Space science and engineering activities

at Department of Space Physics, Institute of Experimental Physics, Slovak Academy of Sciences

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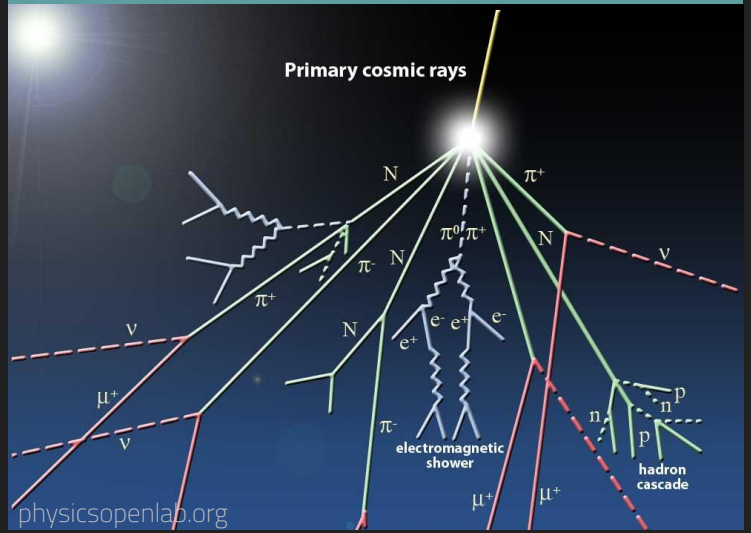
SPACE::LAB

Bezovec 2020 / Astronomický výskum na Slovensku / 2. 10. 2020

Main topics:

Cosmic rays



Space weather

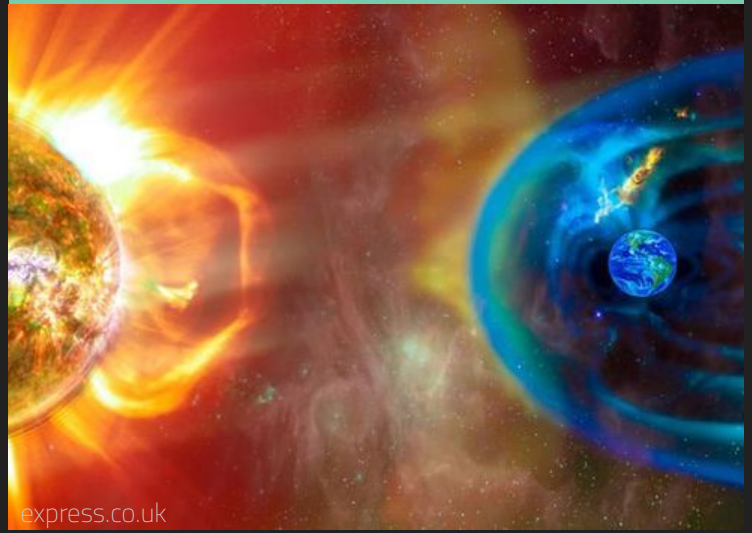
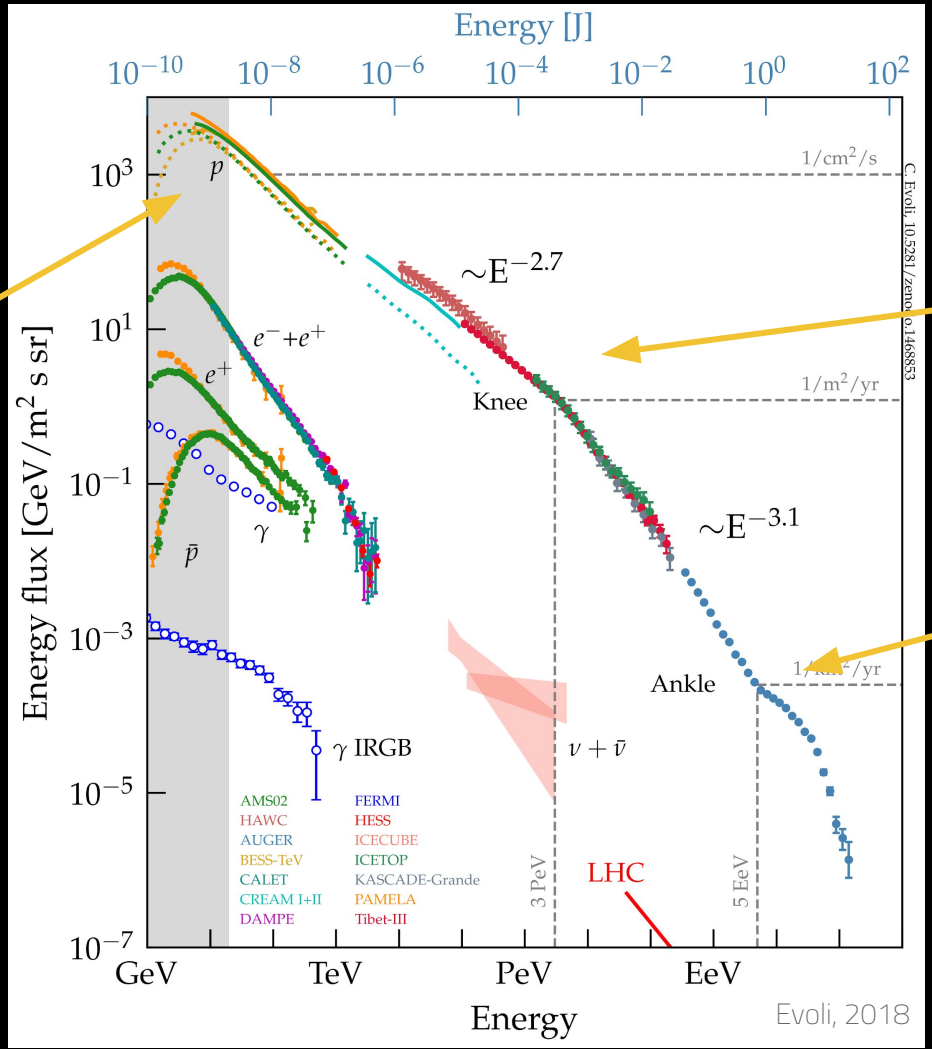


Image by: S. Mackovjak

Solar cosmic rays



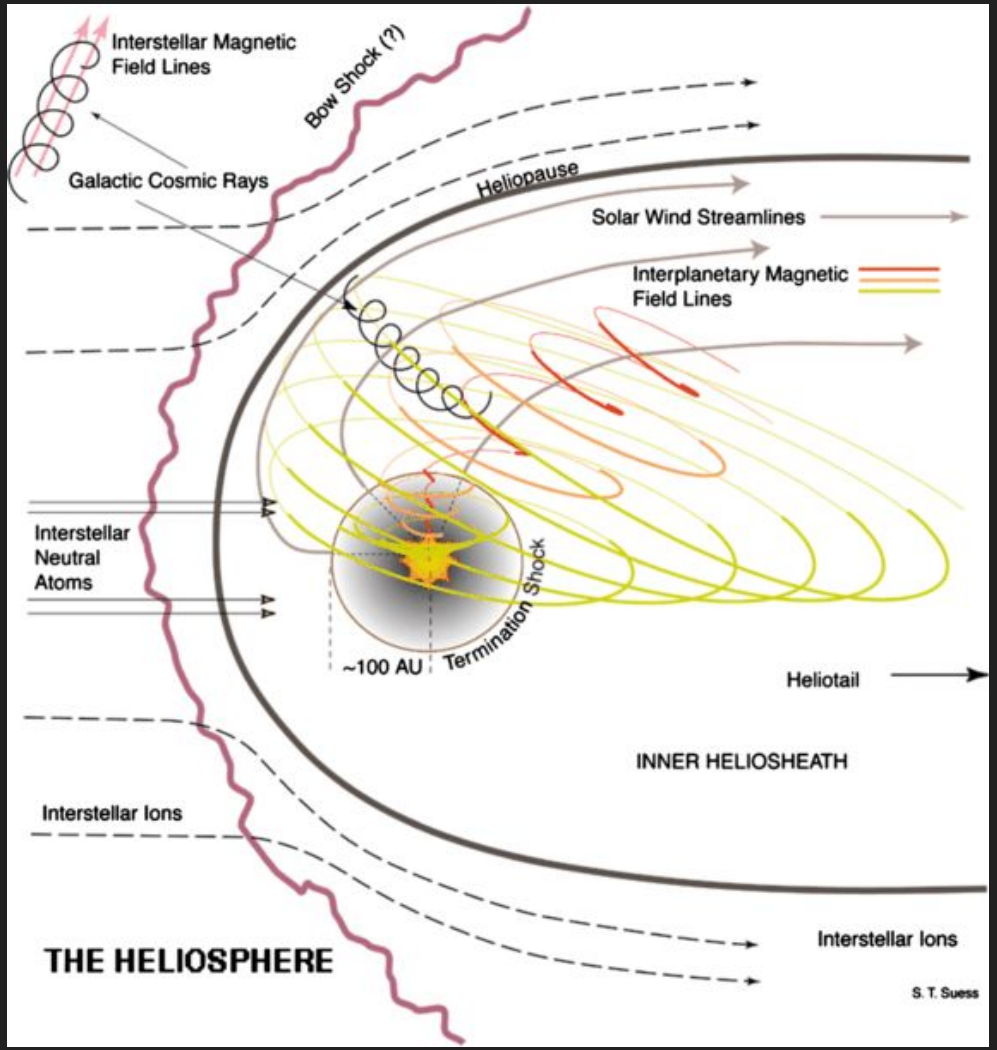
Galactic cosmic rays

Extra-galactic cosmic rays

Cosmic rays - important part of multi-messenger astrophysics

Provide info about:

- sources
- propagation environment

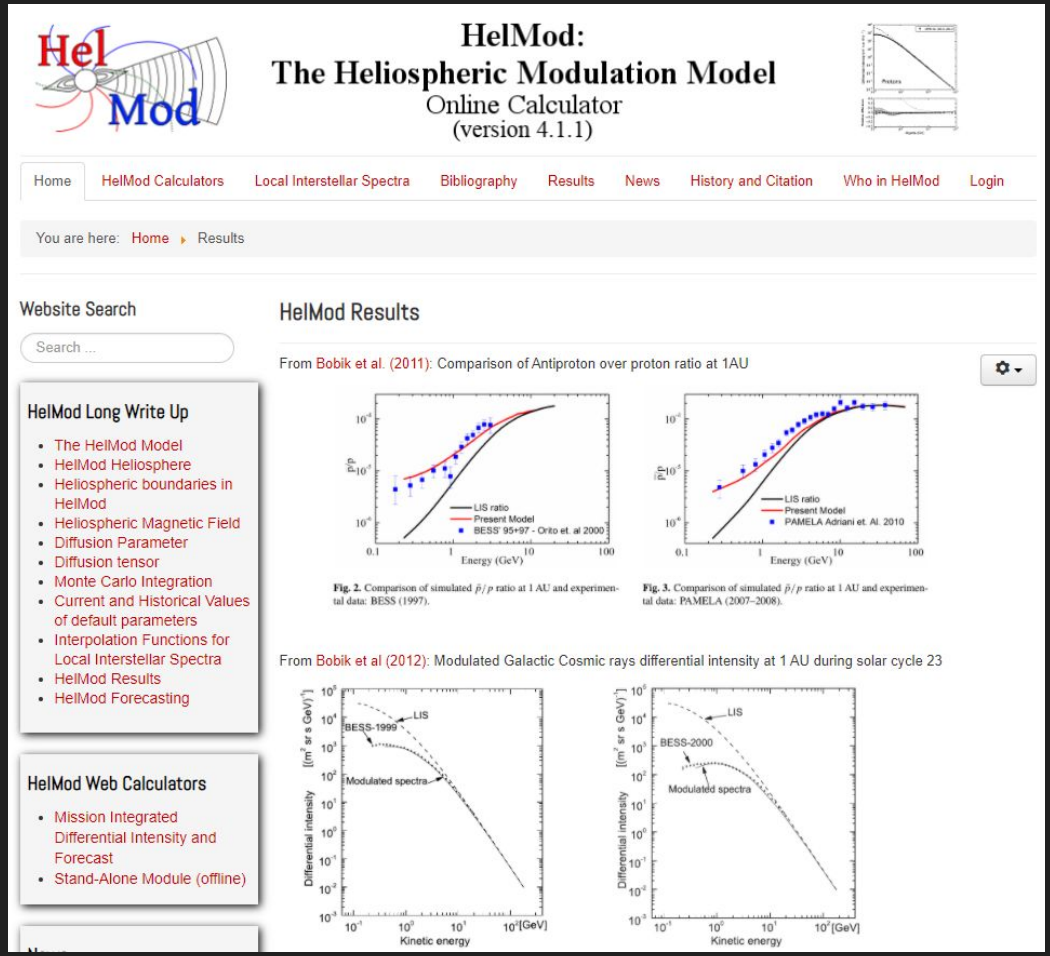


HelMod: Heliosphere Modulation Monte Carlo Code

- propagation of Galactic Cosmic Rays through the Heliosphere from the Termination shock down to Earth
- based on Parker transport equation

$$\frac{\partial U}{\partial t} = \nabla\cdot(\mathbf{K}^{\mathbf{S}}\cdot\nabla U) - \mathbf{V}_{\mathbf{sw}}U - \langle\mathbf{v}_{\mathbf{D}}\rangle U) + \frac{1}{3}(\nabla\cdot\mathbf{V}_{\mathbf{sw}})\frac{\partial}{\partial T}(\alpha T U)$$

Selected papers: Bobik et al. (2012), Bobik et al. (2016), Kolesnyk, Bobik et al. (2017, 2019)

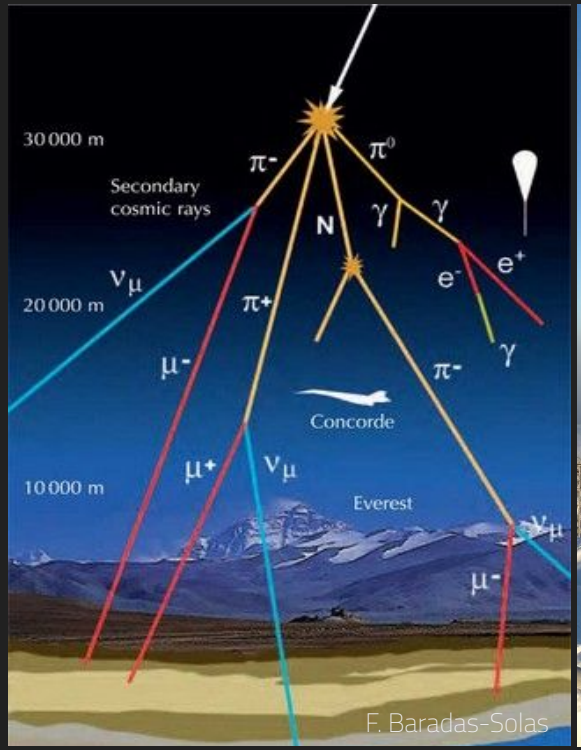


www.helmod.org

NMDB: Neutron Monitor Database

- operational infrastructure at Lomnicky Stit Observatory
- proxy for detection primary cosmic rays (0.5 - 100 GeV)
- continuous data since 1957
- network of 27 stations

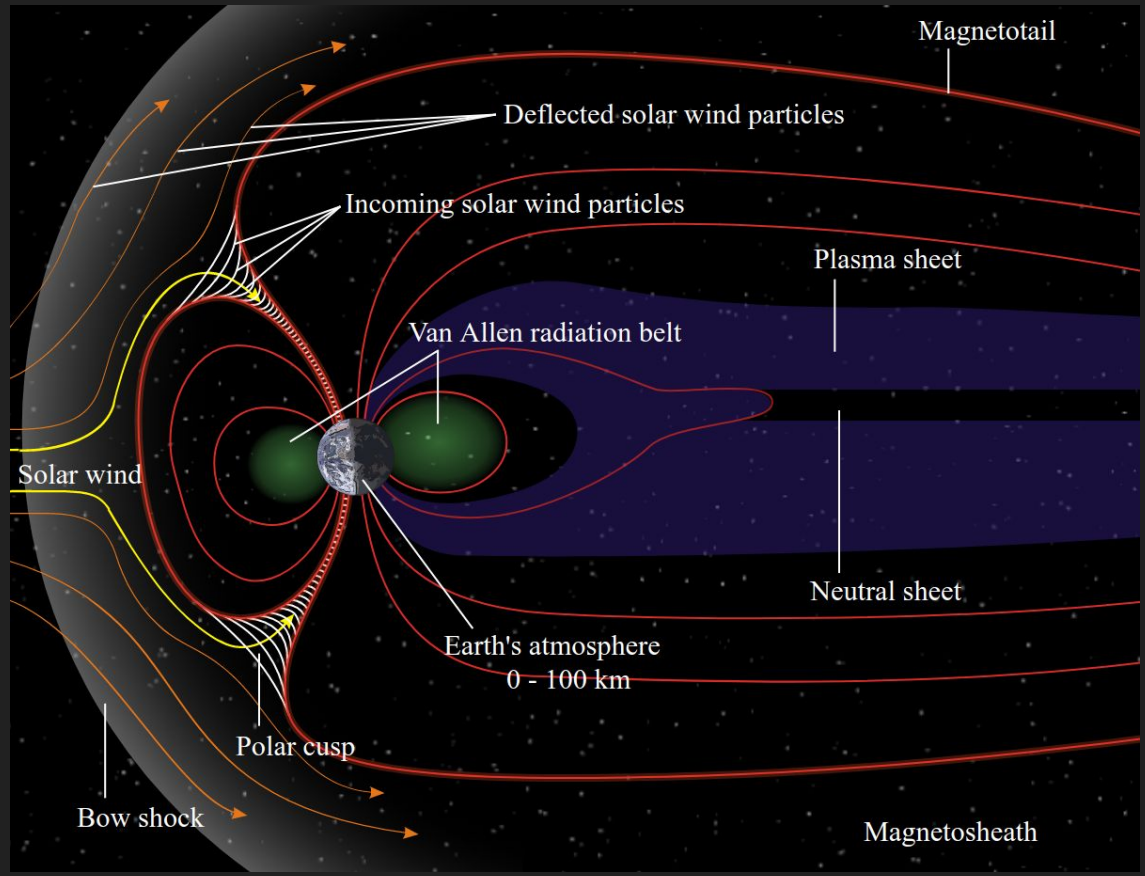
Selected papers: Kudela et al. (2000), Kudela & Langer (2009), Kudela et al. (2017)



www.nmdb.eu

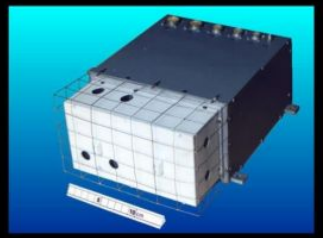
Space missions

- since 1977
- mainly in-situ energetic particles detection
- more than 20 instruments
- design, development, testing, integration, operation
- HW - detectors, electronics, connectors, mechanics
- SW - embedded, communication, data storage
- Experts: Ján Baláž, Igor Strhárský

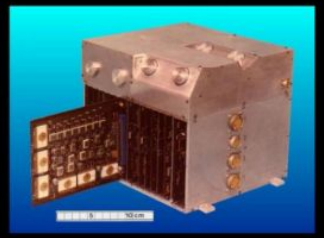


SK-1
Interkozmos-17 (1977)

DOK-T
Prognoz-10 (1981)

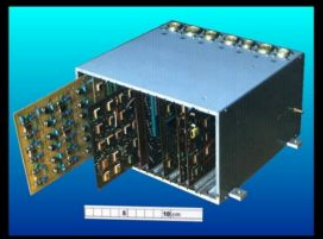


DOK-1
Intershock (1985)

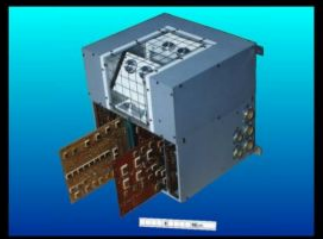


SPE-1
Active (1989), MIR (1996)

DOK-S
Active (1989)...1996 (4x)



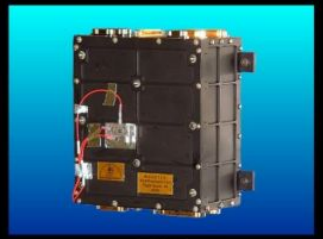
SONG-E
Coronas-I (1994), -F.(2001)



DOK-2
Interball (1995, 1996)

SLED-2
MARS-96 (1996)

NUADU
Double Star (2004)



ESS
ESA-Rosetta (2004)

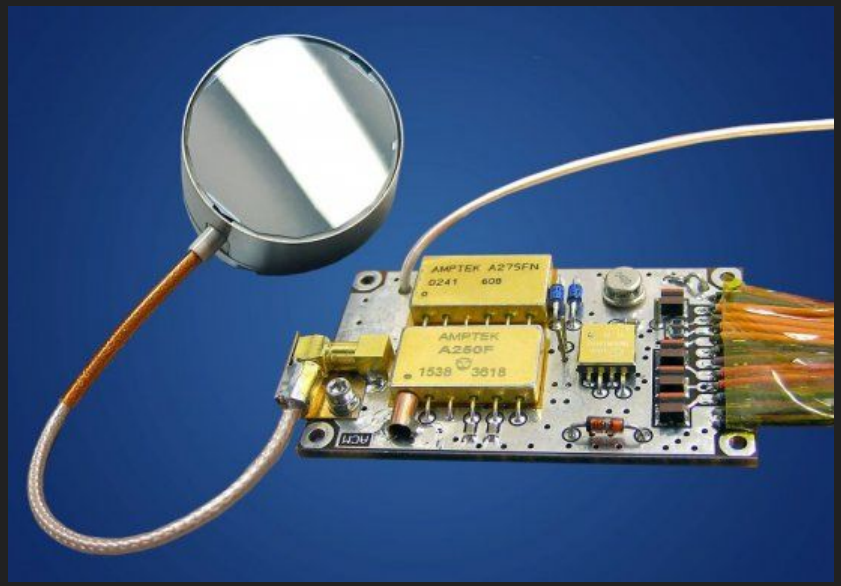
MEP-2
Radioastron (2011)

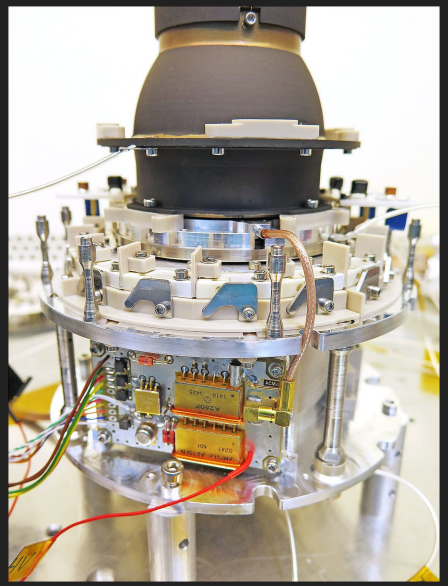
PICAM
BepiColombo (2018)

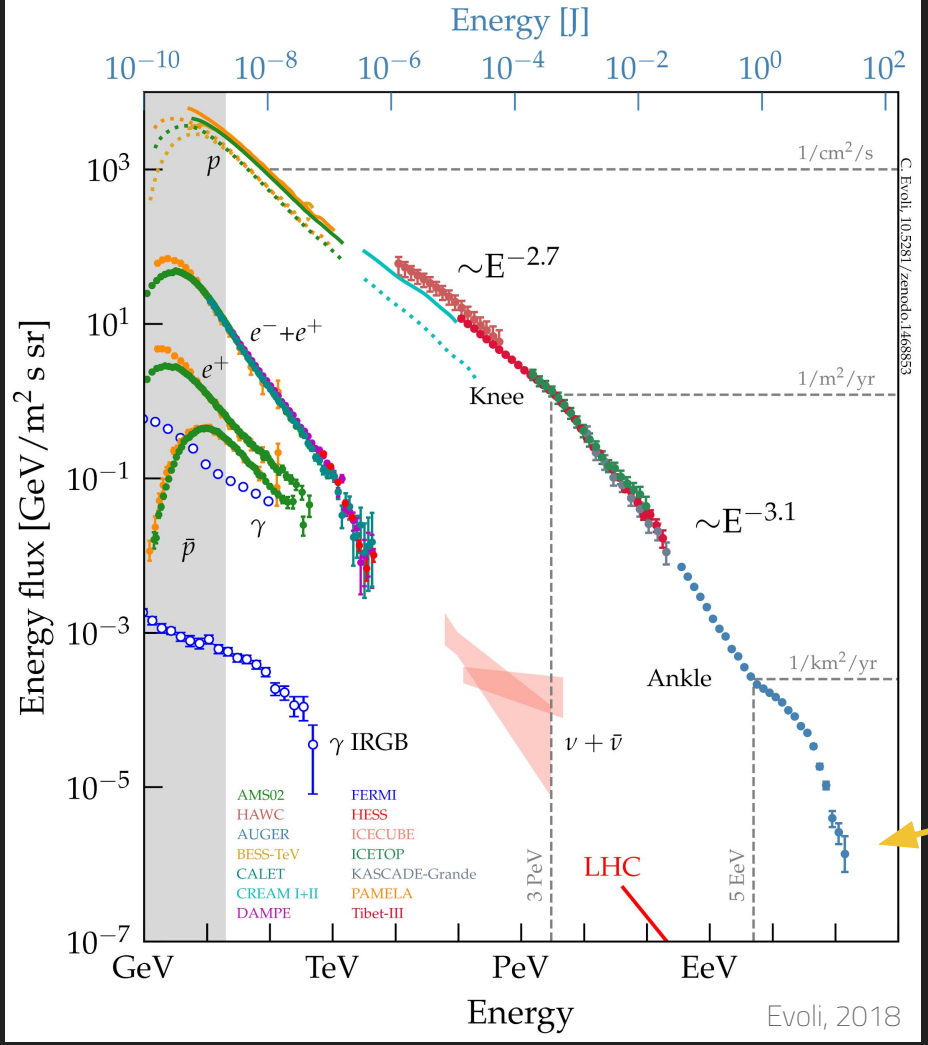
JUICE: JUpiter ICy moons Explorer

European Space Agency

- Complete development of ACM detector for Particle Environmental Package
- Flight spare model delivered for integration in July 2020





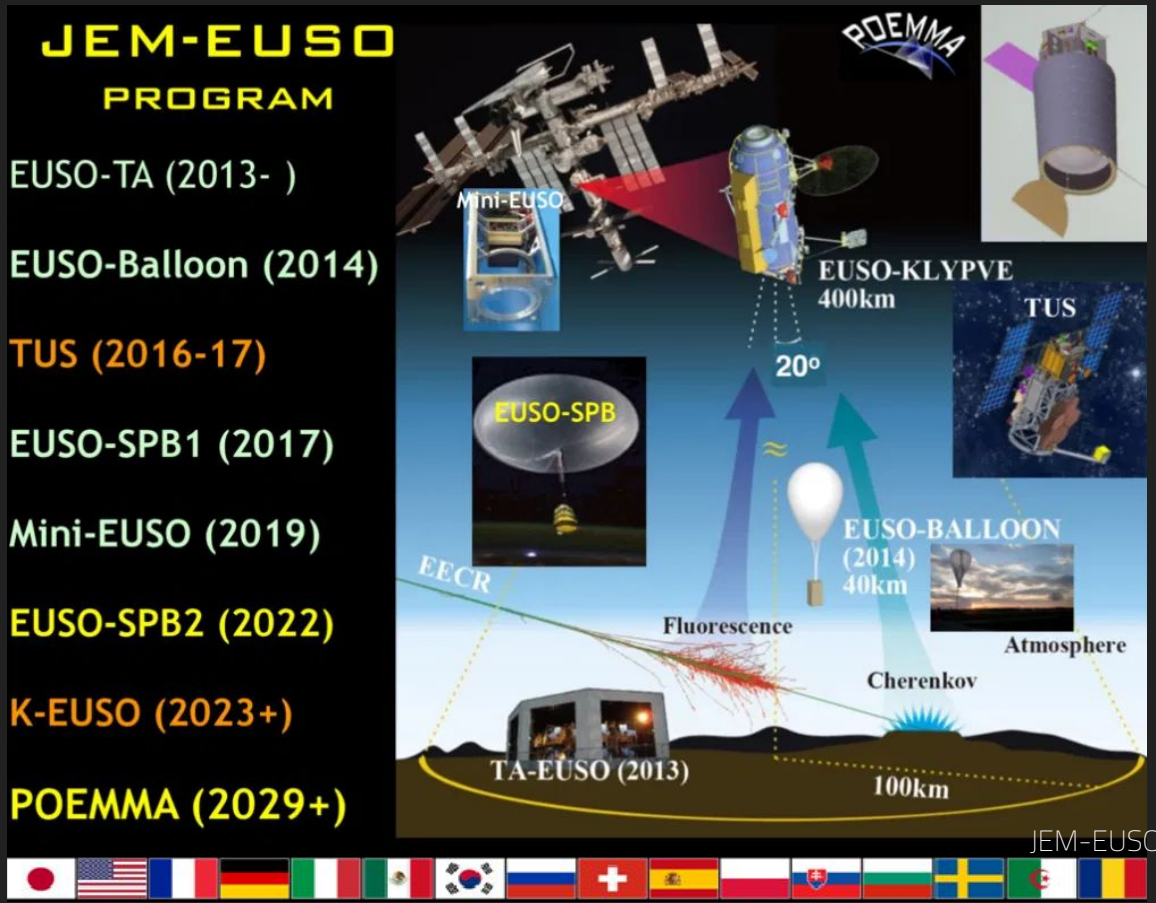

Energy [J]
10^{-10} 10^{-8} 10^{-6} 10^{-4} 10^{-2} 10^{0} 10^{2}
Energy flux [GeV/m^2 s sr]
10^{3} 10^{1} 10^{-1} 10^{-3} 10^{-5} 10^{-7}
1/cm^2/s
1/m^2/yr
1/km^2/yr
p
e^-+e^+
e^+
γ
$\bar{p}$
γ IRGB
$\sim$E$^{-2.7}$
$\sim$E$^{-3.1}$
Knee
Ankle
$\nu + \bar{\nu}$
LHC
3 PeV
5 EeV
AMS02
HAWC
AUGER
BESS-TeV
CALET
CREAM I+II
DAMPE
FERMI
HESS
ICECUBE
ICETOP
KASCADE-Grande
PAMELA
Tibet-III
GeV
TeV
PeV
EeV
Energy
Evoli, 2018
C. Evoli, 10.5281/zenodo.1468853

UHECR

UHECR: Ultra High Energy Cosmic Rays

- detection is possible but very rare -> what is the source?
- members of JEM-EUSO collaboration since 2008

Selected papers: Experimental Astronomy (2015), Mackovjak & Shinozaki (2019)



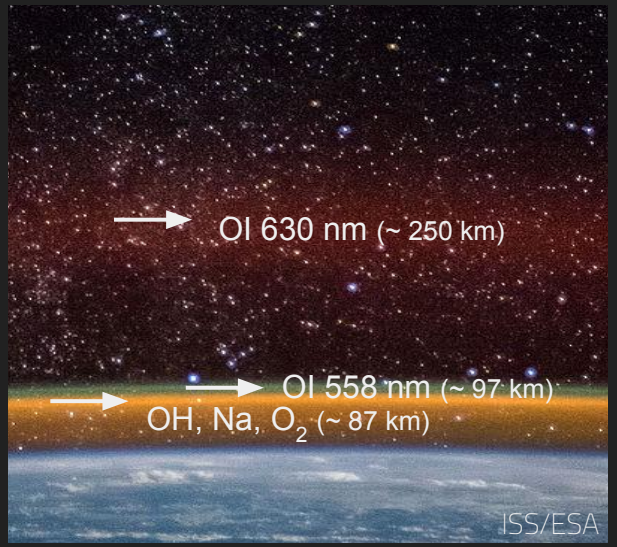
jem-euso.roma2.infn.it

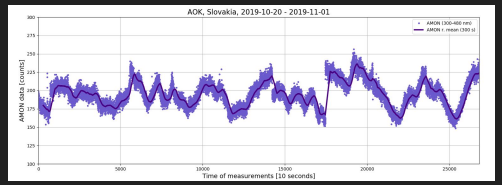

ISS/NASA

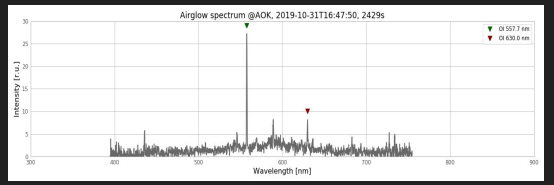
AMON: Airglow Monitor

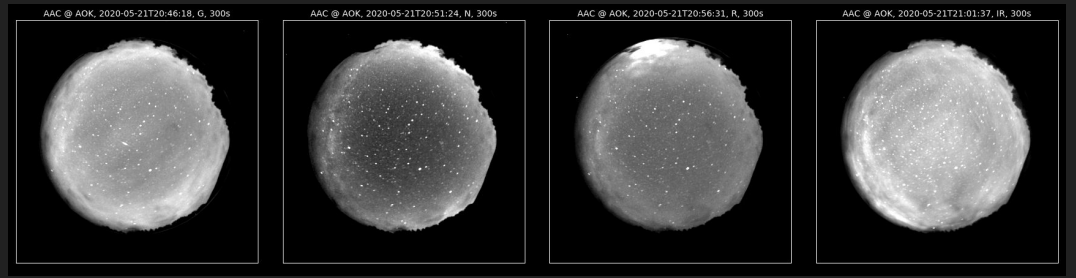
- estimation of UV background for JEM-EUSO
- study of disturbances in thermosphere-ionosphere
- cooperation with esa

Selected papers: Putis, Bobik & Mackovjak (2018), Mackovjak et al. (2019)









SPACE::LAB

esa

- ATTRACT young generation with passion for SPACE
- EDUCATE the attracted community directly in our lab
- INVOLVE the best students to our actual space science & engineering projects

www.space-lab.sk

Facebook SPACE::LAB

YouTube SPACE::LAB

Instagram SPACE::LAB

Meetup SPACE::TALK

Students projects:

TLE

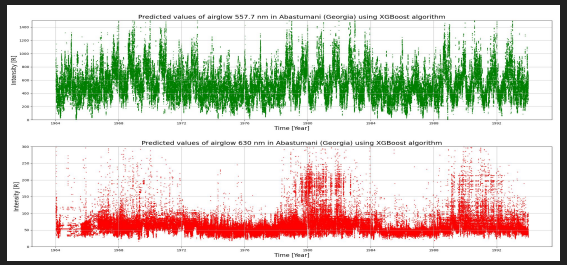
Samuel Amrich,
2 yr, MFF UK, Prague

- Design and integration of HW
- SW for operation and automatic data reduction
- Cooperation with DSP, IAP, ASCR

Airglow

Matej Varga,
4 yr, KKUI, FEI, TUKE, Košice

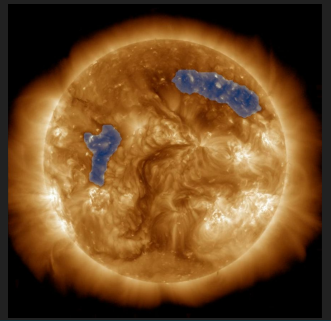
- Machine Learning approach to model airglow intensities
- Data processing from 30 years
- Useful for airglow studies



Solar Corona

Martin Harman,
5 yr, KKUI, FEI, TUKE, Košice

- Deep Learning approach for image segmentation
- Original training dataset of coronal holes and ARs
- Wide usage



Our space science and engineering activities:

- Ground-based stations: Lomnicky stit observatory, AO Kolonica
- Space-based instruments: … Rosetta, BepiColombo, JUICE, …
- Theoretical models: HelMod, ML models
- International collaborations: JEM-EUSO, POEMMA
- Infrastructure: complete HW & SW development

Next challenges:

- closer collaboration with ESA
- engagement of IT community
- participation on world-class missions
- keep focus on cosmic rays and space weather