The ASACUSA scintillating fiber tracker: commissioning and characterization

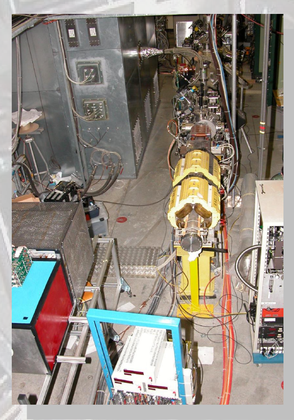
A. Mozzanica[a†], D. Bolognini[b], M. Corradini[a], M. Leali[a], E. Lodi Rizzini[a], V. Mascagna[b], M. Prest[b], E. Vallazza[c], L. Venturelli[a], N. Zurlo[a]

[a] Università degli Studi di Brescia - INFN sezione di Pavia
[b] Università degli Studi dell'Insubria - INFN sezione di Milano Bicocca
[c] INFN sezione di Trieste

The detector goal

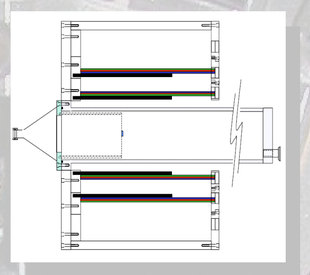
Cross section measurement of slow antiprotons (<5 MeV) on gaseous and solid targets, through annihilation vertex reconstruction.

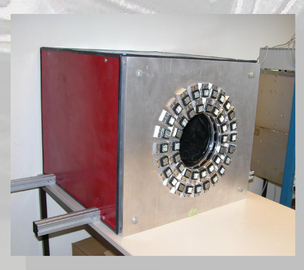
With the CERN Antiproton Decelerator high intensity pulsed beam ($\approx 10^7$ pbar every 120s), in the framework of the ASACUSA collaboration.



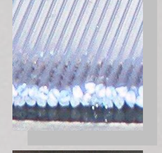
The detector during the insertion in the ASACUSA transfer line

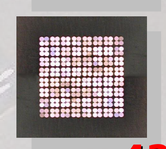
The detector design





- Cylindrical geometry, inner shell ϕ=12cm, outer shell ϕ=16cm, 50 cm active region length
- 3 layers per shell of 1mm multicladding scintillating fibers by Bicron (BCF 10)
- Two axial and four stereo layers
- Multianode photomultipliers readout (Hamamatsu H7546B)
- Four fibers in a single anode, for a readout pitch of 2 mm
- A total of 2688 channels and 42 photomultipliers



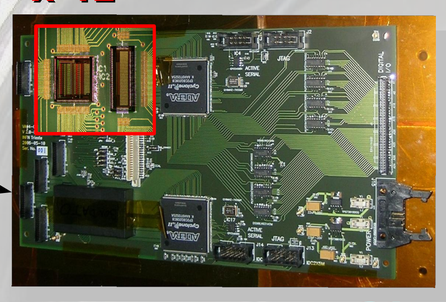


x 42

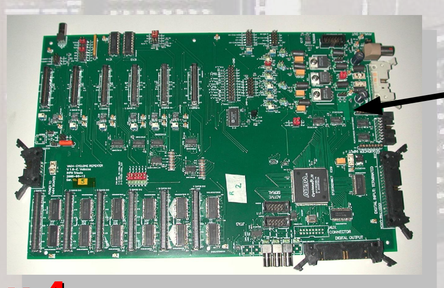
The electronics

The frontend boards house a VA64TAP2.1+LS64 chip pair (by IDEAS) and a Cyclone II FPGA by Altera.
The ASICs perform amplification, shaping and discrimination of analog signals, with parallel output.
The FPGA implements a 640 Mhz sampling over a 800 ns gate.

x 42



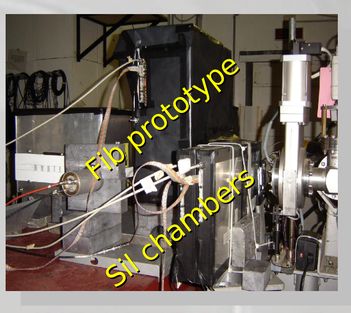
x 21



The repeater boards provide biases, digital controls and analog signals multiplexing
Repeaters are controlled and read out by a VME I/O

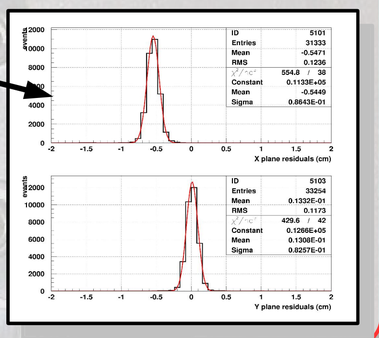
x 4

Prototype on e⁻ test beam



•Resolution = 830µm, with a 1.25mm readout pitch
•100% detection efficiency

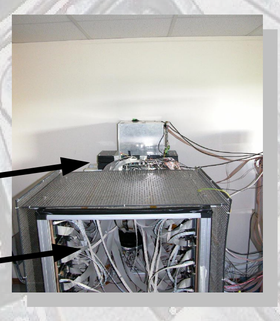
@ INFN-LNF Beam Test Facility
Electron energy up to 500 MeV
Reference silicon tracking system



Cosmic ray setup

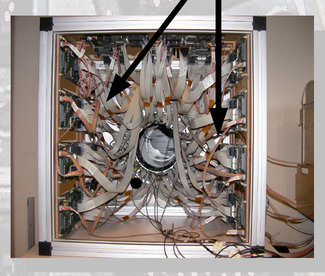
The coincidence among 4 scintillators provides the trigger system

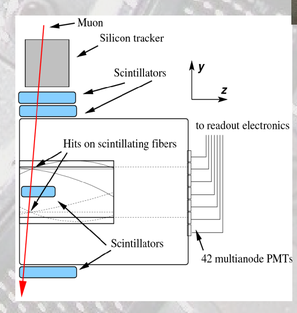
A silicon tracking system with 40µm resolution allows resolution studies



Repeaters

FE boards



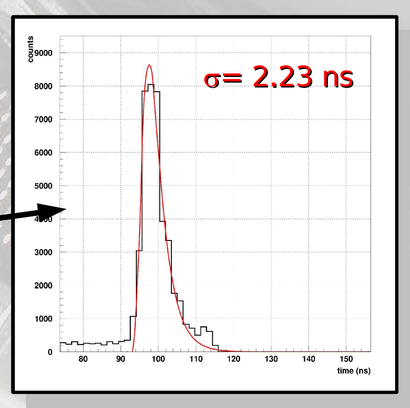


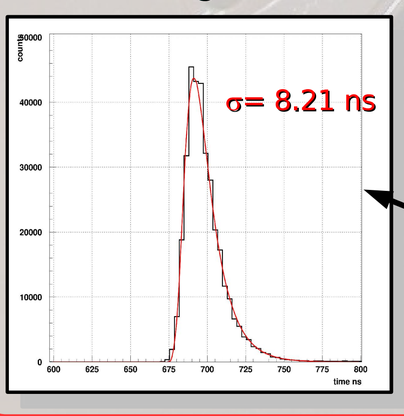
Two readout modes:
•Analog, with a single hold signal and a multiplexed ADC conversion
•Digital, accessing the samplers on the Cyclone FPGAs
For cosmic rays a common stop sampling strategy has been used.

Time resolution results

Time resolution has been evaluated, with digital readout, using a reference scintillator as trigger on cosmic rays.

Single MA-Photomultiplier module, in a small Z region.



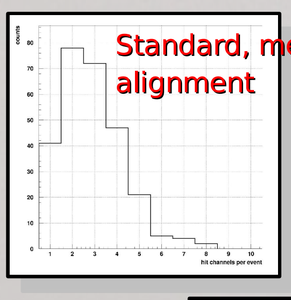


Time resolution for the whole tracker, including different fiber and cable lengths

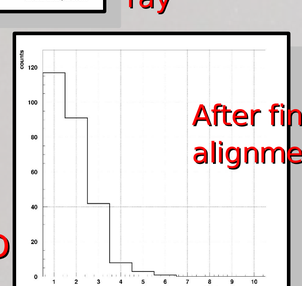
The cross talk problem

Optical cross talk present at mask-PMT interface in 50% of events

	20.9%
	5.5%
+	14.9%
Others	8.9%



Number of hit pads on a single PMT, for a single cosmic ray

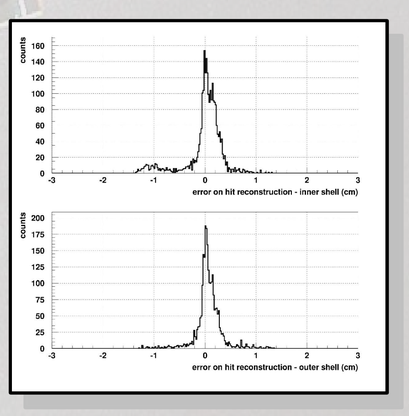


Fibers of different channels overlap

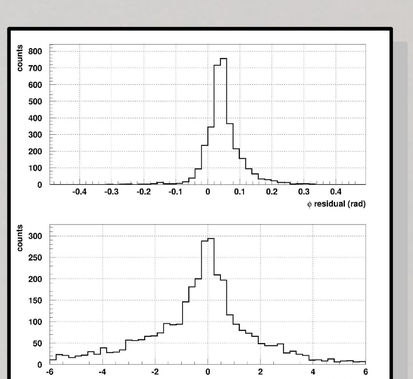
Solution: a better mask alignment with the help of a LED system
Now on a prototype, to be performed on the whole tracker

Hit reconstruction

The 3 layers of one shell identify 3 points in space; the distance among them, due to errors in the fiber placement, is of the order of 5 mm (rms)



Hits on outer shell are interpolated on the inner shell and residuals are computed.



Residuals in the ϕ direction are in agreement with the expected resolution
For the Z direction displacements and cross talk are more important (±20° stereo layers) and residuals are broadened but still acceptable; for the new run the mask realignment will improve the situation.

The 11th Vienna conference on Instrumentation, February 19-24, 2007

† mozzanica@bs.infn.it