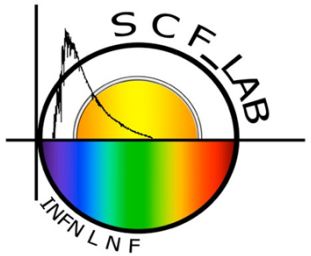
Completion of ETRUSCO-2, thermal test results and thermal optical simulation of the standard GNSS Retroreflector Array (GRA)



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[2] University of Rome "Tor Vergata" , Italy
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18th International Workshop on Laser Ranging

11-15 November 2013 Fujiyoshida, Japan

Outline

1. ETRUSCO-2
2. SCF_Lab
3. SCF and SCF-G
4. SCF-Test and SCF-Test Revision ETRUSCO-2
5. New collaborations
6. GRA experimental results and thermal simulations
7. Conclusions

ETRUSCO-2 (2010-2013)

Development and SCF-Test of GNSS Retroreflector Arrays (**GRA**)

LAGEOS used as a reference, standard target

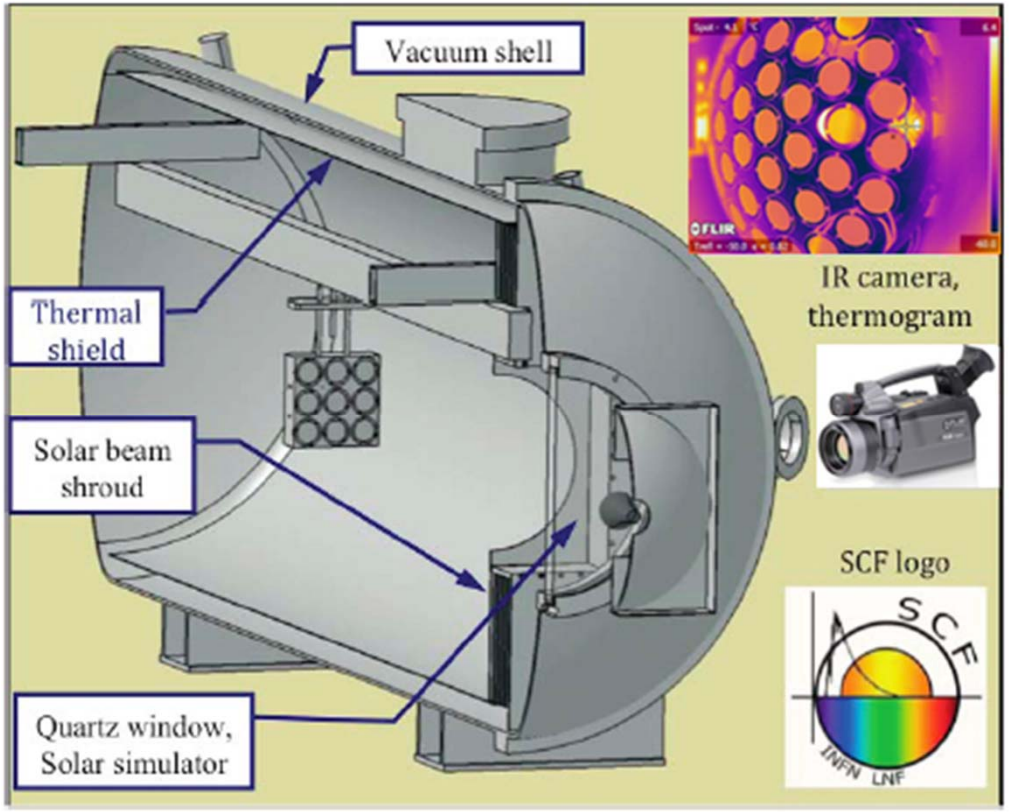
PI:
S. Dell'Agnello

Co-PIs:
R. Vittori, ESA
G. Bianco, ASI

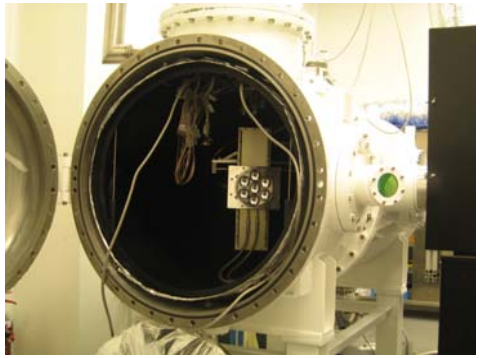
SCF_Lab

SCF and SCF-G

Two world-unique **OGSE** (Optical Ground Support Equipment) facilities in a clean room to characterize the space segment of laser ranging altimetry

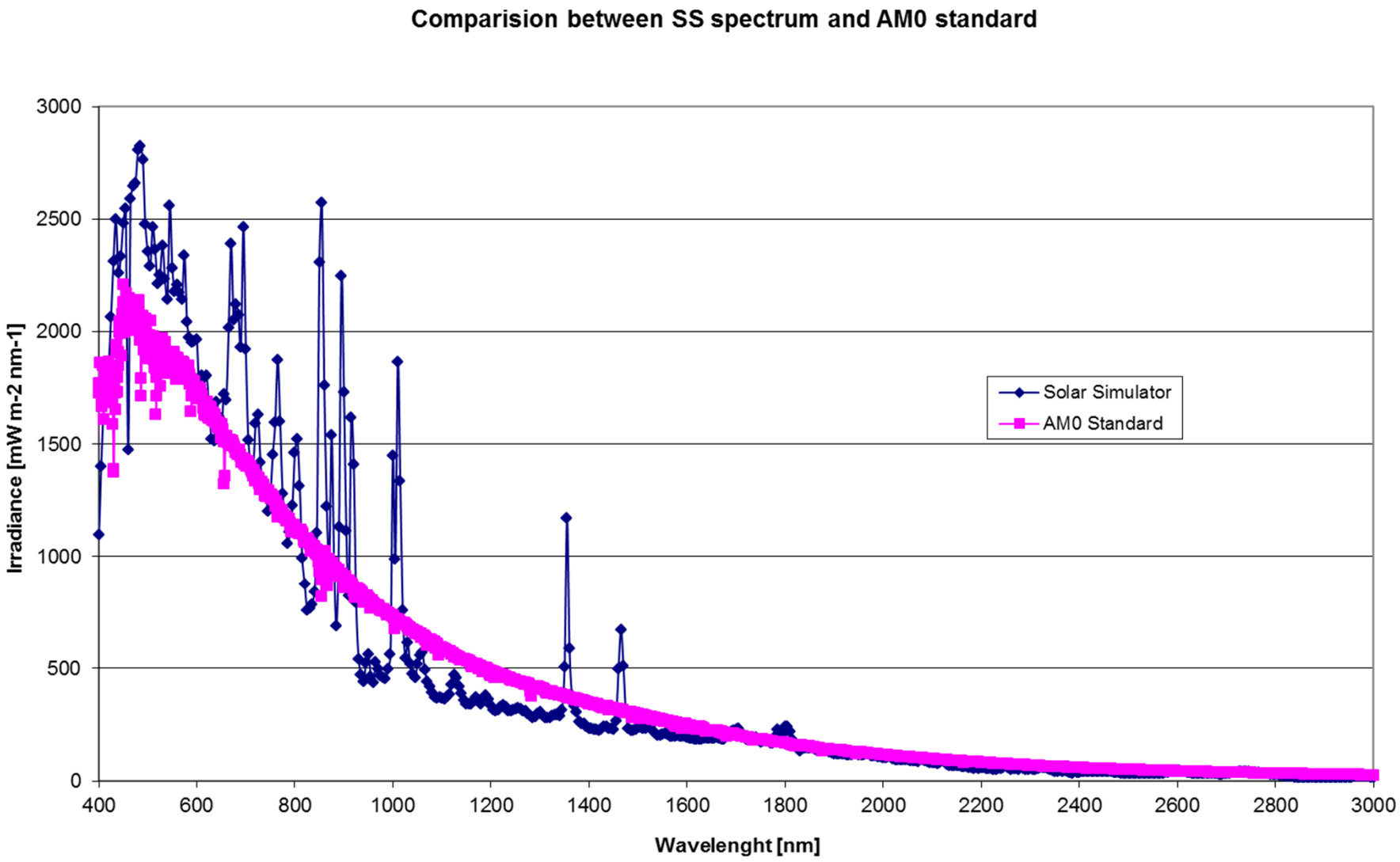


SCF for SLR/LLR/ GNSS/Alti metry

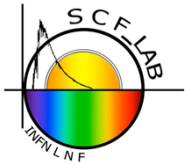


SCF-G for GNSS

Comparison AM0 and SS spectra



The SCF-Test (background IP of INFN)

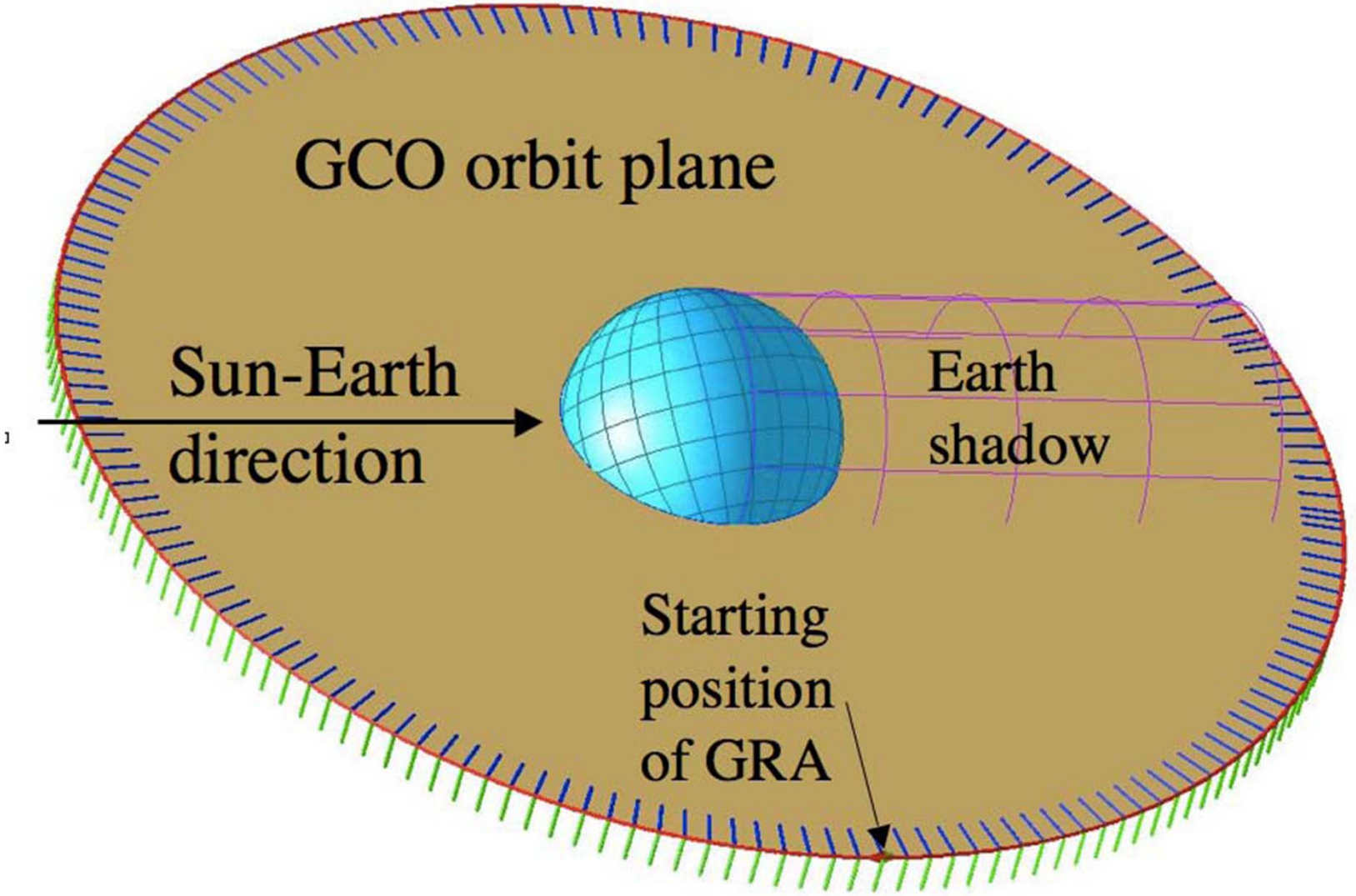


- Accurately laboratory-simulated space conditions. Concurrent/integrated:
  - Dark/cold/vacuum, Sun (AM0) and Earth IR **simulators**
  - Non-invasive IR and contact **thermometry**
  - Payload **roto-translations** and **thermal control**
  - **Laser interrogation and sun perturbation at varying angle**

- Deliverables / Retroreflector Key Performance Indicators (KPIs)
  - **Thermal behavior**
    - Thermal relaxation time of retroreflector (τ_{CCR}) and its mounting elements
  - **Optical response**
    - Far Field Diffraction Pattern (FFDP)
      - Orthogonal polarizations for single uncoated reflectors
- Note: reduced, partial, incomplete tests (compared to the full space environment) are randomly misleading (either optimistic or pessimistic)

- Also GRA invariant Optical Cross Section (OCS) in air/isothermal conditions

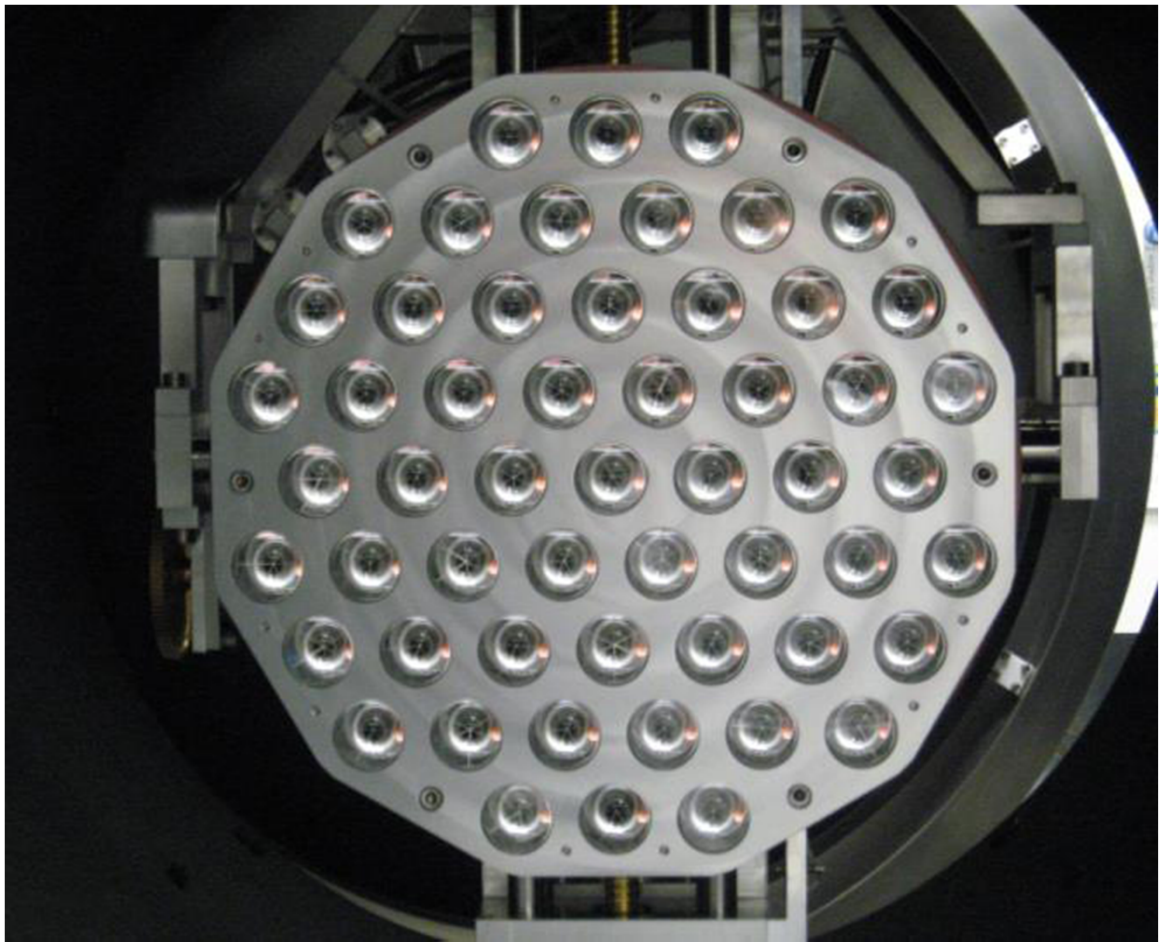
SCF-Test of Galileo Critical half-Orbit (GCO)



New collaborations

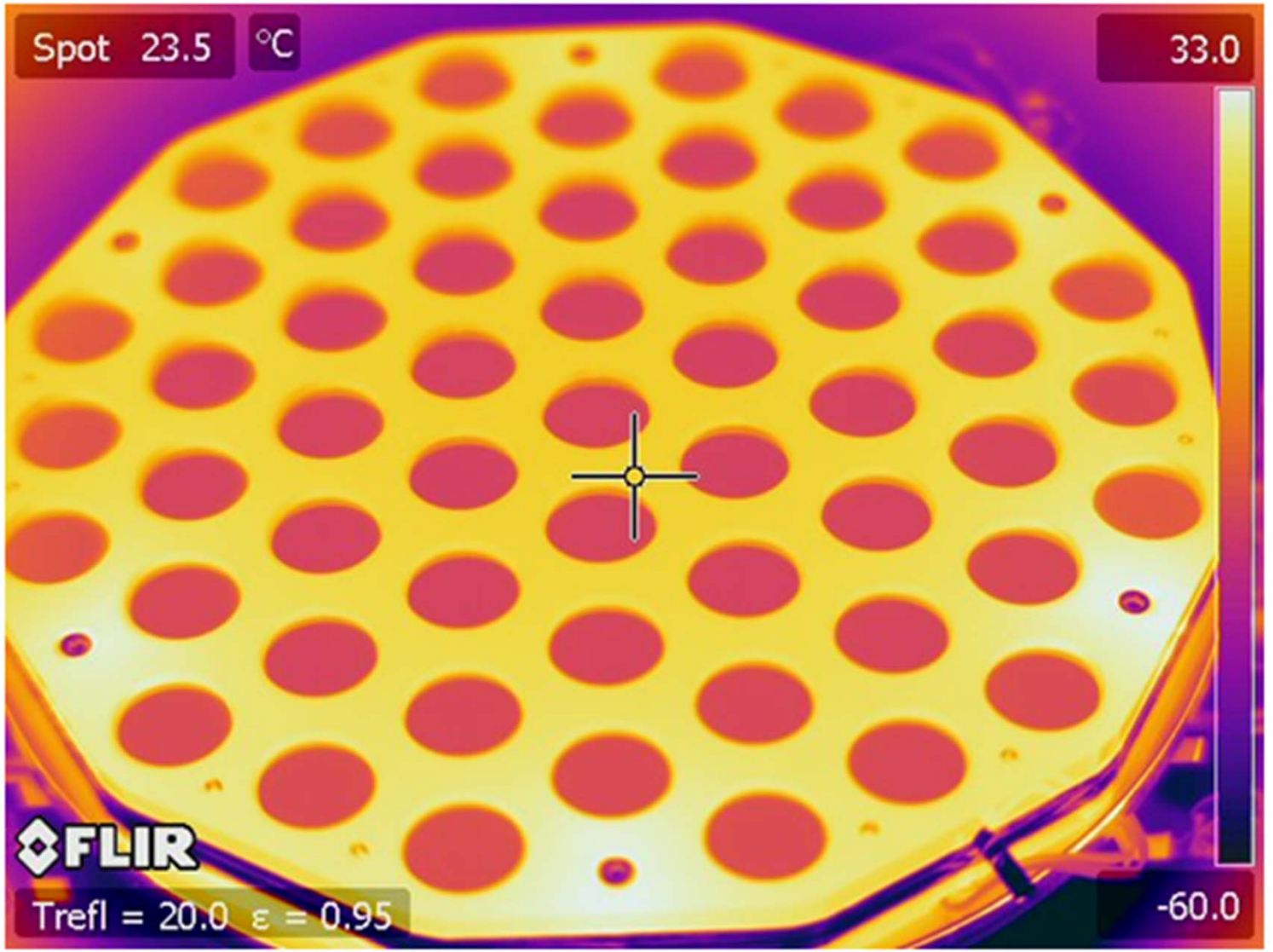
- ESA - INFN: ETRUSCO-IOV
  - SCF-Test of Galileo IOV CCRs
- ISRO - INFN: ETRUSCO-IRNSS
  - SCF-Test of IRNSS CCRs
- Italian Ministry of Defense – INFN: G-CALIMES
  - Research activity focused on the Italian satellite COSMO-SkyMed

The GNSS Retroreflector Array (GRA)

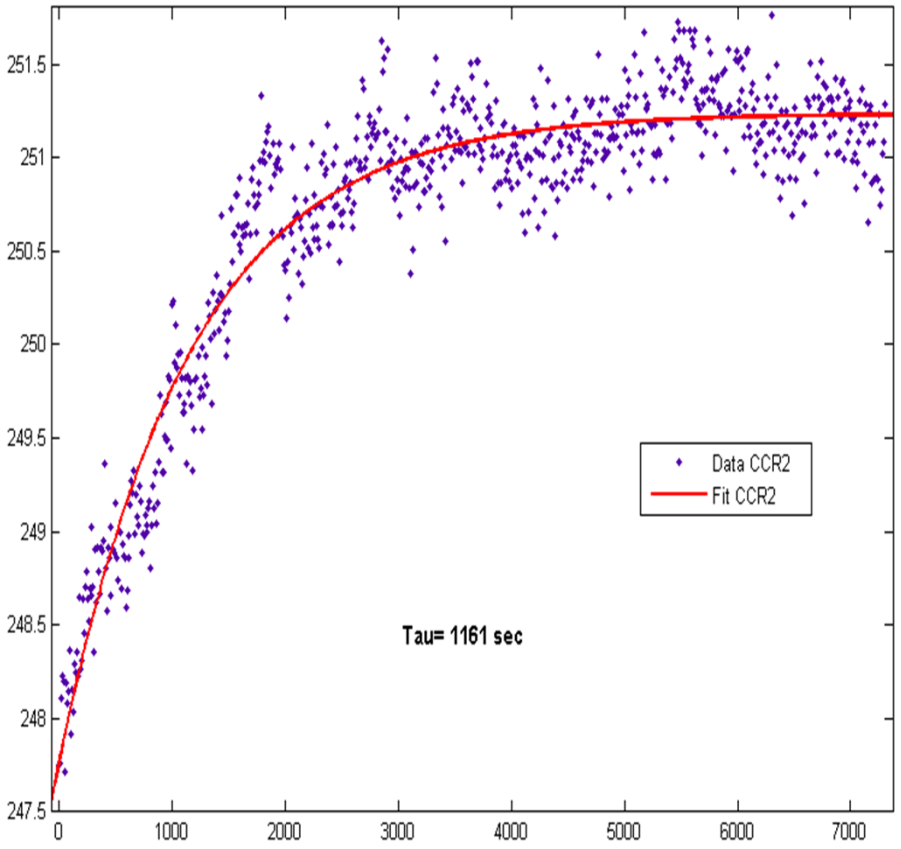


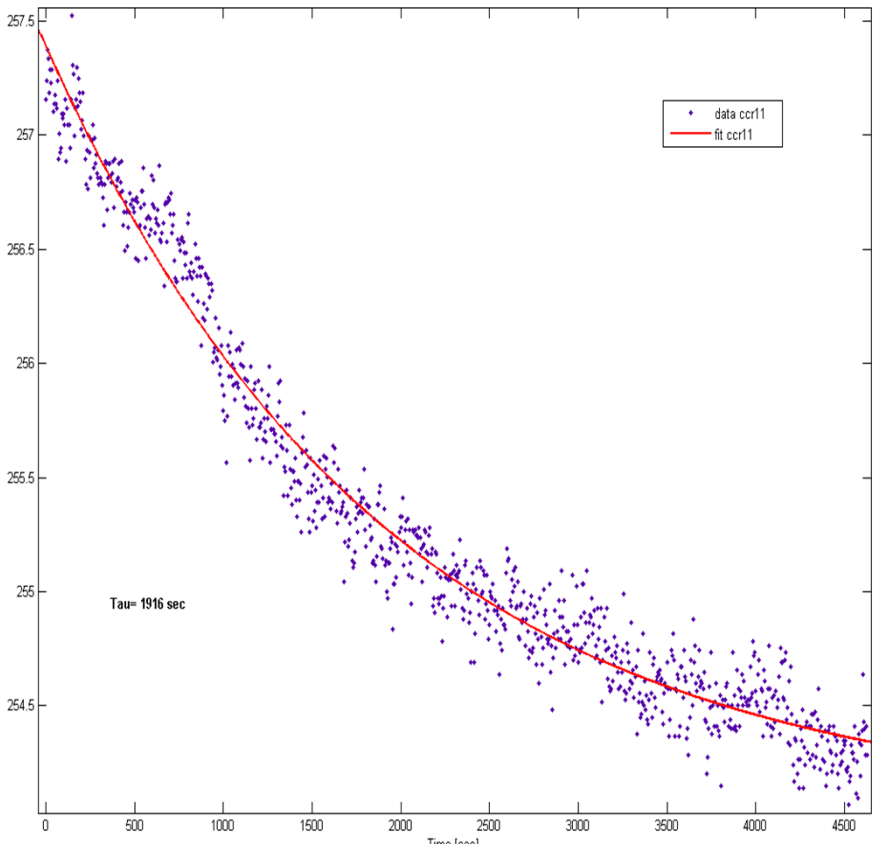
- 55 solid CCRs
- SCF-Test
- SCF-Test revision ETRUSCO-2
- Integrated thermal-optical simulation

IR thermograms



SCF-Test Revision ETRUSCO-1



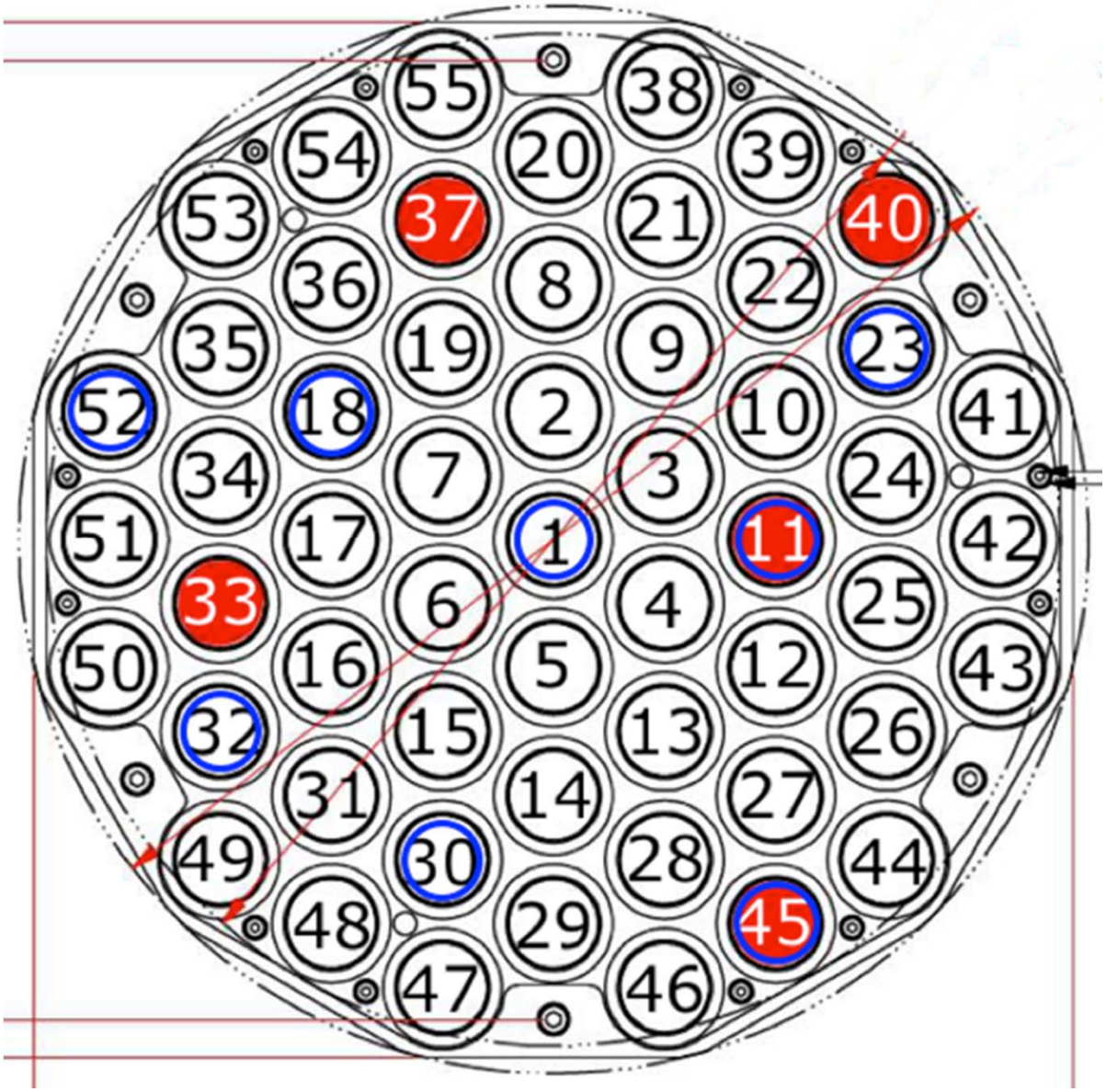


One typical heating phase

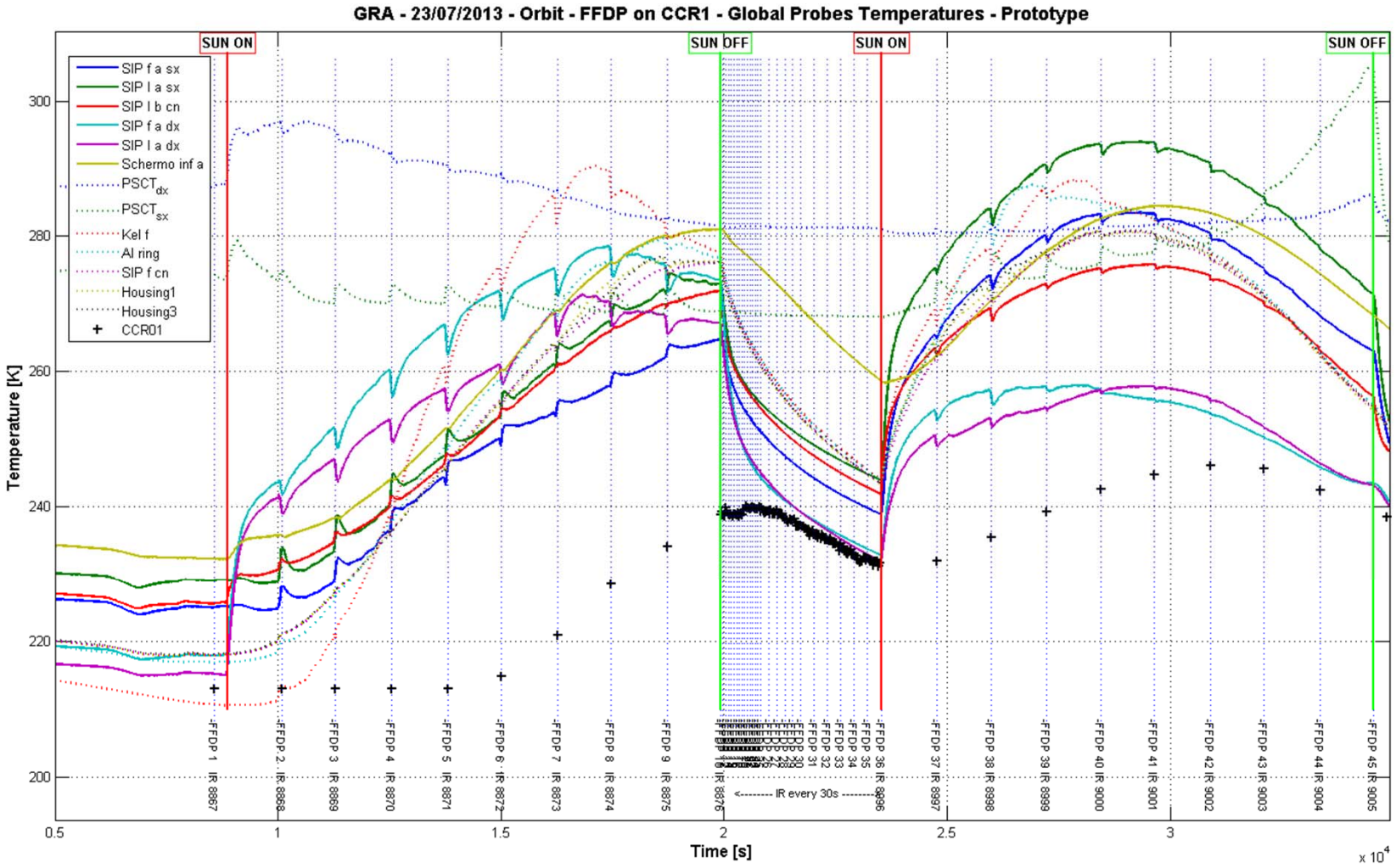
One typical cooling phase

SCF-Test at 280, 300 and 310 K

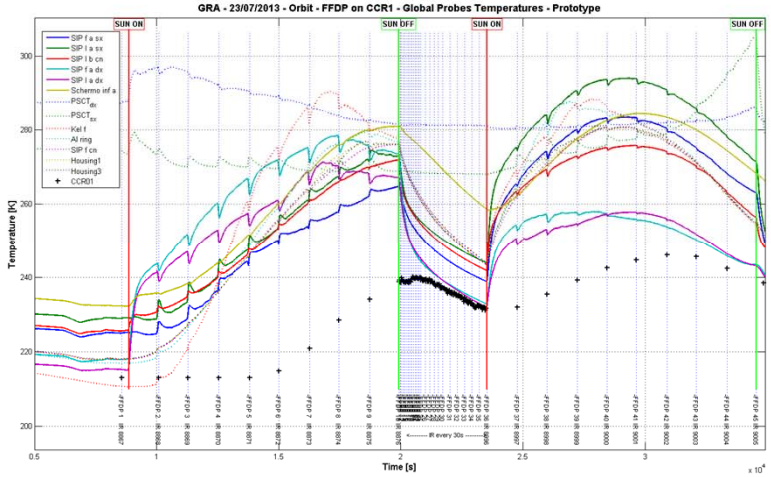
8 CCRs, SCF-Tested Revision ETRUSCO-2

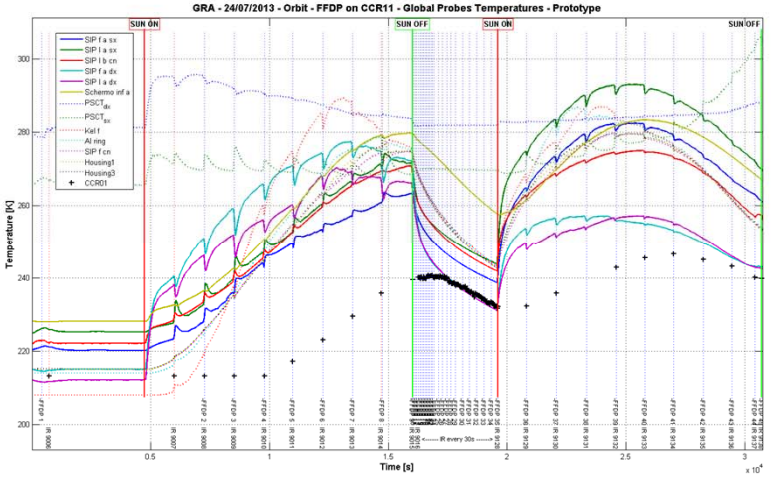


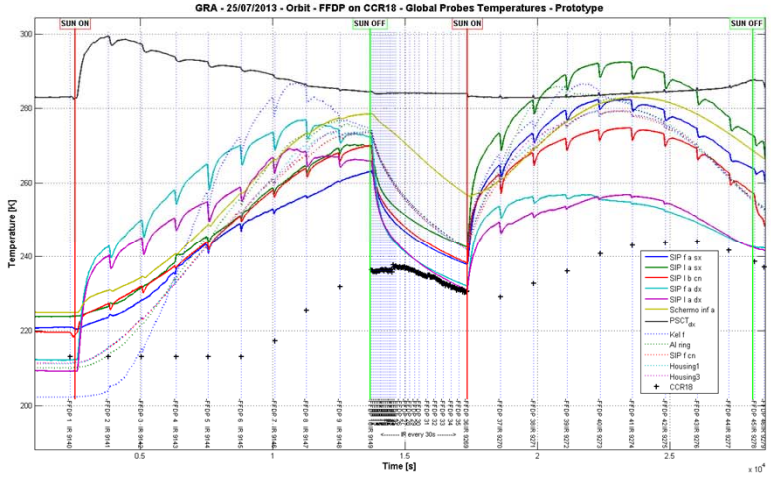
SCF-Test Revision ETRUSCO-2

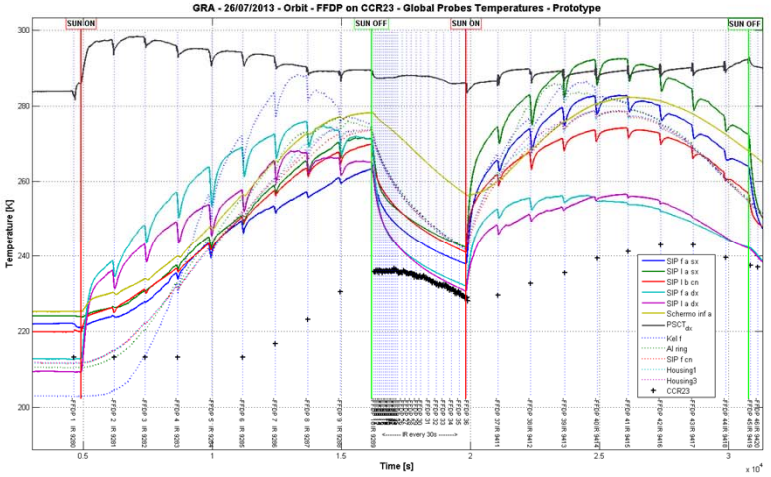


CCRs 1, 11, 18 and 23 SCF-Test Revision ETRUSCO-2

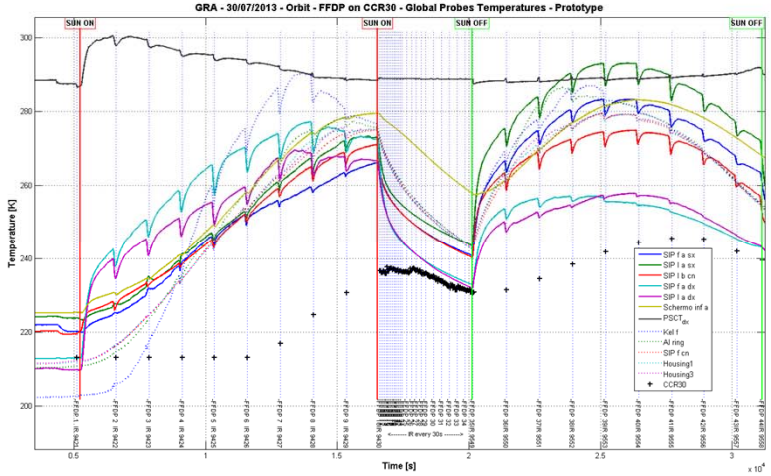


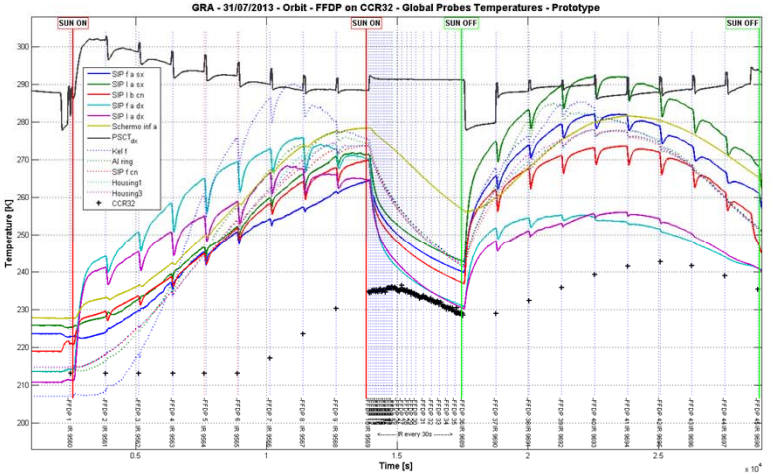


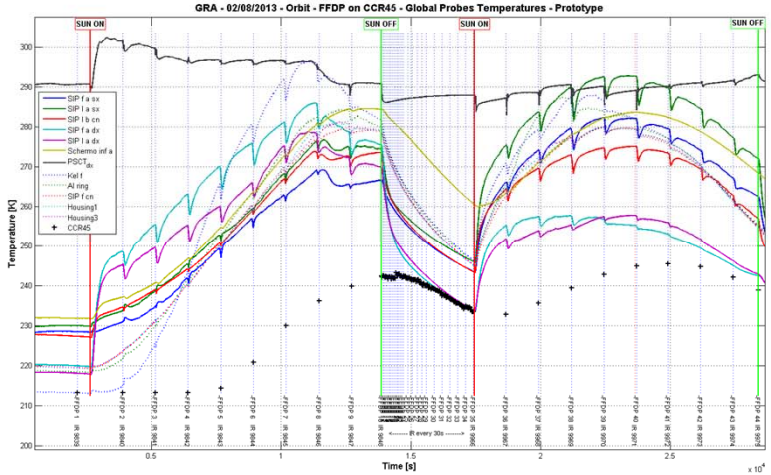


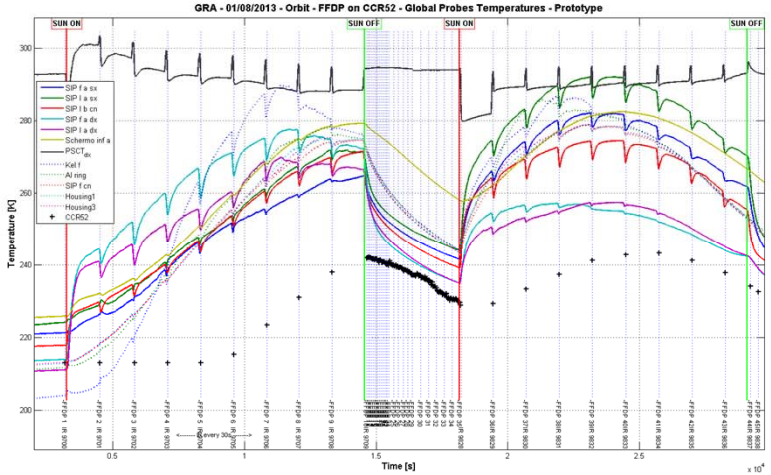


CCRs 30, 31, 45 and 52 SCF-Test Revision ETRUSCO-2

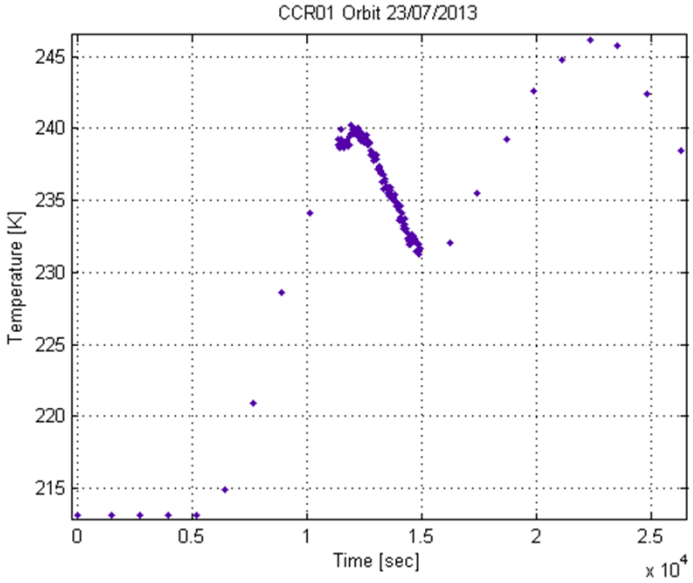


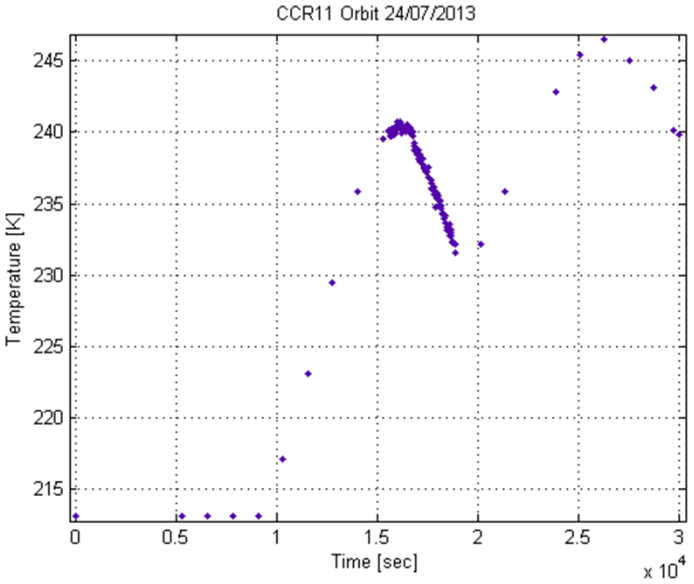


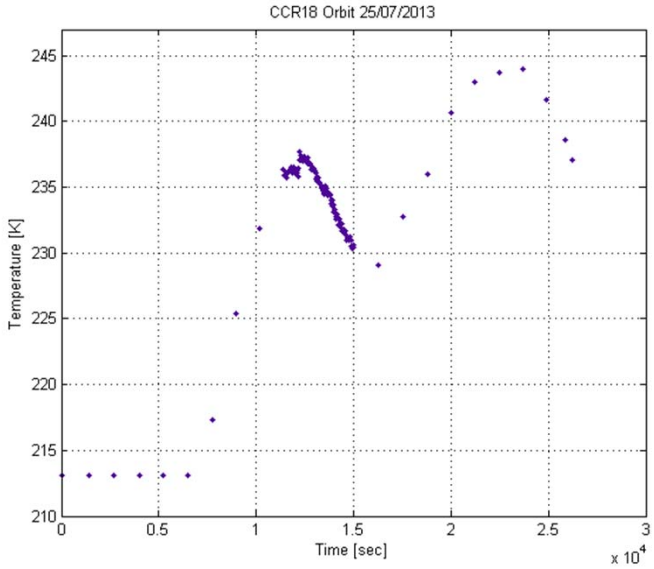


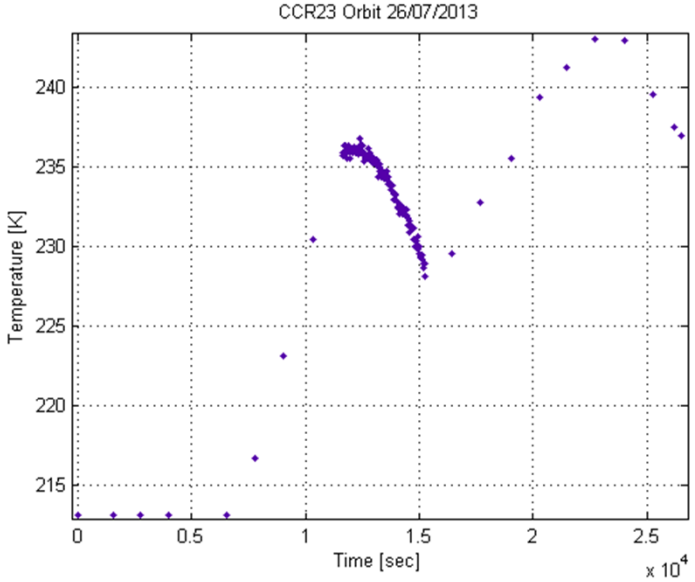


Orbit Temperature only for CCRs 1, 11, 18 and 23

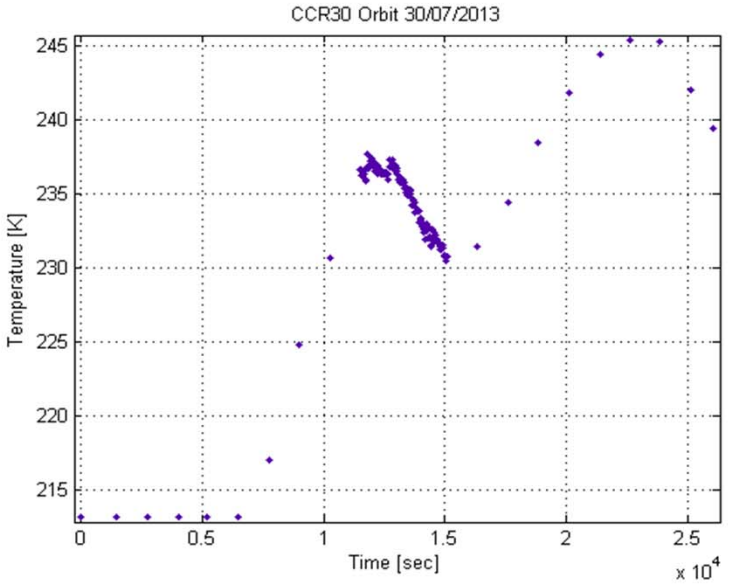


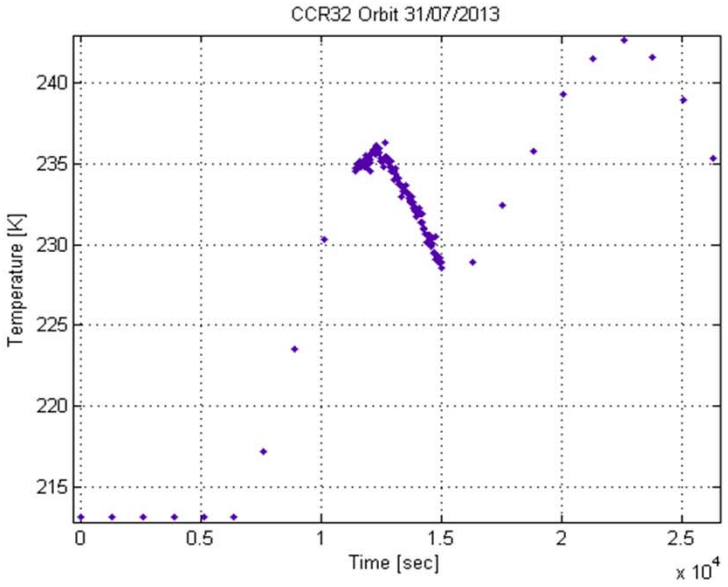


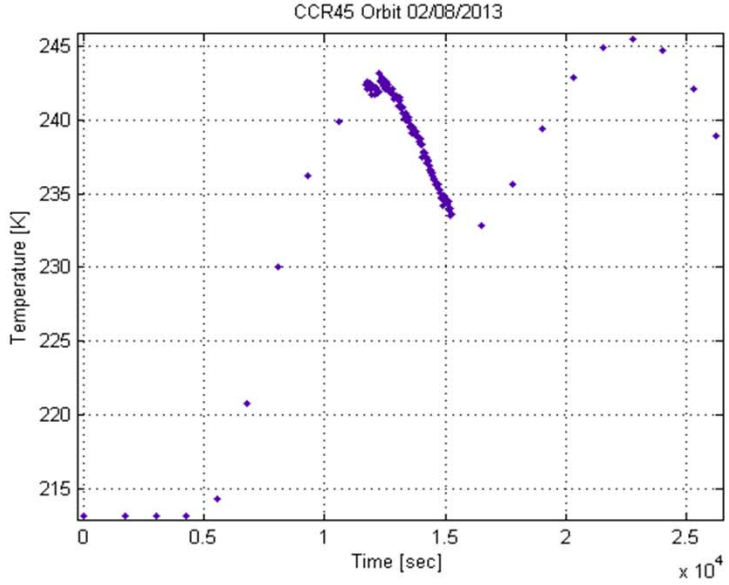


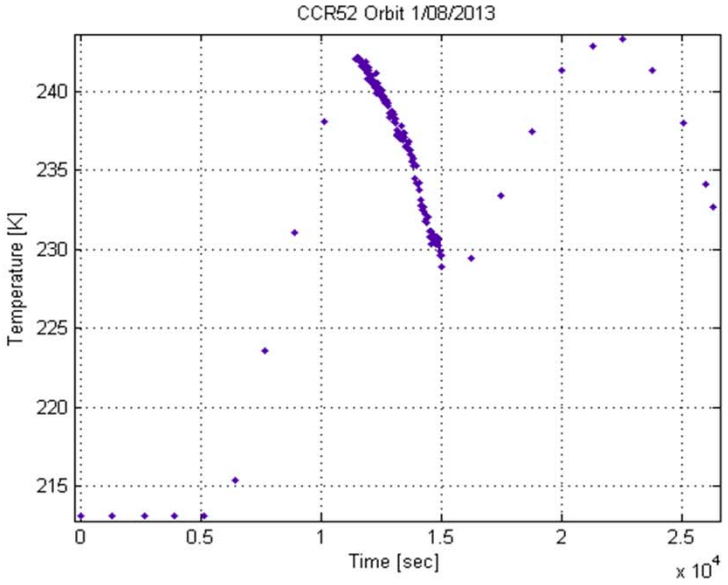


Orbit Temperature for CCRs 30, 31, 45 and 52

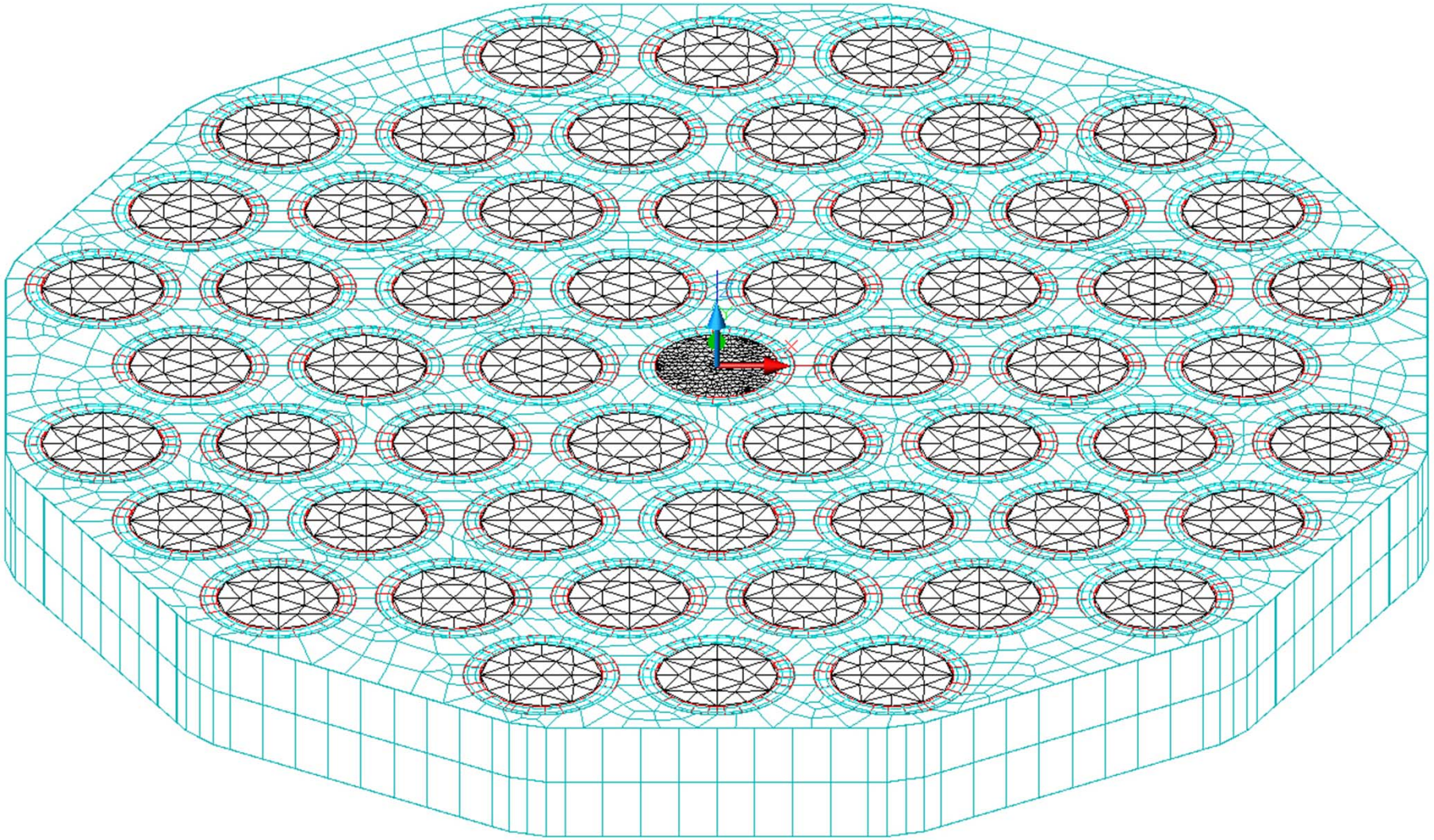






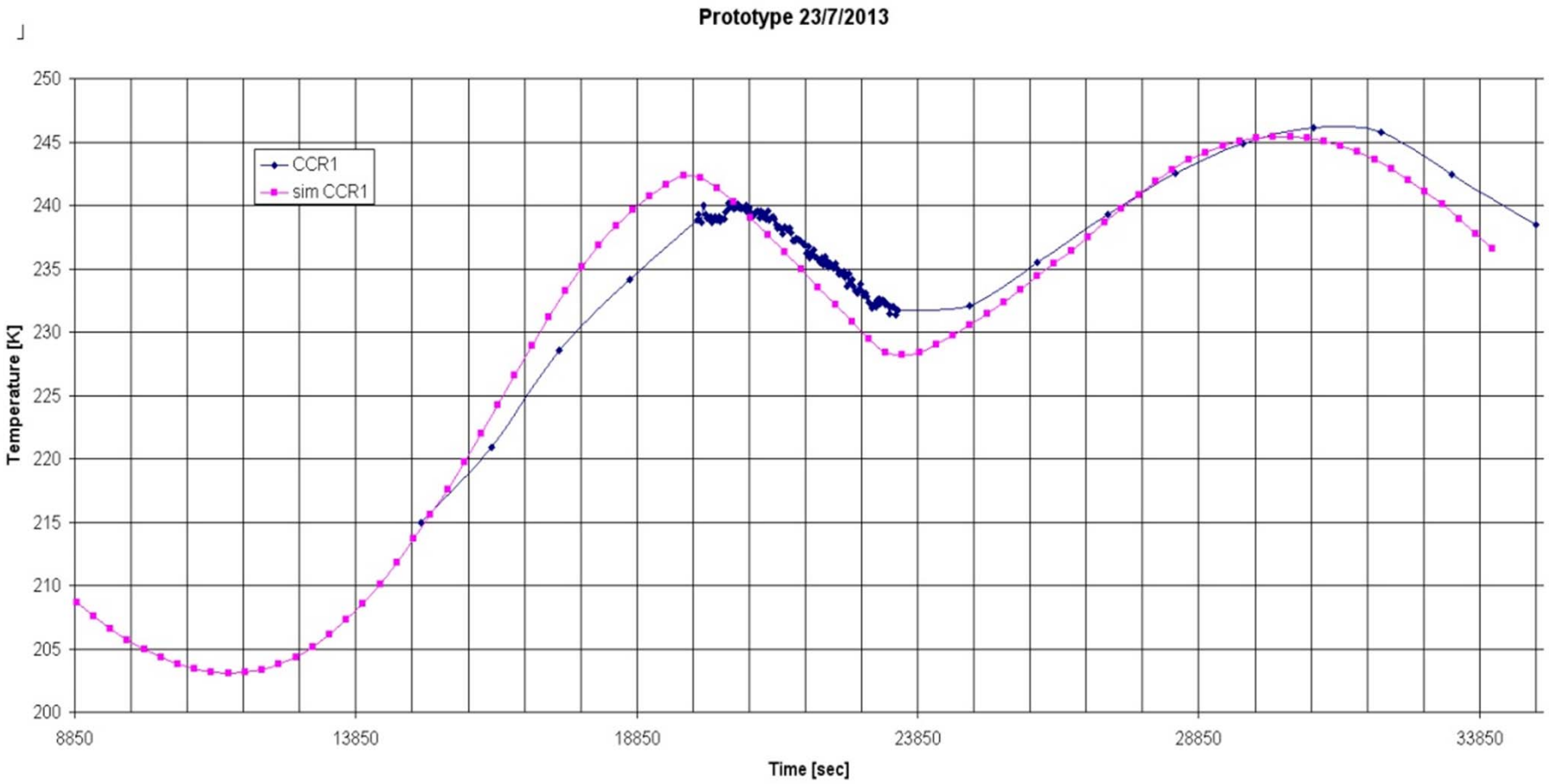


Thermal model

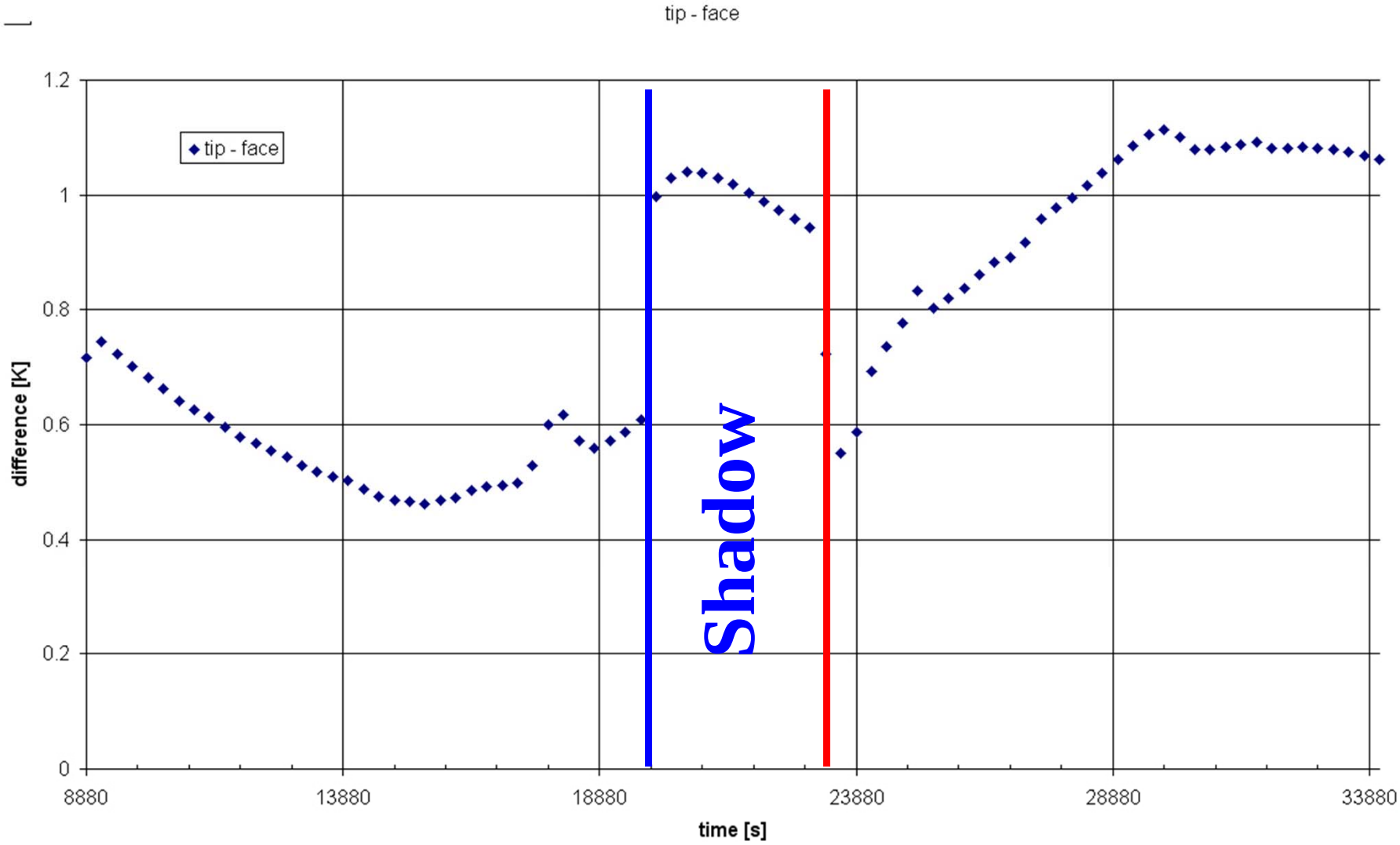


Comparison with simulations

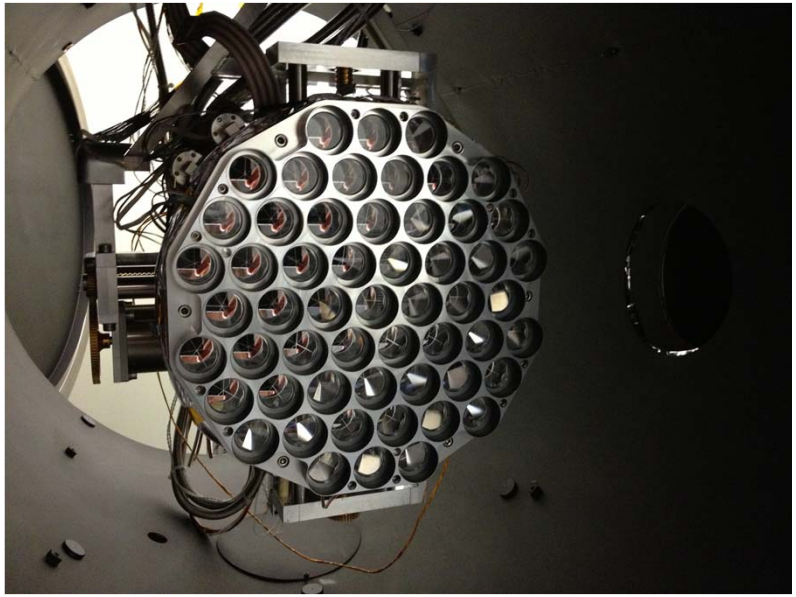
SCF-Test/Revision ETRUSCO-2



Tip-Face temperature difference for CCR 1

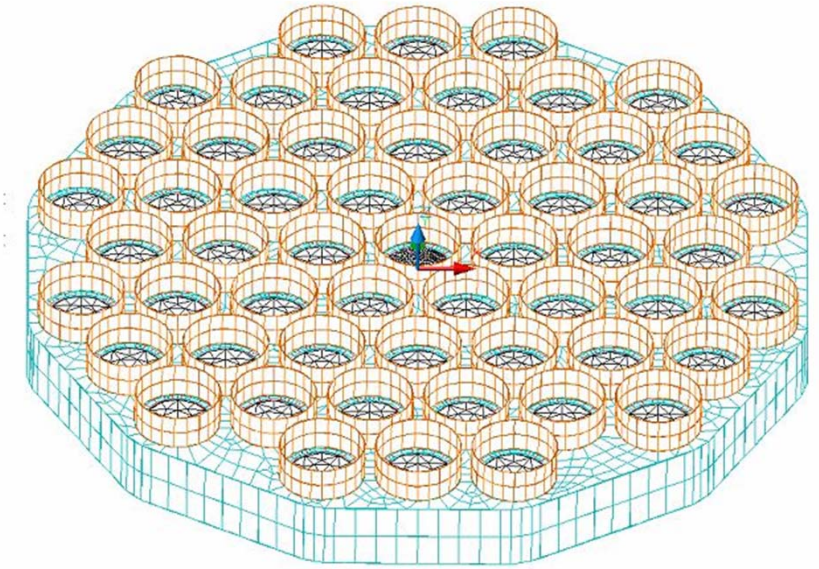


Work in progress



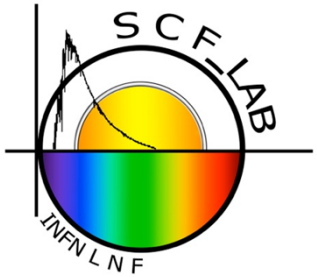
Cylindrical shading around every CCR to protect it from the Sun

It is rather heavy (about 2.5 kg) and the GRA still performed very well



Conclusions

- With ETRUSCO-2 (ASI-INFN project) we have doubled our metrological capabilities for retroreflector testing
- We have developed a new kind of test
- We have started new collaborations
- We have built a full-size, standard GRA which performed very well
- The GRA could be a standard for all GNSS constellations: INFN and ASI will propose it for Galileo evolution



Thank you for your attention