

30th IADC Meeting

22nd to 25th Mai 2012

Montréal - CANADA

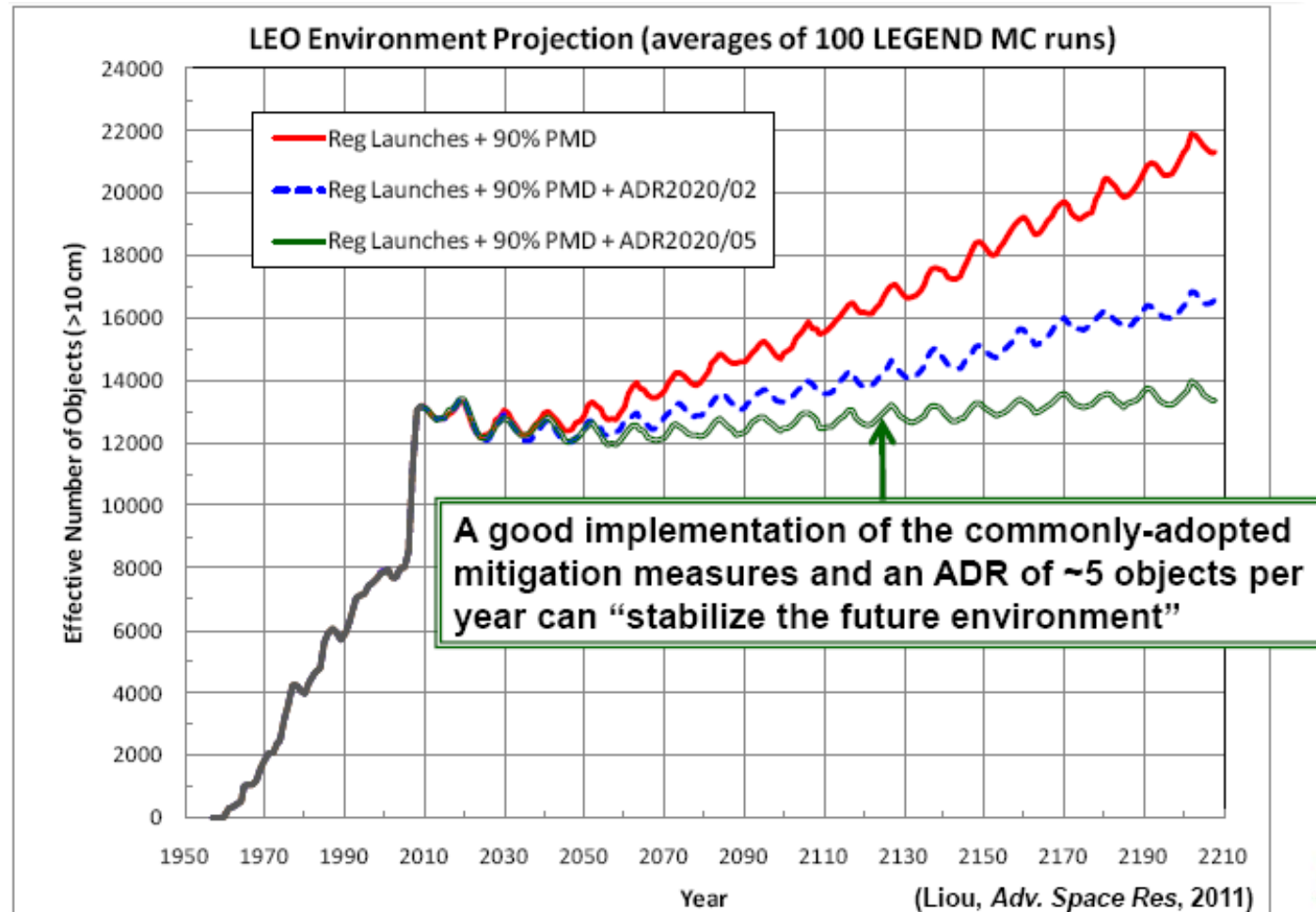
Attitude Evolution Estimation of Conductive Objects Subjected to the Earth's Magnetic Field

J.C. Dolado Pérez

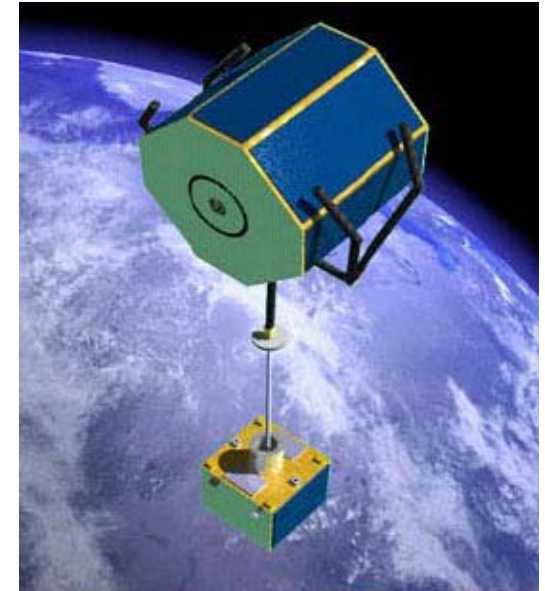
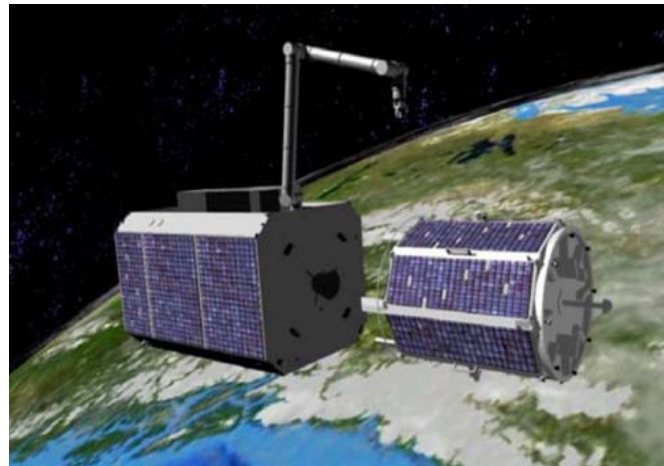
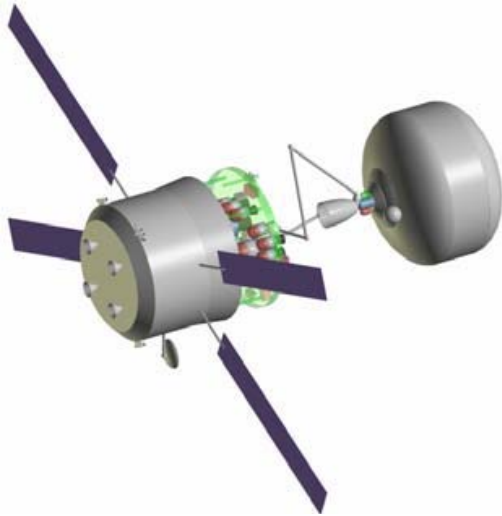
OUTLINE

- **BRIEF DESCRIPTION OF THE PROBLEM**
- **EDDY CURRENTS EFFECTS**
- **PROBLEM TO SOLVE**
- **DEVELOPED APPROACH**
- **MAIN RESULTS AND CONCERNS**

BRIEF DESCRIPTION OF THE PROBLEM



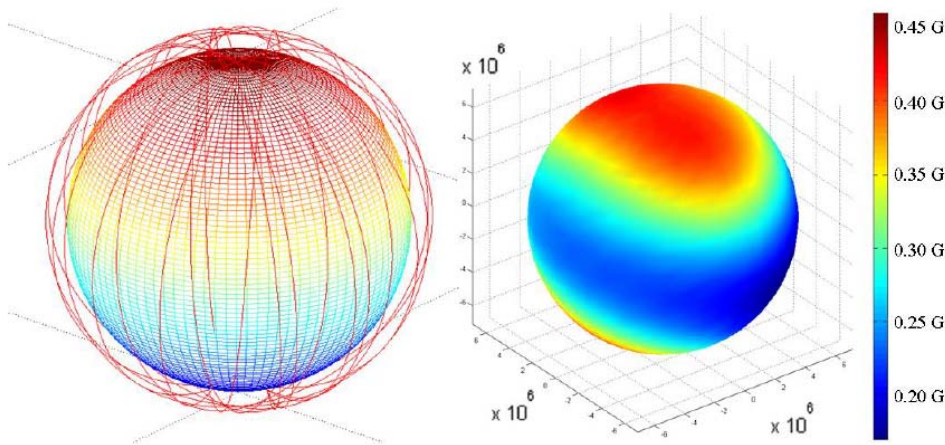
BRIEF DESCRIPTION OF THE PROBLEM



**MOST OF THE PROPOSED ADR TECHNIQUES REQUIRES
A PHYSICAL COONTACT WITH THE DEBRIS**

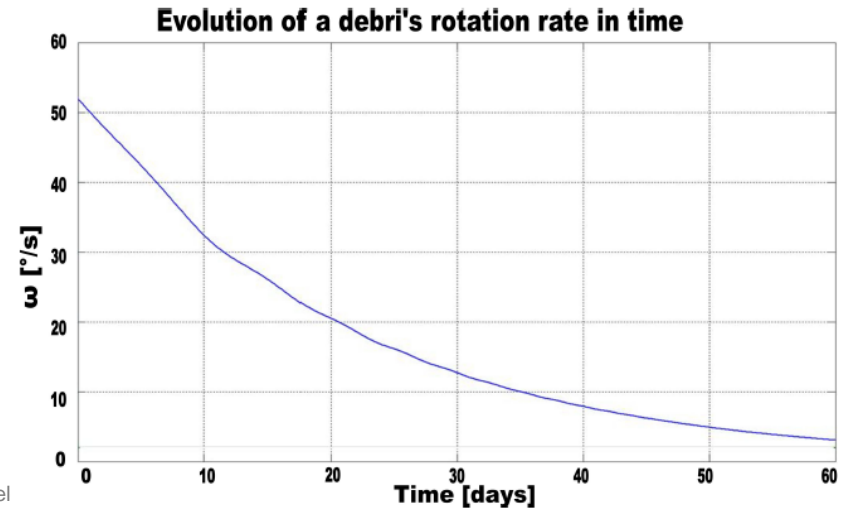
EDDY CURRENT EFFECTS

“Study on the Eddy current damping of the spin dynamics of spatial debris from the Ariane Launcher”. Nicolas Praly et al. (4th EUCASS - 2011)



Ariane Sun-Synchronous upper Stages orbits and intensity of the Encountered magnetic field

Eddy current damping of the Debris rotation rate with time



PROBLEM TO SOLVE

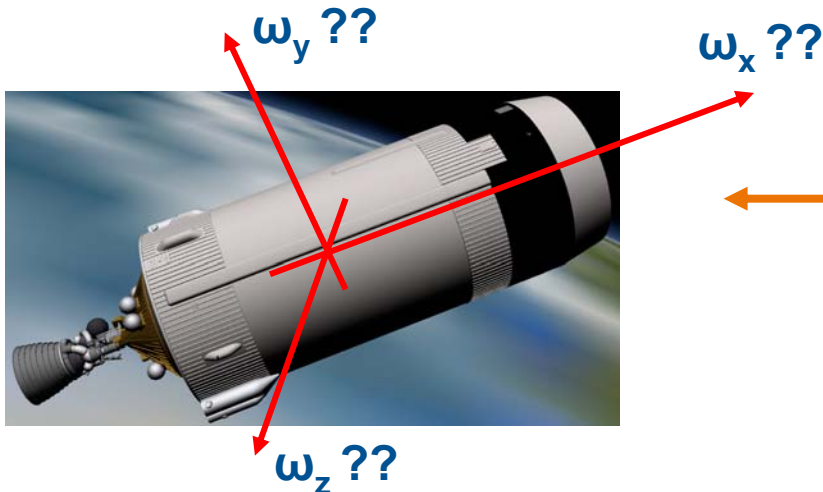
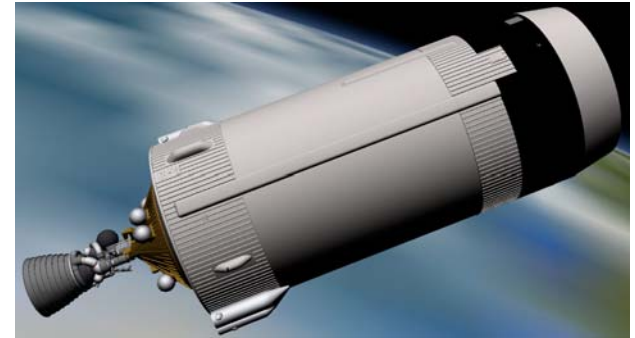


MONGE

ARMOR 1 & 2 → Bande C Radars
NORMANDIE → Bande L Radar



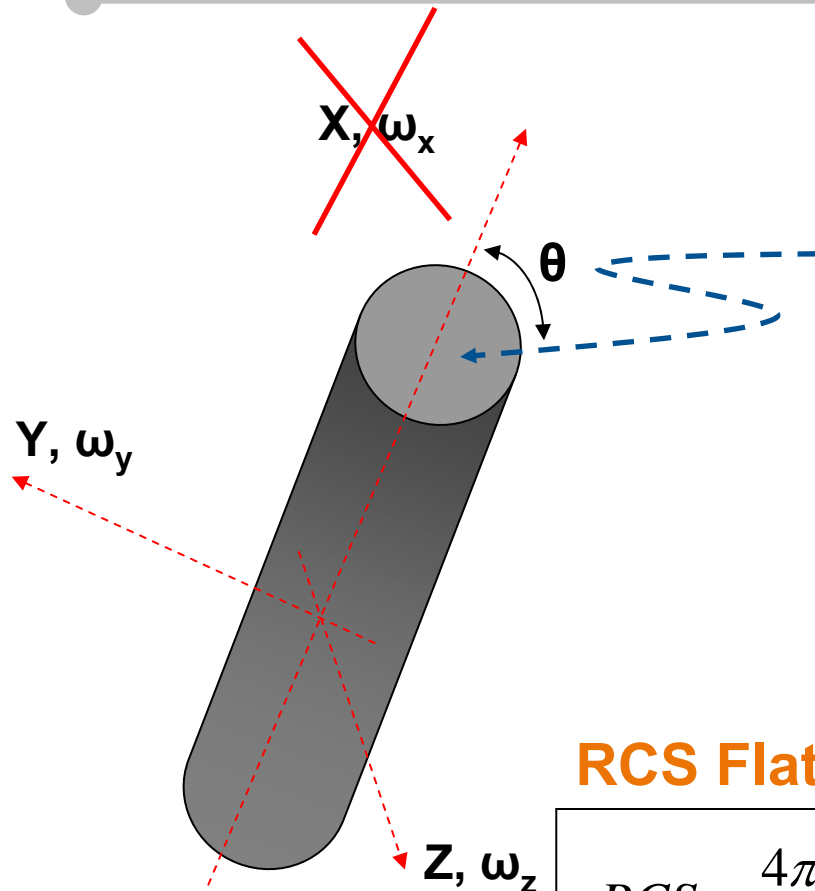
ARIANE R/B in SSO



- Azimuth
 - Elevation
 - Range
- } $f(t)$
- S/N
 - RCS
- } Polarizations : H,V,
HCG,VCG,HCD, VCD



DEVELOPED APPROACH



RCS Cylinder $f(\theta)$

$$RCS = \frac{2\pi H^2 r}{\lambda} \quad \theta = 90^\circ$$

$$RCS = \frac{\lambda r \sin \theta}{8\pi (\cos \theta)^2} \quad \theta \neq 90^\circ$$

RCS Flat Circular Plate $f(\theta)$

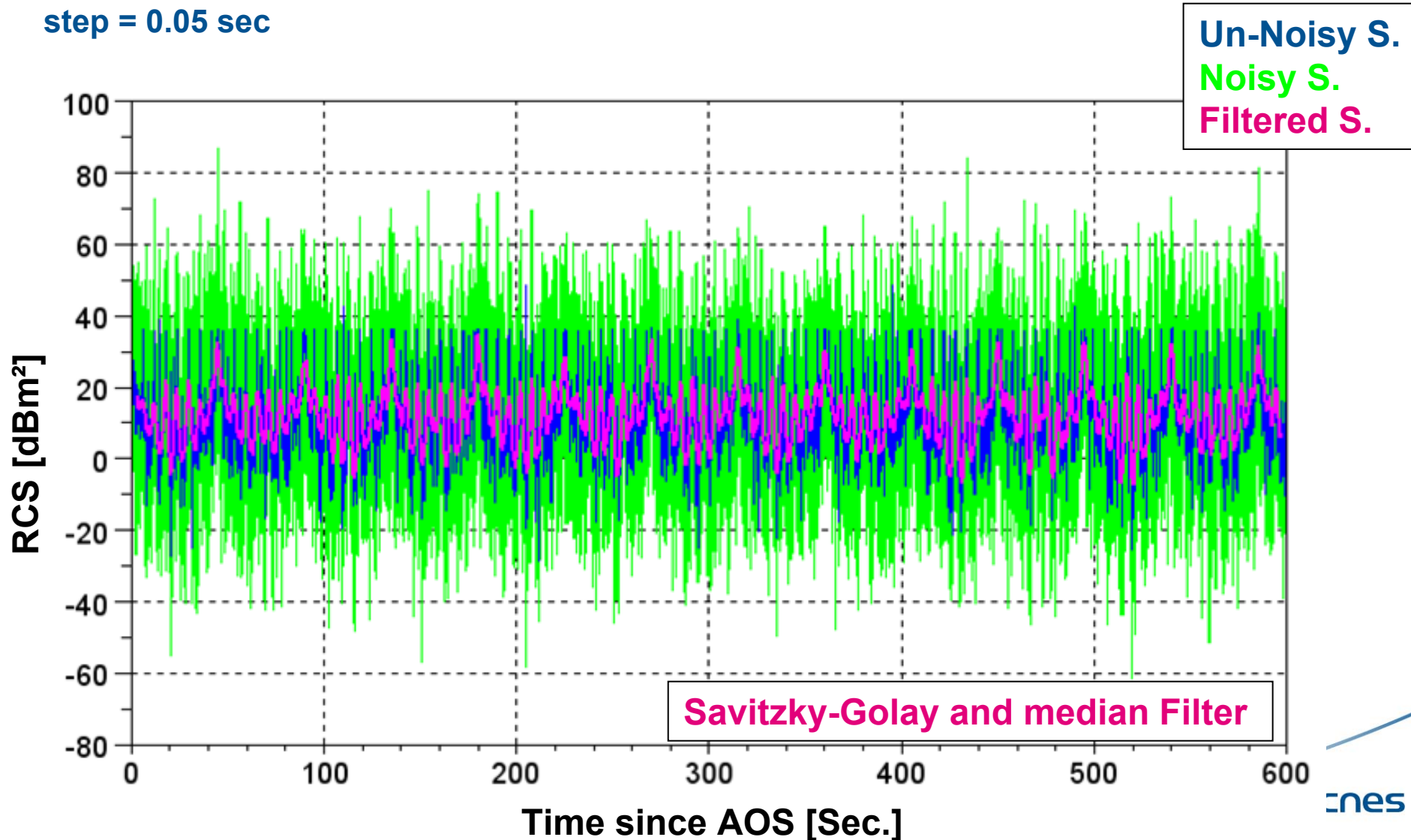
$$RCS = \frac{4\pi^3 r^4}{\lambda^2} \quad \theta = 0^\circ \text{ ou } 180^\circ$$

$$RCS = \pi k^2 r^4 \left(\frac{2J_1(2kr \sin \theta)}{2kr \sin \theta} \right)^2 (\cos \theta)^2 \quad \theta \neq 0^\circ \text{ ou } 180^\circ$$

$$k = 2\pi / \lambda$$

DEVELOPED APPROACH

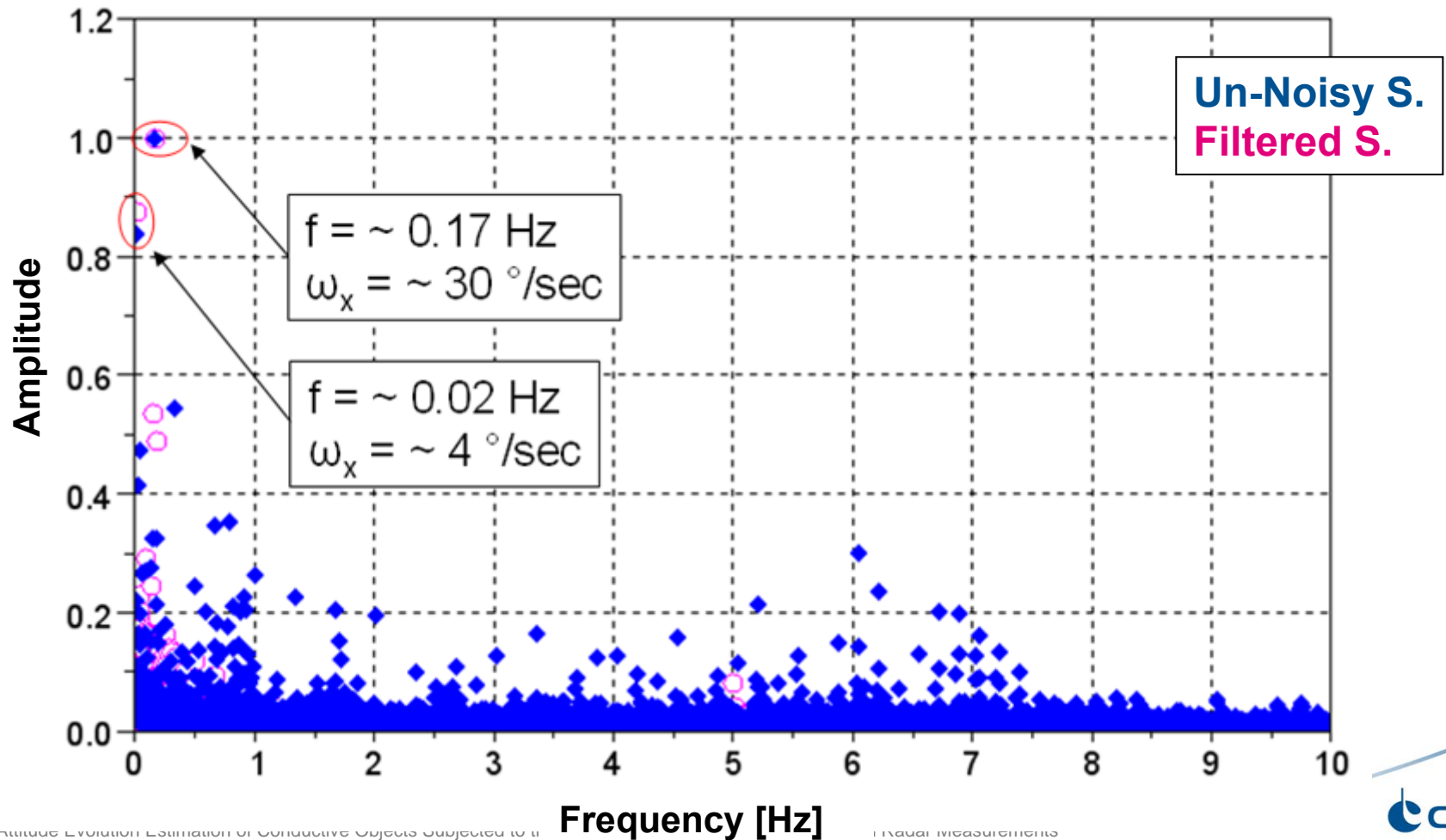
Validation Test A: $\omega_y = 30^\circ/\text{sec}$, $\omega_z = 4^\circ/\text{sec}$, Freq.=1.5 GHz, Pass. Duration = 10 min.,
step = 0.05 sec



DEVELOPED APPROACH

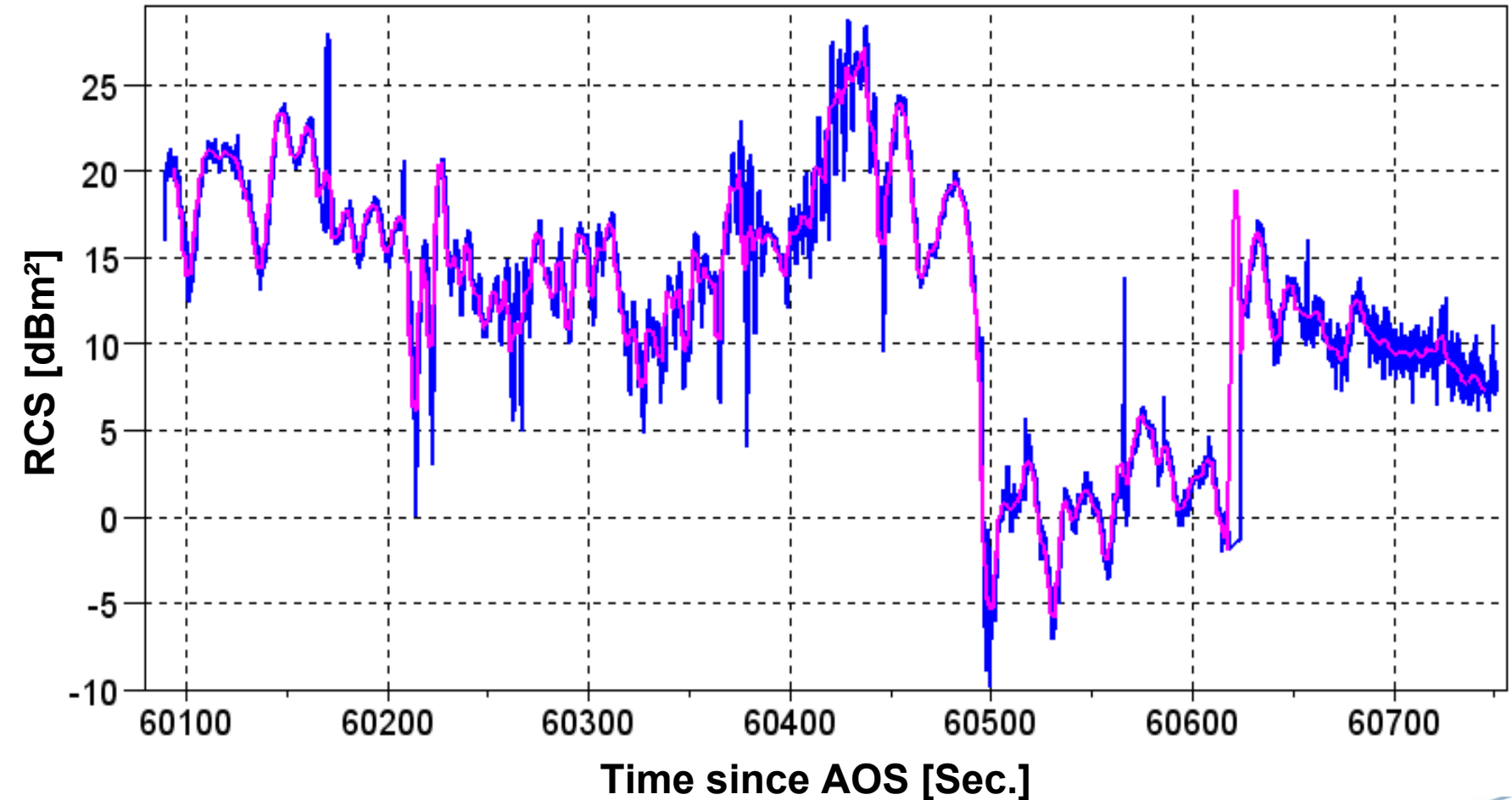
Signal filtering using Savitzky-Golay second order polynomial filter (sliding window of Variable support) and median filter.

FFT superposition for the original and for the noisy Signal



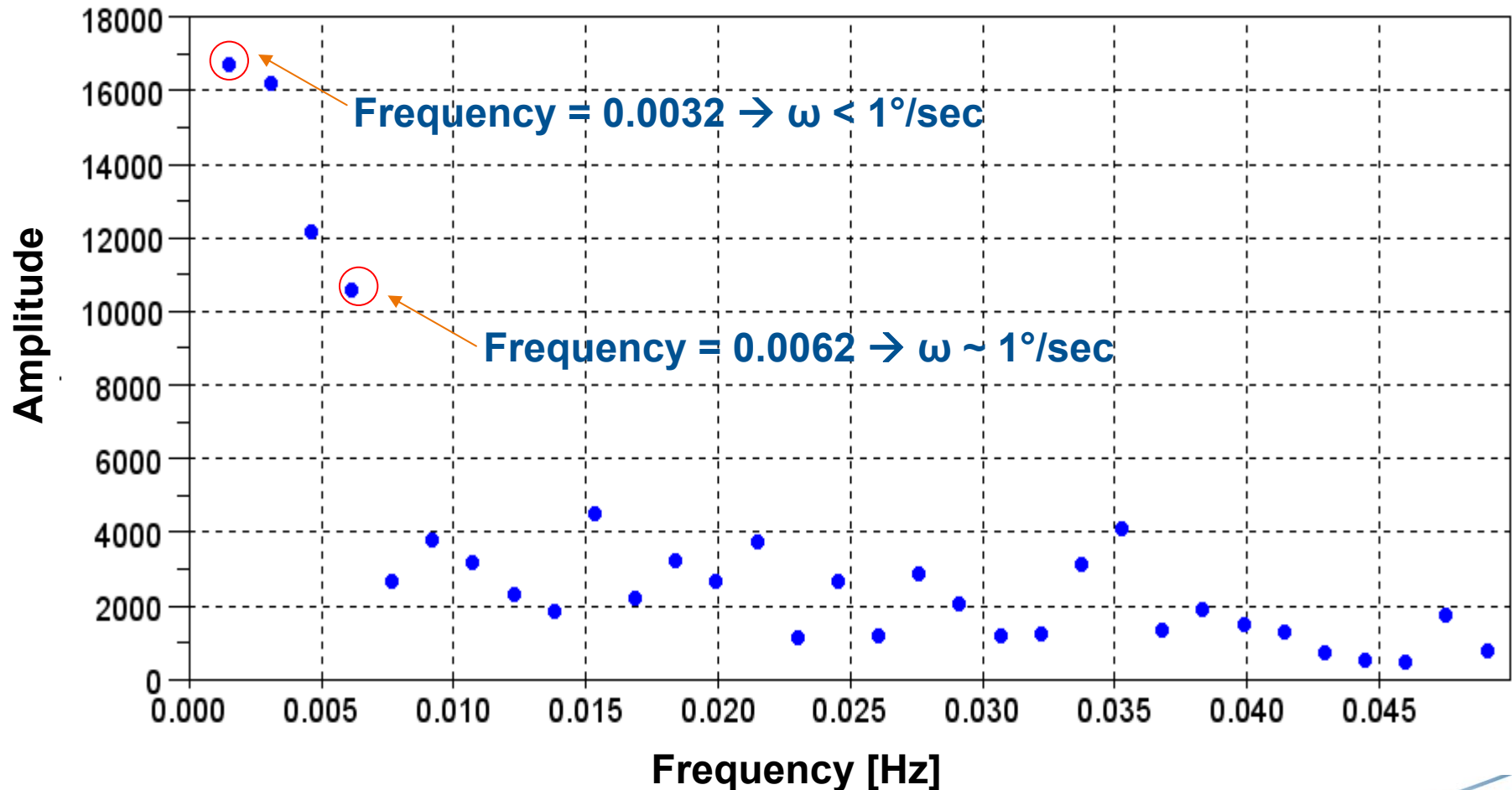
MAIN RESULTS AND CONCERNS

ARIANE 40 H10 III (1995-033D)



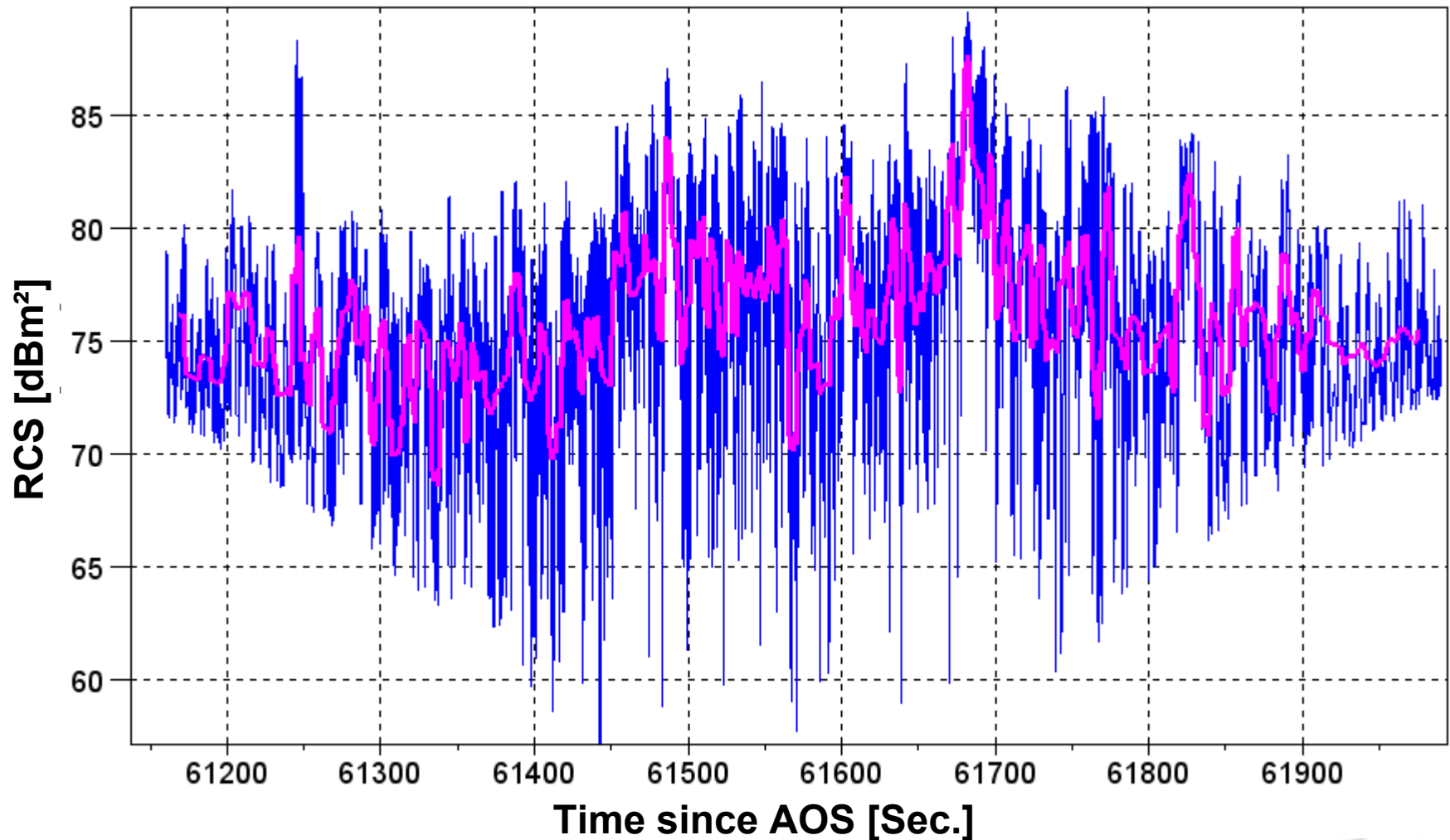
MAIN RESULTS AND CONCERNS

ARIANE 40 H10 III (1995-033D)



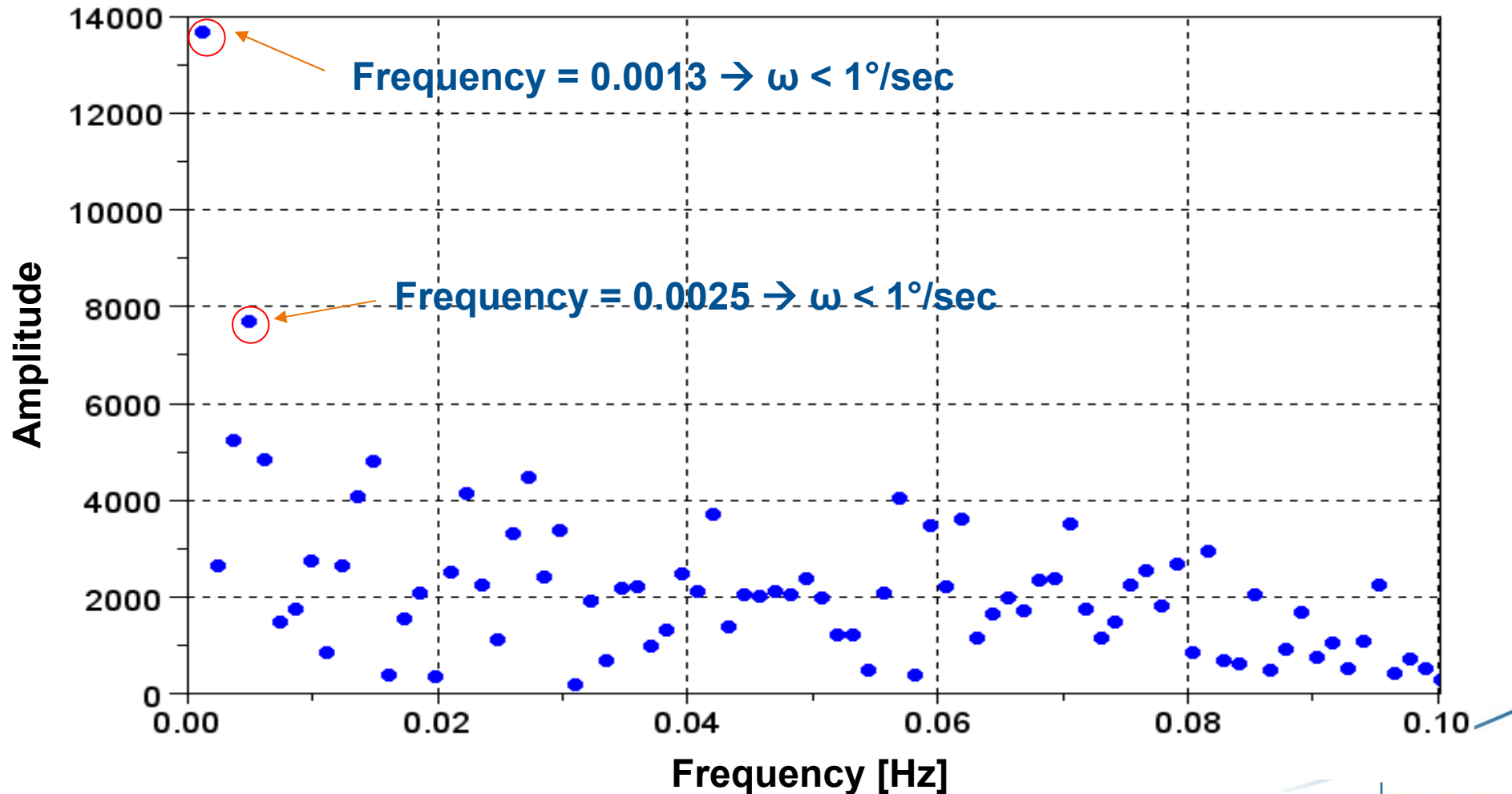
MAIN RESULTS AND CONCERNS

ARIANE 40 H10 III (1998-017B)



MAIN RESULTS AND CONCERNS

ARIANE 40 H10 III (1998-017B)



MAIN RESULTS AND CONCERNS

CONCLUSION

- **The presented analysis seems to confirm the dumping effect of Eddy currents on conductive space-objects (Nicolas Praly et al.)**

CONCERNS

- **Non Fully Validated Approach**
- **Non identified Space object to validate the approach (Object for with a known spin rate. i.e. A newly launched ARIANE R/B)**



THANK YOU FOR YOUR ATTENTION !!