DKIST CSP Workshop
Las Cruces, NM
5 December 2018

DKIST Critical Science Plan Workshop #10 (5b): Wave generation and propagation

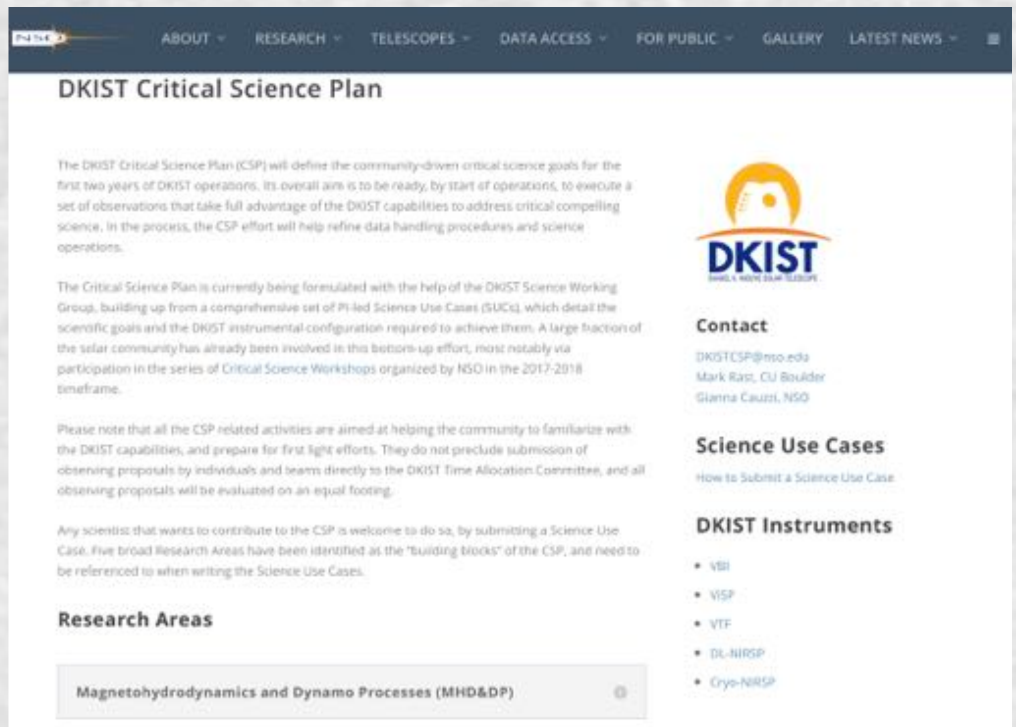
Critical Science Plan and Science Use Cases

[DKIST Critical Science Plan (CSP)](https://www.nso.edu/telescopes/dkist/csp/)

Aim: To be ready *as a community*, by science first light, to execute a set of observations exploiting the DKIST capabilities to address critical, compelling science in the first two years of operations (nominally 2020, 2021).

Bottom-up approach, community based. Workshops one of the tools, but NOT exclusive

https://www.nso.edu/telescopes/dkist/csp/



Critical Science Plan Structure:

- Research Areas
- Research Topics
- Science Use Cases

DKIST Critical Science Plan (CSP)

As a community we must:

- understand forthcoming capabilities
- define science goals
- compile Science Use Cases – write CSP document (SWG)

- complete Science Use Cases

- coordinate to form a complementary set of PI lead teams
- convert Science Use Cases into PI led Observing Proposals

This will enable:

- Service Mode observations
- Scientific analysis
- PI led publication of first-light results

At this workshop:

Develop a set of well defined, complementary Science Use Cases, detailing the topics to be investigated, the reasons why DKIST is necessary, and the type of DKIST observations necessary to address the science.

1. Formulate science context and goals; specify *why* DKIST
2. Identify observational needs (spectral lines of interest, pattern, cadence, sensitivities)
3. Determine useful DKIST instrument suite
4. Assess instrument performance capabilities

http://nso-atst.atlassian.net/
Collaborative JIRA environment for Science Use Case development

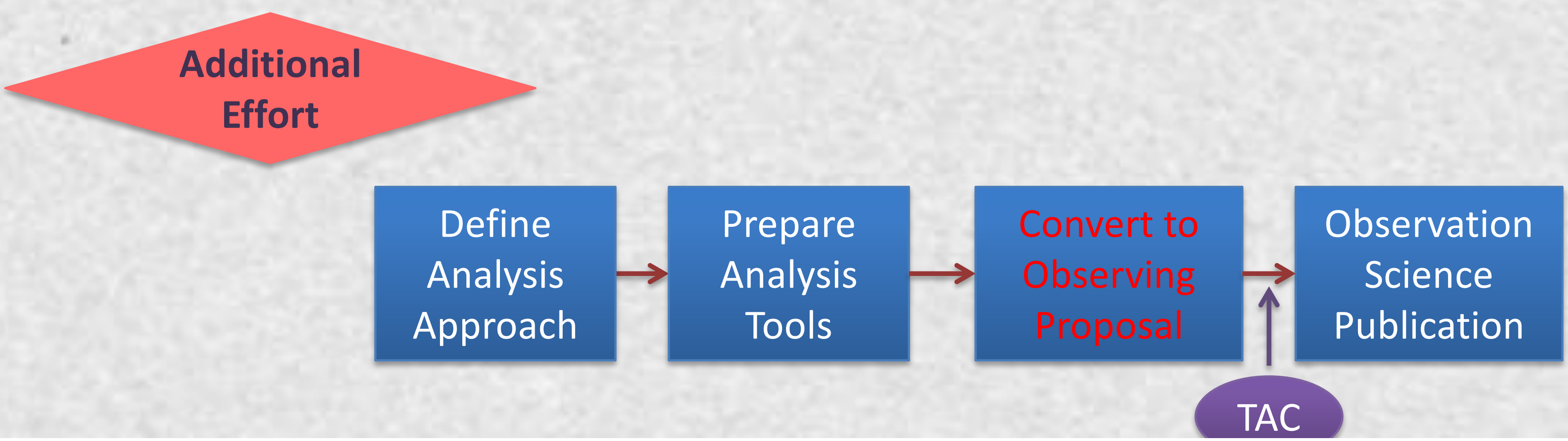
If you do not yet have an account, email an account request to:

DKISTCSP@nso.edu

Science Use Cases provide feedback to DKIST. The existing (and future) Science Use Cases will inform the project about:

- Science most relevant to the community;
- Instruments, lines, modes of operation most requested (desired?) by the community;
- Allow definition of efficient operation, data management

After this workshop: Conversion of Science Use Case to Observing Proposal



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- Critical science description (living document) with links to Science Use Case titles and abstracts, and ultimately their full text
- Links to Instrument and other summary documents
- Links to beam-splitter configuration and data rate analysis tool (FIDO)

NOTE: Links to ALL documents, FIDO tool, and IPCS can be found at https://www.nso.edu/telescopes/dkist/csp/docs/

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Collaborative JIRA environment for Science Use Case development, and ultimately Observing Proposal development

https://www.dropbox.com/sh/uzwdc03ayovxr5o/AABuZbWtCnfPqG8F2zHaeCFta?dl=0
Dropbox link with summary documents (Instruments, Data Handling System (DHS), Facility Instrument Distribution Optics (FIDO), JIRA User's guide), and Instrument Performance Calculators (IPCs)

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Compile a set of well defined, complementary Science Use Cases, detailing the topics to be investigated, the reasons why DKIST is necessary, and the type of DKIST observations necessary to address the science.

1. Formulate science context and goals; specify *why* DKIST

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Determine useful DKIST instrument suite

DKIST Instrument Summary Table

https://www.nso.edu/telescopes/dkist/csp/docs/

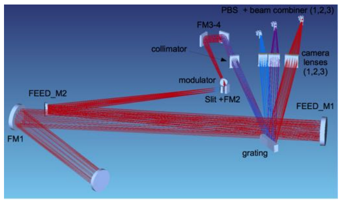
	Instrument type	Spectral range	Spectral resolution	Spatial sampling	Maximum Instantaneous Field of View	Maximum Sampled Field of View	Peak Cadence	Analogous Instruments
Visible Broadband Imager *VBI (Blue)*	High Cadence, High Resolution Imager	390–550nm (sequential filter sequencing)	N/A	0.011″	45″ x 45″	2′ x 2′ (sequential field sampling)	3.2 sec (reconstructed) 0.03 sec (raw images)	ROSA, Hinode/BFI *High cadence, high spatial resolution*
Visible Spectropolarimeter *ViSP*	Scanning Slit Spectropolarimeter	380-900nm (3 spectral windows at a time)	>180,000	0.0195″ (arm 1) 0.0236″ (arm 2) 0.0295″ (arm 3) [sampling along slit]	*5 slits* *Width* x *Length* 0.028″ or 0.041″ or 0.053″ or 0.106″ or 0.214″ x 50″ (arm 1) 60″ (arm 2) 75″ (arm 3)	Slit length x 2′	0.5-10 sec per slit position (polarimetry) 0.02-0.2 sec per slit position (intensity-only)	SPINOR, Hinode/SP, IRIS, GRIS *Scanning spectrograph, high spectral fidelity*
Visible Tunable Filter *VTF*	Fabry Perot Imaging Spectropolarimeter	520-870nm (sequential scans through multiple spectral lines)	FWHM 6-8 pm	0.014″	60″ x 60″	60″ x 60″	Typical scan times per spectral line: 0.5-2 s (intensity only); 2-10 s (polarimetry)	IBIS, CRISP, GFPI *Imaging spectropolarimeter*
Visible Broadband Imager *VBI (Red)*	High Cadence, High Resolution Imager	600–860nm (sequential filter sequencing)	N/A	0.017″	69″ x 69″	2′ x 2′ (sequential field sampling)	3.2 sec (reconstructed) 0.03 sec (raw images)	ROSA, Hinode/BFI *High cadence, high spatial resolution*
Diffraction Limited Near Infrared Spectropolarimeter *DL-NIRSP*	Integral Field Unit Spectropolarimeter	500–900nm 900–1350nm 1350-1800nm (1 filter band per channel)	125,000	0.03″ (high res) 0.077″ (mid res) 0.464″ (wide field)	2.4″ x 1.8″ (high res) 6.16″ x 4.62″ (mid res.) 27.84″ x 18.56″ (wide)	2′ x 2′	Depends on resolution and and total field of view. E.g. 6s for one tile, on-disk, high resolution, full polarimetry	SPIES *True Imaging Spectropolarimeter: simultaneous 2D FOV and spectral information using fiber-fed IFU*
Cryogenic Near Infrared Spectropolarimeter *Cryo- NIRSP*	Scanning Slit Spectropolarimeter	1000-5000nm (1 filter band at a time. About 70 s to switch filters)	100,000 on-disk 30,000 off-limb	0.12″ [along slit] (no Adaptive Optics)	*2 slits* 0.15″ x 120″ slit 0.5″ x 240″ slit	4′ x 3′ (near limb) 5′ round (off-limb)	Heavily depends on signal to noise. Maximum frame rate is 10 frames per second e.g. 1s per slit position near-limb/ chromosphere	CYRA (BBSO) *Cryogenic, scanning spectrograph, novel diagnostics*
Cryo-NIRSP *Context Imager*	Imager	1000-5000nm (1 filter band at a time, with fast switching time to support sequential observations during a single-band spectrograph scan.)	N/A	0.052″ (no Adaptive Optics)	100″ x 100″	4′ x 3′ (near limb) 5′ round (off-limb)	Heavily depends on signal to noise. Maximum frame rate is 10 frames per second e.g. 1s per slit position near-limb/ chromosphere	CYRA (BBSO) *Cryogenic, scanning spectrograph, novel diagnostics*

This table is meant to give an idea of the capabilities of the DKIST first light instrument suite. It cannot capture the large trade space that is provided by the flexibility of the instruments. For more information, visit http://dkist.nso.edu/CSP/instruments

Instrument Summary Documents:

Visible Spectro-Polarimeter (ViSP):

(PI: Roberto Casini, High Altitude Observatory)
(IS: Alfred de Wijn, High Altitude Observatory)



The ViSP is a slit spectrograph that will provide precision measurements of the full state of polarization (intensity plus a full description of the linear and circular polarization states) simultaneously at diverse wavelengths in the visible spectrum. It stresses spectral flexibility, has multiline capability, and will fully resolve the profiles of lines over a wide range of wavelengths.

Spatial Field of View and Resolution:

Optical: 2×2 arcmin^2 (of the the full 2.8 arcmin diameter round post-AO DKIST field of view)
Along slit: 0.0295/0.0236/0.0195 arcsec sampling for arm 1, 2, and 3, respectively (@ 617.3 nm)
Slit widths: 0.028 (diffraction limited at 900 nm), 0.041, 0.054, 0.107, 0.214 arcsec.
FOV height: Camera arm 1: 75 arcsec, Camera arm 2: 60 arcsec, Camera arm 3: 50 arcsec (@ 617.3 nm)

Sampling along slit is critical at about 920 nm, 745 nm, and 620 nm, for arm 1, 2, and 3, respectively
(e.g. 1.22 lambda / D = 1.22*620e-9/4*206264.81 / 2 = 0.0195")

The ViSP uses co-aligned images from VBI Blue for context

Spectral Range and Resolution:

Range: 380 – 900 nm
with continuous spectral coverage over this range. Up to three spectral bands (about 1nm wide at 630 nm) can be observed simultaneously; any portion of the spectrum can be imaged individually on any of the 3 spectral arms.

Resolution: better than 3.5 pm (1.75 pm sampling) at 630 nm (R > 180000)

Example photospheric and chromospheric lines accessible:

1. Ca II K 393.37 nm (photo/chromosphere)
2. Ca II H 396.85 nm (photo/chromosphere)
3. Fe I 404.58 nm (photosphere)
4. H δ 410.17 nm (E-field diagnostics)
5. Ca I 422.67 nm (PRD)
6. H γ 434.05 nm (E-field diagnostics)
7. Ti I 453.60 nm (second solar spectrum)
8. Ba II 455.40 nm (second solar spectrum)
9. Sr I 460.73 nm (Hanle effect)
10. H β 486.13 nm (chromosphere)
11. Mg I b1 517.27 nm (photo/chromosphere)
12. Mg I b2 518.36 nm (photo/chromosphere)
13. Fe I 525.04 nm (photosphere)
14. Mn I 553.78 nm (HFS)
15. He I 587.59 nm (prominences; spicules)
16. Na I D2 589.00 nm (photo/chromosphere; PRD)
17. Na I D1 589.59 nm (photo/chromosphere; PRD)
18. Fe I 617.33 nm (HMI)
19. Fe I 630.20 nm (Hinode/SP)
20. H α 656.28 nm (chromosphere)
21. Ni I 676.78 nm (photosphere)
22. Ca I 714.82 nm (photosphere)
23. Fe I 751.15 nm (photosphere)
24. K I 769.90 nm (photosphere)
25. Na I 818.33 nm (photo/chromosphere)
26. Na I 819.48 nm (photo/chromosphere)
27. Ca II 849.81 nm (photo/chromosphere)
28. Ca II 854.21 nm (photo/chromosphere)
29. Ca II 866.22 nm (photo/chromosphere)
30. Mn I 874.10 nm (HFS)

Temporal Cadence:

10 sec per slit position (10 sec or shorter integration to reach 10^{-3} I_{cont} polarimetric signal from 450 nm longward, 2×10^{3} I_{cont} at 380 in 10 sec). The slit can be stepped between two adjacent positions in less than 200 ms.

10 minute reconfiguration for each spectral channel

Polarimetric Capabilities and Accuracy:

Full Stokes vector polarimetry.

ViSP is a dual-beam polarimeter; the simultaneous, orthogonal states of polarization (*I* +/- *U*, *Q*, *V*, after polarization modulation) are imaged on the same camera, thus limiting the spectral coverage available in a single exposure.

Photometric Capabilities (Precision):

Flat fields repeatable to the 2% level.

Instrument Modes Available:

Polarimetric mode: full Stokes; slit steps from one position to the next after integration

Intensity-only mode: *I* only; slit moves continuously during exposure. Some blurring of the image but substantially faster. Read-out rate of camera can be selected.

Example Modes of Operation:

It is important to note that the ViSP instrument is designed for operational flexibility to meet a range of research needs, both those currently known and well understood and many unknown or only poorly understood. The instrument thus aims to serve a wide range of exploratory science, and the use cases below are only examples.

Use Cases:

1. Common use profile example – study of prominences

Example #1:	**Prominences**		
SPATIAL COVERAGE AND RESOLUTION			
Slit Width	0.0406″ (matched to 650 nm)		
Spatial Sampling	0.0406″ slit step size		
Steps	500		
Total Field of View	20.3″ x 77.8″	20.3″ x 61.0″	20.3″ x 49.4″
X Spatial Resolution	0.082″	0.082″	0.083″
SPECTRAL INFO:	Band #1	Band #2	Band #3
Wavelength:	Ca II 396.85 nm	He I 587.59 nm	Ca II 854.21 nm
Y Spatial Binning	1	1	2
Y Spatial Resolution	0.061″	0.048″	0.077″
Bandwidth:	0.807 nm	1.224 nm	1.629 nm
Spectral Sampling	0.907 pm/pixel	1.375 pm/pixel	1.830 pm/pixel
Spectral Binning	1	1	1
Spectral Resolution	218000	213000	234000
TIMING SUMMARY			
Integration Time	10 s		
Map Duration	1:25:00		
Repeats	1		
Total Duration	1:25:00		
DATA RATES			
Data Rate	22.8 MB/s		
Data Volume	114 GB (does not include calibration data)		

[DKIST Instrument Summary Table](https://www.nso.edu/telescopes/dkist/csp/docs/)
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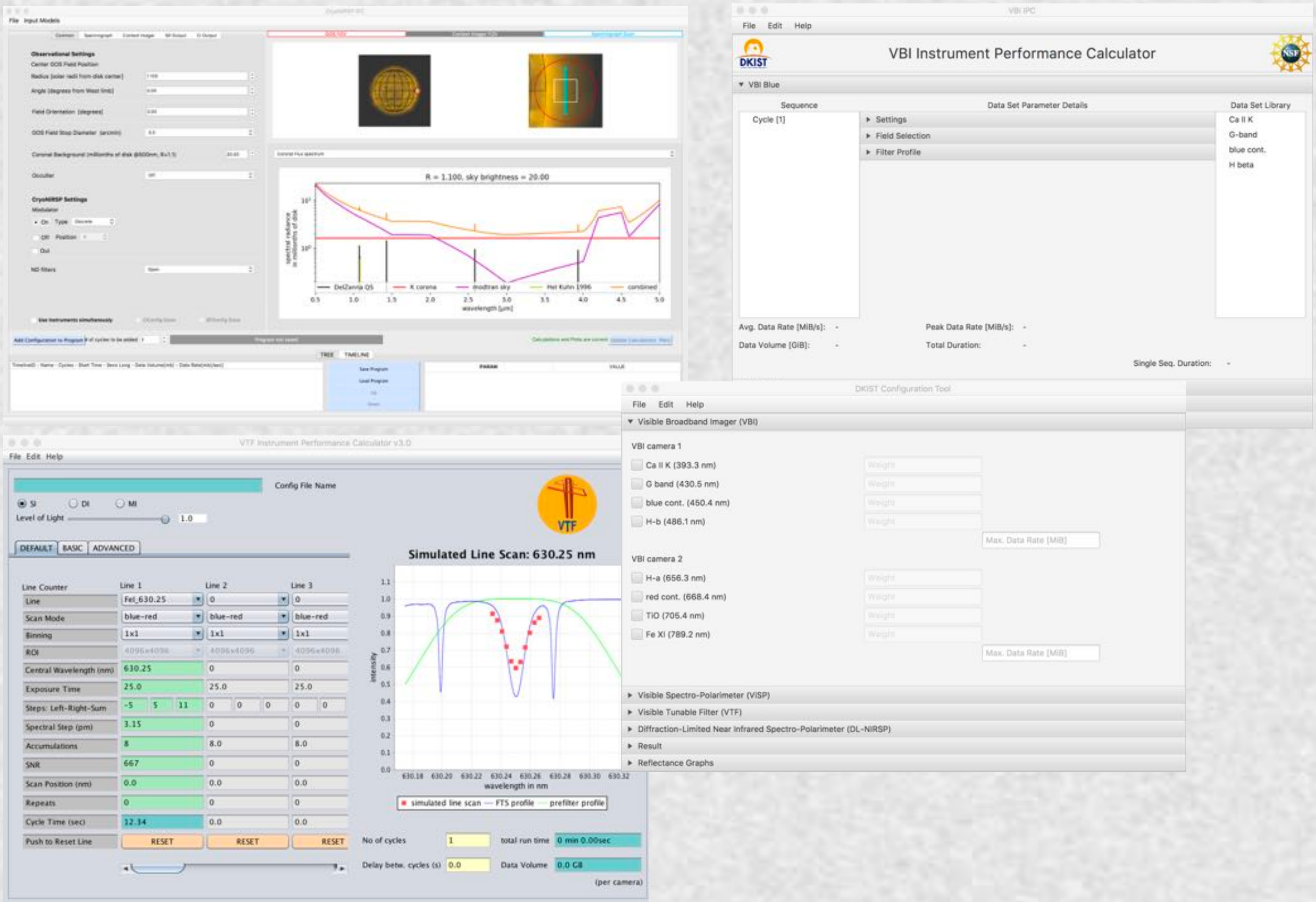
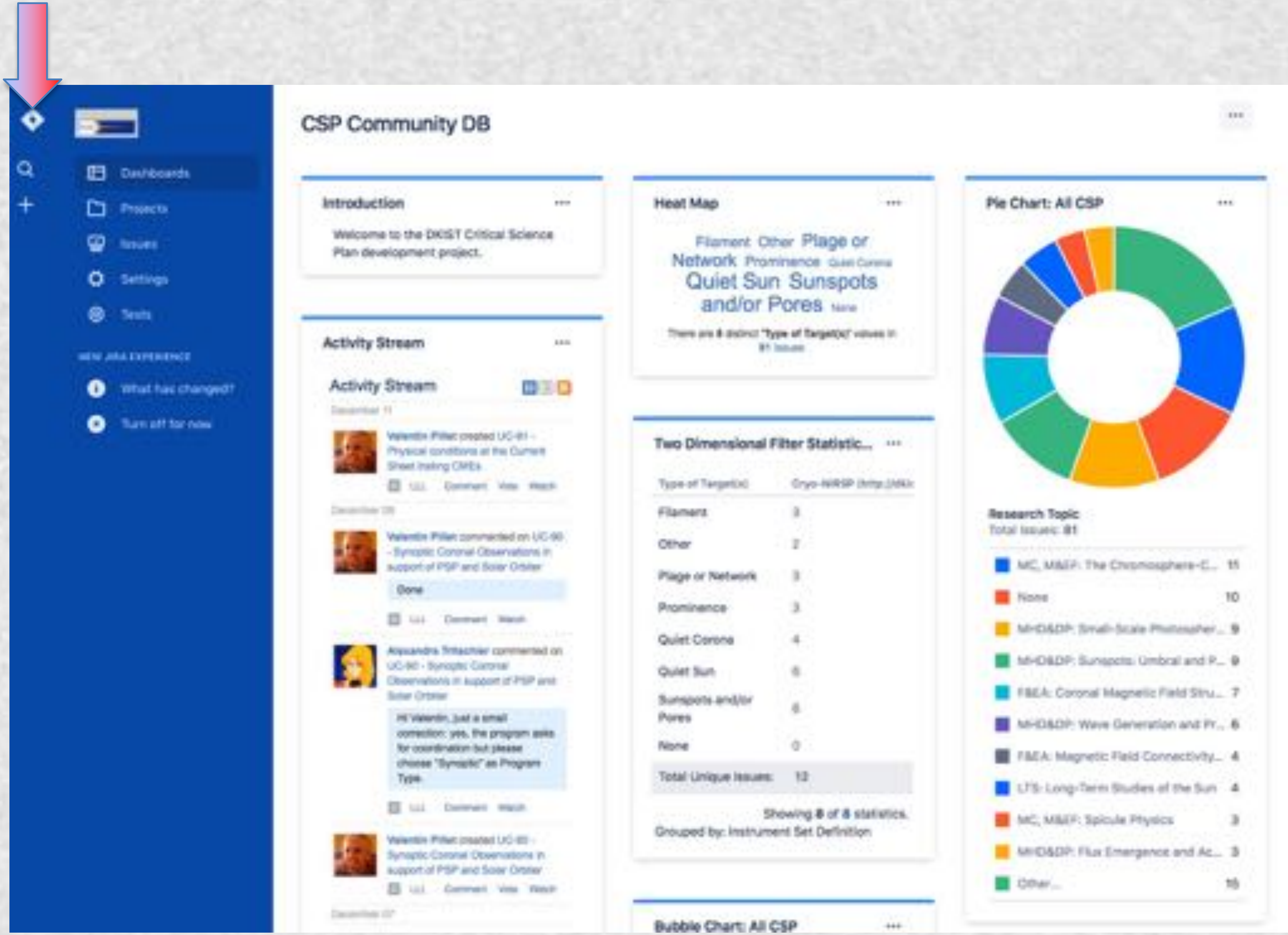
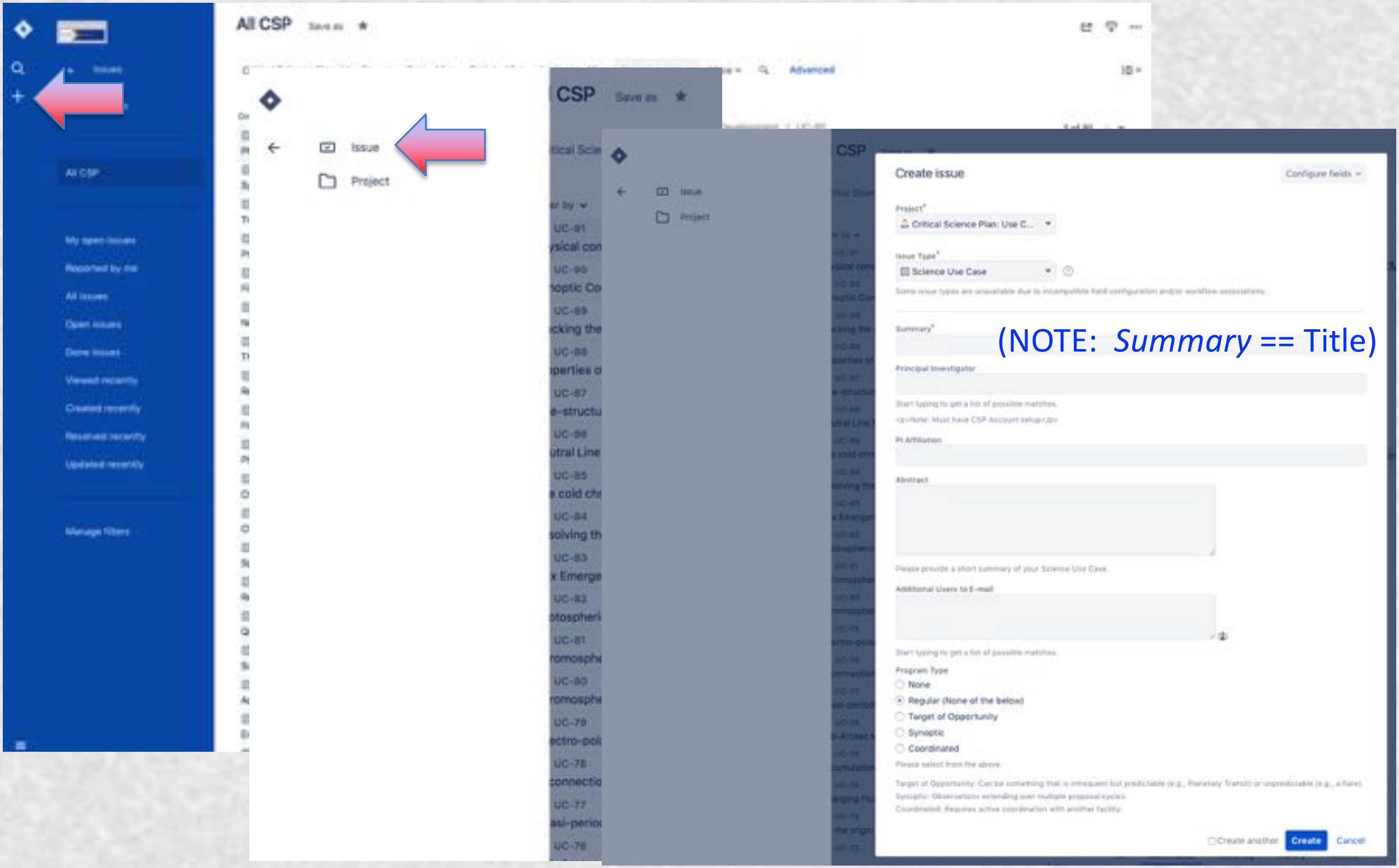
Instrument performance calculators:
https://www.nso.edu/telescopes/dkist/csp/docs/



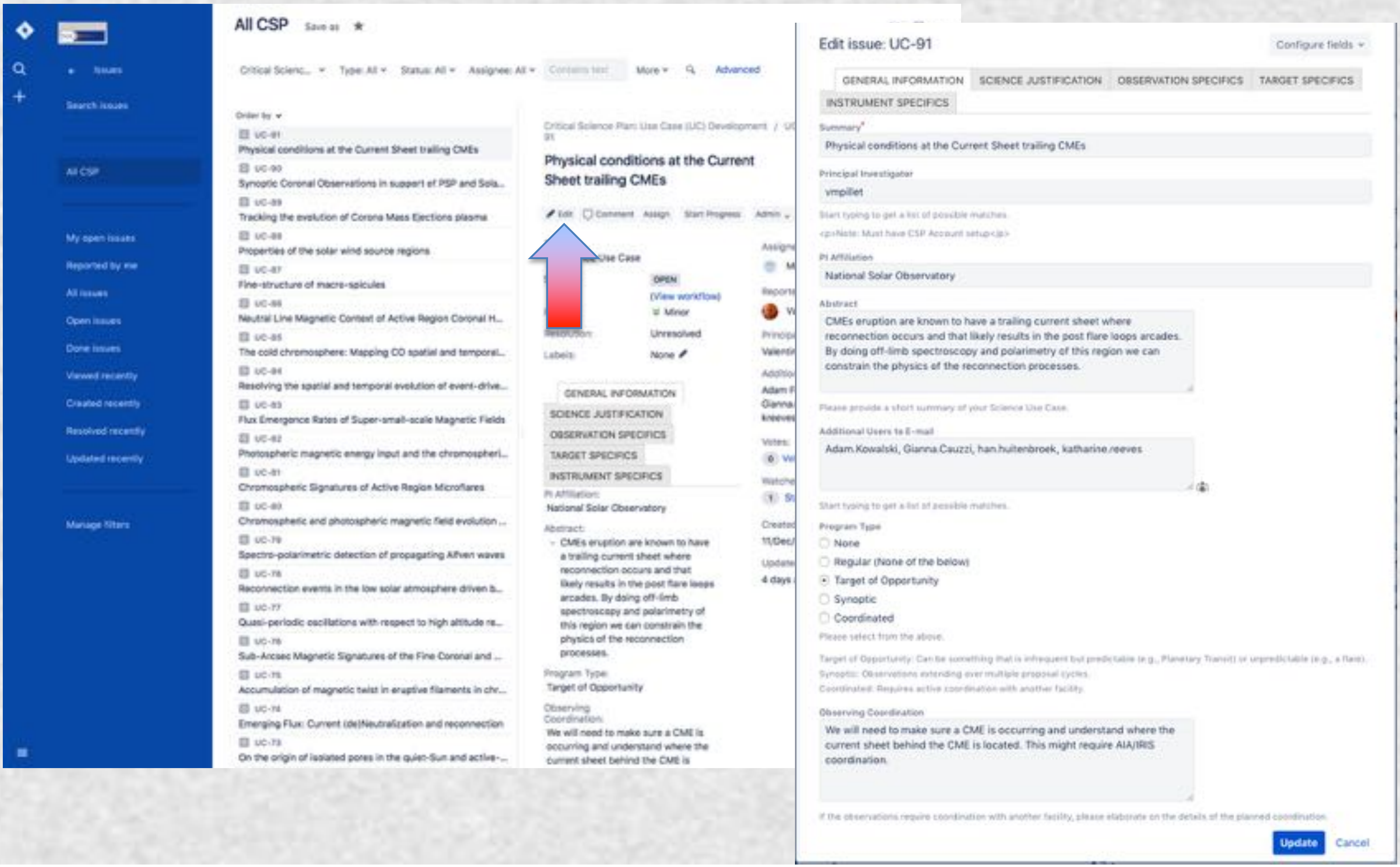
DKIST CSP JIRA Site (https://nso-atst.atlassian.net/secure/Dashboard.jspa)



Create a new Science Use Case



DKIST CSP: JIRA User's Guide
Editing your Science Use Case (PI, Co-I)



DKIST CSP Science Use Case development strategy:

1. Formulate science context and goals

   (JIRA form tabs – General Information, **Science Justification**, Target Specifics)

2. Identify observational needs (spectral lines of interest, pattern, cadence, sensitivities)

   (JIRA form tab – **Observation Specifics**, Instrument Specifics)

3. Determine useful DKIST instrument suite

   (JIRA form tabs – Observation Specifics, **Instrument Specifics**)

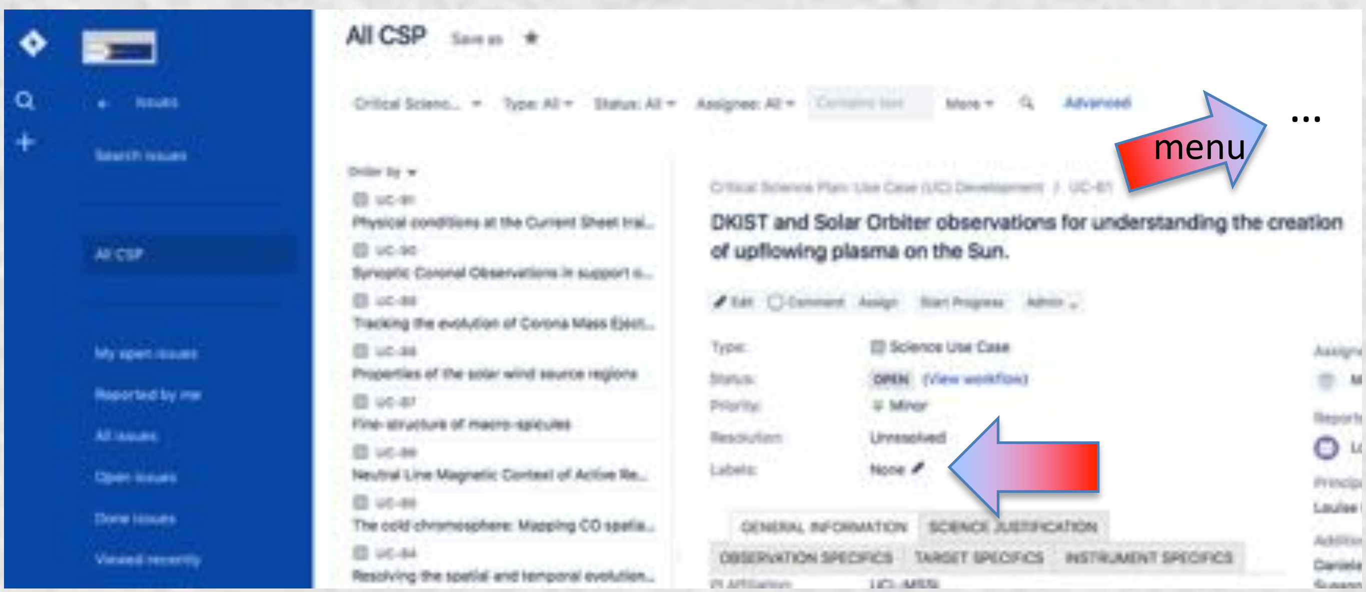
   FIDO – aka Coudé configuration and Data Rate tool, aka Beam Splitter Tool

4. Assess individual instrument performance capabilities

   (JIRA form tabs – **Instrument Specifics**)

   Instrument Performance Calculators (IPCs)

DKIST CSP: JIRA User’s Guide
Status and *Labels* Fields



- For now please do not select *Start Progress* (which changes the *Status* field)
- If you worked on your Science Use Case as part of a DKIST CSP Workshop, please edit *Labels* as:
  - CSPW-SPD2016
  - CSPW-Huntsville
  - CSPW-DC
  - CSPW-Freiburg
  - CSPW-Nagoya
  - CSPW-JHU/APL
  - CSPW-Newcastle
  - CSPW-NMSU
  - CSPW-Rice
  - CSPW-Maui
  - CSPW-Bozeman
  - CSPW-Synoptic
  - CSPW-LasCruces

  as appropriate.

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