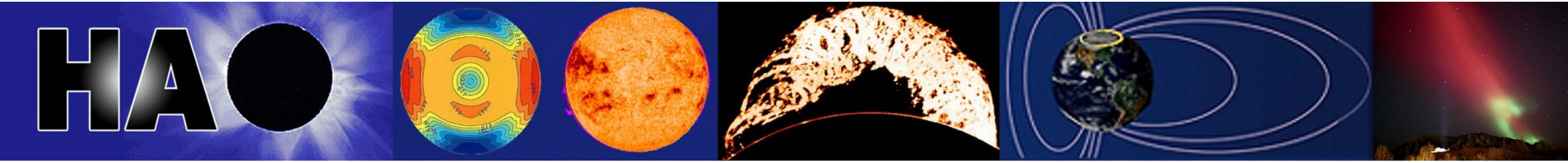

Coronagraphs

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NCAR

Why Observe the Corona?

- Rationale for GBSON: observe CMEs
- Critical for Space Weather prediction
- Also lots of interesting science, e.g., waves, free energy build-up, connection to dynamo

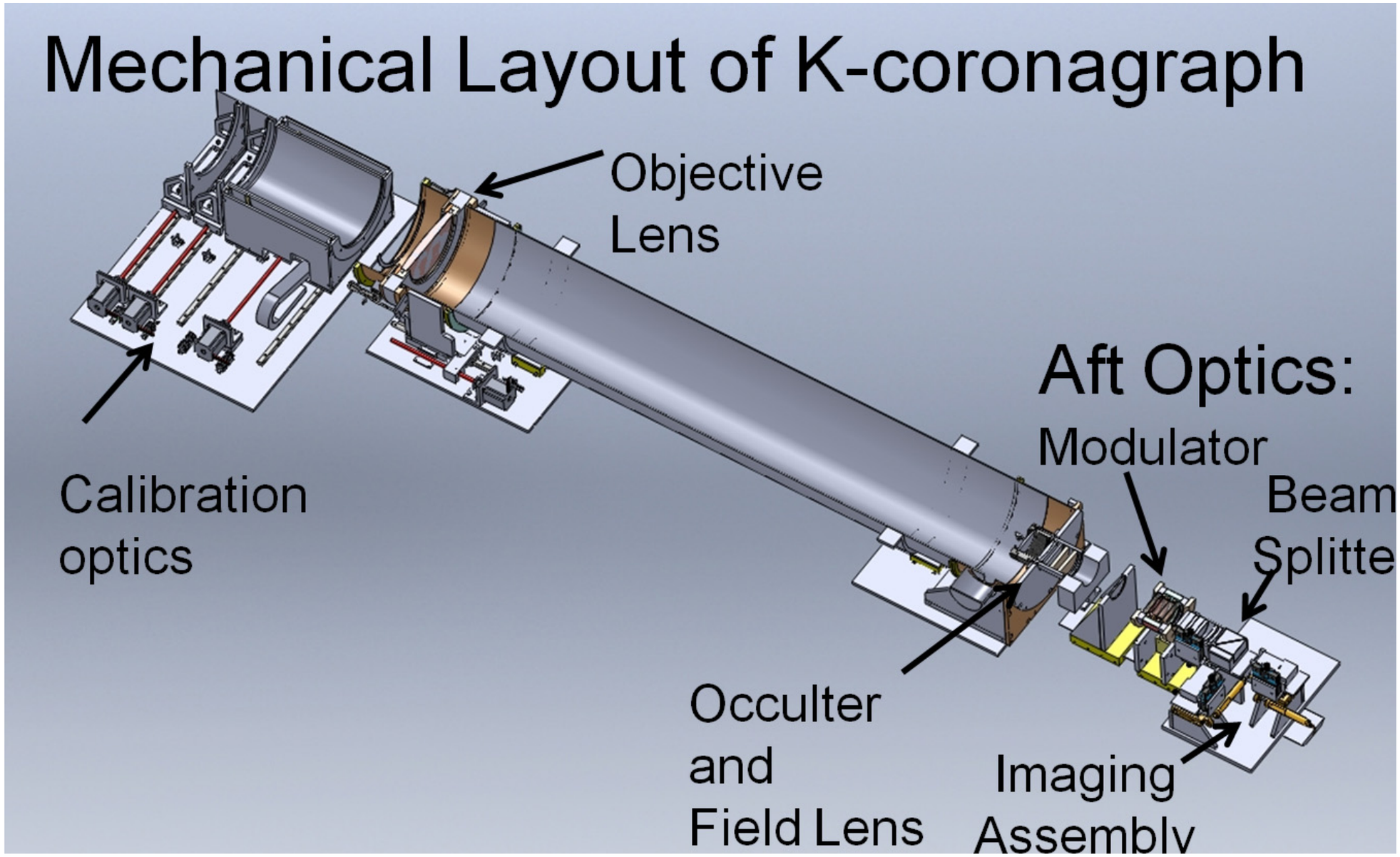
How Hard Can It Be?

- Need to observe 10^{-11} B_{sun} at 4 R_{sun}
- Scattered light kills!
  - Special considerations for optics
  - Need sites with low sky brightness, e.g., low Earth orbit
  - On the ground must be linear polarimeters to discern corona from sky

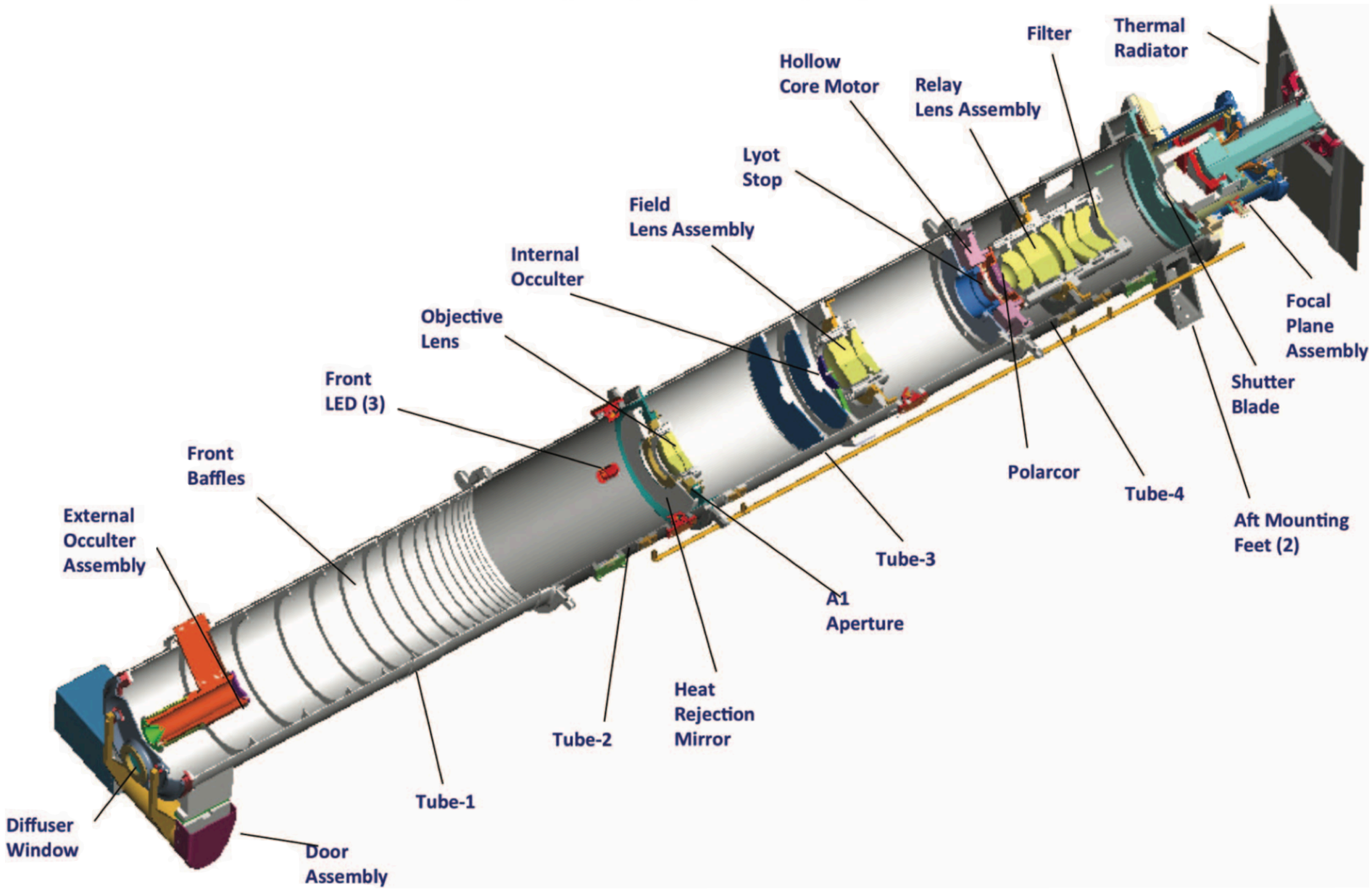
Types of Coronagraphs

- Internally Occulted
  - Needs a super-polished uncoated and pristinely clean singlet objective lens
  - Can observe really low in the corona but is limited by scatter from the objective
- Externally Occulted
  - Uses an occulter in front of the telescope to block the disk of the sun
  - Has less instrumental scatter but cannot observe the low corona

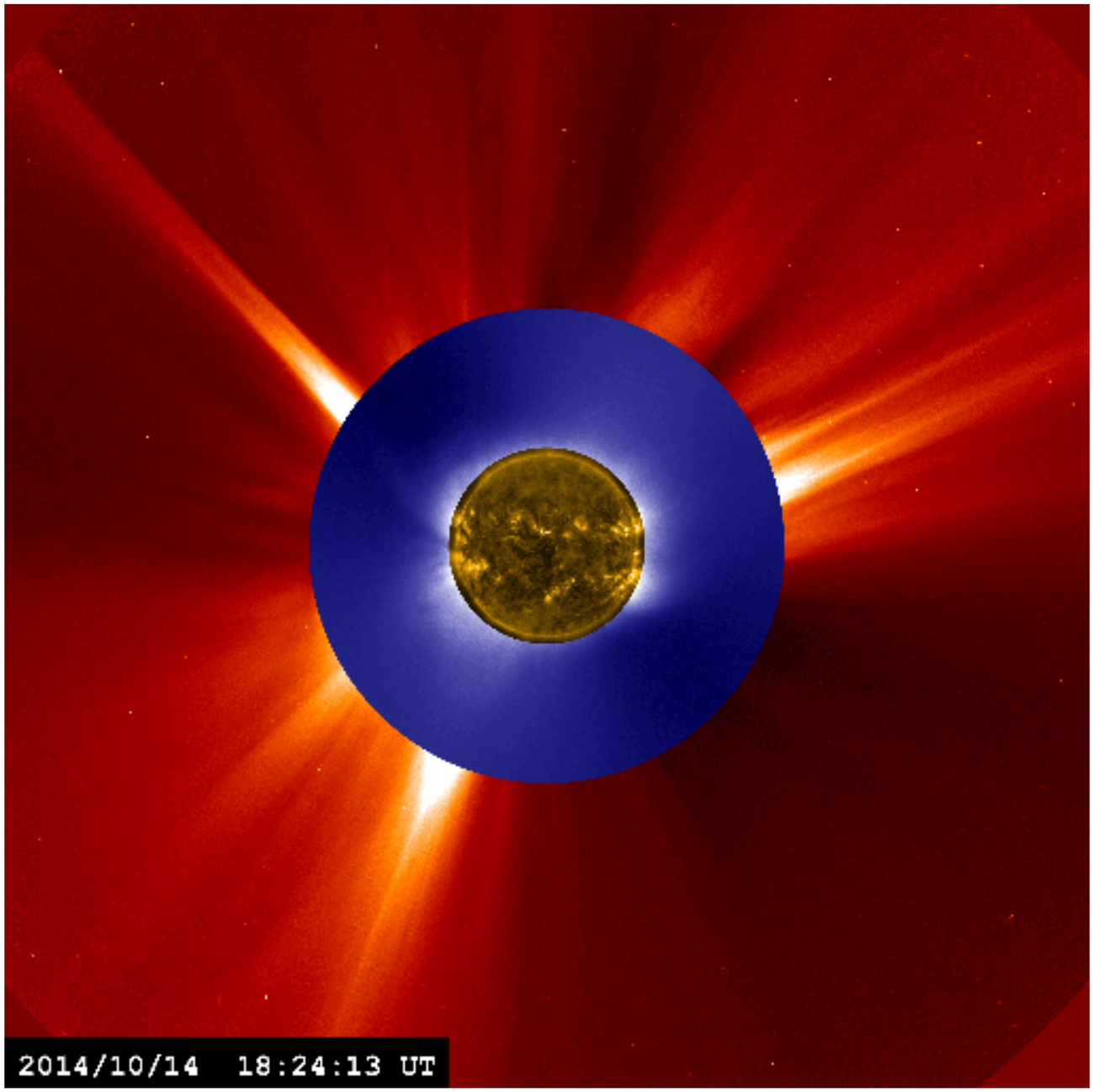
Anatomy - Internally Occulted



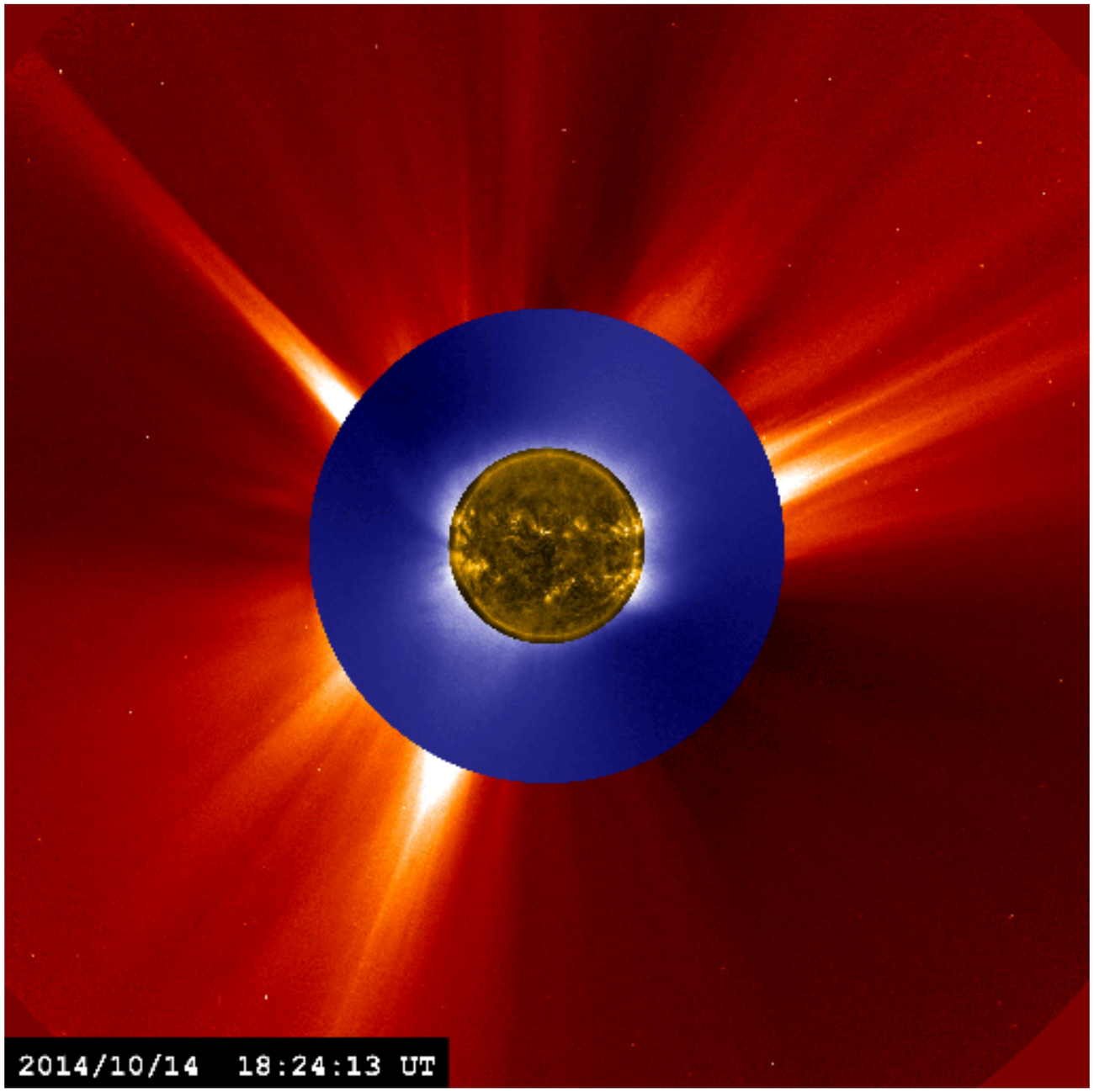
Anatomy - Externally Occulted



Coronagraph FOVs

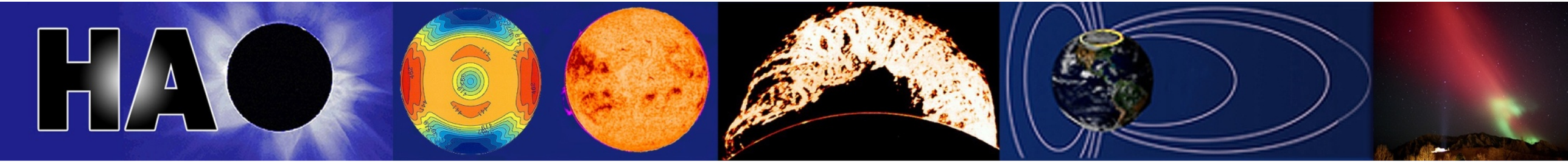


Coronagraph FOVs



GBSON Concept

- Includes both an internally and an externally occulted coronagraph
- Broadband white-light only for monitoring coronal morphology and density, and CME detection
- No spectroscopy for Doppler and magnetic field diagnostics



ChroMag

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The National Center for Atmospheric Research is operated by the University Corporation for Atmospheric Research under sponsorship of the National Science Foundation. An Equal Opportunity/Affirmative Action Employer.

NCAR

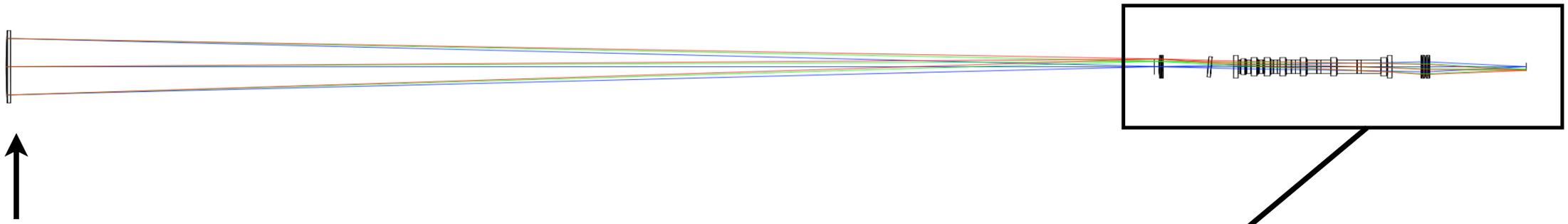
Concept

- Flexible imaging spectropolarimeter intended to diagnose chromospheric magnetism, dynamics, and structure
  - 5 bandpasses: Fe I 617.3 nm, H I 656.3 nm, Ca II 854.2 nm, He I 587.6 and 1083.0 nm
  - Data serves many research topics but is crucially important for Space Weather topics

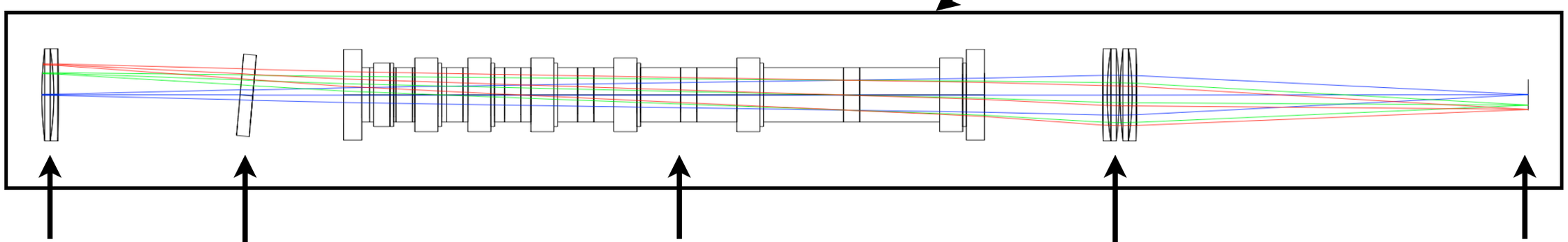
Science Case

- Chromospheric and coronal structure is dominated by magnetic field.
- We must know the magnetic field at the force-free bottom boundary in order to understand solar activity in the heliosphere: flares, CMEs, etc.
- Extrapolating from photospheric (vector) field does not work.

Instrument Prototype



Primary achromat lens
13.5 cm aperture, 2 m focal length



Field lens

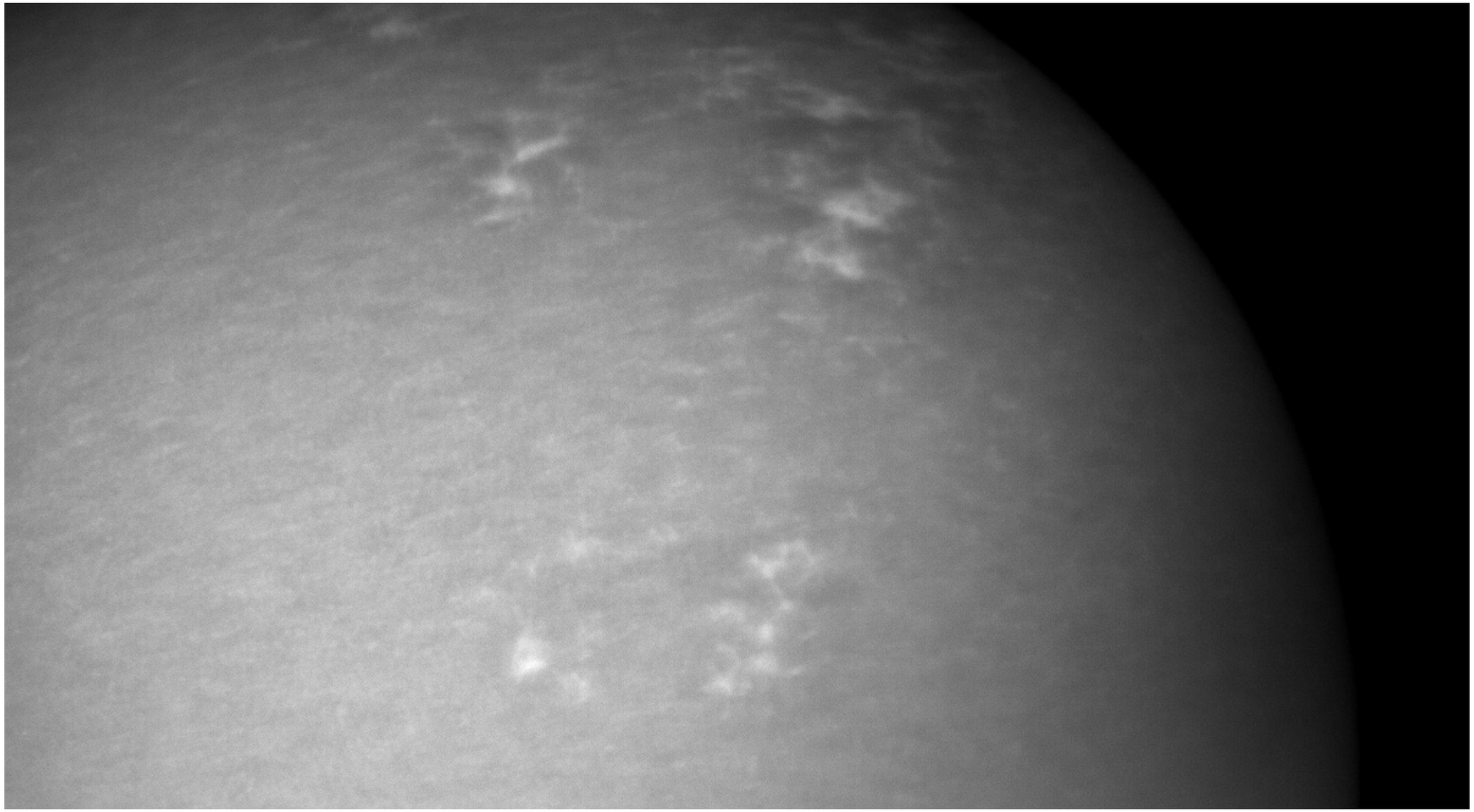
Pre-filter

Polarimeter & Lyot filter

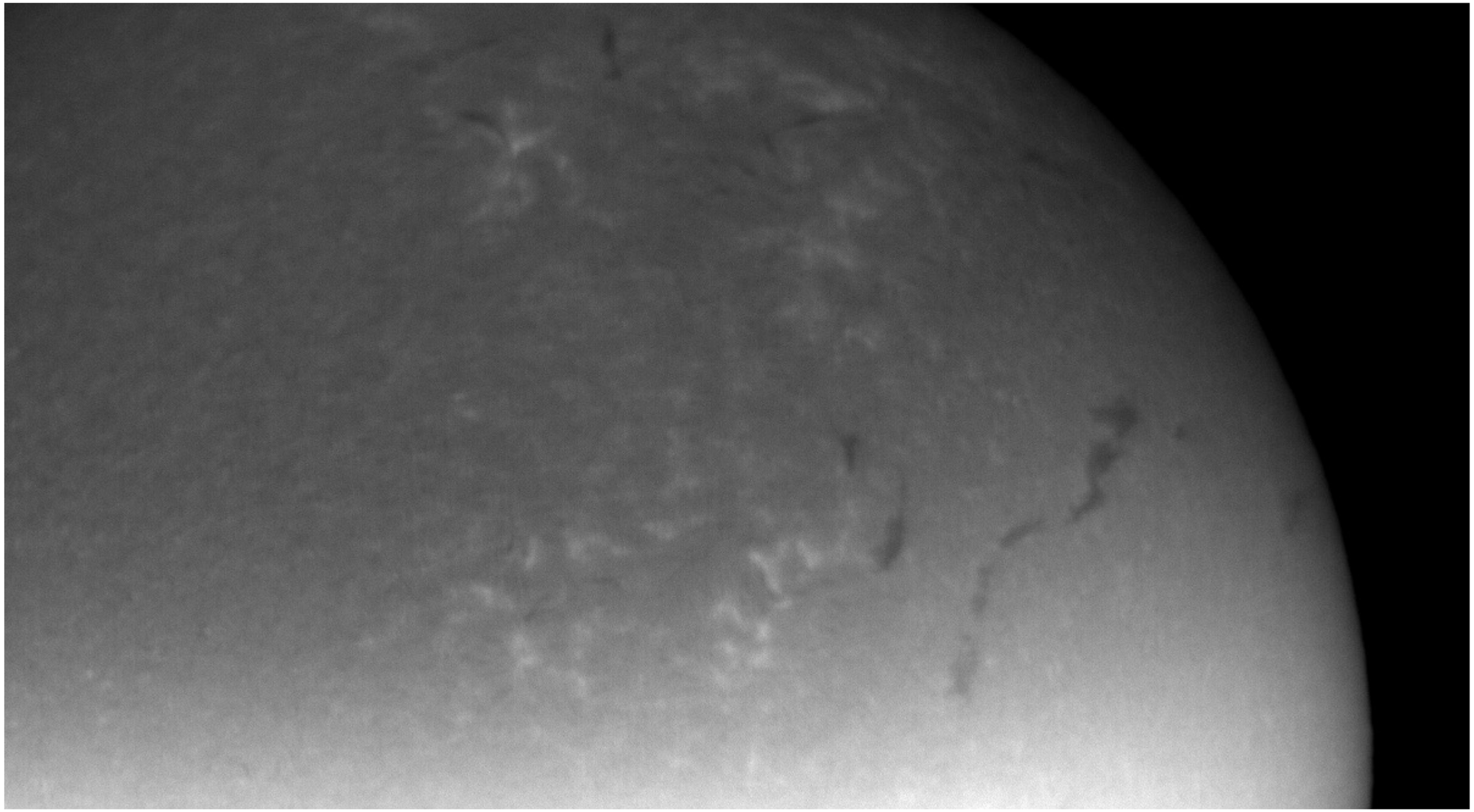
Camera lens

Focal plane

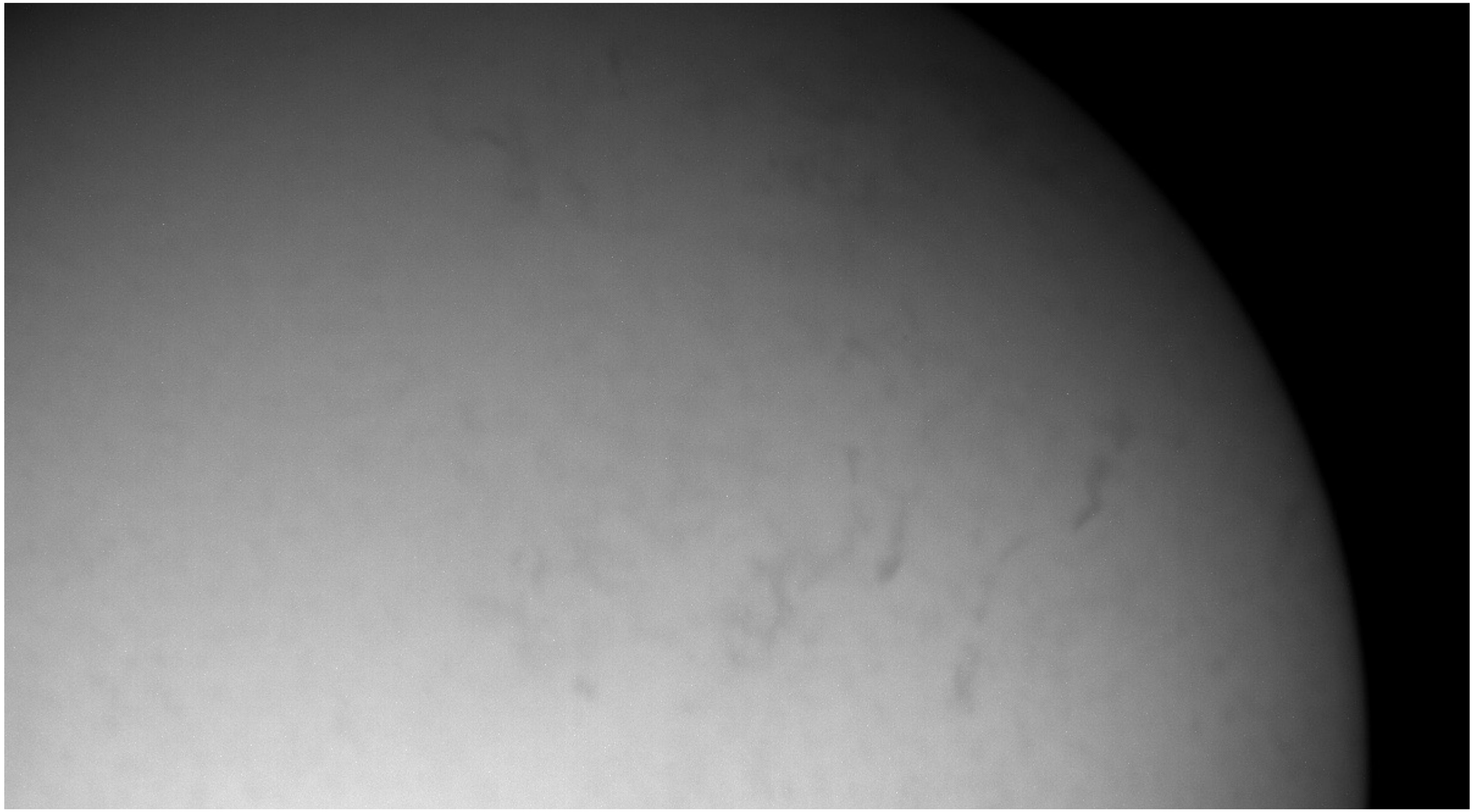
ChroMag “First Light”



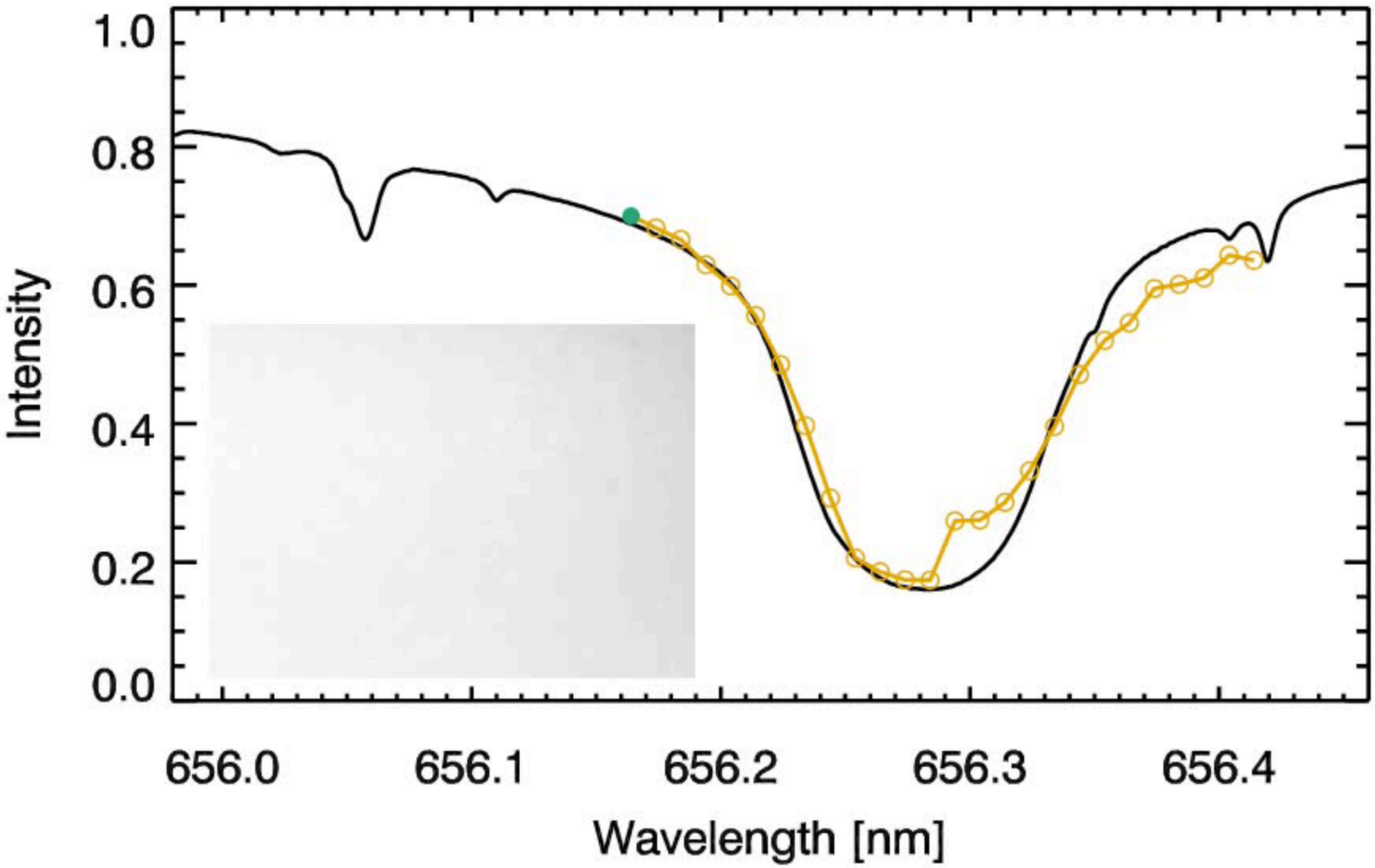
ChroMag “First Light”



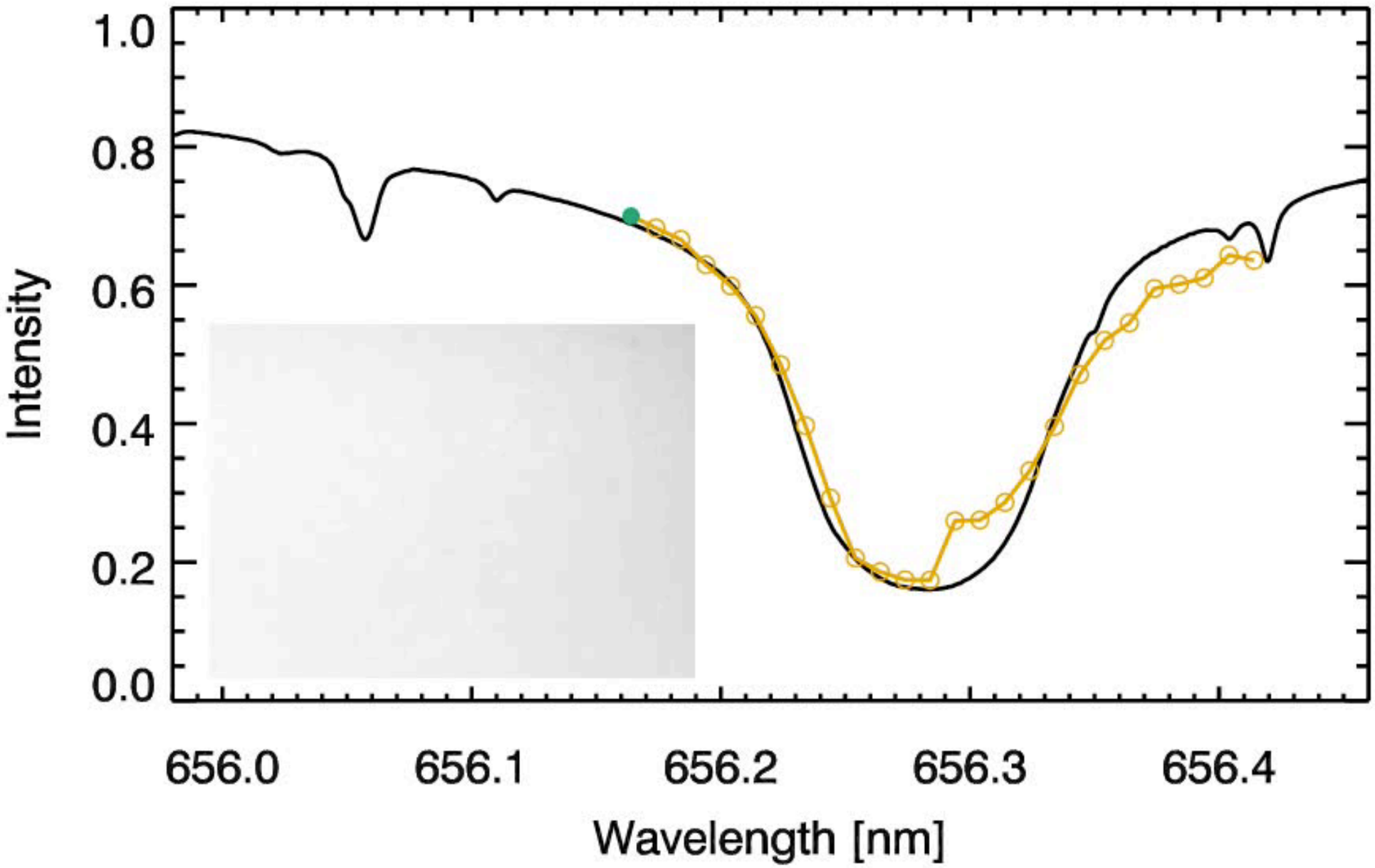
ChroMag “First Light”



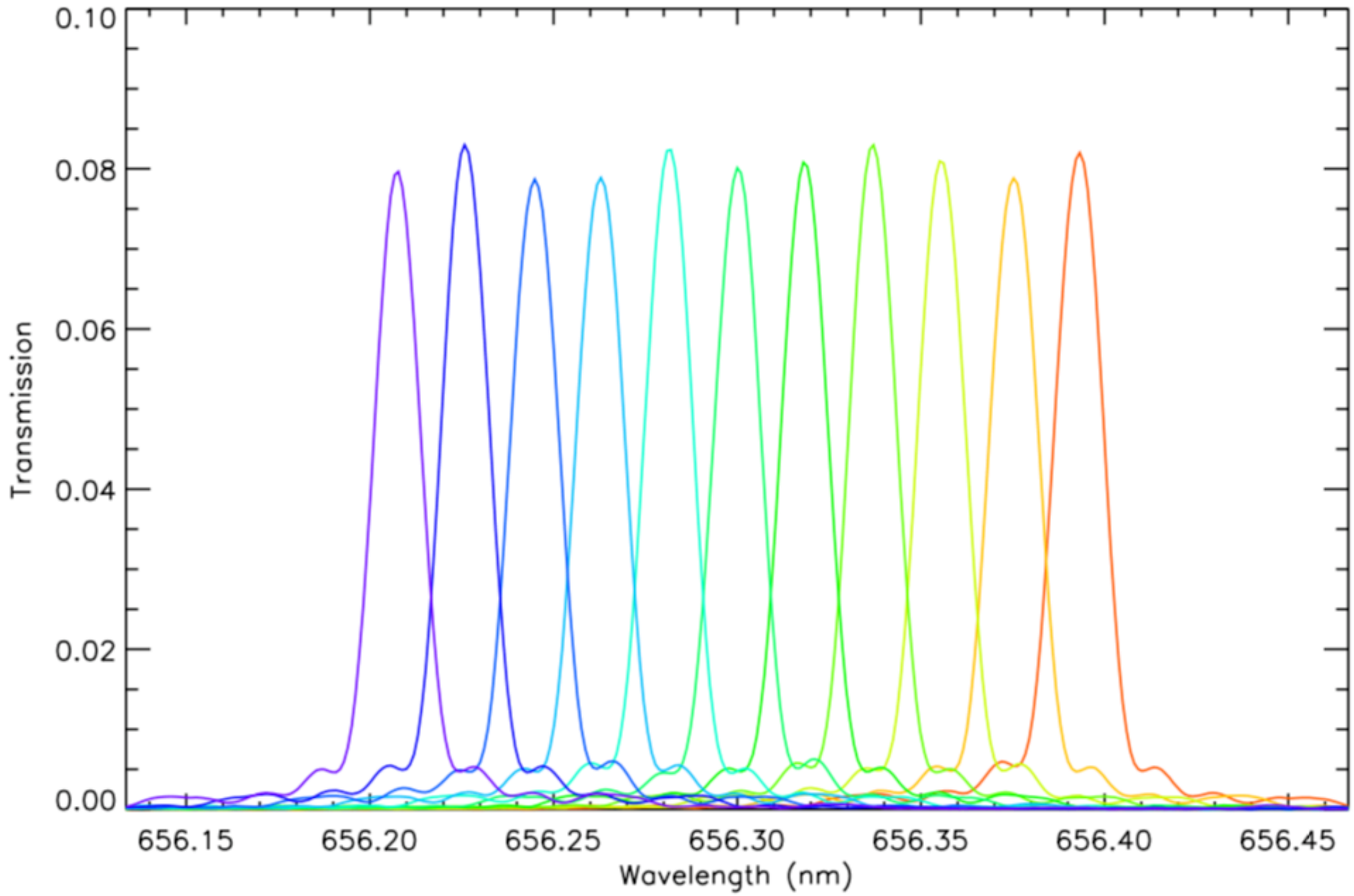
Hα 656.3 nm


1.0
0.8
0.6
0.4
0.2
0.0
Intensity
656.0
656.1
656.2
656.3
656.4
Wavelength [nm]

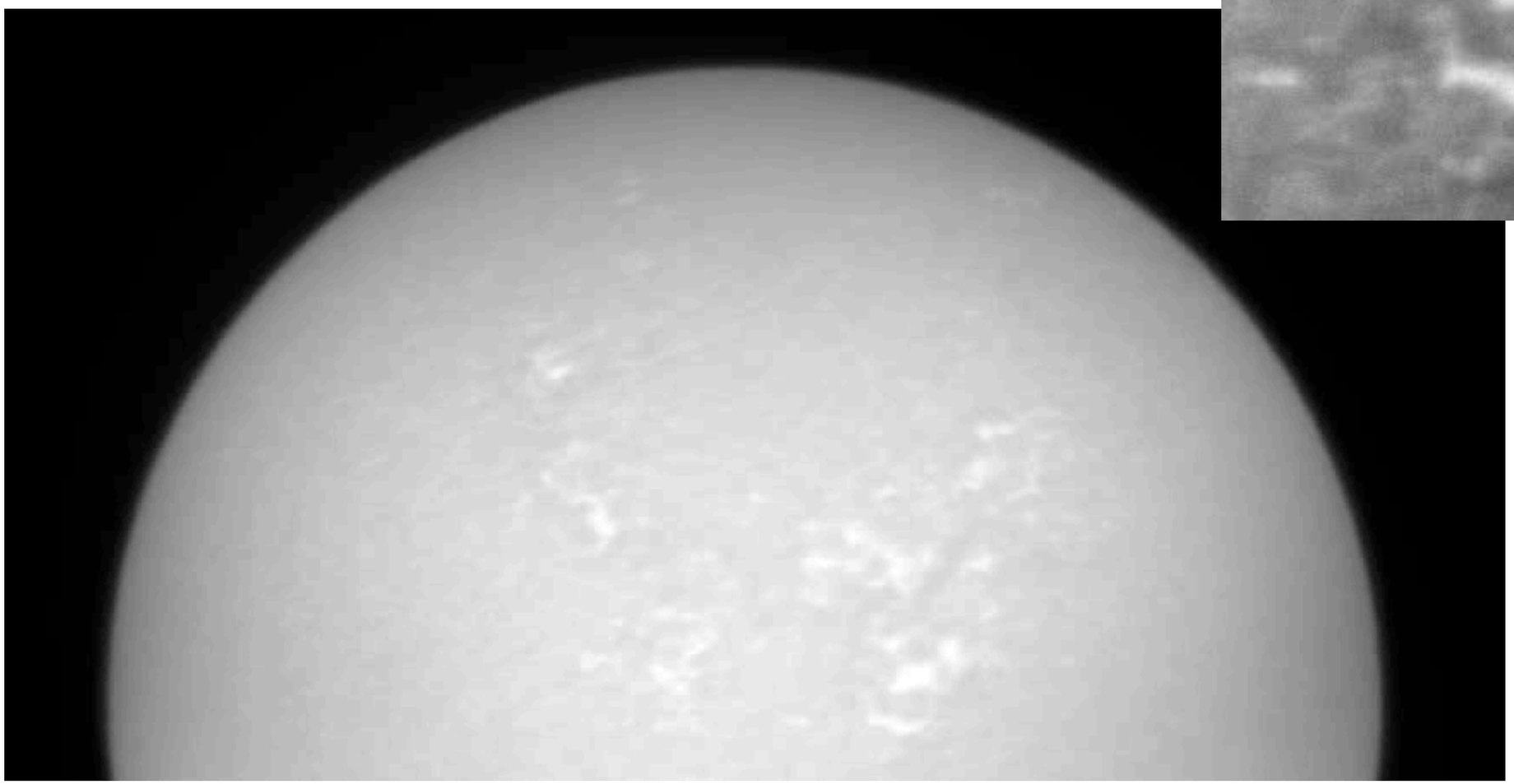
Hα 656.3 nm

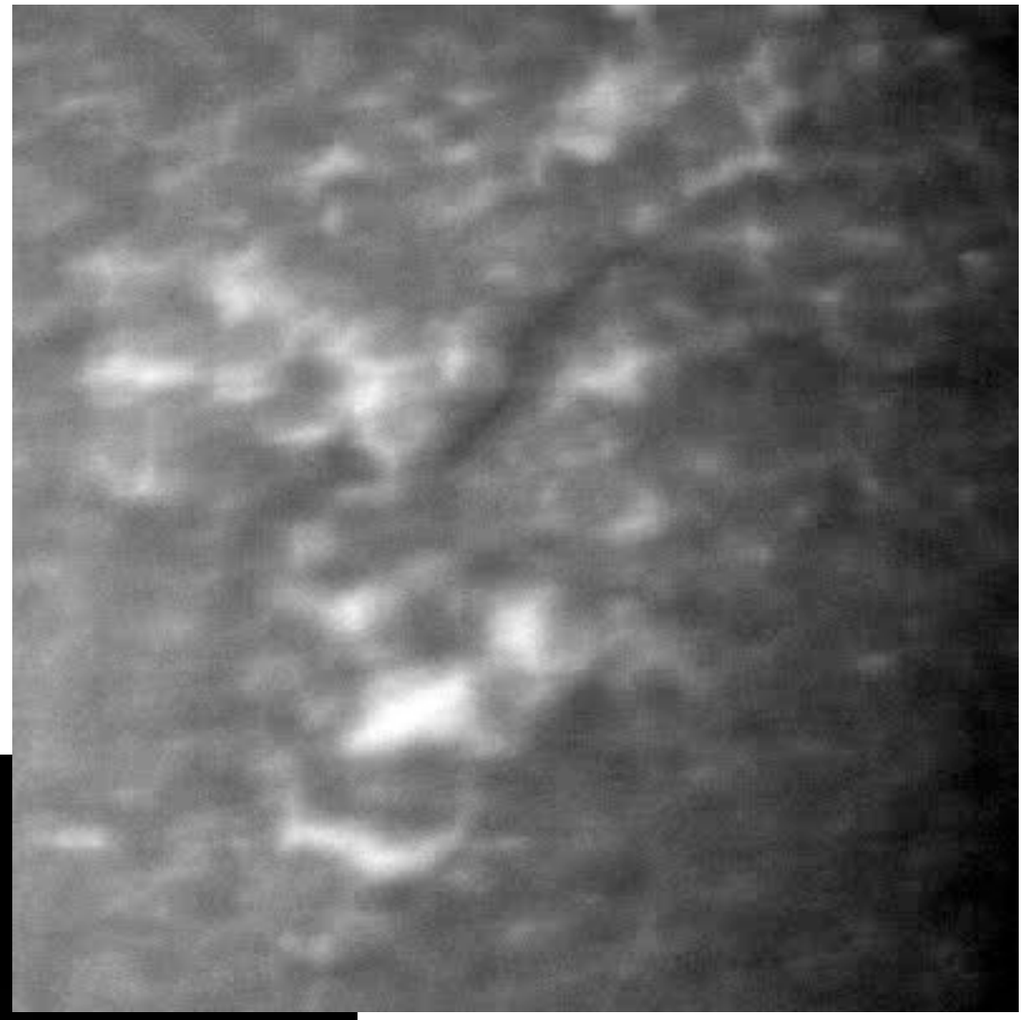

1.0
0.8
0.6
0.4
0.2
0.0
Intensity
656.0
656.1
656.2
656.3
656.4
Wavelength [nm]

Measured Profiles

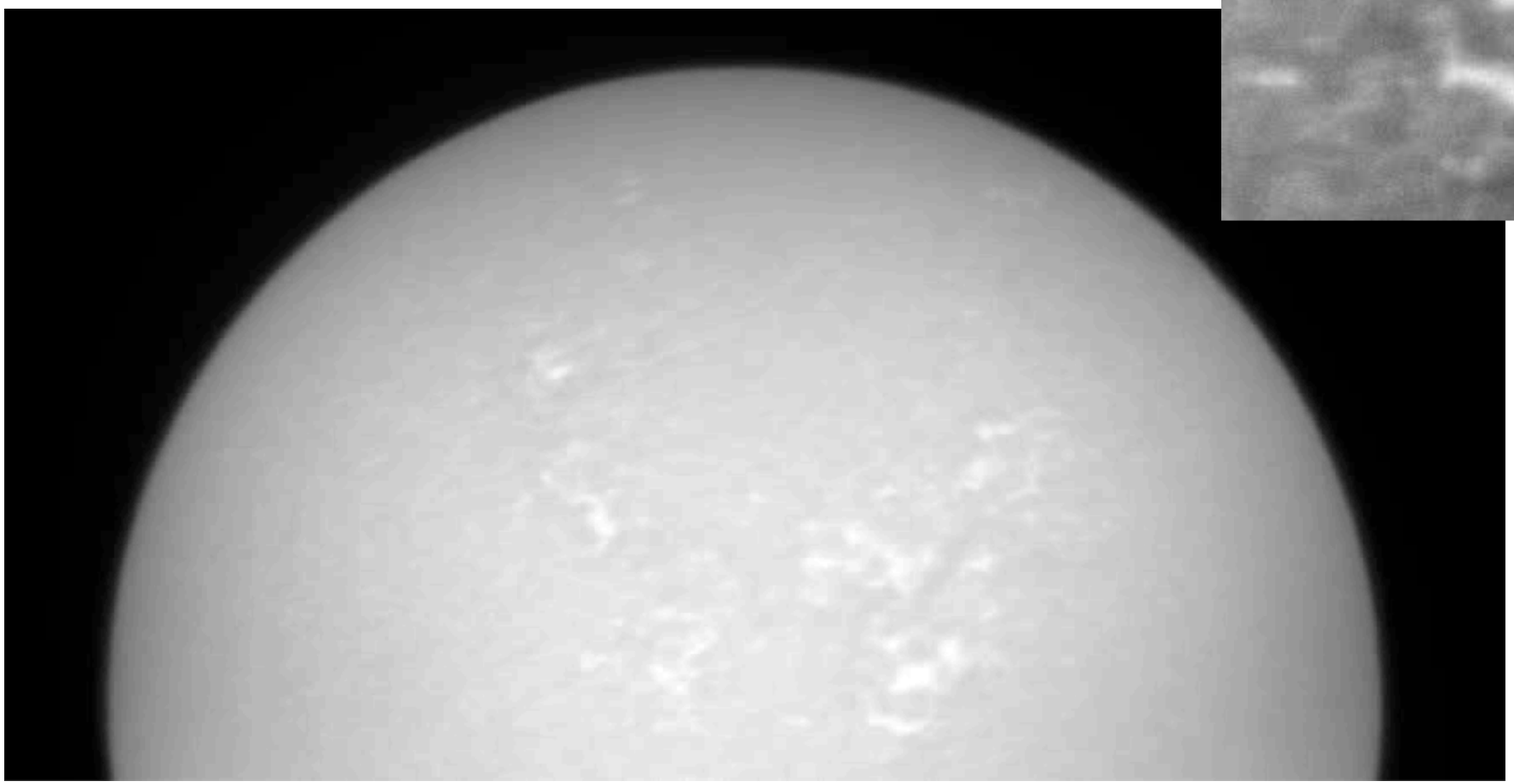


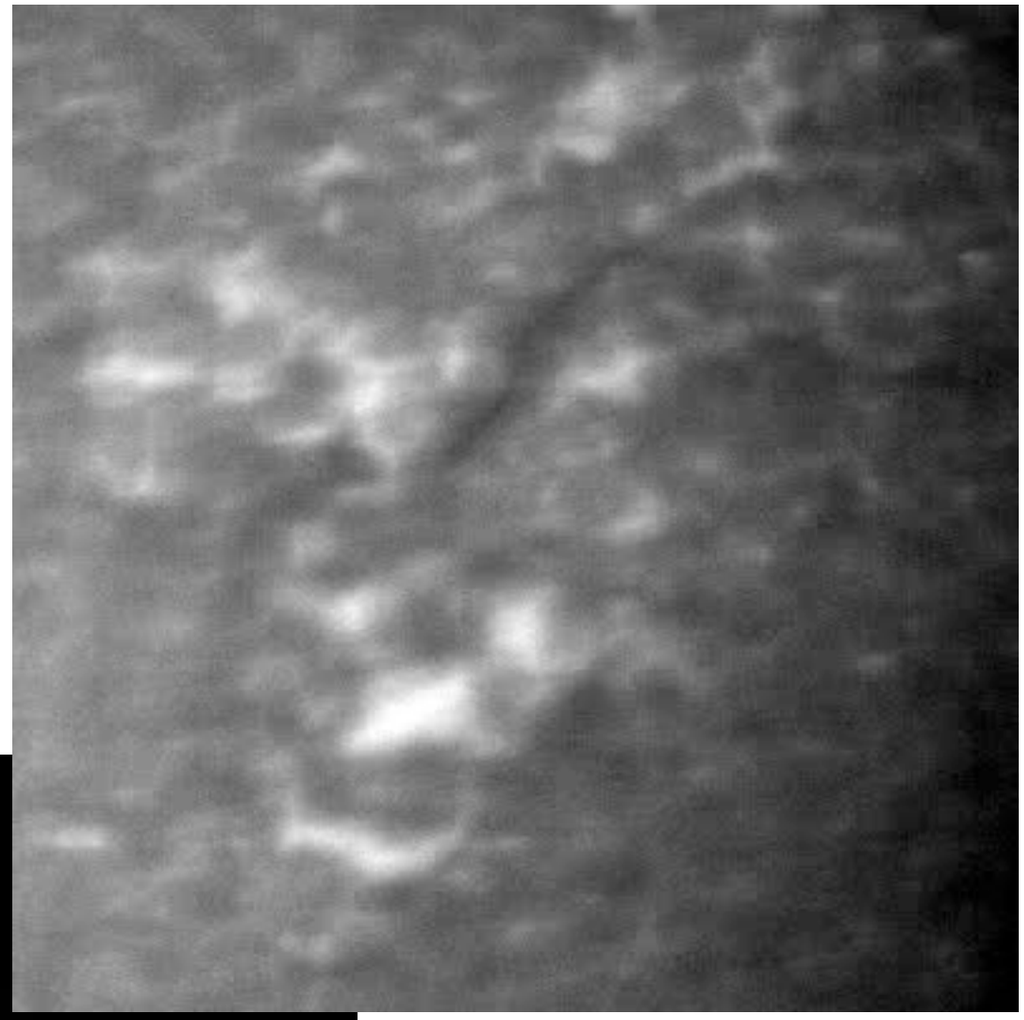
Ca II 854.2 nm



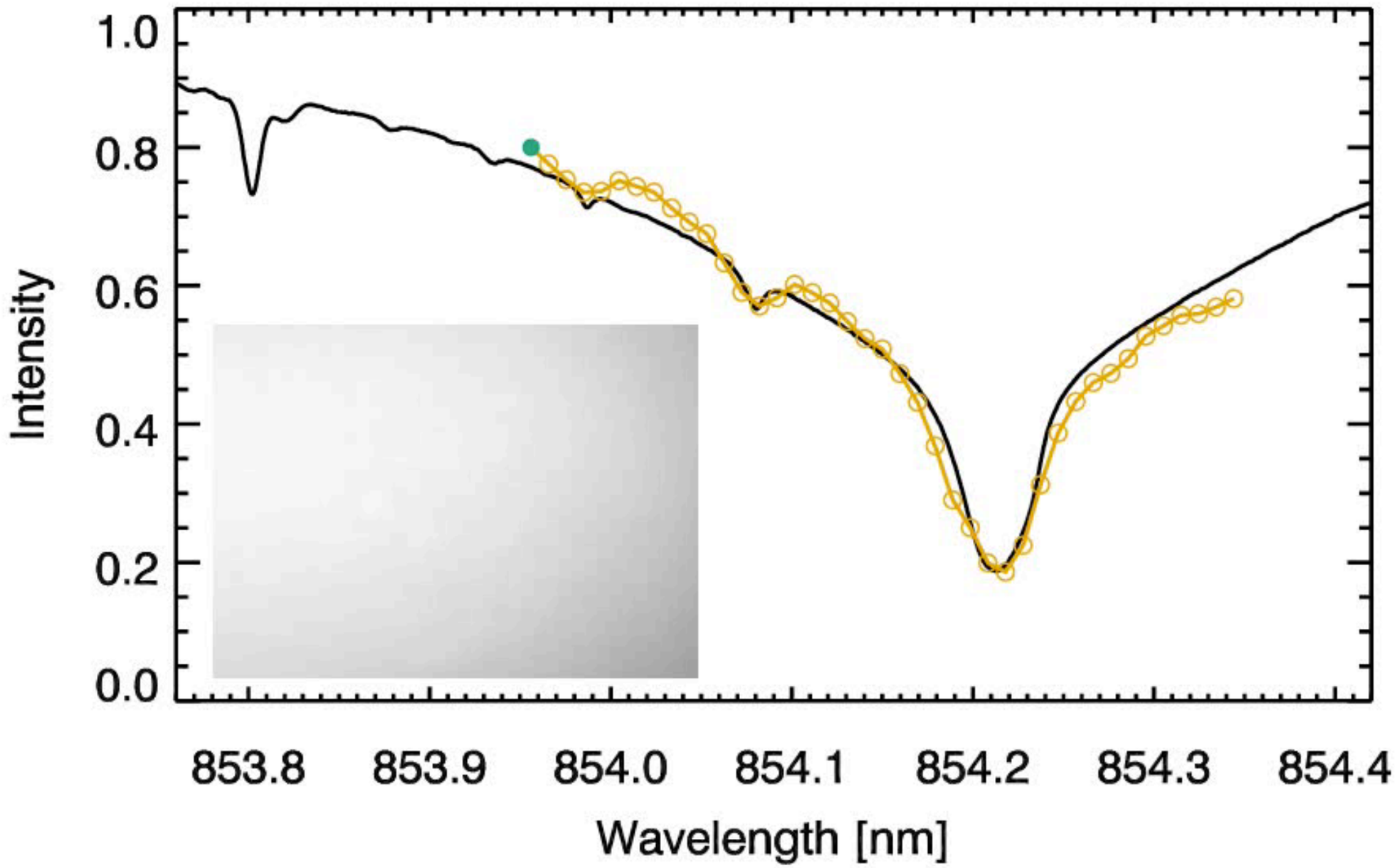


Ca II 854.2 nm

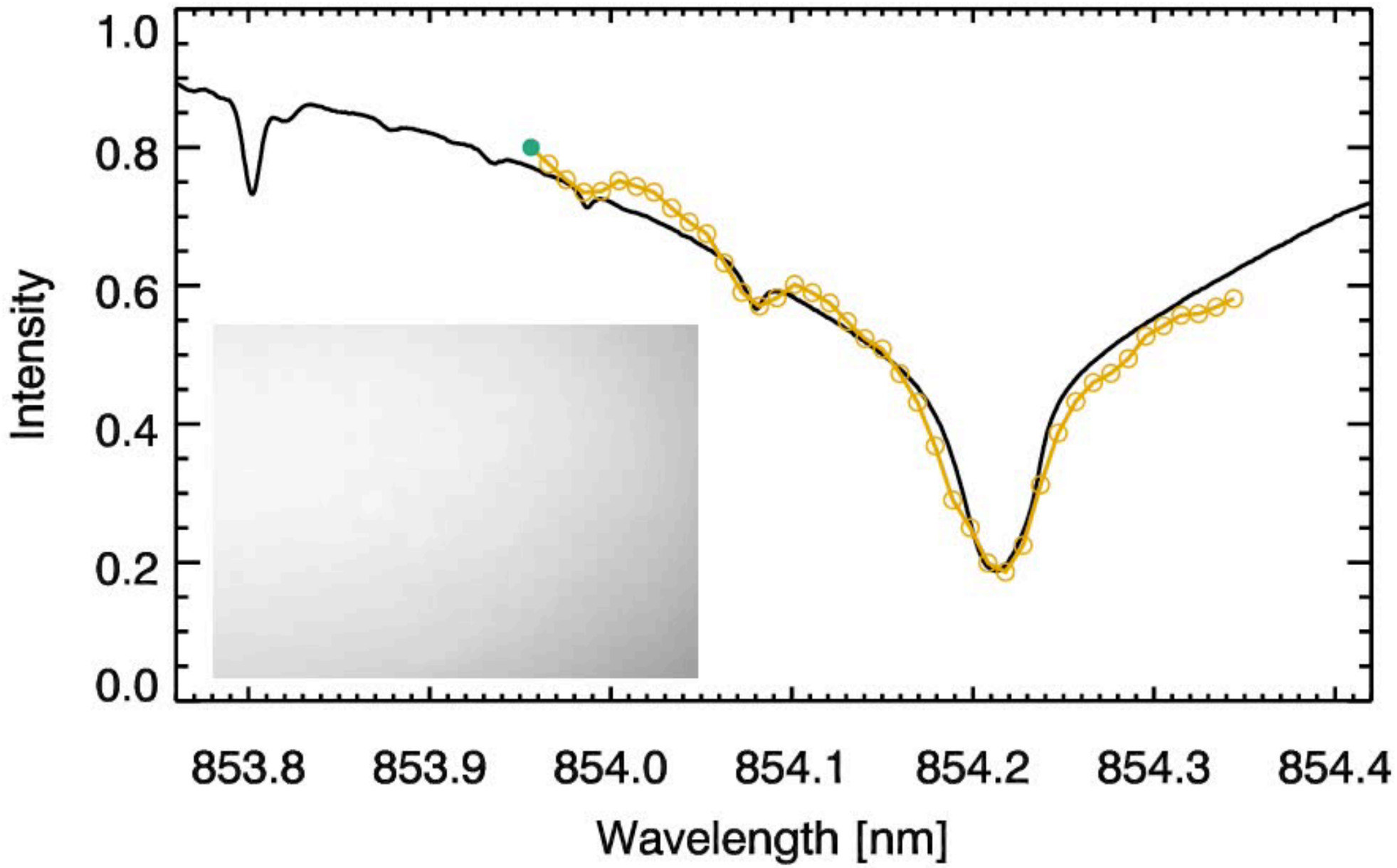




Ca II 854.2 nm


1.0
0.8
0.6
0.4
0.2
0.0
Intensity
853.8
853.9
854.0
854.1
854.2
854.3
854.4
Wavelength [nm]

Ca II 854.2 nm


1.0
0.8
0.6
0.4
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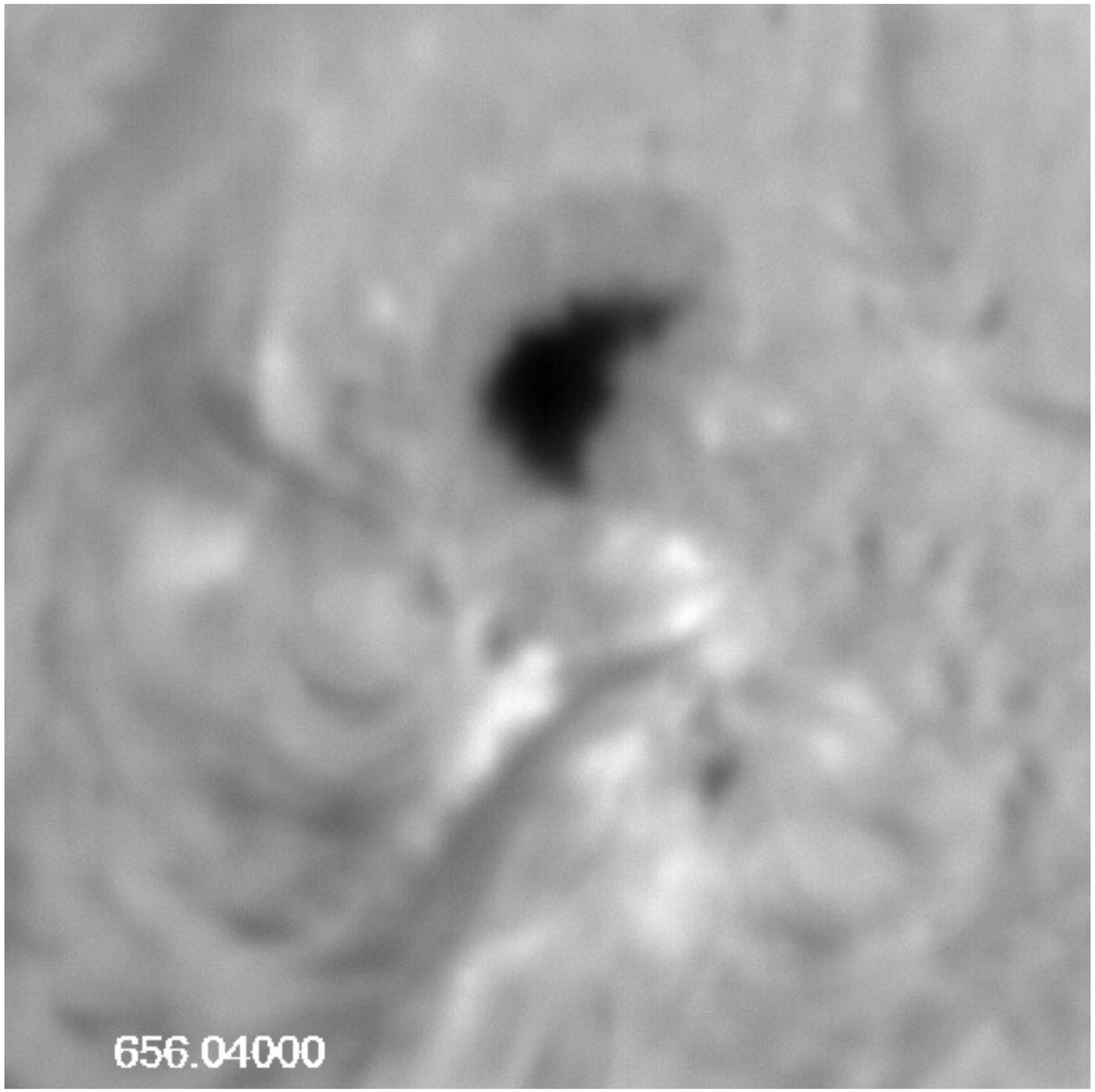
0.0
Intensity
853.8
853.9
854.0
854.1
854.2
854.3
854.4
Wavelength [nm]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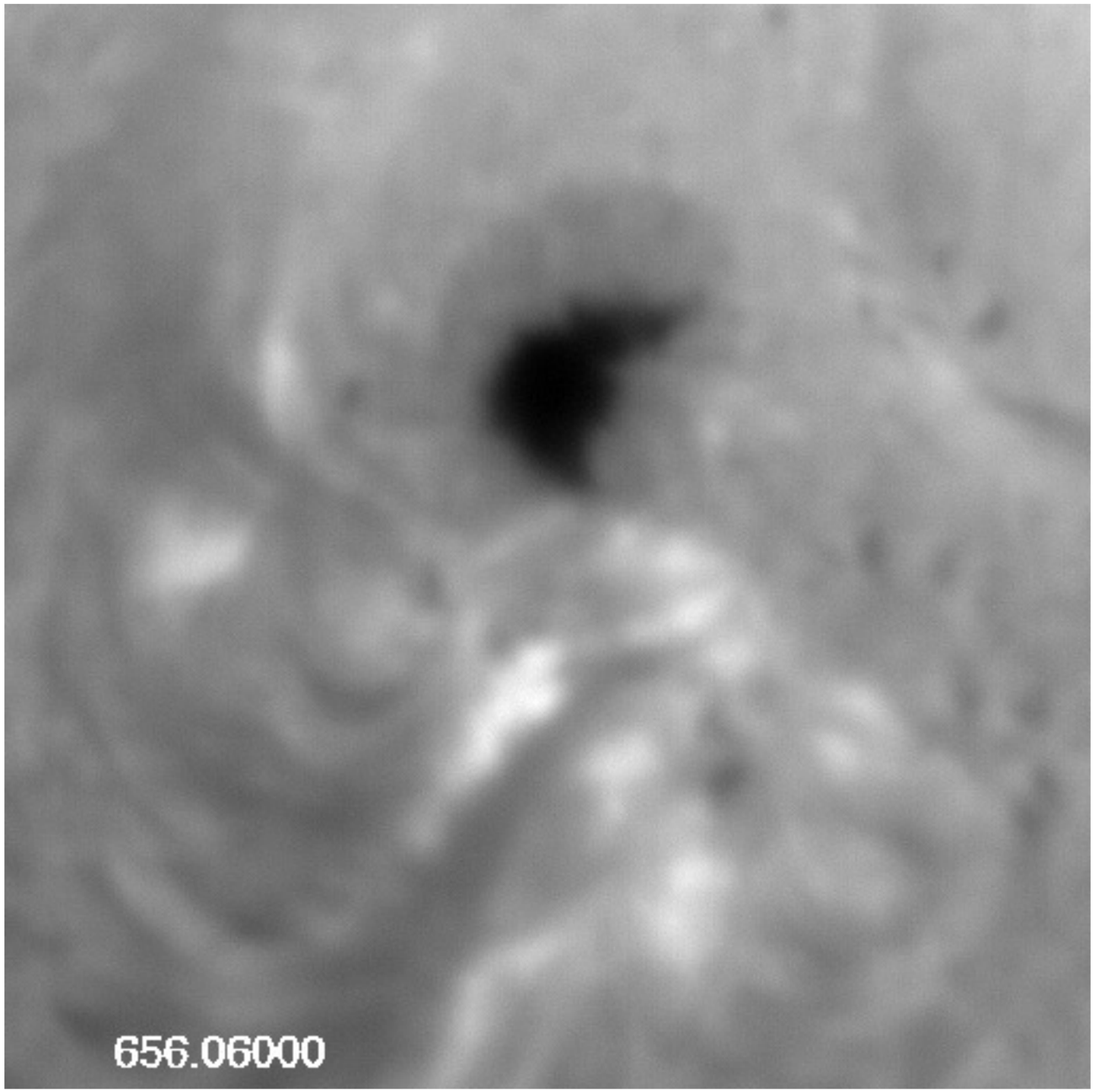
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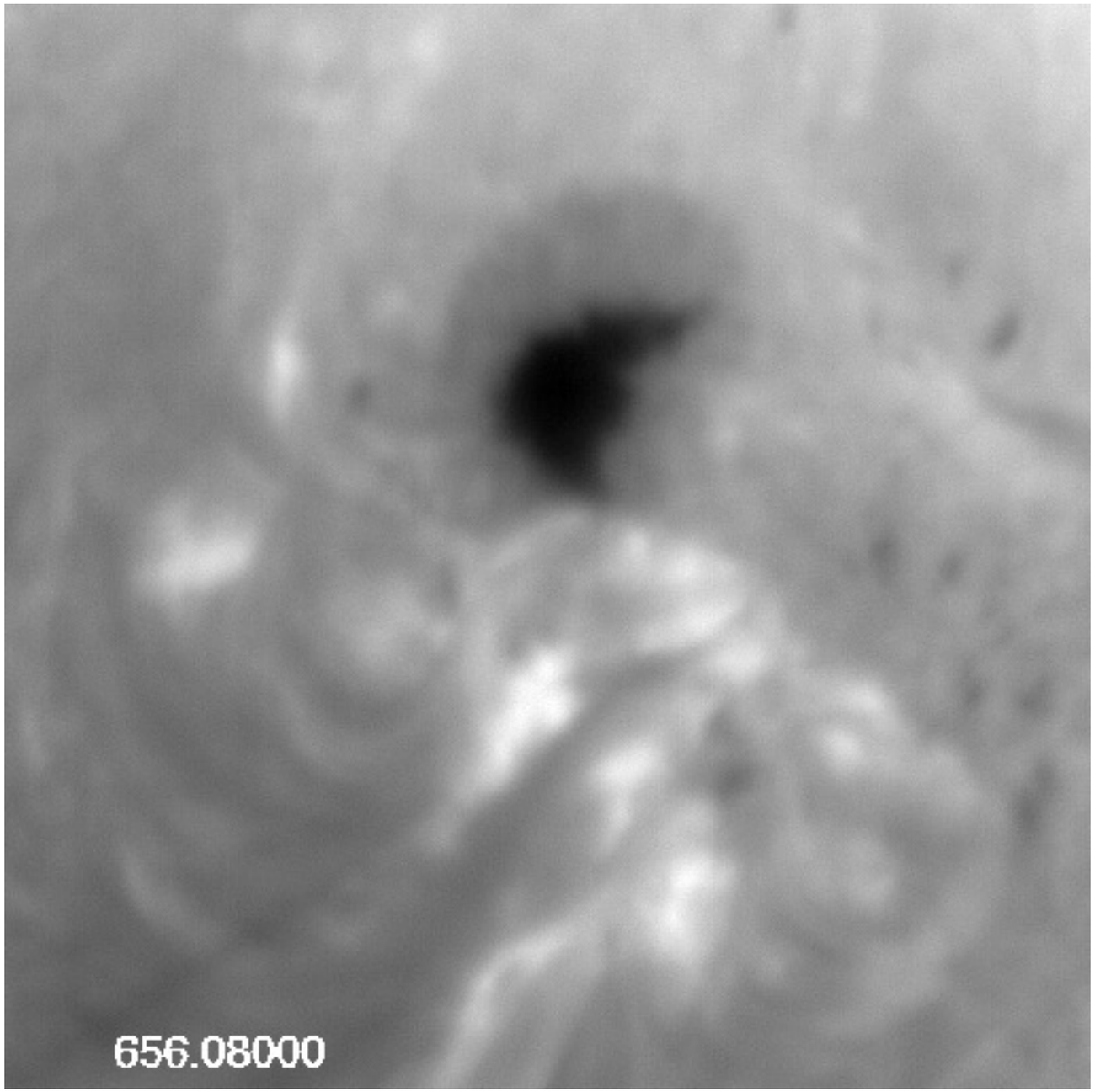
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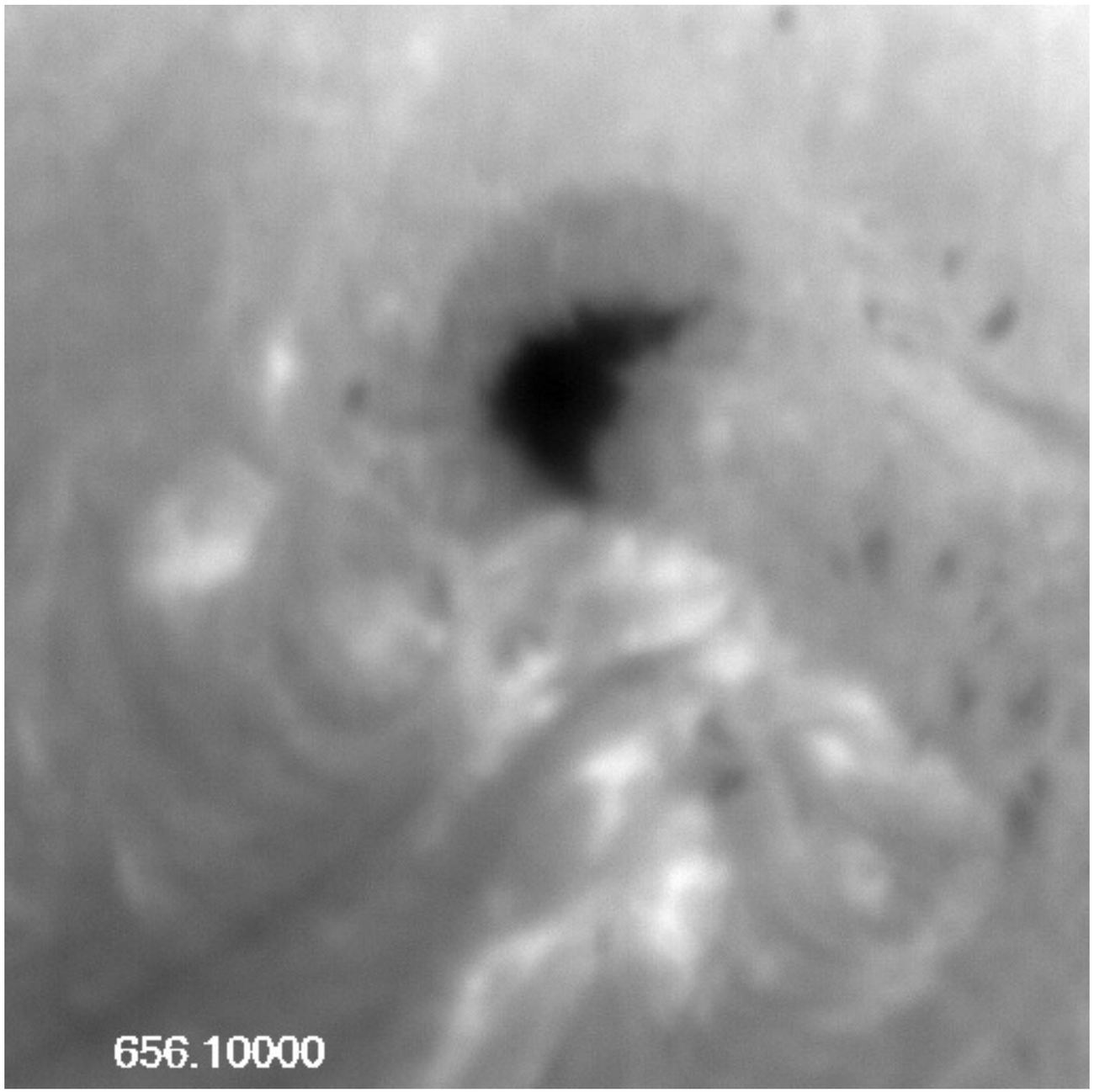
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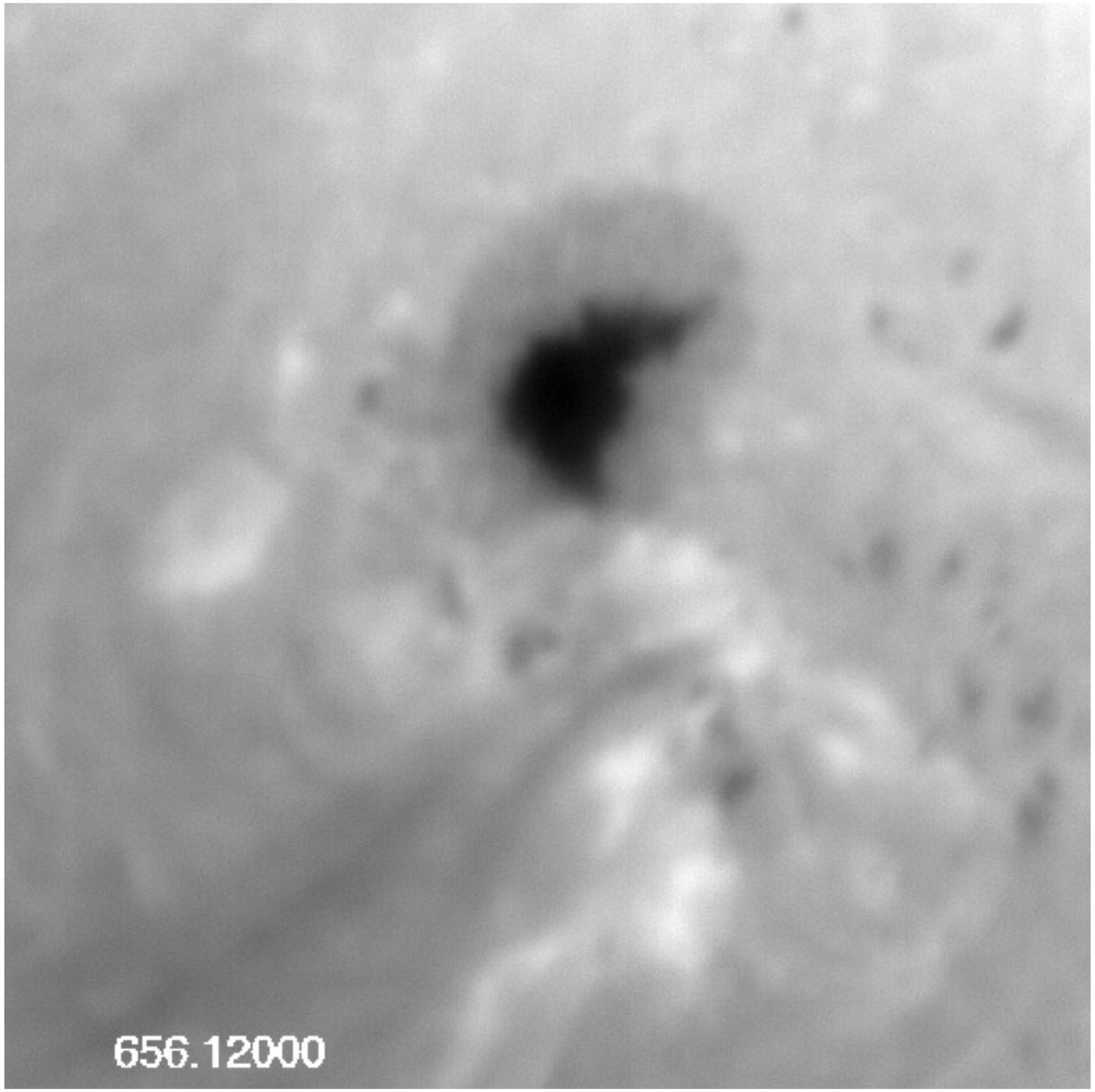
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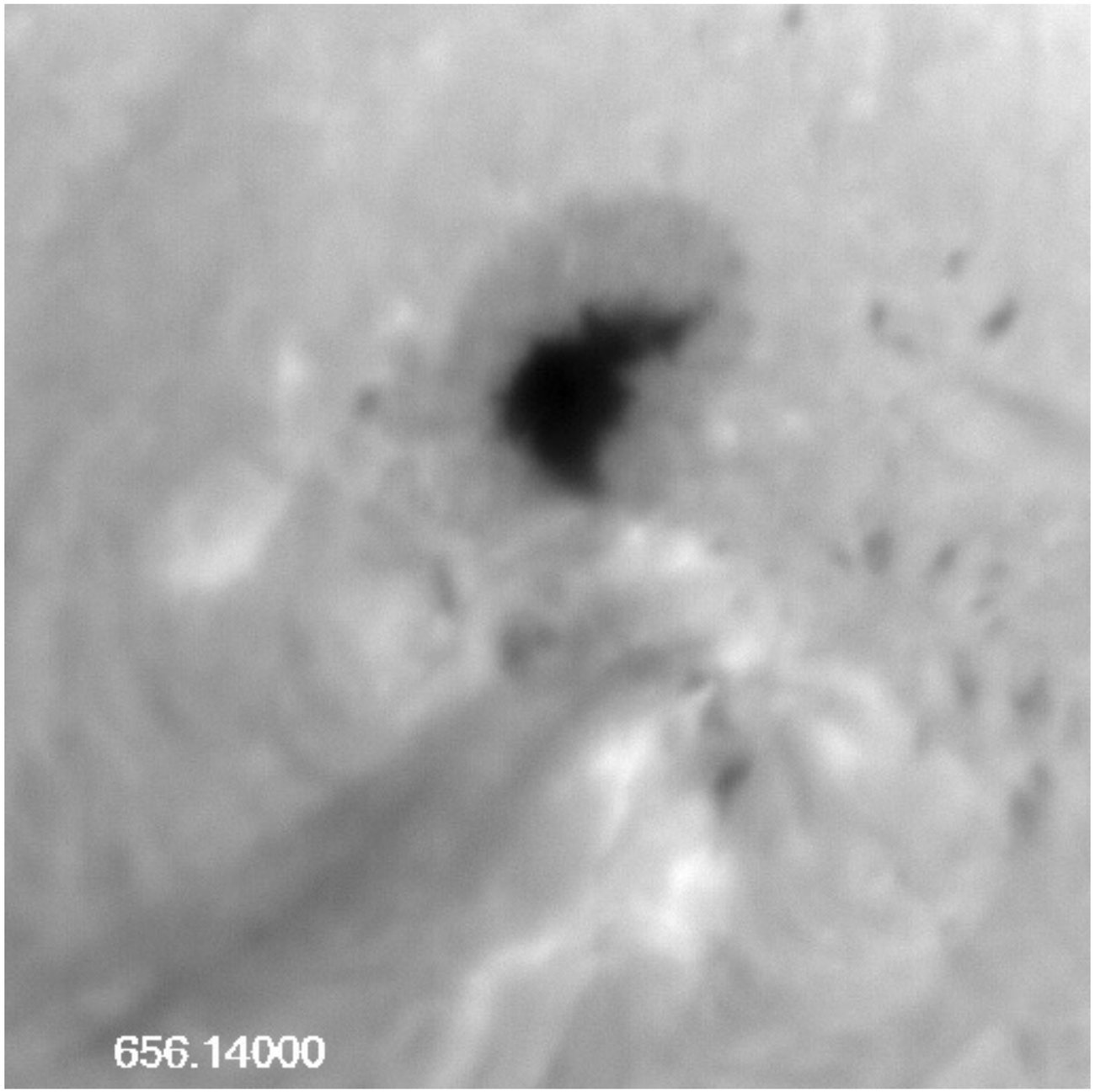
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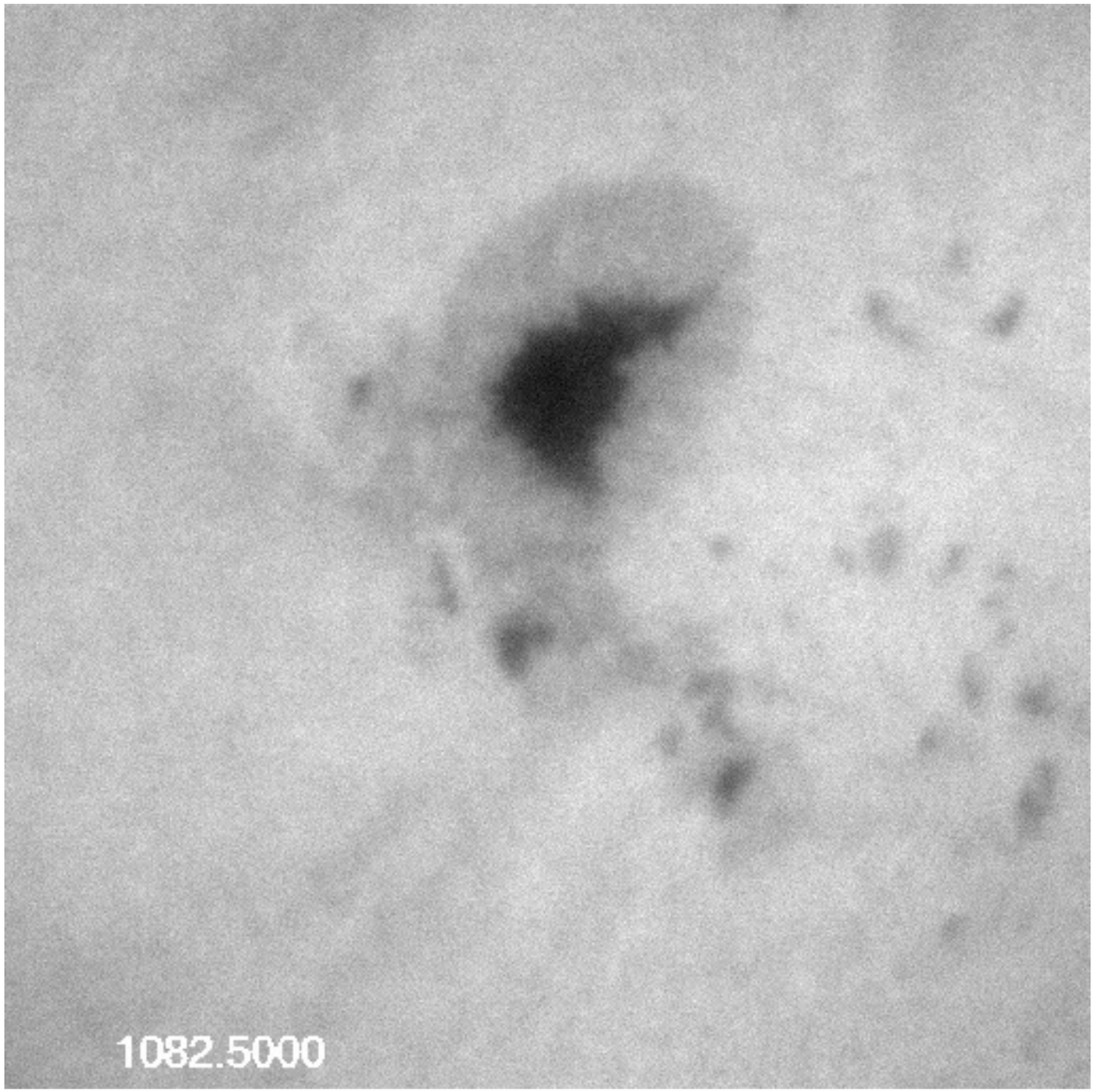
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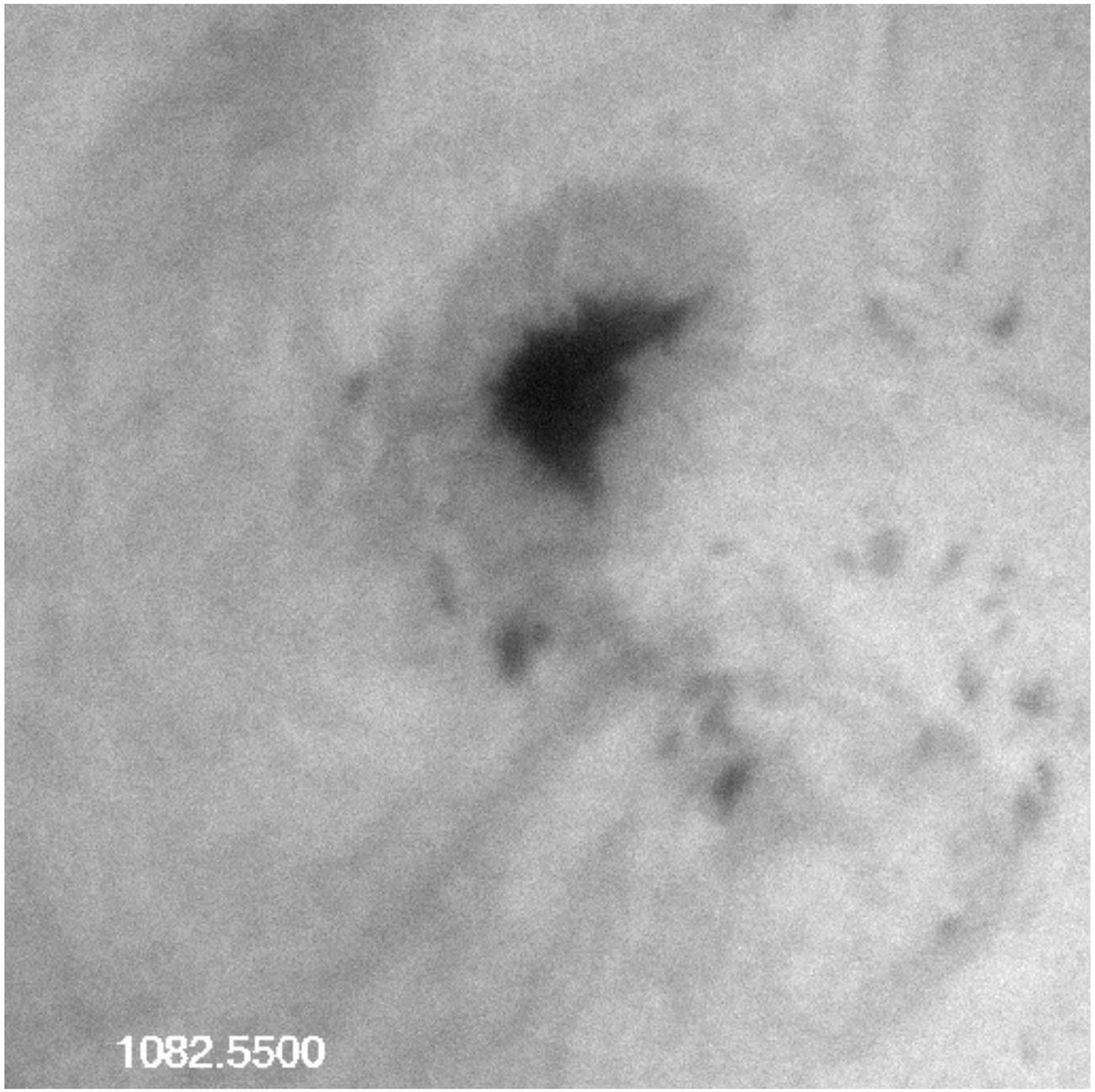
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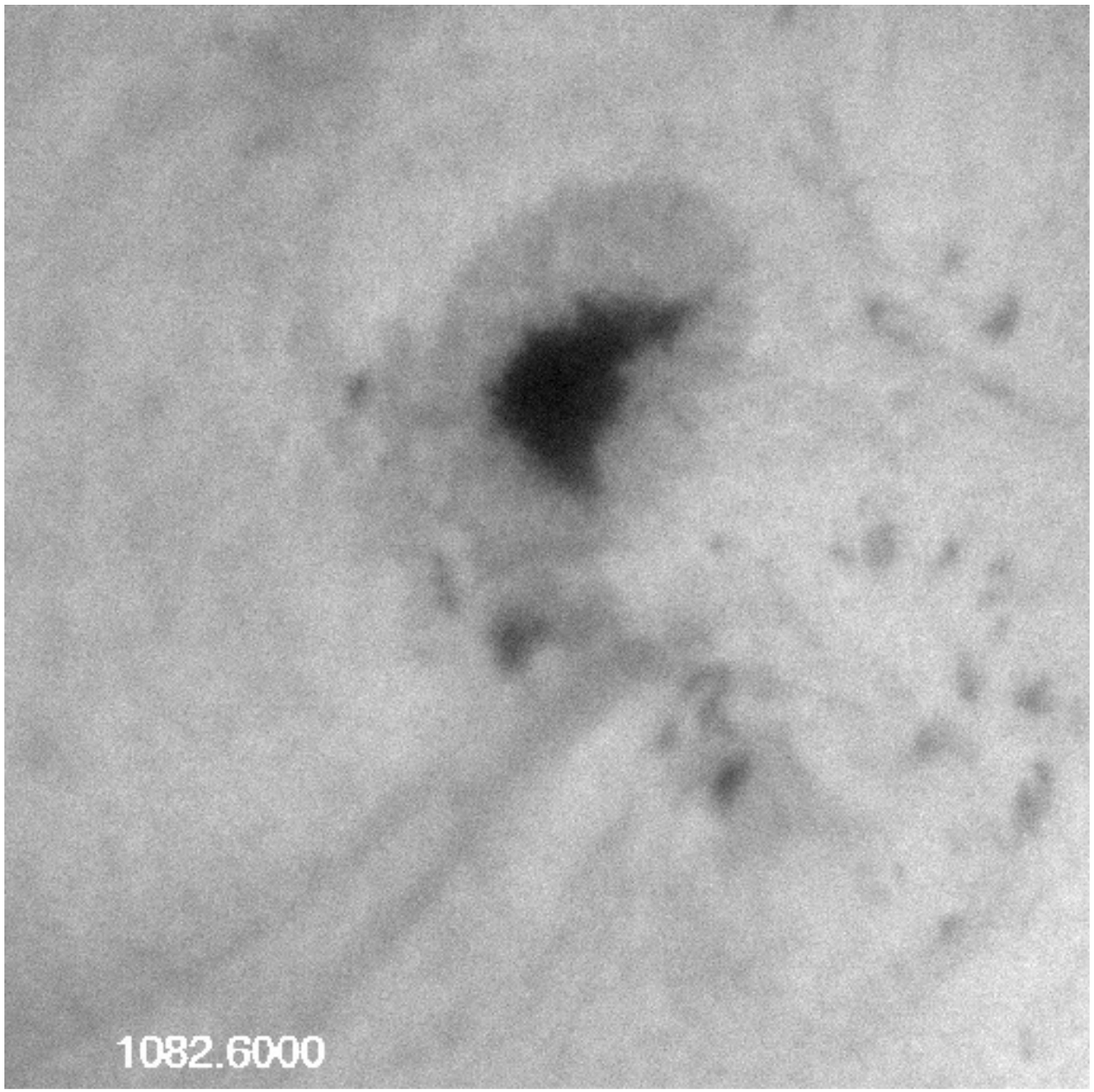
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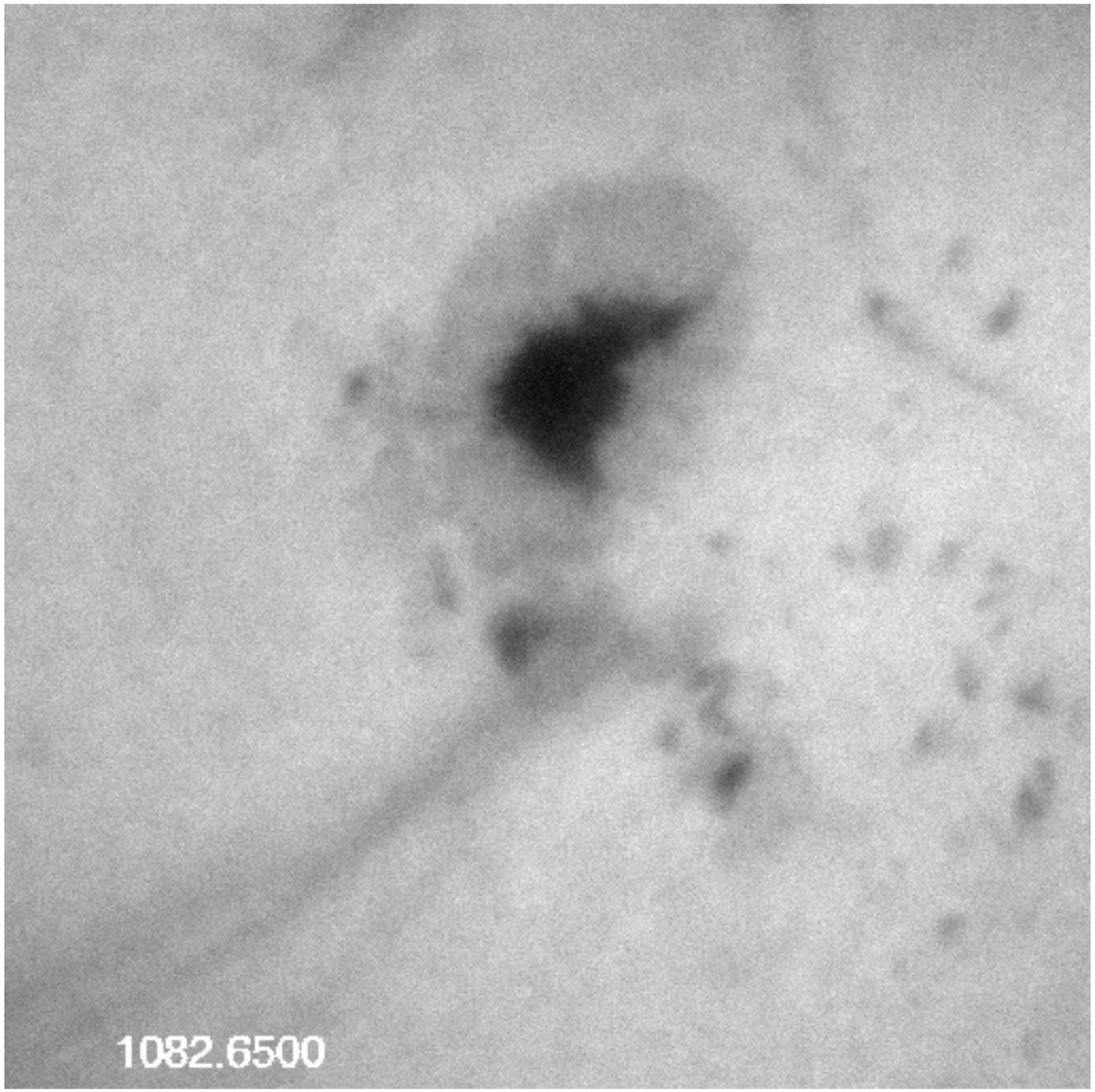
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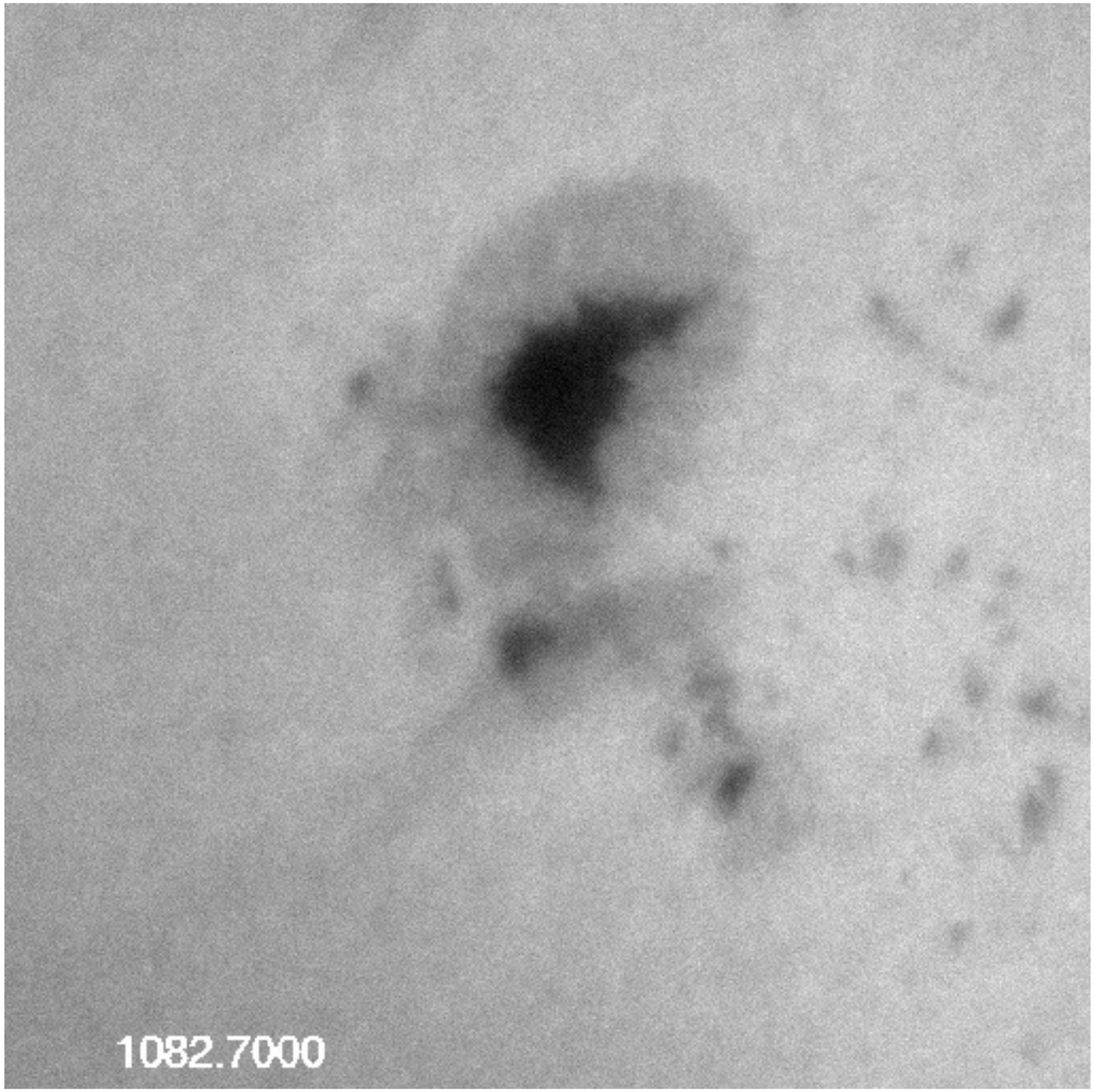
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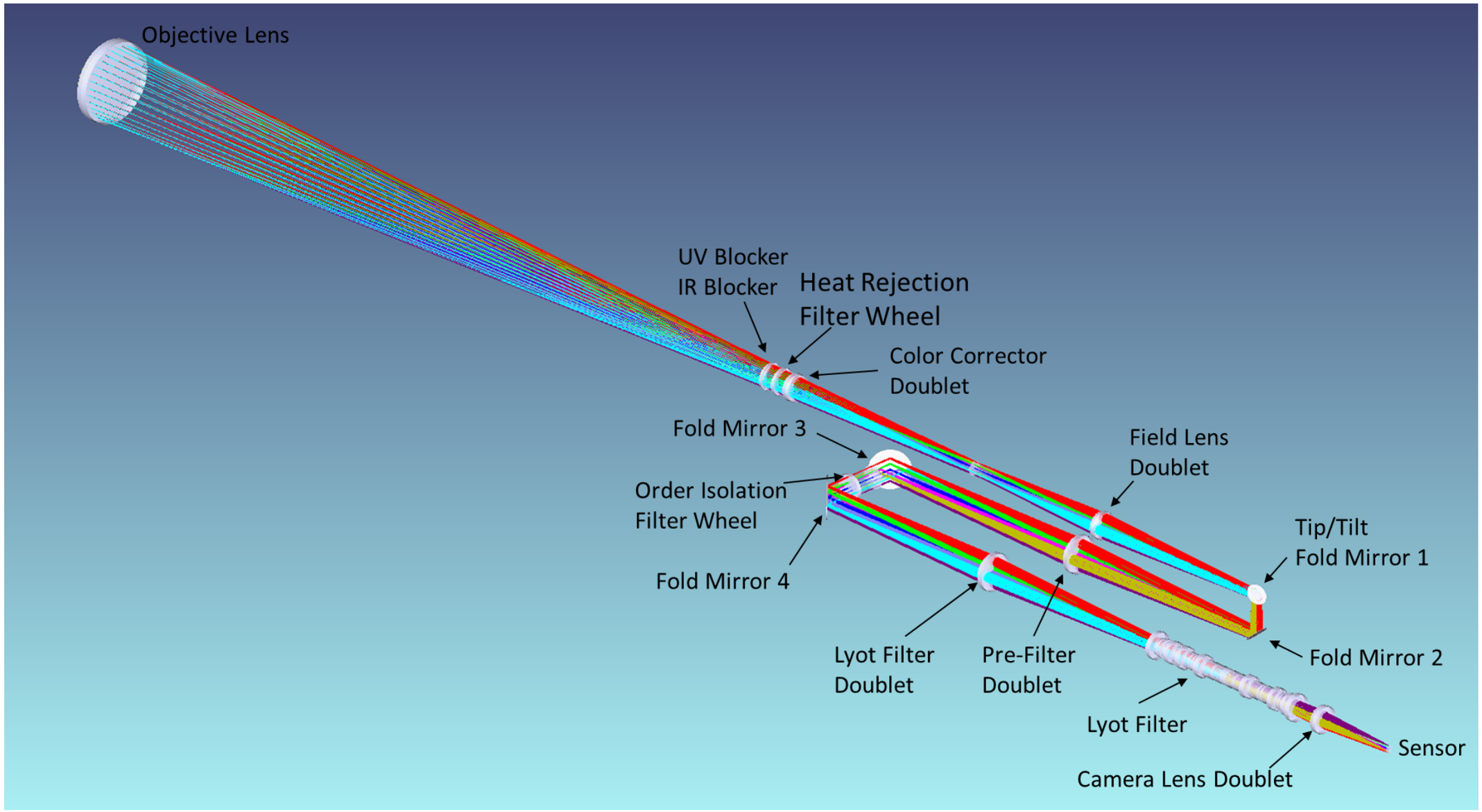
MLSO Instrument Improvements



ChroMag in GBSON

- Performs the tasks of the AFRL Full-Disk imager: chromospheric intensity and Doppler measurements
- Added polarimetric capability to include polarimetry for high-cadence magnetometry
- Network enables studies of solar evolution on timescales of days to weeks

Discussion Points

- Overlap with multi-height helioseismology instrument?
- Lyot filter vs. Fabry-Perot trade-offs