


NEXT-100 neutrinoless double beta decay with Xe at Canfranc underground laboratory

R. M. Gutierrez
Universidad Antonio Nariño, Bogotá, Colombia
On behalf of the NEXT collaboration

Valparaiso – January 2012




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NEXT Collaboration


U. GIRONA • IFIC (VALENCIA) • U. SANTIAGO • U.P. VALENCIA • U. ZARAGOZA • **U. A. MADRID**


LBNL • TEXAS A&M • **JOHNS HOPKINS U.**


CEA (SACLAY)


U. COIMBRA • U. AVEIRO


JINR (DUBNA)


UAN (BOGOTÁ)

- 80 collaborators
- 14 institutions
- 6 countries




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NEXT COLLABORATION

U. Antonio Nariño, Bogotá, Colombia, U. Autónoma de Madrid, U. de Aveiro, Aveiro, Portugal, Lawrence Berkeley National Laboratory, Berkeley CA, USA, U. de Coimbra, Coimbra, Portugal, U. de Girona, Girona, Spain, Joint Institute for Nuclear Research, Dubna, Russia, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, France, U. de Santiago de Compostela, Santiago de Compostela, Spain, Texas A&M University, College Station TX, USA, I3M, U. Politécnica de Valencia, Valencia, Spain, U. Politécnica de Valencia, Valencia, Spain, Instituto de Física Corpuscular (IFIC), CSIC & U. de Valencia, Valencia, Spain, Johns Hopkins University, Lab. de Física Nuclear y Astropartículas, U. de Zaragoza, Zaragoza, Spain;

Spokesperson: *Juan José Gómez-Cadena, gomez@mail.cern.ch*

Corresponding Author: *Rafael M Gutierrez, rafael.gutierrez@uan.edu.co*




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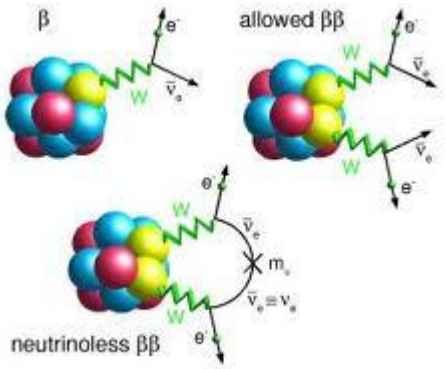
NEXT motivation

The Search for Neutrinoless Double-Beta Decay remains a central focus in contemporary particle physics.

The main goal is to establish whether **the neutrino is its own anti-particle**.

A positive detection would have profound implications in our understanding of nature…



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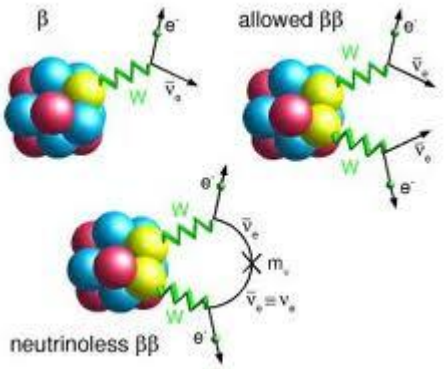
A positive detection would have profound implications in our understanding of nature...

"But, even if the neutrino is its own anti-particle, experiments may see no decays! Still, the high physical significance of a positive result makes the quest attractive, perhaps even irresistible." David Nygren (Lawrence Berkeley National Laboratory).



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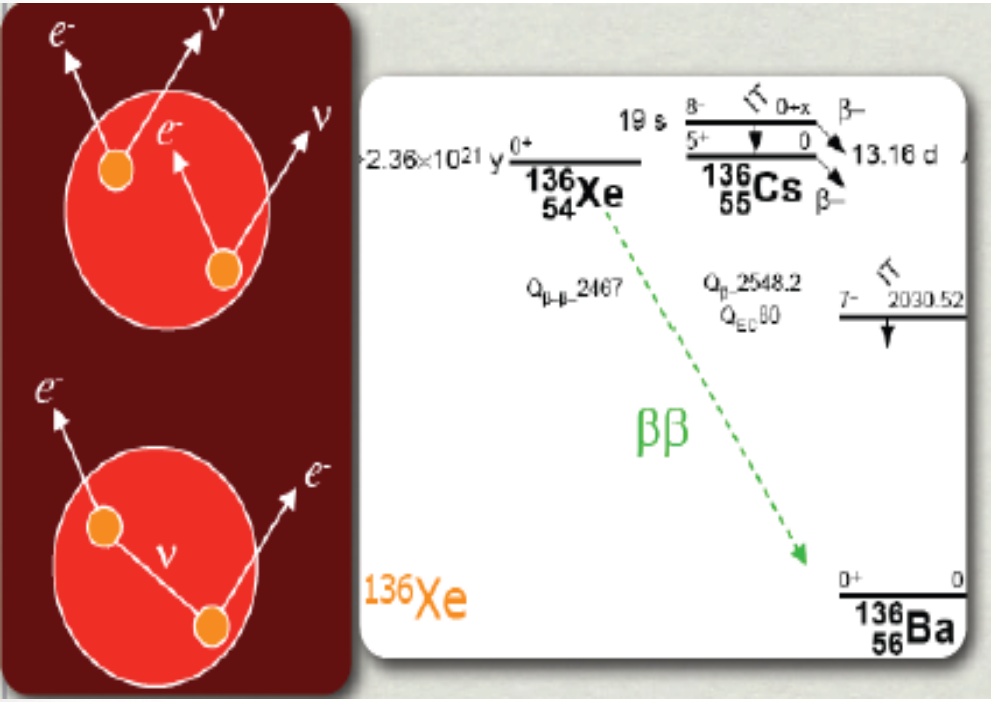
NEUTRINOLESS DOUBLE BETA DECAY, ββ0ν



ββ: 35 isotopes, Xe

Z → Z + 2 and A → A

- **ββ2ν:**

2 electrons and 2 ν

10^{18} years to 10^{21} years

- **ββ0ν (rare and hypothetical):**

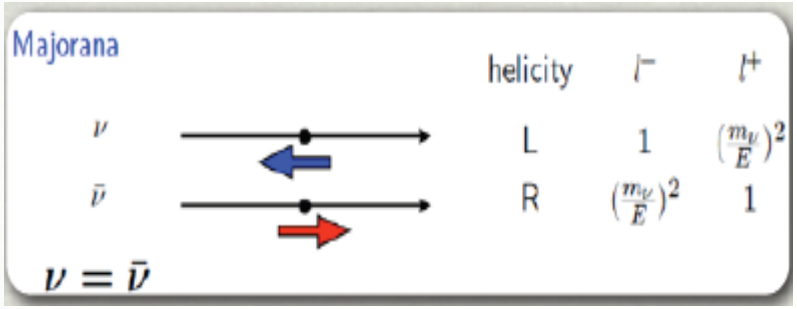
2 electrons and 0 ν

1948, ^{124}Sn: > 3×10^{15} years

2001, ^{76}Ge: > 1.9×10^{25} years




ββ0ν



ββ2ν: second order weak transition, STANDARD MODEL, lepton number conservation

Neutrino oscillations → mass ν ≠ 0

ββ0ν would imply:

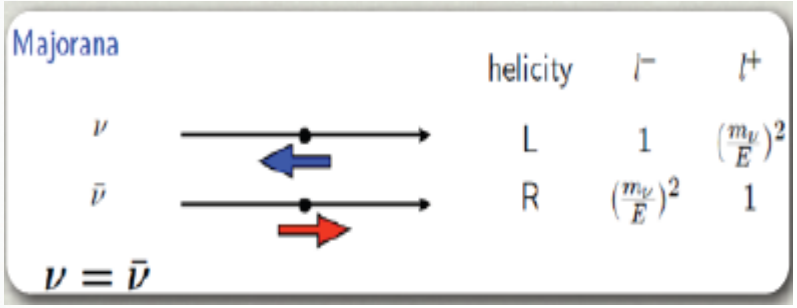
- lepton number violation
- neutrino is its antiparticle: Majorana particle (not Dirac field)

With interesting theoretical consequences:

- explanation of the small neutrino mass
- explanation of baryonic asymmetry of the universe
- **suggest the existence of processes beyond the Standard Model and reach of terrestrial accelerators**




ββ0ν



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The exceptional opportunity to experimentally demonstrate the consistency of all these phenomena

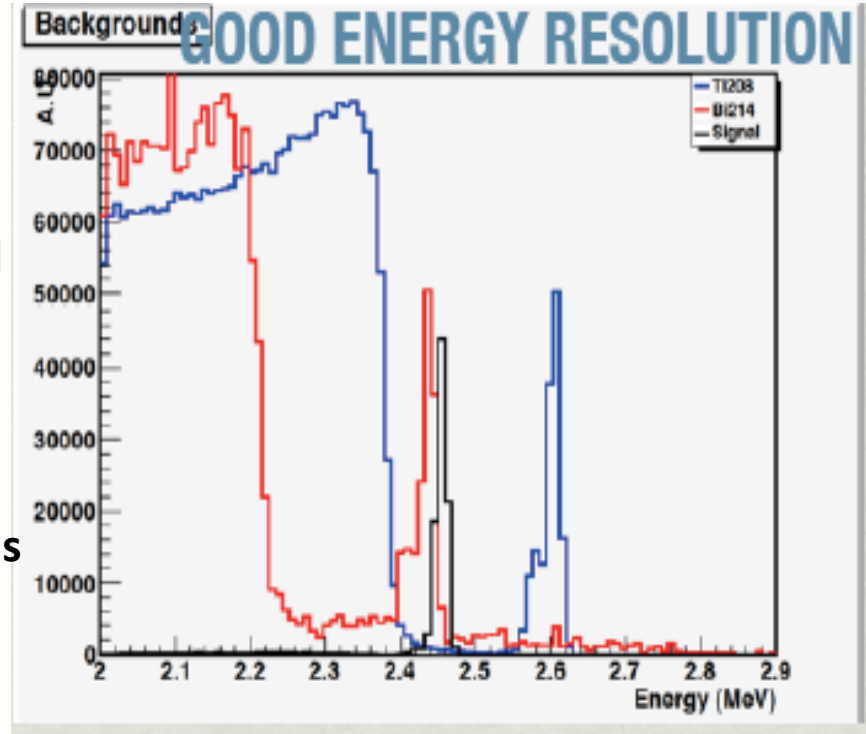
Experimental Challenge

To eventually detect ββ0ν events:

- **mass ν < 1 eV → high energy resolution**
- **large life time → large isotope masses**
- **weak signals → high sensitivity**
- **abundant noise and background → shielding and noise rejection**

There is not an ideal experiment without conflicting requirements?

Efforts: 6 experiments with different combinations of isotope, mass and technologies for optimization of the requirements.



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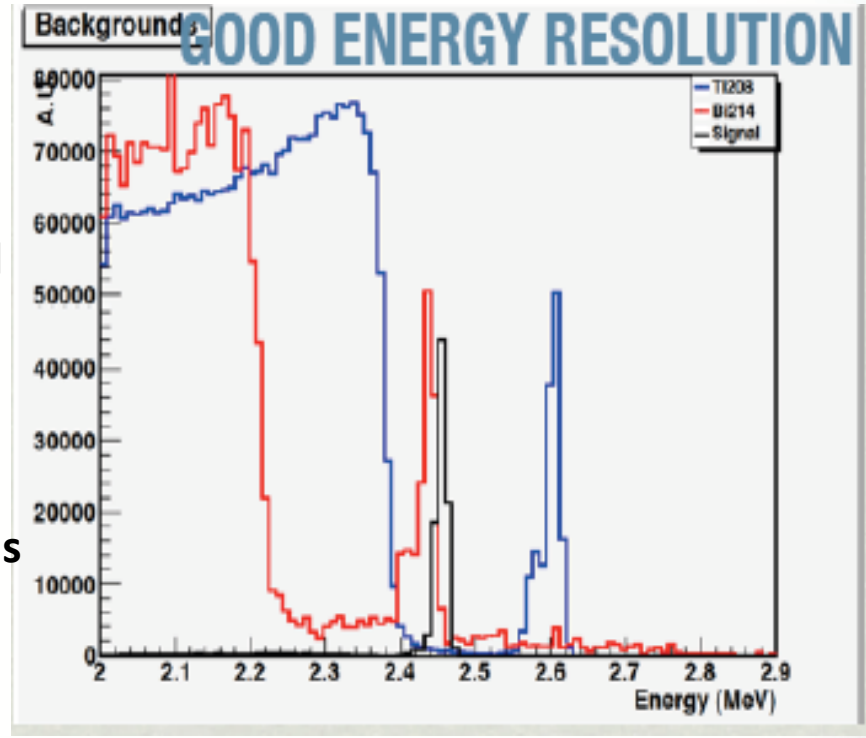
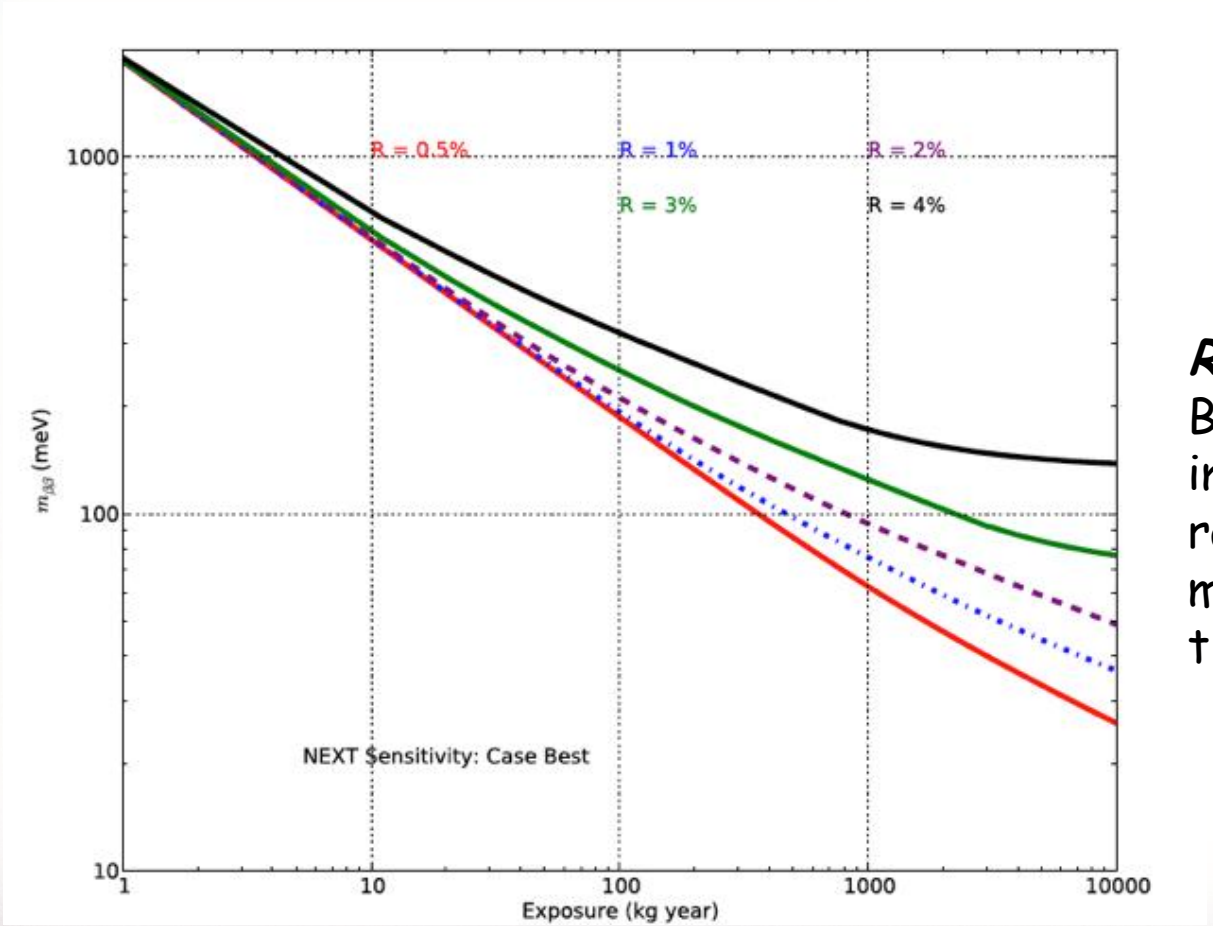


ENERGY RESOLUTION: INDISPENSABLE BUT NOT SUFICIENT



Resolution matters

But there are other important factors: radio purity, feasibility, maturity of the technique, time, etc… costs!

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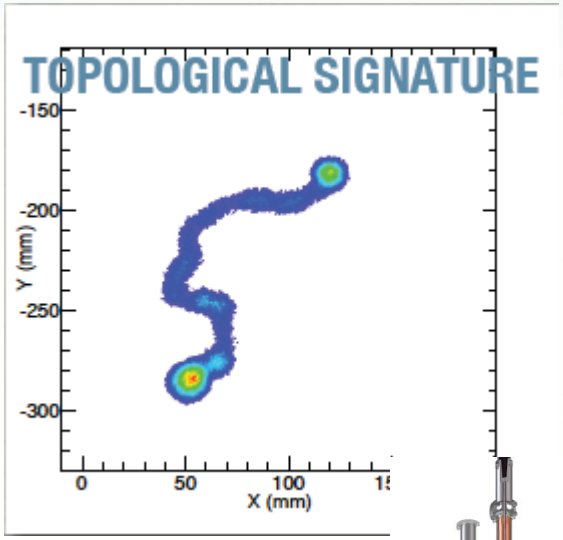
Topological Solution

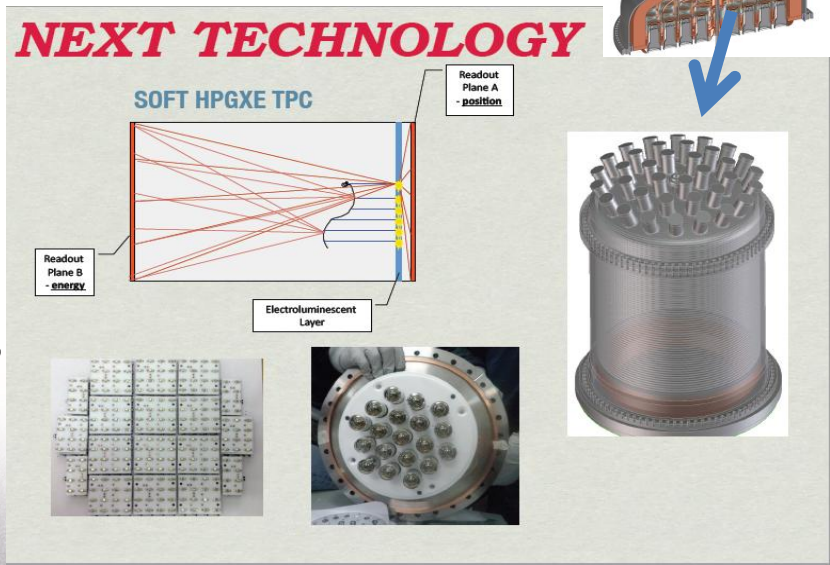
NEXT exploits the unfamiliar phenomenon of **electroluminescence**: drifting electrons excite Xe that emits UV

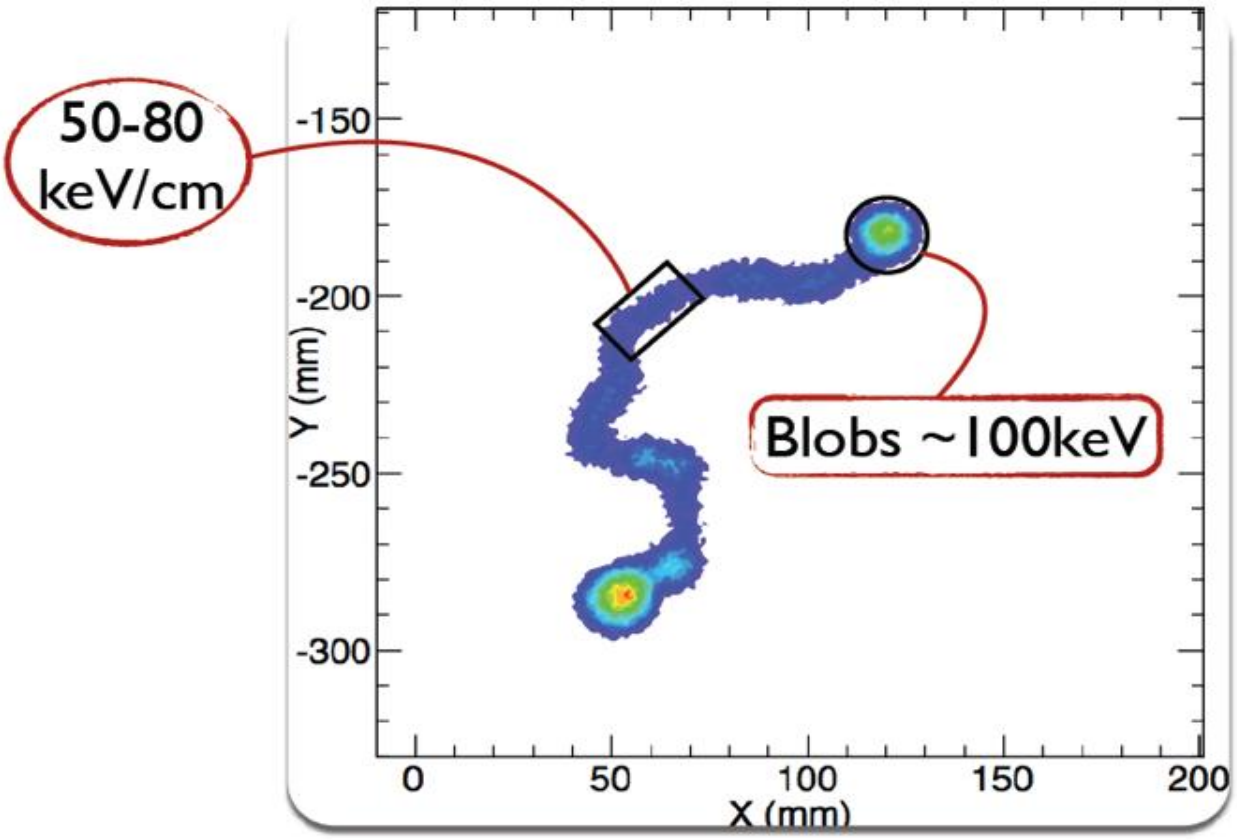
event ββ → two simultaneous electrons → typical topology

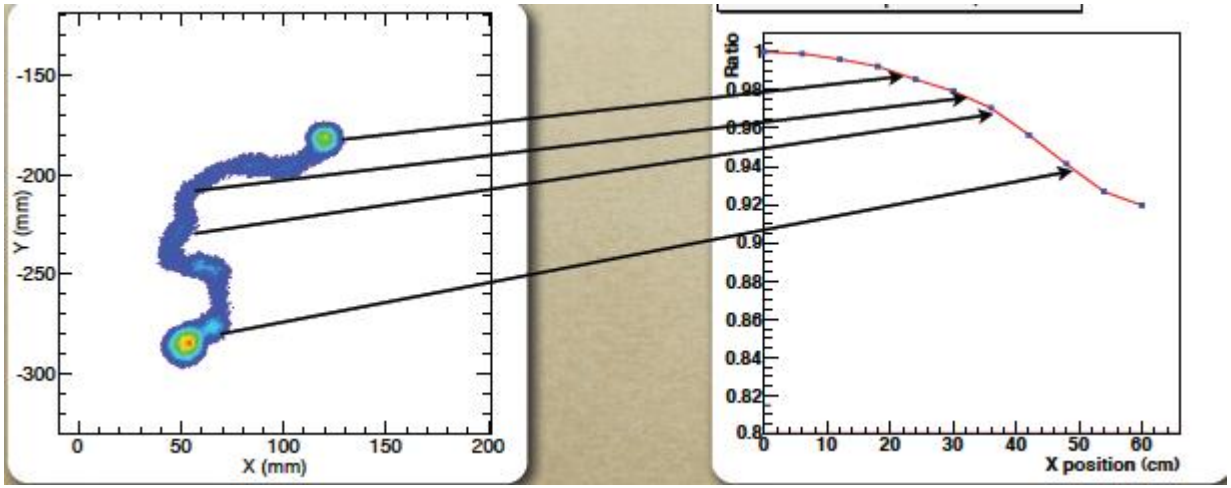
NEXT TECHNOLOGY:
efficient and elegant for rare events

SOFT: Separated Optimization FuncTions
HPGXe: High Pressure Gaseous Xe
TPC: Time Projection Chamber






50-80
keV/cm
Blobs ~100keV
-150
-200
-250
-300
Y (mm)
0
50
100
150
200
X (mm)



Temporal and spatial information: estimate of the total number of photons detected per unit of time

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Prototypes

NEXT-DEMO: detector concept

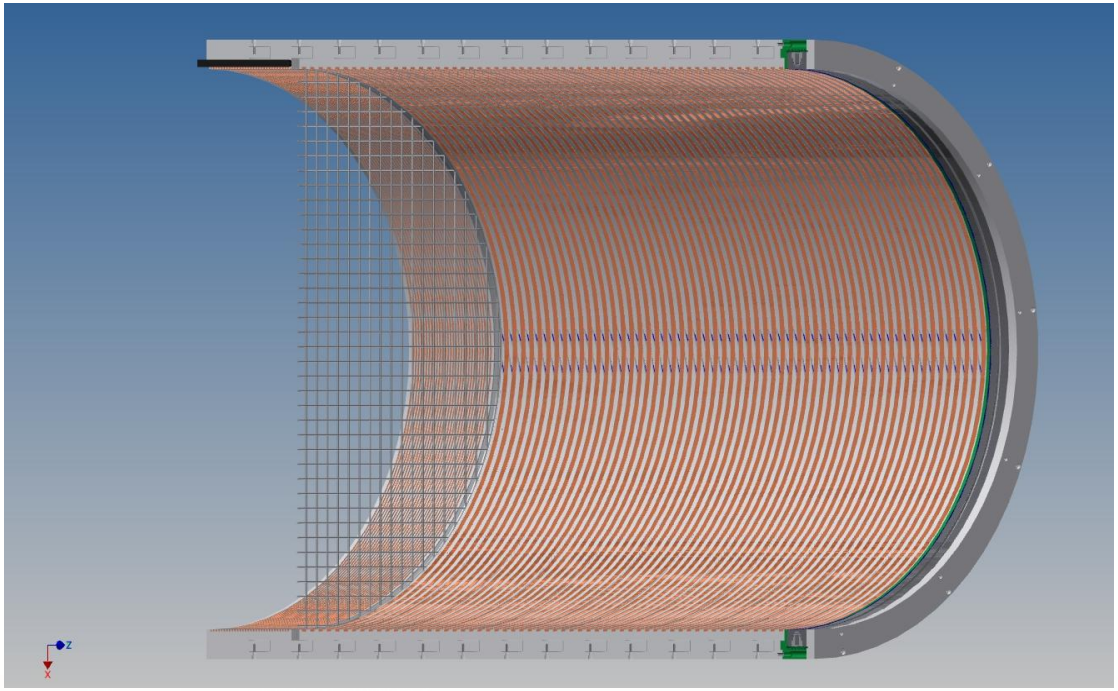
NEXT-DBDM: energy resolution in HPXe and possible application to DM searches

IFIC (SOFT)

LBNL (SOFT)

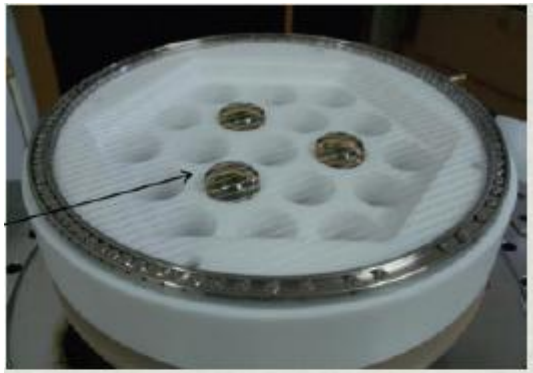
The Field Cage

Cathode: Large open area crossed mesh

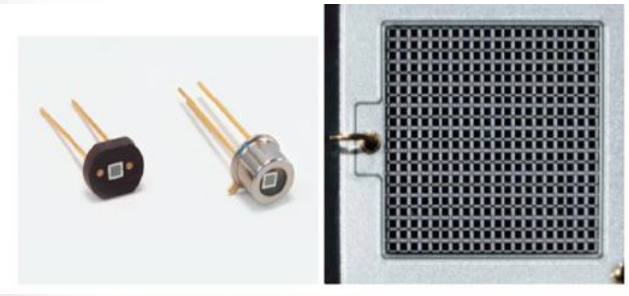


Photodetectors

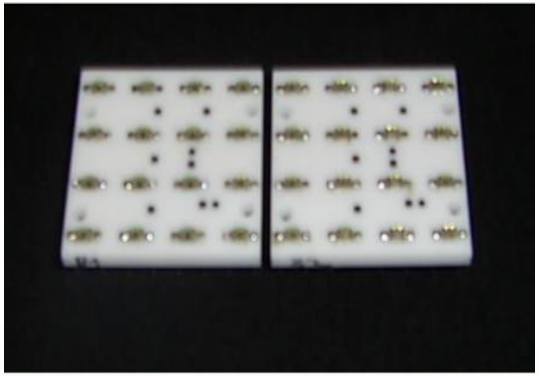
PMTs plane (cap)

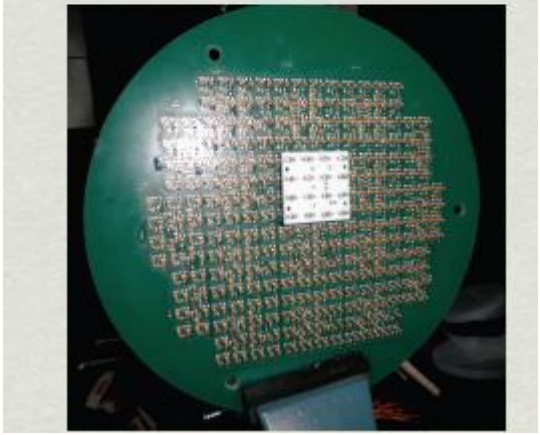


SiPM plane (cap)

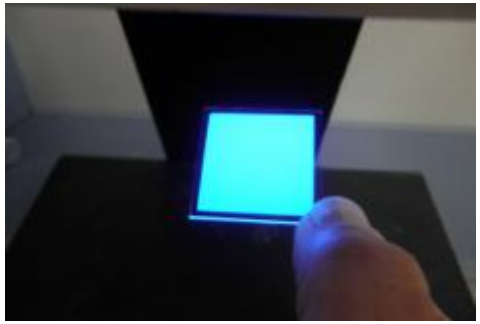


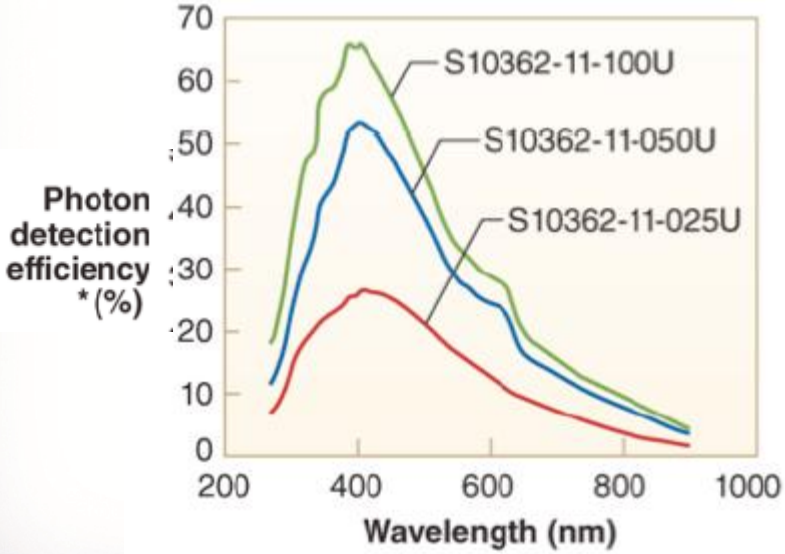
400 pixels
per sensor

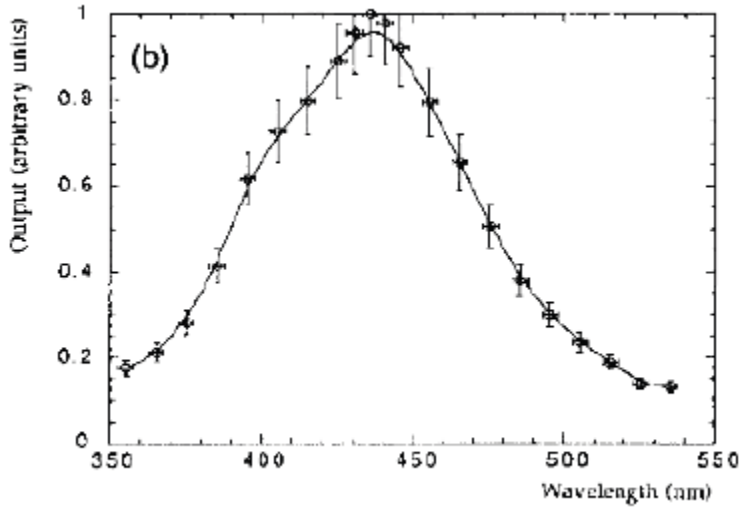




SiPMs are coated with TPB





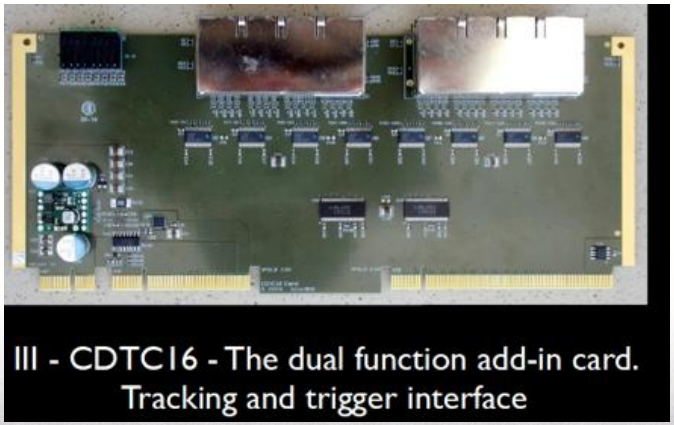


DAQ & Electronics

Three main components

I - The FEC card

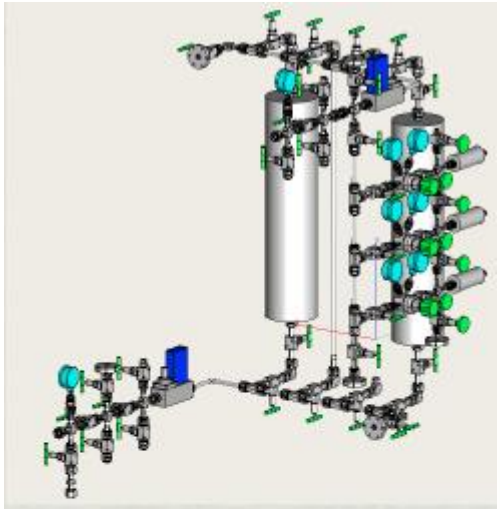
II - The CERN ADC add-in card.
PMT readout



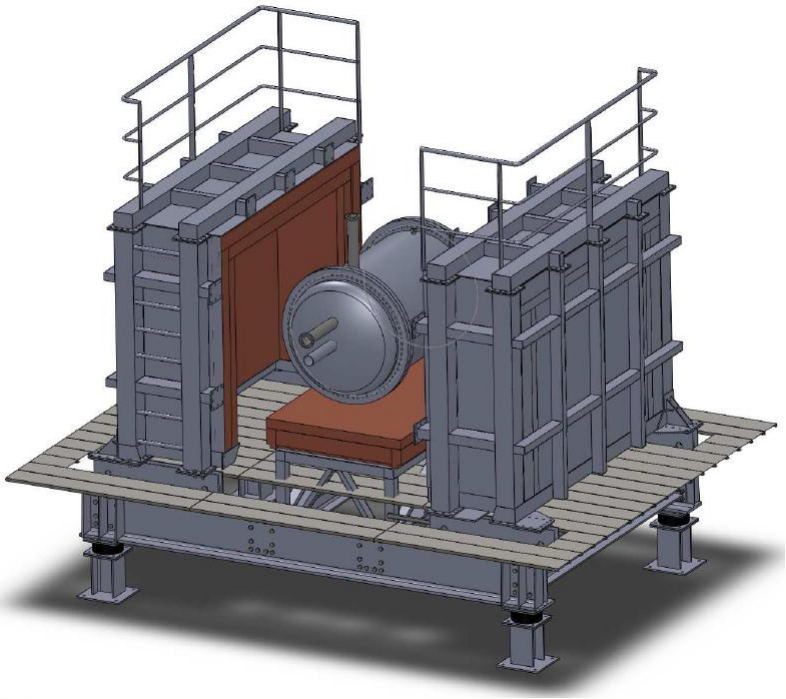
III - CDTC16 - The dual function add-in card.
Tracking and trigger interface

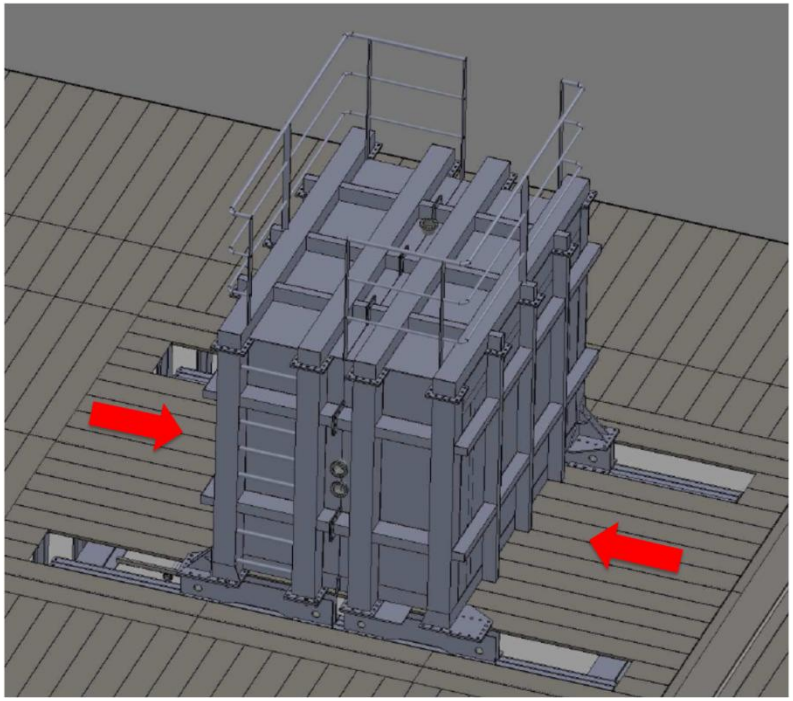
Gas System

- 100 kg of “depleted” Xe + 100kg enriched Xe without leaks
- Valves structure with “buffer”, vacuum pump, recuperation, purification, recirculation pomp, purity monitoring, equalization, etc: **383 k€**

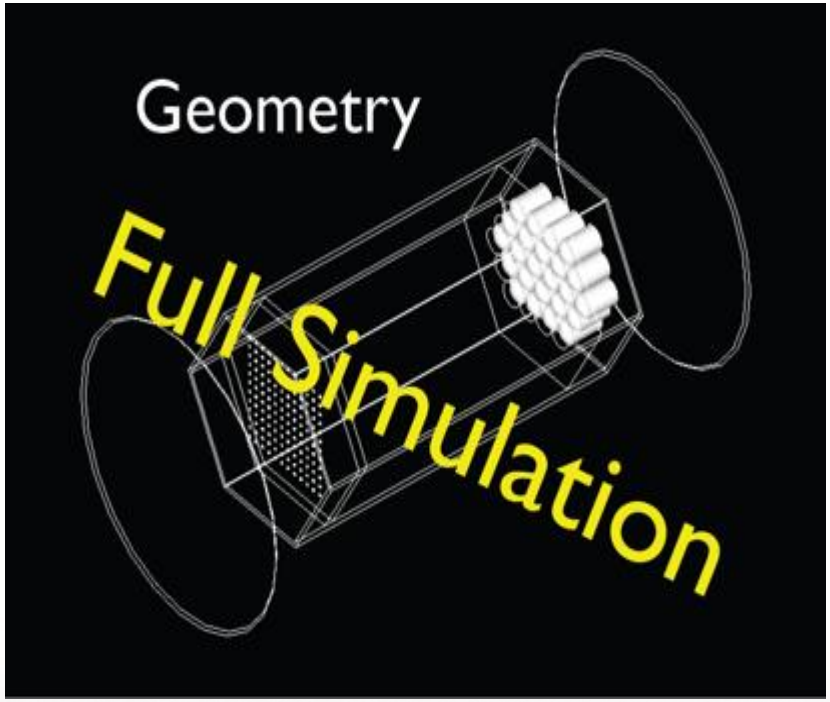


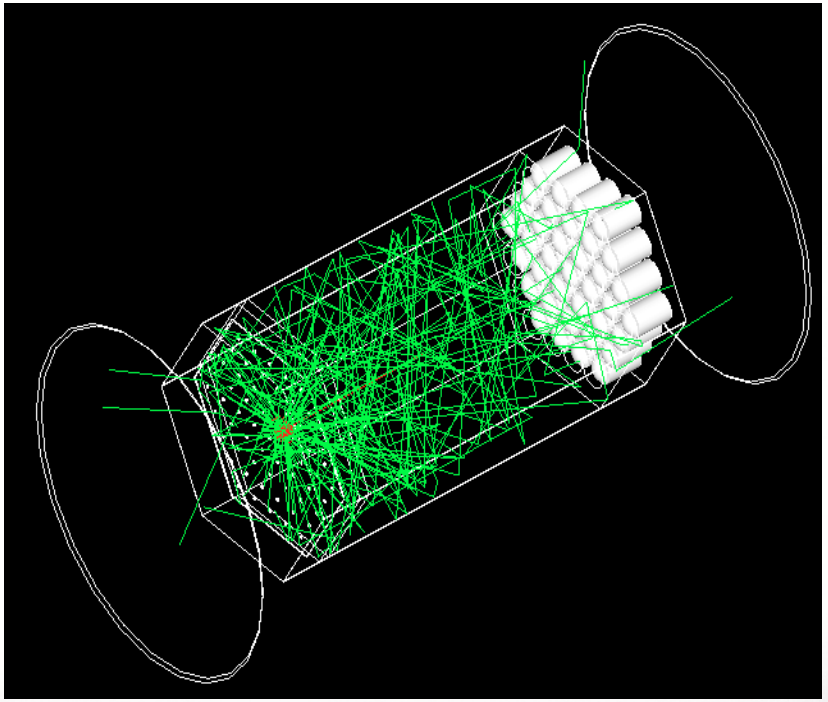
Shielding





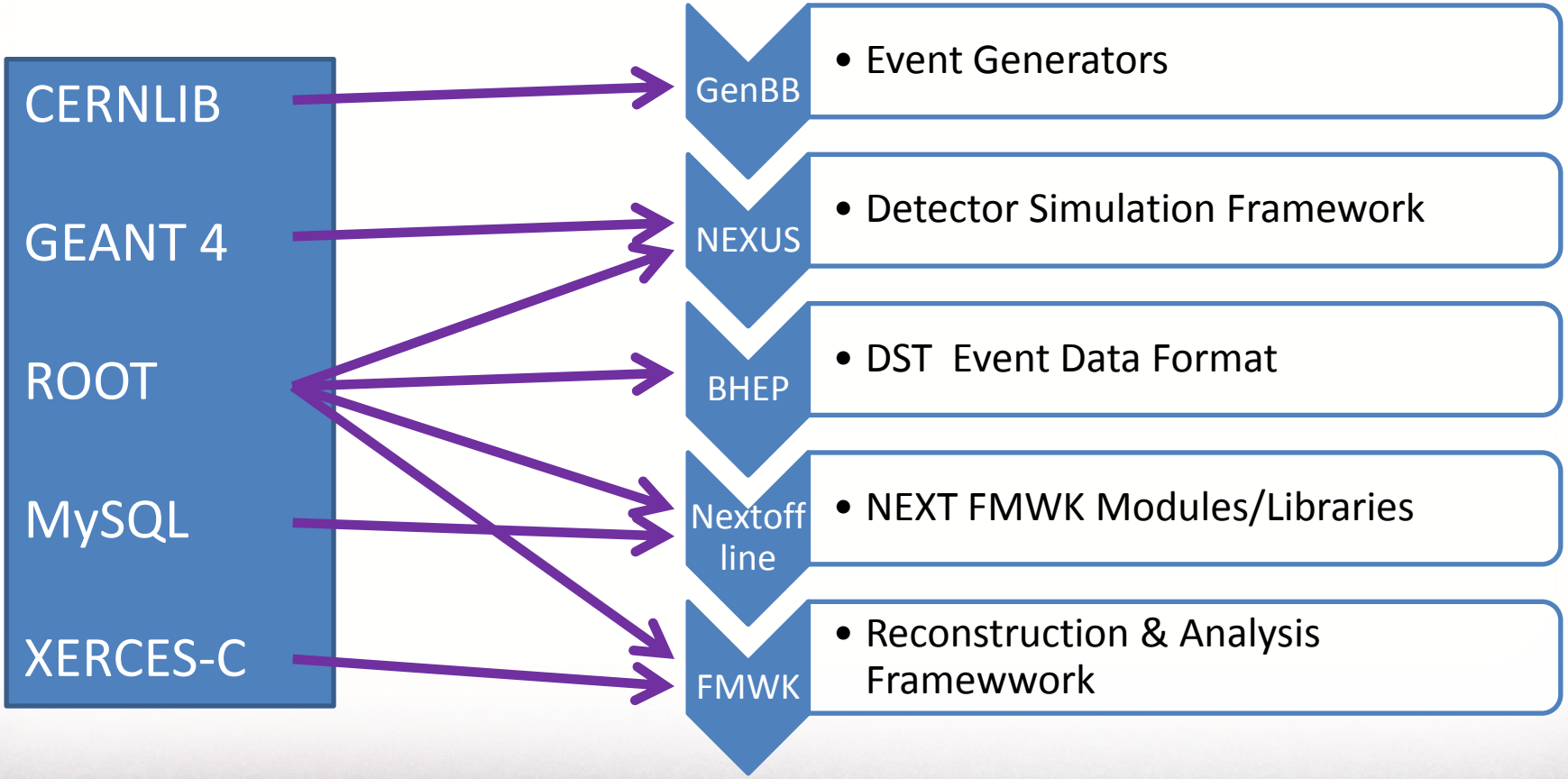
Simulation and Analysis








NEXT Software



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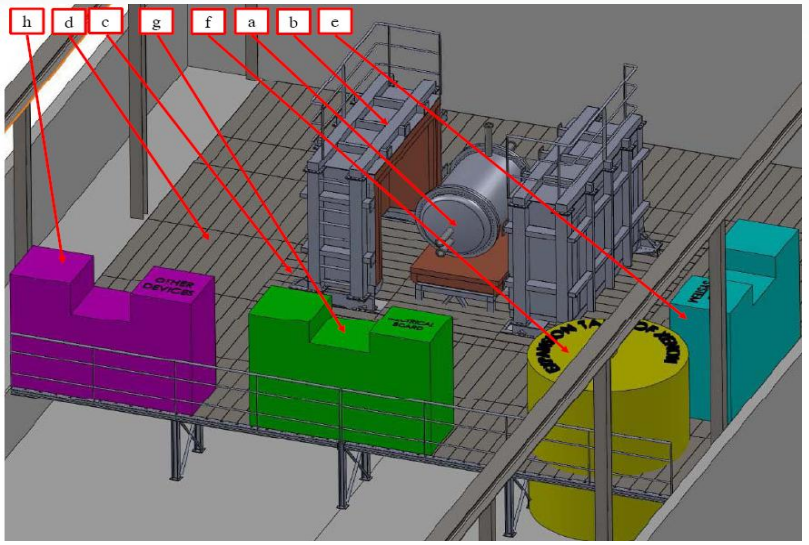
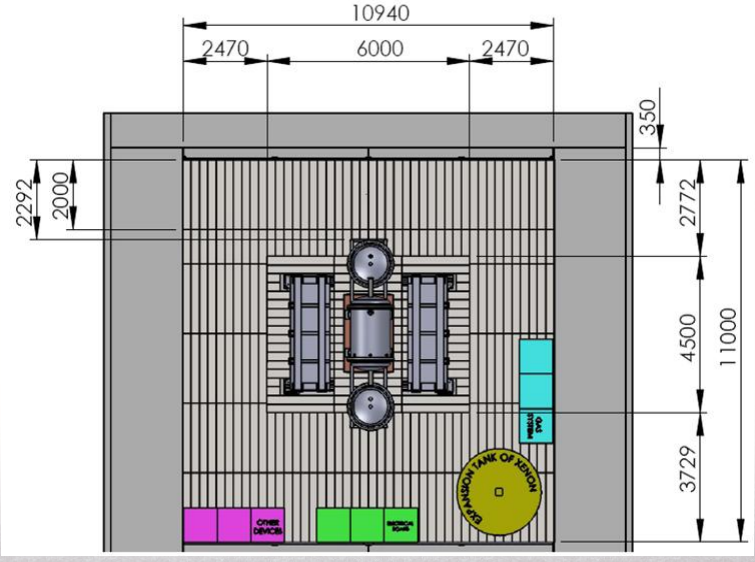
BUDGET NEXT 100

- Gas system 400 k€
- Shielding 350 k€
- Pressure vessel 600 k€
- Parts and components 150 k€
- Informatics equipment 150 k€
- Costs: mobility, materials, services, administration and management, etc., and in particular qualified personnel by international cooperation ~ 2.5M k€

TOTAL ~ 4.5 M€

NEXT at Canfranc LSC





Canfranc Underground Laboratory, LSC

Main hall

Building

Main entrance

Under the Pyrenees mountain "El Tobazo"

- 1985: main hall 120 m2 and two halls of 18 m2 each (Train tunnel)
- New facility for Underground Science (parallel Road Tunnel)
- 2006 signs of rock instabilities … 2010: optical fibers continuously monitors rock stability
- Two experimental halls and all the necessary services: total A 1250 m2 , V 10 000 m3
- 850 m deep providing 2500 meters water equivalent of shielding from cosmic rays and offers a low background environment
- 214 scientific users from 15 Countries

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NEXT Spokesperson:
Juan José Gomez-Cadena

LSC Director:
Alessandro Bettini

Executive Board
Scientific Committee

"El Tobazo" and
Canfranc Train Station




Summary and Conclusions

- NEXT marries two old instrumental concepts (TPCs and EL) in a novel approach, providing very good energy resolution and tracking for background rejection: TDR finished in December, 2011 (CDR in December 2010).
- Construction and commissioning of shielding, gas system, pressure vessel, detector planes, field cage and HV system: 2012.
- Commissioning of the NEXT-100 detector at the LSC: early 2013.
- Running in 2014




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•NEXT: new-generation double beta decay experiment, lead by Spanish and American groups… increase American, in particular Latin-American institutes as an important opportunity to make an outstanding contribution to modern physics

•At LSC with interesting timing and new experience that could be very useful for ANDES: Agua Negra Deep Experiment Site.




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Thank you
Gracias