Brief Information of Proton-ICCHIBAN-2 experiments

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Low LET beams

- Because of lack of comparison and calibration in low LET region, we will have intercomparison experiments in some facilities.
- In NIRS, there is a cyclotron which has capability to accelerate protons up to 80 MeV (LET is about 1keV/micron) and ICCHIBAN Working Group attempts to establish irradiation field in the Cyclotron. Also, HIMAC and a medical accelerator of National Cancer Center in Kashiwa have high energy proton fields.
- Luminescence detectors like as TLD/OSLD will be irradiated in the proton fields.
- We got a grant (Kakenhi Kiban (B), FY2009-2010) from JSPS for construction and perform intercomparison experiments in the Cyclotron.
Plan

• Objects: Luminescence detectors and other passive detectors.

• Beams:
  – 70 MeV proton (0.95 keV/um) on Jan. 29\(^{th}\) (Fri)
  – 40 MeV proton (1.48 keV/um) on Feb. 5\(^{th}\) (Fri)

• Beams in Future:
  – 30 (1.86 keV/um), 50 MeV (1.24 keV/um) proton
  – 100 (0.72) ~ 150 MeV (0.54) proton in HIMAC
Specification of the NIRS-Cyclotron

• AVF Cyclotron
• Available Beams:
  – proton 5-80 MeV
  – Deuteron 10-55 MeV
  – $^3$He 18-147 MeV
  – $^4$He 20-110 MeV
  – Heavy ions ...

• This cyclotron is used to produce radioisotopes for SPECT/PET mainly.
• It is usable for scientific experiments about one day per a week.
• Typical experiment time is from 11 am to 7 pm (8 hours).
NIRS-Cyclotron Overall View

RI Production
Small Cyclotron
Therapy Room
Large Cyclotron
Experimental Exposure Room

Preparation of Proton Field in NIRS Cyclotron

Proton: 10 ~ 70 MeV, He4: 100 MeV, ...

- Exposed dose is monitored by a large ion chamber.
- The monitor chamber is evaluated by a calibrated Ion Chamber (Marcus).
- Velocity of beam is measured by TOF detectors (2 plastic scint.).
- Beam profile is measured beam a profile monitor (scint.).
Beam image on a luminescence $\rho$. 
Beam Pipe

Beam Profile Monitor

Stage for passive detectors or biology samples

XZ and Theta Stage
Standard Ion Chamber

PTW 23343 Marcus Chamber

Nominal sensitive volume: 0.055 cm³
Sensitive volume radius 2.65mm, depth 2mm
Nominal response 2nC/Gy
Long-term stability <1% per year
Chamber voltage 300 V nominal
Polarity effect < 1%
Leakage current < ±4fA

Keithley 6517A Electrometer

Sensitive range: 10fC to 2uC
0.75fA p-p noise
Built-in ± 1kV voltage source
170mm diameter Ion Chamber

Dose was confirmed by this large ion chamber which is calibrated to a standard ion chamber.
Scintillator Array for Beam Profile Confirmation

- 5 cm coverage
- 1.5 cm interval
- Optical Fiber
- Multi-Anode PMT
- 1 x 1 cm² Scintillator
Beam Profile (proton 70 MeV) at C8

Measured by YU and HK at 20th June 2008
• a = 38.5 (mm)
• b = 34.0 (mm)
• σ = 23.6 (mm)
• x₀ = 2.32 (mm)
• y₀ = 2.31 (mm)

by H. Kitamura
For each energy, detector holders were irradiated for the following conditions.

- **Linearity Exposures**
  - 1, 10, 50 and 100 mGy
  - 50 mGy with an aluminum absorber (5mm for 70MeV and 3mm for 40MeV)

- **Blind Exposures**
We established radiation field in the Cyclotron facility in NIRS for physics experiments. The radiation field of proton beams is characterized by several chambers and detectors.

Proton-ICCHIBAN-2 experiments were performed on Jan. 29th and Feb. 5th, 2010 with participation of 14 institutes and universities from 11 countries.

ICCHIBAN Working Group is planning to have more experiments using other energies proton beams.
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