

# Hypernuclear DAQ

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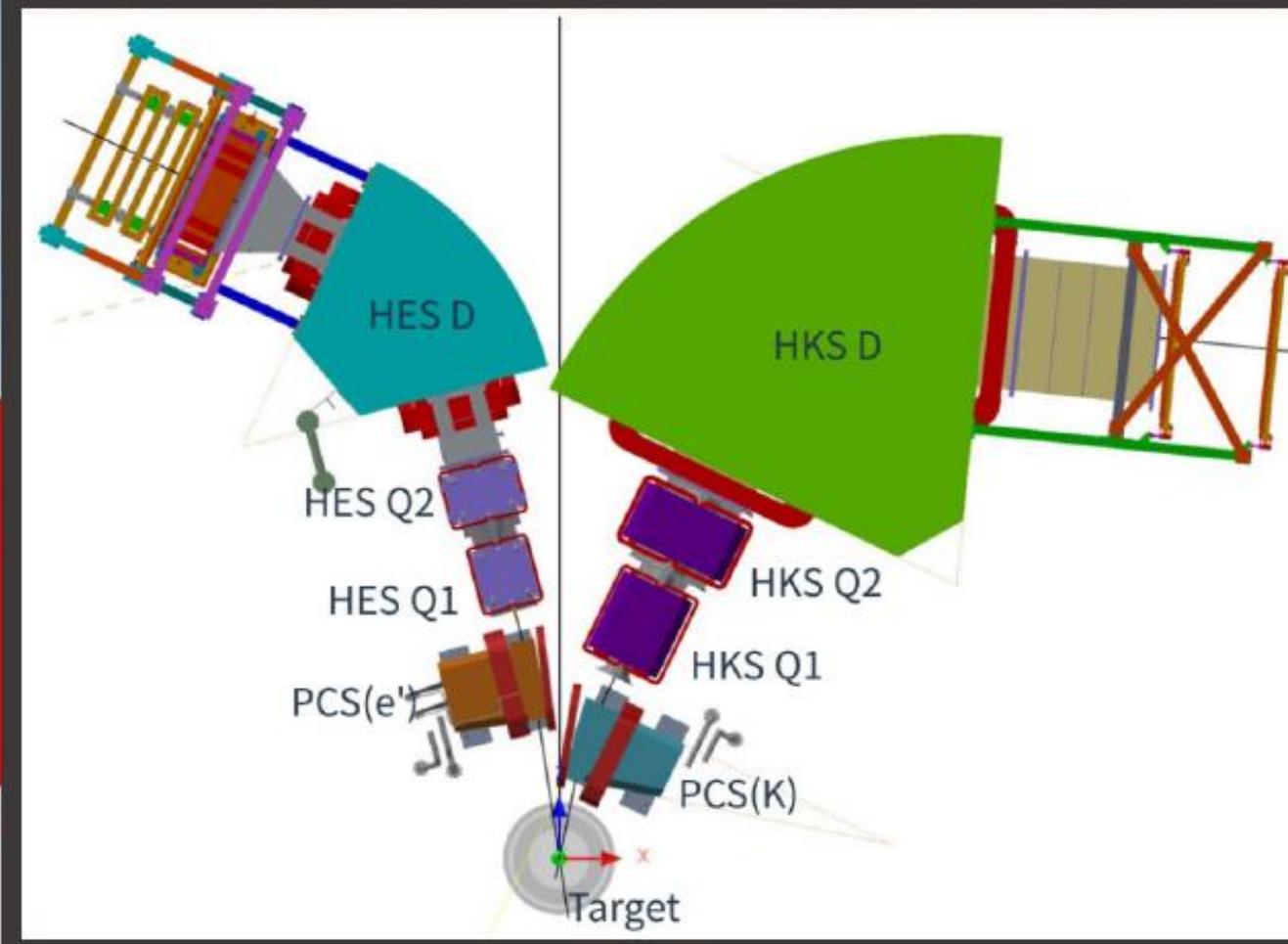
Toshiyuki Gogami

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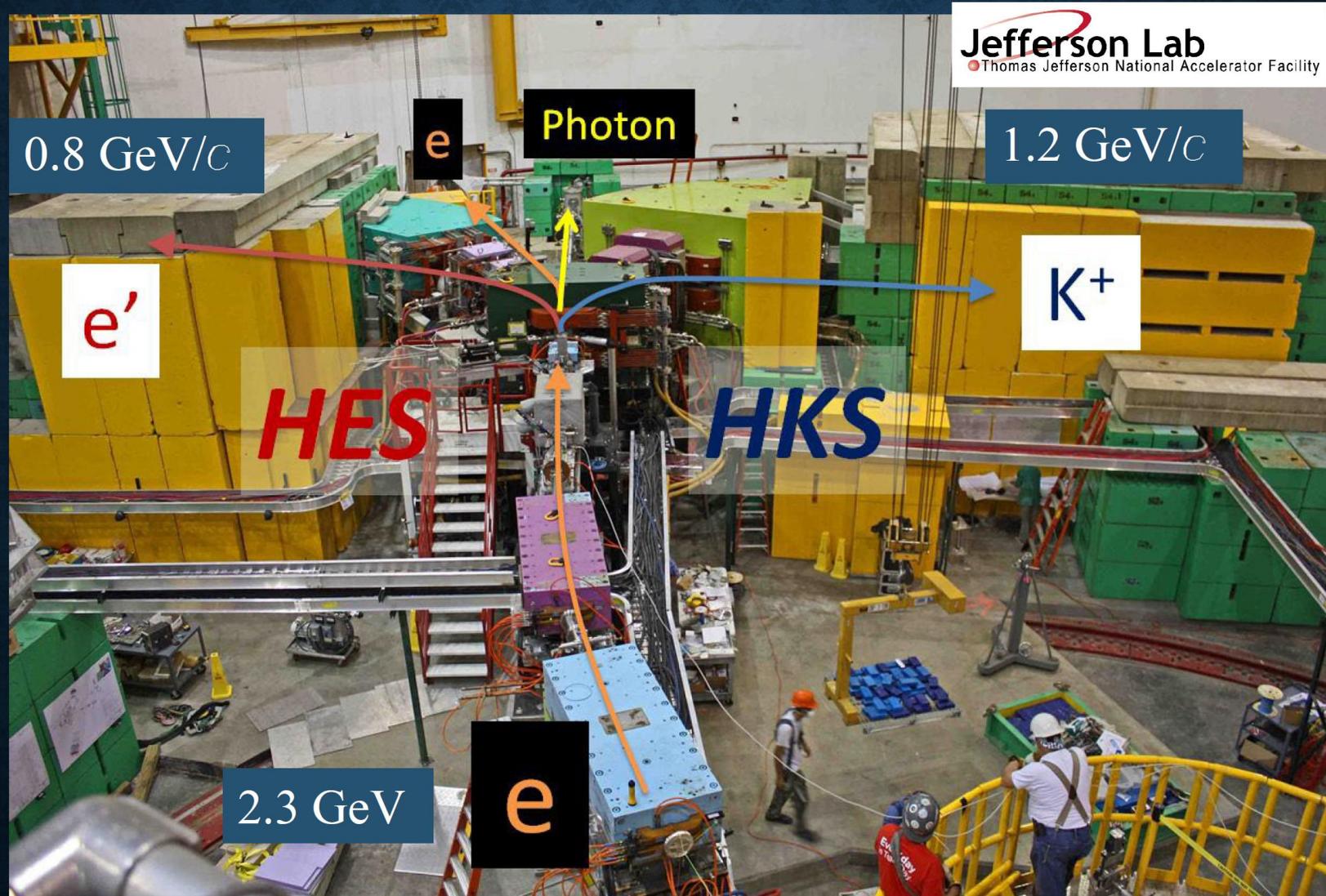
# Outline

- Experiment overview
- Channel count
- Trigger overview
- To do
- Conclusion

# Experimental setup at Hall C



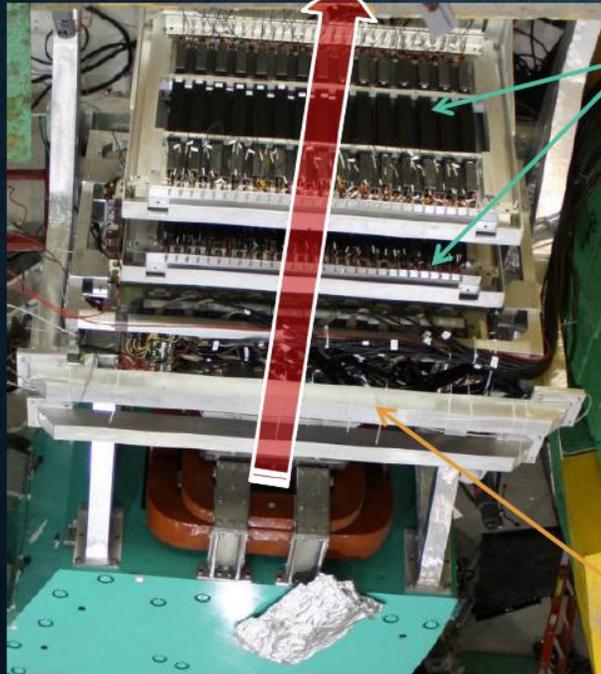
# Experimental setup for E05-115 (2009) at JLab Hall C



# PARTICLE DETECTORS

HES

$e^-$



TOF walls  
(Plastic scintillators)

Cherenkov detectors  
• Aerogel ( $n=1.05$ )  
• Water ( $n=1.33$ )

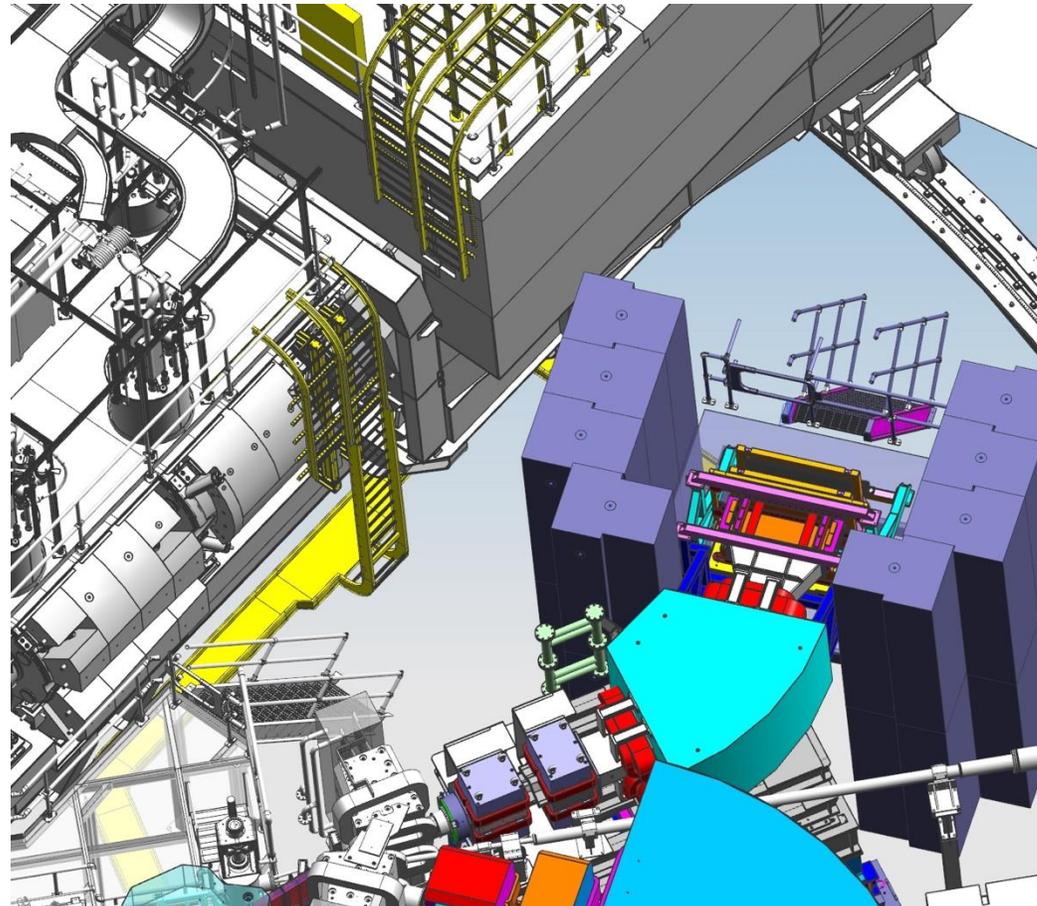
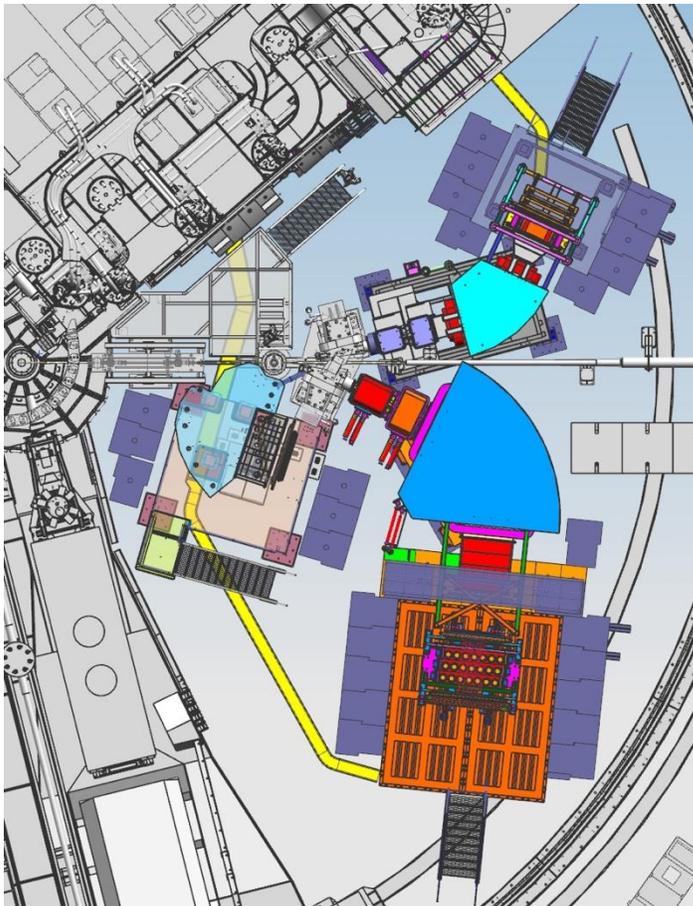
Drift chambers

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

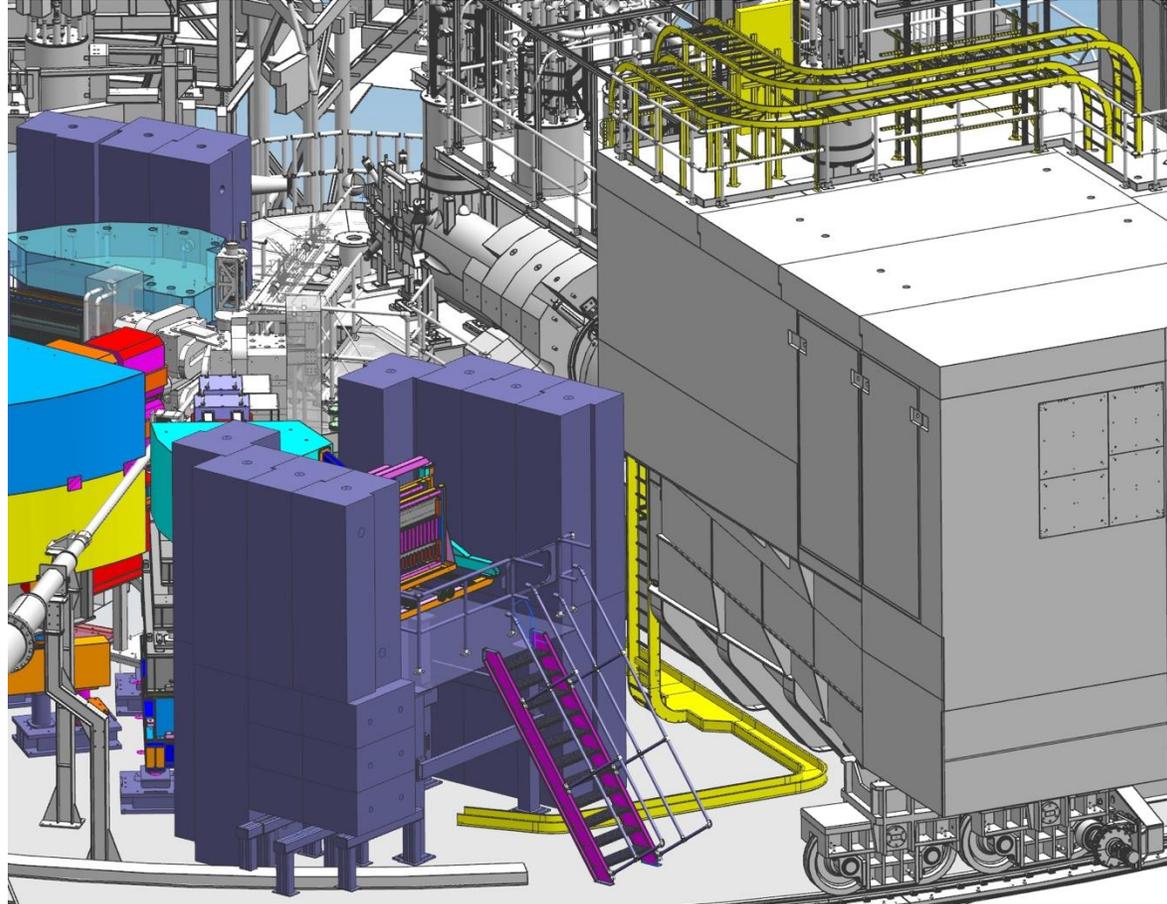
HKS



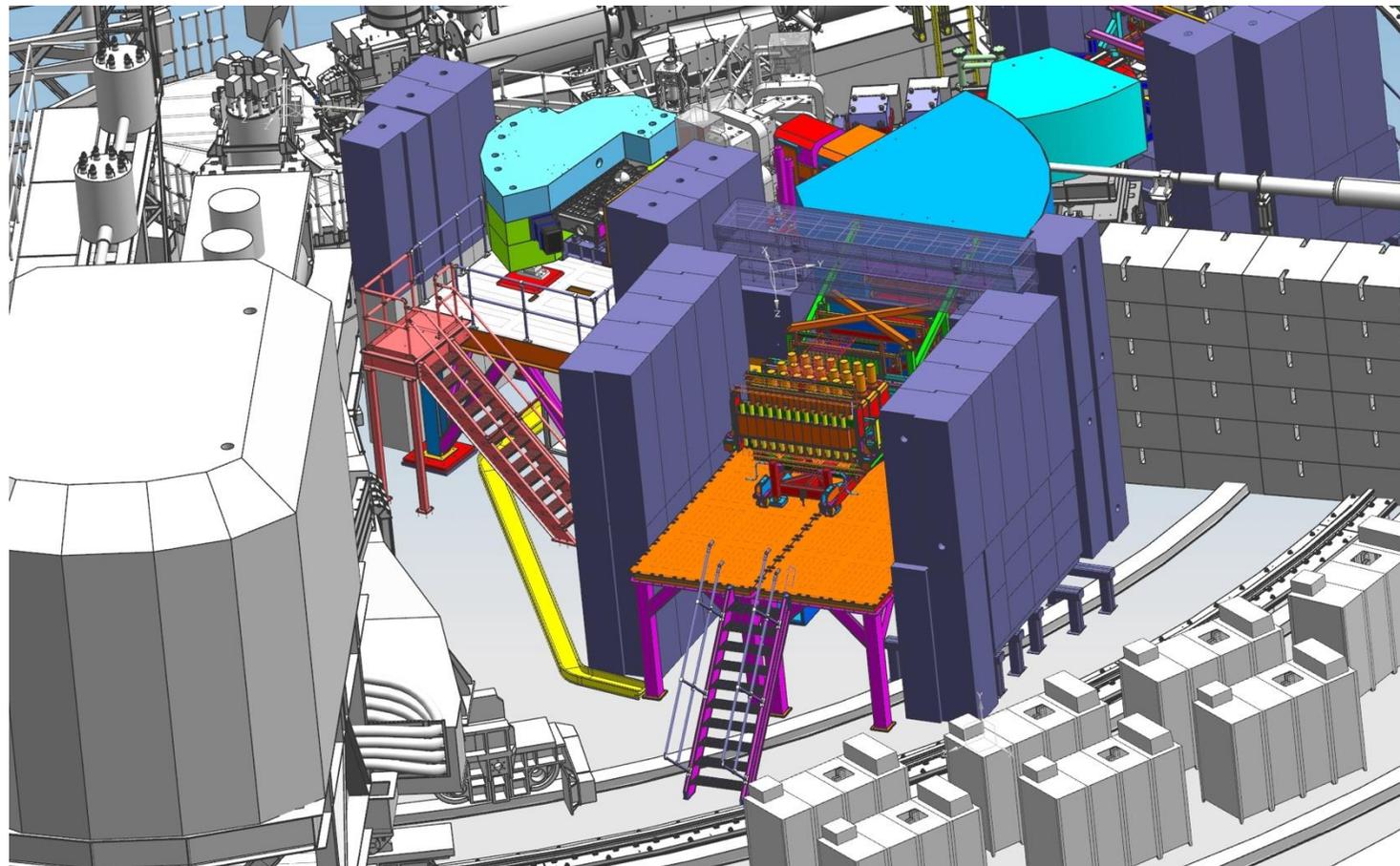
# Cable layout



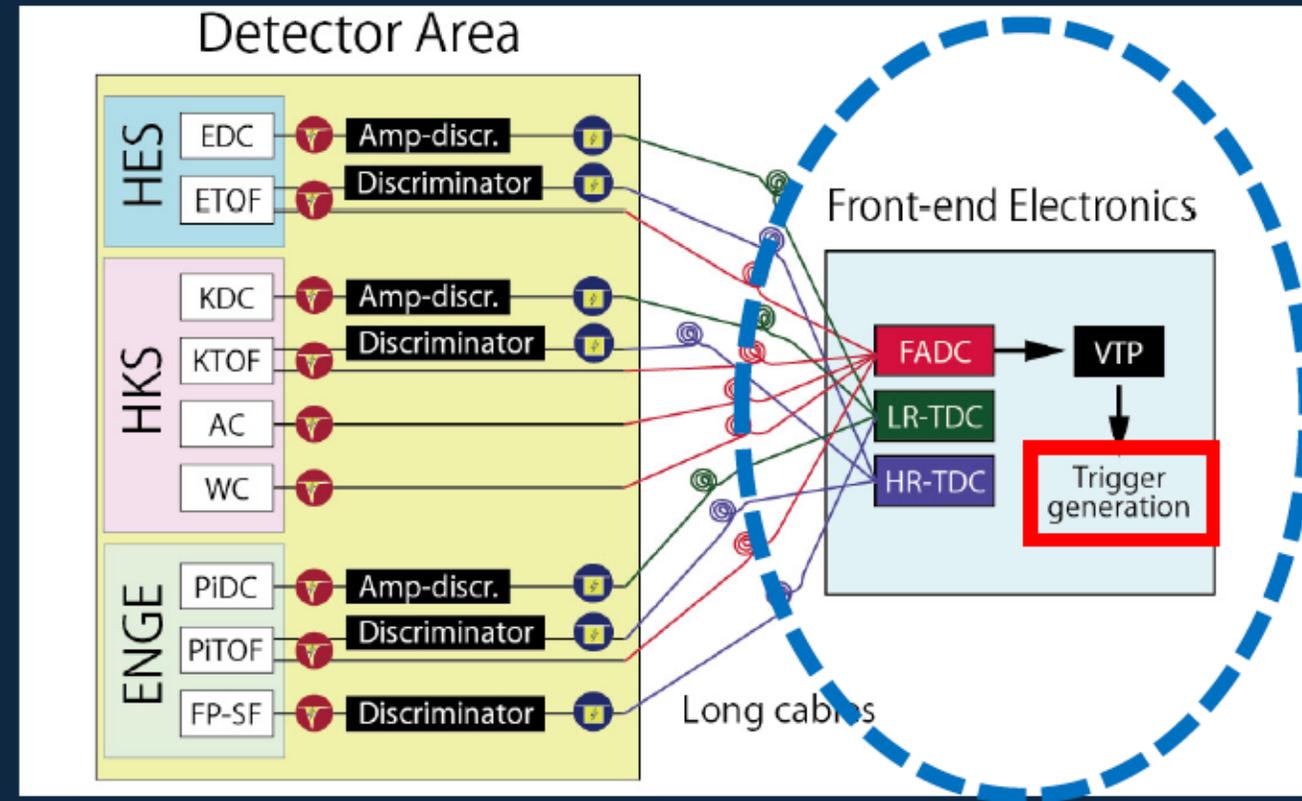
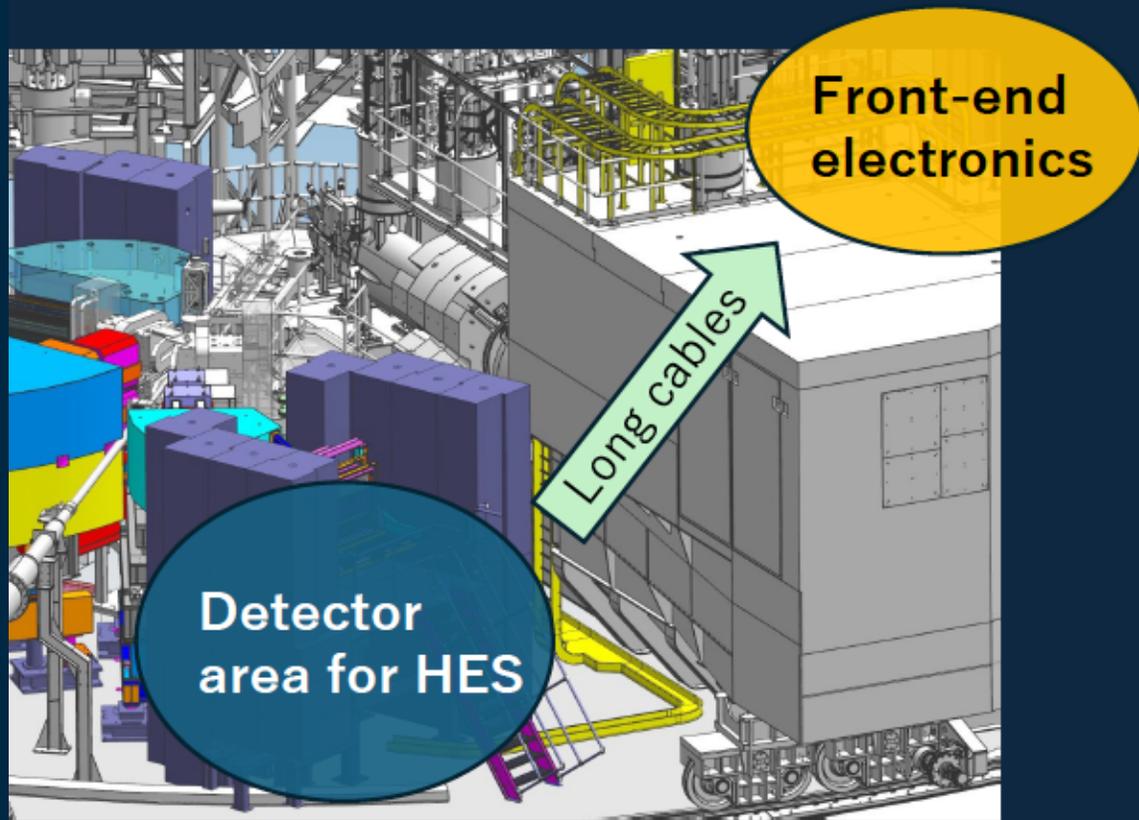
# Cable layout



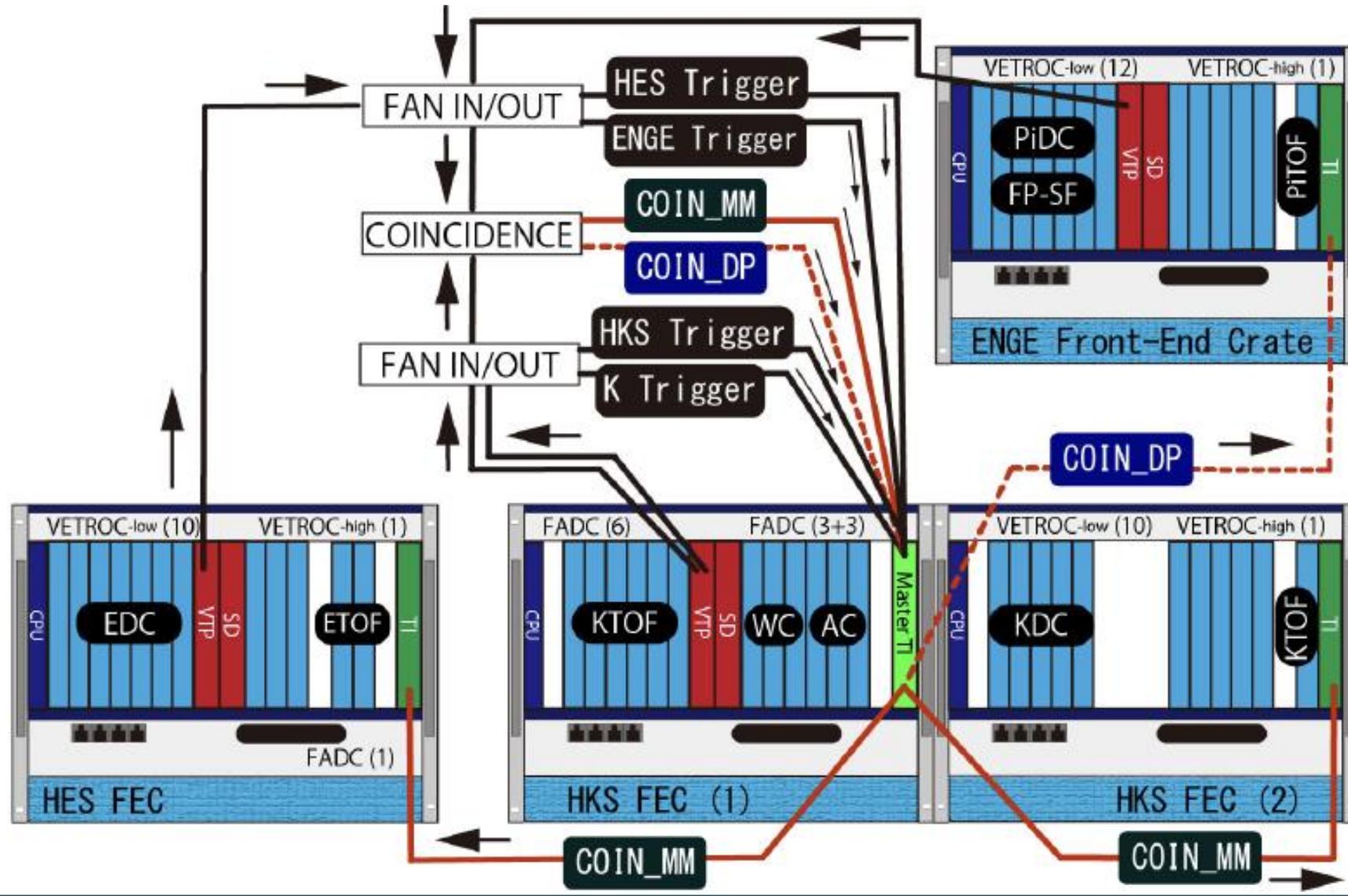
# Cable layout



# Discriminators are near by the detectors



# Crates for HKS

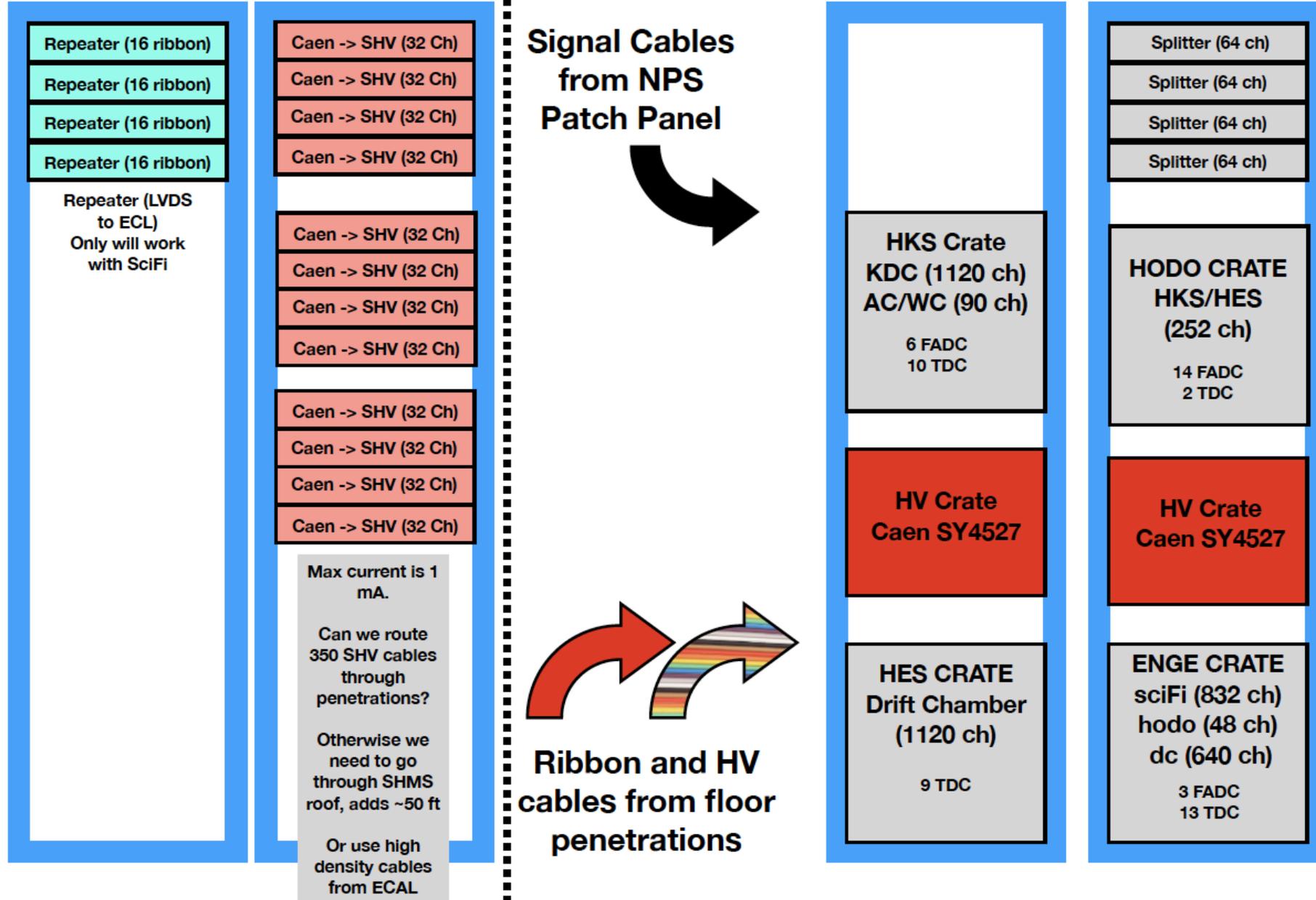


# Channel count

	Detector	FADC	Low Resolution TDC	High Resolution TDC	TDC 1190	VETROC	FADC F250
<b>HKS</b>	KDC		1280		10		
	TOF	88		88		1	6
	AC	42					3
	WC	48					3
<b>HES</b>	EDC		1120		9		
	TOF	116		116		1	8
<b>ENGE</b>	PDC		640		5		
	TOF	48		48		1	3
	SciFi		832		7		
<b>Total</b>					<b>31</b>	<b>3</b>	<b>23</b>

# On Hall Floor

# SHMS HUT



# Trigger rates

Target	Areal density [/(g/cm <sup>2</sup> )]	Beam intensity (/ μA)	HES rate (/kHz)	HKS rate (/kHz)			Accidental coincidence <sup>(*)</sup> (/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>

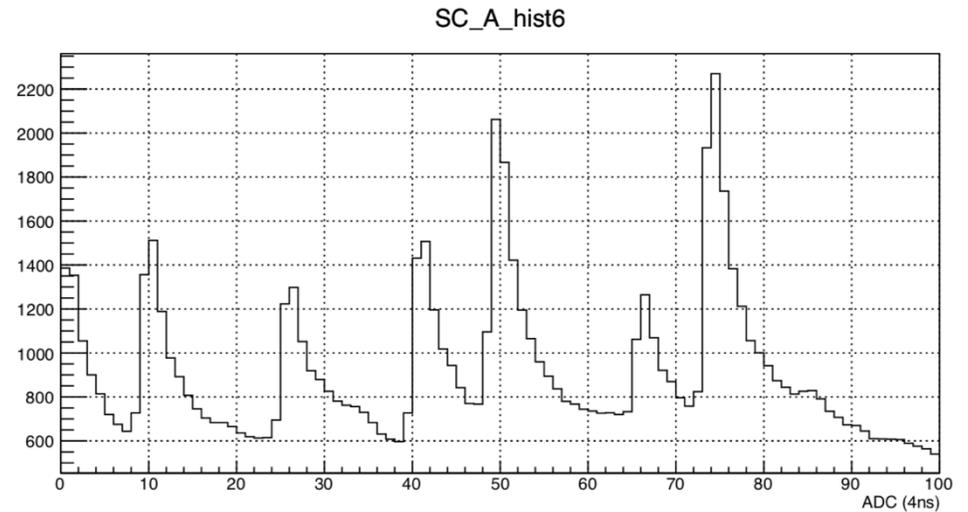
(\*) Assuming,  
HES: 30 ns width  
HKS: 200 ns width

# Updated rates from simulation

Target [thickness / (mg/cm <sup>2</sup> )]	Beam current / $\mu\text{A}$	Rate / kHz				
		HES $e'$	HKS			Coincidence
			$\pi^+$	$K^+$	$p$	
<sup>6</sup> Li(100)	50	99	20	0.24	25	$1.0 \pm 0.3$
<sup>9</sup> Be(100)	50	110	19	0.23	23	$1.1 \pm 0.2$
<sup>11</sup> B(100)	50	130	18	0.22	23	$1.3 \pm 0.3$
<sup>27</sup> Al(150)	50	500	24	0.29	30	$6.0 \pm 0.5$
<sup>40</sup> Ca(150)	50	770	23	0.27	29	$9.0 \pm 0.4$
<sup>48</sup> Ca(150)	50	650	22	0.27	28	$7.4 \pm 0.6$
<sup>208</sup> Pb(150)	25	1200	9	0.11	11	$5.3 \pm 0.5$

# 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
- Need test event blocking max rate in Hall C
- Need to evaluate detector occupancies
- If useful can record full FADC waveforms



Example scintillator SoLID beam test

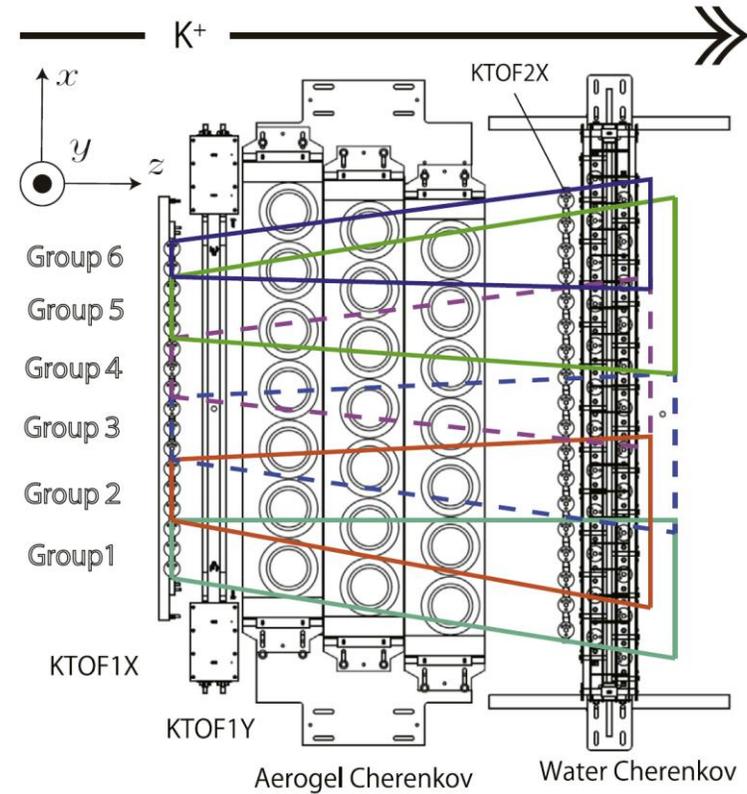
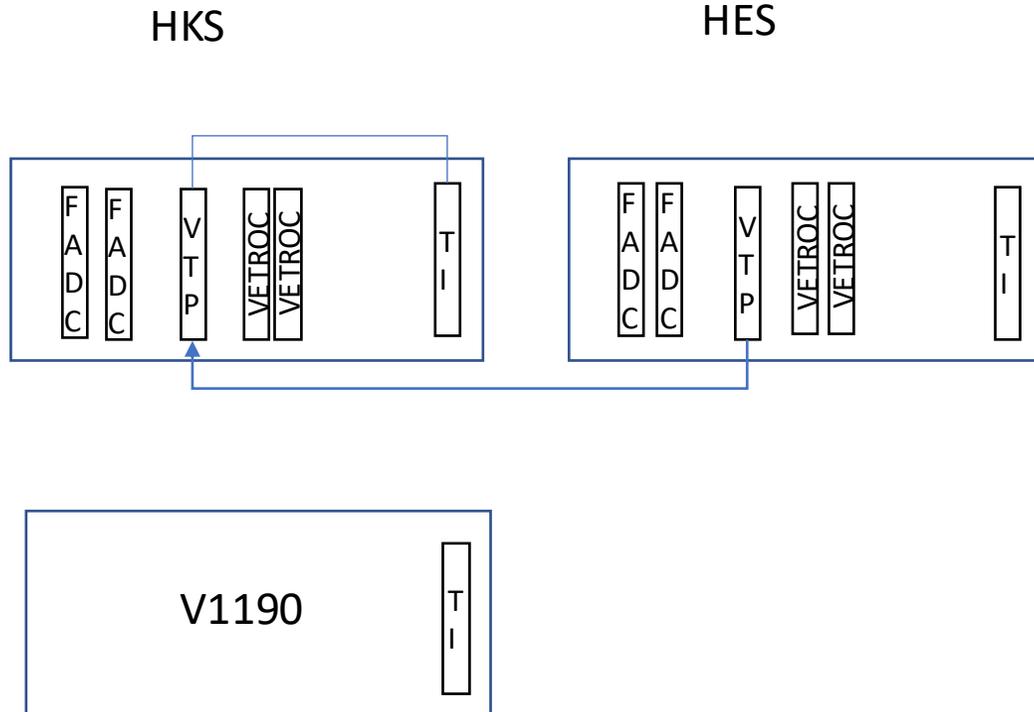
# Data rates with full sampling

- 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  
Development of C++/FPGA code for VTP

# VTP trigger development

## Waveform results (signal widths = 40 ns)



Offset = 30 ns

Offset = 25 ns

Offset = 25 ns

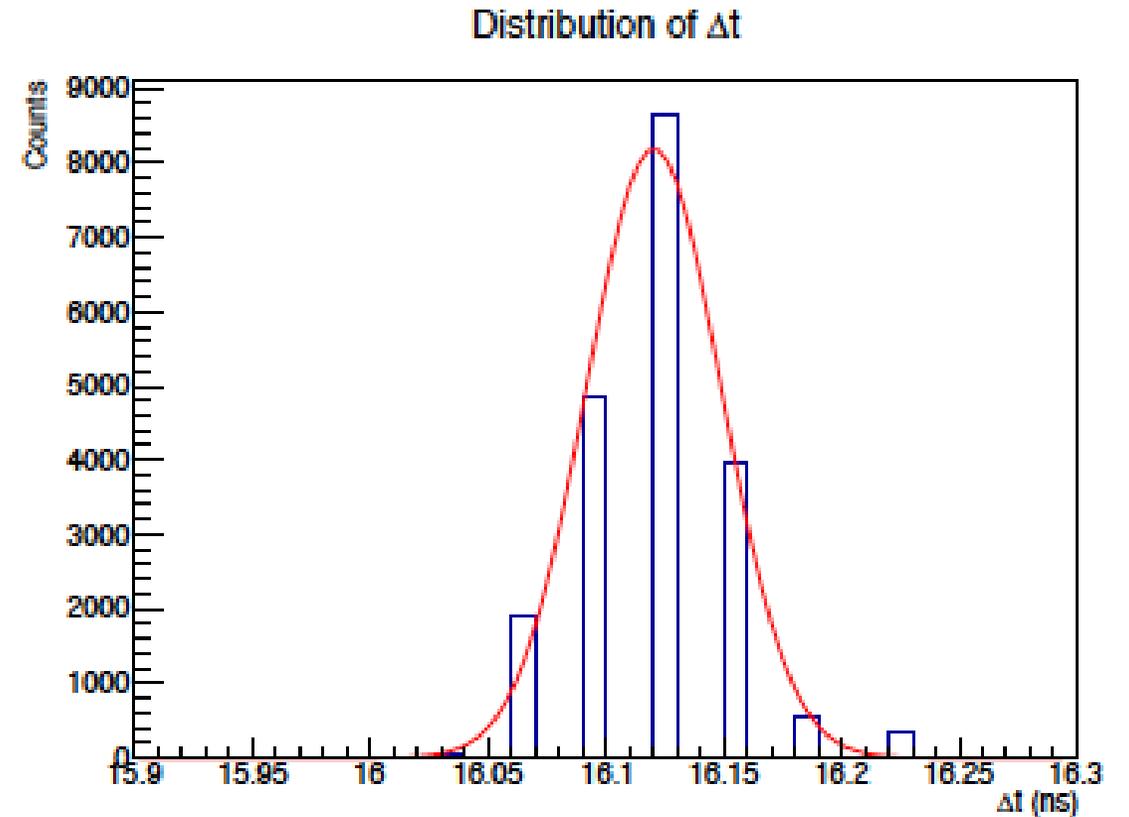
Offset = 25 ns

# Additional electronics

- Beamline info
  - Target BPM
  - Raster
  - 1C12 BPM cabling
- Installing additional crate
- Need to recable BPM patch in counting house
- Trying to setup before next run begins to test software and raster correction

# Test vfTDC

- Several tests with pulser
  - Around 30 ps with rough measurement
  - Need to use twisted pair to reduce crosstalk at input
  - Should be adequate for 150 ps timing resolution detector
  - Software developed for SBS Cdet
  - HCANA software upcoming



# To do / Testing

- Bench testing and testing with detector VETROC ( done )
- Setup FADC trigger with VTP (done)
- Setup testing in ESB ( on going )
  - Cable all WC and PMTs for Cerenkov and TOF
- Check cable attenuation
- Hall C setup
  - Dedicated account created
  - Setup crates in SHMS hut
  - Beamline crate
  - Finalize FPGA trigger
  - Set up triggers
  - Check timing resolution of electronics
  - Analysis with HCANA

# ESB testing

- FADC for TOF and Cerenkov
- VETROC
- VTP for cosmics trigger and development of final trigger



# Conclusion

- HKS and HES
  - Crates ADC and vfTDC in ESB
  - Crates setup with small subset on detector
- Cable full detector in ESB for checkout of full detectors upcoming
- Can setup in Hall C
  - Beamline crate being setup
  - SHMS crates for testing