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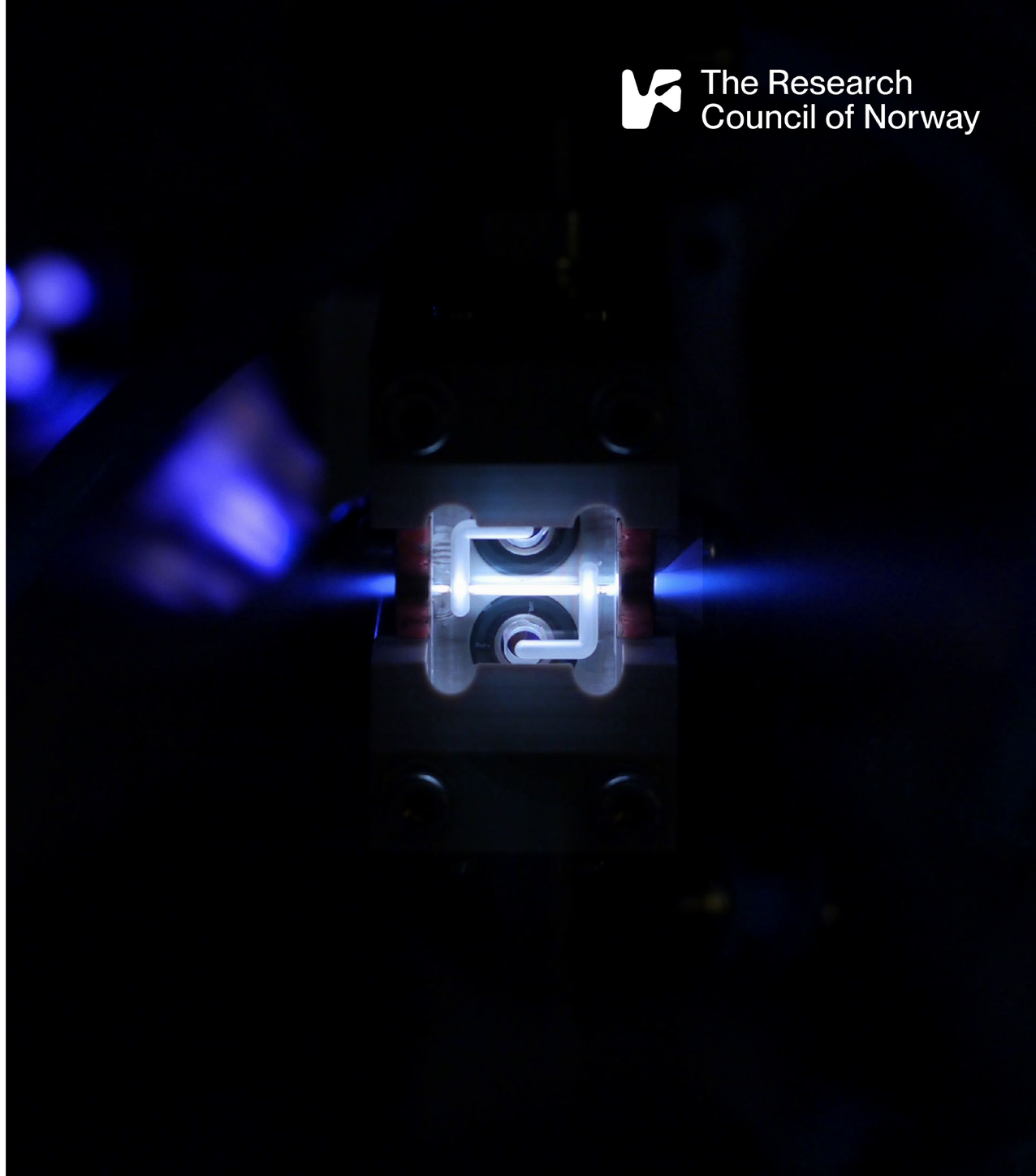

The Research Council of Norway

Plans for E302

Results + planning

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Date

Outline

- E302's objectives.
- Shift summary.
  - Results & analysis.
- Plan for future shifts & analysis.

E302's objectives.

Two-part objectives: measure and mitigate.

- The E302 proposal was approved in 2019 (PI Erik Adli. First beam: time April 2025.)
- The first goal of E302 is to measure the beam-breakup instability as a function of efficiency.
  - We will use the spectrometer to image angles projected on CHER.
- Results from our Instability-efficiency study can be probed directly by experiment (Finnerud, Lindstrøm, Adli 2025).
- Then we would like to mitigate the instability.
  - Energy spread (BNS damping) (T. J. Mehrling et al. 2019).
  - Ion-motion (Benedetti et al. 2017).
  - Operation in the quasi-linear regime (Lehe et al 2017).

Shift summary

- Two shifts in April.
  - Decent beam conditions, saw good acceleration after tuning the sextupoles.
- Got a lot of data where we scan collimators and L2phase.
- Some calibration data
  - (DTOTR2 was saturated on some shots).
  - No TCAV phase characterisation on day 1.

Main results

We have been mainly looking at the dataset where we scan L2phase.

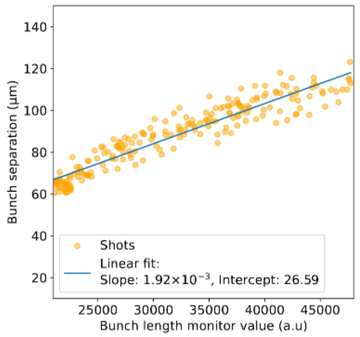

Figure 2: The correlation between bunch spacing found from the electro-sampling crystal and the readback value from the bunch length monitor in BC14 obtained from a L2 linac section phase scan dataset.

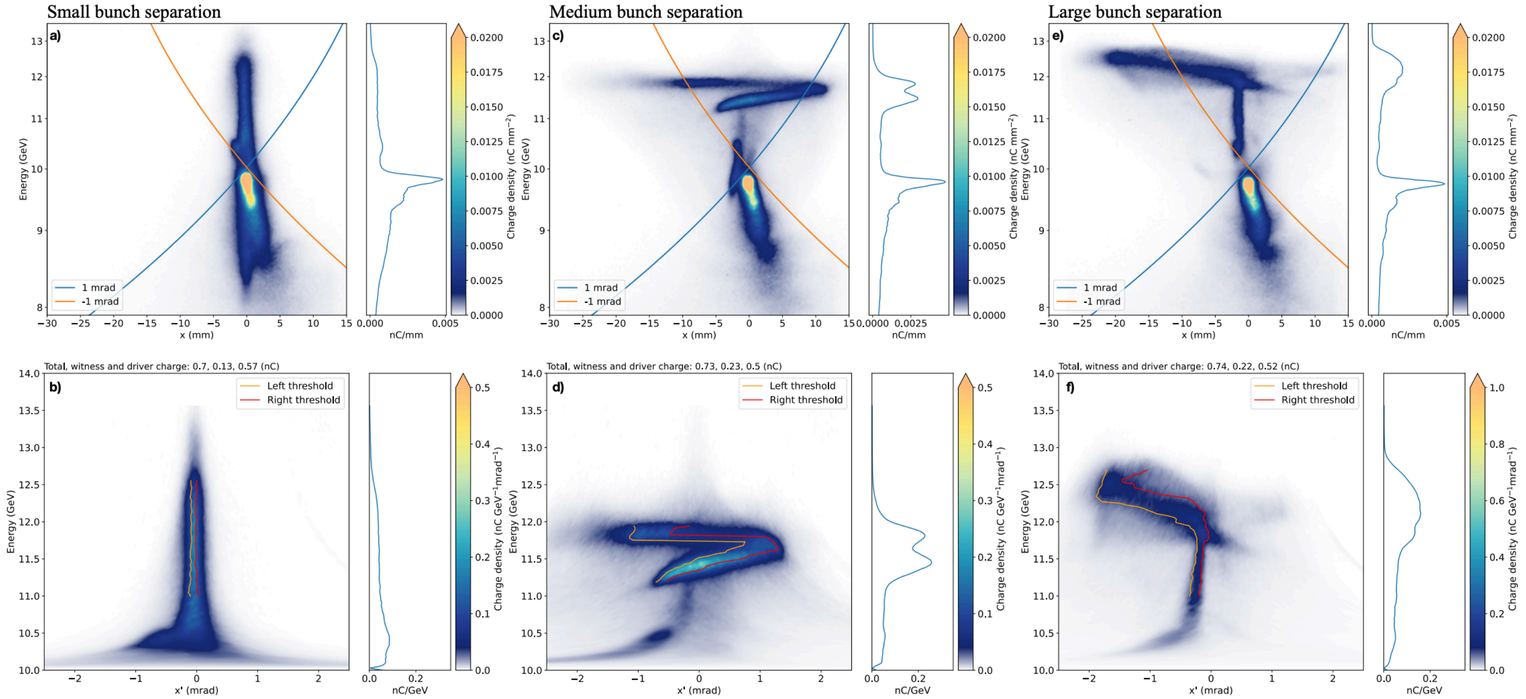

Figure 4: Three spectrometer shots (a,c,e) with lines drawn to indicate the chromatic expansion of the beam due to imaging effects for bunch slices with initial divergences of -1 and 1 mrad. The x'-E distributions (b,d,f) are shown after conversion using the known lattice parameters. Bunch separation and efficiency are estimated to be around 71 microns and 0.17 (a,b), 95 microns and 0.36 (c,d) and 112 microns and 0.43 (e,f).

Looking at correlations across dataset

Apply threshold filters to the data.

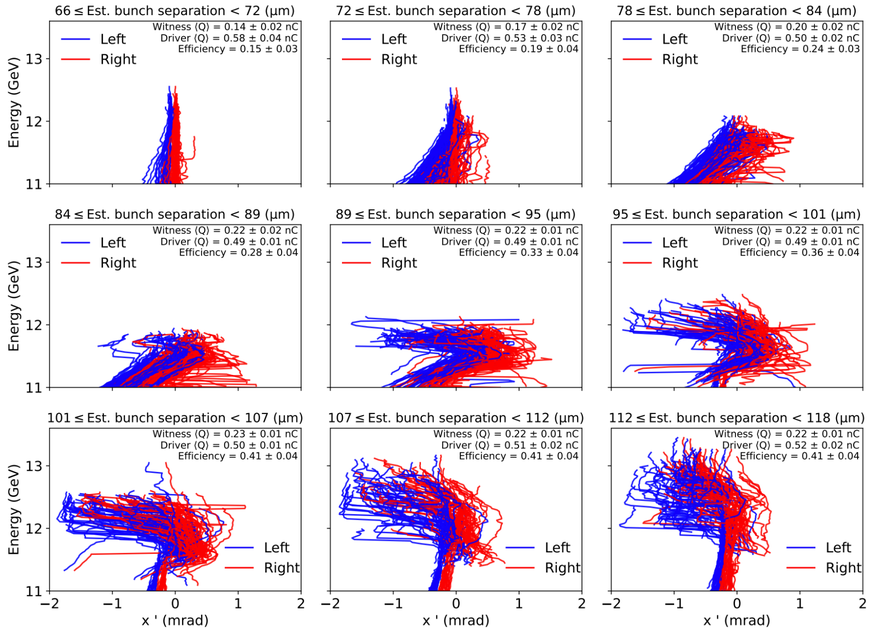

Figure 5: Left and right threshold value lines drawn for each shot in the scan of the L2 phase. Mean charges and efficiency calculated from the spectrometer screen are annotated on each window of the figure for each estimated bunch separation interval, along with their standard deviation.

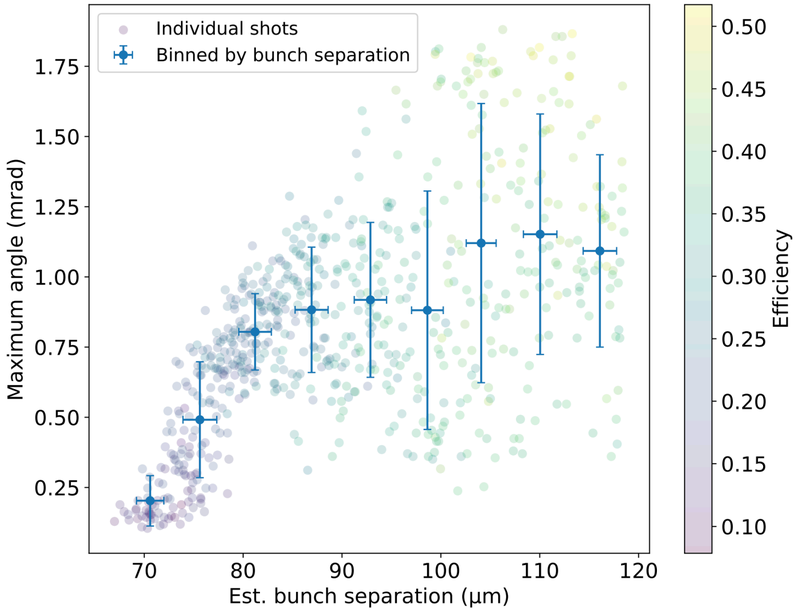

Figure 6: The maximum absolute angle reached by parts of the bunch using a left and right threshold filter on each shot in the dataset is shown against bunch separation found from applying the linear calibration to the bunch length monitor signal.

Simulating the data

Use approximate twiss parameters and bunch length on the order of 20 microns.

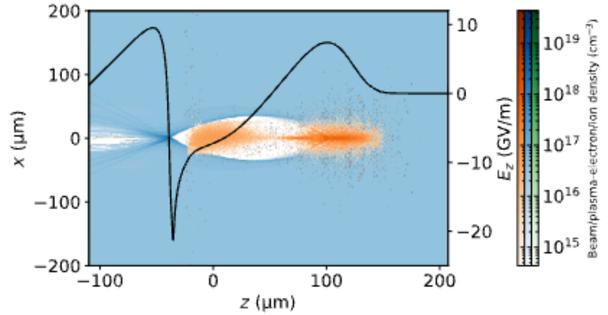

FIG. 9. Beam, plasma, and ion density are shown for a shot in the simulation with 111 μm bunch spacing in the middle of the ramps.

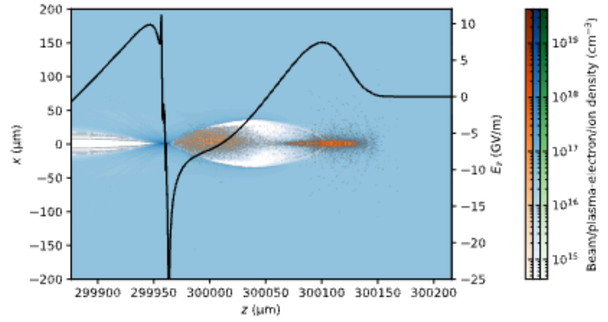

FIG. 10. Beam, plasma, and ion density are shown for a shot in the simulation without transverse instabilities at 111 μm bunch spacing in the middle of the ramps.

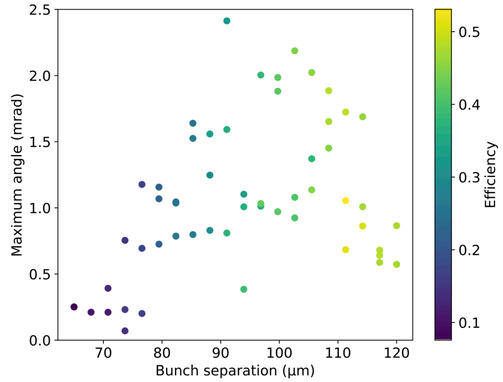

Figure 8: Simulated maximum angle versus bunch separation from HiPACE++. The maximum absolute angle reached by parts of the bunch using a left and right threshold filter, as well as the efficiency, is calculated for each shot using the simulated spectrometer screen.

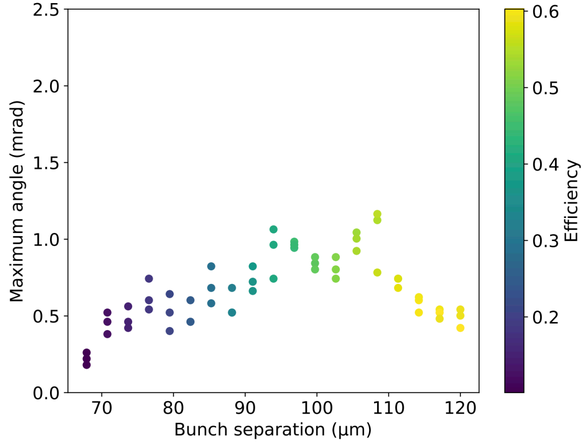

Figure 10: Simulated maximum angle versus bunch separation from WakeT. Again, the maximum absolute angle reached by parts of the bunch using a left and right threshold filter, as well as the efficiency, is calculated for each shot using the simulated spectrometer screen.

Conclusions

- We see large transverse kicks up to 2 mrad.
- We see characteristic transverse oscillations of the trailing bunch along the energy axis.
- There is a systematic change in the shape of these oscillations when scanning BC14 (bunch separation, efficiency).
- This can be understood in terms of instability + field loading + BNS damping.
- We simulate the data both with and without instabilities and see a clear difference aswell as similar patterns in the simulated HiPACE++ data as the experimental.

EAAC proceedings

First results from the E302 efficiency–instability experiment at the FACET-II facility

O G Finnerud[1], E Adli[1], R Ariniello[2], S Corde[3], T N Dalichaouch[4], C Emma[2], S Gessner[2], C Hansel[6], M J Hogan[2], C Joshi[5], D Kalvik[1], A Knetsch[2], C A Lindstrøm[1], M Litos[6], N Majernik[2], K A Marsh[5], B D O'Shea[2], I Rajkovic[2], S Rego[3], D Storey[2] and C Zhang[5]

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Thoughts on improvements for next shifts.

- Have the beam be of the best quality (same as E300 goals; control over transverse phase space, matching, etc.).
- Stronger blow-out (higher DB current) to increase oscillation amplitudes.
- Diagnostics (EOS-BPM status, CHER field of view).
  - CHER FOV is related to the m12 being used. Large m12 -> smaller uncertainty -> more dispersed beam.
- Full characterisation for quantitative comparisons to simulations.
- We have developed analysis tools that should be converted to live tools for next shifts.