Study of Intrabeam Scattering (IBS_Study)

PERSONNEL

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PURPOSE AND METHODS

The goal of this experiment is a verification that we understand the machine and its instrumentation. The data analysis will verify the accuracy of the measurements for bunch length, bunch sizes/emittances and momentum spread. It also will result in independent verification of dynamic/physical aperture and the average vacuum in the ring. This study is a continuation of the studies which we carried out earlier but with acquiring important details previously missed.

GOALS

- Verify accuracy of our instrumentation
    - Bunch length
    - Beam emittances
    - Momentum spread
    - Bunch and beam current measurements
- Optics verification as a byproduct of beam size measurements
    - Actual decoupling achieved (vertical emittance increase due to scattering at the residual gas is accounted)
- Measurements/calibration of RF voltage
    - Beam deceleration due to interaction with vacuum chamber and RF
- Characterization of longitudinal impedance and non-Gaussian tails produced by single IBS (Touschek)
- Characterization of vacuum: measured by gages versus actual

The above measurements/parameters are related through: IBS, Touschek scattering, scattering at the residual gas, longitudinal impedance, RF voltage calibration, calibration of sync-lights.

PREREQUISITES

- Optics measurements are performed. Optics is decoupled. Optics is stable and verified.
- Datalogging for sync-lights operational.
- Datalogging for vacuum gages
    - RGA measurements would be good supplement but not required
- Software for measurements of the longitudinal bunch density is operational and calibration of dispersion in the RWM (Resistive Wall Monitor) cable is complete and used in calculation of the distribution.
    - In emergency (pressure to do measurements fast) this step can be omitted, and manual data acquisition is allowable
- Longitudinal damper is operating
- Recalibration of RF voltage is performed and corresponding updates in the control system have been done

- Band stop filter for the RF frequency is installed at the RF prob signal exit to observe HOMs induced by the beam in the RF cavity (one channel of buffered RF prob signal is used)

BEAM CONDITIONS

Beam circulating in the IOTA with up to 4 mA beam current. Operating sync-light monitors, BPMs, longitudinal damper and well-known (measured) optics.

APPARATUS

Nothing in addition to the listed above in prerequisites

RUNPLAN

We need one shift. If data analysis will show discrepancies it may require another shift for more detailed measurements. Data analysis will require few days.

FUNDING

No additional finding.

MEASUREMENT PROCEDURE

1. Perform measurements in a wide range of beam current (4 mA -> 0.1 μA). Inject ~4 mA beam and perform measurements while the beam current is reduced due to Touschek and vacuum scattering. Below 0.5 mA beam current the process can be accelerated with temporary RF voltage reductions.
2. Keep RF voltage at 500 V or maximum available
3. Set 1NL optics.
4. Perform data acquisition twice: (1) fully decoupled optics, (2) strongly coupled optics.
    a. Acquire the following data through the archiver and verify data accuracy in the course of measurements
        i. Beam current (DCCT and sync-lights)
        ii. Vacuum (all vacuum gages in the ring)
        iii. Beam sizes measured by sync-lights. If automatic gain control is not working use manual gain control.
        iv. RF voltage
    b. Acquire bunch longitudinal distributions simultaneously with RF waveforms with and without stop-band filter (measured from cavity RF probe) while the beam current is reduced and save data with time stamps. It is desirable to have measurements for at minimum every 20% reduction in the beam current.
        i. If data can be acquired through control system – use it. Otherwise use the scope and save data to a memory stick.

DATA ANALYSIS

After data analysis is complete save all data and used scripts for permanent storage in IOTA experimental area.