Beam Requiremenets for the Next Generetaion Muon Experiments

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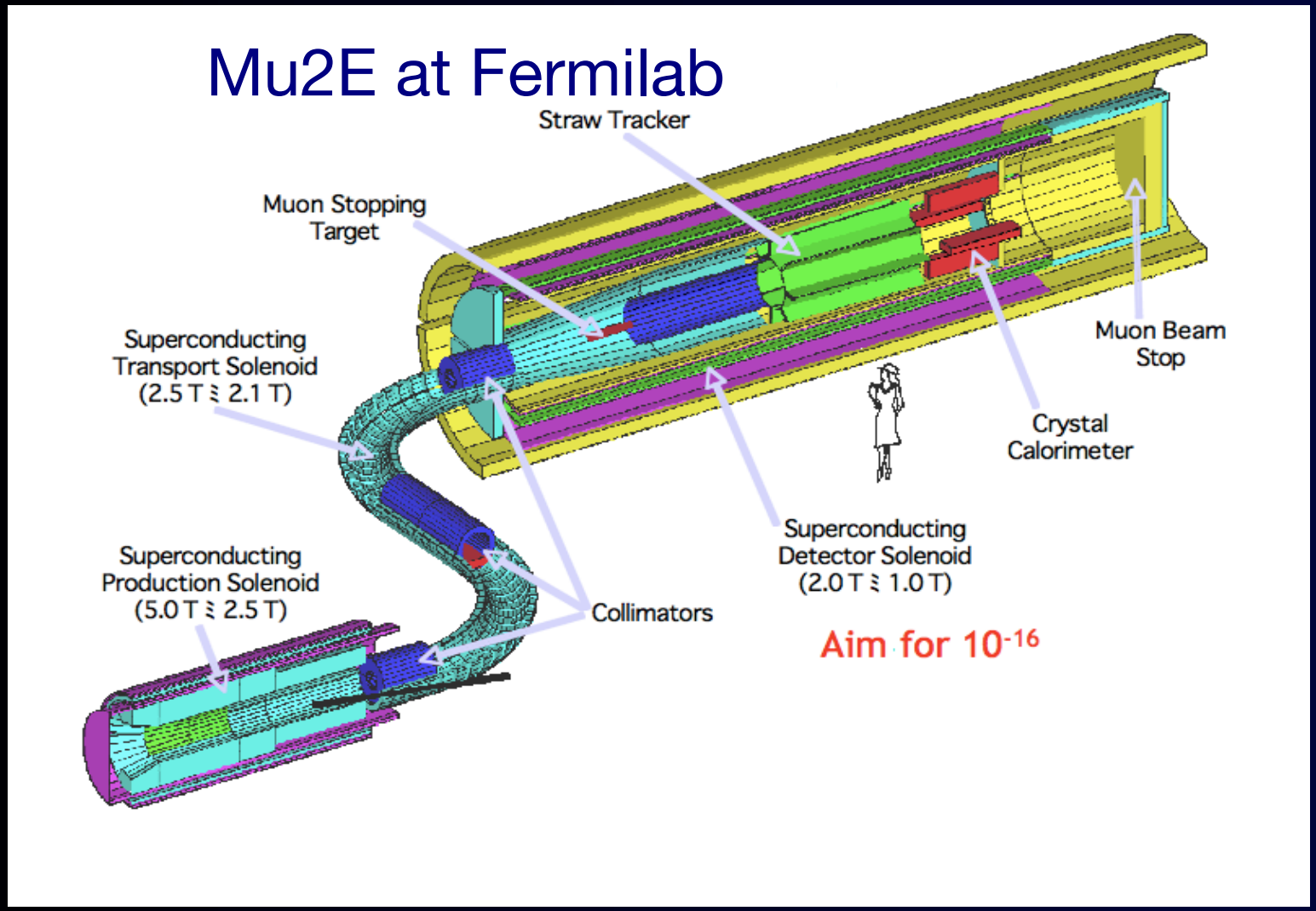
List of Muon Experiments in the World

- muon to electron conversion
  - Mu2e
  - COMET
  - stage-2 Mu2e
  - PRISM/PRIME
- $\mu \rightarrow e\gamma$
- $\mu \rightarrow eee$
- muon g-2
- muon EDM
- muoninum to antimuonium
- muon lifetime

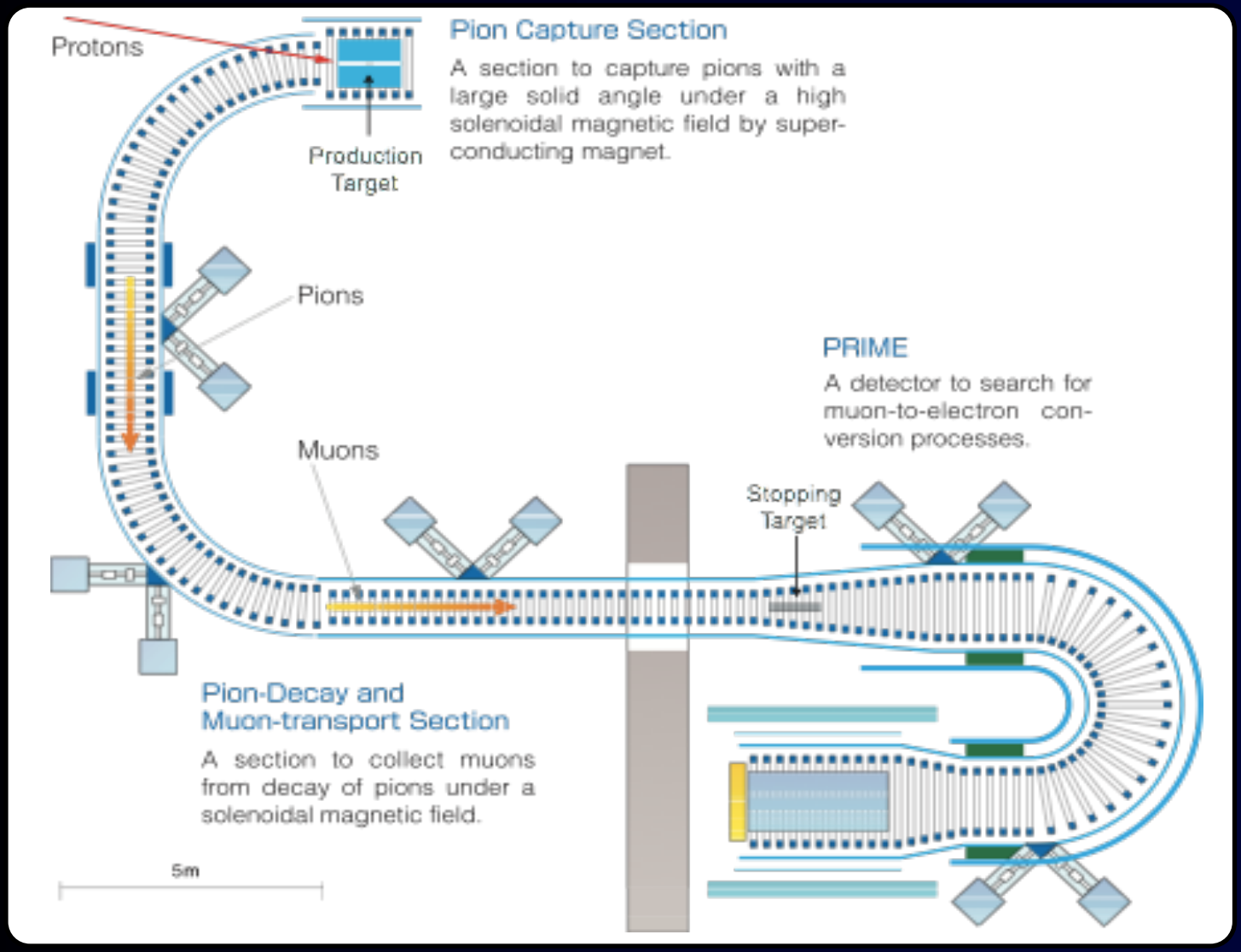
Mu2e at Fermilab



Mu2e

- beam time structure: pulsed
- beam pulse width: <100 nsec (full width)
- beam pulse internval: ~1.7 microsec
- beam extinction: 10^{-9}
- beam power: 20 kW
  - Estimated maximum power:
    100 kW from MECO studies (50% duty)→
    200 kW for Mu2e (90% duty)

COMET at J-PARC



COMET

- beam time structure: pulsed
- beam pulse width: 60 nsec (FWHM)
- beam pulse interval: ~1.3 microsec
- beam extinction: 10^{-9}
- beam power: 50 kW
- duty factor J-PARC MR ~1/3

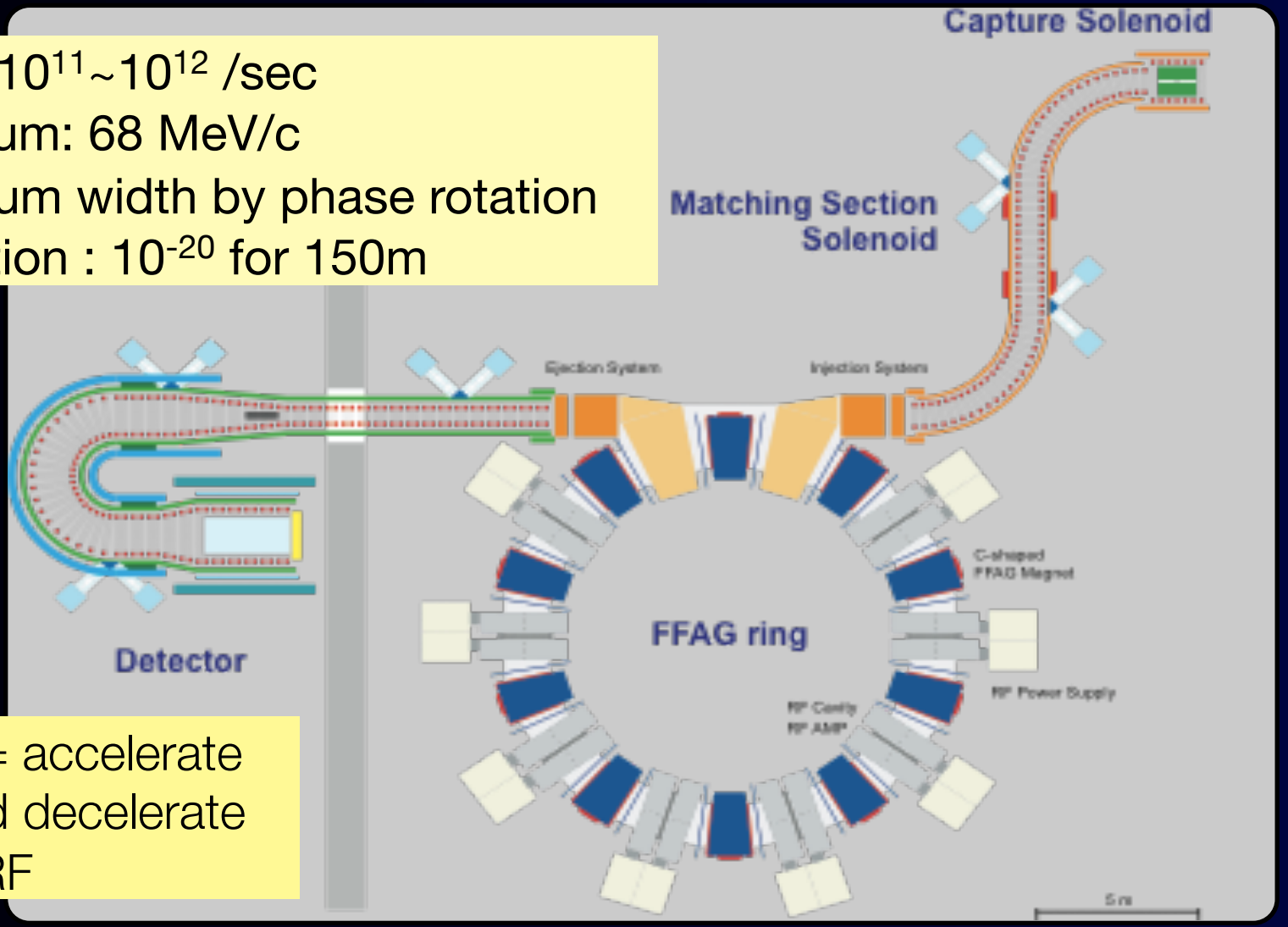
Muon to electron conversion@Project-X

- beam time structure: pulsed
- Beam energy: 2 – 5 GeV
- beam pulse width: <10-30 nsec
- beam pulse interval: 0.3(High Z targets)~2 microsec
  - pion free beam for heavy targets
- secondary beam extinction needed at stopping target (proton beam + muon beam): 10^{-11}
- beam power: 2 MW

PRISM Muon Beam

PRISM=Phase Rotated
Intense Slow Muon source

muon intensity: 10^{11}~10^{12} /sec
central momentum: 68 MeV/c
narrow momentum width by phase rotation
pion contamination : 10^{-20} for 150m



Phase rotation = accelerate slow muons and decelerate fast muons by RF

PRISM

- beam time structure: pulsed ~ 10 (fast) - 500 (slow) kHz
- Beam energy: 2-5 GeV
- beam pulse width: <10 nsec
- beam pulse repetition: detemined by a kicker magnet for the FFAG muon storage ring
  - 500 kHz (need optimization)
  - 1 - 10 kHz (need inputs from kicker experts)
- beam extinction: 10^{-11}
  - proton beam extinction + muon beam extinction
- beam power: 2 MW

$\mu \rightarrow e\gamma$

- beam time structure: DC (or pulsed protons, tau (beam) <tau(muon)
- charge: positive
- surface muon beam (28 MeV/c)
- beam intensity: 10^8 /sec for BR<10^{-14}
- Overall rate limited by rates in detectors, accidental coincidences
- Proton beam energy: 2 GeV better than 8 GeV per Striganoff
- ? 1 MW ?

$\mu \rightarrow$eee

- beam time structure: continuous (or pulsed with tau (beam)<tau(muon)
- charge: positive
- beam intensity: 10^8 /sec for BR<10^{-14}
- Similar to $\mu \rightarrow e\gamma$ beam requirements

muon g-2 (BNL method at magic momentum)

- beam time structure: pulsed
- beam pulse width: <50 ns
- beam pulse interval: 1 ms
- Magic momentum requires 3 GeV/c muons
- Go to a backward muon beam? (less background, need ~5 GeV pions)
- Negative polarity (factor of three less mu- than mu+ at 8 GeV)
- Reduce storage ring aperture to reduce uncertainty in average B field at cost of stored beam intensity
- Extinction <1e-3
- Beam energy 8 GeV
- Beam power 200 kW

muon g-2 with cold muons

- beam time structure: pulsed
- beam pulse width: ?
- beam pulse interval: ~10 microsec (?)
- beam extinction: 10^{-9}
- Need lots of beam: cold muons made by laser ionization of muonium

muon edm

- beam time structure: pulsed
- beam pulse width: <50 ns
- beam pulse interval: ~10 microsec
- beam extinction: 10^{-9}
- Muon momentum < 700 MeV/c
- Beam energy 1-8 GeV
- 2 MW

muonium to antimuonium conversion

- beam time structure: pulsed
- beam pulse width: <100 ns
- beam pulse interval: ~1 microsec
- beam extinction: 10^{-9}

muon lifetime

- beam time structure: pulsed
- beam pulse width: <500 ns
- beam pulse interval:10 microseconds
- beam extinction: 1e-5
- 200 kW ?