Partitioning of the 197Au + 197Au system at an energy of 23A MeV (preliminary results)

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(for CHIMERA Collaboration)

Experiments

- 197Au + 197Au @ 15A MeV (2004)
- 197Au + 197Au @ 23A MeV (2010)

- Why this energies?
- Why this system?
- What phenomena are we looking for?

Reactions at energies around and below 20A MeV

Not so heavy system:

- Semiperipheral and central collisions:
  - Fusion and formation of the compound nucleus
  - Fusion – evaporation reactions
  - Fusion – fission reactions
- Peripheral collisions
  - Binary deep inelastic reactions

Very heavy system:

- Semiperipheral and central collisions:
  - ~~Fusion and formation of the compound nucleus~~
  - ~~Fusion – evaporation reactions~~
  - ~~Fusion – fission reactions~~
- Peripheral collisions
  - Binary deep inelastic reactions

197Au + 197Au

- Very heavy system (almost 400 nucleons)
- Symetric system which due to the Coulomb repulsion cannot fuse at all.

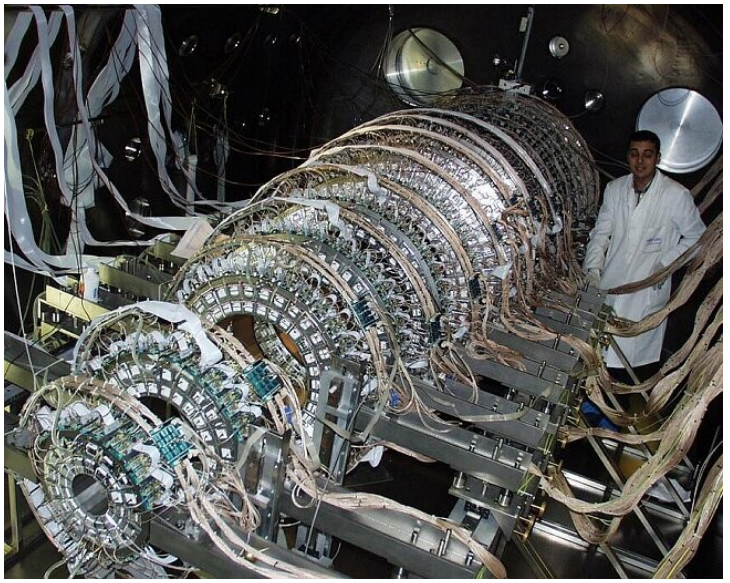
Open question: what kind of partitioning can be observed in collisions of very heavy systems like Au + Au?

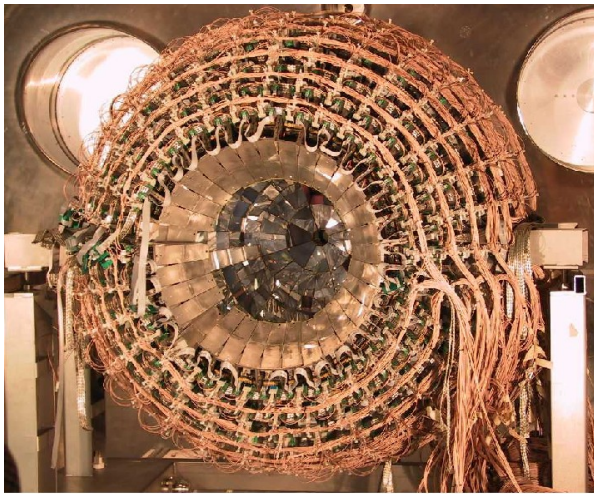
Partitionig into:

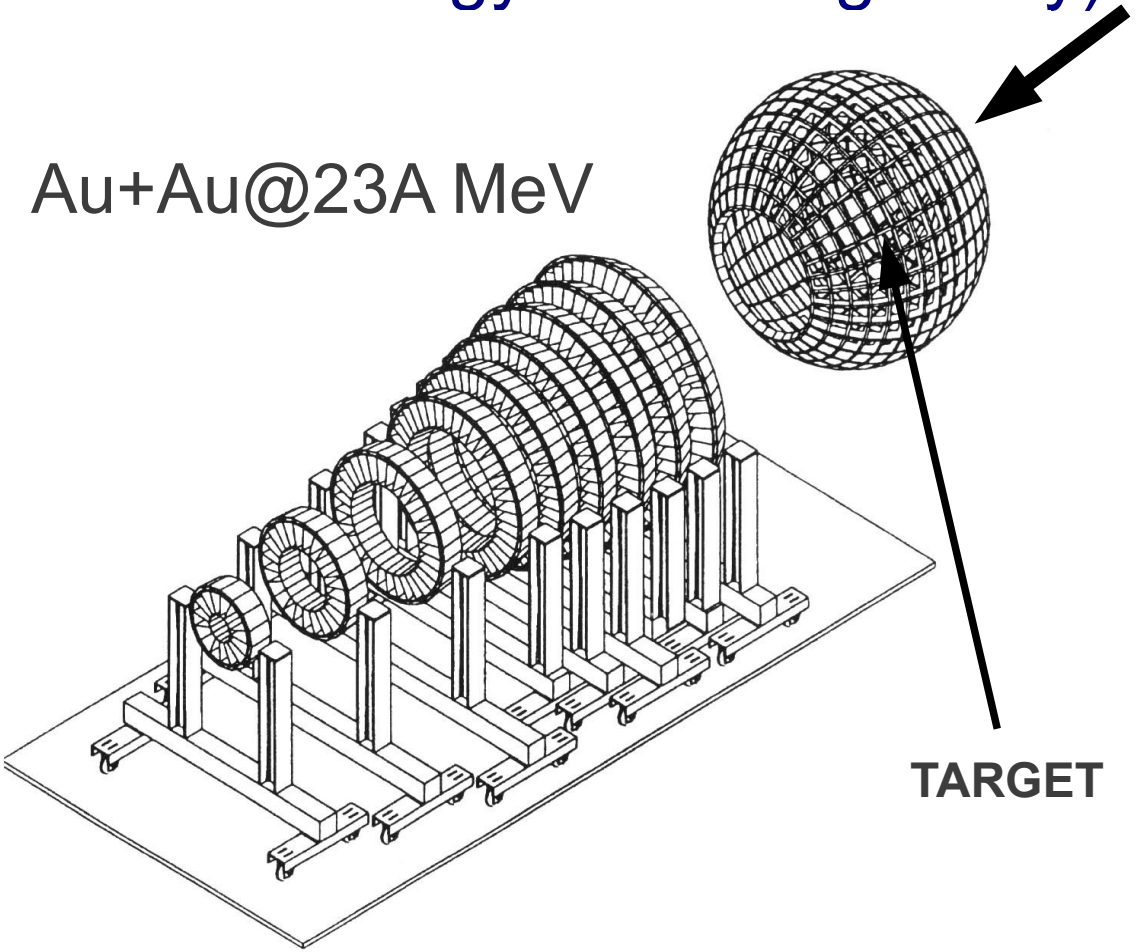
- 3 fragments?
- 4 fragments?
- 5 and more fragments?
- Multifragmentation?

CHIMERA detector

(Charged Heavy Ion Mass and Energy Resolving Array)





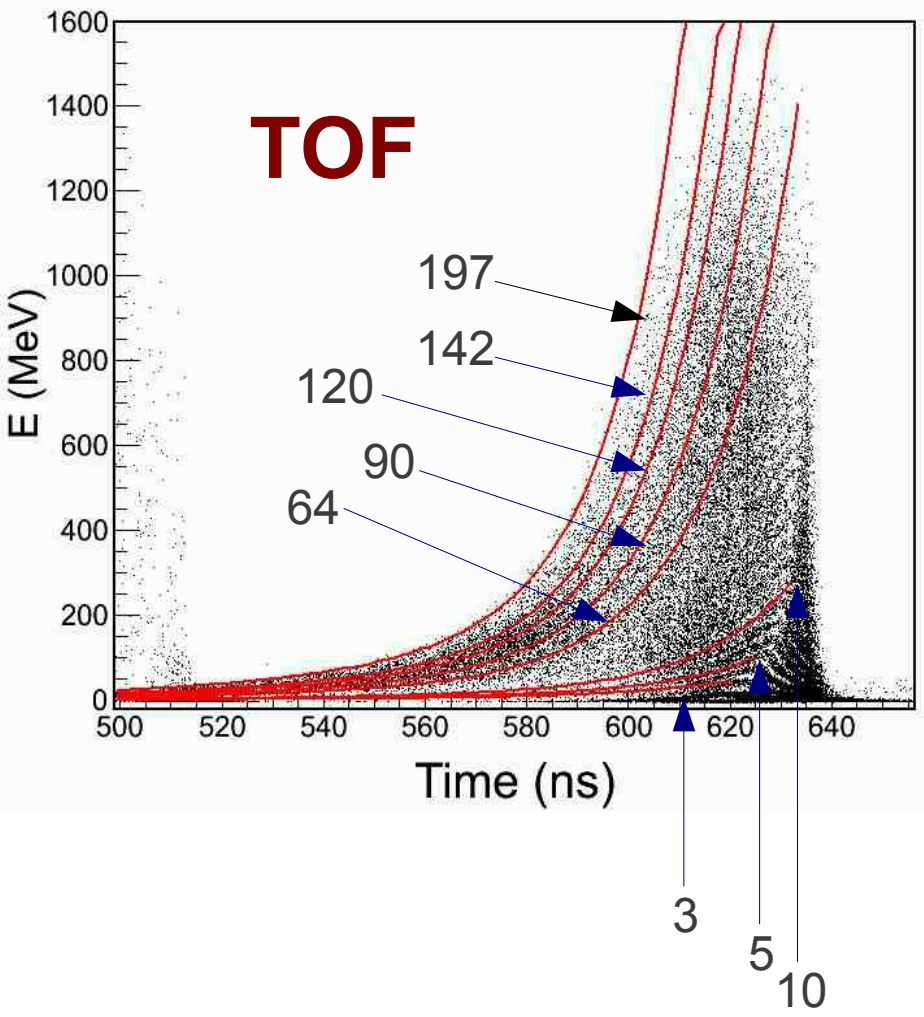


1192 Si-CsI(Tl) telescopes in 4pi geometry

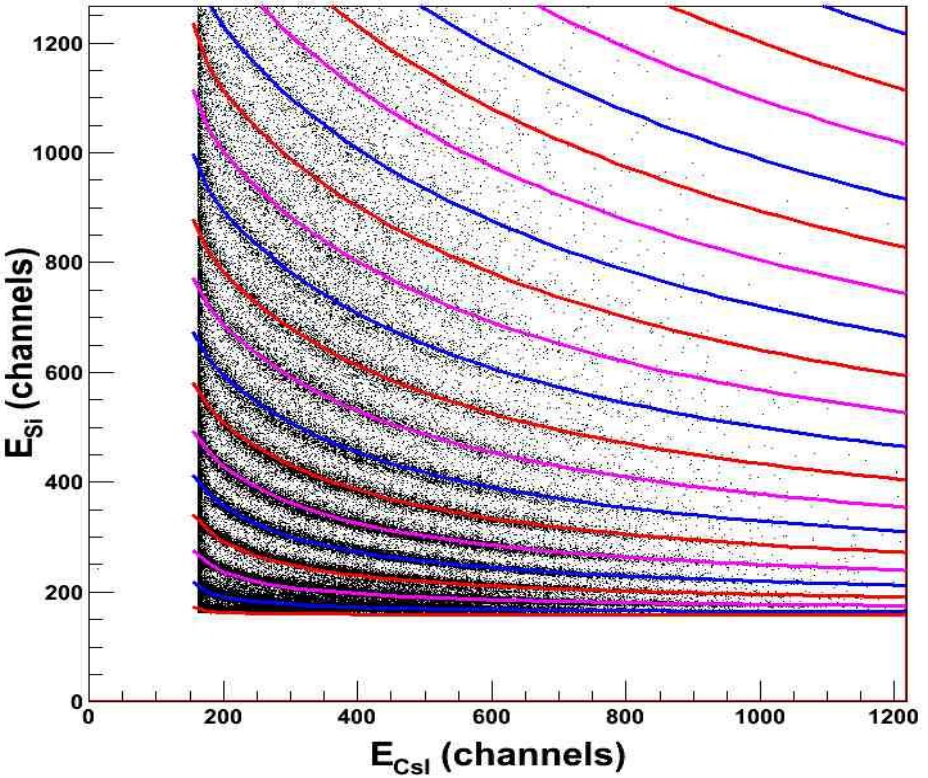
CHIMERA detector

(Charged Heavy Ion Mass and Energy Resolving Array)

Au+Au@23A MeV

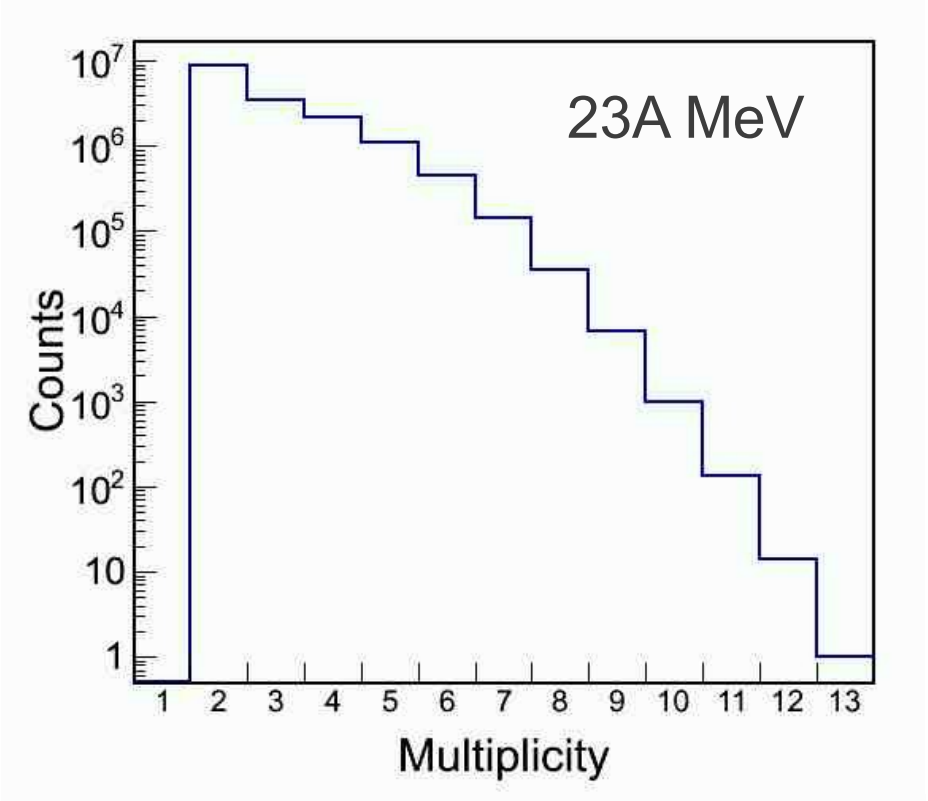


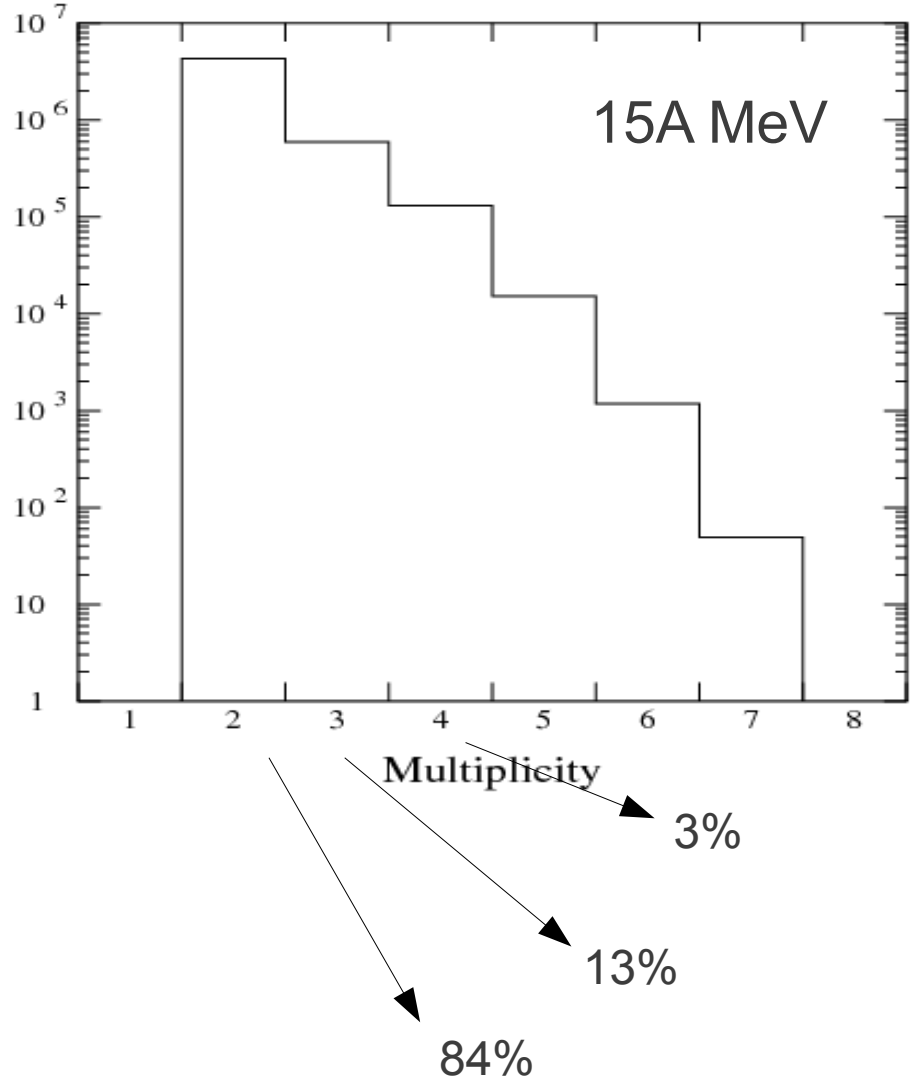
DE-E



2.6 deg < θ(LAB) < 86 deg

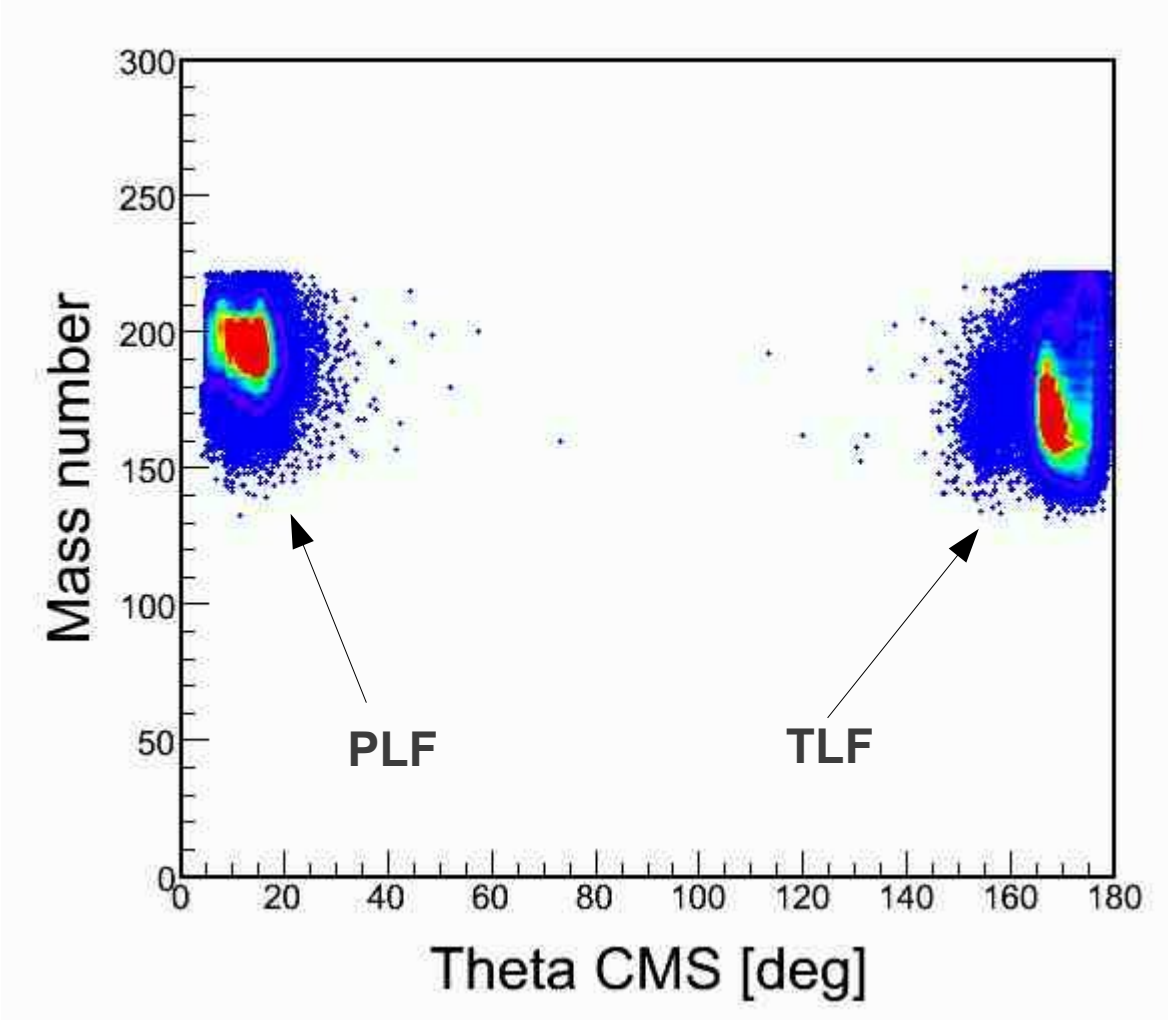
Multiplicity distribution of fragments of Z≥3

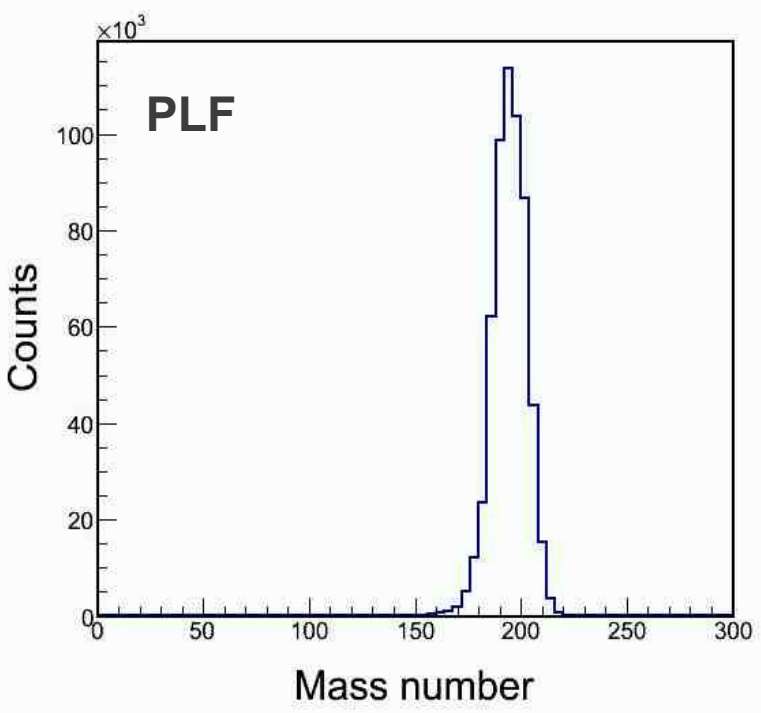


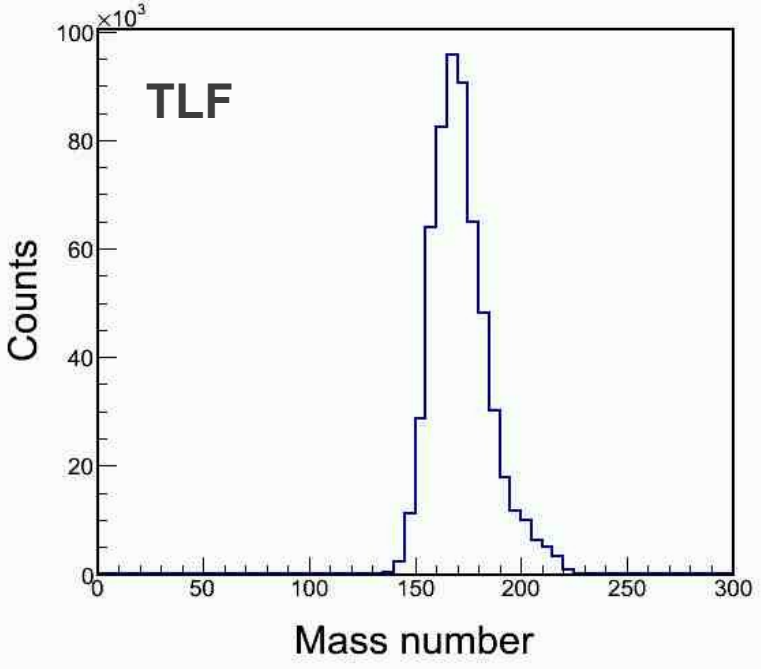


54 % of events – Binary events
21 % of events – Ternary events
13 % of events – Quaternary events
12 % of events – Events with more than 5 fragments

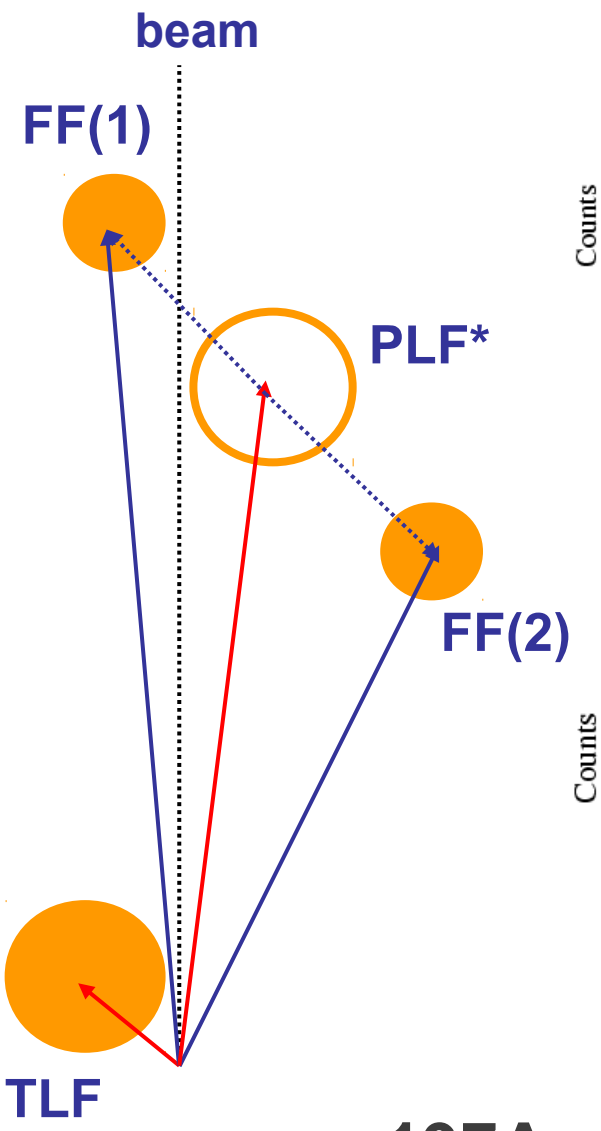
Binary events

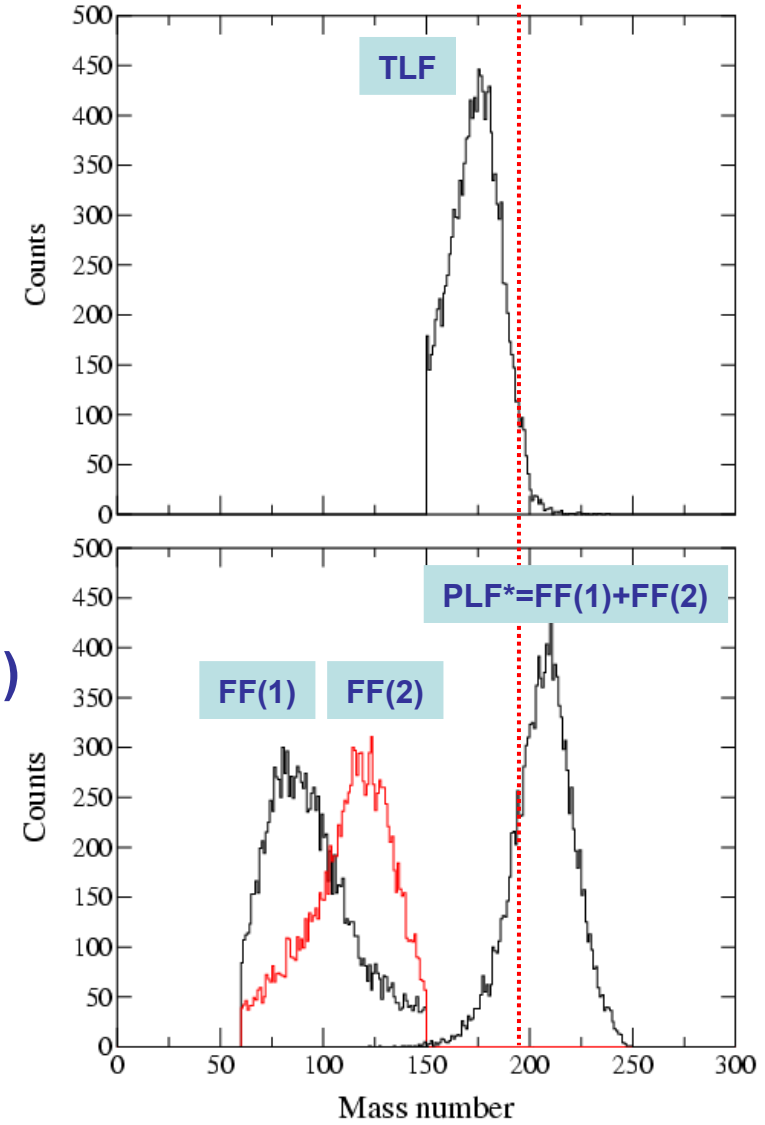






197Au + 197Au @ 15A MeV



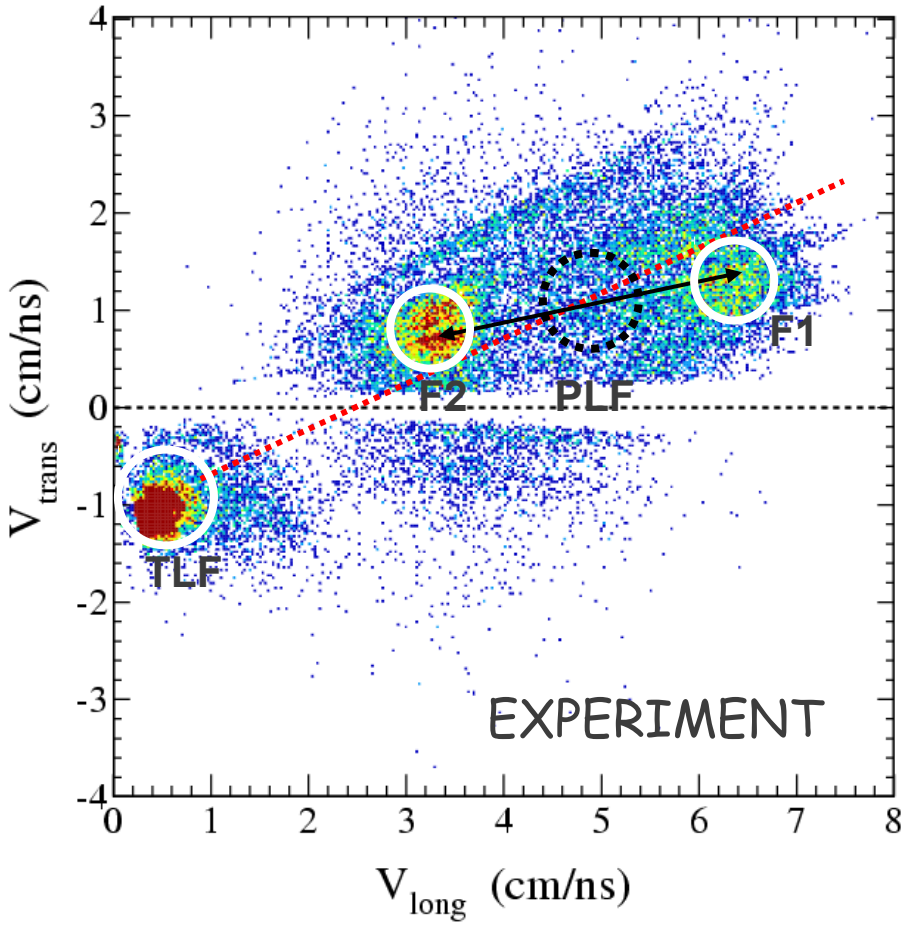


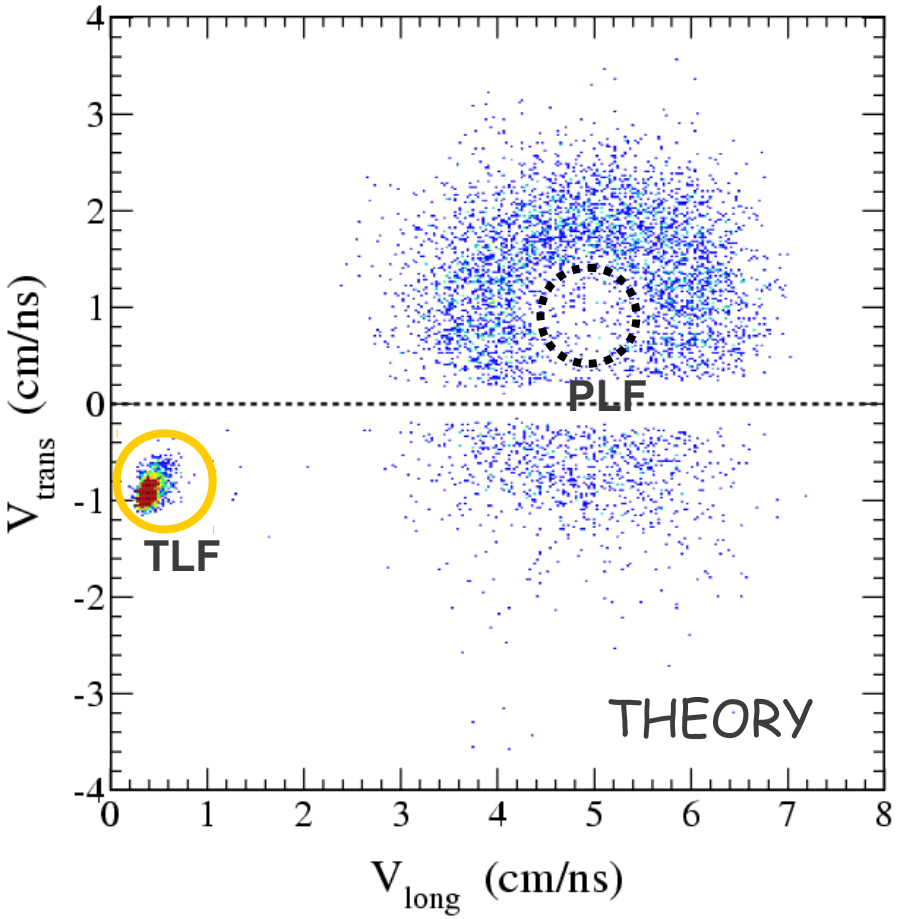
- Fast ternary and quaternary breakup
- 50 fm/c after collision
- Dominate process in semi-peripheral collisions
- Two step reaction
- Fragments are aligned along a common reseparation axis

197Au + 197Au -> TLF + PLF -> TLF + F1 + F2
197Au + 197Au -> TLF + PLF -> PLF + F1 + F2

197Au + 197Au @ 15A MeV

197Au + 197Au -> TLF + PLF -> TLF + F1 + F2

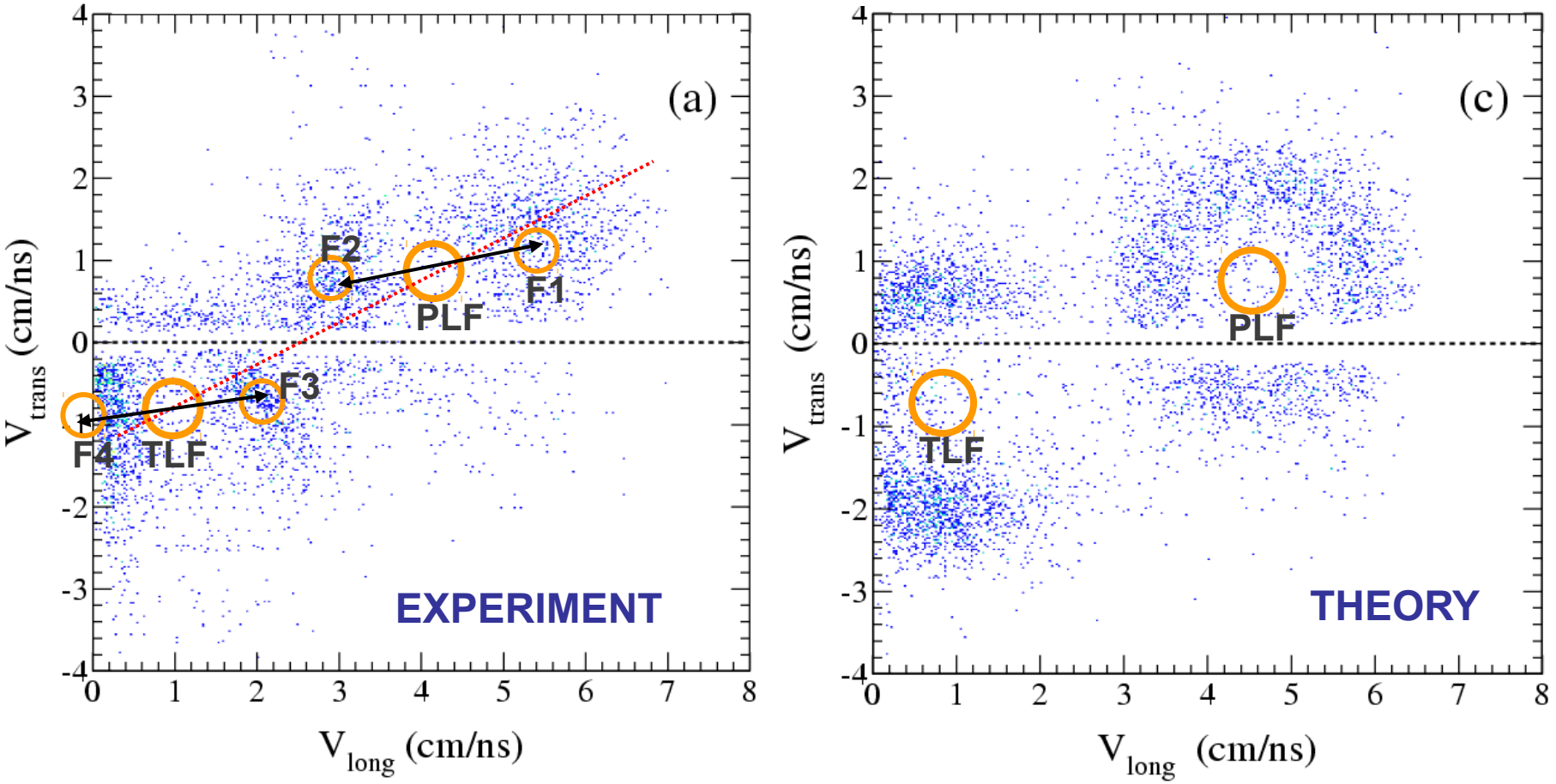




Phys. Rev. Lett. 101, 262701 (2008)
Phys. Rev. C 81, 024605 (2010)

Quantum Molecular Dynamics
(QMD, J. Łukasik)

197Au + 197Au @ 15A MeV



197Au + 197Au -> TLF + PLF -> F1 + F2 + F3 + F4

Phys. Rev. Lett. 101, 262701 (2008)
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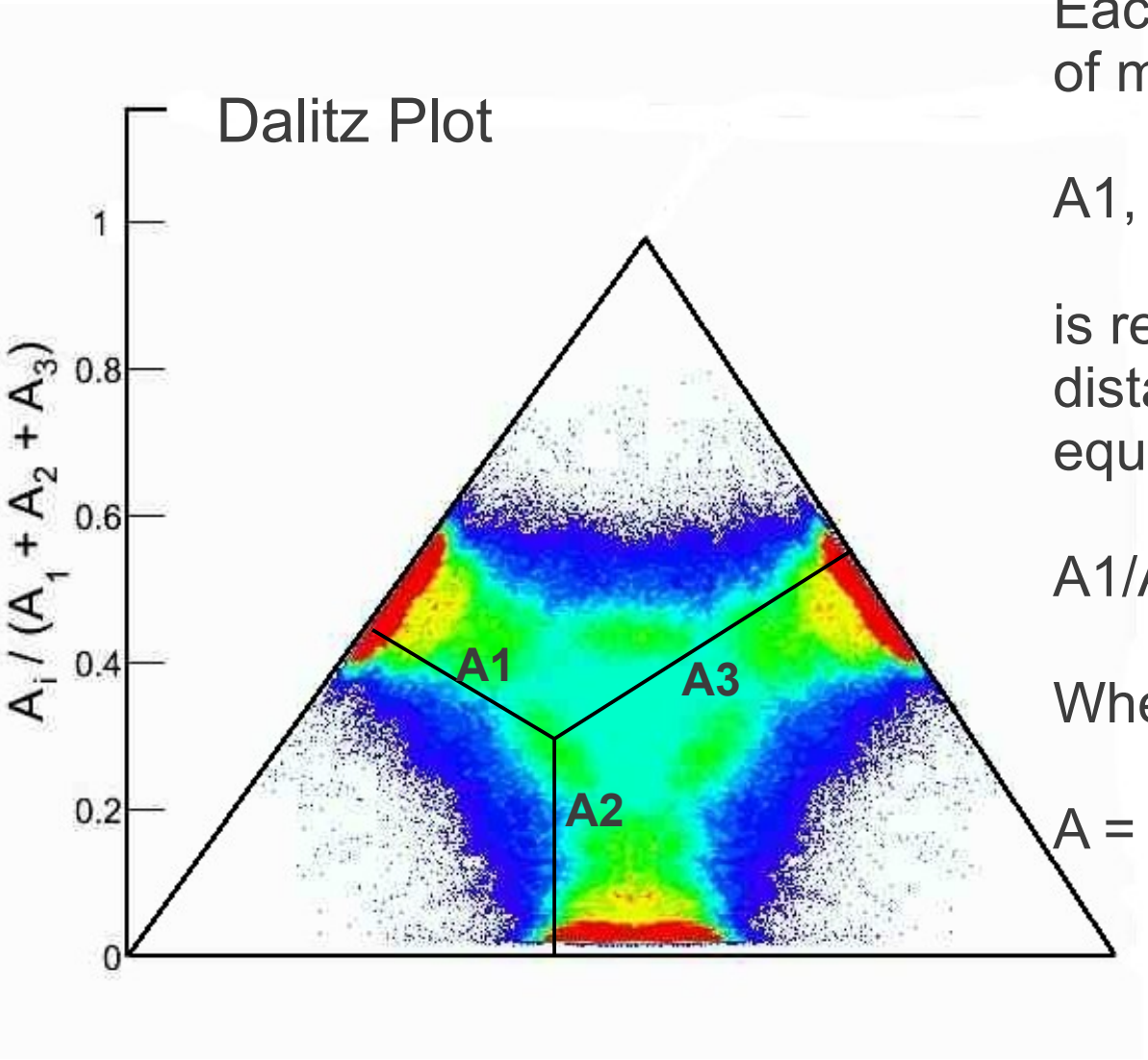
Ternary events selection at 23A MeV



Each ternary event with fragments of mass numbers:

A1, A2, A3

is represented by a point placed at distances from three sides of the equilateral triangle by:

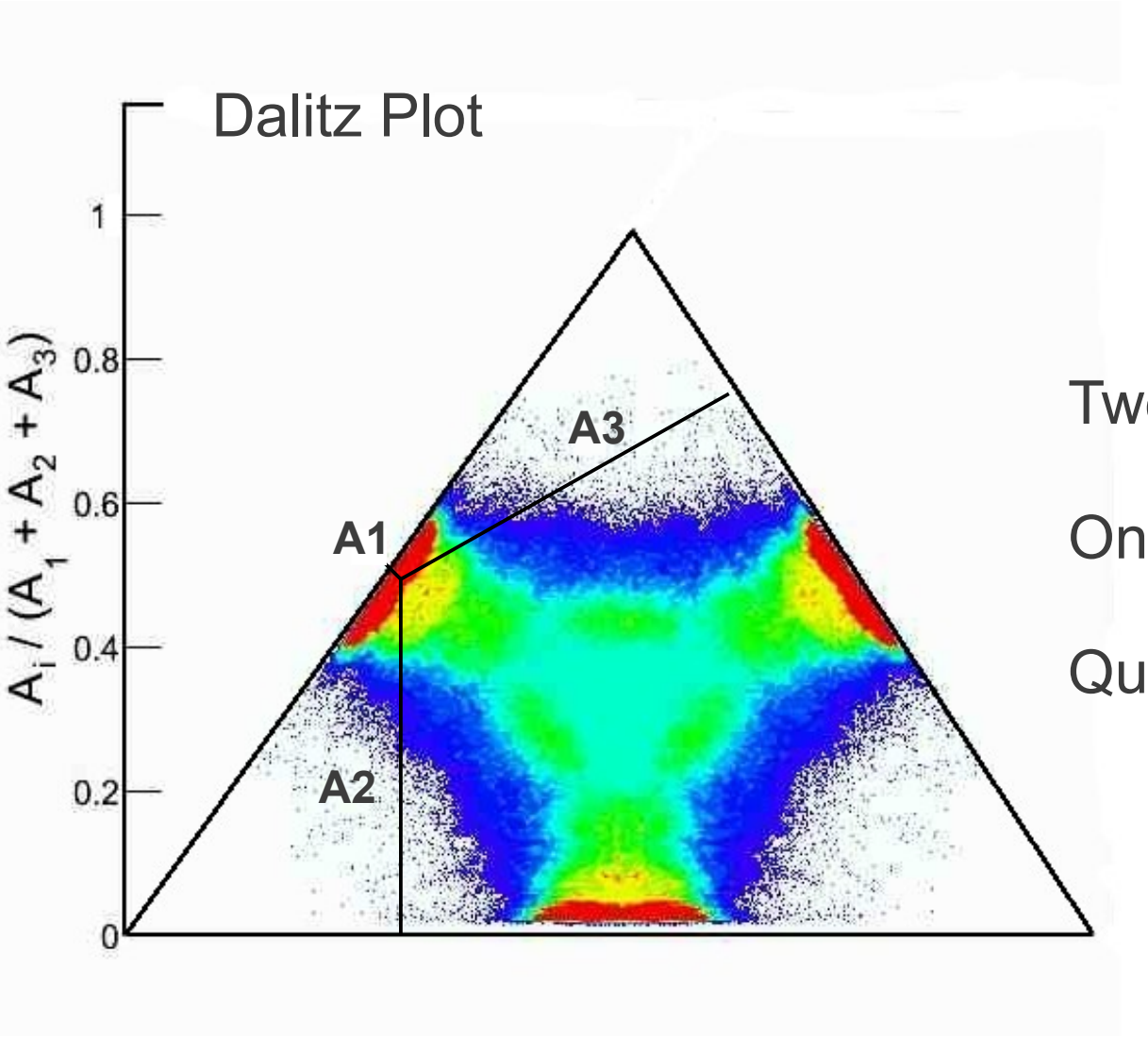
A1/A, A2/A, A3/A,

Where:

A = A1 + A2 + A3

One heavy fragment and two fragments of comparable sizes

Ternary events selection at 23A MeV

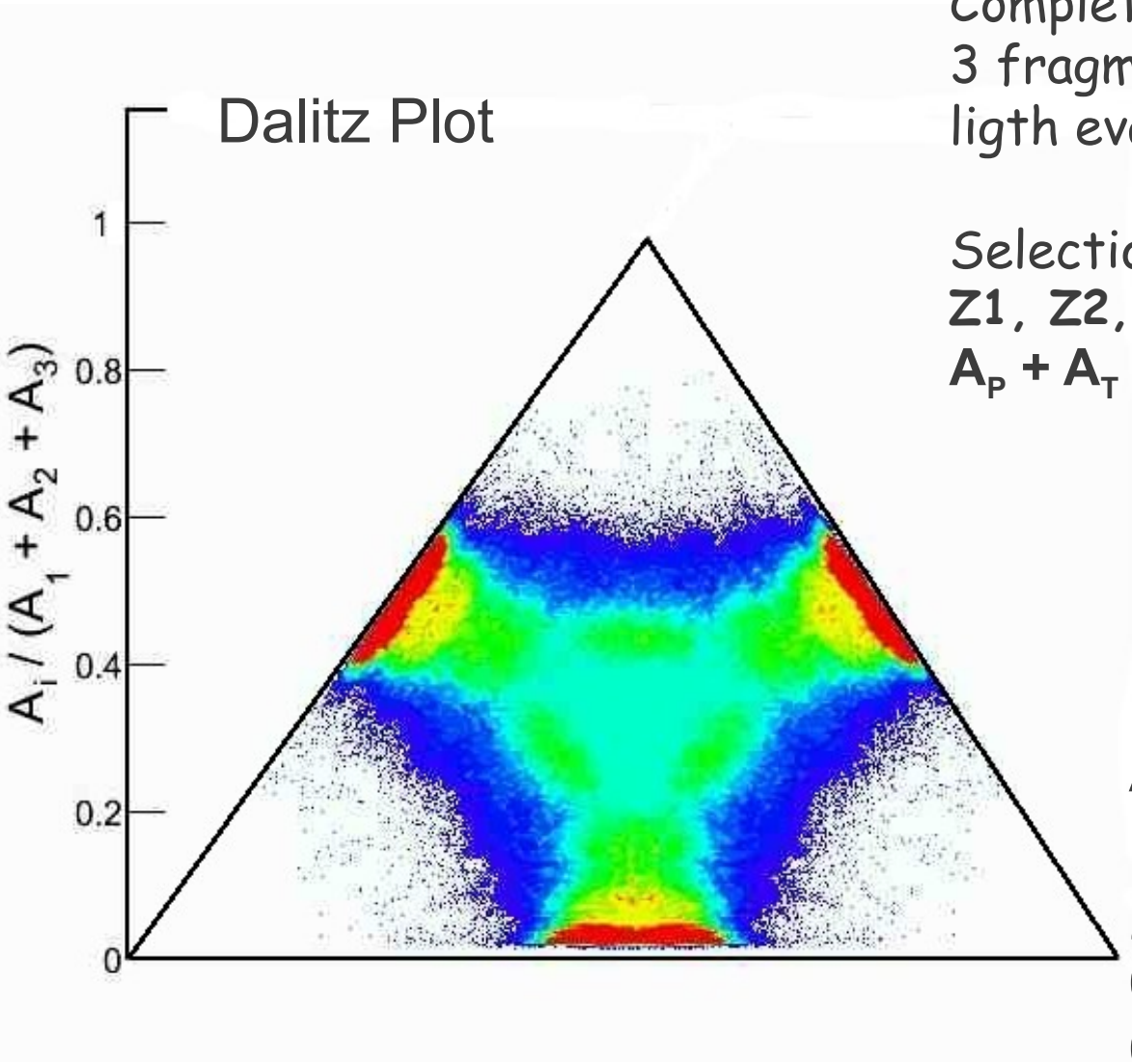


Two very heavy fragments

One very light fragment

Quasi-binary process

Ternary events selection at 23A MeV



Complete events:
3 fragments + nucleons and
ligth evaporated particles

Selection of events:
Z1, Z2, Z3 ≥ 3, Z4, Z5 ... ≤ 2
$A_P + A_T - 70 \leq A_1 + A_2 + A_3 \leq A_P + A_T$

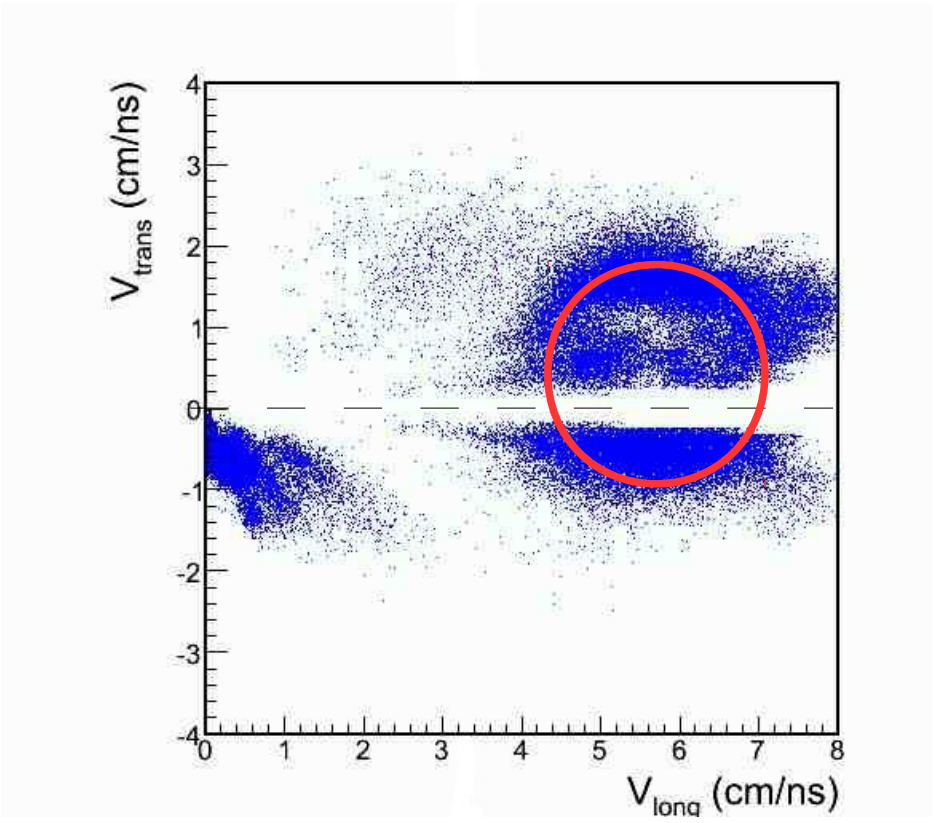
$|\sum p_{long}(1,2,3)| > 0.8\ p_o$

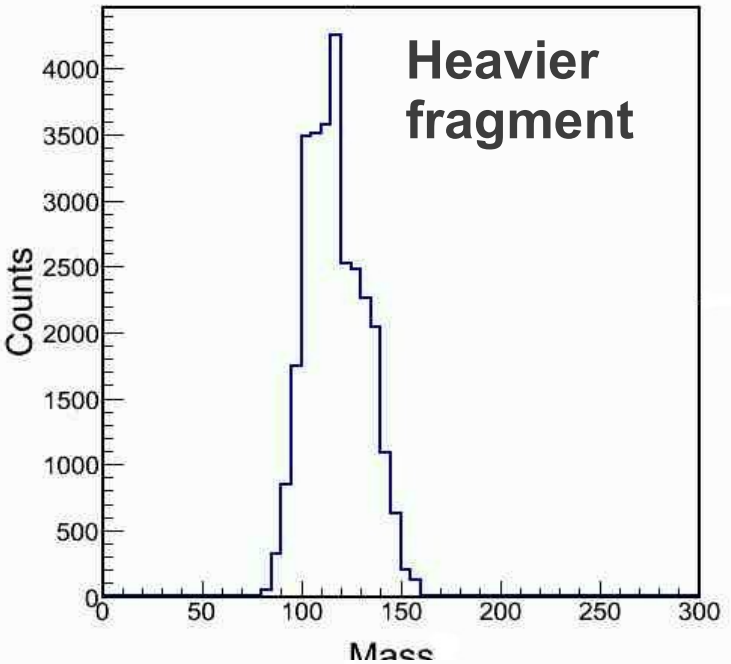
$|\sum p_{trans}(1,2,3)| < 0.04\ p_o$

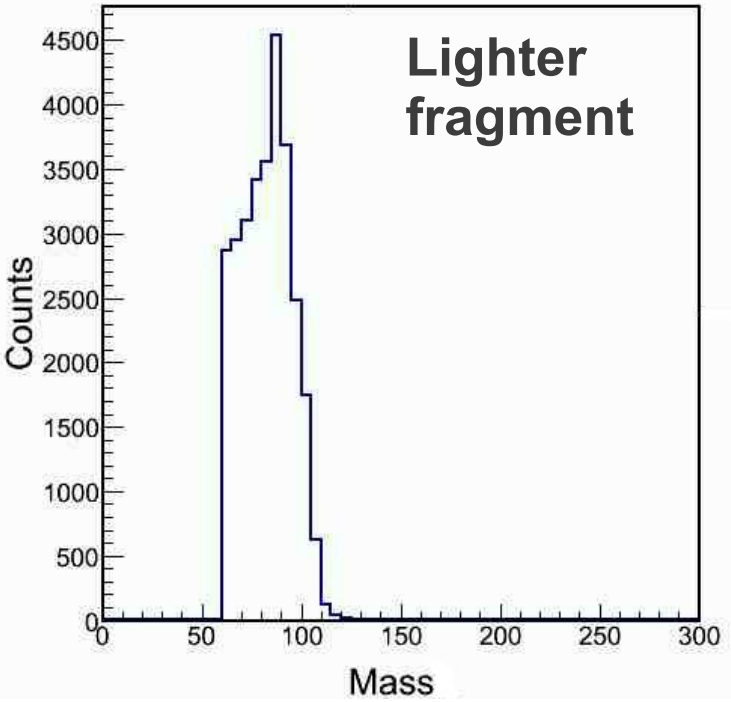
A_3 = TLF (Target-Like-Fragment)

Most probable ternary events
$0.38 \leq A_{TLF}/A \leq 0.53$
$0.15 \leq A_1/A, A_2/A \leq 0.38$

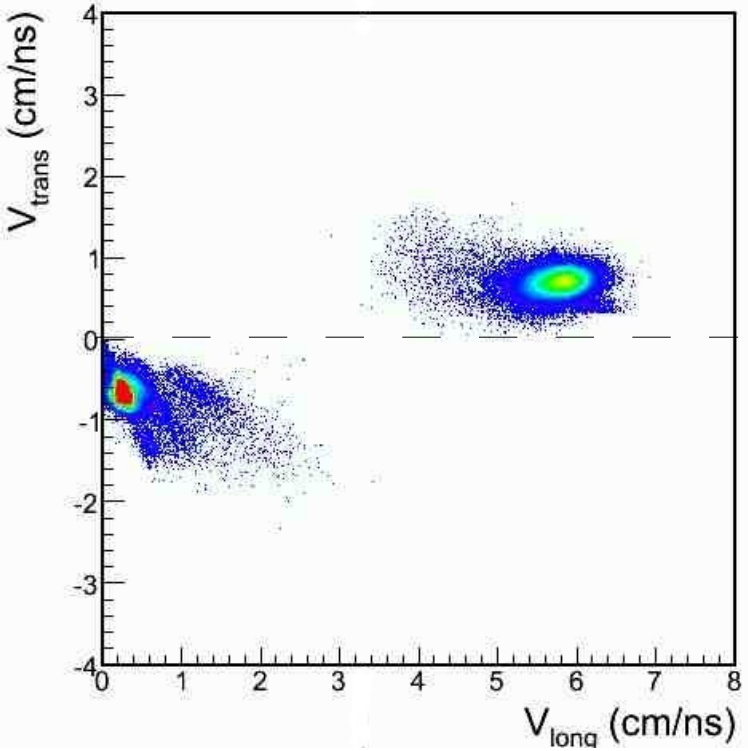
Ternary events (23A MeV)

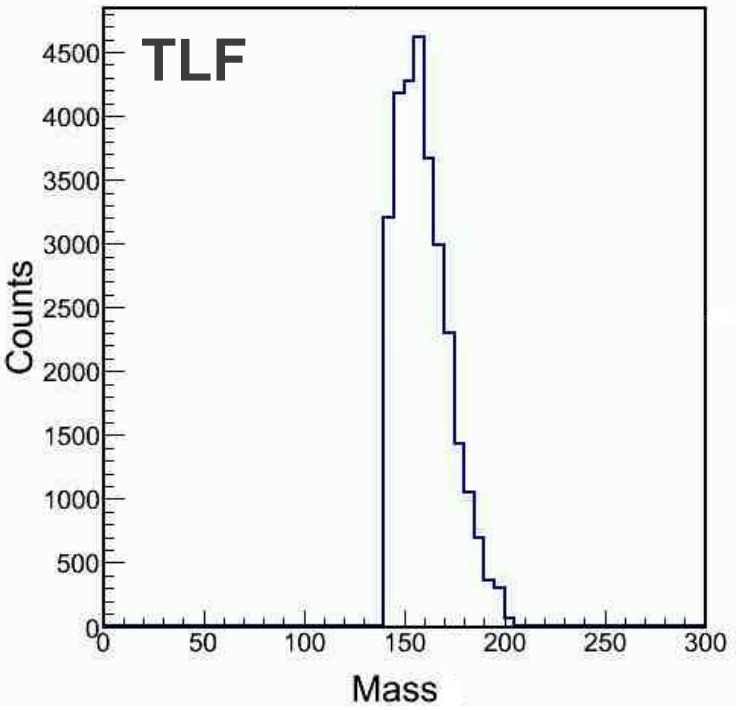


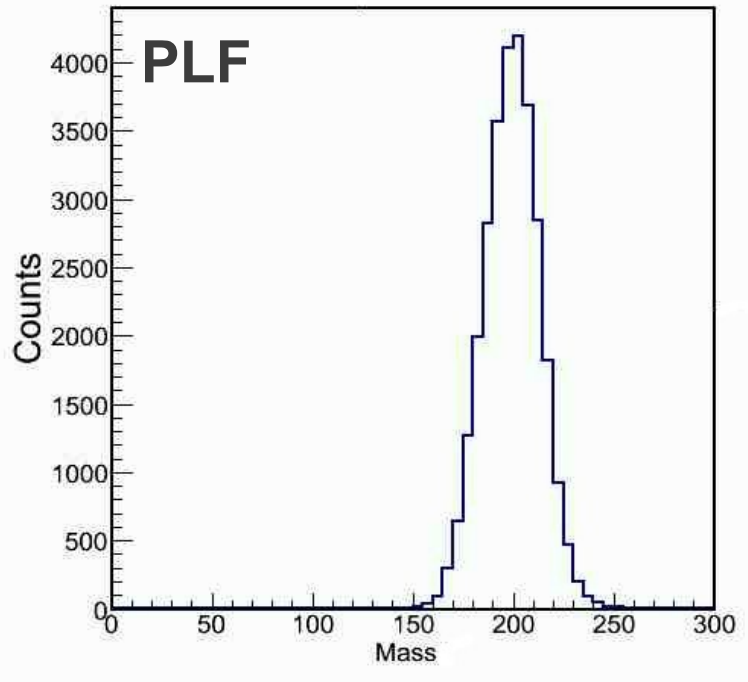


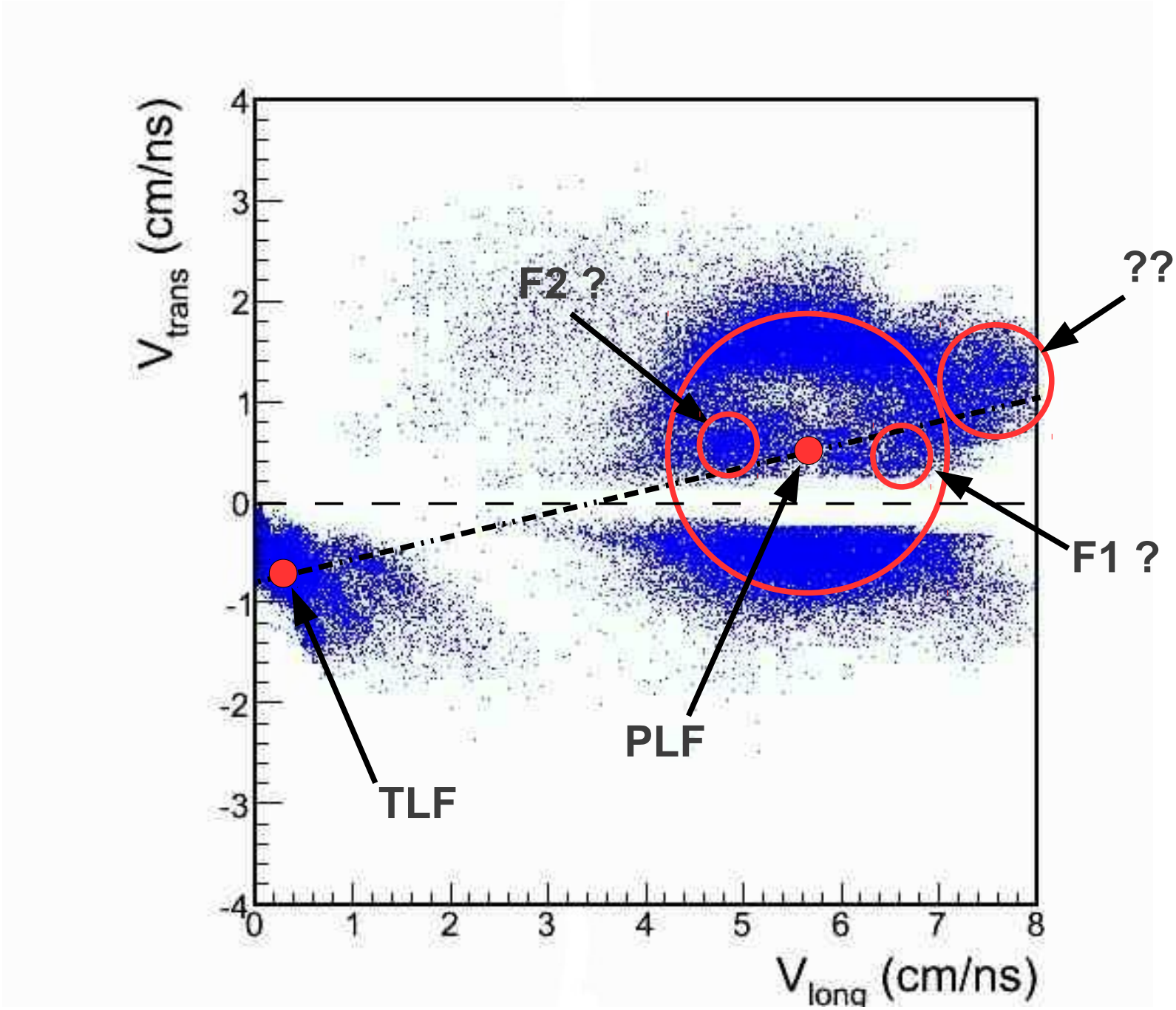


PLF reconstruction









Open question: is there is a ternary breakup of Au+Au system at 23A MeV?