

GOCE Science Data Processing System Status and Plan

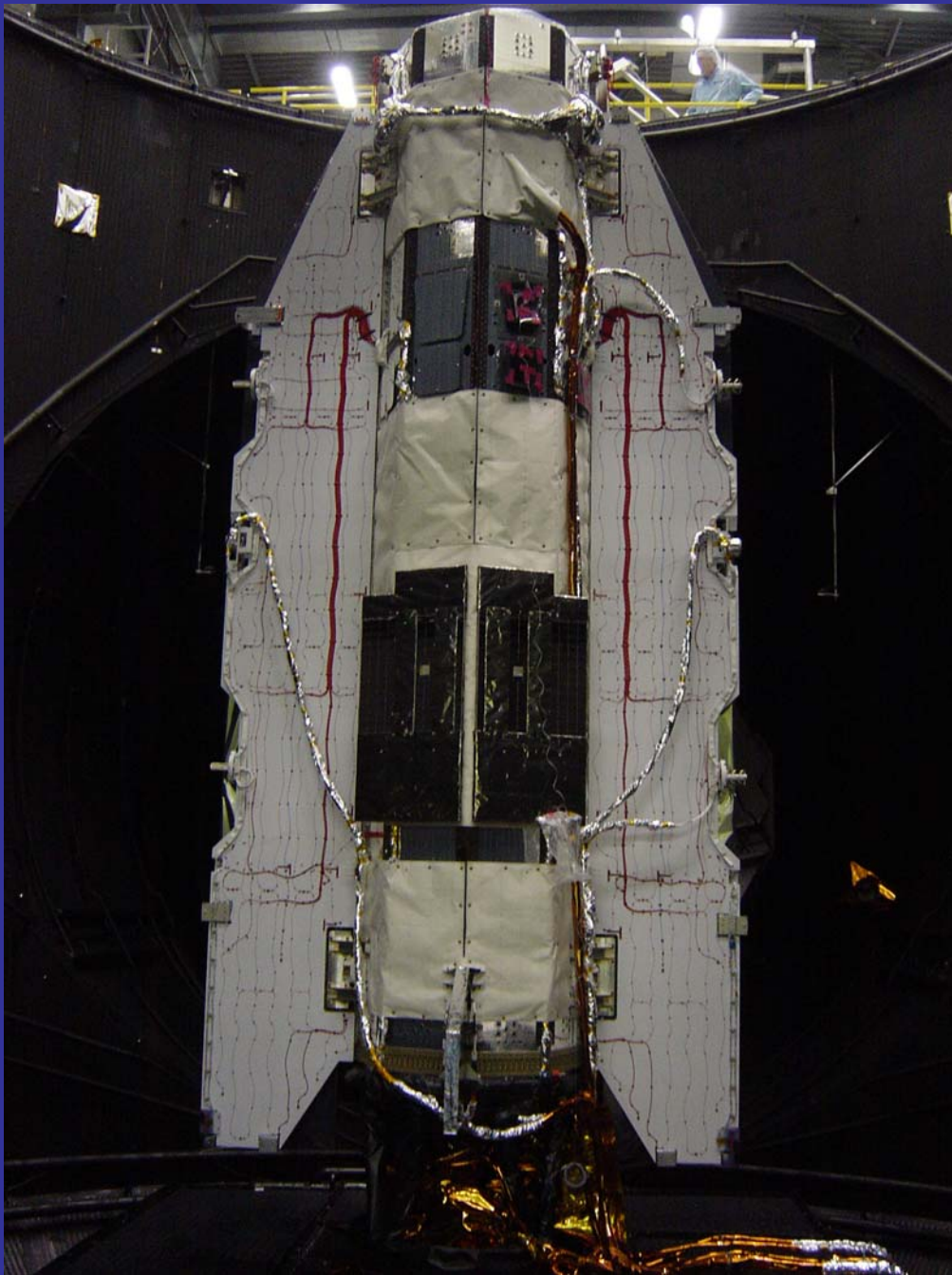
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on behalf of the European GOCE Gravity Consortium
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GOCE launch took place on
March 17, 2009 at 15:21
with a Rockot
from Plesetsk, Russia





GOCE

first mission of ESA's
"Living Planet Programme"

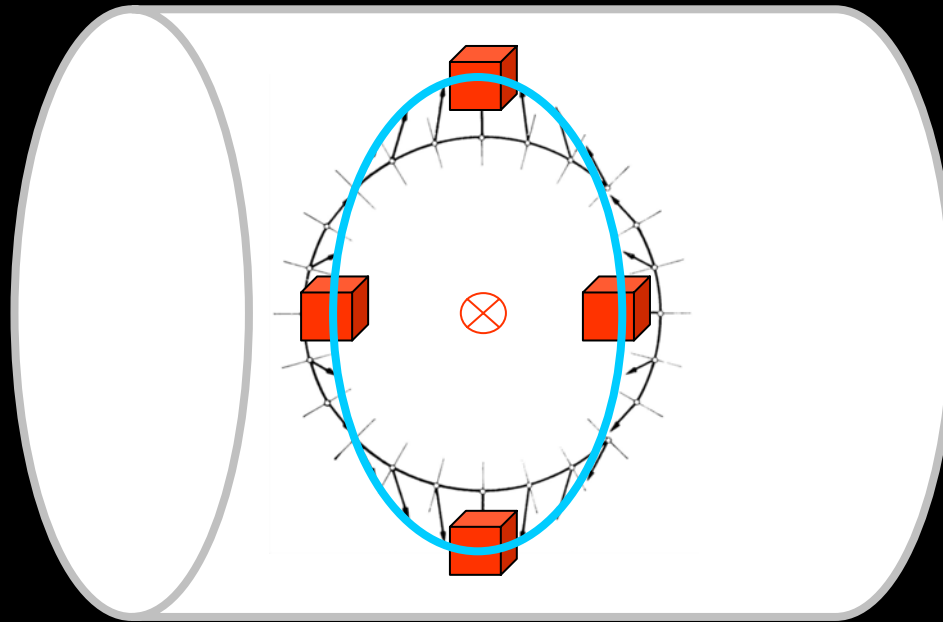
first satellite equipped
with a
gravitational gradiometer

GOCE mission goals

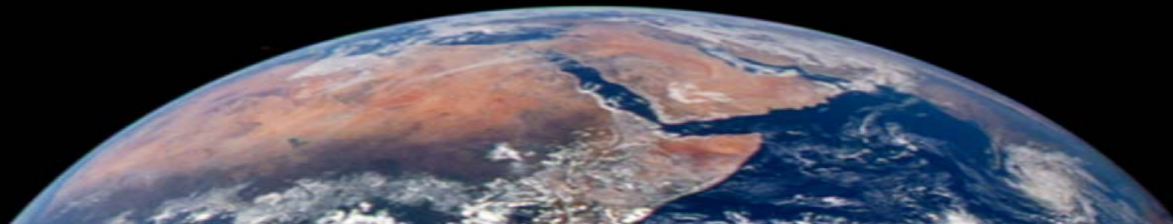
Gravity and steady-state Ocean Circulation Explorer



- geoid heights with a precision of 1 cm
- gravity with a relative precision of 1 ppm (1 mGal)
- both with a spatial resolution of 100km ($n_{\max}=200$)



test masses
subject to the
Earth's
tidal field



gravitational gradients or gravitational tensor

gravitational tensor

=

tidal tensor

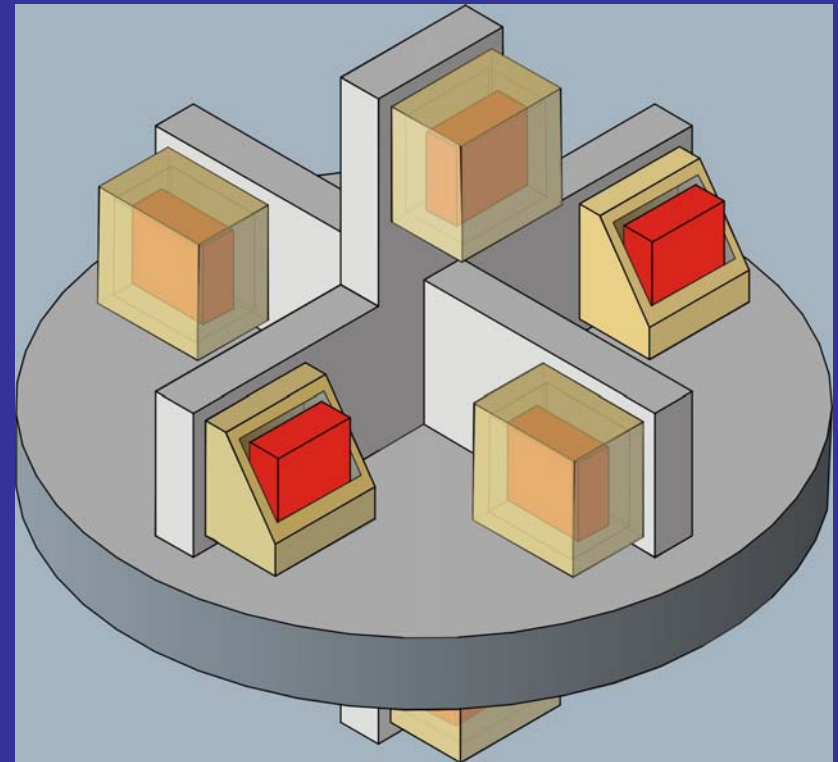
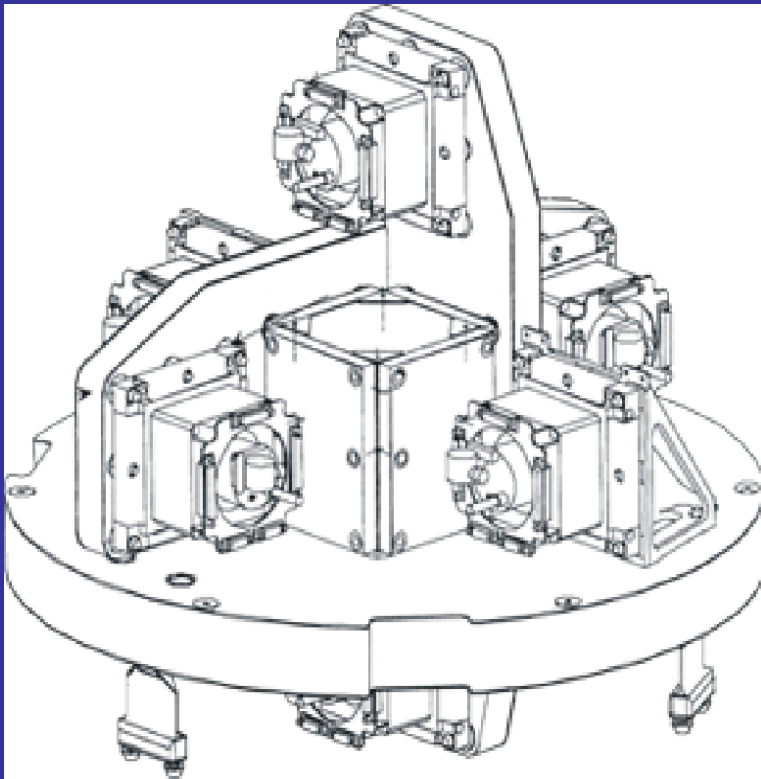
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curvature tensor

$$\begin{pmatrix} \partial g_x / \partial x & \partial g_x / \partial y & \partial g_x / \partial z \\ \partial g_y / \partial x & \partial g_y / \partial y & \partial g_y / \partial z \\ \partial g_z / \partial x & \partial g_z / \partial y & \partial g_z / \partial z \end{pmatrix} = \begin{pmatrix} V_{xx} & V_{xy} & V_{xz} \\ V_{yx} & V_{yy} & V_{yz} \\ V_{zx} & V_{zy} & V_{zz} \end{pmatrix}$$

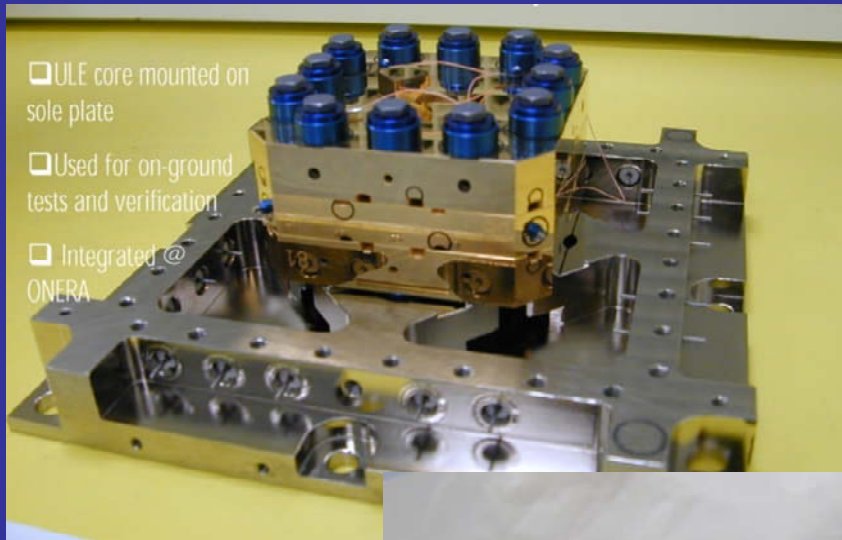
principle of GOCE-gradiometry

GOCE gravity gradiometer
six test masses - kept levitated in a capacitive electric field

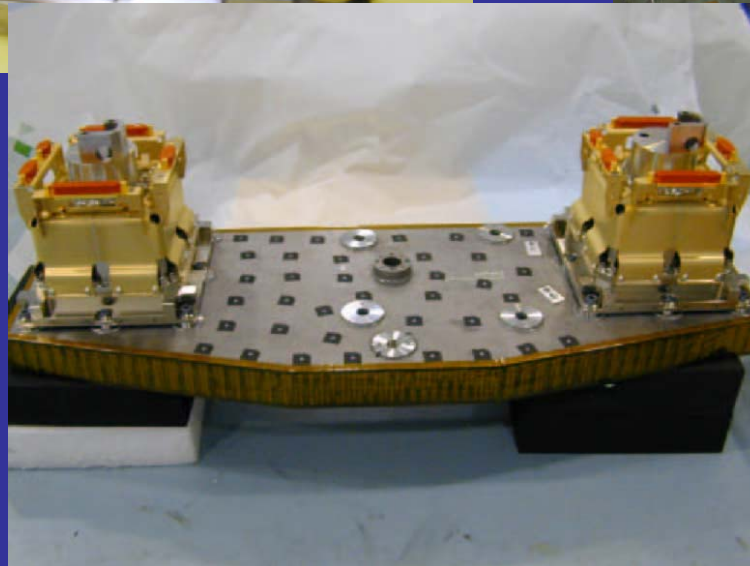


principle of GOCE-gradiometry

single accelerometer

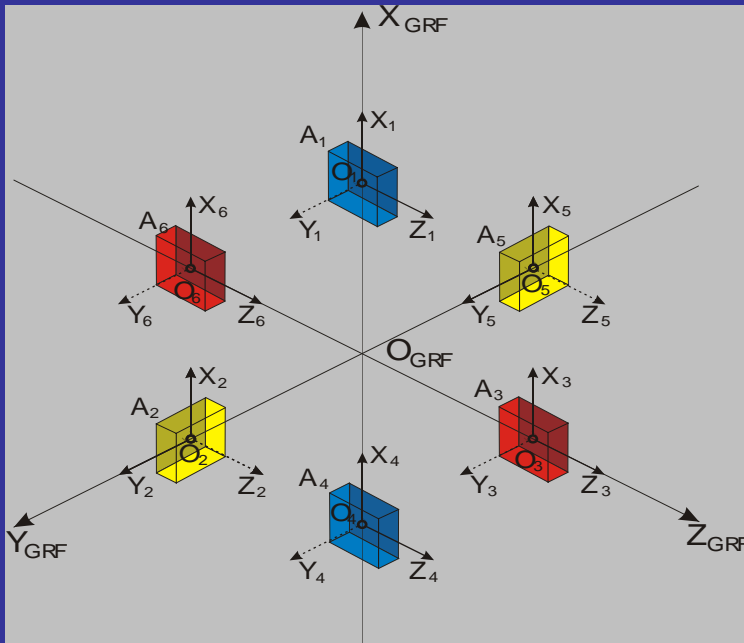


one axis gradiometer



three axes gradiometer consisting of 6 accelerometers

principle of GOCE-gradiometry



gravitational
tensor

centrifugal part
(angular velocities)

angular
accelerations

$$\begin{pmatrix} V_{xx} & V_{xy} & V_{xz} \\ V_{yx} & V_{yy} & V_{yz} \\ V_{zx} & V_{zy} & V_{zz} \end{pmatrix} + \begin{pmatrix} -\omega_y^2 - \omega_z^2 & \omega_x \omega_y & \omega_x \omega_z \\ \omega_y \omega_x & -\omega_z^2 - \omega_x^2 & \omega_y \omega_z \\ \omega_z \omega_x & \omega_z \omega_y & -\omega_x^2 - \omega_y^2 \end{pmatrix} + \begin{pmatrix} 0 & \dot{\omega}_z & -\dot{\omega}_y \\ -\dot{\omega}_z & 0 & \dot{\omega}_x \\ \dot{\omega}_y & -\dot{\omega}_x & 0 \end{pmatrix}$$

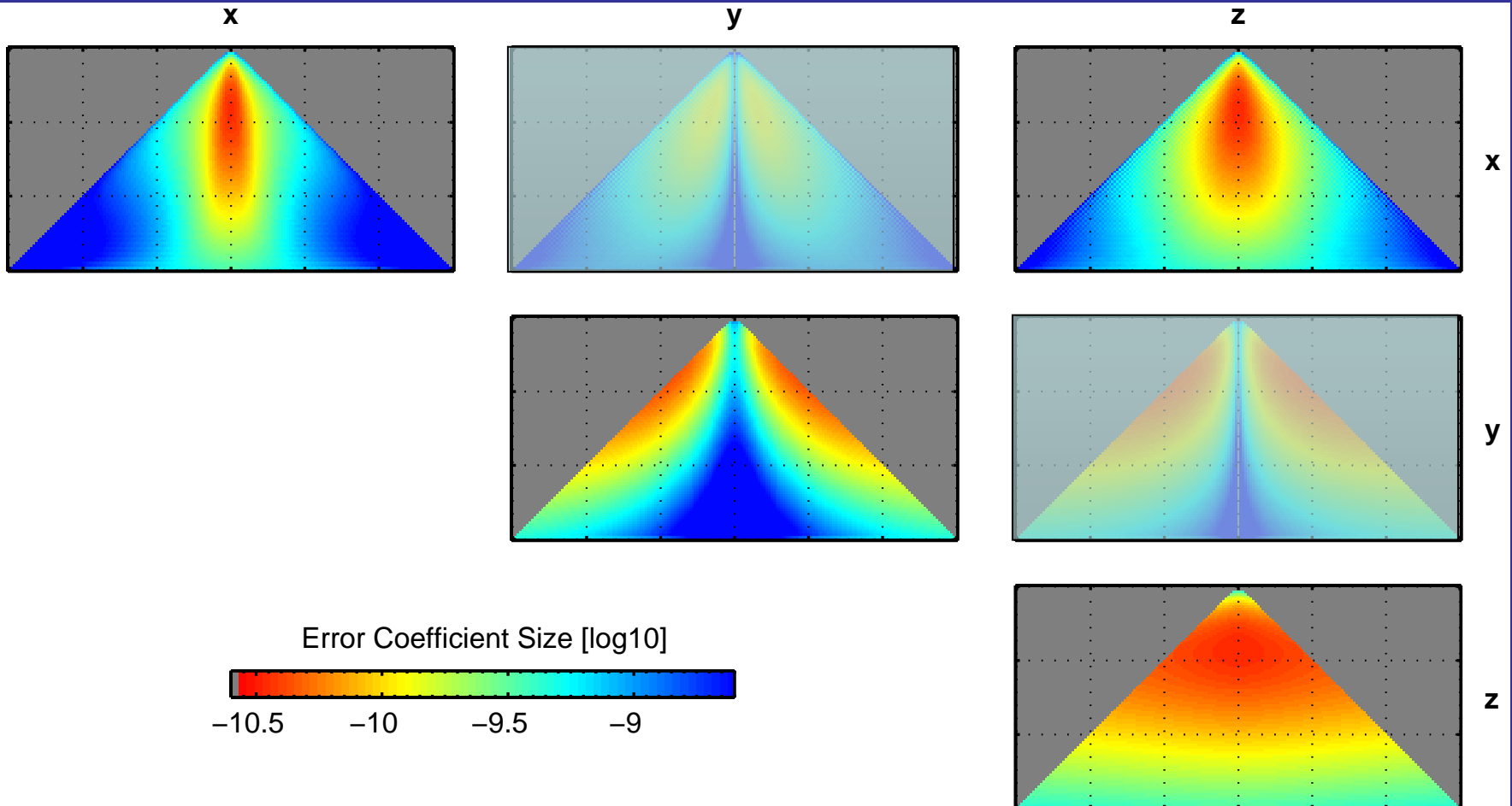
symmetric

symmetric

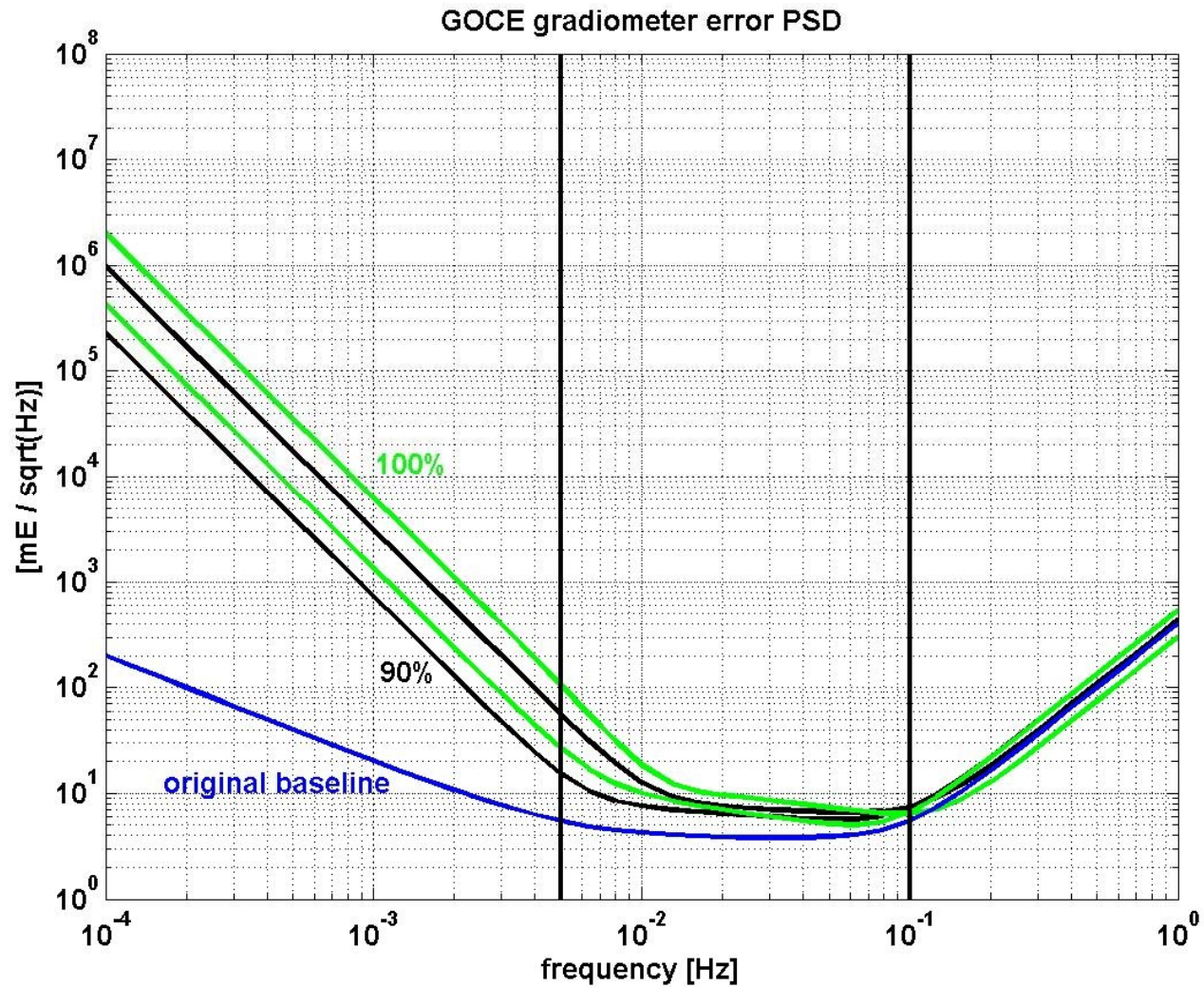
skew symmetric

principle of GOCE-gradiometry

error structure of the tensor components



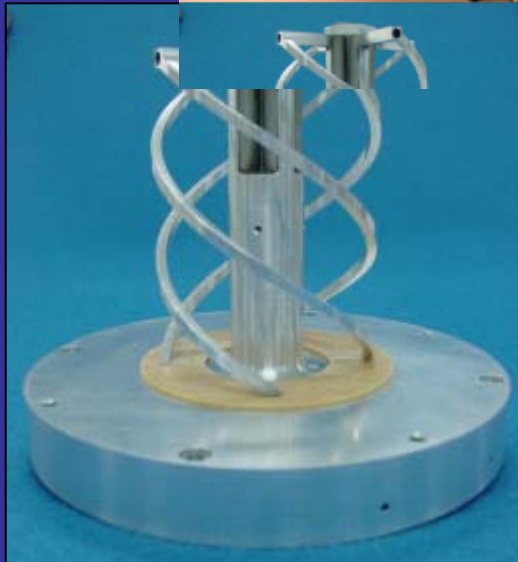
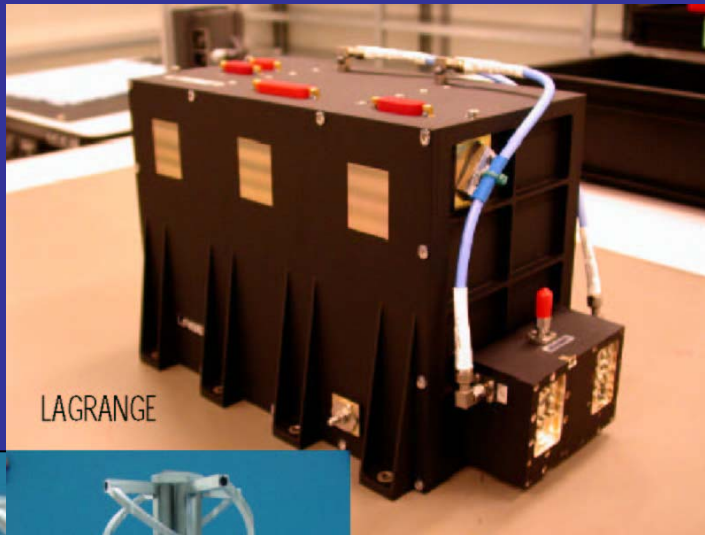
gradiometer measurement bandwidth (MBW)



GOCE sensor concept

orbit and gravity field determination

using GPS and SLR



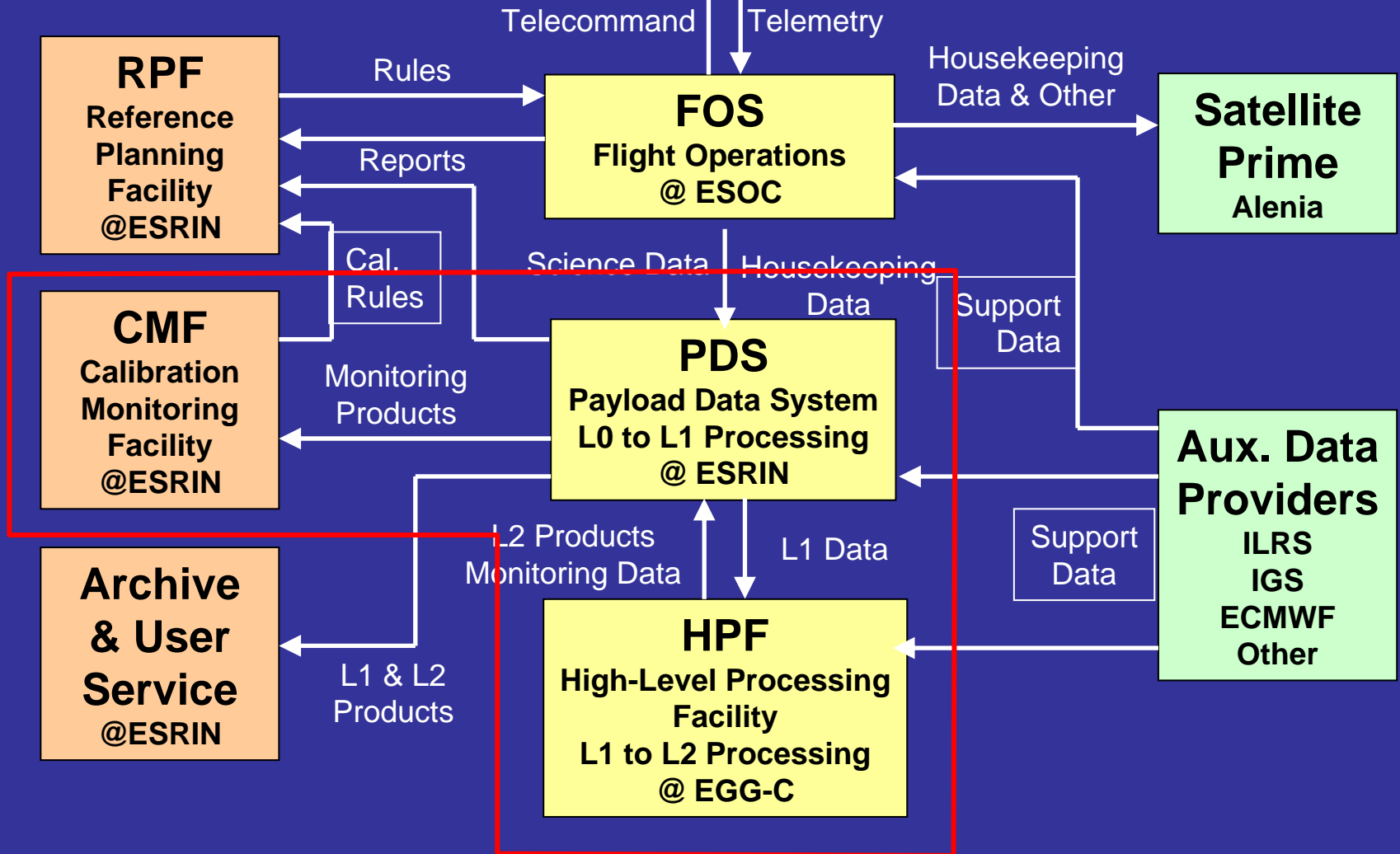
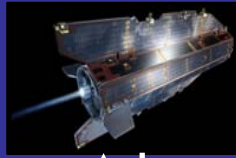
newly developed
European
GPS-receiver

laser
retro-
reflectors

GOCE sensor concept

1. First gravity gradiometer in space
2. Extremely low orbit (265 km)
3. Active (proportional) along track drag free control
4. Angular control
5. New material
6. Perfectly quiet environment

GOCE Ground Segment



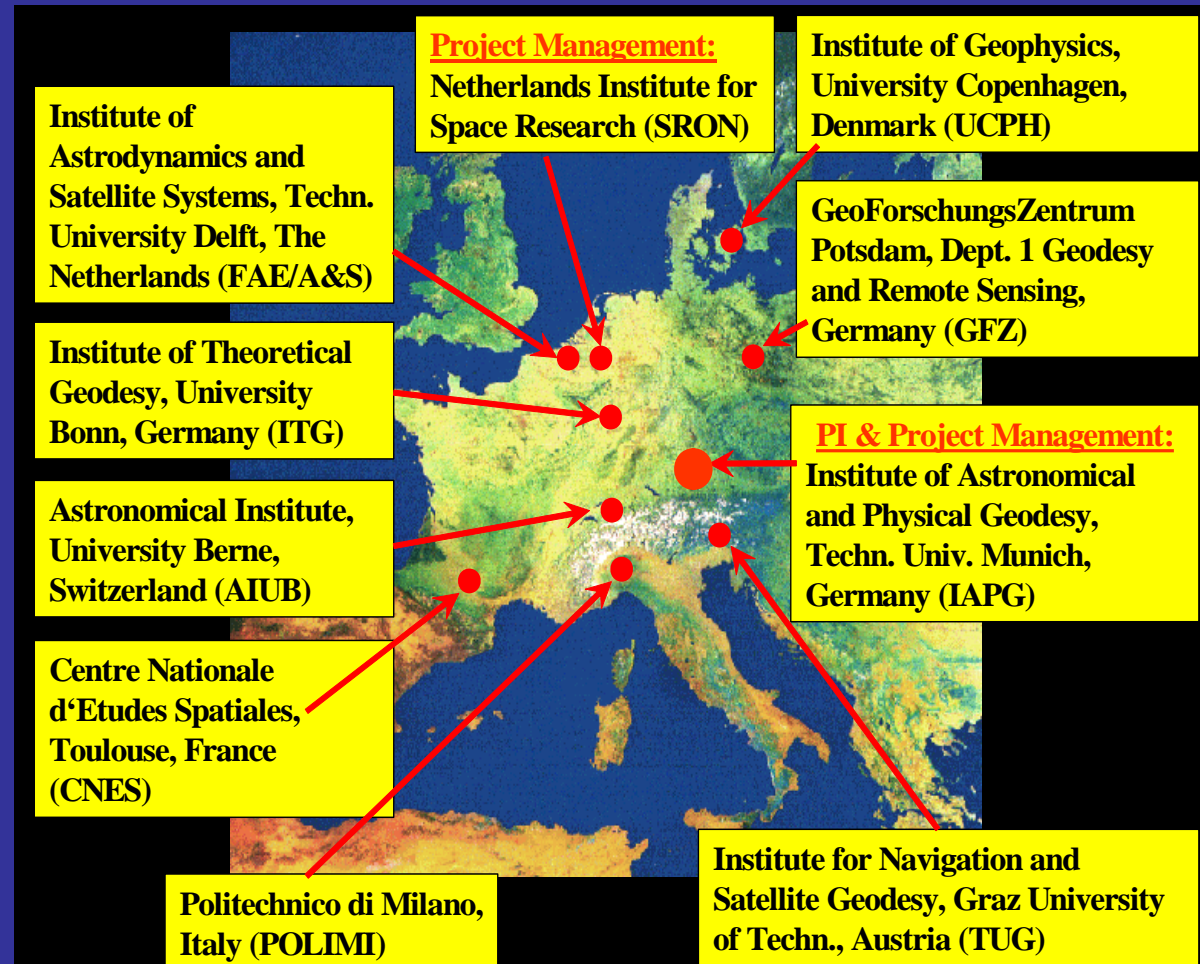
GOCE Ground Segment

Key Features

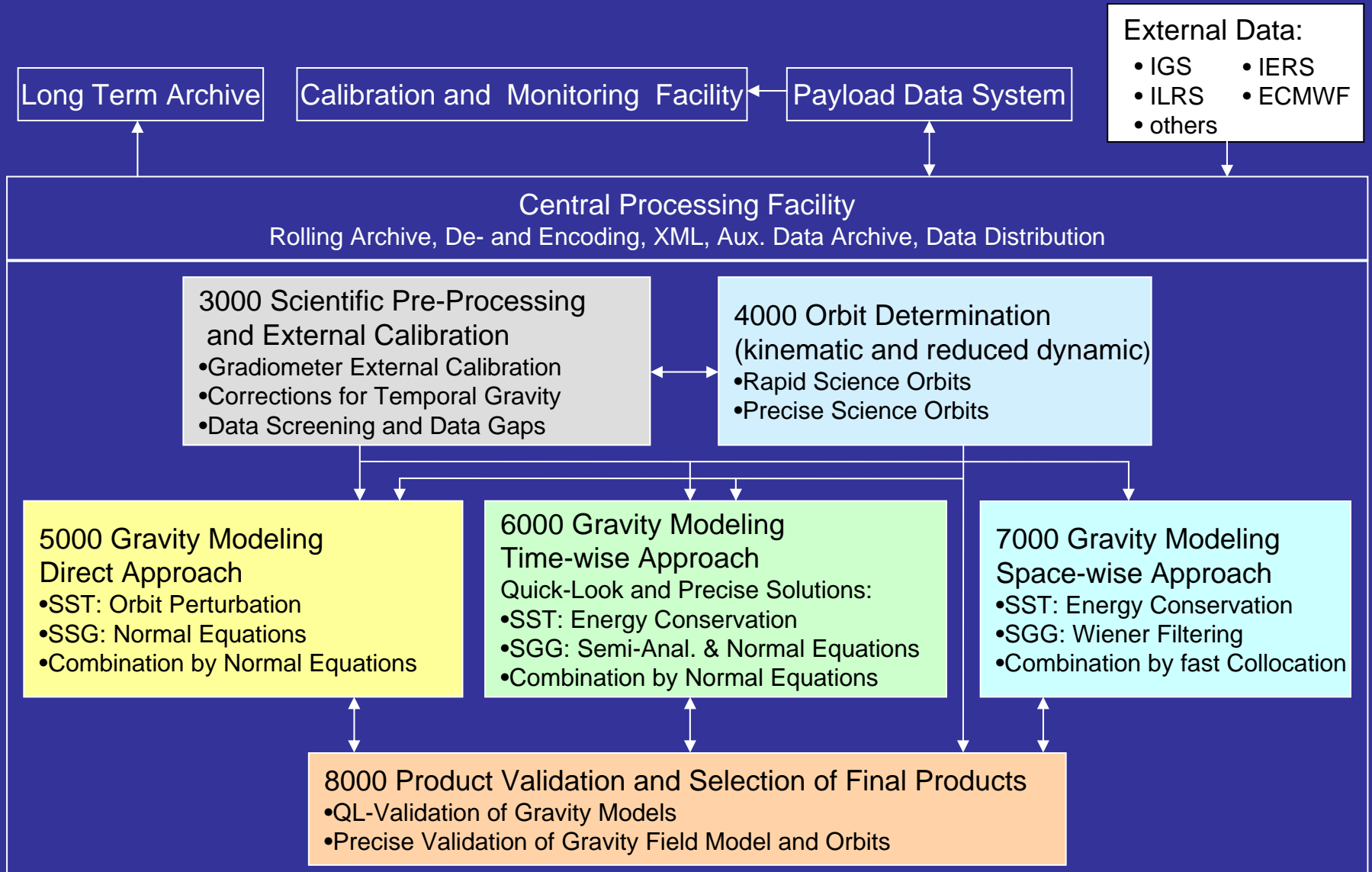


- development & operation by European GOCE Gravity Consortium (EGG-C)
- EGG-C is a group of European universities & institutes with complementary experience in gravity field research
- significant national & institutional support
- distributed system
- independent validation by overlap of expertise

High Level Processing Facility HPF



High-level Processing Facility



High-level Processing Facility

GOCE Level 2 Products

Identifier	Description
EGG_NOM_2	<ul style="list-style-type: none">• Externally calibrated and corrected gravity gradients in GRF (2 weeks latency)• Corrections to gravity gradients for temporal gravity variations• Flags for outliers, fill-in gravity gradients for data gaps with flags• Statistical information
EGG_TRF_2	<ul style="list-style-type: none">• Externally calibrated gravity gradients in Earth fixed reference frame including error estimates for transformed gradients• Transformation parameters to Earth fixed reference frame
SST_PSO_2	<ul style="list-style-type: none">• GOCE precise science orbits final product• Quality report for precise orbits
EGM_GOC_2	<ul style="list-style-type: none">• Final GOCE Earth gravity field model as spherical harmonic series including error estimates. Target: 1-2 cm / 1 mGal up to degree and order 200 corresponding to 100km spatial resolution.• Grids of geoid heights, gravity anomalies and geoid slopes computed from final GOCE Earth gravity field model including propagated error estimates• Quality report for final GOCE gravity field model
EGM_GVC_2	<ul style="list-style-type: none">• Variance-covariance matrix of final GOCE Earth gravity field model

High-level Processing Facility

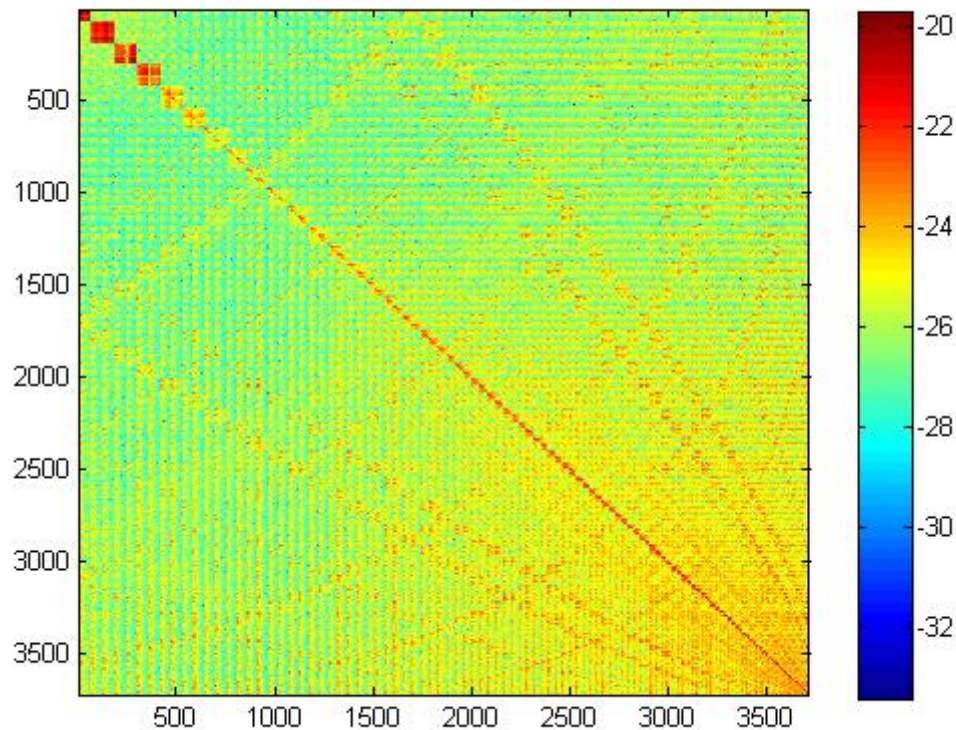
L2 Product Formats

all products available for users from PDGS archive in XML format.



Identifier	Format	Coverage	Resolution
EGG_NOM_2	GG format (timewise)	1 day	1 s
EGG_TRF_2	GG format (spacewise)	1 MOP	1 s
SST_PSO_2	SP3c	1 day	1 s (KN) / 10 s (RD)
EGM_GOC_2	ICGEM (SHC) GRID	1 MOP, Mission	Lmax
EGM_GVC_2	VCM format	1 MOP, Mission	Lmax

High-level Processing Facility

Example to EGM_GVC_2:
Variance-Covariance-Matrix up to $L_{\max}=60$




GOCE-HPF documents

		<p>GOCE Standards</p> <p>Doc. Nr: GO-TN-HPF-GS-0111 Issue: 3.0 Date: 05.08.2008 Page: 1 of 81</p>
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GOCE High Level Processing Facility

GOCE Standards

Doc. No.: GO-TN-HPF-GS-0111
Issue: 3
Revision: 0
Date: 05 / 08 / 2008




Prepared by: The European GOCE Gravity Consortium
EGG-C

		<p>GOCE Level 2 Product Data Handbook</p> <p>Doc. Nr: GO-MA-HPF-GS-0110 Issue: 4.0 Date: 09.06.2008 Page: 1 of 75</p>
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GOCE High Level Processing Facility

GOCE Level 2 Product Data Handbook

Doc. No.: GO-MA-HPF-GS-0110
Issue: 4
Revision: 0
Date: 09 / 06 / 2008



Prepared by: The European GOCE Gravity Consortium
EGG-C

GOCE status:

currently in commissioning phase

GPS receiver works fine

star tracker okay

ion thrusters perform well

all 6 accelerometers of gradiometer are healthy

first computed orbits look good

first PSDs from accelerometers look promising