

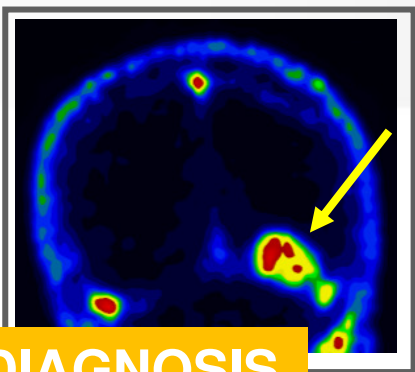


Beam Monitoring in an Industrial Particle Therapy System

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DIAGNOSIS



THERAPY

- 2 -

Protect, enhance and save lives.

Iba

IBA focus on healthcare

Pharmaceuticals

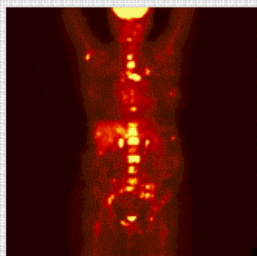
Pharmaceuticals

Radiopharmaceuticals

- Molecular Imaging
- Nuclear Medicine (diagnostics & therapy)

Bioassays

- In vitro medical diagnostics
- Drug screening

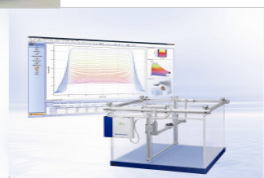


Dosimetry

Dosimetry equipment

to measure radiation dose for

- Radiotherapy
- Radiodiagnostics

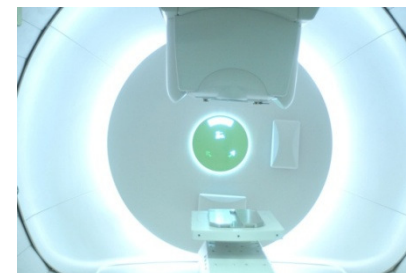


Protect, Enhance, and Save Lives

Equipment

Proton Therapy

Proton Therapy is increasingly considered as the ultimate radiotherapy for cancer due to its superior dose distribution



Accelerators

Cyclotrons

- To produce Radioisotopes

E-beam / X-rays

- To irradiate / treat many industrial products



Beam monitoring in an Industrial PT system

Simple designs
Driven by robustness, maintainability
Cost-effective solutions

Internal to the system

- accelerator
- beam line
- treatment head

External to the system

- characterisation
- quality assurance

Beam monitoring at the cyclotron

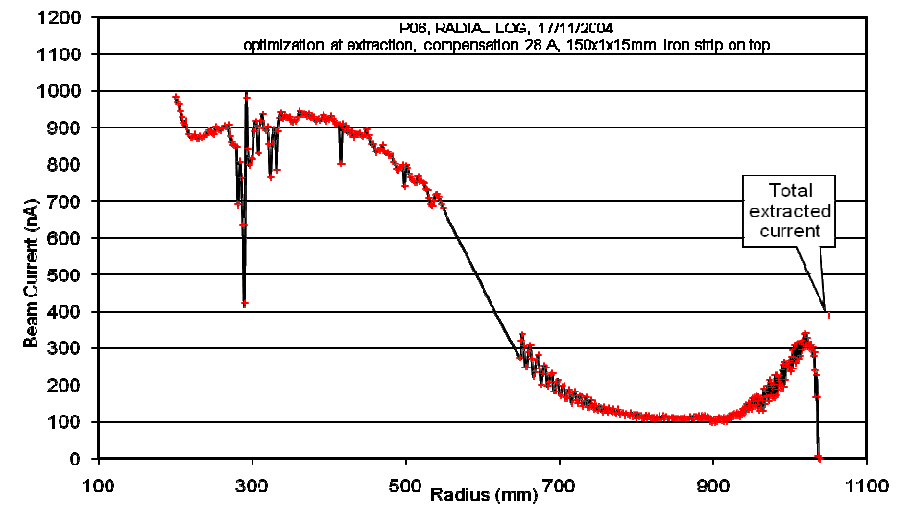
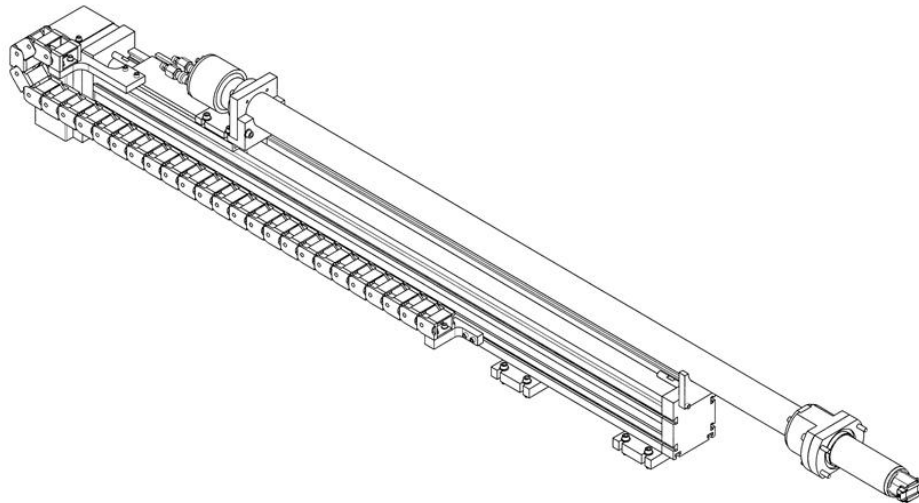
Inside the machine:
the radial probe



At cyclo exit:
« IC-cyclo »

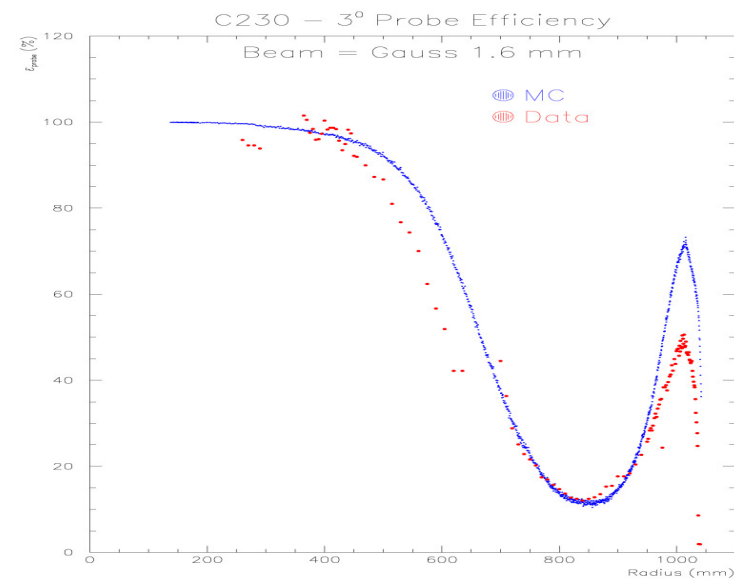
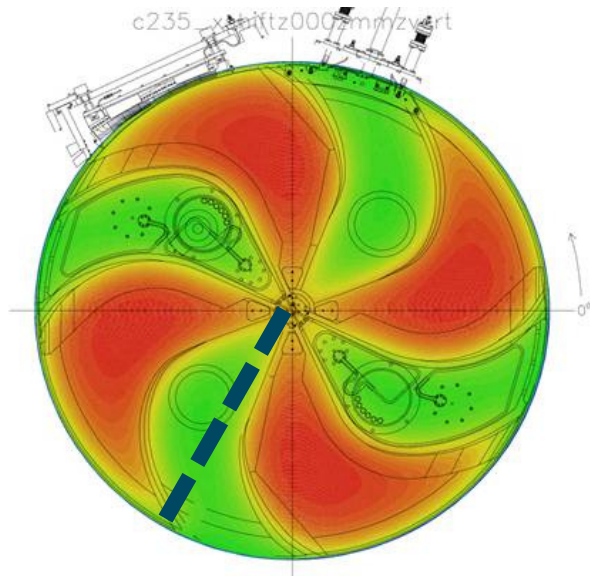
Radial probe

- Beam detection on a copper head
- Output: beam current as a function of the radius



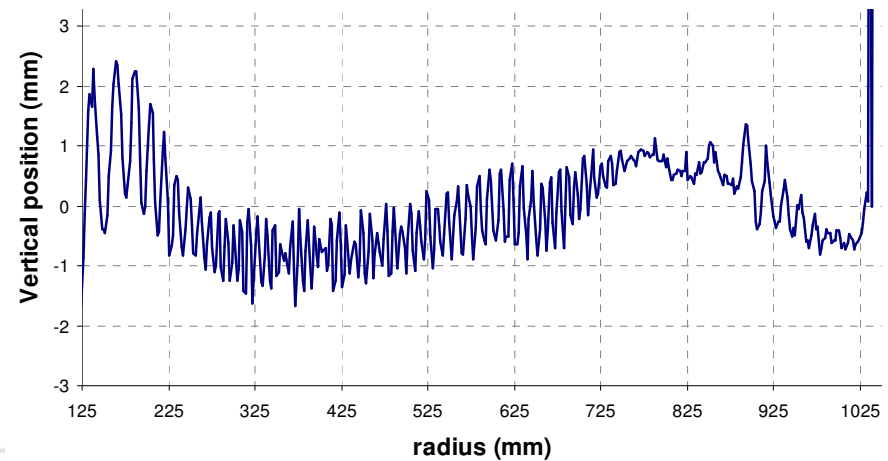
Understanding radial probe output

- Detection efficiency depends on the radius

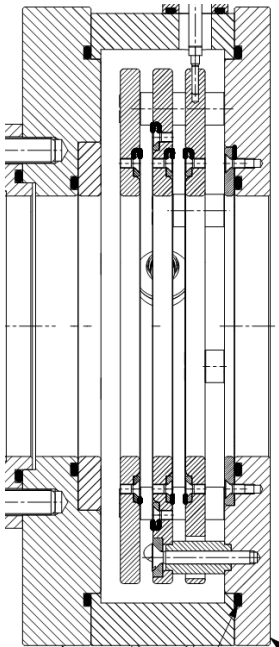


Modified version: visual probe

- Alumina screen coupled to a commercial camera
- Used to monitor beam oscillations in the median plane



Beam current at cyclo exit: IC-cyclo

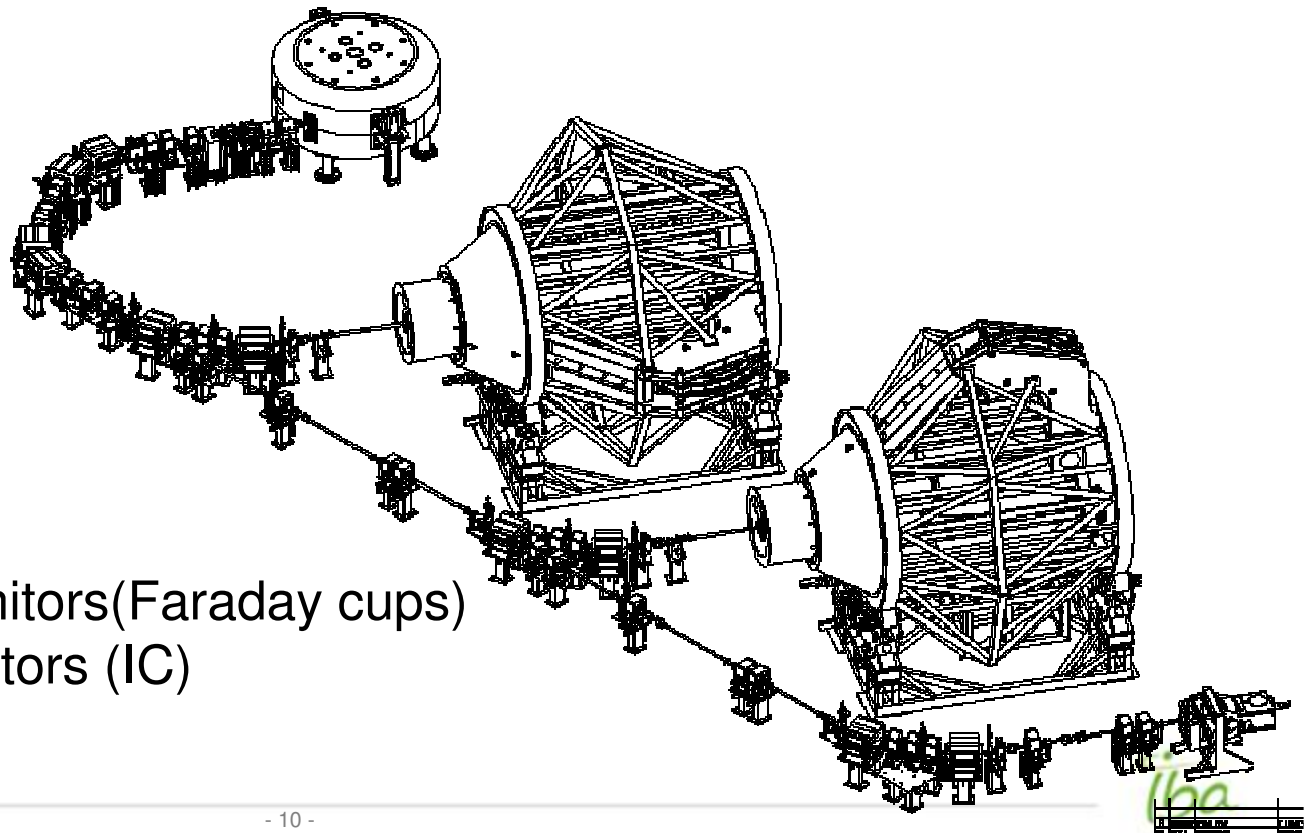


- Once properly calibrated, IC is a simple and reliable method for online beam monitoring
- IC-cyclo is a 4-mm gap chamber with measurements on two plates
 - Checks on beam current
 - Feedback to the beam regulation
- Continuous dry air flush for better signal stability

Beam monitoring in the beam line

Two categories:

- Beam current monitors(Faraday cups)
- Beam profile monitors (IC)

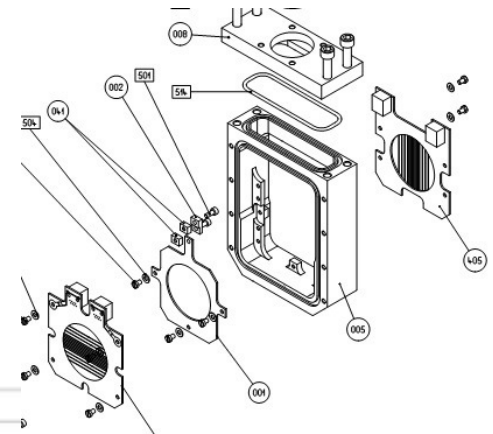
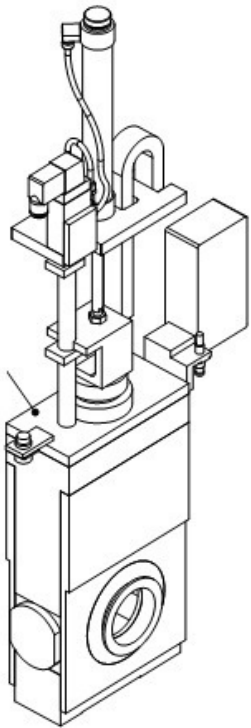


Beam current monitors

- Purpose is to monitor the beam fluence (Faraday cup principle)
- Readout performed on Brass or nickel blocks
- Different locations:
 - Beam stops (degrador wheel and room entrances)
 - Collimators (cyclo extraction and degrador exit)
 - On the slits of the Energy Selection System

Beam profile monitors

- IC with stripped electrodes (X and Y directions) mounted on PCB supports
- Purpose is to determine the beam size / shape (information on beam current also available from channels summing)
- Location: various places along the beam line (retractable)

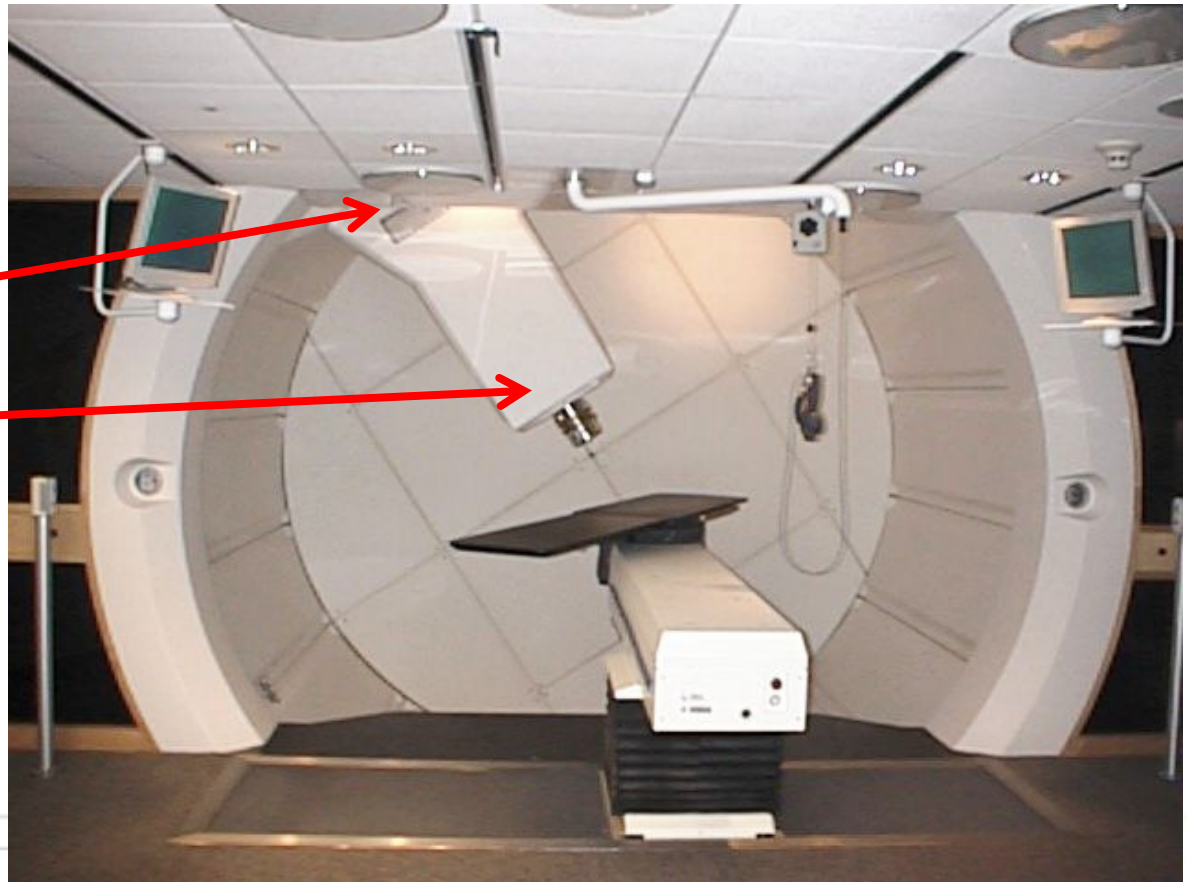


Beam monitoring in the treatment head (nozzle)

ICs used to control treatment parameters (dose, beam position & size)

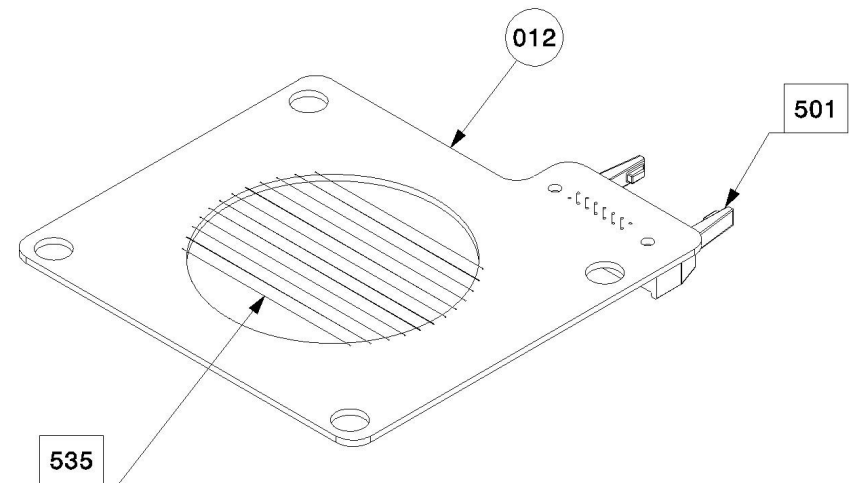
IC1 at nozzle entrance

IC2/3 at nozzle exit



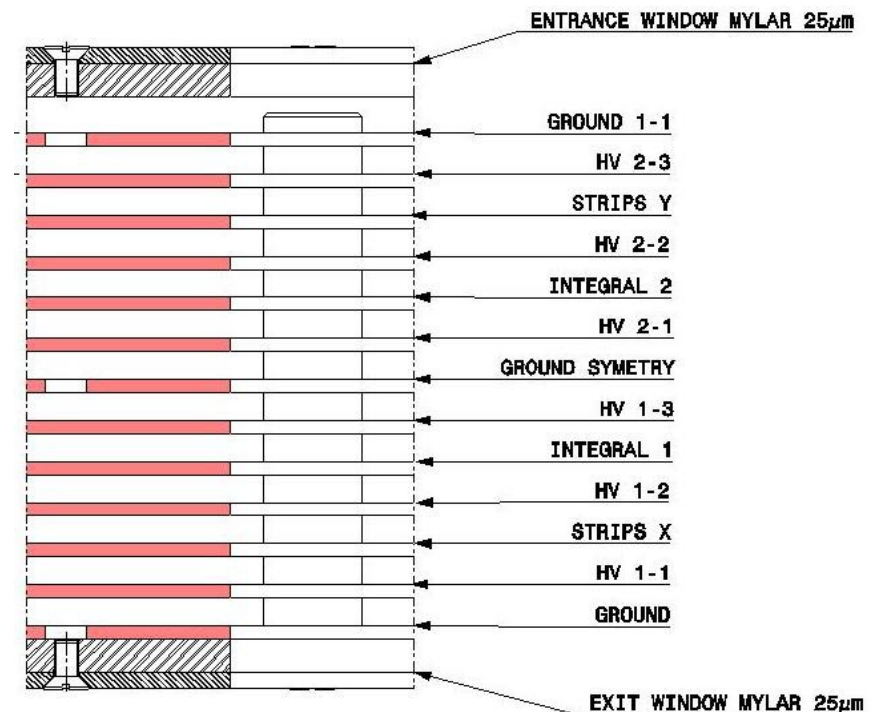
IC 1: validation of the beam tuning

- Essentially measures beam size and position at nozzle entrance (validation of the beam tuning)
- Modified to allow permanent stay in the beam path: array of tungsten wires



IC 2/3 : treatment dosimetry

- Redundant measurements used as reference for treatment control
- Determination of the beam size and position (X-Y strips) and monitor units (integral dosimetry pads)
- Thin mylar films (10 μm) with Al evaporation (100 nm) to minimize beam scattering
- Several HV plates between measurement foils to equilibrate electrostatics forces



External beam monitoring

- Purposes
 - Acceptance testing
 - System commissioning
 - Equipment QA processes
 - Patient specific QA protocols
- Measured quantities
 - Beam size (transverse profile)
 - Depth-dose curves (longitudinal profile)
 - Relative or absolute dosimetry

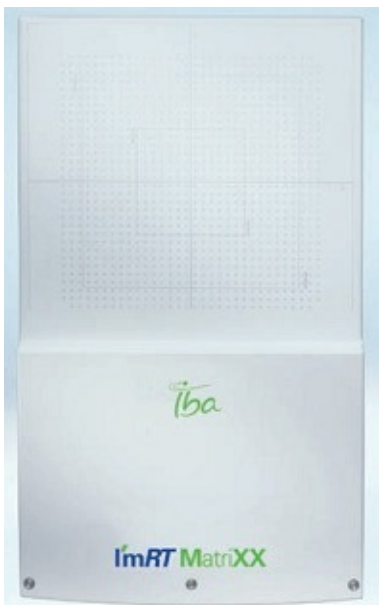
Water phantom

- Classical tool in all radiotherapy facilities
- Can be equipped with a wide set of probes
- Allows measurements with accuracy down to 0.1 mm



MatriXX and DigiPhant

- 32 x 32 air cavities for transverse profile measurement
- Can be mounted in water phantom (DigiPhant)



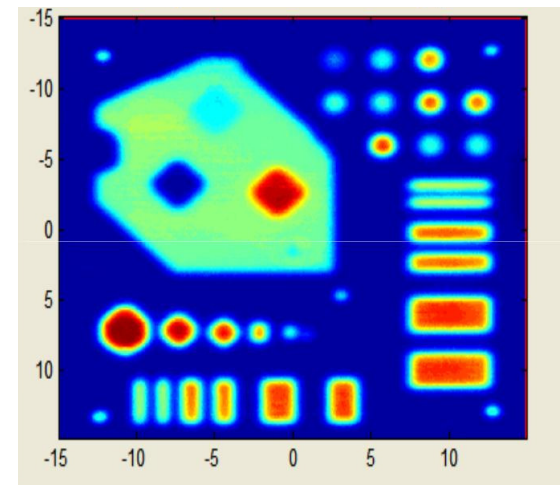
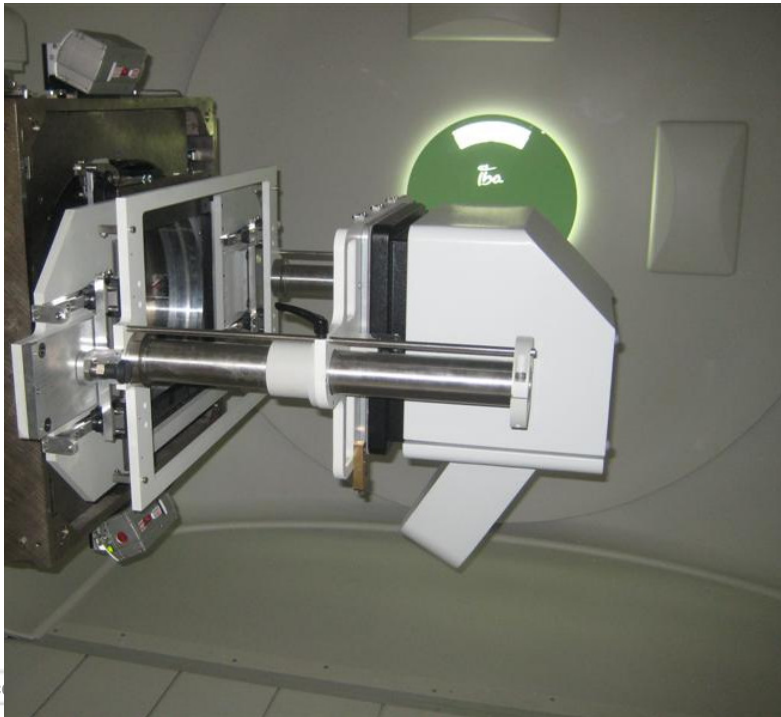
ZEBRA (MLIC)

- Fast depth-dose profile acquisition
- Stack of 180 ion chambers



LYNX

- 2D scintillating screen coupled to CCD camera
- 0.5 mm pixel size, 300x300 mm² field





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Thank you

