



Status of the GOCE Mission

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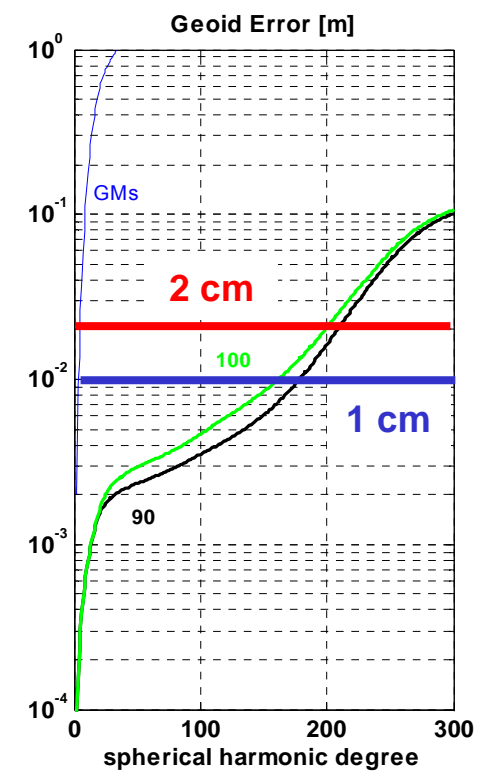
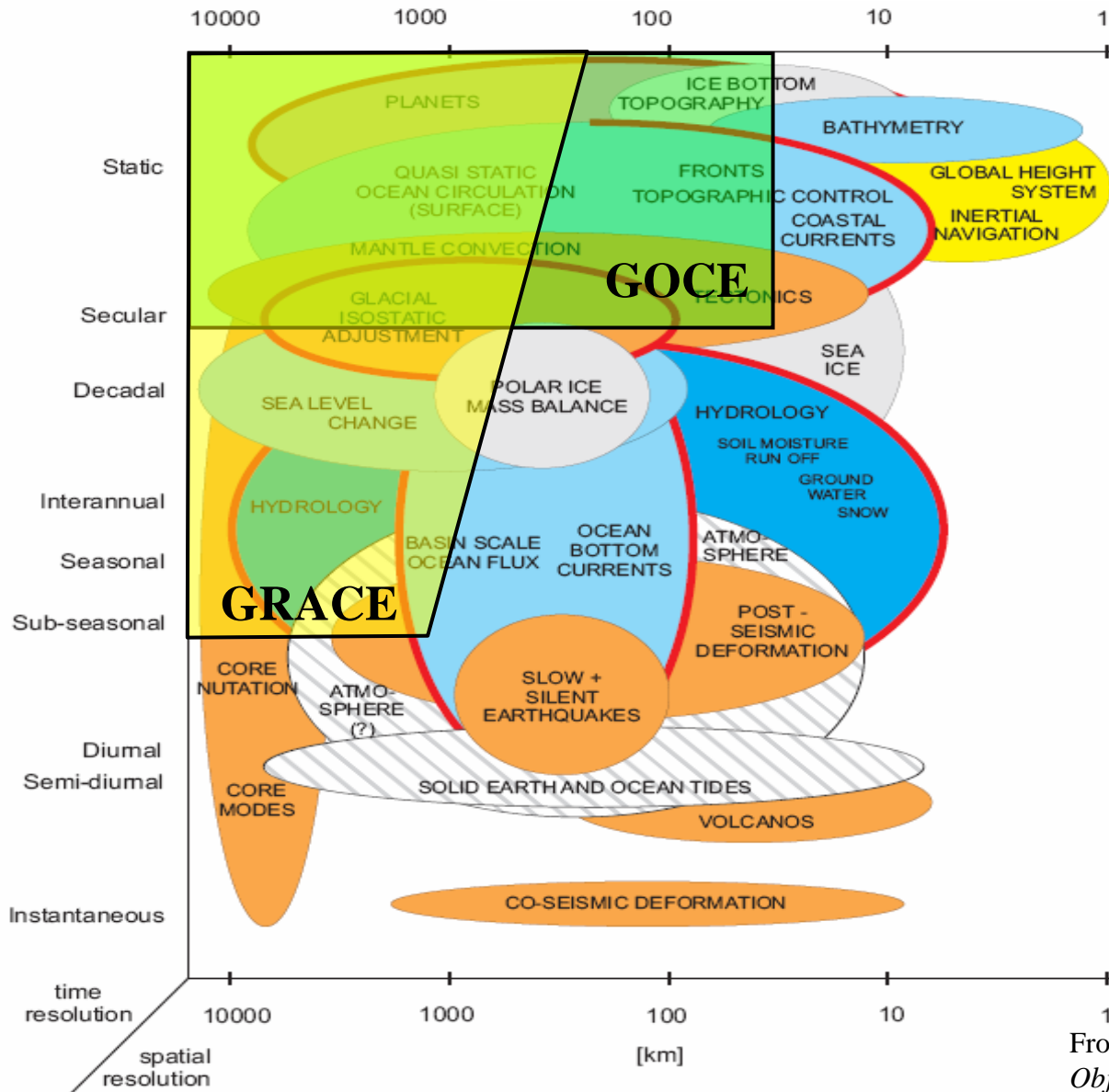
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GRACE Science Team Meeting, 8. & 9.12.2006, San Francisco

Goals of GOCE Mission



From Simulation Study

From ESA-Study: „Scientific Objectives for Future Geopotential Missions“



- To determine the Earth's **gravity field** with an **accuracy** of **1 mGal** ($1 \text{ mGal} = 10^{-5} \text{ m/s}^2$)
 - 1 “milli-Galileo” is $\sim 10^{-6}$ of the acceleration of gravity, g
 - Requires determining the 3d rate of change of gravity between pairs of accelerometers with a desired sensitivity of $\sim 4 \text{ mE}$ (milli-Eötvös) in each axis
where $1 \text{ E} = 1 \text{ mGal} / 10 \text{ km} = 10^{-9} \text{ s}^{-2}$ (i.e. $\text{m/s}^2 / \text{m}$)
 - Noise specification for single accelerometer in MBW: $2 \times 10^{-12} \text{ m/s}^2 / \text{Hz}^{0.5}$ (c.f. CHAMP $\sim 10^{-9}$; GRACE $\sim 10^{-10}$)
- To determine the **geoid** (= equipotential surface for a hypothetical ocean at rest) with **1-2 cm accuracy**.
- achieve this at a **resolution** or half wavelength scale of **100 km** (approx. degree and order 200)

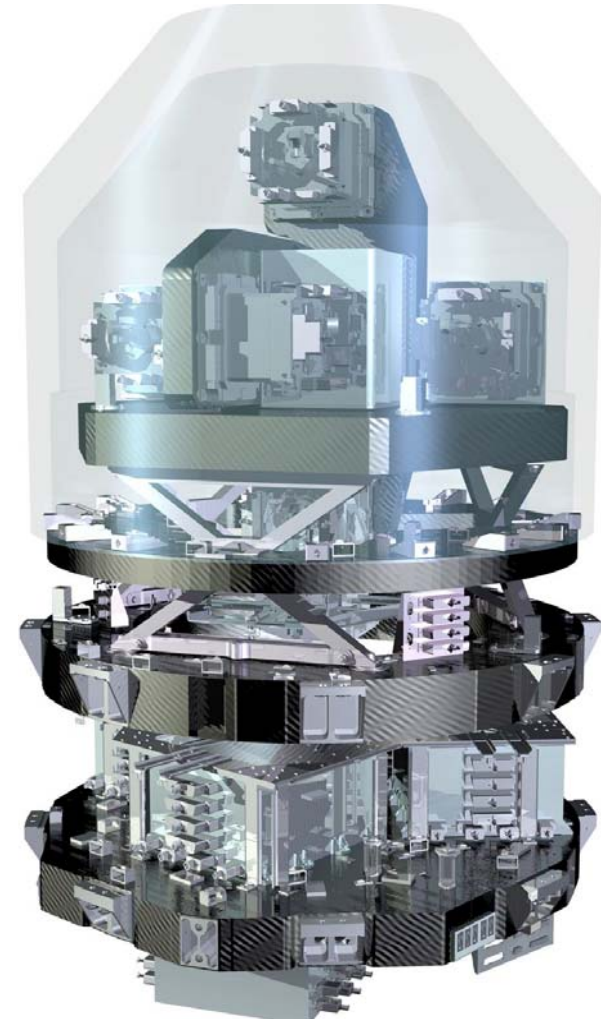


– GOCE Space Segment Development Status –



(taken from Muzi / ESA-ESTEC; 3rd GOCE User Workshop; GOCE Mission Development Status)

- **Gradiometer Structural and Thermal Model (STM) programme completed** with, in particular, qualification of the Carbon-Carbon technology used for the Gradiometer Structure.
- **Satellite Structural Model programme completed.**
- **Payload Engineering Model (EM) programme (i.e. Gradiometer and Satellite to Satellite Tracking Instrument) completed.**
- **Satellite EM integration completed** and functional verification in progress.



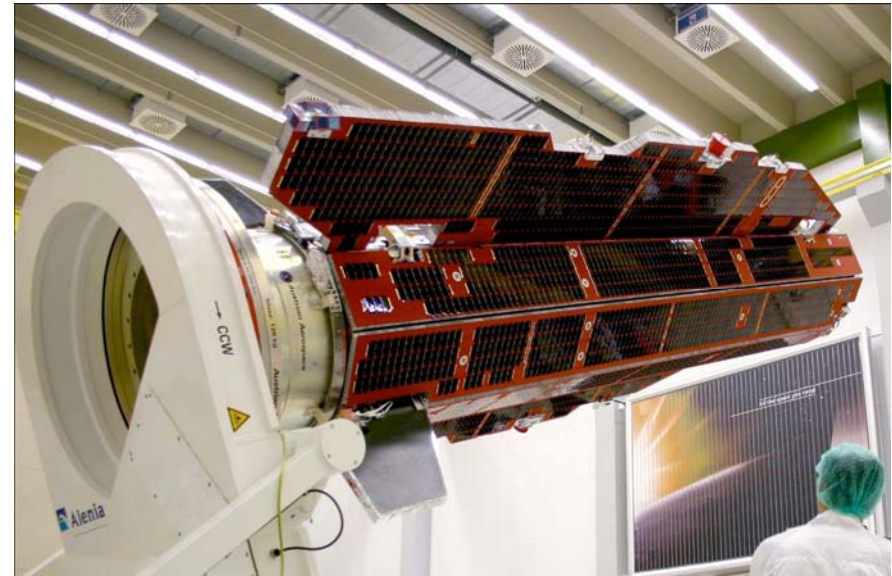


– GOCE Space Segment Development Status –



(taken from Muzi / ESA-ESTEC; 3rd GOCE User Workshop; GOCE Mission Development Status)

- **Platform Flight Model (FM) integration completed** with the exception of Ion Propulsion Assembly (IPA).
- **2 Satellite to Satellite Tracking Instrument FMs** completed.
- **Gradiometer Electronics FMs** completed.
- **6 Accelerometer Sensor Heads** completed.
- **First Gradiometer arm** integrated and aligned.



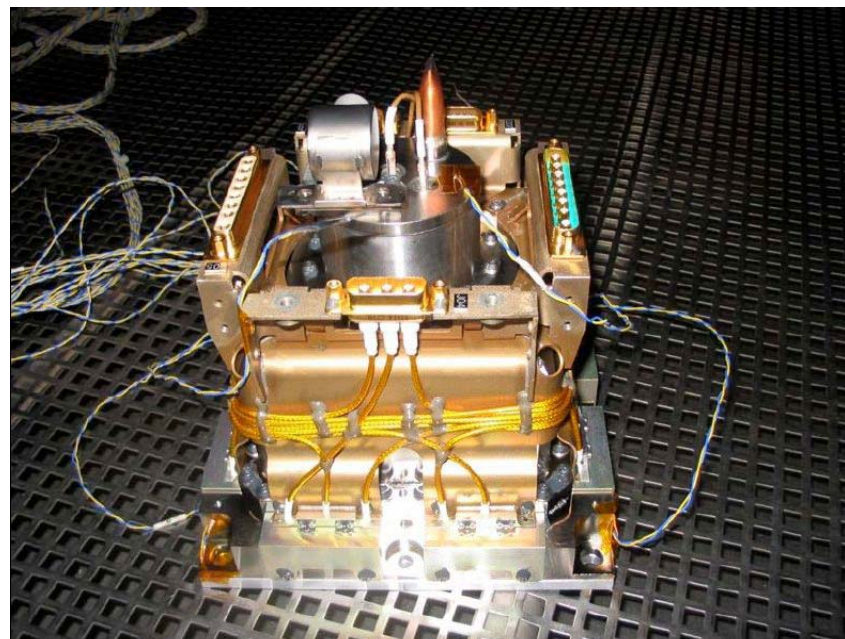


– GOCE Space Segment Remaining Activities –



(taken from Muzi / ESA-ESTEC; 3rd GOCE User Workshop; GOCE Mission Development Status)

- **FMs Gradiometer Electronics** and upgraded Core STM integration on Platform FM.
- **Reintegration** of CDMU and PCDU.
- **Completion of IPA testing** and integration on Platform FM.
- **Satellite functional verification.**





– GOCE Space Segment Remaining Activities –



(taken from Muzi / ESA-ESTEC; 3rd GOCE User Workshop; GOCE Mission Development Status)

- **Satellite environmental testing.**
- **Completion of Gradiometer Core and swap with Core STM.**
- **Satellite final functional verification.**
- **Shipment** to launch site (Plesetsk) and launch campaign.
- **Launch: September 2007** (Rockot launcher)





The GOCE Ground Segment

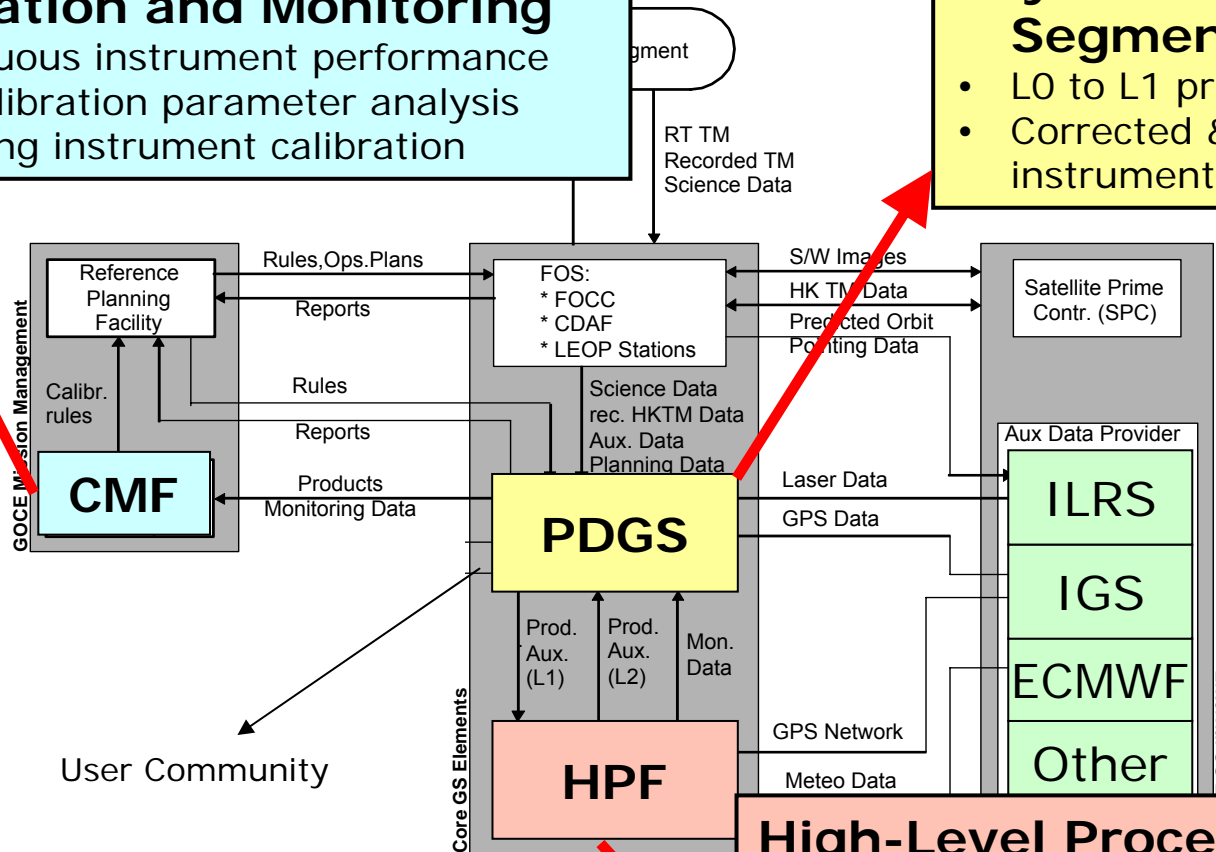


Calibration and Monitoring

- Continuous instrument performance and calibration parameter analysis
- Initiating instrument calibration

Payload Data Ground Segment

- L0 to L1 processing
- Corrected & calibrated instrument data time series



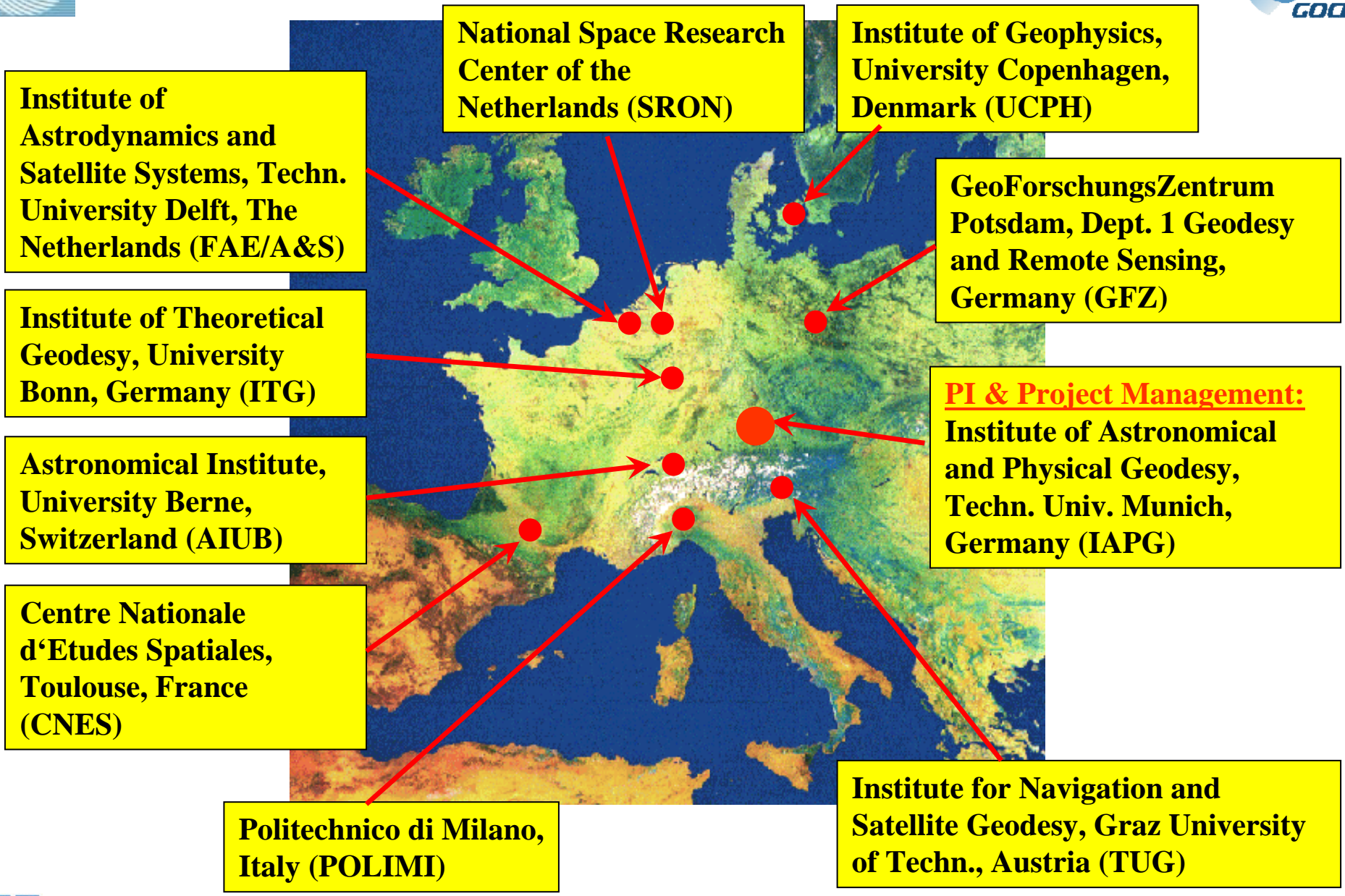
User Community

High-Level Processing Facility = Science Data Processing System

- L1 to L2 processing (gravity fields & orbits)
- Continuous quick-look gravity field performance analysis
- Developed and operated by EGG-C



— The GOCE High Level Processing Facility



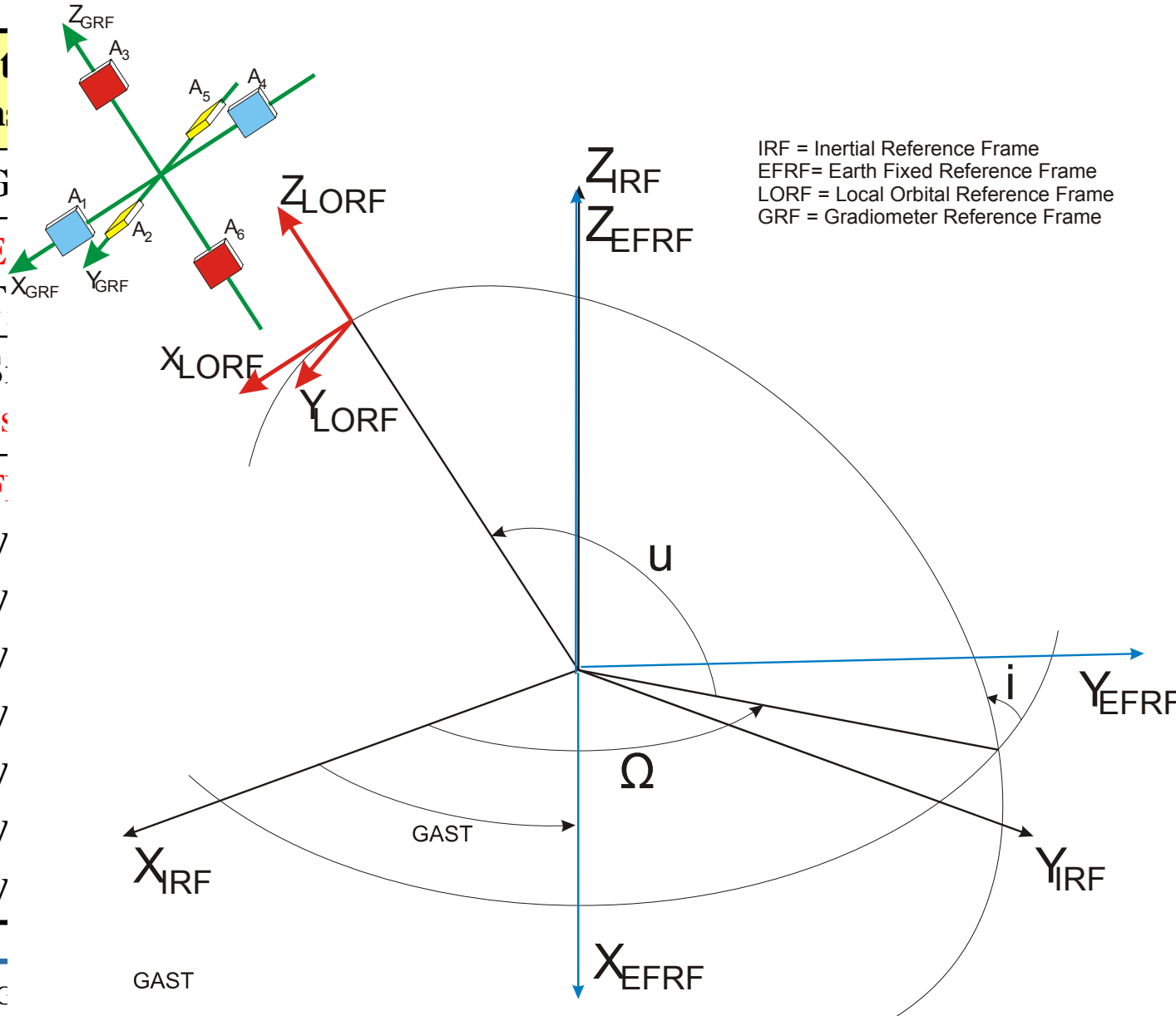


- Calibrated & Corrected Gravity Gradients -



Content of EGG_NOM_2

Gravity Gradients in the gravity field variation	
GPS Time	G
Gravity Gradients	E T
Errors of Gravity Gradients	S es
Gradient Flags	F V V V V V V V V



IRF = Inertial Reference Frame
 EFRF = Earth Fixed Reference Frame
 LORF = Local Orbital Reference Frame
 GRF = Gradiometer Reference Frame

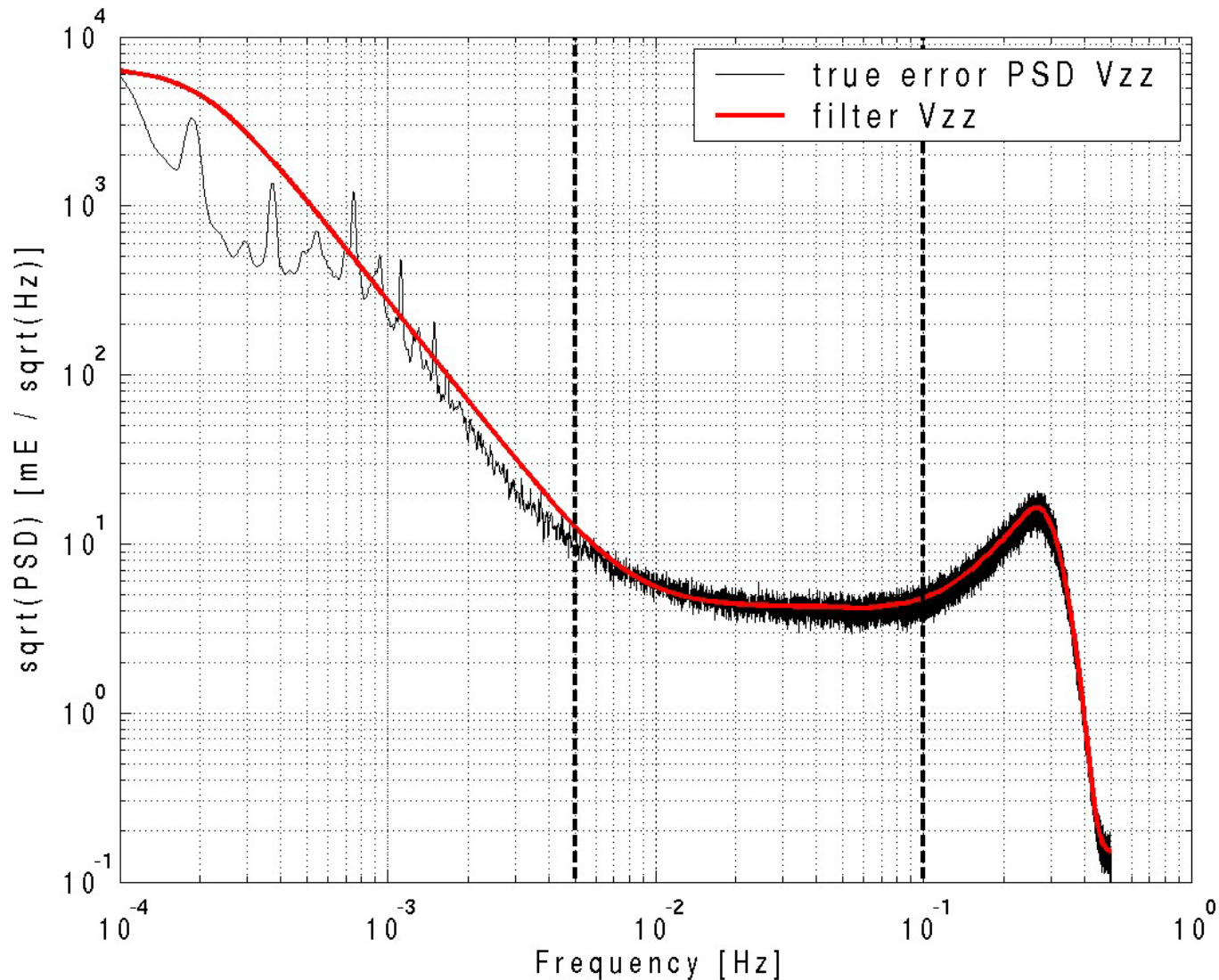


- Calibrated & Corrected Gravity Gradients -



Content of EGG_NOM_2 (Cont.)

Gravity Gradients in the gravity field variations	
Direct Tides	C
Solid Earth Tides	C
Ocean Tides	C
Pole Tides	C
Non-Tidal Mass Variations	C va
External Calibration	C al



- Gravity gradients a
- Errors are estimate
- GRF to IRF rotatio
- Attitude Quaternio



Gravity Gradients in Earth-fixed Frame



EGG_TRF_2

Gravity Gradients in Local North-Oriented reference Frame (LNOF) corrected for temporal gravity field variations, outliers, data gaps and externally calibrated

GPS Time	Gradient observation time in [sec]
Position	Geocentric latitude in [deg], longitude in [deg], height in [m]
Gravity Gradients	Externally calibrated & corrected gravity gradients T_{xx} , T_{yy} , T_{zz} , T_{xy} , T_{xz} , T_{yz} in [1/sec]
Errors of Gravity Gradients	Sigmas of all 6 gravity gradients derived from a-priori or HPF estimated gradiometer error model in [1/sec]
Gradient Flags	Flags for each gravity gradient as 1 byte integer. Meaning of values as for EGG_NOM_2.

- In order to minimize errors due to gradient transformation (badly observed gradients map to high quality gradients) a **global model is used as reference**.
- Gravity gradients are filtered, i.e. GOCE observations only in MBW, long wavelength part from a model.



SST_PSO_2

Precise science orbits from reduced dynamic approach (positions and velocities) and kinematic approach (positions), both in EFRF. Additionally included is variance-covariance information for the kinematic orbits (over 9 epochs) and the rotation matrix for each epoch from the EFRF to the IRF in terms of quaternions.

Kinematic Orbit	GPS time in [sec] X,Y,Z position in [m] in Earth fixed frame Clock correction Standard deviation of position and clock Variance-covariance matrix for positions (over 9 Epochs)
Reduced Dynamic Orbit	GPS time in [sec] X,Y,Z position in [m] in Earth fixed frame X,Y,Z velocity in [m/sec] in Earth fixed frame Standard deviation of position and clock
Rotation Matrix from EFRF to IRF	GPS time in [sec] Quaternions (4) describing rotation angles



GOCE Gravity Field Model



EGM_GOC_2

GOCE gravity field model in different representations including geoid error:

Spherical Harmonic Series (SHS)	Degree; order; C/S- coefficients ; Sigmas of coefficients (dimensionless)
Geoid Heights	30'x30' global grid with geoid heights computed from SHS in [m] using wgs84 as reference ellipsoid.
Gravity Anomalies	30'x30' global grid with gravity anomalies computed from SHS in [m/s ²] using wgs84 as reference ellipsoid.
North-South Deflection of the Vertical	30'x30' global grid with North-South deflections of the vertical computed from SHS in [arc-sec] using wgs84 as reference ellipsoid.
East-West Deflection of the Vertical	30'x30' global grid with East-West deflections of the vertical computed from SHS in [arc-sec] using wgs84 as reference ellipsoid.
Geoid Height Error	30'x30' global grid with geoid height standard deviation computed from error propagation of full variance-covariance matrix in [m].



GOCE Gravity Field Model



EGM_GVC_2

Complete variance-covariance matrix for the coefficients of the spherical harmonic series of the GOCE gravity field model EGM_GOC_2

Header File

GM (Earth mass times gravity constant)
a (Radius)
Maximum degree
Sequence of coefficients
Sequence of files

Data File(s)

Harmonic order of the file
Number of data values
Data entries for this order