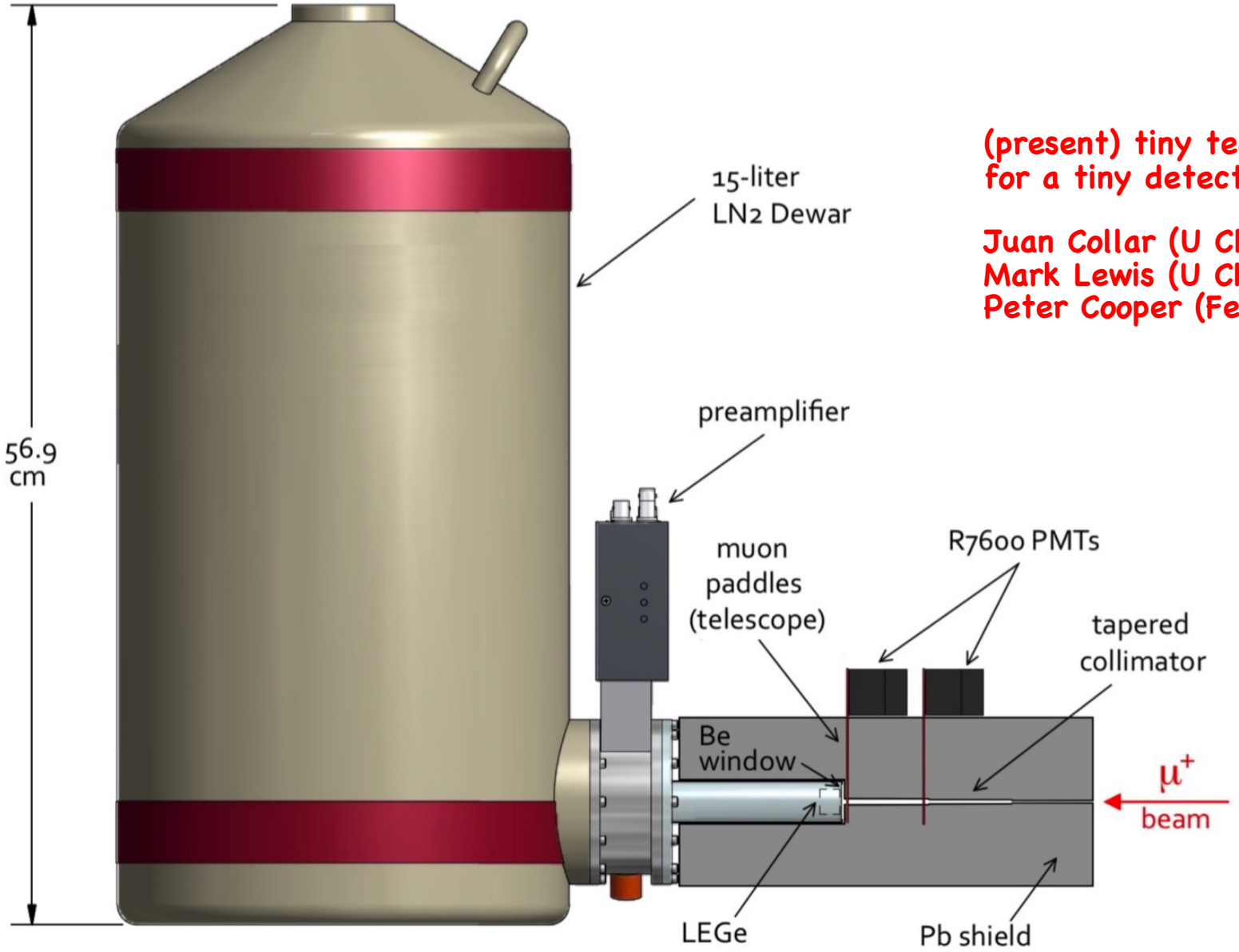
TRIUMF S2129 update & request

Search for a cosmologically-relevant boson in muon decay

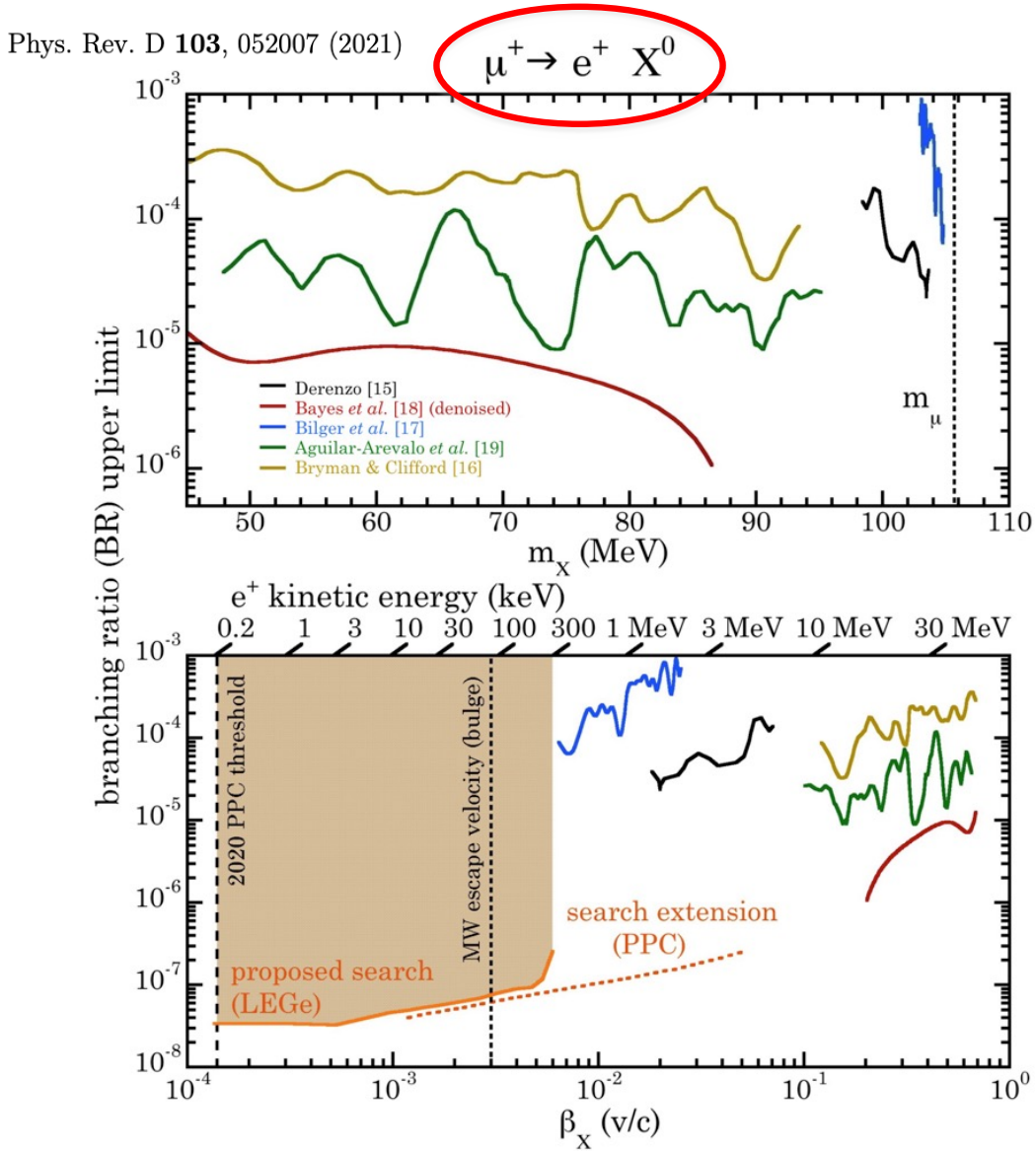


(present) tiny team
for a tiny detector:

Juan Collar (U Chicago)
Mark Lewis (U Chicago)
Peter Cooper (Fermilab)

"motivation"

(isn't CLFV enough?)



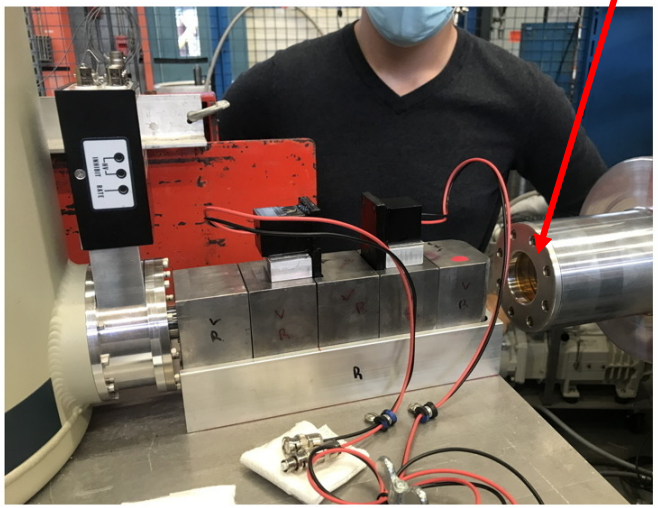
conventional

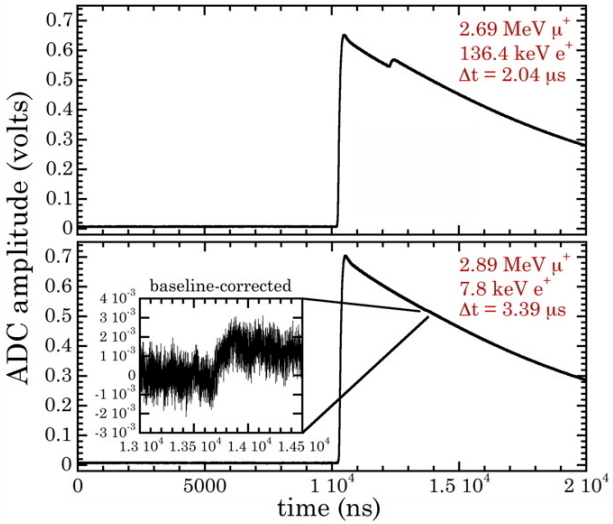
avant-garde

(some not-totally-stupid possible cosmological roles for this X^0 beast)

First run (5d) October 2021 @M15

Excellent results… but one small unexpected issue





- Initial local RFI/EMI noise issues resolved.
- Sensitive to E_{e+} as small as 3.5 keV just 1 μs after μ^+ stop!
- Ultra-thin (25 μm) muon telescope worked as advertised.
- Backgrounds as predicted. Negligible steady-state component (beam-related and environmental). Excellent beam purity.
- Tapered collimator design validated. No alignment issues.
- 1.16×10^8 μ^+ stops collected (but can do much better than this).
- However, insufficient trigger rate and lower $E_{\mu+}$ than expected
  -> both traced to 80 μm Kapton beam exit window. Initially resigned… 25 μm window located last day.

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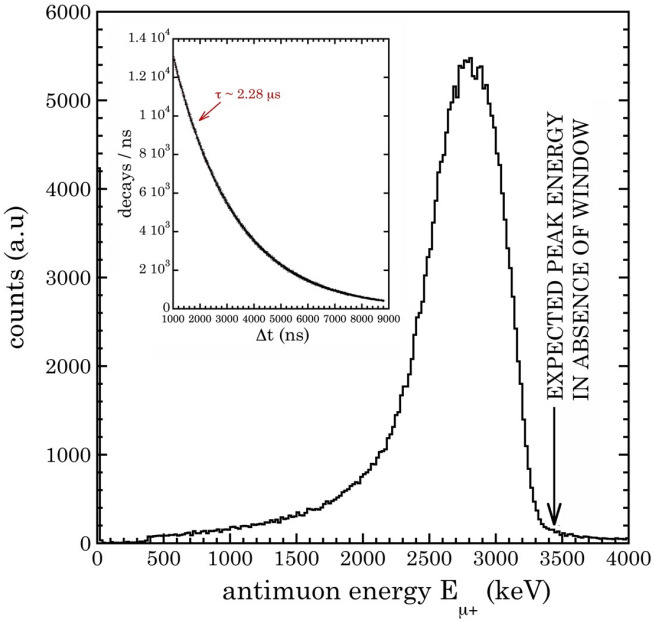

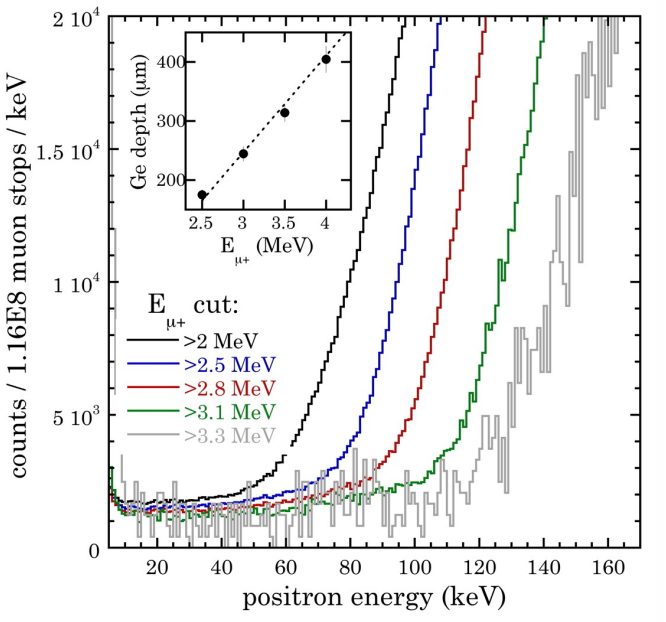

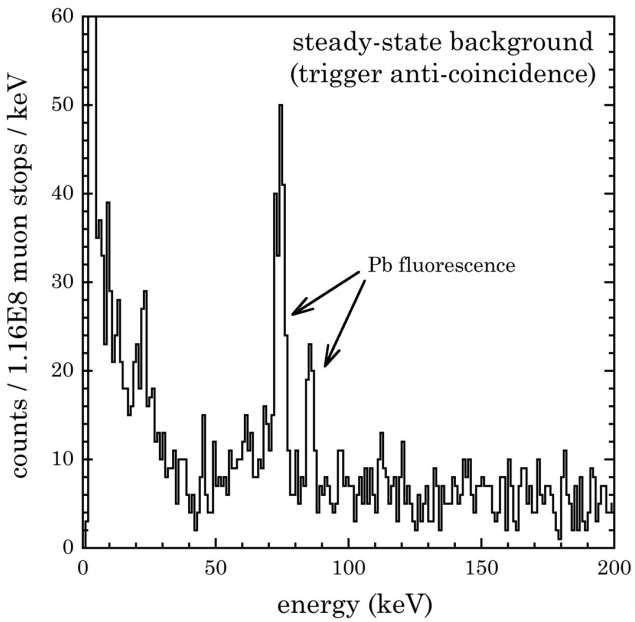

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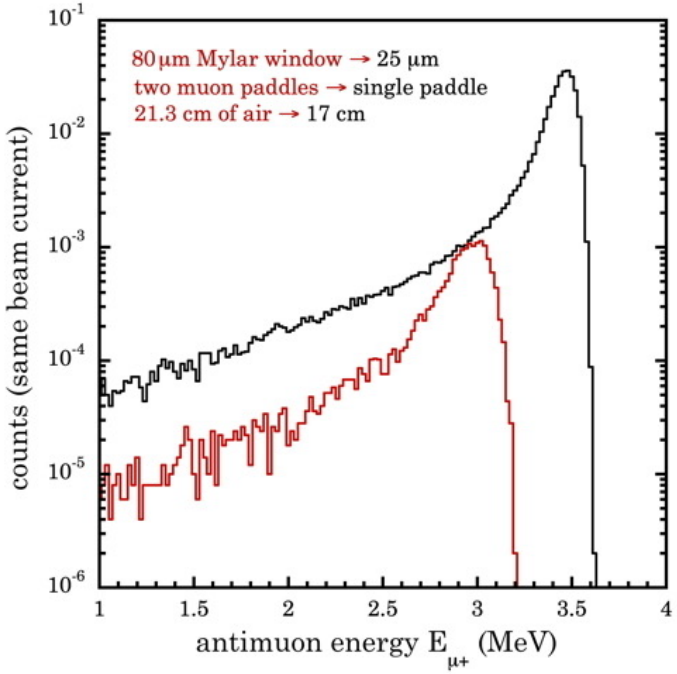
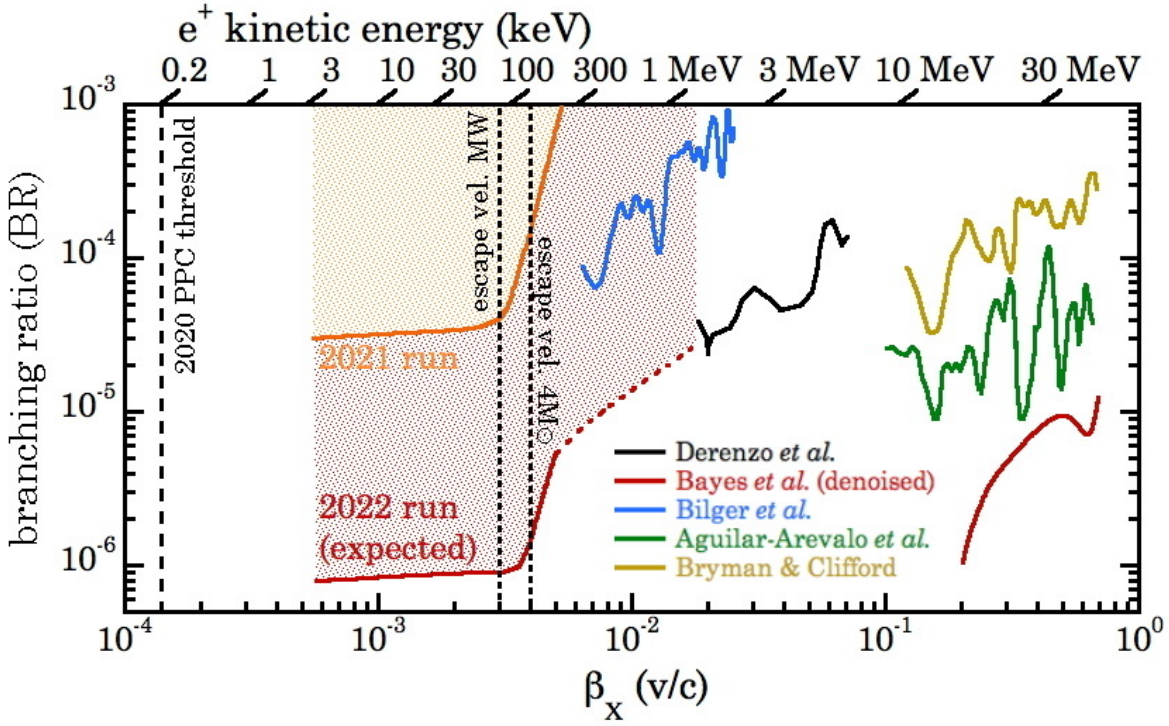
This request





- Background in E_{e+} ROI below ~200 keV will be drastically reduced with minor modifications (left panel here). Very small risk based on experience already acquired.
- Statistics will increase by x45 (use of all data w/o bckg penalty) x6.7 (increased trigger rate) x2.4 (full utilization of beam allocation) over another similarly short run.
- Order of magnitude increase in sensitivity within reach. Publication this summer (analysis is ready).
- Waiting to hear from DOE/NSF for second phase (future proposal).

Reserve

one thing leading to another…

Physics Letters B 348 (1995) 19–28

Anomaly in the time distribution of neutrinos from a pulsed beam stop source

KARMEN Collaboration

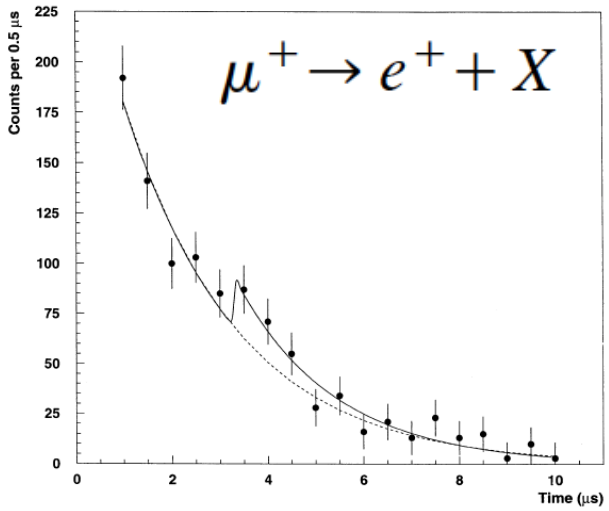


Fig. 2. Time distribution of events in the KARMEN calorimeter after the subtraction of the cosmic background.[3] The solid curves are a fit to the points by a sum of two exponentials. The first exponential describes the time distribution in the region from 1.0 to 3.3 μs and the other in the region from 3.3 to 10 μs with time constants of $(2.29 \pm 0.34)\mu s$ and $(2.1 \pm 0.6)\mu s$, respectively. The broken line corresponds to the extrapolation of the first exponential. The fit procedure results in χ^2 of 9.7 for 15 degrees of freedom.

Does the KARMEN time anomaly originate from a beam-correlated background?

F. Atchison, M. Daum*, P.-R. Kettle, C. Wigger

(womp-womp)

Physics Letters B 434 (1998) 163–168

Exotic muon decays and the KARMEN anomaly

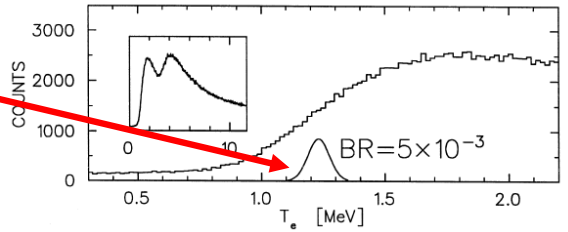
S.N. Gninenko [1], N.V. Krasnikov [2]

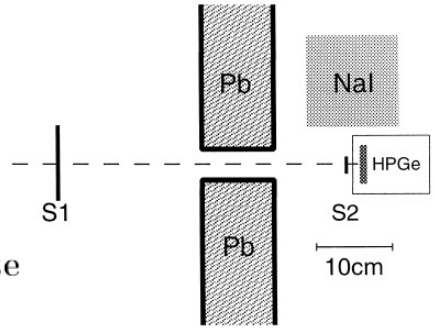
Physics Letters B 446 (1999) 363–367

Search for exotic muon decays [1]

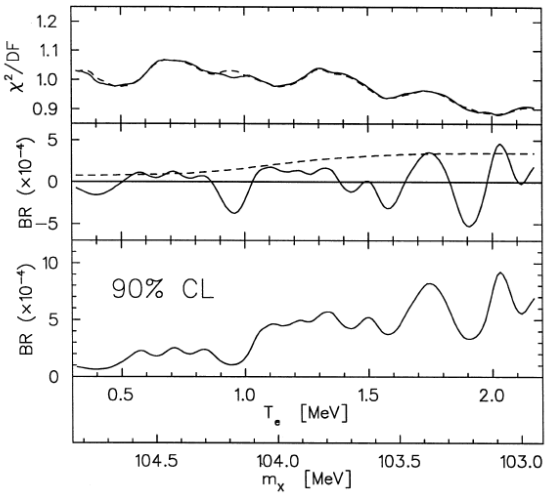
R. Bilger [a,2], K. Föhl [b], H. Clement [a], M. Cröni [a], A. Erhardt [a], R. Meier [a], J. Pätzold [a], G.J. Wagner [a]

THIS
(but much skinnier!)

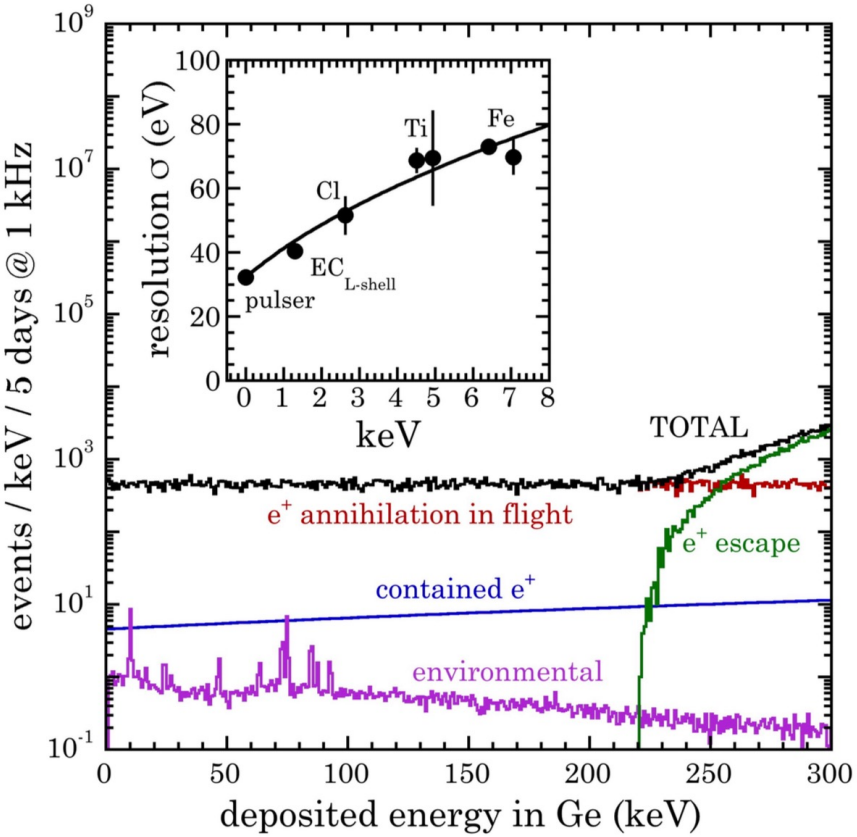


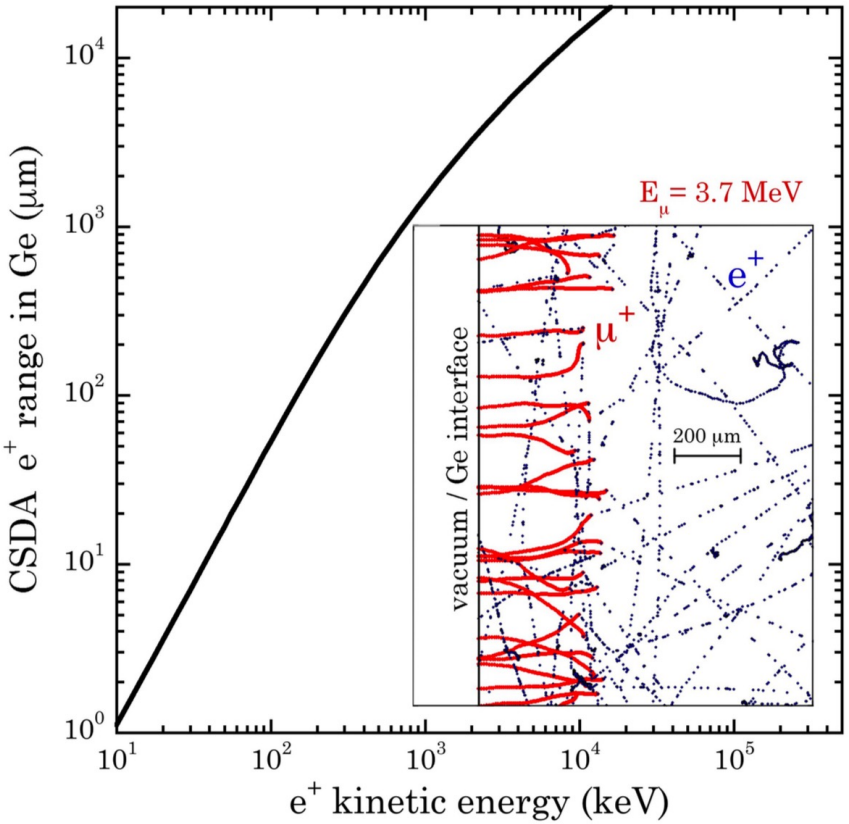


"Germanium beam-dump"



Preparation: simulation





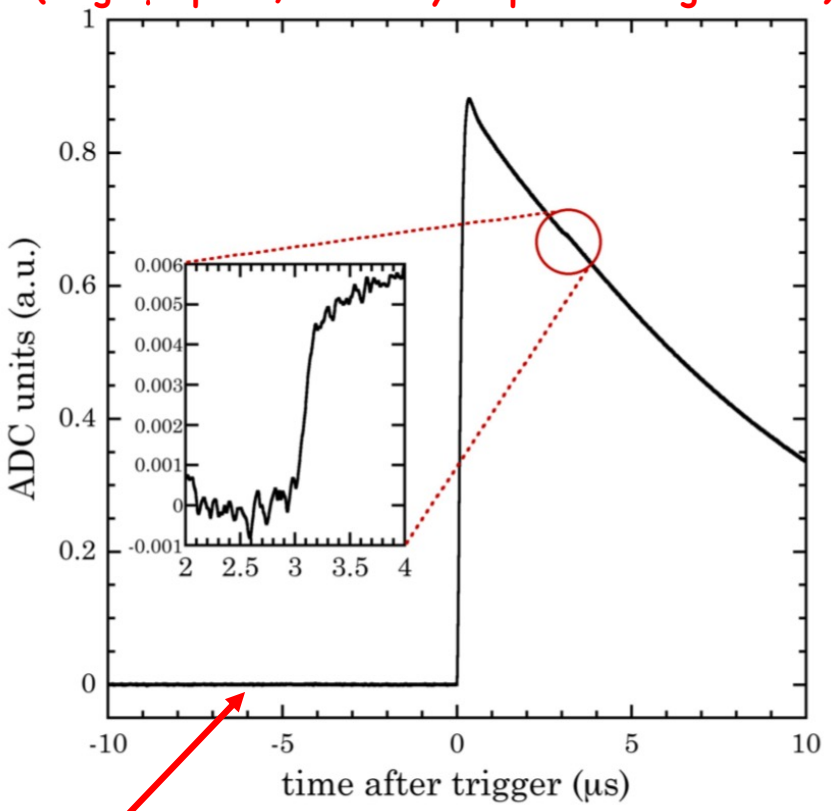
Excellent BR sensitivity from:

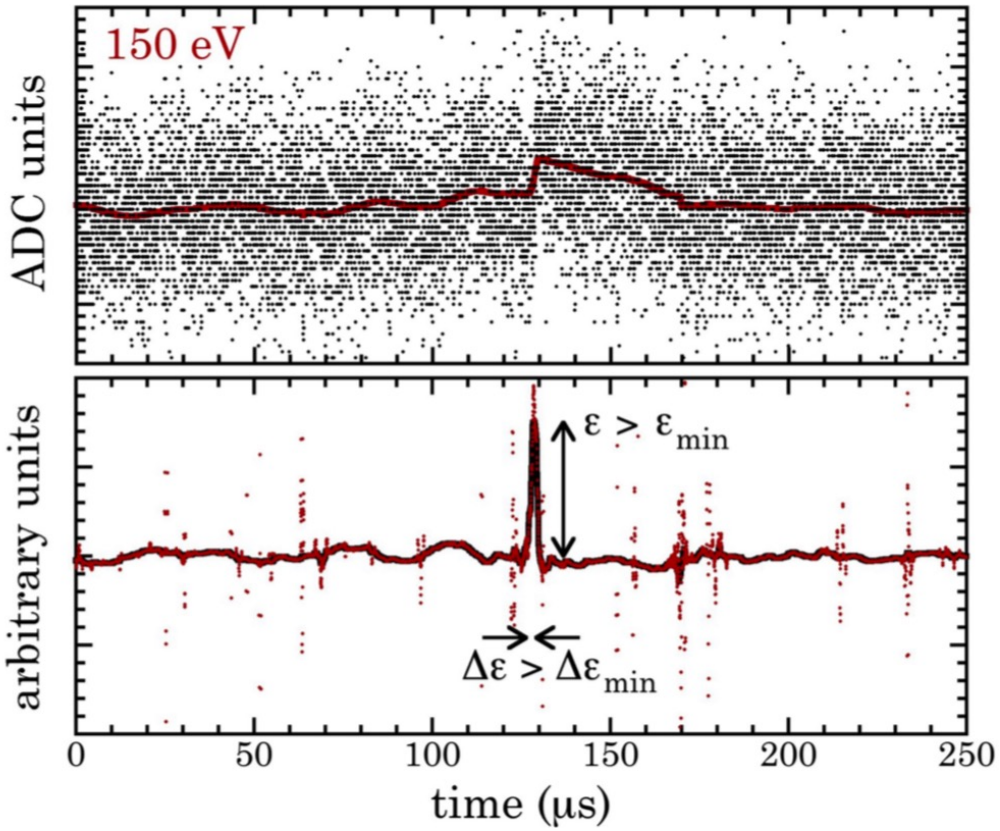
1) low-mass detector (2g)
2) Small fraction of Michel e+ at low-energy
3) Superb detector energy resolution

Preparation: DAQ & analysis tools

Badabing-badabang

(large μ^+ pulse, then tiny e^+ pulse riding its tail)





Modern approach: digitize and you shall conquer
(avoid analog electronics, move fancy analysis offline)

BONUS: characterize steady-state backgrounds in pre-trigger trace.