# Preliminary Responses to Laser Notcher External Review questions

1. I’m concerned that the seed laser is under-specified. It might have narrow linewidth, but the real measure is whether the amplitude is constant with time. If there are poorly suppressed adjacent modes, the amplitude could be varying and would hurt performance. In fact, the laser used so far appears to be running on multiple modes, so the performance with a constant-amplitude laser might be better, up on a higher curve than the “2mJ for saturation” one experimentally measured so far.

Yes I agree that the really want a good seed. It is supposed to be a single-mode spectrum stabilized laser diode, but I can’t answer the on stability. I reached out to IPS about the amplitude stability and the suppression of adjacent modes. Their response was that their ECL has only 1 mode. They have measured the RIN to be less than -155 dB.

Yes I agree the seed laser does have multiple mode. Concerning the last half of the question, I’m not sure I understand.

1. There should be machine protection against SBS, which could cause damage and down time, so there should be appropriate detectors. Also against unwanted lasing oscillation and back reflections. Diodes for backward-going light would be good. A diagnostic for SBS is needed, such as a scanning Fabry-Perot, which is commercial.

We currently have PD circuits for monitoring the backward taps, in addition to the forward taps, which are to be connected to an interlock. It is not clear that these will protect against a single SBS event. The thought is that we will set the operating point with the phase modulator so that the SBS threshold is beyond the highest pump power, then set the threshold just above. Are you suggesting that we incorporate the FP cavity in the operational system or just utilize it for setting up the phase shift?

1. With the system in a poorly temperature controlled environment (estimated 20 degrees variation), and with multiple different metals involved in holding the laser, there might be thermal pointing drift in the output beam. There should possibly be a pointing control loop that uses the beam position monitors and the piezo mirrors.

We have considered this and it certainly possible with our configuration. The plan was to measure the stability and implement, if possible. However, maybe we could get someone work on that sooner than later.

1. The key features of the laser system design include temporal structure formation, multiple-reflection optical cavity, and beam spatial profile shaping. Based on the laboratory demonstration and initial commissioning results, the design is successful and the laser system is very promising to meet the neutralization requirement for the laser notcher. The design concept can be used in other applications in accelerator facilities where a laser based high efficiency H- neutralization is required.

Thank you.

1. The plans of quadrupling the laser pulse energy mainly rely on a more stable seed laser source and suppression of instabilities and/or excessive pulses created in previous fiber amplifiers. Can one look into the option of using single frequency, narrow line width fiber laser instead of diode lasers as the seeder? The Stimulated Brillouin Scattering in the fiber amplifier is currently considered to be the primary source of instabilities in the amplification process. On the other hand, a weak optical reflection from the downstream optics/fiber surface can also cause instabilities especially at high gain. Is it possible to experimentally investigate the origin of the observed instabilities?

 Yes, we can look into the utilization of a single frequency, narrow line width laser as the seeder. How is your experience with the “ROCK”? Does it have the tuning range for us to set right on 1064.15 nm? It must be able to be tuned to 1064.15 nm (air) and have on the order of ~100 mW output. We would welcome any references to such units.

 I think we have identified the origin of the instabilities. The root cause of the instabilities that we see are really with the seed source and how it is behaving. The requirements on the seed, for our system are pretty stringent, mainly the center wavelength and spectral width to match the ND:YAG gain bandwidth. On the other hand we need to make sure the spectrum does not stimulate SBS in the fiber amplifiers. I think the plan to phase modulate the seed to distribute the power over a large number of sidebands with constant amplitude should mitigate the SBS issue.

Weak optical reflections can cause issues, in fact this was the issue we had with the previous seed source which we had to attenuate. We tried the air gap attenuator, which, I believe, an instability in the seed source (even though we had an isolator between the diode and air gap attenuator). Looking back a better option would have been to use a different tap coupler ratio.

Other than this we have not had any evidence of optical reflections. The experimental verification of the instabilities in the fiber amp and the Grumman’s is fairly convincing, I think. We can discuss further.

1. The present instrumentation is very well designed to fit in the limited space. Since fiber amplifiers are very vulnerable to the empty input, can one considers to install an electronic shutter between the last fiber amplifier and the RBA?

 All fiber amplifiers have an automatic shutdown circuit built into the amplifier that will remove the pump permit if the input power drops below a predefined threshold. I’m not sure what an electronic shutter between the last fiber amplifier and the RBA will do for us?

1. Spares of parts for an operational system are inevitable. Before generation of a list of spares, it might help to list the lifetime of key components (eg. pumping diode bar/stack) to get a reasonable estimation of the cost and expected frequency of parts replacement.

Good suggestion!