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Buildings and Costs

At MURA, design studies are being completed for a 200 Mev proton linear accelerator. This linac will consist of 6 accelerator subsections with particle energy distribution as indicated in the following table:

TANK	ENERGY (Mev)	RF LOSSES(no beam)	r_{sh}	$r_{sh} T_o^2$ *
I	.75 - 10	0.6 Megawatts	- - - -	- - - -
II	10 - 50	2.5 "	50 Megaohm/m	36
III	50 - 90	2.6 "	49 "	32
IV	90 - 130	3.4 "	38 "	24
V	130 - 165	4.3 "	37 "	16
VI	165 - 200	4.9 "	36 "	13
(	230			14) **

The energy gain in the first tank will be small in order better to accomodate protons with low β values. The energy gain in the last tanks will be lower because of the required rf power. The axial field strength to be used will be rather conservative and of the order of $1,7.10^6$ V/m.

The six tanks will have different diameters with the smaller diameters at the high energy end. The total length will be approximately 120 meters.

The total rf power necessary for excitation of all tanks will be of the order of 18 Megawatts peak power with a duty cycle of 1.5%. The frequency to be used is 200 Mc/s.

These design parameters were used to come to an architectural design. The linac building will be similar in appearance to the Brookhaven National

* T_o =transit time coefficient

** The figures in parenthesis were quoted by R. Gluckstern for comparison.

Laboratory linac building. The accelerator itself will rest on pilings which are based in a bedrock foundation. Because the high vacuum ("Vac-ion") pumps will be mounted underneath the linac, a trench has been incorporated in the plans in order to be able to transport these pumps to a service area.

This linac is intended for use as an injector for a FFAG type accelerator and possibly also as a tool for high energy particle physics. Therefore, at the high energy end of the linac a 50 ft. long area has been planned as an experimental area.

Two approaches can be used to come to sensible cost estimates. First, using all inclusive cost figures of existing linacs, one might by some scaling procedure, come to an approximate cost for a 200 Mev linac. The second method is to estimate directly for a 200 Mev linac the most expensive items, which will then be regarded as 90% of the final cost estimate. The last method seems a more straightforward procedure leading to a closer cost estimate.

The following table indicates estimated costs for the various items for a 200 Mev linac.

Building: Space required 40,000 - 50,000 sq. ft. at $20 per sq. ft. This figure includes one 5 ton crane (20 ft.), one 20 ton crane (40 ft.), air compressors, power distribution, ion exchanger, facilities, etc.	1,000 Mb*
Linac tanks: $205,000 per tank, 5-1/2 sections needed	1.127 Mb
Drift tubes: $2000 per drift tube + quadrupole magnet 290 each	0.580 Mb
Injector: Cockcroft Walton type 0.75 Mv	0.200 Mb

* 1 Mb = 10^6 dollars

Controls:	0.200 Mb
Vacuum: $30,000 per tank, 6 each	0.180 Mb
RF system: Bids for the complete rf power source have been solicited and received from two companies; based on this and an independent evalutation of the individual items, the total cost for rf power tubes, resonant structures, modulators, preceding stages and power supplies should be	1.5 to 2.0 Mb

Therefore the total cost is estimated at 4.8 Mb to 5.3 Mb, exclusive of salaries, administration and development work. Construction time is estimated at 4 years with an average staff during this period of 20 people. Taking this at $10,000 per person per year, an additional sum for salaries will be approximately 0.8 Mb.

Exclusive of salaries and administration, the final figures compare rather well with the tested Brookhaven National Laboratory formula: cost = $300,000 + $24,000 per Mev, which leads to a figure of 5.1 Mb for a 200 Mev linear accelerator.