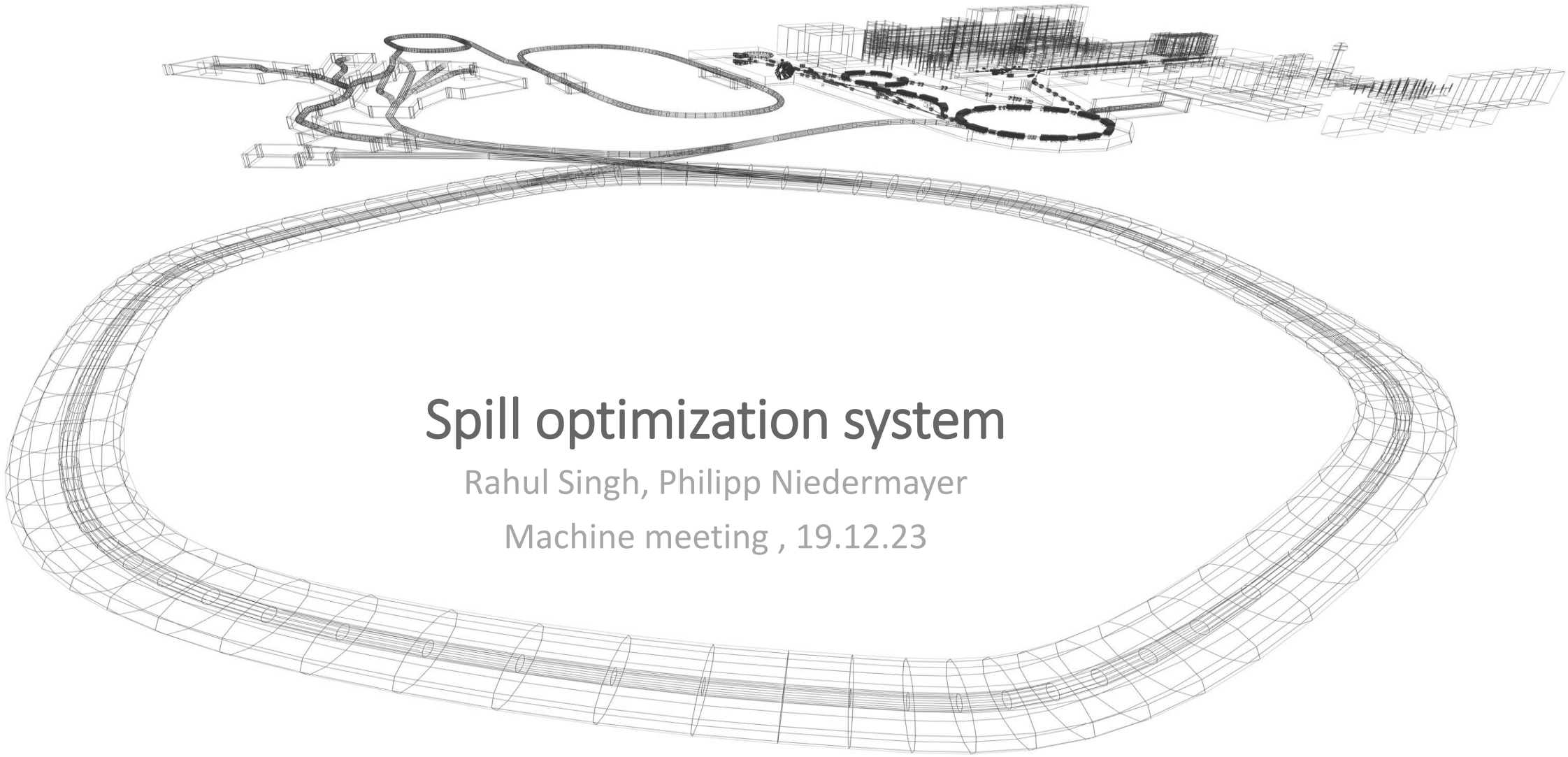


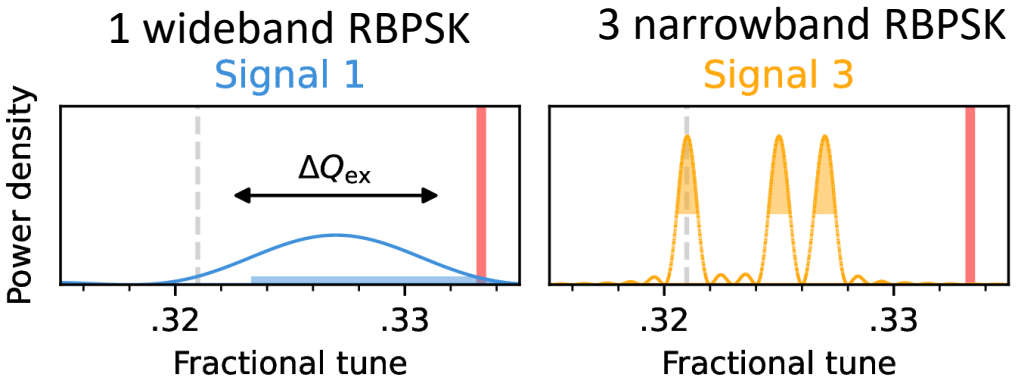
Spill optimization system

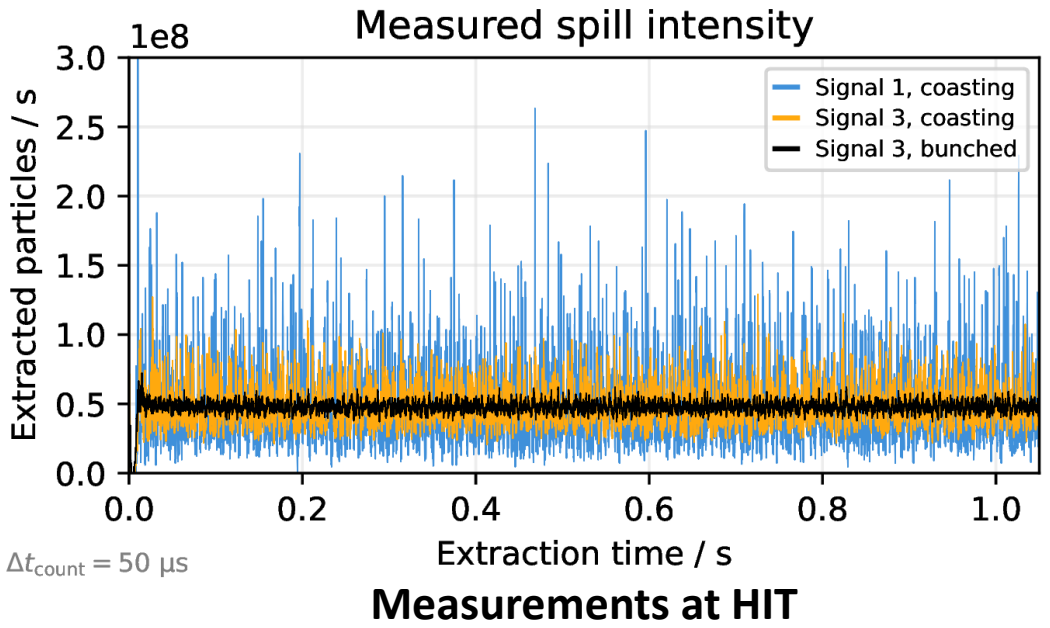
Rahul Singh, Philipp Niedermayer

Machine meeting , 19.12.23

KO waveforms and microspill structure

- The choice of excitation signal in KO extraction has a huge implication for the spill microstructure. Every facility has investigated this topic and came out with some optimal excitation signal. **At GSI SIS-18, single RBPSK is used.**
- PhD project (P. Niedermayer) started two years ago, one of the goal is finding the optimal waveform for microspill quality.
- With large scale particle simulations along with experiments at HIT and COSY, an answer was found → fixed frequency sinusoids are the best waveforms for microspill. Need to be mixed with noise waveform for a good extraction efficiency (Noise ++ excitation).
- Developments in the past year:
  1. Slow extraction is a sensitive non linear dynamics process, thus finding the optimal frequencies for sinusoids is dependent on precise extraction settings. **Optimization routine built into excitation waveform generator**
  2. The waveforms suitable for microspill often create undesired macrospill structure. **Macrospill feedback**
  3. Noise ++ KO signal amplitude levels required is significantly higher compared to RBPSK. **Higher excitation power needed**





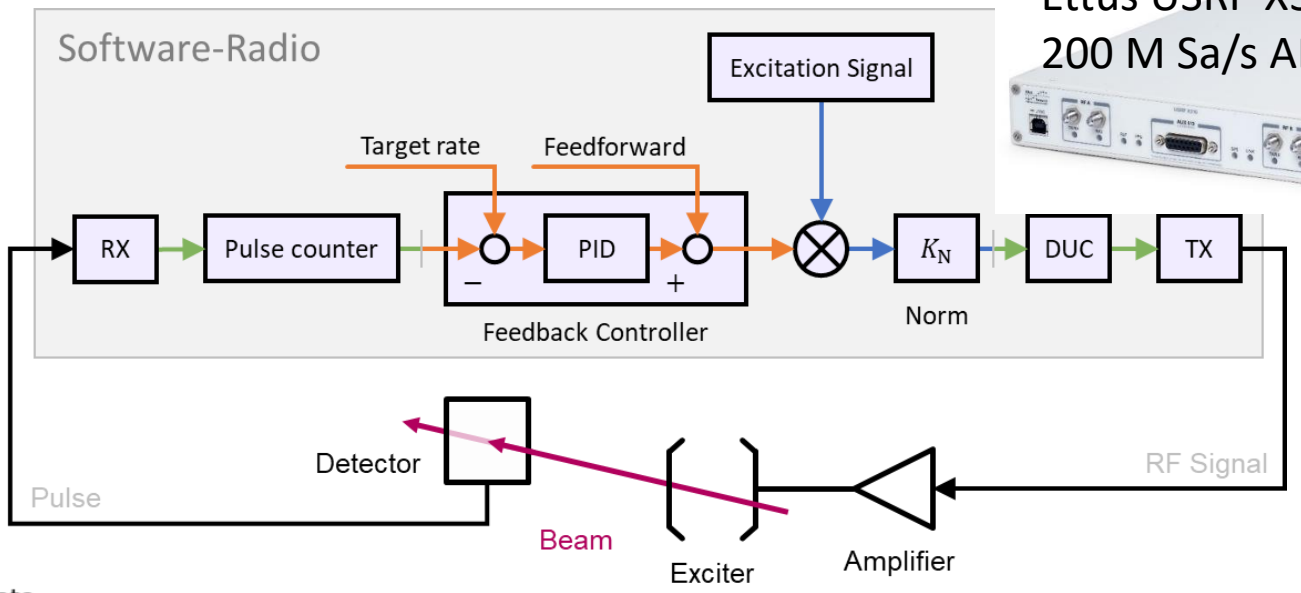
Measurements at HIT

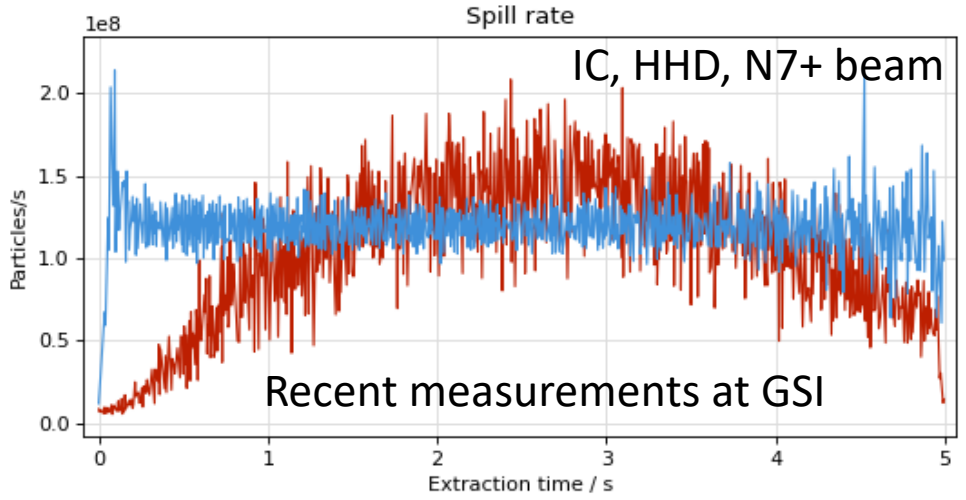
Slow macrospill feedback using generic transceiver+CPU

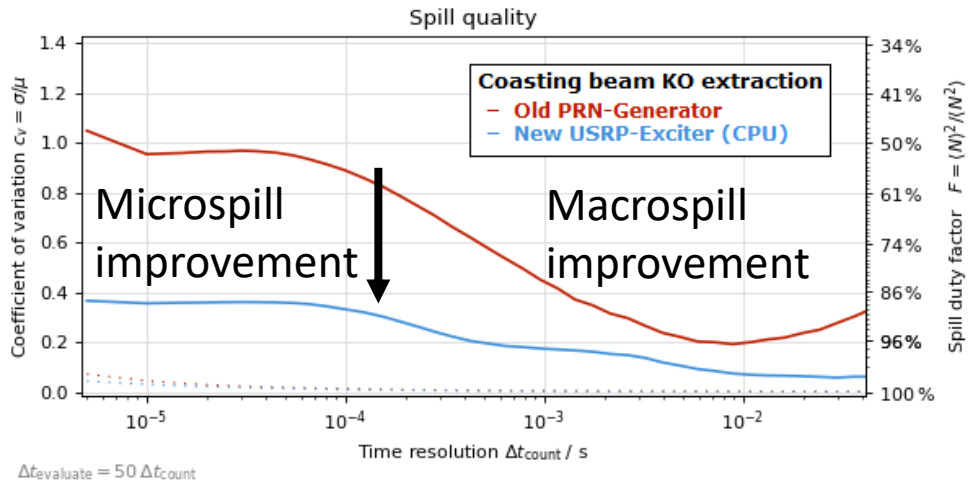
- Pulse counter implemented in the FPGA. Feedback logic and excitation signal generation implemented in the CPU. Loop latency minimized to ~ 1 ms
- Amplitude of excitation signal is controlled by a feedback loop for a flat macrospill (10 Hz).

Detectors tested with so far:

- LGAD (HADES) Detector (at COSY)
- Ionisation Chamber (IC)
- SEM Grid
- Plastic Scintillator
- BLM at E-Septum

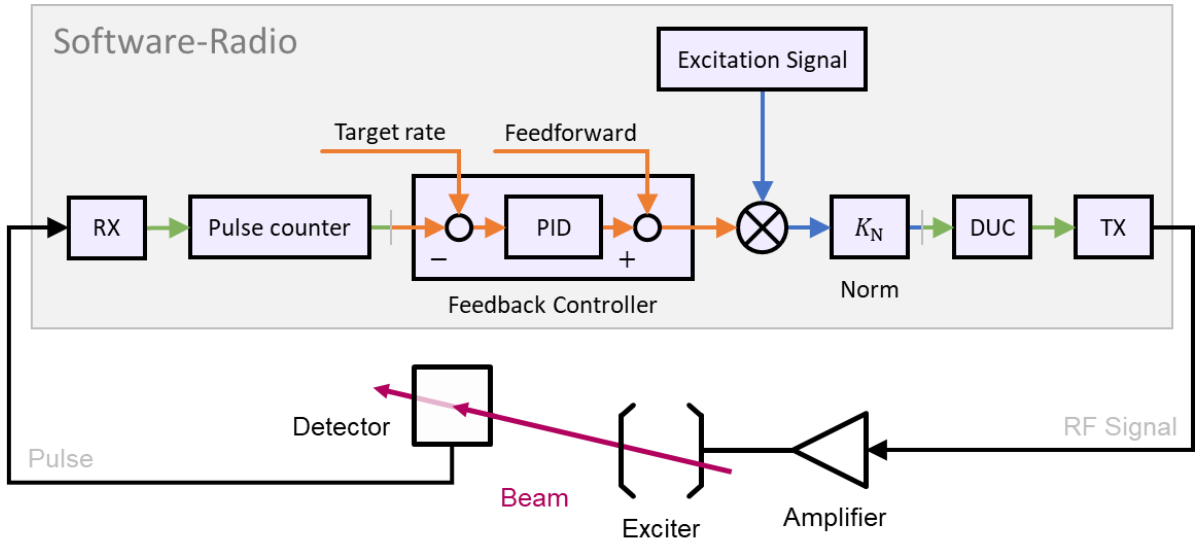






Fast macrospill feedback with RFNoC (FPGA)

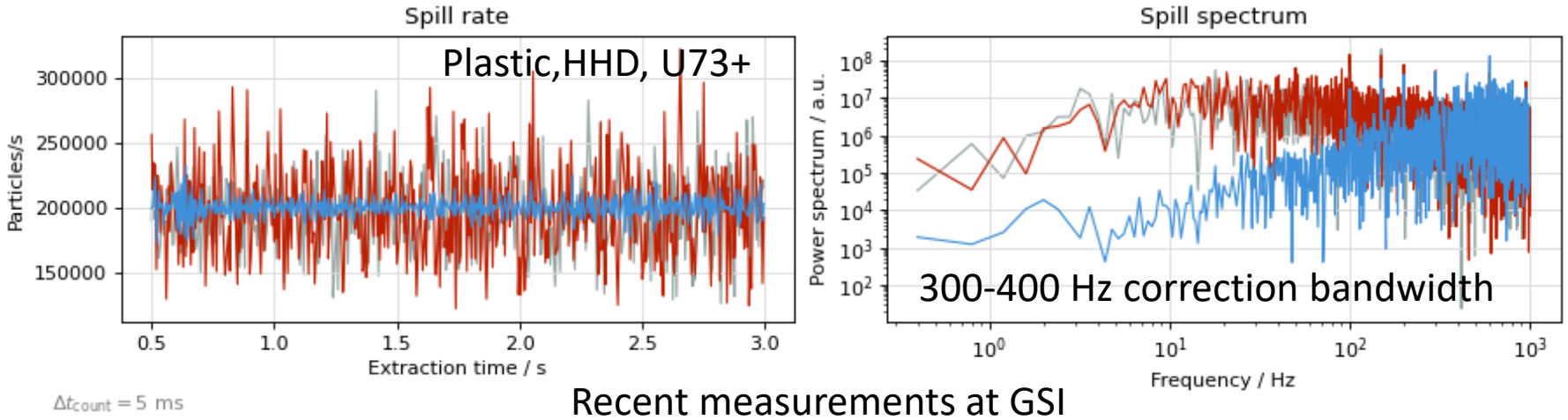
- FPGA-based feedback for low loop latency
- Project with support from COSY/HESR
  - Intense exchange with experts (GRCon23)
    - → Optimized parameters (buffers, package sizes, …) ~ 30 µs latency achieved
    - → Pre-recorded signal played back from FPGA (replay block)



CPU based Feedback

FPGA Feedback with high latency control parameters

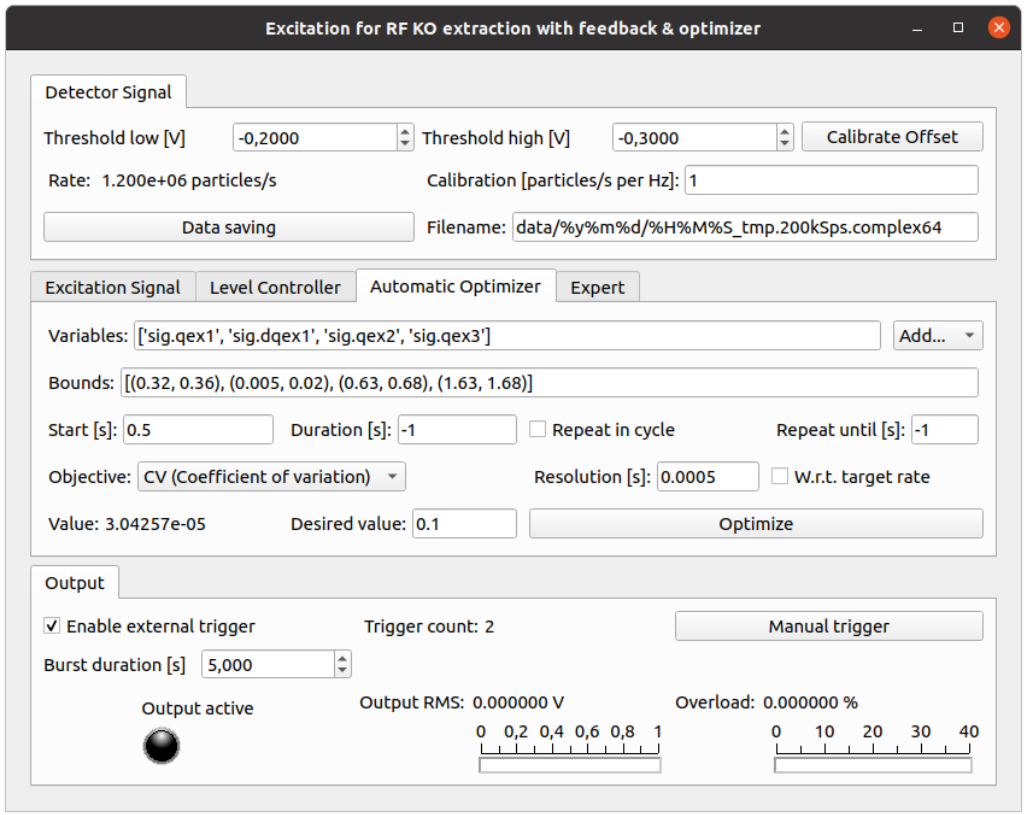
FPGA feedback with low latency control parameters



Recent measurements at GSI

Summary

- A spill optimization system is developed → improvement of spill quality by generating optimal excitation waveforms. An integrated optimizer routine assists with this procedure.
- Two feedbacks (CPU and FPGA based) are implemented to tackle macrospill shape. They control the excitation signal amplitude based on a variety of particle intensity detectors. Many detectors have been tested.
- The power required for new waveform (Noise ++) is higher than RBPSK signal. Requires knock out (KO) power amplifier upgrade for usage with highest rigidity beam.
- System is available for usage



THANK YOU to many GSI, COSY and HIT colleagues!