

WP3 summary

ESSNUSB/EuroNuNet meeting
Zagreb, October 21-24, 2019

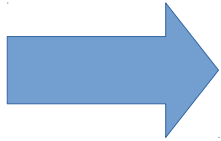
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Uppsala University

Technical issues to consider

- Kicker magnets for
 - Injection to the ring
 - Rise time of $< 100 \mu\text{s}$
 - Recharging time $\sim 0.7 \text{ ms}$
 - Extraction from the ring
 - Rise time of $< 0.1 \mu\text{s}$
 - Recharging time of $\sim 0.7 \text{ ms}$

Final Beam Emittance

- Space charge no longer a worry.
 - Small emittance beneficial for extraction and switchyard – and cost!
- With 60π mm mrad and optimized injection, foil hits from the circulating beam is not the biggest issue.



How small can we make the emittance before we encounter problems like excessive beam loss?

Recommended tune spread at 5 MW $\lesssim 0.05$

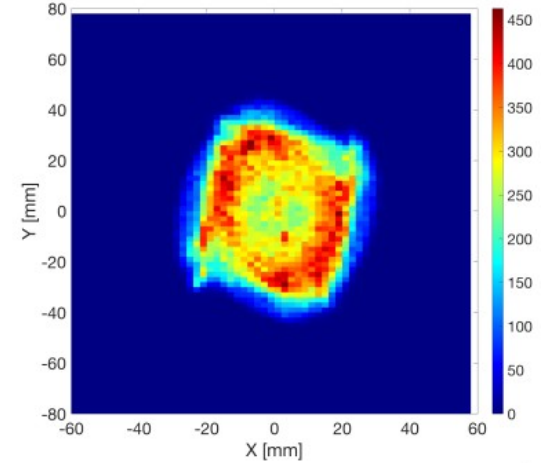
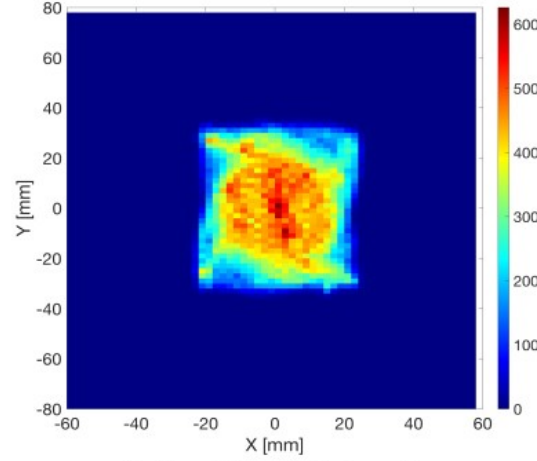
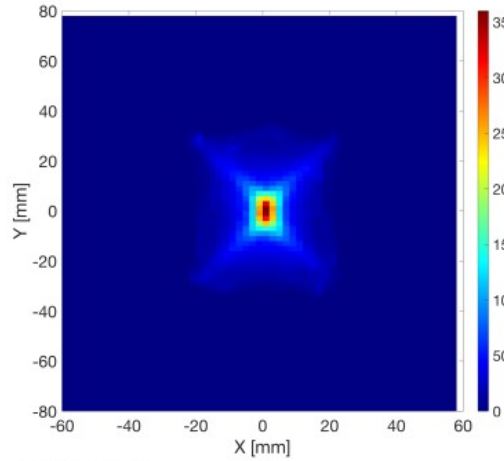
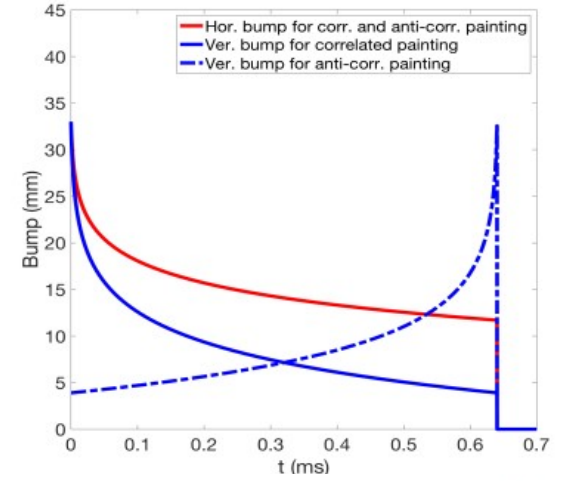
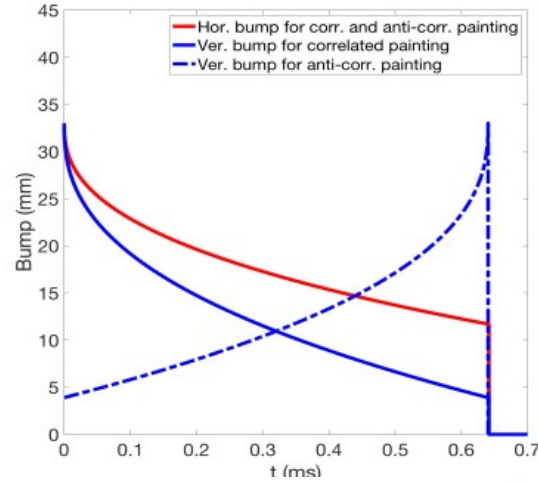
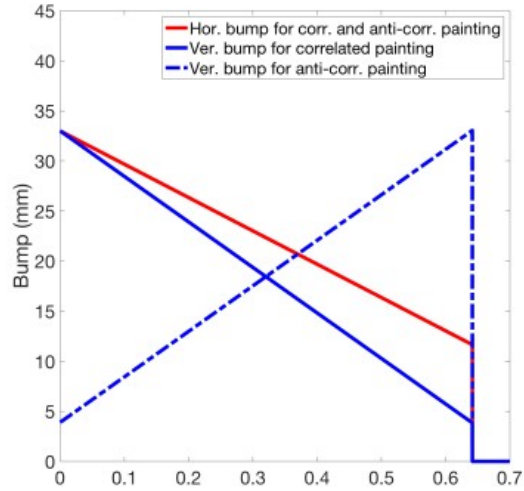
Emittance and acceptance

- Primary collimator acceptance determines max emittance out from the ring
- Once beam emittance has been set, we set the acceptance of the primary collimator.
- That give us the machine acceptance.

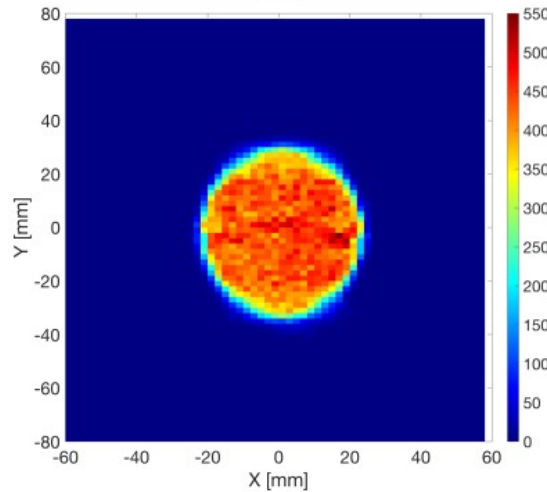
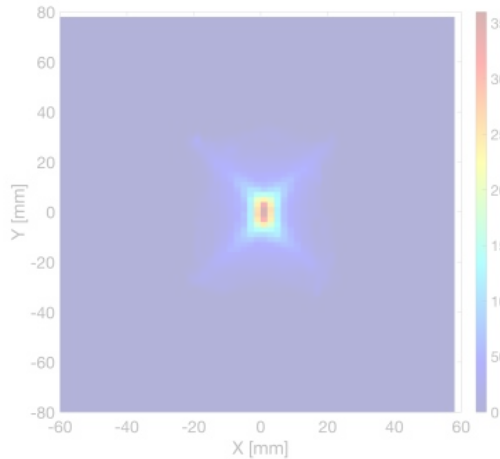
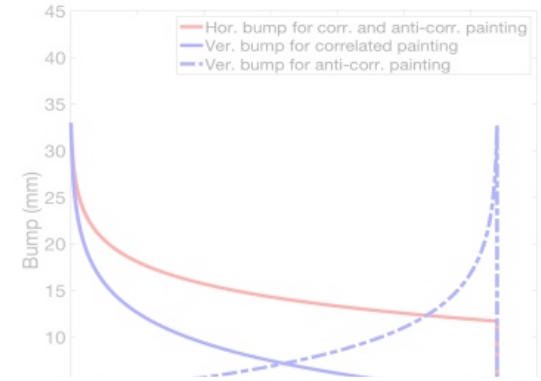
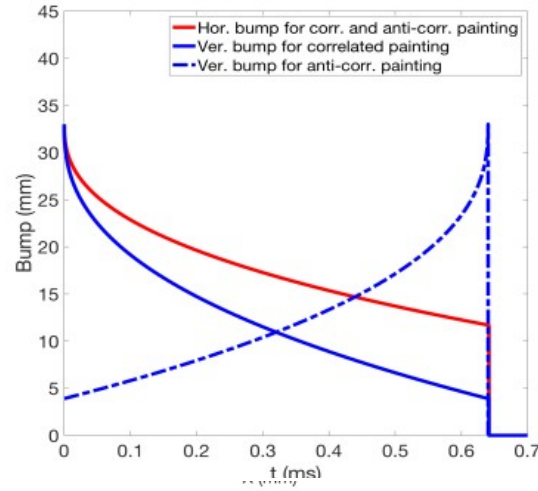
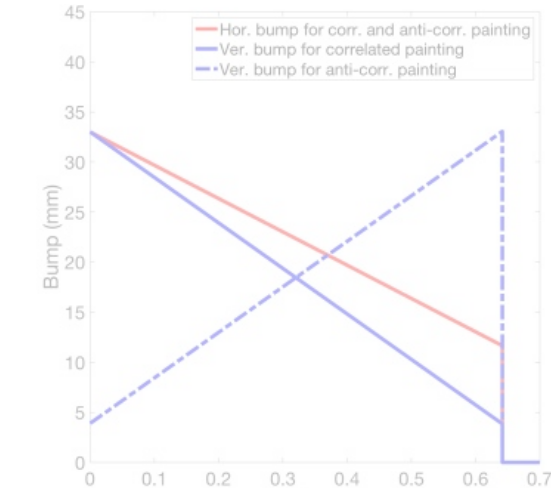
Longitudinal beam control

- Barrier RF seems very promising.
- Minimal additional energy spread.
- Can the very small energy spread become a problem?
 - Instabilities
- Estimation of this needed.

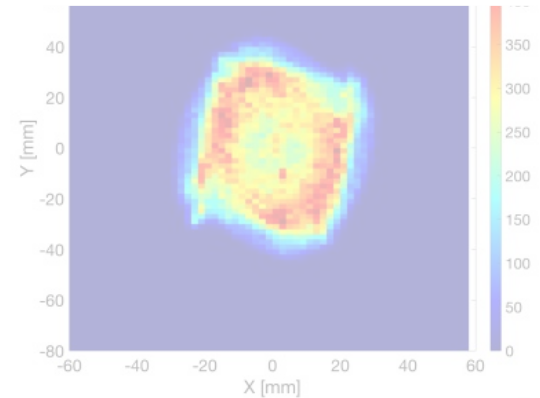
Injection painting optimization



Injection painting optimization



Anti-correlated painting gives a nice round beam with close to uniform distribution.



Foil Vs. laser stripping

- Confusing to have a baseline - which is not operational anywhere - while spending much effort on the alternative scheme.
- However, so far the alternative scheme, based on generally reliable technology, has not seemed feasible for our parameters, hence the current baseline.
- Change baseline now that we have a promising technical solution for foil stripping?
- Follow laser stripping progress more closely.
 - Higher ion energy is good: longer wavelength laser (700 nm?).
- Note: SNS planning for foil stripping for their upcoming power upgrade!
- “Simple” collimator just after injection needed in any case. Also system for safe disposal of stripped electrons.

Foil stripping

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S. Henderson et al. / Nuclear Instruments and Methods in Physics Research A 763 (2014) 610–673

- ESSnuSB injection largely copied from the SNS injection.
- Better put foil outside of magnet.
- Foil temperature and lifetime still a challenge.

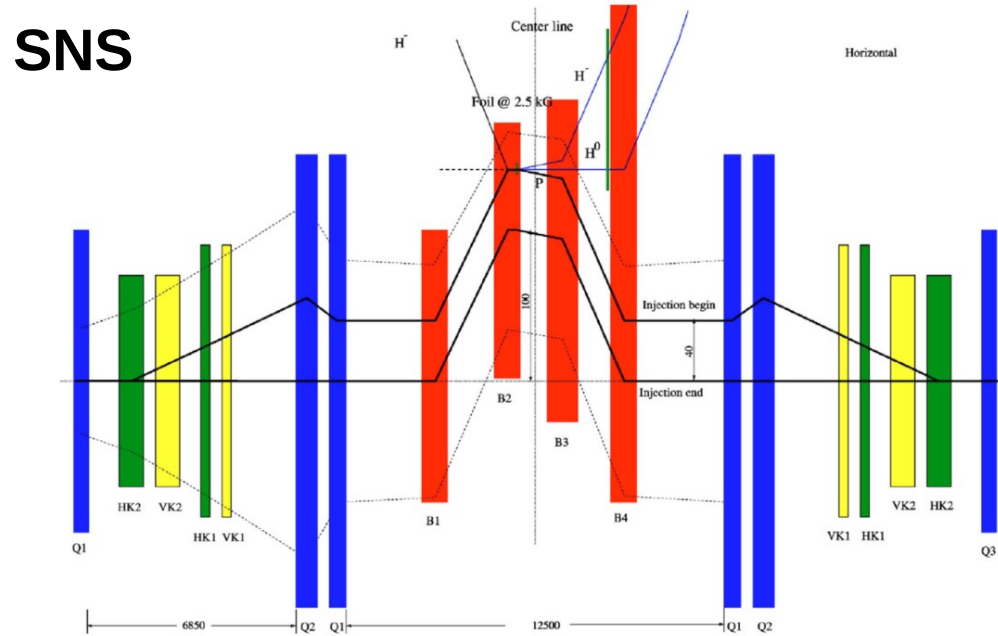
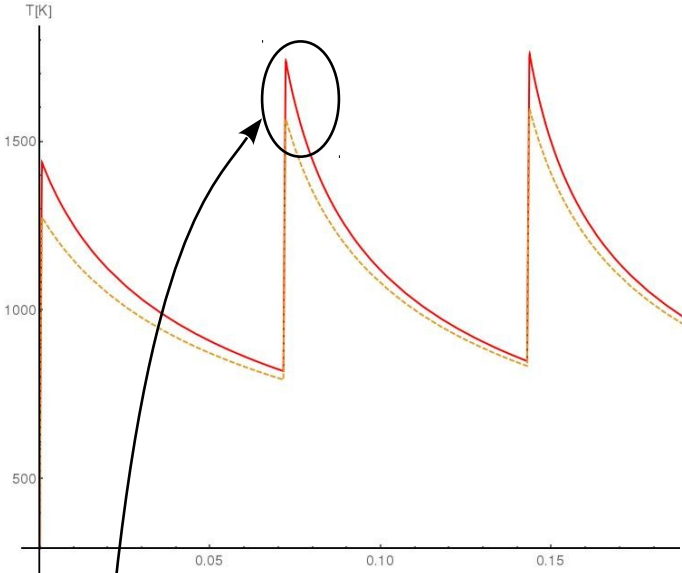


Fig. 87. Schematic layout of the horizontal plane of the beam injection region of the accumulator ring. Reprinted Figure with permission from Ref. [89] (<http://link.aps.org/abstract/RMP/v75/p1383>). Copyright 2003 by the American Physical Society.

Max foil temp. with a moving injection point

Peak Foil Temperature

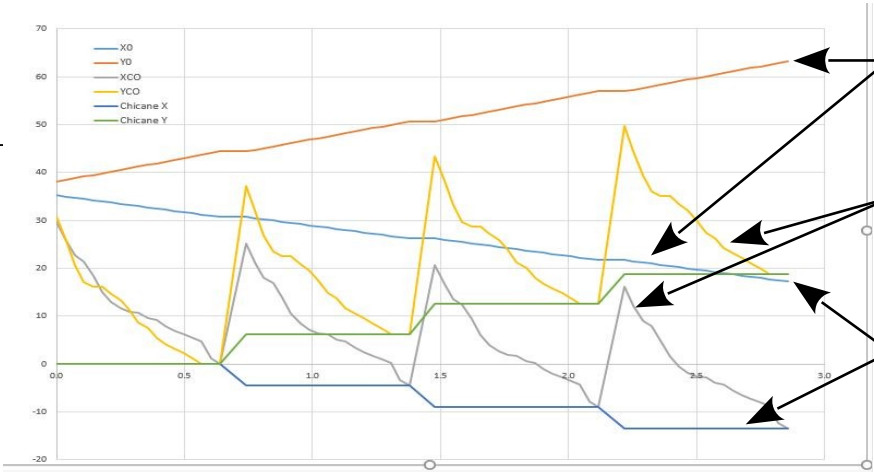


Linac + circulating beam
 $T_{\max} \lesssim 1800 \text{ K}$

Linac beam
 $T_{\max} = 1600 \text{ K}$

Limit is 2000 K

Each peak is from four batches

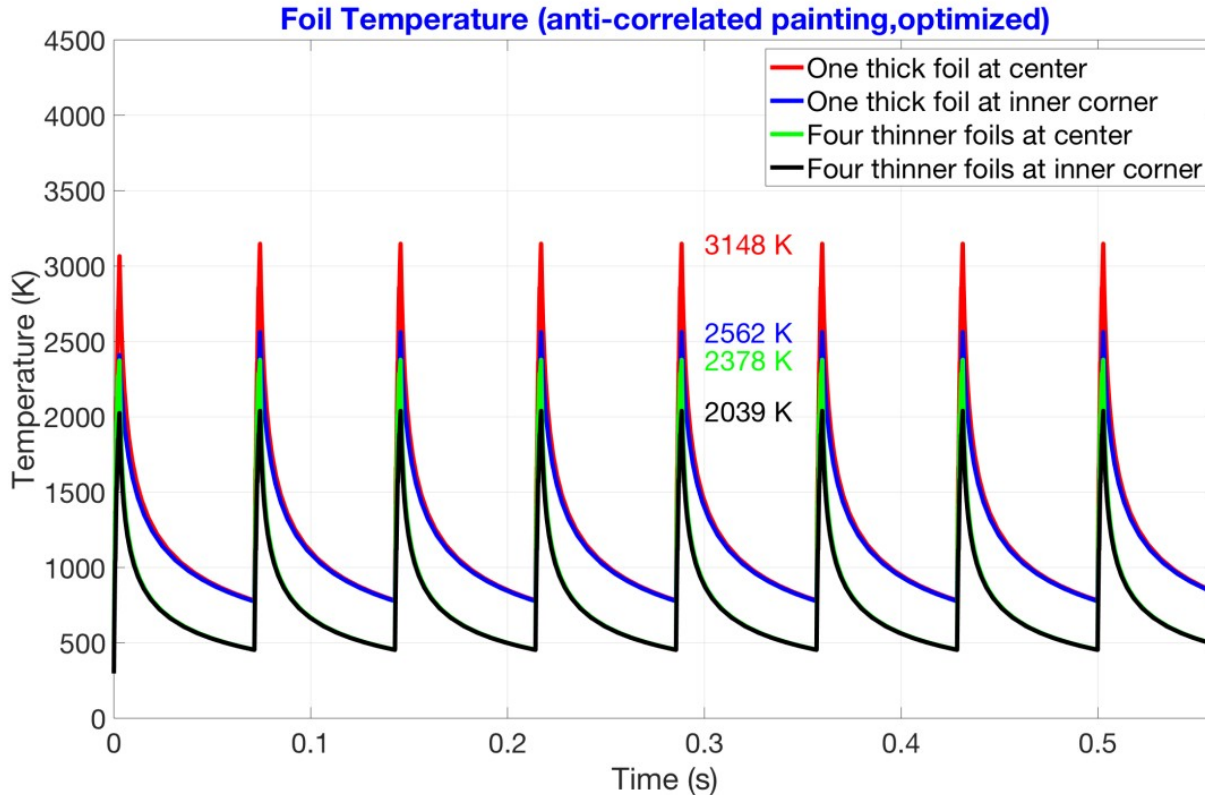
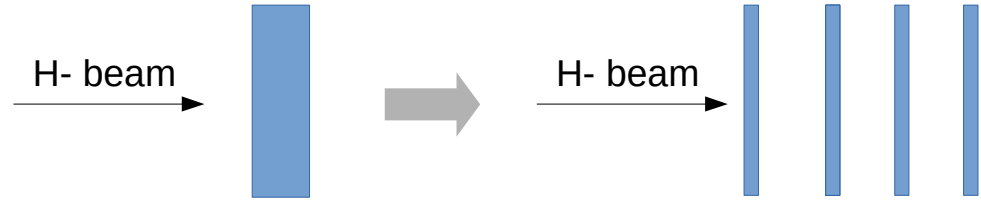


Injection point moving continuously

Painting bump

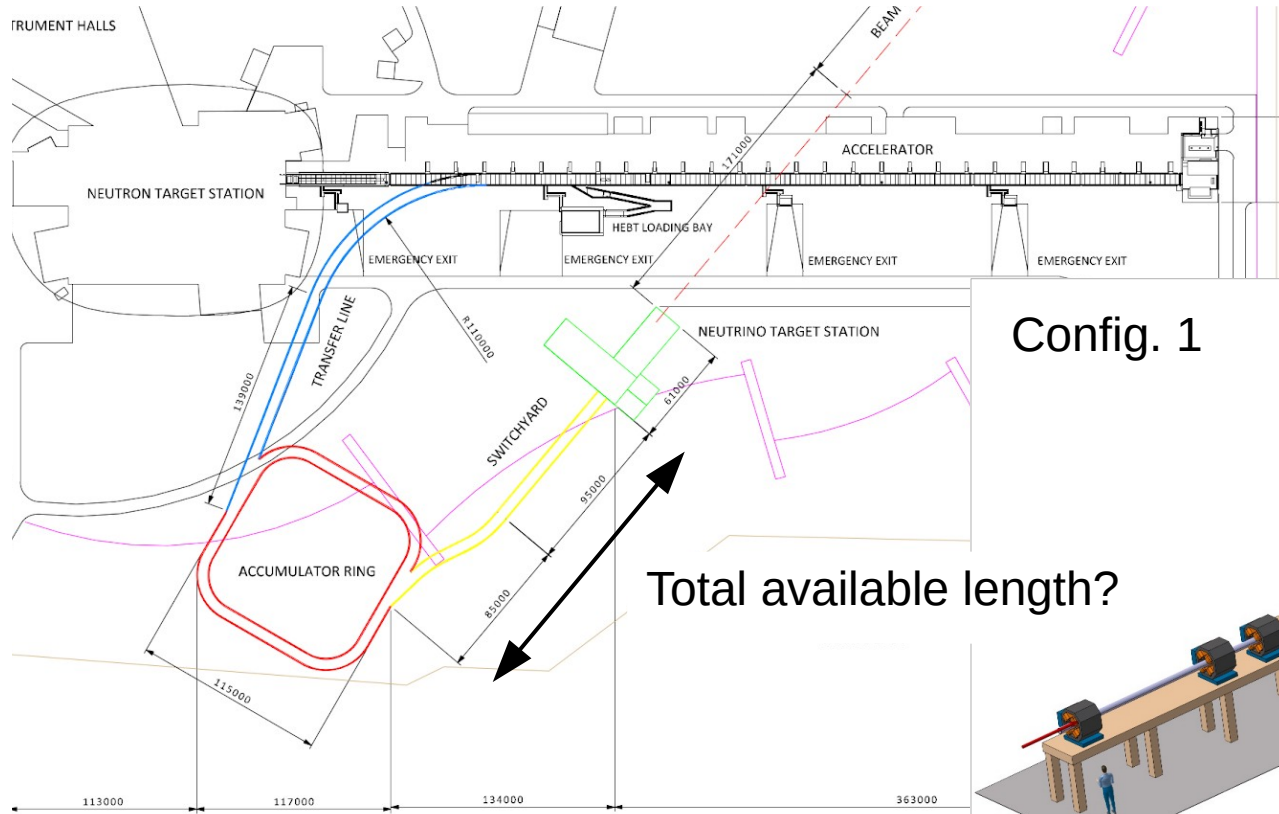
Orbit bump shifted in four steps

Several thinner foils



- Combined stripping efficiency of four thin foils?
- Thermal cross-talk between foils?
- Combine several thinner foils with moving injection point?
- Reduce peak temperature at center through mismatched injection.

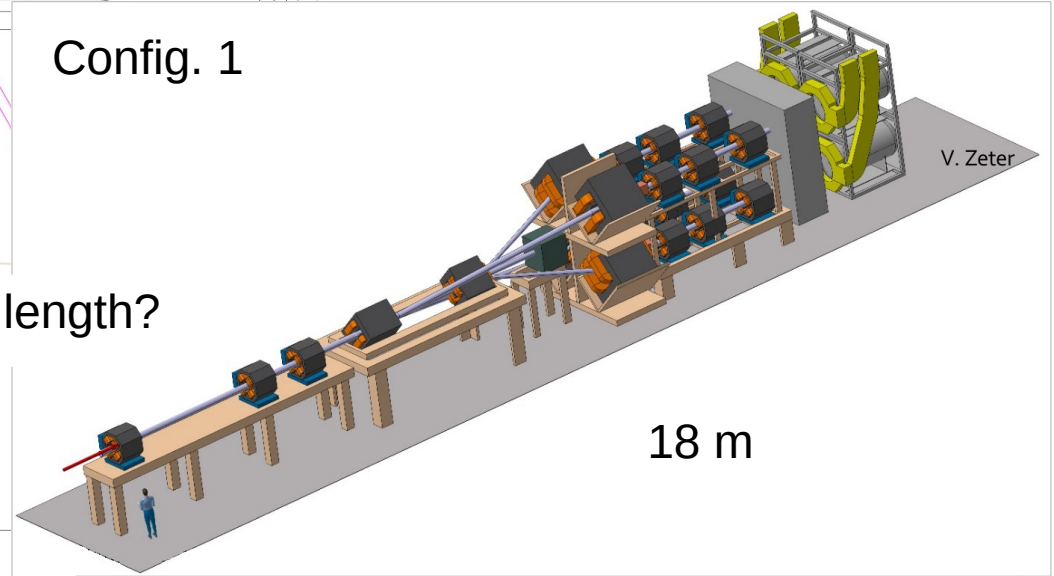
Layout and Switchyard



- Two configurations, designed for compactness (18 m/26 m).

Config. 1

Total available length?



Switchyard

- Two configurations, designed for compactness (18 m/26 m).
- Negligible beam loss with provided beam distribution.
- From square beam to round beam, better for the target (energy deposition).
- “Collimator” to be replaced by thick wall for access to last quadrupoles?
- Need solutions for failure scenarios.
- Very high field in the fast switching dipoles. Feasible?
 - Switch in steps with kicker

We must freeze the layout soon!

Thank you to everyone involved!