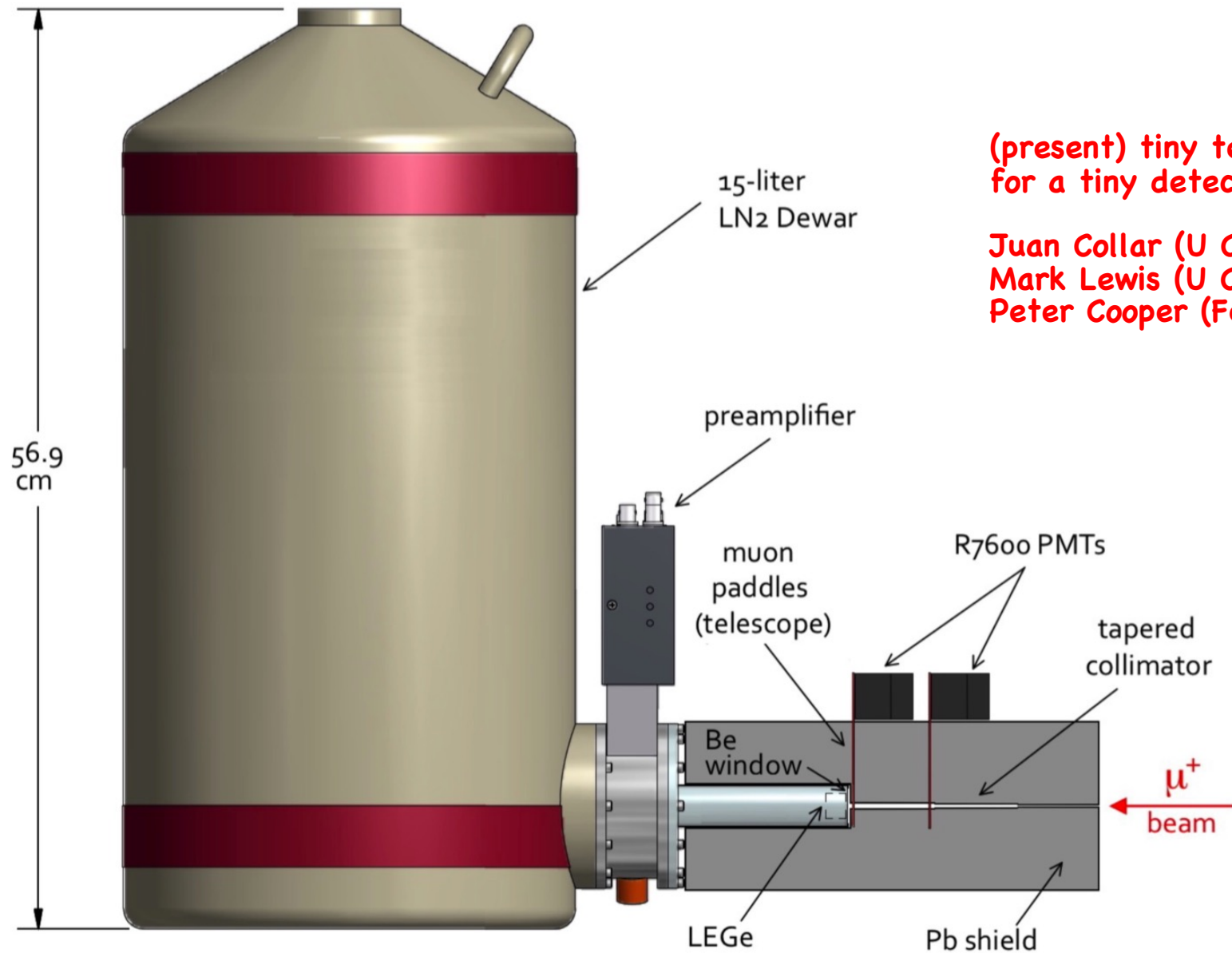


# TRIUMF S2129: final report on 1<sup>st</sup> result

Search for a cosmologically-relevant boson in muon decay



(present) tiny team  
for a tiny detector:

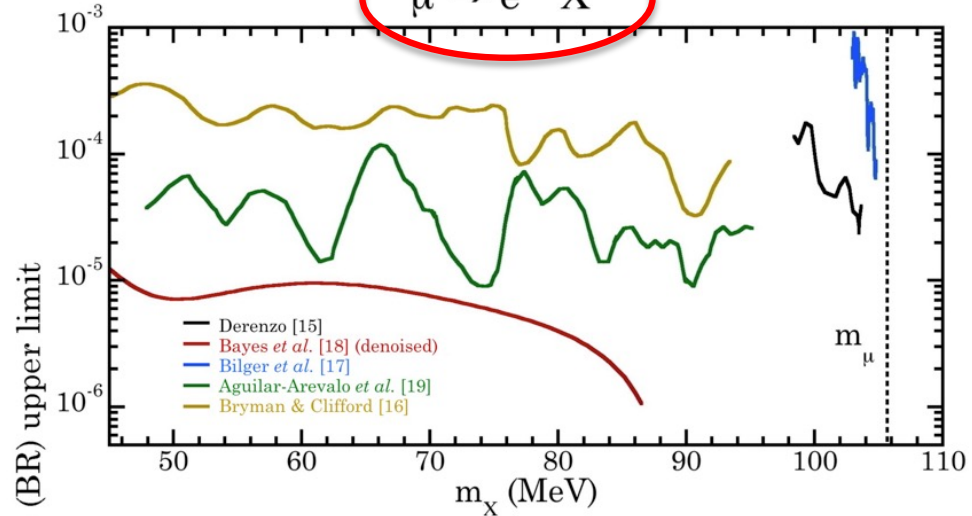
Juan Collar (U Chicago)  
Mark Lewis (U Chicago)  
Peter Cooper (Fermilab)

# "motivation"

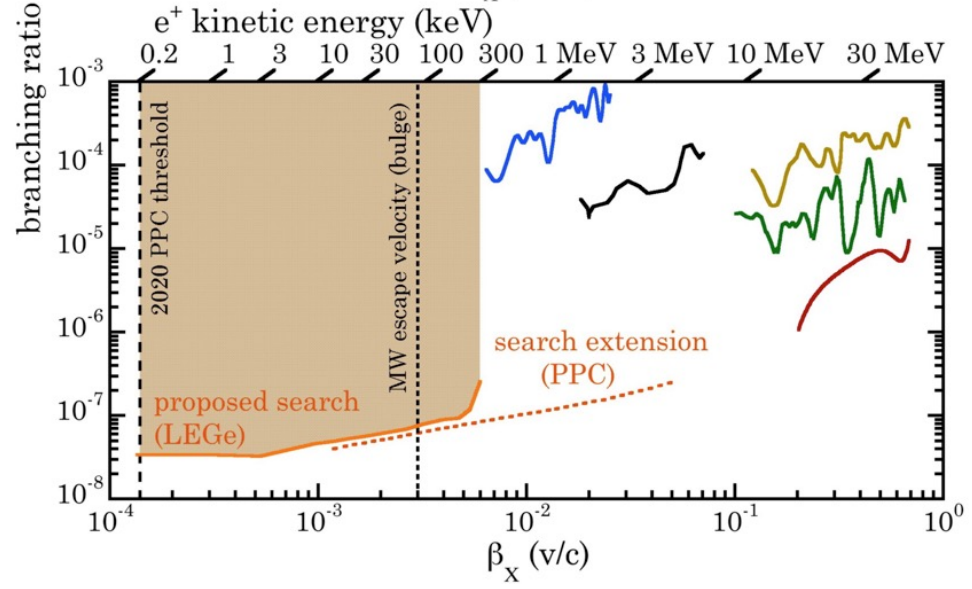
(isn't CLFV enough?)

Phys. Rev. D **103**, 052007 (2021)

$$\mu^+ \rightarrow e^+ X^0$$



conventional  
view

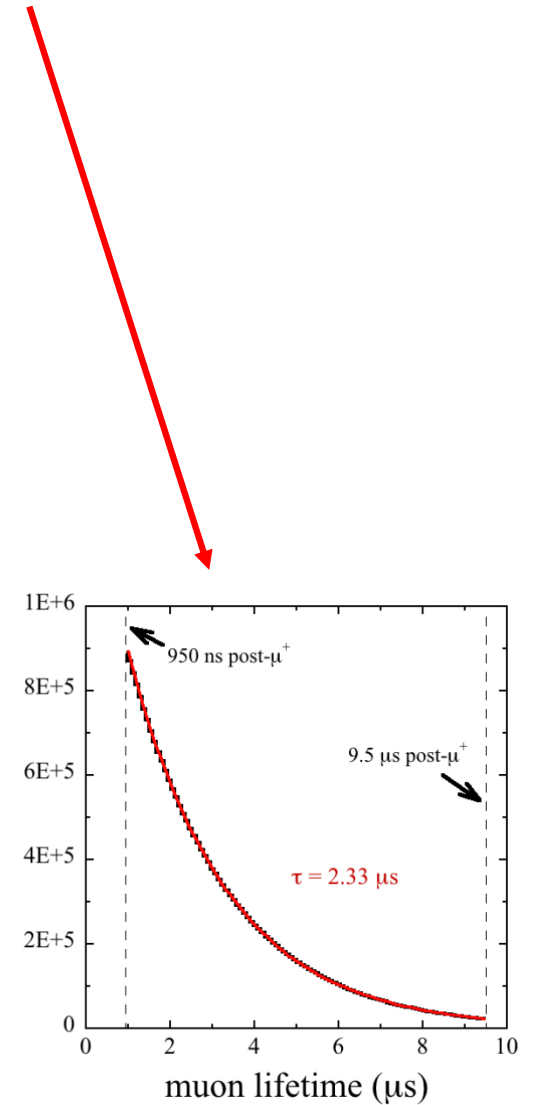
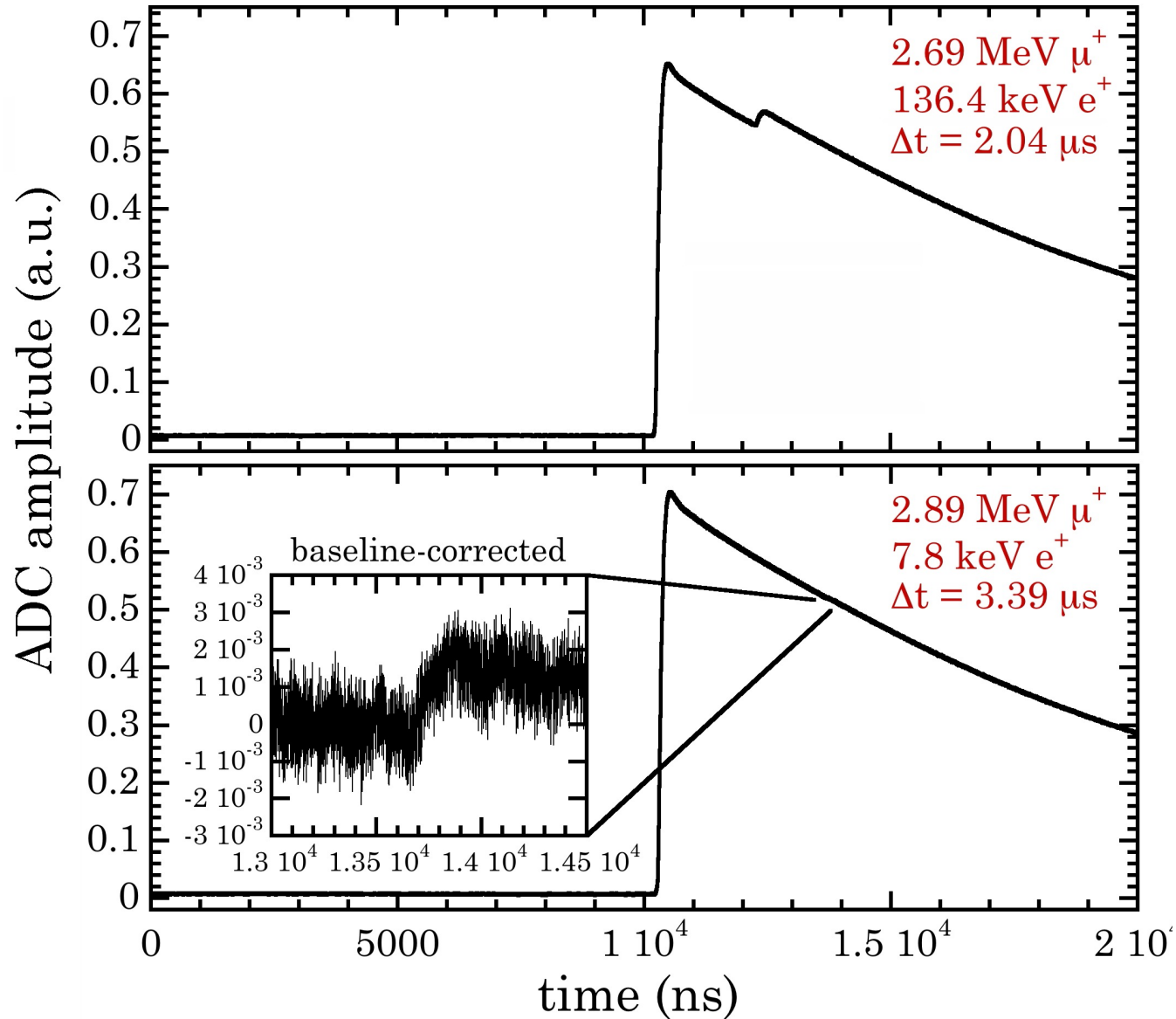


l'avant-garde

(some possible cosmological roles for a nonrelativistic  $X^0$ )

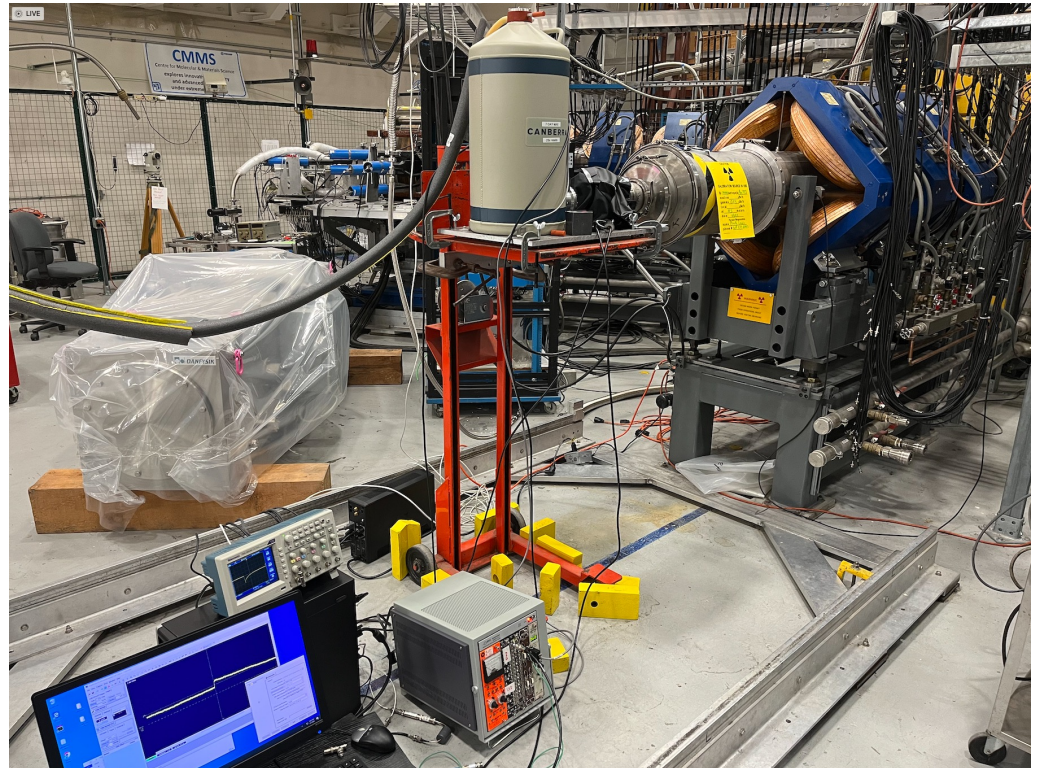
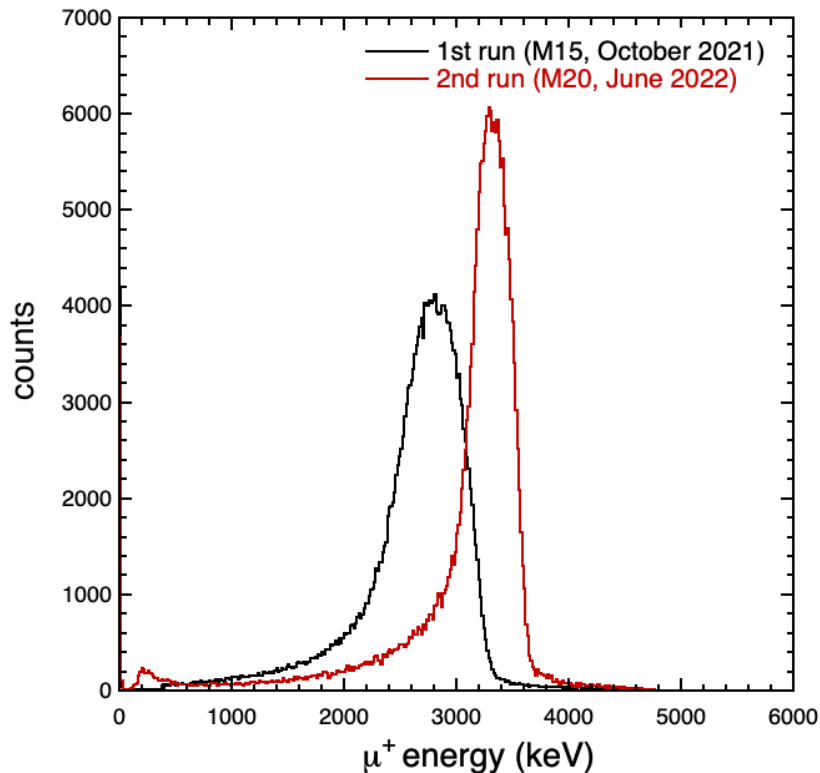
# Main difficulty

(identification of smallest possible  $E_{e^+}$  a.s.a.p. after large  $E_{\mu^+}$ )



# Second run (6d) June 2022 @M20

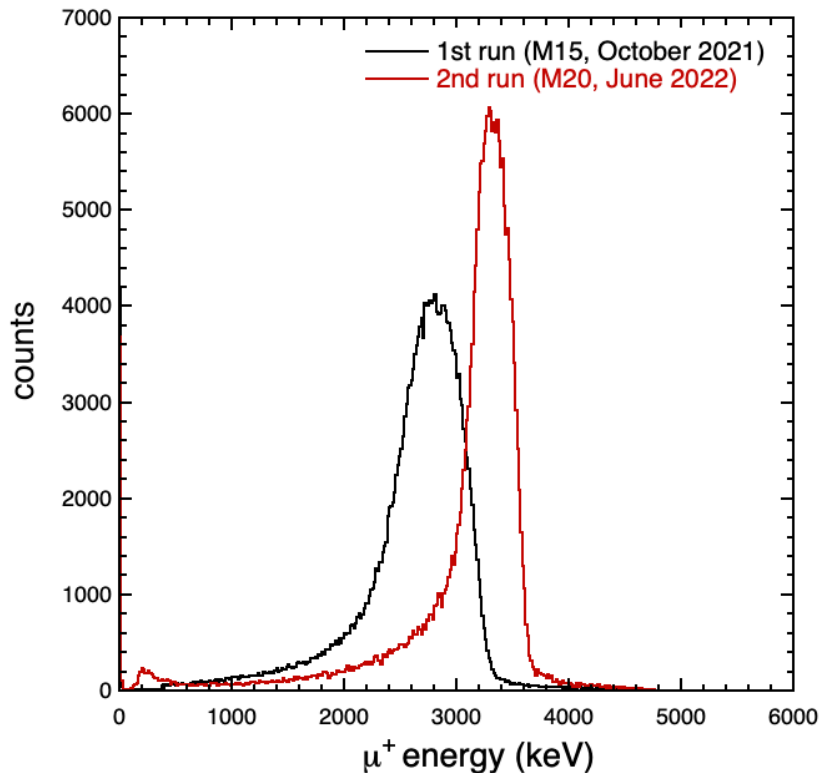
(mission accomplished!)



- Successful increase in  $\mu^+$  energy (exit window thickness was limitation during Oct. 2021 run).
- Problems with beam delivery at the beginning of schedule 142 limited the exposure to 2 days (reaching only 60% of maximum current). However,  $1.1E8$  muon stops were collected ( $4E7$  "golden" events).
- Use of analysis tools employed in reactor CEvNS to extract tiny Ge signals (see arXiv:2202.09672 and arXiv:2108.02880).
- Intrinsic noise of digitizer available limited lowest  $E_{e^+}$  reachable. Still,  $1E-5$  BR reached (comparable to best prior, now in a new region of  $\mu^+ \rightarrow e^+ X^0$  parameter space). PRL submission in preparation.
- Now NSF-funded for final detector ( $<1E-6$  BR expected in broader  $\beta_x$  region). Must wait for beamline M9H completion before request for final run ( $\sim 30$  MeV muon energy required).
- Thanks to all for a great first result!

# Second run (6d) June 2022 @M20

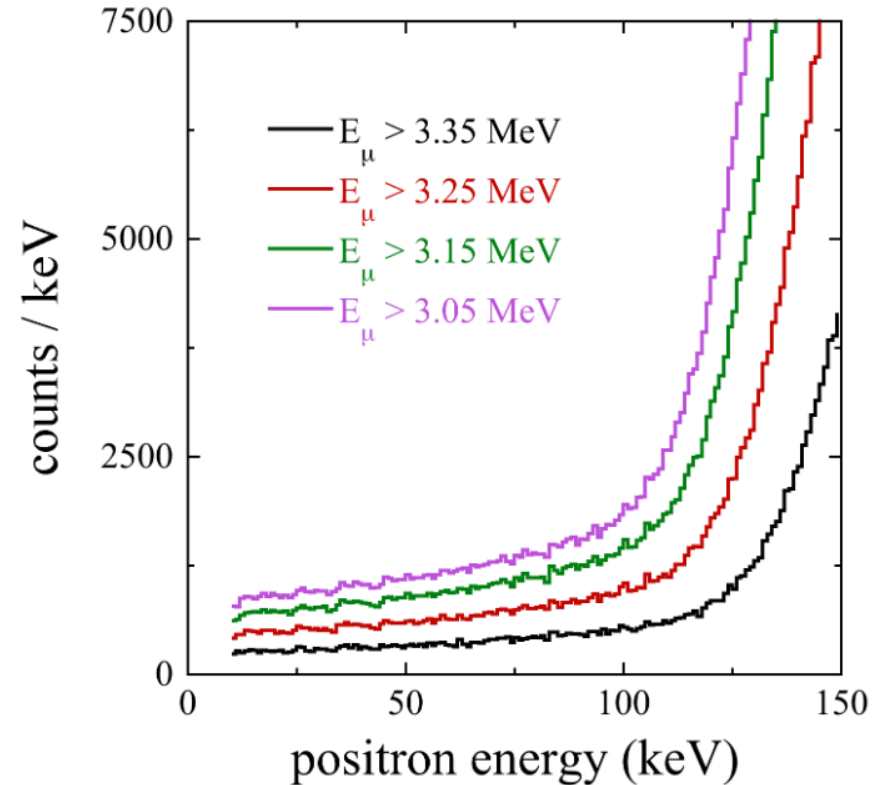
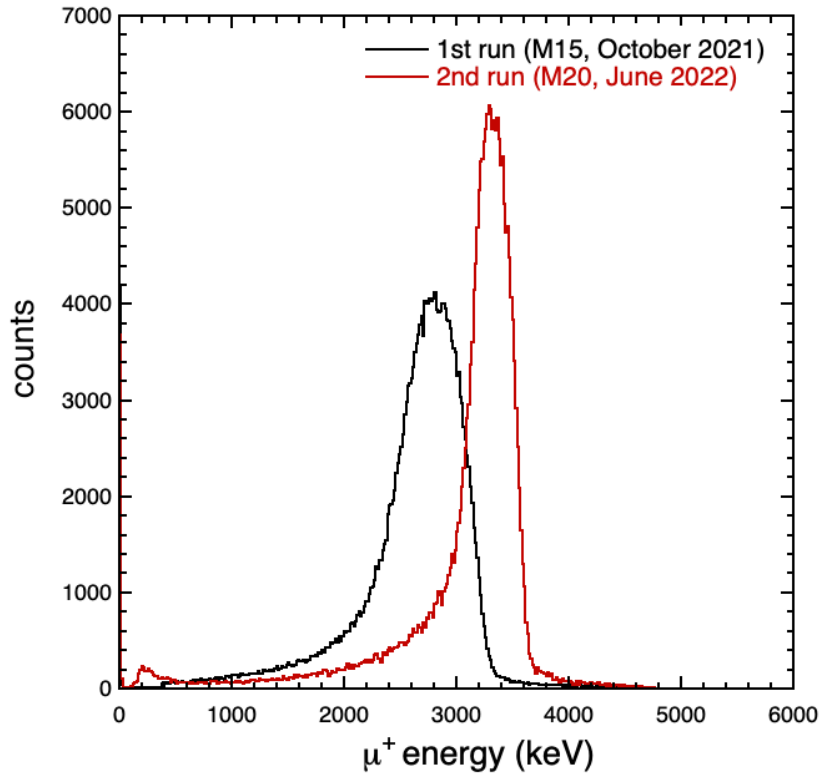
(mission accomplished!)



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# Second run (6d) June 2022 @M20

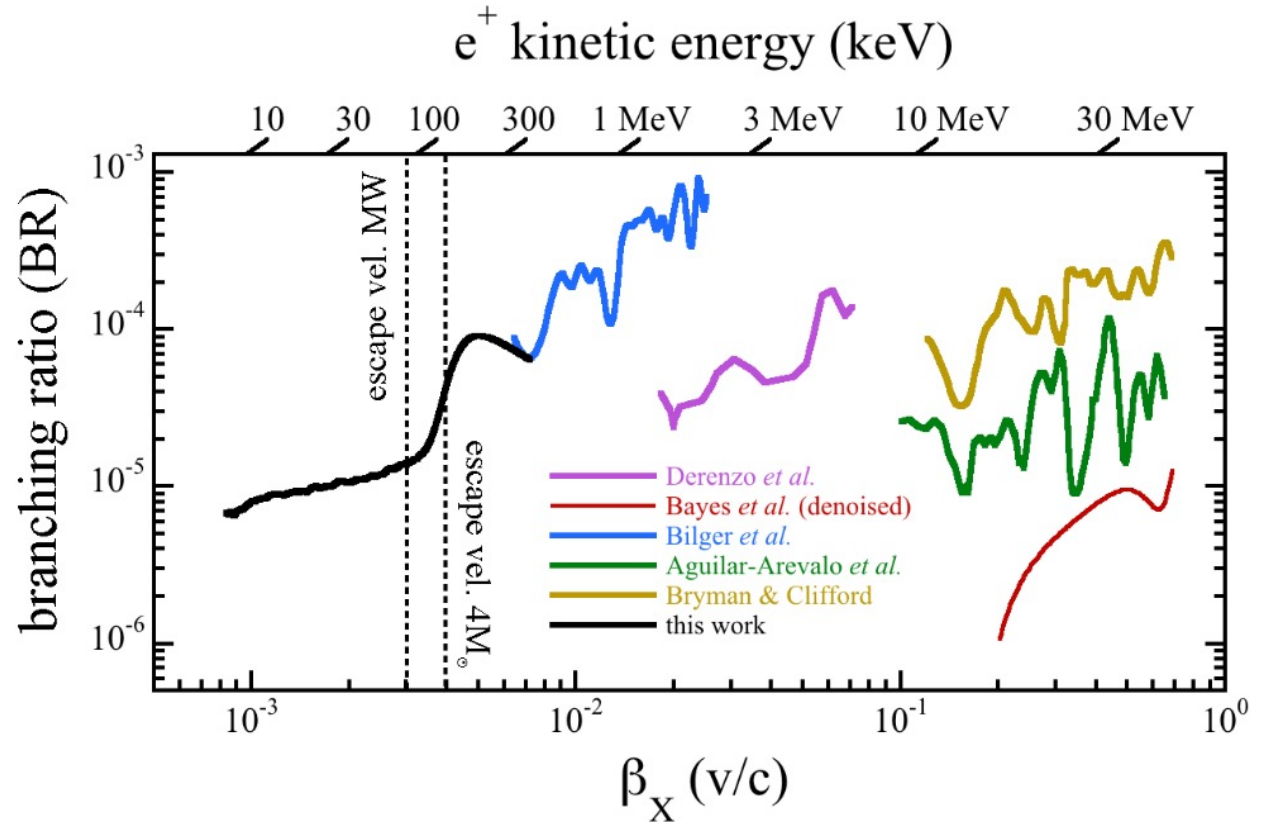
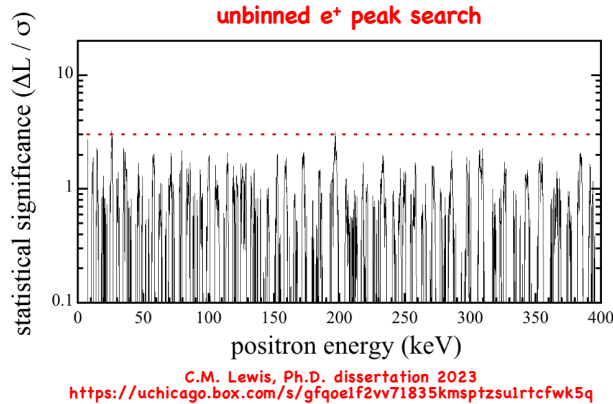
(mission accomplished!)



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# Second run (6d) June 2022 @M20

(mission accomplished!)

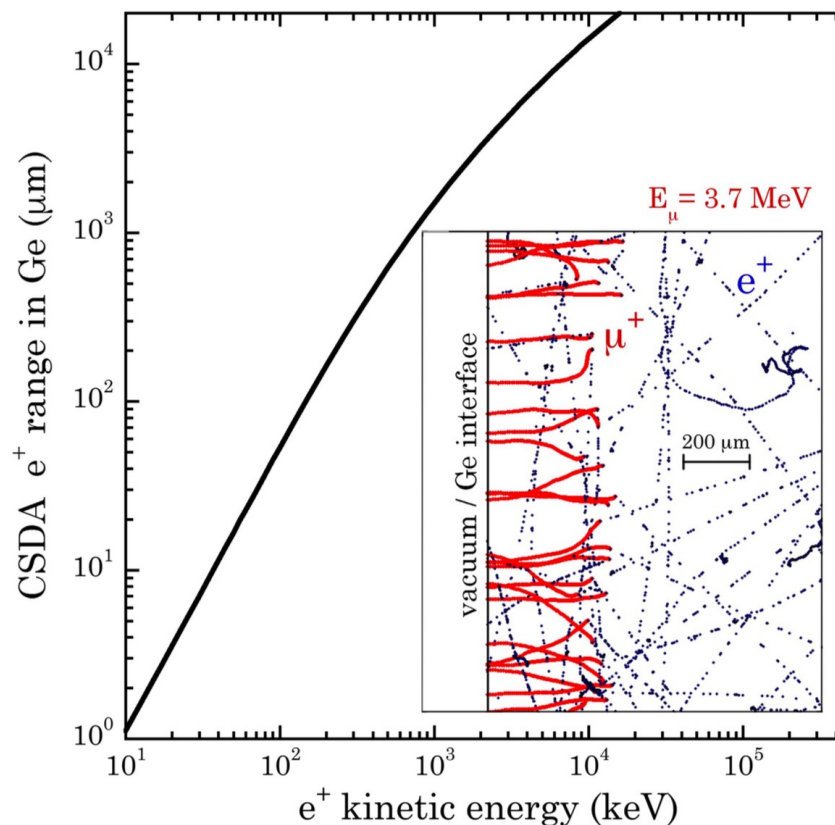
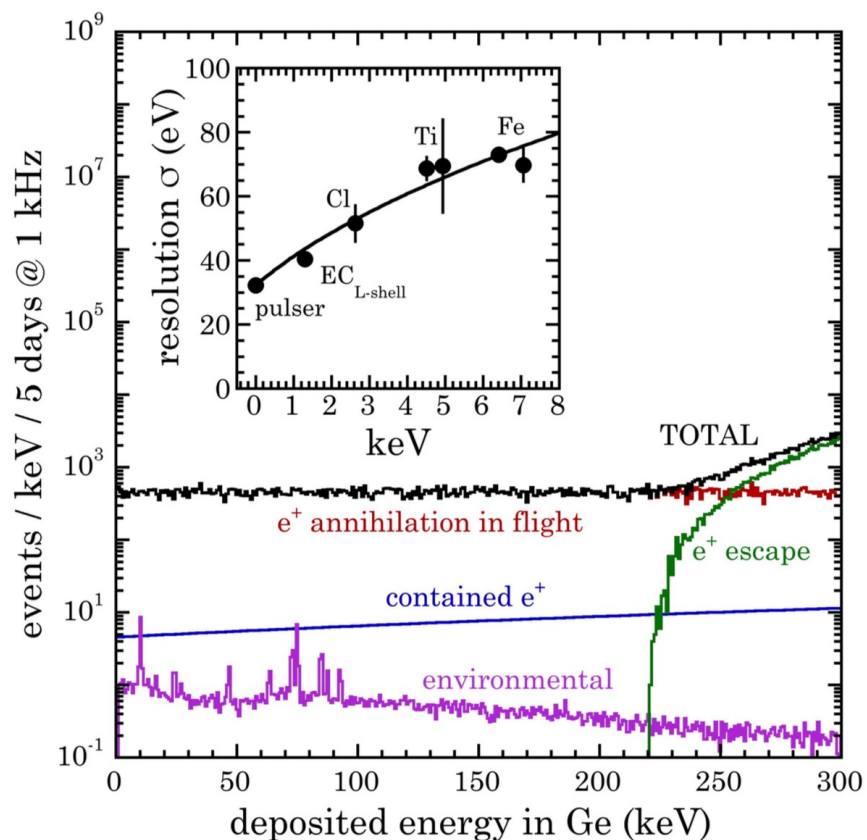


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- Thanks to all for a great first result!

**Reserve**



# 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

# 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

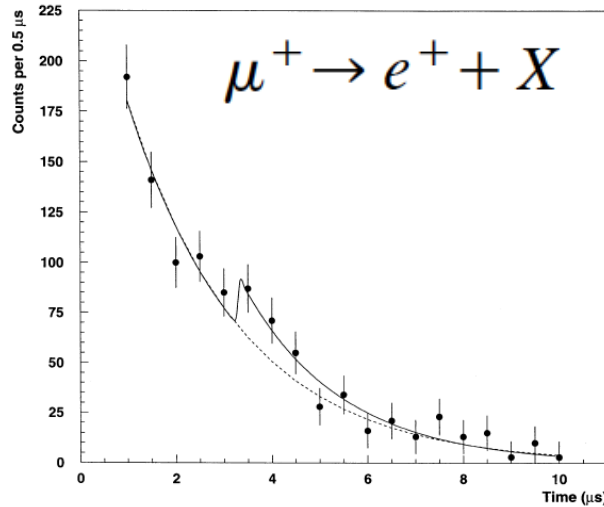


Fig. 2. Time distribution of events in the KARMEN calorimeter after the subtraction of the cosmic background.<sup>3</sup> The solid curves are a fit to the points by a sum of two exponentials. The first exponential describes the time distribution in the region from 1.0 to 3.3  $\mu s$  and the other in the region from 3.3 to 10  $\mu s$  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  $\chi^2$  of 9.7 for 15 degrees of freedom.

[arXiv:hep-ex/0008073v1](https://arxiv.org/abs/hep-ex/0008073v1) 30 Aug 2000

## 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

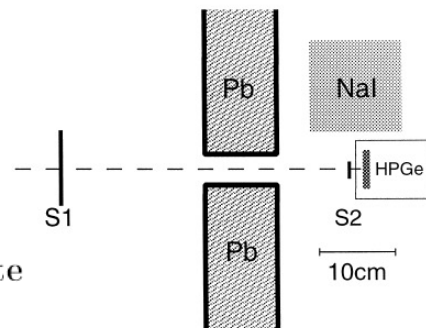
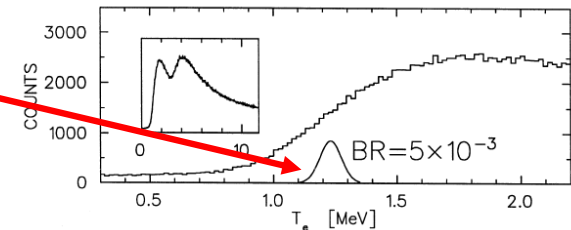
S.N. Gninenko<sup>1</sup>, N.V. Krasnikov<sup>2</sup>

Physics Letters B 446 (1999) 363–367

## Search for exotic muon decays<sup>1</sup>

R. Bilger<sup>a,2</sup>, K. Föhl<sup>b</sup>, H. Clement<sup>a</sup>, M. Cröni<sup>a</sup>, A. Erhardt<sup>a</sup>, R. Meier<sup>a</sup>, J. Pätzold<sup>a</sup>, G.J. Wagner<sup>a</sup>

THIS  
(but much skinnier!)



"Germanium beam-dump"

