

# SphinX mission results

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# OUTLINE

About SphinX

SphinX data

SphinX data analysis

# SphinX – team



## **SRC PAS:**

Principal Investigator: **Janusz Sylwester**

Project Manager: **Mirek Kowalinski**

Project Constructor: **Jarek Bakała**

Project Scientist: **Szymon Gburek**

Co-I: **Marek Siarkowski, Barbara Sylwester, Zbigniew Kordylewski, Piotr Podgórski, Witold Trzebiński, Stefan Płoceniak, Anna Kępa**



## **FIAN:**

**Sergey Kuzin**, TESIS PI, SphinX Co-I



## **MEPhI:**

**Yury Kotov**, CORONAS-Photon Project Manager, SphinX Co-I



## **AI CZAS:**

**Franta Farnik**, SphinX Co-I



## **INAF, Palermo University:**

**Fabio Reale**, SphinX Co-I



## **UCL, London:**

**Ken Phillips**, SphinX Scientist Co-I



## **NASA GSFC:**

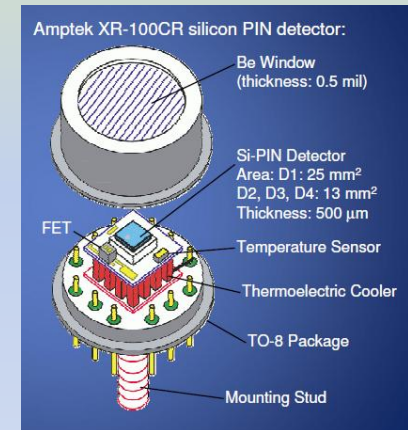
**Brian Dennis**, SphinX Scientist Co-I

# SphinX Solar Photometer in X-rays



~4kg/~10W (peak)  
~1 keV - ~15 keV  
Time resolution ~6  $\mu$ s

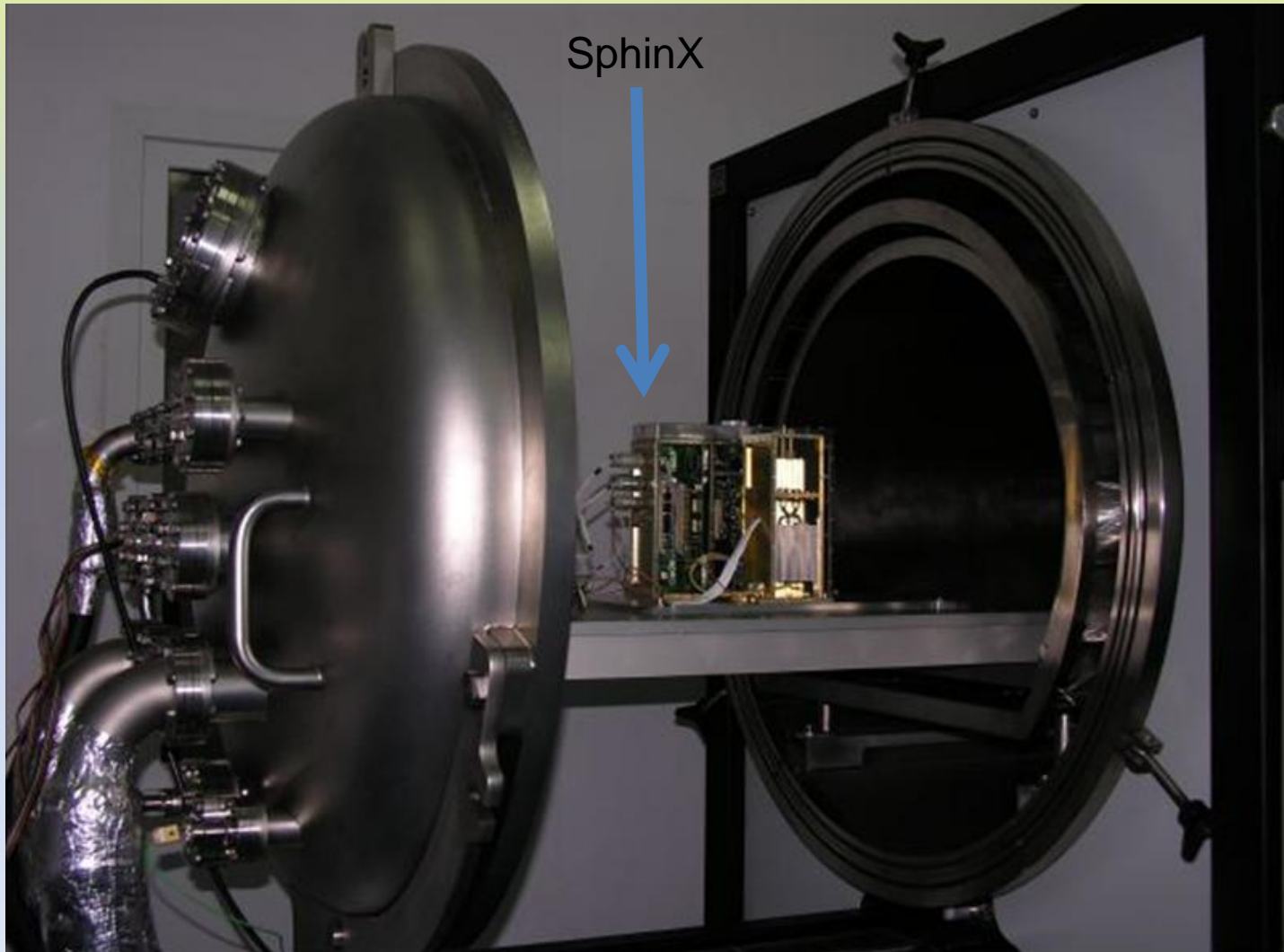
## DETECTORS



AMPTEK  
Si PIN-DIODES  
XR-100CR

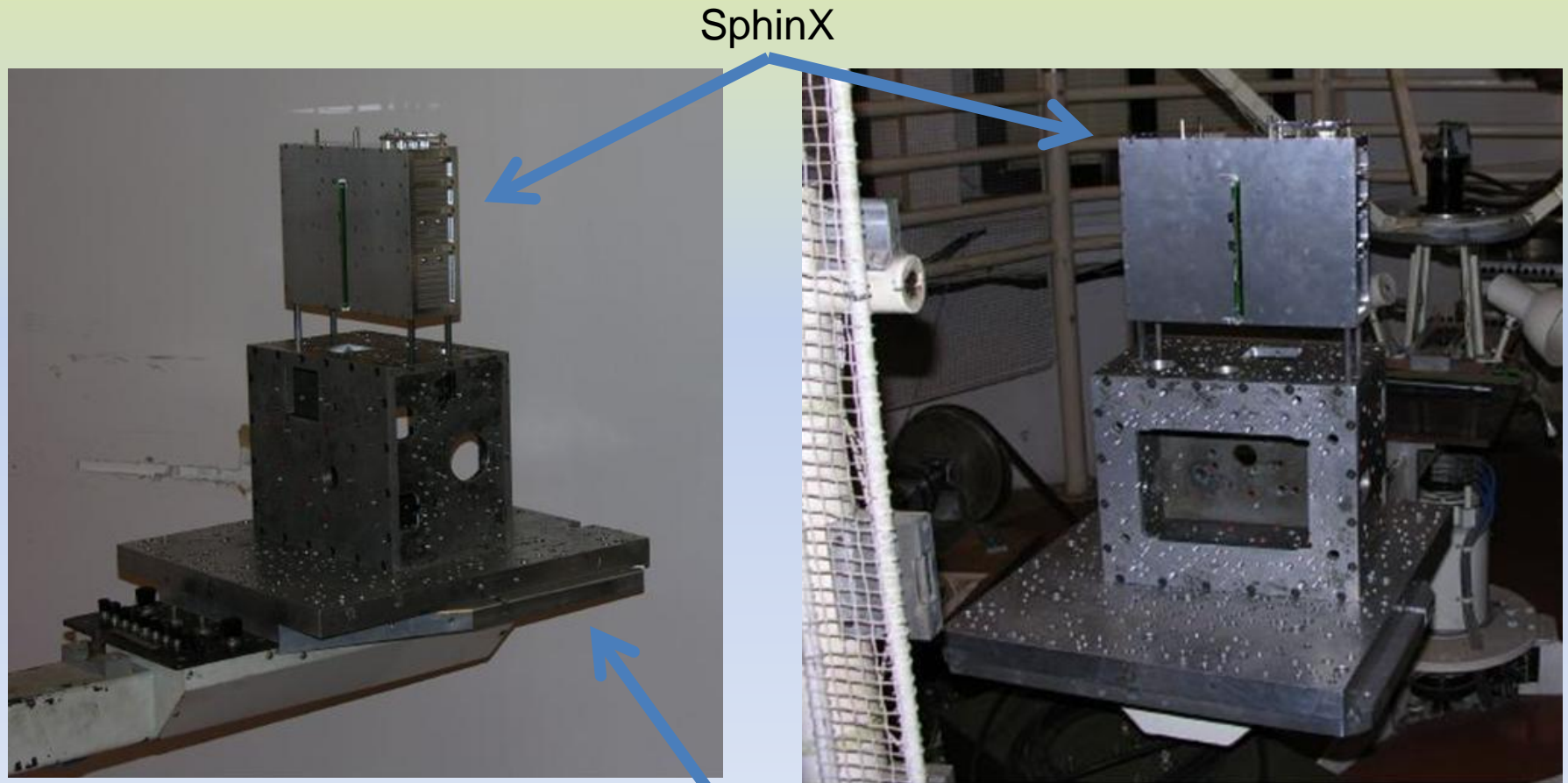
Launch: January 30, 2009 at 13:30 UT, Plesetsk, Russia  
Mission duration: February 20, 2009 – November 29, 2009  
CORONAS-Photon satellite

# SphinX calibration - TV tests in Warsaw



# SphinX calibration/tests

Vibration/Acceleration/Acoustic tests in Prague





# SphinX X-ray response calibration



XACT, Palermo  
October 2007

BESSY II, Berlin,  
Feb/Mar 2008

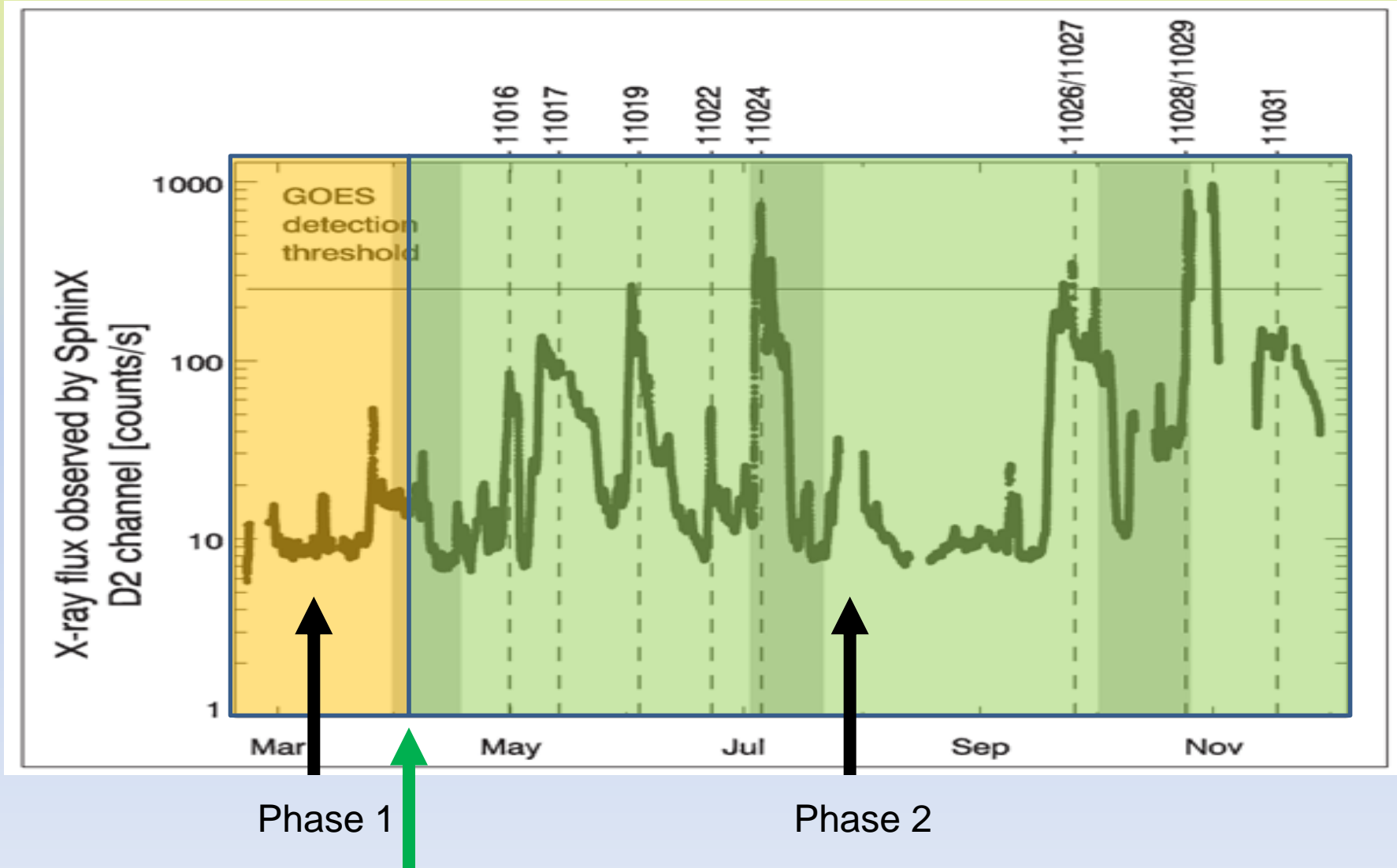


# **SphinX**

The first fully  
tested and calibrated  
solar spectrometer



# SphinX mission phases



**April 6, 2009** optimum on-board operation and data collection strategy achieved

# SphinX data – summary

February 20, 2009 – November 29, 2009

Measurements during very low solar activity

# SphinX data – status

All data reduced to Level -1

Level -1 data available in FITS format

All data available as event lists

EVENT = (Tphot, Ephot)

~ $5 \times 10^9$  EVENTS registered

# SphinX data distribution map

SphinX dedicated  
data servers  
at PI, Co-is institutions  
All data

Moscow LPI

SRC PAS, Wrocław, Poland

AI ASCR Ondrejov,  
Czech Republic

UNIGRATZ, Austria  
SphinX event catalog

DSFA, University of Palermo

## Synchronized SphinX data servers

[http://156.17.94.1/sphinx\\_catalogue/SphinX\\_cat\\_main.html](http://156.17.94.1/sphinx_catalogue/SphinX_cat_main.html)

[http://147.231.104.188/catalog/SphinX\\_cat\\_main.html](http://147.231.104.188/catalog/SphinX_cat_main.html)

<http://www-sphinx.astro.unipa.it/>

in Wrocław, Poland

in Ondrejov, Czech Republic

in Palermo, Italy

# SphinX data catalog

## SphinX data catalogue

All SphinX data available here are Level\_1 data.



2009																															
January	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
February	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28			
March	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
April	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
May	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
June	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
July	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
August	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
September	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
October	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
November	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
December	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Last update: Tue Mar 22 22:29:55 2011 (UTC+1)

contact

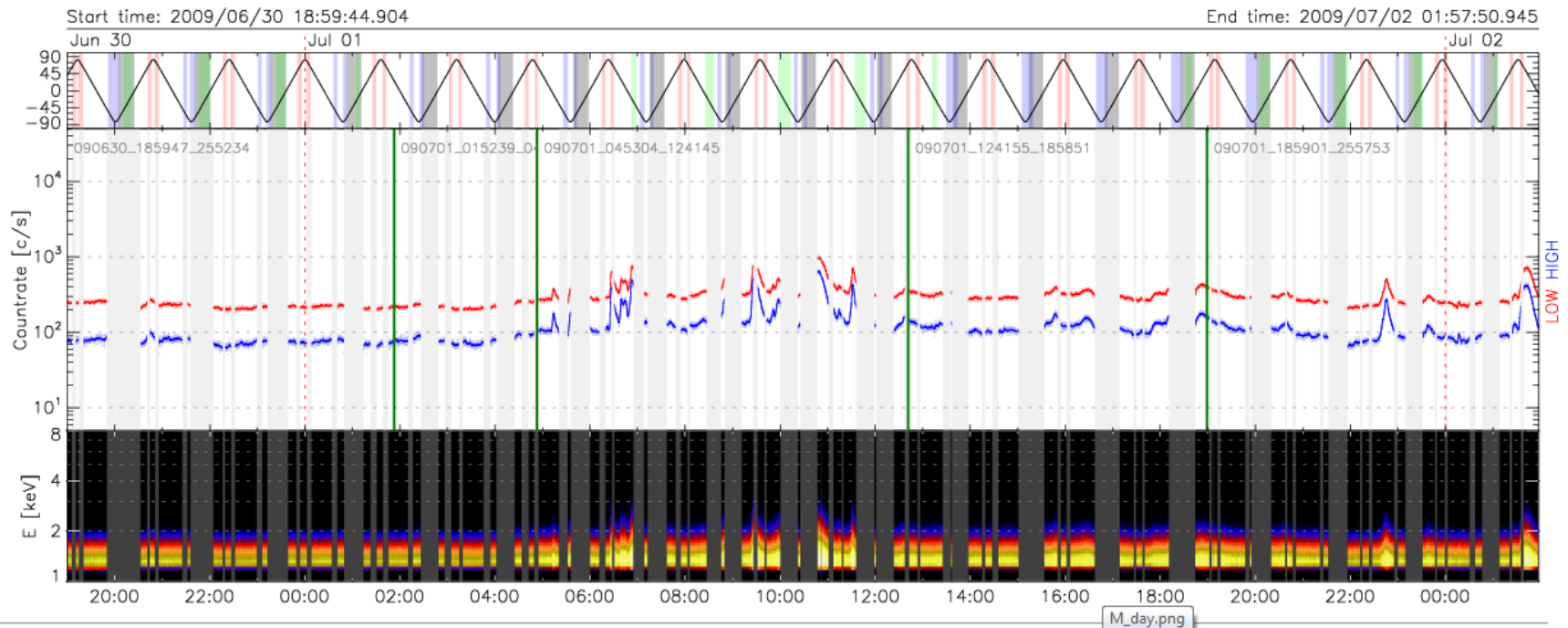
[Szymon Gburek](#) - Any questions concerning content of data from SphinX catalogue.

[Piotr Podgorski](#) - Report any technical problems with SphinX data catalogue.

# Example of SphinX daily summary page

SphinX data catalogue

< 01 July 2009 >



SphinX Level\_1 data:

<a href="#">090630_185947_255234</a> <a href="#">evn.fits</a> (152.94 MB)	<a href="#">090701_015239_045254</a> <a href="#">evn.fits</a> (70.109 MB)	<a href="#">090701_045304_124145</a> <a href="#">evn.fits</a> (184.49 MB)	<a href="#">090701_124155_185851</a> <a href="#">evn.fits</a> (150.19 MB)	<a href="#">090701_185901_255753</a> <a href="#">evn.fits</a> (169.01 MB)
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Download FITS files (OGIP format)

# SphinX data goes to Virtual Observatories

**SODA** – European VSO SphinX Level-1 FITS

developed under SOTERIA

SOLar-TERrestrial Investigations and Archives – FP7 Space Science project

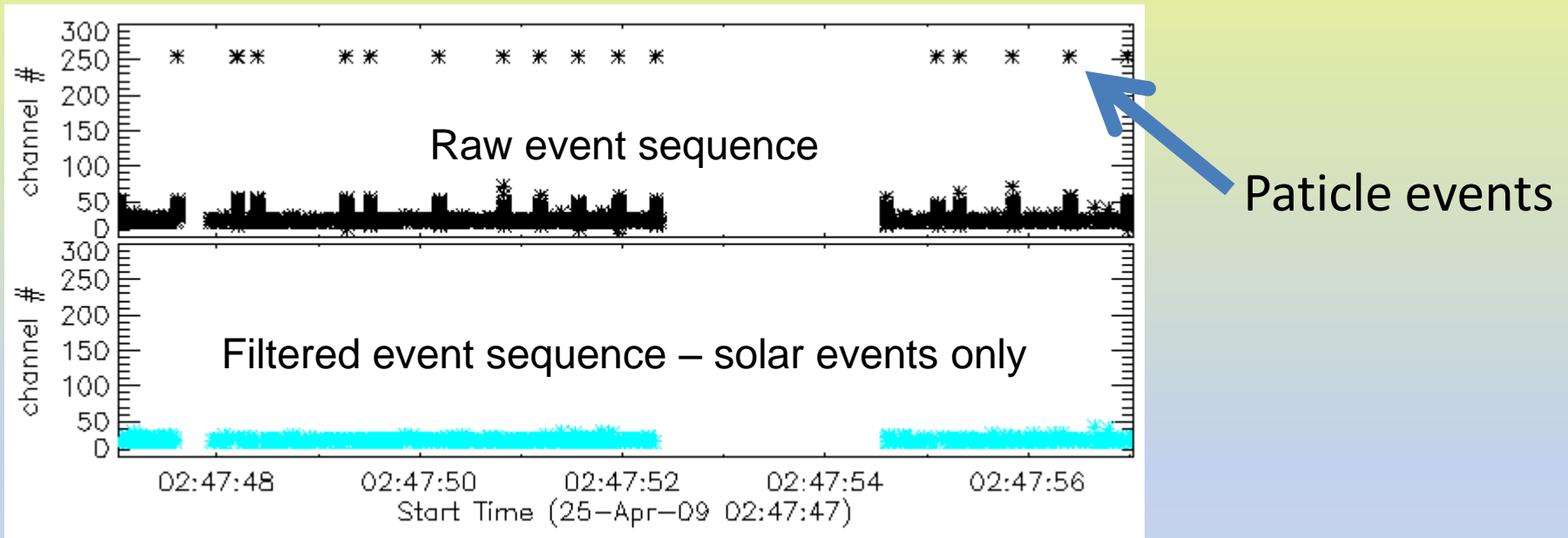
SODA is maintained at ROB

**VSO** – in preparation

*EvolvSys* – Prague

- help with SphinX Servers maintenance and security
- help with instalation of software component for SODA VSO

# SphinX data analysis strategy



- Filter out/select events of interest using **FLAGS**
- Construct higher level data products (spectra, lightcurves)
- Add calibration information (detector response matrix)
- Perform analysis with spectral analysis packages.



# SphinX tools

Existing data analysis tools. For example FTOOLS ...

<http://heasarc.gsfc.nasa.gov/docs/software.html>

The screenshot shows the HEASARC website interface. At the top left, it displays the NASA logo and the text "GODDARD SPACE FLIGHT CENTER" and "Smithsonian Astrophysical Observatory". To the right, there are links for "Help/FAQ", "What's New", "Site Map", and "NASA Homepage". A search bar is present with the text "Search enter search terms" and a link to "Advanced Search". Below this is a "HEASARC Quick Links" dropdown menu. A horizontal navigation bar contains buttons for "HEASARC HOME", "OBSERVATORIES", "ARCHIVE", "CALIBRATION", "SOFTWARE" (highlighted), "TOOLS", and "STUDENTS / TEACHERS / PUBLIC". The main content area features a large graphic with the text "NASA's HEASARC: Software" and "Xanadu". The graphic includes a table of data:

Chi-Squared	Lvl	Fit param #	1	2	3
924.178	-2	5.087	5.076	0.4056	
305.507	-2	4.525	3.791	0.1249	
140.460	-2	2.930	3.367	6.5553E-02	
			2.244	1.4635E-02	
				1.2279E-02	

Below the graphic is a row of software tool buttons: "FITSIO", "FTOOLS", "FV", "HEASOFT", "HERA", "MAKI", "PIMMS", "PROFIT", "XANADU", "XSELECT", "XSTAR", "ASTRO-Update", and "FITS".

SphinX IDL dedicated software provided by the instrument team

# SphinX IDL software components

sphinx\_select.pro – filtering tool

sphinx\_lightcurve– event list to lightcurve conversion tool

sphinx\_spectrum – event list to spectra conversion tool

Detector Response Matrix DRM is provided in a FITS file

**data = mrdfits(filename, i, hdr, status=status)**

↑  
IDL structure

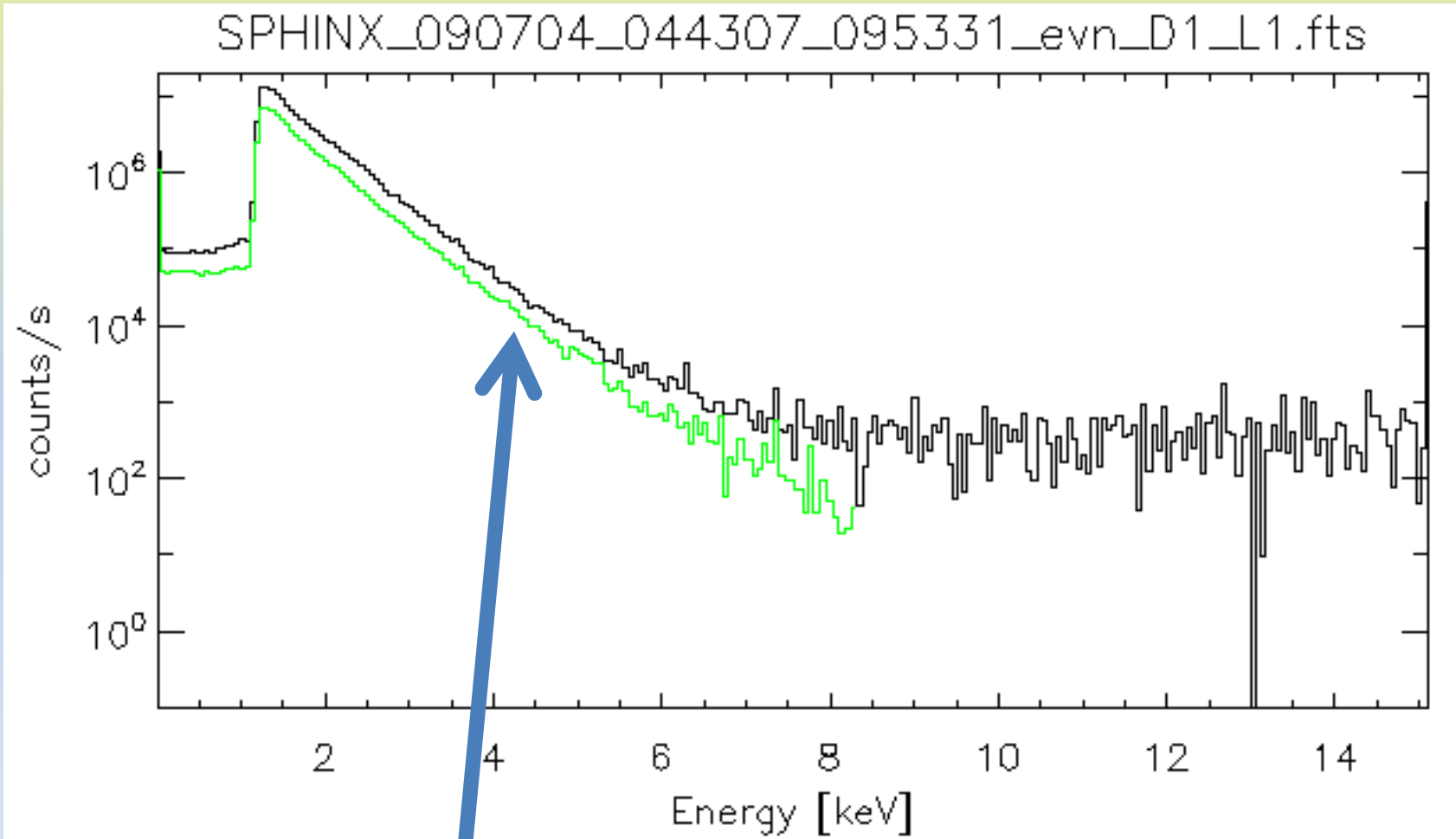
Header – string array with  
description of data

↑  
i=0 - primary header, data =0  
i=1 – events HDU  
i=2 – exposure HDU  
i=3 – GTI HDU

IDL> pm, hdr

IDL> help, data, /st

# SphinX data filtering and analysis - example



Clean filtered spectrum of solar origin

# SphinX DRM for spectral analysis

$$\text{OUT} = \text{DRM} \# (\text{IN} * \text{DE})$$

SphinX  
observed  
Spectrum

[counts/s]

Matrix  
multiplication

Input – a real  
spectrum  
Model

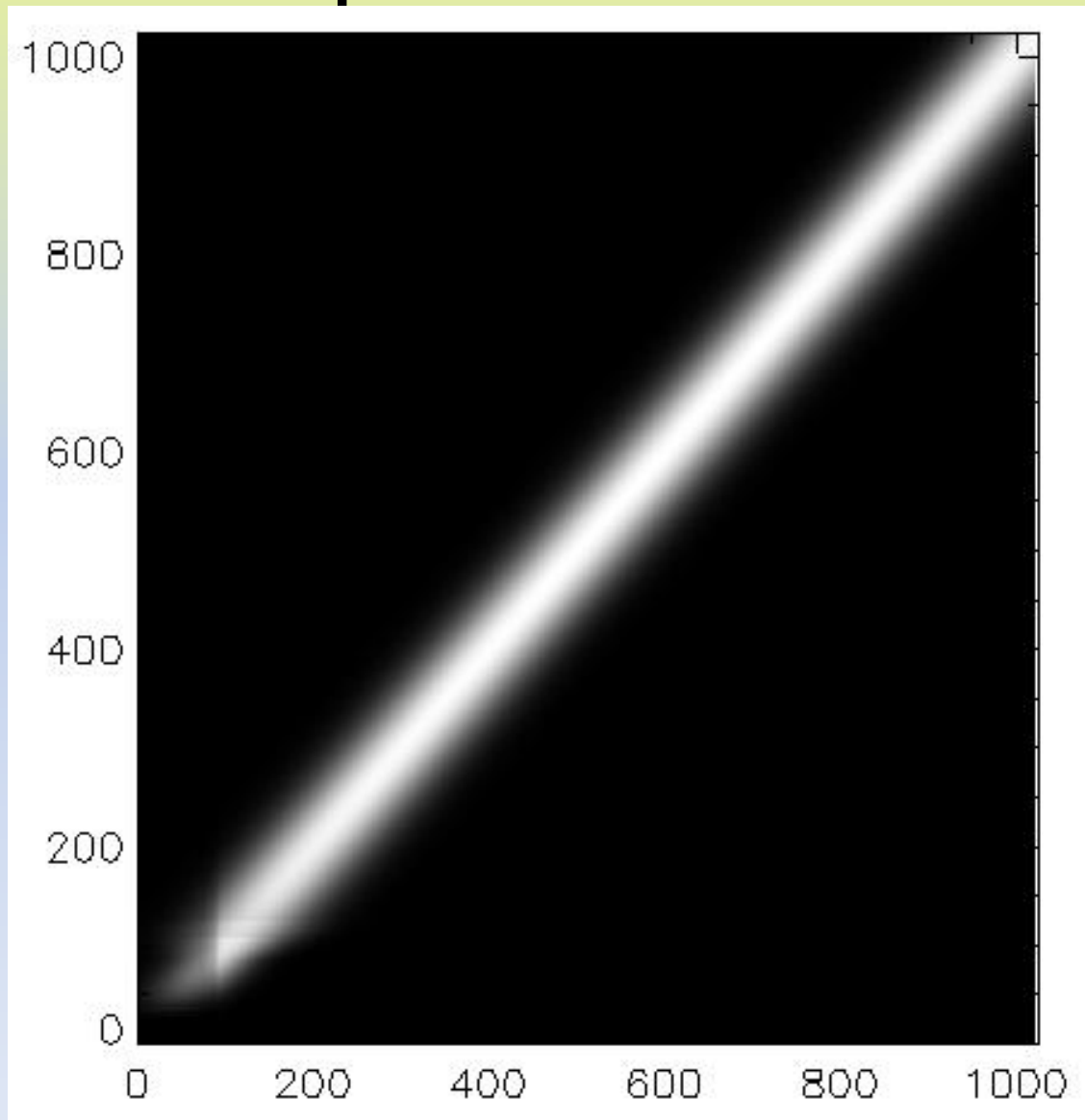
[photons/s/cm2/keV]

Detector Response Matrix

DE – IN spectrum energy bins

DRM was determined from calibration data – Palermo/Bessy

# SphinX DRM



# Analysis in OSPEX

SPEX Main Window

File Plot\_Control Window\_Control Help

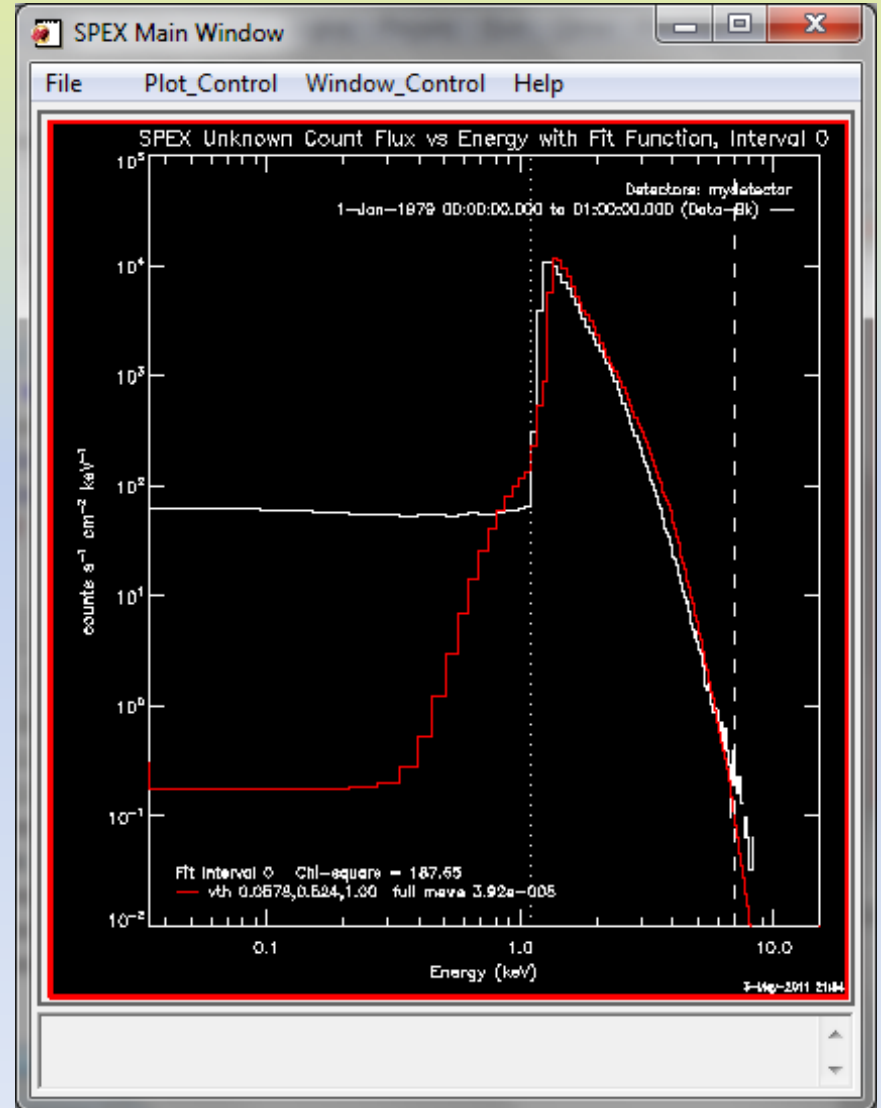
## OSPEX

### Spectral Data Analysis Package

Use the buttons under File to:

1. Select Input Data Files
2. Define Background and Analysis Interval and Select Fit Function Components
3. Fit data
4. View Fit Results
5. Save Session and Results

Use Plot\_Control buttons to change display of current plot.  
Use Window\_Control buttons to redisplay previous plots.



# SphinX – scientific analysis areas

Quiet Sun analysis in X-rays (observed as a star)

Investigations of active regions

Small events investigations (GOES A-C class)

Determination of T, EM

Relationship between solar X-ray flux variability and CME

Identification and analysis of very small solar flares/brightenings

Monitoring of Earth energetic particle distribution

Cross-comparison with other instruments measurements

Determine upper limits for coupling constant - Axions

THANK YOU



# Useful links

## **HERA**

<http://heasarc.gsfc.nasa.gov/webHera/index.html>

## **FTOOLS/XANADU**

<http://heasarc.gsfc.nasa.gov/docs/software.html>

## **FITS I/O IDL routines**

<http://idlastro.gsfc.nasa.gov/fitsio.html>

## **FITS I/O IDL routines in SolarSoft**

<http://www.lmsal.com/solarsoft/>

## **IDL Sphinx specific software (TBD)**

[http://156.17.94.1/sphinx\\_l1\\_catalogue/Sphinx\\_cat\\_main.html](http://156.17.94.1/sphinx_l1_catalogue/Sphinx_cat_main.html)