



Demonstrator Summary



Chris Rogers*, ISIS Neutron and Muon Source,
On behalf of the **international Muon Collider
Collaboration**

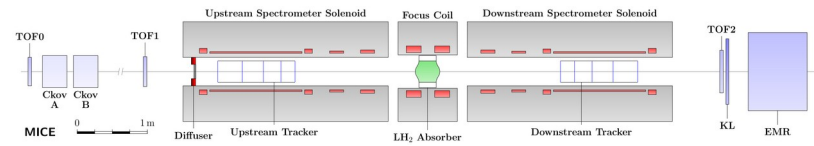
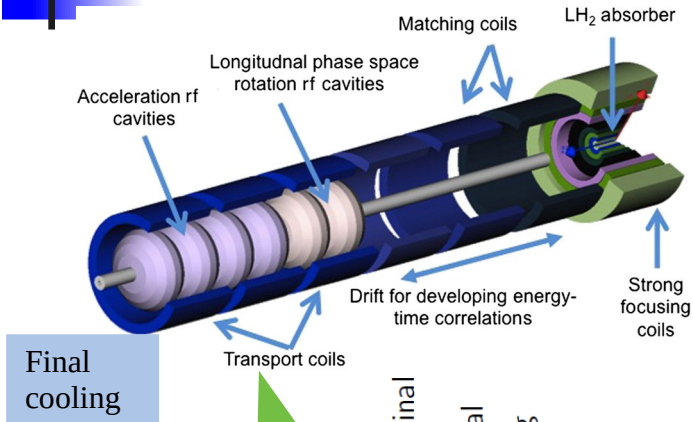
*chris.rogers@stfc.ac.uk



Science & Technology Facilities Council

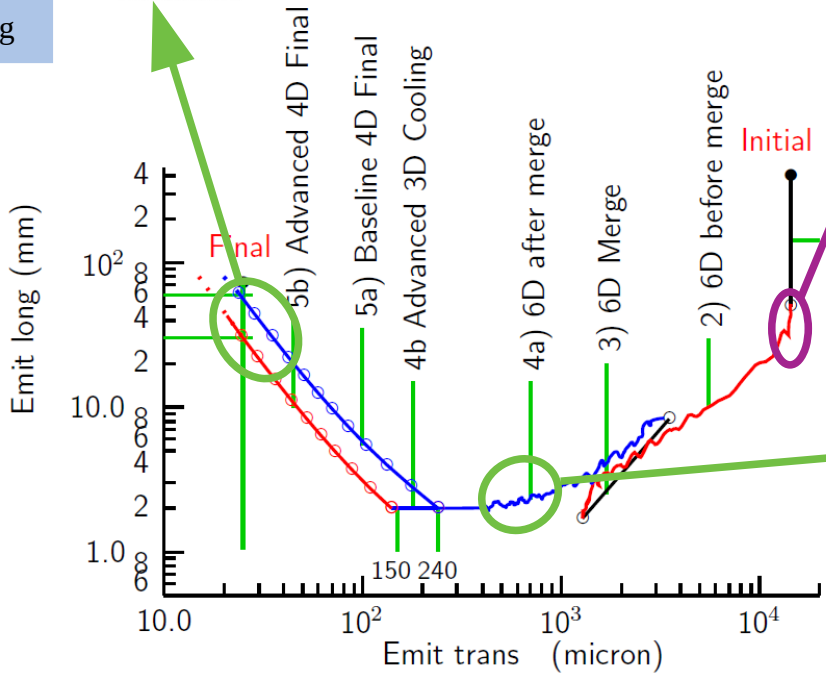
ISIS

Cooling for a Muon Collider (MAP)

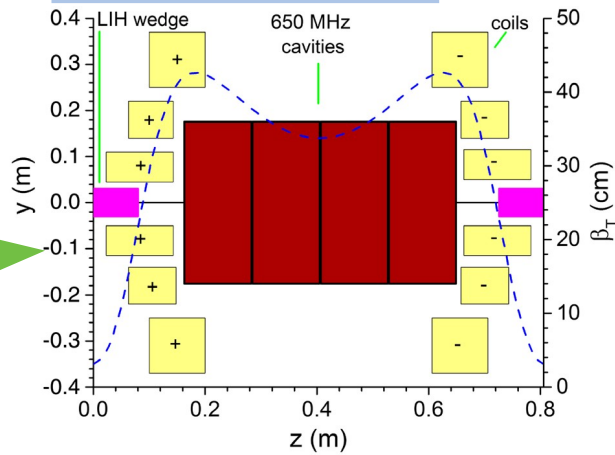


Final cooling

“MICE-like”



Rectilinear B (Stage B8)

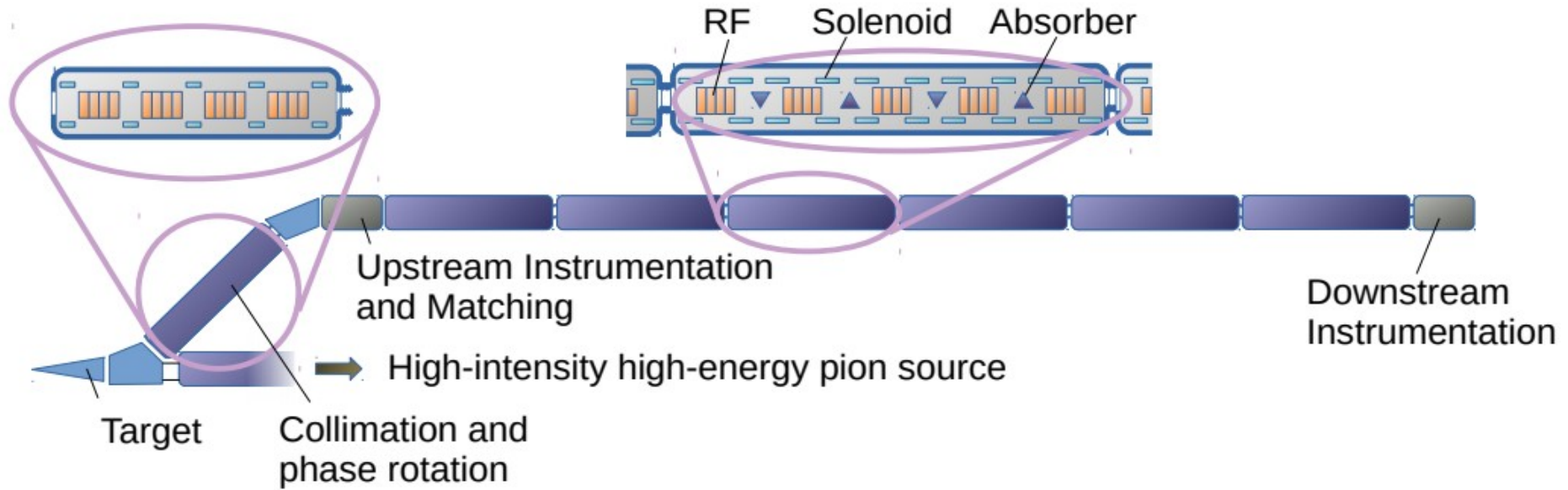


What needs to be done?

- Demonstrator
 - Larger emittance change
 - Longitudinal and transverse cooling
 - Multiple absorbers & chaining cooling cells
 - Reacceleration including RF
 - RF breakdown in magnetic fields
 - Commissioning and operation with bunched beam
 - Instrumentation requirements
- Intensity effects out of scope
 - Consider proton demonstrator

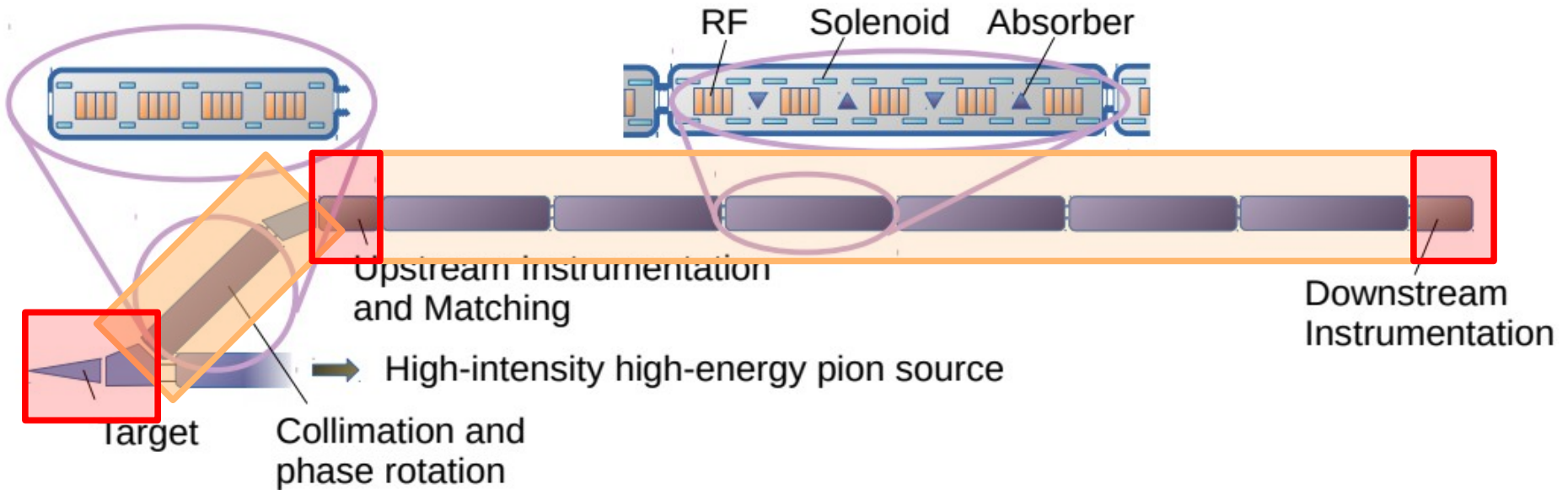


Layout



- Cooling system test Demonstrator
 - Produce pions on a target
 - Collimate + capture longitudinally
 - Characterise the incoming muons
 - Cool the muons
 - Characterise the outgoing muons

Layout



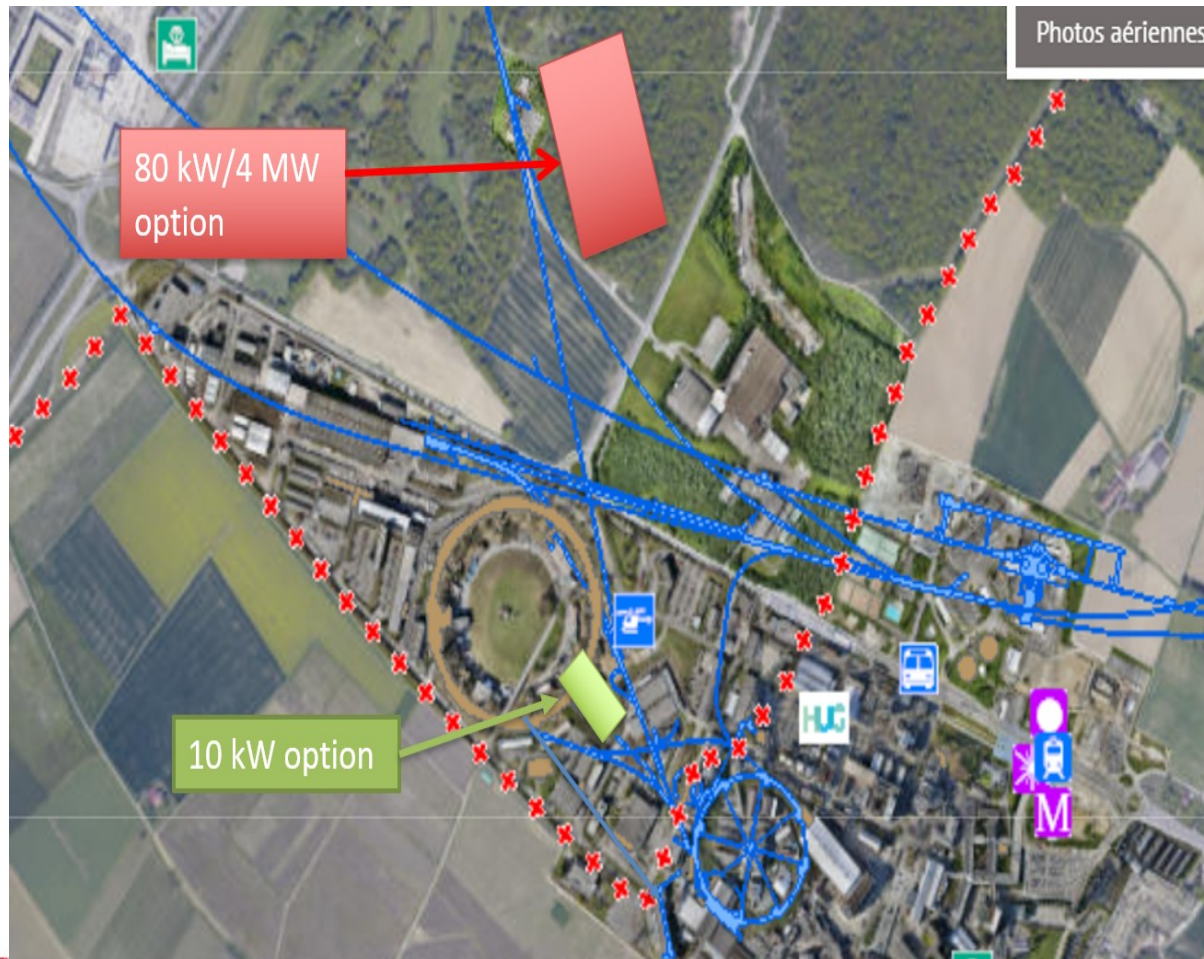
- Status
 - Preliminary physics design exists
 - No design exists



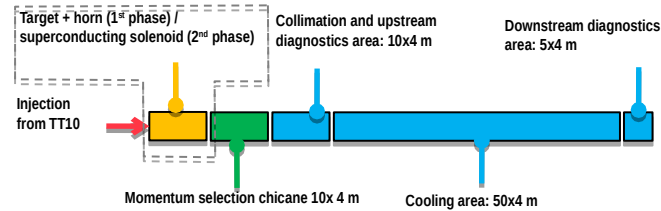
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Two main ideas / locations

- First ideas proposed by Marco C. in the 1st Community meeting. TT10 line option seen as most attractive ([Roberto L. presentation](#)).

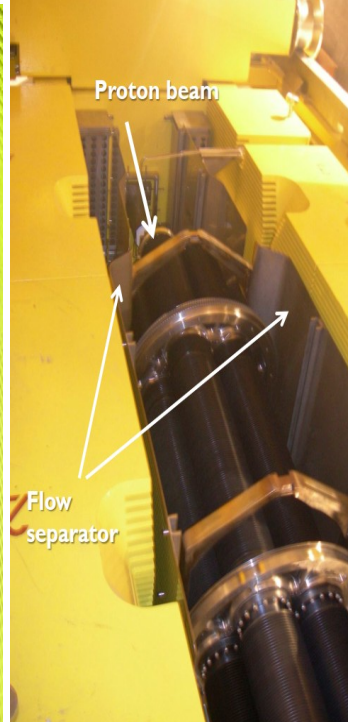
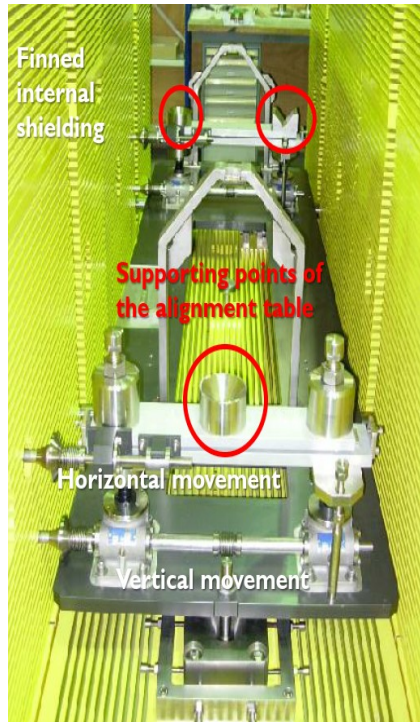


Layout ideas

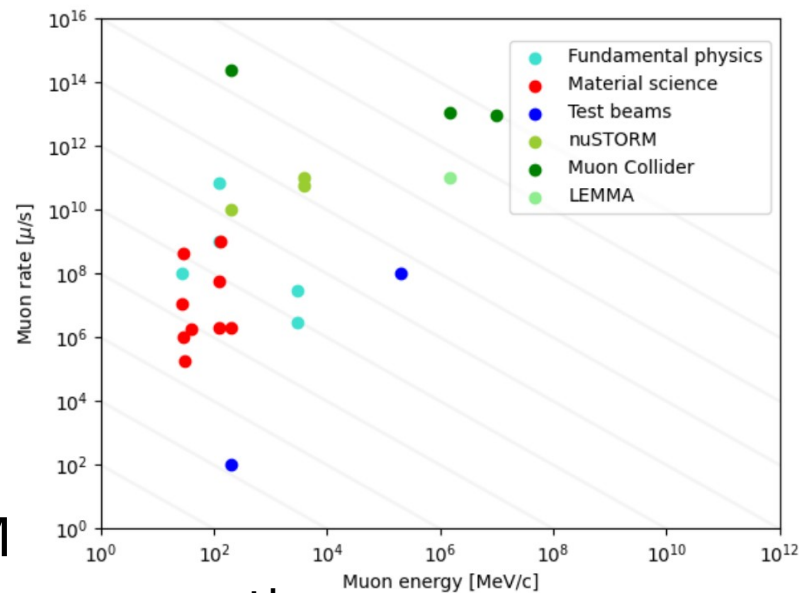
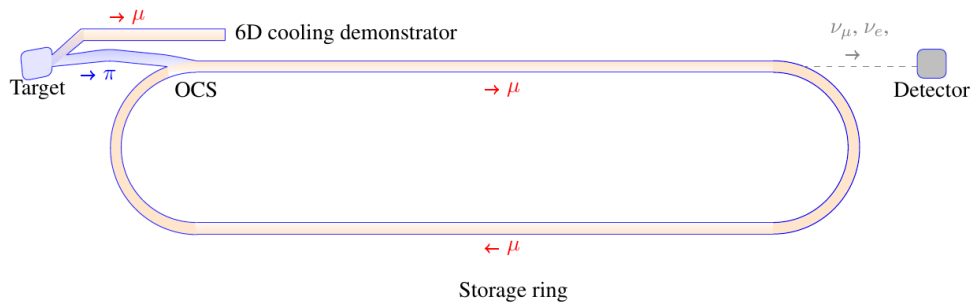


Target + Horn (and/or superconducting solenoid) - CNGS

- Vertical handling with longitudinal rail system
- Target sits on a alignment table controlled laterally from the outside of the shielding.
- Shielding with fins for cooling



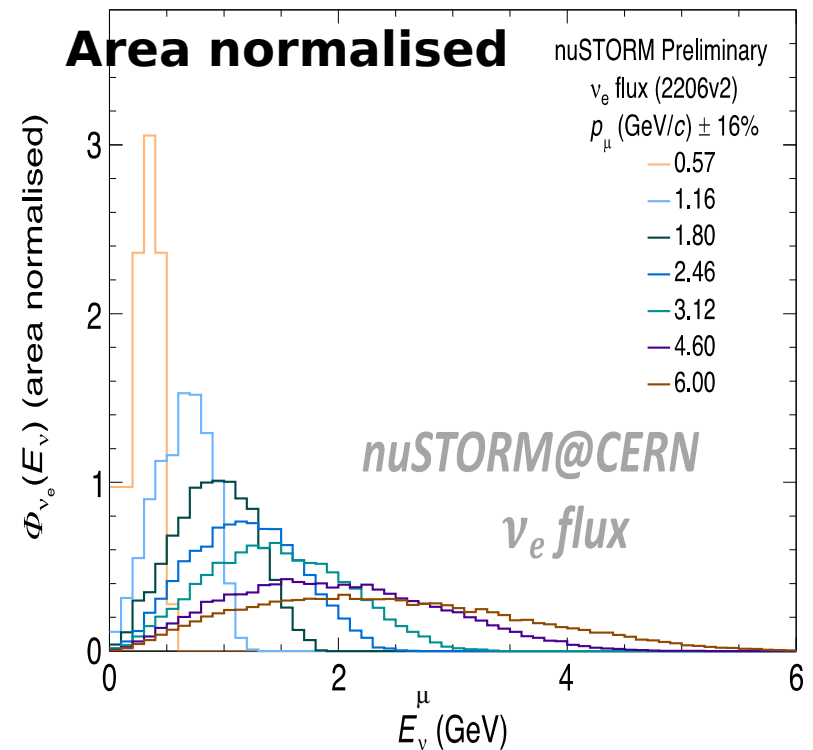
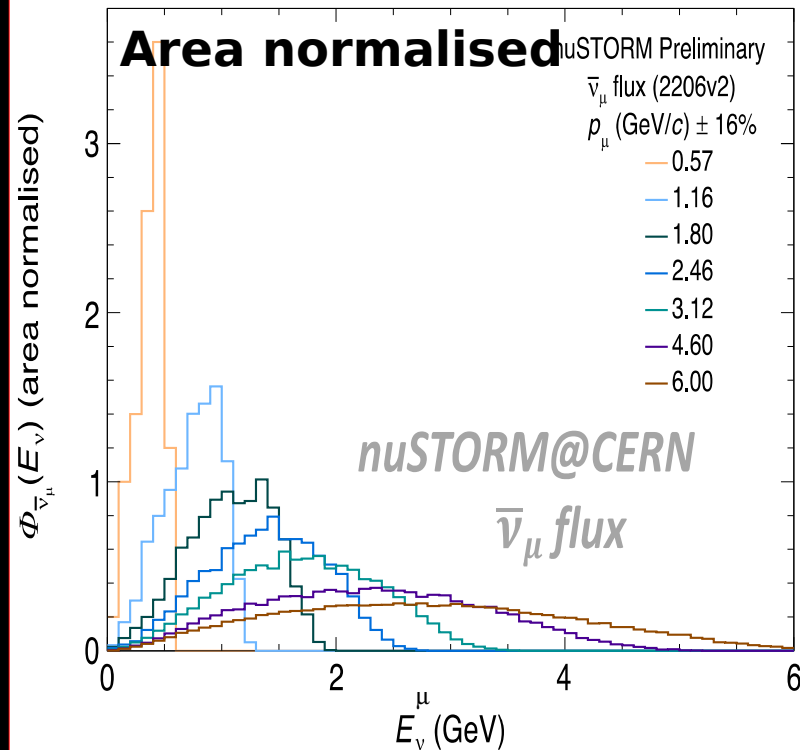
M.Calviani, Design, maintenance and operational aspects of the CNGS target, 4th HPTW,



- New site compatible with nuSTORM
 - Measurement of neutrino scattering cross sections
 - Beyond Standard Model physics programme
 - Muon beam test area for Demonstrator
- Demonstration of highest-current high-energy muon beam facility
 - Pion beam handling
 - Target concepts can be tested
 - FFA storage ring → rapid acceleration concepts

nuSTORM@CERN: flux estimation

nuSTORM, arXiv:2203.07545



- **Oscillation-relevant energy regime**
 - **Hyper-K: 0.6 GeV**
 - **DUNE: 2.4 GeV**
- **Set by stored-muon momentum**
- **Accelerator "tune" gives fine control**
 - **E.g. optimise flux shape (or spread) by adjusting the ring acceptance**

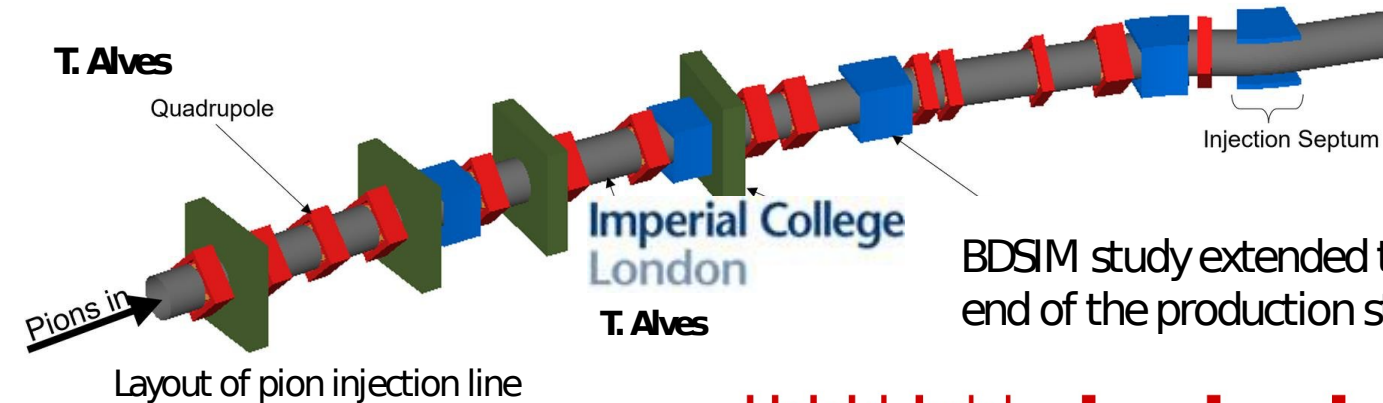
Unique opportunity:

- **E_ν -scan measurements**
- **Monoenergetic flux (ν_e !!) emulated by flux combination**
 - **Like PRISM, but with more degree of freedom in component shaping**

Alves, M. Pfaff nuSTORM@CERN: simulation model

Imperial College
London

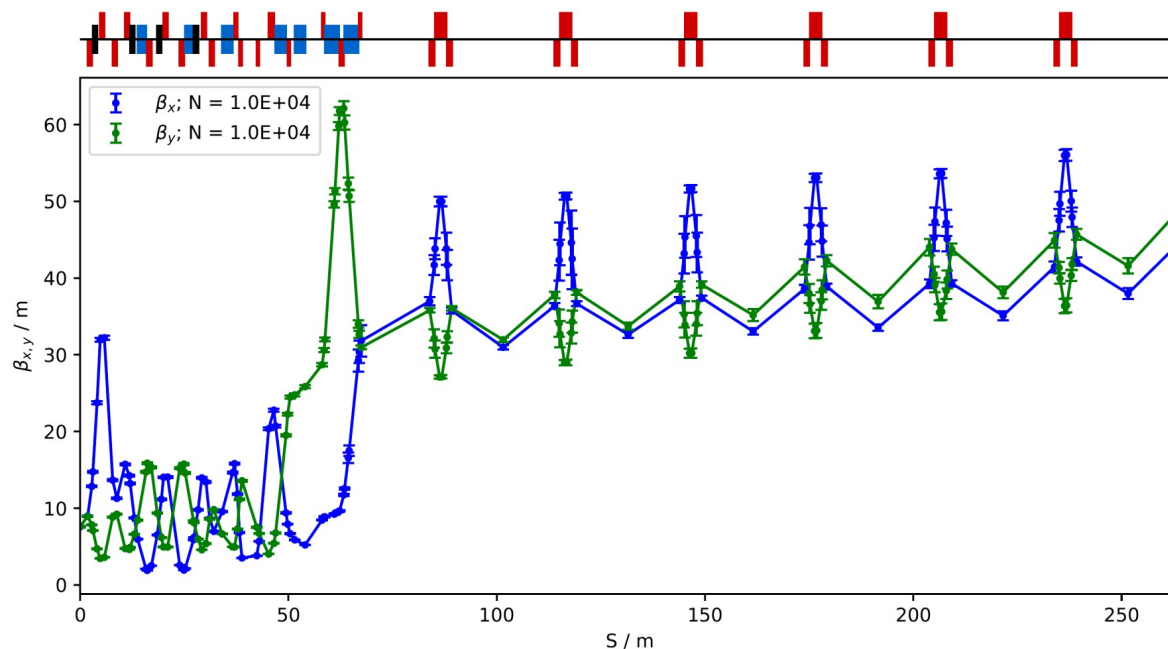
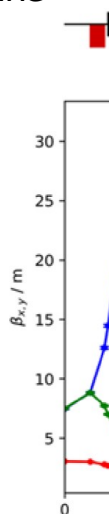
Pion beam line simulation in BDSIM



BDSIM study extended till the end of the production straight



Betatron functions and dispersion for pion beam from the horn until the injection point in the nuSTORM ring calculated by tracking in BDSIM



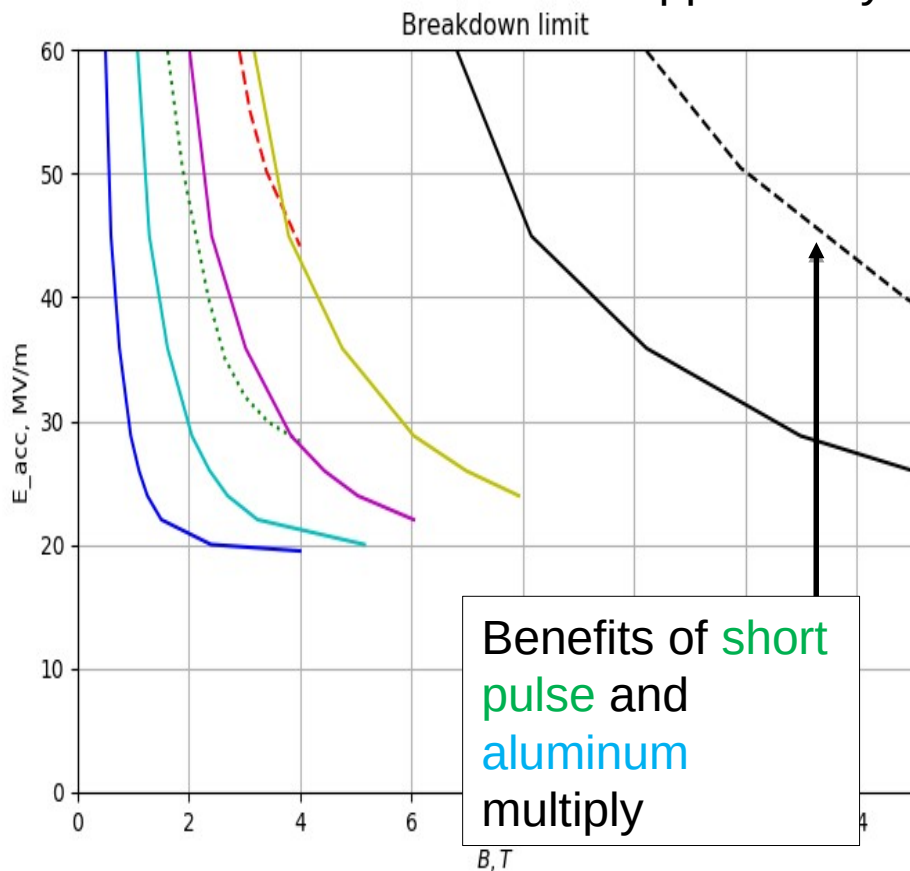
Betatron functions of pions from the horn until the end of the production straight in the nuSTORM ring calculated by tracking in BDSIM



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Comparing breakdown mitigation ideas

This plot is not intended to give absolute values for breakdown threshold, but only a feeling of which solutions can be more promising. We scale curves from MUCOOL cavity study (so the no-diffusion model applies only approximately)



- Cu 300K (Bowring 2020)
- ... Al 300K (Bowring 2020)
- - - Be 300K (Bowring 2020)
- Cu 77K (estimate)
- hard Cu allow (CuBe) (estimate)
- short pulse, Cu 300K (estimate)
- short pulse, Cu 77K (estimate)
- - - short pulse, alum (estimate)

Scaled from the first 3 curves using the scaling model (slide 6)

Aluminum cavity with a short pulse looks very promising



Conclusions

- A lot to do
- Critical path for muon collider
- Rough plan:
 - RF Physics Tests at labs e.g. CEA, Daresbury
 - Test module facility @ CERN
 - Test module → Demonstrator staging facility
- Need to look at
 - Instrumentation
 - Engineering integration