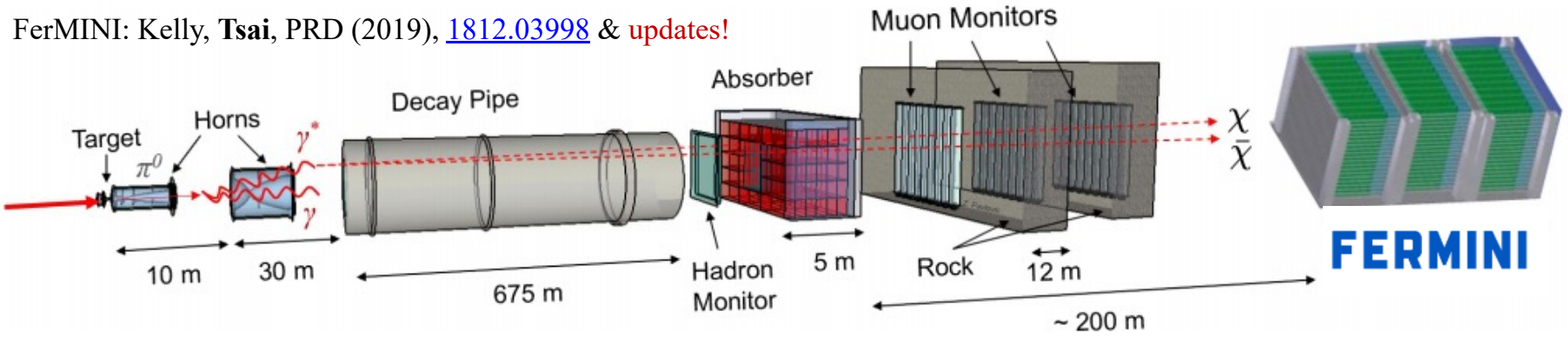
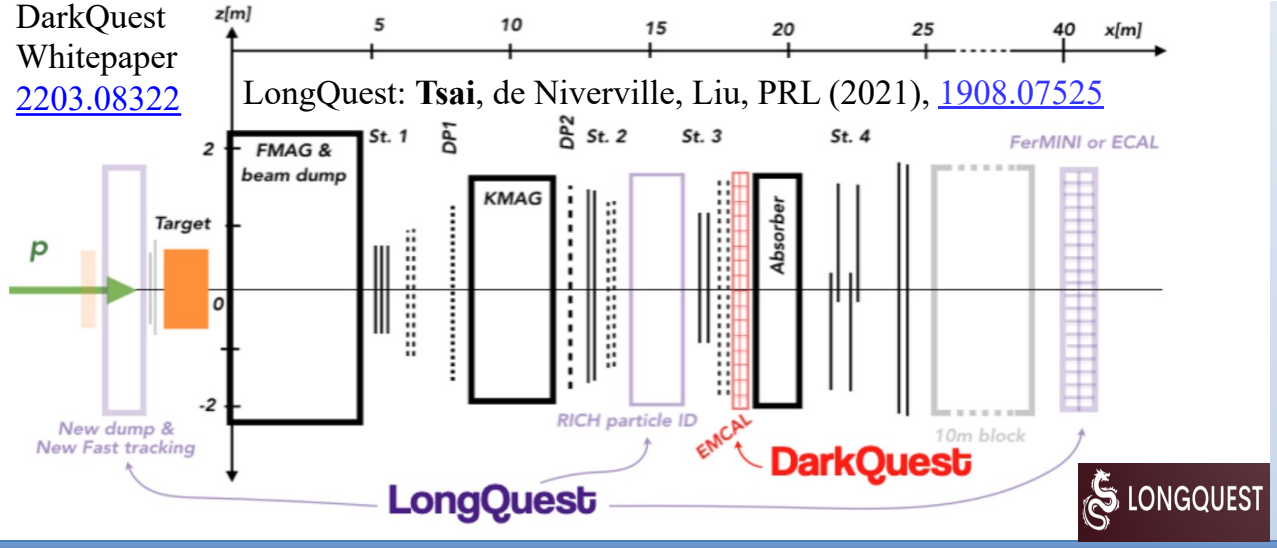
FerMINI: Kelly, **Tsai**, PRD (2019), 1812.03998 & updates!



DarkQuest Whitepaper 2203.08322

LongQuest: **Tsai**, de Niverville, Liu, PRL (2021), 1908.07525



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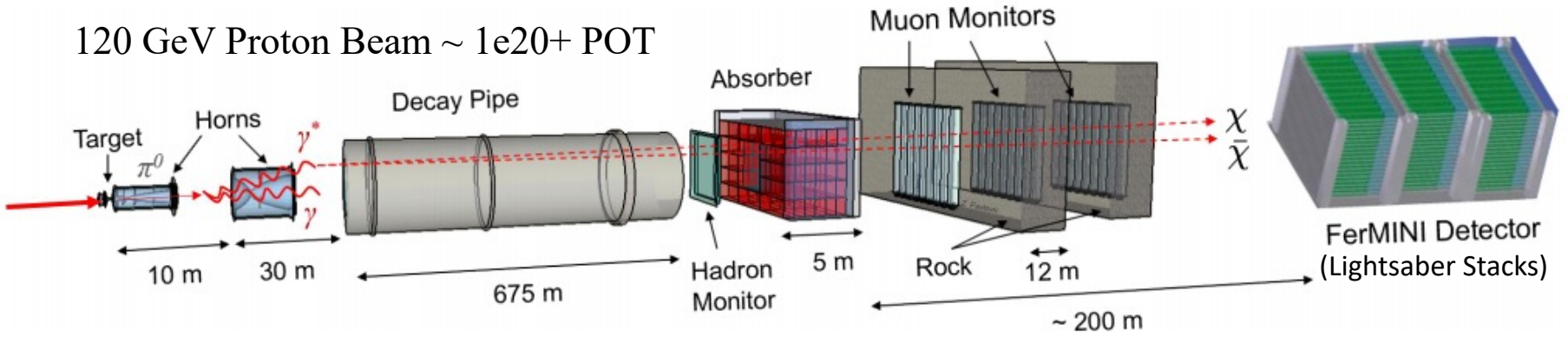
Millicharge and Long-Lived Particle Searches at FerMINI & LongQuest

Low-cost add-on detectors with robust capabilities studying BSM physics

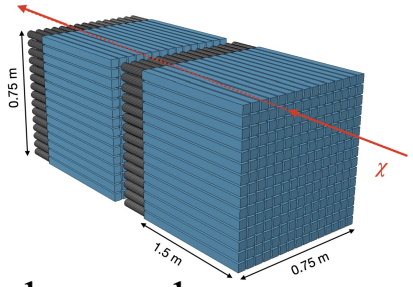
FerMINI: Fixed-Target Millicharged Particle Search



milliQan: Haas et al, PRD (2015)

FerMINI: Kelly, **Tsai**, PRD (2019), 1812.03998
SUBMET: Kim, Hwang, Yoo, JHEP (2021), 2102.11493

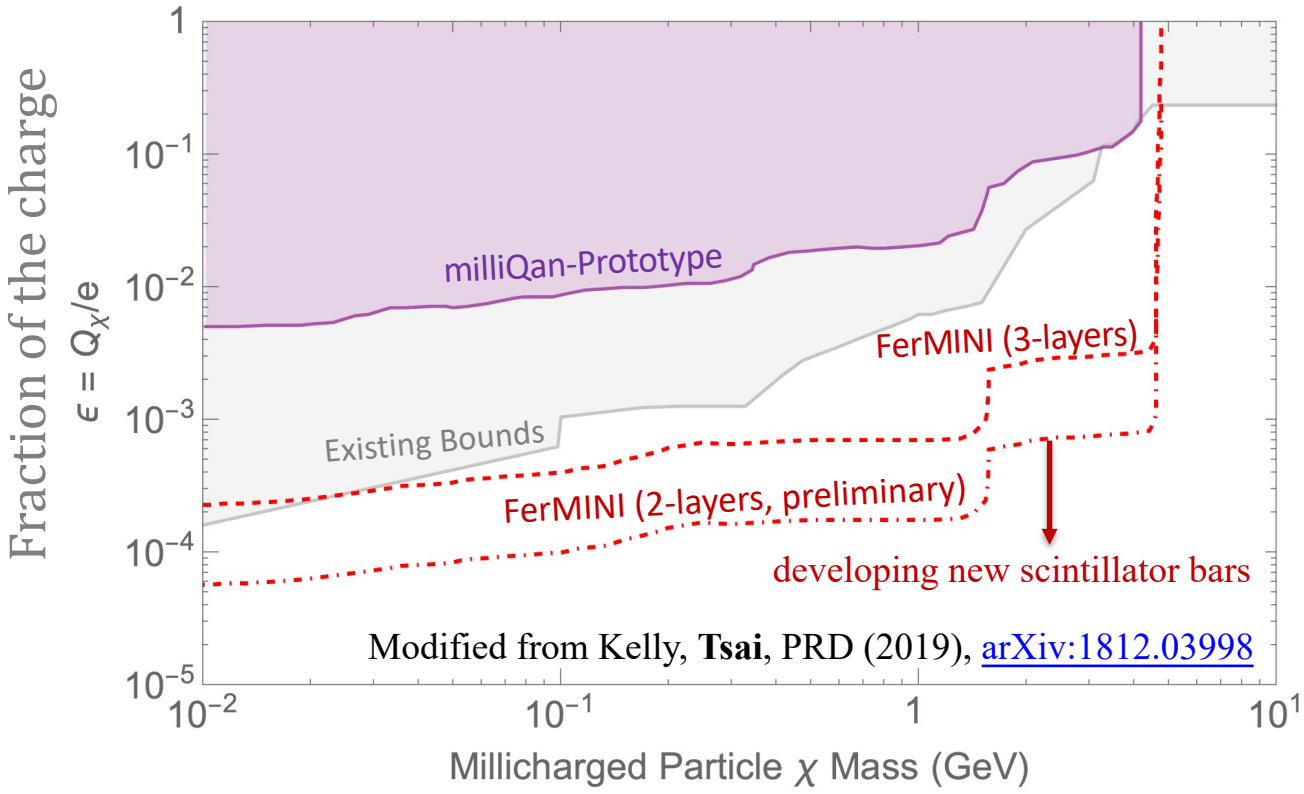
Using stacks of scintillators studying triple or double coincident signature for millicharged particles (mCP)



- Consider a 2-Layer setup being tested at J-PARC (SUBMET)
- NuMI beam cycle time is 1.2s, spill duration ~ 8-10 μsec:

  using timing information to drastically reduce the dark-current background
- Consider **double-coincidence signature within ~ 10 ns time window**

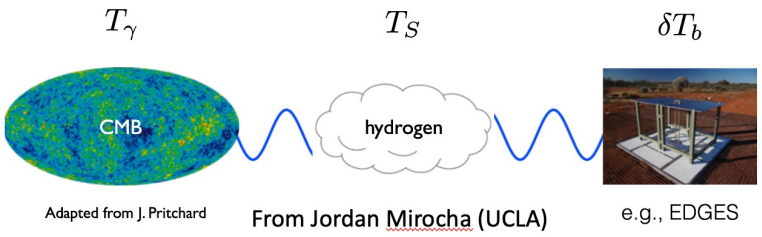
FerMINI at MINOS (& DUNE ND)



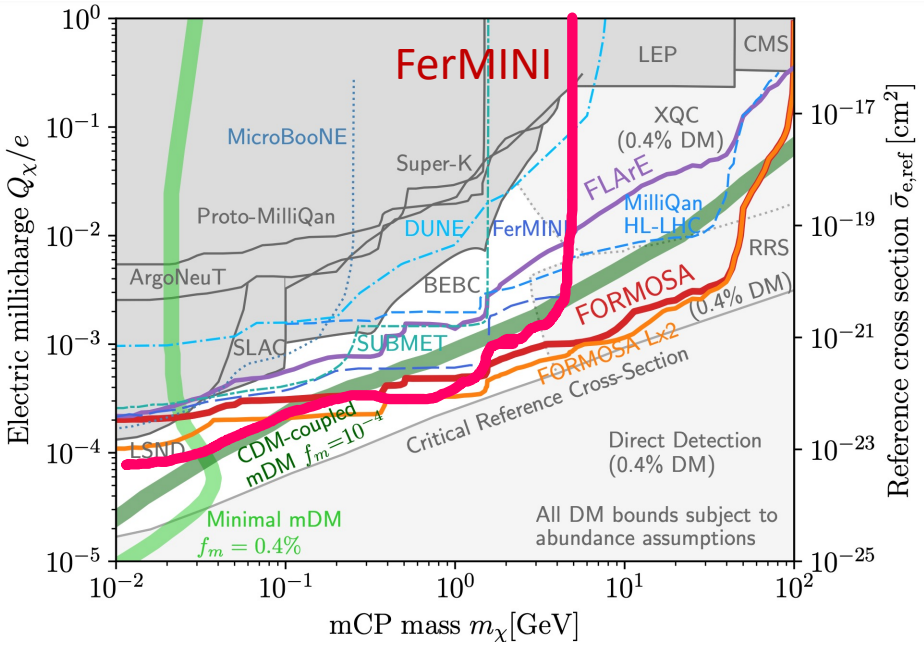
Motivations to study mCPs

- Charge quantization; GUTs & string compactifications (e.g., Shiu, Soler, Ye, PRL 13)
- Direct link to dark photon models (e.g., Holdom, PLB 85)
- **Important implications on 21 cm absorption spectrum studies**

Millicharged Dark Matter & EDGES Motivation



Foroughi, Kling, **Tsai**, PRD (2021), 2010.07941

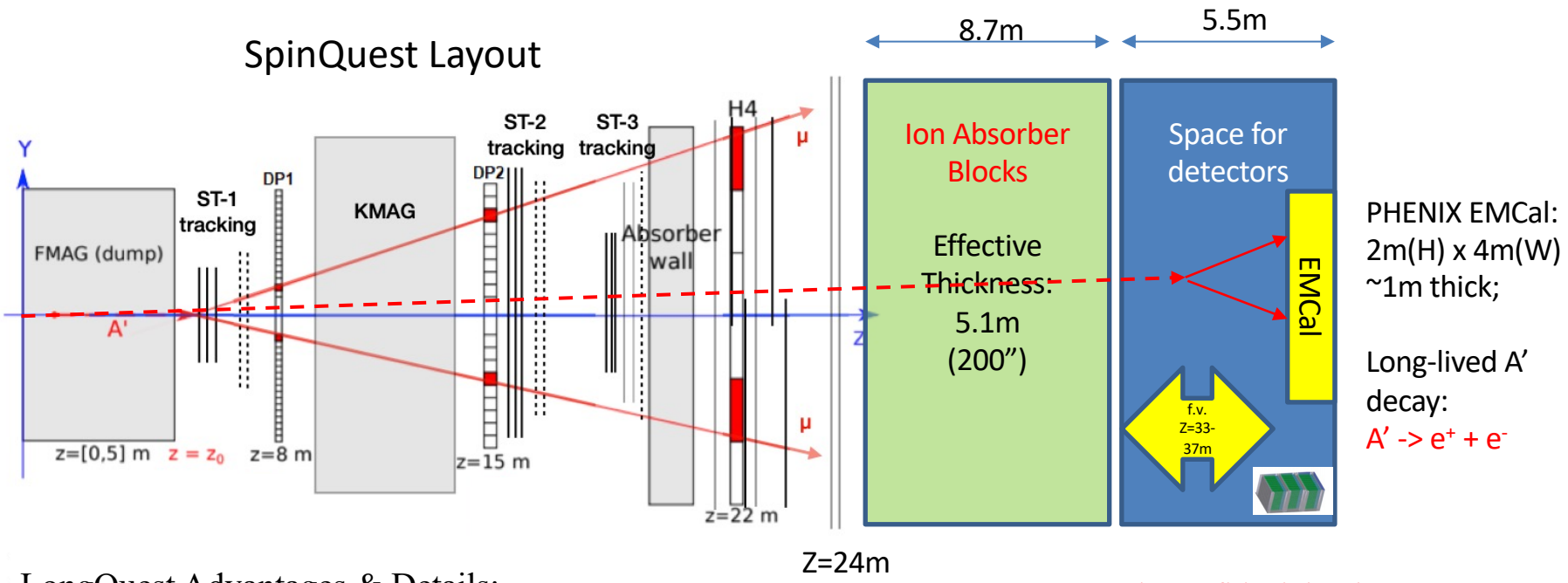


- Many 21 absorption spectrum experiments coming on-line soon
- **Even a small fraction (<0.1%) of dark matter that has millicharge can have significant implications on such measurements**

- **Green areas** are parameters motivated by the EDGES anomaly
- See, Bowman et al, Nature (2018) & follow-up works

LongQuest: Long-Lived Particle Searches at SpinQuest Facility

LongQuest: **Tsai**, de Niverville, Liu, PRL (2021), 1908.07525



LongQuest Advantages & Details:

- Better shielded; no interference with SpinQuest operations
- An alternative site for FerMINI
- Additional upgrades adding particle ID detectors and front dump (see *David Sperka's talk*)

A' decay fiducial volume:

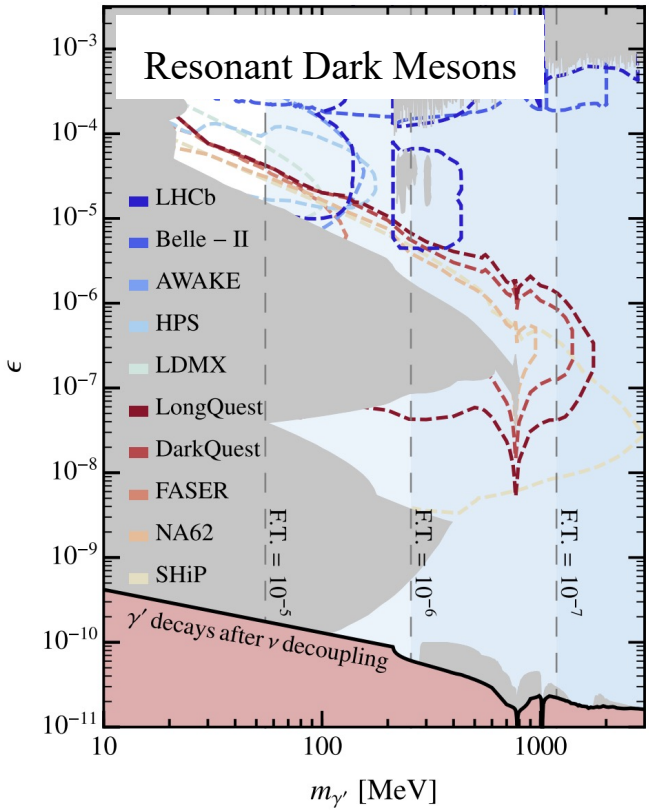
- Baseline distance = 33 ~ 37m
- To measure di-electrons (or di-photons)
- w/ EMCal + pre-Shower Det.
- POT ~ 1e18 to 1e20

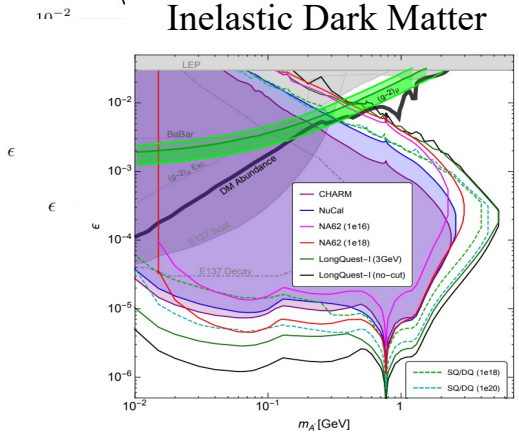
LongQuest layout from Ming Liu, more details to in the backup

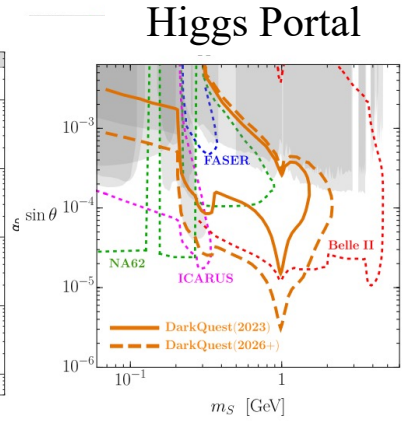
LongQuest Decay Search Sensitivity

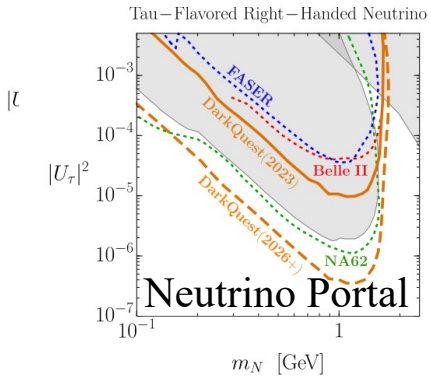
Tsai, McGehee, Murayama, PRL (2022)
arXiv:2008.08608

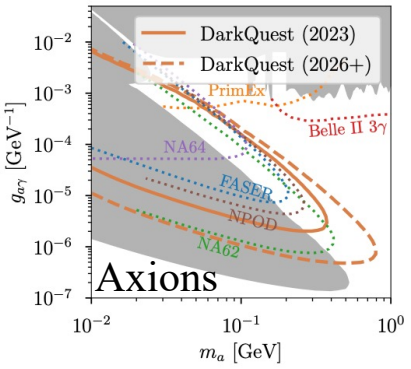
Studies conducted for DarkQuest,
Berlin, Gori, Schuster, Toro, PRD (2018)
& DarkQuest Whitepaper: 2203.08322











Detailed analyses of **LongQuest physics cases** in progress

Plan & Timeline

1. FerMINI & LongQuest papers regarding updated sensitivity & physics cases are in progress (expect to appear this summer)
2. In preparation of 2023 & 2024 LDRD applications
3. In coordination with NuMI Facility, DUNE, and DarkQuest

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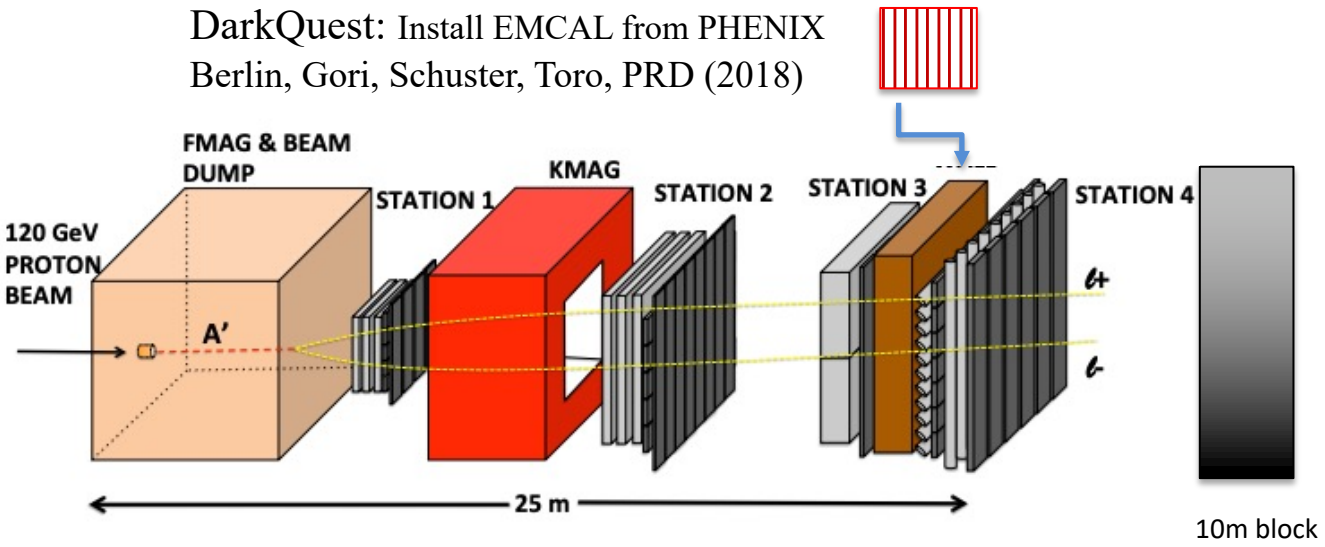
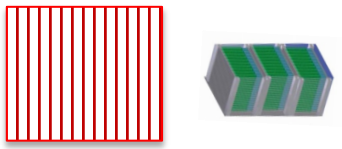
LongQuest: LLP Search at SpinQuest Site

DarkQuest: Install EMCAL from PHENIX
Berlin, Gori, Schuster, Toro, PRD (2018)



LongQuest:
Tsai, de Niverville, Liu,
PRL (2021), 1908.07525



Another ECAL from PHENIX

Install EMCal in the back room.

LongQuest Details:

- Baseline distance: ~ 35 meters from the target
- POT ~ 1e20+
- Better shielded; installation has much less interference with SpinQuest operations
- Additional upgrades adding particle ID detectors and front dump