The CBM Experiment at FAIR

- An Update -

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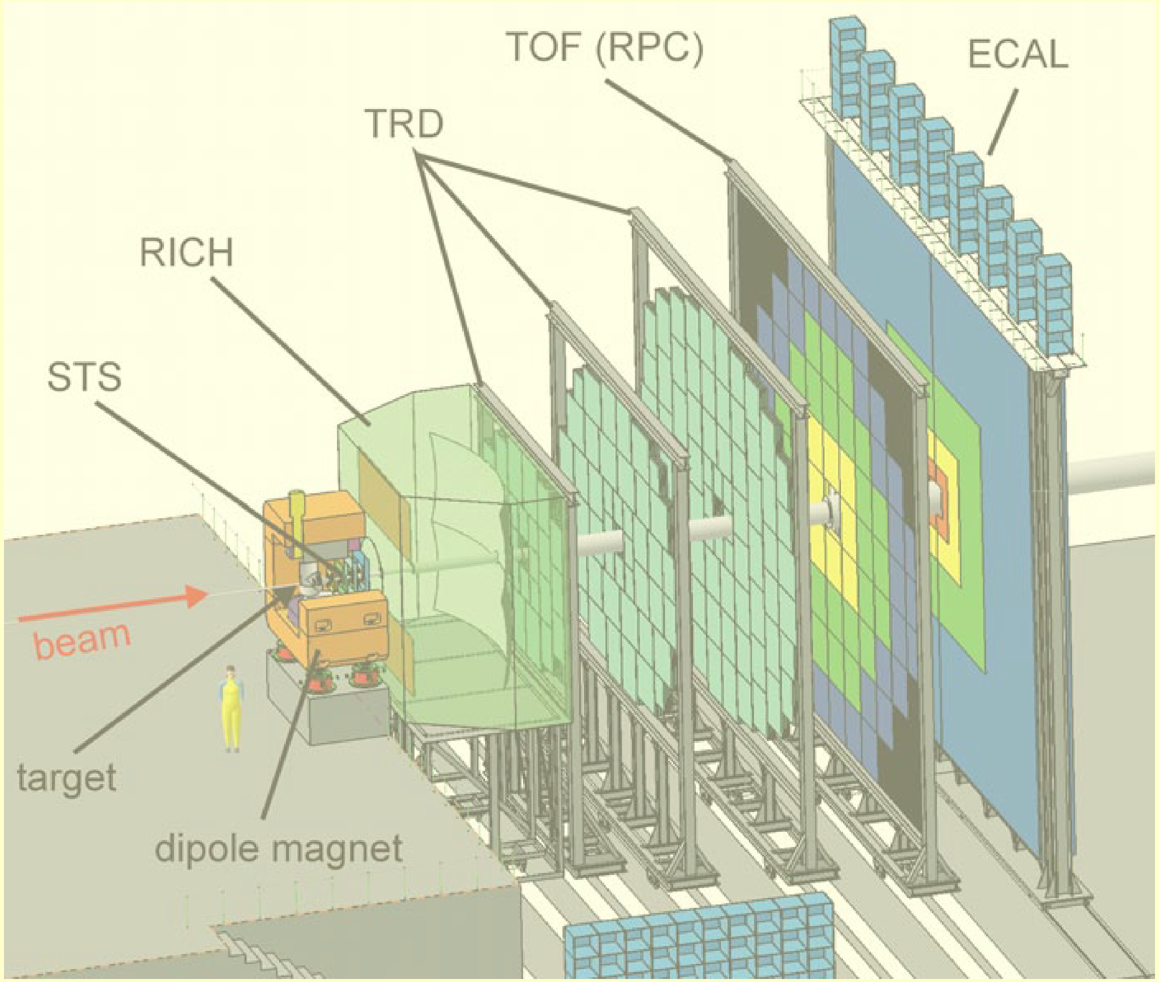
Workshop on The Physics of Compressed Baryonic Matter
Trento, May 28 – June 2, 2006

Baseline Detector Setup



Tracking: STS, TRD

Vertexing: STS

Hadron ID : TOF

Electron ID: RICH, TRD, ECAL

γ, n: ECAL

CBM Feasibility Studies

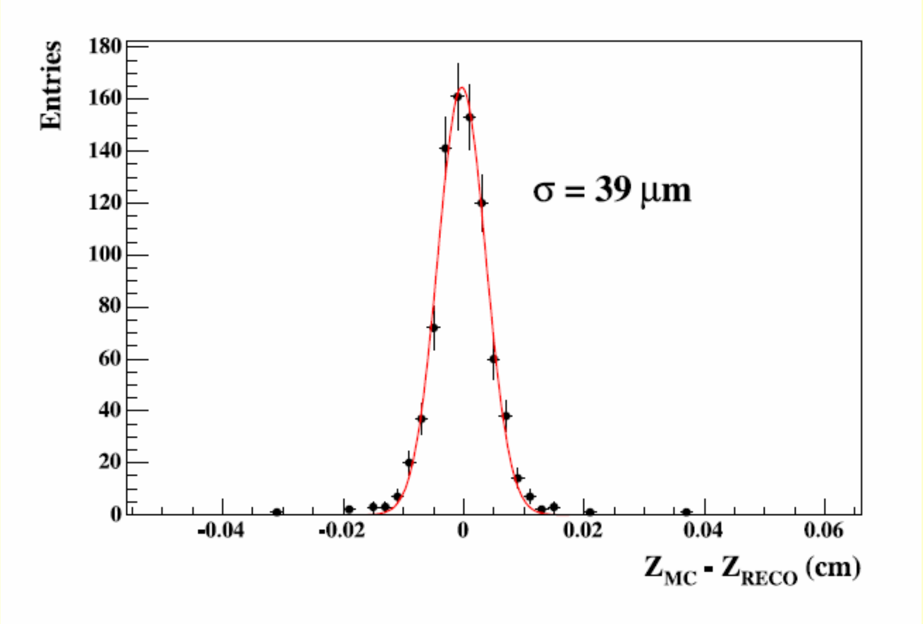
- $D^0 \rightarrow \pi^+ K^-$ ($D^\pm \rightarrow \pi\pi K$)
- $J/\psi \rightarrow e^+ e^-$
- $J/\psi \rightarrow \mu^+ \mu^-$
- $\rho, \omega, \varphi \rightarrow e^+ e^-$
- $\Lambda \rightarrow \pi^- p$, $\Xi^- \rightarrow \Lambda \pi^-$, $\Omega^- \rightarrow \Lambda K^-$
- K/π fluctuations

Simulation levels:

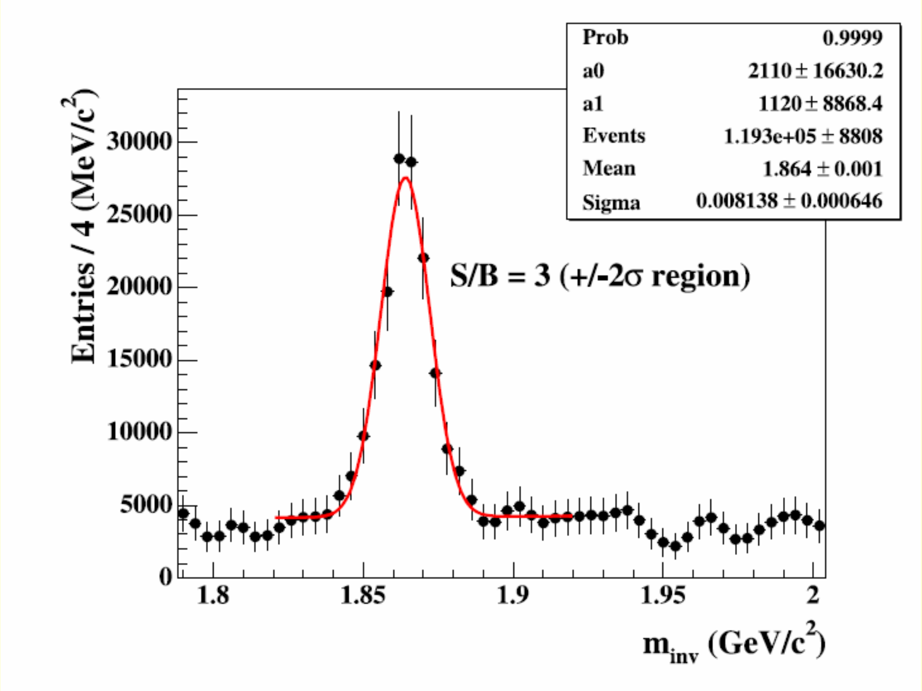
- pure Monte-Carlo (principal feasibility; acceptance, estimated yields)
- anticipated detector response, track and vertex reconstruction
- full detector simulation including global tracking and PID

Performance of STS for D^0 Mesons

vertex resolution



invariant π^+K^- mass



without PID

similar studies for $D^\pm$ (larger cτ, better vertex, 3-particle combinatorics)

Optimisation of the STS

geo/ eff	Ref. Prim.	Ref. Sec.	Ref.	All	Extra Prim.	Extra Sec.	Extra	Clone	Ghost	MCT/ event
2m3h2s/o	0.994	0.58	0.95	0.92	0.92	0.37	0.80	0.00	0.02	547
2m3h2s/r	0.993	0.57	0.95	0.91	0.92	0.36	0.80	0.00	0.02	558
2m3h2s/p	0.992	0.56	0.95	0.91	0.92	0.35	0.79	0.00	0.02	567
2m1h4s/r	0.975	0.57	0.94	0.89	0.87	0.34	0.76	0.00	0.04	511
short	0.987	0.58	0.95	0.91	0.91	0.36	0.79	0.00	0.03	519
50	0.959	0.55	0.92	0.87	0.85	0.33	0.74	0.00	0.05	501
80	0.940	0.53	0.90	0.85	0.82	0.32	0.72	0.00	0.06	488
Strasbourg	0.983	0.58	0.94	0.89	0.87	0.33	0.74	0.00	0.01	524

Optimisation of STS: open charm

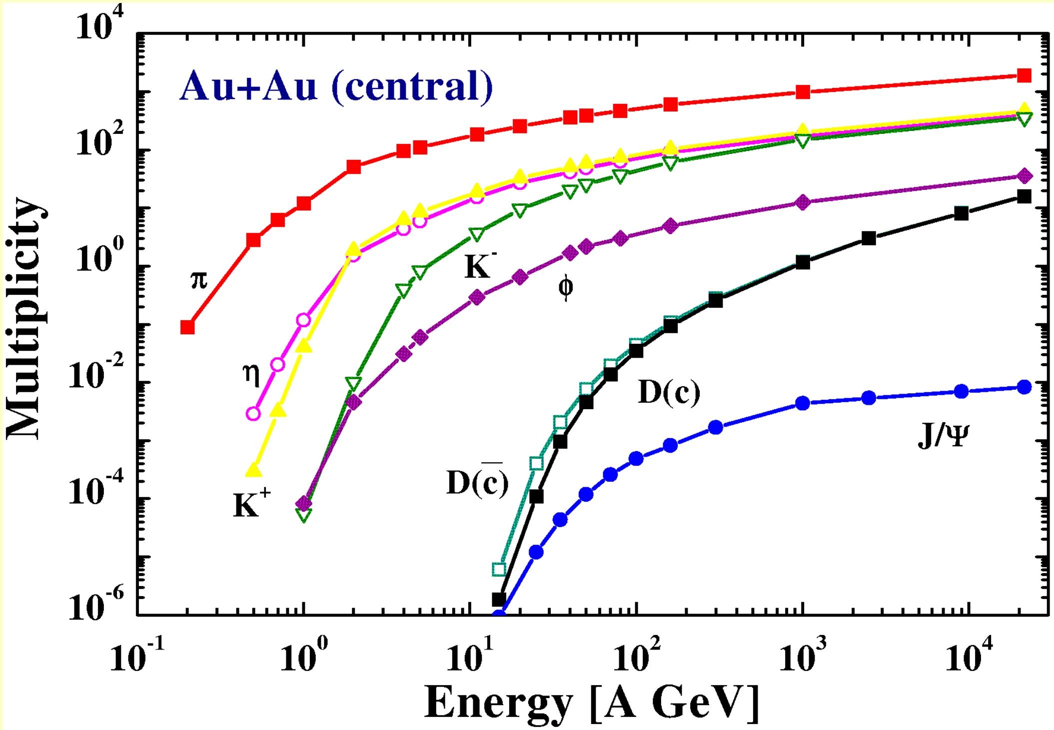
geo/ eff	D^0 eff. (%)	SV res. (µm)	D^0 mass (MeV)	dP/P	S/B
2m3h2s/o	10.3	33	10	0.68	
2m3h2s/r	9.2	44	11	0.80	
2m3h2s/p	8.3	57	11	1.2	
2m1h4s/r	8.6	43	11	0.84	
short	7.7	40	11	1.15	
50	7.0	48	11	0.90	
80	7.2	47	11	1.15	
Strasbourg	7.2	48	12	1.15	

Open Charm: Questions

What should me measure: yields, spectra, flow?

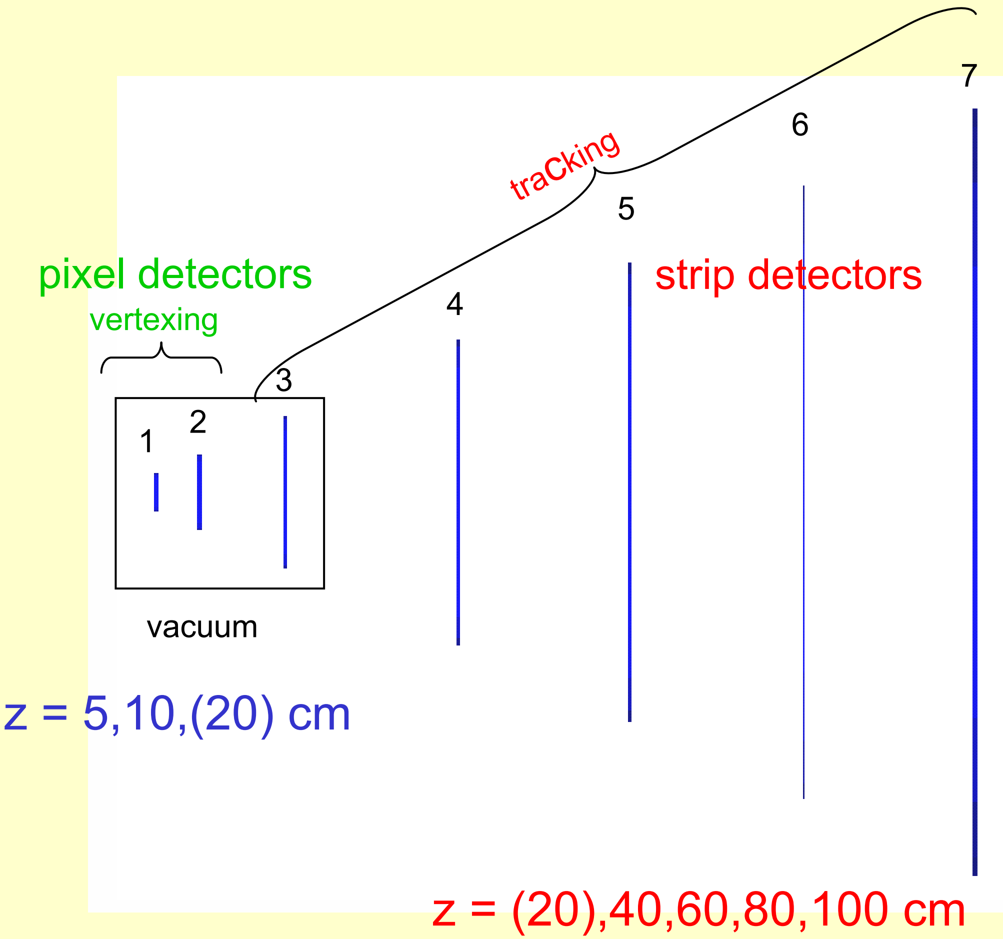
How close to threshold do we have to go?

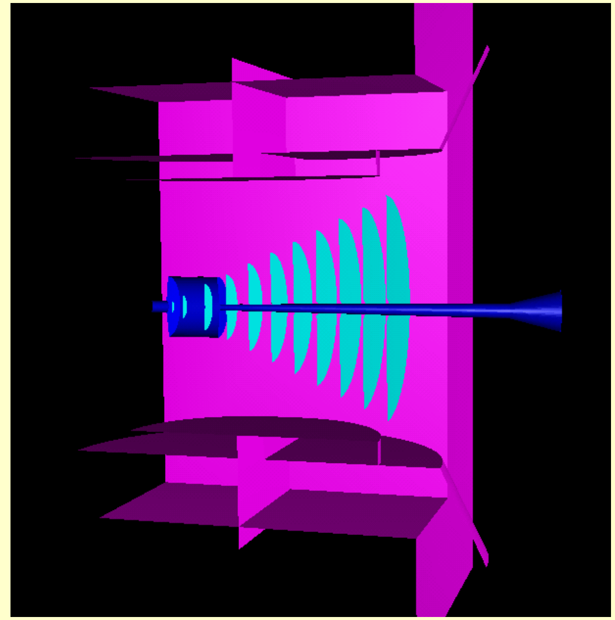
What about charmed baryons?
(Λ_c, τ = 60 µm, very challenging!)



Huge impact on design of STS!

The Silicon Tracking System



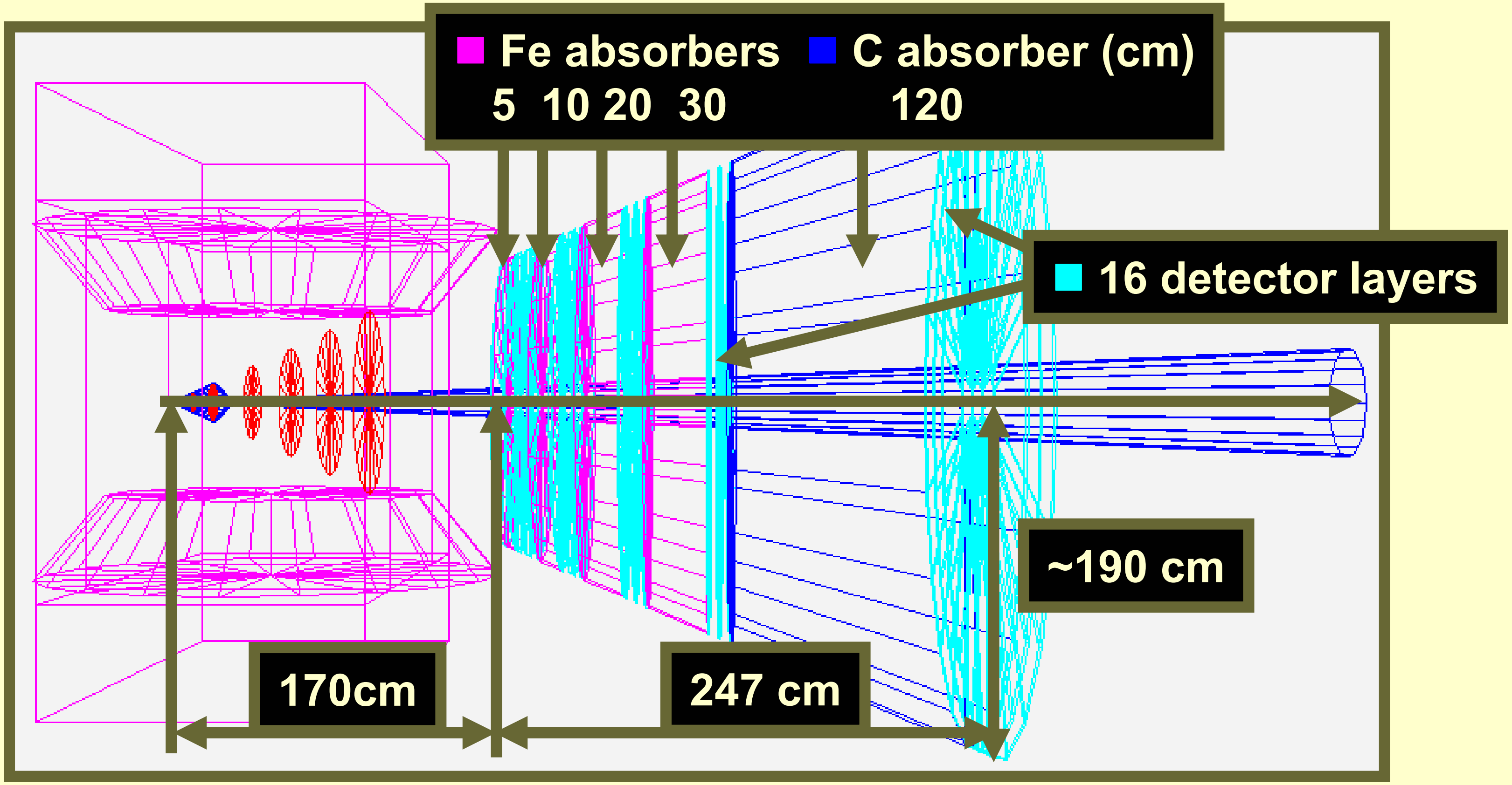


Main Tracker (hybrid pixel + strip)

Vertex tracker: MAPS
in-vacuo operation
removable, for open charm only
(not maximum intensity)

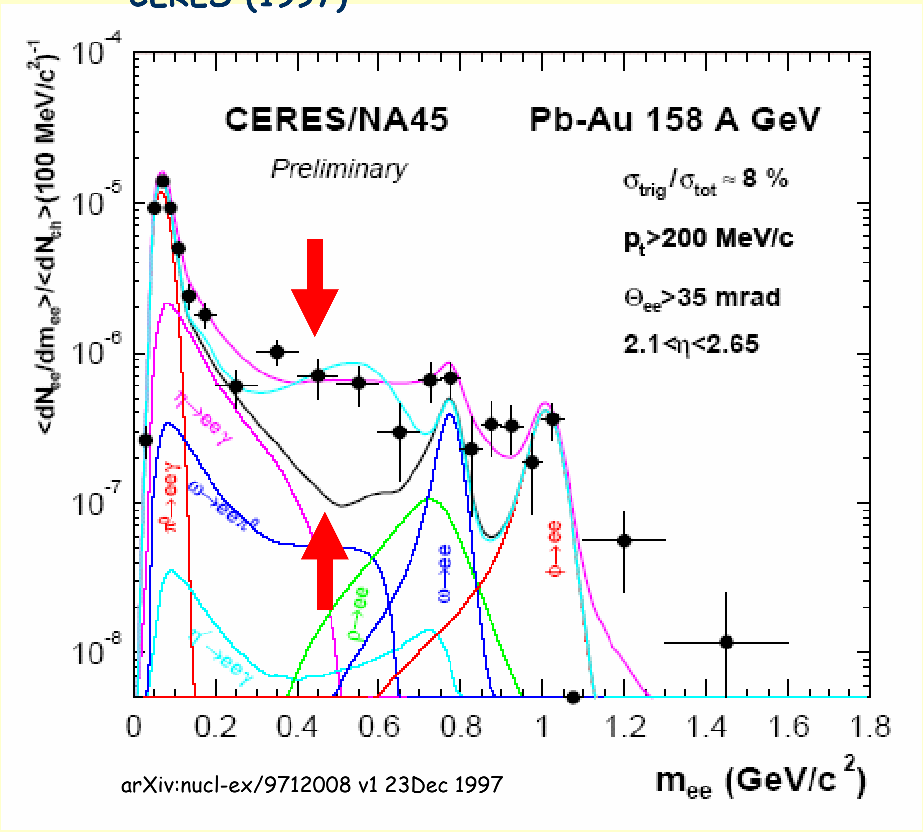
Electrons or Muons?

Concept of an active absorber setup for muon identification

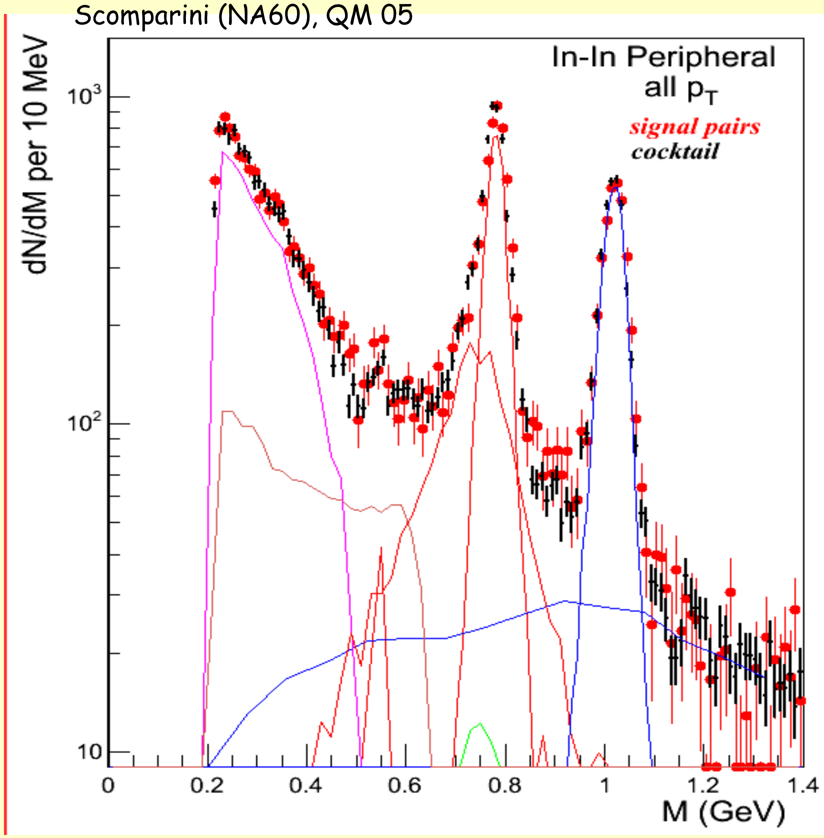


Electrons vs muons: physics difference

CERES (1997)



Scomparini (NA60), QM 05



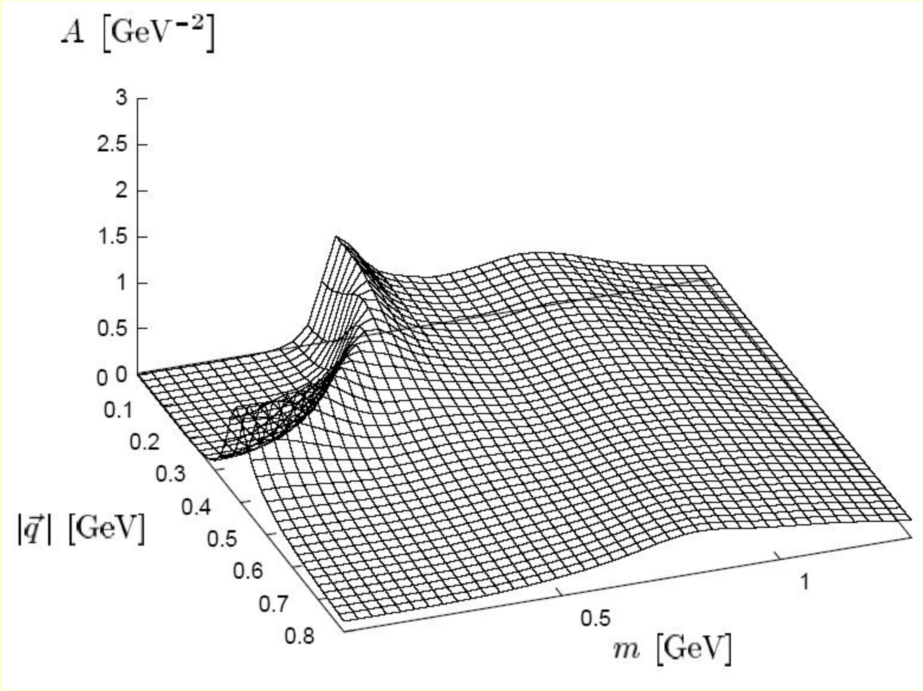
Electrons vs. muons: physics difference (2)

Both dielectrons and dimuons measure LVM and charmonium

Muon measurements exclude mass range below $2\ m_\mu \approx 200$ MeV

Relevant physics: (modified ρ) : 200 – 600 MeV → close to edge of phase space.

No π Dalitz peak in spectrum (efficiency control, normalisation of cocktail)



Electrons vs muons: Identification

- electron identification is complicated: cherenkov, TR
  needs dedicated detectors, but: established technologies

- muon identification: simple in principle: absorber
  details are tedious: optimisation of absorber material / thickness
  usually optimised to one beam energy, not well suited for energy scan
  problem: matching of track before and after absorber

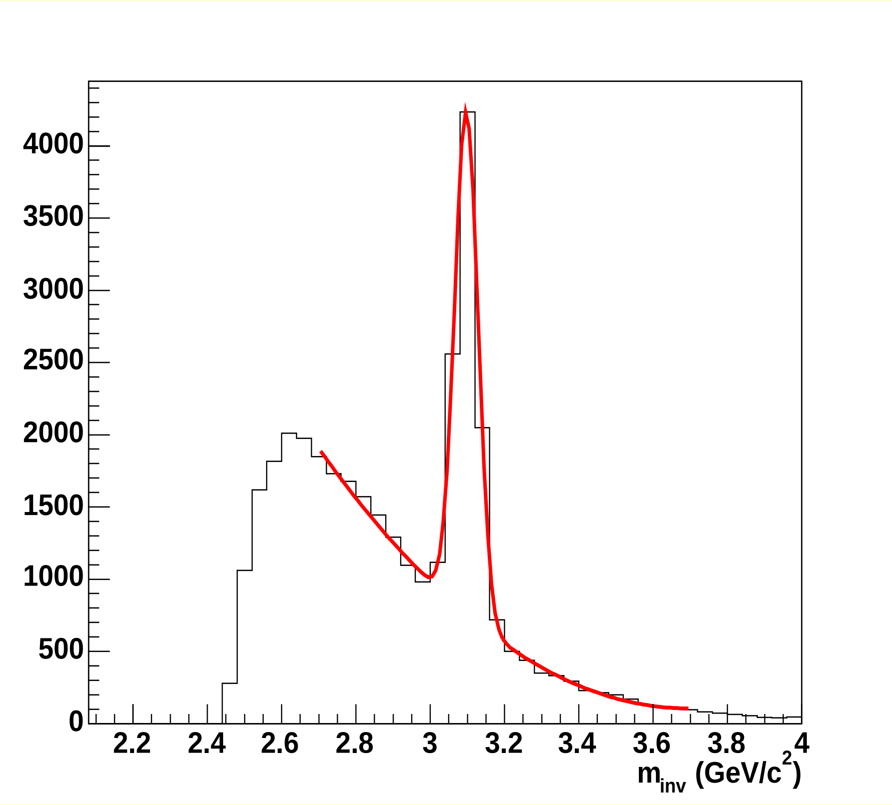
Electrons vs muons: Background

- Electrons: abundant background from conversion and π Dalitz
  - conversion: can be reduced by target thickness
  - Dalitz: requires sophisticated suppression strategy
  - misidentified hadrons: performance of eID detectors

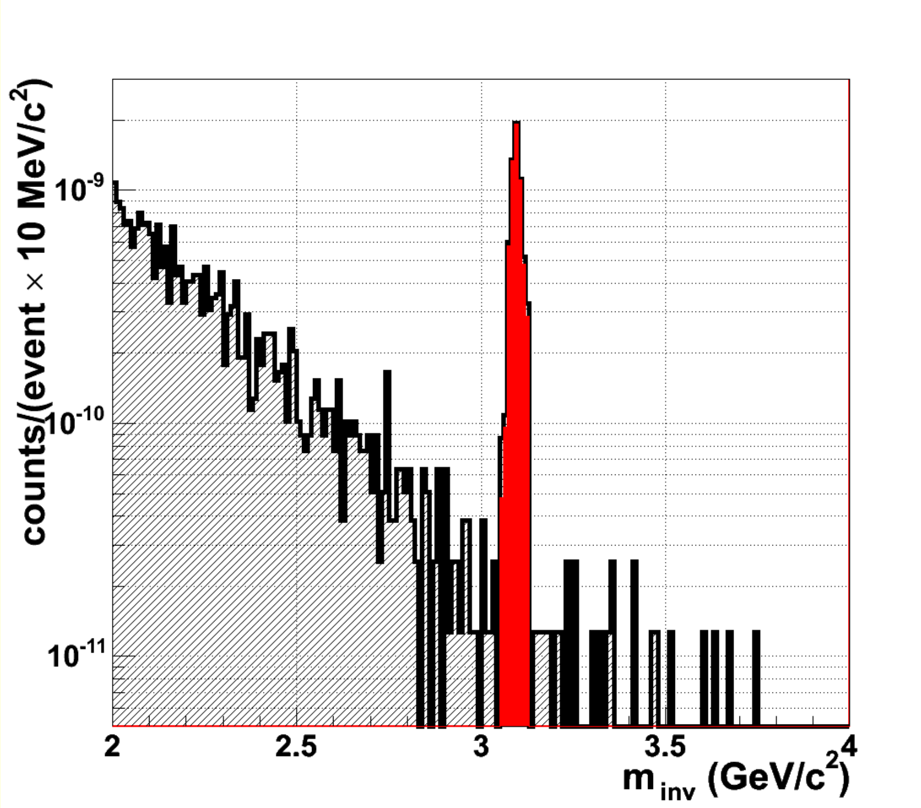
- Muons: main background from charged pion decay
  - reduced by minimising distance of muID from target
  - detection of decay topology (kink)
  - misidenified hadrons: performance of muID detector

CBM performance: Charmonium

Electrons



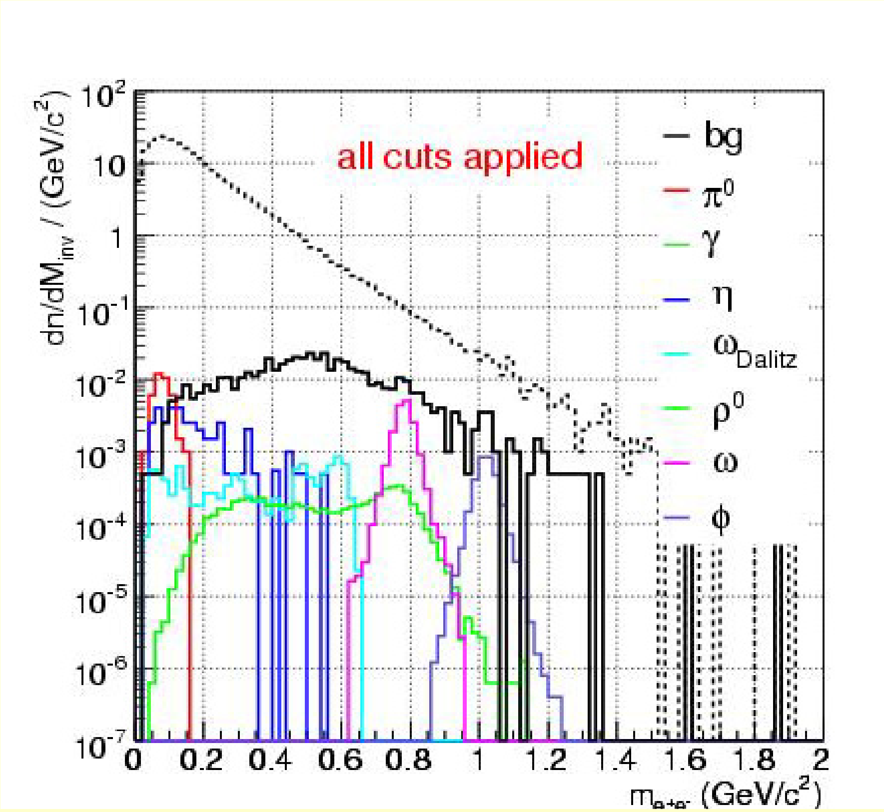
Muons



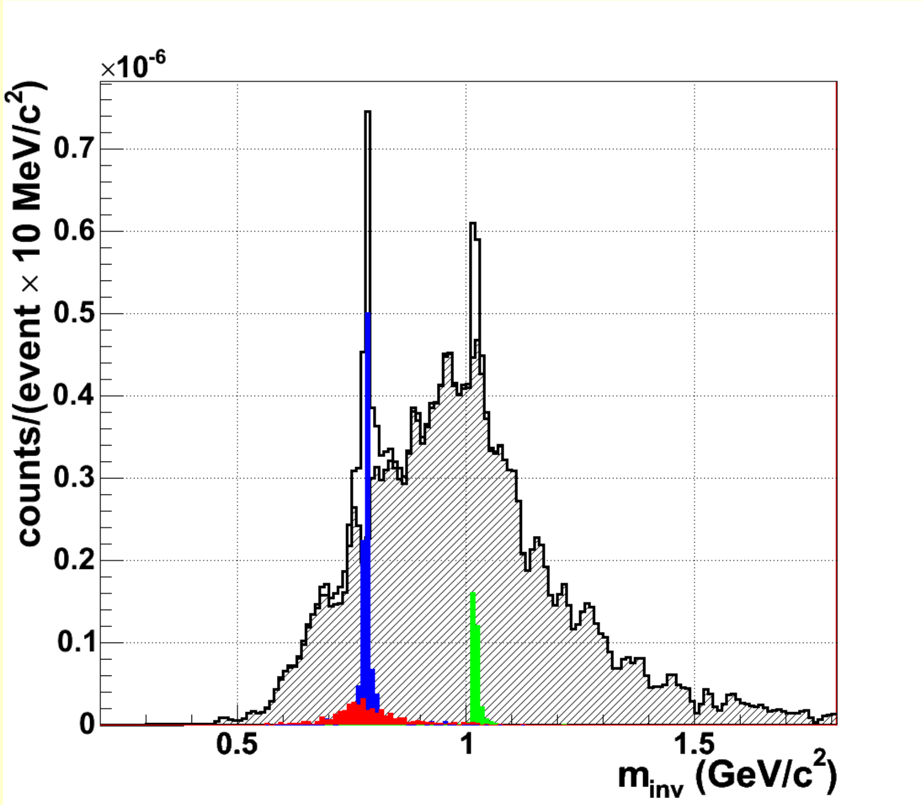
Both feasible; muons seem to work better
What about higher-mass states?

CBM performance: Low-mass vector mesons

Dielectrons



Dimuons



"Level of reality"

- Dielectrons
  - MC only, perfect tracking, perfect PID
  - more realistic simulation started, first look: performance decreases
  - detector concepts available, R&D under way
  - not expected to be very sensitive to beam energy
- Dimuons
  - Tracking and PID already included
  - detector concept under development (GEM / MWPC)
  - for one beam energy only (might be very sensitive)

Options for setup with muID

Setup	Open charm	J/ψ	LVM	hadrons	hyperons	Fluctuations	Photons
STS + RICH + TRD + TOF + ECAL	+	+	+	+	+	+	+
STS + MUID	?	+	+	-	+	-	-
STS + MUID + TRD + TOF + ECAL	+	++	+	+	+	+	+

"Minimal setup" already accesses a big part of CBM physics
"Minimal change" : Replace RICH by MUID

Decision aspects

	dielectrons	dimuons
Performance charmonium		(+)
Performance LVM	(?)	(?)
Impact on other CBM physics	+	-
Trigger feasibility	-	+
Costs	(?)	(?)

Input needed

- Dielectron simulations
  - perform simulations with realistic tracking and electron ID
  - study ψ'
- Dimuon simulations
  - implement realistic detector response
  - study energy dependence of performance
  - make code available
- Open charm simulations
  - D^0 possible without TOF?
- Low-mass vector mesons
  - Develop quality criterion of measurement (e.g. power to discriminate in-medium scenarios)
- MUID detector
  - develop detector concept (tracking stations)
  - cost estimate
- **Theory**
  - **how important is ψ' (higher states?)**
  - **limitations in low-mass spectrum due to 2μ threshold?**
  - **relative importance of physics observables to be potentially skipped**
  - **prioritised observable list**