



ONERA contribution to GRACE-FO accelerometers post processing

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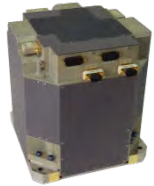
r e t u r n o n i n n o v a t i o n

Status of GRACE-FO accelerometer

ACC PFM2
On Sat FM1



ACC PFM1
On Sat FM2



Thermal Vacuum test



EMC test



Acoustic Noise test

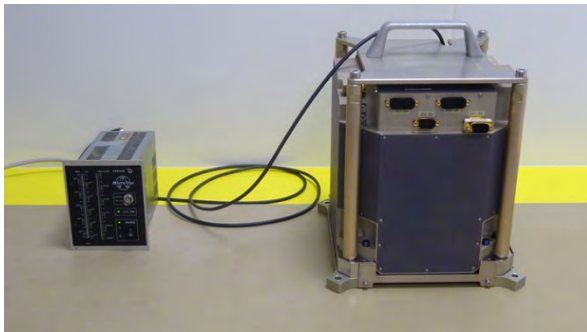


Shock test



Ready for Pre-ship Review

Spare Model in clean room at ONERA



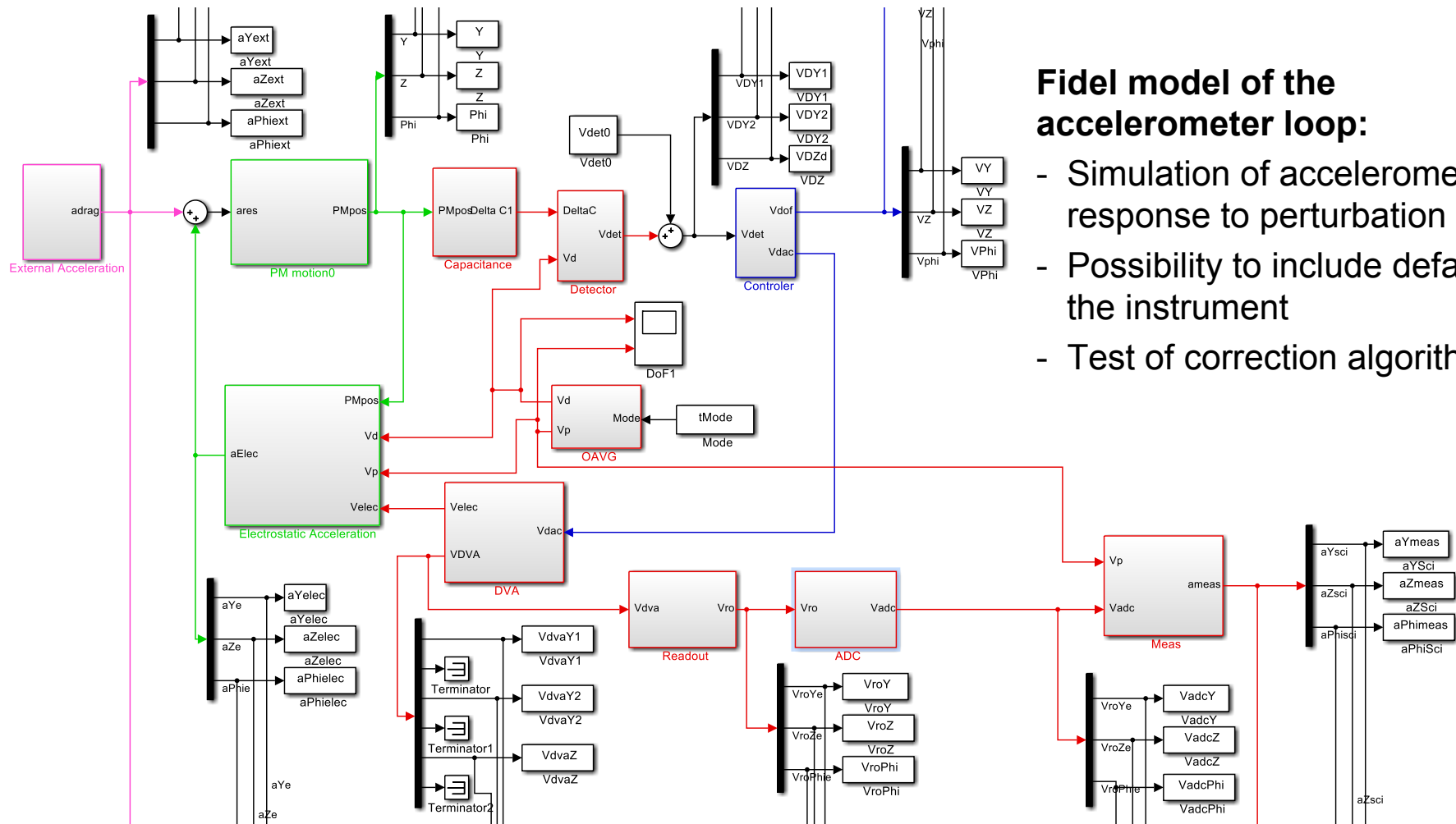
Ready for delivery

ONERA accelerometer team can help the flight data post-processing

1. Knowledge and tool for accelerometer behavior
2. Experience from MICROSCOPE Scientific Mission Center

GRACE-FO Accelerometer simulation (1/2)

Simulink model of the accelerometer

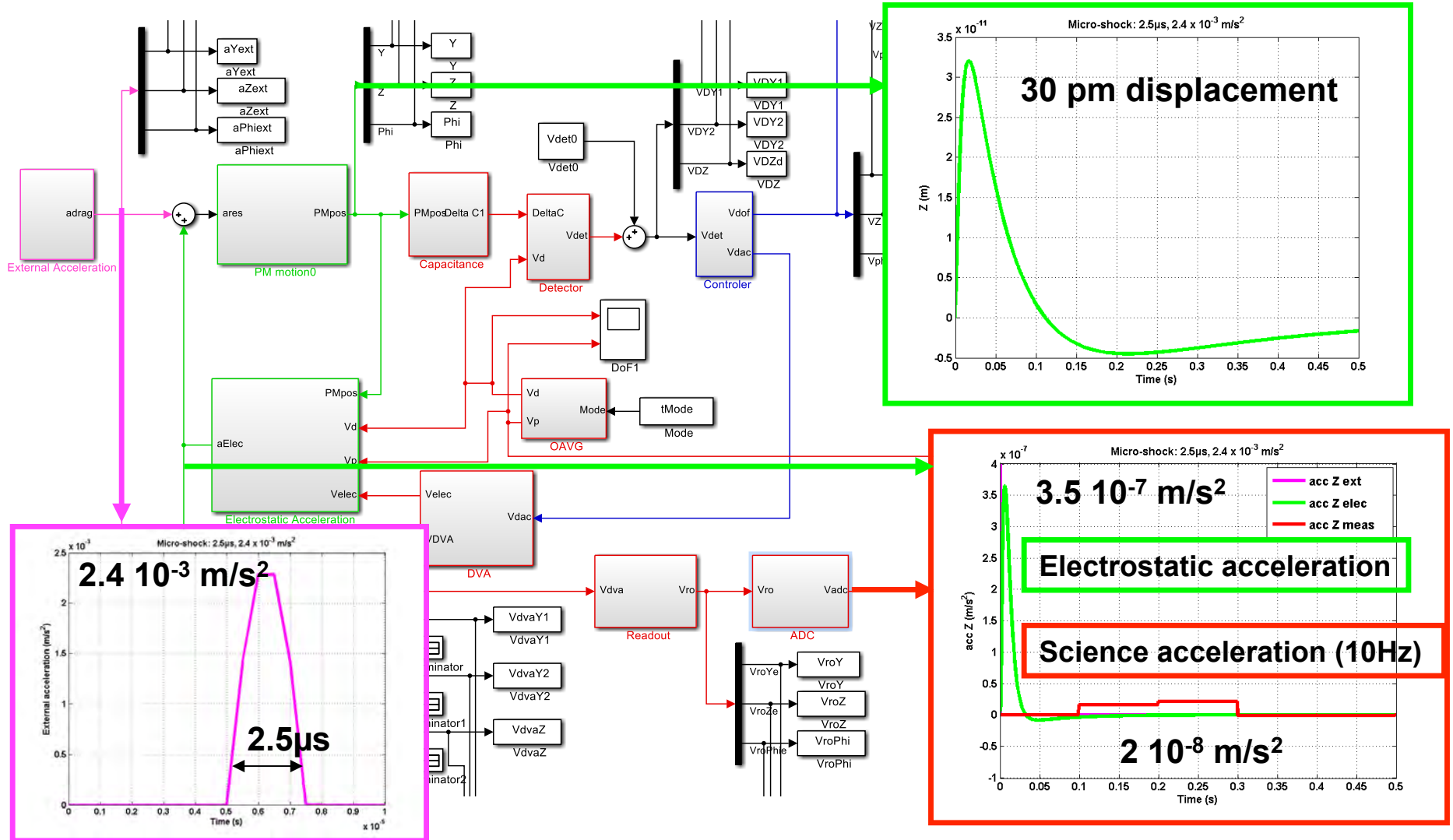


Fidel model of the accelerometer loop:

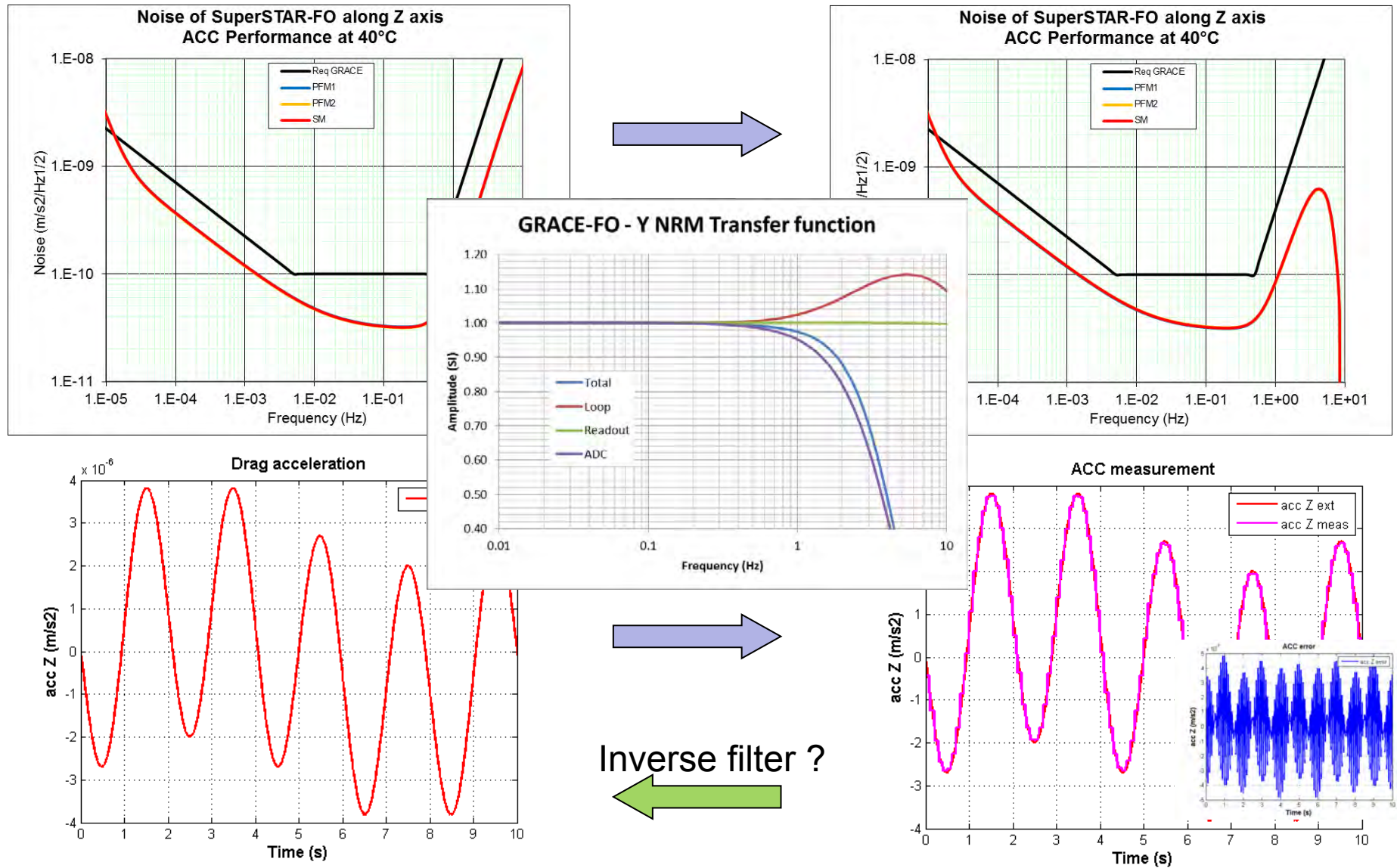
- Simulation of accelerometer response to perturbation
- Possibility to include default of the instrument
- Test of correction algorithm

GRACE-FO Accelerometer simulation (2/2)

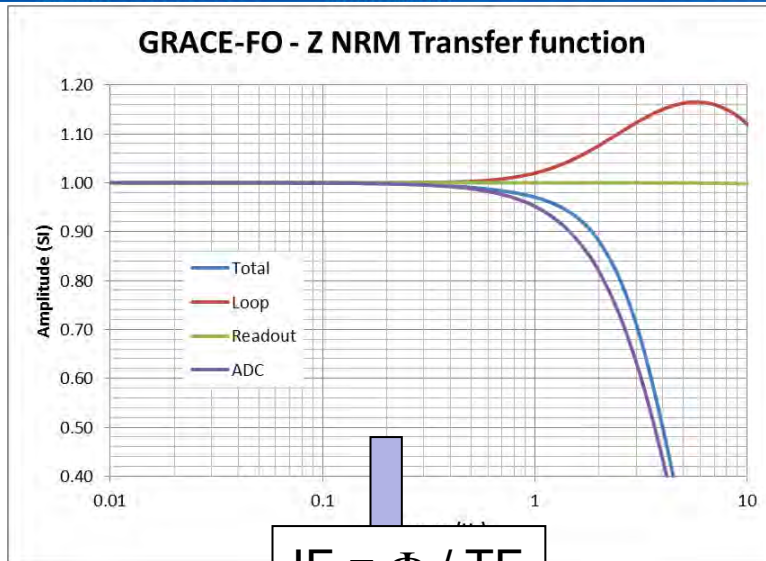
Response to shock acceleration ($2,5\mu\text{s}$, $2,4 \cdot 10^{-3} \text{ m/s}^2$)



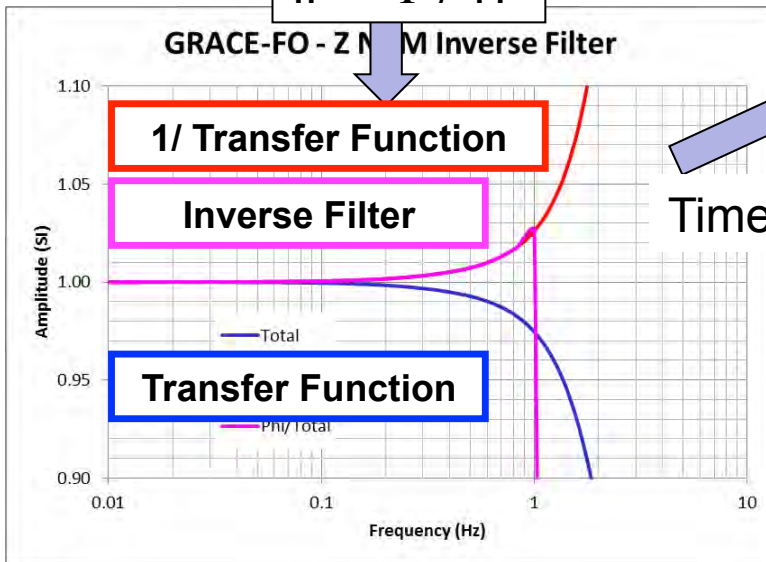
Accelerometer transfer function



Accelerometer Inverse Transfer Function

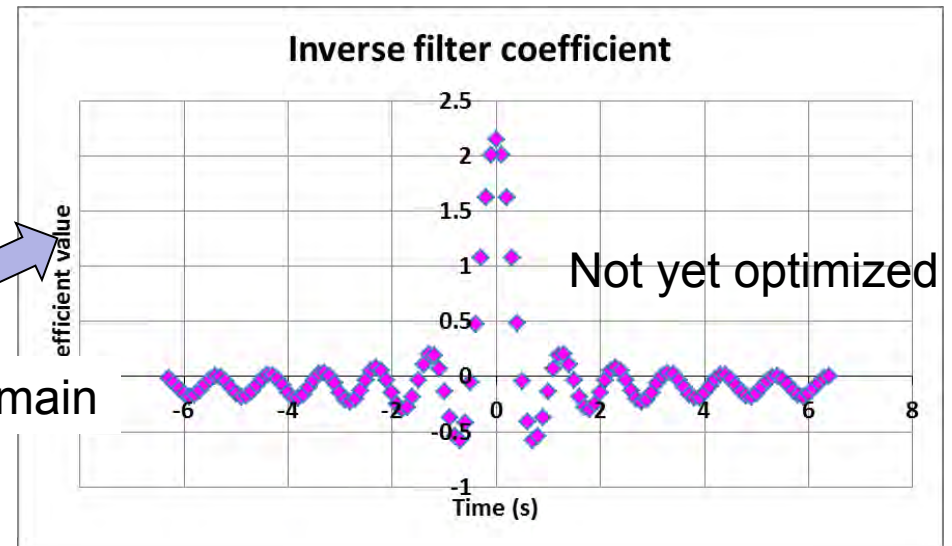


$$IF = \Phi / TF$$



Filter Φ in order to not amplify noise at high frequency (here $> 1\text{Hz}$)

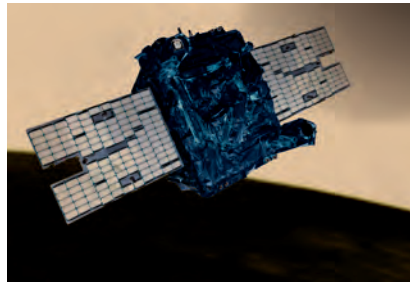
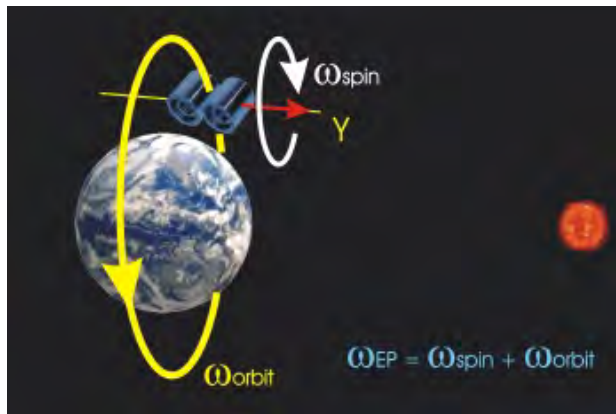
FIR inverse filter in time domain



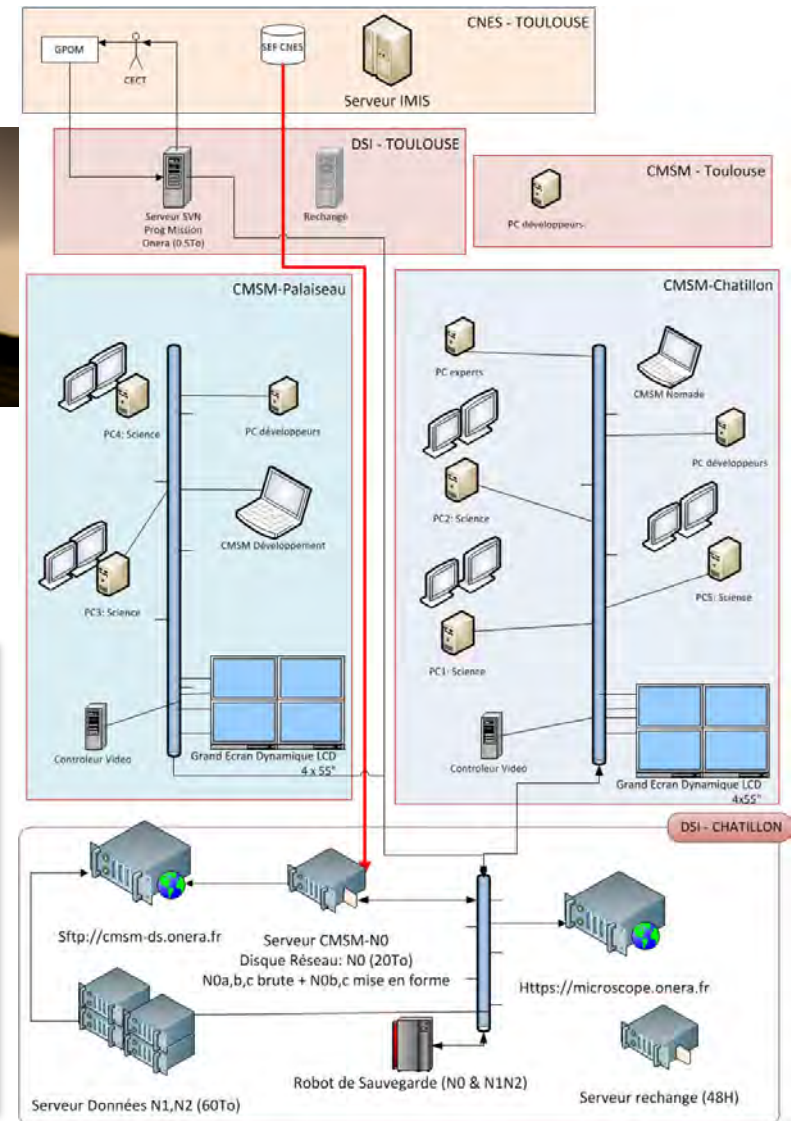
Verification and optimization shall be done

MICROSCOPE Scientific Mission Center

MICROSCOPE – CNES Mission to test EP

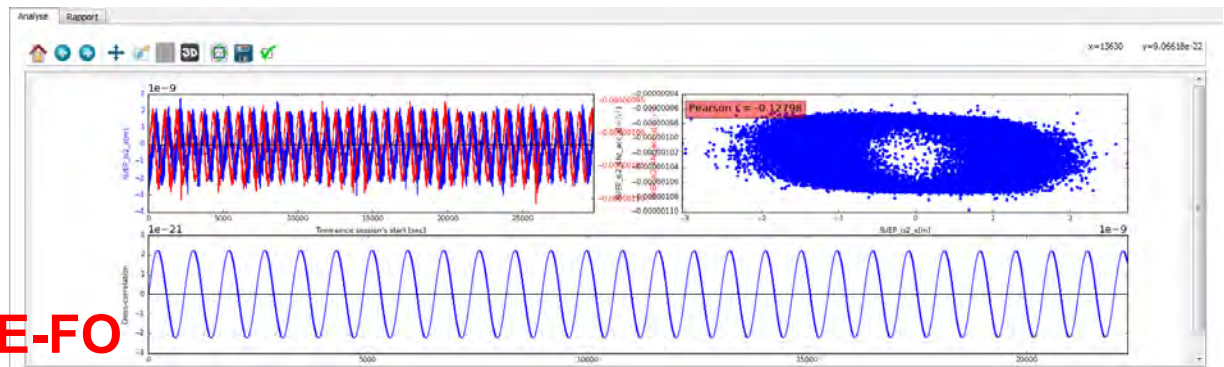
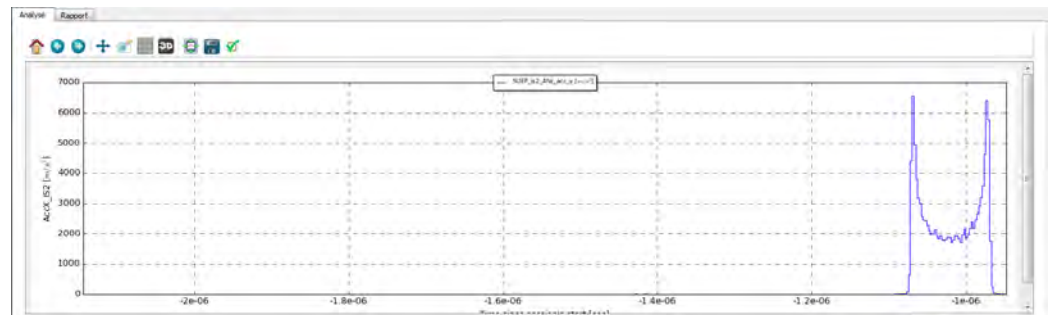
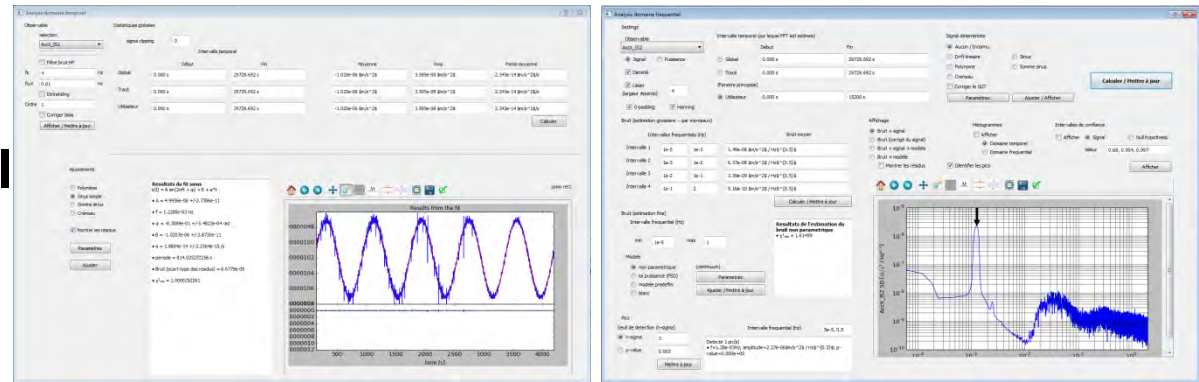


- ONERA has built the instrument
- ONERA is responsible of the scientific mission center



First level analysis tool of Microscope data

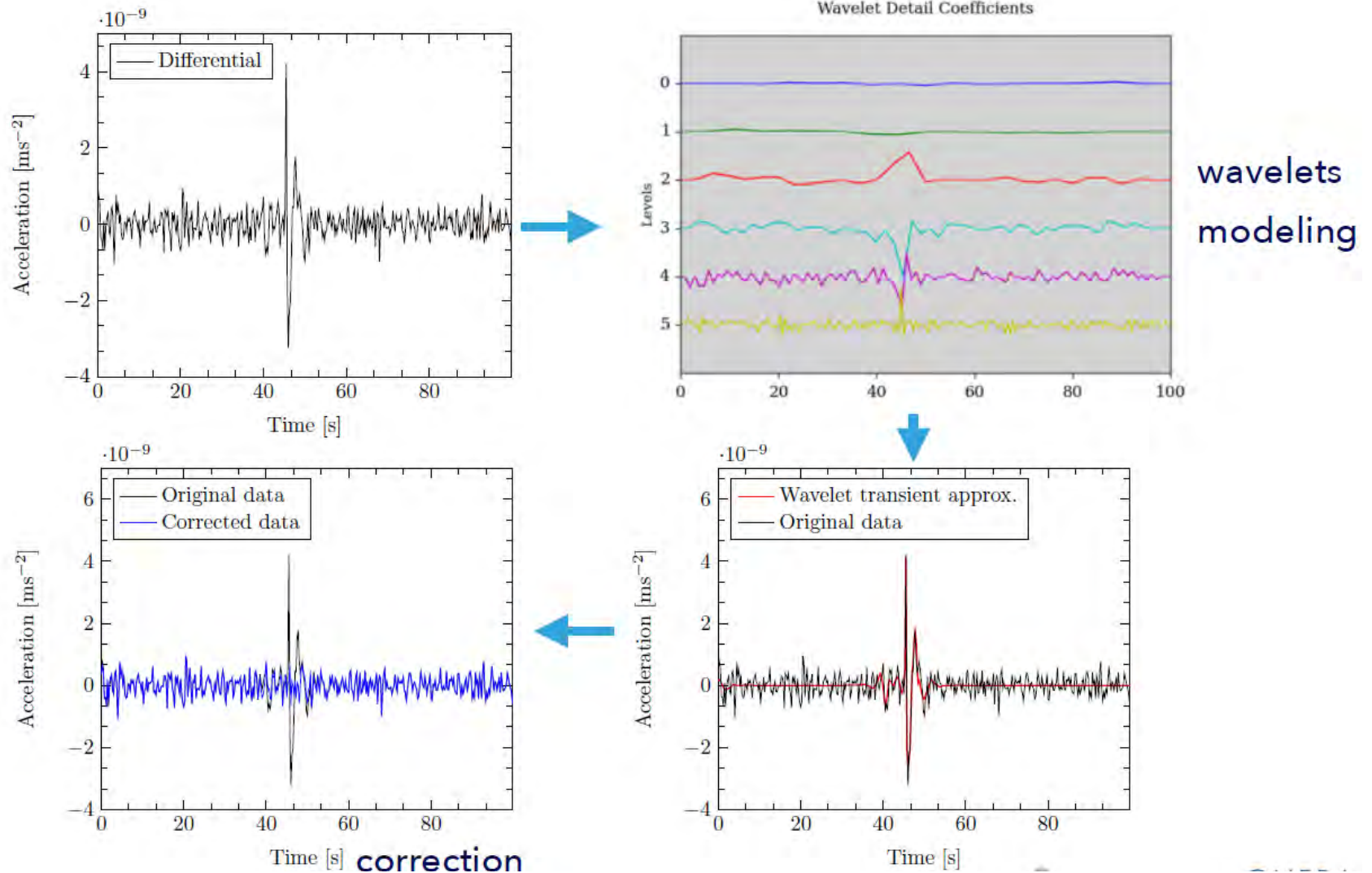
- Linear combination
- Fit wrt specific signal
 - Polynom
 - Sinus
 - Step
- High frequency filtering
- Detrending
- Noise estimation
- Peak detection
- Signal detection
- Histogram
- Correlation



Can be used for GRACE-FO

Handling transients in MICROSCOPE

The modeling method



Off-centring calibration

Microscope off-centering is done as for GRACE-FO, by oscillating the satellite

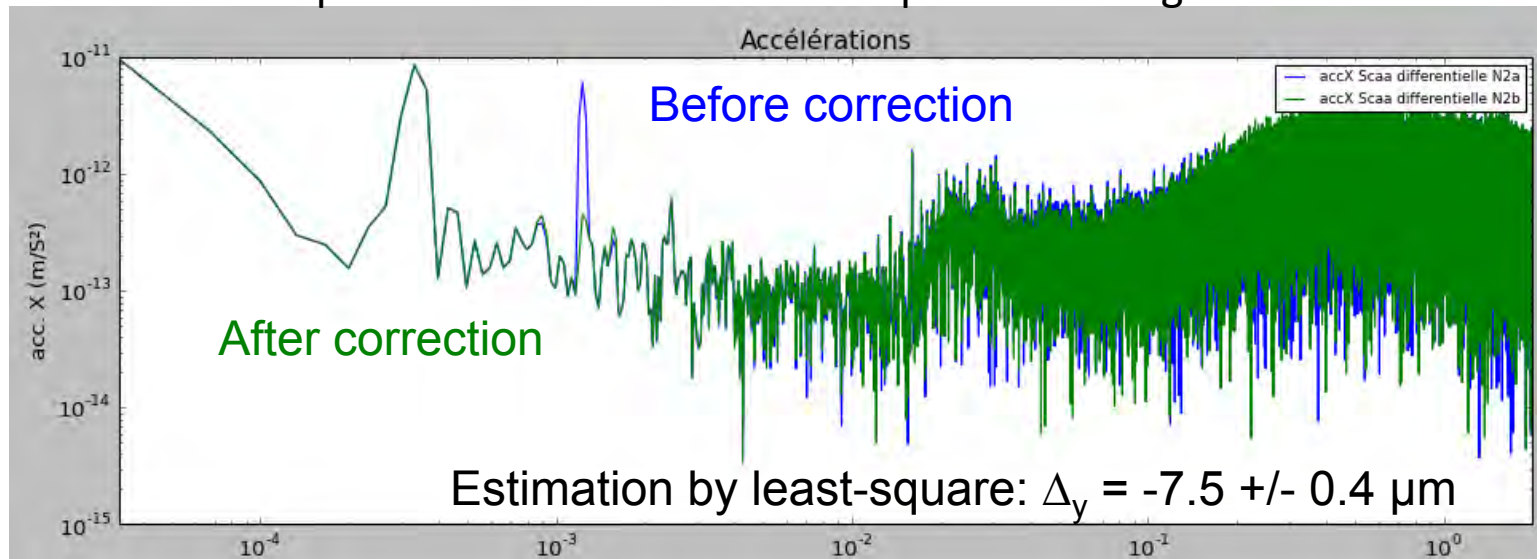
$$\Gamma_{mes,dx} = \frac{1}{2} (\Gamma_{mes,1} - \Gamma_{mes,2}) = \frac{1}{2} K_{1cx} \cdot \delta \cdot g_{x/sat} + \frac{1}{2} \begin{bmatrix} K_{1cx} \\ \eta_{cz} + \theta_{cz} \\ \eta_{cy} - \theta_{cy} \end{bmatrix}^t \cdot [T - In] \cdot \begin{bmatrix} \Delta_x \\ \Delta_y \\ \Delta_z \end{bmatrix} + \dots$$

S/C oscillation around Y,

- amplitude α_0 ,
- pulsation ω_{cal}

$$\Gamma_{mes,dx}(f_{cal/ang}) = \frac{1}{2} K_{1cx} \cdot (T_{xy}(f_{cal/ang}) - \alpha_0 \omega_{cal/ang}^2) \cdot \Delta_y$$

Microscope - Differential acceleration spectrum along sensitive axis



Conclusions

- **Flight models accelerometer delivered and ready after all satellite environmental tests**
- **Now, ONERA is preparing for the post-processing of flight data**
 - Knowledge of the accelerometer
 - Capability to simulate accelerometer behavior
 - Experience acquired through Microscope scientific mission center
 - Data analysis
 - Peak
 - Off-centering estimation