WG3 Summary

Accelerator Physics Working Group
NuFact 2018

Ben Freemire
Tetsuro Sekiguchi
Mamad Eshraqi

WG3 Parallel Sessions

1) Targets (4 talks)
2) Muon Ionization Cooling Experiment (3)
3) Beamlines (2)
4) Future Facilities (4)
5) Lepton/Hadron Production Studies (3)
6) Muon Beam Facilities (with WG4) (4)
7) Muon g-2 & IsoDAR (2)

- 22 Talks total

Talk Highlights

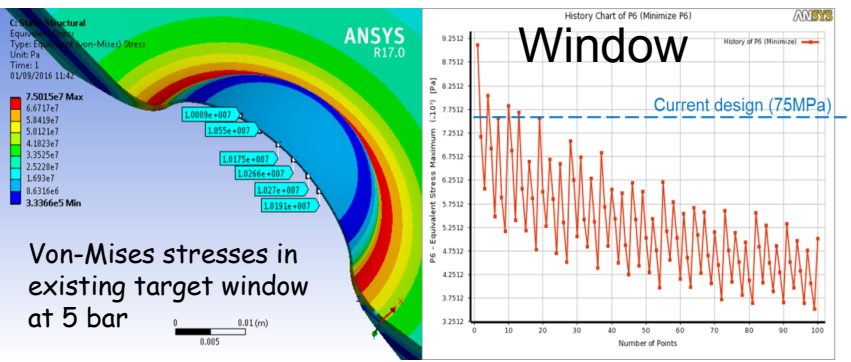
Targets

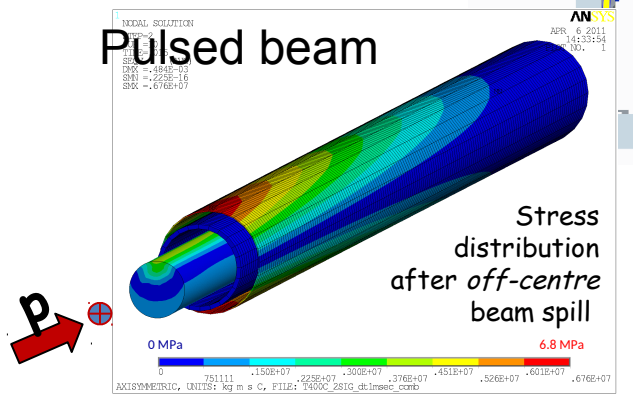
1) T2K Target and Beam Window Upgrades for 1.3 MW Operation – Chris Densham
2) Recent Progress on Radiation Damage Studies at RaDIATE – Taku Ishida
3) Status and Physics Potentials of the MOMENT Study – Nikos Vassilopoulos & Jian Tang
4) The ESSnuSB Target and Horn Studies and Future Developments – Marcos Dracos

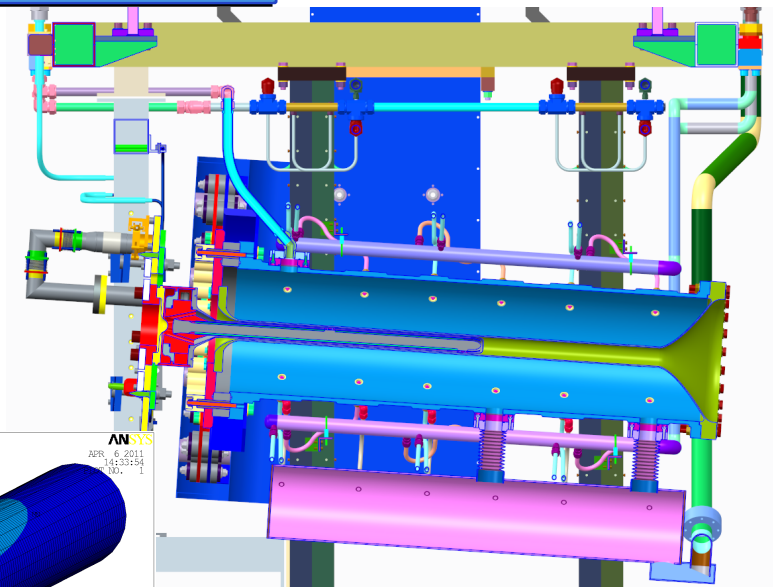
T2K Target and Beam Window Upgrades for 1.3 MW Operation

C. Densham

- Beam power increase from 0.75 → 1.3 MW dictates target improvements
- Studies of flow rate, cooling, pressure & pulsed beam done
- “Operation at 1.3 MW appears feasible with incremental design changes to target … upgraded beam window”



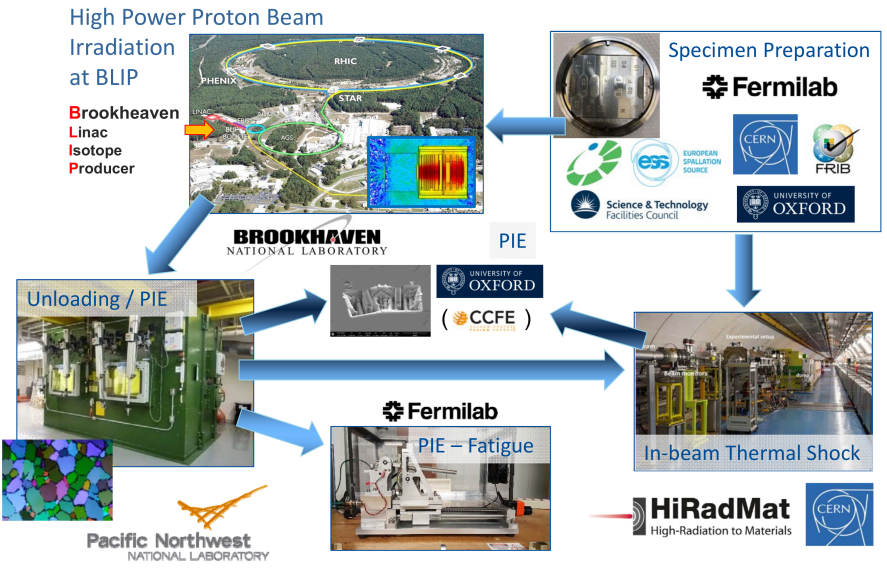




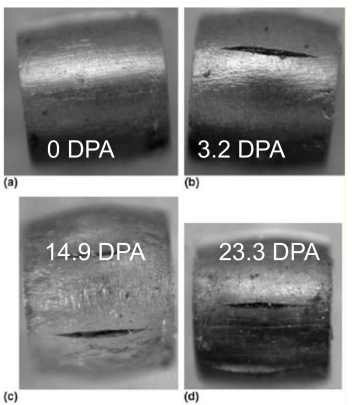
Target & horn assembly

Recent Progress on Radiation Damage Studies at RaDIATE

T. Ishida



- RaDIATE aims to replicate HEP target environment & include post-irradiation examination
- International & inter-facility cooperation working well
- Goals:
  - Predict accurately targetry component lifetime
  - Design robust multi-MW targetry components
  - Develop new materials to extend lifetimes

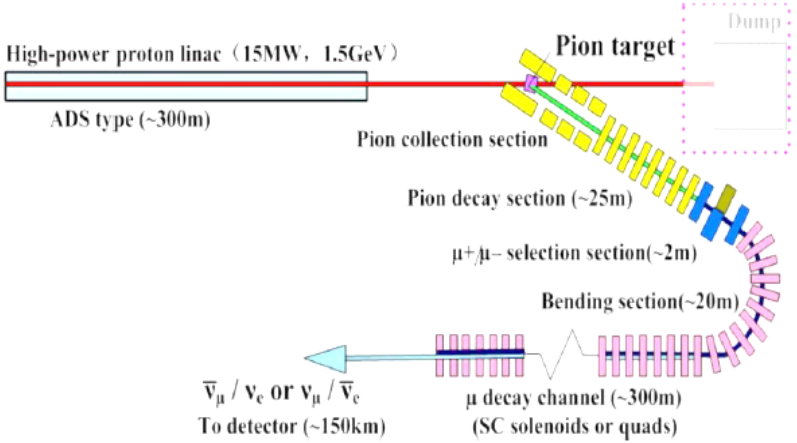


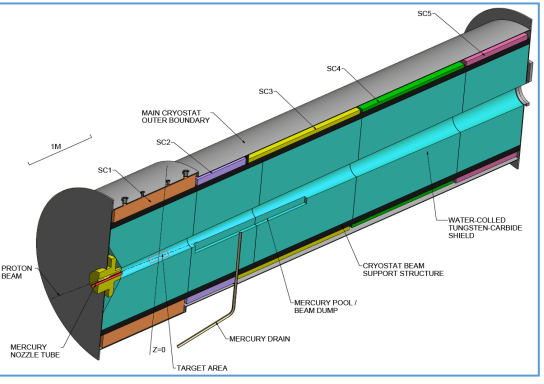
Radiation damage

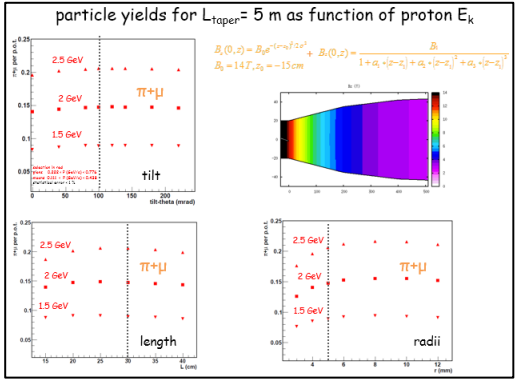
Status and Physics Potentials of the MOMENT Study

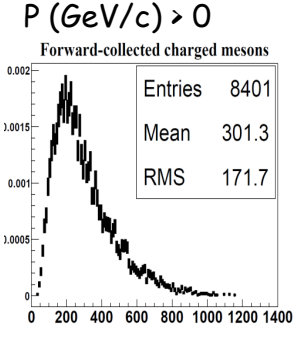
N. Vassilopoulos & J. Tang

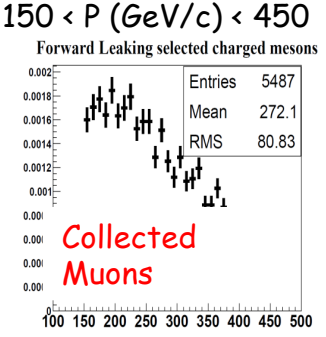
- MuOn-decay MEdium baseline NeuTrino beam facility
- Neutrino energy range 100-800 MeV
- Recent work on:
  - High-field superconducting solenoid
  - Target optimization
  - Efficient pion capture
  - Beamline optimization

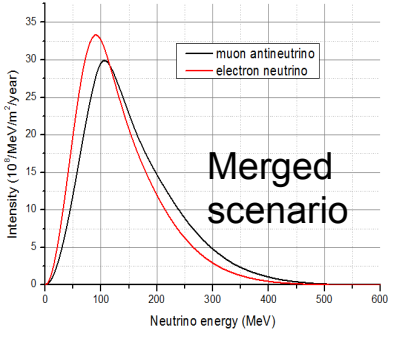






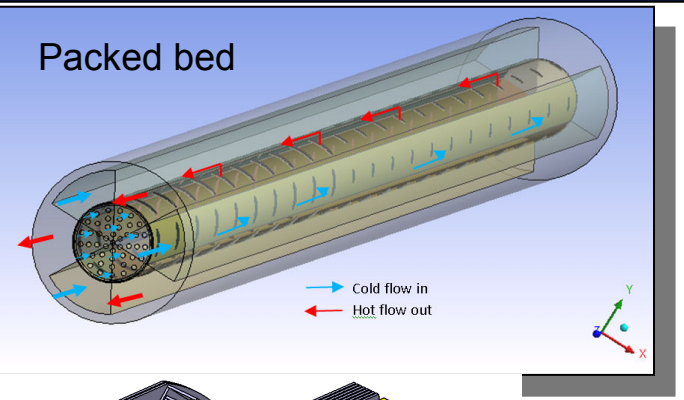




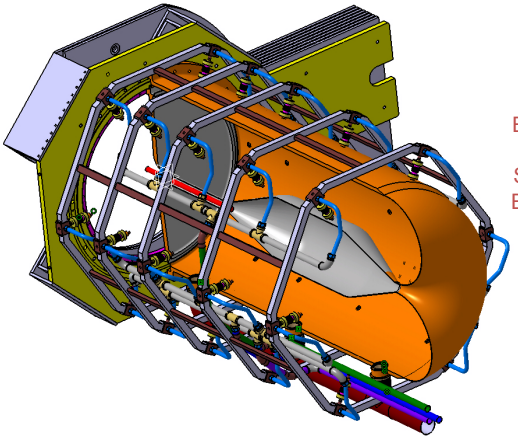


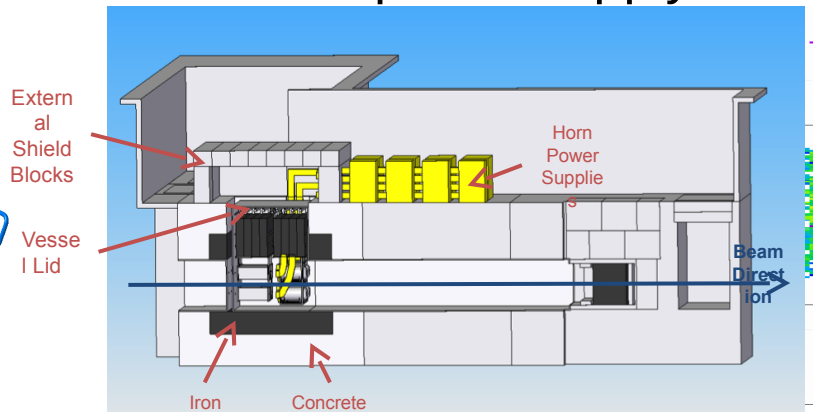
The ESSnuSB Target and Horn Studies and Future Developments

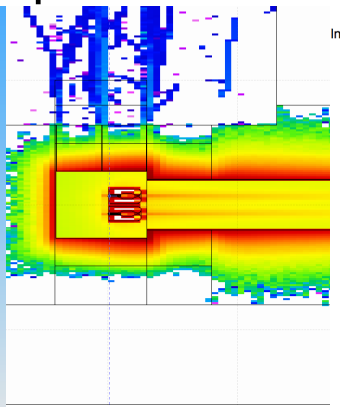
M. Dracos

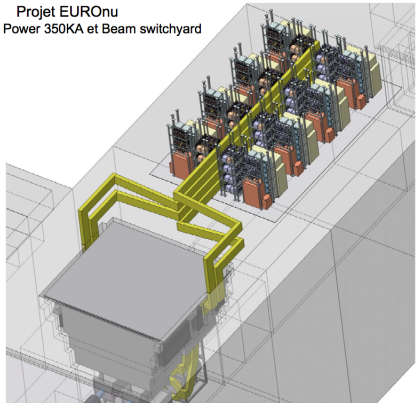


- Target concepts – Granular or Packed Bed
- Horn geometry, cooling system to be optimized
- Analysis of auxiliary equipment and lifetime of horn
- Target station: concept, energy deposition, beam dump, material activation
- Horn power supply & strip lines









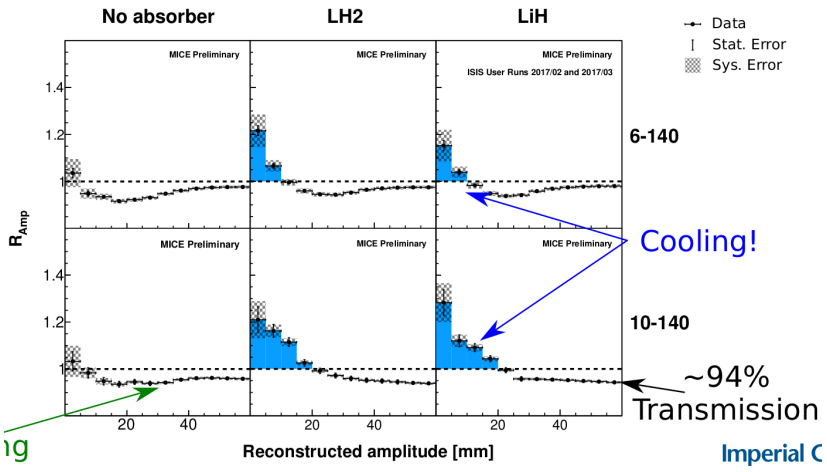
MICE

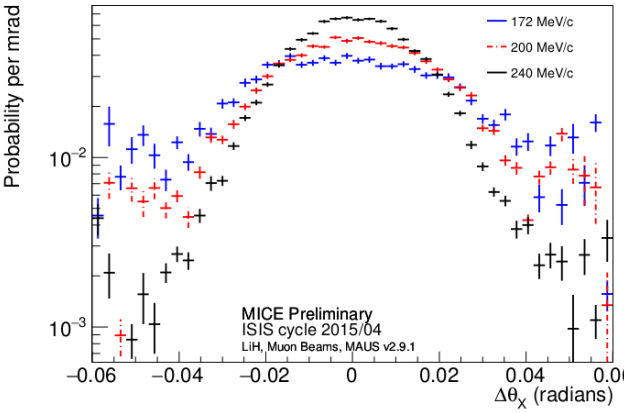
1) Recent Results from MICE on Multiple Coulomb Scattering and Energy Loss – John Nugent
2) Recent Results from the Study of Emittance Evolution in MICE – Chris Hunt
3) Measurement of Phase Space Density Evolution in MICE – Yağmur Torun

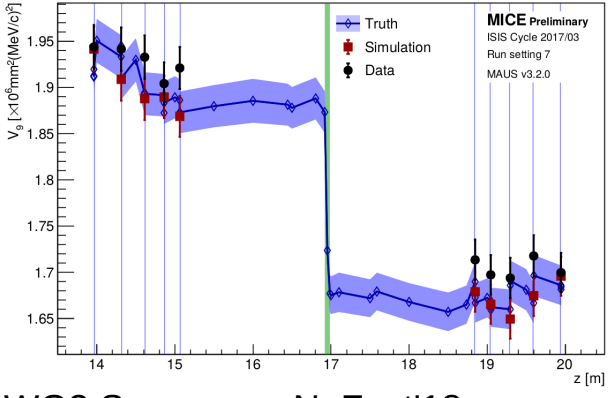
Muon Ionization Cooling Experiment

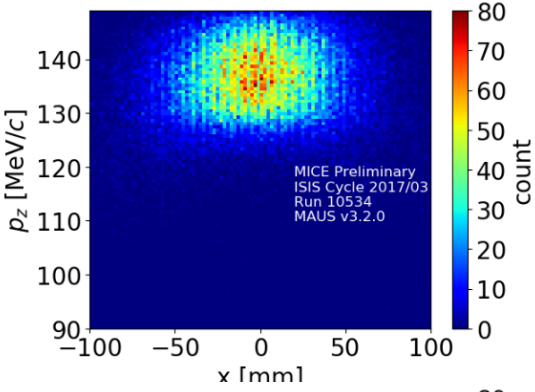
J. Nugent
C. Hunt
Y. Torun

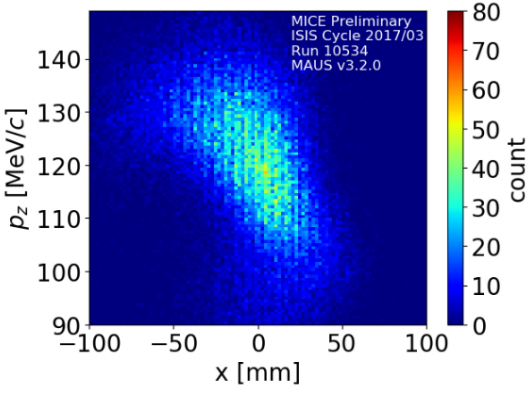
- MICE data taking has concluded
- Results of:
  - Multiple Coulomb scattering off lithium hydride
  - Particle amplitude evolution – *Cooling*
  - Phase space density evolution
  - Reverse emittance exchange









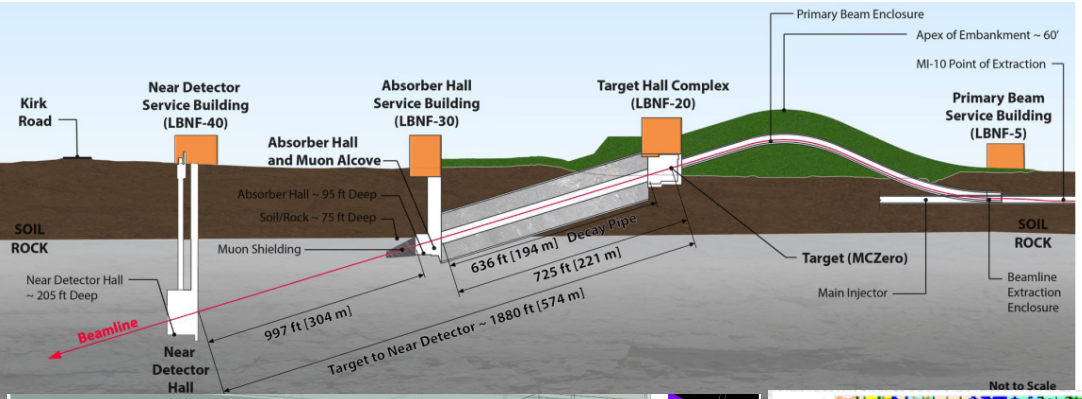


Beamlines

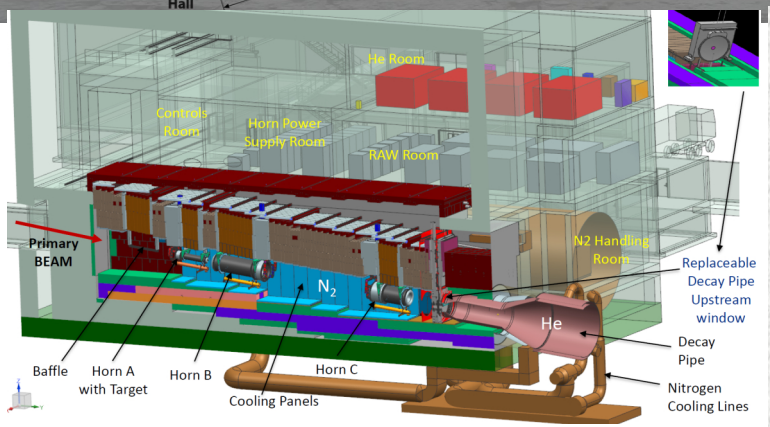
1) The Science and Design of the LBNF Beamline – Mary Bishai
2) Upgrade Possibility of the ESS Linac for the ESSnuSB Project - Björn Gålnander

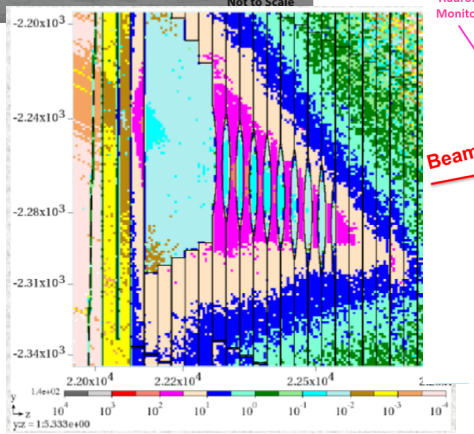
The Science and Design of the LBNF Beamline

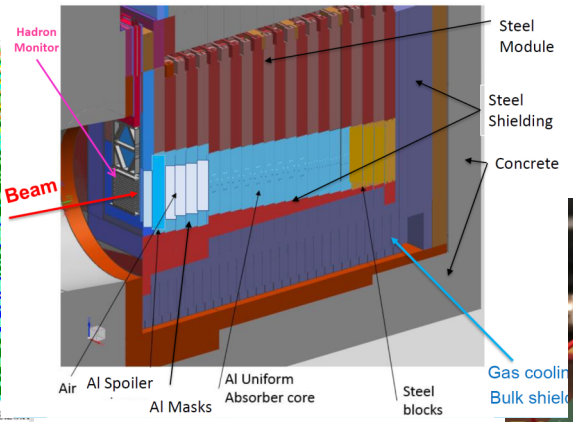
M. Bishai

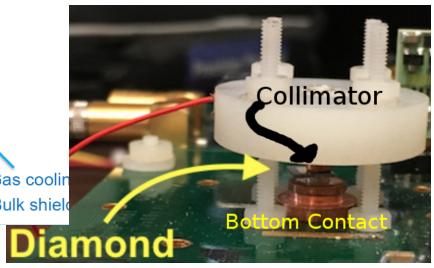


- Proton beam 60-120 GeV
- Beam power 1.2 → 2.4 MW
- Target/horn & hall optimized
- Hadron absorber optimized
- Neutrino flux monitoring R&D ongoing





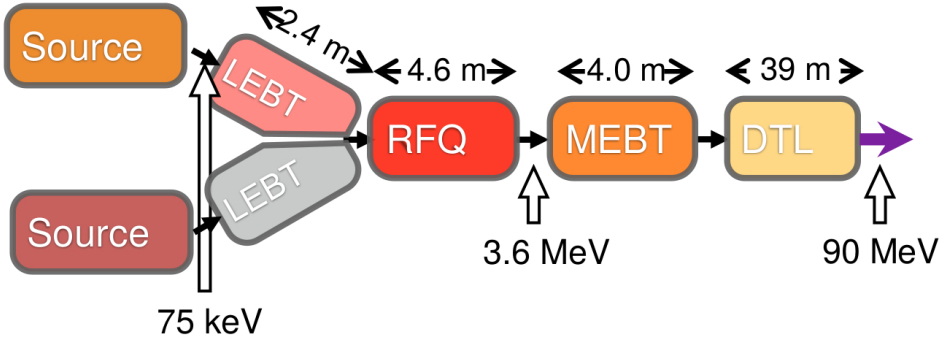


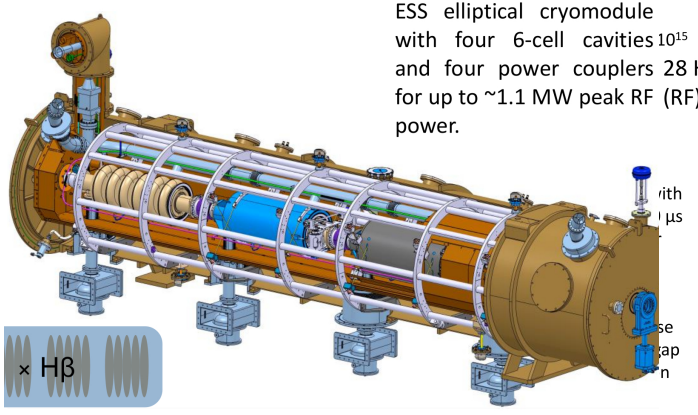


Upgrade Possibility of the ESS Linac for the ESSnuSB Project

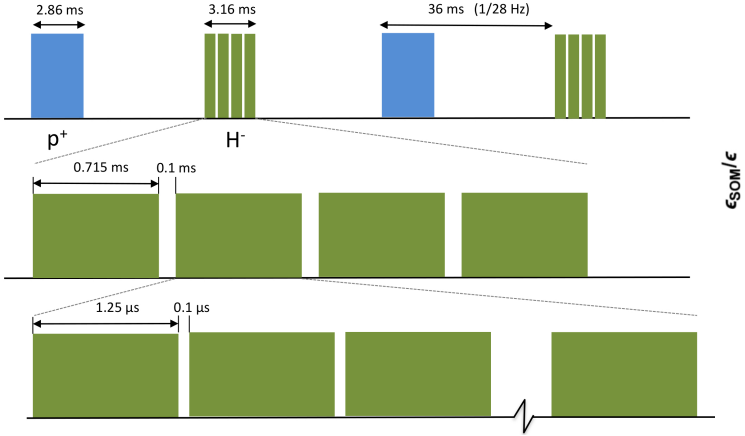
B. Gålnander

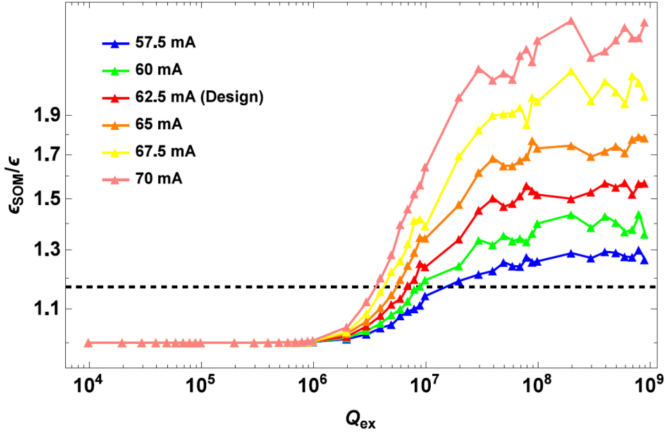
- 5 MW additional power needed for neutrino production
- H^- source needed
- Energy upgrade to ≥2.5 GeV simplifies RF requirements
- RF cavity design ongoing
- New klystrons needed for 28 Hz operation
- Extraction gap in pulse structure requires chopper
  - Effect of HOM in SC cavities being studied





ESS elliptical cryomodule with four 6-cell cavities and four power couplers for up to ~1.1 MW peak RF power.



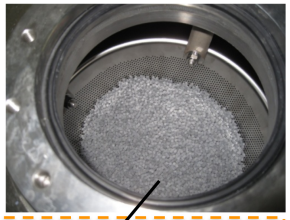


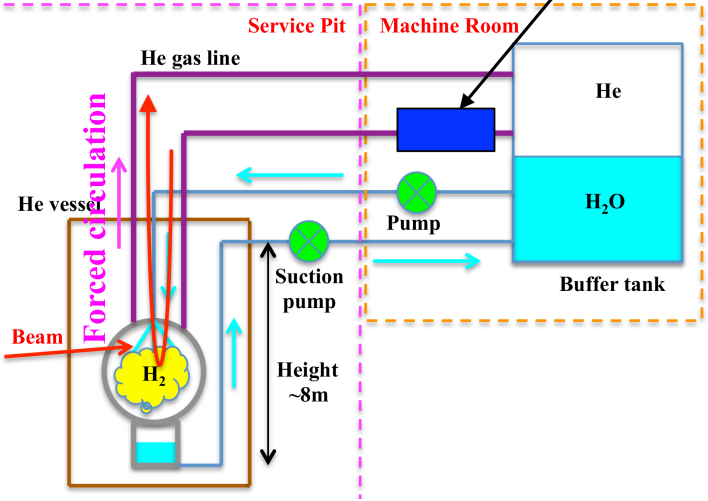
Future Facilities

1) Development and Operational Experience of T2K Magnetic Horn for over-MW Beam – Tetsuro Sekiguchi
2) Challenges and Status of the ESSnuSB Accumulator Design – Ye Zou
3) Integrable Optics Test Accelerator – Ben Freemire
4) Low Emittance Muon Accelerator Studies – Manuela Boscolo

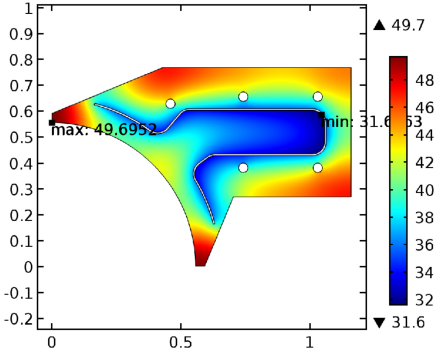
Development and Operational Experience of T2K Magnetic Horn for over-MW Beam

T. Sekiguchi





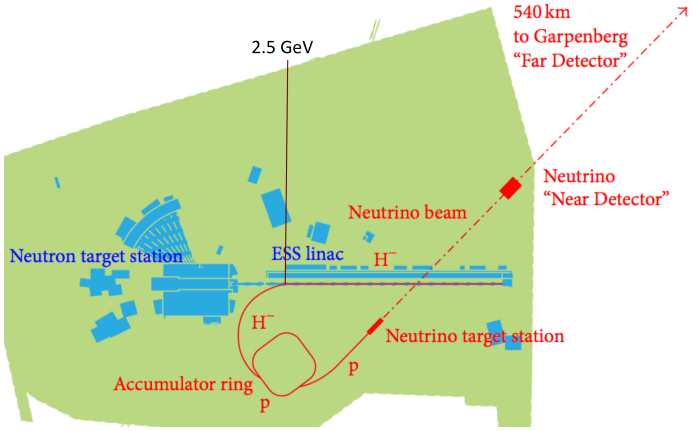
- T2K horns need to be upgraded for 1.3 MW with 320 kA @ 1 Hz
- Issues being addressed:
  - Hydrogen production
  - Electrical system upgrade
  - Cooling upgrade

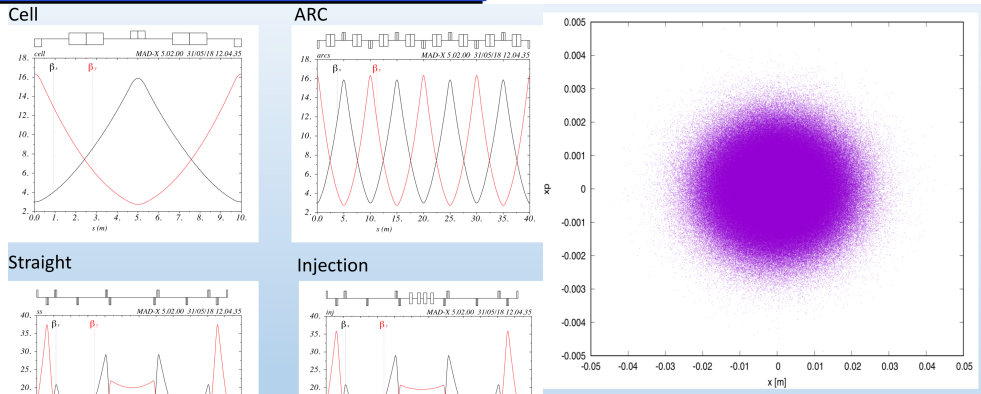


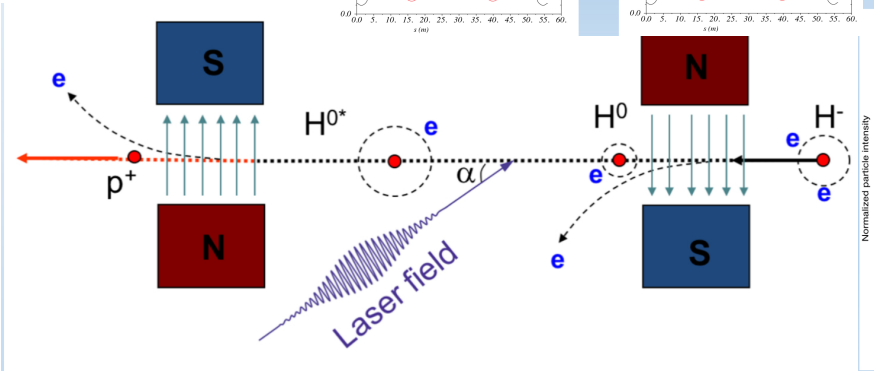
Challenges and Status of the ESSnuSB Accumulator Design

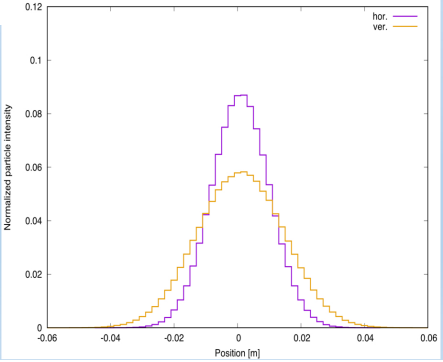
Y. Zou

- ESS linac beam is 2.86 ms long, horn flattop time is 1.5 μs
  - Accumulator needed to shrink beam pulse time
- Primary concern is radioactivation caused by beam loss
- H- stripping techniques under investigation
- Injection and extraction schemes considered
- Initial lattice designed & first simulations done



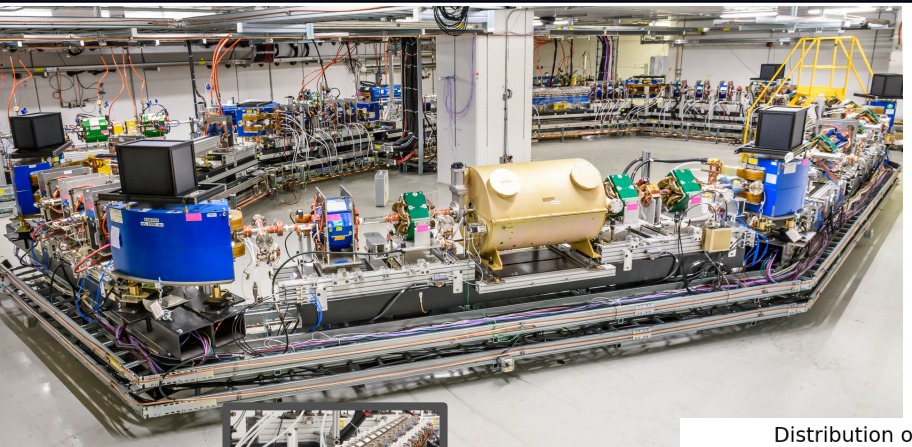




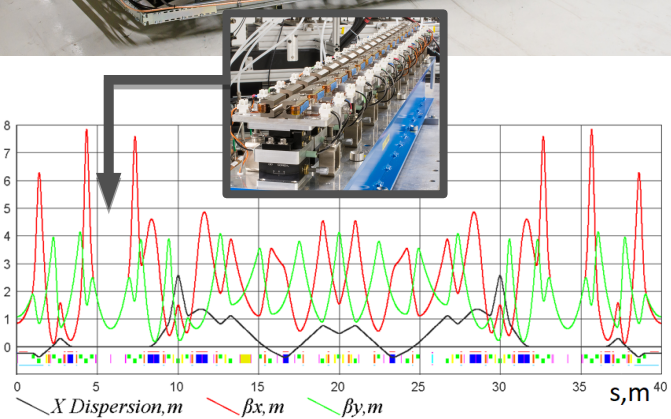


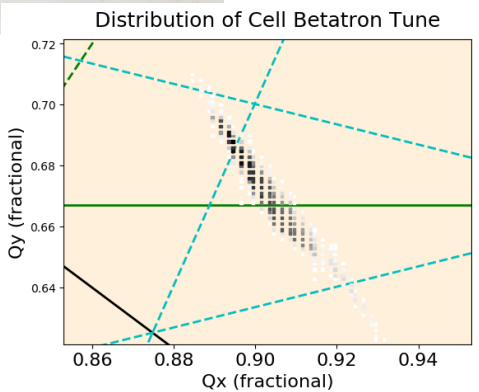
The Integrable Optics Test Accelerator

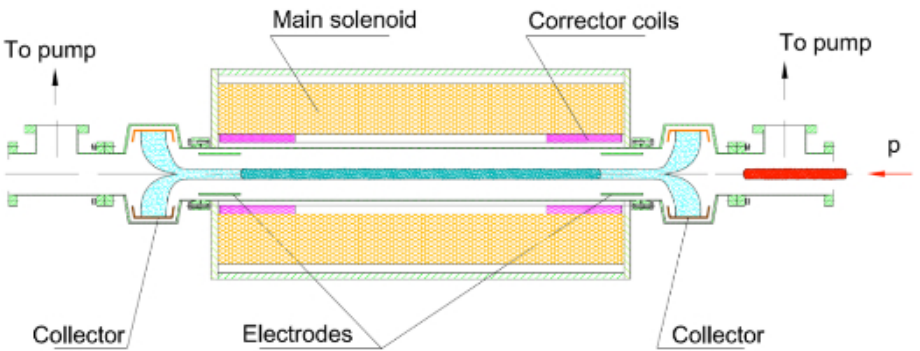
B. Freemire
& J. Eldred



- IOTA is a storage ring for advanced beam physics research
- Nonlinear integrable optics aims to accommodate large space charge tune shifts without beam loss
- Space charge compensation using electron columns aims to minimize beam loss by negating Coulomb repulsive force
- Experimental program with electrons first, protons to follow



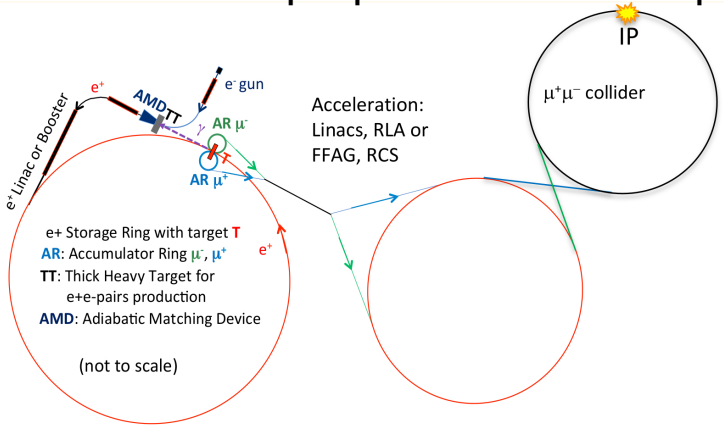


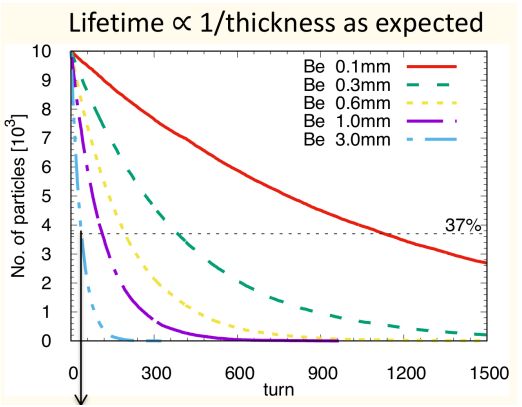


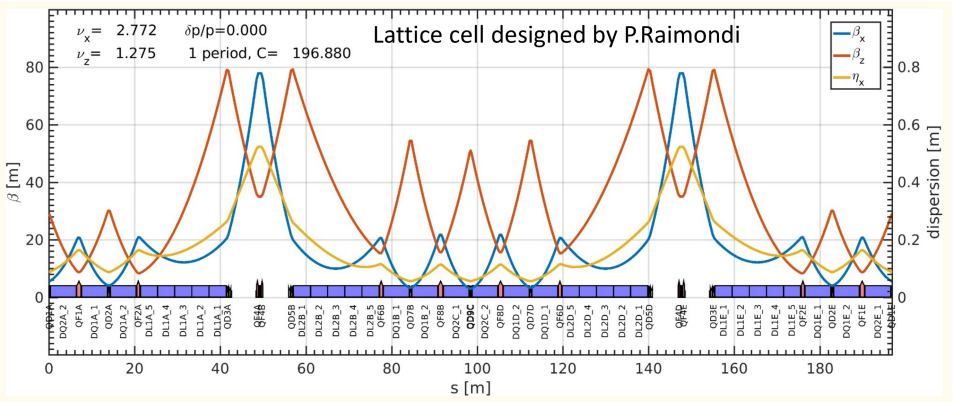
Low Emittance Muon Accelerator Studies

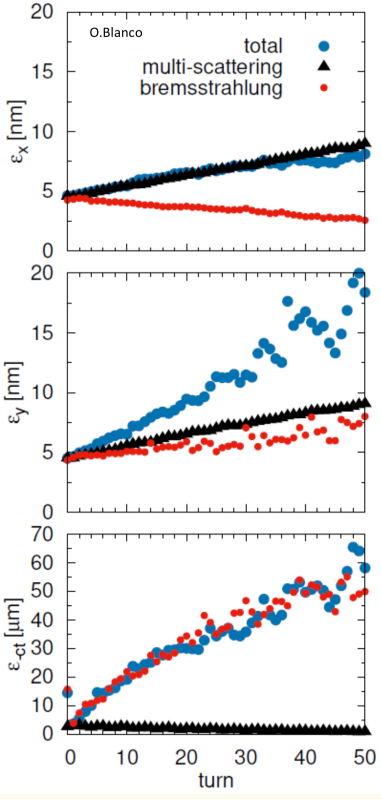
M. Boscolo

- Low emittance muon beam created by colliding positrons with target
- No need for cooling of beam, but small production rate
- R&D ongoing to determine feasibility: positron source, muon production target, muon accumulator rings, acceleration, collider design
- Material in preparation for European Strategy Update







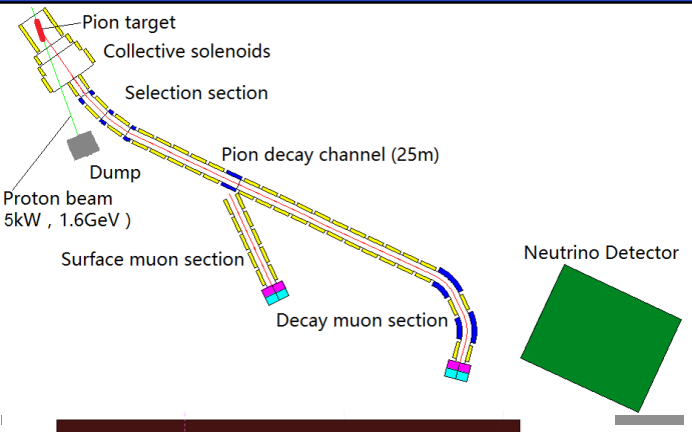


Lepton/Hadron Production Studies

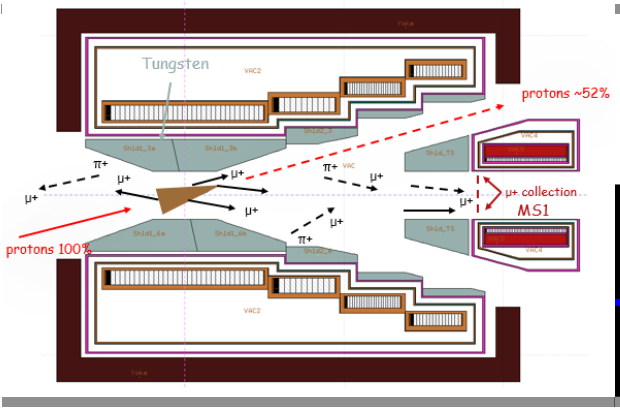
1) Experimental Muon Source (EMuS) Target System Studies – Nikos Vassilopoulos
2) Status of NA61/SHINE Measurements for Neutrino Experiments – Athula Wickremasinghe
3) ENUBET – Enhanced NeUtrino BEams from kaon Tagging – Giulia Brunetti

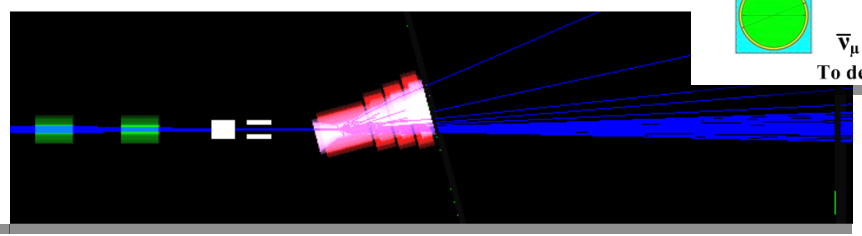
Experimental Muon Source (EmuS) Target Systems Studies

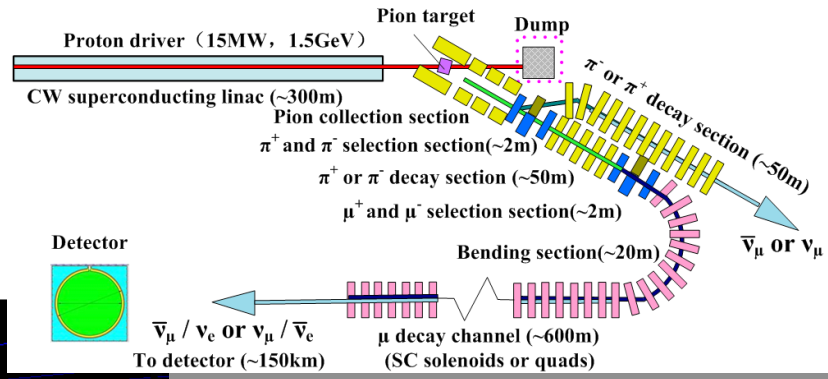
N. Vassilopoulos



- EMuS first muon source in China, at China Spallation Neutron Source
- Three operating modes – surface muon, decay muon, and neutrino
- Proton beamline baseline design complete
- EMuS could also act as R&D platform for MOMENT



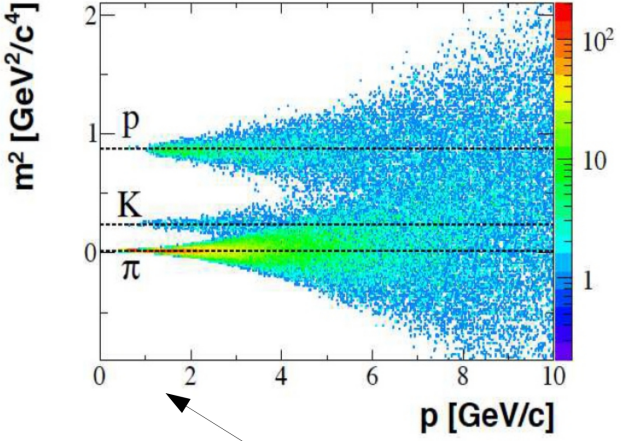


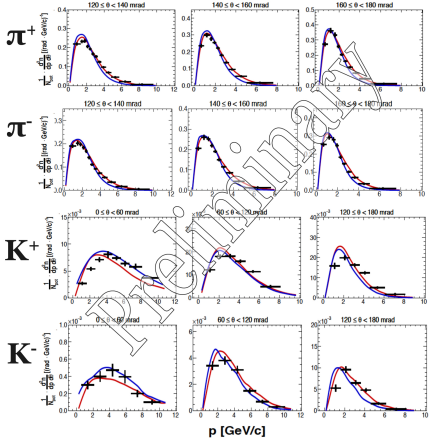


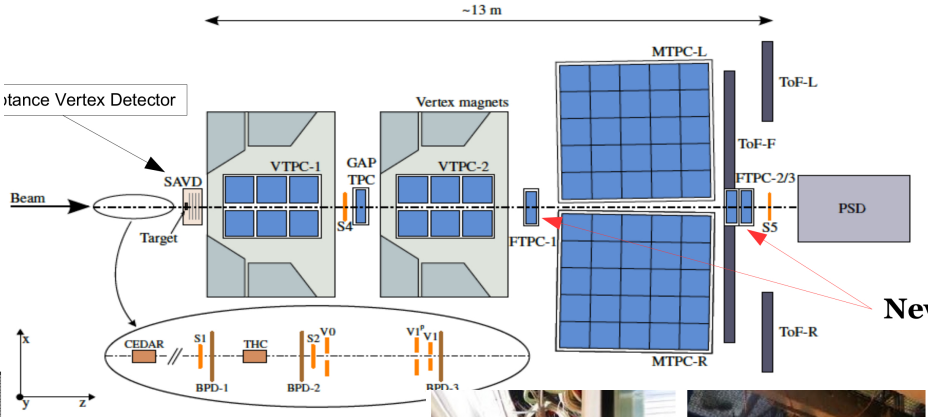
Status of the NA61/SHINE Measurements for Neutrino Experiments

A. Wickremasinghe

- Fixed target, large acceptance hadron production measurement experiment at SPS at CERN
- Data taken using T2K & Fermilab replica targets
- Hardware upgraded in 2017 to improve forward acceptance
- Further upgrades planned for 2019-2020, followed by runs with LBNF & Hyper-K/T2K II replica targets





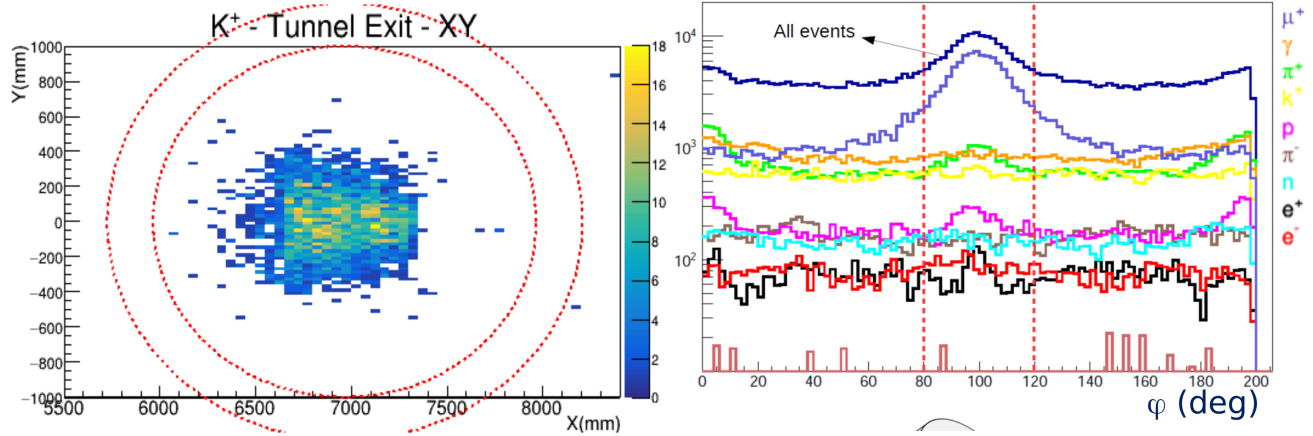


FTPC 1

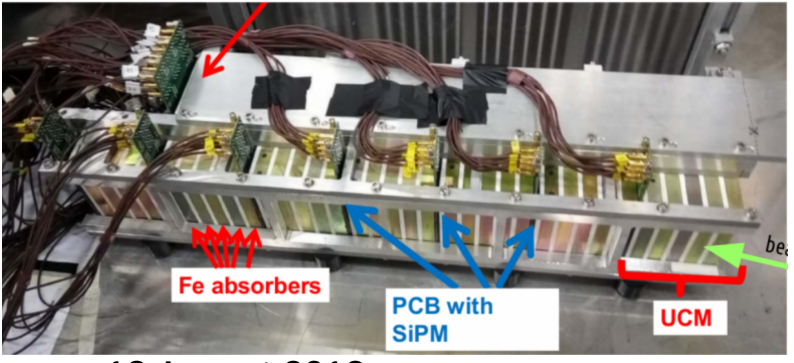
FTPC 2/3

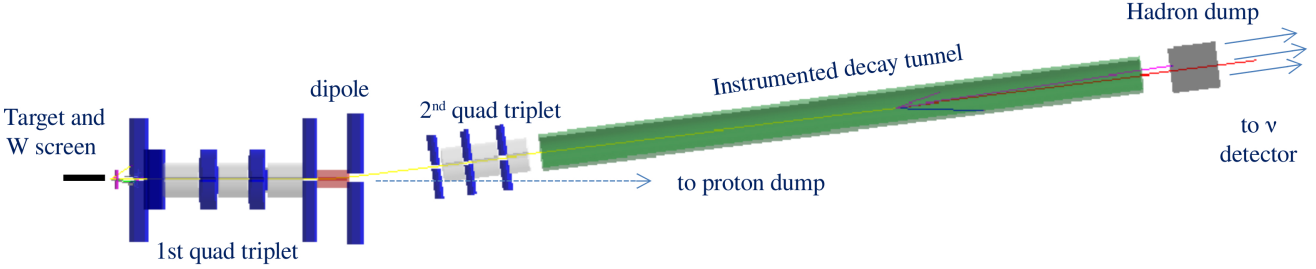
ENUBET – Enhanced NeUtrino BEams from kaon Tagging

G. Brunetti



- Narrow band GeV beam with superior control of neutrino flux
- Designed for 1% precision measurement of neutrino cross sections
- First end-to-end simulation of beamline & positron reconstruction simulation
- Decay tunnel instrumentation identified





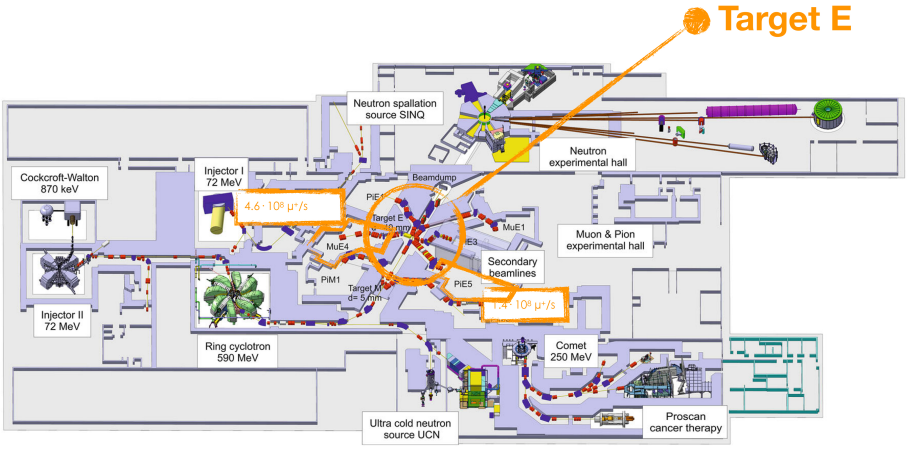
Muon Beam Facilities (with WG4)

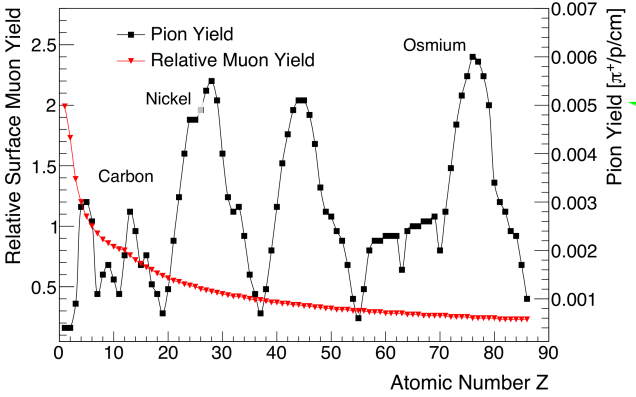
1) Towards a High intensity Muon Beam (HiMB) at PSI – Angela Papa
2) Status of the Facility/Accelerator/Beam-line for Muon Programs at J-PARC – Hajime Nishiguchi
3) Cold Muonium Beam for Atomic Physics and Gravity Experiments – Anna Soter
4) Commissioning and First Results of the Fermilab Muon Campus – Diktys Stratakis

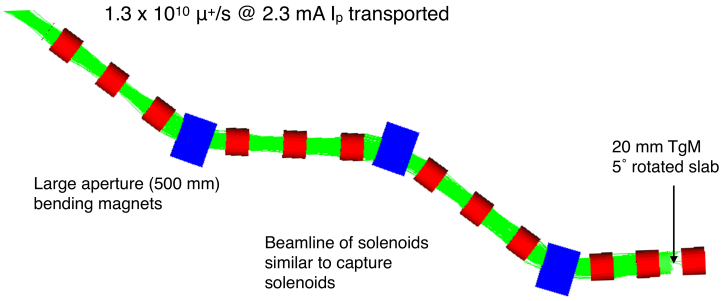
Towards a High intensity Muon Beam (HiMB) at PSI

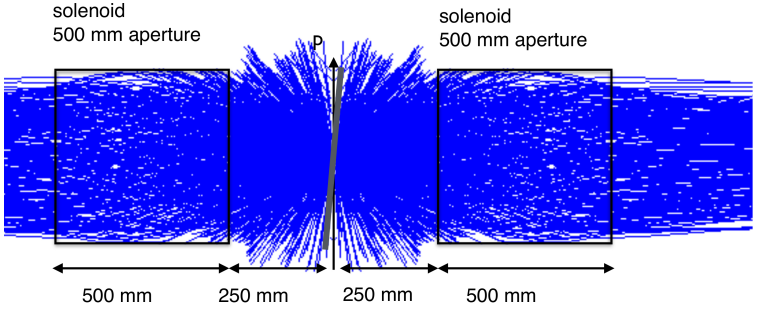
A. Papa

- Aims at surface high intensity muon beam O(10^{10} muons/s)
- DC beam for cLFV, μSR, and future muon based experiments
- Beam optics and proton beam modifications underway
- Optimization of target done, capture & final focusing ongoing



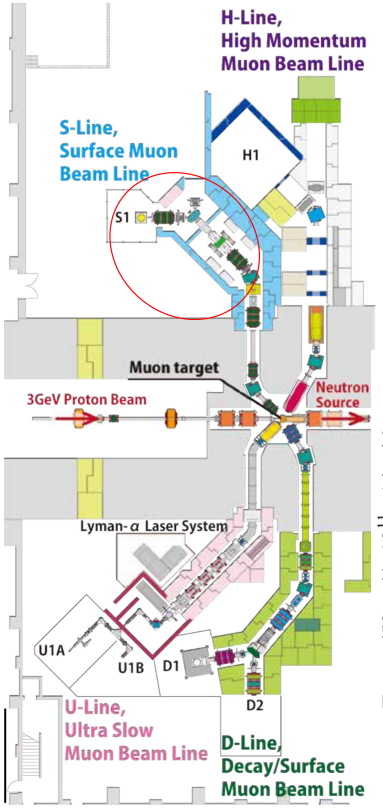




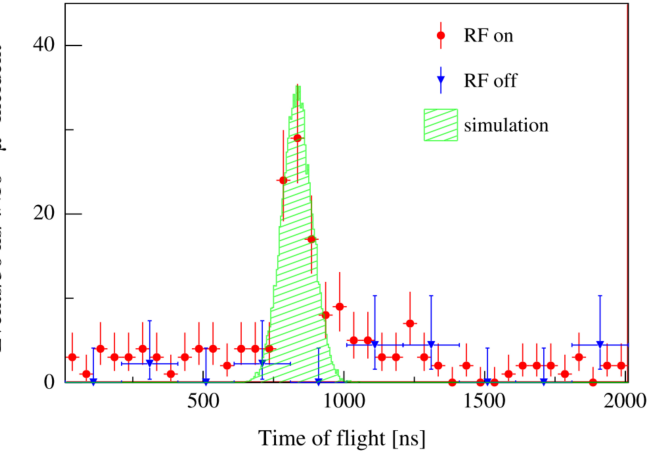


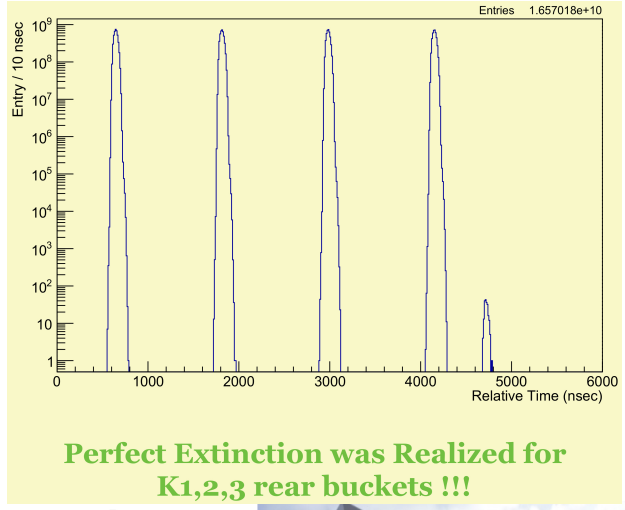
Status of the Facility/Accelerator/Beam-line for Muon Programs at J-PARC

H. Nishiguchi

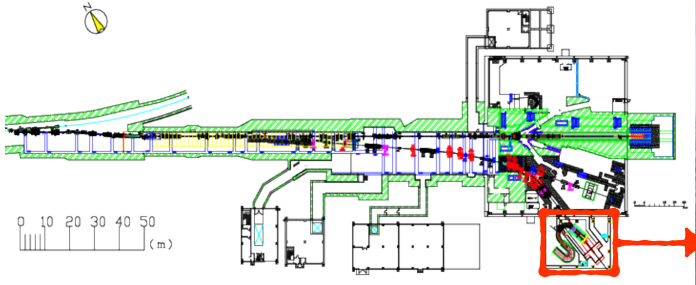


- Two new beamlines & COMET under construction for muon programs at J-PARC
- g-2/EDM, MuSEUM, DeeMe experiments planned
- First muon acceleration by RFQ
- 8 GeV extinction studies done



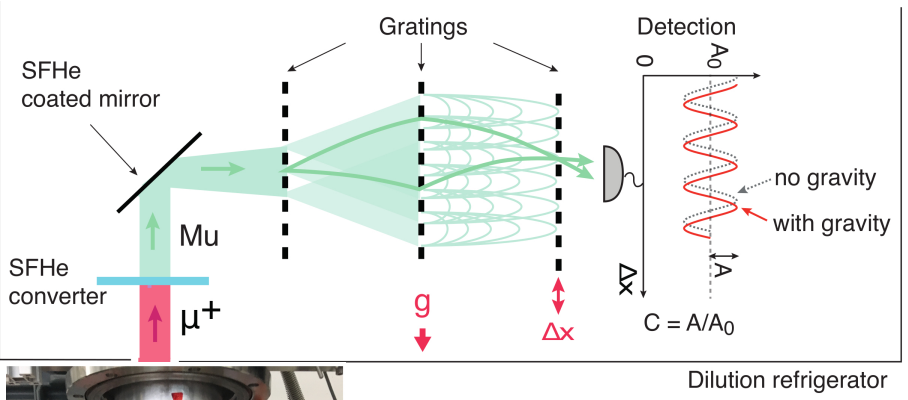


Perfect Extinction was Realized for K1,2,3 rear buckets !!!

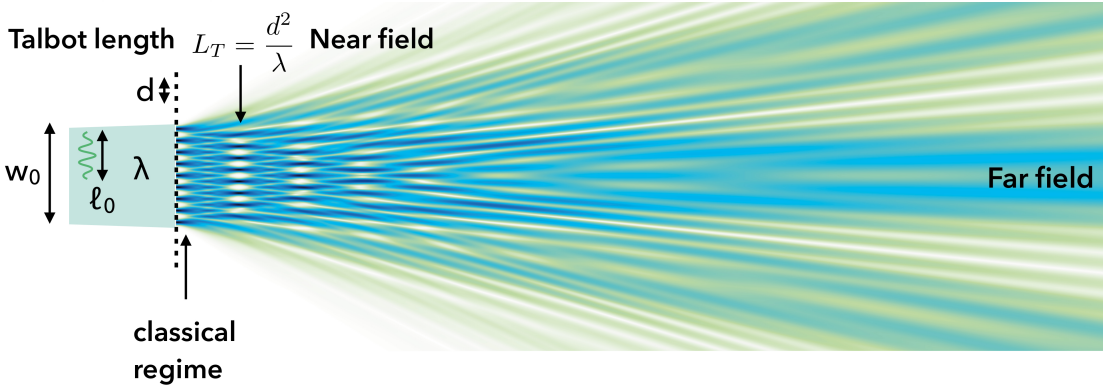


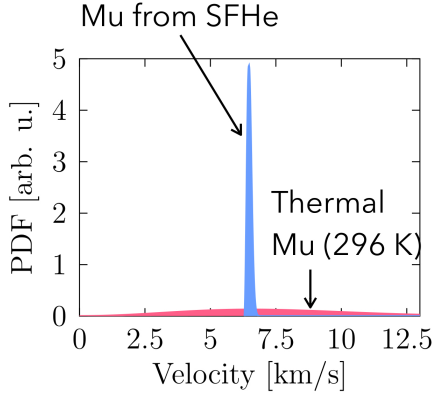
Cold Muonium Beam for Atomic Physics and Gravity Experiments

A. Soter



- Goal is to measure effect of gravity on antimatter using muonium
- Send μ^+ through superfluid helium to make muonium, then through gratings to interferometer
- Short lifetime dictates small grating, many atoms, large contrast
- Far field will be measured; beam quality dictates contrast

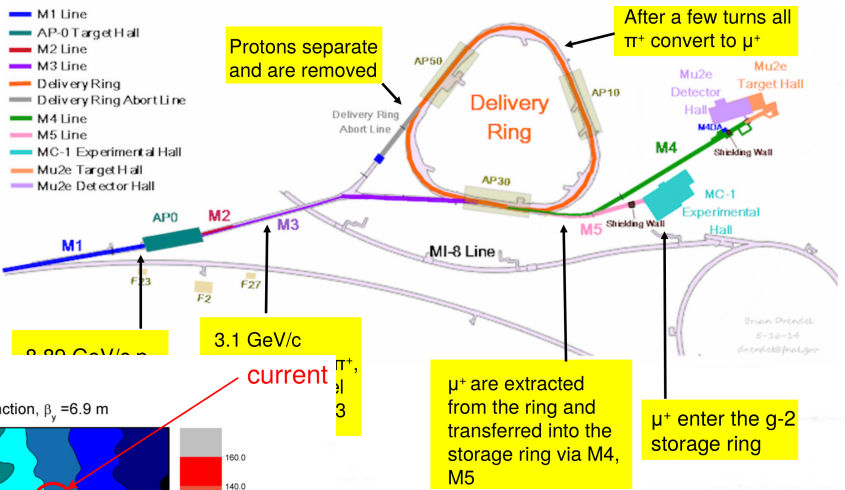


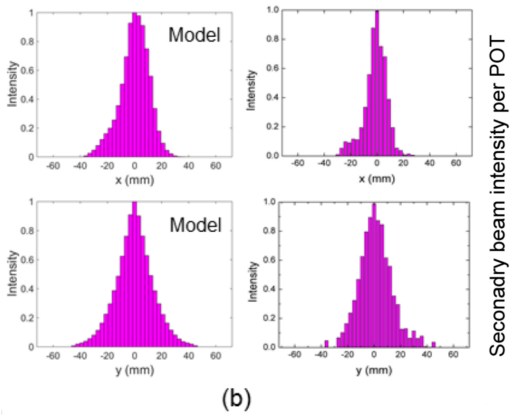


Commissioning and First Results of the Fermilab Muon Campus

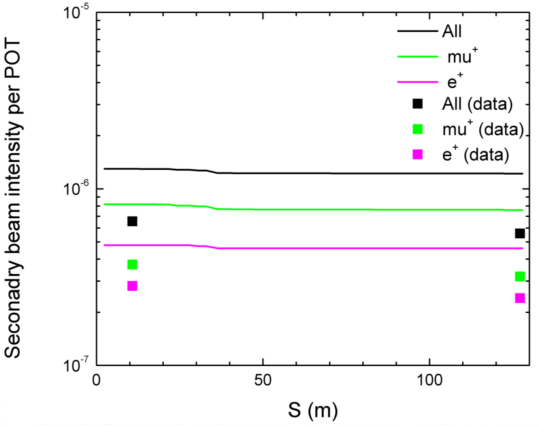
D. Stratakis

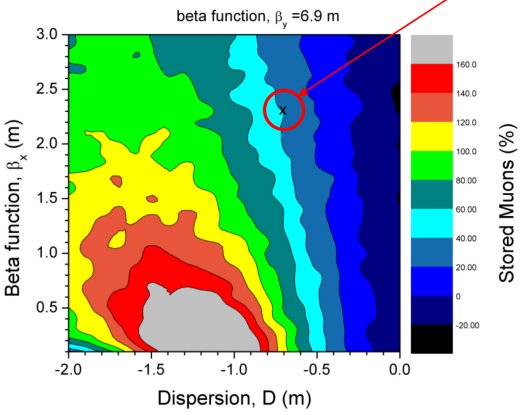
- Muon g-2 beamline performing as expected up to injection line
- Simulation tools agree with measurements
- Transmission to g-2 ring not yet at design value
- Upgrade plans for wedge cooler in g-2 beamline





(b)



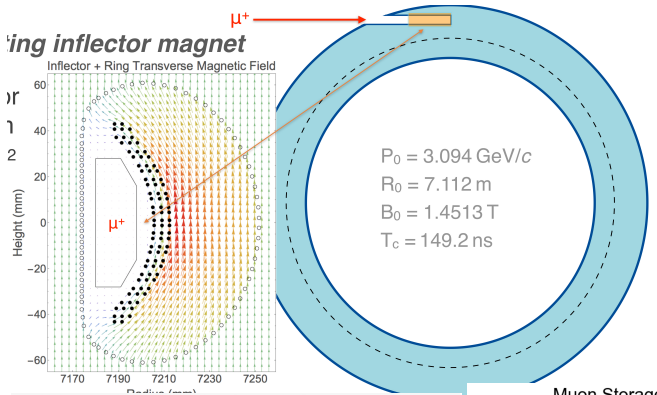


Muon g-2 & IsoDAR

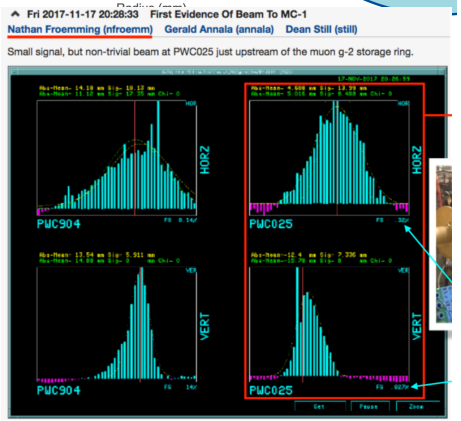
1) The Muon g-2 Beamline – Nathan Froemming
2) The Proton Driver for IsoDAR – Joe Smolsky

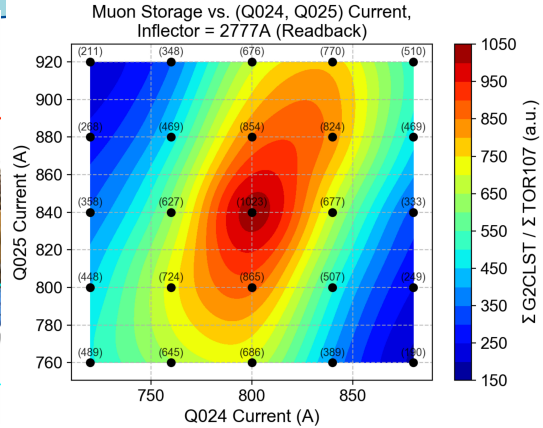
The Muon g-2 Beamline

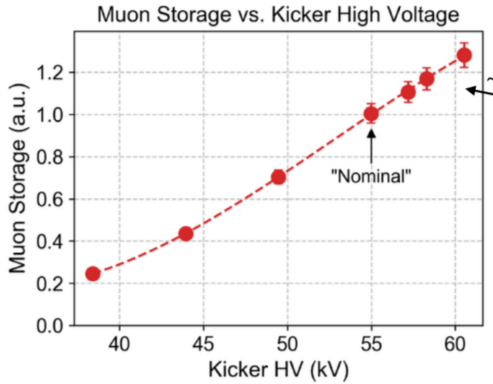
N. Froemming

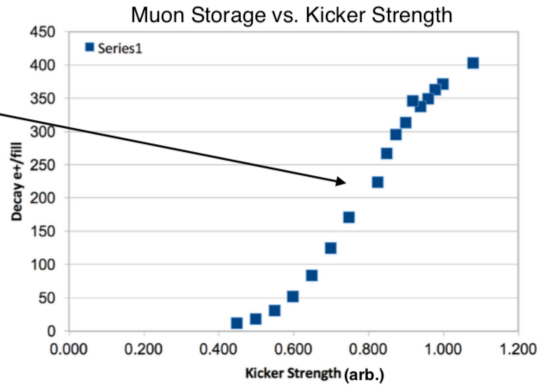


- Injection into g-2 ring accomplished by superconducting inflector magnet & fast pulsed kicker magnets
- First beam in ring Nov. 2017
- Beam tuning automation well developed
- Incorrect kicker strength identified and corrected





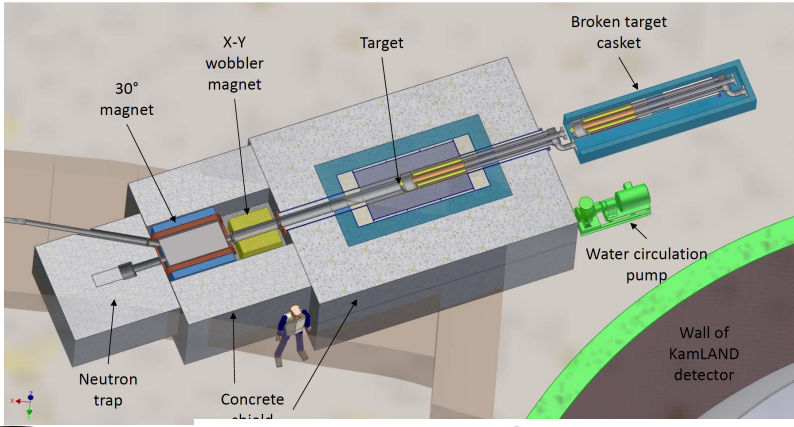


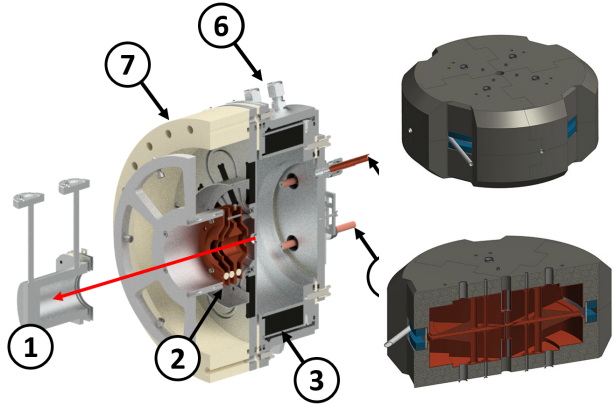


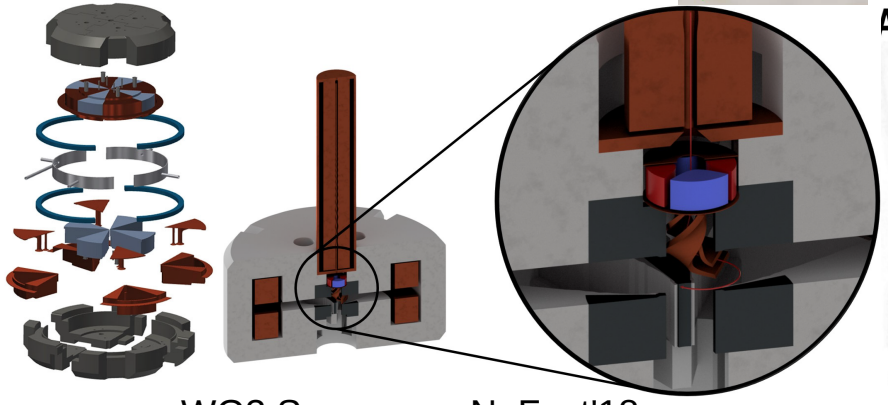
The Proton Driver for IsoDAR

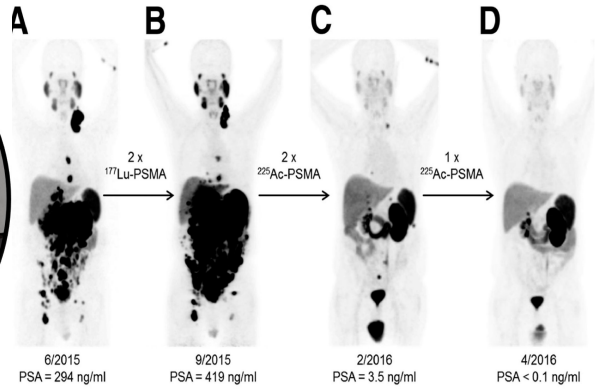
J. Smolsky

- High intensity proton beam used to produce neutrinos near detector for sterile neutrino searches and scattering experiments
- Ion source, RFQ, inflector, & cyclotron designs progressing
- Could be used as injector for DAEδALUS
- Medical isotope production possible









Thank you to all WG3 Participants!