FIDO TOOL, DATA HANDLING AND INSTRUMENT PERFORMANCE CALCULATORS

DKIST TEAM

NATIONAL SOLAR OBSERVATORY

Overview

- Science Use Case Design
- Beamsplitter (FIDO)Tool
  - What is it for?
  - What does it look like and how does it work?
- Instrument Performance Calculators
  - Preliminary Remarks
  - VBI
  - VTF
  - ViSP (Christian)
  - DL-NIRSP (Christian)
  - Cryo-NIRSP (Valentin ☺)

Science Use Case Design

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

FIDO Tool 1

What is it for?

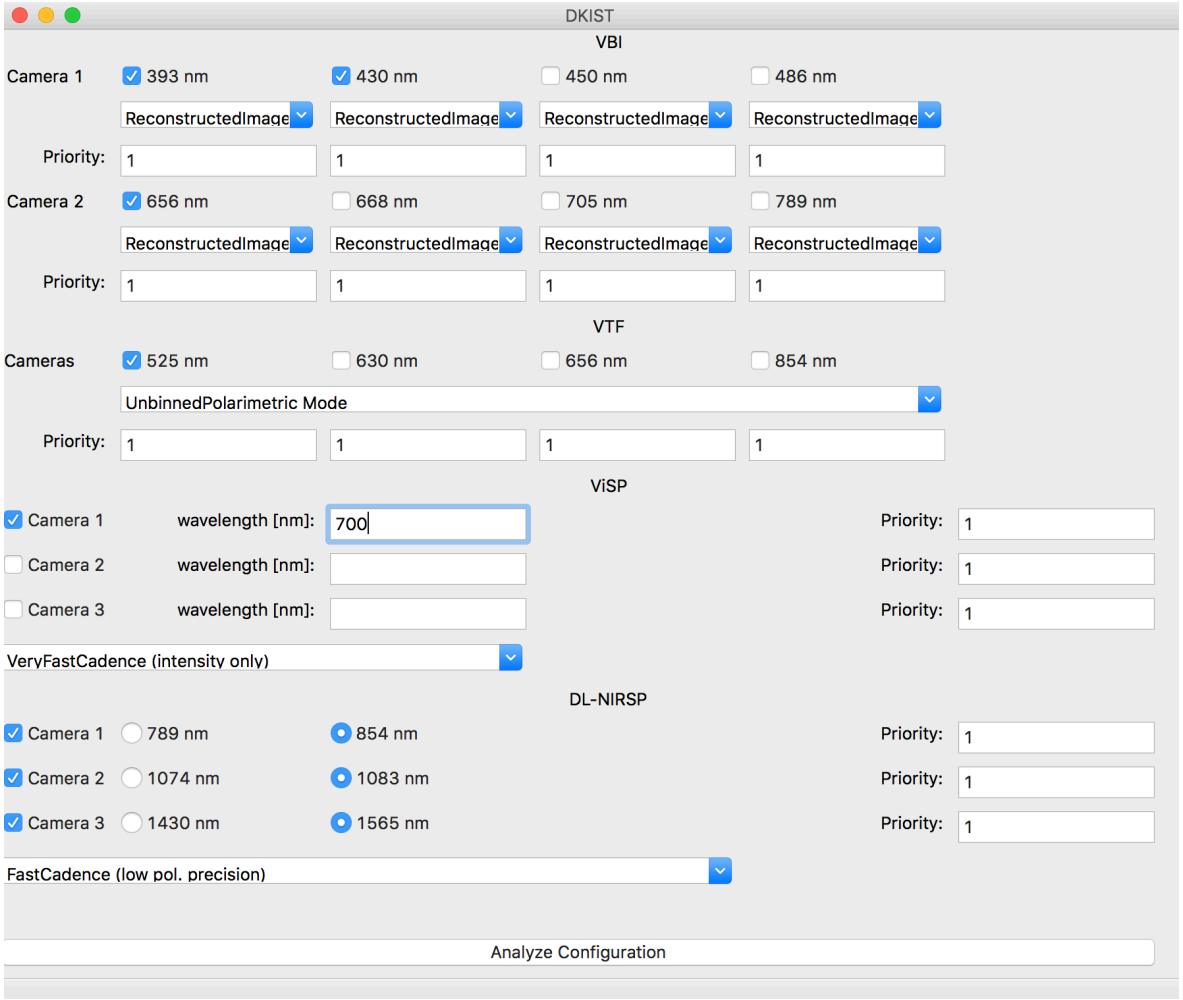
- Verifies whether the proposed wavelength distribution to the instruments is compliant with what FIDO can do.
  - Directive: “Either all light or no light” to an instrument.
  - There is no sharing of the same wavelength range between instruments; there are no grey beamsplitters (e.g. 50/50).
- Verifies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

FIDO Tool 2

What does it look like?
How does it work?

INPUTS:
wavelengths and modes for each requested instrument

priorities can also be used for optimization (instrument selection)



FIDO Tool 3

Outputs 1:
success or failure in wavelength bands

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

FIDO Tool 4

Outputs 2: individual instrument data rates rates and aggregated data rate

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==================================================================
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
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::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
==================================================================
```

Detour: Data Handling System 1

- DHS uses dedicated **physical camera lines** (hardware) for its purposes: transport/transfer of data, display of data, etc.
- Each camera line is supporting a total bandwidth of 960 MiB/s.
- There are 5 camera lines for first light, ergo in theory a total aggregated bandwidth of 5 x 960 MiB/s/4800 MiB/s is supported.
- Caveat: there are 11 cameras in total (+2 for Cryo, but standalone).
  - Camera lines can be configured to share multiple cameras (**virtual camera lines**) within 960 MiB/s limit (e.g. when binned or not running at the highest framerate).
  - Practical max is 3500 to 4000 MiB/s (due to overhead).
- Data acquisition at the max possible rate might have to be limited in duration due to data volume issues; typical daily data volumes of 5-30 TB; total summit capacity is 90/100 TB.

Detour: Data Handling System 2

- **VBI**: 2 x (4096 x 4096) [Andor Balor].
  - Max rates: 2 x 960 MiB/s.
- **VTF**: 3 x (4096 x 4096) [Andor Balor].
  - Max rates: 3 x 960 MiB/s.
- **ViSP**: 3 x (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-NIRSP**: 2 x (2048x2048) [H2RG].
  - Max rates: 2 x 80 MiB/s.

Instrument Performance Calculators

- Instrument Performance Calculators (IPCs) are tools (i.e. software programs/applications) intended to help the user familiarizing with and exploring instrument capabilities (e.g. filter/line selection, exposure times, field sampling, scanning, instrument modes, etc.).
- IPCs are developed by instrument partners; different look and feel (this will remain for first light and even beyond); user input on individual functionality is most welcome (please contact Gianna).
  - Each instrument has its own IPC, all run separately; VBI and VTF are Java applications (Java 1.9); ViSP and DL-NIRSP run in IDL (8+); Cryo-NIRSP IPC not ready for distribution.
- **Note**: it is useful to run FIDO ahead of the IPCs, to check if the intended spectral distribution is feasible.
- **Recommendation**: if possible use the basic capabilities to fulfill the science; try to avoid the extended or advanced mode of the IPCs.

VBI IPC

- **Features**: comes in Java 1.9; drag and drop functionality; allows defining sub-groups of filter combinations (up to 5 levels) over which can be iterated; saving and loading of parameter settings; basic and expert mode; incorporates limb darkening model for flux budget calculation underneath the hood for observations at different angles (mu values); cadence calculations take into account the filter change times very accurately); manual and online Help.
- **Reminder**: VBI can field sample: either whole field or central field can be selected; VBI can speckle (default), frame select, both, none (non-standard mode).
- **Comments**: red/green color = parameter can/cannot be changed; not all exposure times are possible; in frame selection mode: up to 10 images can be saved out of Y; in frame selection and rec mode: up to 80 images out of Y; binning is not allowed when rec is activated; speckle does only work with the full FOV, no ROI yet (only when robustness is there maybe open up for ROI/binning and speckle); going from expert mode to normal mode clears all settings (and vice versa) coronal SNR corresponds to the continuum.

VTF IPC

- **Features**: comes in Java 1.8+; default/basic/advanced mode; selection of Spectropolarimetric/Doppler/Monochromatic Intensity mode; allows defining combination of filter/spectral scan sequences up to 8 over which can be iterated individually; number of scan steps (equidistant; fixed in default; upper limit); selection of scan pattern (nested or monotonic); allows repetition over whole sequence; saving and loading of parameter settings; adjustable light level (SNR); manual and online Help.
- **Reminder**: VTF does not field sample: if larger FOV is necessary then telescope mosaicking is necessary;
- **Comments**: yellow/green color = parameter can/cannot be changed; ROIs are allowed but predefined; non-equidistant user defined wavelength sampling in advanced mode; binning options in all modes; spectral step size (dependent on filter) with two options in basic mode; number of accumulations; instrument mode applies for all filters/lines in sequence – cannot be changed on a per filter basis; scan position in MI mode is user definable;

Thanks!

http://dkist.nso.edu/