ULTRASLOW MUON MICROSCOPE

Tuning of the ultra slow muon beamline by utilizing ionized hydrogen

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August 27, 2014
NuFACT2014

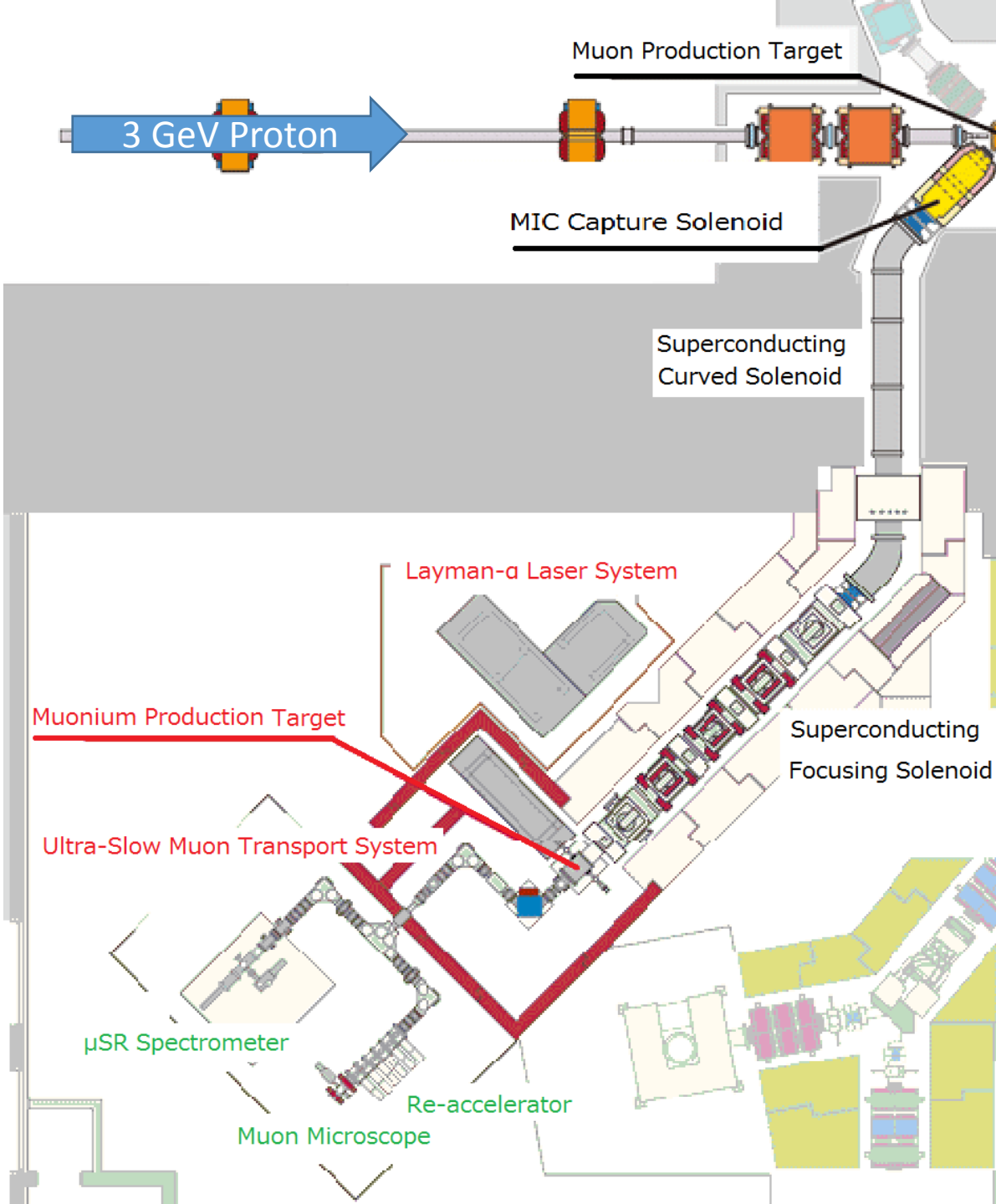
Content

- Overview of the ultra slow muon transport system
- Commissioning by using thermal ionized Li^+
- Commissioning by using laser resonant ionized H^+
- Schedule

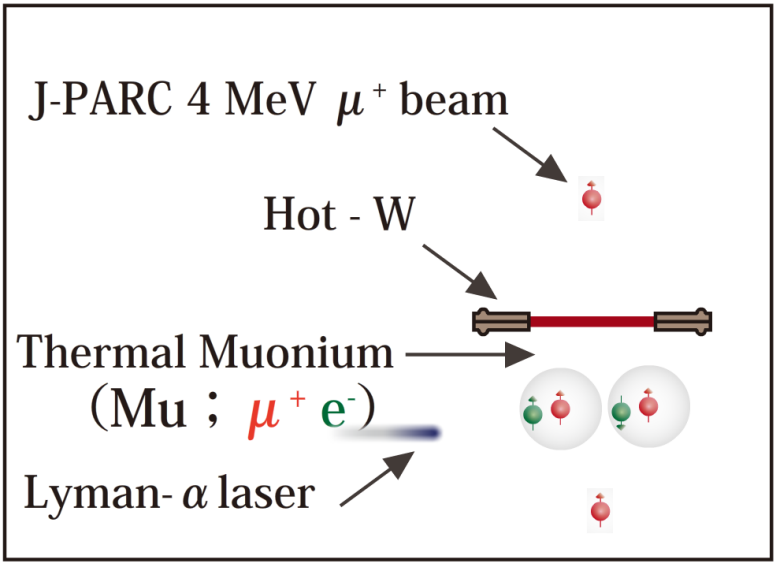
Overview of the ultra slow muon transport system

U-Line

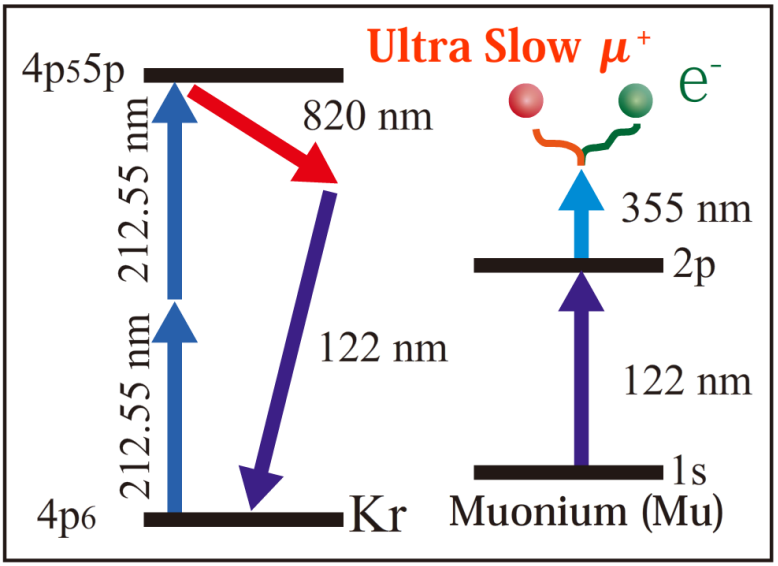
Muon Production Target
↓
MIC Capture solenoid
↓
Superconducting curved solenoid
↓
Superconducting focusing solenoid
↓
Muonium Production Target
↓
Ultra Slow Muon Transport System
↓
μSR Spectrometer
or
Re-Acceleration

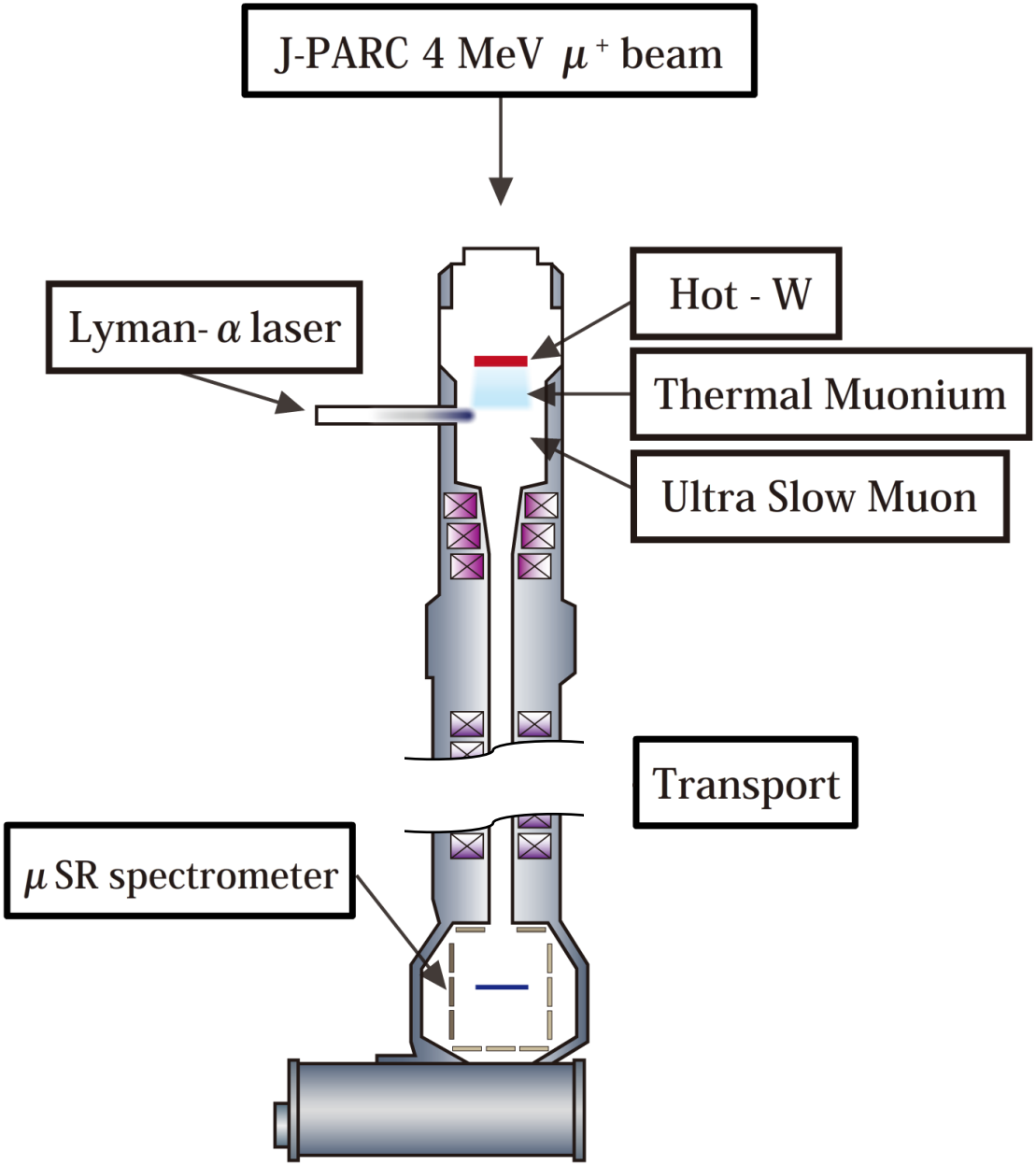


Schematics of the ultra slow muon beamline

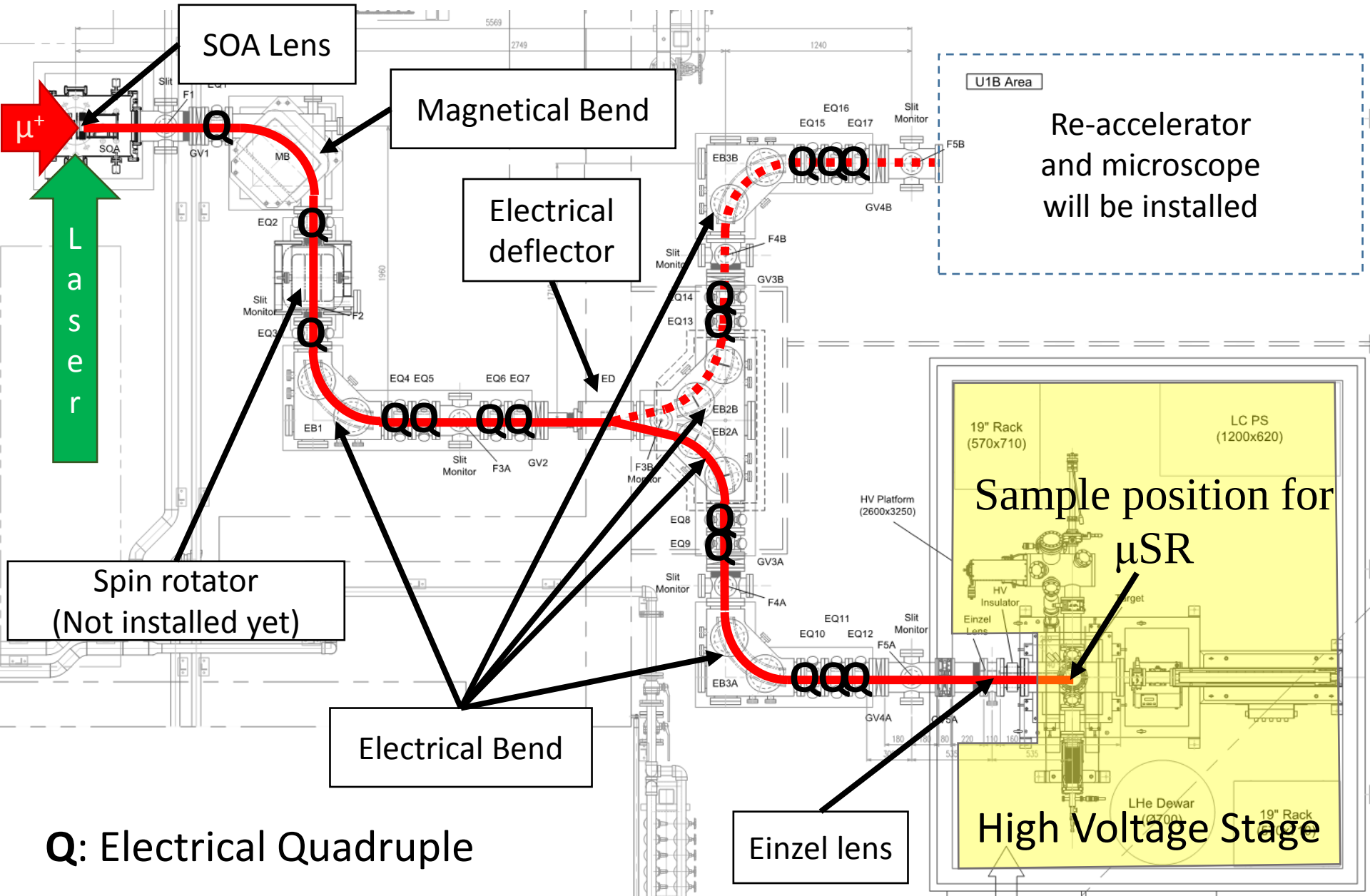


Muonium generation



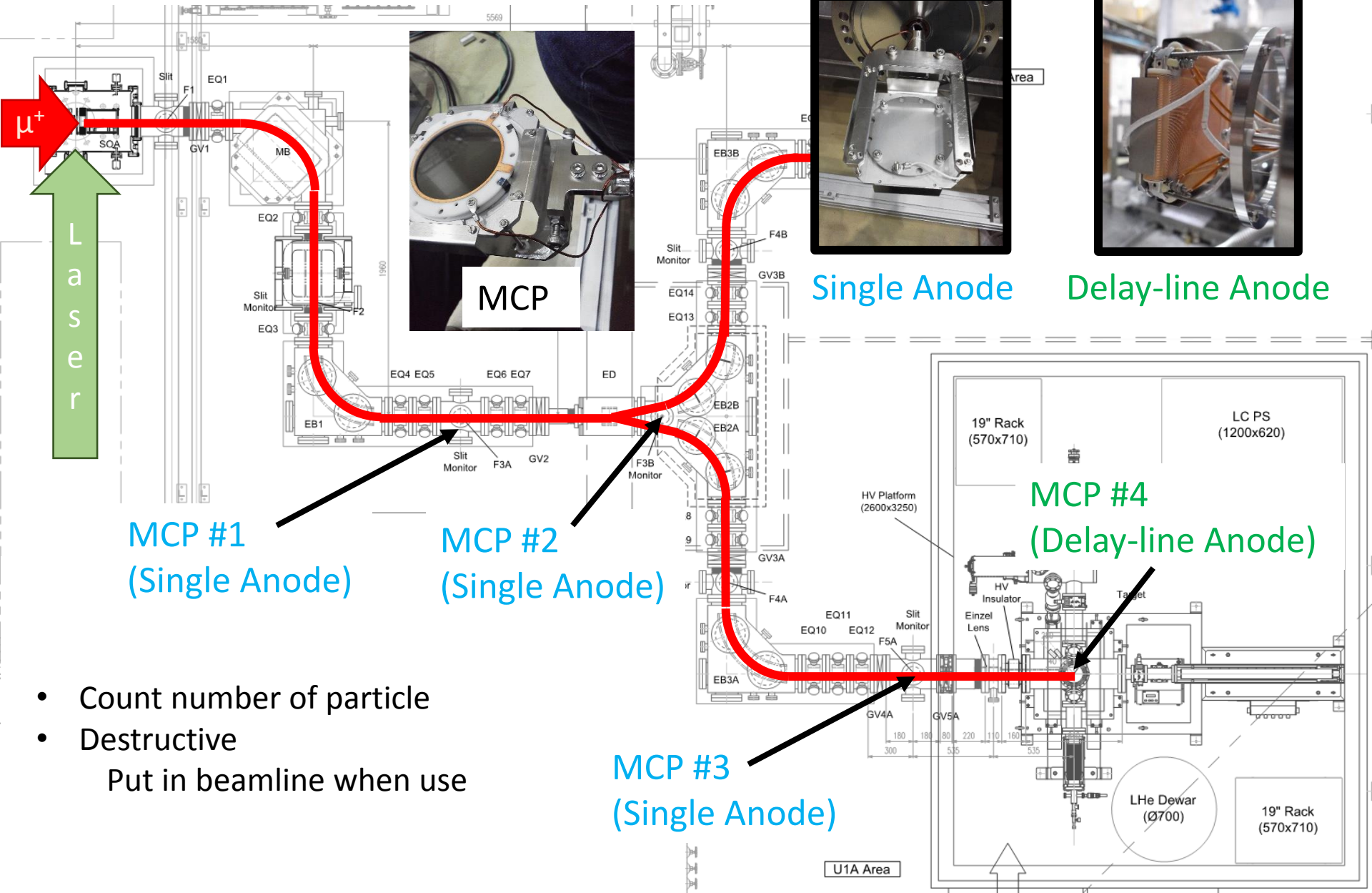


Overview of the Ultra slow muon transport system

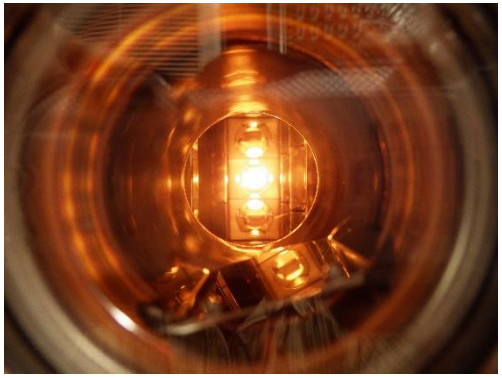


Q: Electrical Quadruple

Beam Detector: MCP (Micro channel Plate)

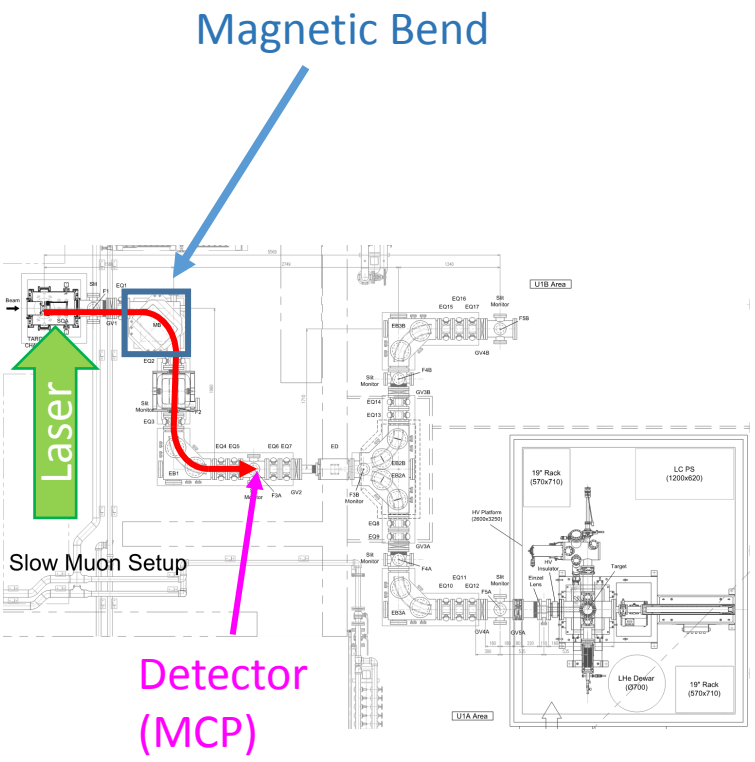


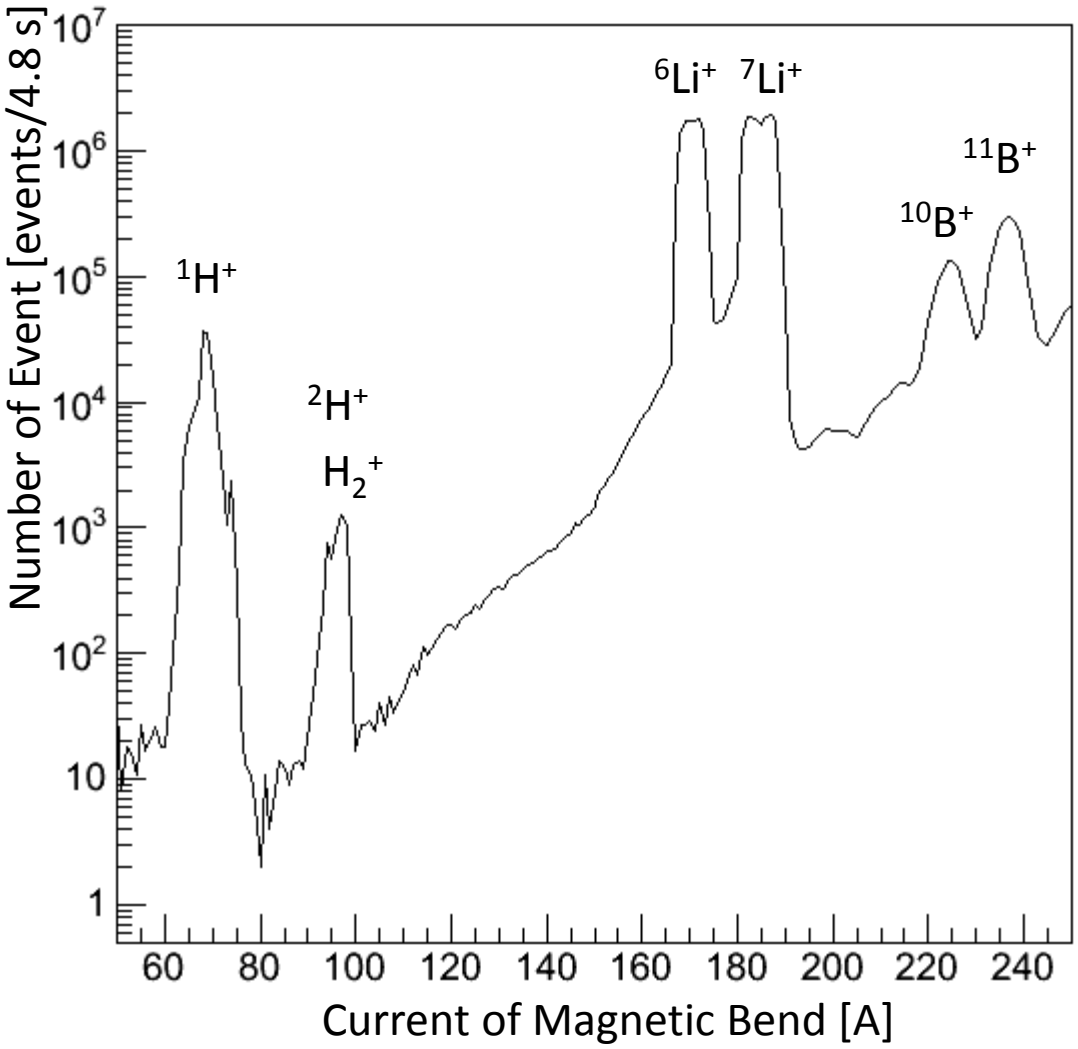
- Count number of particle
- Destructive
  Put in beamline when use



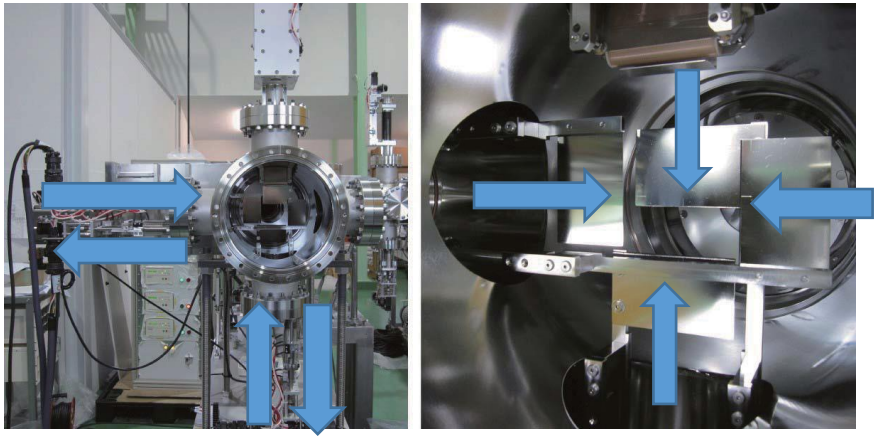
Commissioning by using thermal ionized Li^+

Mass Separation by Magnetic Bend





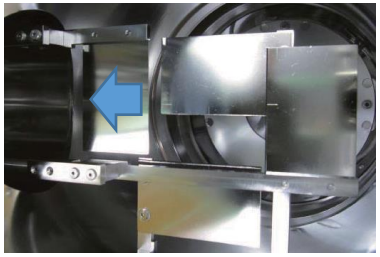
Scanning with Slits



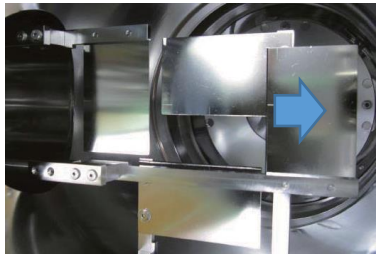
Picture of a set of slits

Position Resolution: 0.1 mm

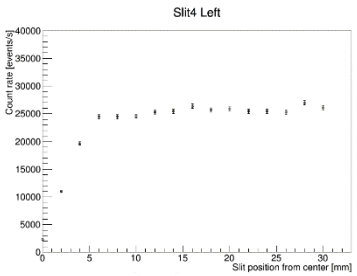
Range: -5 mm ~ 30 mm from center

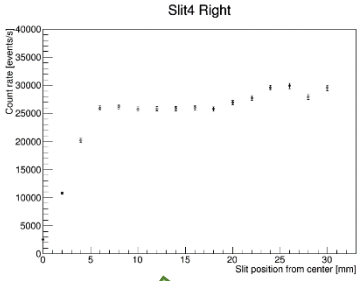


Move & Measure

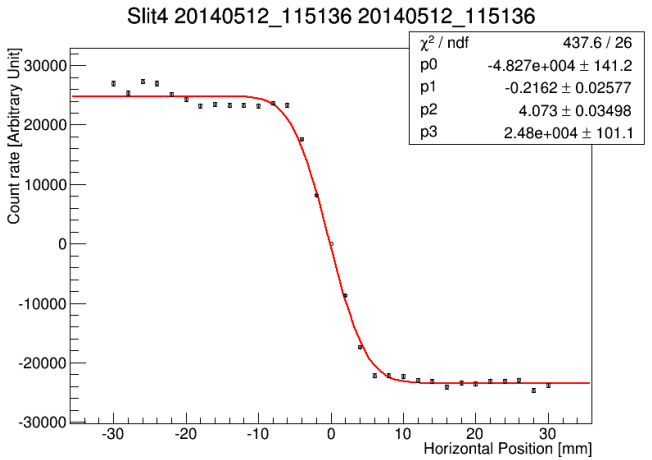


Move & Measure

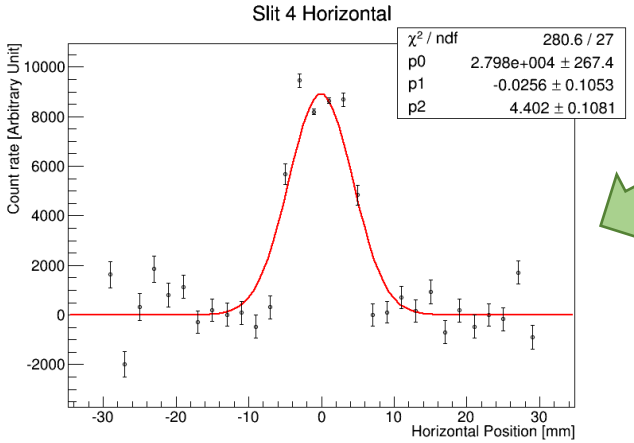




Combine & Fit



Subtract & Fit



$$N = p_0 e^{-\left(\frac{x-p_1}{\sqrt{2}p_2}\right)^2}$$

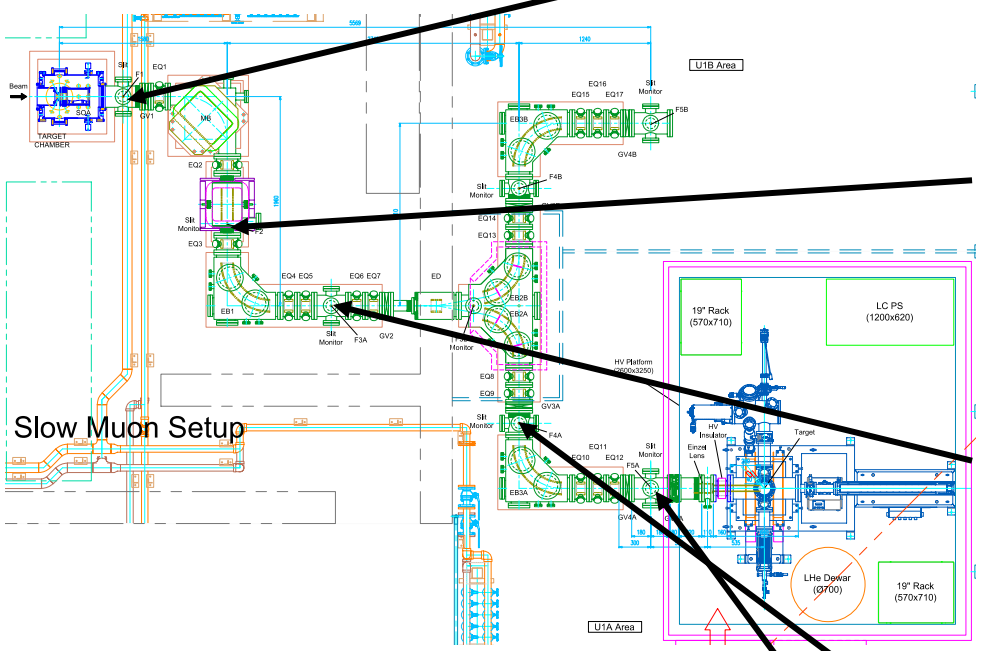
Fitting Function

$$N = \frac{p_0}{2}\left\{1 + \frac{2}{\sqrt{\pi}}\int_0^x e^{-\left(\frac{t-p_1}{\sqrt{2}p_2}\right)^2} dt\right\} + p_3$$

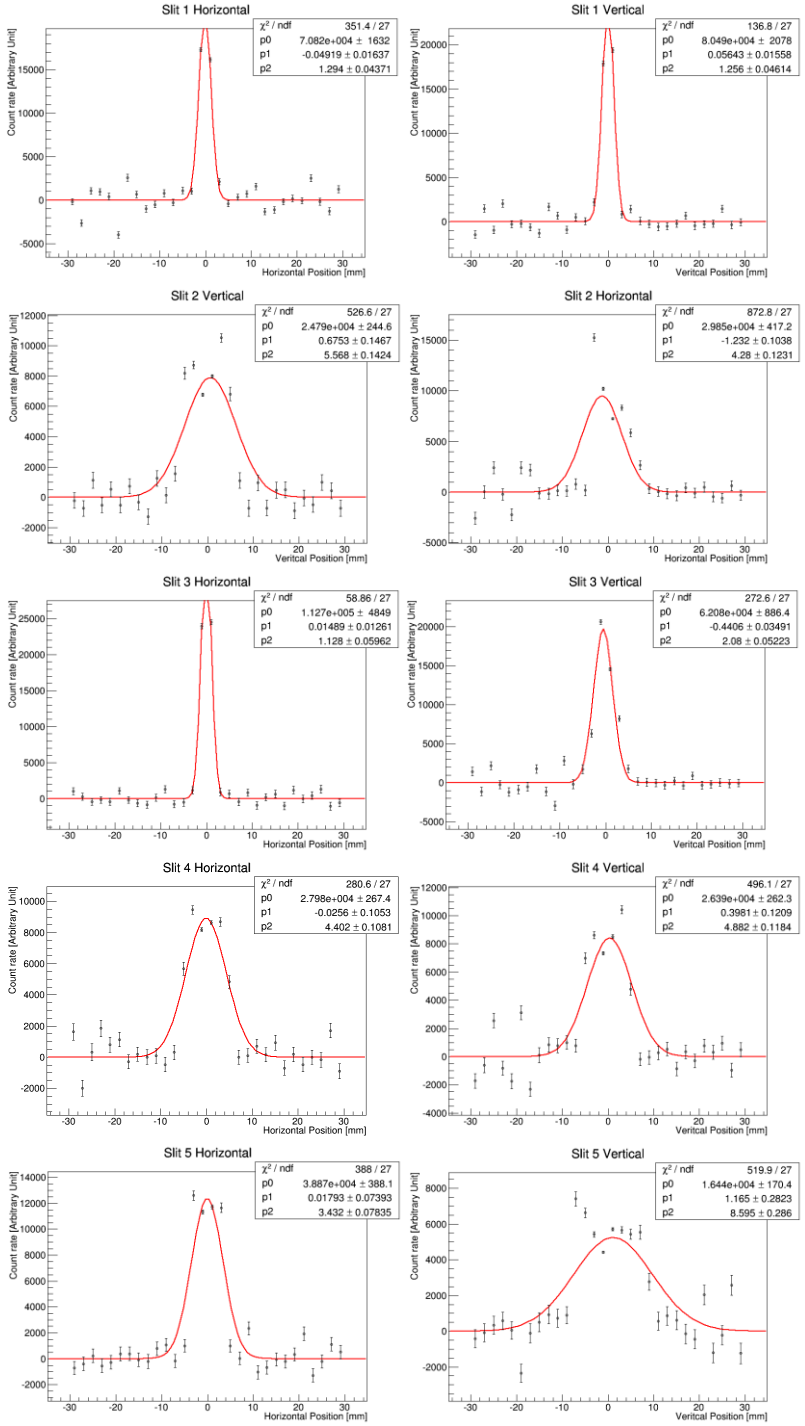
P1: Beam Center

P2: Half Width (1σ)

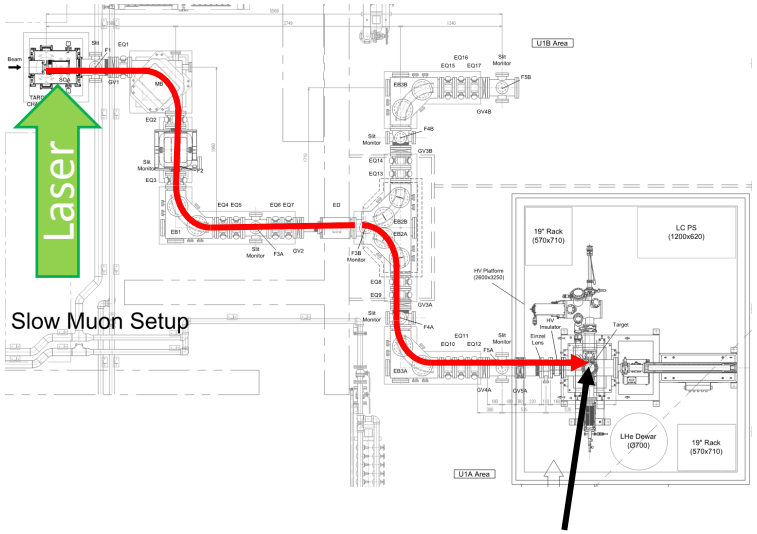
Beam Profiles (L^+ Tuning)



	X mean	X sigma	Y mean	Y sigma
Slit 1	-0.02 mm	1.2 mm	-0.02 mm	1.3 mm
Slit 2	0.02 mm	3.8 mm	-0.10 mm	4.1 mm
Slit 3	0.06 mm	1.0 mm	-0.00 mm	2.1 mm
Slit 4	0.18 mm	3.8 mm	-0.36 mm	4.0 mm
Slit 5	0.05 mm	2.9 mm	0.26 mm	6.4 mm

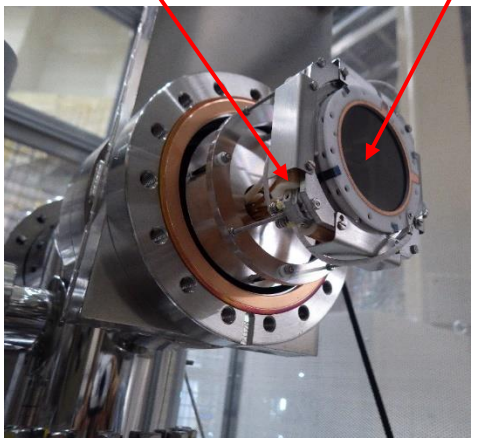


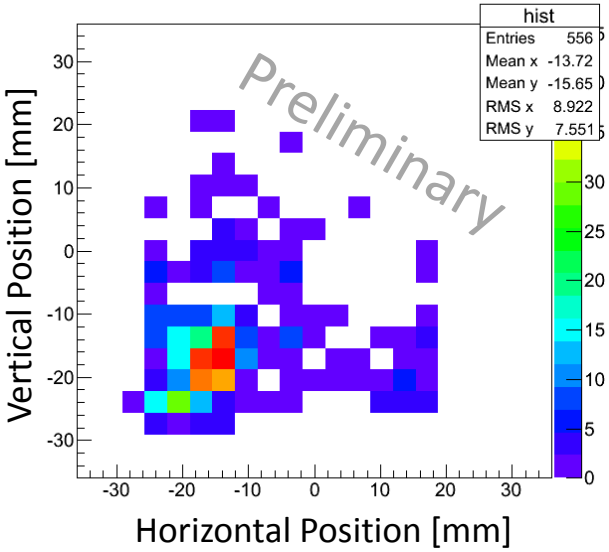
Measurement at Sample Position by using a MCP with delay-line anode



Sample Position
(MCP with Delay-line anode)

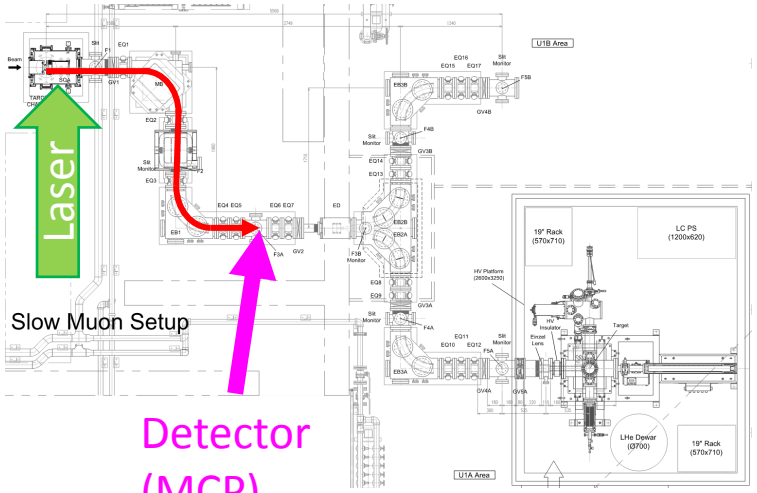
Delay-line-anode MCP

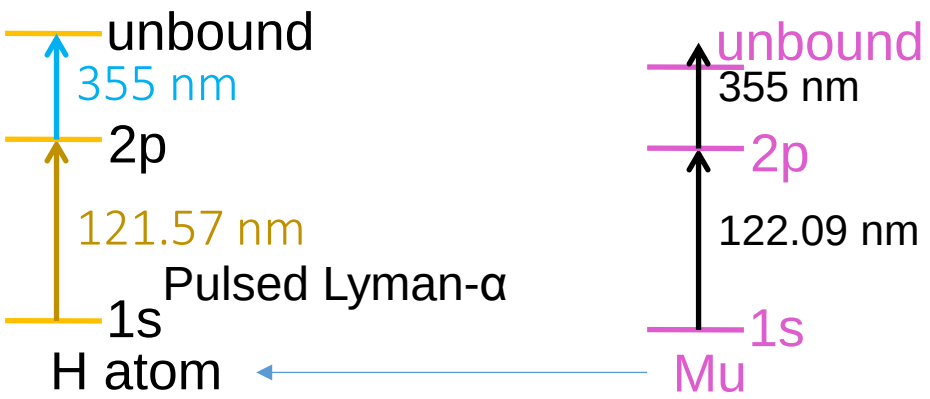




Commissioning by using Laser resonant Ionized H^+

Measurement of Laser Ionized H^+

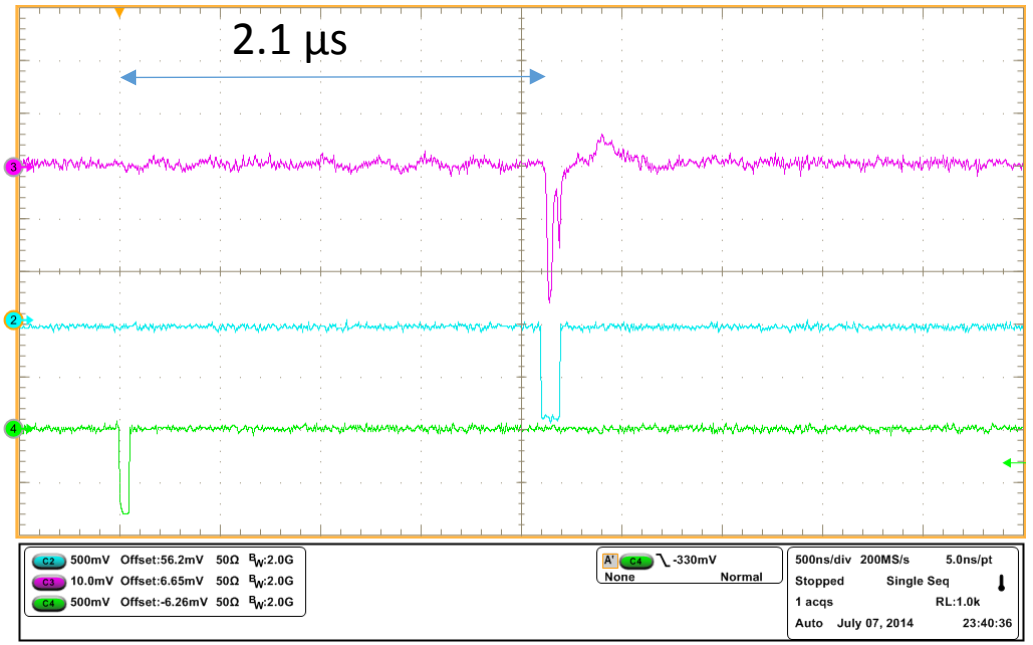




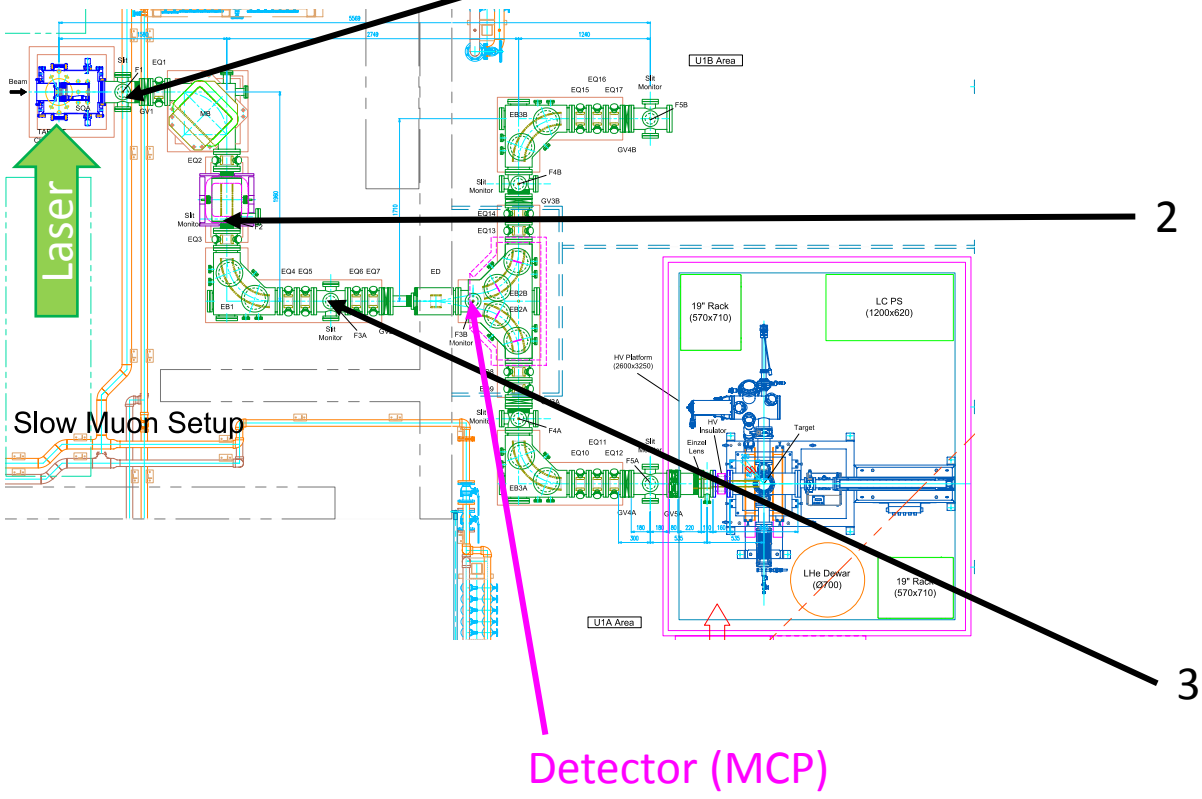
MCP signal

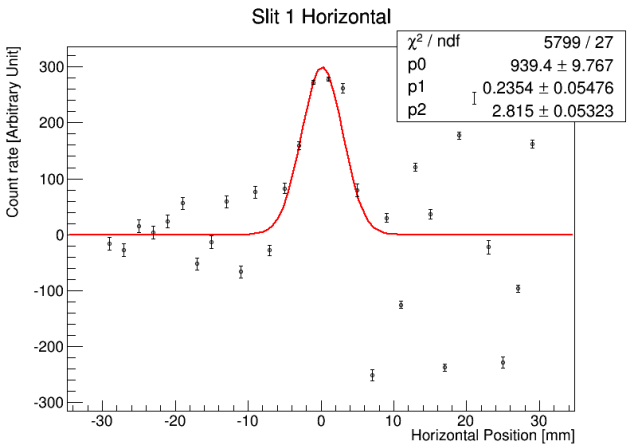
QDC gate

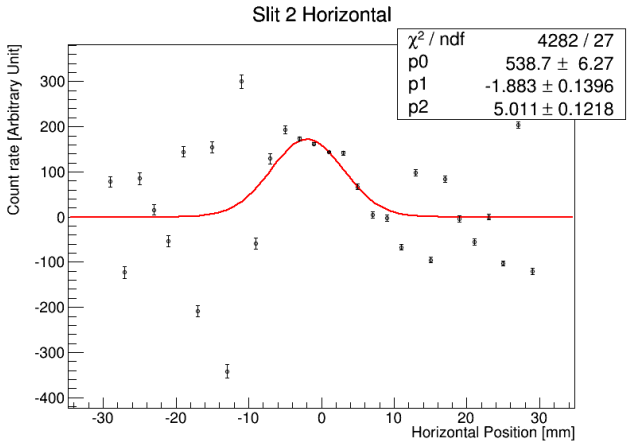
Laser Timing Signal

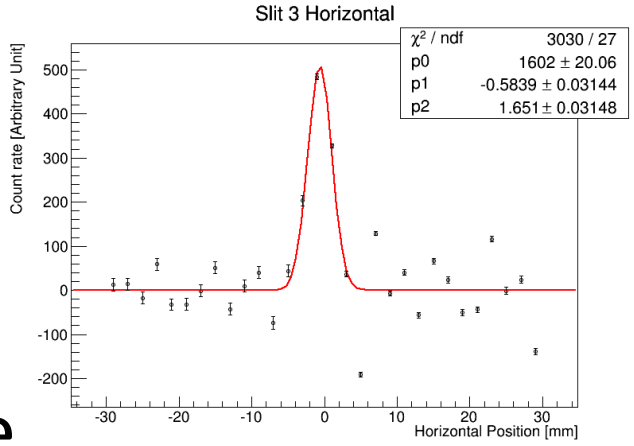


Beam Profiles (Laser Ionized H+)



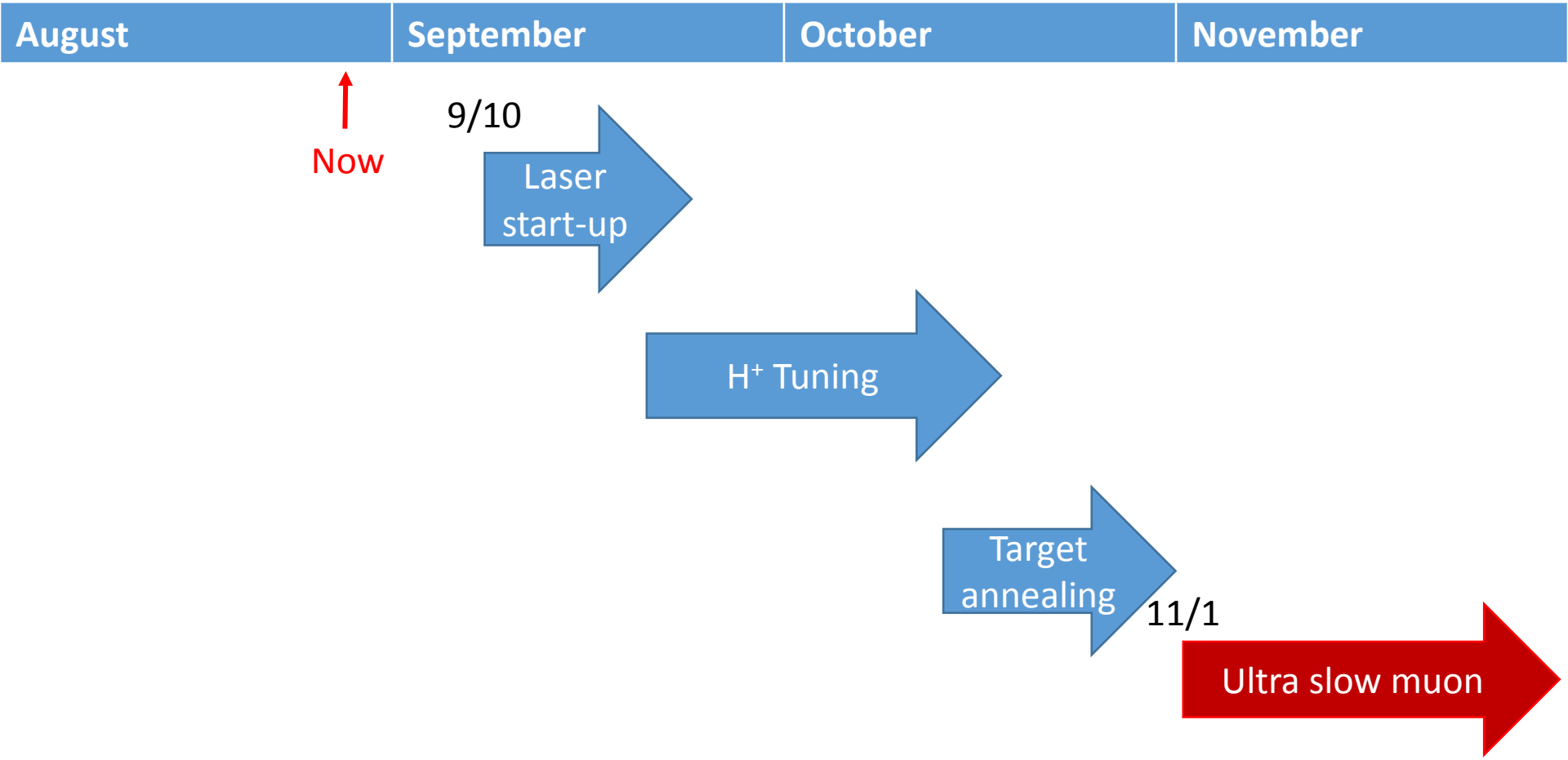






Rate ~ 1 @ middle of the beamline

Schedule


August
September
October
November
Now
9/10
Laser start-up
H+ Tuning
Target annealing
11/1
Ultra slow muon

Summary

- A part of ultra slow muon beamline is installed.
- Commissioning by utilizing laser ionized H^+ is on going.

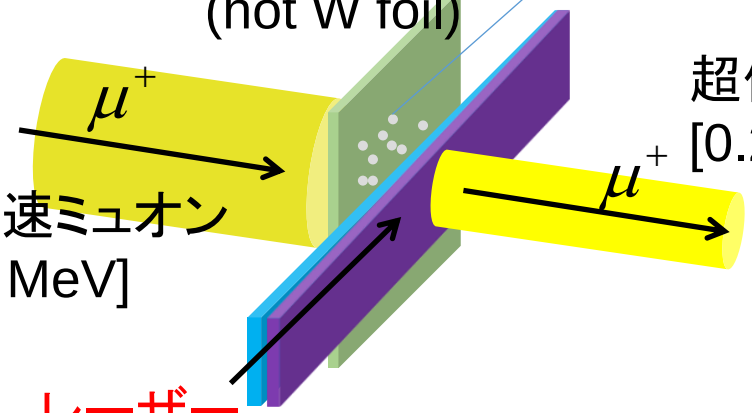
- The first ultra slow muon beam at J-PARC will be created at next November!

超低速ミュオン顕微鏡

超低速ミュオン　冷却　[エネルギーで7桁]

ミュオニウム
生成標的
(hot W foil)

$\mathrm{Mu}: \mu^+e^-$

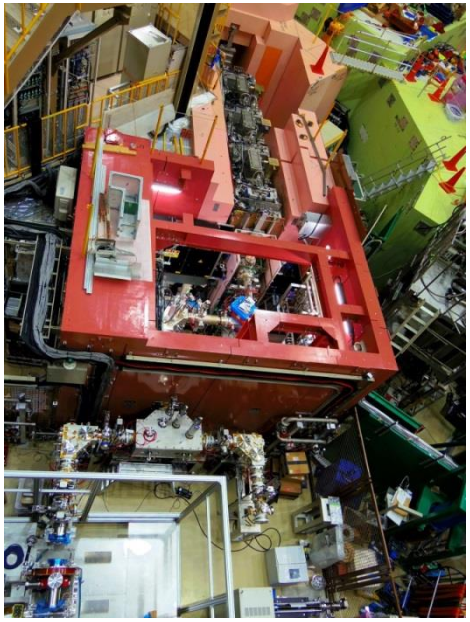


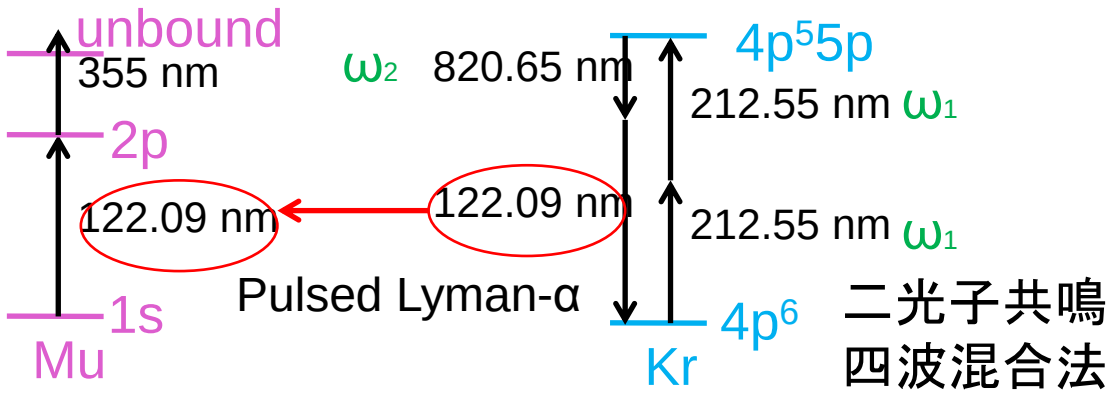
低速ミュオン
[4 MeV]

超低速ミュオン
[0.2 eV~]
→30keV (加速)

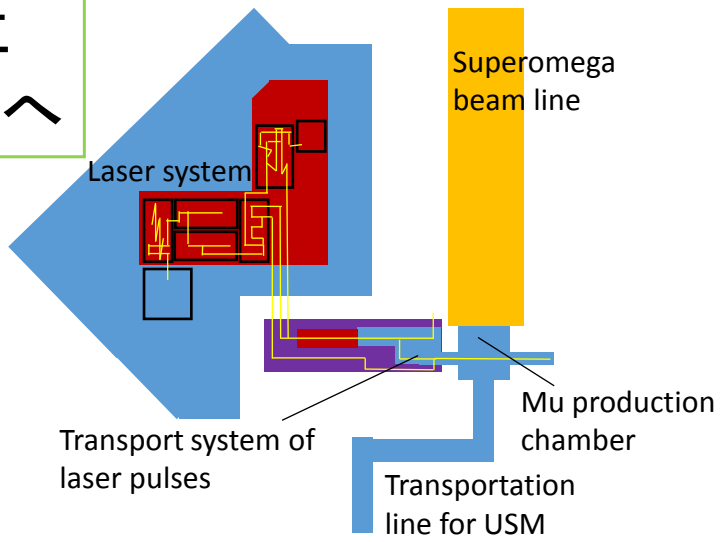
レーザー
122 nm (Mu;1S→2P)
355 nm (Mu;2P→unbound)

物性実験に
使える強度へ





二光子共鳴
四波混合法



“H atom laser ionization” at MLF of J-PARC

July 2, 2014

All-solid-state laser system as Lyman-α driving laser

J. Nakamura, T. Adachi (KEK)
Y. Oishi, K. Miyazaki, N. Saito (RIKEN)

ULTRASLOW MUON MICROSCOPE

From laser cabin

840 nm 212 nm

355 nm

dump

Gas cell
(2.4kPa Kr-Ar mixture)

Sodium salicylate painted plate

W

dump

H^+

Transportation line

Observed laser ionization of hydrogen atom by MCP signal

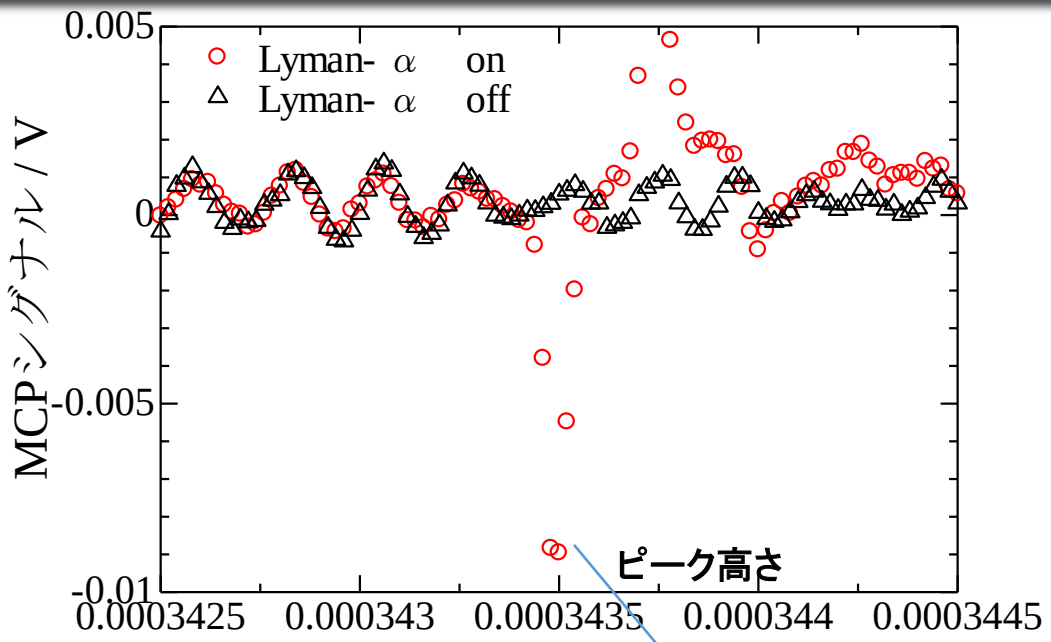
MCP
(Micro Cannel Plate)

Mass Analyzing Magnet

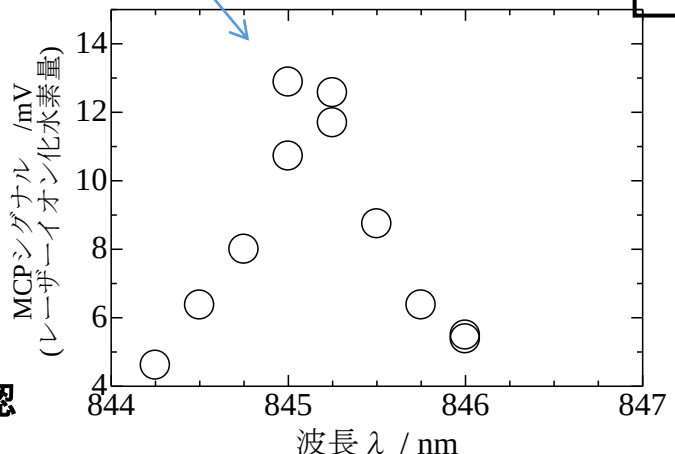
“H atom laser ionization” at MLF of J-PARC

July 2, 2014

ULTRASLOW MUON MICROSCOPE



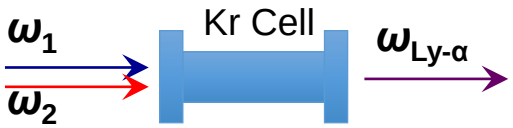
レーザーに同期 (25Hz) して
水素がイオン化している様子
を確認



ピーク高さの
ω_2 波長依存性を確認

Lyman-α on

Two-Photon Resonance
Four-Wave Mixing



Lyman-α off

ω_1 (212.556 nm): Input to Kr Cell

ω_2 (845.25 nm): Blocked