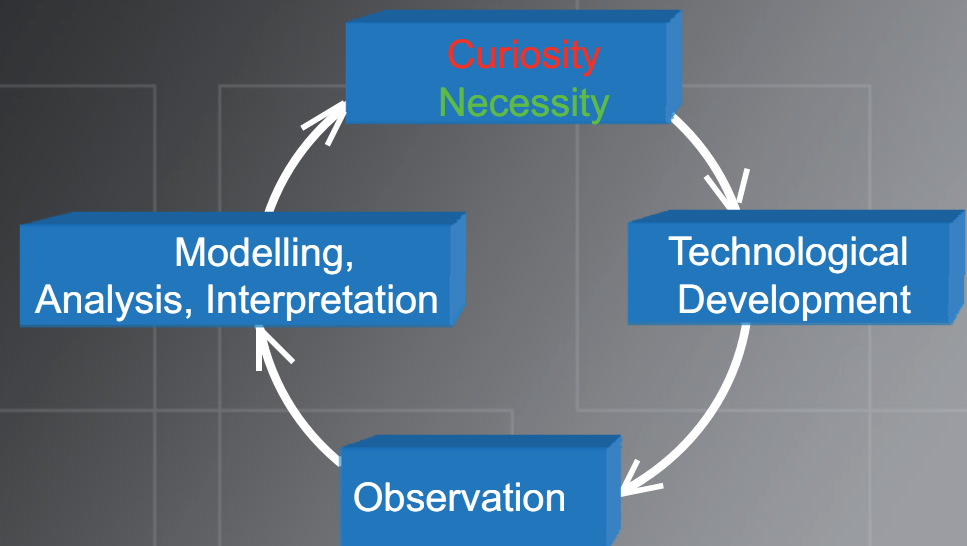


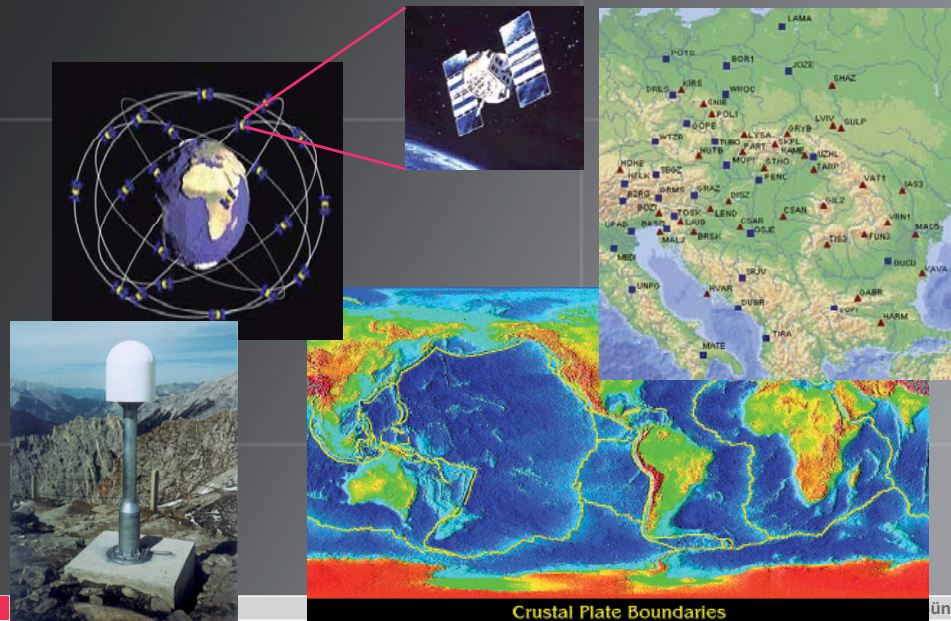
The Future of Surveying Education: Committed to Excellence

Hans Sünkel
TU Graz

Curiosity and Necessity



Earth Exploration / GPS for Geodynamics

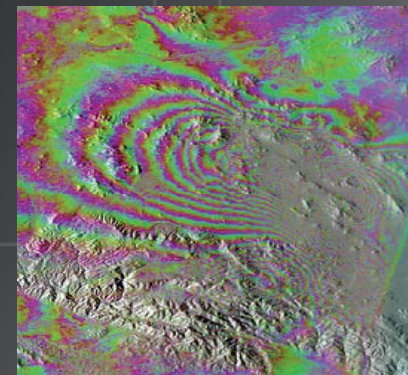


Crustal Plate Boundaries

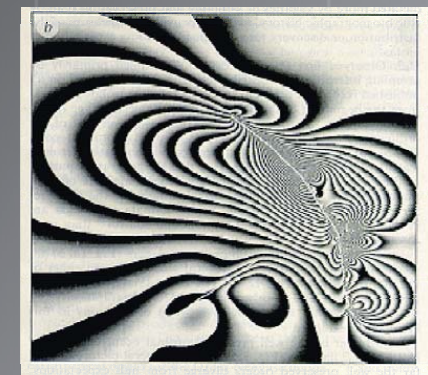
Earth Exploration / DINSAR

Monitoring of surface deformation
Loma Prieta Earthquake (M 7.1)

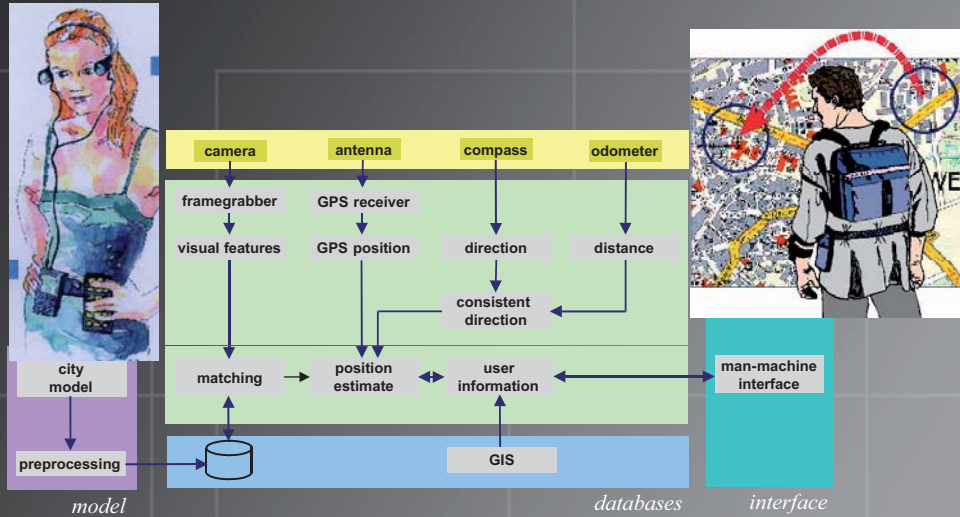
Reality



Model



Navigation for the Blind



Vienna, Feb. 26, 2009

FIG Commission 2 / Workshop

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GOCE Mission of ESA: 2009

Gravity Field and **S**tady-state
Ocean **C**irculation **E**xplorer



First Core Mission of ESA's
Earth Explorer Programme

Launch: March 16, 2009, 15:21

Vienna, Feb. 26, 2009

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GOCE Mission: SST-hl + SGG

GPS - Satellites

$$\lim_{\Delta x_j \rightarrow 0} \frac{V_i^{(2)} - V_i^{(1)}}{x_j^{(2)} - x_j^{(1)}} \approx \frac{\partial^2 V}{\partial x_i \partial x_j} = V_{ij}$$

SST - hl

SGG

GOCE
2009

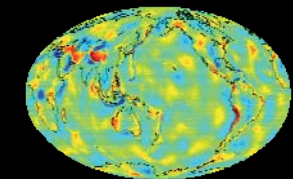
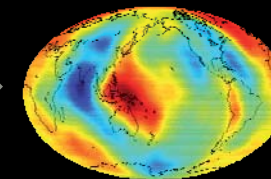
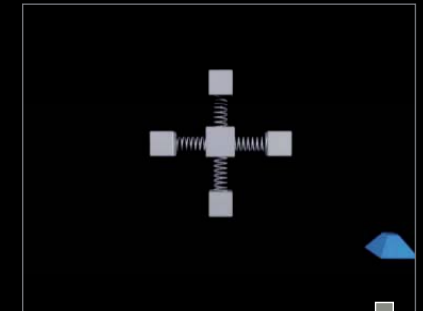


Vien

GOCE: SST-hl + SGG

SST-hl

SGG



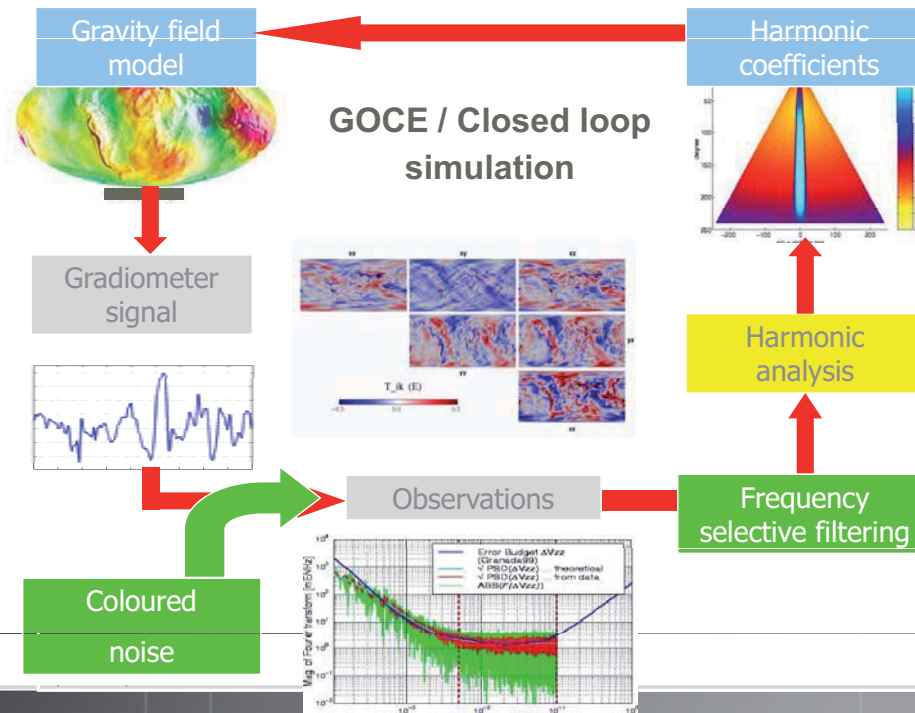
Vien

Satellite Laser Ranging

Satellite Observatory Graz - Lustbühel

Technologically leading:

- Very high accuracy (2 mm)
- Very high Data rate (2 kHz)
- Very high long-time stability
- Detection of satellite rotation possible



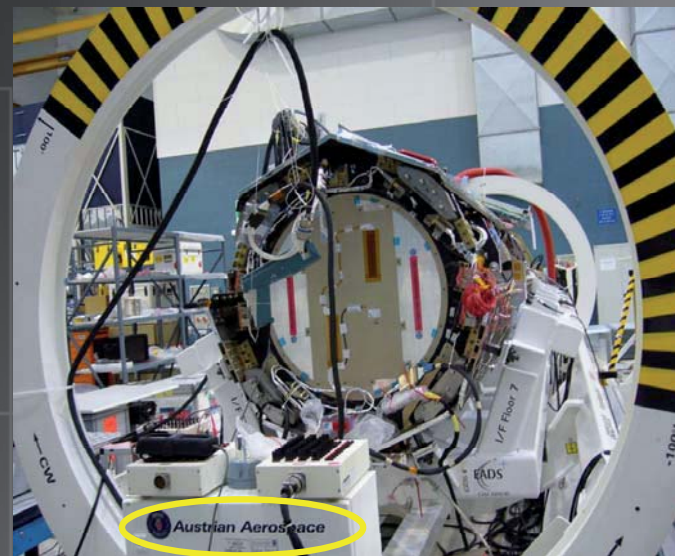
GOCE Mission

Spacecraft assembly at Alenia Spazio, Italy



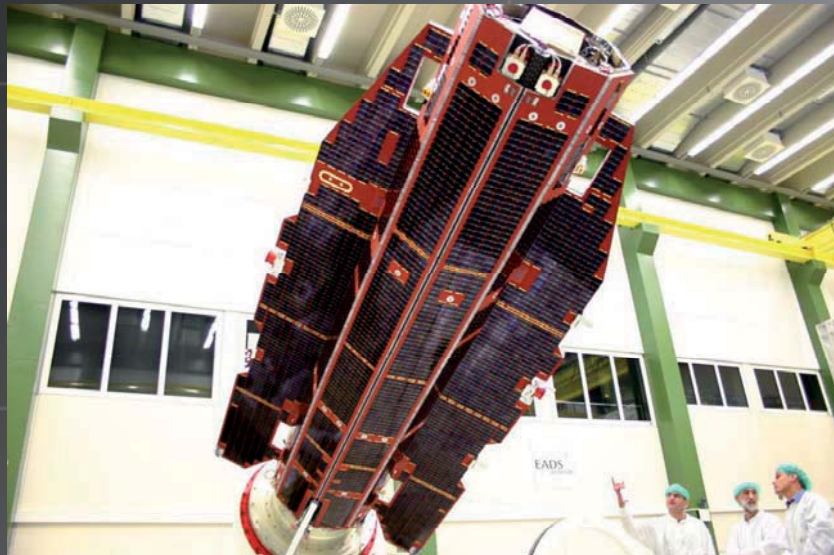
The GOCE Mission

Spacecraft assembly at Alenia Spazio, Italy



The GOCE Mission

Spacecraft assembly at Alenia Spazio, Italy



Vienna, Feb. 26, 2009

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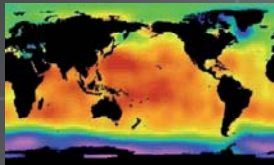
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GOCE Mission of ESA / Goals

Oceanography:

- Global Ocean circulation
- Ice mass development
- Sea level change
- Meteorology and Climate research



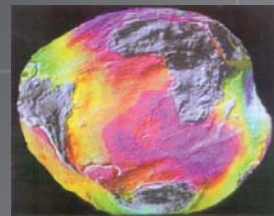
Geophysics:

- Improved models of the lithosphere and mantle
- Geodynamic processes (earthquakes, volcanism)



Geodesy:

- Precise global height reference system
- Navigation (GPS, Galileo)
- Satellite orbit prediction



100.000.000+ Data

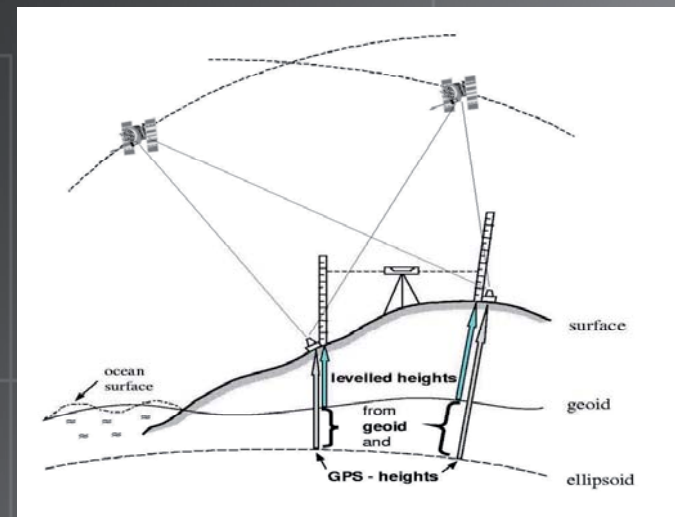
70.000 Parameters

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Surveying

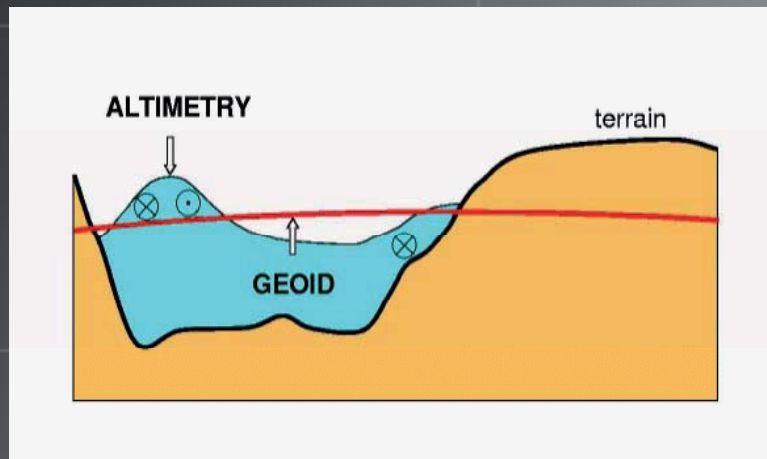


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Orthometric height: terrain and ocean surface



Dynamic ocean topography

Navier-Stokes equation

Steady - state flow: $\dot{u} = \dot{v} = 0$

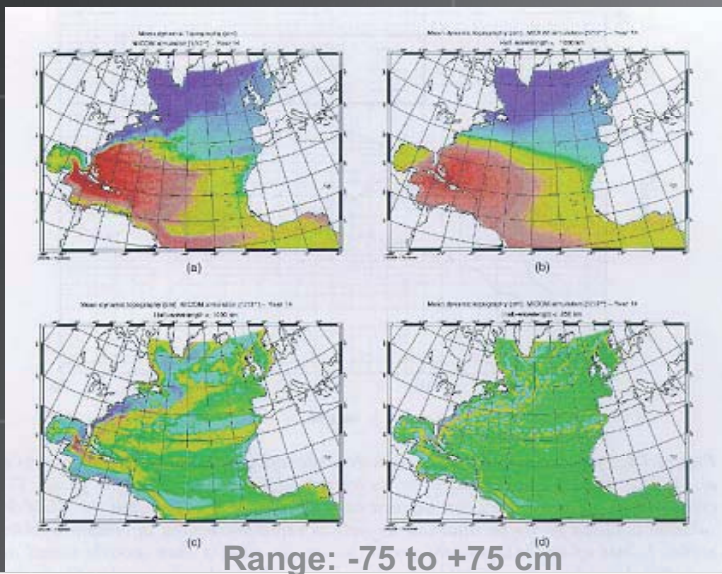
$$f u_s = -g \frac{\partial H}{\partial y}$$

$$f v_s = g \frac{\partial H}{\partial x}$$

- H ... Sea surface height (SSH) relative to geoid
- x, y ... Local cartesian coordinates (W-E, S-N)
- u, v ... Surface velocity (W-E, S-N)
- g ... Gravity
- f ... Coriolis term

Ocean topography signal

Signal



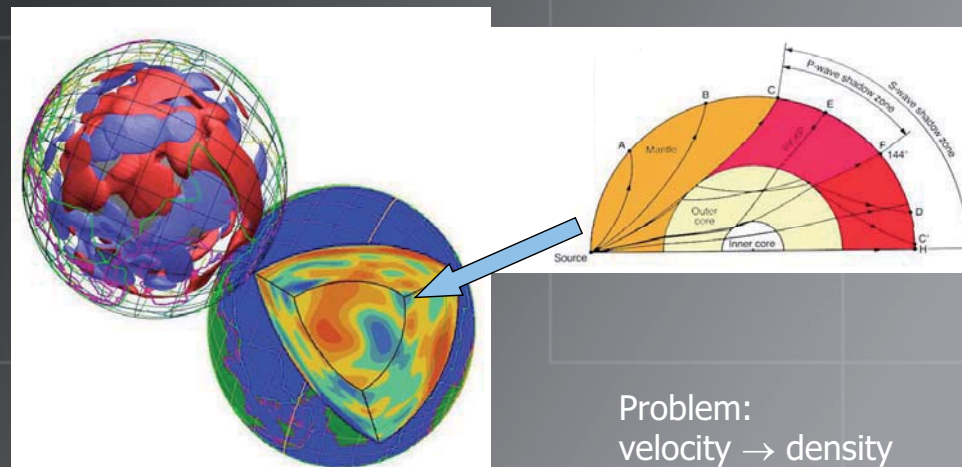
$l = 20$

$l = 200$

Range: -75 to +75 cm

Geotomography

Propagation of seismic waves



Problem:
velocity \rightarrow density

Research is an expedition

Complex problems

Global dimension



Intellectual freedom

Interdisciplinary cooperation

Internationality



Barcelona / Forum:

*"In a globalized world problems cannot be exported.
In a globalized world there is no outside.
In a globalized world everything is local."*



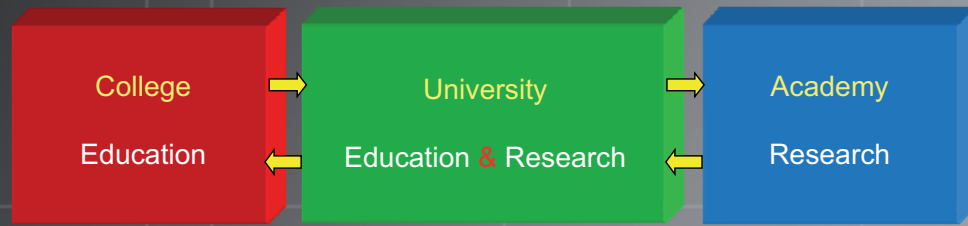
Education and Society

- A country with very high salaries must strive for a leading position at the top of the performance pyramid and not at its bottom
- Not just territories and natural resources are important, but people
- Global competition, also in research and education (USA, Europe, Far East)
- Employment market: reduced chances for people with low qualification, good options for top qualified people
- → Qualification, qualification and again, qualification

Educational cascade (1/2)

- Complementarity within the entire educational system
- Institutional cascade: output of a school becomes the input of the next higher school
- Requirement for clearly defined entry profile of supplying institution and receiving institution
- Universities have to define the entry requirements and not the providers of potential students!
- Information exchange between schools and universities
- No hurdles, but mutual support!

College - University - Academy



Educational cascade (2/2)

- Learning by playing at pre-school level
- Good basics at primary and high school level (best practice model: South Korea)
- Excellent education at universities
- No successful career without mobility in space and time + intellectual mobility
- Worktime flexibility
- Consistent life long learning

Implications

Our academic mission

Important node as part of the international scientific research and educational network
 Responsibility for the development of our society, economy and environment

Goals

- Securing and expanding the national and international competitive strength
- Development of core competences at highest international level („profile building“)
- Brain gain: appointment of the best possible scientists

Sustainability of Knowledge

Knowledge types Decay time (yrs)

School	20
University	10
Job	5
Technology	3
ICT	2

Sustainable University

- Long-lasting knowledge in a fast spinning world
- Sustainability of education and research
- Education and research with same priority
- Curiosity-driven fundamental research, necessity-driven applied research
- Trial and error
- Failures must be tolerated at a university
- No permanent demand for „Return on Investment“
- A university as an academic educational institution of highest level must also give home to different opinions

Think globally, act locally

Problems: global

- Cooperation across national boundaries
- Importance of international organizations such as FIG, IAG, ISPRS et al.
- Cooperation with industry
- Exchange of students and professors

Problems: complex

- Cooperation across educational and professional boundaries
- Sensor fusion – data fusion – expert fusion
- Scientific platform of mutual understanding
- Think globally, act locally

FIELDS OF EXPERTISE SUPPORTED BY A STRONG SCIENTIFIC PLATFORM



Fields of expertise

3 criteria:

- ? Competence and critical mass
- ? Future perspectives
- ? Available funds

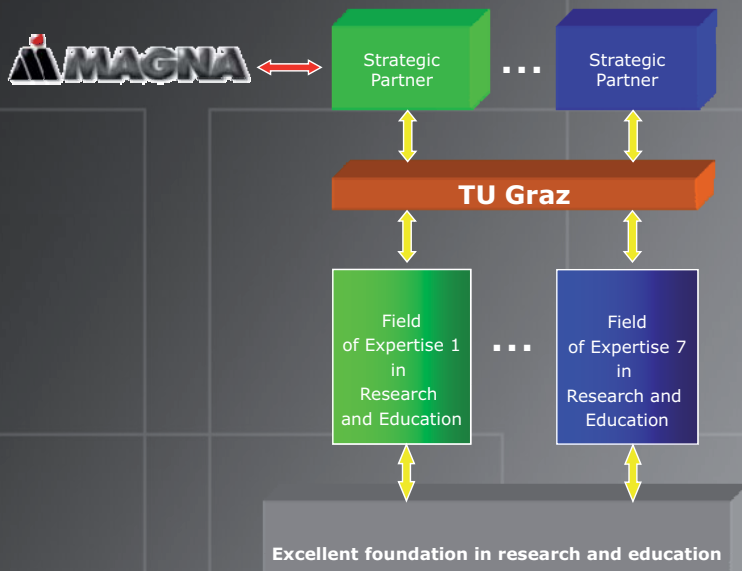
Sustainable platform:

scientific
broad and stable
top quality

Profile building at TU Graz 7 Fields of Expertise (FoE)

- 1 Human- and Biotechnology
- 2 Transportation Science
- 3 Advanced Materials Science
- 4 Sustainable Systems
- 5 ICT and Scientific Computing
- 6 Design and Construction Science
- 7 Production Science and Management

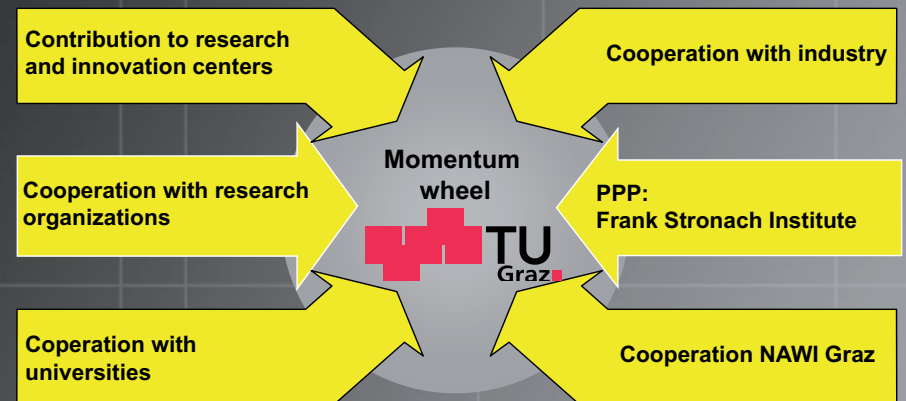
Fields of Expertise and Strategic Partners

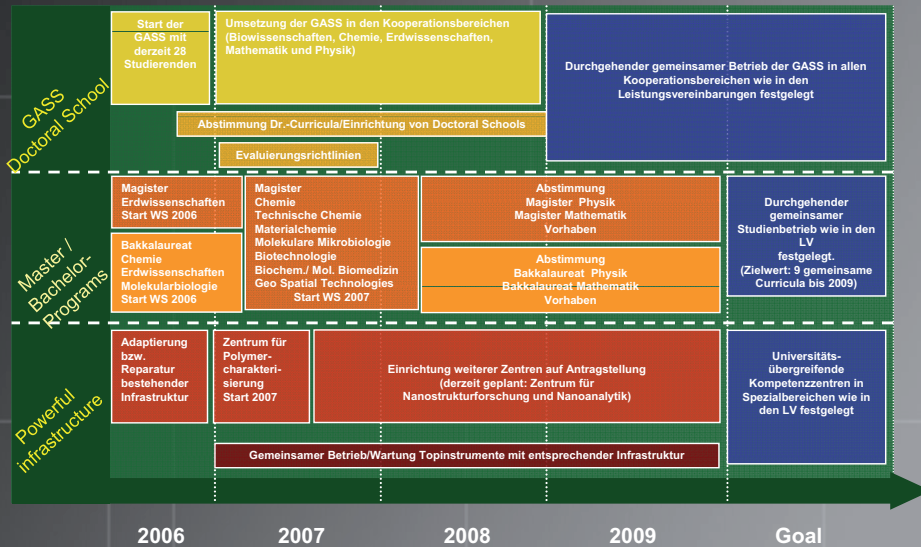


Cooperation

Embedding into a national and international research network

Cooperation with universities, non-university research organizations and industry





University cooperation



Implications for Surveying Education

Geodesy, Surveying, Remote Sensing, Geoinformatics

- Natural sciences + informatics + geoinformatics + economics as natural building blocks
- Applied mathematics and numerics
- Optimization theory
- Estimation theory
- Filtering
- Inverse problems
- Visualization
- Virtual reality
- Solution of super-large systems of equations
- Parallel processing techniques

Geodesy, Surveying, Remote Sensing, Geoinformatics

- Top level teaching
- Focus on core subjects
- Interdisciplinary projects
- Language skills
- English as teaching language
- Soft skills
- Joint study programs
- Speed wins: short study times

Excellence – General Attributes

- Intelligence
- Performance
- The art to drink from a hydrant
- Learning ability
- Flexibility
- Mobility
- Language competence
- Social competence
- Tolerance

Excellence – Educational Attributes

- Strong educational background and broad intellectual horizon combined
- Strong scientific basis
- Excellent proficiency
- Mastering of methods
- Communication ability
- Presentation ability
- Decision ability
- Negotiation ability

Racing Team of TU Graz

GRAZER BOLIDE BRICHT WELTREKORD



Neue Rekorde. Extrem erfolgreich war die Teilnahme des Grazer Tankia-Teams am internationalen Formula-Student-Wettbewerb im englischen Bruntingthorpe. Die Studenten der Technischen Universität Graz wurden nur ganz knapp Zweiter hinter dem kanadischen Team. Sie errangen zudem in sieben Einzelka-

tegorien Pokale und stellten einen neuen Beschleunigungs-Weltrekord (75 Meter in 3,97 Sekunden vom Stand aus) auf. Das Team existiert erst seit drei Jahren und feierte heuer schon tolle Erfolge in Deutschland und Italien. Fast der gesamte steirische Autocluster sponsert diese Aktivitäten



TUGSAT-1 / Brite Target Explorer

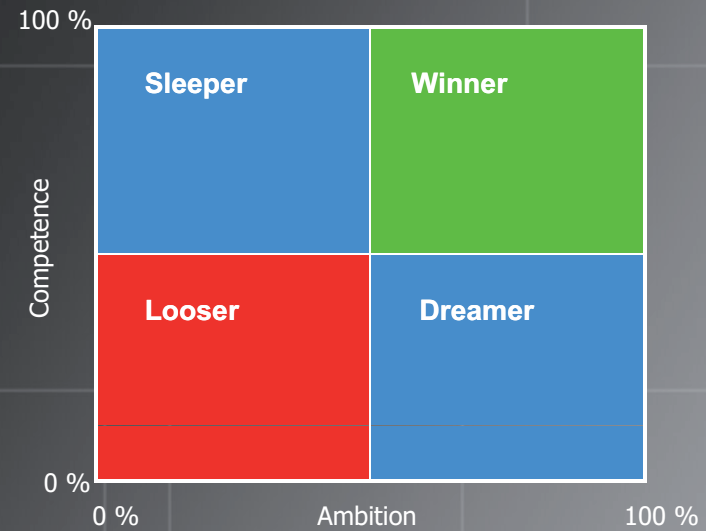
First Austrian Satellite

Mass: 6,5 kg

- Goal:
Investigation of bright stars by means of a precise star camera
- Opens up a new dimension for astronomy without atmospheric noise due to the Earth's atmosphere using inexpensive instruments
- Launch: late 2009 (planned)
- Launch site: India



Ambition and Competence



C³redo

Competence

Competition

Cooperation