Programme for Research-Development-Innovation on
Space Technology and Advanced Research – STAR

Cluster Flux Gate Magnetometer Daily Calibration TUNED

D. Constantinescu

dragos@spacescience.ro

Institute for Space Sciences - INFLPR

Romanian Space Week, 12-16 May 2014, Bucharest, Romania

Project Information: Short Description

The task of the project is to perform the daily in-flight calibration for the Flux Gate Magnetometer (FGM) instruments onboard the four ESA Cluster satellites. The project takes advantage of the calibrated data to investigate non-stationary processes at the Earth's bowshock

Cluster Spacecraft

- first ESA multi-spacecraft mission (launched in August 2000)
- mission extended to Dec 31 2016
- multi-point measurements require careful calibration

FGM instruments

- 6 separate ranges to measure fields up to 65000 nT
- digital resolution from 8 pT to 8 nT

Project Information: Goals and Objectives

Project goals

- In-flight calibration for the Cluster FGM
- Study of the non-stationary processes at the Earth's bowshock

Project objectives

- Develop a software package for automatic calibration
- Perform the FGM daily calibration
- Investigate the electron dynamics at high Mach number

Project duration

- 3 years: 19.11.2012 – 18.11.2015

Project Information: Results and Team

Estimated results

- Software package for automatic FGM calibration
- Production of daily FGM in-flight calibration parameters
- Better understanding of high Mach number shock dynamics
- Publications and presentations at international conferences
- Tighten the relations with prestigious international institutions
- Increase the international visibility

Human resources

- 3 PhD: Mircea Ciobanu, Horia Comișel, Dragoș Constantinescu
- 2 young scientists: Costel Bunescu, Vlad Constantinescu

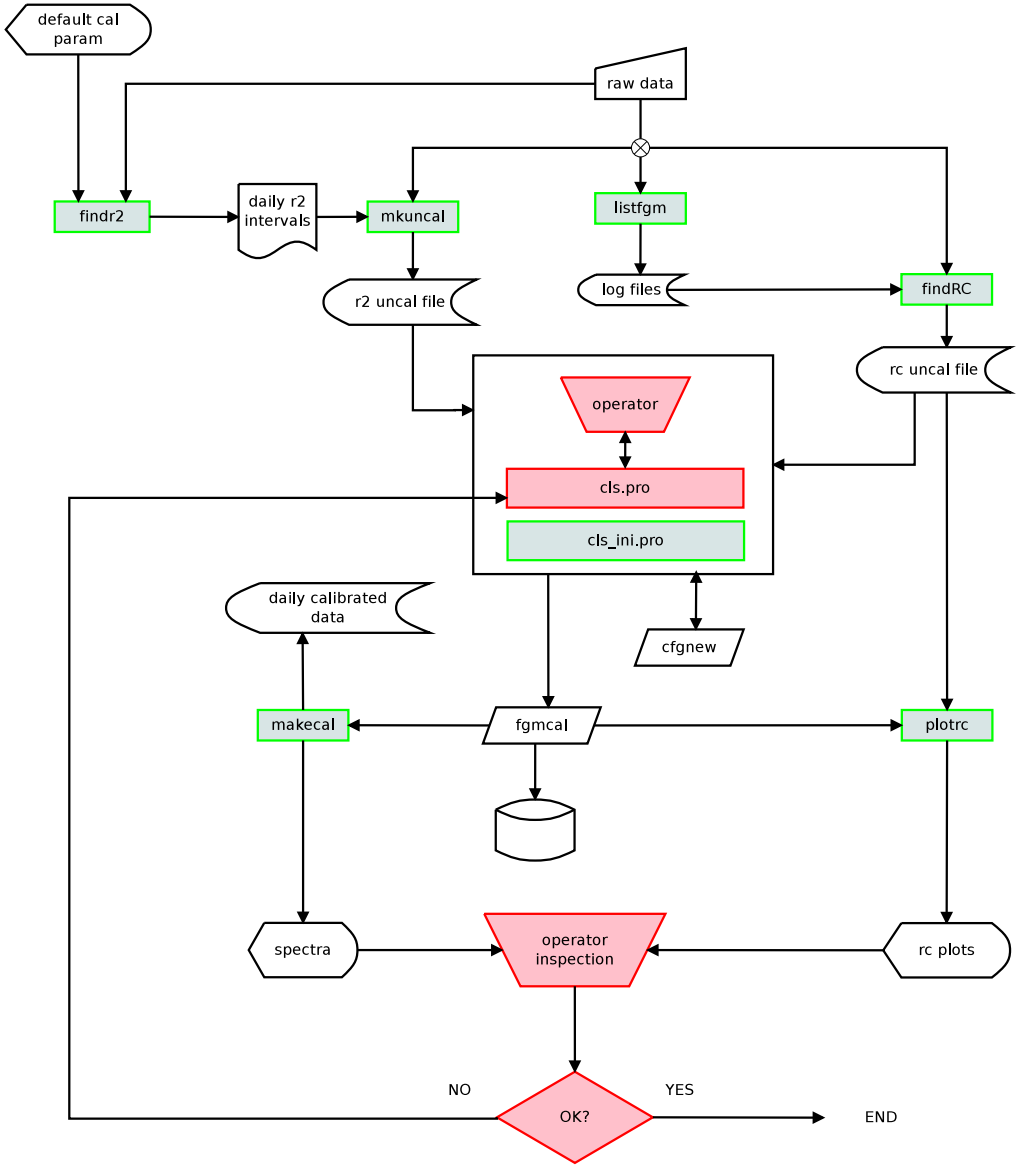
Project Information: Work Plan

- Software development — month 1 $\rightarrow$ 12
- FGM daily calibration — month 1 $\rightarrow$ 30
- Bowshock investigation — month 1 $\rightarrow$ 36
- Management and reporting — month 1 $\rightarrow$ 36

Implementation Status

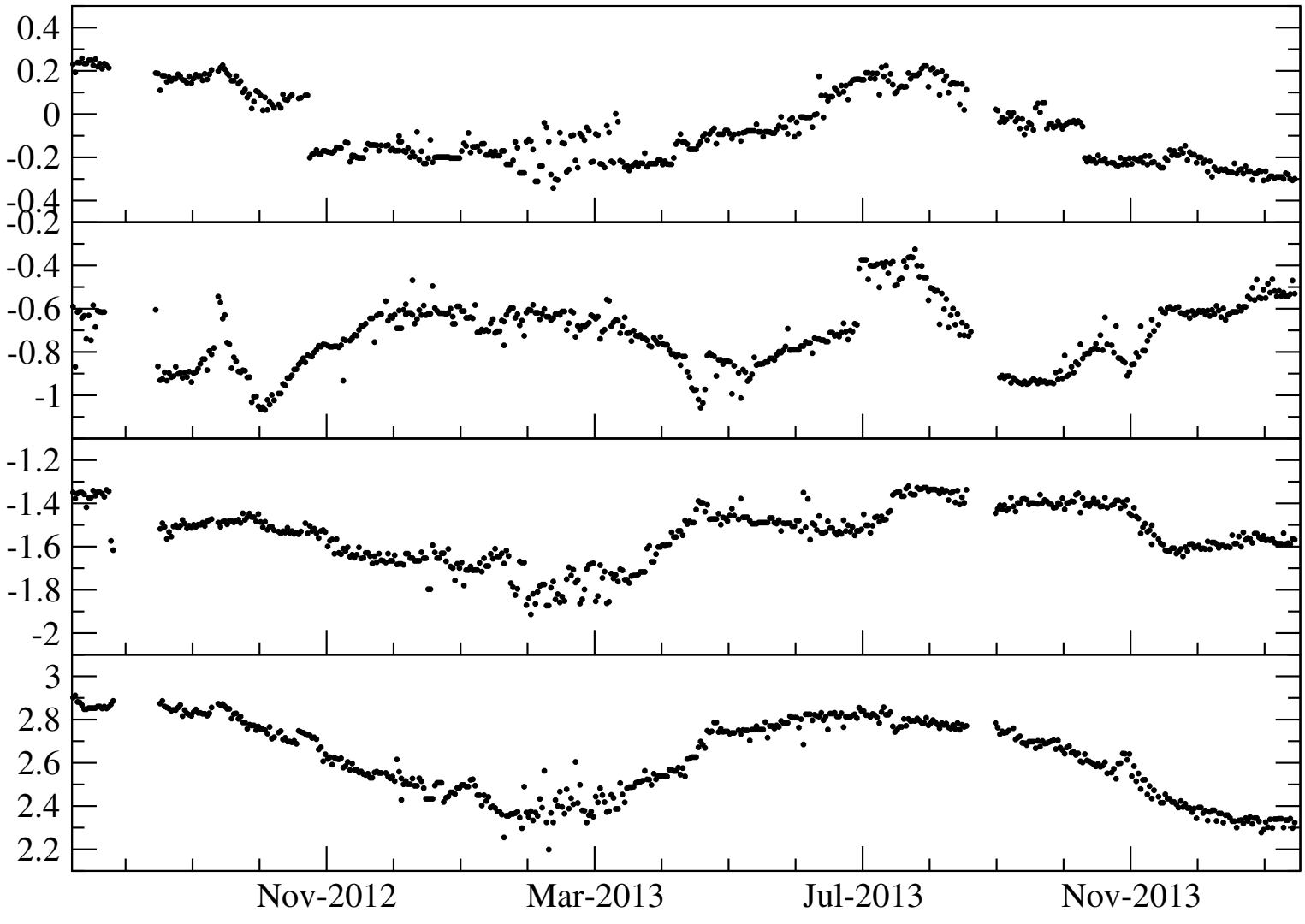
- Calibration package:
  - design: Finalised
  - development: Finalised
  - documentation: 80% available
  - start TRL: 1; acheived TRL: 8; intended TRI: 9
- Daily calibration: On schedule (done up to January 2014)
- Bowshock investigation:
  - software tools preparation: Finalised
  - the cross-shock potential was obtained from the PIC simulation
  - the CSP was obtained from the Liouville mapping

Results: Calibration package



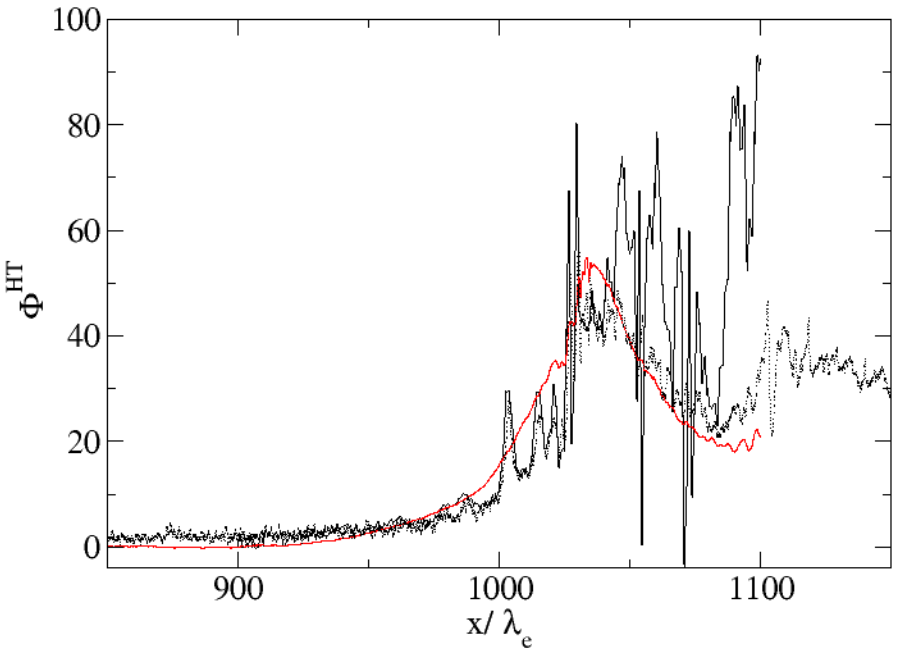
- mix of
  - C
  - Fortran
  - IDL
  - perl
- one month at a time
- minimum operator intervention

Results: Daily calibration



Results: Bowshock investigation

- One-dimensional full particle simulation code (EM1D) was run for various test cases.
- The cross-shock potential in the deHoffmann-Teller was determined.



- black solid line: from minimizing the actual and Liouville mapped distribution functions
- red line: from direct integration of electric field
- dotted line: politrope approximation of the fluid theory

Contribution to STAR goals

- Increases the visibility of the participants in the scientific community
- Builds the expertise for future participation in hardware projects
- Strengthens the connection of the ISS with prestigious institutions
- Enhances the Romanian contribution to ESA
- Contributes to the identification of a research niche
- Helps the development of the national space research capacity
- Promotes the development of a highly qualified research team
- Enables high quality scientific results at international level

Contribution to ESA programmes

- Directly contributes to the ESA mission Cluster

Dissemination

- Cluster FGM daily calibration parameters database open to the Cluster principal investigators on the FTP server `ftp.geophys.nat.tu-bs.de/clusterg_data`
- TUNED helped the organisation of two FGM calibration workshops with international participation in Romania:
  - 17 – 23 March 2013
  - 14 – 21 May 2014
- Results of the TUNED project were presented at the Magnetometer Workshop, March 2014, Czech Republic

Conclusions

- TUNED brings a valuable contribution to the first ESA multi-spacecraft mission, Cluster. This increases the Romanian participation to ESA activities.
- TUNED builds Romanian expertise in advanced multi-processor full-particle plasma simulations.
- So far the project advanced as planned and the following stages will be implemented by the project team.