



INSTITUTI

SMILE

Solar wind Magnetosphere Ionosphere Link Explorer

Rene Hudec, Graziella Branduardi-Raymont, Steve Sembay and Chi Wang for the SMILE collaboration

SMILE and THESEUS

- Both missions with Czech participation on main consortium level and payload contribution
- Both mission with SXI soft X ray telescope with Lobster Eye type optics



ESA-CAS (China) joint call

- Call issued in January 2015
- Small class mission
- Small spacecraft (<300 kg) and payload (<60 kg)
- 13 proposals received by deadline of 16 March 2015
- SMILE recommended in June 2015 by a joint European and Chinese scientific committee as candidate for a collaborative science mission with launch in 2021
- SMILE formally selected by ESA SPC in early November 2015
- The mission has been adopted by ESA as of March 2019

SMILE Instruments and Spacecraft

Soft X-ray Imager (SXI) Ultraviolet Imager (UVI) PI: Steve Sembay (Uni. Leicester, UK) PI: Eric Donovan (Uni. Calgary, Canada) FEE Assembly

Light Ion Analyser (LIA) PI: Lei Dai (NSSC, China)

Straylight Baffle







Platform (CAS)

SXI Consortium – Current Status

				UoL- PI, Primary Structure, Optic, Harness, Instrument SIMs, GSMSSL- FEE, Science SIMs, GSWCEI/OU- CCD Testing, Background Modelling, GSW					
	Austria:		Czech Republic:	Norway:	Spain:	Switzerland:			
	IWF, UVIE		СТU	BCSS	ΙΝΤΑ	FHNW			
	DPU OBSW		Ground SW (under application)	Radiation Shu	tter DPA Structure Environ. Testing	Thermal Subsystem			
			esa						
	ESA			China:	US:	US:			
ESA CCD procurement (Te2v, UK) PSU procurement (Terma, Den Baffle procurement (TAS, UK)		rement (Te2v, UK) rement (Terma, Denmarl		BTU, NASA/GSF	-C				
Baffle procurement (TAS, UK) Engineering support				GSW	Science & Instru GSW	Science & Instrument Design Support GSW			
	l				Optics BB testing	Optics BB testing			



SMILE scientific objectives



- Investigate the dynamic response of the Earth's magnetosphere to the solar wind impact in a unique and global manner
- Combine Solar Wind Charge eXchange (SWCX) X-ray imaging of the dayside magnetosheath and the cusps with simultaneous UV imaging of the northern aurora, while monitoring the solar wind conditions in situ
- → Full chain of events that drive Sun-Earth relationships: dayside reconnection / magnetospheric substorm cycle / CME-driven storms



This is an artist's concept of the magnetosphere's boundary as seen from the moon in soft X-rays emitted by solar wind charge exchange (SWCX).

Credit: NASA / Rob Kilgore

SMILE Payload Module (PLM):



ESA Provide: Launcher, PLM, spacecraft Integration, European Science Operations Centre (SOC) CAS Provide: Spacecraft Service Module (SVM), Propulsion module (PM), Mission Operations Centre (MOC), Chinese Science Operations Centre (SOC)



SXI Science Performance

Parameter	Value (at 0.5 keV if	Comment			
	relevant)				
Optic focal length	300 mm				
MPO pore size	40 µm				
MPO pore length	1.2 mm	L/D = 30:1			
Optic coating	Iridium				
PSF FWHM	8.1 to 9.6	Across 60% of the			
	arcminutes	detector plane			
PSF HEW	~2.8 degrees				
Optic total effective	14.6 cm ²	At centre of FOV			
area					
Optic FOV	32.1° x 15.8°				
Straylight baffle	~0.9 (<mark>TBC</mark>)				
vignetting					
CCD QE	0.89				
CCD energy resolution	50 eV (FWHM)	Assuming 4.5 e ⁻¹ noise,			
		No CTI			
CCD frame integration	~4 seconds (TBC)				
time					
Filter Transmission	0.82	Assuming 100 nm			
		Aluminium			
Baseline SXI instrument parameter					
Total instrument	9.6 cm ²				
effective area					





Many bright X-ray sources

Many well-known calibration sources & IACHEC¹ standard candles (1ES0102, N132D, PKS2155, Zeta Puppis, AB Dor, LMC-X2, LMC X-3, Vela Pulsar...)

Analysis of all RASS sources >2 cps (237) over full year of SXI observations (m05, S8, a0):

- Only occurrences of 6+ sources in the SXI FOV when observing the LMC...

> 1: IACHEC: International Astronomical Consortium for High-Energy Calibration

Cosmic sources passing through the SXI FOV

Optical stars X-ray sources UV sources 00 0, 0 0 0 SHEATH 50.0k k

RASS catalogue PSPC count rate > 1 cps Bright Star catalogue V mag brighter than 4th mag TD1 catalogue 1565Å flux > 2e-10 cgs

AXRO 2018

MOVIE SHOWING UV STARS AND PLASMASPHERE



Red + Green (>2x10⁻⁹ ergs s⁻¹ cm⁻² Å⁻¹) circles are UV (B stars) from TD1 catalogue

5 R_E sphere around Earth represents plasmasphere (4 R_E radius within SXI FOV ~23% of SXI ontime)

AXRO 2018

SXI Exposure Map – Msec exposures towards SGP



				AXRO 2018				
1	1	1	1	1	1		1	1
2.60e+04	1.64e+05	3.96e+05	7.19e+05	1.14e+06	1.65e+06	2.25e+06	2.94e+06	3.73e+06



SMILE impact



- X-rays from the magnetosphere: from 'unwanted background' for X-ray astrophysical observatories to diagnostic tool of Sun-Earth relationships
- SMILE will trace and link processes of solar wind injection with those acting on charged particles precipitating into the cusps and the aurora
- **Outreach**: Captivate public to science (magnetic field) so far invisible
- Cooperation with China: SMILE is a showcase, building on Double Star experience

Expected Czech Participation

- Onboard and dada evaluation software
- Science
- Data analyses
- Secondary science: high energy astrophysics, X ray astronomy, evaluation and analyses of X ray sources located in the SXI FOV
- Originally design and development of SXI optical baffle but funding proposal rejected

Conclusions

- Participation in ESA HE astrophysics projects with emphasis on X ray monitors
- Accepted/selected ESA space projects with wide field Lobster Optics: SMILE, THESEUS
- SMILE 1st imaging of Earth magnetosphere using WF X ray telescope (LE)

The End

AXRO 2018