LNS Users Meeting INFN-LNS, Catania, December 15th 2015



News on irradiation beam lines and new projects for in-vivo experients

Francesco Romano

INFN - Laboratori Nazionali del Sud, Catania, Italy

francesco.romano@Ins.infn.it

Multidisciplinary beam lines at INFN-LNS

Two rooms are available at LNS for interdisciplinary activities irradiations:

- CATANA beam line (clinical proton beams at 62 MeV)
- **0° beam line** (protons and light ions up to 80 AMeV)

both equipped with detectors for beam diagnostics and dose monitoring.



CATANA beam line

- Mainly dedicated to proton irradiation (eye melanoma treatments)
- Dosimetry and radiobiology experiments
- In-air (and only p @ 62 MeV)
- Energy passively degraded
- Fast and easy positioning systems



- Double scattering system for lateral spread \rightarrow homogeneity $\approx 3\%$
- Collimated beams 1 mm / 35 mm
- Fixed elements limiting some applications:
 - Fluence not maximized
 - High level of homogeneity but no point-like spot size
 - Radiation protection issues during the patient treatments may limit beam current

0° beam line

- Transported beams:
 p, He, C, O, Ne, Ar, Kr, Xe, …
- Relative and absolute dosimetry
- Certified beam line for ESA experiment by the MAPRAD Group.
- Mainly dosimetry and radiobiology *in-air* irradiation but also possibility to use vacuum chambers
- Fast and easy positioning systems
- Collimated beams 1 mm / 30 mm
- No particular constrain from fixed elements but
 - Homogeneity \approx 15% (non focalized beams)
 - Final collimator can be removed but alignment procedure must be repeated (4 h)



Lateral spread monitoring



New setup for beam monitoring



On line beam monitoring

з

Monitor chamber (transmission air ionization chamber)

Secondary electron emission (tantalum foil optionally inserted)

Dose distributions measurements

✓ Reference absolute dosimetry in a water phantom using plane-parallel PTW Markus ionization chamber, calibrated according to IAEA code of practice.





✓ Lateral dose distribution finally checked with radiochromic films (EBT3, HD-V2)



Approved BTU in the interdisciplinary beam lines



Radiobiology: cell positioning



46 ¹⁶O @ 62 MeV/n 7,1 8,1 4,1 5,1 6,1 Depth in water [mm] 50 µm positioning accuracy achieved combining Gafchromic films with Markus Chamber

PMMA

Geant4 Monte Carlo simulations to support Users and predict fluence/dose/LET distributions

Radiobiology: irradiation device

The software for remote cell positioning has been updated



- Motorized system with 100 um precision
- Remotely controlled
- Interfaced with beam control system
- Real time dose-rate monitoring



Req. 1: cell growth laboratory

- Requirement for a larger and more equipped • laboratory
- Fully equipped with the basic system for a biological ٠ analysis
 - Centrifuge ٠
 - Incubators •
 - Sterilizer
 - Microscope
- CO_{2 "}centralized" system



Overlapping of several groups no more critical

Req. 2: high current irradiations

- Requirements for high currents → radiation hardness experiments
- Upgrade for enabling **100 nA** beam current at 0° room (10 nA so far)
 - Test of CVD diamond detectors \rightarrow radiation damage for HI-LHC (10¹⁶/cm² protons)
 - Radioprotection issues \rightarrow environmental radiation due on neutron production
 - Labyrinth for shielding realized with "Progetto Premiale IRPT " funds



MC calculations of environmental radiation with p @ 62 MeV in zero degree room (by S. Russo and R. Leanza)

- Funds still remaining to develop detectors for high currents measurements:
 - Dose/fluence measurements with dedicated Faraday cup
 - SEM for X/Y beam profiles monitoring
 - To be possibly used for high intensity beams after the CS upgrading

Preclinical studies with in-vivo irradiations



Preclinical work-flow

Monte Carlo simulations

Customized version of the public advanced example "Hadrontherapy"

Room for temporary animal handling

Building features:

- Humidity: 55%
- Noise < 70 db
- PVC floor sp. 2mm
- Air filter
- Day/Night cycle with white light
- Room with negative pressure (about 6 replacement/hour)

Request for authorization submitted in June 2015

3 BTU of p @ 62 MeV assigned by PAC

ELIMAIA @ ELI-Beamlines

ELIMED beam line layout

Graphics by G. Gallo

ELIMED test beamline @ INFN-LNS

med

40° LNS beamline

TANDEM beams scheduled in 2016

ELIMED R&D (prototypes)

4-10 MeV p delivered by the TANDEM

 Faraday cup characterization with TANDEM beams is on going

ELIMED R&D (dosimetry)

Thank you for your attention

...and thanks to:

Candiano Giacomo Leanza Renata Manna Rosanna Marchese Valentina Milluzzo Giuliana Petringa Giada