Proposal for a test at CNAO

Information

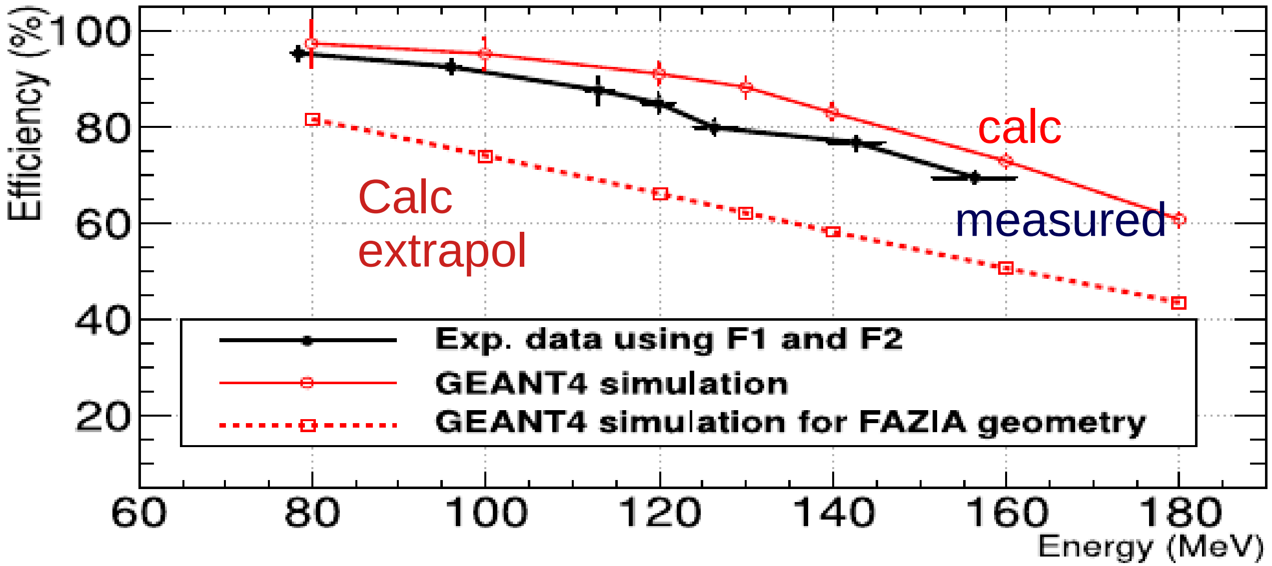
-experiments in atmosphere
-proton beams from 70 to 230 MeV
-C beams 150- 400 MeV/u
-currents from O(kHz) to 10^8 (machine control only for high intensities)
-Possibility for a scanning system (135x135mm2 at 1000mm)
-Visit to CNAO in april

The motivations of this (first) PROPOSAL: scientific and opportunistic

-**test of an entire BLK with energetic protons**
-in line with the tests at CCB in 2018,2019
-easy access; easy mounting operation in air
-we have detectors and 'no' beams
-opportunity to get experience for possible new runs at CNAO (C and p)
-good in view of FRIB activity

Proposal for a test at CNAO

C Frosin et al NIM A 2019



GOALS were
Energy-LO calibration: check (non)linearity with protons
IED effects and Efficiency: bad recognition of HE particles

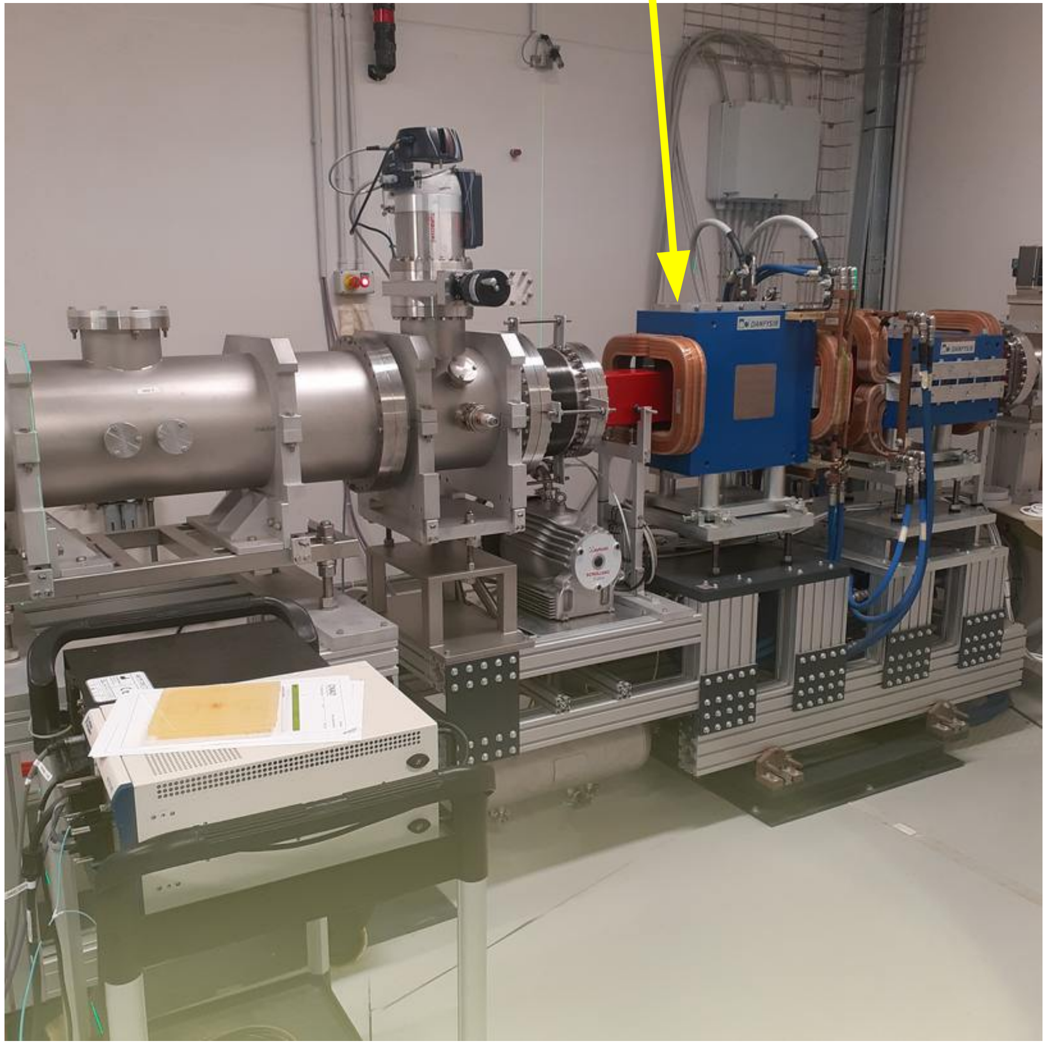
A second experiment at CCB, using Fazia telescope without collimation was unsuccessful: so now the basic idea is to do this with an entire blk also to check with new data part of the crosstalk of IED (i.e. correlations among telescopes possible)

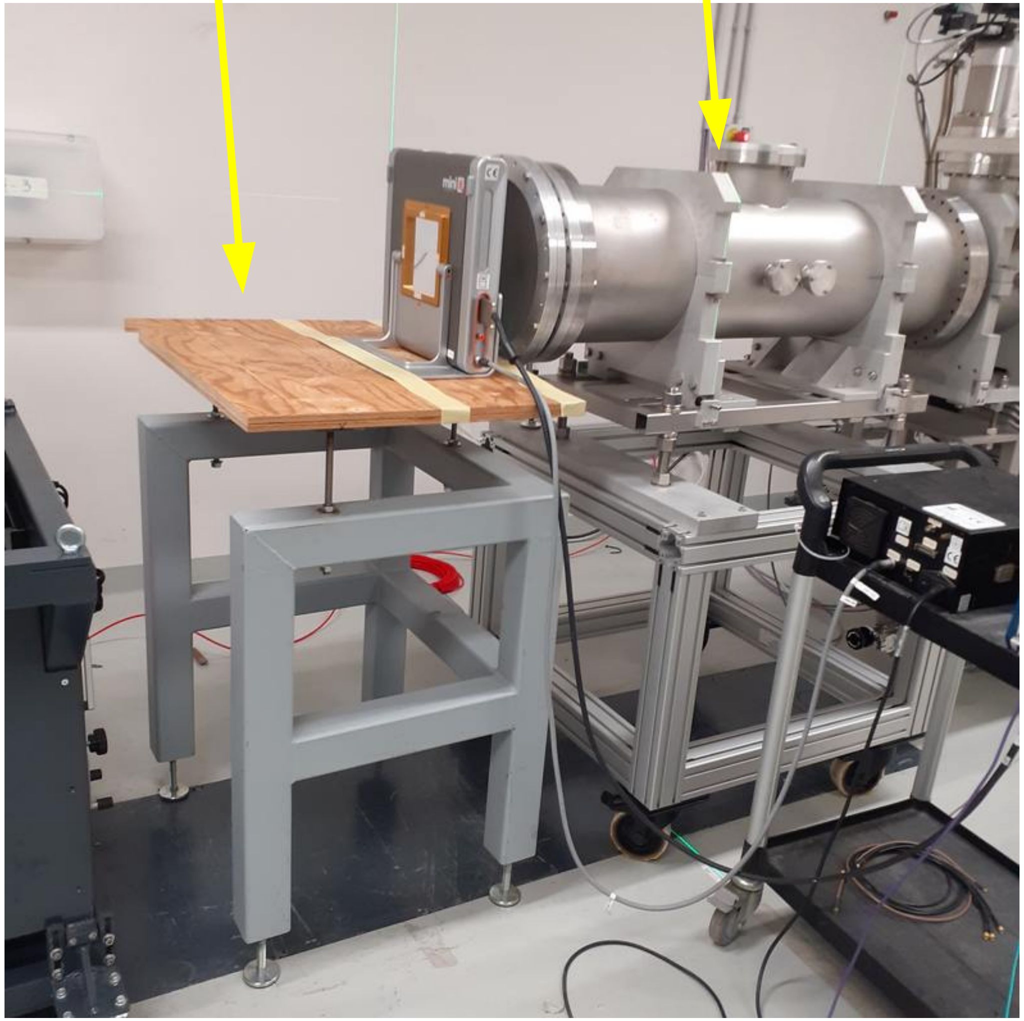
XTR hall at CNAO

Removable pipe

Scanning magnets

FAZIA support (or similar)





Proposed test: a typical scattering experiment

Considered effects (prelim calculations; if/when also Geant4)

Beam spot size (declared FWHM radius=5mm(@230) to 12 (low-E)
Energy losses in target and in air 1000mm
Multiple scattering spread in target and air (radiation length, see PDG)
Collision event in target and air (collision length, see PDG)

Energy losses (AtimaWeb)

10micron is an
Upper limit →

E0	p@70 AMeV MeV	p@100	p@230	
Eout - DE Au 10micron	69.91 0.09	149.95 0.05	229.96 0.04	
1000mm air	68.9 1.02	149.37 0.58	229.52 0.44	
Eout-DE Si1	68.3 0.61	149.03 0.35	229.26 0.26	
Eout-DE Si2	66.95 1.36	148.27 0.77	228.69 0.58	
Eoiut-DE CsI	0 66.95	0 148.27	93.91 135.75	
Eresidue	0	0	93.91	

Evaluation parameters

Assumed: d=1000mm, Au foil 2micron

Proton energy	current	Rate open telescope at 2.6deg	Rate open telescope at 6.5deg	Au foil micron	Stats /1h at 6.5deg	βγ	Int probability in air	Int probability in target
							Relat.part assumpt.	Relativ.part. Assumpt.
70MeV	10^8	9000	50	2	180000	0.394	0.019	0.00003
200MeV	10^8	390	3	2	10800	0.690	0.019	0.00003
70MeV	10^7	900	5	2	18000	0.394	0.019	0.00003
200MeV	5*10^7	975	7	5	25200	0.690	0.019	0.00003

Some calculations for CNAO

Fixed parameters: Fazia Tele angle 2deg; distance 1000mm; azimuth=-90 (left of beam)

Proton beam E=230MeV

Effect of the finite SPOT SIZE

SPOT DISTR

POLAR PLOT

Effect of the MS in air

Angular broadening

Distance broadening

1mm

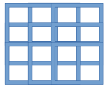
Declared spot diameter 10mm
Angular uncertainty st_dev=0.143deg

Air multiple scattering effect 1000mm
Angular broadening st_dev=0.081deg

Some calculations for CNAO

Fixed parameters: Fazia Tele angle 2deg; distance 1000mm; azimuth=-90 (left of beam)

MS in gold and air



Proton beam E=230MeV

Combined target Gold **10**micron and Air multiple scattering (MS) effect 1000mm
Angular broadening st_dev=0.111deg

Some calculations for CNAO

Fixed parameters: Fazia Tele angle 2deg; distance 1000mm; azimuth=-90 (left of beam)

Proton beam E=70MeV

Beam spot size effect

Declared spot diameter 24mm
Angular uncertainty st_dev=0.341deg

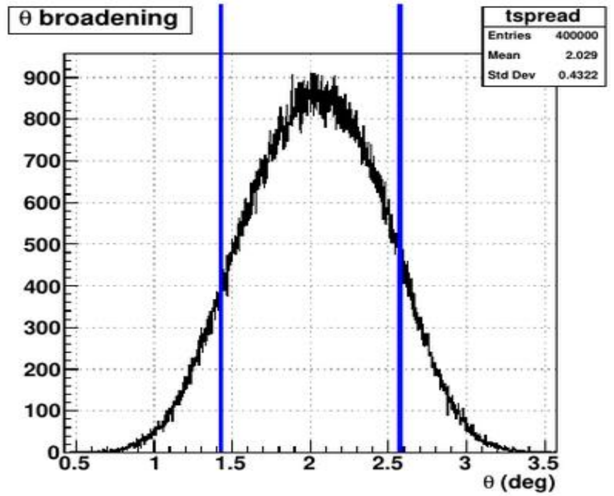
Combined target Gold 10micron and Air multiple scattering effect 1000mm
Angular broadening st_dev=0.341deg

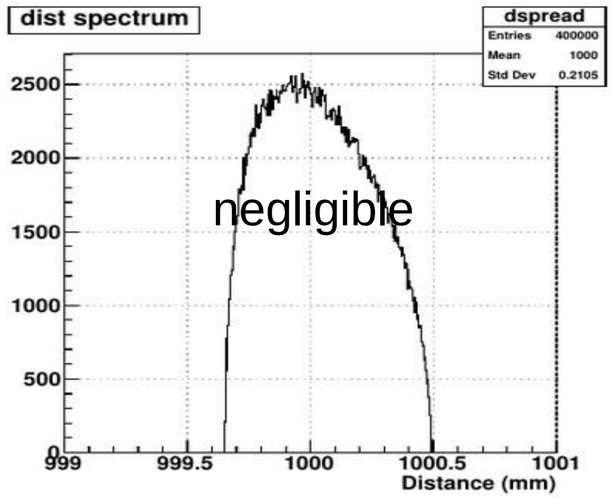
Some calculations for CNAO

Fixed parameters: Fazia Tele angle 2deg; distance 1000mm; azimuth=-90 (left of beam)

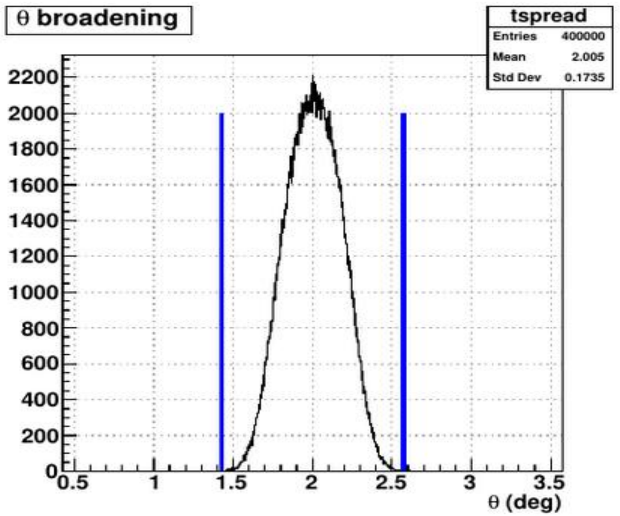
Ang. BROADENING

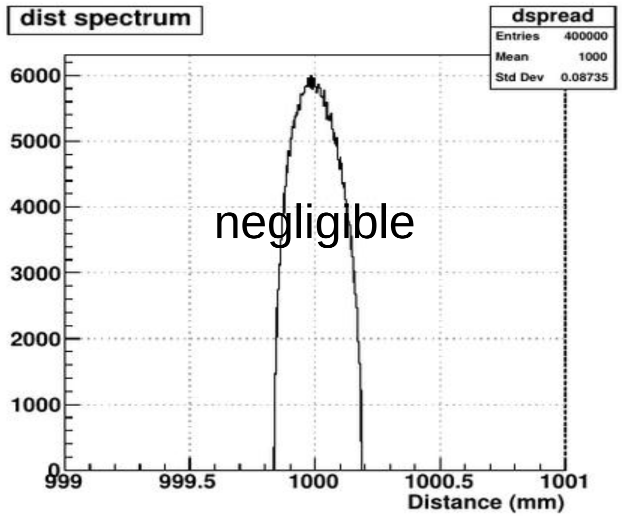
DISTANCE SPREAD





E=70AMeV
Overall dispersion 0.43deg





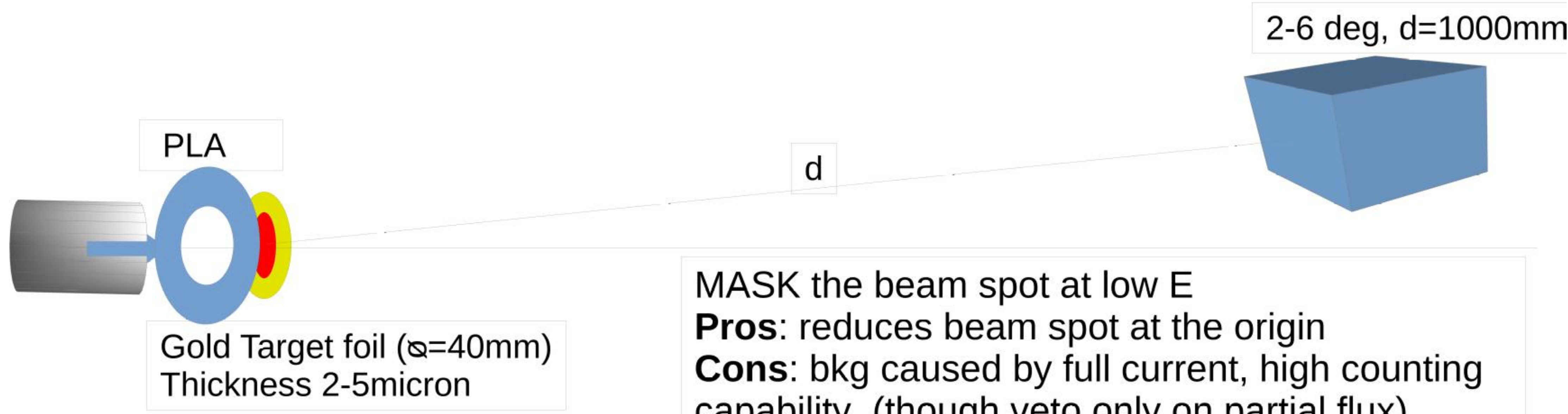
E=200AMeV
Overall dispersion 0.17deg

Comments

1) energy losses are small and under control, no concern;
2) the spot size at low Energies (70MeV) causes spurious tracks at borders;
3) Also MS is larger in air and in target at low E (additional spurious tracks)
4) at High energy, overal less spoiling effects of any type
5) may be that some active collimation tool is useful to improve track conditions (in particular at low En.)

Two collimator (not equivalent) choices

MASK ONLY ONE SELECTED TELESCOPE
Pros: bkg caused only from low intensity scattered ions. All bkgs cut away (almost...)
Cons: only one Tele at a time



MASK the beam spot at low E
Pros: reduces beam spot at the origin
Cons: bkg caused by full current, high counting capability (though veto only on partial flux)

Timeline

- **Proposal sent 16 june 2023**

- **Approval by ‘phone’ 23 june 2023**

- **Proposed run periods:**

  12-13 august or
  19-20 august or
  1 october (this is booked for us, so far) or
  perhaps jan 2024 (calendar non available yet)

- **Decision to be taken: is october 1st fine?**
- **This is one shift (I guess 12-16h to be confirmed)**
- **Mounting friday 29 september (to be confirmed)**

Suggestions for further cases

LO- Energy calibration for INDRA CsI+MESYTEC (probably not now

Marian: Comparison of PD vs. PM readout for 2 'identical' FAZIA CsI

Measurements at zero-degree and low currents i.e. direct irradiation with scanning magnets; Case A) no-target configuration means repeating the test in alternative way Case B) With-target means interaction cross section (a-la FaziaZERO)

Measurements with C. Towards C fragmentation studies? (competitors are arriving!)

C+X reactions: how well we can identify fragments at 30-60deg in lab (target spectator physics?)
One can put a Fazia-Block at 45 deg (d=1000mm or less) and test the id-capability from fragments emitted from X* (X=Ni,Sn,Au,Pb)

Measurements of cross sections (a scanning arm for FAZIA blk is already available)

Measurements of new gas properties (ionization, average radiation and collisions lenghts, energy loss for (quasi)-relativistic p and C, ageing)

Geant4 calculations welcome!! (Silvia, Alberto, Simone,etc….)

Some calculations for CNAO

Fixed parameters: Fazia Tele angle 2deg; distance 1000mm; azimuth=-90 (left of beam)

Angular dispersion for Carbon are better   E=100-200AMeV

E=100AMeV
St-dev   0.121 deg

E=200AMeV
St-dev 0.063 deg

Declared spot diameter 8mm
Angular uncertainty st_dev=0.115deg

Combined target Gold 10micron and Air multiple scattering effect 1000mm