ALICE Masterclasses at GSI

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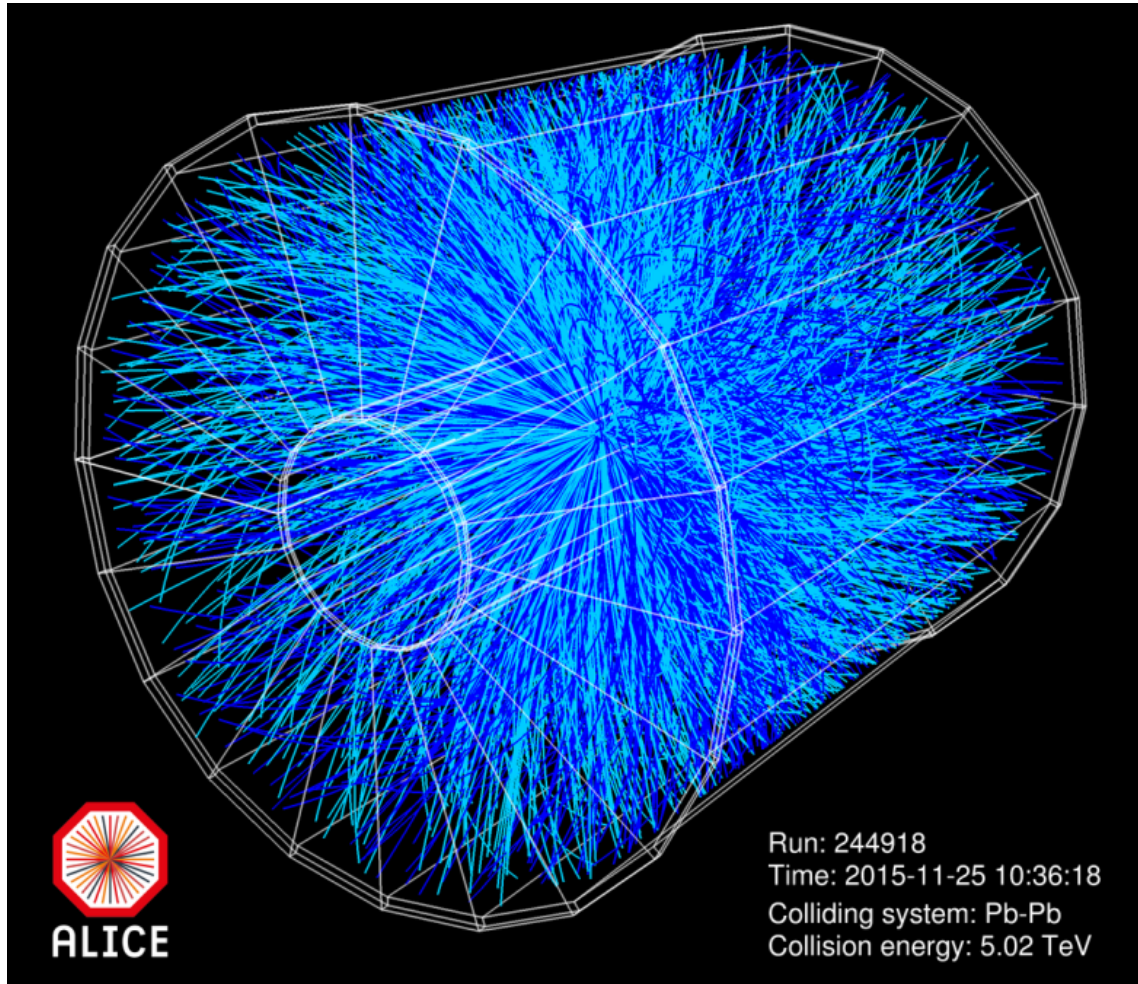
17th IPPOG Meeting

Darmstadt,

May 23, 2019

ALICE

- ## heavy-ion experiment at the LHC
  → **investigation of quark-gluon plasma properties**

- **central Pb-Pb collision with total collision energy above 1 PeV: ~3200 primary, charged particle tracks in $|\eta|<0.9$**
- **main tracking device: Time Projection Chamber**
- → **major GSI involvement**

Run: 244918
Time: 2015-11-25 10:36:18
Colliding system: Pb-Pb
Collision energy: 5.02 TeV

ALICE

Masterclasses at GSI: since 2013

- **yearly participation in the International Masterclass**
- **additional events in local schools and at GSI**
  (yesterday: Masterclass for children of FAIR/GSI employees)

- **measurement: nuclear modification factor R_{AA}**
  - **can we witness quarks/gluons loosing energy when they propagate through a QGP produced in central Pb-Pb collisions?**
   **→ current Masterclass workhorse at GSI**

Nuclear modification factor R_{AA}

- $R_{AA} = \dfrac{yield\ (Pb-Pb)}{\langle N_{coll} \rangle\ yield\ (pp)}$

  - ratio of yields of charged particles produced in Pb-Pb and pp collisions, taking into account the collision geometry

  - $R_{AA} < 1$ implies quark/gluon energy loss in the QGP

- ## measurement

  - necessary concepts:
    - charged-particle momentum
    - collision centrality
  - event-display based visual analysis
    → R_{AA} simply via counting of tracks
  - ROOT based large scale analysis
    → R_{AA} as a function of momentum and collision centrality
    → students discover jet suppression!

R_{AA} for different centralities
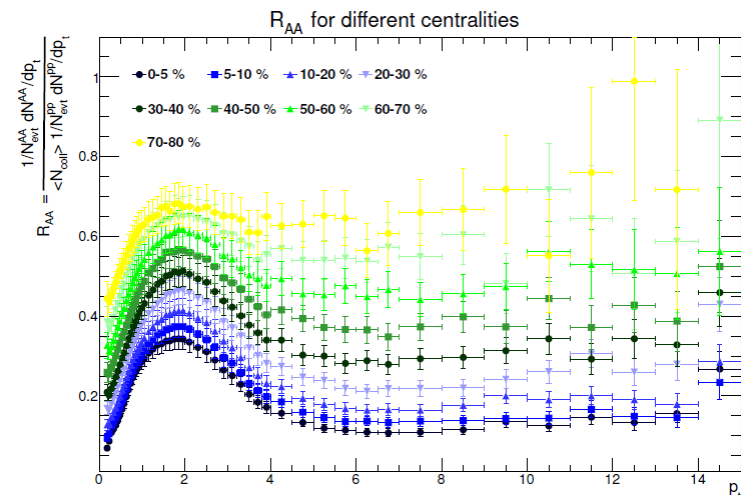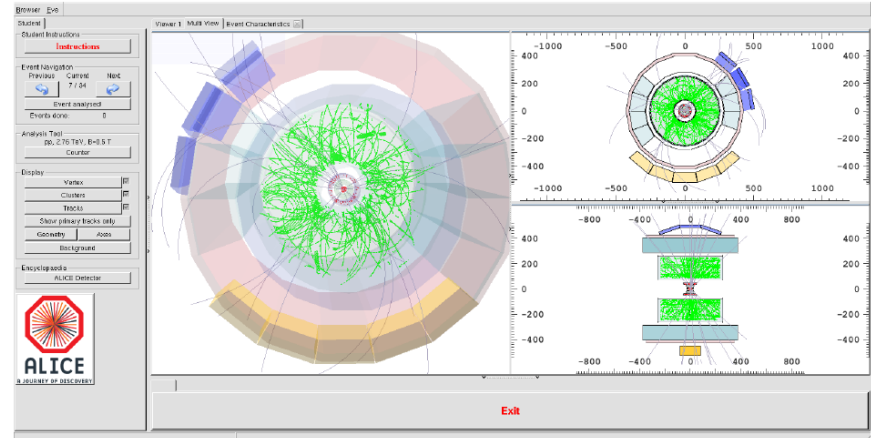
R$_{AA}$ measurement: pros & cons

- ## advantages

  - **genuine heavy-ion physics observable**
  - **no need for difficult concepts**
  - **teaches the value of collaborative work**

- ## disadvantages

  - **large-scale analysis challenging without programming experience**
  - **challenging to complete the full measurement in time**
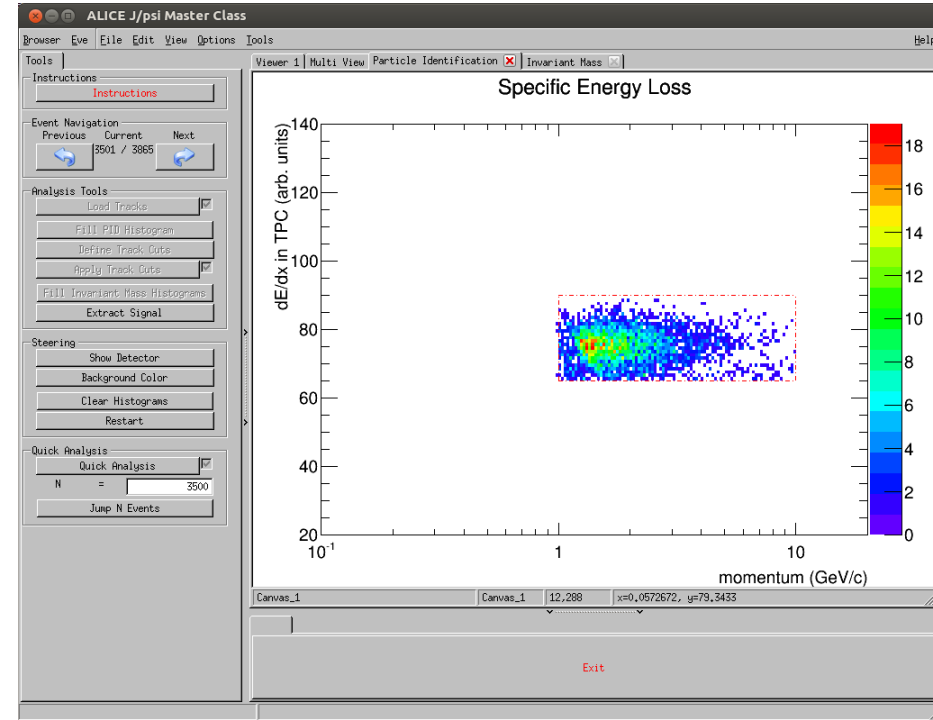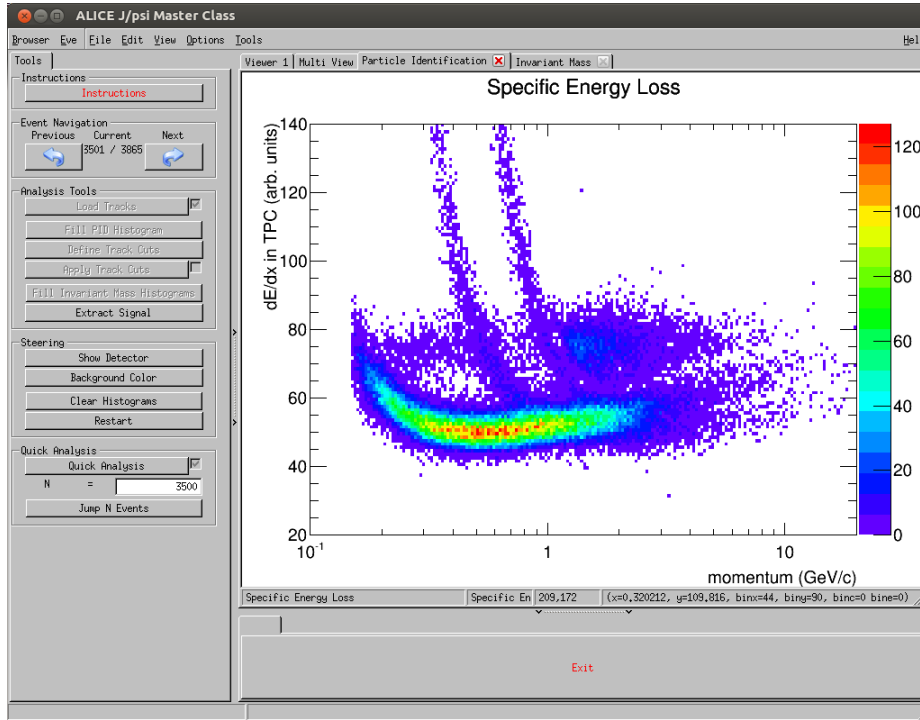 - **no use of particle identification techniques**

- ## action taken

  - **various versions developed (all work well for their purpose)**
    - **"full", "copy and paste", "demonstration" version**

- ## → development of a new ALICE Masterclass on J/ψ

  - **main emphasis: particle (electron) identification**
  - **other necessary concepts: decay, invariant mass, combinatorial background**
  - **no programming skills needed**

J/ψ Masterclass: the GUI

●inspired by R$_{AA}$ Masterclass

●**developed mainly by S. Weber (Münster)**

●**workflow**

● load charged-particle tracks

● fill PID histogram

● define PID selection

● fill inv. mass histograms

● extract J/ψ yield

J/ψ Masterclass: PID in pp

- **electron selection in dE/dx vs. p**

J/ψ Masterclass: m_{ee} in pp
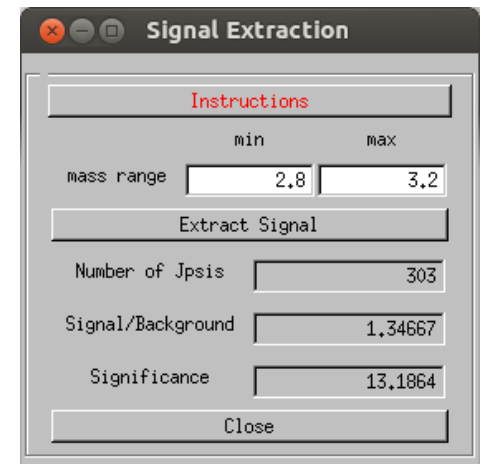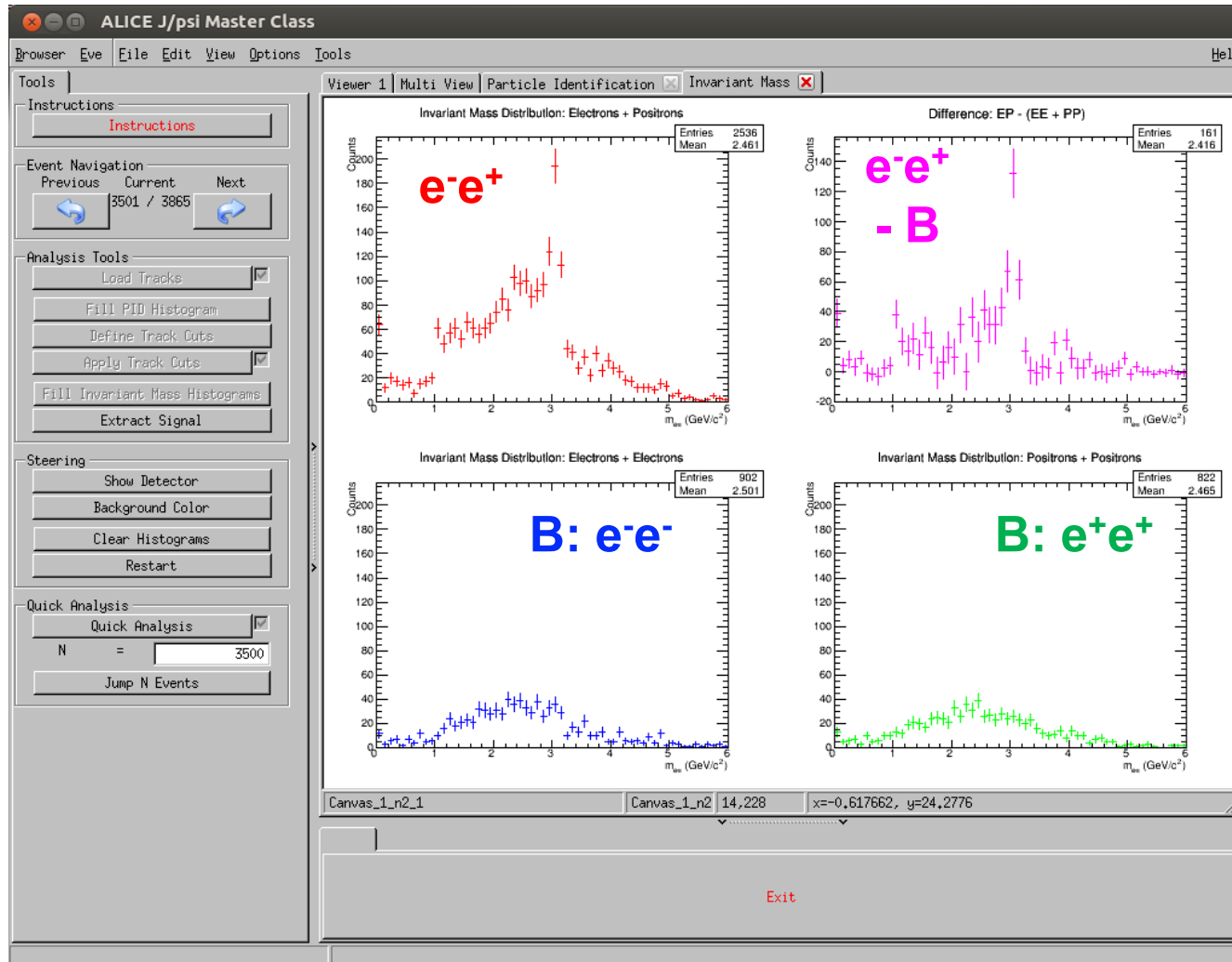
● **J/ψ signal extraction via invariant mass analysis**

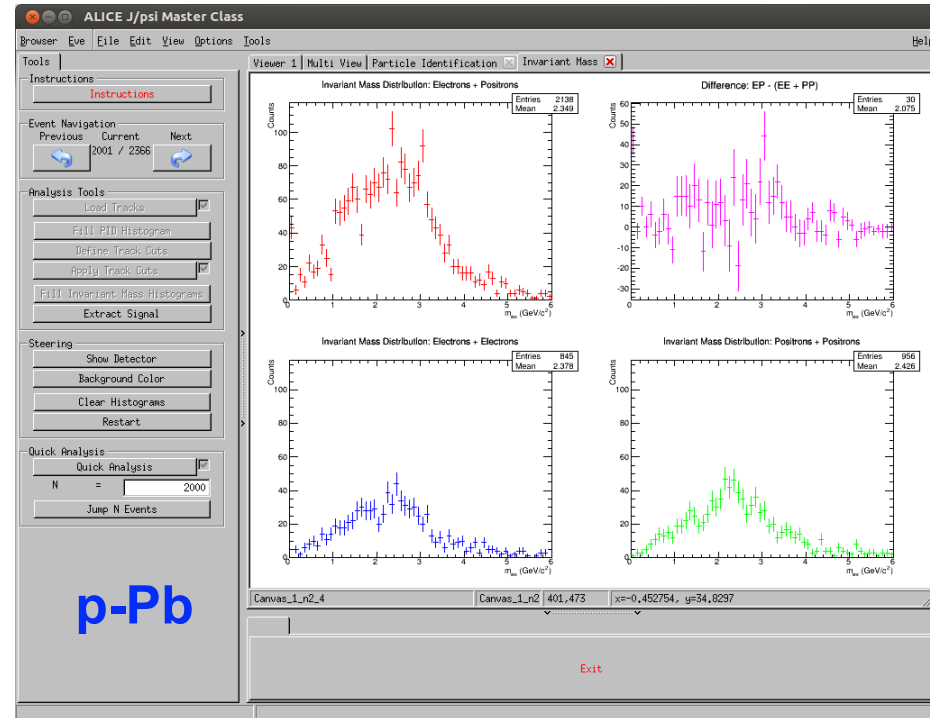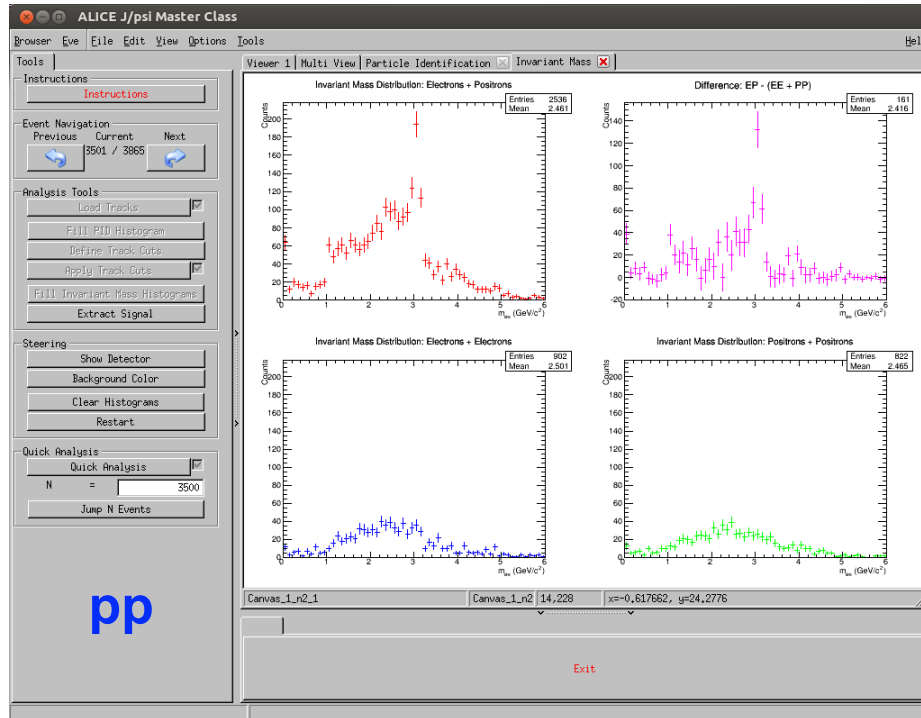● **observations**

● **signal emerges and can be quantified**

  ● **yield**

  ● **S/B**

  ● **significance**

J/ψ Masterclass: pp vs. p-Pb

● **combinatorial background grows with multiplicity**

pp

p-Pb

● **signal extraction much more challenging in larger systems**
● **going to Pb-Pb collisions to make connection with heavy-ion physics**
   ● **being discussed**

Masterclasses at GSI: next steps

● **signal extraction part of J/ψ Masterclass is ready**

➔ **will be tested in a pilot run on June 7, 2019**

- ● physics class from Eleonorenschule, Darmstadt
- ● 6 out of 22 students have experience with the ALICE R_{AA} Masterclass!

● **looking forward to further ALICE R_{AA} and also J/ψ Masterclasses in the future**