

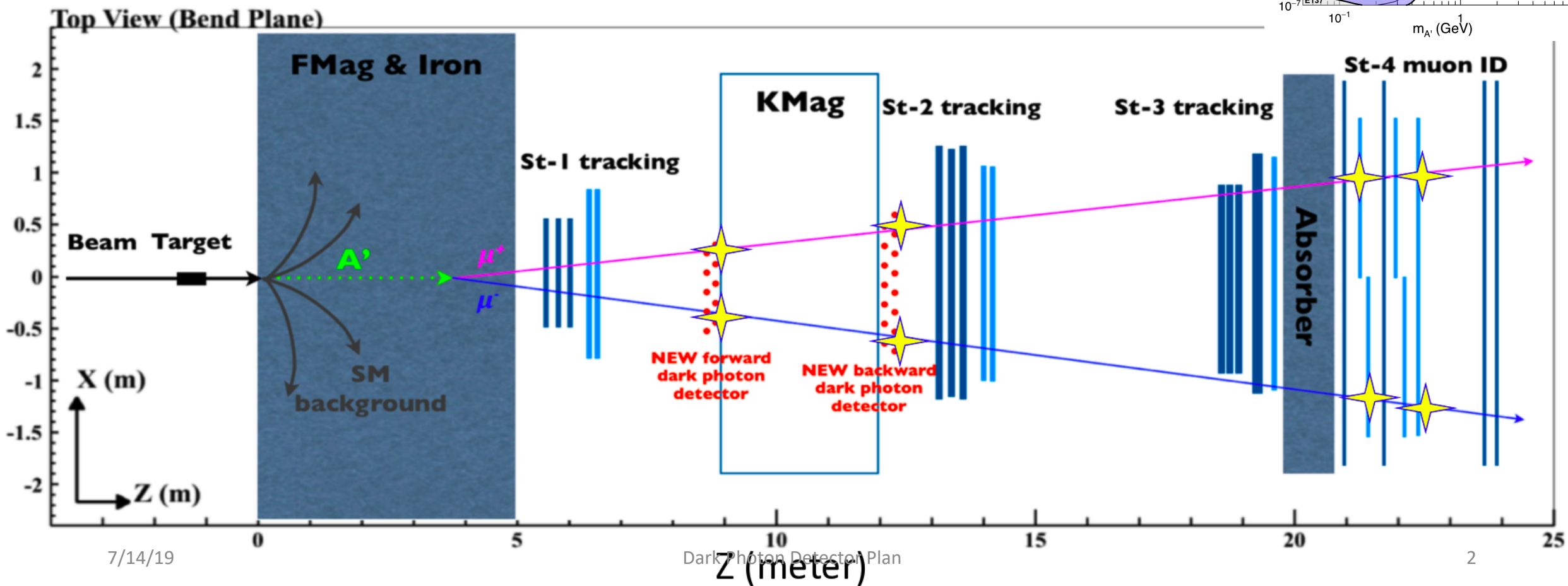
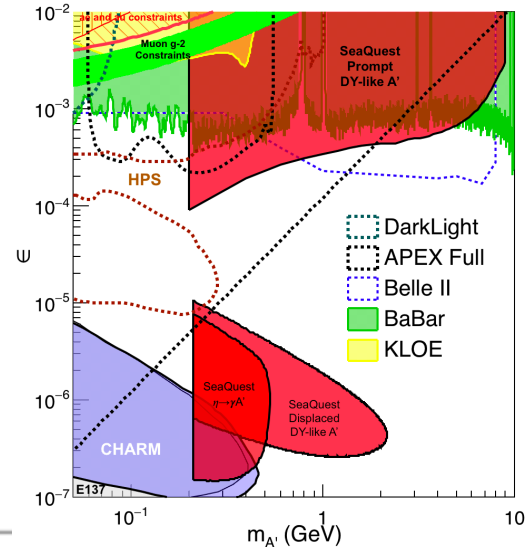
Dark Photon Detector Status and Plan

Ming Liu, LANL

E1039 Collaboration Meeting

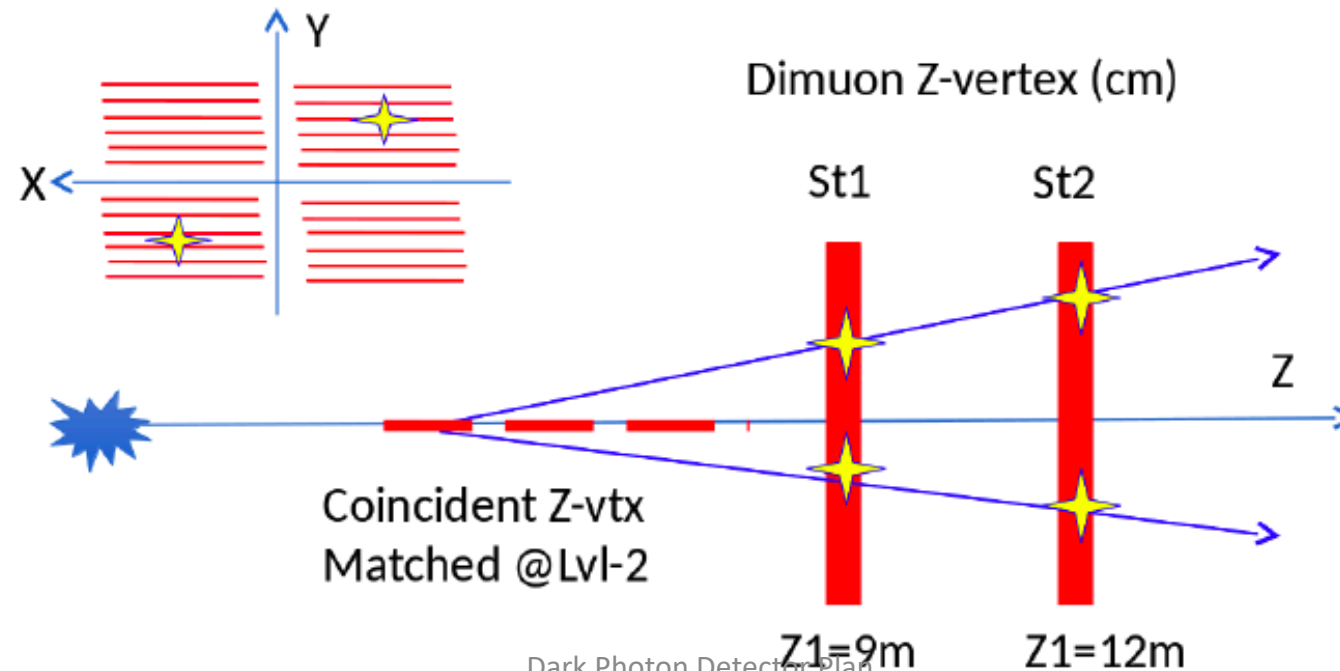
07/15-16, 2019, Fermilab

Dart Photon Detectors – Introduction



Displaced Vertex Trigger

- Two stations of fine-grained scintillator hodoscopes measure track Y
- FPGA trigger extrapolates tracks to the beam plane (and H4Y hodoscopes) and fires on pairs of tracks with matching Z



Basic Design - Hardware

- Constructed in quadrants (4×4 ft boxes, light-tight); quadrants are bolted together using 1.5" 80-20 hardware and supported by I-beams
- Coverage: both stations are dead $|y| < 7.5$ cm
 - ▶ St-1: $|x| < 80$ cm, $|y| < 80$ cm
 - ▶ St-2: $|x| < 100$ cm, $|y| < 100$ cm



ST-1 Quadrant

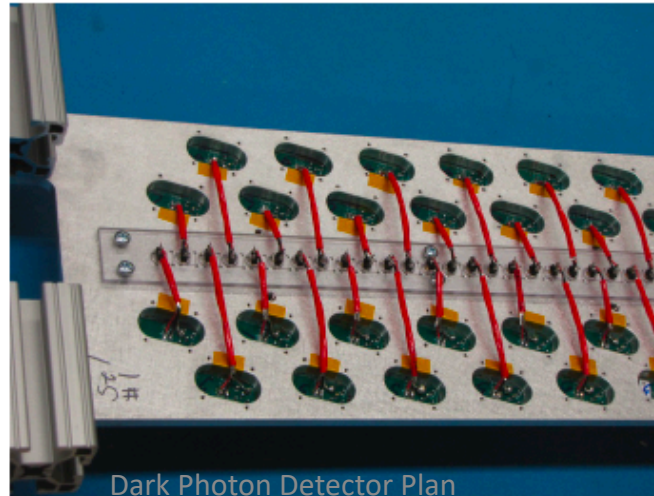
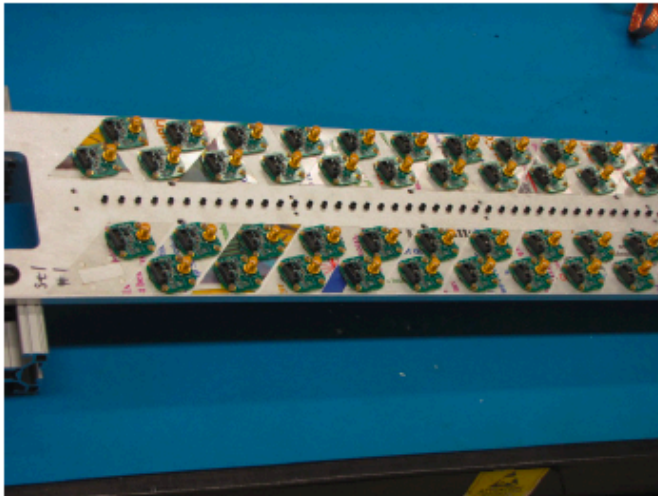


ST-2 Quadrant



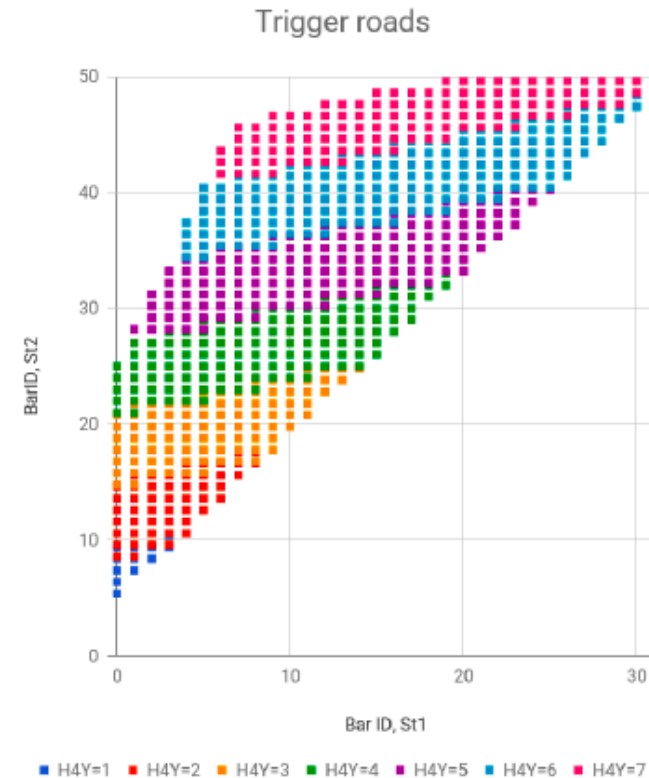
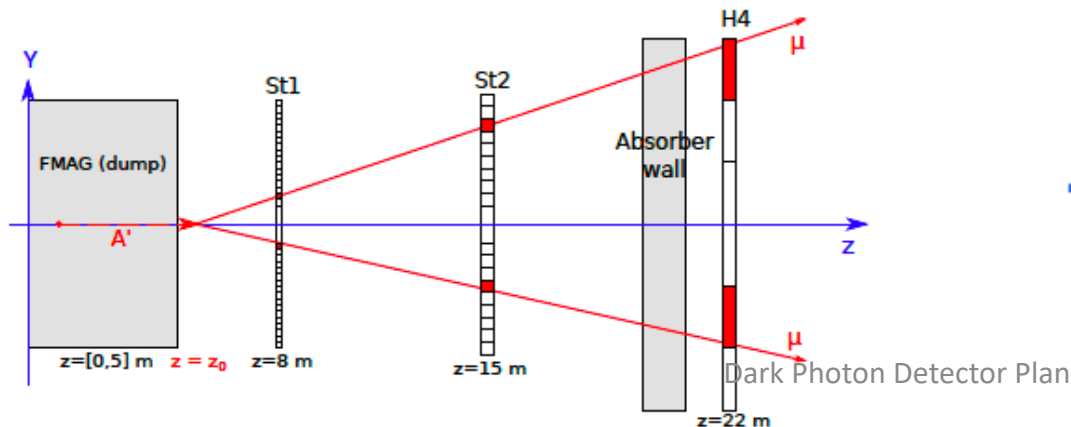
Basic Detector Design Parameters

- Extruded scintillator bars with wavelength-shifting fiber+SiPM readout
 - ▶ St-1: 1×1 cm bars, 80 bars/quadrant
 - ▶ St-2: 2×2 cm bars, 50 bars/quadrant
- Preamps push analog signals out over coax to LeCroy 4413/4416 discriminators, same as other hodoscopes



Trigger Logic – Can also help DY & J/Psi from Upstream Target

- Two levels: identify displaced tracks, trigger on pairs
- L1: three-way coincidence within each quadrant
 - ▶ Identify displaced tracks ($z_0 \in [400, 650]$ cm) in each quadrant using roads
- L2: two-out-of-four coincidence between opposite-sign quadrants
- In 2017, we wired this to NIM2



Readout Status – 11/2018 (from Sho)

- Tested and installed LeCroy 4413 discriminators from SeaQuest spares
 - ▶ Need six more discriminators to finish instrumenting DP1; we have seven believed-good 4413/4416 between LANL and SeaQuest
 - ▶ Each quadrant has 130 bars and 9 discriminators (144 channels), so we can use discriminators with bad channels if necessary
- Discriminators are cabled to V1495s
- LED pulsers are cabled, pulse input from patch panel
- V1495s are programmed for 160-ch readout and cosmic trigger
- Dark photon DAQ is set up as it was last year: standalone CODA and single ROC

DP Detector Status

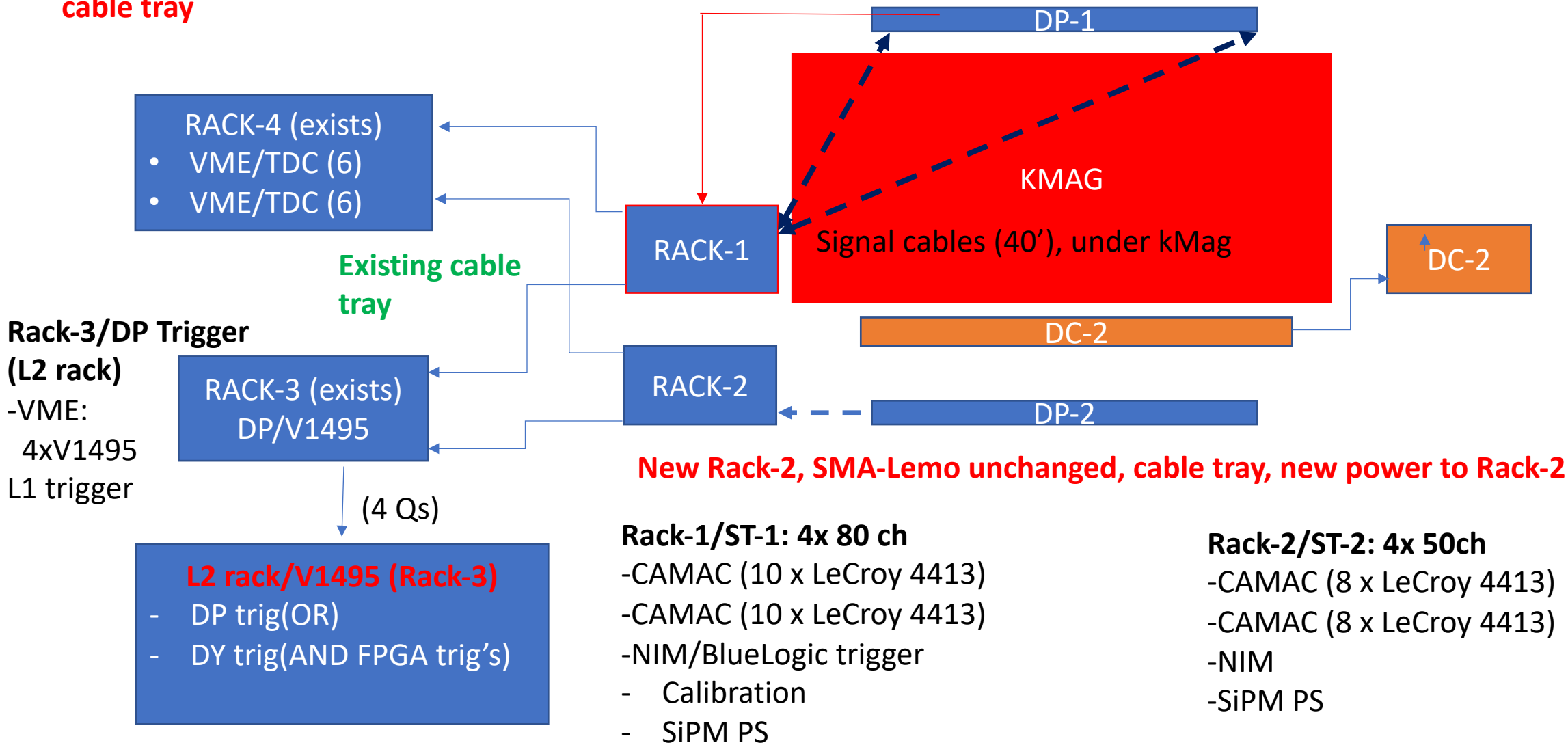
- All broken channels fixed in Nov, 2018, by Sho, Hubert, Kun et al.
<https://sequest-docdb.fnal.gov/cgi-bin/private/ShowDocument?docid=4615>
- This summer work in progress, July – September, 2019
 - Reconfigure the readout/power cables route
 - Relocate racks for readout and PS, to break the ground loop
 - TDC crates, DAQ integration

DP Trigger New Layout (5/28/2019)

Possible extended SMA-Lemo, ~5' (NOT needed! 7/2019); cable tray

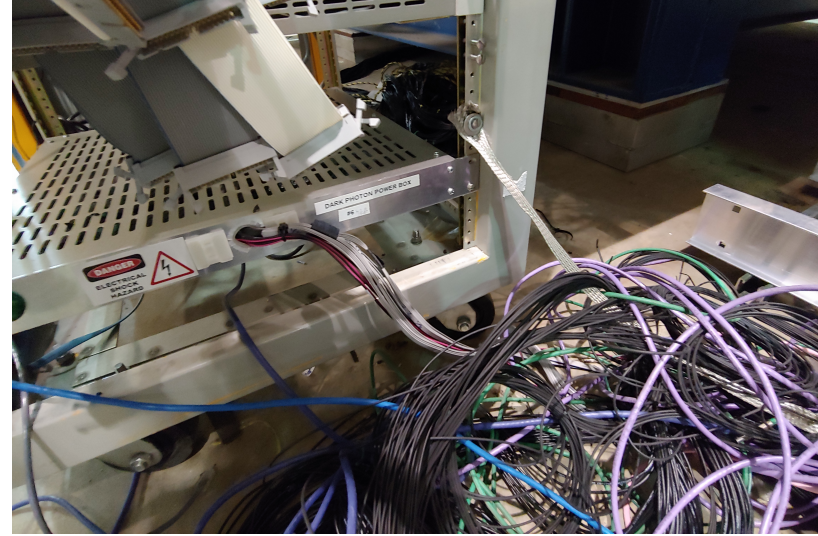
beam

- Run all cables under the KMag, with cable tray



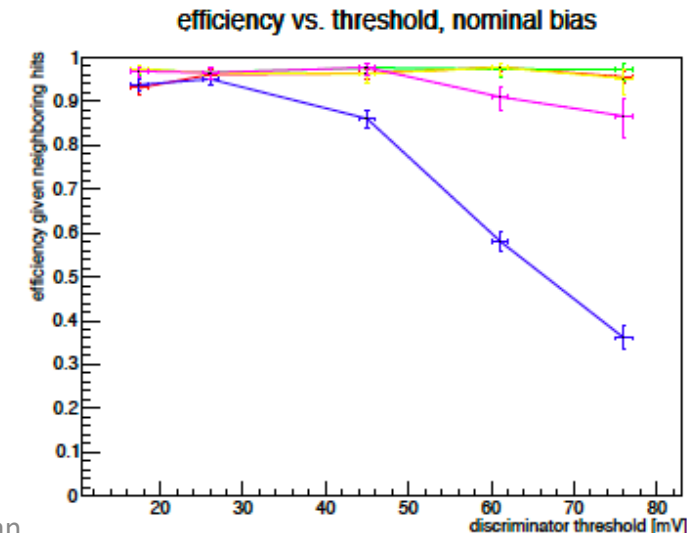
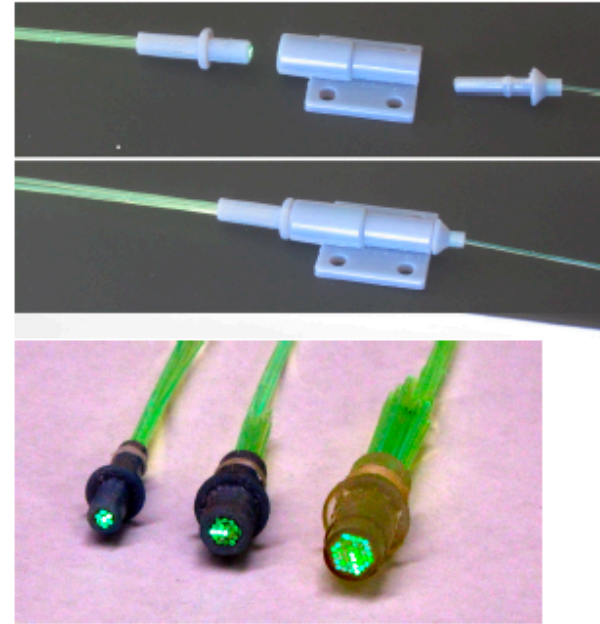
Work in Progress – Summer 2019

All cables are pull off and ready for reconnection in the new locations,
Thanks Marshall, Kun, Mindy et al



Test Plan: Aug. – Sept. 2019

- LED pulser: each LED is connected to 19 bars through a splitter
 - ▶ The splitters were not designed for perfect uniformity, but we see similar amplitudes between bars pulsed from a single splitter; we see large variations between different splitters
 - ▶ With oscilloscope, this tells us when the detector response changes as we tweak the optical coupling
- Cosmics: use V1495 trigger+readout to measure efficiency as a function of bias or threshold (as seen on right)
 - ▶ Final test of detector efficiency and signal margin



Target/Dump Simulation Study - Work in Progress

Thanks Haiwang Yu's help for setting up the simulation framework for DP,
Also Kenichi, Kun and Mindy et al.

MC samples from target:

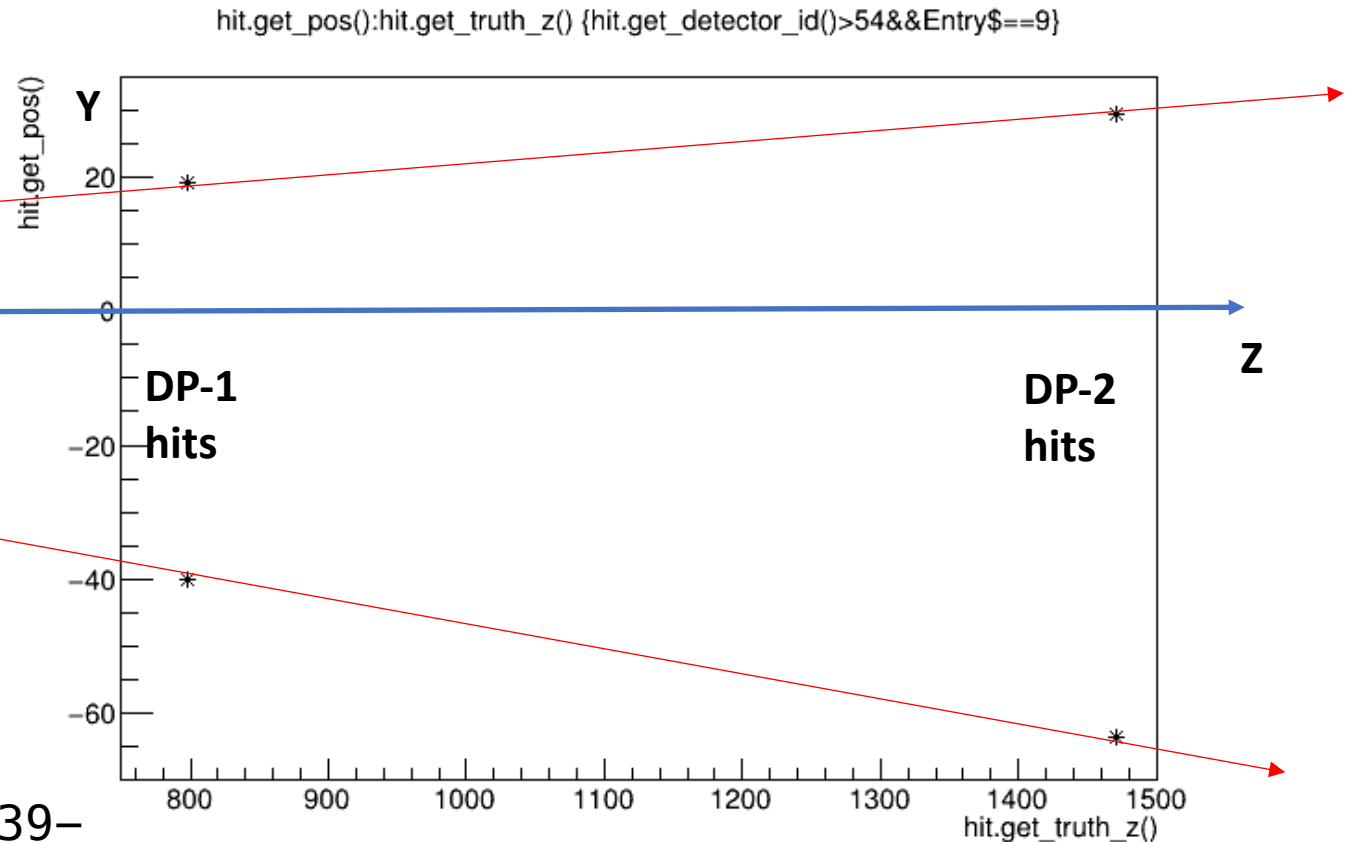
- DY
- J/Psi
- Single muons

Target-Dump separation @Trigger level

Dimuon simulations: Evt: #9

10K Dimuons @Z = -300cm:

/sequest/users/mxliu/DP_Trig_Sim/e1039-
analysis/SimChainDev



Simulation To-Do's

- Generate MC samples at
 - target ($Z = -300\text{cm}$)
 - beam dump ($Z = 0\sim 50\text{cm}$)
- Physics signal samples
 - J/Psi
 - Drell-Yan, $M = 4\text{-}8\text{GeV}$
 - Single muons ($\pi/K/\text{Charm}$)
- Trigger lookup tables
 - Beam-Dump separation
 - FPGA

To be ready for Day-1 Physics

1. J/Psi A_N
2. Dark Photon search
3. Single Muons A_N
4. Drell-Yan A_N

Summary

- Dark Photon Detector re-configuration in progress
 - Re-cabling
 - Install TDCs,
 - Trigger & DAQ integration
 - Test run w/ calib system
 - Cosmic run, including other DCs, in Aug/Sept. 2019
- Dark photon trigger optimization for target
 - Signal simulations: J/Psi, DY, single muons
 - Dark photon and alike
 - Update FPGA lookup table

People involved -
Sho, Kun, Mindy, Marshall, Huizi, Zongze, Hubert, Ming
Haiwang, Kenichi,
Noah, Minjung,
Dylan, Cristina, Nhan et al (HEP groups)

To be ready for beam in mid October, 2019

Welcome to join us!

① DP trigger.

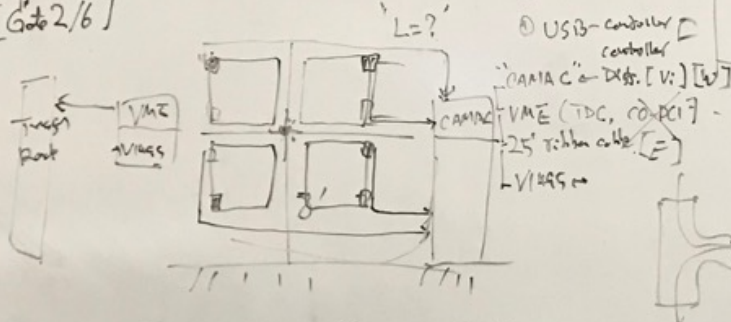
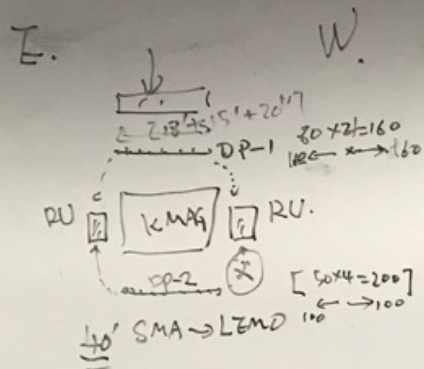
- * Cabling: Det. → RD/Crot
- * 8-array Readout Cables
- * TDC cables { [station cables]}
- * Trig. cables

② Ssh RPI @ ER [LW@Spinduct]

- * master + 6 slaves [Goto 2/6]
- * SPM HV. table [Man's settings]
- * set V. Readout (I, Top.)

③ select Rack [E → W]

- * Recable,
- * Remap
- * Ground loop
- ④ Software
- * Tracking
- * Trigger [Add DP, Trig/Drop Sigs.]



Lemo → Lemo [320 + 200]
 * [10'] #1 "MEB" [160 x 60] 300
 60' SMA → Lemo [550] (8K) "SCV"

July 7 → [15-16]
 X ORC done b DP. prep.

* Prep. Tub.

- ① check/pickup 2/Modules [4 good ones]
- ② Japhie "2 modules" ⇒ ready done? [Aug.]
- ③ Simon Read

- * DP. F. Hodo,
- * Prep. tub
- * DC-2/3

* Sept. 17-18
 "full sys. test" → Det.
 * DC-2/3.
 * prep. tub.
 Trig. by DP + Hodo

* beam: mid. Oct.



05/26/2019 Planning Discussion @FNAL

