
Detector Checkout and Optics Commissioning

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with SHMS optics working group

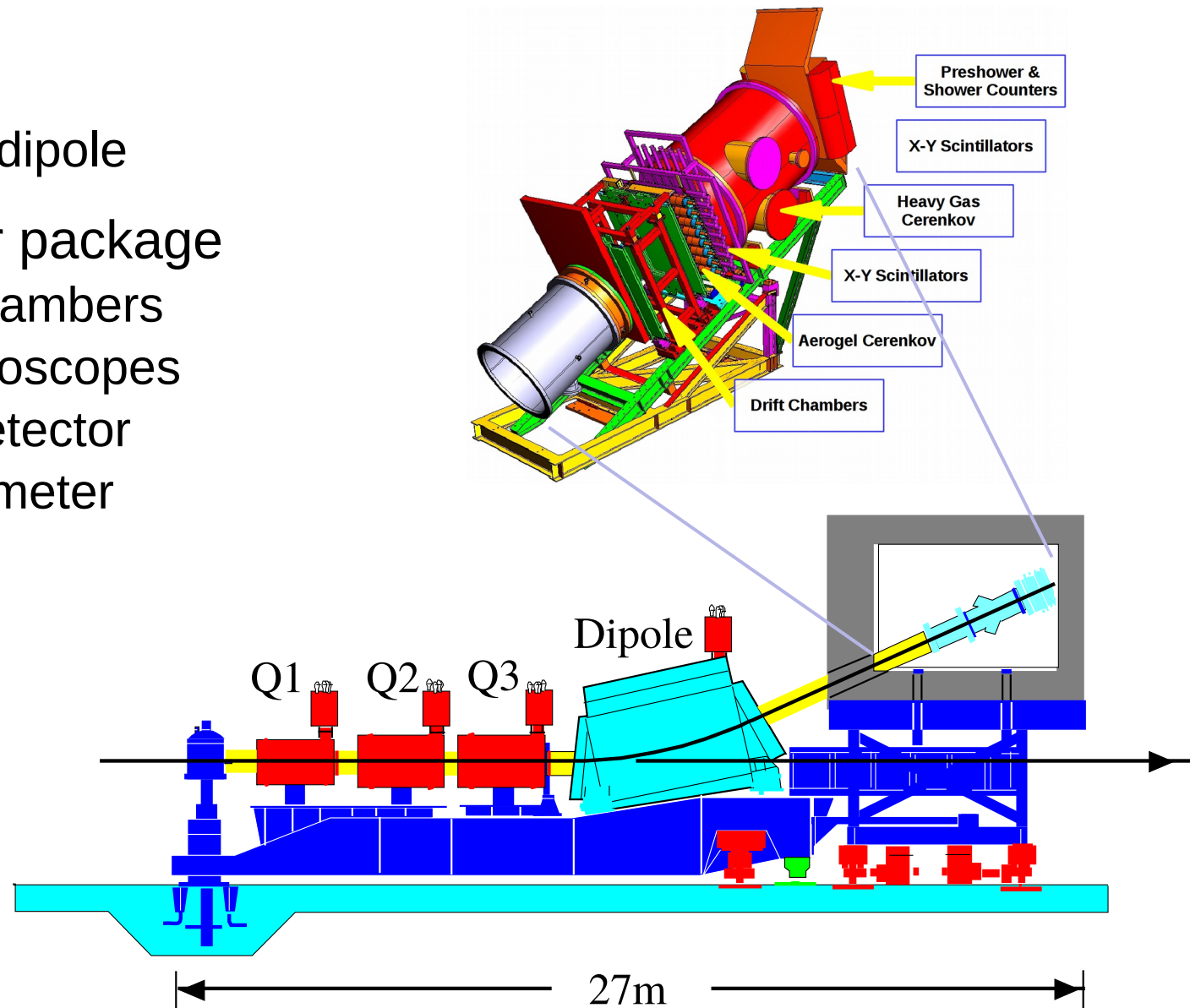
Hall C Winter Collaboration Meeting
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overview

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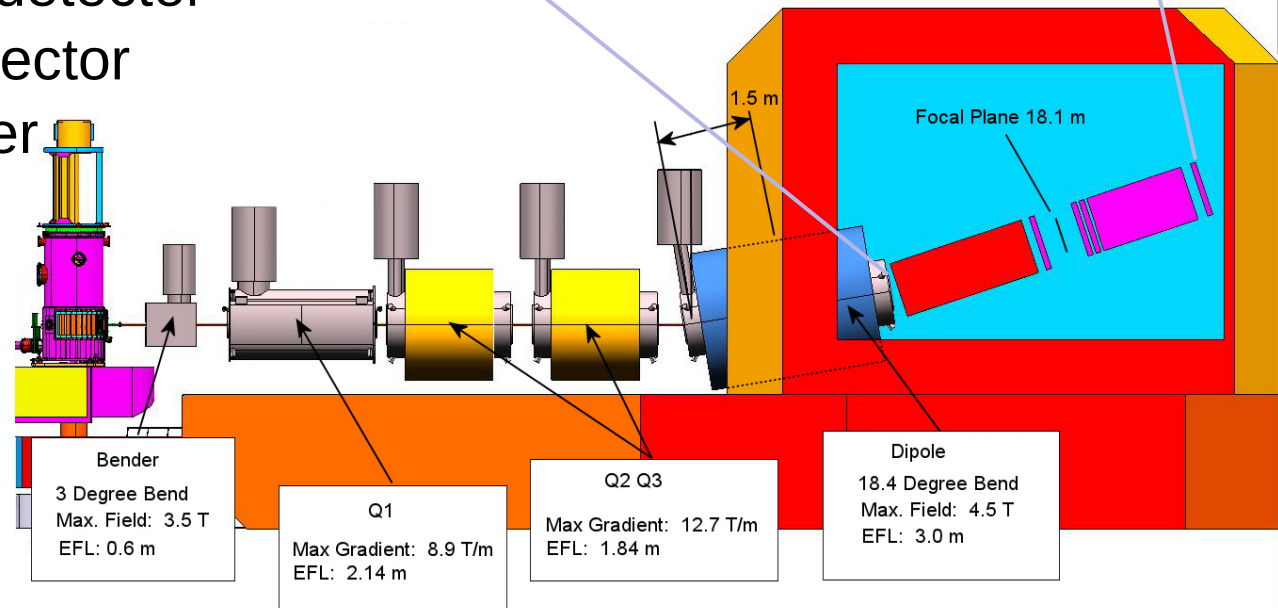
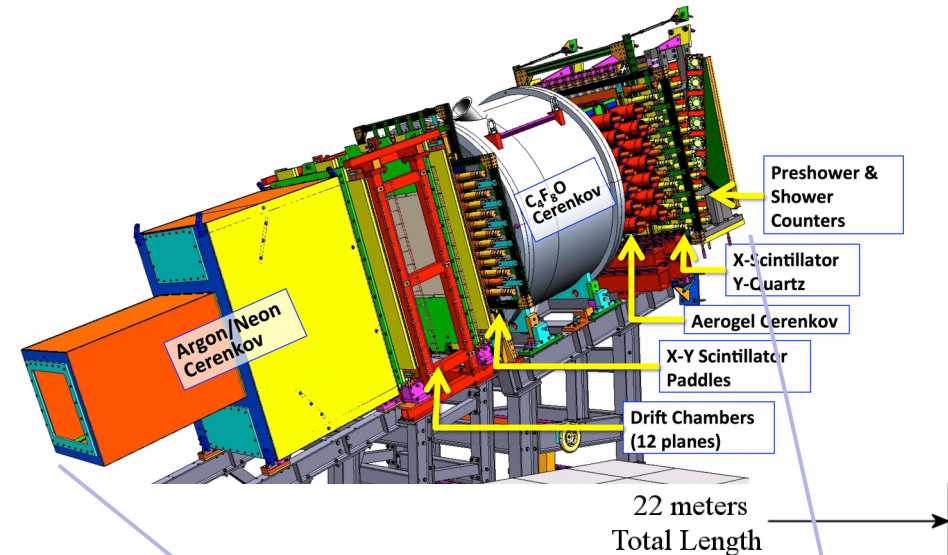
HMS overview

- 4 magnets
 - Q1, Q2, Q3 and dipole
- standard detector package
 - 2 pairs of drift chambers
 - 2 sets of x-y hodoscopes
 - gas Čerenkov detector
 - four-plane calorimeter



SHMS overview

- 5 magnets
 - bender, Q1, Q2, Q3 and dipole
- standard detector package
 - noble-gas Čerenkov detector
 - 2 pairs of triplets of drift chambers
 - 2 sets of x-y hodoscopes
 - heavy-gas Čerenkov detector
 - aerogel Čerenkov detector
 - pre-shower calorimeter
 - shower calorimeter



commissioning plan – part 1a

- electronics and detector functionality check
 - check that all signals are well timed
 - determine correct thresholds
 - verify that all detector channels are counting
 - determine scintillator plane efficiency for e-
 - verify that all scalers are incrementing and rates are OK
- beam checkout
 - superharp scan to check beam size ($< 200 \mu\text{m}$)
- last beamline girder commissioning
 - monitor the values of three BPMs
 - check data stream for BPM information
 - compare BPM information with super harp scans while changing beam position, beam current and raster size

beam energy : $> 6 \text{ GeV}$
beam current : $10 \mu\text{A}$
beam raster : $1 \times 1 \text{ mm}^2$

target : central carbon

HMS angle : 15°
HMS momentum : $-3.0 \text{ GeV}/c$
HMS collimator : large

SHMS angle : 15°
SHMS momentum : $-3.0 \text{ GeV}/c$
SHMS collimator : large

commissioning plan – part 1b

- standard HMS tune reestablishment
 - select electrons and make x_{fp} - y_{fp} plot
 - check if you see a “spider”
- beam-target interaction point verification
 - make x_{fp} - y_{fp} and x'_{tg} - y'_{tg} and y_{tg} plots
 - is central leg of x_{fp} - y_{fp} spider straight?
 - is the reconstructed y_{tg} position close to 0?
 - is central sieve slit hole in x'_{tg} - y'_{tg} close to (0,0)?
 - make corrections to beam position and repeat
- target-ladder verification
 - make short run with carbon hole target
 - this ensures consistency, cross-checks ladder position relative to beam, raster size on target and BPM readbacks

beam energy : > 6 GeV
beam current : 10 μ A
beam raster : 1 x 1 mm²

target : central carbon

HMS angle : 15°
HMS momentum : -3.0 GeV/c
HMS collimator : sieve

commissioning plan – part 1c

- SHMS quadrupole settings verification
 - make x_{fp} - y_{fp} plot – “tilted hourglass”
 - verify that we have point-to-point focus
 - check if waist of hourglass is at (0,0)
 - change quadrupole strength until it is
 - check time-to-distance maps, align wire chamber positions in software, check detector positions, ...
- standard SHMS tune establishment
 - take runs with sieve
 - make x_{fp} - y_{fp} plot – “spider”
 - check if center of spider is at (0,0)
 - compare with simulated patterns
 - change quadrupole strength until they match

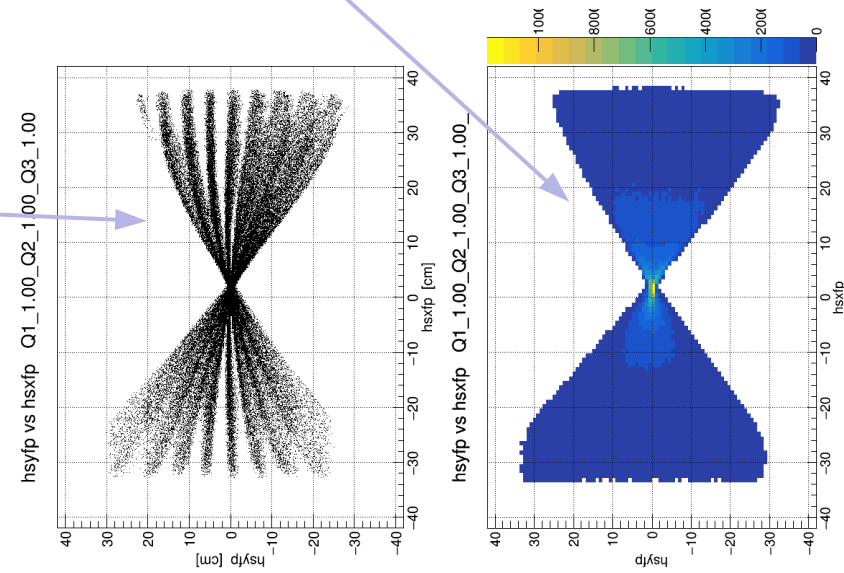
beam energy : > 6 GeV
beam current : 10 μ A
beam raster : 1 x 1 mm²

target : central carbon

SHMS angle : 15°

SHMS momentum : -3.0 GeV/c

SHMS collimator : large



commissioning plan – part 1d

- detailed detector checkout
 - wire chamber high-voltage plateaus
 - shower counter calibration run
 - calibration spectra: carbon
 - check wire chamber time-to-distance maps, align wire chamber positions in software, optimize tracking properties, ...
 - calibrate calorimeter and Čerenkov
 - scintillator calibration run
 - defocused run: HMS and SHMS
 - adjust Q2 to illuminate whole focal plane
- would need input from detector builders
 - what kind of checks are needed?
 - what kinematics would be preferred?
 - some have already provided information

beam energy : > 6 GeV
beam current : 10 μ A
beam raster : 1 x 1 mm²

target : central carbon

HMS angle : 15°
HMS momentum : -3.0 GeV/c
HMS collimator : large

SHMS angle : 15°
SHMS momentum : -3.0 GeV/c
SHMS collimator : large

commissioning plan – part 2

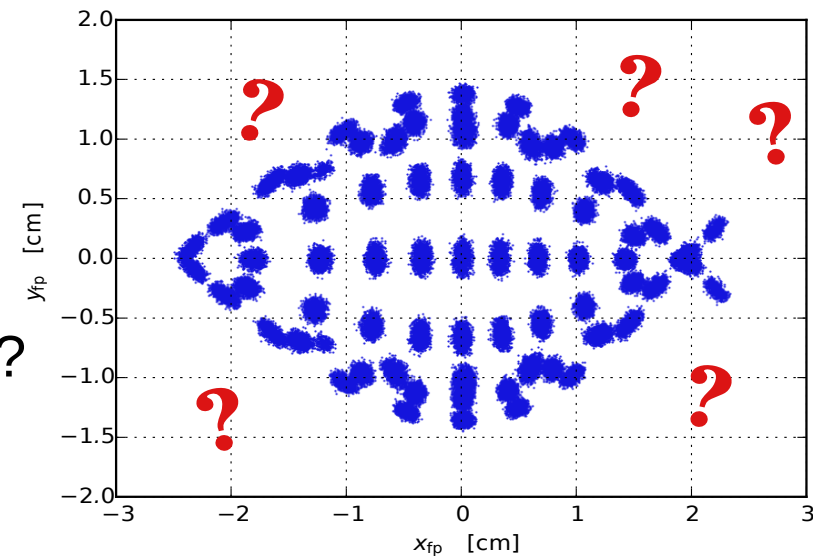
- SHMS quadrupole tuning
 - inelastic region
 - recheck tune from 3-pass beam
 - carbon elastic
 - check ground state to 2+ state ratio (0.5 : 1)
 - optimize tune for energy resolution
 - make x_{fp} - y_{fp} plot and compare it to simulation
- dispersion calibration
 - make 4% changes in the momentum
 - determine dispersion matrix elements
- beam sweep
 - influence on aberrative matrix elements?
- extended optics target running
 - determine the angular matrix elements

beam energy : 2.1 GeV
beam current : 20 μ A
beam raster : off

target : central carbon

SHMS angle : 7°
SHMS momentum : -1.2 GeV/c
SHMS collimator : sieve

no SHMS noble-gas Čerenkov



commissioning plan – part 3a

- beamline and optics verification
 - do superharp scans to check beamsize
 - check SHMS spider plots to verify optics
- discriminator thresholds setup
 - take small runs to setup PId trigger thresholds
- coincidence electronics timing checkup
- $1\text{H}(e,e'p)$ coincidence verification
- 1H or $12\text{C}(e,e'\pi)$ coincidence verification
- $1\text{H}(e'K)$ and $1\text{H}(e,e'K)$ running
 - write HMS and SHMS singles, and coincidences
 - check for evidence of kaons
 - check for evidence of $(e,e'K)$ coincidences


beam energy : > 6 GeV
beam current : 50 μA
beam raster : 1 x 1 mm^2

target : 10 cm LH2

HMS angle : 25°
HMS momentum : -2.6 GeV/c
HMS collimator : large

SHMS angle : 15°
SHMS momentum : +3.6 GeV/c
SHMS collimator : large

commissioning plan – part 3b

- beamline and optics verification
- sieve slit measurements
 - calibrate angular and vertex position reconstruction for future L/T experiments
 - check spectrometer pointing at various angles
- $1\text{H}(e,e')p$ elastic checkout 
 - make series of elastic runs at different angles
 - verify optics and acceptance understanding of spectrometers
- $1\text{H}(e,e'p)$ coincidence checkout
 - take several runs (single, coincidence) with and without sieves
 - check angle and dp/p offsets for the spectrometers
- current dependence test
 - monitor e rates with LH2 (+ dummy) target for different currents

beam energy : 6.4 GeV
beam current : $> 20 \mu\text{A}$
beam raster : $1 \times 1 \text{ mm}^2$

target : 10 cm LH2

HMS angle : 27.5°
HMS momentum : $-3.6 \text{ GeV}/c$
HMS collimator : large

SHMS angle : 27.5°
SHMS momentum : $-3.6 \text{ GeV}/c$
SHMS collimator : large

additional information

- SHMS optics working group wiki:
https://hallcweb.jlab.org/wiki/index.php/SHMS_Optics_Working_Group
- commissioning plan – wiki edition:
https://hallcweb.jlab.org/wiki/index.php/Commissioning_Plan_2017
- KPP run plan – wiki edition:
https://hallcweb.jlab.org/wiki/index.php/KPP_Run_Plan

- welcome to join the SHMS optics working group