

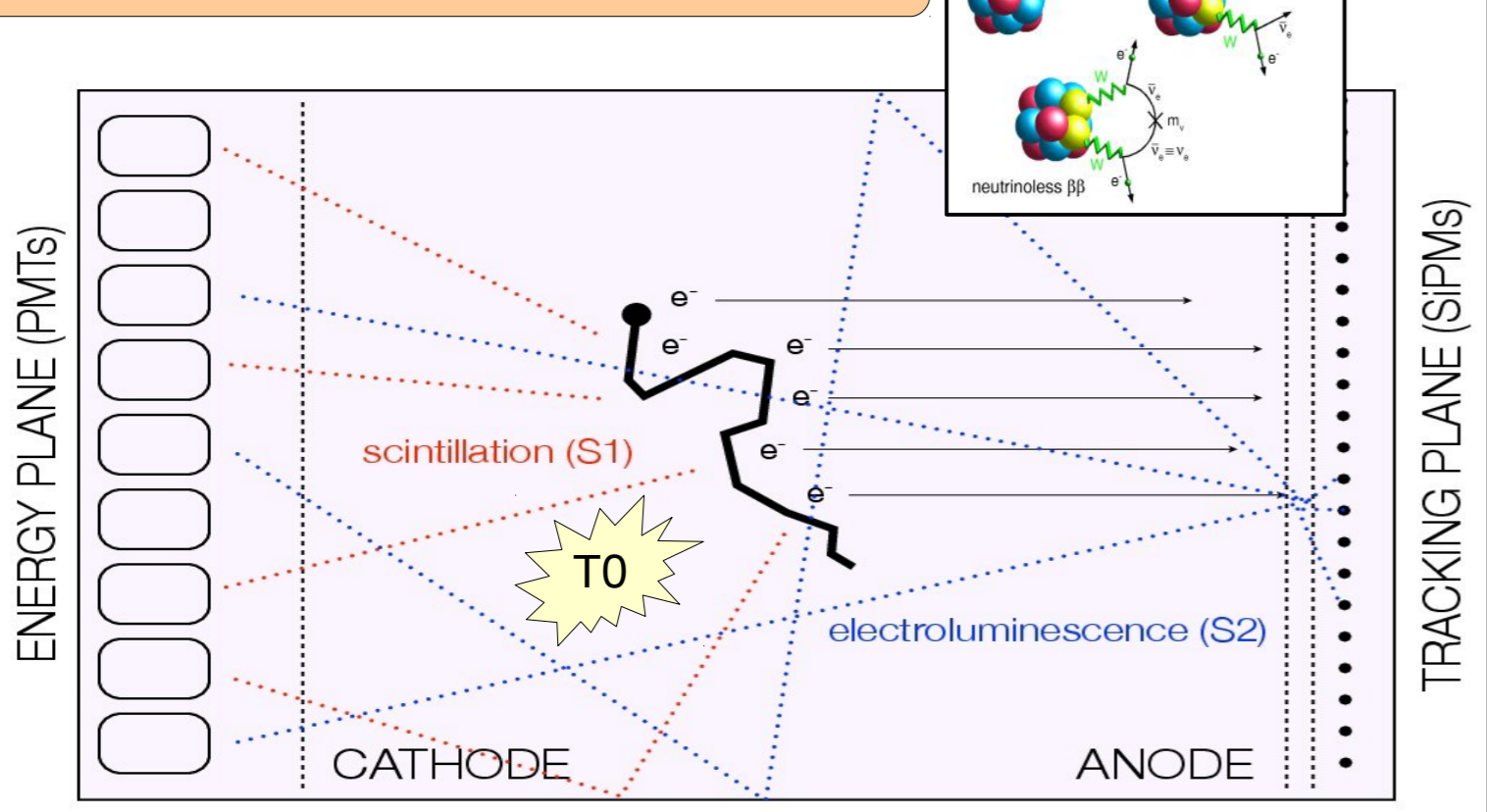
NEXT: Background @ NEXT-White

A. Simón^a, M. Sorel^a, B. Palmerio^a, P. Novella^a, J.J. Gómez-Cadenas^{a,b}, on behalf of the NEXT collaboration
^aInstituto de Física Corpuscular (IFIC), CSIC & Universitat de València; ^bDonostia International Physics Center (DIPC)

The NEXT experiment aims at the sensitive search of the neutrino-less double beta decay of ¹³⁶Xe at the LSC. A large-scale prototype (NEXT-White) is being operated since 2016, proving both the excellent energy resolution and the topological capabilities for background rejection. NEXT-White is currently measuring the backgrounds for the $\beta\beta$ searches. The internal ²²²Rn activity has been estimated and the corresponding extrapolation to the NEXT-100 detector demonstrates that Rn will not be a dominant background. NEXT-100 will thus reach a sensitivity to the $\beta\beta_{0\nu}$ half-life of 6×10^{25} y after 3 years of data taking.

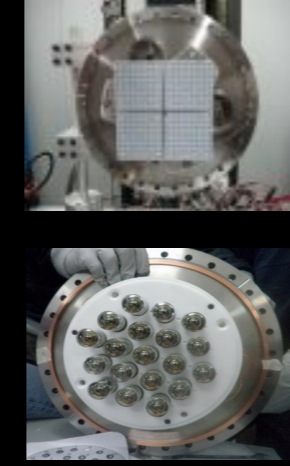
The NEXT Experiment

Gas TPC with 2 dedicated readout planes

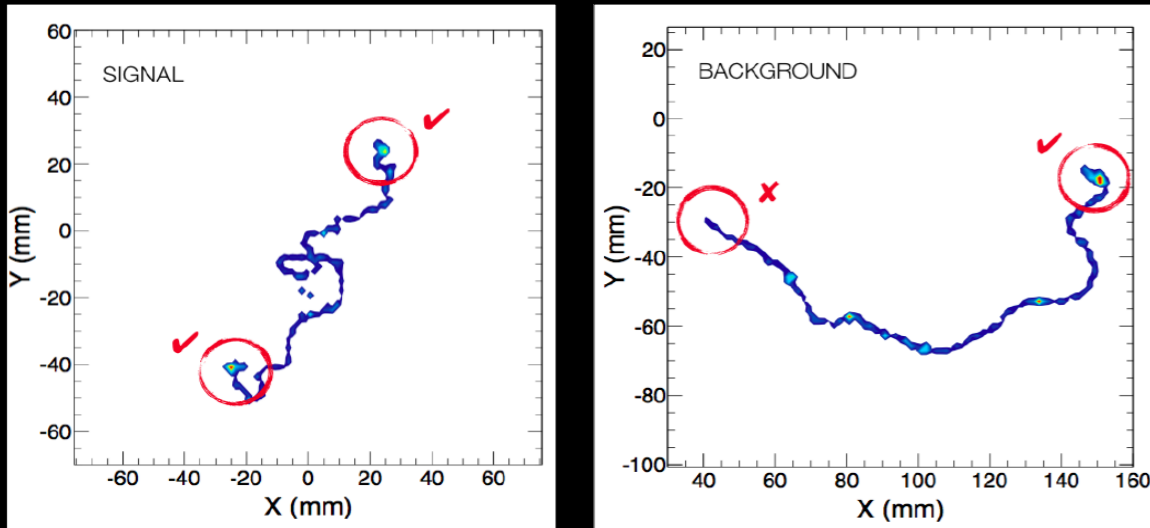


EL: linear gain, no avalanche fluctuations: optimize ΔE

R&D 2012-214



- Nucl.Instr.Meth. A708 (2013)
- JINST 8 (2013) P0400
- JINST 8 (2013) P09011
- JINST 9 (2014) 10, P10007
- JINST 8 (2013) P05025
- JINST 10 (2015) 03, P03025



Building blocks for n optimal $\beta\beta_{0\nu}$ experiment:

- Energy resolution
- Background rejection
- Scalability

The NEXT-White Detector

arXiv:1804.02409

First phase of the NEXT-100 experiment
In stable operation since 2016

- TPC: 5 kg active region, 50 cm drift length
- Tracking plane: 1792 SiPM, 1 cm pitch
- Pressure Vessel: Steel, up to 30 bar
- Energy Plane: 12 PMTs, 30% coverage
- Inner shield: 6 cm of copper
- $\beta\beta_{2\nu}$ 2018-19
- $\Delta E=0.5\%$ FWHM
- Event Topology
- Certify technology
- $\beta\beta$ BG measurement (2018)

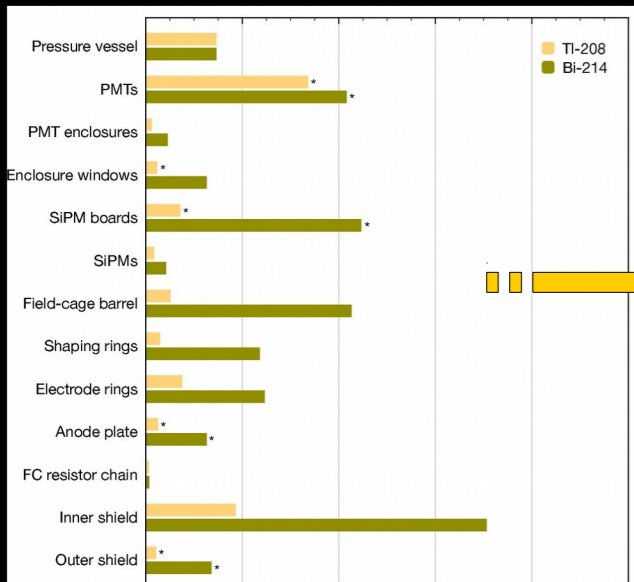
NEXT-White @ LSC

Energy plane

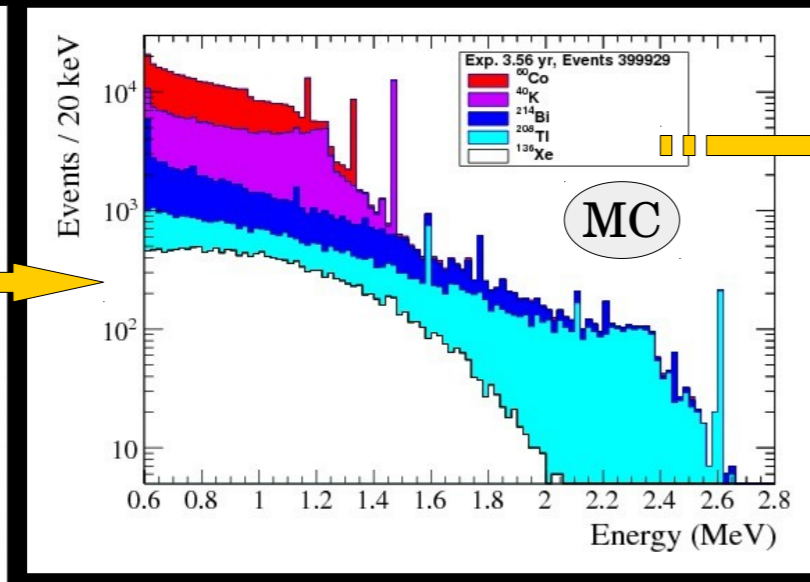
Tracking plane

Background Model

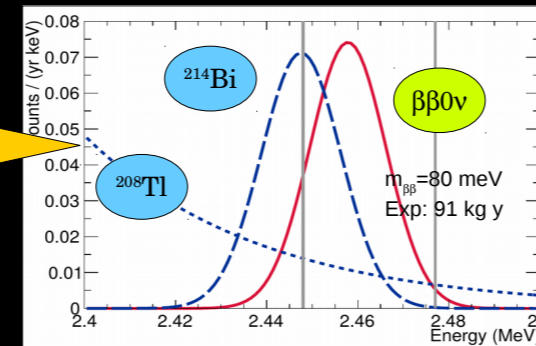
Radiopurity measurement campaign:



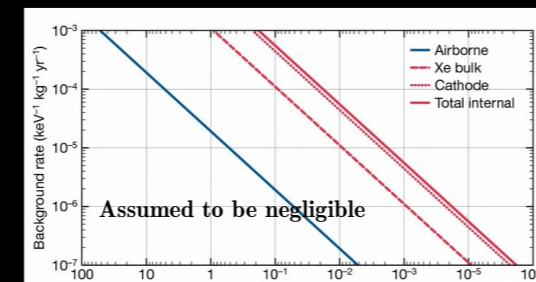
Background spectra:



$\beta\beta_{0\nu}$ background:



Rn-induced background:



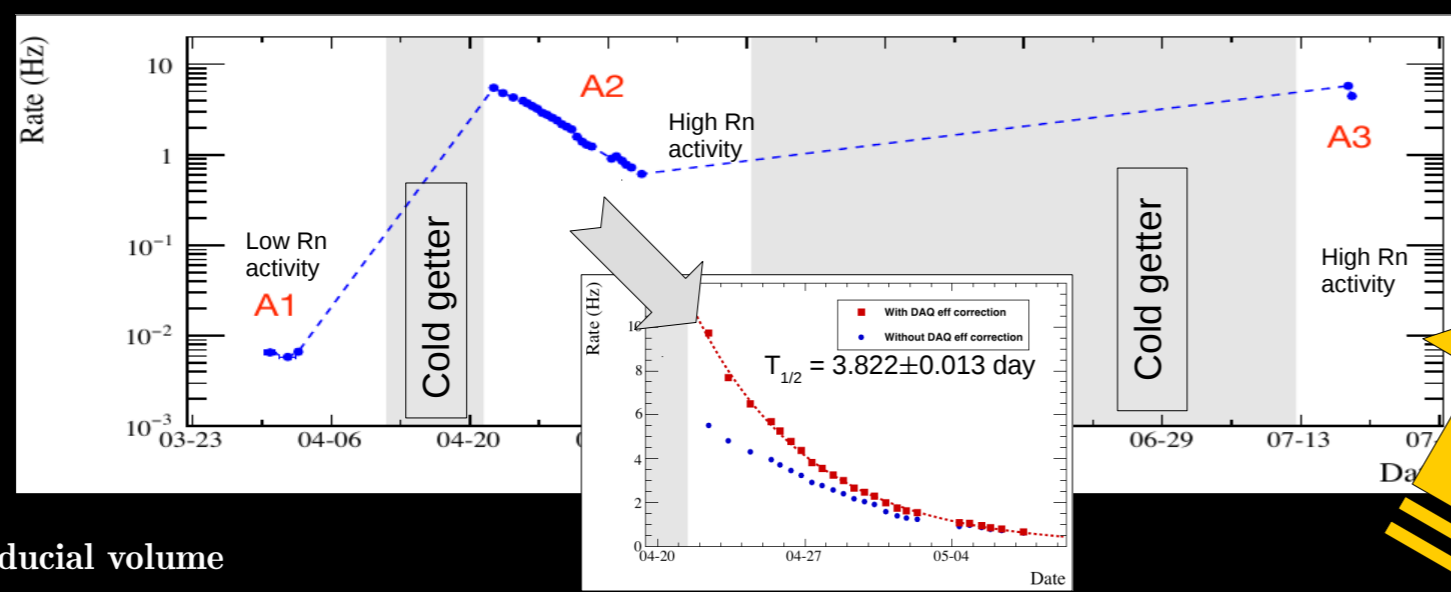
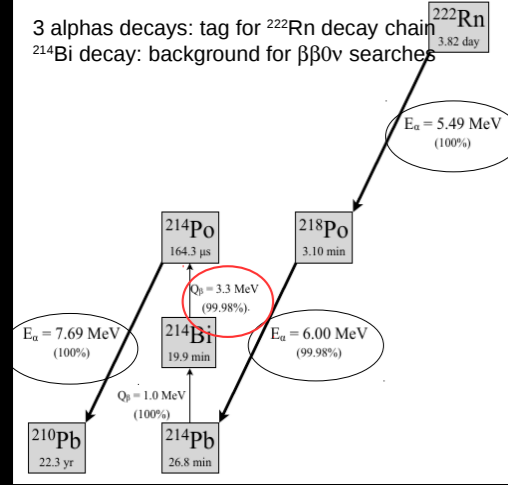
More than 200 measurements (HPGe, GDMS, ICPMS)
 JINST 8 (2013) T01002, JINST 10 (2015) 05 P05006,
 JINST 12 (2017) no.08, T08003

$\beta\beta_{0\nu}$ background target:
 4×10^{-4} c/keV/kg/yr (0.7 c/yr)

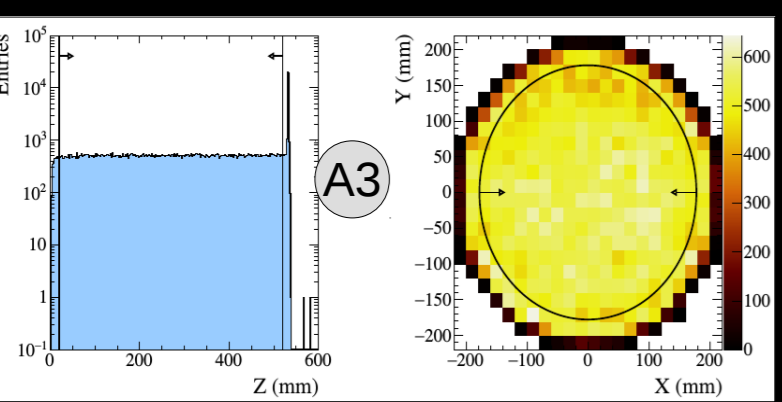
JHEP 1605 (2016) 159

Rn activity @ NEXT-White

Rn-induced alpha production rate measured in three periods:



- Uniform distribution within fiducial volume
- Charged Rn daughters plate out on cathode

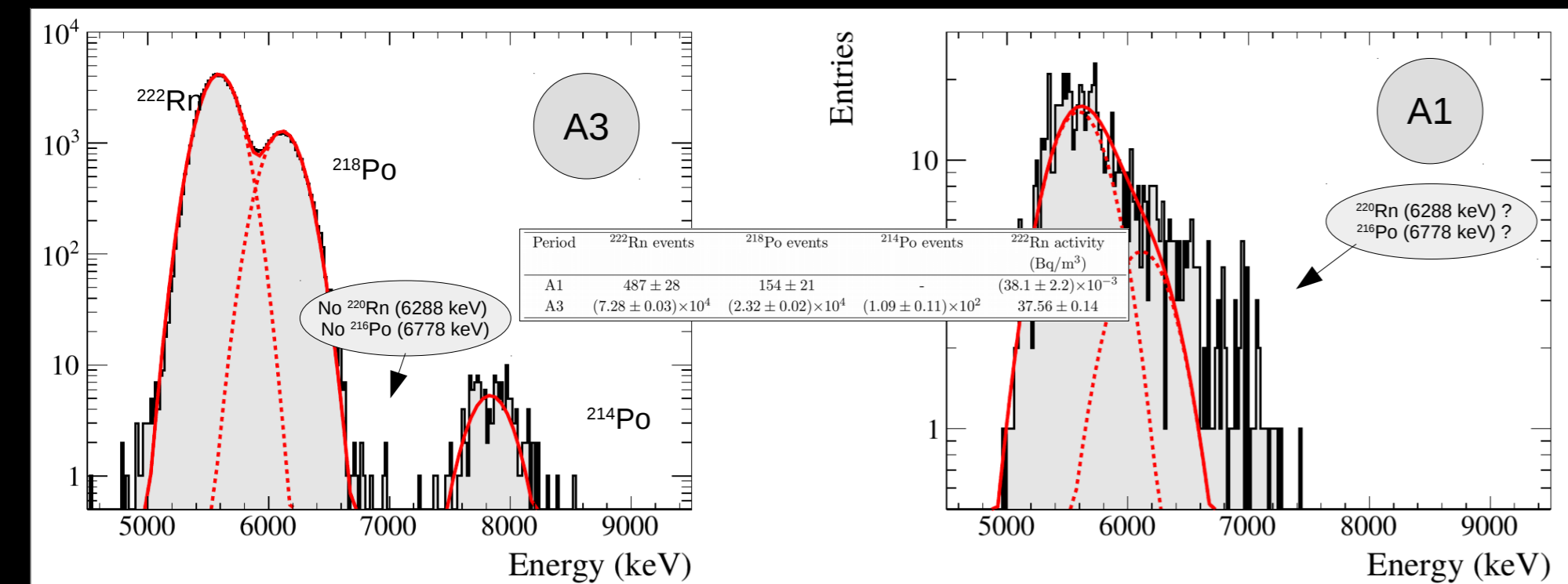


Energy estimator combining S1/S2 yields

$$E \equiv \lambda(N_1 + N_2/\eta)$$

- Reduce recombination fluctuations
- η providing best energy resolution
- λ : keV-scale from ²²²Rn peak

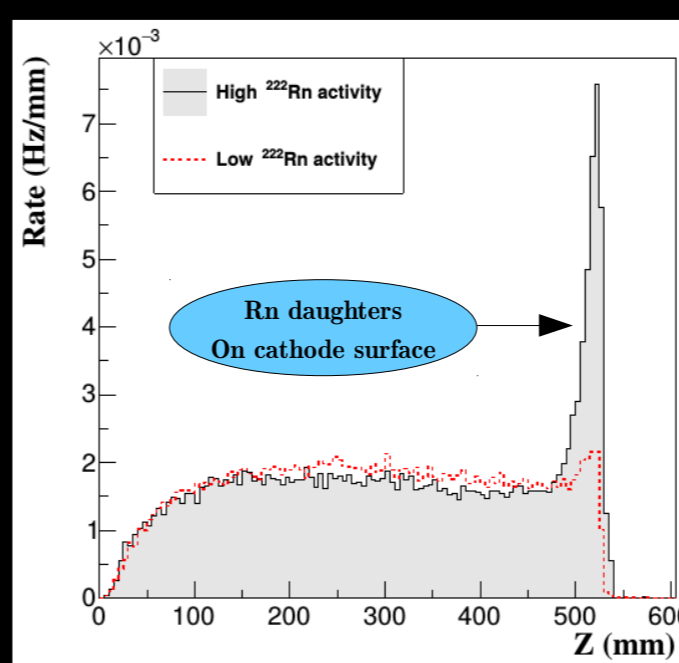
Spectroscopic analysis in fiducial volume:



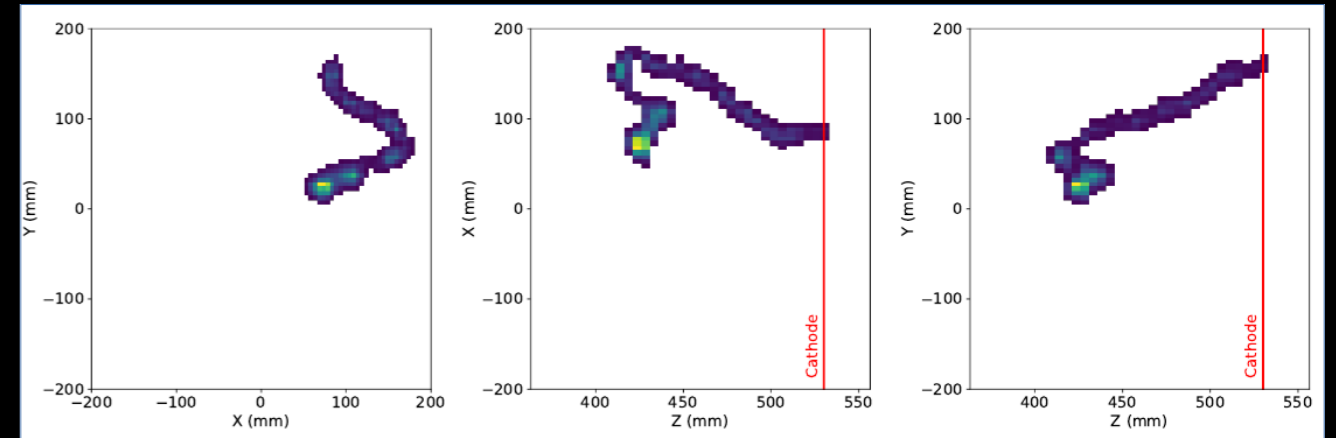
Rn activity in physics runs (A1): 38.1 ± 6.3 mBq/m³ (16% systematic)

- ²²²Rn/²¹⁸Po ratio: $68.08 \pm 0.25\%$ of ²¹⁸Po ions (plate out on cathode, outside fiducial vol)
- ²²²Rn/²¹⁴Po ratio: \sim all ²¹⁴Po decays take place on the cathode (same applies to ²¹⁴Bi)

Rn-induced electron background



- Background runs taken during high and low Rn activity periods
- Rn-induced backgrounds emanate from cathode surface
- e- from cathode reconstructed with a ML-EM, JINST 12 (2017) no.08, P08009

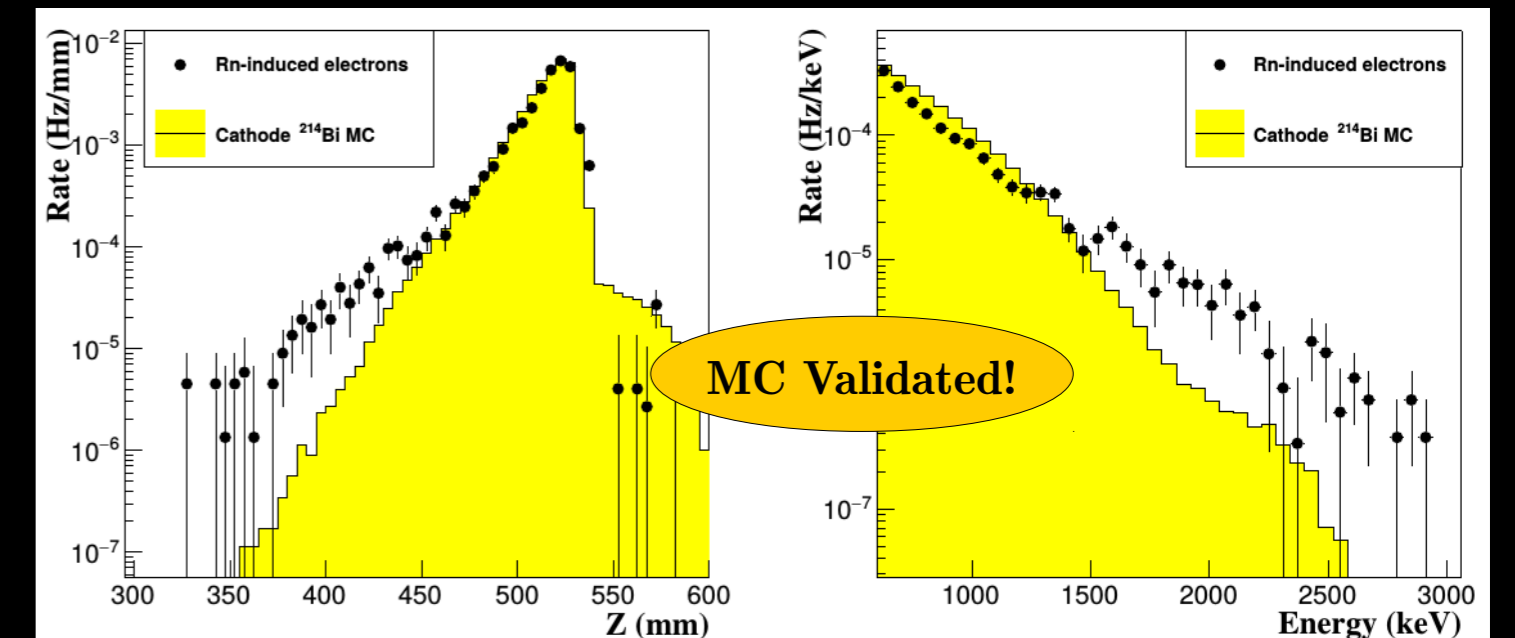


- Rn-induced e- sample subtracting low to high Rn-activity periods
- BiPo @ cathode MC: rate estimated according to measured Rn activity

MC used to compute Rn BG acceptance for $\beta\beta_{2\nu}$ and $\beta\beta_{0\nu}$ selection cuts:

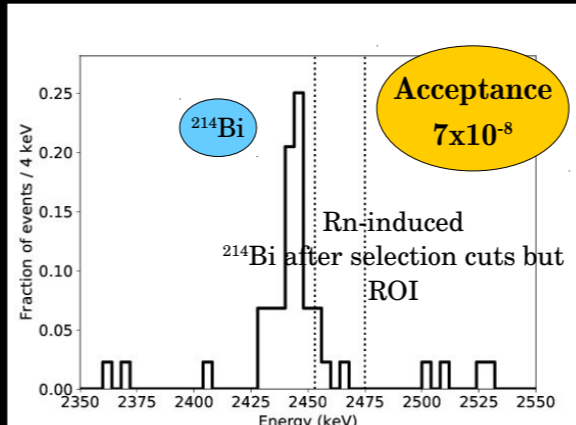
- Min. deposited energy: 1 S1 and 1 S2
- Non-zero active volume hits
- Fiducial
- Single track
- Blob cut
- Energy ROI

$\beta\beta_{2\nu}$ @ NEXT-White:
 Rn BG: 60 ± 20 c/year
 Negligible!



NEXT-100 Sensitivity

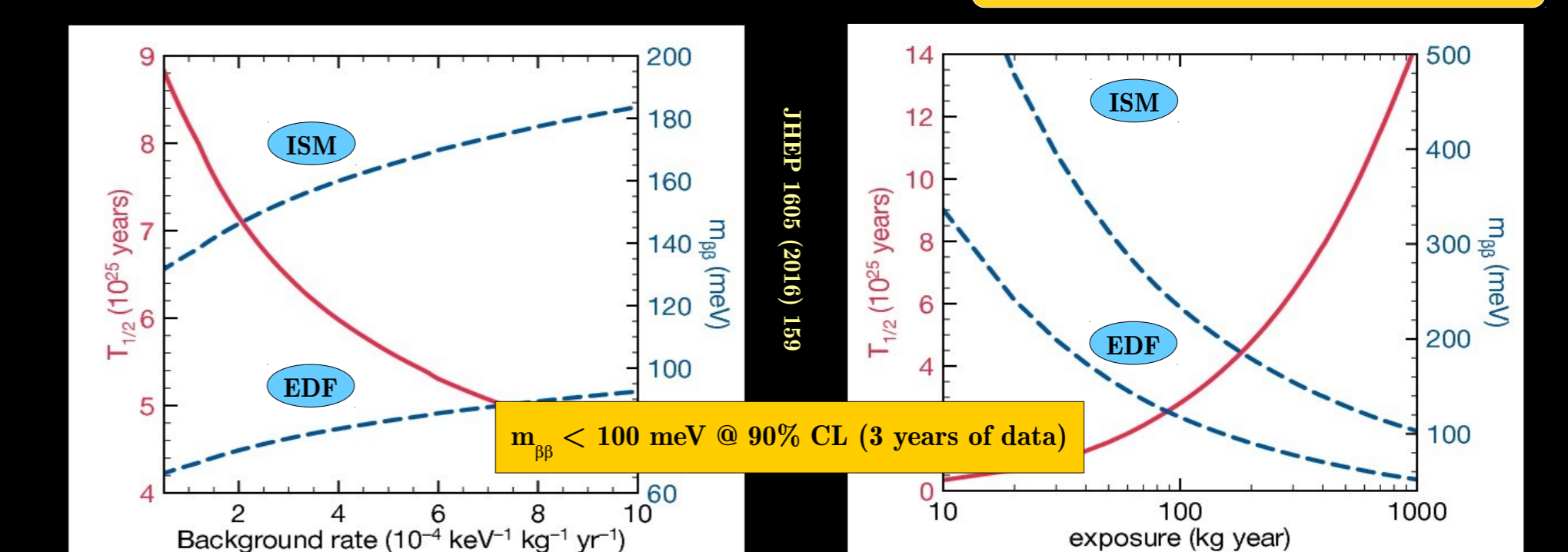
NEXT-100 (2019): search for $\beta\beta_{0\nu}$ with 100 kg of ¹³⁶Xe scaling up the NEXT-White technological solutions



- BG rate from selection acceptance and measured Rn activity @ NEXT-White
- Optimistic: Rn emanation dominated by gas system (same as in NEXT-White)
- Pessimistic: emanation dominated by detector components (scales with surface)

Scenario	Total ²¹⁴ Bi activity from cathode (counts/yr)	Background acceptance	$0\nu\beta\beta$ background rate (counts/yr)
Optimistic	$(9.8 \pm 1.6) \times 10^4$	7×10^{-8}	$(6.9 \pm 1.1) \times 10^{-3}$
Pessimistic	$(6.1 \pm 1.0) \times 10^5$	2.7×10^{-7}	0.16 ± 0.03

Rn-induced background negligible w.r.t. other BG sources (0.7 c/yr): $\beta\beta_{0\nu}$ Rn-induced background: < 0.16 c/yr



$m_{\beta\beta} < 100$ meV @ 90% CL (3 years of data)

Room for improvement: Phys.Lett. B773 (2017) 663-671, JINST 12 (2017) no.01 T01004, Phys.Rev.Lett. 120 (2018) no.13, 132504