nuSTORM

Common requirements

νSTORM

- What is νSTORM
- What is νSTORM looking for
- Muons as a tool for fundamental discoveries and analytical science
- Properties of an "ideal" muon source
- How νSTORM could contribute to the development of such a source

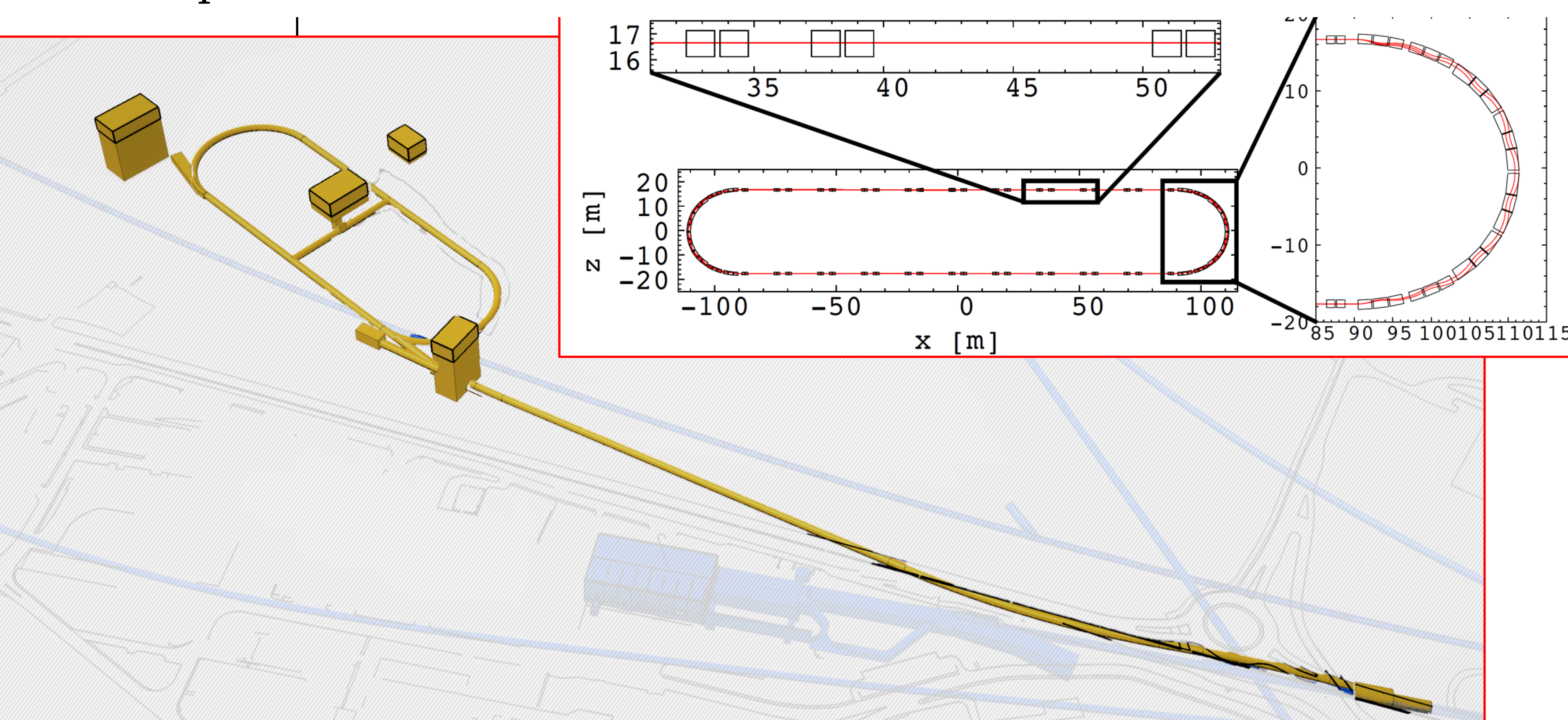
Proton beam … fast extraction at 100 Gev. CNGS-like

Target and Capture – based on FNAL scheme

Low Z target in magnetic horn; pair of quads collect particles

Graphite target: based on CNGS

Transport based on scheme for AD in the PS



νSTORM machine

Pion beam injected into a storage ring.

Ring capture and coast – components a natural step up from existing systems

ν_e and $\overline{\nu}_\mu$ beams produced - pure

No $\overline{\nu}_e$
ν_μ time separated

Beams from 1 to 6 GeV with a 15% momentum bite, parabolic around the mean value

Beam intensity known to 1%

Charge conjugate running

νSTORM Physics

Cross section $\nu_e\ \overline{\nu_e}\ \ \nu_\mu\ \overline{\nu_\mu}$

High Luminosity allows precision

Oscillation measurements
Sterile and non-sterile

Beam purity allows excellent control of systematics

Measurement synergy with long baseline

Charge conjugate running

Probing fundamental physics

Mu3e, μEDM, g-2, MEG μeγ,

$\mu\,\bar{\mu}$ oscillations: current best measurement is from $4.9*10^{13}$ μs

Muon collider, ν–Factory

Atomic Parity Violation in muonic atoms

Analytical Tools for material science

μSR

MIXE – muon induced X-ray Emission – extension of the well established PIXE (proton) technique – elemental sensitivity is parts per billion

current best measurement is $8*10^6$ per second at 26 MeV and 1730 hours running.

PIXE applications
chemistry,medicine biology, archaeology, agriculture, materials science, fisheries science, geology, petrology,environmental study, contamination monitoring, resource search, semiconductors, metal, astrophysics,earth science, criminal investigations, and food.

From HIMB physics workshop April 2021

Difficult to produce and control

Tertiary beams

Short lifetime

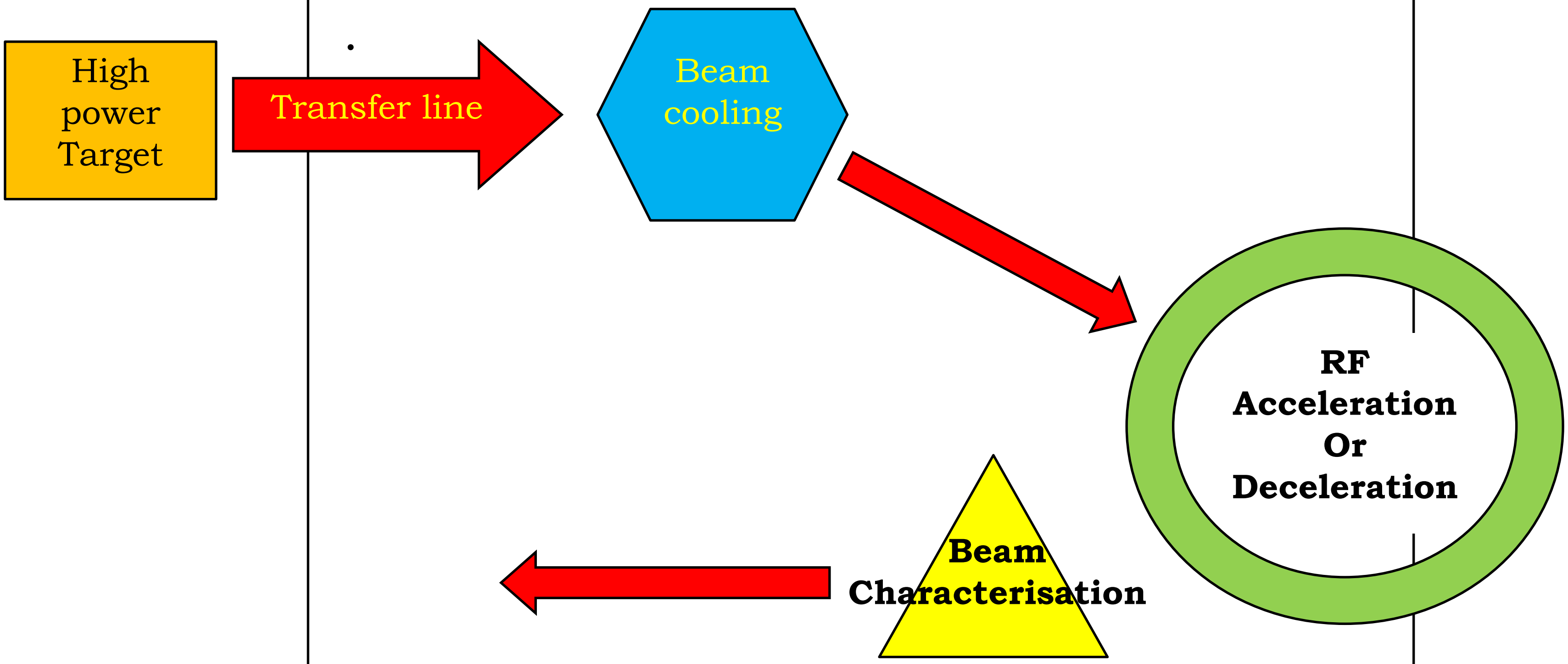
Beam quality

Radiation hazard – during transport

Highly penetrating

Most potential uses gain from high intensity, low emittance, well characterised beams

Ideal Muon Source



High powered target
Transfer line – uncooled beam
Cooling (if required)
Transfer line – cooled beam
RF manipulation

The beam of your dreams

νSTORM

Needs and opportunities

Source

A high intensity source
But not that much beyond current sources
Experience and developments

Transfer line

From the source to the νSTORM ring
Working in the muon decay environment, study mitigation techniques with a medium intensity beam

High enough to test mitigation techniques, low enough that they are not essential

νSTORM Ring

Circulating beam:

study of radiation problems.
beam diagnostics.

Muon Radiation Hazard

Operation in, and mitigation of high muon radiation environments

Decay length of a beam is $\frac{p_\mu c\tau}{m_\mu}$

Energy deposited per unit length $\frac{E_\mu m_\mu}{p_\mu c\tau}$

$p_\mu/E_\mu = \beta$ β is 0.9 by 216MeV

Energy/m ~ $\frac{m_\mu}{\beta\tau}$

Measurements at νSTORM are applicable everywhere.

Beam Intensity

Measure beam intensity … this is an important requirement for νSTORM

First opportunity to make the measurement in high energy ring environment.

We will have a methods, but the ring will be available to try new methods and compare with existing techniques

- Wire scan
- Gas jet target
- Electron beam
- Backscattered photons
- Electron halo
- Beam pickups

A testbed for beam measurement

At various energies

Conclusion

Creating high intensity, well focussed and characterised muon beams, brings potential for fundamental investigations and tools for analytical investigations in material science.

In the course of building and running νSTORM, we will face and solve the problems:
of muon beam transport,
of operation in a radiological environment
of beam characterisation

All of these will find application elsewhere and in some of those future applications, solution of these problems, in the absence of νSTORM, will require building of a test facility of similar capability but without the physics output.