Mu2e/Mu2e-II/AMF : Future Fermilab Muon Programme

Key physics deliverables
Mu2e : sensitivity to muon-CLFV in μN → eN to 6 x 10^{-17} at 90% CL (4 orders of magnitude beyond current sensitivity)
Mu2e-II : CLFV (μN → eN) sensitivity to 6 x 10^{-18} or potential to study underlying physics with different targets if Mu2e CLFV observation
AMF : CLFV (μN → eN) sensitivity extended x10-100 that of Mu2e-II; μ → eγ sensitivity x100 that of MEG-II, μ → 3e sensitivity x 20 Mu3e-II.

Please quote the datasets and running/exposure time required for the numbers above.
Mu2e: running/analysis from 2027 - 2035 (including PIP-II shutdown); Mu2e-II: 5 years of data : 2035-2040; AMF: 2040s

Environmental cost of construction
PIP-II is under construction. Mu2e-II needs upgrade to PIP-II. Estimate 25% of PIP-II construction CO2e so 10kt CO2e
AMF will be a more significant construction in 2040s: expect to be ~ PIP-II, so 40 kt CO2e

Environmental cost of operation per year
Total PIP-II operation of which Mu2e uses a ~ 1/3rd subset of (DUNE the majority) is 1.5 kt C02e per year. So Mu2e and Mu2e-II ~ 0.5 kt CO2e/year and expect AMF to be similar.

Estimate of financial costs
Mu2e is already paid for: total R&D/construction cost was ~ $300M (US accounting, so x2 CERN); running costs ~ $5-10M/year (*mostly staff)
Mu2e-II ~ $150M : this is construction + R&D; running costs ~ $5-10M/year.
AMF : PIP-II was a $1B. AMF is a substantial project: compressor to rebunch protons; production solenoid & target; FFAG ring + injection/extraction much of which is applicable to Muon Collider. Cost hasn't really been estimate but likely to be ~ Mu2e if not more : so O($500M) (US accounting).

Does your project plan dedicated submission(s) for the ESPPU
Not yet known - there is likely to be a CLFV submission from Mu2e, Mu3e, COMET

Comparison of physics goals with the current state of the art in the area.
Ultimately 6 - 7 orders of magnitude on sensitivity to muon-CLFV in μN → eN at 90% CL. Mu2e: 4 orders of magnitude; Mu2e-II: 1 more; AMF: 1-2 more. AMF can also extend sensitivity to μ → eγ by x100 that of MEG-II, and μ → 3e sensitivity x 20 Mu3e-II.

List the project's main advantages compared to competitor projects.
Mu2e sensitivity is x100 beyond beyond COMET-I and similar to COMET-II (not yet approved). Mu2e-II has sensitivity beyond any envisaged projects as does AMF and AMF can improve on all three CLFV channels.

Preferred location for the project
Fermilab

Project timeline
Mu2e: running/analysis from 2027 - 2035 (including PIP-II shutdown)
Mu2e-II R&D/construction 2030-2035; Mu2e-II exploitation: 2035-2040
AMF R&D/construction: 2040s

Main risks/obstacles for realisation of physics goals (*e.g. development of new technologies, construction of a new facility*)
Mu2e-II challenge is development of suitable the low mass tracking detectors and production target / solenoid for 100 kW pulsed proton beam vs 8 kW at Mu2e.
AMF is a new facility requiring new accelerator infrastructure: compressors to rebunch protons; FFAG ring to operate in both pulsed and continuous mode for the different CLFV channels.

Anticipated area(s) of UK involvement
Low mass detectors for Mu2e-II (and AMF). Also synergy with muon collider R&D for AMF notably FFAG ring & production target.

Total number of FTE/year required for construction/operation. What is expected UK FTE?
Expect Mu2e-II in total to be comparable to Mu2e : so ~ 200 FTE. UK share ~ 5-10%. AMF likely to be a larger endeavour : 500 FTE total with UK ~ 5-10%.