# Passive Microwave and Sub-millimetre-wave Imager Technologies for Met-Op SG


## Presented by Simon Rea

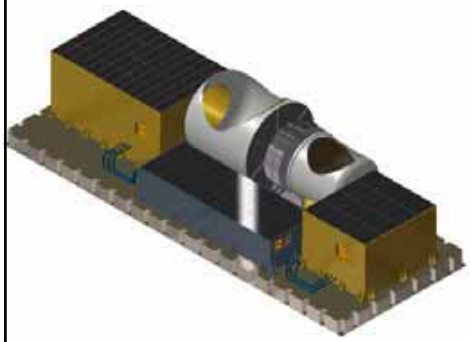
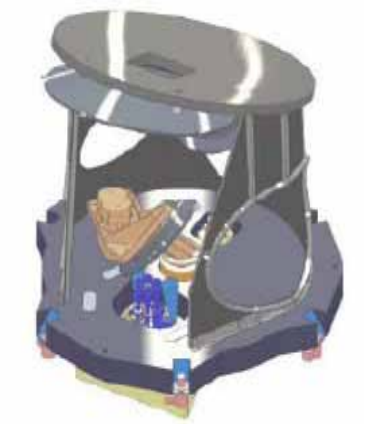
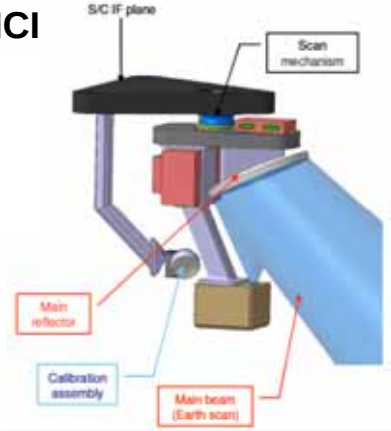
**Slides prepared by Astrium, JCR Systems, SEA,**

**STFC RAL**


7 September 2011

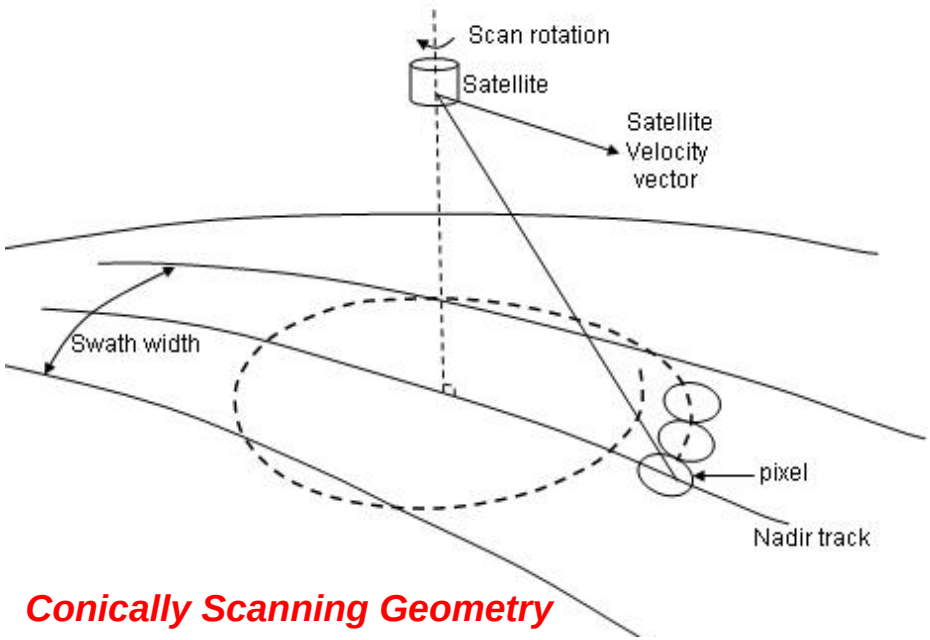
Centre for EO Instrumentation

# MetOp-SG Passive Microwave Missions

| Mission | **MWS** | **MWI** | **ICI** |
|---|---|---|---|
| |  |  |  |
| Objectives | Temperature/humidity profiles in clear and cloudy air<br>cloud liquid water total column | Precipitation products | Cloud ice products |
| Instrument | Across-track scanning sounding radiometer | Conically scanning imaging radiometer | Conically scanning imaging radiometer |
| Heritage | AMSU-A, MHS | WINDSAT, SSMI-S, AMSR, MADRAS, EGPM, MIMR, | WINDSAT, SSMI-S, AMSR, MADRAS, EGPM, MIMR |
| Priority | 1 | 2 | 2 |

# Technical Challenges of Imaging Radiometers

- Robust instrument calibration
  - *History of poor calibration*
  - *New techniques developed to improve calibration*
- Minimisation of platform disturbance
  - *Large rotating mass displaced from platform centre of gravity*
- Stringent sensitivity requirements
  - *Short integration times*
  - *Minimisation of optics loss / Rx noise*




***Conically Scanning Geometry***

# Study Objectives

- To bring together a strong UK Systems team in preparation for MetOp SG Phase B2/CD
- To address the key technical challenges of the imaging radiometers
- To help position UK industry to win an instrument prime role on one of the imaging instruments

# Study Scope

- Activities focused on four inter-related subsystems
  1. *Calibration Subsystem*
     - *Development of advanced calibration performance models*
     - *Consolidation of calibration subsystem requirements*
  2. *Quasi-optics Subsystem*
     - *Review current QO design, identification of improvements*
     - *Design and breadboarding of 183 GHz feedhorns*
  3. *Receiver Subsystem*
     - *Breadboard of 183 GHz receiver*
     - *Investigation of key receiver issues including advanced calibration procedures, feedhorn loss, mixer VSWR*
  4. *Active Balancing Subsystem*
     - *Consolidation of active balance control requirements*
     - *Breadboard of active balance subsystem*

# Calibration Issues

- Previous imaging radiometers have used standard two-point calibration
- Scanning & orbital geometries make standard calibration difficult
  - *Solar intrusion on hot target*
  - *Lunar intrusion on cold space view*

- Four-point (or more) calibration has been proposed
  - *Use of additional internal noise sources*
    - *Noise diodes, matched loads, active cold loads*

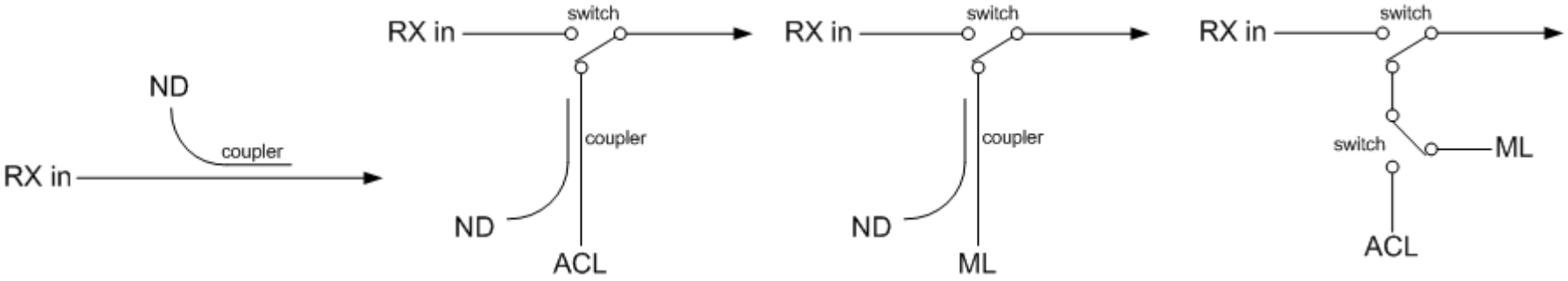
- Benefits of using internal noise sources calibration
  - *Can monitor performance of primary targets*
  - *Can replace primary targets if contaminated*
  - *Can reduce post-launch non-linearity errors*

- However leads to degradation in sensitivity and increase complexity/cost

# Calibration Issues

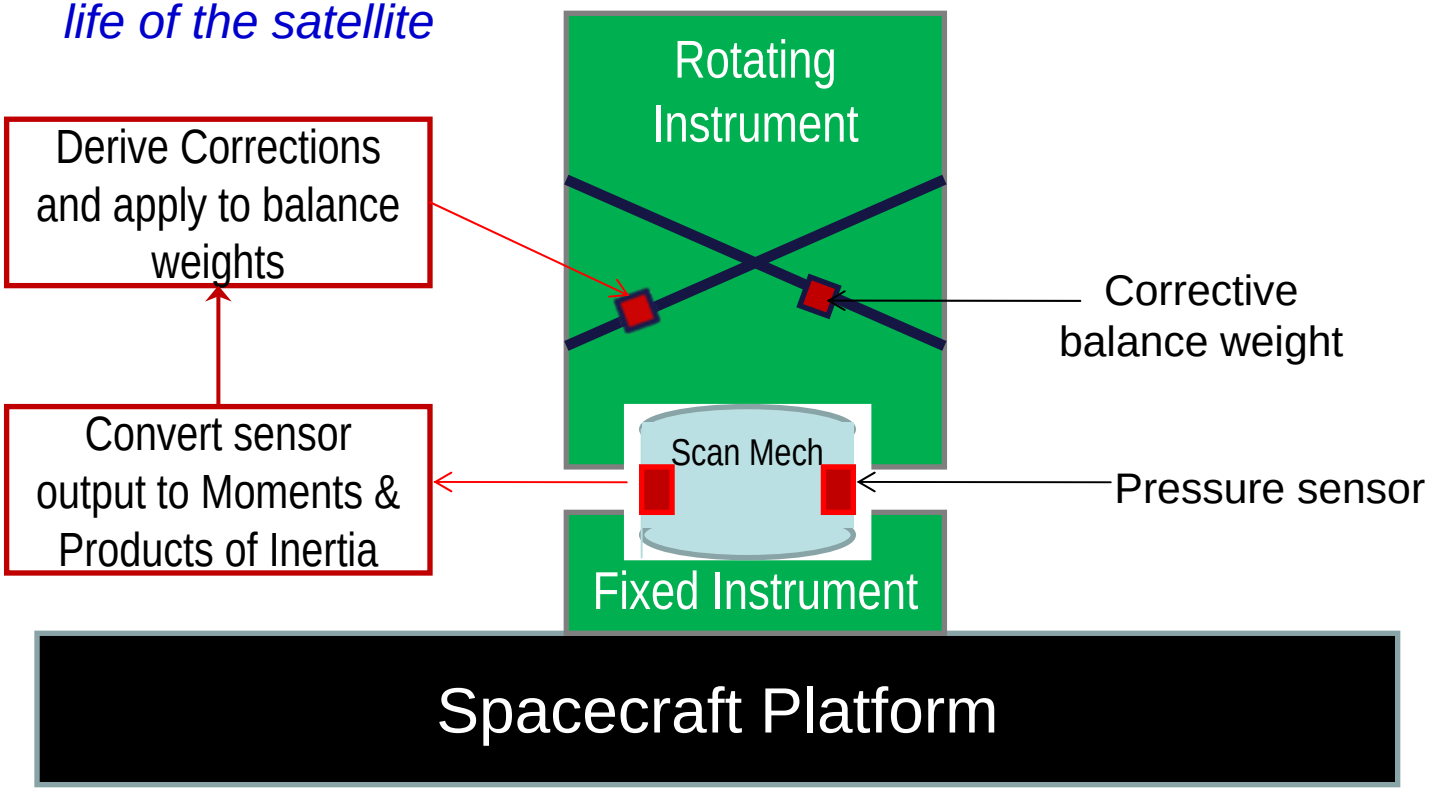
- What is the most appropriate calibration method?
  - *Combination of internal noise sources?*
  - *How should the noise sources be coupled to the receiver?*
    - *Passive couplers, switches*
- Recommended method to be characterised as part of 183 GHz receiver tests

*Examples of Internal Calibration Configurations*



# Active Balancing Issues

- Initial platform balancing performed during Ground AIV
- Additional displacements expected due to launch and outgassing
  - *Analysis suggests periodic active balancing will be required throughout the life of the satellite*



# Active Balancing Issues

- Active Balancing System comprises
  - *Sensors to identify the displacement torque*
  - *Mechanism to correct for imbalance*
  - *Control algorithms to calculate and apply corrections*

- Main focus on optimisation of control algorithms

- Existing scan mechanism breadboard used for ABS demonstrator
  - *Tests with varying levels of imbalance shall be conducted*
  - *Confirmation that control algorithm is converging and sufficiently sensitive to meet the anticipated balancing requirements*