The Radiation Budget Instrument (RBI): Instrument Overview and Calibration Features
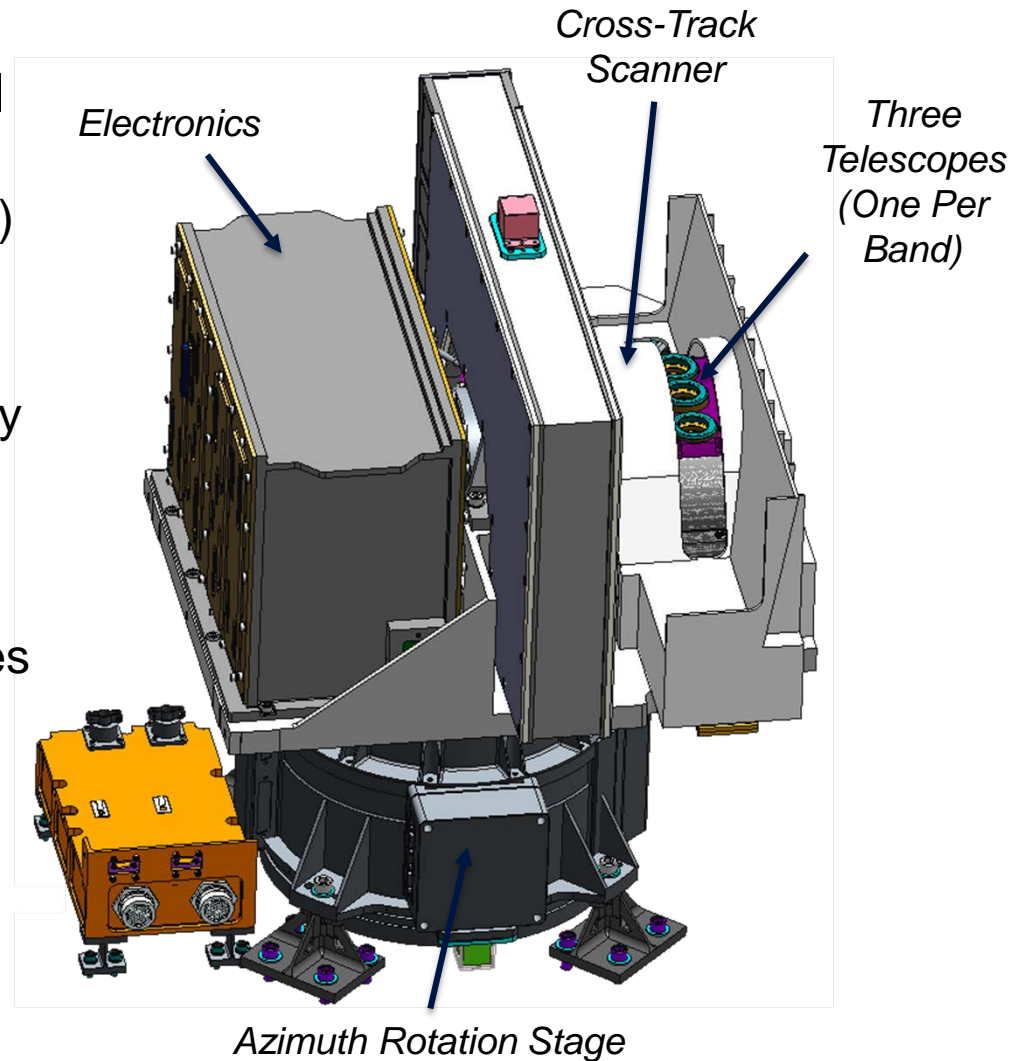
Ronald Glumb, Christopher Lietzke, Jay Overbeck, Merritt Webb

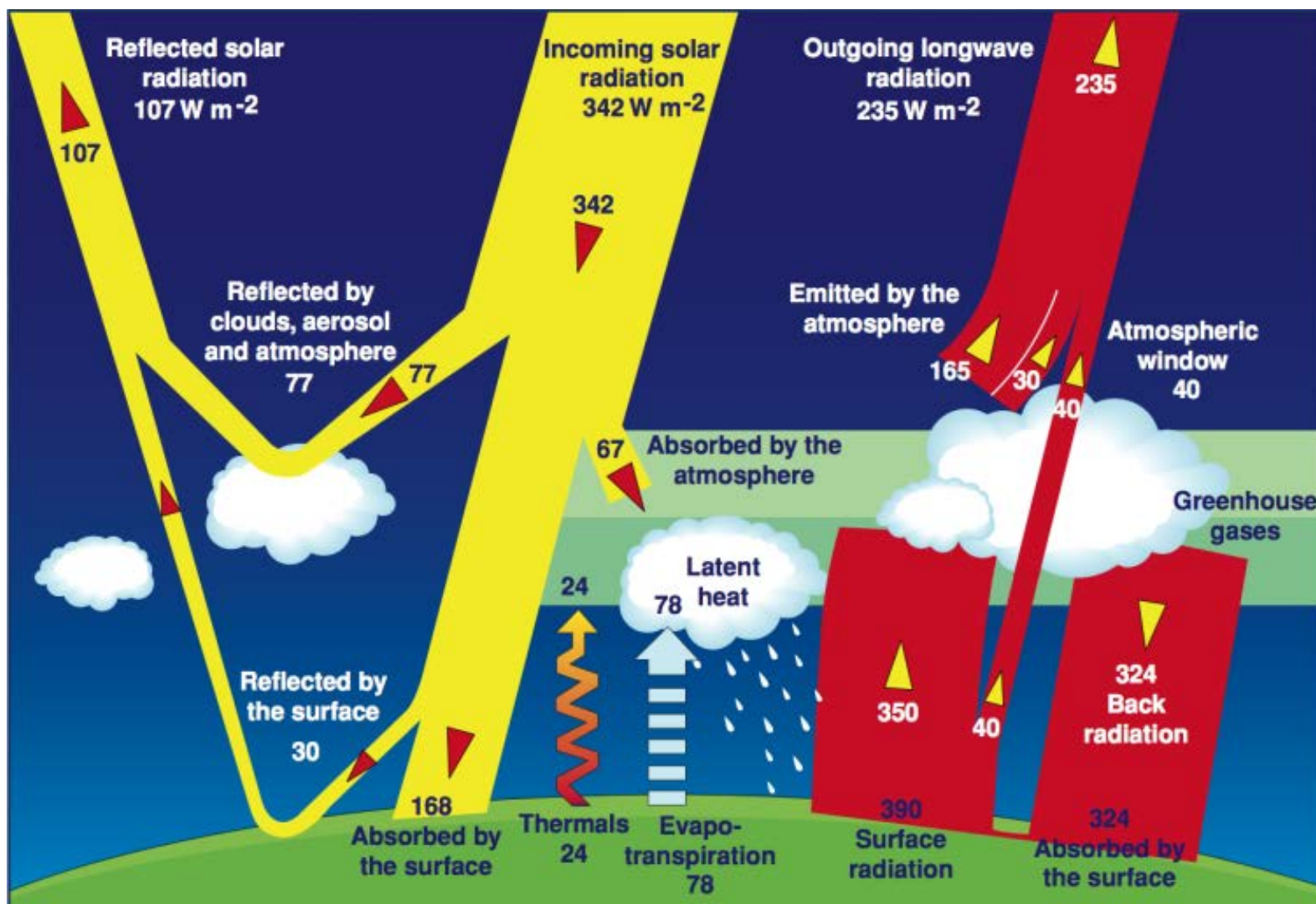Harris Space and Intelligence Systems

Fort Wayne, Indiana USA

Agenda

- RBI Mission
- Key requirements for RBI Mission
- Instrument design
- On board calibration sources
- RBI predicted performance

Radiation Budget Instrument

- **Collects upwelling earth radiance over a wide spectral range**
  - Ultraviolet to far-infrared (100um)
  - Continuous cross-track scans
- **Three spectral bands**
  - Shortwave: reflected solar energy
  - Longwave: emitted earth energy
  - Total: independent check of the other two bands
  - One telescope per band simplifies detectors and operations
- **Very precise calibration**
  - Extensive ground calibration program sets the calibration
  - Multiple onboard targets hold calibration over mission life

Electronics

Cross-Track Scanner

Three Telescopes (One Per Band)

Azimuth Rotation Stage

| **CALCON: RBI Overview**

RBI's Mission: Earth's Radiation Budget Measurement Continuity
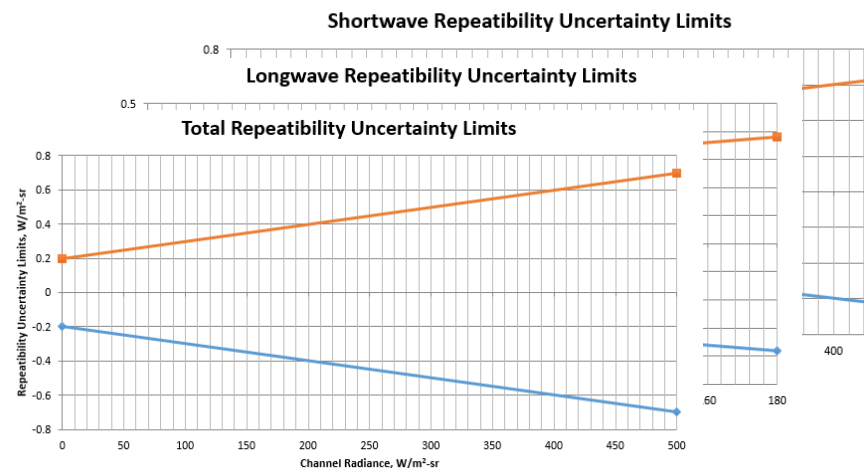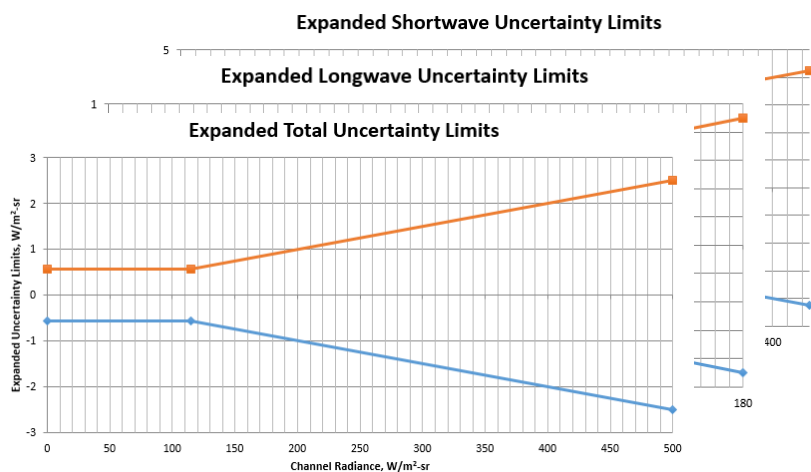
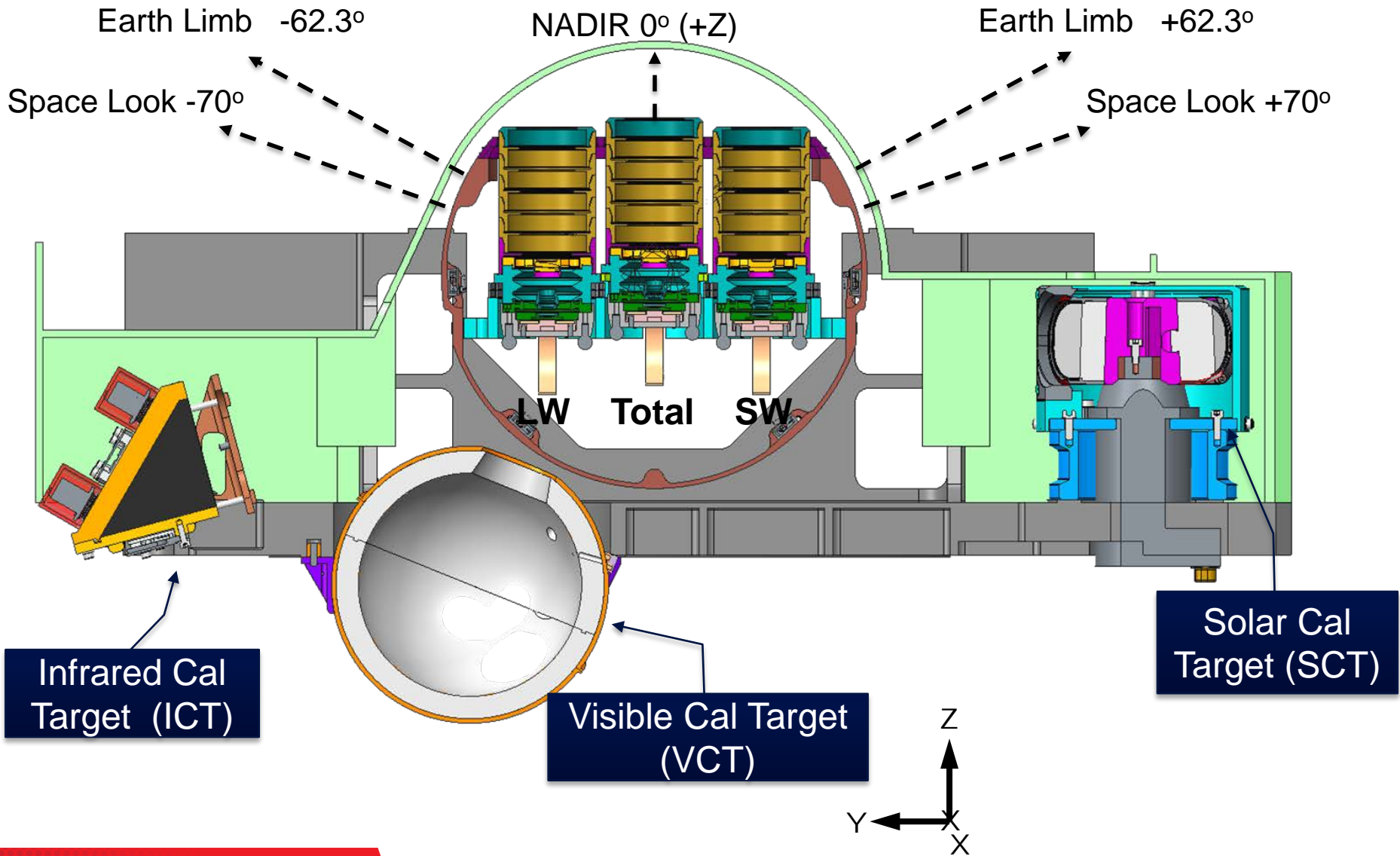# Key Requirements Drive Calibration and Traceability to CERES

- Radiometric Uncertainty (SW, LW and Total channels)
  - Long Term Uncertainty   --- Repeatability
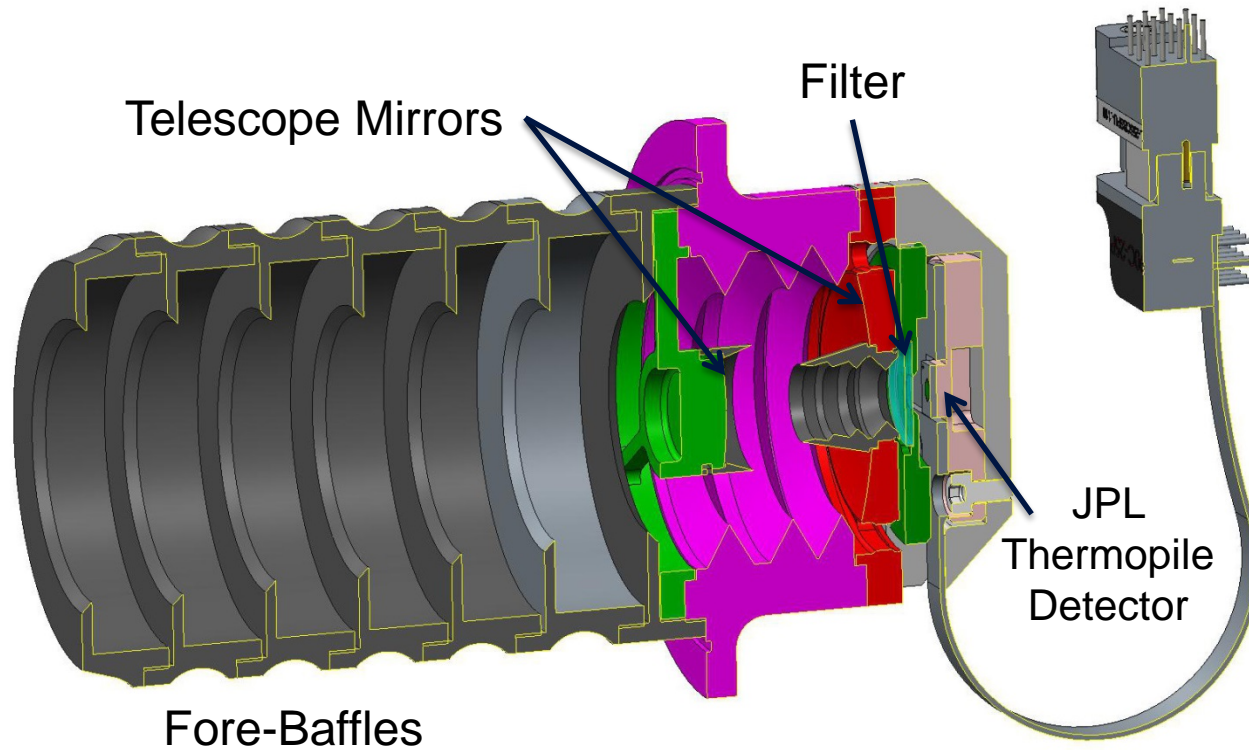 (within 1-month)

  - Relative Spectral Response by channel
    - SW: 200nm – 5 μm; LW: 5 μm – 50 μm; Total: 200nm – 100 μm
  - Point Spread Function (PSF) 95% match to CERES
  - Channel to channel registration of 98%
  - Calibration sources for SW, LW and solar calibration

Instrument Channels and Targets

Earth Limb   -62.3°

Space Look -70°

NADIR 0° (+Z)

Earth Limb   +62.3°

Space Look +70°

LW   Total   SW

Infrared Cal Target (ICT)

Visible Cal Target (VCT)

Solar Cal Target (SCT)

Z
Y
X
X

| CALCON: RBI Overview

Optical Module Designed to Control Straylight and Provide Stable Thermal Environment

Telescope Mirrors

Filter

JPL Thermopile Detector

Fore-Baffles

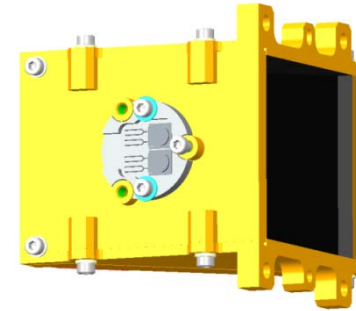# Visible Calibration Target Provides SW and Total Calibration Standard

- The VCT provides 6 active sources
  - 375, 405, 445, 660, 915, 1470 nm
- Si and InGaAs photodiode provides quick reference of radiance
- ESR (Electrical Substitution Radiometer) provides stable absolute measurement traceable to NIST
  - Used monthly to calibration Si and InGaAs photodiode along with SW and Total channels
- Neutral density filters in filter wheel provide adjustment for flux level
- Laser diodes remotely located, fiber coupled, providing thermal stability of diodes and sphere

Photodiodes

Sphere Aperture

Electrical Substitution Radiometer (ESR)

Fiber Optic Ports for Laser Illumination Input

SCT and ICT
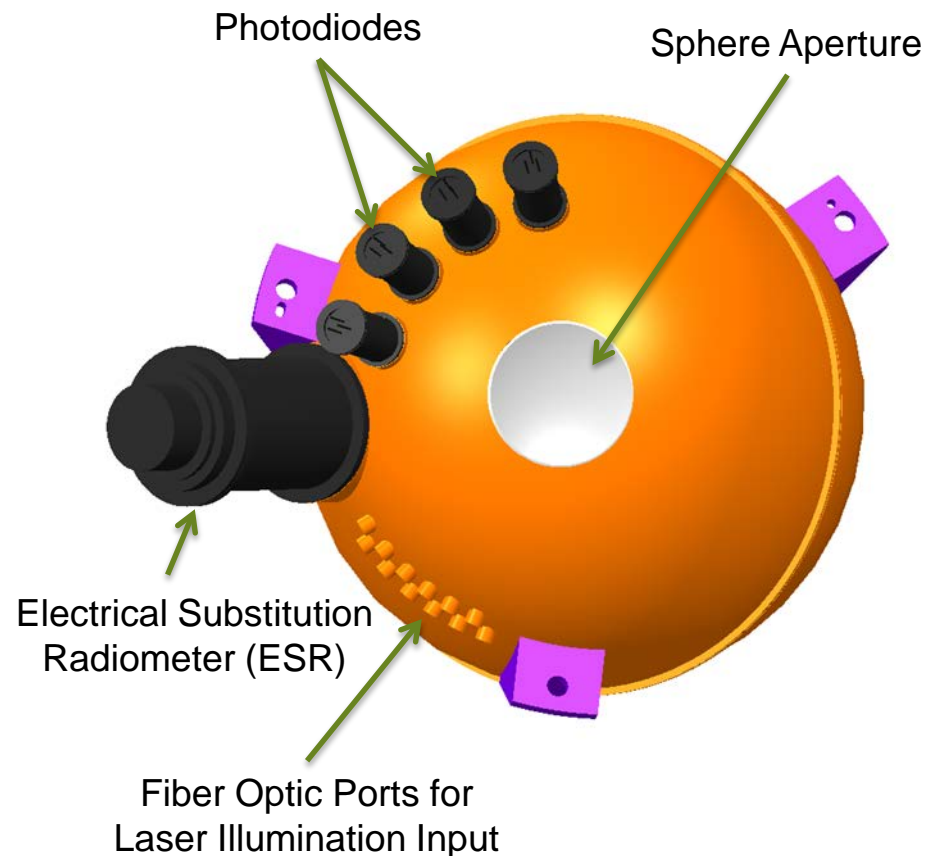
- **ICT**
  - Provides for IR calibration (LW and Total)
  - Flight heritage design from CrIS and AHI-8
  - Trap design provides >0.995 emissivity
  - Design provides the capability to raise the temperature to provide the opportunity to perform linearity measurements while on-orbit
- **SCT**
  - Three Spectralon® panels provide opportunities for solar or lunar calibration
    - Diffuser 1 used Bi-Weekly
    - Diffuser 2 used Quarterly
    - Diffuser 3 used Yearly
    - Cover fills opening when SCT not in use
  - Used as a cross check with legacy CERES data
  - Solar calibration target is not used to meet radiometric uncertainty requirements
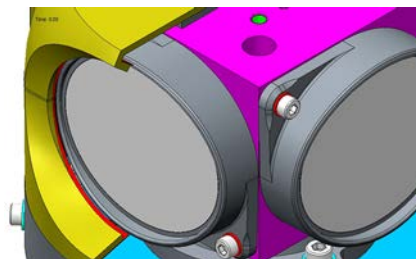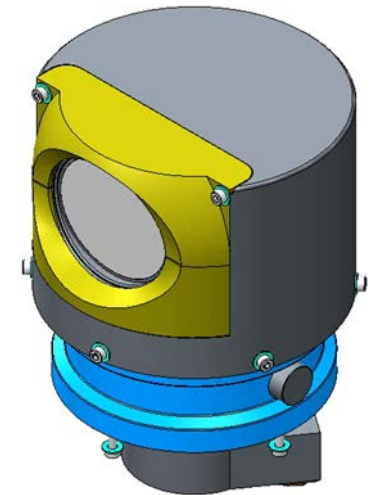
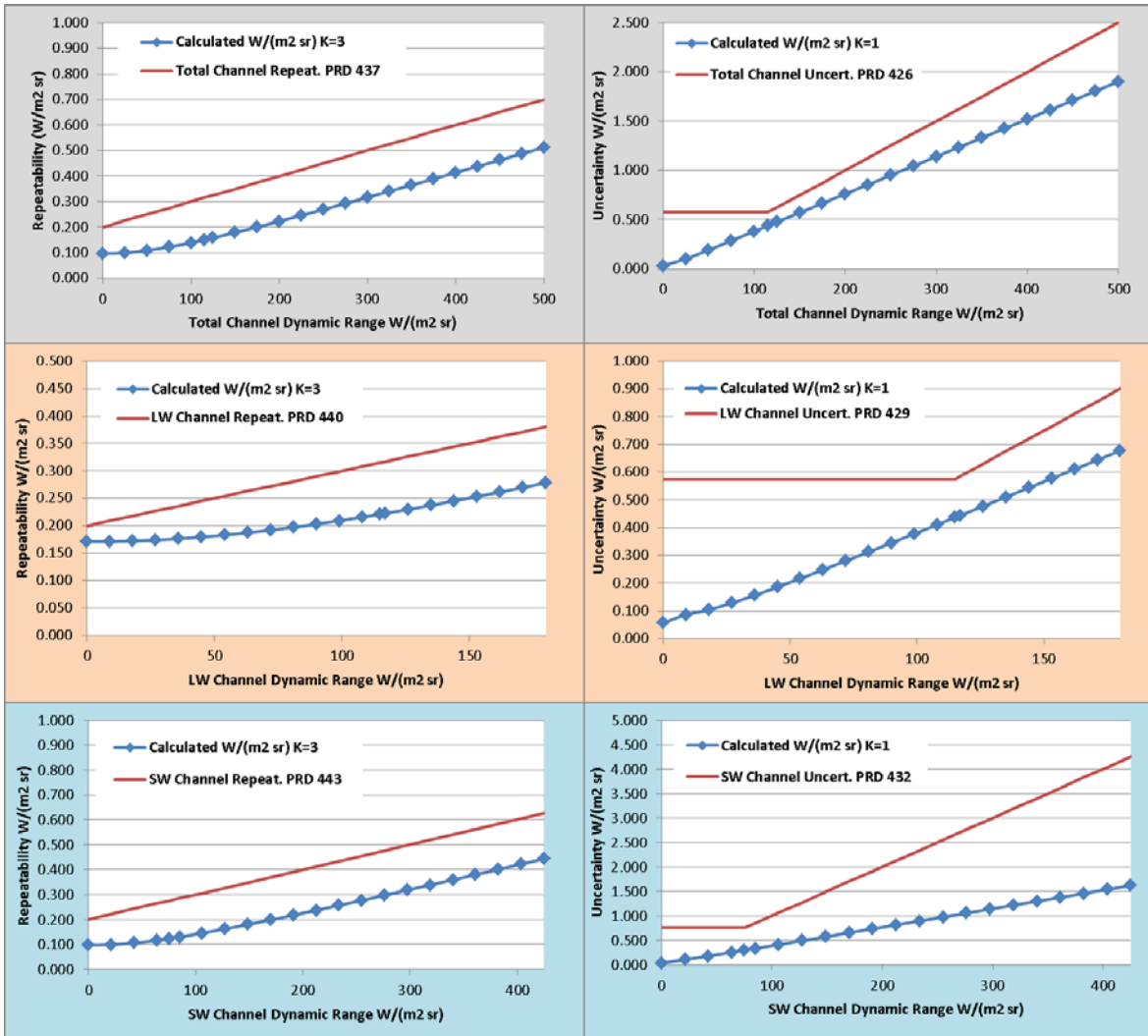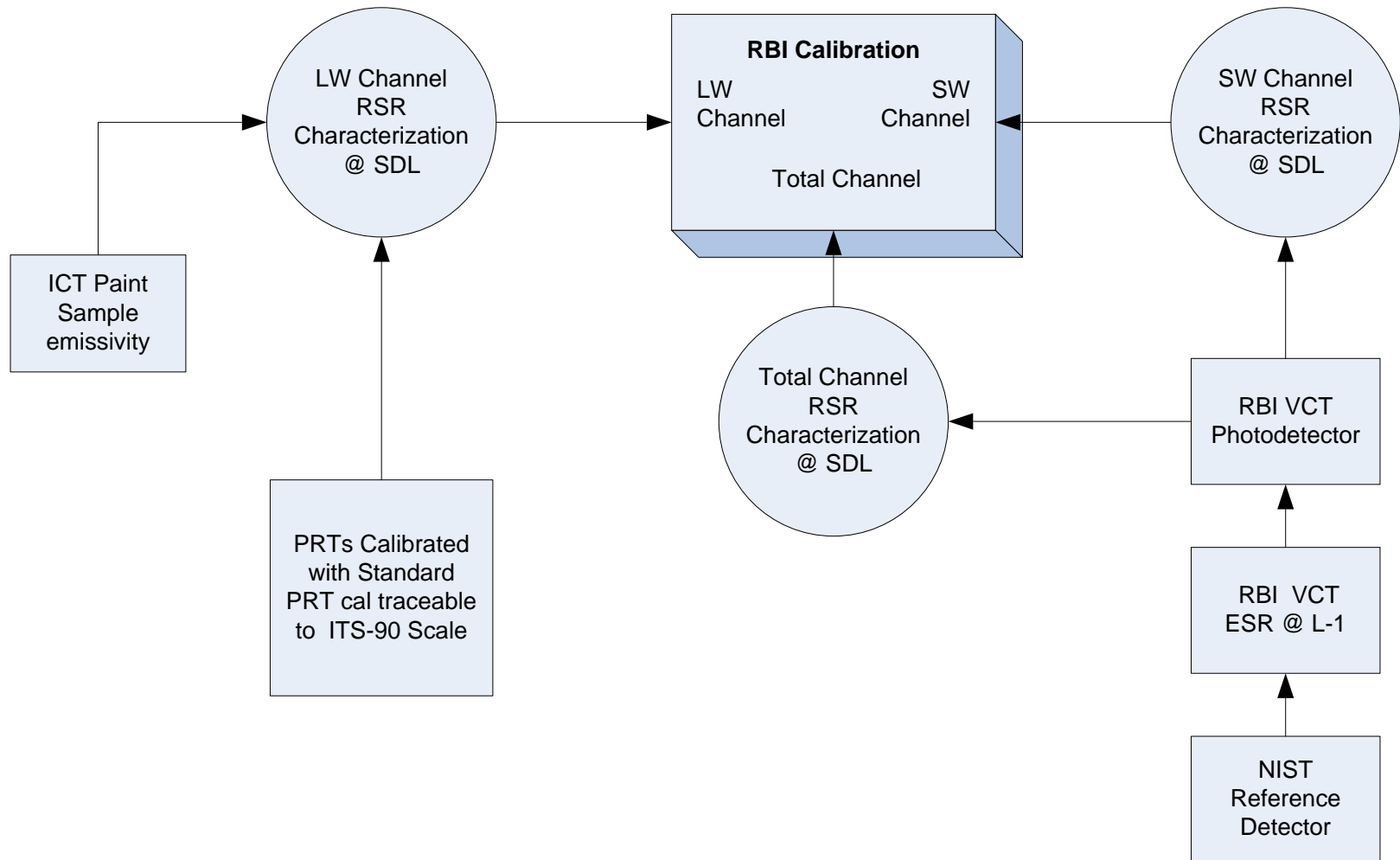# RBI 30 day Calibration Timeline

| CALCON: RBI Overview
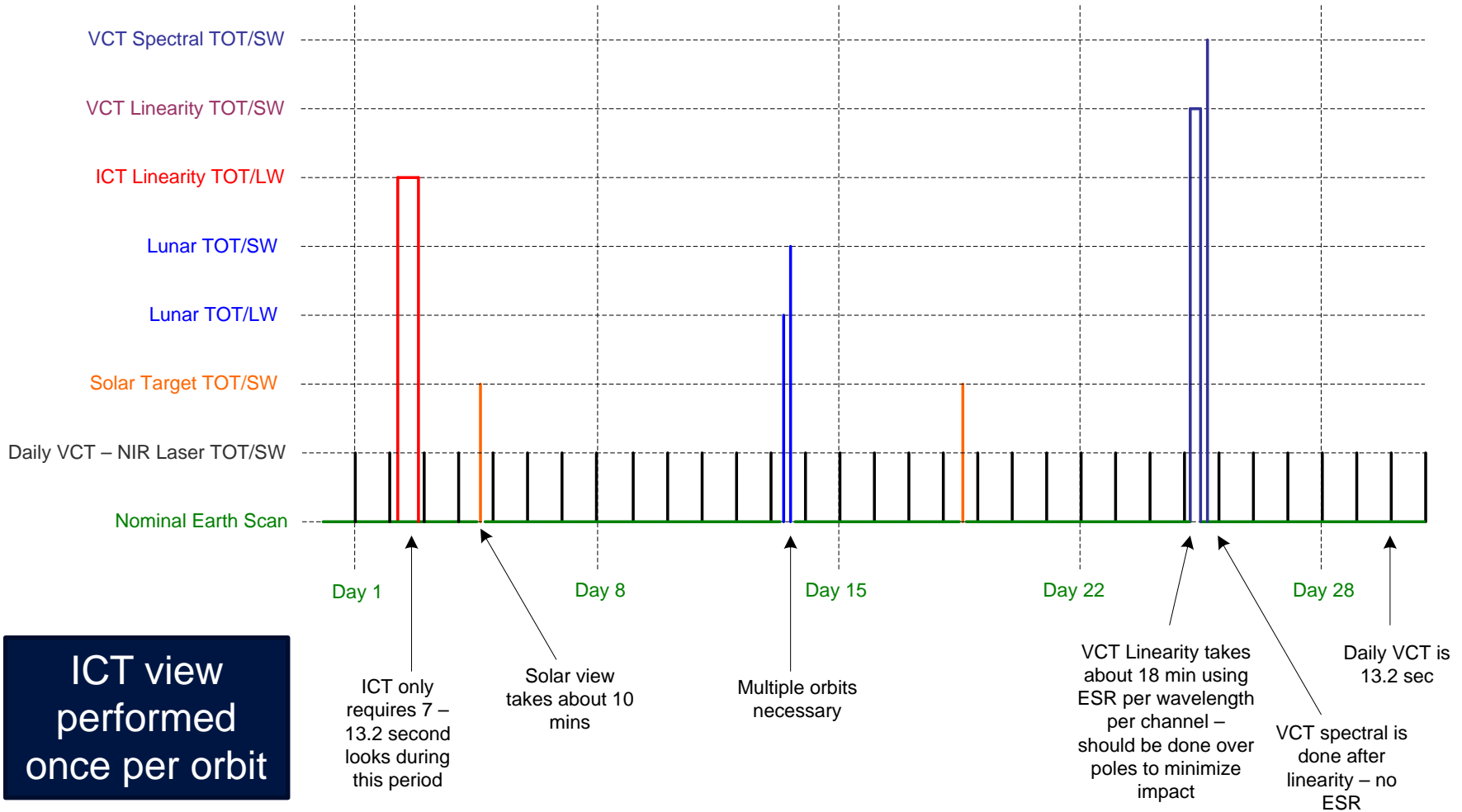
Predicted Performance Demonstrates Margin on Radiometric Uncertainty Requirements

Performance margin on Radiometric Uncertainty requirements on closest approach

Channel	Repeat	LongTerm
Tot	36.69%	31.20%
LW	16.87%	31.58%
SW	41.07%	156.36%

RBI Calibration Traceability

LW Channel RSR Characterization @ SDL

RBI Calibration

LW Channel   SW Channel

Total Channel

SW Channel RSR Characterization @ SDL

ICT Paint Sample emissivity

Total Channel RSR Characterization @ SDL

RBI VCT Photodetector

PRTs Calibrated with Standard PRT cal traceable to ITS-90 Scale

RBI VCT ESR @ L-1

NIST Reference Detector

RBI Programmatic

- SRR was held Dec 2014
- PDR planned for Q1 – 2016
- CDR planned for Q1 – 2017
- Flight delivery date November 2018
- Instrument flies on JPSS-2, launch 2021

- RBI will carry on the important ERBE and CERES data records
  - PSF and spectral coverage traceable to CERES
  - RBI has an enhanced shortwave calibration source providing accurate multi-wavelength sources with a NIST-traceable reference detector

- Thanks to the NASA LaRC RBI program team

Program is on Track for Successful Delivery of RBI FM1

Summary

- RBI will carry on the important ERBE and CERES data records
  - PSF and spectral coverage traceable to CERES
- RBI includes several new calibration features
  - Stable NIST traceable IR calibration source
  - Visible calibration target (VCT) provides accurate multi-wavelength source with NIST-traceable reference detector
  - Solar calibration target provides cross check with VCT