Hall C Detector Systems Required for Pol. He3 Experiment Group

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Jefferson Lab

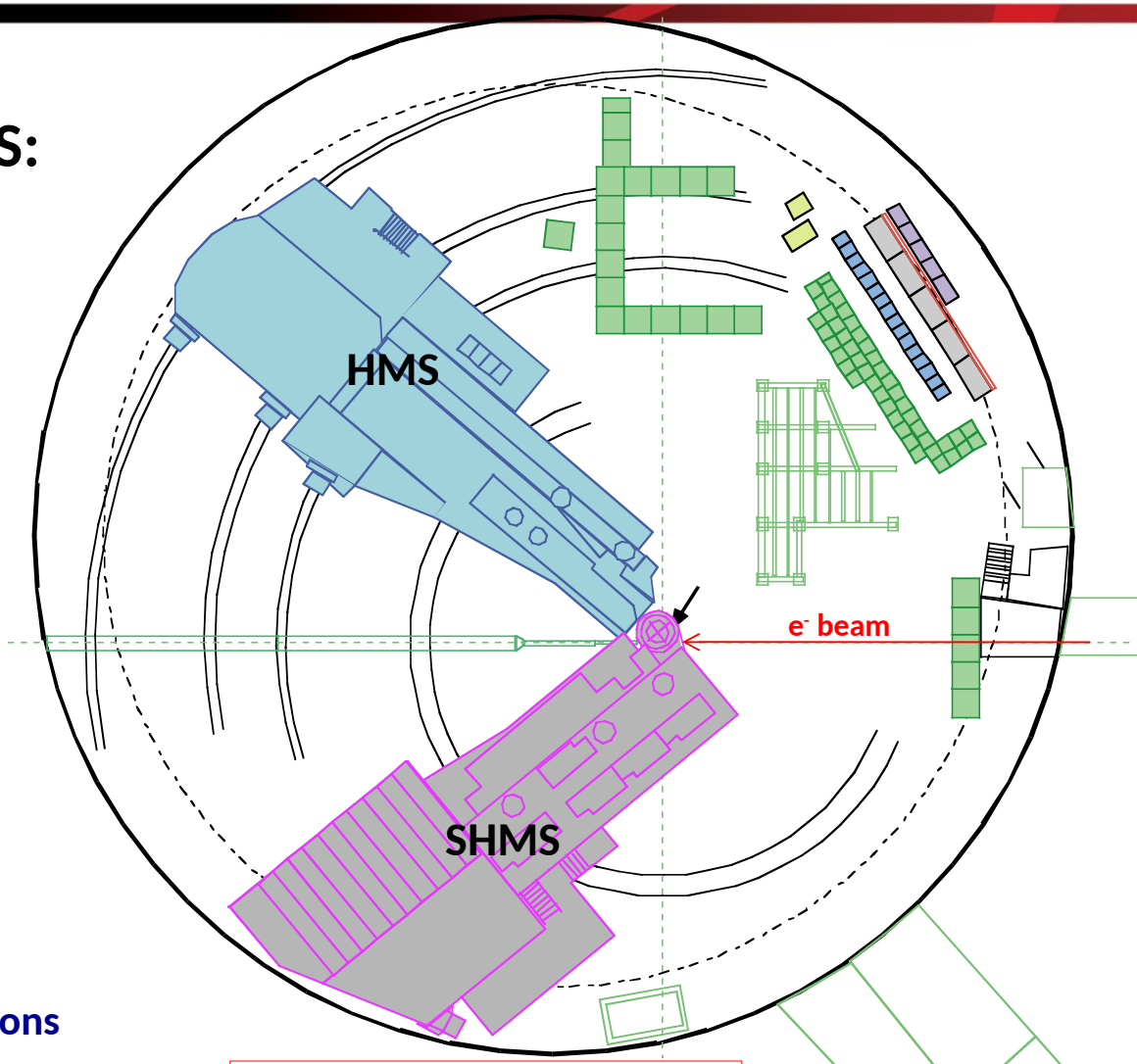
Upgraded Hall C Spectrometers

Retain Key Features of HMS:

- Pivot
- Rail System
- Point-Point Optics Design
- "Flat" Acceptances
- Shield House
- Redundancy in Detectors

Incorporate them in the SHMS to Provide:

- Pair of magnetic spectrometers
- Full momentum capability
- Large acceptance
- Angle accuracy and reproducibility
- Small angle capability
- Very good particle identification
- Compatibility with all target configurations



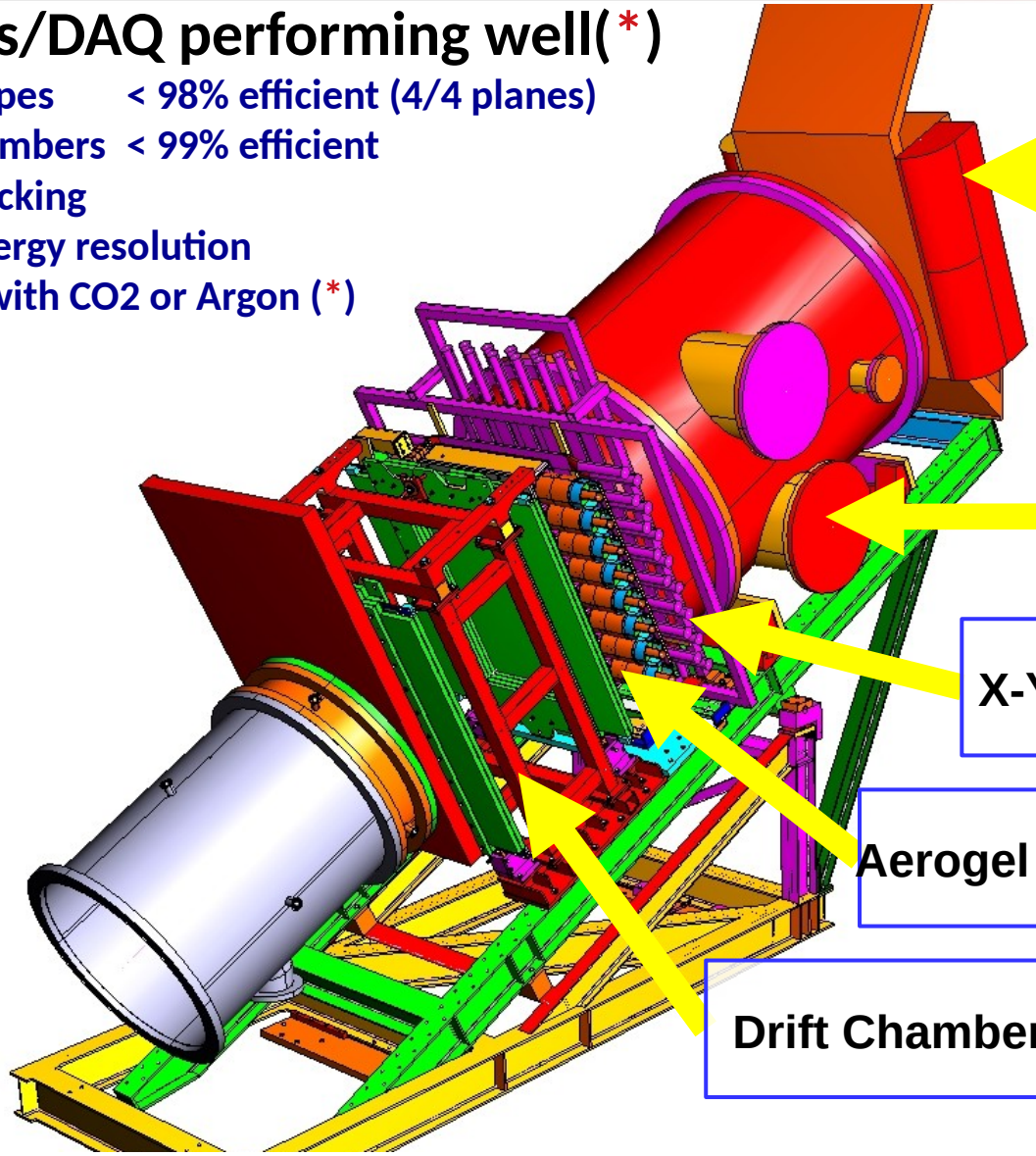
Hall-C with HMS and SHMS (12-GeV Configuration)

Slide from H. Fenker

HMS: Standard Detector Configuration

Detctors/DAQ performing well(*)

- Hodoscopes < 98% efficient (4/4 planes)
- Wire chambers < 99% efficient
- Good tracking
- Good energy resolution
- HGC fill with CO2 or Argon (*)



Preshower & Shower Counters

X-Y Scintillators

Heavy Gas Cerenkov

X-Y Scintillators

Aerogel Cerenkov

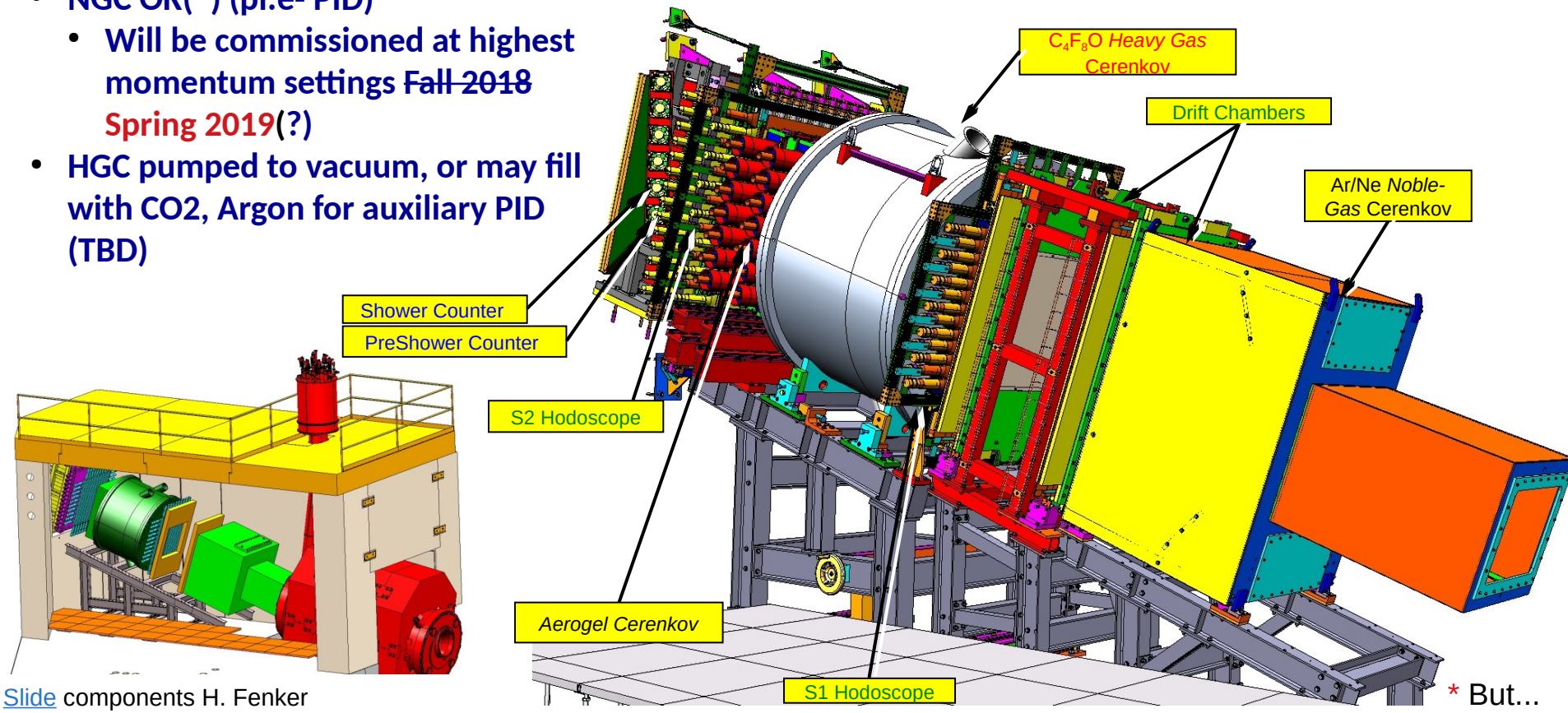
Drift Chambers

* But...

SHMS Standard Detector Configuration

Detctors/DAQ performing well(*)

- Hodoscopes < 98% efficient (4/4 planes)
- Wire chambers < 99% efficient
- Good tracking
- Good energy resolution
- NGC OK(*) (pi:e- PID)
  - Will be commissioned at highest momentum settings ~~Fall 2018~~ Spring 2019(?)
- HGC pumped to vacuum, or may fill with CO2, Argon for auxiliary PID (TBD)



Slide components H. Fenker

* But...

Both SHMS and HMS running since Fall 2017

Hall C production running began in January 2018

Detectors/DAQ (generally) performing well

- Hodoscopes < 98% efficient (4/4 planes)
- Wire chambers < 99% efficient
- Good tracking, Good energy resolution

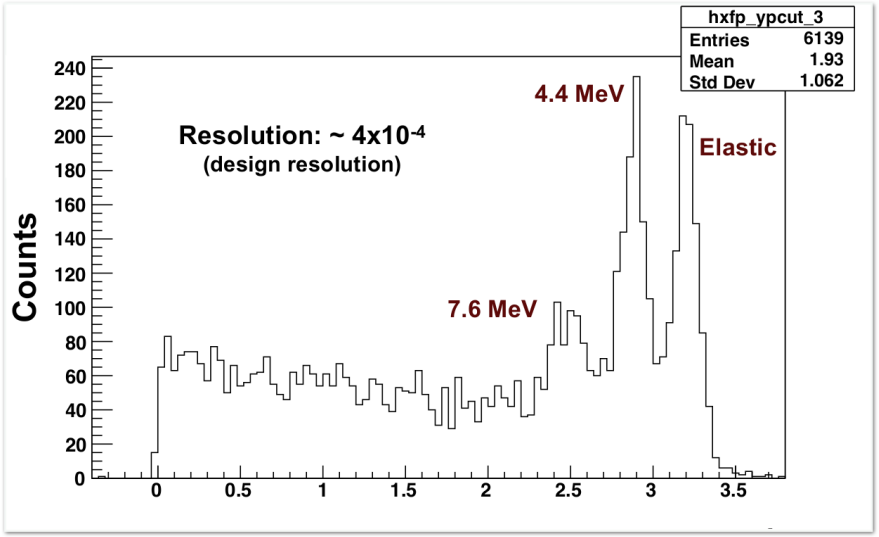
Analysis, Calibrations underway!

But…

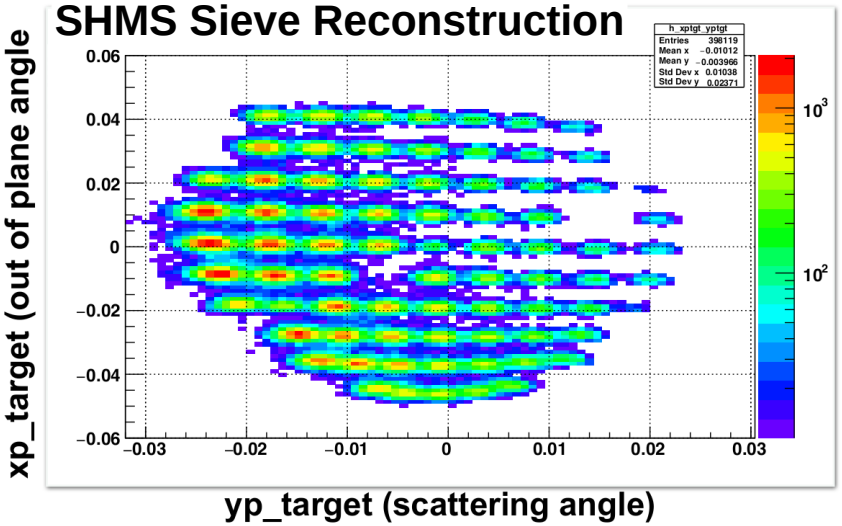
- SHMS HGC has lower npe yield than predicted (13 pe vs >25 pe), investigate over Summer 2018
- SHMS NGC yield is lower than predicted, may want to be conservative with PID performance at high momenta (ie. large neon fraction)?
- HMS HGC mirrors found to be damaged
  - Spares available(!), repair underway now

Plots on right from Commissioning data taken last December, January

- See also: Update on Dec/Jan Running (D. Dutta, Jan 2017 Hall C Collab. Meeting)
- See also: Upcoming Hall A/C Meeting / Analysis Workshop!



plot from M. Jones

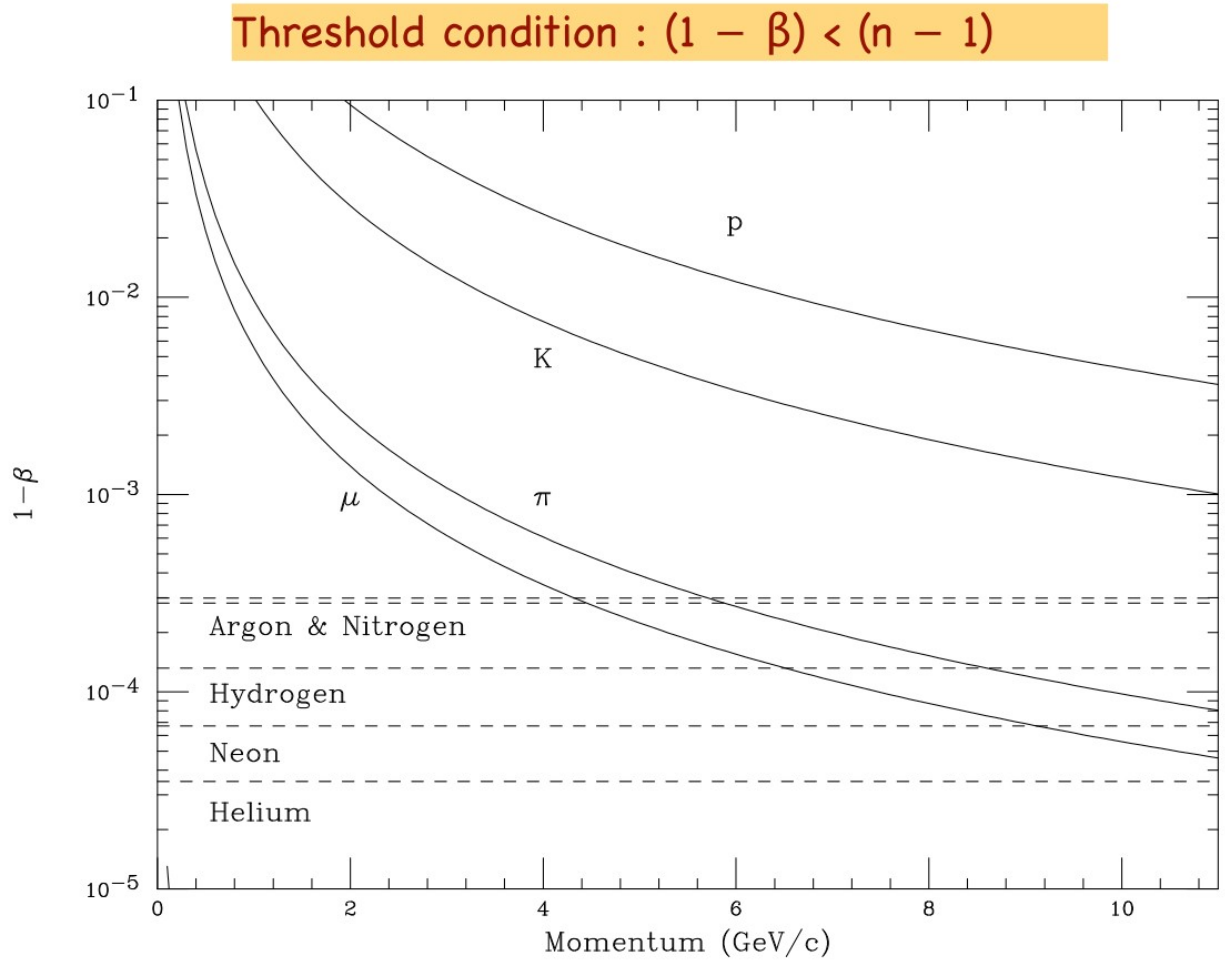


using COSY matrix elements without any optimization

SHMS HGC (Heavy Gas Cerenkov)

- Low yield theories investigated and eliminated
  - → ~~Poor mirror reflectivity~~
  - → ~~Poor mirror focus~~
  - → PMT optical coupling absorbing UV?
    - » ~~Optical grease between PMT and~~
    - » ~~RTV joint between PMT adapter and optical gas window~~
    - » ~~PMT photocathode and curved → flat surface adapter~~
- Work in progress...
  - → Directly measure PMT QE in the UV range
    - » Will also measure UV absorption of quartz gas window and quartz PMT adapter while we're at it...

SHMS NGC (Noble Gas Cerenkov)



Concern:

As neon fraction rises, the npe yield drops. At 100% neon, it is down by a factor of ~3–4 from 100% Argon.

Simulation:

~40 p.e. (100% Ar)

~ 9 p.e. (100% Ne)

[~ 55 p.e. (CO_2) *estimated*]

Data:

~ 17 (100% Ar)

~ 25 (100% CO_2)

→ ~ 3.8 p.e. (Ne)

NOTE: VERY PRELIMINARY!

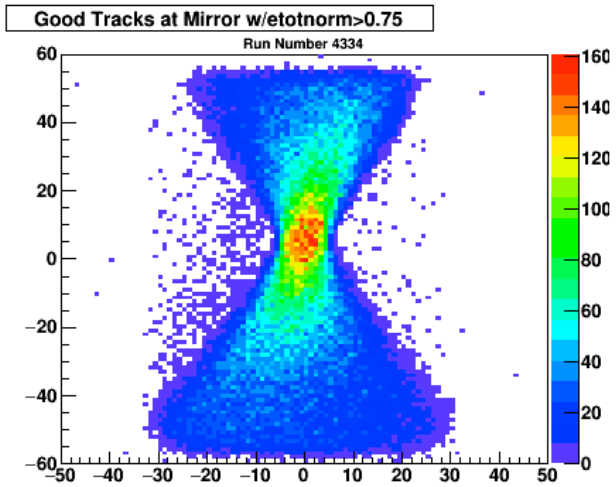
HClog 3519060

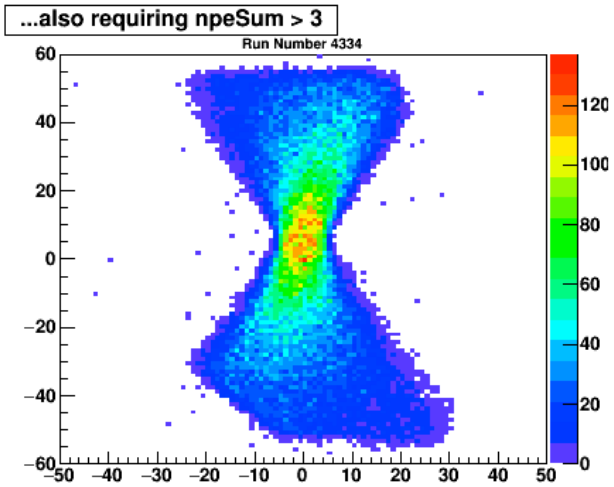
Slide from D. Day (Hall C ERR)

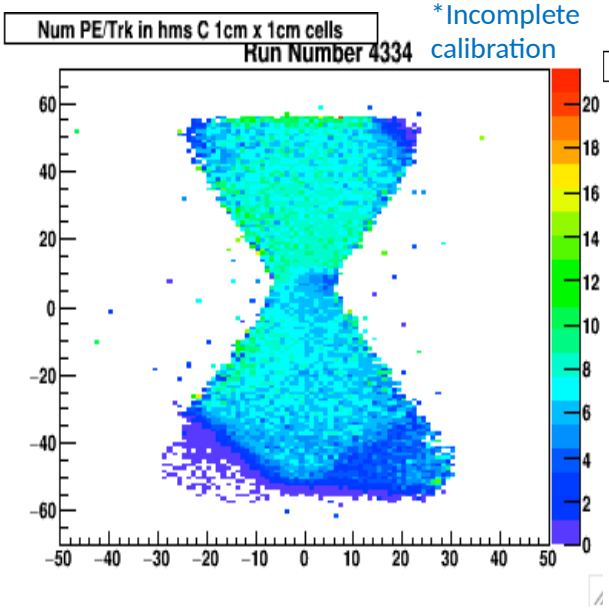
Choice of gases

Argon up to 6 GeV and a mixture of Argon and Neon up to 11 GeV

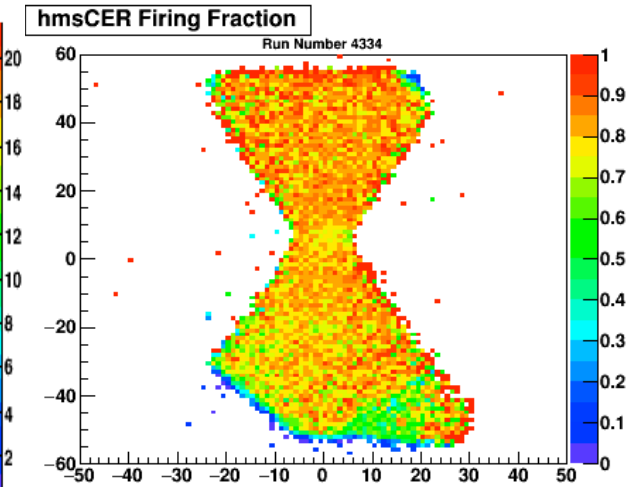
HMS Cerenkov vs. Projected Track

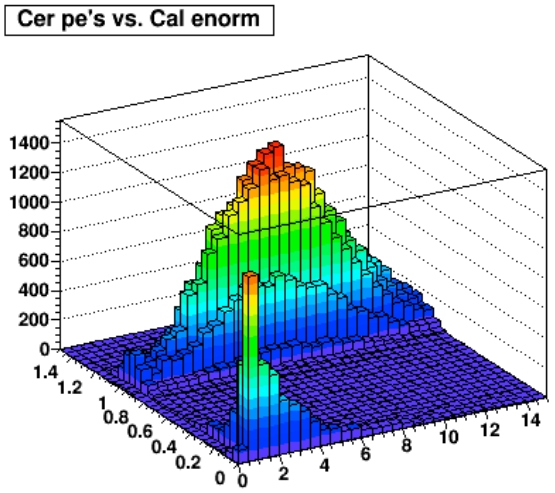






*Incomplete calibration

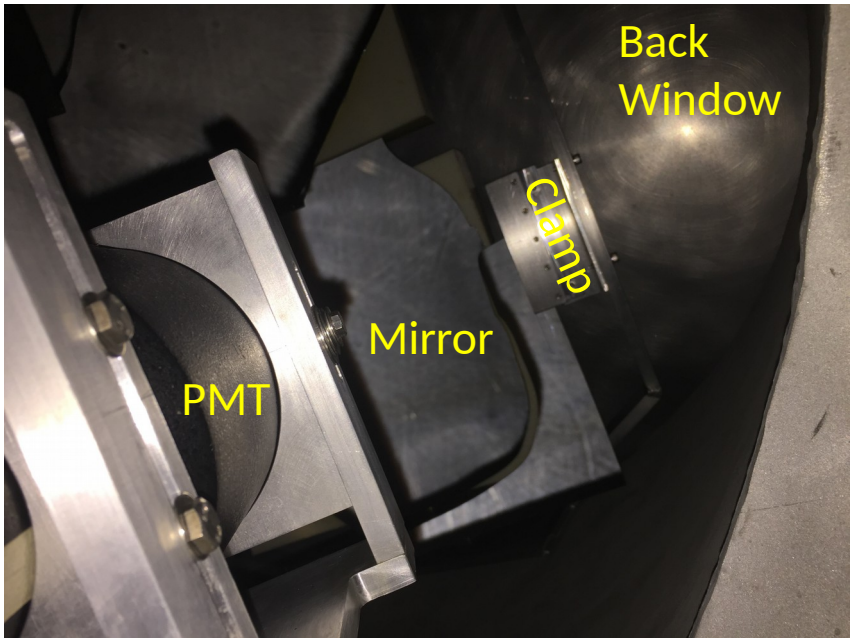


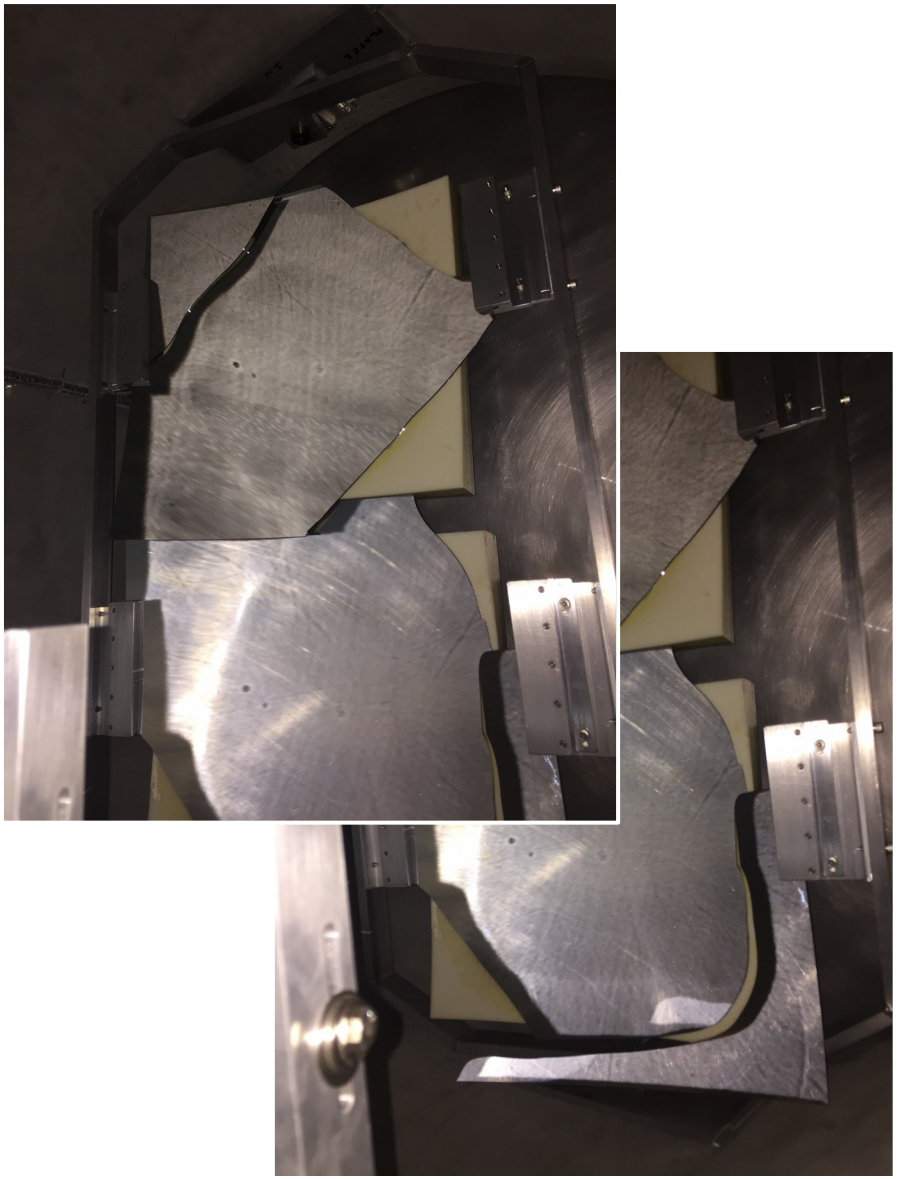


Slide from H. Fenker (June 2018)

Jefferson Lab

HMS Cerenkov: $#%@ ?!!!!

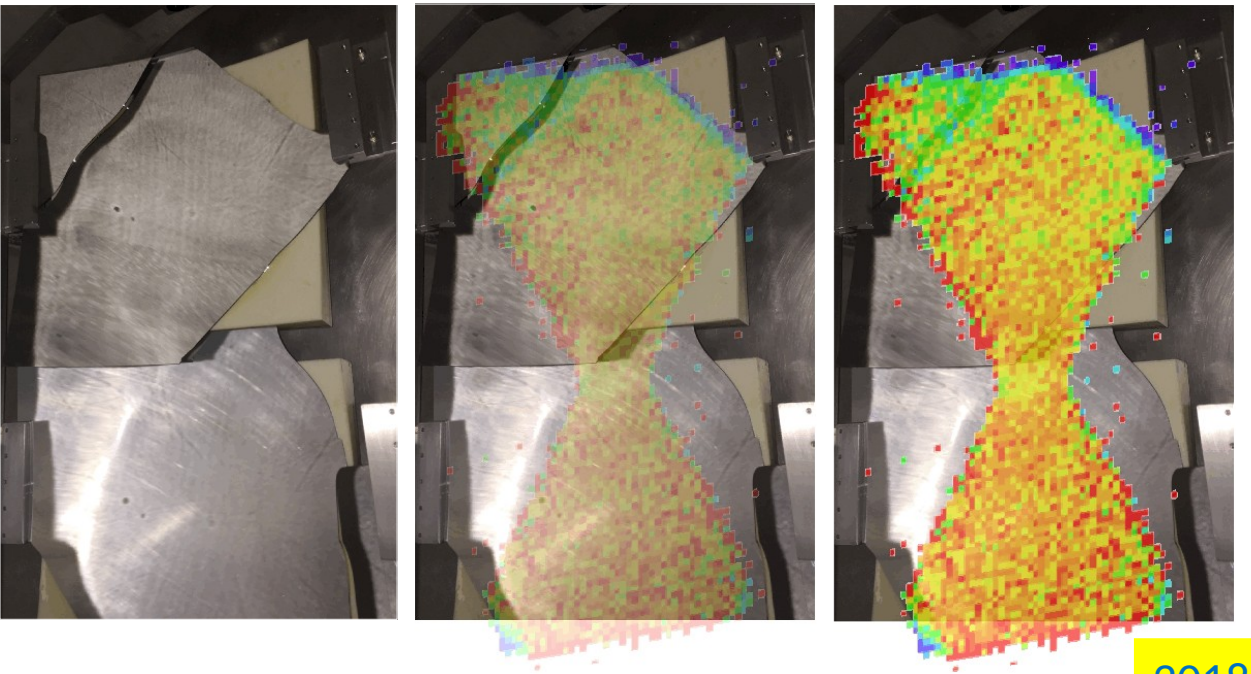




"We need a plan."
D. Day 6/1/18

Slide from H. Fenker (June 2018)

HMS Cerenkov: Have we really been taking data that way, or did the mirrors just break after the “Spring-18 Run”?



2018

2003

Certainly the mirrors were broken during the (end of) ”Spring 18”, at least.
They may have been broken (breaking?) for a very long time.

Slide from H. Fenker (June 2018)

Summary

- *Generally* Detectors/DAQ are working as planned
  - Calibrations, cross-checks are in progress
    - See upcoming Hall A/C collaboration meeting and Analysis workshop!
  - SHMS gas Cerenkov yields are lower than predicted, investigations underway
    - SHMS NGC has one very noisy PMT
      - Spare PMT available, will be replaced this summer
    - SHMS NGC yield *may* be concern at high momentum settings (> 7 GeV/c)?
      - May want to be conservative with PID expectations at such settings?
    - SHMS HGC yields are also lower than predicted
  - HMS mirrors found to be badly damaged
    - Seems probable it has been like this for years (since 2008/9?)
    - Spare mirrors located and being installed now

BACKUP SLIDES

Hall C Detector System Ownership

SHMS Detectors

- Hodoscopes
  Simona Malace
- Drift Chambers
  Eric Christy
  Howard Fenker
- Noble Gas Cerenkov
  Donal Day
  Brad Sawatzky
- Heavy Gas Cerenkov
  Garth Huber
  Brad Sawatzky
- Aerogel
  Hamlet Mkrtchyan
  Vladimir Berdnikov
- Calorimeter
  Hamlet Mkrtchyan

HMS Detectors

- Hodoscopes
  Simona Malace
- Drift Chambers
  Liguang Tang
  Howard Fenker
- Cerenkov
  Howard Fenker
  Brad Sawatzky
- Calorimeter
  Hamlet Mkrtchyan

Other

- DAQ
  Brad Sawatzky
  Steve Wood
- High Voltage
  Steve Wood
  Brad Sawatzky
- Hall A/C Spectrometer Support Group
  Jack Segal
  Joe Beaufait
  Chuck Long
  Ethan Becker
  - Slow controls, Instrumentation support, Secondary detector support

Hall-C with SHMS and HMS

SHMS:
- 11-GeV Spectrometer
- Partner of existing 6-GeV **HMS**

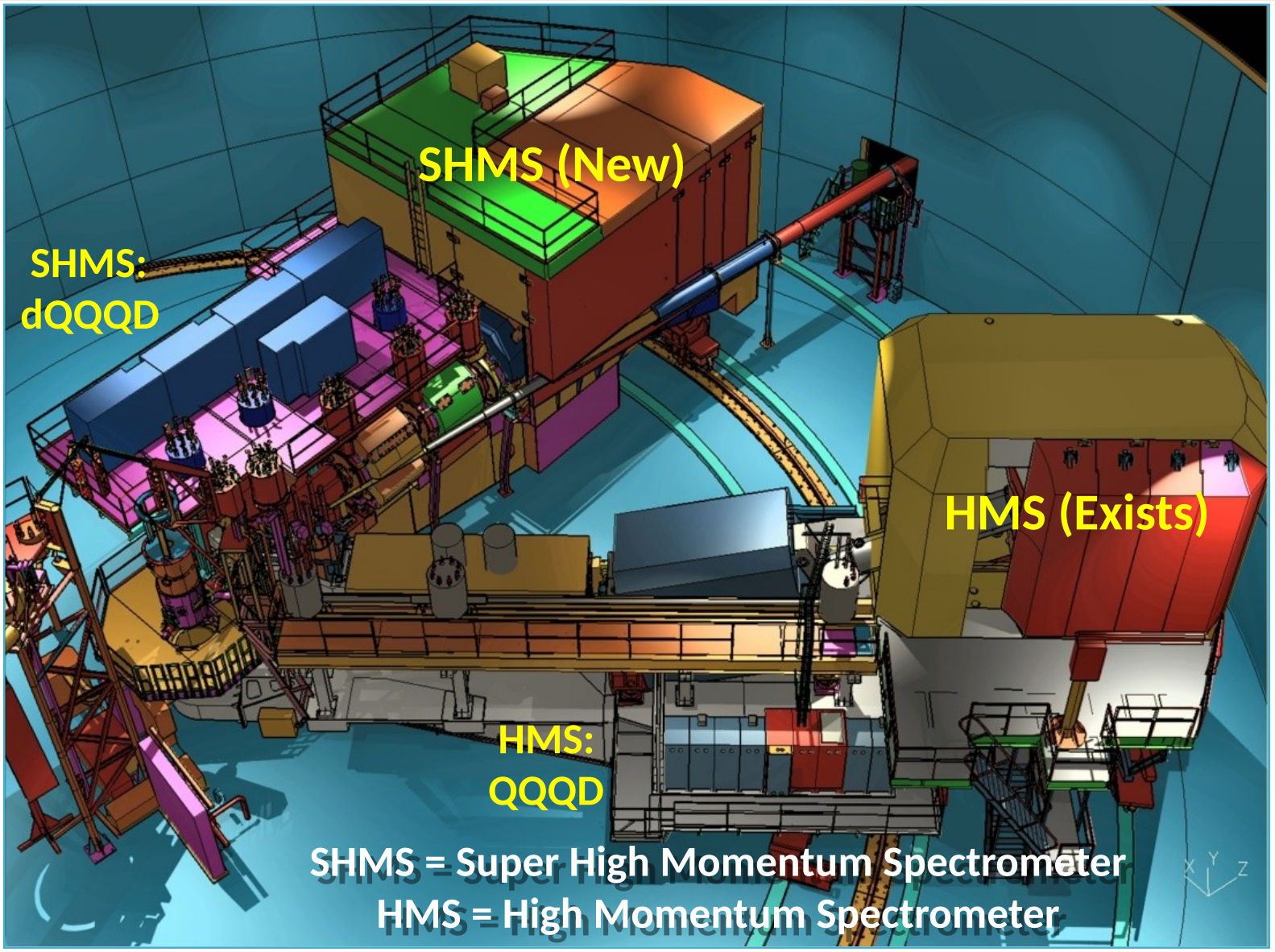
MAGNETIC OPTICS:
- Point-to Point QQQD for easy calibration and wide acceptance.
- Horizontal bend magnet allows acceptance at forward angles (5.5°)

Detector Package:
- Drift Chambers
- Hodoscopes
- Cerenkovs
- Calorimeter
- All derived from existing HMS/SOS detector designs

Well-Shielded Detector Enclosure

Rigid Support Structure
- Rapid & Remote Rotation
- Provides Pointing Accuracy & Reproducibility demonstrated in HMS

Slide from H. Fenker

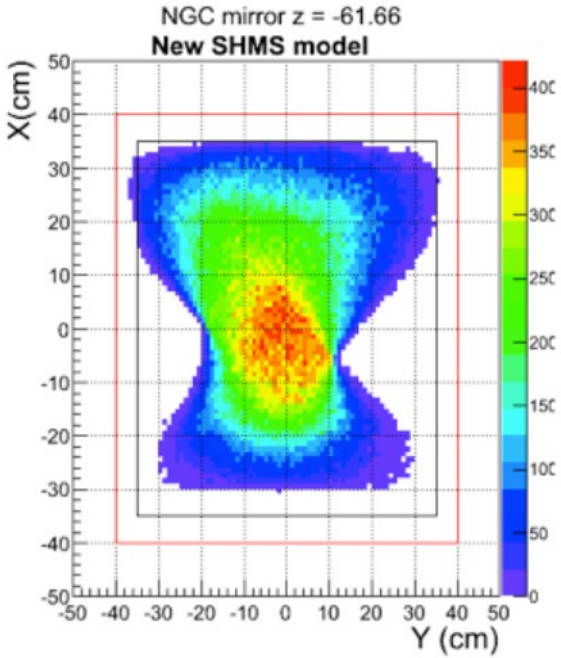


Hall C: SHMS Design Parameters

Parameter	SHMS Design
Range of Central Momentum	2 to 11 GeV/c for all angles
Momentum Acceptance	-10% to +22%
Momentum Resolution	0.03-0.08%
Scattering Angle Range	5.5 to 40 degrees
Solid Angle Acceptance	>4.5 msr for all angles
Horizontal Angle Resolution	0.5 - 1.2 mrad
Vertical Angle Resolution	0.3 - 1.1 mrad
Vertex Length Resolution	0.1 - 0.3 cm
Tracking Rate Capability	5 MHz
Beam Capability	Up to 90 μA, 11 GeV beam
Protection from	Hazards: Magnetic, Cryogenic, Fall, etc.
Angle Changes	Rapid, Remote, Reproducible

SHMS PID Requirements : negative polarity

Experiment	p (GeV/c)	Req'd $e^-:\pi^-$ Disc.	Spec'd NG Cerenkov	Spec'd Calorimeter	Total Expected
E12-06-101 (Fpi-3)	2.2 - 8.1	$4.5 \bullet 10^3$:1	50:1 (HMS Cerenkov gives up to 300:1 now)	>200:1 (1000:1 above 6 GeV/c)	$>10^4$:1
E12-06-104 (σ_L/σ_T)	5.4 - 5.8	10^3:1			
E12-07-103 (pion factorization) (d)	2.4 - 8.5	10^3:1			
E12-06-105 (x>1)	4.8 -10.6	$5 \bullet 10^3$:1			
E12-06-110 (c)	2.2 - 6.8	10^3:1			
E12-06-121 (g_2^n, d_2^n)	6.3 - 7.5	$>10^2$:1			



4 overlapping spherical mirrors

R = 135 cm, 43 by 43 cm

2 m of active length

Noble gas at 1 Atm

Slide from D. Day (Hall C ERR)