



INSTITUTO DE ASTROFÍSICA DE CANARIAS

An R20 suite for Space Weather on the Canary Islands

ESAC, MADRID
JUNE 9th, 2026



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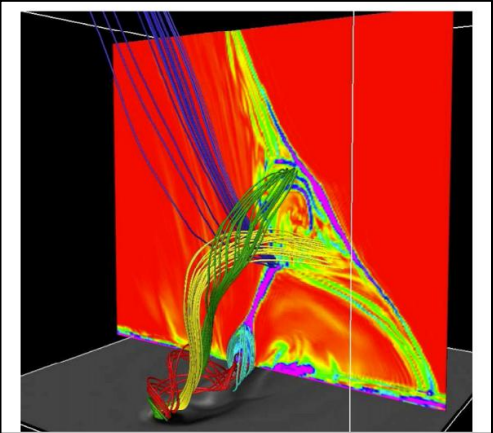
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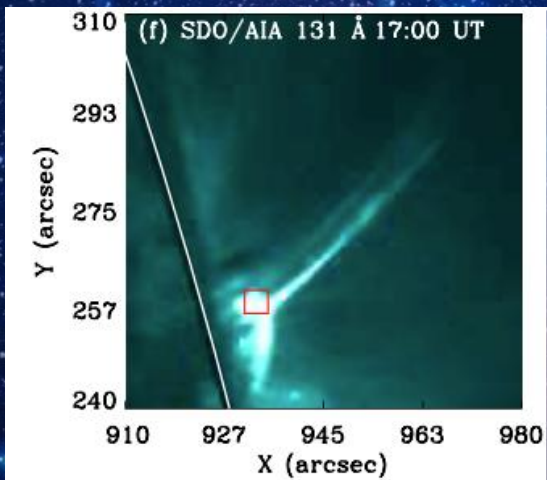
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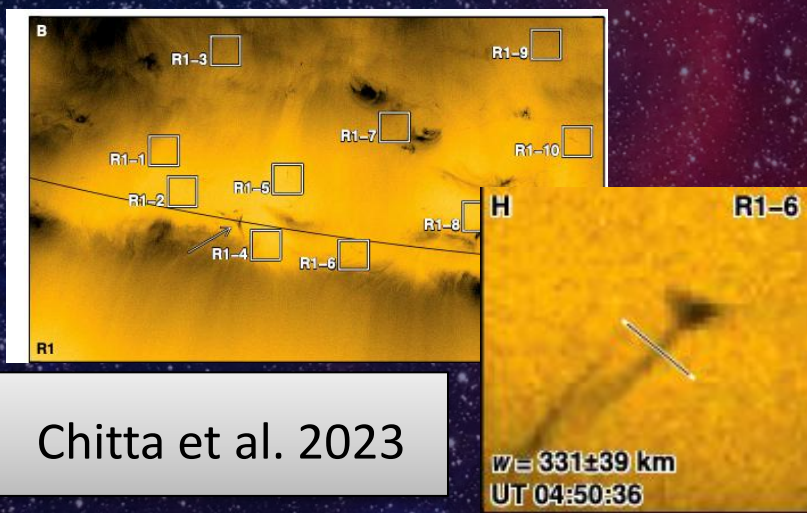
Sun in a box: numerical modelling of SW relevant coronal phenomena



Moreno-Insertis & Galsgaard 2013



Joshi et al. 2020



Chitta et al. 2023

- Decade long experience in 3D modelling of coronal jets
 - Both ideal-MHD and radiation-MHD bifrost models
 - Forward modelling: direct comparison to TR coronal observations
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- Coronal jets are a natural consequence of bipolar flux emergence
 - They can also follow stressing of the coronal field by photospheric motions
 - Interchange reconnection (closed field line with open field line) is their core mechanism
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- Jets in coronal holes can be a relevant mass/energy input for the solar wind
 - SOLAR ORBITER: picoflare jets (100 km, 100km/s) could sustain the solar wind emerging from coronal holes

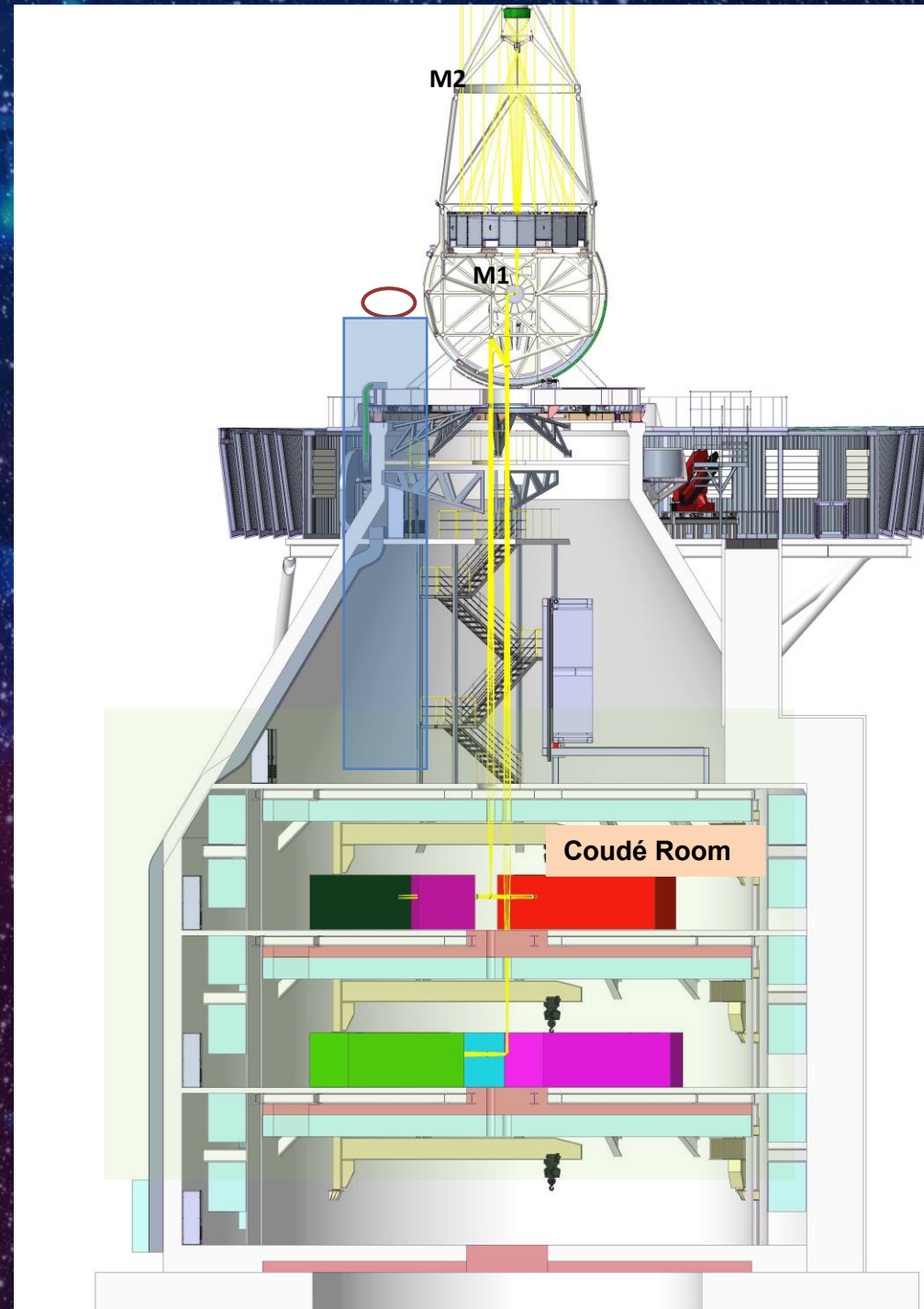
European Solar Telescope (EST)

Science

- Understand origins of solar activity
- Measure the 3D magnetic structure near its fundamental scales
- High-resolution 3D boundary condition for models of eruption

Innovation

- Thin primary (7cm vs 4.2m)
- Adaptive secondary
- MCAO (5 adaptive mirrors)
- Large etalons
- Thermal control



Status

- Consolidated design (PDRs)
- Interim legal entity (Foundation)
- Project Office and Eng. Team
- BGR -> ERIC application
- 75% of Phase I funding

ESFRI project led by Spain
12 hours apart from DKIST (Hawaii)

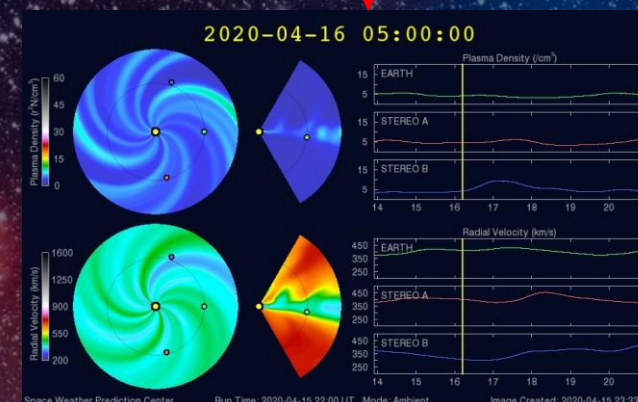
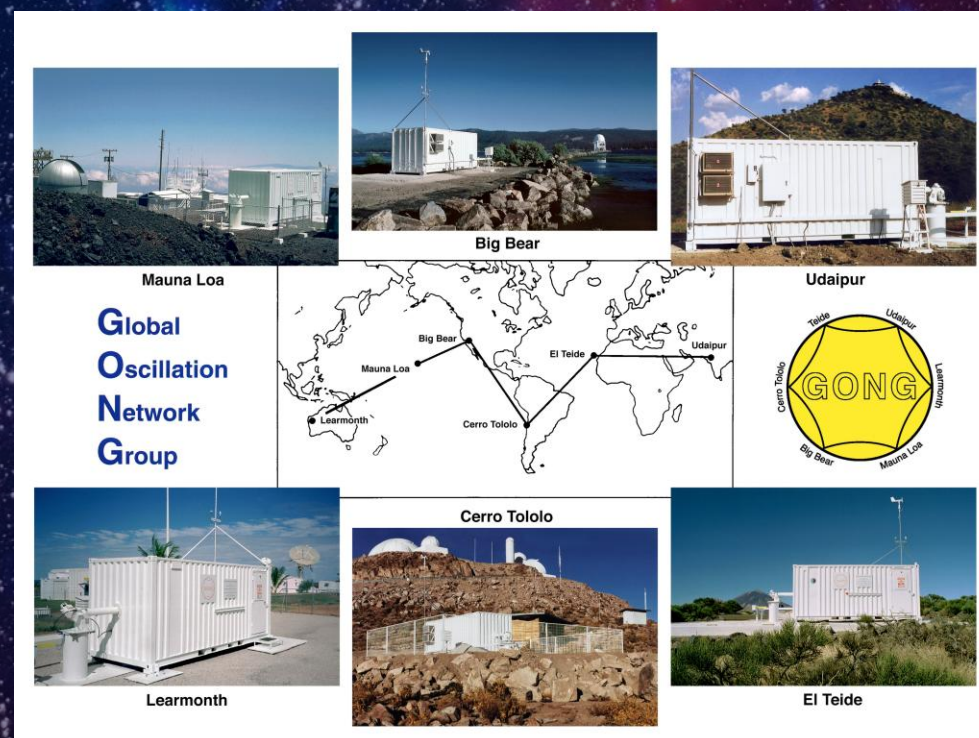
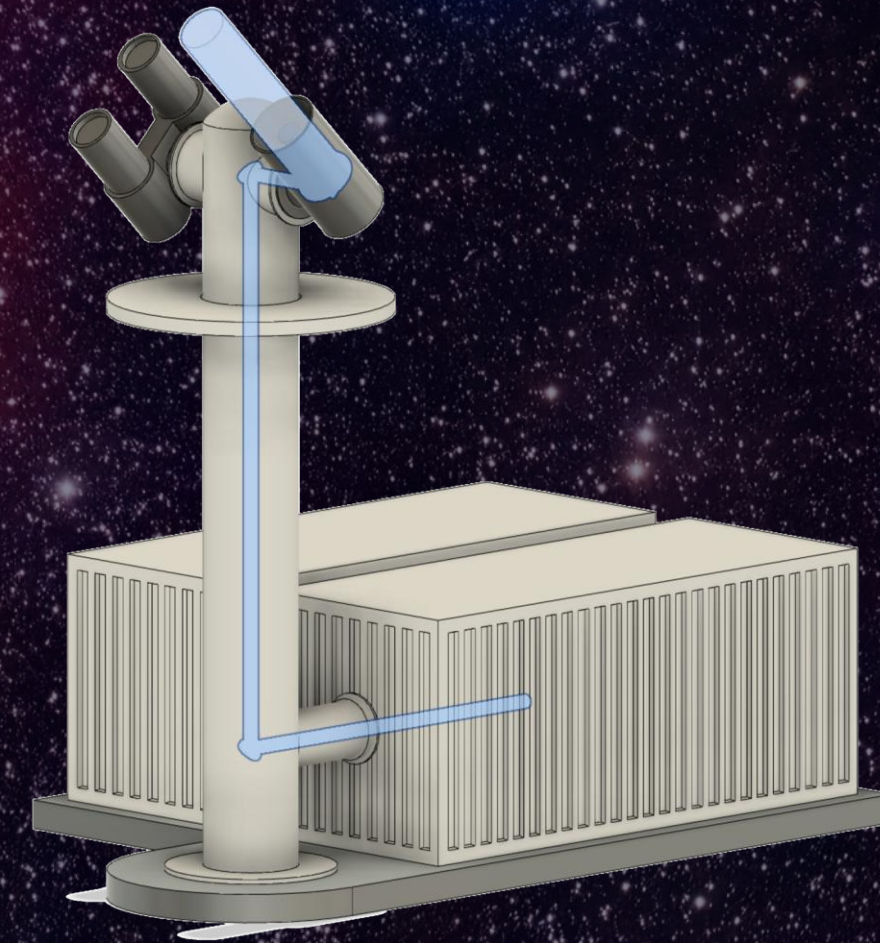


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The GONG & ngGONG networks

- GONG: 6 sites network to monitor the Sun all the time (91% duty cycle)
- National Solar Observatory (USA)
- Started in 1995 to measure solar oscillations (velocity): 31 years old
- One site at Teide Observatory (Tenerife)
- R20 modified for magnetic field measurements in 2006. Also added H α
- Operations fully funded by NOAA SWPC since 2017: not designed for SW
- NSF has approved the study phase for next generation GONG (ngGONG)
- Provide boundary data to **propagate magnetized CMEs**



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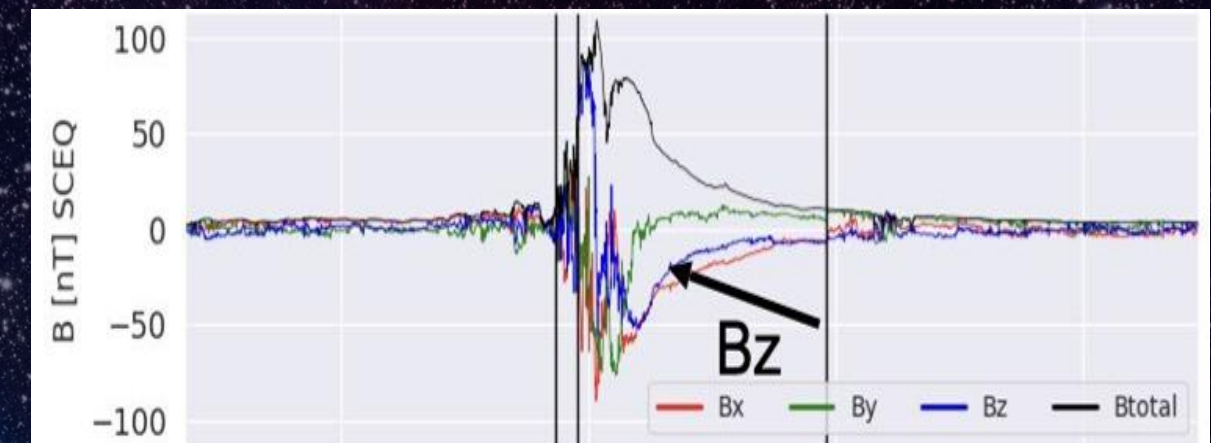
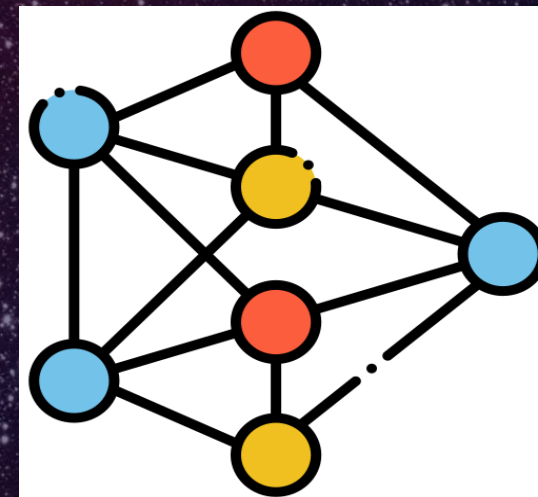
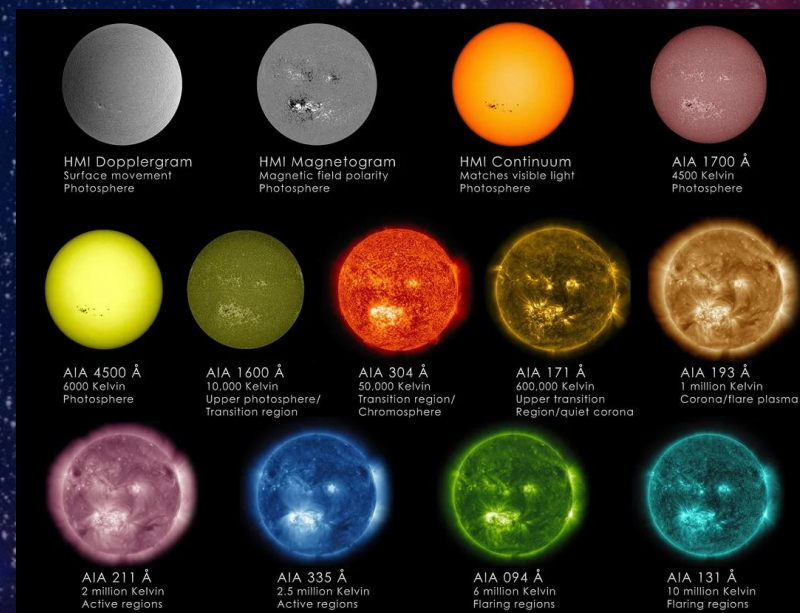
Using AI to Predict Bz from CMEs

Core idea: can we train ML models with HMI+AIA images & predict Bz at L1?

- CME's from active regions
 - Use SHARPS for active regions on the surface
 - Aggregate information to make predictions
- Bz & polarity inversion lines@HMI+sigmoids/filaments@AIA
 - Extract features from images
- Potential problems
 - Sparse and scarce data
 - Coronal and heliospheric propagation

Dr. Tamitha Skov @TamithaSkov

If the NASA model is correct, we could be looking at a G3+ level storm. If NOAA is more correct and we get a slower, flanking blow, we will likely see a shorter G2 level storm. Of course, all of this depends upon whether the magnetic field orientation in the coming storm points southward (which we cannot predict before arrival). The previous set of storms this week hardly had any southward pointing field. That is why they fizzled out.



A collaboration with Ellis Max Planck Campus Tübingen

The Solar Orbiter & Vigil suite

- Vigil part of ESA's Space Safety Program (S2P).
- Preliminary Design Review (PDR) in December 2024.
- Monitor space weather: 4 remote sensing & 4 in-situ instruments from L5
- **IAA** leads Spanish participation in the Polarimetric and Magnetic field Imager (PMI)
- Direct heritage from Solar Orbiter PHI instrument
- IAC contribution FPGA firmware: device architecture.
- Launch expected in 2031

- Ingestion of PMI magnetograms into synoptic data regularly used for heliospheric modeling and Space Weather forecast (GONG, etc.)

- Use PHI as a testbed



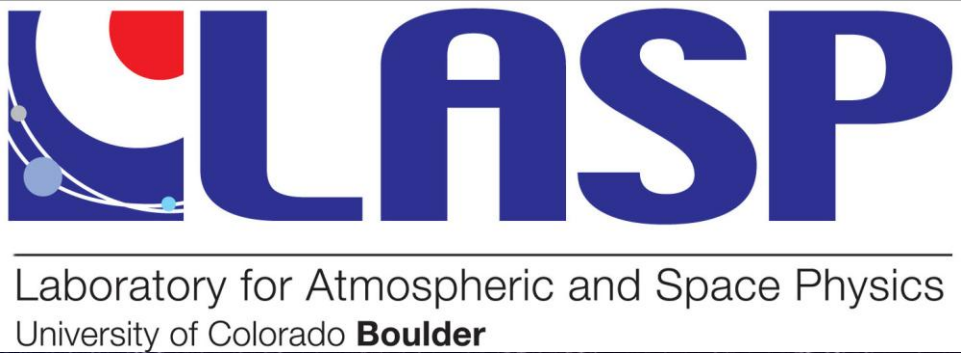
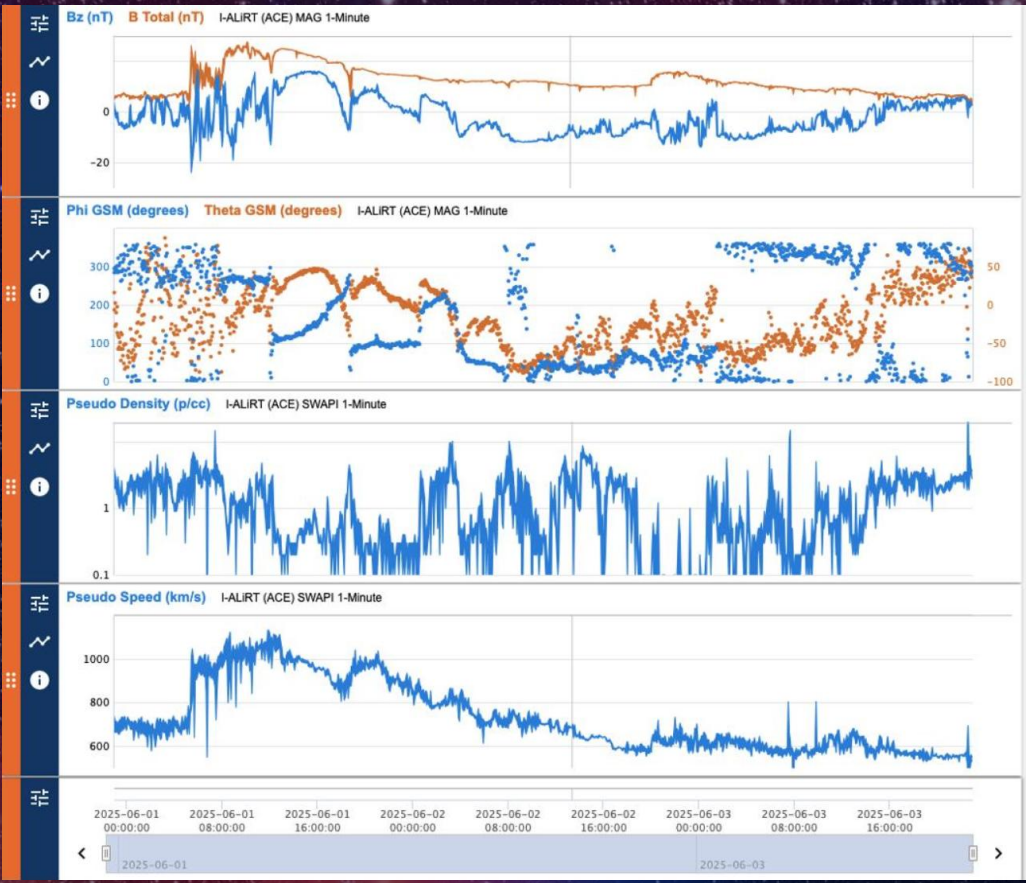
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IMAP I-ALiRT real time Space Weather collaboration

- NASA’s Interstellar Mapping and Acceleration Probe (IMAP). PI is Princeton Univ.
- Launch in September 2025. Spin stabilized satellite at L1. 5 in-situ instruments
- SOC located at CU Boulder’s Laboratory for Atmospheric and Space Physics (LASP).
- IMAP Active Link for Real-Time (I-ALiRT) Space Weather service
- 24/7 data ingested into NOAA SWPC: DSN & international partners
- Mando del Espacio (ISDEFE), INTA & IAC talks to potentially use Maspalomas antenna

Instrument	Data product	Cadence
Magnetometer (MAG)	Magnetic Field Vector, Total Magnetic Field, Magnetic Field Clock and Cone Angles	4 sec
Solar Wind Electrons (SWE)	Suprathermal Electron Anistropy	1 min
Solar Wind and PickUp Ions (SWAPI)	Pseudo Solar Wind Ion Flow Speed, Proton Number Density, Solar Wind Ion Temperature	12 sec
Compact Dual Ion Composition Experiment (CoDICE-Lo)	Solar Wind Charge State Ratios	4 min
CoDICE-Hi	Suprathermal and Solar Wind Proton Fluxes	1 min
High-energy Ion Telescope (HIT)	Energetic Proton and Electron Fluxes	1 min





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