



UNIFYING SOLAR AND
HELIOSPHERIC PHYSICS



Craig DeForest

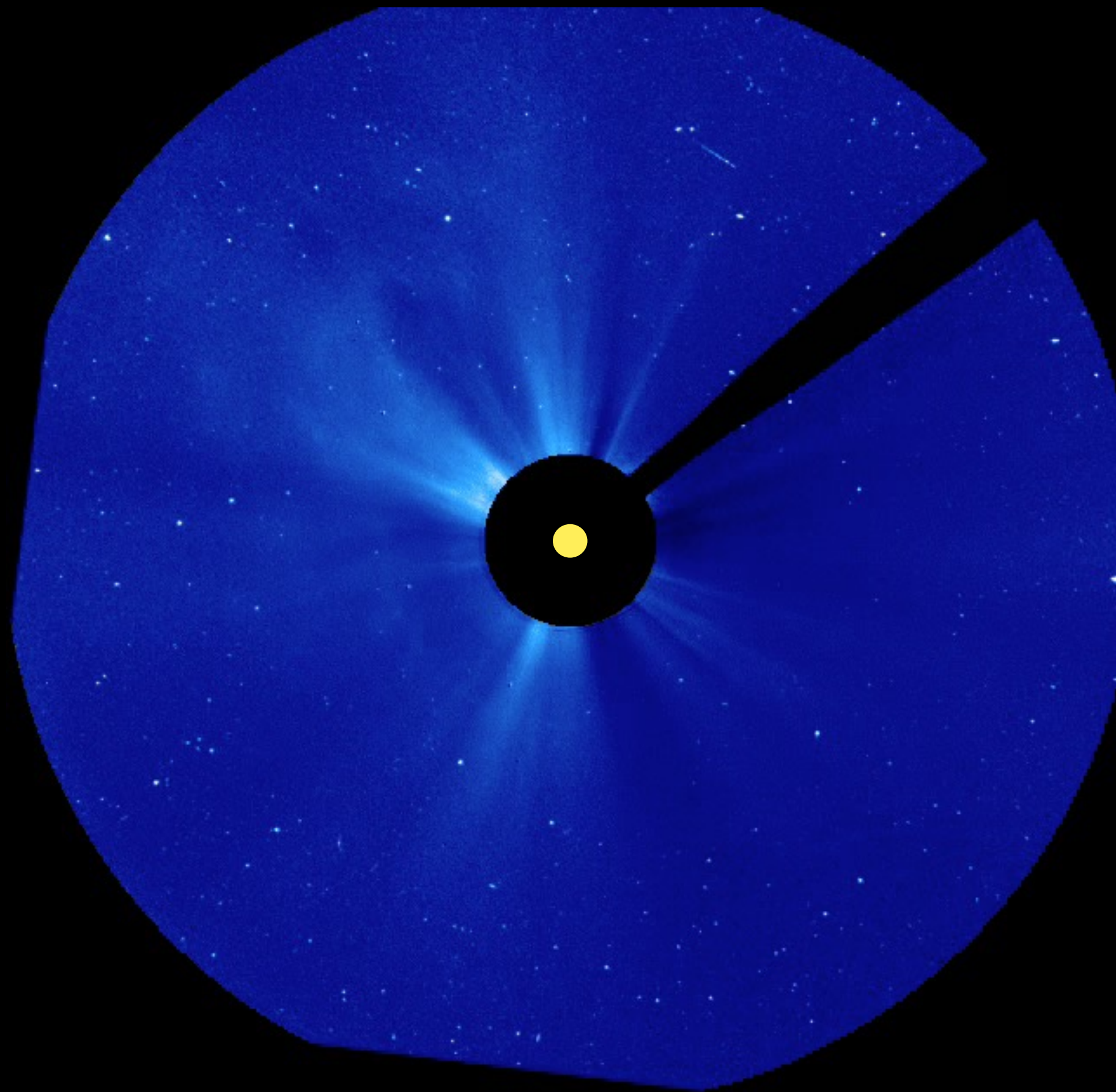
THE PUNCH MISSION



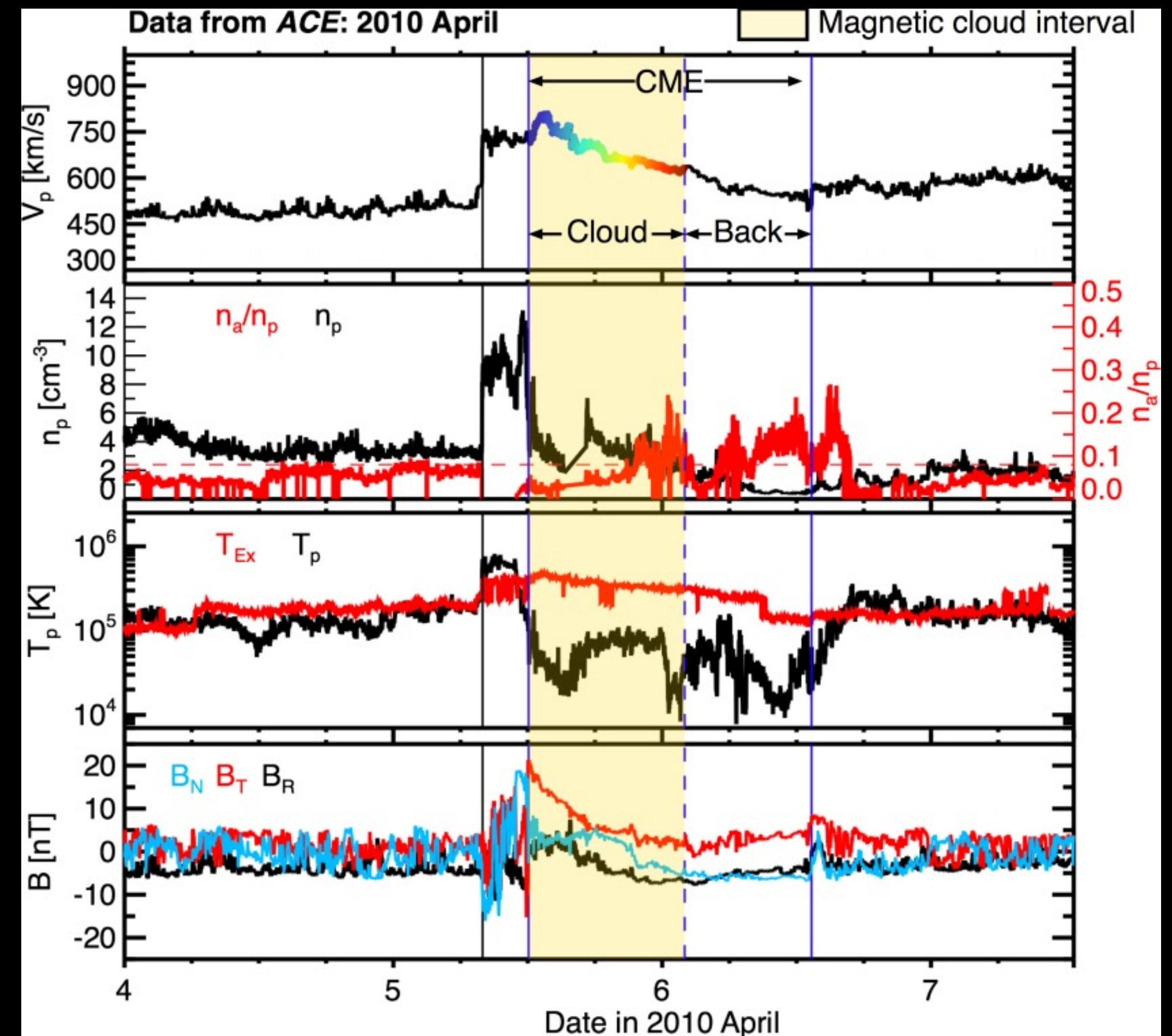


WHY PUNCH? TO UNIFY SOLAR PHYSICS & HELIOSPHERIC PHYSICS

Solar physics studies the Sun and corona, primarily through remote sensing and spectral analysis



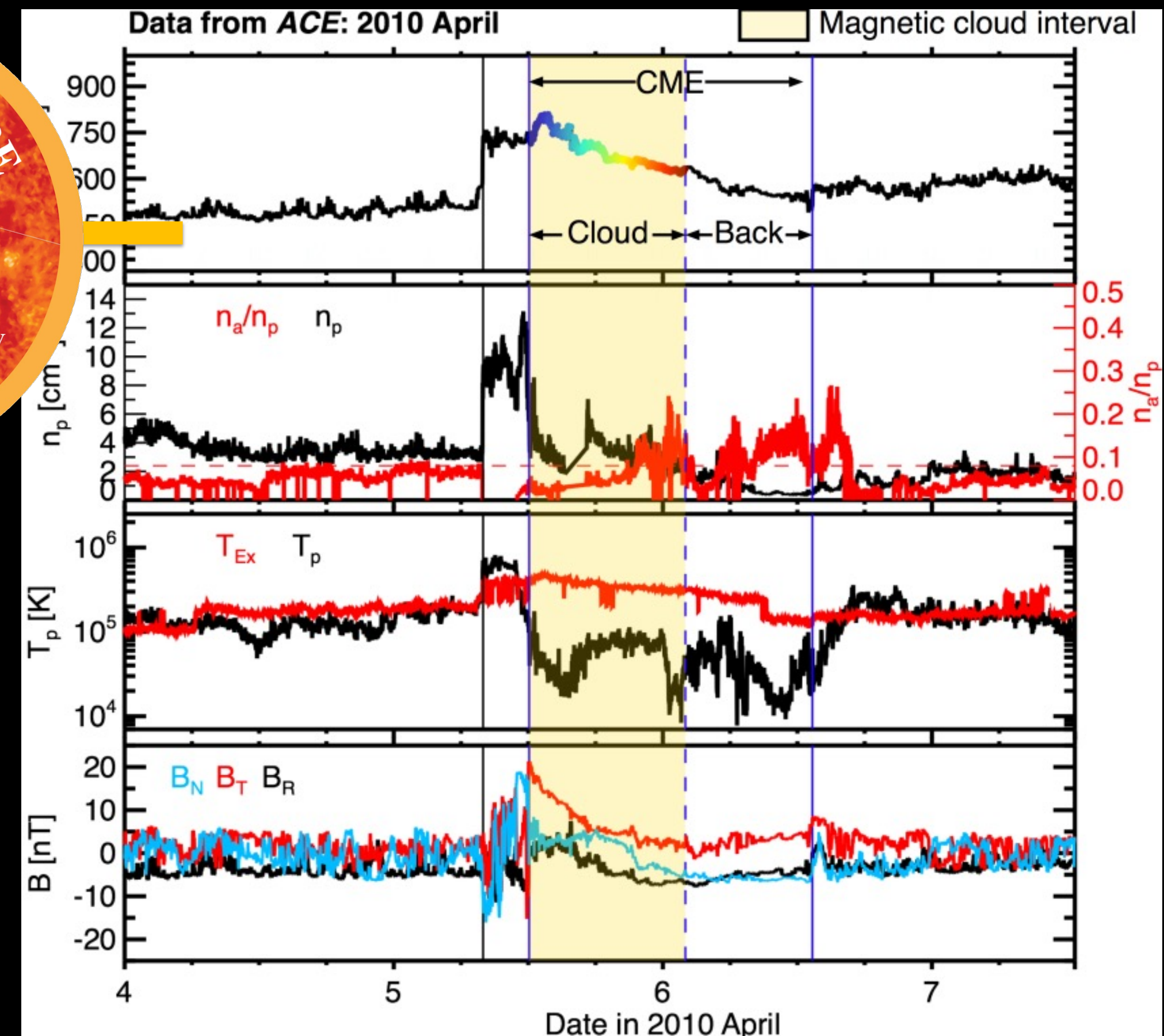
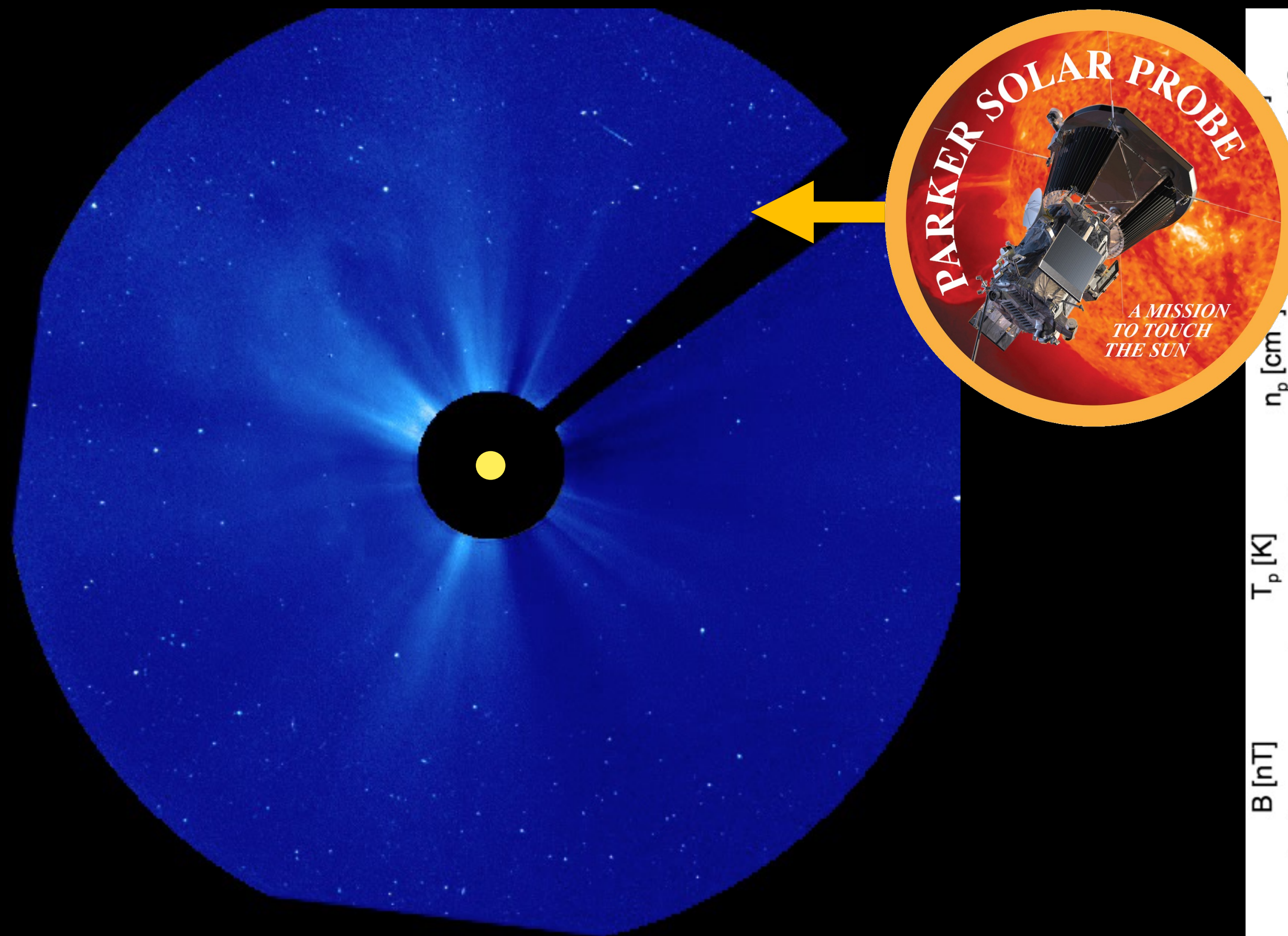
Heliospheric physics studies the solar wind in interplanetary space, primarily through in-situ sampling



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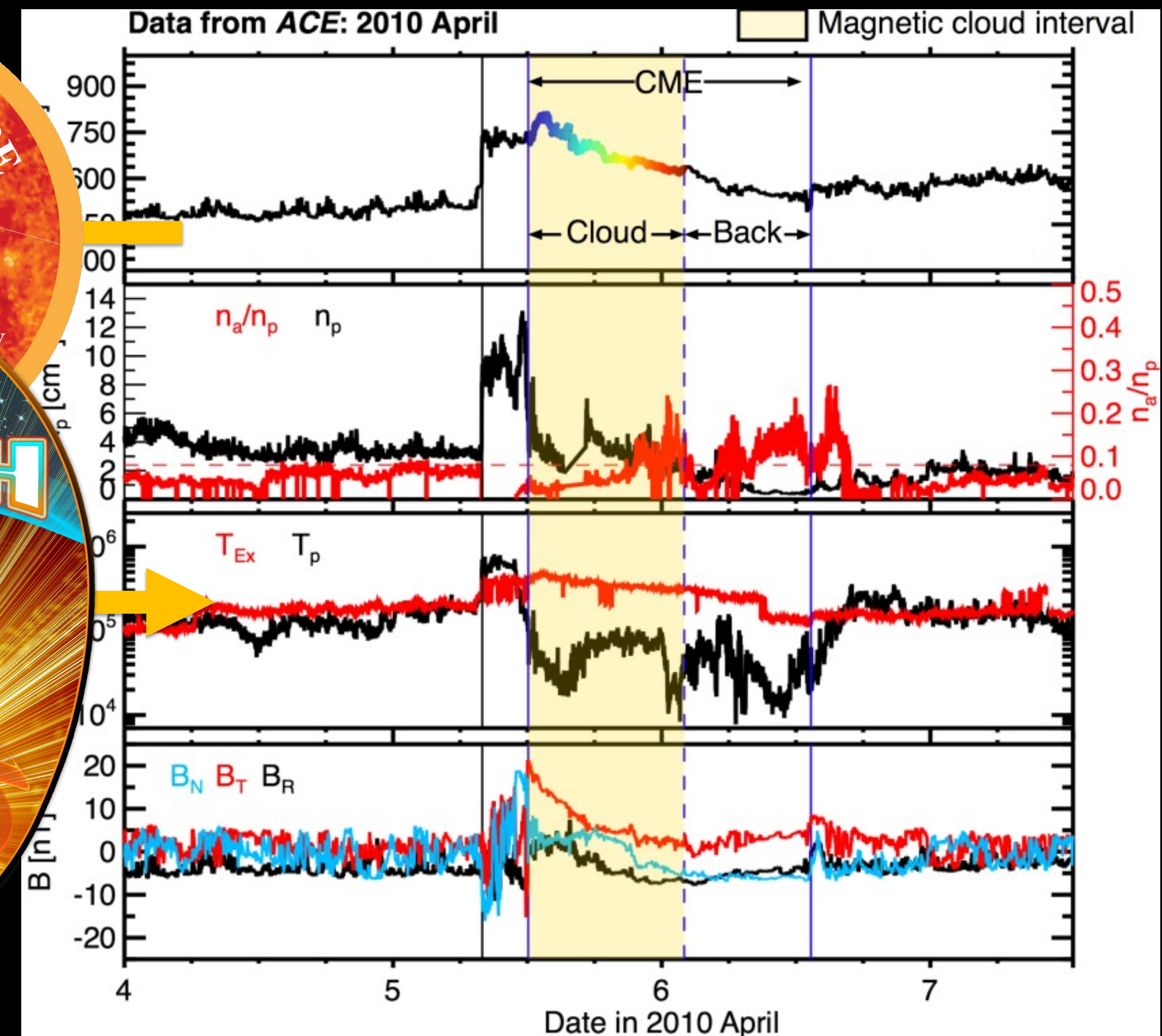
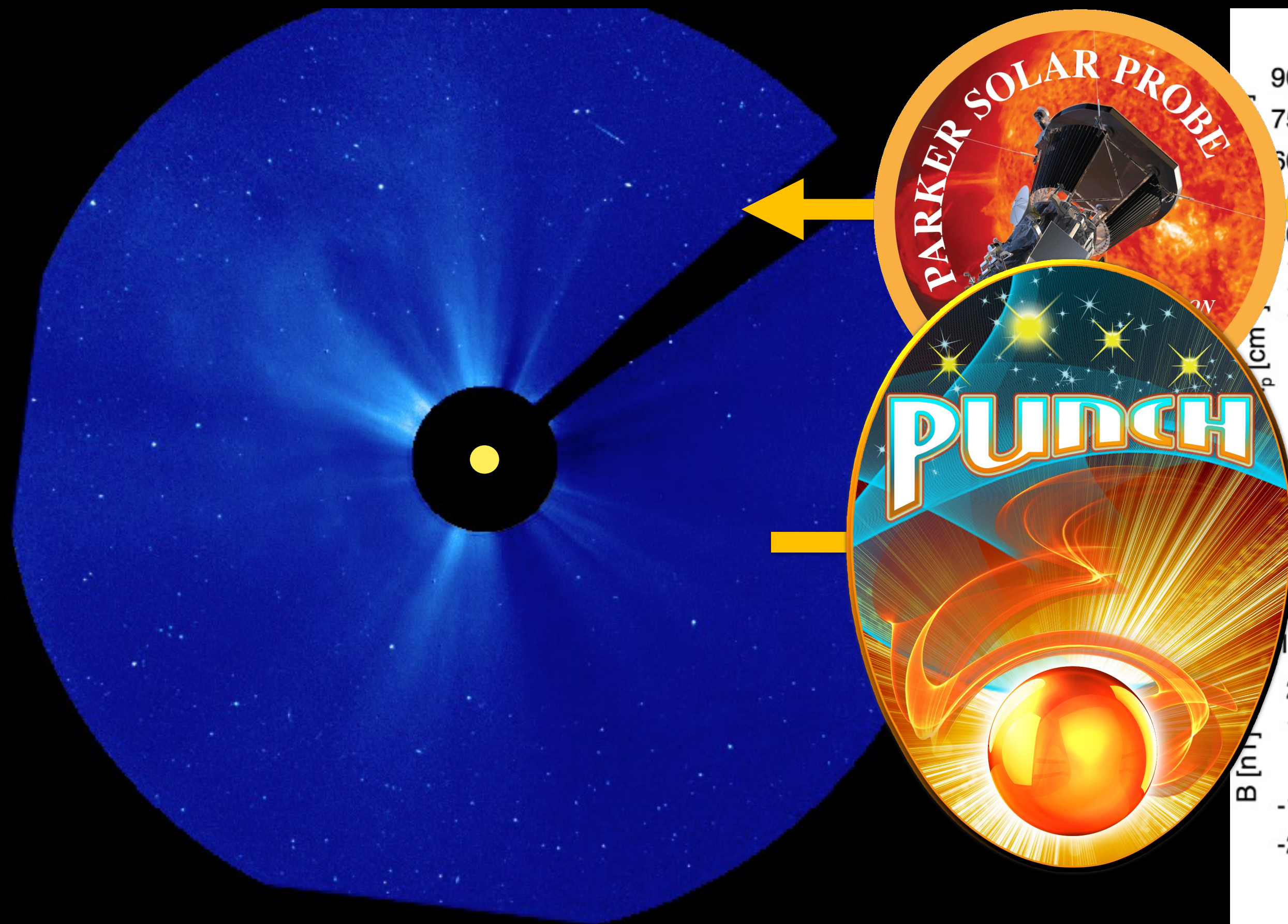
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WHAT IS PUNCH?

GOAL: To understand how the corona gives rise to the heliosphere and solar wind

APPROACH: direct, continuous, 3D imaging of the entire inner solar system (up to 45° from Sun)

DATA: polarized visible-light images

STRUCTURE:

- four smallsats
- 620km sun-synchronous polar orbit
- two year mission launches Spring 2025

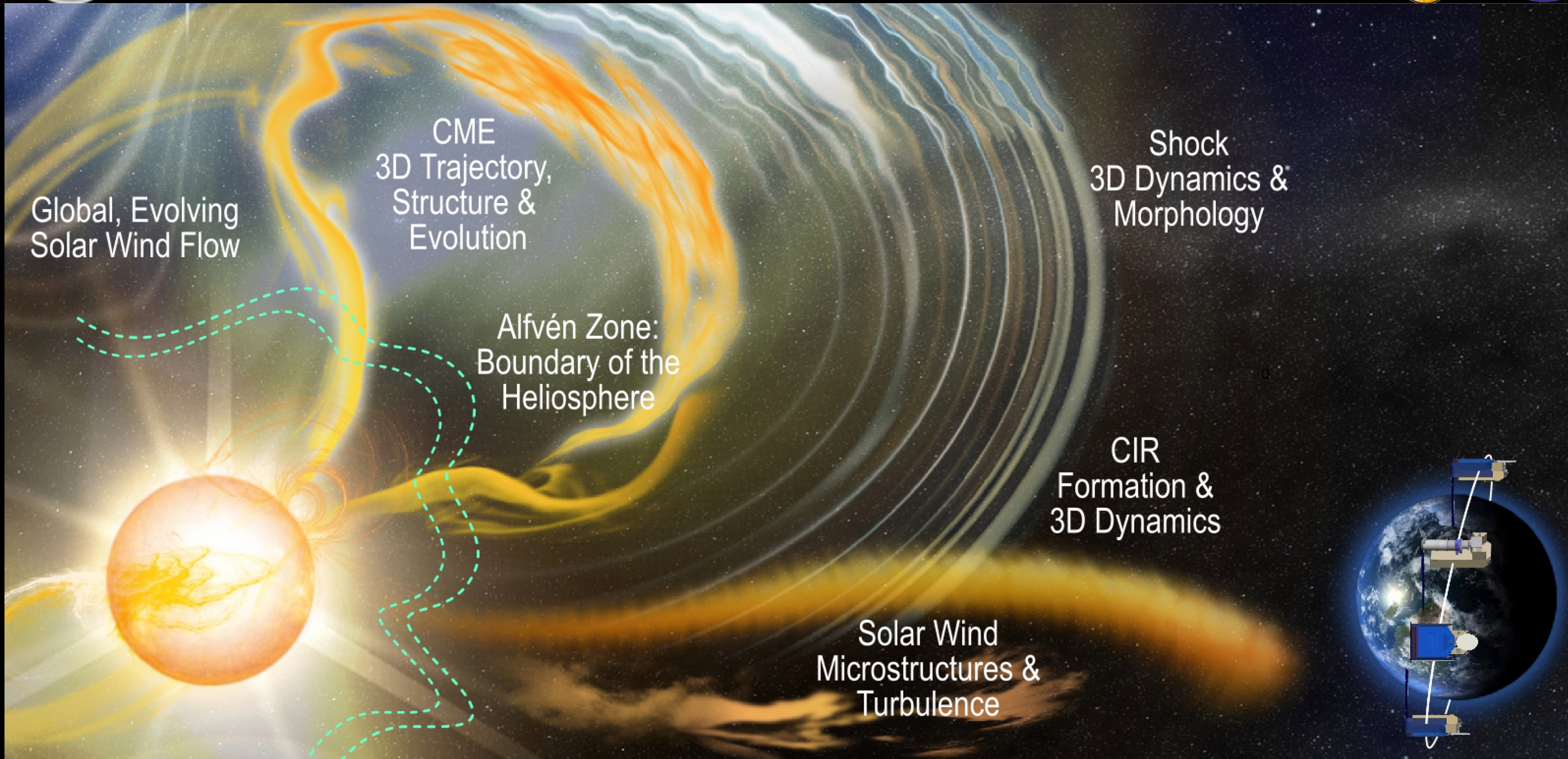
STATUS: Phase C/D (Assembly, Integration, Test)

NEXT MILESTONE: Pre-Environmental Review
Sep 2023



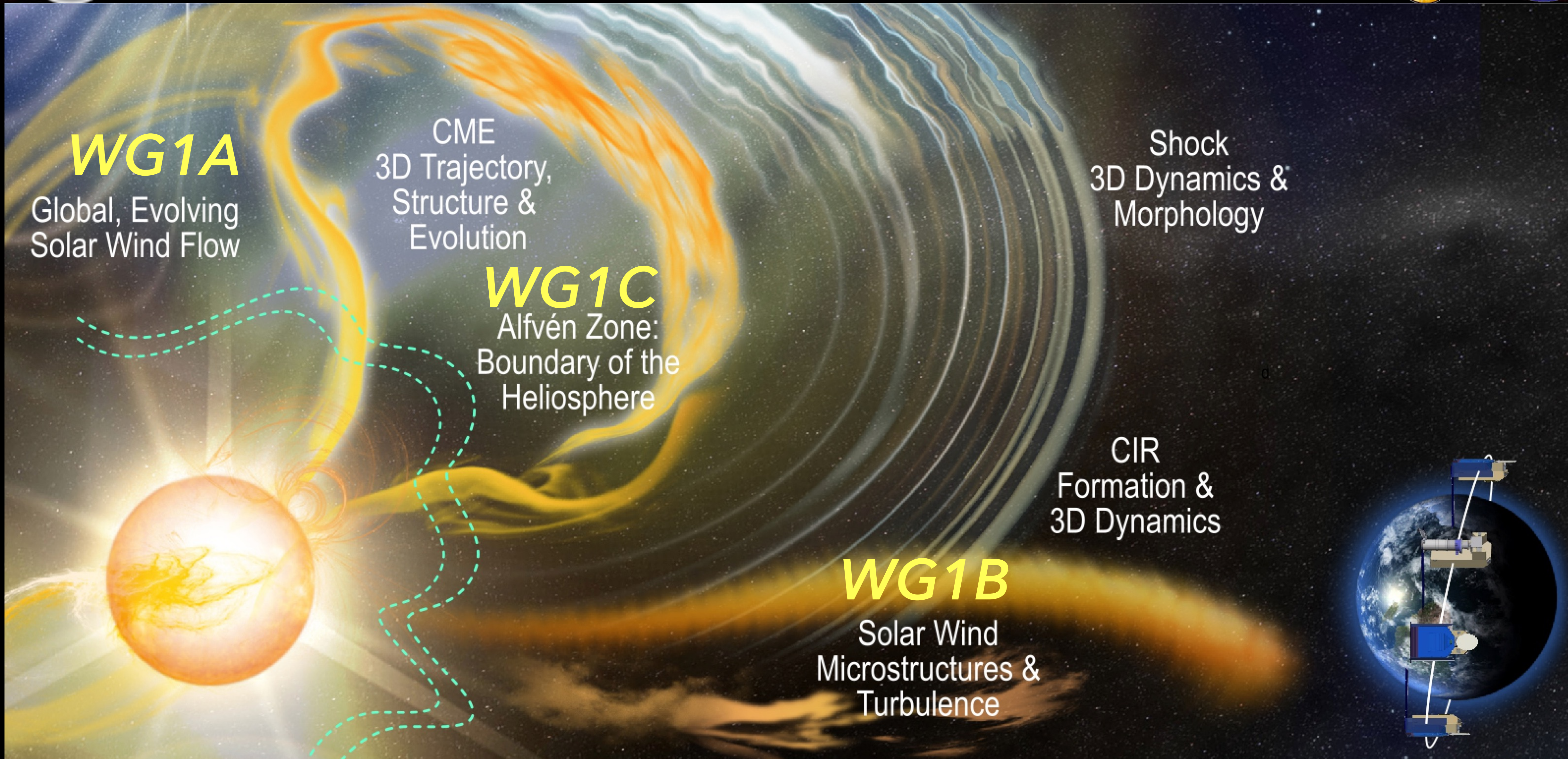


PUNCH Science: Focused on Unification



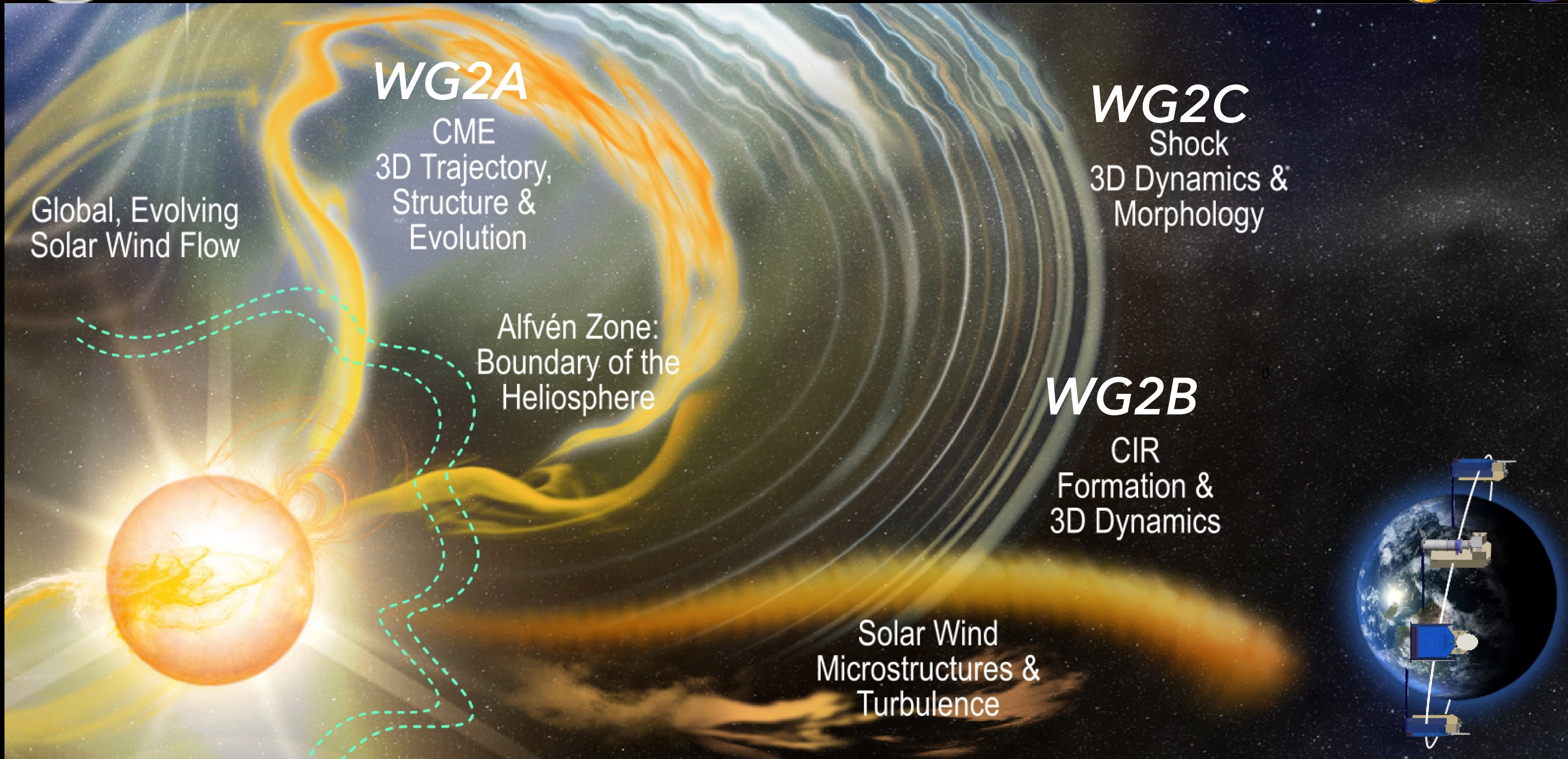


PUNCH Science: Focused on Unification



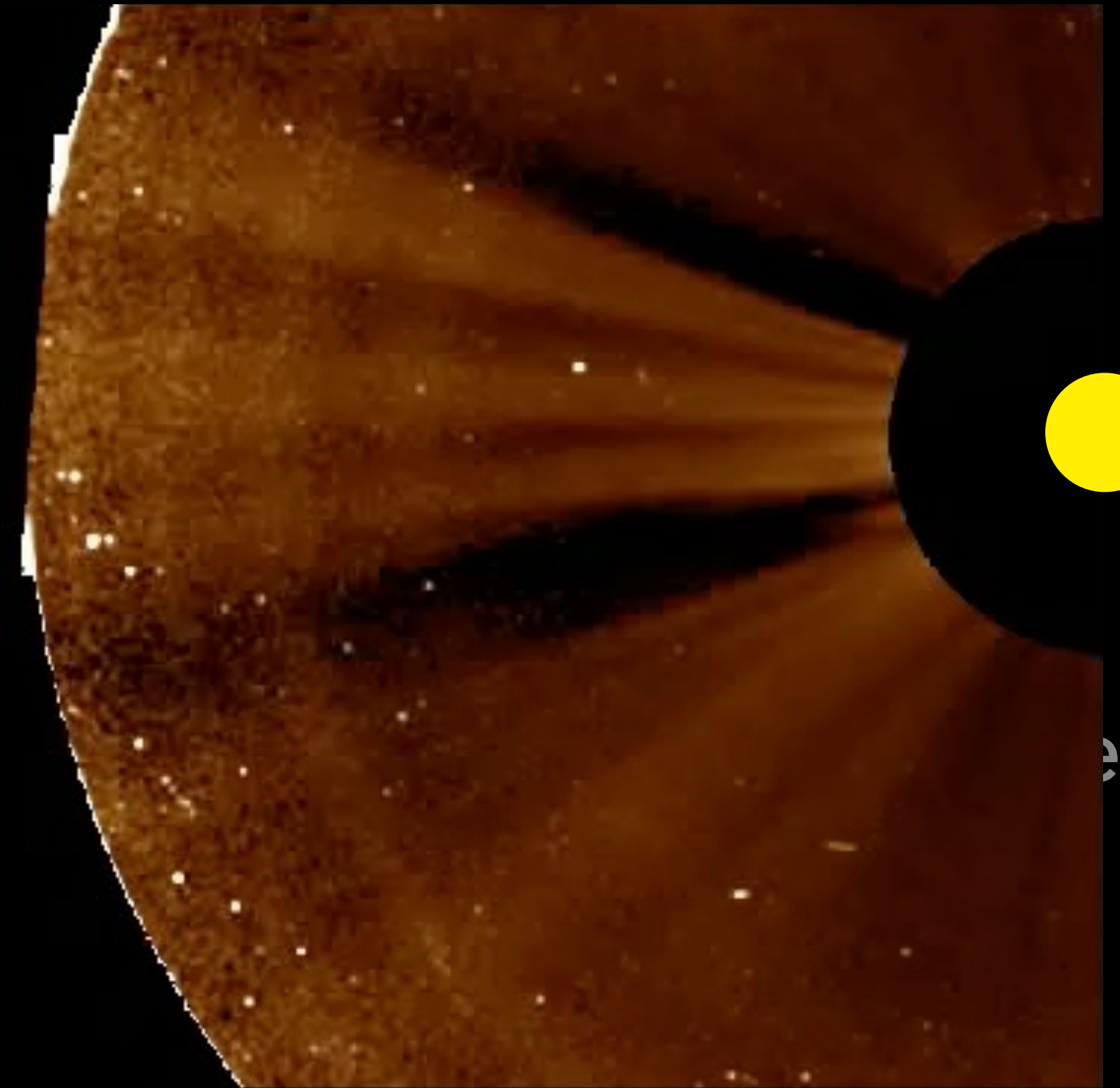


PUNCH Science: Focused on Unification





PUNCH will reveal the shift from corona to solar wind



STEREO/HI-1:

Isotropic/unstructured blobs with weak, fading radial structure

$\beta=1$ surface?

Alfvén surface?

STEREO/COR2:

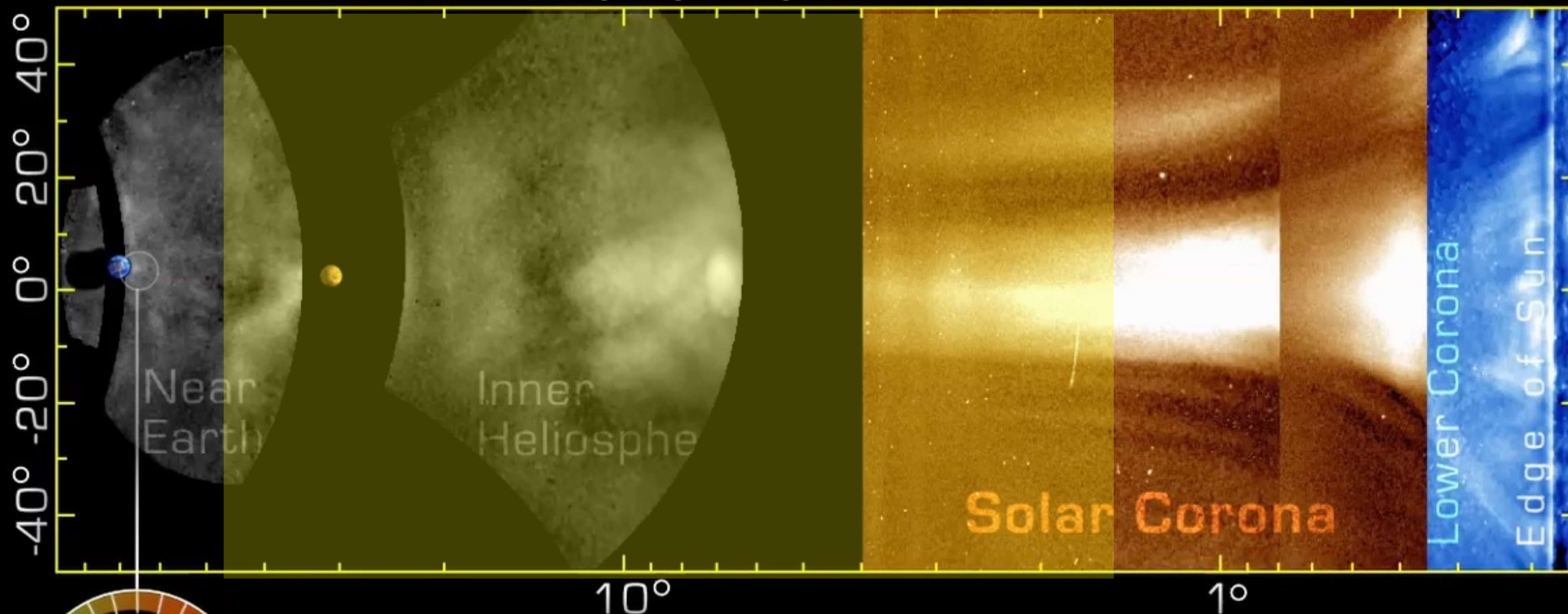
Striated/structured corona with small flowing blobs & puffs



PUNCH will track wind features across the solar system



PUNCH FOV



STEREO-A: 12/11/08 12:40:00 AM



What's new with PUNCH?



Wide, continuous FOV: 5-180 Rs radius, 360° P angle

High sensitivity: 30x improvement vs. legacy instruments

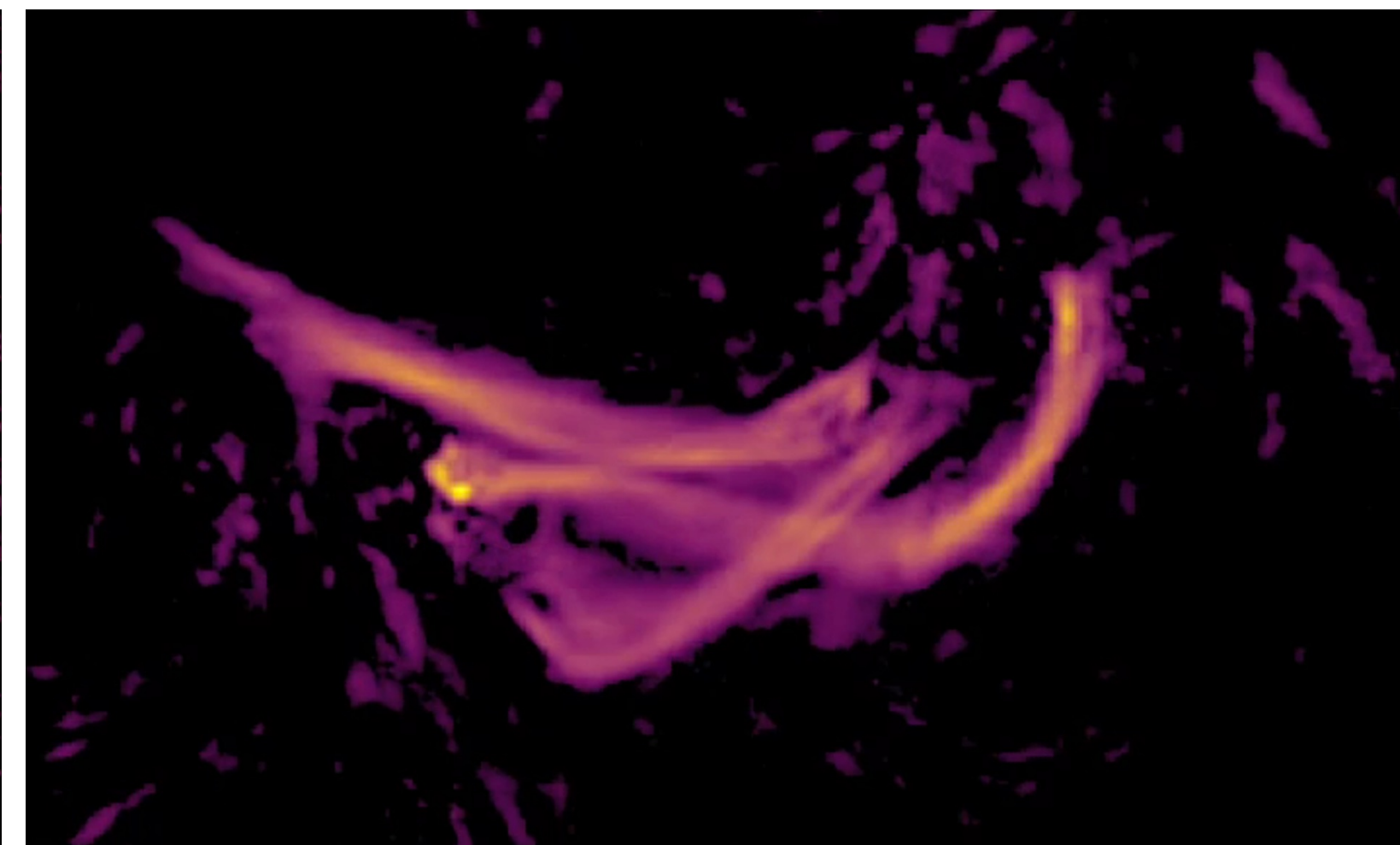
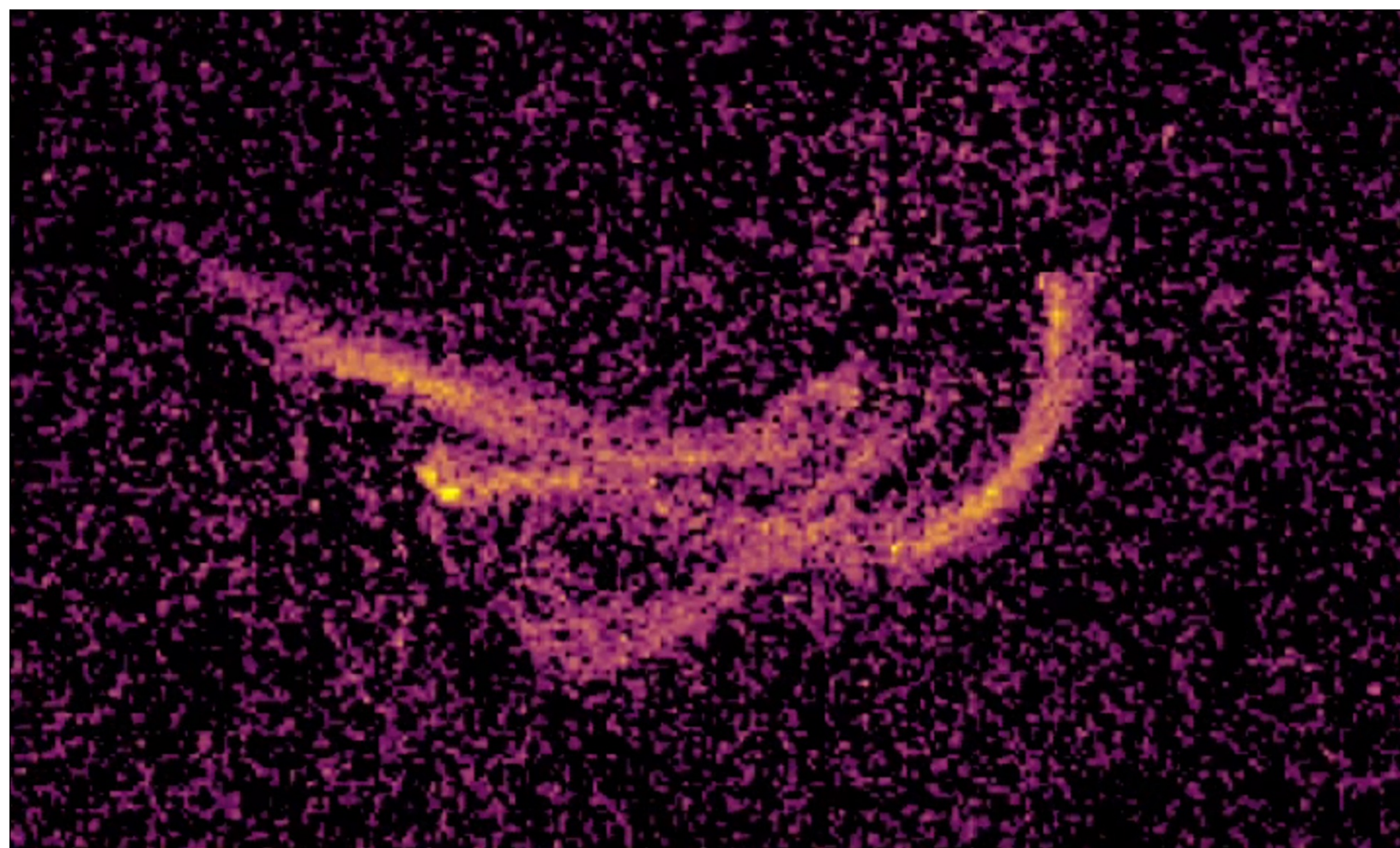
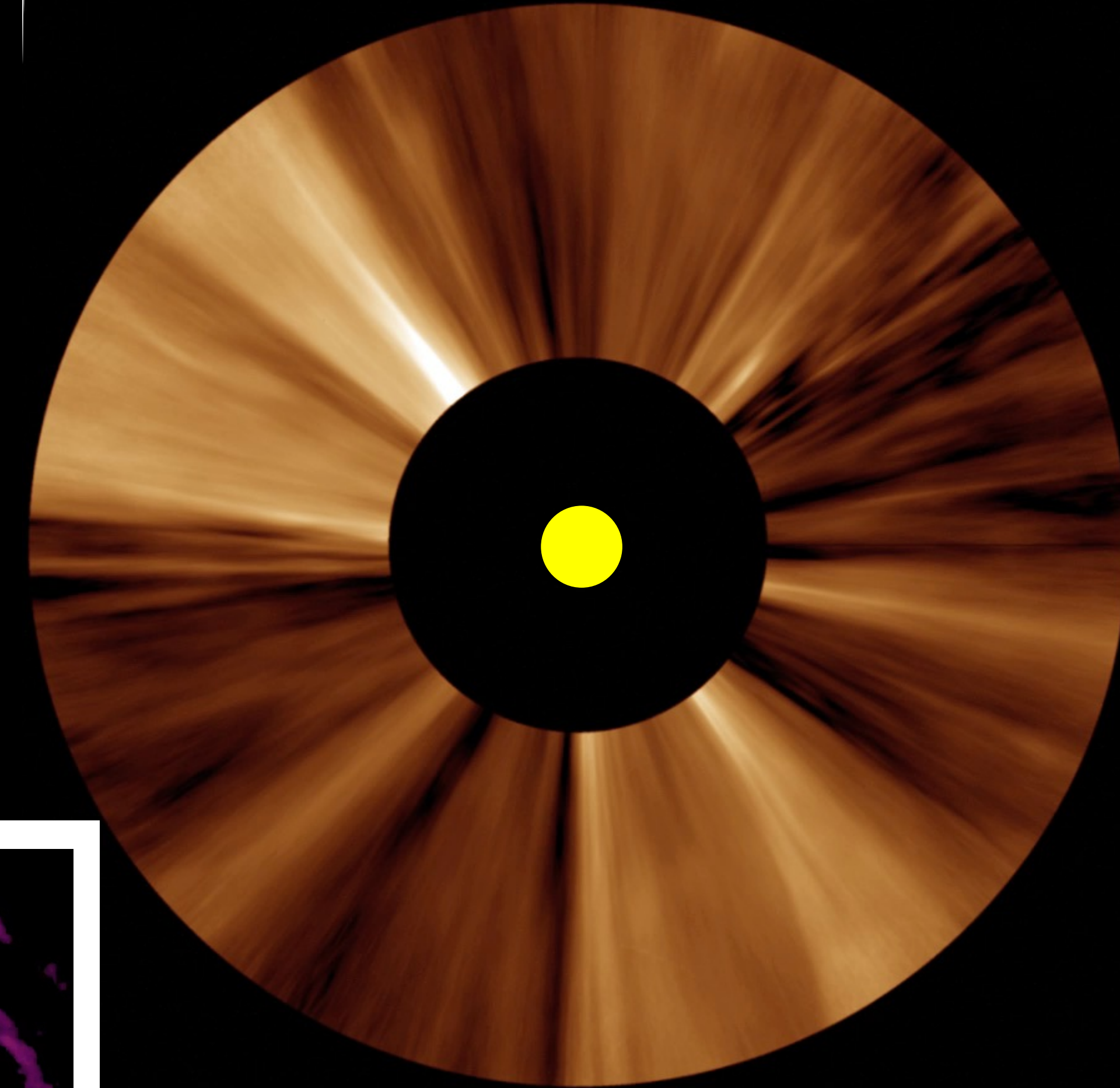
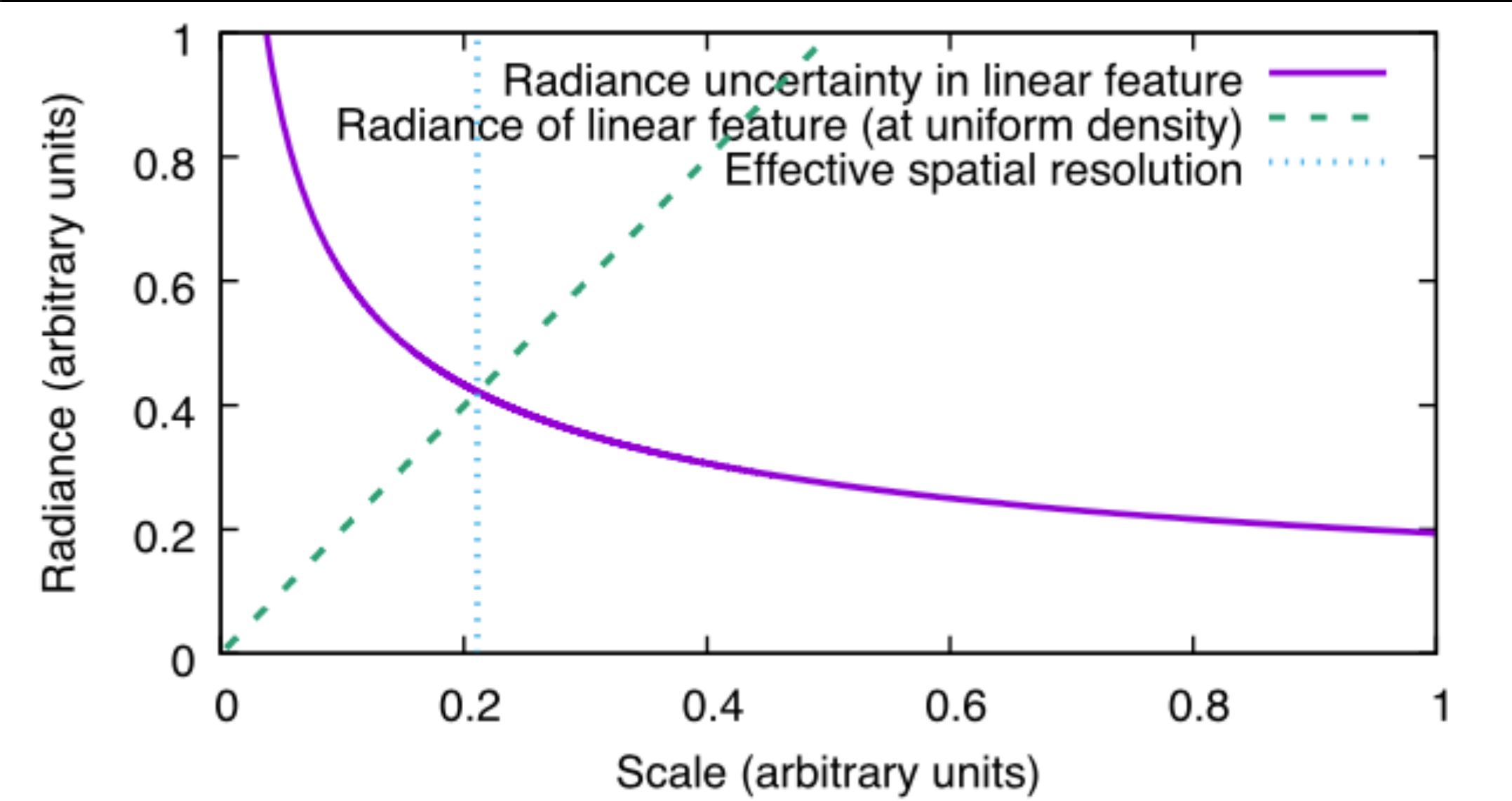
High resolution: ≤ 3 arcmin (optical) across full FOV.
- (3x-20x improvement vs. legacy instruments)

High cadence: 4 min throughout mission
- (3x-30x improvement vs. legacy instruments)

Polarization: Polarimetric data (B, pB) for 3-D imaging
- New capability outside 30 Rs!



Lower noise gives better resolution

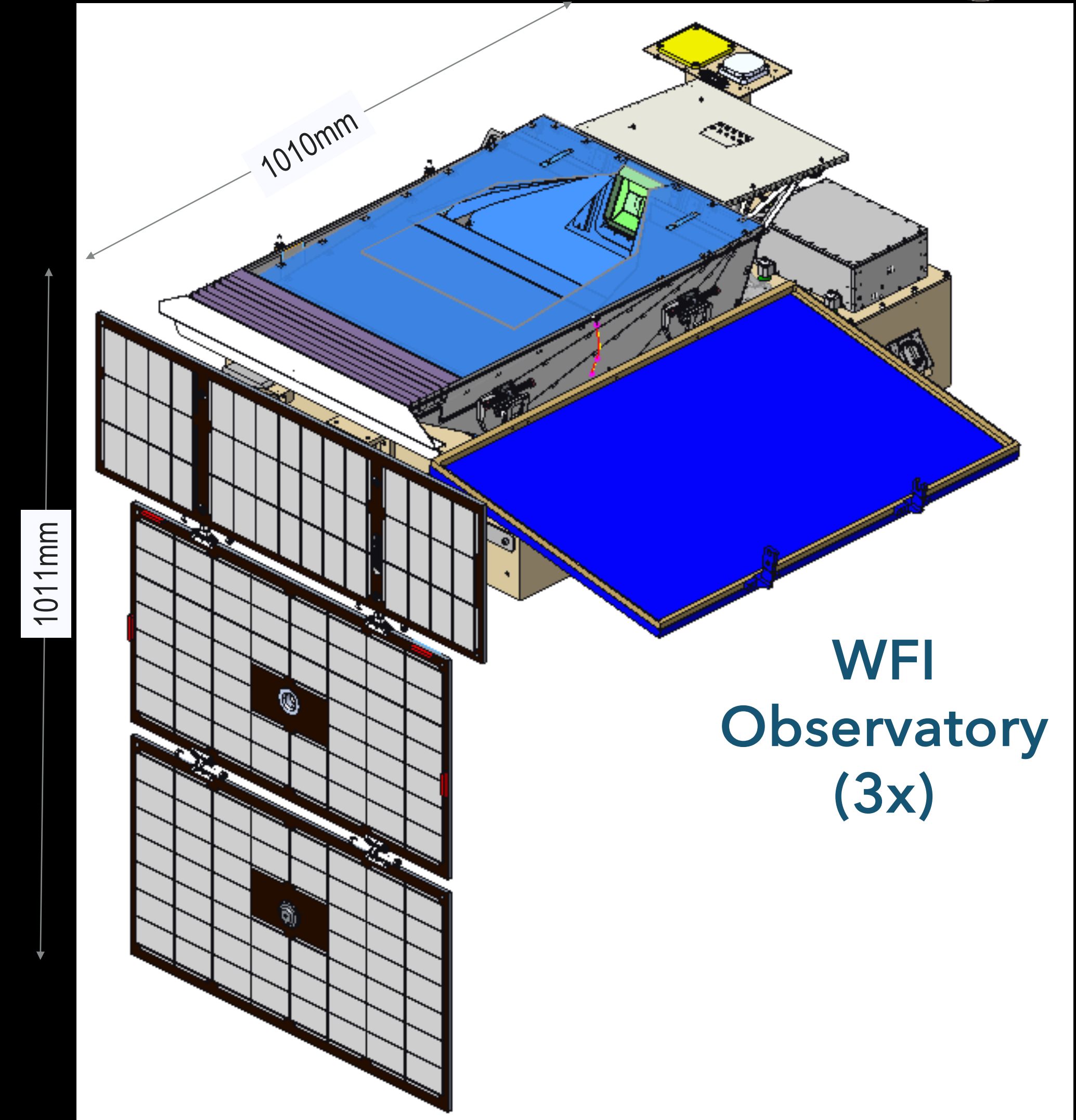
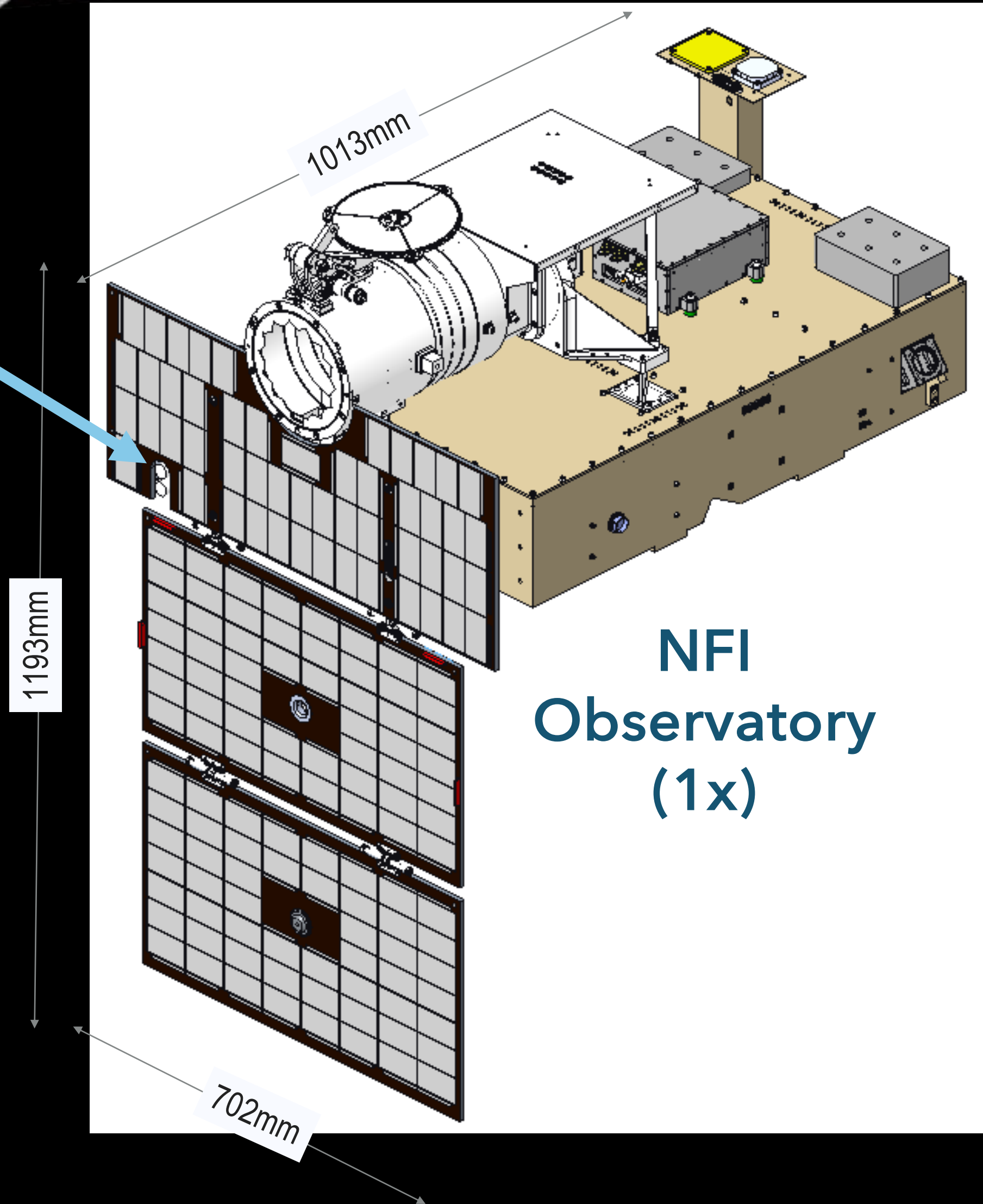




PUNCH Observatories



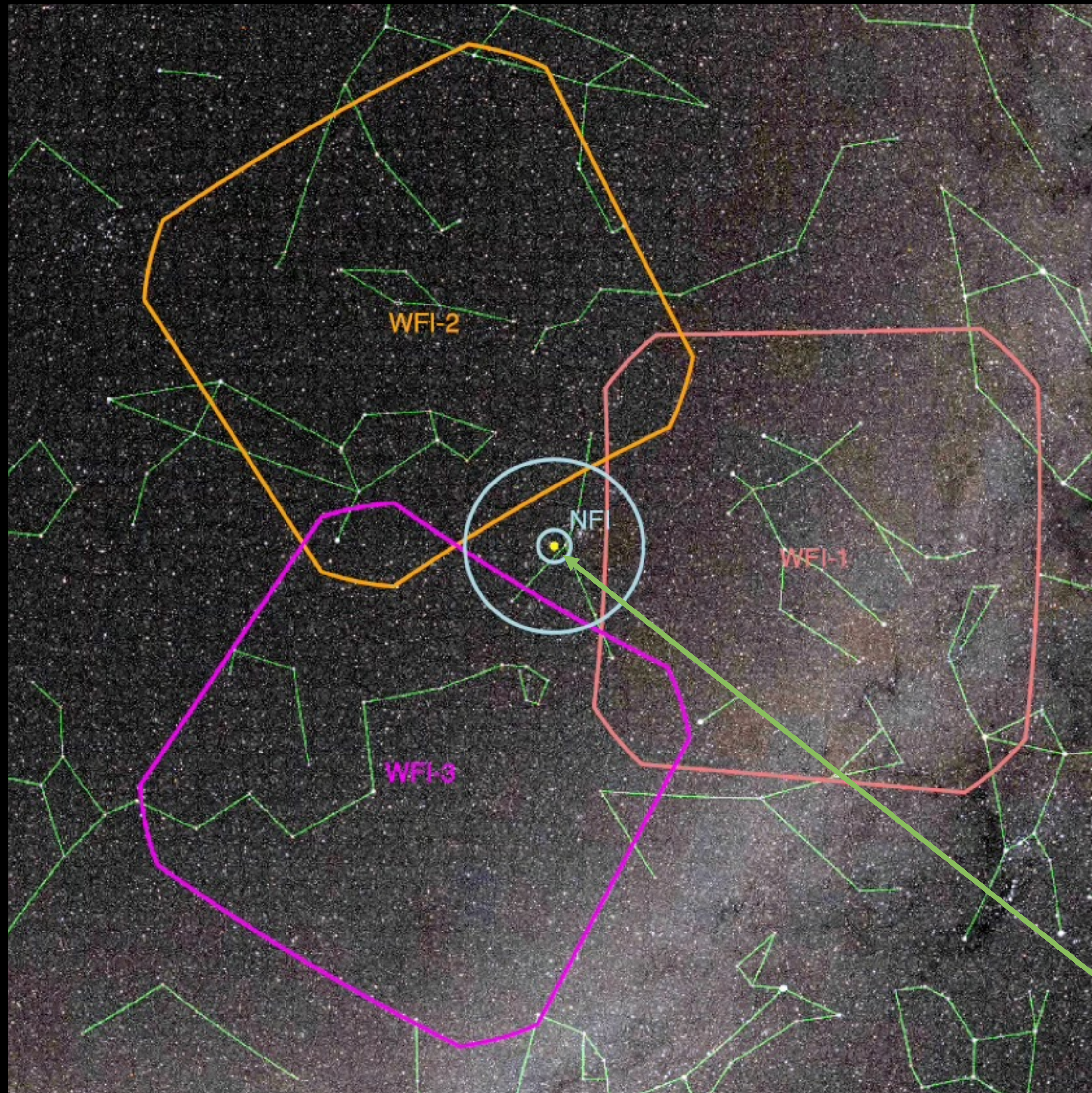
STEAM



Each PUNCH spacecraft carries one primary instrument; the spacecraft are interchangeable.

HOW DOES PUNCH WORK?

PUNCH MERGES IMAGES TO CREATE A SINGLE LARGE FOV

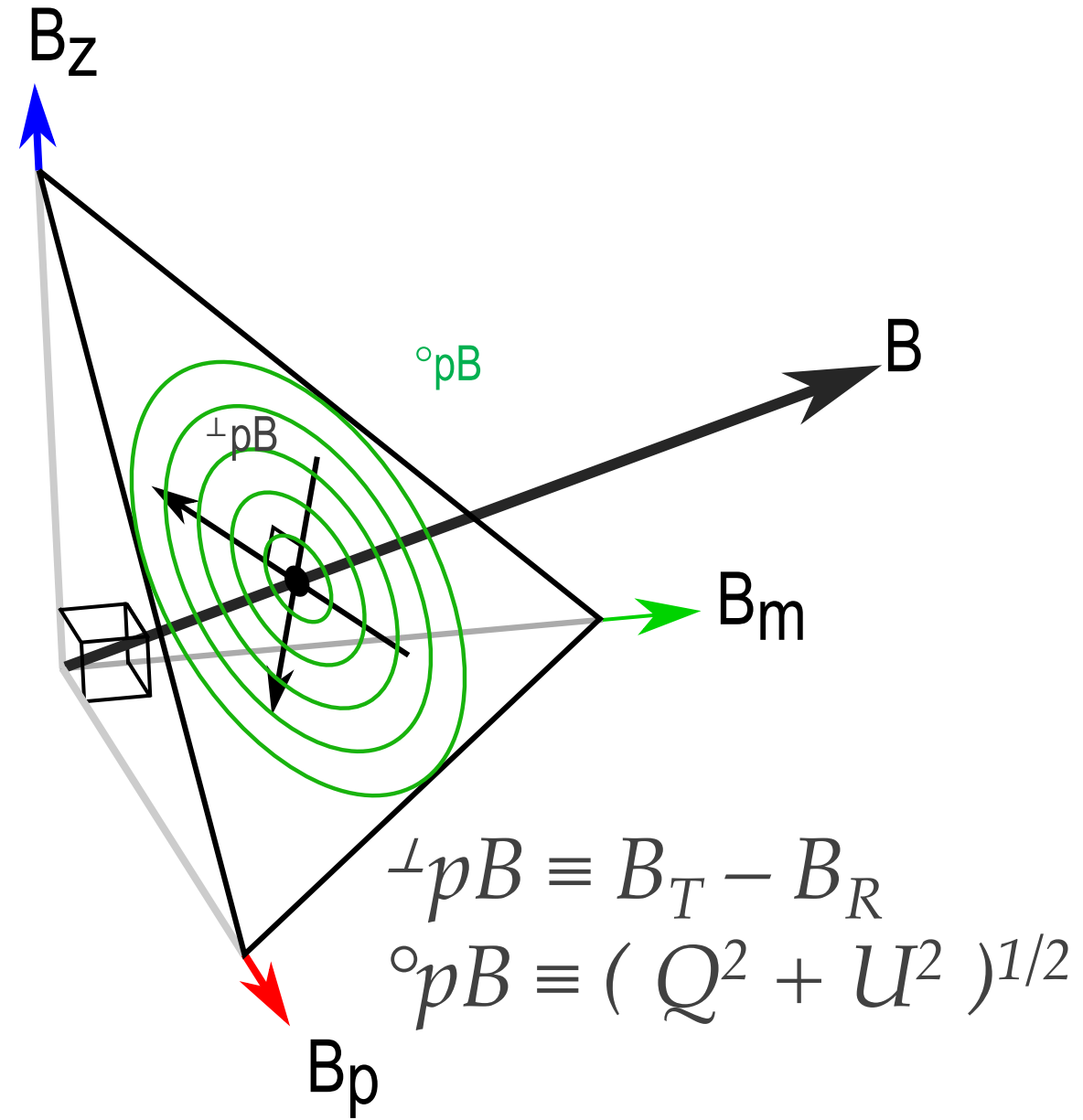


- Exposures are combined on the ground.
- Image characteristics are matched.
- L2/L3 data: B & pB images from a single “virtual instrument”.

Sun

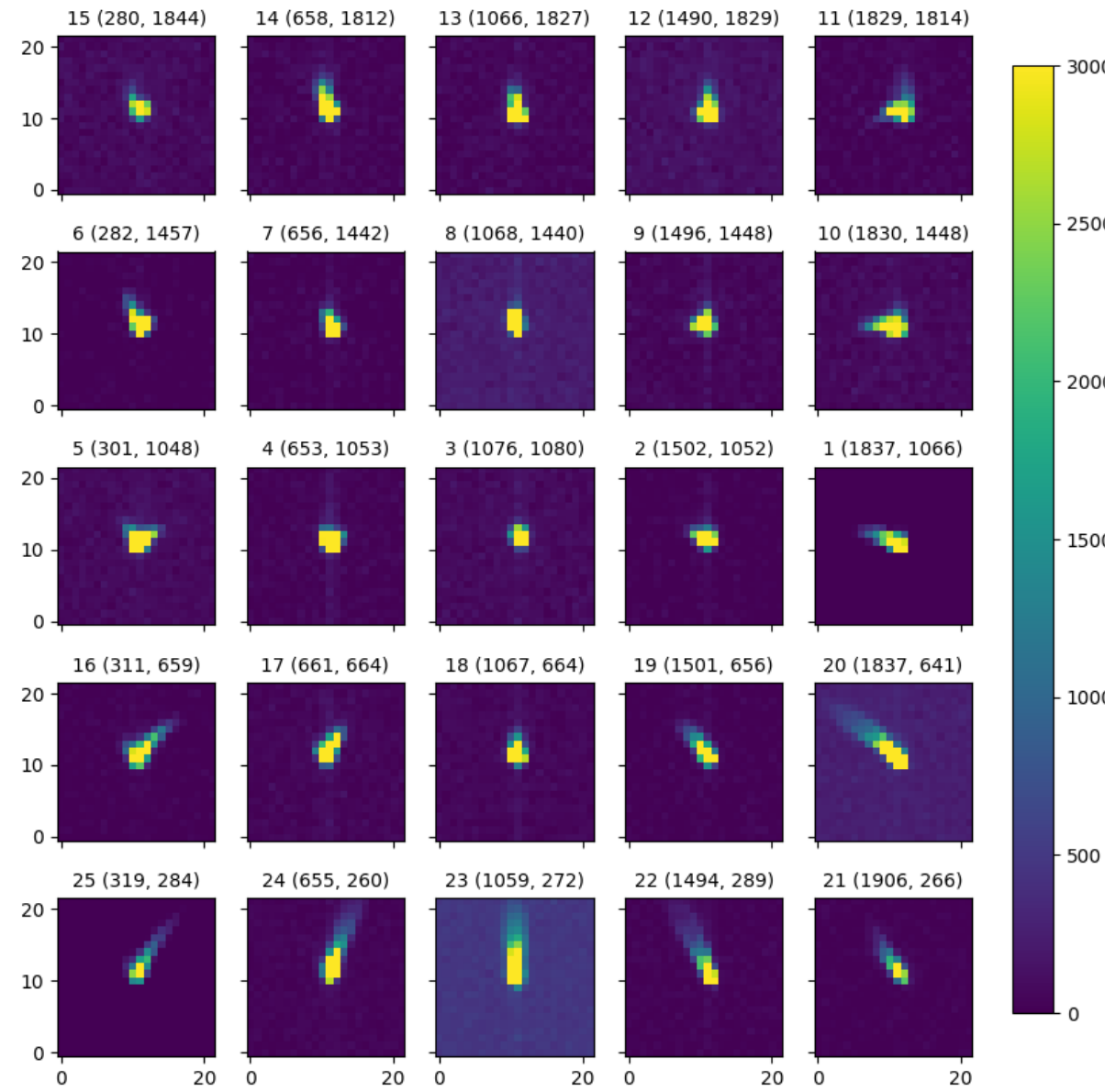


SOC Data product development: more than meets the eye

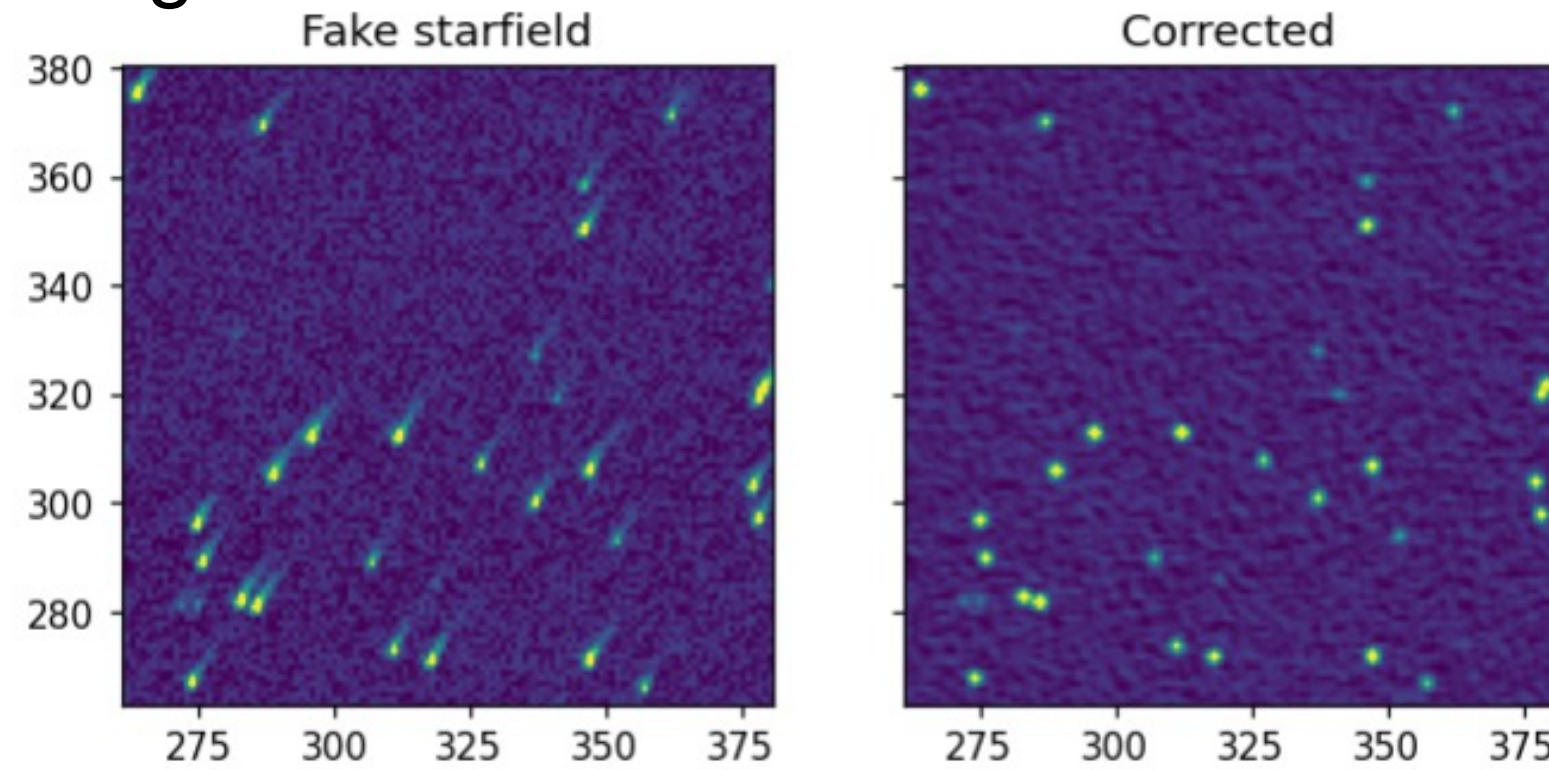


Polarization: old theory,
new analysis, new methods

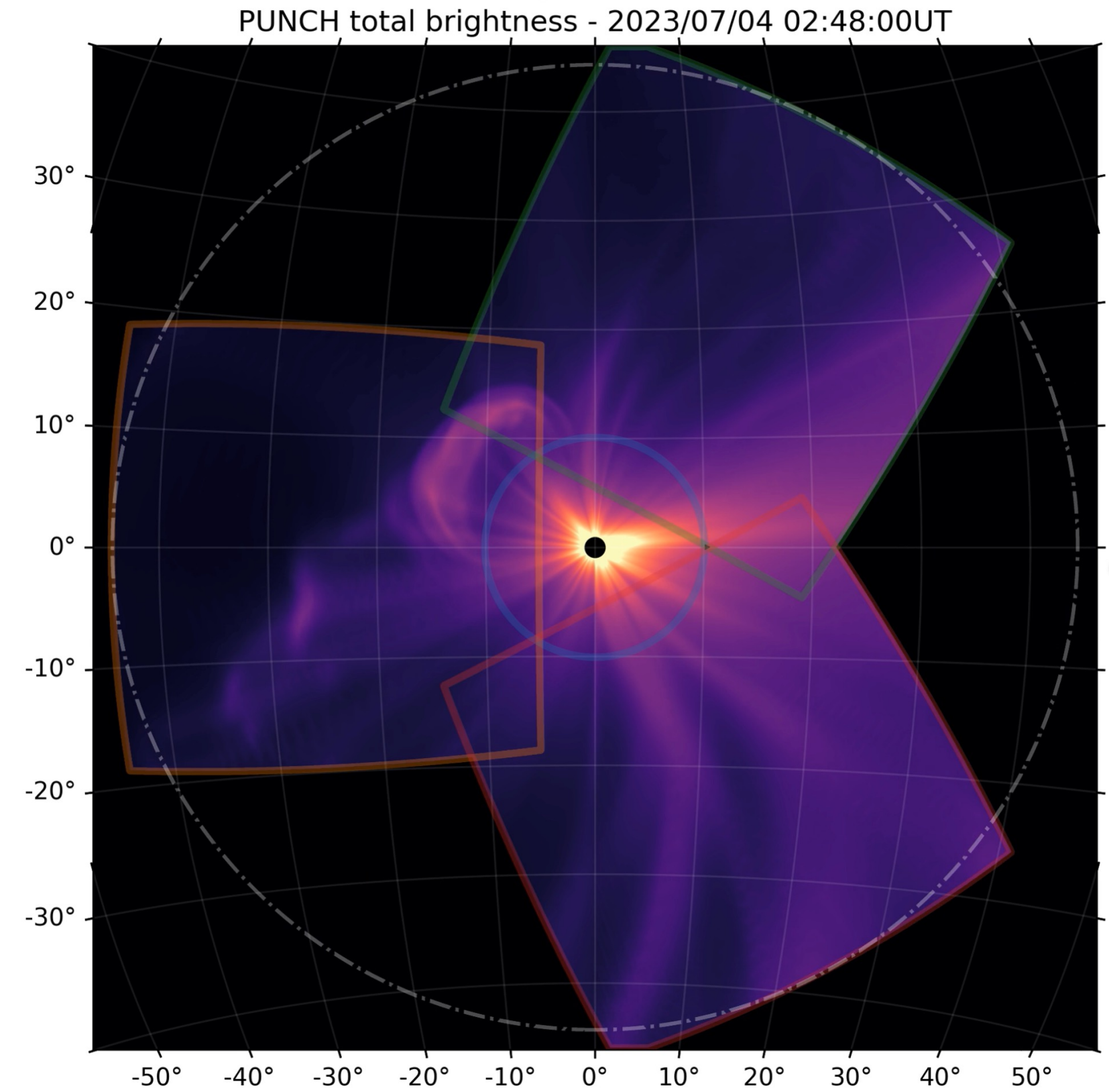
Details:
DeForest et al. 2022 (ApJ);
Patel et al. 2023 (in work);
Gibson talk (upcoming)



PSF regularization enables seamless mosaics



Details:
Hughes et al. 2023 (ApJ);
Hughes poster (this meeting)



SOC is producing
forward-modeled PUNCH mosaics

Model: Elena Provornikova
Coding: Chris Lowder
Seaton SOC talk (upcoming)



PUNCH Outreach Program



PUNCH Public Engagement
Monthly Newsletter Issue 3: Jan 2023
 Shining New Light on Diverse Views of the Sun
 with our Ancient & Modern Sun-Watching Theme

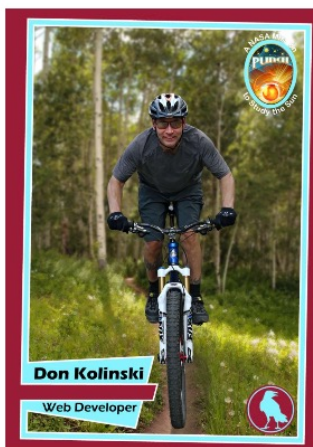


Did You Know?

PUNCH science is aimed toward sparking a revolution in *space weather* monitoring akin to when humanity first began to track terrestrial storms like hurricanes using Earth-observing satellites? Earth-orbiting PUNCH spacecraft will track storms from the Sun that can also harm people and property.

PUNCH Team Trading Cards to be Field Tested

PUNCH Outreach is developing a suite of Team Trading cards that represent the diverse community of people and skill sets needed for a NASA mission to succeed. The cards include scientists and engineers as well as other vital mission roles, including financial, administrative, and outreach specialists. The two-sided cards showcase images of PUNCH team members and their answers to carefully designed questions that both inspire STEM learning and evoke social connection with people of all ages.



The Cards aim to offer relatable role models for young people by featuring *both* the expertise and the broader humanity of leading-edge NASA professionals in a light-hearted way. We are field testing digital & physical cards with Girl Scouts, Native American learners, and other partners. Our novel Card activities aim to make NASA careers feel more accessible.

PUNCH Featured at American Meteorological Society

On January 10, PUNCH PI Craig DeForest featured several PUNCH Outreach prototype activities and materials, including the *3-Hole PUNCH Pinhole Projector*, our *Can You 'See' With Your Hands* tactile activity, and our PUNCH Team Trading Cards at the 2023 American Meteorological Society meeting in Denver. If you would like to be notified when PUNCH Outreach products become broadly available, please let us know at tinyurl.com/PUNCHOutreachProducts.



Your Solar Photo of the Month

Every month we feature a photo submitted by readers that portrays a personal experience of the Sun. Get creative and multi-sensory! See the bottom of page for submission info.

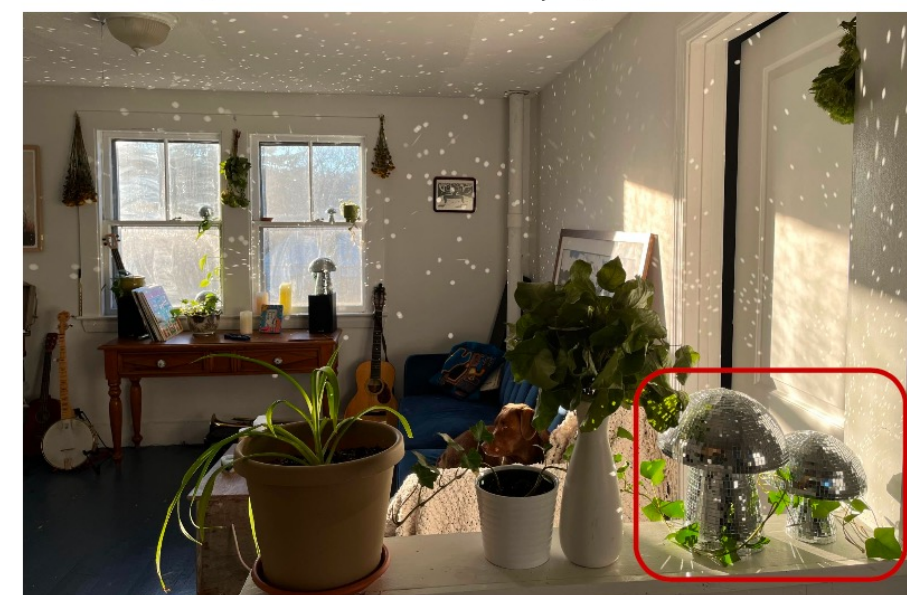


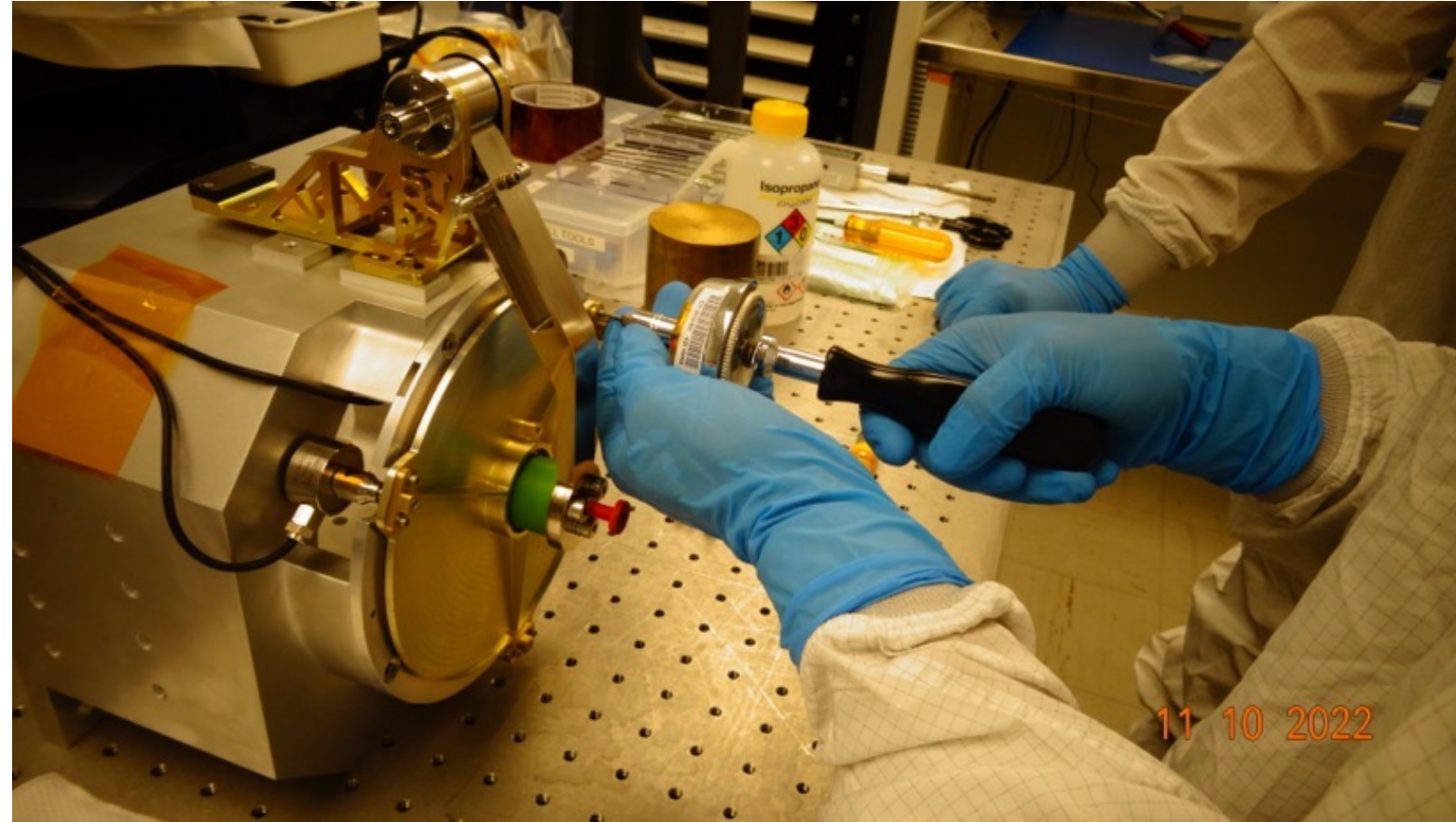
Photo by Nina Byers

This room is adorned with sunlight reflected from two mushroom-shaped disco balls (lower right) whose surfaces are covered with tiny square mirrors. Note the *square* shapes of light on the wall close to the mushrooms, and the *round* shapes on the far wall. The round ones are images of the Sun! Disco balls act similarly to a square-holed pinhole projector.

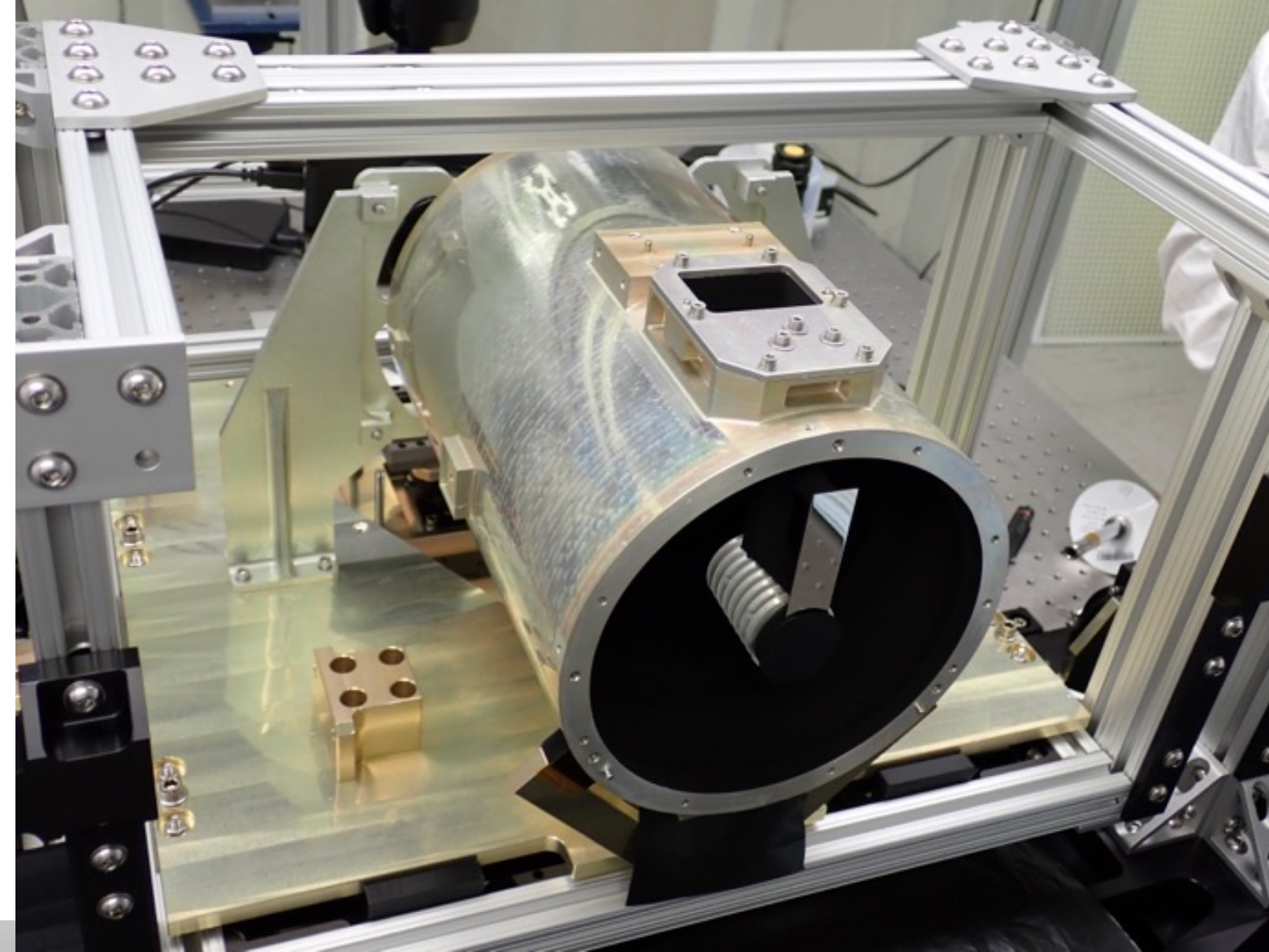
- Focused on under-represented groups in STEM, from the American southwest
- National impact
- Multiple vetted outreach products
- Tied in to many other missions and events



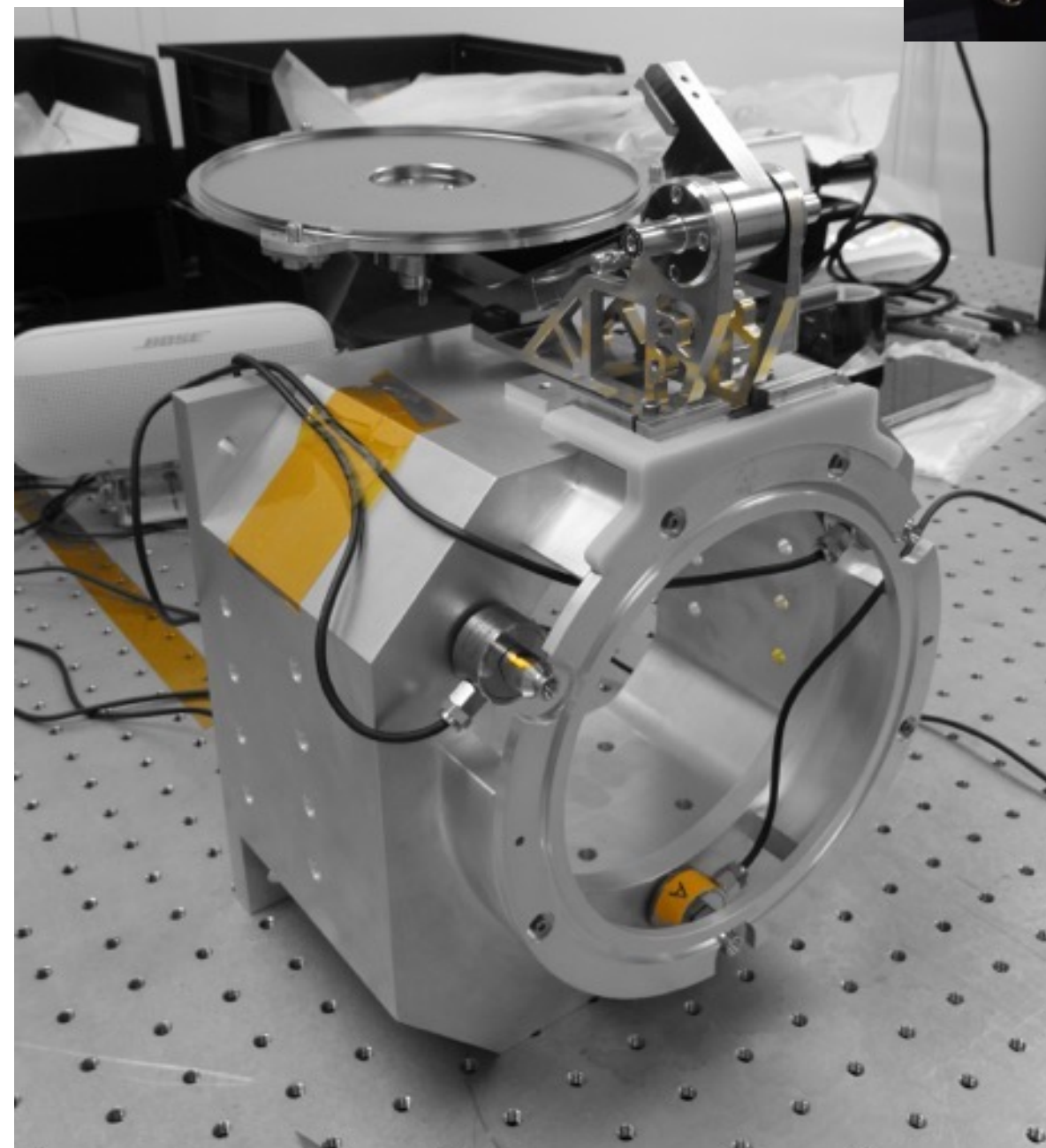
NFI AI&T Is Nearly Complete



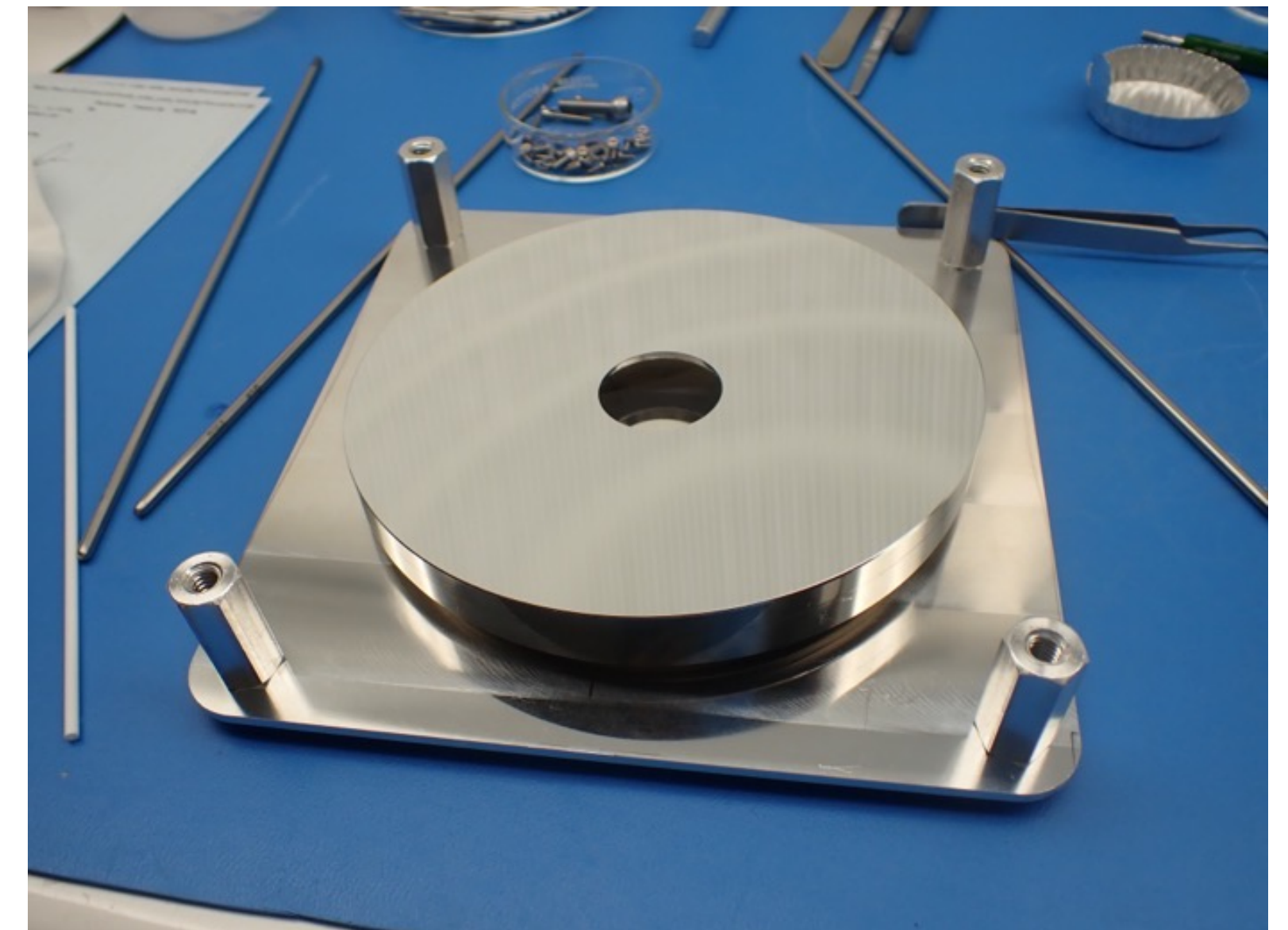
Torquing of Door Cone to GSE Force Gauge Interface



Assembled Baffle for HRM Alignment Testing



Assembled Flight Door on GSE Fixture



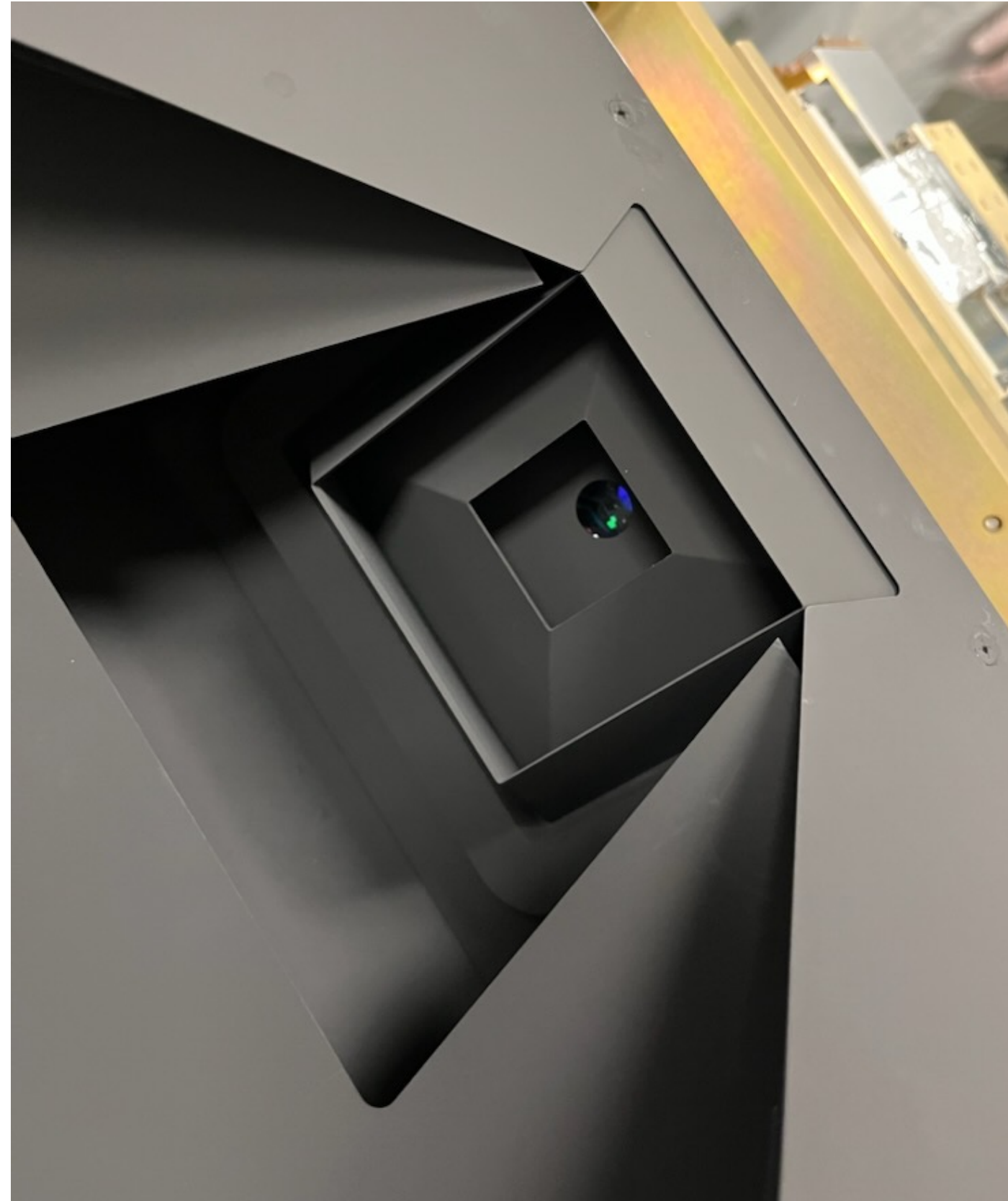
Flight HRM After Helicoil Installation



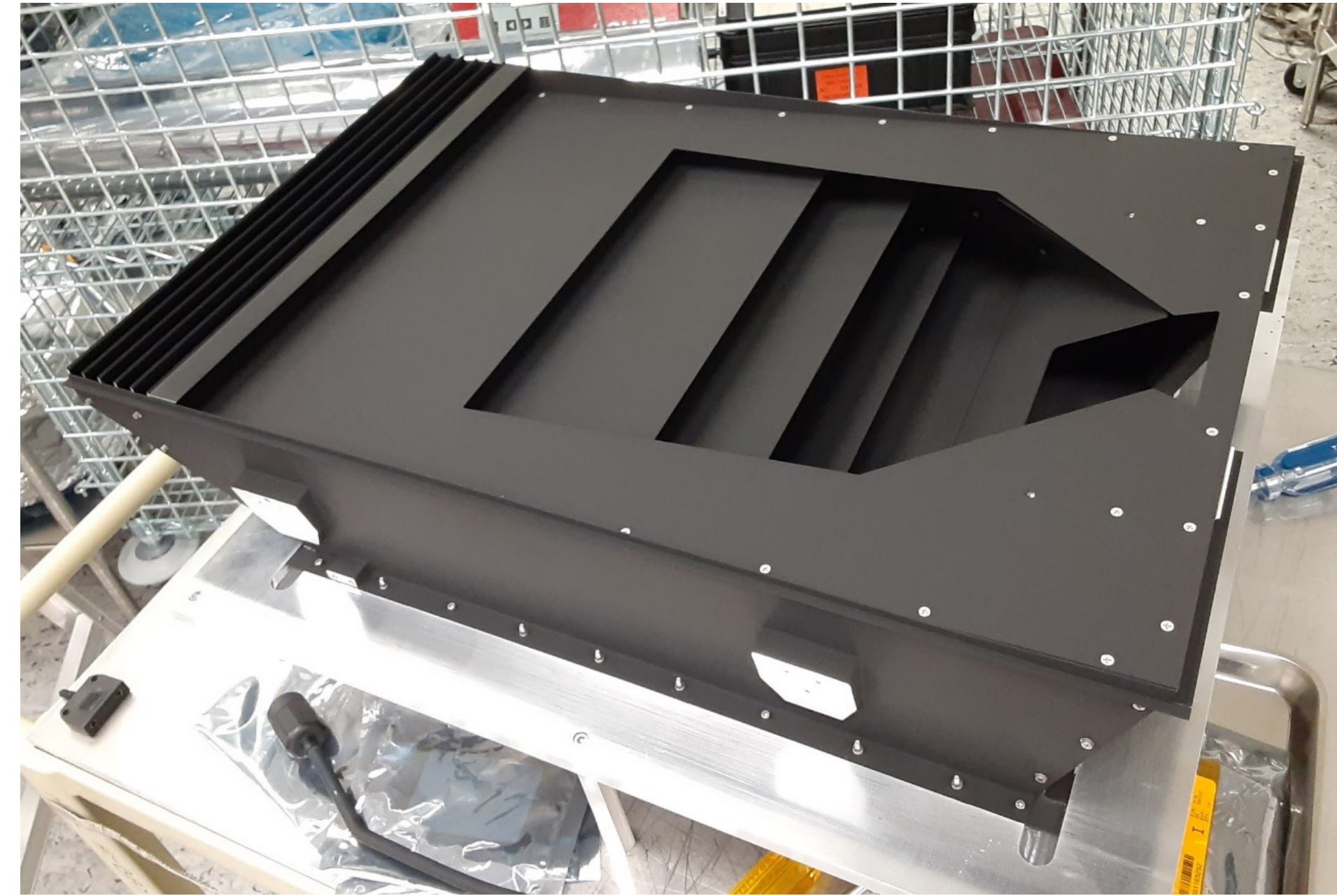
WFI I&T: underway (WFI-2/3: approaching vibe & TVac)



WFI-1 Integration



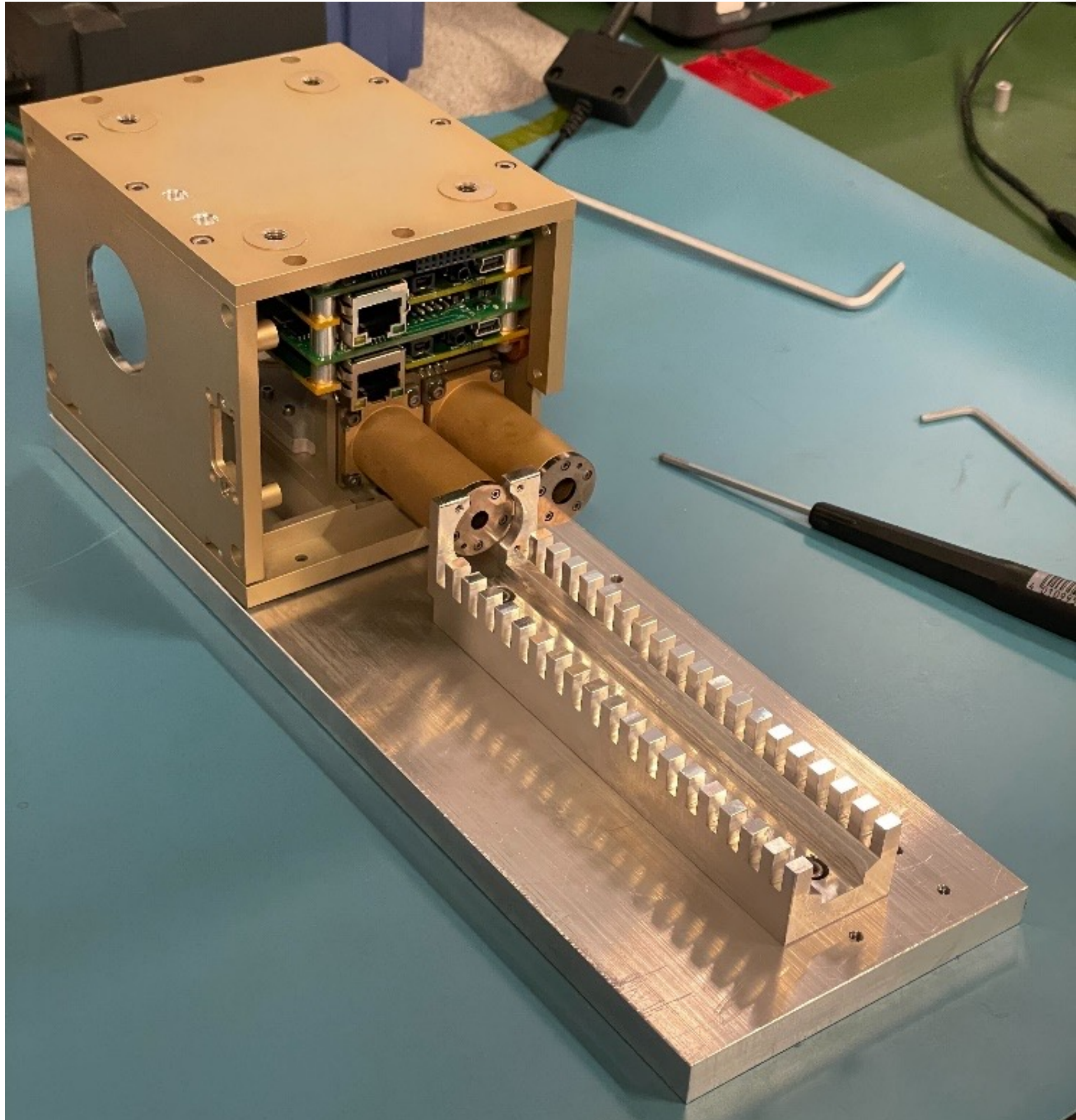
WFI-1 aperture



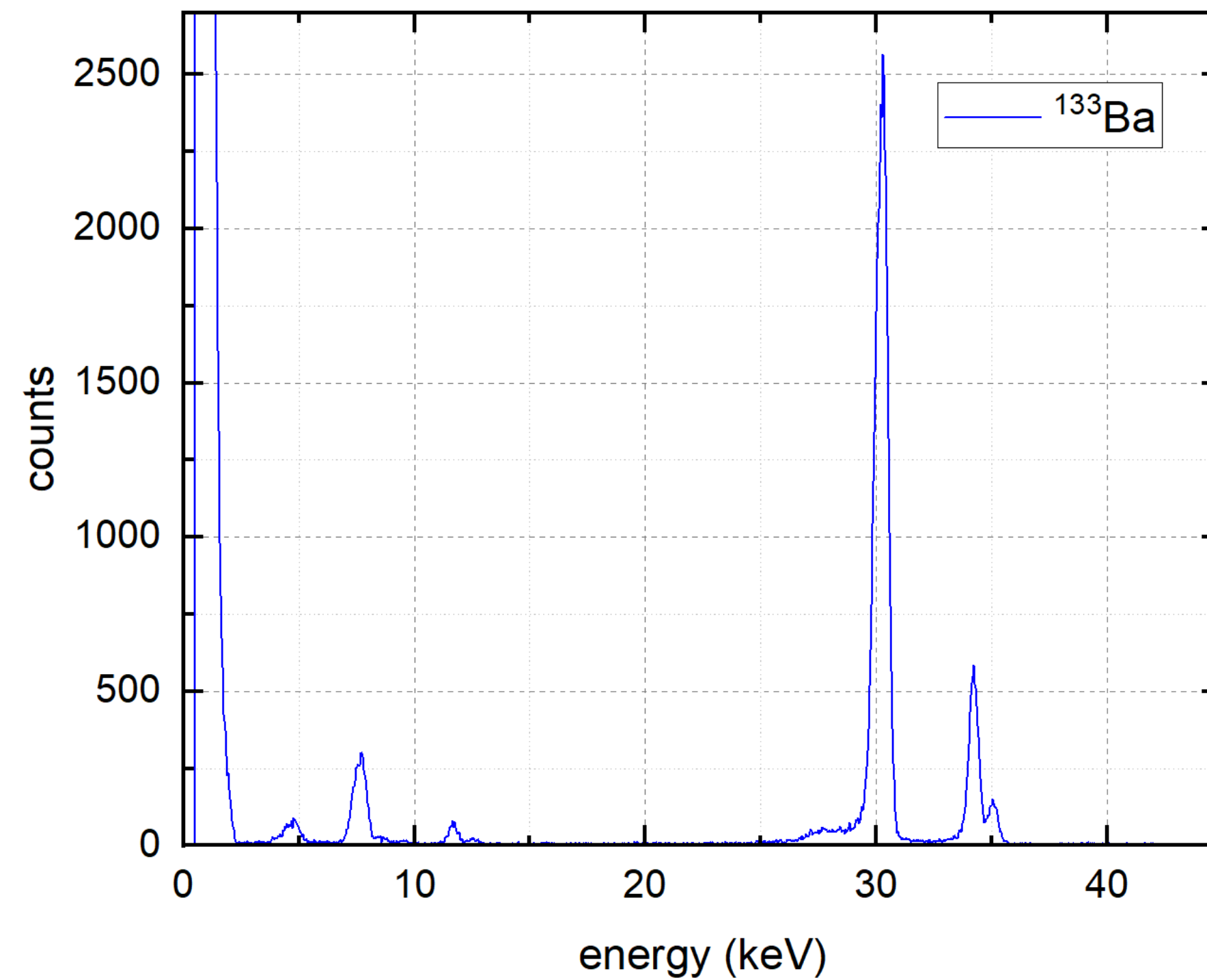
WFI-2 baffle



STEAM progress



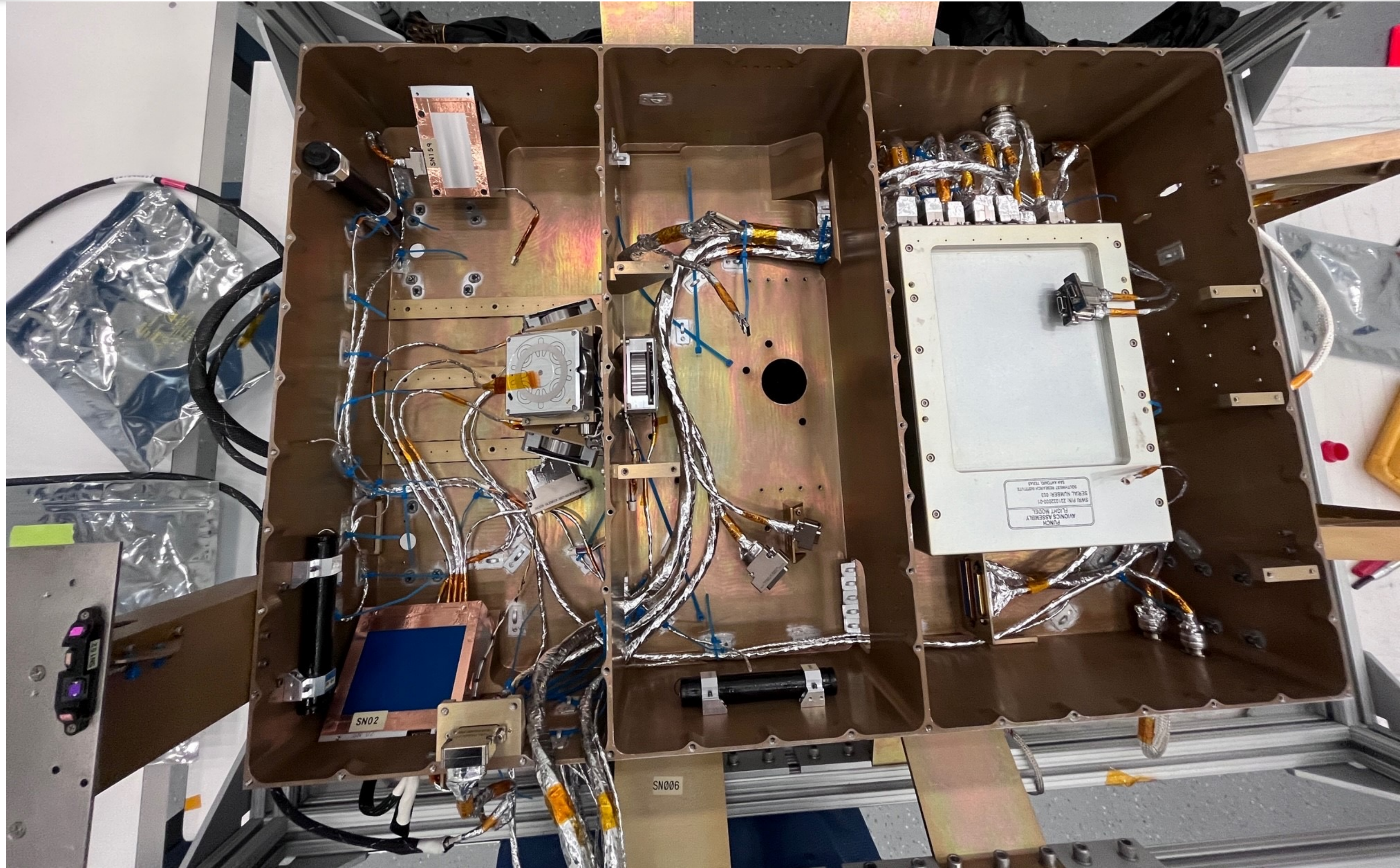
STEAM testing setup
with both spectrometers



Barium
spectrum from
Hard X-Ray
spectrometer
testing



NFI microsat (fleet leader) undergoing integration





PUNCH Status



- PUNCH is in Phase C/D: Integration & Test.
 - Instruments (FM):
 - NFI: In AI&T, nearing delivery
 - WFI (x3): In AI&T; FM2 & FM3 nearing vibe/TVac
 - Spacecraft:
 - Subsystem integration in progress
 - Ground:
 - SOC L1 pipeline substantially complete; L2 pipeline in development
- Launch: April 2025 (Rideshare w/SPHEREx from Vandenberg)
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GO PUNCH!