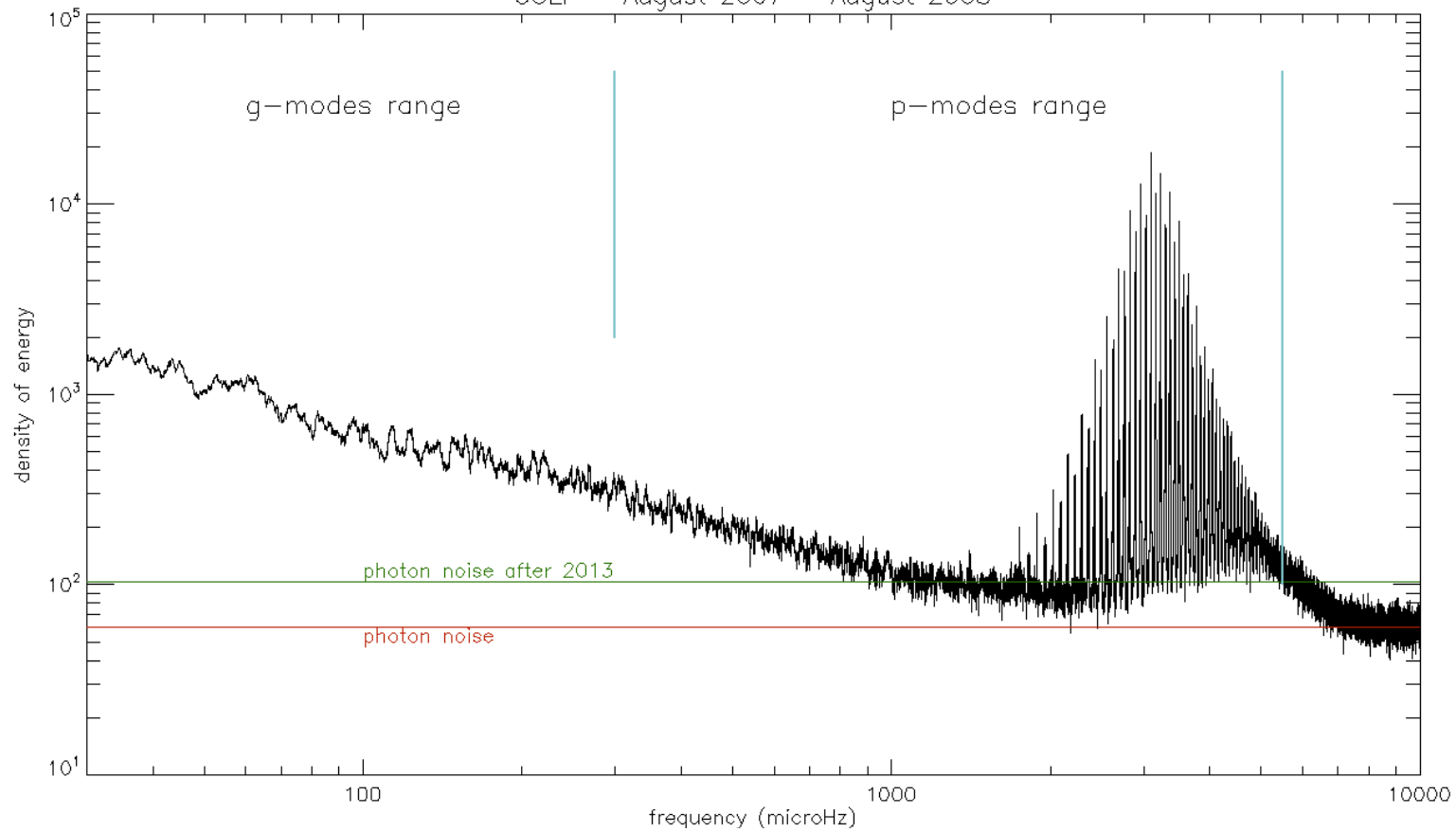
entrance window transmission

### GOLF\_PM2\_counting

(at minimum radial Sun-SOHO velocity)



GOLF - August 2007 - August 2008



## **Science Activities**

Extended time series with  $> 99$  % continuity enhances sensitivity for the detection of g-modes

Known g-mode searches in progress

asymptotic modes studies (Garcia et al)

techniques based on cross-products of filtered series (Grec et al)

techniques based on possible solar cycle modulation (Gabriel et al)

techniques based on joint analysis with other series (MDI) (Phoebus Group, Appourchaux)

Other studies unknown to the PI !

## **PUBLIC DATA and ARCHIVE.**

Level 1 data - daily intensities files - Submitted to SOHO Archive,  
up to September 2008-10-08

project to modify headers to include accurate timing information

Level 2 data - single calibrated time-series up to July 2008 (Garcia et al)  
data available for public access

Will be available from GOLF web-site within 2 weeks

Can be available from SOHO archive as soon as interface is adapted

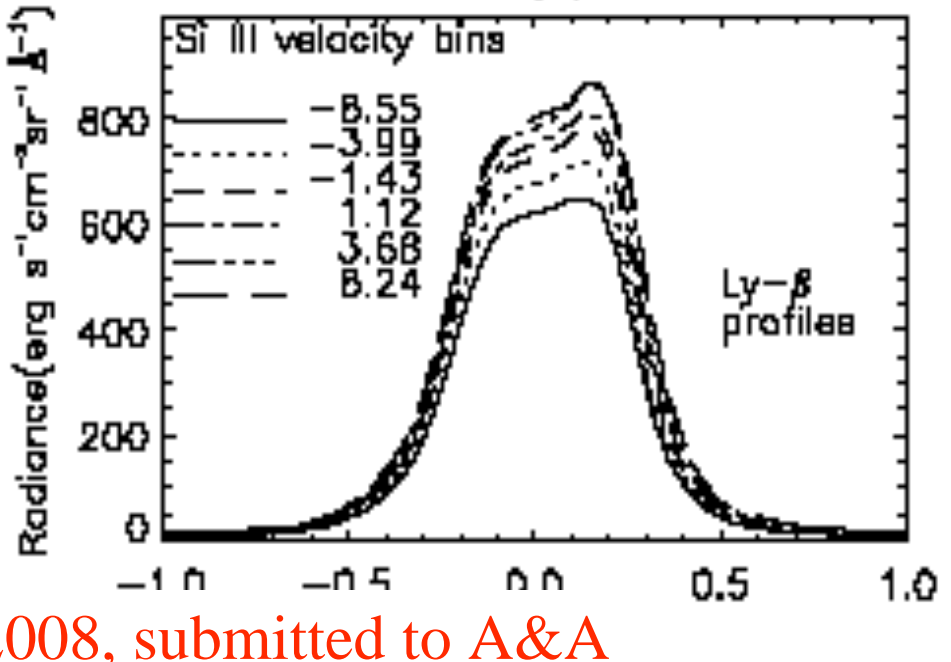
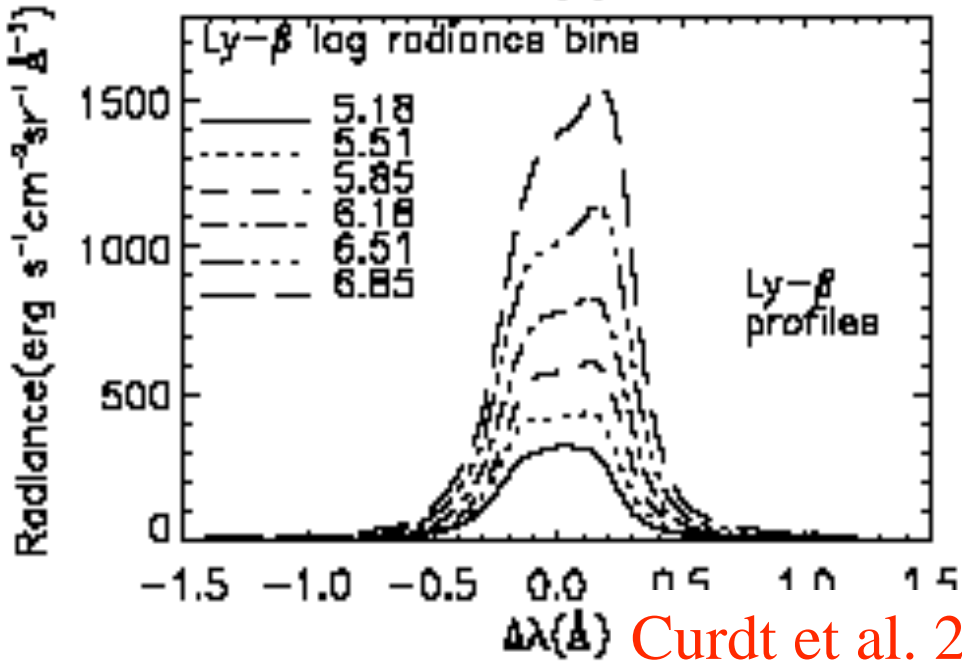
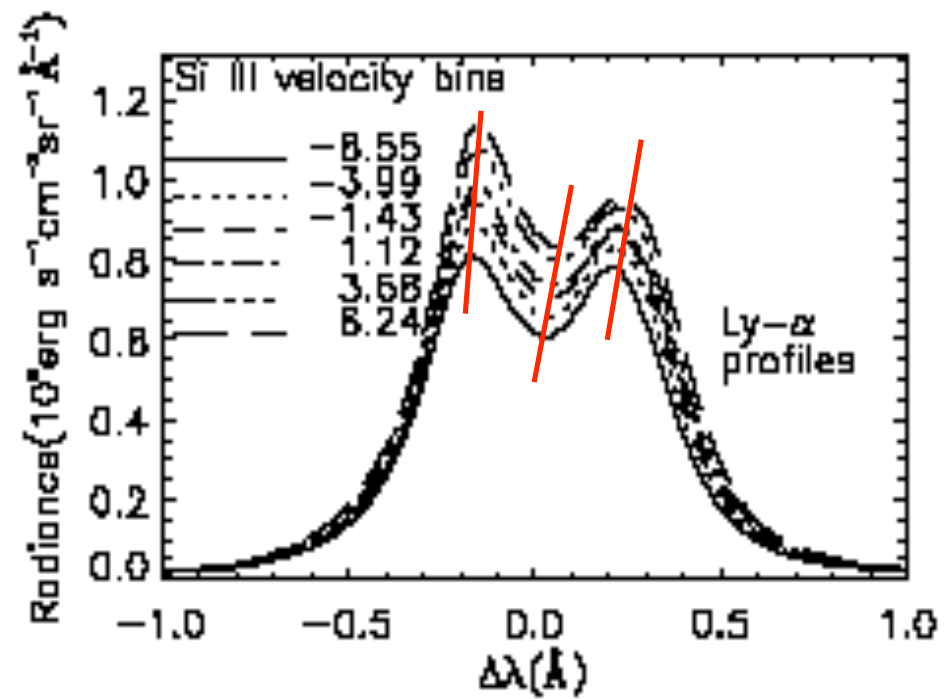
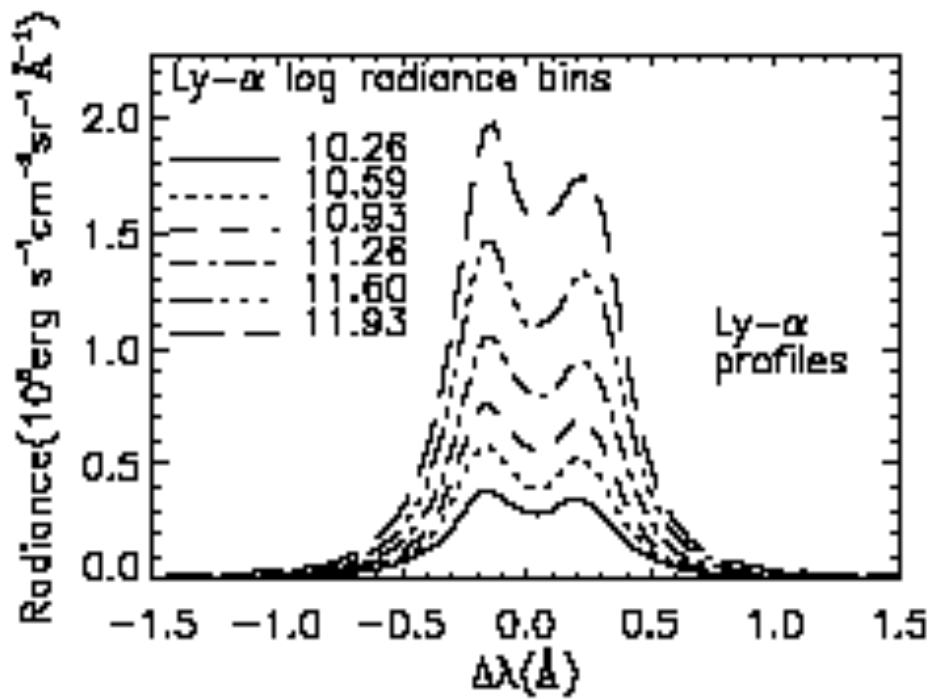
NOTE : Definitive long-term archive requires both Level 1 and Level 2 data.

SUMER

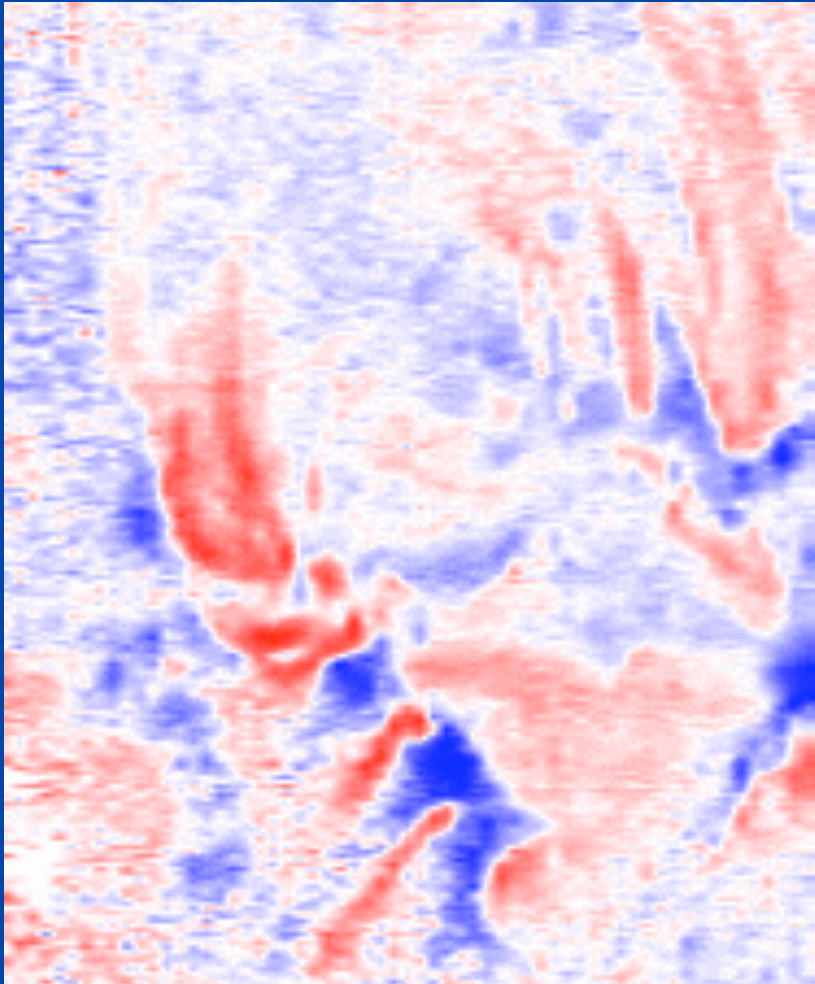


# Summary of SUMER status

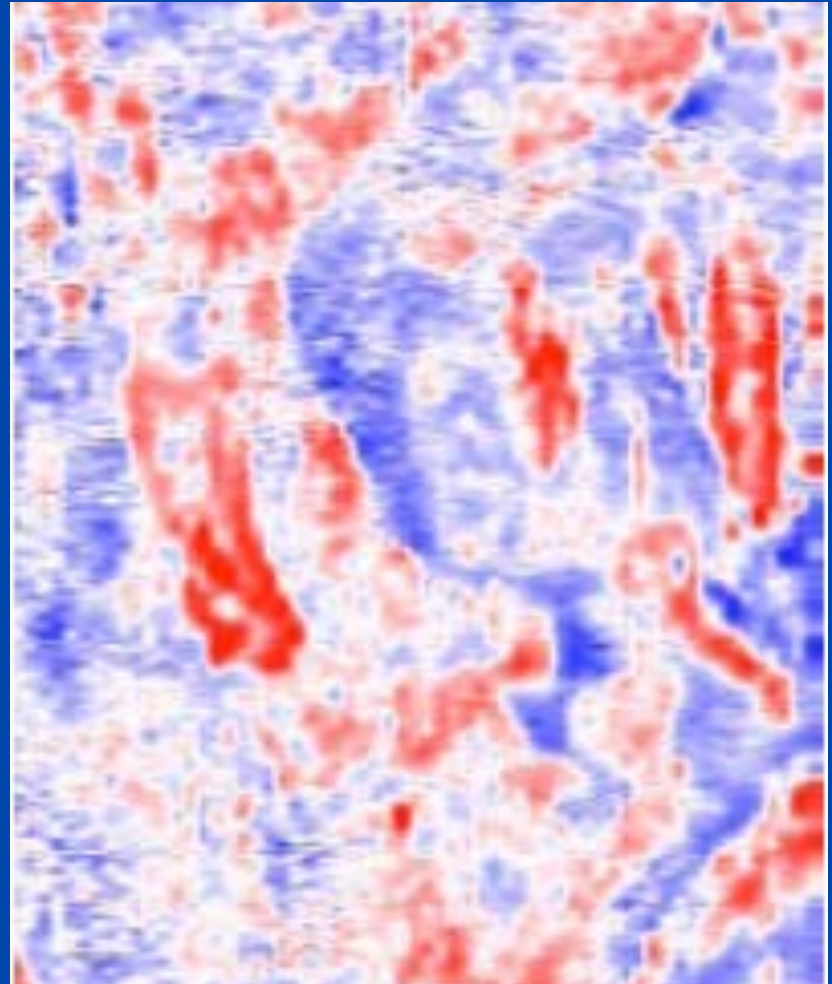
- λ SUMER is nominal.
- λ The rate of SUMER papers is still high and even rising again.
- λ We have demonstrated that even after 12 years we can produce highlights.
- λ We have plans for coordinated observations with Hinode, STEREO and last not least SDO.



Curdt et al. 2008, submitted to A&A



Ne VIII



O IV

EIT

## **EIT STATUS**

### **CCD degradation**

Slight recovery over the past years due to

Bake-outs

Low solar activity

Faster degradation is to be expected as the cycle picks up

### **Calibration status**

Flat field SSW database pipeline is operational again after almost a year of interruption

Photometric calibration still 3 years behind

Automation operational soon...

UVCS

## “UVCS Status”

G. Noci and J. Kohl



# Instrument

- UVCS continues to be capable of performing all of its primary science observations.
- . Star observations have been used to track the UVCS radiometric responsivity, which has decreased by about 11% per year since November 1998, for observations at 2 solar radii with lower rates for larger heights .
- All UVCS mechanisms are nominal except the Ly-alpha Channel grating drive, which is sluggish.
- The UVCS visible light channel has not been used since 27 April 2004.

## UVCS Detectors

- The Ly-alpha detector retains its original pulse height distribution and sensitivity over the entire detector area, and the OVI detector retains these characteristics over 60% of its area.
- Both detectors are affected by a problem with an analog to digital converter chip that shifts the counts in some 64 row groups to the first row of the group. The quality of the spectra are not affected.
- After binning, about 25% of the spatial area retains its original spatial resolution and 75% has a spatial bin size of 7.3 arcminutes, which is appropriate for observations of large structures (e.g., coronal holes).

## New UVCS Detector Problem

- It was recently discovered that a small fraction of the counts in the lowest numbered rows of two 64 row groups are being transferred to row number 87.
- A new characterization procedure, which utilizes the data from a daily one hour background measurement, is now being used to determine the fraction being transferred and use this information to reconstruct the spatial images.
- The reconstruction effectively returns the UVCS capability to the level prior to this latest problem, but does not restore it to the original level.

## UVCS Archive Effort

- A new wavelength scale has been developed that is accurate to about 0.005 nm. The time dependence of this scale is being determined.
- Radiometric calibration, background files and spatial flat field characterization files for the entire mission to date have been developed.
- The capability to produce a stray light spectrum in absolute units for each observation is in process.
- The UVCS White Light Channel calibration is complete and being used to produce pB values for the entire mission.
- The plan is to put calibrated spectral data files in the SOHO Archive for the entire mission by summer of 2009.

LASCO

# LASCO Status & Highlights

Russ Howard

13 October 2008

# LASCO Status (1)

- C2 and C3 continue to operate extremely well
  - The degradation of the instrument sensitivity is  $\sim 0.4\%$  per year, so that the shielding from the optical box (COB) and lens barrels has protected the glass from darkening due to energetic particles.
  - CCD bias increases slightly with time
  - The number of dark and hot pixels increasing, but not a problem except for the very faint, single-pixel comets
  - No other issues
- C1 failed at the 1998 offpoint due to the extreme cold that the instrument experienced ( $< -80\text{C}$ ). No further attempts to recover it this past year.



# LASCO Status (2)

- The LASCO Electronics Box (LEB)
  - Other than the failure of the oscillator keeping time (also in 1998) the LEB is working fine
  - Still on the A-Side. The B-side has never been operated in space.
- The flight software has not been modified since July 1997.
- The Ground Software in the EOF has been recently modified to be compatible with the latest Operating System
- The operational concept continues to be to take the same types of images day after day (synoptic program) with occasional special operations.

# LASCO/EIT Images

|          | Number of Images | Compression Factor<br>Average (Range) |
|----------|------------------|---------------------------------------|
| • C1:    | 126,069          | 2.5                                   |
| • C2:    | 287,053          | 4.0 (2-6)                             |
| • C3:    | 196,854          | 3.1 (2-5)                             |
| • EIT:   | 489,672          | 4.0                                   |
| • Total: | 1,099,948        |                                       |

# LASCO Anomalies

- The LEB controls both the LASCO and EIT telescopes.
- There have been a number of failures over the years (~6 months apart) of “Sector Wheel Hang”, in which a command to move the EIT sector wheel puts the LEB into a hung condition and only a power cycle (off/on) from the S/C resets it. The FOT has implemented a watch condition on this greatly reducing the loss of data. No permanent degradations have been seen from this.
- There has also been an EIT shutter hang a few times. This is more serious since if the shutter is left open then the detector is receiving continuous solar exposure.
- No understanding of where the problem is occurring – checks were put into the software (before 1997) at a number of places to catch any anomalous behavior to no avail.
- No anomaly had been experienced since March 13, 2007 until August 23, 2008. This last anomaly was different in that the output of the LASCO power converter dropped unexpectedly, resulting in the automatic detection of a number of out-of-limit conditions and the instrument safing. After reabling the power, everything was nominal.

- The spacecraft continues to perform in an outstanding manner
- The mission was a breakthrough one after 2 years but has become one of the most successful ones after 13 years

**THANK YOU!!**

# Two LASCO Major Results

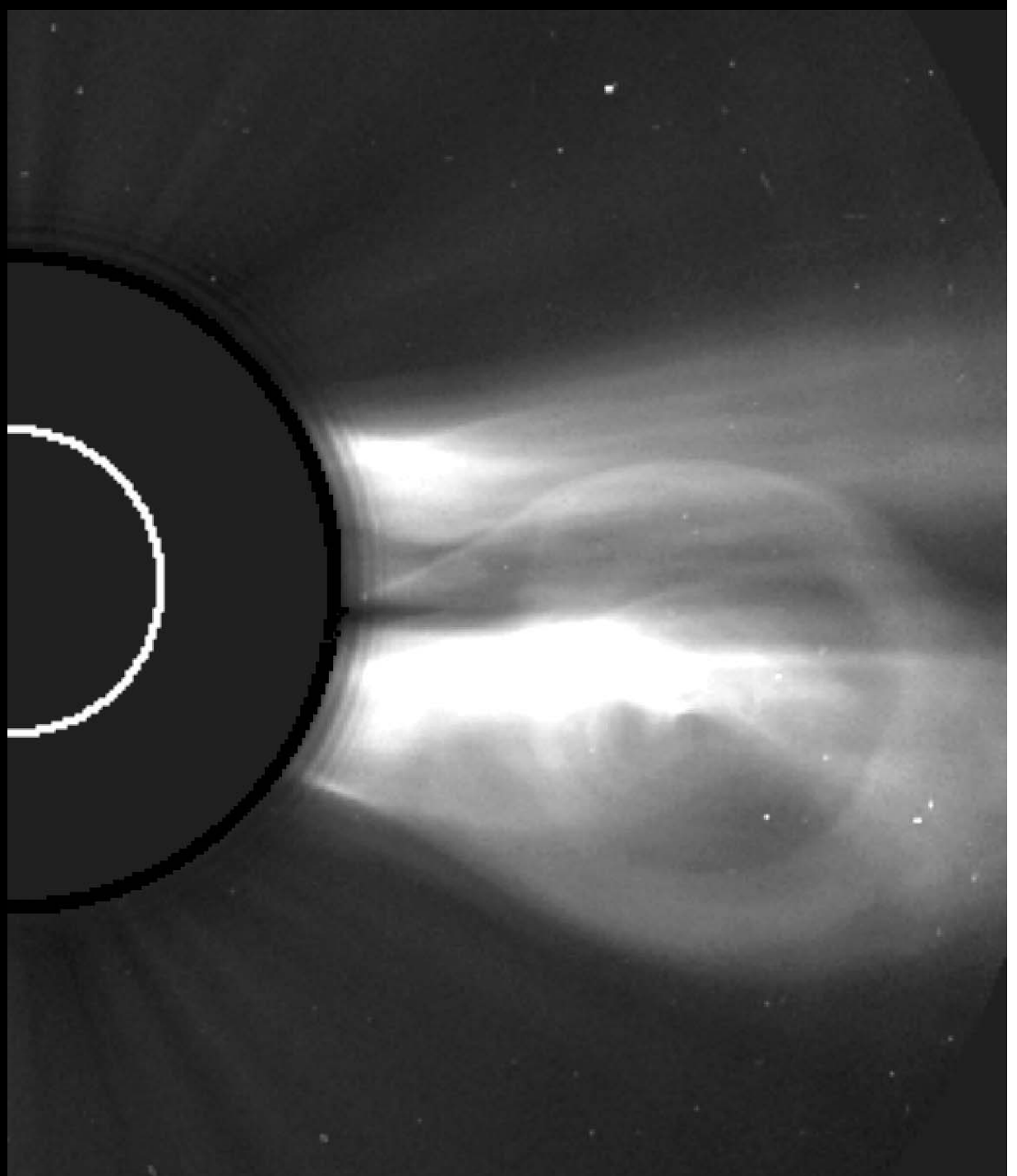
- While there have been lots of highlights, three stand out
  - The view of the extended corona that is in continuous evolution
  - ~14,000 CMEs identified and catalogued
  - 1500 Comets Discovered

# CME Observations

- Prior to SOHO, 4 space missions had observed white light CMEs: (OSO-7, Skylab, P78-1, SMM)
- These missions showed that CMEs occur in a number of different forms: loop-like, halos, streamer blowout, etc. Their appearance depended on the sensitivity, SNR and dynamic range of the coronagraph.
- The prototypical CME was defined by Illing & Hundhausen (1984) to be a three-part structure consisting of the front, a cavity and prominence material

Flux Rope CME  
April 13, 1997  
1630 UT

Note the circular  
cross-section  
and the  
cylindrical tube

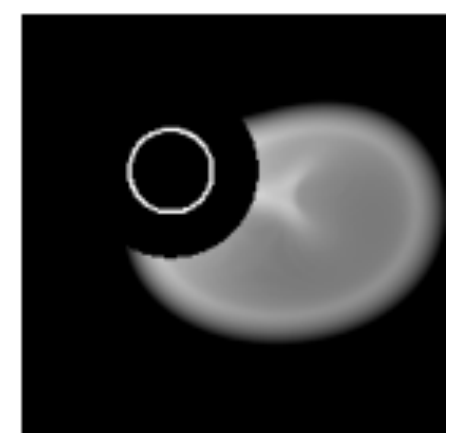
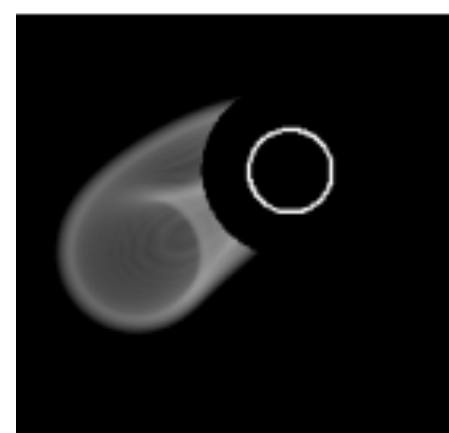
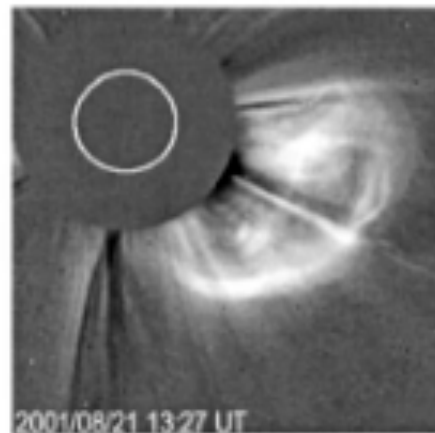
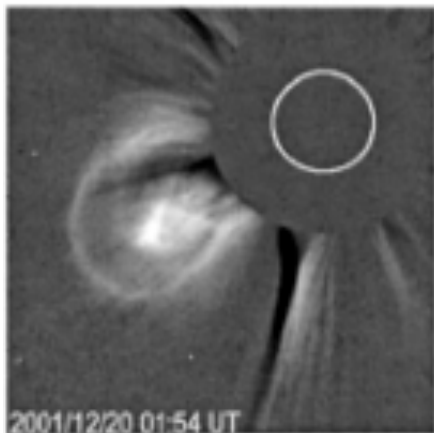
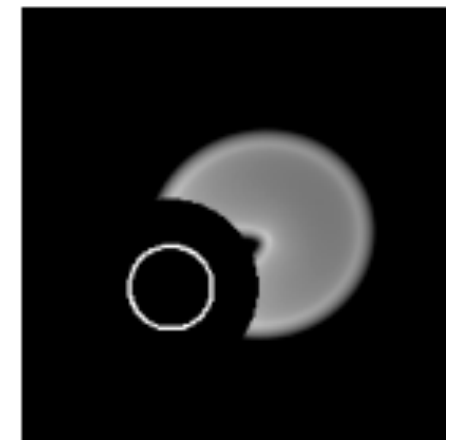
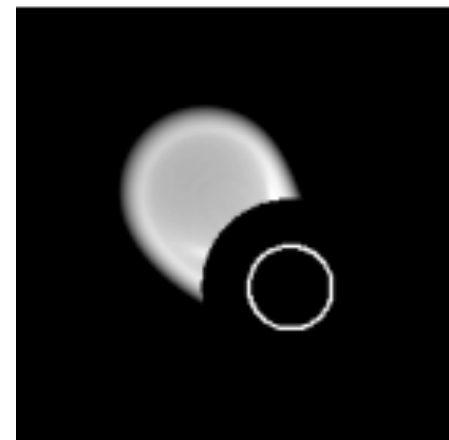
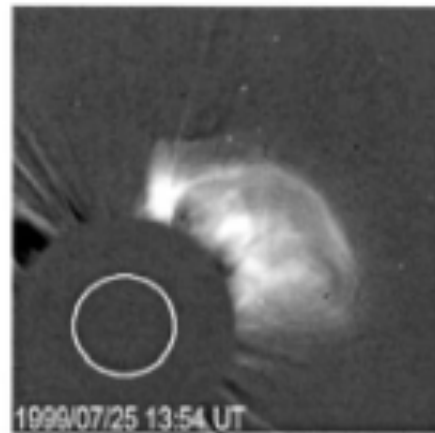
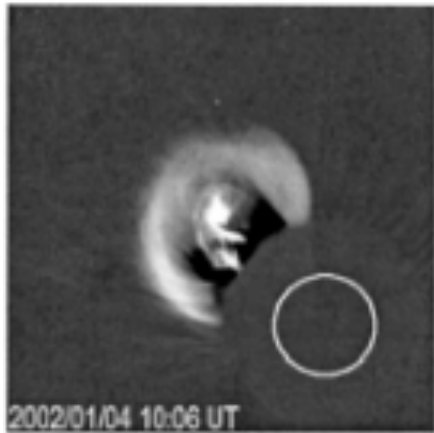




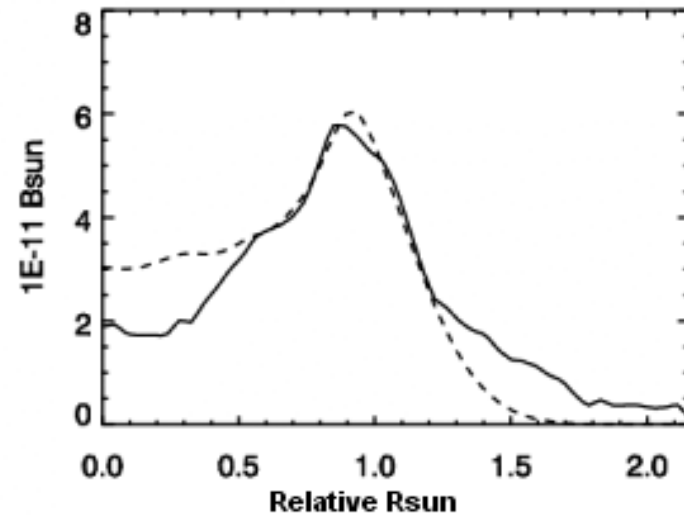
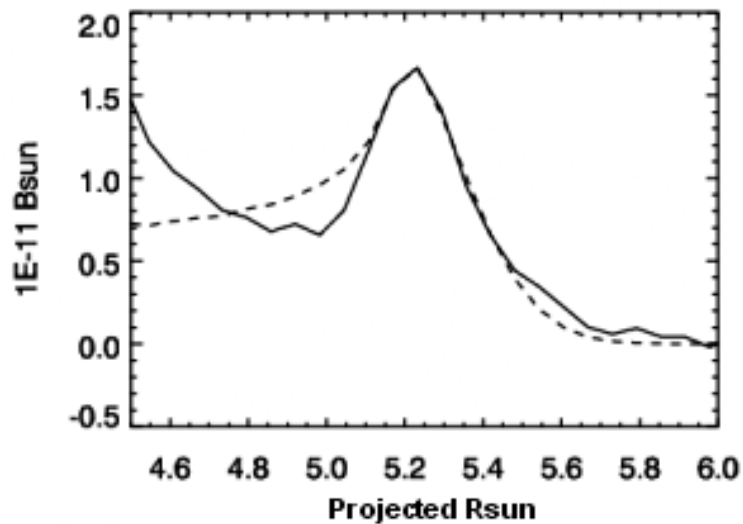
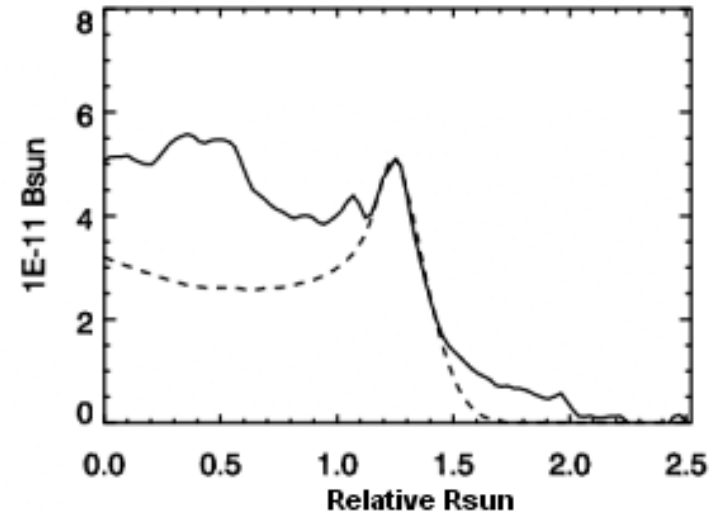
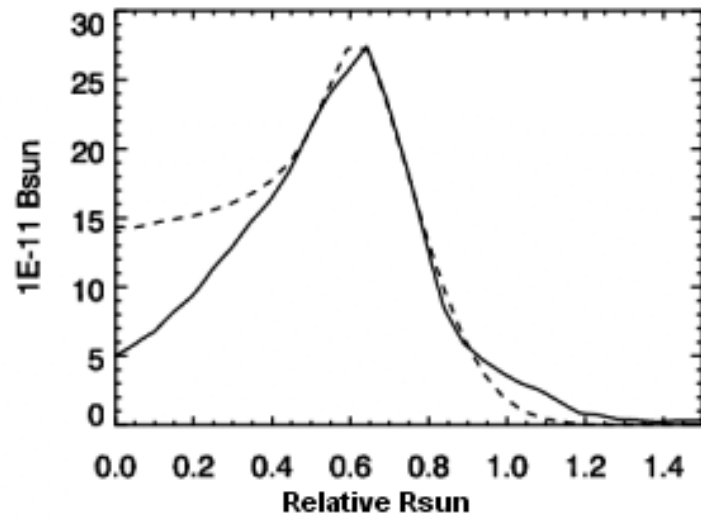
# Modeling of LASCO CMEs as Fluxrope

Observations

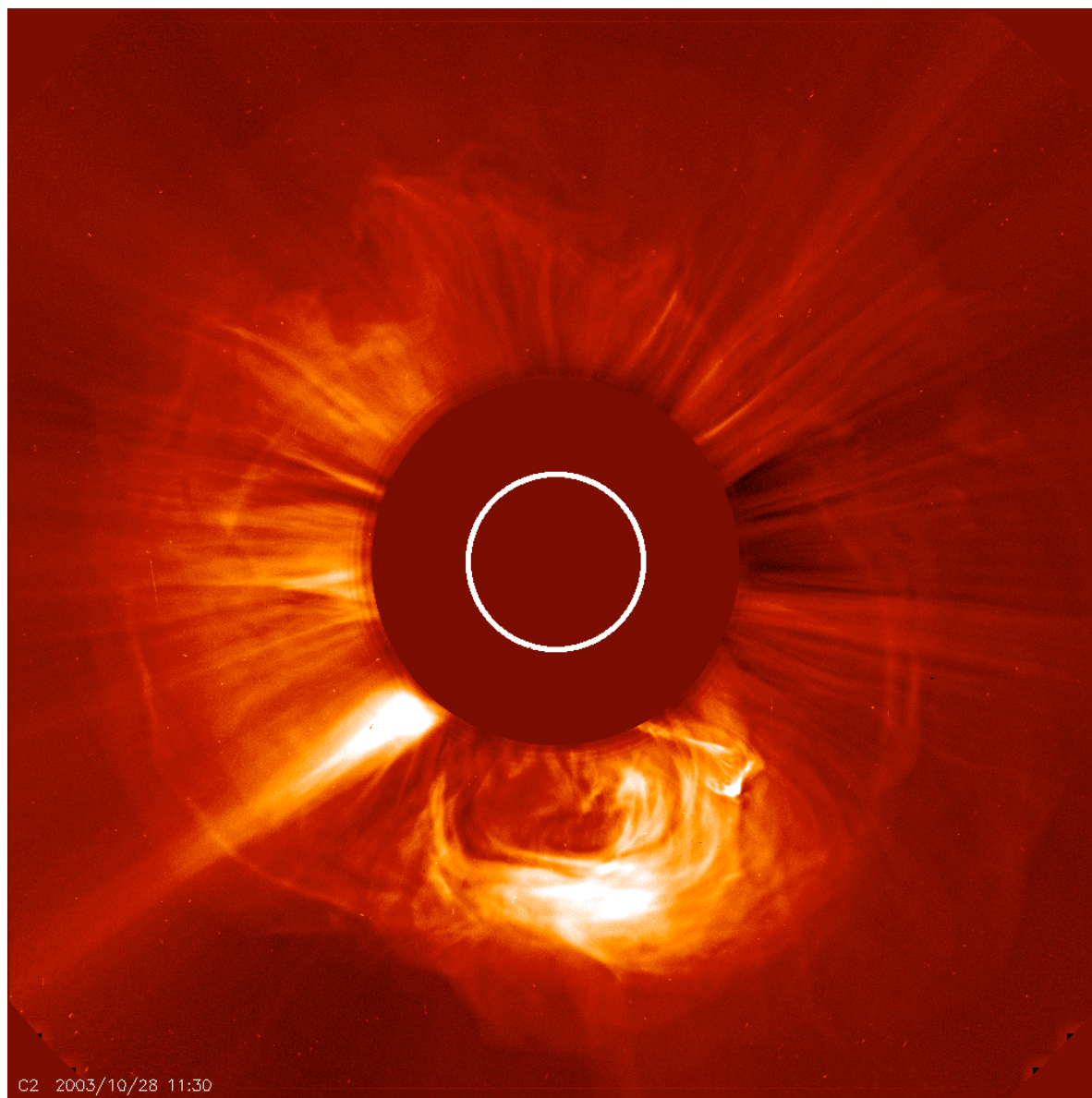
Model



# Radial Profiles of the CME Fronts

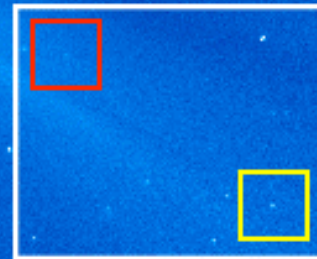
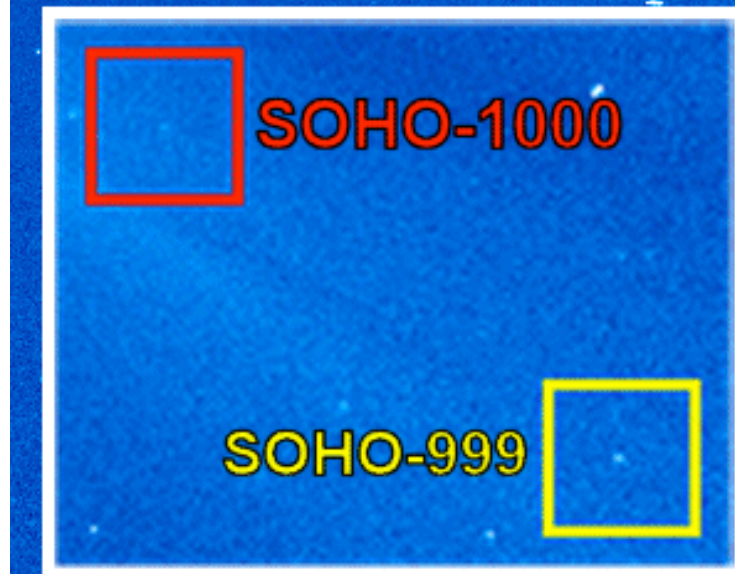


# Halo CME 28 Oct 2003



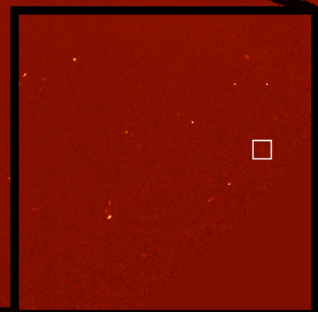
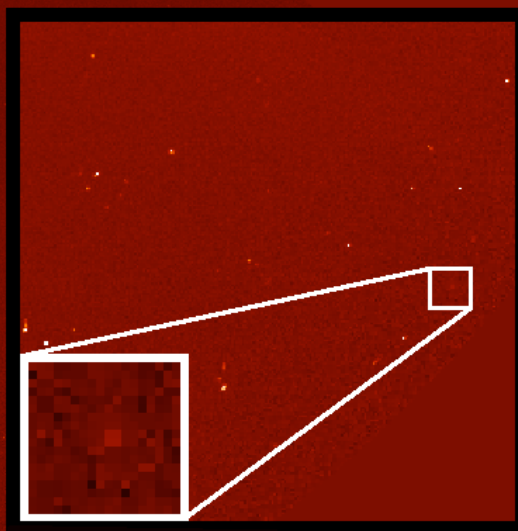
# Comets SOHO-999 and SOHO-1000!

SOHO's  
1000<sup>th</sup>  
Comet

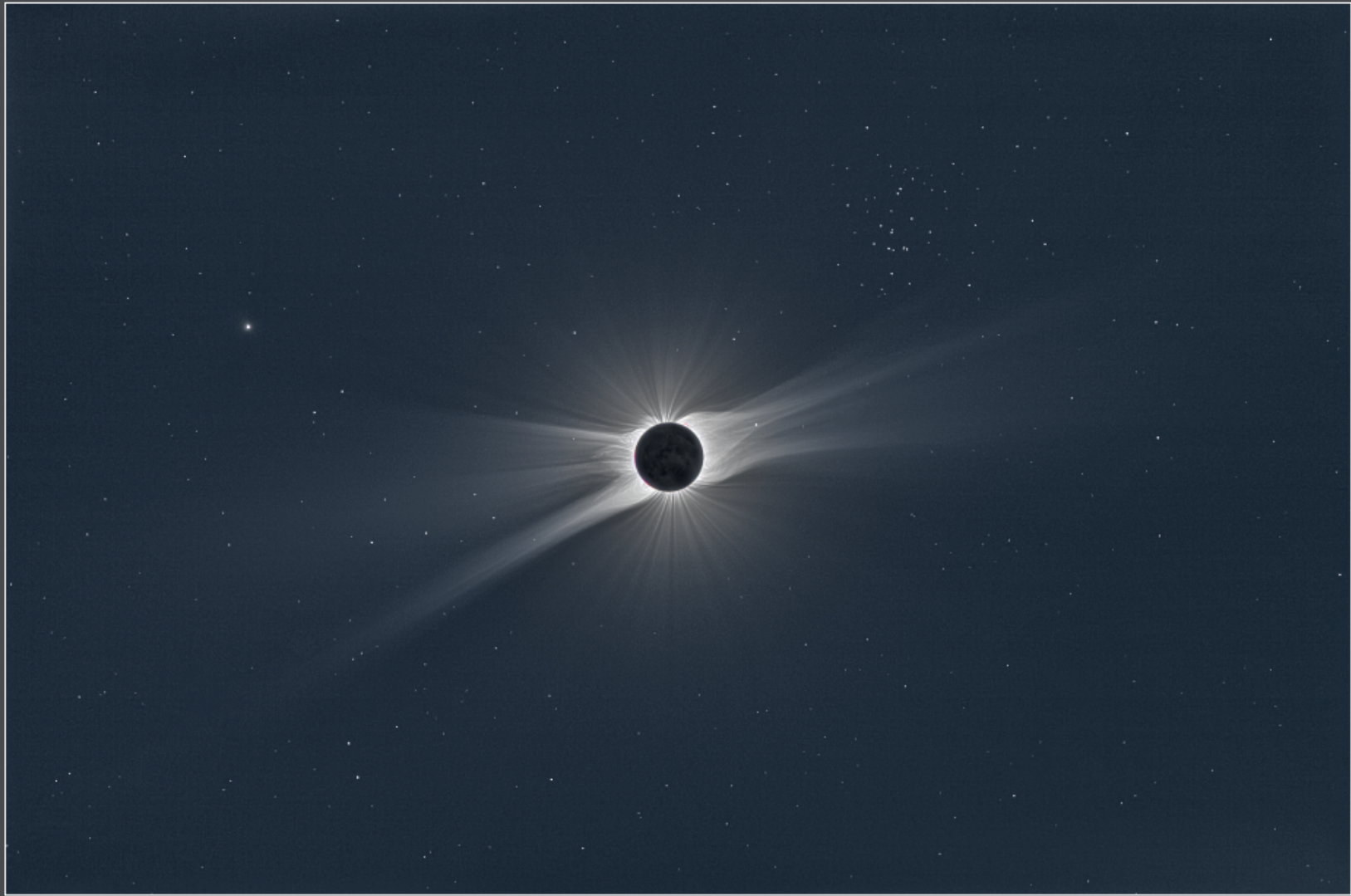




Kreutz-Group Comet SOHO-1500  
23:50UT, June 25, 2008



# Eclipse 1 Aug 2008 Mongolia

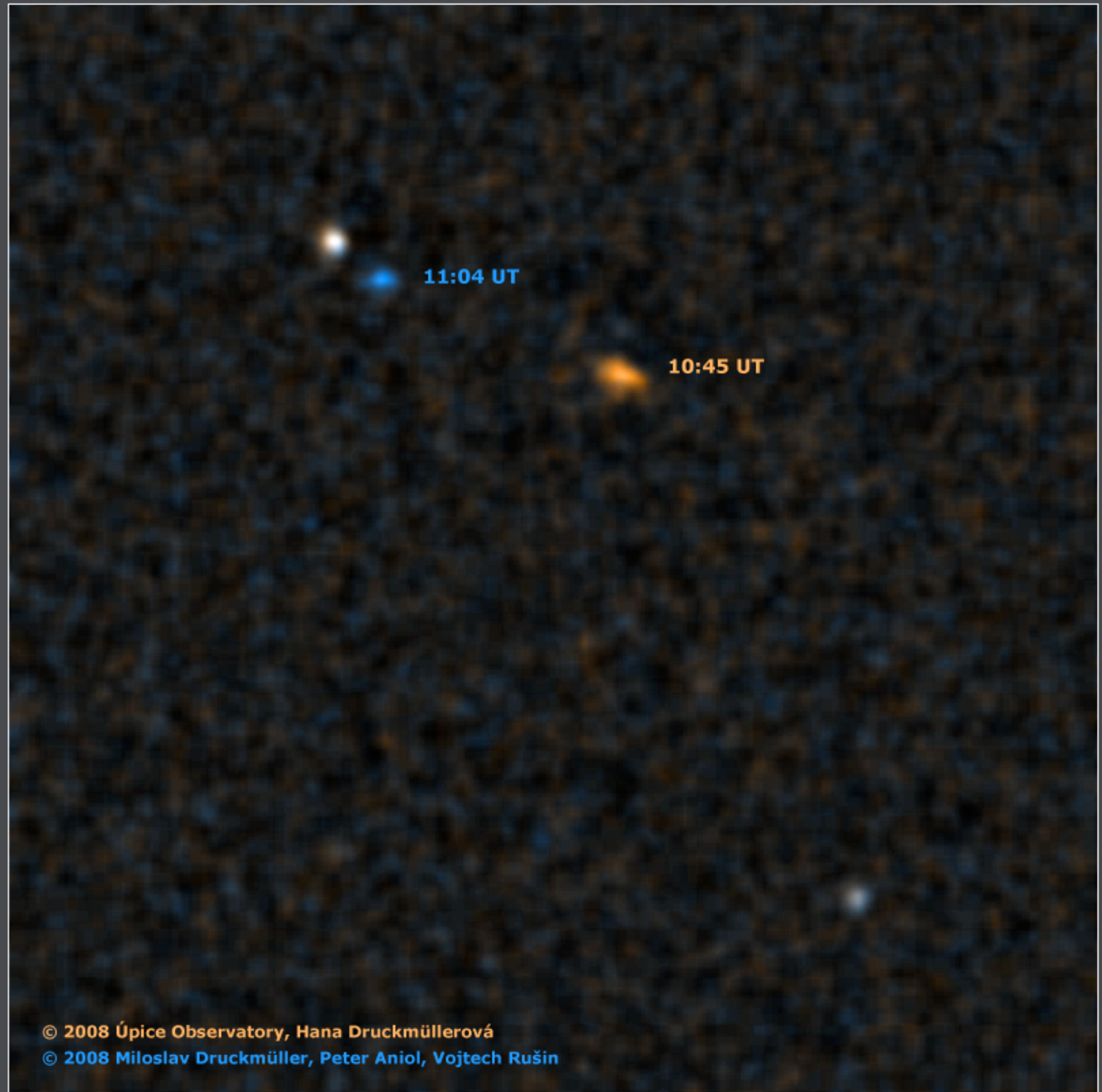


Total Solar Eclipse 2008

© 2008 Miloslav Druckmüller, Peter Aniol, Vojtech Rušin



# SOHO Kreutz Comet Seen in Eclipse Images at 2 Times



© 2008 Úpice Observatory, Hana Druckmüllerová  
© 2008 Miloslav Druckmüller, Peter Aniol, Vojtech Rušin

Comet C/2008 O1 (SOHO) during Total Solar Eclipse of 2008 August 1



**CELIAS**

# SOHO SWTM 40, TOULOUSE, OCTOBER 14, 2008

## CELIAS STATUS

| <b>Instrument</b> | <b>Status</b>   |
|-------------------|---|
| PM                | Operational   |
| MTOF              | Operational   |
| HSTOF             | Operational   |
| STOF              | Operational, but low efficiency (degradation of MCPs) |
| CTOF              | non operational                                       |
| SEM               | operational   |

No new problems in sensor performance.

## **ACTIVITIES**

- SEM cross calibration activities with sounding rocket flight data (Ne cell) and SDO/EVE sounding rocket flight data
- Result: less than 5% difference between SEM/CELIAS and sounding rocket data (Leonid Didkovsky, USC)

## **SCIENCE ACTIVITIES**

HSTOF will provide ENA measurements complementary to IBEX (higher energy)

Coordinated Observations of Solar Wind Structures (CIRs) with STEREO

## ARCHIVING STATUS

Last Data in Archive

### MTOF/PM Solar Wind V, NT

- M T O F/PM 15 sec avg 2008 Day 283 - 10-09-2008
- M T O F/PM by Carrington Rotation (1h avg): 2008 Day 270 - 09-26-2008  
(CR 1905 - 2074)

<http://sohowww.nascom.nasa.gov/data/archive.html>

<http://umtof.umd.edu/pm/crn/>

- L ist of Interplanetary Shock s : 2008-06-24

### SEM UV, 0.1 - 50 nm

<http://sohowww.nascom.nasa.gov/data/data.html>

[http://www.usc.edu/dept/space\\_science/semdatafolder/semdownload.htm](http://www.usc.edu/dept/space_science/semdatafolder/semdownload.htm)

SEM Calibrated Data - 1 day averages 2008, Day 244

**COSTEP**



# COSTEP

## EPHIN / LION

### Instrument and data status

Reinhold Müller-Mellin, Univ. of Kiel

[mueller-mellin@physik.uni-kiel.de](mailto:mueller-mellin@physik.uni-kiel.de)



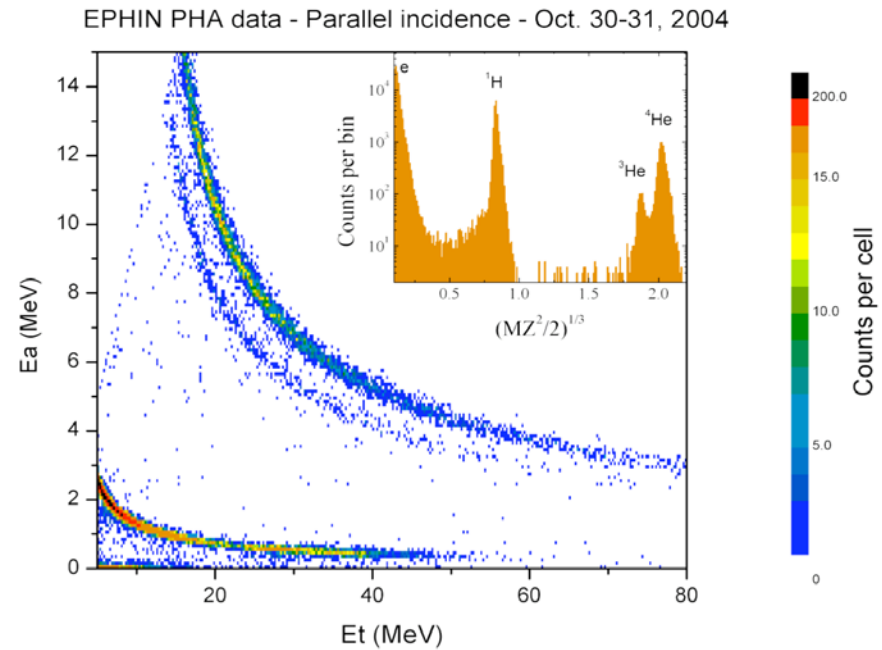
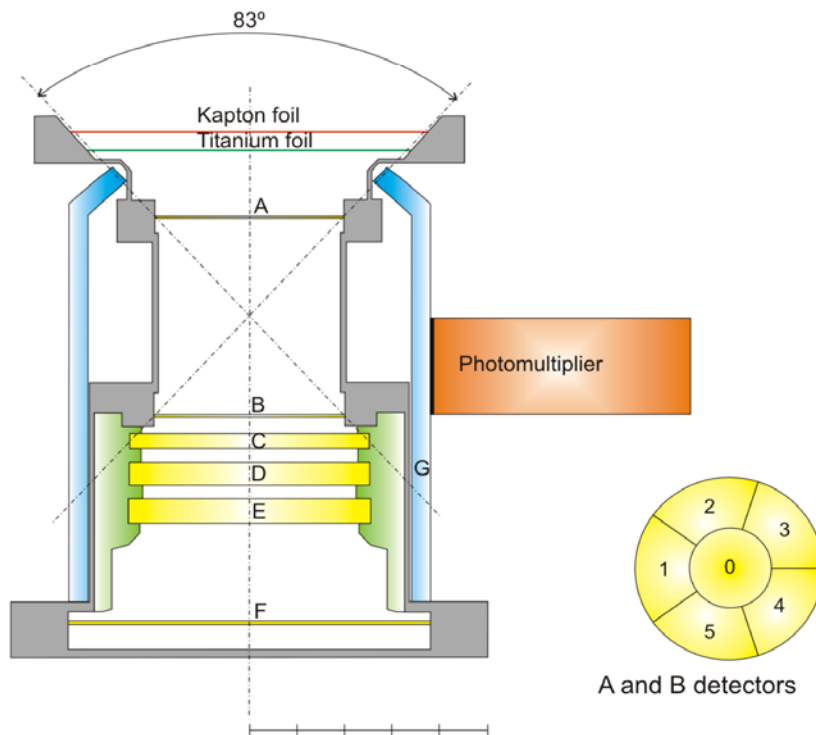
# EPHIN Sensor



## Electron Proton Instrument (EPHIN)

Universität Kiel

on bord SOHO and Chandra





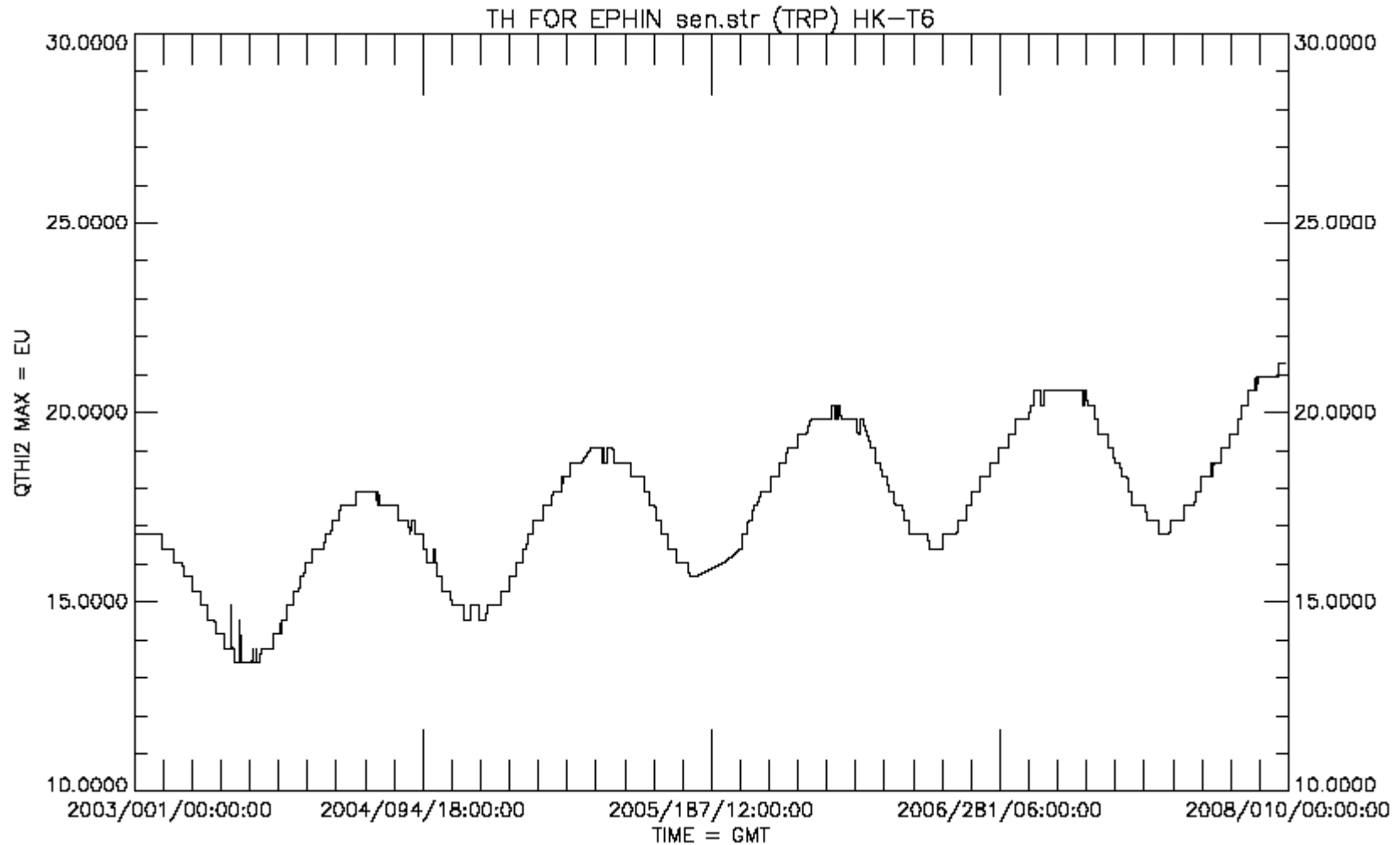


## EPHIN Problems / Failures

- **Noise in detector E**
  - $> 10^5$  counts/min
  - known since 1996
- **Corrective action**
  - set Failure Mode E (31-OCT-96)
- **Noise in detector A**
  - attributed to degradation of aperture foil thermal characteristics
    - Gradual temperature increase:  $0.5^\circ\text{C}$  per year
    - Annual cyclic variation (perihelion/aphelion):  $4.3^\circ\text{C}$
  - effect on center segment A0 single rate:
    - 400 counts/min (January 1996 perihelion, TRP  $16^\circ\text{C}$ )
    - 80,000 counts/min (January 2008 perihelion, TRP  $22^\circ\text{C}$ )
    - 26,000 counts/min (June 2008 aphelion, TRP  $18^\circ\text{C}$ )
    - Note: Large temperature gradient. Front detector A much hotter !!!
- **Corrective action**
  - apply dead time correction



# EPHIN/SOHO Temperature Reference Point Variation



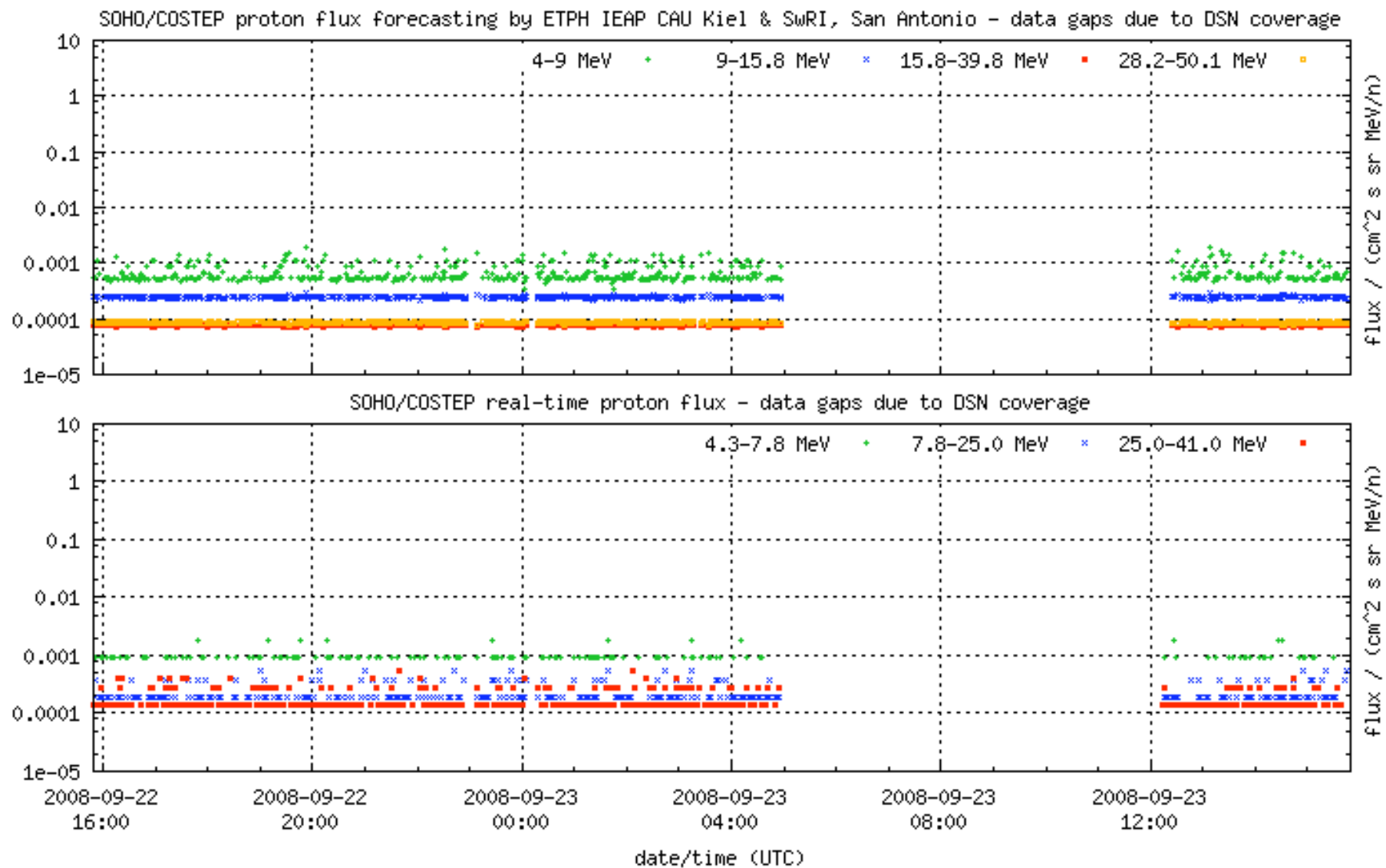


## COSTEP Data Processing Status

- **EPHIN and LION Level 2 data** generated with a delay of some weeks
  - As of today (23-SEP-2008) data is available until 31-AUG-2008, ready for FTP transfer into SOHO Archive at GSFC.
- **EPHIN Level 2 data browser** online
  - <http://www2.physik.uni-kiel.de/SOHO/phpeph/EPHIN.htm>
  - Browser data provided with a delay of some weeks
  - Feature: “generate plot”
  - New feature: “generate ASCII file” is available now
- **EPHIN Near Real Time data plots** online
  - <http://www-etph.physik.uni-kiel.de/missions/soho/costep/realtime/forecast/>
  - SEP event forecasting runs in real time at Kiel and GSFC. Method by A. Posner uses relativistic electrons to predict a proton storm. Used previously .rel files which are generated every 15 minutes during station contacts. Is now improved to use telemetry files from CEPAC workstation at GSFC with 1-minute time resolution.

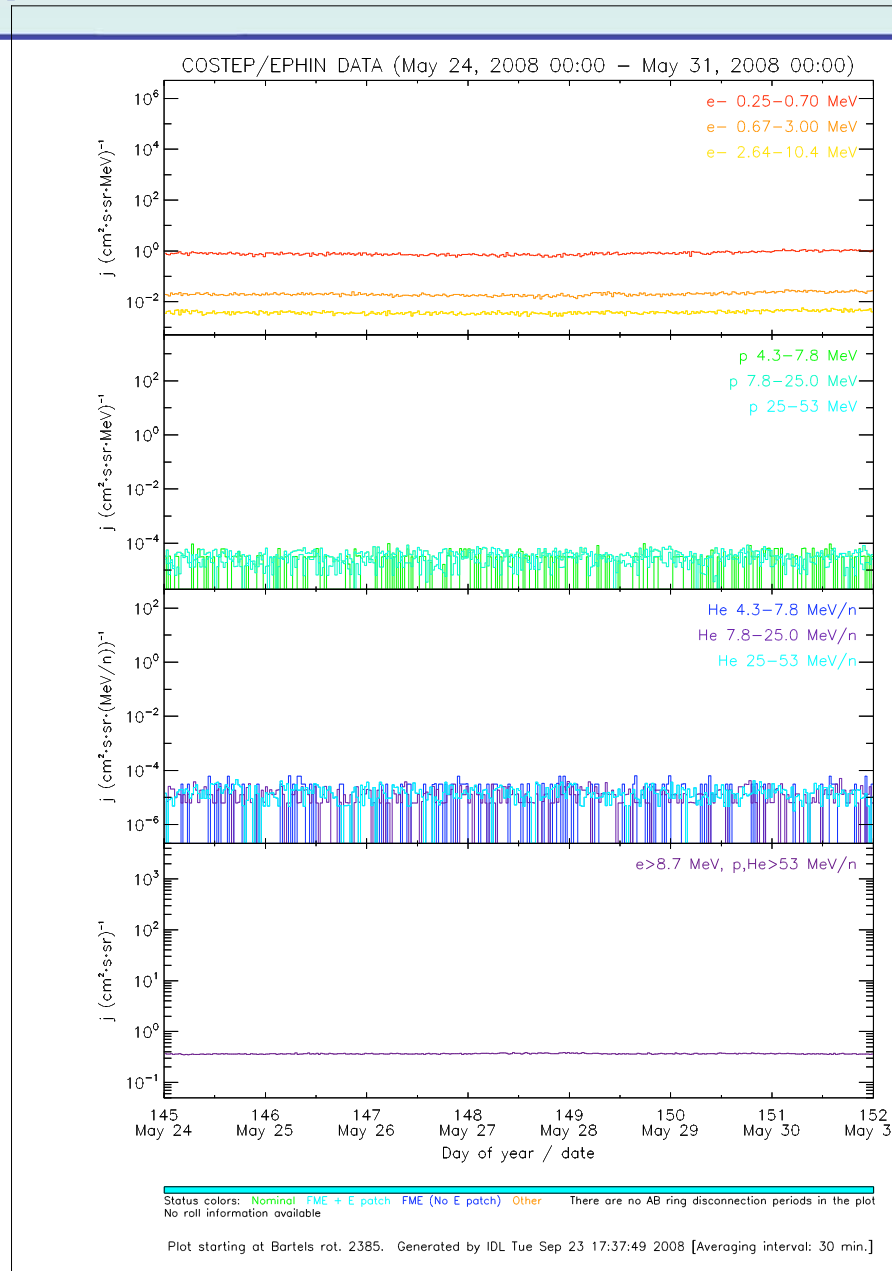


## Example: EPHIN Realtime Forecast





# Example: EPHIN Level 2 Data Browser Plot



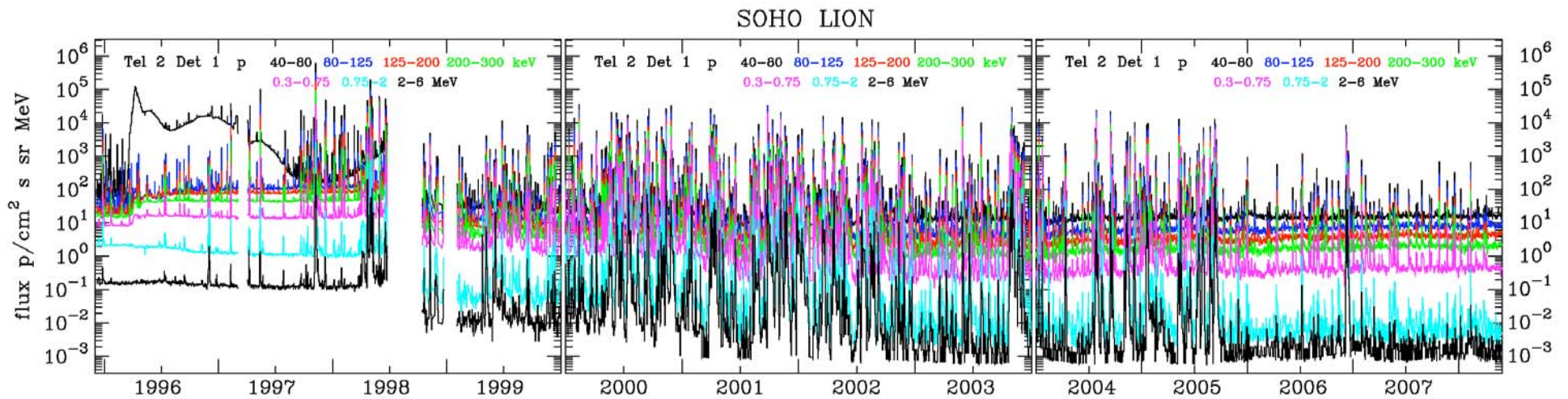


## LION Problems / Failures

- Telescope 1 (without magnet, measures p+e 40 keV-6 meV)
  - Detector 1 performed well in prime mission, developed episodes with noise in extended mission, not useful since 2004
  - Detector 2 features noise in lowest energy channel (40-80 keV) since launch, developed episodes with noise in higher channels since 1999
- Telescope 2 (with magnet, measures p 40 keV-6 MeV)
  - Detector 1 started with noise in 1996, improved after SOHO hibernation, performs well ever since
  - Detector 2 developed noise in lowest energy channel since 1996, higher channels are OK, but detector is dead since 3-JAN-2006



# LION 1996-2008







# Radiation Storm Forecasting with SOHO/COSTEP

Arik Posner<sup>2,3</sup>, Bernd Heber<sup>1</sup>,  
Oliver Rother<sup>1</sup>, and Reinhold Müller-Mellin<sup>1</sup>

(1) IEAP, Universität Kiel, Germany

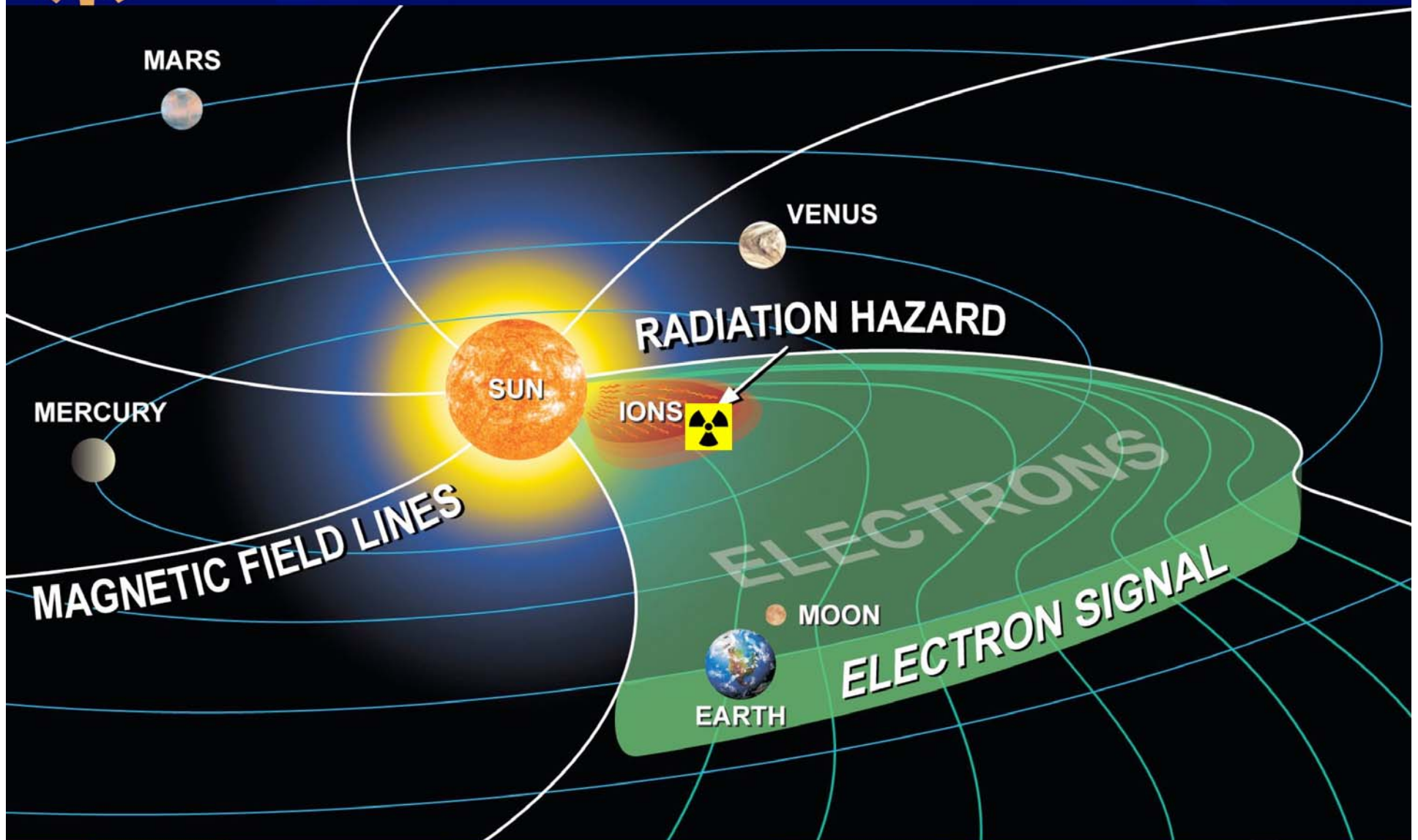
(2) Southwest Research Institute, San Antonio, TX, USA

(3) also at NASA/HQ, SMD, Washington, DC, USA



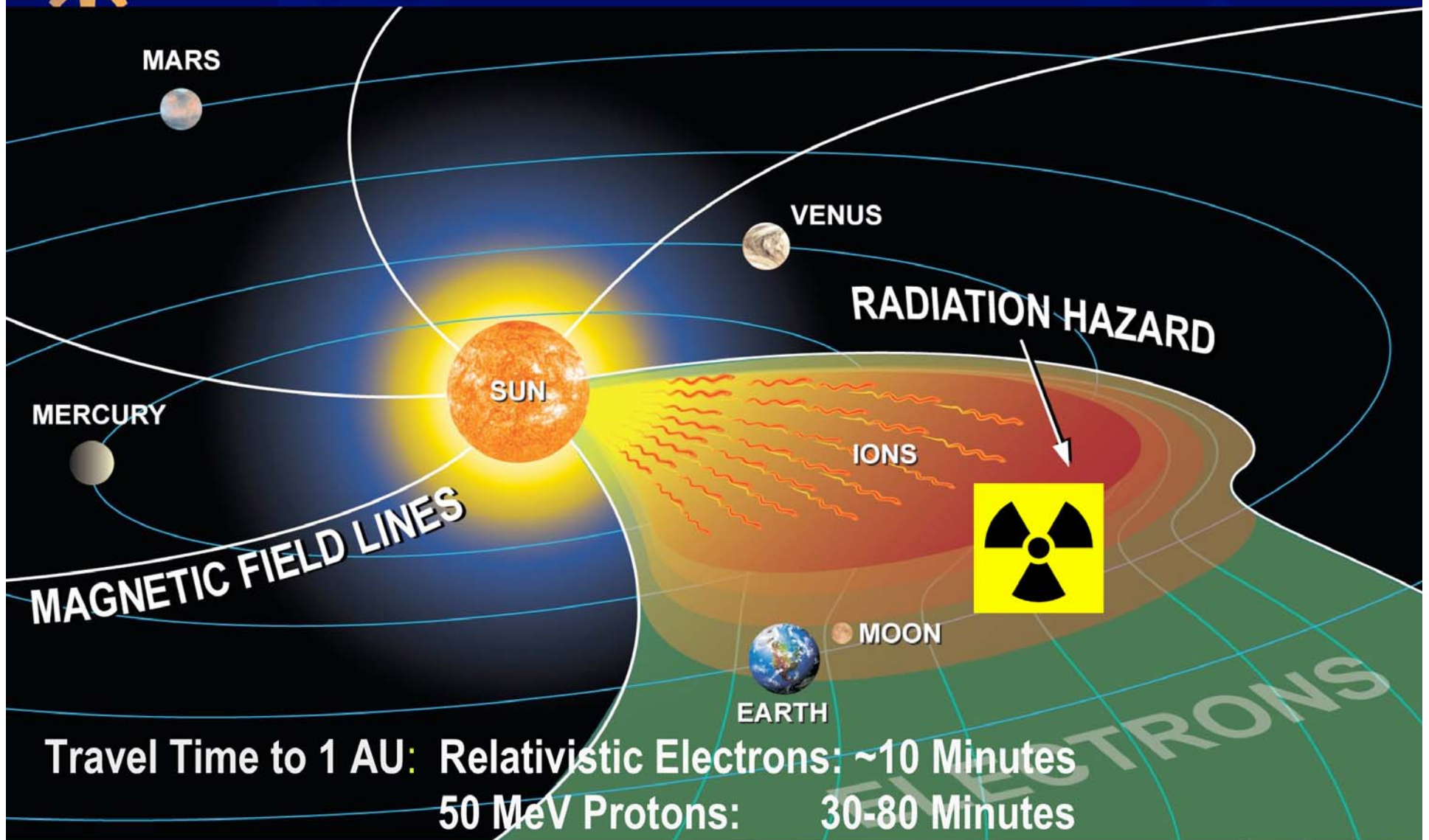


# The Forecasting Technique: Alert





# The Forecasting Technique: Hazard Arrival





# Why should it work?

Assumptions:

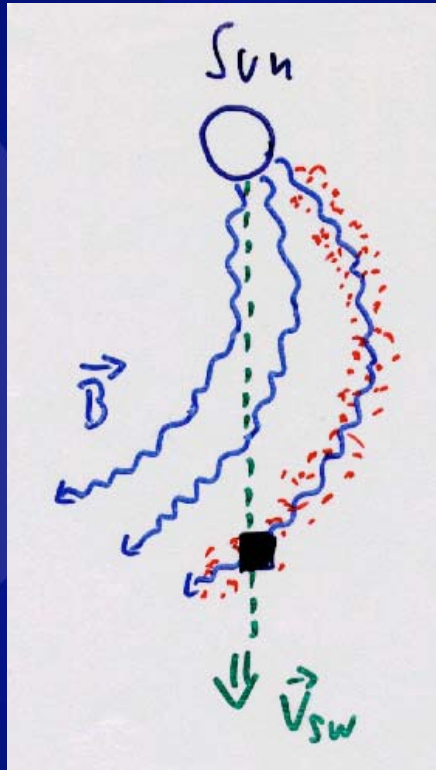
1. Particles from the Sun
2. Propagate along the Parkerspiral
3. Measured profile depends on

1. Particle injection (prompt)

$$q(\tau) = \frac{C}{\tau} \exp \left\{ -\frac{\tau_c}{\tau} - \frac{\tau}{\tau_L} \right\}$$

2. Particle propagation (diffusive)

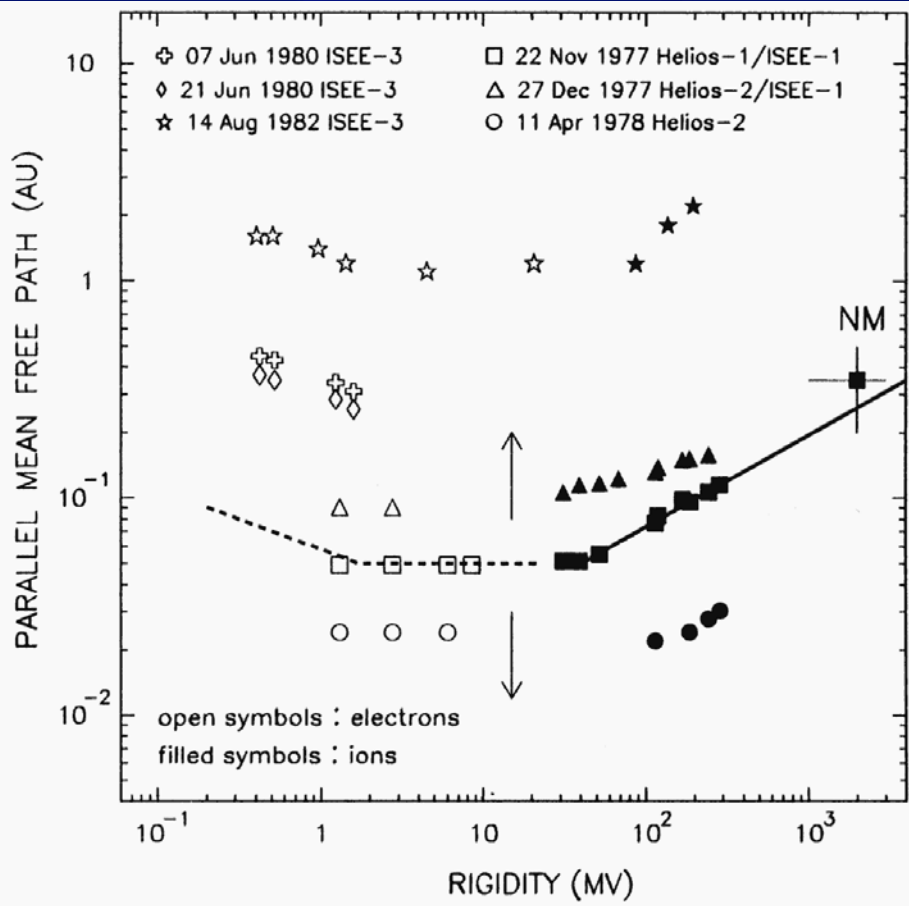
$$\frac{\partial f}{\partial t} + \mu v \frac{\partial f}{\partial z} + \frac{1 - \mu^2}{2L} v \frac{\partial f}{\partial \mu} - \frac{\partial}{\partial \mu} \left( D_{\mu\mu}(\mu) \frac{\partial f}{\partial \mu} \right) = q(z, \mu, t)$$







# Physical Causes for Correlation: Mean Free Paths Correlated



Rigidity Dependence of Mean Free Paths:

flat between 1–10 AU  
increasing towards  
lower rigidities

} electrons

increasing towards  
higher rigidities

} ions

for MFPs 0.02 – 2 AU

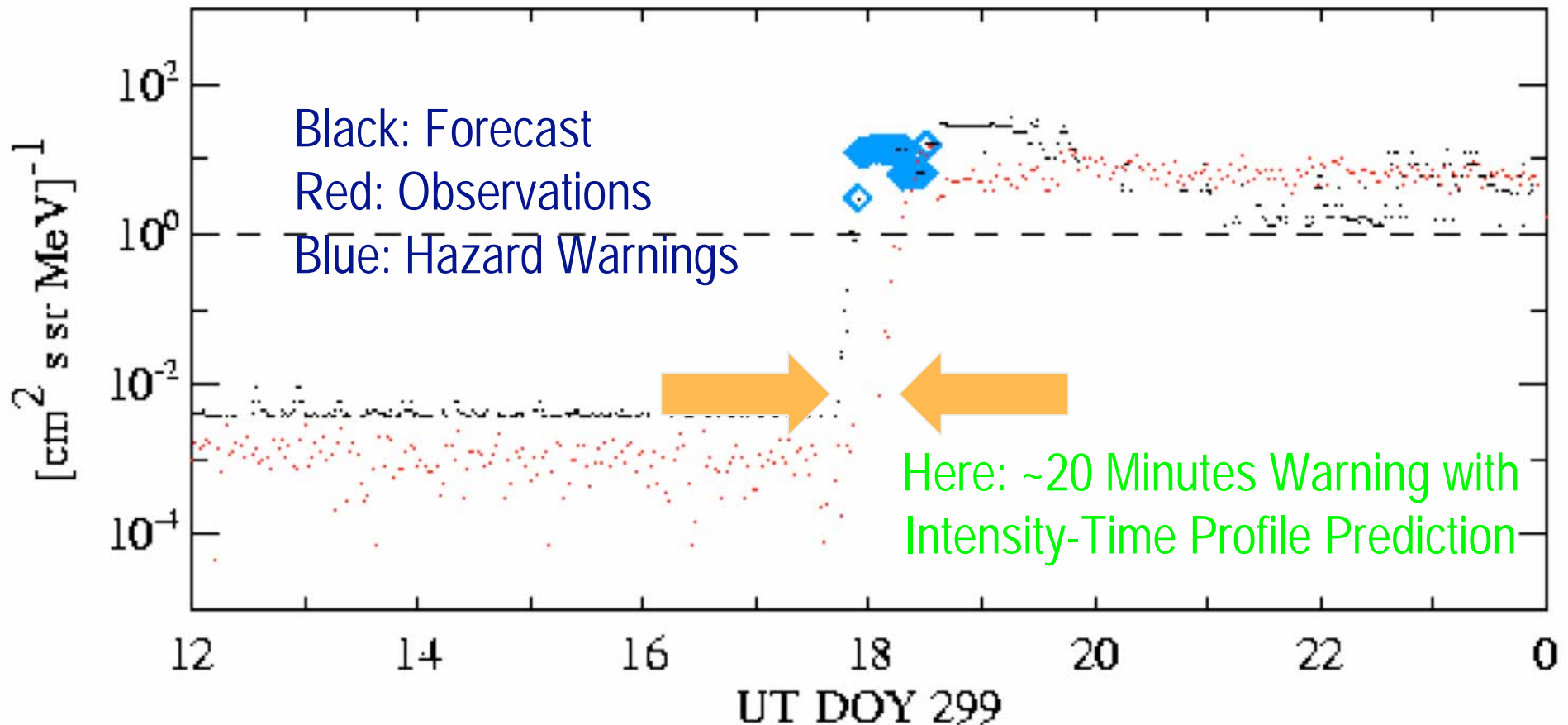
**Strong Correlation between  
Electrons and Ions, but  
Event-to-Event Variability!  
Origin unknown**

[Dröge, *Ap.J.* 537, 2000]



## Early Test Results for 2003 only: 30-50 MeV Proton Forecast

### Proton Event Prediction DOY 299, 2003



Posner, *Space Weather*, 2007



# Summary

- First SPE ion intensity-time profile forecasts
- Forecasting successful because in rise phase, SPE electron and proton intensities closely correlated
- 4.5 Year verification highly successful for prompt SPEs
- Method helps with delayed events, but is not sufficient (not designed to do this)
- COSTEP Workstation is set up at SOHO SOC (GSFC)
- **Live Forecasting Web-Sites**  
<http://www-etph.physik.uni-kiel.de/missions/soho/costep/realtime/forecast>



# Spare transperencies

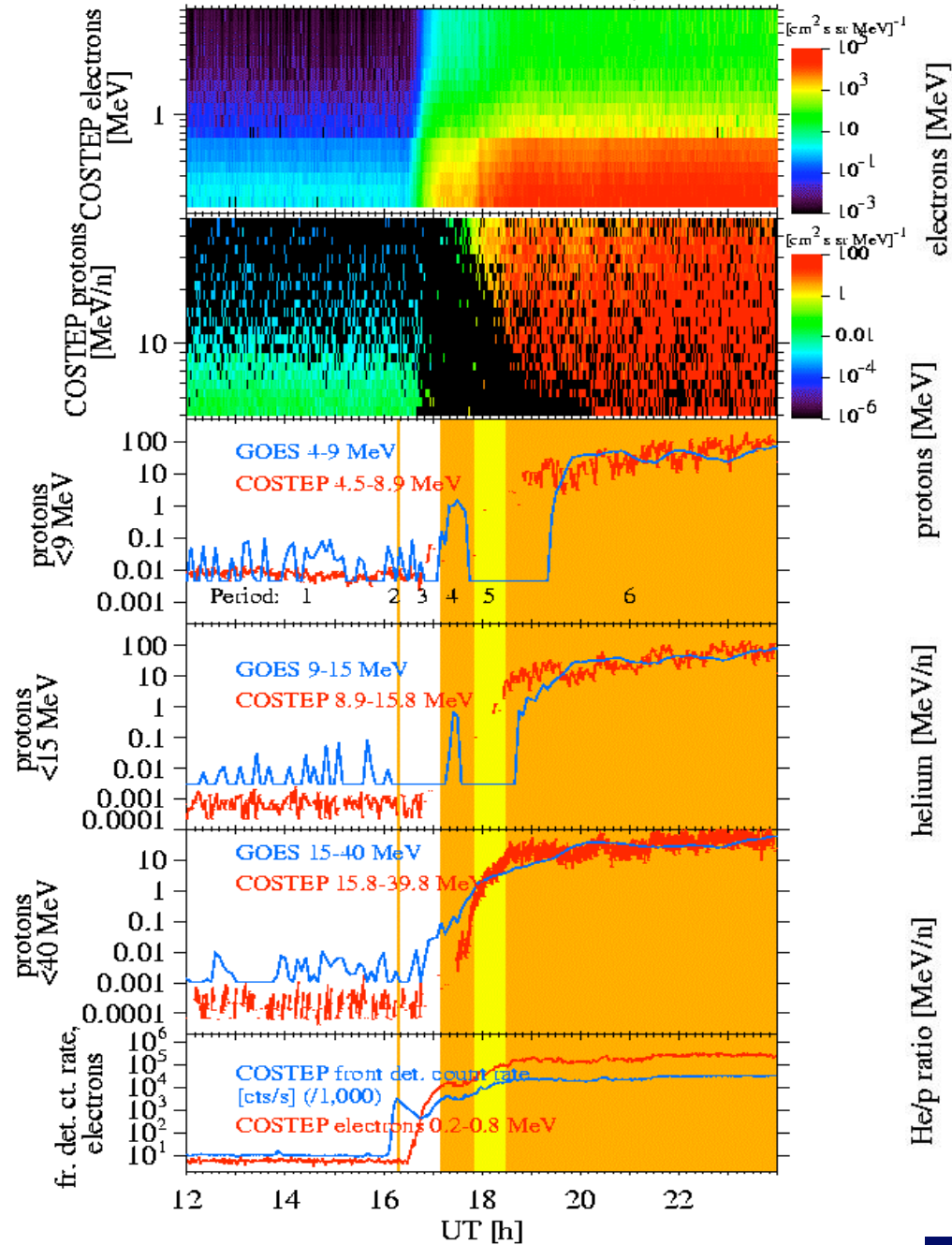




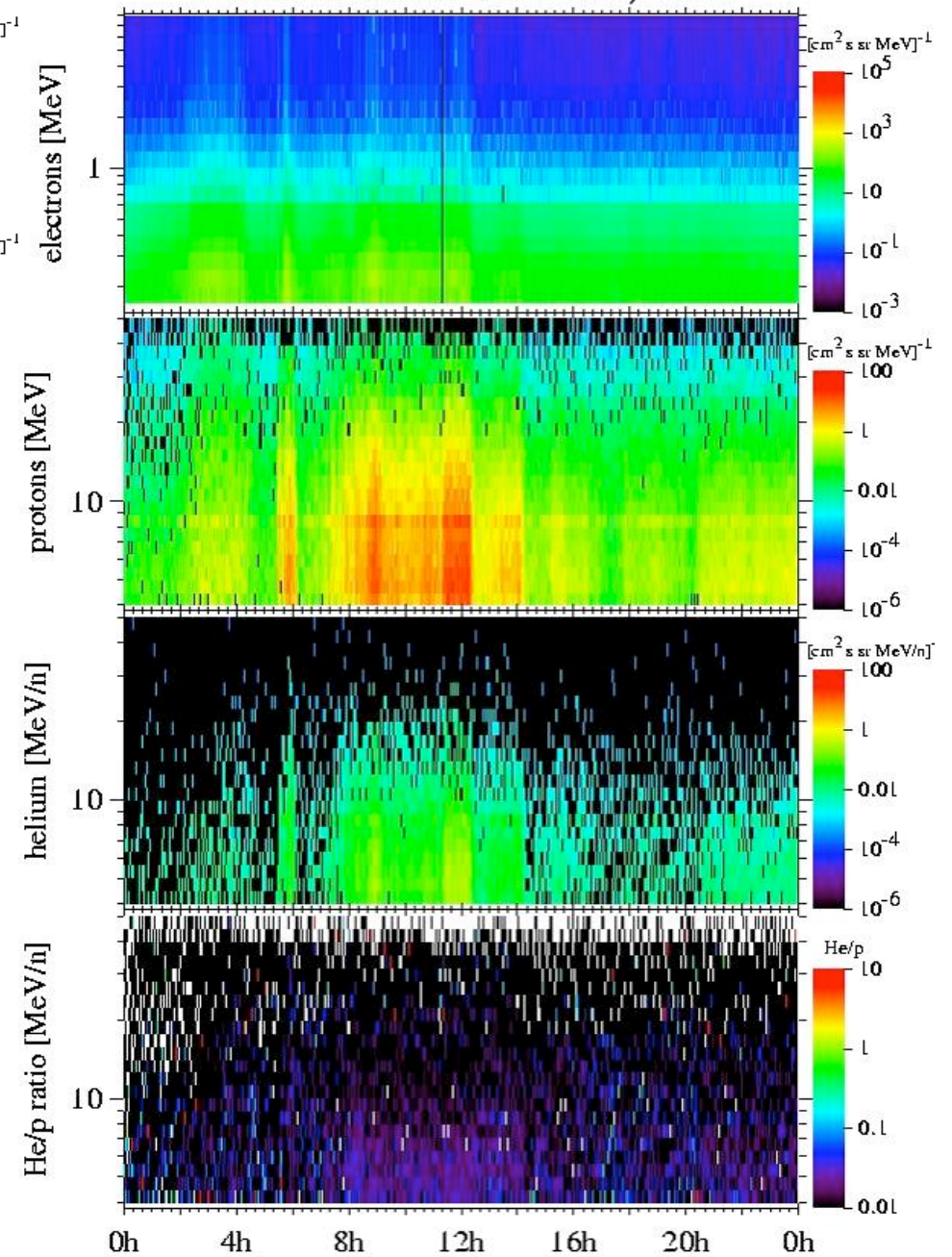
## Implementation

- SOHO will Continue 16h/day Real-Time Coverage until End of 2009, Uncertain Thereafter
- ] Held Informal Meetings with SOHO Project Scientists and COSTEP PI Team
- ] Held SOHO Implementation Telecon (**SOHO Project, COSTEP Team, JSC-SRAG, CCMC**, NOAA/SEC, NASA/ESMD)
- ] VMS-Based COSTEP Software Transfer to UNIX, Transition to SOHO Real-Time Stream
- ] COSTEP Workstation to be Set Up at SOHO SOC (GSFC) for Real-Time Data Usage
- ] **Forecasting Software to be Adjusted to Real-Time Data Usage**
- **Live Forecasting Web-Sites**

SOHO/COSTEP Nov. 04, 2001



SOHO/COSTEP DOY 210, 2000





# Superposed Epoch Analysis of GOES List (48) Events

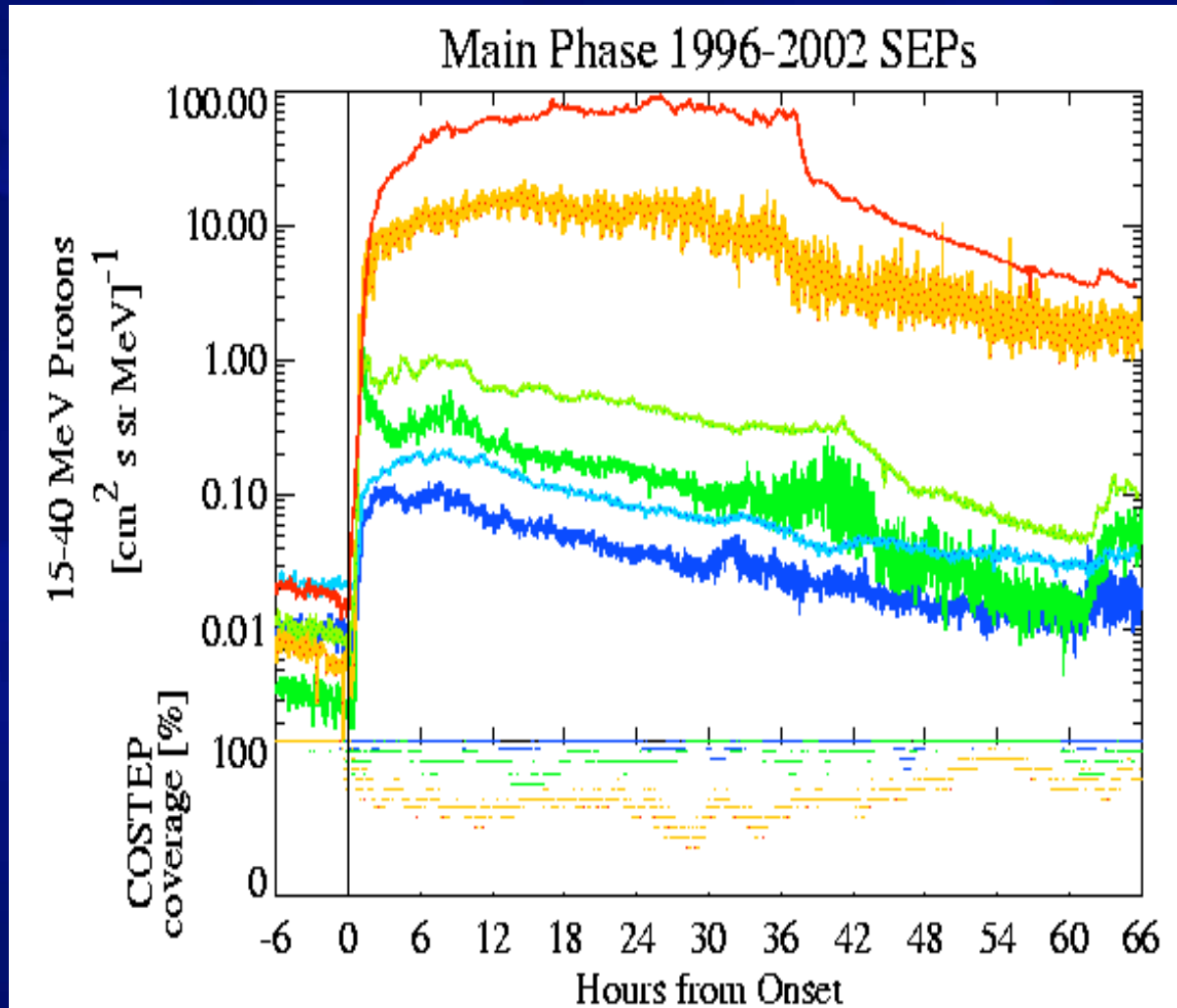
## Prompt and Delayed Events

Ordered by Fluxes  
(str, med, wk), 16 each

θ ~40 MeV Protons  
Always Delayed  
over Electrons

θ Warning Time for  
Astronauts

θ Average 3-day Time  
Profiles: Possibility  
for Long-Term  
Forecasting



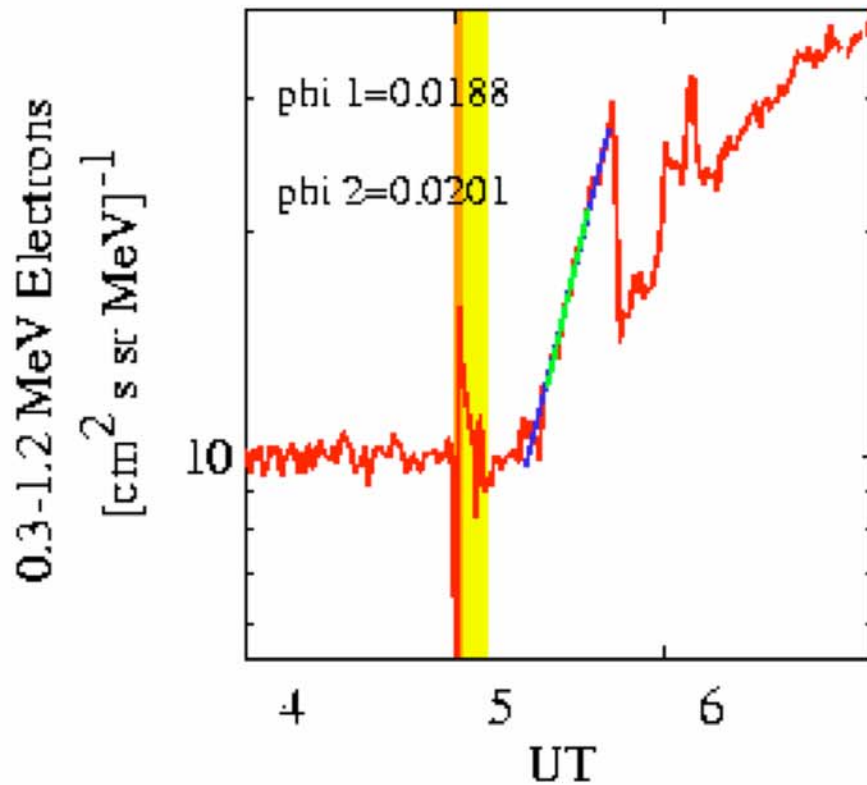




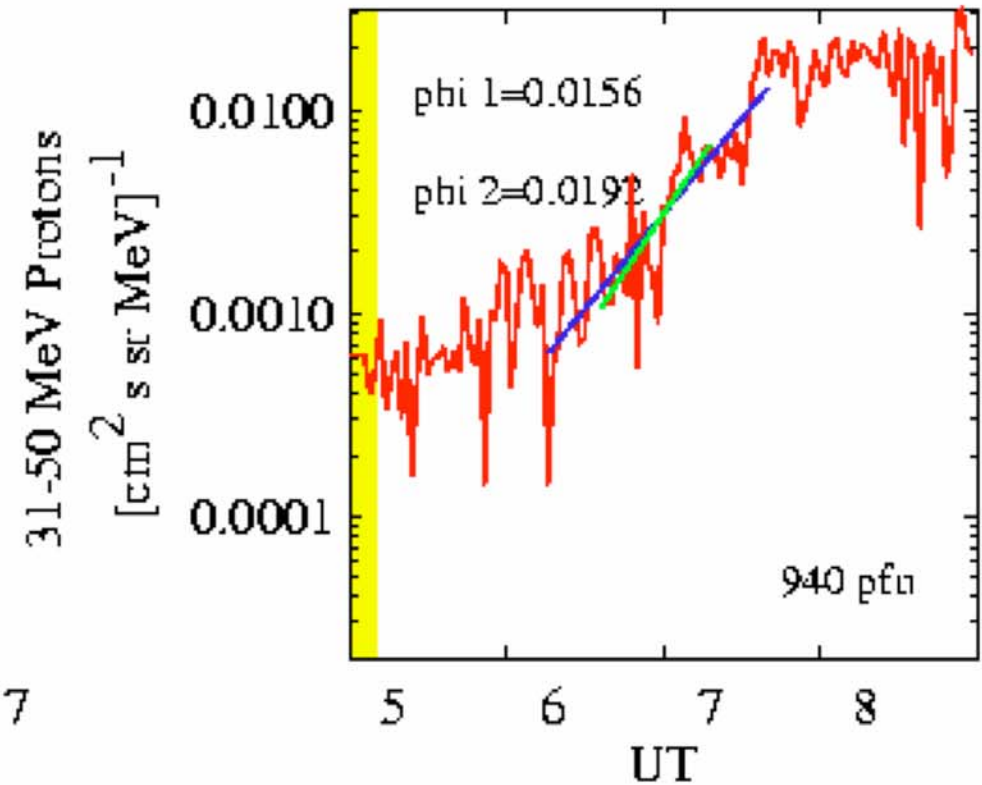
# Physical Causes for Correlations: Magnetic Sector Structure as Transport Barrier

Single Event in 2000 shows Two Slopes when Wind/MFI observes Multiple Sector Boundary Crossings

329/2000



329/2000





# e-p Relationship in SEPs: Intensity Increase Parameter $\Phi_e$ vs. Connection Longitude Difference

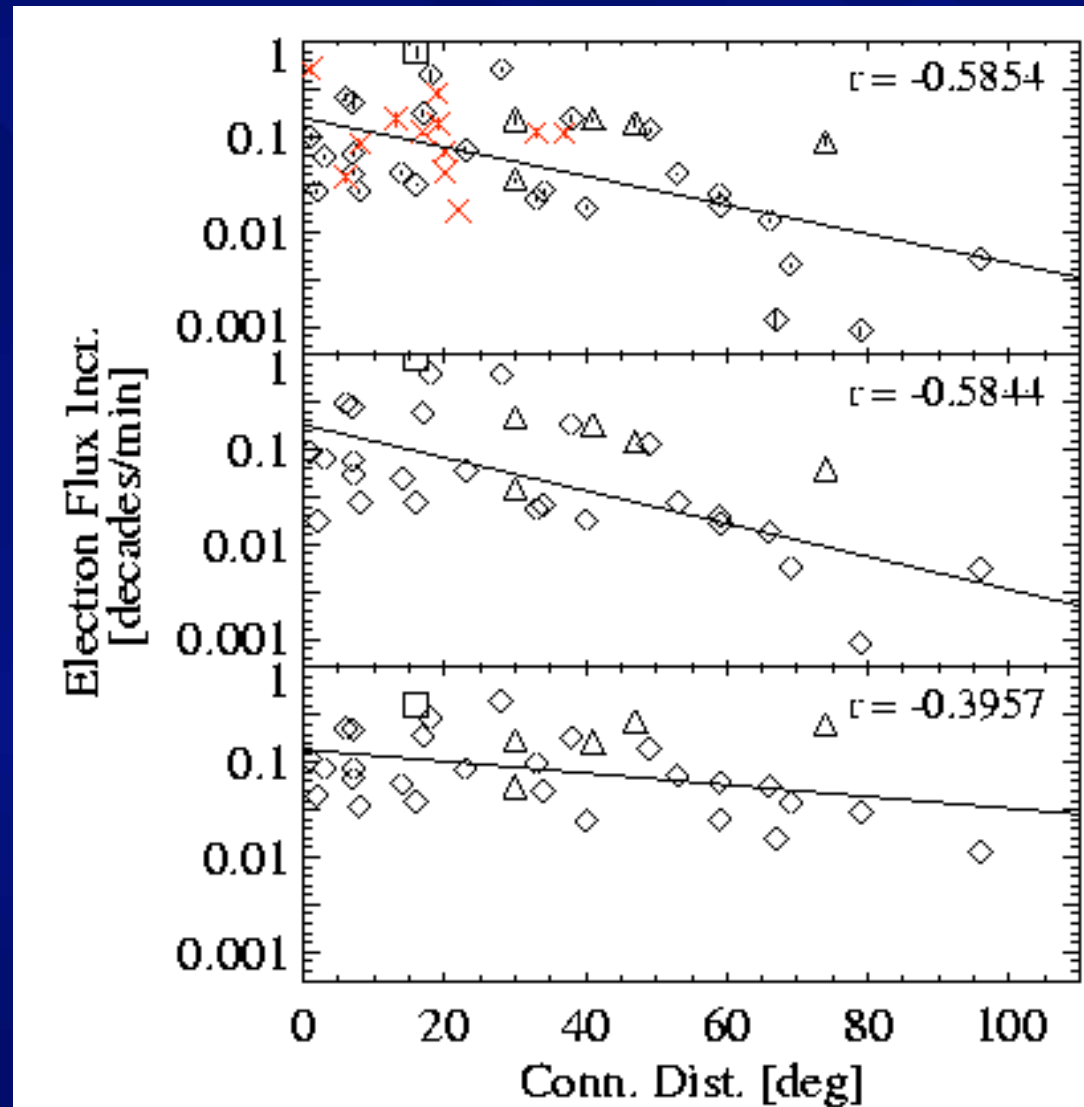
$r = -0.59$ :

Highly Significant  
Correlation for Electron  
Flux Increase with  
Connection Distance

Triangles: High Flux Levels at  
COSTEP, low geometric factor  
mode

Method 3: Steepest 10-min  
Slope

Impulsive Events from List in  
Reames and Ng, ApJ, 2004





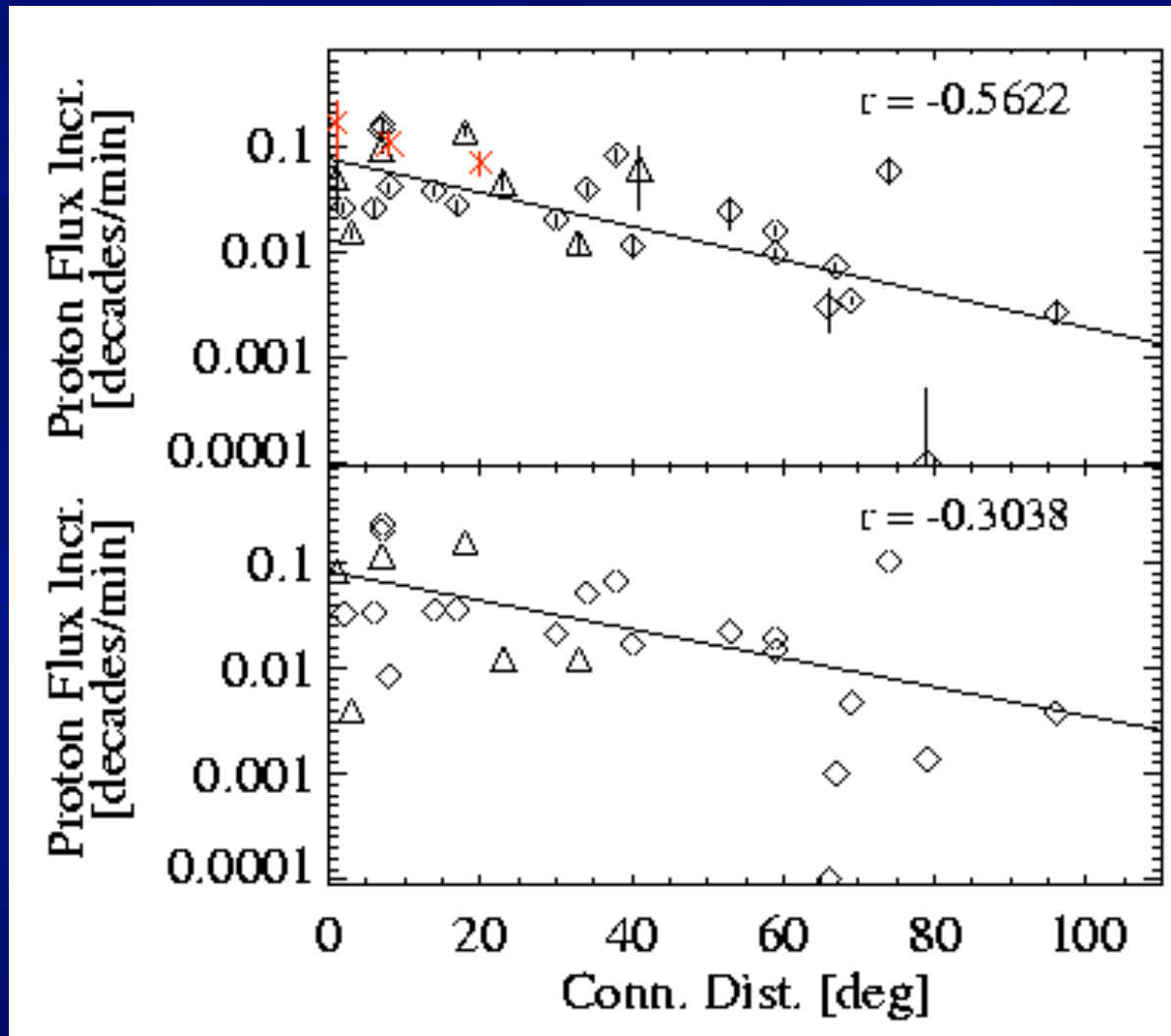
# e-p Relationship in SEPs: Intensity Increase Parameter $\Phi_p$ vs. Connection Longitude Difference

$r = -0.6$ :

Highly Significant  
Correlation for Proton Flux  
Increase

Triangles: High Flux Levels at  
COSTEP, low geometric factor  
mode

Impulsive Events from List in  
Reames and Ng, ApJ, 2004





## Impulsive vs. Gradual Events: The Paradigm

### Composition Differences?

- Yes:  $^3\text{He}/^4\text{He}$  Hsieh & Simpson 1970; e/p Reames, v. Rosenvinge & Lin 1985
- But:  $^3\text{He}$  Enhanced in Gradual Events (Desai et al., 2005); Charge States increase with E Reminiscent of Impulsive Events (Oetliker et al., 1997; Möbius et al., 1999; Labrador et al., 2003); higher  $^3\text{He}/^4\text{He}$  Enhancements in smaller Flares (Reames & Ng, 2004).

### Differences in $\Phi$ Distributions?

- No! Used Impulsive Event List of Reames & Ng (2004) for Comparison with GOES List

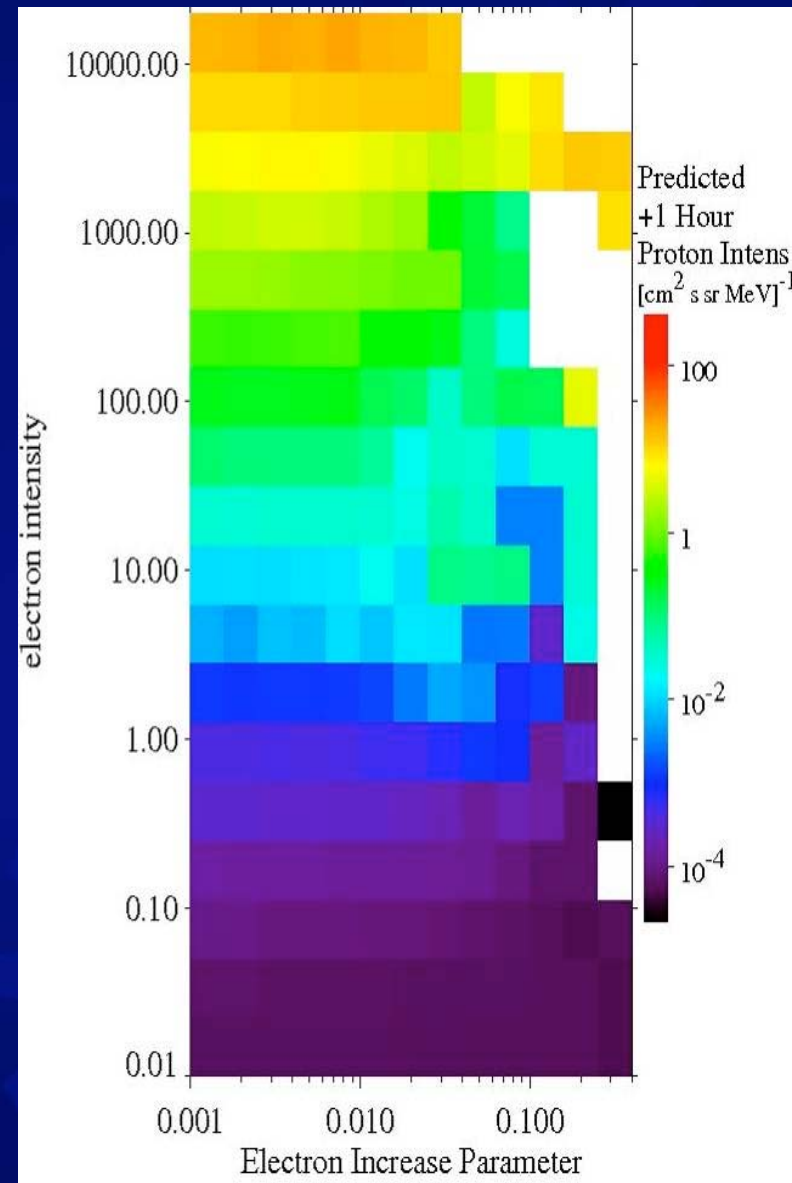
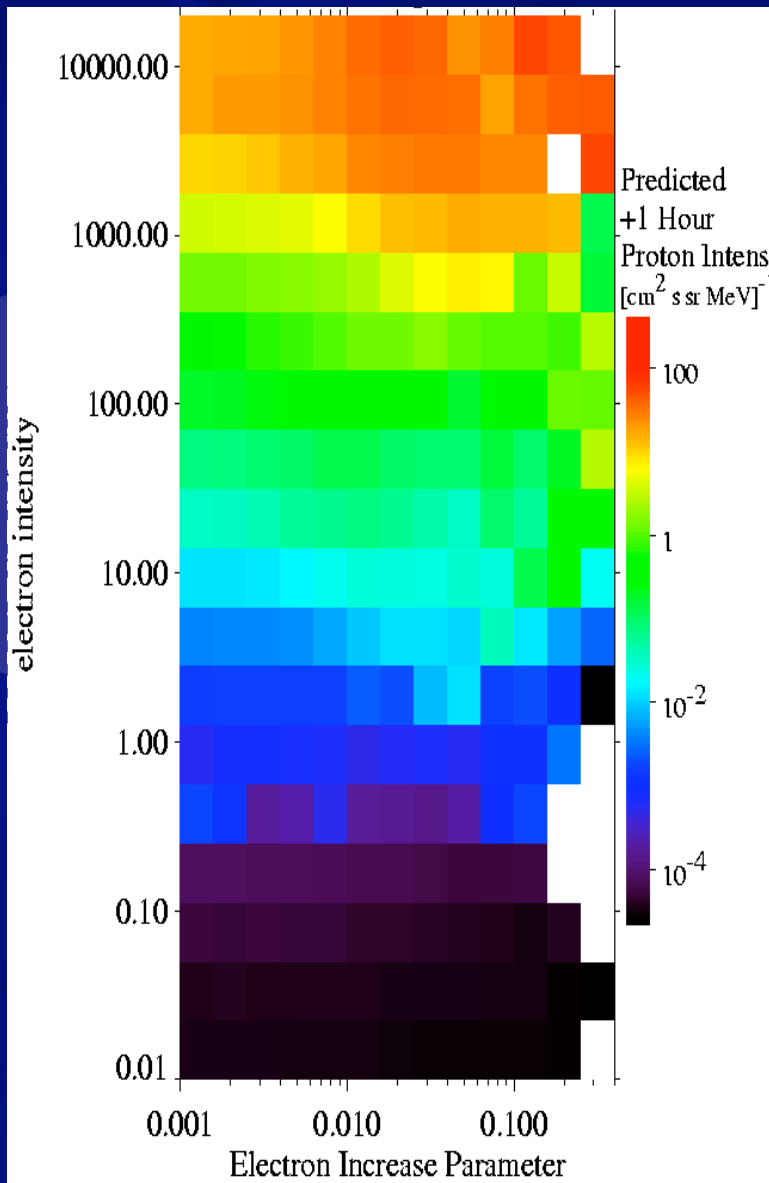




# Adjustments to Solar Minimum?

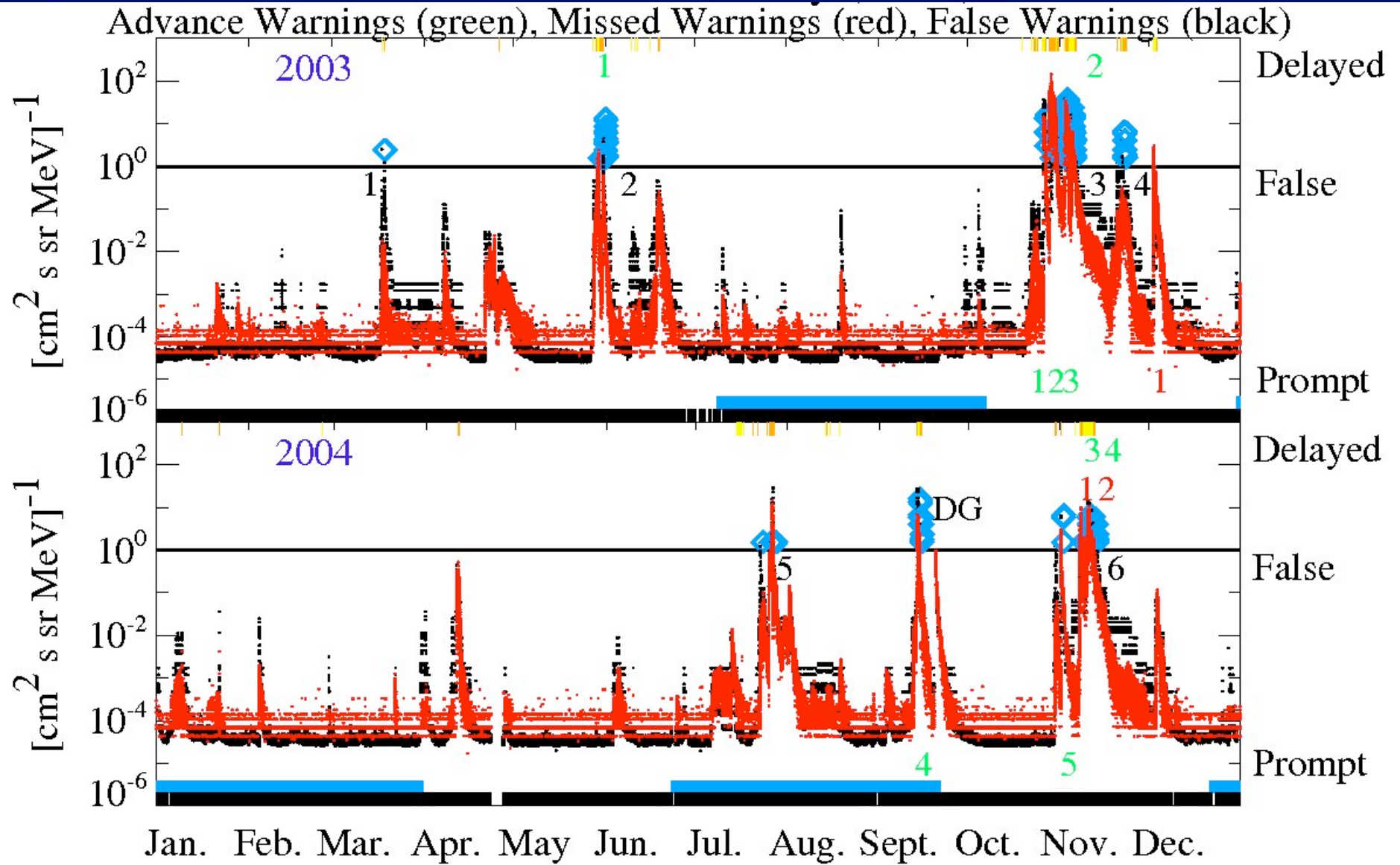
1996-2002

Solar Minimum only



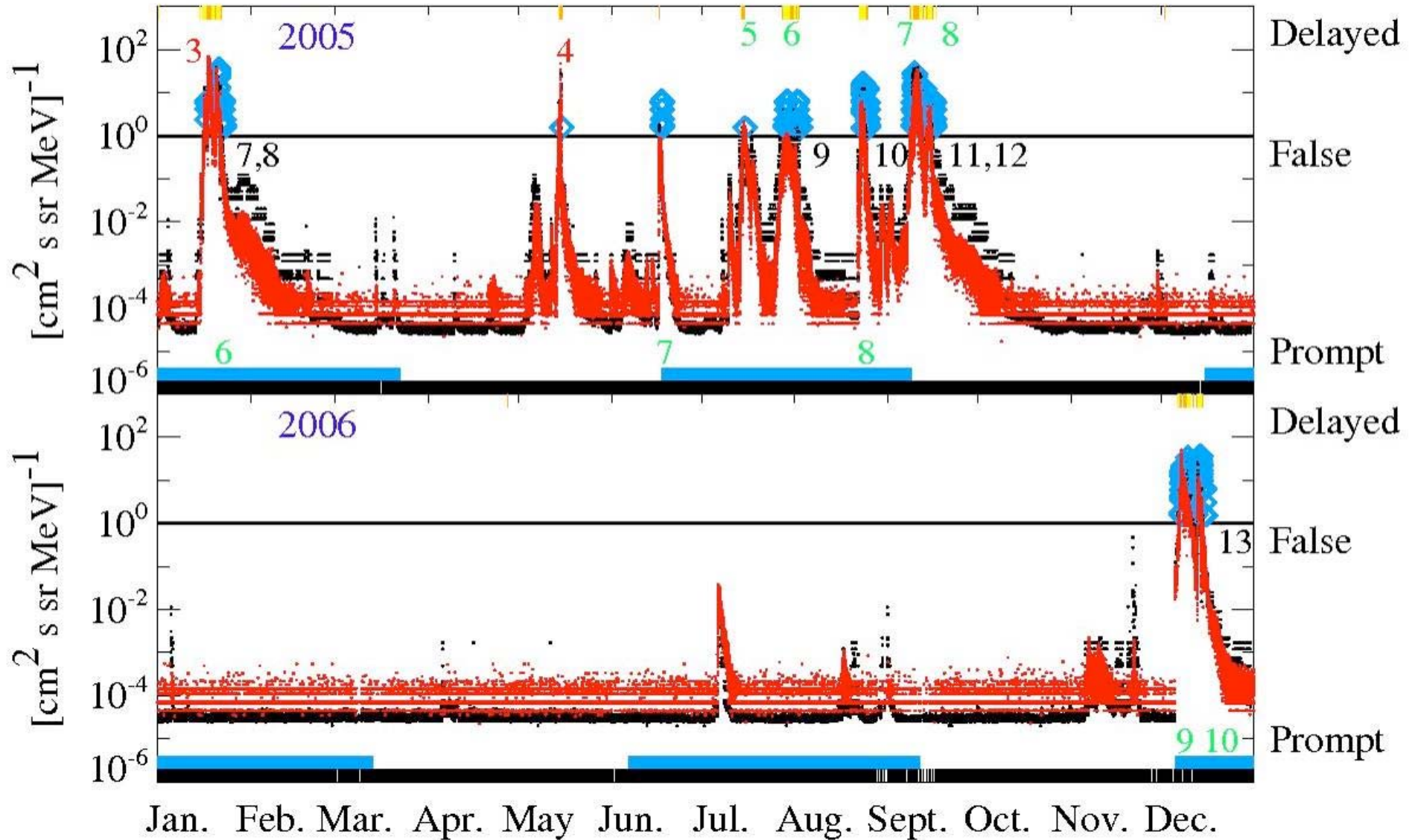


# New Test Results – Part 1: 2003-2004

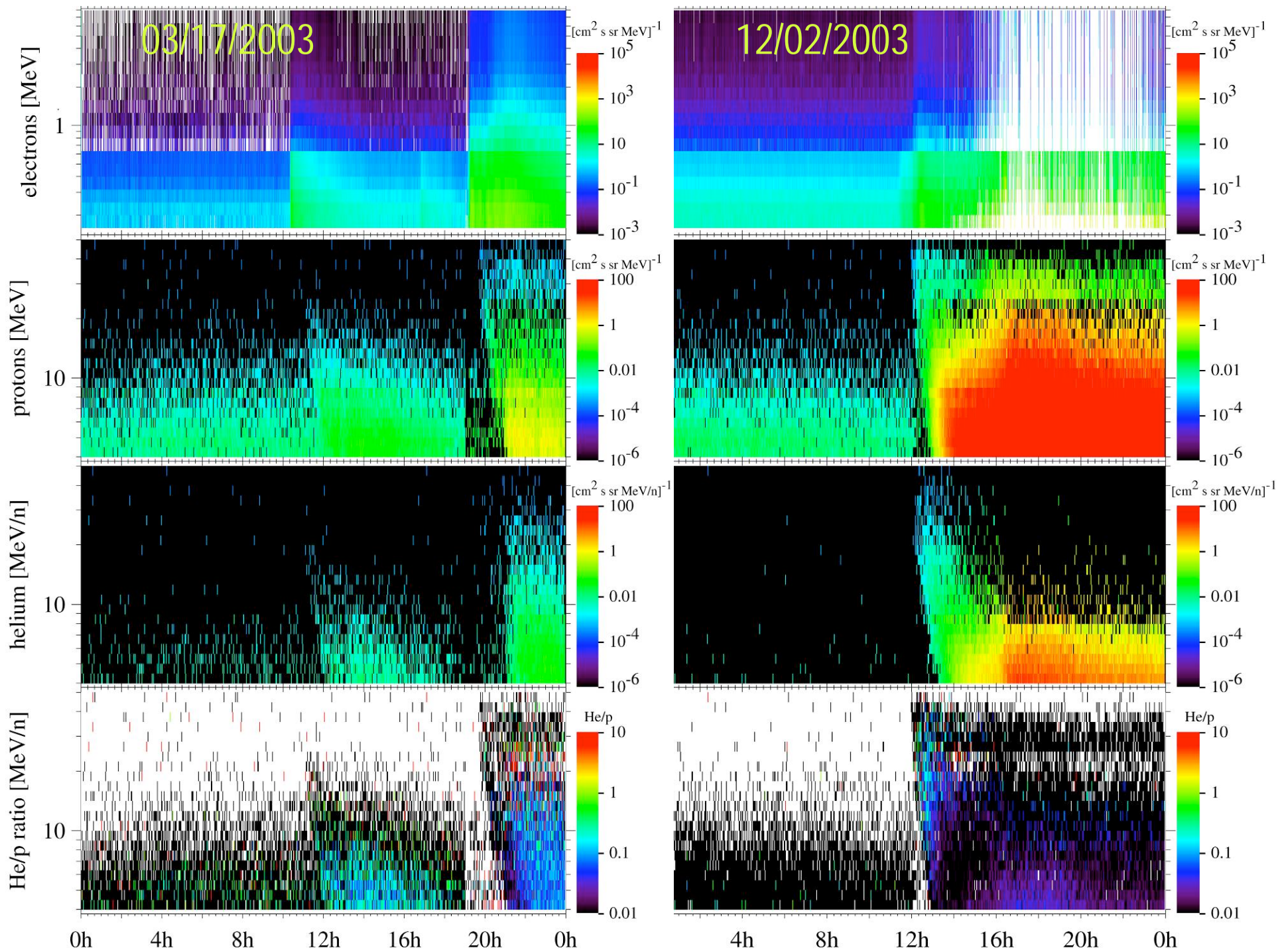




## New Test Results – Part 2: 2005-2006



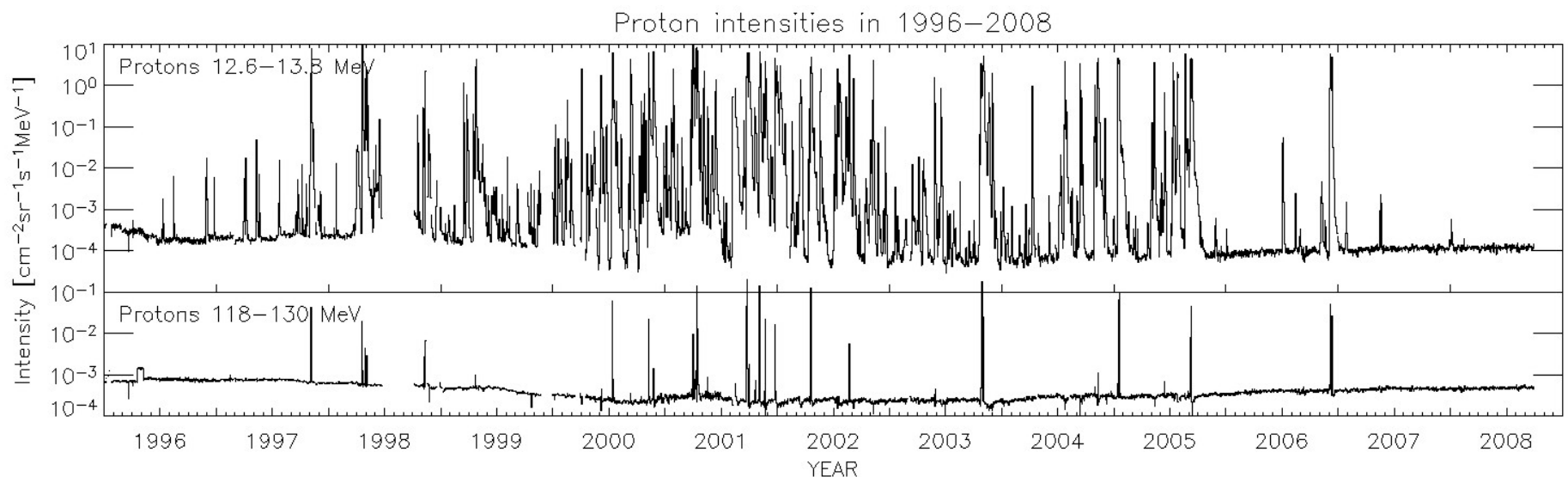




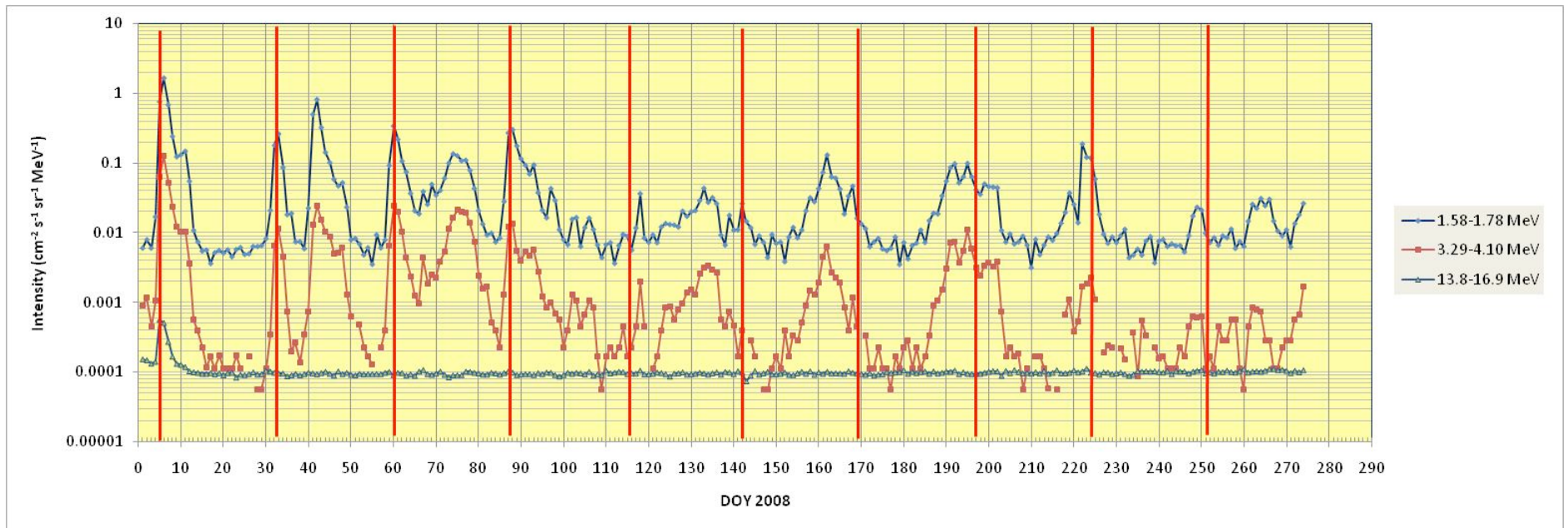
ERNE

# ERNE status

- LED
  - Nominal
- HED
  - No significant change since November 2000, when one of the strip detector coordinate channels malfunctioned (high noise level)
    - Software update to handle the noisy detector signals
  - Consequences of coordinate noise
    - Unreliable directional measurements with the noisy detectors
    - Statistical fluctuations in the total energy measurements of  $\geq 20$  MeV/n protons and helium
    - Heavy ions unaffected



- Proton intensities January 1 - September 30, 2008
  - CIR events at low energies

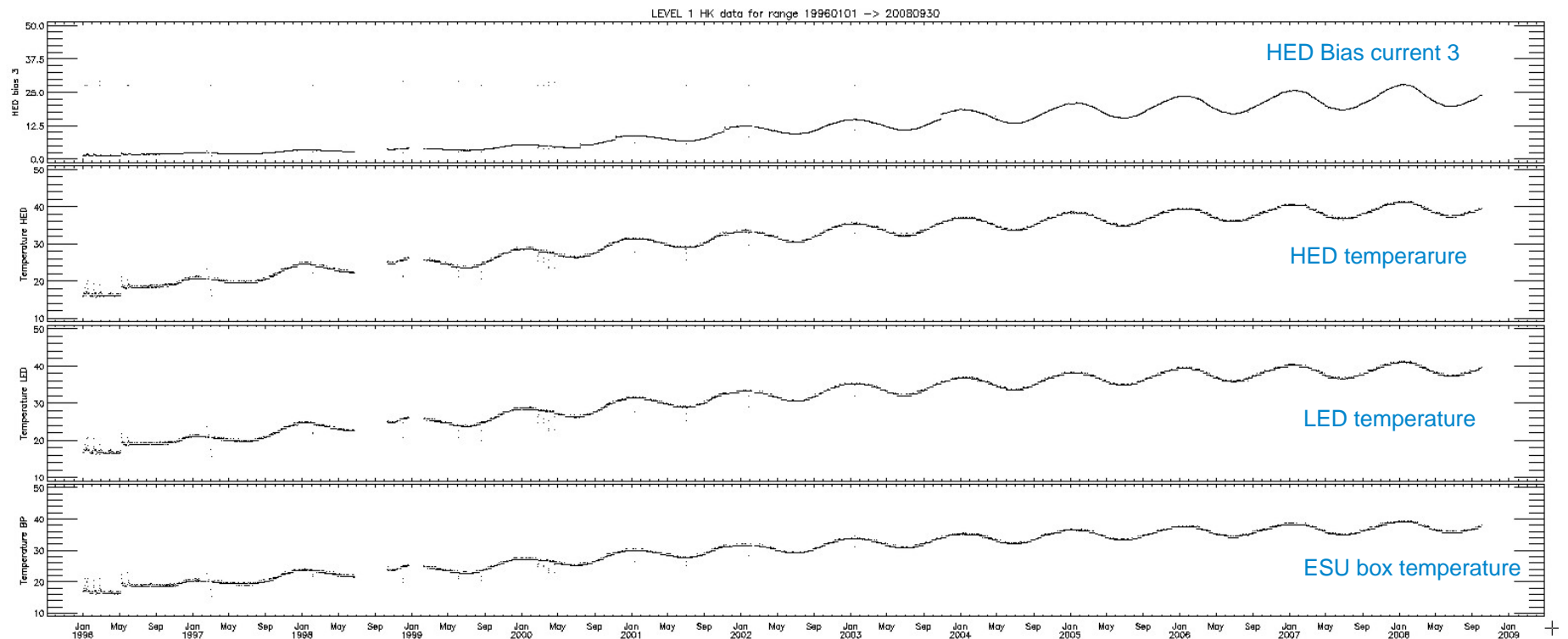


October 14, 2008

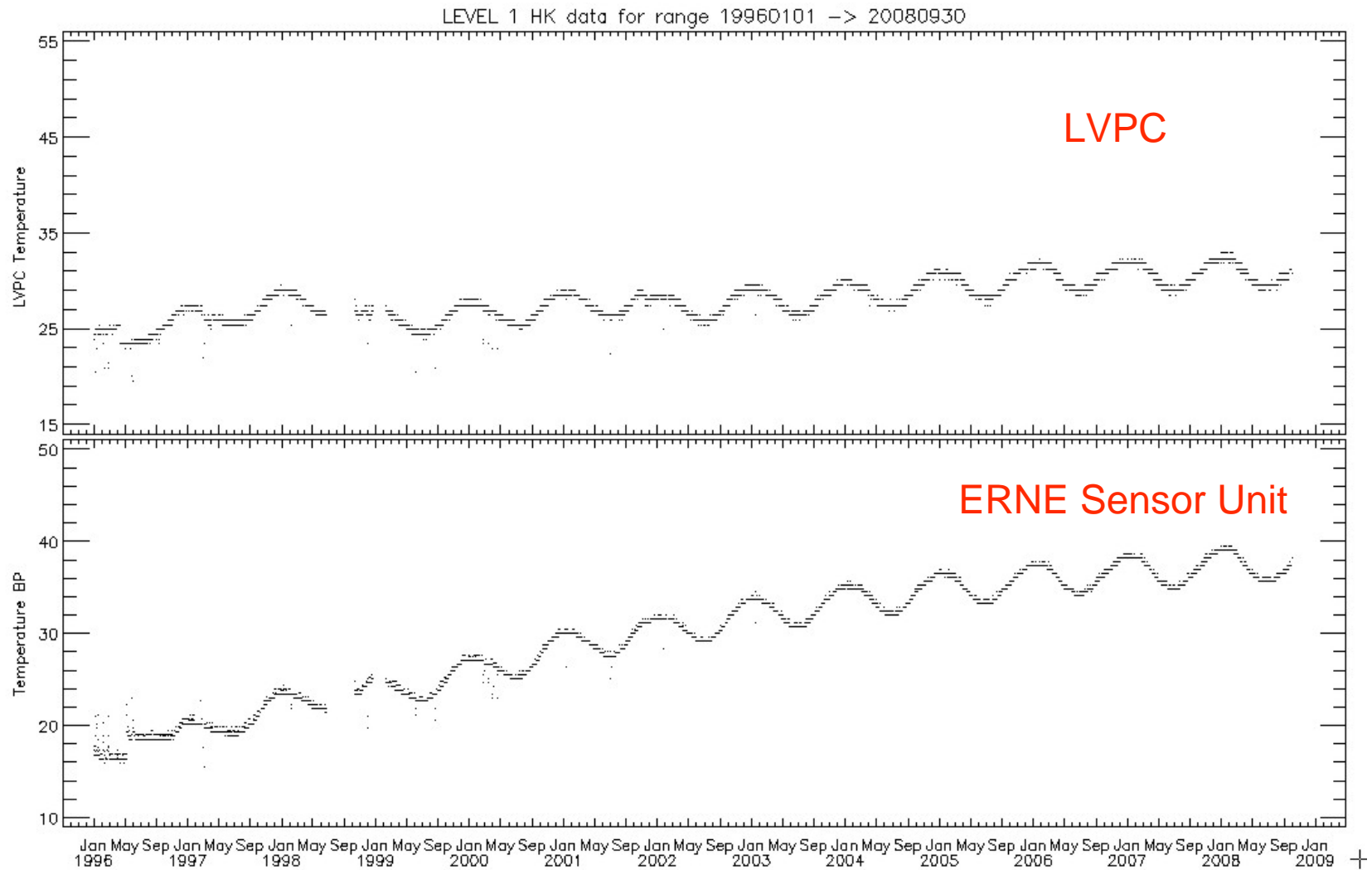
SOHO SWT-40  
E. Valtonen



- ERNE temperature development



- Comparison of LVPC (collectively controlled) and ESU (individually controlled) temperatures



October 14, 2008

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- ERNE data availability:
  - [http://www.srl.utu.fi/erne\\_data](http://www.srl.utu.fi/erne_data)
  - SOHO archive

The screenshot shows a web browser displaying the SOHO ERNE data availability page. The page title is "ERNE data is available from 1996-05-08 to 2005-01-24". It contains a navigation menu on the left with options like SUOMEKSI, VISPA, GENERAL, RESEARCH, PROJECTS, PERSONNEL, PUBLICATIONS, LINKS, PH. D. THESES, ERNE DATA, GALLERY, INFO, SITE MAP, STATISTICS, and PHYSICS. The main content area has a search form with fields for Start time, End time, and Resolution. Below the form is a table of channels with columns for New channel, Start channel, End channel, Proton energy nominal, and He-4 energy nominal. The table lists channels 0 through 6 with their respective energy ranges and nominal values. There are also options for channel selection and a "SUBMIT REQUEST" button. On the right side of the browser window, a "Plot frame" displays a graph titled "SOHO ERNE (Väisälä Institute for Space Physics and Astronomy, www.srl.utu.fi)". The graph shows Intensity [1/cm<sup>2</sup>sec-MeV/na] on a logarithmic y-axis (from 5.0e-06 to 5.0e03) versus time on the x-axis (from 0801 00:15 to 0926 16:45). The plot shows several peaks in proton and helium intensities. A legend on the right lists parameters for the plot, such as p: [1.33-3.06] 2.20 and He-4: [13.8-28.0] 19.7. Below the plot, there are controls for selecting specific energy channels and options to generate a GIF image or download data in PROTON (584 KB) or HE-4 (584 KB) formats.

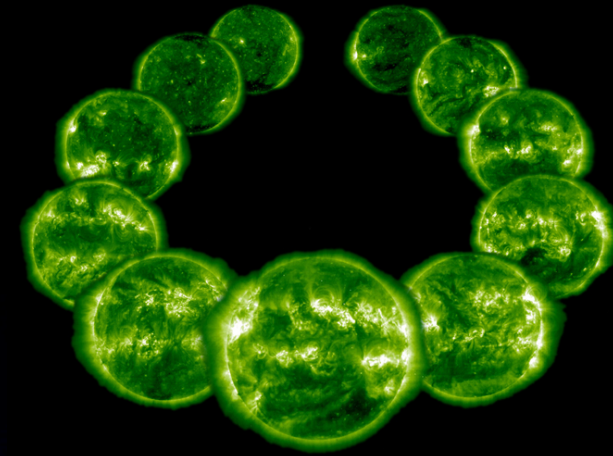
Free search for proton and helium intensities:

- time span
- time resolution
- energy channels





# SOHO SWT-40

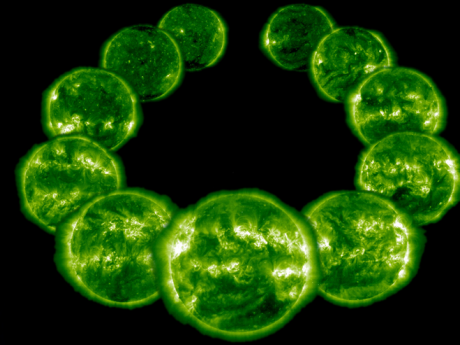


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# *Changes to Operations (I)*

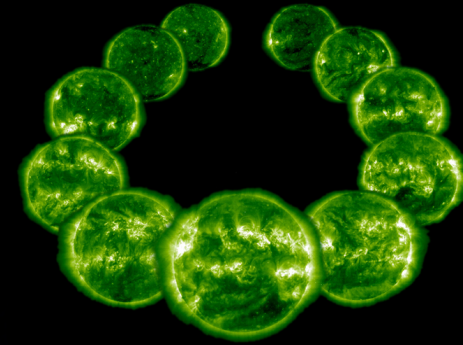


- Changes to operations (steady-state, CY2010 and after)
  - Much less realtime contact
  - Not necessarily geared to EOF local time
  - Fully automated spacecraft operations
  - FOT reduced to Observatory Engineers (including managing engineer) and a part-time DSN scheduler





# Changes to Operations (II)

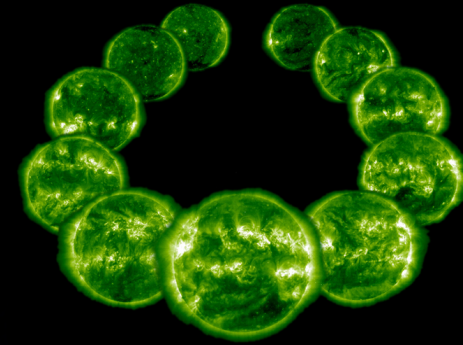


- To get to that steady state, we will go through:
  - Overtime for Observatory Engineers to assure minimum loss of MDI high-rate during MDI-HMI intercalibration
  - Transition to fully automated s/c operations
  - Porting of EOF Core System (ECS) to more sustainable platform (Linux), rackmount hardware
  - Porting of LASCO science ops software to more sustainable platform (newer Solaris, Mac OS X)
  - Porting of DPS to more sustainable platform (TBD)





# EOF-BOF transition (I)

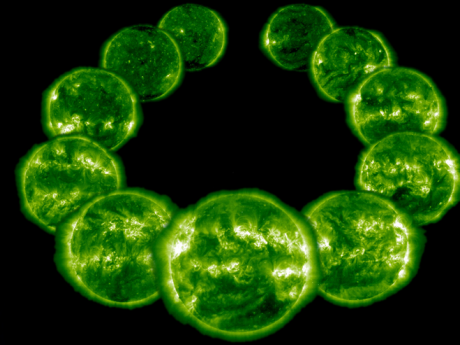


- “Science Exploration” building now being constructed at Goddard (where Soil Conservation Road used to be); will house almost all of Astrophysics and Planetary, but none of Heliophysics
- Heliophysics will take over most of Building 21 (library, cafeteria)
- After MDI is turned off, no more SOCs
- *SOHO* science personnel and remaining IWS systems move out of EOF ~ CY2010 Q2 or Q3





# *EOF-BOF transition (II)*

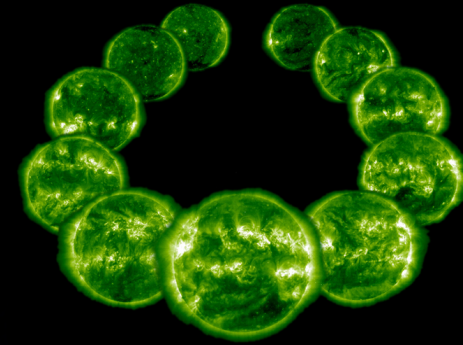


- Our network (IONet) connections will be preserved
- Office/ops space for science ops teams (LASCO, UVCS, SUMER/other visitors), project scientists
  - Considerably less floor space per team than at EOF
  - Will need to reduce number of workstations per team
- Computer room for rackmount h/w (ECS, SDAC)... two floors away (would also prefer COSTEP use rackmount)
- “Dungeon” for remote teams will remain in Bldg. 3
- CDS accommodation TBD





# Remote Teams' IT Infrastructure (I)

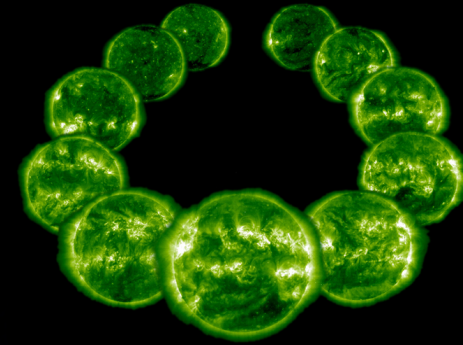


- Hardware currently in “dungeon” may not be bootable
  - > 15 years old in many cases
  - not patchable for strict IT security regime in IONet
  - could make some
- The Bogart mission is designed to last the full, 5-year lifetime of SDO – at least until 2013
  - We can't really expect 1993 systems to work in 2013
  - But remote teams have limited resources (e.g. COSTEP laptop)





# Remote Teams' IT Infrastructure (II)

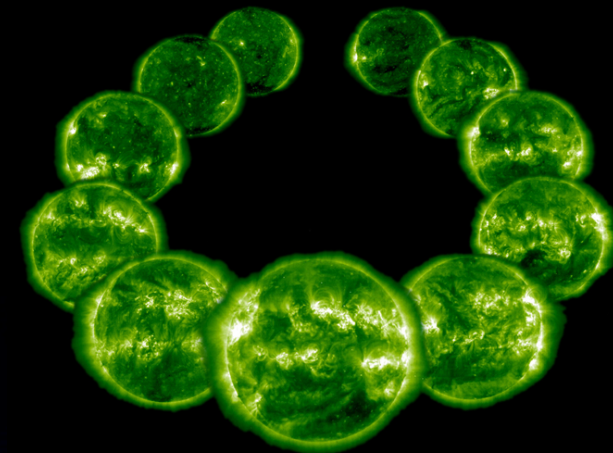


- All remote teams should verify by NLT 2008 November 30:
  - the bootability of current dungeon systems
  - the patchability of those systems
- If systems cannot be booted or patched, they should be replaced by NLT 2009 May 31 with something more sustainable
- If constrained resources prevent such h/w refreshment,
  - unusable systems should be removed/excessed in place
  - the expectation will be that any PI team troubleshooting will be carried out remotely... or not at all





# SOHO SWT-40

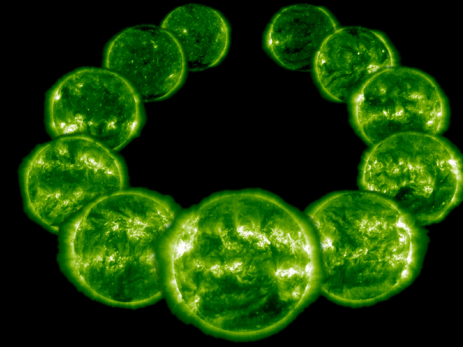


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# SOHO Archive Status

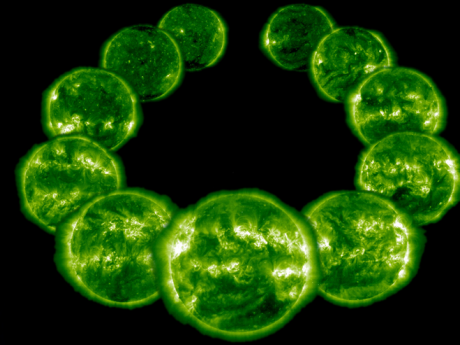


- **GSFC:**
  - Database migration from Oracle v.8 to MySQL v.5 completed in August
  - New data ingestion procedures to avoid Oracle PL/SQL and gain performance tested and verified in August.
  - Inclusion of ancillary data and telemetry after switch to new ingestion SW ongoing
- **ESAC:**
  - First version of new archive already functional (ingestion, search, distribution)
  - Currently in alpha test using data from 3 instruments (CDS, EIT, VIRGO)
  - New capabilities for image, movie and time series data visualization after all science data has been ingested
  - Data duplication GSFC ↔ ESAC complete providing disaster recovery
  - Refining user interfaces before testing with actual users





# SOHO Archive: *Current Issues*

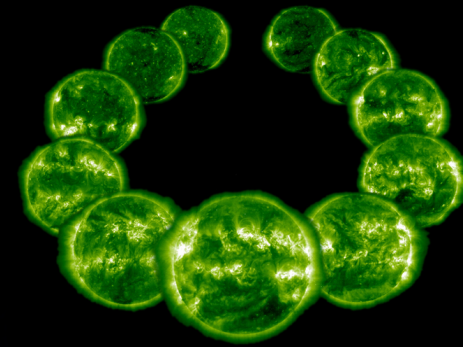


- **We are reviewing every data set we hold, as we believe some are not complete. For a few science data sets, Luis Sanchez will contact the PI teams for clarification or to fix delivery problems in certain cases.**



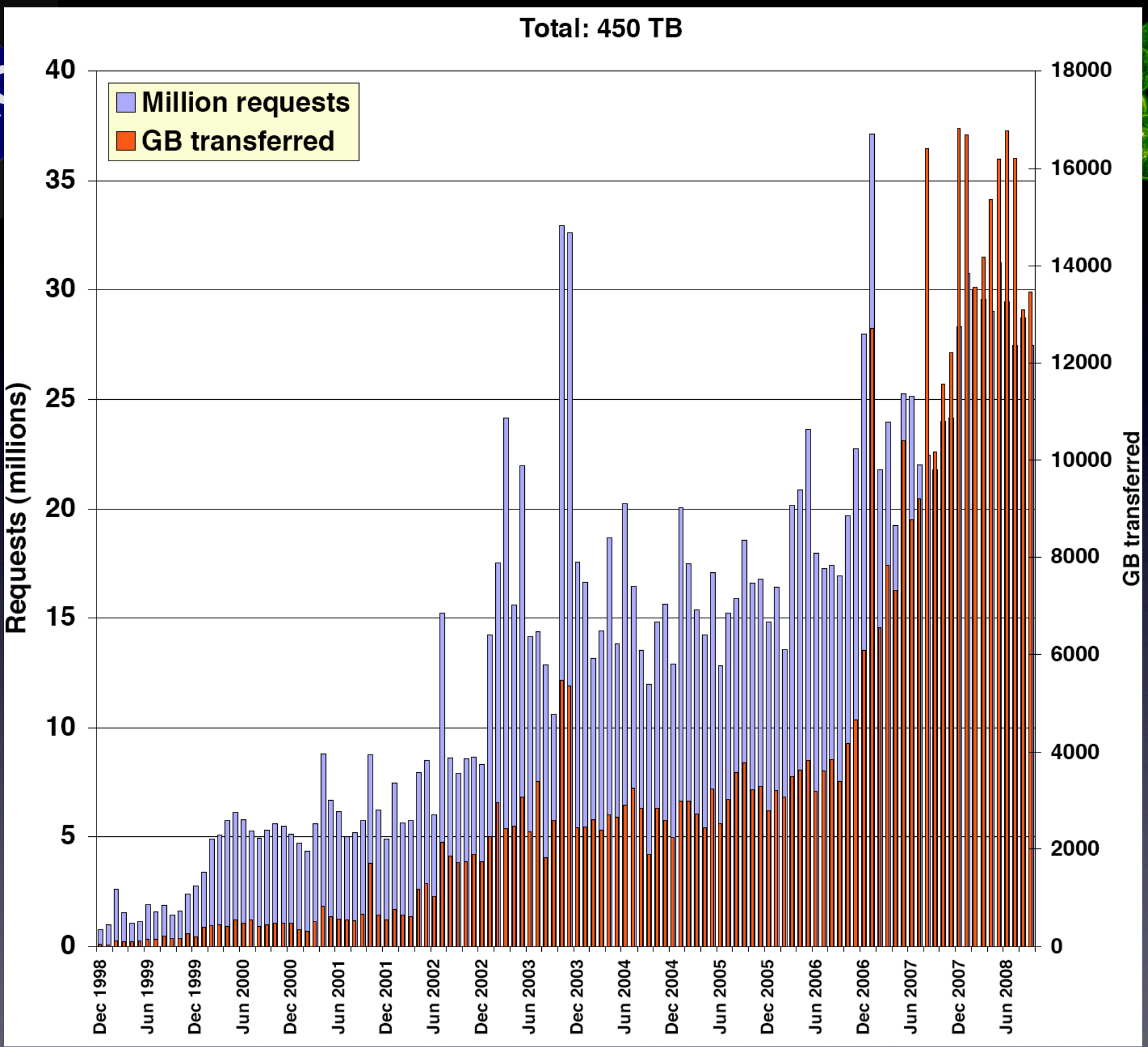
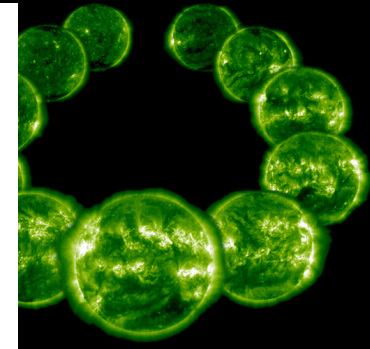


# Current Archive Status



| Instrument | Latest data | Updated on  |
|------------|-------------|-------------|
| CDS        | 03-OCT-2008 | 04-OCT-2008 |
| CELIAS     | 30-SEP-2008 | 04-OCT-2008 |
| COSTEP     | 01-SEP-2008 | 24-SEP-2008 |
| EIT        | 31-AUG-2008 | 04-OCT-2008 |
| ERNE       | 01-SEP-2008 | 23-SEP-2008 |
| GOLF       | 10-SEP-2008 | 19-SEP-2008 |
| LASCO      | 29-SEP-2007 | 06-AUG-2008 |
| MDI        | 30-SEP-2008 | 04-OCT-2008 |
| SUMER      | 03-JUL-2008 | 19-SEP-2008 |
| SWAN       | 10-SEP-2008 | 19-SEP-2008 |
| UVCS       | 28-JUN-2008 | 08-AUG-2008 |
| VIRGO      | 30-SEP-2008 | 04-OCT-2008 |

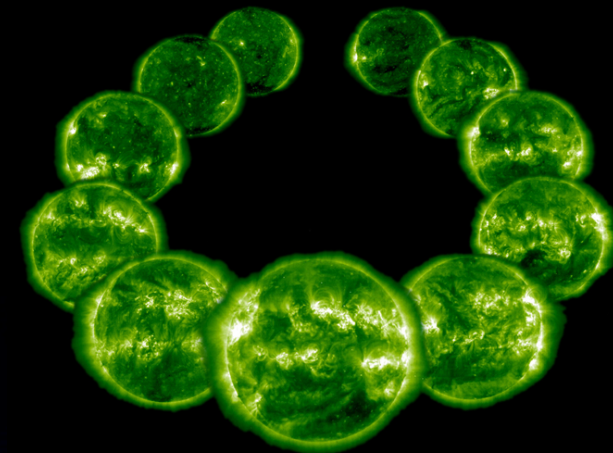
*Some additional data are already available and pending ingestion.*







# SOHO SWT-40

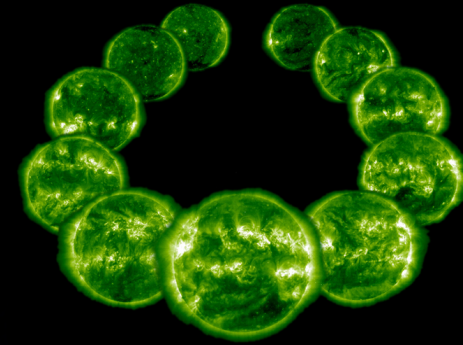


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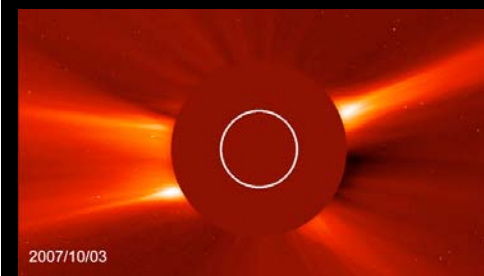
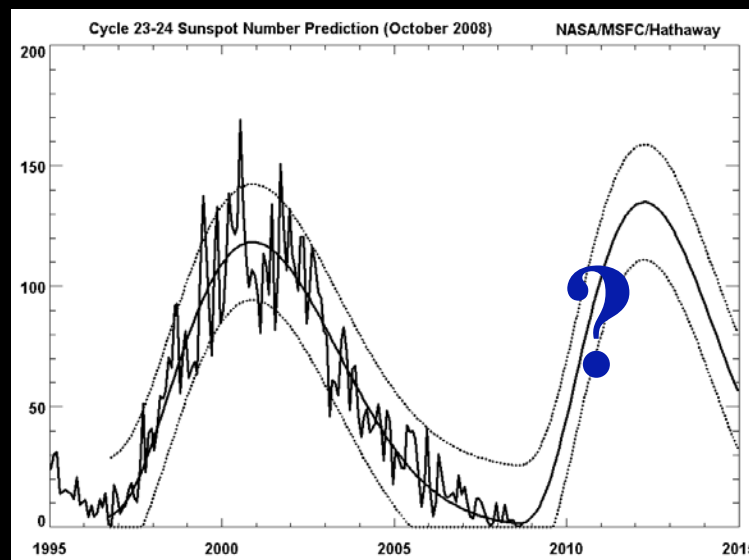
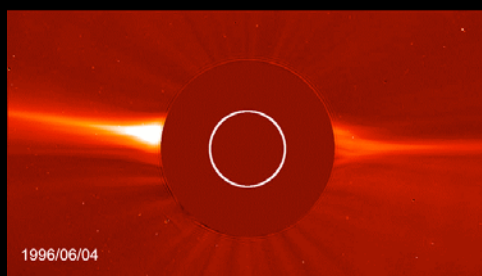
# *Future Meetings*



- STEREO-3 / SOHO-22:  
“Three Eyes on the Sun - Multi-spacecraft studies of the corona and impacts on the heliosphere”
  - April 27 - May 1, 2009, in Bournemouth, UK
  - Chair SOC: R. Harrison, RAL
- SOHO-23: “Understanding a Peculiar Solar Minimum”
  - 21-25 Sep 2009, Northeast Harbor, Maine
  - Co-chairs SOC: J. Kohl & S. Cranmer (SAO)

*Proposal for:*

# ***SOHO-23: Understanding a Peculiar Solar Minimum (working title)***



The “new millennium solar minimum” has surprised solar and space physicists in several ways:

- **A longer-than-expected dearth of sunspot/active-region activity**
- **Non-appearance of a “quiescent equatorial streamer belt”**
- **Anomalously low heliospheric magnetic field, density, temperature**



# ***SOHO-23: Understanding a Peculiar Solar Minimum***

## ***Key Questions to be addressed by the Workshop:***

- How (and eventually *why*) is this minimum different from prior ones?
- Can the broadened “parameter space” of minima help answer the fundamental questions about coronal heating and solar wind acceleration?
- Were conditions at the maximum of Solar Cycle 23 precursors of the unusual minimum conditions? (e.g., CME rates, active region fluxes)
- How is SOHO’s 12+ year data set contributing?

## ***Example Science Topics for Sessions:***

- Solar dynamo: theoretical models and observational validation
- Magnetic flux emergence & the full range of “magnetic carpet” behavior
- Coronal magnetic fields, coronal heating and solar wind acceleration
- *In situ* heliospheric plasma physics linked to solar conditions
- Testing short- and long-term solar cycle (and space weather) predictions

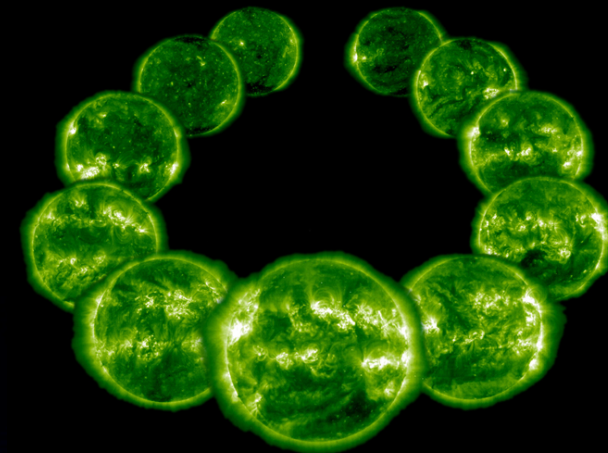
# ***SOHO-23: Understanding a Peculiar Solar Minimum***

## ***Site details:***

- **Asticou Inn, Northeast Harbor, Maine**
- **Same site as successful SOHO-7 Workshop, as well as 1998 and 2000 UVCS Science Meetings.**
- **All meeting and poster rooms provided at no cost**
- **Asticou has wi-fi**
- **Room charge is \$119 per day; suite charge is \$149 per day.**
- **Asticou is available for arrival on 21 or 22 September 2009.**
- **Proposed Meeting date is September 22, 23, and 24. A four day meeting ending on September 25 is also possible.**
- **Participants can stay after the meeting at the meeting room rates.**
- **We propose a single serial session for this well focused topical meeting, but rooms would be available for potential break out sessions.**
- **John Kohl and Steve Cranmer would organize the meeting.**
- **The LOC would come from SAO and the SOC would be drawn from the SOHO SWT and other missions.**



# SOHO SWT-40



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