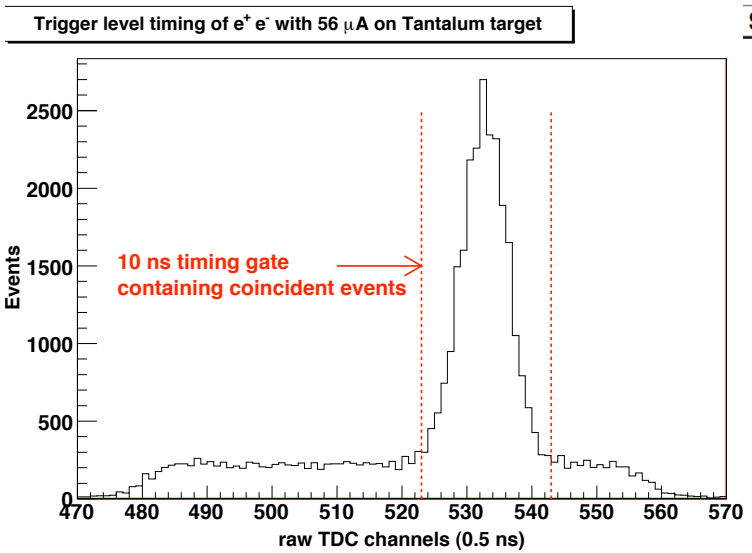
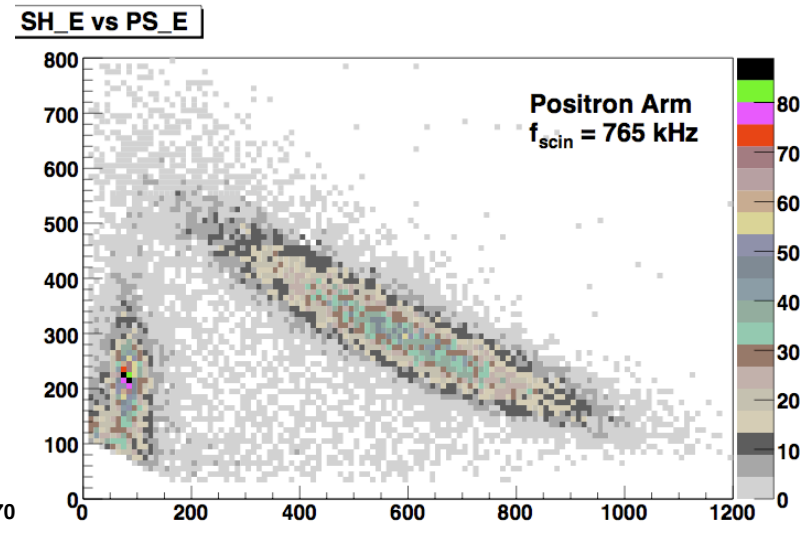
Test Run, June 2010: Collected data to address issues per PAC 35 report

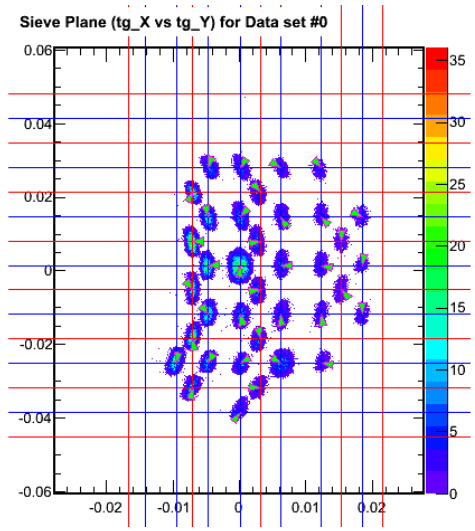
- ✓ Use of the Gas Cherenkov in trigger, timing – proposed 20 ns, demonstrated 10 ns
- ✓ Operation of the VDC at 5 MHz track rate – demonstrated up to 8 MHz
- ✓ Operation of the positron arm PID – demonstrated up to 0.8 MHz (more than needed)
- ✓ Operation of trigger/DAQ – demonstrated total dead time of 8% at full luminosity

Extended multi-foil target designed and built; not installed due to time, manpower constraints and high radiation left after PREX.

- Also checked: optics calibration, singles rates in the HRS spectrometers, signal to background in trigger and offline analysis, a thin Ta foil with 150 μA beam.
- Accumulated about 2 million true e+e- coincidence events & optics data for new physics result for mass range around 200 MeV.







APEX: A Search for Dark Photons in Hall A

What are the specifics of the APEX optics?

$$m^2_{A'} = |p_{positron} + p_{electron}|^2 = |p_+ + p_-|^2$$

$$m^2_{A'} = 2m^2_e + 2|\vec{p_+}| \cdot |\vec{p_-}| \cdot (1 - \cos\theta_\pm)$$

$$\delta m/m,\ \theta_\pm \sim 0.15; 1 - \cos\theta \approx 1 - \theta^2/2 + \theta^4/24$$

$$m^2_{A'} \approx |\vec{p_+}| \cdot |\vec{p_-}| \cdot (\theta_\pm)^2$$

$$m_{A'} \approx p_{+(-)} \cdot \theta_\pm$$

$$\frac{\delta m}{m} = \frac{\delta p}{p} \bigotimes \frac{\delta\theta}{\theta}$$

APEX: A Search for Dark Photons in Hall A

What are the contributions to mass resolution?

δp - momentum resolution

$\delta\theta_{central}$ - spectrometer central angle uncertainty, CA

$\delta\theta_{optics}$ - matrix reconstruction quality, OP

$\delta\theta_{track}$ - focal plane tracking, incl. window, TR

$\delta\theta_{scatt}$ - scattering in the target, MS

$$\frac{\delta m}{m} = \frac{\delta p}{p} \otimes \frac{\delta\theta_{CA}\times[\Delta p/\sqrt{12}p]}{\theta_{\pm}} \otimes \frac{\delta\theta_{OP}}{\theta_{\pm}} \otimes \frac{\delta\theta_{TR}}{\theta_{\pm}} \otimes \frac{\delta\theta_{MS}}{\theta_{\pm}} \sim 1/200$$

$< 1/1000$ $\quad$ $0.5(^{o})/300$ $\quad$ each $\sim< 0.4/150$

APEX: A Search for Dark Photons in Hall A

What are the contributions to mass resolution?

δp - momentum resolution

$\delta\theta_{central}$ - spectrometer central angle uncertainty, CA

$\delta\theta_{optics}$ - matrix reconstruction quality, OP

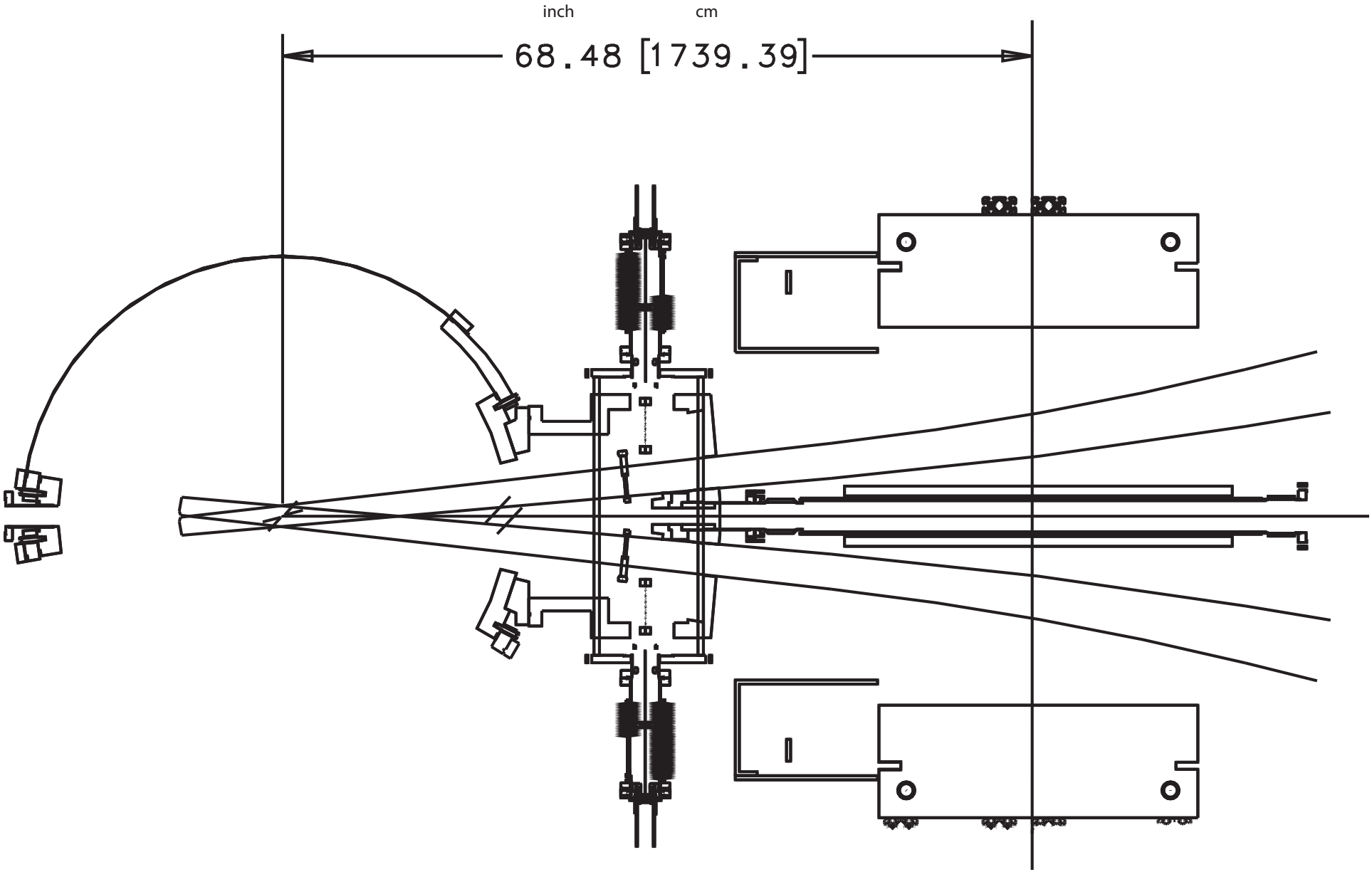
$\delta\theta_{track}$ - focal plane tracking, incl. window, TR

$\delta\theta_{scatt}$ - scattering in the target, MS

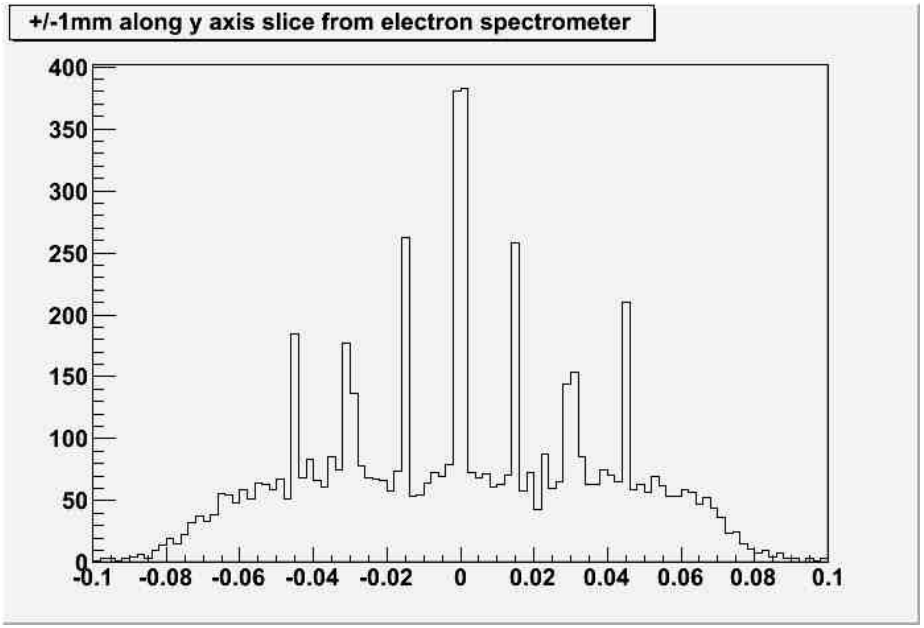
$$\frac{\delta m}{m} = \frac{\delta p}{p} \otimes \frac{\delta\theta_{CA}\times[\Delta p/\sqrt{12}p]}{\theta_{\pm}} \otimes \frac{\delta\theta_{OP}}{\theta_{\pm}} \otimes \frac{\delta\theta_{TR}}{\theta_{\pm}} \otimes \frac{\delta\theta_{MS}}{\theta_{\pm}} \sim 1/200$$

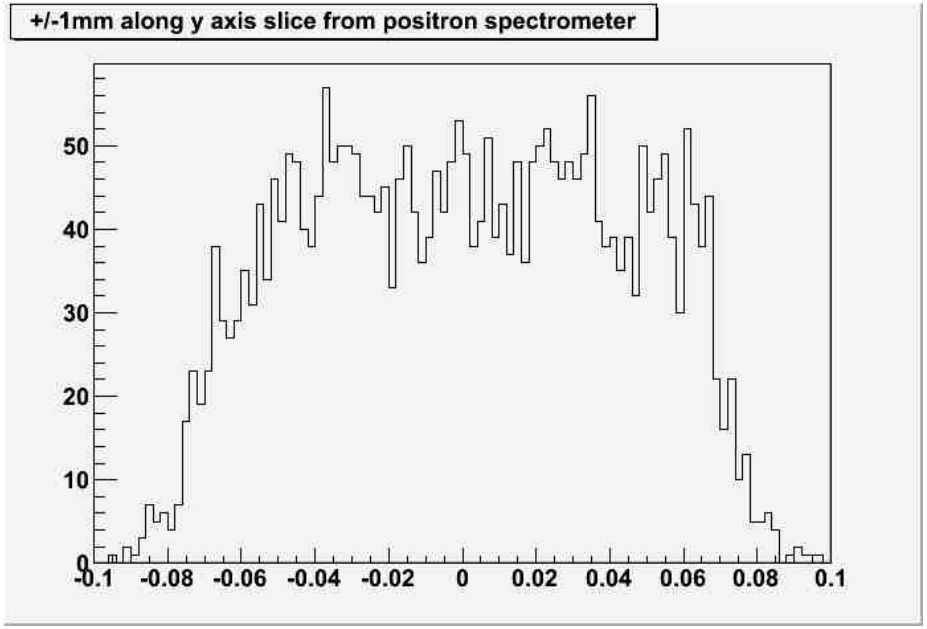
$< 1/1000$ $\quad$ $0.5(^{o})/300$ $\quad$ each $\sim < 0.4/150$

Layout of equipment



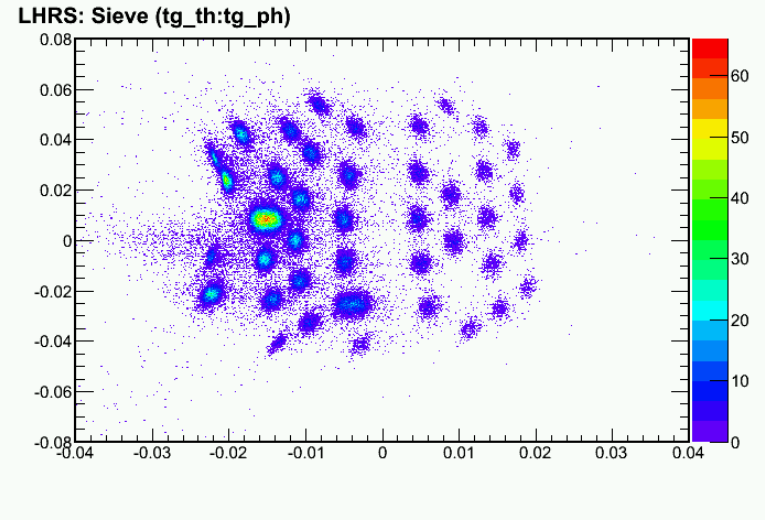
Monte Carlo Simulations for 10-mm sieve slit electron and positron distributions





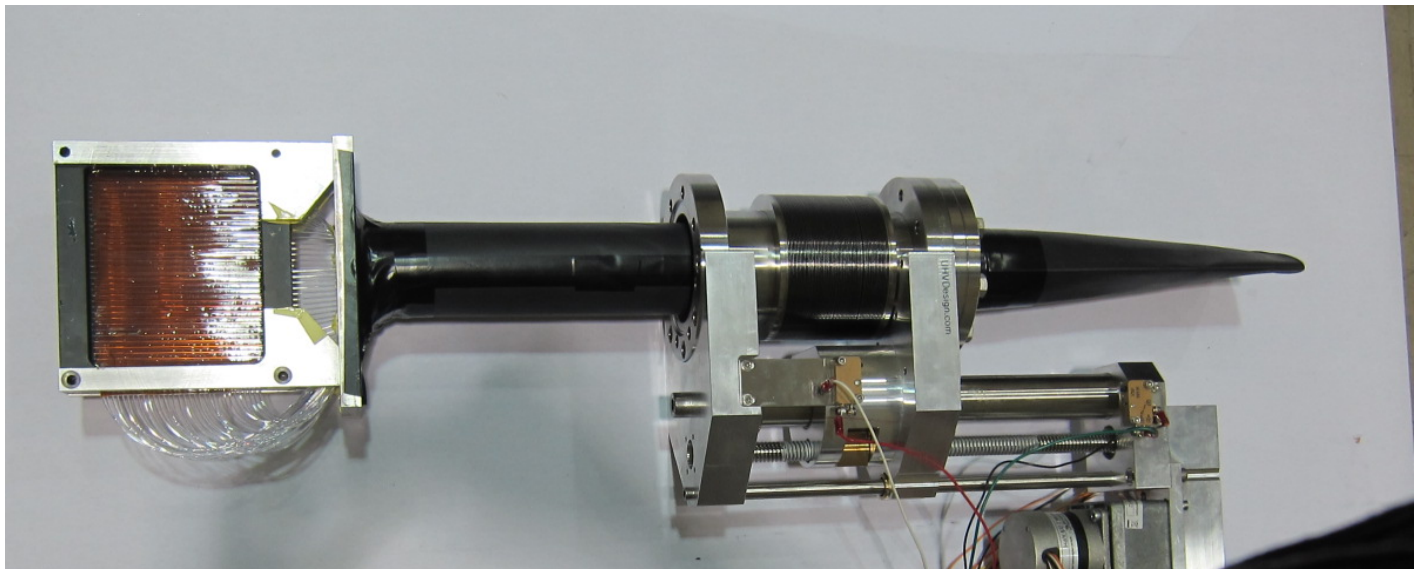
HRS optics

Traditional sieve pattern

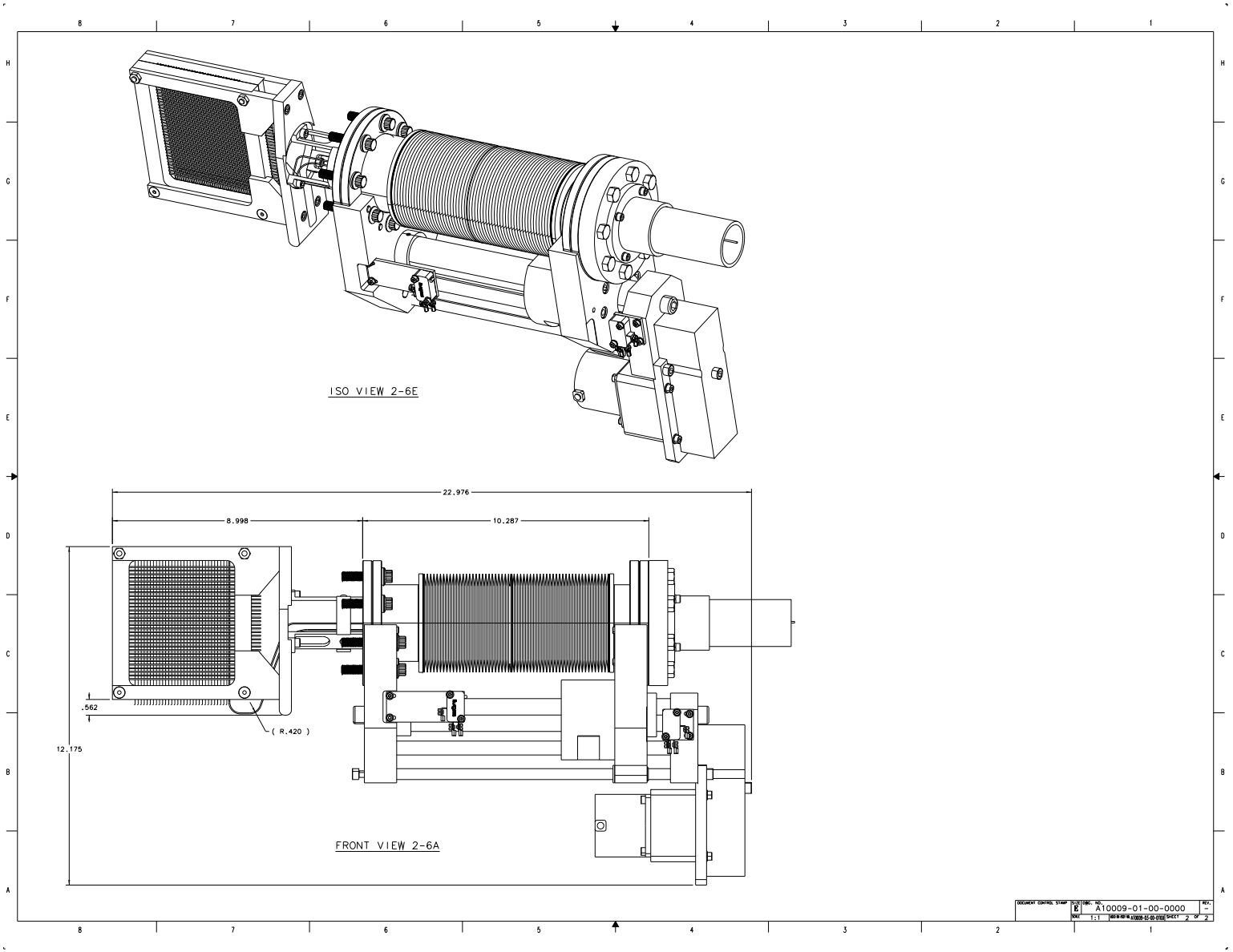


Active "sieve slit": a Sci Fiber detector with 1 mm fibers with 1/4" pitch connected via a bundle of 1.5 mm clear fibers to a 64-channel PMT. **Effectively a 1024-hole sieve slit.**
Readout via 1877S TDC; 1-3 MHz rate per fiber; off-line time window of < 5 ns
All components are constructed.
One arm was assembled in February.

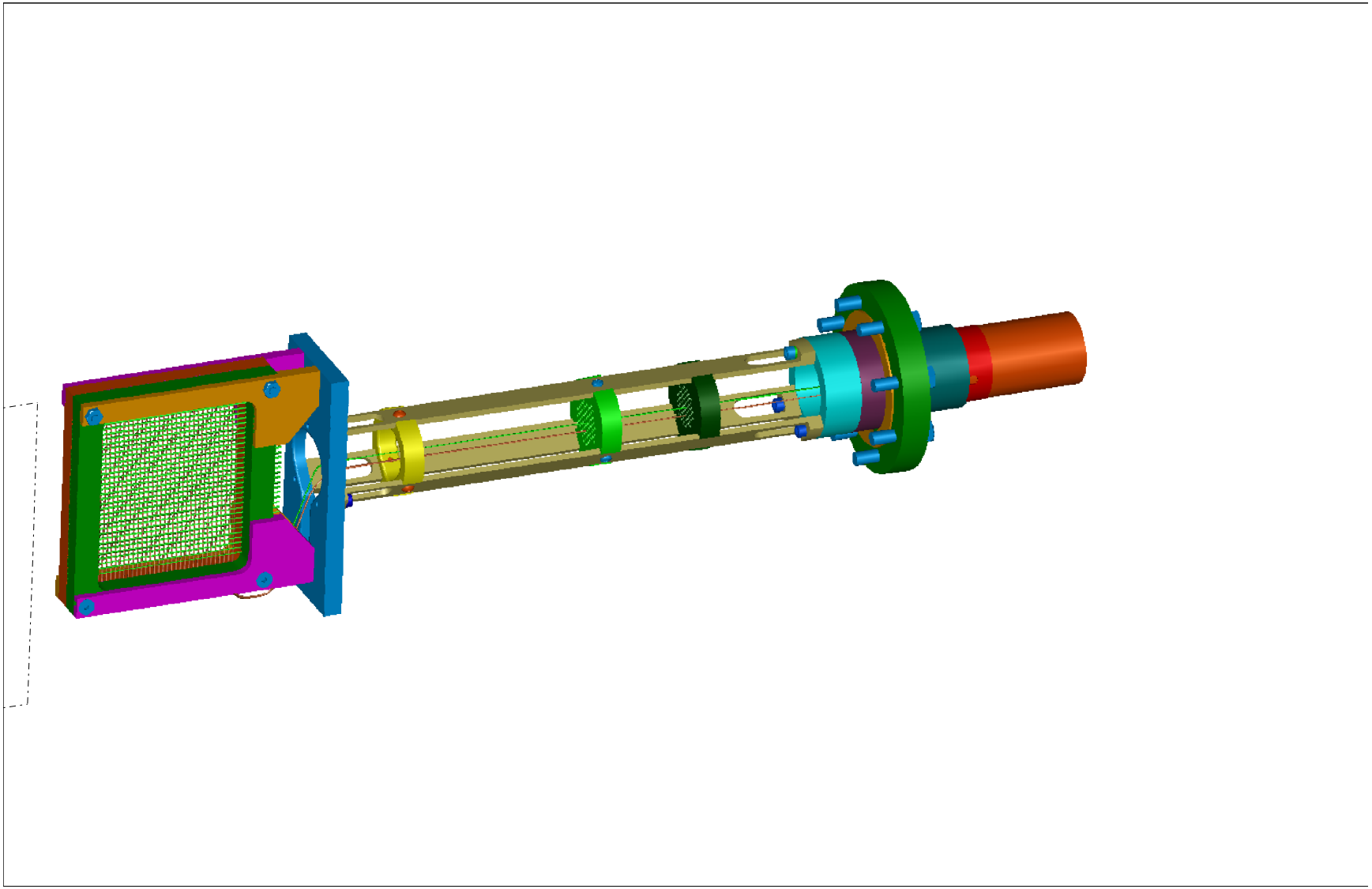
Positively charged particle optics needs the SciFi



Detector design



Detector design



Detector components

- Detector is in vacuum
- Step motor controled position
- 32 1 mm scintillator fibers in X and Y, 6.35 mm pitch
- 64 pixel maPMT
- 1.5 mm clear fiber couples the scintillator fiber to PMT
- 6-mm long clear fiber cable from detector head to PMT
- 4 amplifier/discriminator cards next to PMT
- LVDS to ESL level translators at 15 m from the A/D
- One Fastbus 1877S TDC in the HRS DAQ

Detector status