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ATA UPGRADE TO 150 MeV

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I. INTRODUCTION

The increased interests in upgrading the ATA accelerator has warranted a preliminary look at applying the magnetic drivers to achieve both higher energy and higher average power.

The goal of this upgrade is to satisfy the FEL requirements and to keep the capability of producing a higher current beam for CPB experiments at reduced energy. *ATA Note 247 showed that a possible solution to obtain higher* energy was simply to add additional cells, run them at higher voltage and accept a 30 ns pulse width with about 5% energy variation. Considering the recent history of the cells and the doubling of the voltage stress that would be required at the insulator, it seemed prudent to review the overall system reliability and try a different approach.

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II. MAGNETIC DRIVE SYSTEM

In any upgrade, the magnetic pulse compression system would be used to achieve higher energy and high average power. The present MAG I drivers on the High Brightness Test Stand (HBTS) have been tested to many millions of shots and it is expected that a similar type of driver will be used in the upgrade. MAG I is capable of driving 80 kA at 150 kV for 70 ns. Pulse compression is done after the switch chassis voltage is stepped up from 25 kV to 300 kV. The final compression stage can then deliver 150 kV into a matched 2 Ω load. The simplest approach for delivering this energy is to drive a multiplicity of cells at the right impedance and voltage level rather than stepping up the voltage a second time.

This approach eliminates a step-up transformer and allows flexibility in re-designing a new accelerator cell about 1/4 the volume of the existing cell (Fig. 1). The new cell incorporates a better match of the radial line to the ferrite cores for improved BBU mode damping; it has eliminated the insulator problem and reduced the overall weight to the point where it can be handled without a crane. Since cost and volume are closely related, it is expected that even though 1,000 of these cells will be required, the elimination of the step-up transformer and the simplification will result in an overall cost saving.

Each cell occupies 5" of axial length and the upgrade will therefore require a total of 420'. This total length does not include pumping ports or diagnostics. The available distance from the Injector wall to the FEL "Y" is 420'; some infringing into the MAR may be necessary to allow room for diagnostics and pumping. Fig. 2 shows a schematic of a MAG I driving 20 cells. The output impedance of MAG I is matched by two water-filled ATA Andrews cables in parallel. To avoid side-to-side imbalance, each cable drives a 10-cell set through an oil-filled T which splits the drive symmetrically to each side. The transmission line from the T to each cell is tapered to keep the proper impedance (Fig. 3). The compensation boxes are included to allow for reset input and pulse flatness adjustments.

The drive to each cell allows 3 kA for beam and 1 kA for compensation and ferrite magnetization. The energy per pulse for one cell is: $E = (70\ 10^{9})(4\,10^{3})(150\ 10^{3}) = 42$ Joules or a total of 840 Joules per MAG I. Allowing for 89% efficiency of MAG I, the input energy required is 944 Joules.

III. INTERMEDIATE ENERGY STORAGE

The intermediate energy from the switch chassis is delivered to MAG I at the 25 kV level in about 1 μs. The total capacitance at this level is 3 μF which results in a drive current of about 150 kA. Due to this low impedance drive it is imperative to keep the inductance between the switch chassis and MAG I at a minimum. This requirement results in multiple low impedance cable drive and the location of the intermediate energy store to be in close proximity of the magnetic driver.

In order to achieve high average power the existing switch chassis would have to be totally rebuilt using ceramic thyratrons. A reasonable intermediate step in this upgrade would be to accept initial operation at low repetition rate (~10 Hz) to begin physics experiments at an earlier time frame. In this mode, the existing switch chassis would require relocation, minor modifications and cabling.

Figure 4 shows a drive arrangement using four switch chassis each with .75 μF for each MAG I. At a later date if and when 1 kHz cw operation is desired, the switch chassis would be rebuilt using plate and bar construction and ceramic thyratrons. At that time the main input power system would also be upgraded.

Since the switch chassis will need to be in close proximity to MAG I's, some physical rearranging will have to be done when all high pressure pipes are removed.

IV. CONCLUSION

The 150 MeV upgrade of the ATA to a completely magnetic drive system and new accelerator cells offers increased reliability and the capability of going to high average power. Once the preliminary experiments have been completed a modification of the switch chassis would result in output beam of tens of megawatts at 150 MeV. At higher currents, the output energy decreases linearly with current and is about 50 MeV at 6.7 kA. The cost estimate for this upgrade will be the subject for a separate report.

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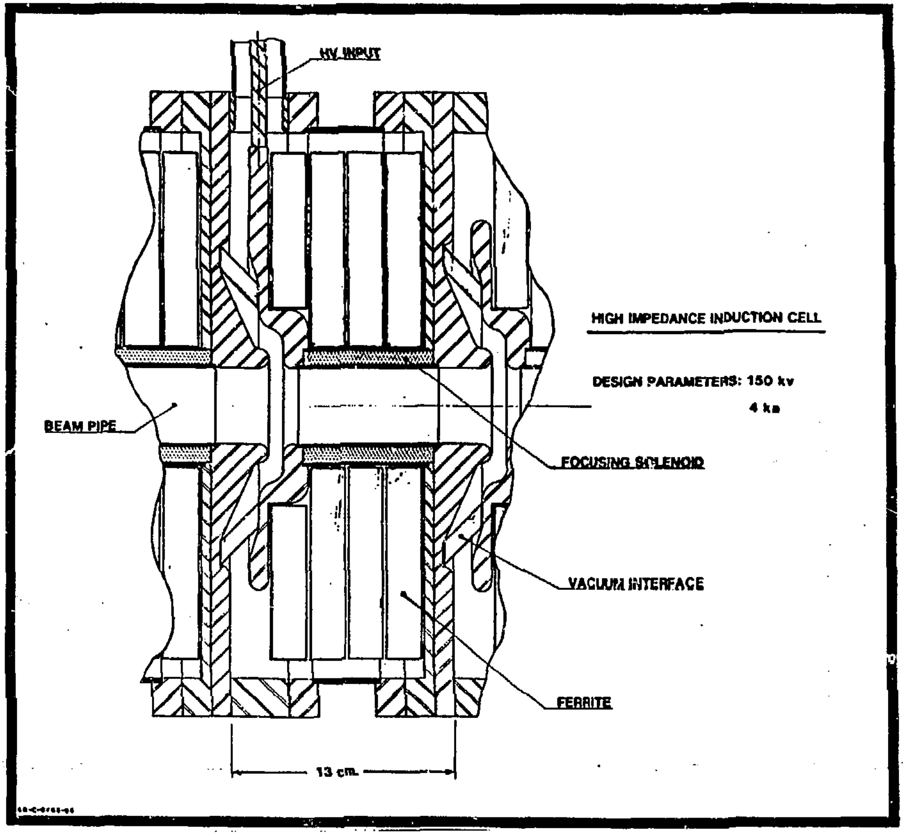

Fig. 1 New 150 KV Accelerator Cell

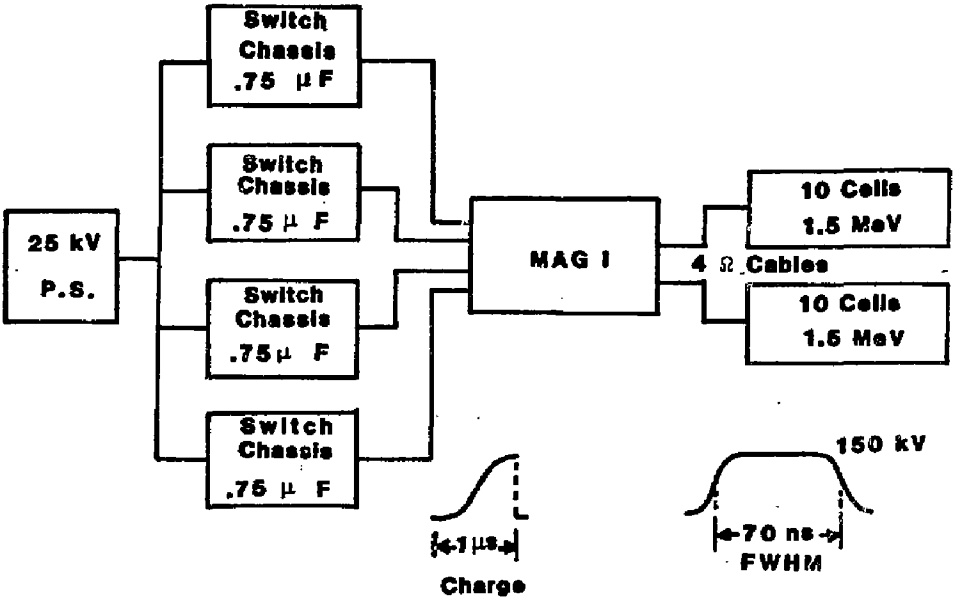

Fig. 4 Drive System for 20 Accelerator Cells using MAG I for a total of 3 MeV