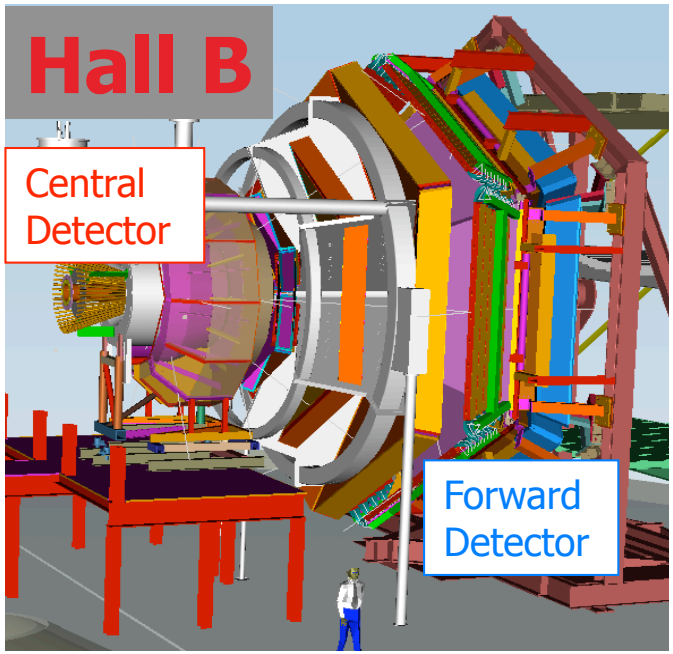
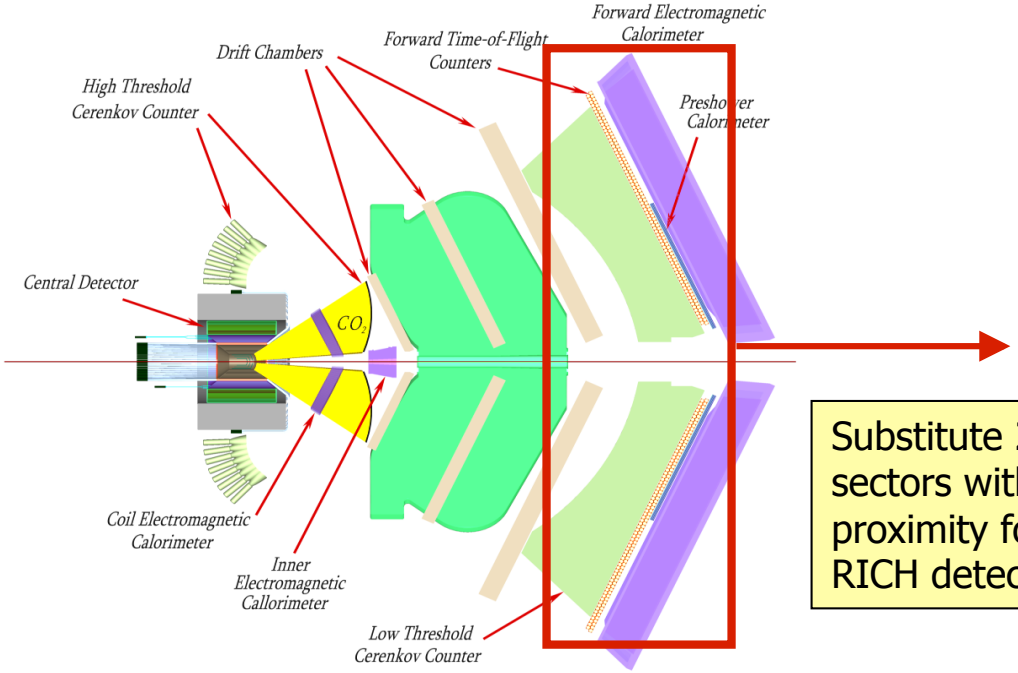
RICH simulation for CLAS12

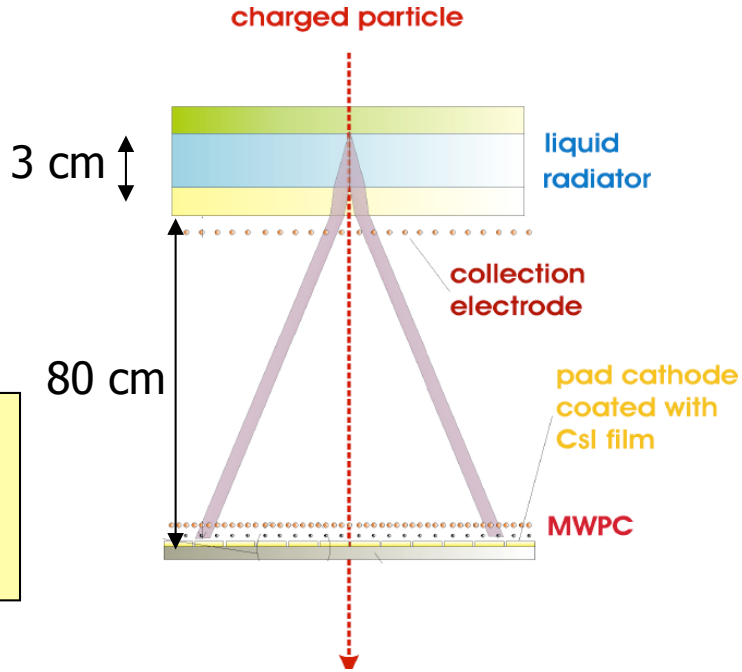


Contalbrigo Marco
INFN Ferrara
Luciano Pappalardo
INFN Ferrara

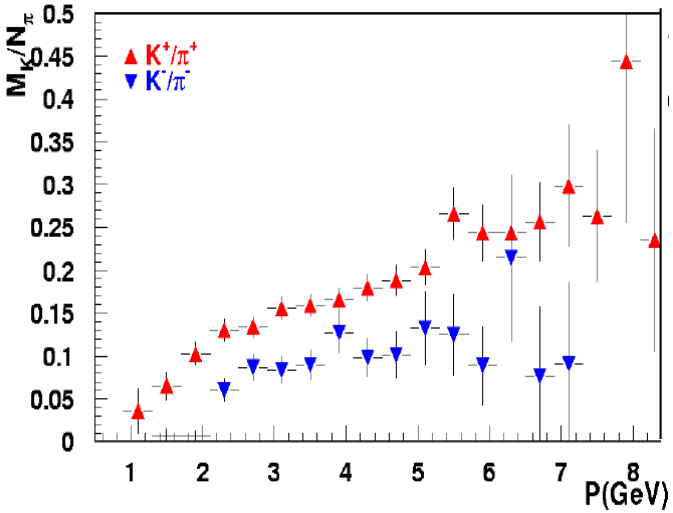
RICH detector



Substitute 2 LTCC sectors with a proximity focusing RICH detector

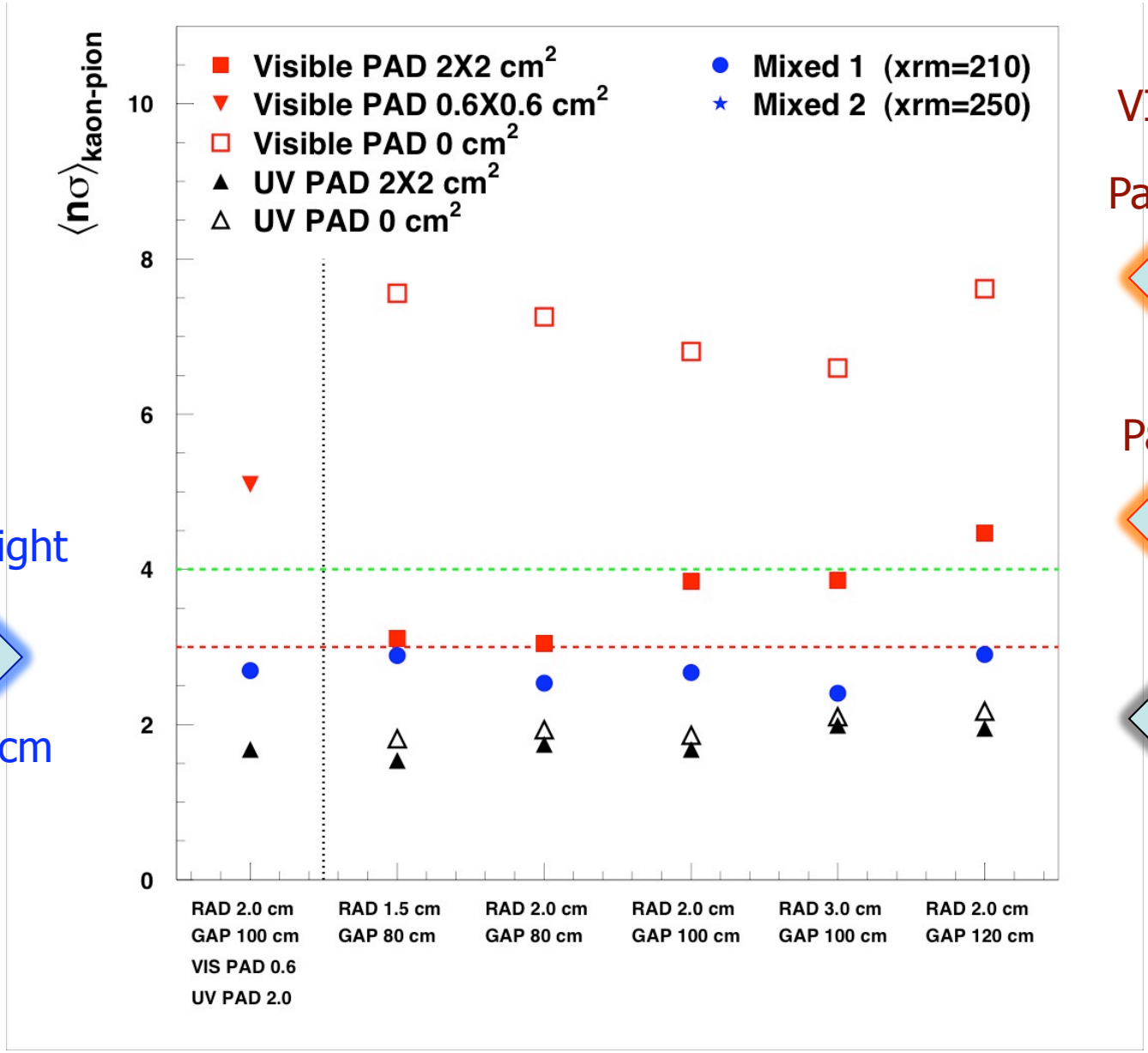


GeV /c	1	2	3	4	5	6	7	8	9	10
π/K	TOF		LTCC							
						HTCC				
π/p	TOF									
			LTCC							
						HTCC				
K/p	TOF									
										LTCC



- ratio K/π ~ 0.1-0.15

Mean πk separation (4.5-5 GeV)



UV+VIS light

Pad size 2 cm

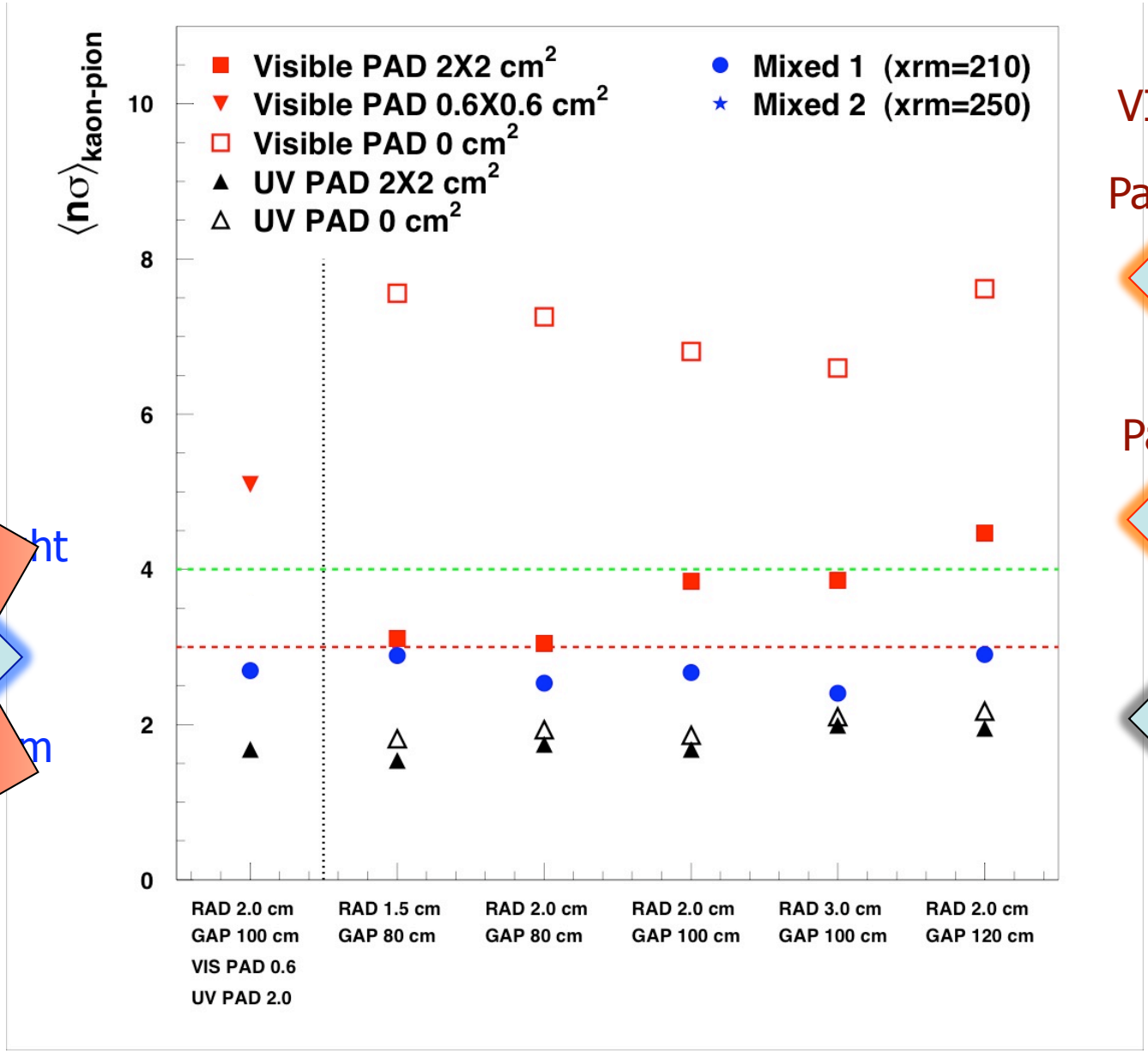
VISIBLE light

Pad size 0 cm

Pad size 2 cm

UV light

Mean πk separation (4.5-5 GeV)



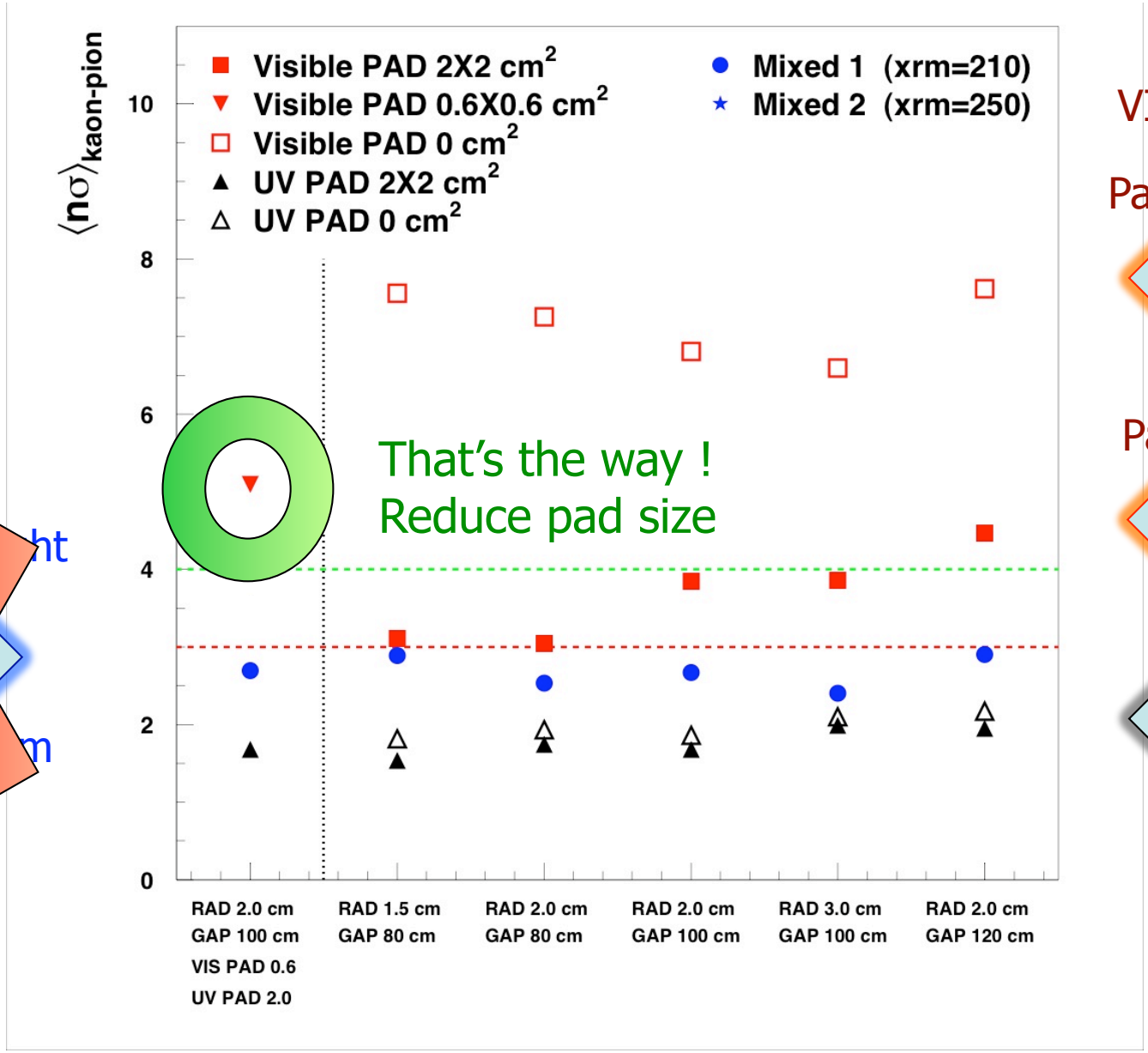
VISIBLE light

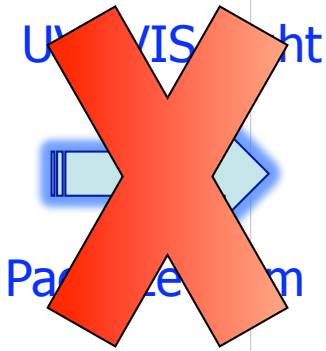
Pad size 0 cm

Pad size 2 cm

UV light

Mean πk separation (4.5-5 GeV)





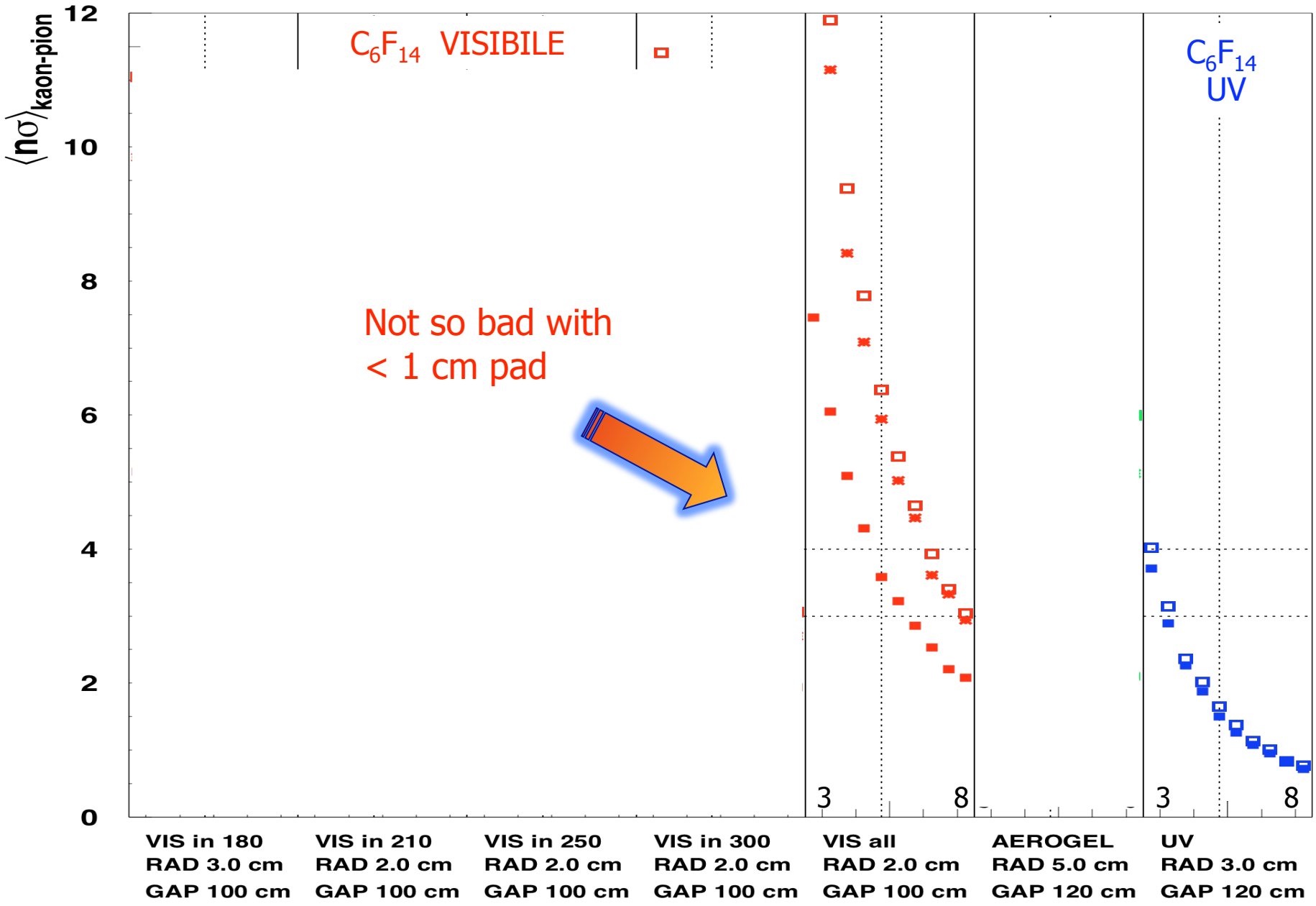
VISIBLE light

Pad size 0 cm

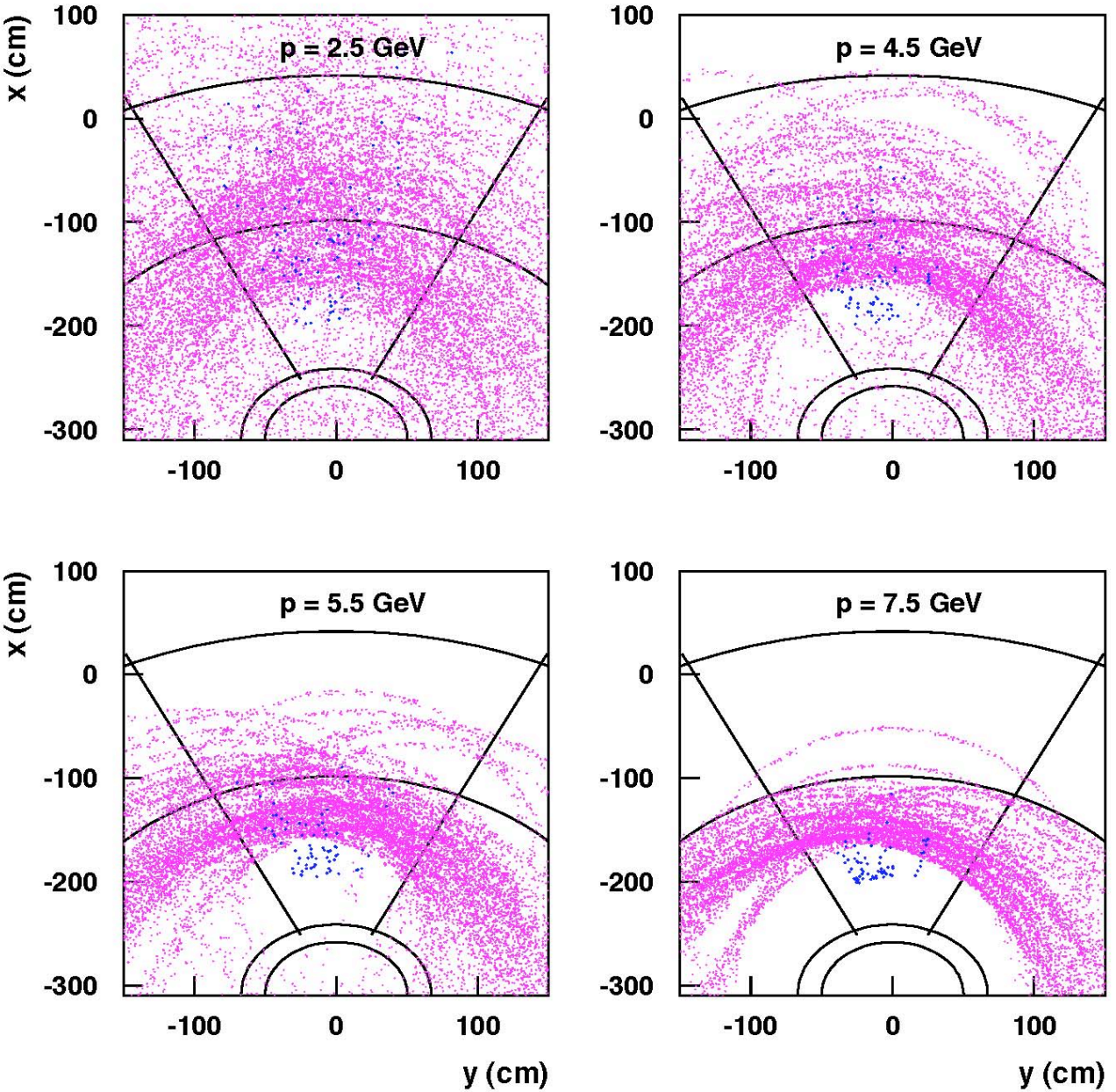
Pad size 2 cm

UV light

Mean πk separation (3-8 GeV)



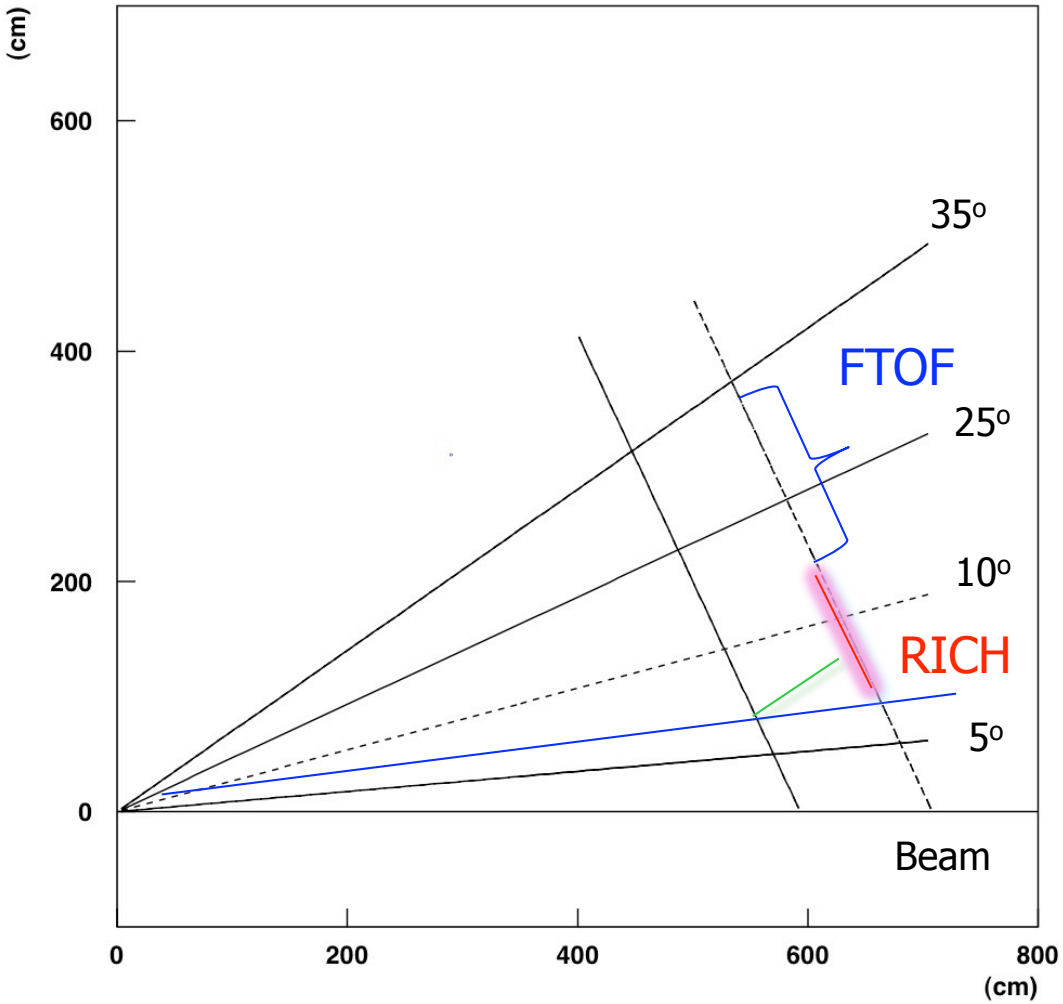
Gamma hits with C_6F_{14}



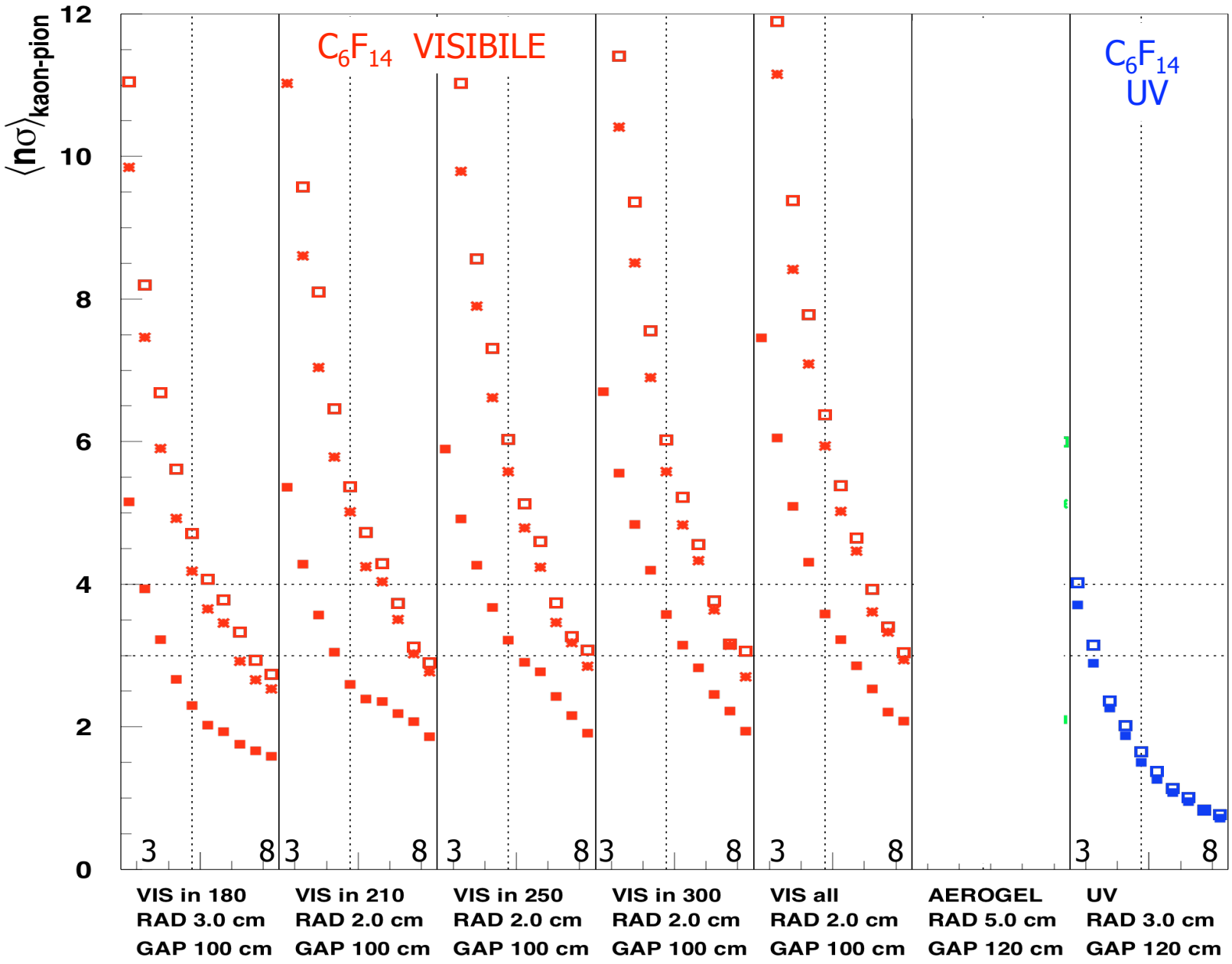
Try to reduce active area

The proximity focus option

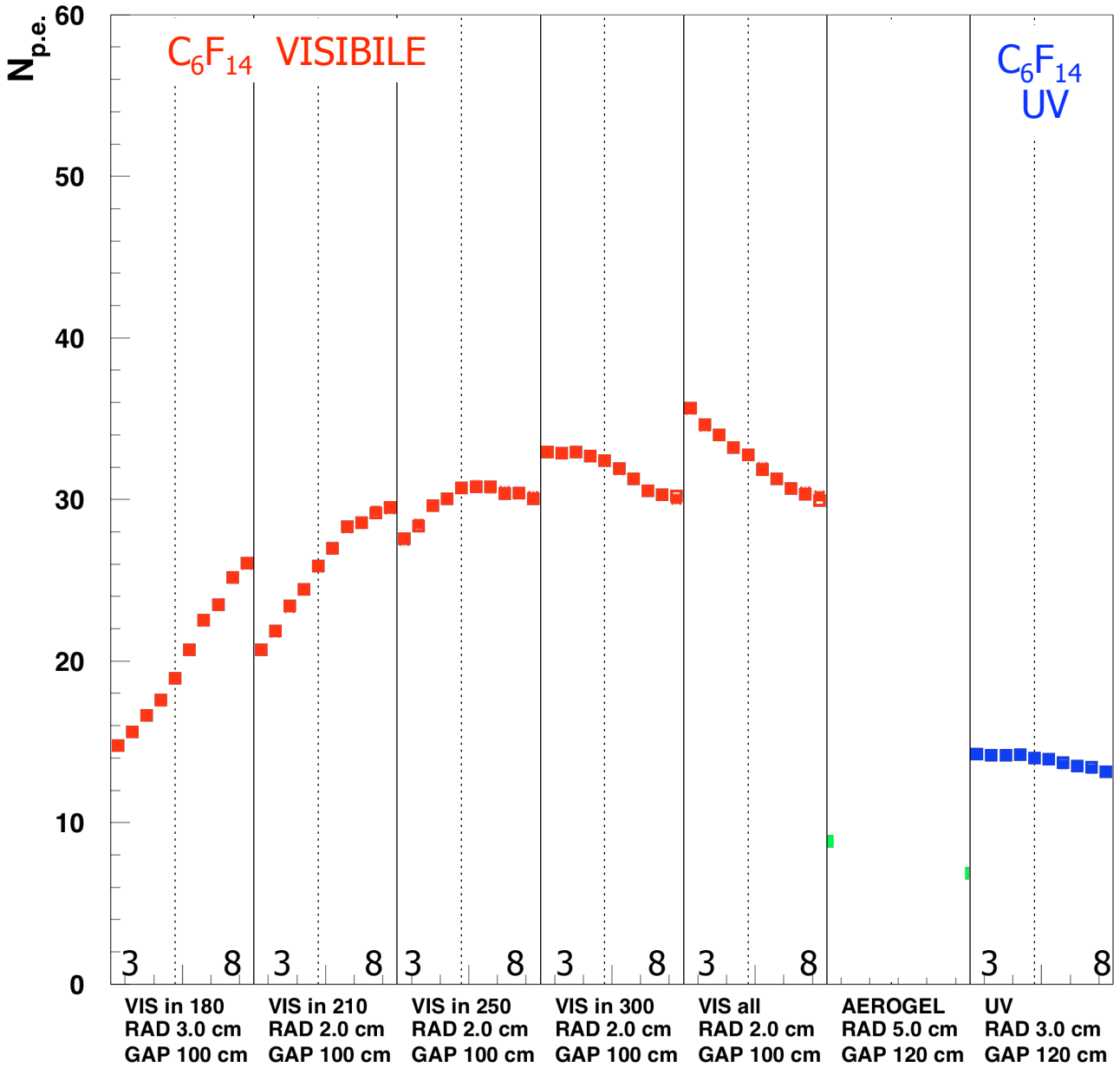
Direct measurement in a restricted area



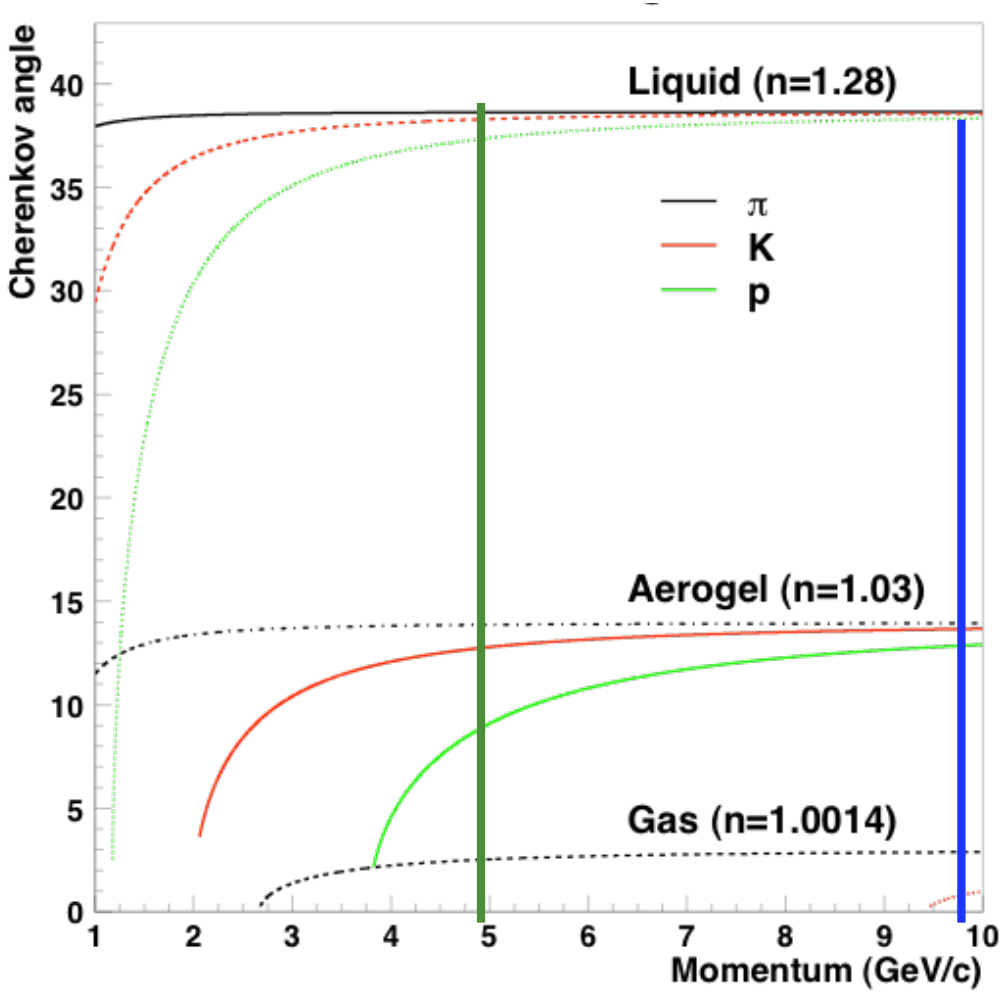
Mean πk separation (3-8 GeV)



Mean p.e. number (3-8 GeV)

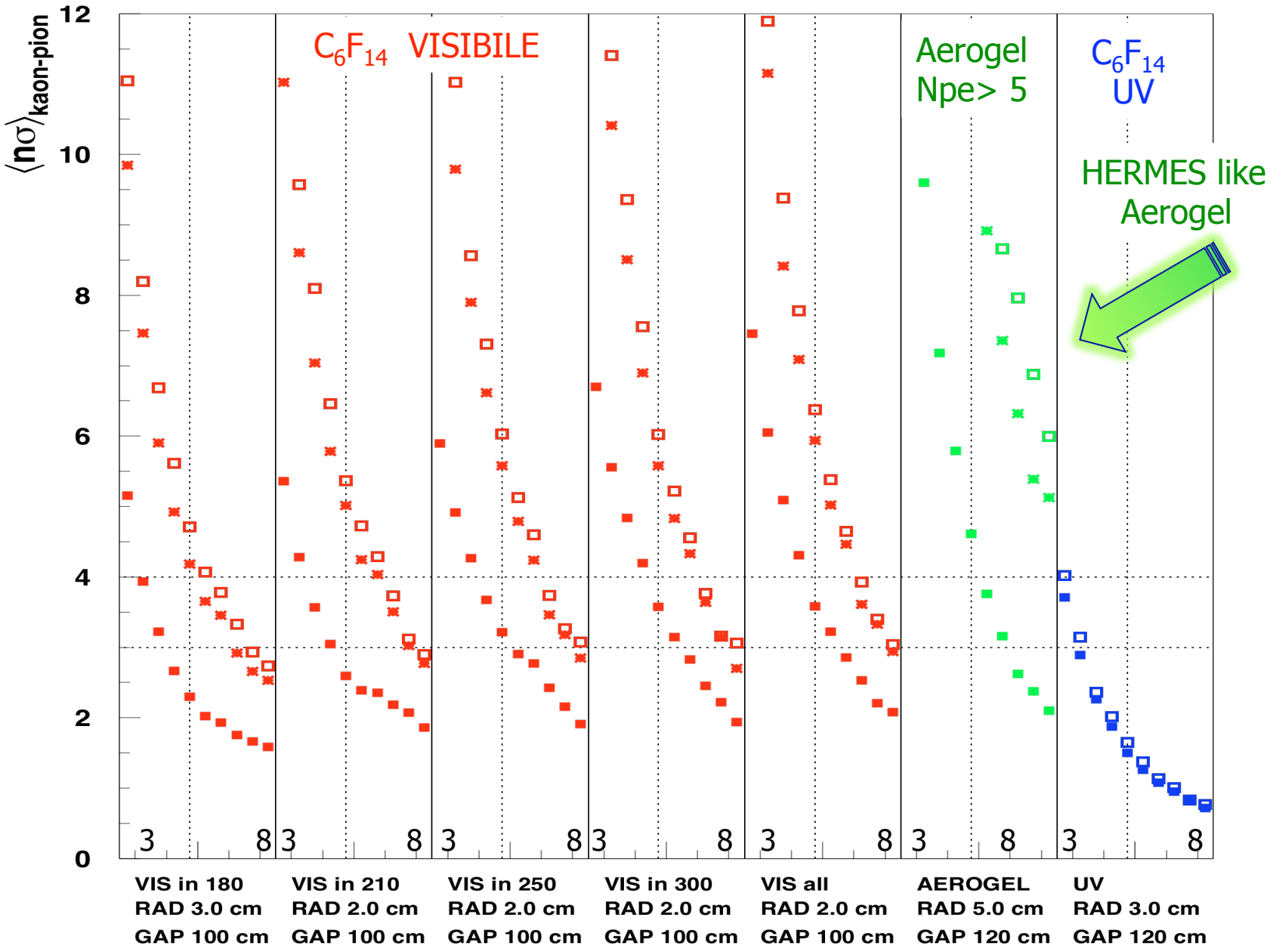


The Aerogel option

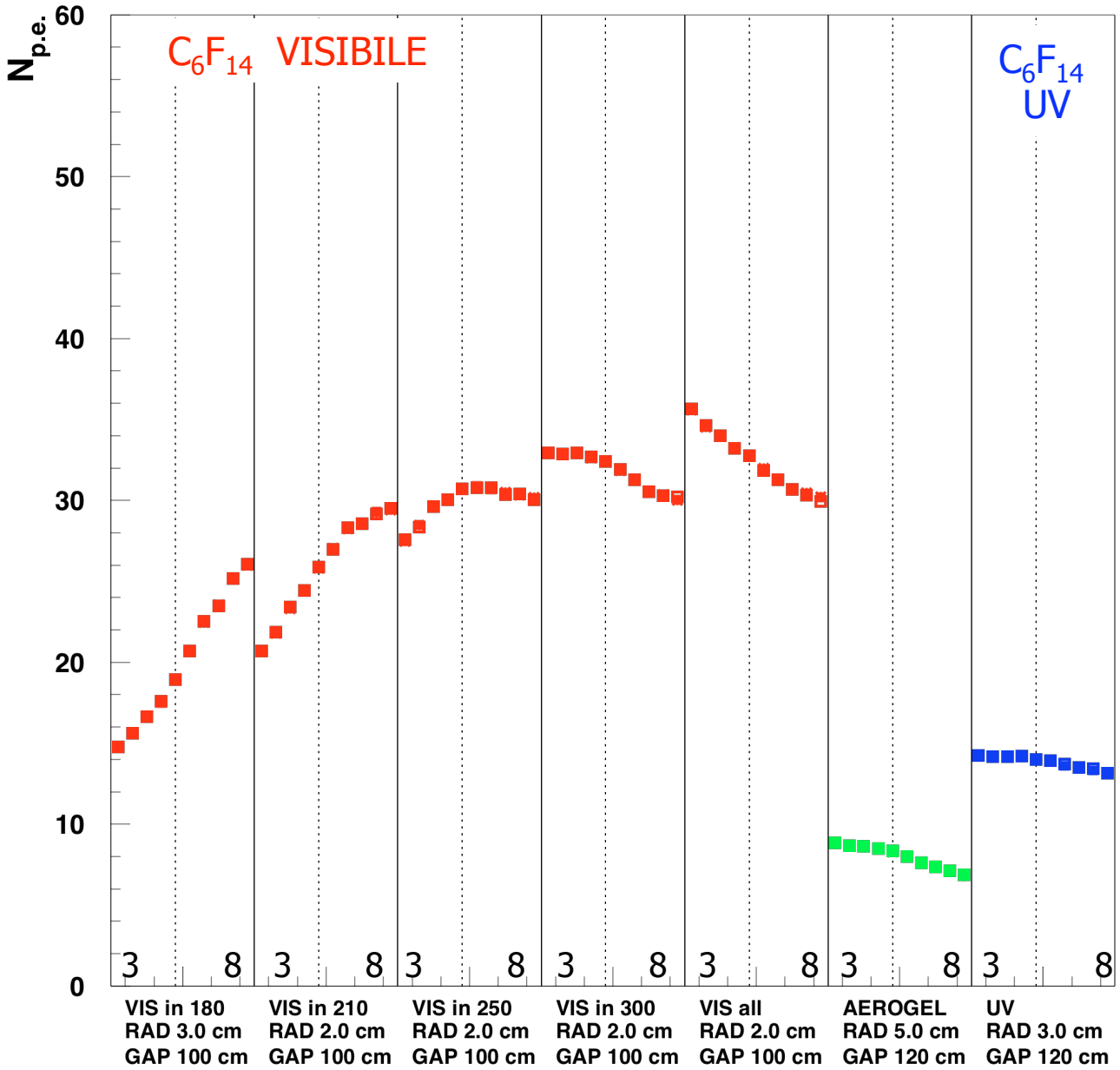


Less photons
Larger angle separation

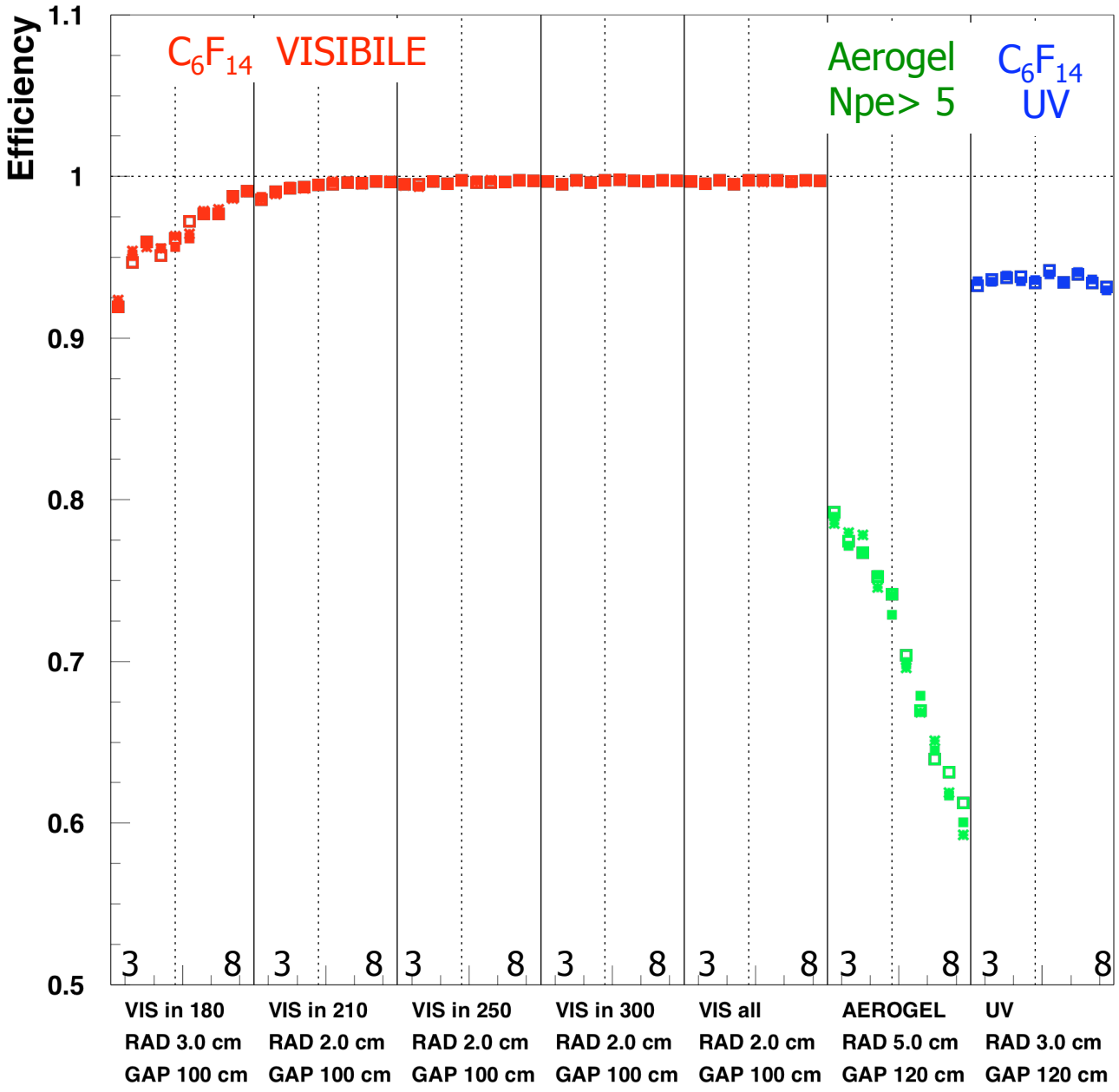
Mean πk separation (3-8 GeV)



Mean p.e. number (3-8 GeV)

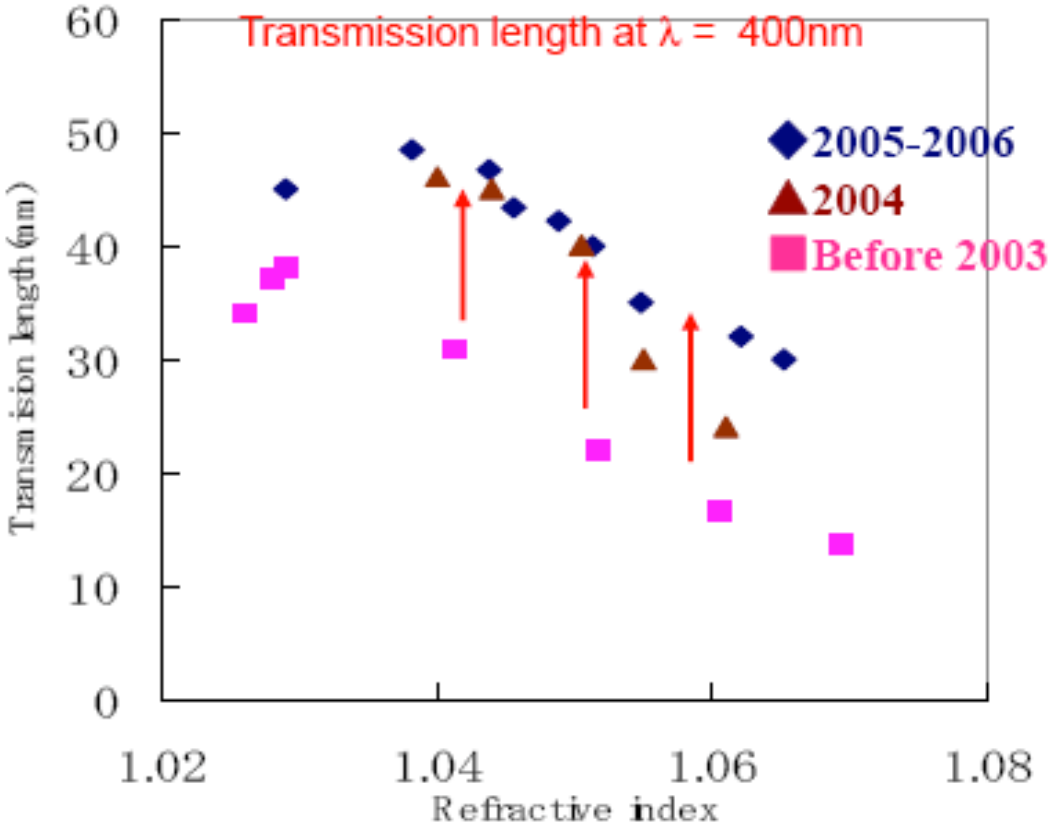


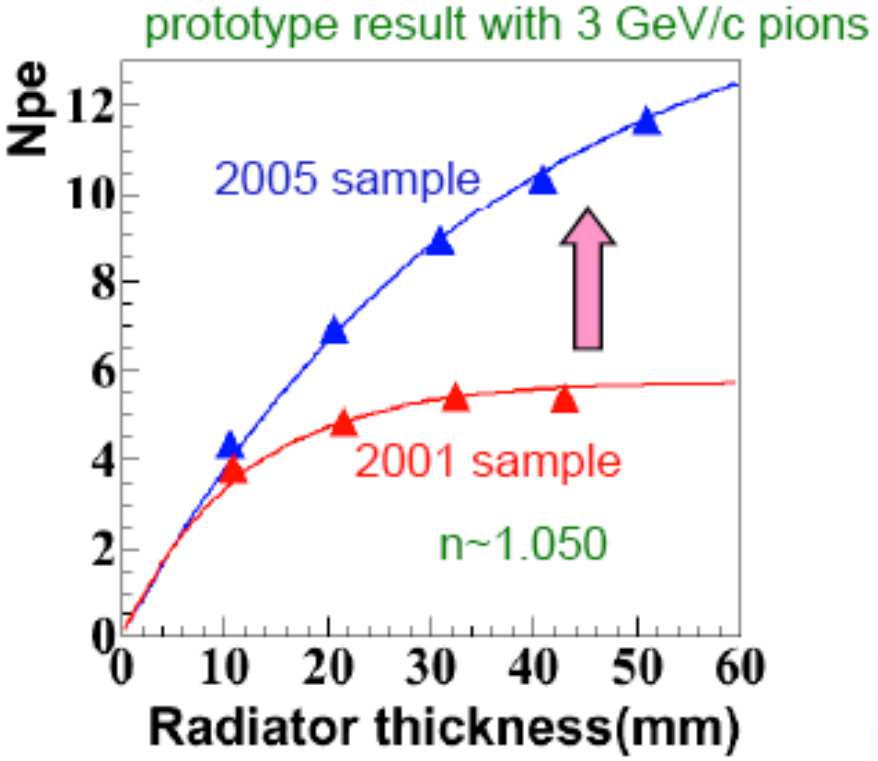
ID efficiency (3-8 GeV)



The Aerogel option

Trasmission length is undergoing significantly improvements



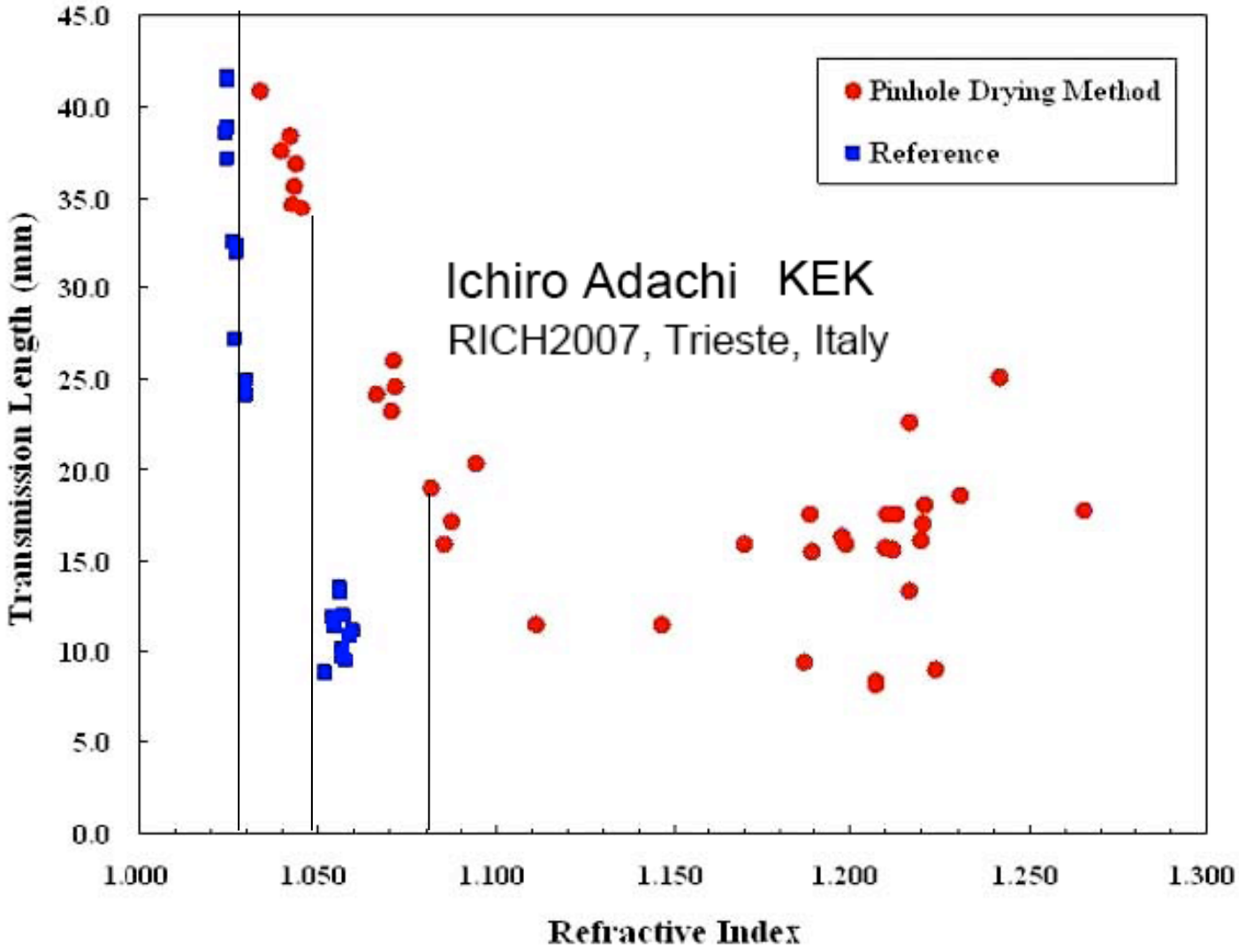


photon yield is not limited by radiator transparency up to ~50mm

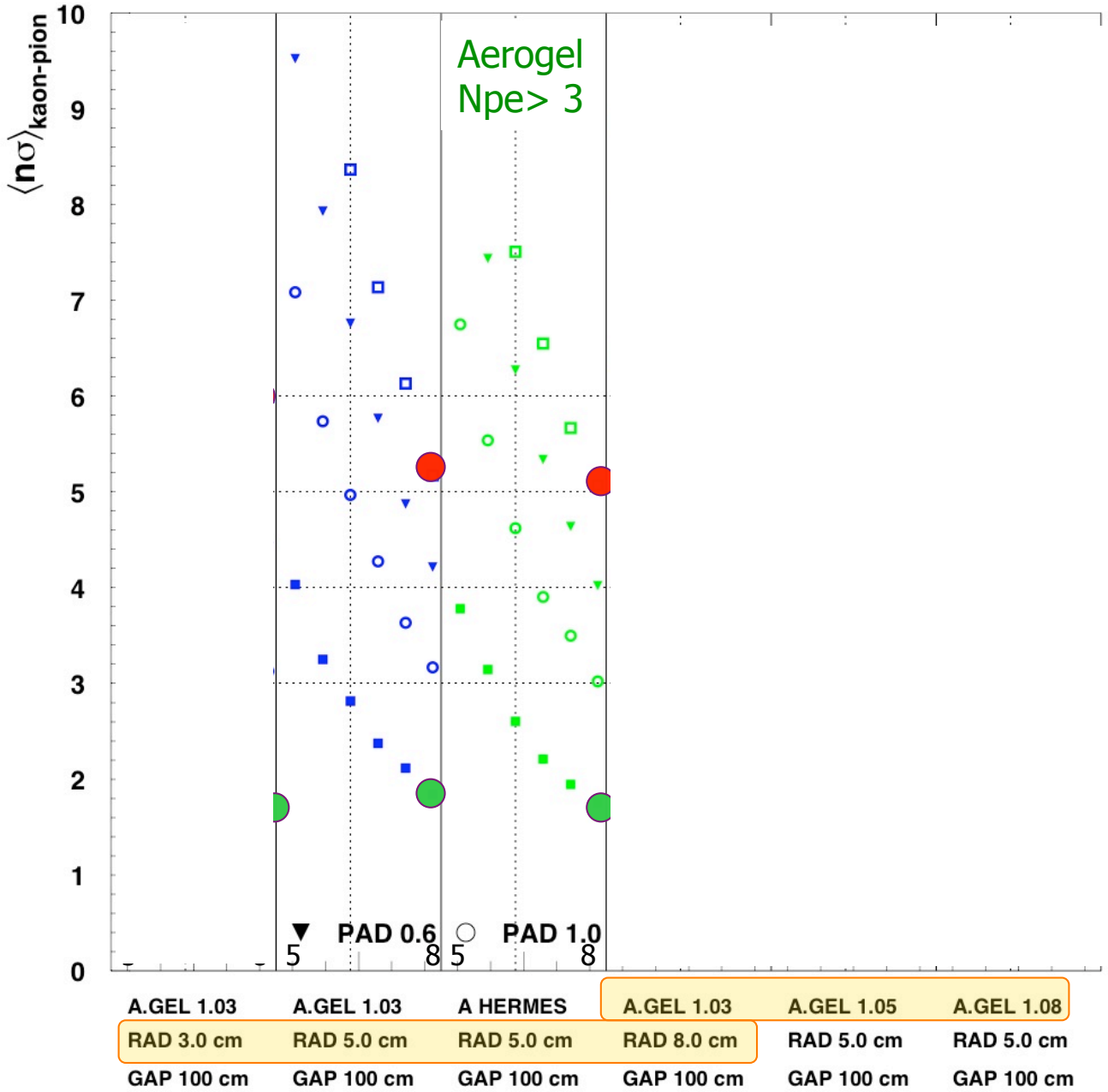
2005 IEEE Nuclear Science Symposium Conference Record

M. Tabata et al.

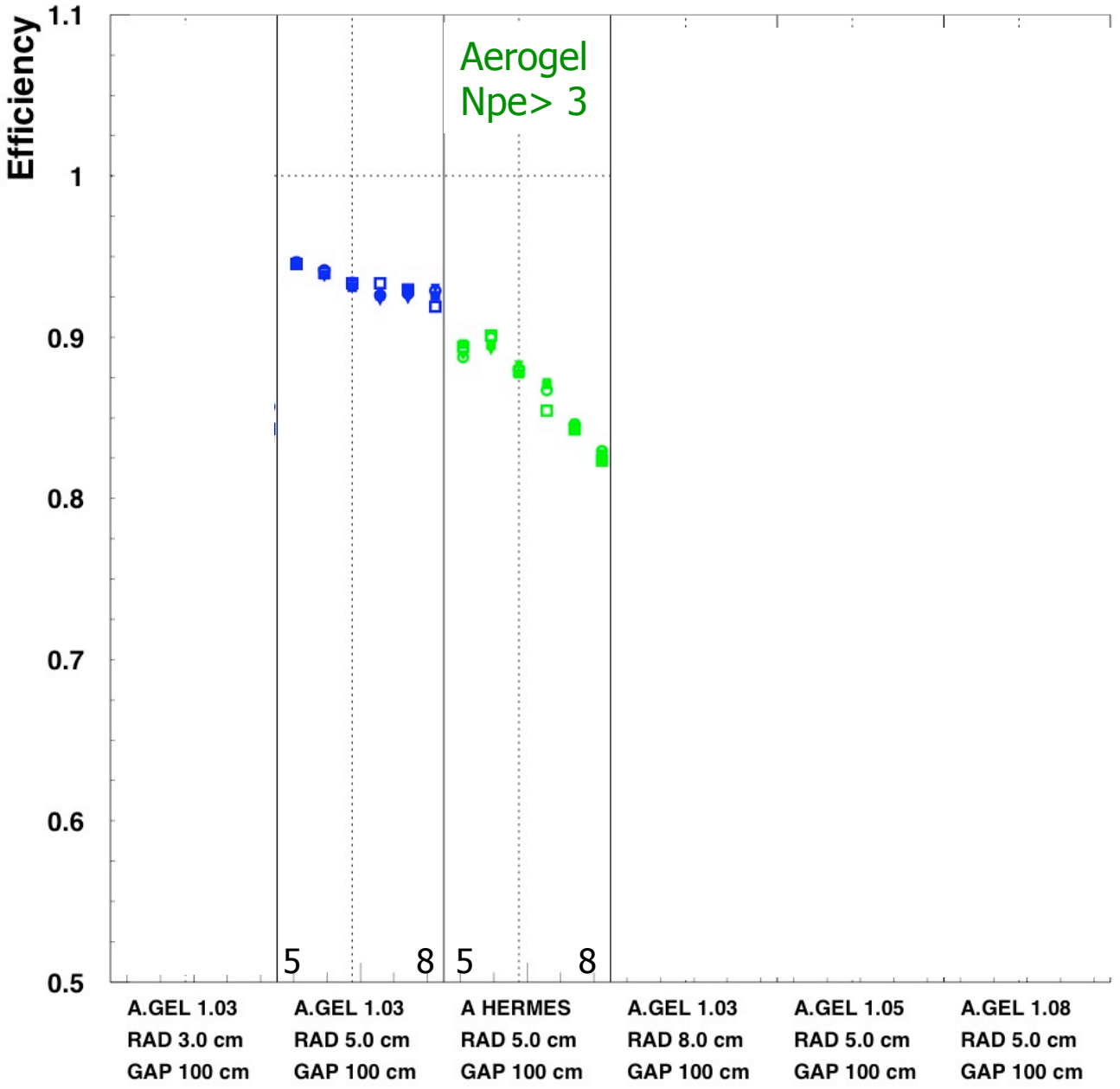
The Aerogel option



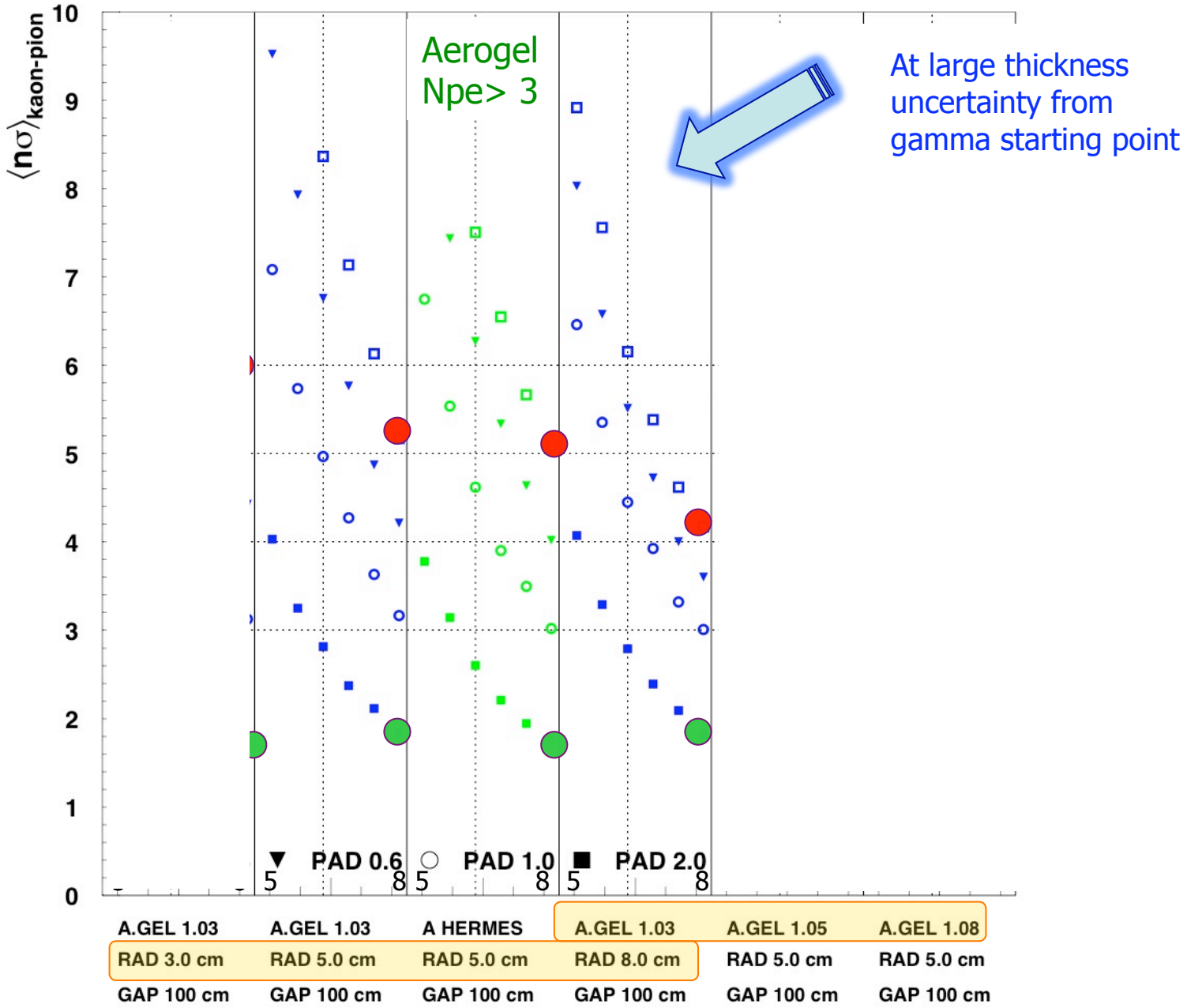
Mean πk separation (5-8 GeV)



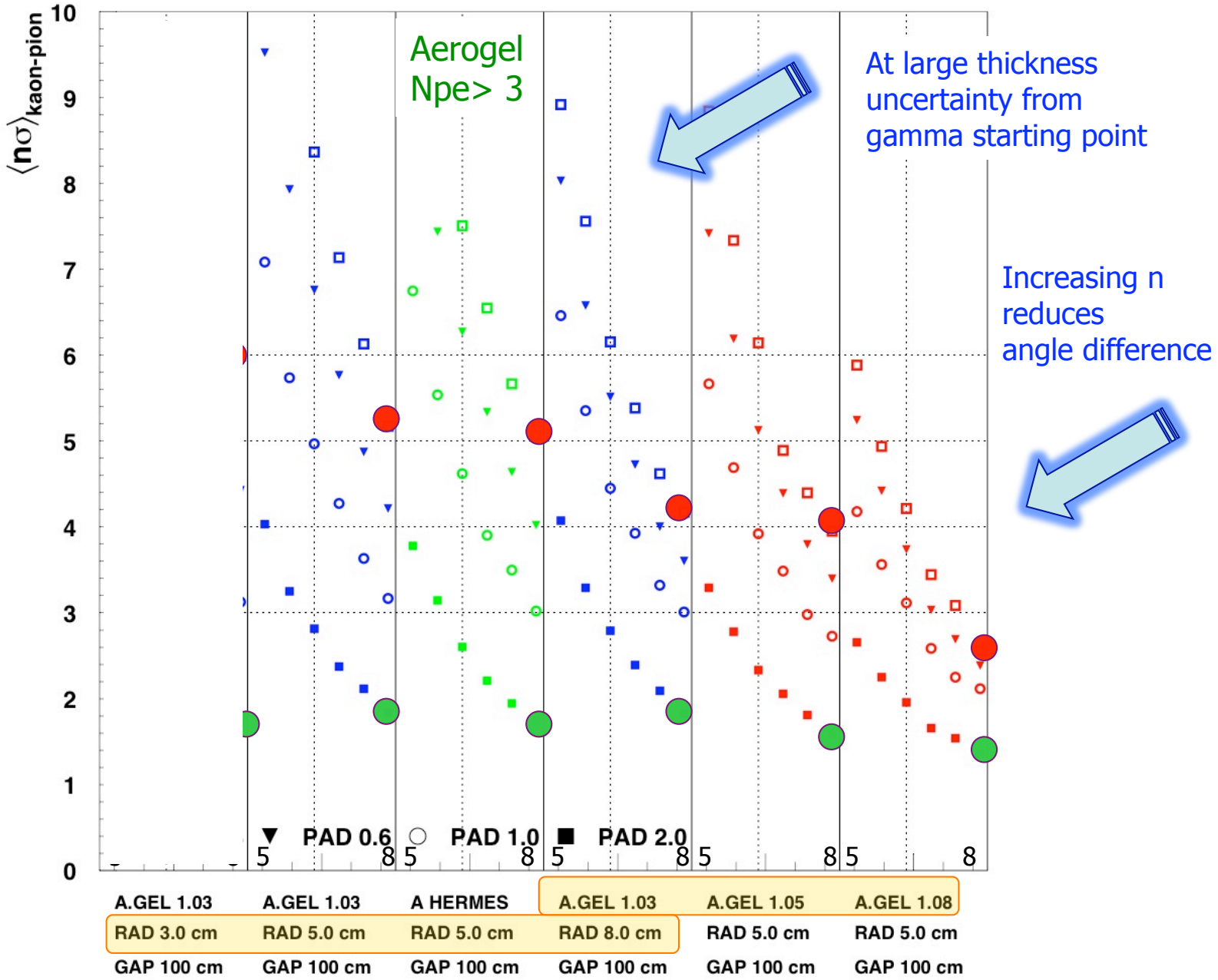
ID efficiency (5-8 GeV)



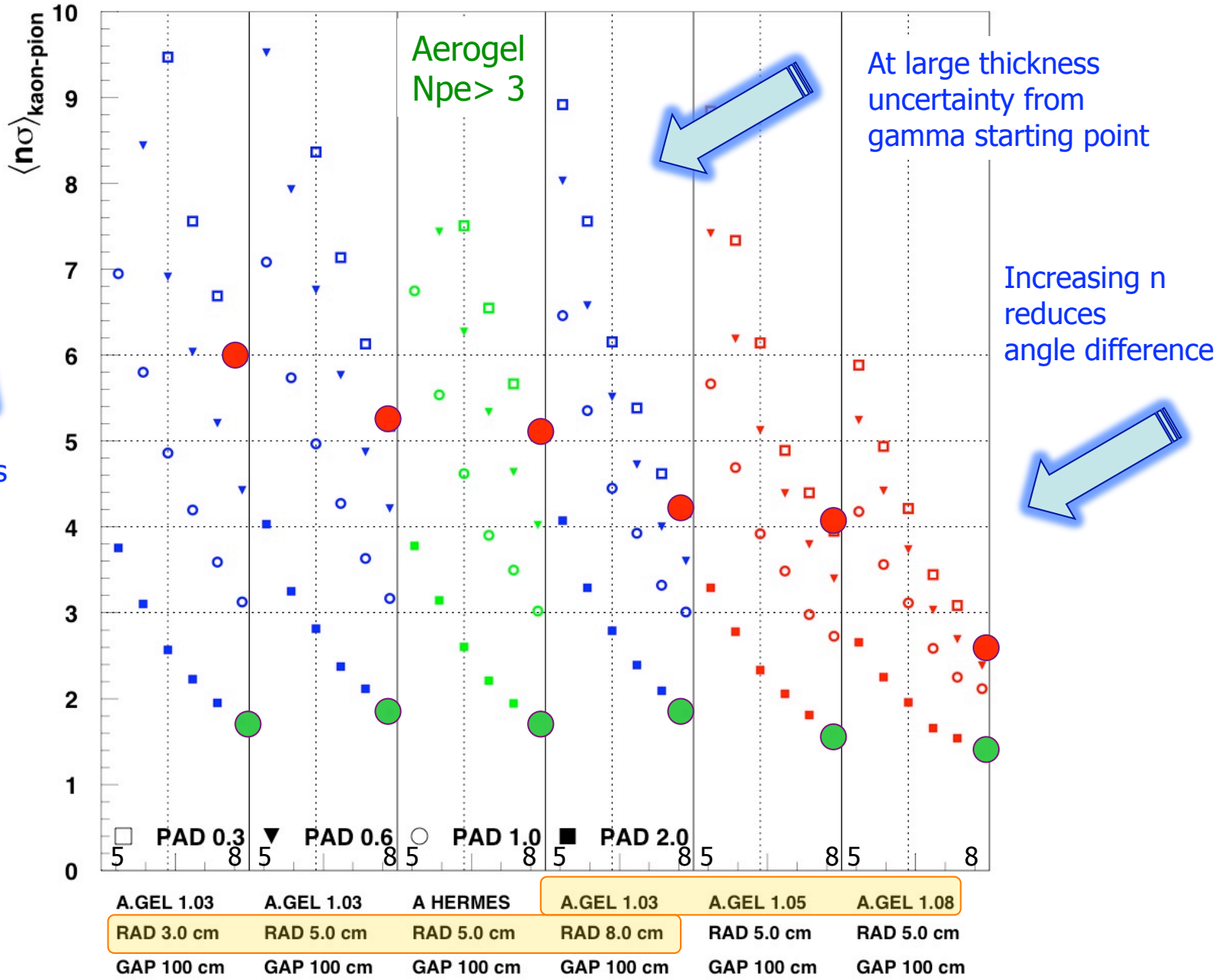
Mean πk separation (5-8 GeV)



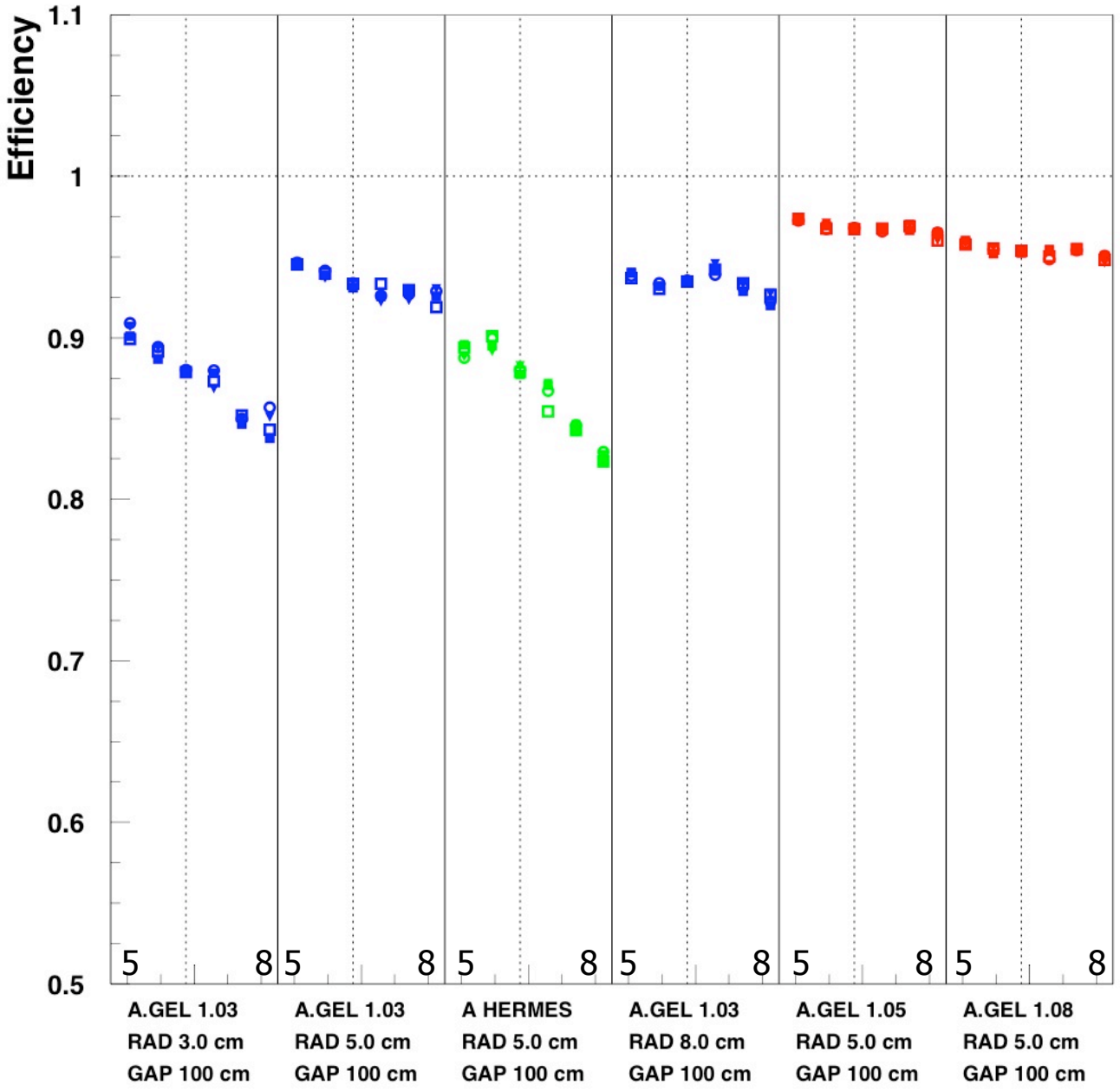
Mean πk separation (5-8 GeV)



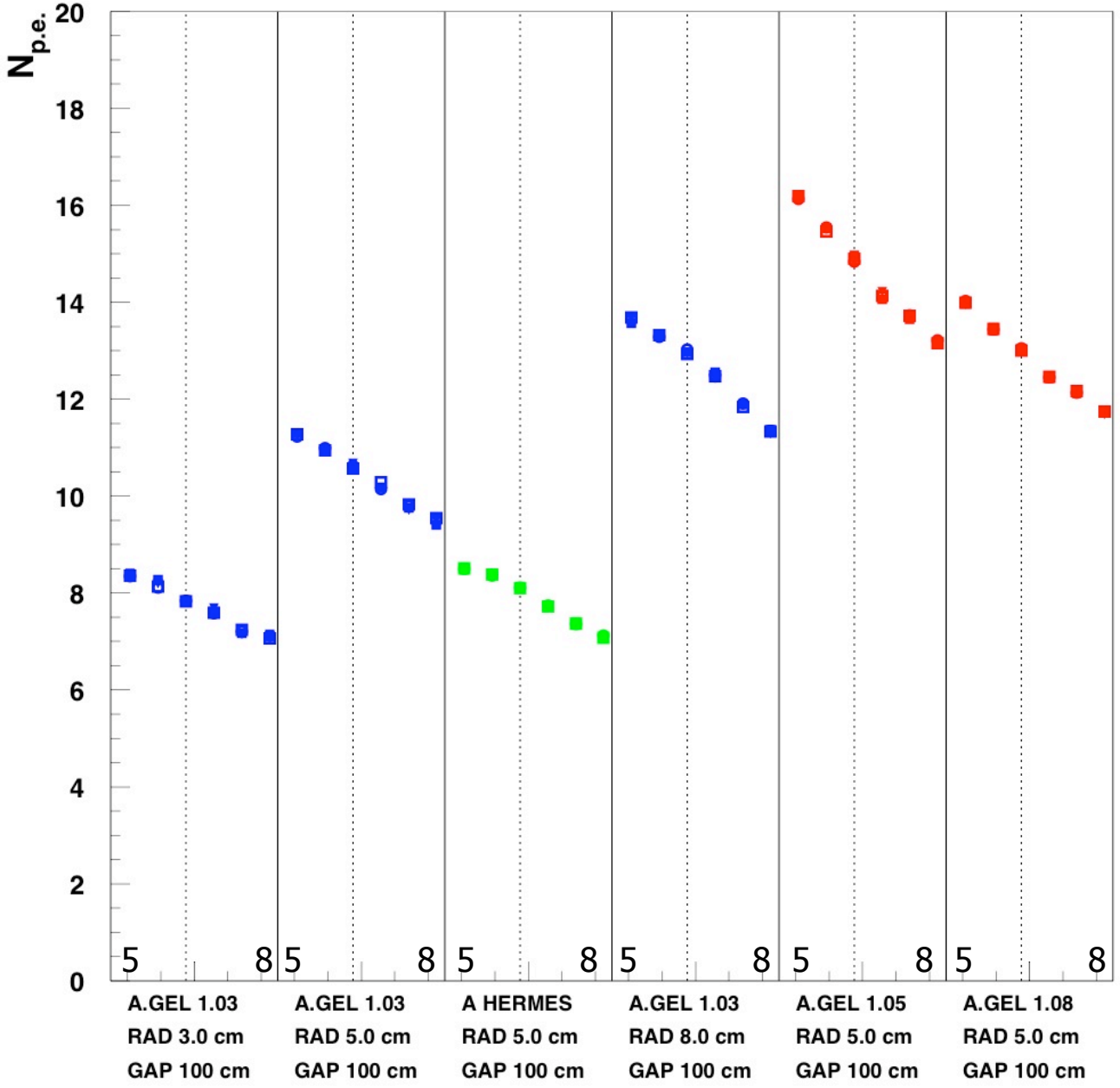
Mean πk separation (5-8 GeV)



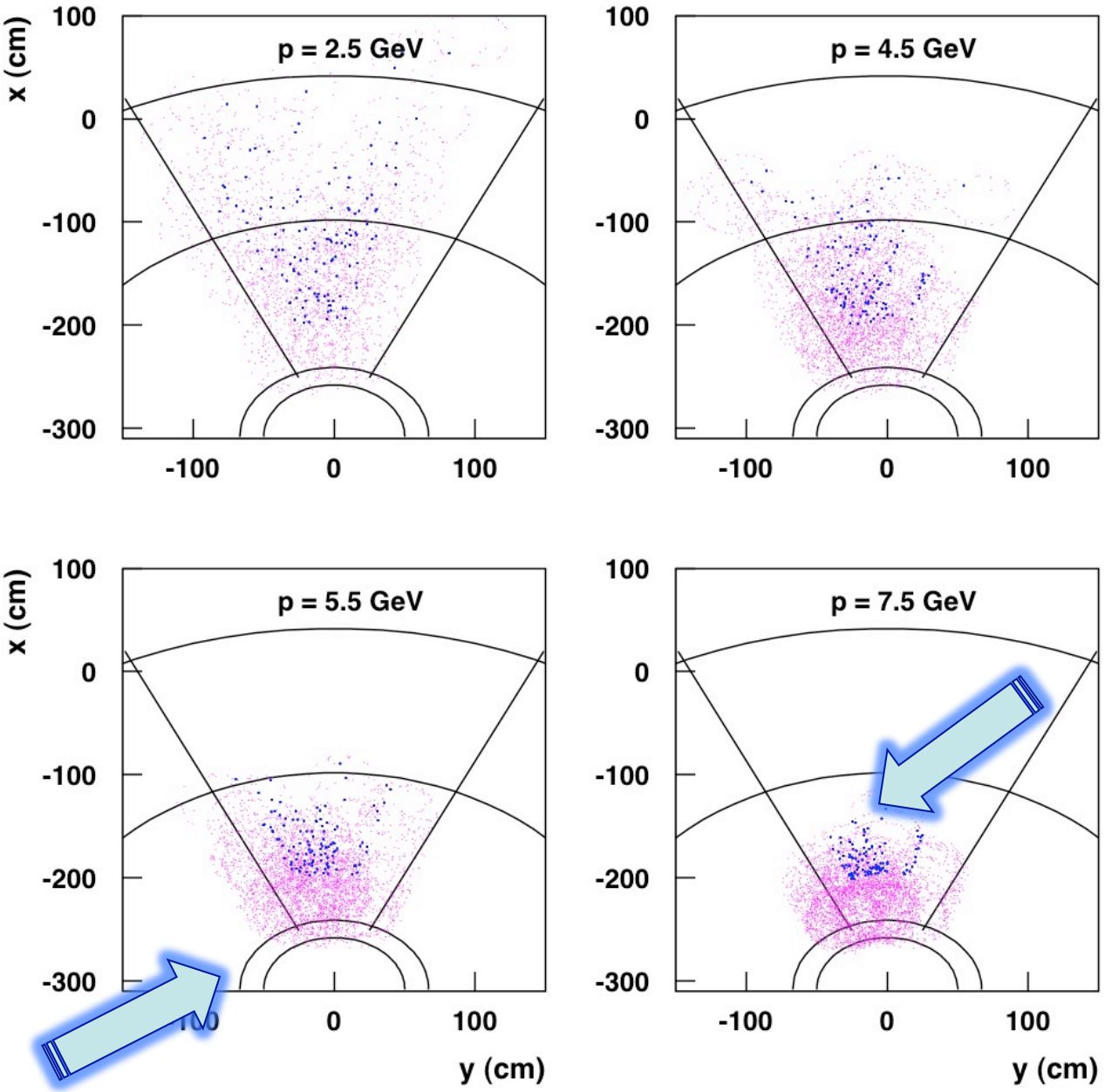
ID efficiency (5-8 GeV)



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



Gamma hits with Aerogel



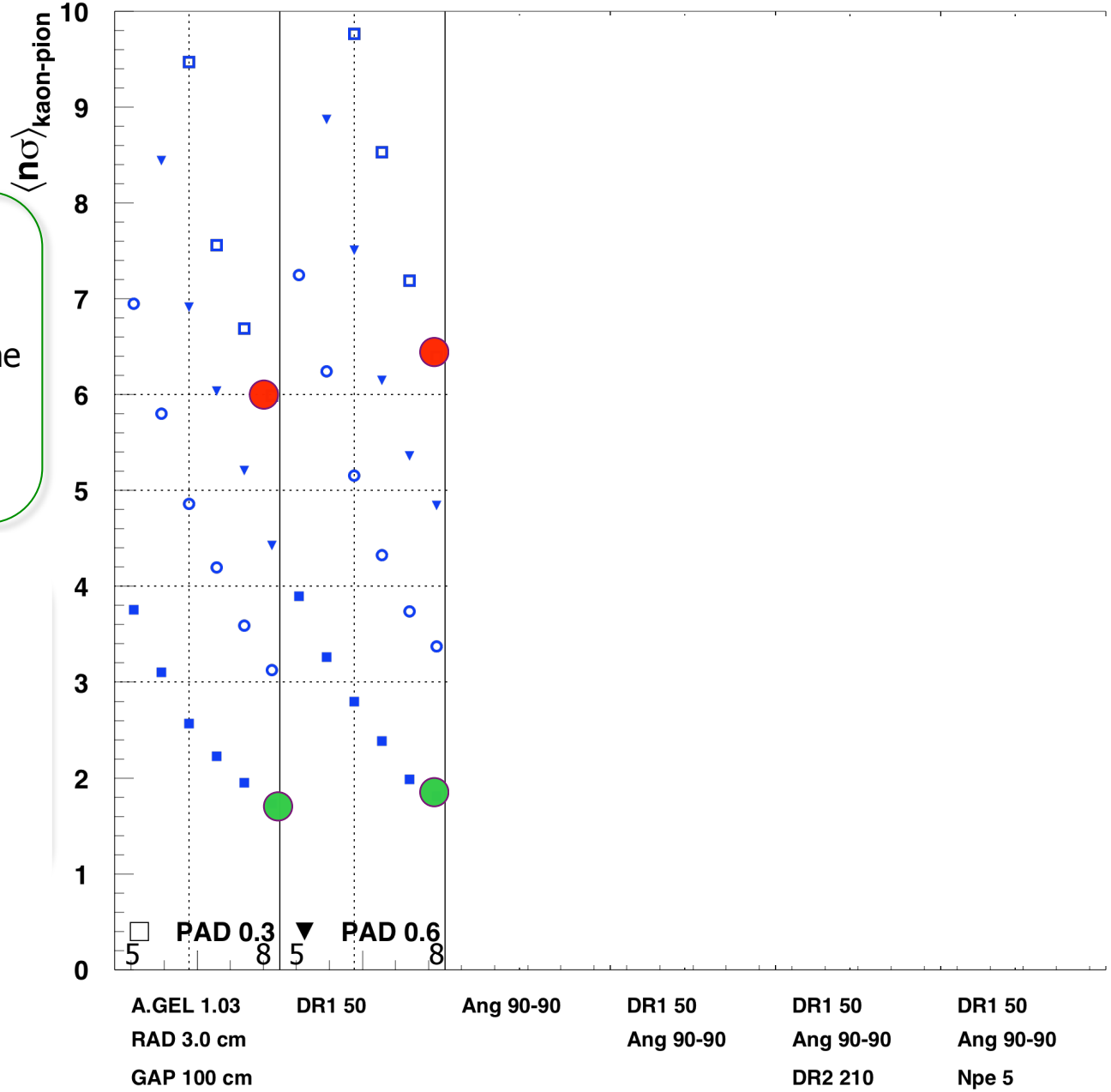
Asymmetric illuminiation (due to 5 T solenoid) suggests better to use multi sectors

Full ring catched if down to 50 cm from beam line

Mean πk separation (5-8 GeV)

Geometry costraints:

minimum radius
down to 50 cm from beam line

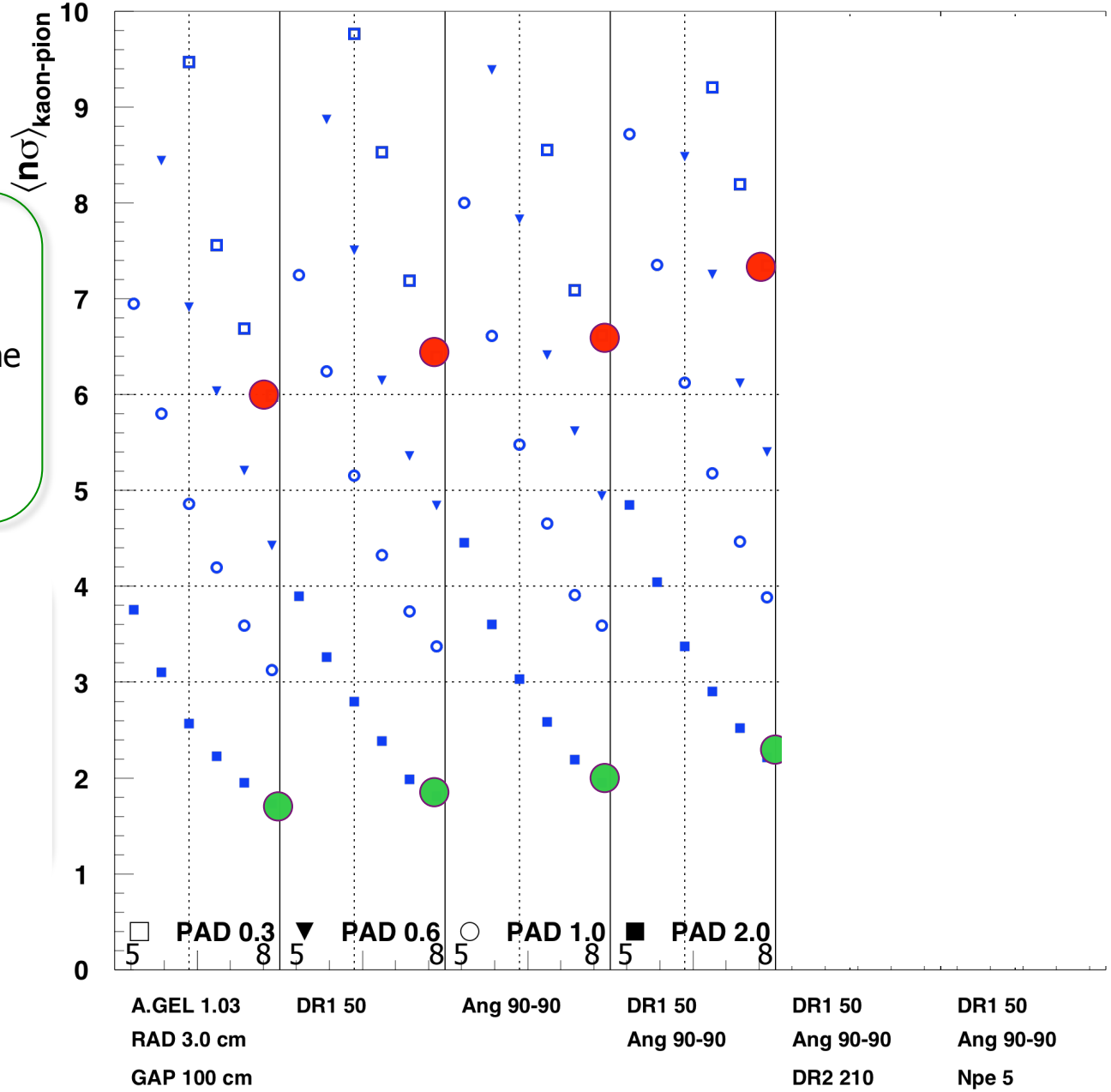


Mean πk separation (5-8 GeV)

Geometry costraints:

minimum radius
down to 50 cm from beam line

left-right symmetry
increase number of sectors



Mean πk separation (5-8 GeV)

Geometry costraints:

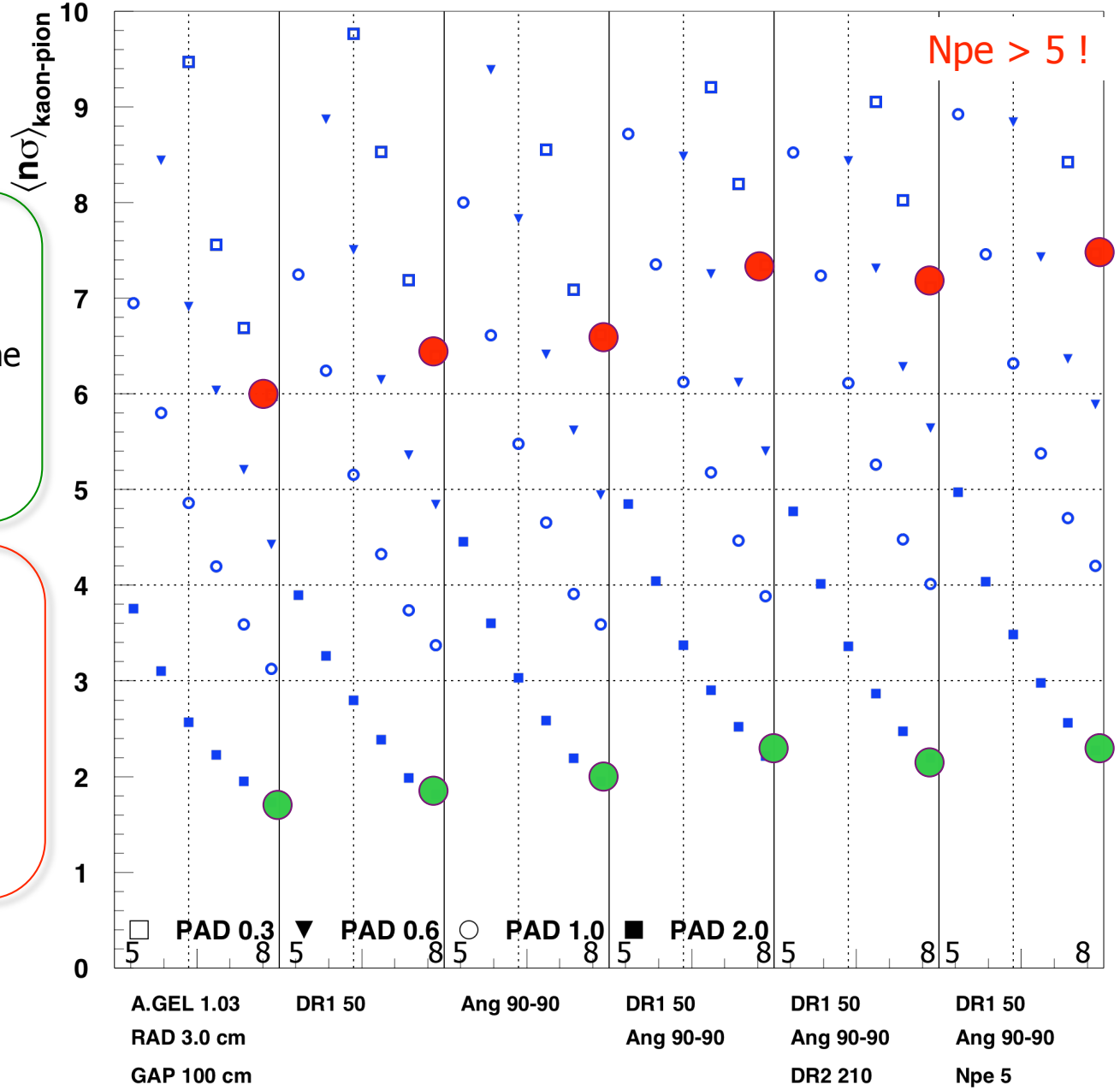
minimum radius
down to 50 cm from beam line

left-right symmetry
increase number of sectors

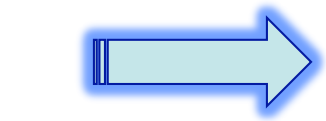
Weak sensitivity on:

reduction of active area
down to 17°

minimum N p.e.

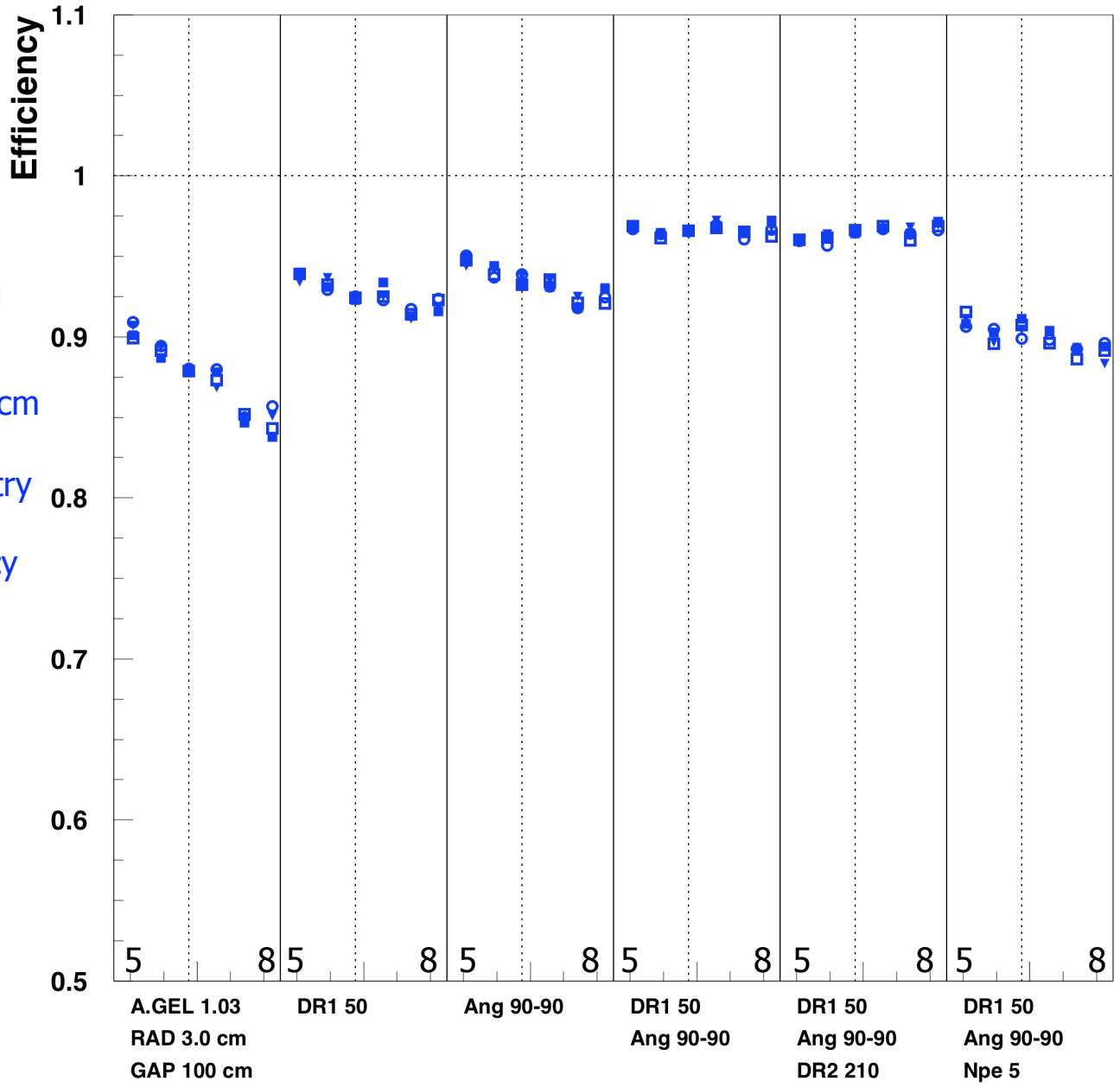


ID efficiency (5-8 GeV)

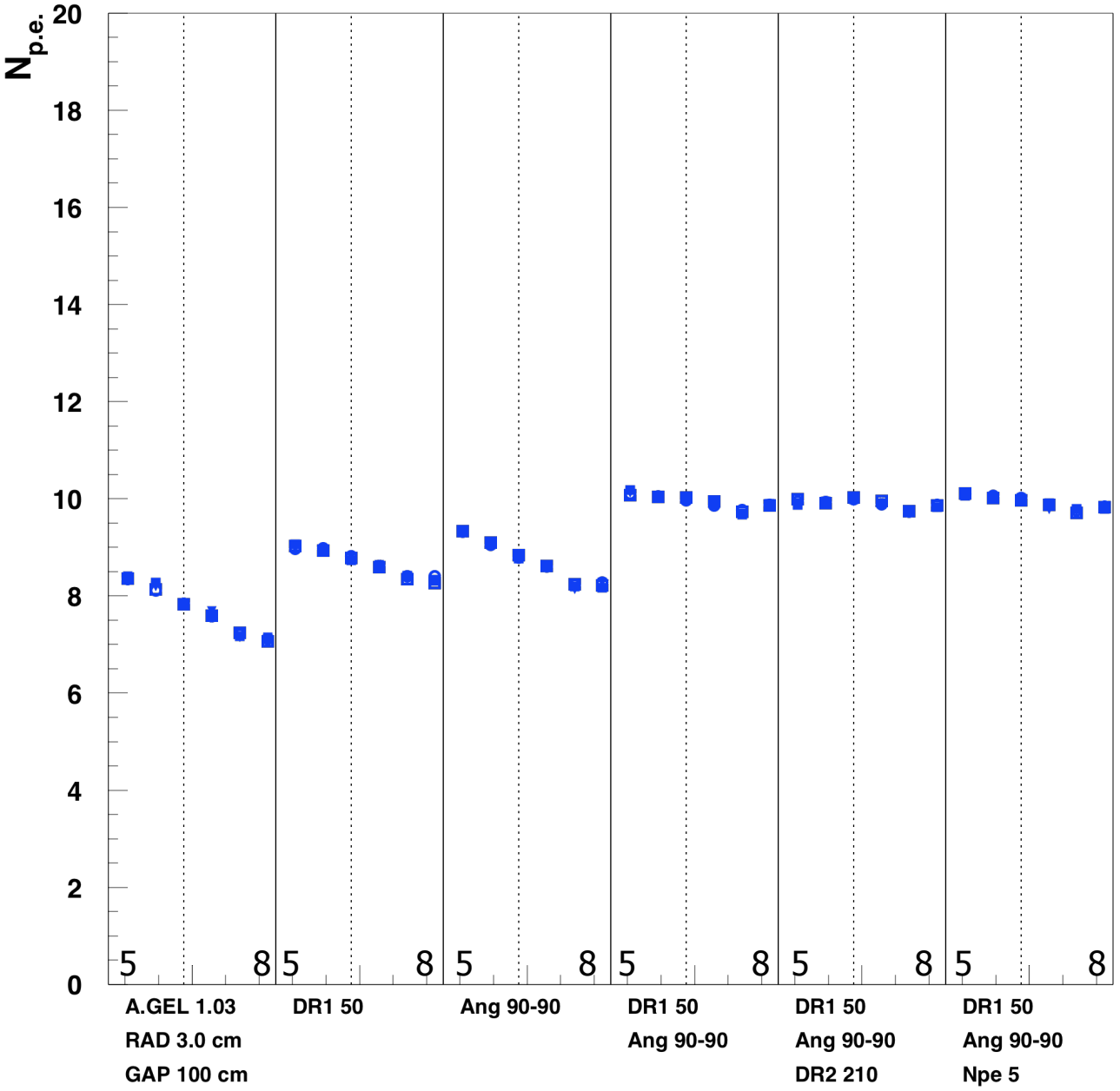


Going down to 50 cm
&
Left-right asymmetry

increases efficiency



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



Executive summary

RICH with Aerogel
matches the required performances

High cost due to the

- Large surface
- Expensive detectors for visible light
- Small pad size required

Interference with TOF

- Material budget

Crucial to minimize
detector area
material budget

The mirror option

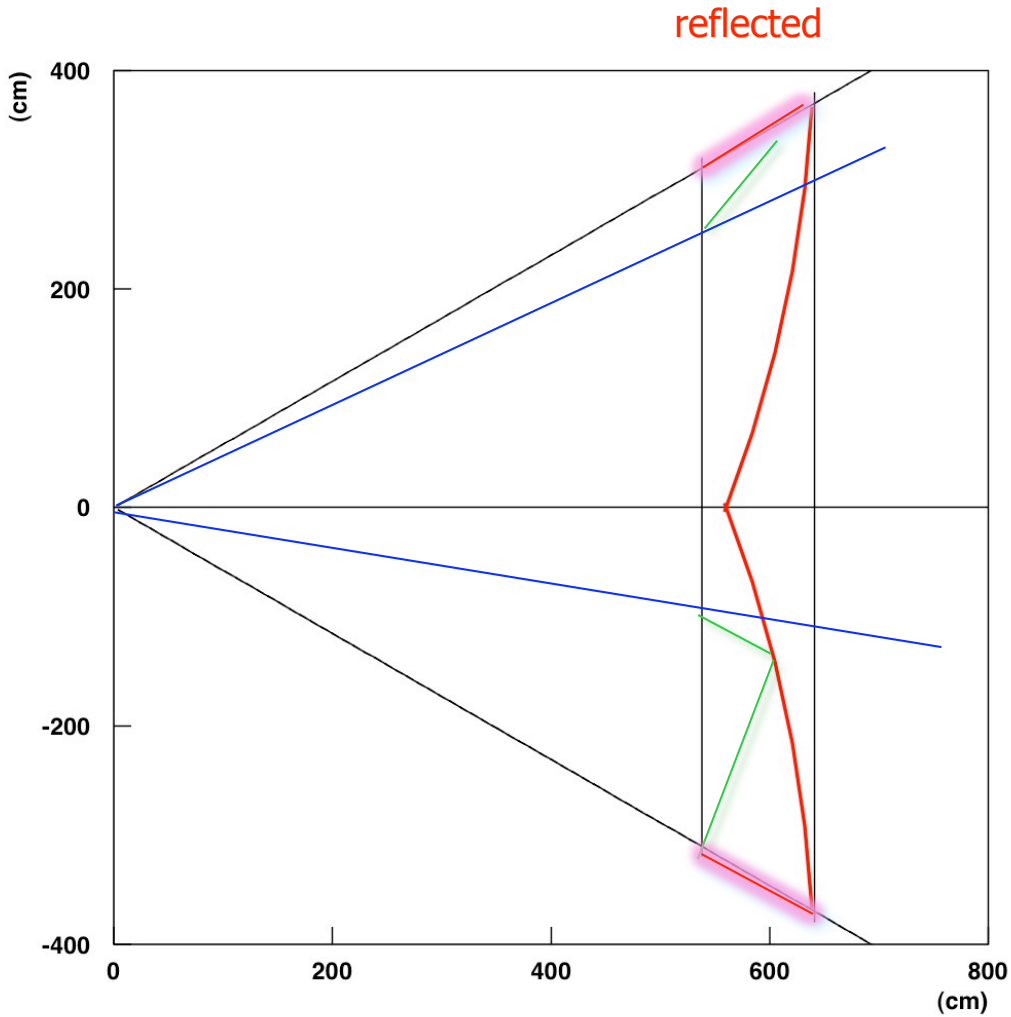
Reflect on a side

does not reduce detector area

hard to find a focusing geometry

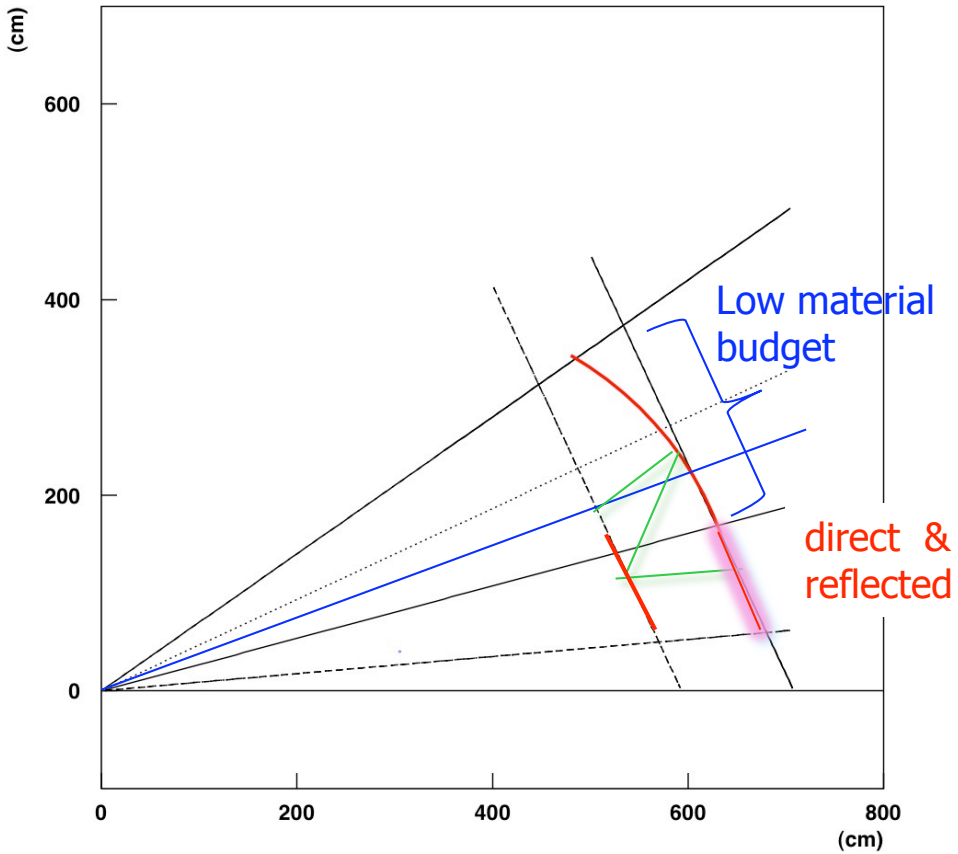
conflict with toroid field

direct photons impinge at large angles

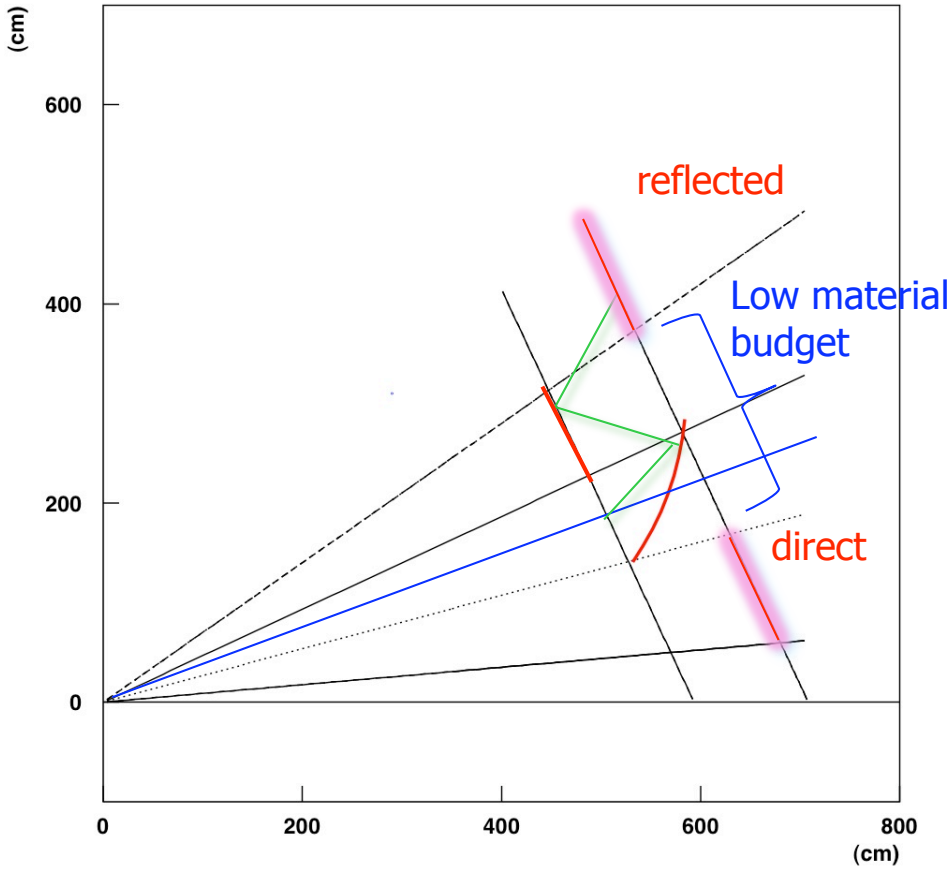


The mirror option

Reflect inside



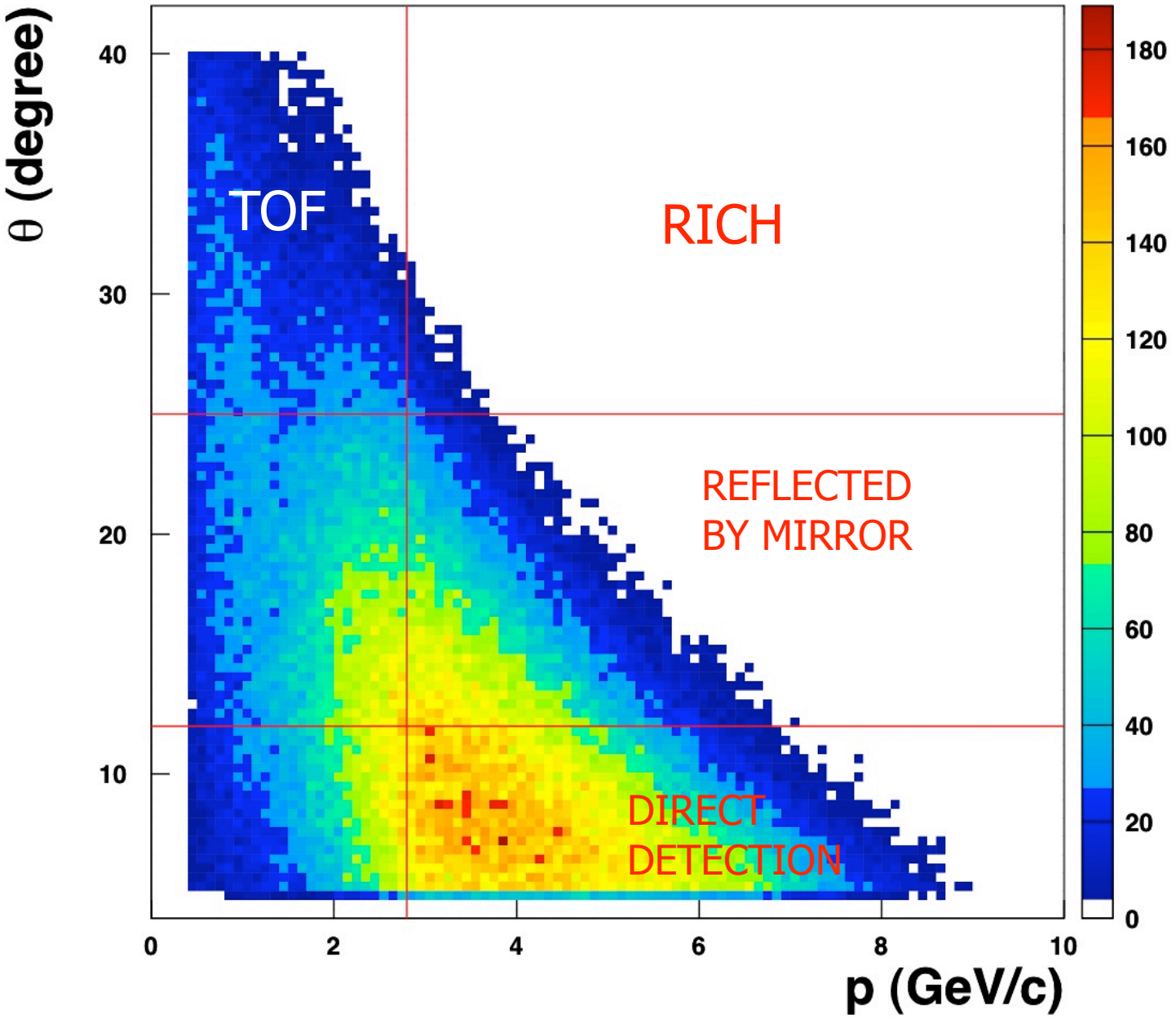
Reflect outside



Direct: high momentum → high performance

Reflected: lower momentum → relax performance requests

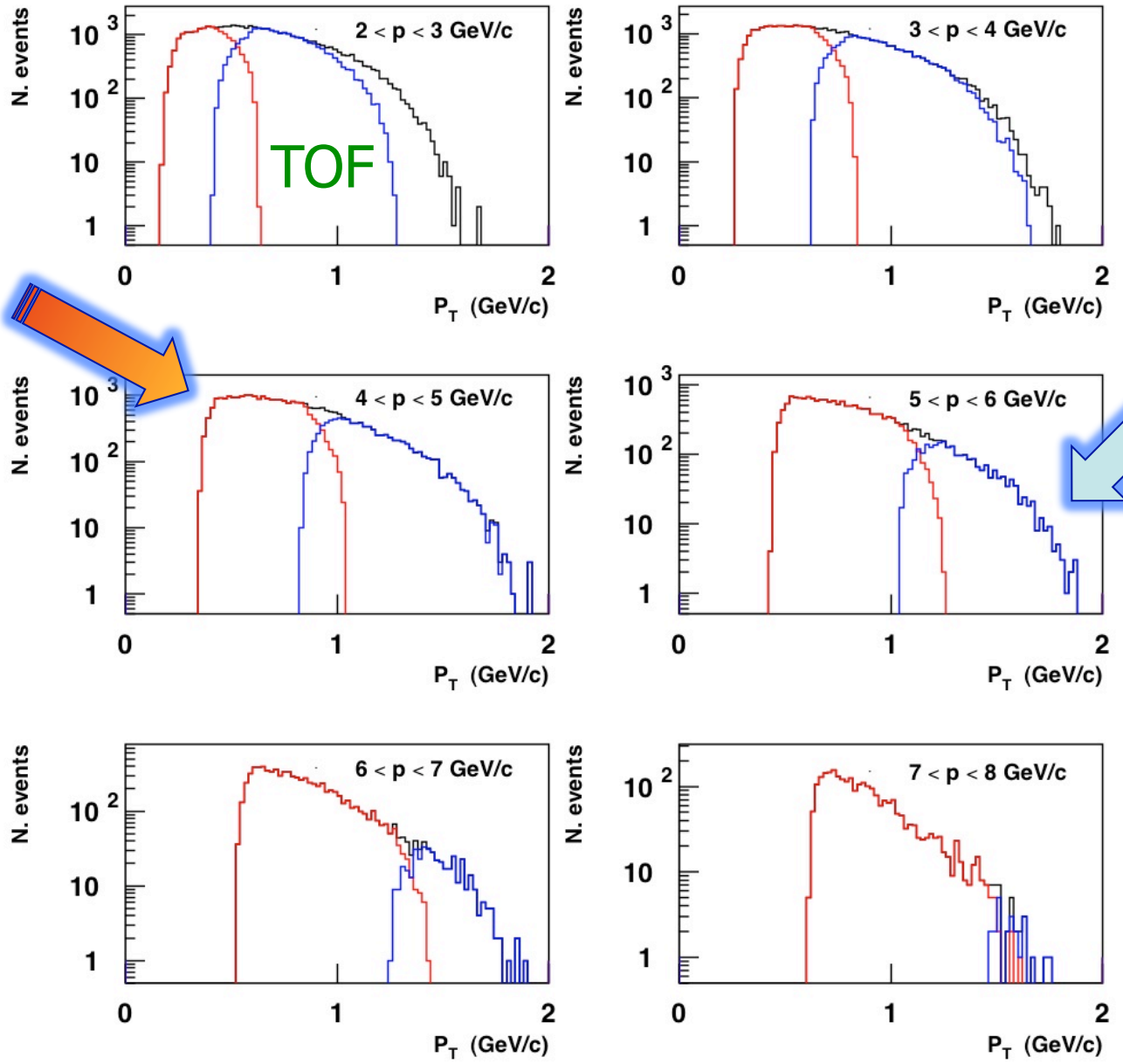
Kinematics


θ (degree)
40
30
20
10
0
2
4
6
8
10
p (GeV/c)
180
160
140
120
100
80
60
40
20
0
TOF
RICH
REFLECTED
BY MIRROR
DIRECT
DETECTION

P_T coverage

RICH DIRECT

RICH REFLECTED



Reflection outside

Minimize
interference with FTOF

Decouple
RICH optics

Simplify
reconstruction

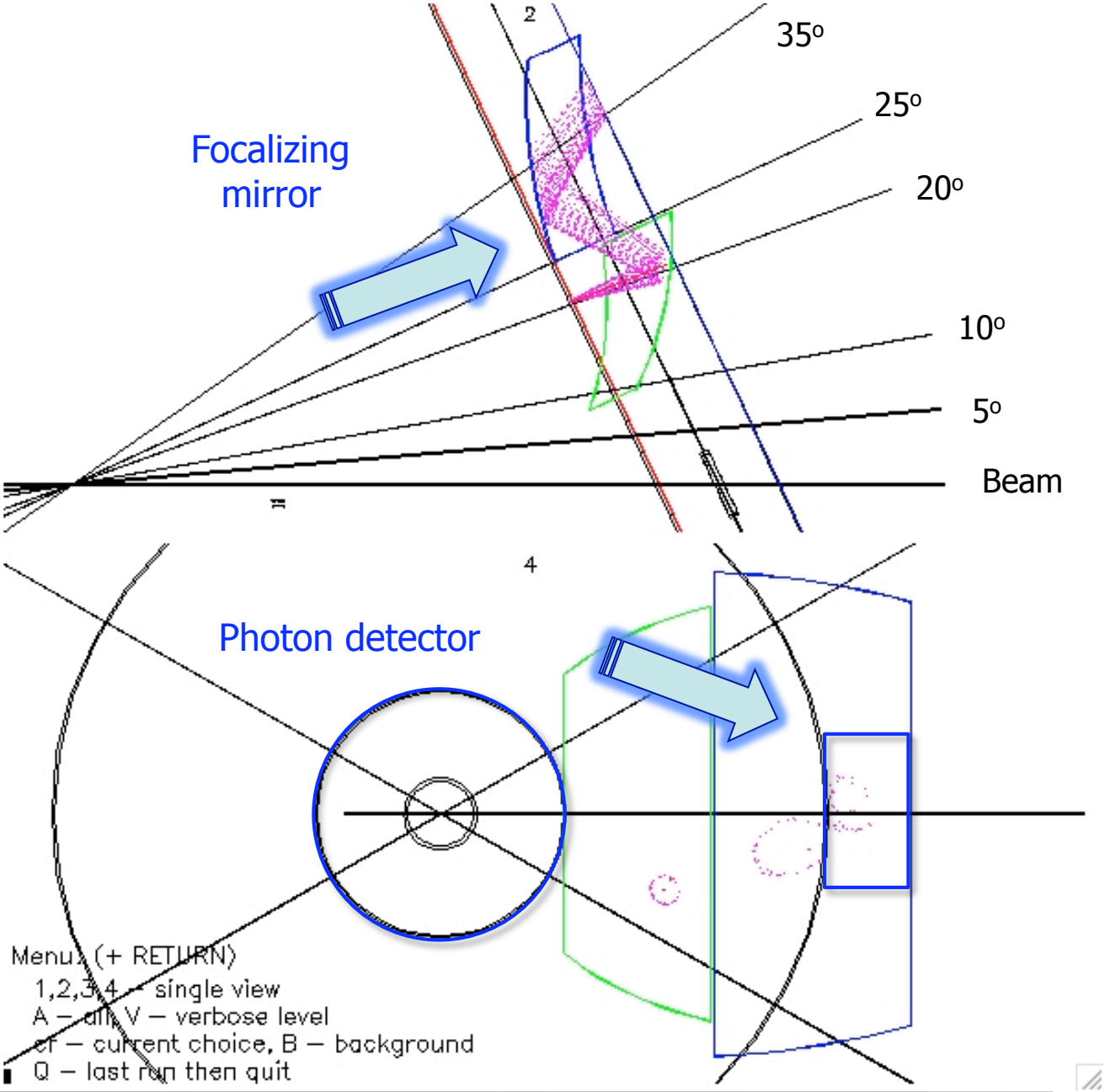
Doubled detector area

Focusing mirrors to reduce detector area to ~ 2 m^2/sec

Relax performance requests for the external half (lower p)

Increase pad size
Reduce channel number
Standard PMTs

Similar to i.e. LHC-b !!!



Reflection inside

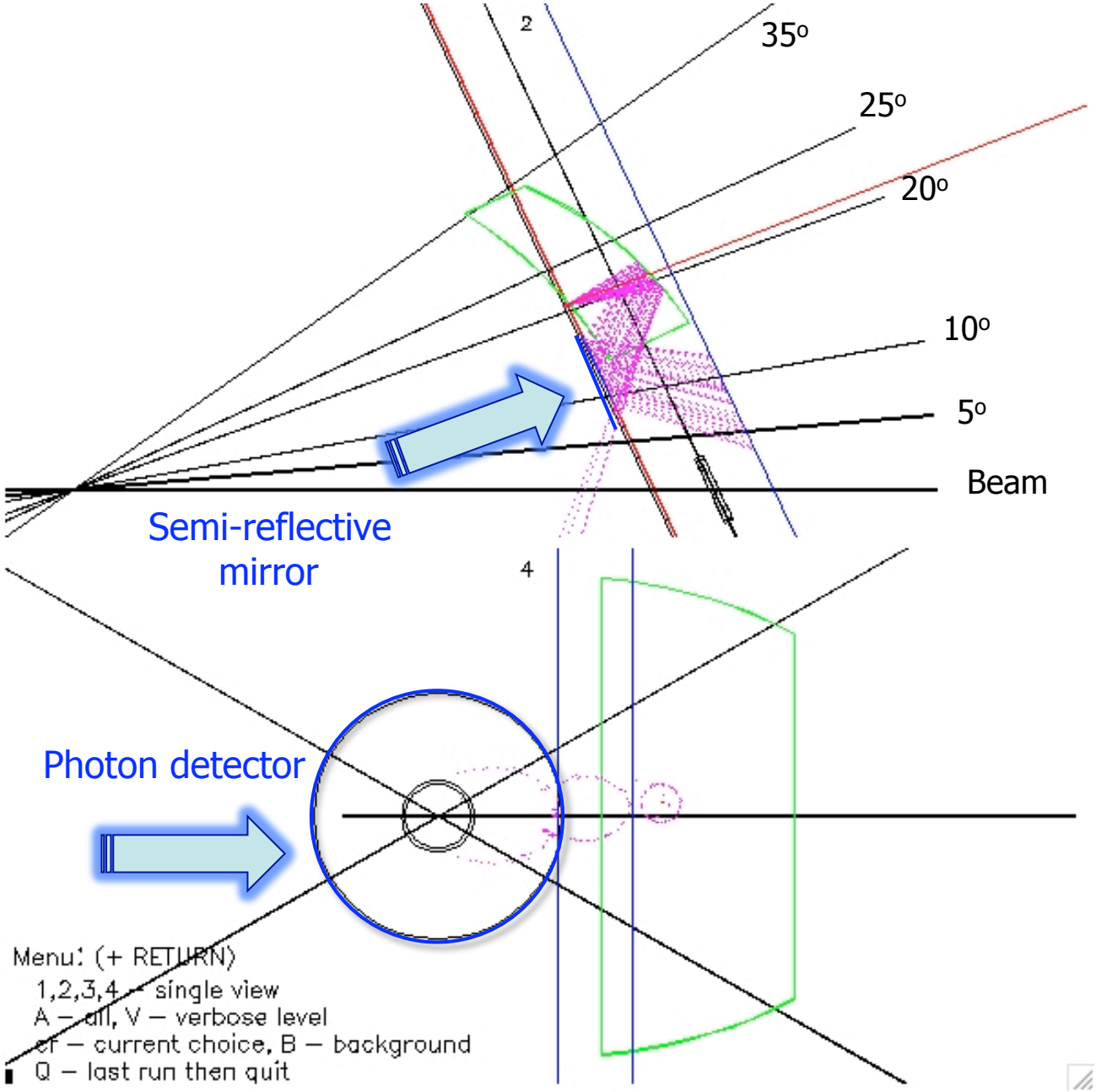
Minimize
- detector area (~1 m^2/sector)
- interference with FTOF

High density of hits
- check with track multiplicity

Too high absorption in aerogel
- semi-reflective mirror

Reduced collection efficiency
- (bi-alcali q.e. 25 %)
- ultra bi-alcali q.e. 45 %
- cost increases by 50 %

New concept !!!



Executive summary

RICH with Aerogel
matches the required performances

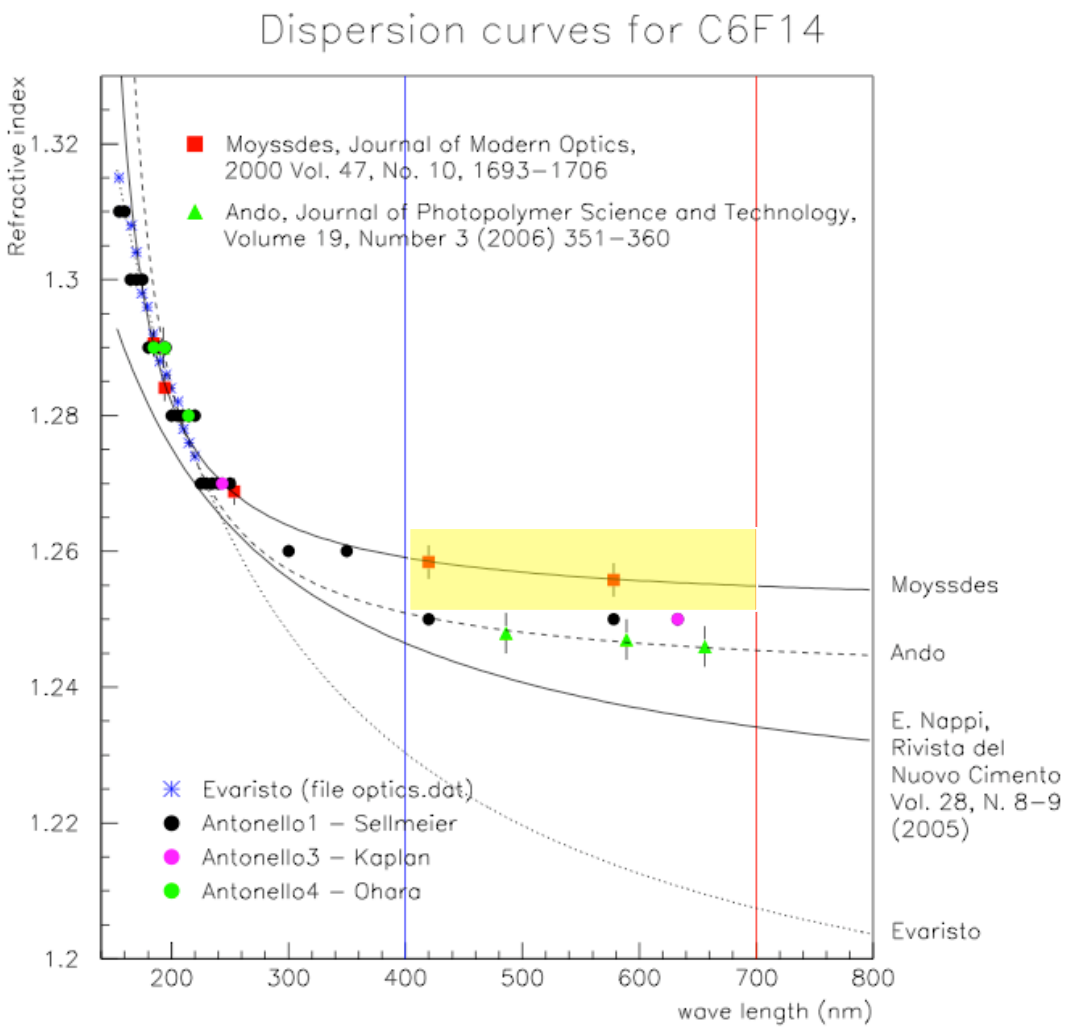
Working to minimize
- detector area
- material budget

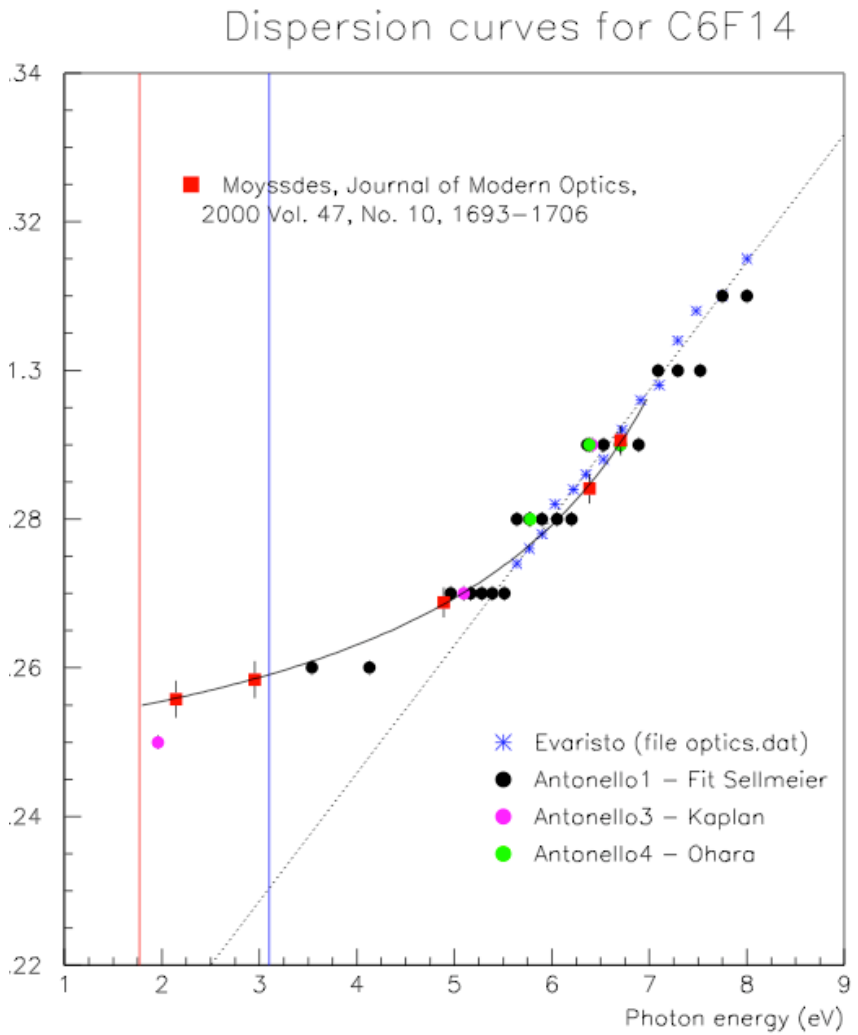
Ongoing:

Genaralize reconstruction algorithm to treat
- multiple track events
- mirrors

Optimize mirror geometry
- minimize detector area
- minimize interference with TOF

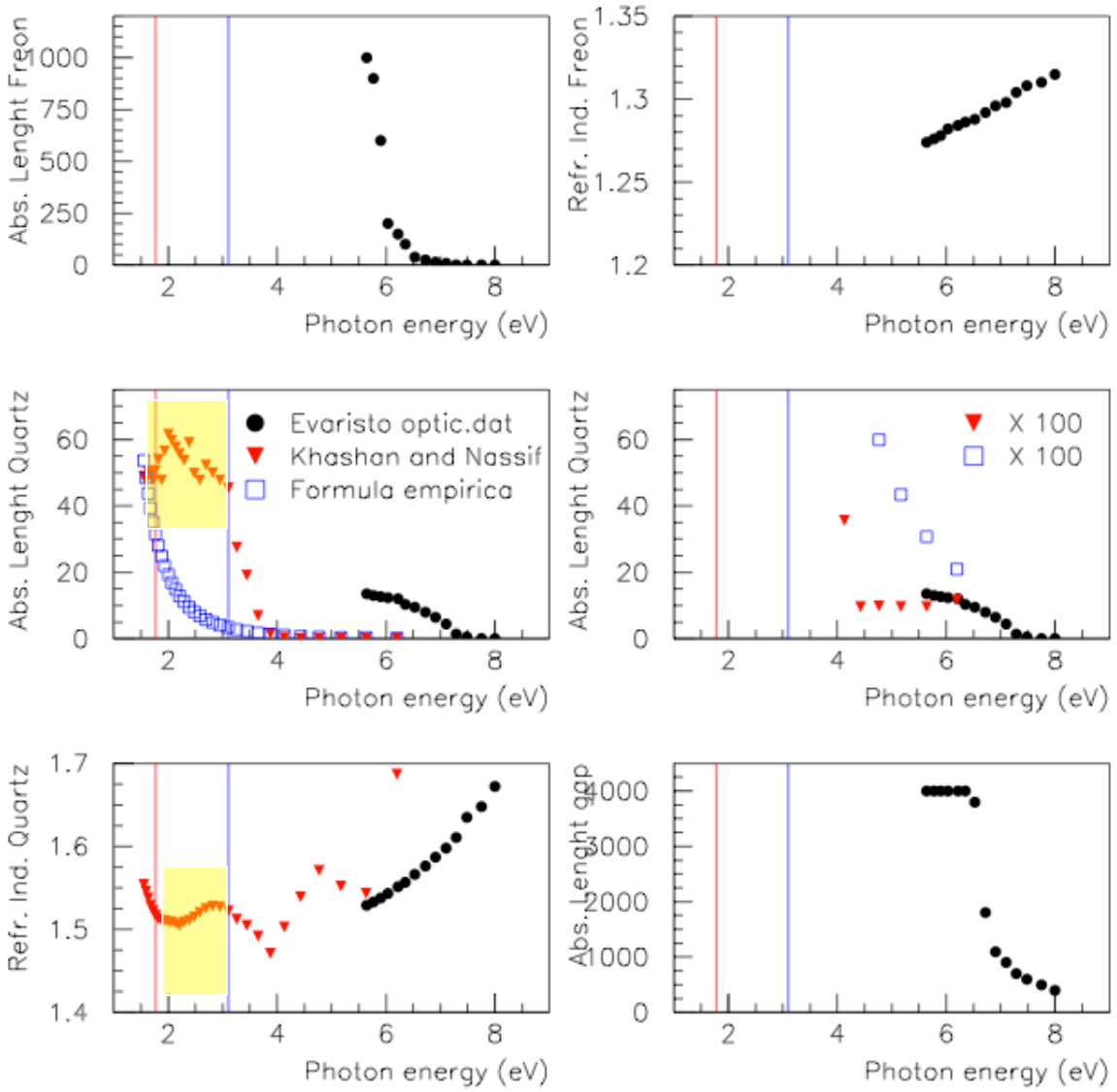
Refraction index: freon





Simulation based on most conservative n (Moyssdes)

Refraction index: quartz



Quartz absorption length and refraction index from
Khashan and Nassif, Optic communications 188 (2001) 129

Reflection outside

Minimize
interference with FTOF

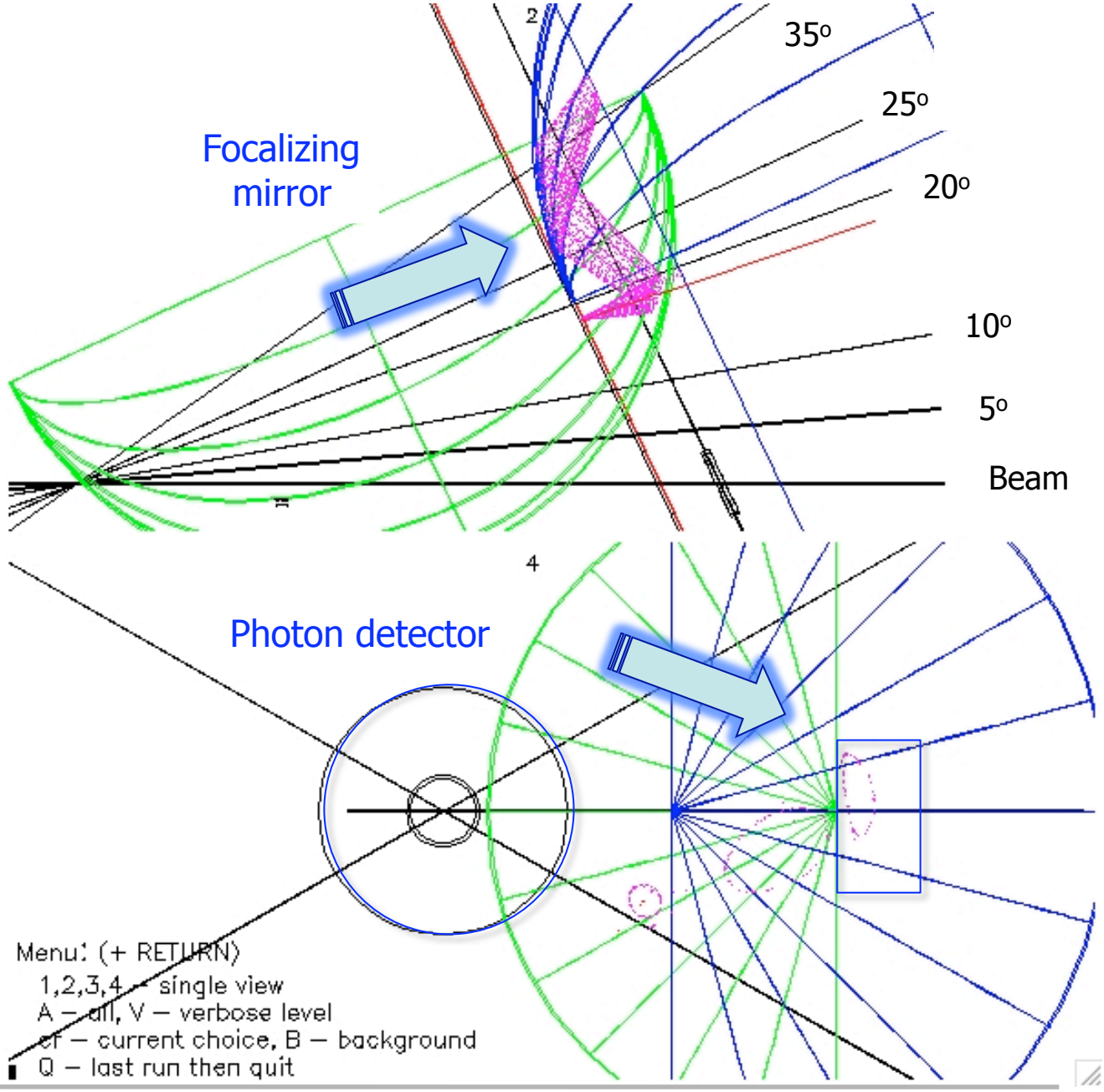
Decouple
RICH optics

Simplify
reconstruction

Doubled detector area
Relax requests for the
external half

Increase pad size
Reduce channel number
Standard PMTs

Similar to LHC-b !!!



Reflection inside

Minimize
- detector area (~1 m^2/sector)
- interference with FTOF

High density of hits
- check track multiplicity

Too high absorption in aerogel
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