Quarkonium detection in ALICE

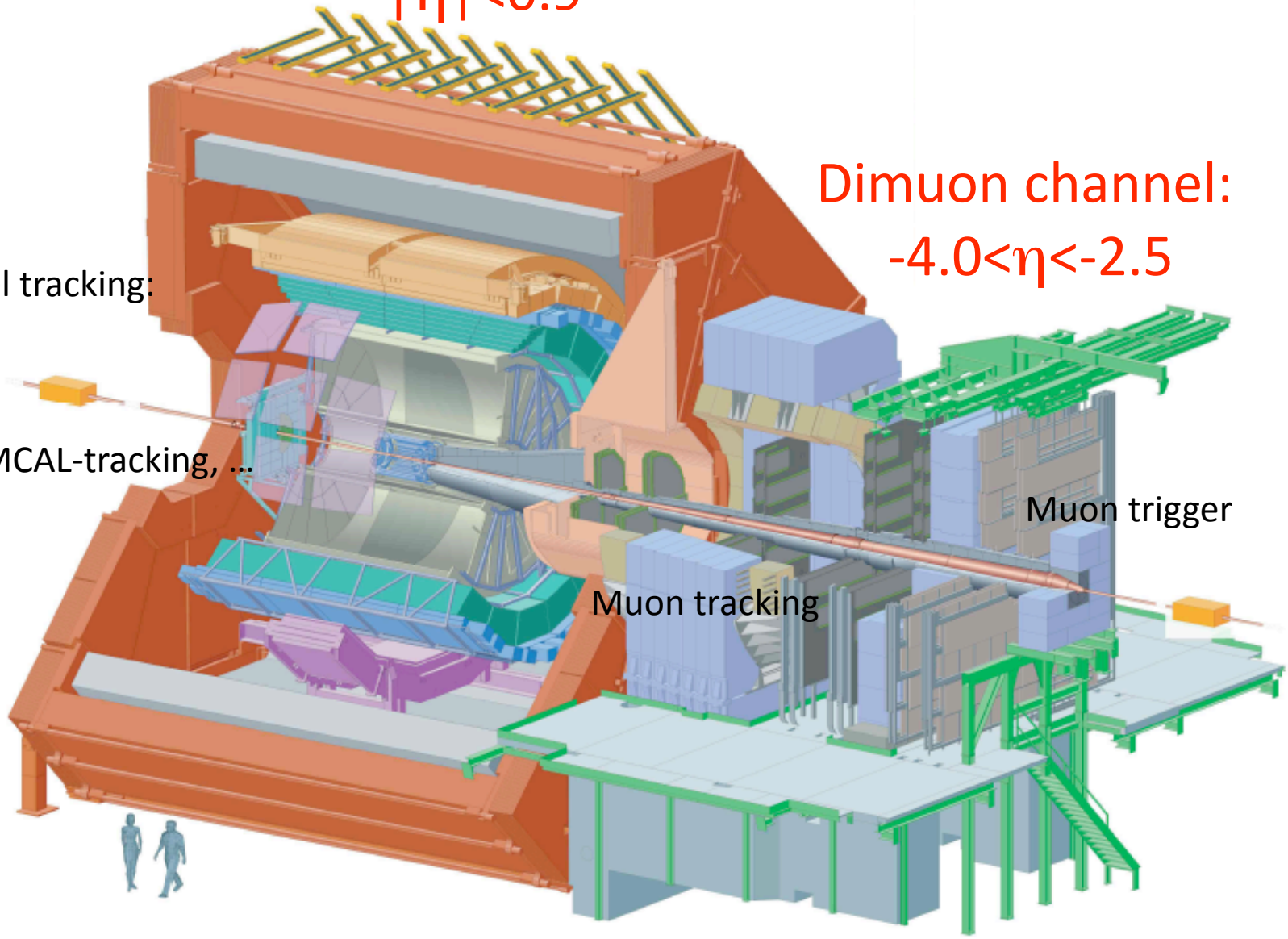
G.M for the ALICE collaboration

Dielectron channel:
$|\eta|<0.9$

Central Barrel tracking:
ITS-TPC-TRD

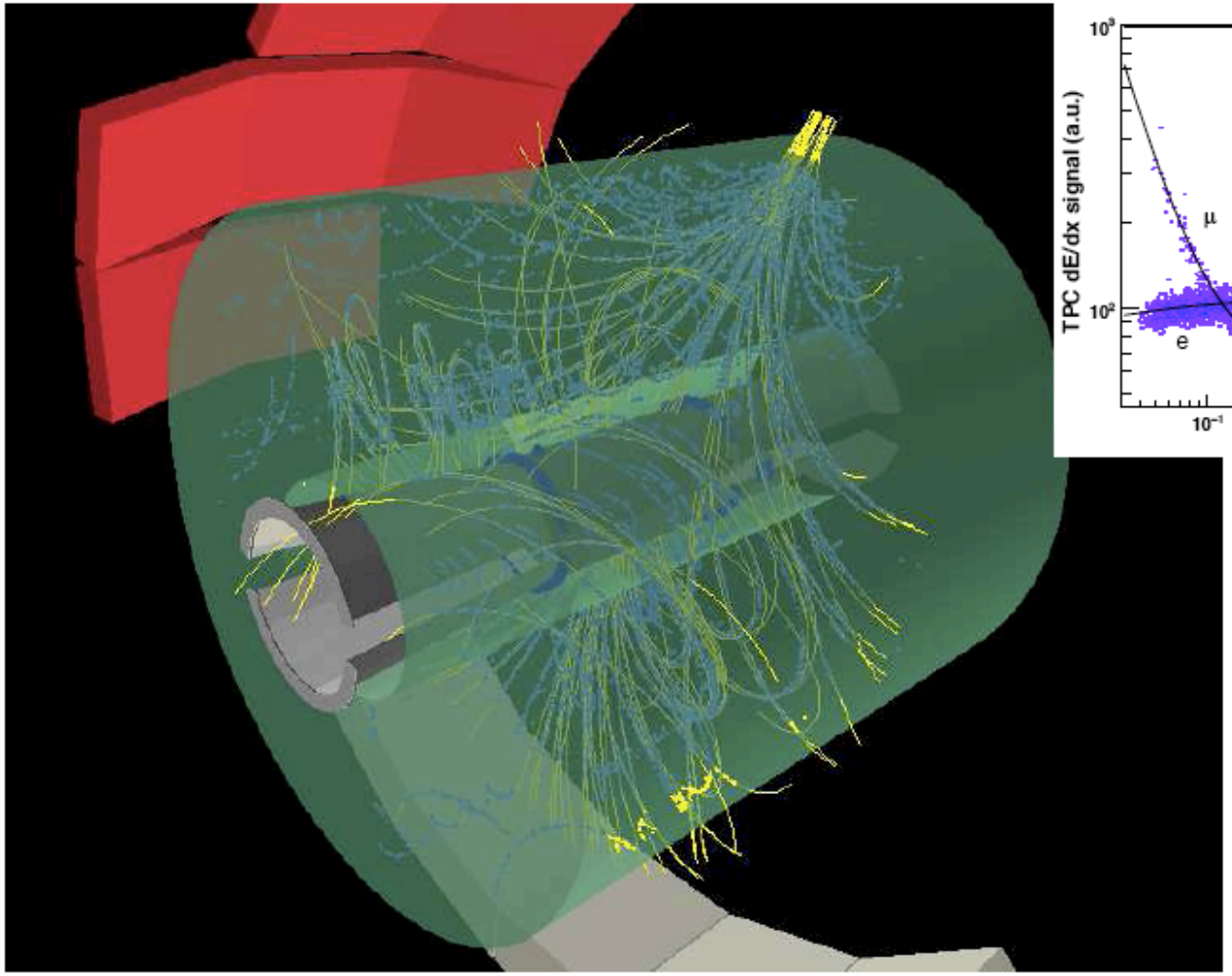
Electron ID:
dE/dx, TR, EMCAL-tracking, …

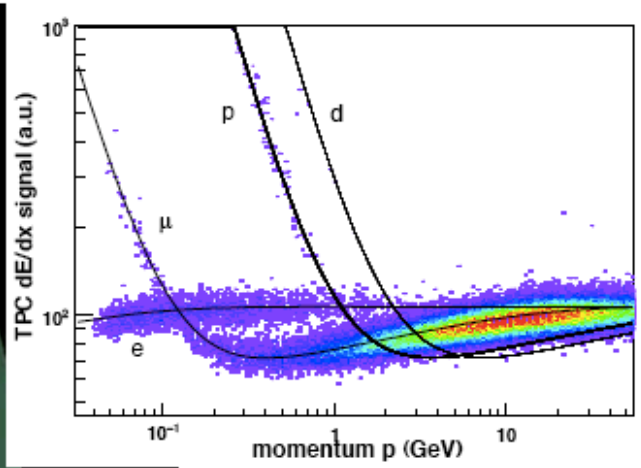
Dimuon channel:
$-4.0<\eta<-2.5$



Time Projection Chamber

...largest ever built, calibrated in 2008-09 with cosmic rays, laser and Kr

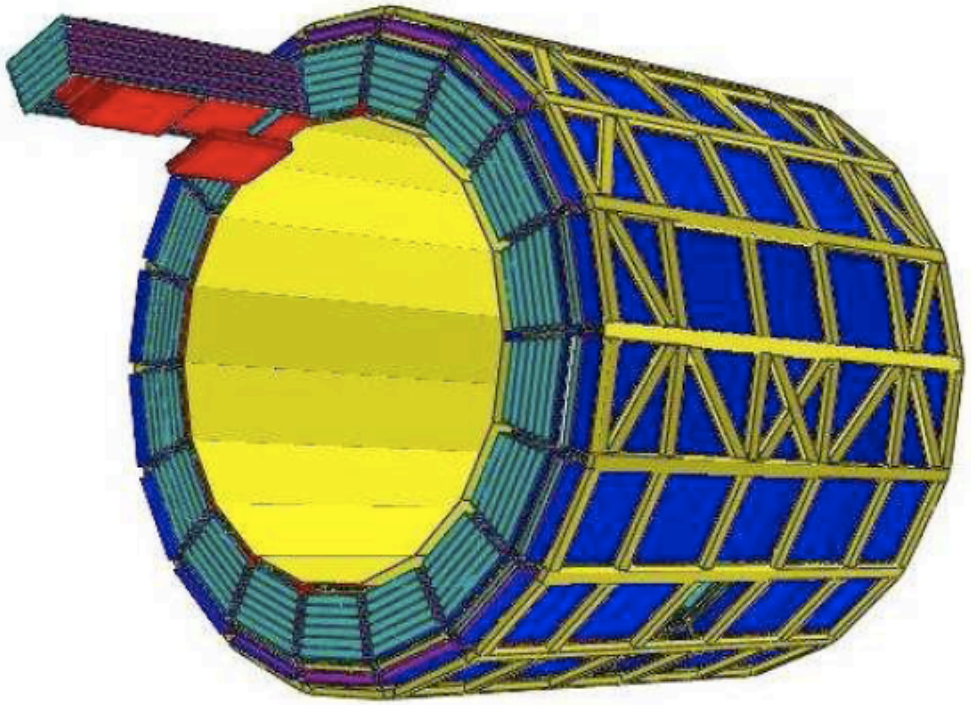




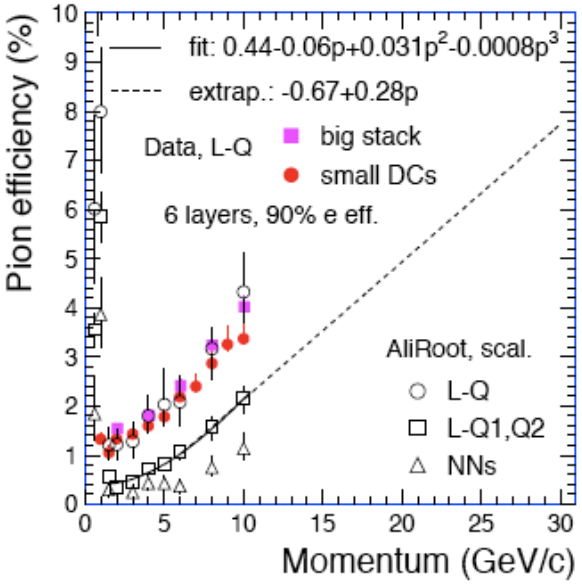
- 90 m^3 active volume
- 500 million "pixels"
- 100 μs drift time
- on-line (digital) signal processing
- 5.5% dE/dx resolution

Transition Radiation Detector

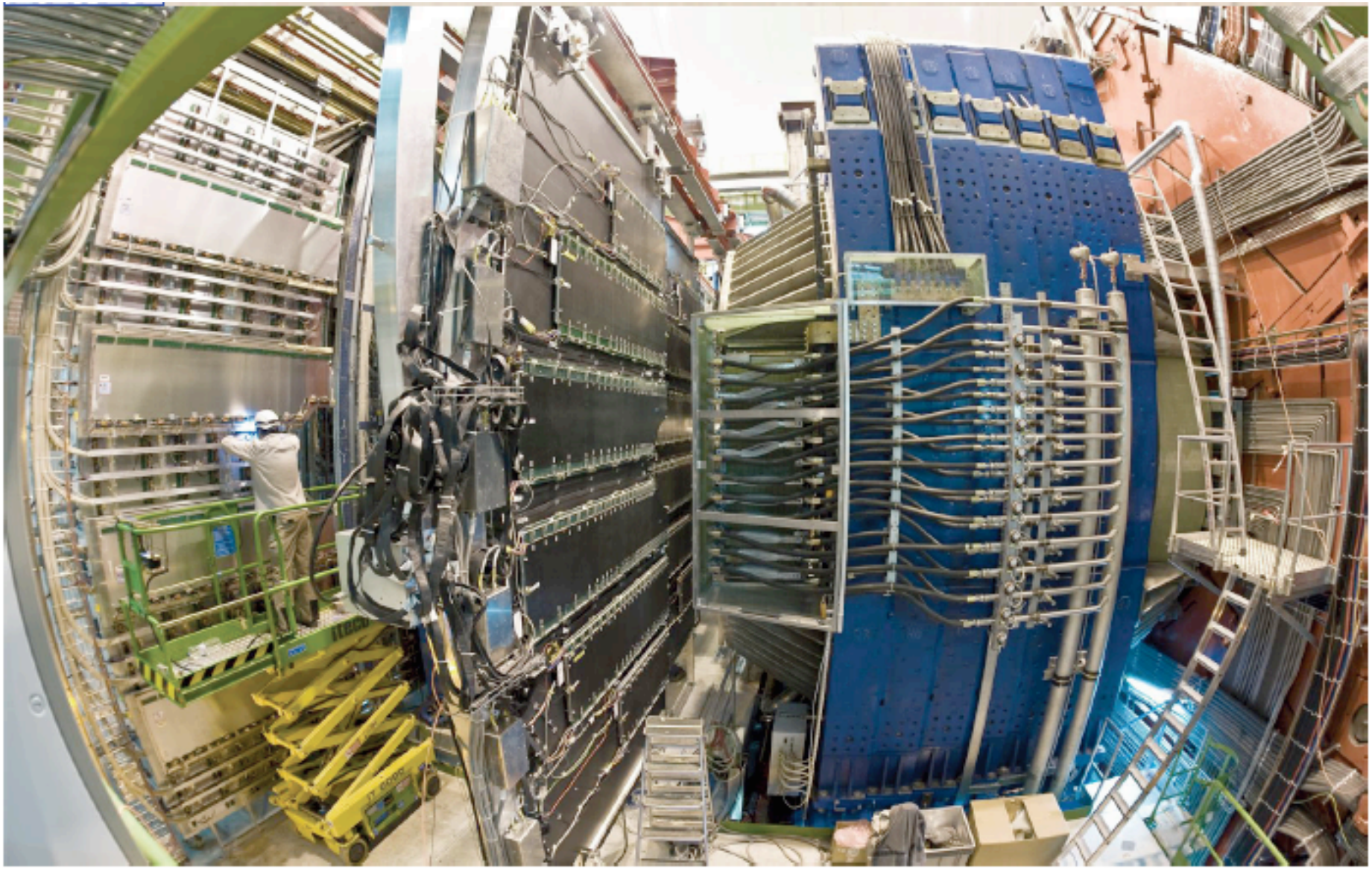
electron identification and fast (6.5 μs) trigger for high-momenta (e)



- 27 m^3 Xe
- 35 million "pixels"
- 2 μs drift time
- 540 chambers (700 m^2)

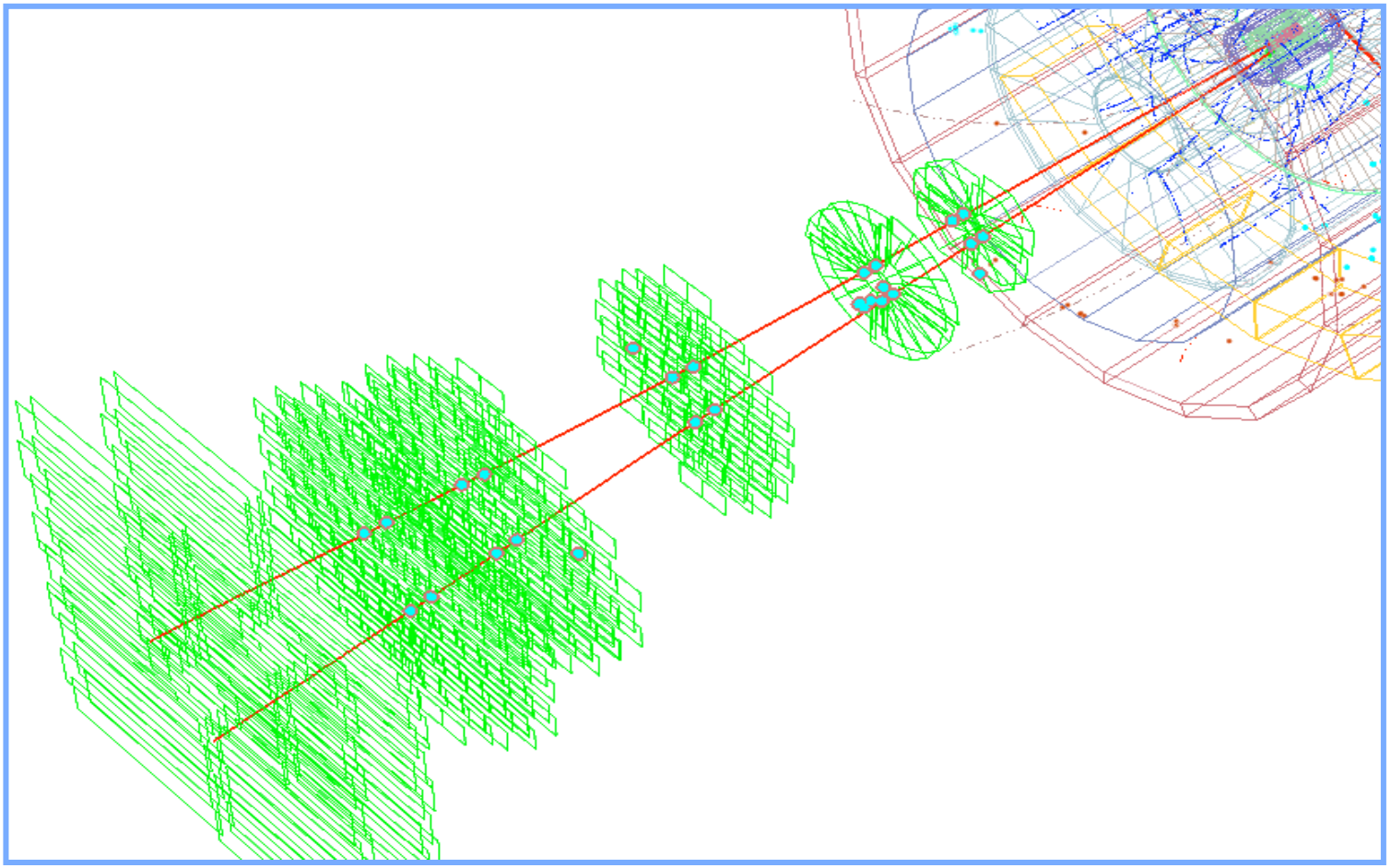


Muon Spectrometer



Muon Spectrometer

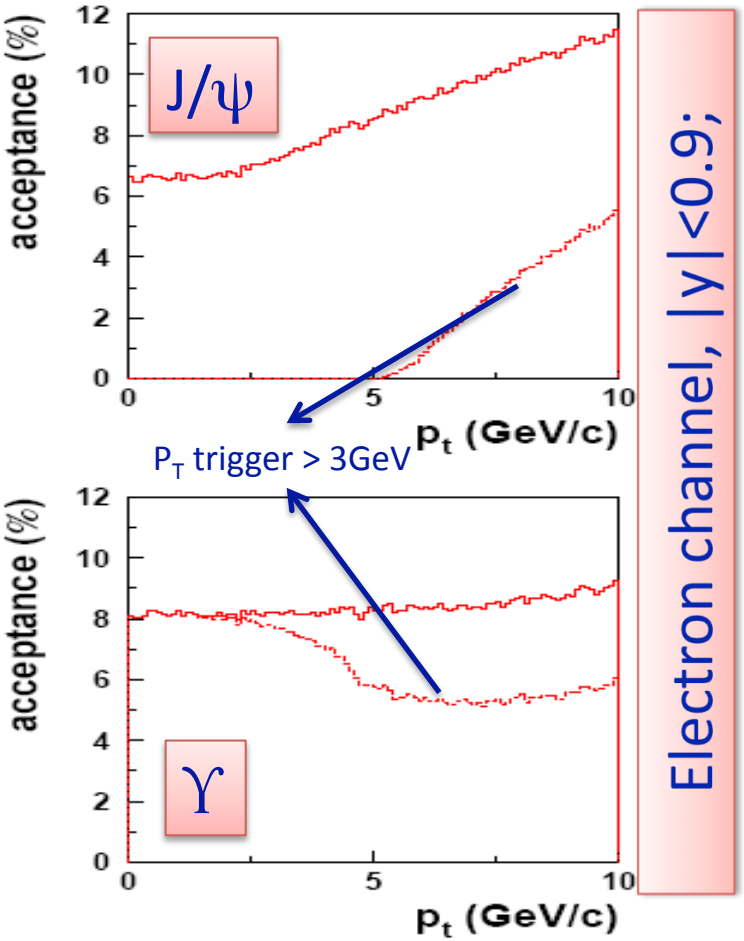
First Dimuon event observed in p+p @ 900 GeV



Alice Running conditions

In proton-proton collisions,
luminosity is limited by the number of pile-up events in TPC to 3.10^{30} $cm^{-2}s^{-1}$
(~240 kHz interaction rates)

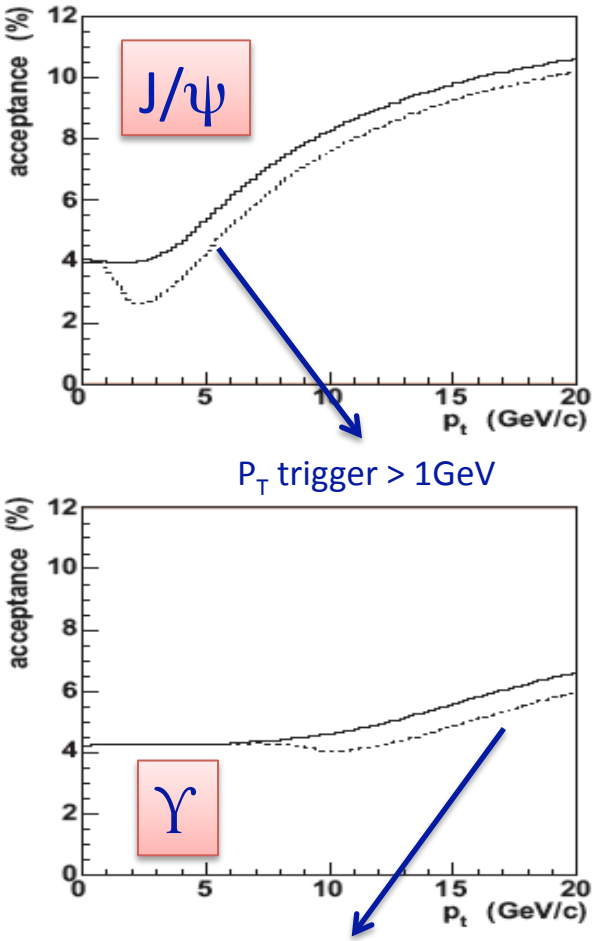
Quarkonium acceptances



Electron channel, |y|<0.9;

Down to p_T=0 for J/ψ & ϒ.

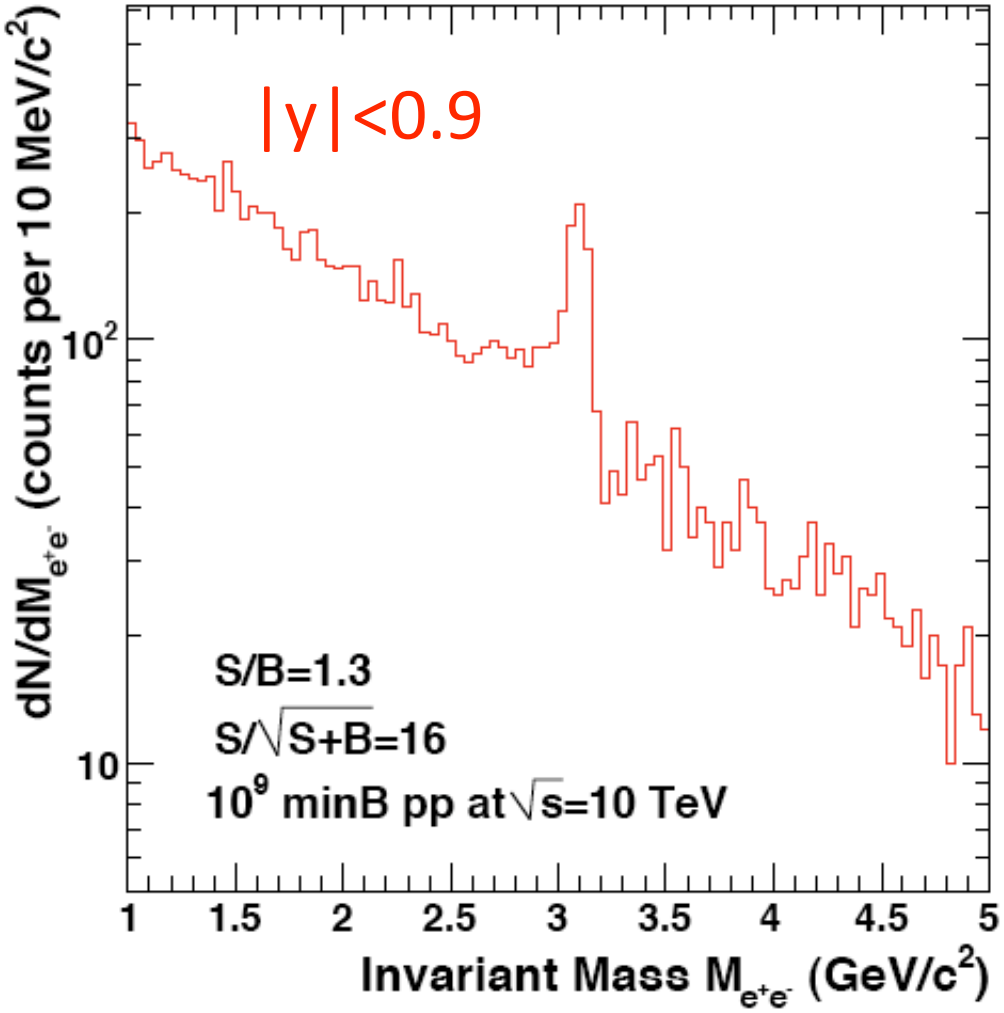
Two η domains



Muon channel, 2.5<|y|<4.0;

For Full-TRD acceptance.
First run with 7/18 TRD modules
Factor 7 acceptance reduction for J/psi

Dielectron performances in pp



- ✓ 7/18 TRD configuration
- ✓ pp first run (10^9 MB events): ~400 J/ψ ;
- ✓ Nominal pp run with electron trigger: 10^6 J/ψ, 10^4 Υ;
- ✓ Gain of a factor ~7 with full TRD configuration

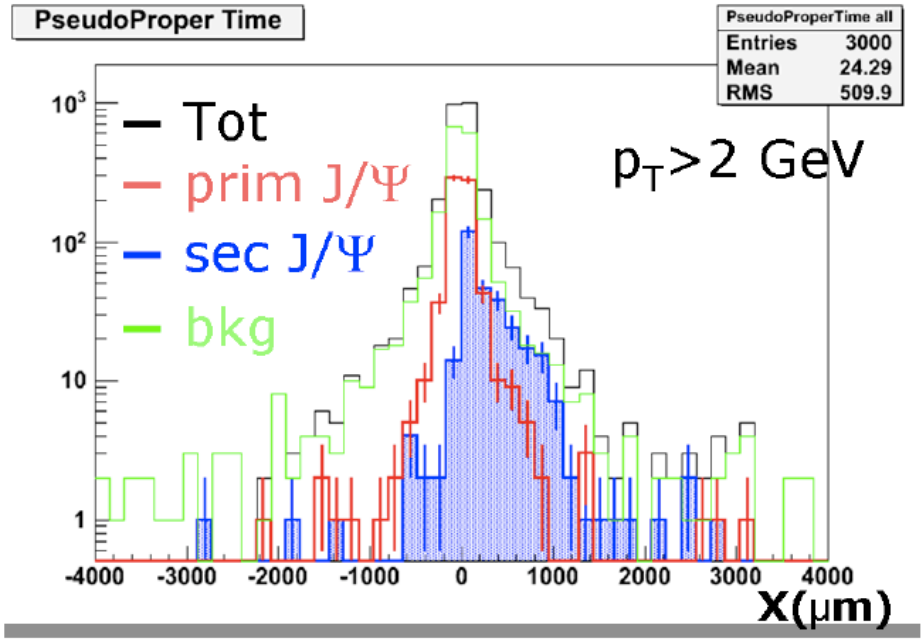
Secondary dielectron J/ψ from B

J/ψ from a displaced vertex ($c\tau \sim 500\ \mu m$);
CDF approach: simultaneous fit of inv mass and the pseudo-proper decay time :

$$x = L_{xy}(J/\psi)\cdot\frac{M_{J/\psi}}{p_T(J/\psi)}$$

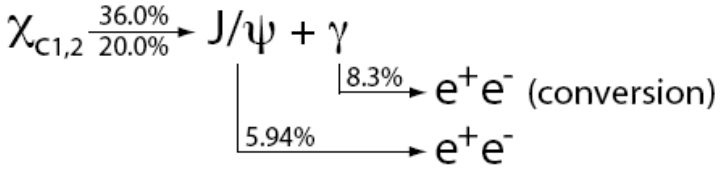
$$L_{xy}(J/\psi) = \frac{\vec{L}\cdot\vec{p}_T(J/\psi)}{\left|\vec{p}_T(J/\psi)\right|}$$

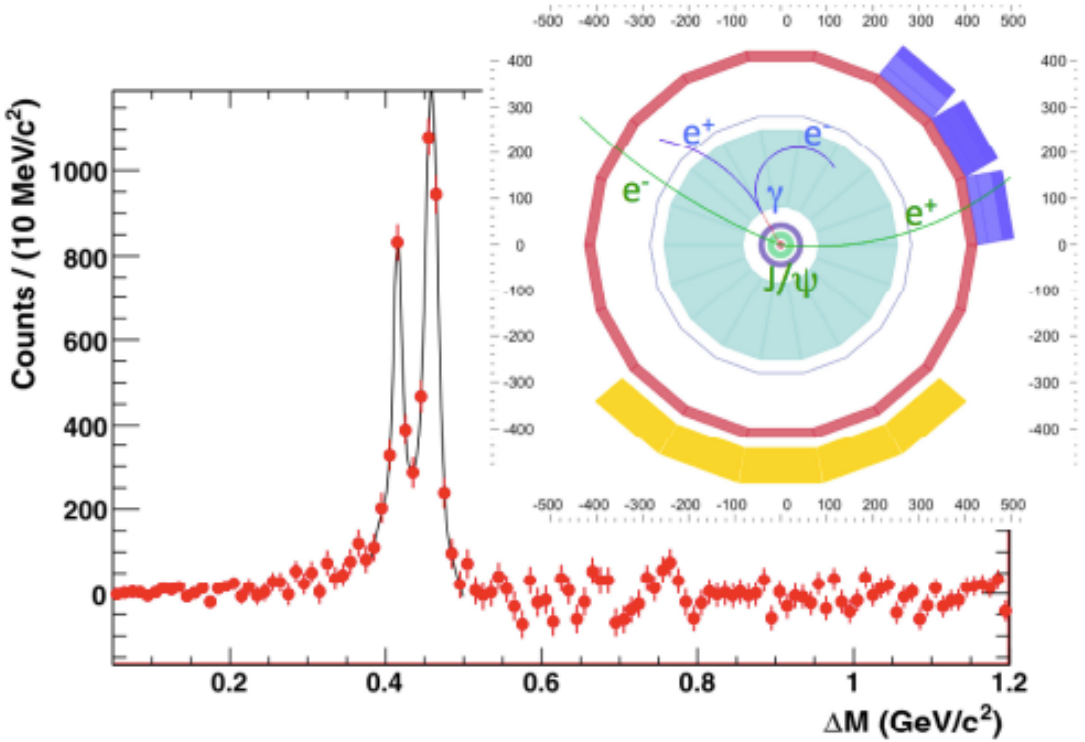
$$\vec{L} = \vec{r}^{\,\mathrm{sec}}_{\mathrm{vtx}} - \vec{r}^{\,\mathrm{prim}}_{\mathrm{vtx}}$$



4 10^9 pp Mb events in 7/18 TRD configuration.

χ_c in the *tetra-electron* channel

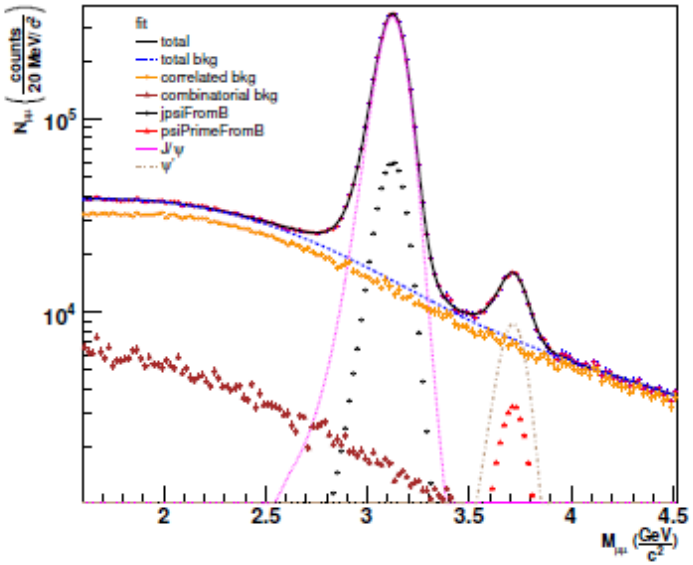


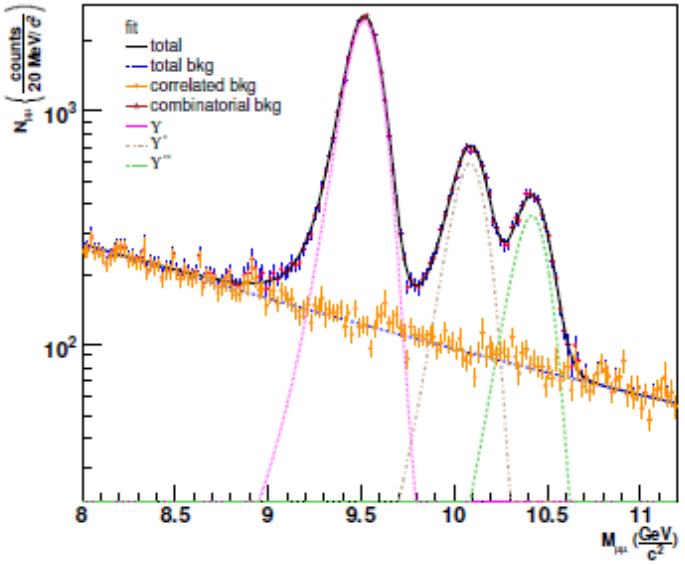


J/ψ invariant mass resolution removed in:
$\Delta M = M(e+e-\gamma) - M(e+e-)$

Nominal p+p 14 TeV,
10^7s at $L = 3 \cdot 10^{30}$ cm^{-2}s^{-1}.
7200 χ_c (perfect trigger)
Realistic background to be evaluated (under progress)

Dimuon performances in pp





	S [x10³]	S/B	S/√(S+B)
J/ψ	2807	12	1610
ψ'	75	0.6	170
Υ	27	10.4	157
Υ'	6.8	3.4	73
Υ''	4.2	2.4	55

It will be possible to study J/ψ p_T differential distribution with reasonable statistics up to 20 GeV/c
The large Υ statistics will allow a study of its differential distributions

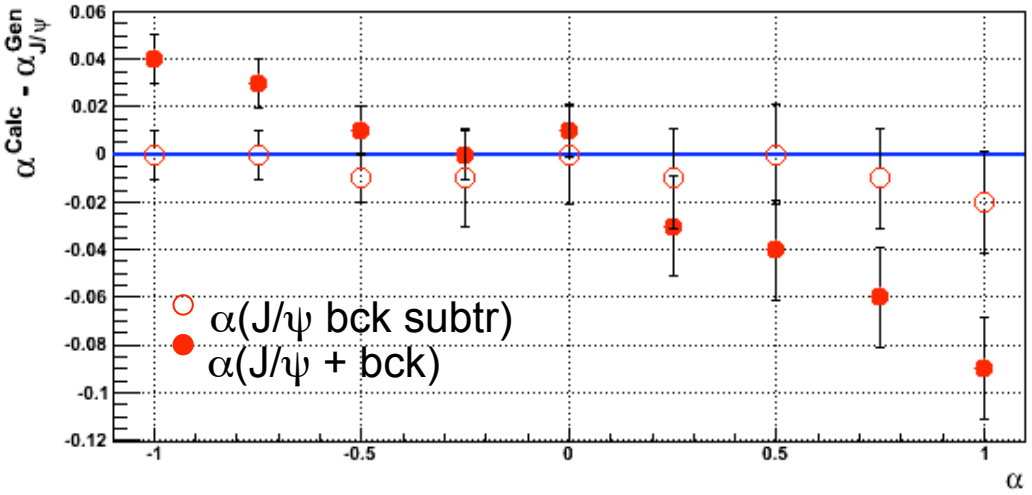
First run (~10 months) : ~50000 J/ψ, ~1000 ψ', and ~350 Υ(1S)

Polarization in dimuon channel

J/ψ

Bias on the evaluation of the J/ψ polarization due to the background is not very large (as expected)

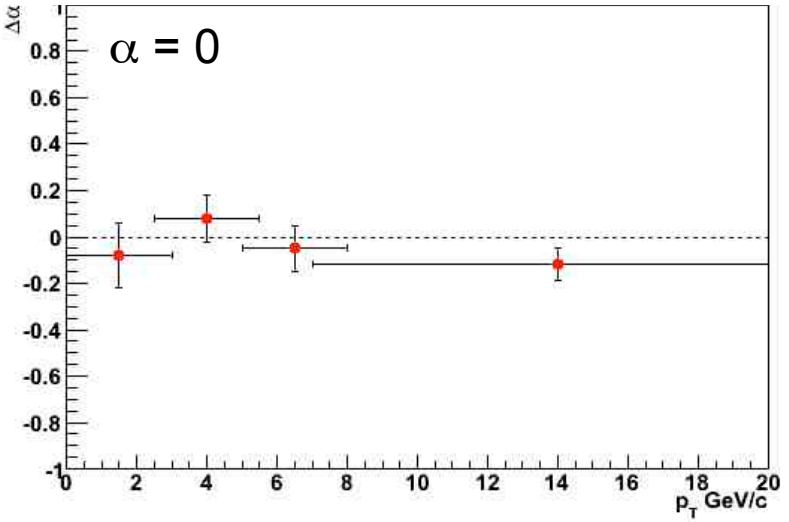
with 200K J/ψ, the error on $\alpha_{J/\psi}$ is < 0.02



ϒ

with the available ϒ statistics we can evaluate the polarization with a statistical error between 0.05 – 0.11;

statistical errors, for the p_T dependence of the polarization, vary between 0.03 -0. 2;
Smaller error at high p_T because the cos(θ) coverage is wider.



More exotic studies foreseen

- Quarkonia+muon azimuthal and invariant mass correlations;
- Quarkonia+hadron azimuthal correlations;
- Quarkonia production in high multiplicity events;
- …

Conclusions

- ALICE will measure J/ψ, ψ', Υ(1S), Υ(2S), Υ(3S) in pp at LHC (with B and higher resonances feed down);
- In two rapidity ranges:
  - $|y|<0.9$ and $-4.0<y<-2.5$;
- Down to $p_T=0$;
- J/ψ from B via secondary high precision vertexing in $|y|<0.9$;
- χ_c detection in $|y|<0.9$ (under progress);
- Polarisation of J/ψ (Υ(1S)). In $-4.0<y<-2.5$ precision below 5 (10)%;
- Quarkonium correlation studies foreseen;

Further References

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