Isospin dyamics and the isospin dependent EOS

MSU-Chimera Collaboration

July 6-13, 2004 (Catania, Italy)

^{112}Sn, ^{124}Sn beam at E/A=35 MeV

$^{112}Sn+^{112}Sn$	16 hr
$^{112}Sn+^{124}Sn$	16 hr
$^{124}Sn+^{112}Sn$	23 hr
$^{124}Sn+^{124}Sn$	23 hr

250 GB of data

Probe: Isospin diffusion in peripheral collisions

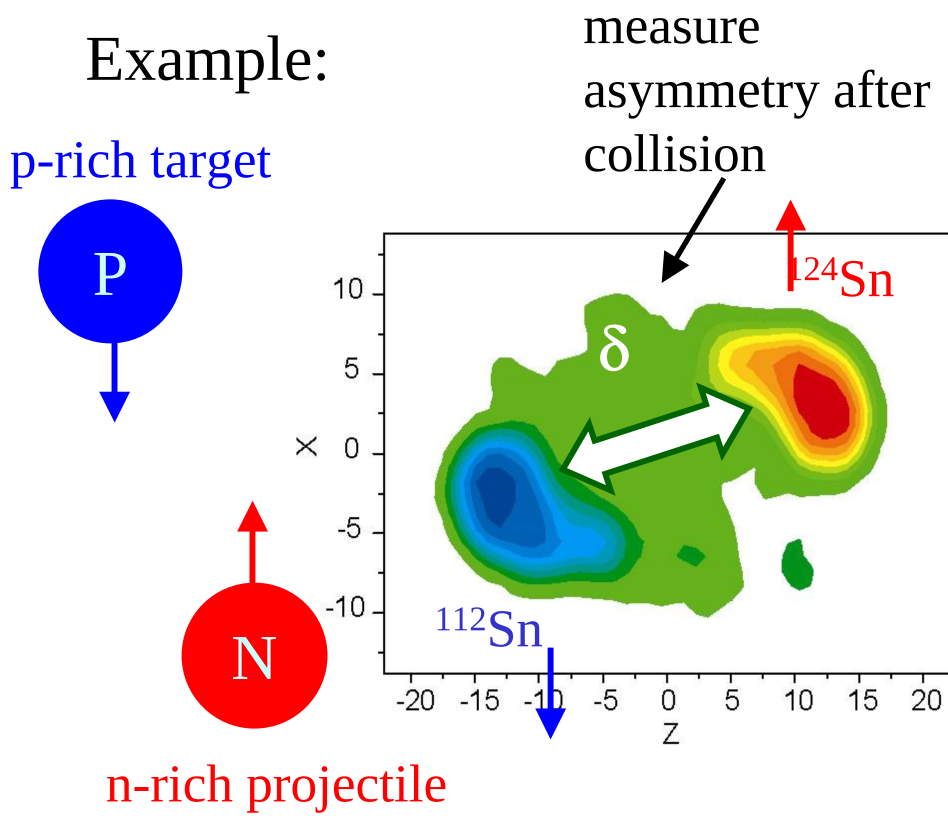
- Collide projectiles and targets of differing isospin asymmetry
- Probe the asymmetry δ=(N-Z)/(N+Z) of the projectile spectator during the collision.
- The use of the isospin transport ratio $R_i(\delta)$ isolates the diffusion effects:

$$R_i(\delta) = 2 \cdot \frac{\delta - <\delta>}{\Delta\delta}$$

- Useful limits for R_i for $^{124}Sn+^{112}Sn$ collisions:
  - R_i =±1: no diffusion
  - R_i ≈0: Isospin equilibrium

Systems
- mixed $^{124}Sn+^{112}Sn$
- n-rich $^{124}Sn+^{124}Sn$
- p-rich $^{112}Sn+^{112}Sn$

Example:



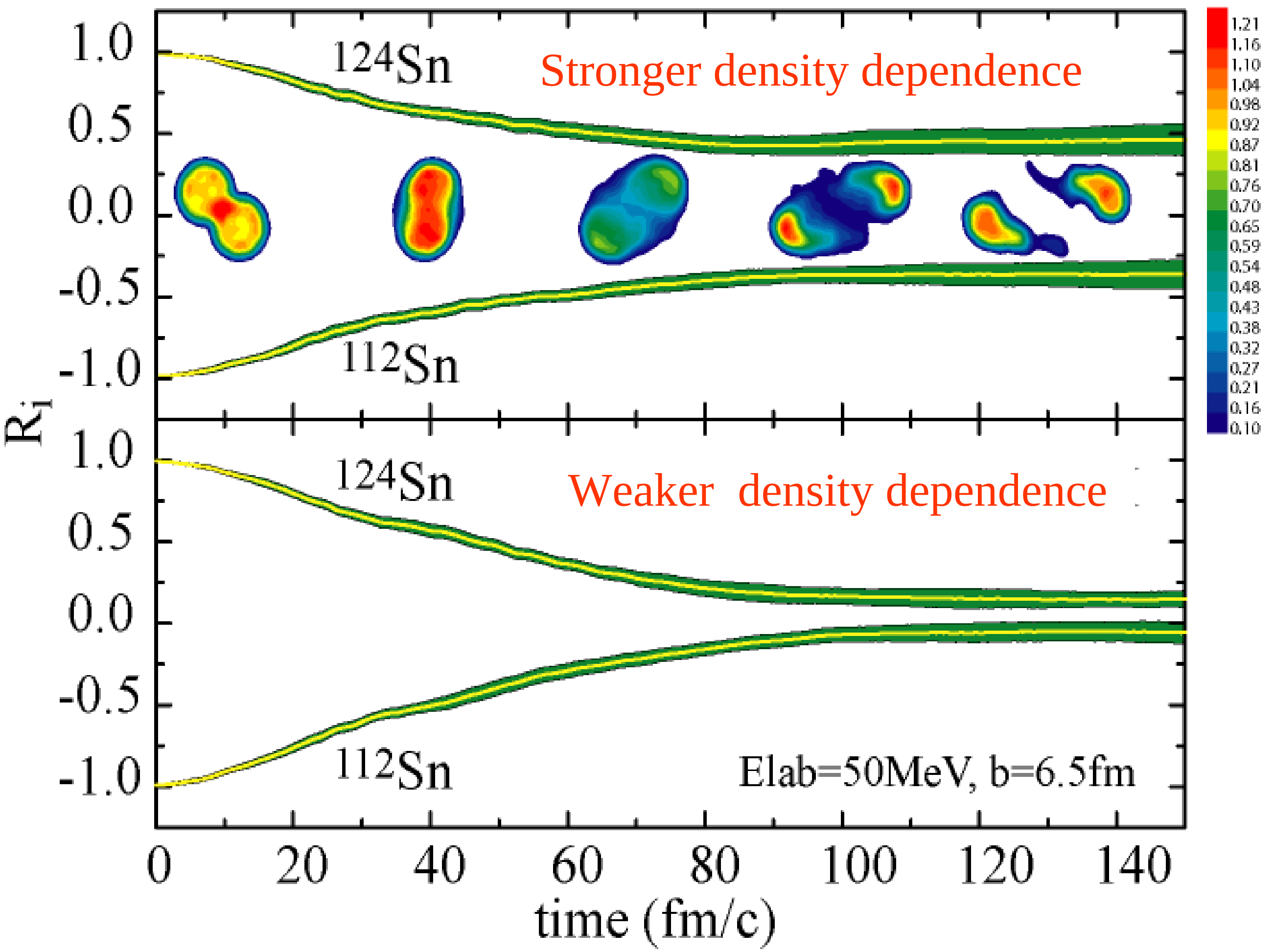
Sensitivity to symmetry energy

$$R_i(\delta) = 2 \cdot \frac{\delta - <\delta>}{\Delta\delta}$$

$R_i = \pm 1$: no diffusion

$R_i \approx 0$: Isospin equilibrium

- The asymmetry of the spectators can change due to diffusion, but it also can changed due to pre-equilibrium emission.
- The use of the isospin transport ratio $R_i(\delta)$ isolates the diffusion effects.

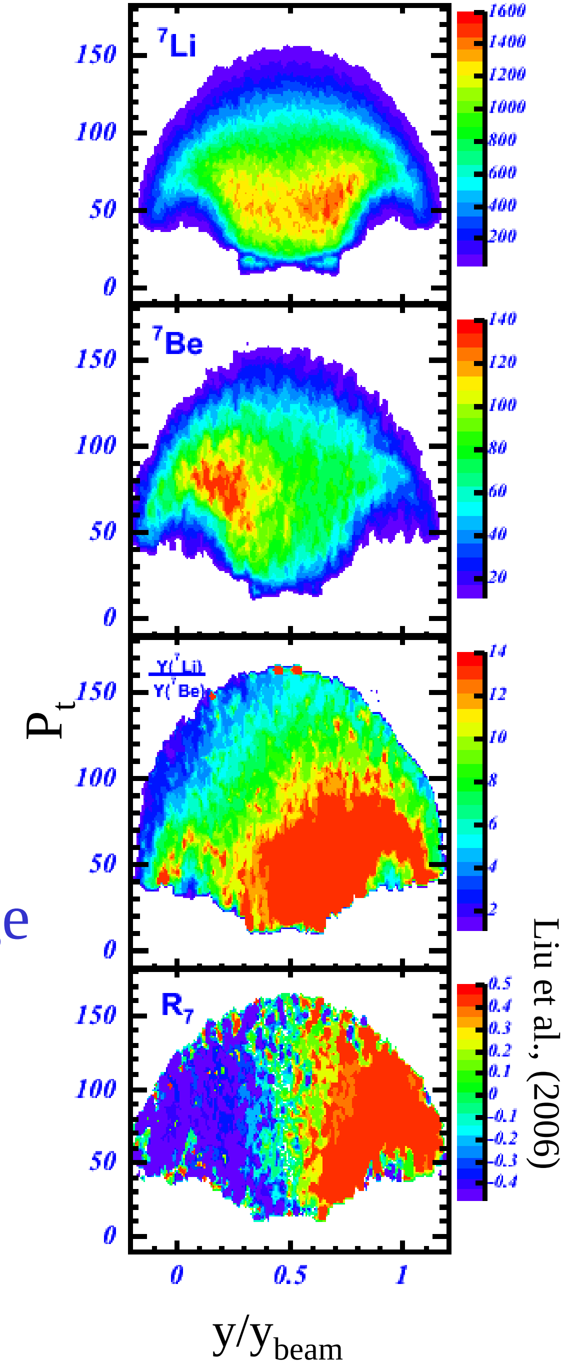


Tsang, shi et al., PRL92(2004)

Isospin diffusions with mirror nuclei such as ^{7}Li, ^{7}Be

The admixture of collective and thermal motion is mass dependent.
  - $E_{coll} \propto A$
  - $E_{thermal}$ is independent of A

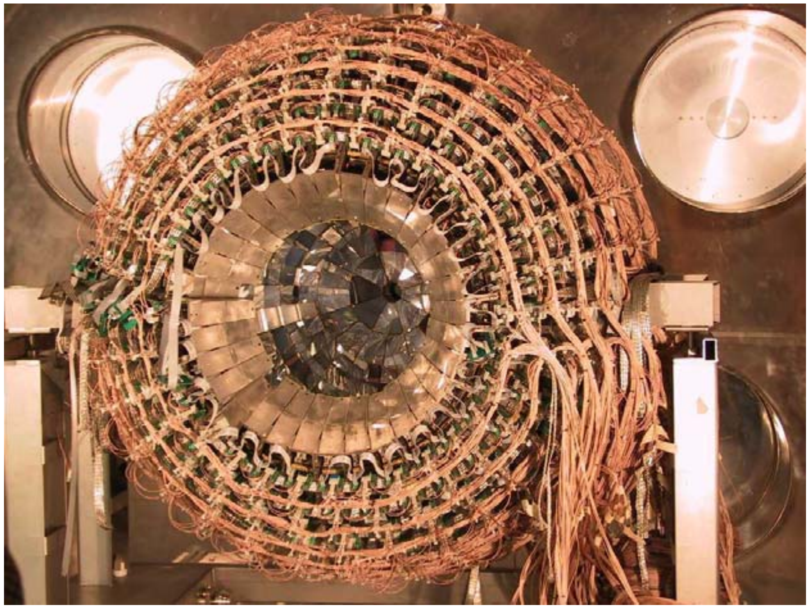
- Mirror nuclei ratios $Y(^{7}Li)/Y(^{7}Be)$ avoid this problem, but have different Coulomb effects.
- $Y(^{7}Li)$ is largest near the rapidity of the ^{124}Sn beam; $Y(^{7}Be)$ is largest near the target
- $R_i(\ln(Y(^{7}Li)/Y(^{7}Be))$ removes the Coulomb ridge
  - It is only weakly dependent on P_t.
  - It is nearly constant near beam rapidity.
- Study the impact parameter and rapidity dependence.

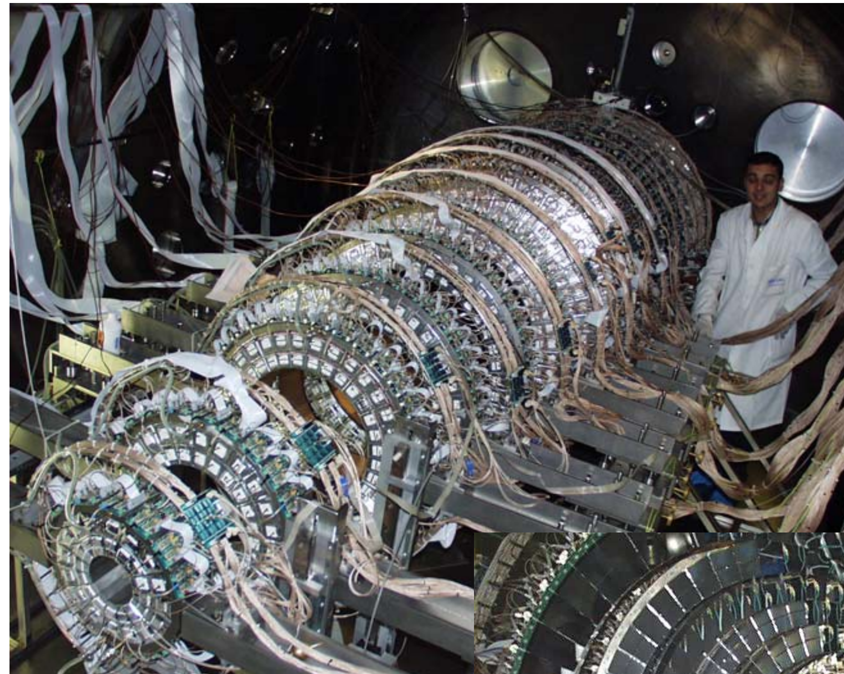


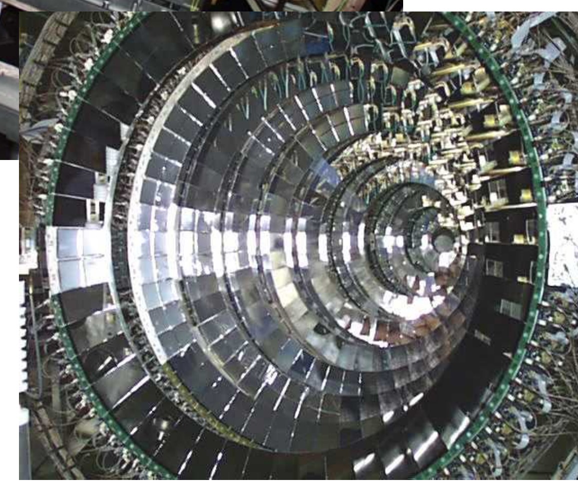
Chimera array

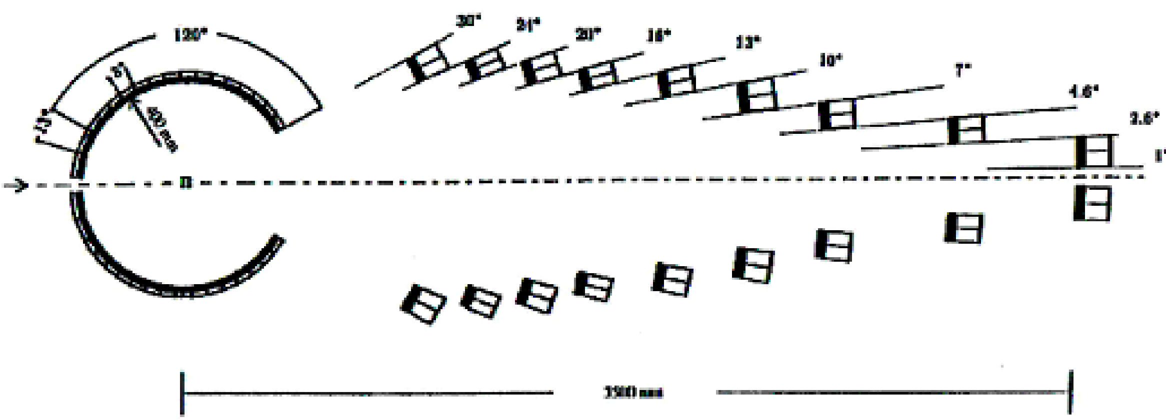
–4π array: 1192 Si + CsI telescopes

– http://www.lns.infn.it/research/chimera/



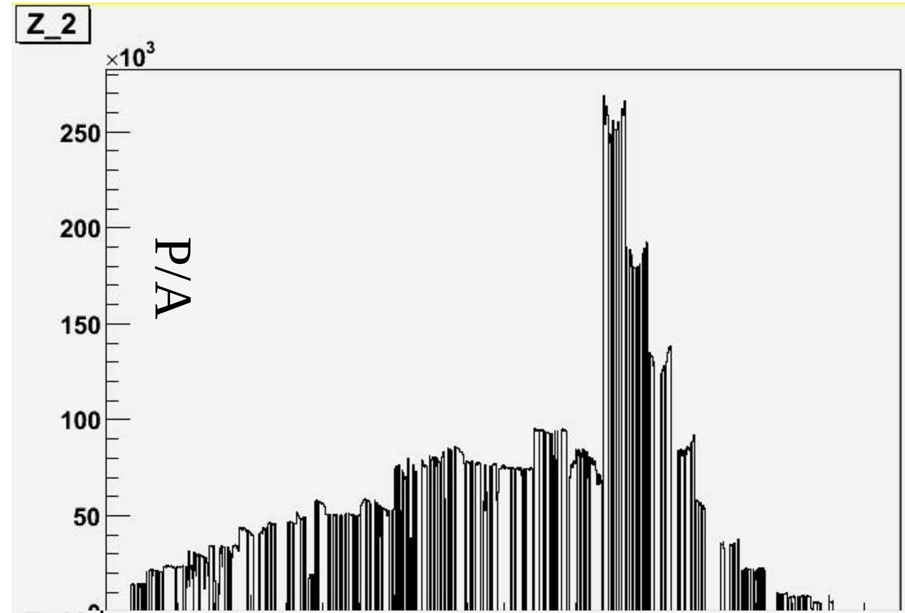


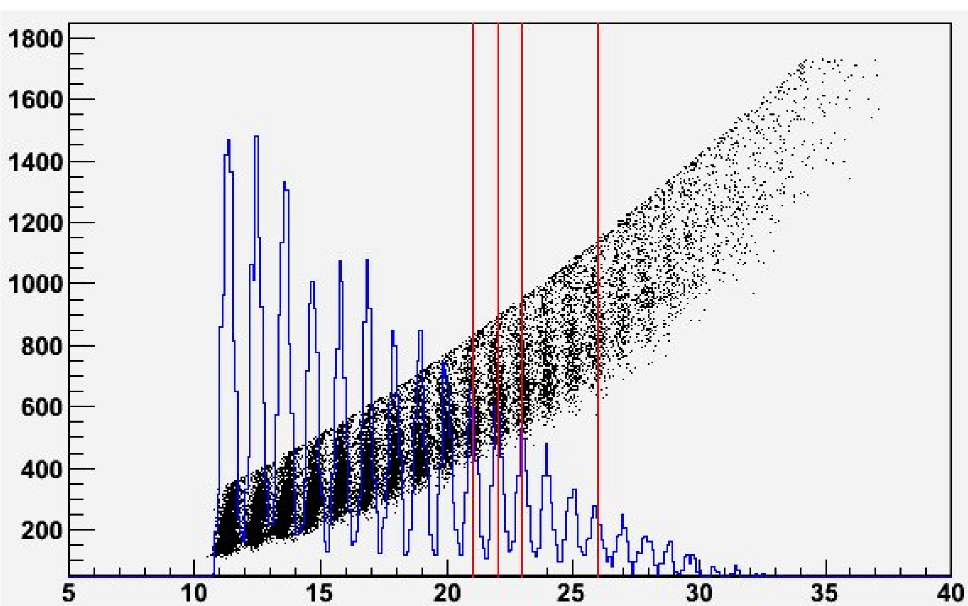


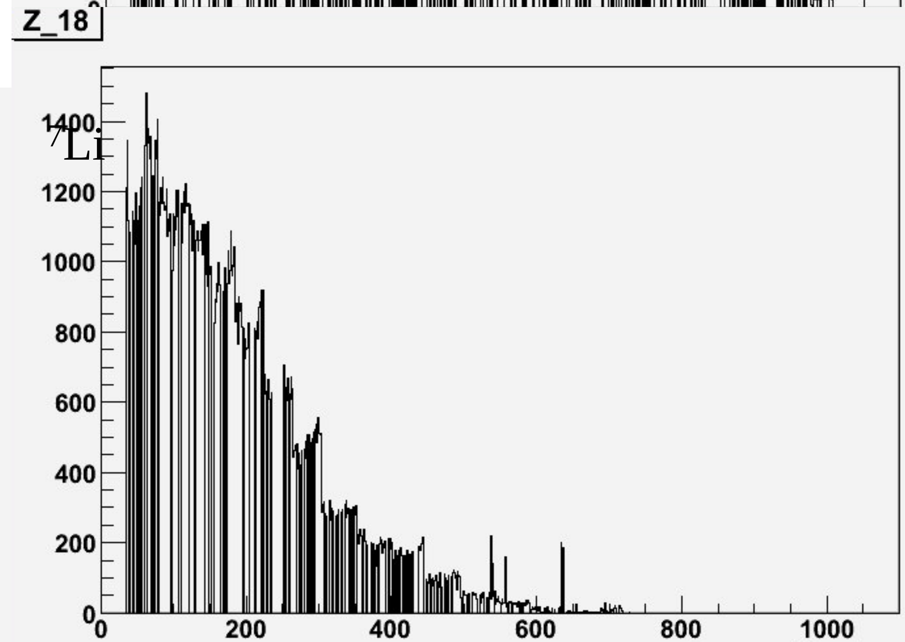


- PID
  - Only Z identification for heavier particles
  - Based on $\Delta E \cdot (\Delta E + E) \propto AZ^2$
  - Can do this only for about 600 telescopes
  - Use Fast/Slow component of the CsI to help the identification of $^{7}Li/^{7}Be$
  - Get $^{7}Li/^{7}Be$ only from 450 telescopes

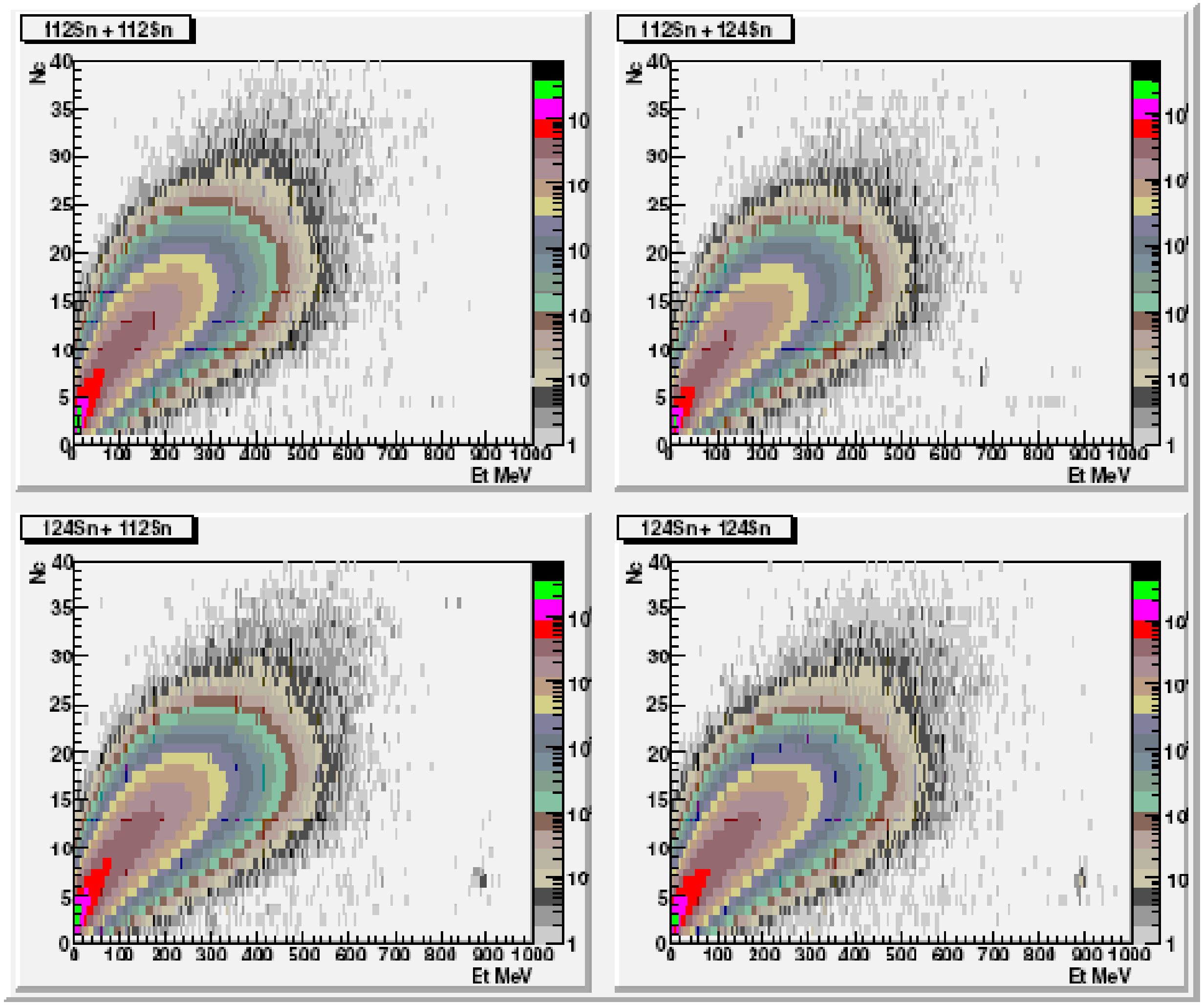
Triggers in DE → efficiencies with H isotopes





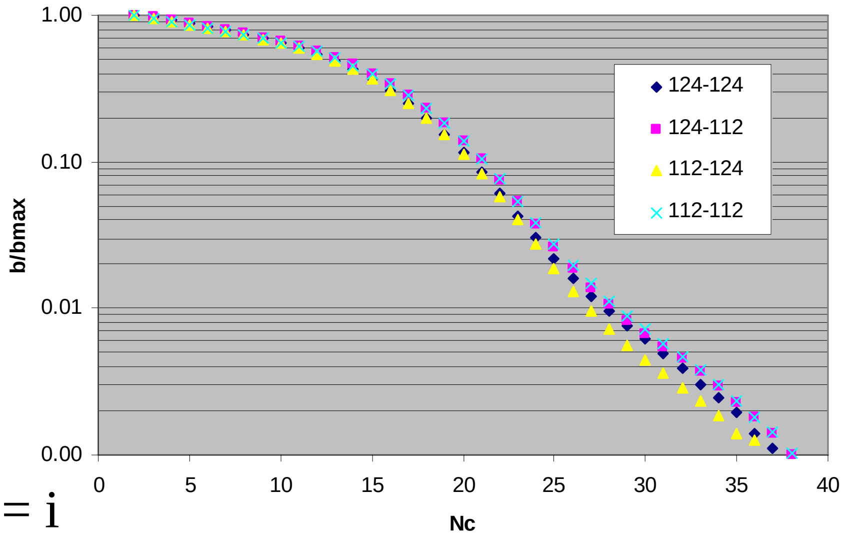


Nc vs. Et



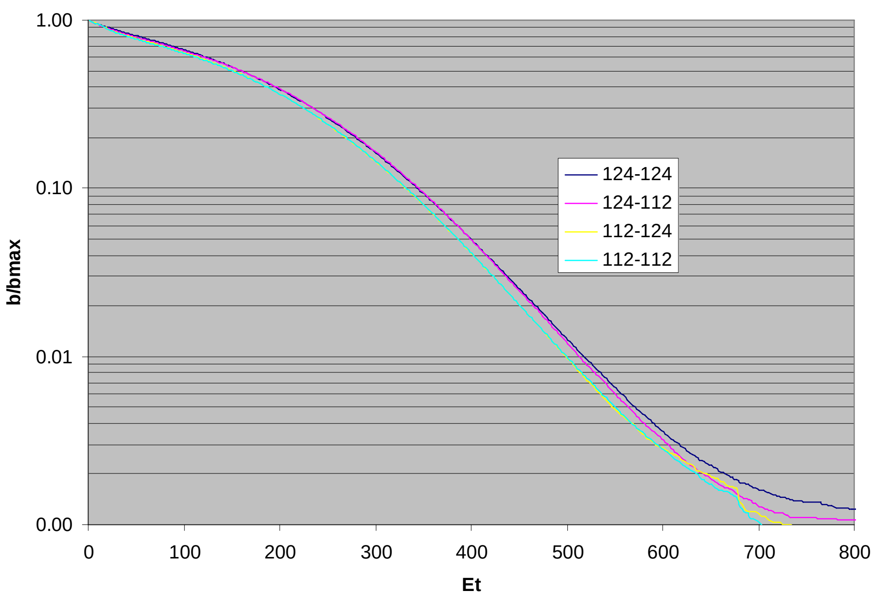
for multiplicity Nc = n :

$$b/b_{max} = \sqrt{\sum_{i=1}^{n} N_i \Big/ \sum_{i=1}^{\infty} N_i}$$



N_i is the event number while multiplicity = i

The total transverse energy Et is calculate with $E_t = \sum_{i=1}^{Nc} E_i \cdot \sin^2\theta$

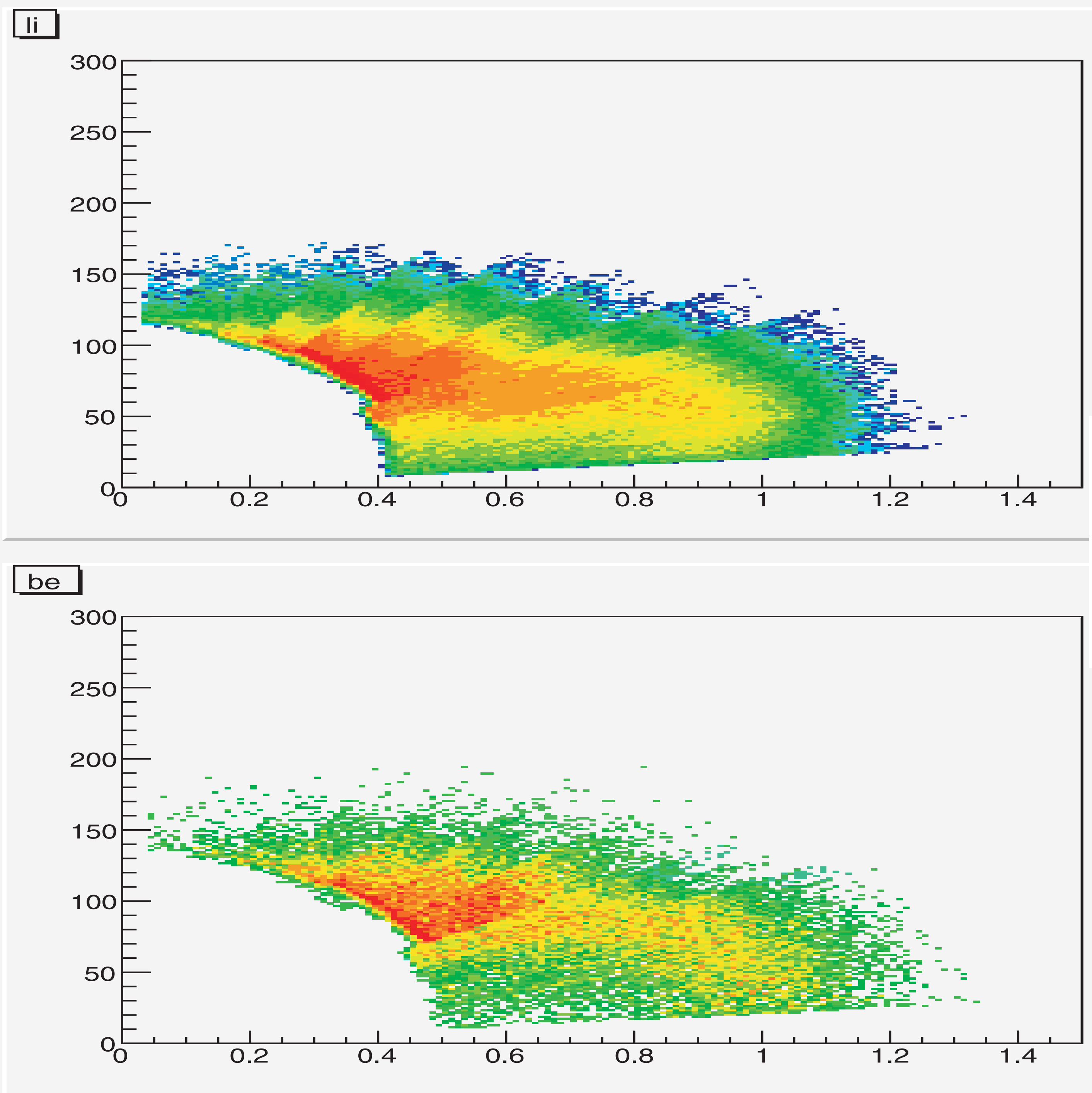


for given Et :

$$b/b_{max} = \sqrt{\int_0^{Et} N(E)dE \Big/ \int_0^{\infty} N(E)dE}$$

N(E) is the event number while the transverse energy = E

Limitations



Energy thresholds in Be → no mid rapisity gates

Impact Parameter selection

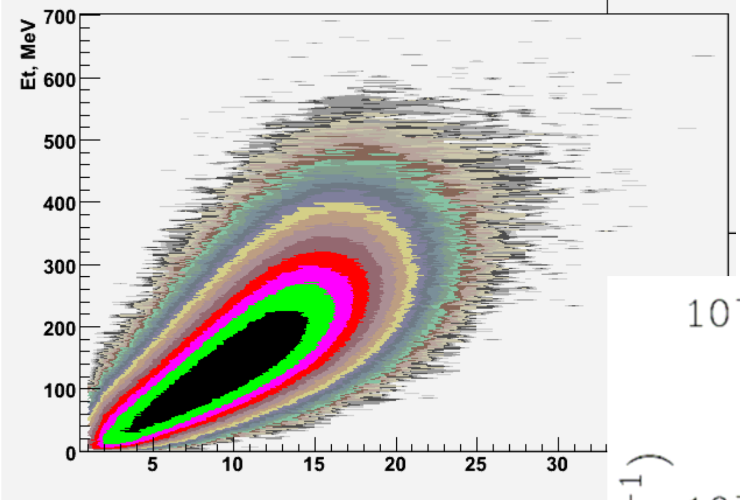
- b_{max} calculation
  - b_{max} calculated from the total reaction cross-section

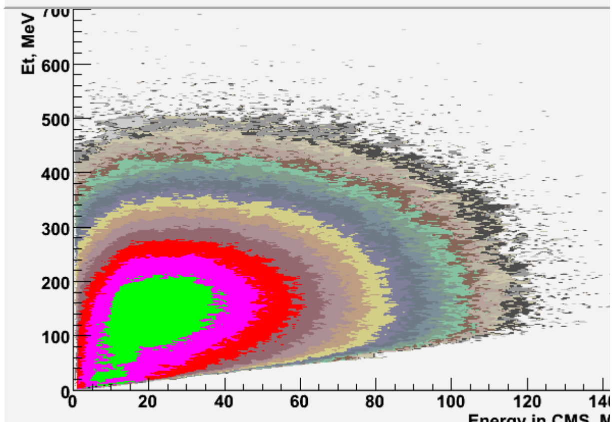
$$\pi \cdot b_{max}^2 = \sigma = \frac{CountingRates_{DAQ} / Efficiency}{N_{Target} \times I_{beam}}$$

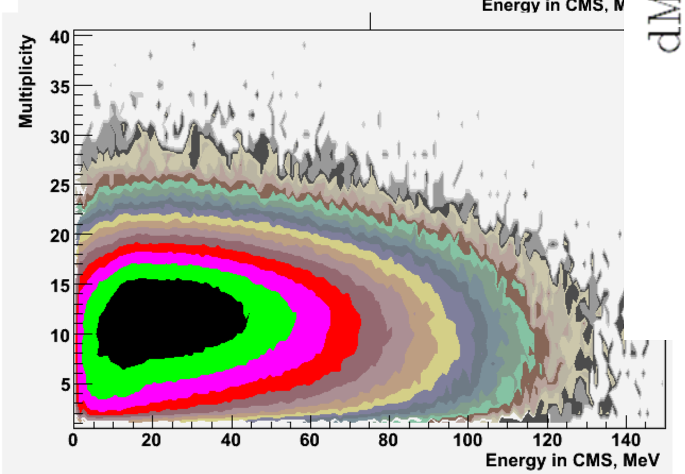
Beam	^{124}Sn	^{124}Sn	^{112}Sn	^{112}Sn
Target	^{124}Sn	^{112}Sn	^{124}Sn	^{112}Sn
b_{max}(fm)	8.56	8.44	8.70	8.76

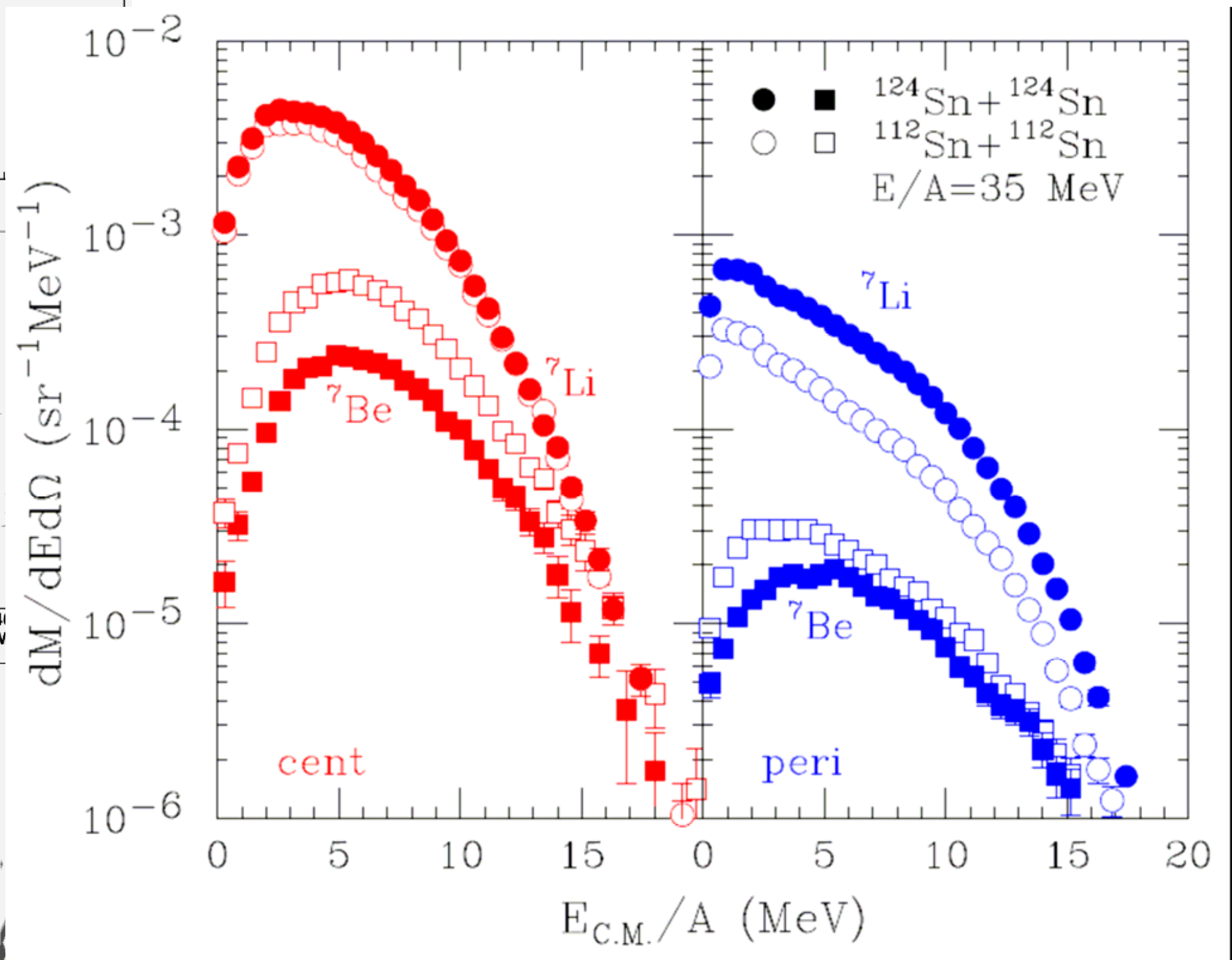
- The impact parameter b is selected by two methods
  - The charge particle multiplicity of each event
  - The total energy in transverse direction for each event

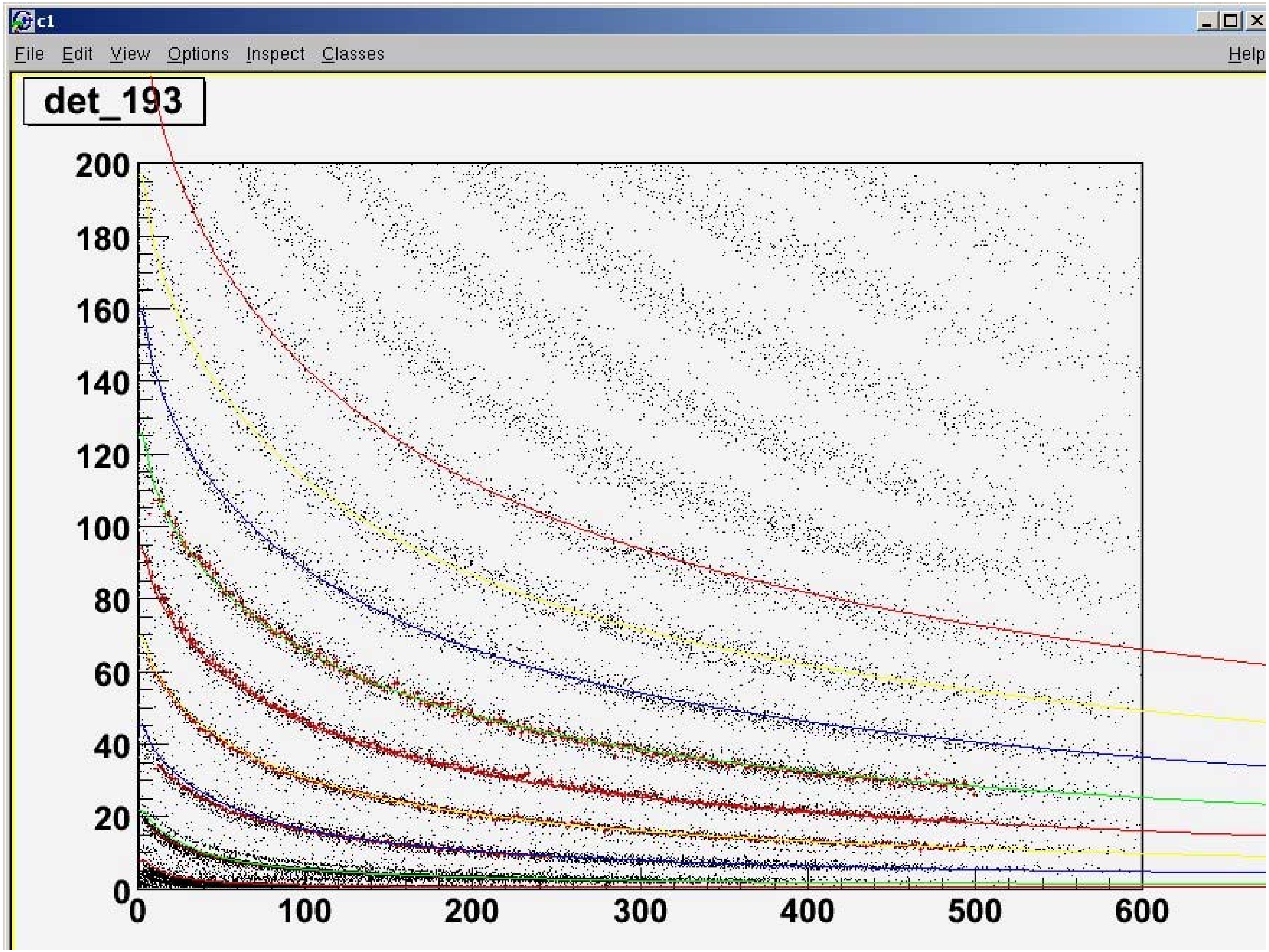
Energy Spectrum of ^{7}Li & ^{7}Be in the CMS







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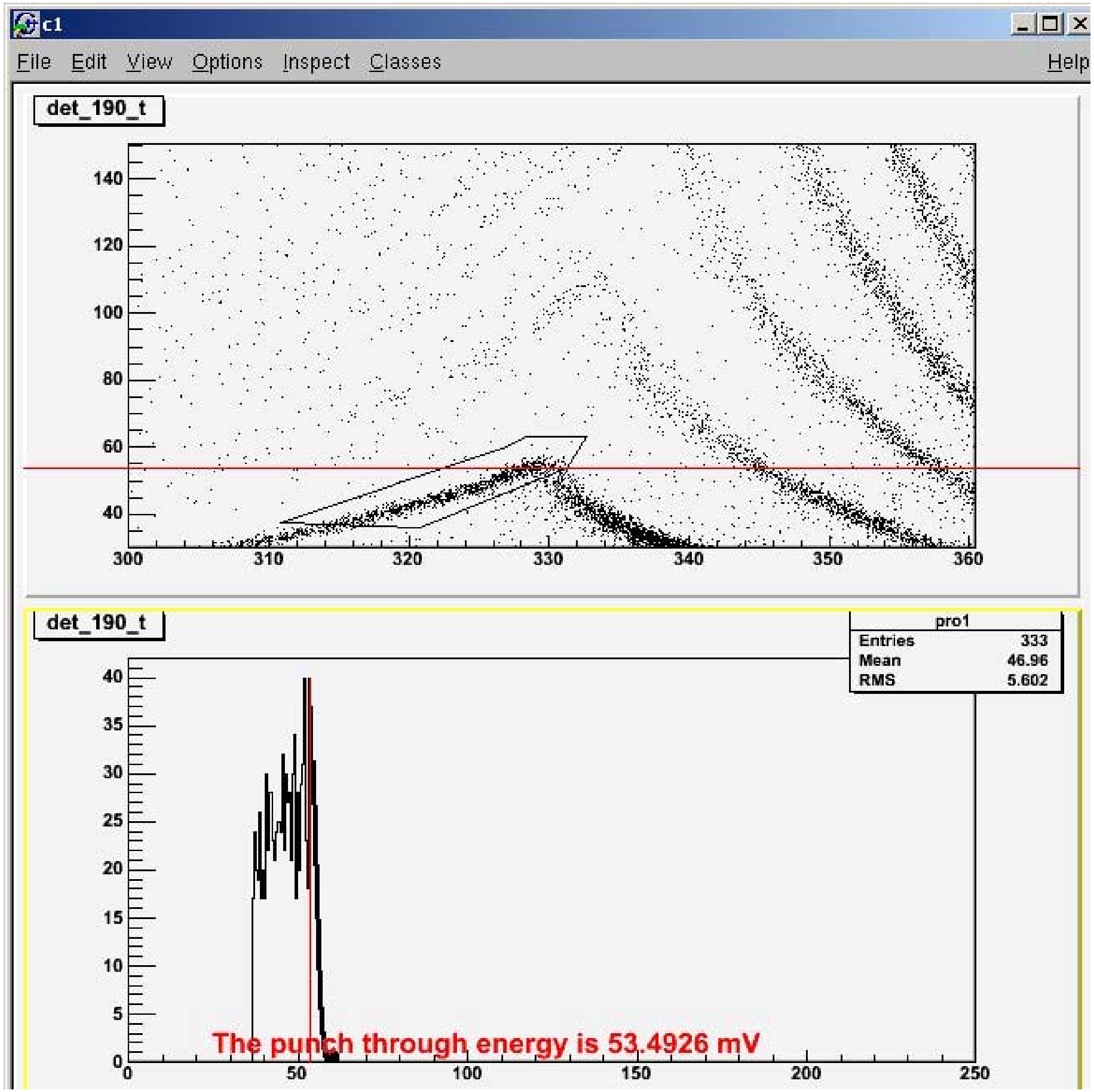
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Entries 333
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RMS 5.602
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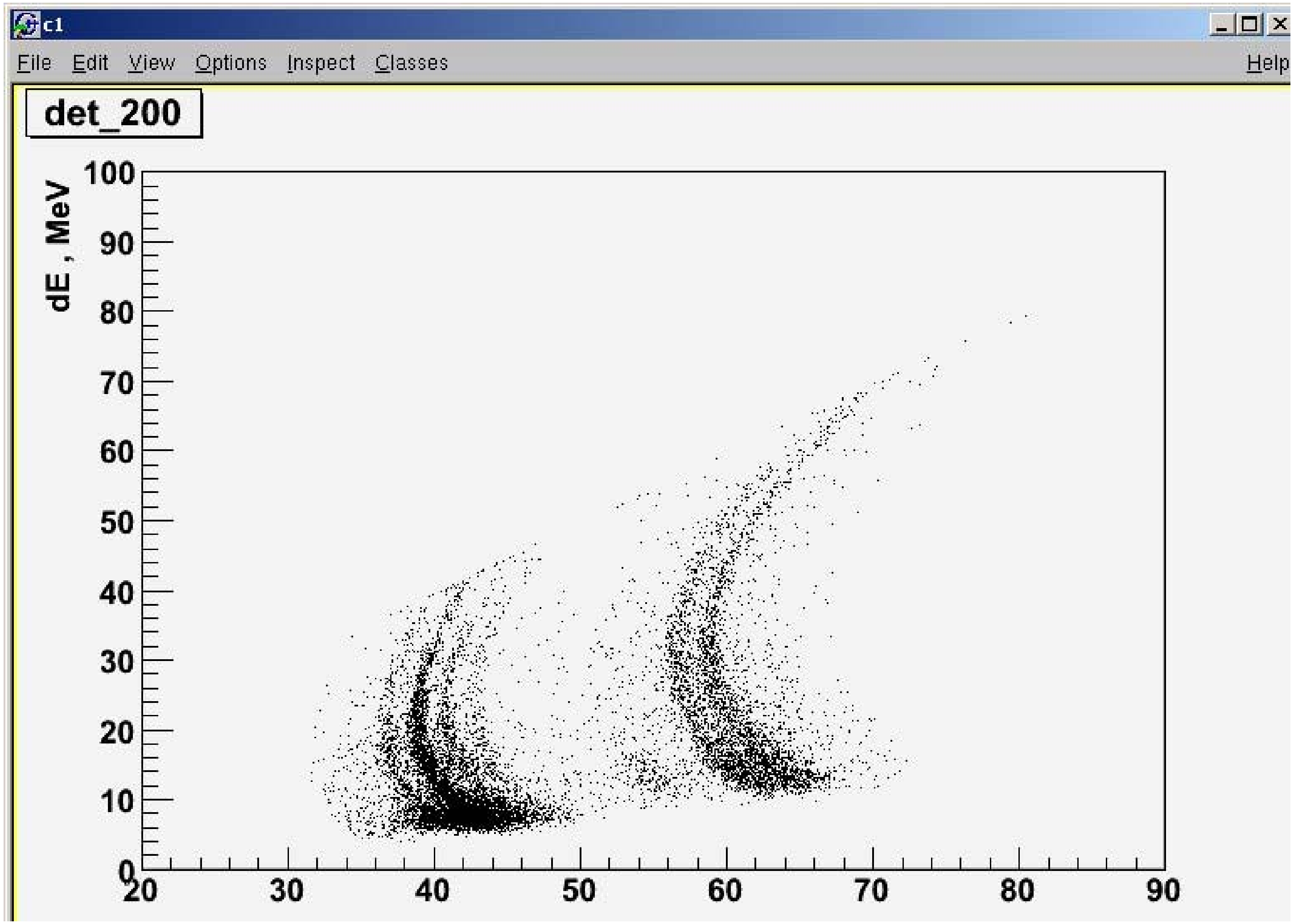

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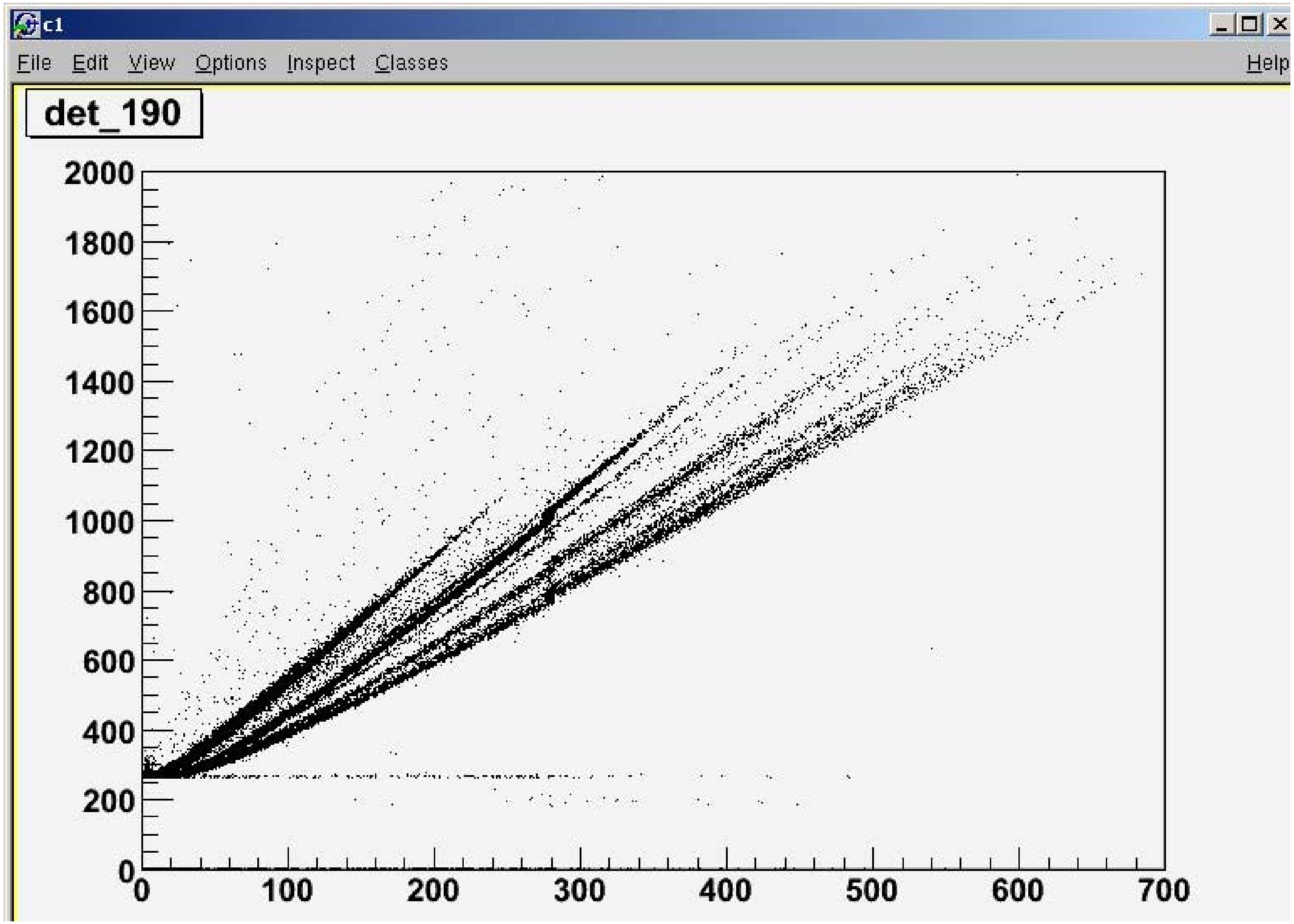
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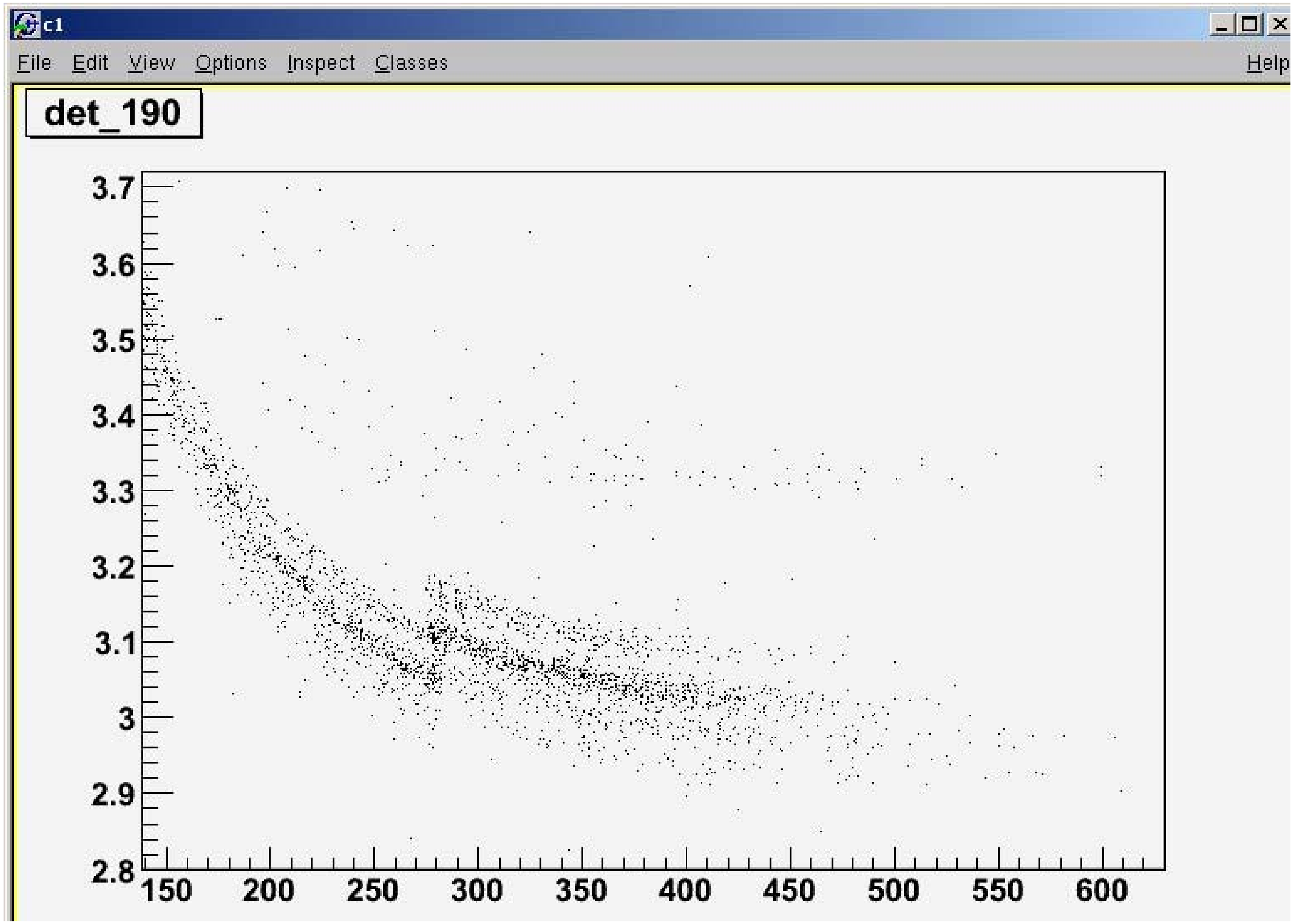

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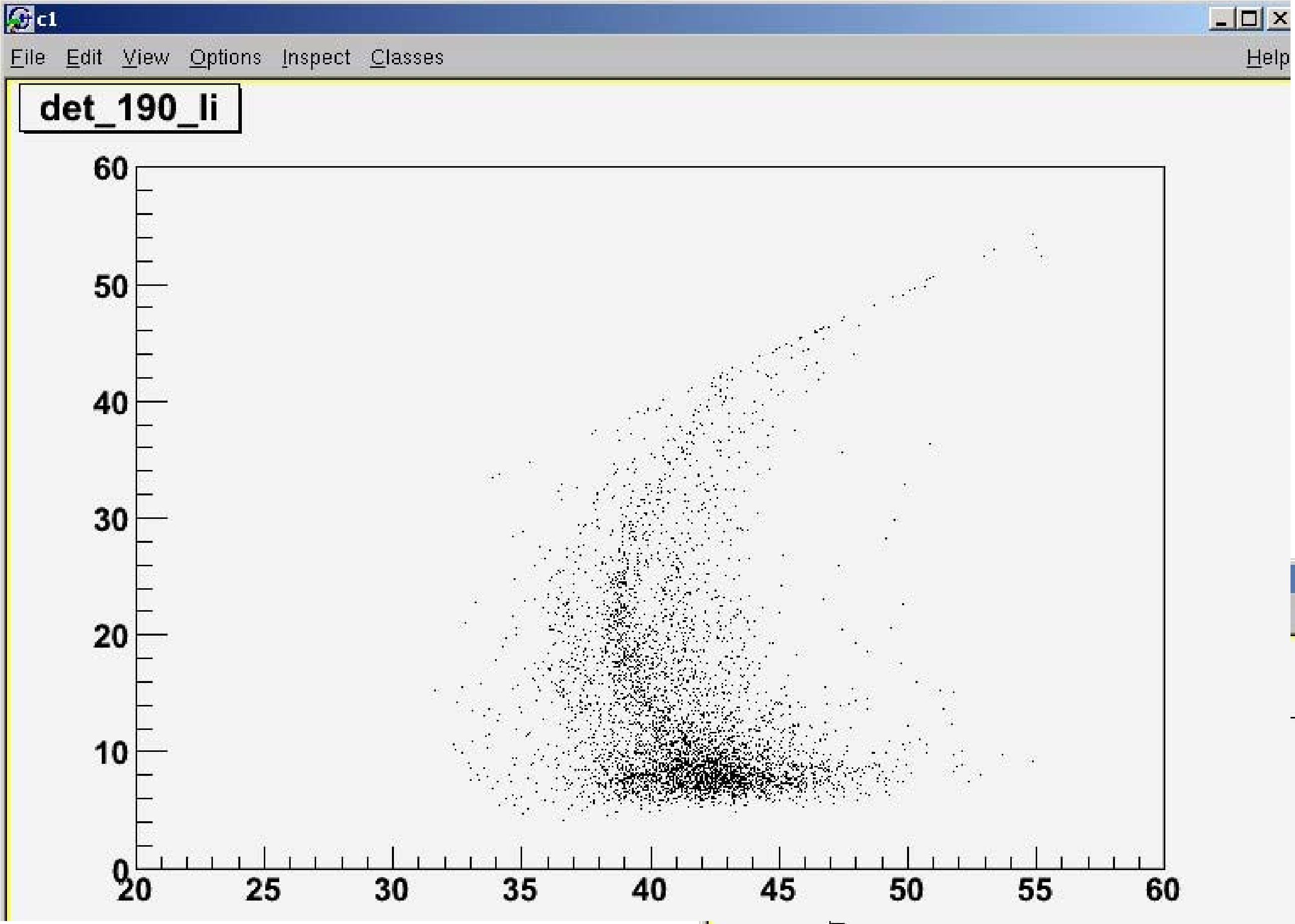
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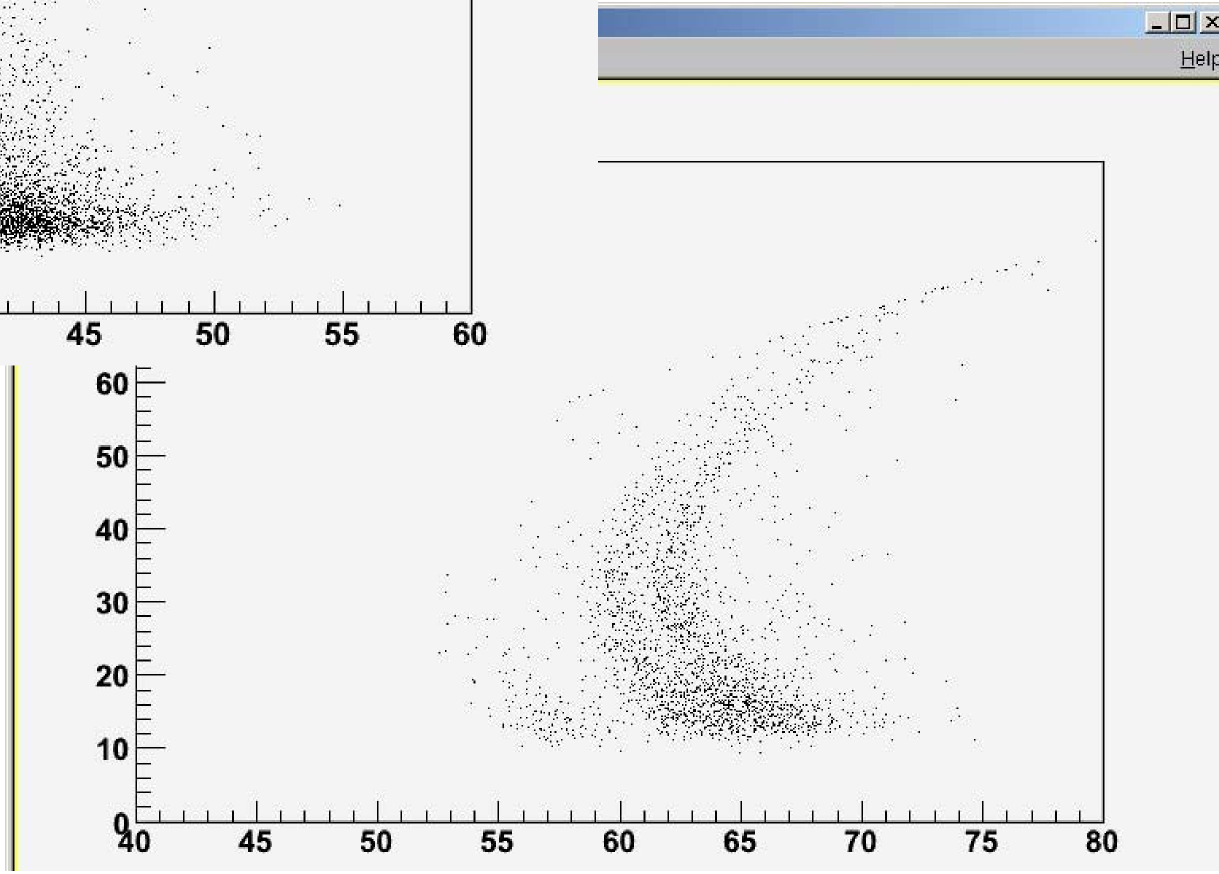
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