Progress Report RICH

Simulation with Real Data from GDH exp.

Rome/Sanità Group

24 Aug 2006

News (including July report)

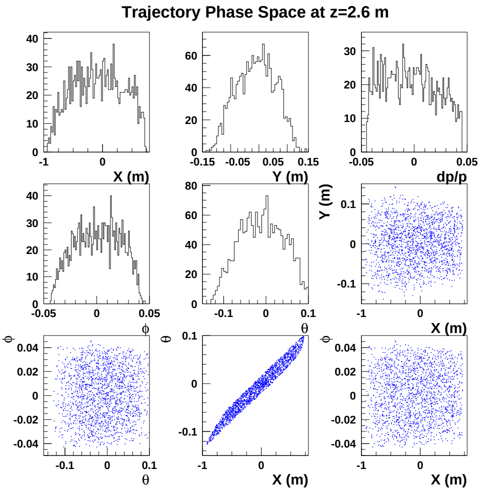
- Simulation with real charge particle trajectories (GDH exp.); first results
- Discussion with Kees and Jack for Jack time allocation next year
- Details from Jack on RICH installation and survay on Hall A, HRS-Left for RICH housing
- Double (independent) check of the analytical computation of the freon heating in the RICH radiator vessel (and very preliminary Finite Element 2D analysis)
- Estimatation of A1 and A2 acceptance efficiencies (using real data)

Real Tracks Simulation / Inputs

- Data from gdh_nt_02698.rz (Karl Slifer) E = 4238.6 GeV, Ep = 1767 GeV
- Particle Momentum scaled to 2.4 GeV/c
- MonteCarlo normalized to the Hypernuclear results (detector at 2.6 m from focal plane, Ep = 2 GeV, LeRose optics with septum included): normalization may be slightly overestimated for real data → following results maybe a little bit conservative.
- To speed up the simulation, we used a small subset of Slifer data (approx. 10000 events); statistic seems to be more than enough.

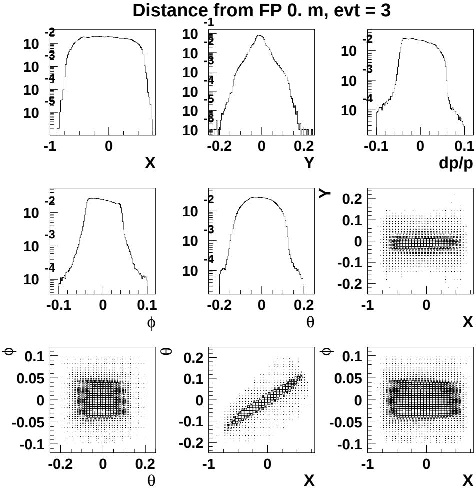
Charge Particle Phase Space

LeRose Optics



Charge Particle Phase Space

Subset of real data from Slifer



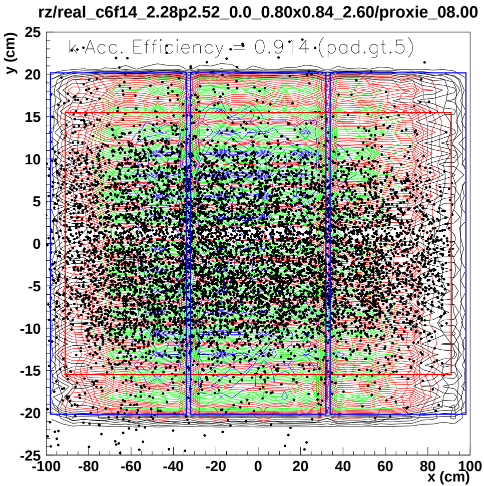
Real Tracks Simulation / Results / Phase Space

C6F14 RICH at 2.6 m (hypernuclear exp.): acceptance efficiency $\sim 91\%$

Blue boxes: photochatodes
Red box: radiator entrance window
Black points: charged particles
Contours: photoelectrons distribution

x and y not on scale

NOTE: the RICH acceptance can be still improved moving the detector few cm left



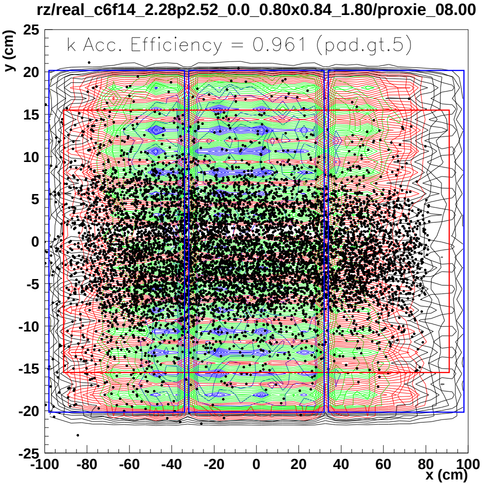
Real Tracks Simulation / Results / Phase Space

C6F14 RICH at 1.8 m: acceptance efficiency $\sim 95\%$

Blue boxes: photochatodes
Red box: radiator entrance window
Black points: charged particles
Contours: photoelectrons distribution

x and y not on scale

NOTE: the RICH acceptance can be still improved moving the detector few cm left



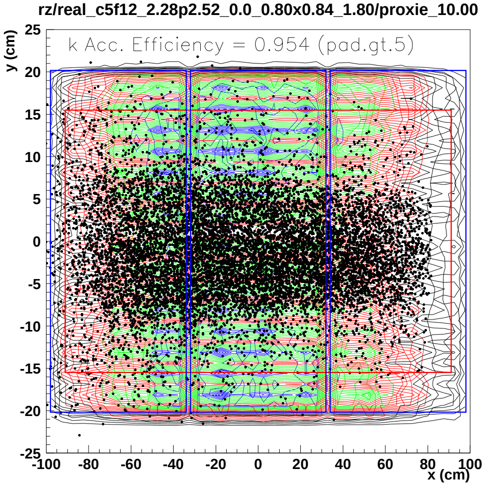
Real Tracks Simulation / Results / Phase Space

C5F12 RICH at 1.8 m (choosen option): acceptance efficiency $\sim 95\%$

Blue boxes: photochatodes
Red box: radiator entrance window
Black points: charged particles
Contours: photoelectrons distribution

x and y not on scale

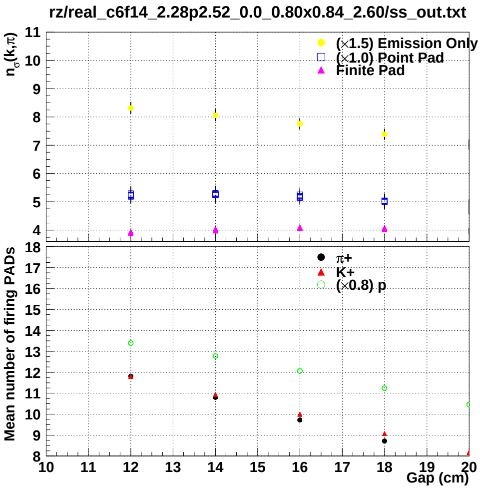
NOTE: the RICH acceptance can be still improved moving the detector few cm left



Real Tracks Simulation / Results / n_σ

C6F14 RICH at 2.6 m (hypernuclear exp.): $n_\sigma \sim 4.0$, (4.1 with LeRose data)

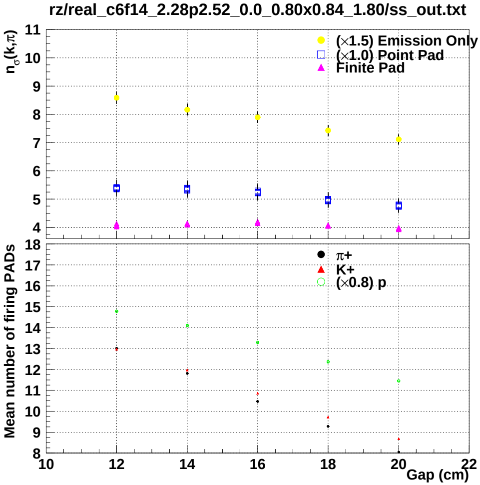
See pink triangle upper plot.
n_σ measure the distance between the kaon and pion reconstructed Cherenkov angle distributions
Larger the n_σ better the rejection.
$n_\sigma \sim 5.0$, rejection is already at $\sim$ 1:1000



Real Tracks Simulation / Results / n_σ

C6F14 RICH at 1.8 m:
$n_\sigma \sim 4.2$ (4.4 with LeRose data)

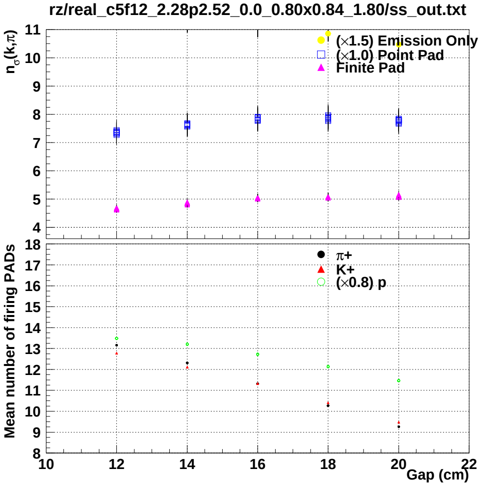
See pink triangle upper plot.
n_σ measure the distance between the kaon and pion reconstructed Cherenkov angle distributions
Larger the n_σ better the rejection.
$n_\sigma \sim 5.0$, rejection is already at $\sim$ 1:1000



Real Tracks Simulation / Results / n_σ

<u>C5F12</u> RICH at 1.8 m (choosen option):
$n_\sigma \sim 5.1$ (5.5 with LeRose data)

See pink triangle upper plot.
n_σ measure the distance between the kaon and pion reconstructed Cherenkov angle distributions
Larger the n_σ better the rejection.
$n_\sigma \sim 5.0$, rejection is already at $\sim$ 1:1000



Real Tracks Simulation / Results / Summary

- Results are slighty worse than those obtained with LeRose optics (phase space are almost similar); no significant degradation (within simulation uncertienties) respect to the previous simulations.
- Optimal gap length larger (2-4 cm) than LeRose optics.
- Realistic acceptance efficiency[a] have been estimated.
  Small glass spacers in the radiator vassel NOT included (approx. 1-2 % to be subtracted to estimated acceptance efficiency).
  In the worst case (at 2.6 m from Focal Plane) the acceptance efficiency is $\sim 90\%$
- Closer to the Focal Plane better the acceptance: the movement of the RICH to 1.8 m from the Focal Plane improves charge particle acceptance efficiency up to ~ 95 %

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[a] Acceptance Efficiency = (incident charge kaons with more than 5 photoelectrons) / (all charge particles)

Proposed upgrade 1/3

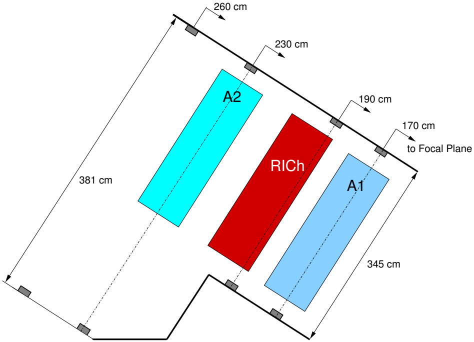
- Increase proximity gap ($\sim$ 5cm)
- Move the detector closer to the focal plane: according to our survey (thanks to Jack) in the detector hut in June: there are rails at about 1.9 and 1.7 m. The RICH can be moved at 1.9 m[a] with some efforts:
  - rearrange the location of some components of the freon circulation system
  - change the 'supporting arms' that fix the RICH to the rails
  - different positions of the A1 and A2 aerogel counters (new 'supporting arms' ?)

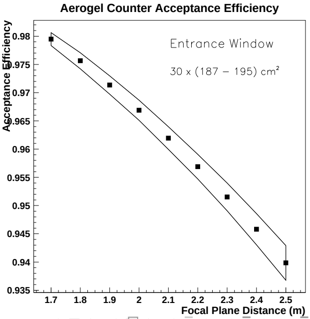
[a] The other position (1.7 m) may be more problematic, mainly for the freon circulation system.

Proposed upgrade 2/3

The final arrangment of the aerogels and RICH can be (see left figure):

- A1 at ~ 1.7
- RICH at ~ 1.9
- A2 at the next available rails (~ 2.3 m); aerogel acceptance efficiency should be about 95% (2% less than in Hypernuclear setup), see right figure





Proposed upgrade 3/3

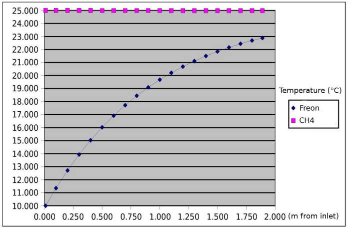
Freon System

- Use the C5F12 (lower refractive index): as already discussed, the following changes are required:
  - cooling system for the freon to be added to the existing circulation system
  - insulating the circulation system
  - (possibly) add forced cooling (fans) for the front-end electronics

According to our current analysis (still underway), cooling is not required inside the RICH

NOTE: the proposed upgrades are 'reversible'

we expect to come back to the existing RICH at any time in a couple of days (probably even less)



JLab Resources needed 1/2

Technical Expert: Jack Segal

- Design and realization of the cooling freon system ($\sim$ 30 days)
- modification of the RICH (and A1/A2 ?) detector 'supporting arms' in order to install the RICH in the rails closer to the focal plane (support from the Machine Workshop)
- Detector Installation (one day)
- Take care of the continuous flushing of the RICH during parking at JLab from the arrival of the evaporated photocatodes to the end of the experiment (few hours in 6 months or so)

DAQ expert: Bob Michaels

Do the job done by Bodo in the past, that is: integrate the RICH DAQ into the Hall A DAQ: same electronics and devices as in the past! No changes

Physics Coordinator for the RICH: ?

To be chosen (Kees is aware of the 'open position')

JLab Resources needed 2/2

Other

- Clean room for assembling the RICH components (1-1.5 months)
- Space for the Glove Box (near the clean room) (2-4 months)

We had a meeting with Kees and Jack where the involvement of Jack has been discussed. Both of them have agreed.
Franco has spoken with Kees about:

- Bob involvement
- a person as Physics Coordinator.

Kees is aware of the needs and will take care of them.

Preliminary plan

- before end 2006:
  - Repair the spare radiator vessel
  - Test of the cooled freon 'concept' in the repaired vessel
- before feb 2007: Frame spacer for the additional $\sim$ 5 cm gap will be built in Italy;
- apr-jun 2007: Jack will take care of the cooling system (support of our technicians, if needed);
- before may 2007: send to Jlab the repaired (spare) vessel and the frame spacer.
- may 2007:
  - evaporate the CsI on the photocatodes at Stony Brook University (the RICH houses 3 photocathodes but we would like to have some spare: we probably will evaporate 6 photocathodes).
  - control the quality of the evaporation (in situ) measuring the 'online' Quantum Efficiency.
  - (end may 2007) transport the photocathodes to JLab (with the Glove Box): continuous flashing or overpressure in the photocathodes boxes (to be decided).
- jun 2007: assembling the RICH and doing some cosmic tests; continuous flushing of inert gas required!
- sep 2007: installation in Hall A and short commissioning

Two months (end of june - beginning of september) of backup time for solving/recovering possible setbacks, delays ...