A ROOT Package for Resonance Study in ALICE

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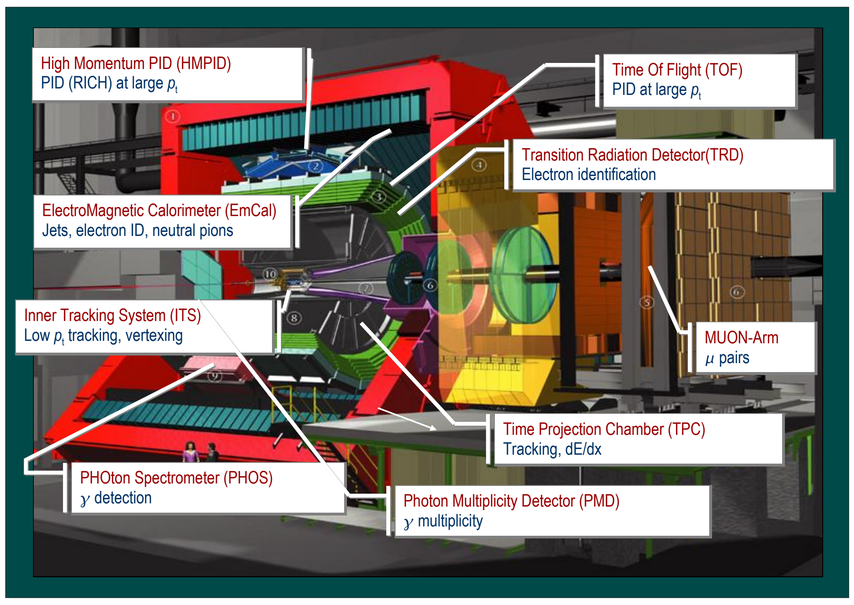
ALICE



ACCEPTANCE

- Central barrel: $|\eta| < 0.9$
  - tracking, PID
  - single arm **Ring Imaging Cherenkov** detector
  - single arm **Electromaghetic Calorimeter (PHOton Spectrometer)**
- Forward **Muon-Arm**: $2.4 < \eta < 4.0$
  - absorber, dipole magnet, tracking & trigger chambers
- Multiplicity detectors: $-5.4 < \eta < 3.0$
  - Including photon counting in a **Photon Multiplicity Detector**
- Trigger & timing detectors:
  - Zero Degree Calorimeter
  - T0: ring of quartz window PMT's
  - V0: ring of scintillation paddles

HADRONIC RESONANCES

- Resonant states of ground state particles ➞ **higher mass**
- Same quark content
- Strong decay, which implies:
  - ***short lifetime*** in the order of few fm / *c* (~fireball lifetime)
  - daughters are ***indistinguishable*** from primary particles

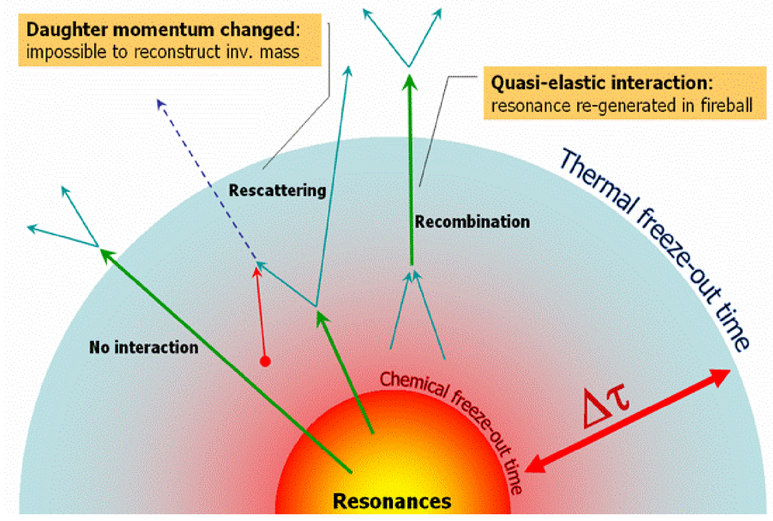
	ρ^0	$\phi(1020)^0$	$K^*(892)^0$
Mass (MeV / c^2)	770	1020	896
Lifetime (fm / *c*)	1.3	45	4
Decay channel	$\pi + \pi$	$K + K$	$K + \pi$

How QGP formation & Fireball interaction affect resonances?

Partial chiral symmetry restoration — *Interaction of the resonance and/or its daughters with fireball medium*

⇓

Modifications of properties of meson resonances (peak, FWHM)



*1) **Rescattering** of daughter particles may prevent their mother from being reconstructed: survival probability depends on the time interval between **chemical** and **kinetic** (thermal) freeze-out, source size and p_t of resonance*

*2) Pseudo-elastic collisions between particles of the same species of the resonance daughters may **regenerate** resonances.*

*Resonances may probe the **timescale** between the chemical and kinetic freeze-out*

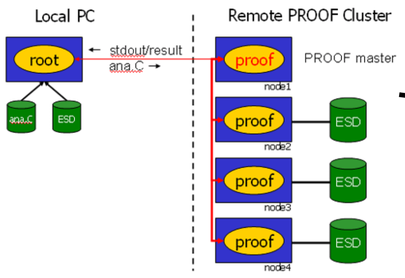
How to find a resonance?

One takes a pair of tracks which have been identified to be of the same type of the expected resonance daughters (for example, two pions for a ρ resonance).
Their 4-vector momenta are then summed, and the relativistic invariant mass of the 4-vector total is computed.
The expectation is that, if the two tracks are daughters of a given resonance, the invariant mass of their sum should be likely to lie close to the expected resonance mass, resulting in a Lorentzian-like distribution (Breit-Wigner peak) whose Full Width at Half Maximum (FWHM) is inversely proportional to the resonance lifetime (the shorter a resonance lives, the wider its peak will be).
The experimentalist objective is then to make a distribution of invariant masses of all candidate pairs of tracks in a sample of events, and obtain this invariant mass distribution.
All track pairs which don't come from a resonance will contribute to such distribution as a combinatorial background which must be subtracted from it in order to obtain a clean peak. This background can be estimated in several ways.

ALICE Analysis Framework

(see talk from A. Gheata)

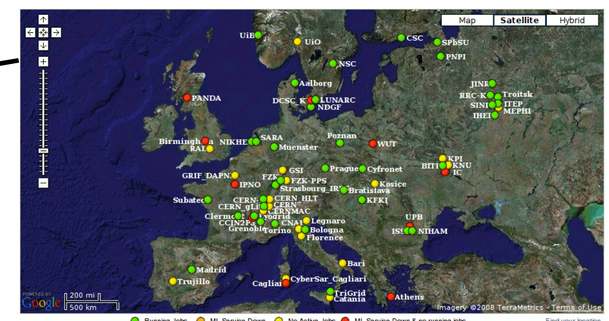
Cern Analysis Facility (CAF) with a PROOF cluster



The CERN Analysis Facility (CAF) is a cluster at CERN running PROOF. It can be used for prompt analysis of pp data as well as selected PbPb data. Furthermore calibration programs can be run on the CAF.
PROOF (Parallel ROOT Facility) allows interactive parallel analysis on a local cluster. Interactive means that one sees the results right away (contrary to a batch job where you have to wait for the job to finish before you see the results). Parallel means that several nodes execute sub sets of whole data at the same time.
It is possible to connect to a PROOF system from usual ROOT prompt, which grant a completely transparent access to it, making it possible to run exactly the same analysis both locally or on the PROOF cluster of computers.

AliAnalysisTask
General implementation of an analysis job.
Adapts the job execution to the used environment, with a unique interface to the user.

AliEn environment: ALICE interface to the GRID



AliEn is a lightweight Grid framework built around Open Source components using the combination of Web Service and distributed agent model. It is being developed by the ALICE collaboration as a production environment for the simulation, reconstruction and analysis of physics data.

Package structure

SOURCE DATA FROM SIMULATION OR DATA-TAKING

AliRsnReader
Convert source data in ALICE standard formats into the internal types used for resonance analysis

AliRsnEvent
Internal object which contains informations on a single analyzed event (list of tracks, multiplicity, primary vertex)

AliRsnEventBuffer
Buffer to store multiple events for event-mixing

AliRsnDaughter
Internal object which contains information on a single event track (momentum, DCA vertex, PID)

DATA CONVERSION

Dedicated AliAnalysisTask

OUTPUT HISTOGRAMS

AliRsnFunction
A specific kind of computation which produces a histogram (inv. mass, resolution, distributions)

AliRsnPair
Analysis engine for a given pair of particle types

AliRsnCutMgr
Collection of all cuts for an analysis

AliRsnHistoDef
Defines binning and edges of output histogram returned by a function (AliRsnFunction)

AliRsnPairDef
Defines the pair of particle types to be analyzed by means of the PID and charge.

AliRsnCutSet
Combination of cuts with all logical operators [AND (&), OR (|), NOT (!)]

AliRsnCut
A single analysis cut on tracks/events/pairs

DATA ANALYSIS

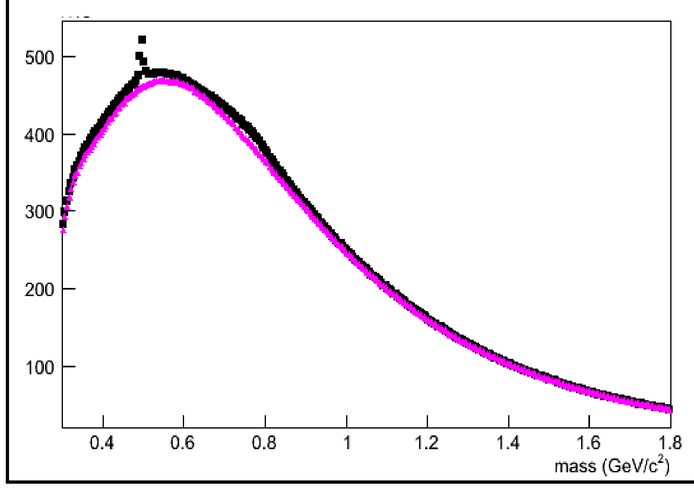
Analysis test on 5000 events with ~2500 tracks each

Created histograms:
1 signal histogram (K^+K^- pairs)
1 background histogram (K^+K^+ + K^-K^- pairs)

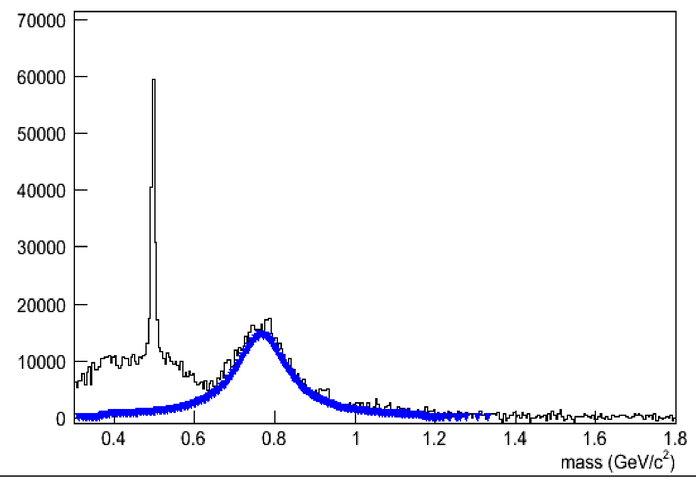
RAM occupance:
250 MB with 5000 events in buffer

CPU time:
6 minutes

SIGNAL & BACKGROUND



Signal – Background ⟶ PEAK



Web references:

Package presentations at the ALICE PWG2 meetings:
http://indico.cern.ch/getFile.py/access?contribId=4&resId=1&materialId=0&confId=24908
http://indico.cern.ch/getFile.py/access?contribId=4&resId=1&materialId=slides&confId=24908

CERN Twiki pages:
http://twiki.cern.ch/ALICE/PWG2Resonances