Resonance production in jets

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A few numbers

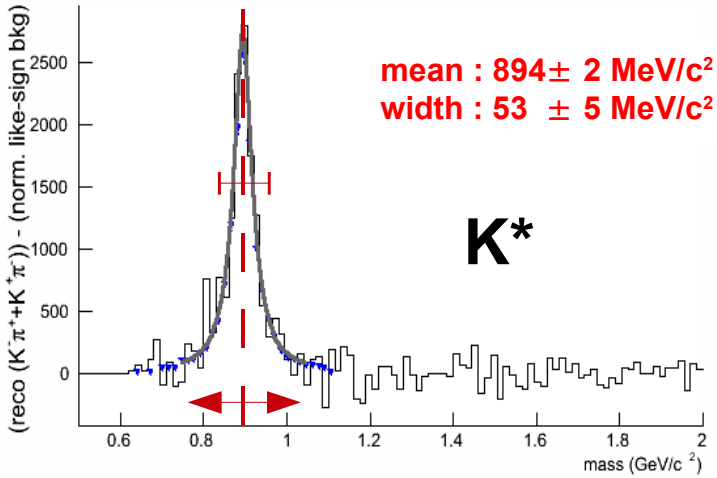
- LHC : factor 30 in $\sqrt{s_{NN}}$ with respect to RHIC

Collision Parameter	SPS	RHIC	LHC
$\sqrt{s_{NN}}$ (GeV)	17	200	5500
ϵ (GeV/fm^3)	2.5	0.8	0.375
Initial T (MeV)	200	300	> 600
Freeze-out volume (fm^3)	$\sim 10^3$	$\sim 10^4$	$\sim 10^5$
Life time (fm/c)	≤ 1	0.375	$\sim 10 - 15$
$dN_{ch}/d\eta$	500	850	2500

- Hotter, bigger, longer-living QGP
- Chiral symmetry restoration ?

Chiral symmetry restoration

- Complicated matter
  - We don't discuss that now
- Should have an effect on particle properties
- Resonances
  - Short life-time
  - Decay in the fireball
  - Expected spectral shapes modification if symmetry restored
    - Mass, width

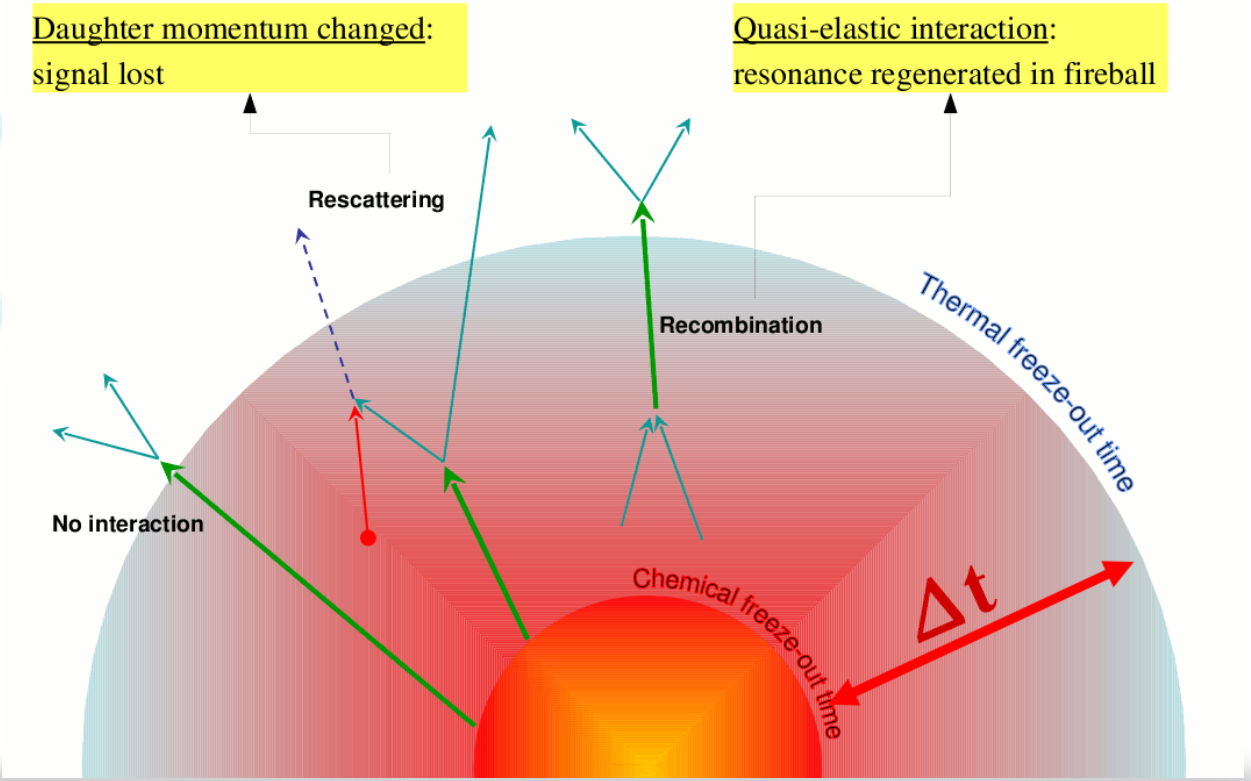


- We should be able to detect these effects with a good trajectography-based detector (STAR, ALICE...)

Life of a resonance

- Very sensitive to late hadronic medium
- Re-scatters and re-generates

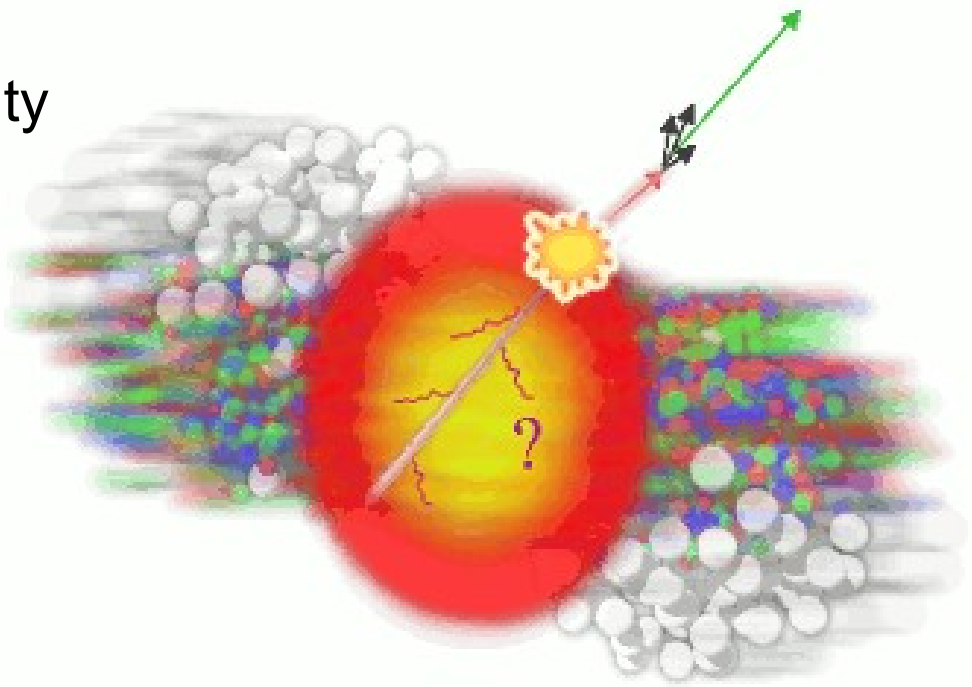
Spectral modification detection isn't an easy task



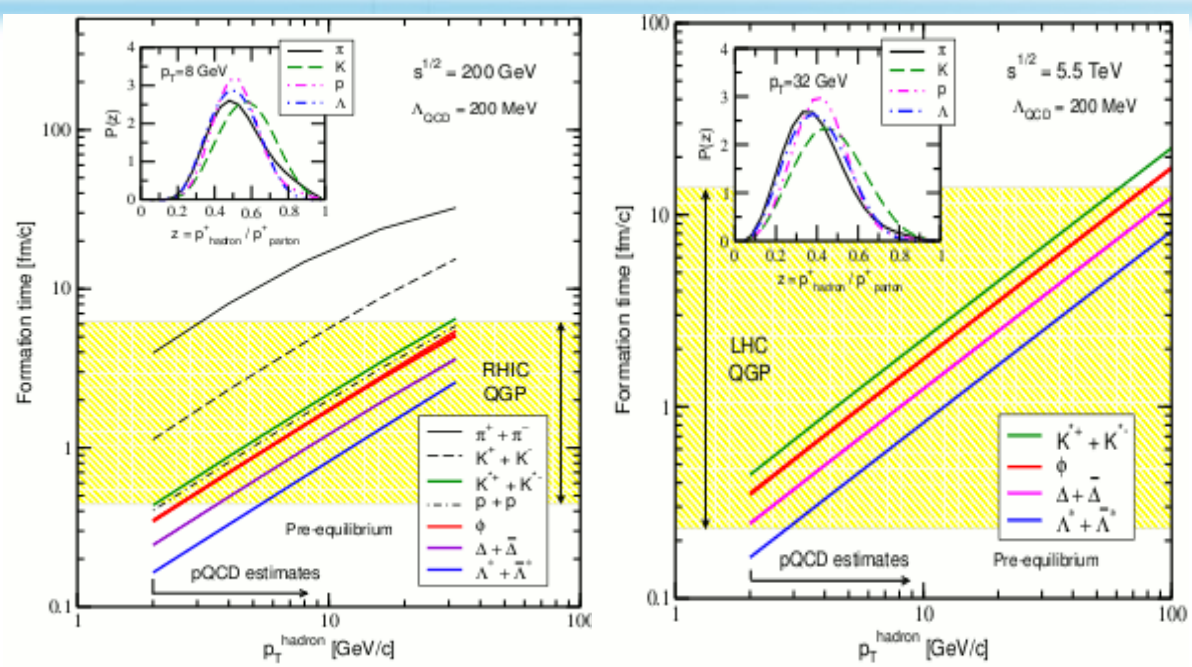
A possible solution

- Trigger resonances created from di jets !
  - → away side jet will cross the medium
  - → associated resonances decay in symmetry-restored medium
- Need :
  - Jet reconstruction capability
  - Low-momentum tracking
  - PID

→ ALICE is the experiment able to search for such a signal



Formation time



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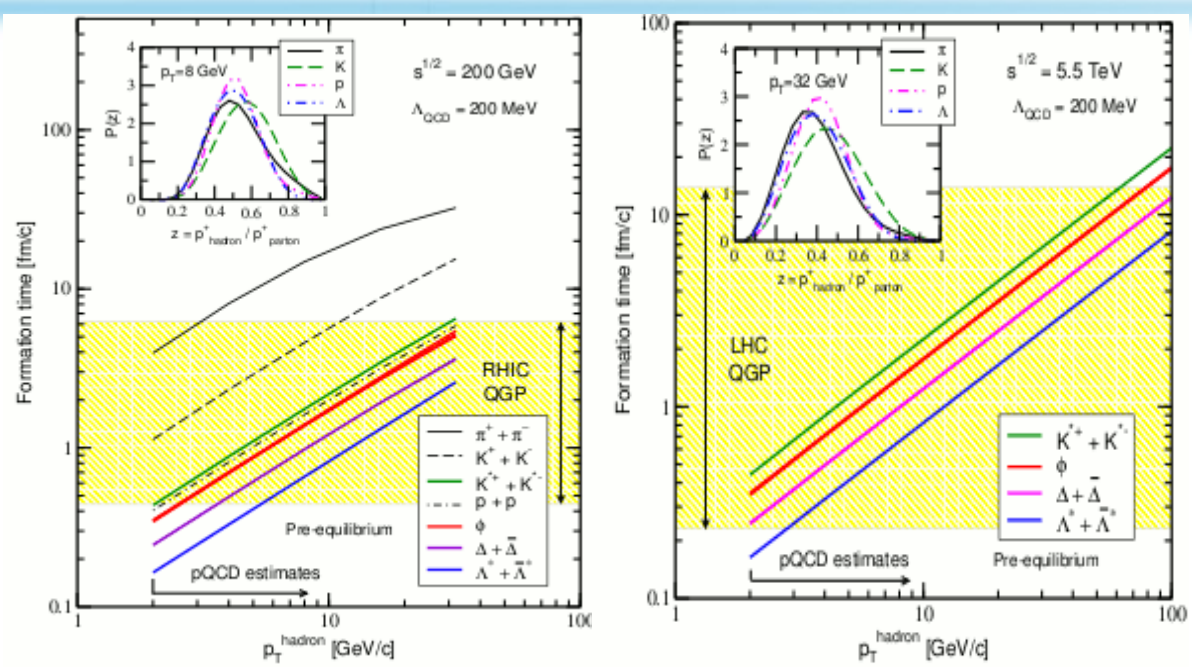
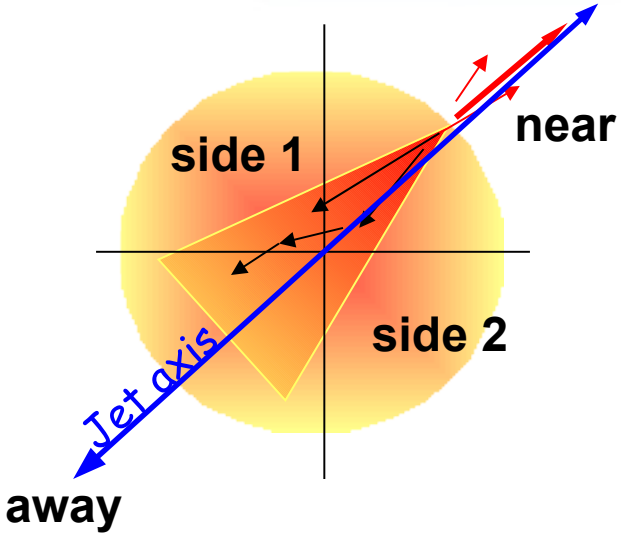
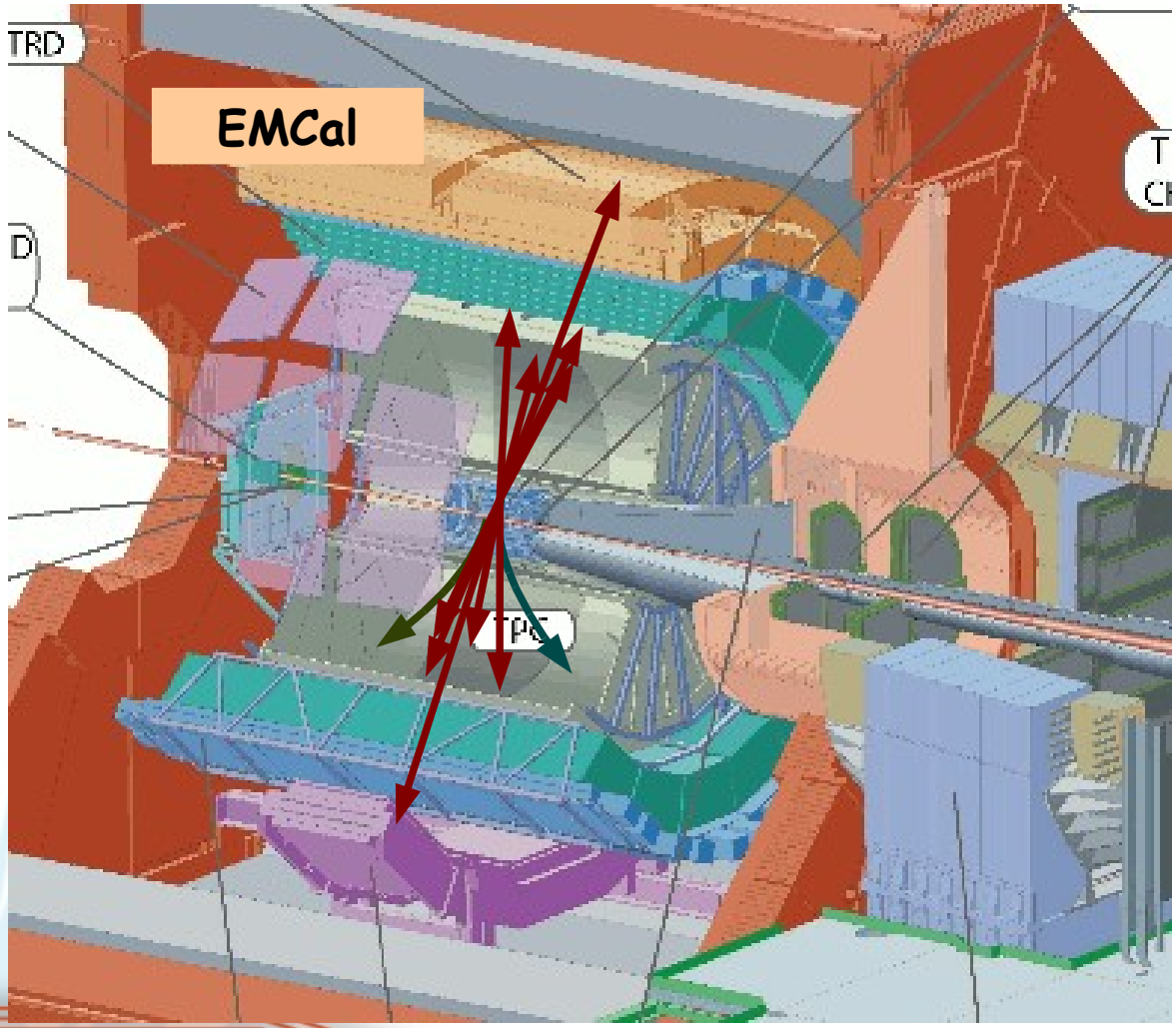




	Low pt	High pt
near side	No medium or late hadronic medium	No medium (reference data)
away side	Late hadronic medium	**Partonic or early hadronic medium (formation time) CSR?**
side 1&2	Thermal hadronic medium	Thermal hadronic medium

Practically...



$K^* \rightarrow K\pi$

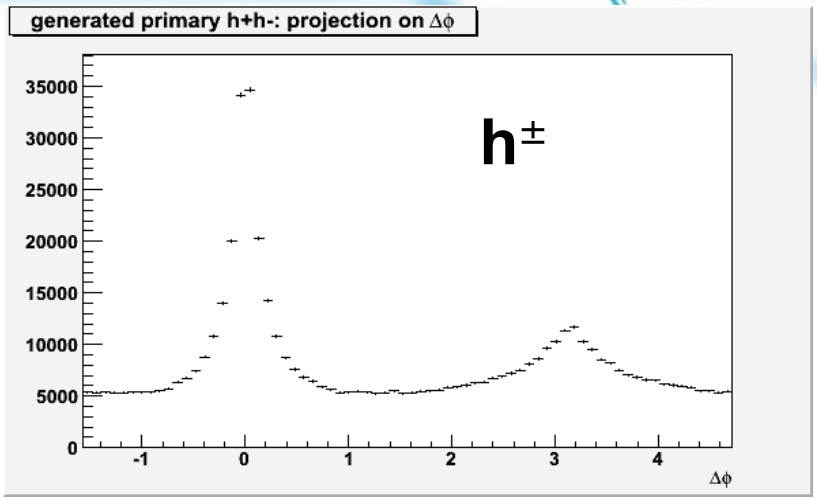
$\phi \rightarrow KK$

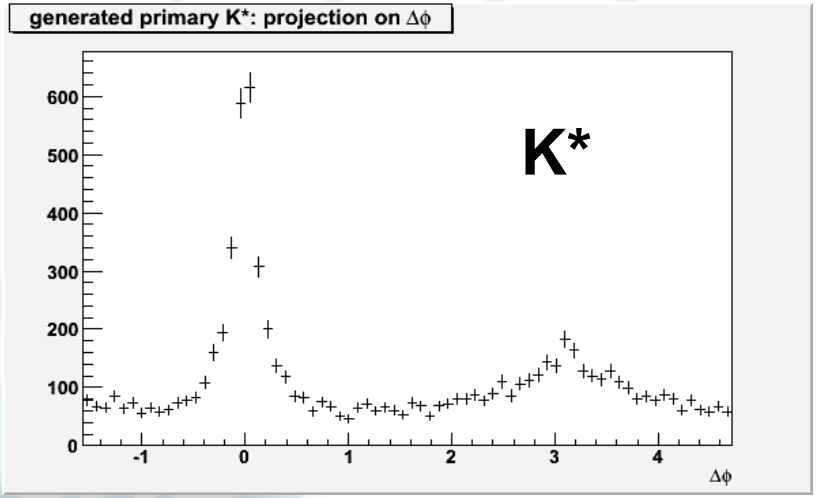
Resonance identification

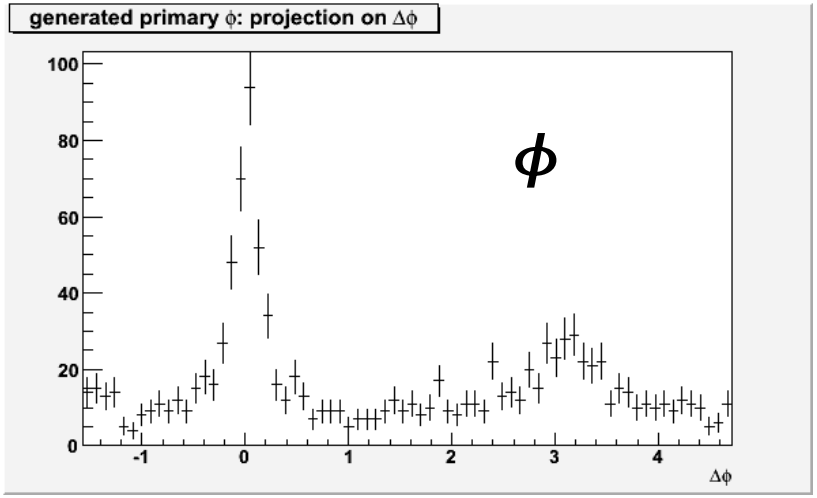
- K^{*0} and Φ resonances considered so far
- Identified via hadronic decay modes
- two resonances considered so far :
  - $K^*0(896) \rightarrow K+\pi-$, $K-\pi+$
  - $\Phi(1020) \rightarrow K+K-$
- Invariant mass spectra
  - Yield
  - Spectral properties

Analysis of pp events (pythia)

- pp (dijet) production
  - UA1 jet finder
  - most of the time only 1 jet is reconstructed (EMCal)
  - no dijet selection
    - second jet can be anywhere in η





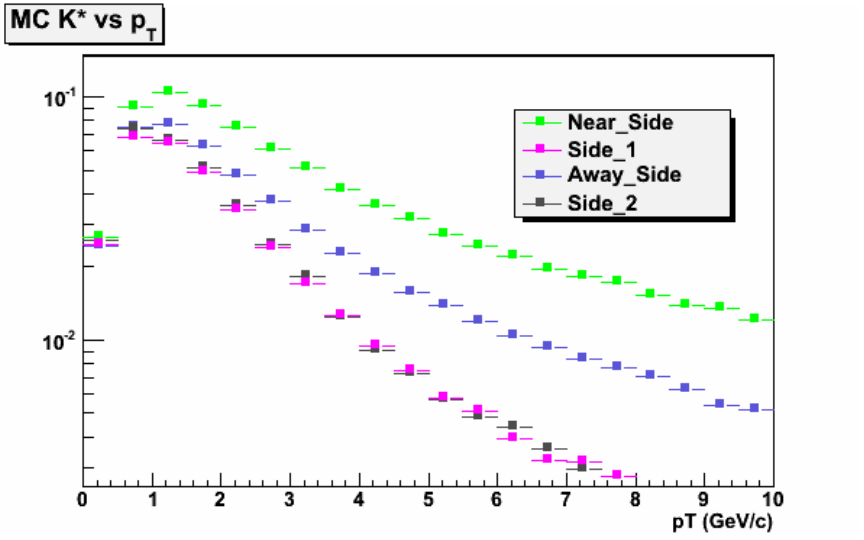


Reference axis = triggered jet (most energetic if >1)

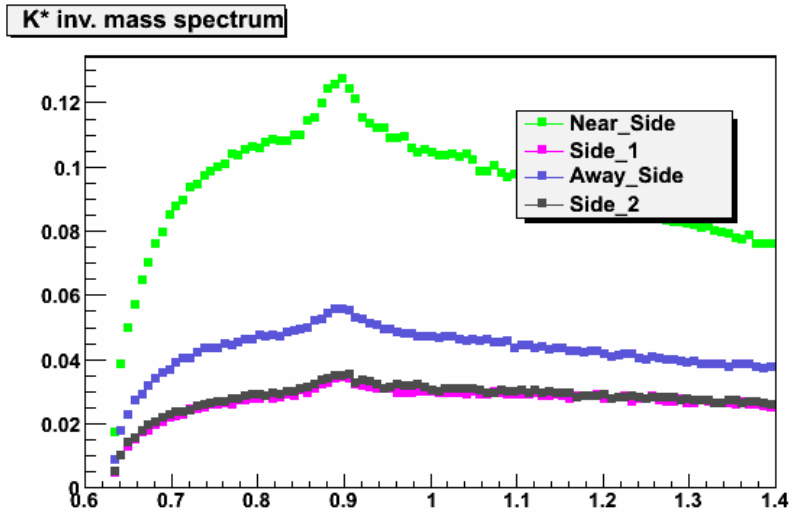
Resonance identification (K*)

- K*0(896) → K+π- , K-π+ BR~67%

200k 1-jet events



pT

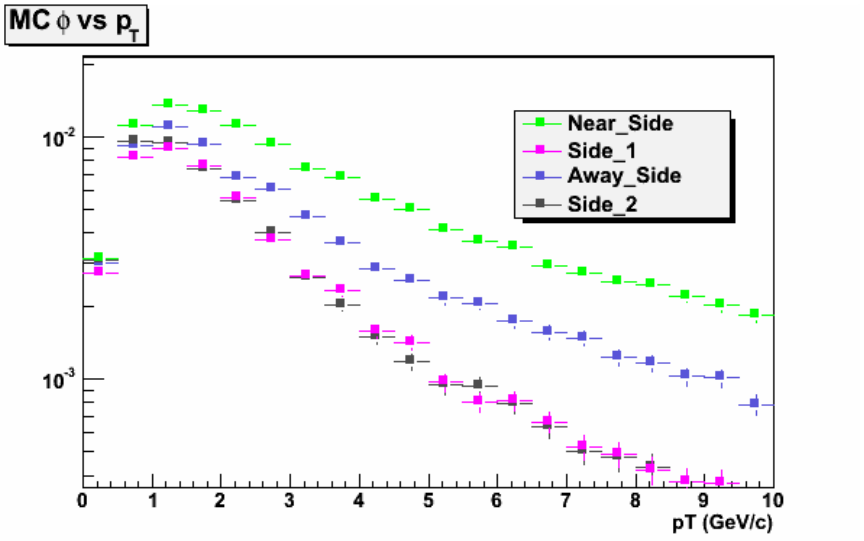


Inv. mass

Resonance identification (Φ)

- $\Phi(1020) \rightarrow K^+K^-$ BR~49%

200k 1-jet events



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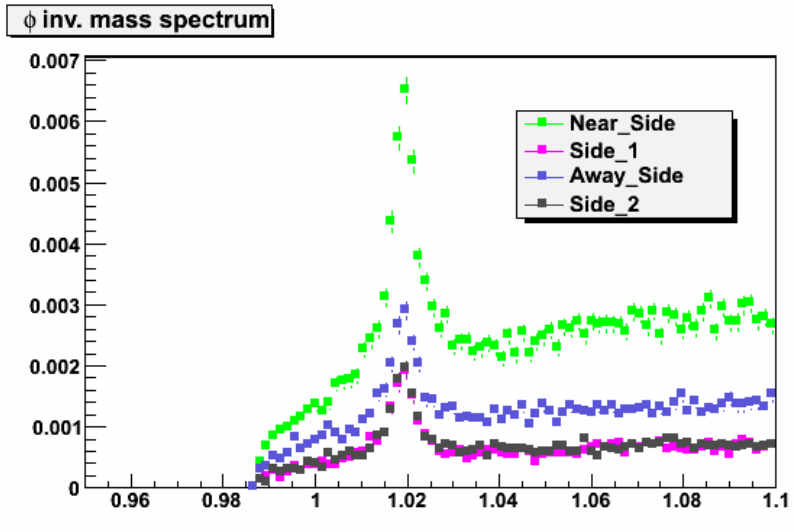
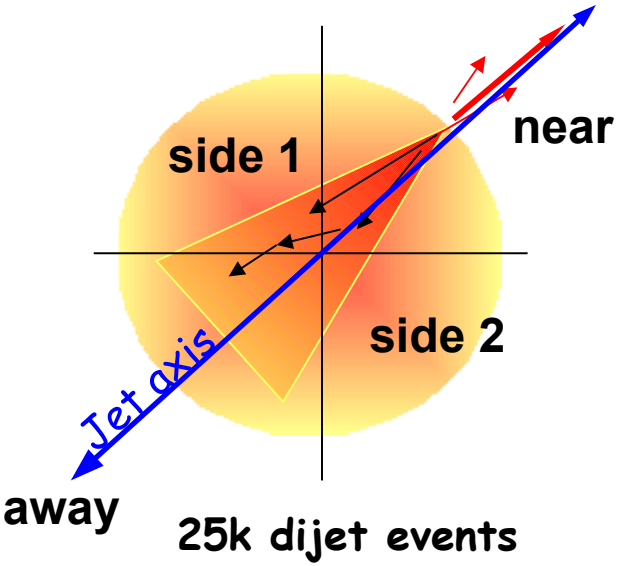


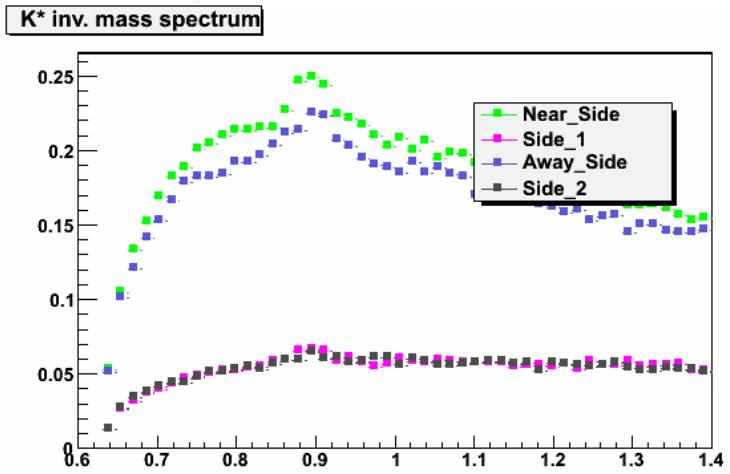
Inv. mass

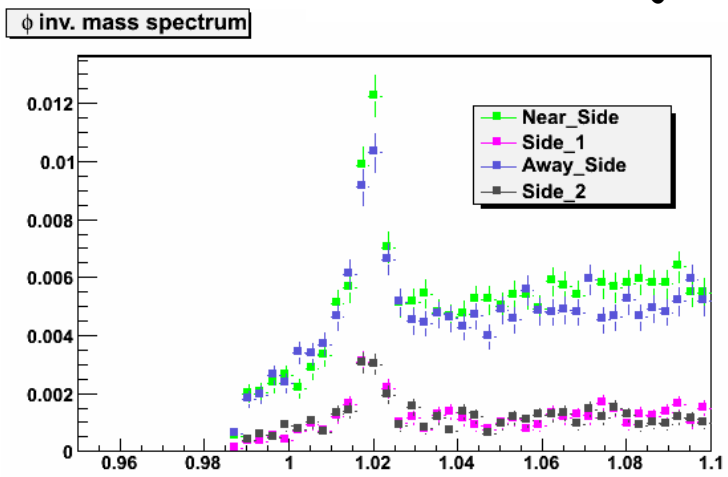
Multiplicity in away side much lower
What gives a di-jet selection ?

Use of di-jet trigger

- Now near side jet AND away side jet required
- 2 jets reconstructed
  - back-to-back ($\Delta\phi$=180°±45°)





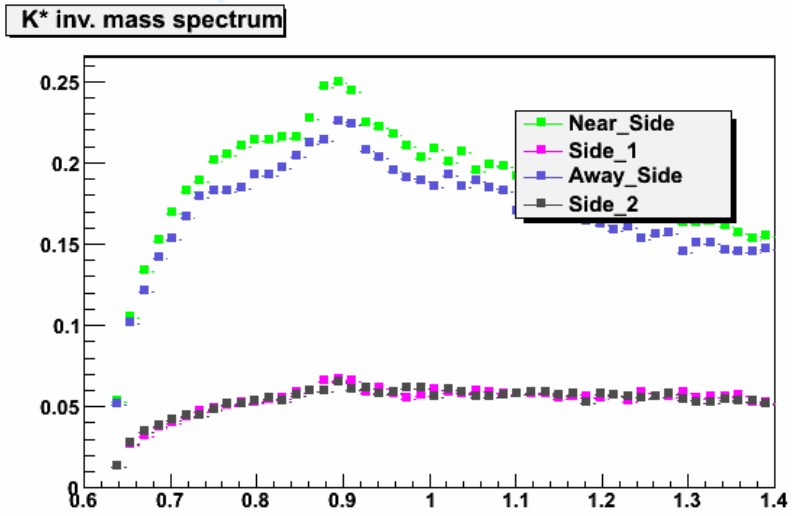


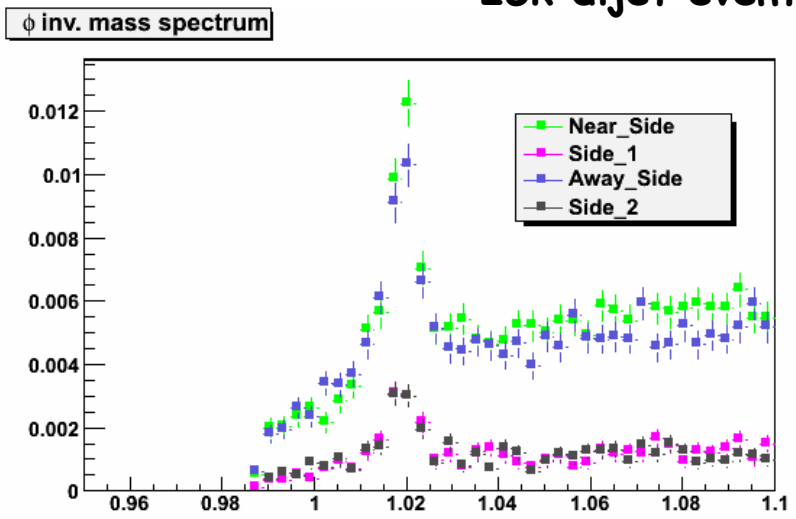
- → statistics drop ; signal still visible and significant
- Criteria on surface jet to be defined

Use of di-jet trigger

- Now near side jet AND away side jet required
- 2 jets reconstructed
  - back-to-back ($\Delta\phi$=180^0±45^0)

25k dijet events





- → statistics drop ; signal still visible and significant

But this is pp...

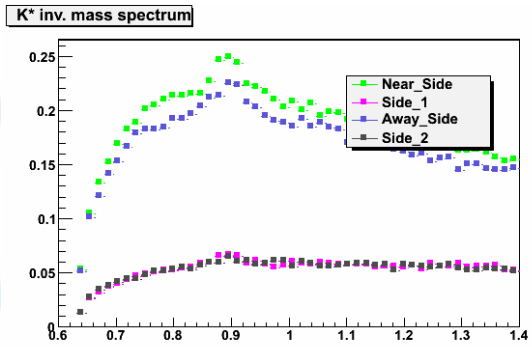
What happens with Pb+Pb ?

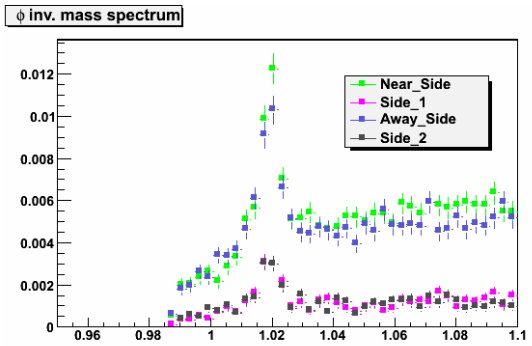
- No clear idea at the moment
  - Issue in ALICE software (Hijing dependent) are being solved
- We can try a simple scaling from the Hijing combinatorial background

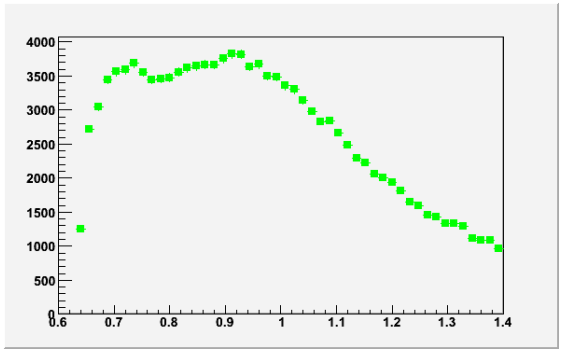
Yields for 1 dijet event

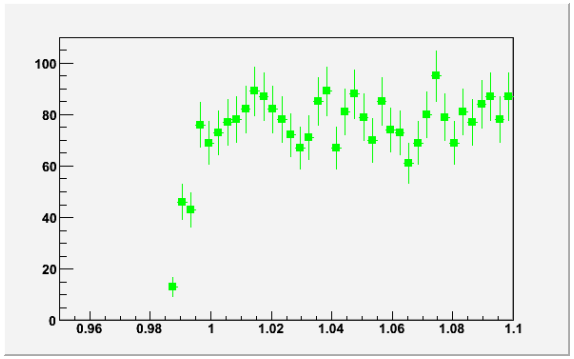
pp

Pb+Pb









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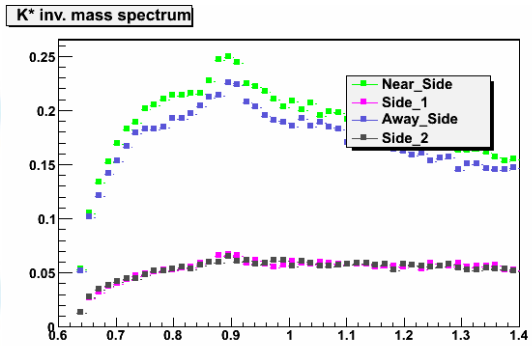

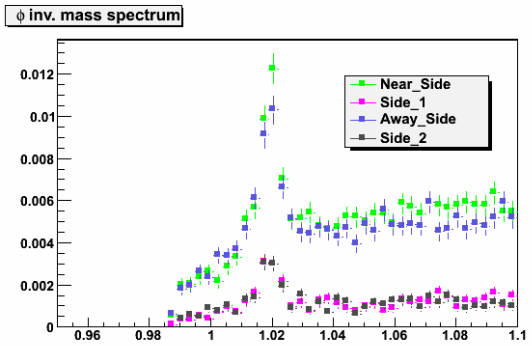

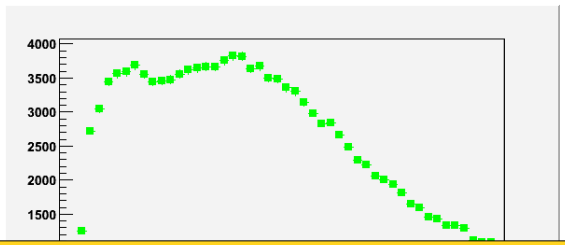

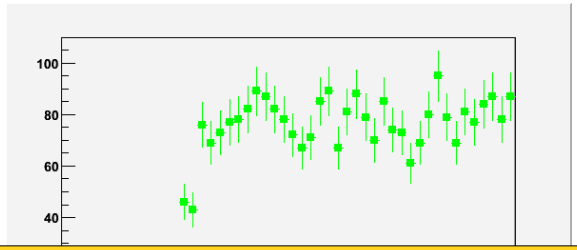

No track quality cut scenario (these plots) : # events PbPb >10^8 !
Tedious track selection study to be performed
Specific trigger needed
Rely on 1-jet events (better statistics) ?

Conclusions & to do...

- Analyse code jet+resonance
  - Validated in pp
  - Under investigation in PbPb
- PbPb data will be tricky
  - Relevant cuts should help a lot
    - Track quality, PID
    - Vertex selection, DCA
  - Need to integrate background estimators and subtraction methods
- Use other jet finders (fast-k_T in progress)
- Definitely not a first-day analysis

fin.

Some info

- pp:
  - LHC08d8/30015,6,7,8
  - ~3800 files = 760k events
- Jet reco
  - UA1 jet finder
  - Min jet energy = 15 GeV
  - Output : AOD jets + mcinfo (AliAODJet + AliAODMCParticle)