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GENERAL AREAS OF TECHNICAL STUDY AND PLANNING

I. Radiobiology and pre-therapeutic studies to be done in experimental area "A" before completion of the biomedical facility.

A. Low-energy pion channel in experimental area "A" - the properties of the channel, as the design now stands, are much the same as described by Burman and Jakobsen in MP-6/RB,MJ-1, June 26, 1969. E_π=50 to 150 MeV. $\frac{\Delta p}{p}$ = ± .1% to ± 10%. Minimum beam spot size approx. 3 cm (horiz) x 1 cm (vert). π^- flux ~ 10^9/sec. Burman hopes, optimistically I think, to have π^-'s around July 1972. Burman thinks there will be no space problem for experiments. The channel will essentially end at a flange to which individual experiments will connect. He would like to know as much as possible about the plans and needs of the radiobiologists, to be included in a report he is writing.

B. Other facilities and equipment needed -- I think that it is important at this time to collect as many ideas, opinions, and plans of radiobiologists and therapists as possible.

C. A planning grant proposal for pre-therapeutic studies has been submitted to the National Cancer Institute by the School of Medicine, the University of New Mexico. A review committee from NCI will be here January 28, 1970.

II. Biomedical facility pion channel design

A. Design criteria - Some consensus as to what kinds of beams are wanted and acceptable must be formulated by the therapists and radiobiologists.

B. Electrostatic separator for reducing electron contamination of the pion beam -- Preliminary study indicates that a crossed magnetic and electric field type separator is feasible. We plan to incorporate this into the channel design.

C. Channel design — I plan to begin, very soon, further design studies using the code TRANSPORT. A useful figure of merit for a channel design is (number of pions surviving flight path) x (acceptance solid angle of the channel).

D. Lateral pion flux distribution -- Nothing has been done to date to calculate how the pions will be distributed across a plane perpendicular to the beam direction. I have begun writing a ray tracing program which will calculate this distribution.

III. Pion production target design -- I have proposed a possible graphite target and production angle (90°). The longitudinal dimension of the target is longer than we want it, though. The next step is to consider targets of heavier elements which will allow a shorter target.

IV. Exposure cell and facilities -- Radiobiology and therapy requirements will have to be coordinated.

V. Dose distribution calculations

A. I plan to calculate more exactly the effect of pions interacting in flight. This will involve determining the energy-dependent interaction cross section and the energy deposited in tissue as a result of these interactions.

B. Determine lateral pion flux distribution (See II.D.).

VI. Dosimetry for therapy -- A method for determining the pion stopping region has been proposed by G. C. Phillips and Morris C. Taylor. The scheme involves coincident detection of back-to-back gamma rays produced by positron annihilation.

$$\pi^- + {}^{16}O(\text{in tissue}) \rightarrow {}^{13}N + 3n$$

$${}^{13}N \rightarrow {}^{13}C + \nu + \beta^+$$

$$\beta^+ \rightarrow 2\lambda.$$

VII. Computer control -- At some time, criteria will have to be established for computer control of the beam.

VIII. We want to include the possibility of proton and neutron therapy by making the pion channel compatible with protons and by including a "hole" for neutrons.