GEMPix at Linac4

An integrated system for 3D energy deposition measurements in hadron therapy with high spatial resolution

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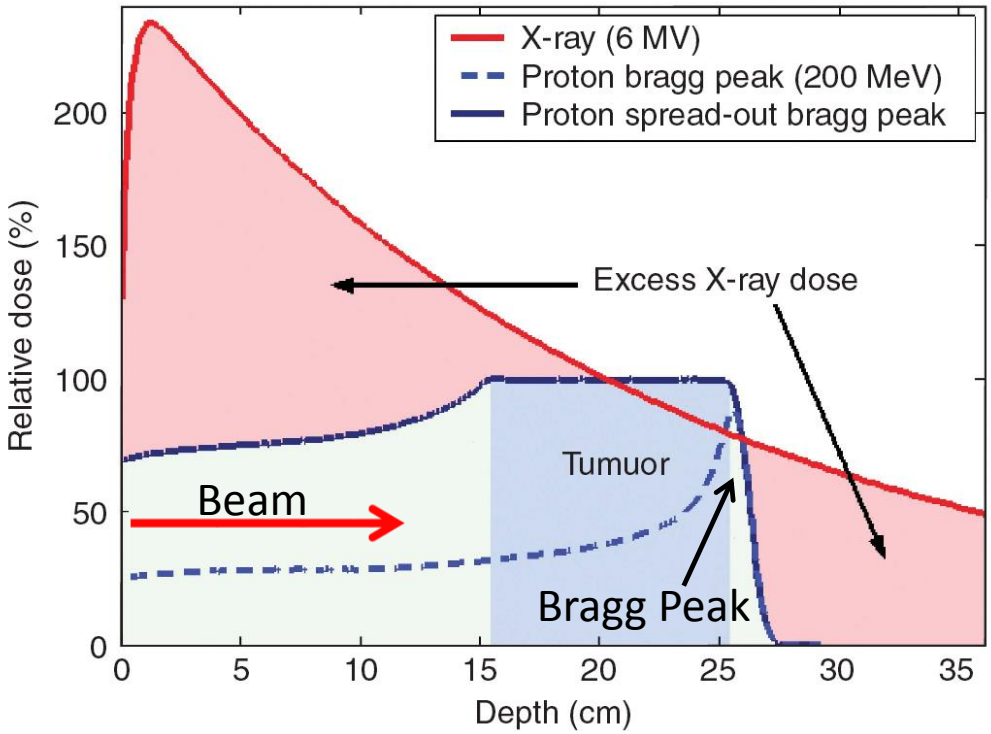
Introduction: Radiation Therapy

- Cancer therapy:
  - Surgery
  - Chemotherapy
  - Radiation therapy
    - X-rays
    - Proton- / Hadrontherapy
- Need for quality assurance tools, beam monitors, …
- Typical system: water phantom + ion chamber
- New detectors needed for Proton- / Hadrontherapy!



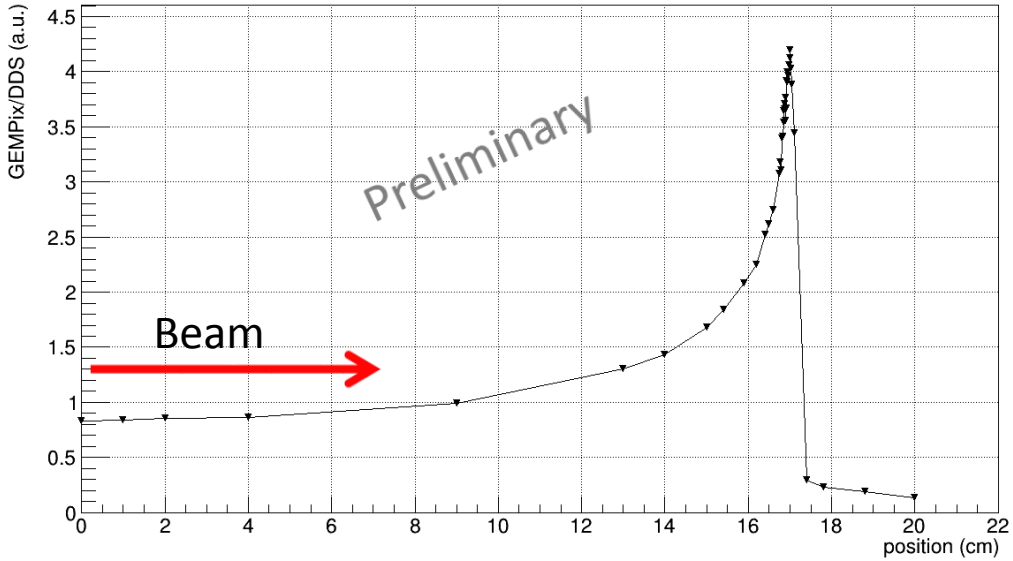
→ GEMPix in water phantom

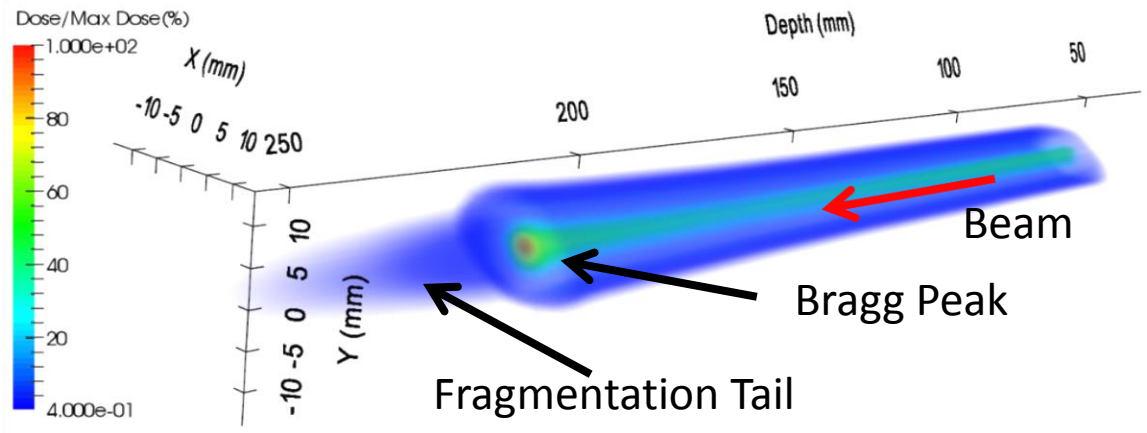
GEMPix in Water Phantom

Development of an integrated system to measure 3D energy deposition

Need for beam time:

- First test with integrated system
- New water phantom
- New ion chamber





Measurement with GEMPix at CNAO

Overview

What do we want to measure?

- 3D energy deposition of proton- / hadron therapy beam in water

How do we measure?

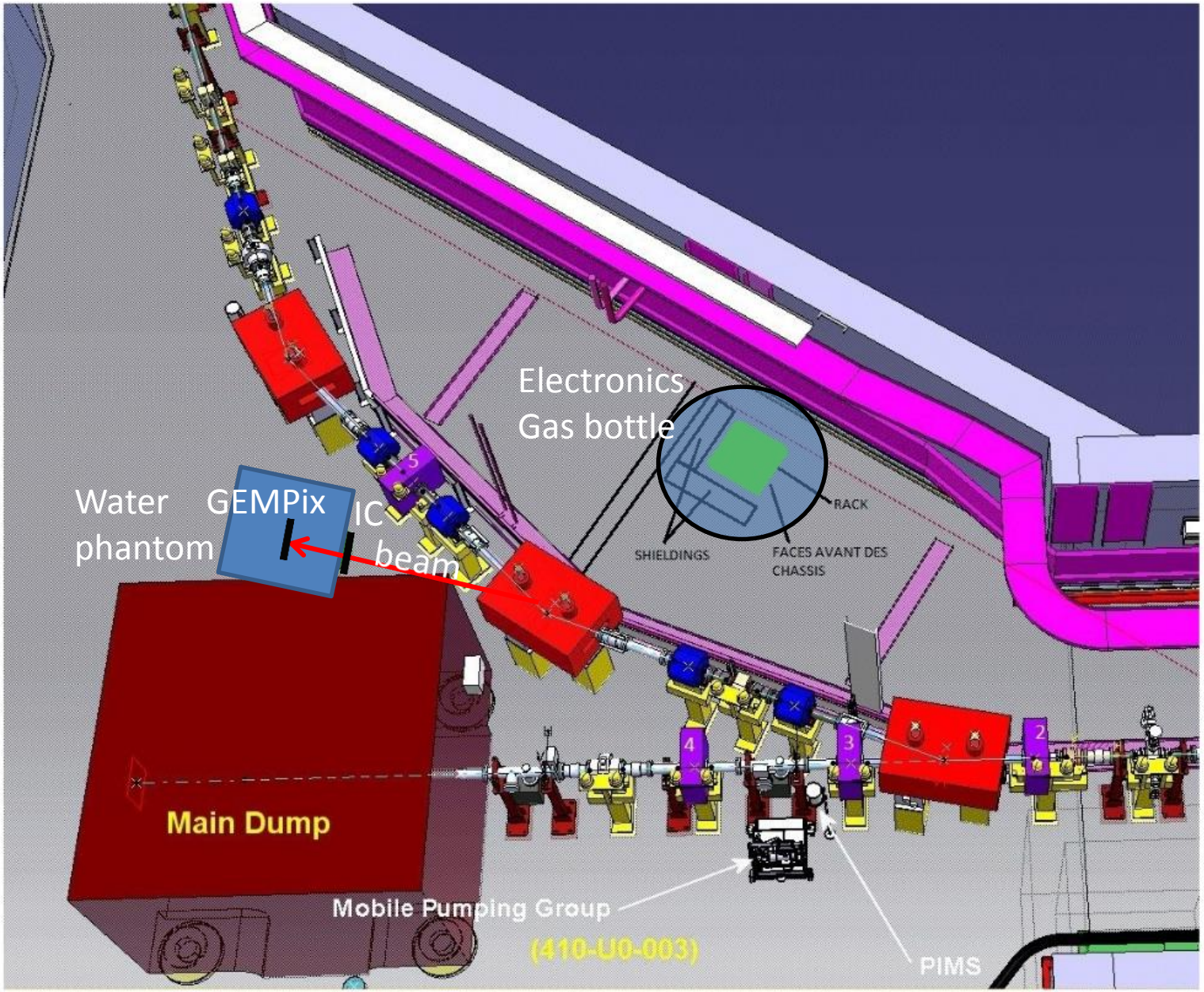
- Beam directly on ion chamber / phantom
- Depth scan with GEMPix in water

What's the setup?

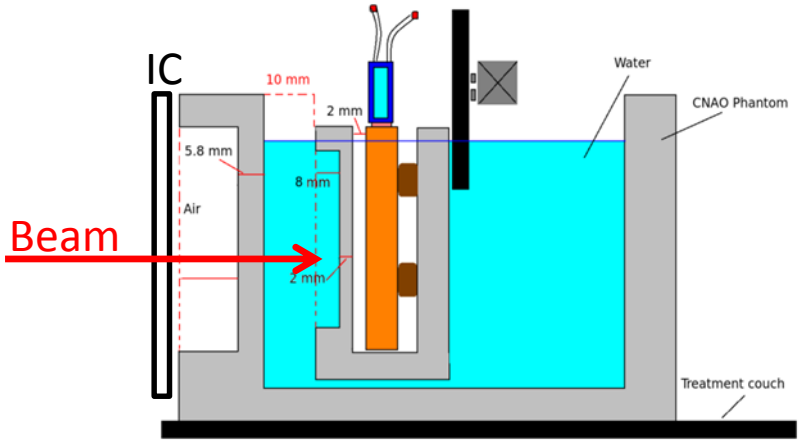
- GEMPix in water phantom
- Ion chamber as reference detector

Beam settings at Linac4?

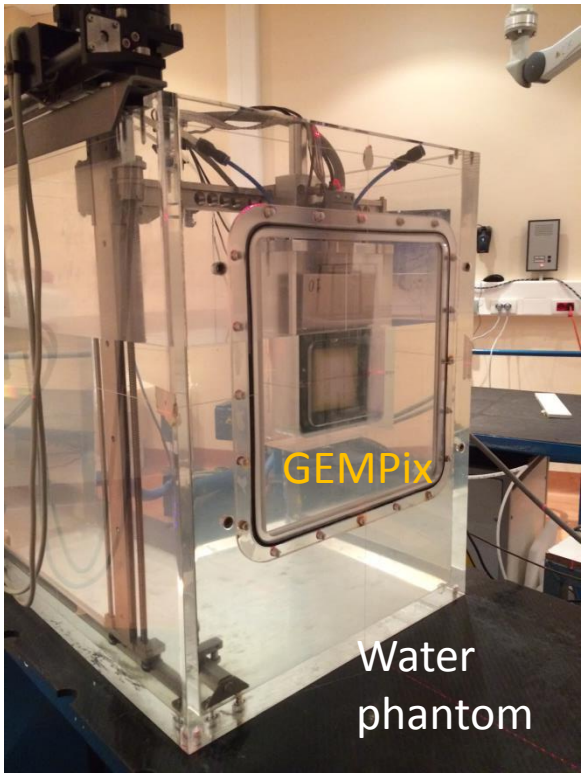
- 160 MeV
- Low intensity


Electronics
Gas bottle
RACK
SHIELDINGS
FACES AVANT DES CHASSIS
Water phantom
GEMPix
IC
beam
Main Dump
Mobile Pumping Group
(410-U0-003)
PIMS
5
4
3
2

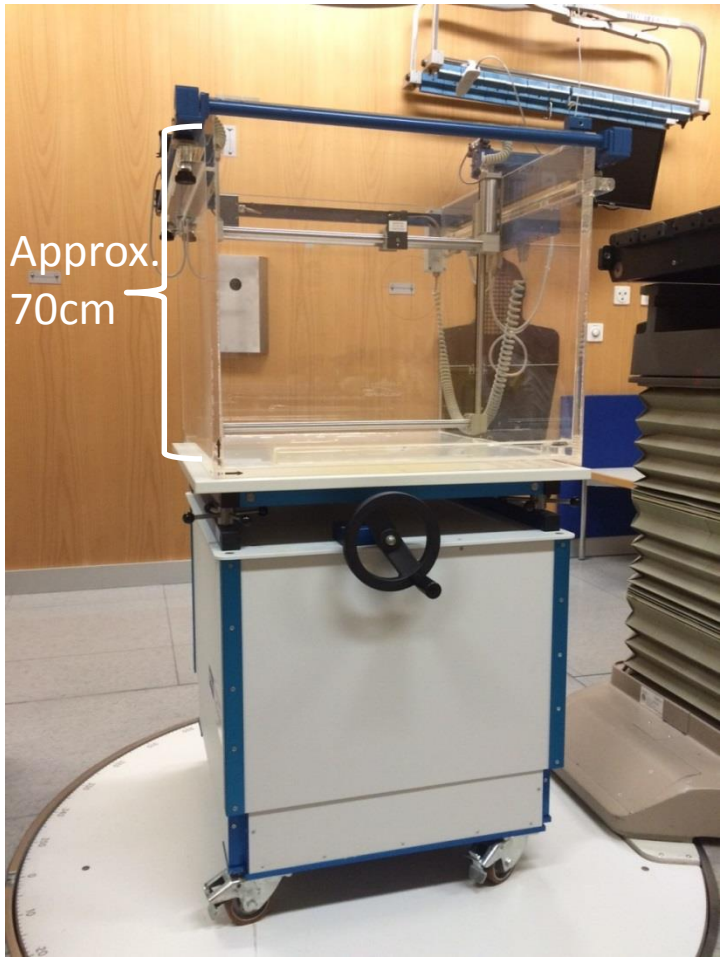
Setup



Schematics (not to scale)



GEMPix inside a phantom



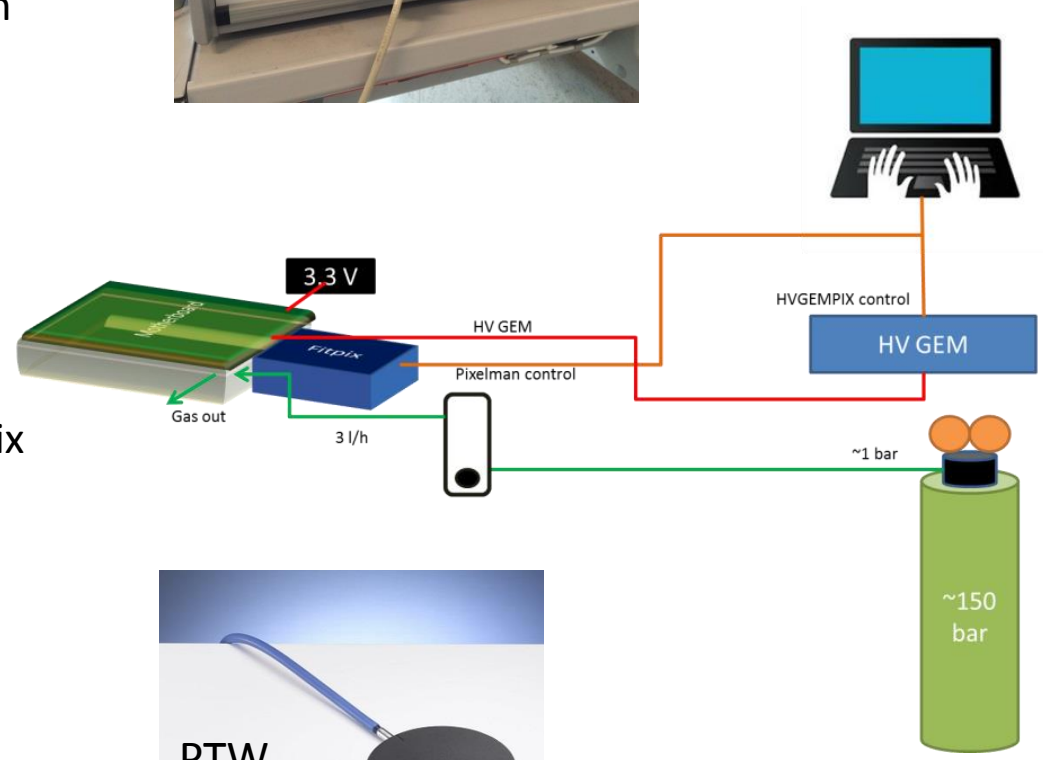
Our water phantom on the support table (Wellhoefer Blue Phantom)

Setup II

Equipment inside the tunnel:

- Water phantom:
  - 250 l water
  - control / power unit
- GEMPix:
  - Continuously flushed at 3 l/h with Ar:CO_2:CF_4, bottle with electro valve, exhaust to environment
  - HV unit (small NIM crate)
  - low voltage
- Ion Chamber:
  - Readout / supply unit
- Laptop
  - Control of phantom, DAQ, GEMPix HV, gas bottle
  - Remote access (WiFi ?)
- Electronics
  - max 5-10m away from water phantom
  - Extra shielding?

Water phantom control



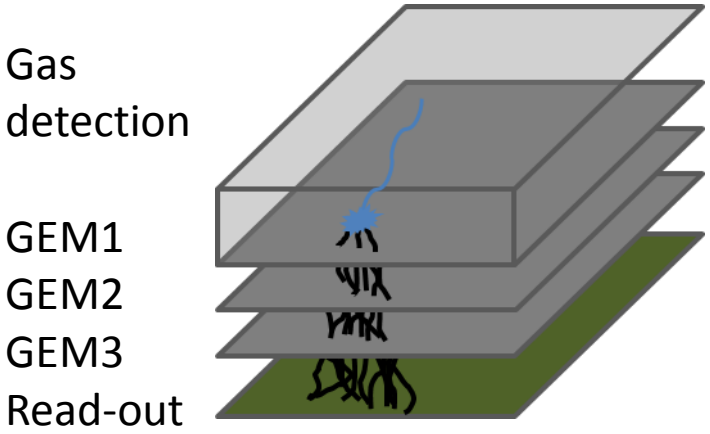
Beam Settings

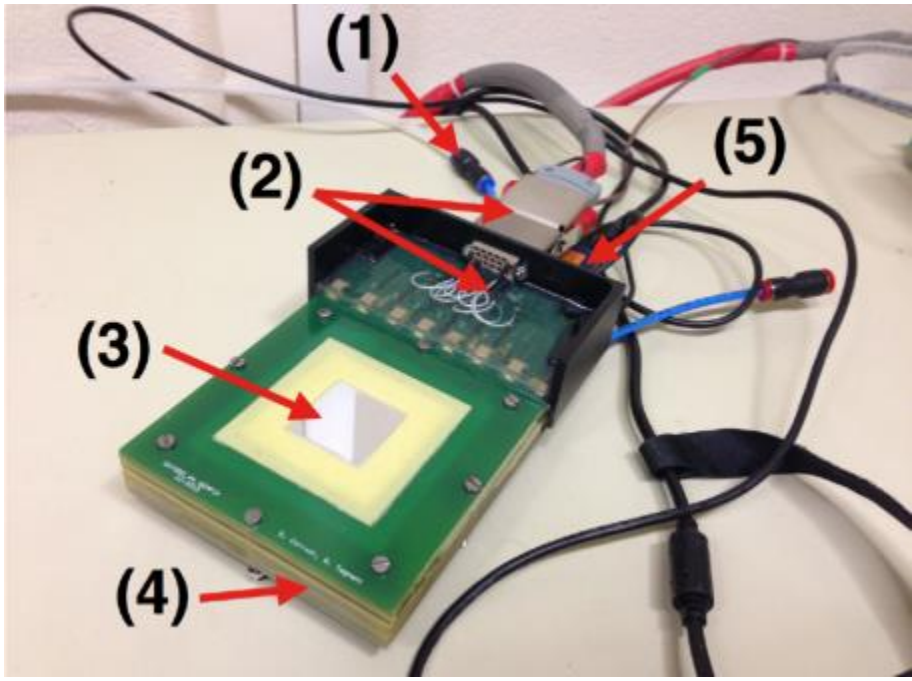
- Second bending magnet turned off
- Beam directed on ion chamber / phantom
- Beam settings ideally like typical beam in synchrotron (CNAO, HIT, …)
- Lowest intensity and longest spill achievable
  - CNAO synchrotron: Intensity 10^8 p/s, spill duration > 1s
- Maybe 600 µs and 1 nA?
- Beam size: FWHM approx. 0.5 cm
- Energy: 160 MeV
- Water phantom serves as beam dump

Backup

The GEMPix Detector

- GEMPix: 3 GEMs + Timepix
- 9 cm^3 Ar:CO_2:CF_4
- Several applications of the GEMPix: Hadrontherapy, Microdosimetry, Radiotherapy, Radioactive waste, …





1) Gas supply
2) HV supply
3) Mylar entrance window
4) GEM foils
5) FITPix readout

GEMPix: GEMs + Timepix

3 GEMs:

- Kapton foil with thin copper layers
- Gas amplification in holes (large field)
- Total gain of max 10^5

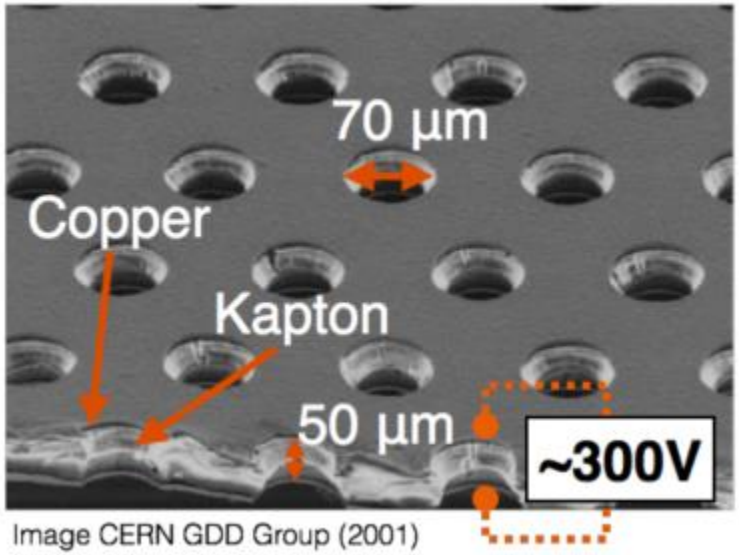


Image CERN GDD Group (2001)

4 Timepix chips:

- 512 x 512 pixels
- each 55µm x 55 µm
- detection threshold per pixel of 1000 electrons