



Shock and transport response of the FPC Hook

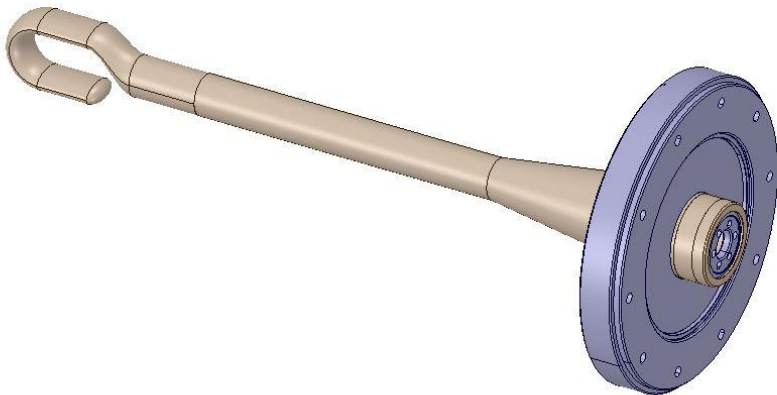
Duarte Cartaxo dos Santos & Eduardo Cano Pleite
CERN, EN-MME



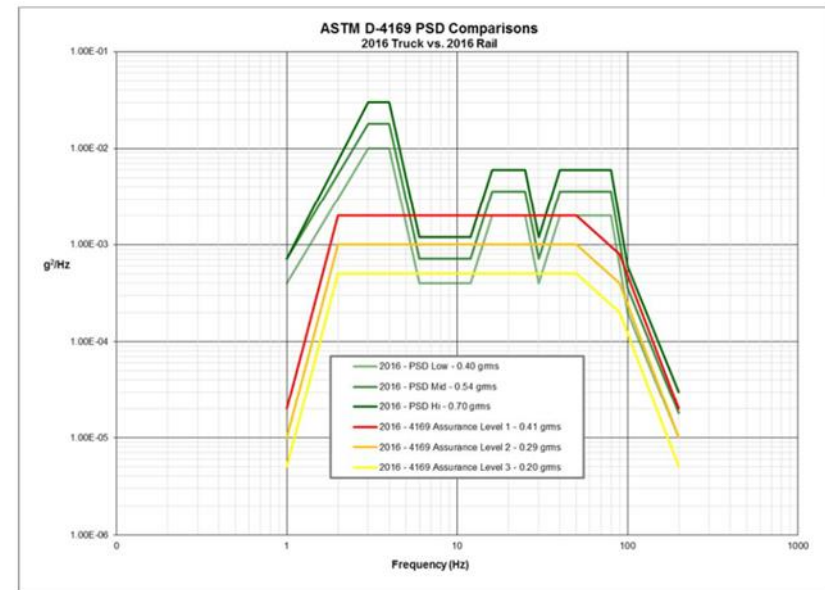
EN/MME Crab Meeting XVIII - CERN – 25/03/2019

Introduction

- **Shock** – Response spectrum analysis.
 - Analysis for a 10G shock, during 20 ms with a 5% damping
- **Random vibration** – Response Power Spectral Density (RPSD)
 - **Input:** ASTM 4169 – Truck PSD



DQW FPC Hook



ASTM 4169 – Truck PSD

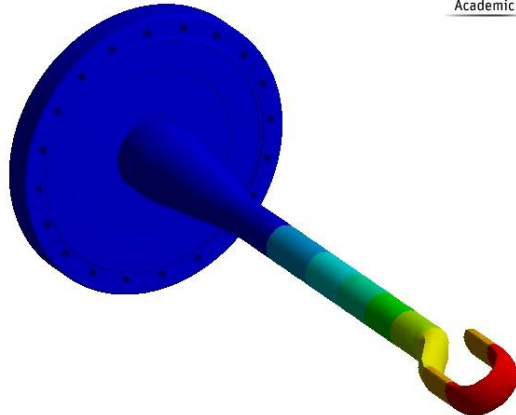
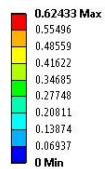
Results DQW Bonded bodies

Response Spectrum Analysis:

- The maximum deformation occurs in the tip of the hook shape.
- Maximum Stress (18.3 MPa) in the Copper Body

E: Response Spectrum - 1% Damping

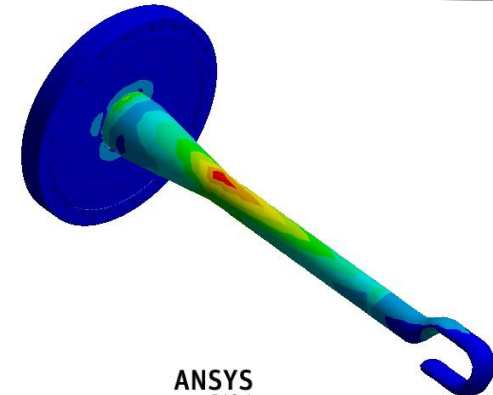
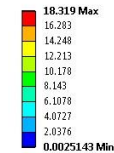
Total Deformation
Type: Total Deformation
Unit: mm
Time: 0



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E: Response Spectrum - 1% Damping

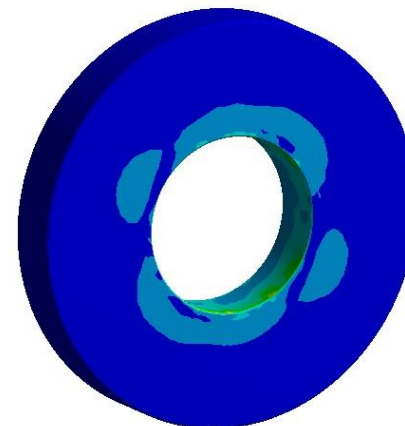
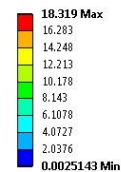
Equivalent Stress
Type: Equivalent Stress
Unit: MPa
Time: 0



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E: Response Spectrum - 1% Damping

Equivalent Stress
Type: Equivalent Stress
Unit: MPa
Time: 0



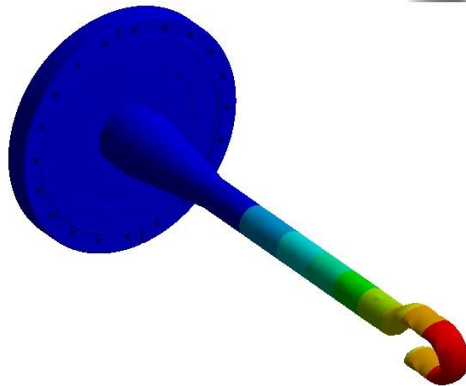
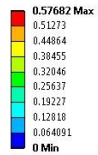
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Results DQW Bonded bodies

Random Vibration Analysis:

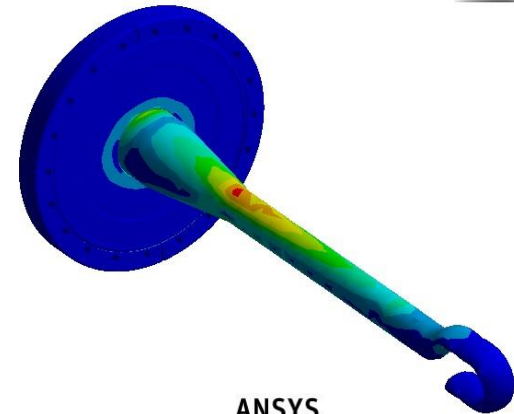
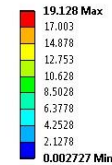
- The maximum deformation occurs in the tip of the hook shape.
- Maximum Stress (19.1 MPa) in the Copper Body

D: Random Vibration
Directional Deformation 2
Type: Directional Deformation(Y Axis)
Scale Factor Value: 3 Sigma
Probability: 99.73 %
Unit: mm
Solution Coordinate System
Time: 0



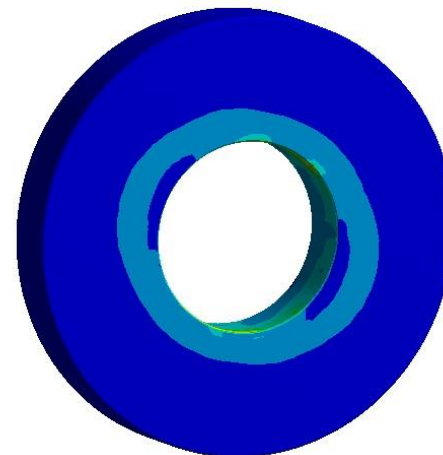
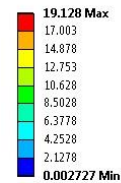
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D: Random Vibration
Equivalent Stress
Type: Equivalent Stress
Scale Factor Value: 3 Sigma
Probability: 99.73 %
Unit: MPa
Time: 0



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D: Random Vibration
Equivalent Stress
Type: Equivalent Stress
Scale Factor Value: 3 Sigma
Probability: 99.73 %
Unit: MPa
Time: 0

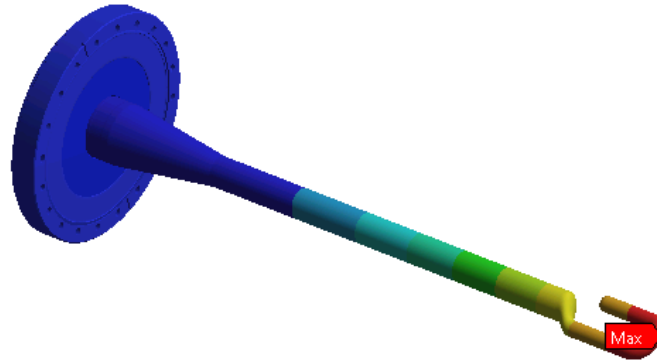
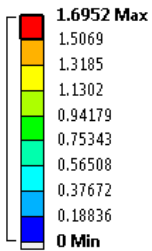


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Results RFD Bonded bodies - Shock

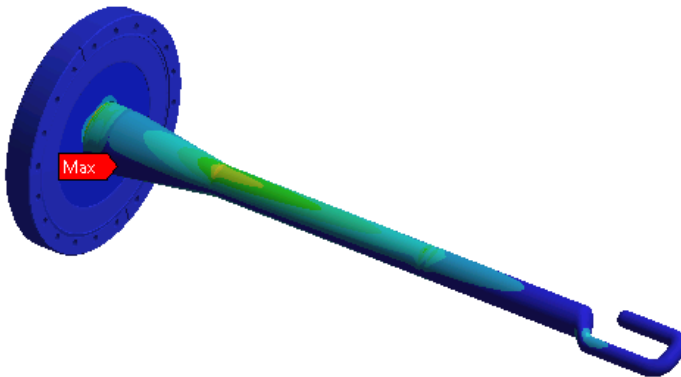
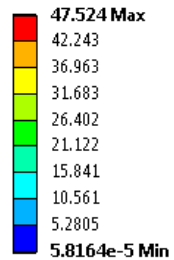
- First mode 60 Hz, second mode 340 Hz
- The maximum deformation occurs in the tip of the hook shape.

F: Response Spectrum
Total Deformation
Type: Total Deformation
Unit: mm
Time: 0
25/03/2019 08:31

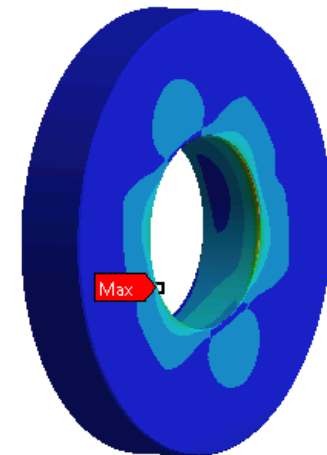
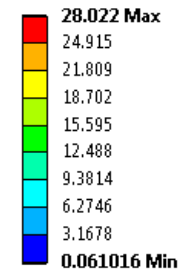


- Small maximum stress. Maximum again in a cooper-copper connection

F: Response Spectrum
Equivalent Stress
Type: Equivalent Stress
Unit: MPa
Time: 0
25/03/2019 08:45



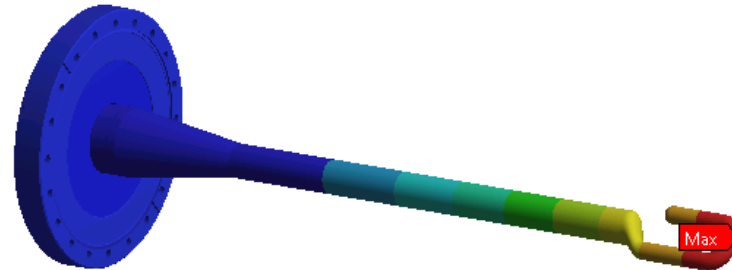
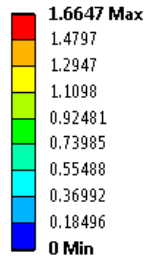
F: Response Spectrum
Equivalent Stress 2
Type: Equivalent Stress
Unit: MPa
Time: 0
25/03/2019 08:48



Results RFD – Random vibration

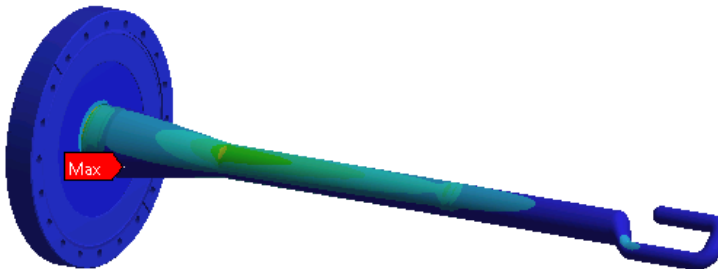
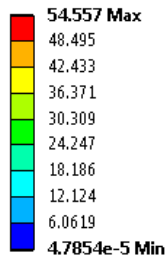
- Maximum deformation and stress larger than in the shock analysis. Similar distribution

G: Random Vibration
 Directional Deformation
 Type: Directional Deformation(Y Axis)
 Scale Factor Value: 3 Sigma
 Probability: 99.73 %
 Unit: mm
 Solution Coordinate System
 Time: 0
 25/03/2019 08:52

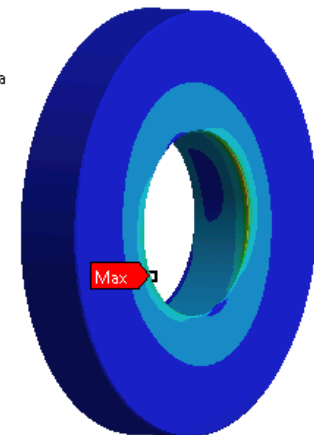
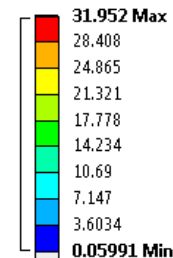


- Small maximum stress. Maximum again in a cooper-copper connection

G: Random Vibration
 Equivalent Stress
 Type: Equivalent Stress
 Scale Factor Value: 3 Sigma
 Probability: 99.73 %
 Unit: MPa
 Time: 0
 25/03/2019 08:51



G: Random Vibration
 Equivalent Stress 2
 Type: Equivalent Stress
 Scale Factor Value: 3 Sigma
 Probability: 99.73 %
 Unit: MPa
 Time: 0
 25/03/2019 08:49



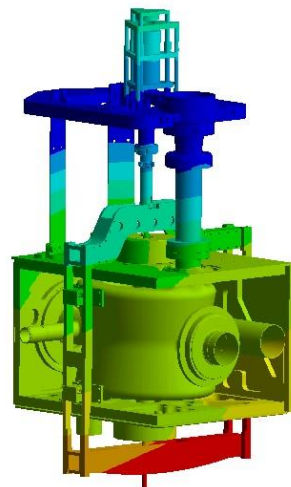
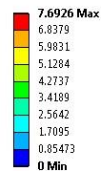
Result – Tuning system

- Modal analysis (taken from Joanna's 3D model)

| Mode number | Frequency (Hz) | Description |
|-------------|----------------|------------------------------------|
| 1 | 28.959 | Helium tank swing around x axis |
| 2 | 30.783 | Helium tank swing around y axis |
| 3 | 43.467 | Helium tank rotation around z axis |
| 4 | 46.661 | Tuner frame rotation around y axis |

- Response spectrum – High computational cost if reasonable mesh is used

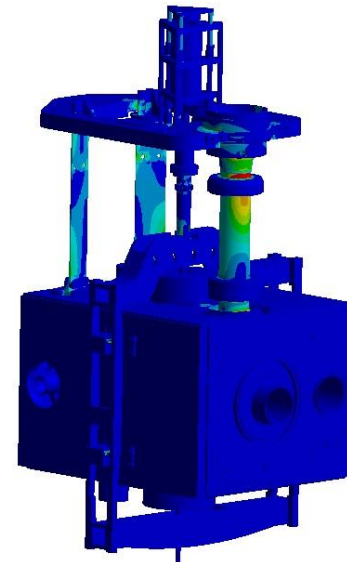
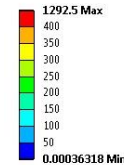
E: Response Spectrum
Total Deformation
Type: Total Deformation
Unit: mm
Time: 0



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E: Response Spectrum
Equivalent Stress
Type: Equivalent Stress
Unit: MPa
Time: 0

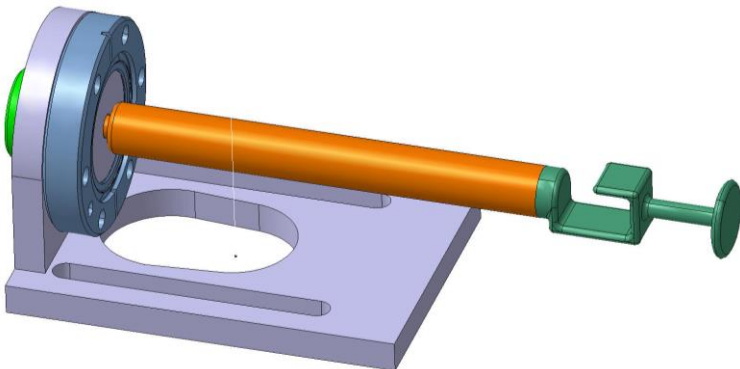
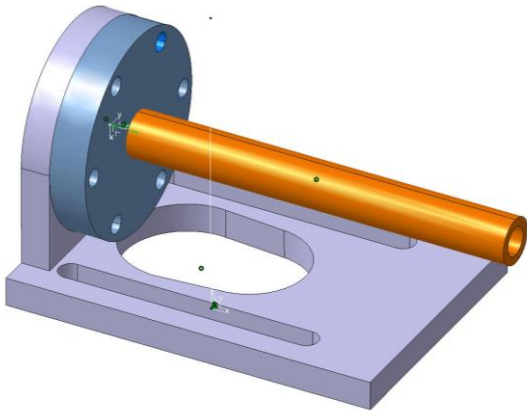


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Benchmark

- Meeting held to discuss about the shaker for the benchmark mockup test.
- Design by Kurt
 - Instrumented with Strain gauge (M. Guinchard)
 - Accelerometer (measure input)
 - Vibrometer



Questions asked:

- Feasibility? Maximum 1 kg ?
- Fixture on machine ? 3D available ?
- Centre of gravity on axis requirements ?
- Availability shaker + people?

Results – Conclusion

- **Linear** analysis were performed.
- The maximum stress takes place in the **copper**. In a contact region between two copper parts. Further analysis in this part.
- RFD FPC presents higher values of deformation and stress than the one of DQW.
- The **stress** in the alumina disks is **low** in both cases.
- Transport analyses of tuner assembly needs large computational resources – waiting for the cluster.
- Excel summarizing all transport results available in EDMS 2112803



Thank you for your attention!

