Machine studies Request for TTF/FLASH 9mA Program
For Period TTF2009_KW02-06
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Main objectives for this studies period
- Better characterize beam loss measurements in the bypass line and dump line and understand how they correlate with LLRF and beam measurements. Explore candidate scenarios that could have lead to the vacuum event in the dump line.
- Test beam loss monitor devices in the beam dump area.
- Commission the laser and rf gun for 3MHz bunch repetition rate
- Continue to prepare for future long-pulse 9mA operation, including improving LLRF system performance for long pulses and running ACC456 close to quench limits
- Make further LLRF & beam measurements to understand RF overhead requirements

We request a total of six 8-hr shifts, grouped as three sets of 16hrs, with some days between each set.

Required beam conditions:
- Maximum of 30nC per pulse: 30 bunches at 1nC, possibly 10 bunches at 3nC
- Long RF flat tops (800us)
- Normally operate into the bypass line, some operation into the FEL line for energy measurements.

There are several topics we wish to study in the context of the 9mA program. The general topic areas and areas of study are described below, along with approximate studies times for each. Specific study details are still being worked out.

1. Beam loss characterization (~2+1 shifts)
(30 bunches, 1nC/bunch at 40kHz - 1MHz, mainly bypass operation, but limited FEL operation needed to measure beam energy)
This study is aimed at improving our understanding of beam operation through the bypass line for safe high beam current operation in subsequent machine studies periods. In particular, we will focus on correlating beam losses with information available from the existing FLASH diagnostics, including mapping out the bypass line energy aperture and understanding the bypass energy server. Beam properties and machine operating conditions to be investigated include: energy profiles over long pulses; measured beam orbit, LLRF parameters (vector sum, cavity tuning, etc).

We plan to temporarily install additional beam loss monitors in the dump line. The study will also be an important test of beam loss monitors in the dump line prior to permanent installation later in the year.

2. Set up the laser and gun for 3MHz operation (~1 shift)
(30 bunches, 1nC/bunch at 3MHz bypass operation)
Being able to run 3MHz bunch trains is a necessary condition for achieving 9mA average beam current. This study is aimed at commissioning new pockel cells on the gun laser and all timing system operation at 3MHz. Currently the limiting factor is the repetition rate of the laser. The laser pockel cells must be upgraded prior to this study in order to be able to commission the 3MHz repetition rate. The primary study assumes a maximum of 30x 1nC bunches. In principle we could try to achieve 3nC per bunch, which would demonstrate the

full 9mA beam current albeit for only 10us.

3. LLRF performance for 9mA studies (~2 shifts)
(30 bunches, 1nC/bunch, various repetition rates, beam into bypass line)
This study will focus on improving LLRF performance for 9mA studies. We will study LLRF performance vs regulator gain for long RF pulses and then increasing the feedback gain as much as possible. We plan to commission beam-loading compensation with manual settings and semi-automatically where information on nominal beam conditions is taken from DOOCS. We also aim to test unified adaptive feed-forward algorithms in ACC1, ACC23, and ACC456. Some of these studies will be contingent on having SimconDSP systems in one or both of ACC456 and ACC23 (to be done by MSK LLRF Group).

We will continue making measurements of HLRF/LLRF system, for example to measure stability over the flat top from pulse to pulse, making measurements at several different gradient vector sums and at different feedback gains. We may also plan other LLRF related measurements and performance studies once data analysis from the September studies has been more completely analyzed.

As time permits, we will use time to prepare for 9mA studies at gradient limits as a preparatory study for high gradient operation will 9mA beam loading. We will begin characterizing RF system operation at gradient limits on ACC456, increasing gradients at ACC456 until we start to see quenches. Quench signatures will be characterized and quench detection algorithms tested.

4. Try to re-establish the 3nC conditions (*if time permits*)
(10 bunches, 3nC/bunch, various bunch rep rates)
This study is aimed at understanding how to reproduce machine conditions that were achieved in the Sept studies period for the 3nC/bunch operation and long bunch trains. We will attempt to reproduce the conditions and achieve stable operation with 10 bunches.

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