Physics Requirements and Solenoid Description

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Solenoid Director’s Review, JLab, Oct 2010
Physics: search for “hybrid” mesons in $\gamma p$ at $\sim 9$ GeV
- Nearly $4\pi$ coverage for $\gamma p \rightarrow Xp$, $X \rightarrow$ light mesons
  - final states $p, \pi^\pm, \pi^0 \rightarrow \gamma\gamma$, $0.3 - 5$ GeV/$c$, multiplicity $> 4$
  - uniform acceptance needed for PWA
- Enough momentum/energy resolution to:
  - separate $\gamma p \rightarrow Xp$ and $\gamma p \rightarrow Xp\pi$
  - minimize contamination by wrong partial waves in PWA

Solution: Spectrometer based on *Solenoidal magnet*
(decided about 10 years ago)
The Choice of the Magnet

Design Feature: Open Yoke - No Endcap

- $\gamma$-detection at $\theta < 10^\circ$ with existing LG-calorimeter
- TOF detectors for charged particles at $\theta < 10^\circ$
- Space of a gas Cherenkov detector
- Requires more Amp-turns than magnets with yoke endcaps

Comparable Spectrometers

- LASS SLAC $K^{\pm}$-beam 11 GeV/c spectroscopy (no $\gamma$-detection)
  - Comparable energy range
  - Solenoid: 2.2 T, bore $\varnothing=1.85$ m
  - Solenoid: open yoke
  - Small angles: dipole 2.5 T·m

- BABAR, CLEO-II, CDF not available
  - 1.5 T, bore $\varnothing=2.90$ m
  - Larger detectors needed
GLueX Detector

**GlueX/Hall D Detector**
Initial coil configuration

*Do we need this field?*

\[ FOM \propto \frac{1}{(EM_{\text{background}} \cdot \sigma_{\text{Mass}})} \]

2.2 T ⇒ 1.5 T ⇒ ×2.5 longer running

- B=2.2 T central
- ID=2 m, L=4 m
- 4 separate coils
- Built at SLAC in 1971
- Used:
  - 10 years at SLAC
  - 4 years at Los Alamos
- GlueX:
  - no gaps between coils
  - more open yoke

Design based on LASS magnet
Adaptation of the LASS magnet

Changes to the Magnet
- The front endcap is opened similar to the back endcap
  - Simplifies detector installation, space for readout cables
  - Lower field in front of the magnet - OK
  - Change of forces
- Fill yoke gaps - smaller stray fields
- Force compensation:
  - Swap coils #1 and #2
  - Baffles
- Run at 1500 A to produce 2.2 T (LASS ran at 1600 A)
Field Simulation

GlueX (Hall D) solenoid - basic, 1500A

1500 A
Lower field at target $Z \sim 60$ cm is beneficial for acceptance

- **POISSON** 2-D simulation: quick and flexible
- **ANSYS** 3-D simulation: takes into account azimuthal non-uniformity
- Consistent results
Problems with the Magnet

- Coil refurbishing was needed to fix known problems:
  - Shorts to ground
  - N2 shield corrosion
  - Various leaks

- Other problems identified:
  - Pressure safety
  - Mechanical stability of windings’ tips in coil #2
  - Potential turn-to-turn shorts

Considerably more work than originally anticipated!
Internal review Nov 2010 (S. St.Loren, B. Schneider, P. Brindza)

- Observations: New magnet cost 3.6-6M, not in time for CD-4; Old magnet: Technical problems, but no obvious showstopper
- Refurbishment recommendations: clarify physics requirements, provide detailed test plan.

Subsequent discussions pinpoint two items:

- Shorts between the coil conductor and supporting strips pose a particular hazard.  
  *Analysis performed*

- Consideration of a back-up replacement solenoid should go in parallel with analysis, refurbishment, risk mitigation and testing of the existing solenoid.  
  *Started*
Current Plans

- Continue working on the LASS solenoid:
  - Finish refurbishing the coils (#2 and #3 left)
  - Test every coil separately at the nominal current 1500 A for performance and forces
    *Testing of coil #1 is in progress*

- Work on a new solenoid in parallel with the refurbishment:
  - Prepare the physics requirements
  - Develop a path to final design

- This review, for consultations with experts in the field
  - Refurbishment plan and test plan - technical risks
  - Time line for completing test and refurbishment
  - Path forward on a possible replacement solenoid
Schedule

- Beam expected in April 2014

Installation schedule: start solenoid installation by Nov 2011
  
  *no float left*

Testing schedule:

- Still considerable uncertainty on the cooling time and other activities
- Current estimate: finish testing of all 4 coils by Nov 2011
  
  *no float left*

How to increase the float?

- Cooling time?
- *Omit the test of Coil #2*