ECFA European Linear Collider Workshop 2013, Hamburg, Germany

Detector Seismic Studies

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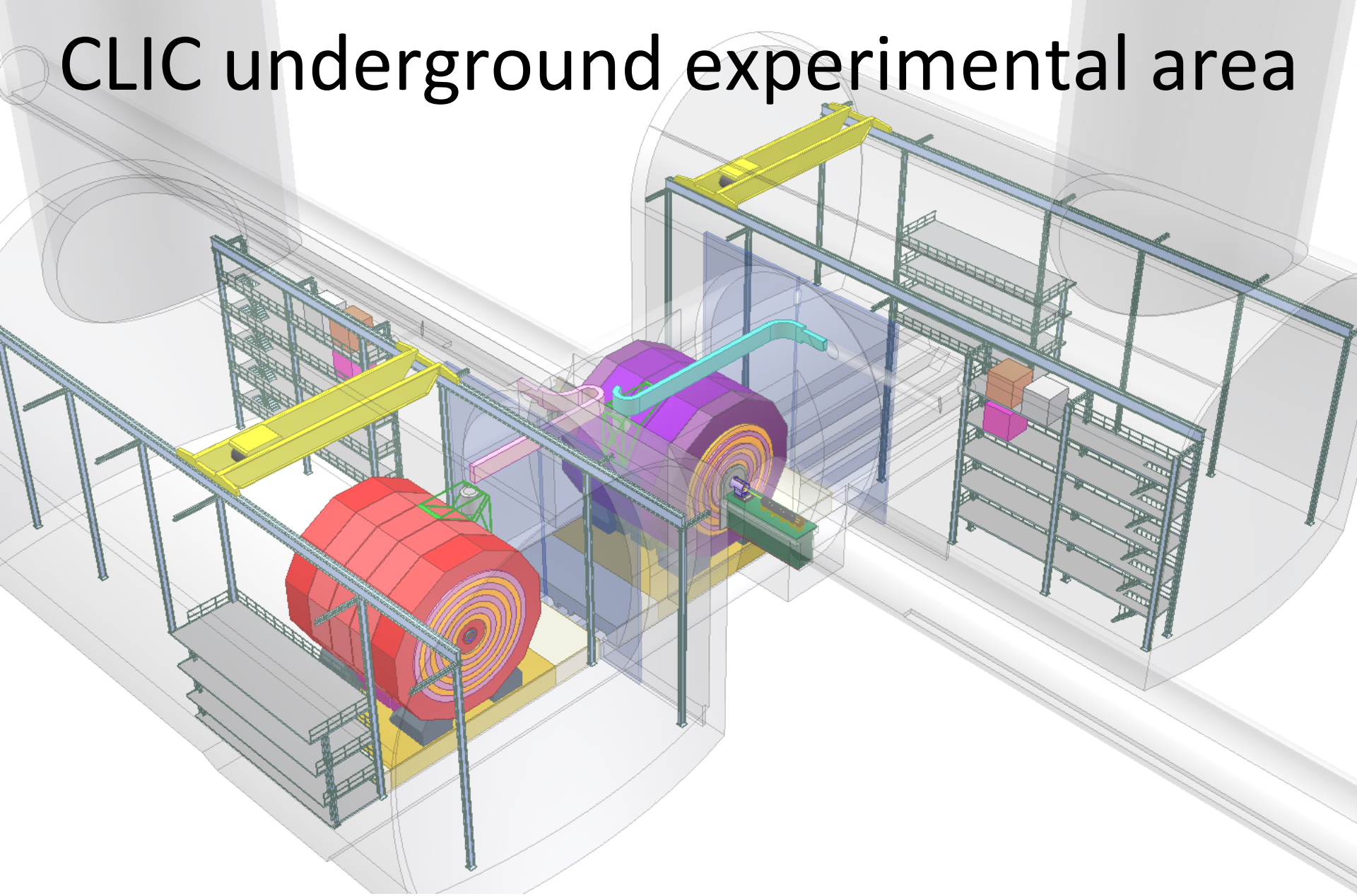
May 30th, 2013

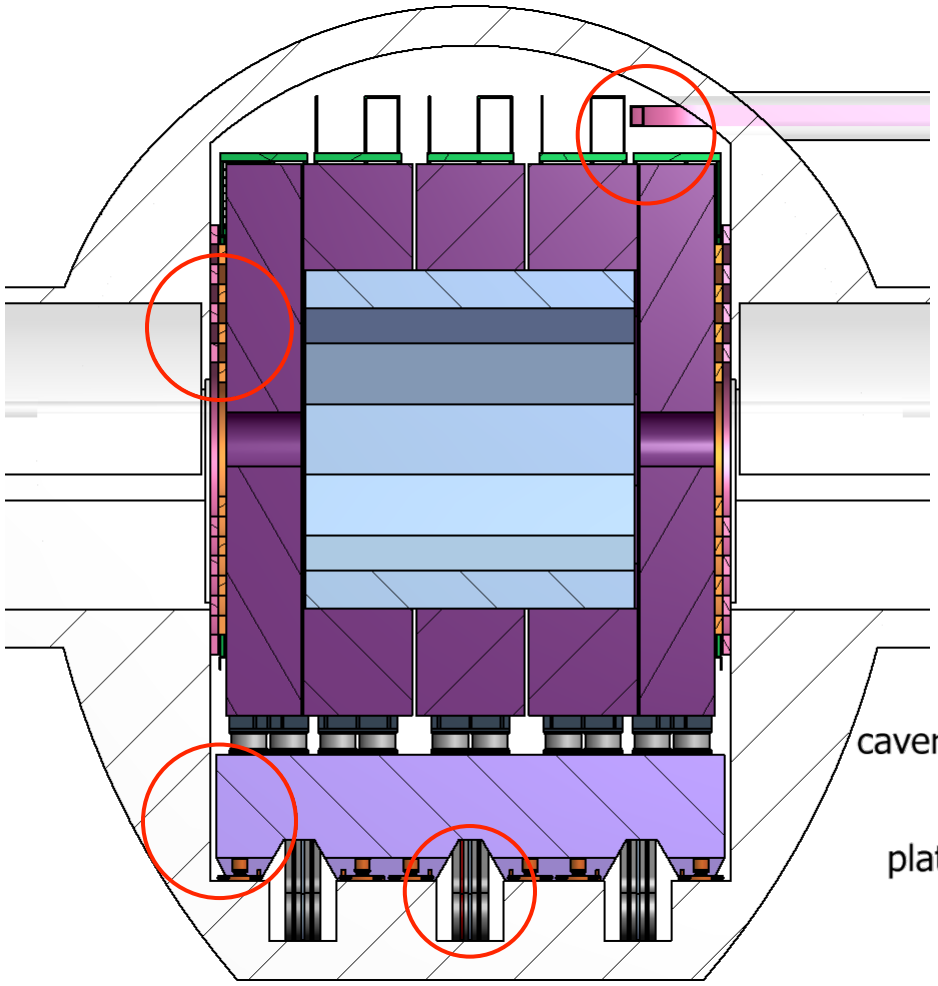
Outline

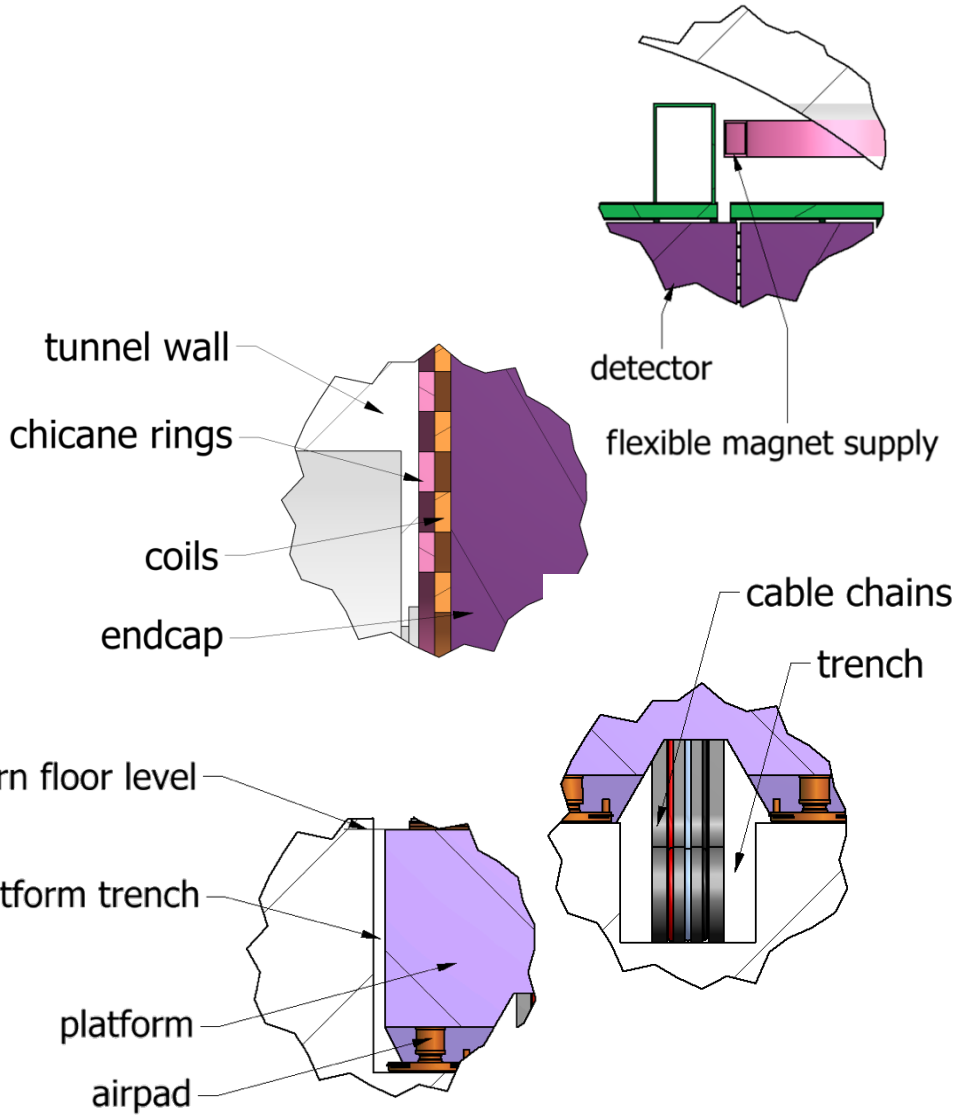
- CLIC experimental area layout;
- Seismic action & legislation at CERN;
- First FEA simulations results (CERN & J-PARC spectra);
- Seismic isolation strategy.

CLIC underground experimental area

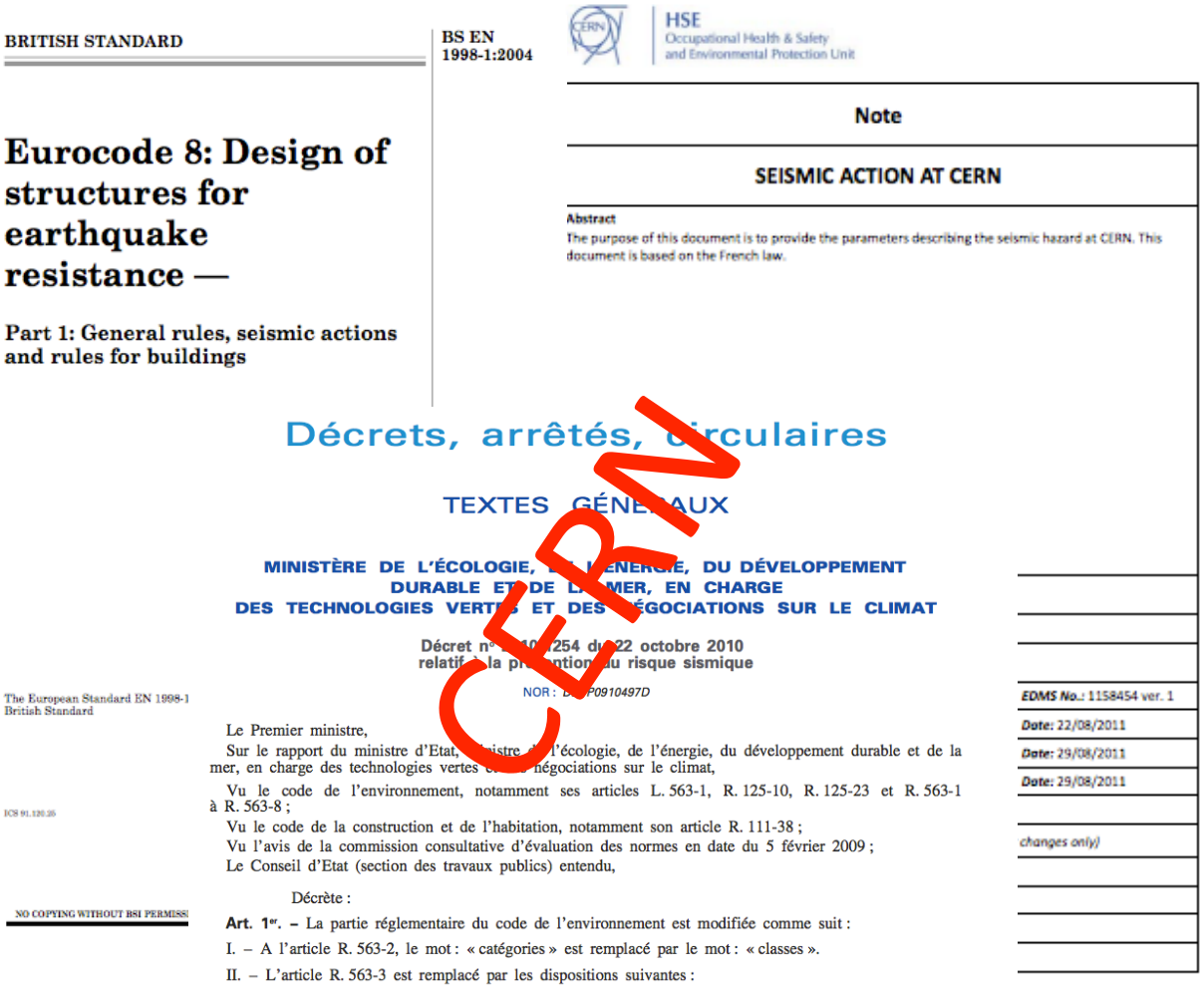


CLIC underground experimental area





Seismic legislation/codes



BRITISH STANDARD

BS EN 1998-1:2004

Eurocode 8: Design of structures for earthquake resistance —

Part 1: General rules, seismic actions and rules for buildings

The European Standard EN 1998-1 British Standard

ICS 91.120.25

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HSE
Occupational Health & Safety and Environmental Protection Unit

Note

SEISMIC ACTION AT CERN

Abstract
The purpose of this document is to provide the parameters describing the seismic hazard at CERN. This document is based on the French law.

EDMS No.: 1158454 ver. 1
Date: 22/08/2011
Date: 29/08/2011
Date: 29/08/2011
changes only)

Décrets, arrêtés, circulaires

TEXTES GÉNÉRAUX

MINISTÈRE DE L'ÉCOLOGIE, L'ÉNERGIE, DU DÉVELOPPEMENT DURABLE ET DE LA MER, EN CHARGE DES TECHNOLOGIES VERTES ET DES NÉGOCIATIONS SUR LE CLIMAT

Décret n° 2010-1254 du 22 octobre 2010
relatif à la prévention du risque sismique

NOR : DEVP0910497D

Le Premier ministre,

Sur le rapport du ministre d'Etat, ministre de l'écologie, de l'énergie, du développement durable et de la mer, en charge des technologies vertes et des négociations sur le climat,

Vu le code de l'environnement, notamment ses articles L. 563-1, R. 125-10, R. 125-23 et R. 563-1 à R. 563-8 ;

Vu le code de la construction et de l'habitation, notamment son article R. 111-38 ;

Vu l'avis de la commission consultative d'évaluation des normes en date du 5 février 2009 ;

Le Conseil d'Etat (section des travaux publics) entendu,

Décrète :

Art. 1er. – La partie réglementaire du code de l'environnement est modifiée comme suit :

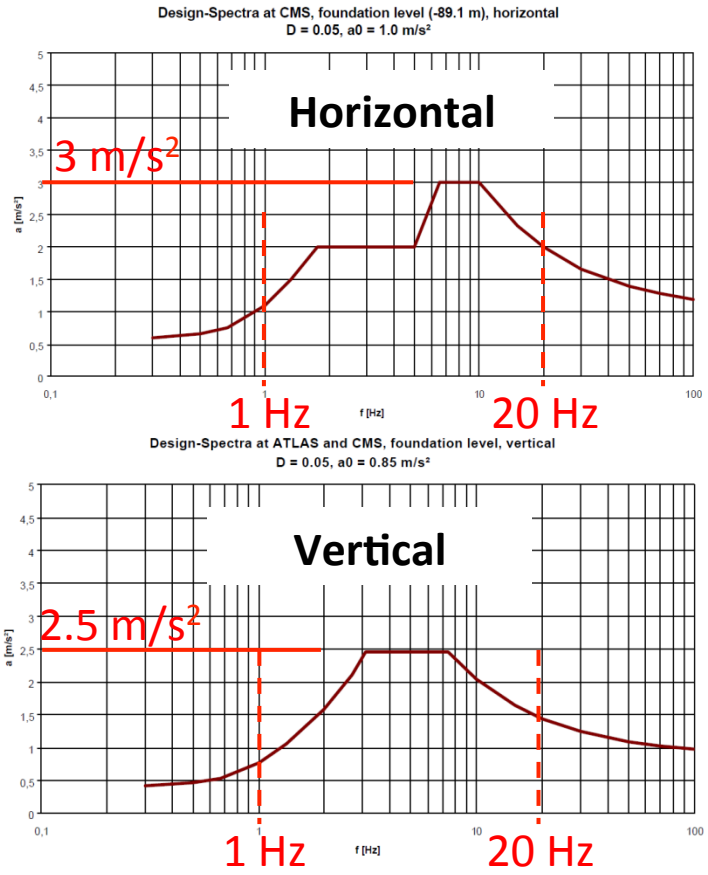
I. – A l'article R. 563-2, le mot : « catégories » est remplacé par le mot : « classes ».

II. – L'article R. 563-3 est remplacé par les dispositions suivantes :

CERN

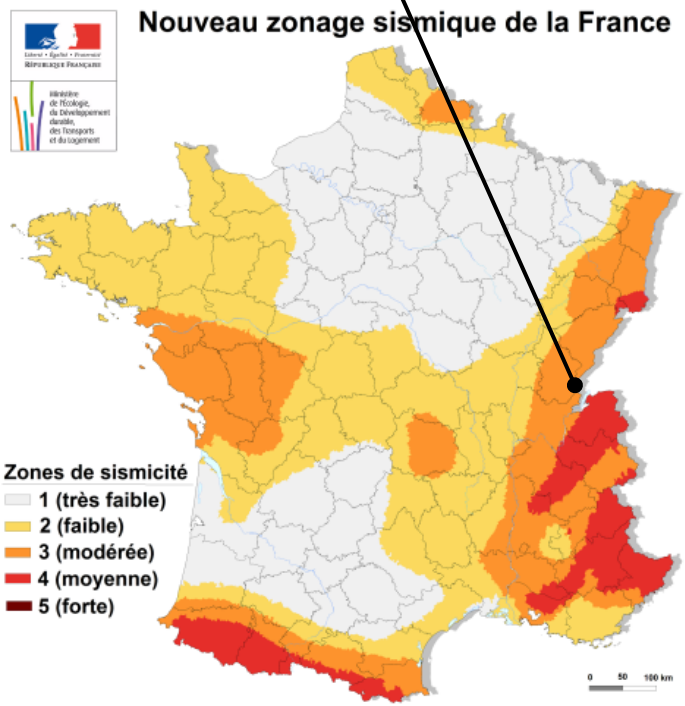
French/Swiss/European regulations enforced;

Expected seismic action



G. Benincasa and R. Schmidt, "Seismic design spectra for ATLAS and CMS", March 2000

CERN is within a "moderate seismicity" zone;

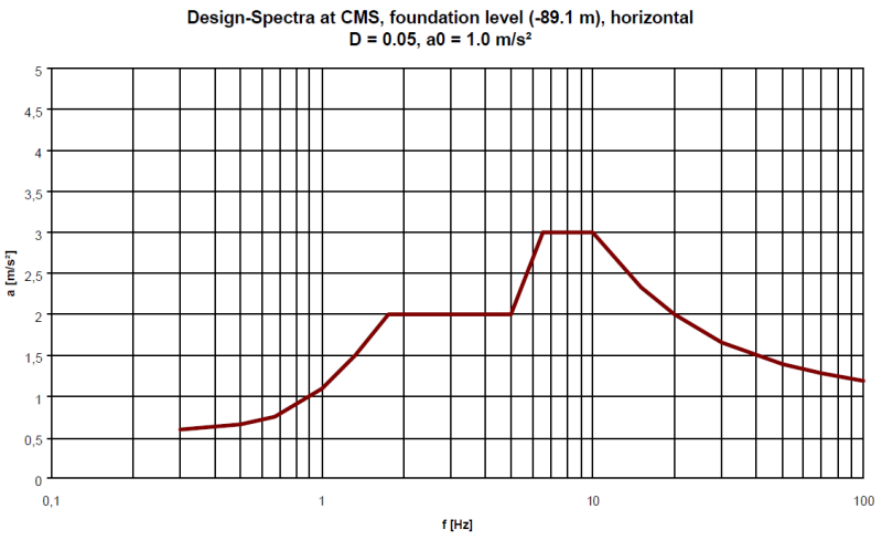


Epicentral distance	Magnitude (Richter)	Duration
15 km	5.5-6.1	15 s

Expected seismic action
(Horizontal direction)

CERN

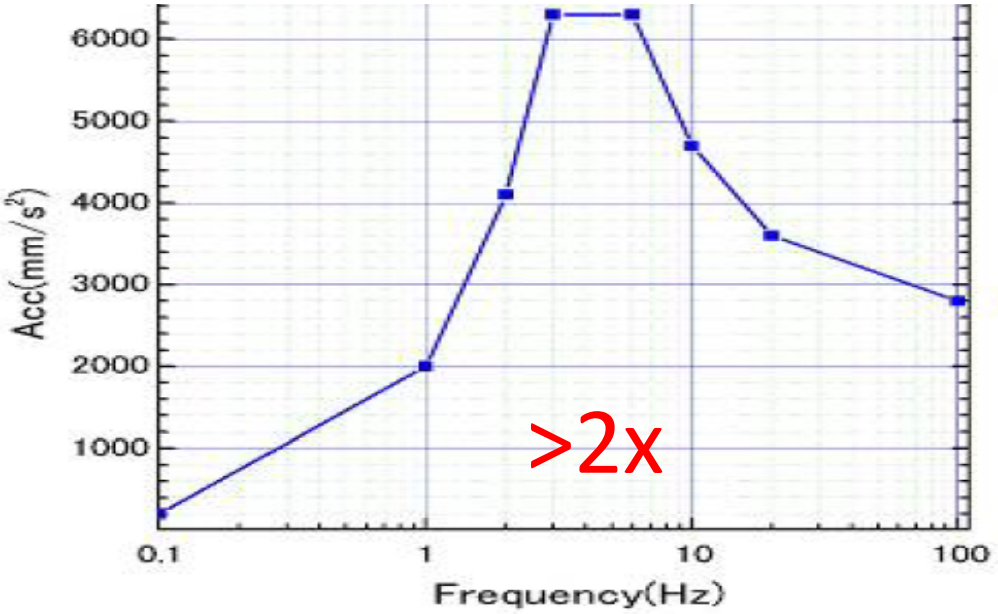
Max. Acceleration: 3 m/s^2



CMS seismic design spectrum

J-PARC

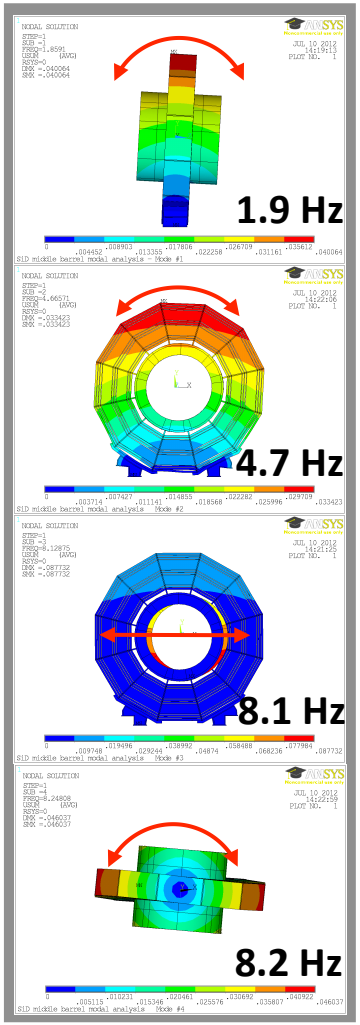
Max. Acceleration : 6.3 m/s^2

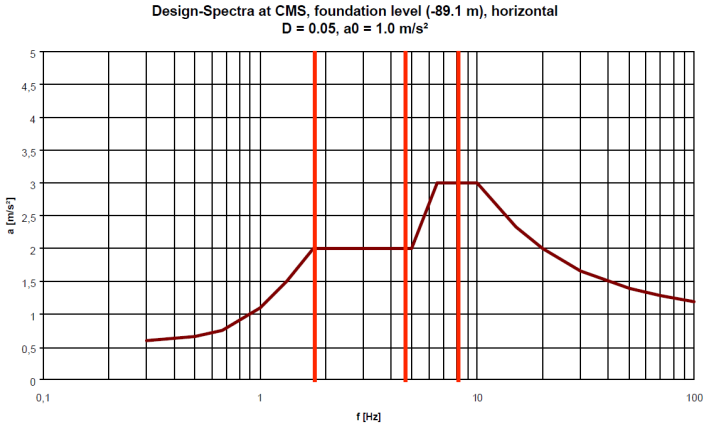


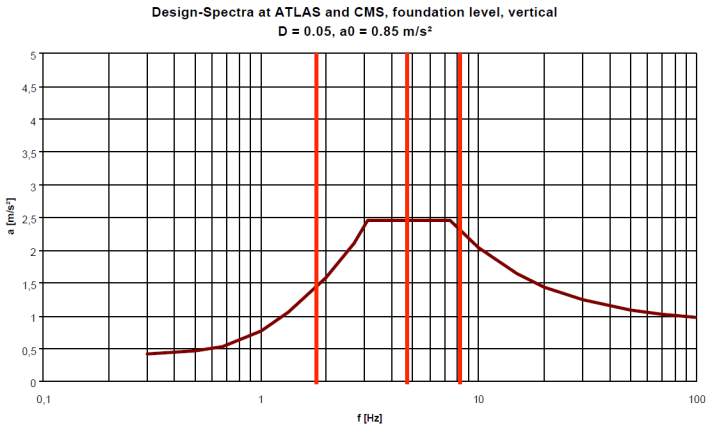
J-PARC - ND280 magnet system seismic design spectrum
Courtesy: T. Tauchi (KEK)

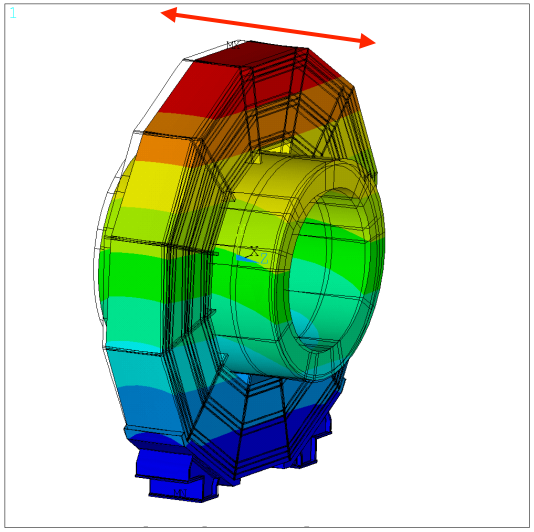
CLIC_SiD yoke – Garage position

Modal analysis

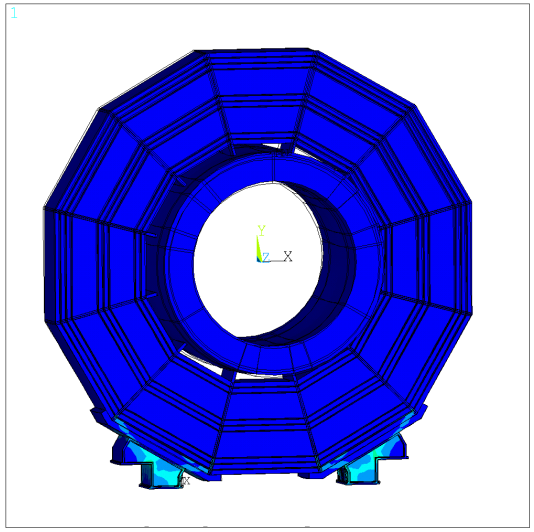








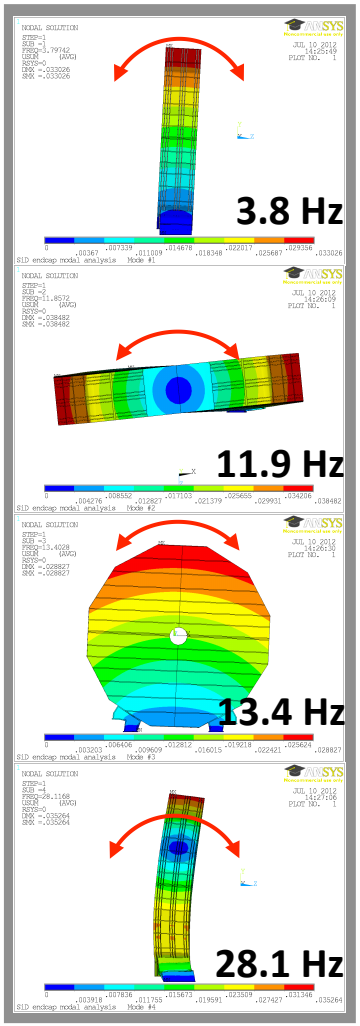
Maximum deformation: **23 mm**

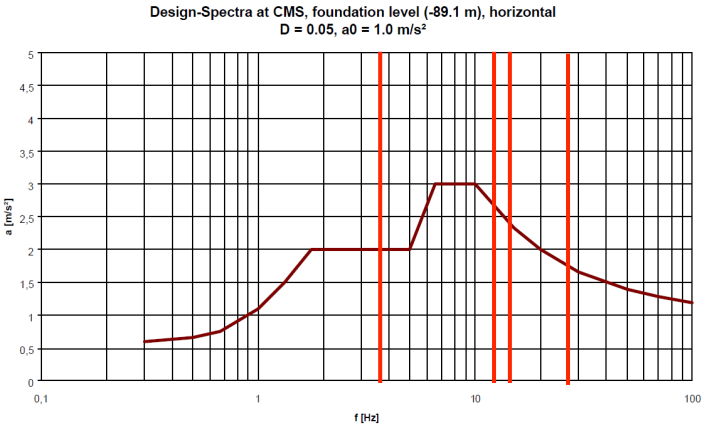


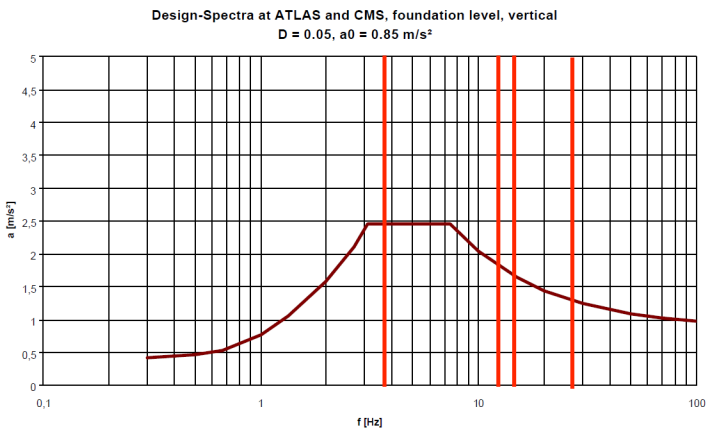
Maximum v. Mises stress: **350 MPa**

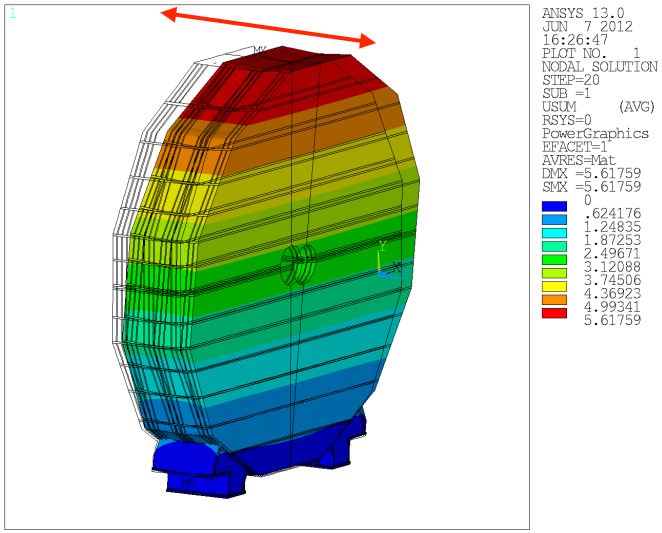
CLIC_SiD yoke – Garage position

Modal analysis

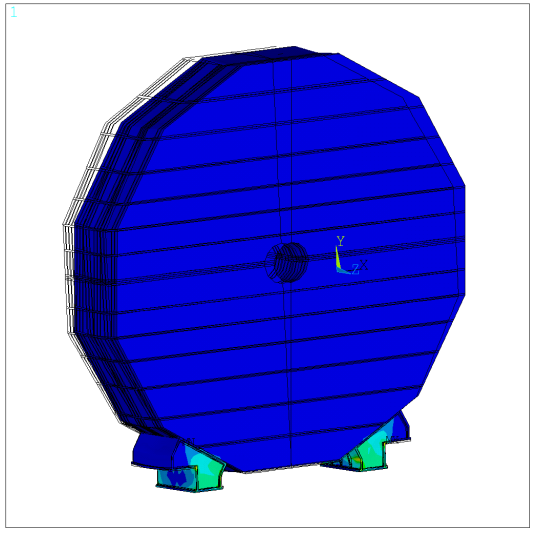








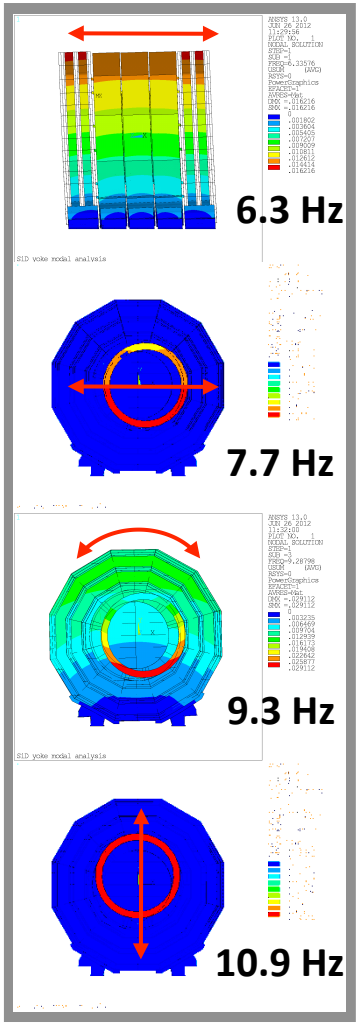
Maximum deformation: **5.6 mm**

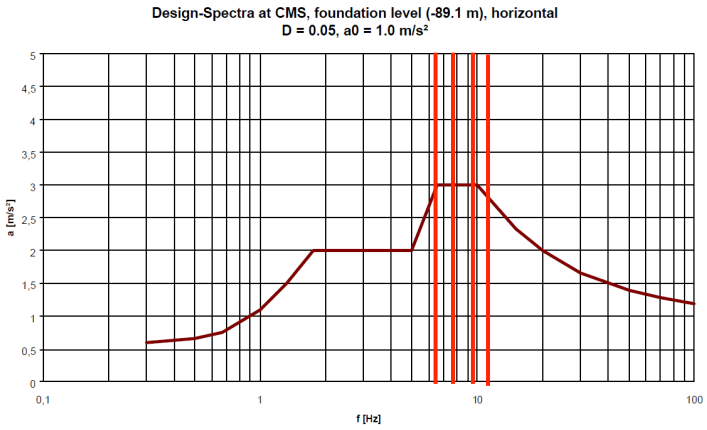


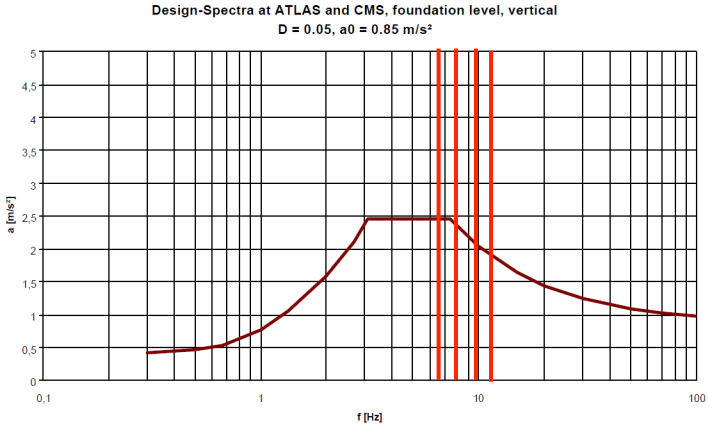
Maximum v. Mises stress: **172 MPa**

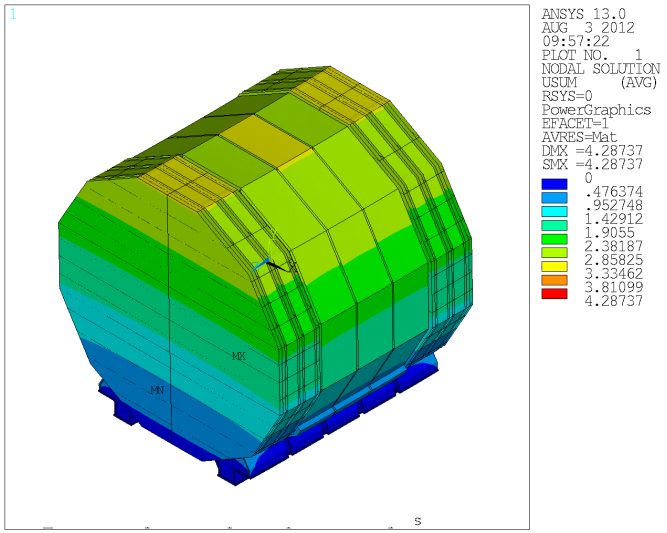
CLIC_SiD yoke – IP position

Modal analysis

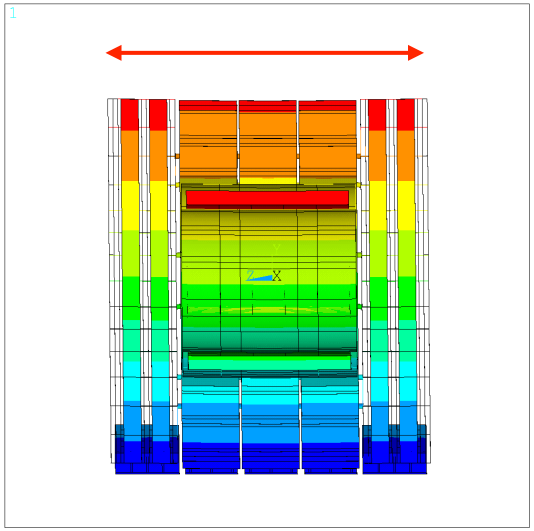








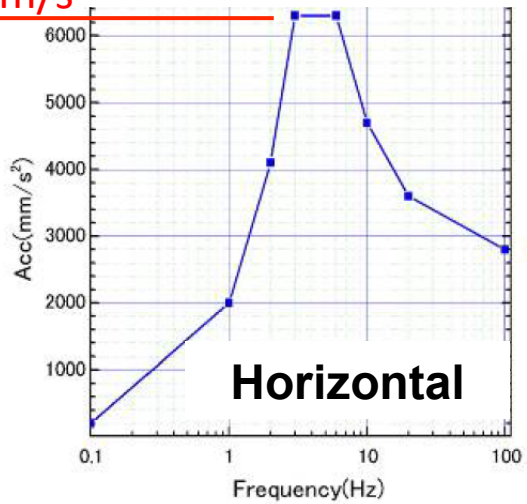
Maximum deformation: **4.3 mm**



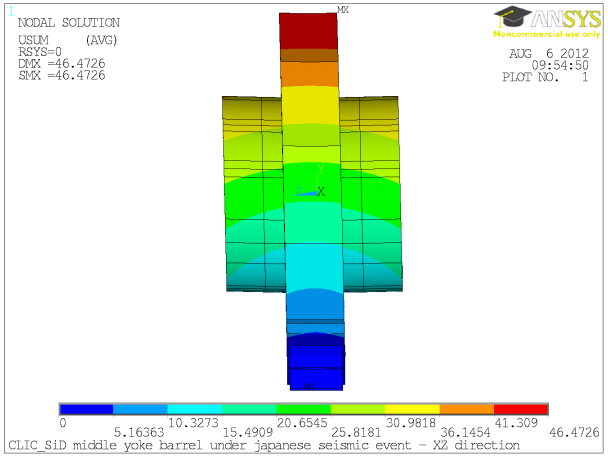
Deformation along beam axis: **2.8 mm**

CLIC_SiD yoke – J-PARC spectrum

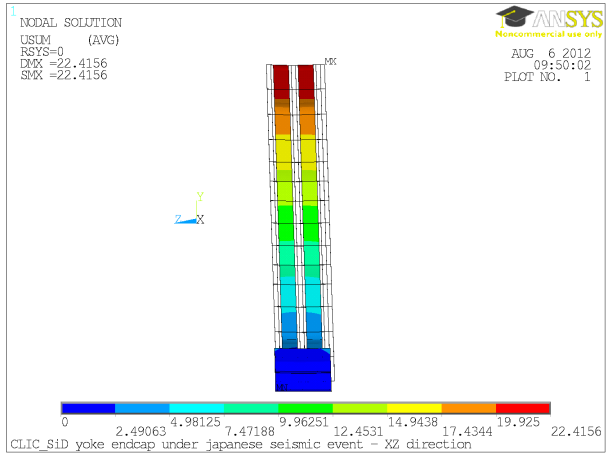
6.3 m/s²



J-PARC - ND280 magnet system spectrum
Courtesy: T. Tauchi (KEK)

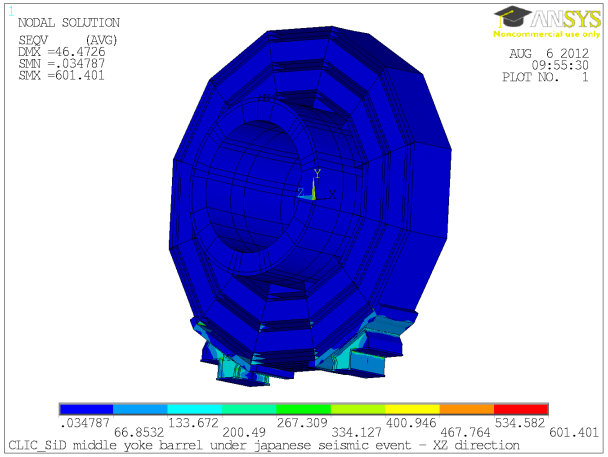


Maximum deformation: **46.4 mm**

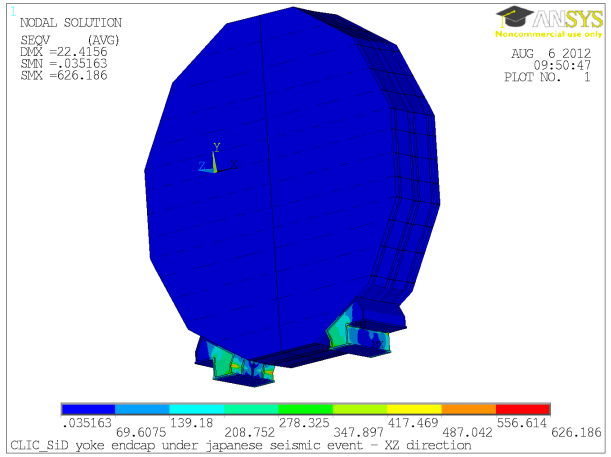


Maximum deformation: **22.4 mm**

Rigid strategy **not feasible** in high seismicity locations



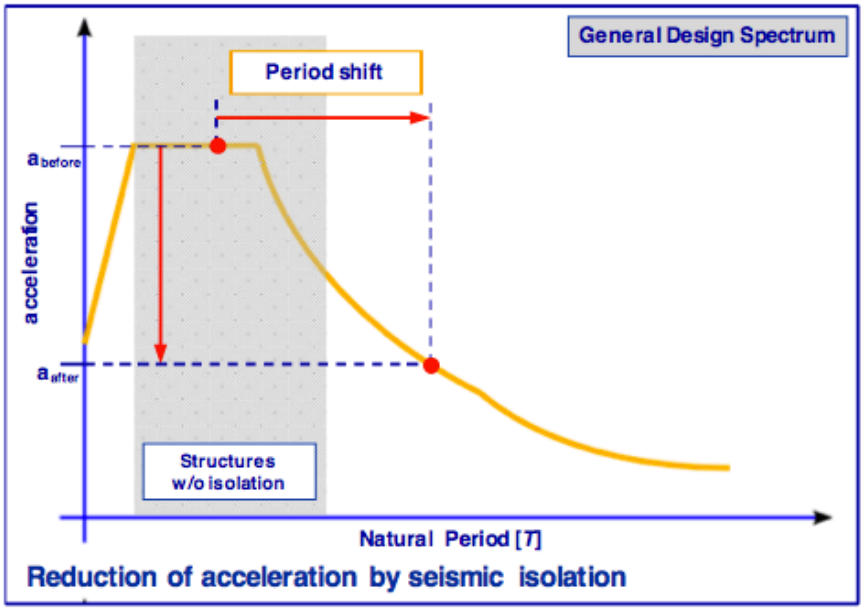
Maximum v. Mises stress: **601 MPa**

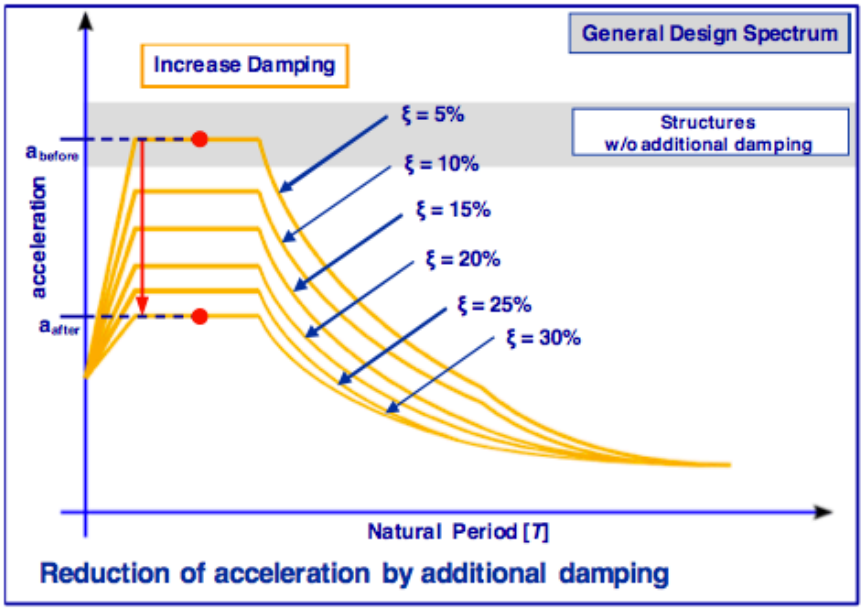


Maximum v. Mises stress: **626 MPa**

Seismic isolation

Two methods available:

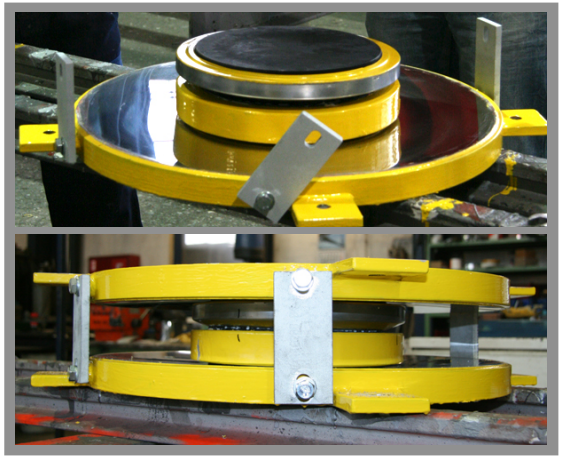


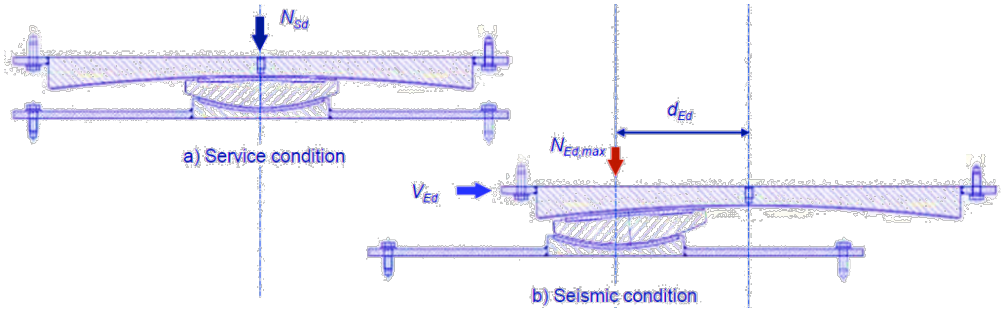


Seismic isolation

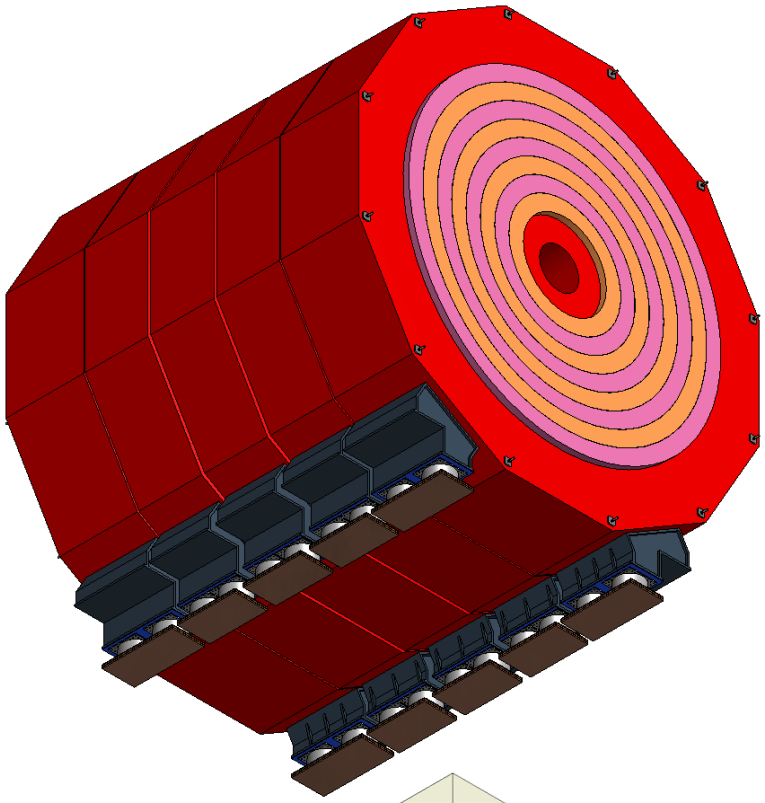
- Friction pendulum isolators beneath the detector feet;
- Energy dissipation due to dynamic friction;
- Reliable technology;
- No high compliance elements (e.g. rubber) improves the positioning of the detector;

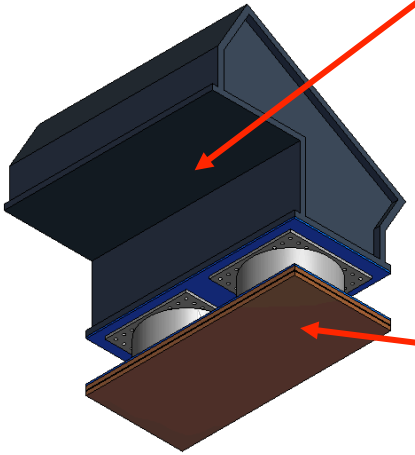
Pendulum isolators

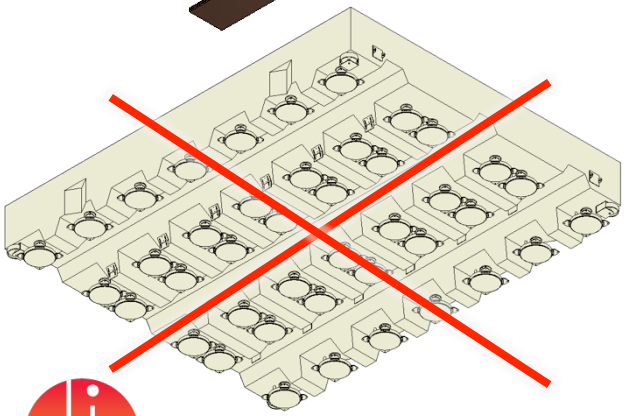


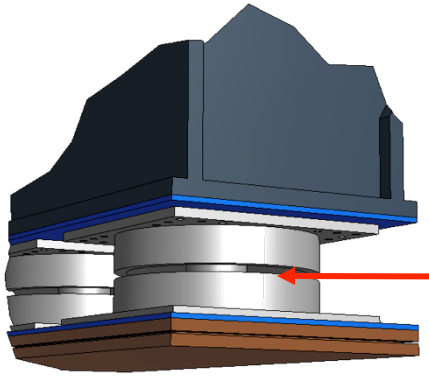


Seismic isolators integration



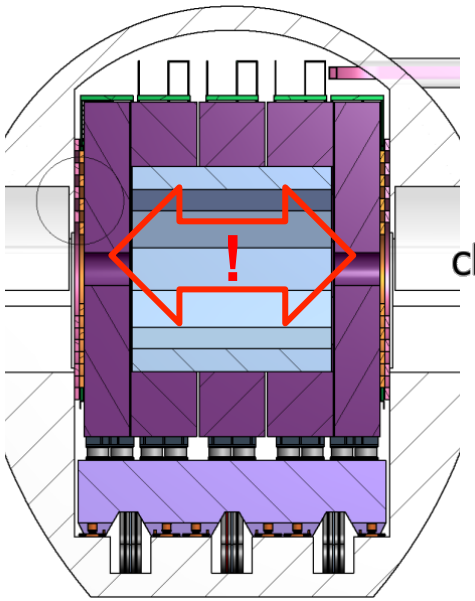


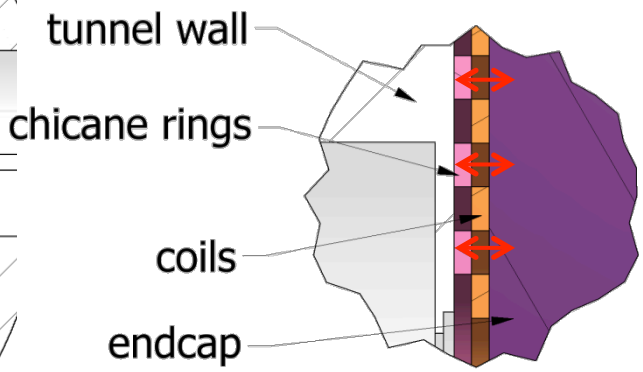




Seismic isolators integration

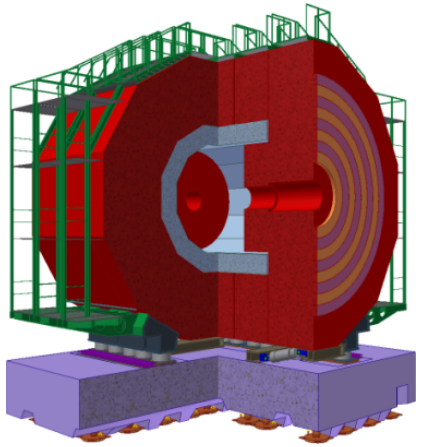
- Movement of detector restricted by cavern walls;
- Viscous dampers can be used to limit oscillation amplitudes along the beam direction;
- Chicane rings can allow longitudinal movement;

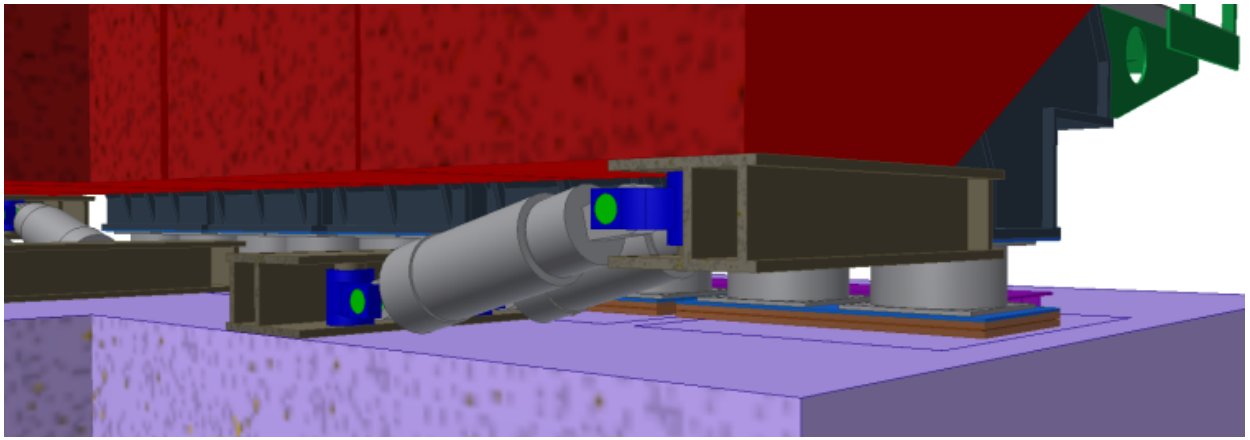




Seismic isolators integration

- 8 dampers connect the closed detector to the platform;
- Mechanical “fuse” provides rigidity under normal operating conditions;
- Removal upon opening of detector;





Summary

- Design of detectors must follow enforced regulations;
- In low to moderate seismicity areas, a rigid detector support might be an option;
- Validation through extensive FEA analyses is needed (special emphasis to calorimeters and inner detectors);
- Otherwise, above platform seismic isolation will be required;
- Cavern design, push-pull operation and available space will dictate the final design.

Thank You.