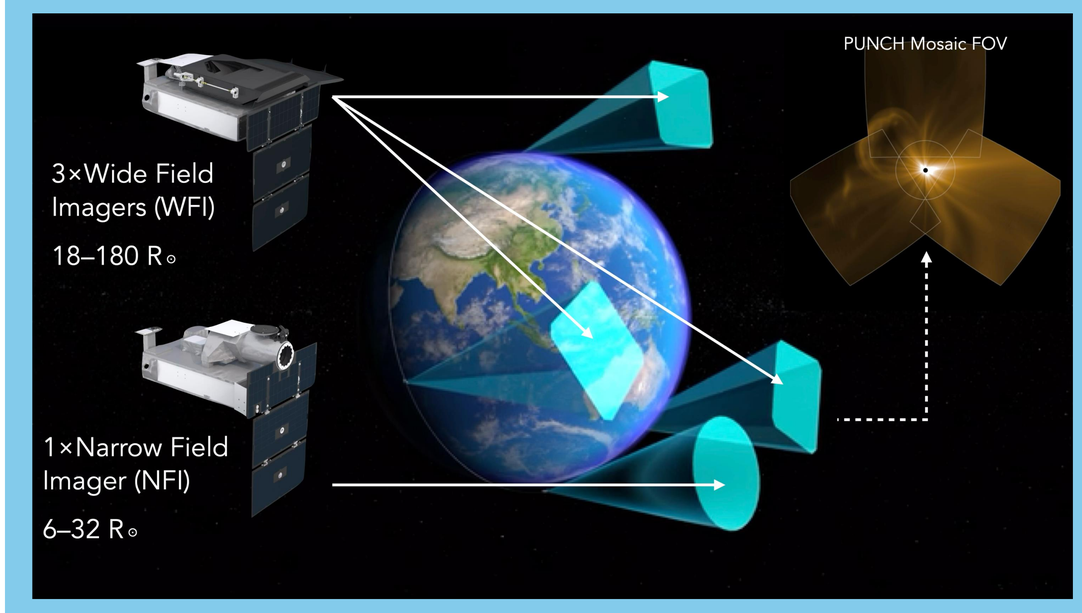
# Space Weather Capabilities of the Polarimeter to UNify the Corona and Heliosphere

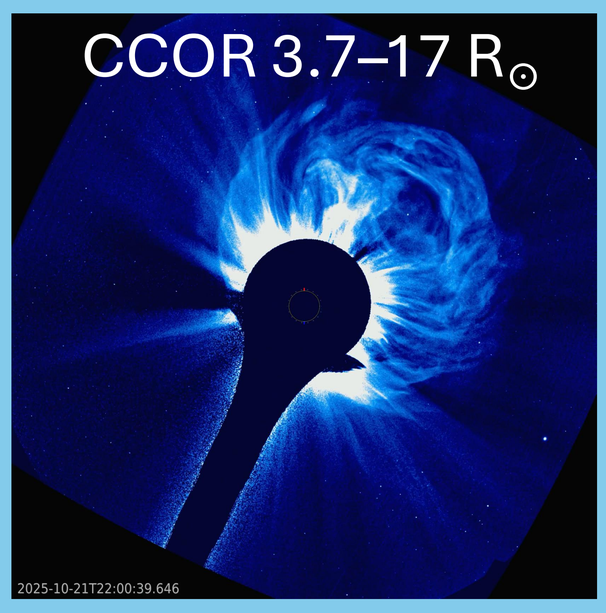
**J. Marcus Hughes**[1], Dan Seaton[1], Michael Burek[2], Craig DeForest[1], Gabriel Dima[3], Sarah Gibson[4], Abby Huff[1], Jeff Johnson[2], Jasmine Kobayashi[1] Derek Lamb[1], Chris Lowder[1], George Millward[2], Timothy Meisenhelder[5], Ritesh Patel[1], Courtney Peck[1], Jillian Redfern[1], Donald Schmit[3],, Sam Van Kooten[1], Nai-Yu Wang[6], Matthew West[7]

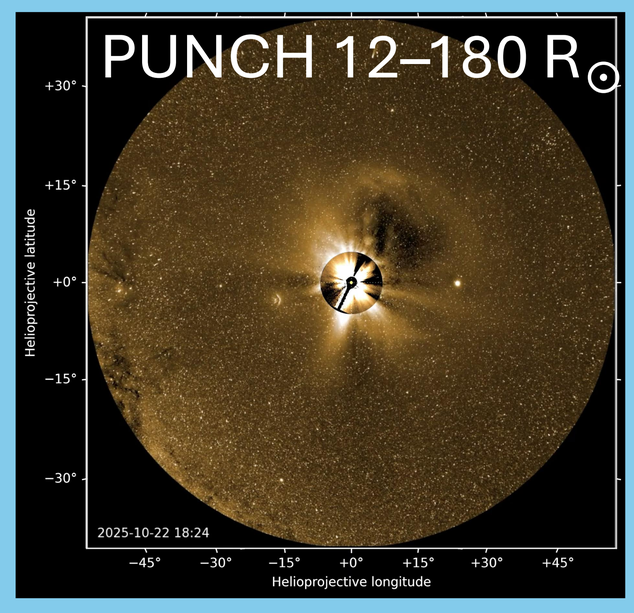
*[1]SwRI, [2]CU/CIRES & NOAA SWPC [3]CU/CIRES & NOAA NCEI, [4]HAO, [5]NOAA NCCF, [6]NOAA SWO, [7]ESA*

## PUNCH is a satellite constellation that extends our space weather FOV



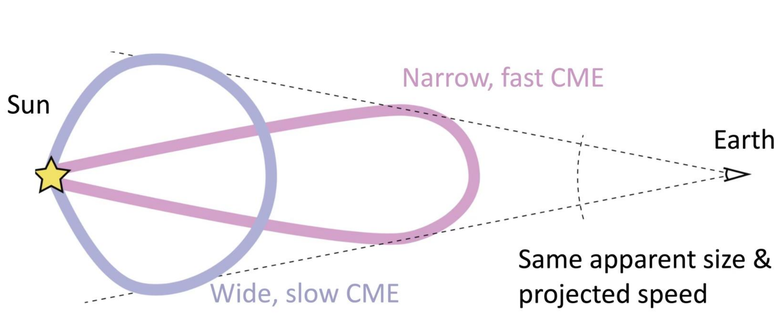

Four PUNCH spacecraft combine to provide a view that extends from the middle corona to far into the heliosphere, enabling observers to track CMEs of space weather significance as they travel to the Earth. QuickPUNCH provides low-latency PUNCH mosaic images directly to SWPC to support real-time space weather forecasting.



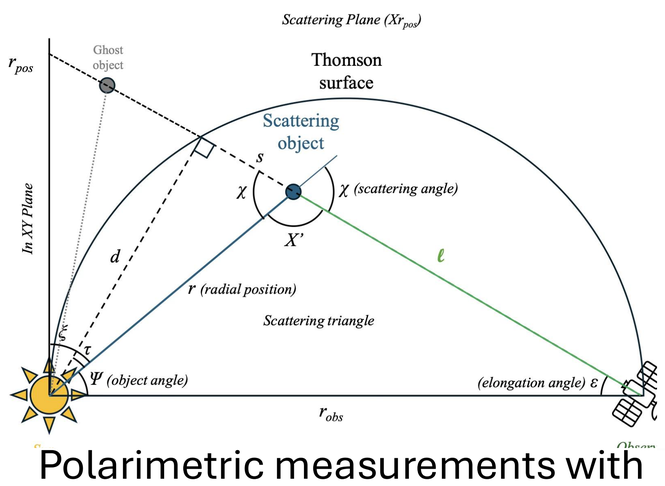




PUNCH mosaic images extend CME tracking time for a 750 km/s CME from 8 to 20+ hours. Additional tracking can be used to refine arrival time predictions, validate model predictions from WSA-Enlil, and to observe interactions between CMEs and solar wind features of space weather significance.

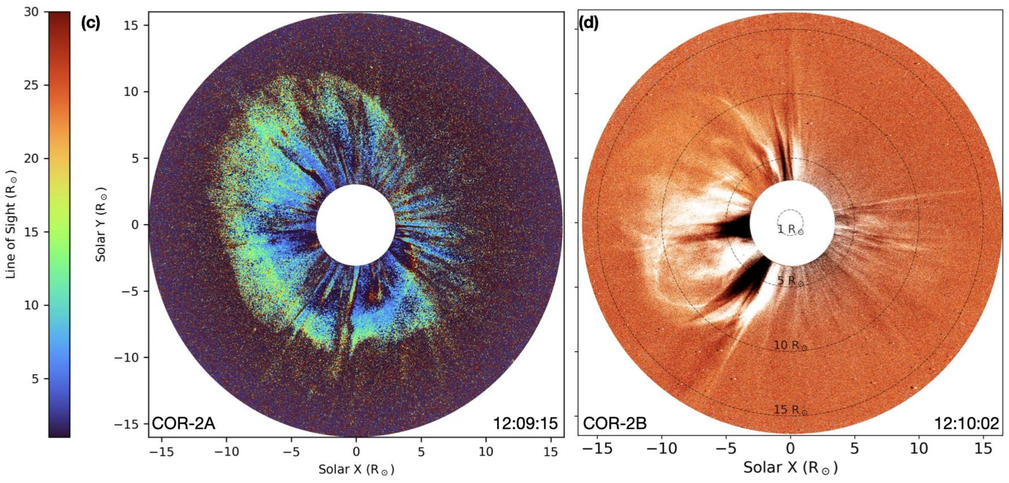
## Polarimetry unlocks 3D position




Narrow, fast CMEs vs. wide, slow CMES cannot be easily distinguished in traditional unpolarized coronagraphic images.

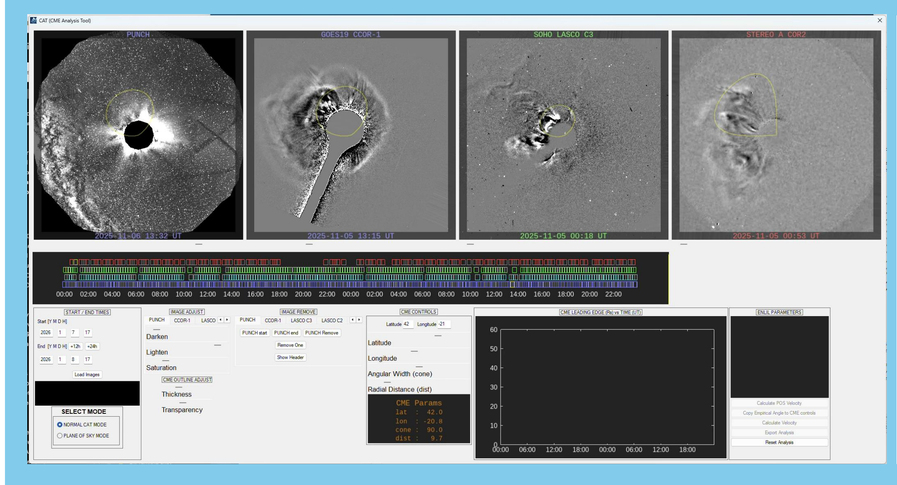



Polarimetric measurements with PUNCH can localize CME features in 3D space to differentiate between CME types.

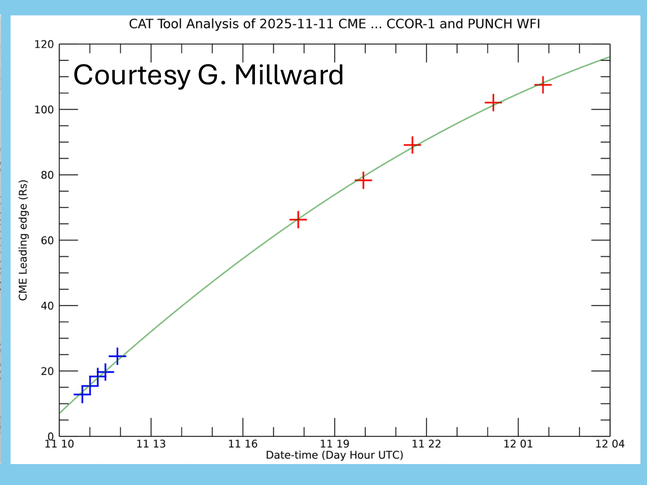



Simple calculations reveal the 3D location of CME-associated features. Ongoing R2O work with polarized PUNCH data will yield real-time 3D CME trajectories.

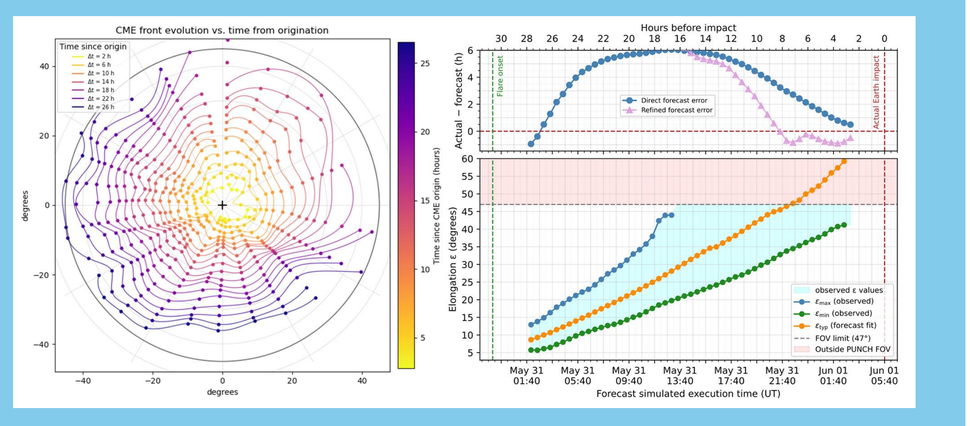
## QuickPUNCH is live now




QuickPUNCH is a lower latency stream of data flowing directly to NOAA SWPC. It is based on clear measurements now but could be extended to polarimetric images. Above, the PUNCH data is shown in the CAT infrastructure for forecasting.




This preliminary CCOR+PUNCH CME trajectory shows the benefit of PUNCH's wide FOV to extend forecast windows and refine arrival times.




PUNCH routinely views halo CMEs out to over 45° from the Sun. This yields evolving maps of the shape of the CME 'front' (left). Fitting a very simplified three-parameter model to the CME at left yielded a very high precision (30 minute error) forecast of the arrival time, eight hours before arrival, in a simulated forecast activity. This work is under peer review now.