Impact of Particles on SEM and EVE data

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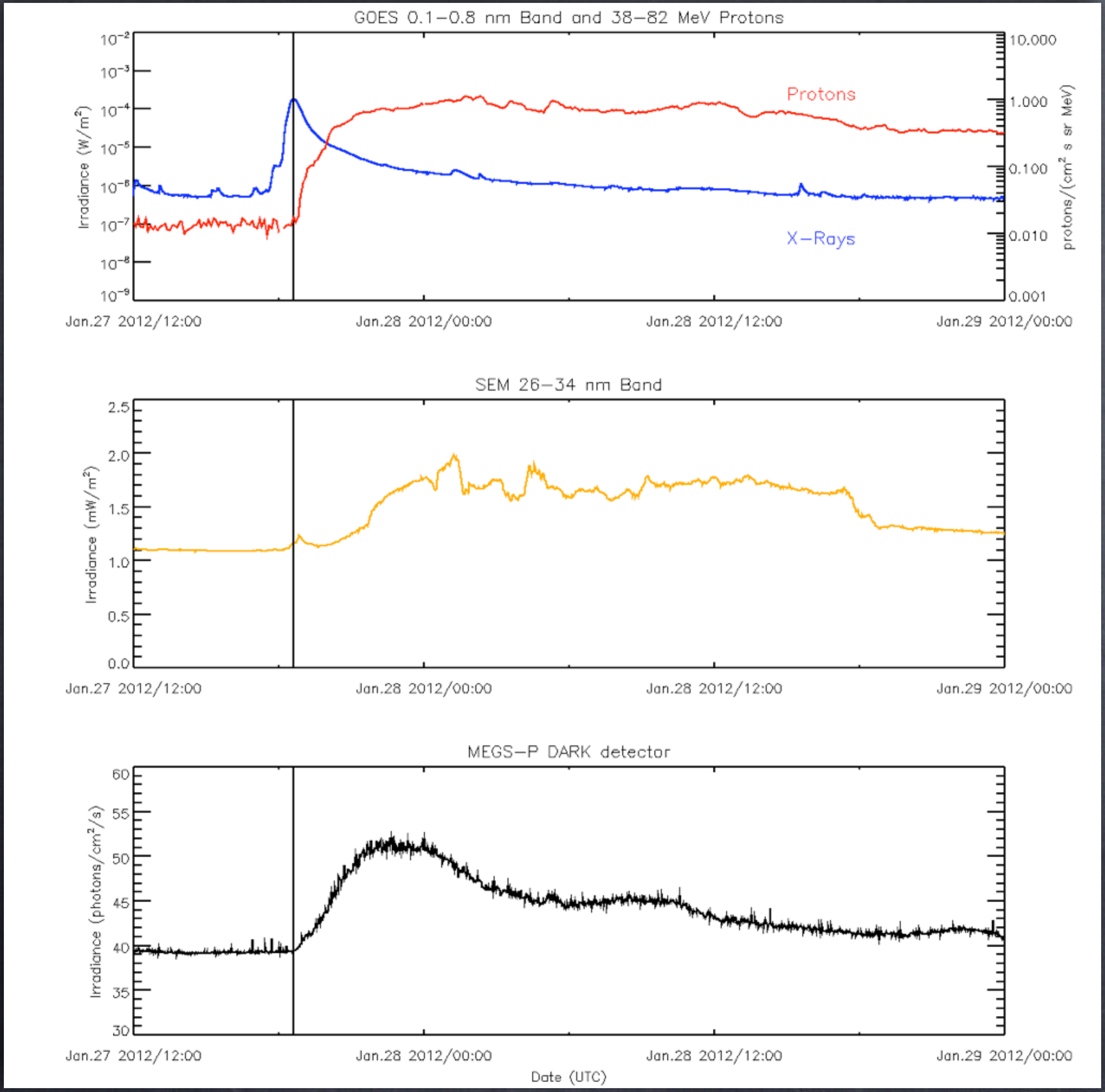
INSTRUMENTS

- SOHO-SEM:
  - Transmission grating spectrophotometer
    - 0-Order: 0-70 nm (Al filter)
    - 1st-Order: 24-36 nm
  - Photodiode detectors
  - Orbit: L1 (particles are mainly solar protons)
- SDO-EVE:
  - Reflection (MEGS) and transmission grating
  - CCD and photodiode detectors
  - Orbit: Geo (solar protons and trapped electrons)

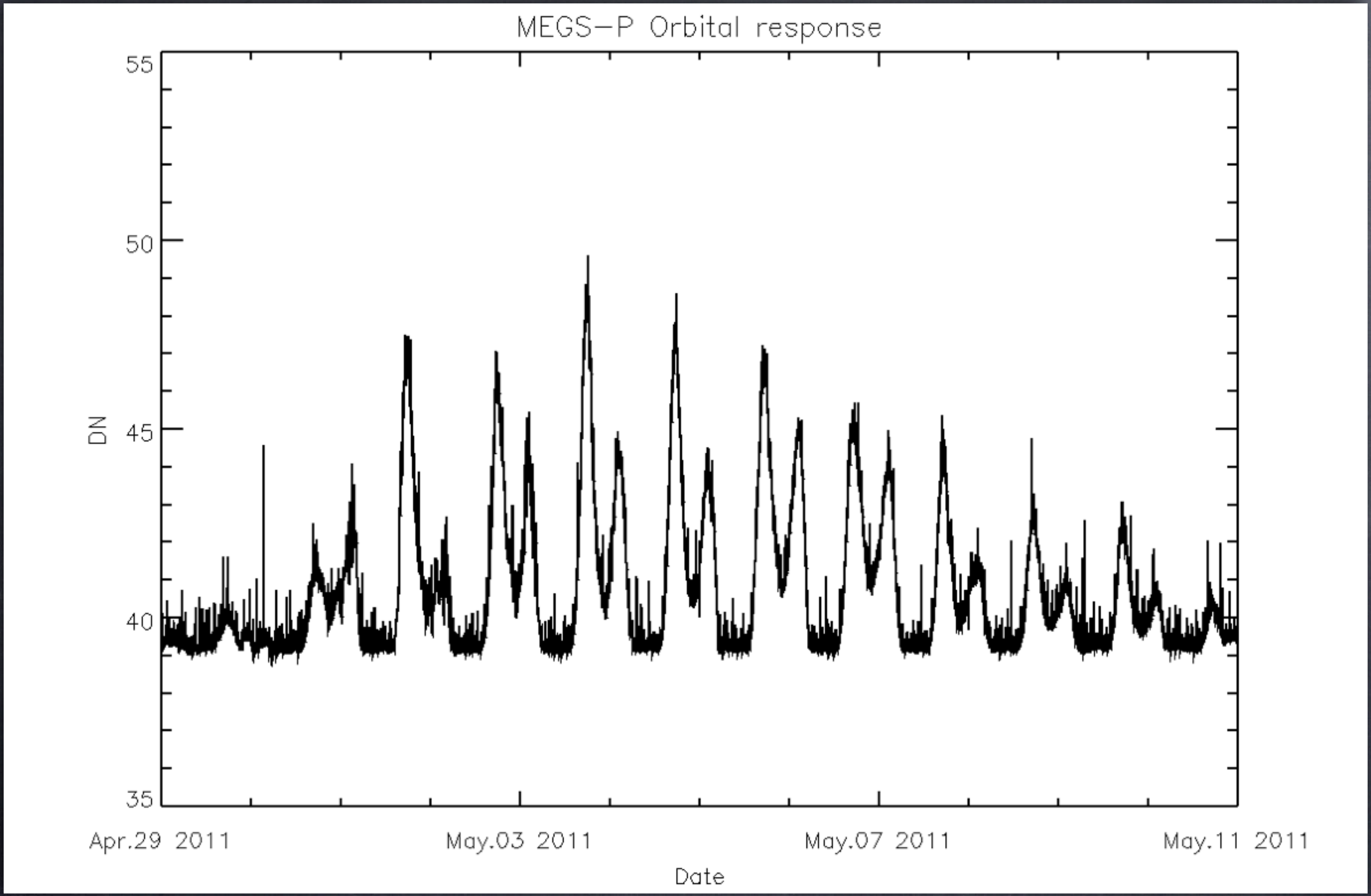
NOISE EFFECTS

- Particles create e^-/h pairs in the detectors just like photons
- For non-imaging detectors no good way to distinguish between signal from particles and photons without other information
- Imaging detectors look for `streaks' and clustered pixels

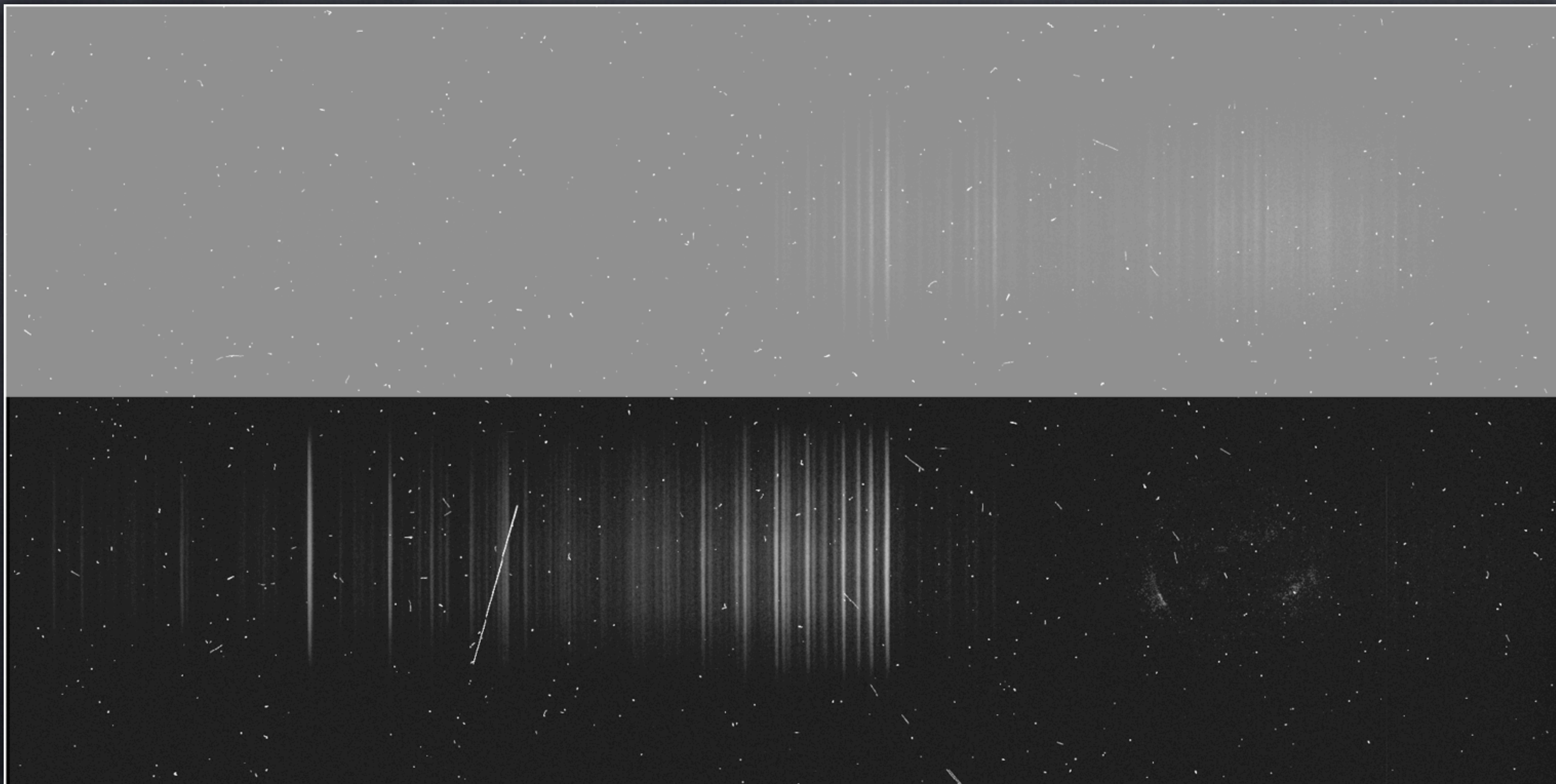
NOISE EFFECTS — DIODES



NOISE EFFECTS - ORBIT



NOISE EFFECTS - CCD



Photodiode Degradation/ Damage

- Si/SiO_2 interface charging
  - Reduced EUV efficiency
  - Nitrideation of interface (IRD/OptoDiode AXUV-G series)
- R_{shunt} decreases with dose
  - Potentially increased noise
    - Cool detectors to maintain high R_{sh} and low noise
  - Can change other circuit parameters
    - Pre-degrade detectors...

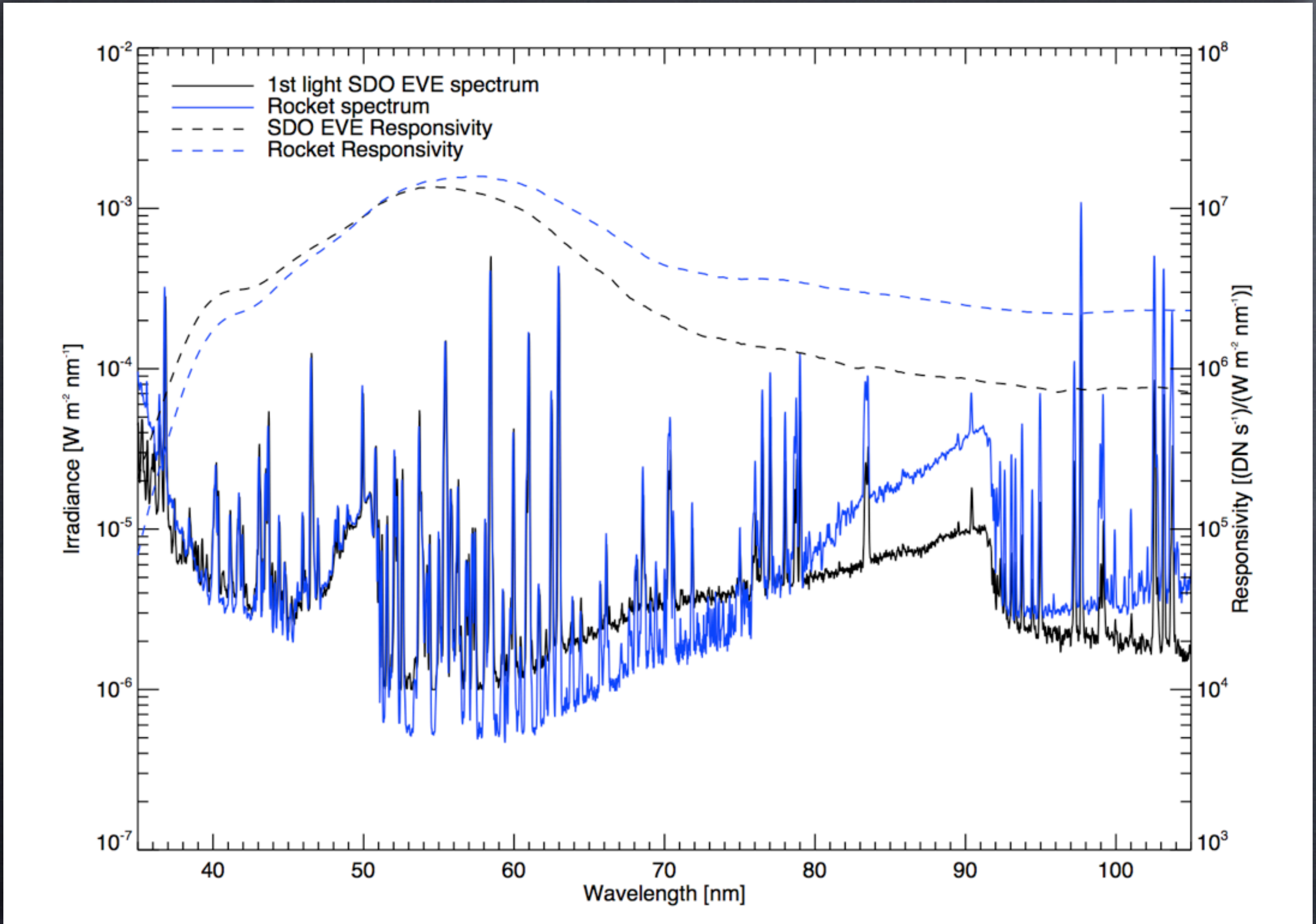
CCD DEGRADATION/DAMAGE

- Si/SiO_2 interface charging
  - Reduced EUV efficiency
  - P-type surface implant
- Lattice Damage
  - Increased noise
    - Cool CCD to increase trap latency
    - Anneal CCDs if possible

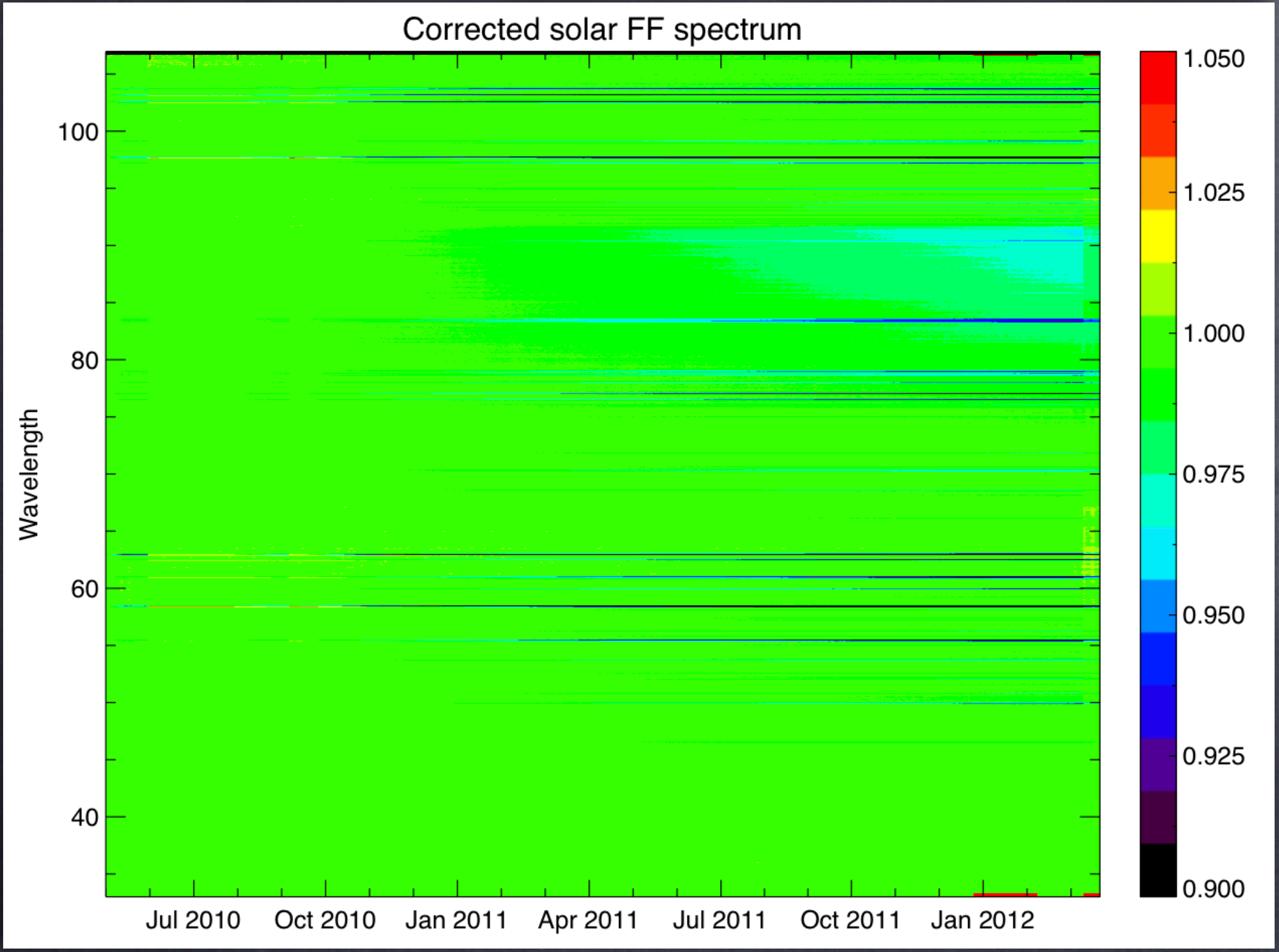
EVE CCD Interface Charging

- Significantly reduced first-light sensitivity especially at longer wavelengths)
- "Burn-in" of spectral features

MEGS-B First-Light Degradation

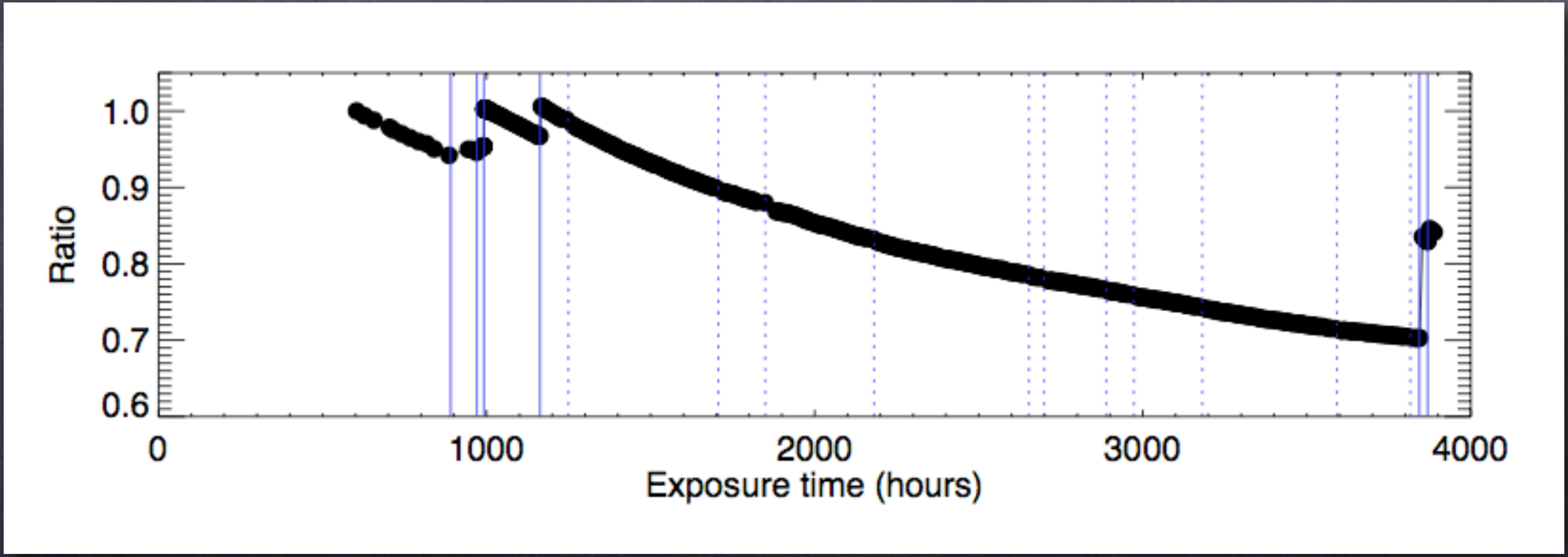


MEGS-B Flat Field



HEATING HELPS A BIT

- ‘Bake out’ for several hours at about 17°C



SOLUTIONS

- Data analysis
  - Using external environmental data (SEM)
  - “Dark” detector (MEGS-P and ESP)
  - Streak removal — temporal and spatial median (CCDs)
  - Degradation corrections
- Shielding
  - Mass: LowZ-High-Z (get rid of e^- then bremsstrahlung)
  - Electrostatic / magnetic for boresights

Modeling and Testing

- Simple sheet absorption models:
  - (estar, pstar, SRIM/TRIM)
- Ray tracing with absorption models
  - Especially to look for ‘holes’ in shielding
- Remember to account for the bremsstrahlung
- More sophisticated geometry modeling:
  - SPENVIS
    - Multi-Layered Shielding Simulation (MULASSIS)
    - GEANT4

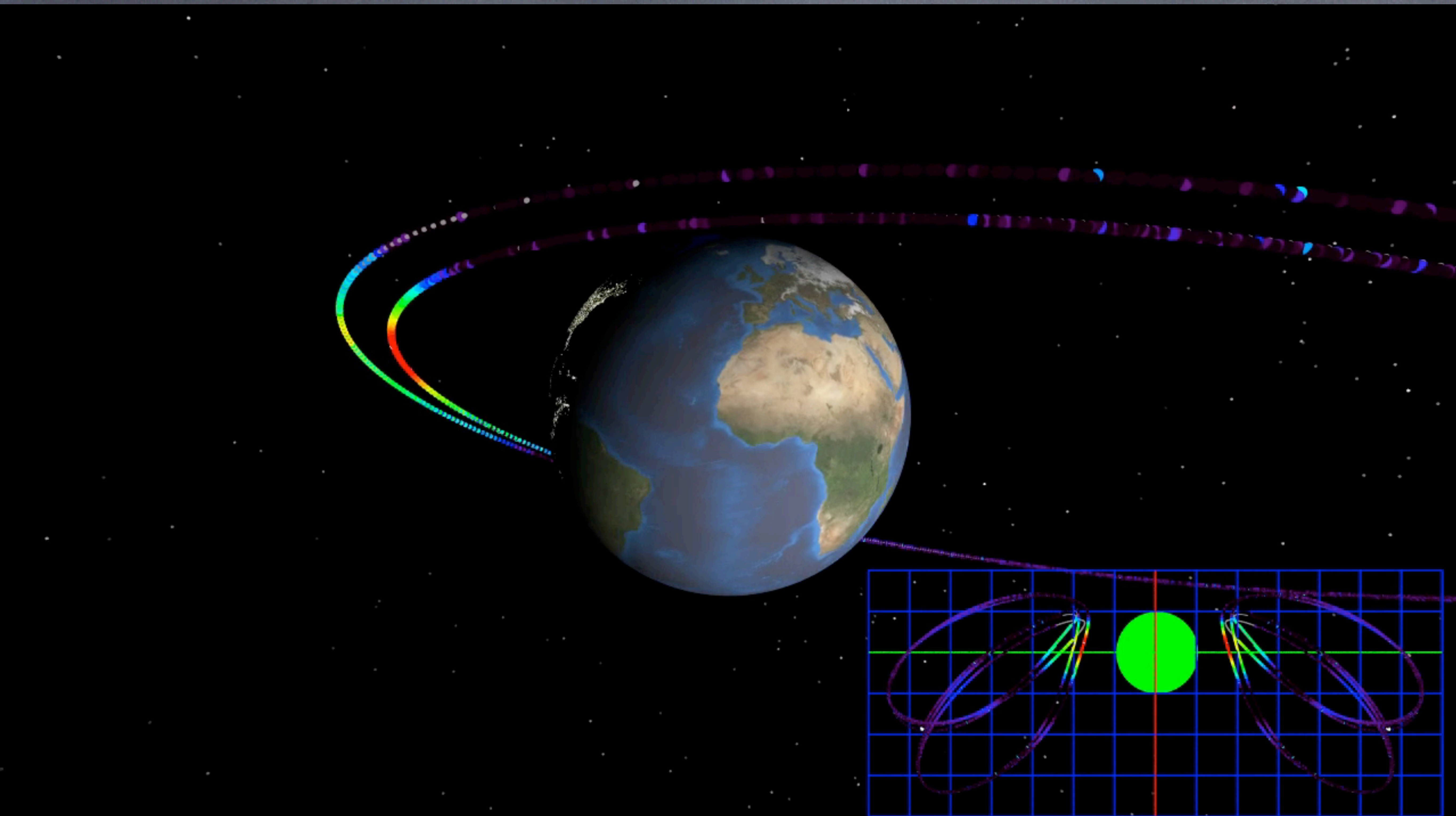
LESSONS LEARNED

- Get the shielding right for the environment
- Test the CCDs you plan to use
- ‘Dark detectors’ work but are not 100% correlated

Resources

- SPENVIS
- GEANT4
- estar
- pstar
- SRIM

EVE MEGS-P GTO



Symptoms of Different Degradation Mechanisms

- **Charging**:
  - Until implanted charge is overcome, QE is independent of back surface charging
  - Completely localized; QE reduced only in areas of charging
  - Charge mobility is low
  - If QE reduction is spatially uniform, implies charging mechanism is spatially uniform
  - QE reduction should be temperature independent
- **Contamination**:
  - Likely to be a nearly uniform contamination layer across device
  - Implies spatial independence of QE reduction for given λ
  - Will charge faster for constant flux than does a clean device
  - Charging proportional to the depth of the absorber
  - QE reduction may improve with temperature due to boil-off of material