MEG II drift chamber characterisation with the silicon based cosmic ray tracker at INFN Pisa

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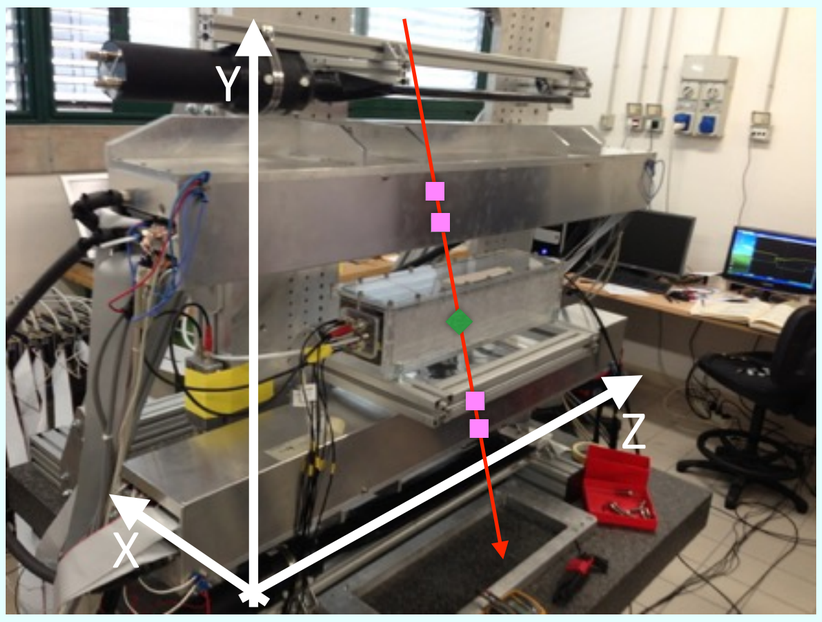
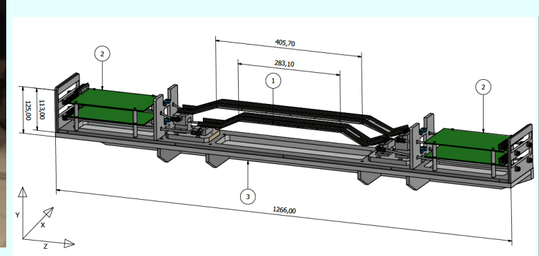
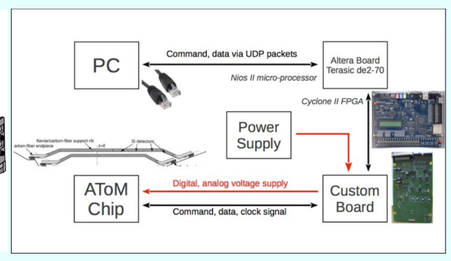


The cosmic ray telescope

In order to **compare** the **performance** of many possible **small-size tracking** prototypes, a **high-resolution** cosmic ray **tracker** may be used as an **external track reference**. We have constructed a **telescope** with an **intrinsic tracking resolution of 15–30 µm** by assembling **four spare ladders** of the **external layers** of the **Silicon Vertex Tracker** of the **BaBar** experiment[1]. The **original DAQ** was **replaced** by **custom-designed boards** coupled with an **acquisition front-end personal computer** through commercial **field-programmable gate array** evaluation boards. The **hit** detection **efficiency** is **>90%** for **each module**. The **tracking performance** is better than **40 µm** for **detector under test thickness** of about 1% X_0[2].





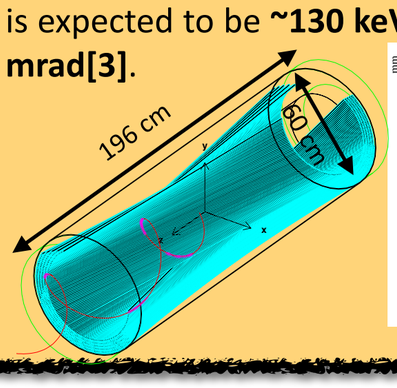
Multiple-Scattering Contribution to Track Projection Resolution as a Function of DUT Thickness (in Units of 300 μm of Si)

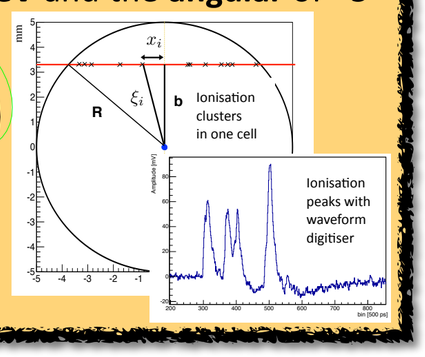
DUT thick (# SVT)	MS-uncert. (μm)	σ (μm, x — z views)
0	2	15 — 30
1	13	20 — 32
2	18	24 — 35
4	26	30 — 40

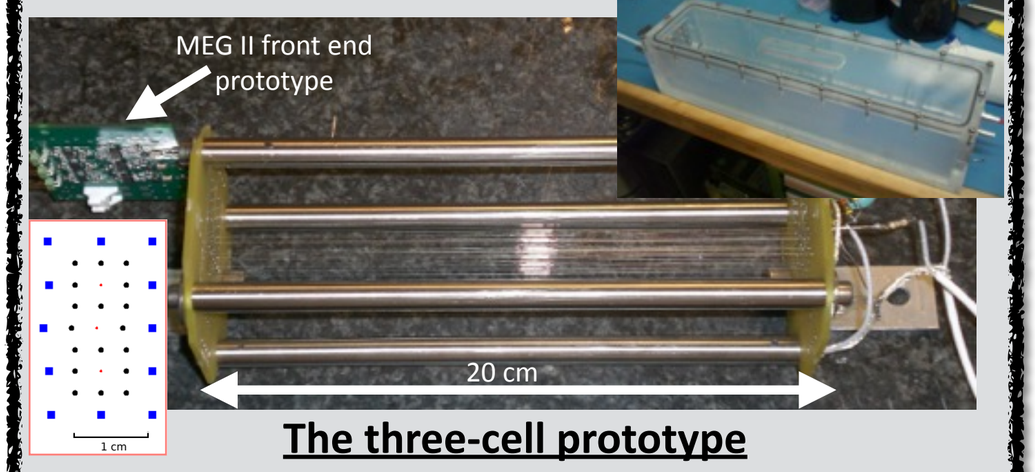
MEG II drift chamber

It is a **2π single volume chamber** filled with **He-Isobutane (85-15%)**. The **1920 drift cells** in are arranged in a **~7 deg stereo geometry**. The **wires** are **read out** at **both ends** by a **GHz bandwidth DAQ chain**. **Many** of the **~13/cm ionisation clusters** will be **identifiable** in the **digitised waveforms** and with **cluster timing algorithms**. The chamber operates at **~1600 V** corresponding to a gain of **~5 x 10^5 electrons**.

Simulation studies show that, given a **single hit resolution ~120 µm**, the **momentum resolution** is expected to be **~130 keV** and the **angular** of **~5 mrad[3]**.





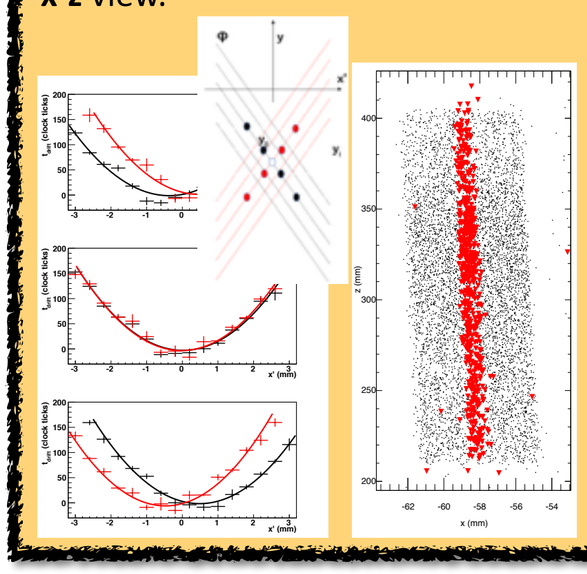


The three-cell prototype

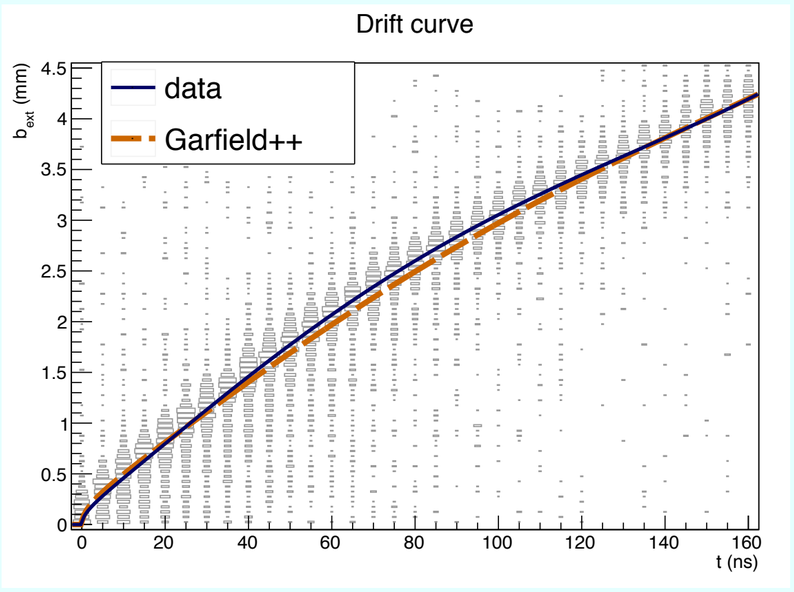
The **pattern** of **three 7 mm squared cells** is implemented on **two FR4 PCB** with the **anode wire (25 µm (Au)W)** of the **central cell staggered** by **500µm** for **self tracking** capabilities. It stays in a **plexiglas gas tight box** having **two thin windows** (1mm thick) looking at the **telescope sensitive area**. The **geometry** and **working parameters** are **equivalent** to the final chamber. The **sense wire signals** are **amplified** by the **DC front-end prototype[4]** and **digitised** by a **CAEN V1729**, **300 MHz** bandwidth, **2 GSPS** waveform digitiser.

Alignment

Iterative alignment into the **telescope frame** with **~150µm precision**. The **height** comes from the **crossing** of the **wire projections** with **tracks** from **opposite directions**. **Wire imaging** is used for **x-z** view.



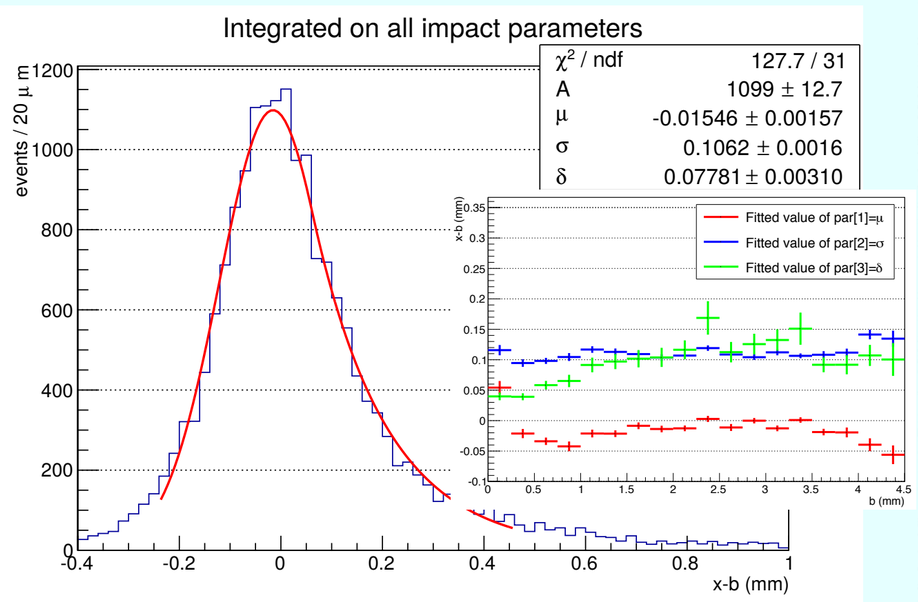
Results



The **r-t relations** are **extracted** form **data** by using the **external track reference**. The results **are in agreement** with the **Garfield++ predictions**.

The **difference** between the **impact parameter** measured by the **telescope** and the **estimation from the first cluster** is the **single hit resolution**. It is **fitted** by a **gaussian** distribution plus an **exponential tail (starting from** a distance **δ** from **µ)**, the tail **models** the **bias expected** in this **gas admixture[5].**

The **measured resolution** is **~110 µm** in the **whole cell**. The **bias** is **present in particular** for **lower impact parameters**.



MEG II

The **MEG II goal** is to reach a **sensitivity of 5 10^{-14}** on the **µ→eγ branching fraction**, a **factor 10 better** than **MEG**. In addition to the **presented tracker** the experiment will be **equipped** with **pixelated Timing Counter** detectors, consisting in **scintillator tiles** read by **SiPMs** to measure the **positron time-of-flight**. The **γ-detector inherits** the **LXe detector** used during the **first phase of the experiment**, the only **difference** being related to the **inner face** read out: **2'' PMTs** will be **replaced** by **MPPCs** to **improve** detector **uniformity** (notably for shallow γ-rays), **single photo electron response** and **imaging** capability as well.

Bibliography

[1] C. Bozzi et al., NIMA, vol. 453, pp. 78–83, 2000
[2] L. Galli et al., TNS, vol. 62, no. 1, February 2015
[2] M. Grassi poster at this conference
[3] A. Pepino poster at this conference
[4] G. Signorelli poster at this conference

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