FIDO Tool, Data Handling
And Instrument Performance Calculators

Science use case design

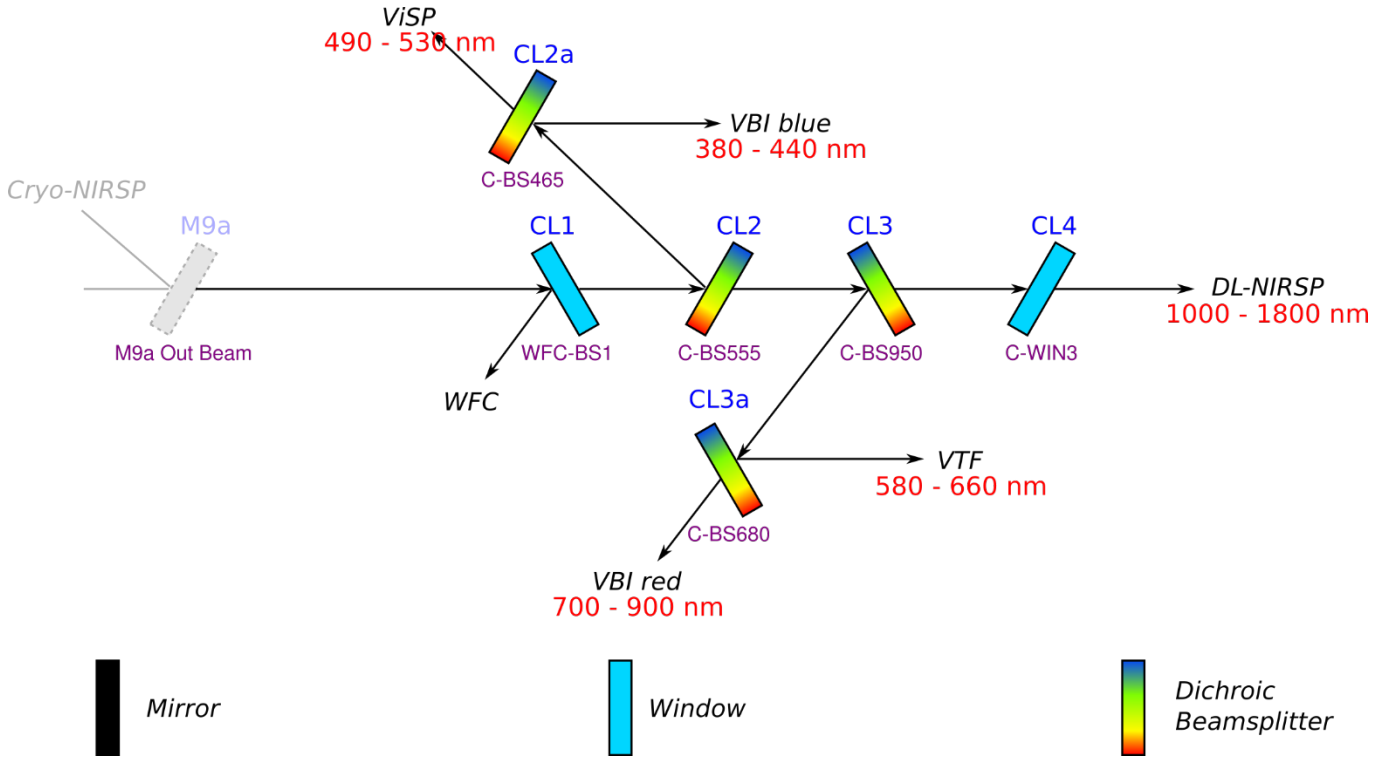
- DKIST instruments are complex, diverse, and flexible to support a very broad science portfolio.
- Users must understand and/or make decisions about:
  1. Telescope field-of-view, mosaicking, field sampling, coronagraphy, etc.
  2. Coudé table orientation (orientation of solar image on detector).
  3. **Spectral distribution of light to instruments.**
  4. Spectral/imaging/polarimetric capabilities of facility instruments.
  5. **Instrument parameters.**
  6. **Cadences and frame rates (limited by DHS capabilities).**

FIDO Tool – What is it for?

- Verifies whether the proposed wavelength distribution to the instruments is compliant with what FIDO can do.
  - Directive: “Either all light or no light” to an instrument.
  - There is no sharing of the same wavelength range between instruments; there are no grey beamsplitters (e.g. 50/50).

- Verifies whether the DHS can handle the proposed data rates.
  - DKIST is built for very high data rates, but still has limits on rate and volume.
  - First-order estimates of rate/volume calculated by FIDO tool.
  - Detailed rates/volumes are calculated by Instrument Performance Calculators.

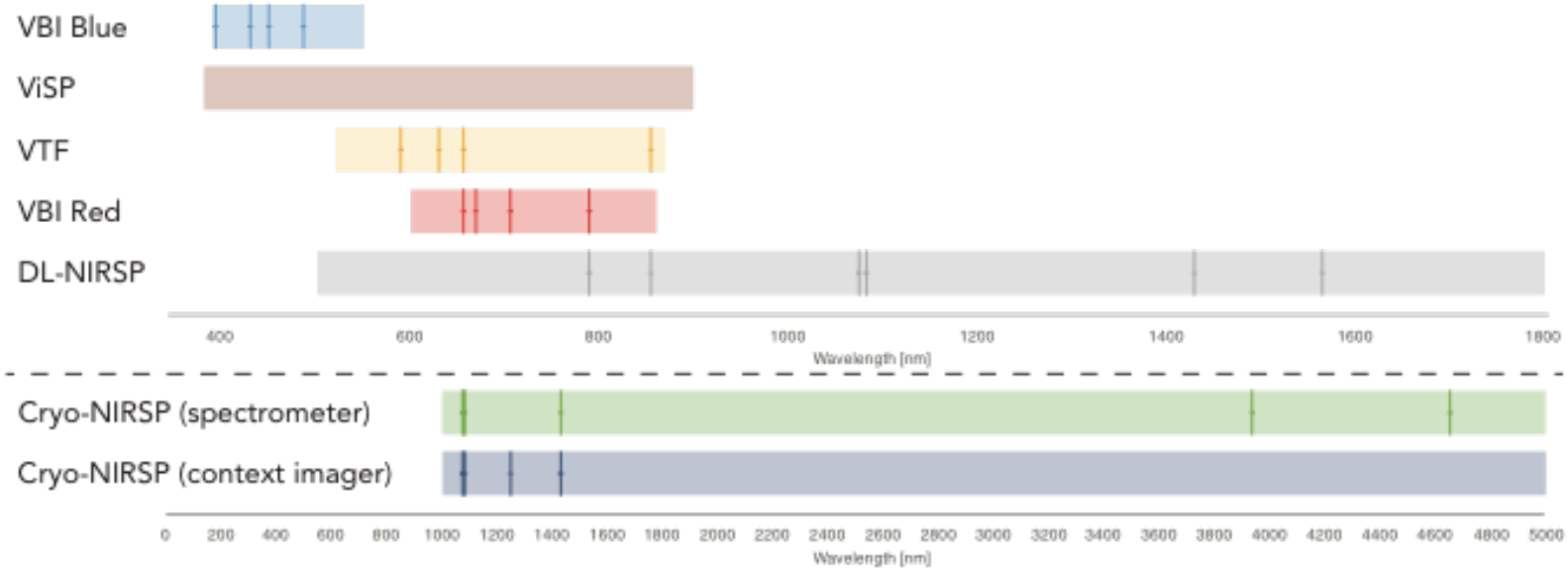
3. Spectral distribution of light to instruments



Dichroics are long-pass filters (transmit longer wavelengths)

FIDO: Many different ways to combine instruments ➡
flexibility (diagnostic power) = data (calibration) challenges

DKIST First Light Instrument Filters



VBI Blue		ViSP	VTF		VBI Red		DL-NIRSP		Cryo-NIRSP		Cryo Context	
Ca II K	393.327nm	Access to entire spectral range between 380-900 nm	Na D	589.6nm	H-alpha	656.282nm	Fe XI	789nm	Fe XIII	1074.7nm	Fe XII	1074.7nm
G-band	430.52nm		Fe I	630.25nm	Continuum	668.423nm	Ca II	854.2nm	Fe XIII	1079.7nm	He I	1083nm
Continuum	450.287nm		H-alpha	656.3nm	Ti O	705.839nm	Fe XIII	1074.7nm	He I	1083 nm	J Band	1250nm
H-beta	486.1nm		Ca II	854.2nm	Fe XI	789.186nm	He I	1083nm	Si X	1430nm	Si IX	1430nm
							Si X	1430nm	Si IX	3935 nm		
							Fe I	1565nm	CO	4651nm		

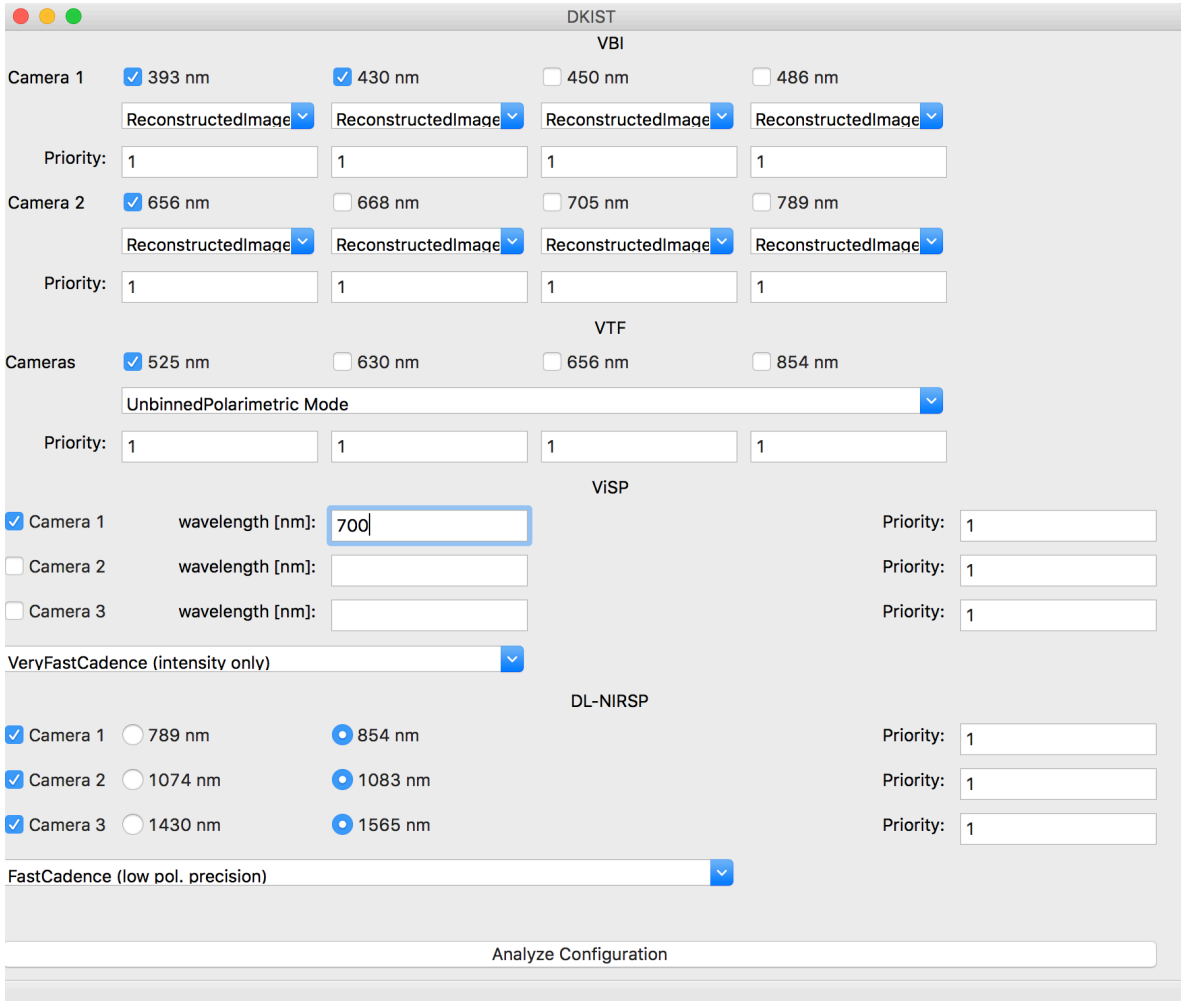
This table is meant to give an idea of the capabilities of the DKIST first light instrument suite. It cannot capture the large trade space that is provided by the flexibility of the instruments. For more information, visit http://dkist.nso.edu/CSP/instruments

Visible light cameras for instruments are provided by a UK consortium.

FIDO Tool – How does it work?

INPUTS:
Wavelengths and modes for each desired instrument

Priorities can also be used for optimization (instrument selection)



FIDO aka Beamsplitter Configuration Tool

Configuration Outputs

```
================================================================
The following Coude Optics configurations [CL2, CL2a, CL3, CL3a]
deliver the highest ranking:
================================================================
[BS_465,BS_950,BS_680,BS_555]; [BS_465,MI_001,BS_680,BS_555];
[BS_465,MI_002,BS_680,BS_555];

::VBI1:: waverange [nm]: [380,440]
-----> Max. Data Rate (successful diagnostics): 960 MB/s
      success: 393; 430;
      fail:
::VBI2:: waverange [nm]: [580,660]
-----> Max. Data Rate (successful diagnostics): 960 MB/s
      success: 656;
      fail:
::VTF:: waverange [nm]: [490,530]
-----> Max. Data Rate (successful diagnostics): 2880 MB/s
      success: 525;
      fail:
::ViSP1:: Channel receives no light!
      success:
      fail:    700;
::DLN1:: waverange [nm]: [700,1800]
-----> Max. Data Rate (successful diagnostics): 67 MB/s
      success: 854;
      fail:
::DLN2:: waverange [nm]: [700,1800]
-----> Max. Data Rate (successful diagnostics): 67 MB/s
      success: 1083;
      fail:
::DLN3:: waverange [nm]: [700,1800]
-----> Max. Data Rate (successful diagnostics): 67 MB/s
      success: 1565;
      fail:

Aggregate Bandwidth (max. 3500-4000 MB/s): 5001 MB/s
================================================================
```

5. Instrument parameters including domain coverage and SNR

- In most cases, must be calculated using the Instrument Performance Calculators. Some examples given in summary docs.
- IPCs available online (dkist.nso.edu/CSP) and will be discussed in a few minutes.

6. Data rate/volume limits

- DKIST is built for very high data rates, but still has limits on rate and volume.
- Rates/volumes are calculated by Instrument Performance Calculators for your detailed use case.
- First-order estimates of rate/volume provided the FIDO beam splitter calculator.

Capabilities of the Data Handling System (DHS)

- The DHS provides **five** dedicated "camera lines" of 960 MiB/s bandwidth each.
- Camera lines can be **shared** among multiple cameras within 960 MiB/s limit (e.g. when binned, or not running at the highest frame rate)
- Max cumulative bandwidth is 4800 MiB/s; however, depending on sharing, practical max is 3500 to 4000 MiB/s
- Data acquisition at the max possible rate might have to be limited in duration due to data volume issues – typically daily data volumes of 5-30 TB

Maximum Instrument Detector Rates

VBI: 2x (4096 x 4096) [Andor Balor].
Max rates: 2 x 960 MiB/s

VTF: 3x (4096 x 4096) [Andor Balor].
Max rates: 3 x 960 MiB/s

ViSP: 3x (2560 x 2160) [Andor Zyla 5.5].
Max rates: 3 x 433 MiB/s

DL-NIRSP: 1 x (4096 x 4096) [Andor Balor] + 2 x (2048 x 2048) [H2RG]
Max rates: 1 x 960 MiB/s; 2 x 240 MiB/S

Cryo-NISRP: 2 x (2048x2048) [H2RG]
Max rates: 2 x 80 MiB/s

FIDO aka Beamsplitter Configuration Tool

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================================================================
```

Instrument Performance Calculators

- Set of tools (i.e. software programs/applications) to explore instrument capabilities – e.g. line selection, exposure times, SNR etc.

- A *separate* IPC needs to be run for each instrument. VBI and VTF are Java applications (1.9); ViSP and DL-NIRSP run in IDL (8+). (The Cryo-NIRSP IPC unfortunately is not yet ready for distribution)

- It is useful to run FIDO ahead of the IPCs, to check if the intended spectral distribution is feasible.

Some examples of IPCs use

Thanks !

http://dkist.nso.edu/