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RESEARCH PROPOSAL

LOS ALAMOS MESON PHYSICS FACILITY

Therapy Beam Development - LET Measurements

Chaim Richman, Spokesman

Participants

Chaim Richman, LASL

REPOSITORY LANL/ARC
COLLECTION MP-DO
BOX No. A-91-011
FOLDER 104-14

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SUMMARY OF EXPERIMENT

Four static beams suitable for therapy will be studied along with a fan beam to be used for future dynamic treatments. The studies utilize solid-state detectors to separate the various particles in the peak and the plateau and also determine the LET distributions at various depths in a phantom.

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PROPOSAL INFORMATION

Beam Area: Area A East

Secondary Channel: biomedical channel

Beam Requirements: full use of biomedical channel

Primary Beam Requirements:

Intensity: 0.3 μA peak current; corresponds to about 300 μA peak in Area A with A3 plug in mid-position -- later will use 1 in 10 low intensity pulse

Energies: Whatever is available on our target

Spot Size: Selected periods of optimum vertical spot size (0.3 cm rms)

Running Time Required:

Installation Time: 6 hrs per set-up

Debug Time: 7 shifts associated with A-east cyle zero

Data Runs: 60 shifts

Scheduling: Approximately 7 shifts per cycle beginning with cycle one

Major LAMPF Apparatus Required: Substantial electronics

Special Requirements: A3 plug in mid-position, later the low intensity 1 in 10 pulse

Special Services: Necessary gates for 1 in 10 low intensity pulse

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STATEMENT OF THE EXPERIMENT

Dr. Kligerman and his clinical staff have decided that they will need four static beams for various clinical irradiations. The beams are

	Area	Depth of Peak
(1)	4 cm diameter	4 cm
(2)	6 x 6 cm^2	4 or 5 cm
(3)	8 x 10 cm^2	4 or 5 cm
(4)	12 x 16 cm^2	7 cm

In addition a fan-shaped beam will be developed for use with the range shifter for clinical dynamic treatments.

The use of any beam in therapy is predicated on a uniform biological effect in the treatment volume. Flatness in terms of total dose is therefore no indication of uniformity since the pion dose contains different LET components with different RBE's. It behooves us, therefore, to measure the various LET components and any flattening procedure has to be evaluated in these terms. Also, the theories of the biological effect must take as their basis the distribution of the various components.

We already have a good example of this in the narrow beam that was used in 1974 to irradiate superficial nodules in the first four patients. Studies of this beam in a phantom without a collimator showed that the peak dose was around 18.75 cm in water. However, the highest biological effects (killing of cells) occurred further downstream by about 0.5 cm. The reason for this was that the high LET component peaked in that region.

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Small silicon detectors with the associated linear electronics are used to make measurements of the energies lost by the particles in traversing the detector at different points in a water phantom. At each point, therefore, a distribution of energy losses is obtained. The great advantage of silicon detectors is the detector thickness parameter which can be used to separate and identify the different particles. With a 5000 μm detector the electrons, muons and pions were separated in the phantom in the last running period. This provides a means in addition to time-of-flight of evaluating the contaminations in the beam. It is worth noting that time-of-flight does not measure the muons produced in the channel by pion decay correctly. If we have to go to different targets or lower energies, the knowledge of the contaminations is important. This thickness detector has also given good distributions of star doses and low LET doses.

It appears from simple calculations that a 100 μm detector will separate the pions from the protons in the stars. This separation in a phantom has not been made so far, and will be very helpful in studying dose distributions. Preliminary data indicates that collimators inter alia have the effect of removing protons coming into a field from the sides of a distribution. The separation of protons from pions gives us, therefore, a way of looking at the behavior of the particles separately under the various configurations of bolus and collimators that will be encountered.

The very thin detector ~ 10 μm on down is useful in separating protons from α- particles. This detector thickness borders on the thicknesses of matter used in the Rossi chamber. The data, however, provides a continuous presentation of the different particles as the thickness of the detector is decreased.

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The study of the effects of inhomogeneities in fields will be initiated. In particular lung tissue and bone will be studied in terms of the particles to see how different LET doses are affected. Simple ways will have to be found to evaluate the effects of these tissues on the treatment of tumors. We will be guided here by the practical situations encountered with patients.

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