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essvb
ESS
NEUTRINO
SUPER BEAM



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European Union

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EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY



The ESSnuSB project: linac upgrade and accumulator design

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European Spallation Source



- First beam at reduced energy and power in 2023
- Full power 5 MW and energy 2 GeV in 2025



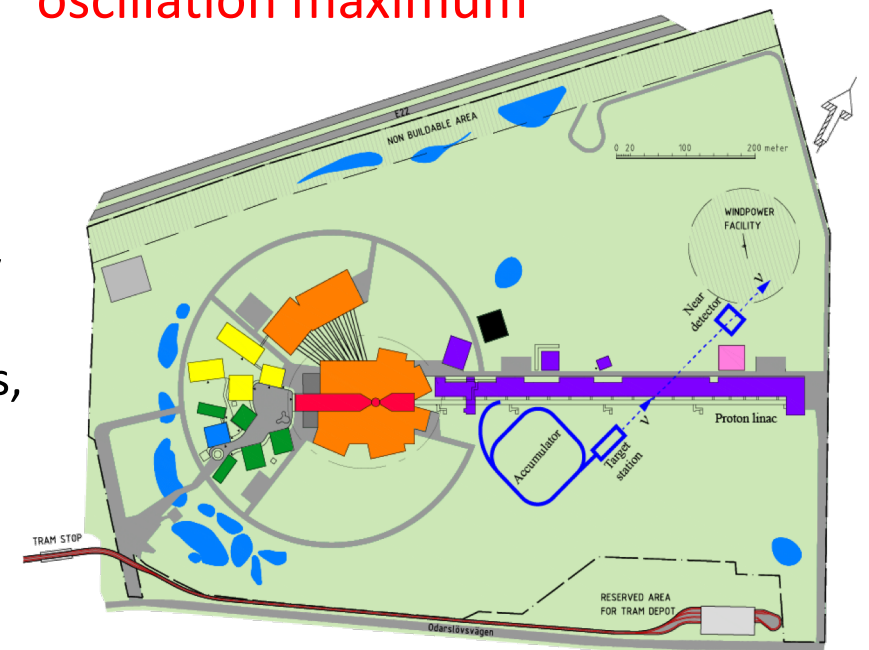
ESS neutrino Super Beam

Motivation

Due to the uniquely high power of the ESS linac, we will have the opportunity to measure with high precision the neutrino CP-violating angle at the 2nd oscillation maximum

How to add neutrino facility?

- The neutron program must not be affected
- Linac modifications: double the rate (14 Hz → 28 Hz), from 4% duty cycle to 8%, average beam power from 5 MW to 10 MW
- Accumulator needed to compress the 3 ms proton pulses to $\sim 1.5 \mu\text{s}$, affordable by the magnetic horn and needed for physics performance
- Neutrino target station (See more details in Loris D'Alessi's talk)
- Underground detector (See more details in Mariyan Bogomilov's talk)

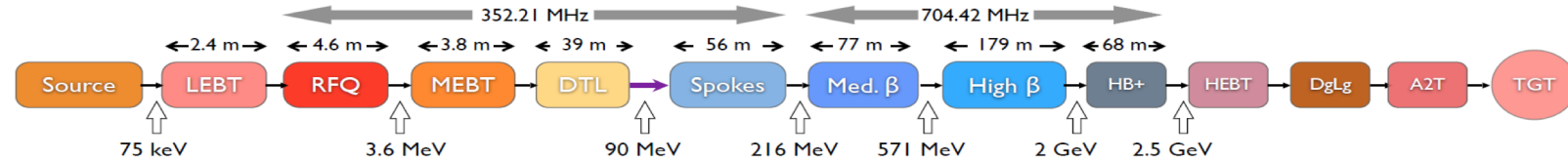


ESSnuSB public report at <https://essnusb.eu/DocDB/public/ShowDocument?docid=706>

ESSnuSB video film available at <https://youtu.be/PwzNzLQh-Dw>



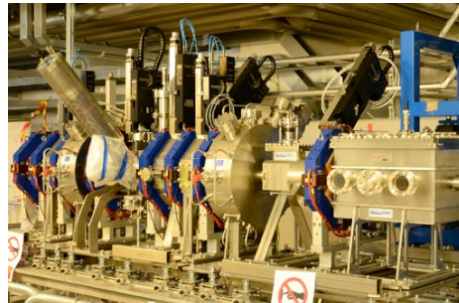
ESS proton linac and its upgrade for ESSnuSB



ESS linac status



RFQ installed in the tunnel



MEBT installed in the tunnel

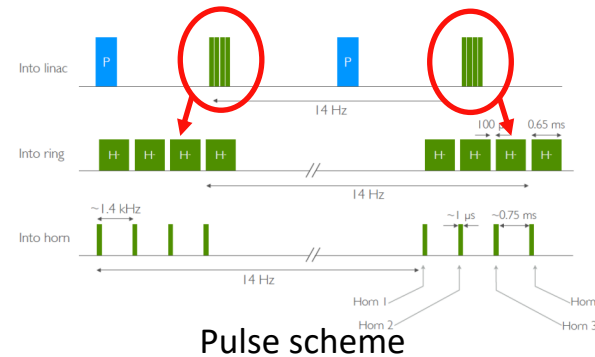


DTL assembled on site

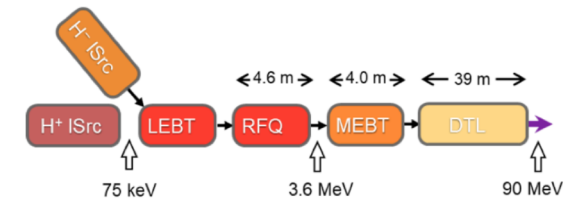


Spoke CM tested in FREIA

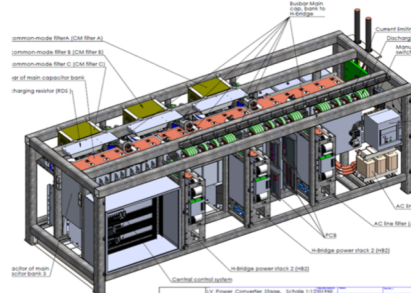
Upgrade for ESSnuSB (5 MW -> 10 MW)



Pulse scheme



H⁺ source added



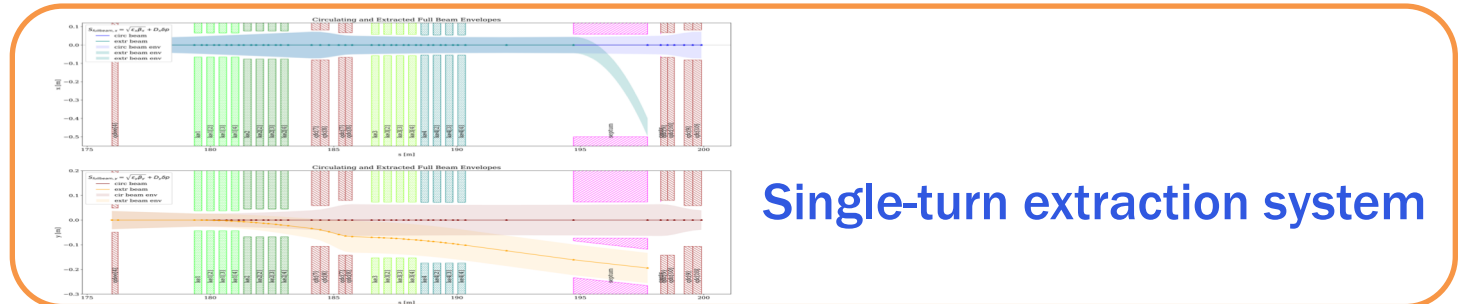
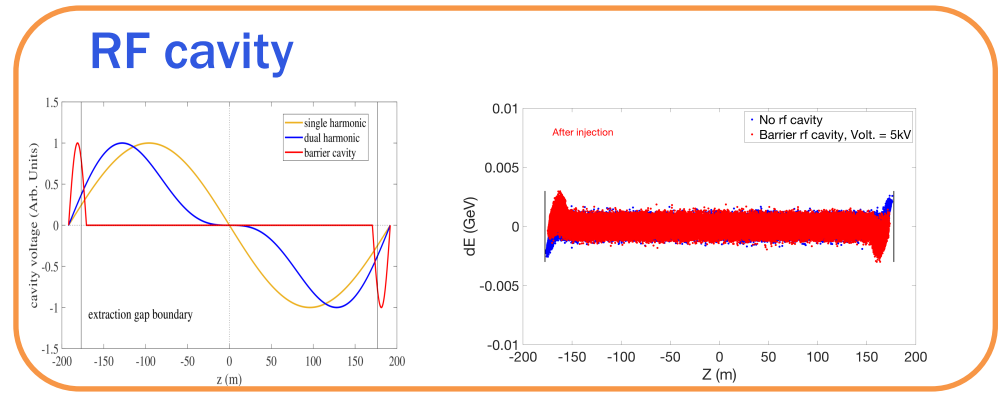
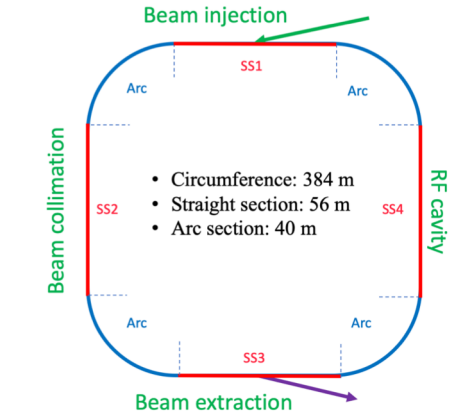
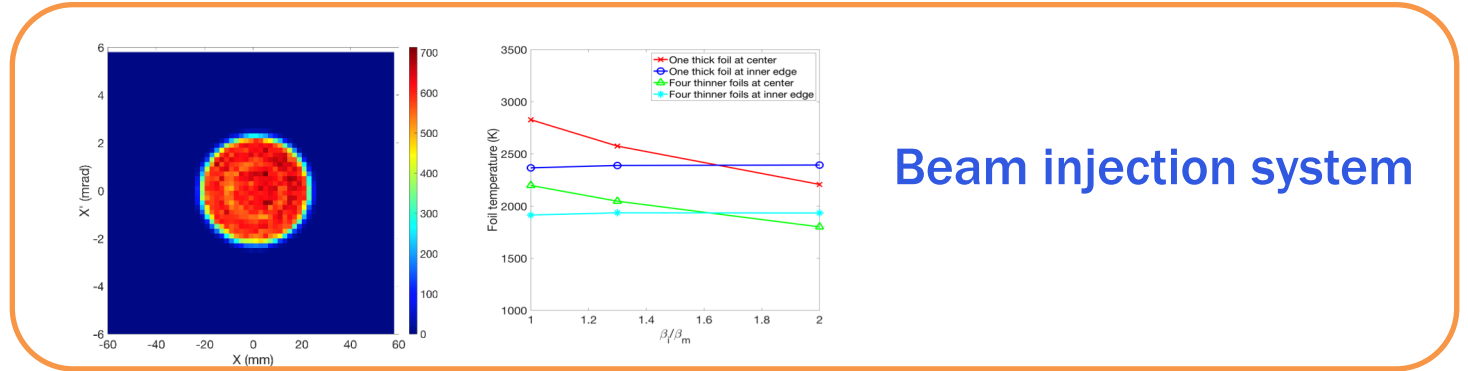
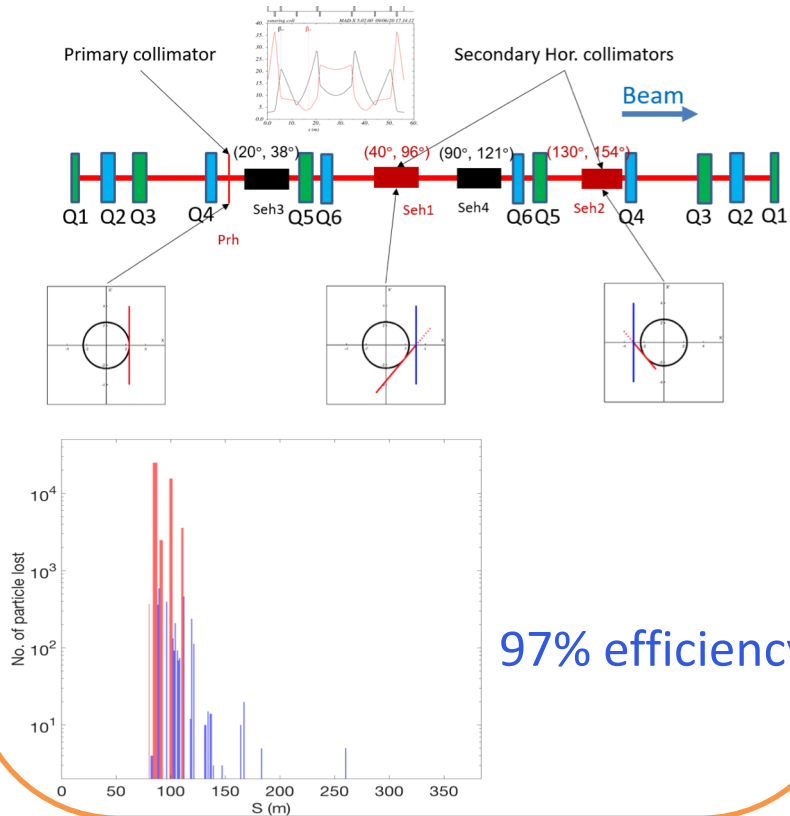
Modulator capacitor upgrade

Beam losses are the main concern for the linac upgrade.



Accumulator design

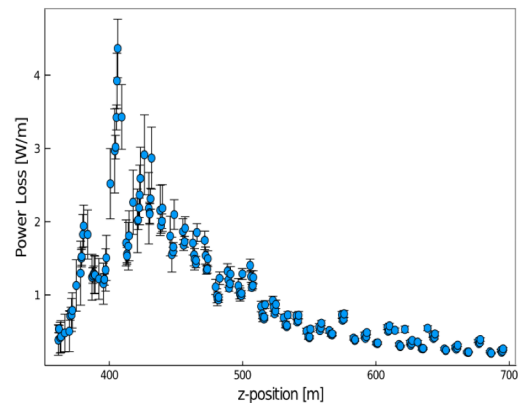
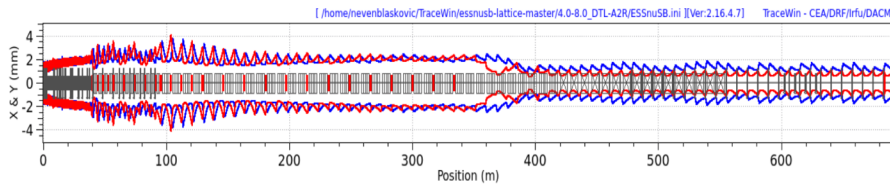
Beam collimation system





Transfer line and switchyard

Transfer line from Linac to Accumulator

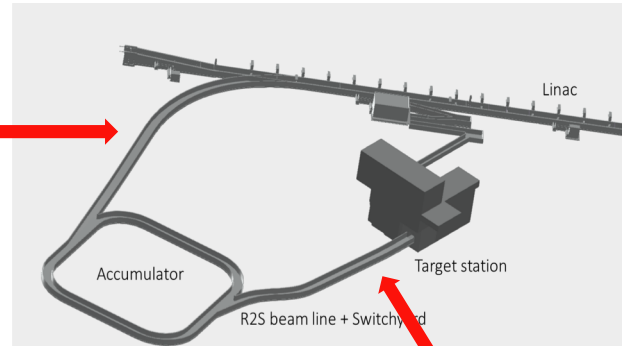


Intra-beam stripping

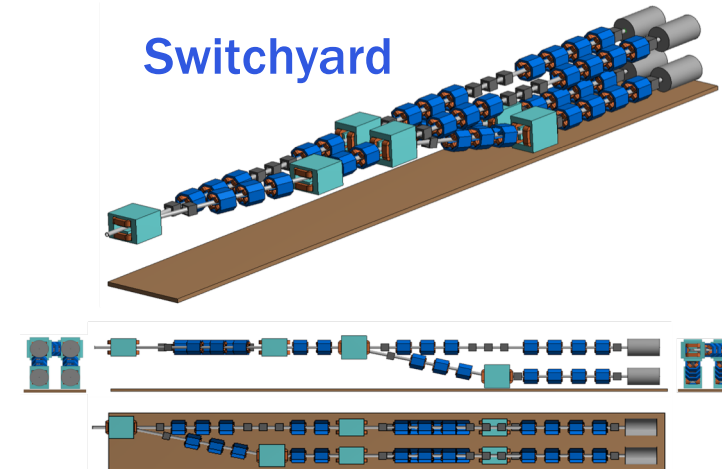
- Blackbody Radiation ~ 0.4 W/m
- Intra-beam stripping ~ 0.3 W/m
- Lorentz stripping ~ 0.29 W/m

Beam losses can be controlled both in the transfer lines and switchyard.

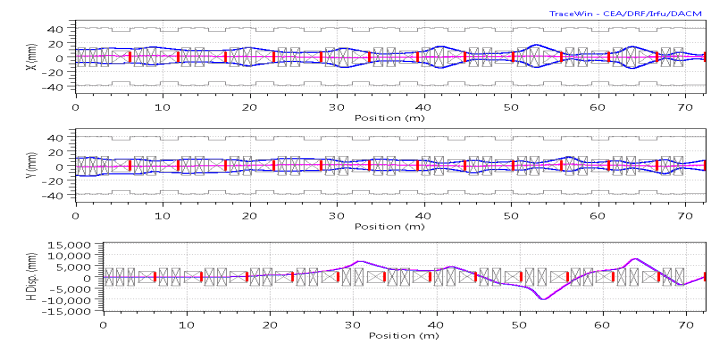
ESSnuSB Layout



Switchyard



Transfer line from accumulator to switchyard





Conclusions

- Beam loss, the main concern in the linac upgrade, can be controlled in the linac.
- Accumulator ring is designed and optimized, which can compress beam pulse for three orders of magnitude with very small space charge effect.
- Two transfer lines are designed and optimized, which can deliver beam pulses with very tiny beam losses.
- Switchyard is well designed, which can deliver pulse to each of the four targets almost without beam losses.

Thank you for your attention!