THE CLAS12 LARGE AREA RICH DETECTOR

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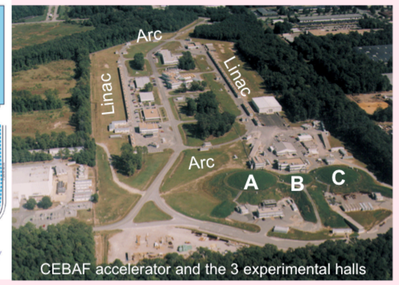
Jefferson Lab and CEBAF

Jefferson Lab at Newport News, Virginia, USA, investigates nuclear physics via electron deep-inelastic-scattering. It uses the "Continuous Electron Beam Accelerator Facility" (CEBAF) providing an electron beam with high polarization, high current and energy resolution.

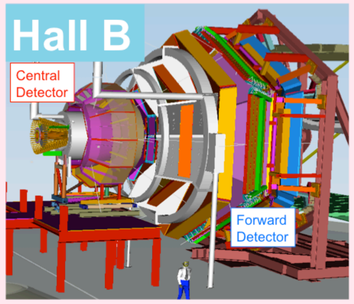


CEBAF accelerator and the 3 experimental halls

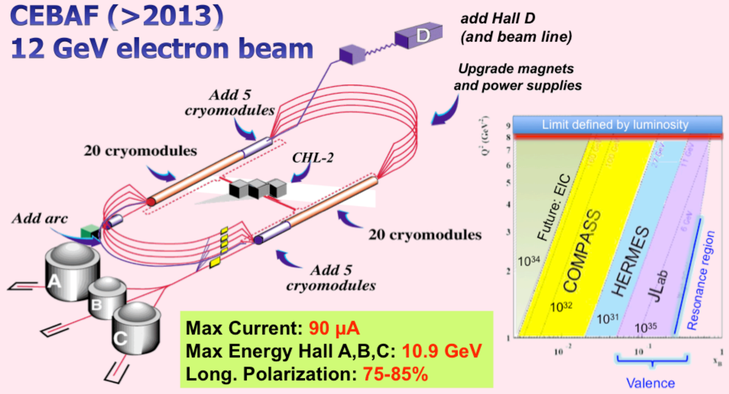
Hall-B

polarized H and D targets
large acceptance detector

Nucleon structure in 3D !!



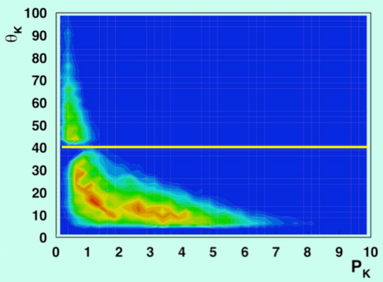
CEBAF (>2013) 12 GeV electron beam

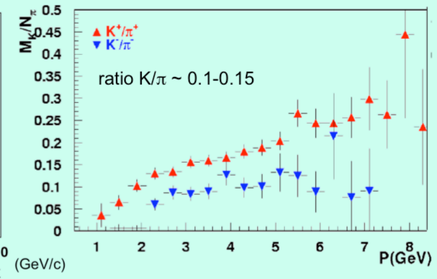


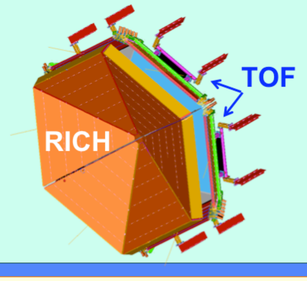
Max Current: 90 μA
Max Energy Hall A,B,C: 10.9 GeV
Long. Polarization: 75-85%

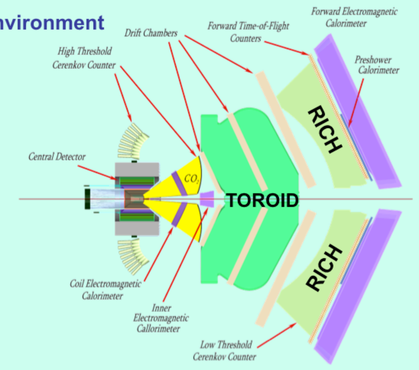
Basic Requirements

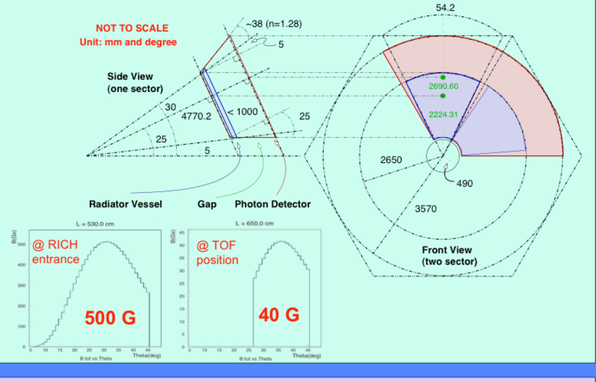
- up to 8 GeV/c momentum
- from 5° to 40° in polar angle
- π/K rejection factor > 100 (< 1 % π contamination)
- non invasive: small and uniform material budget (minimize interference with Time-of-flight detector)
- minimize photon detector surface (minimize cost)
- operate in large background environment
- projective geometry (6 radial sectors, ~ 1 m gap)











Proximity focusing option:

Aerogel radiator

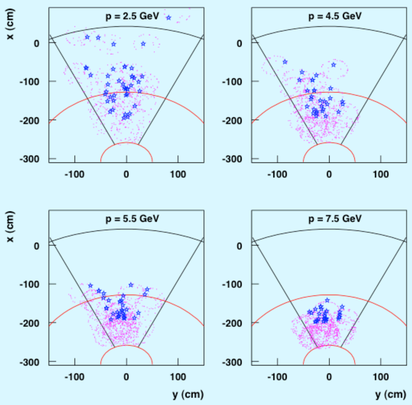
- 3 cm thickness
- 1.03 refraction index
- 40 mm transmission length

1 m long gap

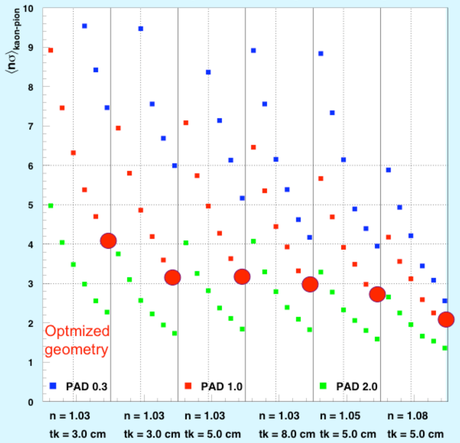
Photon Detector:

- around 12 m² surface (6 sectors)

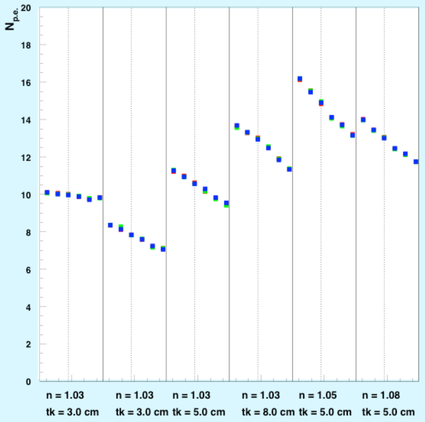
K-π separation > 4σ at 8 GeV with detector pixels smaller than 1 cm



Mean πk separation (5-8 GeV)

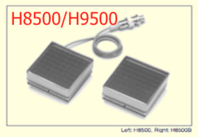


Mean p.e. number (5-8 GeV)



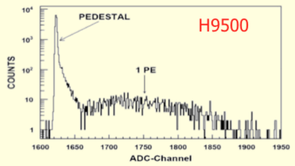
Photon detector option with light concentrators: (a` la COMPASS)

MAPMT's:

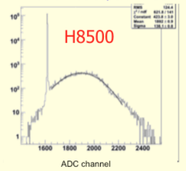


- Pros: excellent packing factor (89%)
- Cons: non optimized for single p.e. detection

R. De Leo, et al., NIMA(2009)



Paolo Musico, INFN-Ge



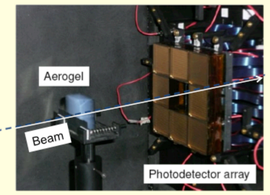
- Pros: optimized for single photon detection
- Cons: quite sizeble dead area (50%)

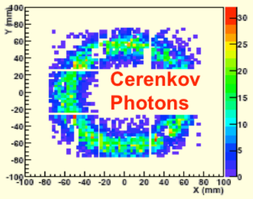
SiPM's:

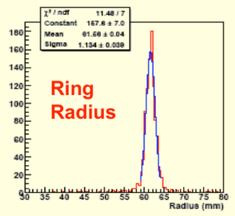
- Pros: robust and light device
- Cons: MHz noise and high sensitivity to tempera

use narrow time window to suppress background

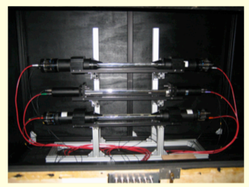
Test-bench at Bari







Test-bench at Genova



Under investigation: focusing mirror system

High momentum (> 6 GeV/c): direct light by proximity focusing

Medium momentum (3-6 GeV/c): reflected light by mirror system

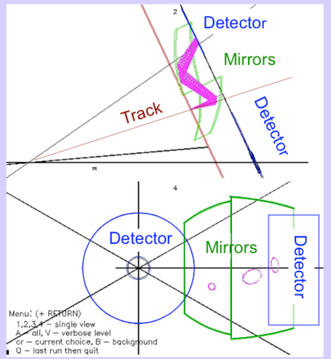
Low momentum (< 3 GeV/c): time-of-flight

Detector area reduced down to ~ 4 m² (6 sectors)

Reflecting outside

Challenge: concentrate light in a restricted area

Focusing mirrors ?



Reflecting inside

Challenge: reflected light largely adsorbed in aerogel

Partially reflective mirrors ?