Target & Capture for PRISM

Koji Yoshimura
On behalf of PRISM Target Group

Institute of Particle and Nuclear Science
High Energy Accelerator Research Organization
(KEK)

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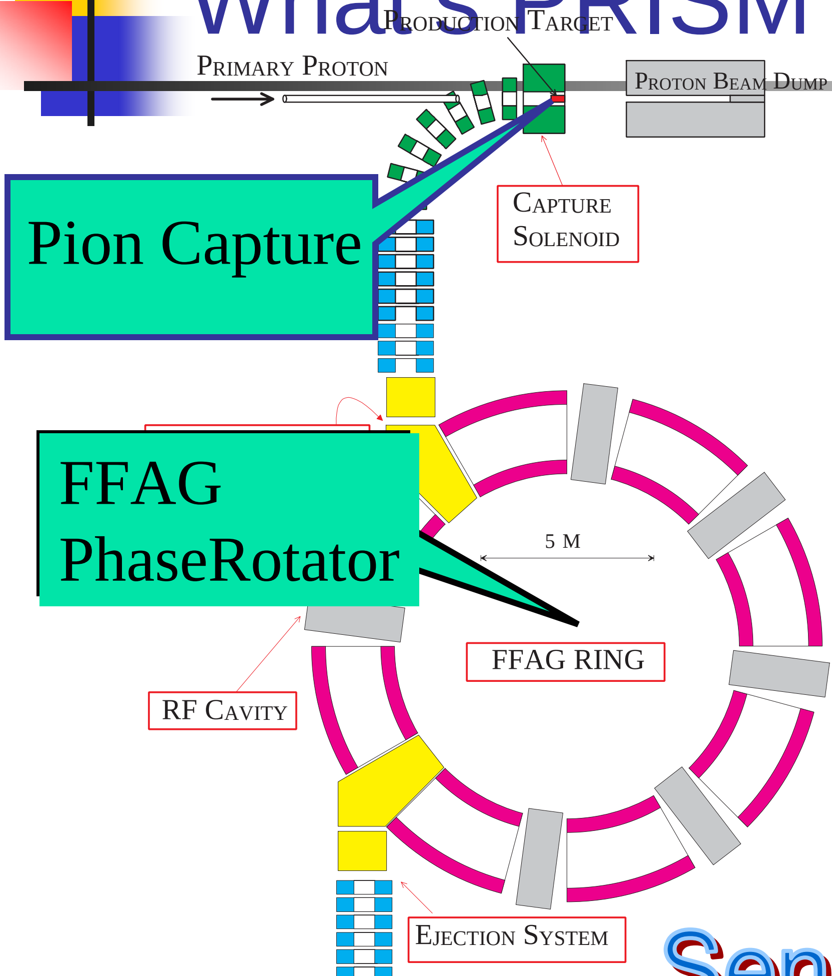
What's PRISM



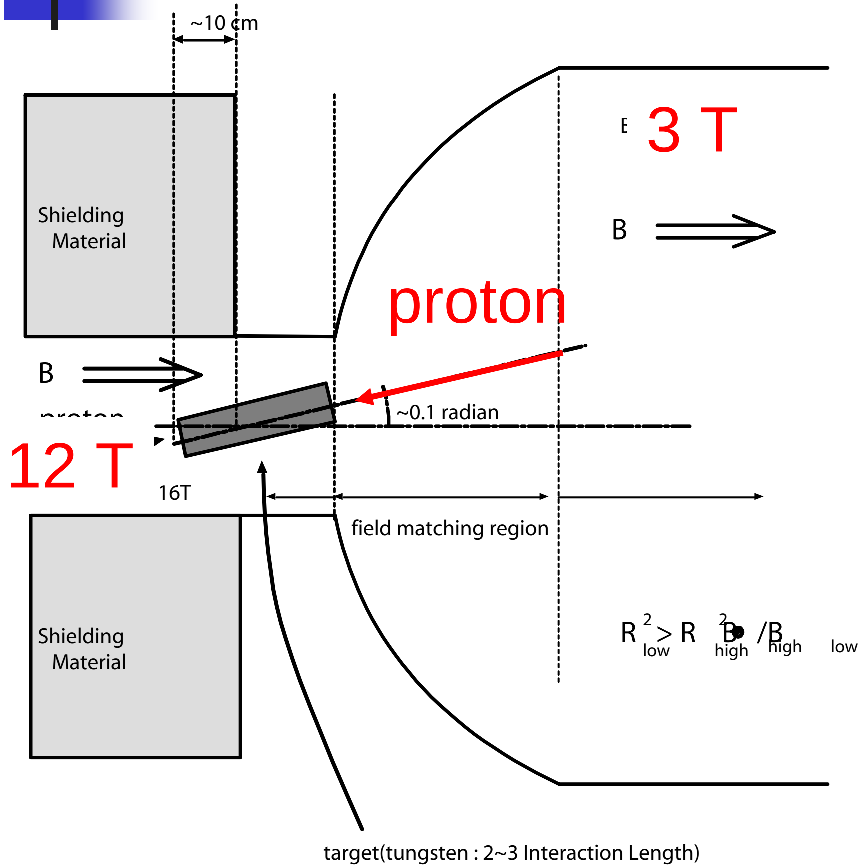
- PRISM(Phase Rotation Intense Slow Muon source)
- A dedicated secondary muon beam channel with high intensity (10^{11}~10^{12}μ/s)and narrow energy spread(a few%) for stopped muon experiments

Sensitivity ~100 x MECO

Requirements of Targetry for PRISM

- Pion Momentum
  - ~100 MeV/c
  - backwards capture scheme available!
- Emittance
  - As low as FFAG acceptance
    - horizontal 10000π, vertical 3000π
- Method
  - Solenoid Capture
  - Conducting Target

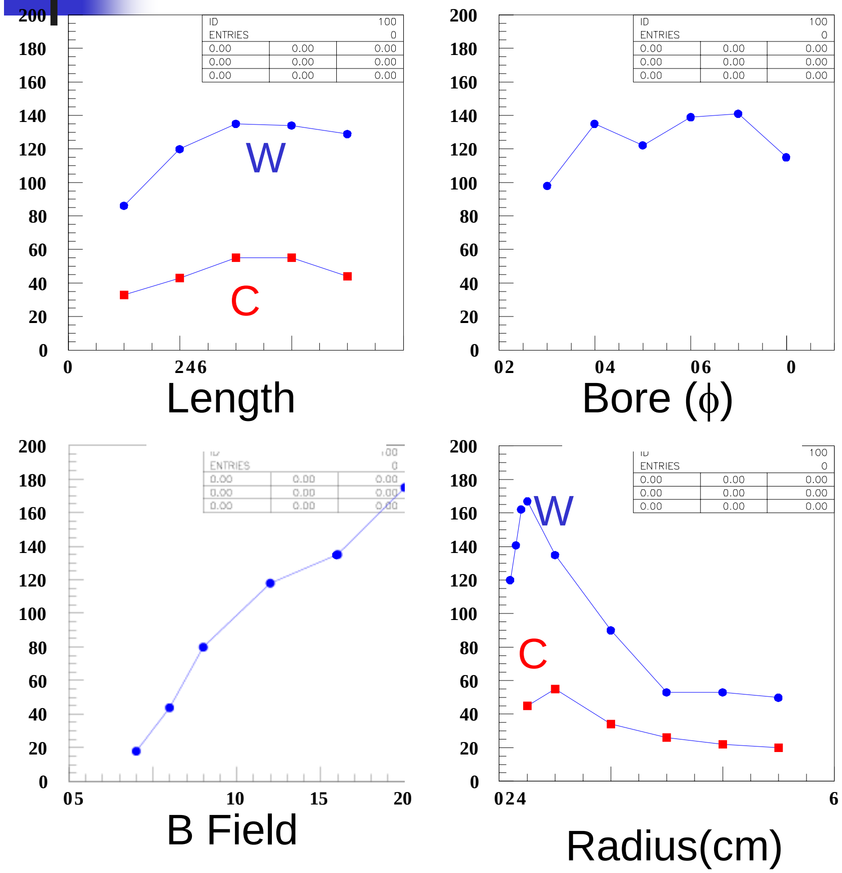
Simulation Study of Solenoid Capture



- Simulation code
  - MARS, GEANT3
- 12 T field -> 3T
  - 47MeV/c ~ 85 MeV/c
  - Backward
  - 2000 π ~ 3000 π vertical acceptance

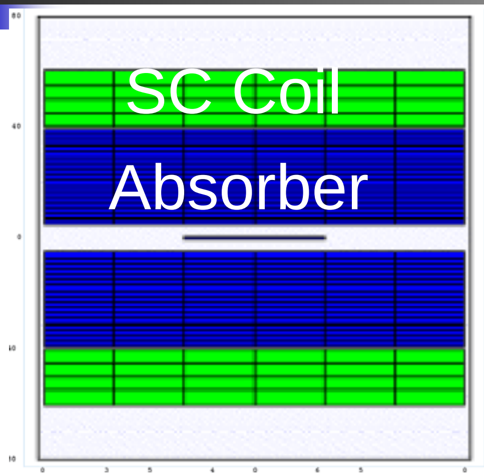
Simulation Results

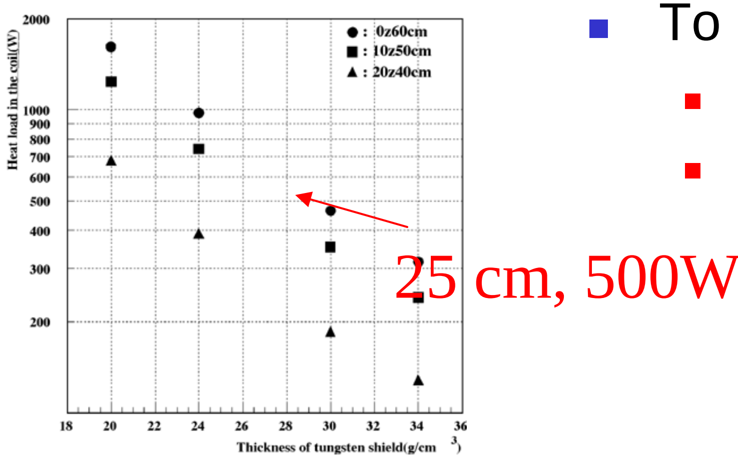
DATA Summmary



- Target material
  - W is better than C
- B field
  - Determined by Capture field
  - Yield∝Bfield
- Target radius
  - Thin target is better

SC Solenoid in High Rad. Env





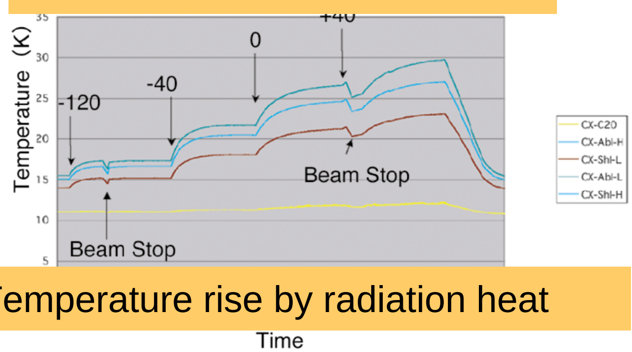
Thickness of Absorber

- Thick radiation shield is necessary
  - ~500 W
  - Radiation shield of 25 cm in thickness is needed
- Large bore for absorber
  - High stored energy
  - Expensive magnet
- To optimize design
  - We totally rely on simulation.
  - Simulation code should be experimentally evaluated!

Direct Measurement of Radiation heat by Beam

Prototype magnet

Beam test at KEK Nov, 2002



Temperature rise by radiation heat

- Prototype magnet of 10.9 Tesla
  - Hybrid coil (NbTi, Nb_3Sn, HiTc)
  - Indirect cooling with GM cryocooler
  - 10.9 T in 6 cm warm bore
- Beam test with Coil-Mockup
  - Direct measurement of heat load by radiation
  - Study behavior of magnet under heating condition
  - KEK 12 GeV proton
    - 10^{11} protons/s
  - Cryo-calorimeter

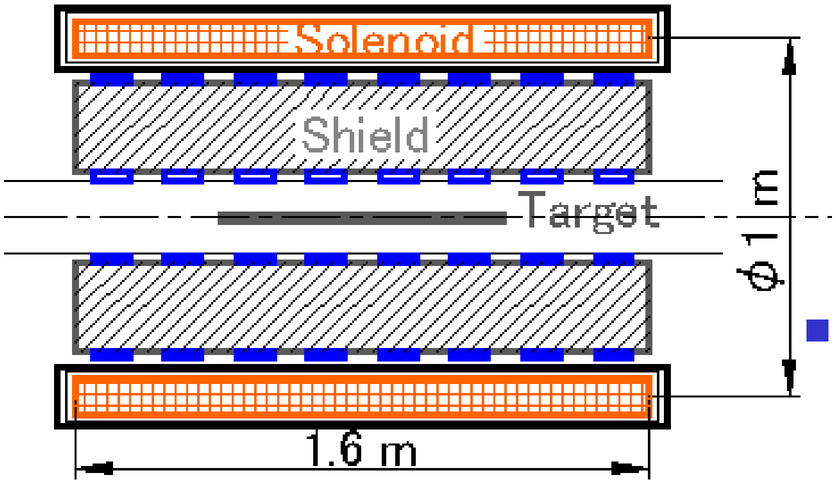
Ohnishi's Talk

Comparison

B	12 T	6 T
Useful aperture R	0.05	0.10
Cryost. IR	0.55	0.4
Coil IR	0.65	0.45
Coil OR	1.1	0.55
Coil length	~1.6	~1.6
S/C	Nb3Sn/NbTi	NibTi
Stored energy	~190 MJ	~16 MJ
Coil mass	~20 Ton	2 Ton
Cost (Estimate)*	~17 M$	~3 M$

*PDG: COST(in M$)=0.523[E/1 MJ)]$^{0.662}$

REALISM

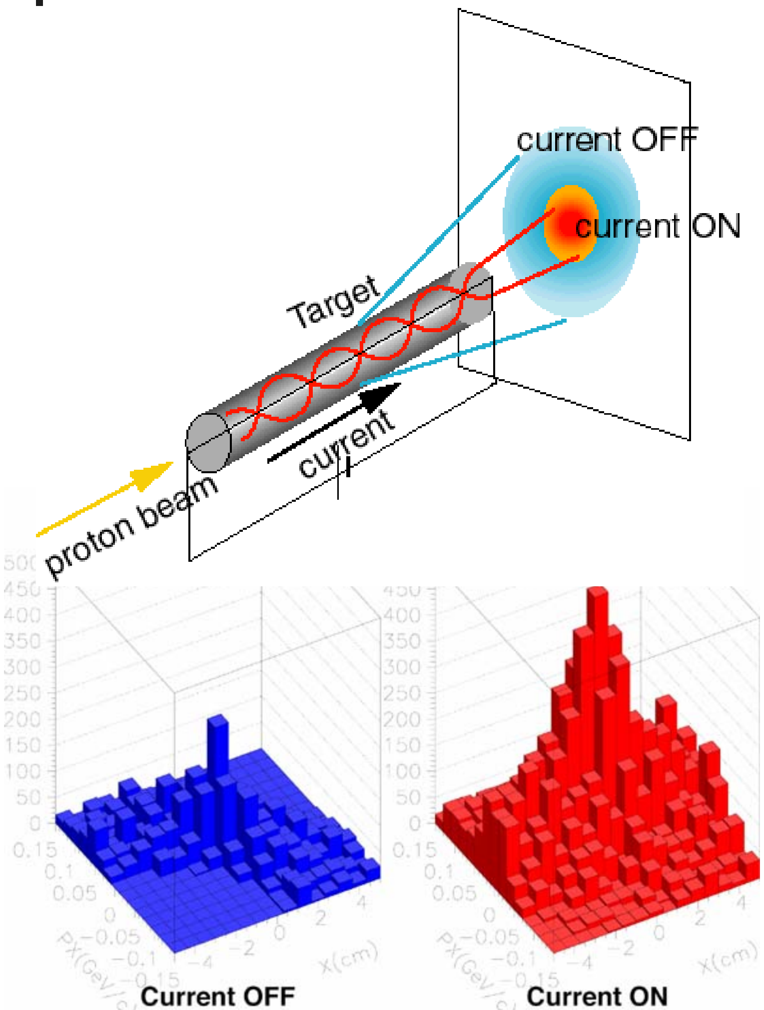


- Baseline option
  - B=6T
  - IR=450 cm, L=160 cm
  - Graphite Target L=2λ=80 cm
  - Shield thickness 25cm
- Still Necessary for R&D
  - Cooling ~500 W
  - Quench protection
  - Radiation safety
  - Thin Graphite target

Further R&D Plan of PRISM Solenoid option

- R&D Coil will be constructed this year
  - Half or Quarter size
  - Heating using AC LOSS
  - Or Special heater
  - Cooling Method ~500W
    - Pool boiling
    - Thermo siphon (Using convection)
- Proto-type of graphite target
  - JHF neutrino group (Hayato, Oyabu et.al)
  - Water cooled graphite (40 kW heat)
  - Thinner Target?
- Engineering Design -> Future Upgade

Conducting Target



- Confine pions inside the target with troidal field
  - B. Autin, @Nufact01
- Advantage over Solenoid
  - Low emittance beam
  - Linear transport element
    - No SC solenoid channel
    - Cheaper!
  - Cooling condition better?

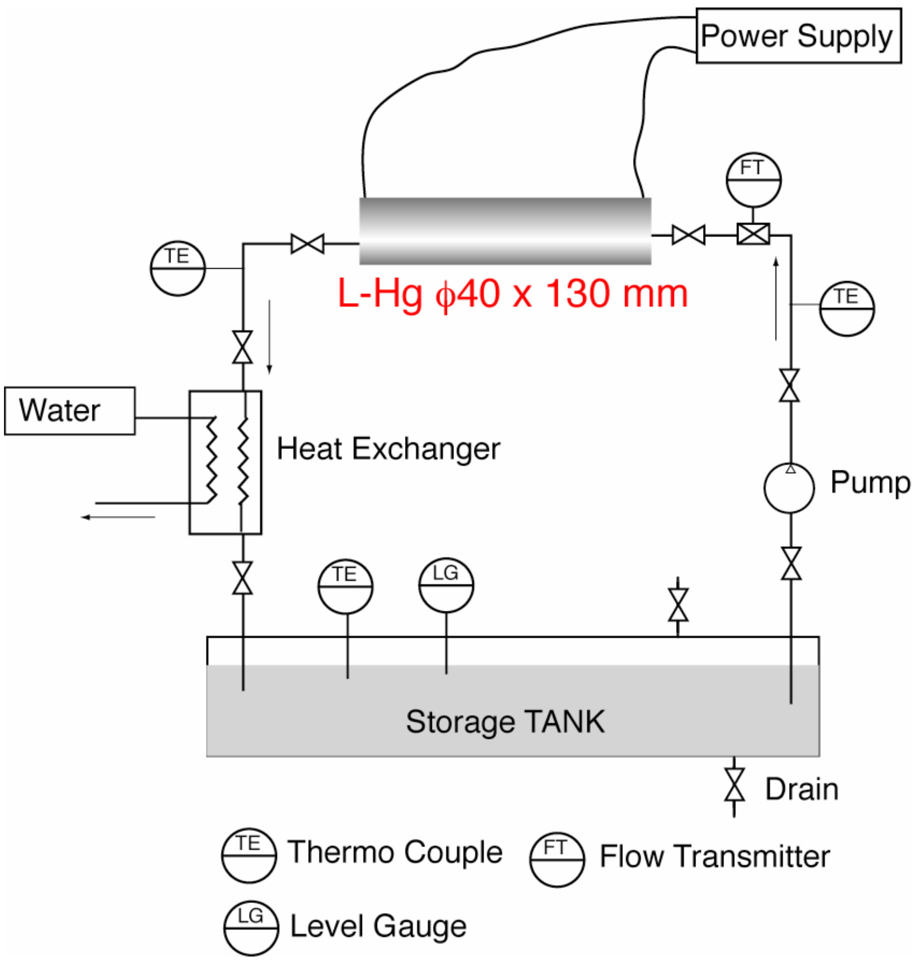
Comparison of target material

	Mercury	Beryllium	Lithium
Power [MW]	3.18	9.95	33.6
Temerature rise per pulse[K]	160	83	142
Field [T]	22.04	21.12	20.84
Intensity [MA]	2.49	2.49	2.49
Frequency [Hz]	50	50	50
Phase[π]	1.	3.	10.
Puls length [ms]	0.264	4.68	3.3
Targe length [m]	0.13	0.407	1.37
Targ radius [m]	0.0226	0.0236	0.024

B. Autin et al.

- Mercury is good candidate
  - Minimum Power
  - Easy to cooling
  - Higher pion yield
- Technical Issues
  - How to cut off electrical circuit?
  - Stress due to pinch effect
  - Container
    - Shockwave
    - Cavitation
    - Thicker wall can be used!
      - No reabsorption
  - Window

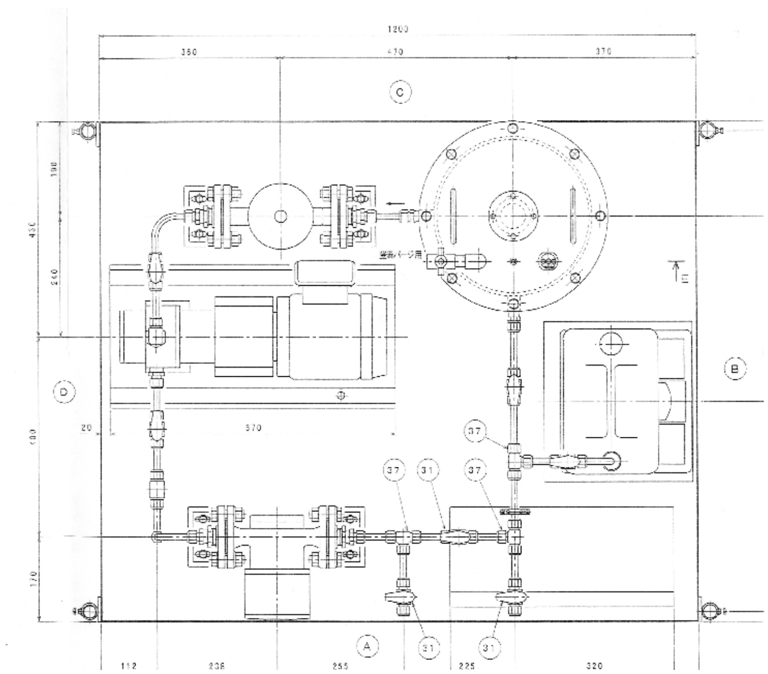
Setup for current test



- 1st phase
  - 1000 A DC
  - 100 J
- 2nd phase
  - 250 KA 2.5ms Pulse (K2K horn PS)
  - 15 KW
- 3rd phase
  - 1 MW?
  - Beam test?

Mercury Test Loop

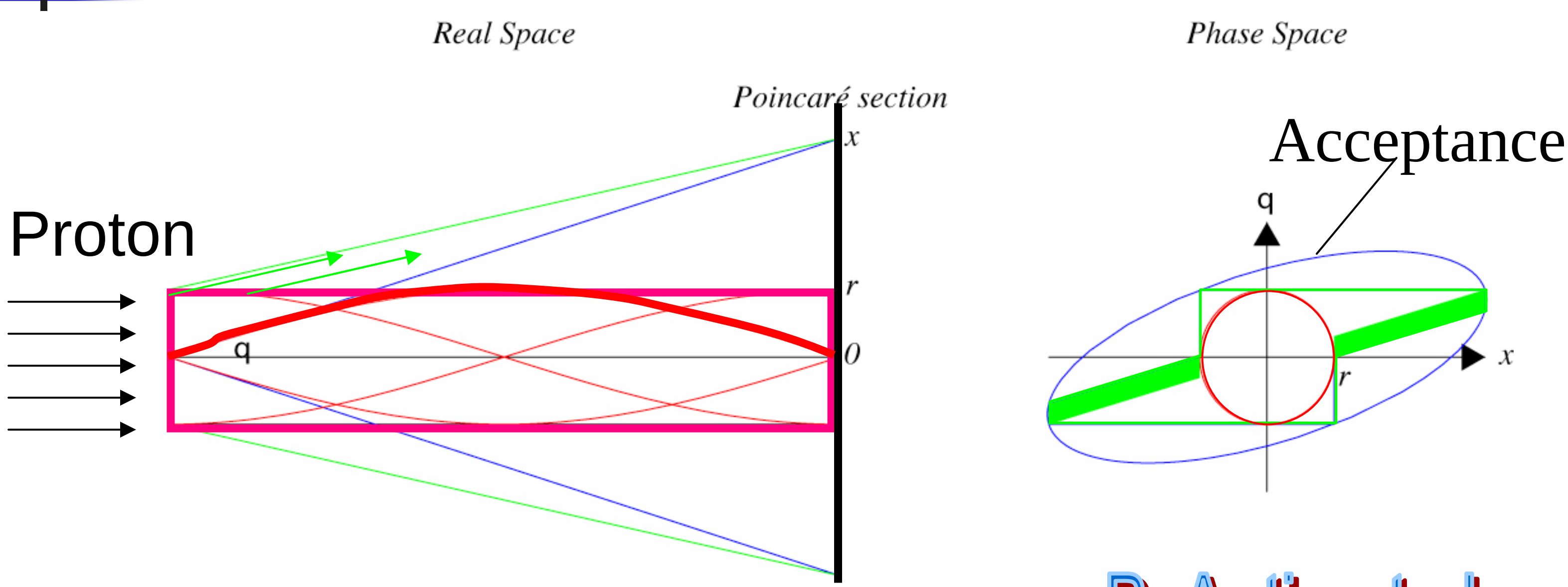
- Mercury 18 litter ~ 250 kg
- Study mercury flow



Summary

- Solenoidal Capture
  - Standard scheme
  - Beam test was successfully performed using the mockup
  - Design parameters will be considered.
  - Realistic R&D Model coil
- Conducting Target
  - merits
  - R&D Work has just started!
    - Proof of principle
    - Feasibility test of High current liquid target

Basic Priciple



B. Autin et al.

$$B \propto r$$

(Inside the target)