Minutes from the First Main Injector "Review" Meeting

May 29, 1991

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The first meeting focussed on the 8 GeV line, with John Johnstone and George Krafczyk describing the layout of the beamline and the power supply system, respectively, and Jim Lackey discussing Booster extraction.

John described the lattice. An MI-Note will be issued in the near future detailing the lattice functions, so the description here will be brief. The beamline lattice functions are shown in the accompanying figure. There are 49 quadrupole locations, with 98° phase advance per cell. There are six horizontal bends (each composed of several discrete dipoles, in general rather spread out), and one vertical dogleg. During his description, a number of points were raised which might require attention by various individuals:

(1) At MI-10, the injection Lambertson will be located just upstream of quad 101; this quad will have to be rotated 90° to give sufficient clearance for the beam. This means a special stand and a special BPM.

(2) There are no horizontal bends in the line until some distance away; this means the separation between the ring and the beamline is generated by the ring itself and the Lambertson angle. The layout of the tunnels should be looked at, i.e. a drawing similar to 6-6-1 CDR-18, with the present design, should be generated, so that the geometry can be examined.

(3) The highest β functions occur very close to the Booster, where the beam elevation is also the highest; for radiation shielding concerns, we should probably use star-shaped beampipes through all the quads upstream of the vertical dogleg.

(4) Of the 49 quad elements, six are approximately twice the strength of the others; John's design shows two SQAs at each of these locations. The question was raised as to what is the most economical solution at each of these six locations: two SQAs, one SQD (running at 10% higher current, but 15% lower power), or one SQA running at twice the current and hence twice the power. Subsequent to the meeting, I looked at this in more detail. The following table lists the properties of these three options:

	One SQA	One SQD	Two SQAs
Current	280 A	150 A	140 A
Resistance	32 mΩ	46 mΩ	64 mΩ
Power	2500 W	1000 W	1250 W
Operating Cost	\$600/yr	\$240/yr	\$300/yr
Capital Cost	\$27,000	\$40,000	\$54,000

The above numbers are for each of the six locations. Incremental capital cost for six quad locations:

	\$15,000 (PS)	\$78,000	\$162,000
5-yr power cost	\$18,000	\$ 7,200	\$ 9,000

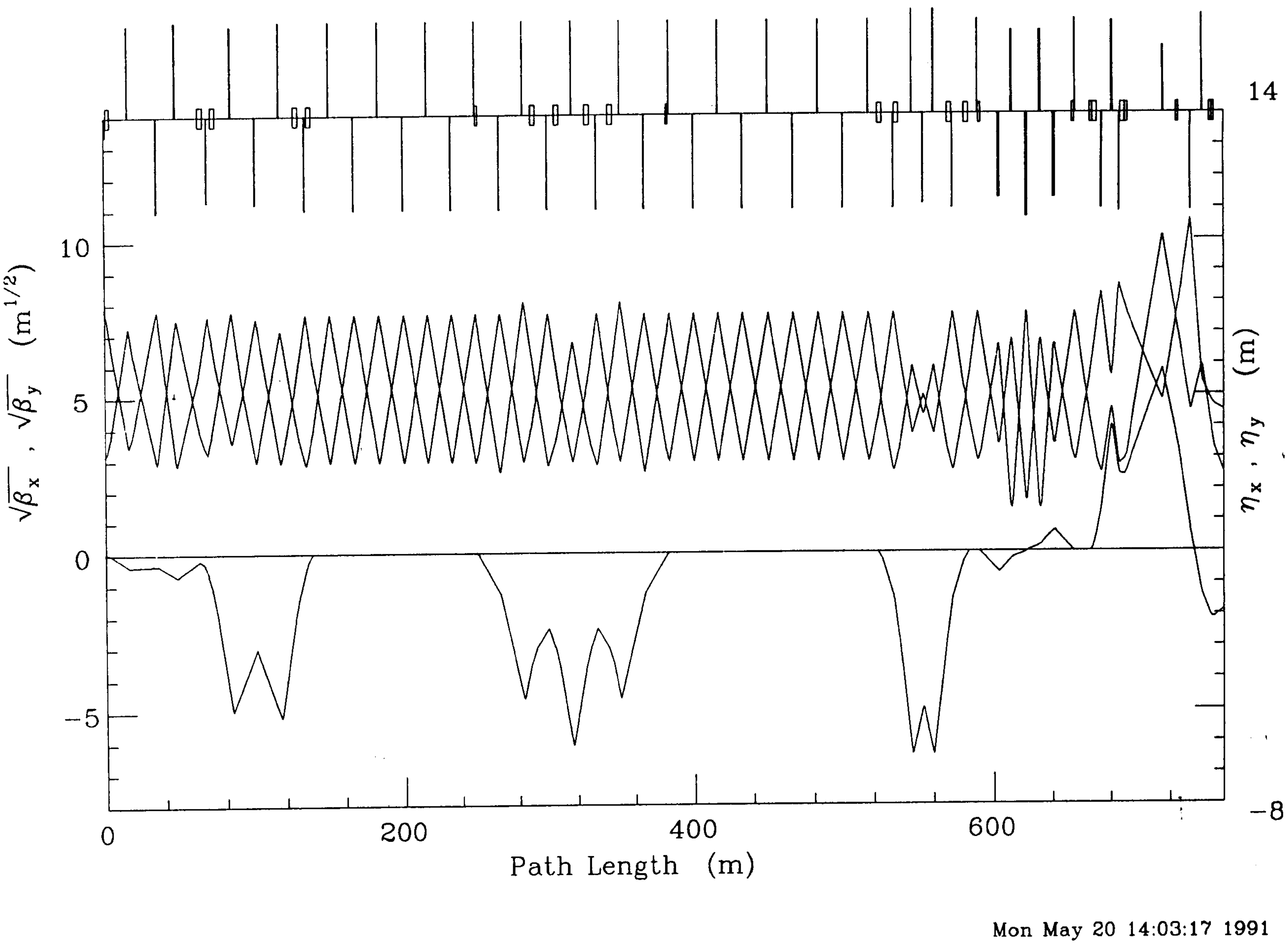
The capital cost for the SQA is taken from CDR Revision 2.3; the SQD cost is a guess based on the SQA cost of material and labor. The operating cost is based on 200 days per year, 24 hours per day, \$.05 per kW-hr. Ignoring such details as setup for making a different style magnet, differences in installation for stands vs. extra cables, etc. and assuming the new 30 kW power supply required for the 280 A case costs \$15,000 installed, the situation is clear: The most economical solution is to use single SQAs and a new power supply (assuming one even needs to be bought--there may be a suitable supply in the present 8 GeV line.) The operation of an SQA at 280 A dc looks OK from the standpoint of temperature rise: $\Delta T = 6.5°C$, according to my calculation.

Other issues raised were the question of diagnostics and trims. Aside from the obvious allocation of a BPM and BLM at every quad, and some fine adjustment (details to be worked out) on each bend element, there is certainly the need for additional trims, especially vertical. Placement of multiwires and collimators is also an open question. I spoke with Mike Syphers the week following the meeting, to try to get some insight into his placement of multiwires in the present 8 GeV line, and to the problems we have had with the use of collimators. Mike commented that placing multiwires in the regular cell regions of the 8 GeV line (either the present one or the MI-8 GeV line) allows one to determine whether the line is matched to the Booster. We also certainly want some at high dispersion points. As for collimators, the present ones, which have been tedious to set up, are located about midway between quads, since the same device is used to collimate both horizontally and vertically. Mike suggested that having BPMs located next to the collimators would make them much easier to set up.

Jim Lackey discussed extraction from the Booster, and although there were some differences of opinion as to interpretation, Jim felt that going to Lambertsons for extraction instead of MP01 and MP02 would be good, in that it would remove the orbit distortion that arises when those two devices turn on. The proposal is to add a fourth kicker at L2 (1 magnet and 2 switch tubes); to make space, SEXL has to be moved. This may result in going to a 24-fold symmetry for sextupoles rather than the present three-fold. To improve the kicker risetime, and hence achieve cleaner extraction, Jim would like to (i) build new charging supplies, (ii) build new switch tube enclosures, and (iii) improve the magnet loads (make them like MK90.) Reducing the kicker magnet lengths by a factor of two should result in risetimes of less than 10 nsec. Jim didn't give any estimate of the cost for these improvements.

George Krafczyk discussed the power supplies briefly. He envisions a single dipole supply powering all the bends in series, with trim supplies for adjusting the strengths of the different bends. The main supply would be running at about 1000 A (roughly 300 V), with trims up to 150 A. Similarly, the SQAs (except the six running at twice the current) would be run on a single supply, with about 15 trim supplies for adjusting the quad strengths at each end of the line for proper matching. A second supply would be used for the six twice-strength quads, with 6 trim supplies. It was noted that the regulation requirements have not been specified for the power supplies. They need to know this! George commented that there has been essentially no discussion of vacuum requirements.

Another major issue was the transition from the Booster elevation to the Main Injector elevation. The Mechanical group would prefer the elevation change (approx. 11' for the beam) to be accomplished through a step, with a crane provided for lifting magnets, etc. (Mike May points out that one of the cranes from the B0 overpass could be moved to the 8 GeV line.) The CES people feel that a sloped transition would be cheaper, although that may have been based on the assumption of a constant floor-ceiling height differential, which would not be the case here. The grade could be as low as 3%, and flat portions could be provided at the places where SDBs (20 tons) are installed. Duane pointed out that sloped floors reduce the need for some sumps. This topic clearly needs much more discussion. The accompanying figure shows one possibility for the transition, with stairs and a crane. The total length of the transition section could be shorter if the magnet mover never needs to be lifted. But it seems reasonable to allow for lifting 20-25' items such as pipes and cable trays. Subsequent discussions and review of magnet dimensions suggest that it is possible to drop the floor elevation of the enclosure between the AP-4 line and the vertical dogleg to 720'6" (beam elevation 726'6"). This reduces the change in floor elevation at the transition to 7', and affords an additional 2' of shielding in the upstream section.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Path Length (m)
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η_x , η_y (m)
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