HALL B UPGRADE PLANS

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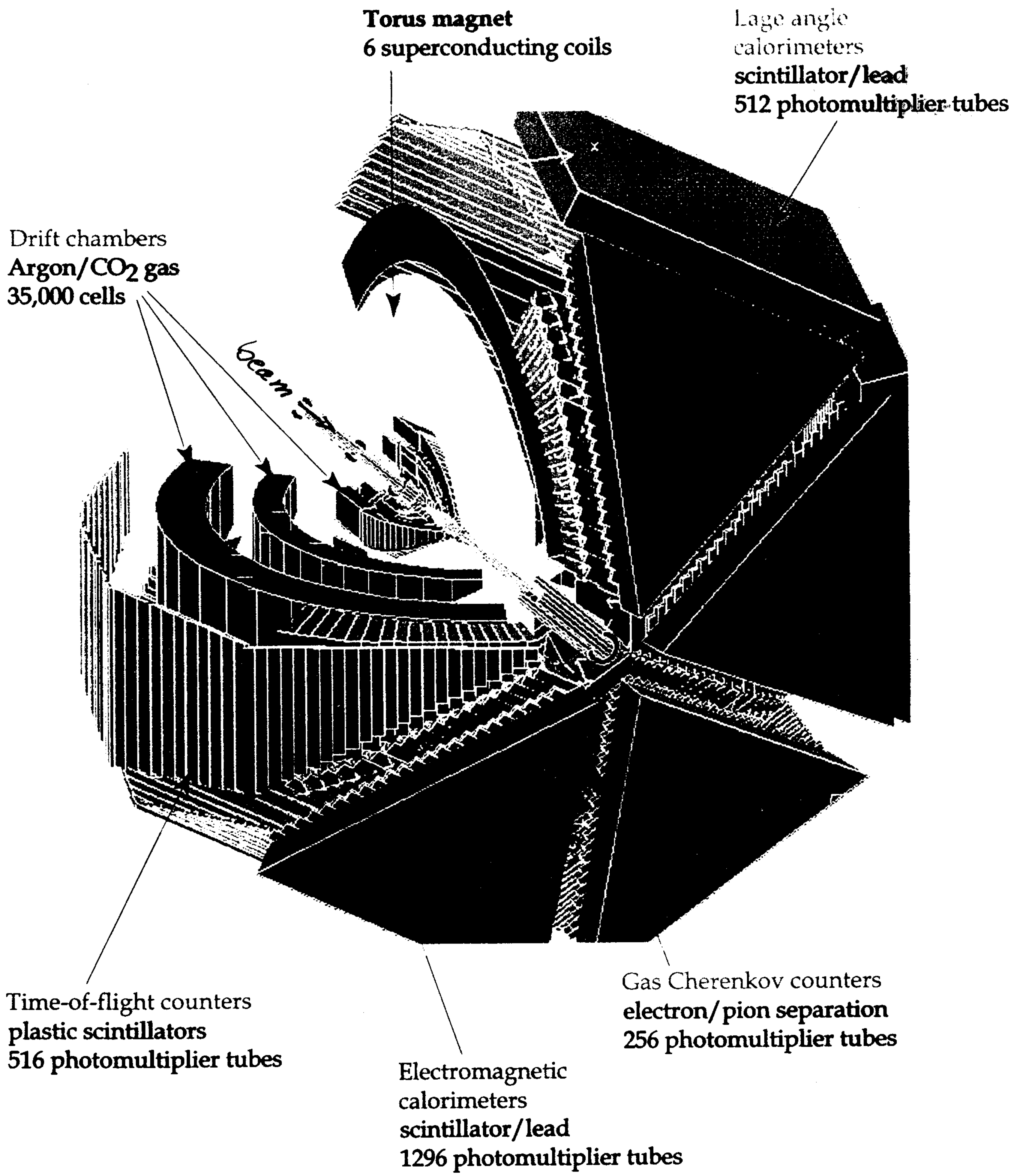
Hall B Status
Equipment Limitations
Upgrade Plans
Summary

CEBAF Large Acceptance Spectrometer



HALL B STATUS

Hall B equipment taking physics data since December 1997

1. CLAS running at $\approx 10^{34} \text{cm}^{-2} \cdot \text{sec}^{-1}$ design
   - tracking resolution close to expected values
   - particle identification close to expectations

2. Tagging system commissioned and fully operational

3. Trigger

   Level I and Level II (adds tracking) trigger in routine use

4. Data Acquisition System

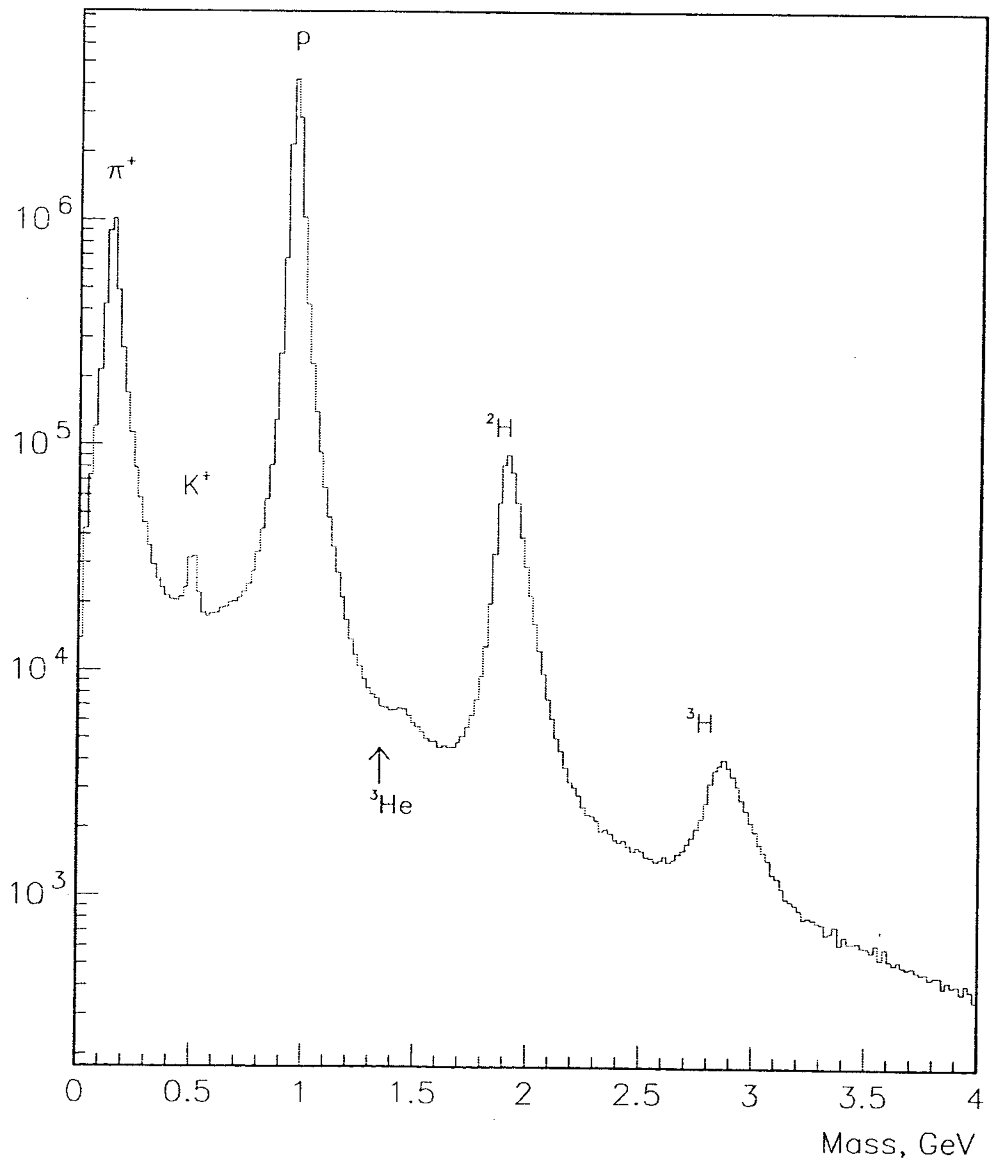
   has exceeded design specifications
   - up to 3,000 events/sec
   - up to 10 MBytes/sec transfer to permanent storage

5. Ten major production runs completed
   - e^- on hydrogen, ^{3,4}He, C, Fe
   - tagged γ on hydrogen, deuterium, ^{3,4}He
   - polarized e^- on polarized hydrogen and deuterium

Particle Identification in CLAS

via combination of time-of-flight and momentum

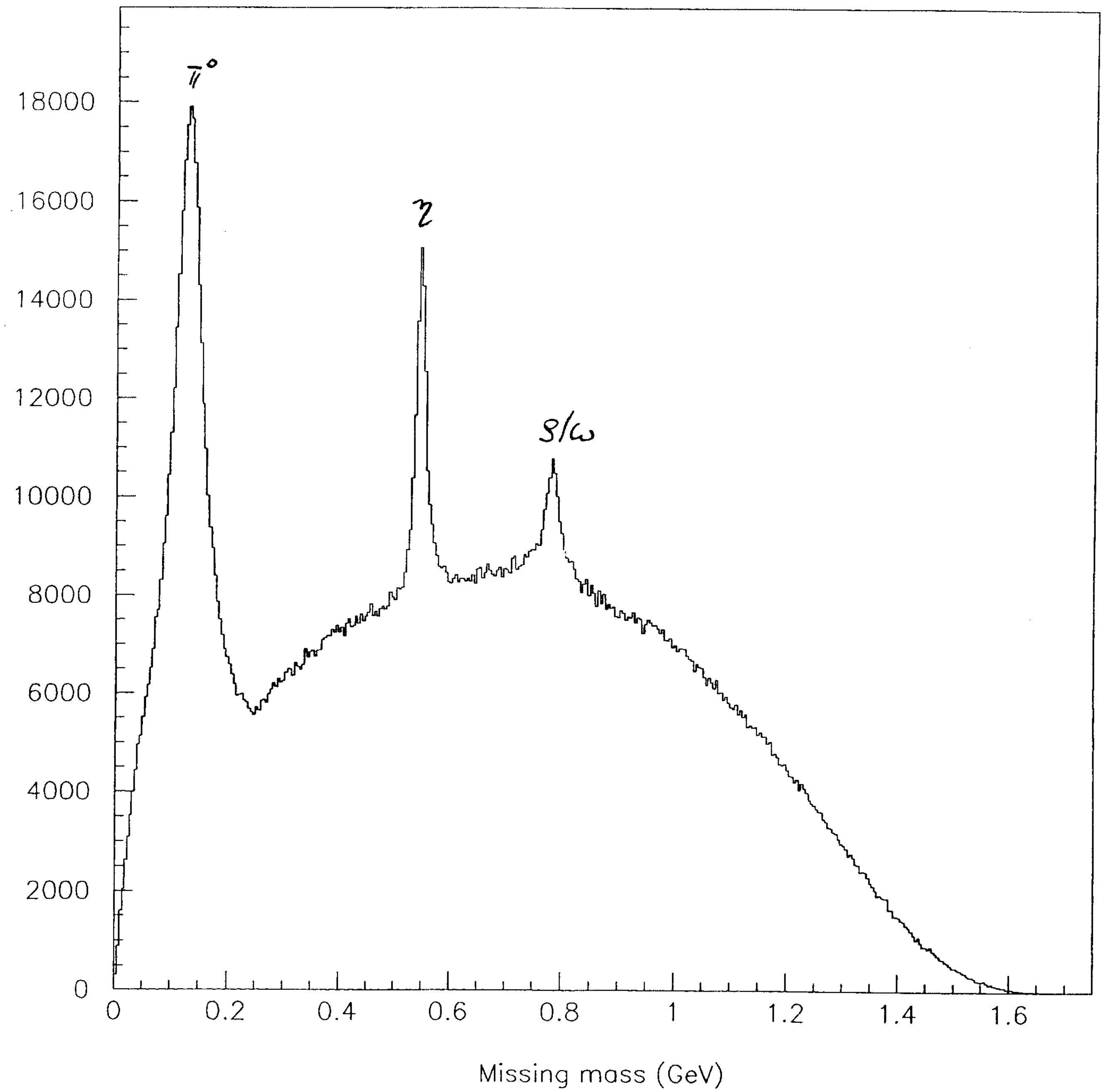
eg1 Run, $\vec{e}$ on $N\vec{H}_3$, $E_o = 2.5$ GeV



Missing Mass Resolution in CLAS

for $e\,p \rightarrow e'\,p\,X$

e1a Run, $E_o = 4.0$ GeV



GOAL OF HALL B UPGRADE PROGRAM

*** Maintain ability of CLAS to identify exclusive processes at high energy

Crucial for (examples):

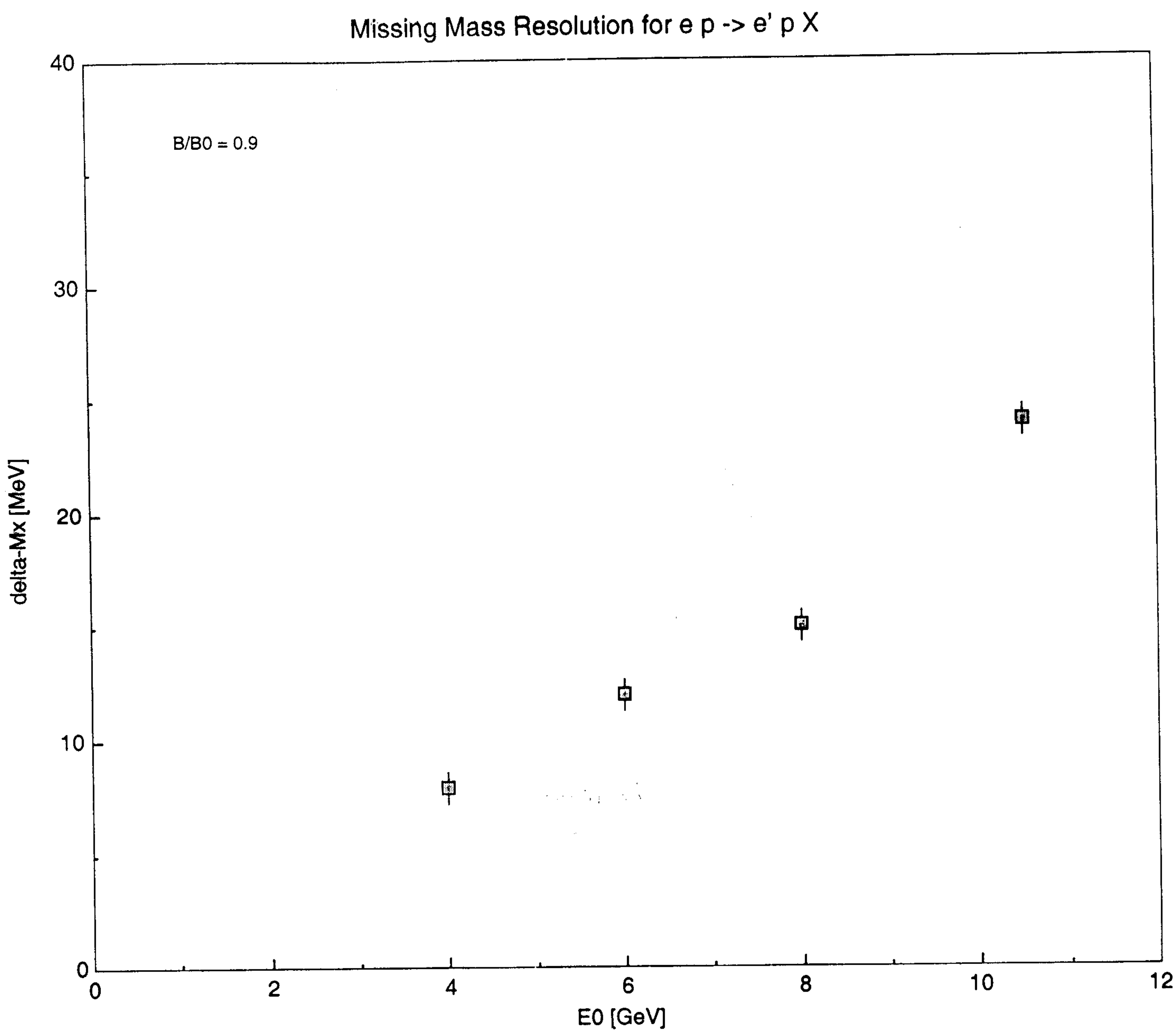
- measurement of Off–Forward Parton Distributions

  $e\, p \to e'\, N\, (\pi, \eta, \rho, \omega, ...)$

- flavor tagging of polarized spin structure functions

  $\vec{e}\, \vec{p}\, (\vec{d}) \to e'\, (\pi, K, \eta, ...)$

* Operate CLAS above the present $10^{34}\mathrm{cm}^{-2}\mathrm{sec}^{-1}$ luminosity (to compensate for lower cross section)


Missing Mass Resolution for e p -> e' p X
B/B0 = 0.9
delta-Mx [MeV]
0
10
20
30
40
E0 [GeV]
0
2
4
6
8
10
12

CLAS LIMITATIONS AT HIGH ENERGY

1. Incomplete coverage for multi-particle final states
   - charged particle detection limited due to torus coils
   - neutral particle detection limited due to torus coils and lack of large-angle calorimeters

2. Process identification more difficult
   - Particle ID
   - Missing mass resolution

→ Need to change strategy:

replace (or complement) missing mass technique by detection of hadronic final state

Limitation for tagged photon experiments:

3. Tagging system max. energy 6–7 GeV

COVERAGE FOR CHARGED PARTICLES

Angular coverage for magnetic analysis is limited by the torus coils

$\Theta =$ $10^o - 140^o$

$\phi =$ 40% of 2π at $\Theta = 10^o$
60% of 2π at $\Theta = 20^o$
80% of 2π at $\Theta = 90^o$

Would like to determine the directions of all charged particles.

Analysis options:

- veto events with incomplete determination of the final state (avoids contaminating lower multiplicity final states)
- reconstruct using kinematical fitting procedure

  one particle missing (only direction known) $\rightarrow$ 2-C fit
  (no assumptions on mass necessary)

  two particles missing (only directions known) $\rightarrow$ 2-C fit
  (need to make assumptions on masses)

Problem:

mini-torus has to be removed to get full ϕ-coverage

$\rightarrow$ have to come up with magnetic shielding that does not block useful solid angle

COVERAGE FOR NEUTRAL PARTICLES

Presently detect photons (and neutrons)

- up to 45^o in all six sectors (forward calorimeters)
- up to 75^o in 2 sectors (large angle calorimeters)
- ϕ-coverage is limited by the torus coils

Would like to measure photons over full solid angle

Possible solution: add photon detectors in front of torus coils

- would like coverage from $5^o - 45^o$ in Θ
- detector will have to be very compact (little space available)

  (ideally, detector should also give some information on charged particles, like energy deposition, range)

PARTICLE IDENTIFICATION

1. Kaon/pion separation
   - presently done by combining momentum and time-of-flight (limited to $p \leq 2\ GeV/c$).
   - for higher momenta: will require Cerenkov counter (aerogel radiator, RICH?).

2. Electron identification
   - presently done by combining energy deposition in the calorimeter and signal in Cerenkov counter
   - problem at high momentum: Cerenkov counters start recording pions above 2.7 GeV (C_4F_{10} gas)
   - options

     *** rely on calorimeter alone
     (relative resolution improves with increasing energy, use longitudinal and transverse deposition pattern)
     $\rightarrow$ π/e separation improves with increasing energy

     * use lighter gas (efficiency ??)

BREMSSTRAHLUNG TAGGING SYSTEM

Present bremsstrahlung tagging system limited to $E_o \leq 7\ GeV$

- difficult to replace due to high field strength required to get the primary beam to the 30^o degree dump line
- difficult to remove due to Hall B geometry

Present assumption:

experiments requiring tagged photons with $E_\gamma \geq 7\ GeV$ will be done in Hall D

CLAS HIGH ENERGY UPGRADE

Re-design inner detector package

1. Replace Region I drift chamber by new inner tracking detector with complete angular coverage and higher rate capability

   Conservative solution: conventional drift chamber technology
   (e.g.: self-supporting straw chamber segments)

   Solution requiring R&D: GEM drift chamber
   (radial drift space followed by GEM amplification stage with pixel readout)

2. Install calorimeters in front of coils

   Possible solution: short radiation length crystals ($PbWO_4$) with optical readout

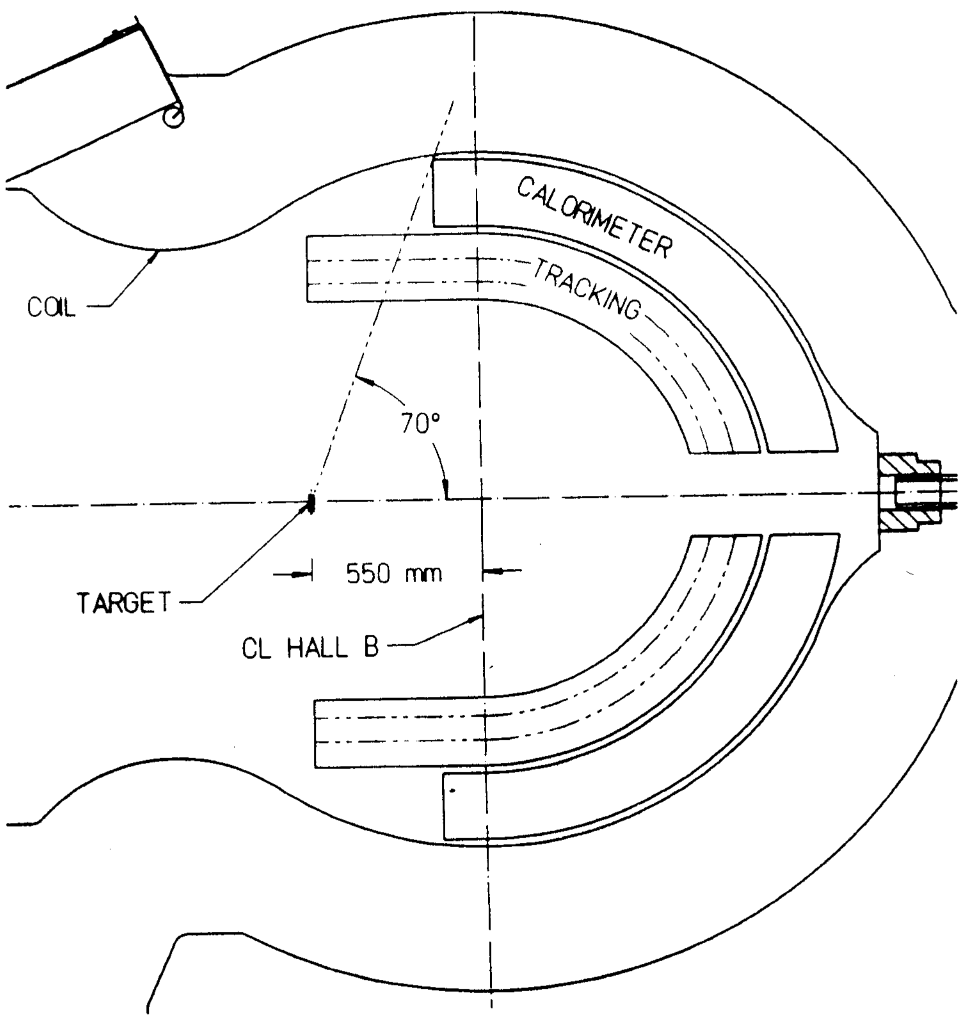
3. Particle identification

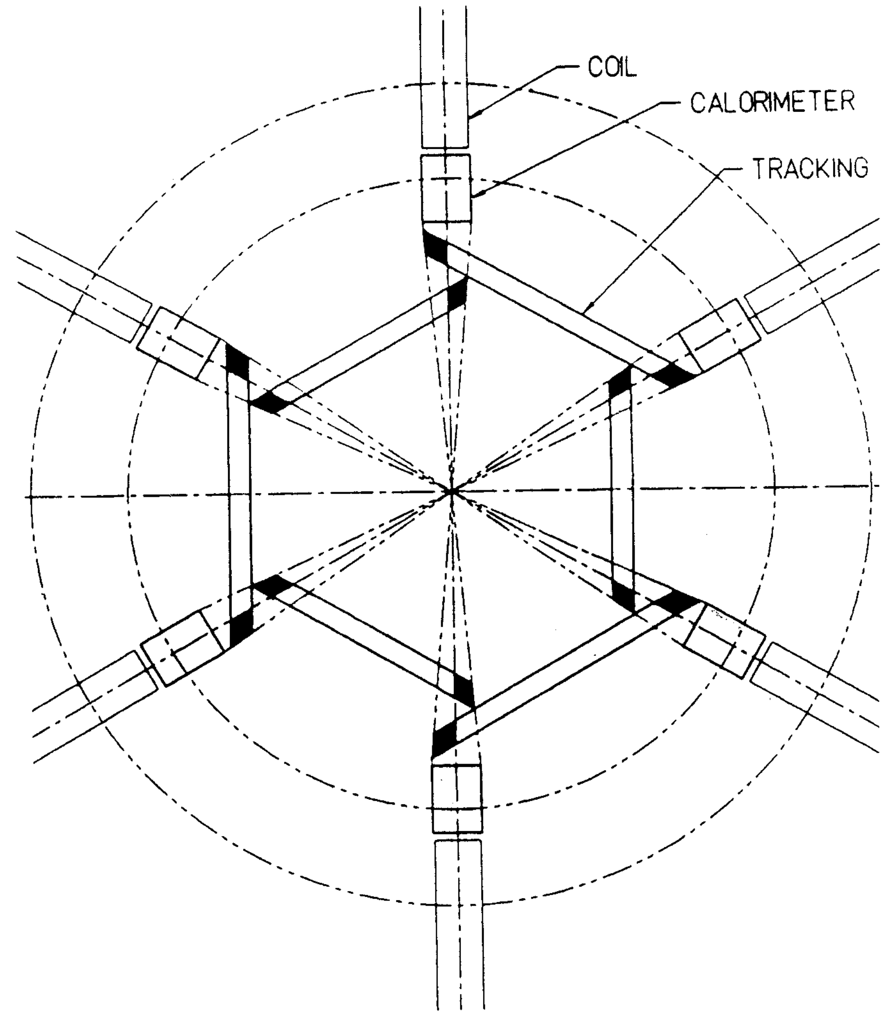
   Possible solution: aerogel RICH with photon detector readout (in front of tracking)

4. Options for the magnetic shielding of inner detectors:

   - a superconducting Helmholtz-type coil arrangement existence proof: 5 Tesla polarized target magnet used during eg1 running (shielding better than mini-torus)
   - a thin, small diameter superconducting solenoid surrounding the target and the beam line

POTENTIAL LAYOUT OF CLAS INNER DETECTOR





PRESENT ACTIVITIES

Simulation

o effort started to simulate physics processes and detector performance

Prototyping

o contract with RPI for prototyping RICH

o contract with ITEP for prototyping inner calorimeters

o first beam test of 5x5 lead-tungstate matrix in November '99 (on loan from Giessen, Germany, to NSU)

TO DO LIST

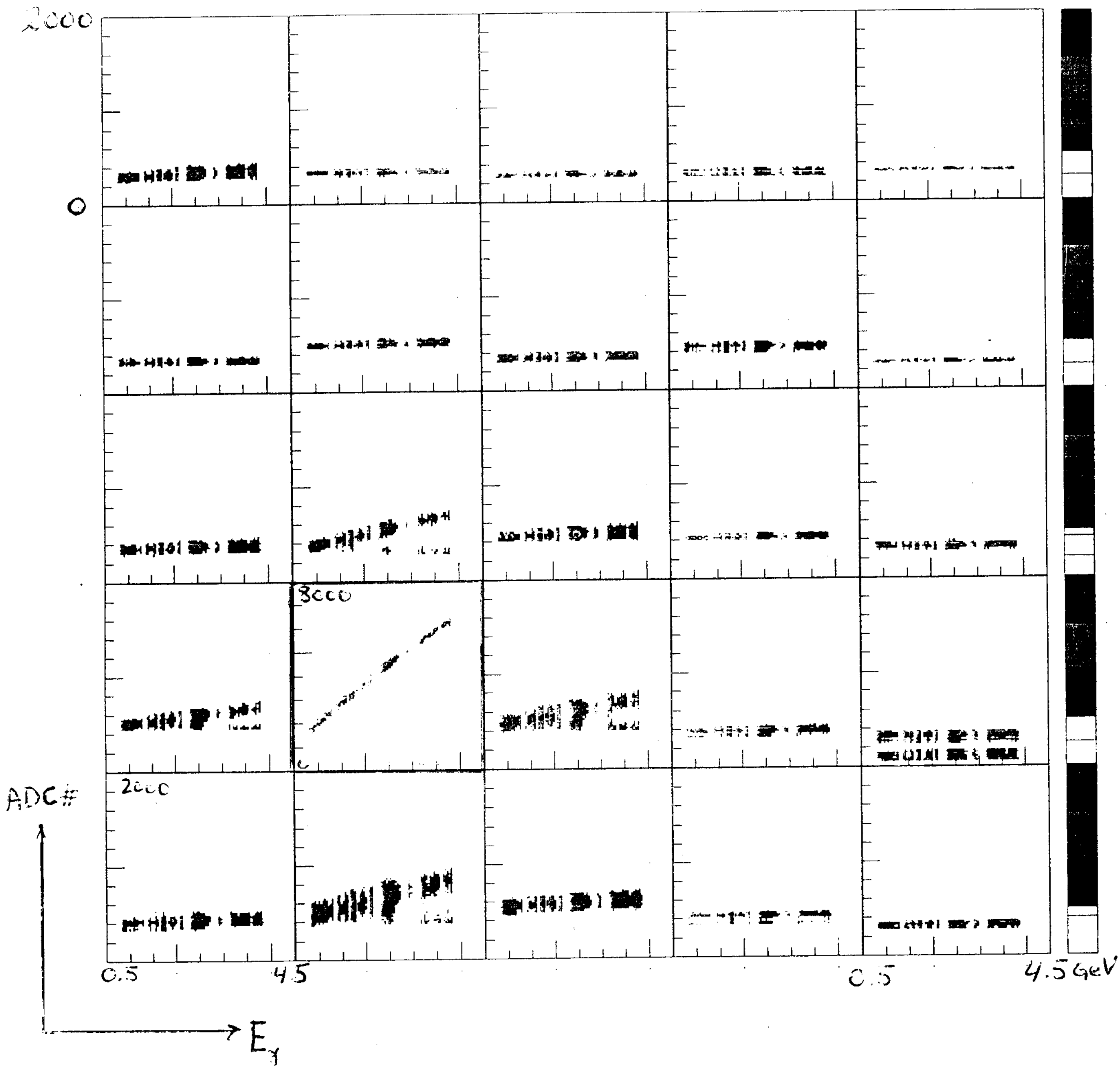
1. Develop detector concept and perform simulations of detector response for a few good physics cases
2. Build detector prototypes and perform beam tests
3. Cost, schedule, manpower
4. Set priorities for detector construction

Test of Lead-Tungstate Crystals

facility development time November 7 - 10, 1999

5x5 matrix (crystal size: 20x20x150 mm^3), cooled to 8^oC

tagged photon beam with $E_\gamma = 0.8 - 3.8$ GeV, collimated to 2 mm ø



SUMMARY

Status:	CLAS commissioned and fully operational (performance at or above design values)
Upgrade Goal:	Maintain CLAS' capability to identify exclusive final states at high energy
Solution :	Re-design inner detector package to give full coverage for charged and neutral particles
	Leave outer detector package as is