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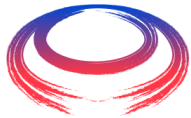
Conceptual layout of the MUC Test Facility

2nd Muon Community Meeting, 12-14 July 2021



by Rui FRANQUEIRA XIMENES*
CERN – Systems Department
Sources Targets Interaction (STI)
Targets Collimators Dumps (TCD)

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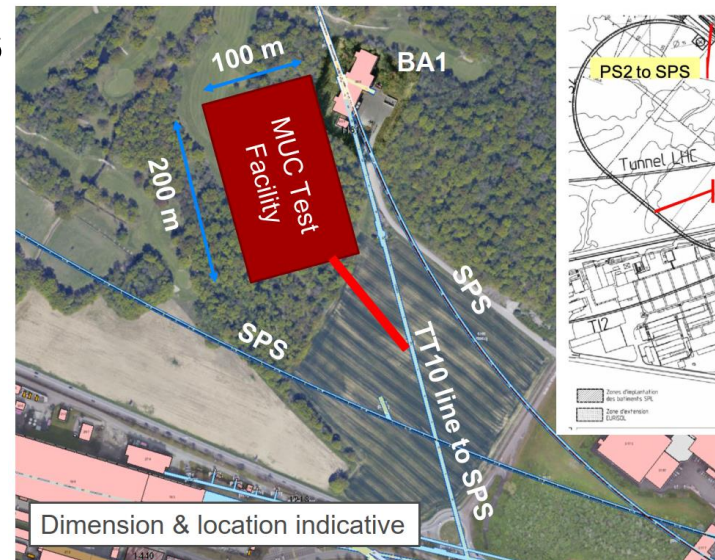


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TT10 line option (recap)



- First ideas proposed by Marco C. in the 1st Community meeting. **TT10 line option seen as most attractive** (Roberto L. presentation).
 - O(80kW) should be easily feasible by going sufficiently underground.
 - 4 MW does not appear to be a showstopper in this layout, but detailed studies will have to be performed.
 - Future upgrades towards a collider and HP-SPL should be compatible with this layout.
 - **Experience** with other facilities available
 - Important to collect all **requirements** at this stage in order to be able to provide a first cost estimate by end of 2021 as requested by the study



Layout

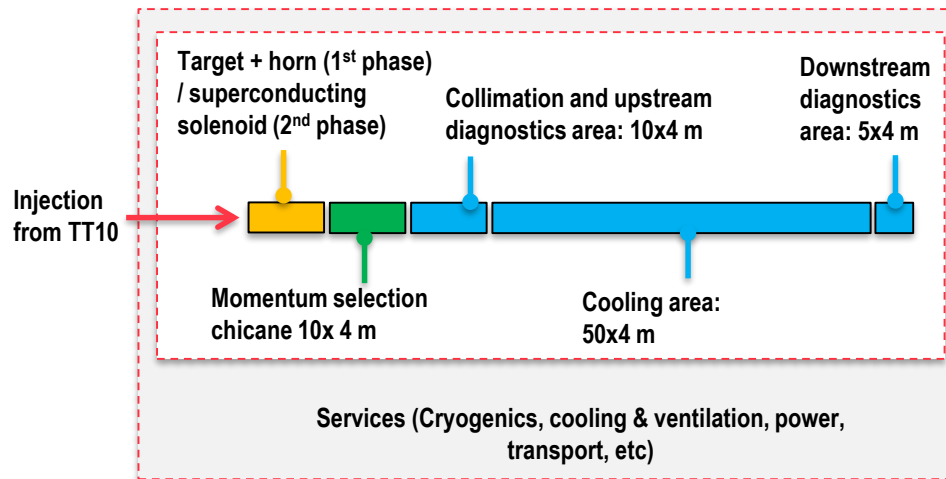
Layout components of the Demonstrator:

- Target & Horn (first stage) and potentially superconducting solenoid at a later stage
- Momentum selection chicane
- Collimation & diagnostics area
- Muon Cooling area
- Downstream diagnostics area

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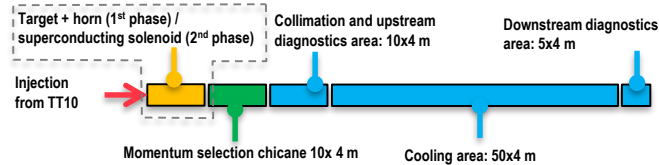
- Service areas (Cooling & ventilation, cryogenics, power, transport, etc...)
- Radioactive storage
- *Branch to other experiments ?*

... other??



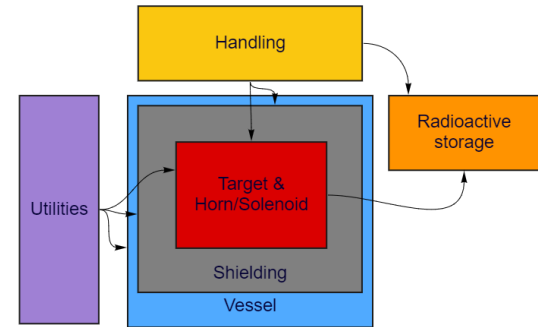
*Indicative dimensions by C. Rogers

Layout ideas

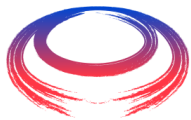


Target + Horn (and/or superconducting solenoid)

- Target + Horn length (O) 5 m. (*What volume with solenoid?*)
 - Cooling (Target + Horn) and power (Horn) supplies required
 - High activation / radiation levels (specially for 4 MW case):
- ↓
- Service rooms for power & Cooling Ventilation
 - Shielding (& space for it)
 - Vessel
 - Handling solutions.
 - Radioactive storage in the surrounding area
 - Access from surface

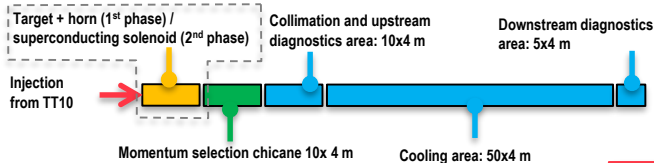


All of these set requirements for the layout

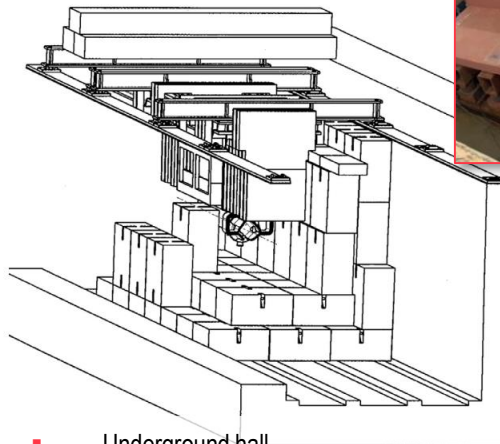


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Layout ideas



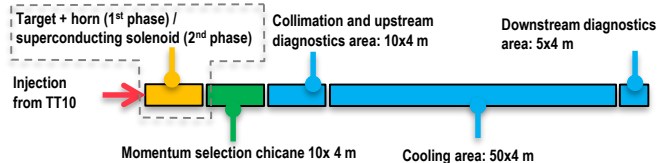
Target + Horn (and/or superconducting solenoid) - NuMI @ FNAL



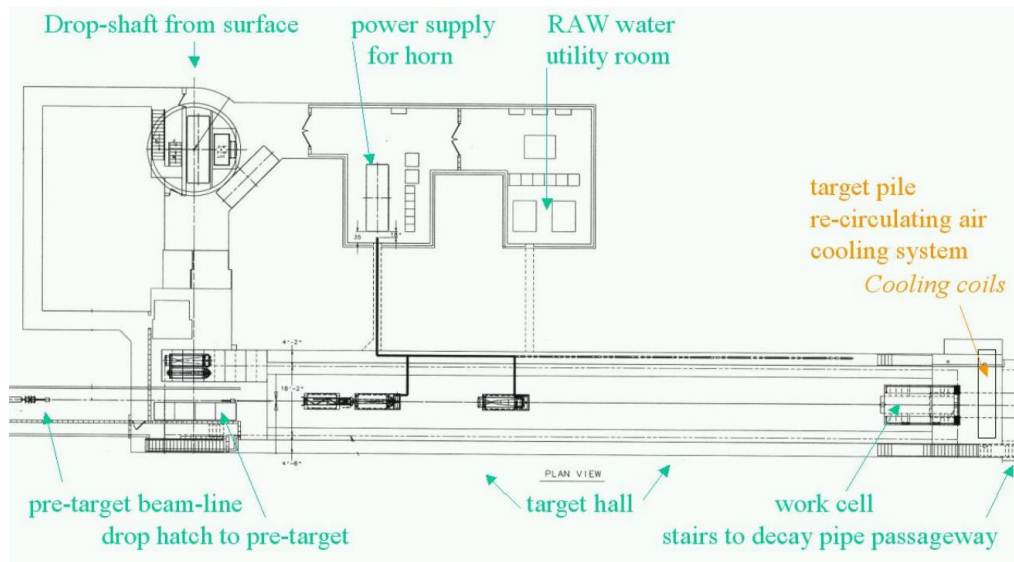
- Underground hall
- Vertical Handling
- Equipment by modules
- Module is a suspended frame w/ equipment + shielding + utilities connections

Yun He, NuMI Neutrino Beam Operations and Megawatt Upgrade, NUFAC2019

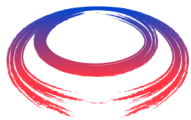
Layout ideas



Target + Horn (and/or superconducting solenoid) - NuMI @ FNAL

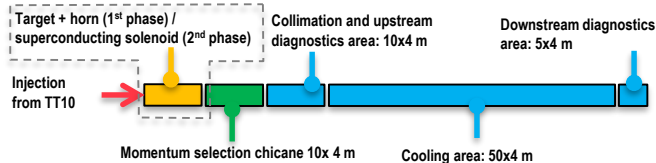


- Utilities room on a separate gallery parallel to the beamline
- Shielding between beam line access shaft

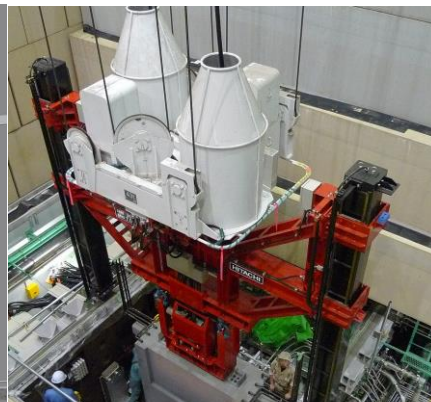
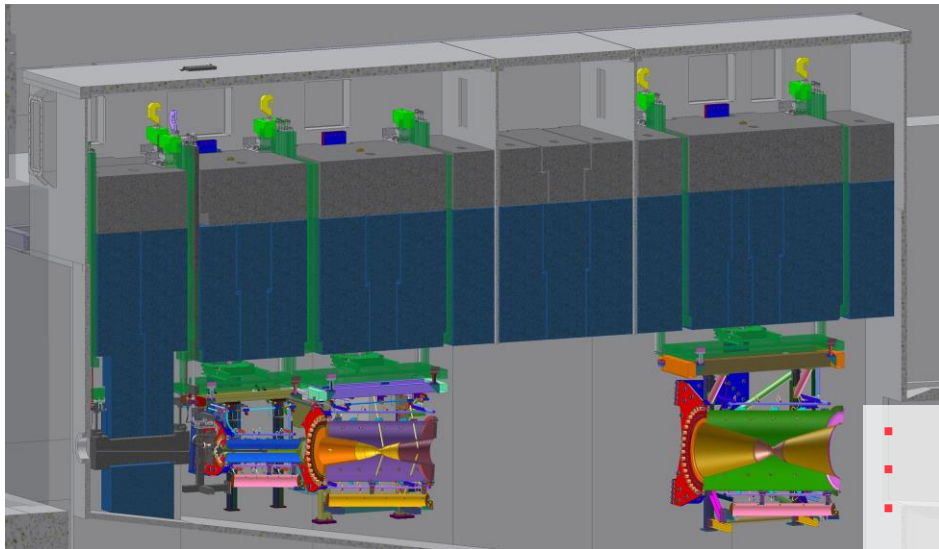


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Target + Horn (and/or superconducting solenoid) - T2K @ J-PARC



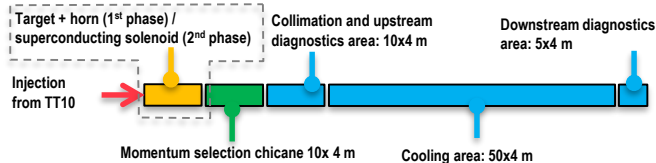
- Vertical Handling
- Equipment by modules
- Module is a suspended frame w/ equipment + shielding + utilities connections
- Installation by steps
- Placed inside a He vessel

<https://t2k.org/docs/photos/beamline>

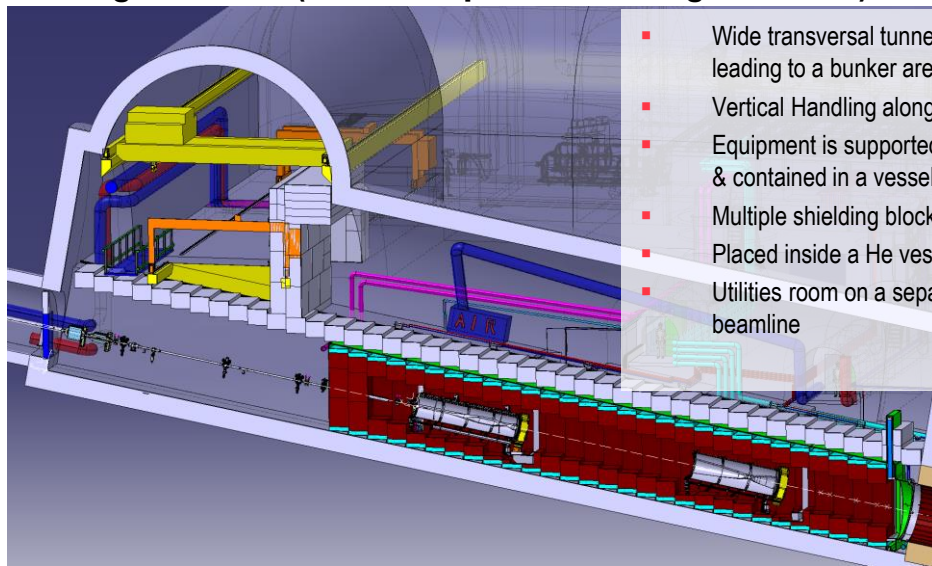
<https://doi.org/10.1016/j.nima.2011.06.067>



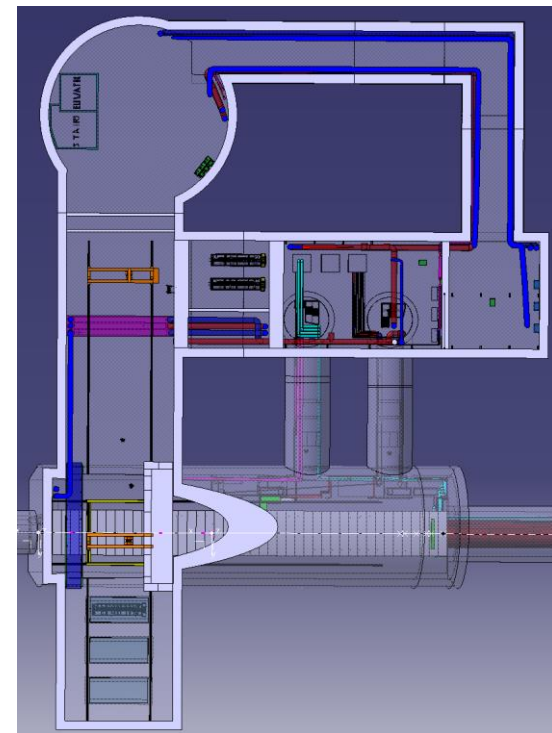
Layout ideas



Target + Horn (and/or superconducting solenoid) - CN2PY - LBNO

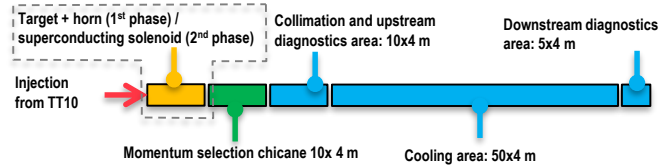


- Wide transversal tunnel offset from target & Horn leading to a bunker area.
- Vertical Handling along the beam line & access tunnel
- Equipment is supported on the ground (shielding blocks) & contained in a vessel.
- Multiple shielding blocks
- Placed inside a He vessel
- Utilities room on a separate gallery parallel to the beamline



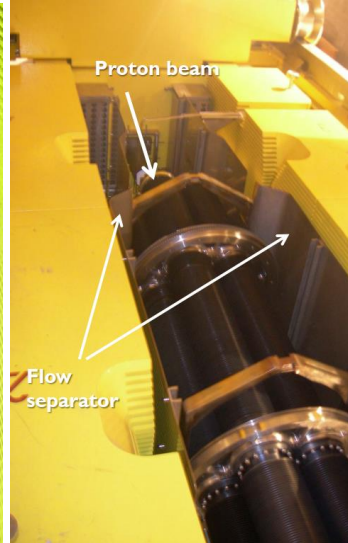
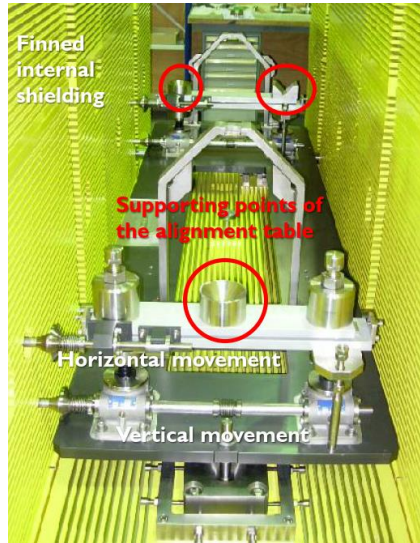
[I. Efthymiopoulos, Design Study For A Future Laguna-LBNO Long-baseline Neutrino Facility At Cern, THPFI056, IPAC2013](#)

Layout ideas



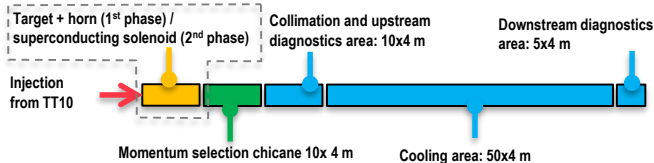
Target + Horn (and/or superconducting solenoid) - CNGS

- 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



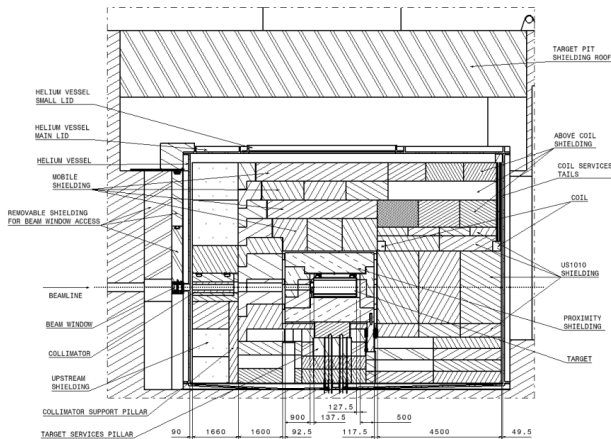
M.Calviani, Design, maintenance and operational aspects of the CNGS target, 4th HPTW,

Layout ideas

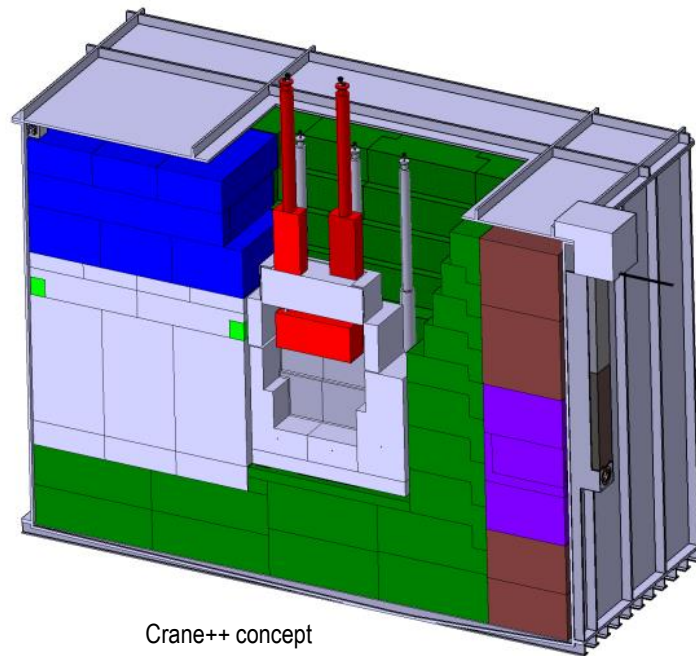


Target + Horn (and/or superconducting solenoid) - BDF

- Very detailed study thought from installation to decommissioning of the target
- Target enclosed in a shielding bunker inside a helium vessel.
- Target handled vertically with the building crane.
- Services chimneys for electrical and cooling connections of the target and proximity shielding.
- Target exchange via a shielded vessel.



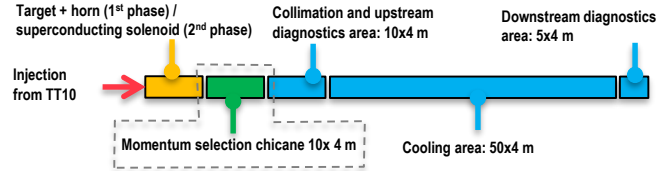
Crane concept



Crane++ concept

<https://doi.org/10.23731/CYRM-2020-002>

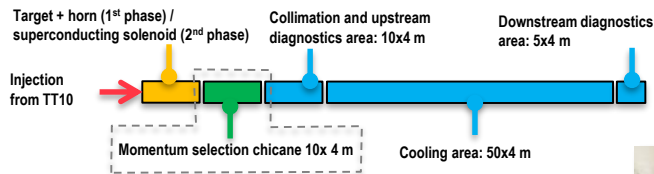
Layout ideas



Momentum selection chicane

- Chicane (“dogleg”) for momentum selection
 - What would be the momentum of the selected muons?
 - And what would be the aperture of the magnets and beam line components?
- Can also serve as extraction to other experiments (nuSTORM / ENUBET ?)
- Set of Collimator, bending magnets, quadrupole magnets and a dump.
- Highly radioactive

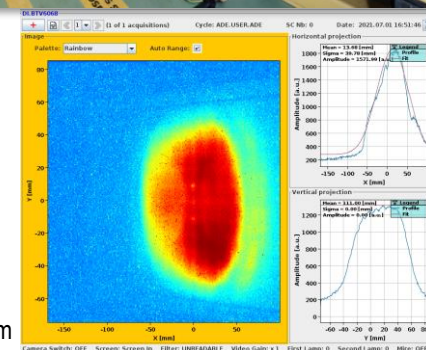
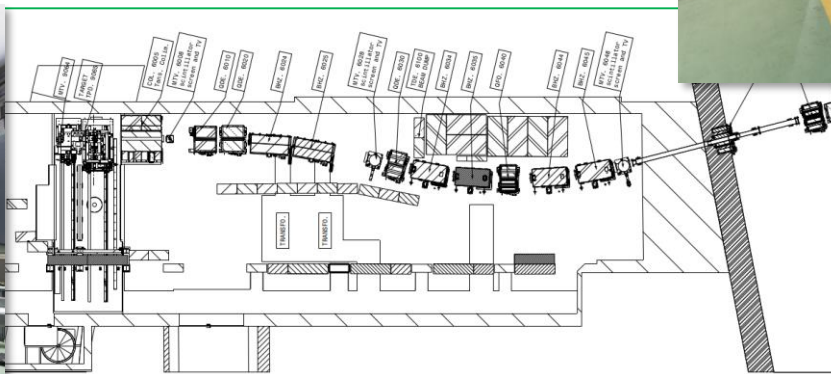
Layout ideas



<https://cds.cern.ch/record/2773294?ln=en>

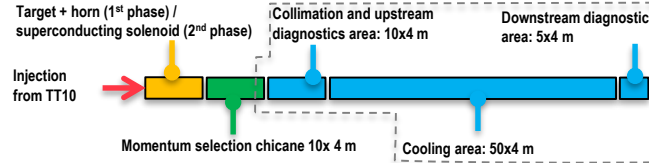
Momentum selection chicane – AD-Target Area @CERN

- Receives 26 GeV/c p^+ beam from PS.
- AD-T Chicane (“dogleg”) for 3.57 GeV/c momentum selection.
- How will it be for the MUC ?



BTV downstream
AD-T area

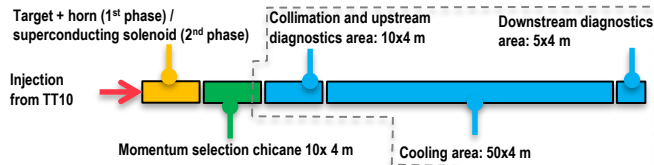
Layout ideas



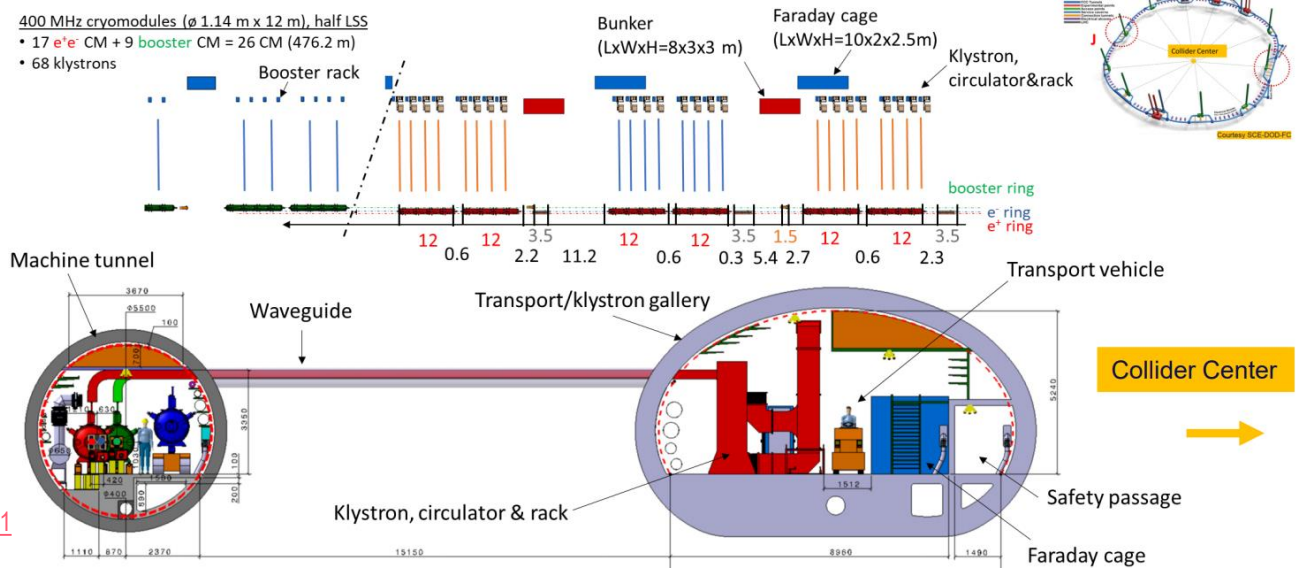
Muon Cooling Area

- Collimation & upstream diagnostics + Muon Cooling area + Downstream diagnostics area
- Collimation w/ ~5 x cryostats (Ø 2x4 m)
- Cooling w/ ~10 x cryostats (Ø 2x4 m)
- Needs a klystron area & other utilities

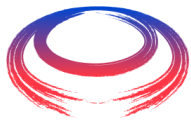
Layout ideas



Muon Cooling Area - FCC e⁺e⁻ Crymodules tunnel & klystrons gallery

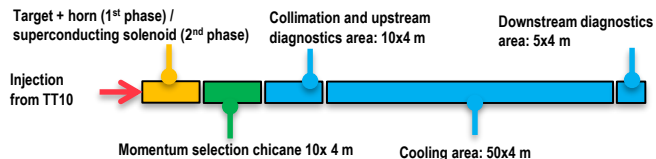


Jean-Pierre Corso,
Integration of the
FCC, FCC Week 2021



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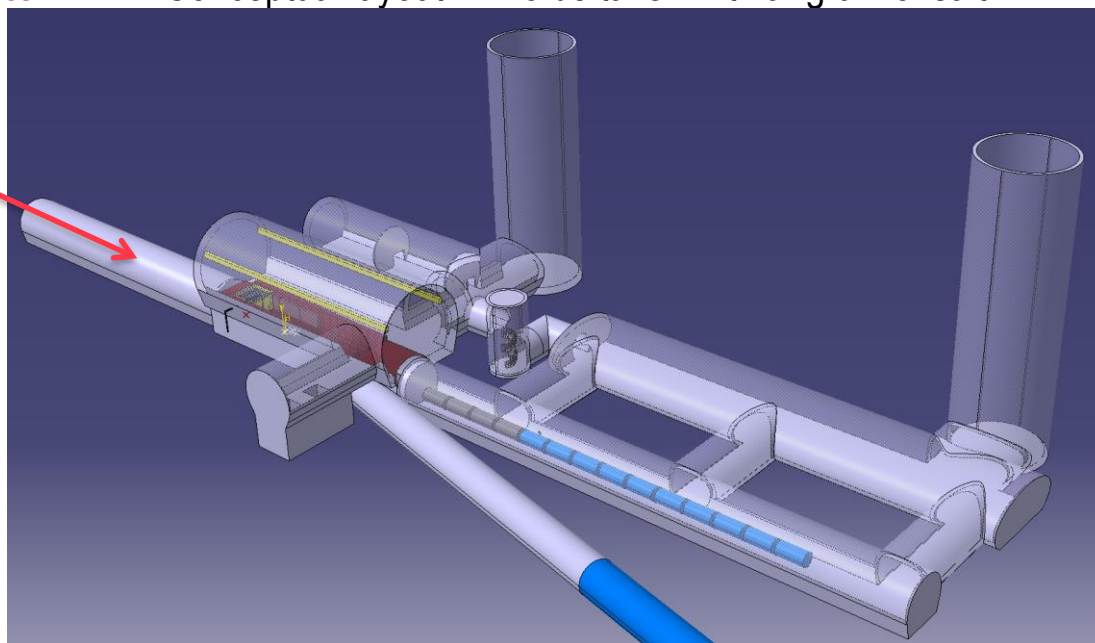
Conceptual layout

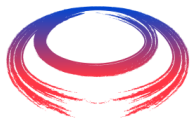


MUC Demonstrator VERY Conceptual layout → To be taken with a “grain of salt”



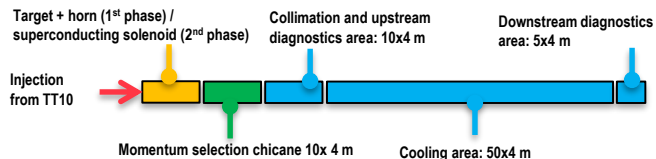
CERN TT10 branch





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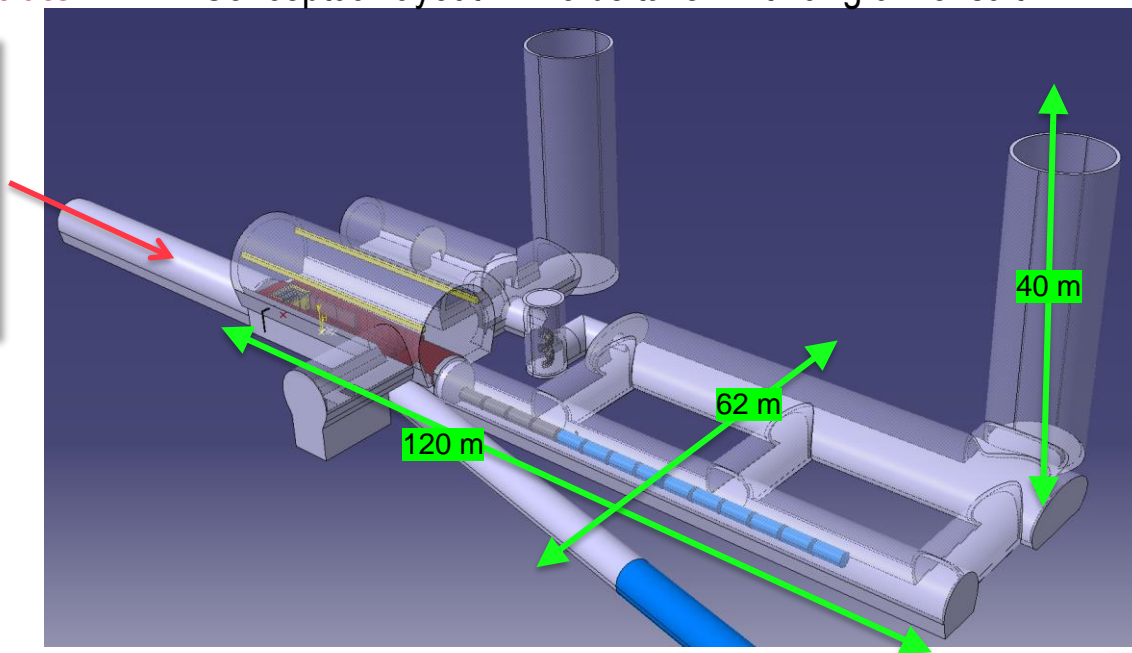
Conceptual layout



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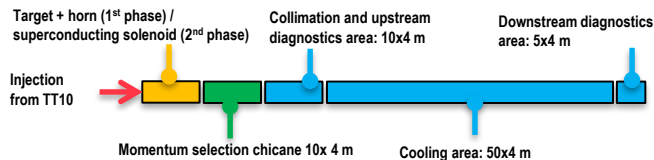


CERN TT10 branch

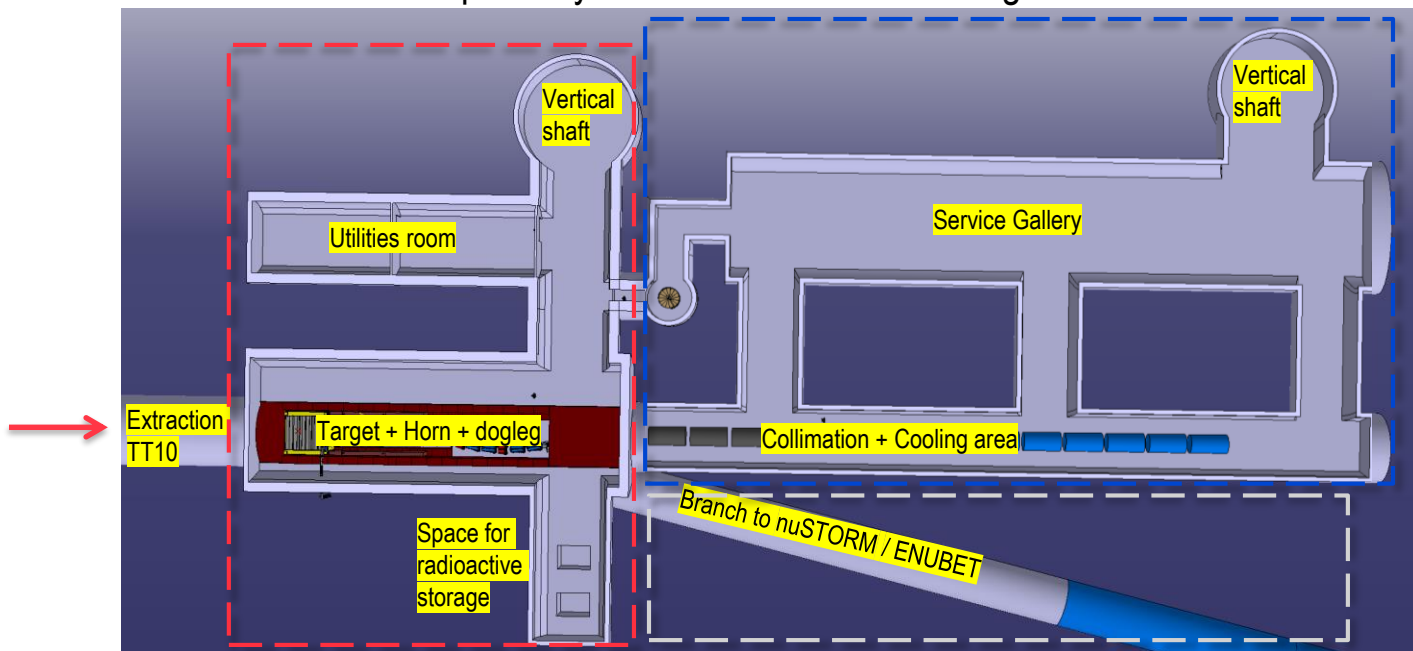


Indicative dimensions. Model is very flexible at this stage

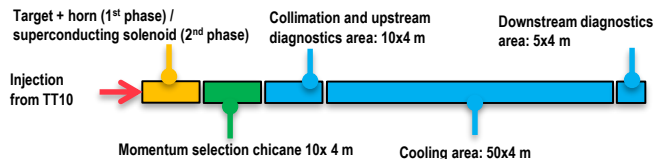
Conceptual layout



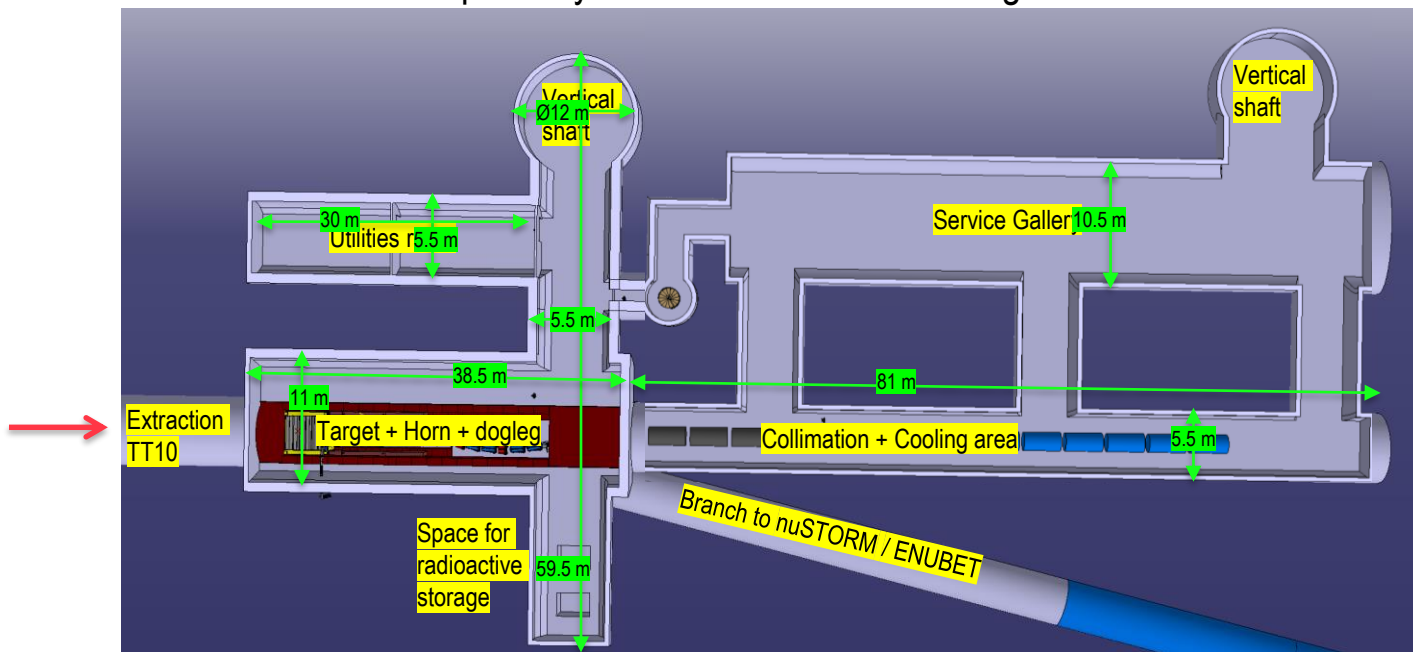
MUC Demonstrator VERY Conceptual layout → To be taken with a “grain of salt”



Conceptual layout

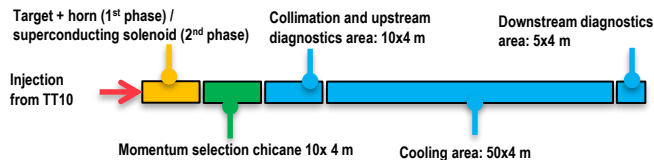


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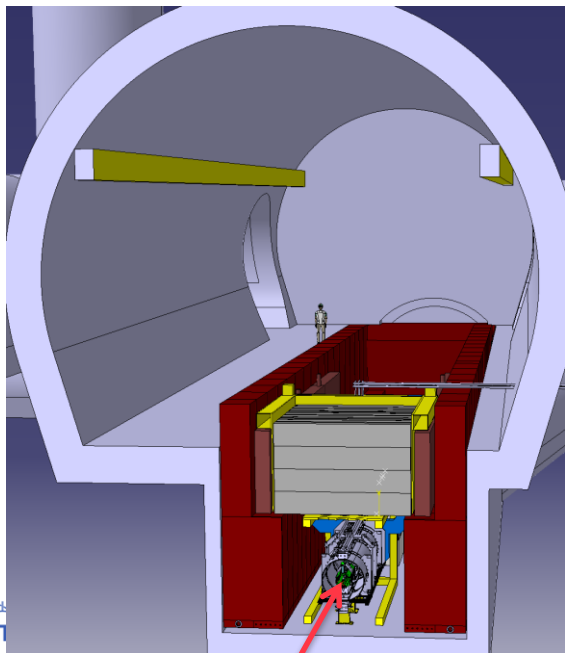


Indicative dimensions.
Model is very flexible at
this stage

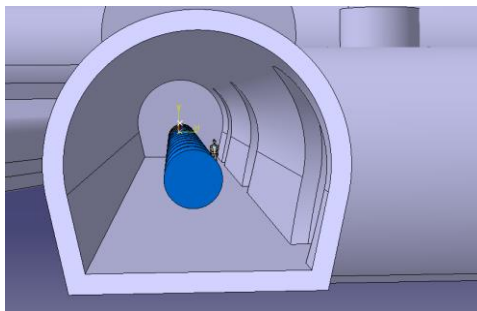
Conceptual layout



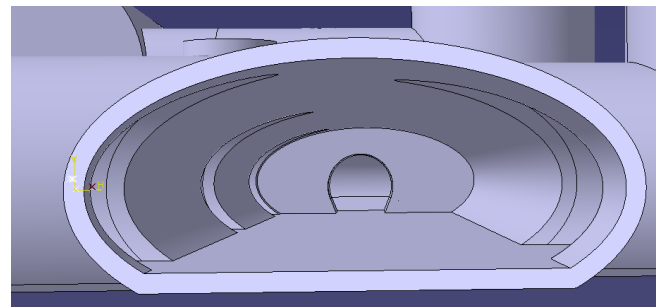
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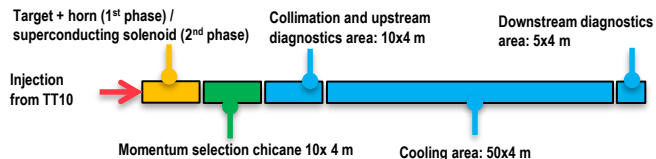
Cooling tunnel



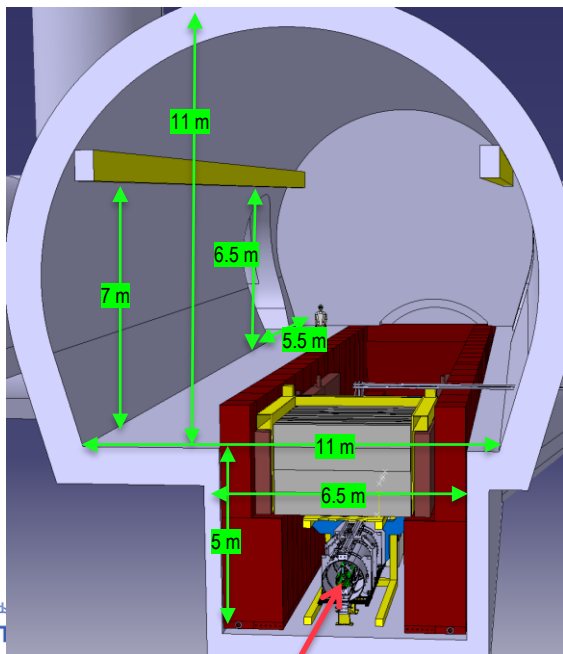
Services Gallery



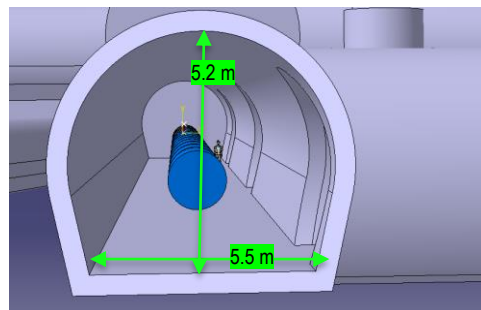
Conceptual layout



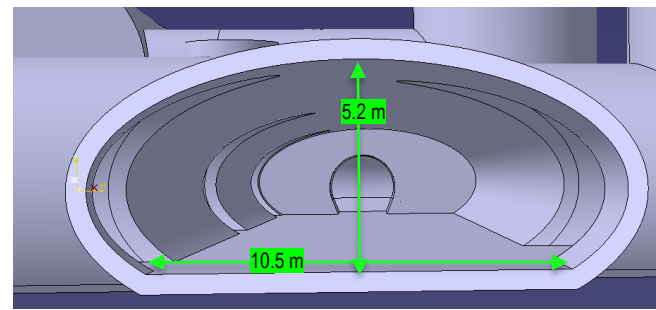
MUC Demonstrator VERY Conceptual layout → To be taken with a “grain of salt”



Cooling tunnel

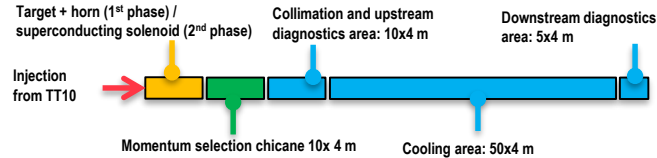


Services Gallery



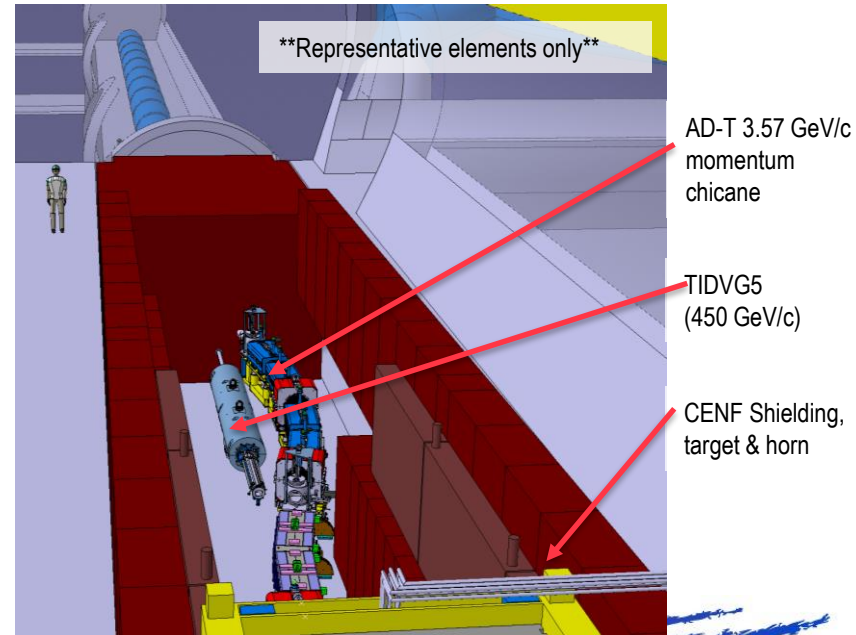
Indicative dimensions. Model is very flexible at this stage

Conceptual layout

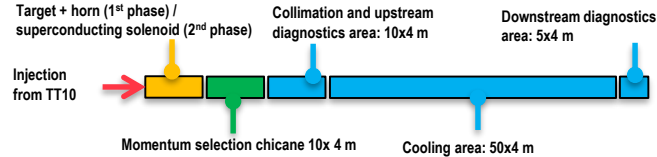


MUC Demonstrator VERY Conceptual layout → To be taken with a “grain of salt”

- Target trench like system with beam line below tunnel floor level → robust solution for radio protection
- Vertical handling with beam equipment in modules, placed in a vessel (N₂) container
- Close-by radioactive storage
- Utilities in parallel gallery
- Clear separation from downstream cooling area
- Possibility to branch to other experiments
- Flexible facility with space accounted for future upgrades. At an early stage (80 kW), shielding may be reduced for cost optimization and could start with a simple target & horn. Flexibility to introduce more complex target systems depending on the progresses of the studies for the final Muon collider .

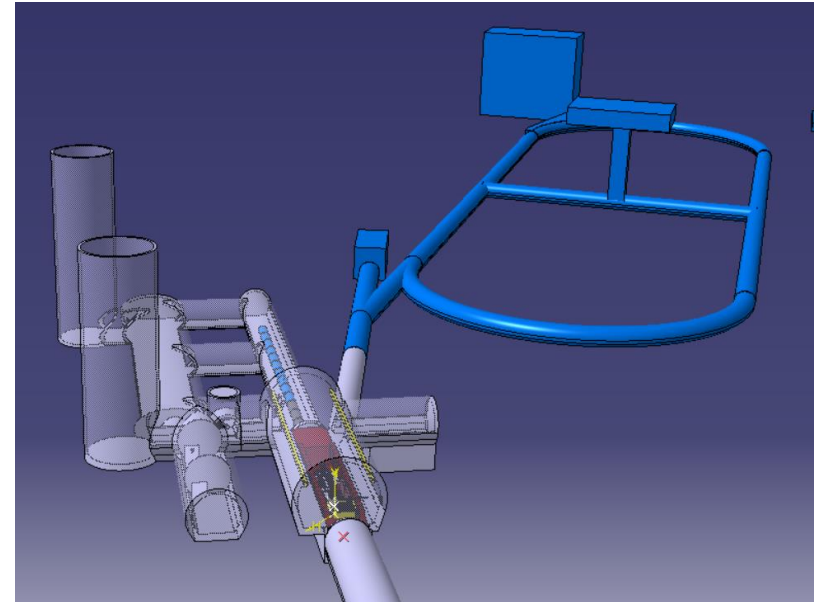


Conceptual layout

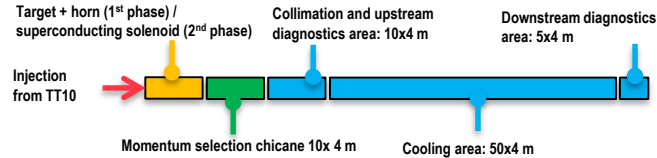


MUC Demonstrator VERY Conceptual layout → To be taken with a “grain of salt”

- The Facility is flexible enough to accommodate other experiments.
- nuSTORM and potentially ENUBET could be branched from the MUC Demonstrator Facility.
- The same target complex would be used profiting from its shielding and general target systems infrastructure, utilities, and accesses.
- The double deflection of the beamline could reduce radiation streaming towards the nuSTORM ring.
- Synergies between experiments would reduce costs on both sides.
- Is the 26 GeV/c beam from the PS appropriate for these two experiments?

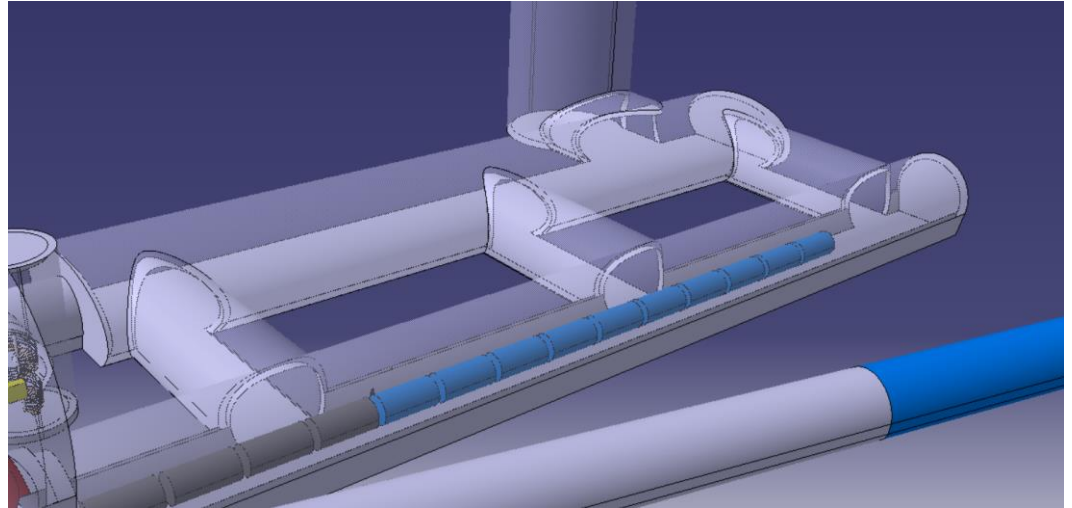


Conceptual layout



MUC Demonstrator VERY Conceptual layout → To be taken with a “grain of salt”

- Muon Cooling section can be extended if needed
- Experimental cavern (e.g. for low energy muons) can be foreseen downstream muon cooling tunnel

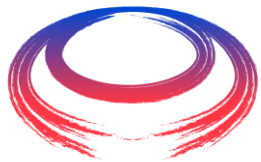


Conclusions

- Supported on existing facilities and previous studies, a first MUC Demonstrator facility “concept” layout is show.
- The facility shall be flexible enough & compatible with future upgrades.
- 3D facility modelling, even if with limited degree of detail is key for costing. Important to collect all requirements at this stage in order to be able to provide a first cost estimate by end of 2021, as requested by the study
- Further inputs are needed, and early discussions with Civil engineering, RP, Transport, Cooling & ventilation, power, etc are of major importance
- Comments and feedback are welcome! e.g. sizes of components in the collimator and muon cooling part, etc

by Rui FRANQUEIRA XIMENES* (on behalf of many other)
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Targets Collimators Dumps (TCD)

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*Thank you
very much for your support
and for your attention*