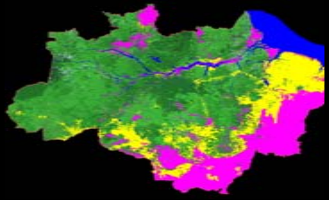
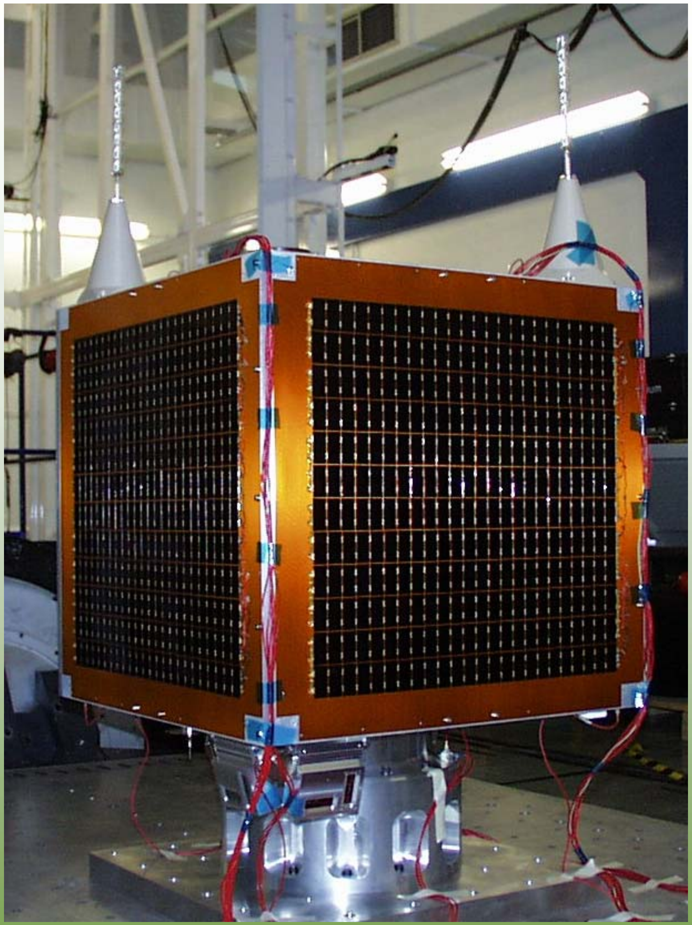
DMCii QA4EO Compliant Prototype Development



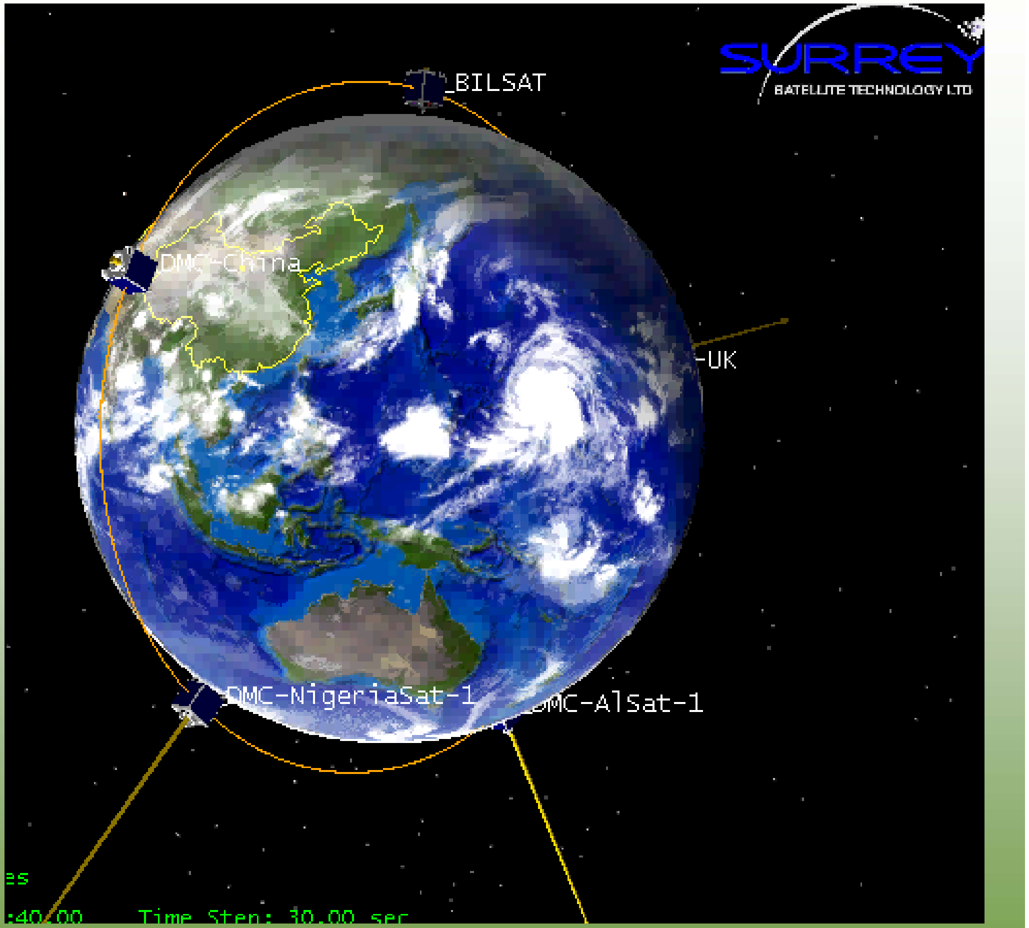
Steve Mackin

DMC International Imaging Ltd

Disaster Monitoring Constellation



DMC Satellite

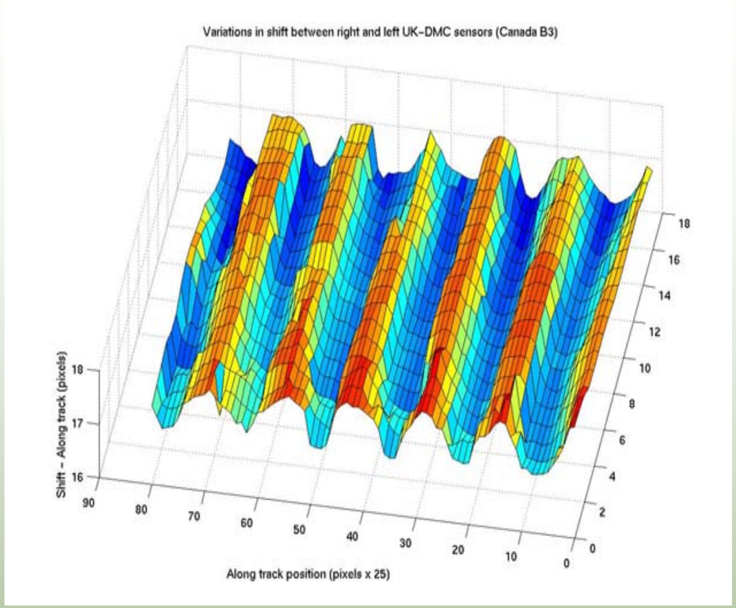


Phased Constellation (Currently five satellites)

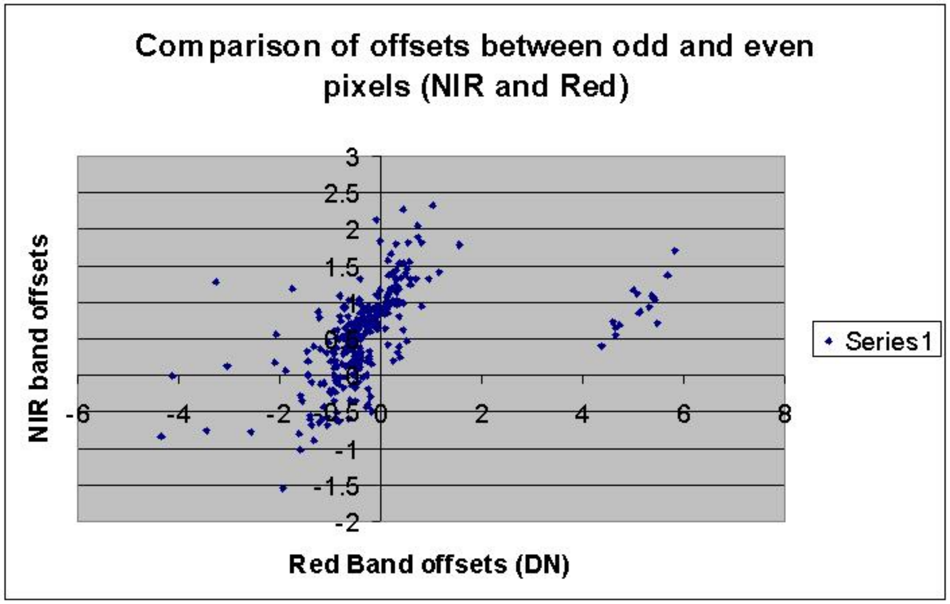
DMC Operations

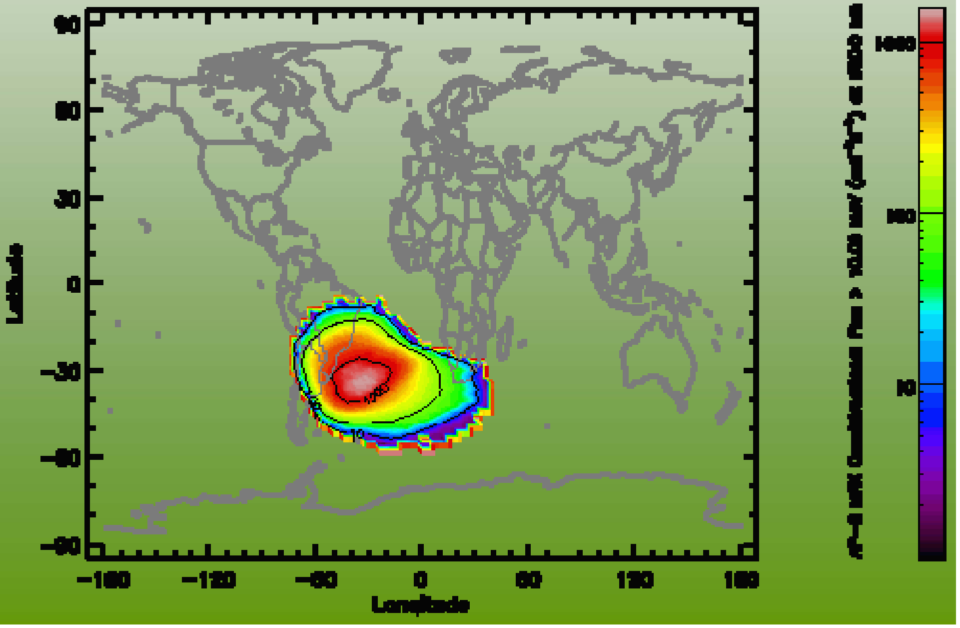
- Small Group (10 people)
- Growing constellation (five satellites, up to seven next year)
- Lot of the Quality Control is manual
- Problems are often not seen until some time after processing
- Source of the problems is often hard to find and is very time consuming

Example Issues



Geometric anomaly (2004)





Radiometric anomaly (2007)

Other Issues

- Difficult to predict exact performance of new systems
- Needs a lot of time to identify anomalous behaviour in the new systems
- Application of QC is patchy
- Missing a feature of the data or calibration of the system may lead to biases

Current Development

- Because of problems identified in previous slides
- Due to the growing requirements from customers and within GMES for a quality indicator
- Due to the growing need for a more rapid delivery of data with high data quality

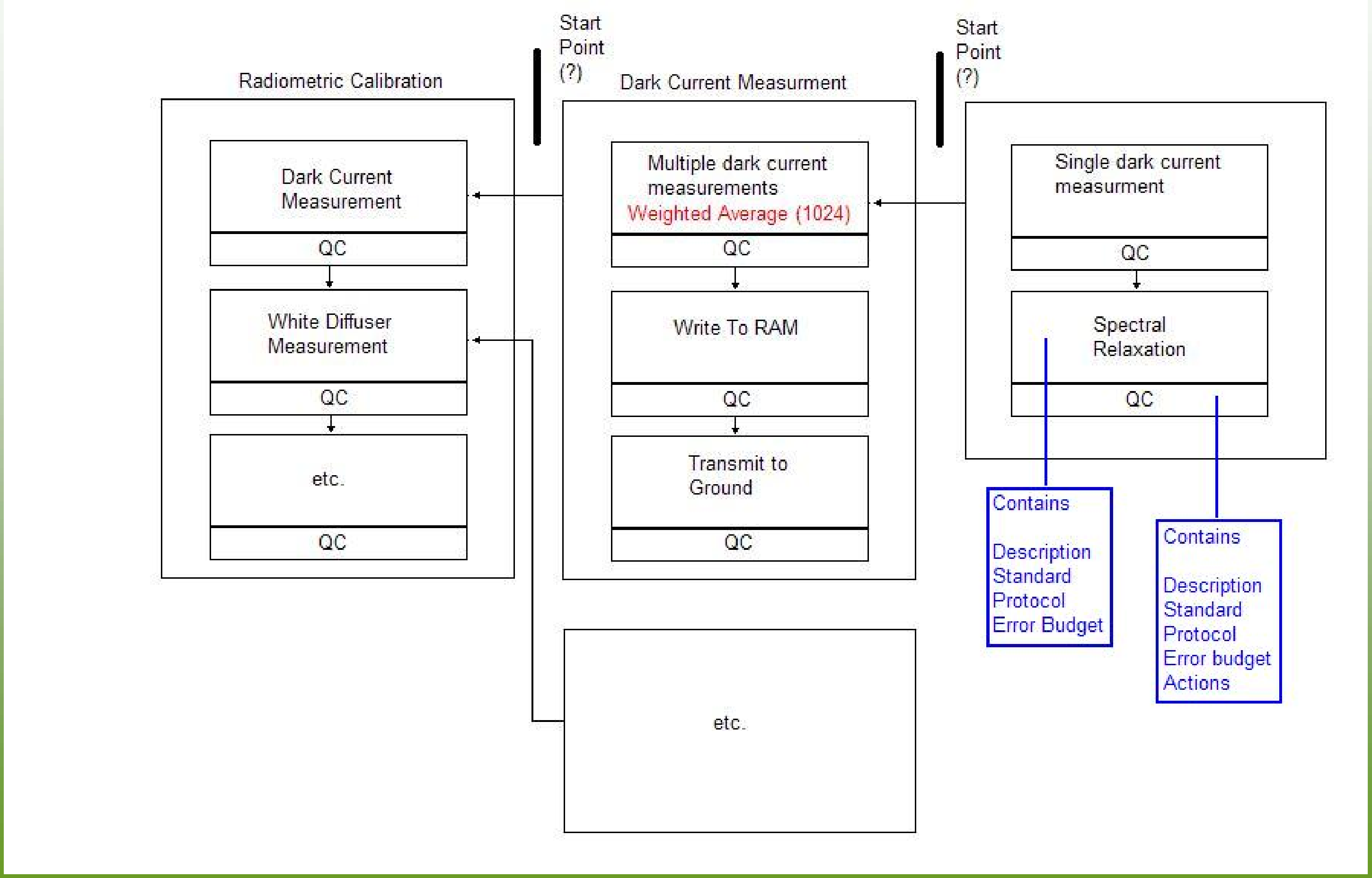
- CONCLUSION : We need an automated system of QA/QC that can produce quality information at the Pixel level.

Approach

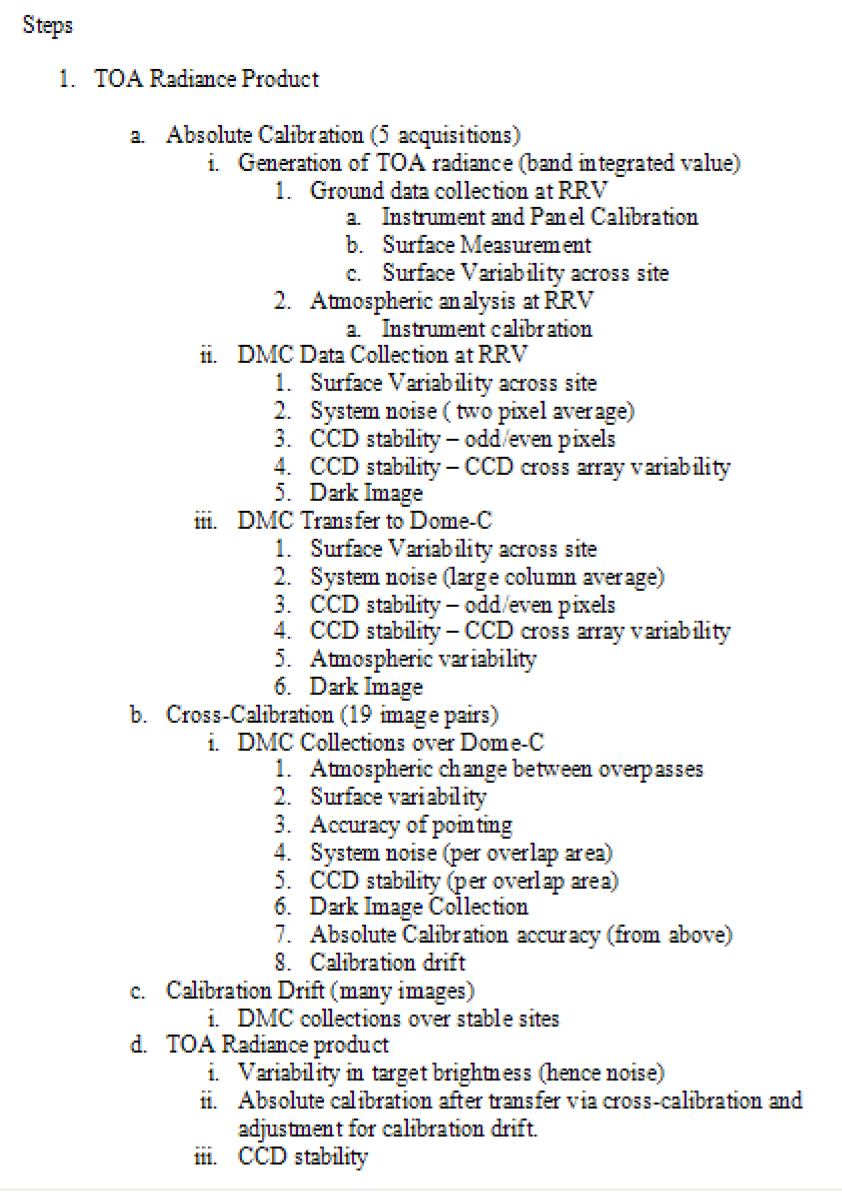
- QA4EO compliant approach
  - Fully documented procedures meeting QA4EO-QAEO-GEN-DQK-002 Standards
  - Meets guidelines of uncertainty measurement (based on GUM) QA4EO-QAEO-GEN-DQK-006
  - Fully traceable QA4EO-QAEO-GEN-DQK-007
  - All documentation and required material to validate derived uncertainty available on a user accessible web site
    - Possibility in future of user directed “drill-down”

How to implement ?

- Approach based in part on an ESA multi-mission generic QA/QC project report (NPL)



How to Implement – TOA Radiance



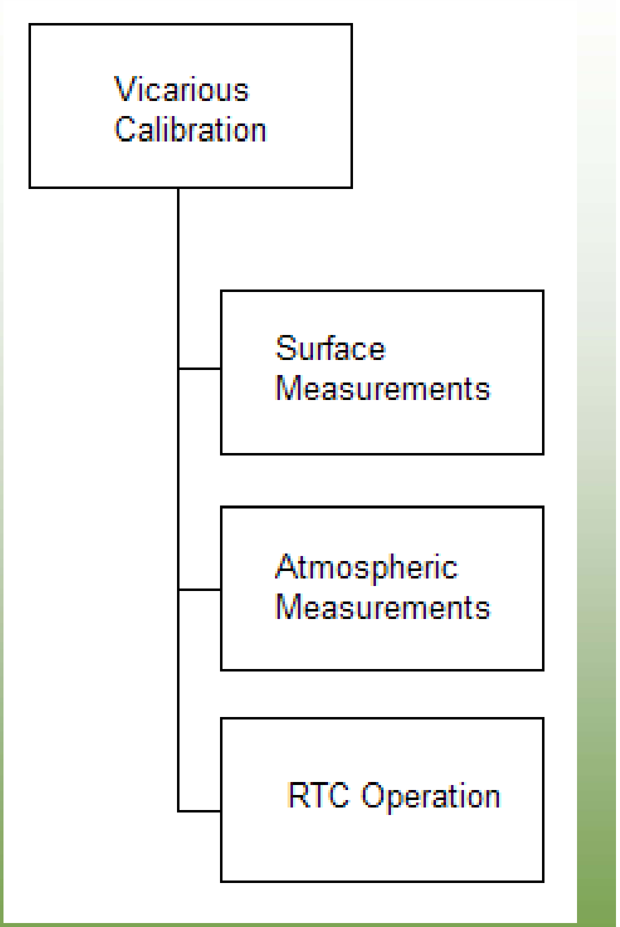
Steps

1. TOA Radiance Product
    a. Absolute Calibration (5 acquisitions)
        i. Generation of TOA radiance (band integrated value)
            1. Ground data collection at RRV
                a. Instrument and Panel Calibration
                b. Surface Measurement
                c. Surface Variability across site
            2. Atmospheric analysis at RRV
                a. Instrument calibration
        ii. DMC Data Collection at RRV
            1. Surface Variability across site
            2. System noise (two pixel average)
            3. CCD stability – odd/even pixels
            4. CCD stability – CCD cross array variability
            5. Dark Image
        iii. DMC Transfer to Dome-C
            1. Surface Variability across site
            2. System noise (large column average)
            3. CCD stability – odd/even pixels
            4. CCD stability – CCD cross array variability
            5. Atmospheric variability
            6. Dark Image
    b. Cross-Calibration (19 image pairs)
        i. DMC Collections over Dome-C
            1. Atmospheric change between overpasses
            2. Surface variability
            3. Accuracy of pointing
            4. System noise (per overlap area)
            5. CCD stability (per overlap area)
            6. Dark Image Collection
            7. Absolute Calibration accuracy (from above)
            8. Calibration drift
    c. Calibration Drift (many images)
        i. DMC collections over stable sites
    d. TOA Radiance product
        i. Variability in target brightness (hence noise)
        ii. Absolute calibration after transfer via cross-calibration and adjustment for calibration drift.
        iii. CCD stability

- Lots of steps…!!
- Each one is an individual module with documentation that meets QA4EO standards
- Each one has a QA Element **and** corresponding QC element
- So first step is breaking down our current activity into such small steps

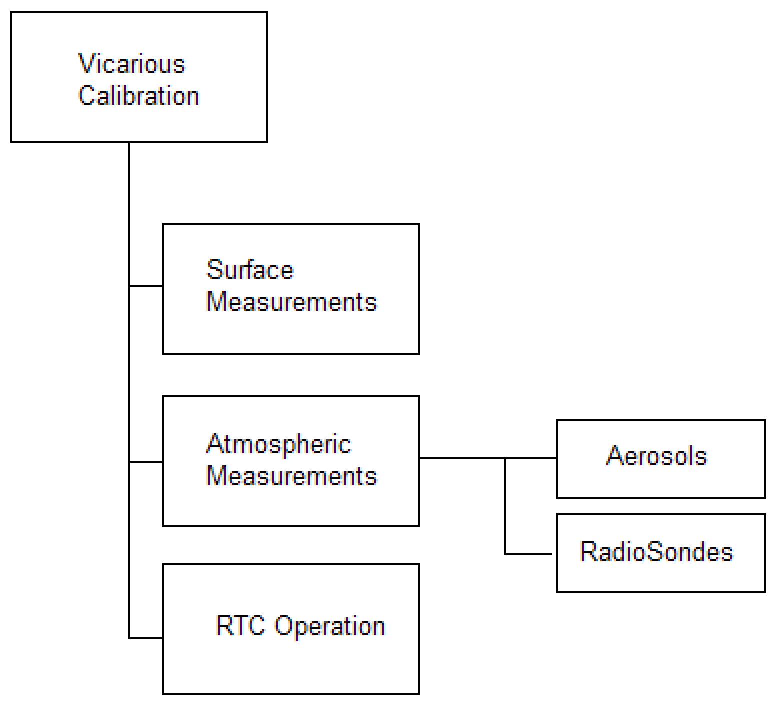
Module Creation

- Generic and final physical implementation
  - Implementation initially of modules for a selected satellite *(very time consuming)*
  - Reuse of some of these (non-specific) modules with minor changes to structure *(rapid development)*
  - Example : Vicarious calibration module has same sub-modules (surface measurement, atmospheric measurement, model. Can be reused for different satellite systems with minor amendments
  - These reusable modules become a generic (non-specific) component

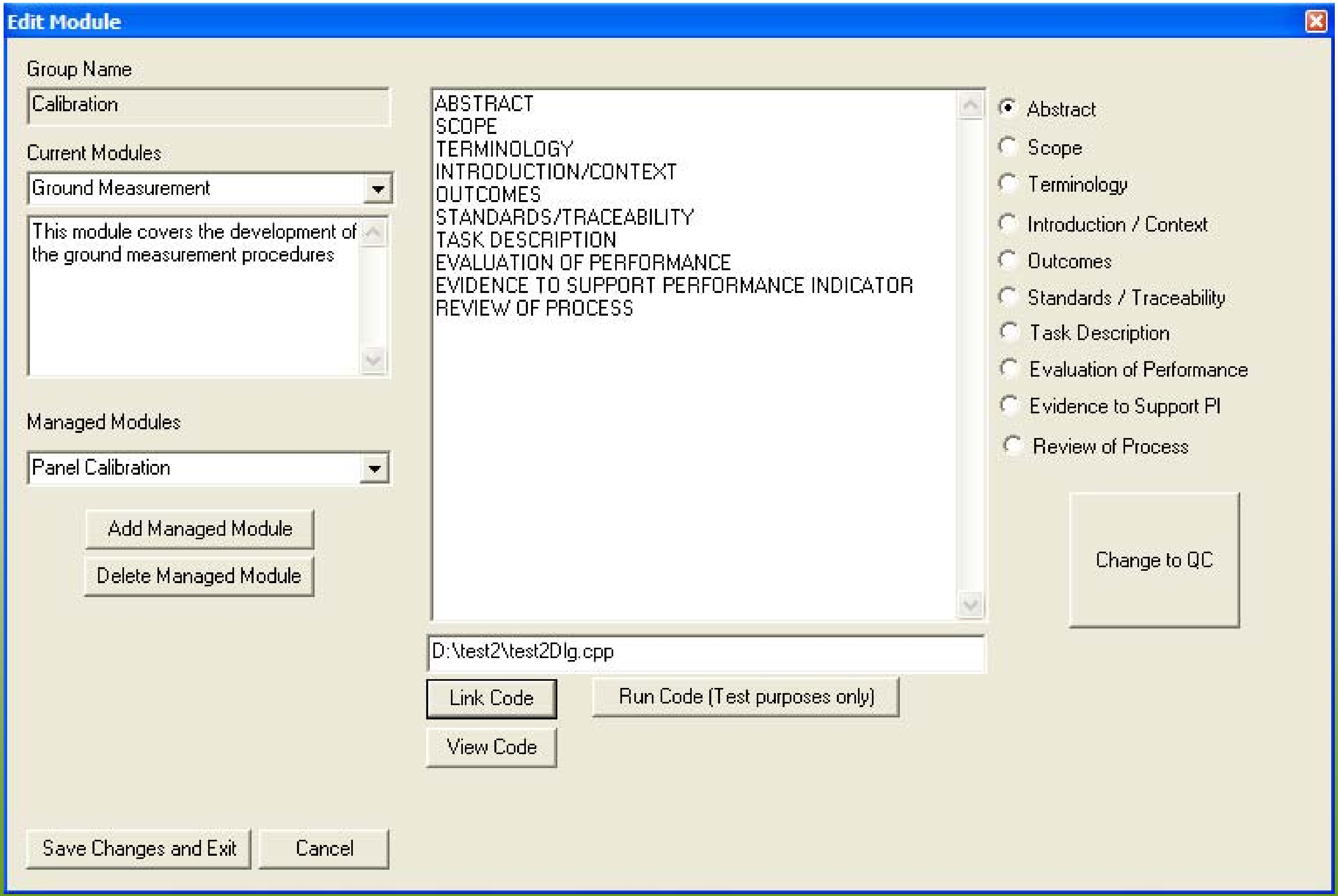


Module Creation

- Management modules (aggregation)
  - – Modules at such a fine level are difficult to manage
  - – In last slide Vicarious Calibration consisted of three sub-modules
    - Ground Reflectance Measurements
    - Atmospheric Measurements
    - Radiative Transfer Code
  - – Each of these may contain lower level modules
  - – Need for an aggregation function still allowing flexibility, but also easier flow control



Module Creation



Group Name: Calibration

Current Modules: Ground Measurement

This module covers the development of the ground measurement procedures

Managed Modules: Panel Calibration

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ABSTRACT
SCOPE
TERMINOLOGY
INTRODUCTION/CONTEXT
OUTCOMES
STANDARDS/TRACEABILITY
TASK DESCRIPTION
EVALUATION OF PERFORMANCE
EVIDENCE TO SUPPORT PERFORMANCE INDICATOR
REVIEW OF PROCESS
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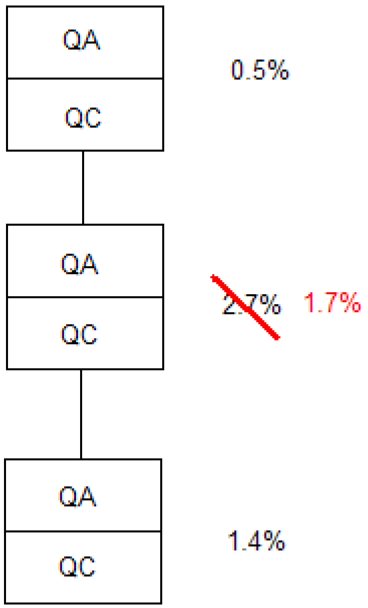
D:\test2\test2Dlg.cpp

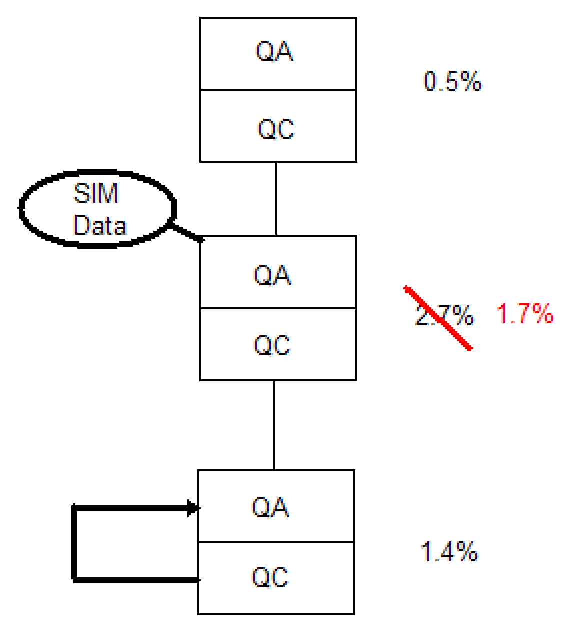
- ● Abstract
- ○ Scope
- ○ Terminology
- ○ Introduction / Context
- ○ Outcomes
- ○ Standards / Traceability
- ○ Task Description
- ○ Evaluation of Performance
- ○ Evidence to Support PI
- ○ Review of Process

Creating a flow



- Linking Modules requires simply connecting them in sequence
  - Requires common interfaces
  - Ability to pass parameters and intermediate data
  - Uncertainty passed and combined at each level and checked using QC check (if possible)
  - Modules can be changed by swapping them out of the flow and replacing them with something else with lower uncertainty
- Passing information
  - Either using dummy variables in a call or
  - Using text or other files for intermediate storage and software that can read these intermediate files.

Process Control

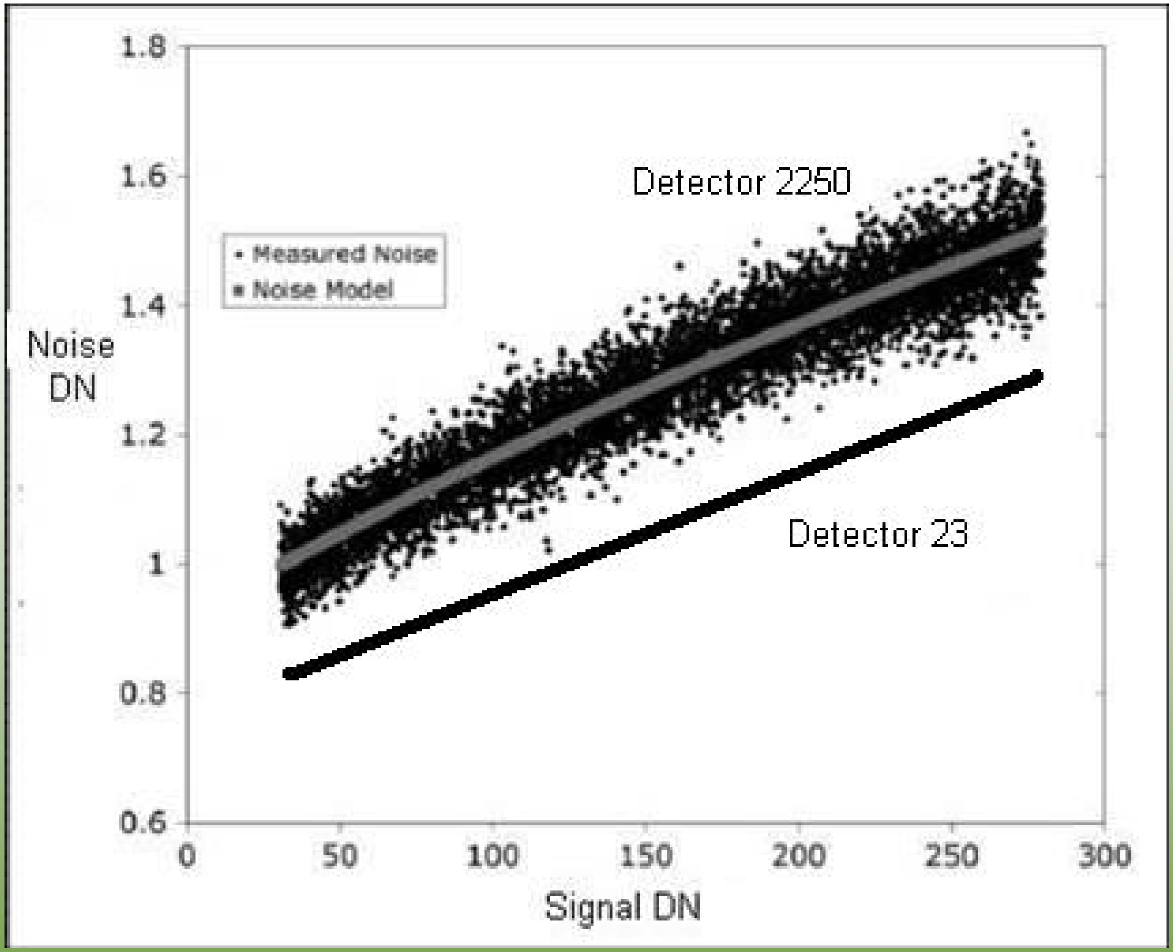


- Simulation
  - By connecting modules using the QA component we automatically determine uncertainty for new systems.
  - Can run dummy data through and check the QC process at each step
- QC Control on process
  - QC is not only to validate the output from the QA
  - Has its own methods which allows in an integrated system, the QC to modify the way the data is processed at the previous step and hence modify the uncertainties (if required)

Uncertainties

- Some still at band level (currently calibration uncertainties, even though can be at more detailed level)
- Some at detector level (noise characteristics)
- Some at pixel level (different targets have different radiances, hence different noise characteristics)

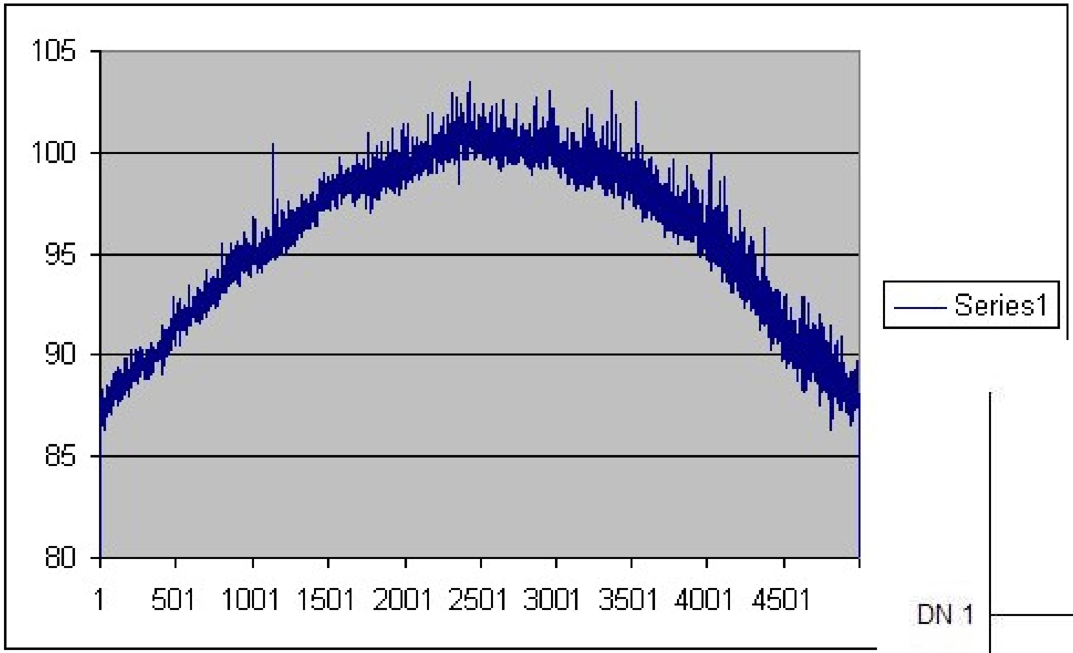
Pixel and Detector Level Effects

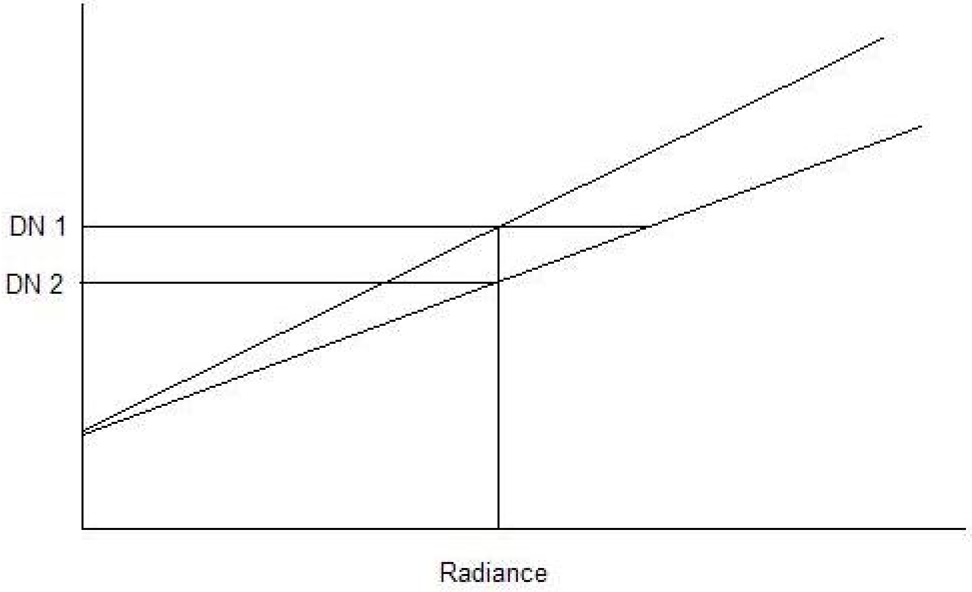


- Noise varies from detector to detector.
- Noise varies from pixel to pixel in the scene depending on target brightness

Detector Level Effects

- Vignetting





Issues

- Versioning
  - Changing a single module changes the whole output, so every MODULE needs to be versioned
  - This information needs to be passed through the system and stored in some manner so correct modules can be applied for any retrospective drill-down to the data
- Data Volume and processing
  - To store all intermediate uncertainties would require a large volume, to process to derive these for a user would be heavy on processing.
  - We expect almost all users will not drill-down
  - We have chosen to use a break-point and process method which stores some intermediate products and processes from these breakpoints.

Current Status

- Simple Prototype under development (pushes users to follow documentary procedures)
- Goes “Live” December 2009 for part of the processing chain
- Continuous development in 2010
- Documentation online in early 2010 and drill-down towards the end of 2010
- Each data product will also have a corresponding quality indicator (uncertainty product) at the pixel level
- It is believed that application of these processes will not only improve data quality, but help in the estimation and removal of biases between satellite systems.

Biases from Calibration

- Cross-Calibration over Dome-C
  - – 19 image pairs over a one month period