MEDICYC 60 MeV R&D

Proton Beam-Line

Technical Specifications

Centre Antoine Lacassagne, Nice, France

1 Accelerator Parameters

Parameter	Value
Accelerator	Isochronous cyclotron
Extracted beam energy	65 MeV
Extracted beam current	10 pA – 10 uA
Beam structure	Bunched at 25 MHz

2 Beam parameters at Device-Under-Test (DUT)

Two beam configurations are possible, each giving different characteristics at the DUT.

1. Gaussian beam
   This configuration produces a narrow beam with a Gaussian lateral profile. The exact beam size and energy depends on the distance traversed in air, after having exited the beam vacuum tube. The DUT can be positioned at any distance between ~5 cm and 300 cm from the vacuum tube.

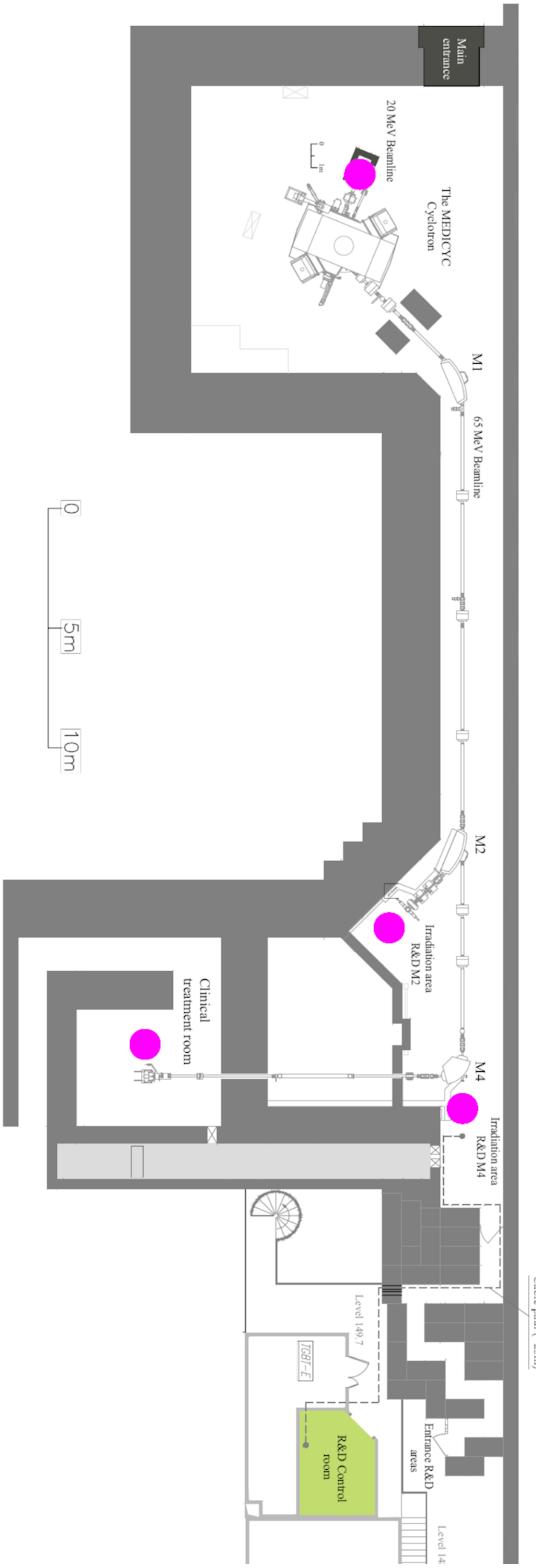
2. Flat beam
   A double scattering system with an occultor produces a large (100 mm) flat beam at a specific distance from the vacuum beam pipe. All irradiations using this configuration are done at this position (229 cm). The beam energy and beam size are thus fix.

Parameter	Value
General	
Energy selection	Range shifters (PMMA)
Energy modulation	Ridge filters (work in progress)
Energy spread	< 0.5 % (~60 MeV) to 7% (20 MeV)
Beam calibration	Fluence or dose
Dosimetry	Faraday cup + ionization chambers
Flux measurement precision	5% (non-degraded), < 10% (degraded)
Available collimators (additional sizes can be made on demand)	2, 6, 10, 20, 50, 60 and 100 mm
Beam cutoff	Dose / Fluence / Time / Manual
Gaussian Configuration	
Primary (non-degraded) energy	63.8 MeV – 60.5 MeV (depending on position)
Energy range	63.8 MeV – 20 MeV
Beam size (σ mm) d = distance to vacuum tube in cm	X : $1.212 + 3.684e{-}02 * d + 1.307e{-}4 * d^2$ Y : $5.381 + 9.98e{-}3 * d + 1.535e{-}4 * d^2$

Flux range	1e6 – 1e10 protons / cm^2 / s (higher fluxes are possible but at a reduced monitoring precision)
Neutron contamination (flux)	n / p < 1e-4
Flat Configuration	
Primary (non-degraded) energy	59.0 MeV
Energy range	59.0 MeV – 20 MeV
Beam diameter	100 mm (59.0 MeV), 95 mm (20 MeV)
Beam homogeneity	±3%
Beam transmission	20%
Flux range	1e6 – 1e9 protons / cm^2 / s (higher fluxes are possible but at a reduced monitoring precision)
Neutron contamination	n / p ~ 1e-2

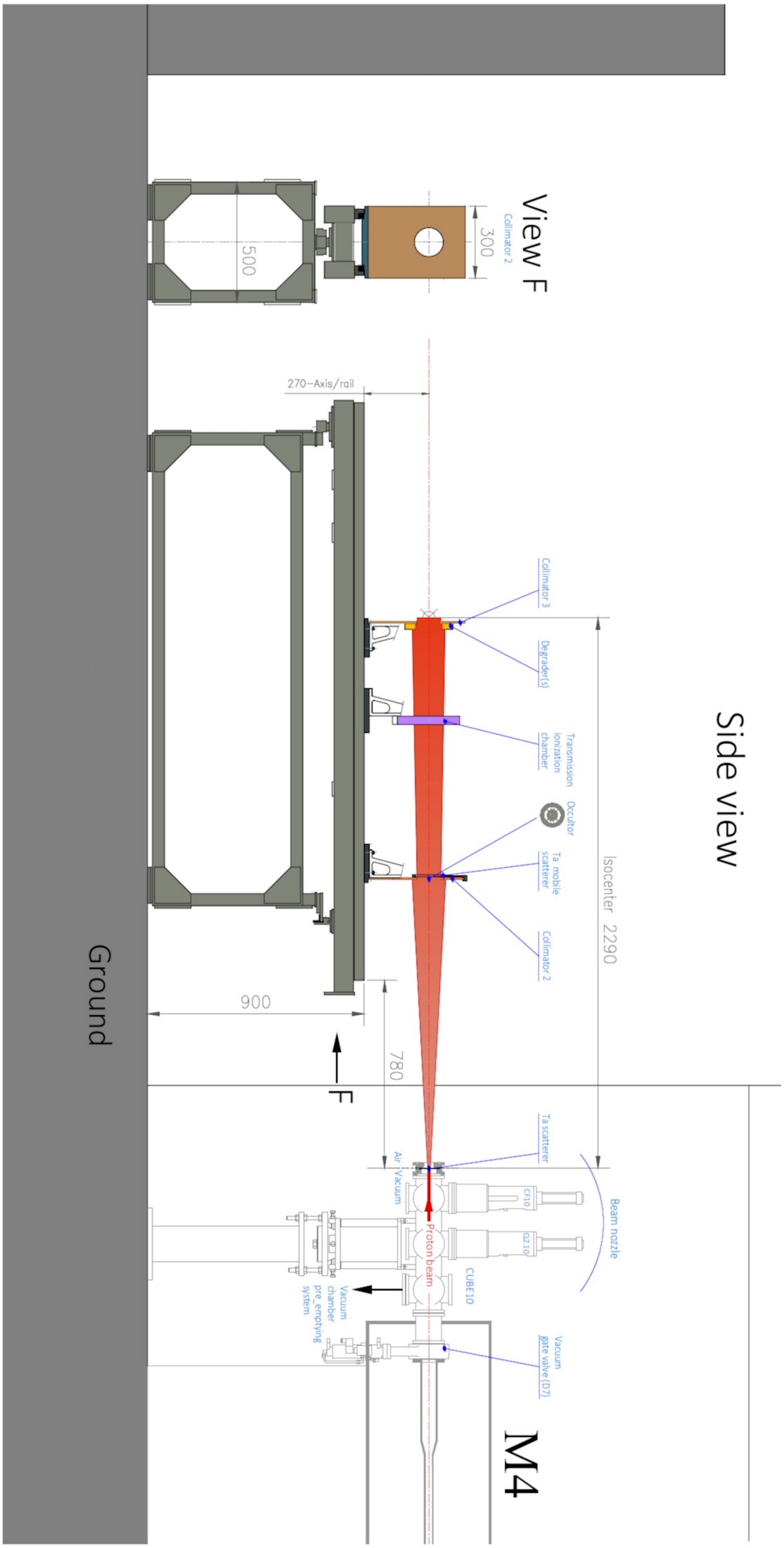
3 Irradiation Points

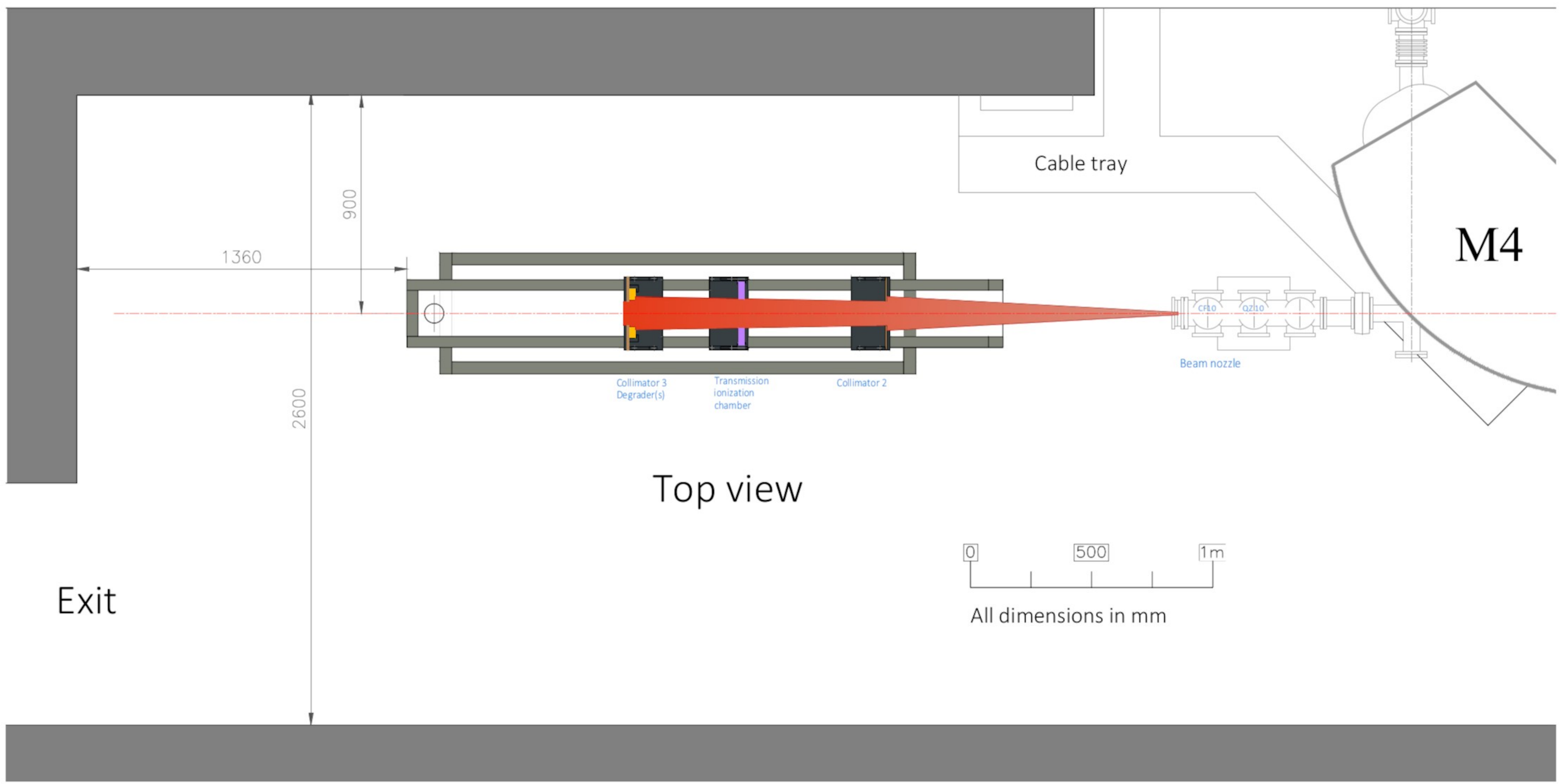
Currently only the M4 irradiation point is available.



4 M4 Irradiation Room Layout

For a flat beam, the DUT is placed at 229 cm from the beam vacuum tube. For a Gaussian beam, the DUT can be placed at any position on the irradiation table, depending on the desired energy and beam size.





Cable tray
M4
1360
900
2600
Collimator 3
Degrader(s)
Transmission
ionization
chamber
Collimator 2
Beam nozzle
Top view
0
500
1m
All dimensions in mm
Exit

5 DUT positionning

- The surface of the irradiation table is located 270 mm below the axis of the beam
- The surface consists of two rails on which dedicated fixation plates are positioned
- All equipment are positioned on the irradiation table via the fixation plates
- To position the DUT in the beam field, four approaches are possible

  1. By using an ESA SEE frame (preferred solution for electronic cards and optical components) (figure 2)

     Drawing: https://escies.org/webdocument/showArticle?id=230&groupid=6

  2. By using one of the PANAVISE instruments (figure 3)
  3. By a custom made frame that is made on demand (figure 4)
  4. By a user-supplied support

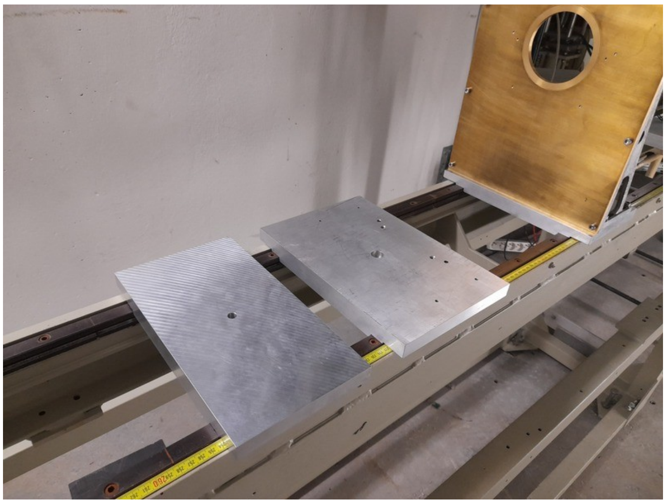


Figure 1: Instrumentation fixation plates

Figure 2: The ESA SEE frame (design by UCL).

Figure 3: Selection of PANEVISE instruments for DUT positioning

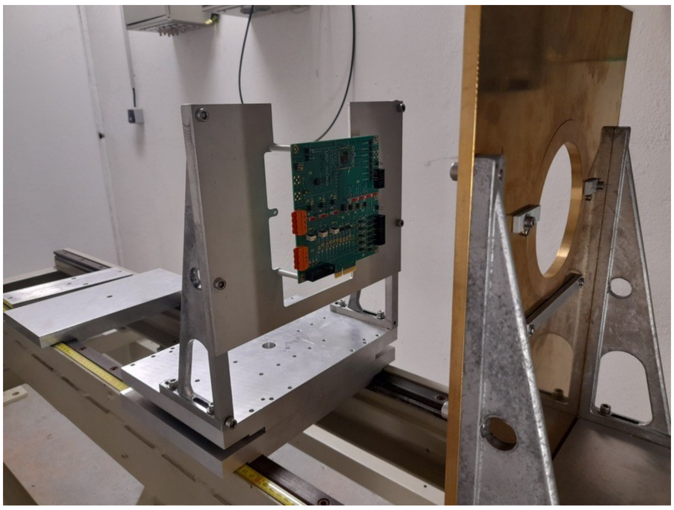


Figure 4: Example of a custom-made DUT holder

6 Pre-installed cabling between the control room and the irradiation room

The following cabling is preinstalled between the irradiation room and the control room and can be used at will. Other cabling can be installed on demand. Users can also install their own cabling during an irradiation. A cable length of atleast 25 m is then required.

- 4 coaxial cables, model C-50-3-1, with BNC connector
  - nominal impedance : 50 +/- 2 ohm
  - nominal capacity : 84 pF/m
  - nominal voltage : 0.8 kV eff

- 2 coaxial cables, model HTC-50-3-1, with SHV connector
  - nominal impedance : 50 +/- 2 ohm
  - nominal capacity : 101 pF/m
  - nominal voltage : 8 kV eff

- 2 RJ45 cables , Cat 6

- 2 double optical fibers (Duplex), with connector LC/LC
  - Fiber type : 50/125 µ
  - Fiber quality : Multimode OM3

7 Installation of temporary cabling

Users of the beam-line can easily install their own cabling between the irradiation room and the control room. The total cable length required is then 25 m. However, instrumentation can also be installed at position 2 in figure 5 where the cable path exits the labyrinth through a 15 cm diameter 1 m long straight shaft (figure 6). To reach this position, a 20 m cable is sufficient (with a ~2 m margin). In that case, the cable makes a single (large radius) 90 degree bend (figure 7).

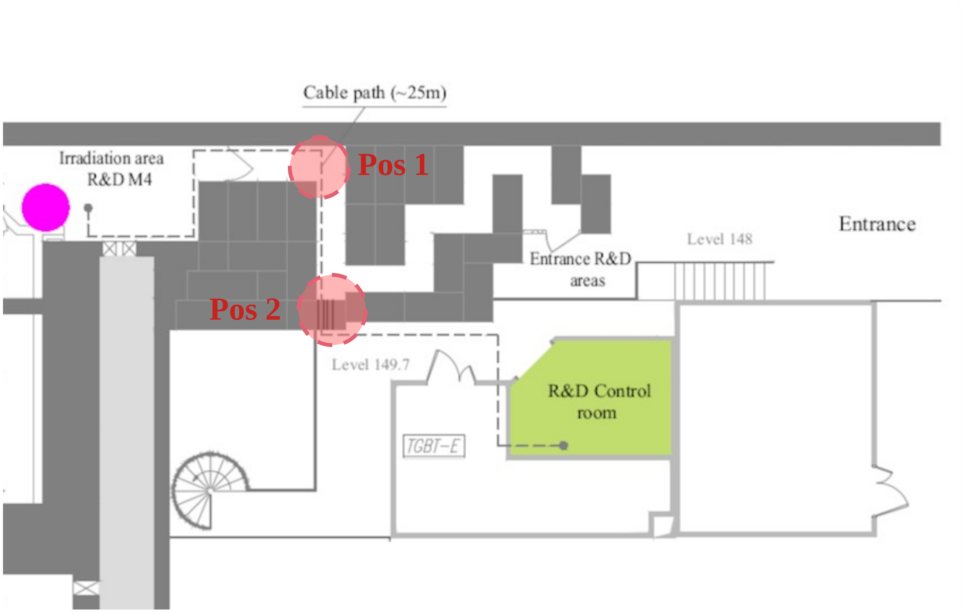


Figure 2: The cable path between the irradiation room and the control room. Cables dont need to follow the dotted path exactly. A single 90 degree bend (pos 1) is required to reach position 2.

Figure 3: Pos 2 : The cable path exit of the labyrinth.

Figure 4: Pos 1 : The 90 degree bend in the labyrinth.

7 Shielded areas in the irradiation room

A shielded area in the irradiation room can be provided on request. It is normally arranged slightly upstream of the beam nozzle, at a distance of roughly 4 m from the irradiation point (pos 1 in figure 8). A slightly less shielded position can be arranged at about 2 m from the iso-center (pos 2) Shielding is done by blocks of polyethylene and concrete and can be adapted according to the user needs. It is off course impossible to reduce the flux of neutrons and gamma to a negligible level, and sensitive equipment should be placed outside the irradiation room unless the beam flux is very low.

Instrumentation can also be installed in the labyrinth, at about 8 m distance from the irradiation point. The radiation levels at this point is negligible and it is thus a preferred location compared to pos 1 and 2 if the additional cable-length can be tolerated.