Simulation Status

LAViSta

Laboratories in Annecy working on Vibration Stabilization

Catherine ADLOFF
Benoît BOLZON
Franck CADOUX
Yan BASTIAN

Andréa JEREMIE
Yannis KARYOTAKIS
Claude GIRARD
Nicolas GEFFROY
Overview

1. Final focus system vibrations
2. Modal analysis
3. Dynamic response predictions
4. Future prospects
5. Conclusions
Structure design

Simulation

Agreement ?

Prototype

Simulation :
- Modal analysis
- Dynamic response prediction

Improve design before building a prototype
Final focus system vibrations

Excitation spectrum

Structural resonances

Ground motion
- Cooling system
- Air flows
- Power supply system…

( Amplified motions)

Develop a know-how concerning modal analysis
Experimental Modal analysis
Experimental Modal analysis

- PULSE
  Fourier transform
  115 Hz

- ME' scope
  Mode shape
Numerical Modal analysis - SAMCEF -

- Identify eigen frequencies
- Display mode shapes

Modal tests on a free-free / free-fixed beam
Preliminary tests
- free free -

Difference between numerical and experimental eigen frequencies

$\Delta f(\text{Hz})$

Good relative accuracy!

Nicolas GEFFROY

CLIC Meeting – CERN – 23/09/2005
Dynamic response

External perturbation → Structure → Dynamic Response

Ground motion

Equations of motion

\{ Accelerations, Displacements, Stresses ... \}
Dynamic response
( free–fixed beam )

SAMCEF - Simulation

Clamping (applied acc.)
Tip (calculated acc.)
No damping…
Dynamic response
( free–fixed beam )

SAMCEF - Simulation

Clamping
(calculated displacements)

Time (AU)

Tip
(calculated displacements)
Dynamic response (free–fixed beam)

Data used as input for the simulation

Data used for the comparison with simulation

Check the accuracy of the numerical prediction
Dynamic response (free–fixed beam)

Model used:

Clamping system

Beam parameters:

\[ E = 74000 \text{ MPa} \]
\[ \nu = 0.34 \text{ (Poisson’s ratio)} \]
\[ \rho = 2825 \text{ kg/m}^3 \]

Damping: \( \epsilon = 0 \% \)

Structure modeled with “beam” elements

Lumped mass:

\[ M = 830 \text{ g} \]
Dynamic response
( free–fixed beam )

Acceleration PSD of ENDEVCO sensors at the edge part of the beam (table off); No damping

- Measurement
- Simulation

Good agreement
Dynamic response (free–fixed beam)

Fit parameters:
- Stiffness
- Damping
- ...

Impressive agreement

Updated FE model

Nicolas GEFFROY

CLIC Meeting – CERN – 23/09/2005
Dynamic response (free–fixed beam)

Root mean square of ENDEVCO sensors at the edge part of the beam

RMS of the updated FE model
Future prospects

Simulation of the WHOLE SYSTEM:

External perturbation

Structure

Dynamic Response

Action of actuators

Results from sensors

Active Feedback Loop

SAMCEF

Equations of motion

MATLAB - Simulink
Future prospects

Simulation of the WHOLE SYSTEM:

Dynamic response + active control

Displacement of the tip of the beam (mm)

Time (s)

Nicolas GEFFROY

CLIC Meeting – CERN – 23/09/2005
Future prospects

**Prediction concerning the FF quad.**

- Computer Aided Design – 1\textsuperscript{st} version

Conical shape - 2.5 meter long
Future prospects

Prediction concerning the FF quad.

CA Design

1\textsuperscript{st} version
Future prospects

Prediction concerning the FF quad.

- **Outer shell** (Stainless steel; 2mm thick)
- **Inner part** (magnet; massive part)
- **Current idea**
- **Option with ribs**
Future prospects

**Prediction concerning the FF quad.**

**Option 1**: no inner ribs

- **Mode 1**: 10 Hz
- **Mode 2**: 29 Hz

- The magnet is “decoupled” to the outer shell …

**Option 2**: with inner ribs

- **Mode 1**: 11 Hz…
- **Mode 2**: 62 Hz

- The inner ribs fix the magnet to the outer shell

Nicolas GEFFROY

CLIC Meeting – CERN – 23/09/2005
Future prospects

Realization of a new test bench

- **Prototype**: fixed-free structure

- Representative prototype
- Easy Boundary Conditions
- Adaptability

Eigen frequencies
Square section
Hollow core (substruc.)

Nicolas GEFFROY
Conclusions

• Simulate dynamic response of structures
  ✔ Check experimentally the accuracy of the models
  ✔ Get reliability of the FE models

• Simulate modal analysis of the future FF quadrupole
  ✔ Propose new design (inner supports …)
  ✔ Propose new materials (composite materials …)
Conclusions

Perform simulations of the whole system:

- Combine simulation of structural dynamics / active control

Improve efficiency of feedback loop

- Type of sensors / actuators
- Location of sensors / actuators along the structure
- Reliability of the feedback algorithm
- ...

Simulation could be a great help!...