Beam optics and dynamics issues of MERIT advance

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ERIT for muon production -MERIT-

- **ERIT: Energy Recovery Internal Target**
  - Storage ring + Internal target + Energy recovery per turn
  - Ordinary ERIT : Particle energy lost by Coulomb(EM) interaction
    - Rutherford scattering, ionization
- **MERIT for $\mu(\pi)$ production**
  - Energy recovery : not only for EM but hadronic (nuclear) interaction → Acceleration + Storage
    - Threshold energy(p+p(n)) : ~230MeV for one π production.

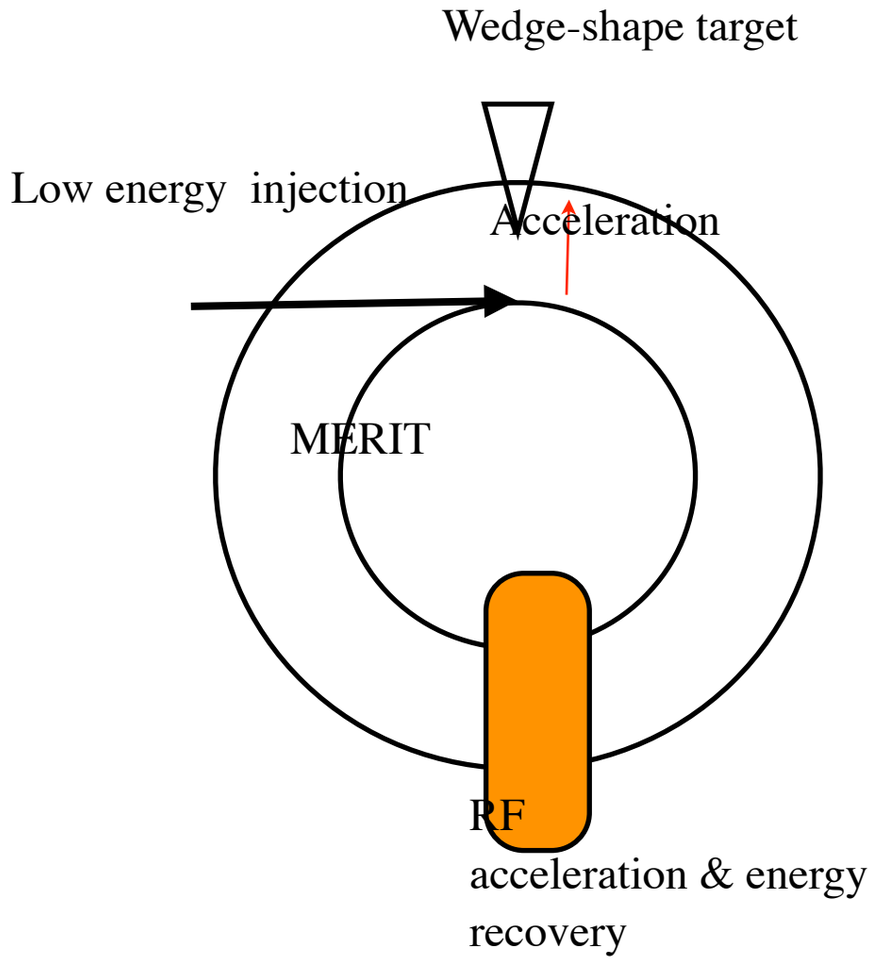
MERIT: π /μ production

- Acceleration & Storage:simultaneously.
  - low energy injection → cost saving.
  - large energy acceptance → increase efficiency.
  - CW beam/operation

- Issues
  - Fixed RF frequency : **isochronism**
  - Fixed magnetic field :**zero_chromaticity** both for acceleration/storage.
  - Large acceptance(3D) : **ionization cooling**

FF-FFAG(Fixed Frequency and Field AG)

MERIT



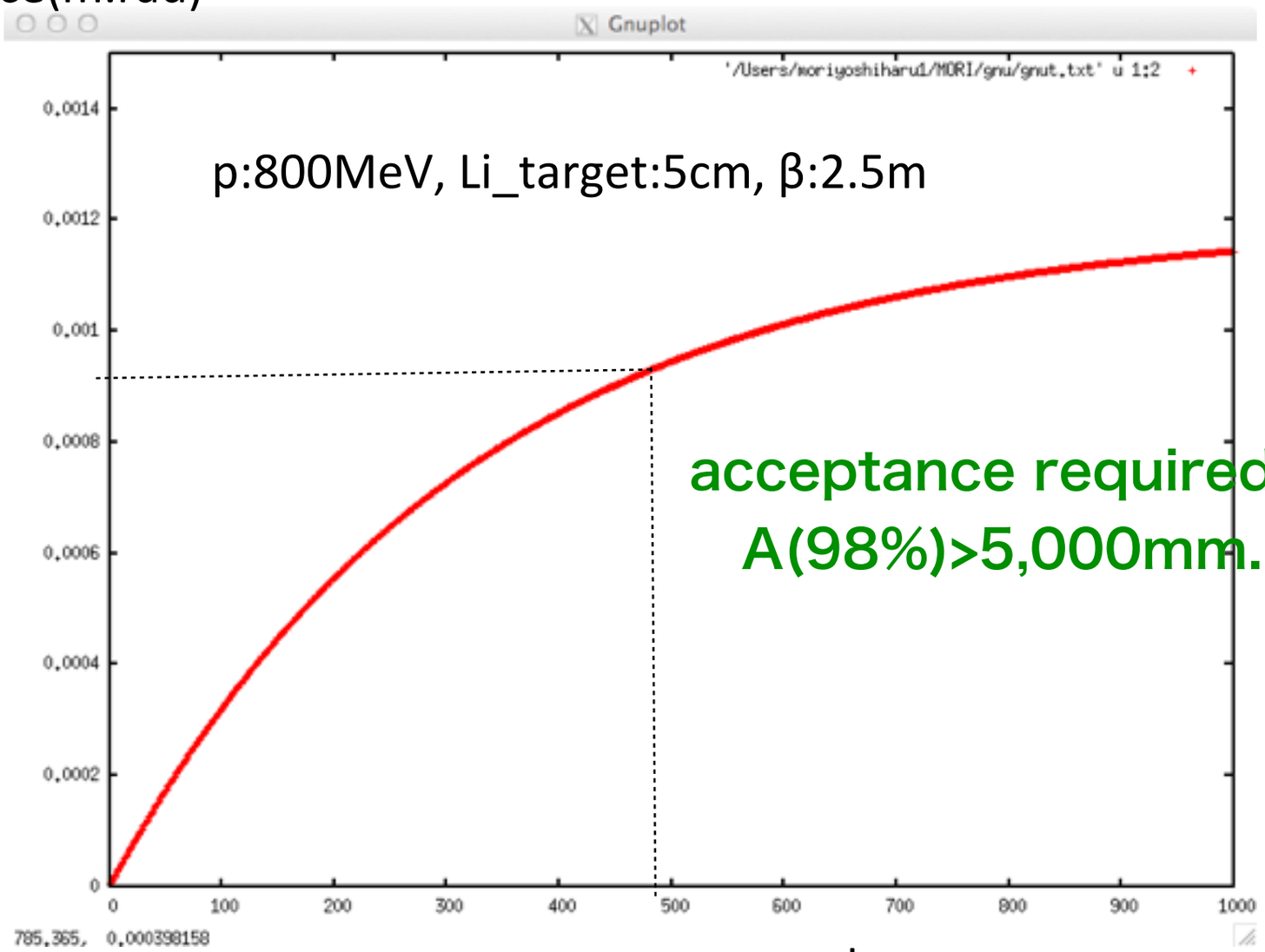
MERIT

- **Characteristics required to be MERIT: (so far, I have believed.)**
  - Fixed(constant) magnetic field
  - Fixed(constant) RF frequency
    - On-γ_t acceleration : $\beta<1$ for proton
  - Wide apertures:transverse & longitudinal
    - Zero-chromaticity
    - Strong(AG) focusing
  - Ionization cooling :3D
    - Wedge target

Acceptance(transverse)

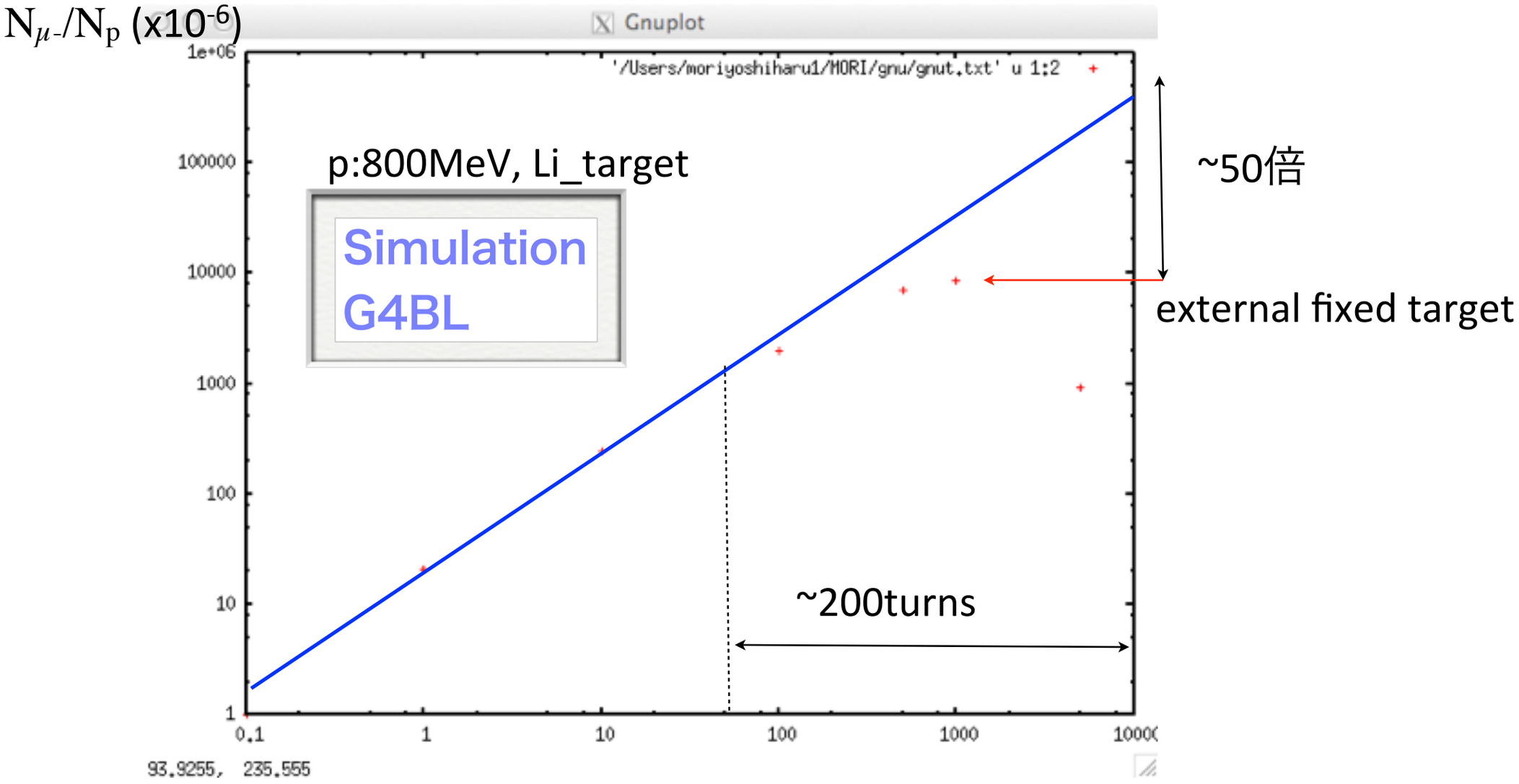
- **Emittance growth evaluation**
  - multiple scattering
  - beam cooling by energy recovery

rms emittance(m.rad)

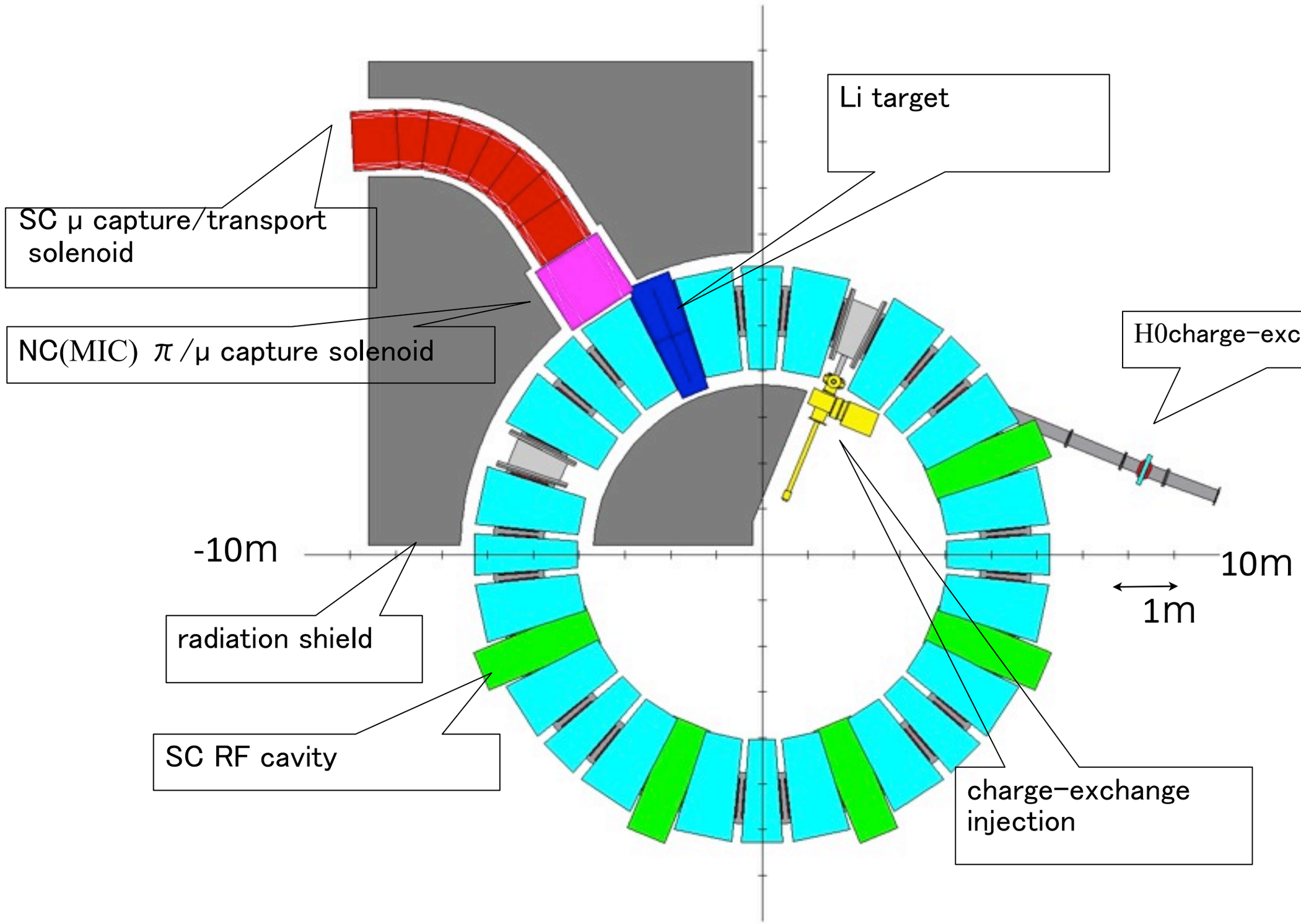


Number of turns in MERIT

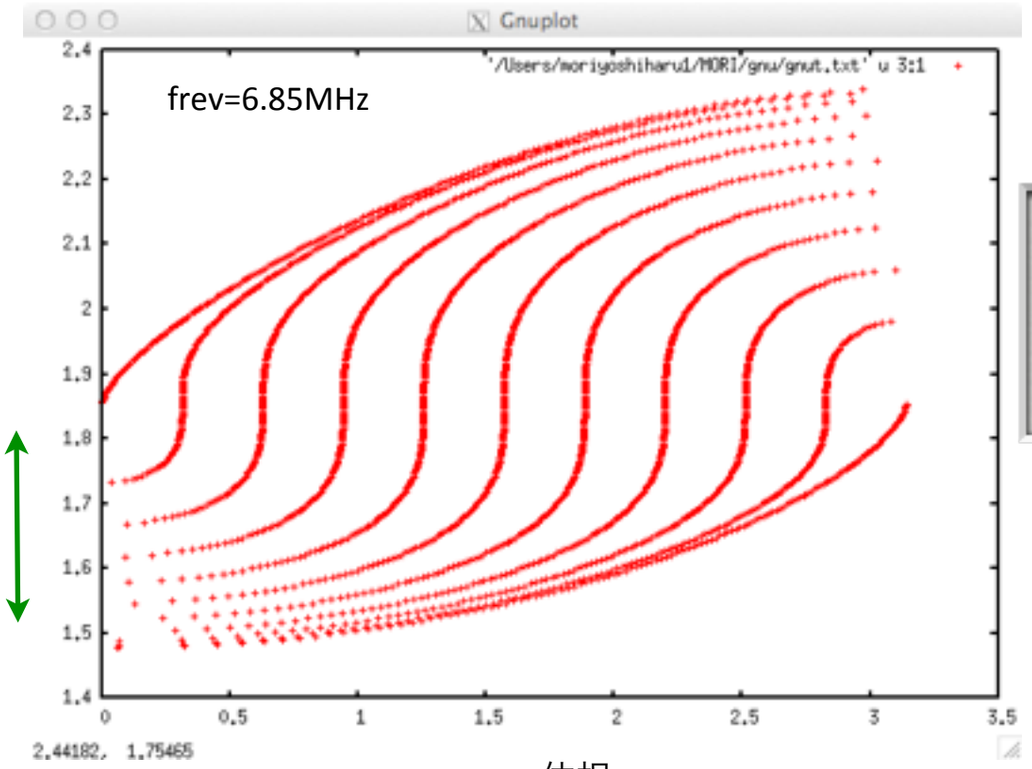
- **More than 200 turns → N_{μ^-}/N_p~0.25 @Ep=800MeV**
  - ~50 times better than fixed target



Schematic layout



Acceptance



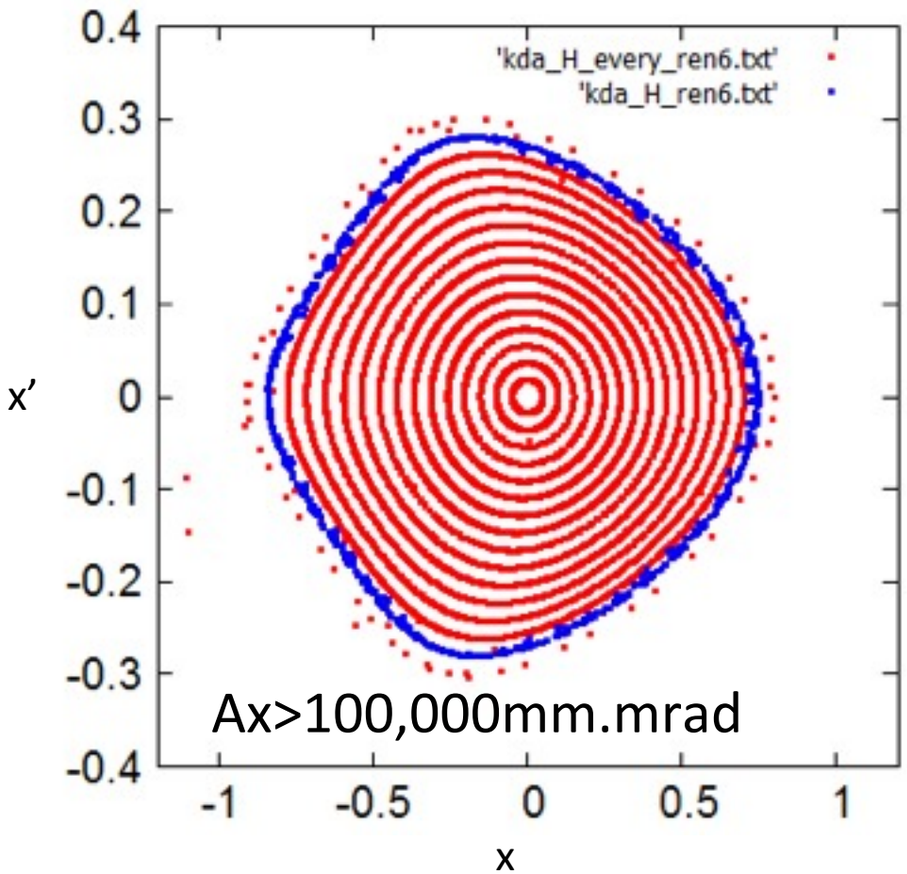
γ

acceleration range

位相

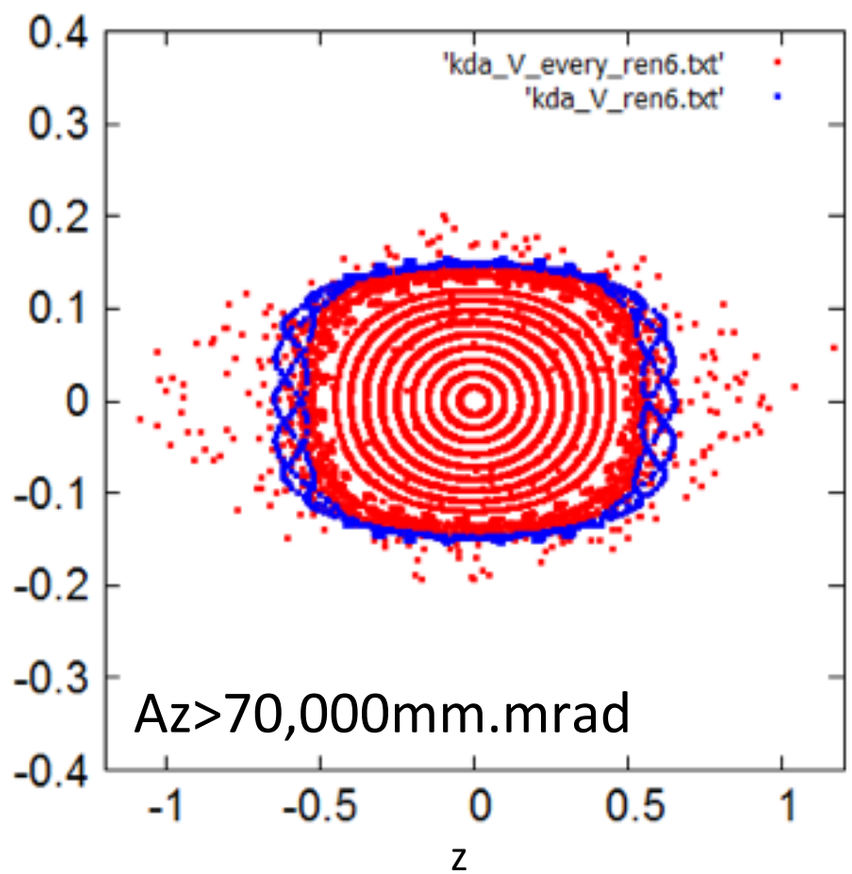
longitudinal : acceleration
E=800MeV,k=2.433,γs=1.853,V=0.01

transverse acceptance



x’

x



z’

z

Simulation

6D phase space:full tracking

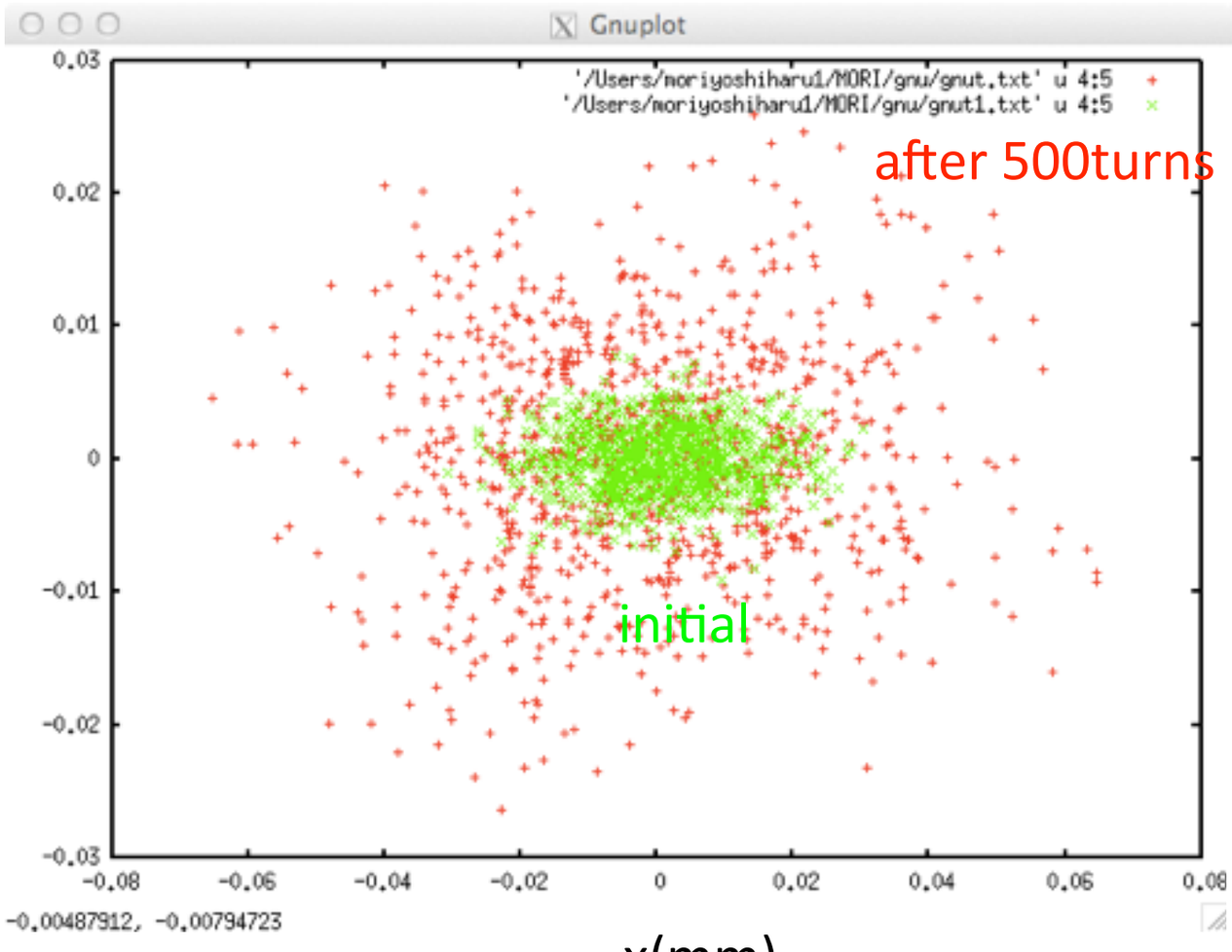
Transeverse

Beam emittance after 500turns :

hor.~2,100mm.mrad, vert.~1,200mm.mrad

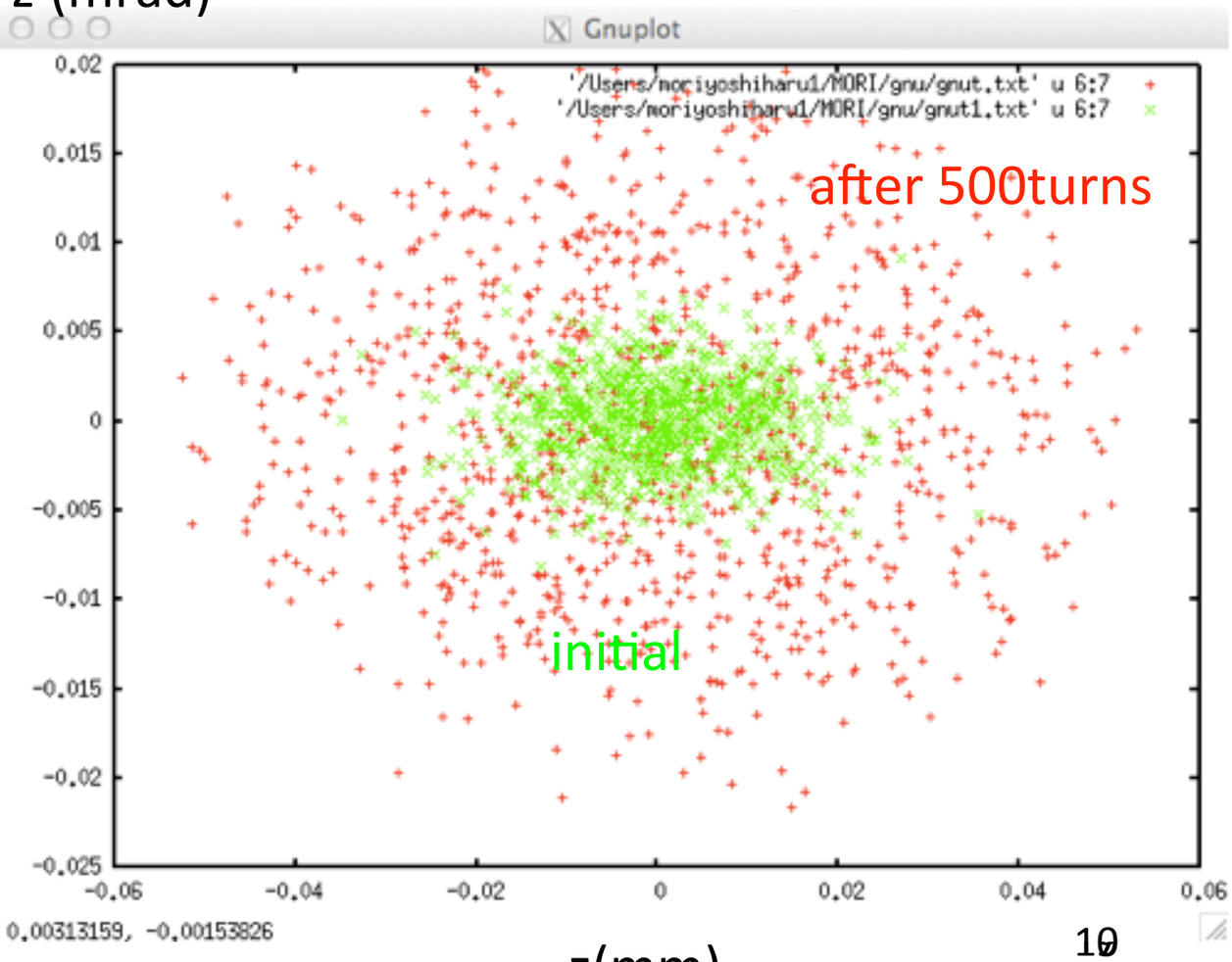
< acceptance (hor. :30,000mm.mrad,vert.:20,000mm.mrad)

x'(mrad)



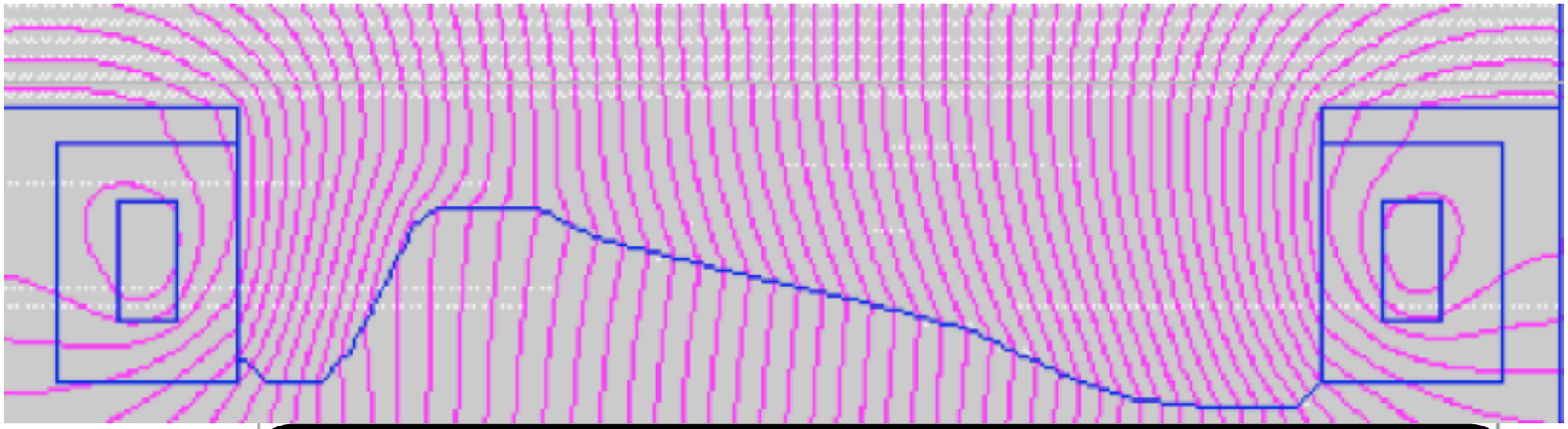
x(mm)

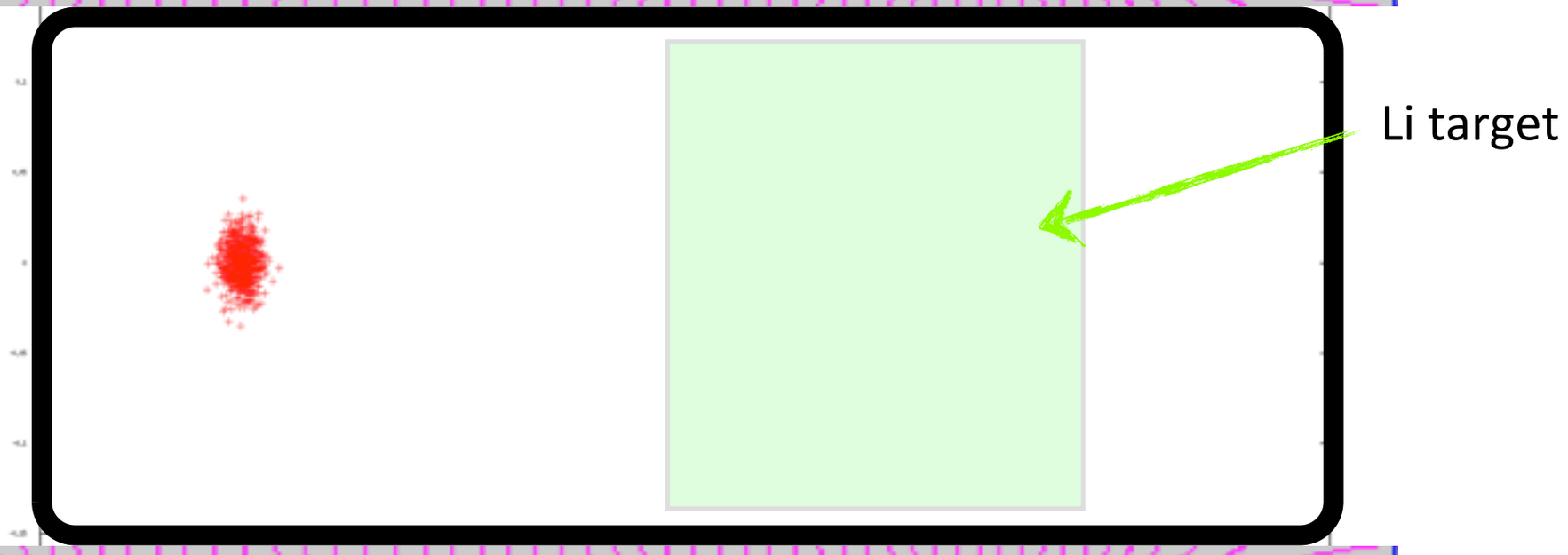
z'(mrad)

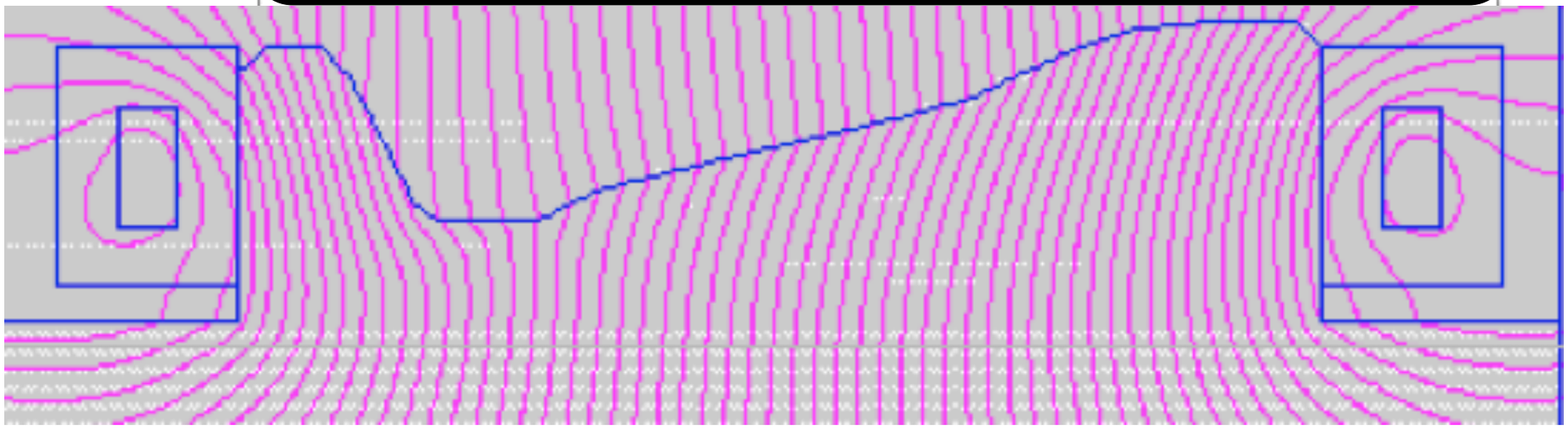


z(mm)

ビームトラッキング





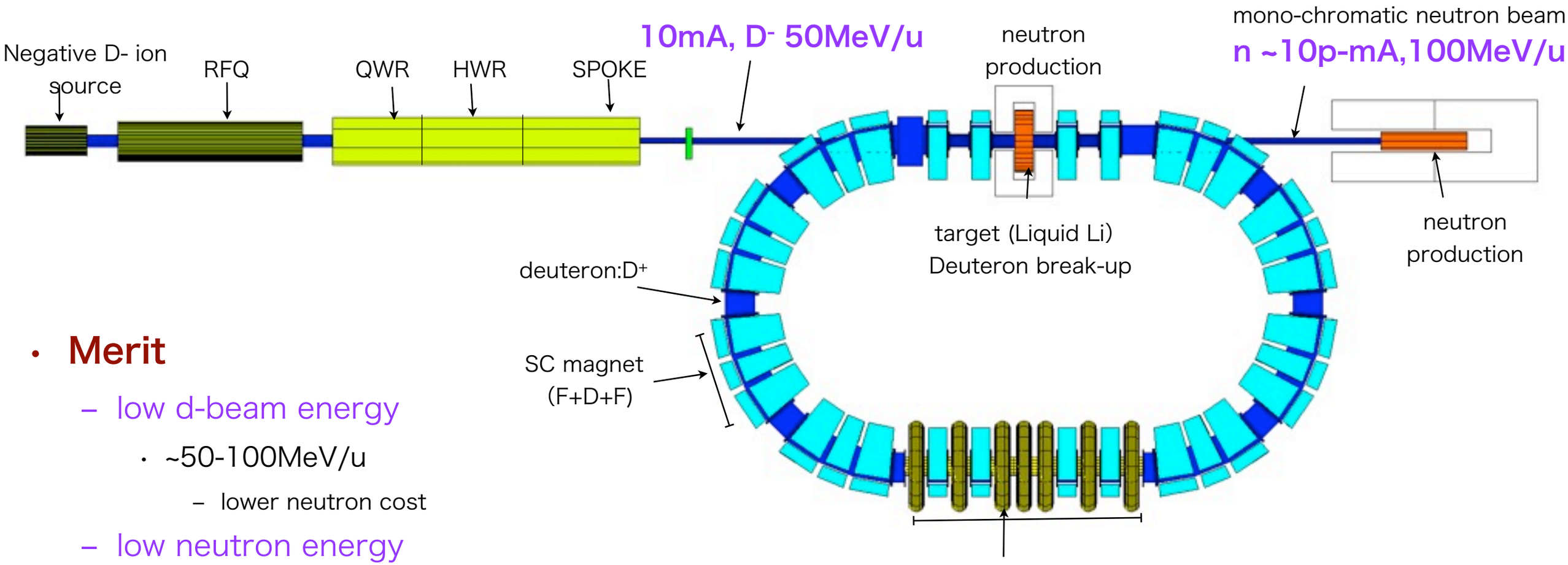


Advance of MERIT in beam optics and dynamics

- **For further flexibility**
  - Broader energy(momentum) range
    - semi-scaling
      - mixed(variable) "k"
    - quick acceleration
      - mixed different RF frequencies
  - Minimizing orbit mismatch
    - small dispersion
    - phase-advance matching
  - Mitigation space charge effect
    - 6D mixing

Racetrack MERIT ring accelerator

-Multiplex ERIT(Energy Recovery Internal Target)-



- **Merit**
  - low d-beam energy
    - ~50-100MeV/u
      - lower neutron cost
  - low neutron energy
    - <50-100MeV (cf. JPARC Emac~GeV)
      - radiation shielding easier
  - thin target
    - localization of neutron production
      - high enrgy (break up):forward
      - low energy (evaporation etc.) around Li target～4π
  - low neutron cost

- **Beam parameters**
  - particle : deuteron
  - energy range: 50-100MeV/u
  - beam current >10mA
- **Target**
  - liquid Lithium
  - heat load：<1MW
- **Neutron**
  - multiplicity(n/d):~2
  - neutron flux ~1.2x10^{18}n/s
- **RF**
  - ΔE ~1.5MeV(t=5mm)
  - RF voltage：2MV