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

Cluster Flux Gate Magnetometer Daily Calibration TUNED

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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 $1 ightarrow 30$
 Bowshock investigation 	month $1 ightarrow 36$
 Management and reporting 	month $1 ightarrow 36$

Implementation Status: Overview

- Calibration package
 - ► design: Finalised
 - development: On going (5 from 7 modules finalised)
- ► Daily calibration: On schedule (done up to Mai 2013)
- Bowshock investigation: 1D full particle simulation code implemented

Implementation Status: Calibration package



- ▶ red: user intervention
- ► green: new modules



before optimisation

after optimisation

Implementation Status: Daily calibration

range 2 (up to 64 nT) z-axis offsets



Implementation Status: Bowshock investigation

 One-dimensional full particle simulation code (EM1D) has been adapted and optimised for the existing hardware



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- Dell HPC cluster
 - ▶ 16 nodes, 128 cores
 - 32 GB/node RAM
 - 2.2 GHz Intel Xeon
 - InfiniBand QDR Network
- 6 TB data storage server

Color coded magnetic field at a quasi-perpendicular high Mach $(M_A = 9)$ collisionless shock

Contribution to STAR

- Increases the visibility of the team members in the scientific community
- Builds the expertise for future participation in hardware projects
- Strengthens the connection of the ISS with prestigious institutions abroad
- 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

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 a FGM calibration workshop with international participation in Romania between 17 and 23 March 2013.

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.