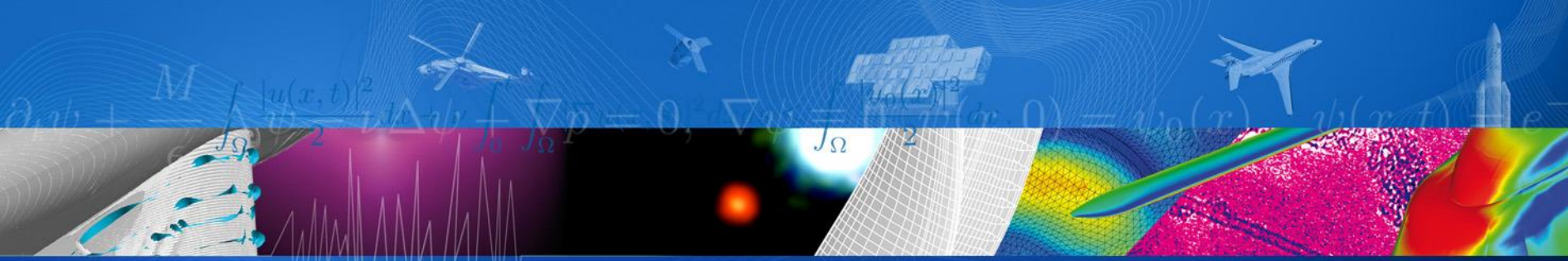


ONERA: participation dans LISA France

Joel Bergé (ONERA / DPhIEE)
Pour l'équipe ONERA / DPhIEE / IEA

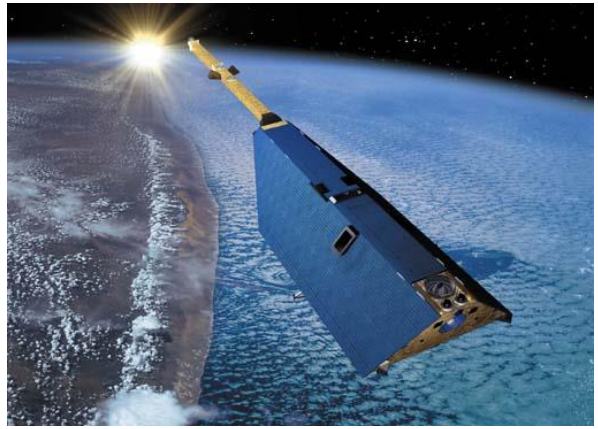
ONERA
THE FRENCH AEROSPACE LAB

return on innovation

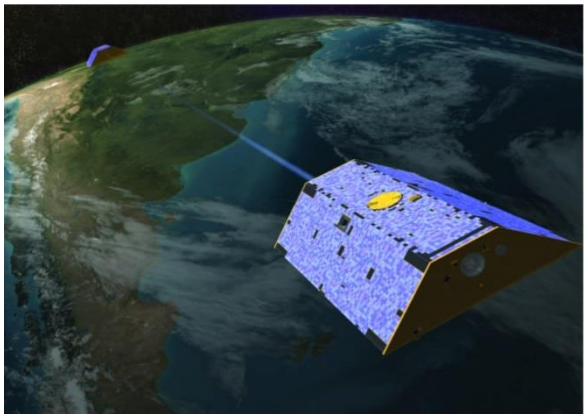
ONERA's Accelerometers in space missions

Castor - D5B 1975 (CNES)

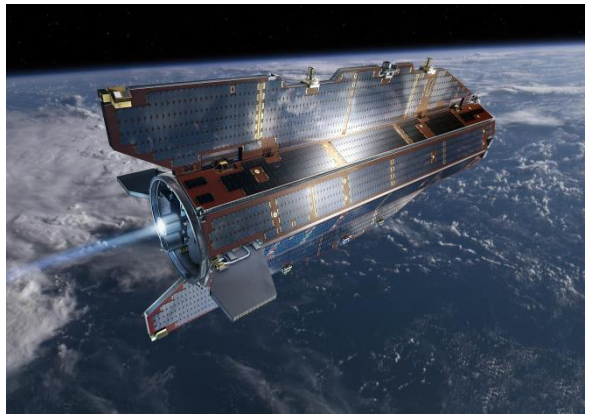
Columbia - 1996&1997 (ESA/NASA)



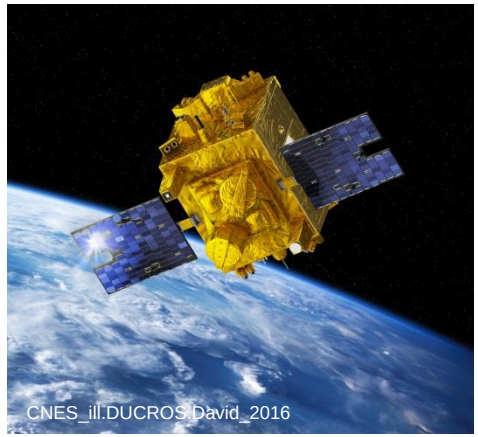
CHAMP - 2000 (DLR, CNES)



GRACE – 2002 (JPL)



GOCE - 2009 (ESA)



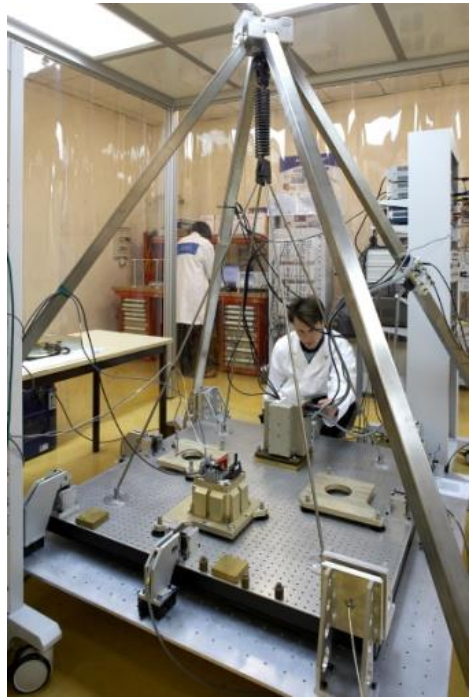
MICROSCOPE - 2016 (CNES)

GRACE Follow ON – end of 2017 (JPL)

ONERA / DPhIEE / IEA (Instrumentation et Equipement Aérospatiaux)

Electrostatic Accelerometers, Capacitive Sensors , Space Equipment tests and integration

Design / conception / integration



Tests

TSAGE accelerometer for MICROSCOPE Mission

Tests environnementaux et sur satellite (en collaboration avec le CNES – MICROSCOPE)

Compétences complémentaires acquises / en cours

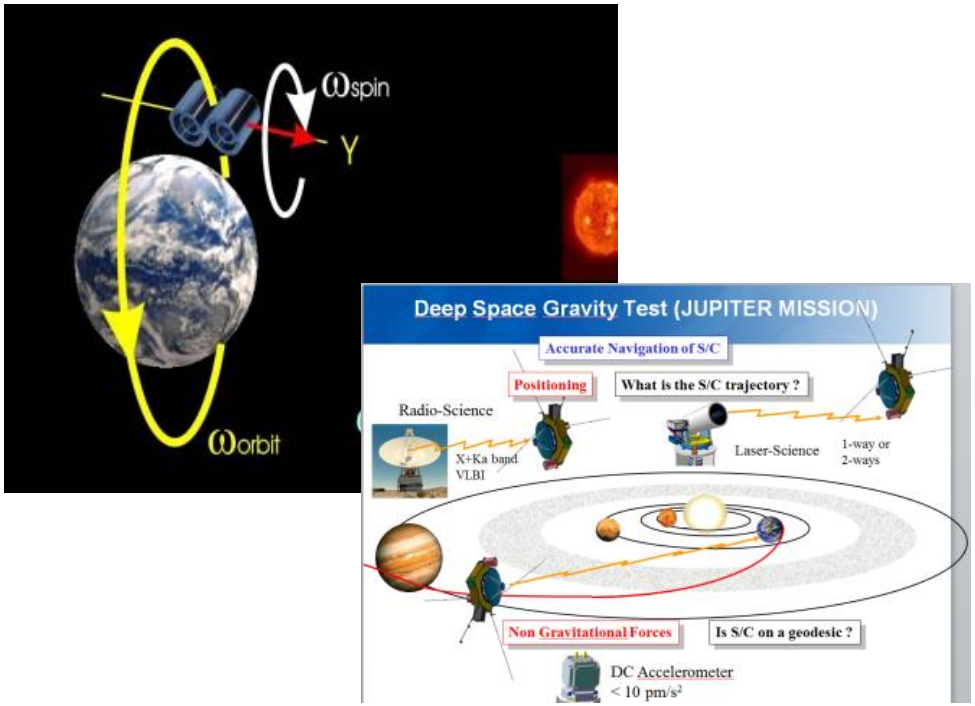
- Mécanisme de blocage des masses d'épreuve (MICROSCOPE)

- Electronique numérique d'asservissement des masses d'épreuve (MICROSCOPE, GOCE) : Ressources ONERA pour amélioration perfos

- Système de décharge : projet de recherche ONERA (2018-2020)

ONERA / DPhIEE / IEA (Instrumentation et Equipement Aérospatiaux)

Space project design and management, science mission center



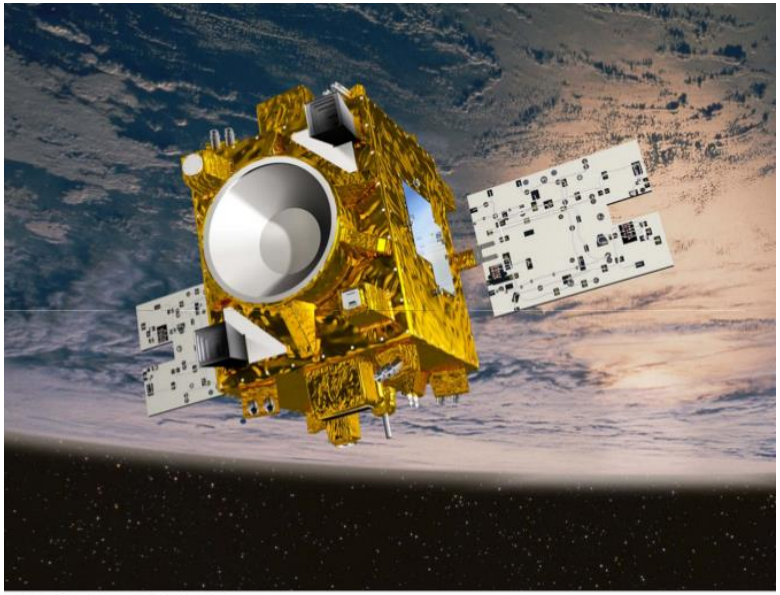
Science Mission analysis

MICROSCOPE Science Mission Center

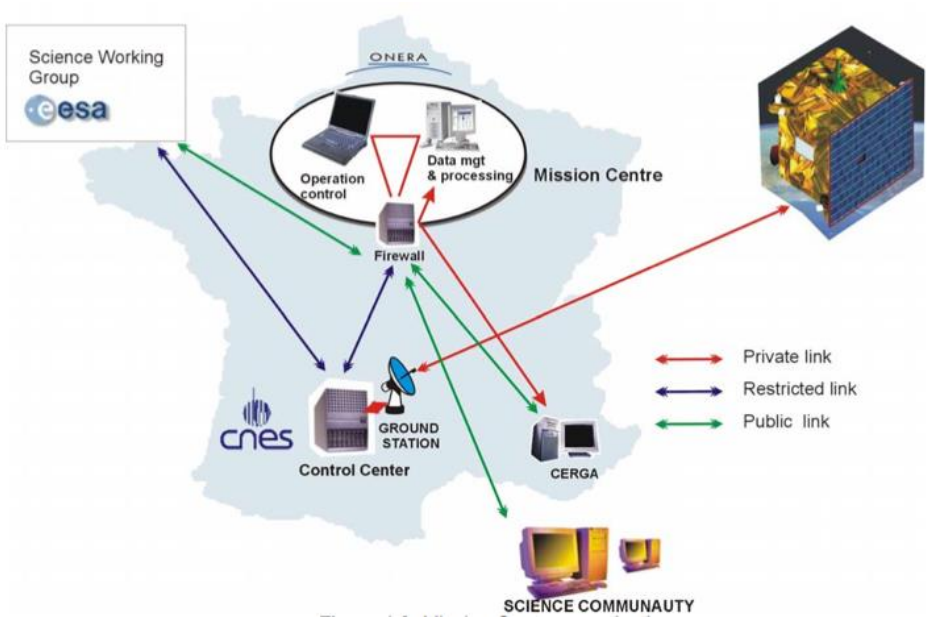
MICROSCOPE

Responsable charge utile + responsable Centre de Mission Scientifique (surveillance instrument, réduction et analyse des données)

Collaboration étroite CNES



© CNES - Juillet 2012 / Illust. D. Ducros



MICROSCOPE Science Mission Center (CMSM)

- Ensure all operational functions to maximize instrument's operation
- Day-to-day instrument management and monitoring
- Weekly mission performance check
- Propose modifications to the mission scenario
- Data release and archiving

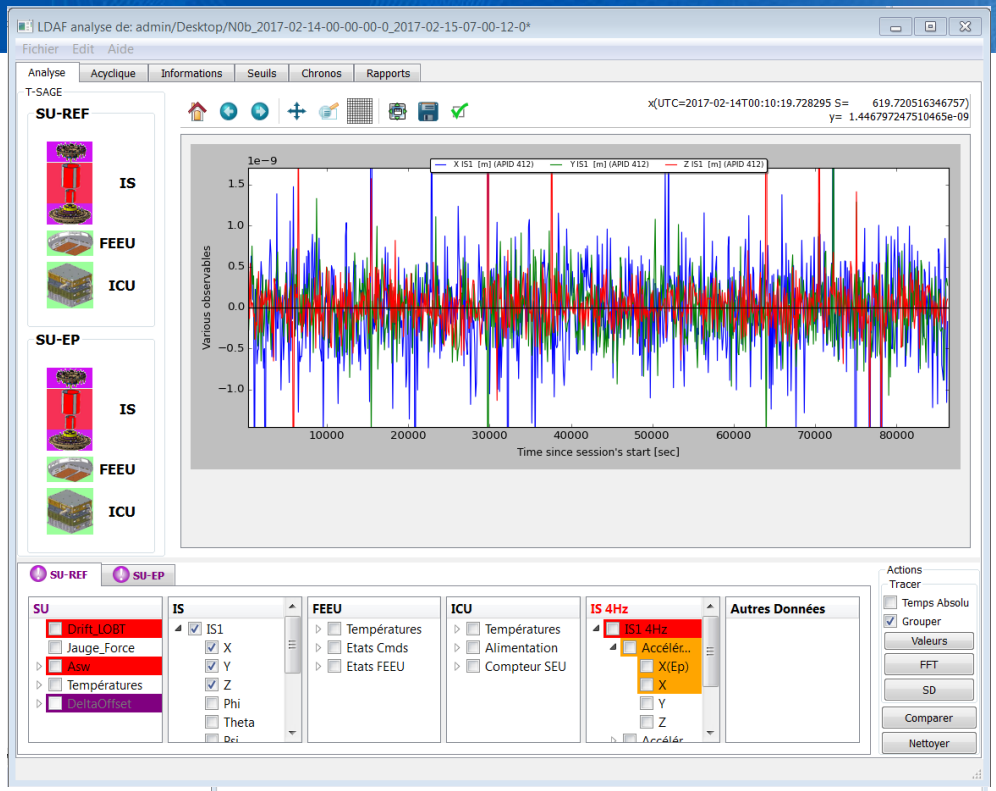
➔ **Different time scales with different flexibilities:**

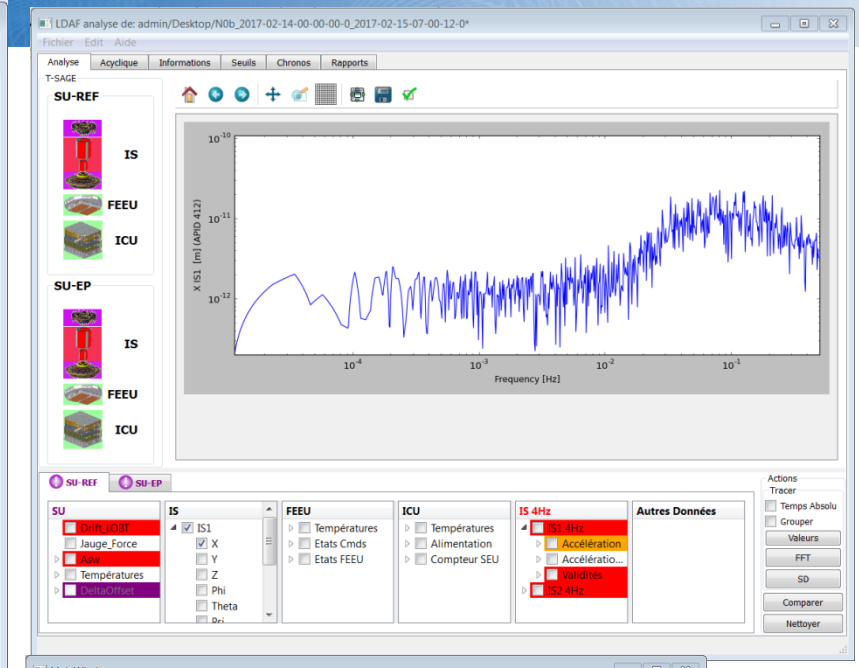
- **1-week horizon: operational loop**
  - Verification of data integrity by automated processing
  - Mission program fixed (except potential stop or extension of a long session)
- **1-month horizon:**
  - Preliminary analysis of data
  - Scenario still modifiable, in the frame of the predefined sessions
- **1-year horizon:**
  - Detailed scientific analysis
  - Detailed performance analysis
  - Optimization of calibration processing
  - Application of data correction models

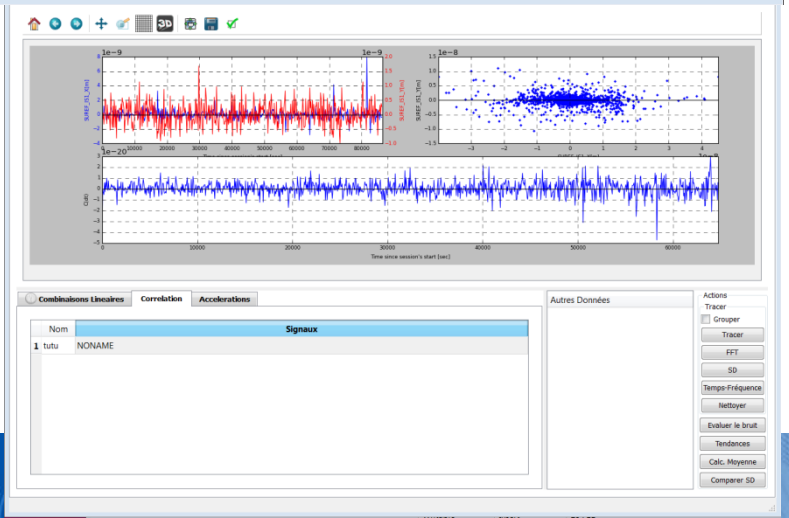
Data processing

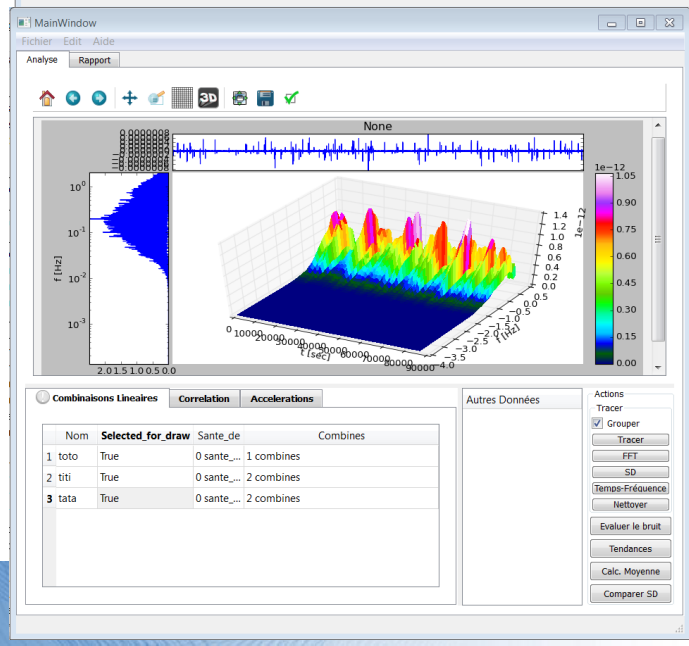
- Raw data (N0 level) automatically fetched from CNES servers
- Automatic detection of missing data
- Data written into CMSM format (binary python files, sorted by session)
- Instrument monitoring: automatic comparison of house-keeping and science data with pre-defined thresholds and behaviors (GUI)
- (Not so) quick-and-dirty data analysis: interactive time-domain and frequency-domain analyses of house-keeping and science data (GUI)
- Creation of upper data levels (N1 and N2)
  - Detection of invalid data
  - Final, calibrated science data
  - Reports
  - Fixed architecture
  - Tracking (who does what)
  - Enables full reprocessing
  - GUI + batch mode
- Signal extraction and measurement

Daily / Weekly operations: instrument monitoring, quick data analysis









Data analysis

- Noise-dominated signal extraction and estimation
  - Colored noise
  - Missing data: KARMA
- Noise characterization
- Missing / invalid data correction: inpainting (collaboration with CEA), M-ECM

Baghi et al 2016

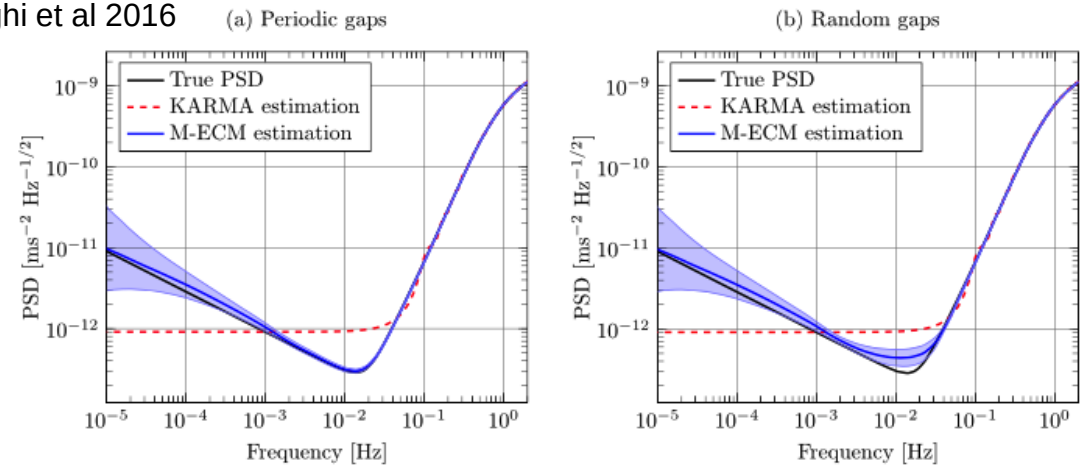
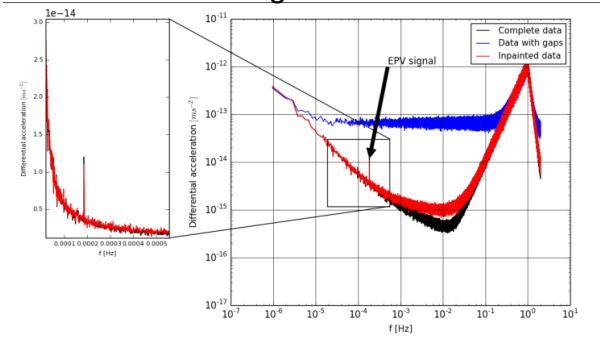


FIG. 4. Sample average of the PSD estimates (blue) along with its 99% confidence interval (light blue area), autoregressive estimate (dashed red), and true PSD (black) for a 20 orbit spin session and for the periodic (a) and random (b) gap patterns.

Bergé et al 2015



Intérêts dans LISA France

- Intégration / Tests instrument
  - En soutien du CNES lors de l'intégration (expérience MICROSCOPE, GRACE-FO, connaissance de l'accéléro)
  - Fourniture de sous-ensembles de l'instrument si besoin

- DPC
  - Soutien au développement logiciel (puis utilisation)
    - Surveillance (semi)-automatique de l'instrument
    - Gestion des house-keeping

  - Calcul scientifique
    - Caractérisation de l'accéléro (défauts, bruits…)
    - Extraction/modélisation de signaux (parasites, ponctuels)

Aspects organisationnels

- Besoin de contrat (soutien intégration, développement DPC)
- Ressources générales ONERA : traitements scientifiques
- Postdoc / Doctorants

- Equipe IEA: 10 ingénieurs de recherche (électronique (2), mécanique (2), physique (6))