Synergies

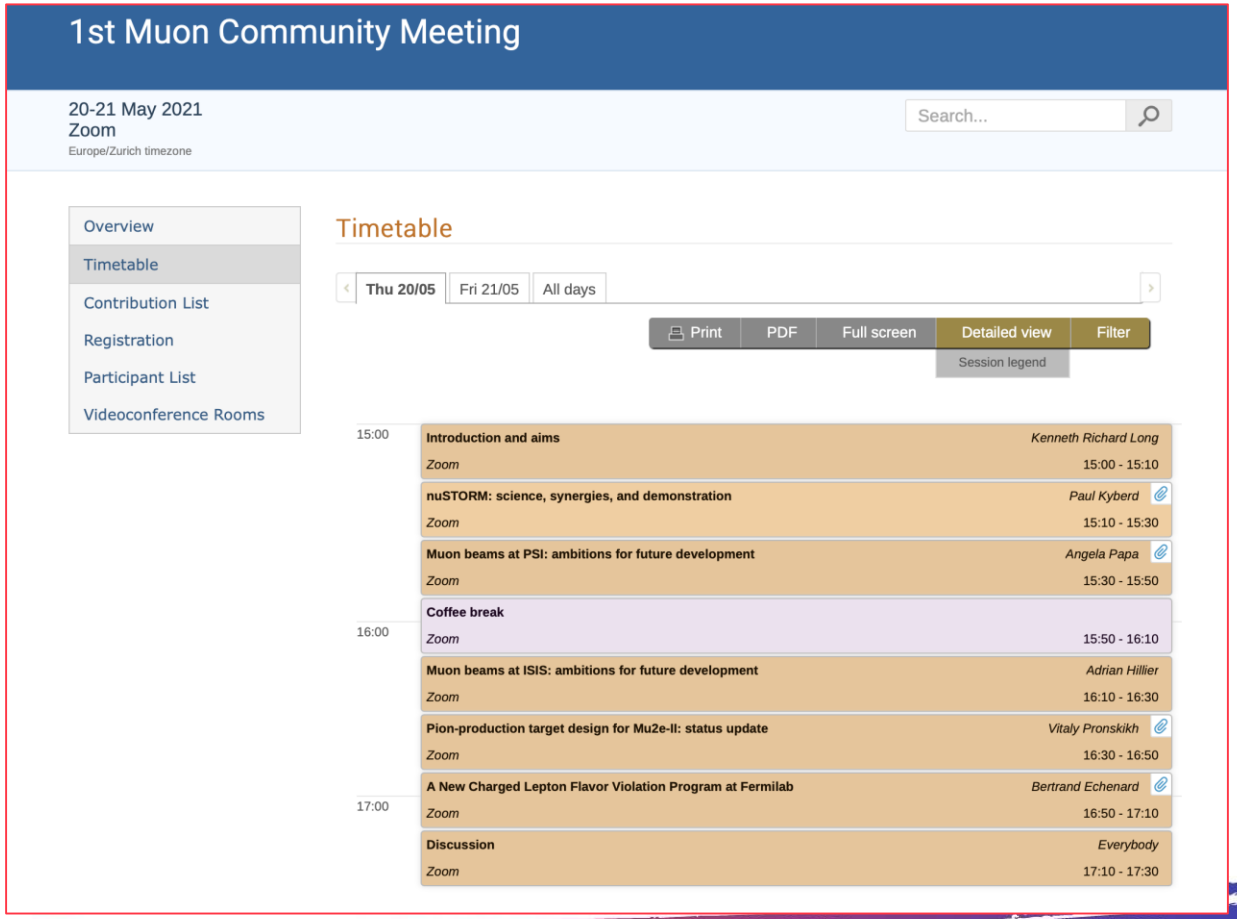
Kenneth Long
Imperial College London/STFC

Synergies

- Synergies:
  - R&D that creates enhanced capabilities to the benefit of:
    - The development of a high energy (multi-TeV) muon collider *and*
    - Another first-rank scientific, innovative, or impactful programme

- Creation of world-class science with intense muon beams
  - As demonstrators, technology test beds, & to create community

Our session at the 1st Muon Community meeting



1st Muon Community Meeting

20-21 May 2021
Zoom
Europe/Zurich timezone

Search...

Overview
Timetable
Contribution List
Registration
Participant List
Videoconference Rooms

Timetable

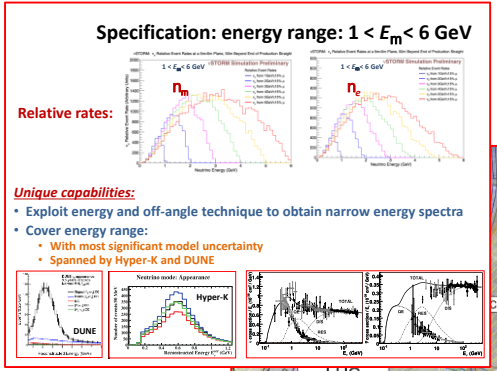
Thu 20/05 | Fri 21/05 | All days

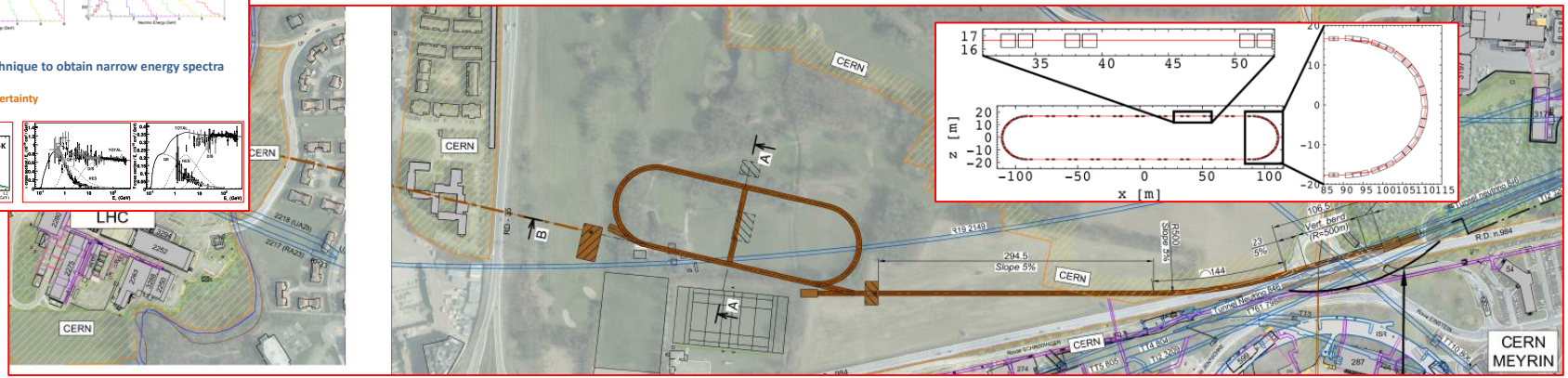
Print | PDF | Full screen | Detailed view | Filter

Session legend

15:00	Introduction and aims	Kenneth Richard Long	15:00 - 15:10
	nuSTORM: science, synergies, and demonstration	Paul Kyberd	15:10 - 15:30
	Muon beams at PSI: ambitions for future development	Angela Papa	15:30 - 15:50
	Coffee break		15:50 - 16:10
16:00	Muon beams at ISIS: ambitions for future development	Adrian Hillier	16:10 - 16:30
	Pion-production target design for Mu2e-II: status update	Vitaly Pronskikh	16:30 - 16:50
	A New Charged Lepton Flavor Violation Program at Fermilab	Bertrand Echenard	16:50 - 17:10
17:00	Discussion	Everybody	17:10 - 17:30

nuSTORM; Paul Kyberd



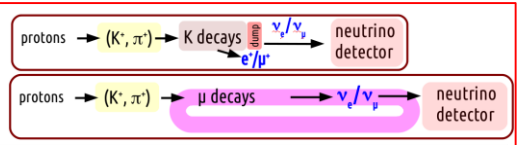


- Specification: stored muon energy: $1 < E_\mu < 6$ GeV
  - ESS implementation offers low-energy option: $E_\mu \sim 0.5$–1 GeV
- Synergies, various:
  - Target, capture, beam preparation, storage ring instrumentation, FFA magnets, neutrino radiation

nuSTORM, ENUBET, …

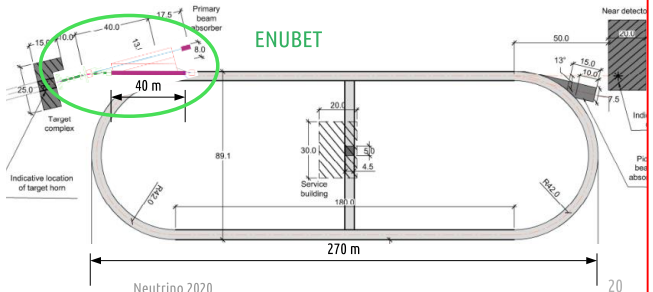
Andrea Longhin, Neutrino 2020

nuSTORM & ENUBET



	Decay region	Hadron dump	Proton extraction	Target, sec. transfer line, p-dump	Neutrino detector
ENUBET	~40 m. Instrumented.	Yes. Dumps muons in addition preventing a (small) ν_e pollution to K_{e3} - ν_e	Slow, 400 GeV (flexible)	Yes, similar	~100 m (some flexibility)
nuSTORM	Replaced by straight section of the ring (180 m).	No. Muons are kept: the most interesting flux parents.	Fast, 100 GeV	Yes, similar	> 300 m from target (ring straight section)

- Different concepts, budget, geometry.
- Main synergy: target facility, 1st stage of meson focusing, proton dump.



A. Longhin Neutrino 2020 20

Opportunity …

Exploit synergies:
Articulate the need

Common requirement:
Advanced neutrino detector

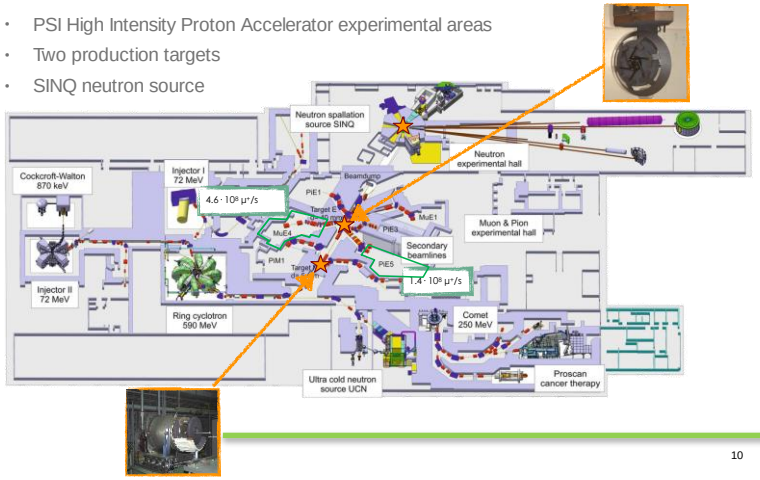
PBC study group:
Ongoing discussion

PSI & synergy; Angela Papa

- High-intensity muon beam

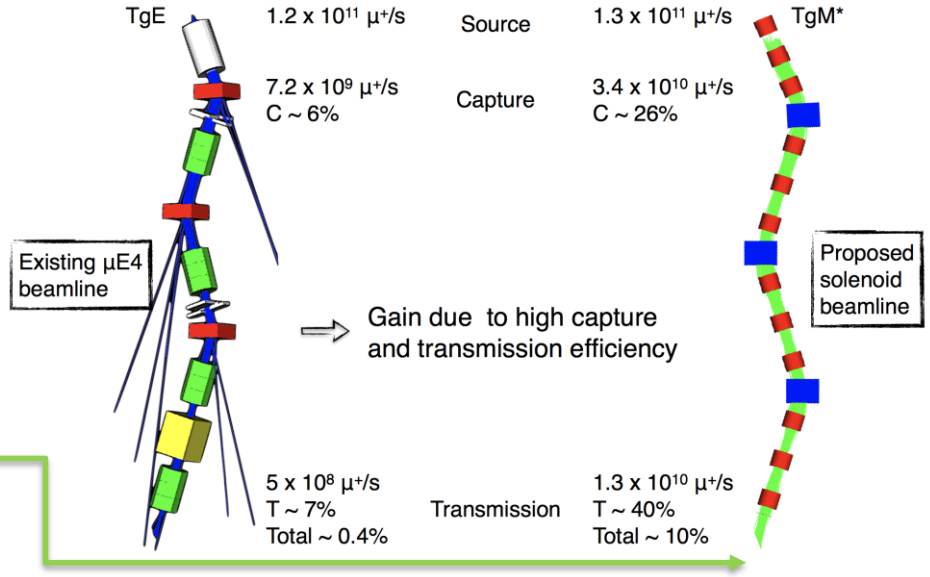
The world's most intense continuous muon beam

- PSI High Intensity Proton Accelerator experimental areas
- Two production targets
- SINQ neutron source



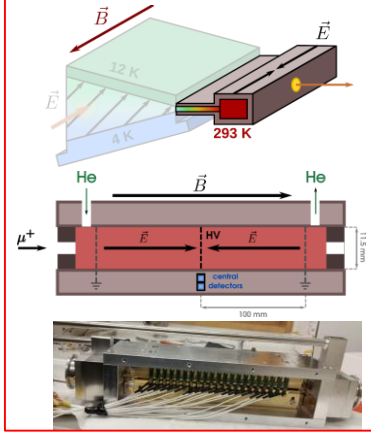
10

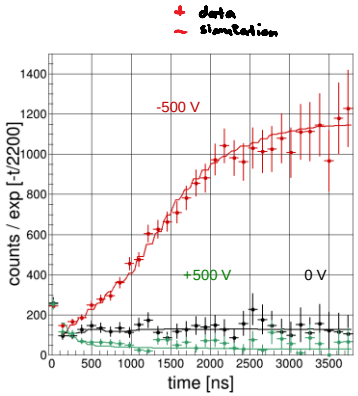
- Aim: O(10^{10} muon/s); Surface (positive) muon beam (**p = 28 MeV/c**); **DC** beam
- Time schedule: **O(2025)**



Alternative, ice-cold, muon source

- Separately longitudinal and transverse compression: **PROVED**
- **Very good agreement between data and simulations**





- Excellent progress cooling μ^+
- Seek solution for μ^-
- Will consider feasibility of $\mu^{+/-}$ source for muon collider

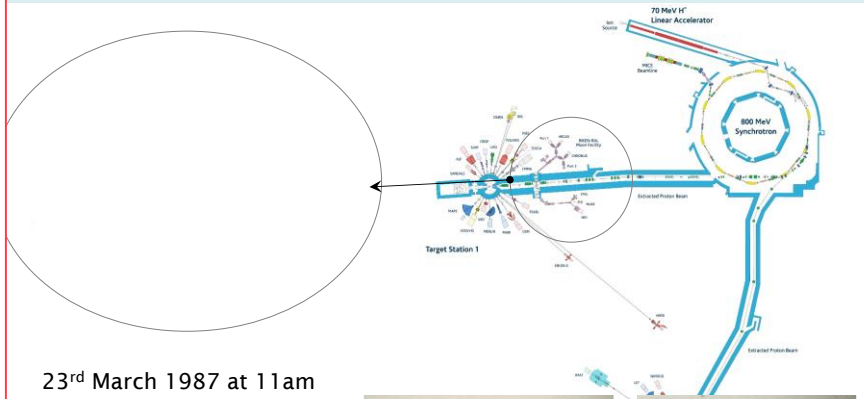
A. Papa: PSI seeks to contribute:

Open questions - We have asked ourself about (discussion just started):

Can HiMB&muCool contribute on this program?
Can a low energy high-brightness negative muon beam be produced?
What about a muon collider/accelerator concept based on low energy high-brightness muon beams subsequently re-accelerated?

Muons at ISIS: Adrian Hillier

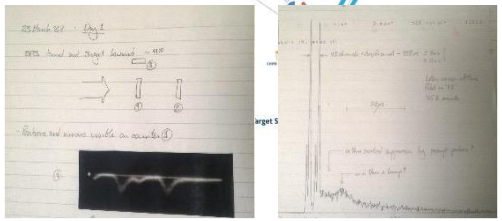
Muons at ISIS



23rd March 1987 at 11am

Since then 3 ISIS Instruments
4 beam ports on RIKEN Side

Over 1200 publications



Cite this article: Hillier AD, Lord JS, Ishida K, Rogers C. 2019 Muons at ISIS. *Phil. Trans. R. Soc. A* **377**: 20180064. http://dx.doi.org/10.1098/rsta.2018.0064

Current Projects

Super-MuSR: a new instrument for muon spectroscopy
- Muon pulse slicer
- Large area detector array
- spin rotator

MuX: a new instrument for muonic X-ray measurements
- Large area HPGe detector array

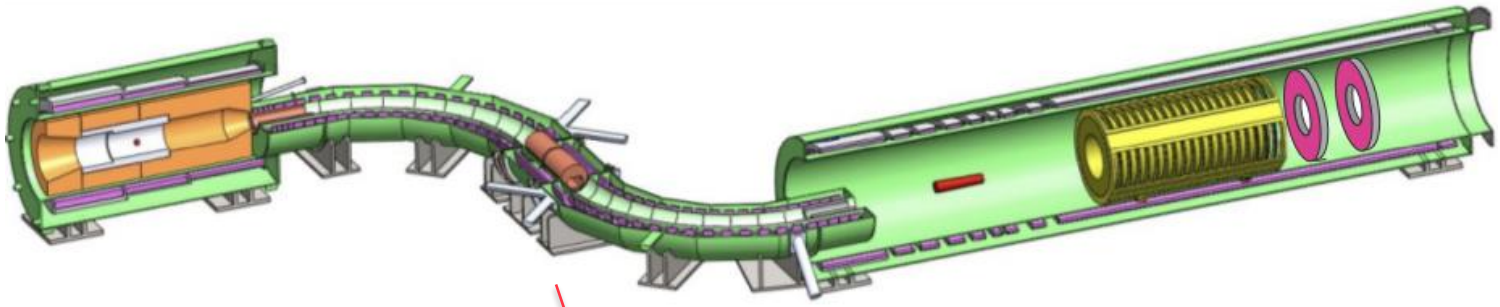
Future Projects:
- target developments
- smaller spot focusing
- superconducting solenoid replacement
- feasibility for RIKEN front end quad replacement
- muon and positron tracking
- beamline diagnostics

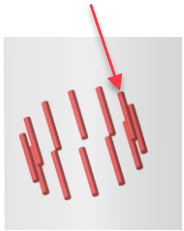
ISIS-II
- The world is our oyster!

Science & Technology Facilities Council
ISIS

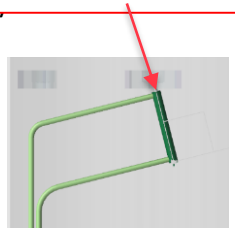
- Clear common interest in a number of areas:
  - Working with UK muon & muon collider community to create resonance

Mu2e upgrade: Vitaly Pronskikh

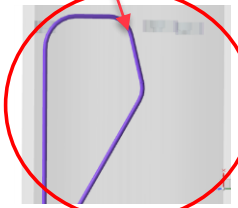




Pros: radiation damage can be distributed over many rods
Cons: its hardware would require a significant space inside the bore (complicates cooling and muon flow)



Pros: small space required
Cons: peak DPA (MARS15) >300/yr; gas cooling cannot be performed efficiently



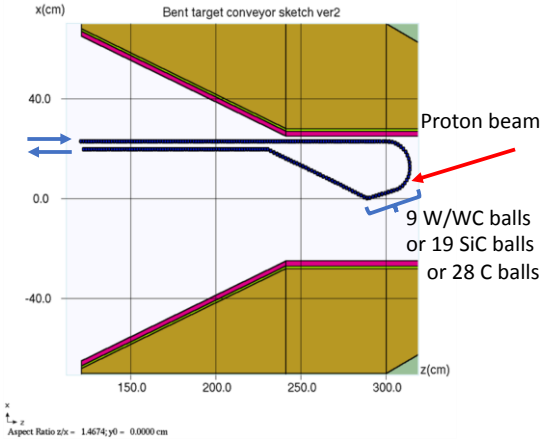
Pros: small space required; He gas could be used for both cooling and moving elements inside conveyor; radiation damage can be distributed; Cons: technical complexity (prototyping needed)

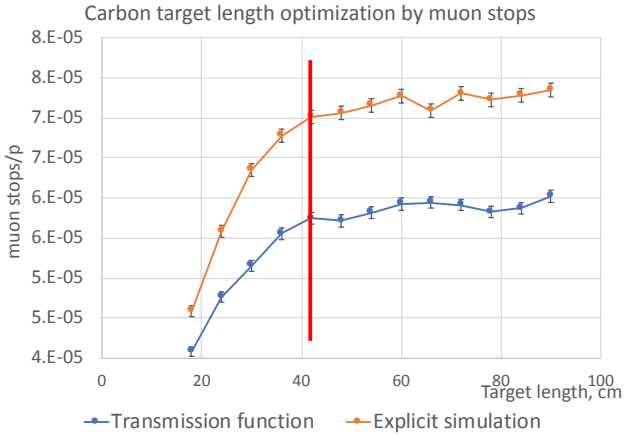
Pion-production target for Mu2e-II | V.Pronskikh

- Upgrade for PIP-II era
- Target upgrade critical

Synergy

Conveyor target length optimization





Rball=0.75 cm; ! = 0.1 cm

Based on muon stopping rate studies with MARS15 and G4beamline optimal target lengths were determined to be: 28 balls (C target), 9 balls (W and WC targets), 19 balls (SiC); MoGRCF was studied. Agreement between transmission and explicit allows saving computation time.

- Clear synergy with target in solenoid design

New muon programme for FNAL; Bernard Echenard

PIP II at FNAL

PIP II

800 MeV H− linac
- Up 165 MHz bunches
- Up to 2 mA CW
- Up 1.6 MW

Upgraded Booster
- 20 Hz, 800 MeV injection
- New injection area

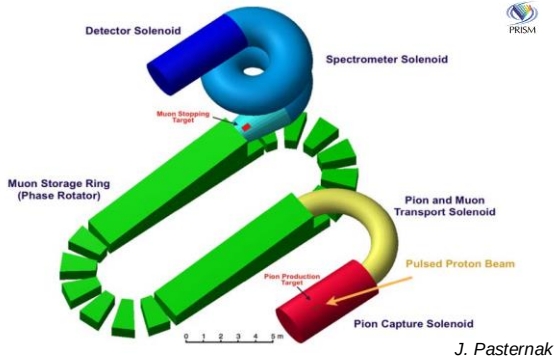
Upgraded Recycler & Main Injector
- RF in both rings

Protons for the High Energy Program
- ~1% of available beam!

Groundbreaking for project in March 2019

PIP-II will deliver 1.2 MW proton beam for LBNF, but that program uses a very small fraction of the available beam → opportunity for a muon facility

PRISM – conceptual design



J. Pasternak et al.

- High-flux muon programme being developed for PIP-II era

Synergies

PRISM – challenges and synergies

FFA ring design

- in full synergy with the Neutrino Factory and a Muon Collider

Target and capture system

- MW class target in a solenoid
- in full synergy with the Neutrino Factory and a Muon Collider studies

Design of the muon beam transport from the solenoidal capture to the PRISM FFA ring

- very different beam dynamics conditions
- very large beam emittances and the momentum spread

Muon beam injection/extraction into/from the FFA ring

- very large beam emittances and the momentum spread

Compressor ring

- Fast kicker to transfer beam from compressor ring at 1kHz

Many synergistic activities with muon collider and neutrino factory

PRISM is in a position to be one of the incremental steps of the muon program

B. Echenard, 1st Muon Community Meeting, zoom, 20-21/05/2021

15

Next steps

- Second meeting; engage with Asia:
  - COMET, PRISM, …

- Consolidate places were R&D programme can benefit muon physics activities beyond the muon collider