CURRENT STATE OF MECHANICAL SOLUTIONS OF TWO INSTRUMENTS DEVELOPED AT SOLAR PHYSICS DIVISION OF SRC PAS

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17th Ukrainian Conference on Space Research, August 21-25, 2017, Odessa, Ukraine
Block of FIAN detectors:
- 3 telescopes – 195, 304 and 584 Å
- 2 spectroheliographs 170-210 Å & 280-330 Å
- X-ray spectropolarimeter SOLPEX (0.5-23 Å)

Kortes will see the Sun only by 10-12 min/orbit.

Perigee 409 km
Apogee 416 km
Orbital inclination 51.65 degrees
Orbital period 92.69 minutes

Kortes Dimensions:
870 x 500 x 450 mm
**KORTES/SOLPEX**

- **EUV entrance filter**
- **B-POL**
  - Bragg Polarimeter
  - Measurements of polarization in soft X-ray continuum emission and possibly in selected emission lines (1-2% detection limit).
- **RDS**
  - Rotating Drum Spectrometer
  - Measurements of X-ray spectra evolution with very high time resolution (0.1 s) rotating drum spectrometer.
  - Idea proposed by Stefan Płocieniak
- **System Pinhole & Detector**
  - (colimator with 1mm² pinhole)
  - Pin-hole imager - will provide location of the source on the disk.
  - Distance between filter and detector is 600 mm

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B-POL
Bragg Polarimeter

View of B-POL from the direction of the Sun.

Pin-hole imager
Dimensions: 77x70x38 mm

Polarimeter block

The unit rotates 1 rotation per second,
- Spectral range 3.9 Å – 4.1 Å
- Maximum supply power is 5W

B-POL Dimensions:
200 x 170 x 145 mm

The total mass ~3kg

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Main science task:
- detect polarisation in flare soft X-rays by means of Bragg spectroscopy

Secondary:
perform high resolution spectroscopy in the vicinity of Brewster angle at ~4.3Å

Purposes of the Pinhole System/ CCD:
1. Locating the X-ray sources on the Sun
2. Detecting & tracing active phenomena on the disk, analyzing individual AR X-ray light curves
3. Image readout: each 0.2 s
4. Focal length of the imager is about 60 cm and the image will be projected on CCD detector.

Instrument concept

The GSENSE400 is backside Illuminated Scientific CMOS Image Sensors:
- Resolution : 2048(H) x 2048(V)
- 11 μm Square Pixels

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4. Focal length of the imager is about 60 cm and the image will be projected on CCD detector.
The instrument will measure the degree of linear polarization of solar flares impulsive phase in the soft X-ray range. Measurements will be carried out in a narrow range of the spectrum by using a bend silicon monocrystal wafer, with reflective plane 111 and a curvature radius of 820.97 mm.
Slip ring can be used in electromechanical device where required. Its role is the transfer of electrical signals & power to the rotating components. The signals transmitted by the slip rings are transmitted continuously, for any number of turns in each direction.
**EUV entrance filter**

Filter dimension - Ø80mm

**Filter Transmission**

For B-POL instrument

**Spectral range**

3.9Å – 4.5Å

- **Al_0.12um**
- **Polyimide_10um**
- **Polyimide10+Al_0.12**

Transmission vs Wavelength [Å]

- 3Å = 4.1KeV
- 5Å = 2.5KeV
- 10Å = 1.24KeV
- 15Å = 0.83KeV

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RDS
Rotating Drum Spectrometer

RDS scanning modes

➤ The spectral line scanning mode
  During a periods of low solar X-ray flux the instrument will be scanning only prominent emission lines. It will “wobble” the crystal around positons where a spectral lines are reflected and will periodically change the crystal to observe different selected spectral lines.

➤ Whole spectra scanning mode
  During a periods of high intensity of solar x-ray flux the instrument will be scanning entire spectral ranges. It will rotate the drum with constant frequency of 10 rev/s scanning entire available spectra from 0.5 Å to 23 Å.

Bragg’s law

\[ 2d \sin \theta = n \lambda \]

\( \theta \) - the incidence grazing angle
\( d \) – separation between crystal lattice planes
\( \lambda \) - the wavelength of incident photon

• Changing the angle of incidence allows scanning different wavelengths
• Different crystals reflect different wavelengths at the same angle if incidence

RDS Dimensions:
200 x 175 x 76 mm
Approximate Mass: 2 Kg
Approximate power consumption:
1 W electric motor
1 W per detector, 4 detectors
1 W Electronics

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Main Components:
- 4 Silicon drift detectors
- 8 Flat crystals
- 1 Stepper motor

The RDS main components:
- 1x VITUS H18LE in TO8 housing with AP3.3 polymer window
- 3x VITUS H50 in TO8 housing with 12.5 µm Be window
- Stepper motor
- Drum with mounted crystals
- Electronics block
Two pairs of detectors (two front and two rear) are placed around rotating drum with crystals placed in locations that broaden the wavelength range covered.

Wavelength range scanned by the instrument for different crystals

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<td>22.859</td>
<td>KAP001</td>
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<td>15.875</td>
</tr>
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</table>
Polycarbonate (Lexan) 2000Å
Aluminum 800Å, 400Å
Mesh- Kevlar thread for mechanical support

Filter dimensions- 38x15mm

EUV entrance filter
Papers published/submitted

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SolpeX: the soft X-ray flare polarimeter–spectrometer for the ISS

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https://www.cambridge.org/core/services/aop-cambridge-core/content/view/51743921315004627

Soft X-ray polarimeter-spectrometer SOLPEX

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http://sun.stanford.edu/~sasha/IAUS320/iau_1600210_PRF.pdf

Figure 2. Simulated X-ray image of the Sun, with a C5 class flare in progress, projected on the pinhole CCD camera (left). The signal profile “observed” along the dashed line cut is shown to the right.
SphinX-NG
PROJECT DESCRIPTION

Description of the SphinX-NG research project

Solar X-ray monitoring:
- Temperature and differential emission measure studies
- Long-term solar flux variability
- Studies of non-active corona
- Active regions’ physics
- Solar flares’ energy release physics
- Coronal sources plasma abundances

Terrestrial X-ray and particle observations:
- X-ray signatures of Terrestrial Gamma-ray Flashes (TGFs)
- Auroral X-ray spectra while in transit
- Orbital particle environment fluctuations

- Spectral range 0.5 keV – 150 keV
- Resolution: 200 eV

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**SphinX-NG** instrument will be equipped with three multi-channel X-ray detectors-analyzers (256 energy channels each) for the soft (0.5-15 keV) and harder (5-150 keV) photon energy domains. A modern type of high-sensitivity silicon drift detectors (SDD) and Schottky diode detectors CdTe sensitive to radiation in the softer and harder X-rays respectively will be used. The detectors are available from the US-based Amptek or German KETEK companies, and have proven space heritage in astrophysical and planetary missions (SOXS - Jain et al., 2006, Pathfinder, SphinX -Sylwester et al., 2008).

**Two detectors** will look towards the Sun.

**One detector** will be directed towards the Earth to search for X-ray signatures of terrestrial gamma-ray flashes (TGFs) that have been observed from powerful thunderstorms. Low-energy threshold for TGF will be investigated.

**Approximate Mass:** ~1 Kg
**Approximate power consumption:**
1 W per detector
1 W Electronics

**SphinX-NG Dimensions:**
150 x 76 x 67 mm
Possible common venture between SRC-PAS and other Institutes

**Satellite and orbit:**
- CubeSat or Firefly type

**Orbit:**
- Sun synchronous
- One-axis directed towards solar disc
- Pointing within ±1 degree on every axis
- Lifetime depends on the orbit
SphinX: Solar Photometer in X-rays
CORONAS- Photon satellite
February – November 2009

A single, unobscured, XR-100CR detector measured correctly the solar flux at low activity levels only, below the X-ray class B5.0, corresponding to count rates of $10^4$.

In order to extend the range of measurements, the other SphinX detectors were equipped with collimators of reduced apertures. In the flight configuration the SphinX X-ray detector assembly came up with one detector (D1) of the entrance aperture of 21.50 mm$^2$ (the nominal factory entrance window area), the second one (D2) with aperture limited to 0.495 mm$^2$ for measuring moderate X-ray fluxes and the third (D3) with aperture of 0.01008 mm$^2$ for measurements of the strongest flares. This configuration of aperture setting allowed to cover seven orders of expected variability of the solar X-ray flux.

SphinX data catalogue
http://156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.html

Spectral range: 0.8-15 keV (0.8 – 20 Å) in 256 channels
THANK YOU!

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