Heavy flavors and quarkonia detection at forward rapidities with ALICE

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Outline

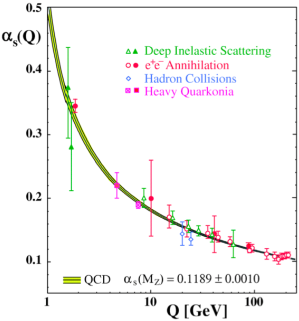
Outline

QCD main features:

- Asymptotic freedom: weak interaction between quarks and gluons at high energy or short distances.

$$\alpha_s(q^2) \simeq \frac{12\pi}{(33 - 2n_f)\ln\frac{q^2}{\Lambda^2}} \qquad \Lambda \approx 200\ \text{MeV} \quad n_f = 6$$

- Confinement: interaction grows strongly at low energy or large distances. Colored constituents cannot be separated.



S. Bethke, Prog. Part. Nucl. Phys. **58** (2007) 351

QCD phase diagram

How to observe the behavior of matter with quasi-free quarks and gluons?

QCD phase diagram

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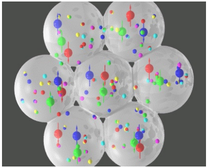
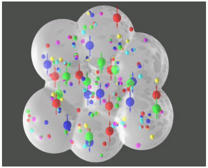
1. Compress nucleons.





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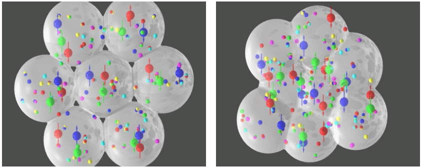
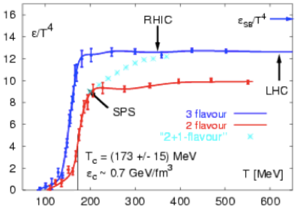


2. Increase temperature.



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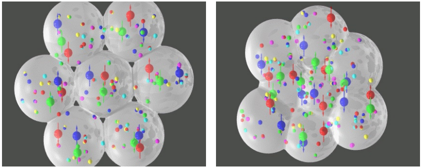

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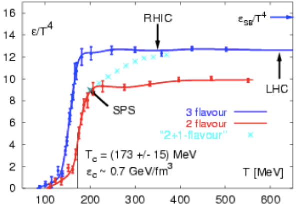
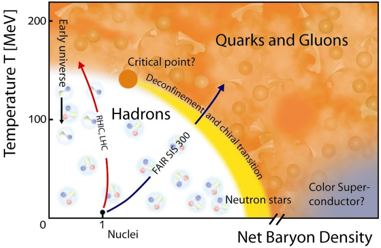
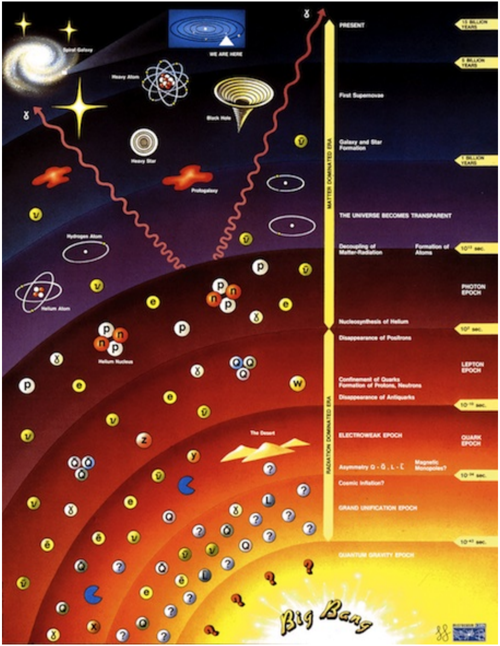


3. Compress nucleons and increase temperature.



At large temperature ($T_c \approx 170 - 190$ MeV) and null baryon density a phase transition is expected to a deconfined state of quarks and gluons: the Quark Gluon Plasma (QGP).

QGP in the universe



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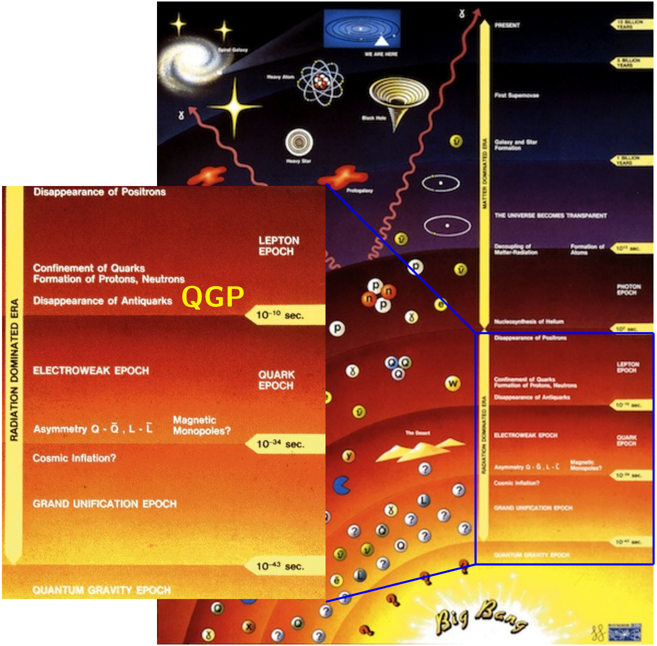
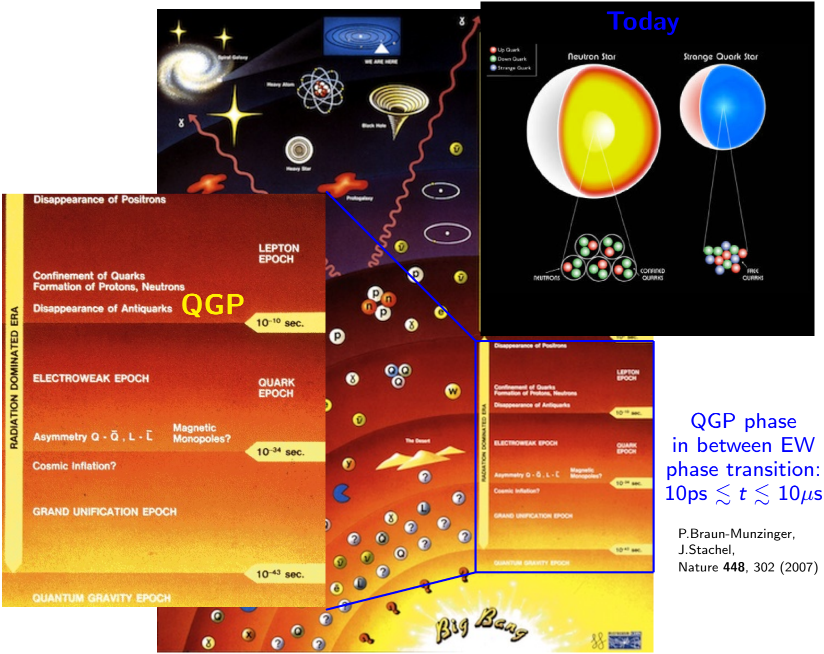


QGP phase in between EW phase transition: $10\text{ps} \lesssim t \lesssim 10\mu\text{s}$

P.Braun-Munzinger, J.Stachel, Nature **448**, 302 (2007)

QGP in the universe

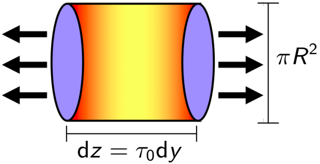


QGP phase in between EW phase transition: $10\text{ps} \lesssim t \lesssim 10\mu\text{s}$

P.Braun-Munzinger, J.Stachel, Nature **448**, 302 (2007)

QGP in the laboratory

- High energy density in laboratory: ultra-relativistic heavy-ion collisions.



Bjorken model

$$\epsilon_{Bj} = \frac{1}{\pi R^2}\frac{1}{\tau_0}\frac{dE_T}{dy}$$

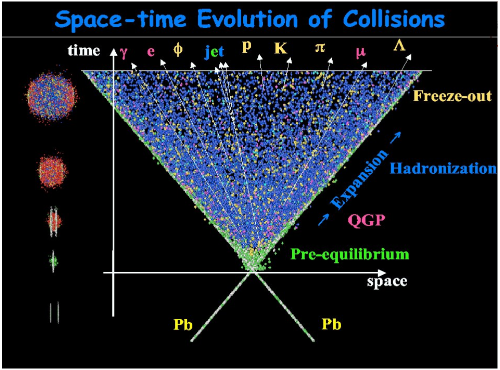
Name	Type	$\sqrt{s_{NN}^{max}}$ (GeV)	Largest ion
AGS @ BNL	fixed target	4.6	Au
SPS @ CERN	fixed target	17.2	Pb
RHIC @ BNL	collider	200	Au
LHC @ CERN	collider	5500	Pb

	SPS	RHIC	LHC	
τ^0_{QGP} (fm/c)	1	0.2	0.1	$\Rightarrow$ faster
T/T_c	1.1	1.9	3.0-4.2	$\Rightarrow$ hotter
τ_{QGP} (fm/c)	$\lesssim 2$	2-4	$\gtrsim 10$	$\Rightarrow$ longer
τ_f (fm/c)	~ 10	20-30	30-40	
V_f (fm^3)	$\sim 10^3$	$\sim 10^4$	$\sim 10^5$	$\Rightarrow$ bigger

P. Crochet, talk @ Excited QCD10, Slovakia

J. D. Bjorken, Phys. Rev. D **27** (1983) 140
J. Schukraft, Nucl. Phys. A **698** (2002) 287

Experimental probes of the medium



- QGP is not directly accessible to experiments ($\tau \sim 10 - 15$ fm/c).
- Detected particles can carry information on the crossed medium.

Heavy flavors are hard probes:

- $Q\bar{Q}$ pair produced at the beginning of interaction ($\tau \sim 1/(2m_Q) \sim 0.1$ fm/c for $c\bar{c}$)
- $Q\bar{Q}$ bound state formation is sensitive to the crossed medium.

Hard probes $\stackrel{def}{=}$ hard processes embedded in the hot and dense environment created in a heavy-ion collision, which are sensitive to the produced matter.

Heavy flavors $\stackrel{def}{=}$ (hadrons containing) charm (c) and beauty (b) quarks.

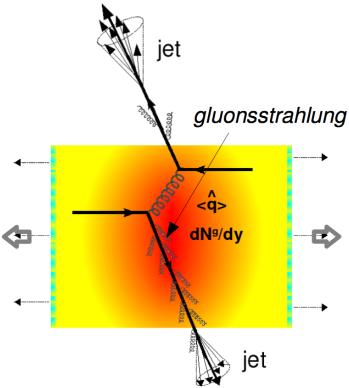
Quarkonia $\stackrel{def}{=}$ $Q\bar{Q}$ bound state. $c\bar{c} = J/\psi,\ \psi'$ $\quad b\bar{b} = \Upsilon,\ \Upsilon',\ \Upsilon''$

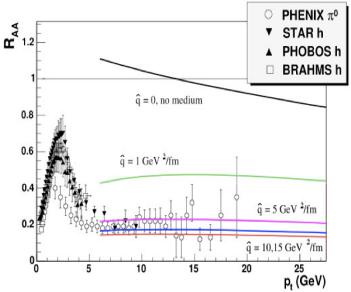
Medium effects: energy-loss

- Energy loss via multiple gluon radiation induced by the interaction with the medium.

$$\Delta E \propto \alpha_s^3 C_R \frac{1}{A_\perp} \frac{dN^g}{dy} L \qquad \text{(GLV)}$$

$$\langle \Delta E \rangle \propto \alpha_s C_R \langle \hat{q} \rangle L^2 \qquad \text{(BDMPS)}$$





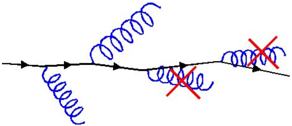
$$R_{AA}(x) = \frac{1}{\langle N_{coll} \rangle} \frac{dN_{AA}/dx}{dN_{pp}/dx}$$

K. J. Eskola, H. Honkanen, C. A. Salgado, U. A. Wiedemann, Nucl. Phys. A **747** (2005) 511

Medium effects: energy-loss of heavy flavors

Dead-cone effect:

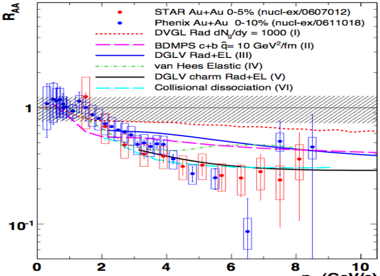
- In vacuum, gluon emission is suppressed for angles $\theta < m_Q/E_Q$.



- In the medium the effect is reduced but still present.

$\Downarrow$

- Energy loss effects should be smaller for heavy than for light quarks.

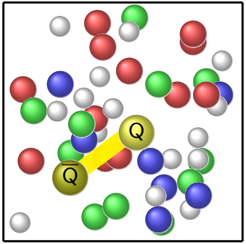


A.P.Suaide, J. Phys. G **34** (2007)

Open issues:

- Difficulties to explain light mesons and non-photonic electron nuclear modification factor for energy-loss models based on gluon radiation.
- Need tests on beauty and charm measurement separately.

Medium effects: quarkonia suppression/recombination



- Quarkonia suppression by color screening.

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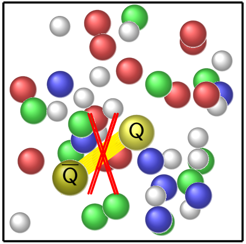

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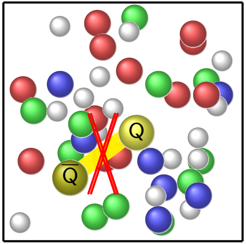
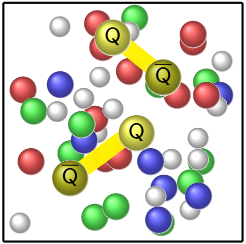
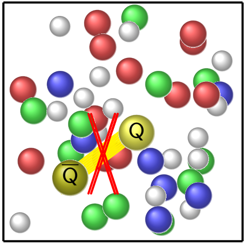
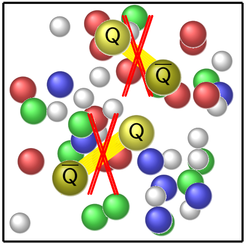




- Quarkonia suppression by color screening.
- Quarkonia recombination with high statistics for heavy flavor production.

Medium effects: quarkonia suppression/recombination





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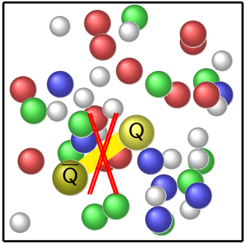

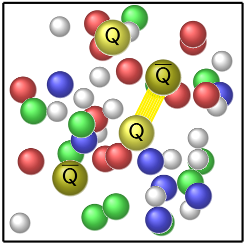

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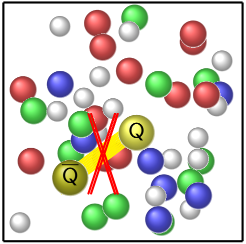

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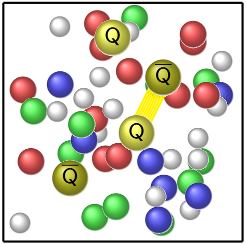

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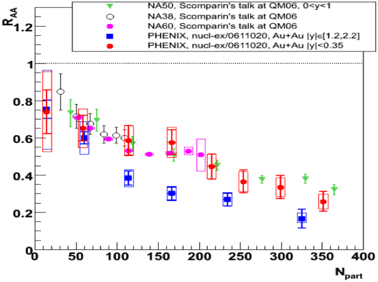


Open issues:

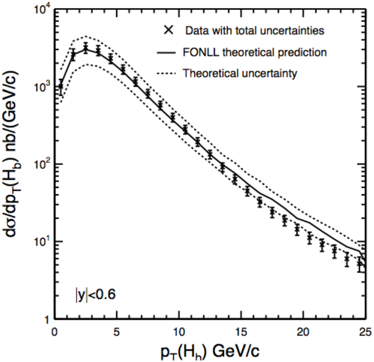
- Similar suppression at SPS and RHIC.
- Higher suppression at forward rapidities.
- Understanding cold nuclear matter effects at RHIC.

P. Braun-Munzinger talk@QM09, fig. by R. Granier de Cassagnac

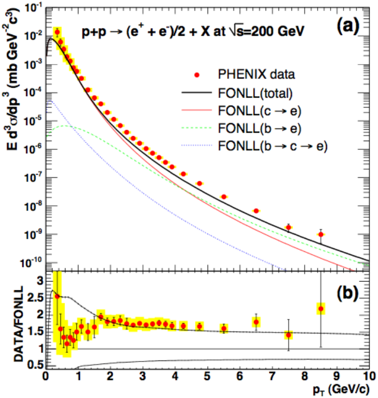
Heavy flavors in pp collisions

- Heavy-flavor mass is high enough to perform accurate perturbative QCD calculations (pQCD).

$p\bar{p}$ @ 1.96 TeV



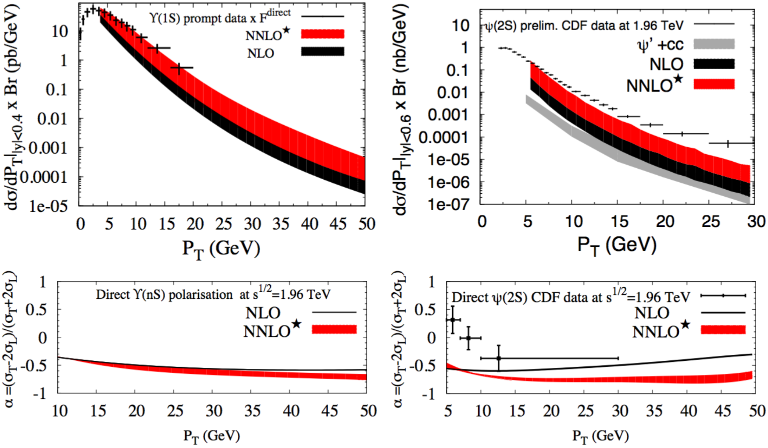
pp @ 200 GeV



D. E. Acosta *et al.* [CDF Collaboration], Phys. Rev. D **71** (2005) 032001
A. Adare *et al.* [PHENIX Collaboration], Phys. Rev. Lett. **97** (2006) 252002

Quarkonia in pp collisions

- Many models to describe the $Q\bar{Q}$ bound state (CSM, CEM, COM, ...): failures in the description of $d\sigma/dp_t$ and/or polarization.
- New QCD corrections for the CSM closer to data, but still some tuning needed.



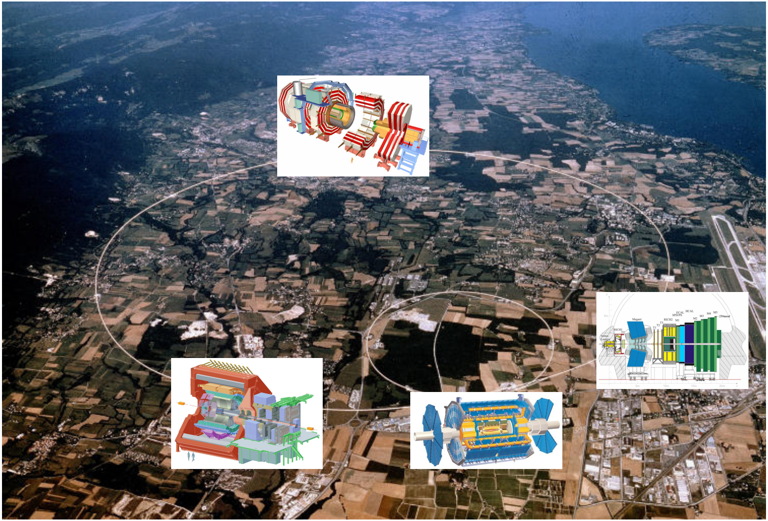
J. P. Lansberg, Eur. Phys. J. C **61** (2009) 693

Outline

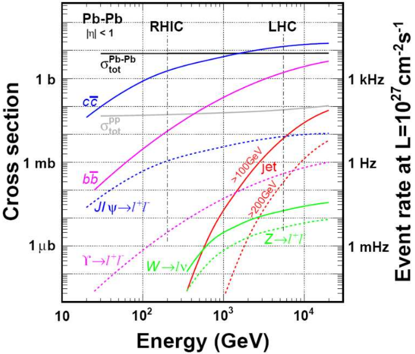
The Large Hadron Collider

- Maximum CoM energies:

pp	$\rightarrow$	$\sqrt{s} = 14$ TeV
PbPb	$\rightarrow$	$\sqrt{s_{NN}} = 5.5$ TeV

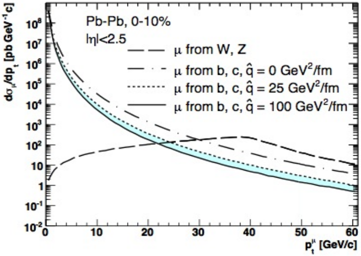


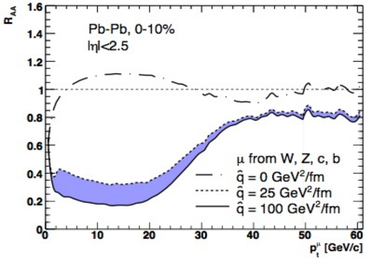
New features at the LHC



@ LHC				@ RHIC
σ_c	$\sim$	10	$\times$	σ_c
σ_b	$\sim$	100	$\times$	σ_b
σ_W	$\sim$	10	$\times$	σ_Υ
σ_Z	$\sim$			σ_Υ

- New medium-blind references available: W is affected by shadowing only.





P.Giubellino, arXiv:0809.1062 [nucl-ex]

Z.Conesa *et al.*, Phys.Lett. B **663** (2008) 202

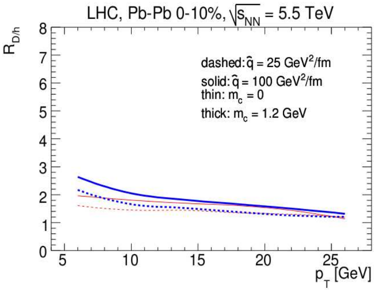
Heavy flavor issues

Medium-induced gluon radiation:

$$\Delta E_g > \Delta E_q > \Delta E_Q$$
$$R_{AA}^{h} < R_{AA}^{D} < R_{AA}^{B}$$

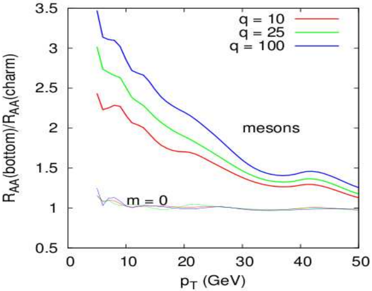
Testing color charge dependence:

$$R^{D/h} = R_{AA}^{D} / R_{AA}^{h}$$



Testing mass dependence:

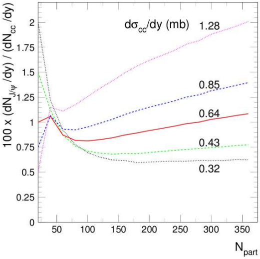
$$R^{B/D} = R_{AA}^{B} / R_{AA}^{D}$$



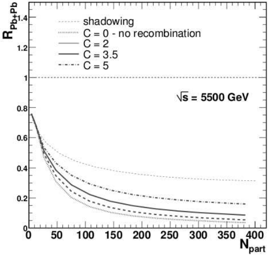
A.Dainese, Eur.Phys.J.C **49** (2007) 135
N.Armesto *et al.*, J.Phys.G **35** (2008) 054001

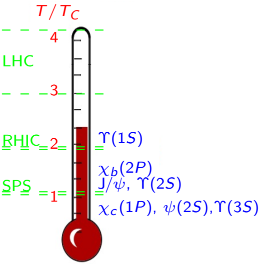
Heavy quarkonia issues

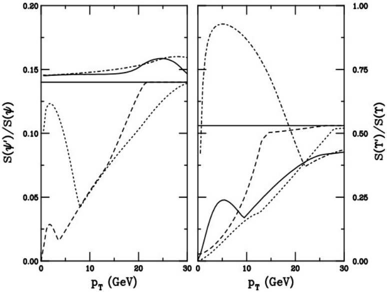
Recombination



Re-dissociation by comovers



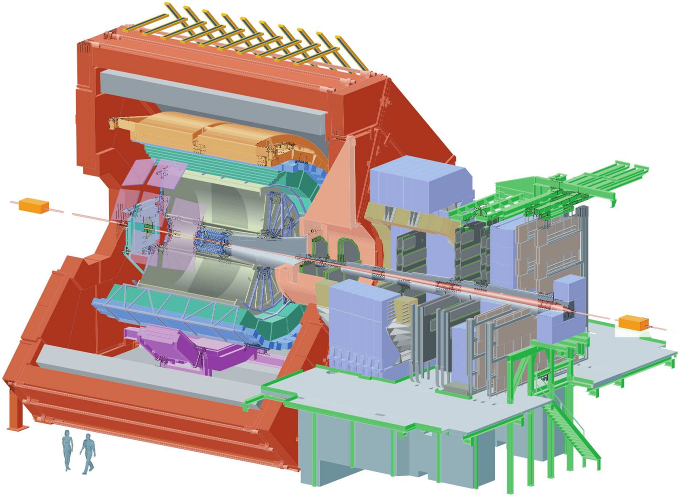




- Many scenarios predicted at LHC. Significant modification expected w.r.t. RHIC suppression pattern.
- Relevance of quarkonia ratio vs p_t.
- $\Upsilon(2S)$ can be used to unravel J/ψ suppr. vs. recombin.

N.Armesto *et al.*, J.Phys.G **35** (2008) 054001
L.V.Bravina *et al.*, arXiv:0902.4664 [hep-ph]

ALICE layout



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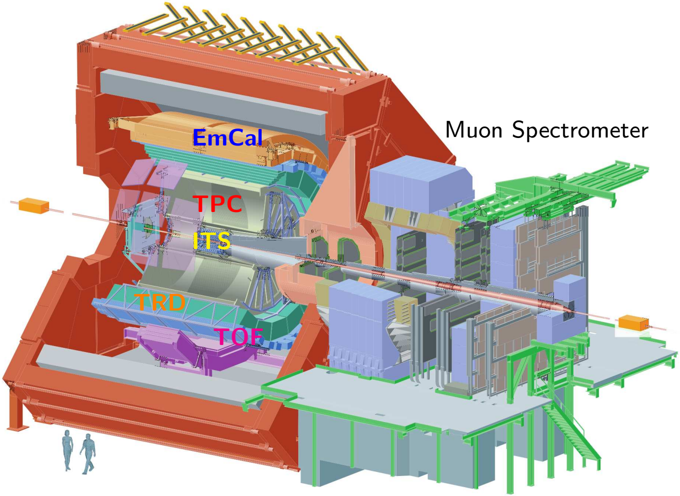

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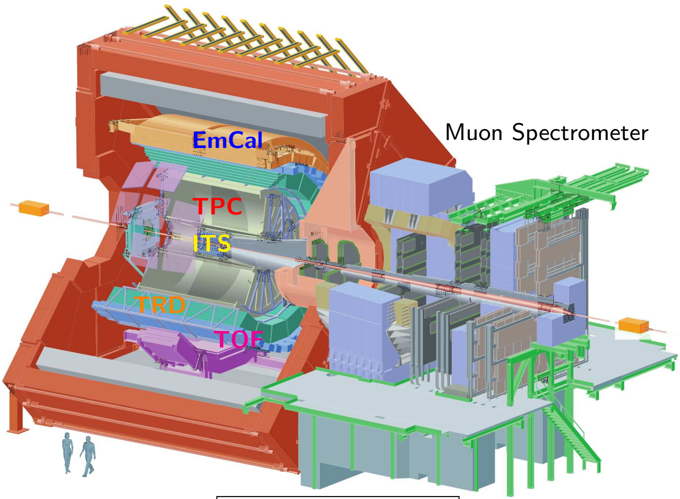


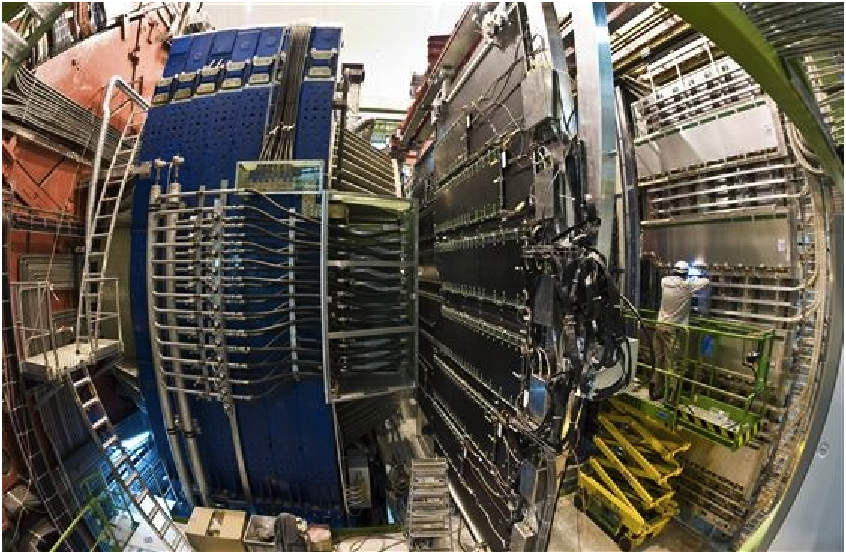
Central barrel		
B	$\rightarrow$	$X + J/\psi \rightarrow l^+ l^-$
B	$\rightarrow$	$X + e$
D^0	$\rightarrow$	$K^- + \pi^+$
D^+	$\rightarrow$	$K^- + \pi^+ + \pi^+$
$Q\bar{Q}$	$\rightarrow$	$e^+ + e^-$

Under study		
B	$\rightarrow$	> 5 prongs
D_s^+	$\rightarrow$	$K^- + K^+ + \pi^+$
D^{*+}	$\rightarrow$	$D^0 + \pi^+$
D^0	$\rightarrow$	$K^- + \pi^+ + \rho^0$
Λ_c^+	$\rightarrow$	$p + K^- + \pi^+$
$Q\bar{Q}$	$\rightarrow$	$X + e + \mu$
D^0	$\rightarrow$	$K^- + \pi^+ + \pi^- + \pi^+$

Forward rapidities		
(B)B	$\rightarrow$	$\mu + \mu + X$
B+D	$\rightarrow$	$\mu + X$
$Q\bar{Q}$	$\rightarrow$	$\mu^+ + \mu^-$

Under study		
(B)B	$\rightarrow$	$J/\psi + \mu$

Muon spectrometer



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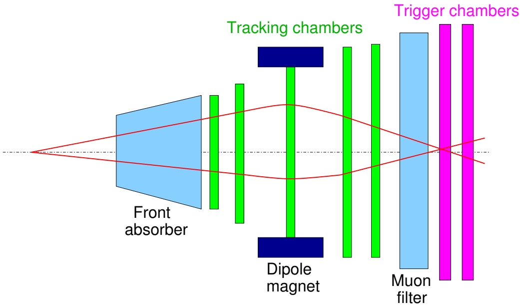

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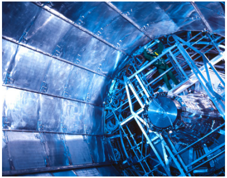

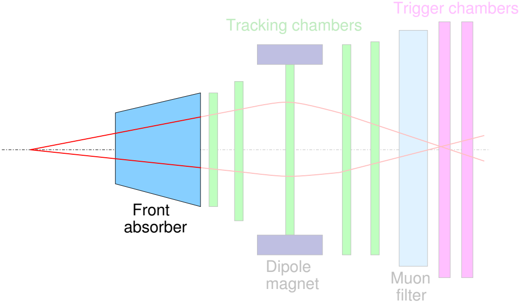

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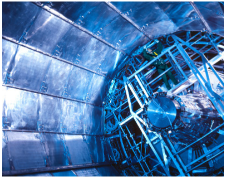
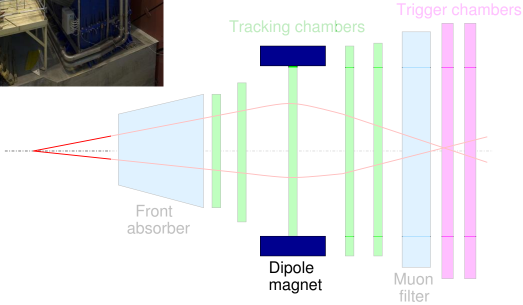
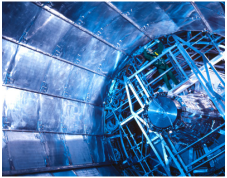
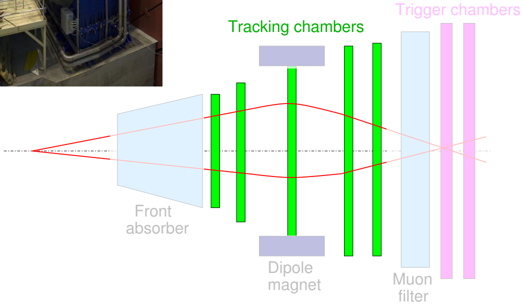




- Warm dipole with 3 Tm integrated field.

Muon spectrometer



- Warm dipole with 3 Tm integrated field.
- Tracking chambers: multi-wire CPC. Resolution $\lesssim 100\ \mu\text{m} \Rightarrow \sigma_p/p \sim 1\%$ $\Rightarrow \sigma_M \sim 100$ MeV/c^2 @ 10 GeV/c^2 (requirement for Υ separation).

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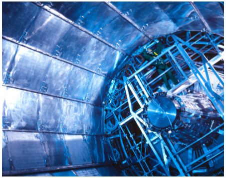

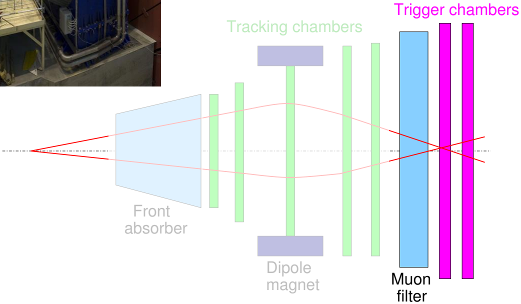

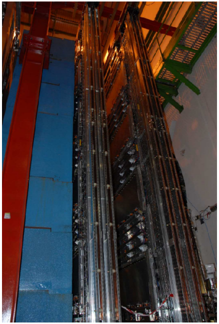

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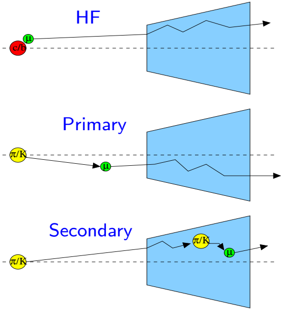
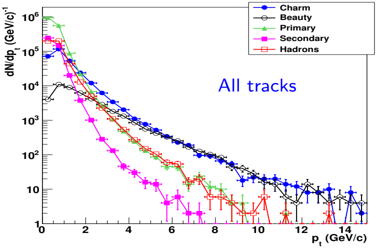
- Trigger chambers: RPC. Two programmable trigger p_t cuts among: $p_t \sim 0.5$ GeV/c (min.) $p_t \sim 1$ GeV/c (J/ψ) $p_t \sim 2$ GeV/c (Υ)

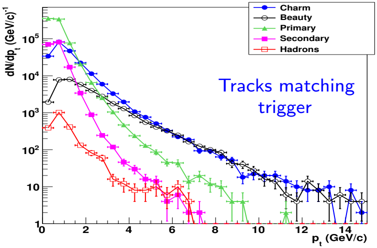
Outline

Tracks in the spectrometer

Particle	Source	$c\tau$
HF muons	Charm Beauty	$\sim 100\ \mu$m
Primary muons	π/K primary (prod. in the IP)	$\sim 4-8$ m
Secondary muons	π/K secondary (prod. in absorber)	
Hadrons		





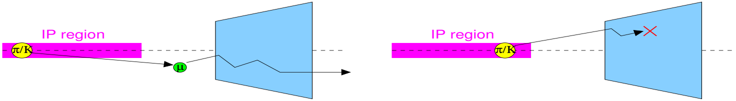


- Main contribution at low p_t from primary decay muons.

How to separate signal and bkg. w/o the information of secondary vertex?

Primary background subtraction

- In colliders, the region of beam crossing is diamond shaped: the Interaction Point (IP) can be localized everywhere in this region.
- The position of the IP is:
  - Almost fixed in the transverse plane ($\sigma \sim 100\ \mu\mathrm{m}$).
  - Distributed as a Gaussian ($\sigma \sim 5$ cm) along the beam direction.

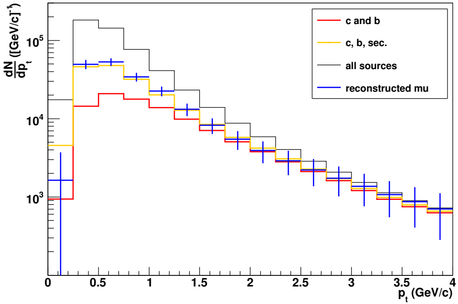


- Probability that hadron decays before reaching the absorber (i.e. prob. of having a primary bkg. muon) is $\propto$ distance IP - Absorber (D).

- Signal yields do not depend on D

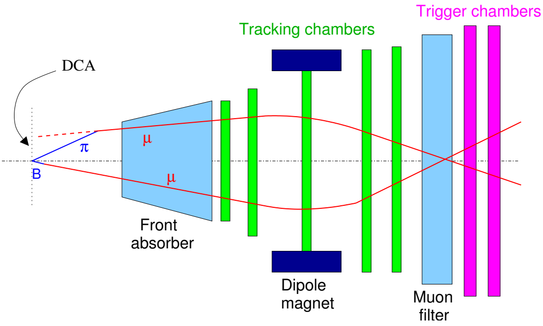
$\Downarrow$

- Possibility to subtract the primary background!



The Distance of Closest Approach

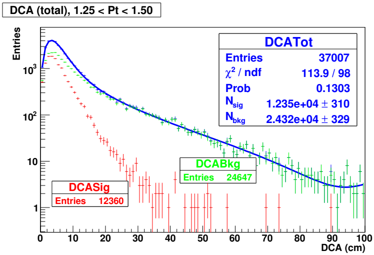
DCA $\stackrel{def}{=}$ distance between the extrapolation of the track through the muon absorber and the interaction vertex, measured in the plane orthogonal to the beam direction at the vertex position.



- For topological considerations, DCA is smaller for signal than background (smaller decay length).
- Multiple scattering in the absorber smears the DCA at low momenta.

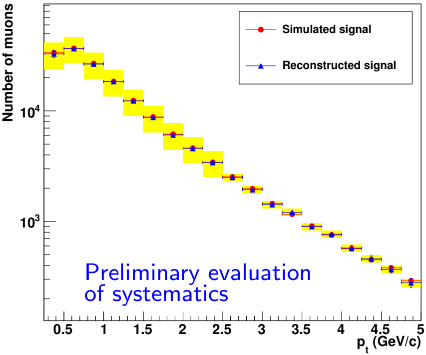
Measuring HF: DCA fit method

- DCA shape is different for signal and bkg: separation possible through fit.



Fit function:

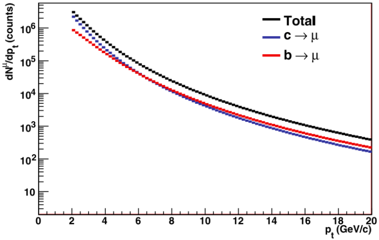
$$f(x;p_t) = N_{sig}\, f_{sig}(x;p_t) + N_{bkg}\, f_{bkg}(x;p_t)$$



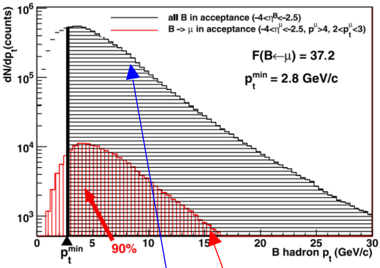
- ✔ Heavy flavors can be extracted down to low p_t.
- ✘ Needs knowledge of sig. and bkg. shapes form MC ⇒ systematics.
- ✔ Good test of absorber effects and bkg. description in MC.

N.Lebris, F.Yermia, D.S. *et al.*, Internal note submitted.

Measuring HF: the UA1 method



1. Extract number of muons from heavy flavors.
   - Subtract bkg.
   - Combined fit



2. Correct for efficiency, acceptance and decay kinematics.

Measured yields

Hadron MC distribution

$$\frac{d\sigma^H}{dy}(p_t^H > p_t^{min}) = \frac{N_{\mu\leftarrow H}(\Phi^\mu)}{\int \mathcal{L}dt} \times \frac{1}{\epsilon} \times \frac{\frac{d\sigma^H}{dy}(p_t^H > p_t^{min})}{\sigma^H(\Phi^\mu)}$$

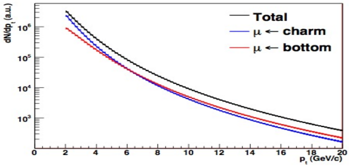
Integrated luminosity

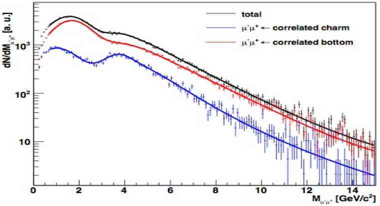
Lepton detection efficiency

MC cross sections for hadrons with a lepton in the phase space of analysis

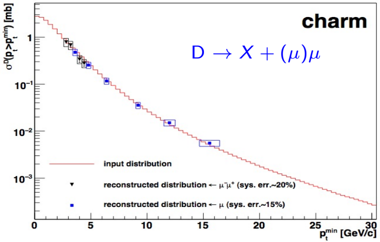
L. Manceau, Eur. Phys. J. C **62** (2009) 9

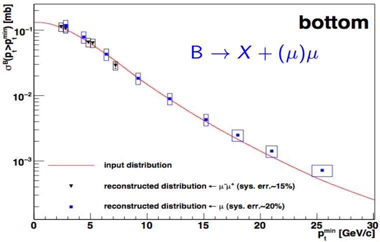
Measuring HF: combined fit





- CAVEAT: assuming perfect combinatorial bkg. subtraction.
- Statistical and systematic errors in 1 month of pp collisions @ 14 TeV, assuming $\mathcal{L} = 10^{30}$.

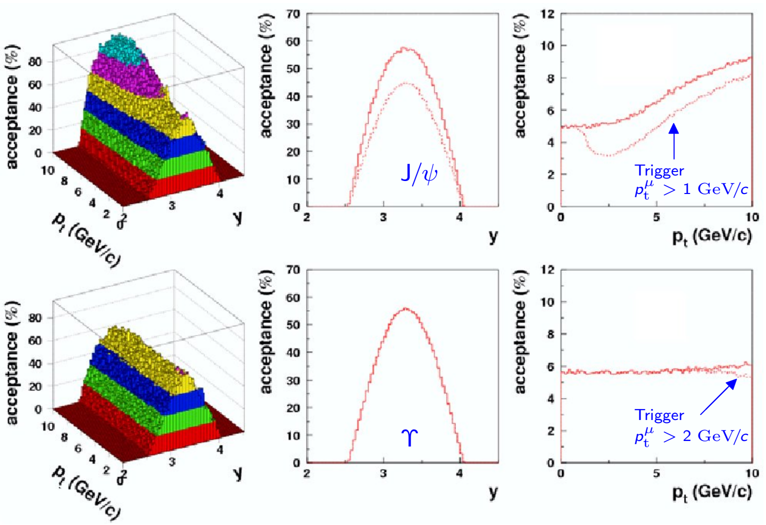




- Systematic error (taking into account comb. bkg. subtraction): $\sim$ 20% for B and $\sim$ 20% for D

L.Manceau *et al.*, Internal note submitted

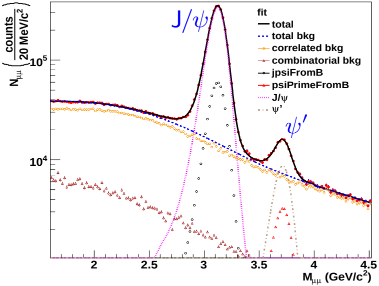
Acceptances

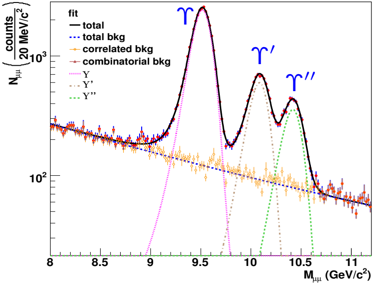


- Dimuon trigger p_t cut on individual muons to reject combinatorial background.
- Quarkonia triggered and detected down to $p_t = 0$.

ALICE Collab., J. Phys. G **32** (2006) 1295

Quarkonia physics performance at $\sqrt{s} = 14$ TeV

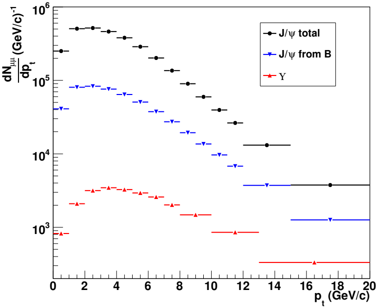




- All quarkonia states can be separated.
- High stat. and wide p_t range.

	σ (MeV/c^2)	S ($\times 10^3$)	$\frac{S}{\sqrt{S+B}}$
L1 trigger $p_t^\mu > 1$ GeV/c			
J/ψ	70	2807	1610
ψ'		75	170
L1 trigger $p_t^\mu > 2$ GeV/c			
Υ	100	27.1	157
Υ'		6.8	73
Υ''		4.2	55

$\mathcal{L} = 3 \times 10^{30}$ cm^{-2}s^{-1} $\mathcal{L}t = 30$ pb^{-1}

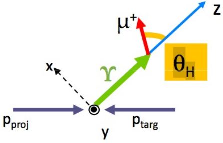


D.S., E.Vercellin, R.Guernane, ALICE-INT-2006-029

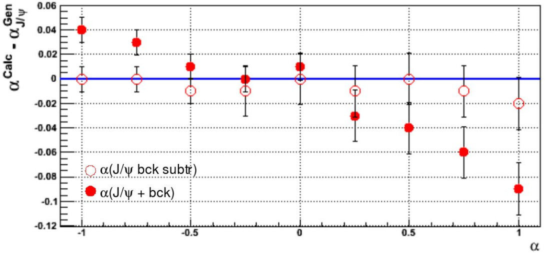
Quarkonia polarization: J/ψ

- Quarkonia polarization is determined by the μ^+ angular distribution in the quarkonium rest frame.
- The distribution is parameterized as: $\frac{d\sigma}{d\cos\theta_H} \propto 1 + \alpha\cos^2\theta_H$

$$\alpha = \frac{\sigma_T - 2\sigma_L}{\sigma_T + 2\sigma_L} \Rightarrow \begin{cases} 1 & \text{transverse} \\ 0 & \text{no polarization} \\ -1 & \text{longitudinal} \end{cases}$$



Helicity frame

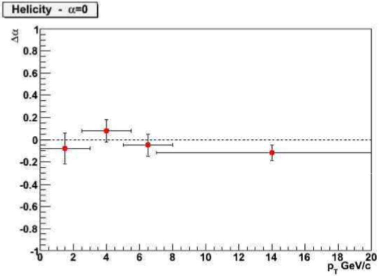


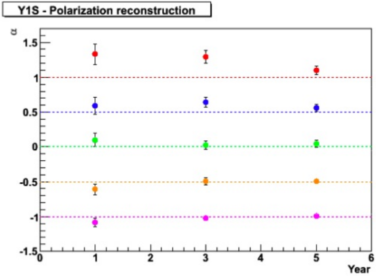
- Results obtained for 200k J/ψ ($\sim$ 7% of the statistics expected in 1 year in pp @ 14 TeV)

L.Bianchi,talk @ V Convegno Nazionale Fisica ALICE, Trieste, Feb. 09

Quarkonia polarization: Υ

- Expected results in 1 year of pp @ 14 TeV.
- $\Upsilon(1S)$ polarization measured with a statistical error between 0.05 - 0.11.
- p_t dependence measured with a statistical error below 0.2.





- Expected results in 1 year of PbPb @ 5.5 TeV
- $\Upsilon(1S)$ polarization integrated over centrality can be measured with an error of $\sim$ 0.1.
- Few years needed to investigate the p_t or centrality dependence of polarization.

L.Bianchi,talk @ V Convegno Nazionale Fisica ALICE, Trieste, Feb. 09

Near-future perspectives

- Long run with pp @ 7 TeV foreseen soon.

But what can we measure with a shorter data taking period?

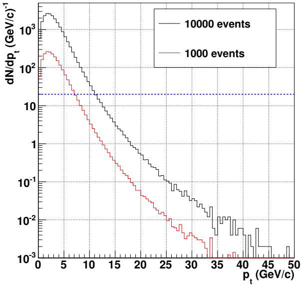
Assuming initially:
- $\mathcal{L} = 2.3 \times 10^{29}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$
- $\epsilon_{\mathrm{LHC}} = 12\%$

We expect:

J/ψ	ψ'	Υ	Υ'	Υ''	
1000	27	10	2	1	in $\sim$ 5 days
10000	267	97	24	15	in $\sim$ 45 days

Examples:

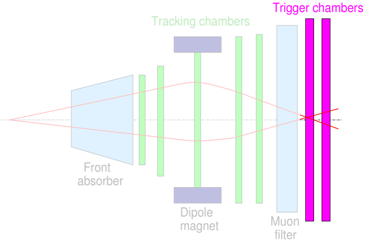
	10^3 J/ψ	10^4 J/ψ
Production cross section	✔	✔
Differential distributions	$p_t \lesssim 7$ (GeV/c)	$p_t \lesssim 12$ (GeV/c)
Polarization	✘	✔

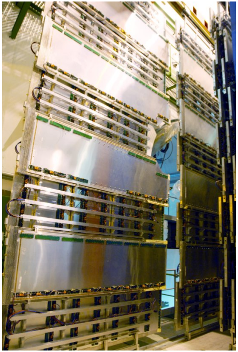


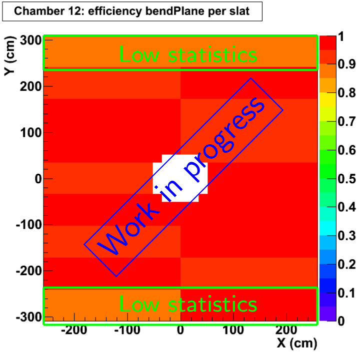
Outline

Trigger system status

- Trigger chamber efficiency measured from real data.
- Limited statistics ($\sim$ 1000 tracks used in the plot): cannot provide a finer map (yet).
- General status of the detector is ok.

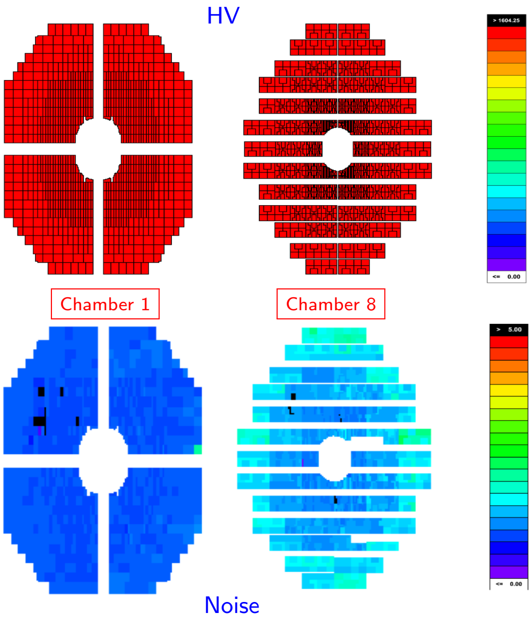






Tracking system status

- All chambers powered at HV = 1.6 kV
- Noise, pedestal and occupancy under control.

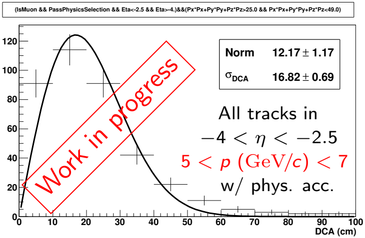


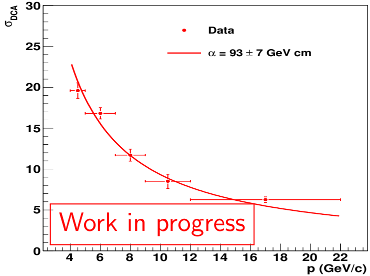
Multiple-scattering effects on DCA

1. Fit spectra in momentum bins with the approximate function:

$$\frac{dN}{dDCA} \propto DCA \times \exp\left[-\frac{DCA^2}{2\sigma^2}\right]$$

CAVEAT: preliminary results with a non-optimised function (high χ^2). Error bars may be underestimated.





2. Extract the width and fit with function:

$$\sigma_{DCA} = \frac{\alpha}{p}$$

- Distribution follows the expected law $\sigma_{DCA} \propto \frac{1}{p}$

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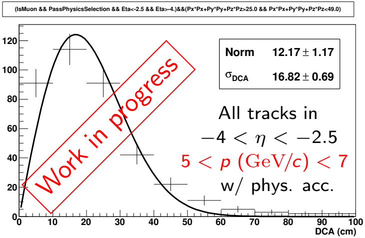
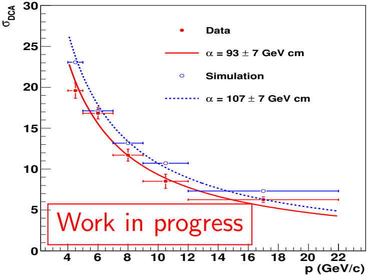




2. Extract the width and fit with function:

$$\sigma_{DCA} = \frac{\alpha}{p}$$

3. Compare with simulations

- Distribution follows the expected law $\sigma_{DCA} \propto \frac{1}{p}$
- Sigma is slightly lower for data.

Outline

Conclusions

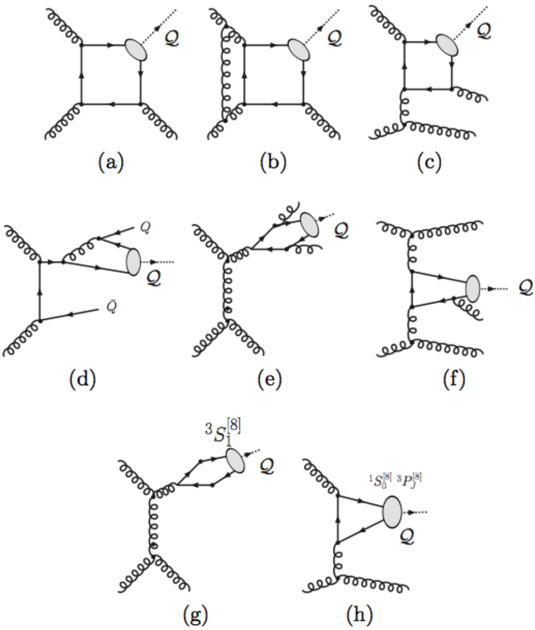
- LHC: a heavy flavor factory.
- High energies and luminosities:
  - New energy domain explored.
  - High statistics for $c\bar{c}$ and $b\bar{b}$.
  - Electroweak bosons can be used as medium-blind references.
- ALICE is well fit for open and hidden heavy flavor analysis, both at central and forward rapidities.
- The Muon Spectrometer performance on open heavy-flavor and quarkonia detection was studied in detail through simulations:
  - all quarkonia states can be separated;
  - quarkonia detected down to $p_{\mathrm{t}} = 0$;
  - quarkonia polarization can be measured both in pp and PbPb collisions.
  - methods for the extraction of heavy-flavor contribution from the single-muon distributions are under study.
- The preliminary analysis of results in pp collisions @ 900 GeV suggests a good status of the detector.

Perspectives

- Understand the detector:
  - validate simulations with data;
  - use DCA distributions to test the effects of absorber.
- First analysis on single muons: test methods for the extraction of heavy-flavor signal from the single muon contribution.
- With higher statistics, study quarkonia $\rightarrow \mu^+\mu^-$.

Outline

Quarkonia production



Color-Singlet

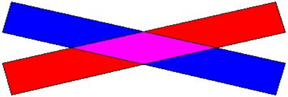
α_s^3 (a)
α_s^4 (b), (c), (d)
α_s^5 (e), (f)

Color-Octet

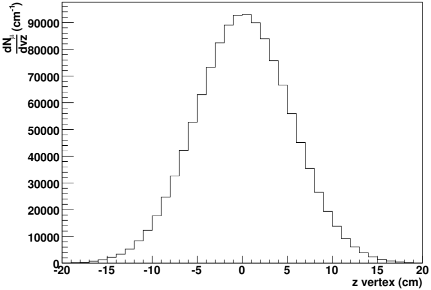
α_s^3 (g), (h)

Interaction point displacement

In colliders, the regions of beam crossing (where interactions take place) are diamond shaped.



The interaction vertex can be localized everywhere inside the diamond.



Interaction vertex longitudinal distribution for events with a reconstructed μ of $p_t > 1$ GeV/c

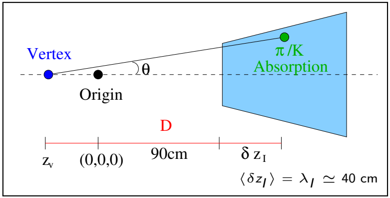
The interaction vertex is:

- almost fixed in the (x,y) plane ($\sigma \sim 100\,\mu$m)
- distributed as a Gaussian $\rho(z_v)$, with $\sigma \sim 5$ cm along beam axis z.

Decay background subtraction (I)

The decay probability for primary $\pi/\mathrm{K} \rightarrow \mu + X$ grows almost linearly with the distance (D) between vertex and absorber:

$$P_\mu \propto 1 - \exp\left(-\frac{\gamma D}{c\tau \cos\theta}\right) \sim \frac{\gamma D}{c\tau \cos\theta}$$



Hence:

$$\frac{\mathrm{d}^2 N_\mu^{\pi/\mathrm{K}}}{\mathrm{d}p_\mathrm{t}\,\mathrm{d}z_\mathrm{v}} = f(z_\mathrm{v})\; f(p_\mathrm{t})\; P_\mu = \rho(z_\mathrm{v})\; A_{\pi/\mathrm{K}}(p_\mathrm{t})\; D$$

The behavior of secondary muons depends on the survival probability $(1 - P_\mu)$ of primary π/K:

$$\frac{\mathrm{d}^2 N_\mu^{sec}}{\mathrm{d}p_\mathrm{t}\,\mathrm{d}z_\mathrm{v}} = f(z_\mathrm{v})\; f(p_\mathrm{t})\; (1 - P_\mu) = \rho(z_\mathrm{v})\; (\; B_{sec}(p_\mathrm{t}) - A_{sec}(p_\mathrm{t})\; D)$$

For heavy flavor muons:

$$\frac{\mathrm{d}^2 N_\mu^{c/b}}{\mathrm{d}p_\mathrm{t}\,\mathrm{d}z_\mathrm{v}} = f(z_\mathrm{v})\; f(p_\mathrm{t}) = \rho(z_\mathrm{v})\; B_{c/b}(p_\mathrm{t})$$

Decay background subtraction (II)

The total muon spectrum is the sum of the different muon sources which can be written as:

$$\frac{d^2N_\mu}{dp_t dz_v} = \frac{d^2N_\mu^{c/b}}{dp_t dz_v} + \frac{d^2N_\mu^{\pi/K}}{dp_t dz_v} + \frac{d^2N_\mu^{sec}}{dp_t dz_v}$$
$$= \rho(z_v)[\ B_{c/b}(p_t) + D\ A_{\pi/K}(p_t) + B_{sec}(p_t) - D\ A_{sec}(p_t)]$$

Collecting the terms depending on the distance D:

$$\frac{d^2N_\mu}{dp_t dz_v} = \rho(z_v)[B_{c/b}(p_t) + B_{sec}(p_t) + D(A_{\pi/K}(p_t) - A_{sec}(p_t))]$$

$$\Downarrow$$

Fit the muon spectrum at a given p_t with function $Gauss \times (\beta + \alpha D)$

$$\begin{cases} \text{Gauss} = \rho(z_v) \\ \beta = B_{c/b}(p_t) + B_{sec}(p_t) \\ \alpha = A_{\pi/K}(p_t) - A_{sec}(p_t) \end{cases}$$

If $\int \rho(z_v) dz_v = 1 \Rightarrow$ the parameter β estimates the heavy flavor contribution, with a bias from secondaries.

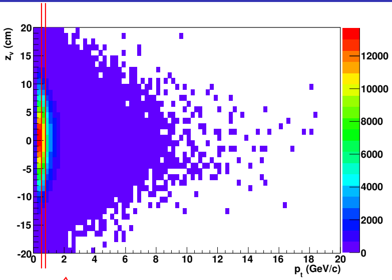
Decay bkg. can be subtracted.

(Other methods required for secondaries).

Applying the method

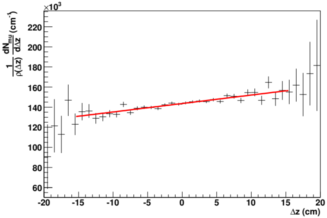
1. Get the muon bi-dimensional distribution $p_t - z_v$ (vertex position measured with SPD).

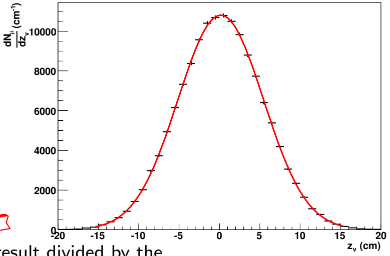
Results refer to p–p collisions @14TeV, but analogous considerations hold in Pb–Pb.



$0.5 < p_t < 0.75$

2. Cut in slices of p_t and fit with function: $Gauss \times (\beta + \alpha D)$
$D \simeq z_v + 130$ (cm)





The result divided by the Gaussian gives a straight line

Decay background subtraction details

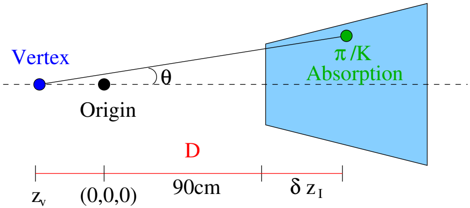
The decay probability for primary $\pi/\mathrm{K} \to \mu + X$ grows almost linearly with the distance (D) between vertex and absorber:

$$P_\mu \propto 1 - \exp\left(-\frac{D \tan\vartheta \, m_{\pi/\mathrm{K}}}{c\tau \, p_\mathrm{t}^{\pi/\mathrm{K}}}\right) \sim \frac{D \tan\vartheta \, m_{\pi/\mathrm{K}}}{c\tau \, p_\mathrm{t}^{\pi/\mathrm{K}}}$$

$$\frac{\mathrm{d}N_\mu^{\pi/\mathrm{K}}}{\mathrm{d}p_\mathrm{t}} = \int \mathrm{d}\theta \int \mathrm{d}p_\mathrm{t}^{\pi/\mathrm{K}} \, P(p_\mathrm{t}, p_\mathrm{t}^{\pi/\mathrm{K}}) \, \frac{\mathrm{d}N_{\pi/\mathrm{K}}}{\mathrm{d}p_\mathrm{t}^{\pi/\mathrm{K}}\mathrm{d}\theta} \int \mathrm{d}z_\mathrm{v} \, \rho(z_\mathrm{v}) \, P_\mu$$

$$\frac{\mathrm{d}^2 N_\mu^{\pi/\mathrm{K}}}{\mathrm{d}p_\mathrm{t}\mathrm{d}z_\mathrm{v}} \simeq D\rho(z_\mathrm{v}) \int \mathrm{d}\theta \int \mathrm{d}p_\mathrm{t}^{\pi/\mathrm{K}} \, P(p_\mathrm{t}, p_\mathrm{t}^{\pi/\mathrm{K}}) \, \frac{\mathrm{d}N_{\pi/\mathrm{K}}}{\mathrm{d}p_\mathrm{t}^{\pi/\mathrm{K}}\mathrm{d}\theta} \, \frac{m_{\pi/\mathrm{K}} \tan\theta}{c\tau \, p_\mathrm{t}^{\pi/\mathrm{K}}}$$

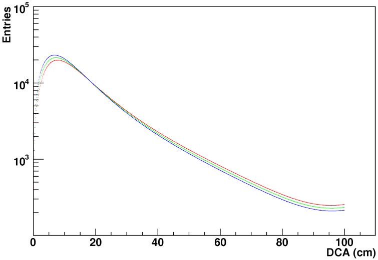
$$= \rho(z_\mathrm{v}) \, A_{\pi/\mathrm{K}}(p_\mathrm{t}) \, D$$

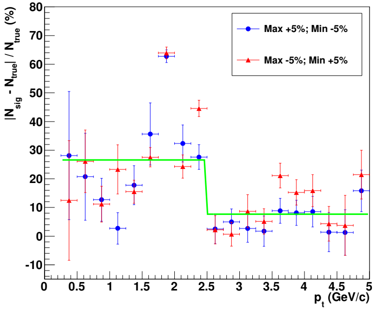


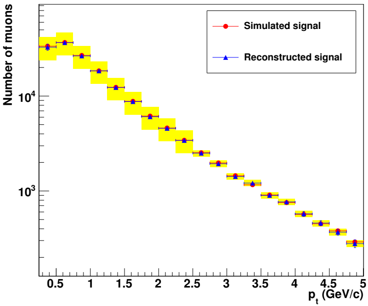
$\langle \delta z_I \rangle = \lambda_I \simeq 40$ cm

DCA method: systematics

- The knowledge of the shape of DCA for signal and bkg. relies on simulations: good absorber description needed.
- Preliminary estimation varying the shape of the DCA for background.

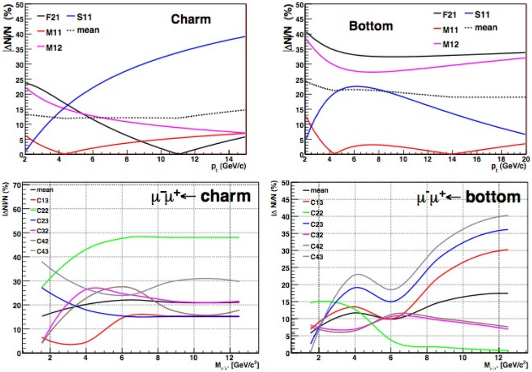




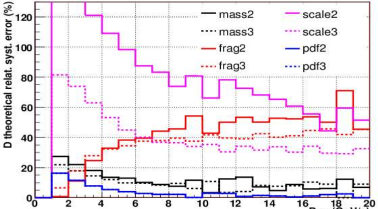


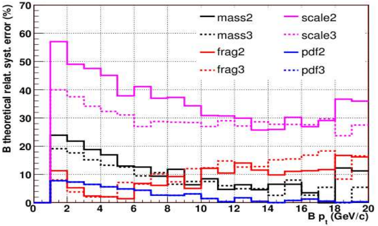
Combined fit method: systematics

- Systematics: varying mass, fragment., and scale parameters in pQCD calc.



- Obtained values $\sim 20\%$, to compare with theoretical uncertainties:





L.Manceau *et al.*, Internal note submitted

Quarkonia simulation inputs

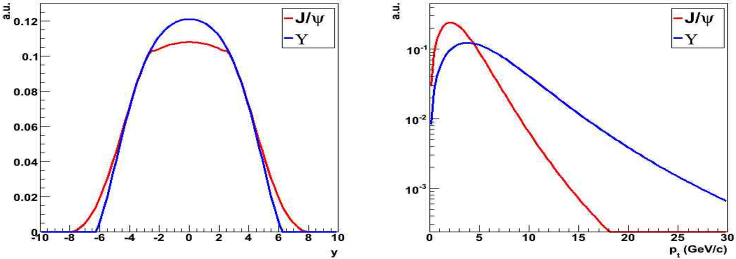
Quarkonia

- Cross section from the Color Evaporation Model (HO)
    - $m_c = 1.2$ GeV/c^2; $\mu = 2m_c$
    - $m_b = 4.5$ GeV/c^2; $\mu = 2m_b$
    - Direct production (e.g. p+p→ J/ψ + X).
    - Feed-down from higher resonances (e.g. p+p→ $Y + \psi' \rightarrow$ J/ψ + X).
- J/ψ from B decay included.
- p_t distribution extrapolated from CDF data.

	$\sigma \times \mathrm{BR}_{\mu^+\mu^-}$	
J/ψ	3.18	μb
ψ'	0.057	μb
Υ	28	nb
Υ'	7	nb
Υ''	4.2	nb
pp @ 14 TeV		

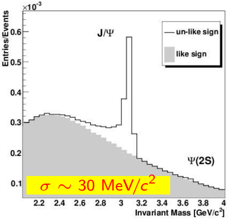
Background

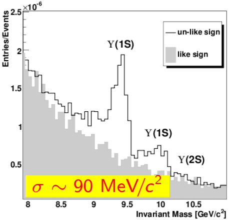
- PYTHIA tuned to reproduce NLO pQCD (MNR).



Expected performances in PbPb collisions

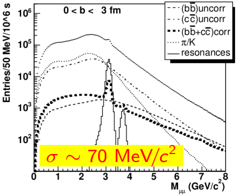
$|\eta| < 0.9$

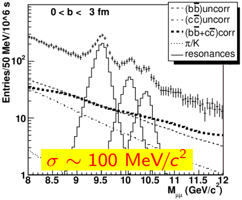




	σ (MeV/c^2)	S	$\frac{S}{\sqrt{S+B}}$
J/ψ	30	120000	245
Υ	90	900	21
Υ'		350	8
$dN_{ch}/dy\|_{y=0} = 3000$			

$-4 < \eta < -2.5$





	σ (MeV/c^2)	S	$\frac{S}{\sqrt{S+B}}$
J/ψ	74	130000	150
Υ	100	1300	29
Υ'		350	12
Υ''		200	8
$dN_{ch}/dy\|_{y=0} = 6000$			

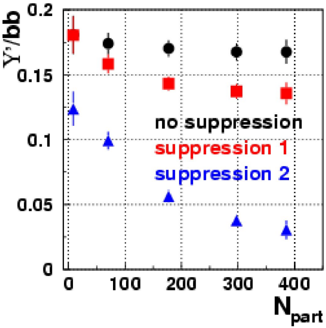
- Expected results in 1 month of PbPb collisions at 5.5 TeV.
- Luminosity of $5 \times 10^{26}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$.

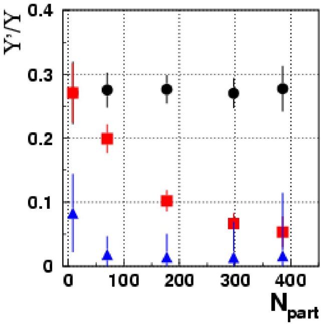
ALICE Collab., J. Phys. G **32** (2006) 1295
W.Sommer *et al.*, arXiv:nucl-ex/0702045

Suppression studies

- Testing suppression scenarii with particle ratios.
- Expectations in 1 month at $\mathcal{L} = 5 \times 10^{26}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$.

	T_C (MeV)	T_D/T_C Υ	T_D/T_C Υ'
Suppr. 1	270	4.0	1.4
Suppr. 2	190	2.9	1.1

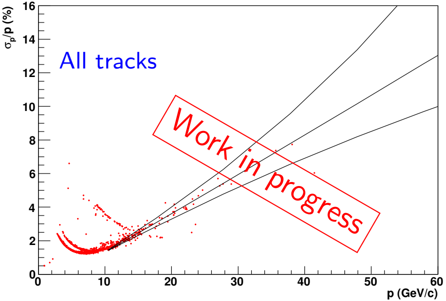




Track resolution

- Testing the track resolution. We expect:
  - Low-p region dominated by multiple scattering in the front absorber.
  - Resolution $\sigma_p/p \propto p$ at higher p (spatial resolution effect: chambers not aligned).

- Expected resolution assuming a chamber spatial resolution of 4 mm.



- Tracks outside the main line mostly outside acceptance.

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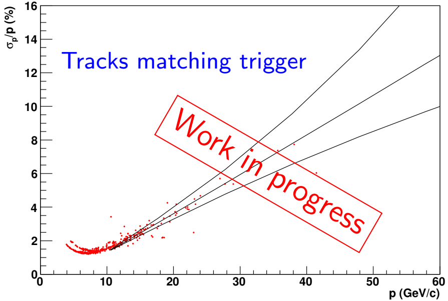

- Tracks outside the main line mostly outside acceptance.
- Tracks matching trigger correctly reconstructed.