LINAC Laser Notch Internal Review

1 Background

Currently Booster needs a 50-60 ns notch in the beam at extraction time in order to accommodate the rise time of the extraction kickers. In LINAC the options being considered are Electrostatic notching and laser notching. In this review effort we mainly go through the laser notch concept and the readiness for the next step, particularly regarding to the installation work during the upcoming shutdown.

Laser notch has some advantages over the electrostatic such as the fast rise time. Also utilizing a laser to neutralize the beam with a combination of a dipole would be effective way of directing the waste beam to an external absorber.

2 Current status

Although the concept seems relatively simple the implementation of the method is not without some major challenges. One of them is the development of stable and powerful laser. For example an average laser pulse energy of 100mJ is proposed by Ray Tomlin to strip 99.9% of the ions. In current design Dave et. al was able to implement a new way of interaction. A laser beam will travel zig-zag through 2 high reflective optical mirrors and incoming H^- will be stripped by the laser at multiple interaction point, which effectively reduced the required laser energy by the number of interactions. At the same time Dave et al also took advantage the recent progress made by the fiber laser industry to get a easily tunable and stable fiber laser as the seed laser source followed by 2-3 solid state amplifier to boost the energy to the desired range. Thus it dramatically simplified the overall setup.

In this stage all the fiber related seed and amplifier has been purchased and delivered. A prototype of the cavity assembly is designed and being fabricated. It is supposed to be ready before the beginning of this year's shutdown. A very nice work has been done by T. Johnson et al to make a uniform transverse laser profile using pulse stacking with BBO crystals.

3 Some comments from the committee

Overall the committee is very satisfied with the progress made so far on this project. The working plan for the shutdown is also very solid. The mechanic part of the design looks well under control and should be able to meet the initial goal. However there's still some points need to be addressed.

a. From the laser point of view the commissioning of the fiber laser is a little bit slower than expected due to the unexpected difficulty of the initial fiber amplifier. More efforts need to be put on this area in order not to slow down the whole project, especially the procurement of the free space amplifier. At the same time some alternative plans probably need to be prepared in the case of lower than expected pulse energy from fiber section is reached. Also the estimation of the gain from the free space amplifier needs to be confirmed as well. For example if we have 10μJ from fiber, we need approximately another 200 time from the free space amplifier, What

will be the gain for each amplifying stage. In the case of 1μJ from fiber what should be our strategy?

b. Once the laser is ready the alignment of the laser through the cavity is not trivial. Is it possible to have a test setup outside the tunnel to get things ready. That can start with HeNe laser instead of Class IV laser.
c. During the committee review it seems very clear that a lot of potential issues could rise when the cavity device is inserted to the beamline. This is exactly the reason to put into the beamline one year before the laser is ready. The potential issues mentioned in the review includes:
    I. How the mirror reflectivity is going to change during the run? Is there any potential beam damage to the coating?
    II. Is it possible for the static charge to build up on the mirror surface? What will that influence the beam running?
    III. How can we prevent the beam to hit the cavity device?

    That's just an initial list of the potential problem it may surface. The committee's suggestion is to have a more complete list of the issues we may face and a more coherent study plan after the device is put in.