

# Hypernuclear DAQ

Alexandre Camsonne, Hanjie Liu, Chandan Gosh

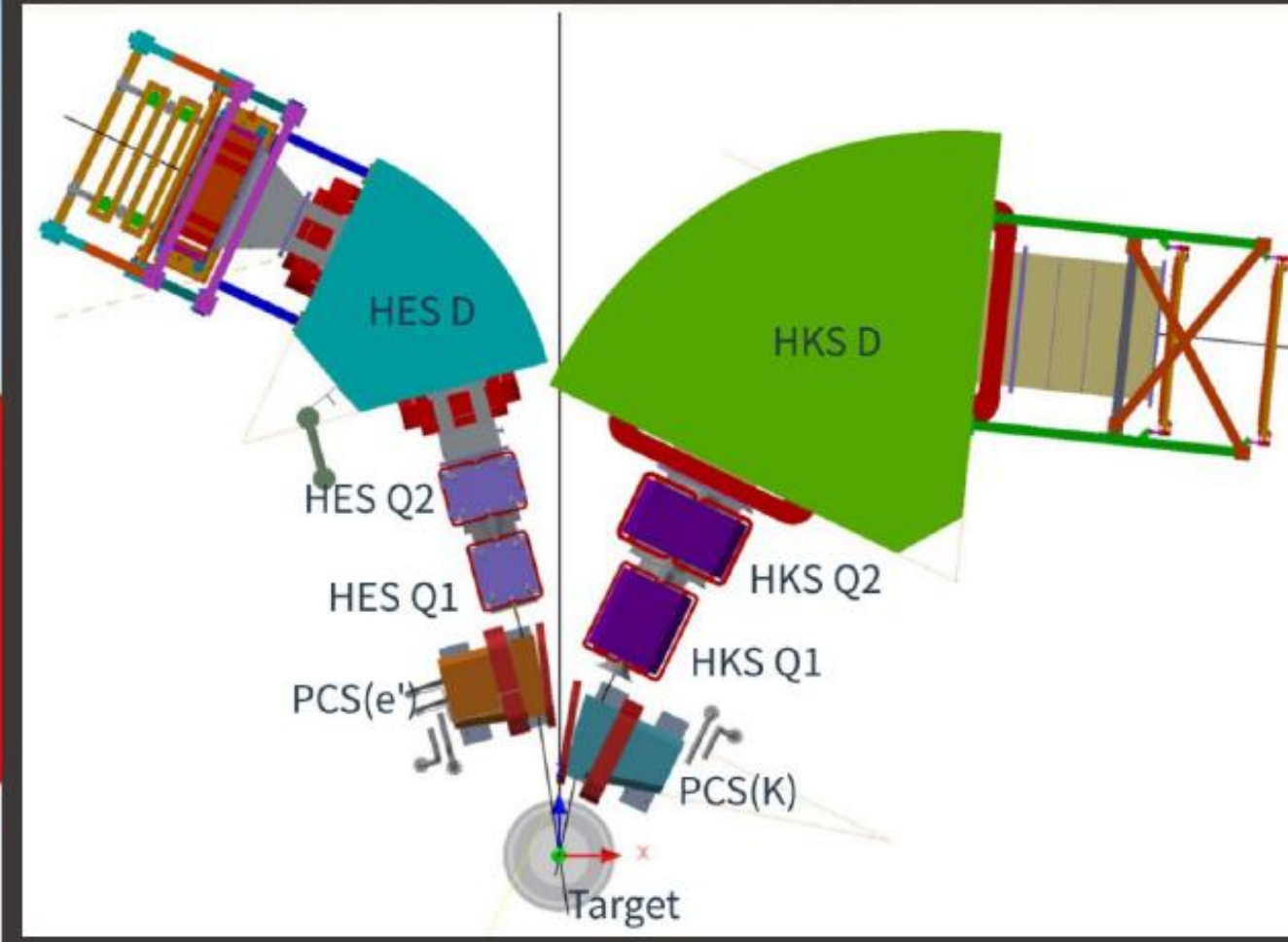
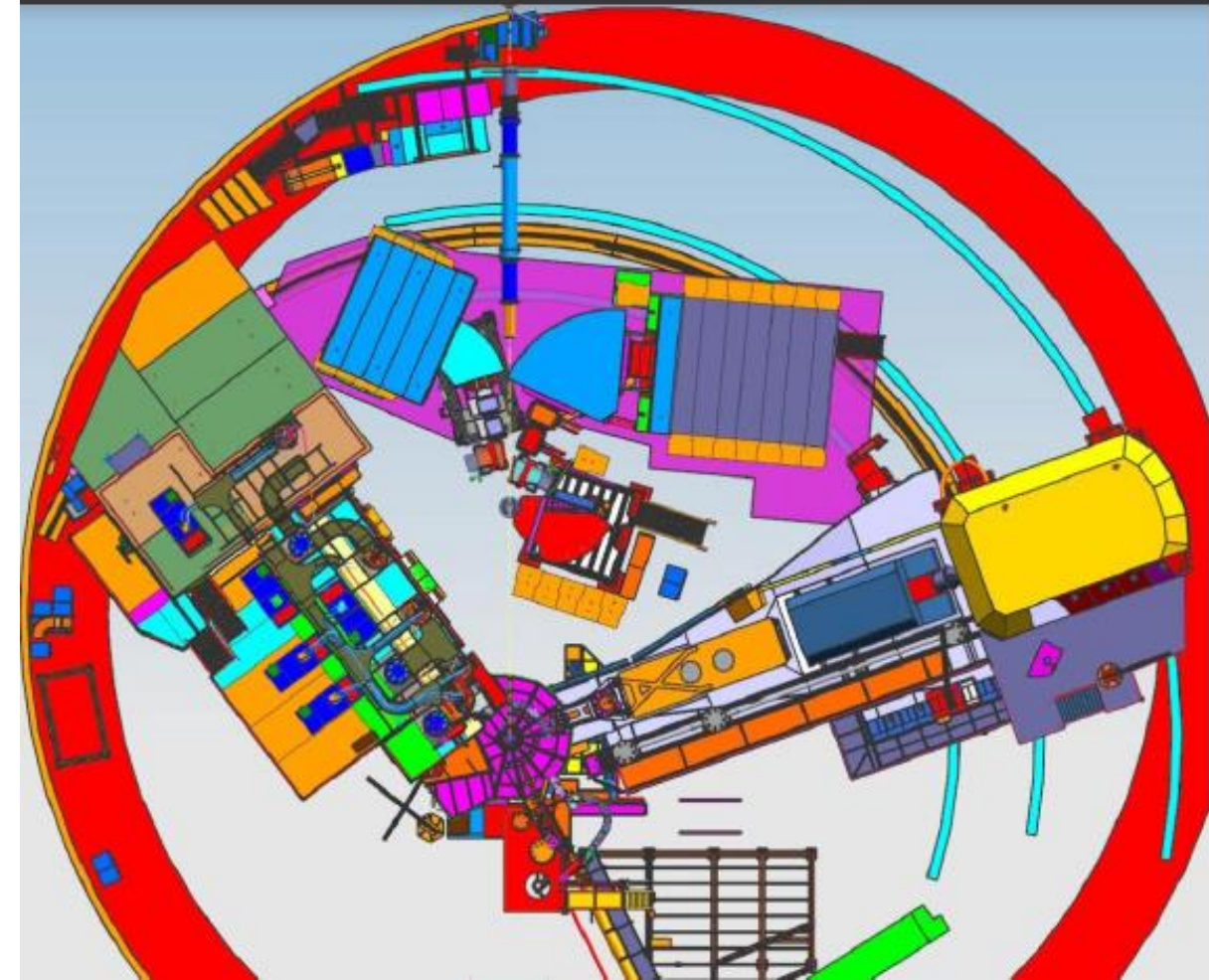
ERR preparation meeting

March 22<sup>nd</sup> 2024

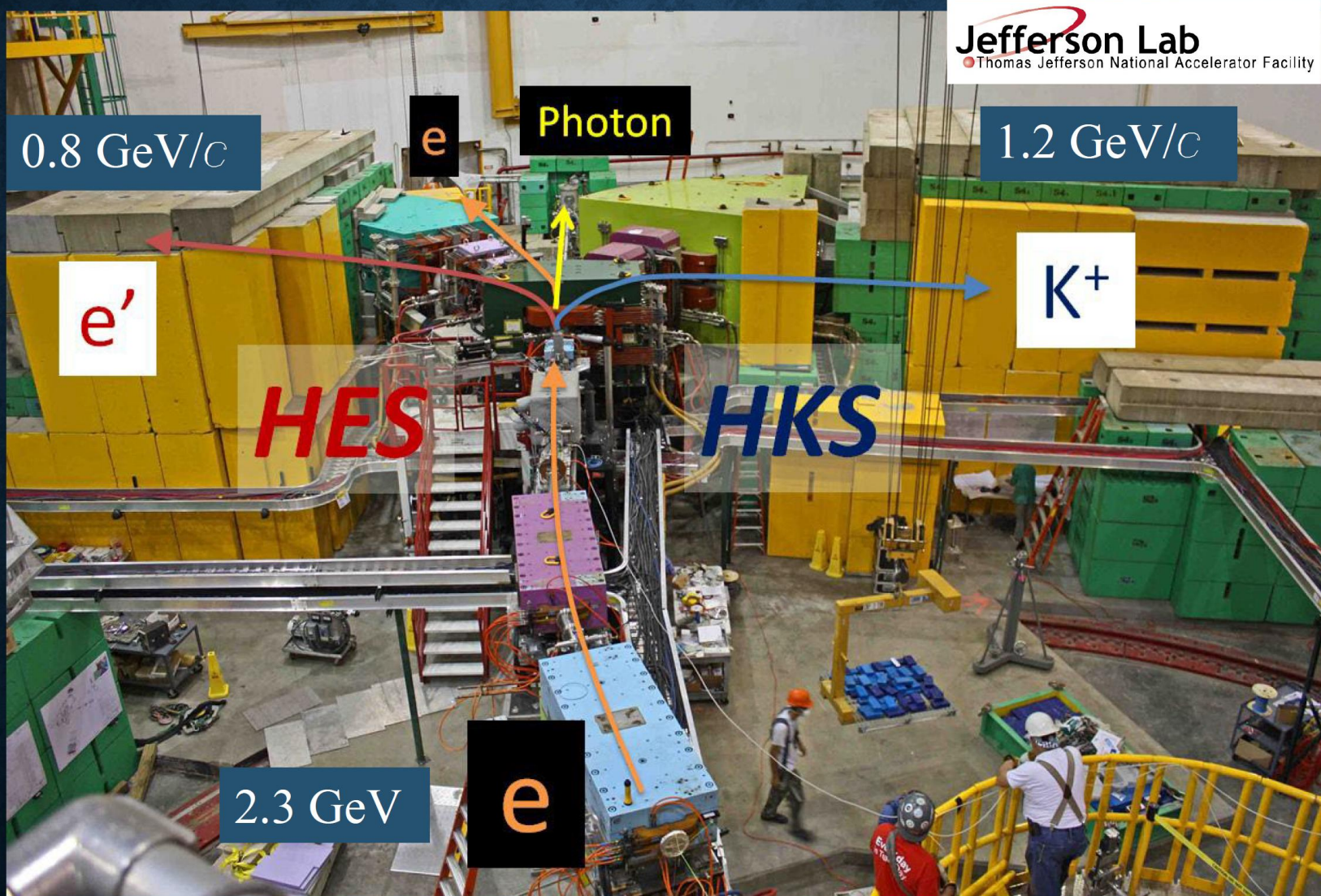
# Outline

- Experiment overview
- Channel count
- Overview pipelined electronics
- Trigger overview
- To do
- Conclusion

# Experimental setup at Hall C



# Experimental setup for E05-115 (2009) at JLab Hall C



# PARTICLE DETECTORS

HES

$e^-$



TOF walls  
(Plastic scintillators)

Cherenkov detectors

- Aerogel ( $n=1.05$ )
- Water ( $n=1.33$ )

Drift chambers

$K^+$   
 $p, \pi^+$

HKS



# Channel count

|            | Detector          | Current status               | No. of channels |           | Ready? |
|------------|-------------------|------------------------------|-----------------|-----------|--------|
|            |                   |                              | ADC             | TDC       |        |
| <b>HKS</b> | Drift Chambers    | To be tested                 | N/A             | 360 + 360 | Yes    |
|            | TOF counters      | All PMTs were checked        | 88              | 88        |        |
|            | Aerogel Cherenkov | Test done                    | 42              | 42        |        |
|            | Water Cherenkov   | New boxes under construction | 48              | 48        |        |
| <b>HES</b> | Drift Chambers    | To be tested                 | N/A             | 1098+360  |        |
|            | TOF counters      | To be tested                 | 116             | 116       |        |

# Channel count

|            | Detector          | Current status               | No. of channels |           | Ready? |
|------------|-------------------|------------------------------|-----------------|-----------|--------|
|            |                   |                              | ADC             | TDC       |        |
| <b>HKS</b> | Drift Chambers    | To be tested                 | N/A             | 360 + 360 | Yes    |
|            | TOF counters      | All PMTs were checked        | 88              | 88        |        |
|            | Aerogel Cherenkov | Test done                    | 42              | 42        |        |
|            | Water Cherenkov   | New boxes under construction | 48              | 48        |        |
| <b>HES</b> | Drift Chambers    | To be tested                 | N/A             | 1098+360  |        |
|            | TOF counters      | To be tested                 | 116             | 116       |        |

FADC =  $88 + 42 + 48 + 116 = 294$  channels = 19 FADCs = 2 VXS crates (NPS)

V1190 = 2268 channels = 18 V1190 = 1 VME64X crate (HMS/SHMS/SBS could use CDET VETROC)

TOF = 204 channels = 7 V1290 = 8 F1 = 3 VETROC (SBS GRINCH)

Will be running during Moller : NPS,SBS,SoLID hardware available, most likely enough FADCs

Can use HMS/SHMS electronics

BPM rasters : 2 FADC

VETROC and FADCs ordered for SoLID

# Trigger rates

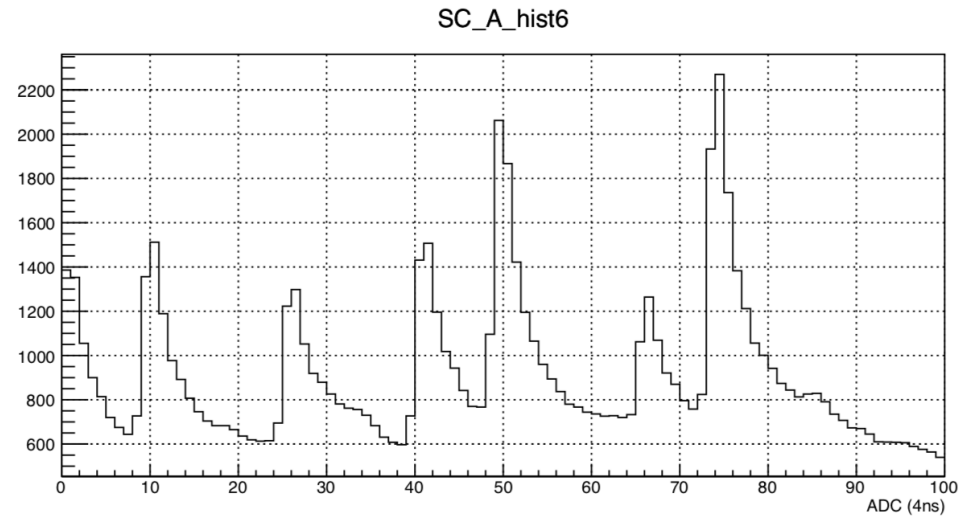
| Target            | Areal density<br>[/(g/cm <sup>2</sup> )] | Beam intensity<br>(/ μA) | HES rate<br>(/kHz) | HKS rate (/kHz) |                |    | Accidental coincidence <sup>(*)</sup><br>(/kHz) |
|-------------------|--|--------------------------|--------------------|-----------------|----------------|----|---|
|                   |  |                          | e'                 | π <sup>+</sup>  | K <sup>+</sup> | p  |   |
| <sup>6</sup> Li   | 100                                      | 50                       | 120                | 22              | 0.27           | 28 | <b>1.0</b>                                      |
| <sup>9</sup> Be   |  |                          | 140                | 21              | 0.26           | 27 | <b>1.8</b>                                      |
| <sup>11</sup> B   |  |                          | 170                | 21              | 0.25           | 26 | <b>2.1</b>                                      |
| <sup>27</sup> Al  |  |                          | 930                | 20              | 0.24           | 25 | <b>10.5</b>                                     |
| <sup>40</sup> Ca  | 150                                      | 20                       | 1100               | 26              | 0.31           | 33 | <b>14.8</b>                                     |
| <sup>48</sup> Ca  |  |                          | 940                | 25              | 0.31           | 32 | <b>13.8</b>                                     |
| <sup>208</sup> Pb |  |                          | 1300               | 8.2             | 0.24           | 10 | <b>4.9</b>                                      |

(\*) Assuming,  
HES: 30 ns width  
HKS: 200 ns width



# Data rates

- Rough estimates
  - HKS = 1 MHz
  - HES = 1 MHz
  - Coincidence =  $1\text{ MHz} \times 1\text{ MHz} \times 20\text{ ns} = 2\text{ KHz}$
- Plan for up to 20 KHz desirable
- If no waveform could take 200 KHz
- Using CODA3 and event blocking should be doable ( similar to CLAS12) will be tested during NPS
- Need to evaluate detector occupancies
- If useful can record full FADC waveforms



Example scintillator SoLID beam test

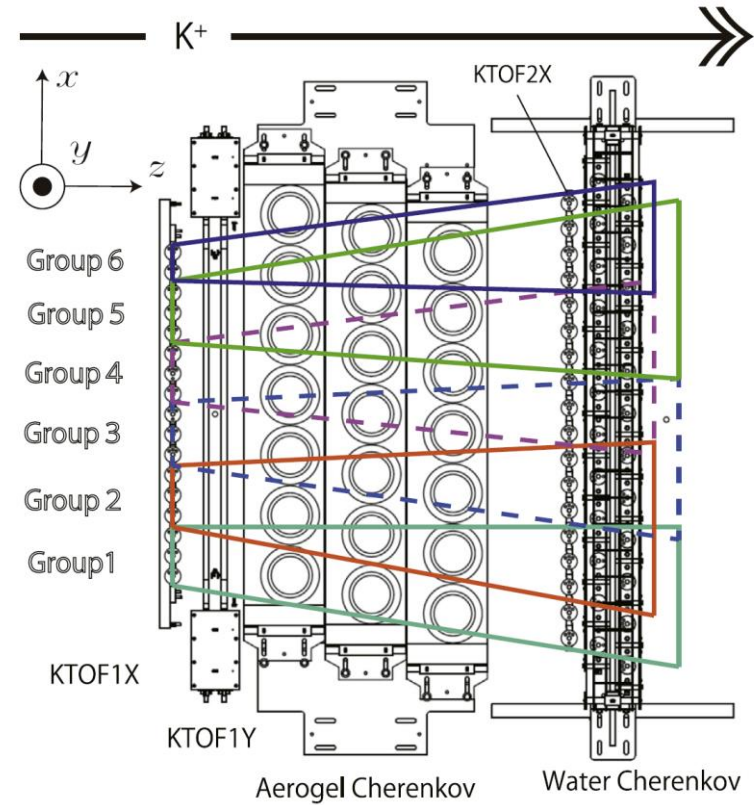
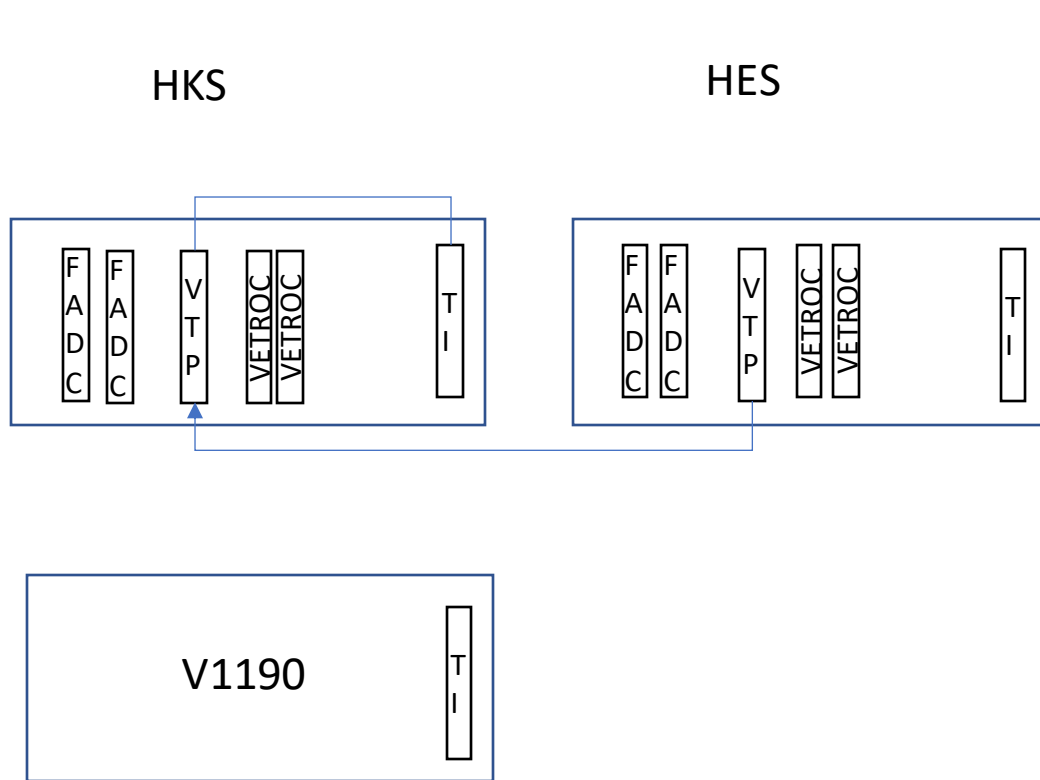
# Data rates with full sampling

- Event size
  - 57 kB with 40 samples 100 % occupancy
- Max trigger rate : 15 KHz
- Data rate : 860 MB/s
- Tape : 12 PB

# Data rates with time / integral

- Event size
  - 13 kB with time and amplitude 100 % occupancy
- Max trigger rate : 15 KHz
- Data rate : 190 MB/s
- Can be handled now
- Tape : 2.6 PB

# Trigger



Can program VTP for coincidences between scintillators  
If use VETROC instead of V1190 could add Drift Chamber to trigger

# Additional electronics

- Beamline info
  - Target BPM
  - Raster
  - 1C12 BPM cabling

# To do / Testing

- Bench testing and testing with detector VETROC
- Setup FADC trigger with VTP
- Setup testing in ESB

# MRPC

- MRPC
  - 12 modules ( 3 planes x 4 ) to cover HKS, HES, ENGE
  - Hope to get 50 ps timing resolution – On bench 25 ps reached
  - 256 channels per module = 3048 channels of high resolution TDC
  - Default : use SBS NINO and VETROC from CDET ( 20 ps )
  - Other readout but need to procure ( few modules to test now )
    - PicoTDC
    - NALU ASOC or AARDVARC

# Labor

- Hanjie Liu ( DAQ, VTP Trigger )
- William Henry
- Chandan Gosh
- Sangwha Park ( Software, MRPC )
- Alexandre Camsonne
- Toshiyuki Gogami
- Ben Raydo (VTP
- Burcu Duran (MRPC)



# Conclusion

- HKS and HES
  - FADC =  $88 + 42 + 48 + 116 = 294$  channels = 19 FADCs = 2 VXS crates
  - V1190 = 2268 channels = 18 V1190 = 1 VME64X crate
  - TOF = 204 channels = 7 V1290 = 8 F1 = 3 VETROC
  - Could use HMS/NPS/SBS hardware
- CODA3 with event blocking should allow 20 kHz trigger rate ( 200 KHz with time and amplitude )
- Digital trigger using FADC and VTP
- If use VETROC instead of V1190 can include in L1 trigger ( High res TOF and Drift Chamber )

Backup



