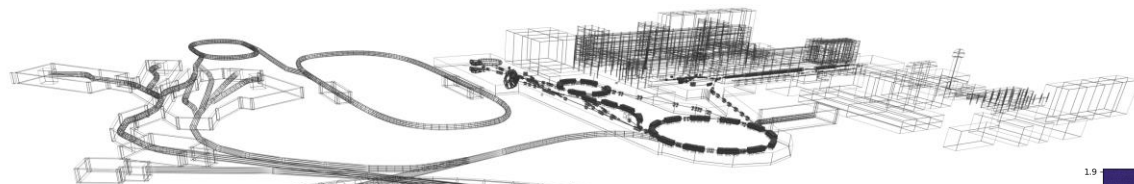
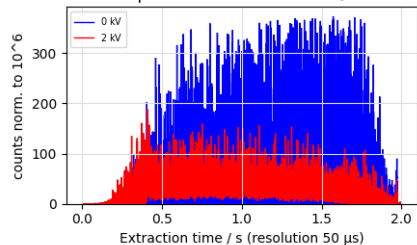
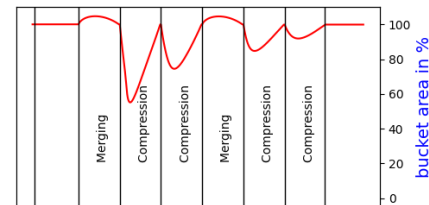
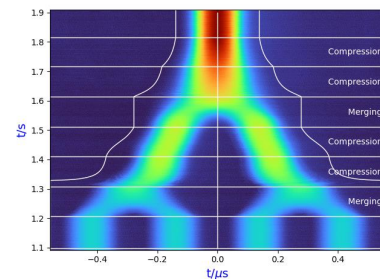


Spill structure for 300 MeV/u



Exp. 240 SIS18 Micro Spill Cavity and Exp. 243 Batch Compression



Overview

Ring RF MDE in 2025

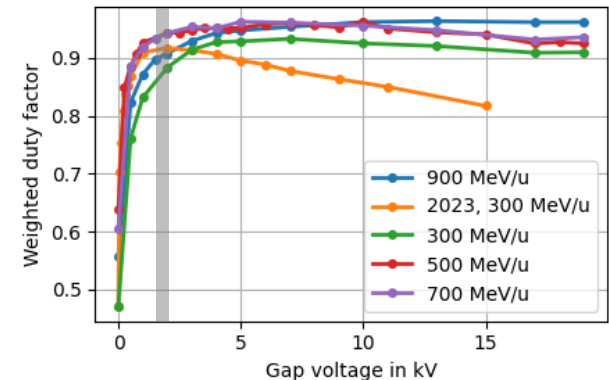
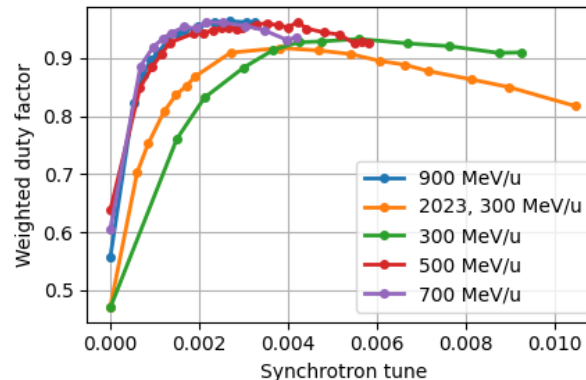
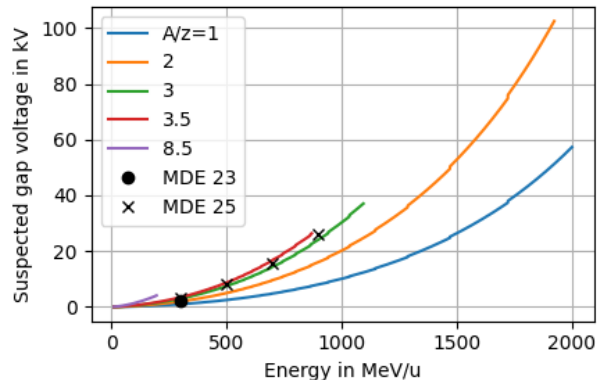


Nr.	Machine	Coordinator	Title
240	SIS18	K. Groß	Micro spill cavity
241	SIS18	B. Zipfel	Beam phase control
242	SIS18	D. Lens	Bunch compression
243	SIS18	K. Groß	Batch compression
244	SIS18	M. Hardieck	Longitudinal Feedback (PhD thesis C. Reinwald, TU Darmstadt)
267	SIS18 & ESR	D. Beck	Phase shifting with Bunch2Bucket SIS18 → ESR
268	ESR	B. Zipfel	Beam Phase Control
269	ESR	M. Frey, K. Groß	Stacking with ESR Barrier Bucket

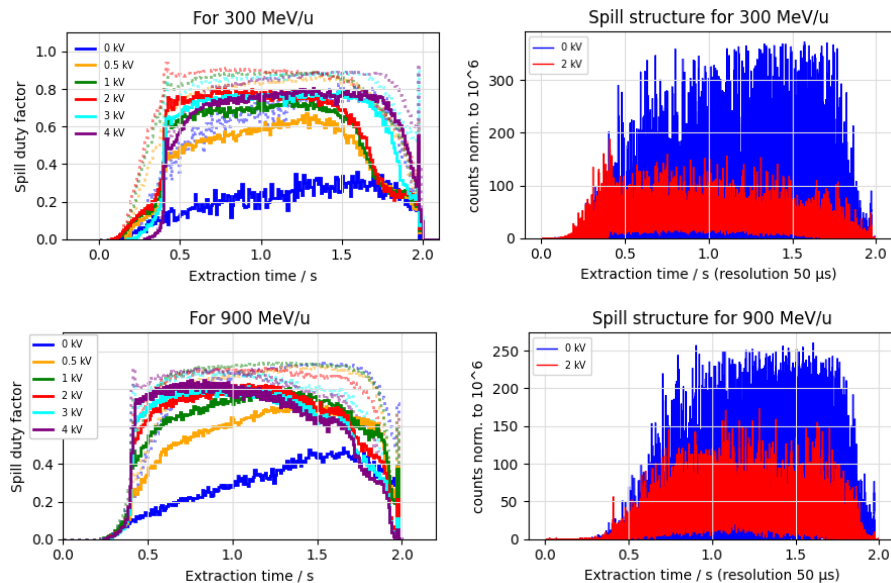
as usual: support from numerous colleagues and groups (sorry they cannot be mentioned here)

Experiments

1. Nov. 29th '23, $^{14}\text{N}^{7+}$, 300 MeV/u
→ opt. 2 kV, $Q_{\text{syn}} \approx 0.0038$
2. July 13th '25, $^{238}\text{U}^{73+}$, 300, 500, 700 & 900 MeV/u
→ “expected” energy dependence not found → low voltages sufficient



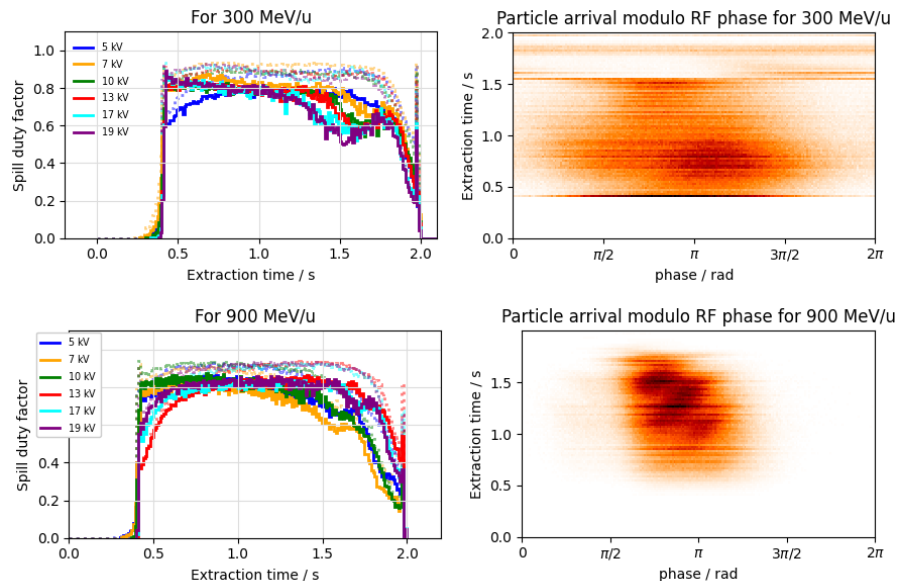
Low voltages for spill improvement



see OP school:

<https://indico.gsi.de/event/23330/>

High voltages for beam dyn. studies



see SX 2025:

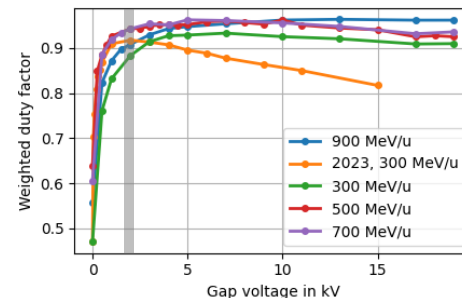
<https://indico.bnl.gov/event/27693/contributions/112722/>

Summary

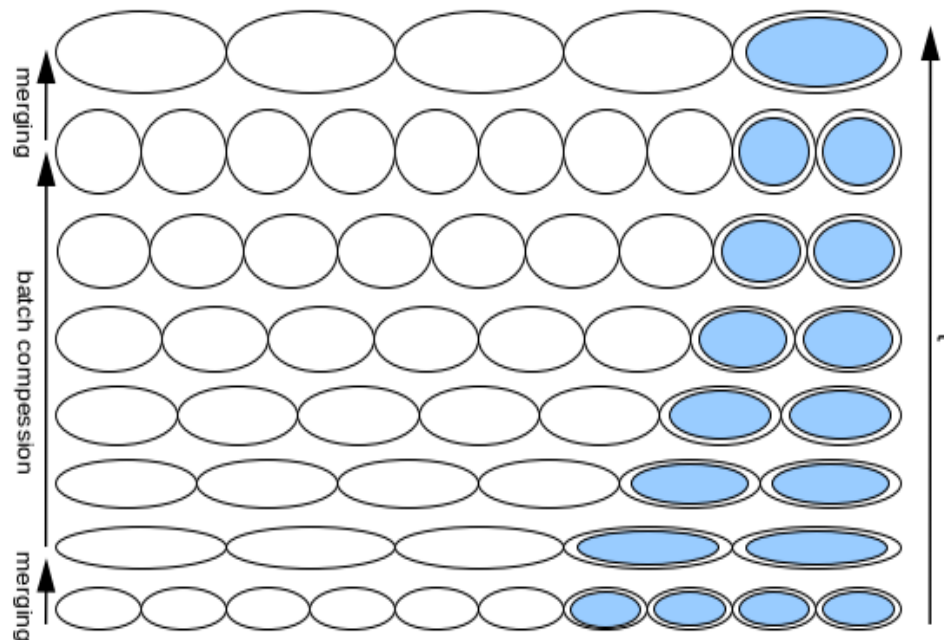
- Reproducible reduction of spill peaks by factor 2
- Low gap voltage 1.5 to 2 kV sufficient for all energies
- More than 5 kV not recommended
- Thanks to P. Forck and J. Yang for their support and interest!

Outlook

- Integration into control system
- Operation to gain **user experience**
- Future experiments (< 2 kV)
 - Limit for high current operation
 - Influence on (/ controllability of) macro spill structure



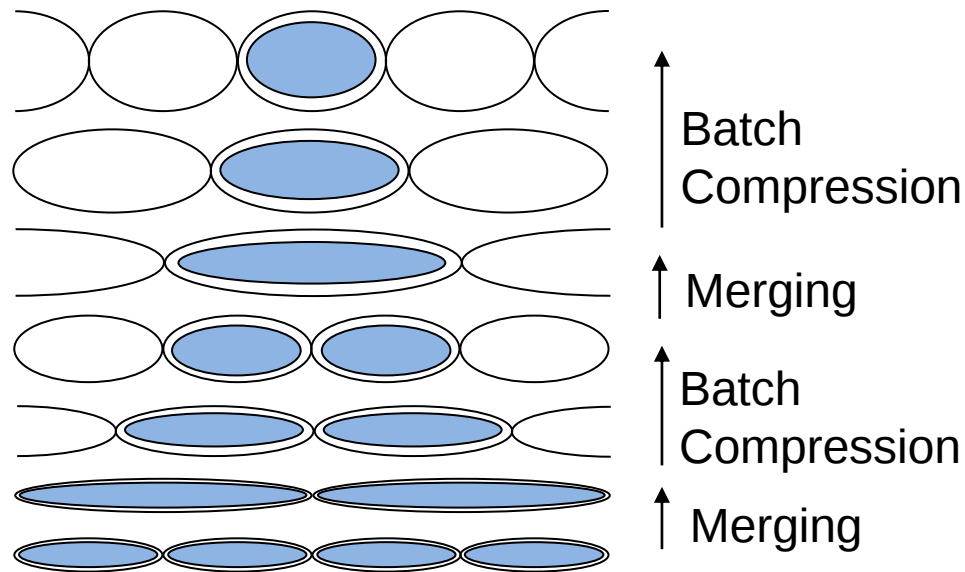
- Batch Compression defined for SIS100 Proton Cycle in „SIS100 Cycles“
- Aim of experiment
 - **First Batch Compression @ GSI**
 - Test case for SIS100
 - Not relevant for operation @ SIS18 (due to limitations)
- July 9th '25 night shift, $^{238}\text{U}^{73+}$



- Pattern prepared by H. Liebermann
- Beam centered
- Limitations (max.):
 - 28 kV @ h=4
 - 2.7 MHz @ h=3→ 295 MeV/u
- only 3 harmonics

During Compression:

- Bucket area $\sim \frac{1}{h} \sqrt{\frac{a}{h}}$
- Phase and amplitude values **manually set** in ParamModi during experiment



- Pattern prepared by H. Liebermann

- Beam centered

- Limitations (max.):

- 28 kV @ $h=4$

- 2.7 MHz @ $h=3$

→ 295 MeV/u

- only 3 harmonics

During Compression:

- Bucket area $\sim \frac{1}{h} \sqrt{\frac{a}{h}}$

$$16 \cdot U, h = 4$$

$$27/4 \cdot U, h = 3$$

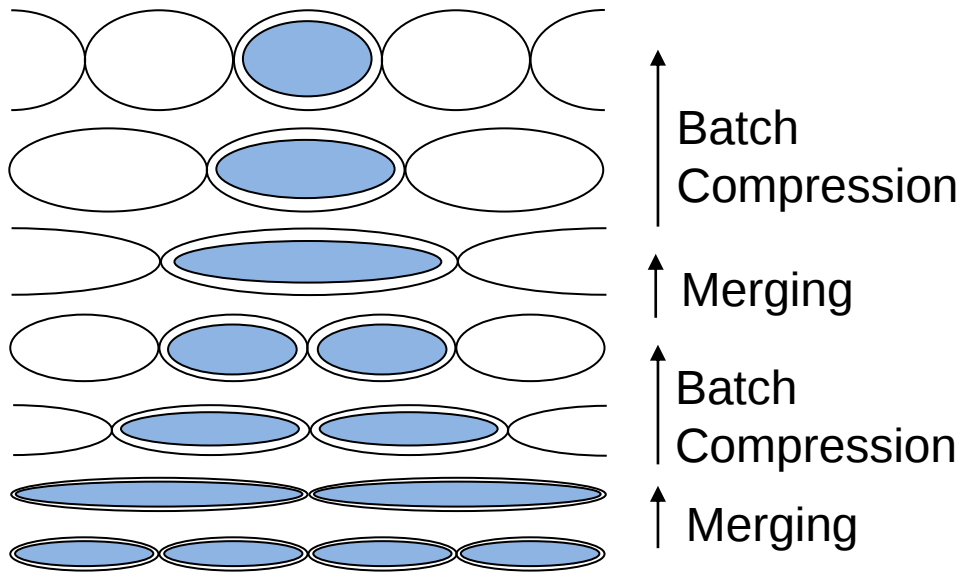
$$2 \cdot U, h = 2$$

$$4 \cdot U, h = 4$$

$$9/16 \cdot U, h = 3$$

$$1/2 \cdot U, h = 2$$

$$a = U, h = 4$$

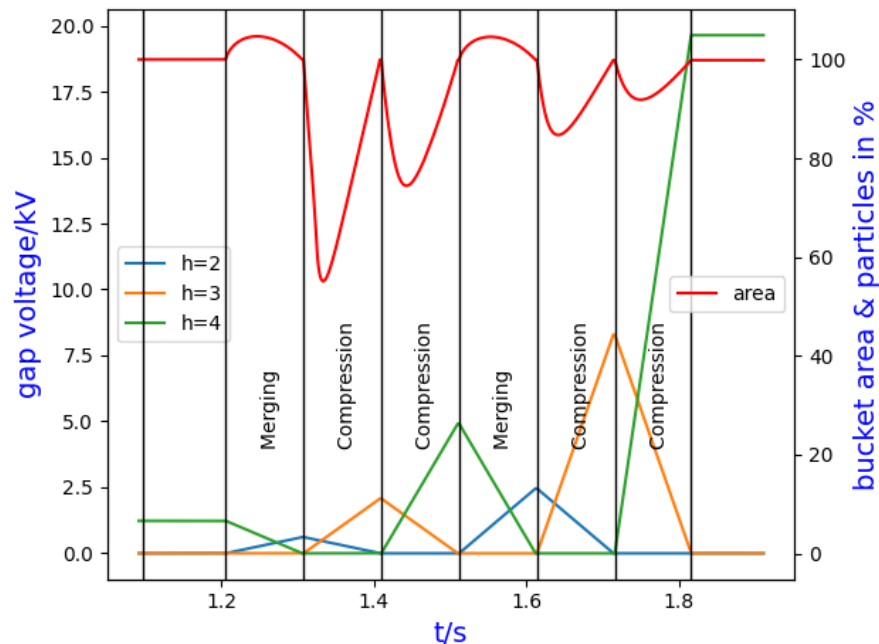


- Phase and amplitude values **manually set** in ParamModi during experiment

Batch Compression

Amplitude Optimization and Bucket Area

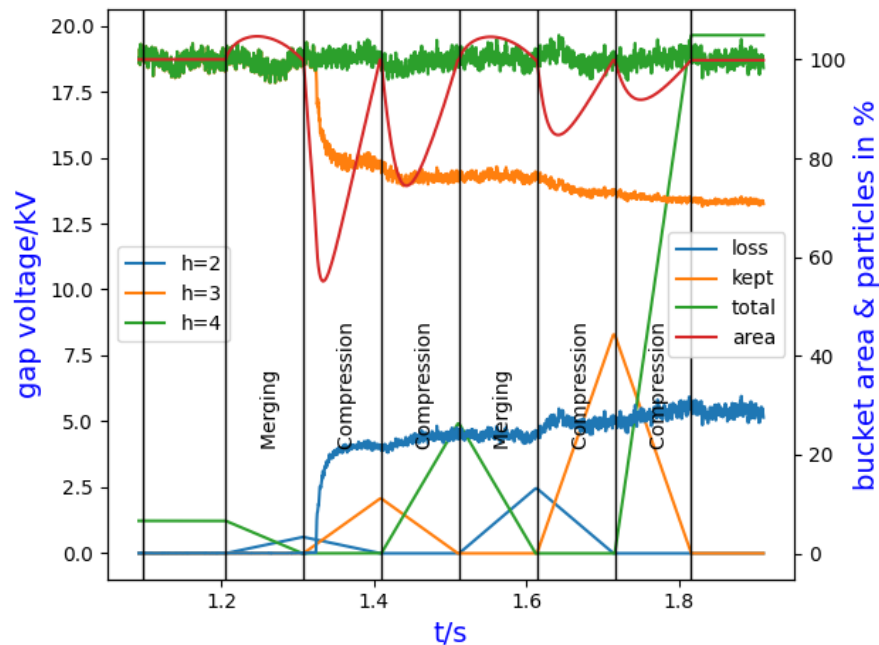
- Voltage ratios as shown & lin. ramps
- Problem: bucket area decreases
- Part of experiment preparation
- Only short test in experiment



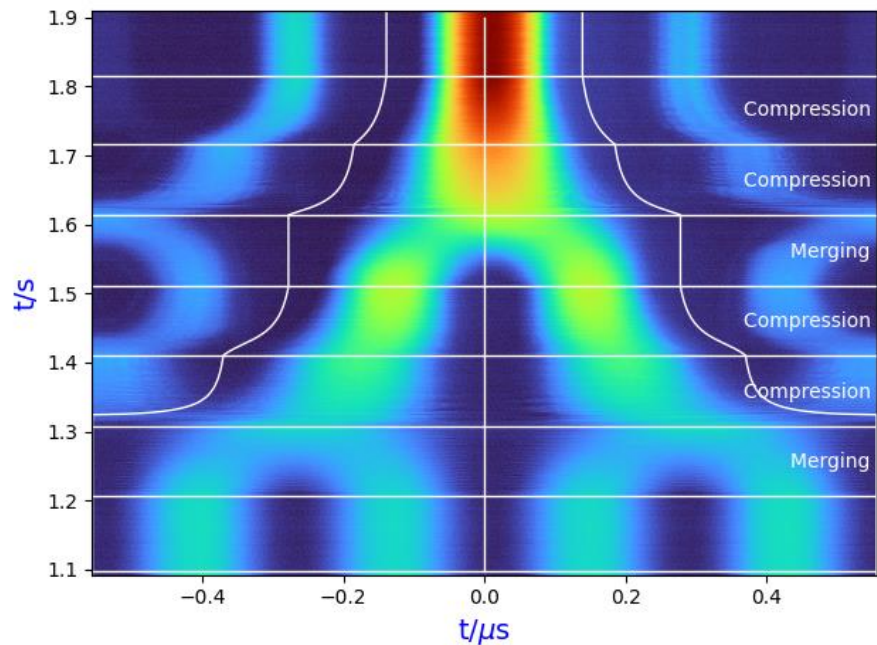
Batch Compression

Amplitude Optimization and Bucket Area

- Voltage ratios as shown & lin. ramps
- Problem: bucket area decreases



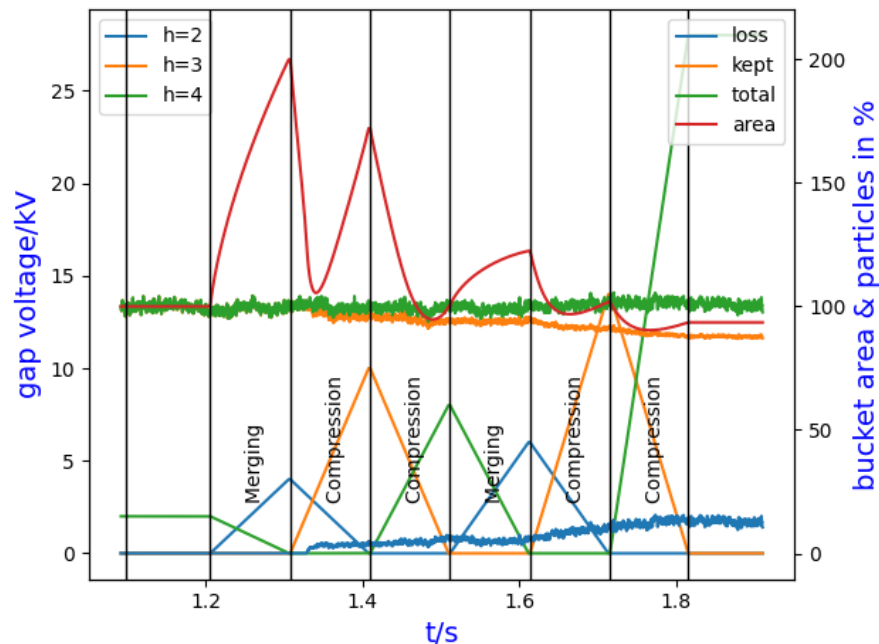
- Part of experiment preparation
- Only short test in experiment



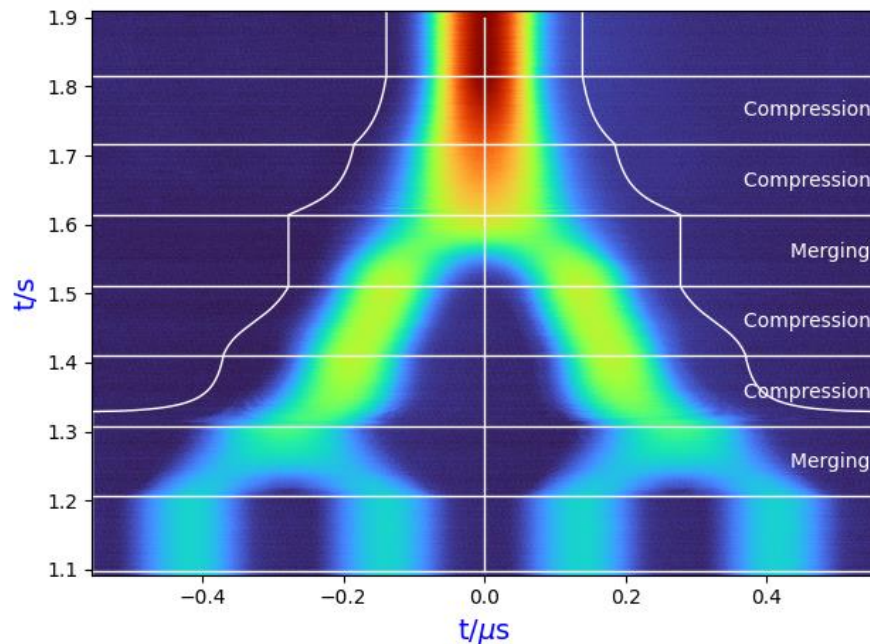
Batch Compression

Amplitude Optimization and Bucket Area

- Simple solution: increase amplitudes
- Optimization by simulations ongoing

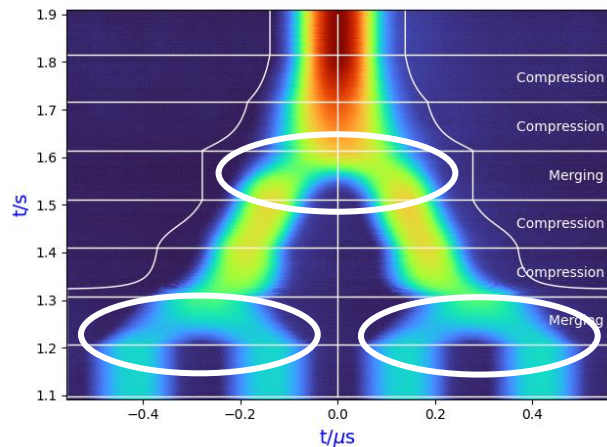


- Successful batch compression
- ← Various amplitudes tested

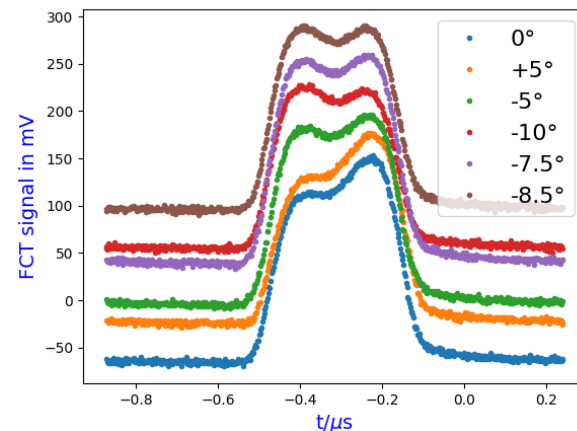
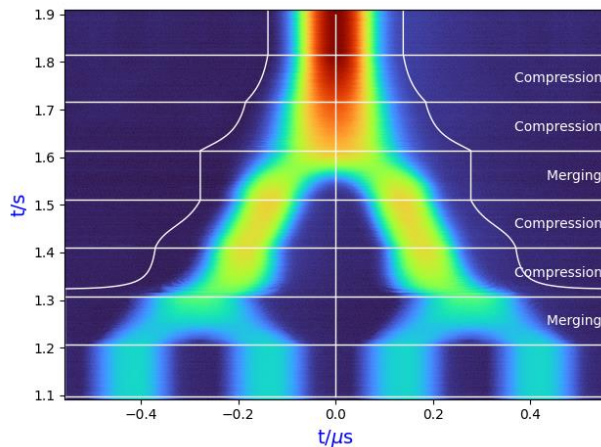


- Bunch merging ($h=4 \rightarrow h=2$) was analyzed online during the experiment for **manual** phase correction in ParamModi

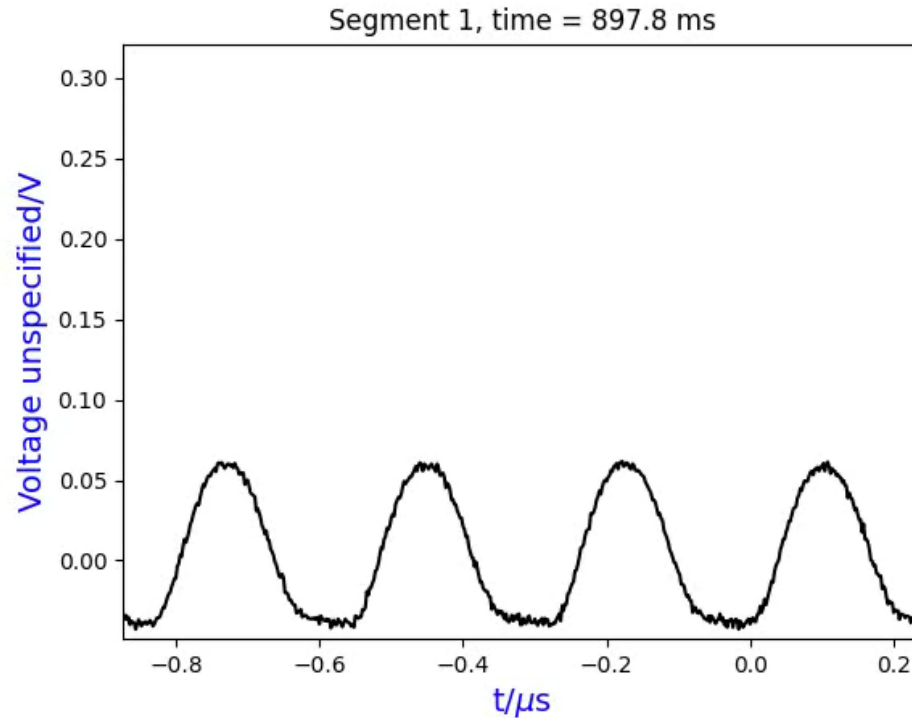
Theoretical phases



Optimum: -8.5° @ BE5 ($h=2$)



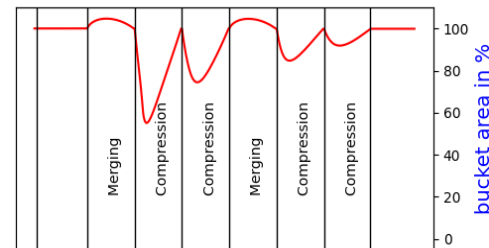
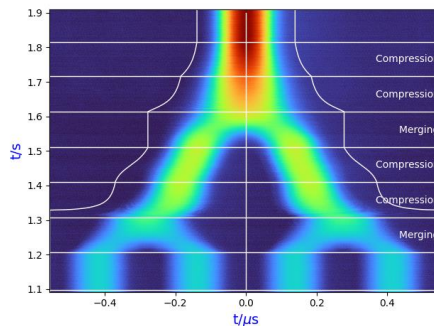
- Detailed evaluation also shows a small mismatch of BE3/4 ($h=3$)
- Result similar to earlier merging experiments. Further experiments needed!



Batch Compression Summary and Outlook

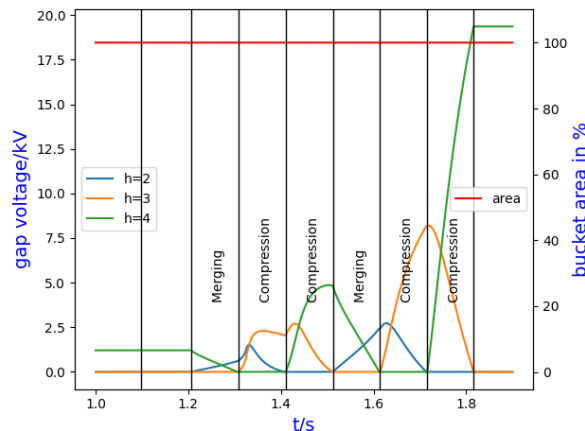
Summary

- First batch compression @ SIS18 successful on July 9th '25
- All ferrite and MA cavities worked well together



Outlook

- Investigation of remaining phase error @ different energies
- Various schemes for Batch Compression to be analyzed for SIS100 cycles

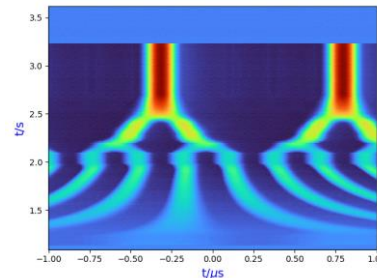


Thanks for your attention!

Special thanks to K. Grigoryev
for providing reliable planning and flexibility

Questions?

Known jitter for the EVT_START_CYCLE (#32):
→ 18.7 ms measured
Reduced by new “deterministic” scheduling?



Used measurements

- Slide 1: from slides 4 and 12
- Slide 3: all from '23 & '25 with correct spill length (trigger)
- Slide 4: as indicated on slide & 19 kV
- Slide 10: # 2
- Slide 11: # 33
- Slide 12: # 13, # 18, # 13-18
- Slide 13: # 33