Particle Physics Opportunities at the Shanghai SHINE Facility with Secondary Beams

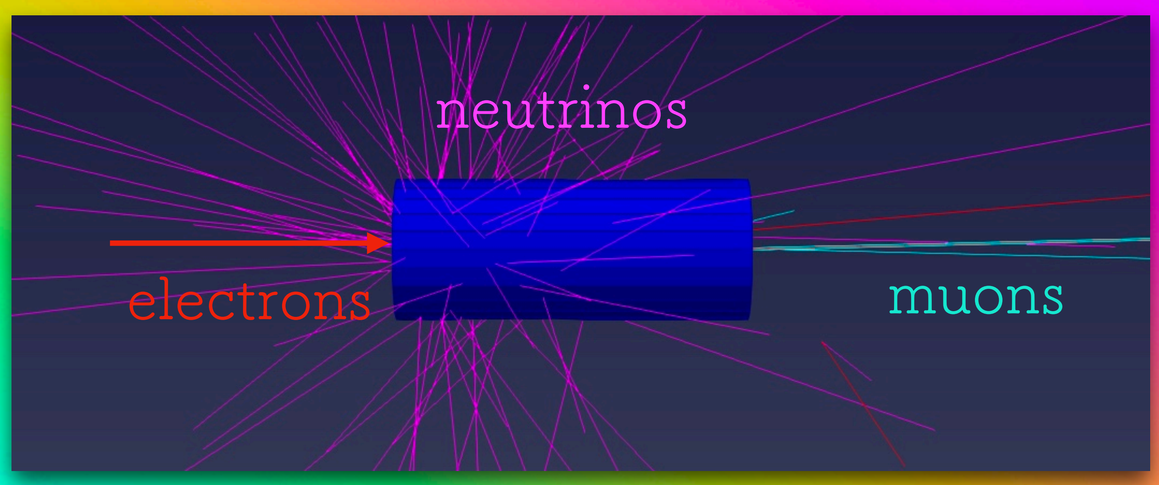
Siyuan Chen, Fangchao Liu, Meng Lyu, Jiangtao Wang, Liang Wang, Kim Siang Khaw
Contact: kimsiang84@sjtu.edu.cn

SHINE: A 4th Generation Light Source

KSK in the SHINE tunnel

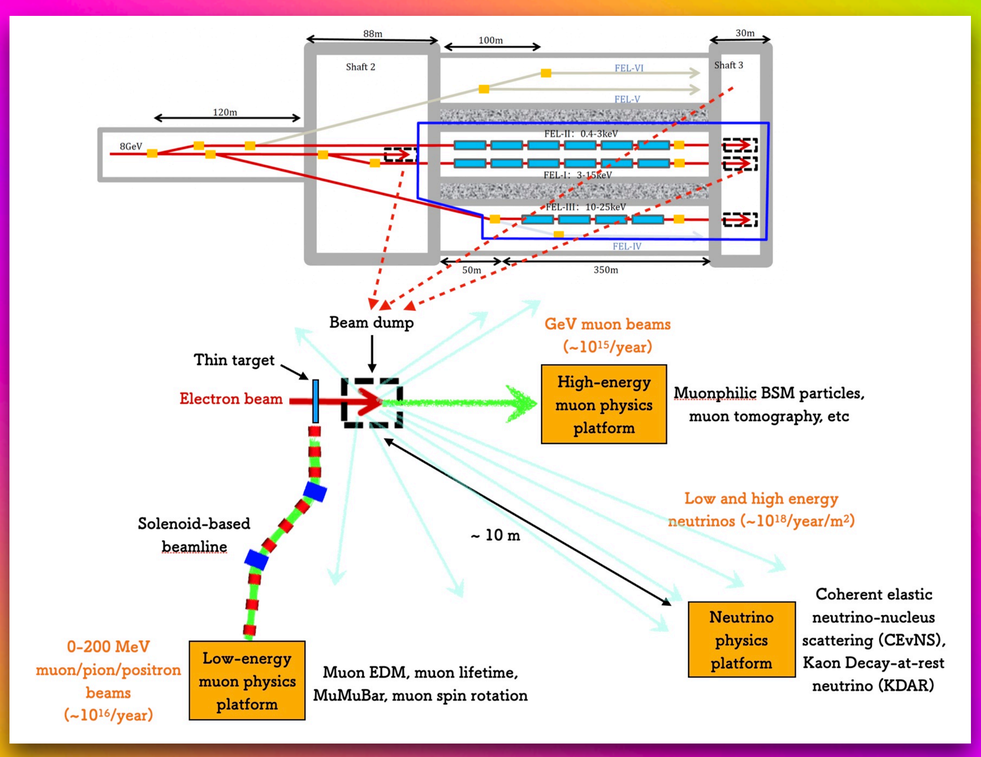
- Based on an 8 GeV CW SCRF linac
- 3.1 km long tunnel underground at Zhangjiang High Tech Park
- Specs: 8 GeV, 100 pC e- bunch (6.25 x 10^8), 1 MHz repetition rate
- The electron beam is directed to a beam dump after passing through the undulators and producing X-rays
- Electron-on-target/year ~ 10^{22}

Research Motivation



- Electro-nuclear, photo-nuclear and muon Bethe-Heitler (pair production) are the dominant processes for electron-on-target
- Over 10^{22} electrons are expected to hit the beam dumps per year
- Produced secondary particles could be used for particle physics experiments (and also condensed matter and applied physics)
- The pulsed operation makes it ideal for background suppression

Secondary Beams at SHINE



- We performed Geant4 simulations (FTFP_BERT physics list) to predict the yield of various secondary particles at SHINE beam dump or on a thin target
- In general, three classes of particles could be produced from EOT
  - Class I: Muons, pions, and positrons (MeV-GeV)
    - Expected rate range from 10^3/bunch to 10^6/bunch depending on target
    - Physics Program: Muon EDM, MuMuBar, muon lifetime, etc
    - Applications: GeV-muon tomography, muonic atomic spectroscopy
  - Class II: Neutrinos (MeV-GeV)
    - Expected rate is 10^{18}/year at several meters away
    - Physics Program: CEvNS, neutrino charged current interactions
  - Class III: Light Dark Matter and Dark Mediator
    - Both visible and invisible final state searches are possible (please visit J. Chen's poster on DarkSHINE)

Proof of principal experiment at SXFEL

- Shanghai soft X-ray Free-Electron Laser facility (SXFEL) is within the SSRF campus and next to SHINE
- 1.6 GeV e- beam, 500 pC bunch with 10 Hz frequency
- Measuring positive and negative muon yield using plastic and inorganic scintillators
- Simulation and hardware preparation in progress (please visit Fangchao Liu's poster)

Summary and outlook

- The interaction of the SHINE high intensity electron beam and the beam dump or target opens up the opportunity of performing particle physics and condensed physics experiments at SHINE
- The pulsed operation makes it ideal for background suppression and a unique high-repetition rate (~100 kHz) muon source not currently available.
- Our Geant4 simulations showed that:
  - A low-or high-energy muon beam with an intensity of about 10^8/s can be expected and has various applications in fundamental muon physics
  - A neutrino beam with distinctive peaks at 100 MeV (Negative Muon Capture) and 152 MeV (Kaon-DAR) can be produced for neutrino physics

References

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