

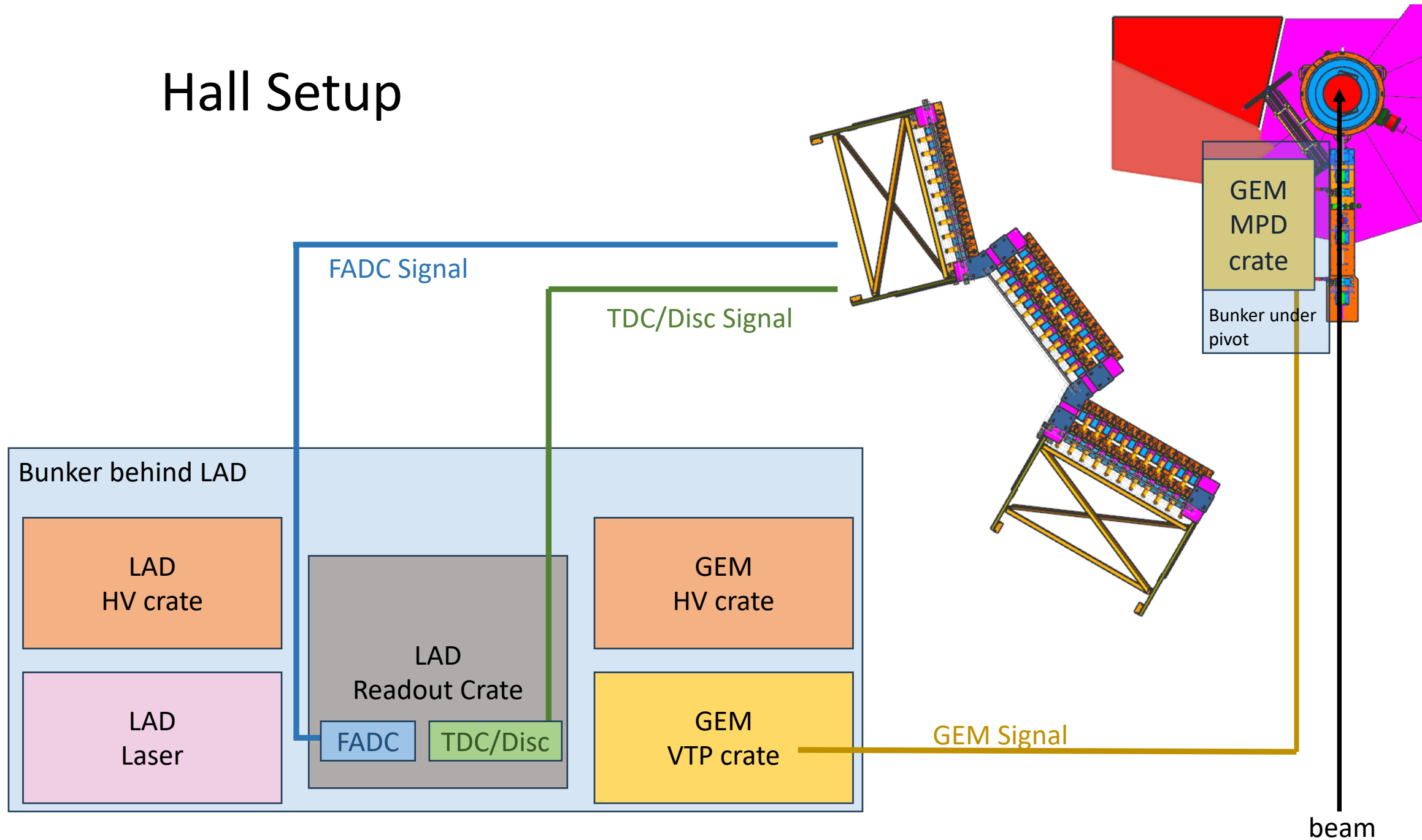
# LAD

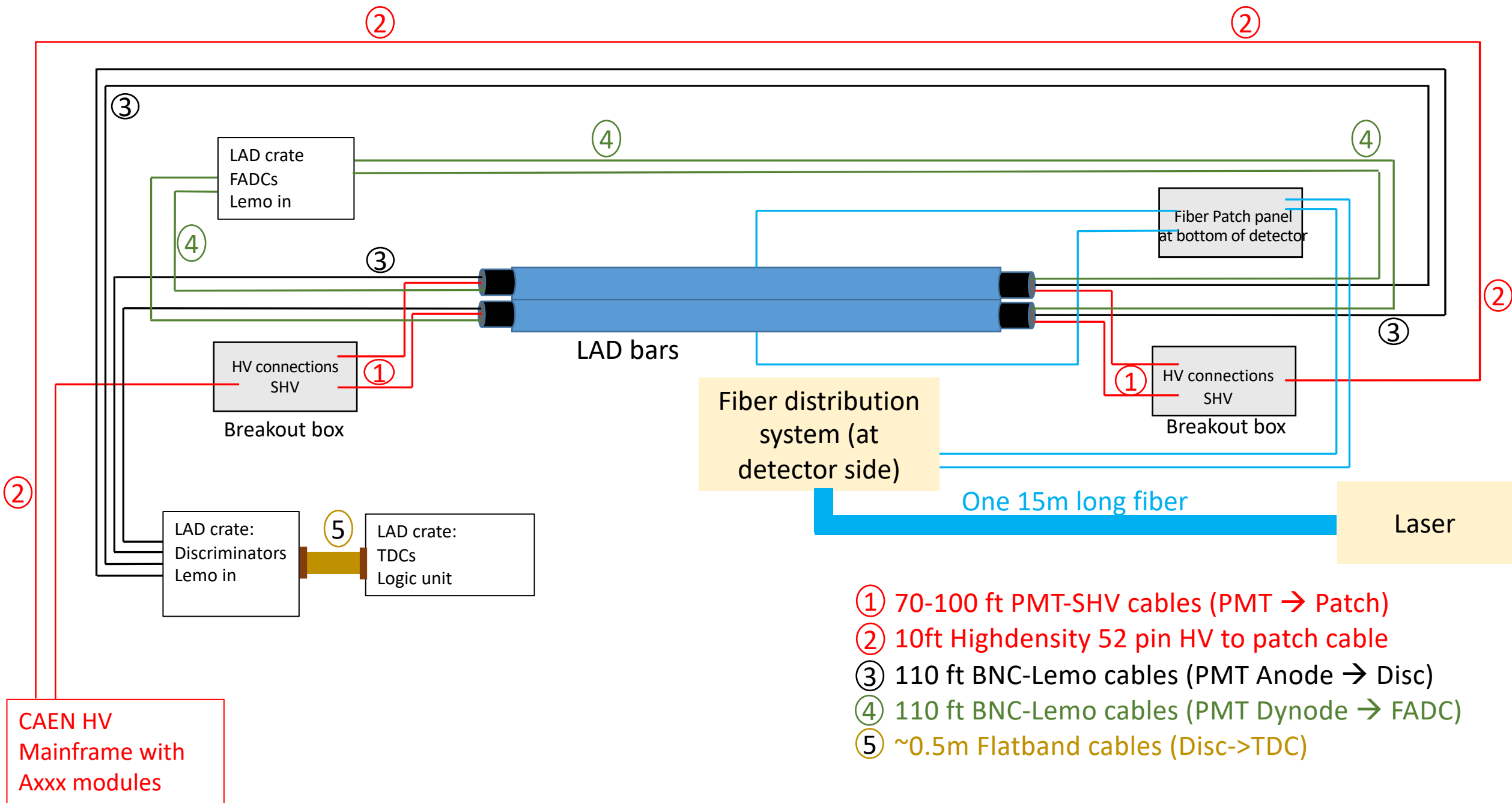
# Cable and Trigger Diagrams

# v0.3

Florian Hauenstein  
11/18/2024

# Hall Setup



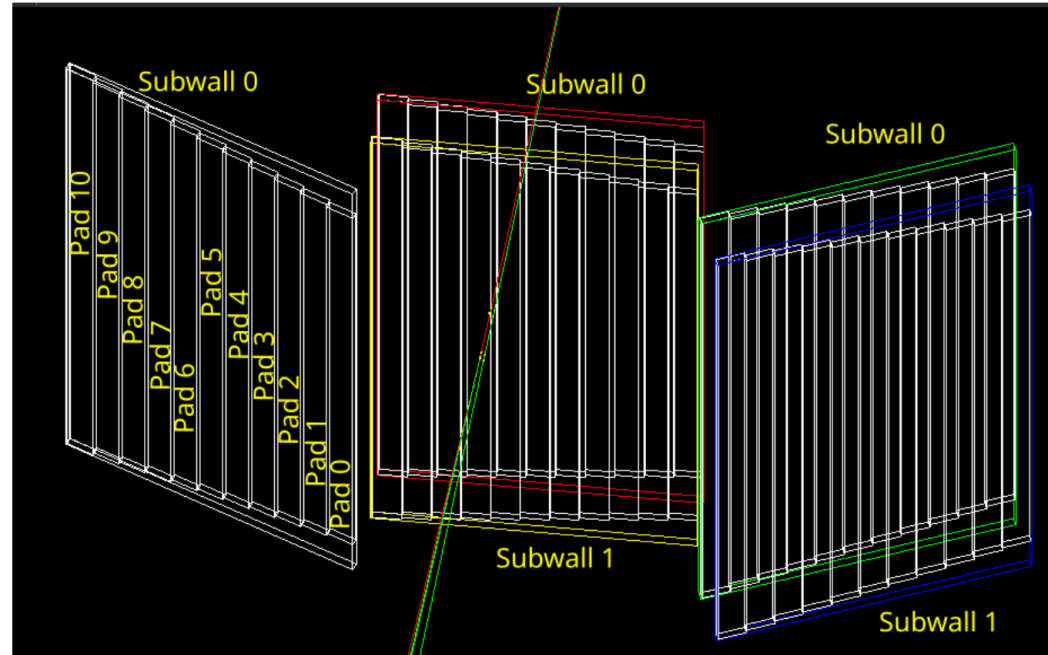
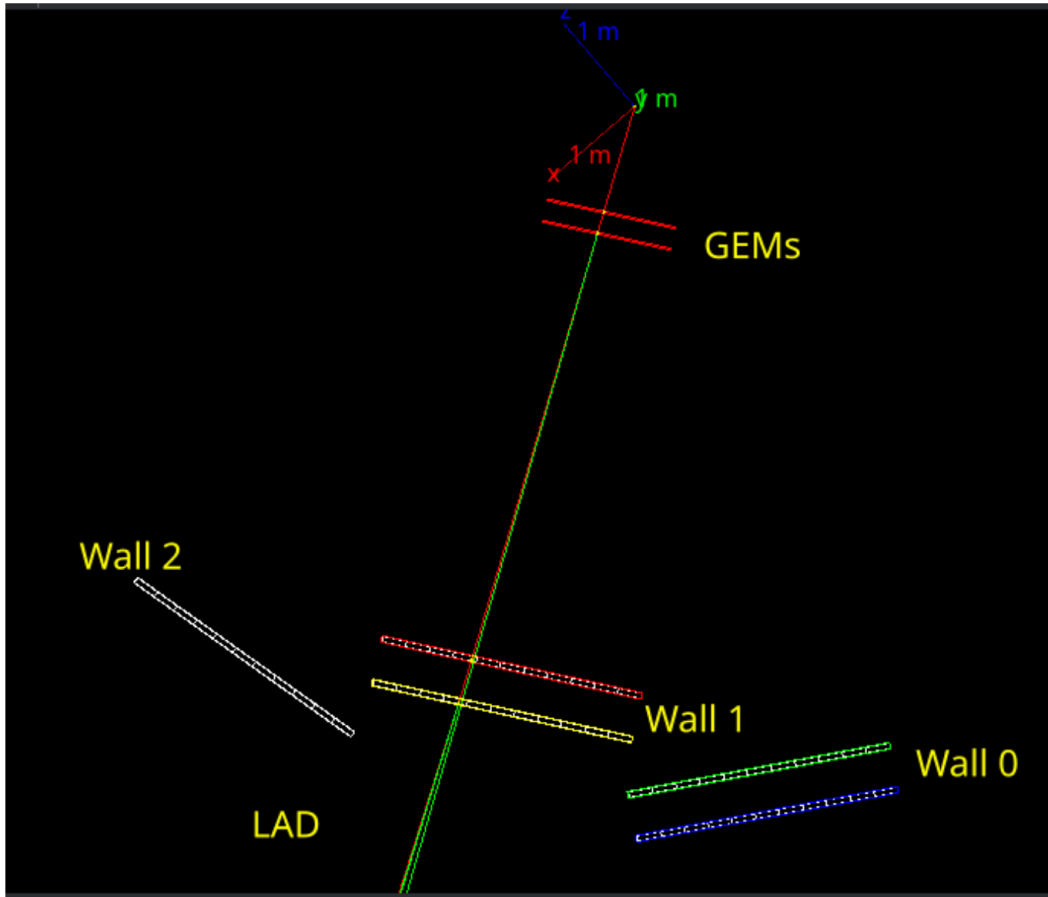


# LAD Readout Crate: Crate Number xx

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
CPU Board: LAD		Trigger Logic Board V1495		Disc G1	Disc G2	Disc G3	TDC 1190A or 1290		Disc G4	Disc G5	Disc G6	Disc G7	Signal Distribution Card		FADC G1 0x6800	FADC G2 0x7000	FADC G3 0x7800	FADC G4 0x8000	FADC G5 0x8800	FADC G6 0x9000	FADC G7 0x9800	Trigger Interface Card	

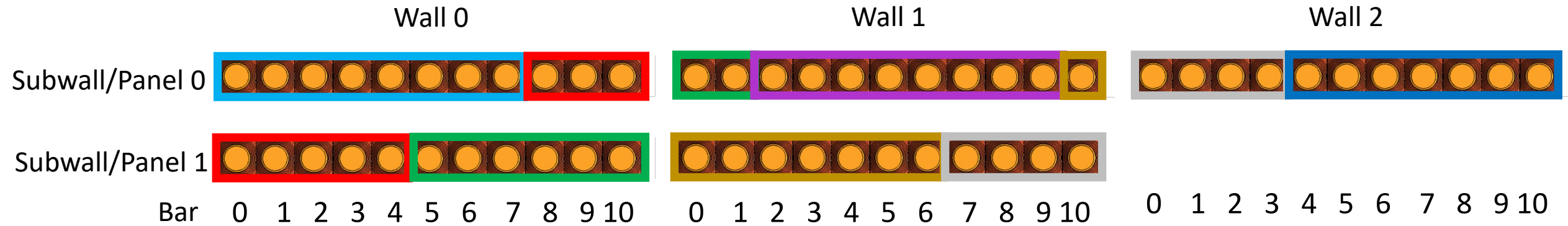
1V Jumper all FADCs probably (maybe 0.5V)

# Plan for Cable Maps



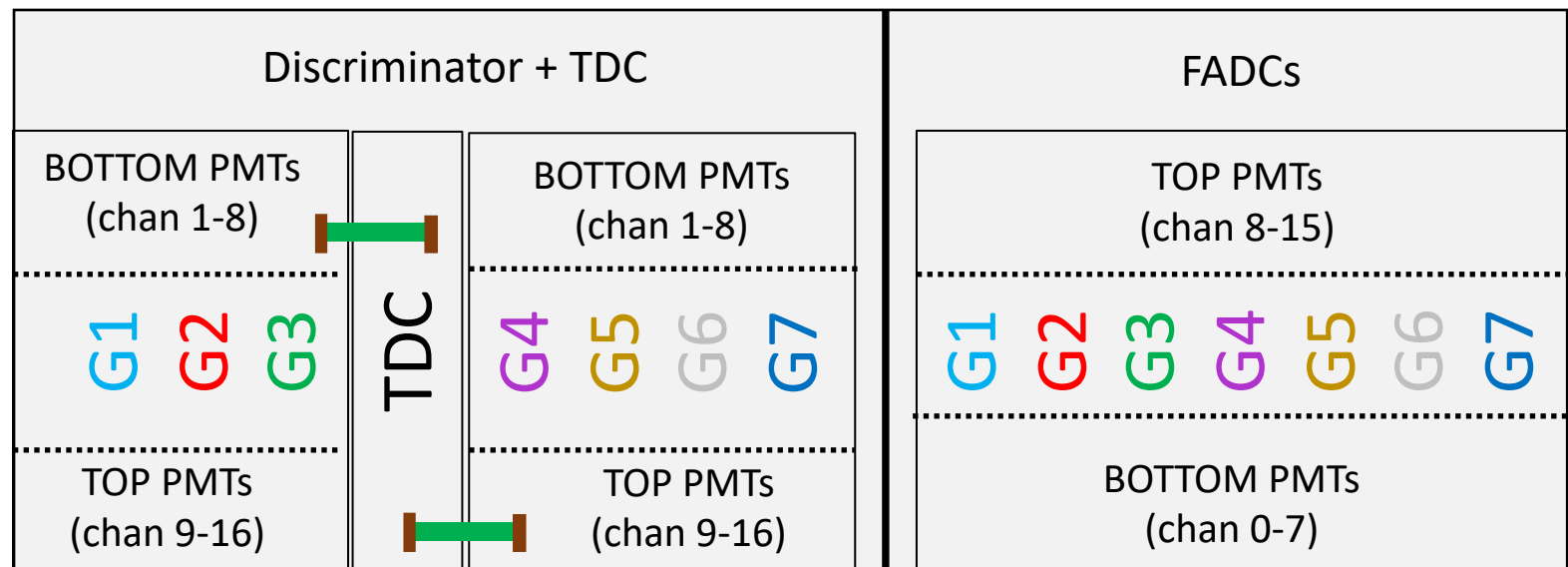
- ADC and TDC channels from PMTs = 110, 7 FADCs and Discriminators = 112 channels
  - 2 spare channels, one will be used for laser reference photo diode
  - Plan: Use top part of FADCs (channels 8-15) for top PMTs and lower part (channel 0-7) for bottom PMTs
- HV:
  - 4 boards each 36 channels = 144 → a lot of spares since 110 required
  - Plan: Wall 2 gets standalone breakout box, skip 12th channel on each breakbox

# Signal Mapping (FADCs and Discriminators/TDC)

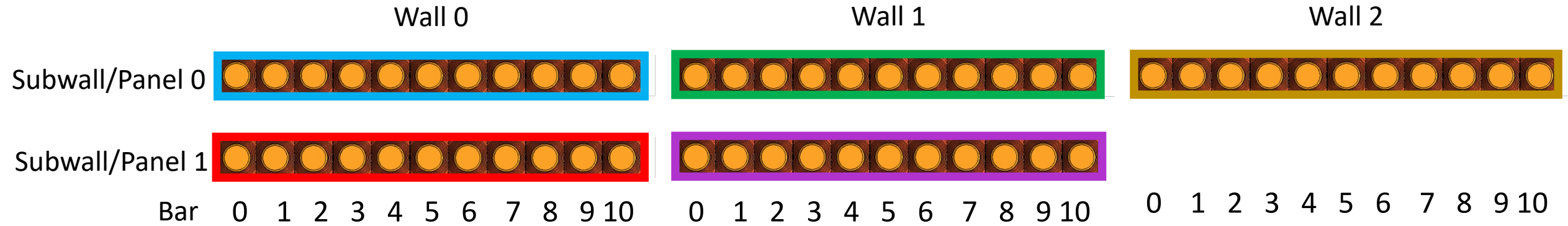


- G1: 00(00-07)
- G2: 00(08-10) + 01(00-04)
- G3: 01(05-10) + 10(00-01)
- G4: 10(02-09)
- G5: 1010 + 11(00-06)
- G6: 11(07-10) + 20(00-03)
- G7: 20(04-10)

- Bottom PMTs: Channels 0-7 on FADC and 1-8 on Disc
- Top PMTs: Channels 8-15 on FADC and 9-16 on Disc

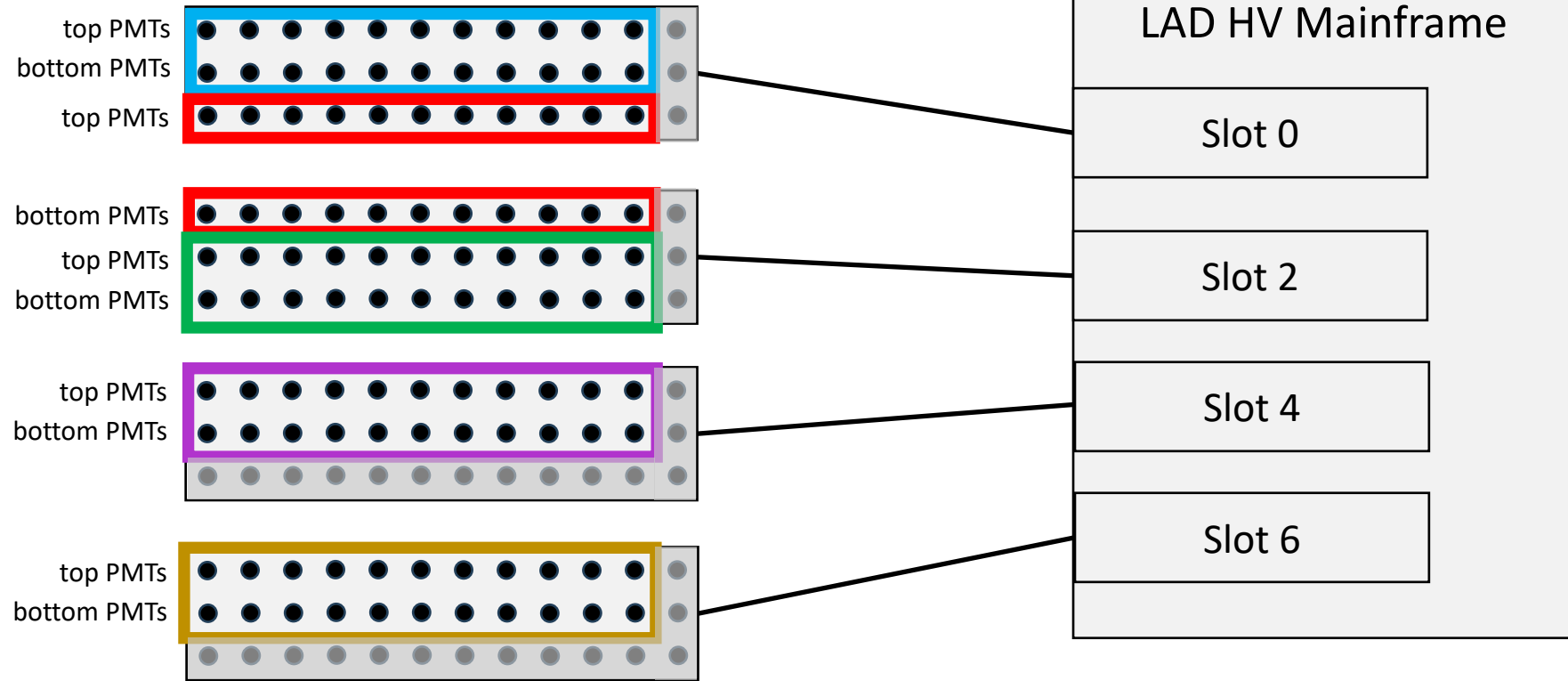


# HV Mapping



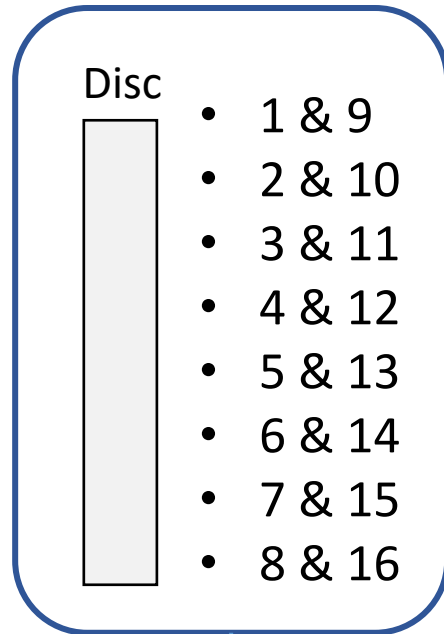
- HVG1: 00(00-10)
- HVG2: 01(00-10)
- HVG3: 10(00-10)
- HVG4: 11(00-10)
- HVG5: 20(00-10)

## HV Break out boxes



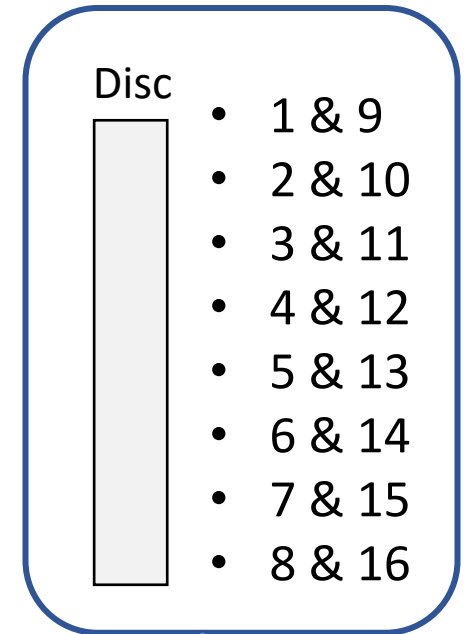
# LAD Trigger Logic within v1495

Step 1:  
Coincidence on  
each bar

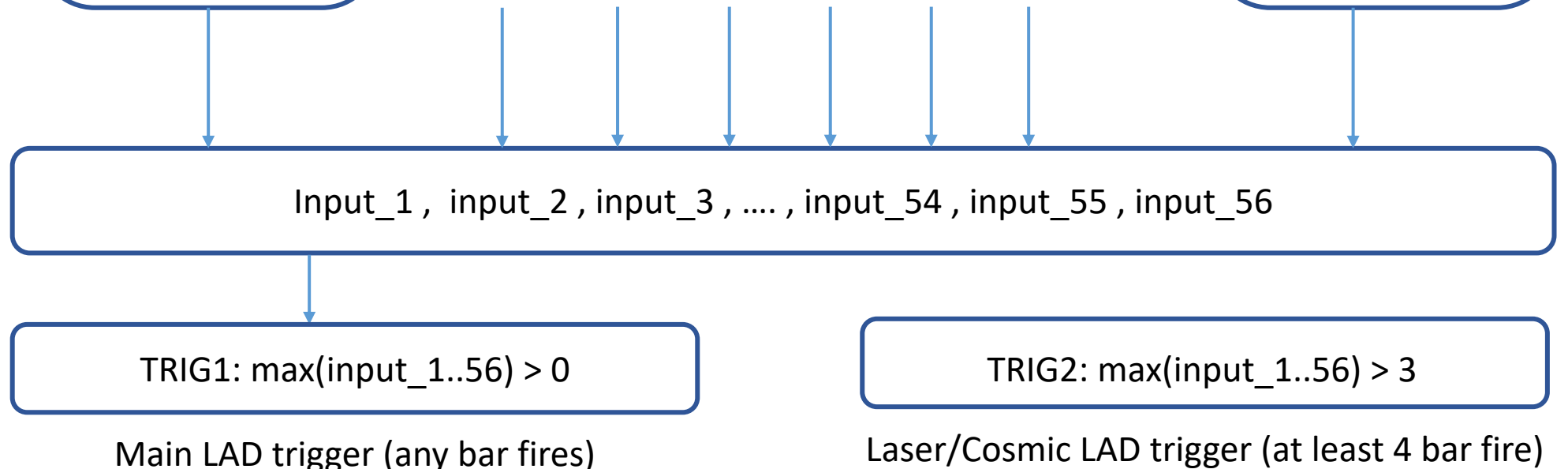


... for channels on each discriminator (7 total)...

Note: G7 discriminator will have channels  
8 & 16 empty to technically only 55 inputs with signal below



Step 2:  
Combine bar  
info for trigger





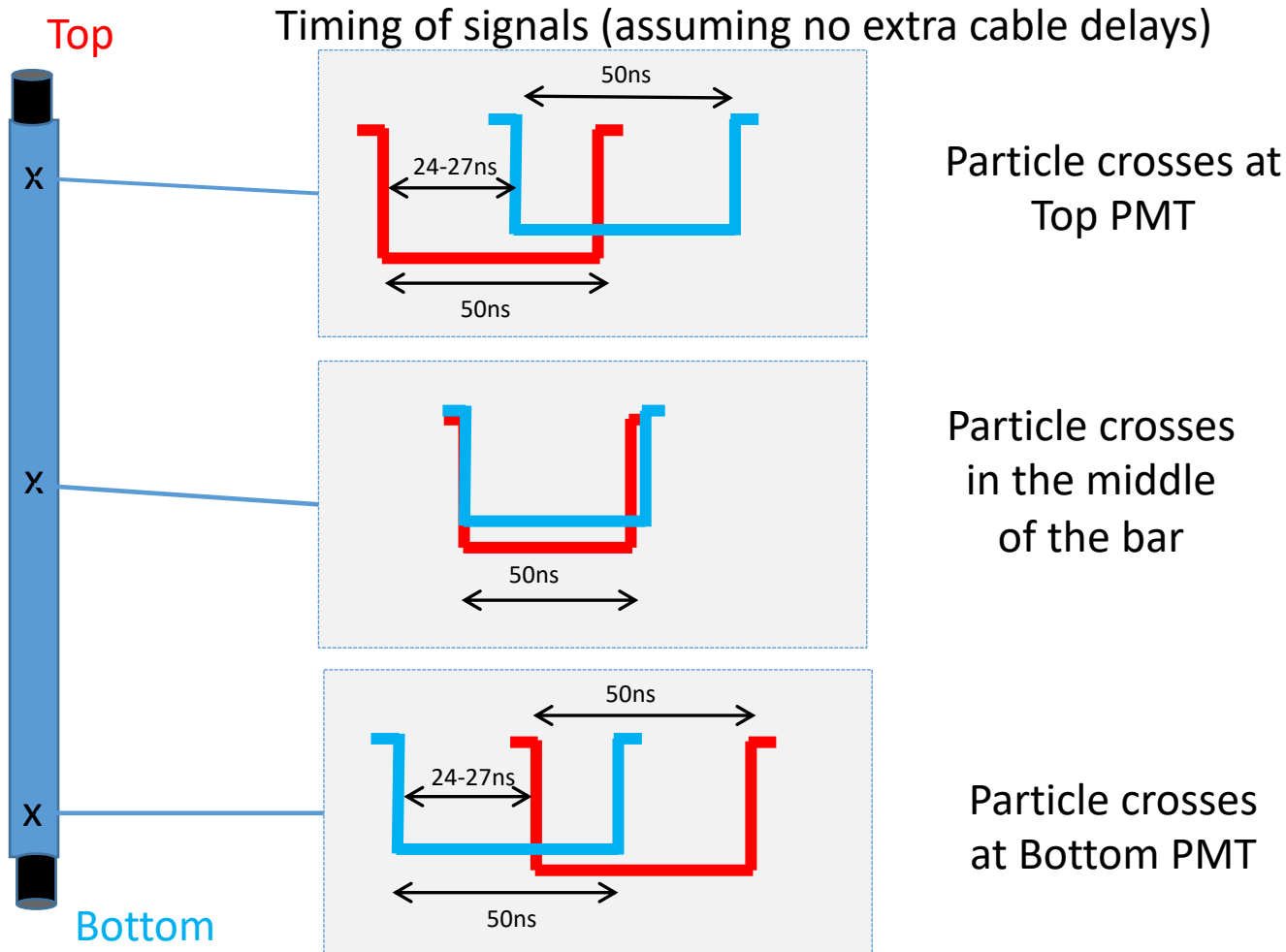
# Next Steps Nov 19, 2024

- Sent logic schema and table to Ben for implementation
- Create HV, FADC, Discriminator mapping table and files (e.g HV file for epics)
- Work on timing measurements for coincidence trigger cables

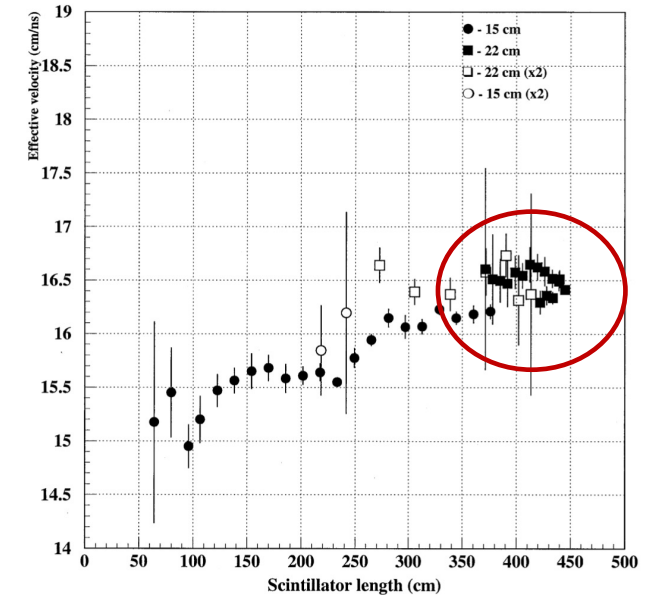
# LAD Trigger Timings

# Bar Coincidence Timing

- Length of bars between 387.5cm and 445.1cm in each panel
- Assuming effective velocity of 16.5 cm/ns  $\rightarrow$  24ns to 27ns difference between signals at PMTs



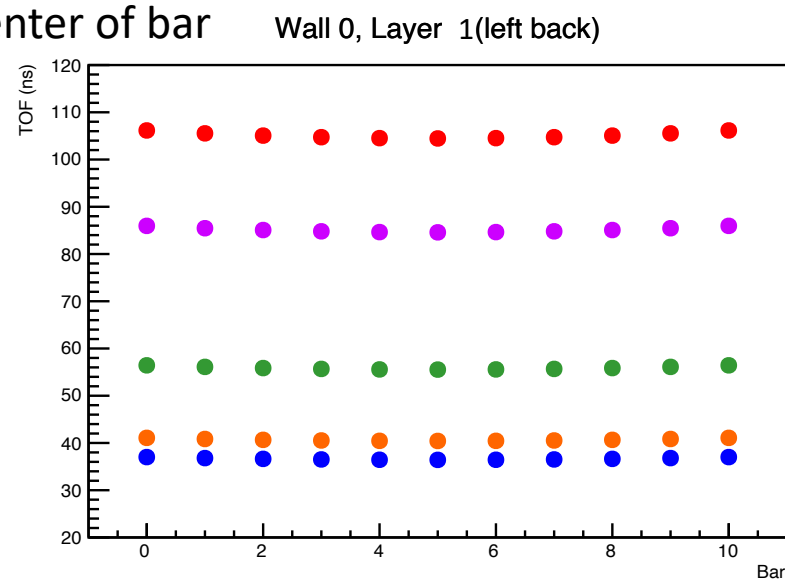
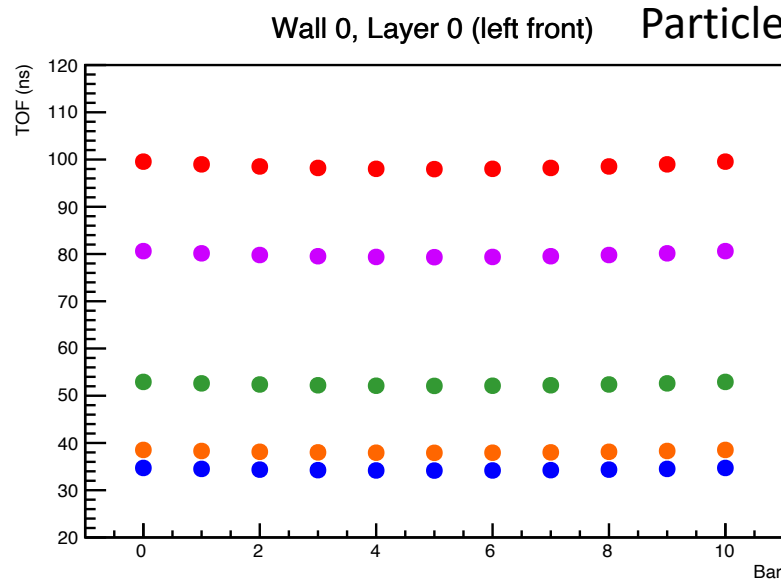
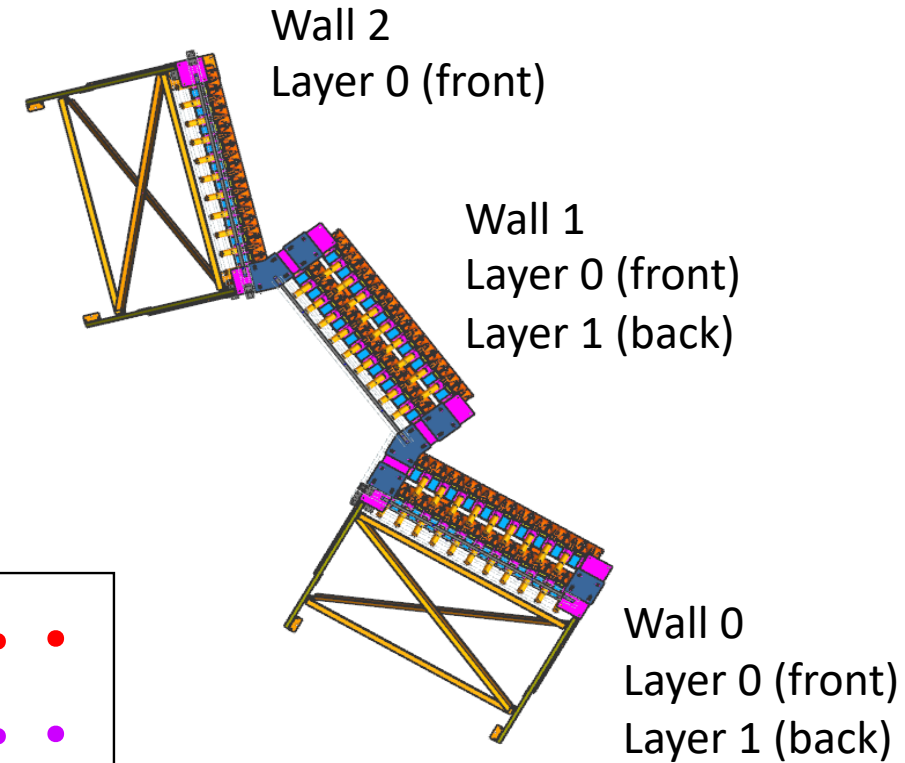
E.S. Smith, NIM A432, 265 (1999)



- Conclusion: Bar coincidence signal within a 30ns window

# Time of Flight for Particles from Target (1)

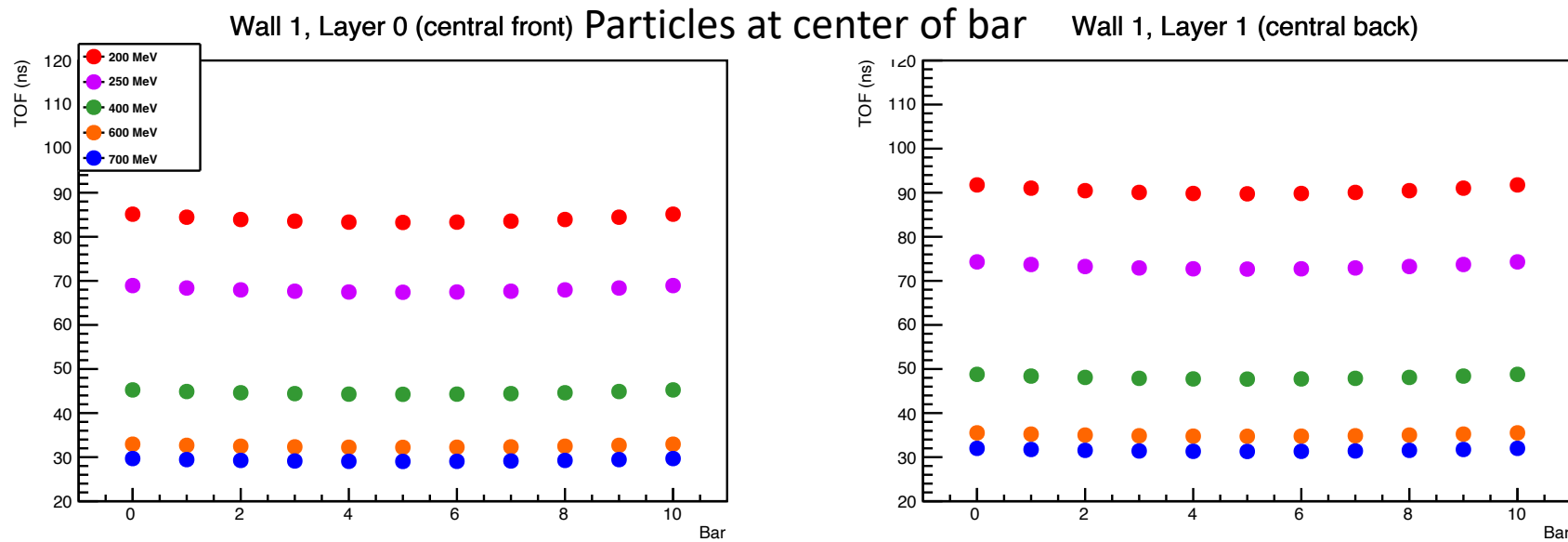
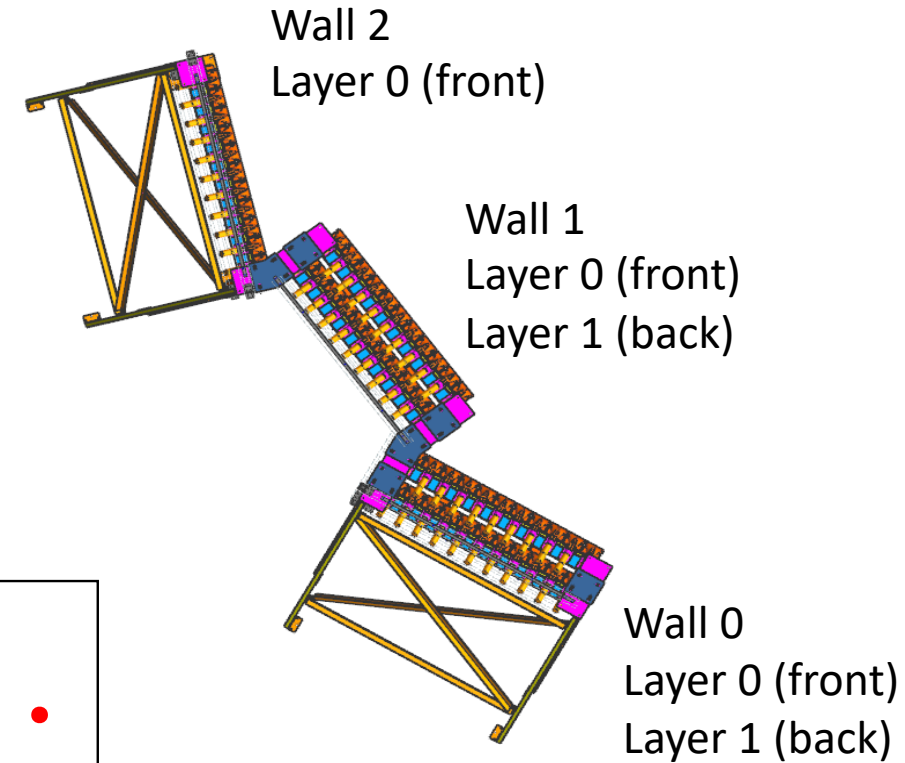
- Wall 2 Layer 0 is symmetric to Wall 0 Layer 0  $\rightarrow$  same ToF from target
- Assume protons from 200MeV/c to 700 MeV/c to be conservative (Note: We expect a higher minimum momentum)



- ToF range from 30ns to 110ns

# Time of Flight for Particles from Target (2)

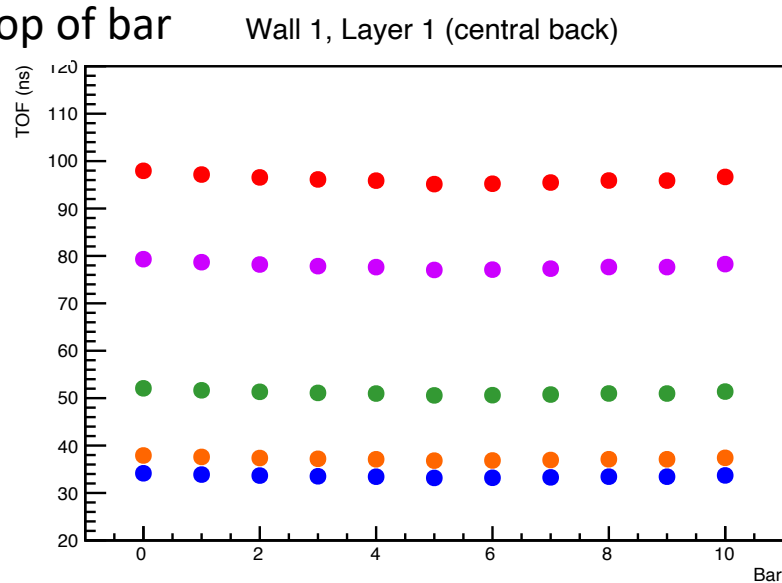
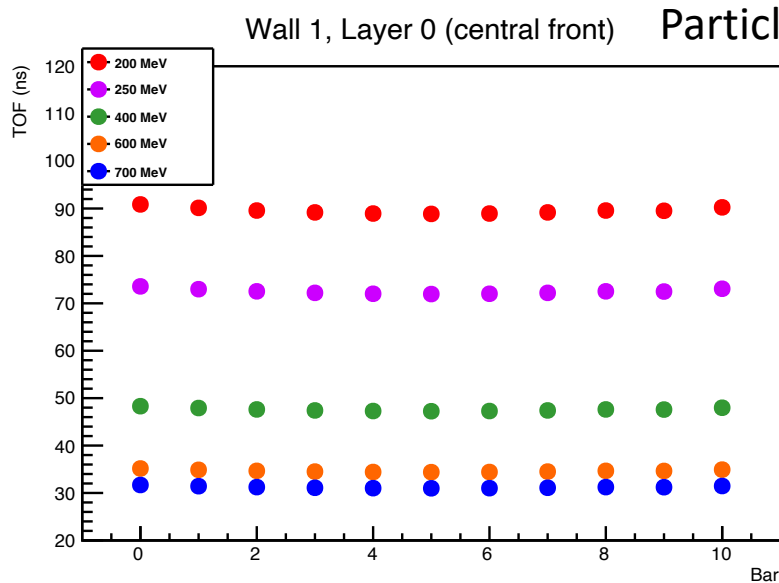
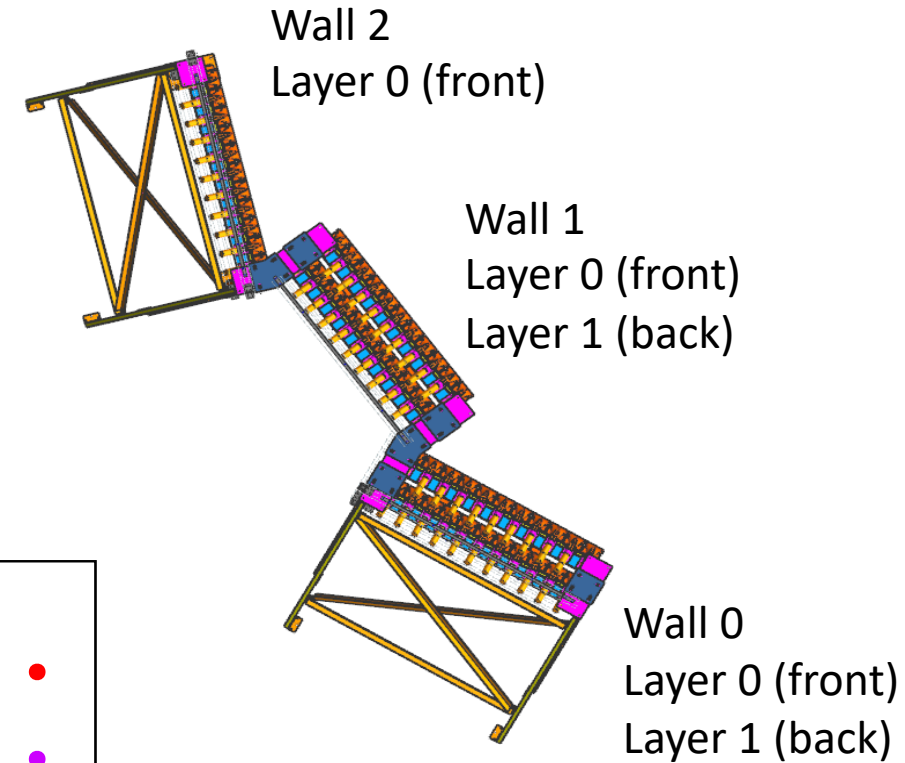
- Wall 2 Layer 0 is symmetric to Wall 0 Layer 0 → same ToF from target
- Assume protons from 200MeV/c to 700 MeV/c to be conservative (Note: We expect a higher minimum momentum)



- ToF range from 26ns to 95ns

# Time of Flight for Particles from Target (3)

- Wall 2 Layer 0 is symmetric to Wall 0 Layer 0 → same ToF from target
- Assume protons from 200MeV/c to 700 MeV/c to be conservative (Note: We expect a higher minimum momentum)



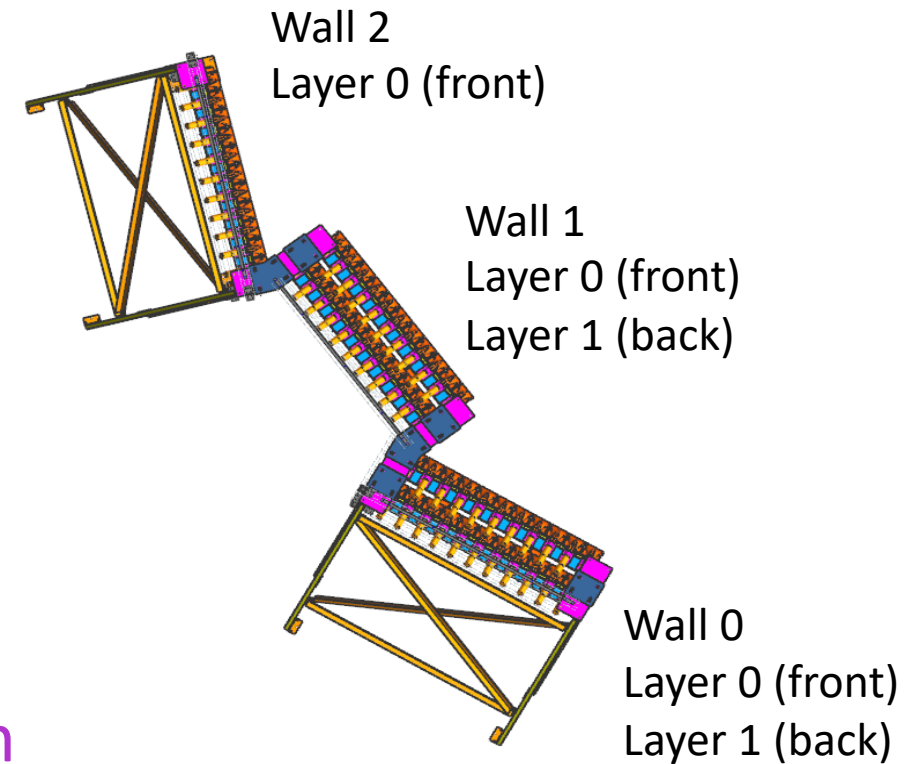
- ToF between 30ns to 100ns
- Not much effect from where it hits (~5ns) since pathlength dominated by distance from target

# Time of Flight for Particles from Target (4)

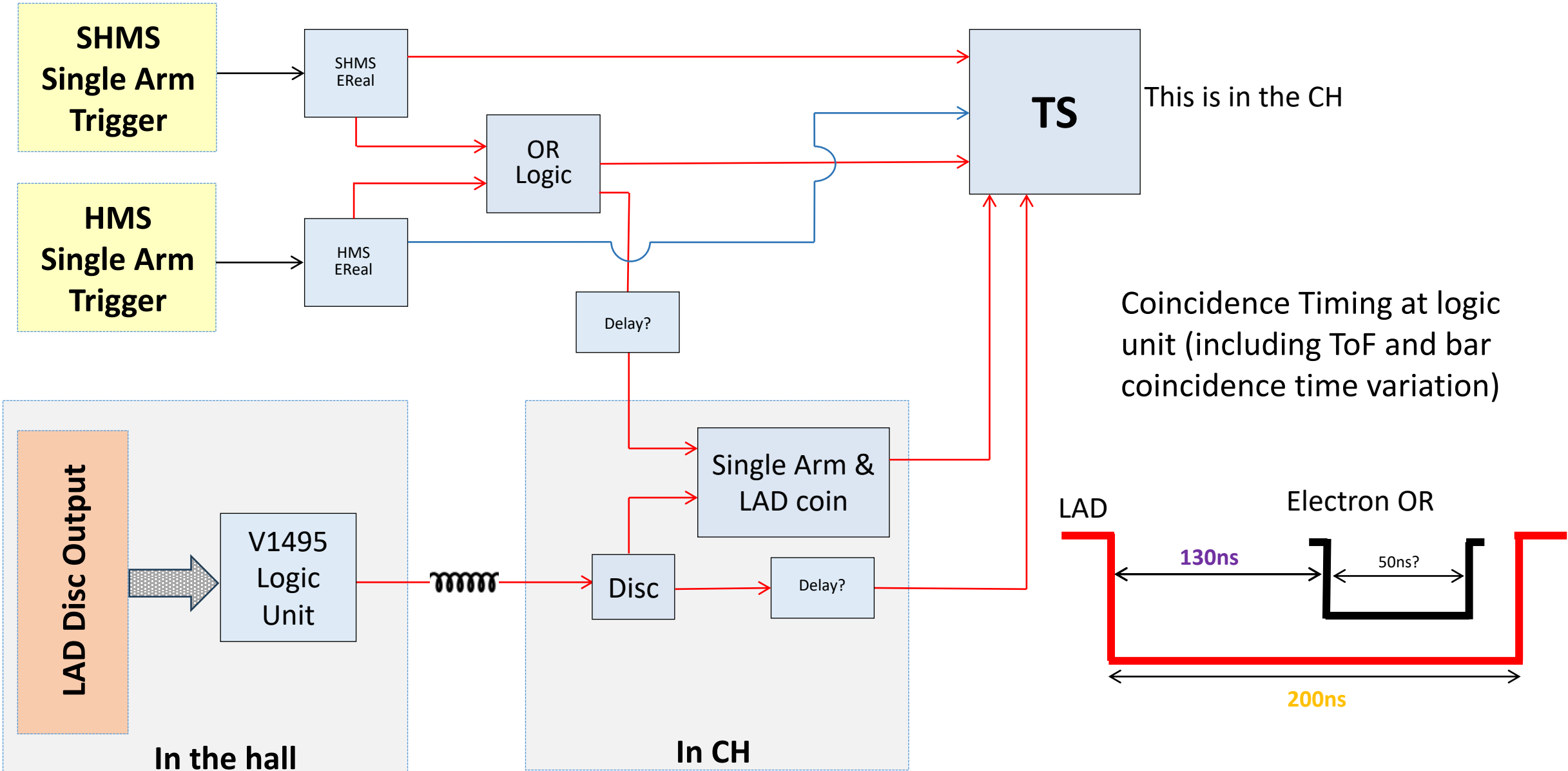
- Wall 2 Layer 0 is symmetric to Wall 0 Layer 0  $\rightarrow$  same ToF from target
- Assume protons from 200MeV/c to 700 MeV/c to be conservative (Note: We expect a higher minimum momentum)
- Minimum ToF of all bars: 25ns
- Maximum ToF of all bars: 115ns

- Conclusion: Have conservative 100ns window from ToF (20 to 120ns)
- Together with bar coincidence variation  $\rightarrow$  130ns

- Might need to check also pion window



# Trigger Setup for coincidence and single arm triggers



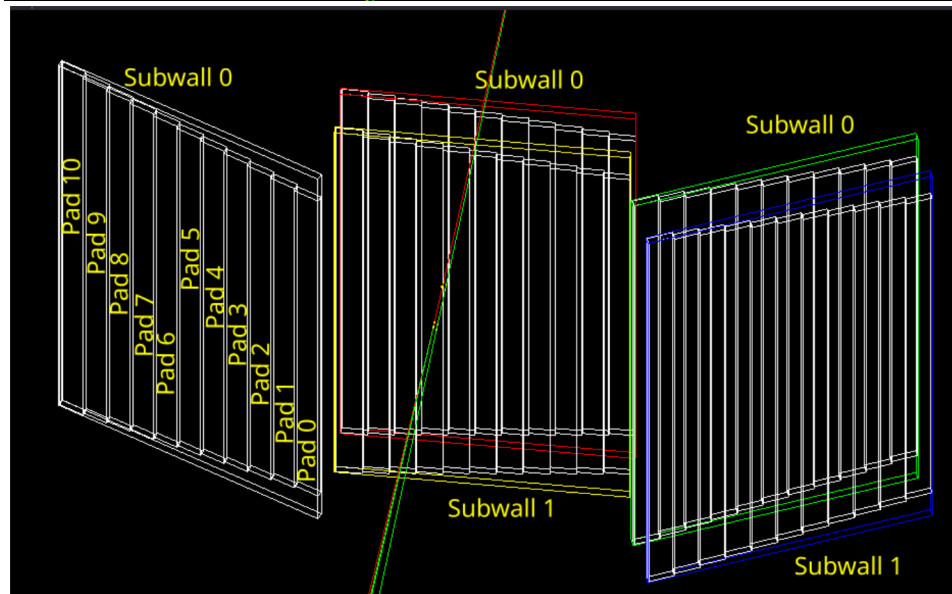
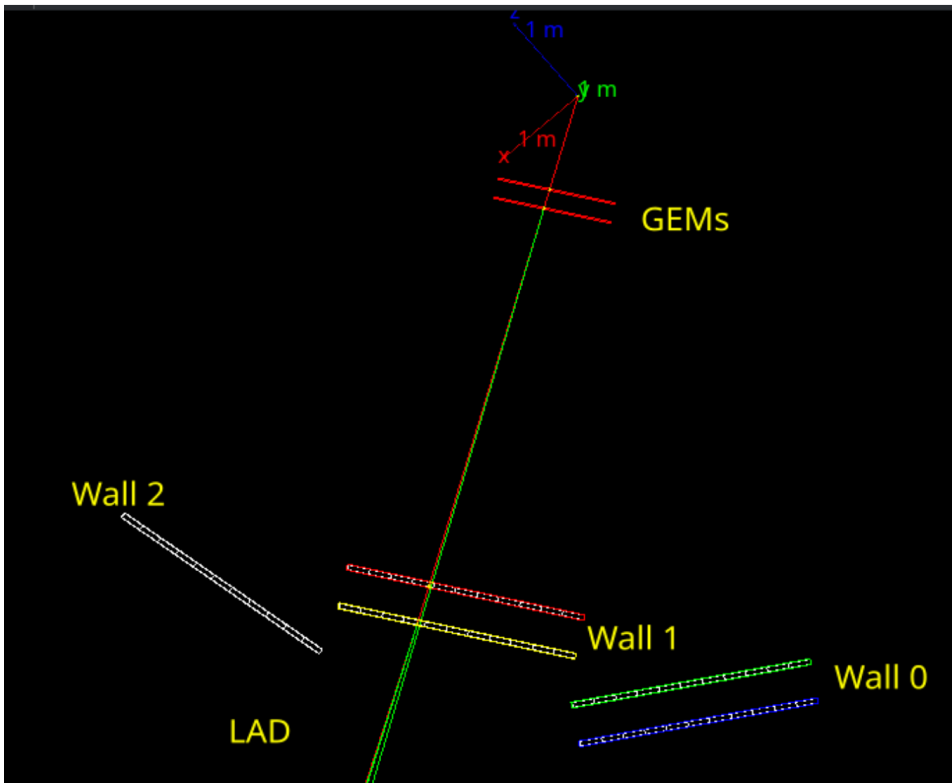
Need to finalize other numbers and cable delays



# Trigger Info and Notes

- Main trigger: OR from both electron single arm triggers
- Supplemental trigger
  - LAD single arm for commissioning, detector checkout
  - Coincidence OR+LAD → might be necessary for absolute timing calibration, diagnostics during experiment if signal is in TDC/Scaler (PS = -1)
- Logic signal from LAD needs to go to counting house to feed TS and coincidence
- Questions:
  - Set timings with EDTM for everything? → Answer yes!
  - Currently, coincidence is timed on electron OR. Is that reasonable? → Answer yes!
  - What are retiming concerns? How does this work with the feedback of the trigger signals into ADCs?  
Answer: Each crate has some reference signal so a subtraction can be made in software via settings file

Old Stuff



# LAD Labeling (to be finalized)

- Four digit numbers for each bar
  - First Number = Wall (0,1,2)
  - Second Number = Layer (0,1)
  - Third and Fourth number = Bar in layer (0-10)
- For every PMT the label is extended by U/T and D/B corresponding to top or bottom PMT

$$\text{Label} = W L XX U/T D/B$$