SHMS Heavy Gas Cerenkov

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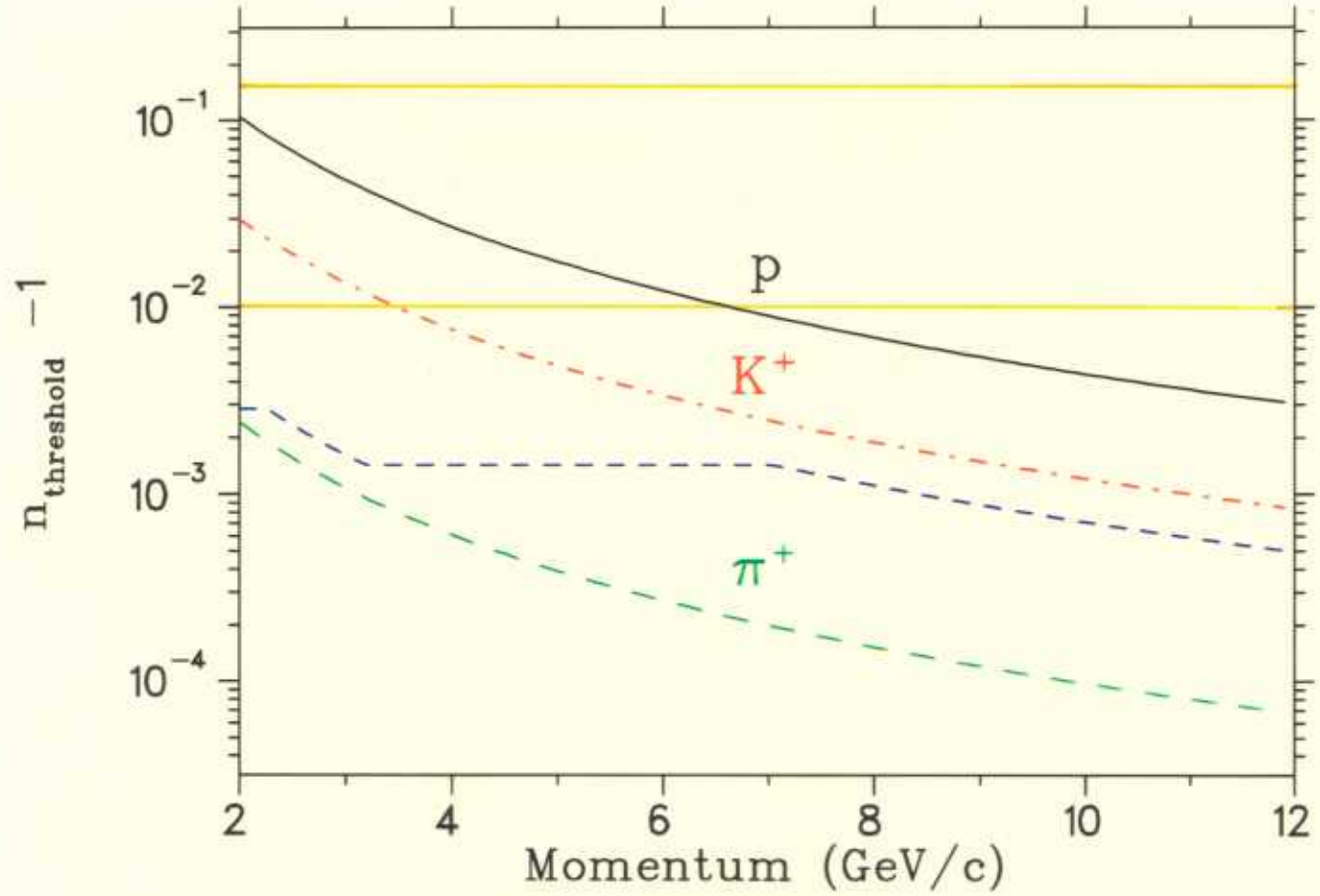
Introduction

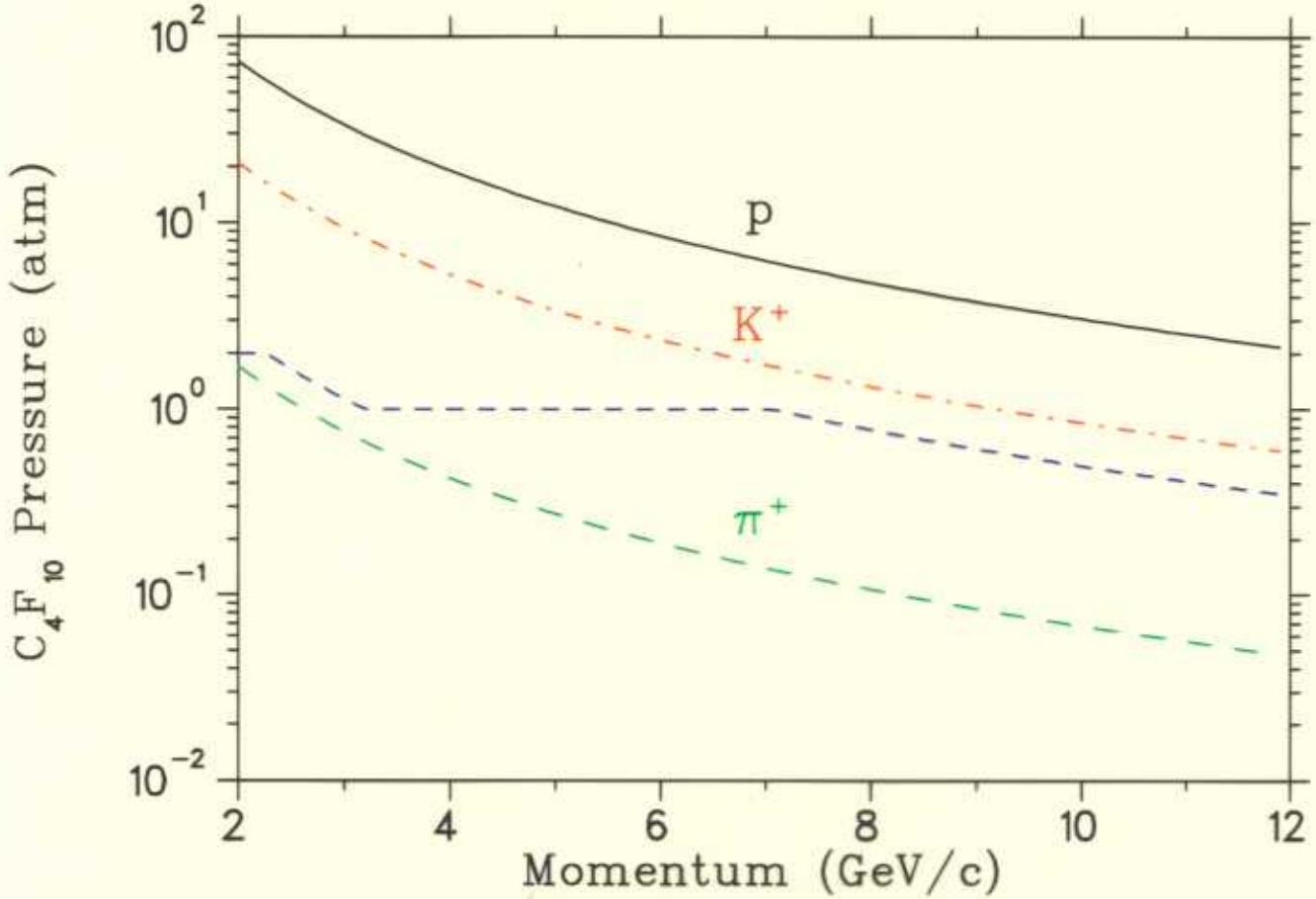
Many experiments planned for the Hall C after the upgrade require good $\pi^{\pm}$ identification in the SHMS.

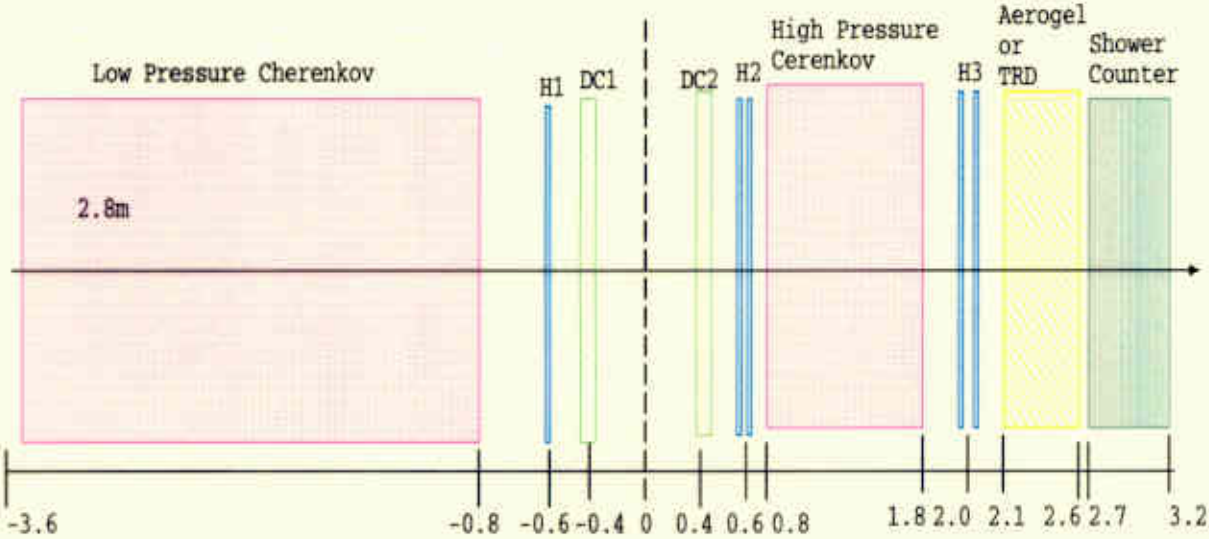
- Pion form factor.
  - With 11 GeV beam, the maximum π^{+} momentum in the SHMS is 8.1 GeV/c.
- Color transparency studies utilizing the $(e, e'\pi)$ reaction at large $z = E_h/\nu$.
- Fragmentation duality studies with semi-exclusive $\pi^{\pm}$ and $K^{\pm}$ detection in SHMS.
- Color transparency studies utilizing the $(e, e'p)$ reaction.
  - Require good π^{+} rejection capability for ejected high momentum nucleon.

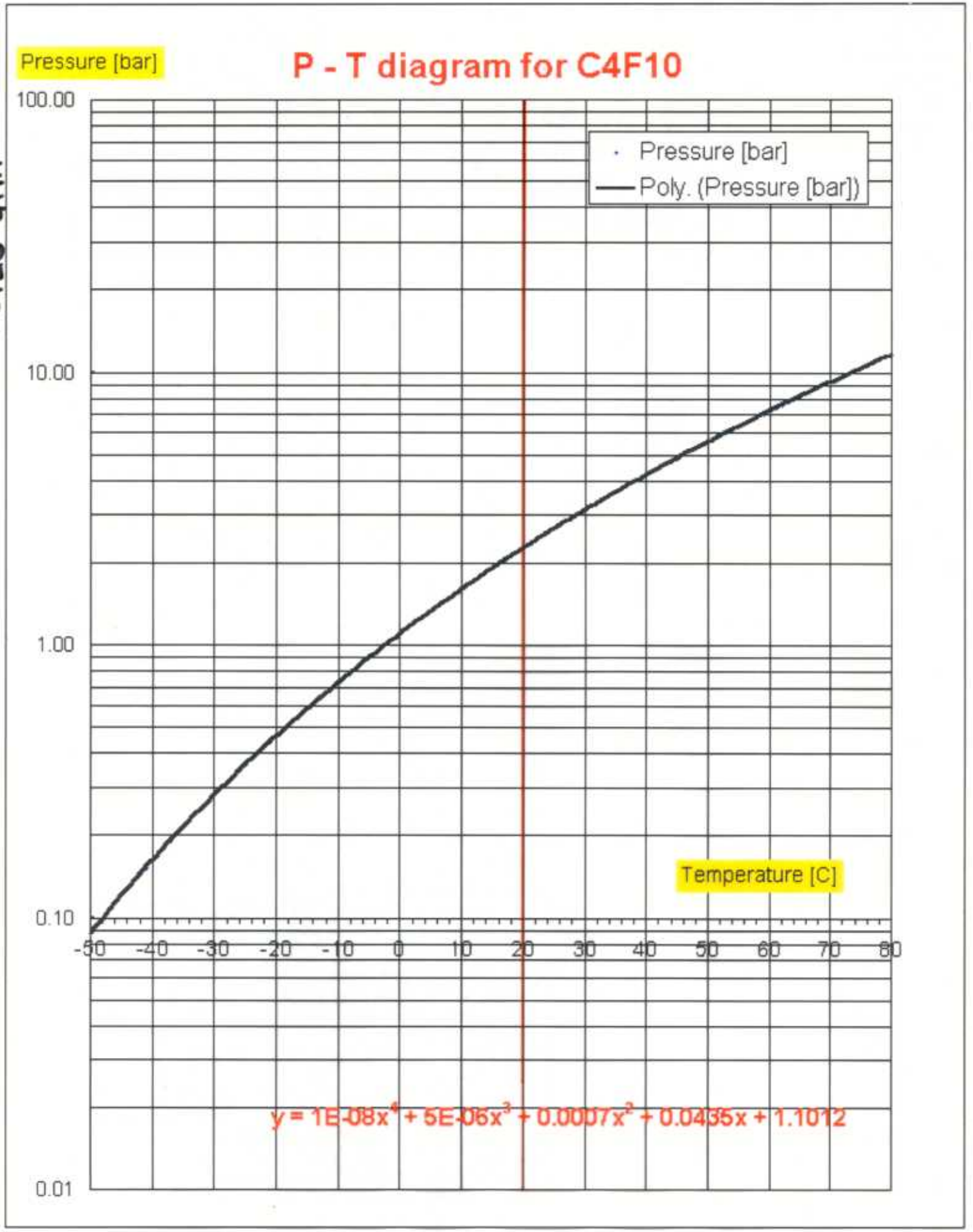
Above ~ 3 GeV/c, hadron species cannot be reliably distinguished by time of flight over the 2.6 m baseline planned for the SHMS detector stack.

- Good PID will therefore require a series of Cerenkov detectors, each with different n
  - $e^{-}/\pi^{-} \Rightarrow$ Low Pressure Cerenkov.
  - $\pi^{\pm}/K^{\pm} \Rightarrow$ Heavy Gas Cerenkov.
  - $K^{+}/p \Rightarrow$ Aerogel Cerenkov.


$n_{threshold} - 1$
10^{-1}
10^{-2}
10^{-3}
10^{-4}
p
K^+
π^+
2
4
6
8
10
12
Momentum (GeV/c)


C_4F_{10} Pressure (atm)
10^2
10^1
10^0
10^{-1}
10^{-2}
p
K^+
π^+
2
4
6
8
10
12
Momentum (GeV/c)


Low Pressure Cherenkov
2.8m
H1
DC1
DC2
H2
High Pressure
Cerenkov
H3
Aerogel
or
TRD
Shower
Counter
-3.6
-0.8
-0.6
-0.4
0
0.4
0.6
0.8
1.8
2.0
2.1
2.6
2.7
3.2

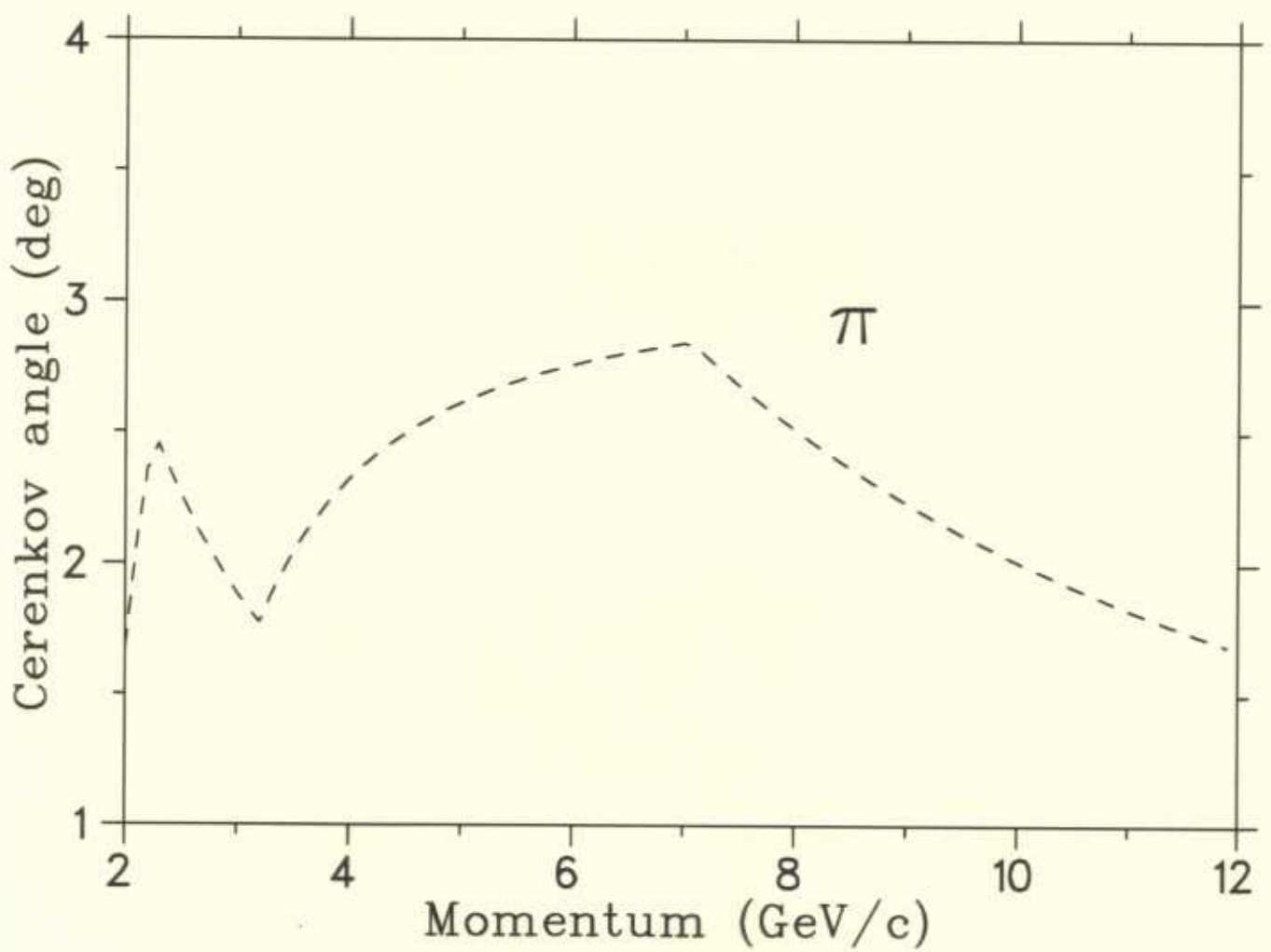


1 bar = 1.0125 atm

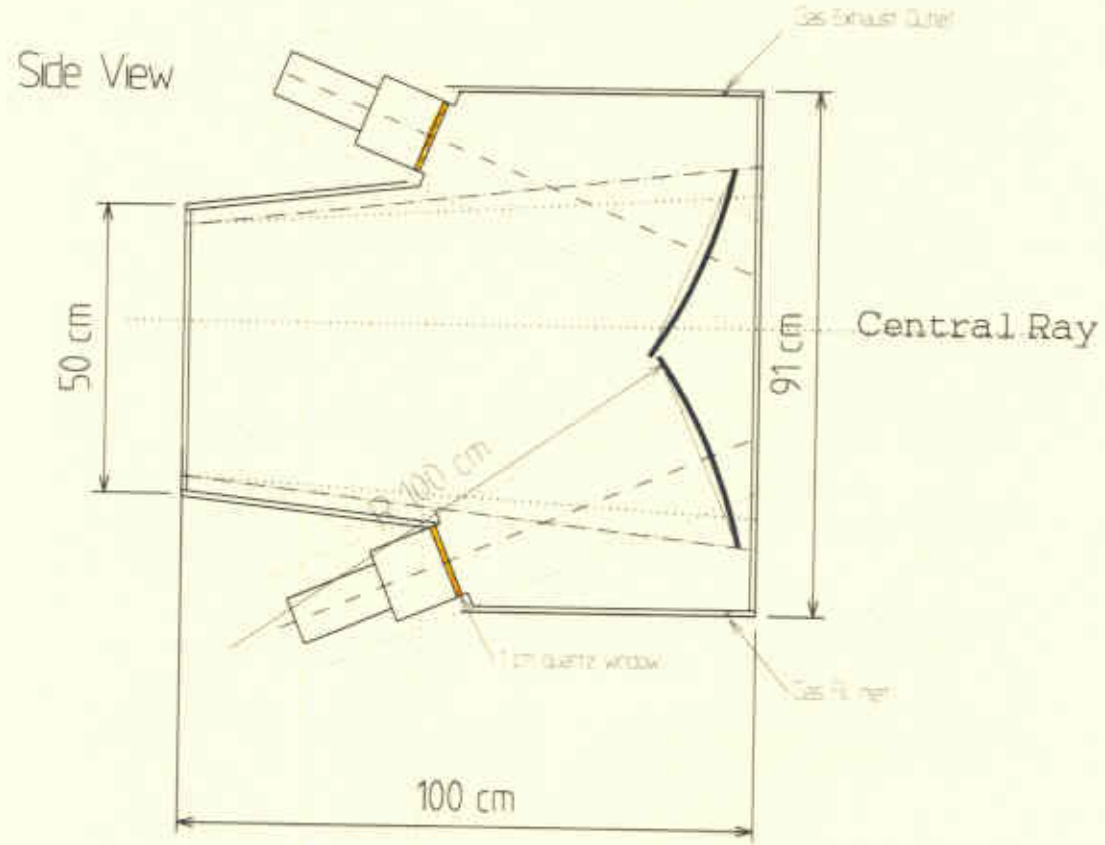
Constraints:

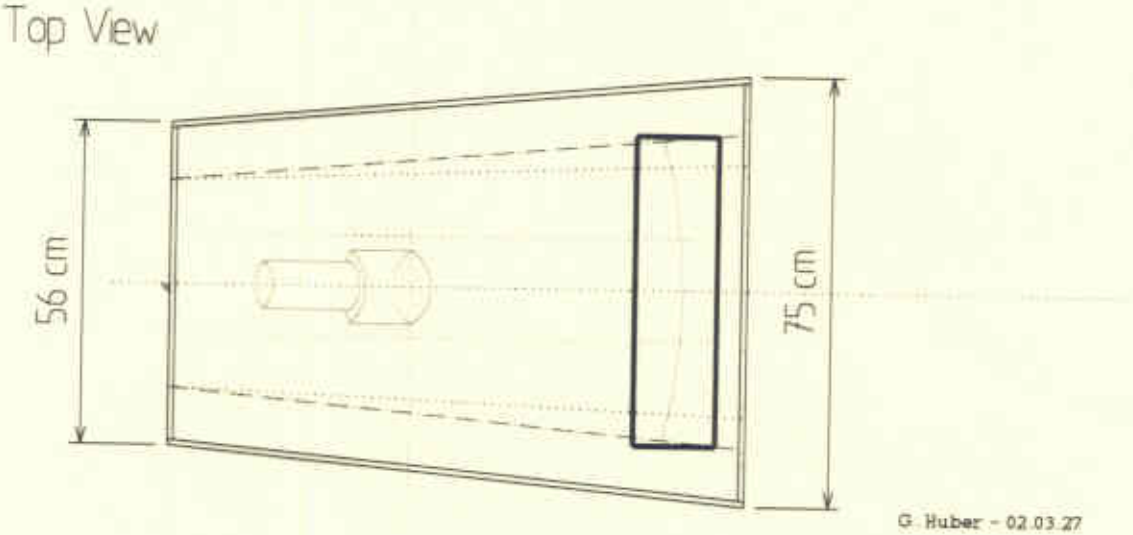
- Maximum pressure for π^+ but not K^+, to maximize Cerenkov light production.
- Detector pressure must be maintained below C_4F_{10} vapor pressure.
  - At 20^oC the vapor pressure is 2.3 atm.
- Allow a gas pressure set accuracy of 0.1 atm (1.4 psi) to protect against accidental trigger of detector by K^+.
- Take into account the $\pm 10\%$ SHMS momentum bite.

$$\mathrm{P}(\pi^+ : \mathrm{p_{SHMS}} - 10\%) \; < \; \mathrm{P}(\mathrm{K}^+ : \mathrm{p_{SHMS}} + 10\%) - 0.1 \; \mathrm{atm}$$



SHMS Heavy Gas Cerenkov

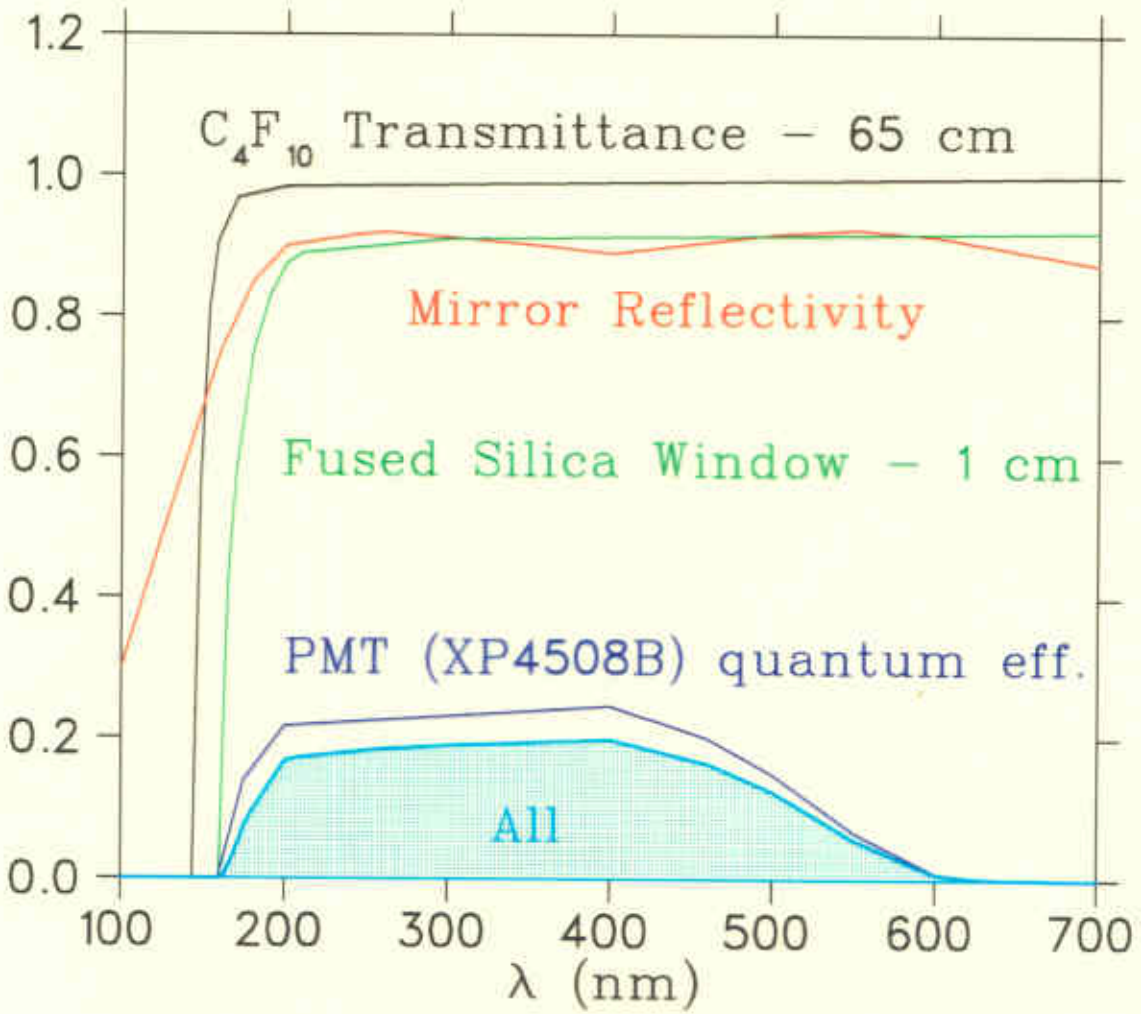


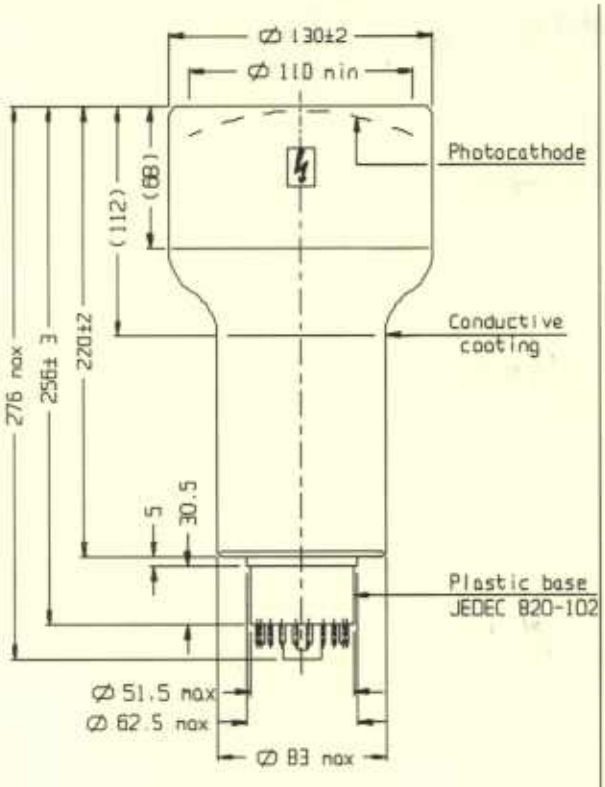


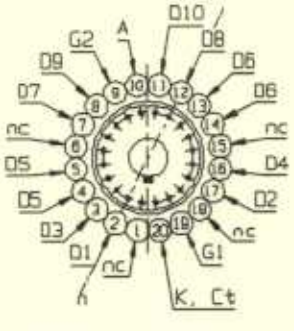
G. Huber - 02.03.27

Heavy Gas Cerenkov Components

- Two high quality thin glass mirrors, structurally reinforced outside beam envelope.
  - Reference aluminum mirror coating from Lambda/Ten Optics.
- PMT views enclosure through 1 cm thick UV-grade fused silica window.
- Photonis XP4508B flat face PMT, mounted flush to window.
- 0.020" titanium beam entrance and exit windows.
  - Windows must safely function with 1 atm differential in either direction.



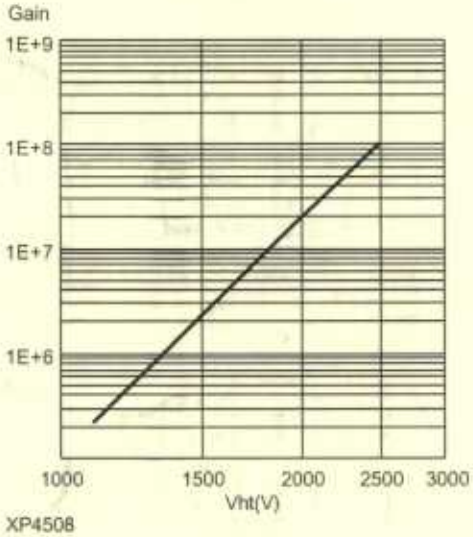




ref.: 51200010
nc: not connected
n: plane of symmetry of the multiplier

K: cathode Dn: dynode
G1, G2: focusing electrodes
A: anode Ct: coating

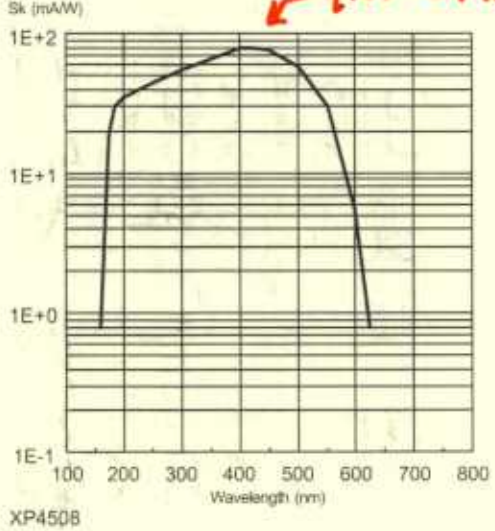
Typical gain curve



XP4508

Typical spectral characteristics

q.e. = 24% @420nm



XP4508

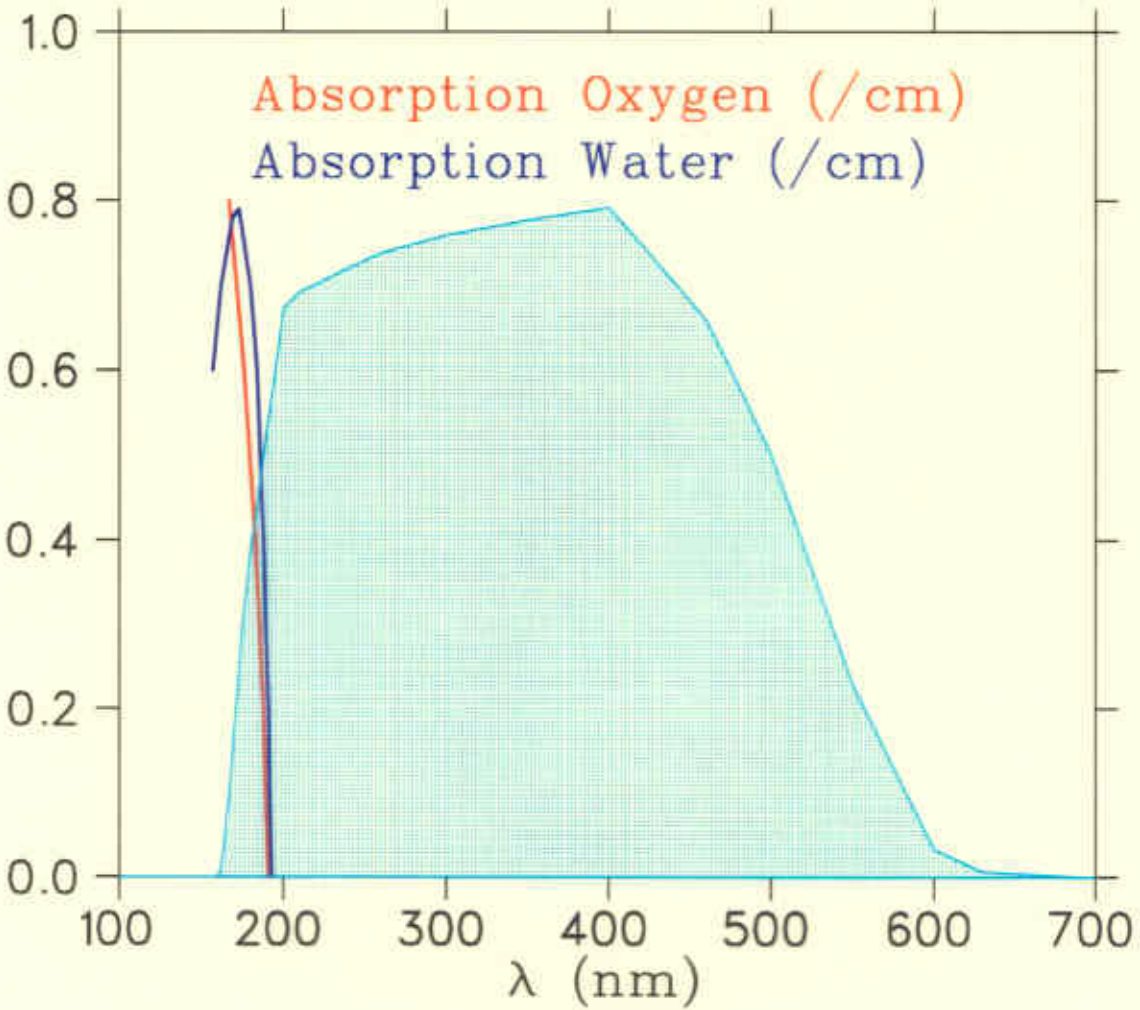
Accessories

Socket : FE1120
Mu-metal shield : MS175
Voltage divider (-HV) : VD105K

PHOTONIS imaging sensors

Effect of Gas Contamination

- Water and oxygen strongly absorb below 200 nm.
  - Cerenkov light has ~ 120 cm mean path length through gas.



- Nitrogen has an effect on the refractive index.

Gas System Requirements

- Although C_4F_{10} is only available in standard industrial quality, it is expensive and so a recovery system is desirable.
- Use of C_4F_{10} is regulated by the EPA.
  - "Final Rule - Protection of Stratospheric Ozone", 40 CFR Part 9 & 82, July 13, 1995
  - Mandates the use of a recovery and recycling system to minimize the release of perfluorocarbons (PFCs) to the atmosphere.
- Hall D C_4F_{10} Cerenkov requirements are more demanding than for SHMS, and so we should be able to copy whatever gas system they eventually build.
  - Cold trap ?
  - Filter ?

Expected Performance

- Conservative estimate assuming 65 cm radiator length, possible optical mis-alignment.
- Offline cut placed at 1.5 p.e.