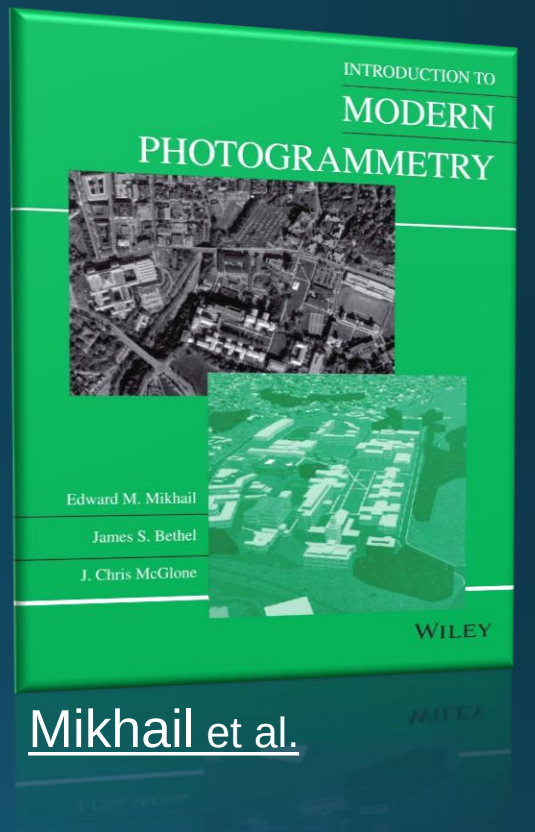
CSM Standard for Planetary

Community Sensor Model

Trent Hare, Jay Laura
& camera model team

Camera Sensor Model Definition

def. to place sensor data onto the surface



Mikhail et al.

Planetary Workflow:

SPICE→ CAMERA → SHAPE

Why?

NASA's PSDI tenant:

support infrastructural **standards**

What standard?

The **Community Sensor Model (CSM)** Working Group was established by the U.S. defense and intelligence community with the goal of **standardizing camera models** for various remote sensor types. The CSM standard, now at version 3.0.3, provides a well-defined application program interface (API) for multiple types of sensors and has been widely adopted by Earth remote sensing software systems.

CSM GOALS for Planetary

Goal 1. Share cameras across photogrammetric systems

- BAE's SOCET GXP
- Python "sandbox" environment *(demo)*
- AutoCNET (image matching environment)

Planned:

- AMES Stereo-pipeline
- ISIS3
- test - Harris Corp's ENVI
- Test - Hexegon's ERDAS IMAGINE

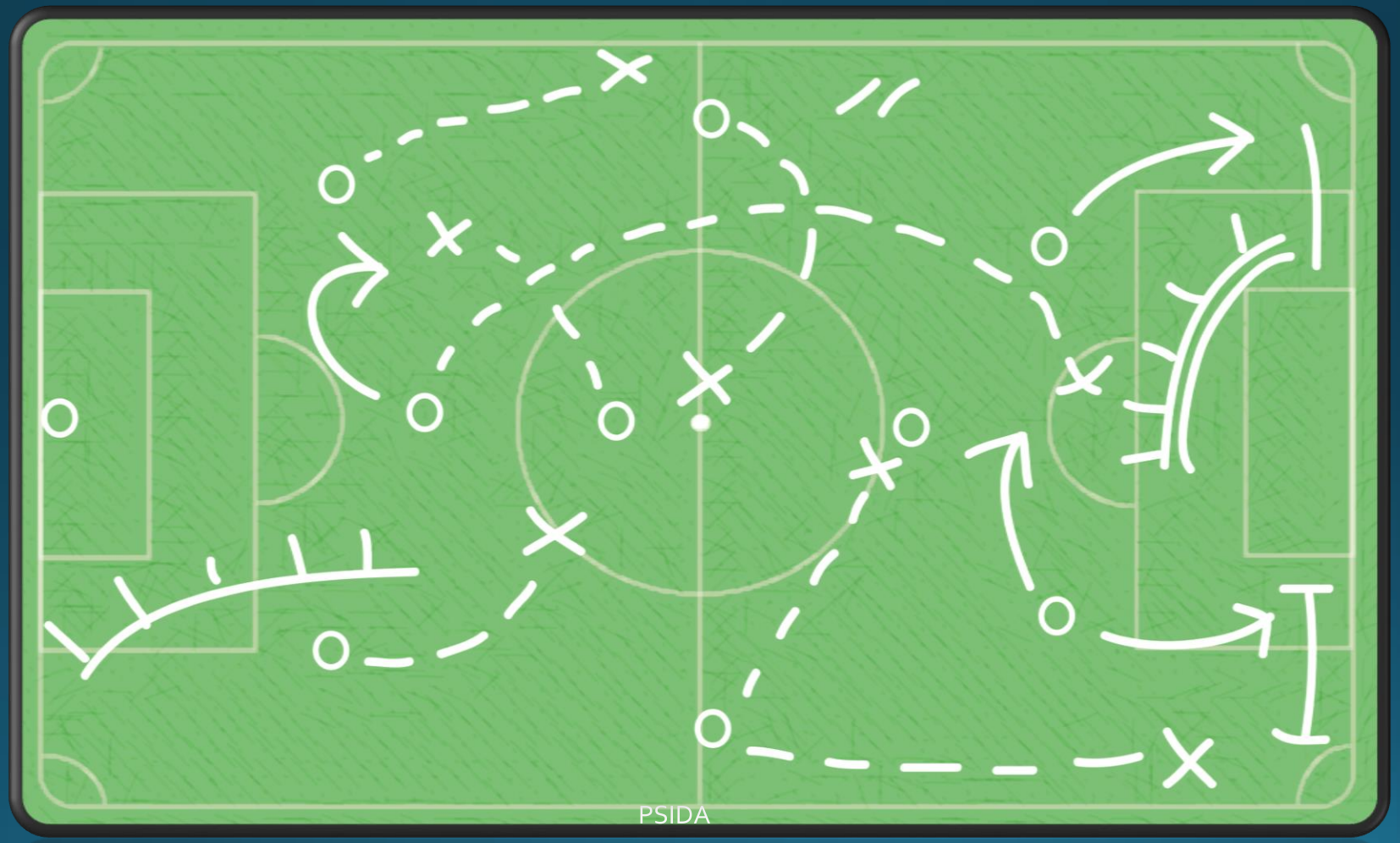
CSM GOALS for Planetary

2. **Serve as example** for future mission instruments

- Caveat: CSM doesn't make writing the software any easier but the API provides a thoughtful design for how it can be used.

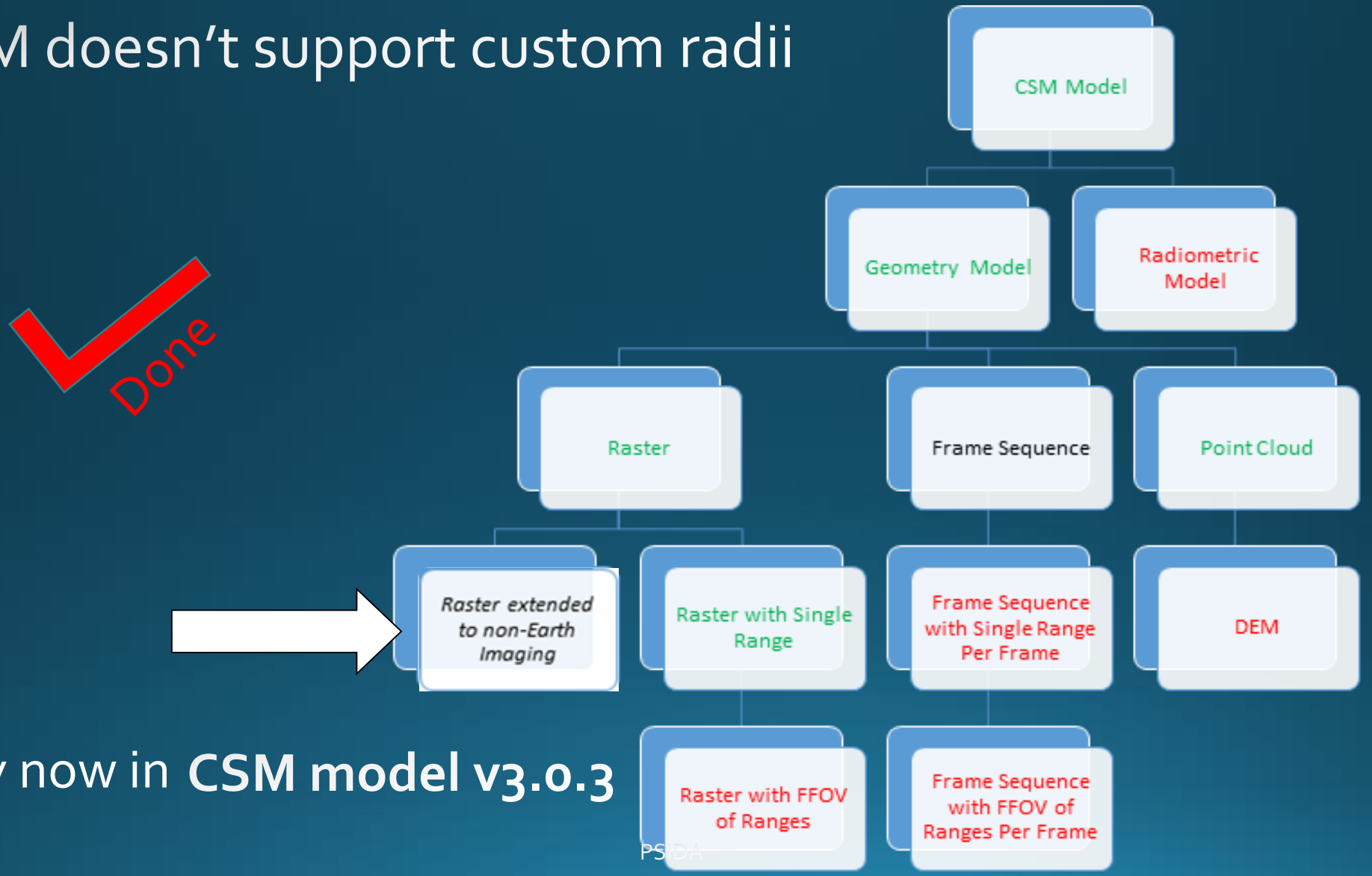
Game plan

How to Implement a Planetary CSM…



STEP 1: Work with the CSM working group

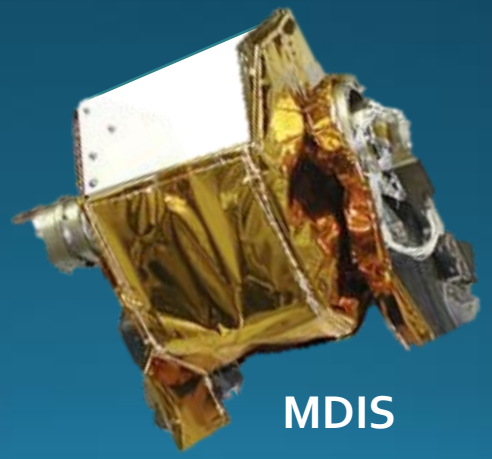
CSM doesn't support custom radii



Planetary now in **CSM model v3.0.3**

STEP 2. Pick a Test Case

- MESSENGER MDIS (NAC/WAC) Framing
- Cassini ISS Framing
- CTX / HiRISE and LROC (NAC) pushbrooms
- HRSC variable line-rate pushbroom
- SARs (Magellan, Mini-RF, Cassini -- not yet started)



MDIS
Applied Physics Laboratory

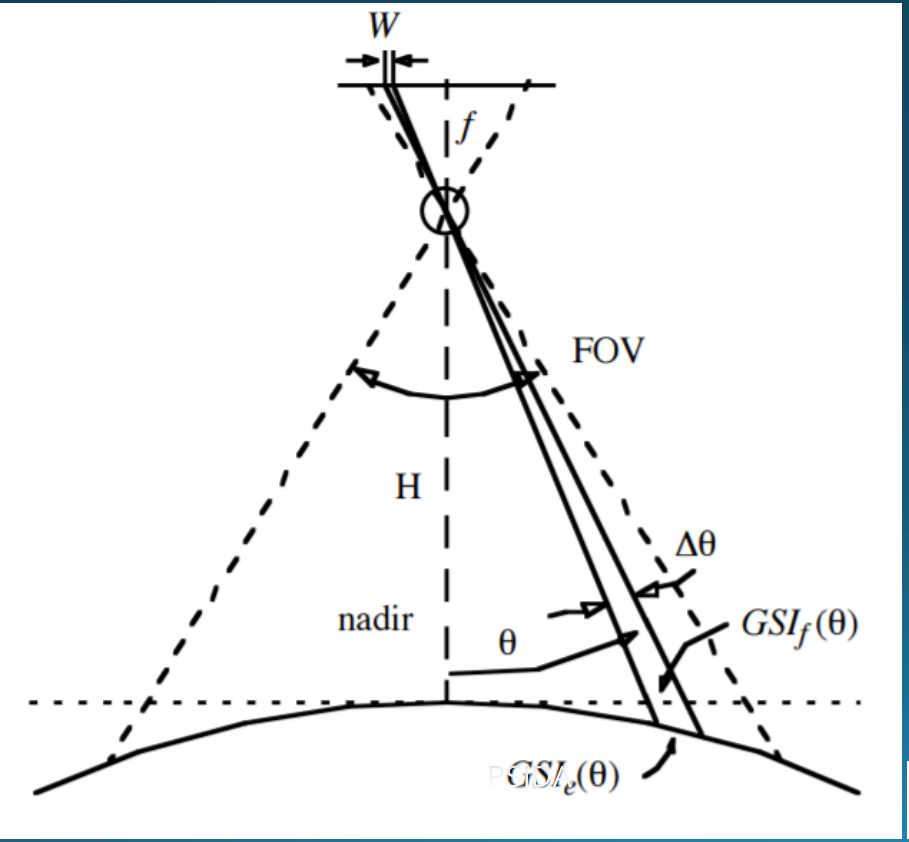
STEP 3. SPICE to ISD

- **Convert SPICE → Image Support Data (ISD)**
- **Pfeffernusse – micro web service (send image get ISD)**
  - **Uses NAIF's SPICE lib and SpicePy** (in memory or JSON object)

STEP 4. Write Camera Model

The heart of the camera model is two functions

Image2Ground( ) ←→ Ground2Image( )

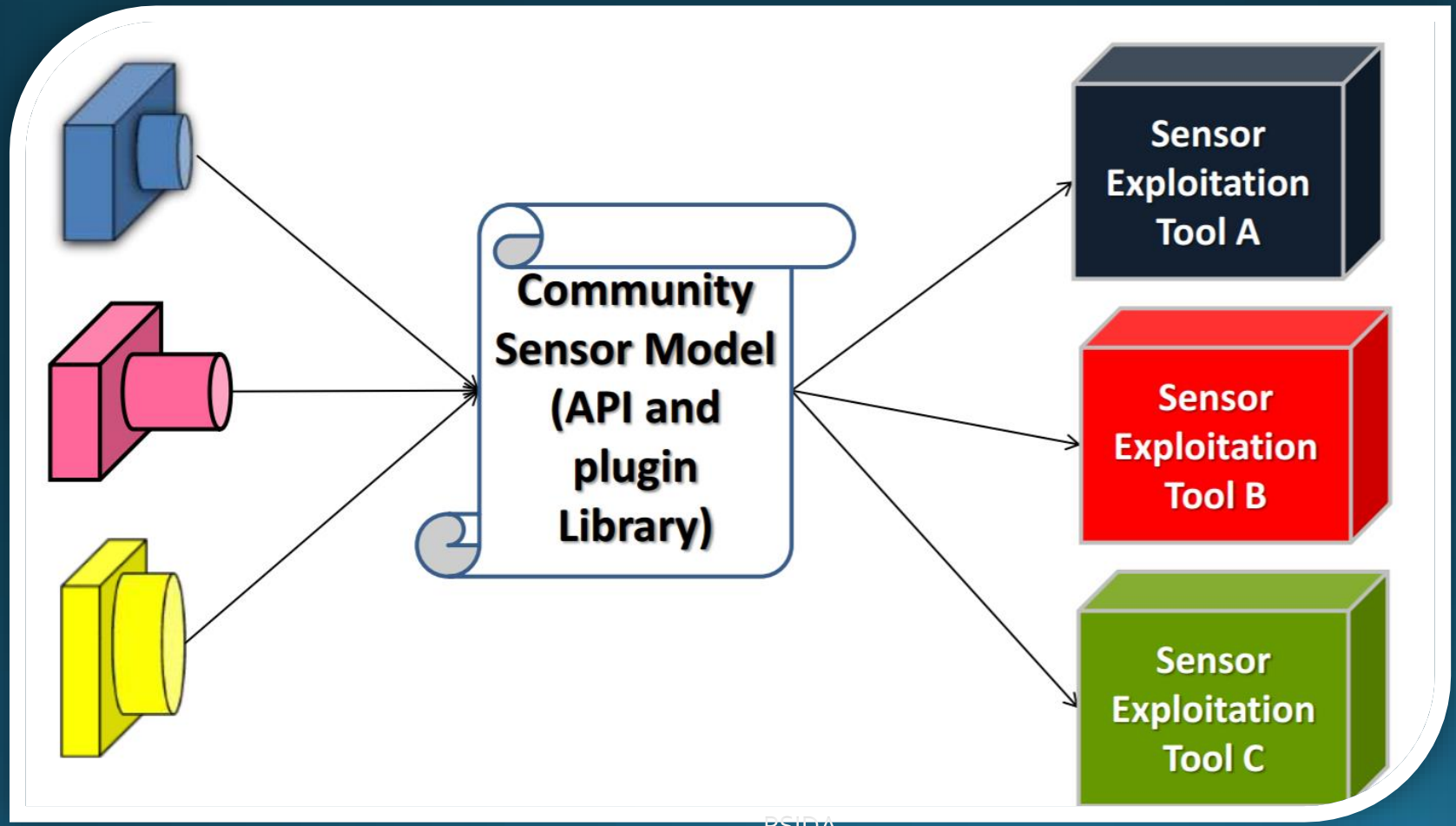


Done

Image by UofA

STEP 5. Test a SET

SET = Sensor Exploitation Tool



ISIS3

Socet GXP

ASP

Image: Hank Theiss (NGA)

STEP 5. Test a SET

In progress

Example Sensor Model Functionality

- Image-to-ground
- Ground-to-image
- Compute sensor partials
- Compute ground partials
- Get/set parameter value
- Get/set parameter covariance
- Get cross covariance
- Get un-modeled error

CSM API

Example Sensor Exploitation Tool (SET) Functionality

- Resection
- Triangulation
- Registration
- Multi-image Geopositioning
- Ortho-rectification
- Direct Geopositioning
- Relative Mensuration

Image: Hank Theiss (NGA)

STEP 6. Share the code

open source examples will be critical for NASA to adopt a new policy

- Code: http://bit.ly/CSM-CameraModel
- Linux/Mac: conda install –c usgs-astrogegeology usgscam
- Juptyer Notebooks: http://bit.ly/CSMSET_Jupyter

Summary

- Implemented: CTX, HiRISE, LROC and HRSC
- Implemented: MDIS NAC/WAC, Cassini ISS
- Created a prototype web-service "SPICE for CSM"

Promote **standard** across NASA planetary missions

Summary - what's next

- Integrate CSM models
  - Socet GXP (new - v4.3 which supports "planetary" CSM)
  - ISIS3
  - NASA AMES Stereo-pipeline
  - Maybe … GDAL/OSSIM/Orfeo Toolbox?
- Continue to work on SPICE API for CSM
- Test in ENVI and ERDAS

Summary - perceived benefits

A standardized sensor model for the planetary community

- Sensor model **infrastructure** for future instruments.
- Decoupling of the target body shape model and map projections.
- Use the same sensor model code across applications.
- Provide common functionality for all sensor types.
- Lastly: provide a standard template for sensor model definition, ensuring that flight teams can deliver a complete description of their instrument's internal geometry and calibration