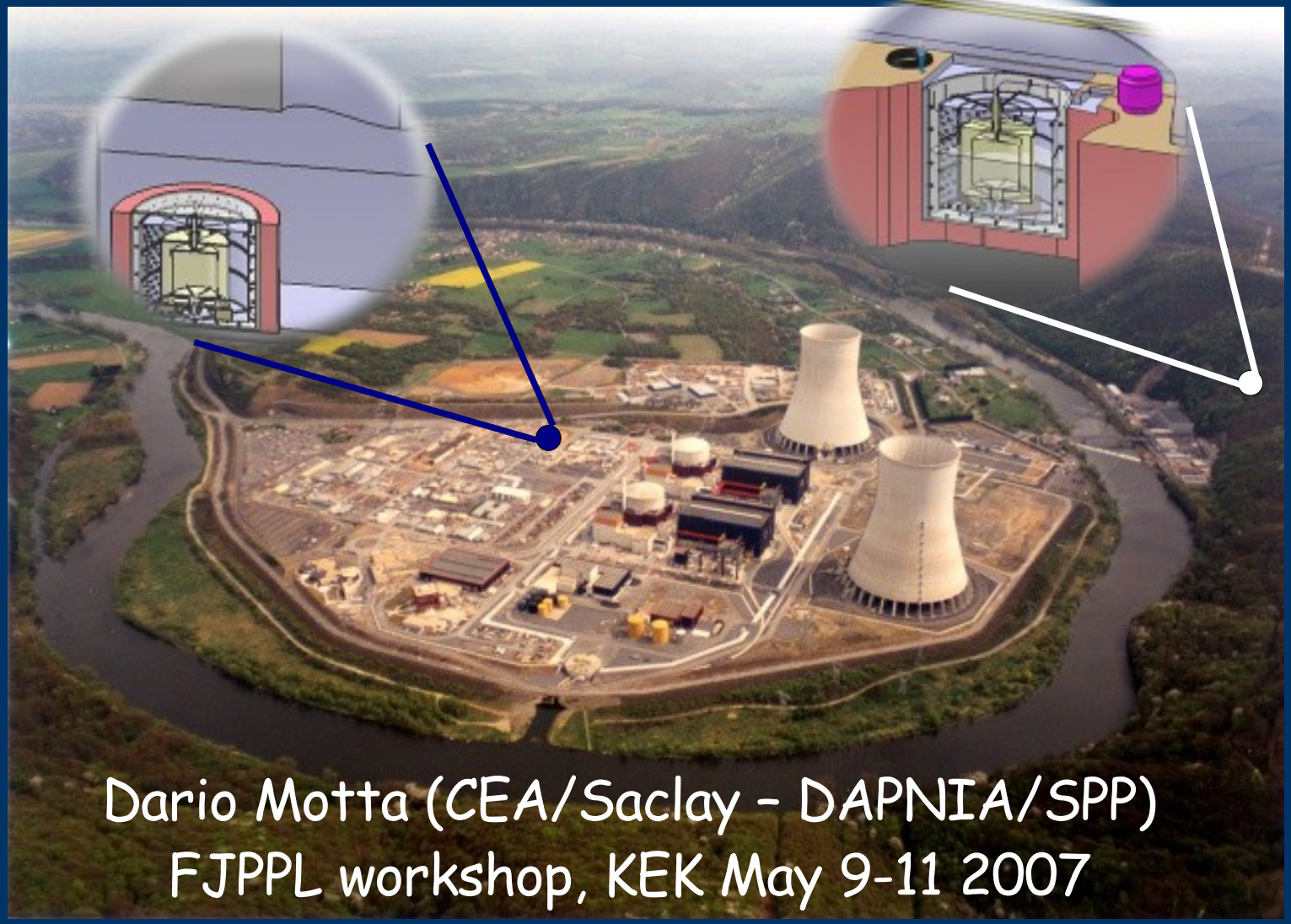
Double Chooz

(status report for France)

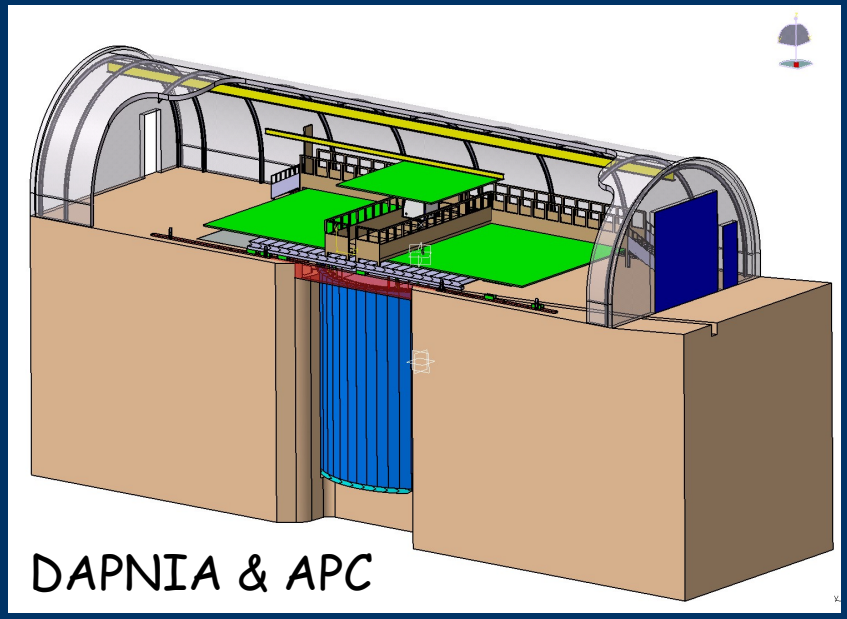


Dario Motta (CEA/Saclay – DAPNIA/SPP)

FJPPL workshop, KEK May 9-11 2007

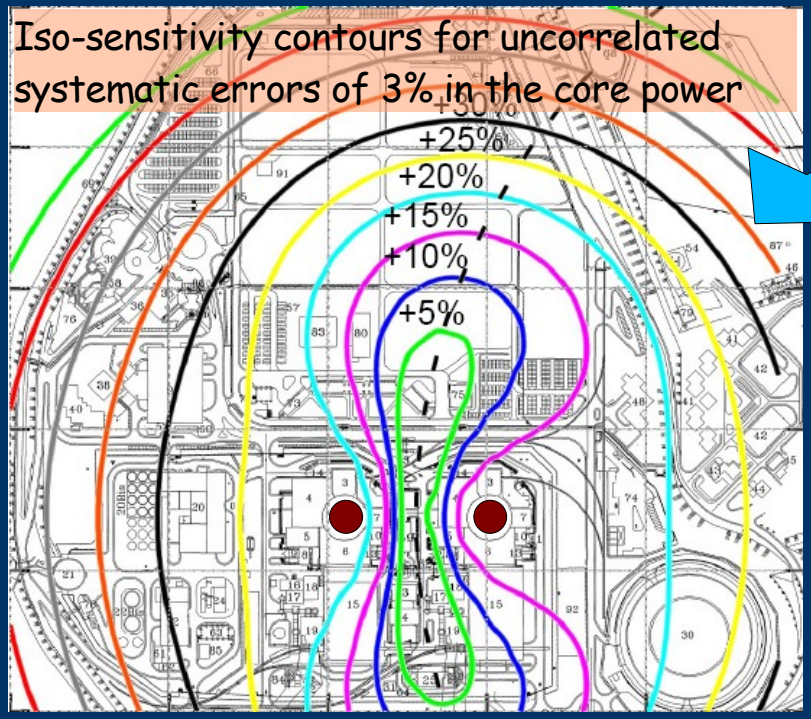
News from the far site & detector

- Refurbishing ongoing
- Safety file ongoing
- External storage building for the liquids available
- Material procurement started !
  - stainless steel for 2 buffer vessels received in Saclay
  - Gd material delivered this summer
  - Tender for 250 tons of shielding steel
- Site already fully available
- Starting detector installation at the beginning of 2008

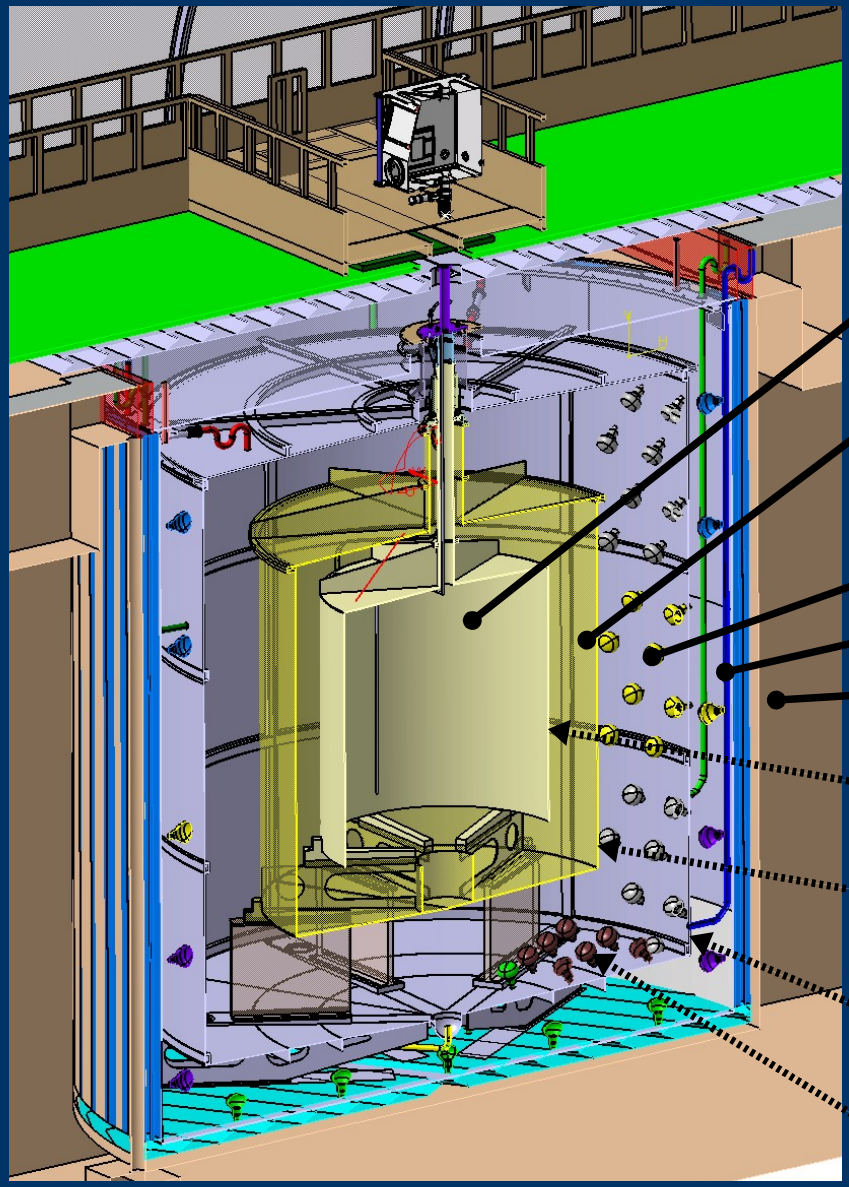


News from the near site

- Contract between CEA/CNRS and EDF signed, towards:
  - Site optimization (physics/costs)
  - Preliminary design
- Foreseen laboratory availability: fall 2009
- Detector integration will start by the beginning of 2010



Detector design finalized ...



$\bar{\nu}$ Target (~ 8.2 tons Gd-doped scintillator)

$\tilde{\gamma}$ catcher (t = 55 cm, undoped scintillator)

Buffer (t = 105 cm, mineral oil)

Veto (t = 50 cm, scintillator)

Shielding (15 cm steel)

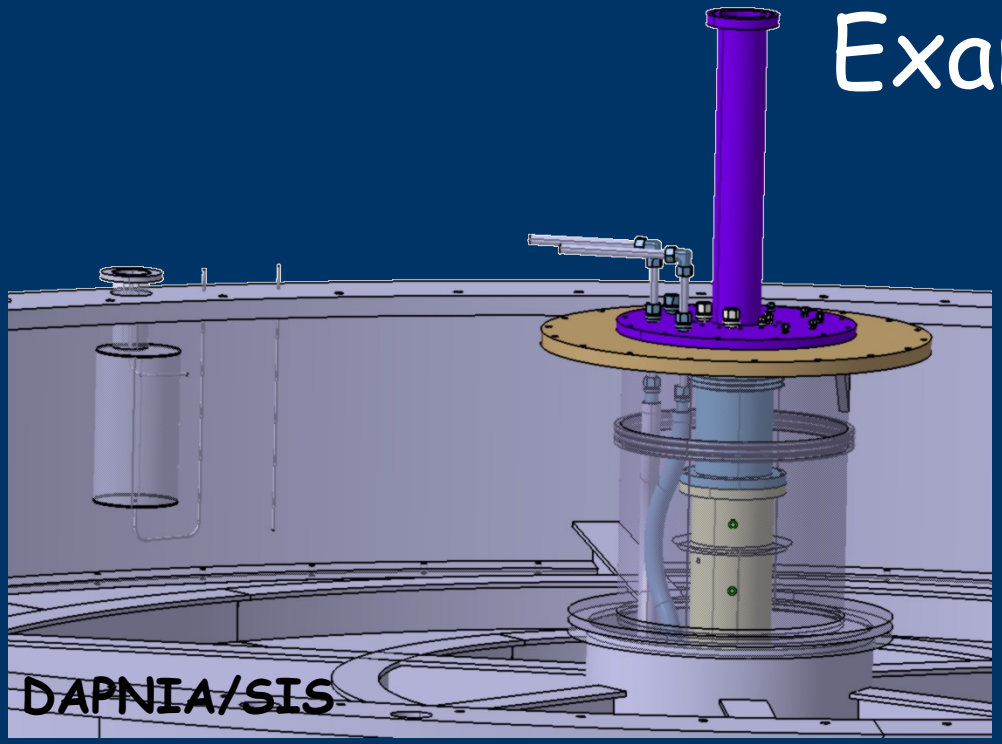
Acrylic target vessel

Acrylic γ - catcher vessel

Buffer tank (stainless steel) & PMT support structure

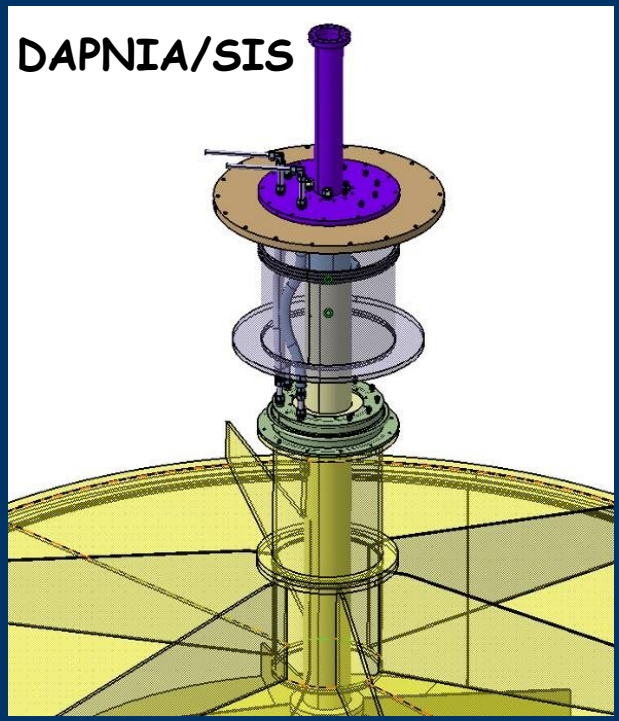
PMTs : 390 x 10 " + 78 x 8 " (Veto)

... down to the finest details



Example : chimney system

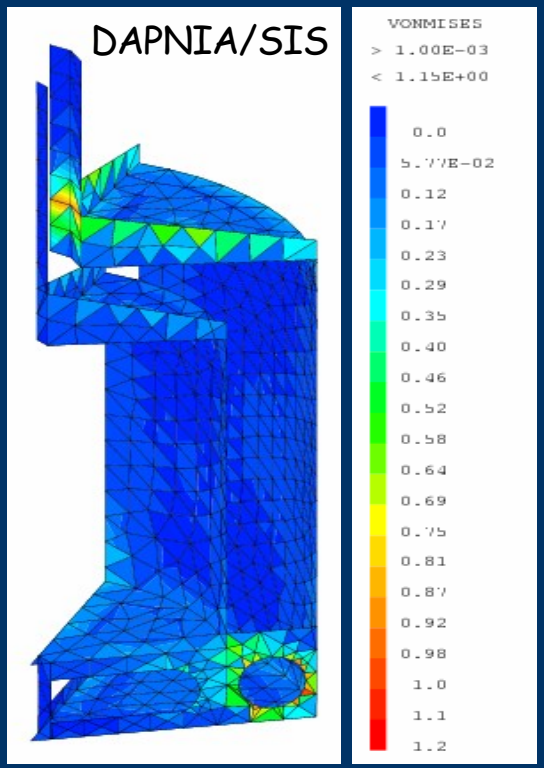
Critical interface for filling and calibration



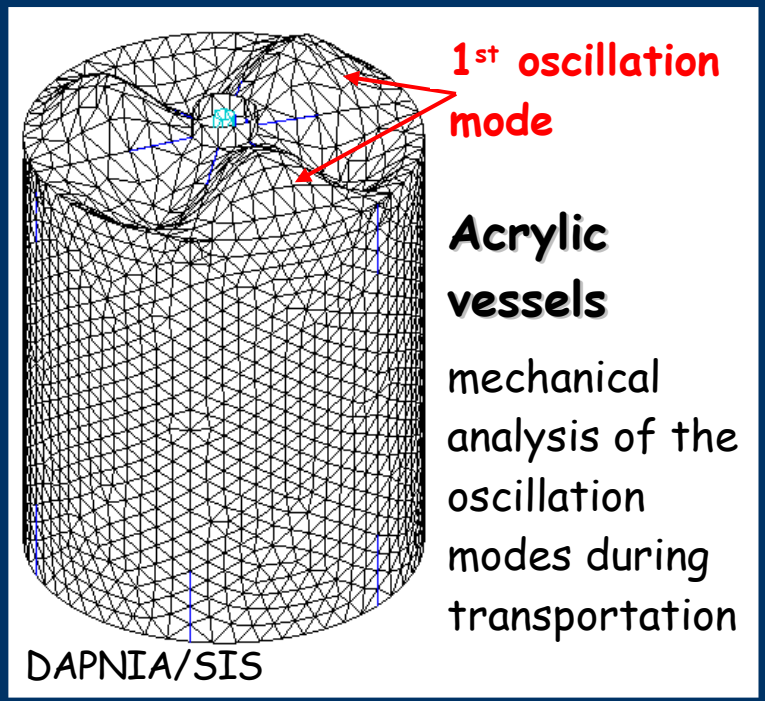
Scale 1 prototype now under construction in Saclay

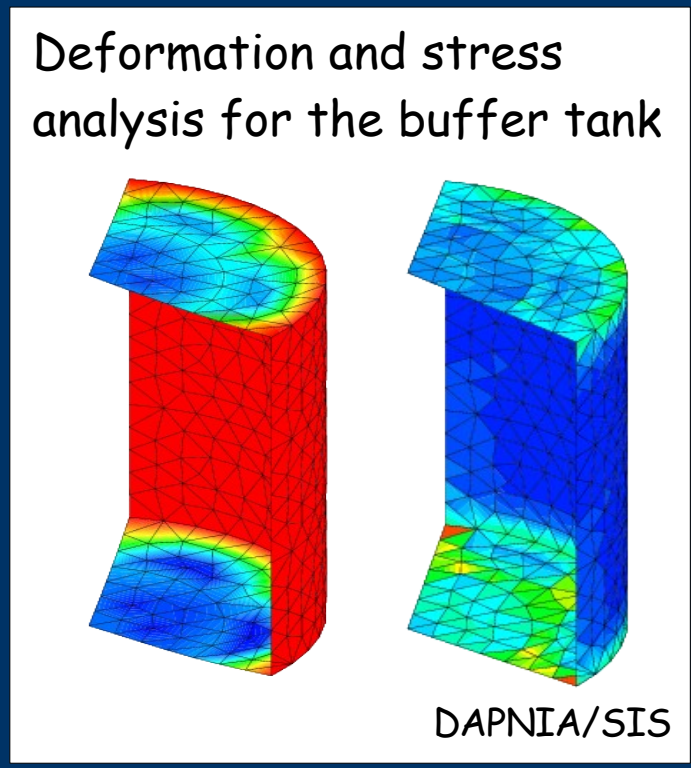
All technical solutions validated by :
1. Mechanical simulations

Most dangerous phases: dead load and detector filling



Acrylic double vessel
max stress: 1.2 MPa



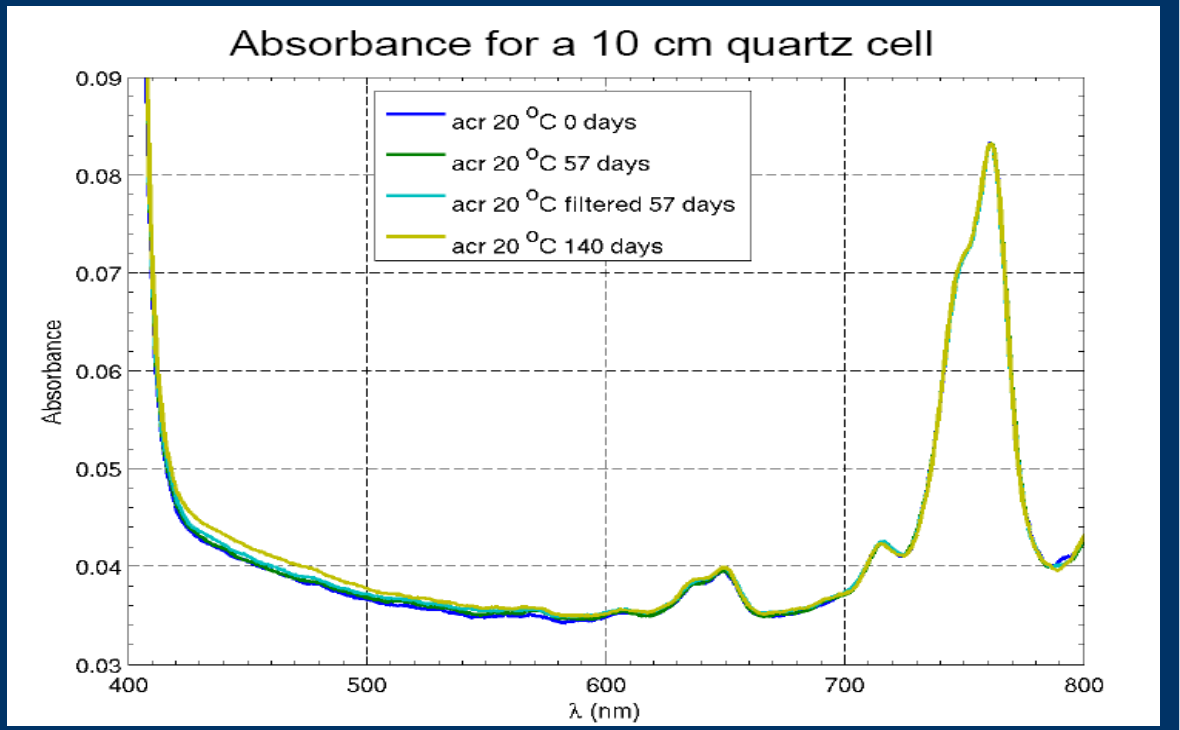


In all cases we assumed a safety factor of 10 with respect to the known material failure stress

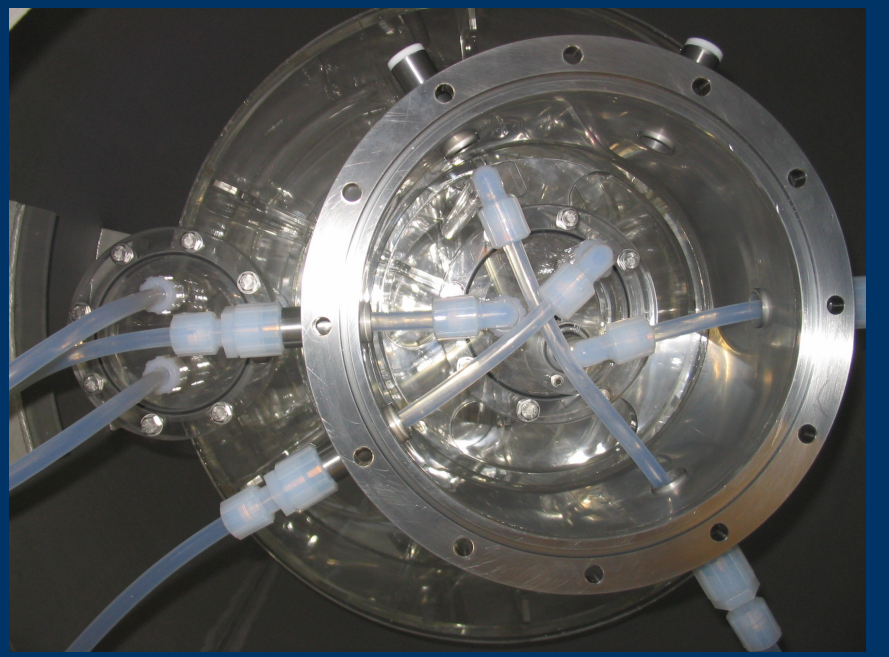
2. Compatibility with the scintillators

Scintillator aging studied by spectrophotometry:

- Gd-loaded scintillator stored under N_2 with/without exposition to materials (acrylic, acrylic glue, steel ...), at 20° and 40°
- periodic transfer into 10 cm optical cells
- measurement of the absorbance spectrum
- validation / rejection upon spectrophotometric results
- if validation, mechanical tests



3. Prototyping

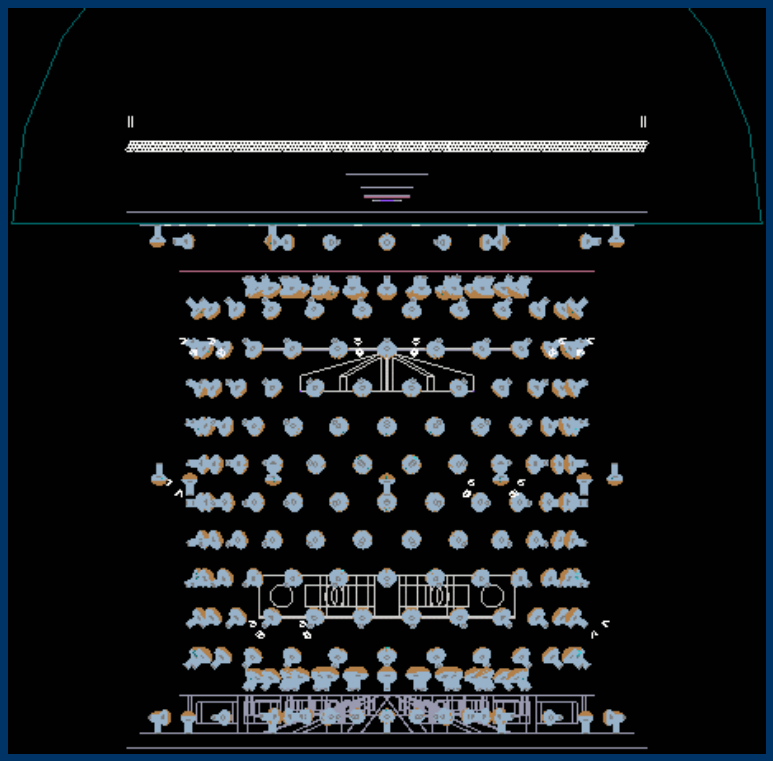


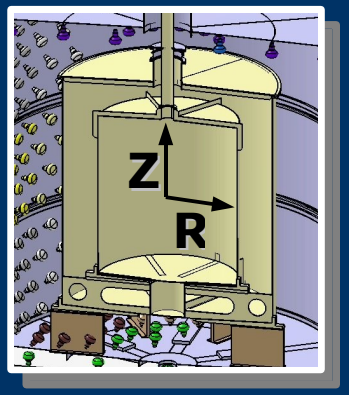
Validation of many technical solutions

- construction
- materials and chemical compatibility
- filling system & interfaces

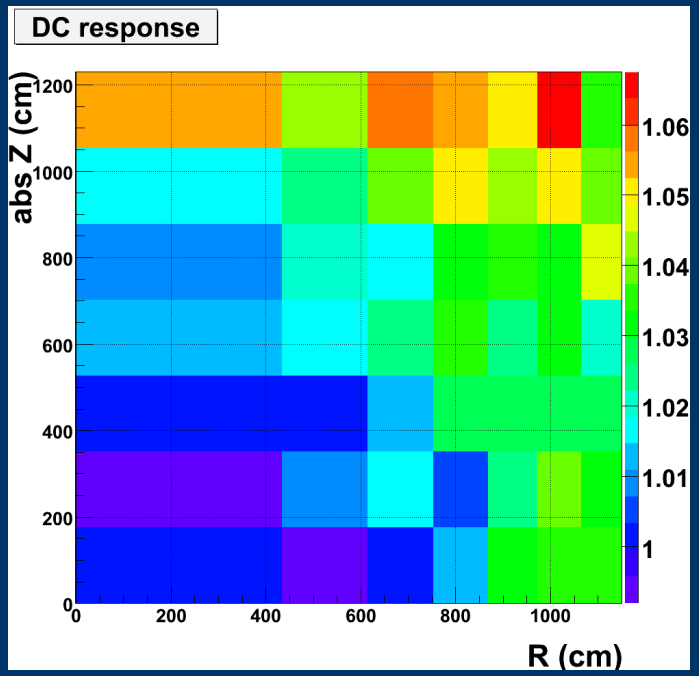
A very learning experience !

... and of course Monte Carlo !



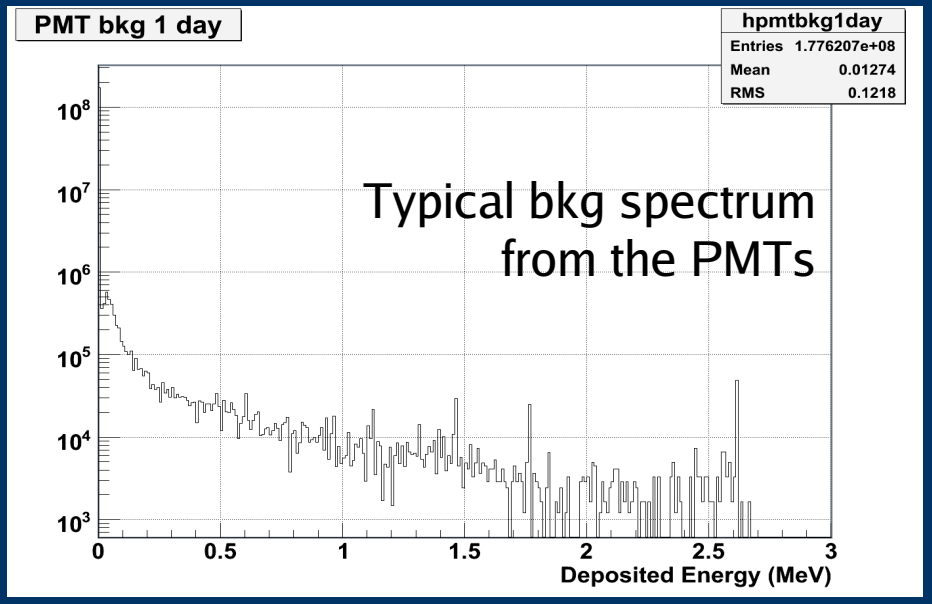


2D-representation of the detector response



MC activities in France:

- detector geometry and materials
- optical model
- detector response & calibration
- read-out system simulation
- backgrounds

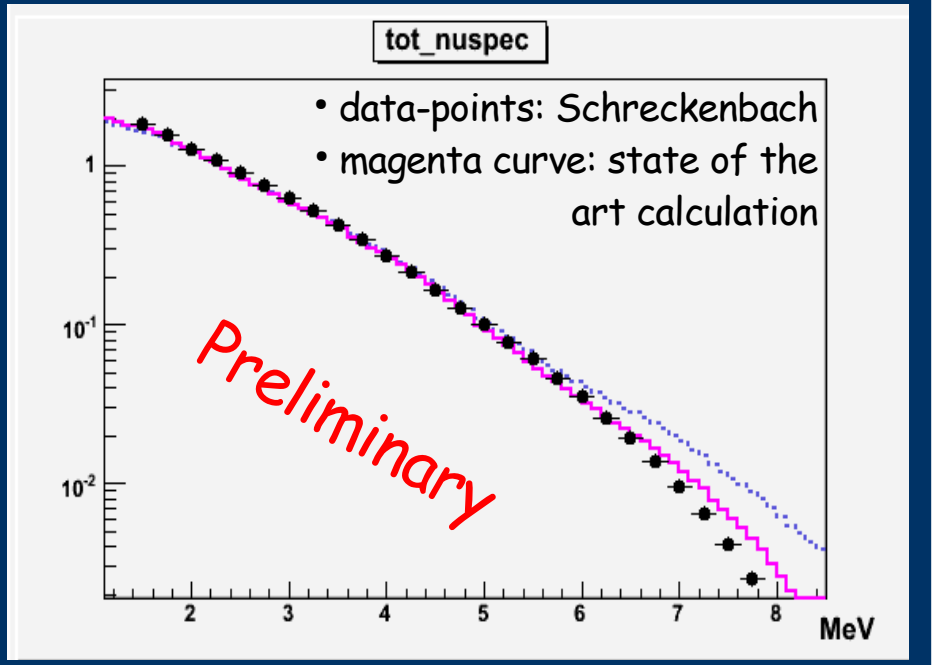


Novel calculation of the reactor anti-neutrino flux and spectra

Ab initio simulations

1. evolution code for the core (MURE)
   - → instantaneous isotope abundances
2. nucl. data-base + exp. β spectra + theory
   - → single β branch spectra

1. + 2. => Total β/ν spectra



Spectral shape in very good agreement with Schreckenbach up to 6 MeV (absolute normalization not yet there)

Advantages of this approach

- unambiguous conversion to ν spectra
- error propagation *ab-initio*, as well !
- correct handling of the error correlations
- work in progress to improve the accuracy w.r.t. present assumptions

(now ~ 2% on average per energy bin, based on Schreckenbach)

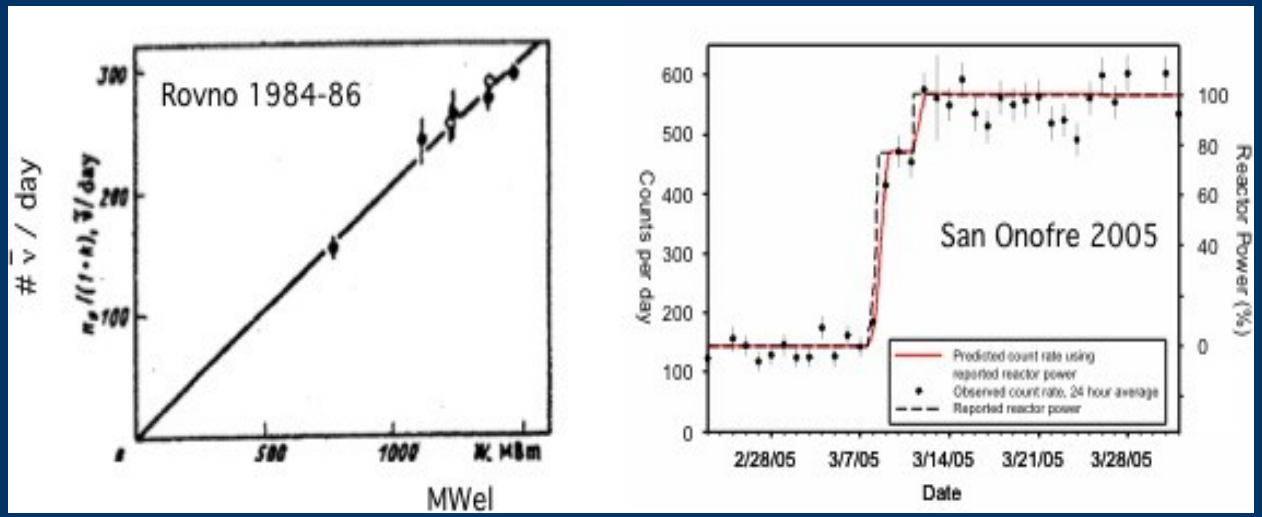
Applied anti-neutrino physics

Double Chooz is a unique laboratory to test novel $\bar{\nu}_e$-physics applications, especially in the domain of nuclear reactor monitoring

1. Independent, non-intrusive, real-time measurement of the reactor thermal power (note: power determination entangled with the fuel isotopic composition)
2. Remote determination of the fuel composition for non proliferation monitoring

Strong initiatives in France. Staged approach considered: 1. and then 2.

Funding request to an independent French agency towards the construction of a prototype for the thermal power measurement



For more on this:

AAP 2007 Applied Antineutrino Physics
APC Paris, France
December 13-14 2007

http://www.apc.univ-paris7.fr/AAP2007/