Status of Double Chooz

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Neutrinos and Dark Matter in Nuclear Physics, Paris, 2006

Collaboration

June 2006: Double Chooz proposal
119 authors from 26 institutions
hep-ex/0606025

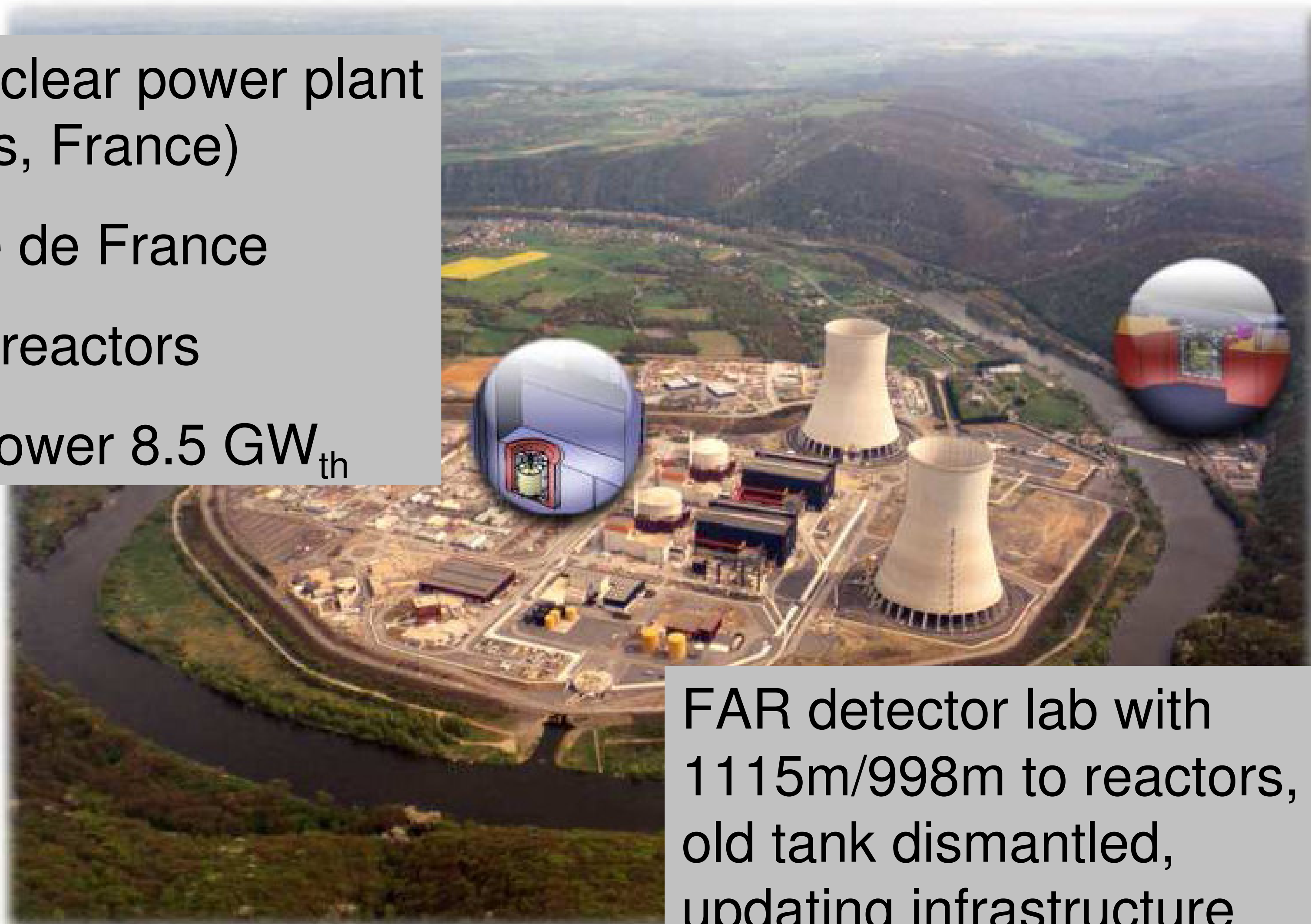
Double Chooz site

Chooz nuclear power plant (Ardennes, France)

Electricité de France

2 N4 PW reactors

thermal power 8.5 GW_{th}



FAR detector lab with 1115m/998m to reactors, old tank dismantled, updating infrastructure

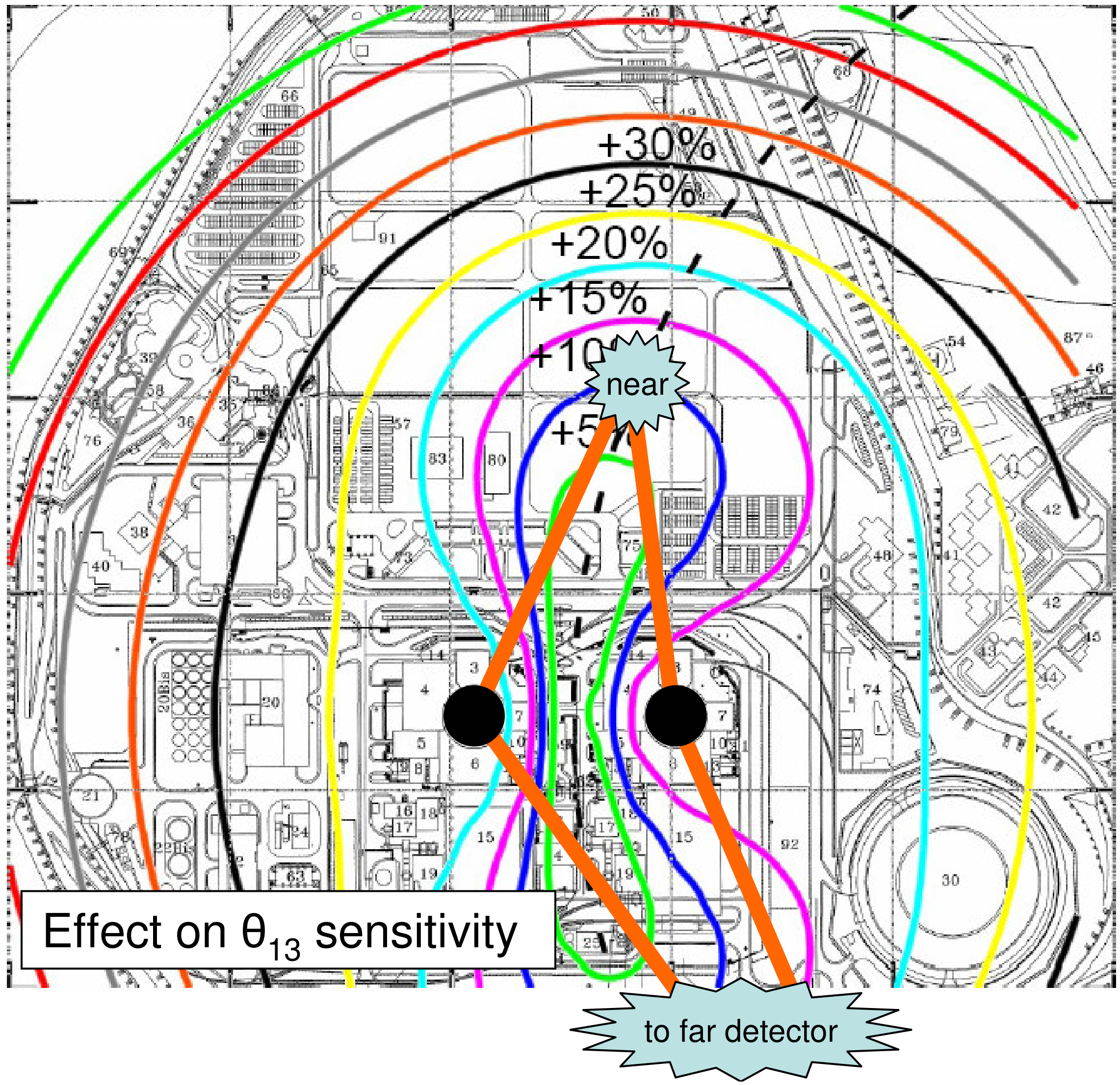
Near detector location

The near detector location has been chosen to

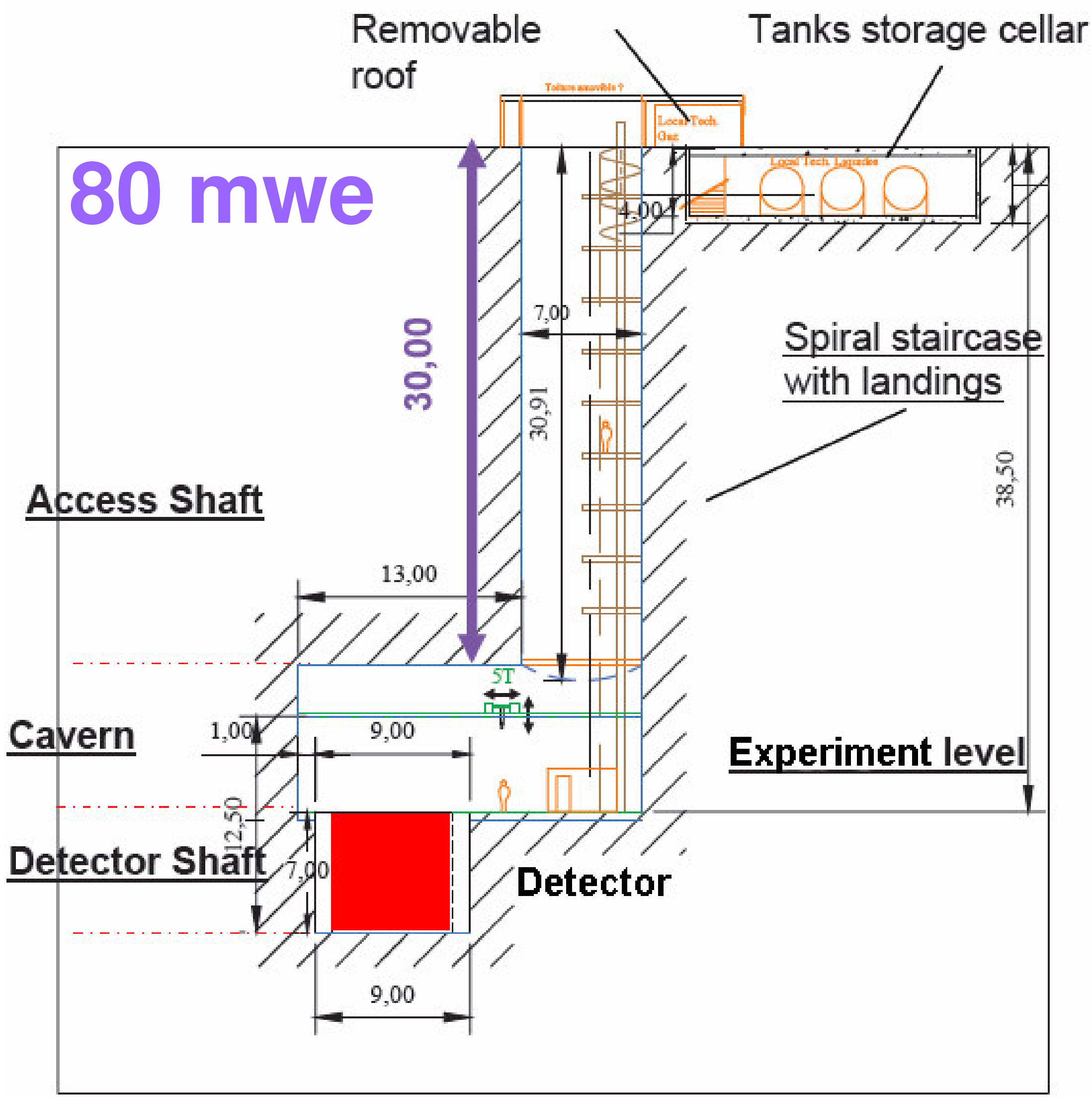
minimize the average distance from cores

maintain the same flux ratio between the two cores as in far location

satisfy the needs for safety and security



Near site (280m)

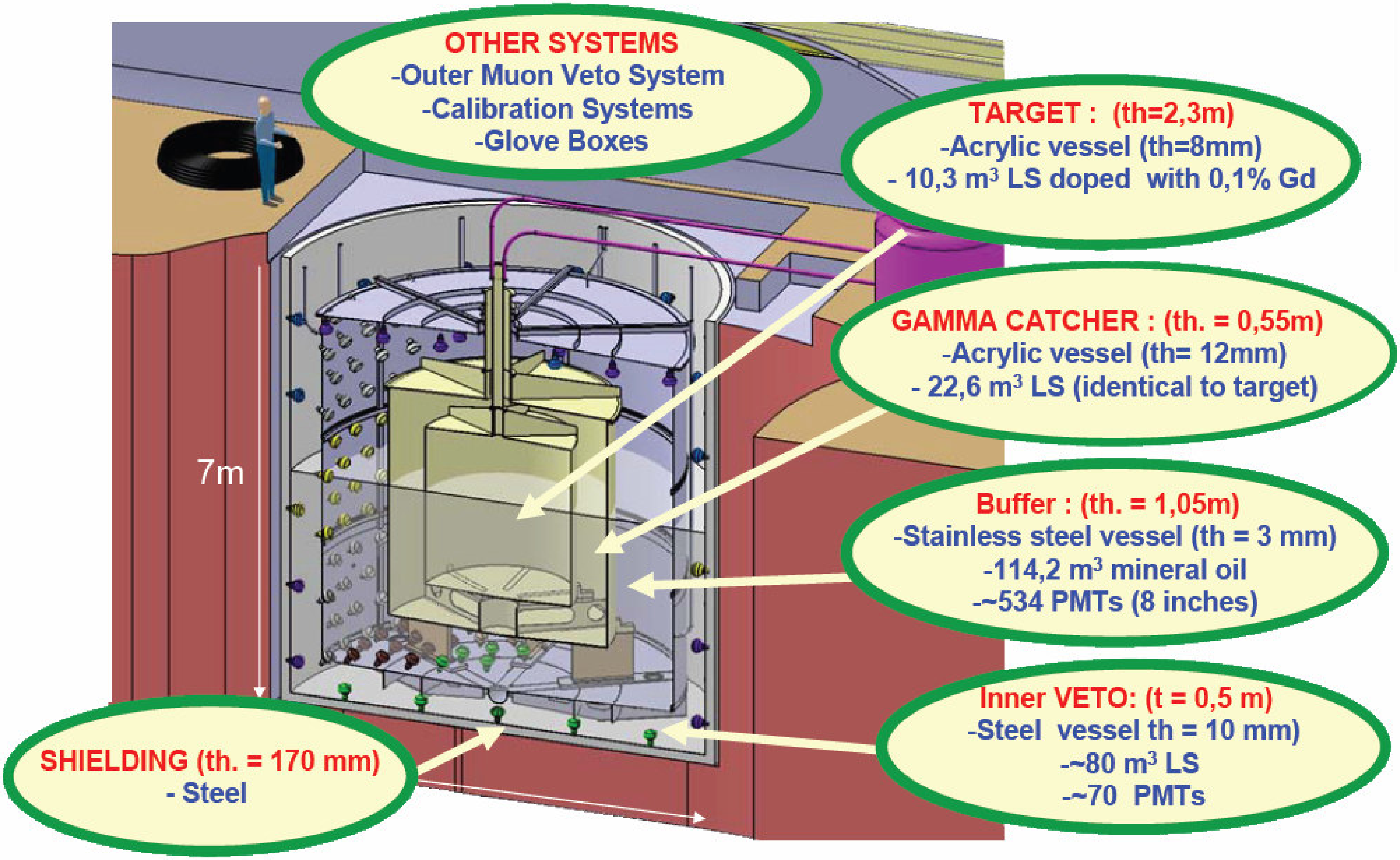


First civil engineering study in January.

Further development of design by working closely with EDF, to be completed in 2007.

We want a rather precise cost estimate to ask for funding at the local authorities.

The two detectors



Systematics

		Chooz	Double-Chooz	
	ν flux and σ	1.9 %	<0.1 %	
Reactor-induced	Reactor power	0.7 %	<0.1 %	two ''identical'' detectors, monitor flux with near det.
	Energy per fission	0.6 %	<0.1 %	
	Solid angle	0.3 %	<0.1 %	distance measured @ 10 cm + monitor core barycenter
	Volume	**0.3 %**	**0.2 %**	**same weight sensor for both det.**
Detector - induced	Density	0.3 %	<0.1 %	accurate T control (near/far)
	H/C ratio & Gd concentration	1.2 %	<0.1 %	same scintillator + stability of scintillator
	Spatial effects	1.0 %	<0.1 %	''identical'' target geometry & LS
	Live time	**few %**	**0.25 %**	**measured with several methods**
Analysis	**From 7 to 2-3 cuts**	**1.5 %**	**0.2 - 0.3 %**	**Low backgr., reduction of accidentals**
	Total	**2.7 %**	**< 0.6 %**	

Towards detector construction

calibration devices

PMT selection

scintillator stability

laboratory layout

correlated background

electronics

spent fuel effect

PMT support

neutron background

muon veto

safety

target mass determination

scintillator production

Gd loaded scintillator

simulations

cabling

magnetic shielding

mechanical integration

μ-induced background

calibration sources

shape uncertainty

slow control

cosmogenics (^{9}Li)

outer muon veto

PMT characteristics

radio assay

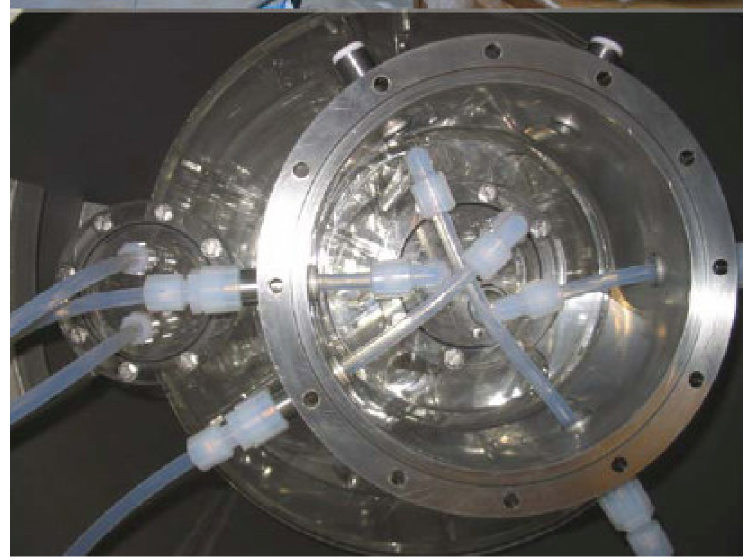
liquid handling

1:5 scale prototype

A 1:5 scale prototype was built and filled with scintillator liquids to validate the design of several mechanical solutions, e.g.

- acrylic vessels
- material compatibility
- liquid handling
- filling procedure
- critical interfaces
- coordination

1:5 scale prototype

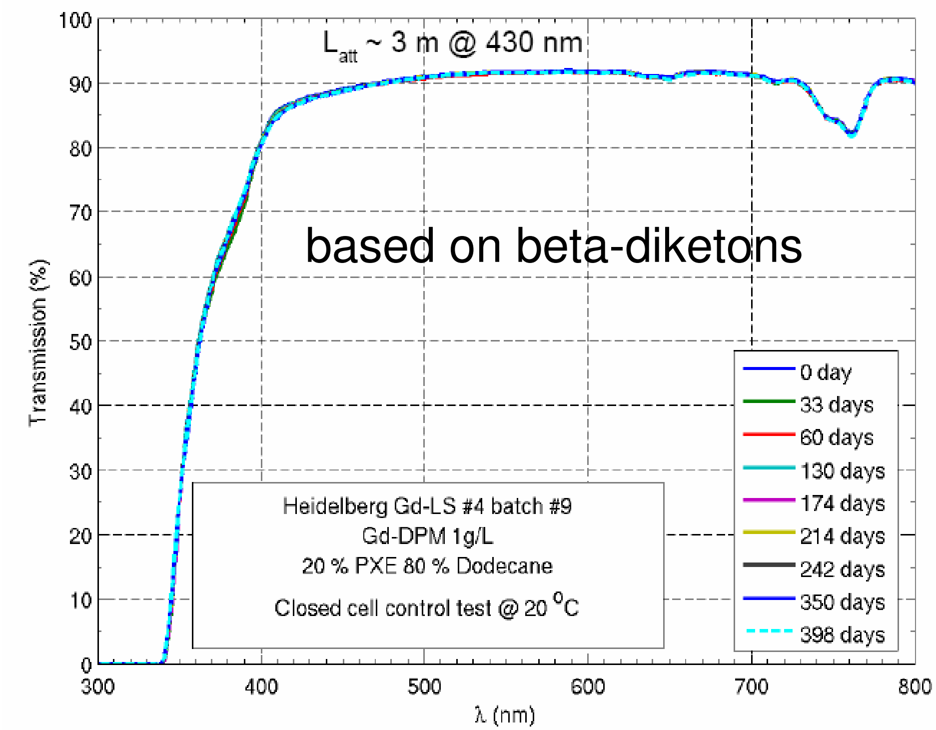


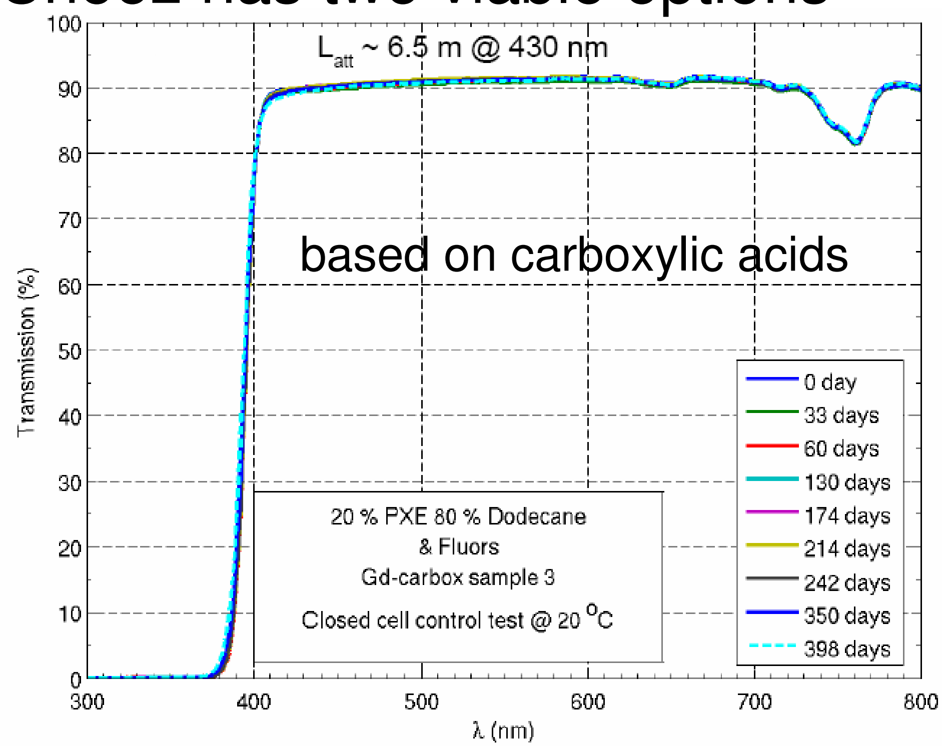
Experience with 1:5 mockup led to revisions of some technical solutions (filling system, interfaces).

Scintillator stability

- Limiting factor in Chooz and Palo Verde
- Development of new Gd doped scintillator compounds in Heidelberg and Gran Sasso (stable over 400 days), based on PXE & dodecane.

► Double-Chooz has two viable options





Gd-scintillator production

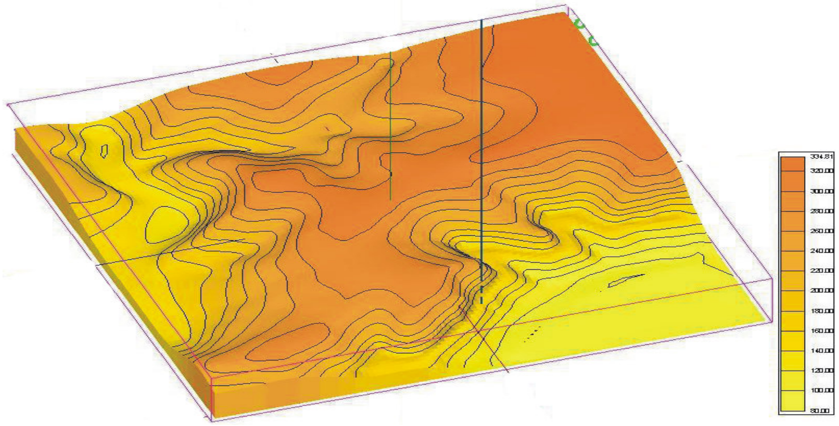
For two detectors, about 100kg is needed. Transition to industrial production:

- Confidentiality agreement with company
- first sublimation test of 50g and 400g finished
- final test for industrial production (700g) started (for sythesis of ~ 150l of scintillator)

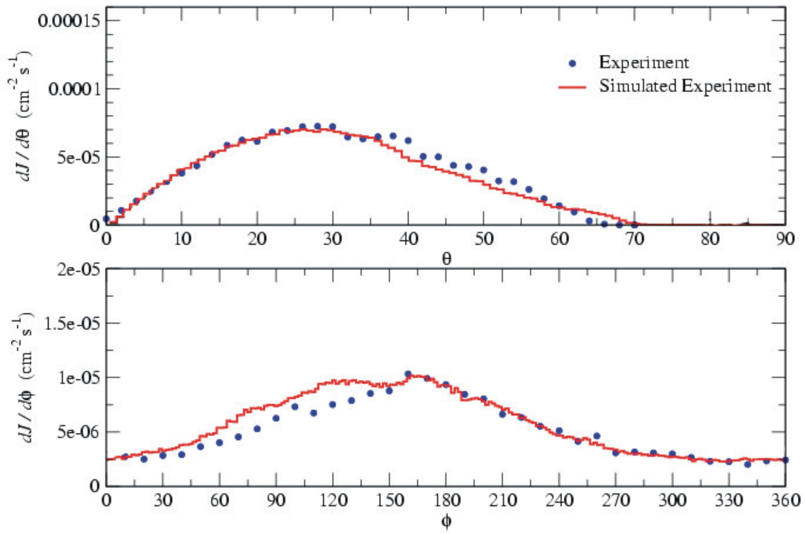
- MPIK Heidelberg is constructing a new building for storage and purification of all scintillators for both detectors.

- On-site storage tanks for scintillators in Chooz (authorization received from EDF)

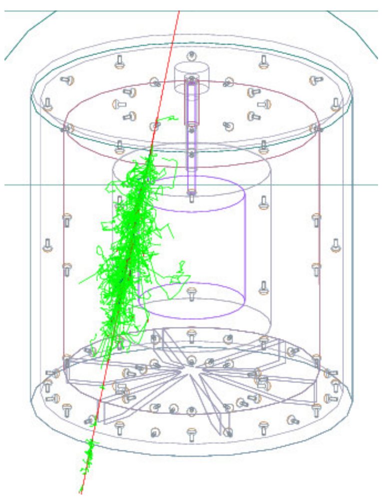
Muon veto system

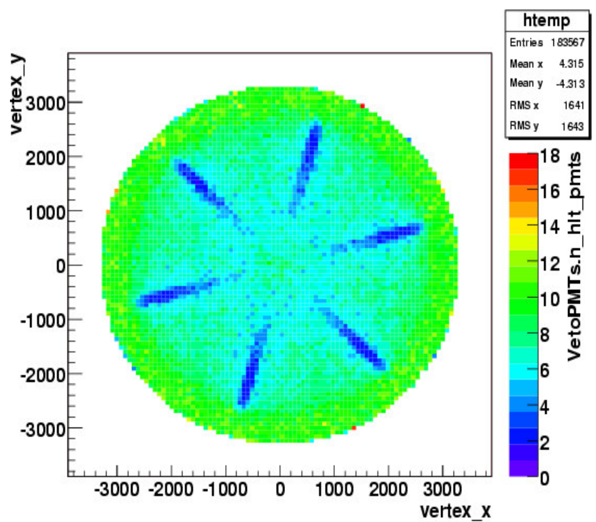


Digitized topographical map of the Chooz site.



Angular dependence of cosmic muons for the far detector.



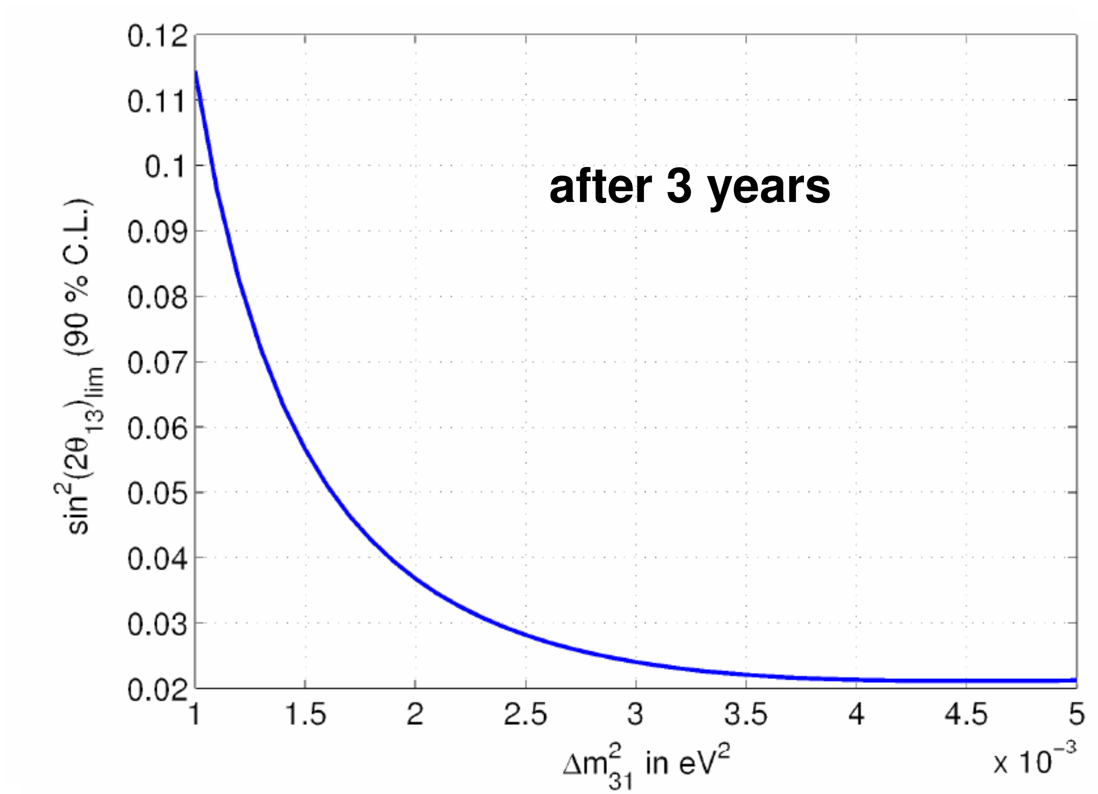


$\langle E_{\mu} \rangle \sim$
- 60 GeV (far)
- 20 GeV (near)

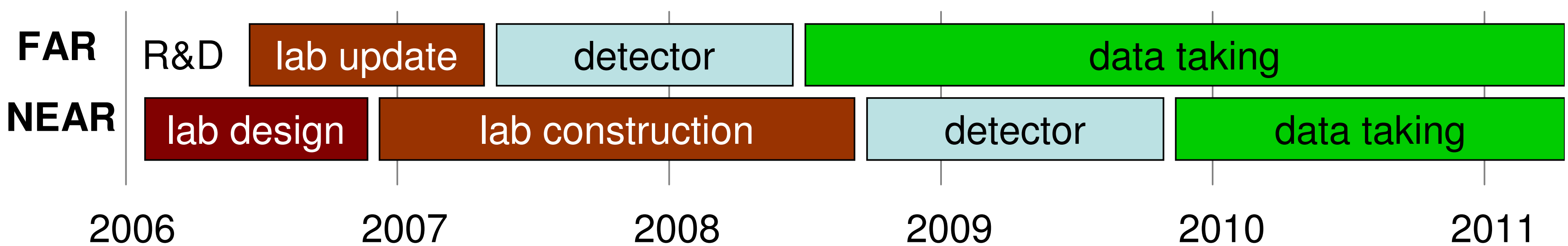
muons: $\varepsilon > 99.8\ \%$

neutrons: $\varepsilon \sim 50\%$

Sensitivity



With the expected schedule, Double Chooz should provide a 90% confidence limit on $\sin^2(2\theta_{13})$ of ~0.05 in 2009 and between 0.02 and 0.03 in 2011.



Conclusions

Significant progress in the details of the design and prototyping of the experiment and its components.

Double Chooz is ready for detector construction!