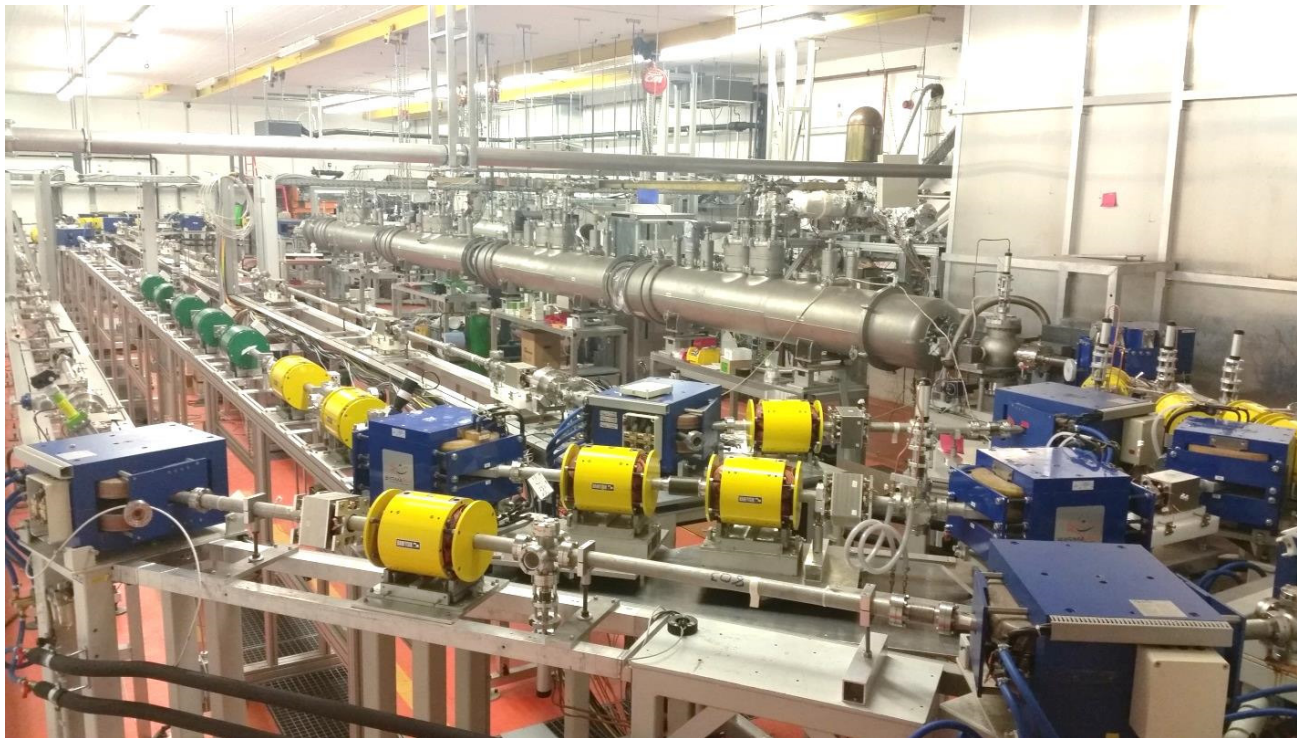


Investigations on Transverse Beam Break Up Using a Recirculated Electron Beam*



TECHNISCHE
UNIVERSITÄT
DARMSTADT

T. Kürzeder, M. Arnold, F. Hug, L. Jürgensen, J. Pforr, N. Pietralla



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Beam Break Up (BBU)

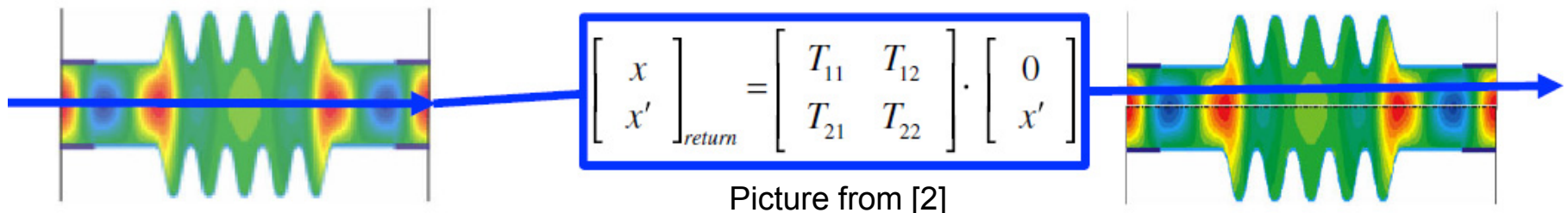
- Transverse beam break-up (BBU) occurs when an accelerated beam excites higher order dipole modes (HOM) in the superconducting accelerating cavities
- Some of these modes can have a high quality factor and thus a long lifetime and deflect the following bunches

- BBU threshold current:

$$I_{th} = \frac{2c^2}{e \cdot R_g \cdot Q \cdot \omega} \cdot \frac{1}{T_{12} \sin(\omega t_r)} \quad [1]$$

(for one cavity and recirculations and for the worst HOM)

- In recirculating design this can be even worse

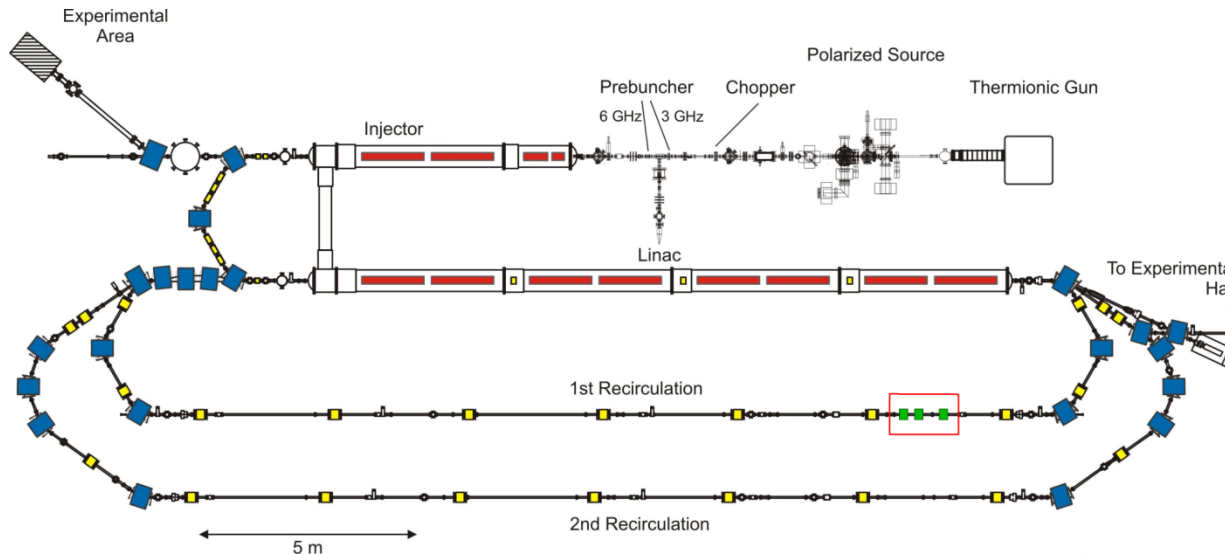


[1] G.H. Hoffstaetter, I.V. Bazarov, Phys. Rev. ST – AB **7**, 054401 (2004).

[2] V. Litvinenko, Phys. Rev. ST - AB **15**, 074401 (2012).

S-DALINAC

Superconducting DArmstadt LINear Accelerator



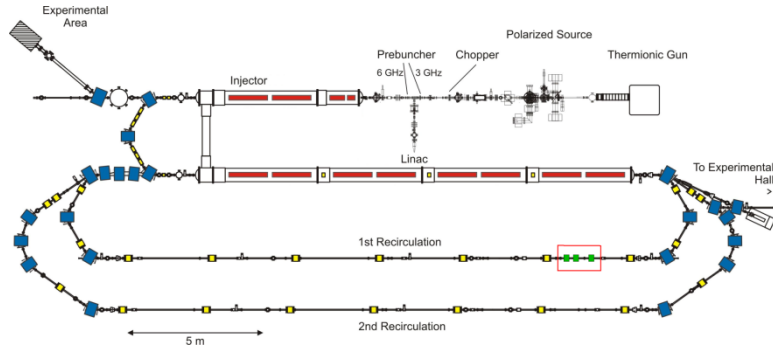
Design Parameters:

Max. Energy:	130 MeV
Beam Current:	20 μ A
Duty cycle:	cw
Frequency:	3 GHz
RF-power/cavity:	500 W



- Built in the 1980s
- First beam in 1987
- 1991 first recirculated beam
- Liquid helium @ 2 K
- Kryoplant: 100 W cooling power
- 12 SRF Cavities

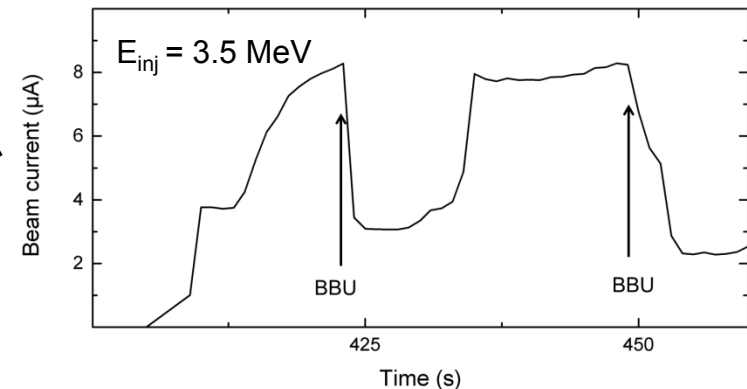
BBU Measurements



Mixing transverse phase space advance by rotating the dispersion plane by 45° using 3 skews



Exp. No.	1	2	3	4
E_{inj} (MeV)	5.8	5.8	3.5	3.5
E_{lin} (MeV)	23.2	23.2	14	14
LINAC passes	2	3	3	3
Skews used	no	no	no	yes
Max. current (μA)	10.7	7.5	5	8.2
BBU observed	no	yes	yes	yes



Conclusion

- The threshold current was lower than early estimates during the design phase of the accelerator [3]

E_{inj} (MeV)	3.5	5.8	10
Estimated I_{th} (μA) [3]	8.4	13.9	24
Measured I_{th} (μA)	5	7.5	-

- One reason might be different beam optics in the recirculations

[3] C. M. Lyneis *et. al.*, *Nucl. Instr. Meth.*, vol. 204, pp. 269-284, 1983.

Outlook

- Further analysis of existing data
- Improve diagnosis concerning BBU
- Investigate BBU with 3 recirculations
- Investigate BBU in single/double ERL mode
- Tests with 5 skew quadrupoles (reflector)

Match optics for highest I_{th}

