Technology Development for the Whipple Mission Concept - Present Status and Future Work

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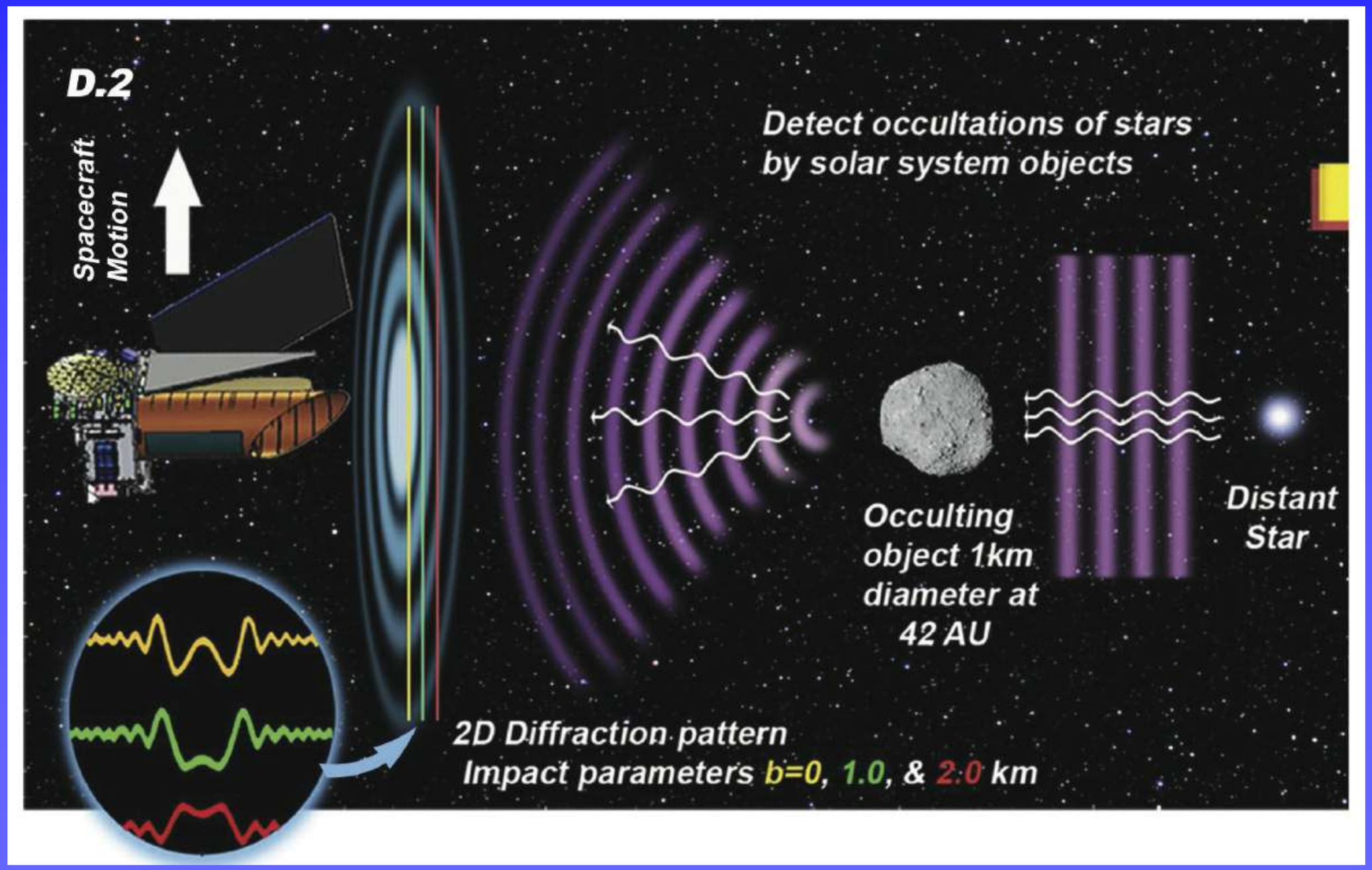
Studying the Outer Solar System

- Only a small volume of the Solar system has been studied in detail
- Remnant of formation of Solar system present in Kuiper belt, Sedna region, Oort cloud
- The rocky population of these regions could provide key inputs to models of formation and early history of Solar system
- Planetary prizes given for work on outer Solar system

Whipple Concept - Blind Occultation Survey



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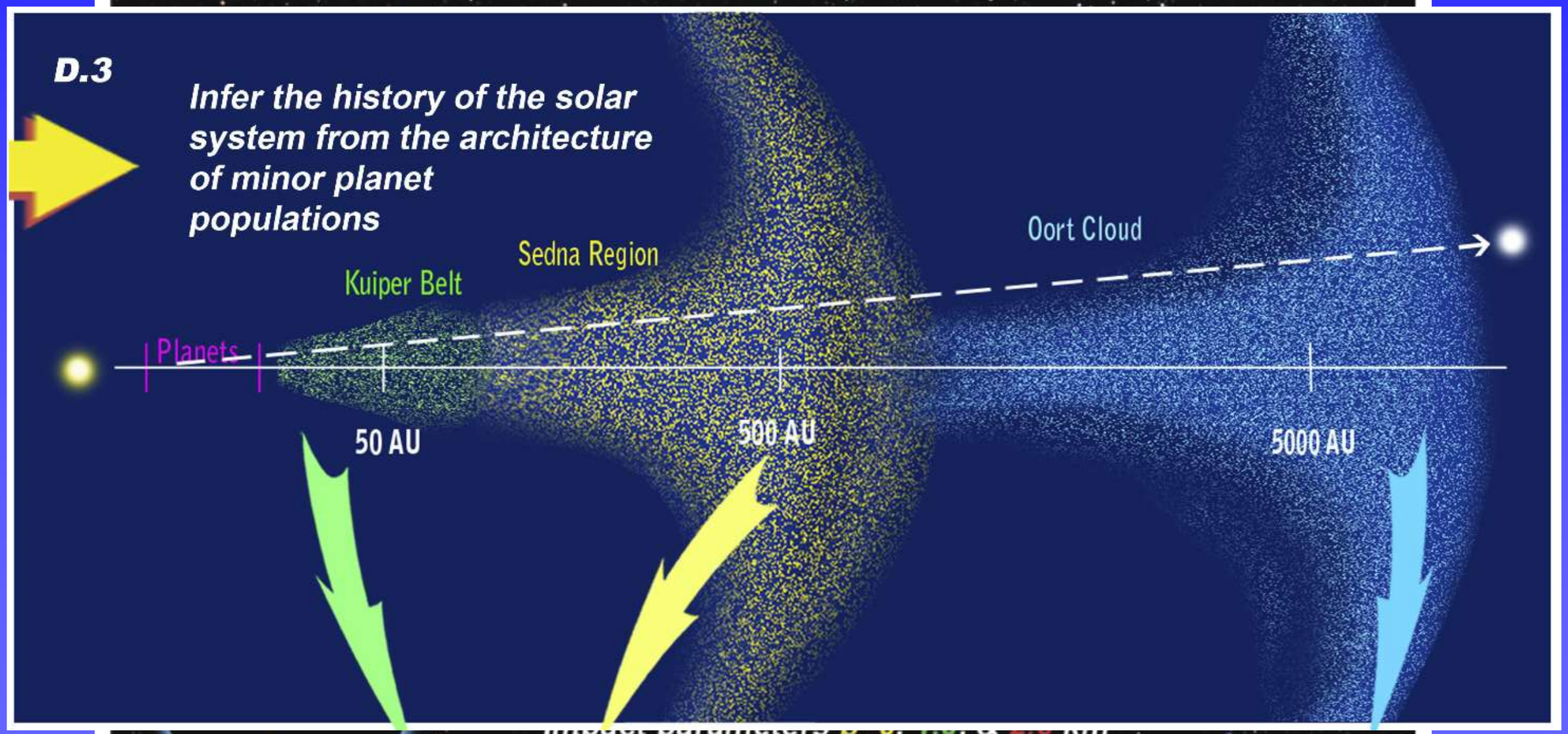

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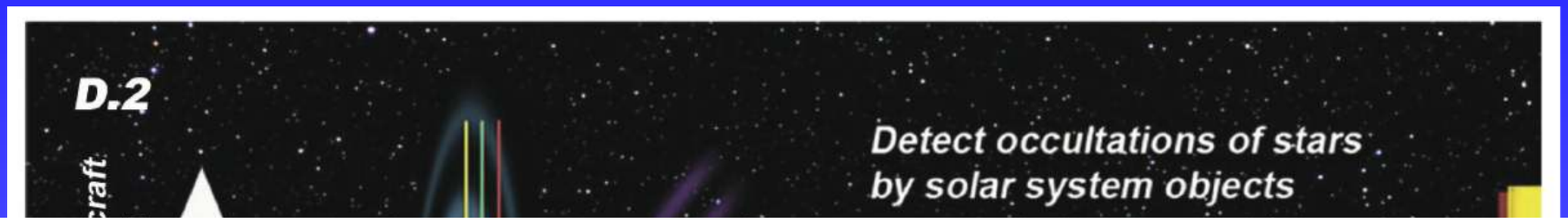
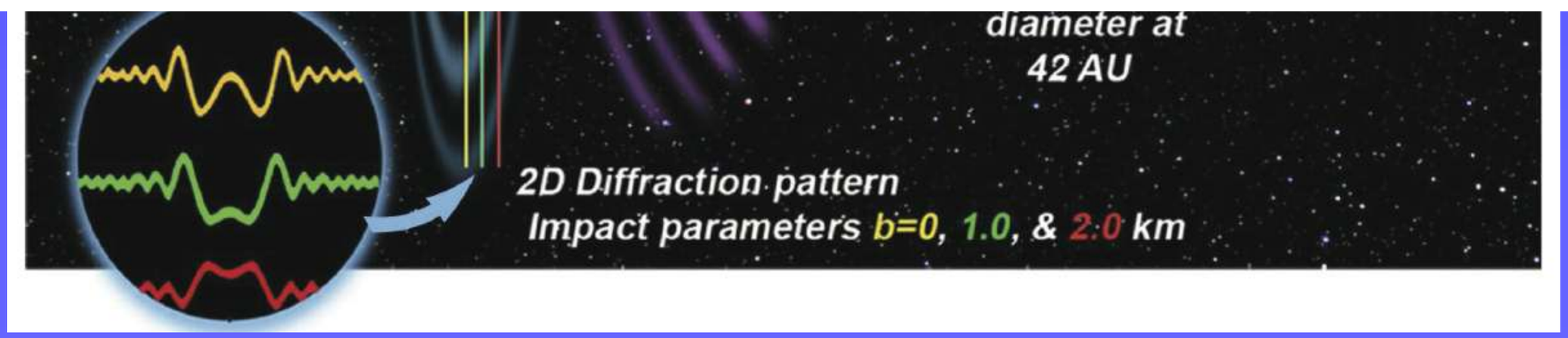


	Min.	Max.	Best Est.
KBO	12,000	40,000	25,000
SRO	15	90,000	1,300
OCO	100	650	260



Whipple Concept - Blind Occultation Survey

2010

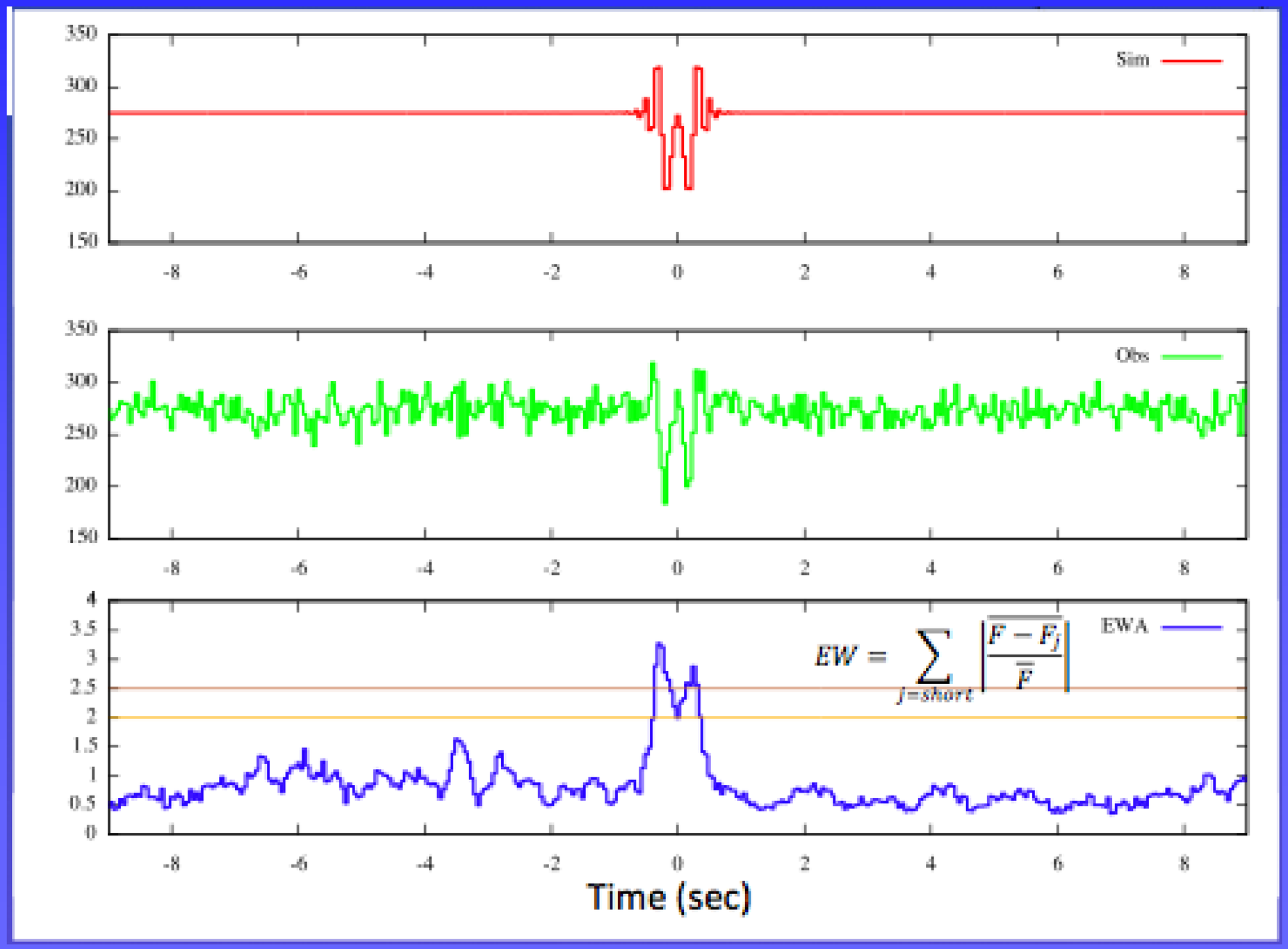
Discovery - Consolation Prize - Technology Development

The Problem

- Need to continuously monitor tens of thousands of stars at 40 Hz
- Occultations occur in less than a second - MUCH faster than Kepler
- Can’t telemeter light curves - require massive onboard processing
- Onboard detection of occultation - Equivalent Width algorithm (Roques+2003)

$$EW = \sum_{i=1}^{7} (1 - F_i/\overline{F})$$

Simulated Whipple Lightcurve



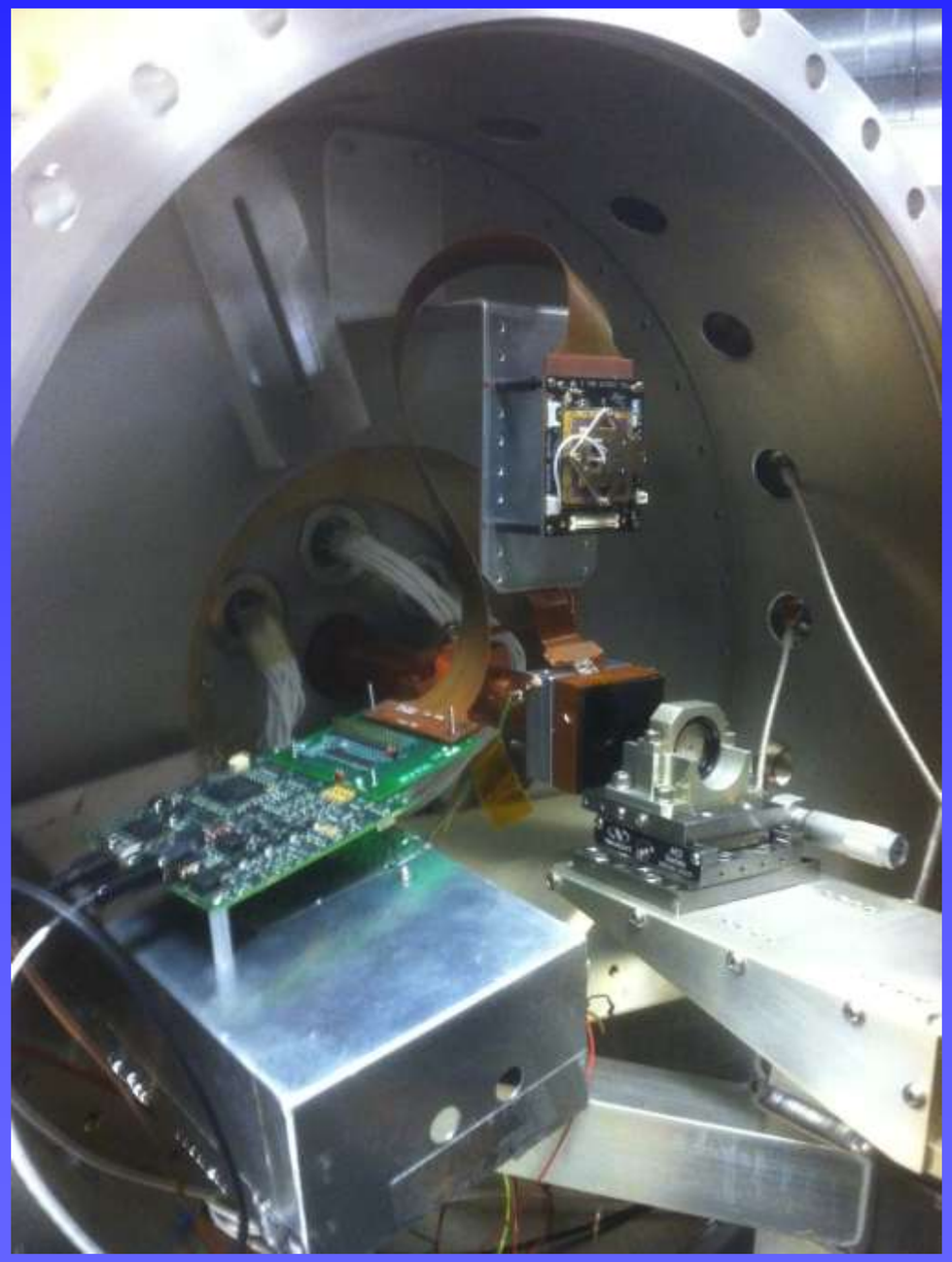
Instrumentation - The Whipple Photometer

- Teledyne H2RG HyVISI sensor + SIDECAR ASIC - 700 windows per sensor at 40 Hz (w/ CDS) - TRL 9
- Lightcurves processed by FPGA using EW algorithm - only candidate occultations sent to telemetry
- Whipple Technology Development - Marry the two! Prove that it works.

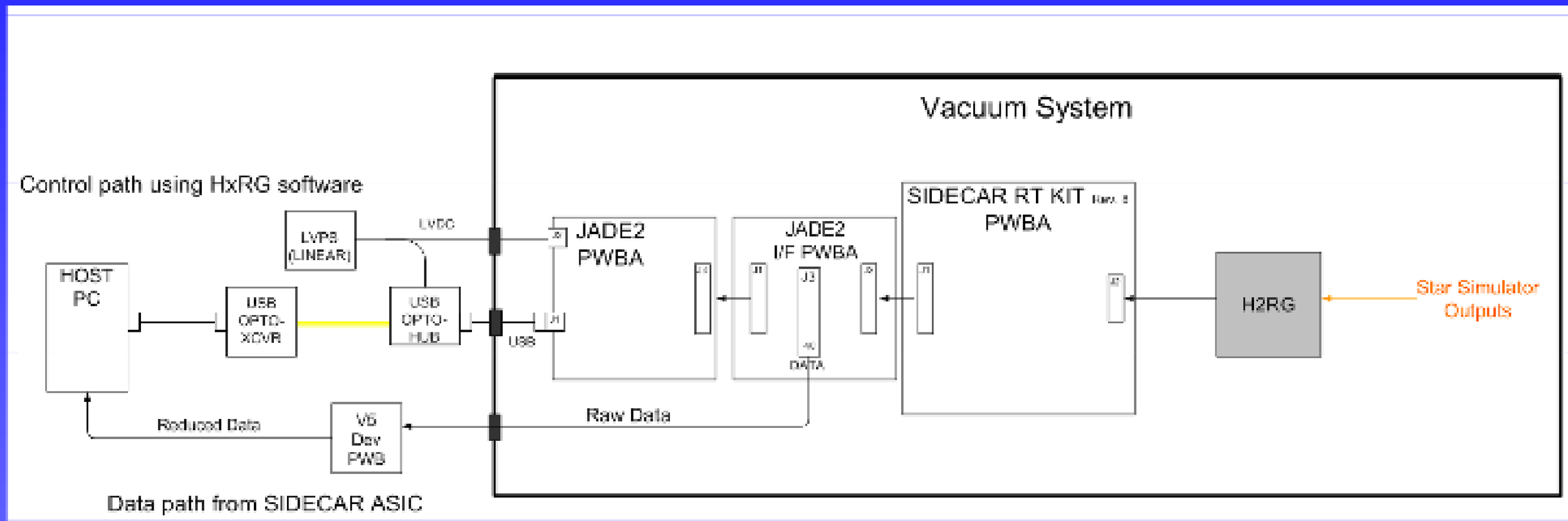
3 Key Goals of WTD

- Demonstrate 700 windows at 40 Hz in H2RG
- Demonstrate 700 data streams at 40 Hz in FPGA
- Demonstrate detection of simulated occultations in complete systems

Laboratory Setup



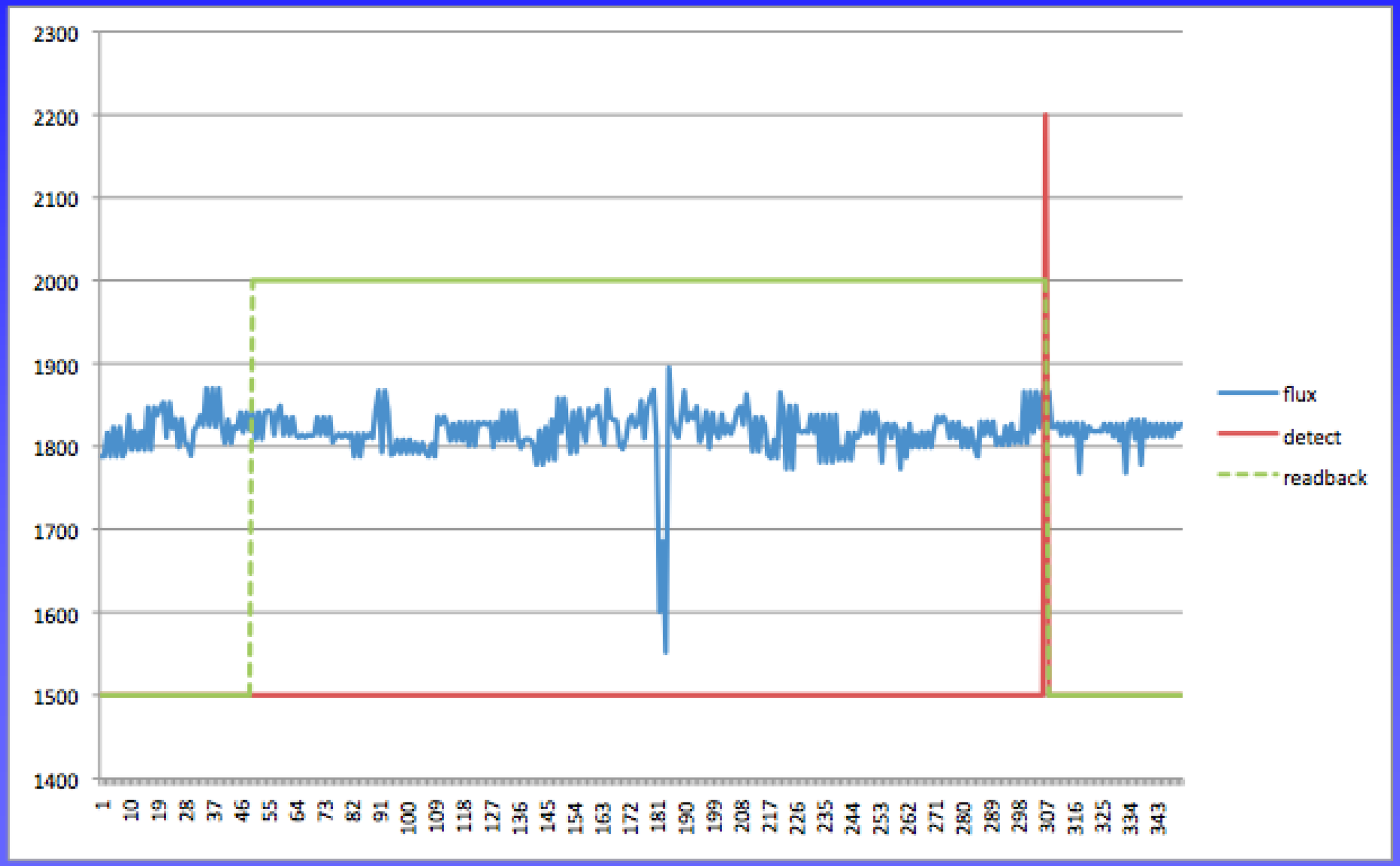
Laboratory Setup - Schematic



Current Status

- H2RG + SIDECAR fully operational (15 e- readnoise)
- Occultation simulator fully operational
- Windowing software delivered and operational - under evaluation
- EW algorithm tested (simulated and real/noisy data) and confirmed in Virtex 5 FPGA
- Multiple data streams confirmed - 2000+ stars per sensor at 40 Hz (Whipple req is 700 stars at 40 Hz)

Whipple Occultation Lightcurves - Lab Data Processed by FPGA

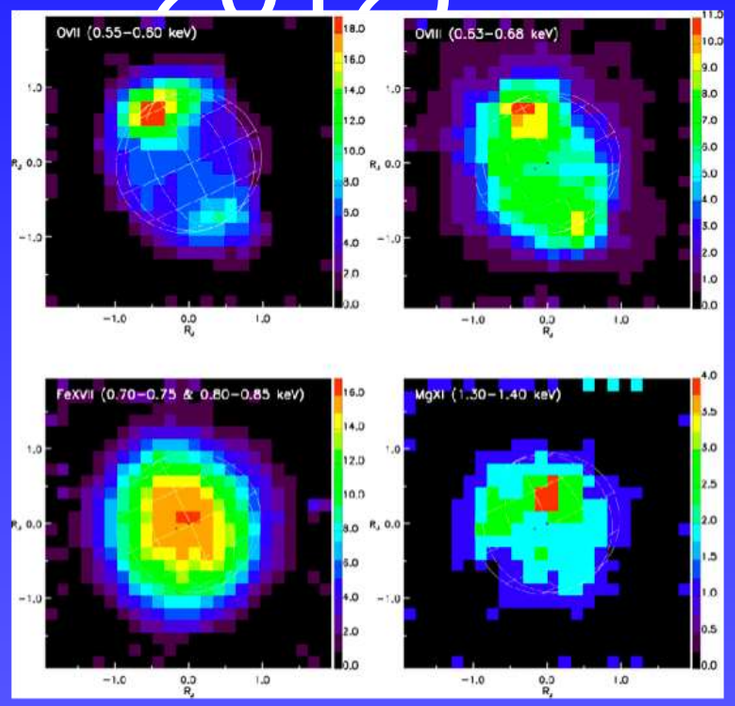


Future Work - We're Almost There!

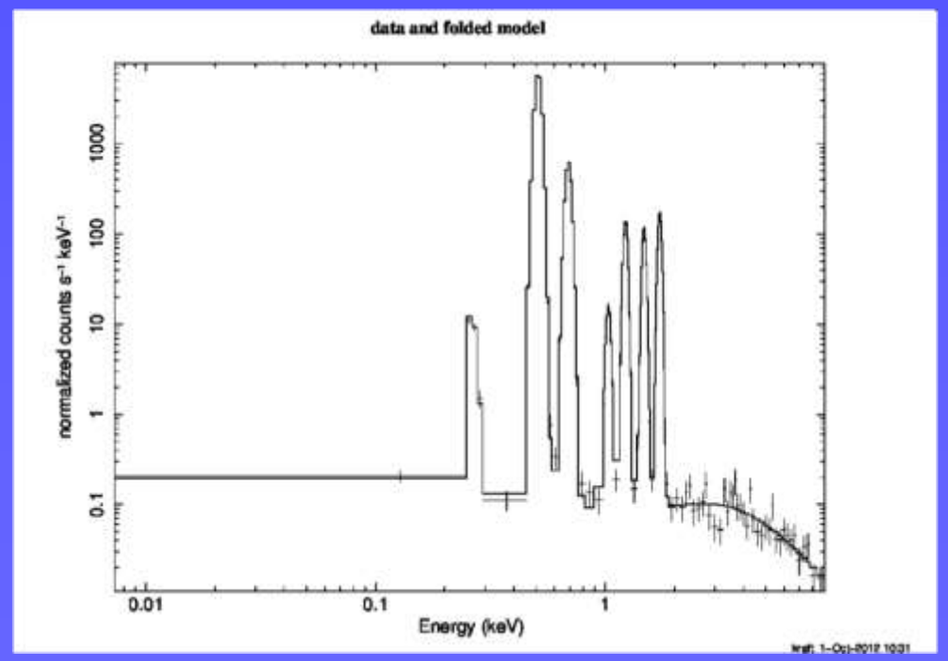
- Interface FPGA development kit with SIDECAR ASIC - in progress
- Construct PCB board for FPGA and command interface
- Laboratory evaluation of EW alg., sensitivity, S/N performance, stability, etc.

Shameless Plug - X-ray Imaging Spectroscopy (Poster Gallery #4 - Kenter+ 2012)

- Monolithic CMOS X-ray imaging spectrometer
- Microchannel plate optic
- X-ray studies of rocky bodies, planetary magnetosphe



Chandra image of Jupiter in four bands (Branduardi-Raymont+ 2007)



Simulated spectra of NEO