FIVE YEARS OF PHYSIC AND DOSIMETRIC EXPERIENCE AT LNS-INFN

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On behalf of

ITALIAN EYE PROTON THERAPY FACILITY
National Institute for Nuclear Physic (INFN)
1. HADRONTHERAPY at INFN:
   • The CATANA proton therapy center
   • Beam line elements

2. PATIENT FOLLOW-UP

3. RESEARCH ACTIVITY
   • New frontiers detectors
   • Monte Carlo simulations
CATANA: the Italian ocular proton therapy facility

Research based facility (CATANA) for the treatment of ocular tumours with 62 AMeV proton beams
CATANA: the Italian ocular proton therapy facility
The Laboratori Nazionali del Sud of INFN, Catania (Italy)
The CATANA proton therapy beam line
141 patients treated (Feb 2002-Apr 2007)

- 131 uveal melanomas
- 4 conjunctival melanoma
- 6 other malignancies (orbital RMS, non-Hodgkin Lymphoma, various metastases)

Follow-up on 103 patients
PATIENT FOLLOW-UP: tumoral thickness evaluation

Local control: 96% (99 / 103 patients)
PATIENT FOLLOW-UP: eye-retention rate

Enucleations:
2 pts for local progression
5 pts for radiation-induced toxicity

Eye-retention rate: 93% (96/103 patients)

PATIENT FOLLOW-UP: survival

Overall survival 96% (99/103 patients)

Disease-specific survival: 97% (100/103 patients)
PATIENT FOLLOW-UP: side effects and visual acuity

- **Retinal detachment**: 31%
- **Cataract**: 35%
- **Neovascular glaucoma**: 5%
- **Haemovitreous**: 8%
- **Rubeosis iridis**: 8%
- **Eyelids alterations or eyelashes loss**: 27%
- **Radiation-induced retinopathy**: 2%

PATIENT FOLLOW-UP: visual acuity

- **Stable**: 26% of pts
- **Reduced**: 71% of pts

Mainteinance of a good visual acuity (>$3/10$): 40% of patients
TALK OUTLINE

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Activity started in 1996 with the first tests on 62 MeV protons

- Gas detector (ionisation chambers)
- Film detectors
- Solid state detectors

10 year of work
43 papers in review journals
61 conference proceeding

Farmer
Exradin
Pin Point
Markus
Advanced Markus

Radiographic films
GAF Chromic films (MD52, EBT, …)

- Plastic scintillators
- Diamond detector
- TLD
- MOSfet
- Silicon diode
- Silicon microstrip
RESEARCH ON NEW DETECTORS: the MOPI *on-line* detector

Two 250 μm transmission microstrip silicon detectors for the verification of the beam stability during the treatment

Colleagues of the INFN Section of Turin, Italy

Beam profile
RESEARCH ON NEW DETECTORS: proton Computed Tomography

TOMOGRAPHIC IMAGE RECONSTRUCTION USING HIGH ENERGY PROTON BEAMS

Single tracking
Acquisition rate up to 1 MHz
Detector: 2 orthogonal microstrip; 200 um pitch x 256 strips; about 5x5 cm of active area
Trigger from the calorimeter

200 MeV, 179 projections at 1°, 5M Histories, 20 cm circular phantom
RESEARCH ON NEW DETECTORS: 2D pixel micro dosemeter

Detector Characteristics:
- 256 x 256 square pixels
- pixel size: 55 μm
- area 1.98 cm² (1.4 x 1.4)

Medipix2
Developed by MEDIPIX2 collaboration
CERN EP Microelectronics Group
CMOS 0.25 μm technology
- pixel: 55 x 55 μm²
- 256 x 256 channels

Colleagues of the Physics Department "E. Fermi" of the University and INFN-Pisa, Italy
RESEARCH ON NEW DETECTORS: 2D pixel micro dosimeter

Beam penumbra def.  
80% - 20%

MPX2  
Penumbra = 800 micron

Gafchromic  
Penumbra = 720 micron

Displacement [mm]
MONTE CARLO SIMULATION: the Geant4 toolkit

We are member of:

**Advanced example group** → application dedicated to the design and dosimetry of a generic hadrontherapy beam line

**Hadronic models group** → Study of pre-equilibrium and evaporation phase (for multifragmentation processes) in nuclear interaction for (0 – 450 AMeV carbon beam on different targets
The “Hadrontherapy” Geant4 advanced example

Hadrontherapy code

is an advanced example freely available inside the GEANT4 toolkit distribution:

gfunt4_installDir/examples/advanced/hadrontherapy

- General geometric proton beam line configuration
- 3D dose distribution calculation using a sensitive detector with cubic voxel in different materials
- Implementation of different physics models

www.cern.ch/geant4
www.lns.infn.it/geant4


Monte Carlo simulation of the proton beam line

- GEANT4 simulation
- Design possibility of a general hadron therapy beam line
- Optimization of its elements
- TPS check respect the very precise Monte Carlo method

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The Monte Carlo helps to better understand dose distribution

**SIMULATION VS EXPERIMENT**

![Graph showing simulation vs experiment results](image)

- **Simulazione Geant4**
- **Dato Sperimentale**

**Dose Relativa (a.u.)** vs **Profondità in PMMA (mm)**
TO CONCLUDE: G4EMU Geant4 European Medical User Group

Create a common base where every Geant4 user interested in medical physics can found material, share experiences and give his/her contribute to the community.

Power and flexibility of the Web 2.0 technology (wiki approach)

Everyone can change and edit the material

Hosted services that facilitate collaboration and information sharing between users

www.g4emu.wikispaces.com
The realization of a ProtonTherapy center in Catania has been stated in the Health Framework Agreement Document signed on 23 dec. 2003 by:

Ministero della Salute

Regione Siciliana

Ministero dell’Economia e delle Finanze

We are working for the realization of a cyclotron based facility for carbon and proton beam
Thank you to the PTCOG and partners for the fellowship

Thank you to everyone for the attention