Simulation and Data analysis working group report

M. Labiche.
University of Paisley

At the
EXL/R3B collaboration meeting,
Milano, 03/10/06

Recent Meetings

2 SWG Meetings since our last EXL/R3B collaboration meeting:

In paisley (27/01/06): Status on EXL, R3B, HISPEC/DESPEC
event generators,
Manpower problem addressed,
GEANT4 dilemma

At CERN : meeting with GEANT4 collaborators

- Ion Energy loss and multiple scattering. ATIMA, TRIM G4 comparisons, atomic charge state...
- Drift electrons in gas detectors (ACTAR),
- Low energy neutrons,
- Cross sections and kinematics,
- PDG coding (extension for ions?),
- Hadronic interaction and decay of exotic nuclei,
- Transfer matrices for magnetic elements of the accelerators

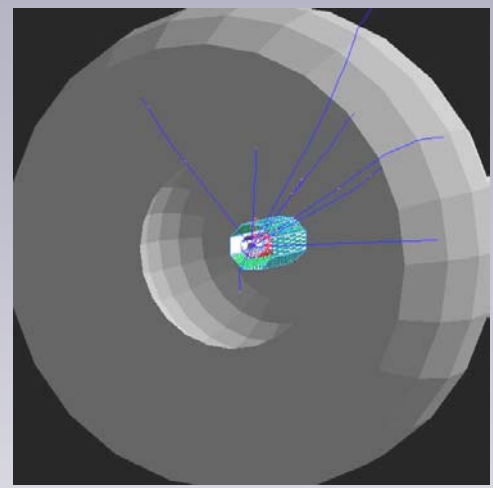
Next meeting : possibly in Valencia in January 2007

- SWG Activities were also presented at the NUSTAR annual meeting (24/02/06) and at the NUSTAR Management Board meeting (13/09/06)

Conclusion of the meeting with the GEANT4 collaboration

- GEANT4 did welcome the NUSTAR SWG
- GEANT4 priories = HEP priorities
- They invite us to the GEANT4 Technical Forums (via vrvs)
- No MoU anymore,
- But they need some kind of agreement with institutions/researchers rather than collaborations

R3B/EXL WG Simulation status



R3B: R3BSim code (http://www.usc.es/genp/r3b/)
(Si tracker + Calorimeter)

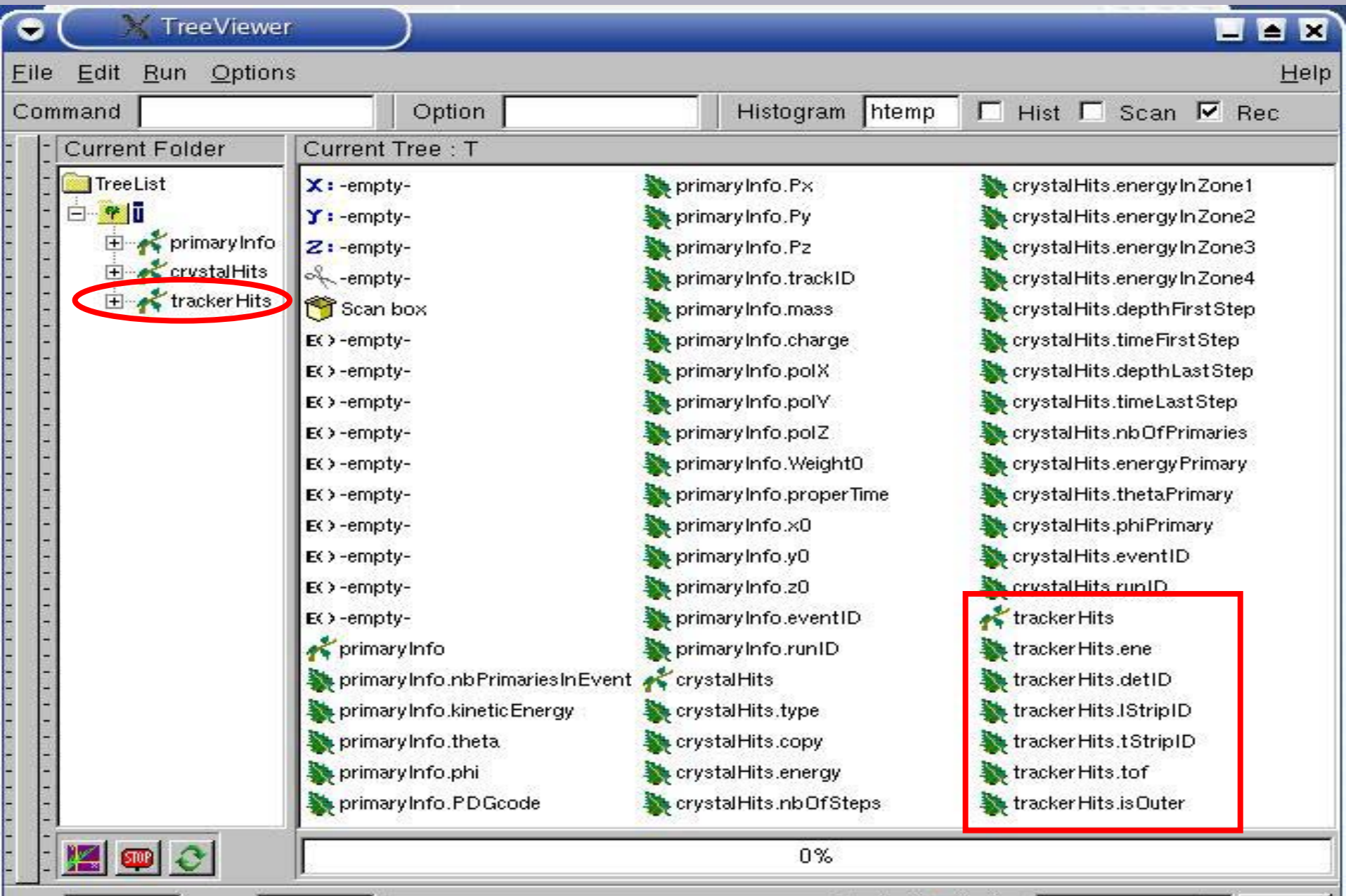
Analysis code for (Si + Calorimeter)

Development of standalone programs
for Newland, TPC, calorimeter,

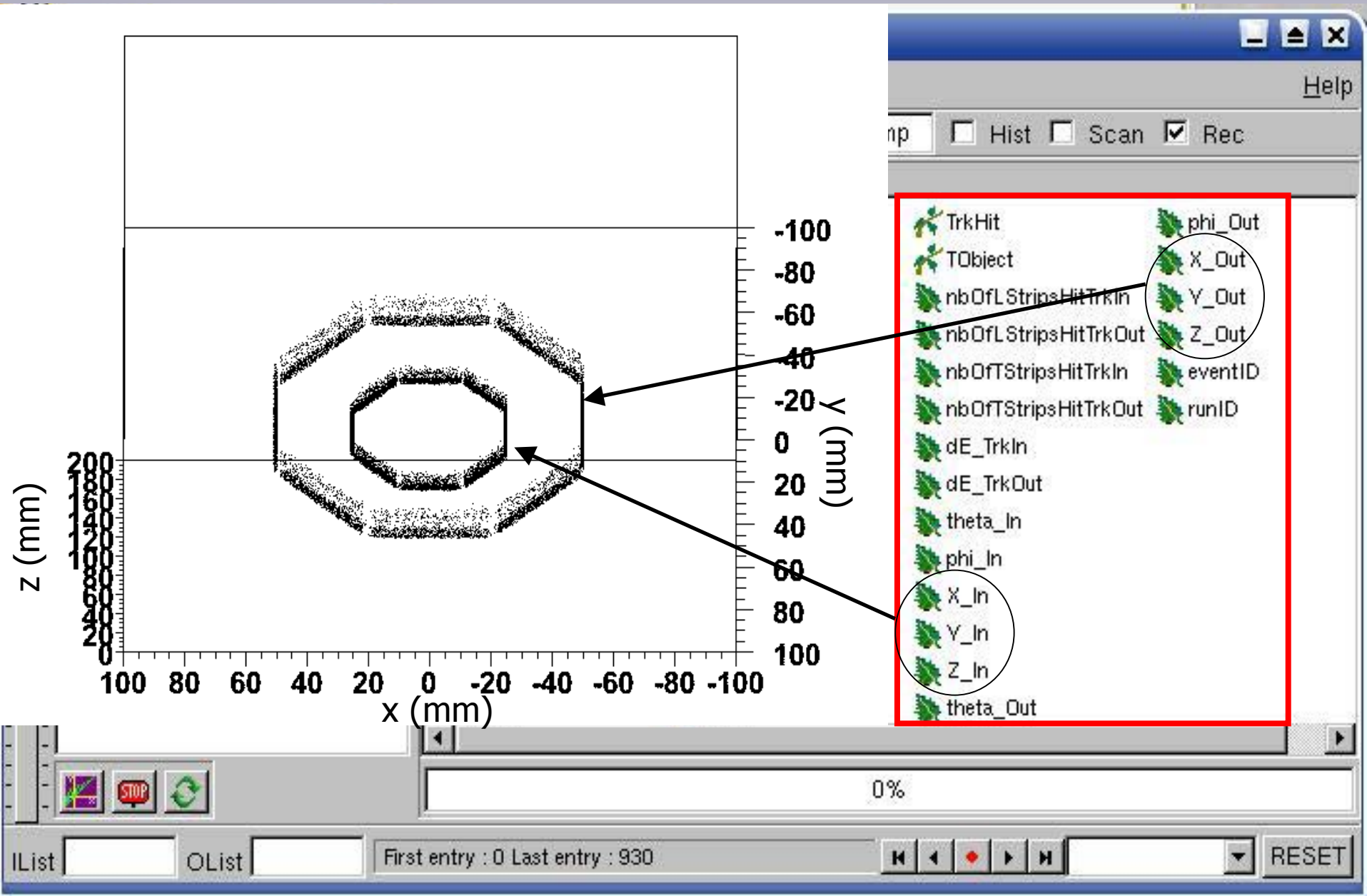
Code Distribution with Subversion (svn: http://subversion.tigris.org/)
The Command to get the R3BSim code is :
svn checkout http://fpcongro.usc.es:/R3BSim
(login and password to be request to hapol@fpddux.usc.es)

EXL: Activities focused on stand-alone program for
- Silicon particle array (ESPA),
- Ion optics,
- Calorimeter

Output of the R3BSim code = primary tree T



Event reconstruction code ► secondary tree



SWG main priorities

R3B/EXL

Simulation of test experiments ⇒ **Event generator urgently required as well as information on the detectors to be used**

Implementation of new detectors in the R3BSim code (Newland, TPC)

Couple EXL detectors in a unique code (EXLSim ?)

Complete the detectors with frames, holders, vacuum chamber

Development of the analysis or event reconstruction code

SWG hot issues

- Still no decision on the Framework
  - not enough expertise in existing framework to make a decision
  → GEANT4 + ROOT seems the only way we can afford

- What do we do with the GEANT4 collaboration ?
  - FLUKA ≠ GEANT4 despite using several Hadronic physics list in GEANT4 (Mihai Potlog, Bucharest)

- Event generator for key experiments

- Need manpower to simulate test experiments

- No assigned manpower for Development/maintenance of the codes

What event generator ?

Several existing event generator interfaces have been identified and tested :

- HepMC
- GENBOD
- TGenPhaseSpace

None are really appropriate for us.

$\Rightarrow$ Develop a self-made interface

We need theory output files before to build a flexible interface.

Event generator for elastic/transfer reactions

= 2-body final state reactions: 2(1,3)4 e.g : (p,p) , (d,p) , (p,d) , …

- The kinematic of the 2-body reaction provide a simple relation $T_3(\theta_3)$ for the light ejectile

-The theories provide the reaction cross-section $\sigma(\theta)$ or $P_\sigma(\theta)=\int_0^\theta \sigma(\theta)/\sigma_{tot}$

To propagate the light ejectile in GEANT4, we need to know its kinetic energy T, its polar angle θ and its azimuthal angle φ.

Thus, the event generator is simply as follow :

- a random number between 0 and 1 is used for $P_\sigma(\theta) \Rightarrow \theta$ is deduced

- The corresponding kinetic energy is then deduced from $T(\theta)$

- φ is chosen randomly between 0 and 2π

Event generators for QFS experiments

Case of 3-body final state reactions: *2(1,34)5* e.g.: (p, 2p)

- 5 independent kinematic variables are necessary to describe the 3-body final state (e.g.: p_3, θ_3, θ_4, φ_3, φ_4)

- In the PWIA theory (Debebe, PRC 31 (1985) 1841) , the number of parameter is reduced to 3:

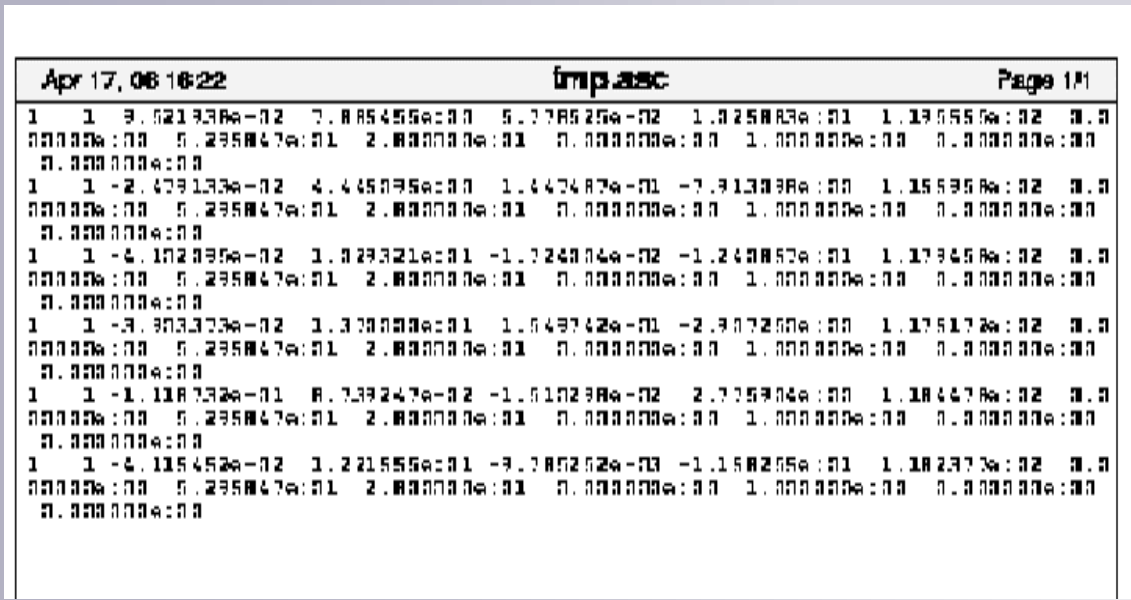
s = $(p_3+p_4)^2$ = total energy of the two outgoing light particles
u = $(p_2-p_5)^2$ = internal momentum of the cluster
t = $(p_1-p_4)^2$ = transfered momentum

Even so, the event generator is still complex

MOCADI as an Event Generator

(M. Taylor, University of York)

- Monte Carlo code to model ion transport and energy loss (uses ATIMA 1.0) (Nuc. Inst. & Meth. in Phys. Res. B 126, 284)
- Used to optimise experimental setup of FRS at GSI
- Models fragmentation reactions using Goldhaber momentum distribution (Phys. Lett. 53B, 306) (uses EPAX2 for cross-sections)
- Option to output events to an ASCII file (no cross-sections applied !)

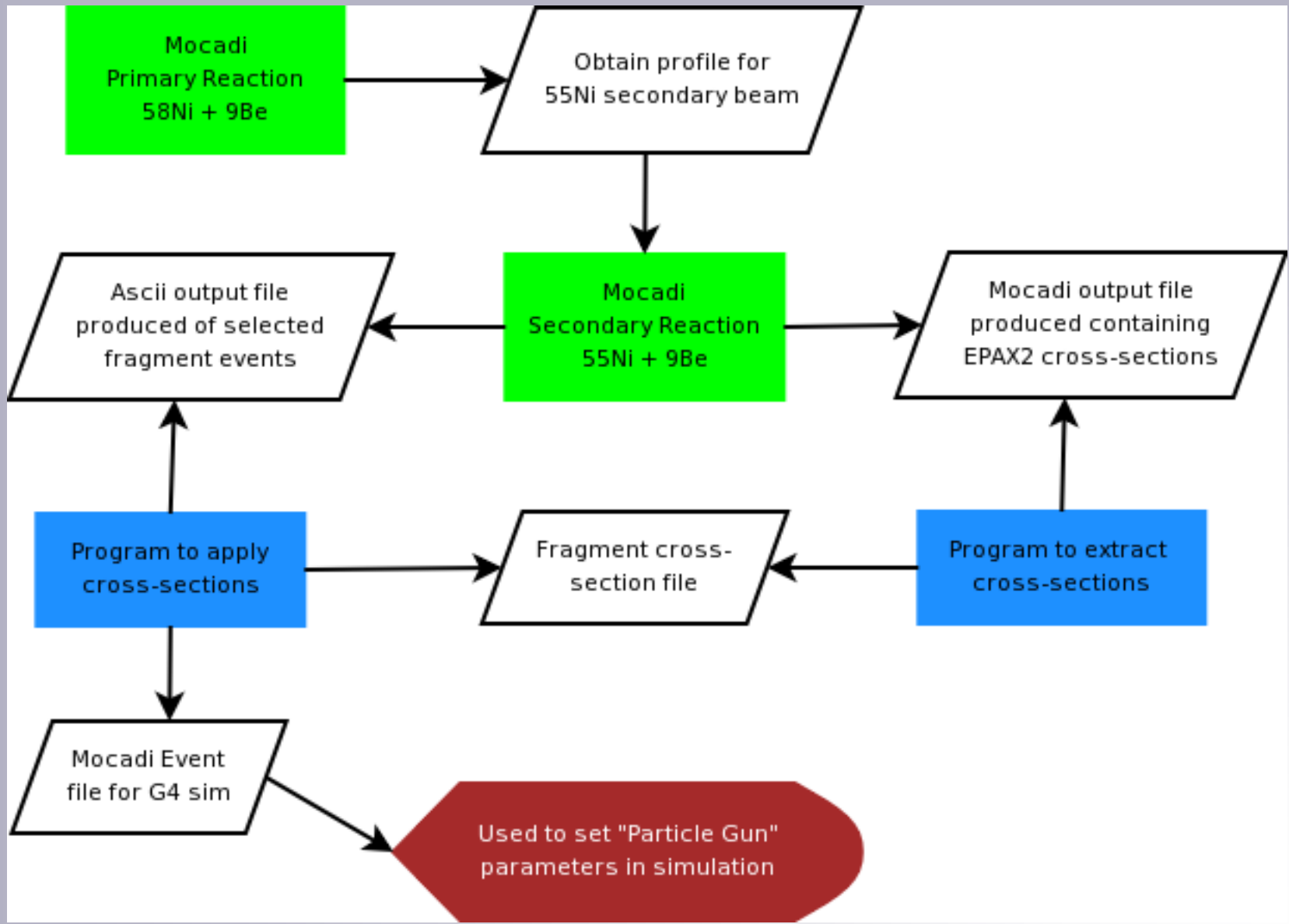


Variables outputted

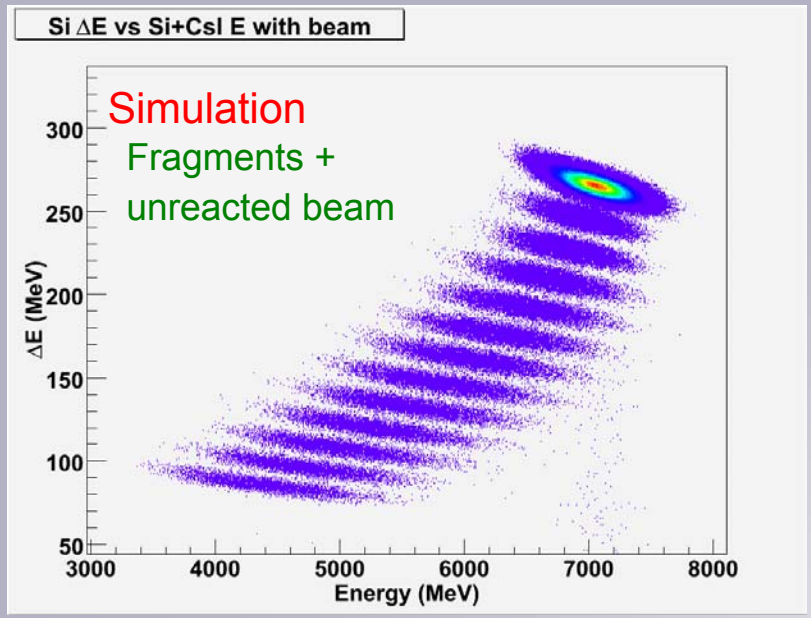
1. Fragment number
2. X-position (cm)
3. X angle (mrad)
4. Y-position (cm)
5. Y angle (mrad)
6. Energy (AMeV)
7. Time (ps)
8. Mass (amu)
9. Z
10. Charge state

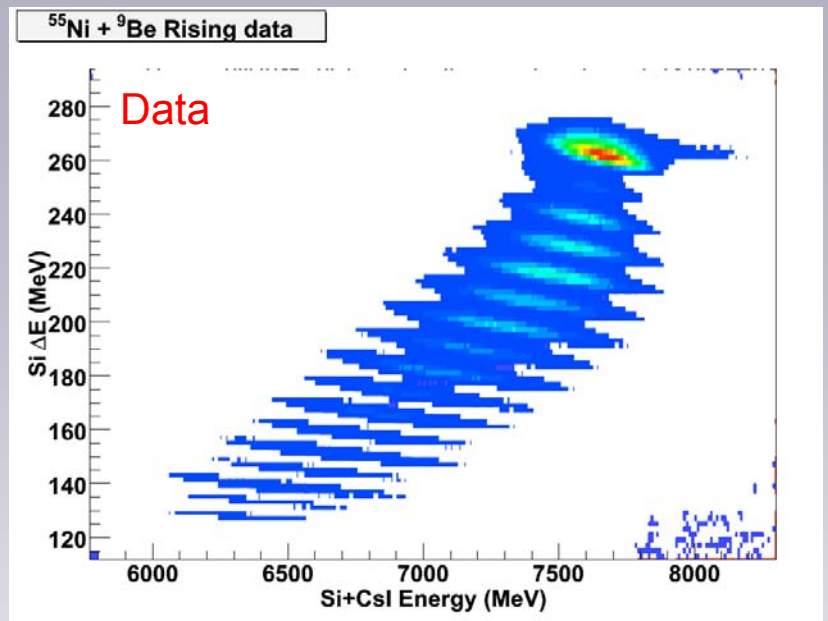
Generation of Simulation Event File

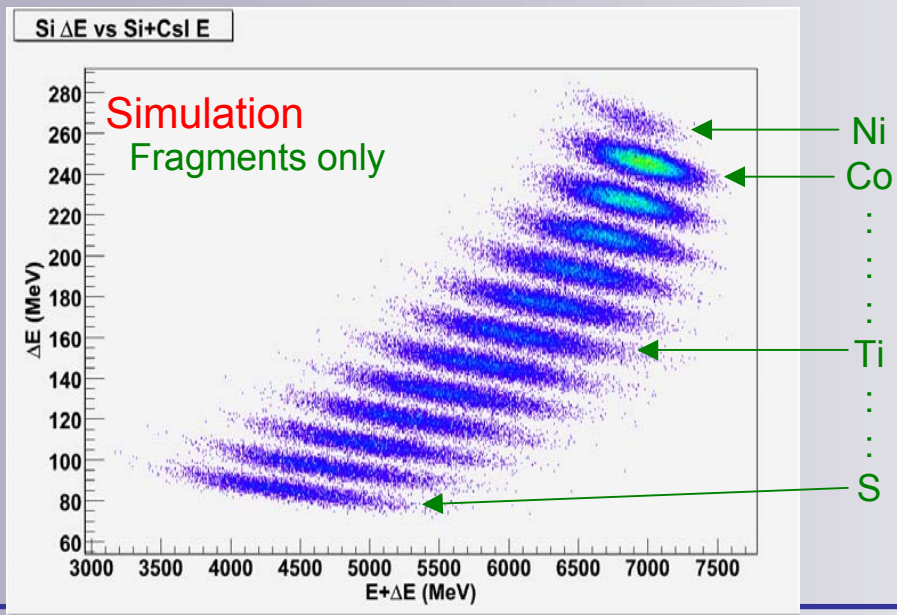
(M. Taylor, University of York)



Fragment Identification From Energy Signals (M. Taylor, York University)







- 175 MeV/u ^{55}Ni beam
  130000 primary events
- 700 mg/cm^2 ^{9}Be target
- 91 fragments produced
  with cross-sections > 10^{-2} mb
  (Z range: Ni – S)
- Tgt-Si distance 2.02m

Event generators for all key experiments

How can we make a unique and efficient event generator for any experiments ?

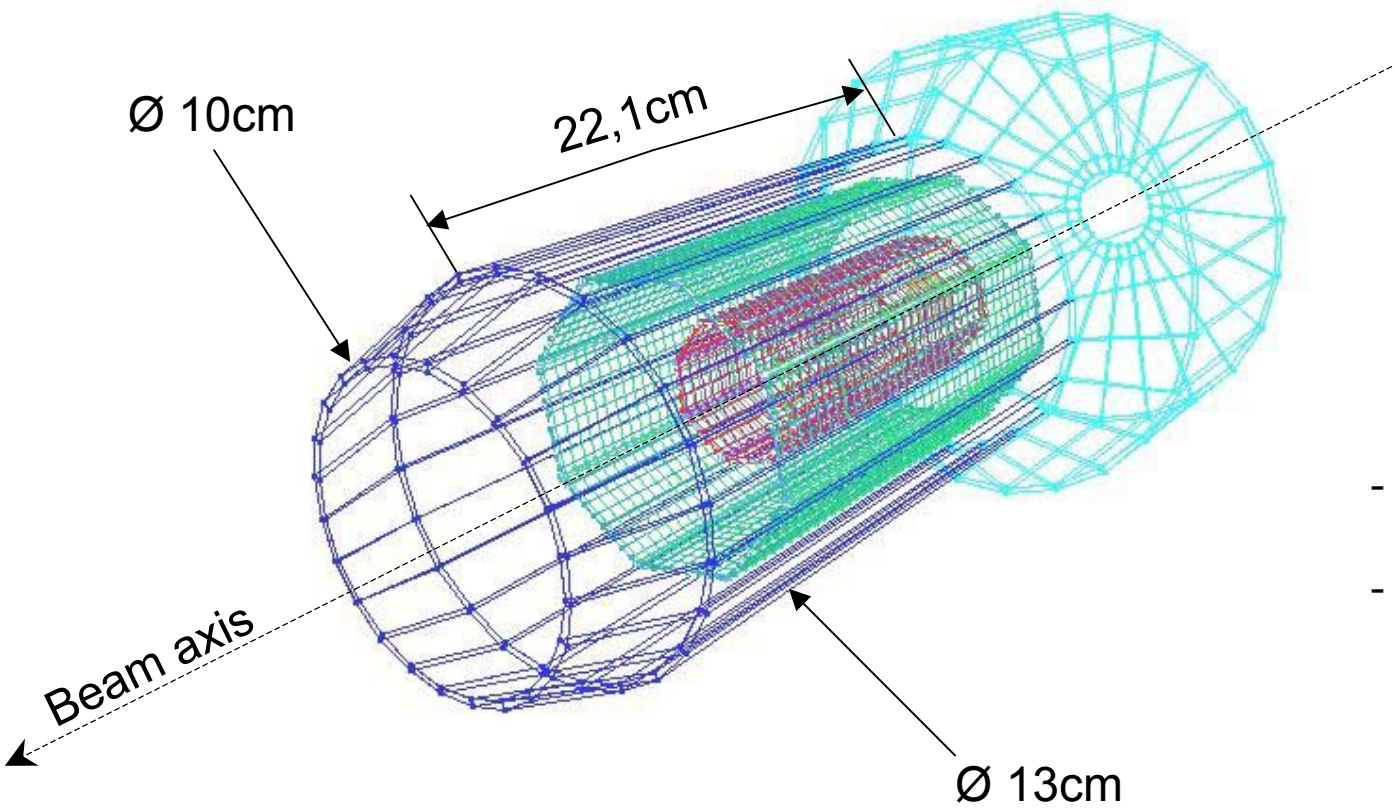
- an event generator on the fly ?

- an input file of events which would give T,θ, φ of all the products of a given reaction and which would reflect the cross section ? (M. Taylor)

- Include Beam characteristics ?

- Include background ?

Vacuum chamber for the target recoil Si Detectors in the R3BSim code



- Material: Aluminium
- Thickness: 2.5 mm

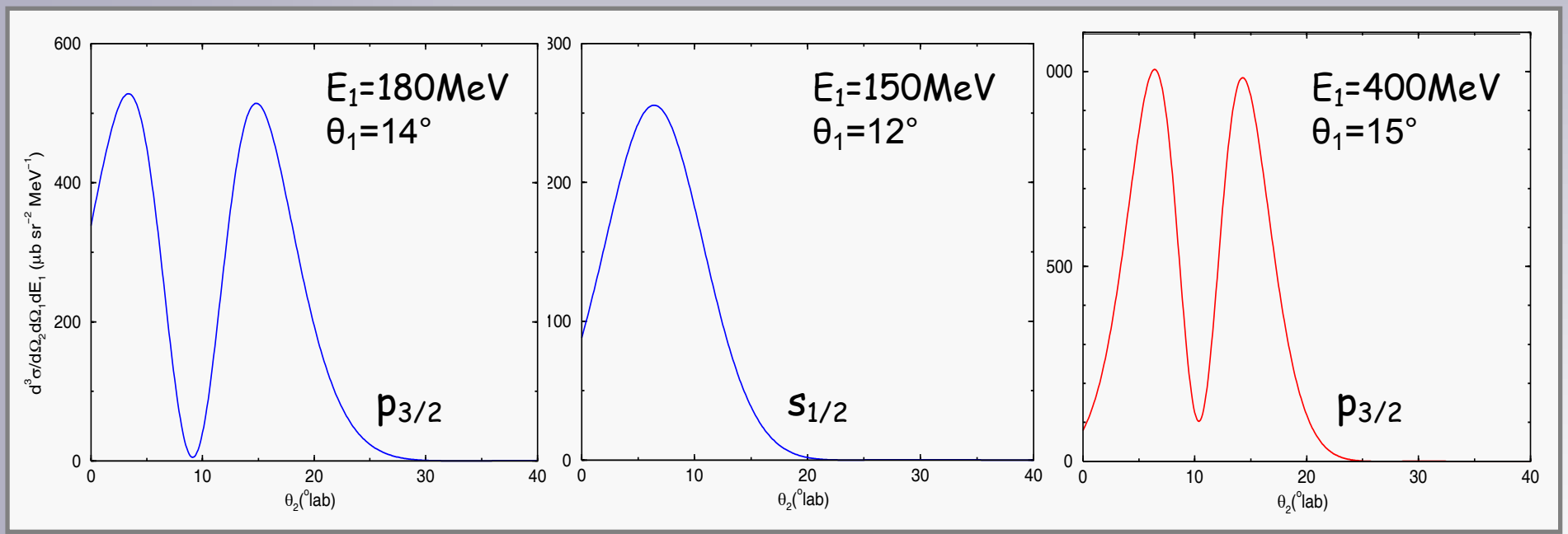
By Jerome Bettarel

PWBA Calculations in Inverse kinematics

C.E. Carter, University of Surrey

@ 150MeV/u

@ 300MeV/u



- cross sections are at forward angles
- $p_{3/2}$ state contributes more to σ_{tot} than $s_{1/2}$ state
- angular correlation is narrower for higher E_0