An experimental muon source for neutrino beam R&D at CSNS

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- Scheme of CSNS experimental muon source
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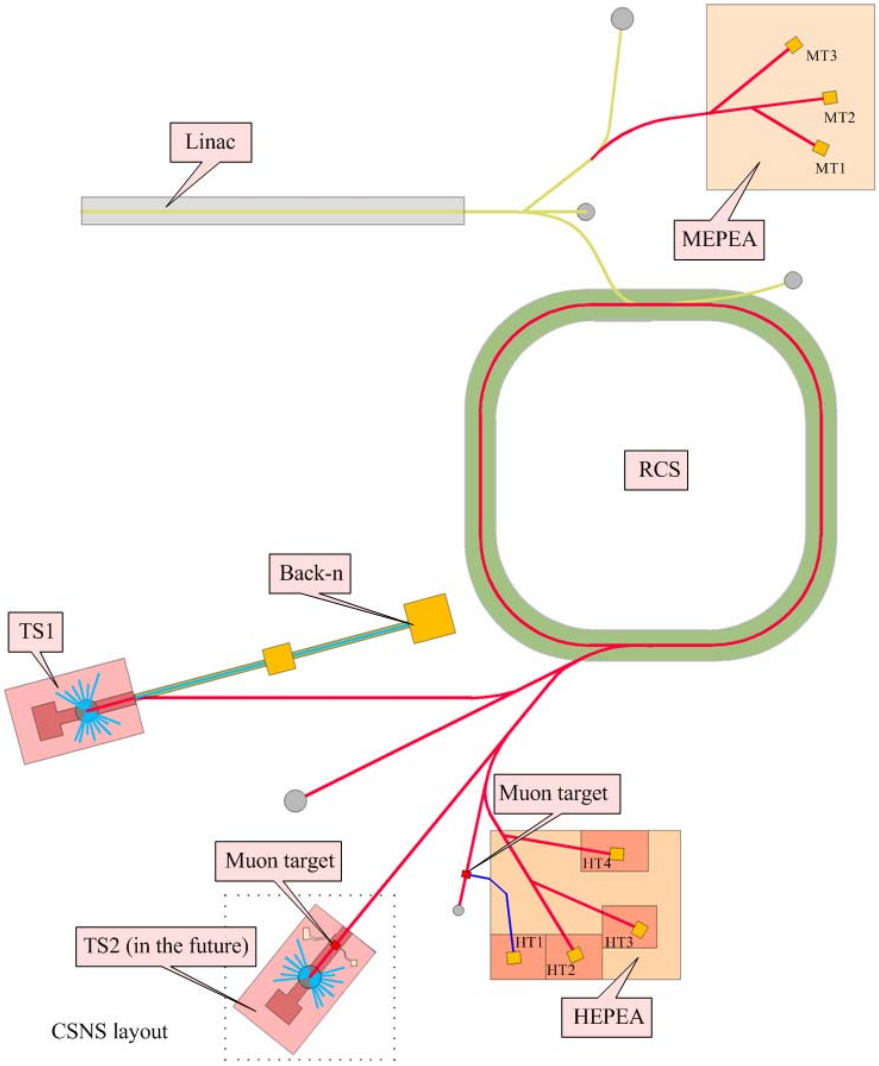
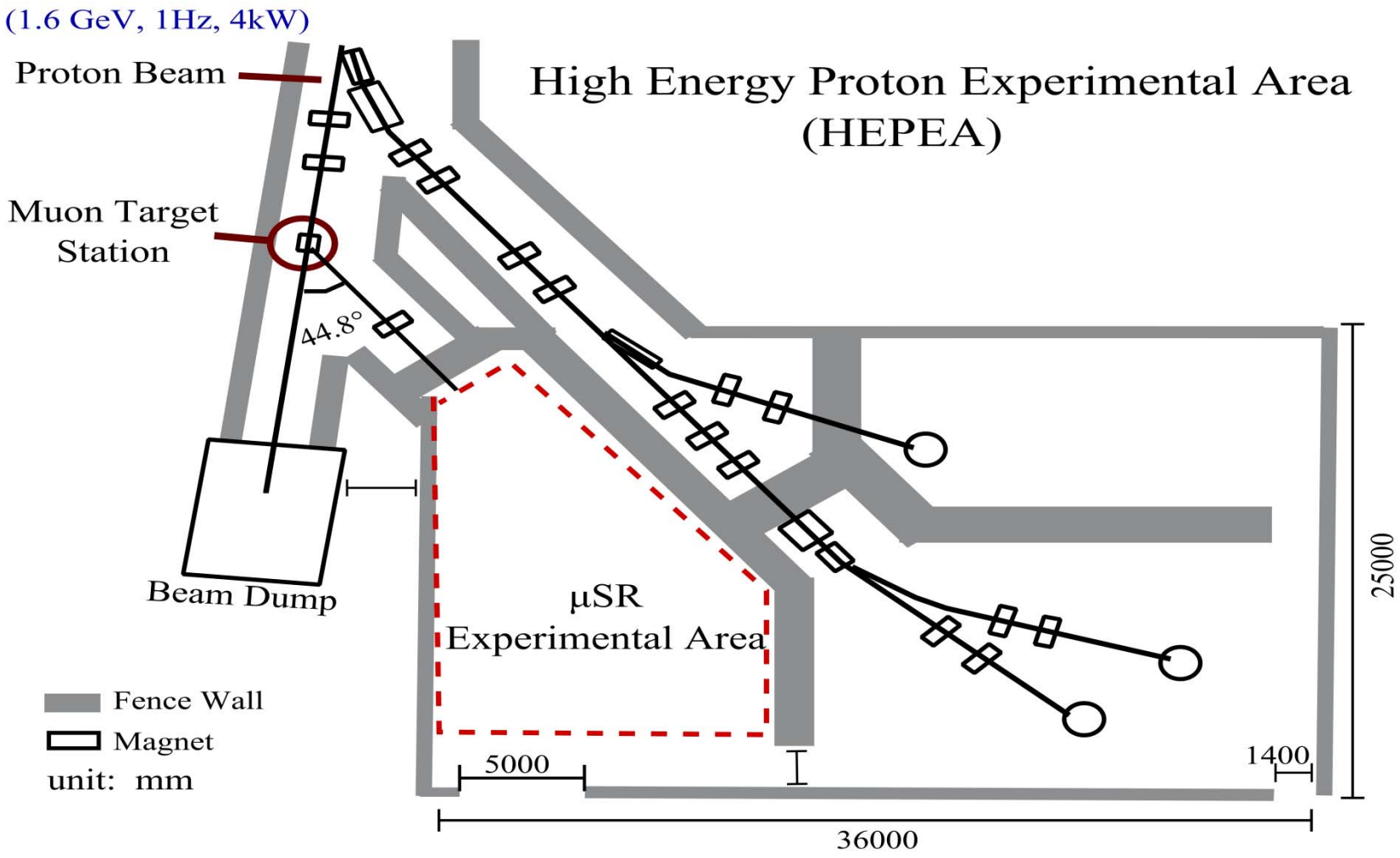
Layout of China Spallation Neutron Source



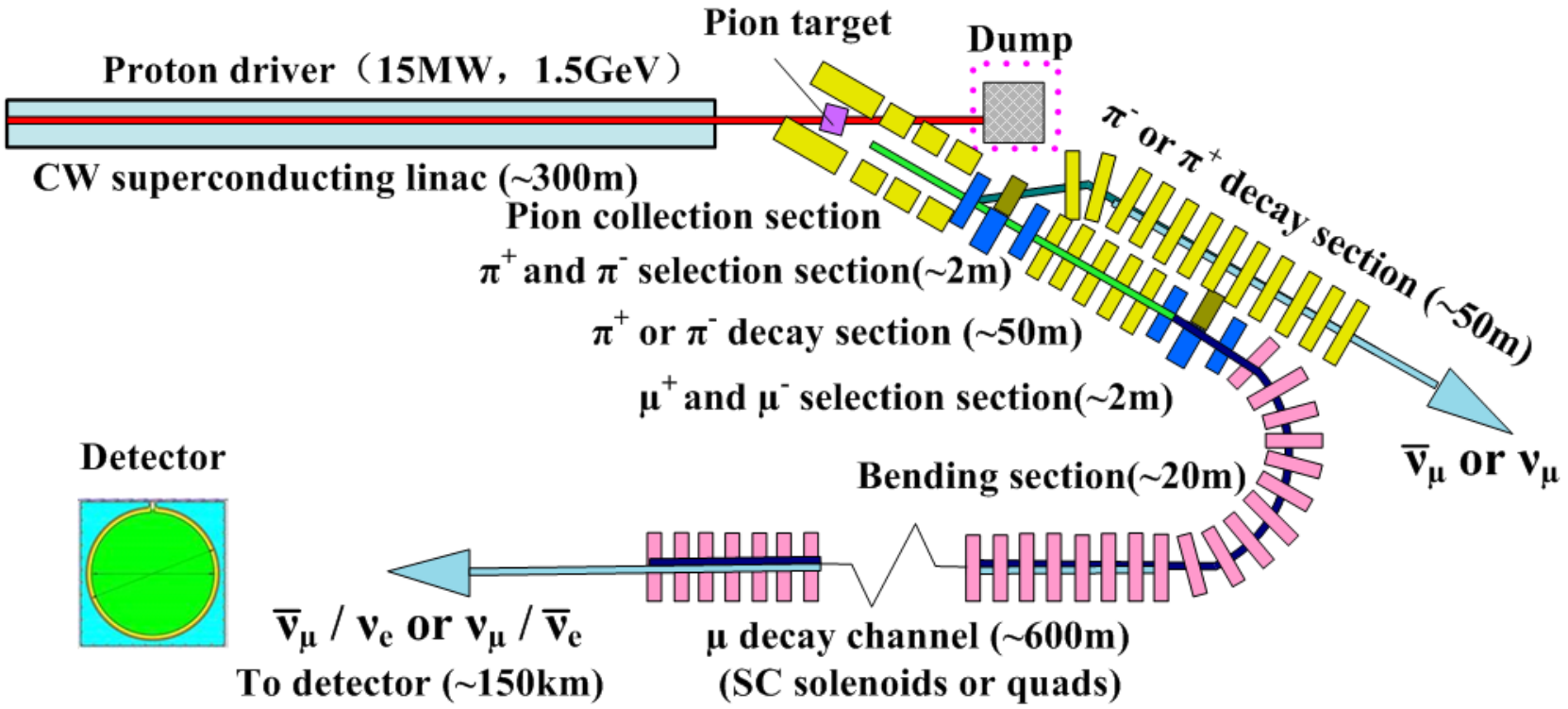
Parameters	CSNS-I	CSNS-II
Linac Energy (MeV)	80	250
RCS Energy (GeV)	1.6	1.6
Power (kW)	100	500
Beam current (μ A)	62.5	312.5
Power of EMS (kW)	4	20
Bunches per pulse	2	2
Length of one bunch (ns)	70	70

Bird’s-eye picture of CSNS

Layout of Experimental Muon Source



MuOn-decay MEdium baseline NeuTrino beam facility (MOMENT) in China



See Prof. J. Y. Tang's talk for details

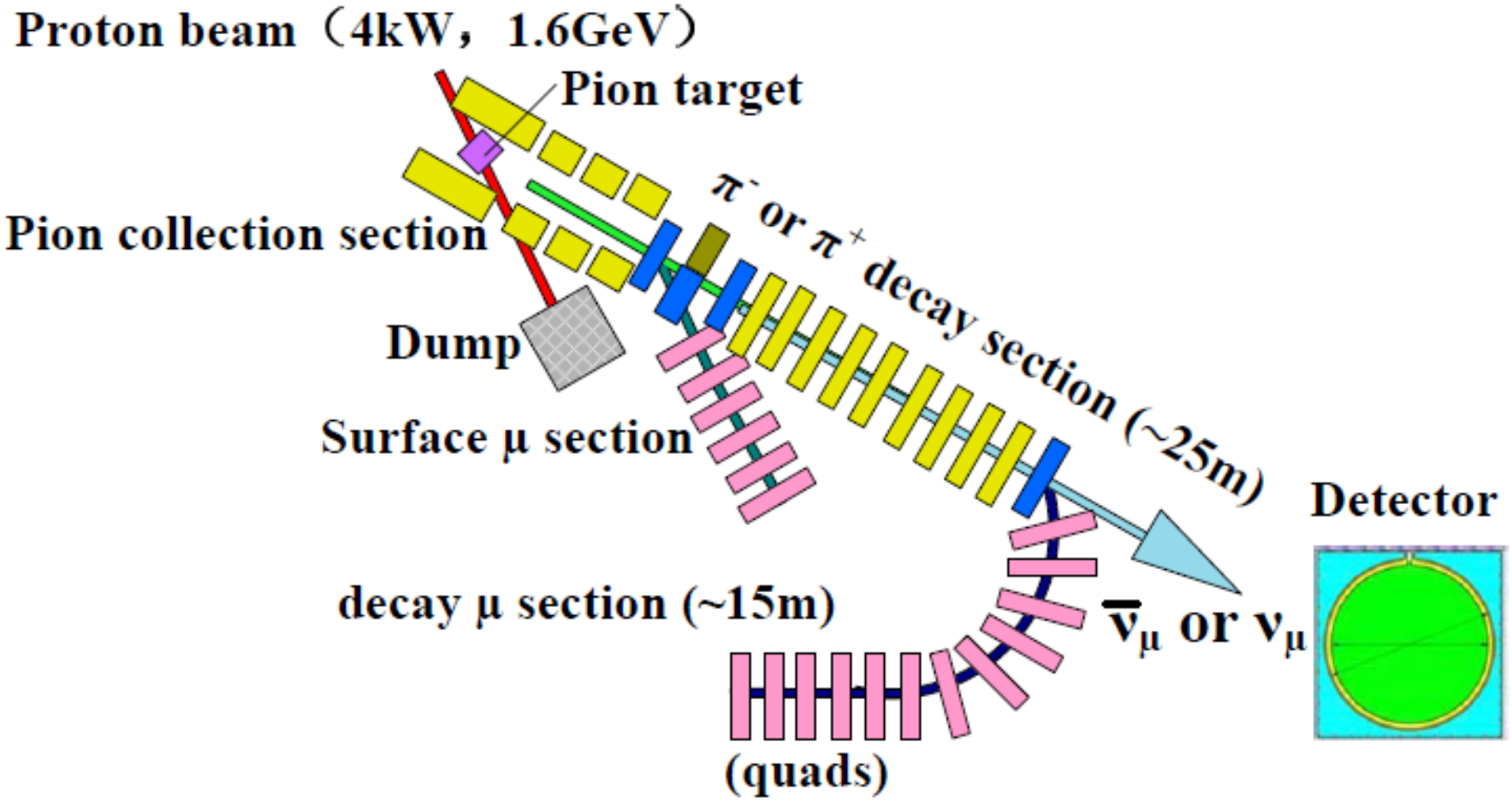
Possible R & D in CSNS

- Main capture solenoid with superconductivity technology
- Decay channel with superconductive solenoid
- Neutrino reaction cross section measurement in medium energy region

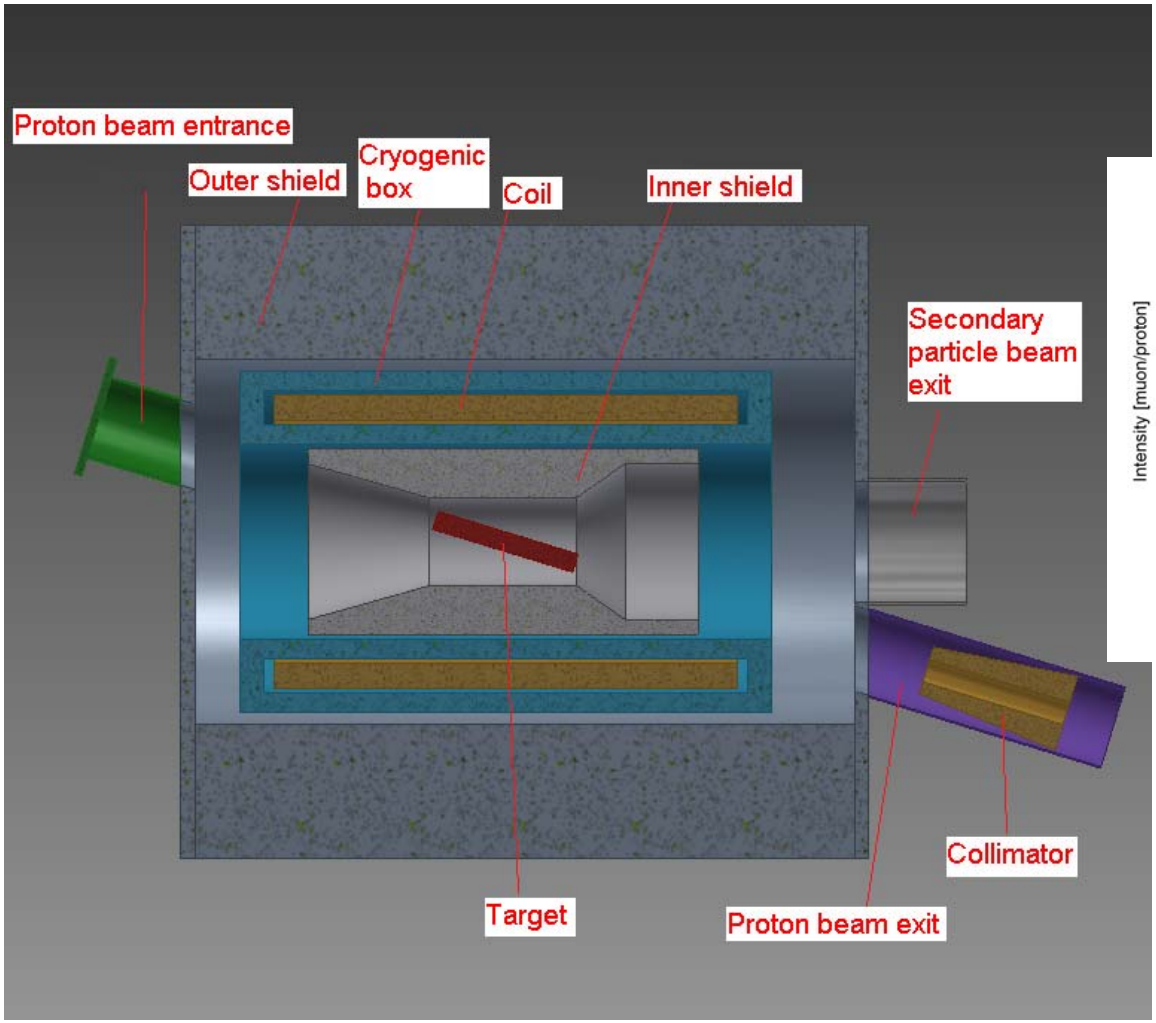
Tentative plan about the muon source

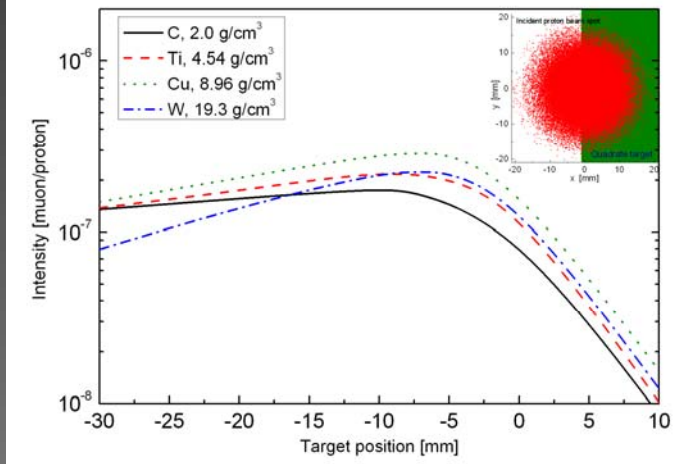
- Experimental muon source with superconducting solenoid for capture & decay channel
- As R&D efforts for future neutrino beam (MOMENT)
  - Target station with superconducting solenoids
  - Charge separation method
  - Bending and decay channels by solenoids
- Neutrino source for cross-section measurement
- Surface and decay muons (very high flux) for μ SR applications are available

Design of EMS beamline



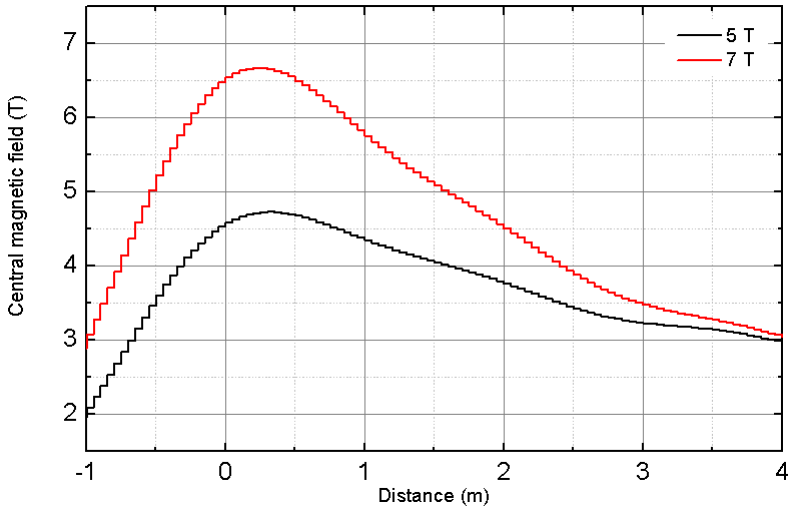
Target station of EMS

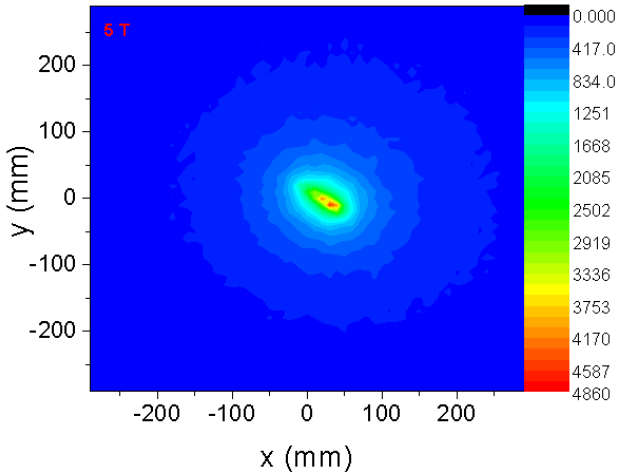


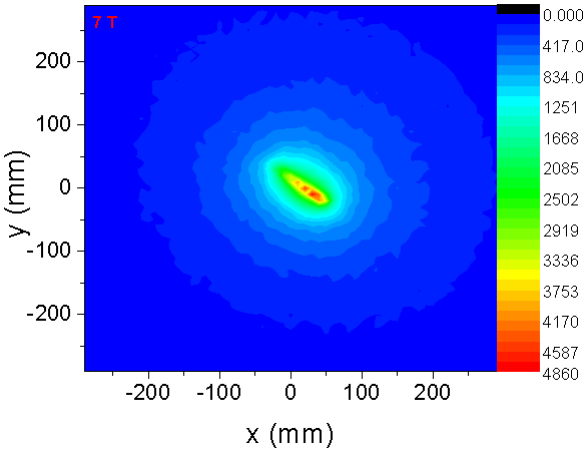


Capture solenoid

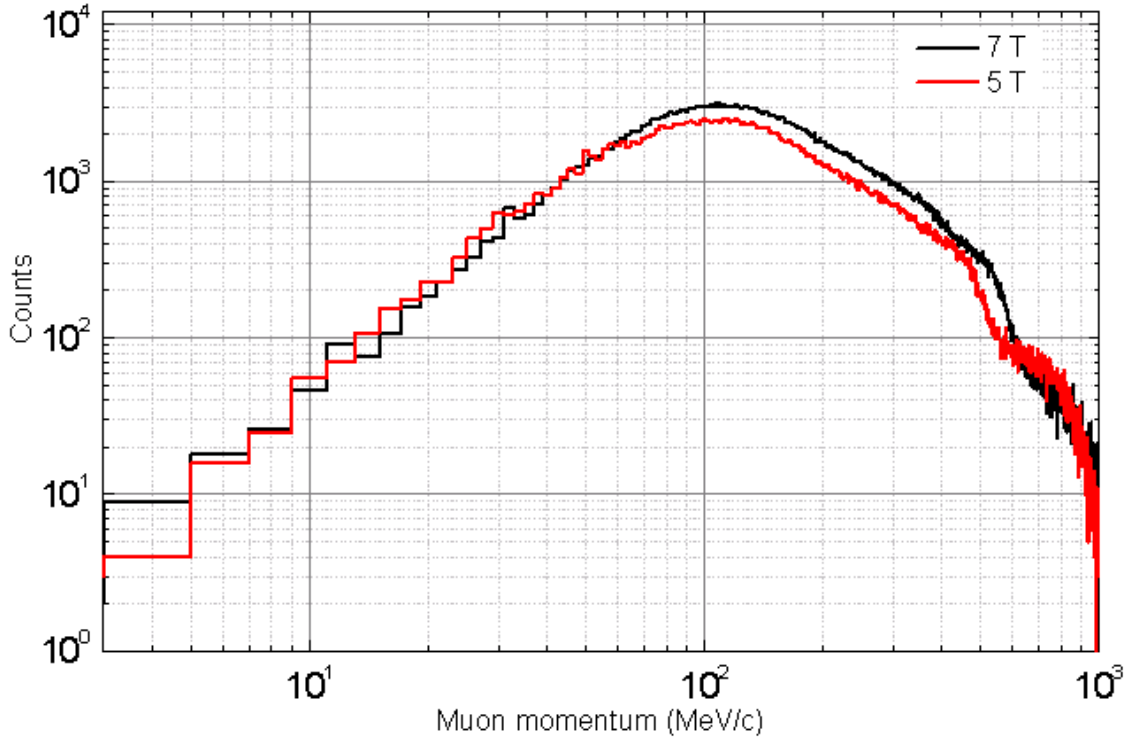
- Superconducting coil: NbTi
- Magnetic field: 5T – 7T
- Inner aperture: 500mm
- Matching with downstream solenoids







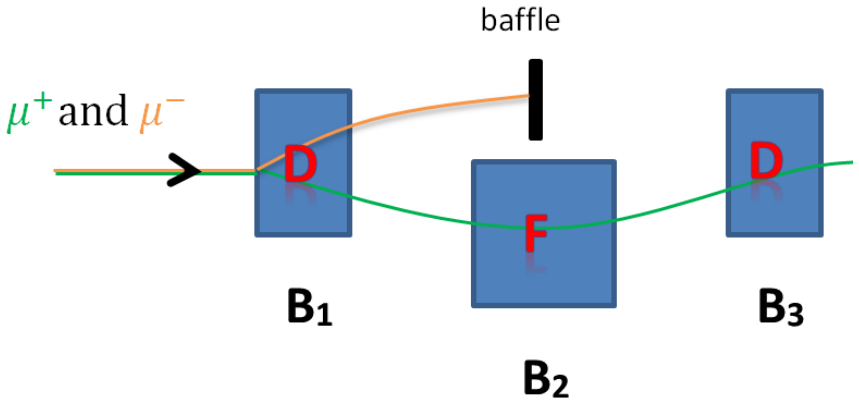
μ^+ momentum spectra at exit of Main solenoid



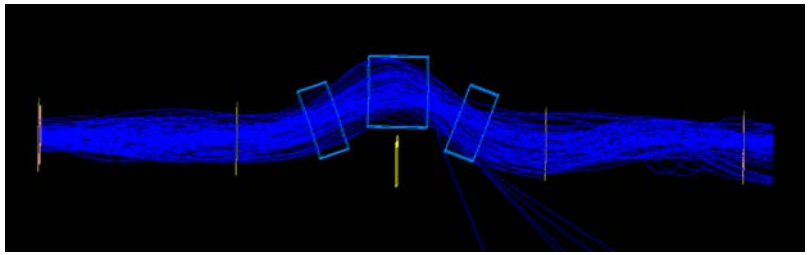
	5 T	7 T
I_{tot} (μ^+/s)	4.2×10^{11}	5.3×10^{11}
I(μ^+/s) [(29±1)MeV]	7.8×10^{8}	6.4×10^{8}

μ +/ μ - selection section

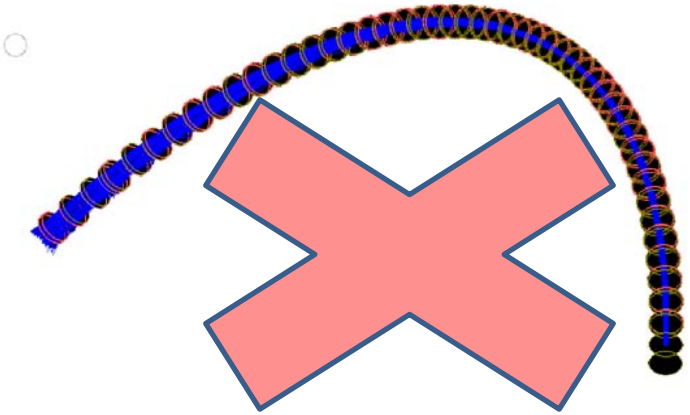
1. Double focusing dipole magnet

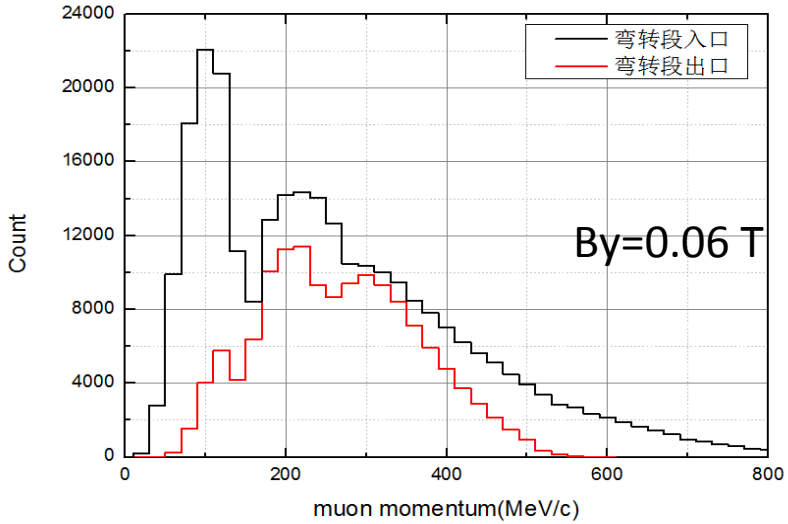


μ^+



2. Solenoid with an additional By-component





Ref. 1. Robert B. Palmer and Richard Fernow, 'Charge Separation for Muon Collider Cooling',BNL-94921-2011-CP;
2. M. Yoshida et al., IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY, VOL. 21, NO. 3, JUNE 2011;

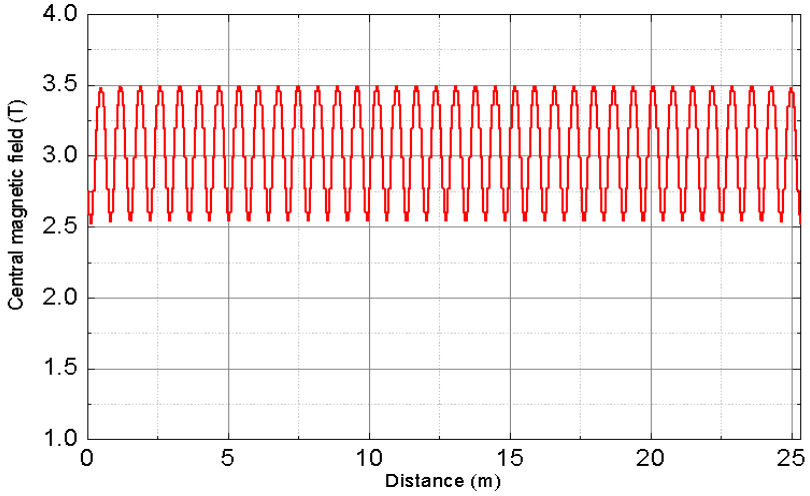
Pion decay section 1

(NOTE: Uniform mag. Field for solenoid)

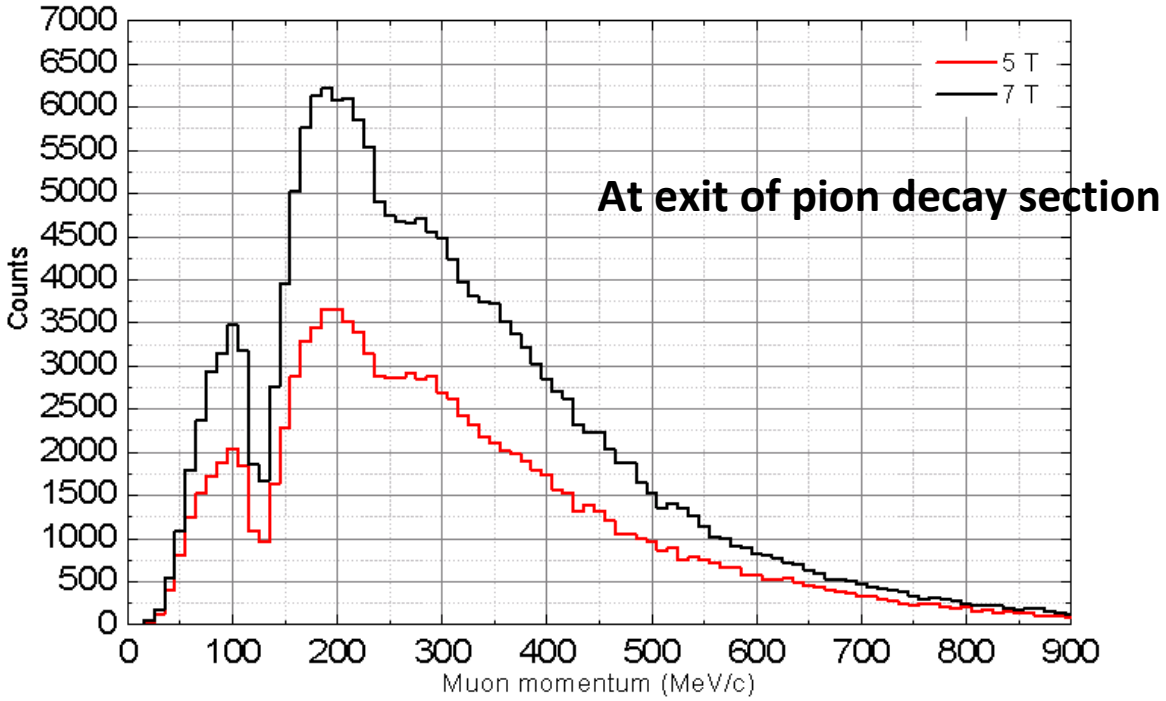
Aperture mm	Max. acceptance pi mm mrad (mm,mrad)		
	Mag. field 1 T	Mag. field 2 T	Mag. field 3 T
400	14820 (x: 190,x': 78)	27650 (x: 175,x': 158)	39950 (x: 170,x': 235)
500	22795 (x: 235,x': 97)	43875 (x: 225,x': 195)	62350 (x: 215,x': 290)
600	33040 (x: 280,x': 118)	63450 (x: 270,x': 235)	91000 (x: 260,x': 350)

Parameters for pion decay channel

- Total length: 25 m (0.5 m solenoid + 0.2 m drift space)
- Mag. Field of single solenoid: 3 T
- Aperture of solenoid : 500 mm



Decay μ^+ momentum spectra

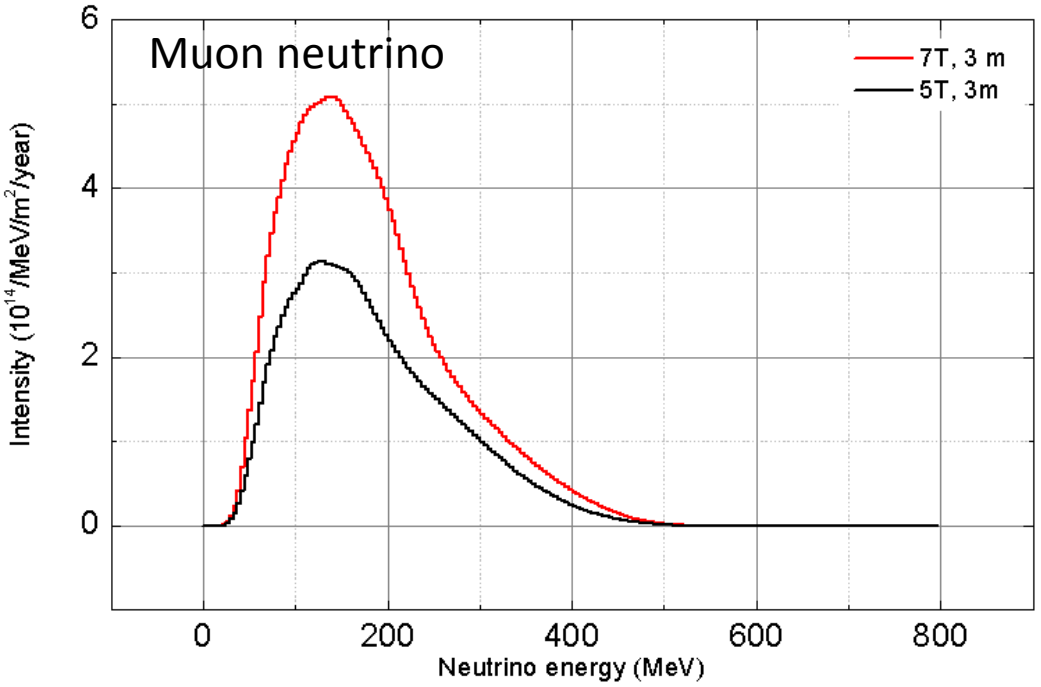


	5 T	7 T
I_{tot} (μ^+/s)	1.8×10^{11}	2.9×10^{11}
I(μ^+/s) [(200±10)MeV]	1.1×10^{10}	1.9×10^{10}

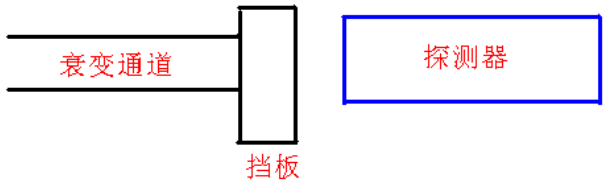
~60%

~72%

Neutrino energy spectra



Neutrino cross section measurement



20 ton (Φ 3m × 3m)
(Same as Daya bay near detector)

7T

Total neutrino number: ~9 × 10^{16} ν_μ/m^2/year

Mean value of neutrino energy: 177 MeV

5T

Total neutrino number: ~6 × 10^{16} ν_μ/m^2/year

Mean value of neutrino energy: 180 MeV

~50%

10^5 cc events/year(7T)

Summary

- SC solenoid and neutrino beam R&D at CSNS experimental muon source can be carry out besides μ SR technology.
- Neutrino reaction cross section can be measured in medium energy range.

Thanks!