ALICE Public Data and Outreach

- Masterclasses in particle physics : concept + history
- Measurement : Looking for strange particles in ALICE
  -Visual analysis of small number of events (+ the data)
  -Large statistics analysis in centrality regions for Pb-Pb (+ the data)
- Measurement : R_{AA} – Nuclear Modification Factor
  -Visual analysis / Large scale analysis / data

ALICE

Hands on Particle Physics – International Masterclasses

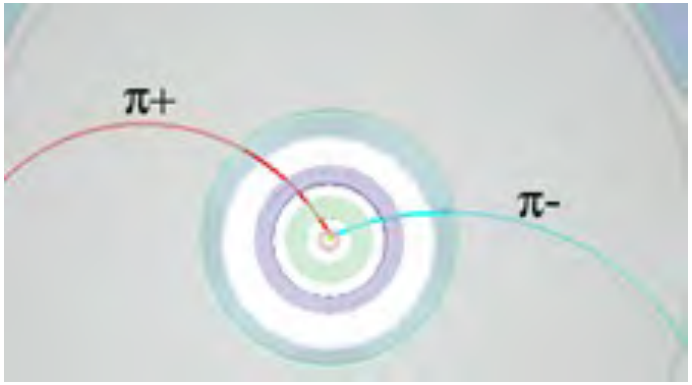
1996: Started in UK
2005: Adopted by EPPOG for all Europe
Use LEP data : OPAL Identifying Particles and DELPHI Hands on CERN
Z0 decays / calculation of branching ratios
2006: U.S. joined program
2010: preparing to move to LHC-based Masterclasses
2011:Use LHC data only

ATLAS W+W- (MINEVA) structure of the proton
ATLAS Z0 (HYPATIA) mass, width (+Z' from MC + Higgs)
CMS J/Ψ / W/Z
ALICE Looking for strange particles (V0 and cascade decays)
ALICE R_{AA}(Nuclear Modification Factor)

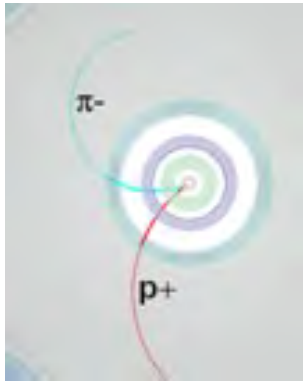
Centrally organised by TU Dresden (Uta Bilow, Michael Kobel)
Taking place 25.2. - 22.3.2013 in 160 Institutes, 37 countries, 10 000 students

http://physicsmasterclasses.org/

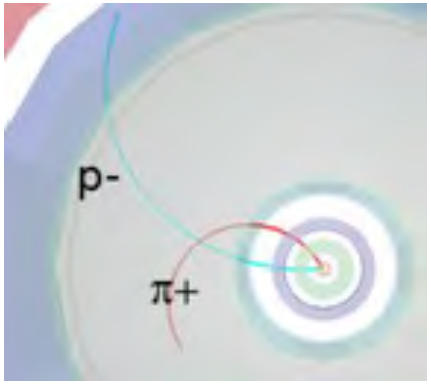
V0 decays of strange hadrons (K^0_s, Λ, anti-Λ)



$K^0_s \rightarrow \pi^+\pi^-$



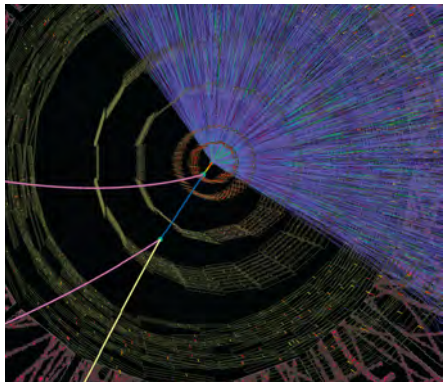
$\Lambda \rightarrow \pi^- p$



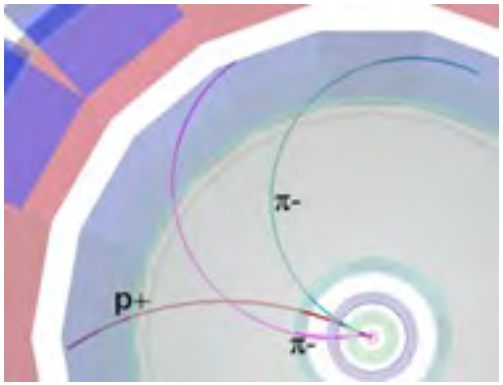
anti-$\Lambda \rightarrow p^-\pi^+$

Two opposite tracks from a secondary vertex

Cascade decays



$\Xi^- \rightarrow \pi^-\Lambda \rightarrow \pi^- p \pi^-$



A single track and two opposite tracks from a secondary vertex

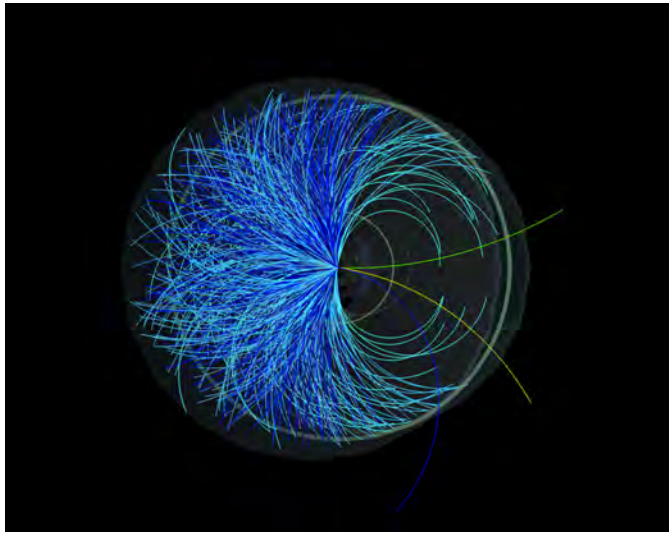
V0 decays of strange hadrons (K^0_s, Λ, anti-Λ)

the tools

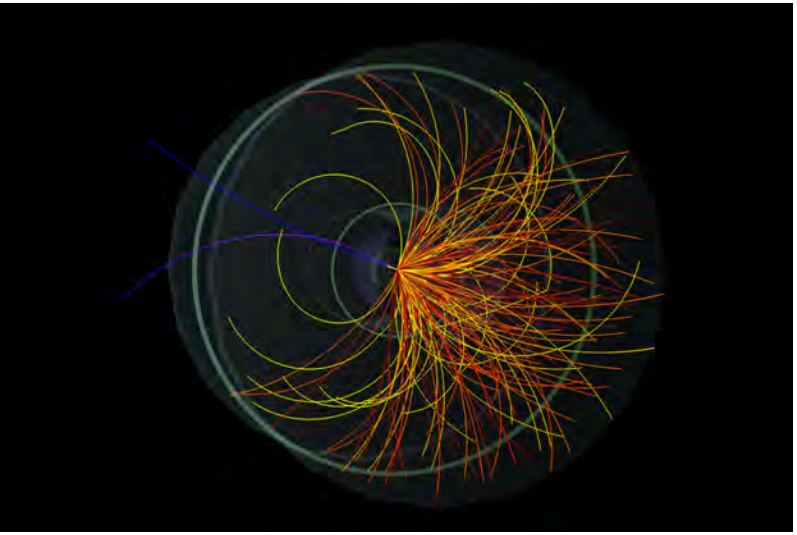
- Simplified ALICE event display based on ROOT
- Histograms, fitting etc : done with ROOT

the method

- Visual analysis of some events (~15)
- Analysis of large-statistics dataset (some thousands)



$K^0_s \rightarrow \pi^+\pi^-$



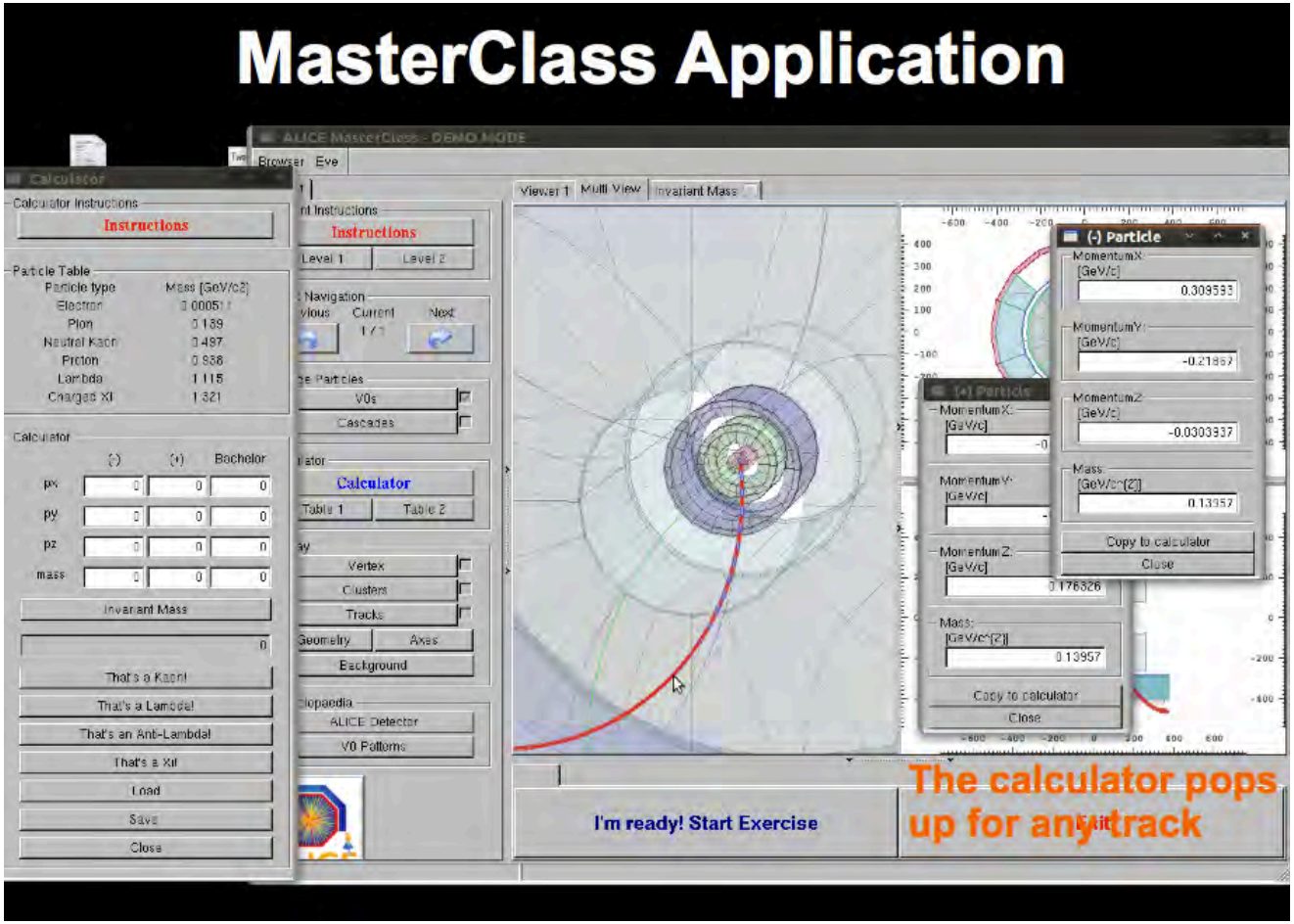
$\Lambda \rightarrow p\pi^-$

the result

- Calculate particle yields
- Observe strangeness enhancement

(first) signature for quark gluon plasma

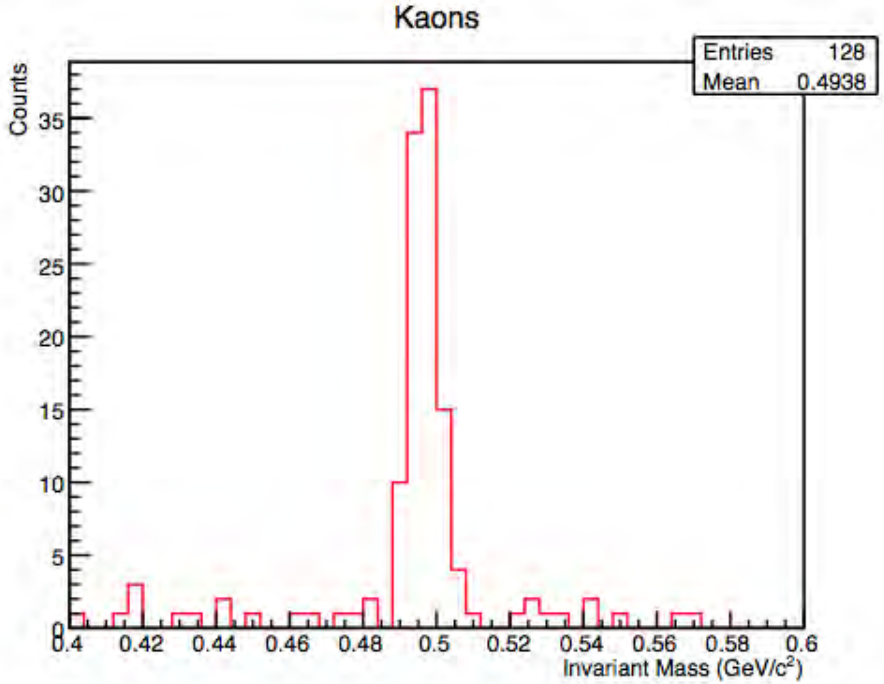
simplified ALICE event display based on ROOT

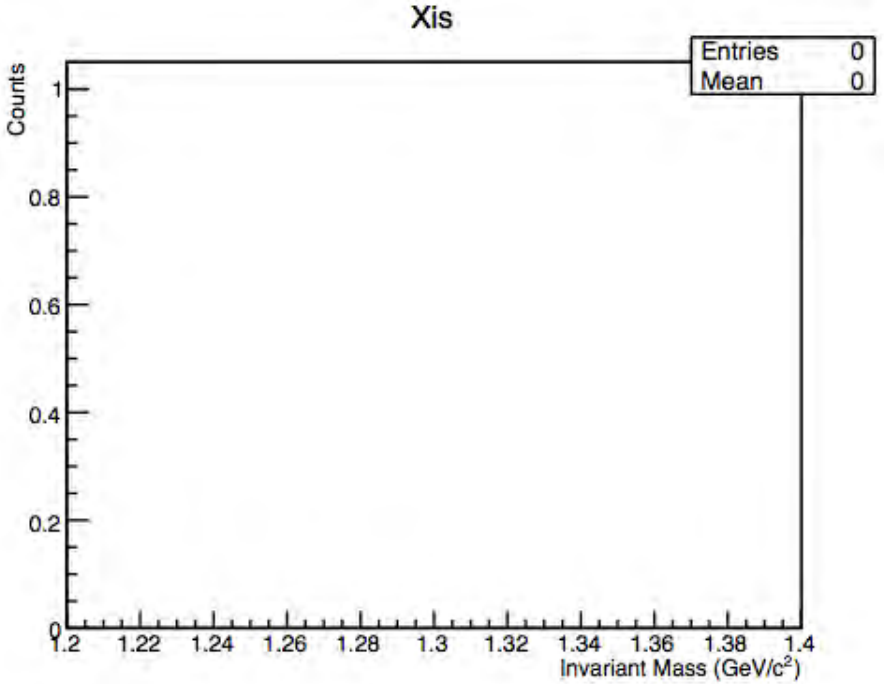


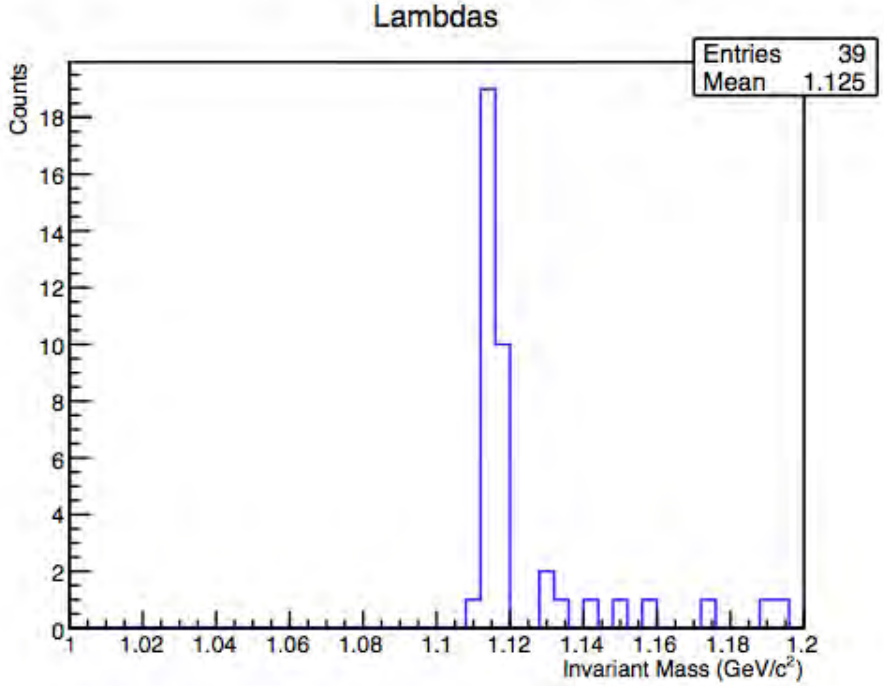
3 views of ALICE (3D, rφ, rz)
V0 finder
cascade finder
Highlights V0 (cascade)
Recognise from decay pattern
Calculate invariant mass
Classify according to mass
Fill tables
Fill histograms

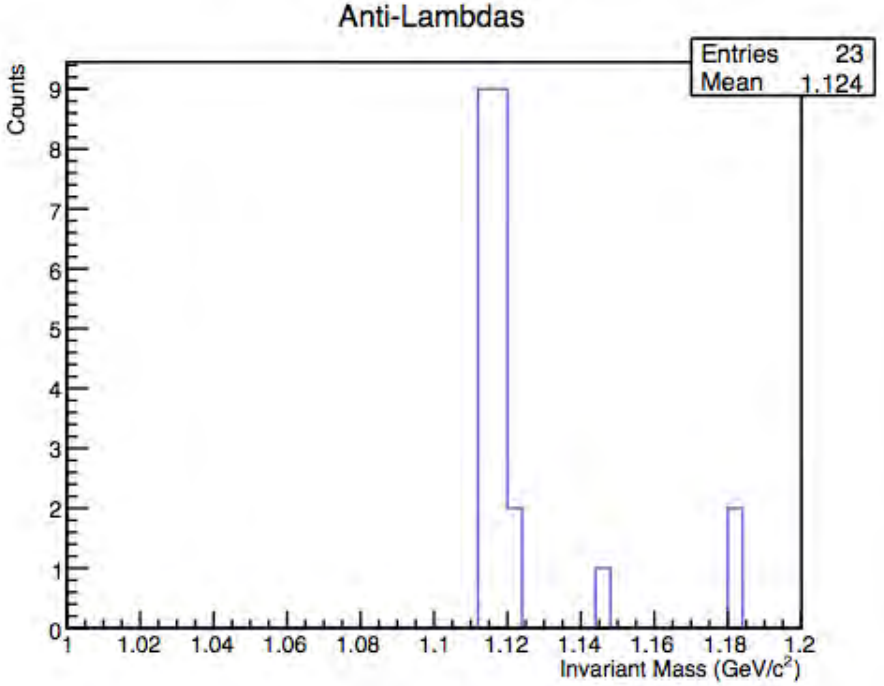
Runs on LINUX, Ubuntu, MacOSX

Developed by Pawel Debski, Matevz Tadel,Yiota Foka, DH, Antonin Maire and Boris Hipolyte
http://aliceinfo.cern.ch/public/MasterCL/MasterClassWebpage.html


Kaons
Entries 128
Mean 0.4938
Counts
Invariant Mass (GeV/c²)


Xis
Entries 0
Mean 0
Counts
Invariant Mass (GeV/c²)

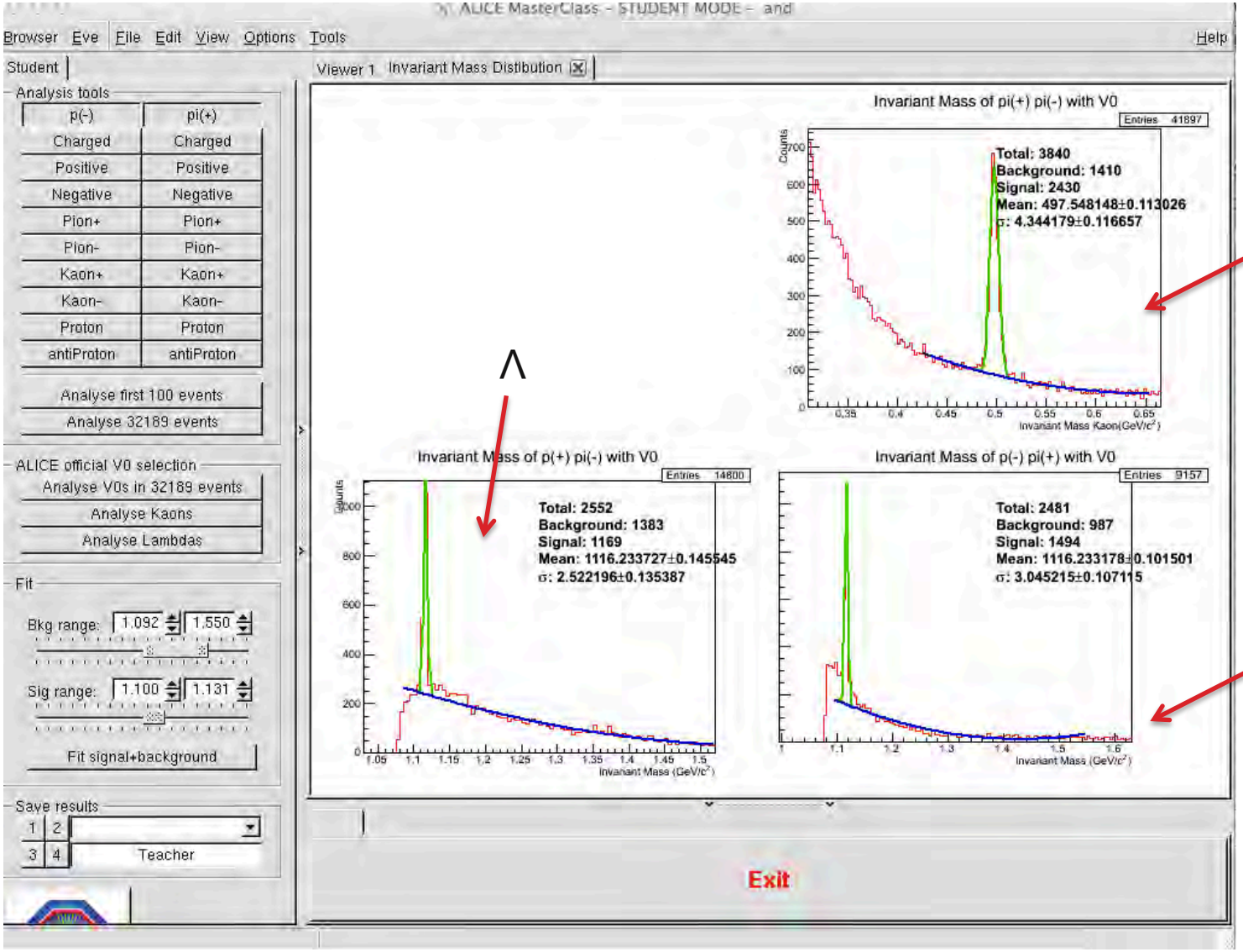

Lambdas
Entries 39
Mean 1.125
Counts
Invariant Mass (GeV/c²)


Anti-Lambdas
Entries 23
Mean 1.124
Counts
Invariant Mass (GeV/c²)

ALICE data used for visual analysis

- Specially selected datasets, containing V0s (K0s, Λ, anti-Λ)
- (V0 : two tracks with opposite charge, coming from a common secondary vertex)
- Cuts in the value of the invariant mass (within a window around the particle mass)
- 2011 : 10 datasets containing 100 events each (from 900 GeV proton collisions)
- 2012 : 10 datasets containing 30 events each (from 7 TeV proton collisions)
  1 dataset containing 4 events (from 2.76 TeV per nucleon pair lead collisions)
- 2013 : 18 datasets containing 15 events each (from 7 TeV proton collisions)
  1 dataset containing 4 events (from 2.76 TeV per nucleon pair lead collisions)

- ROOT files containing selected information from each event
- TRACKS (momentum components, associated particle ID, angles, vertex)
- V0s (information on V0 tracks, as above)



K_s

$\bar{\Lambda}$

ALICE data used for this part of the measurement*

- Specially selected datasets, containing V0s (K0s, Λ, anti-Λ)
- (V0 : two tracks with opposite charge, coming from a common secondary vertex)
- No cuts on mass – include combinatorial background

2013 : 1 dataset with 15000 events (from 7 TeV proton collisions)

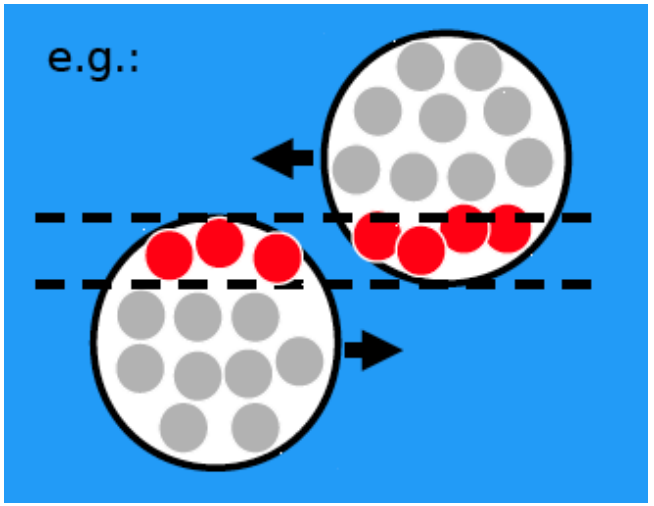
1 dataset with 32000 events (from 2.76 TeV per nucleon pair lead collisions)

- ROOT files containing selected information from each event
- (momentum components, associated particle ID, angles, vertex))
- V0s (information on V0 tracks, as above)

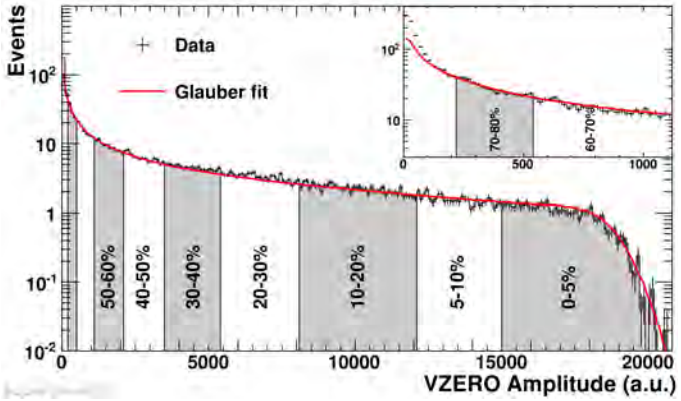
Fit curves to background (2^{nd} degree polynomial) and peak (gaussian)
Find number of K_s, Λ, anti-Λ after background subtraction

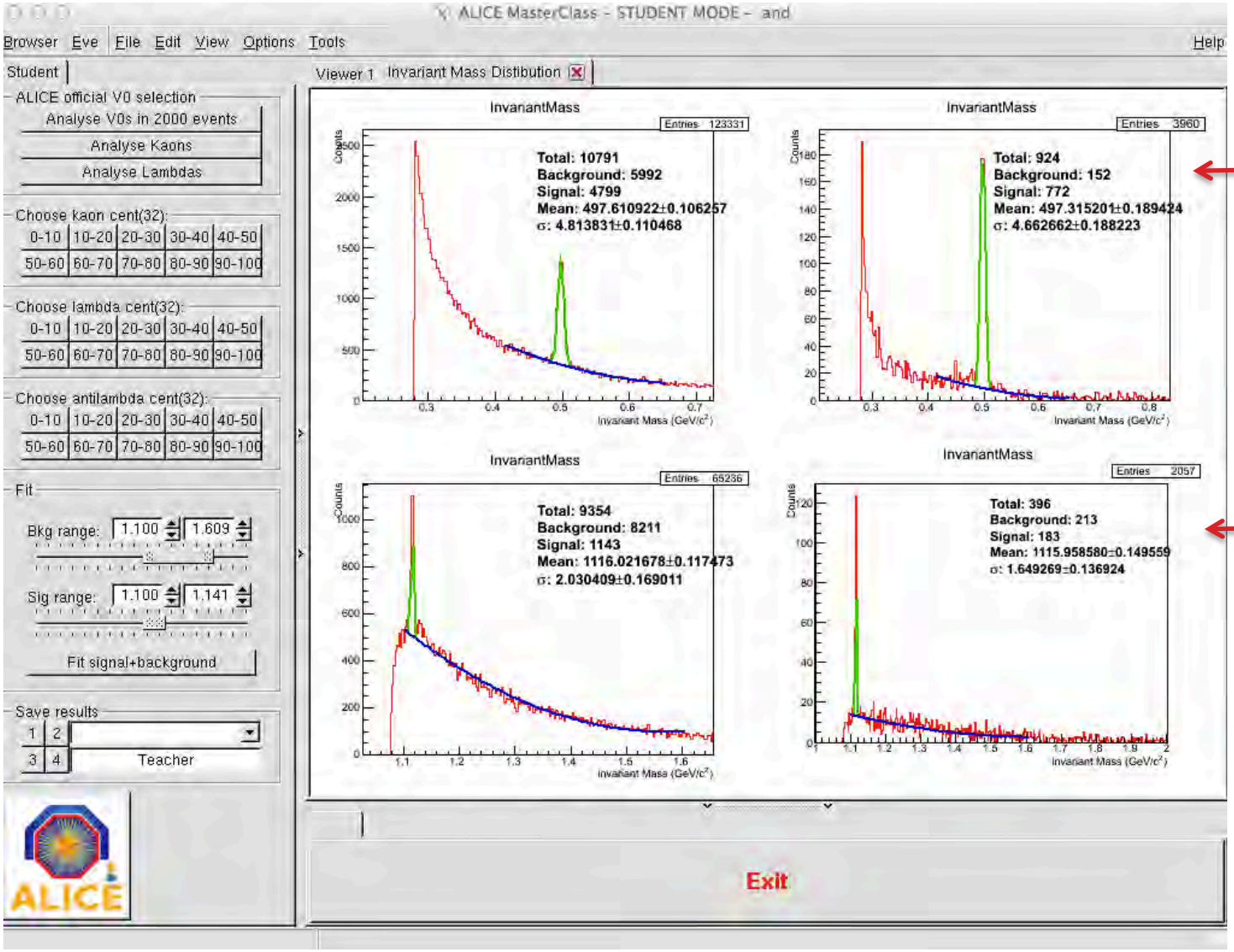
Analysis in centrality regions

- Lead collisions can be very different depending on the collision geometry
- Impact parameter – centrality – number of participants
- Number of K_s, Λ, anti-Λ after background subtraction in different centrality bins for Pb-Pb collision data



Centrality	$dN_{ch}/d\eta$	$\langle N_{part}\rangle$	$(dN_{ch}/d\eta)/(\langle N_{part}\rangle/2)$
0%–5%	1601 ± 60	382.8 ± 3.1	8.4 ± 0.3
5%–10%	1294 ± 49	329.7 ± 4.6	7.9 ± 0.3
10%–20%	966 ± 37	260.5 ± 4.4	7.4 ± 0.3
20%–30%	649 ± 23	186.4 ± 3.9	7.0 ± 0.3
30%–40%	426 ± 15	128.9 ± 3.3	6.6 ± 0.3
40%–50%	261 ± 9	85.0 ± 2.6	6.1 ± 0.3
50%–60%	149 ± 6	52.8 ± 2.0	5.7 ± 0.3
60%–70%	76 ± 4	30.0 ± 1.3	5.1 ± 0.3
70%–80%	35 ± 2	15.8 ± 0.6	4.4 ± 0.4





K_s

Left: 0-10% centrality

Right : 50-60% Centrality

Λ

Left: 0-10% centrality

Right : 50-60% Centrality

ALICE data used for this part of the measurement

- From some thousands of PbPb collisions at 2.76 TeV per nucleon pair, the data have been split in centrality regions and, using the V0 finder, V0s have been found

  (V0 : two tracks with opposite charge, coming from a common secondary vertex)
- For these V0s the invariant mass has been calculated
- The datasets used for this part of the exercise are **ascii files**, with the values of the **V0 invariant mass** (separate files for K^0_s, Λ, anti Λ, according to the ID of the decay products)

- 10 datasets containing K0s (centrality : 0-10%, 10-20%, 20-30,…90-100%)
- 10 datasets containing Λ (centrality : 0-10%, 10-20%, 20-30,…90-100%)
- 10 datasets containing antiΛ (centrality : 0-10%, 10-20%, 20-30),…90-100%)

Status and future

- Looking for strange particles in ALICE one of the “measurements” for the International Masterclasses – Hands on particle physics in 2011, 2012, 2013

Also

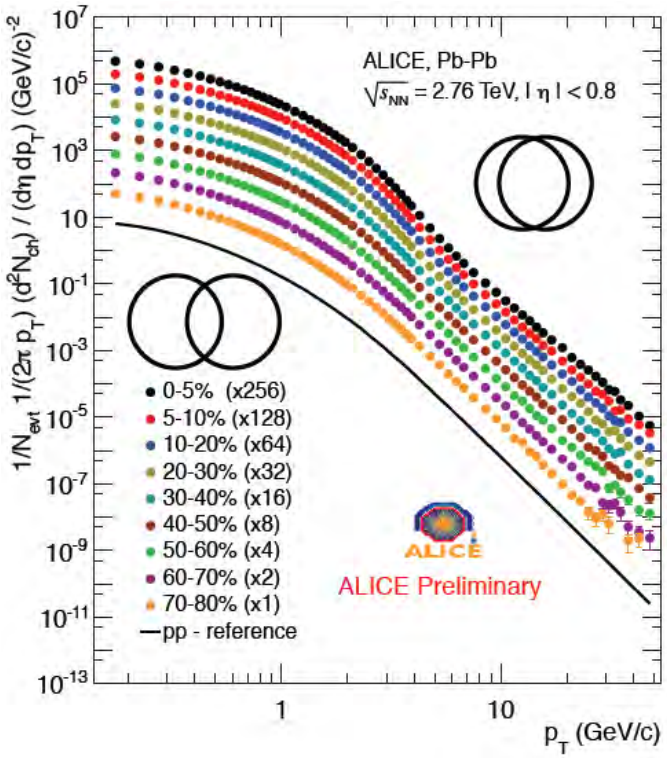
- Masterclasses pilot run (nov. 2010)
- Masterclasses to Swedish teachers (part of CERN Swedish Teachers’ Programme)
- Part of a week-long “stage” of Italian students

- Request to be independent of ROOT – for teachers to use in their school
- Thinking of making a web-based application (without ROOT), maybe using java

R_{AA} – Nuclear Modification Factor

- Pb-Pb collision ≠ many independent pp collisions
- → comparison of unidentified charged particle momentum spectra in pp and Pb-Pb collisions taking into account different collision centralities

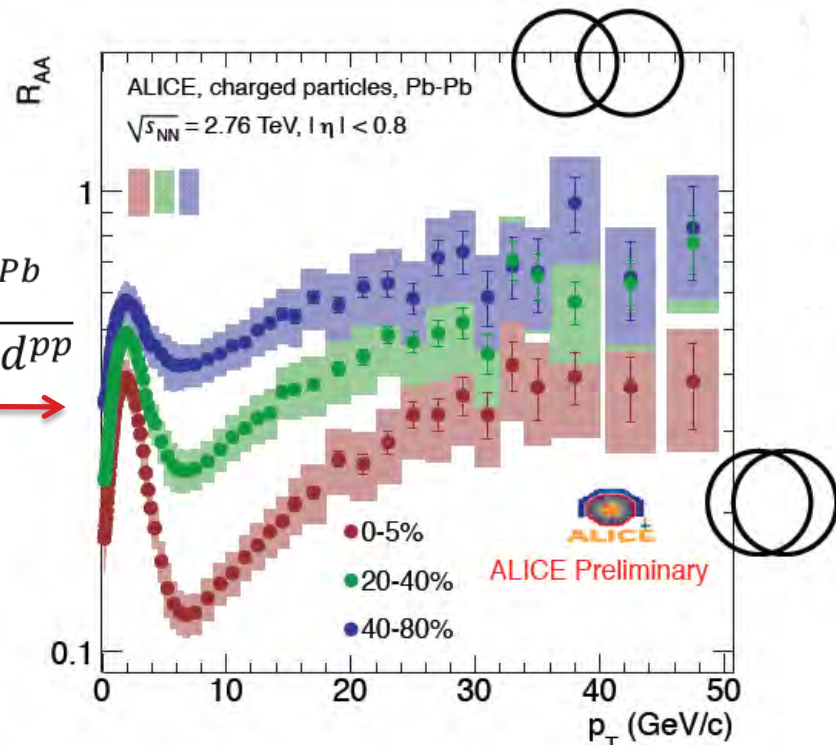
transverse momentum spectra



$$R_{AA} = \frac{yield^{Pb-Pb}}{\langle N_{coll}\rangle yield^{pp}}$$

Ralf Averbeck

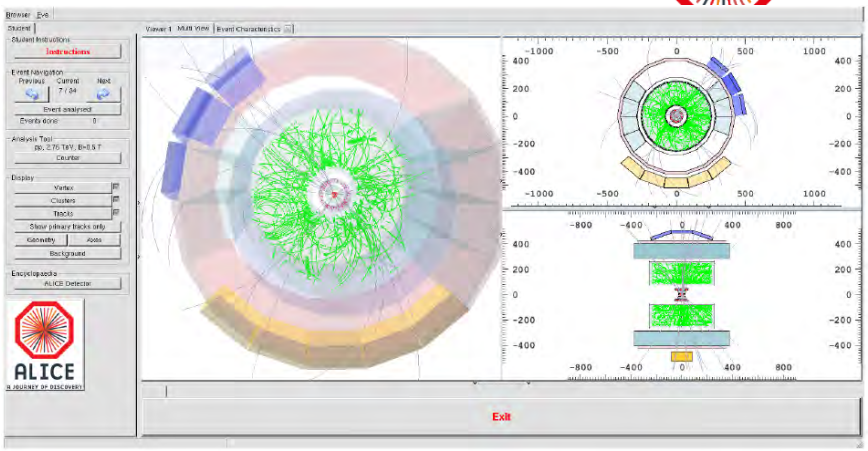
nuclear modification factor



Visual analysis

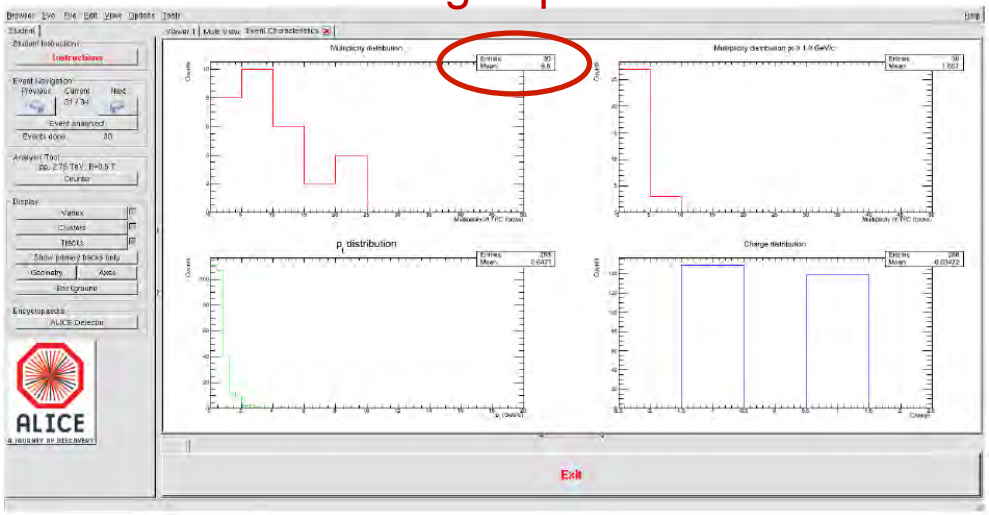
A Large Ion Collider Experiment

- tool: simplified ALICE event display
- task: count particle tracks, determine their p_T and charge



http://www-alice.gsi.de/masterclass/

mean number of charged particles



- ALICE data used
  - 10 data sets, each with
    - 1 pp event without B field
    - 30 pp events with B field
    - 1 peripheral Pb-Pb event
    - 1 mid-central Pb-Pb event
    - 1 central Pb-Pb event

→ typical result from the visual analysis of one of the data sets

Event class	Mean number of charged particles	N_{coll}	R_{AA}
pp	9.6		
PbPb (80- 90%)	15	6.32	0.41
PbPb (20- 40%)	850	438.80	0.33
PbPb (0- 5%)	2000	1686.87	0.20

Large scale analysis

- not done within event display tool!
- ROOT files with ALICE data are analyzed with simple macro
  → students edit macro to generate p_T spectra and calculate R_{AA}
- ALICE data used: 1 ROOT file containing
  - centrality and number of reconstructed tracks per event for ~120000 Pb-Pb collisions at 2.76 TeV
  - p_T of each track in these events (~38 million tracks)
- typical result of large scale analysis is close to published result