CERN, April 1999

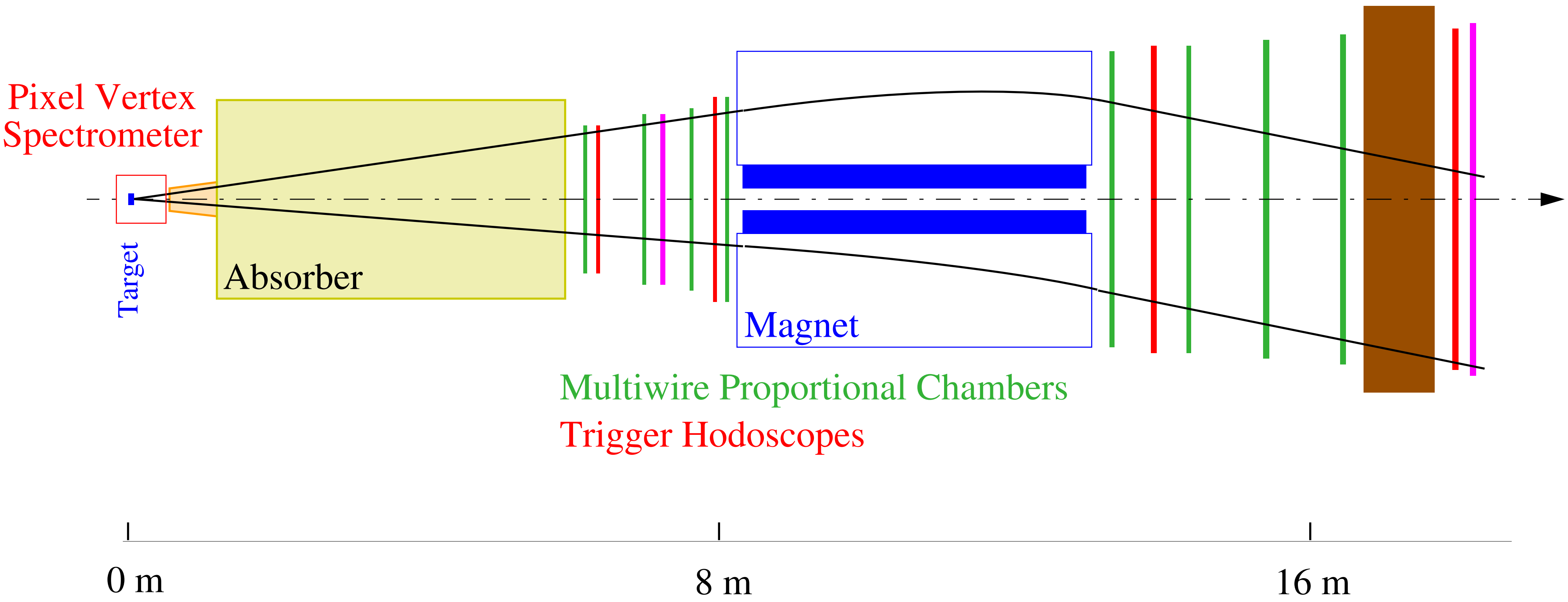
Study of open charm production in HIC combining a dimuon and a vertex spectrometer

Luca Casagrande, LIP

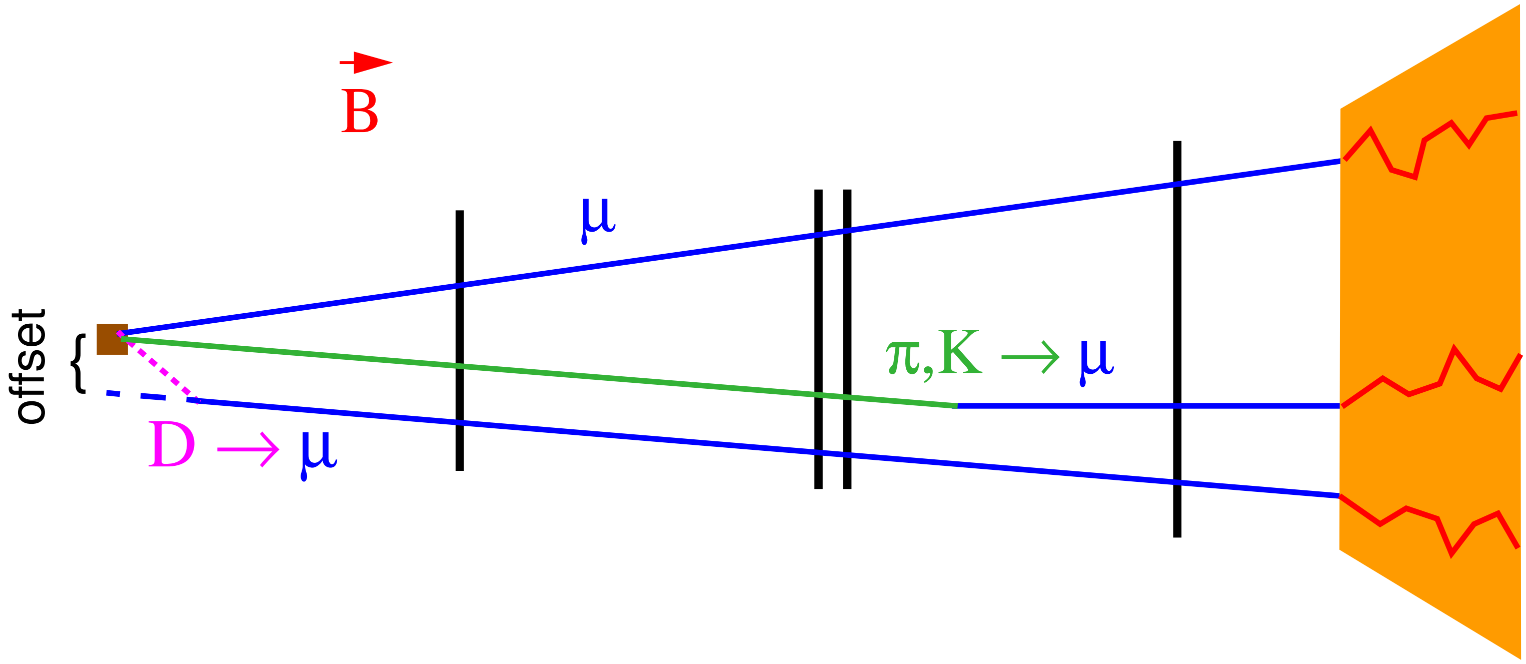
- ☞ Detector strategy
- ☞ Simulations results
- ☞ Test beam results
- ☞ Conclusions

C. Lourenço, I. Ropotar,
R. Shahoian, P. Sonderegger

NA6i Experimental Setup



Vertex Spectrometer



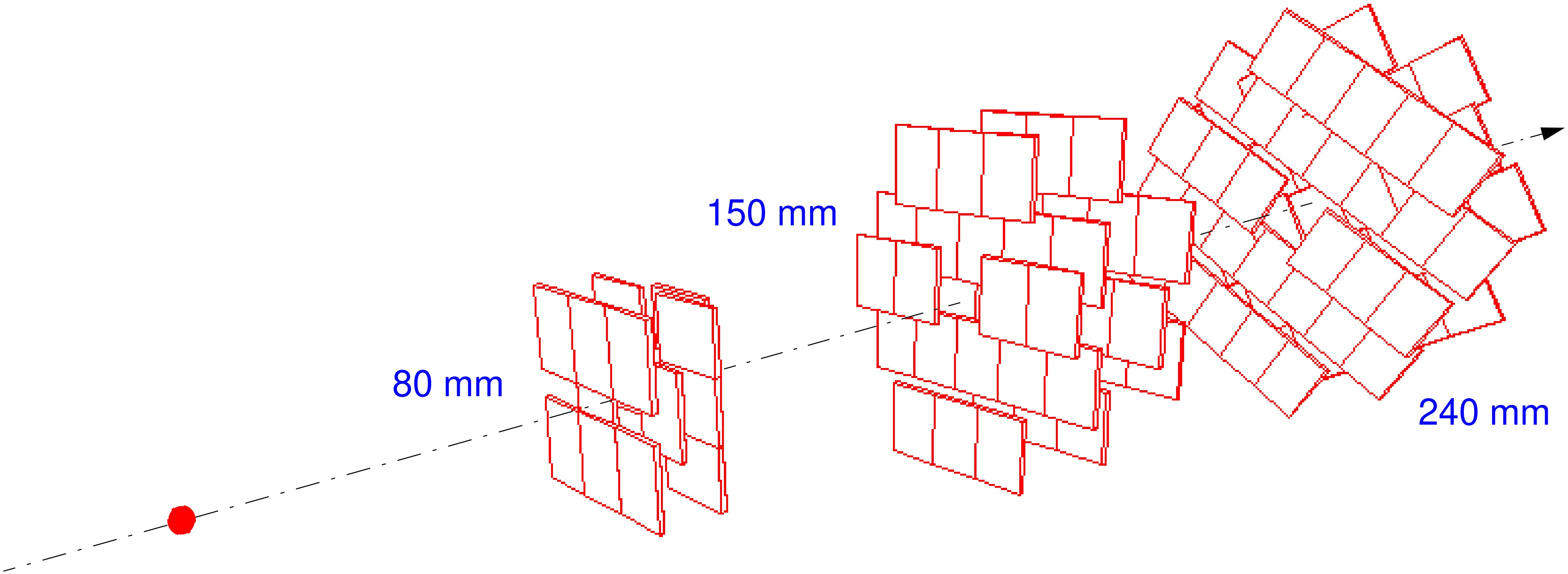
- track matching (angles and momentum) before & after the hadron absorber
- combinatorial background rejection (π, K)
- improved mass resolution
- offset measurement: open charm capability

- Pb-Pb: high multiplicity → spatial resolution
- high interaction rate → good timing

→ Silicon Pixel Detector

Vertex spectrometer layout

- Baseline setup: 130 chips, ~ 1 M channels



ALICE1 pixel readout chip

- pixel size: 50 x 300 μm^2
- 32 columns x 256 rows
- commercial 0.25 μm technology + enclosed-geometry transistor design: radiation tolerance ~ 30 Mrad

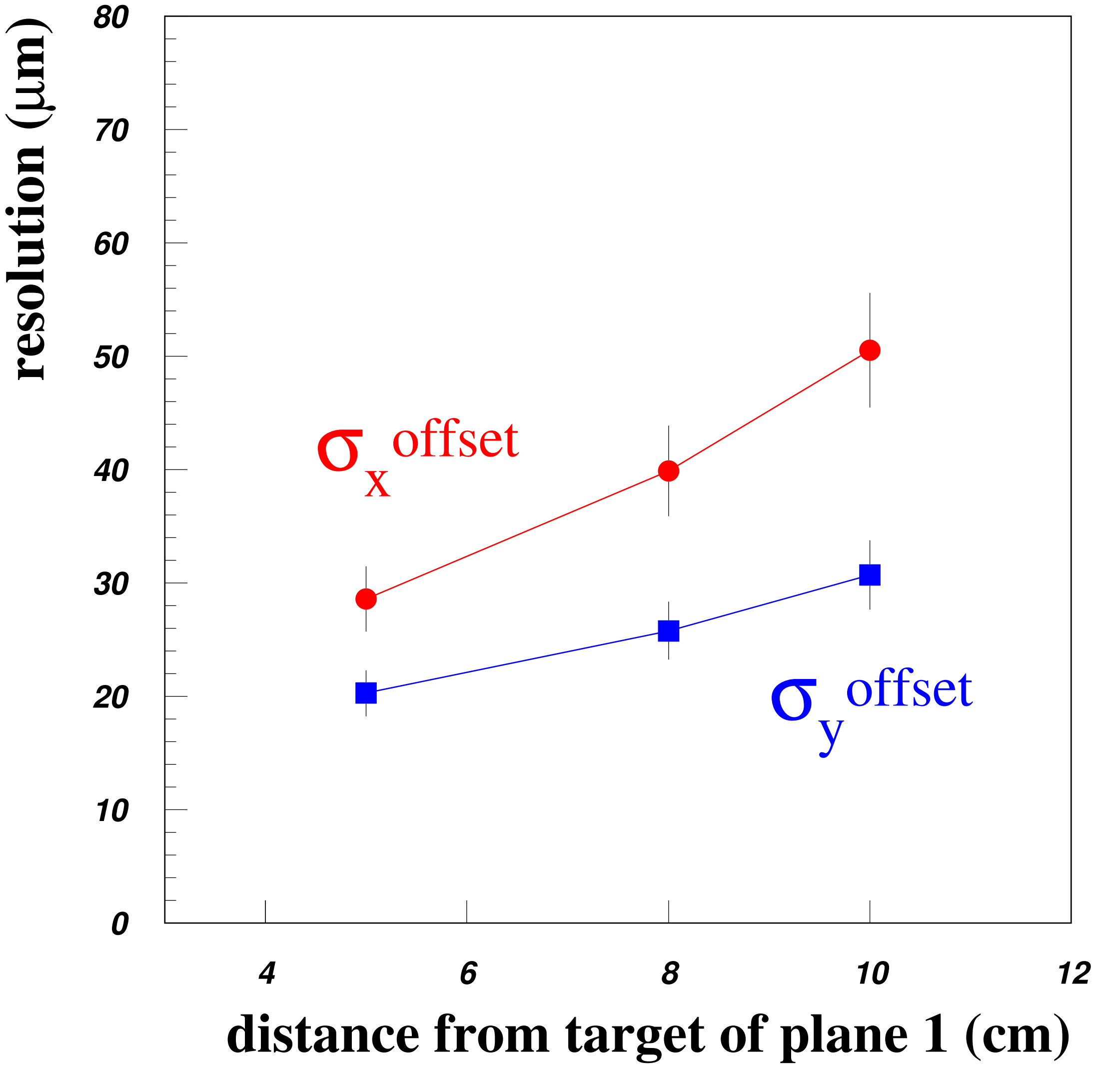
ALICE1 fits NA6i requirements:

- spatial resolution
- timing
- radiation tolerance
- radiation inhomogeneity

Offset resolution

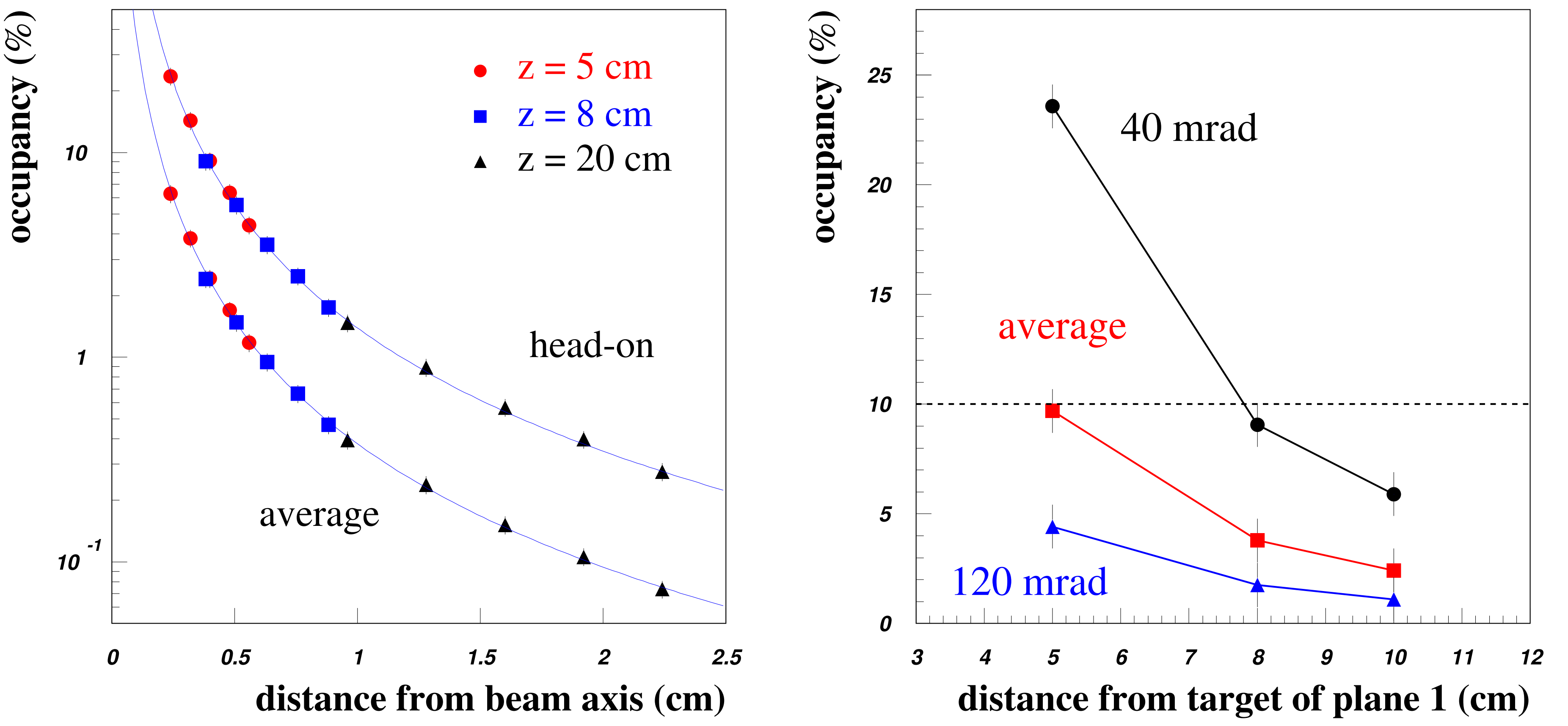
$c\tau\ (D^{\pm}) = 317\ \mu m$

$c\tau\ (D^{0}) = 124\ \mu m$



Occupancy

head-on PbPb $\left(\frac{dN^{ch}}{dy} = 450\right)$



Track matching procedure

1. (a) μ_1 & μ_2 reconstructed in muon spectrometer

   (b) x and y of interaction point from beam-scope

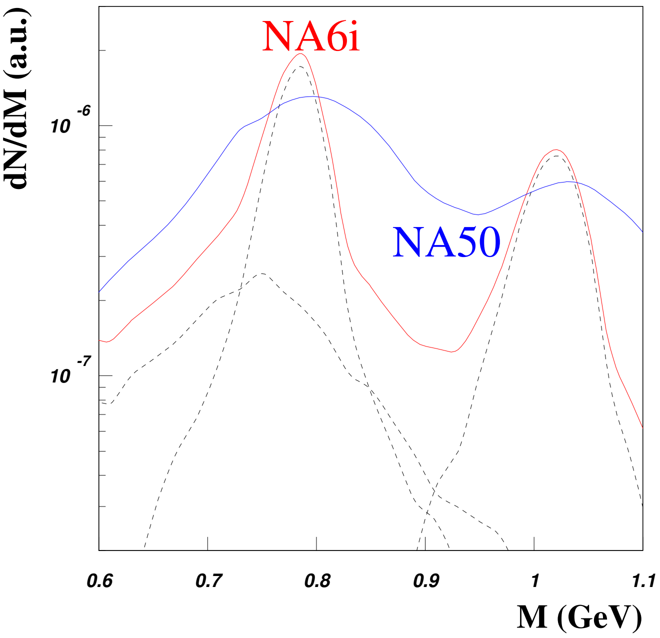
   (c) pattern recognition in pixel vertex spectrometer using (b) as constraint

2. Fill in lists of N_1 [N_2] matching candidates for μ_1[μ_2] depending on event selection: *prompts* or *charm*

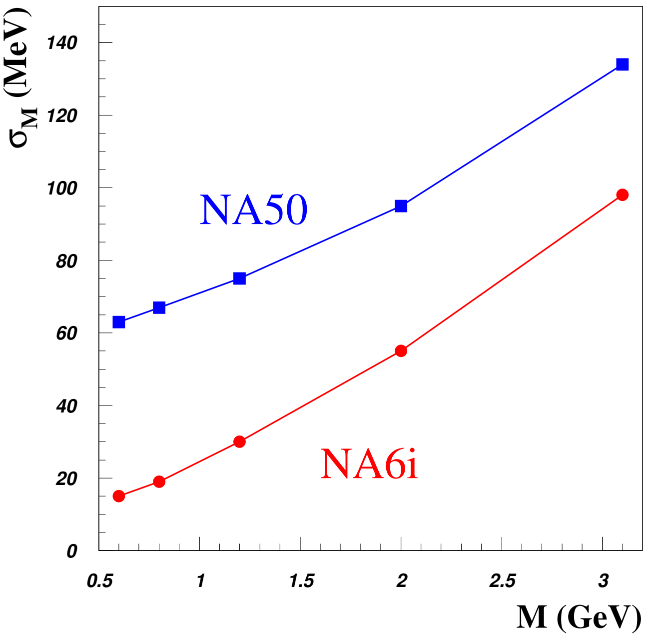
   $\rightarrow$ N_1*N_2 dimuon candidates
   (good + fake matches)

3. Obtain mass spectrum with all candidates

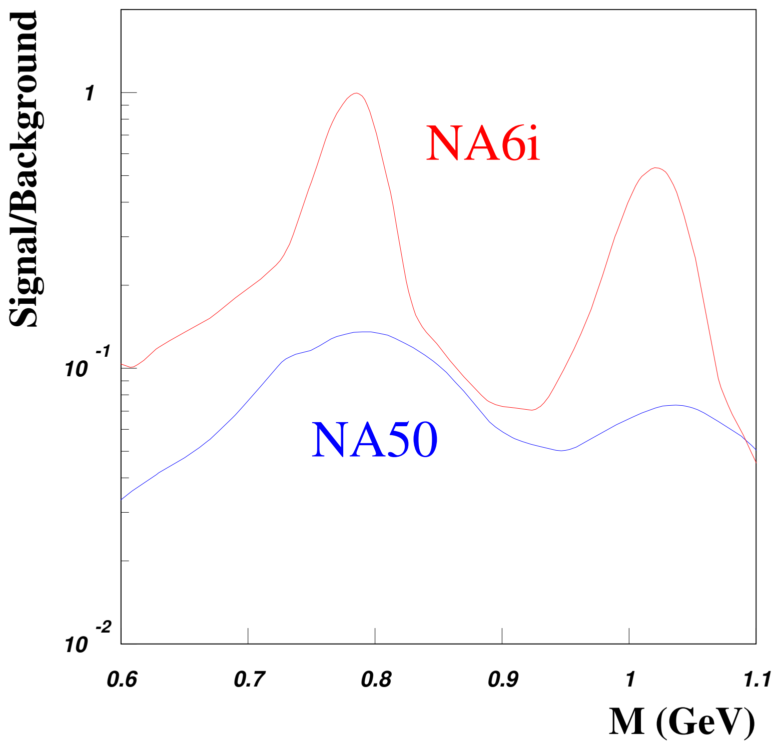
4. Subtract fake matches and combinatorial background using mixed event technique



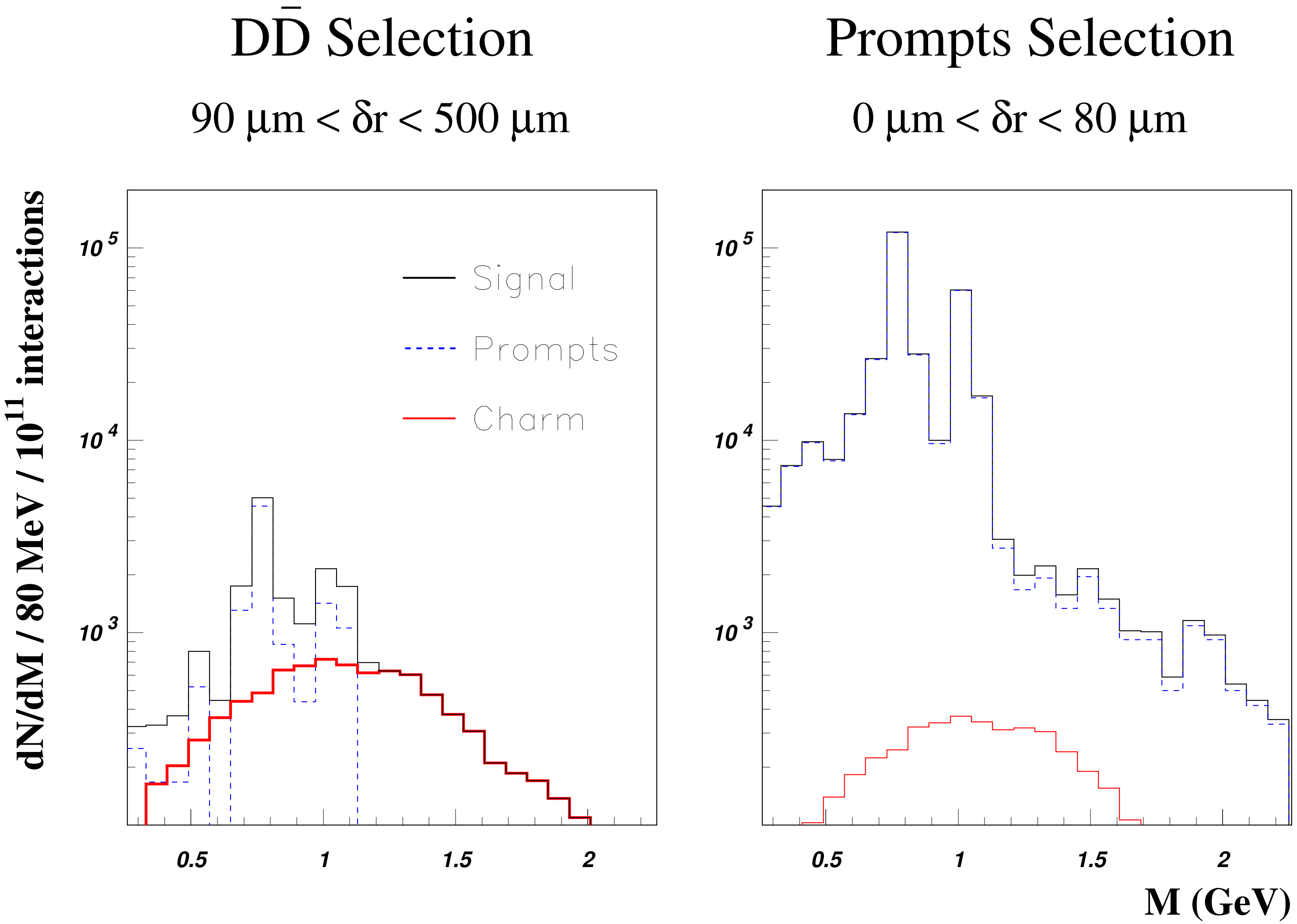
NA6i
NA50
dN/dM (a.u.)
10 -6
10 -7
0.6
0.7
0.8
0.9
1
1.1
M (GeV)



NA50
NA6i
σM (MeV)
140
120
100
80
60
40
20
0
0.5
1
1.5
2
2.5
3
M (GeV)



NA6i
NA50
Signal/Background
1
10 -1
10 -2
0.6
0.7
0.8
0.9
1
1.1
M (GeV)



$D\bar{D}$ Selection
90 μm < δr < 500 μm
Prompts Selection
0 μm < δr < 80 μm
dN/dM / 80 MeV / 10^{11} interactions
Signal
Prompts
Charm
10^5
10^4
10^3
0.5
1
1.5
2
M (GeV)

Beam-scope

- measuring x and y coordinates of each incoming Pb ion
- cryogenic silicon microstrips

(in collaboration with RD39)

Lazarus effect : charge collection efficiency recovery in heavily irradiated silicon detectors when operated at $T < 130$ K

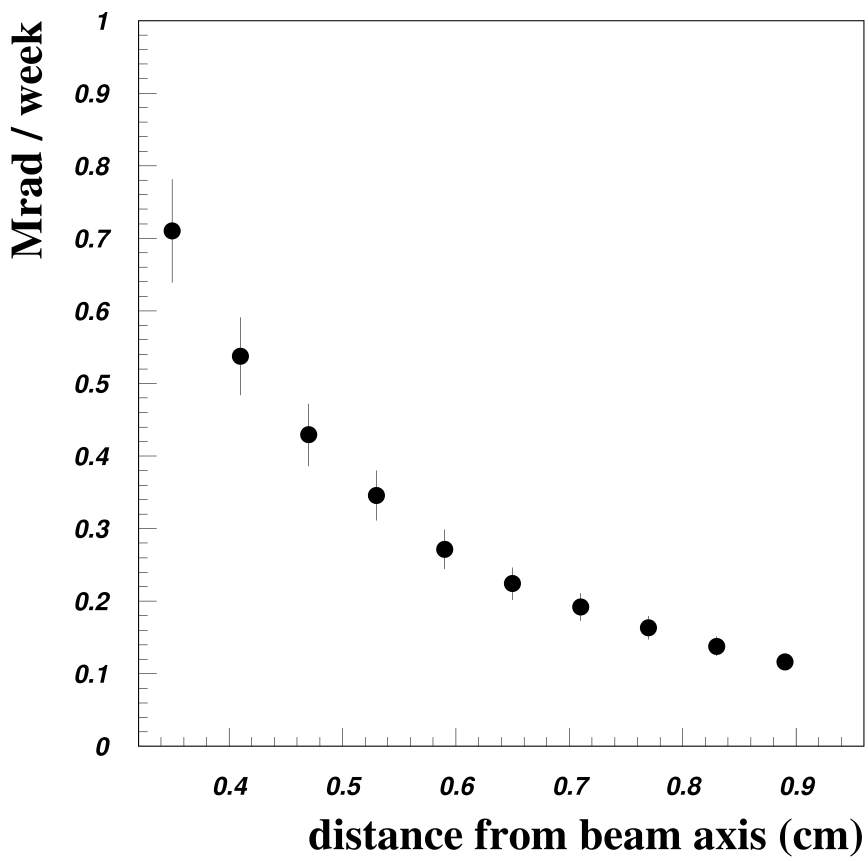
- 2 (x,y) planes before the target
- 50 μm strip pitch
- $\sigma_x = \sigma_y \sim 20$ μm @ interaction vertex

- test beam in Nov ’98 with Pb ion: survived well more than 10^{10} ions

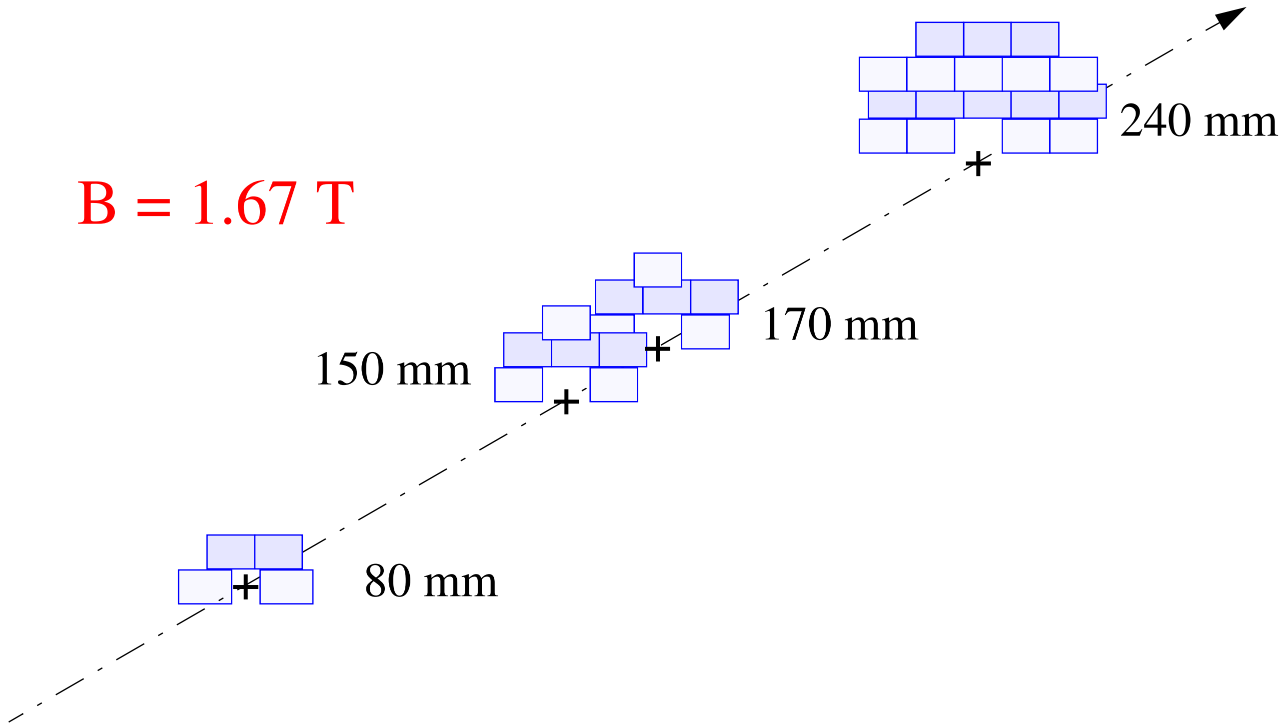
Radiation dose

- $I_{beam} = 5 \times 10^7$ ions/burst, $\varepsilon_{beam} = 0.8$
- $L_{tgt} = 4.5$ mm Pb, 12 % λ_{int}

z = 8 cm



Test beams in 1998

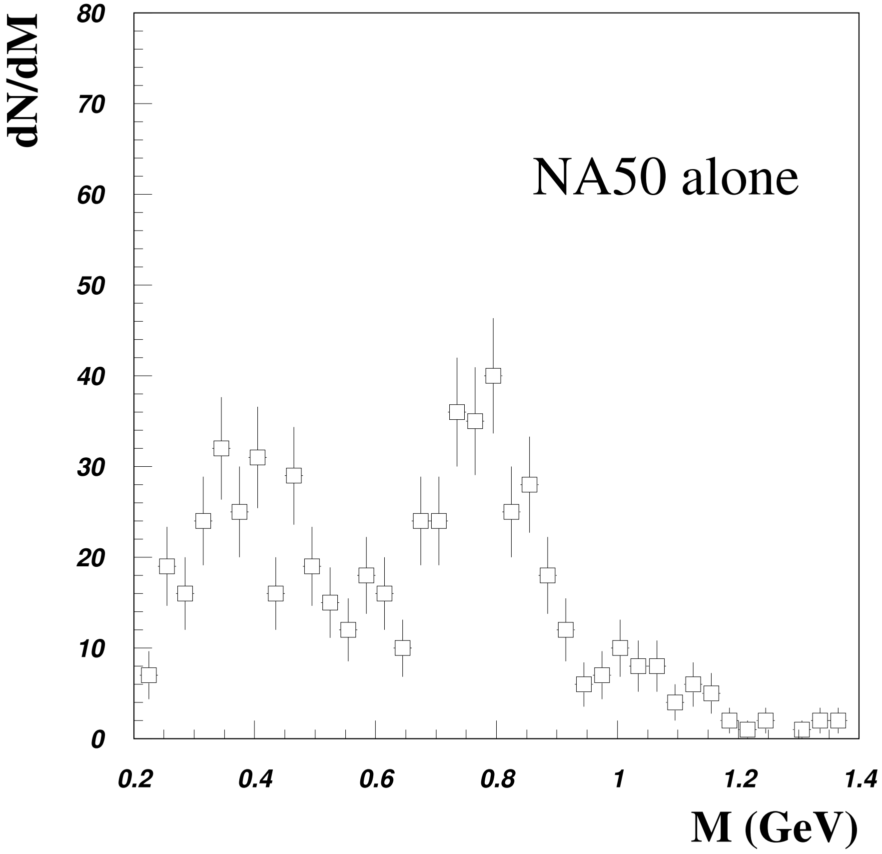


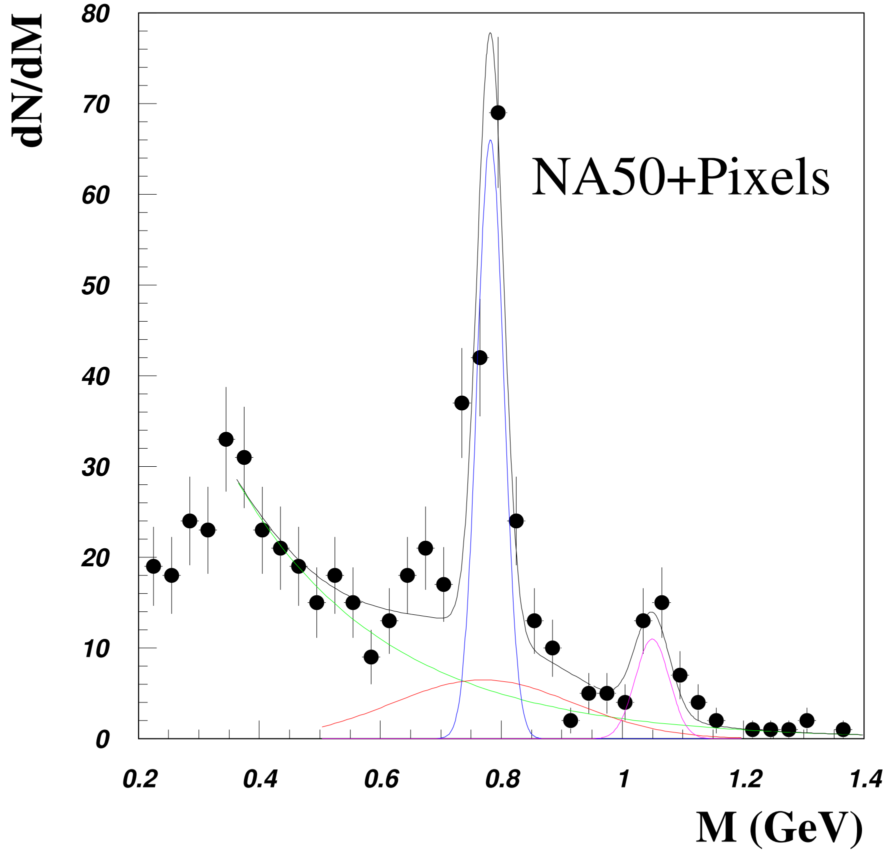
- 'half setup' with LHC1 chips (RD19/WA97); pixel size 50 x 500 μm^2; not rad-hard

	April	November
reaction	p+Be @ 450 GeV/c	Pb+Pb @ 158 GeV/c A
number of chips	33	54
data taking	~ 60 hours	~ 50 hours

pBe data

595 events with
successful track matching



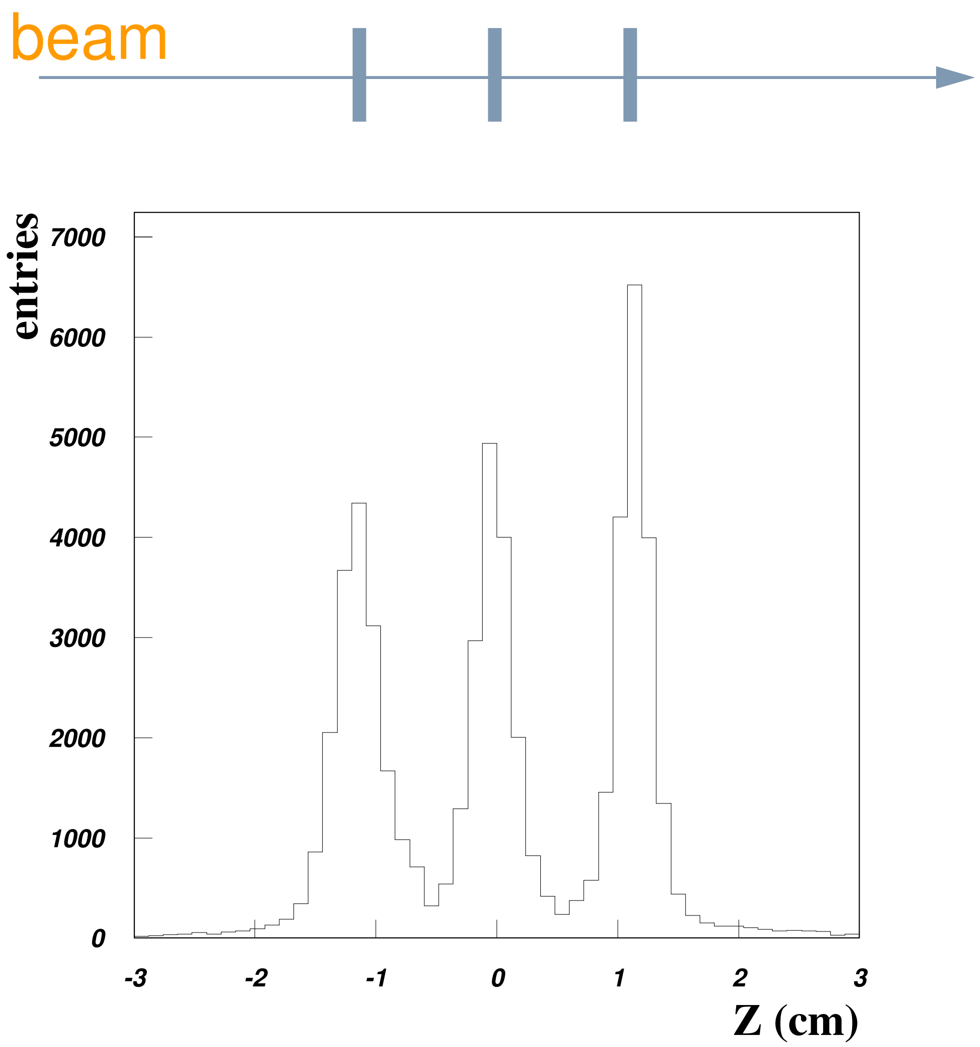


$\sigma_M = 20$ MeV

Pb-Pb data:

- 3 x 1.5 mm thick Pb targets

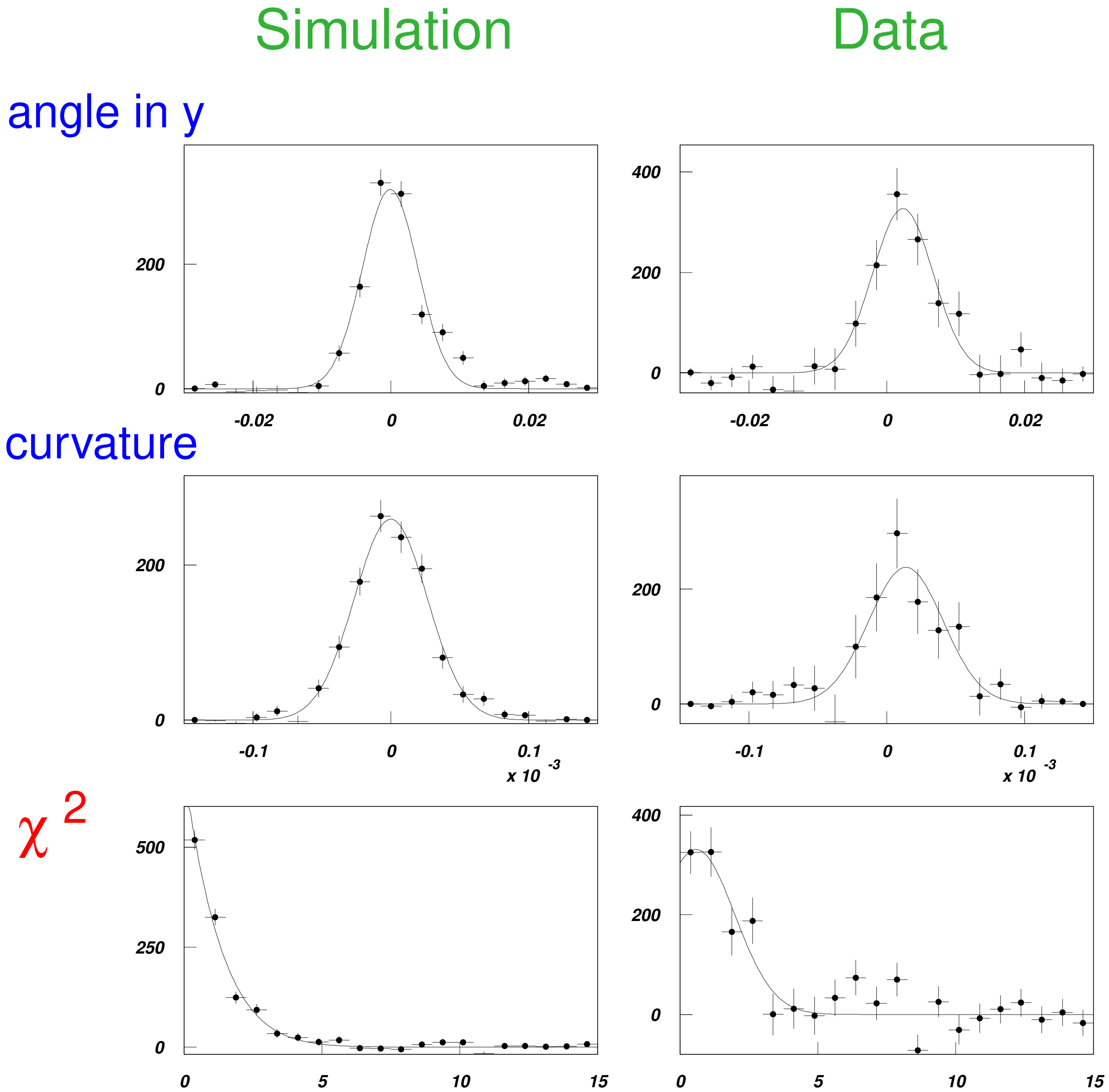
vertex reconstruction (*preliminary*)



Track matching in PbPb

(data analysis in progress...)

- difference between the matching variables as measured in the dimuon and in the vertex spectrometer



Expected $D\bar{D}$ yield

- Beam intensity: ~ 5 x 10^7 ions/burst
- Target: 4.5 mm of Pb
- 30 days, $\varepsilon_{beam} = 0.8$

- ~ 12 kbyte / event (~ 50 kbyte / head-on)
- 4000 triggers / burst

$\rightarrow$ Number of $D\bar{D}$ events: ~ 3'000 (± 10%)

Conclusions

- break-through in dimuon spectrometry
  thanks to a new radiation hard pixel detector

- new physics becomes accessible:

  (1) low mass dimuons production
  with good mass resolution
  and signal to background ratio

  (2) open charm capability via offset
  measurement of intermediate mass
  dimuons

- test beam results validate detector concept

- what better than a (NA)6i experiment to look
  for charm ?