Europa Laser Altimeter

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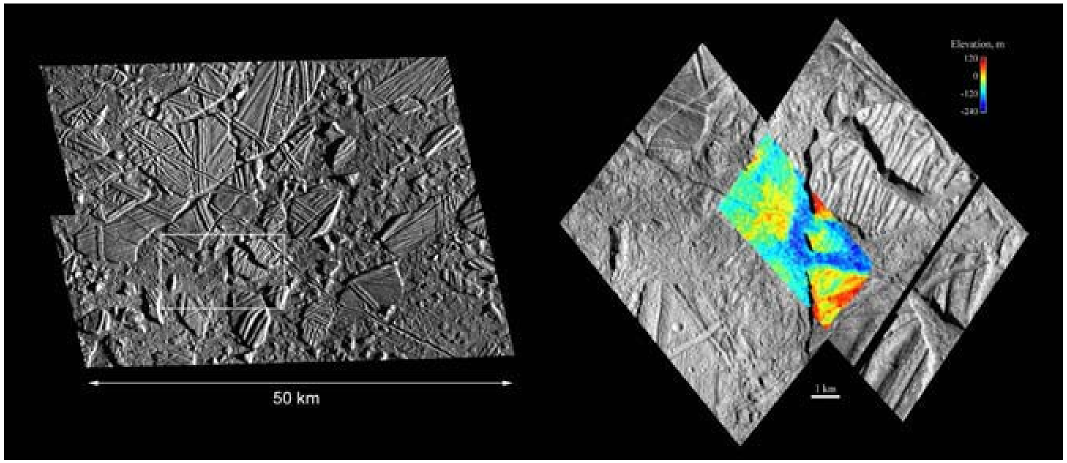
DLR

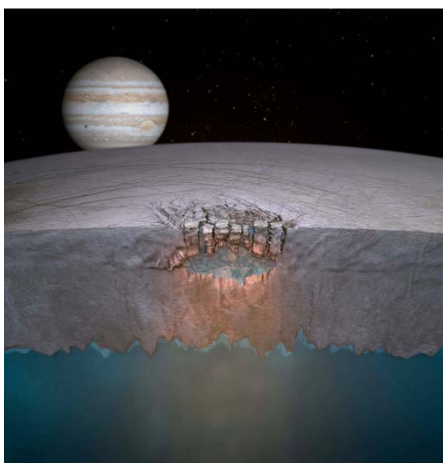
Science cases

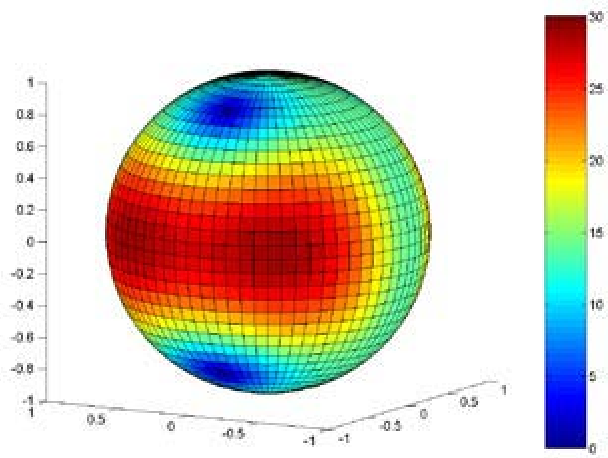
Geology



Conamara Chaos as an example of chaotic terrain on Europa (digital elevation model derived by Giese et al.). Ice blocks are broken apart, shifted, rotated, and tilted within the matrix material which appears to be at different topographical levels. Laser altimetry can measure the elevation and slope along the spacecraft ground track.

Geophysics





Laser altimetry data reveal periodic signatures in topography. Surface deformations are an order of magnitude larger in the presence of a global subsurface ocean. The measurement of these deformations can constrain the thickness, rigidity and dissipation of the ice shell.

Science cases II

1. Global and regional topography (DTM)
    - Vertical resolution of 10 cm
    - Horizontal resolution between 25 km in the equatorial regions up to several tens of meters at the poles.

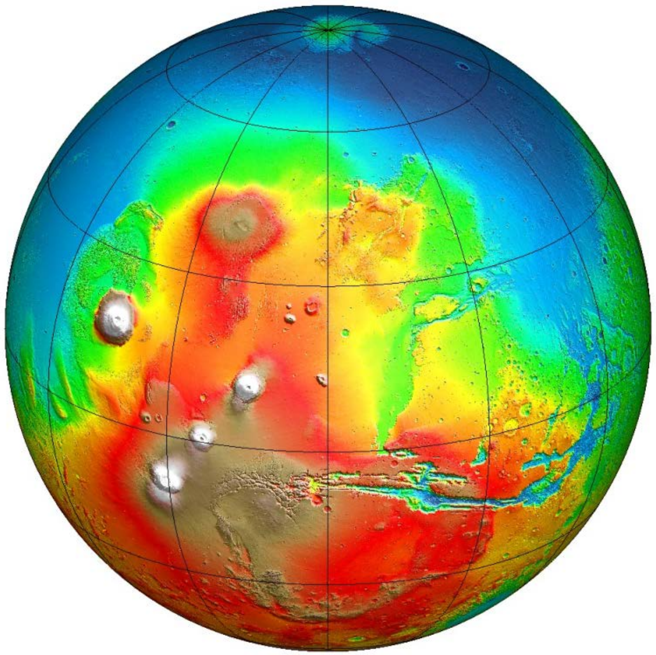
2. Constraining Europa‘s ice shell thickness to < 5km
    - Determination of h2 with accuracy < 1% and phase-lag < 1°
    - Distinguish conducting vs. convecting ice shell
    - Measure tidal dissipation
    - Distinguish between dissipating silicate layer and dissipating ice shell
    - Constraining the rheologic properties of the ice shell

3. Provide a geodetic reference frame
    - Measurement of Europa‘s spin axis orientation
    - Dermination of rotation rate and librations

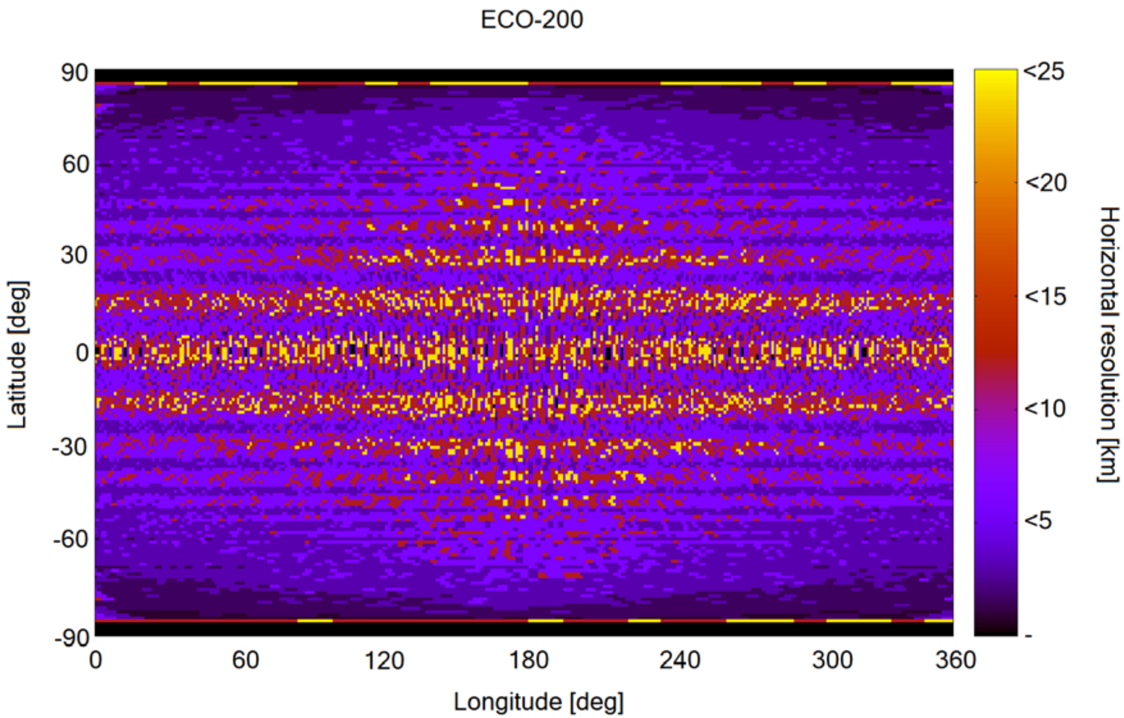
4. Global slope, roughness and albedo map
    - Slopes from spot to spot (scale of tens-hundreds of meters)
    - Small scale roughness at footprint size (few tens of meters)
    - Global albedo map at laser wavelength (1064 nm)

Science Return 1): Global Topography

Global topographic coverage with horizontal resolution between 25 km in the equatorial regions up to several tens of meters at the poles.



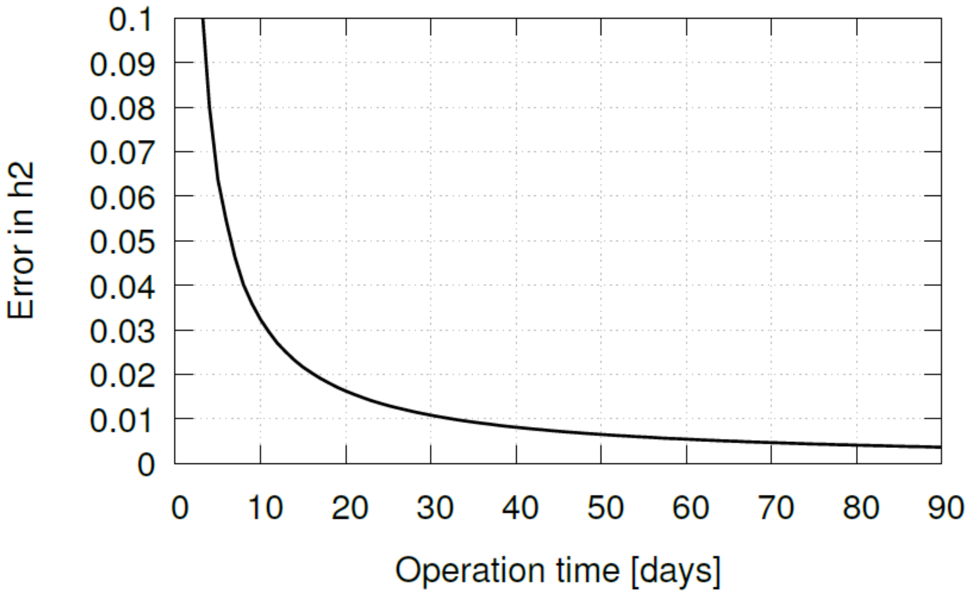
Example of a laser derived global DTM Mars by MOLA (Smith et al. xxxx)

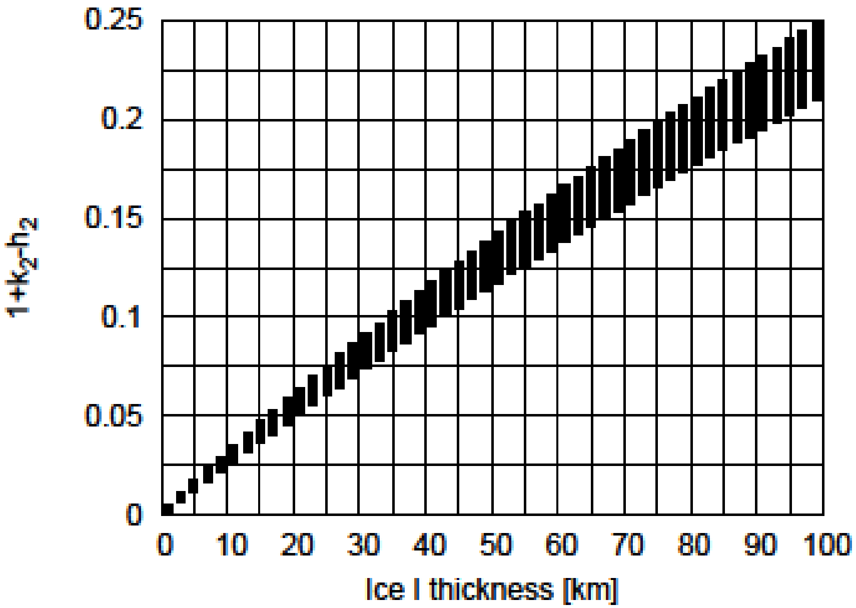


Horizontal DTM resolution assuming a 200 km orbit around for Europa and an operation time of 3 months. The horizontal resolution is constrained by the distance between the ground tracks.

Science Return 2): Europa's ice shell thickness

800,000 cross-over during an operational time of 3 months (assuming continuous operation).
Tidal Love number h2 with an accuracy of < 1% assuming 50 m orbit error
Constraining the ice thickness < 5 km (for thin shells and assuming a k2 measurement)



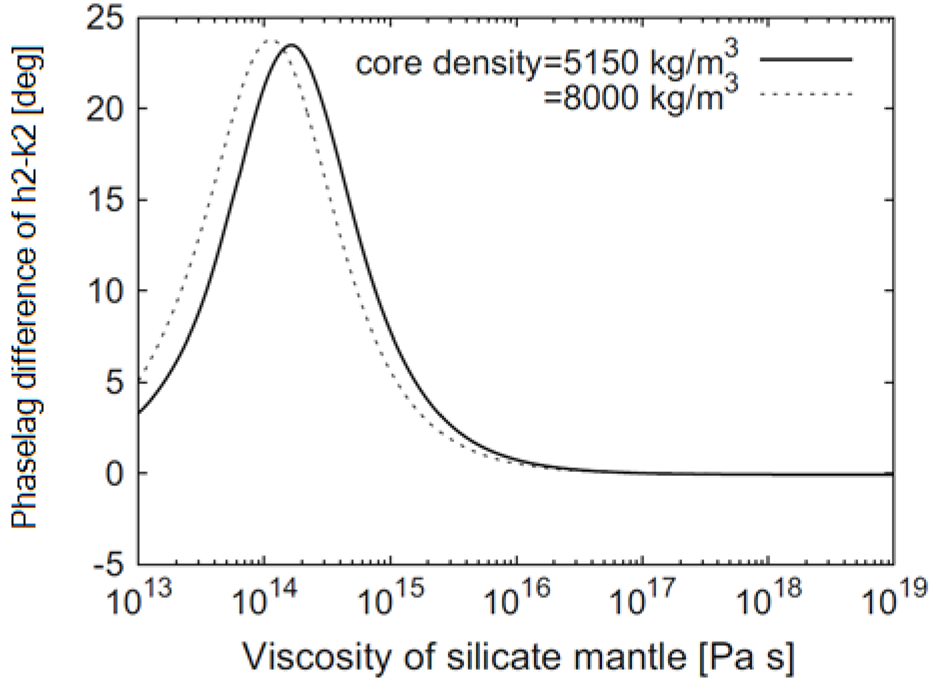


(Steinbrügge et al. 2016, in review)

Science Return 2): Europa‘s tidal dissipation

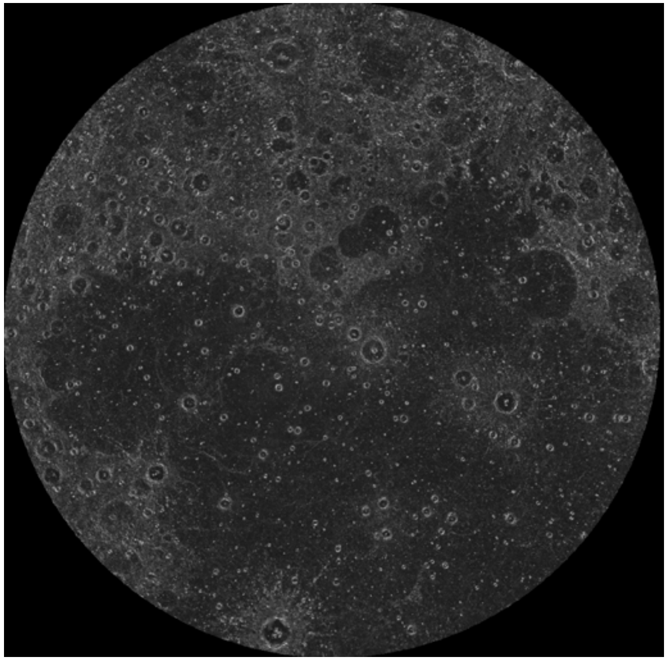
Phaselag can be measured with an accuracy of about 1° (assuming full operation over 3 months) can be used to:

- Constrain rheology of the ice shell,
- Measure tidal dissipation,
- But also, when measured with k2 lag, to distinguish between dissipating ice & silicate shell.

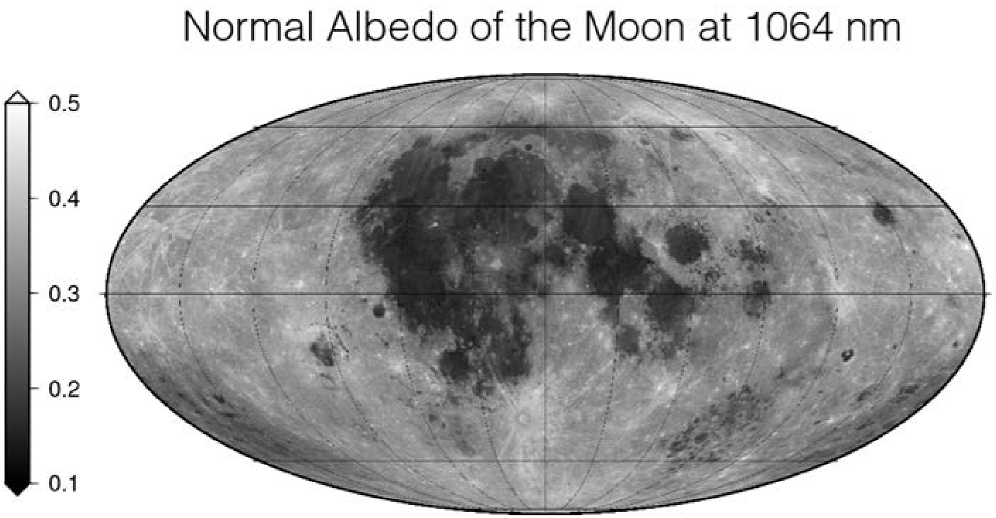


(Hussmann et al. 2016)

Science Return 3): Slopes and Albedo



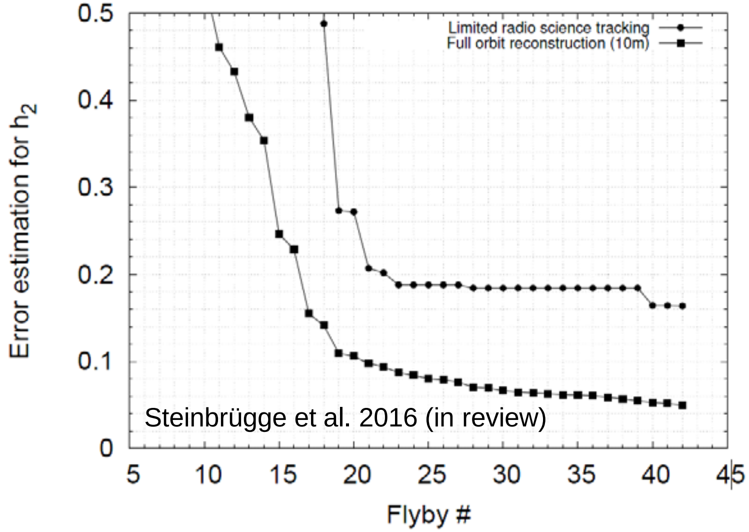
Slopes on Mercury‘s North pole
(> 80° latitude) derived from MLA laser tracks.

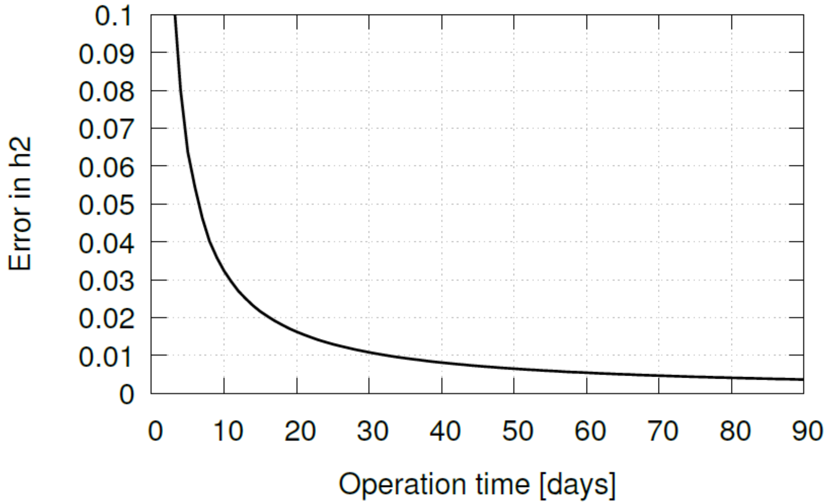


Normal albedo of the Moon at laser wavelength derived from LOLA laser tracks (Smith et al. 2016).

Relation to Europa Clipper

Synergies:

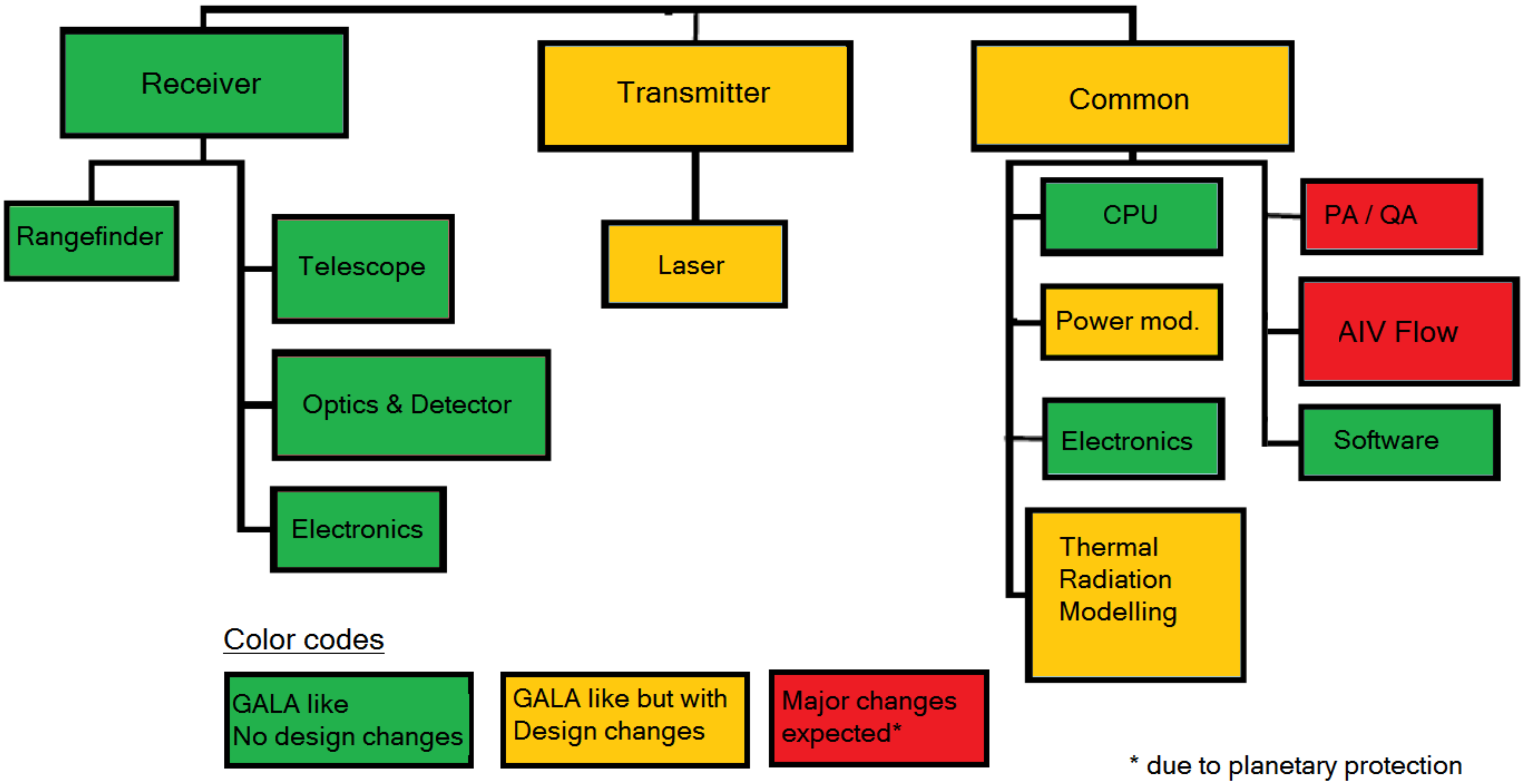




- The Clipper would allow to constrain the ice thickness to +/- 20 km. Orbiter could determine the thickness with +/- 5 km and **distinguish a thick (convecting) from a thin (conducting) ice shell**.
- Phaselag can constrain the **ice rheology** and measure **tidal dissipation**.
- Global DTM is **complementary** to EIS stereo images in terms of **day / night** or **equatorial / polar** data sets.
- Due to the polar orbit one would get a better global coverage, addressing the **global shape** and **hydrostatic equilibrium** of Europa.

Instrument

GALA like instrument to comply with tight schedule, i.e. keep main electronic components and receiver system.



Instrument budgets

Main parameters are chosen as for GALA. Main change is the laser energy to account for the lower orbit and Europa‘s higher mean albedo. However, we expect a high mass budget due to shielding requirements.

Parameter	Value	GALA
Laser energy	3 mJ	17 mJ
Shot frequency	30 Hz	30 Hz
Pulsewidth	5.5 ns	5.5 ns
Telescope radius	12.5 cm	12.5 cm
Bandwidth	100 MHz	100 MHz
Quantum efficiency	0.36	0.36

Ressource	Value
Power operation	~ 40 W
Power non-operation	~ 5 W
Instrument mass	~ 16 kg
Shielding mass*	**~ 12 kg**
Volume	~ 0.08 m^3

* Shielding mass assumes 2.5yr Jovian phase including 120 d Europa circular 200 km orbit