Particle Identification (PID)

- Barrel, h-Arm, e-Arm
  - **GEM RICH, mRICH, dRICH, DIRC, TOF**
    - Pro/Con matrix
    - Requirements on "external" systems

Thomas K. Hemmick
Patrizia Rossi

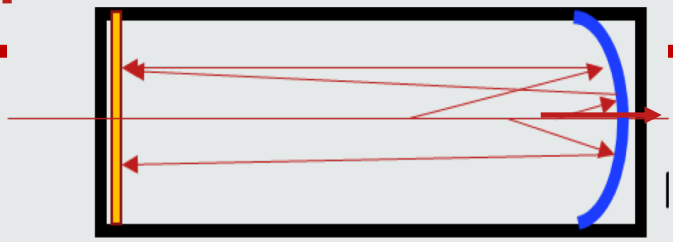
Summary Table

	p-Range (GeV) @ Radiator L	Contr. ϑ_c	Param.	Pro/Con	Ext Const	MONTECARLO Simulatoin
psec TOF LGAD TOF	Up to 10 Depends on σ_T and L	NO	~YES	YES	~ YES	NO
dual RICH (aerogel, gas)	2-60 @ 1.6 m	YES • Chroma • Emission • Pixel • Field • Tracking	YES	YES	YES • Simulated constant w/ momentum	YES • GEMC/Geant4 • AI-driven Optimization
GEM RICH (Gas Electron Multipliers)	20-50 @1m	• Chroma • (Emission) • Pixel • Tracking	YES	YES	YES	YES
modular RICH (mRICH)	2-10 @ 3 cm	YES • Chroma • Emission • Pixel • Tracking	~YES	YES	YES (tracking)	~YES • GEMC/Geant4 work in progress
Detection of Internally Reflected Cherenkov (DIRC)	0.8-6 @ 1.7 cm	YES • Tracking • Mult. Scat • Chroma, Emission, pixel	YES	YES	YES	YES • GEMC/Geant4 without B-field

High Momentum GEM RICH

H. Klest

- 1m of CF_4 radiator at 1.003 bar (slightly overpressure)
- CsI Photocathode on top GEM
- Particles ~perpendicularly incident on spherical mirror, focused onto a GEM stack directly

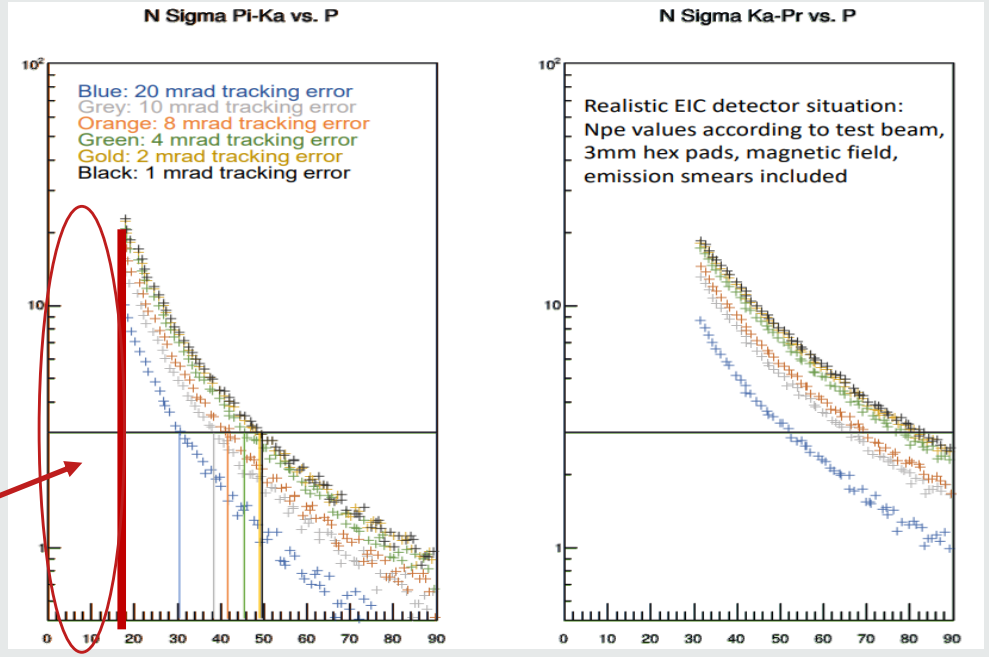


Pro

- Sensor insensitive to B-field
- Short (12pe/m windowsless)
- Thin photo-cathode leads to more ideal optics.

Con

- Unknown how to bridge the gap in π-K
- Loses light with contaminants @ few ppm level -> requires superb gas system
- Photo-cathode in high radiation zone.



- Tracking is leading error contribution if worse than ~7mrad.
- Negligible resolution factor around 2 mrad.
- Between 2 and 7mrad , more detailed investigation is required.

- More detailed simulation required

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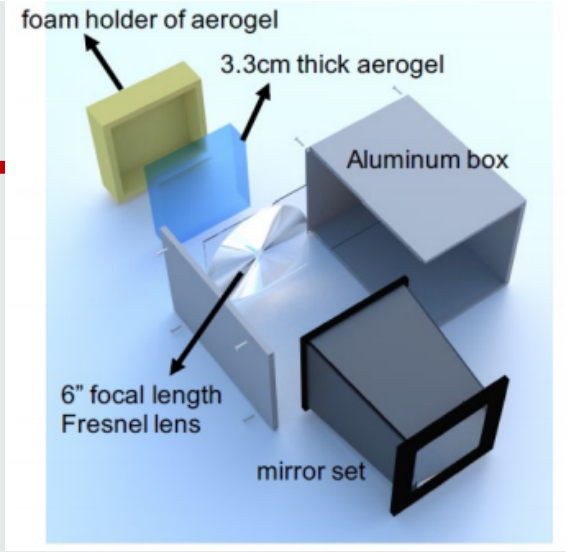
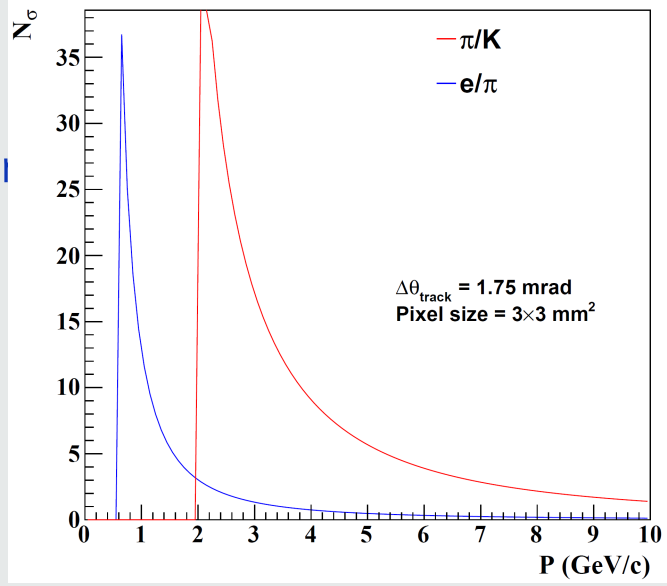


mRICH

X. He
M. Sarsour

- 3 cm aerogel radiator (n=1.03)
- Lens with focal length, f = 6"
- 3mm pixel size photon detector



Pro

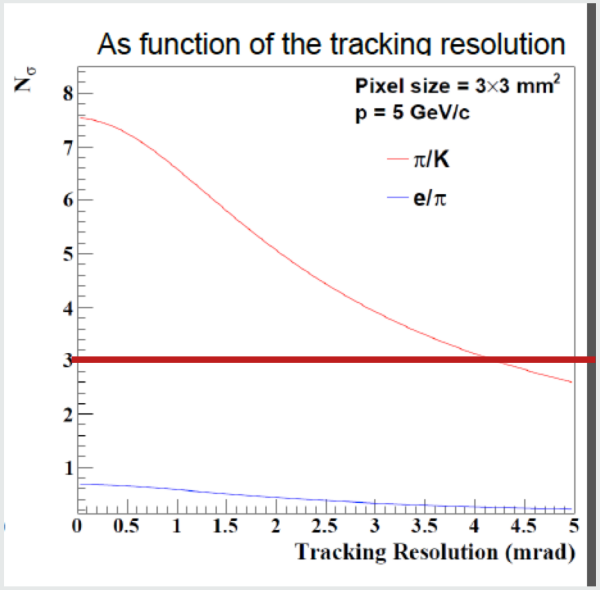
- Momentum coverage 3-10 GeV/c
- Modular design
- Can provide time measurements with proper sensors?

Con

- Photon sensors in high B field
- Sensors and readout electronics in the detector acceptance -> radiation hardness concern

- More quantitative estimate of dead area (foam holder/box/Fresnel corners).

- e/π excellent at lowest p
- Can be configured differently for e/π or π /k separation
- Tracking resolution not highly demanding



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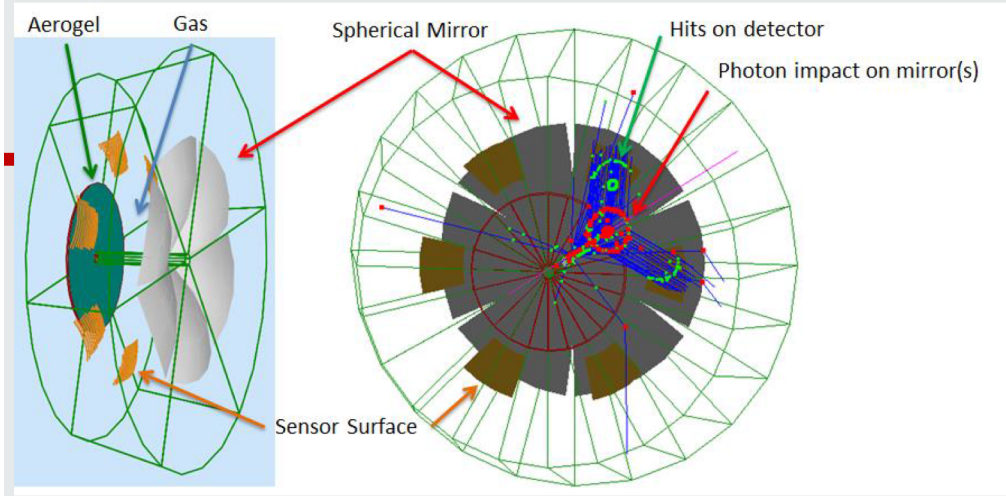
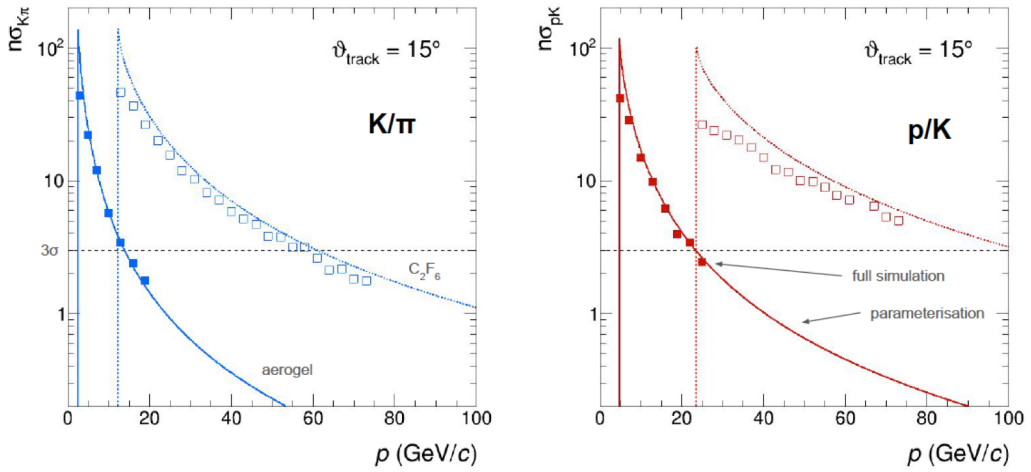
dRICH

E. Cisbani
M. Contalbrigo
R. Preghenella



- 4 cm aerogel (n=1.03) + 160 cm C_2F_6
- Mirrors
- 3mm pixel size 200-500 nm MAPMT



K/π and p/K separation as a function of momentum

Pro

- > 3σ π/K separation in 3-50 GeV/c
- Photon detector out of acceptance
- Material budget likely smaller than 2 detectors solution

Con

- More demanding PID
- R&D on photon sensors needed
- Aerogel chromatic performance critical
- Gas procurement could be an issue

- More quantitative estimate of the material budget

- Exquisite detail in simulation
- AI-based optimization
- Good parametrization

External assumption

- Constant external angular resolution: s=0.5mrad
- Momentum resolution:+/- few %
- Magnetic field : 3 Tesla.

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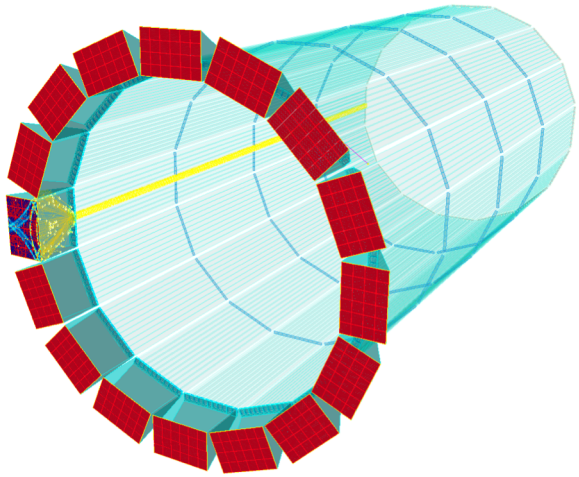
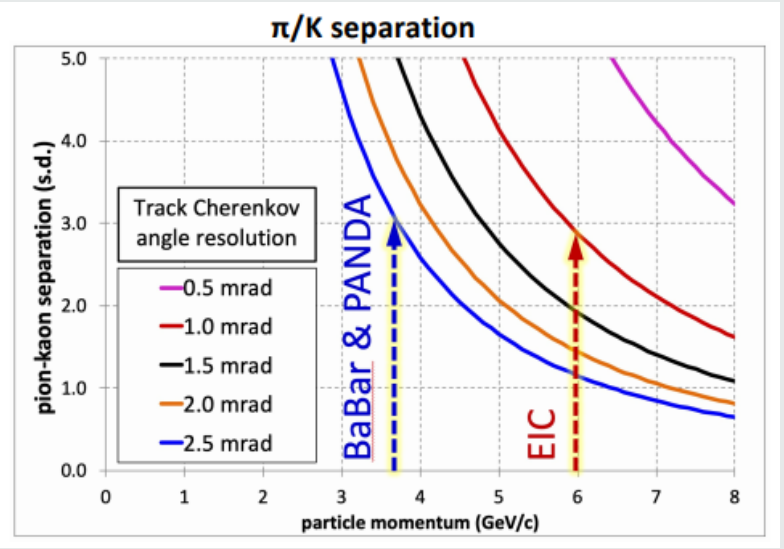


DIRC

G. Kalicy
J. Schwiening

- 1m barrel radius, 16 sectors
- 176 bars of synthetic fused silica,17mm (T) ´ 32mm (W) ´ 4200mm (L)
- Photo sensors: MCP-PMTs -3x3mm2 pixels



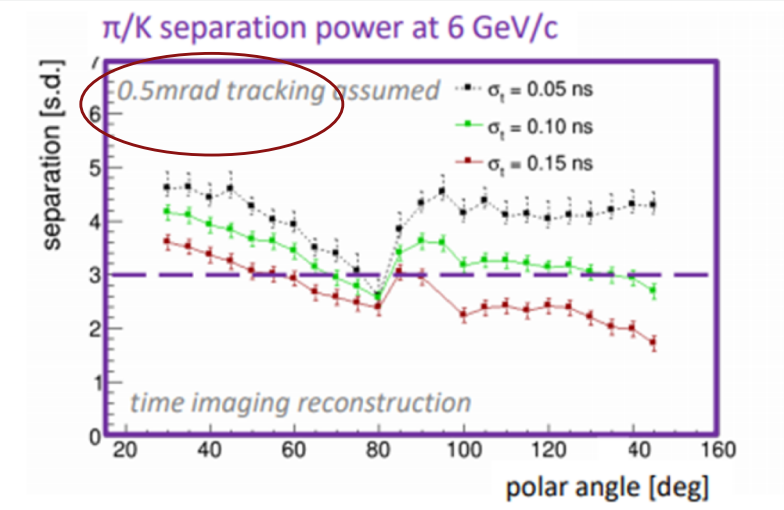
Pro

- Excellent performance over wide angular range: >3σ π/k up to 6 GeV/c; low mom e/π (3σ @ 1 GeV/c)
- Radially compact
- Supplemental ToF measurement

Con

- Potential challenge of integrating expansion volume
- No currently proven sensor solution for 3 T magnetic field

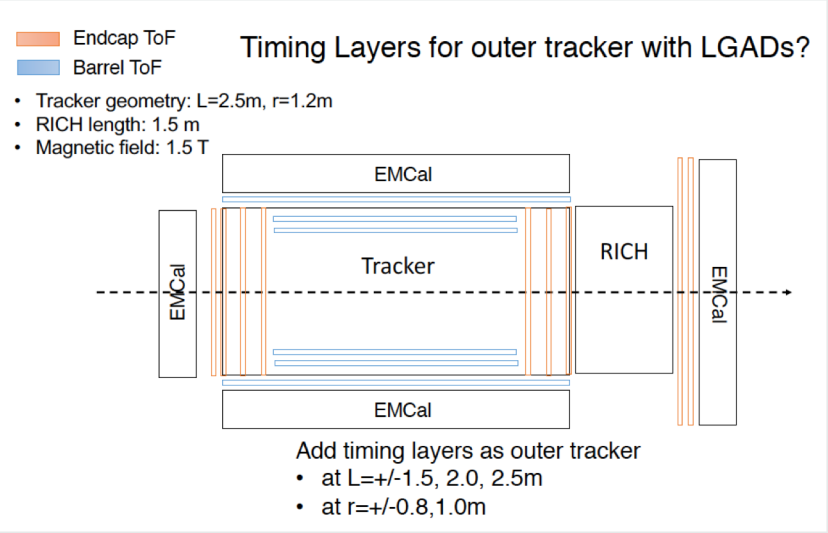
- More R&D on sensors

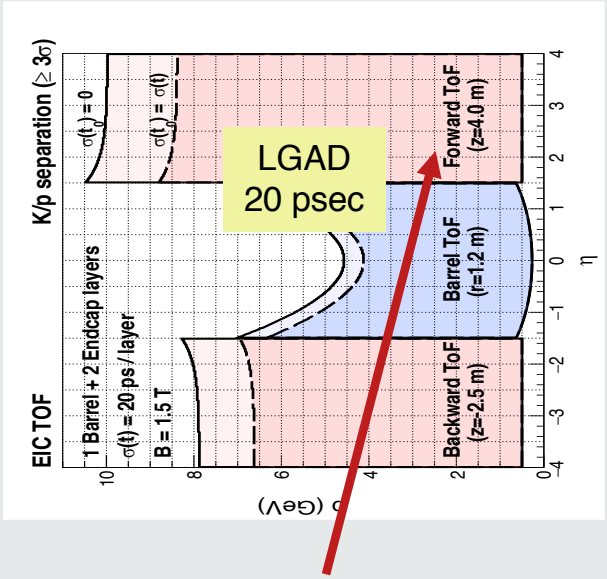


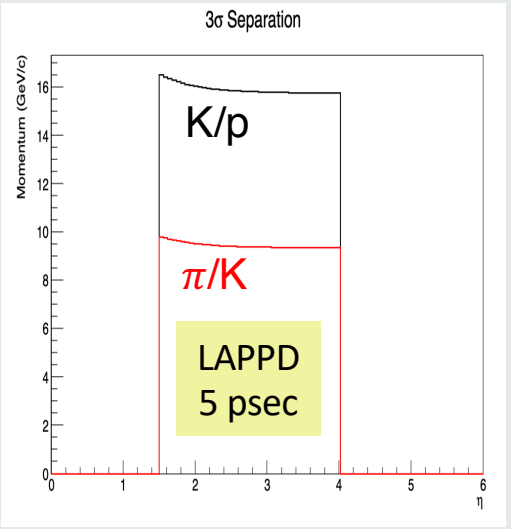
Lab

psTOF

M. Chiu
W. Li



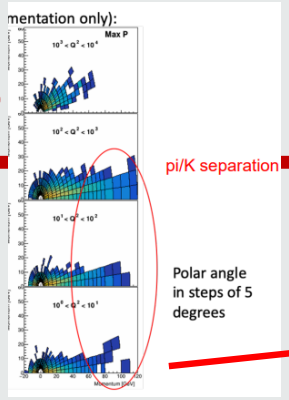


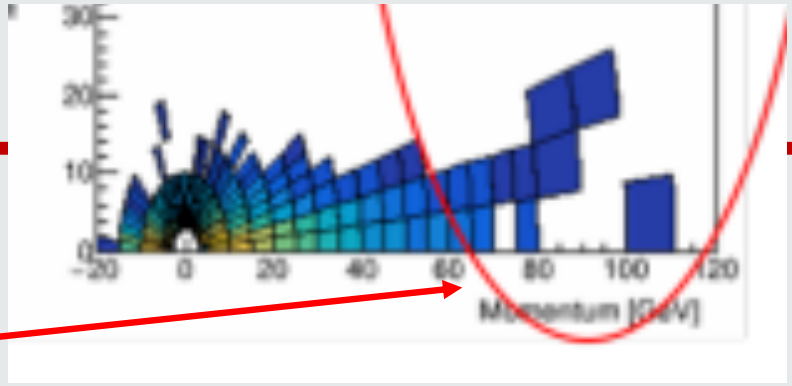


- **Multiple technologies (two examples):**
  - **LAPPD:** best σ_t B-field ~⊥, moderate pixel size
  - **LGAD:** excellent σ_t field tolerant, tiny pixels

- Assumes 4m flight path (conflict?)
- Time resolution very challenging
- Multiple scattering may contribute path length uncertainty (coupling to tracking)
- Requires understanding of t_0 counter

Conclusions





- PID is challenging!
- Tracking requirement for Cherenkov indicates 0.5 -1.0 mrad level
- Good progress but still some open questions:
  - Simulations are still preliminary except for a few detectors
  - Sensors and electronics in the detector require an evaluation of radiation hardness.
  - R&D on photon sensors is on going (magnetic field tolerance a primary concern: Visible light sensor solution for 3T magnetic field problematic.)
  - No discussion on the material budget
  - Available space is a driving concern for some technologies.
    - Shifting vertex is expensive, but helps most technologies in hadron arm.
    - Need quantitative optimization of cost/benefit
  - Resolution for TOF includes multiple terms in addition to superb σ_t
    - Clock reference/distribution
    - Path length.
- Address e-π separation between now and the next YR meeting
- Work on PID detector envelop