Alikhanov Institute for Theoretical and Experimental Physics
Russian Federation State scientific center

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FLINT experimental data on Dense Cold Matter search with special trigger

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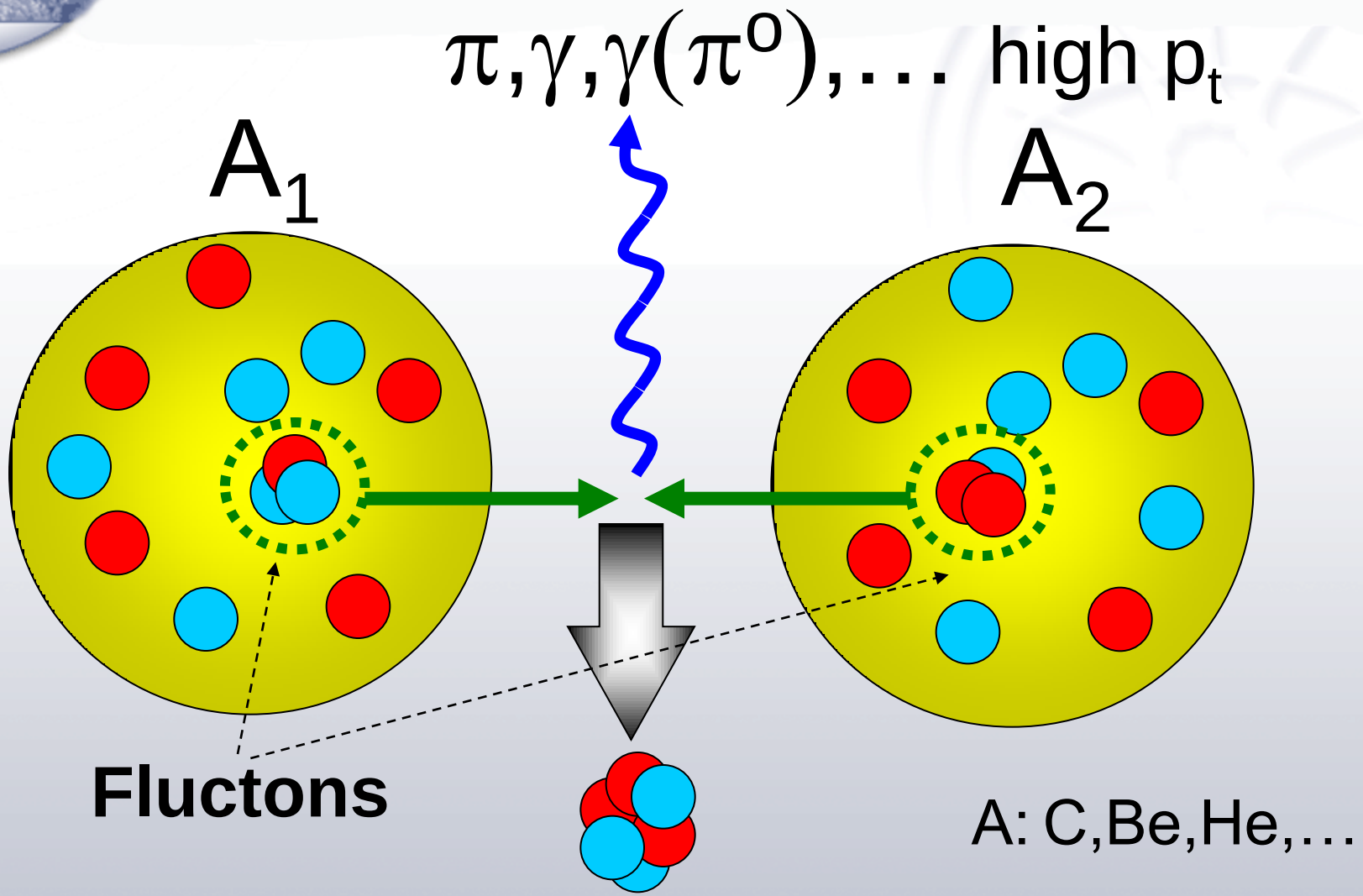
for FLINT

ITEP, Moscow

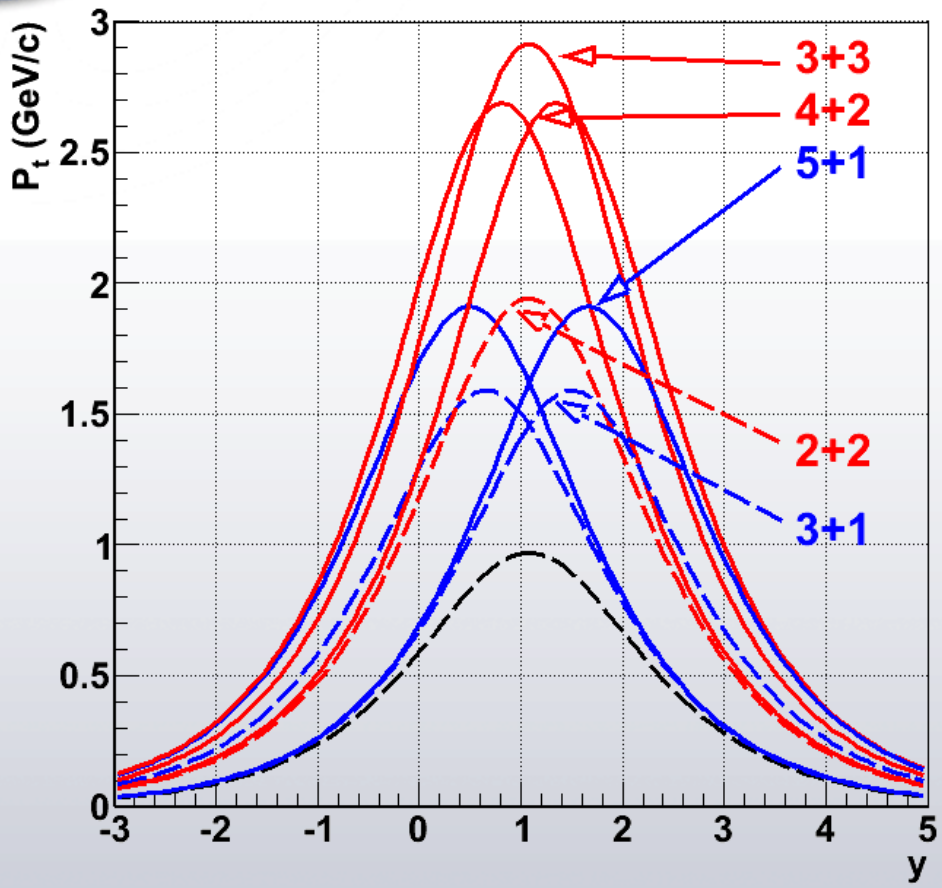
Outline

- Physical motivation
- Experimental setup
- Results of run 2007
  - cumulative numbers
  - indication for high density
- run 2010
- conclusions

Flucton-flucton interactions



Kinematics choice



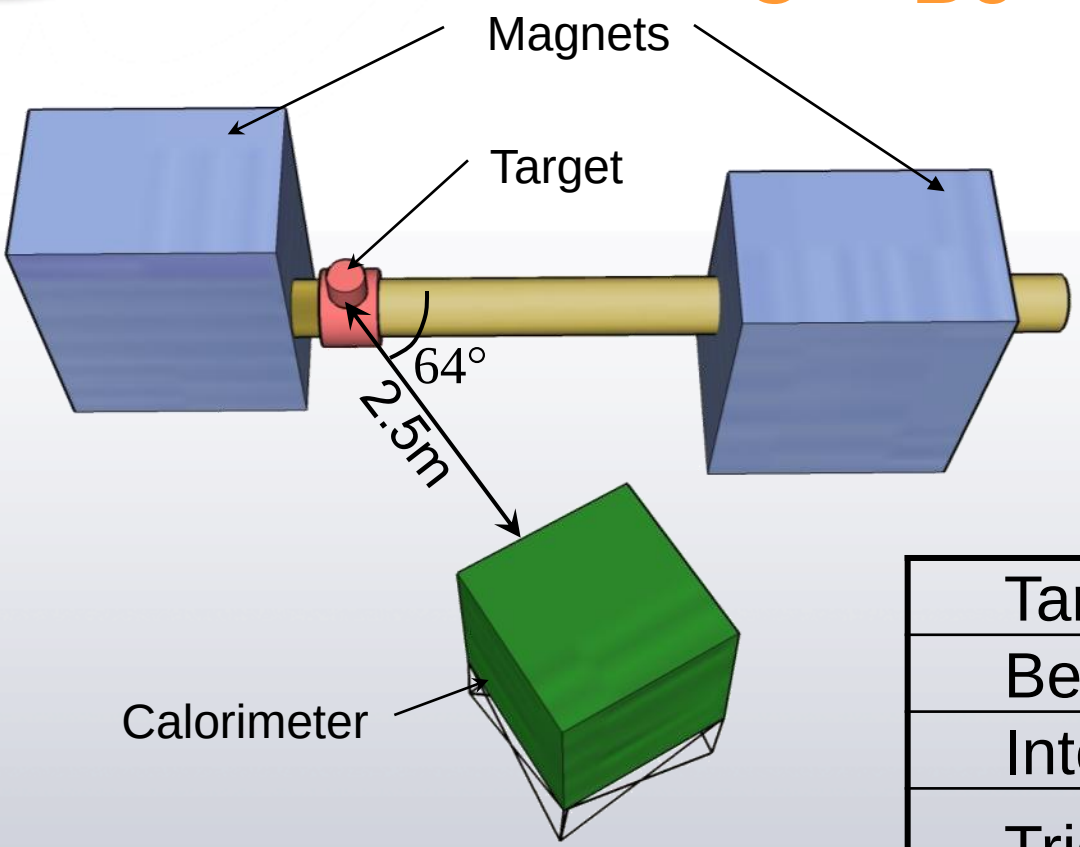
P_t-y_{lab} plot of kinematical boundaries for iN+jN flucton interactions

Reaction: C+Be→γ + X
–Initial energy 3.2 AGeV
–Light nuclei
–Central rapidity

Experiment @ ITEP
magnet hall
may 2007

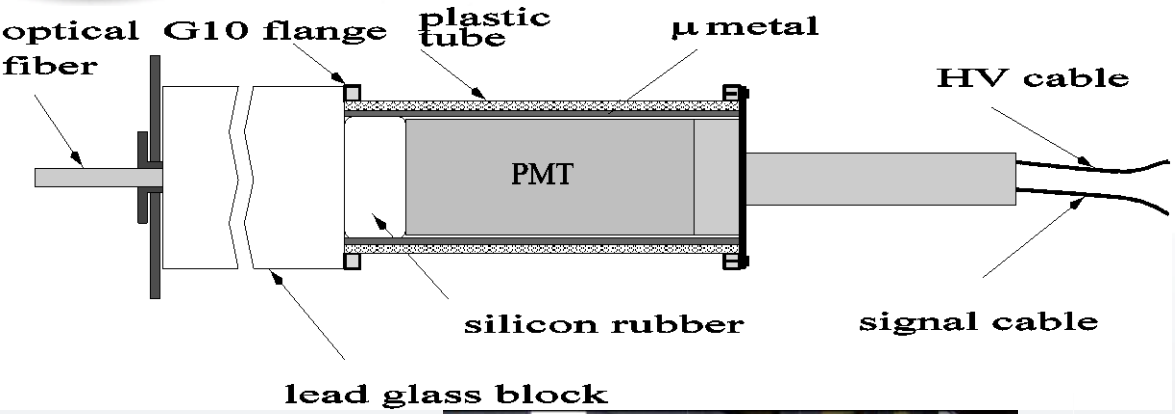
Experiment @ ITEP magnet hall 2007

$^{12}C + Be \rightarrow \gamma + X$



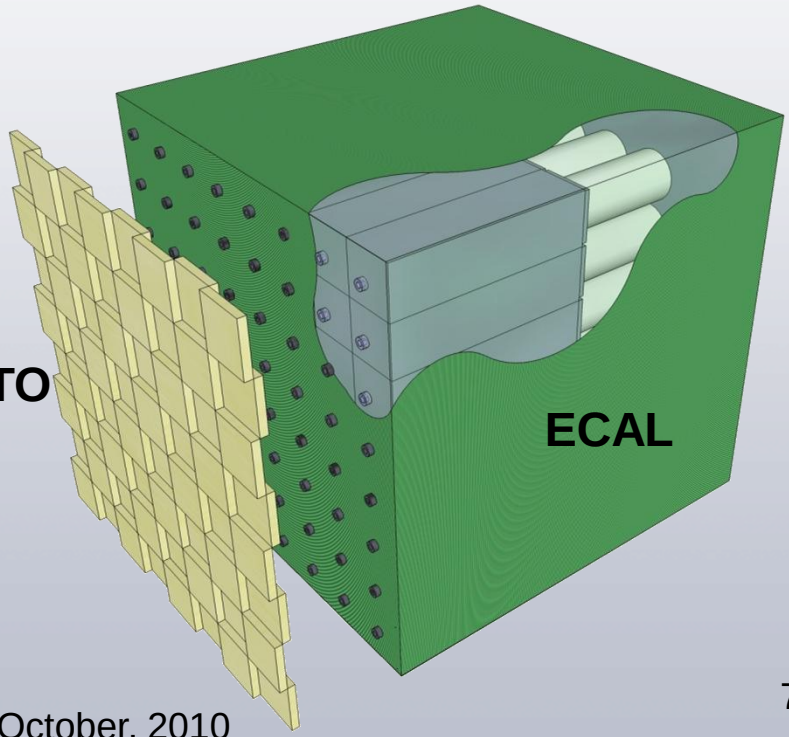
Target:	Be
Beam:	^{12}C E_K=3.2 AGeV
Intensity:	~10^7N/spill
Trigger:	E>1. GeV in any glass block
Exposition:	8 days
Data:	~750K events

FLINT supermodule



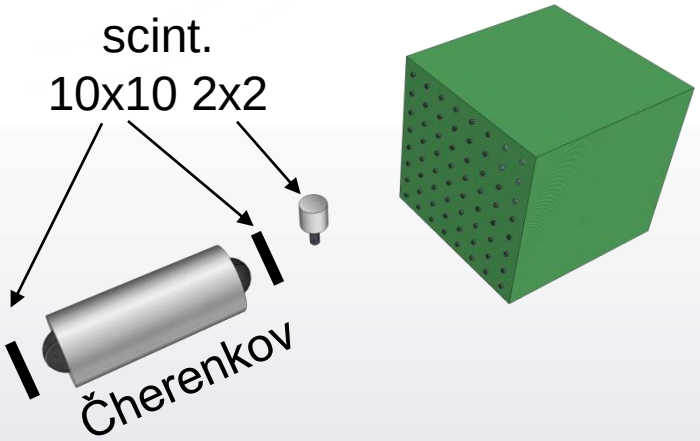
matrix 8x8
100x100x380 mm^3
Lead glass F8
$\rho=3.6 g/cm^3$
$X_{rad}=3.1cm$
$R_M=3.6cm$
Mass~1.5 Tonn

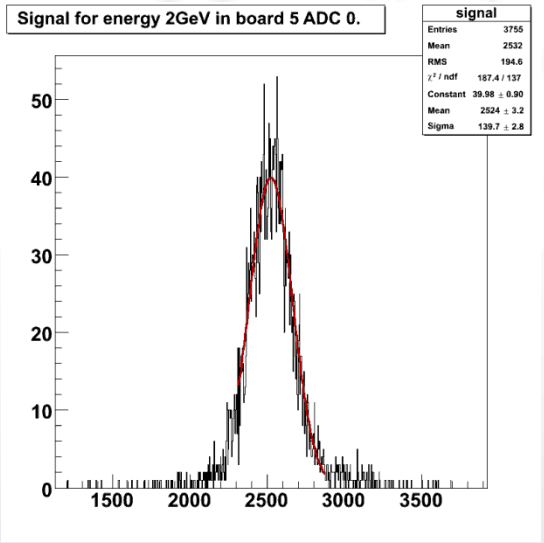
VETO

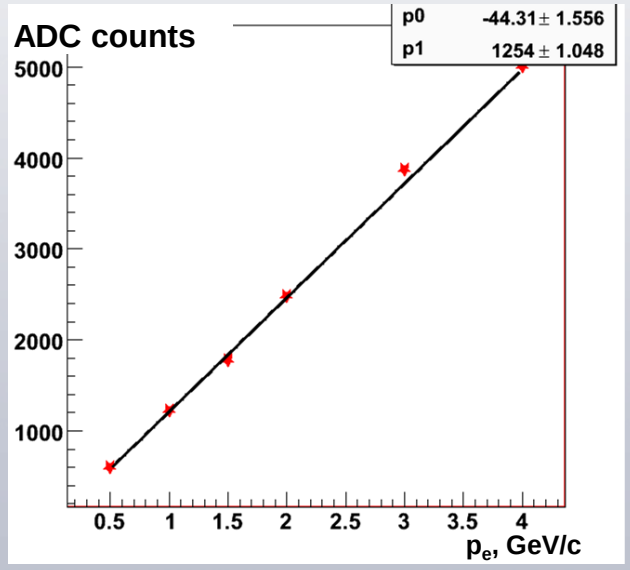


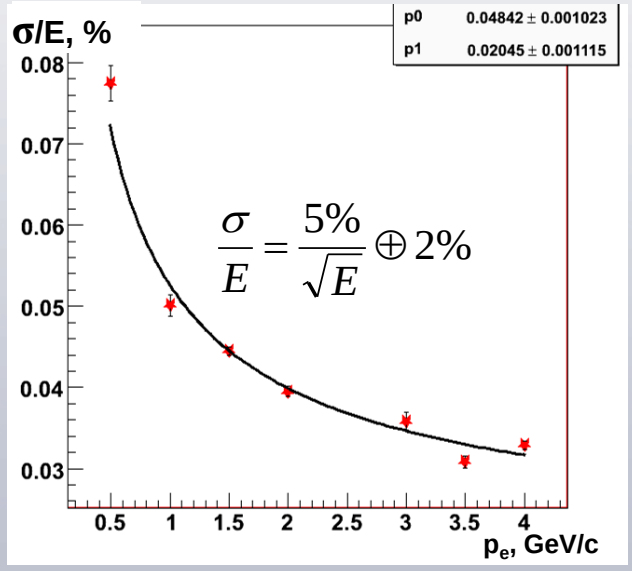
Calibration with electron beams @ ITEP accelerator facility

p_{e^-}: 0.5,.. 4.0 GeV/c

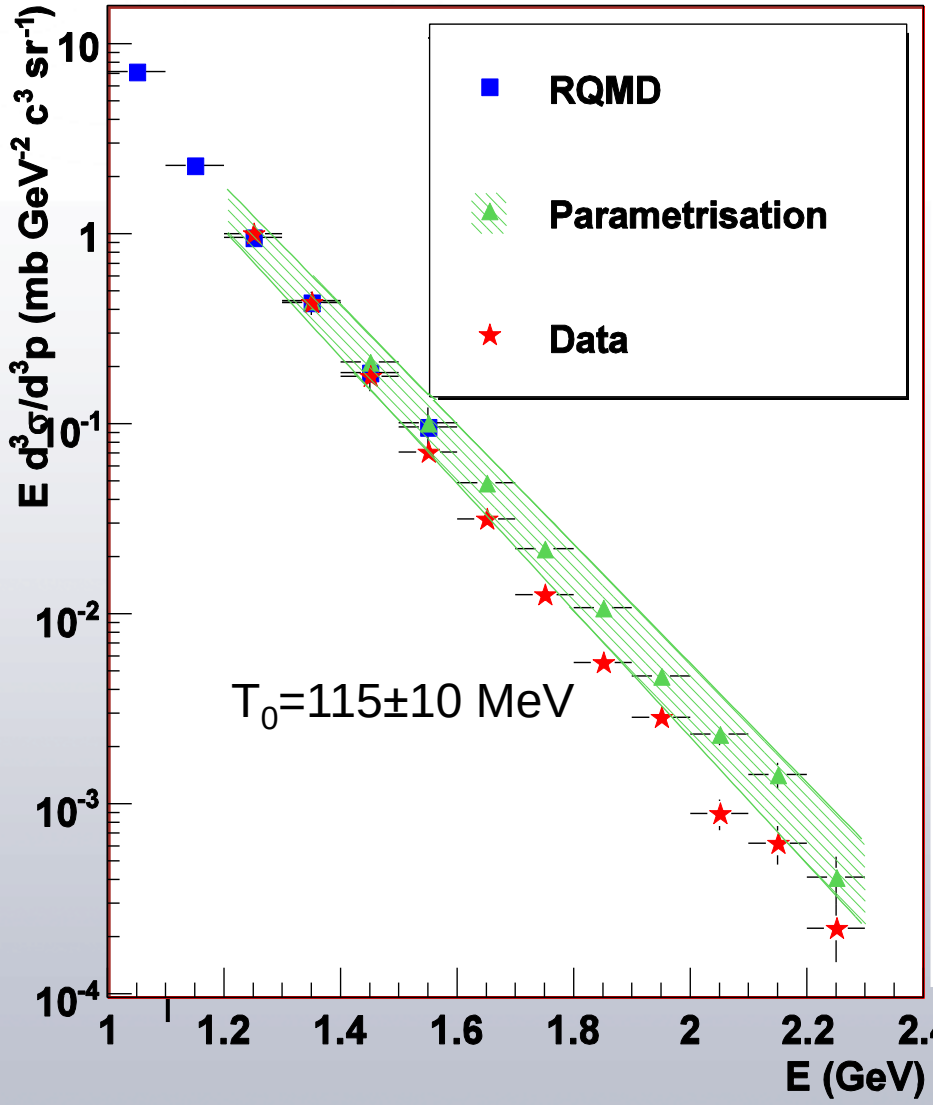


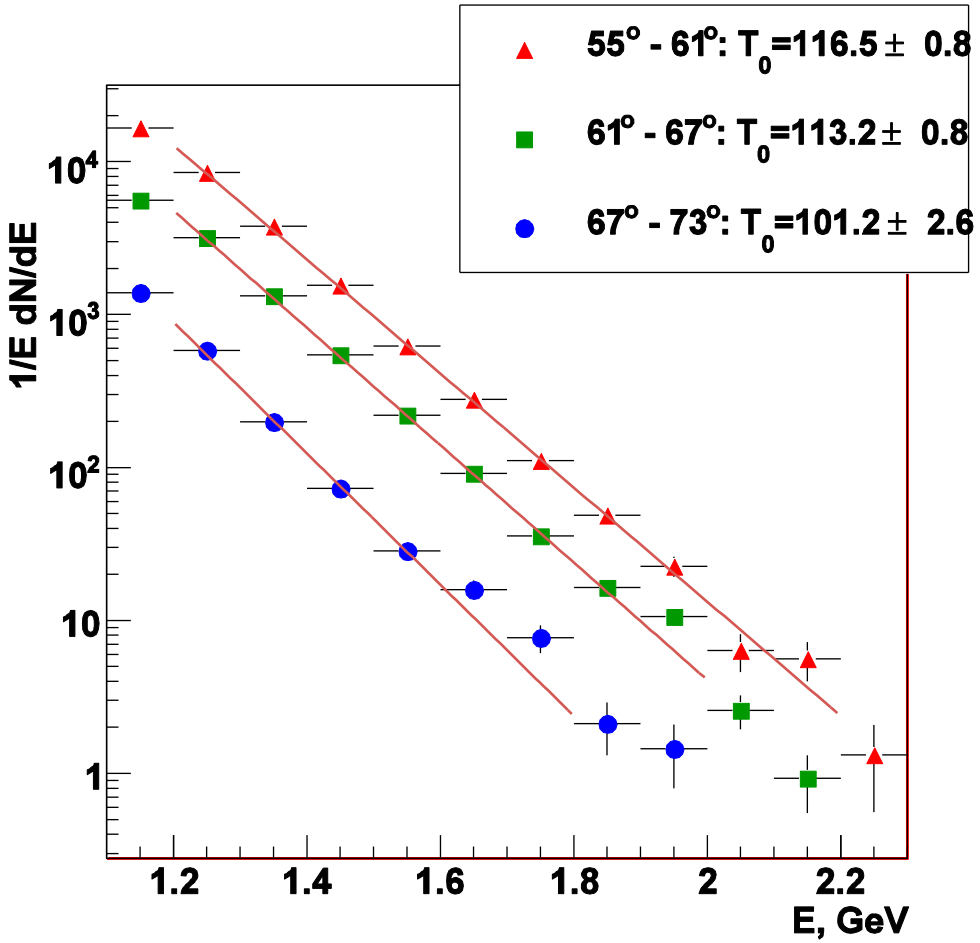






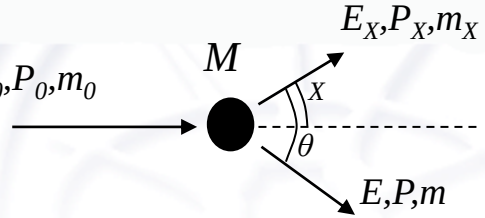
run 2007 results





Cumulative number

Cumulative number



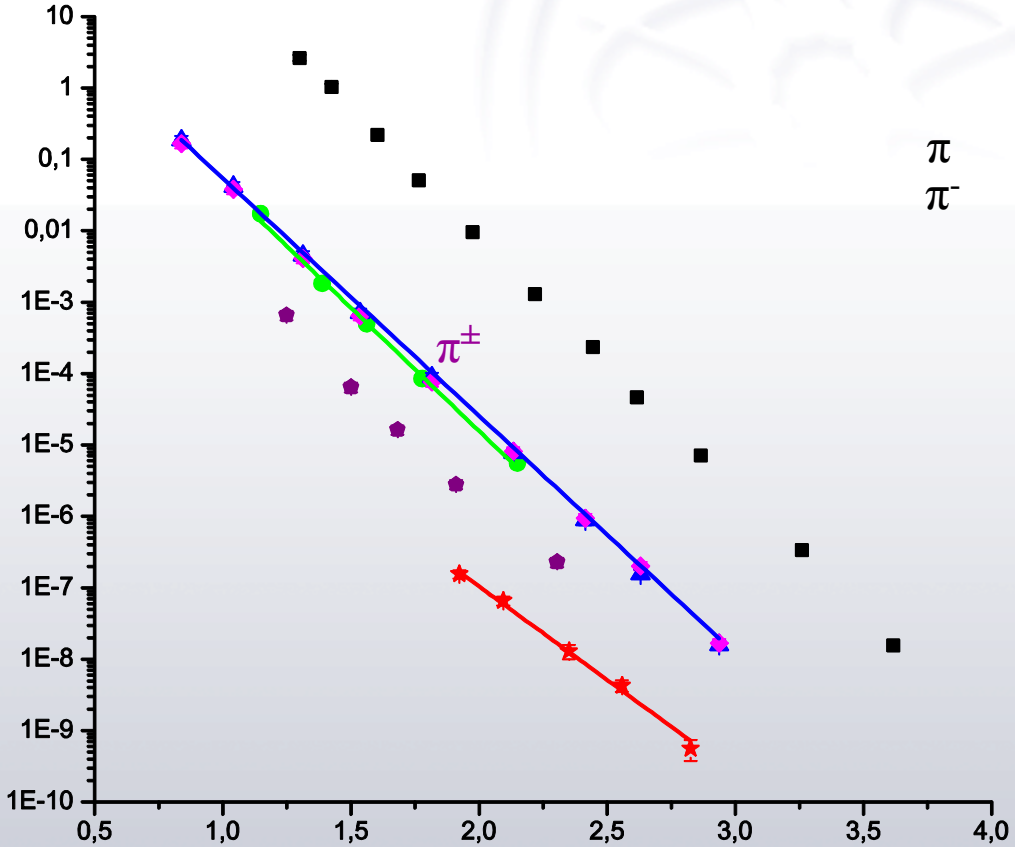
$$\begin{cases} E_0 + M = E + E_X \\ p_0 = p \cdot \cos\theta + p_X \cdot \cos X \\ 0 = p \cdot \sin\theta + p_X \cdot \sin X \\ m_X^2 = (m_0 + M)^2 \end{cases} \Rightarrow \begin{cases} E_X^2 = E_0^2 + M^2 + E^2 + 2E_0M - 2EM - 2E_0E \\ p_X^2 = p_0^2 + p^2 - 2p_0p\cos\theta \\ m_X^2 = (m_0 + M - m)^2 \end{cases}$$

$$X \cdot m_N = M = \frac{E_0E - p_0p\cos\theta - mm_0}{T_0 - E + m}$$

1+N	4,0	1+(N+1)	5,0
2+N	1,9	2+(N+2)	3,9
3+N	1,6	3+(N+3)	4,6

Cumulative effect

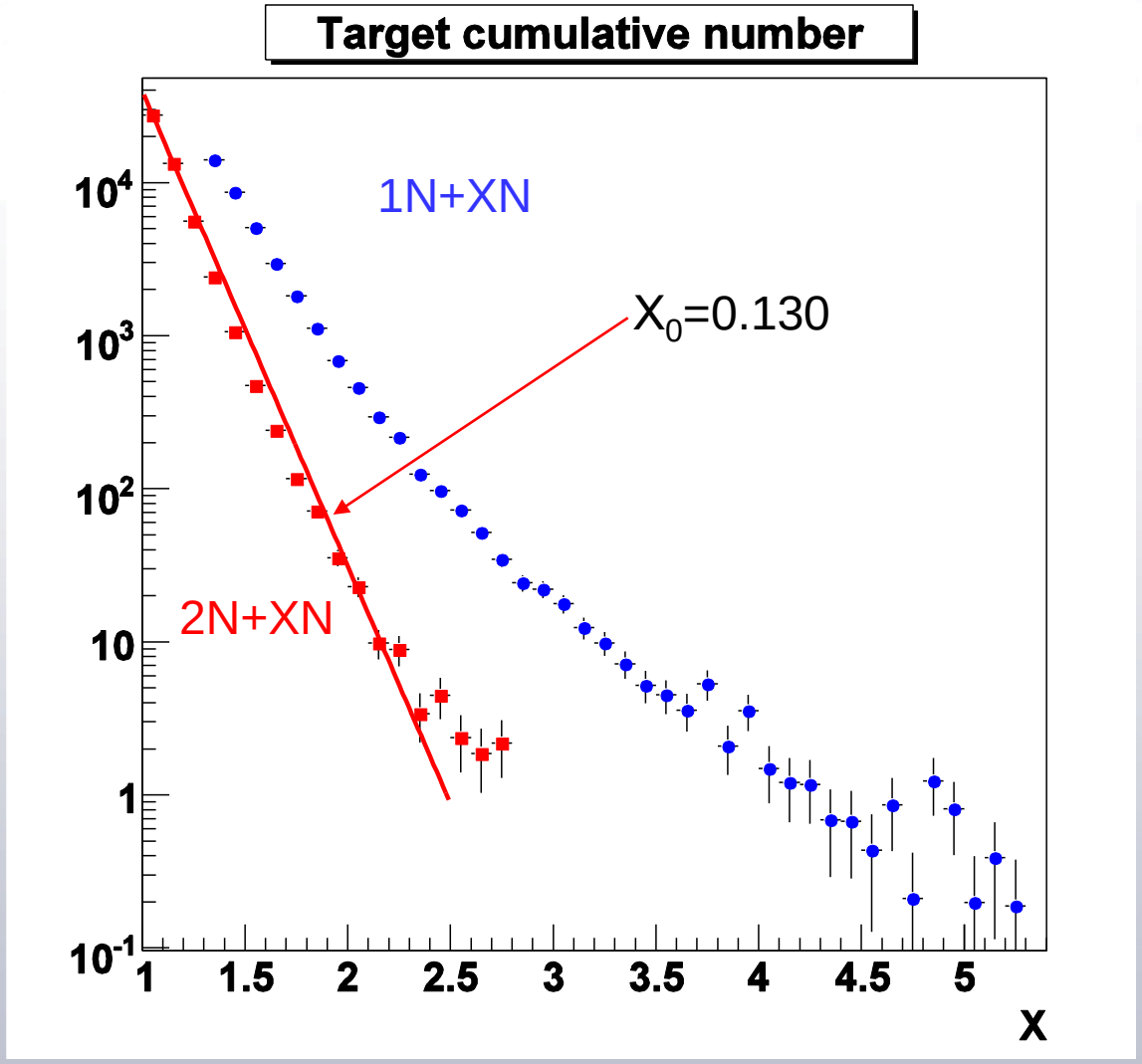
- multinucleon
- local
- exponential spectra T_o~130MeV
- 1N+3N interaction achieved for “not fragments”
- adding 1 unit to X causes drop of c.s. by 1000!



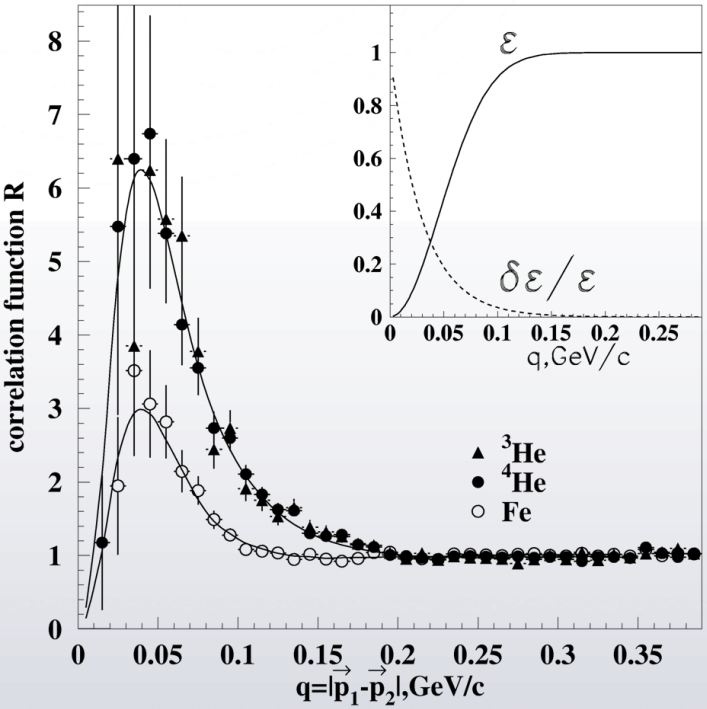
X – minimal target mass [m_N] needed to produce particle

FAS @ ITEP (Boyarinov et.al Yad.Fiz 57 (1994) 1452)

Flucton-flucton interaction

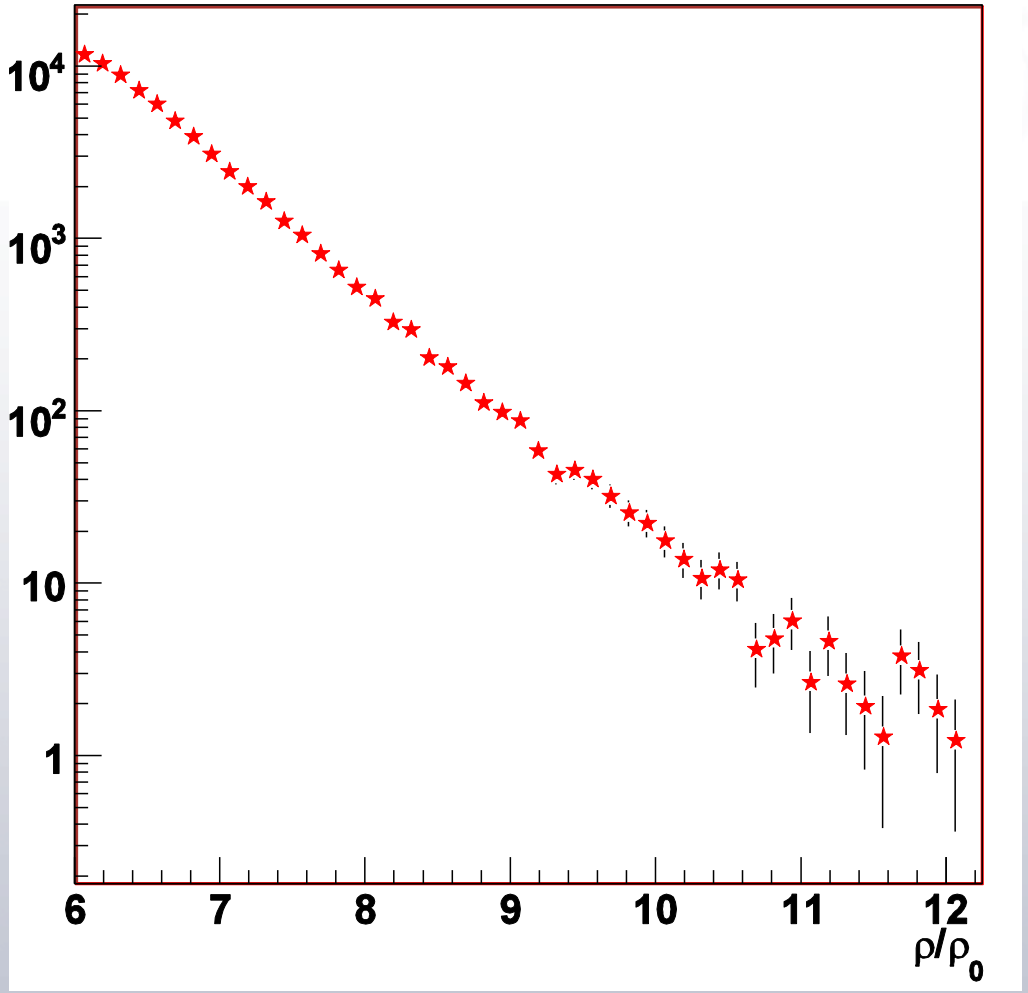


Minimal baryon density



r_f~1-1.5fm

A.Stavinsky.et al., Phys.Rev.Lett. 93,192301 (2004)



indication for high density creation

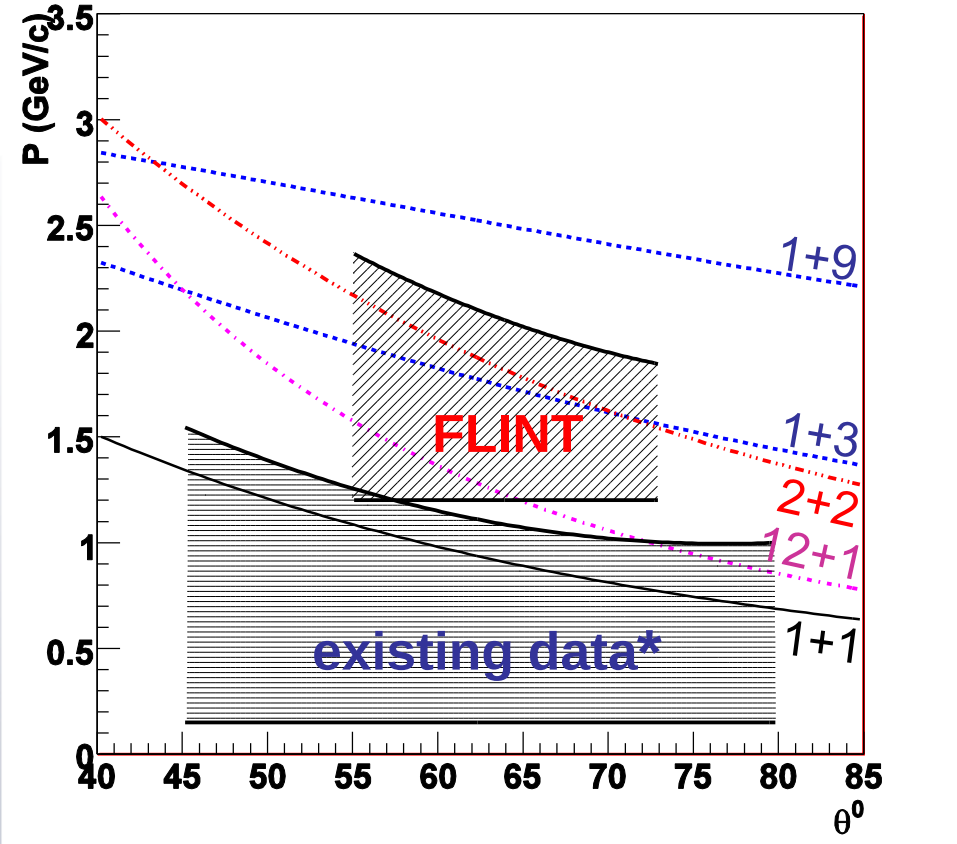
Run 2007 results
p-θ plot

•data go out of 12N+1N limit
→ no projectile fragmentation

•no combination of 4 nucleons is enough
→ data enter iN+jN≥5 range

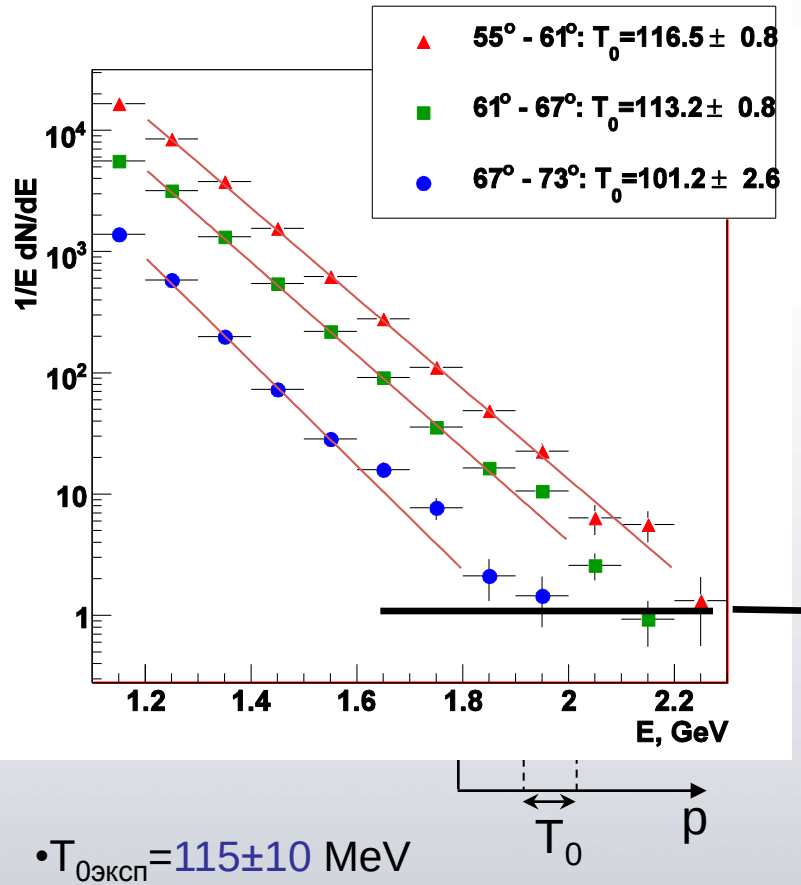
new kinematical area

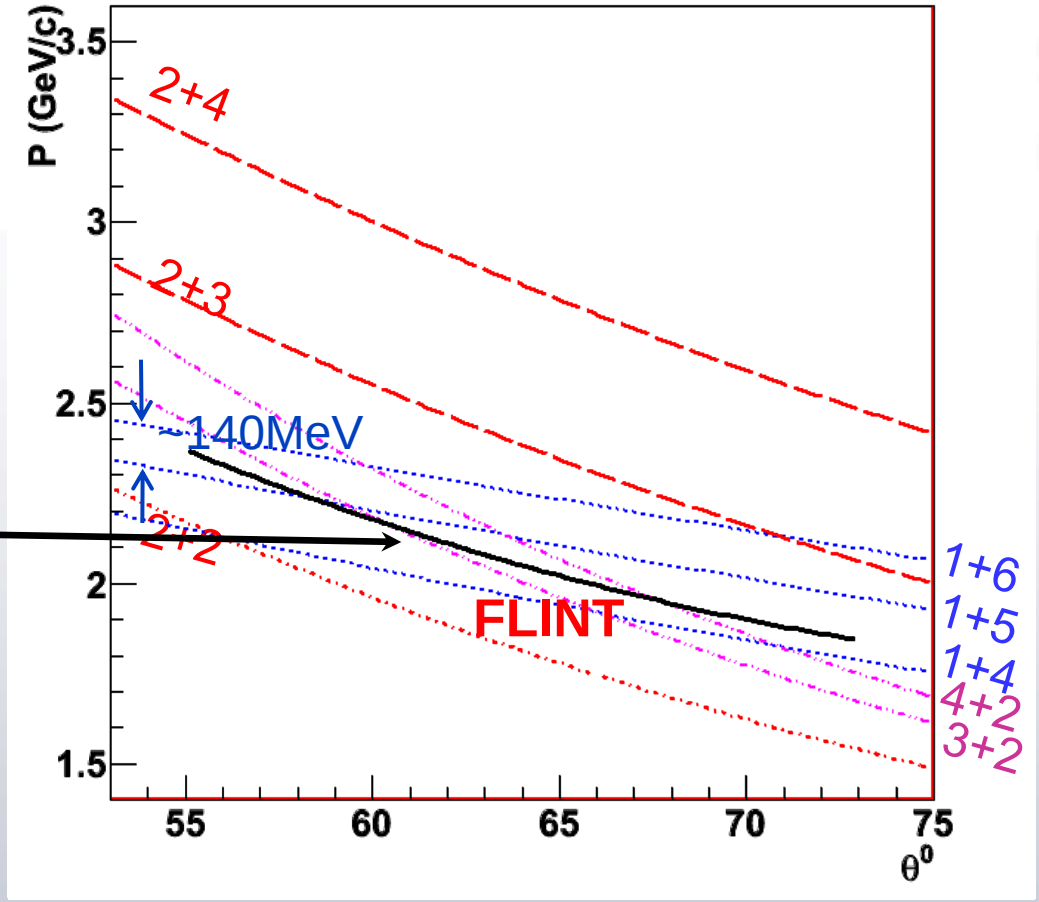
•1N+9N above data
→ single cumulative not forbidden absolutely



*G.N. Agakishiev et al., Yad. Fiz. 51, 1591 (1990)
C+C→πX @ 3.77AGeV

slope of spectra





- $T_{0эксп}$=115±10 MeV
- $\Delta X=1 \rightarrow \Delta\sigma(X)\sim\exp(m_p/T_{0X}) \sim e^{-7}$
- $\Delta\sigma=\exp(1) \rightarrow \Delta p=T_{0p}$ m_π
- $\Delta p(X+1)=7T_{0p} \rightarrow T_{0p}=\Delta p(X+1)/7$

2N+3N: T_0 closest to $T_{0measured}$

$\Delta X=1 \rightarrow \Delta\sigma(X) \sim \exp(-m_p / T_{0X}) \sim e^{-7} \sim \mathbf{10^{-3}}$

- 1N+jN (target fragm.)

$\Delta\theta=30° \rightarrow \Delta X \sim 1$

$\rightarrow \Delta\sigma \sim 10^{-3}$

- iN+2N

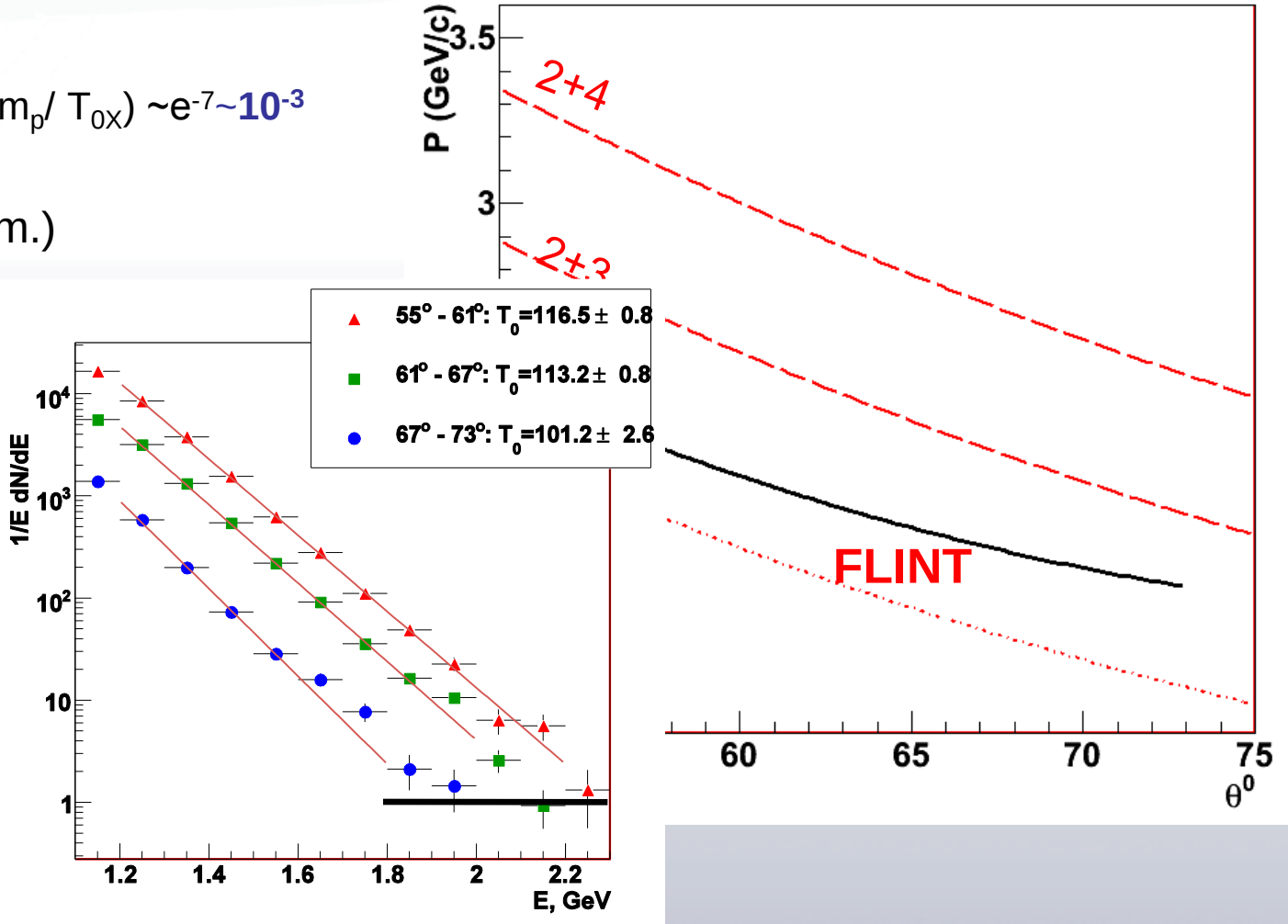
$\Delta\theta=30° \rightarrow \Delta X \sim 2$

$\rightarrow \Delta\sigma \sim 10^{-6}$

- 2N+3N

$\Delta\theta=30° \rightarrow \Delta X << 1$

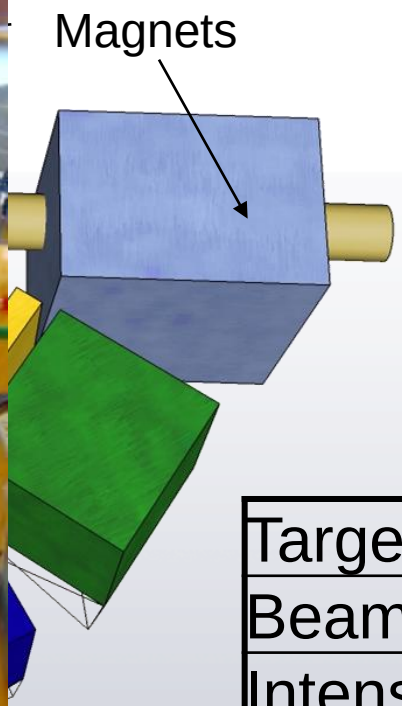
$\rightarrow \Delta\sigma \sim$ const !

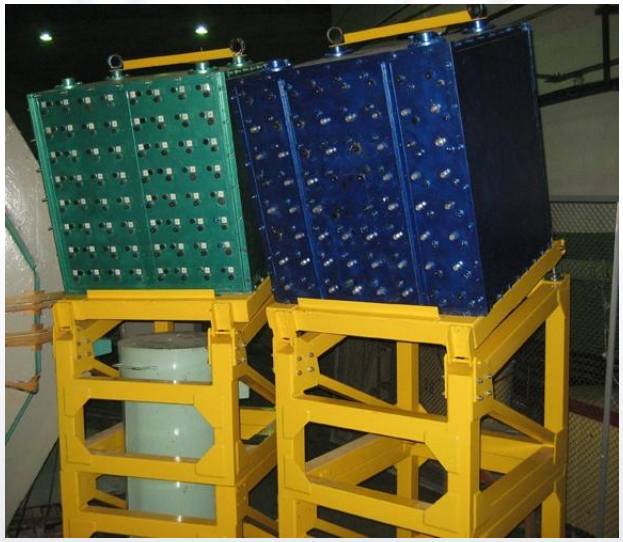


2N+3N: Angle dependence corresponds with experimetal

Experiment @ ITEP
March 2010
PRELIMINARY RESULTS

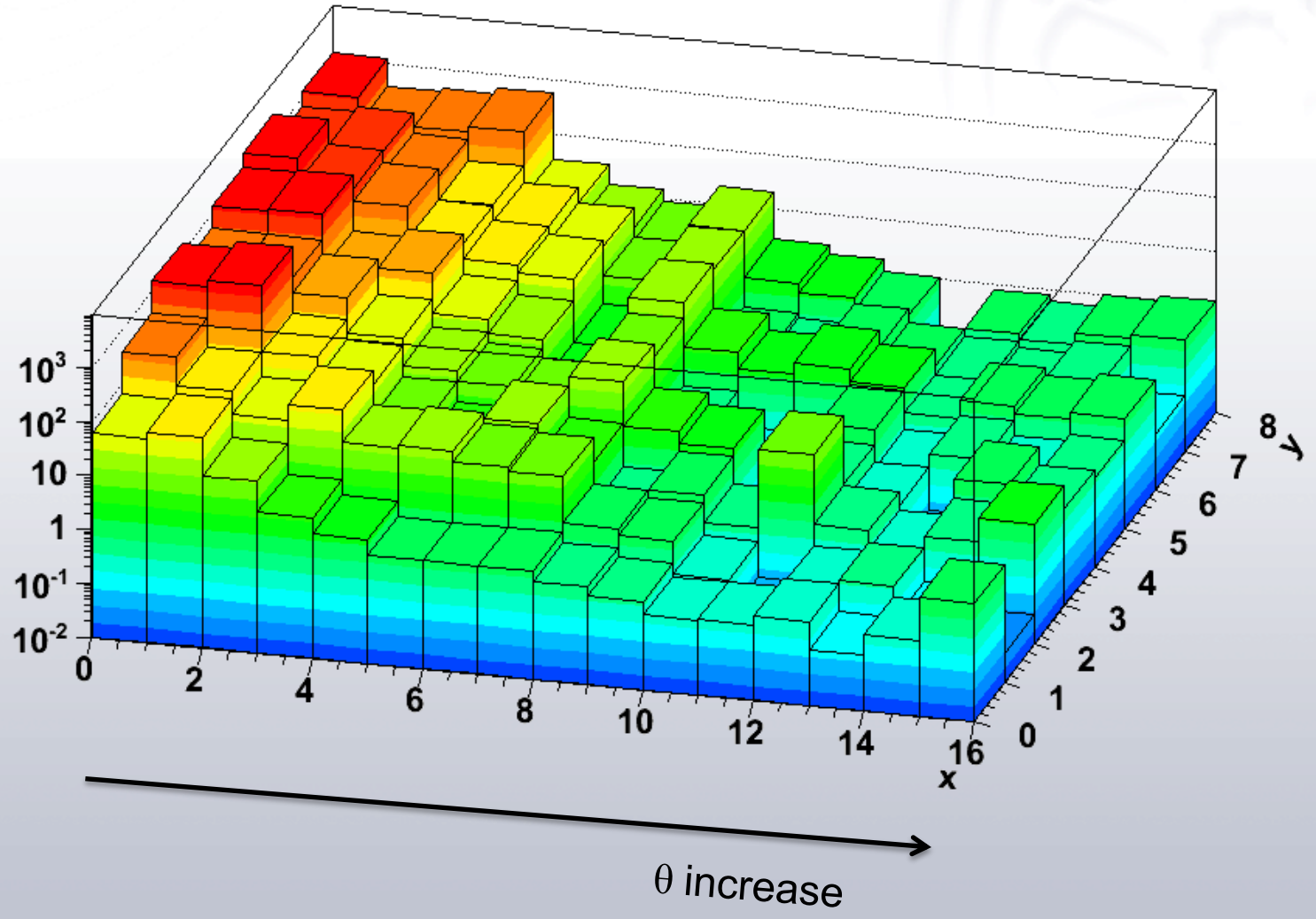
Experiment @ internal target of ITEP accelerator



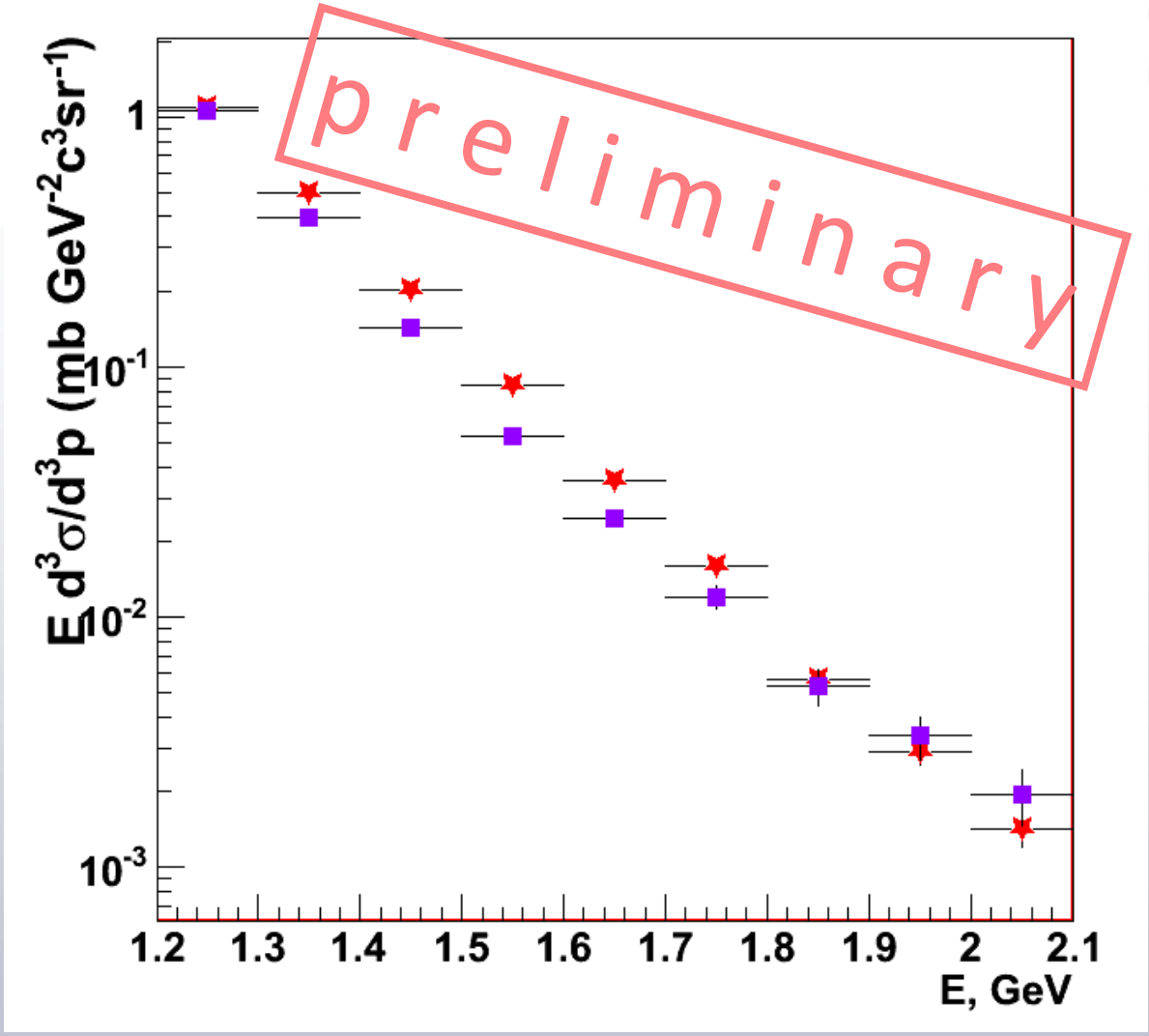


Target:	Be (foil)
Beam:	^{12}C E_K=4, 3.2, 2 AGeV
Intensity:	~10^8N/spill
Trigger:	E>1. GeV in any channel
Exposition:	18 days
Statistics:	~2.5M Events

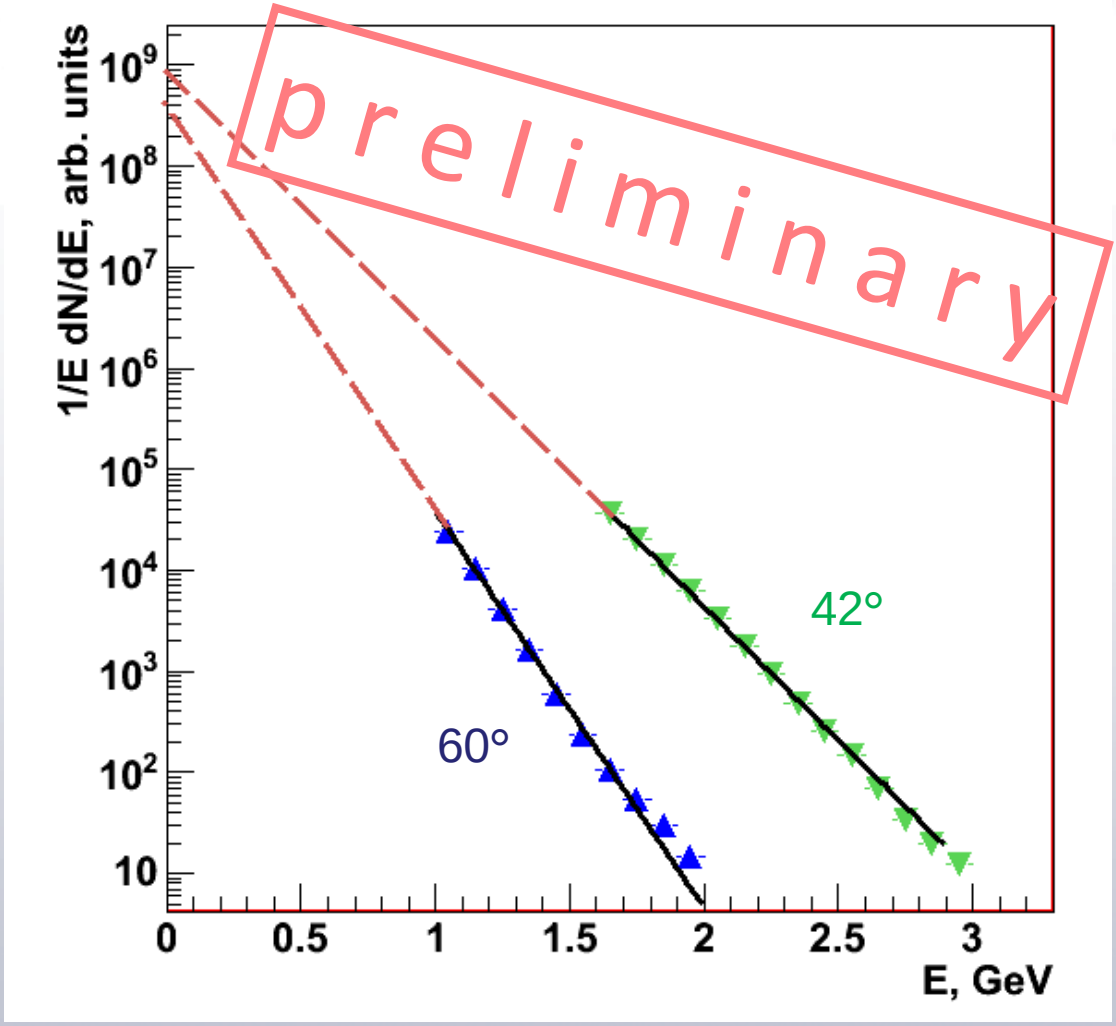
Rate in calorimeters

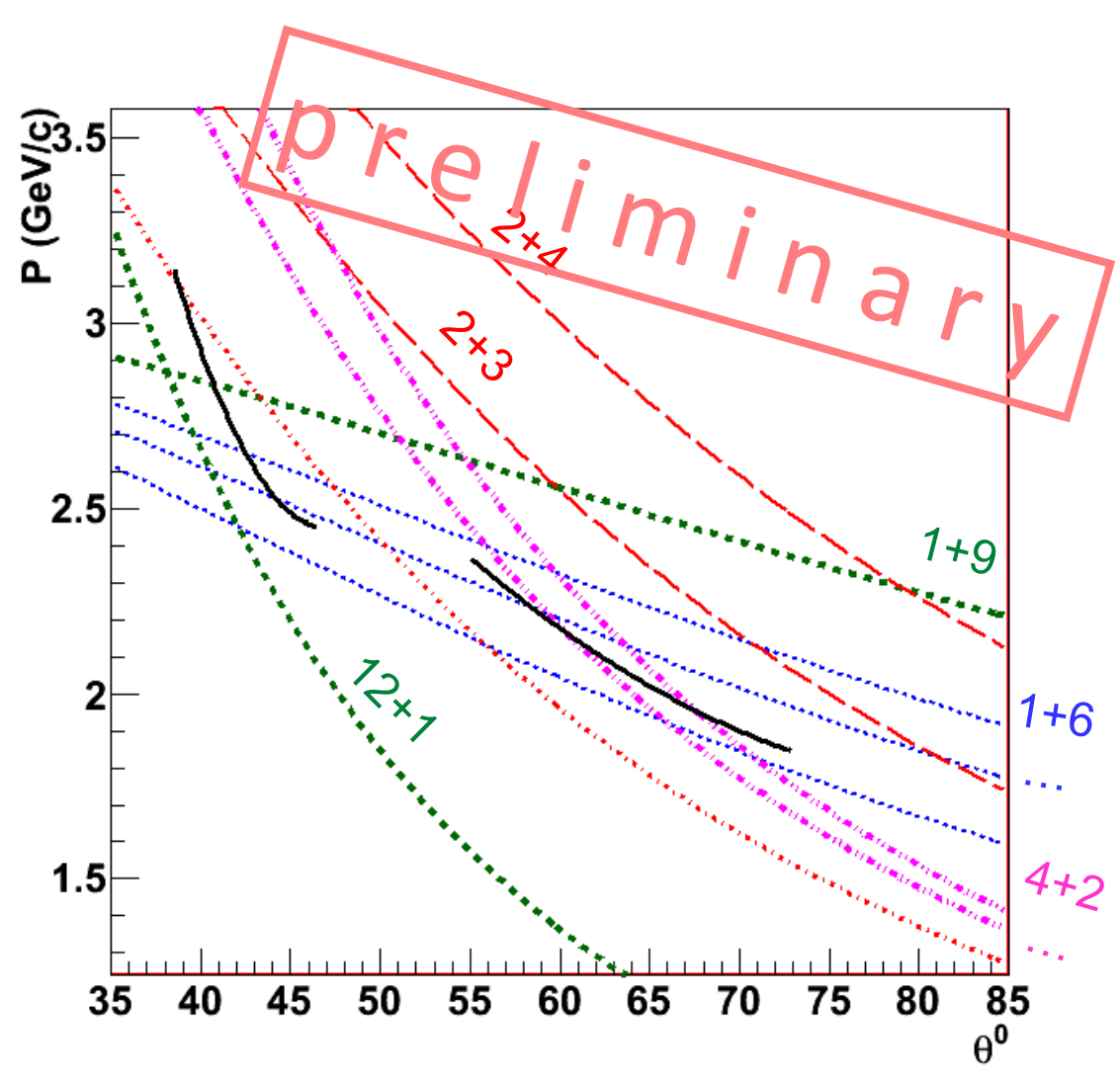


runs 2007&2010 comparison



θ dependence




preliminary
P (GeV/c)
3.5
3
2.5
2
1.5
35
40
45
50
55
60
65
70
75
80
85
θ0
2+4
2+3
1+9
12+1
1+6
...
4+2
...

conclusions

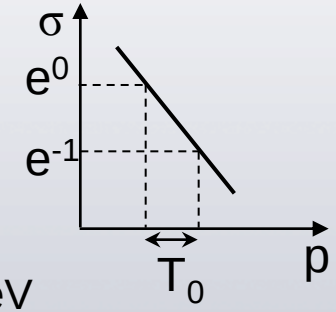
- ✓ indication for high density creation
- ✓ indication for 2N+3N flucton-flucton interaction
- ✓ Second supermodule, double acceptance
- ✓ runs 2007 & 2010 consistent
- ✓ spectra for 42° & 60°
- ✓ point behind absolute 1X cumulative process
- ➢ looking forward for second arm and DCM study

preliminary

Extra slides

slope of spectra

	$\Delta p(X+1)$, MeV	T_0, MeV	$T_0 \pm \sigma(E)$, MeV
1N+jN	140±20	20±3	~ 34±4
iN+2N	160±80	23±11	~ 36±15
2N+jN	570±70	81±10	~ 85±11



- $T_{0эксп}$=115±10 MeV
- $\Delta X=1 \rightarrow \Delta\sigma(X) \sim \exp(m_p / T_{0X}) \sim e^{-7}$
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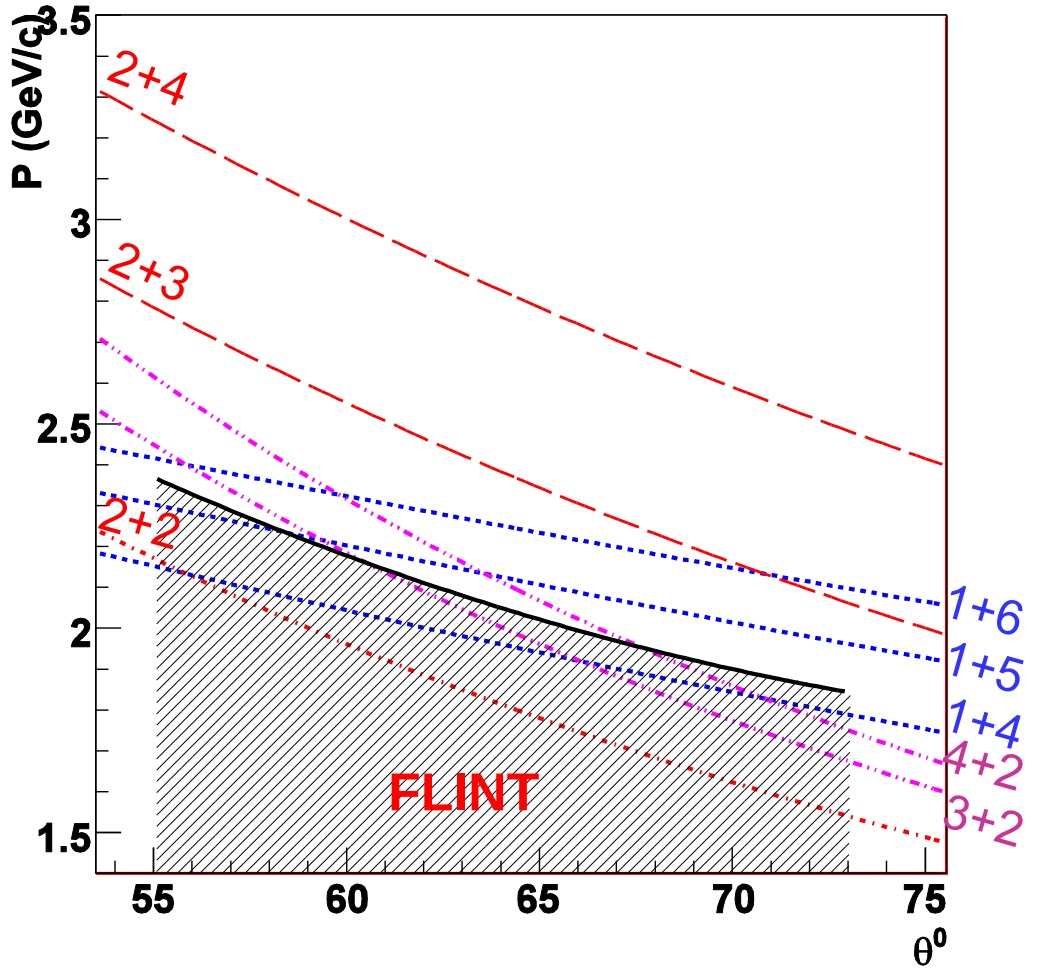

2N+3N: T_0 ближе всего к $T_{0эксп}$

$\Delta X=1 \rightarrow \Delta\sigma(X) \sim \exp(-m_p / T_{0X}) \sim e^{-7} \sim \mathbf{10^{-3}}$

- 1N+jN (target fragm.)

$\Delta\theta=30° \rightarrow \Delta X \sim 1$

$\rightarrow \Delta\sigma \sim 10^{-3}$

- iN+2N

$\Delta\theta=30° \rightarrow \Delta X \sim 2$

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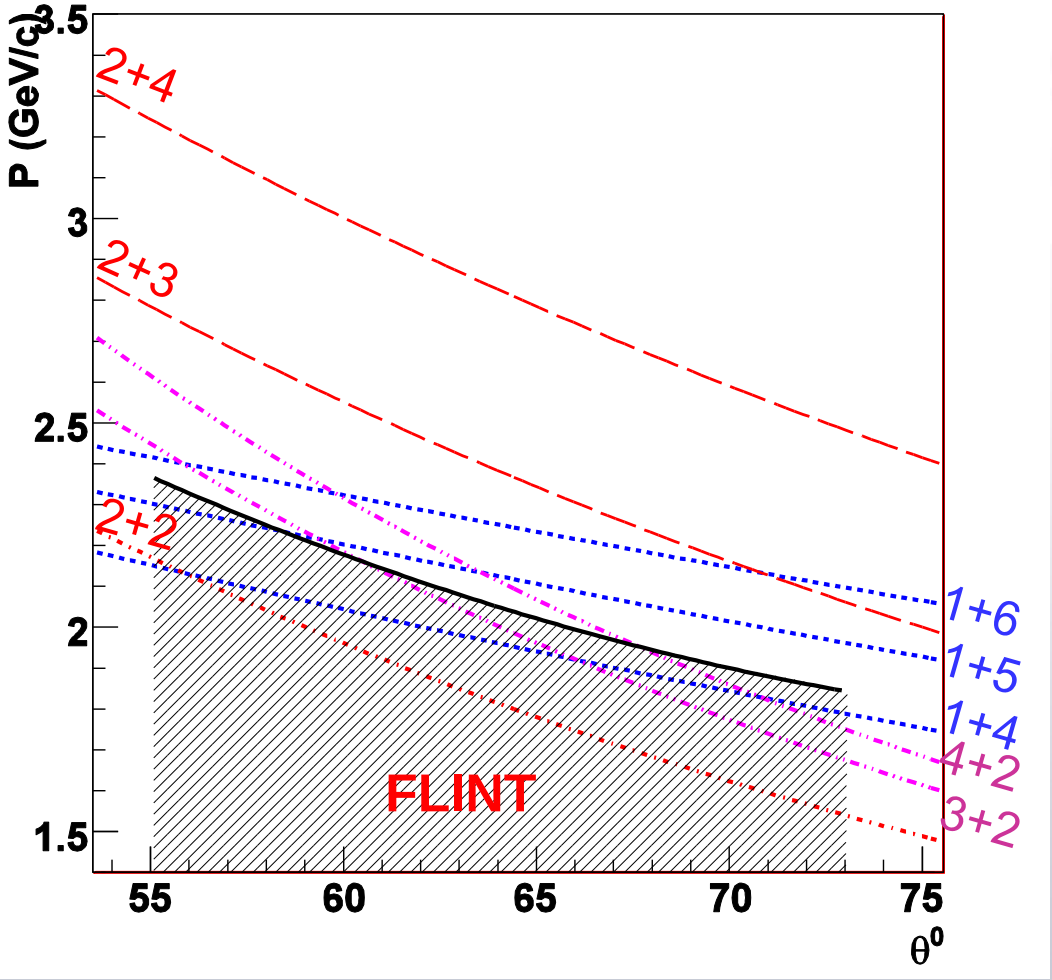
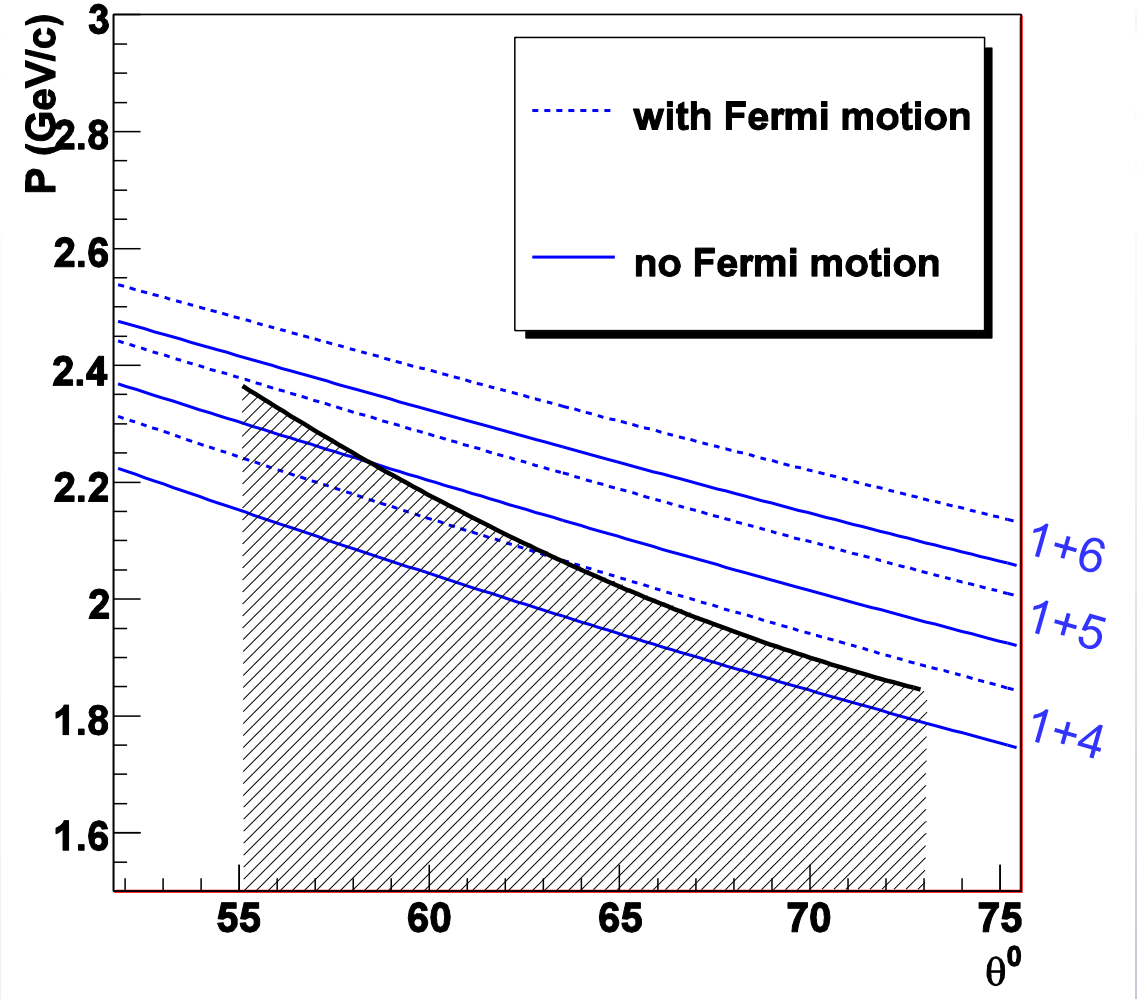
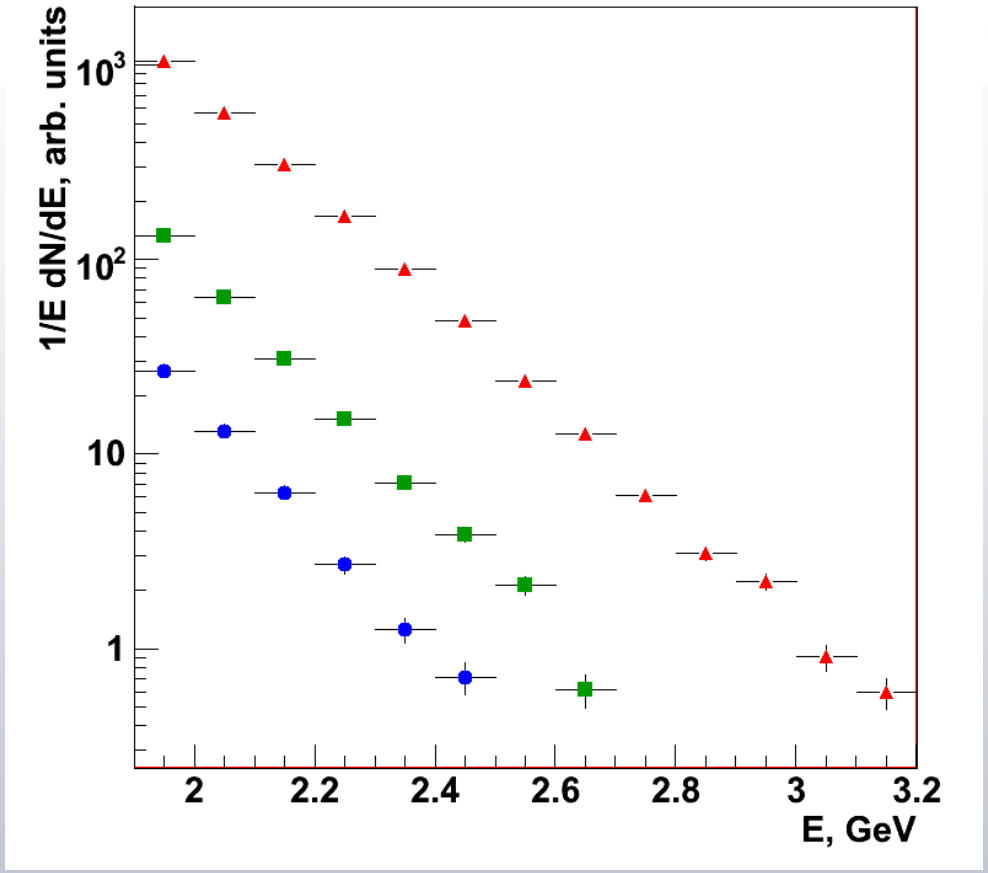


2N+3N: Angle dependence corresponds with experimetal

Оценка роли Ферми движения




1/E dN/dE, arb. units
10³
10²
10
1
2
2.2
2.4
2.6
2.8
3
3.2
E, GeV

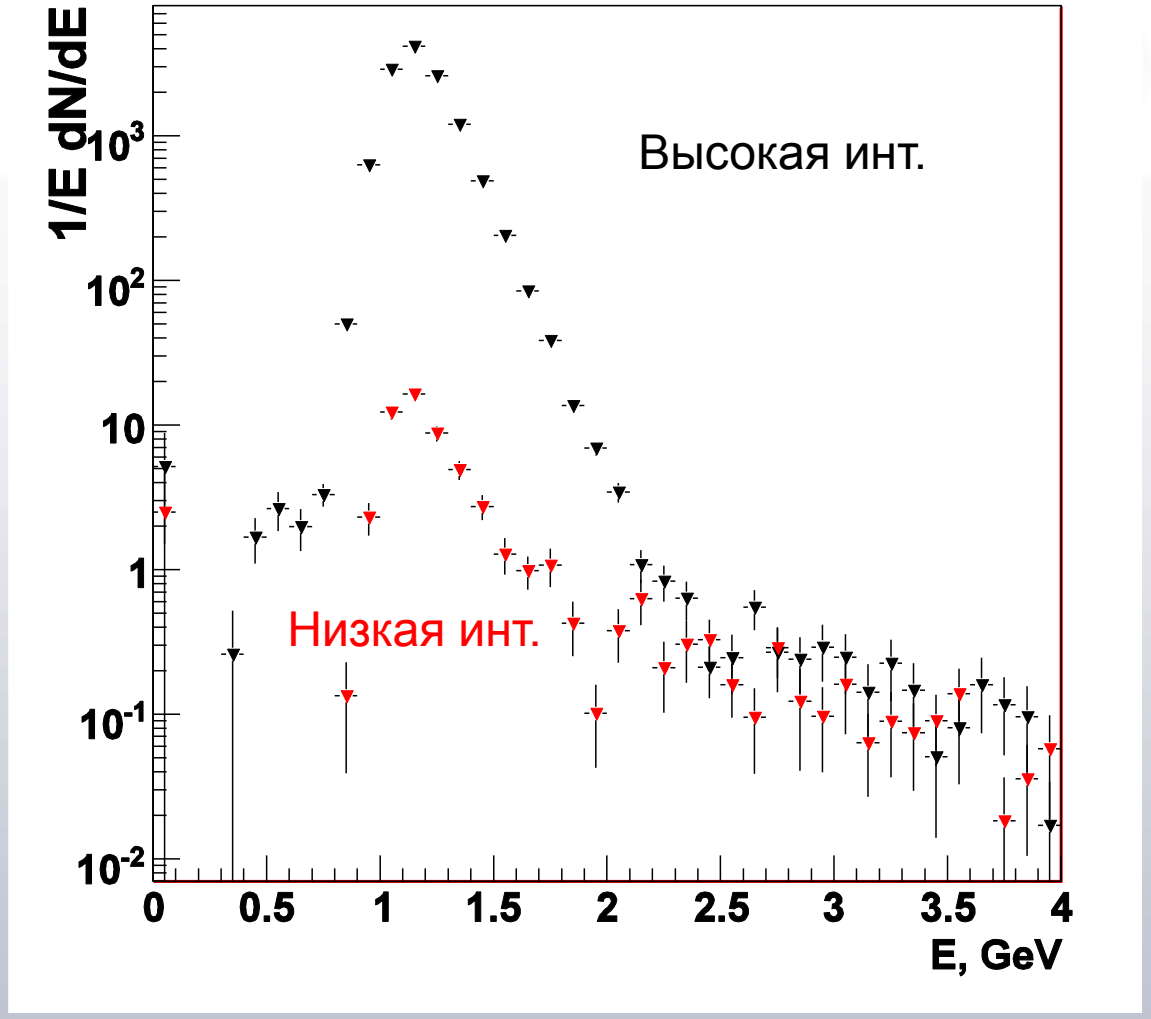
фоновые события

частота триггера :
- > 1.0 Гц → Высокая инт.
- < 0.2 Гц → Низкая инт.

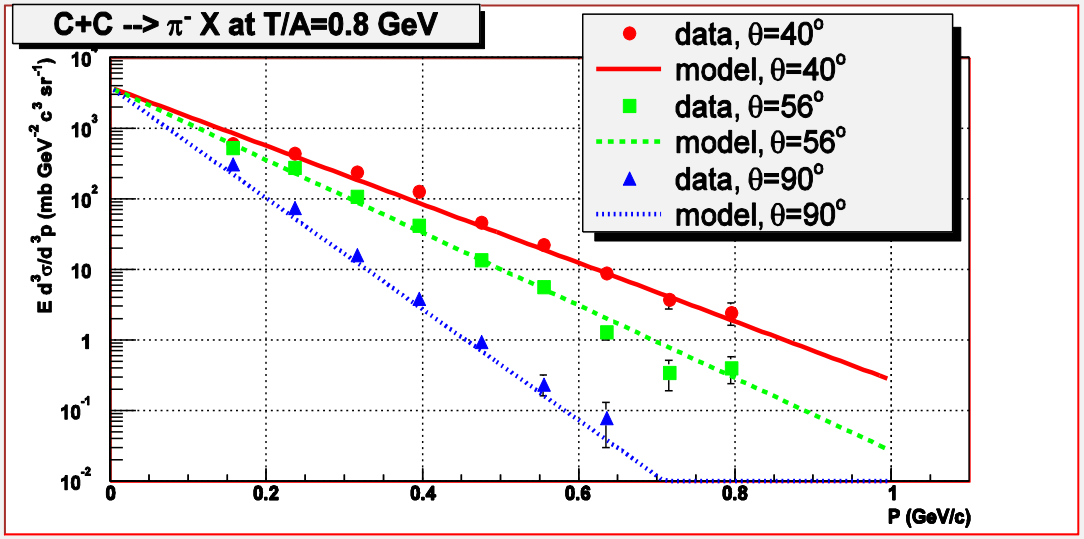
Нормировка по времени экспозиции

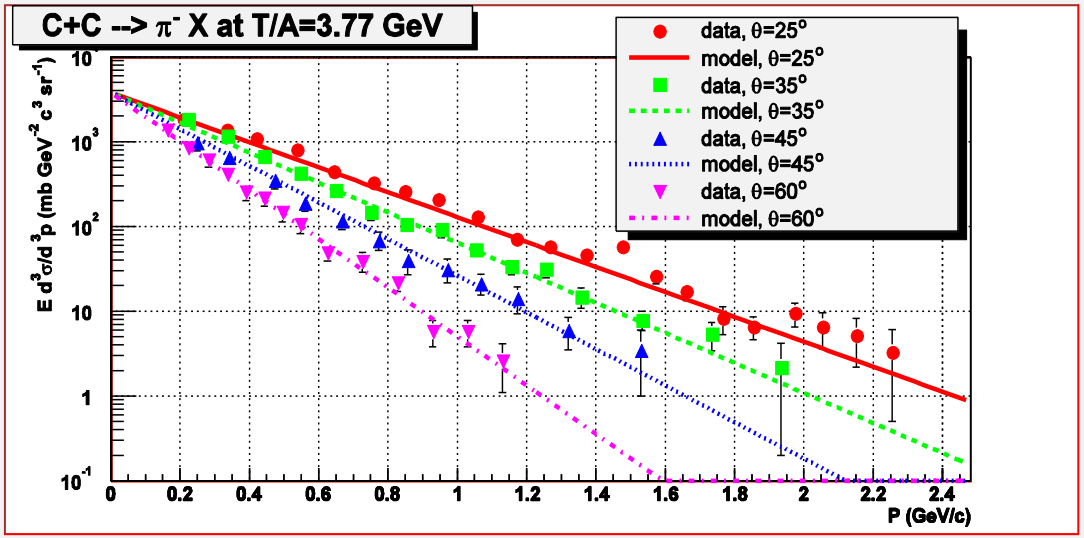
Наводки на HV?

Результаты показываем до уровня, где «Фон» < 30%



параметризация





$$\sigma_I = C \cdot \exp\left(-\frac{p}{p_0}\right)$$

$$p_0 = \frac{k \cdot \beta\gamma}{1 - \beta(\cos\theta - \cos 45^\circ) - \cos^2 45^\circ}$$

describes:

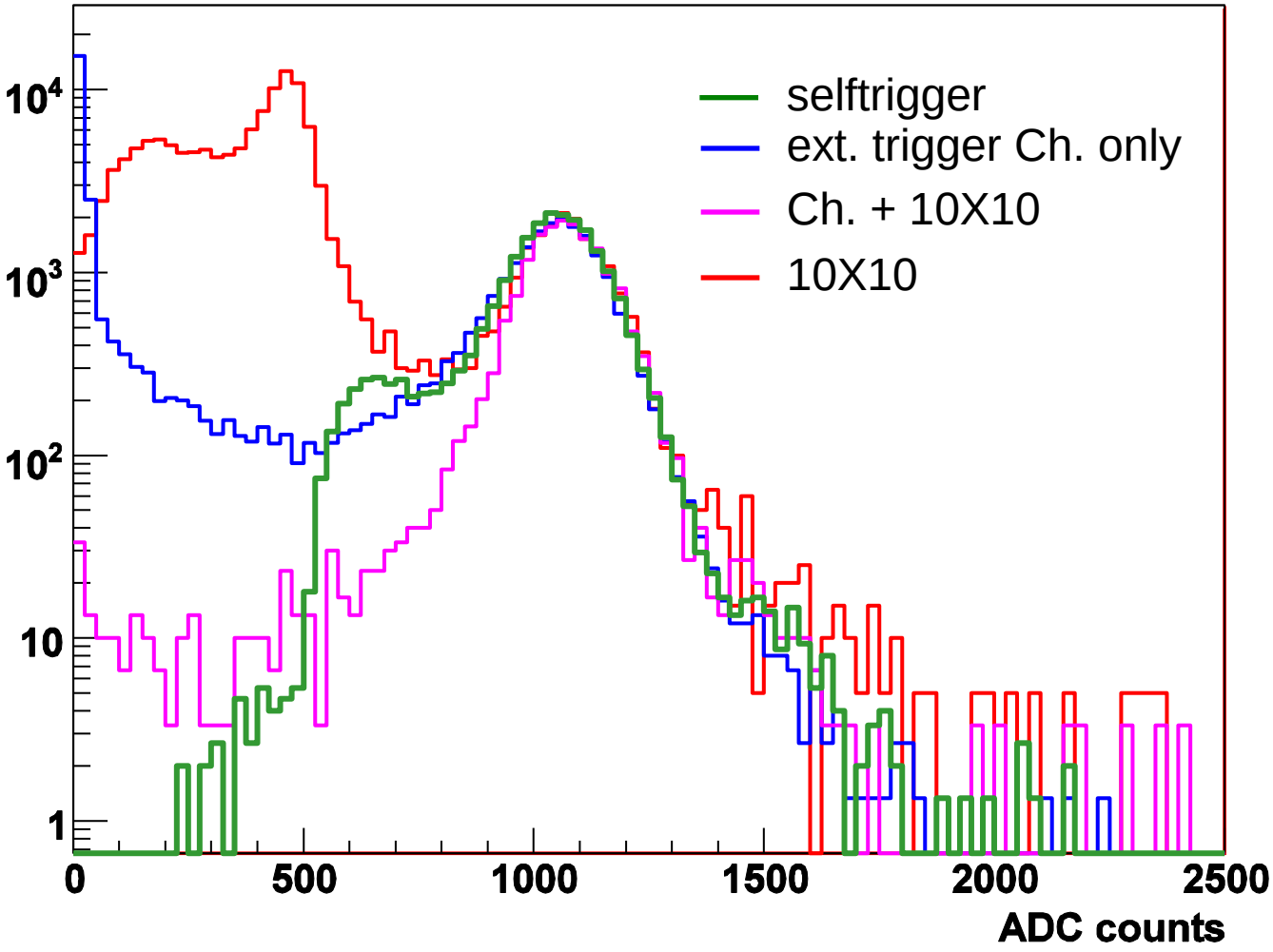
- ✓**different initial energies (*γ* and *β*)**
- ✓**different angles *θ***

Parameters *C = 3800(mb GeV⁻²c sr⁻¹)* ,

k = 0.075

S. Nagamiya et. al. Phys. Rev. C24, 971 (1981)

G.N. Agakishiev et al., Yad. Fiz. 51, 1591 (1990)


selftrigger
ext. trigger Ch. only
Ch. + 10X10
10X10
10^4
10^3
10^2
10
1
0
500
1000
1500
2000
2500
ADC counts