



# Fluctuations in Undulator Radiation (FUR)

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Proposal presentation

Tue Mar 10<sup>th</sup>, 2020

Aliaksei Halavanau, SLAC: theory, design, data analysis

Zhirong Huang, SLAC: theory, design

Valeri Lebedev, FNAL: theory, design

Ihar Lobach, UChicago: theory, design, experiment setup, data analysis

Sergei Nagaitsev, FNAL/UChicago, *spokesperson*: theory, design, funding

Aleksandr Romanov, FNAL: ring setup, light detection

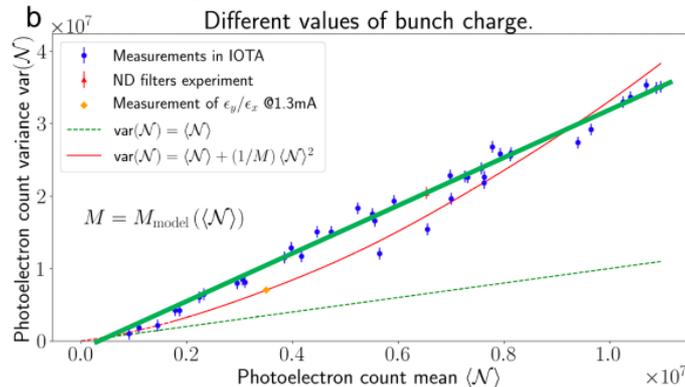
Jamie Santucci, FNAL: apparatus, light detection

Giulio Stancari, FNAL: design, apparatus, analysis

Alexander Valishev, FNAL: design, IOTA lattice

# Motivation

- Respond to the PRAB referee's criticism (<https://arxiv.org/abs/1912.06737>)
  - "The most striking fact is that the authors indicated that IOTA has a beam size measuring system from its dipole, but used it only for a SINGLE beam size measurement at 1.3 mA."  
This time we'll record the bunch size at all times during the experiment
  - Regarding using the comb filter: "...makes the argument of using this technique instead of a direct measurement of the signal with the 8-bit digital scope pointless. A 2660-bin sample used by the team would allow for  $\sim 8 \times 10^{-5}$  RMS error, which seems to be sufficient for  $N \sim 2 \times 10^7$ "  
This time we'll record waveforms without the comb filter too
  - One could draw a straight line instead of the parabola:



This time we'll record data with FLAT and ROUND. The points for the ROUND beam should sit lower. Also we'll collect more data point with neutral density filters.

- The measured signal was 3 times weaker than predicted.  
This time the alignment procedure is much better. We are certain we're in the optimal location. I will also measure the transmission in the cable and comb filter with a network analyzer.

# Requirements

- a) Up to 4 mA beam. Flat and Round
- b) BB2-E03 mirrors at M4R
- c) Closed irises to avoid synchlight saturation

# Run plan

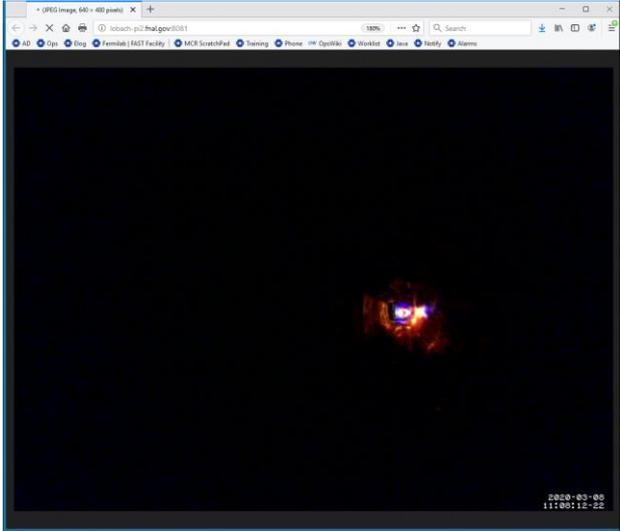
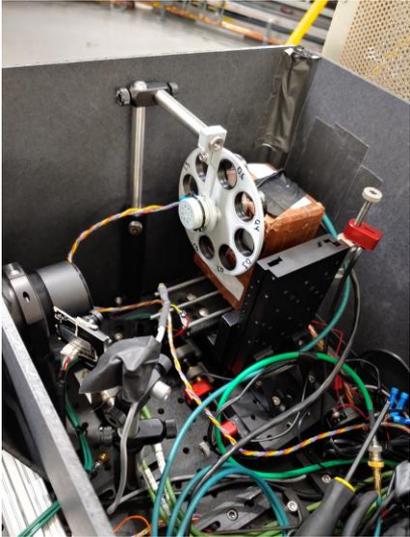
- Replace the SPAD with the InGaAs photodiode. **Accomplished.**
- Perform the alignment. **Accomplished.**
- Collect waveforms at different values of the beam current without ND filters and without the comb filter for the FUR\_FLAT lattice. **Attempted.**
- Collect waveforms at different values of the beam current without any filters with FLAT and ROUND knobs files and with the comb filter. **FLAT has been attempted. ROUND has not.**
- Install filter wheel. **Accomplished.**
- Collect waveforms at fixed current (~3.0mA) with different neutral density filters for FLAT knobs file and with the comb filter. **Attempted today.**
- Save some x,y,z scans

Shift 1

Shift 2

Right now I would like to take 2 days to analyze the data we've already collected during the commissioning

# Current status of the apparatus



Up to  $\sim 1.2-1.4$  V signal (without comb filter)



# Current status of the measurement procedure

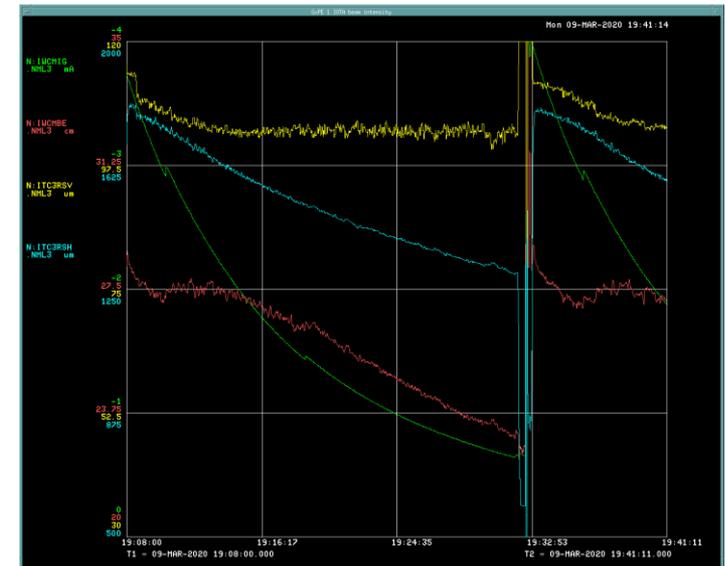
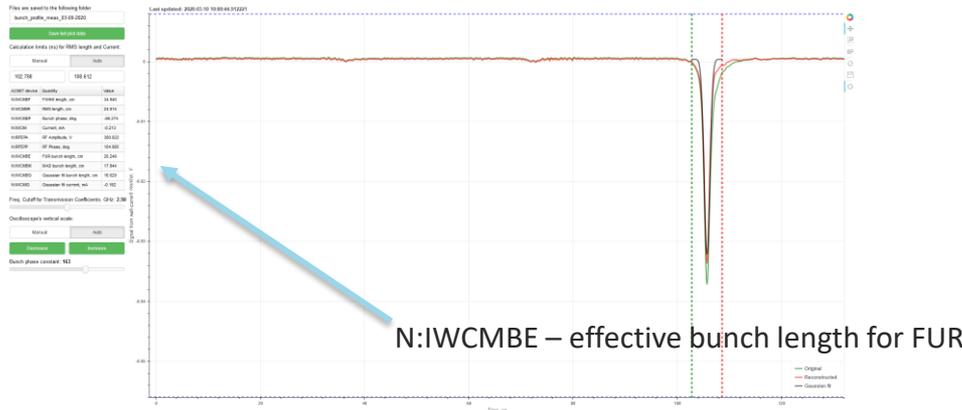
Alignment: we divide the detector signal by the DCCT signal, so that the resulting signal doesn't depend on the current



On Monday, Sasha V., Sasha R. and I established that the signal on the detector doesn't change with change of beam orbit, including change between FUR\_FLAT and FUR\_ROUND knobs files.

No ND filter.

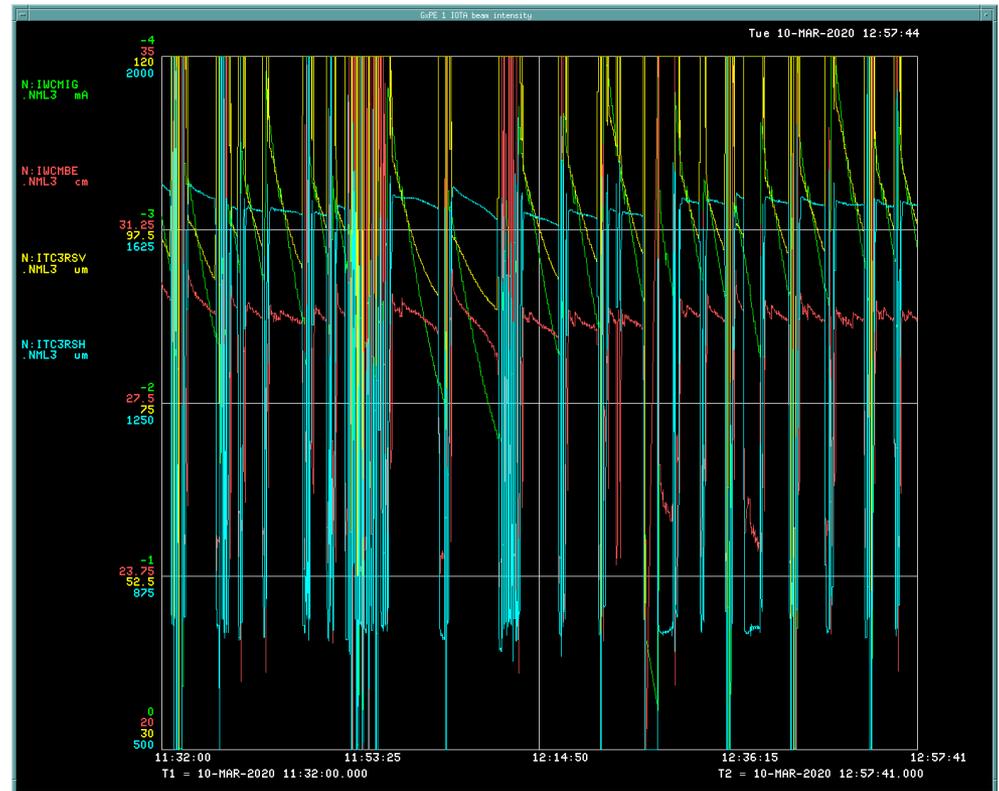
One data set takes about 30 min



# Current status of the measurement procedure (this morning)

- Taking ND filters data:
  - Inject  $>3$  mA
  - Change orbit to FUR\_FLAT
  - Split x and y tunes
  - Save waveform at 3 mA

It took about 1 hr 30 min.



# Things to remember

- Open the irises after each shift
- Replace the E03 mirrors with E02 mirrors after each shift
- Turn off the LED after each shift
- Remove the undulator after every shift
- ...?