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A program for the study of reaction mechanisms in the *GeV* range

Instrumentation

ACTAR meeting

Bordeaux – Gradignan

16th of June, 2008

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R³B multi-track detector: first thoughts

- **Needs for a new multi-track detector**

→ Wider spatial distribution of the fragments at the exit magnet

→ Vertical drift of the primary electrons required for higher resolutions

→ MUSIC 4 detector cannot be used for R³B for a complete coverage of the final-state phase space

- **Time-projection chamber**

→ 3D-tracking of multi-particle events

→ Cheapest solution for such a detector

- **Parameters**

→ H = 0.8 *m*, L = 1.2 *m*, W = 3 to 4 *m*

→ σ_x = 100 μm

→ 1 main direction for the fragments with small track angles

→ Large dynamics of the signals → two gas amplifications

→ 5 samplings for low Z fragments, 4 samplings for high Z fragments

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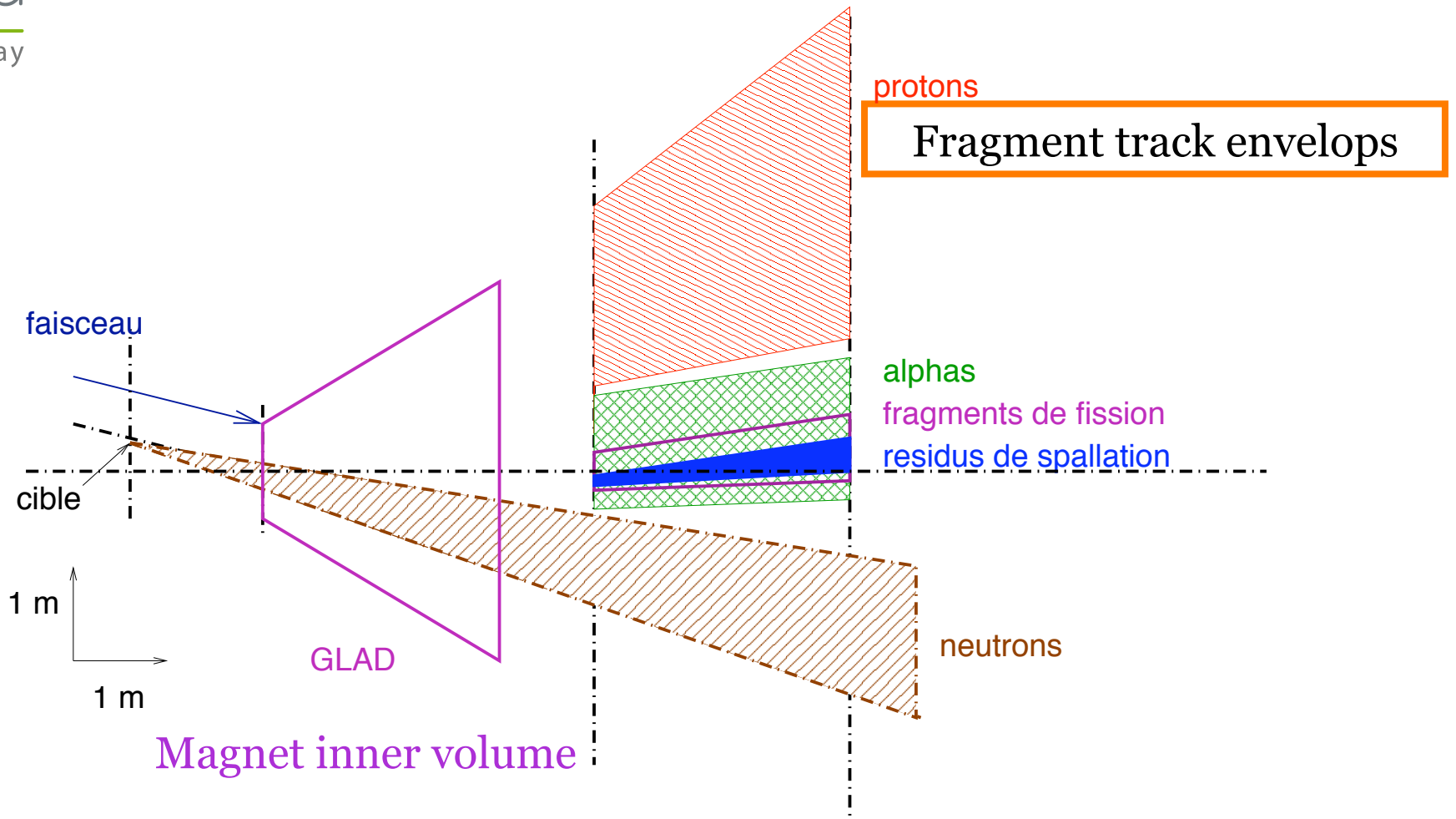
R³B time-projection chamber



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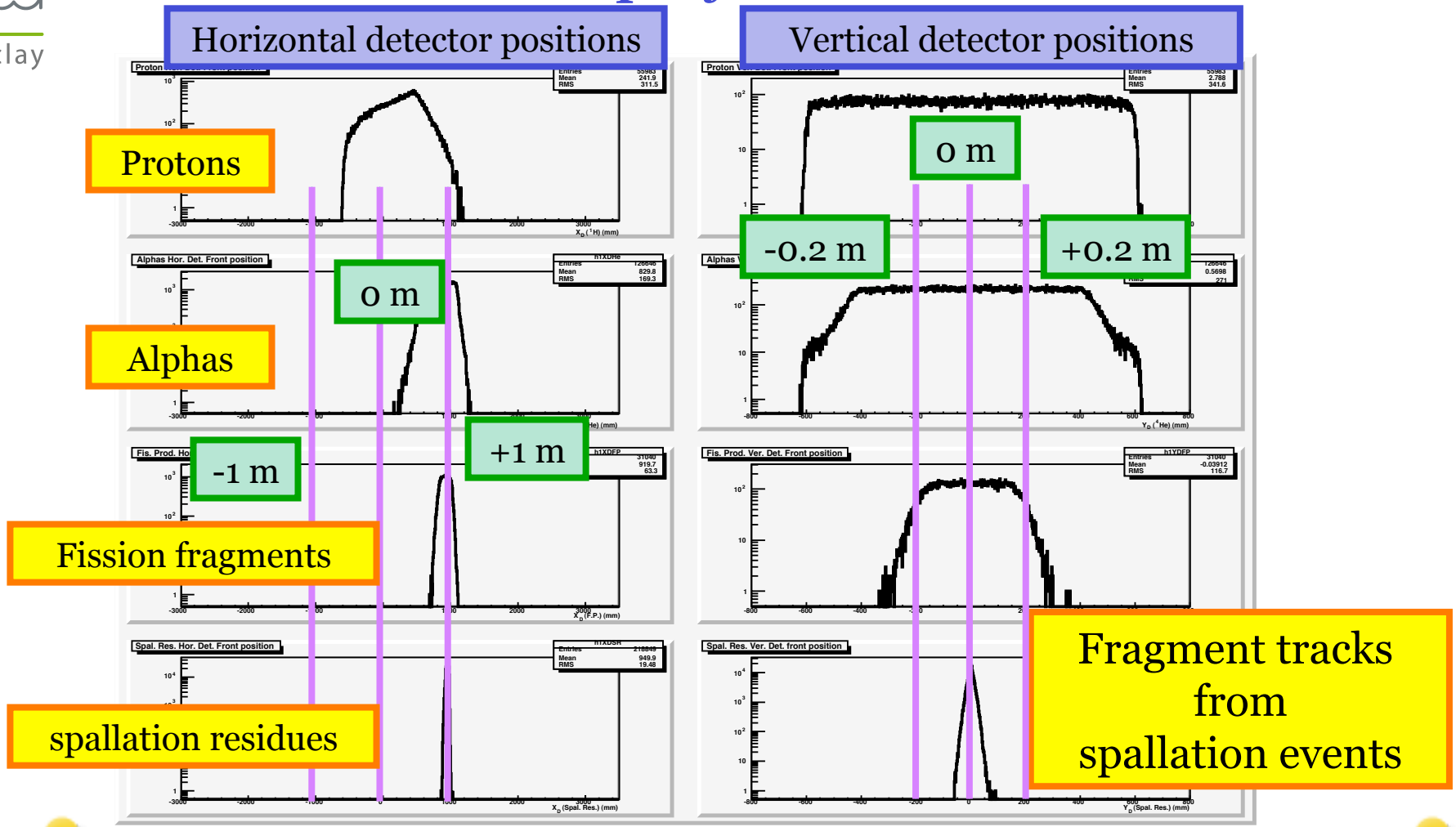
R³B time-projection chamber



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R³B time-projection chamber

New idea: Push the detectors away from the magnet exit

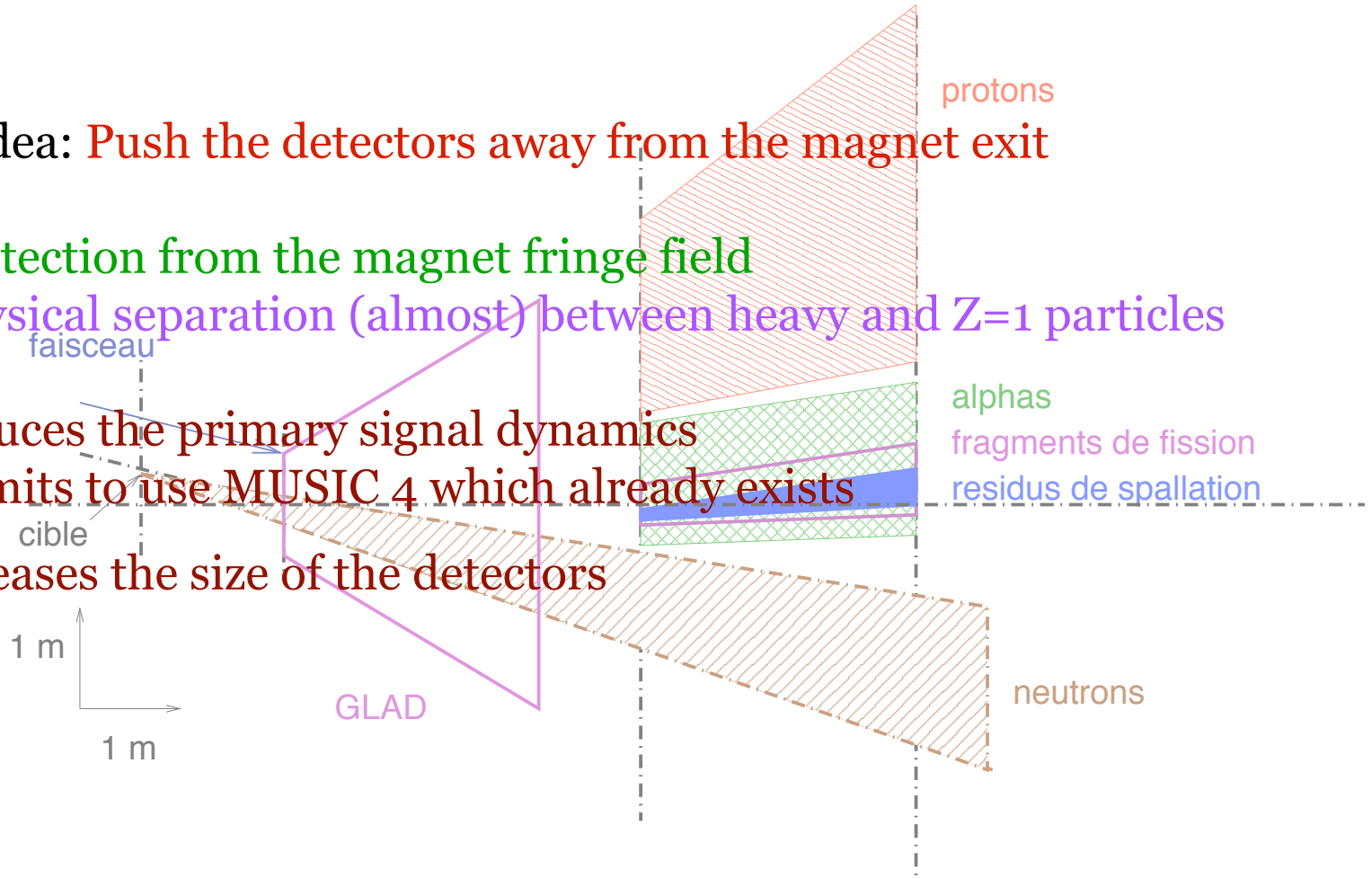
➔ Protection from the magnet fringe field

➔ Physical separation (almost) between heavy and Z=1 particles

+ Reduces the primary signal dynamics

+ Permits to use MUSIC 4 which already exists

– Increases the size of the detectors



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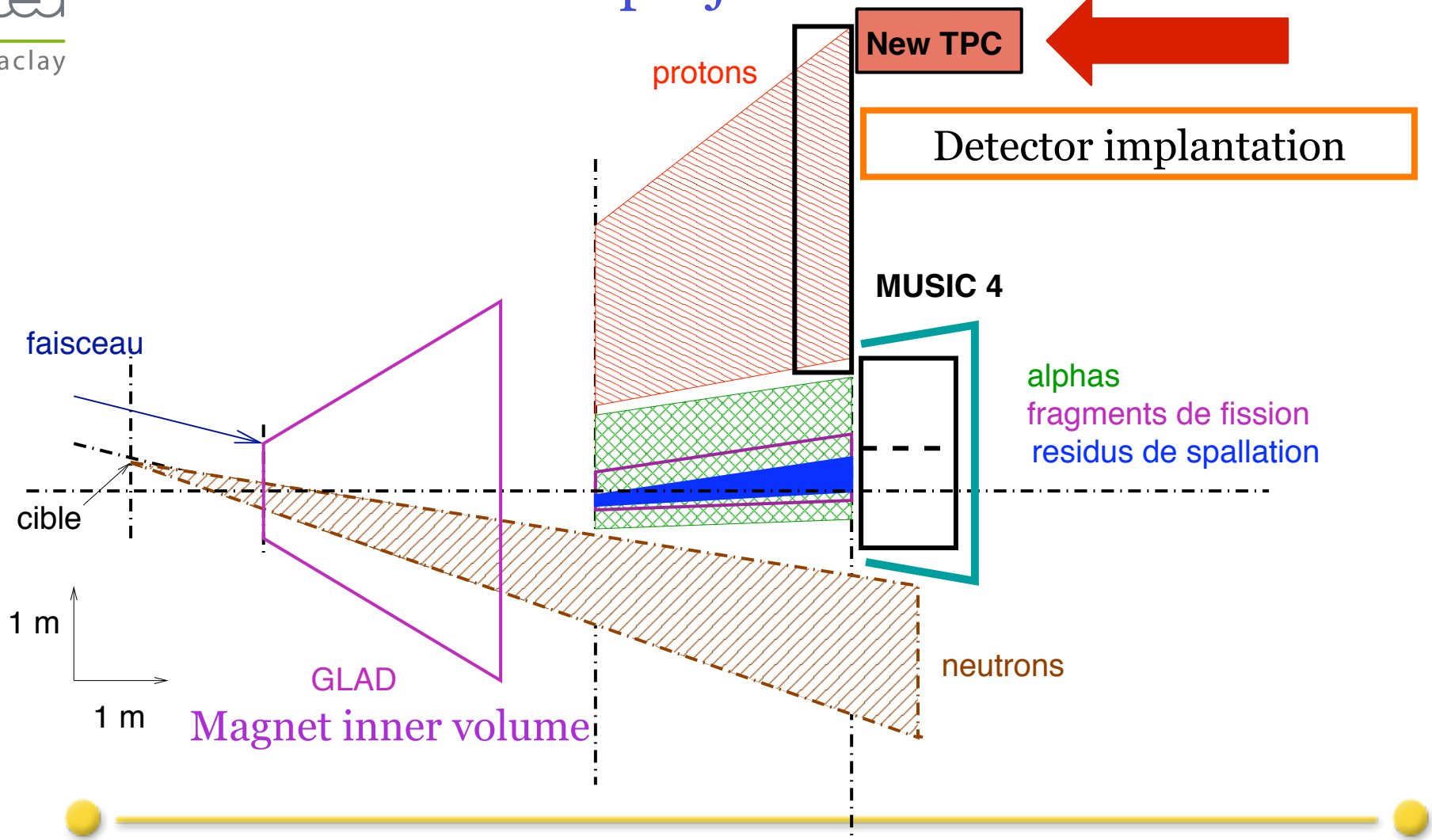
R³B time-projection chamber



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R³B time-projection chambers

TPC electrostatics:

- **MUSIC 4:** horizontal drift of the primary electrons
- **New TPC for protons & alphas:** vertical drift

MUSIC 4 sampling scheme

4 **PC**: Proportional counters (high gas amplification)
→ low Z fragments
3 **IC**: ionisation chambers (low gas amplification)
→ higher Z fragments

New TPC

3 rows of high gas amplification MicroMegas equipped with pads for charge division

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New R³B TPC parameters

✦**MicroMegas gas amplification**

→ Well known technology in Saclay/IRFU, rather inexpensive

→ Use of resistive & capacitive amplification layers to spread the primary signals on at least three pads in order to

- Reduce the number of readout channels
- Obtain a position resolution independent of the drift length
- Decrease the probability of discharges of the micromesh

(e.g. M. Dixit *et al.*, NIM A518, 721(2004), NIM A566, 281 (2006))

→ Will allow a direct measurement of the drift time on the pads

✦**~ 3000 channels (pads)**

→ Discrete electronics for the pre-amplification/amplification

→ No requirement for a large development (ready-to-use solutions)

→ Not very expensive, will allow for possible evolution

✦**Flash-ADC readout**

→ No big constraints on track density and pile-up, counting rate ≤ 1kHz

→ 40 MHz sampling, 10-12 bit coding

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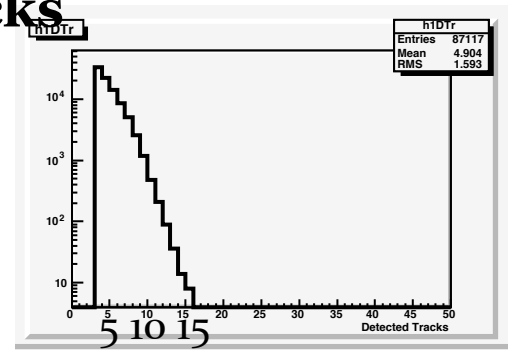
New R³B TPC

- **Track densities**

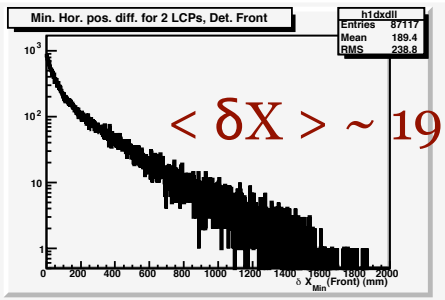
  Minimum distance between
  two protons of a spallation event
  Probability that two tracks are closer than 10 mm in X or Y: $< 10^{-3}$
  Probability that two tracks are closer than 10 mm in X & Y: $< 10^{-4}$

- **Number of tracks**

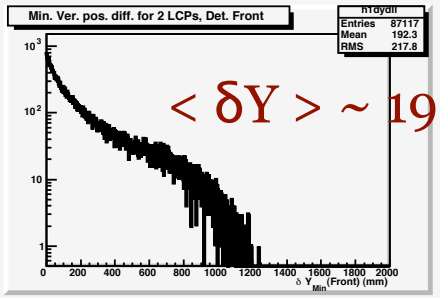
< N(track) > ~ 5



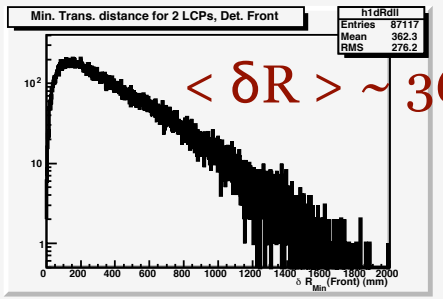
protons



< δX > ~ 190 mm



< δY > ~ 190 mm



< δR > ~ 360 mm

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R³B MUSIC 4

- **Track densities**

  Minimum distance between two fragments of a spallation event in MUSIC 4:

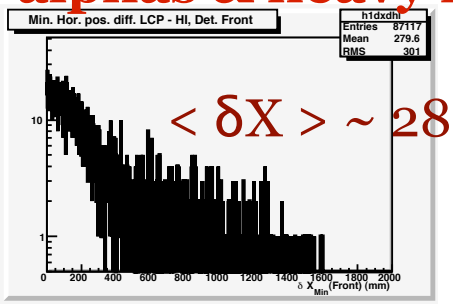
  Probability that two tracks are closer than 10 mm in X or Y: $< 10^{-3}$

  Probability that two tracks are closer than 10 mm in X & Y: $< 10^{-4}$

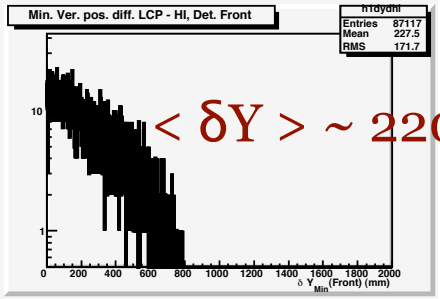
- **Number of tracks**

< N(track) > ~ 3

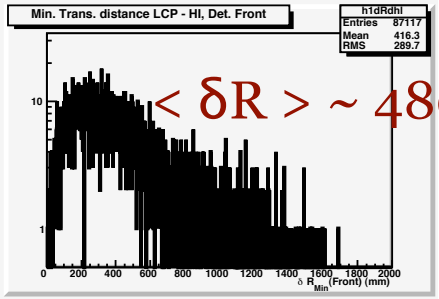
alphas & heavy ions



< δX > ~ 280 mm



< δY > ~ 220 mm



< δR > ~ 480 mm

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Readout & coding

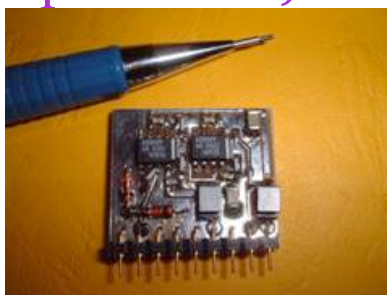
- **Discrete amplification: The Antioche preamplifier card**

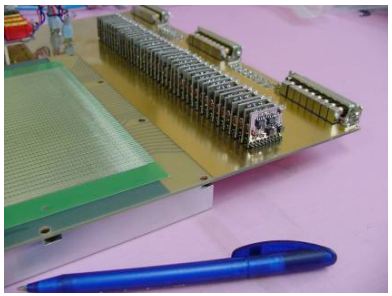
➔ Experience from other projects (DEMIN, KABES), FAMMAS module

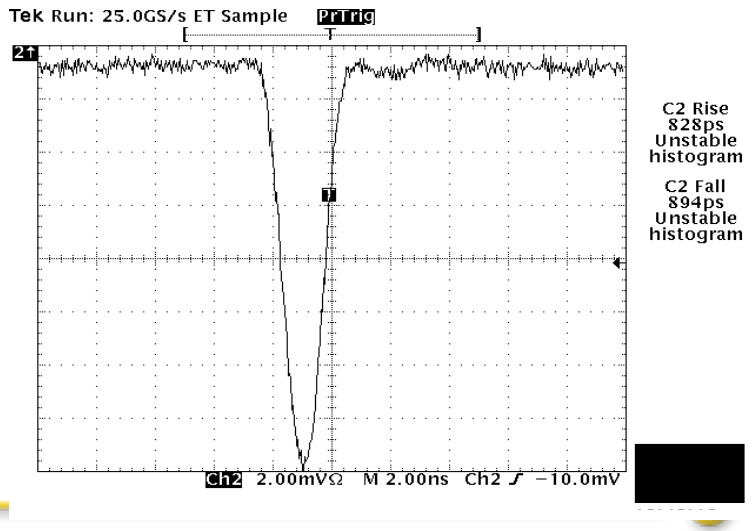
➔ Same modules for MUSIC4 & the new TPC

➔ Tested in ion beams with small MicroMegas tracker prototypes in April 2008 at GSI

➔ This will allow to use them, perhaps with different shaping time, to build high-position resolution beam trackers for R³B (thin entrance windows, low pressure, MicroMegas amplification)







- **Coding to be determined…**