

Space Weather activities in Slovakia

Ivan Dorotovič (1), Šimon Mackovjak (2)

1 SCO Hurbanovo

2 IEP, SAS Košice

ivan.dorotovic@suh.sk, mackovjak@saske.sk

- The research related to **space weather (SWE)** has one of the longest history among other space research topics in Slovakia.

• SK-AD03 Slovakia National Space Safety Programme (S2P) Study



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Technical report 4

Collection of Capabilities and Assets in Slovakia related to SWE frameworks

Table 4.1: List of Slovak assets in space weather framework (according domains presented in Section 3).

NAME	TECHNOLOGY	OPERATOR	COUNTRY	Location	LON [deg]	LAT [deg]	ALT [m]
<u>Coronographs</u>	Telescopes for solar corona observations	AI SAS	SK	<u>Lomnický štít</u>	20.2131	49.1951	2634
<u>CoMP-S</u>	<u>Spectropolarimeter</u> for solar corona and prominences	AI SAS	SK	<u>Lomnický štít</u>	20.2131	49.1951	2634
Solar telescopes	Telescopes for solar atmosphere observations	SUH	SK	<u>Hurbanovo</u>	18.1911	47.8734	114
Solar telescopes	Telescopes for solar atmosphere observations	AOP	SK	<u>Prešov</u>	21.2563	48.9997	282
Solar telescopes	Telescopes for solar atmosphere observations	AOR	SK	<u>Rimavská Sobota</u>	20.0051	48.3742	218
Space R&D	Laboratory infrastructure for Space R&D	IEP SAS	SK	<u>Košice</u>	21.2609	48.7060	203
Neutron Monitor	Detectors of secondary cosmic rays	IEP SAS	SK	<u>Lomnický štít</u>	20.2131	49.1951	2634
SEVAN	Detectors of secondary cosmic rays	IEP SAS	SK	<u>Lomnický štít</u>	20.2131	49.1951	2634
AMON-ES, AMON-net	Detectors of thermosphere-ionosphere	IEP SAS	SK	<u>Kolónické sedlo</u>	22.2737	48.9347	448
INTERMAGNET	Detectors of the Earth's magnetic field	ESI SAS	SK	<u>Hurbanovo</u>	18.1911	47.8734	114

Table 5.1: List of Slovak entities in space weather framework.

Entity	HQ	Industry	Domains	Type of business	Website
Institute of Experimental Physics, Slovak Academy of Sciences (IEP SAS)	<u>Košice</u> , Slovakia	Academia, R&D institution, Observatory	SWE - Heliospheric Weather SWE - Space Radiation SWE - Ionospheric Weather	HW, SW, services, expertise	https://uef.saske.sk
Astronomical Institute, Slovak Academy of Sciences (AI SAS)	<u>Tatranská Lomnica</u> , Slovakia	Academia, R&D institution, Observatory	SWE - Solar Weather	HW, SW, services, expertise	https://astro.sk
Slovak Central Observatory <u>Hurbanovo</u> (SUH)	<u>Hurbanovo</u> , Slovakia	Academia, Observatory	SWE - Solar Weather	services, expertise	www.suh.sk
Earth Science Institute, Slovak Academy of sciences (ESI SAS)	Bratislava, Slovakia	Academia, Observatory	SWE - Geomagnetic Conditions	services, expertise	http://www.geosav.sk
Faculty of Mathematics, Physics and Informatics (FMPI)	Bratislava, Slovakia	Academia, University, Observatory	SWE - Geomagnetic Conditions	expertise	https://fmph.uniba.sk/
Astronomical Observatory <u>Prešov</u> (AOP)	<u>Prešov</u> , Slovakia	Observatory, Public outreach	SWE - Solar Weather	public outreach	https://astropr.esov.sk/
Astronomical Observatory <u>Rimavská Sobota</u> (AOR)	<u>Rimavská Sobota</u> , Slovakia	Observatory, Public outreach	SWE - Solar Weather	public outreach	http://www.astro.rs.sk
<u>Roztoky</u> Observatory (RO)	<u>Roztoky</u> , Slovakia	Observatory, Public outreach	SWE - Solar Weather	public outreach	https://roztoky.space
Astronomical Observatory <u>Hlohovec</u> (AOH)	<u>Hlohovec</u> , Slovakia	Observatory, Public outreach	SWE - Solar Weather	public outreach	http://hvezdar.en.org
Faculty of Electrical Engineering and Informatics, Technical University of <u>Košice</u>	<u>Košice</u> , Slovakia	Academia, University, R&D institution,	SWE - Ionospheric Weather	SW, services, expertise	https://kkui.feituke.sk
<u>GlobalLogic</u> Slovakia s.r.o.	<u>Košice</u> , Slovakia	IT company	SWE - Ionospheric Weather	SW, services	https://www.globallogic.com/sk/
SPACE::LAB startup	<u>Košice</u> , Slovakia	Startup	SWE - Ionospheric Weather	SW, services	https://spaceoffice.sk/space-incubator/
Q-Products a.s.	Bratislava, Slovakia	Company	SWE - Heliospheric Weather	HW, services	https://www.qproducts.sk
CTRL s.r.o.	<u>Košice</u> , Slovakia	Company	SWE - Heliospheric Weather	HW, services	http://www.ctrl11.eu



SLOVAK NATIONAL SPACE SAFETY PROGRAMME (SK-S2P) WORKSHOP

- Space Weather (SWE)
- Planetary Defence, Near-Earth objects (NEO)
- Space debris and Clean space



**15th
FEBRUARY
2022**

- **Astronomical Institute (AI) of Slovak Academy of Sciences (SAS),
Tatranská Lomnica**

3.1) Solar Weather [<https://swe.ssa.esa.int/solar-weather>]

- Development of instruments for ground-based observations of solar disk and corona in VIS and IR spectral lines by the coronagraph
- Observations of solar prominences and solar corona in emission spectral lines with the coronagraph
- New instrument for spectropolarimetry of the solar corona and prominences at the Observatory Lomnický Štít:

COMP- S: Coronal Multi-channel Polarimeter for Slovakia

- Lyot filter with polarimeter (VIS and IR, 500 – 1100nm)

<https://www.astro.sk/l3.php?p3=iso>

- **Solar telescopes for solar atmosphere observations at public observatories:**
 - Slovak Central Observatory in Hurbanovo, Astronomical Observatory in Prešov, Astronomical Observatory in Rimavská Sobota, Astronomical Observatory in Hlohovec

3.1) Solar Weather [<https://swe.ssa.esa.int/solar-weather>]

- Study of solar activity during solar cycles:
 - Telescopes with a lense and with a mirror for optical observation of the sunpots in the solar photosphere
 - LUNT telescope with H-alpha filter for photographic observation of the solar chromosphere and prominences

Hurbanovo:

- Radio spectrometer CALLISTO: registration of solar radio bursts at 45 – 800 MHz (ISWI instrument)
- Spectrometer Ocean Optics HR4000 and horizontal solar telescope (50/3500 cm): measurements of solar continuum in VIS spectral band with the aim to detect solar flares (Astronomical institute, CAS, Ondřejov, Czech Republic)
- publication of Modified Coronal Index (MCI, <https://suh.sk/online-data/modifikovany-koronalny-index>) and Modified Homogeneous Data Set (MHDS, <https://suh.sk/online-data/modifikovany-homogeny-rad>) of solar coronal intensities.

- **Institute of Experimental Physics (IEP), SAS, Košice**
(Department of Space Physics)
 - **3.2) Heliospheric Weather** [<https://swe.ssa.esa.int/heliospheric-weather>]
 - Measurements of energetic particles by own instruments on space missions: as Radioastron, Double Star, BepiColombo, JUICE, and etc.
 - Infrastructure for Space R&D projects
 - **3.3) Space Radiation** [<https://swe.ssa.esa.int/space-radiation>]
 - Cosmic Rays measurements (ground based observations using Neutron monitor and SEVAN) [<http://neutronmonitor.ta3.sk>]
 - **3.4) Ionospheric Weather** [<https://swe.ssa.esa.int/ionospheric-weather>]
 - AMON (Airglow MONitor) - processes in the thermosphere-ionosphere system
 - ASPIS - predictions of ionospheric scintillations

More at <http://uef.saske.sk>

- **Earth Science Institute (ESI), Slovak Academy of sciences (ESI SAS), Bratislava**
 - Geomagnetic Observatory located in Hurbanovo
- **Faculty of Mathematics, Physics and Informatics (FMPI) of the Comenius Univ., Bratislava**
 - Astronomical and Geophysical Observatory (AGO), located in Modra

3.5) Geomagnetic Conditions [<https://swe.ssa.esa.int/geomagnetic-conditions>]

- Registration of the Earth's magnetic field:

Technical details of instruments in Hurbanovo within the **INTERMAGNET**:

- DI-fluxgate magnetometer (type ELSEC 810, Zeiss Theo 015B)
 - DI-fluxgate magnetometer (type LEMI 203)
 - proton magnetometer (type PMG 1)
 - Torsion photoelectric magnetometer (TPM) employing Bobrov-type quartz variometers
 - Magson fluxgate magnetometer
- Investigation of the **geomagnetic bursts**.

- **Potential new players:**
 - **Q-Products a.s.** (ruggedized computers and displays, <https://www.qproducts.sk/about-us/>)
 - **CTRL s.r.o.** (cyber-physical systems, <http://www.ctrl1.eu>)
 - **Faculty of Electrical Engineering and Informatics, Technical University of Košice** (space/geo data processing and support of their decision processing using machine/deep learning approaches, <https://kkui.fei.tuke.sk/en/>)
 - **GlobalLogic Slovakia s.r.o.** (leader in digital engineering, <https://www.globallogic.com>)
 - **SPACE::LAB startup** (Slovak Space Incubator team connected directly to the IEP SAS in Košice: digital solutions by advanced machine learning techniques)

- **EU Space Programme and European Union Agency for the Space Programme (EUSPA)**
- Two Slovak scientists are nominated as National representatives to the EU Space Programme Committee - the Space Situational Awareness (SSA)/Space Weather (SWE).



- The National **Commission for Space Activities in the Slovak Republic** is coordinated by the Slovak Space Office at the Ministry of Education, Science, Research and Sport of the Slovak Republic.



http://stara.suh.sk/id/iswi/summer_school

- **COSPAR and SCOSTEP:**

Slovak scientists are actively participating also in both the

- COSPAR, <http://nccospar.saske.sk/>

and the

- SCOSTEP/PRESTO, <https://scostep.org/presto-science-program/>

activities.