7th symposium on large TPCs for low energy rare event detection

NEXT-generation HP Xe-TPCs for the NEXT-ββ0ν experiment

Diego Gonzalez Diaz
for the NEXT collaboration

next

Universidad Zaragoza
1542

16/12/2014

IS NEUTRINO MAJORANA OR DIRAC (-TYPE)?

Majorana

Keep it simple:
reduce the degrees of freedom!

Baryogenesis

+non-thermal equilibrium.
+CP violation sources.
+sphaleron process.

Smallness of neutrino mass scale

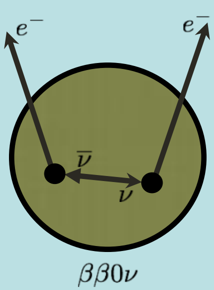
+see-saw mechanism

Dirac

Keep it simple:
respect analogy with charged leptons and conserve lepton number!

How to answer?

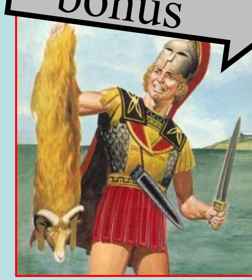
Most promising way:
Study neutrino-less double beta decay (ββ0ν) for checking the Majorana hypothesis!



+Neutrino oscillations.
All neutrino flavors are massive!
"***If it is*** *(Majorana-type)*, ***it will happen*** *(bb0ν)*"

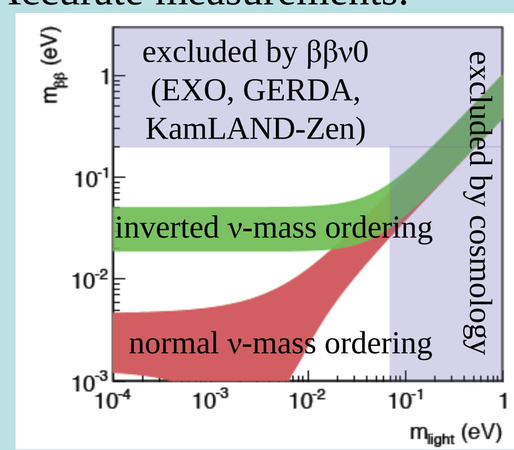
+Black box theorem (Schechter-Valle, 1982):
"***If it happens*** *(bb0ν)*, ***it is*** *(Majorana-type)*"

bonus

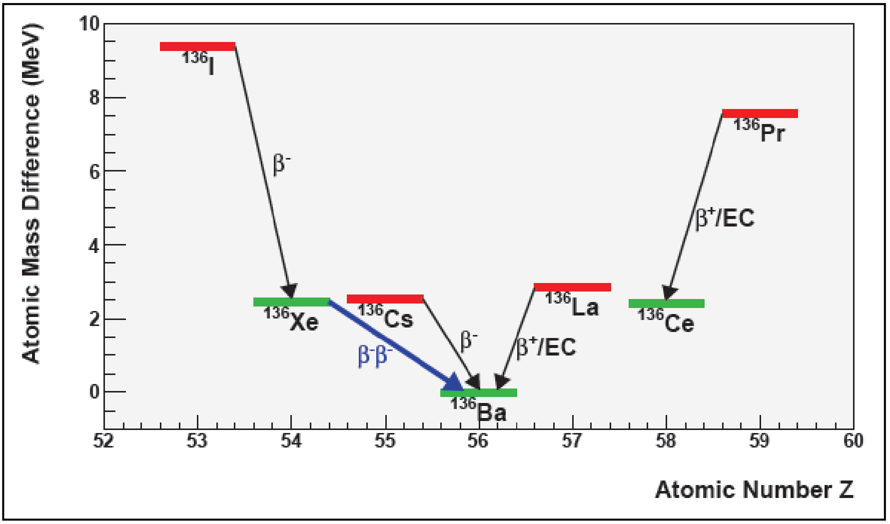


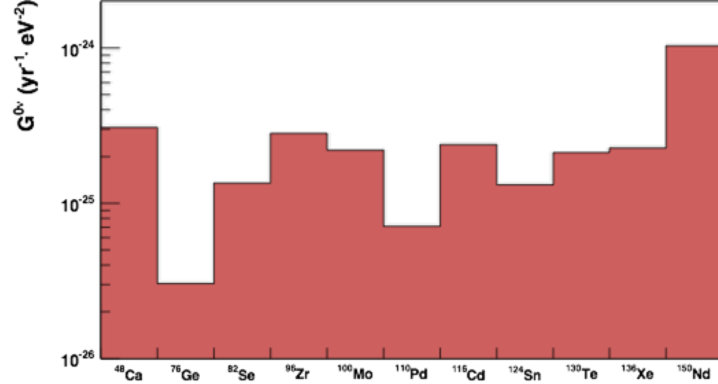
Access to the neutrino mass scale

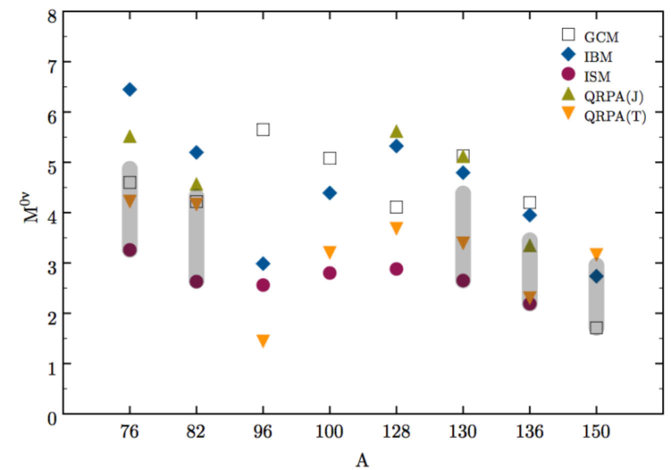
+Nuclear physics.
+Physics beyond SM.
+Accurate measurements.



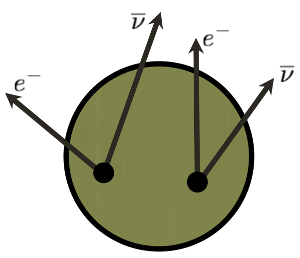
double-beta decay (ββ)







1)

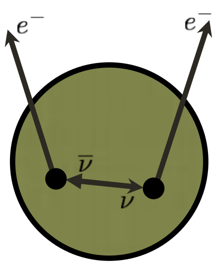


$\beta\beta 2\nu$

$T_{1/2} \sim 10^{18} - 10^{20}$ y

measured!

2)



$\beta\beta 0\nu$

$$(T^{0\nu}_{1/2})^{-1} = G^{0\nu}(Q,Z)\,|M^{0\nu}|^2\, m^2_{\beta\beta}$$

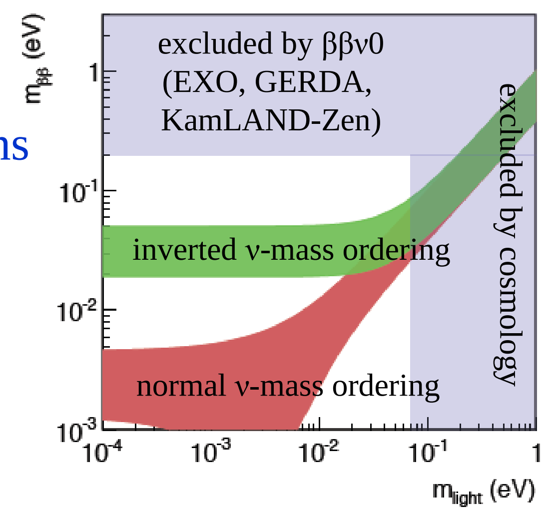
phase-space factor

nuclear matrix element

ν oscillations

$T_{1/2} > 10^{25}$ y

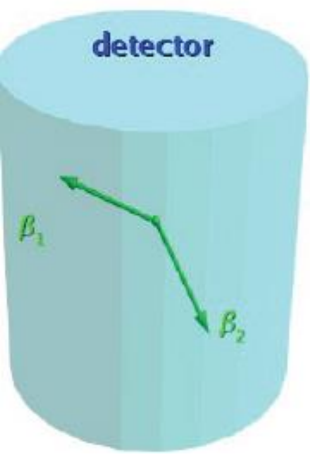
no convincing evidence!



$$m_{\beta\beta} = ||U_{e1}|^2 m_1 + e^{i\alpha_1}|U_{e2}|^2 m_2 + e^{i\alpha_2}|U_{e3}|^2 m_3|$$

Source = Detector

double-beta decay (ββ) experimentalist ‘how to’



exposure

efficiency

$$T_{1/2}^{-1} \propto a \cdot \epsilon \cdot \sqrt{\frac{Mt}{\Delta E \cdot B}}$$

bck

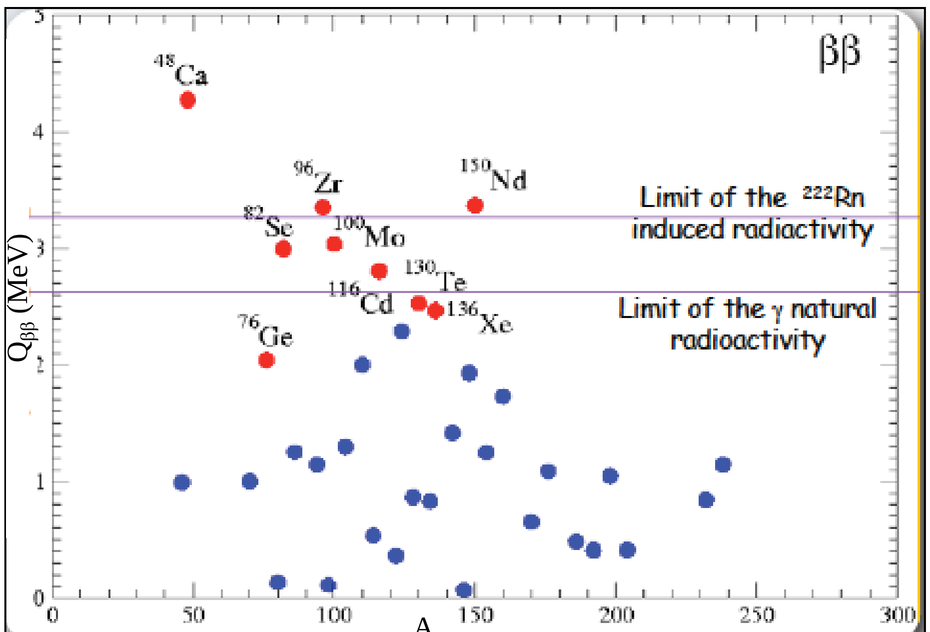
bck

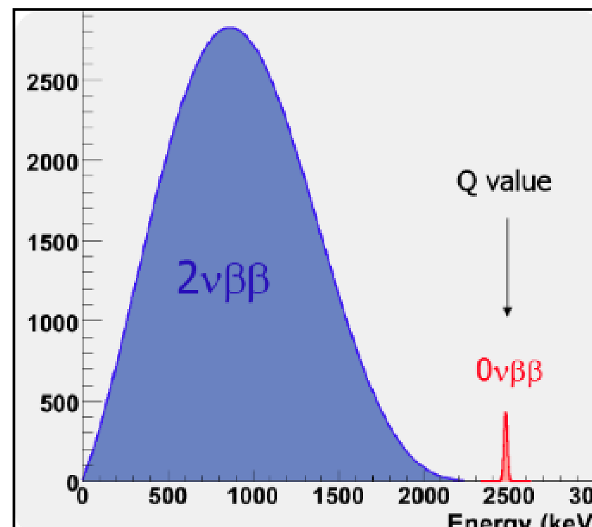
isotope type

energy resolution

background

$a \propto G^{0\nu} \sim Q_{\beta\beta}{}^5$





next

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Neutrino Experiment with a Xenon TPC

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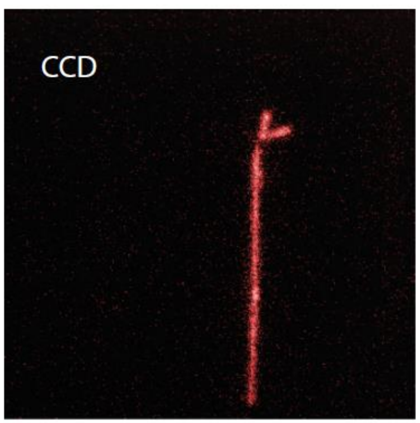

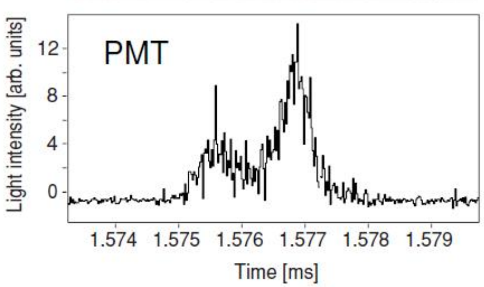

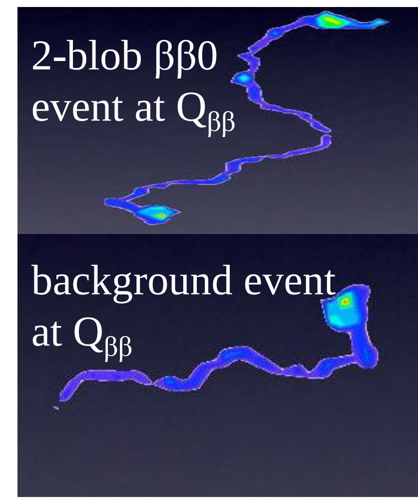

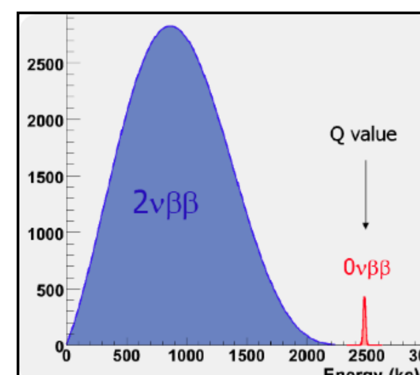

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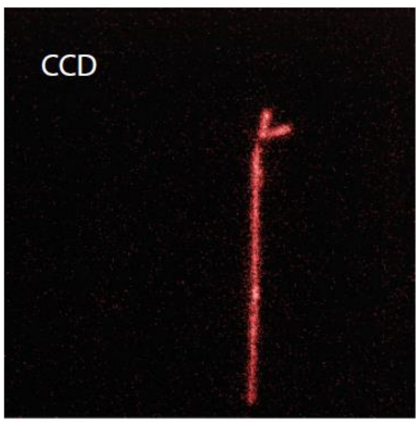

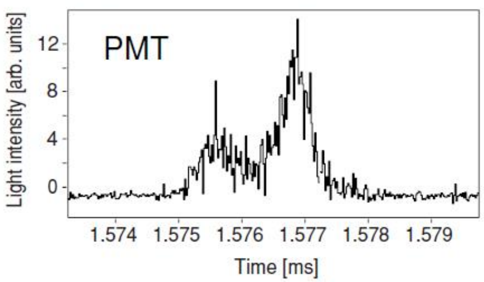

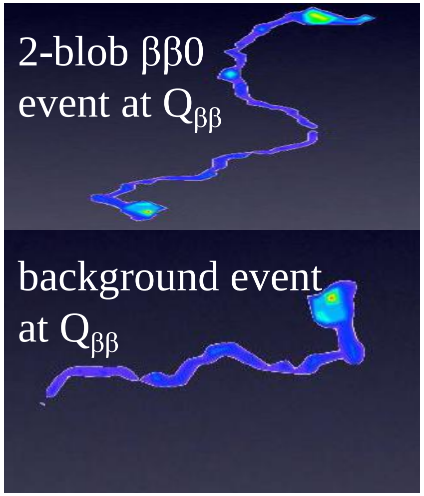

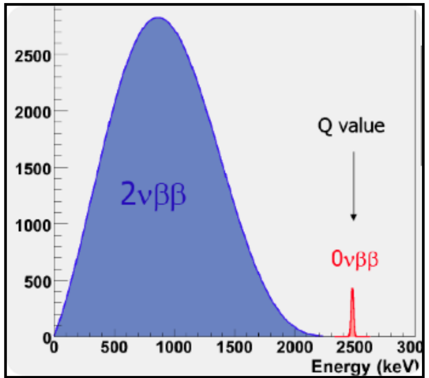

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next

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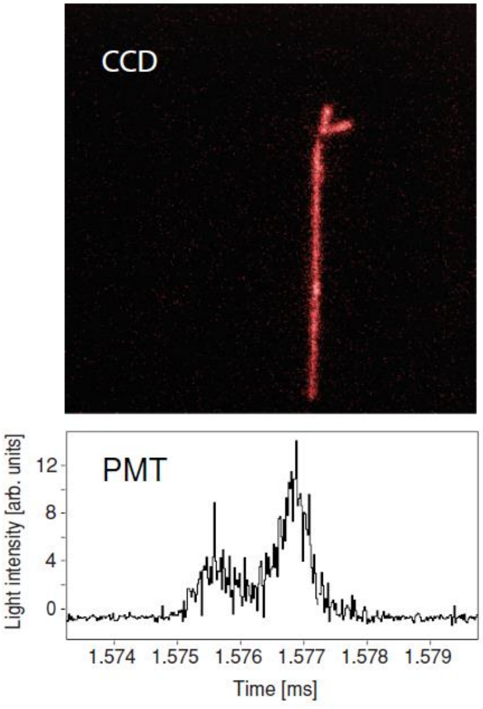
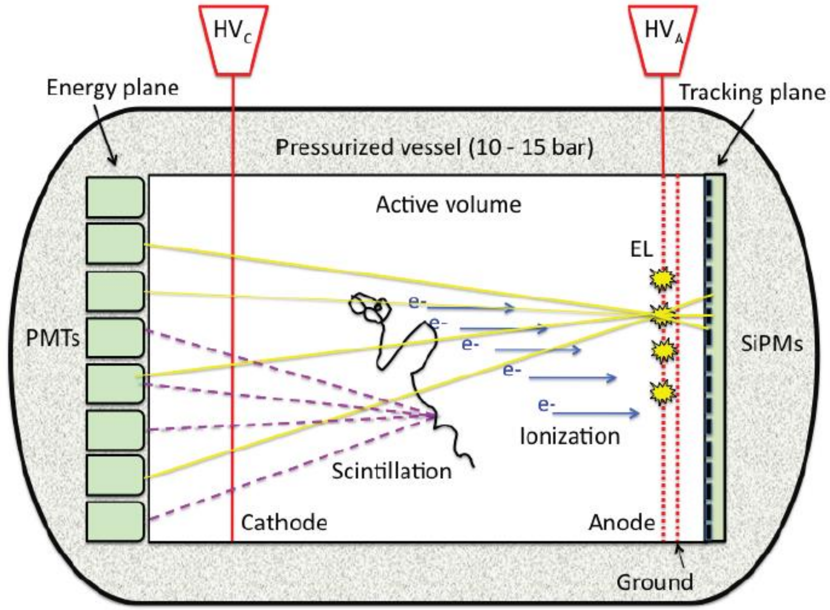
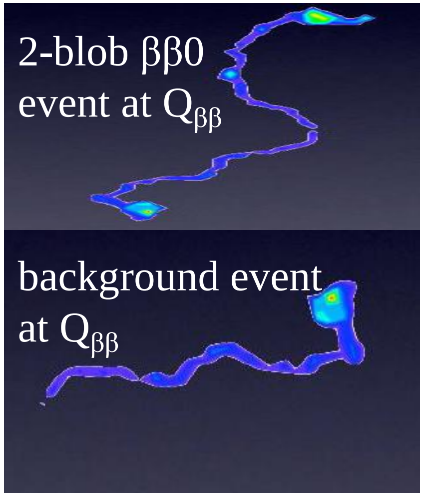
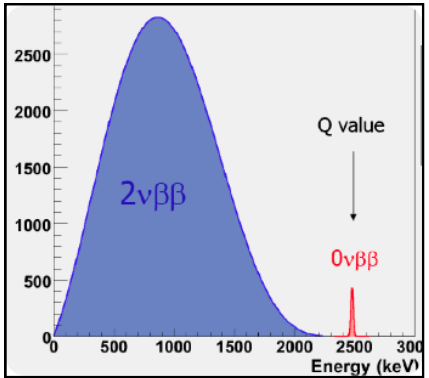


The NEXT concept







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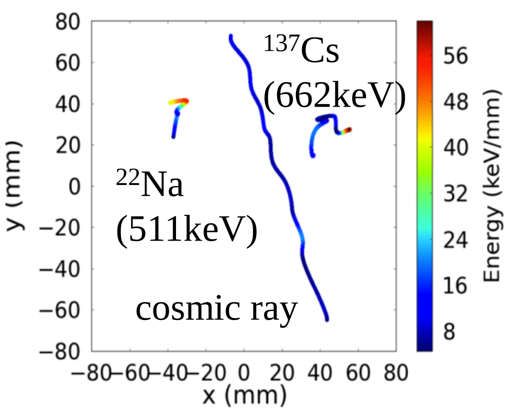

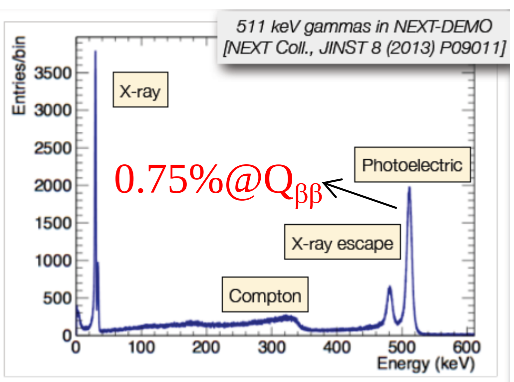

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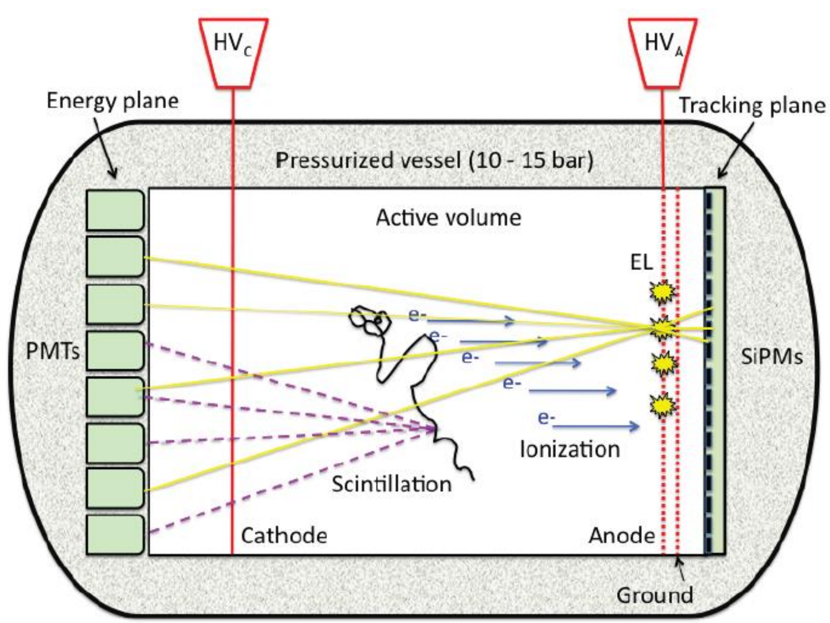

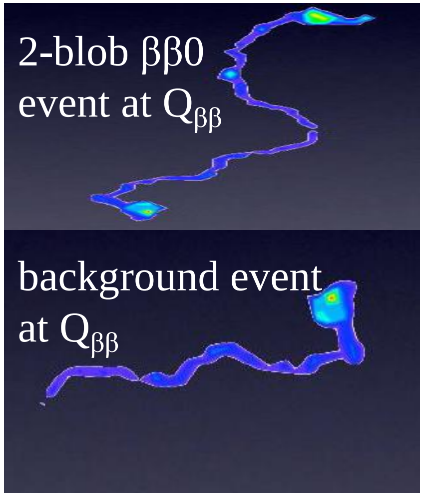

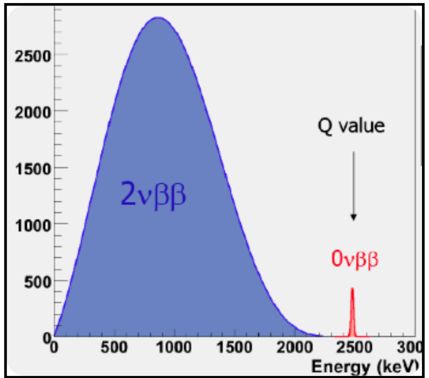

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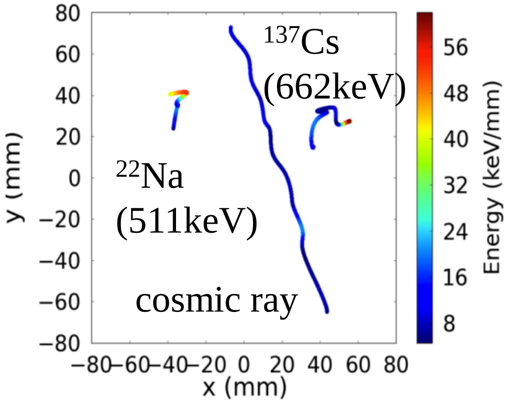

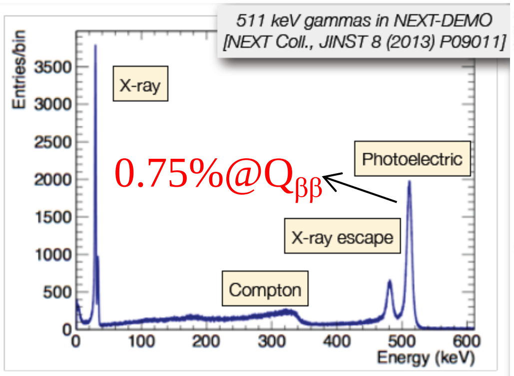

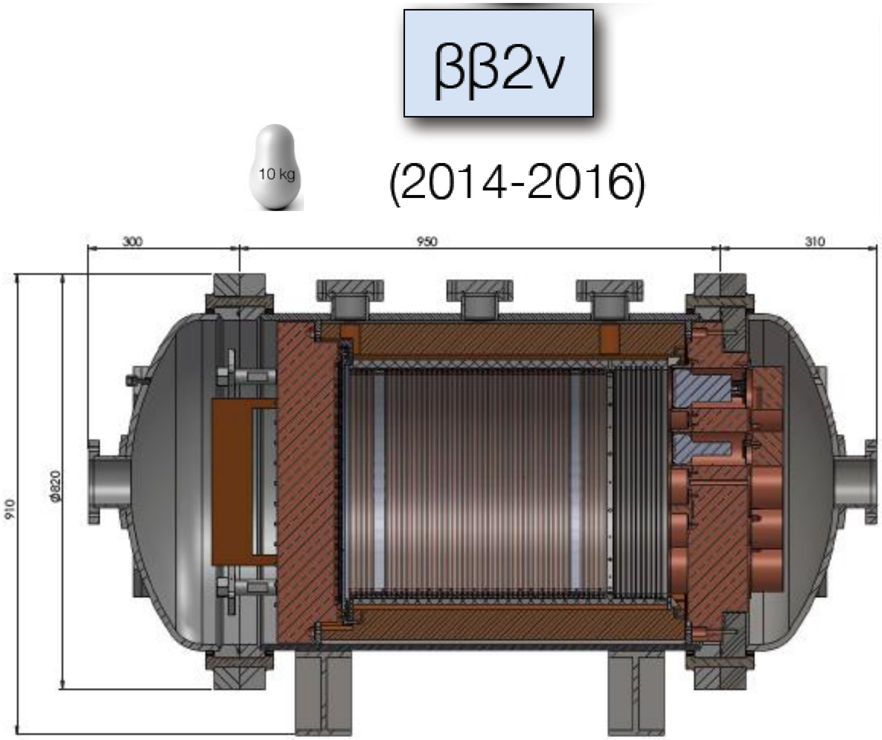

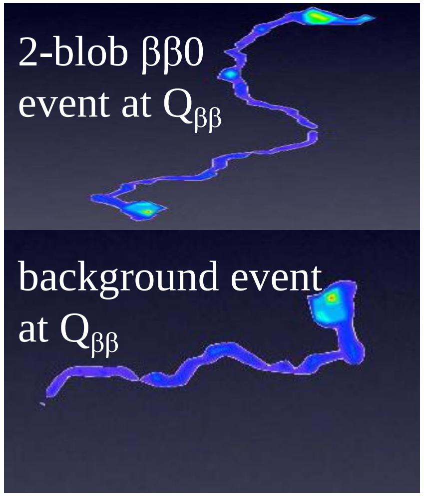

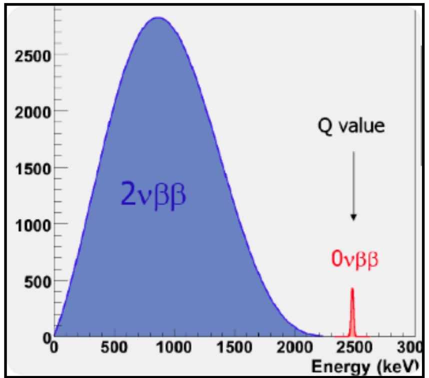

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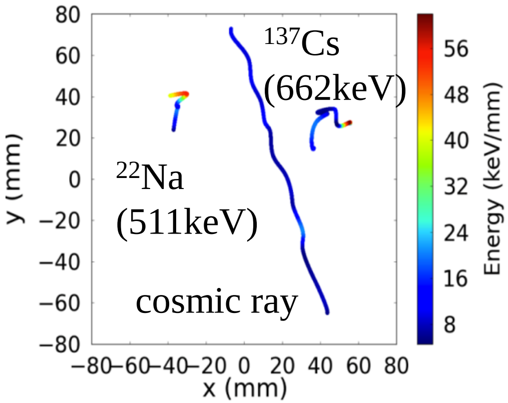
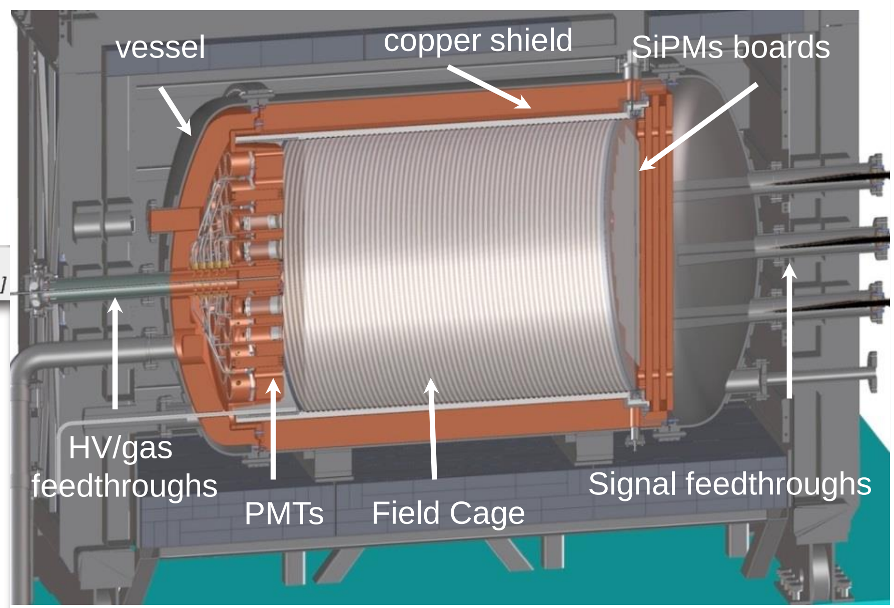
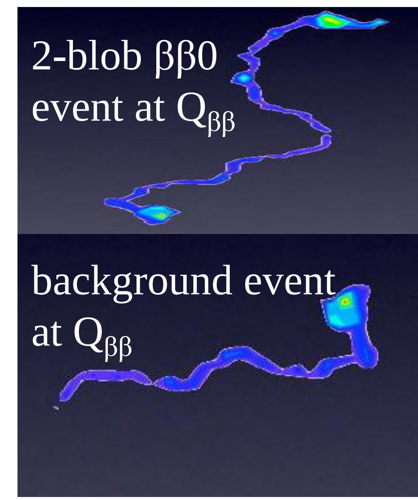
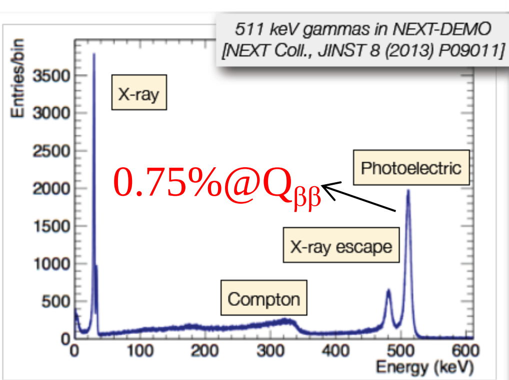


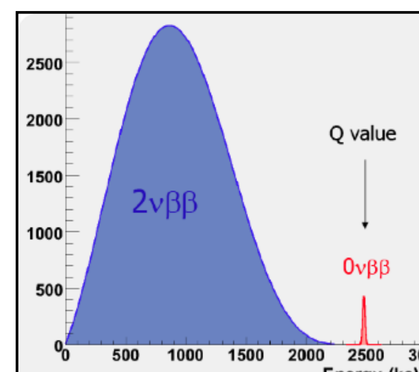
ββ0ν (100 meV)

(2016-2020)









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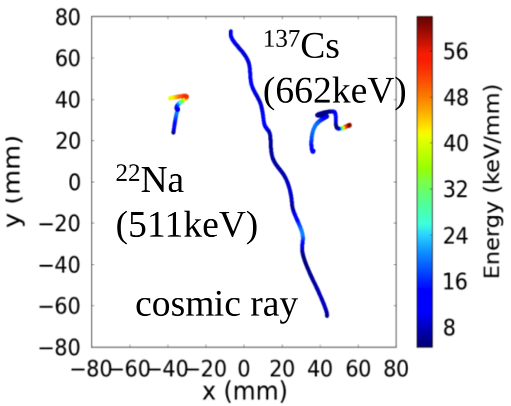
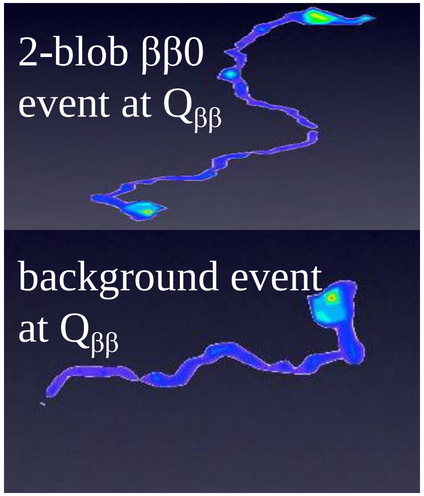
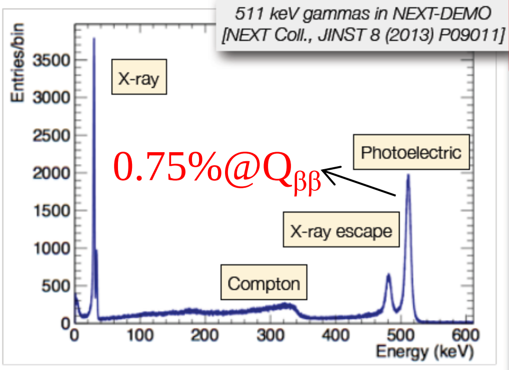
Neutrino Experiment with a Xenon TPC

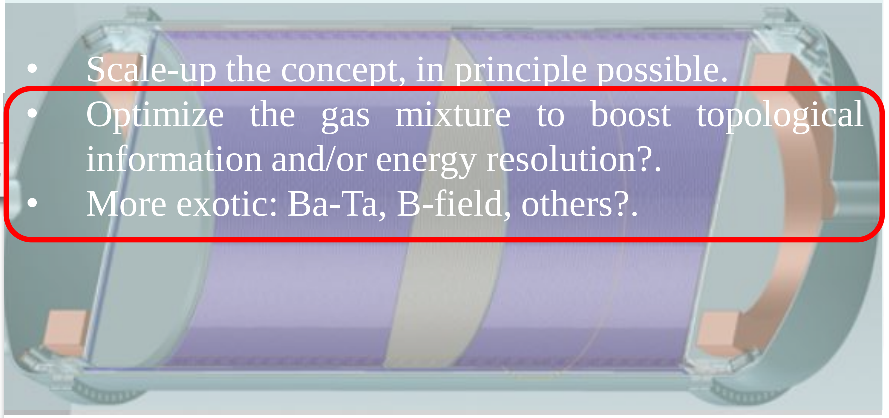


ββ0ν (20 meV)

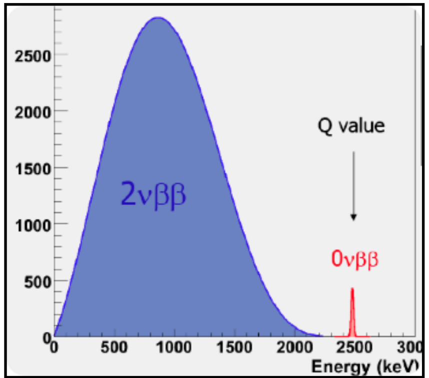
(2020?)



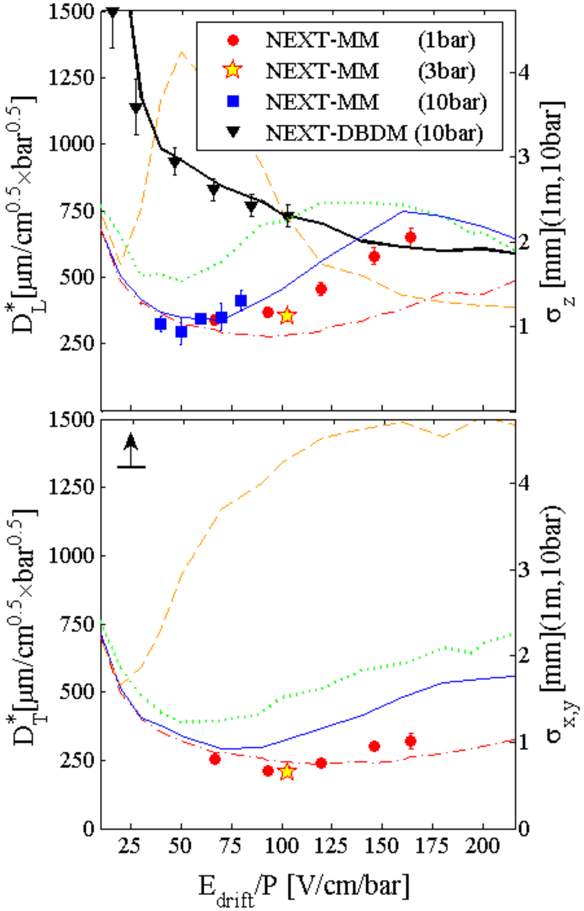


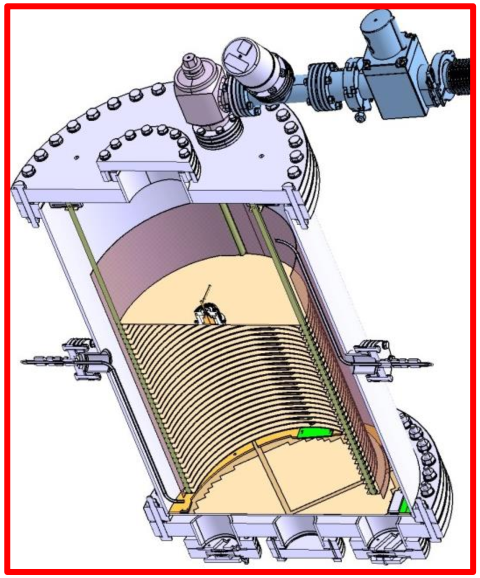


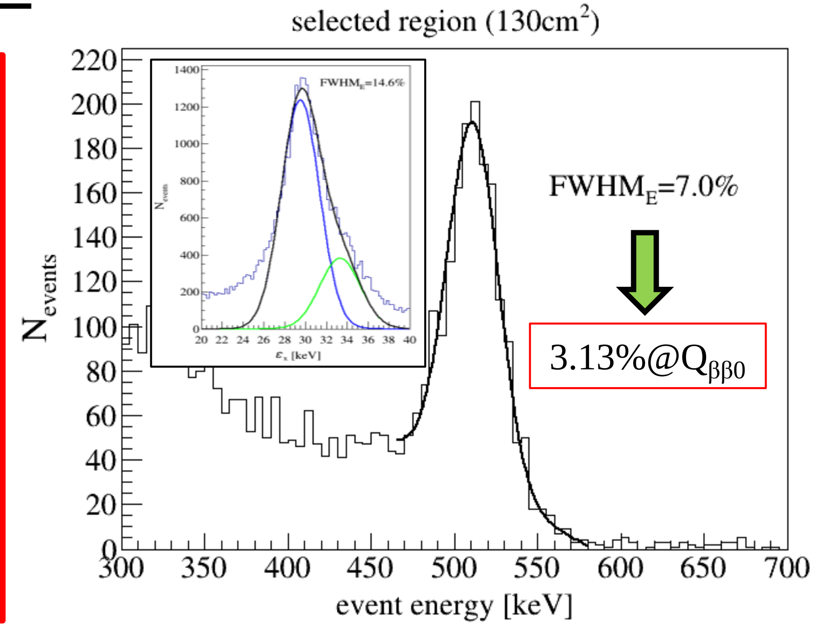
- Scale-up the concept, in principle possible.
- Optimize the gas mixture to boost topological information and/or energy resolution?.
- More exotic: Ba-Ta, B-field, others?.

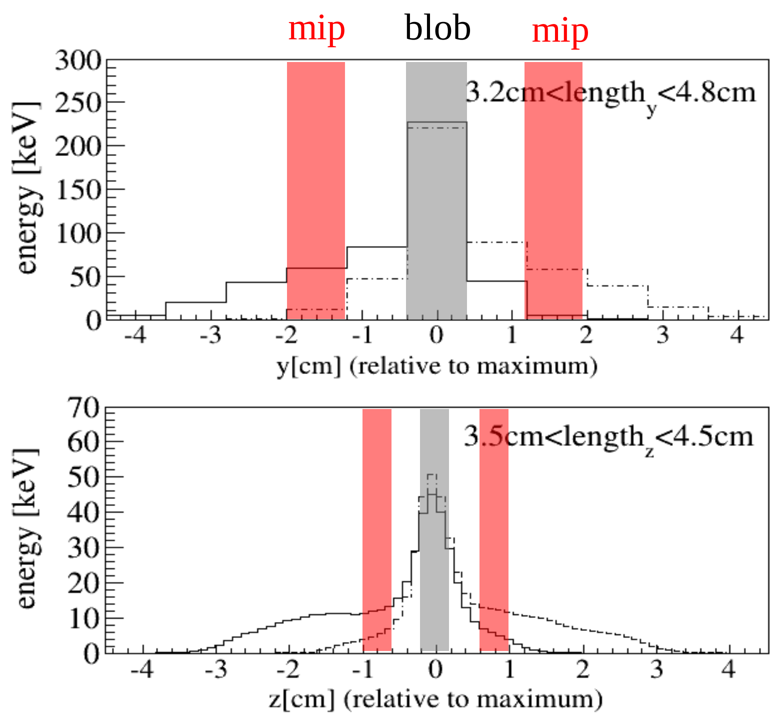


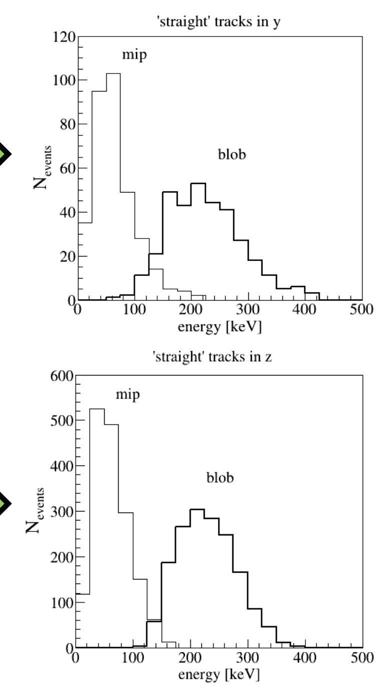
NEXT-MM (in a nutshell)











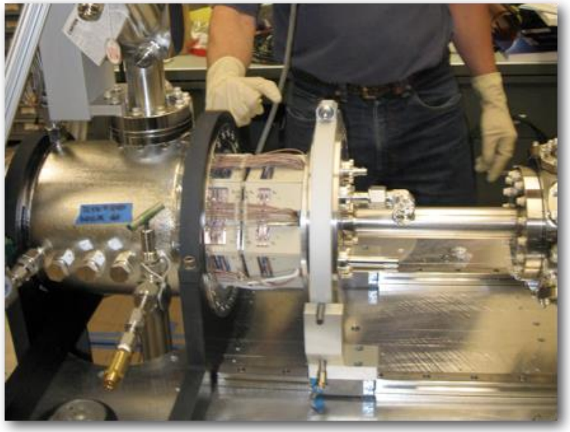
University of Zaragoza

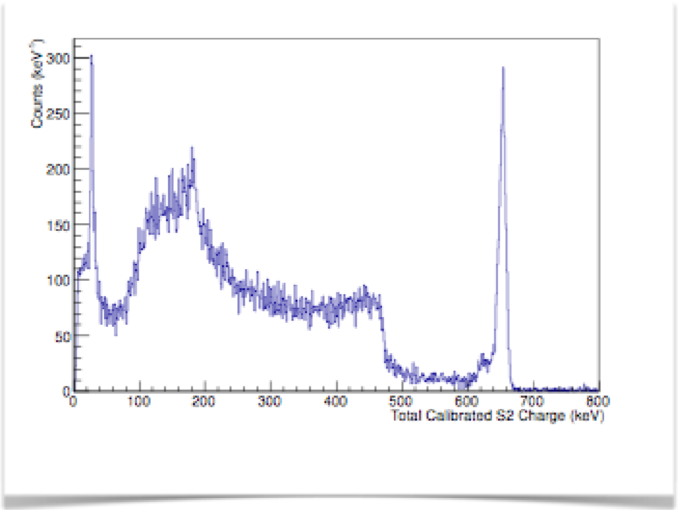
- 4kg.
- 10bar, Xe-TMA.
- 700cm^2, charge amplification.
- 38cm drift.
- No T_0.
- Simultaneous calorimetry and tracking with Micromegas.

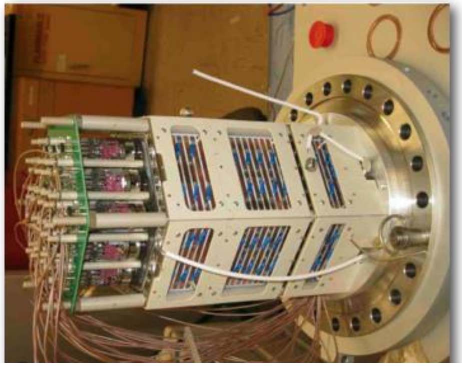
NEXT-DBDM (in a nutshell)

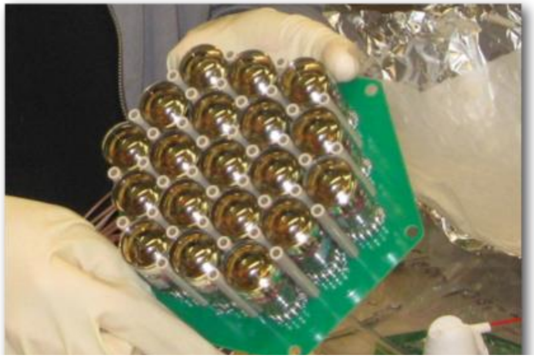
LBL-Berkeley

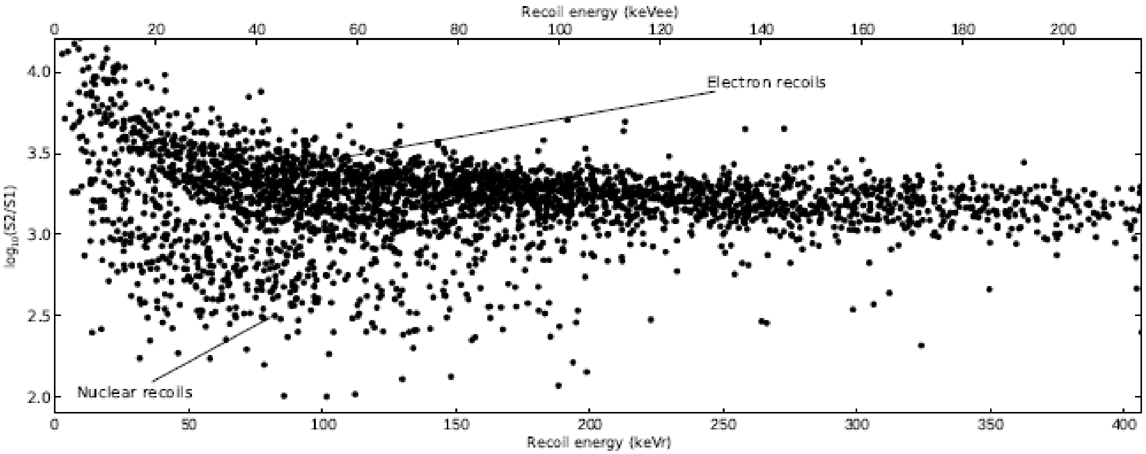
- 1kg.
- 10-15bar, pure Xe.
- $64 cm^2$, light amplification (EL).
- 8cm drift.
- SiPM for tracking.
- PMT for T_0 and calorimetry.









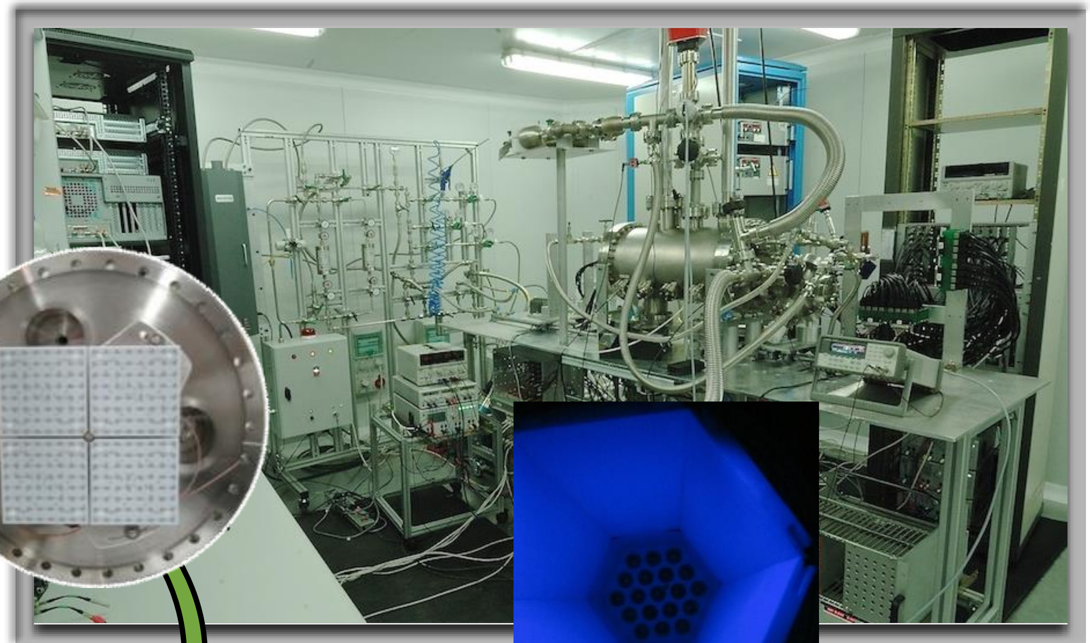


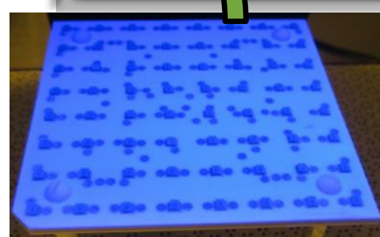
0.5 % FWHM extrapolated @ $Q_{\beta\beta}$

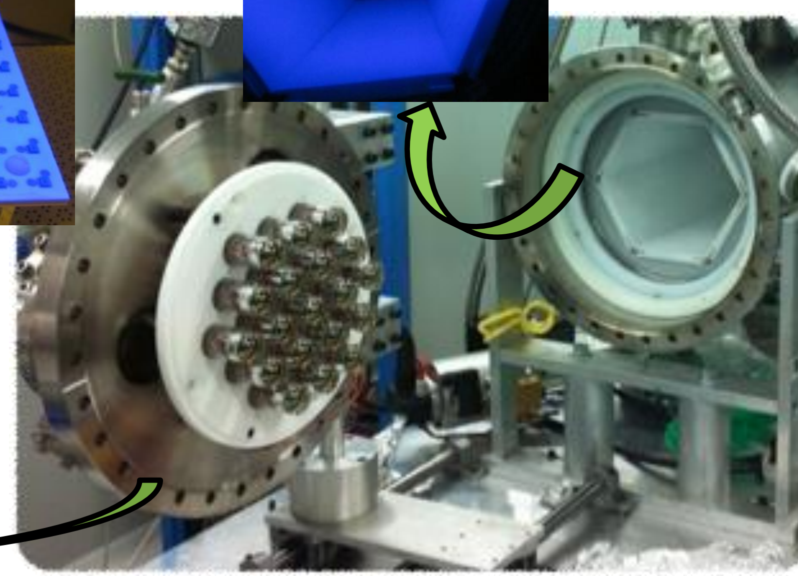
NEXT-DEMO (in a nutshell-I)

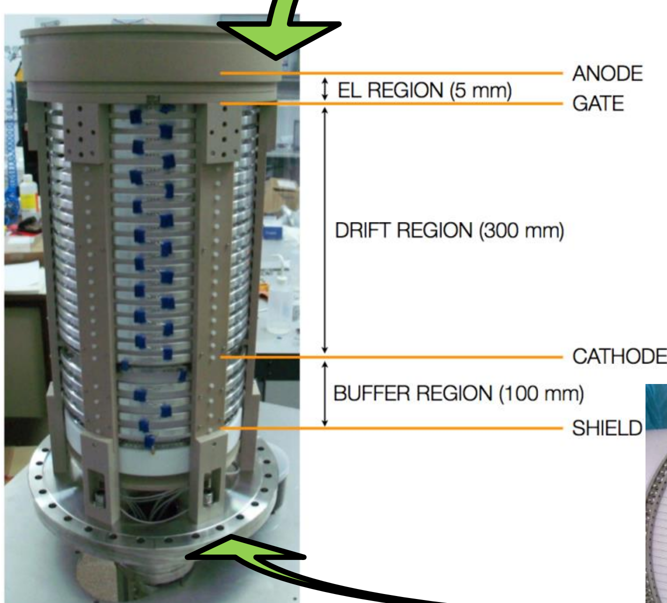
IFIC-Valencia

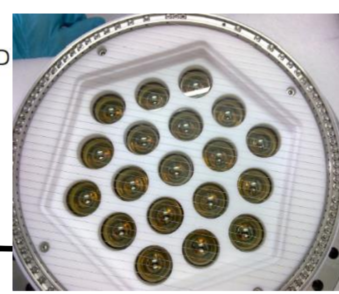
- 2.5kg.
- 10bar, pure Xe.
- 150cm^2, light amplification (EL).
- 30cm drift.
- SiPM for tracking.
- PMT for T_0 and calorimetry.



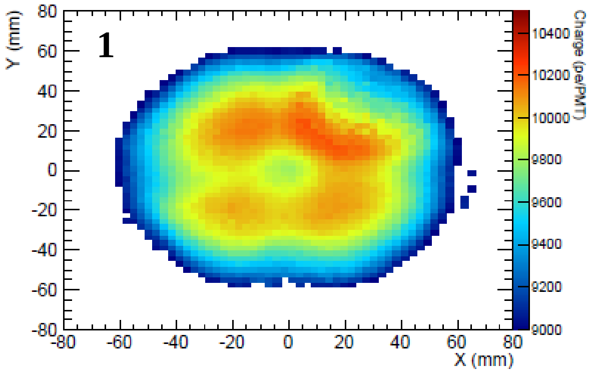


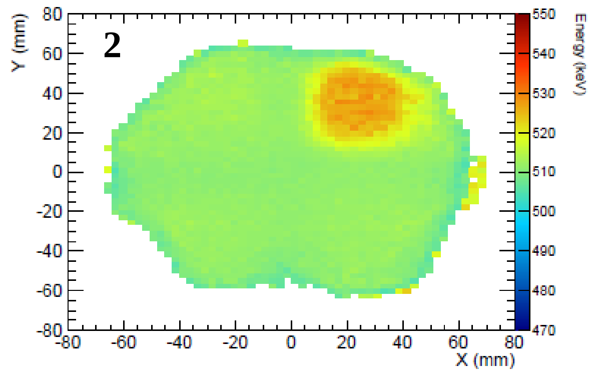


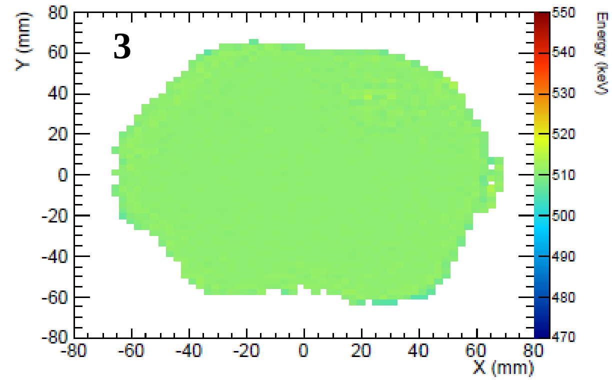




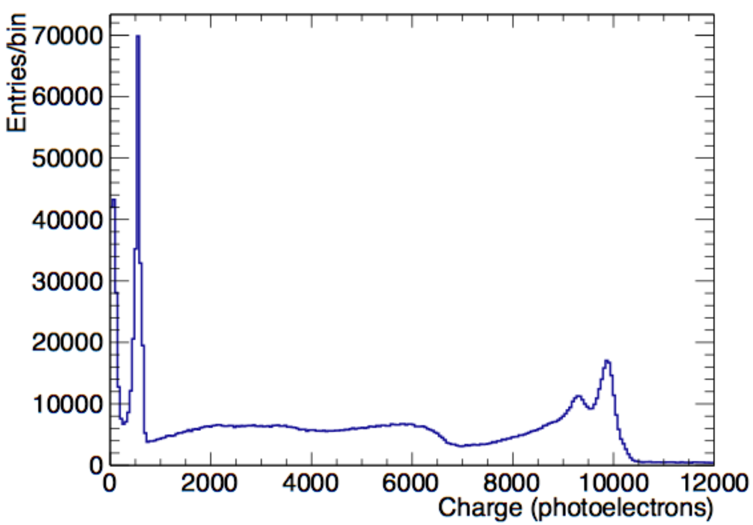
NEXT-DEMO (in a nutshell-II)



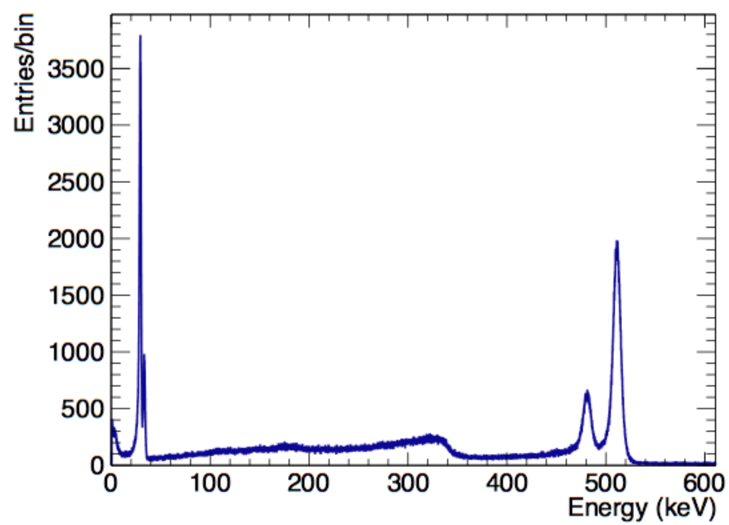




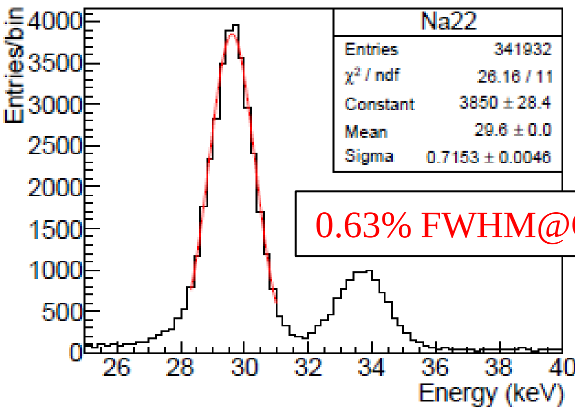
before correction

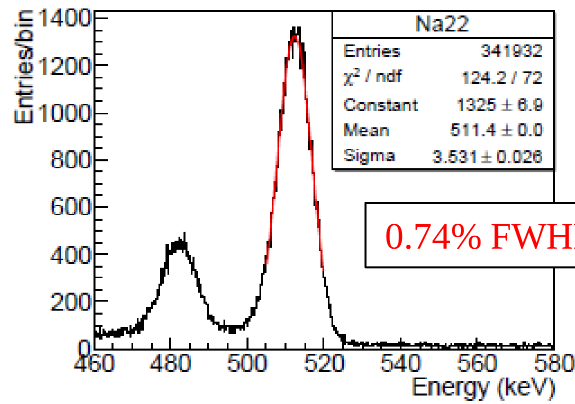


after correction



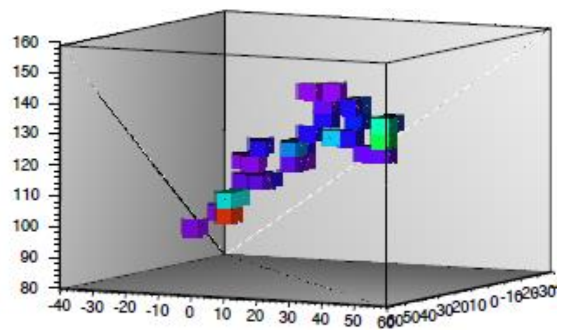
NEXT-DEMO (in a nutshell-III)

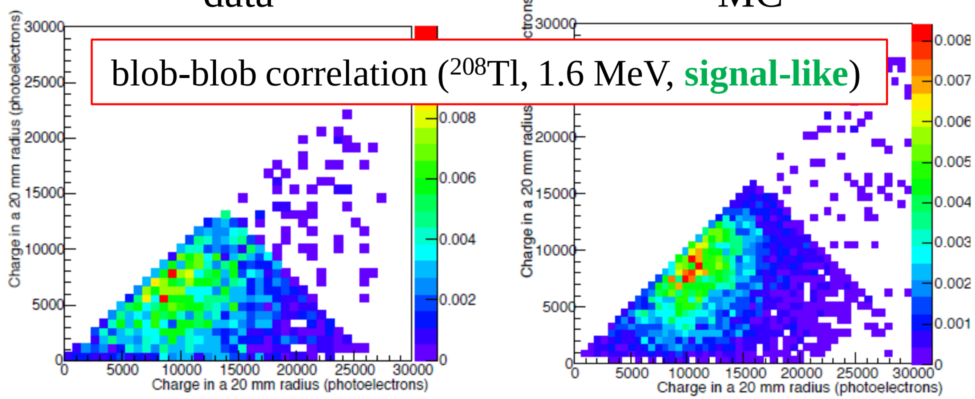




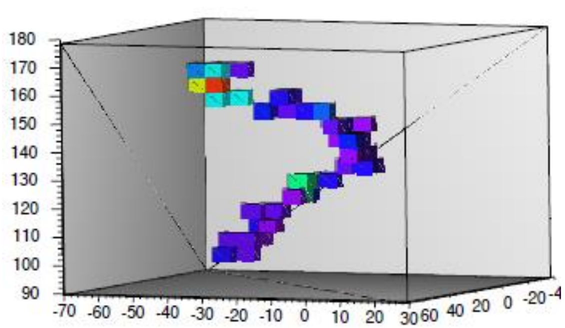
data

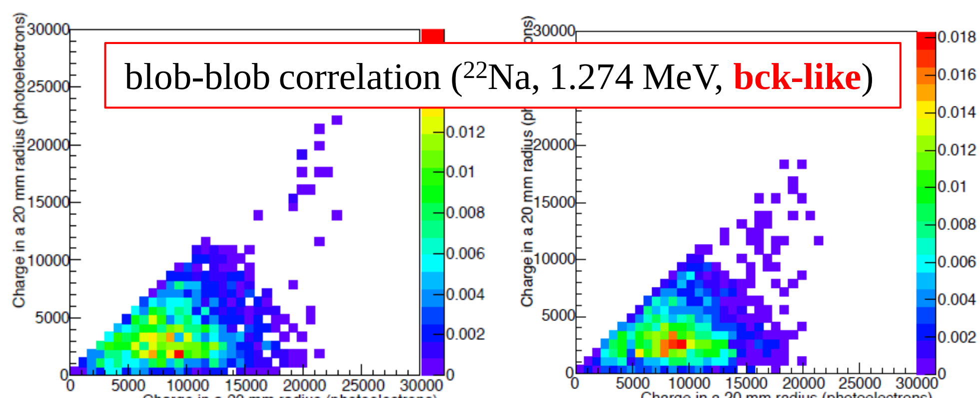
MC





blob-blob correlation (^{208}Tl, 1.6 MeV, **signal-like**)





blob-blob correlation (^{22}Na, 1.274 MeV, **bck-like**)

some remarkable R&D results relative to fundamental properties of HP-Xenon (HP)

Pure

- Drift velocity and longitudinal diffusion.
- W_{exc} and W_I for γ-rays.
- W_{exc} and correlation scintillation-ionization for α-particles.
- Nuclear recoil quenching factors for scintillation and ionization. → submitted

Mixtures

- Drift velocity, longitudinal and transverse coefficients for Xe-TMA. } t.b.p.
- Light yields, recombination and Penning rates for Xe-TMA. } t.b.p.
- EL yields for Xe-CH_4. → ongoing
- Columnar recombination in Xe-TMA → ongoing

NEXT stage-I (NEWhite)

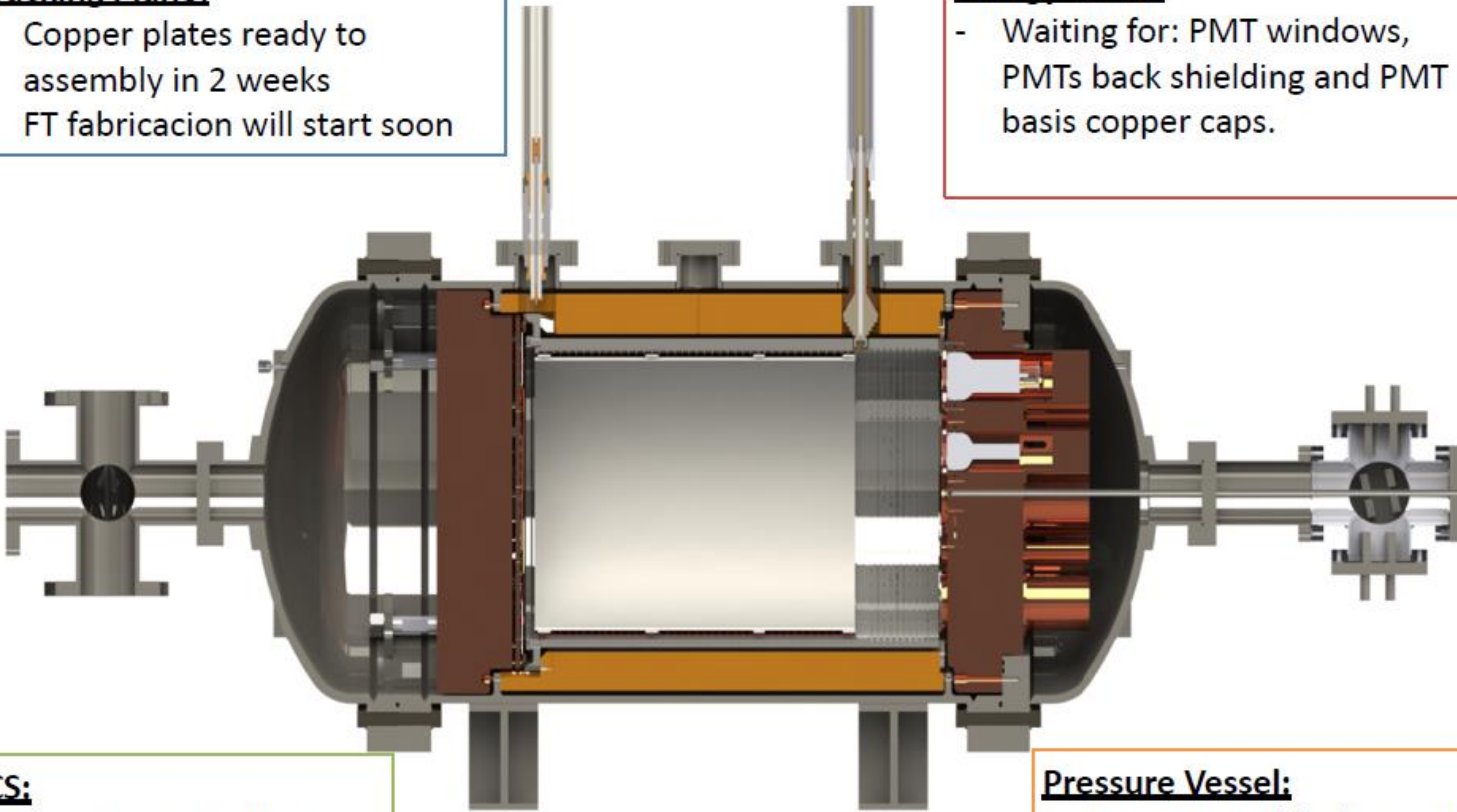
- NEXT-stage 1 (NEWhite):
  - NEW==NEXT-100 at scale 1:2.
  - 10-15 kg of ^{136}Xe (10-15bar).
  - 20% of sensors: 12 PMTs, 20 SiPMs boards.
- Objective:
  - Consolidate the project (now supported through the European Research Council (AdG)).
  - Validate the background model.
  - Characterize exhaustively the ββ2ν ^{136}Xe signal and extract the discrimination power of the 2-blob topological signal in Xenon gas.
- Construction and commissioning: 2014-2015.
- Data taking: 2015-2016.

In memoriam of James White

description and status of NEW

Tracking Plane:
- Copper plates ready to assembly in 2 weeks
- FT fabricacion will start soon

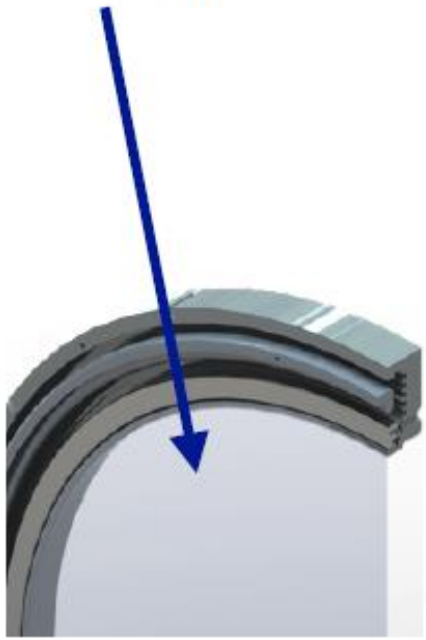
Energy Plane:
- Waiting for: PMT windows, PMTs back shielding and PMT basis copper caps.



ICS:
- Completely finished

Pressure Vessel:
- Pressure and leak tests will be done this month

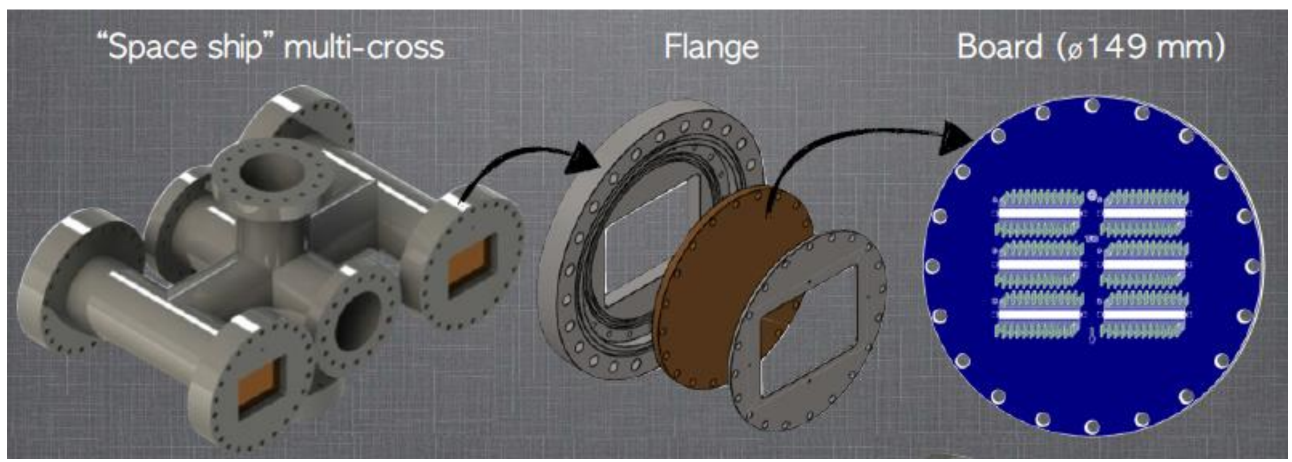
Quartz plate in the anode

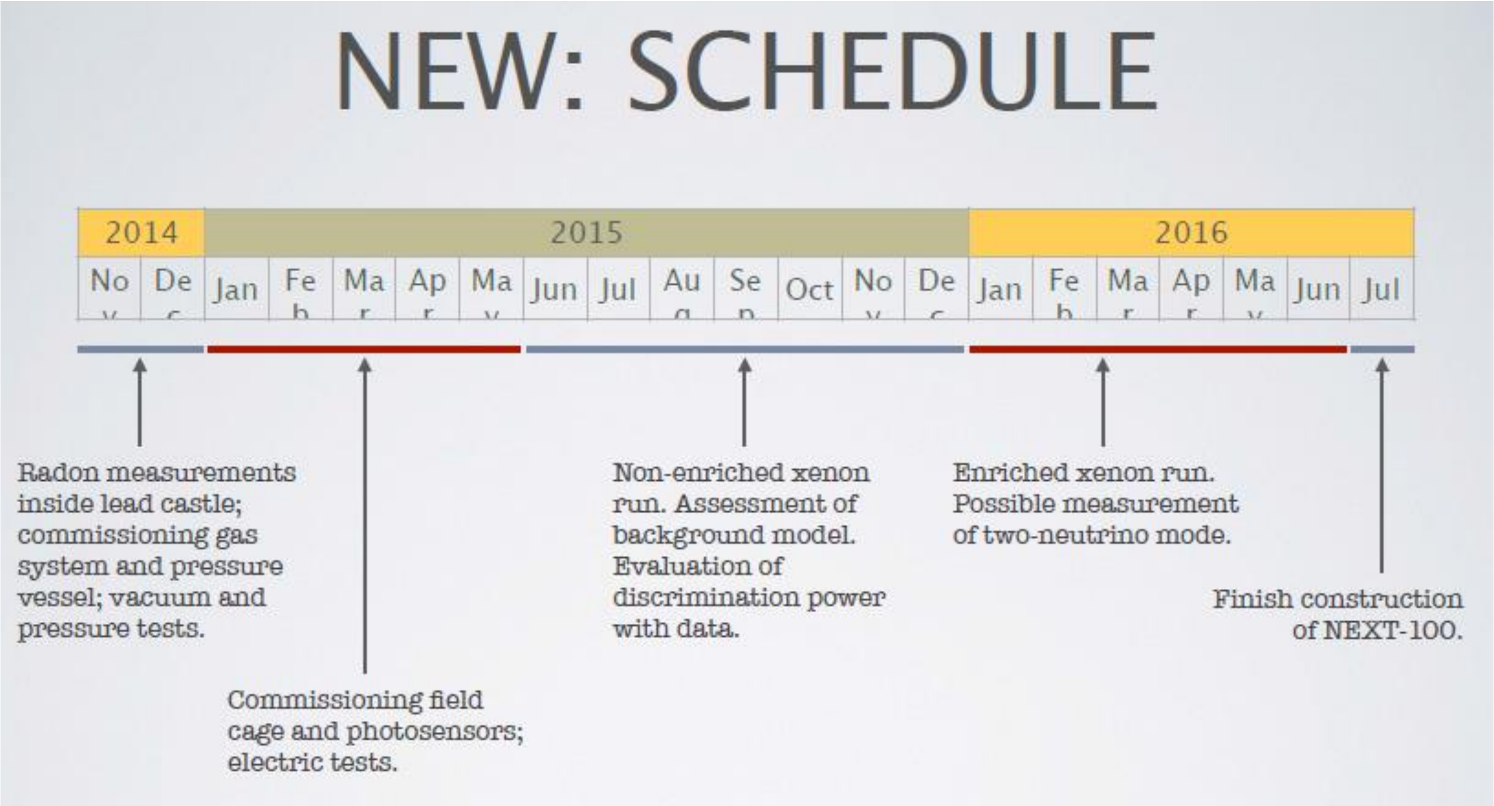


Quartz plate TPB-coated on top of SiPM plane (‘a la’ Dark Side)

NEW important additions

New flat-cable feed-throughs

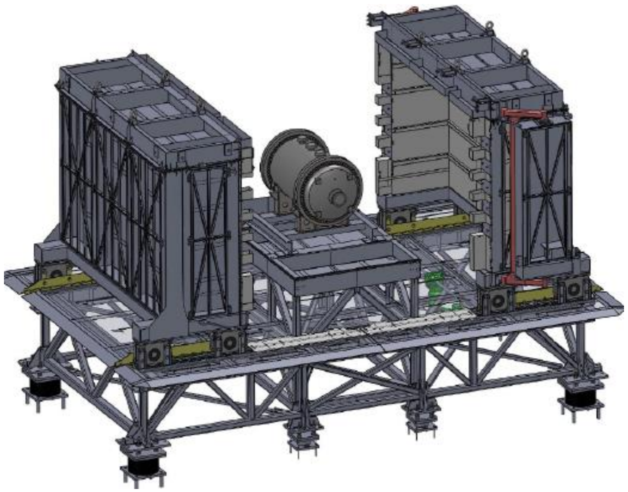




Idea: re-use as much materials as possible. Notable exceptions:

1) NEXT-100 vessel: *already built*.
2) Cathode and EL grids: *TAMU or DarkSide*.
3) Field cage and light tube to be re-built.
4) Copper end-caps to be re-built.

NEW installation



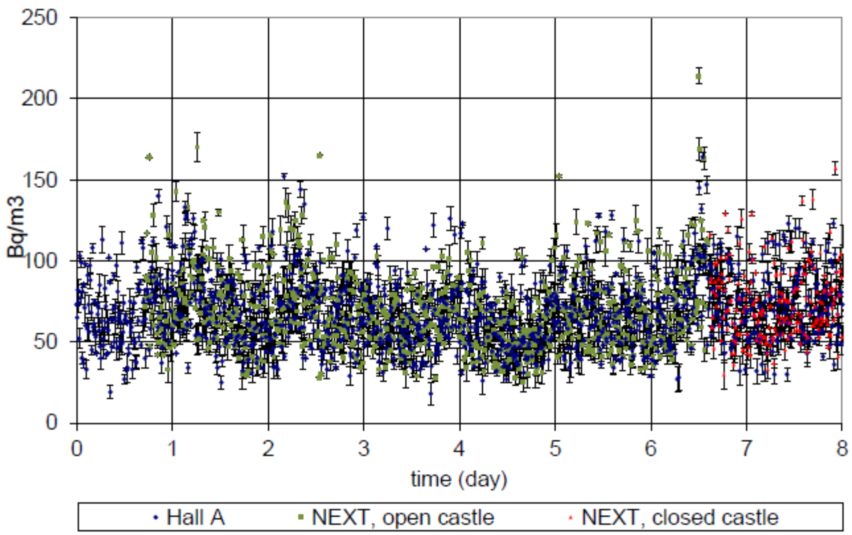
vessel, ICS and field-cage (just polyethylene) once assembled in Madrid.
(will be un-mounted and cleaned at LSC during February)

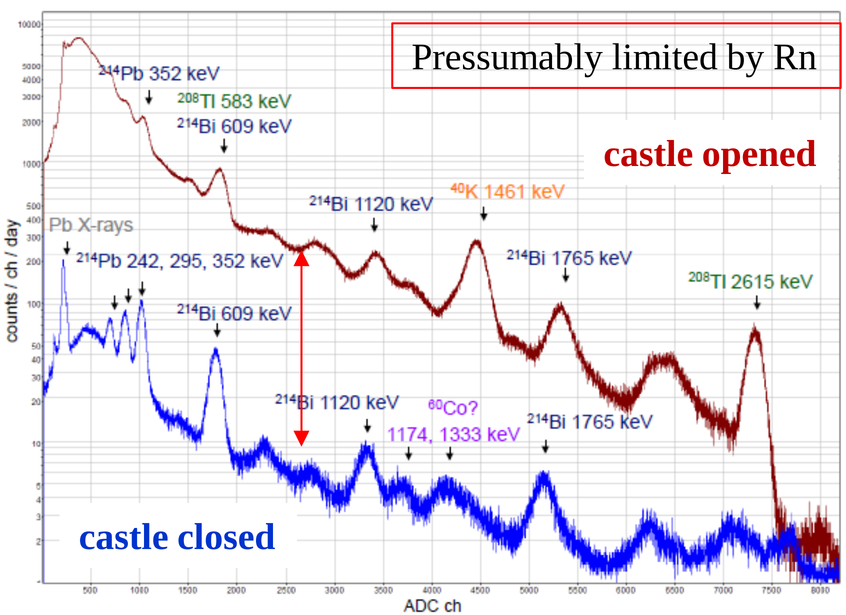
Seismic platform + castle + re-casted lead bricks (thanks to OPERA), pedestal at LSC

- Gas purification and recovery (ready at LSC).
- Slow control ready.

NEW (external backgrounds)

Rn and γ measurements inside the castle

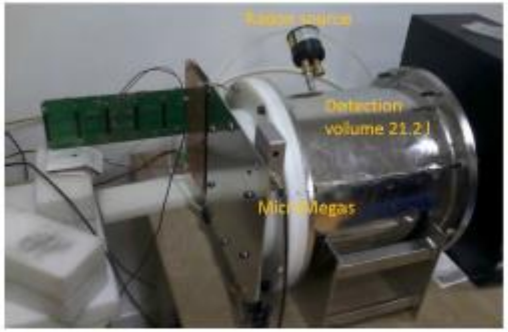




to be suppressed by x100!

Anti-radon device approved by Canfranc (similar to the one used in LSM)

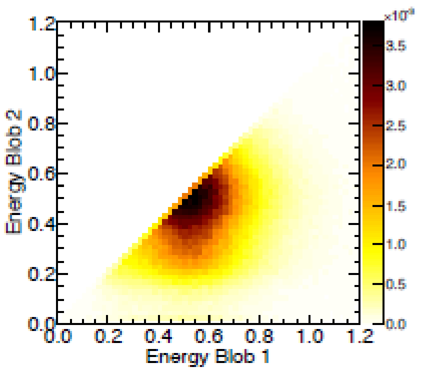
Ultra-sensitive Rn detector to be built at Zaragoza (Micromegas-based)

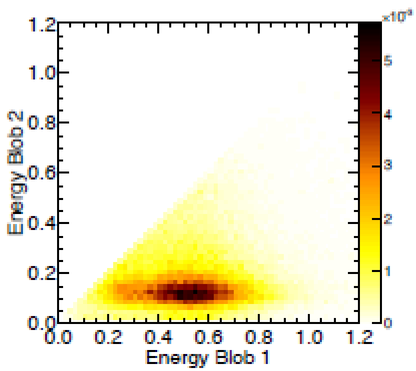


background model

signal efficiency + rejection ratios

Selection criterion	$0\nu\beta\beta$	$2\nu\beta\beta$	^{208}Tl	^{214}Bi
Fiducial, single track $E \in [2.4, 2.5]$ MeV	0.4759	8.06×10^{-9}	2.83×10^{-5}	1.04×10^{-5}
Track with 2 blobs	0.6851	0.6851	0.1141	0.105
Energy ROI	0.8661	3.89×10^{-5}	0.150	0.457
Total	0.2824	2.15×10^{-13}	4.9×10^{-7}	4.9×10^{-7}

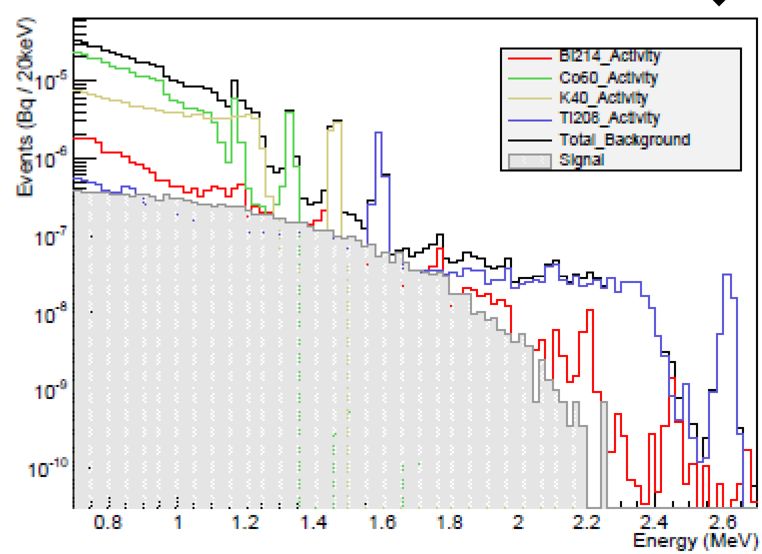




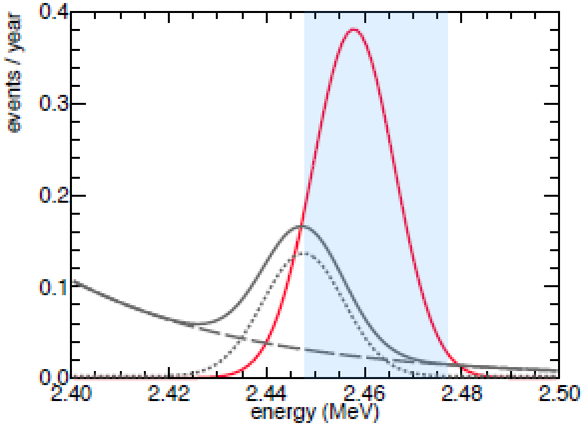
radiopurity campaign

Detector subsystem	Activity (mBq)		Rejection factor		c (10^{-4}/(keV kg yr))	
	^{208}Tl	^{214}Bi	^{208}Tl	^{214}Bi	^{208}Tl	^{214}Bi
Pressure vessel						
Total	<194	<603	$1.0(3) \times 10^{-8}$	$1.0(5) \times 10^{-9}$	< 0.23	< 0.06
Energy plane						
R11410-10 PMTs	15(8)	<58	$2.41(16) \times 10^{-7}$	$1.64(13) \times 10^{-7}$	0.43(2)	< 1.13
Enclosures	<0.36	<3.0	$1.48(12) \times 10^{-7}$	$1.05(10) \times 10^{-7}$	< 0.0063	< 0.038
Sapphire windows	2.4(6)	<19	$4.2(2) \times 10^{-7}$	$3.9(2) \times 10^{-7}$	0.12(3)	< 0.89
Support plate	<0.57	<4.9	$2.01(14) \times 10^{-7}$	$7.0(8) \times 10^{-8}$	< 0.014	< 0.041
Tracking plane						
Dice boards	1.5(2)	3(1)	$4.9(2) \times 10^{-7}$	$4.9(2) \times 10^{-7}$	0.088(12)	0.19(6)
SiPMs	<5.3	<5.3	$4.9(2) \times 10^{-7}$	$4.9(2) \times 10^{-7}$	< 0.31	< 0.31
Electric-field cage						
Barrel	<1	<8	$3.83(19) \times 10^{-7}$	$4.4(2) \times 10^{-7}$	< 0.05	< 0.4
Shaping rings	<0.4	<3.6	$3.83(19) \times 10^{-7}$	$4.4(2) \times 10^{-7}$	< 0.018	< 0.189
Electrode rings	<1.5	<4.6	$3.83(19) \times 10^{-7}$	$4.4(2) \times 10^{-7}$	< 0.07	< 0.2
Anode plate	0.16(3)	0.39(15)	$4.9(2) \times 10^{-7}$	$4.9(2) \times 10^{-7}$	0.009(2)	0.02(9)
Shielding						
Outer (Pb)	2060(420)	21200(4200)	$1.0(5) \times 10^{-10}$	$1.0(5) \times 10^{-10}$	0.027(13)	0.25(14)
Inner (Cu)	<13	<111	$1.08(10) \times 10^{-7}$	$5.3(7) \times 10^{-8}$	< 0.05	< 0.7

Table 3: Background rate predicted for each subsystem of the NEXT-100 detector.

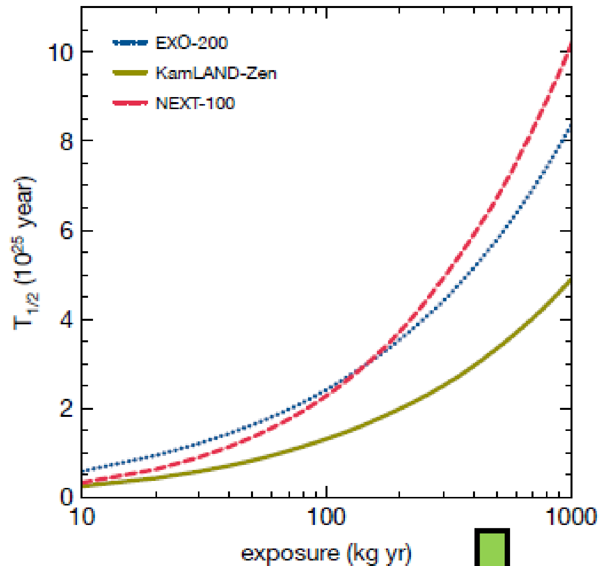


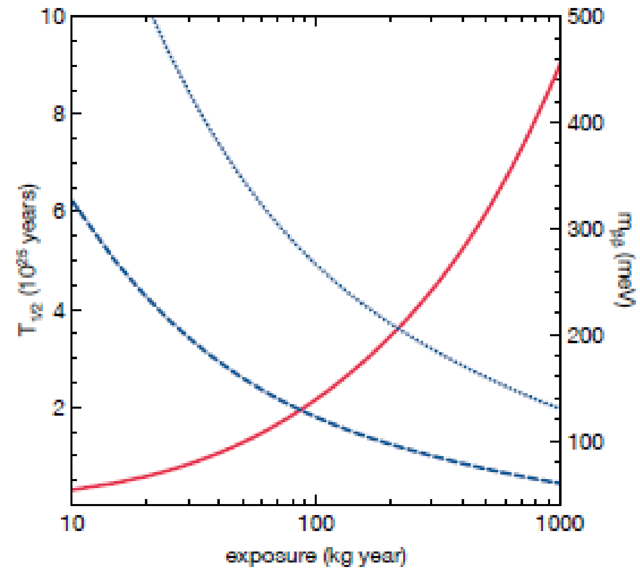
NEXT-100



Detector subsystem	^{208}Tl	^{214}Bi	*Total*
Pressure vessel	< 0.23	< 0.06	< 0.29
Energy plane	< 0.57	< 2.10	< 2.67
Tracking plane	< 0.40	< 0.50	< 0.90
Electric-field cage	< 0.15	< 0.81	< 0.96
Inner shielding	< 0.05	< 0.7	< 0.75
Outer shielding	0.027(13)	0.25(14)	0.28(14)
Total	< 1.43	< 4.42	< 5.85

Table 4: Contribution of major subsystems to the expected background rate of NEXT-100, expressed in 10^{-4} counts keV^{-1} kg^{-1} yr^{-1}.





NEXT-100++/NEXT-1Ton

I. The perfect mixture?

(2 families identified)

Ia). Penning-Fluorescent

(2 candidate molecules identified)

1. Suitable for **Penning** transfer. Can potentially reduce Fano factor.
2. Strongly **fluorescent at higher λ** and self-transparent.
3. Able to **reduce electron diffusion** in gas.
4. Allows for **EL at lower field** due to low-lying TMA excited states.

(already presented at the symposium)

Ib). Low diffusion/light preserving

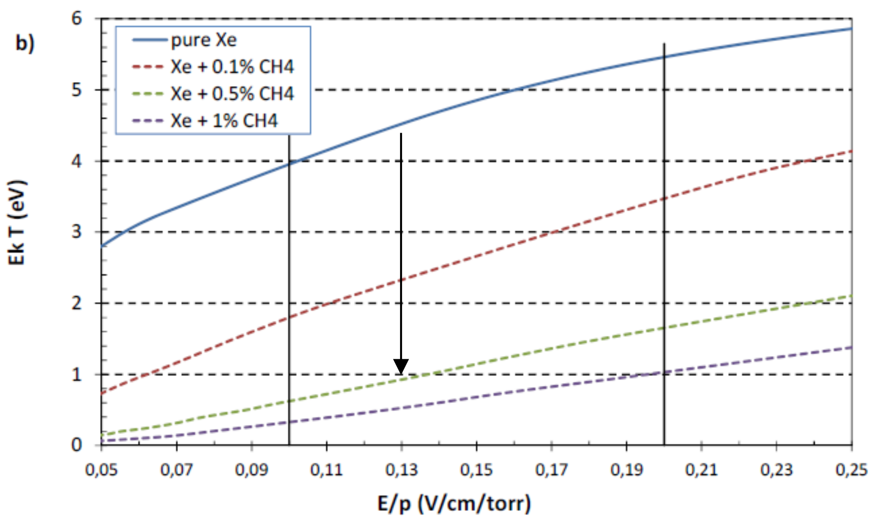
(6 candidate molecules identified)

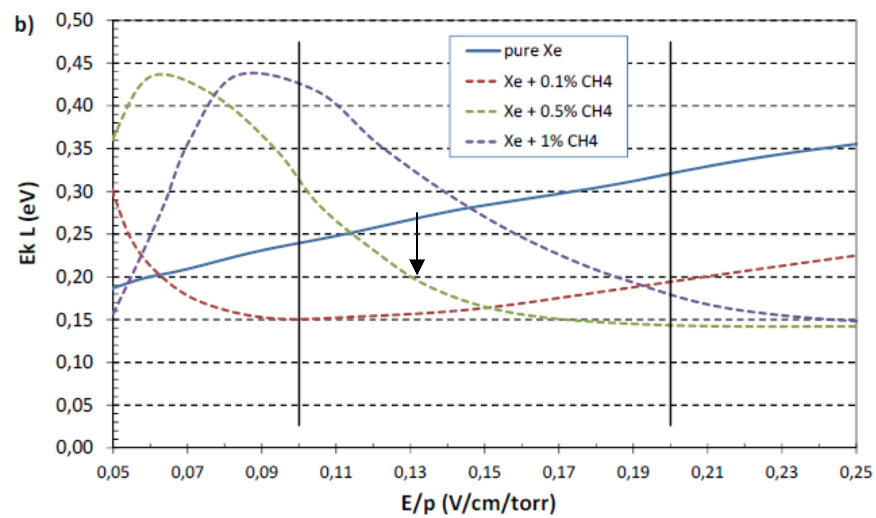
1. Able to **reduce electron diffusion** in gas.
2. Light mechanisms unaffected.
   - **a)** **Highly transparent** to Xe-light.
   - **b)** **Small quenching for S_1 and small fluctuations in EL**.
3. **Recombination small.**

example: CH_4

First measurement of electroluminescence in Xe/CH_4 mixtures:

E/p (V/cm/torr) =	3.5			0.15
	ER(%) for 5.9 keV	ER(%) for 2458 keV	HV (kV) Scint. region	HV (kV) Drift region
Xe	7,7	0,38	7.98 @ 10 bar 11.97 @ 15 bar	114 @10 bar 171 @15 bar
$Xe+0.5\%CH_4$	8,3	0,41		
$Xe+1\%CH_4$	12,0	0,59		
$Xe+2.2\%CH_4$	27,0	1,32		





- Light quenching factor for $0.5\%CH_4$ should be around an acceptable x1/2 from the known quenching rates.
- Charge recombination unknown.
- Transparency ok.

NEXT-100++/NEXT-1Ton (getting started)

II. operation under magnetic field

estimated NEXT-100 background = 5ckky

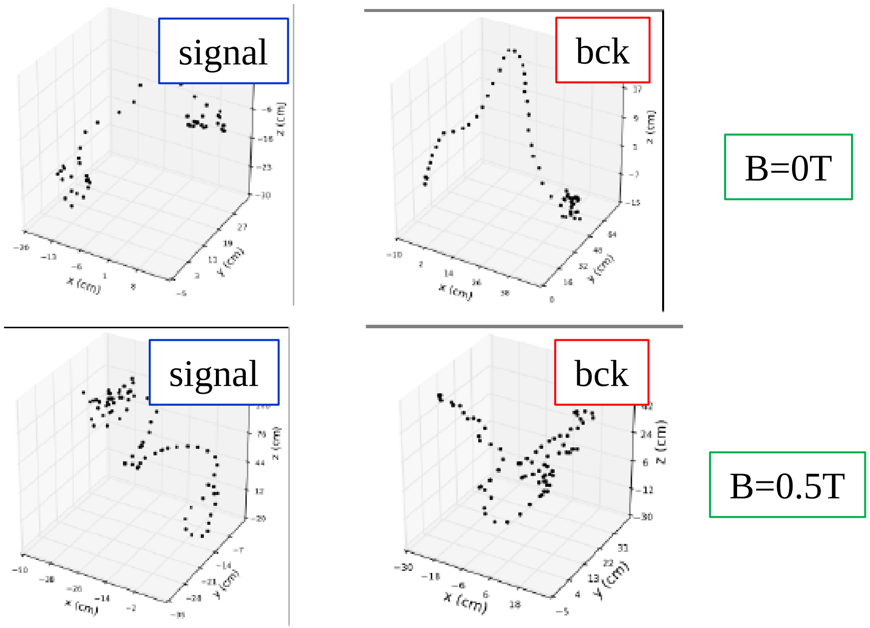


Figure 6: Top Left: two electrons emitted in a $\beta\beta0\nu$ decay in the absence of magnetic field. Top right: a single (background) electron produced by the photoelectric interaction of a 2.45 MeV photon emitted in ^{214}Bi decays, interacting in the chamber. Bottom left: two electrons emitted in a $\beta\beta0\nu$ decay, turning into a double helix that originate in a common vertex, in a magnetic field of 0.5 T. Bottom right: a single background electron turning into a single helix in a magnetic field of 0.5 T.

An additional topological rejection factor of 1/10 would allow to operate NEXT-100 in background-free conditions (tantalizing!)

III. Ba-Tagging

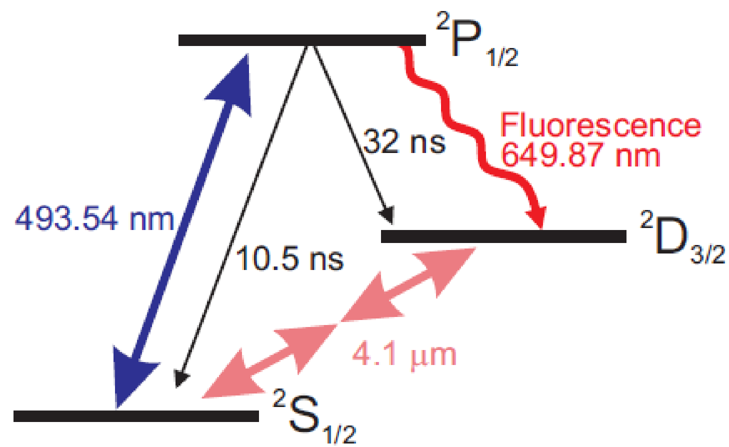


Figure 7: The BaTa concept.

pioneered by EXO!

NEXT will focus on in-situ tagging

(hence, we will make different mistakes)

conclusions and outlook

- Several HP-Xenon (1kg) TPCs successfully developed over last years and presently operational.

- EL-technique consolidated.

- The first stage of NEXT-100, NEW, will be deployed early 2015 at LSC. It will contain 10-15kg of ^{136}Xe and it will validate the background model and topological algorithms by surveying the ββ2ν region.

- With present background estimates and reconstruction algorithms, NEXT-100, seems capable of exploring ββ0ν down to 100 meV effective ν masses for a exposure of about 300 kg year, starting in 2016.

- With the energy resolution well under control (at the 0.5-0.7% level, $Q_{\beta\beta0}$) the main focus in the near future will be to improve the topological handles, by optimizing gas diffusion and event reconstruction.

- Ba-Tagging and B-field opportunities will be also studied.

The NEXT collaboration

IFIC (Valencia), U. Zaragoza, U. Santiago, U. Girona, U. Politécnica Valencia, U. A. Madrid

U. Coimbra, U. Aveiro

LBL, Texas A&M U., Iowa State U.

JINR (Dubna)

U. Antonio Nariño (Bogotá)

LSC
Laboratorio Subterráneo de Canfranc

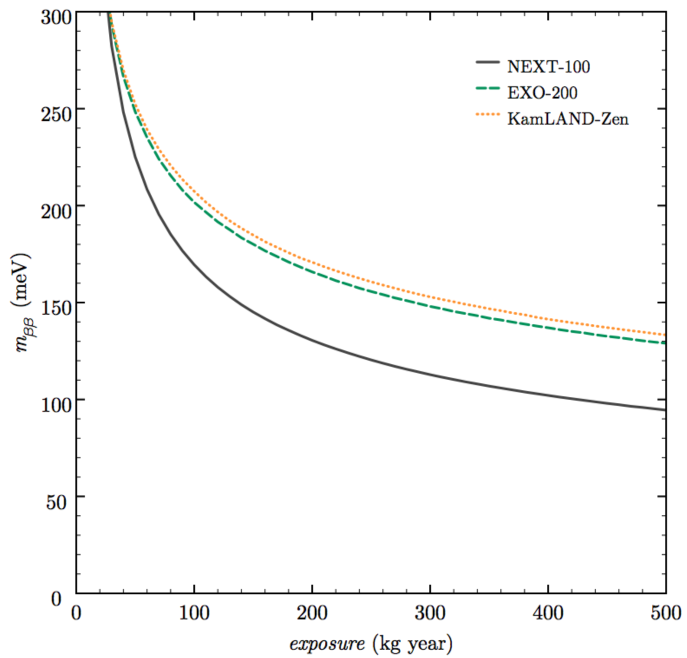
Collaboration members at Canfranc Underground Laboratory (LSC), 80 people, 5 countries

Grants: Consolider-2010 (Spain), ERC-ADG 2013 (EU)

appendix

NEXT-100 into the future

- EXO200 and KamLAND-Zen set current best limits on ^{136}Xe $\beta\beta0\nu$
  - Assume same background and energy resolution that currently measured
- NEXT-100 sensitivity to $m_{\beta\beta}$
  - Using estimation of background contamination and measurements of energy resolution with prototypes



Experiment	M (kg)	enrichment (%)	efficiency (%)	resolution (% FWHM)	b (10^{-3} ckky)
EXO-200	110	81	52	3.9	1.5
KamLAND-Zen	330	91	62	9.9	1.0
NEXT-100	100	91	31	0.5–1.0	0.4–0.9

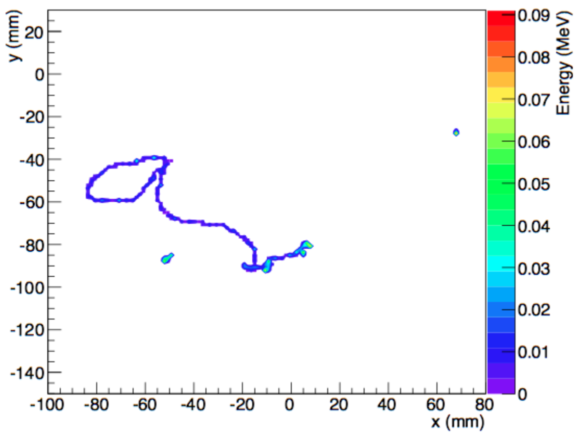
NEXT-100

NEXT-100. Simulation

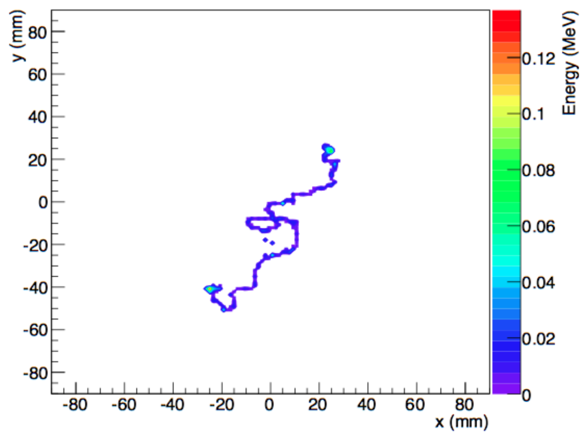
Complete Geant-4 MC simulation of detector and physics

- Main contamination (from Th, U chains): ^{208}Tl (γ,2615 keV), ^{214}Bi (γ,2448 keV).
- Simple cut analysis for recognizing a blob (more detailed analysis work soon).

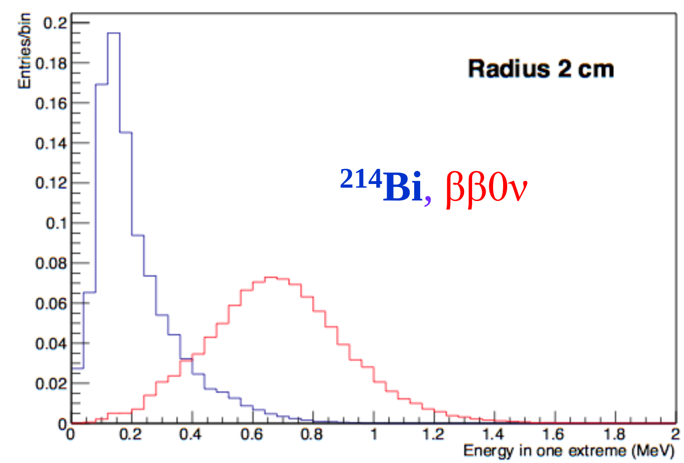
^{214}Bi (1 electron and extra activity)



ββ0ν (2 electrons)



Energy in second blob candidate
Bi, ββ0ν



Selection cut	Fraction of events			
	$\beta\beta0\nu$	$\beta\beta2\nu$	^{214}Bi	^{208}Tl
$E \in (2.3, 2.6)$ MeV	0.776	3.31×10^{-6}	1.52×10^{-4}	8.02×10^{-3}
Fiducial	0.678	2.95×10^{-6}	1.13×10^{-4}	4.77×10^{-3}
Single track	0.508	2.27×10^{-6}	1.36×10^{-5}	8.44×10^{-4}
dE/dx	0.381	1.70×10^{-6}	1.36×10^{-6}	8.10×10^{-5}
ROI				
0.5% FWHM	0.311	3.24×10^{-12}	1.23×10^{-7}	3.23×10^{-7}
1.0% FWHM	0.315	3.57×10^{-11}	3.69×10^{-7}	5.40×10^{-7}

reduction factor: 0.45 signal, 3 10^3 Bi

NEXT-stage I

NEXT-stage I (NEWhite). Radiopurity

Most of the needed elements **already screened** for radiopurity:
PTFE, high-density polyethylene, copper, steel, lead, tracking plane (board, resistors, capacitors, solder paste, connectors), and PMTs.

Missing (already partially shielded):
Cables, bolts, PMT cans

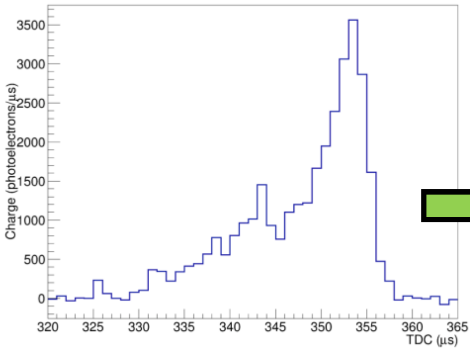
V. Alvarez et al., 'Radiopurity control in the NEXT-100 double beta decay experiment: procedures and initial measurements', JINST 8 T01002(2013).

#	Material	Supplier	Technique	Unit	^{238}U	^{226}Ra	^{232}Th	^{228}Th	^{235}U	^{40}K	^{60}Co	^{137}Cs
	Shielding											
1	Pb	Cometa	GDMS	mBq/kg	0.37		0.073			<0.31		
2	Pb	Mifer	GDMS	mBq/kg	<1.2		<0.41			0.31		
3	Pb	Mifer	GDMS	mBq/kg	0.33		0.10			1.2		
4	Pb	Tecnibusa	GDMS	mBq/kg	0.73		0.14			0.91		
5	Pb	Tecnibusa	Ge	mBq/kg	<94	<2.0	<3.8	<4.4	<30	<2.8	<0.2	<0.8
6	Pb	Tecnibusa	Ge	mBq/kg	<57	<1.9	<1.7	<2.8	<22	<1.7	<0.1	<0.5
7	Cu (ETP)	Sanmetal	GDMS	mBq/kg	<0.062		<0.020					
8	Cu (C10100)	Luvata (hot rolled)	GDMS	mBq/kg	<0.012		<0.0041			0.061		
9	Cu (C10100)	Luvata (cold rolled)	GDMS	mBq/kg	<0.012		<0.0041			0.091		
10	Cu (C10100)	Luvata (hot+cold rolled)	Ge	mBq/kg		<7.4	<0.8	<4.3		<18	<0.8	<1.2
	Vessel											
11	Ti	SMP	Ge	mBq/kg	<233	<5.7	<8.8	<9.5	3.4±1.0	<22	<3.3	<5.2
12	Ti	SMP	Ge	mBq/kg	<361	<6.6	<11	<10	<8.0	<15	<1.0	<1.8
13	Ti	Ti Metal Supply	Ge	mBq/kg	<14	<0.22	<0.5	3.6±0.2	0.43±0.08	<0.6	<0.07	<0.07
14	304L SS	Pfeiffer	Ge	mBq/kg		14.3±2.8	9.7±2.3	16.2±3.9	3.2±1.1	<17	11.3±2.7	<1.6
15	316Ti SS	Nironit, 10-mm-thick	Ge	mBq/kg	<21	<0.57	<0.59	<0.54	<0.74	<0.96	2.8±0.2	<0.12
16	316Ti SS	Nironit, 15-mm-thick	Ge	mBq/kg	<25	<0.46	<0.69	<0.88	<0.75	<1.0	4.4±0.3	<0.17
17	316Ti SS	Nironit, 50-mm-thick	Ge	mBq/kg	67±22	<1.7	2.1±0.4	2.0±0.7	2.4±0.6	<2.5	4.2±0.3	<0.6
18	Inconel 625	Mecanizados Kanter	Ge	mBq/kg	<120	<1.9	<3.4	<3.2	<4.6	<3.9	<0.4	<0.6
19	Inconel 718	Mecanizados Kanter	Ge	mBq/kg	309±78	<3.4	<5.1	<4.4	15.0±1.9	<13	<1.4	<1.3
	HV, EL components											
20	PEEK	Sanmetal	Ge	mBq/kg		36.3±4.3	14.9±5.3	11.0±2.4	<7.8	8.3±3.0	<3.3	<2.6
21	Polyethylene	IN2 Plastics	Ge	mBq/kg	<140	<1.9	<3.8	<2.7	<1.0	<8.9	<0.5	<0.5
22	Semitron ES225	Quadrant EPP	Ge	mBq/kg	<101	<2.3	<2.0	<1.8	1.8±0.3	513±52	<0.5	<0.6
23	SMD resistor	Farnell	Ge	mBq/pc	2.3±1.0	0.16±0.03	0.30±0.06	0.30±0.05	<0.05	0.19±0.08	<0.02	<0.03
24	SM5D resistor	Finechem	Ge	mBq/pc	0.4±0.2	0.022±0.007	<0.023	<0.016	0.012±0.005	0.17±0.07	<0.005	<0.005
	Energy, tracking planes											
25	Kapton-Cu PCB	LabCircuits	Ge	mBq/cm^2	<0.26	<0.014	<0.012	<0.008	<0.002	<0.040	<0.002	<0.002
26	Cuflon	Polyflon	Ge	mBq/kg	<33	<1.3	<1.1	<1.1	<0.6	4.8±1.1	<0.3	<0.3
27	Bonding films	Polyflon	Ge	mBq/kg	1140±300	487±23	79.8±6.6	66.0±4.8	60.0±5.5	832 ±87	<4.4	<3.8
28	FFC/FCP connector	Hirose	Ge	mBq/pc	<50	4.6±0.7	6.5±1.2	6.4±1.0	<0.75	3.9±1.4	<0.2	<0.5
29	P5K connector	Panasonic	Ge	mBq/pc	<42	6.0±0.9	9.5±1.7	9.4±1.4	<0.95	4.1±1.5	<0.2	<0.8

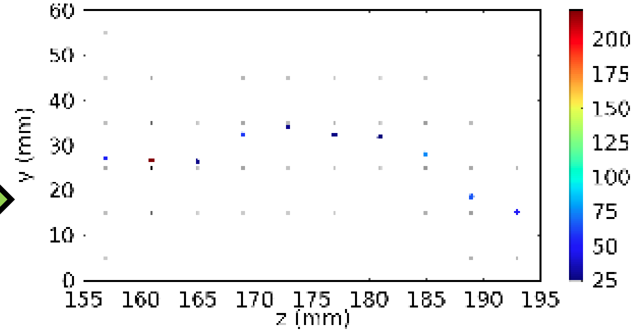
NEXT-DEMO (track reconstruction)

demonstrator

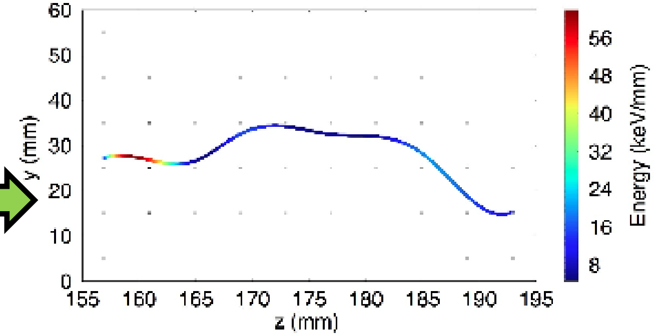
total SiPM signal vs time



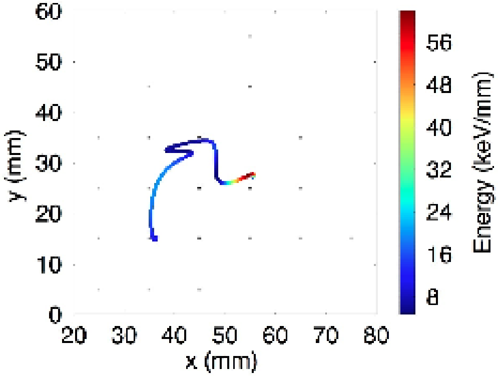
all SiPM signals vs calibrated time



slice-barycenter + 3D-spline (yz-plane)

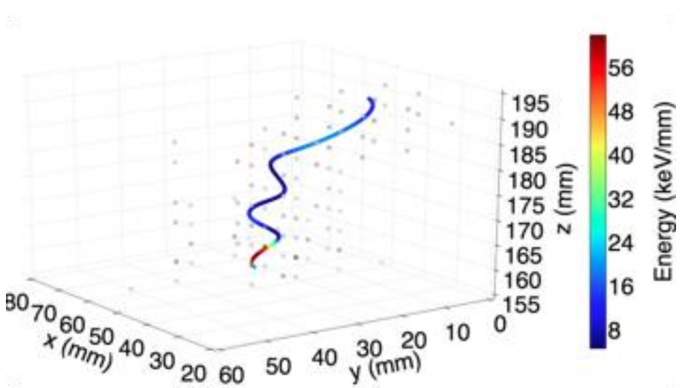


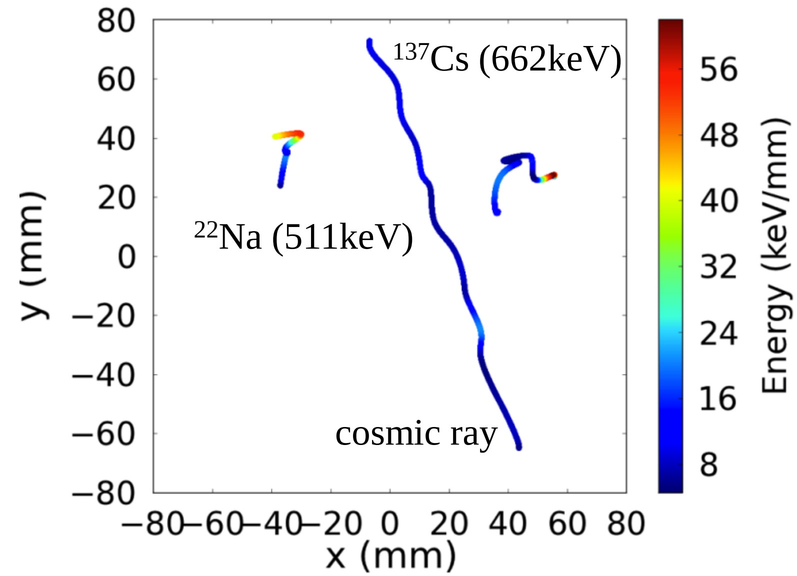
slice-barycenter + 3D-spline (xy-plane)



‘blob’ of the electron clearly visible!

3D track



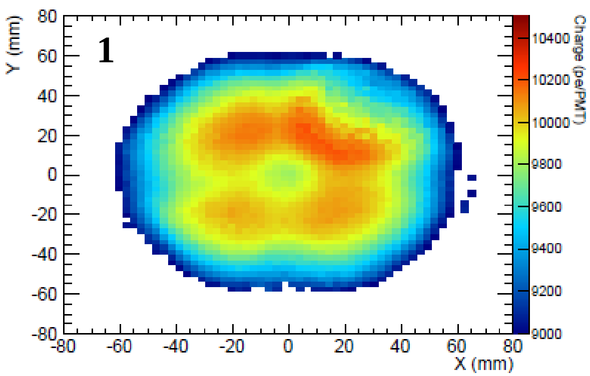


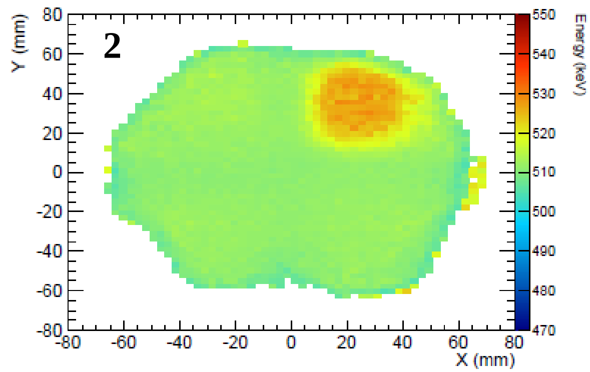
demonstrator

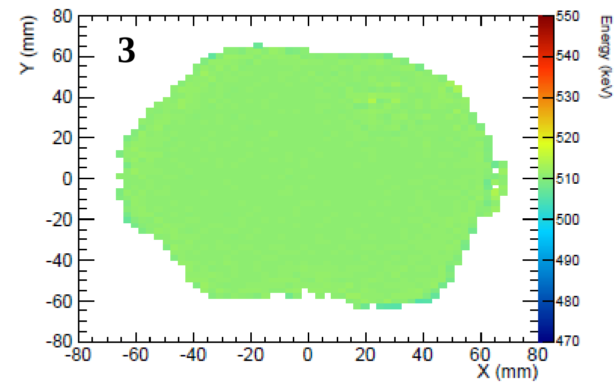
NEXT-DEMO (energy correction)

V. Alvarez et al., 'Initial results of NEXT-DEMO, a large-scale prototype of the NEXT-100 experiment', JINST 8, P04002(2013)

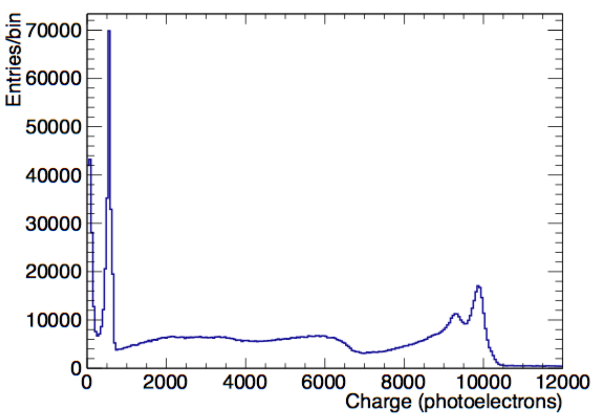
V. Alvarez et al., 'Operation and first results of the NEXT-DEMO prototype using a silicon photomultiplier tracking array', arXiv:1306.0471 [physics.ins-det]



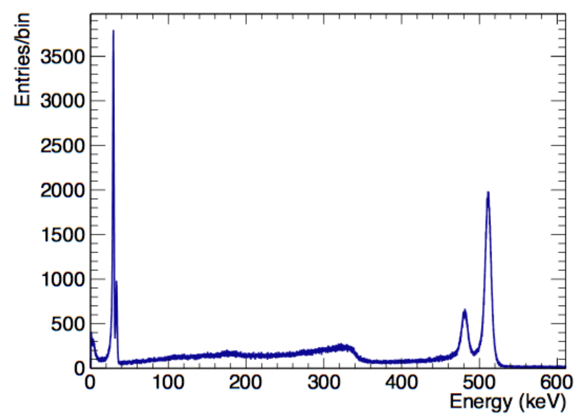


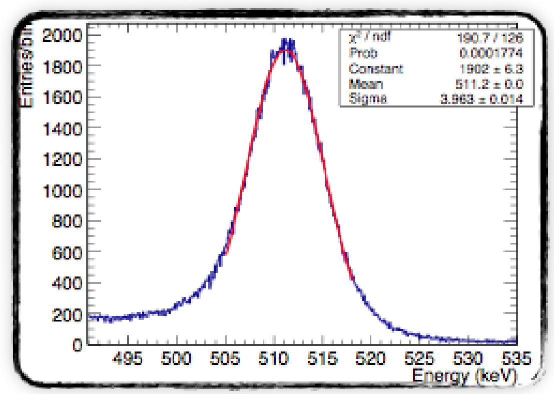


before correction



after correction

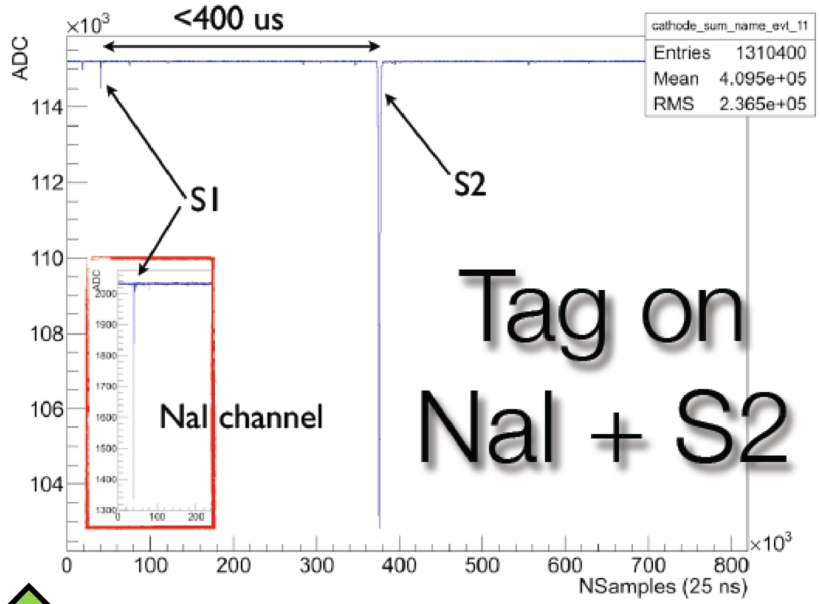




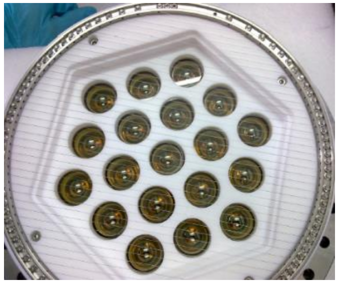
- σ_E/E = 0.83% FWHM@$Q_{\beta\beta}$!
- 40% fiducial volume

(extrapolates to 88% for NEXT-100)

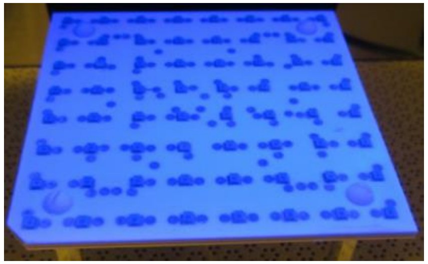
NEXT-DEMO (sensor calibration)

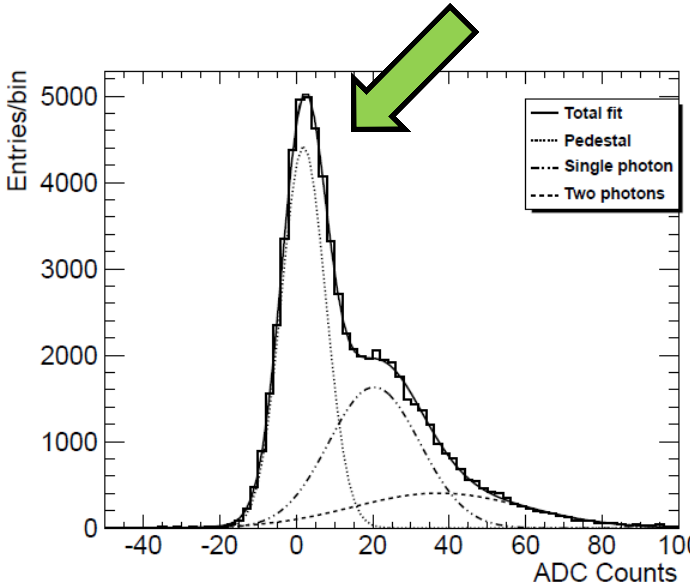


energy plane

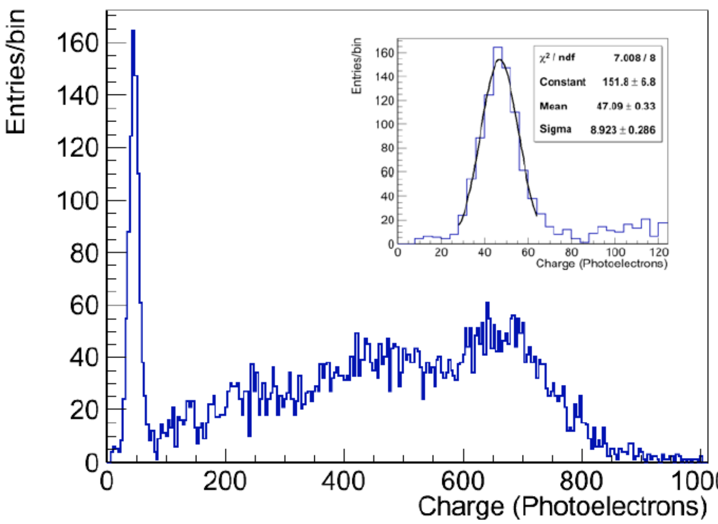


tracking plane





minimum bias PMT spectrum



SiPM spectrum (for the SiPM with highest charge)

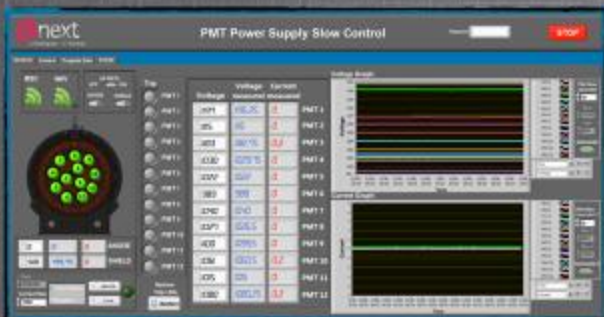
Gas Purification and Recovery

- Purification Loop bought and Delivered
- Compressor will be delivered next month
- Hot getter delivered in January
- Emergency pneumatic valve in Madrid being welded
- Control Recovery cylinders and buckets ordered
- System will be assembled and commission in situ using hard pipes and orbital welding equipment rented from Swagelock
- Will have only 3 short flexible hoses 2 x 1/2" and 1 x 100mm ID about a foot long to go from seismic platform to the working platform
- Still missing:
  - $30m^3$ emergency expansion tank
  - Multi channel RGA with scripting software

NEW Slow Control (software)

There are 5 areas to control established for NEW.

The slow control programs are prepared to work in NEW, and now they are running to be debugged.



PMT HV (PMT power supply)

- Control and monitor the PMT power supply.
- Alarm if overcurrent occurs.
- Every day 2 reports are created with all measures (voltage and current), the interval time is set via control.
- Is connected with Grids High Voltage slow control and with Main slow control via TCP/IP protocol.

SENSORS (Sensors (temperature & humidity),Pumps, RGA, Hot-Getter & Pressure regulator)

- Control and monitor the temperature and humidity sensors and pressure gauges.
- Alarm if temperature or pressure is out of the thresholds.
- Every day a report are created with all measurements.
- Send email to the shifter if problems happen.Is connected with PWR slow control and with Main slow control via TCP/IP protocol.