LEReC BPM Status

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Status

- V301 modules on order
  - Delivery expected October 2016
- Prototype analog switch board and 20 dB amplifier board have been designed and assembled.
  - Module was installed in tunnel on May 27, 2016
    - Connected to blue and yellow horizontal LEReC buttons closest to Q3 magnet.
    - 40 dB attenuators installed in tunnel to produce low signals similar to that expected for LEReC ion beam.
  - One V301 module is installed in 1002D trailer
  - Testing with beam is in progress

Issues

- Prototype amplifier module testing has not gone smoothly.
  - Several component failures occurred; cause continues to be investigated
    - Excessive heat on components during soldering may be contributing
- Many small details contribute to errors.

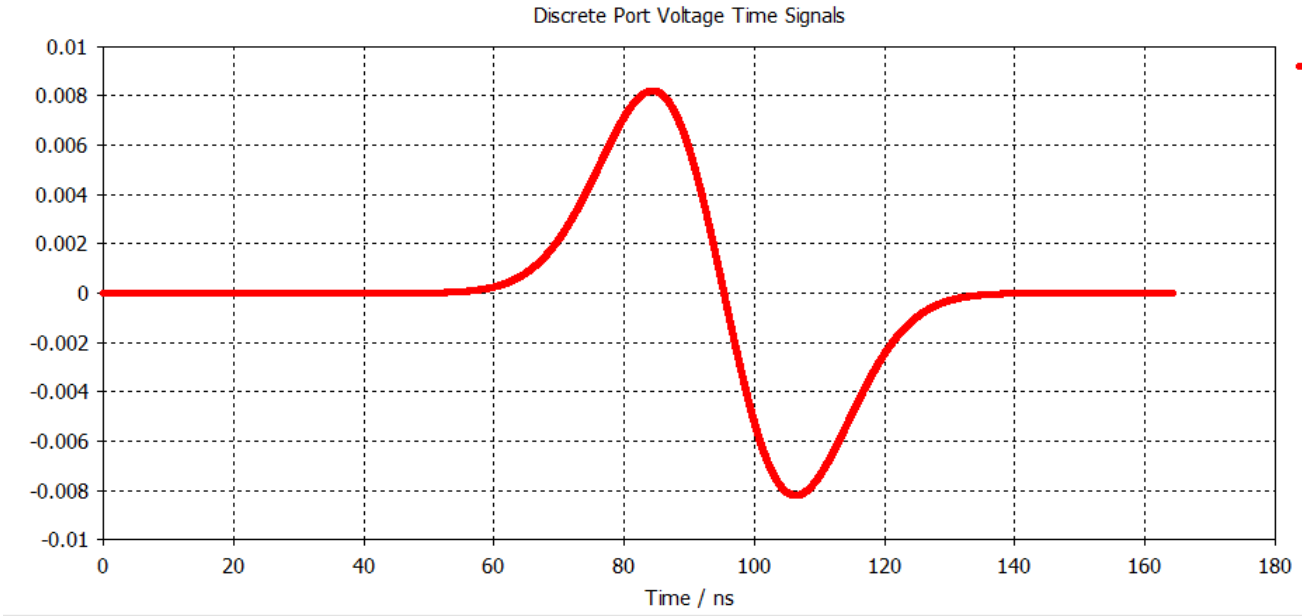
Contributions to error

- Cable mismatches, including from button to switch board.
  - 700 MHz phase mismatches are significant
- Analog switches
  - Switches will need to be calibrated for both normal and reverse positions, and calibration must include cables to buttons.
- Button mismatches
- Crosstalk on V301 at 700 MHz frequency
- Temperature variations in electronics and cables
- Filter response at different frequencies and different bunch repetition rates

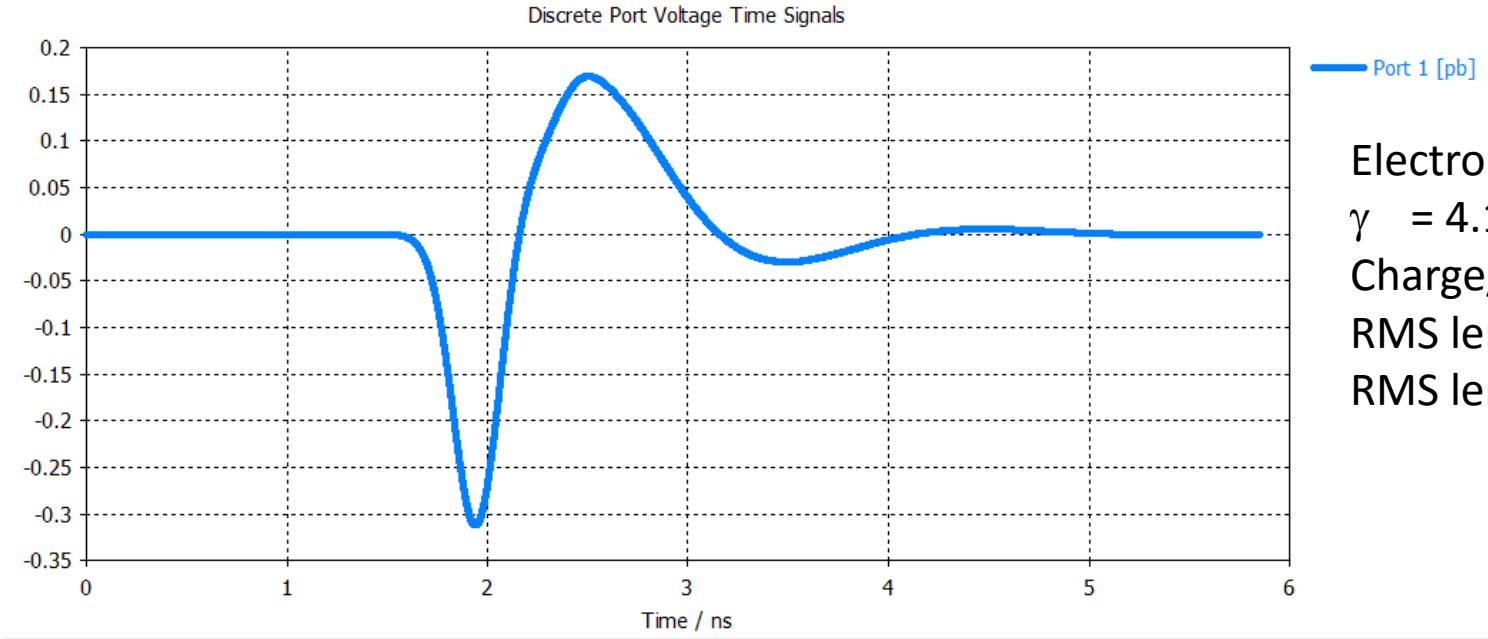
Design options under consideration

- Switches and 20 dB amps in tunnel, split cooling section BPMs to 2 V301 modules – one for electrons, one for ions
- Switches and 20 dB amps in tunnel, down-convert electron signals from 704 MHz to about 100 MHz in tunnel
  - Benefit: lower frequency signal is sent on cables from tunnel.
  - Downside: Each button requires 2 signals – I and Q
  - Ion signal would be mixed with electron I/Q signals and one V301 would be used (per plane) to measure both electrons and ions
  - Benefit: A common sine wave locked to the RHIC RF (~600 MHz or ~1300 MHz) can be used as the I/Q mixing frequency. This could also be the clock reference for phase (and time-of-flight) measurements.
  - Benefit: Measuring the second harmonic (1408 MHz) is possible
- Use a 700 MHz low-pass filter instead of a ringing 700 MHz band-pass filter. This would rely on the train of 700 MHz bunches to oversample the electron beam. One module would be used to measure both electrons and ions.

Particle Studio simulations (P.Thieberger, 01/22/2015)

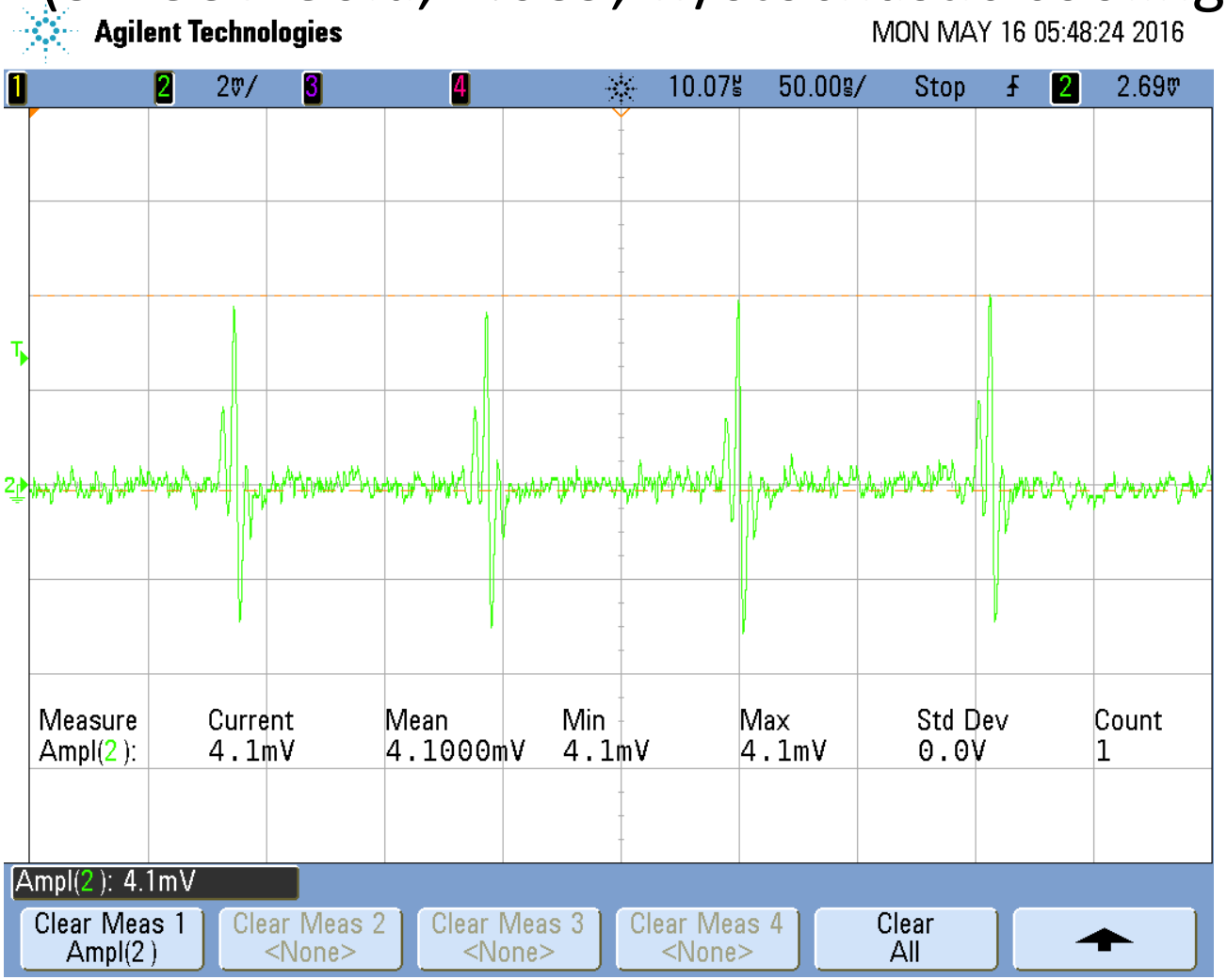


Gold beam
γ = 4.1
Ions/bunch = 7.5E8
Charge/bunch = 9.48E-9 C
RMS length = 3.2 m



Electron beam
γ = 4.1
Charge/bunch = 100 pC
RMS length = 100 ps
RMS length = 30 mm

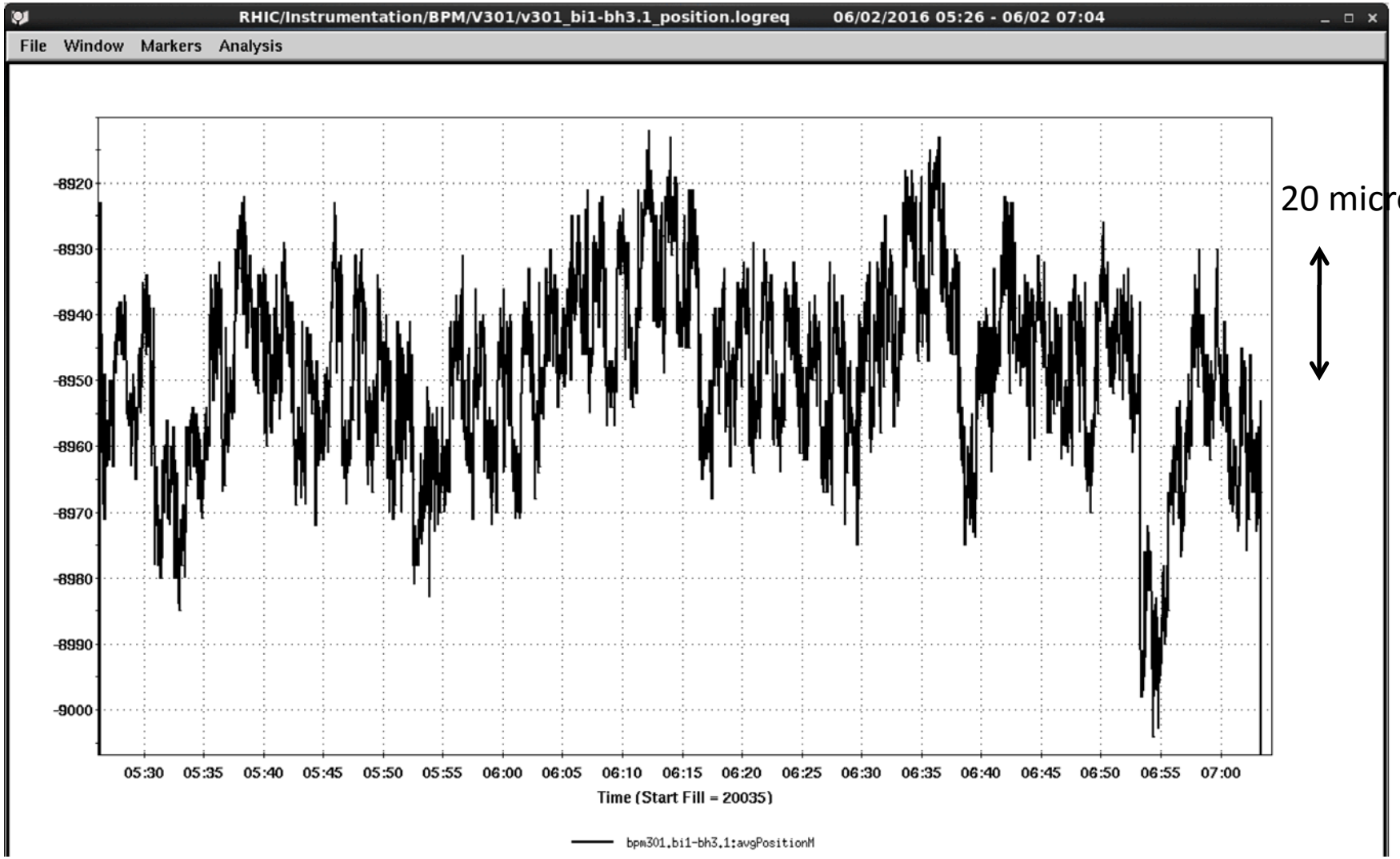
Raw yellow LEReC button measurement with 40dB attenuators in tunnel, measured in 1002d patch panel (31 GeV Gold, 1.6e9, w/stochastic cooling)



~4 mV peak signal – Peter Thieberger's estimate at the button is 8 mV.

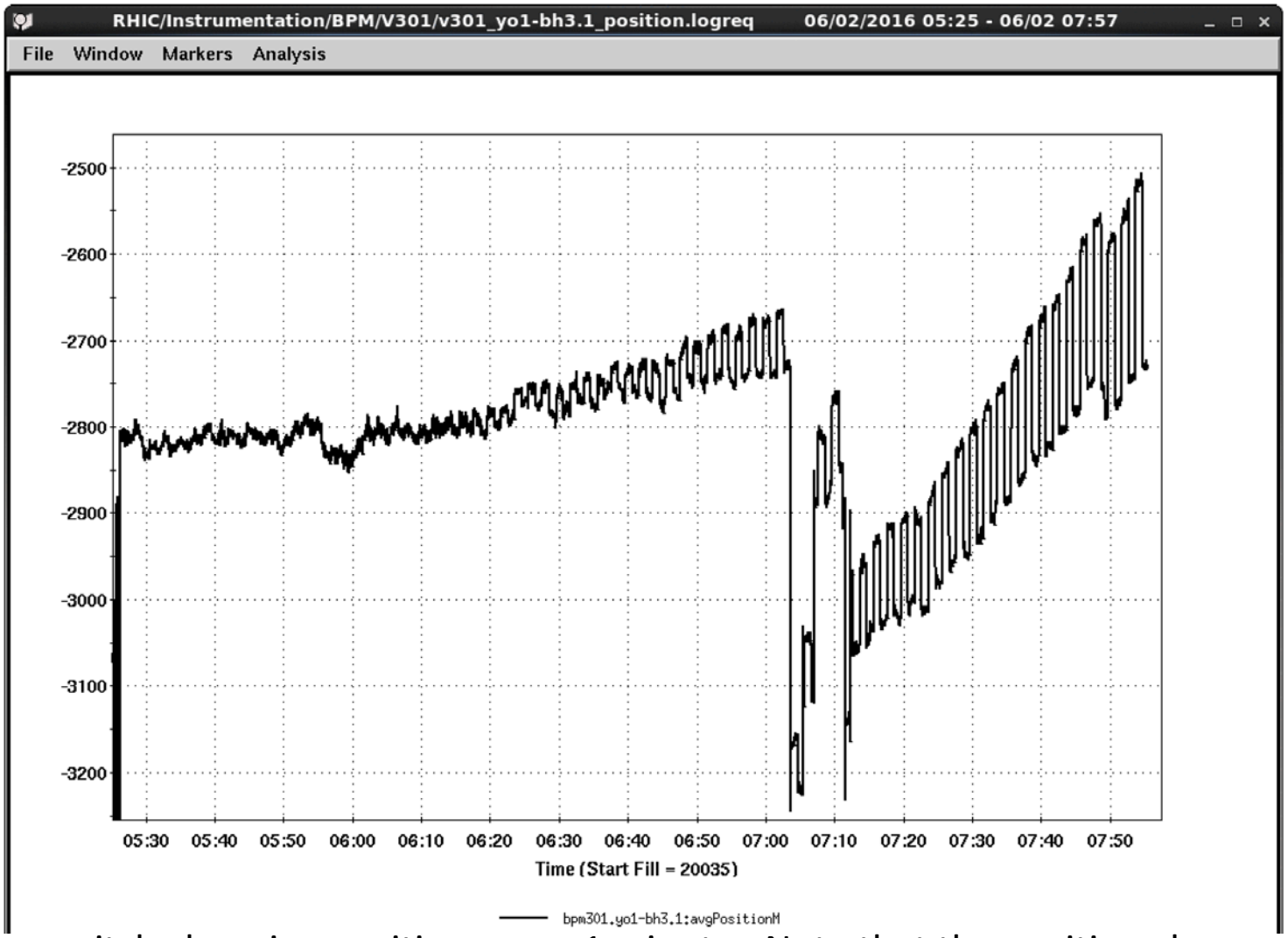
Note that the bunch width here is much narrower than the expected LEReC ion beam.

Blue LEReC button measurements with 40dB attenuators, analog switch and 20 dB amplifiers in tunnel (9.8 GeV Deut)



Analog switch changing position every 1 minute. Note ~20 micron change when switched

Yellow LEReC button measurements with 40dB attenuators, analog switch and 20 dB amplifiers in tunnel (9.8 Gev, gold)



200 microns

Analog switch changing position every 1 minute. Note that the position changes due to switching increase during the store. This is an indication that calibration changes during the store due to changes in beam, for example beam frequencies affecting filter response.

Phase (time-of-flight) Measurements

- No solid solution yet
- Beam sync link carrier is not a low jitter clock source and this will likely cause difficulties

BPM sum signal as loss detection

- BPM sum signals can be monitored to determine relative intensities over time
- Calibration between BPMs will be difficult (mainly due to cable length differences)
- Calibration to Rad loss would not be easy (would this be required?)