New science windows with ground-based observations: the Daniel K Inouye Solar Telescope

Gianna Cauzzi[1,2] for

the DKIST team

(1) INAF – Osservatorio Astrofisico di Arcetri, Italy
(2) National Solar Observatory, USA

IRIS-9, Göttingen, 25-29 June 2018

Invited Talk

6. Science together with future facilities

New science windows with future ground-based observations - the Daniel K. Inouye Solar Telescope

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The NSO-led, 4-m Daniel K. Inouye Solar Telescope (DKIST) is nearing completion on Maui, Hawaii, with first light foreseen for early 2020. The DKIST will herald a new era of ground-based solar observations, with its polarimetric capabilities, unprecedented spatial resolution, and novel diagnostics in the near IR. In particular, DKIST is expected to revolutionize coronal science, providing high-sensitivity, high-resolution measurements of the coronal polarized spectrum.
After a brief update on the current status of the project, I will present the efforts under way to prepare for the scientific exploitation of the new data during the first two years of operation, the so-called "Critical Science Plan". A number of thematic workshops are currently being held, involving a large fraction of the solar physics community, with the final goal of identifying science topics that can best be addressed with the DKIST capabilities. Many of these science projects, in particular the ones addressing the physics of the outer solar atmosphere, will benefit from coordination with IRIS, exploiting its high spatial and temporal resolution, and complementary diagnostics.

New science windows with ground-based observations: the Daniel K Inouye Solar Telescope

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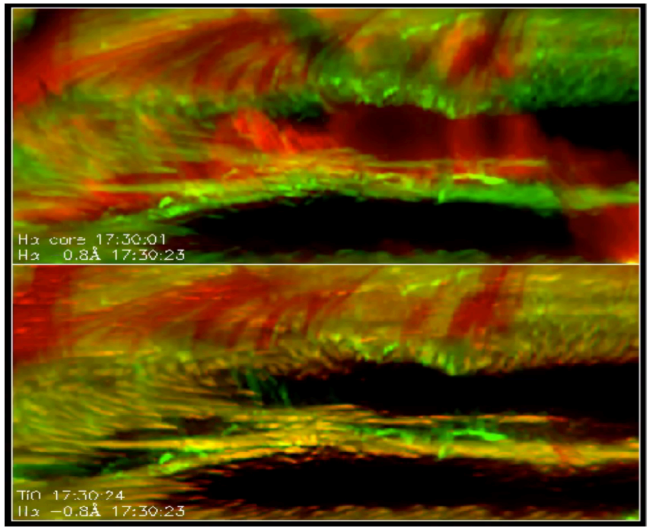
IRIS and GBOs

Chromosphere/TR diagnostics, dynamics, high fidelity spectra

Polarimetry, high cadence, high resolution

Two types of surges



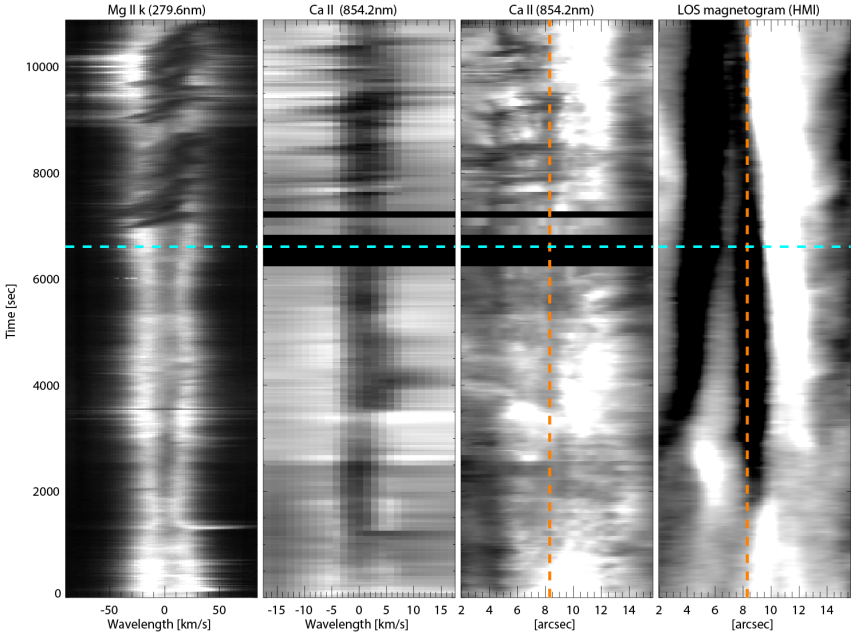
~~Reconnection~~ or Shocks

↓

Reconnection and Shocks

Base on IRIS SJI observations, Hou et al. (2017) came to a similar conclusion.

J. Zhang, this meeting



M. Kubo, this meeting

Daniel K Inouye Solar Telescope (DKIST)

It’s coming ….. (Haleakala, Maui)

Daniel K Inouye Solar Telescope: The Team

DKIST PI:

NSO/AURA

DKIST Director: T. Rimmele

DKIST co-Is:

P. Goode, M. Knoelker,

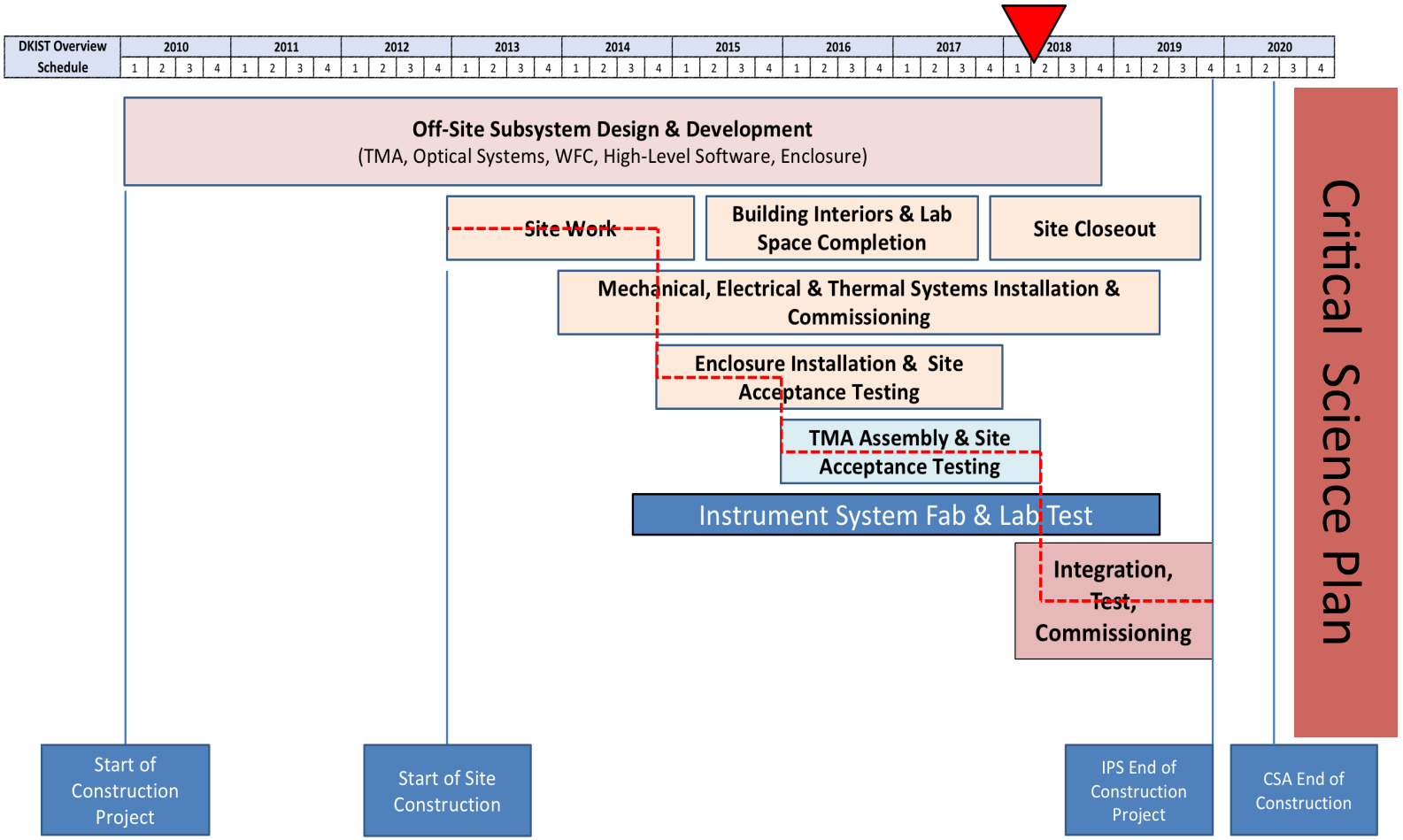
J. Kuhn, R. Rosner

First light instruments

- NSO
  - VBI PI: F. Woeger
- University of Hawaii, IfA
  - CRYO-NIRSP PI: J. Kuhn
  - DL-NIRSP PI: H. Lin
- High Altitude Observatory
  - ViSP PI: R. Casini
- KIS, Germany,
  - VTF PI: O. vd Luehe
- UK DKIST Consortium
  - Visible Detectors,

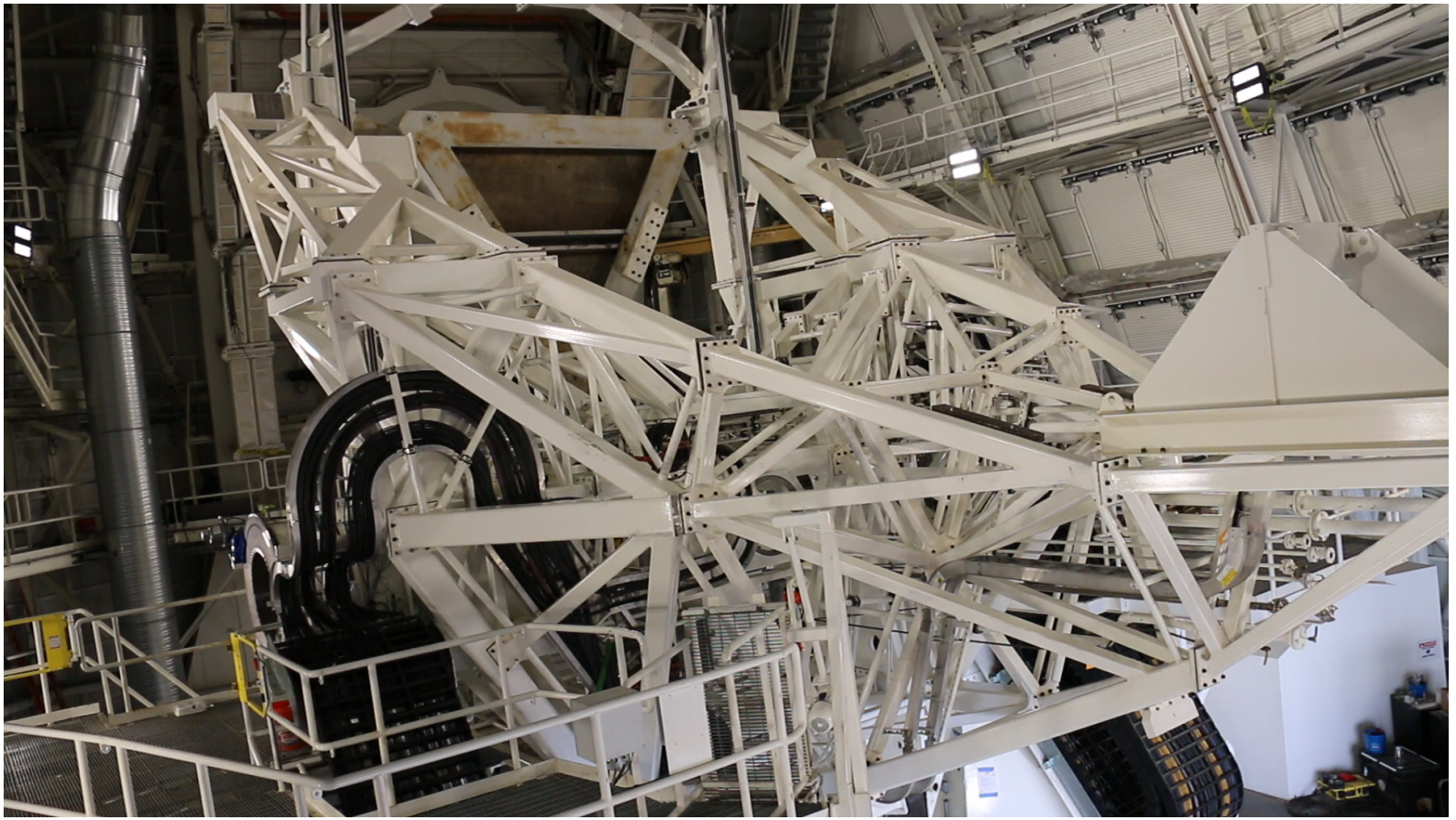
    PI: M. Mathioudakis, QUB

The DKIST: status and timeline



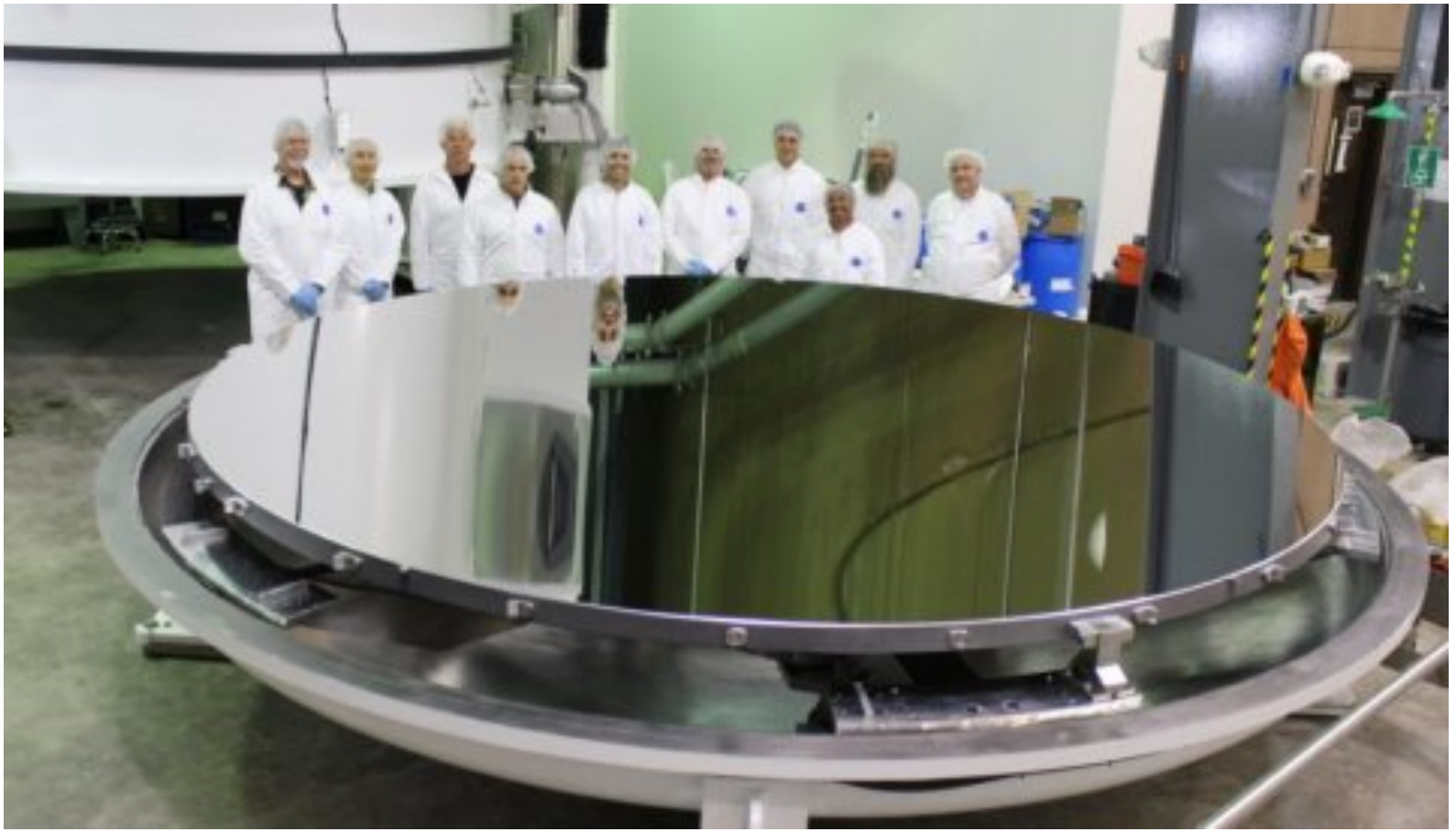
8 years of construction; 85% complete

Telescope mount



Science first light: mid 2020

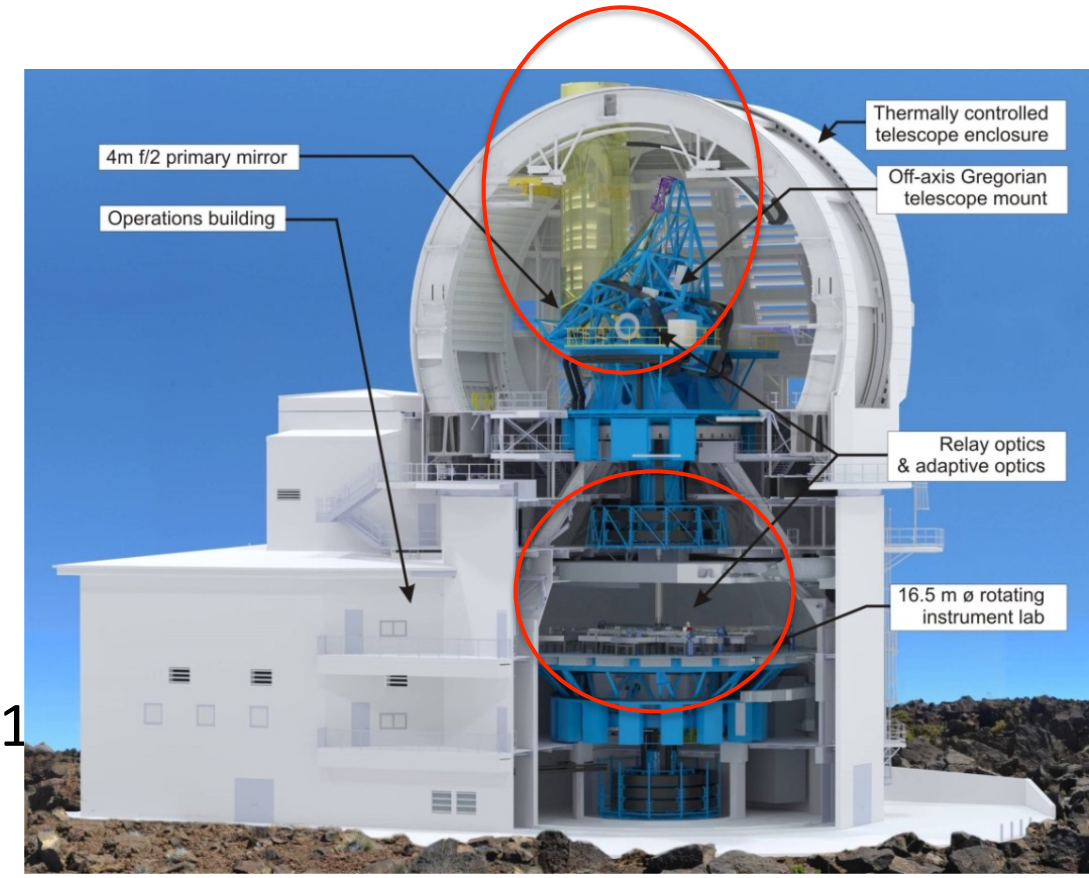
Telescope mirror



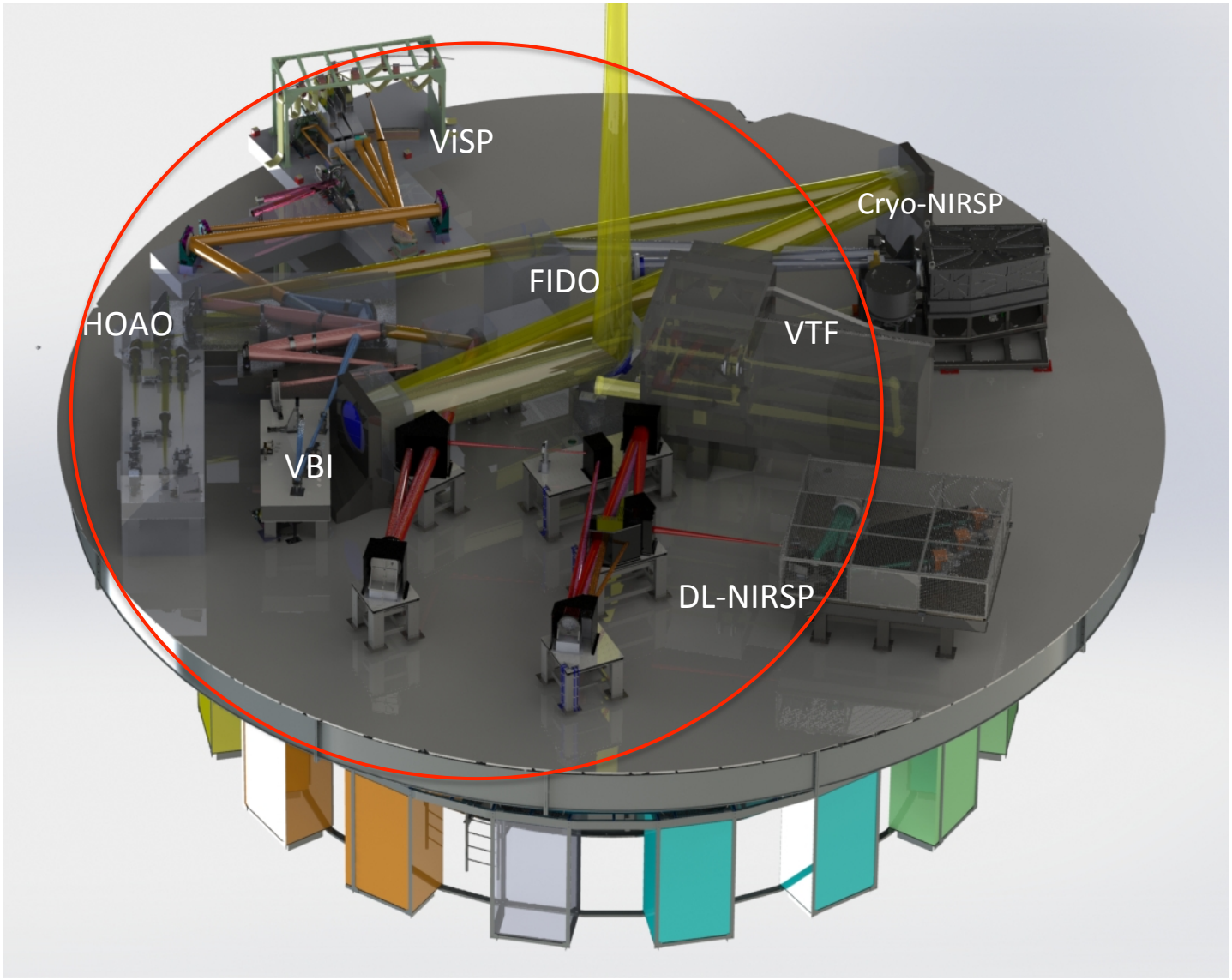
Science first light: mid 2020

DKIST: a transformational facility

- 4-meter aperture, f/2
- Alt/az mount
- All reflecting optics
- Off-axis design
- Low-scattered light
  - Coronagraph
  - Lyot stop & limb occulter
  - In situ clean & wash of M1
- Integrated adaptive optics
- High-precision polarimetry



First light instruments



DKIST Instrument Suite Overview

Instrument Name	Acronym	Wavelength Range	Analogs
Visible Broadband Imager	VBI (blue, red)	390 – 550 nm 600 – 860 nm	Hinode/BFI; ROSA *High cadence, high spatial res.*
Visible Spectro-Polarimeter	ViSP	380 – 900 nm	SPINOR, Hinode/SP, IRIS *Scanning spectrograph, high spectral fidelity*
Diffraction-Limited Near IR Spectro-Polarimeter	DL-NIRSP	500 – 900 nm 900 – 1350 nm 1350 – 1800 nm	SPIES, Image Slicer @ GREGOR *True IFU, variable spatial resolution / FOV*
Visible Tunable Filter	VTF	520 – 870 nm (590 – 870 nm)	IBIS, CRISP, GFPI, HMI *Imaging spectro-polarimeter*
Cryogenic Near IR Spectro-Polarimeter (with context imager)	Cryo-NIRSP	1000 – 5000 nm	CYRA (BBSO) *Cryogenic, scanning spectrograph, novel IR diagnostics*

ALL instruments (but VBI) are meant to perform polarimetric obs.

What is so special about DKIST

4 meter diameter:

- super-high resolution (~20 km @ 400 nm)
- “light bucket” -> high cadence
- “light bucket” -> high precision polarimetry (goal: S/N = 10^4 in Q/I)

All reflective:

- access to new IR diagnostics (mostly coronal; but not only)

Off-axis:

- low scattered light (coronal physics; but also sunspots!)

Multi-instrument:

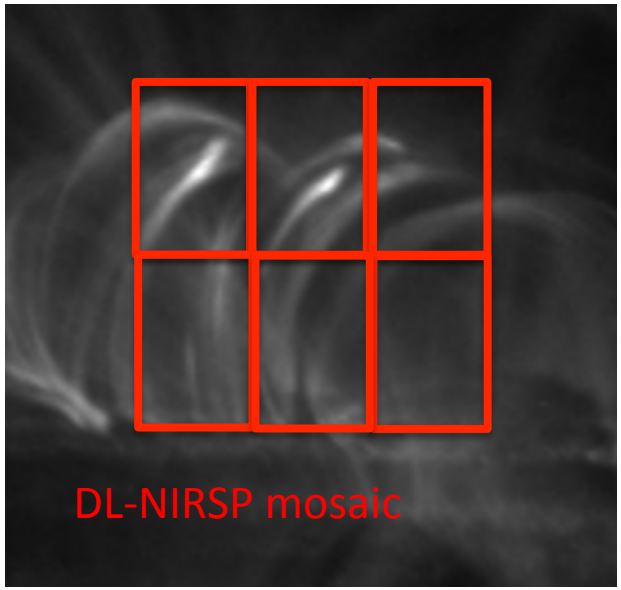
- multi-height diagnostics

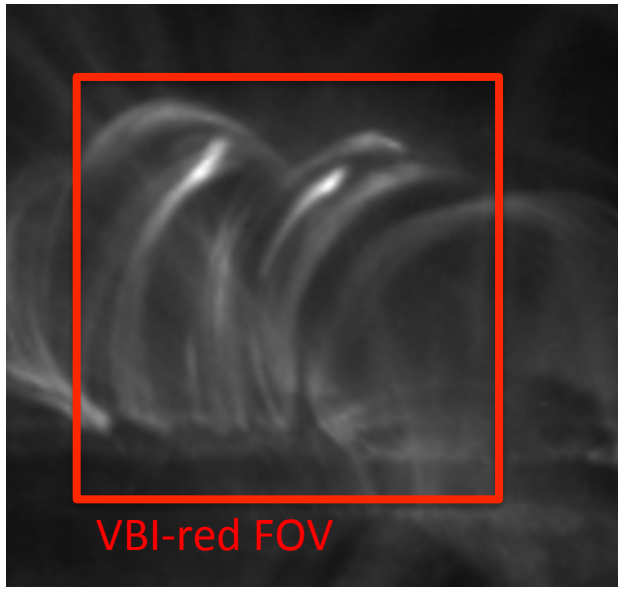
Science ideas ("use cases")

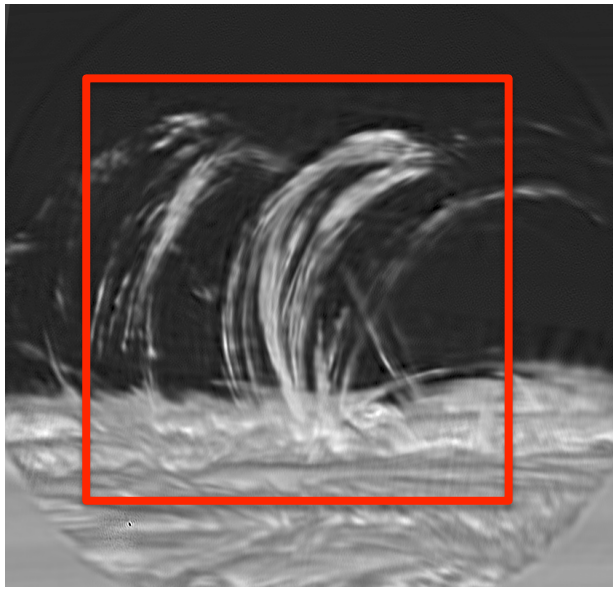
Collective behavior of spicules? Coronal rain? (T. Van Doorsselaere)

Limb observations with VBI blu (CaII K) + red channel (FeXI 789.2; Halpha), + DL-NIRSP chromospheric (coronal?) magnetic maps

0.05"- 1" resolution, few s – 2 min cadence







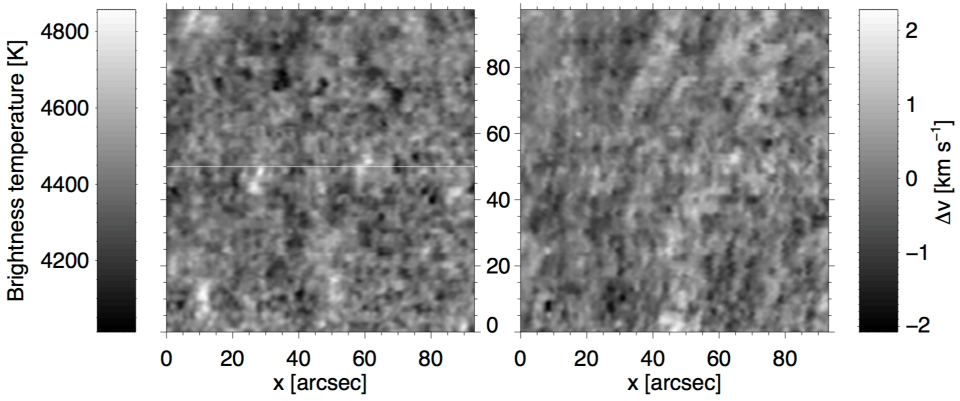
SDO/AIA 171 – 900 km resolution

IBIS Hα – 130 km resolution

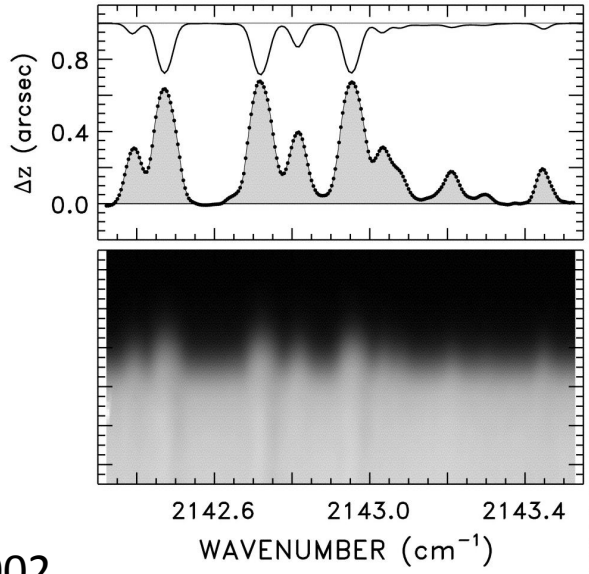
Science ideas (“use cases”)

Cold bubbles in the chromosphere? (J. Martinez Sykora, A. Sukhorukov)

Cryo-NIRSP observations ON DISK, of CO band at 4.7 μm (Te < 3700 K). Resolution = 0.3”-0.5”



Uitenbroek 2000



Ayres 2002

The DKIST Critical Science Plan (CSP)

The DKIST Critical Science Plan (CSP)

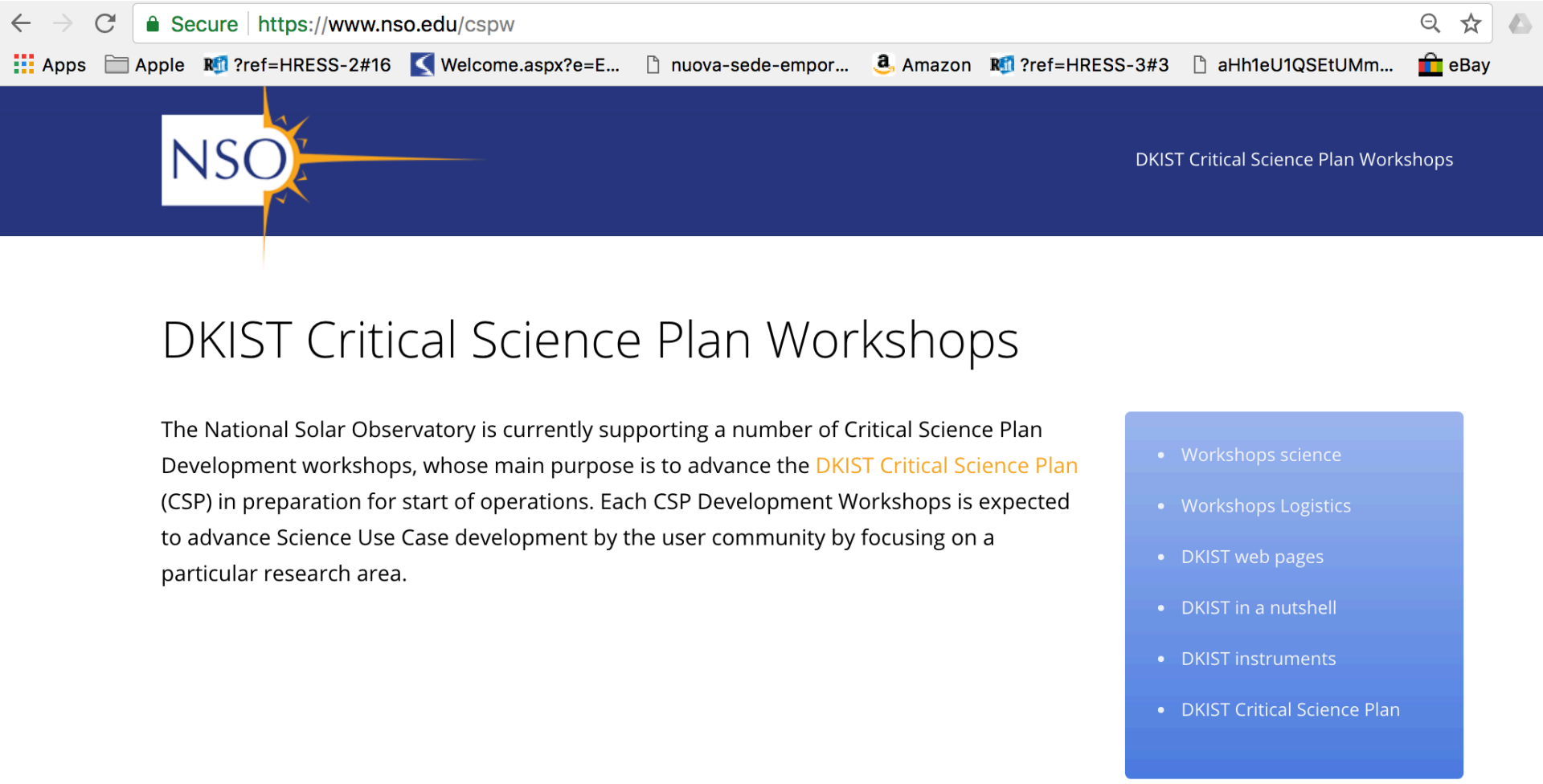
Aim: By science first light, to be ready, as a community, to execute a set of observations exploiting the DKIST capabilities to address critical, compelling science.

Planned: two years (mid 2020, mid 2022)

How (1): Bottom-up approach, community based. NSO is actively engaging the community, informing it of the DKIST capabilities and offering practical tools to develop “proto-proposals”.

The DKIST Critical Science Plan (CSP)

CSP Workshops



The DKIST Critical Science Plan (CSP)

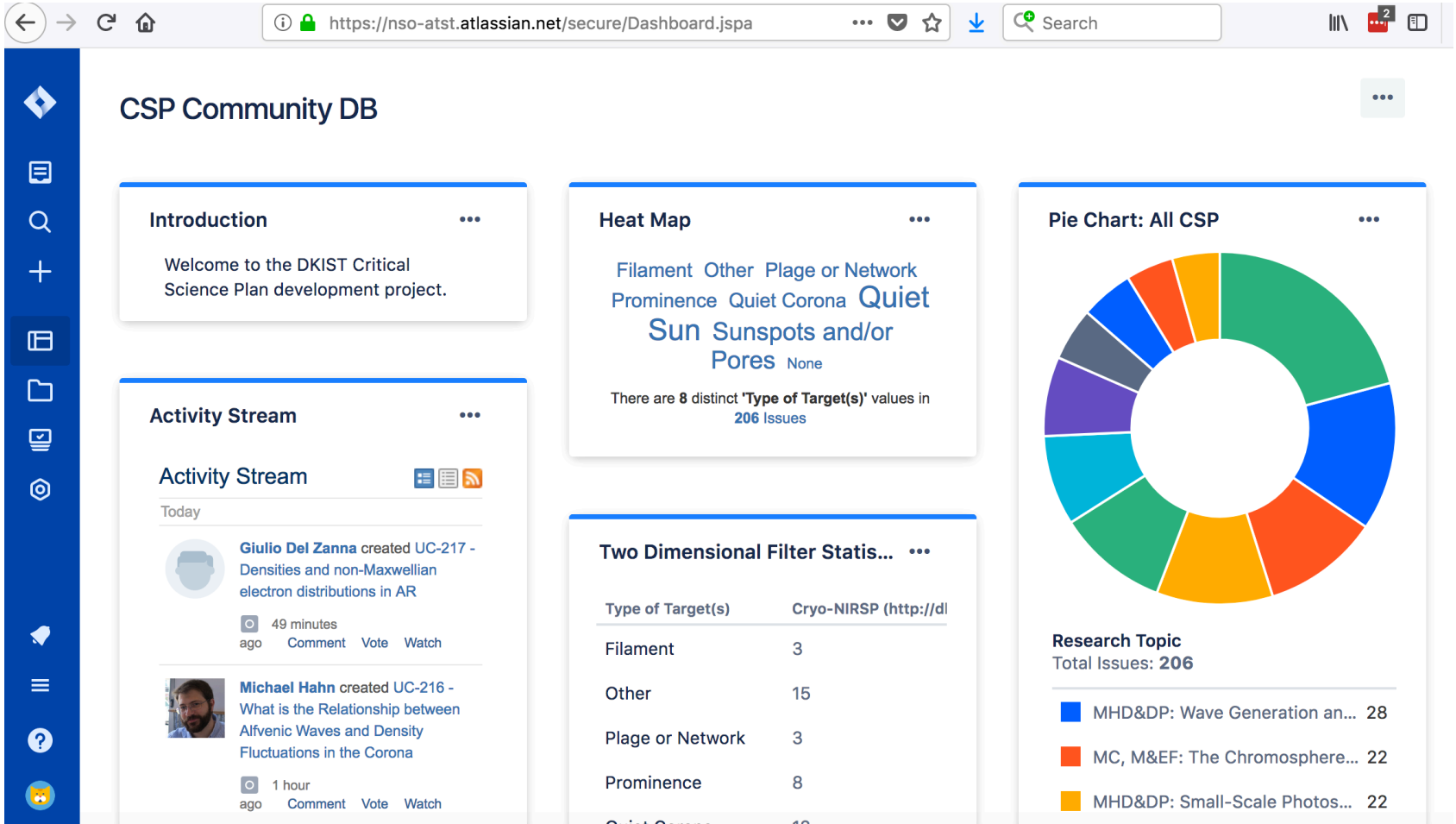
Nine CSP Workshops: https://www.nso.edu/cspw

CSP Workshops

9 thematic workshops
8 US Universities
3 Foreign Institutes
200+ scientists
200+ “science use cases”

The DKIST Critical Science Plan (CSP)

How (2): Compile an extensive set of complementary Science Use Cases, detailing the topics to be investigated, and the type of DKIST observations necessary to address the science.



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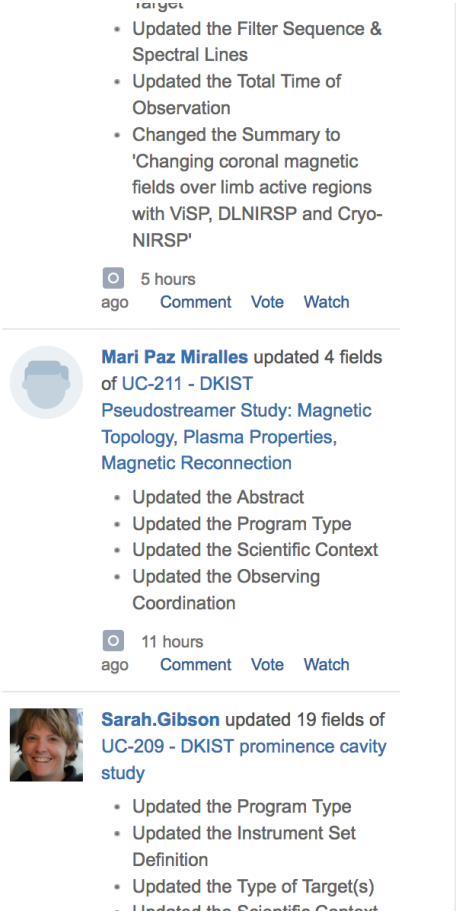

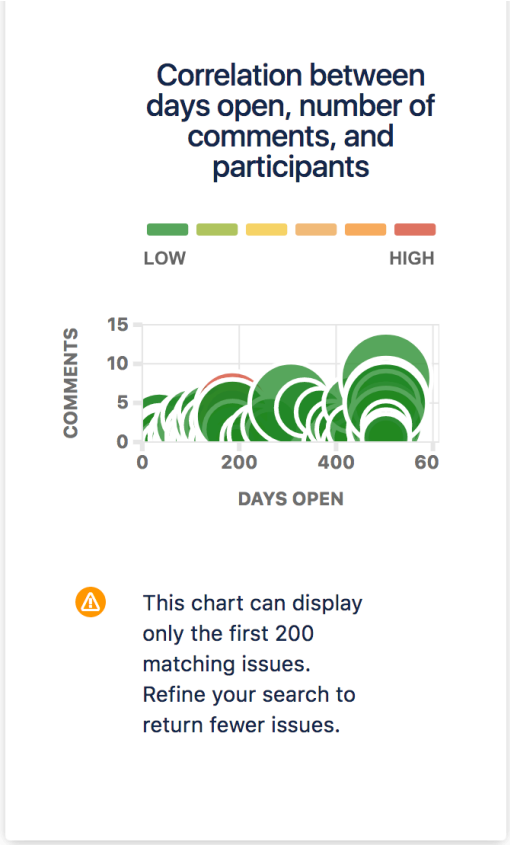

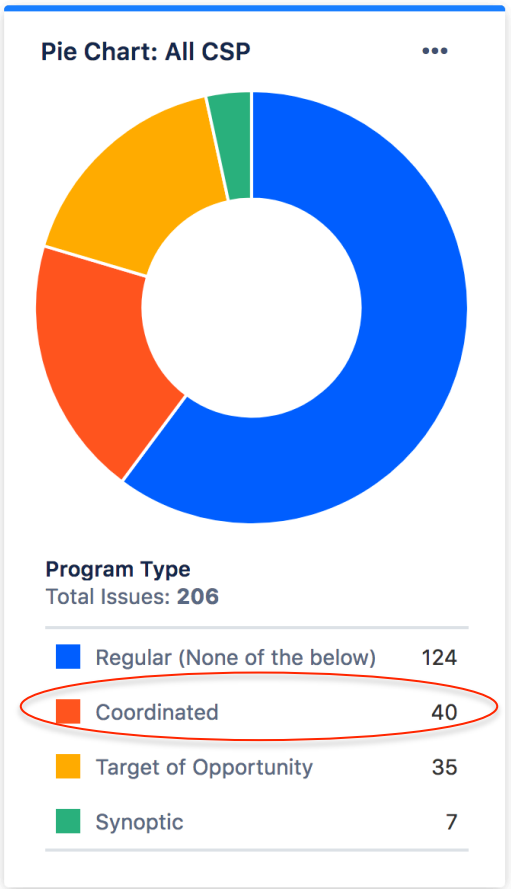

The DKIST Critical Science Plan (CSP)

Feedback: The Science Working Group (DKIST SWG) will provide feedback to PIs, including suggestions for team consolidation, comments on best use of DKIST capabilities, etc. Final goal is to articulate the community vision for essential DKIST science in the early years.

Warning:

The CSP Science Use Cases are NOT proposals, and the Science Working Group is NOT a Time Allocation Committee.

Useful links; email

- https://dkist.nso.edu/CSP
- https://dkist.nso.edu/CSP/instruments
- https://www.nso.edu/cspw.php
- https://nso-atst.atlassian.net
- mark.rast@lasp.colorado.edu; gcauzzi@nso.edu

Thanks !

http://dkist.nso.edu/