

Opportunities for Experiments Based on Stored Muon Beams at Fermilab

(in next ~5-10 years, for ~3-20M\$)



Milorad Popovic

*MAP Meeting
May, 2015*



How to get 100k events

- In next year or two there will be stored muon beam at ~ 3 GeV/c in the storage ring with ~ 60 meters long straits (Debuncher ring as g-2 delay beam line).
- There will be ~ 400 CC neutrino events in some imaginary 100 ton detector, 10 meters downstream from the one ring's straits, running for 10^7 sec Booster at 3 Hz, 8 GeV beam (5×10^{12} protons per pulse) and storing muons for 100 turns.
- Numbers in point 2., are g-2 beam , and are just to establish reference point.
- Running (two Booster batches stacked) 120 GeV beam from MI on the same target and using ICARAUS (600 ton) detector for 2×10^7 seconds (Fermilab year) will create 40000 CC neutrino events.

All this is for investment of ~ 10 M\$ in building to house detector and willingness to move ICARUS detector in suggested location!

Motivation

- Measure neutrino cross-section with better than 10% precision
- Take advantage of the existing accelerator complex configuration providing beam to the New Muon g-2 Experiment
- Utilize existing detectors (MicroBooNE, ICARUS)
- Minimize initial investment. Providing a suitable building to house the detector would be the only investment required
- Describe possible improvements in collecting and storing muons that would allow cross-section measurements with a precision of a few percent with a modest additional investment.
- Provide a suitable test facility for future NF

Muon Campus = Mu2e + g-2 + ???



Proton Beam Like for g-2, but with g-2 off

- 5×10^{12} protons in a Booster pulse
- 3 Hz, 8 GeV Booster
- Muons are stored for ~ 100 turns
- Running time 10^7 Sec (1 year)
- 100 ton detector, 10 meters downstream from ring

~ 400 CC neutrino events

This is for about the cost of moving an existing detector (mBooNE??, 60T) and building a new detector housing (about 3M\$)

Looking in the near future (cost~\$3M)

- 1×10^{13} protons from MI (two Booster pulses slip stacked)
- ~ 1 Hz, 120 GeV MI (every 1.33 sec)
- Muons are stored for ~ 100 turns
- Running time 1year(2×10^7 Sec)
- 100 ton detector, 10 meters downstream from ring

$\sim 2/3/1.33 * 120/8 * 2 \times 400 \longrightarrow 6000$ CC neutrino events

So in 10 bins even if detector is only 50% efficient, cross section
Can be measured with error less than 10%

Looking Into the Future (cost~\$10M)



- 1×10^{13} protons from MI (two Booster pulses, slip stacked)
- ~ 1 Hz, 120 GeV MI (1.33 sec)
- Running time 1year(2×10^7 Sec) Fermilab year is $\sim 2 \times 10^7$ Sec
- Larger detector, ~ 500 ton detector(x5) ICARUS is 600 ton

~ 30000 CC neutrino events

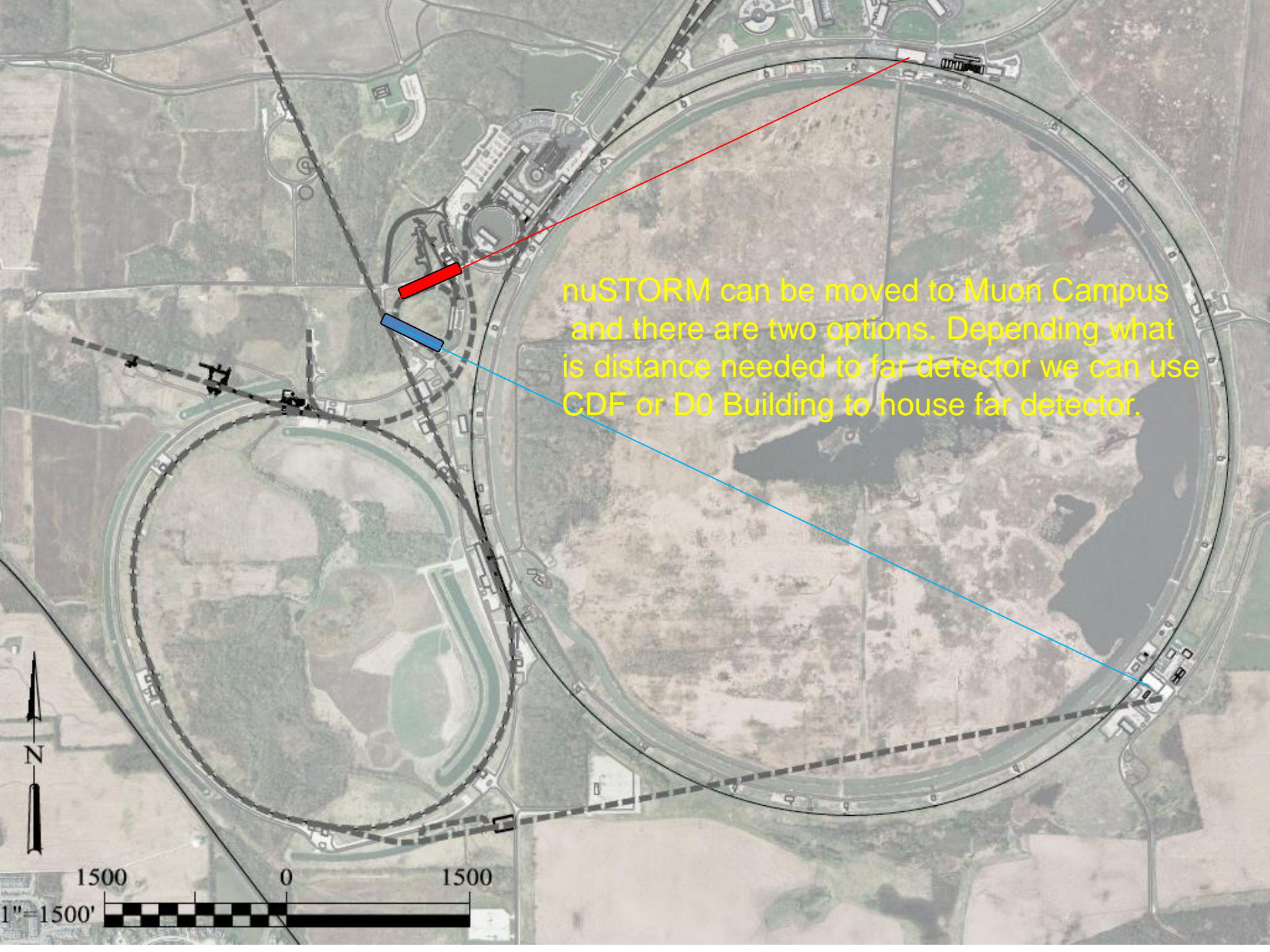
Looking Into the Future (cost~\$??)

- 1×10^{13} protons from MI (two Booster pulses, slip stacked)
- 1 Hz, 120 GeV MI
- New Li lens $r = 2$ cm to increase collection of pi's (x1.5)
CERN has made this size Lens
- Make ring to be racetrack (x1.5x2) Provide a suitable test facility for future NF
- Running time 1year(2×10^7 Sec) Fermilab year is $\sim 2 \times 10^7$ Sec
- Larger detector, ~ 500 ton detector(x5) ICARUS is 600 ton

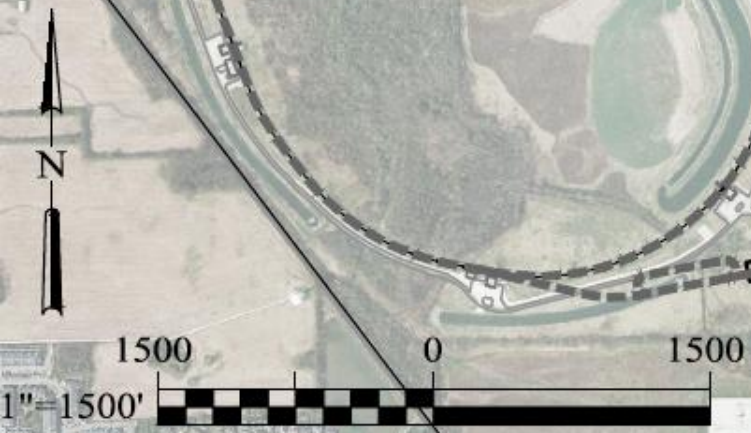
$\sim 100\text{k}$ CC neutrino events

Questions ?

The End and New Beginning
Or
The way to the nuSTORM
(everything is used in upgrade)



nuSTORM can be moved to Muon Campus and there are two options. Depending what is distance needed to far detector we can use CDF or D0 Building to house far detector.



If Far Detector is in CDF



If Far Detector is in D0



Questions ?

May be there is more to all this