

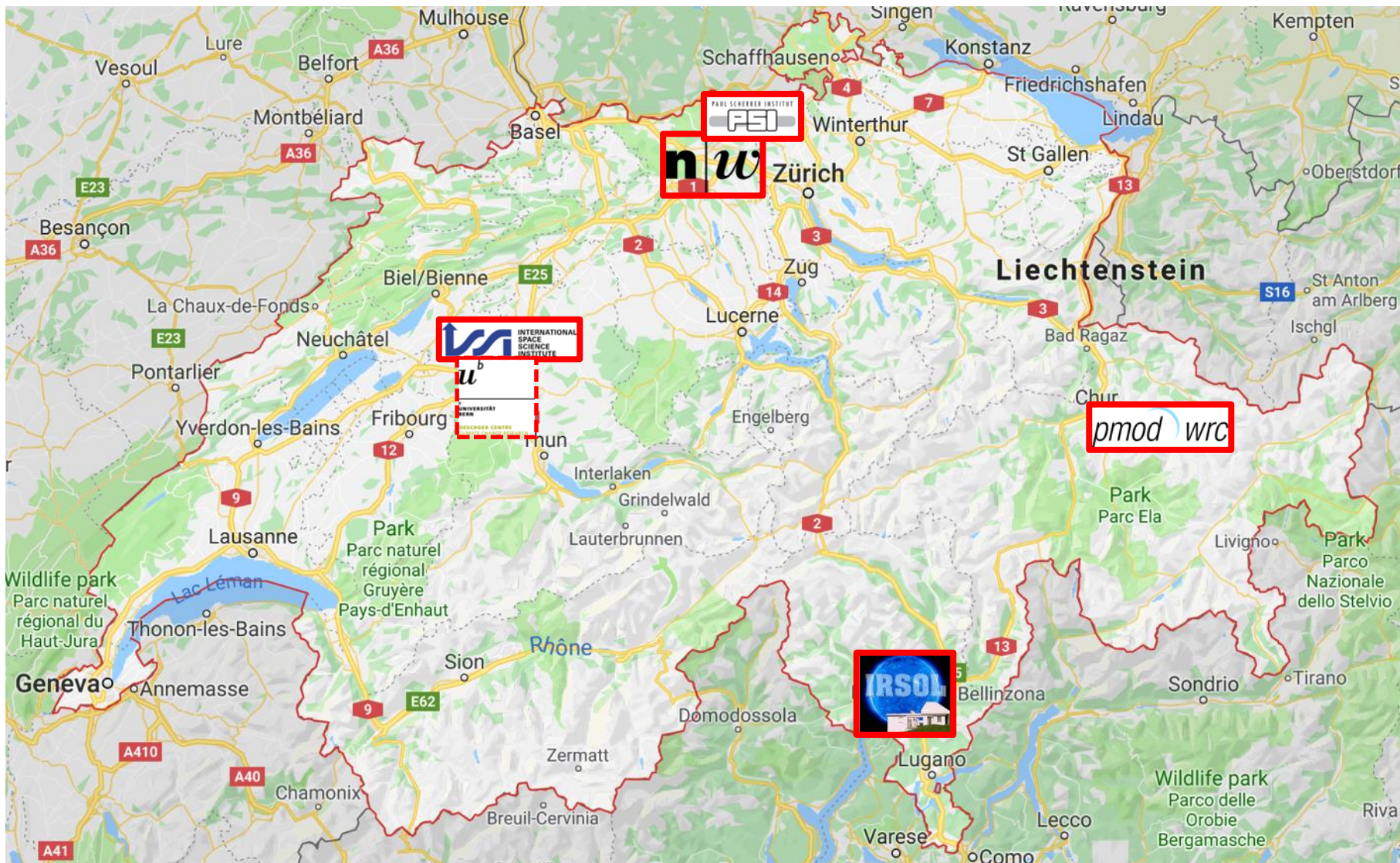
Recent and future solar-terrestrial activities in Switzerland

Marina Battaglia*

Fachhochschule Nordwestschweiz (FHNW), Switzerland

*SCOSTEP National Adherent Representative

The solar-terrestrial community in Switzerland



The solar-terrestrial community in Switzerland

The Swiss solar-terrestrial community is small but very active. Switzerland becoming a member of SCOSTEP in 2015 was taken as opportunity to establish an actual Swiss solar-terrestrial community and represent it within CH and internationally

Main institutes

n|w Fachhochschule Nordwestschweiz (FHNW), Brugg/Windisch

 Physikalisch-Meteorologisches Observatorium Davos / World Radiation Center (PMOD/WRC), Davos

 Paul Scherrer Institute (PSI), Villigen

 International Space Science Institute (ISSI), Bern

 Istituto Ricerche Solari Locarno (IRSOL), Locarno

 Öschger Center for Climate Research, Uni Bern, Bern

Activities

1 Fundamental research

Solar physics and solar activity

Effects of the Sun and solar activity on the atmosphere and climate

n|w pmod wrc IRSOL

UNIVERSITÄT BERN
DESCHEIDER CENTRE

2 Instrument development

pmod wrc

n|w
PAUL SCHERRER INSTITUT
FSD
IRSO

3 Solar monitoring

n|w pmod wrc

4 Computation, Big Data

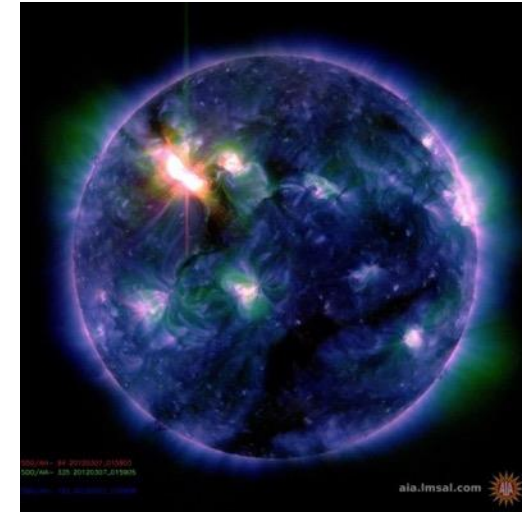
n|w IRSOL pmod wrc

5 Community building and support

SOSTEP INTERNATIONAL SPACE SCIENCE INSTITUTE sc|nat
Swiss Academy of Sciences
Akademie der Naturwissenschaften
Accademia di scienze naturali
Académie des sciences naturelles

1 Fundamental research

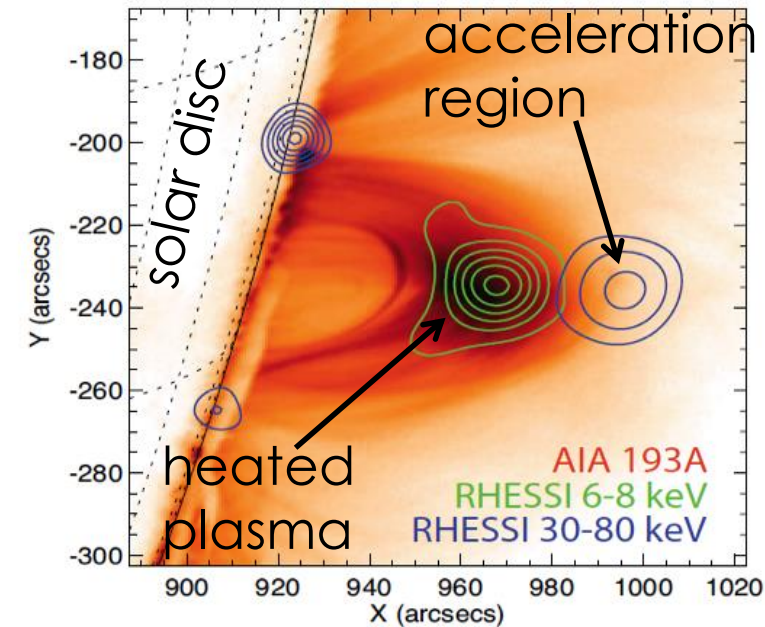
1.1 Solar flares as drivers of space weather **n|w**



Solar Flares are the most powerful explosions in the solar system and one of the drivers of space weather

X-ray observations provide information on

- Energy release site
- Particle acceleration
- Response of the solar atmosphere to flare energy input (heating)

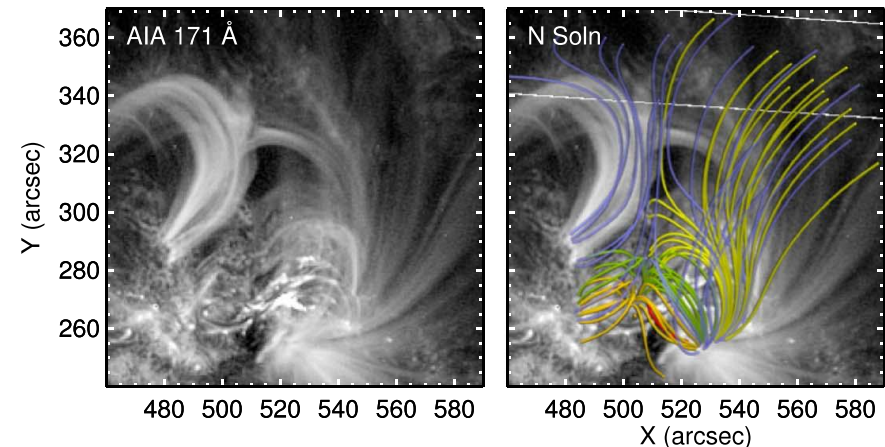


Krucker & Battaglia 2014

Magnetic fields **n|w**



Underlying cause of solar activity
Can be measured near the solar surface
directly through spectropolarimetry
Coronal magnetic field through (NLFF)
extrapolations

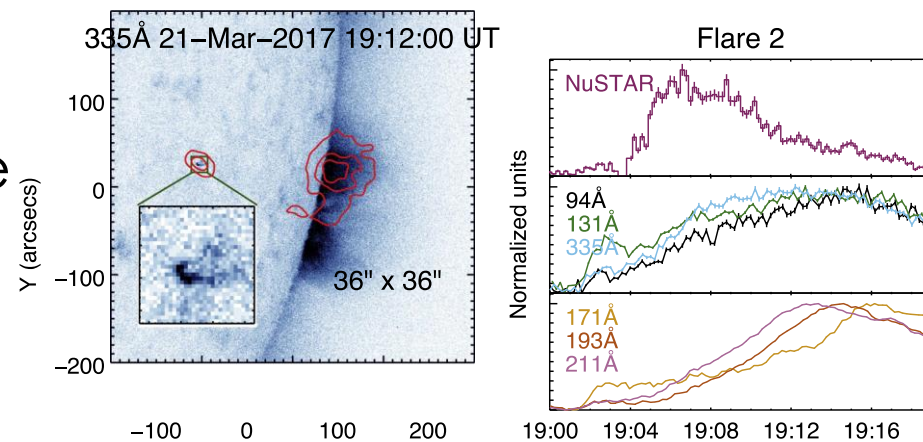


Kleint et al. 2018

Small scale heating events **n|w**

X-ray observations with the NASA NuSTAR
telescope reveal small-scale energy release
events in the quiet Sun

→ A solution to the “coronal heating
problem”?

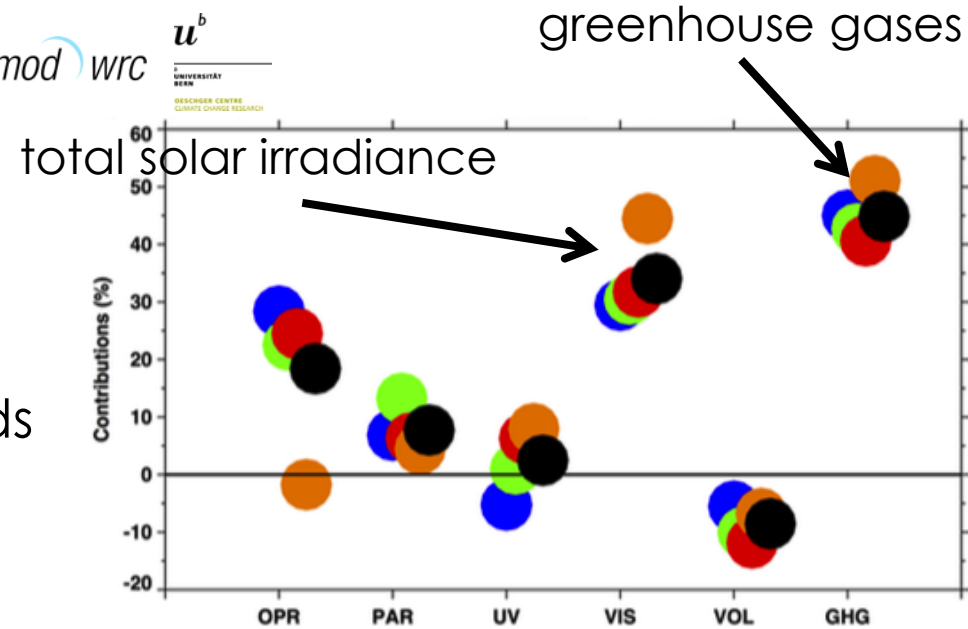


Kuhar et al. 2018

1.2 Effects of solar activity on climate *pmod* *wrc* *u^b*

The contribution of solar activity to early 20th century warming

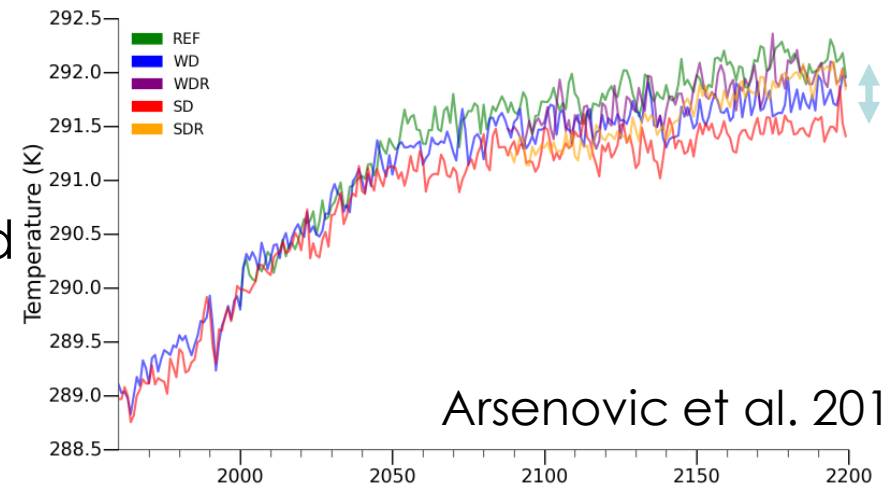
Contribution (%) of different forcing agents to global and seasonal mean temperature trends for the period 1910–1940



Egorova et al. 2018

The influence of potential solar activity decline on future climate and ozone layer

On the global scale a reduced solar forcing compensates for at most 15 % of the expected greenhouse warming at the end of the 21st and around 25 % at the end of the 22nd century.



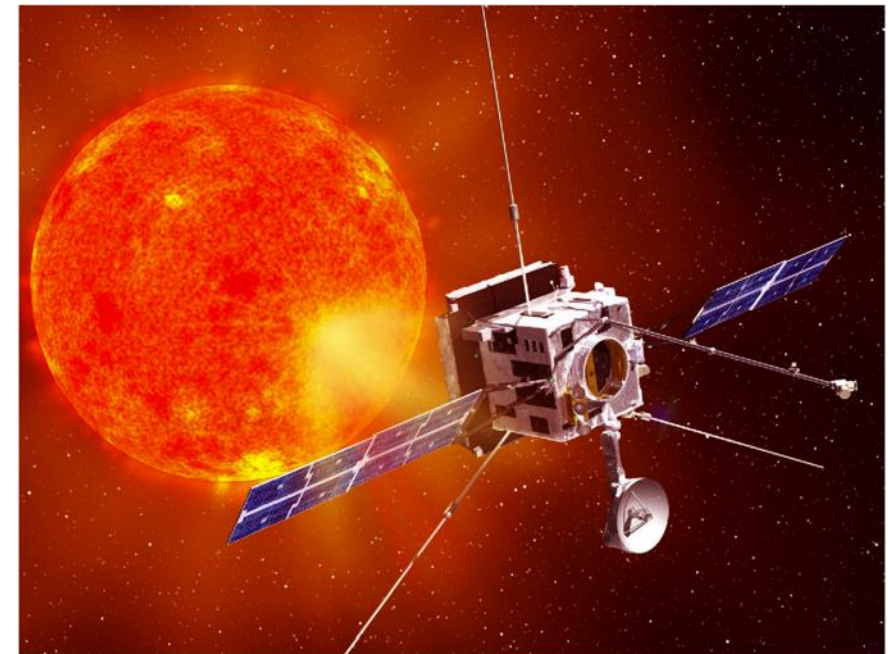
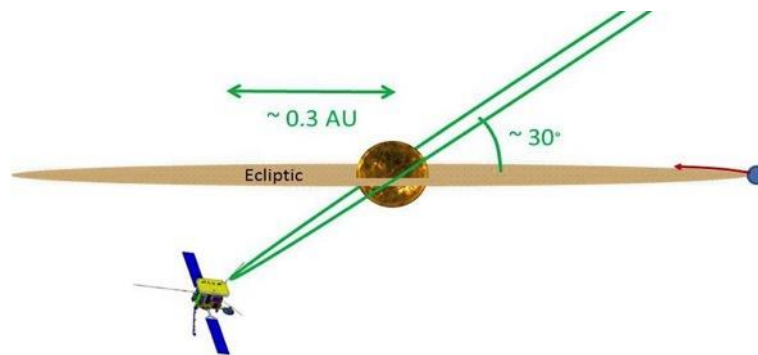
Arsenovic et al. 2018

2 Instrument development



Swiss involvement in 3 instruments of ESA's **Solar Orbiter** Mission

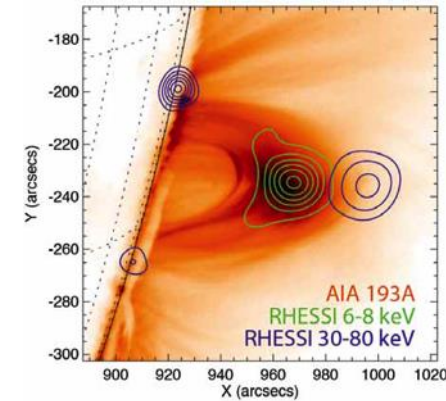
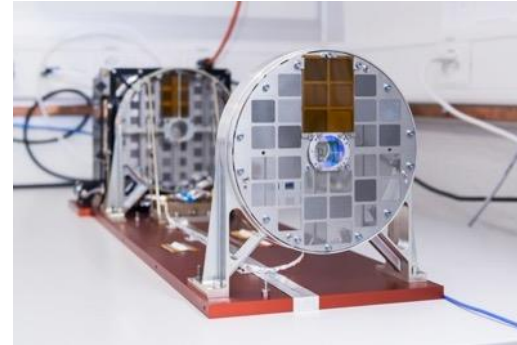
- ESA M-Class Mission to study the link of the Sun and formation of the heliosphere
- 10 instruments: remote sensing and in-situ
- Launch date: **February 6 2020**
- Extra-ordinary orbit:
 - Out of ecliptic orbit
 - 0.3 AU



STIX (Spectrometer/Telescope for imaging X-rays) **n|w**

Swiss lead instrument (FHNW, S. Krucker)

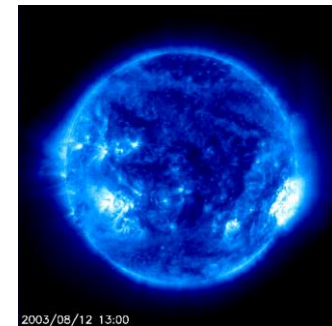
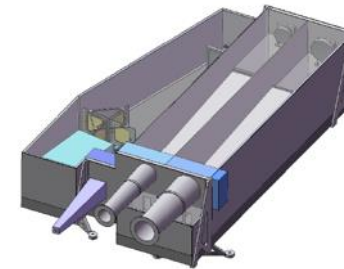
Imaging and spectroscopy of
X-ray emission in solar flares



EUI (Extreme UV Imager) *pmod wrc*

Belgium lead instrument

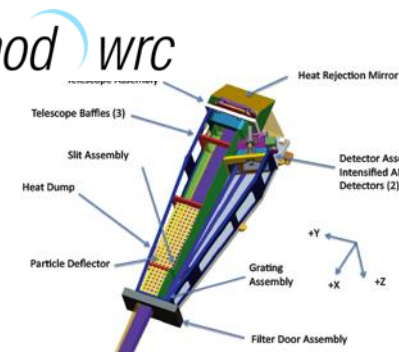
High resolution ultraviolet images of the Sun



SPICE (Spectral Imaging of the Coronal Environment) *pmod wrc*

ESA lead instrument

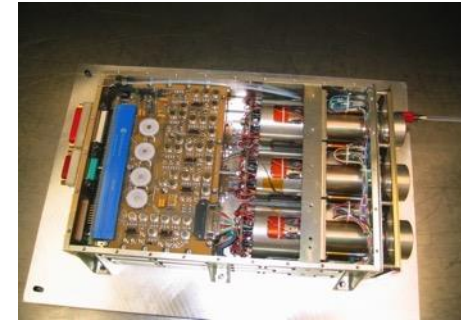
Observations of spectral lines in the ultraviolet



Other instruments

LYRA on board proba-2 (since 2009) *pmod wrc*

Developed and built at PMOD/WRC
Measures the solar EUV/UV radiation
Onboard PROBA-2 Mission

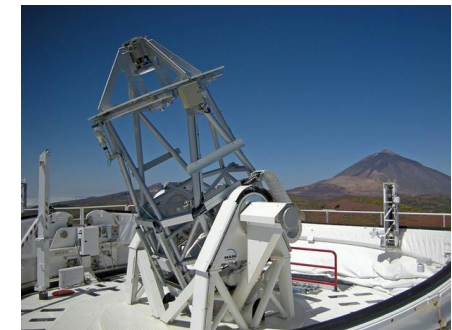
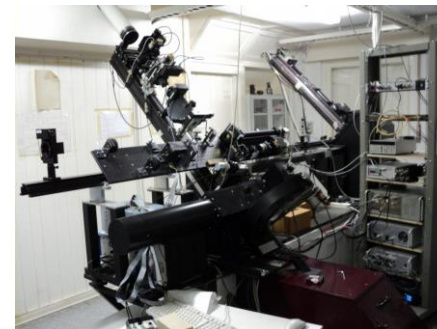


Current

ZIMPOL



High sensitivity imaging polarimeter
Developed by IRSOL
In use e.g. at the German
GREGOR telescope on Teneriffe (since
2014)

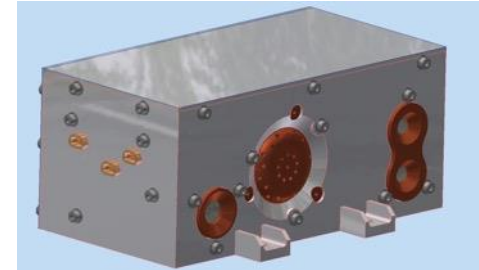


Other instruments

Radiation Monitor for ESA Lagrange mission

LGR is ESA solar weather mission concept led by UCL (UK)
Currently in Phase B1

Radiation monitor in development at PSI for measuring charged particles, particle directionality, and particle spectra



Future

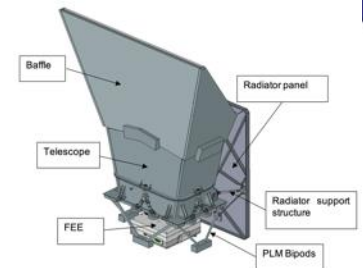
SXI on SMILE **n|w**

SMILE: joint mission between ESA and Chinese Academy of Sciences to measure the solar wind and its dynamic interaction with the magnetosphere.

FHNW leads thermal design of soft X-ray imager (SXI)

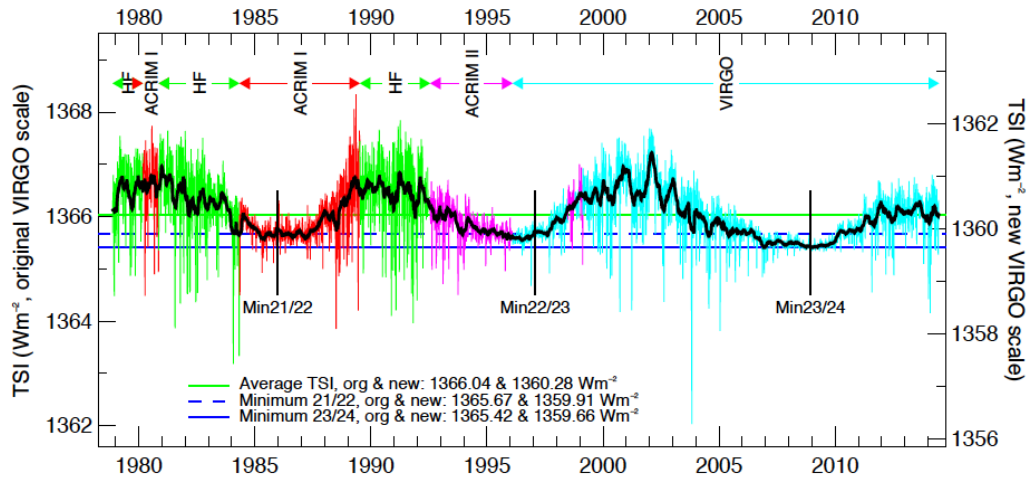


Timeline	PDR:	June 2019
	CDR:	Oct 2020
	Delivery:	Jan 2020
	Launch:	Nov 2023

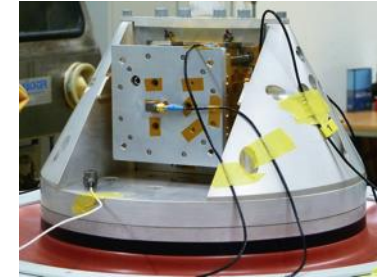


3 Solar Monitoring

Monitoring TSI (total solar irradiance) *pmod wrc*



Claus Fröhlich
<http://www.pmodwrc.ch/pmod.php?topic=tsi/composite/SolarConstant>

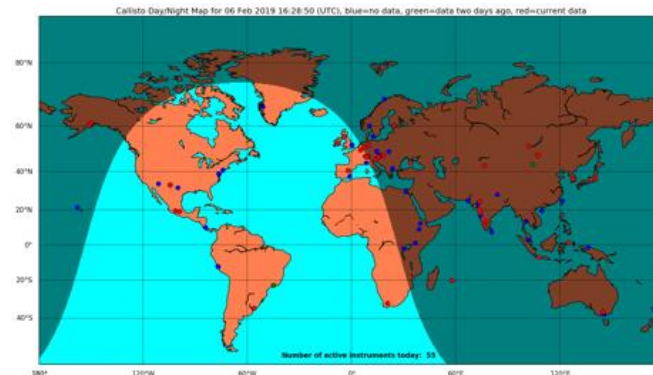


CLARA on NORSAT-1
Monitoring of total solar irradiance
Instrument is placed NORSAT-1

e-CALLISTO Network **n|w**

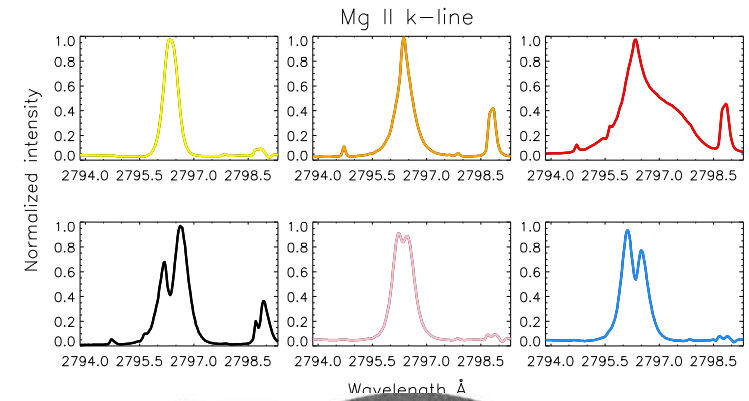
Solar Radio Burst Observation
Education and Training
Radio Monitoring

Initiative of C. Monstein, former ETHZ. Data center at FHNW.



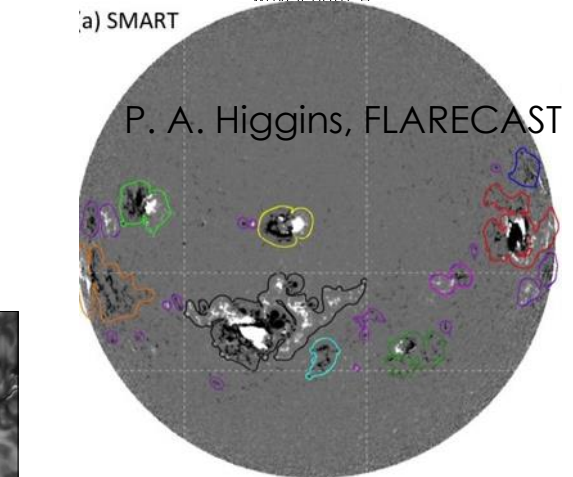
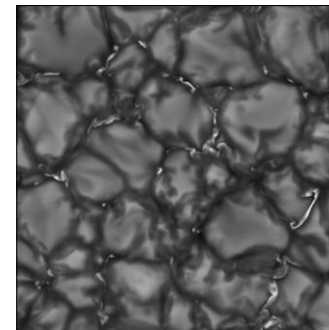
4 Computation & Big Data

- Identification of MgII line spectra during solar flares using **machine learning** (Panos et al. 2018)



- **FLARECAST** (EU Horizon 2020 project until 2017)
Automated solar flare forecasting
Greek lead, FHNW contribution

- Magneto-hydrodynamic **numerical simulations** of the near surface layers of the solar atmosphere for direct comparison with real observations



IRSOL

- Past- and future climate modelling (PMOD/WRC, Uni Bern)

5 Community building and support



ISSI Bern supports international science teams, workshops, and organisations.

Upcoming: FORUM “Next scientific Solar-Terrestrial Program (SCOSTEP)”,
Feb 25 – 27, 2019



The Swiss National SCOSTEP committee, part of the Swiss Academy of Sciences consists of members from all participating institutes and represents the community.

Upcoming: 3rd Swiss SCOSTEP workshop, Mar 6 – 7, 2019, PMOD/WRC,
Davos

Summary

- Switzerland has a long history of solar-terrestrial science
- Activities include: fundamental research, instrument development, solar monitoring, and community building
- The community makes significant contributions to major international missions such as Solar Orbiter

Conference picture,
2nd Swiss SCOSTEP workshop
October 2017, Locarno

