SUNRISE-III: HIGH-RESOLUTION EXPLORATION OF THE SOLAR ATMOSPHERIC STRATIFICATION

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SUNRISE III CONSORTIUM

SUNRISE III - TEAM

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PM, Telescope, PFI infrastructure, ISLiD, ICS, SUSI

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Applied Physics Laboratory, Johns Hopkins University, USA

Gondola, Interface to CSBF

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Instituto de Astrofisica de Andalucia, Spain, Spanish SIII consortium

TuMag

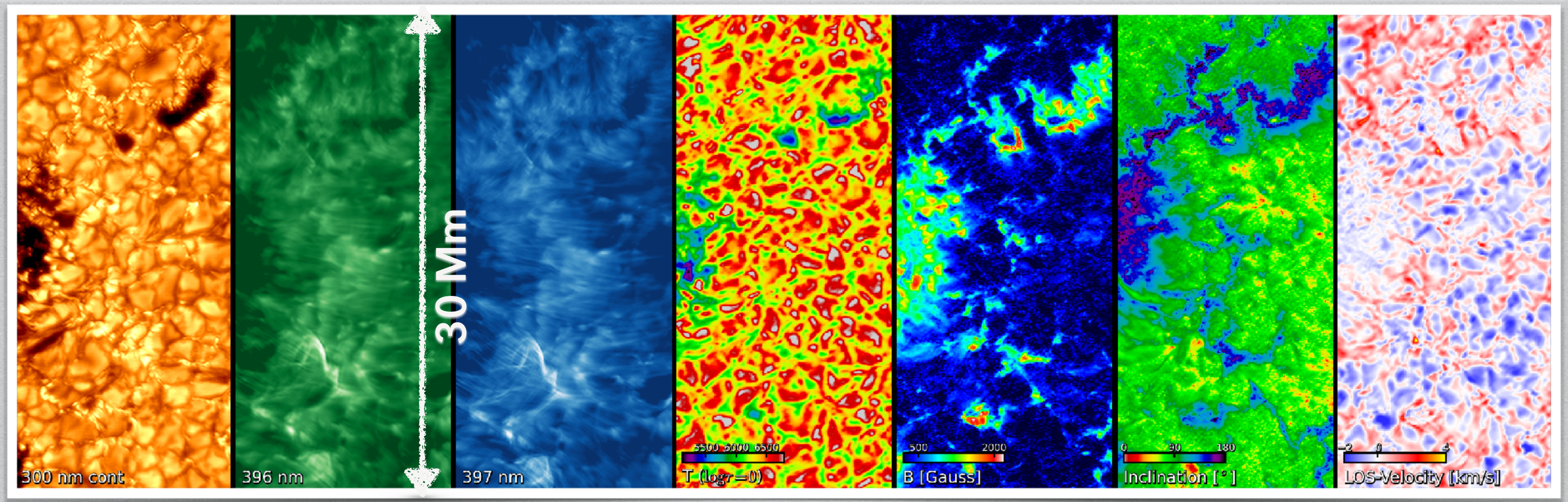
Y. Katsukawa + NAOJ Team
National Astronomical Observatory of Japan

SCIP

T. Berkefeld + KIS Team
Leibniz Institut für Sonnenphysik, Germany

CWS

SUNRISE II



Intensity image: photosphere

Narrow-band Ca-image: chromosphere

Temperature 'solar surface'

Magnetic field strength

Magnetic field orientation

Line-of-sight velocity

Sunrise I+II: Results

Sunrise I+II, 2009 & 2013
so far >100 refereed
publications

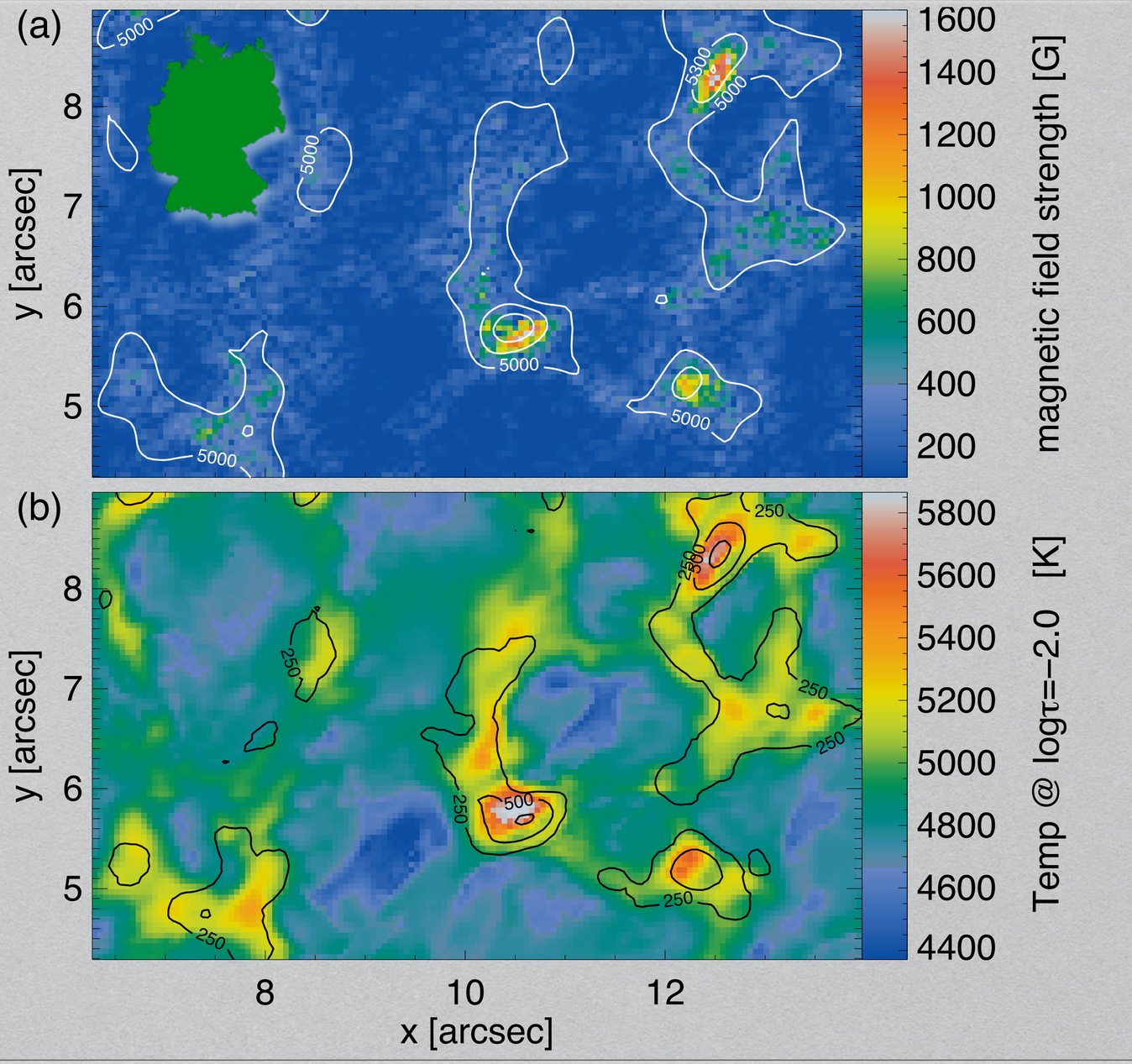
To our knowledge >10x
more papers than any other
balloon-borne solar mission

About same number of papers as
SOFIA, but at over an order of
magnitude lower cost!

Sunrise I: Resolving Small-Scale Structures

Lagg et al., 2010; Martínez González et al 2012, Requerey et al. 2015

- First ever spatially resolved images of small-scale intense magnetic flux concentrations in the quiet Sun show that semi-empirical flux tube models provide a reasonable description of such structures (Lagg et al. 2010).

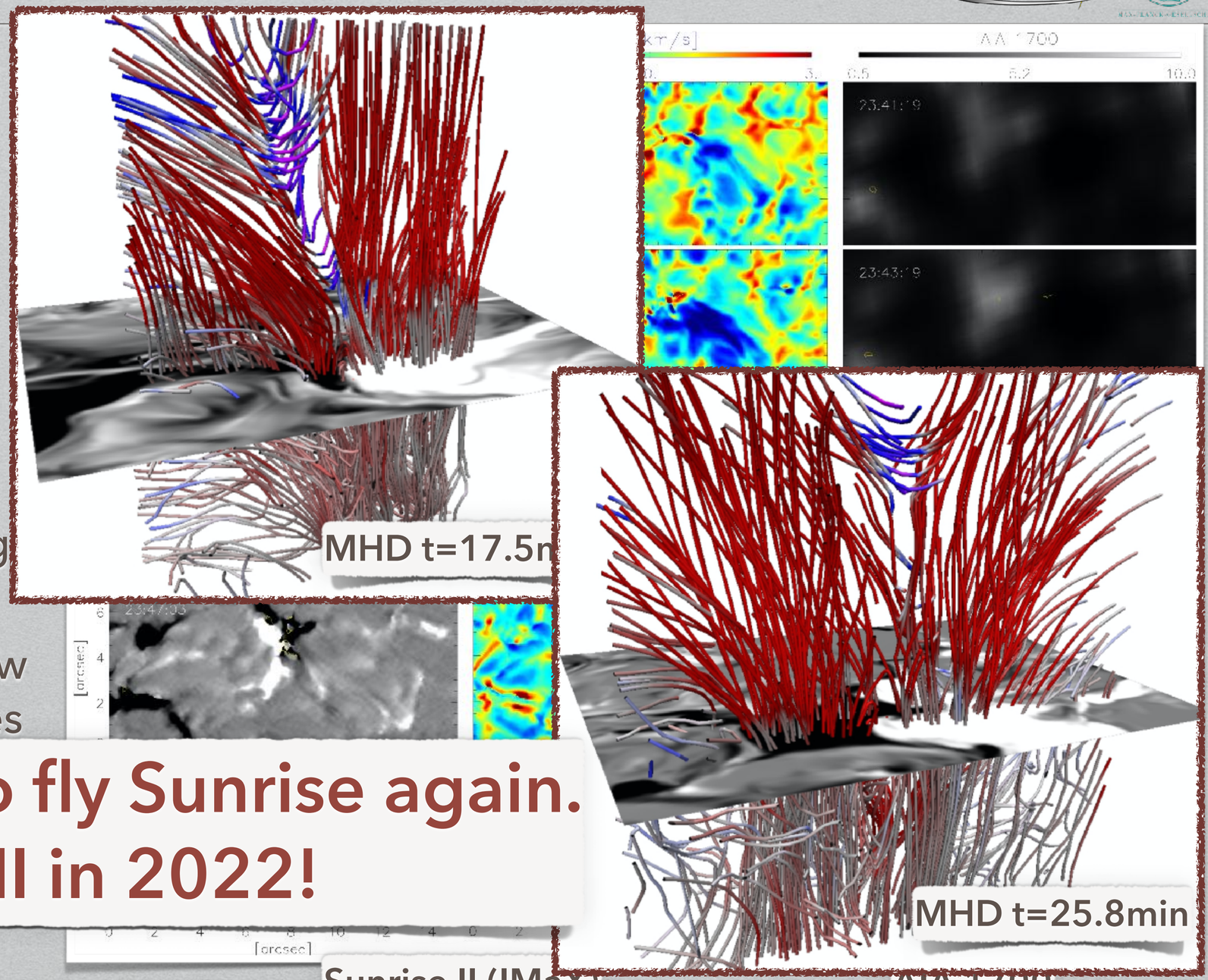


Photospheric Response to an Ellerman Bomb-like Event

Danilovic et al. (2019)

- analyze Sunrise/IMaX data + 3D MHD simulations
- aim to reproduce the exact scenario proposed for the formation of EBs.
- The simulations also reveal the full complexity of the underlying process.
- The simulated observations show that the Fe i 525.02 nm line gives no ir… whe…
- Bette…

2017: decided to fly Sunrise again.
Sunrise III in 2022!

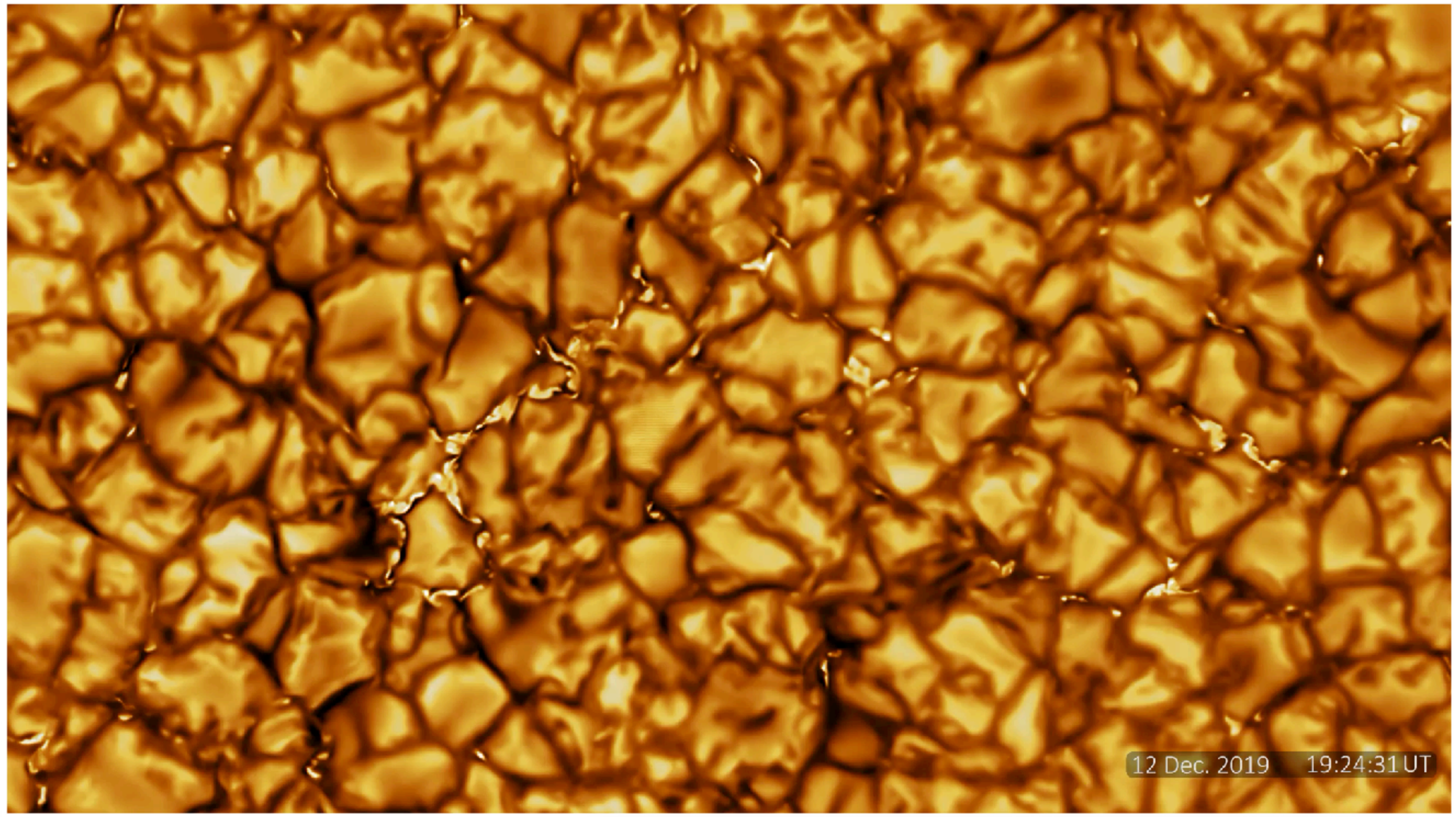


Why Sunrise III?

Ground based observations caught up:

- Fast cameras
- sophisticated instrumentation (e.g. MiHI)
- powerful image reconstruction techniques
- 4m solar telescope: DKIST first light Dec 12 2019

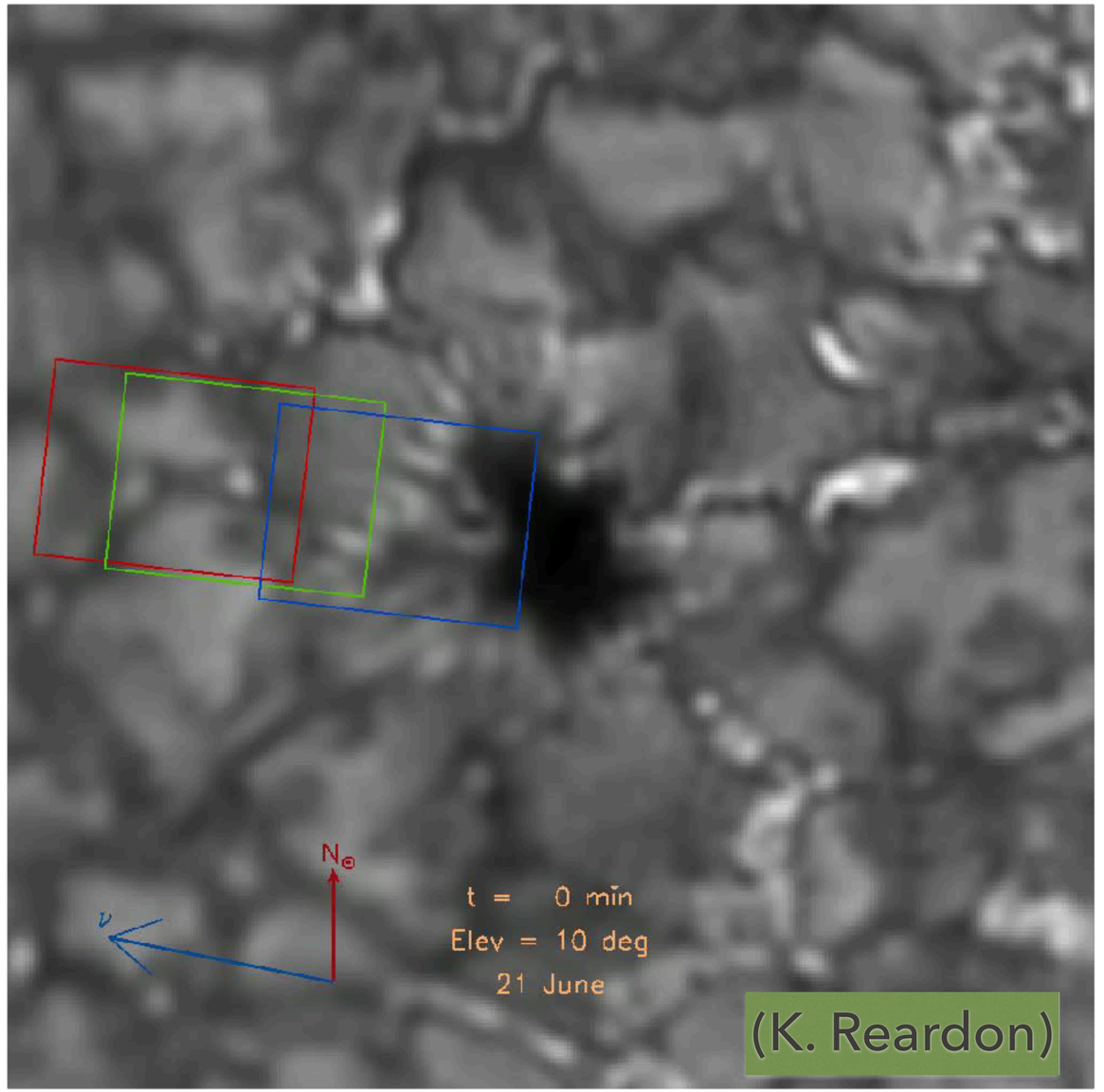
A 1-m telescope in the DKIST era?



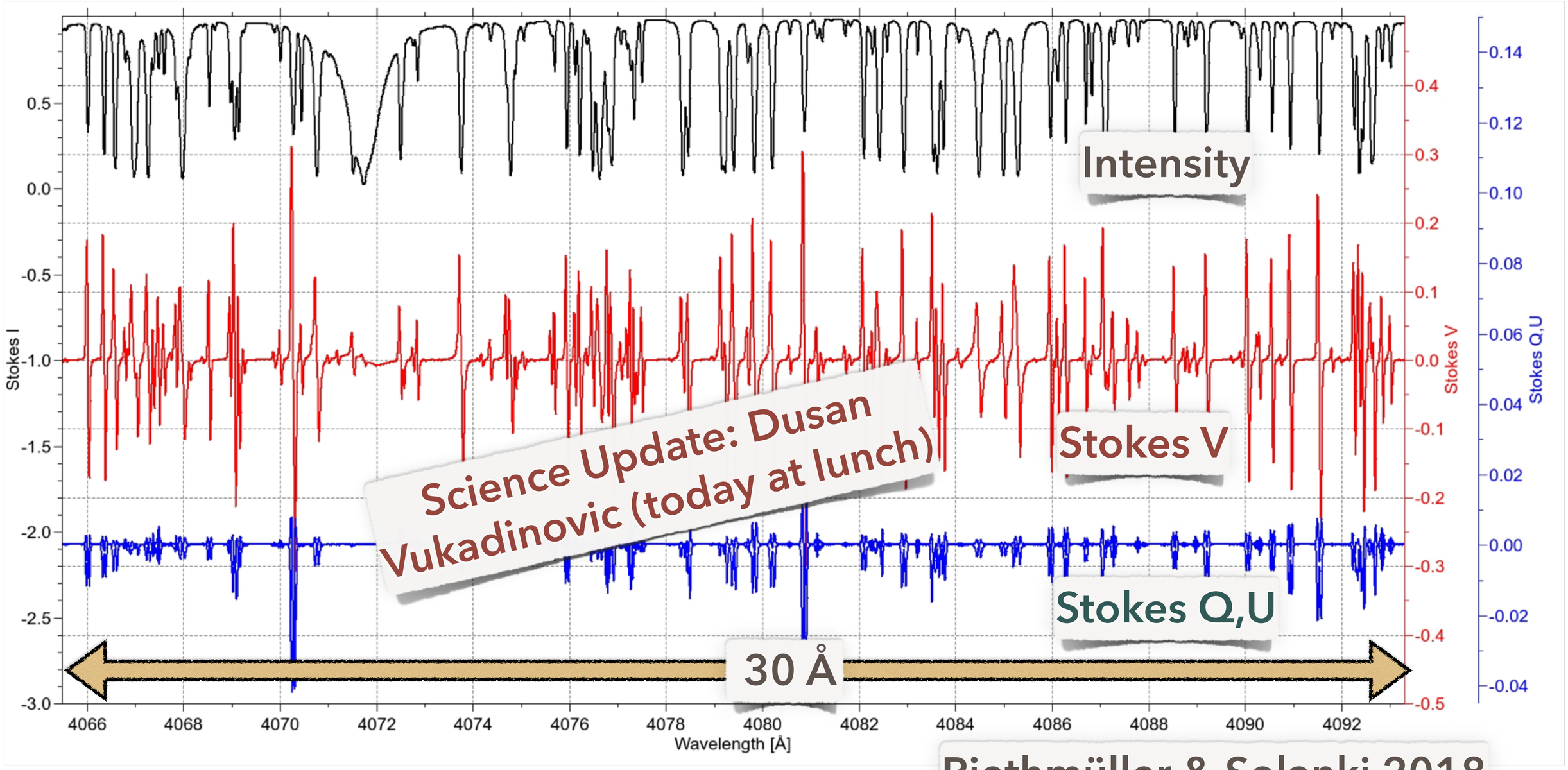
DKIST First Light, 12-Dec 2019

Why Sunrise III?

- no atmospheric dispersion
  combine various wavelengths
  - **8542 Å**
  - **10830 Å**
  - **15000 Å**
- long, constant-quality time series
- access to UV
- Seeing-free environment
- well-known PSF (high pol. S/N ratio, no noise increase from reconstruction)
- no telluric lines
- sky brightness

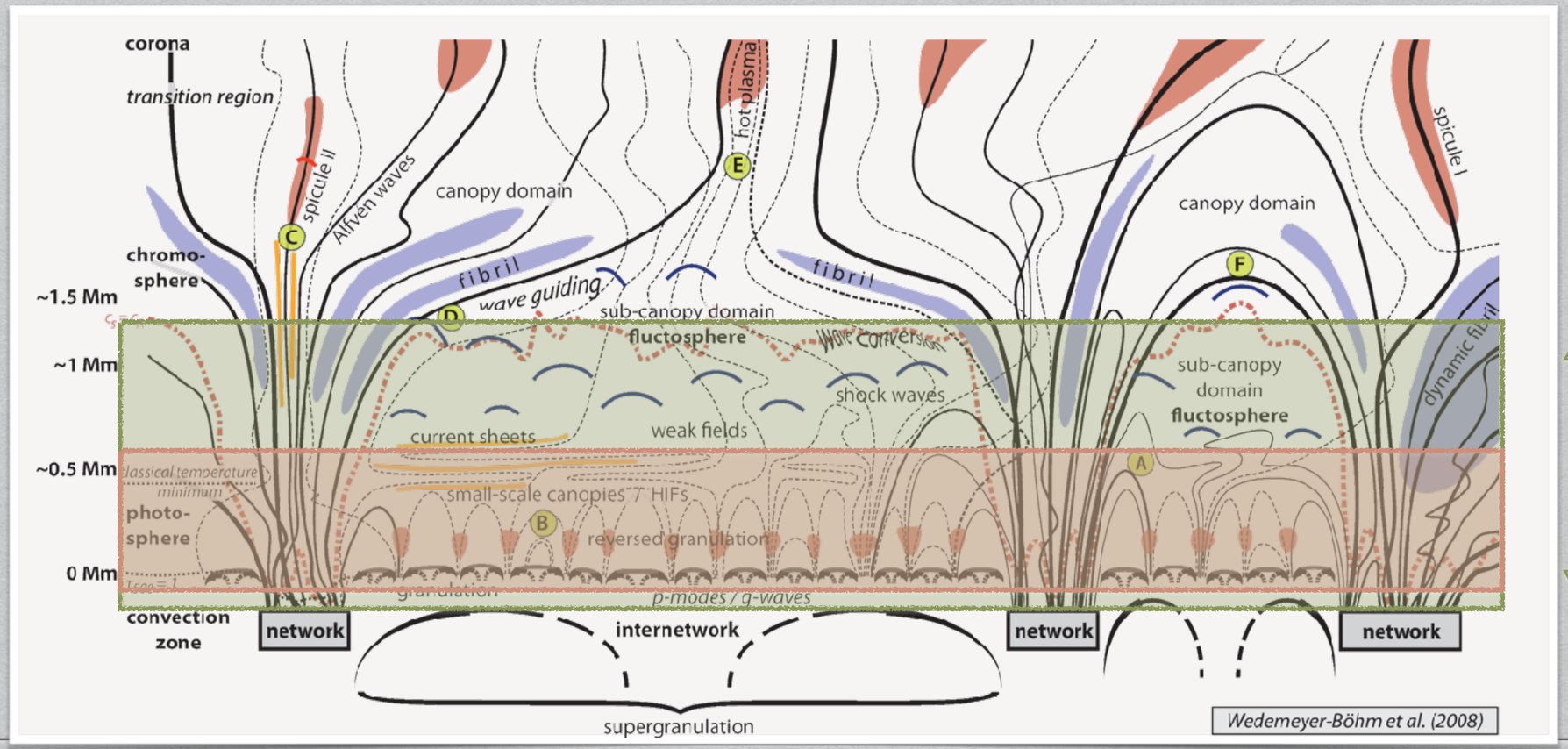


Many-Line Analysis with Sunrise III



SUNRISE III - PROBING DEEPER AND HIGHER

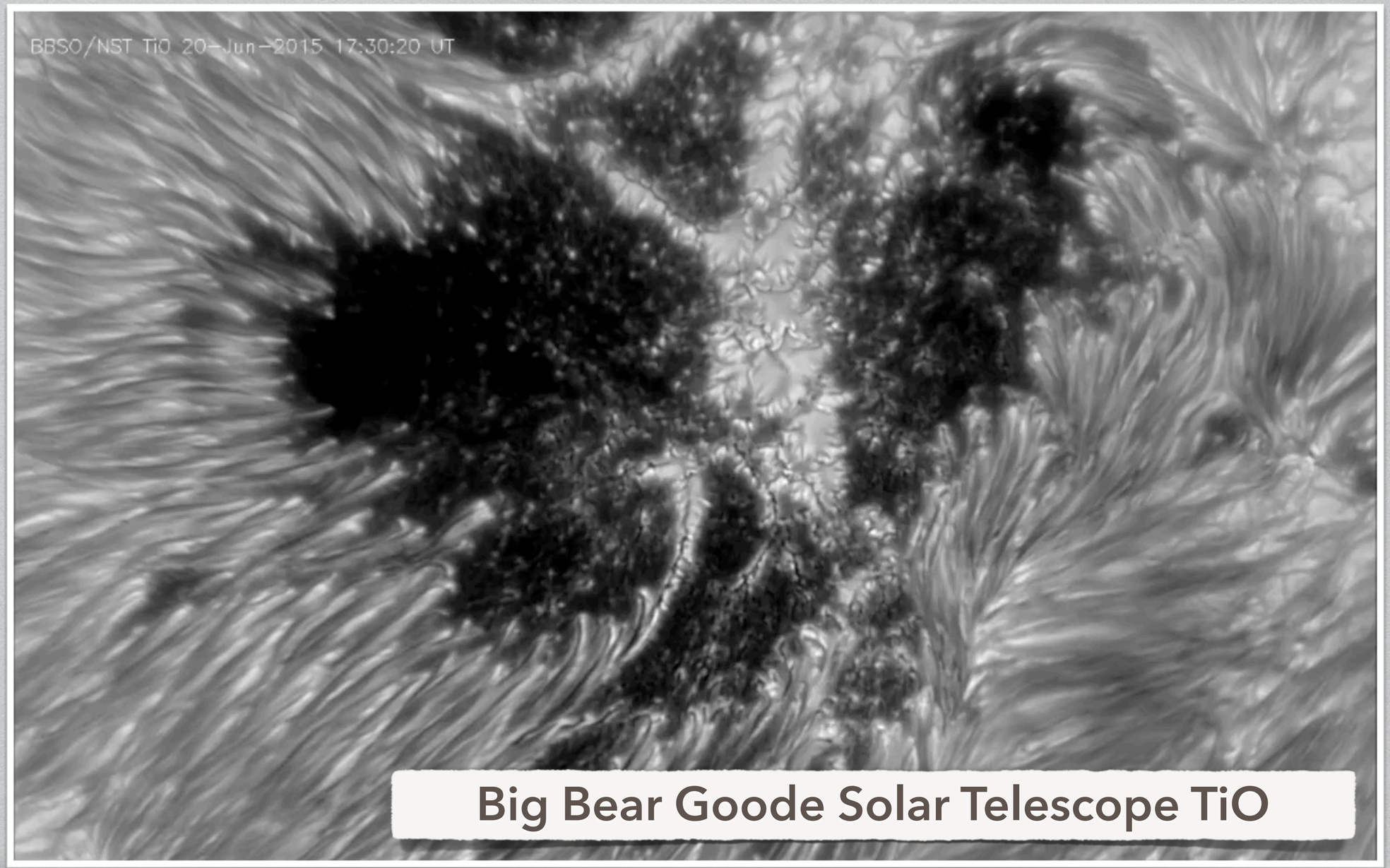
- Sunrise I & II resolved elementary magnetic structures, uncovered chromospheric waves & a possible new way to heat the corona
- Sunrise III will use new instruments and a new gondola to probe the magnetic field & its influence on the plasma over larger height range



Sunrise advantages: High-Res & Stability

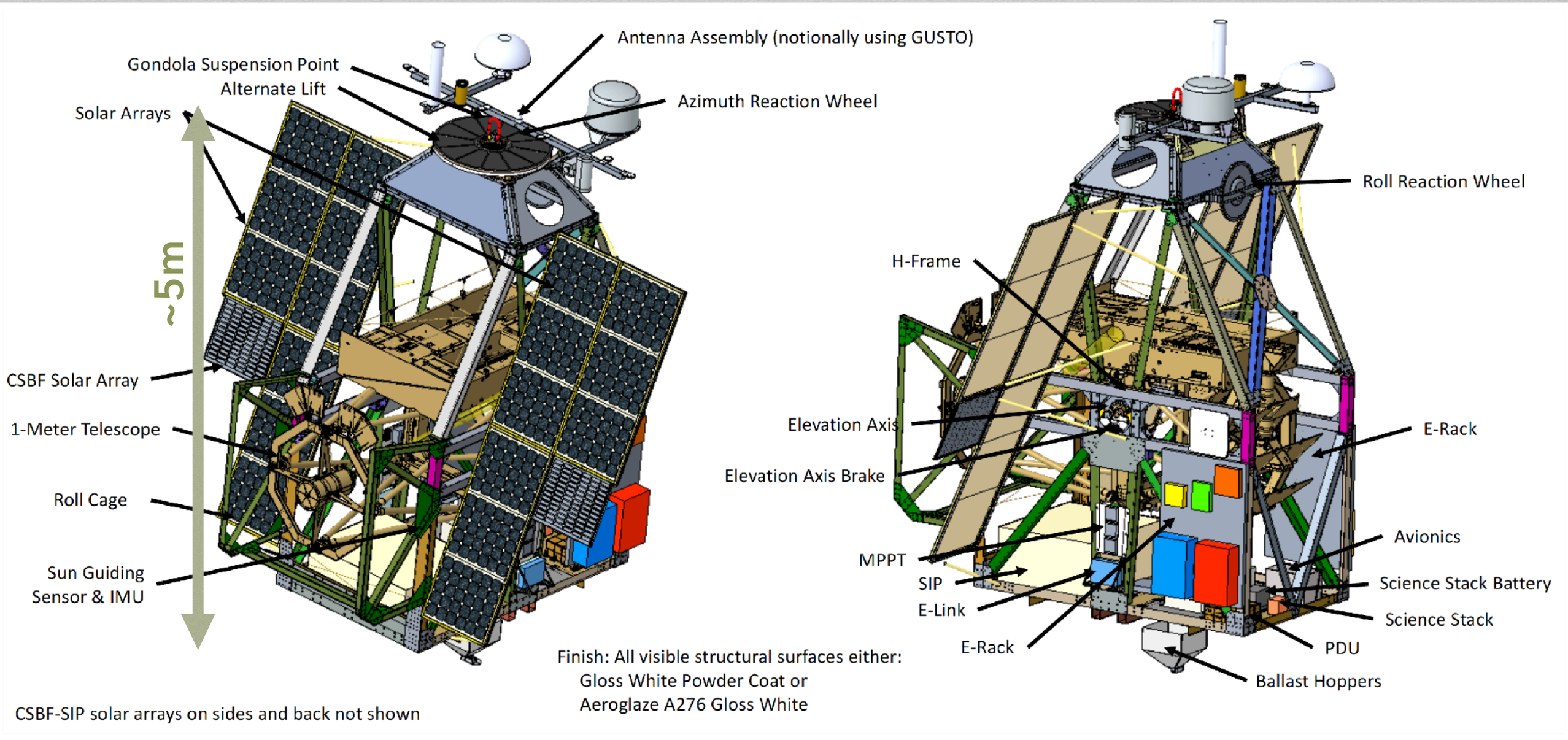
observing waves requires:

- high resol. (kink, sausage)
- high magnetic sensitivity (Alfvén)
- high temporal cadence
- high stability
- height coverage



Big Bear Goode Solar Telescope TiO

Sunrise III: The New Gondola



Sunrise III Status: Telescope & Gondola

- Optics:
  - M1+M2 recoated (Calar Alto, Nov 2019) and re-measured (SAFRAN, Paris)
  - M1, M2 shows absolutely no change as compared to the last measurement in 2011!
- Thermal:
  - New heat reje
- Mechanical:
  - Assembly of t ongoing
- Gondola:
  - mounted at APL. Sun pointing tests this week

Der Spiegel wird am Calar Alto Observatorium im Süden Spaniens neu bedampft – Göttinger Wissenschaftler begleiten die Arbeiten.

...adtspiegel des Sunrise-Teleskop

wird neu beschichtet

Göttinger bereiten unbemannte Mission zur Sonnenerforschung vor

ke

Höhe von mehr
htet die Ballon-
hochauflösen-

cher Flug an dem Spiegel aber nicht vorbei", erklärt Sunrise-Projektleiter Dr. Andreas Lagg vom MPS. Die äußere Schicht aus spiegelndem Aluminium würde leiden und müsse

MPS-Wissenschaftler Dr. Achim Gandorfer, der zusammen mit weiteren MPS-Kollegen vor Ort war.

Reise startet im

struktur der Sonnenatmosphäre mit bisher unerreichter Genauigkeit bestimmen", fügt er hinzu.

Ebenso entscheidend für den einzigartigen Blick auf die Sonne ist

Schichten des Gas
dengebundenen T
deshalb dieser Te
nicht zur Verfügur

Das unbemannte Observatorium blickt aus seiner Flughöhe auf die Sonne und landet nach einem mehrtägigen Flug mit einem Fallschirm. Zweimal hat der empfindliche Hauptspiegel des Teleskops die Forschungsreise unbeschadet überstanden. „Ganz spurlos geht ein sol-

torium, das unter anderem die grundlegenden physikalischen Prozesse des Magnetfeldes in der unteren Sonnenatmosphäre untersucht. Diese Prozesse sind entscheidend für das Verständnis der magnetischen Aktivität

in ihren äußeren Schichten, wo die Energie in Eruptionen und koronalen Massenauswürfen an den Weltraum abgegeben wird, was wiederum Auswirkungen auf die Erde hat. Das Observatorium

flugt, in einer Höhe von etwa 37 Kilometern. Damit entkommt es dem störenden Einfluss der erdnahen Atmosphäre und kann gleichzeitig das Sonnenlicht im ultravioletten Bereich untersuchen. Sunrise ist im Juni 2009 und Juni

startet von der Weltraumbasis Esrange bei Kiruna in Nordschweden und dauerten mehrere Tage. Dabei konnte das Observatorium die Sonne sowohl im ruhigen als auch im aktiven Zustand untersuchen.

ckelt. Das IAA, das National Astronomical Observatory of Japan (NAOJ), das Leibniz-Institut für Sonnenphysik (KIS) in Freiburg sowie das Applied Physics Laboratory der John Hopkins University in den USA tragen weitere Messinstrumente und Hardware-Komponenten zu der Mission bei.

Sunrise III Status: ISLiD / PFI / ICS / CWS

Complete redesign compared to Sunrise 1+2!

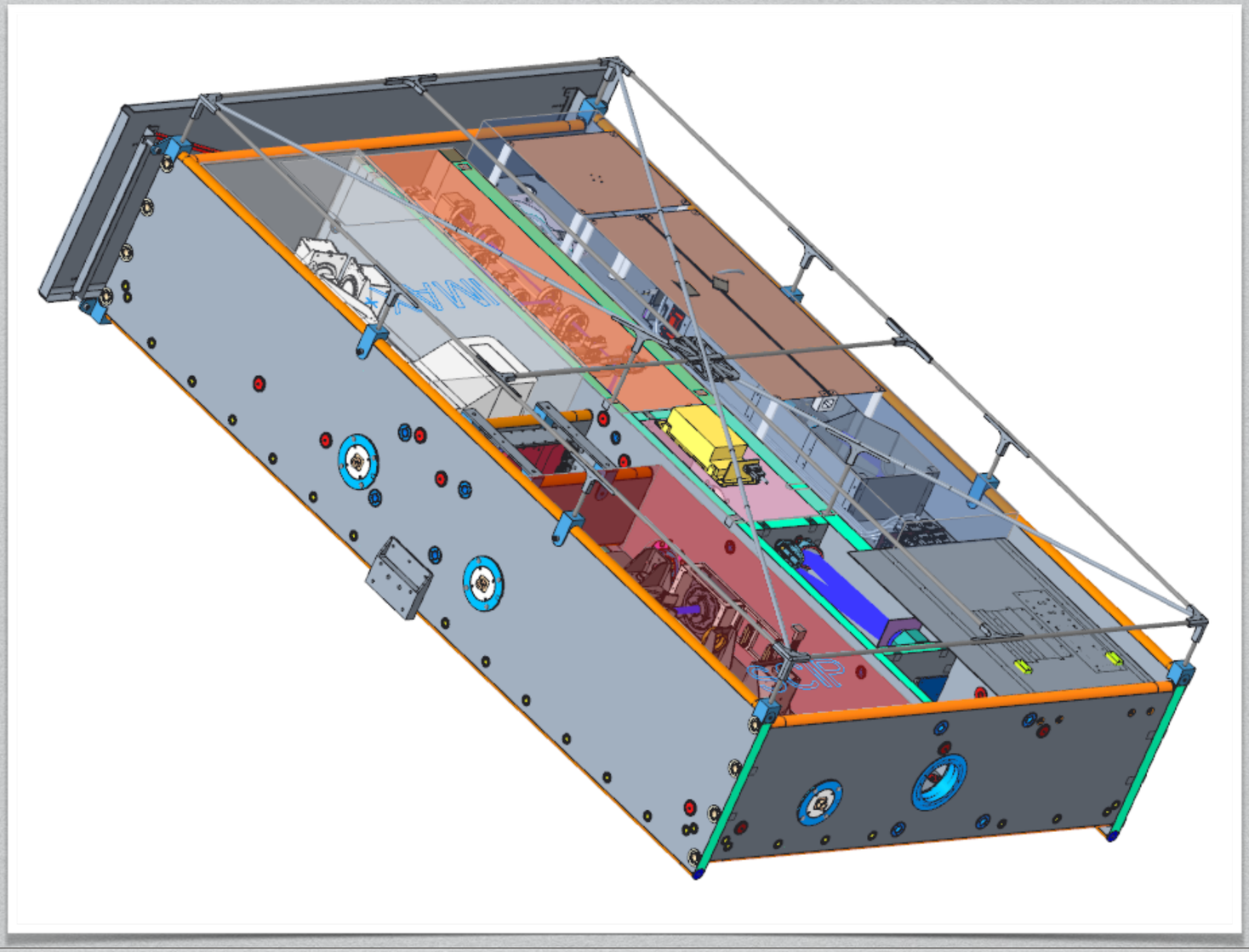
- all optical components received and tested
- mounting of optics to CF structure will start in October

ICS = Sunrise III brain

- 32 CPU cores, frame grabber, 320 TB hard disks
- 150 W in pressurized box

CWS: Image stabilization

- down to 0.005 arcsec (=3.5 km on the Sun)



Sunrise III Status: Science Instruments

SUSI (UV spectropolarimeter):

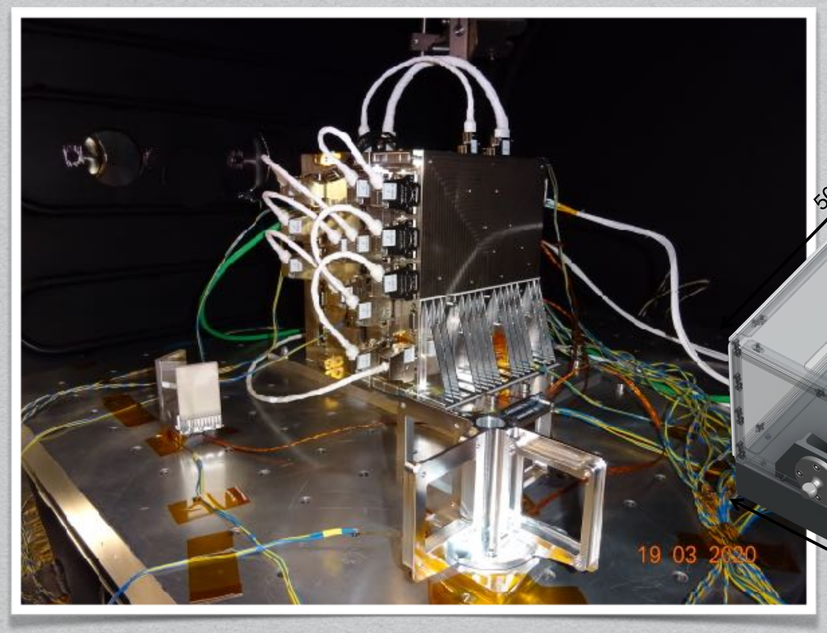
- FM Hardware almost ready
- Now: testing (TV)
- Integration: Q1/2021

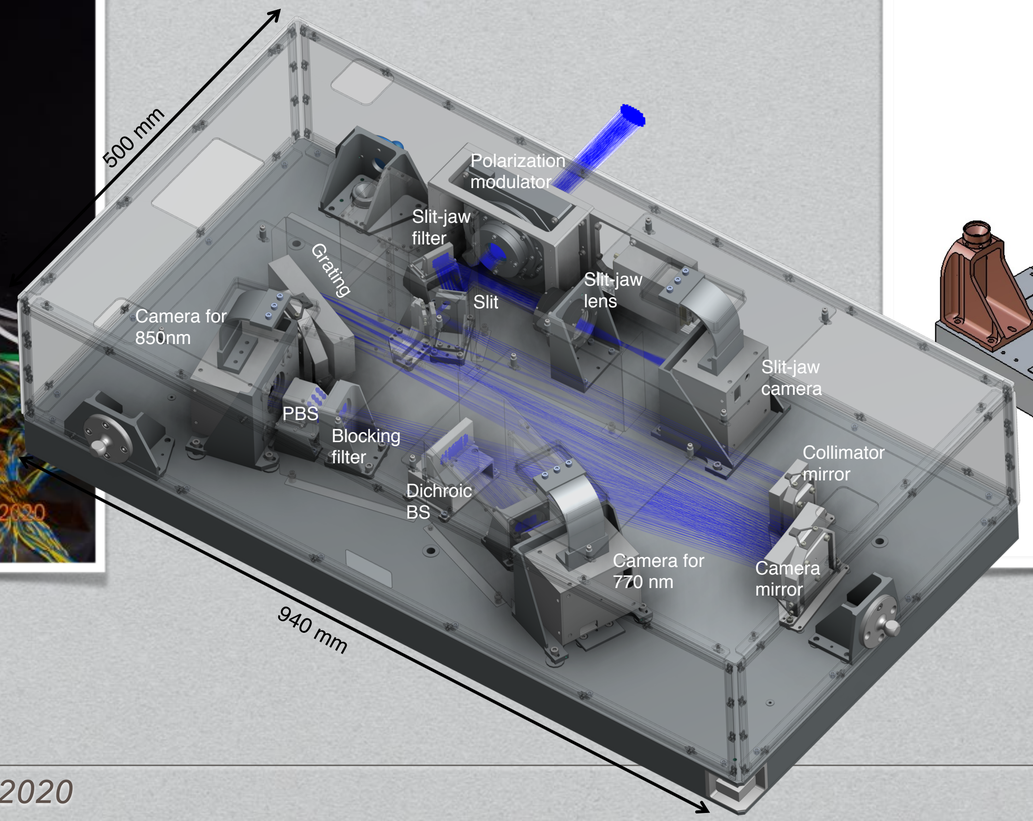
TuMaG (imaging spectropol.)

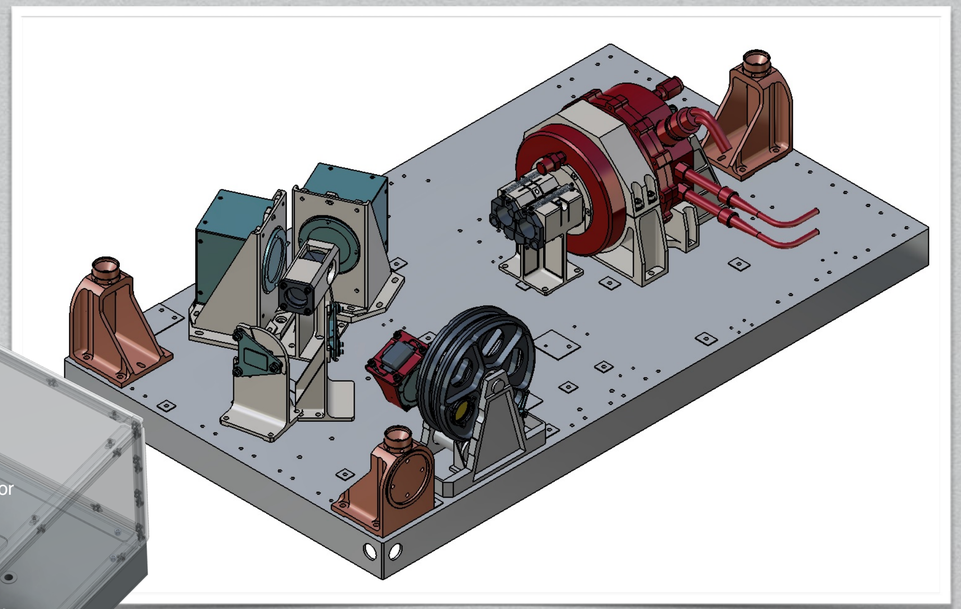
- FM Hardware in fabrication
- Spain: corona impact
- Integration: Q2+3/2021

SCIP (IR sepctropolarimeter)

- FM Hardware almost ready
- testing ongoing
- Integration: Q1/2021







SUNRISE SCHEDULE: CORONA ADAPTED PLANNING

Date start	Days	End	Name
01/11/2020	30	01/12/2020	ISLiD integration to PFI (TT & EGSE TT must be available)
01/12/2020	21	22/12/2020	CWS integration to PFI (part I)
22/12/2020	17	08/01/2021	xmas / contingency
08/01/2021	21	29/01/2021	CWS integration to PFI (part II)
29/01/2021	0	29/01/2021	ICS ready
29/01/2021	3	01/02/2021	ICS mounting on E-rack
01/02/2021	42	15/03/2021	SCIP integration to PFI
15/03/2021	42	26/04/2021	SUSI integration to PFI (ICS required)
26/04/2021	35	31/05/2021	PFI full functional test with integrated instruments in vacuum setup (in air)
31/05/2021	14	14/06/2021	PFI into Tvac chamber
14/06/2021	35	19/07/2021	PFI Tvac
19/07/2021	42	30/08/2021	TuMAG integration to PFI
30/08/2021	14	13/09/2021	merging of PFI and telescope
13/09/2021	7	20/09/2021	PFI Pol. calibration from F1 (all instruments)
20/09/2021	21	11/10/2021	Mating gondola & payload
11/10/2021	28	08/11/2021	Hangtest@MPS
08/11/2021	60	07/01/2022	Operation Training & Final tests (all instruments)
07/01/2022	14	21/01/2022	unmount gondola and payload
21/01/2022	25	15/02/2022	contingency
15/02/2022	14	01/03/2022	PFI 2nd TVac with Sun
01/03/2022	14	15/03/2022	packing
15/03/2022	7	22/03/2022	transport to Kiruna
22/03/2022	70	31/05/2022	Assembly & Verification @ ESRANGE
31/05/2022	**0**	**31/05/2022**	**ready for launch**

PFI

TV-Test

Hangtest

Test & Training

Kiruna

Thank you.

Updated flight video will be presented at the AG Tagung 2022.
Sunrise Science Splinter AG 2023?