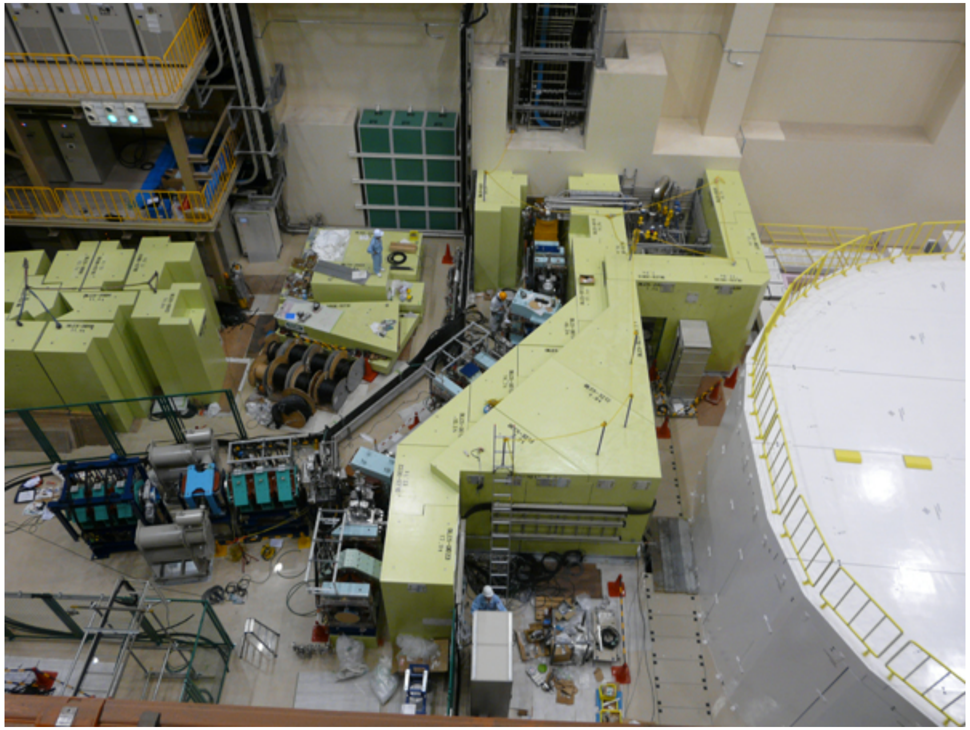
Nufact10, October 20−25th, 2010

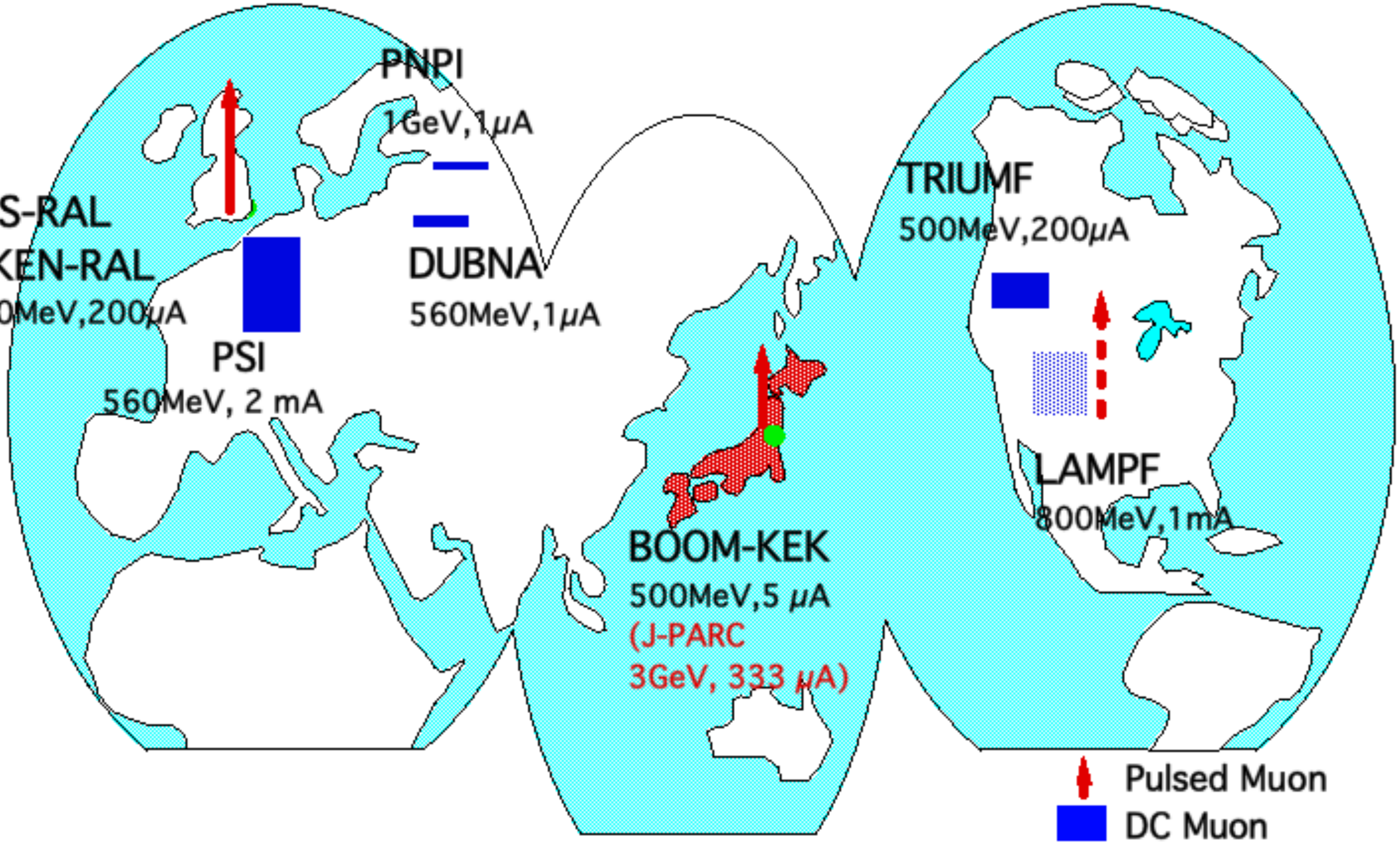
J-PARC Muon Facility
MUSE (MUon Science Establishment)

J-PARC Center/KEK Y. Miyake

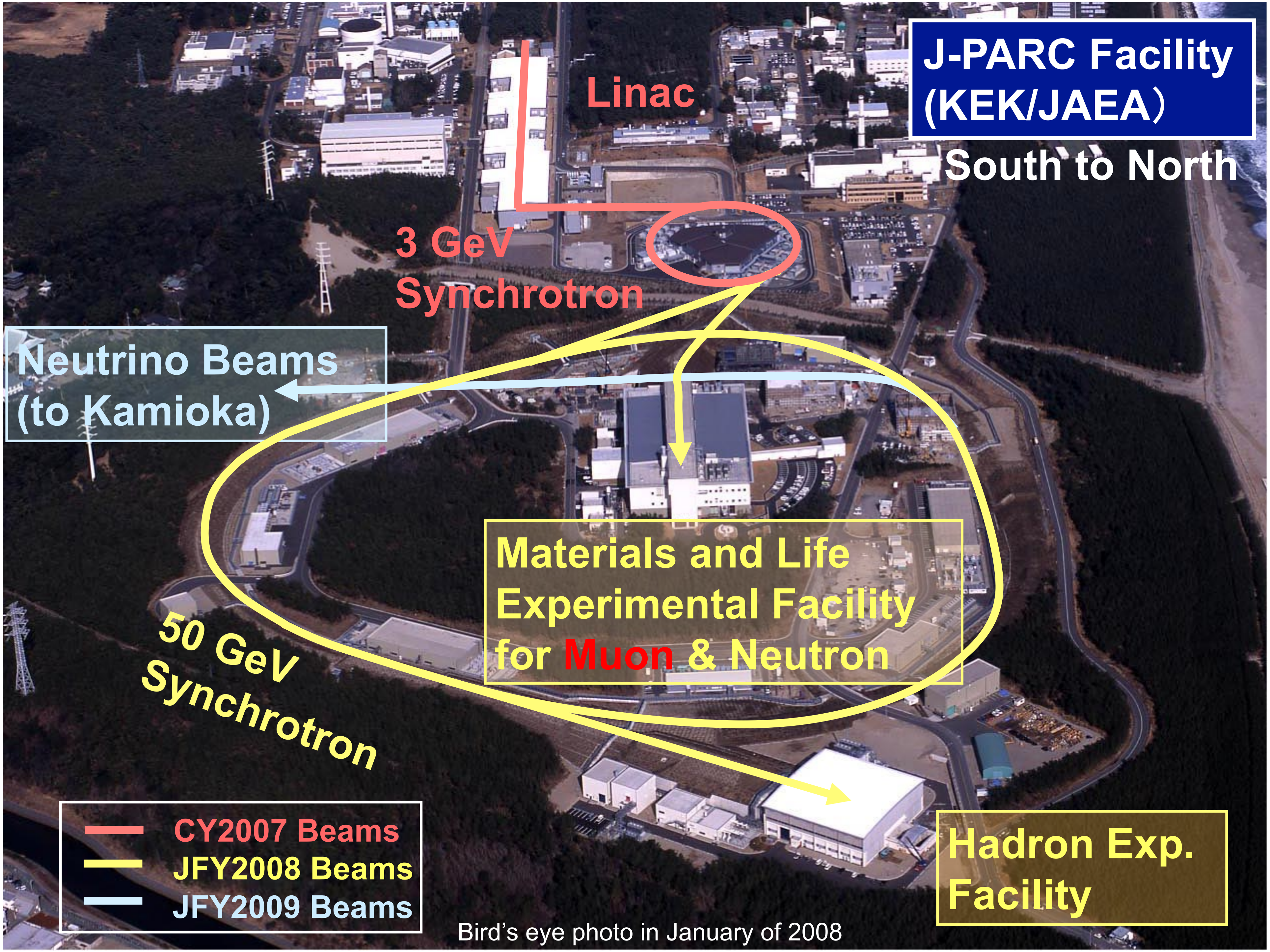
K. Shimomura
N. Kawamura
P. Strasser
S. Makimura
A. Koda
H. Fujimori
K. Nakahara
M. Kato
Y. Ikedo
S. Takeshita
W. Higemoto
T. Ito
K. Ninomiya
R. Kadono
K. Nishiyama
K. Nagamine



J-PARC Muon Science Facility

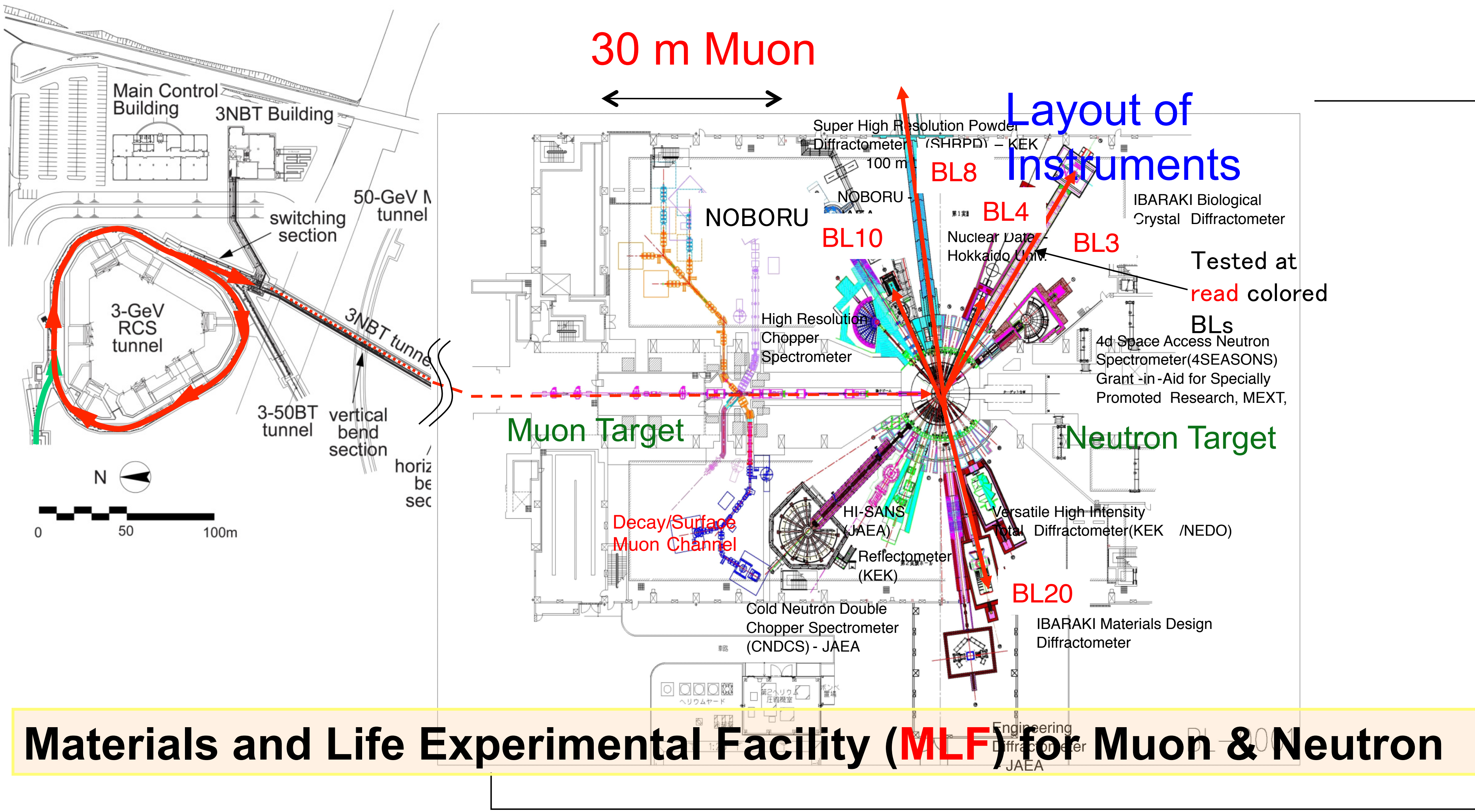


Muon Sources in theWorld


J-PARC Facility
(KEK/JAEA)
South to North
Linac
3 GeV
Synchrotron
Neutrino Beams
(to Kamioka)
Materials and Life
Experimental Facility
for Muon & Neutron
50 GeV
Synchrotron
Hadron Exp.
Facility
CY2007 Beams
JFY2008 Beams
JFY2009 Beams
Bird's eye photo in January of 2008

Proton Beam Transport from 3GeV RCS to MLF

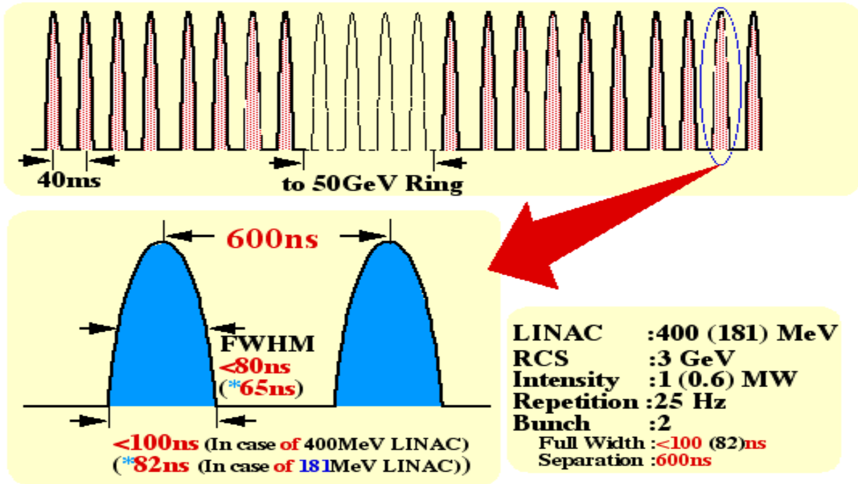
On the way, Muon Graphite Target



Materials and Life Experimental Facility (MLF) for Muon & Neutron

Proton beam from 3-GeV Rapid Cycling Synchrotron (*RCS*)

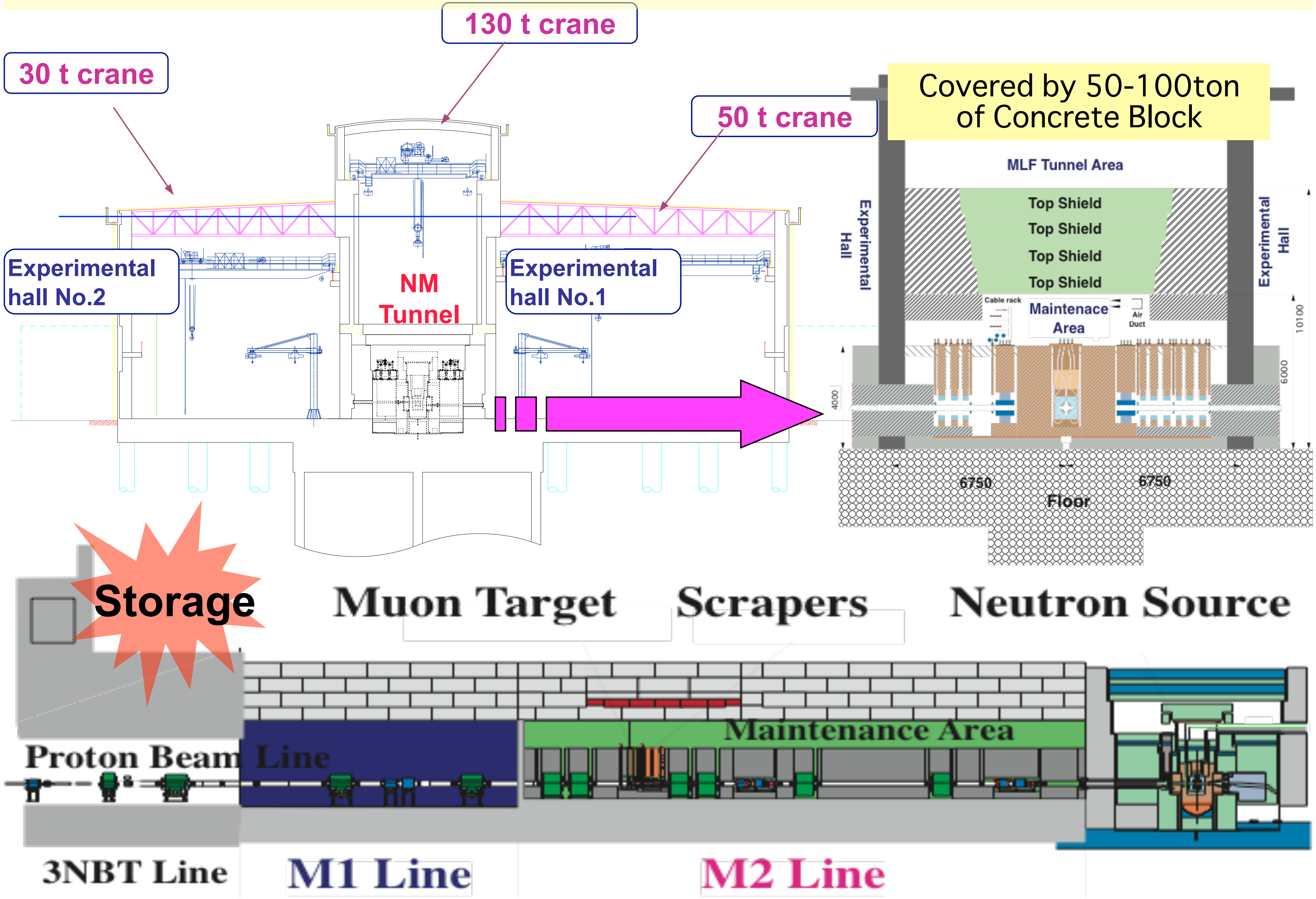
Beam energy	**3 GeV (High Cross-section of μ^-)**
Number of protons	**8.3 x 10^{13} / pulse**
Repetition rate	**25 Hz, Pulsed Laser (25 Hz) can be synchronized!**
Average beam current	**333 μA (LINAC 400 MeV) (*Goal*)**
Average beam power	**1 MW (LINAC 400 MeV)** **0.6MW (LINAC 181 MeV)** **0.1MW (since Nov., 2009)**
Transverse emittance (ε)	**81π mm·mrad (beam core)** **324π mm·mrad (max. halo)**
beam profile	$\sigma_x = \sigma_y$=3mm (@20 kW)@target



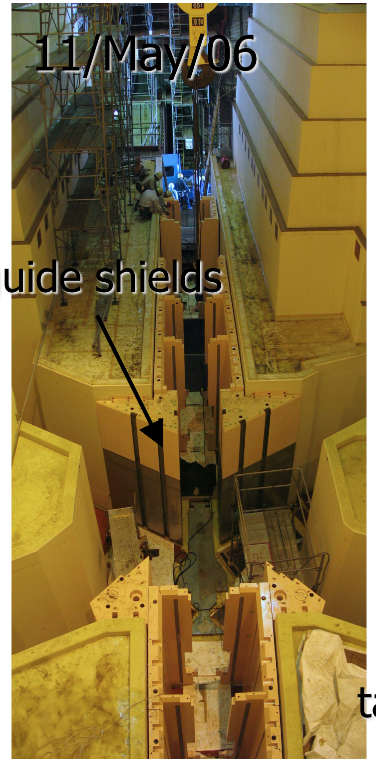
Longitudinal Structure of 3GeV Proton Beam (25Hz)

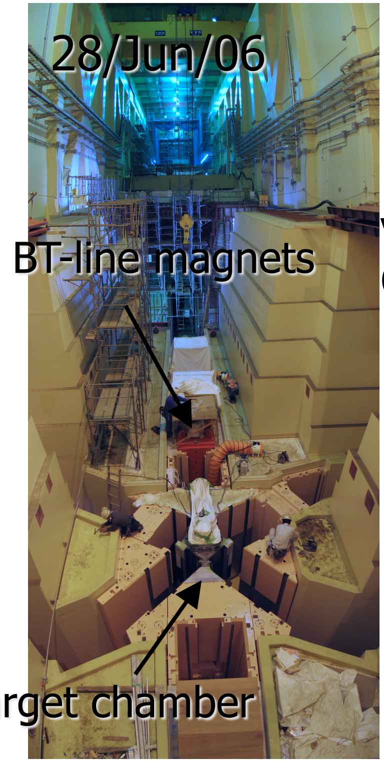
From Pulsed Proton beam from 3-GeV Pulsed Muon beam

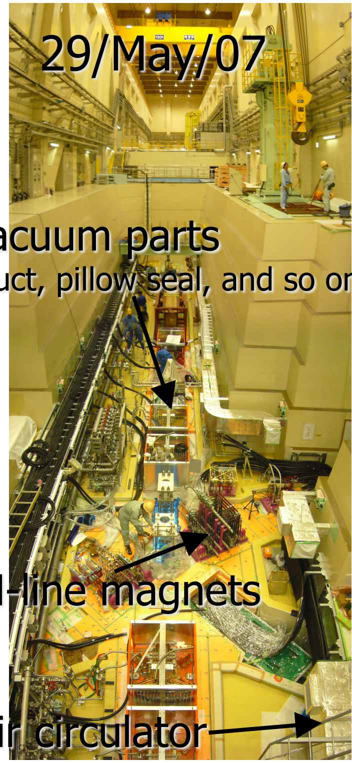
MLF Tunnel Structure I（Crossed View）

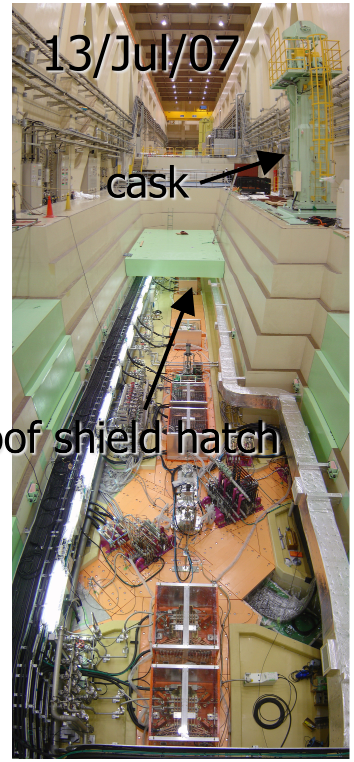


M2 tunnel construction history







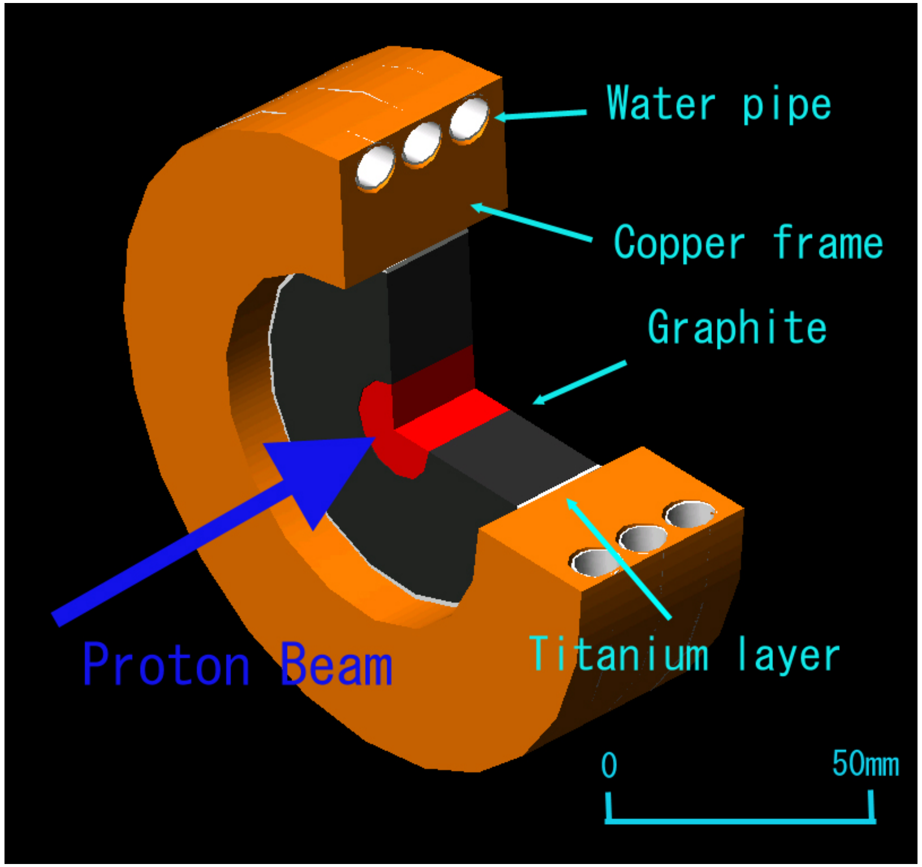


FY2004	FY2005	FY2006	FY2007
buried iron block		BT magnet M magnet	CW pipe, cabling
base plate	alignment plate	air circulator	cask
	guide shield	BT shield	roof shield hatch
	target chamber	vacuum parts	system commissioning

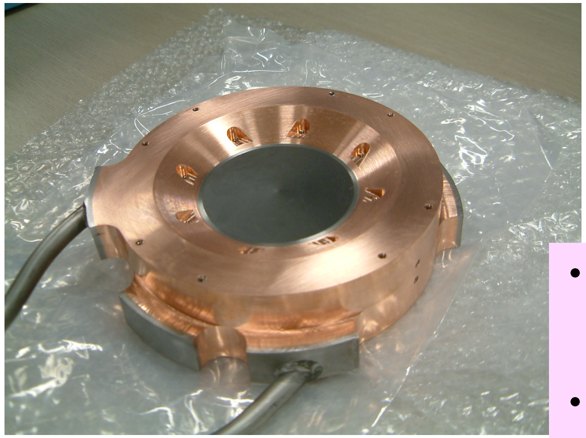
Muon graphite target

In the beginning up to 0.6 MW,
We use an edge cooled graphite Target.

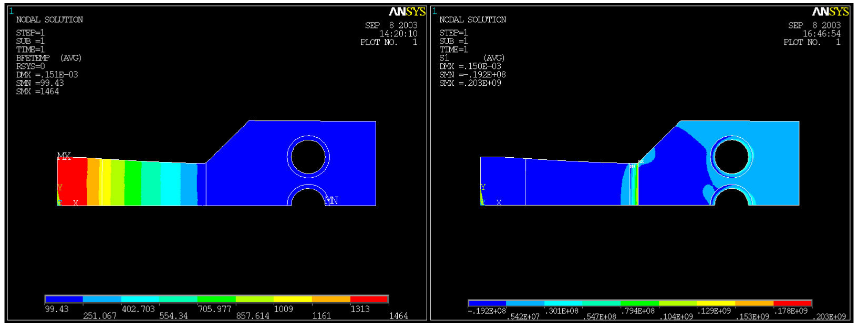
- 3GeV333μA, 25Hz pulsed proton beam
- Isotropic graphite（IG43）
  like a cylinder, thickness 20mm
  Neutron irradiation effect
  Thermal conductivity, dimension
- Heat Deposit
  3.3kW on graphite(ϕ25mm)
  600W on copper frame
- **Indirectly cooling** by Copper frame,
  placing Ti buffer layer to reduce stress!



ANSYS simulation
•Temperature
•Stress



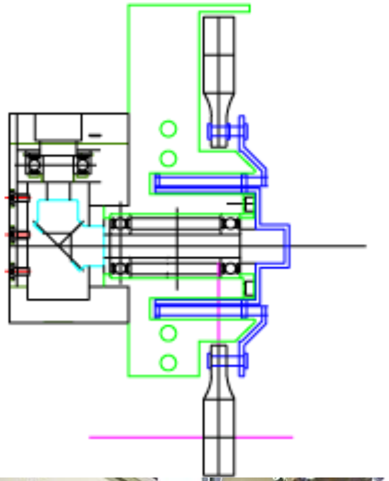
- Copper –Stainless pipe -->**HIP**(Hot Isostatic Press)
- Copper –Ti-Graphite --> **Silver Blazing in vac.**

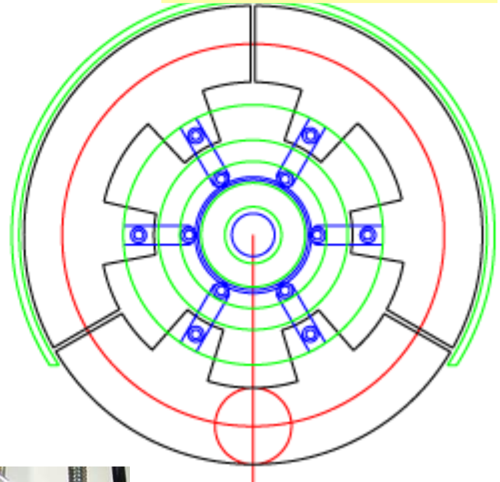


Rotating Muon Graphite Target

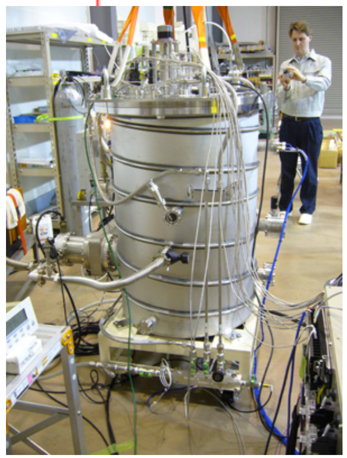
will be installed in 2012

Makimura et al.

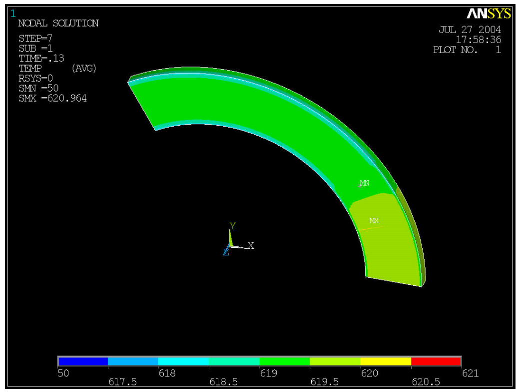




Target wheel
O.D. 350mm, I.D. 250mm
Thickness 20mm
Emissivity 0.8
Temperature 600℃



Difference between max. and min. temperature
Repetition 40rpm 1℃
1rph 100℃
Target does not have to be rotated so fast.



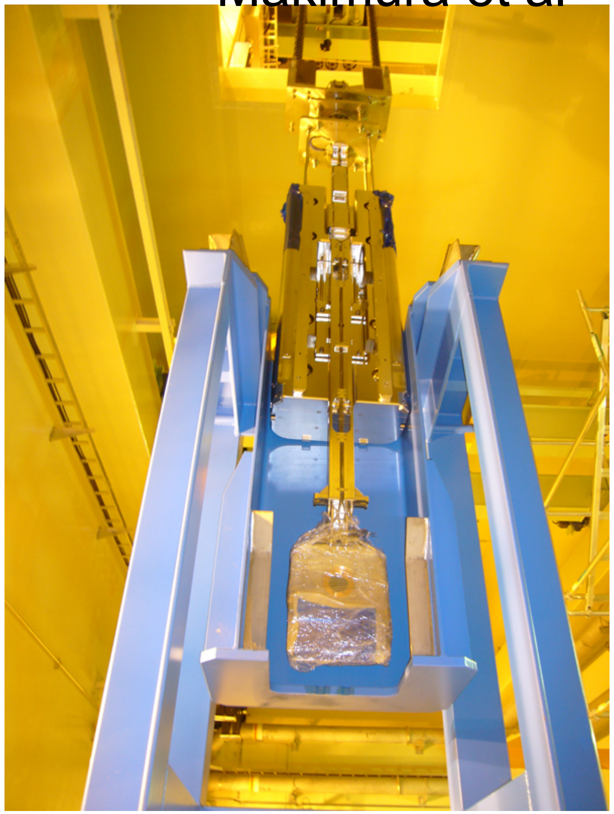
Maintenance of Muon Target, Scrapers, pillow seal, & profile monitor in the hot cell!

March-May, 2008, all the practice had to be completed before Neutron DAY 1, May 30th, 2008

Prepared by Makimura et al

Several kinds of atachments were prepared and tested.

A picture of the maintenance commissioning of the target slide table in the hot cell

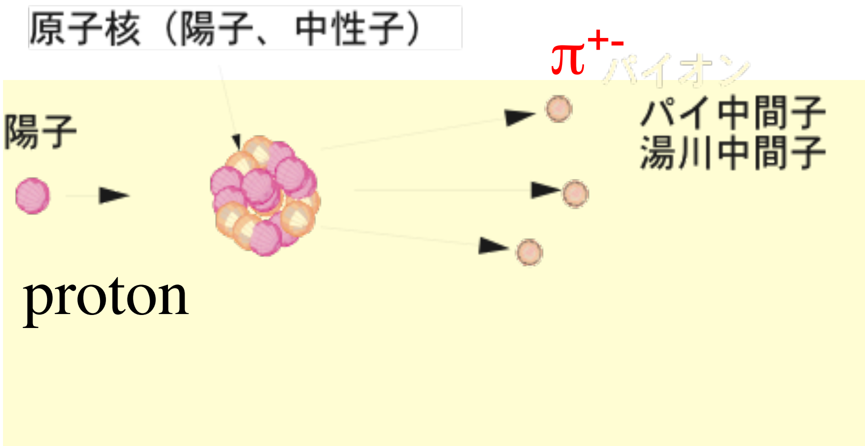


A picture of the target assembly transported down to the storage basement

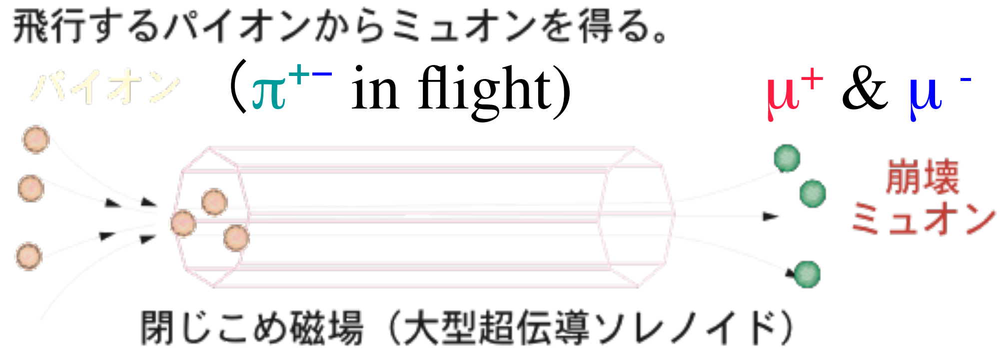
Secondary Muon Channel

Two kinds of conventional Muon Beams

Nucleus(p,n)



Decay Muon(up to 50MeV=120MeV/c)



Superconducting Solenoid

μ is a decay product of π

$\pi^+ \rightarrow \mu^+ + \nu_\mu$ Decay

$\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$ Decay

26ns

π is generated by

$p + p \rightarrow p + n + \pi^+$

$p + n \rightarrow p + p + \pi^-$

$p + n \rightarrow n + n + \pi^+$

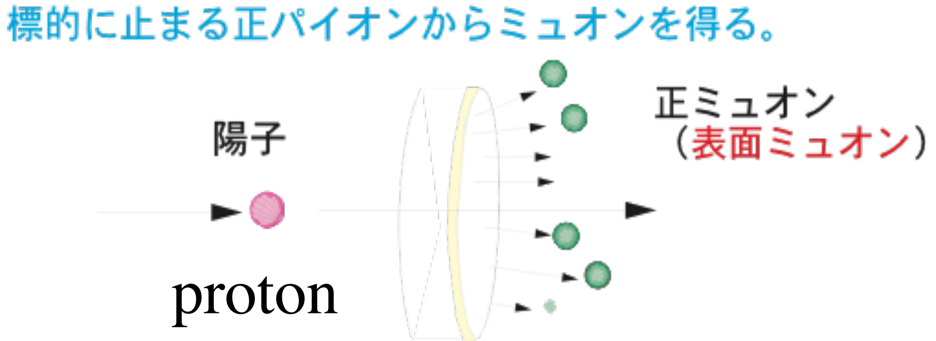
$n + n \rightarrow p + n + \pi^-$

$p + p \rightarrow p + p + \pi^+ + \pi^-$

10-40 mbarn

Threshold Energy of proton beam 300MeV

Surface Muon(4MeV = 30 MeV/c)



μ^+ emitted from stopped π^+

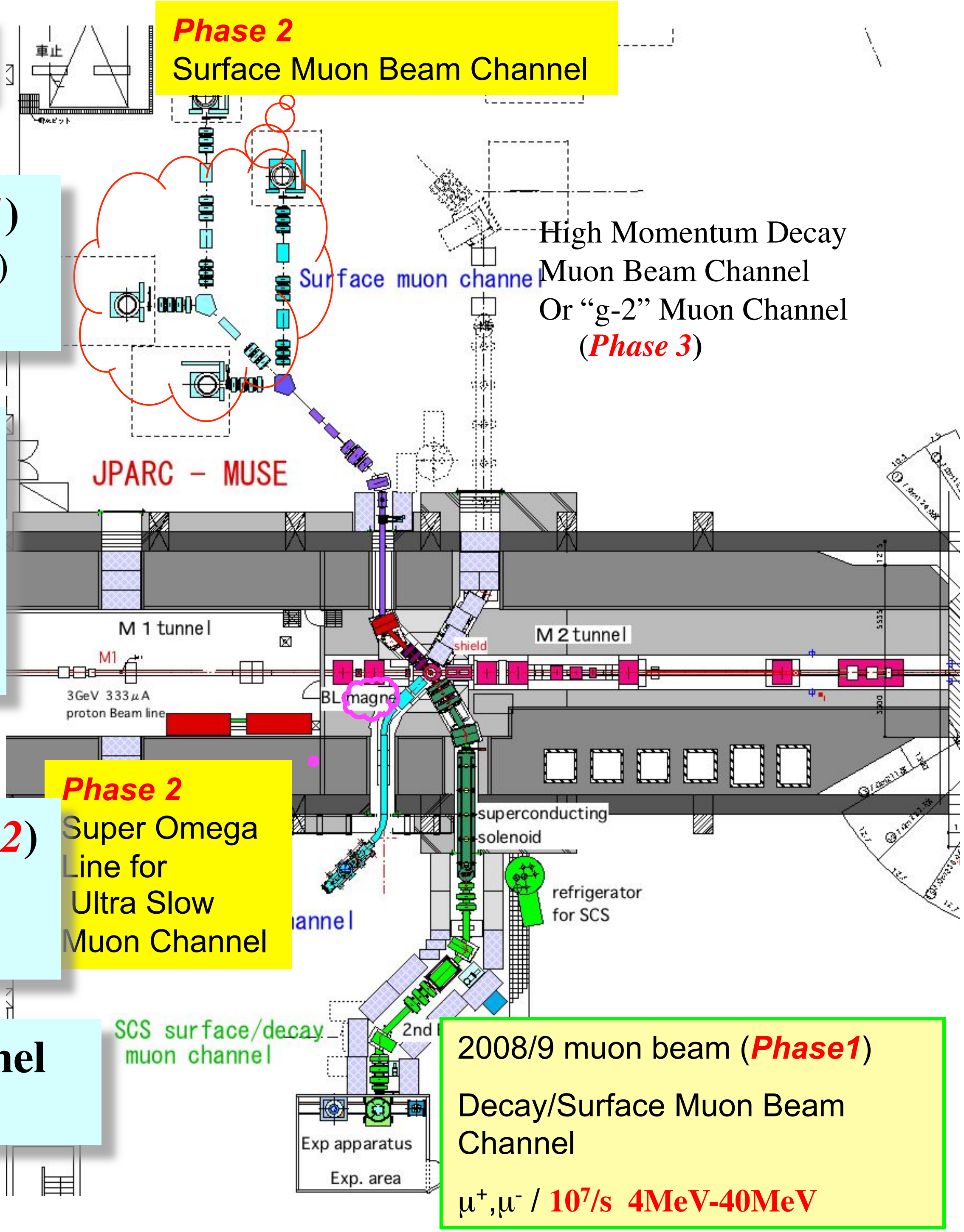
4-Muon Secondary Channels

Decay Muon Beam Channel (*Phase 1*)
(Superconducting Solenoid Beam Channel)
Highest Pulsed μ^+/μ^- Beams

Super Omega Muon Beam Channel (*Phase 2*; Ultra Slow Muon Beam)
Low energy,
Highest Energy resolution,
Shortest pulse width muon

Surface Muon Beam Channel(*Phase 2*)
(S1-S4 Port)
Highest Intensity pulsed 4MeV μ^+

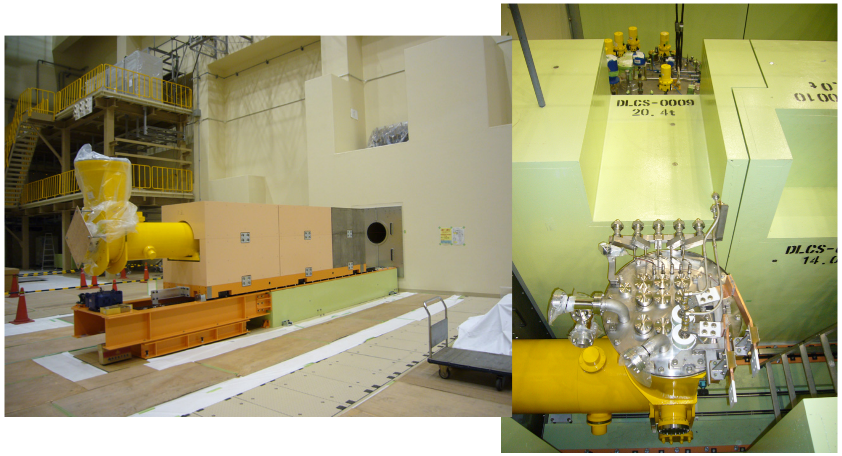
High Momentum Muon Beam Channel or "g-2" Muon Channel (*Phase 3*)



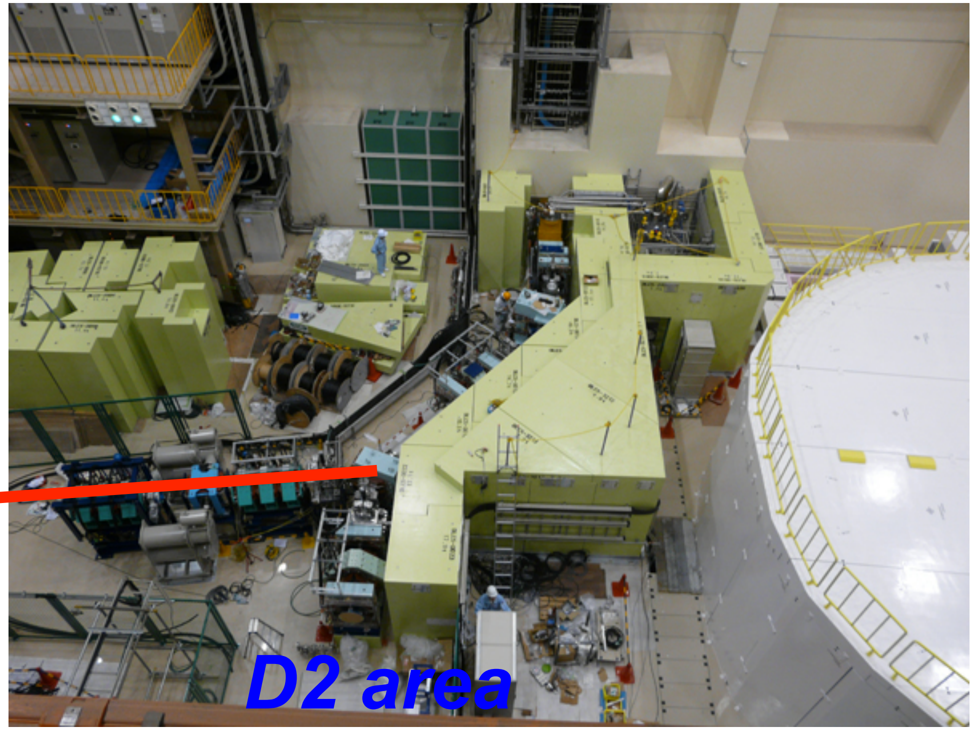
Decay-Surface Muon Channel

We completed its construction in the end of August, 2009

At first, we tried a surface muon extraction toward D1 area!



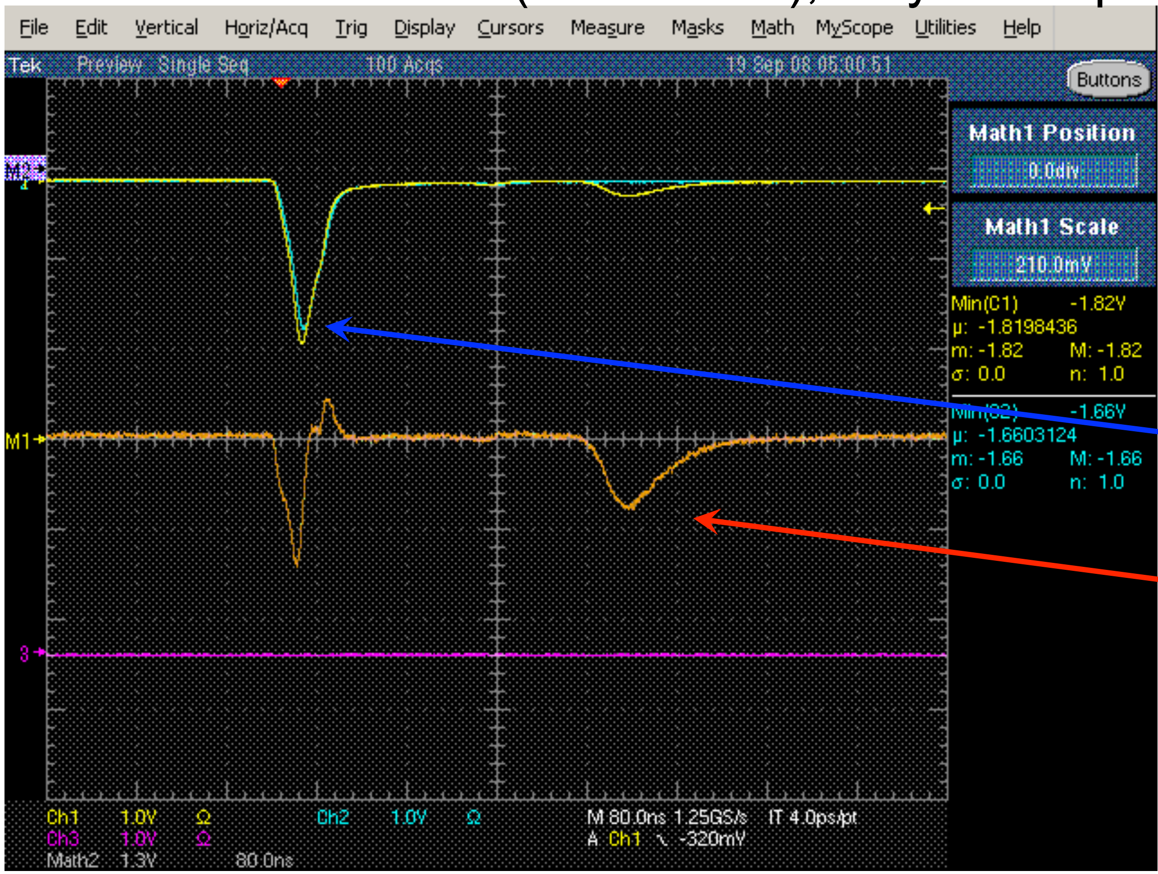
D1 area



The first surface muon signal obtained at Sep.19th by the muon counters

The first counter (0.5mm thick) ; only μ^+ stop, e^+ penetrate!

The second counter(6 mm thick); only e^+ stop!



Yellow:Muon Counter
0.5 mm thick

Blue:e^+ Counter
6mm thick

Red: Difference

The first peak; e^+
light speed

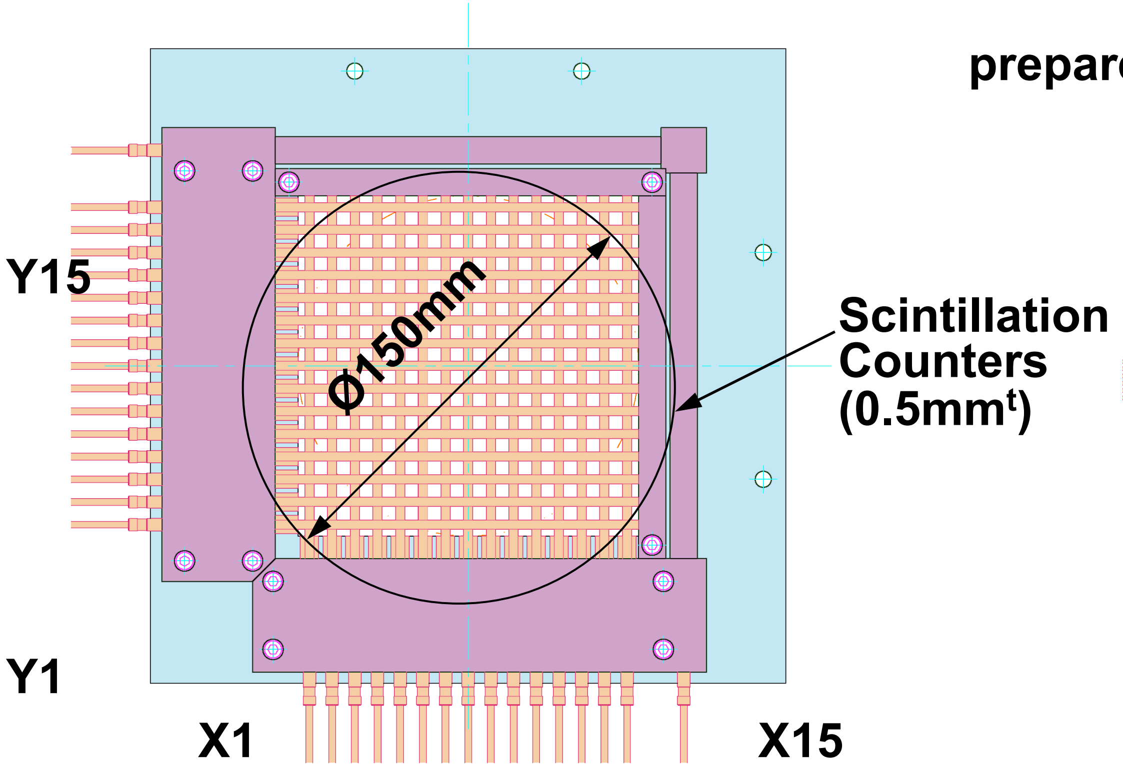
The second peak; μ^+

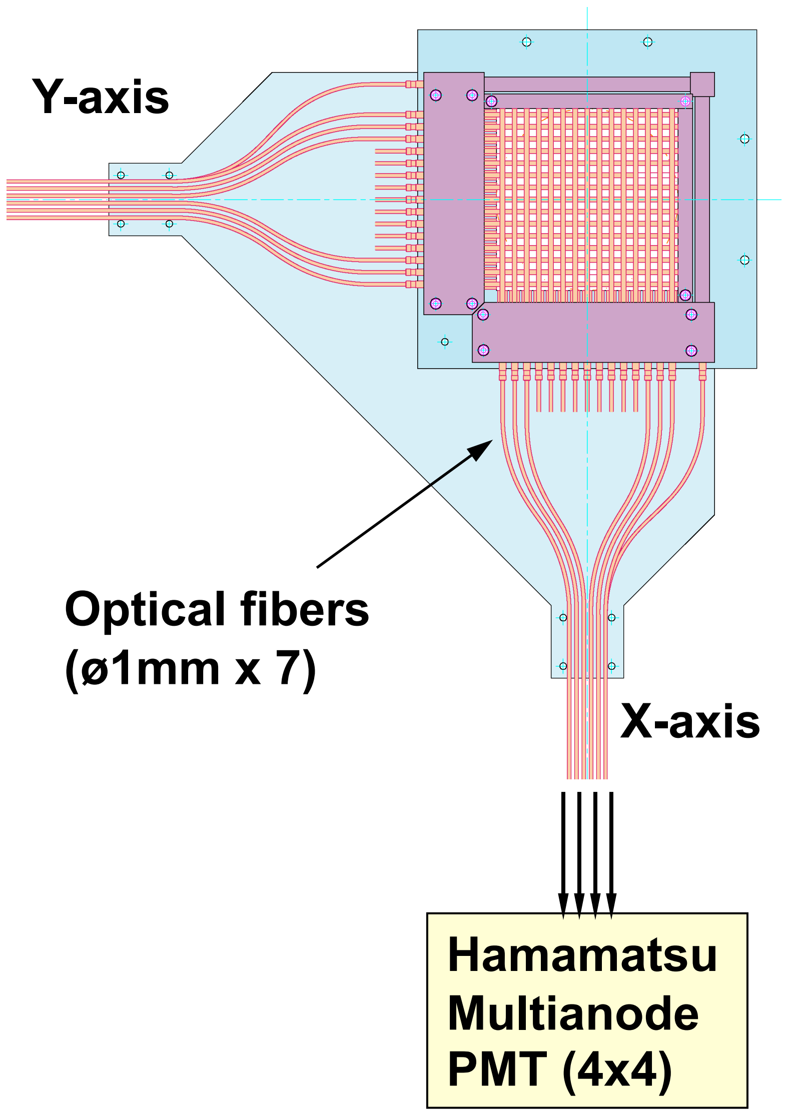
¼ of light speed

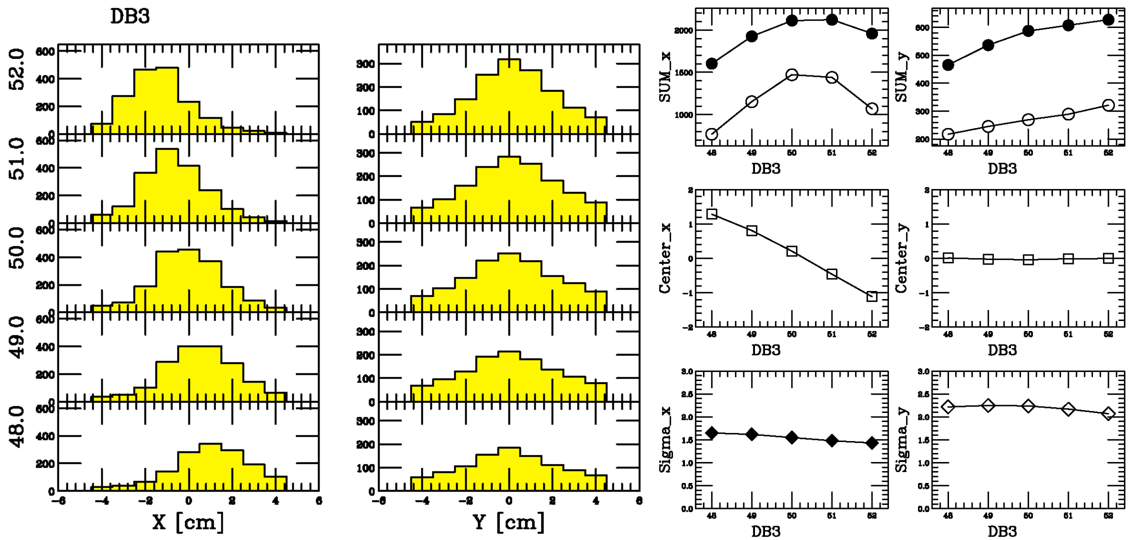
Finally, we managed to separate μ^+ from e^+ by DC separator

J-PARC Muon Beam Profile Monitor

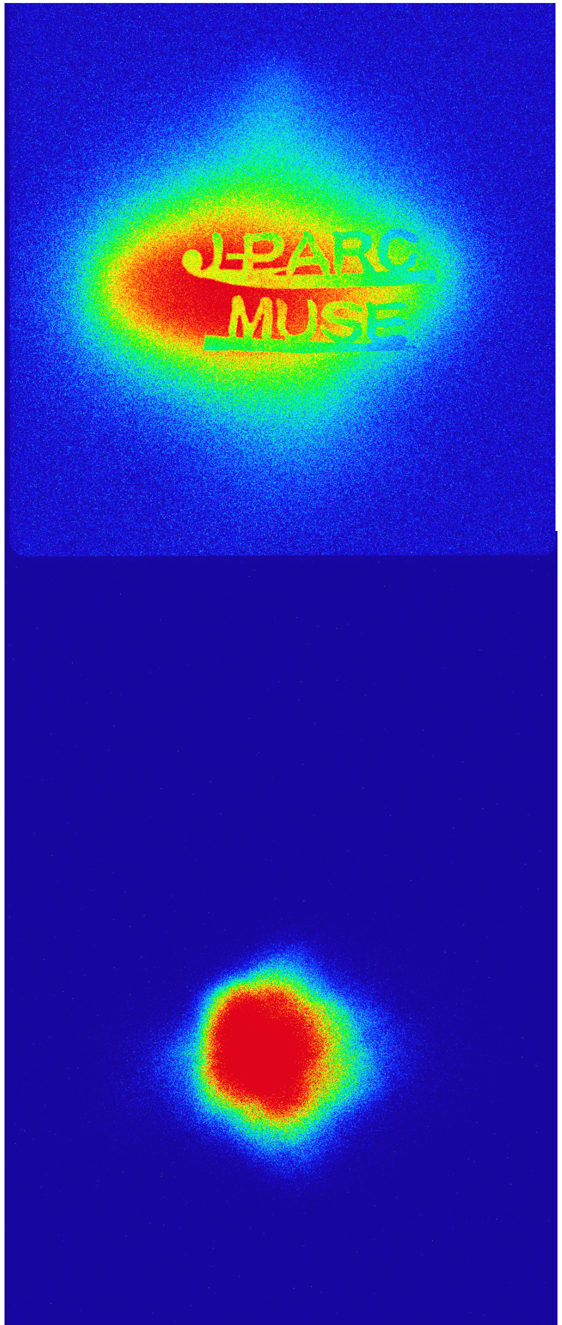
prepared by Patrick Strasser

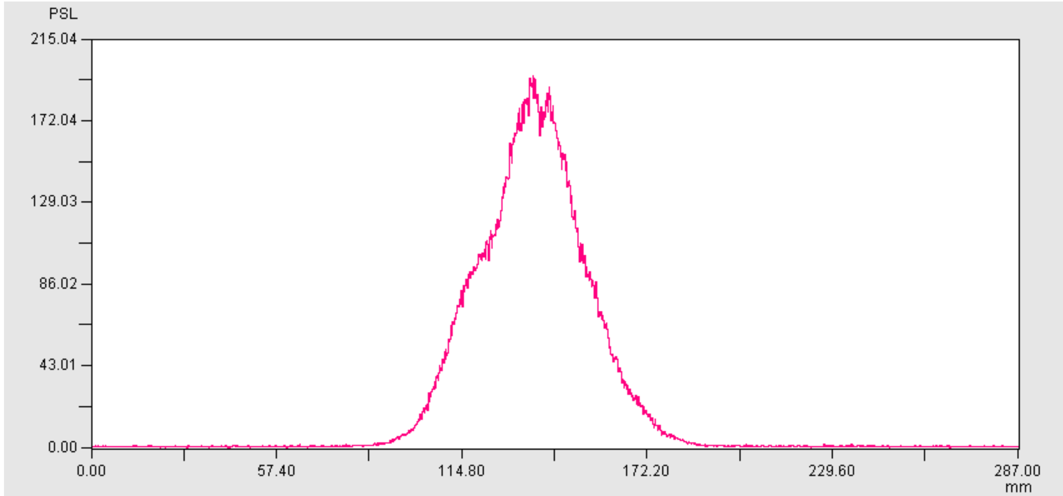


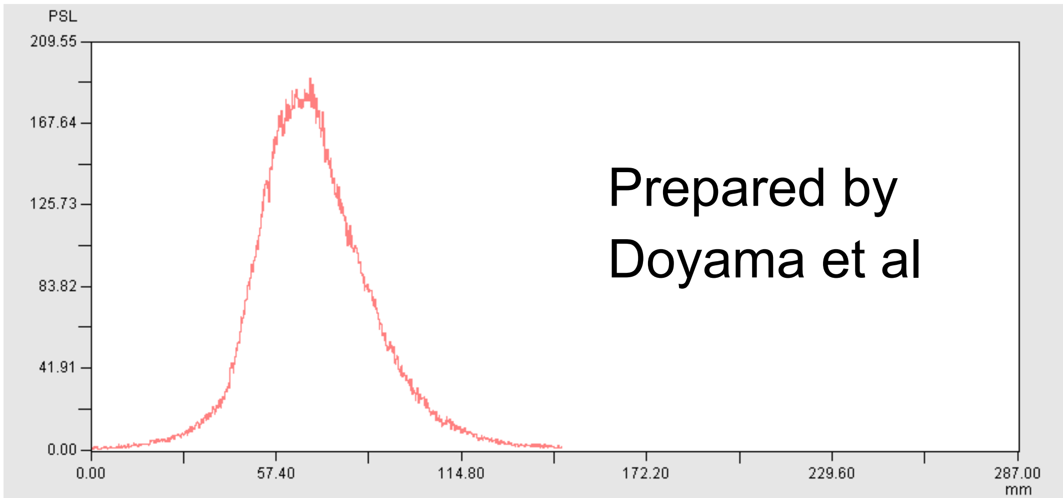




Imaging Plate Profile after tuning but not completed!





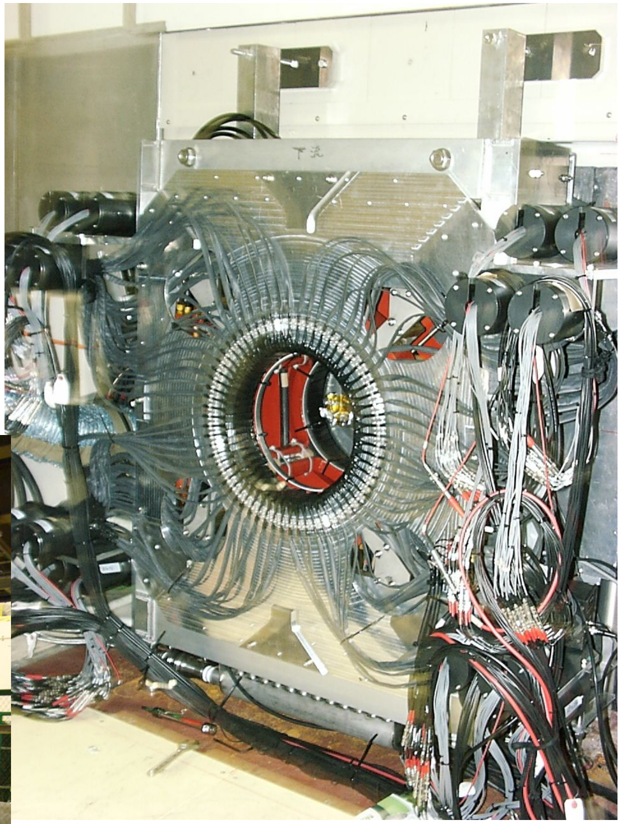


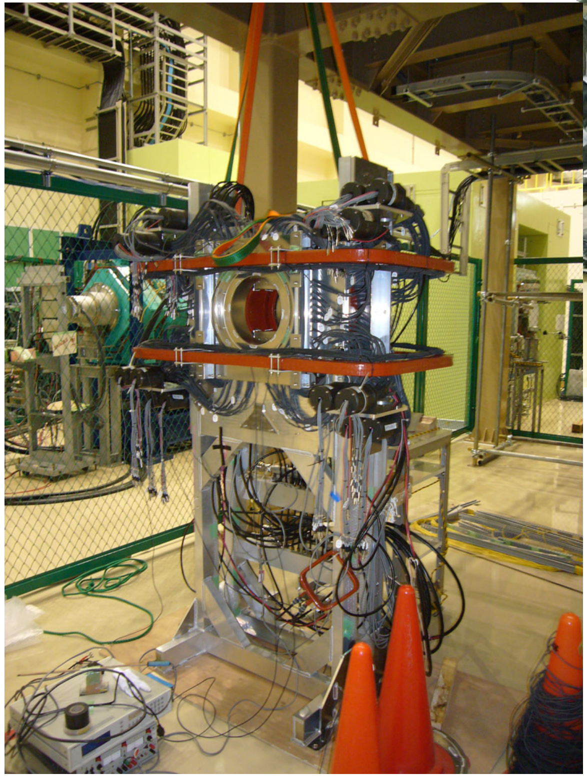
Prepared by Doyama et al

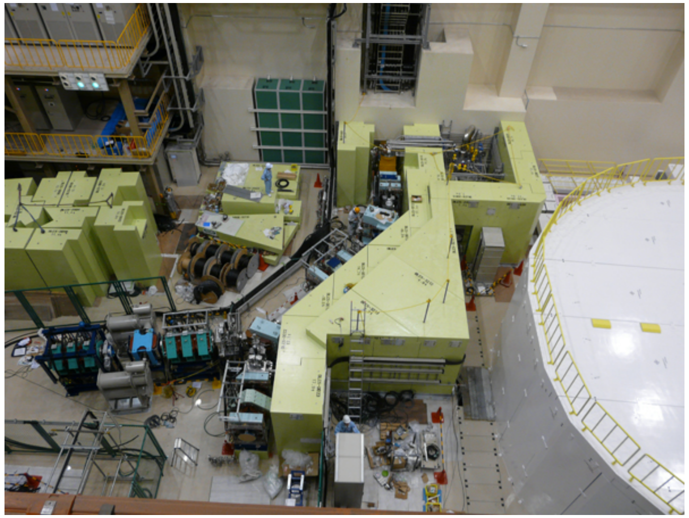
μSR Spectrometer at D1 area

Upstream Downstream
64ch ×2 64ch ×2
(16ch PM× 8) (16ch PM ×8)
256 scintillators
Inner radius 100mm
Outer radius 126mm

8% of all solid angle
TF 200 G
LF 1.5 kG



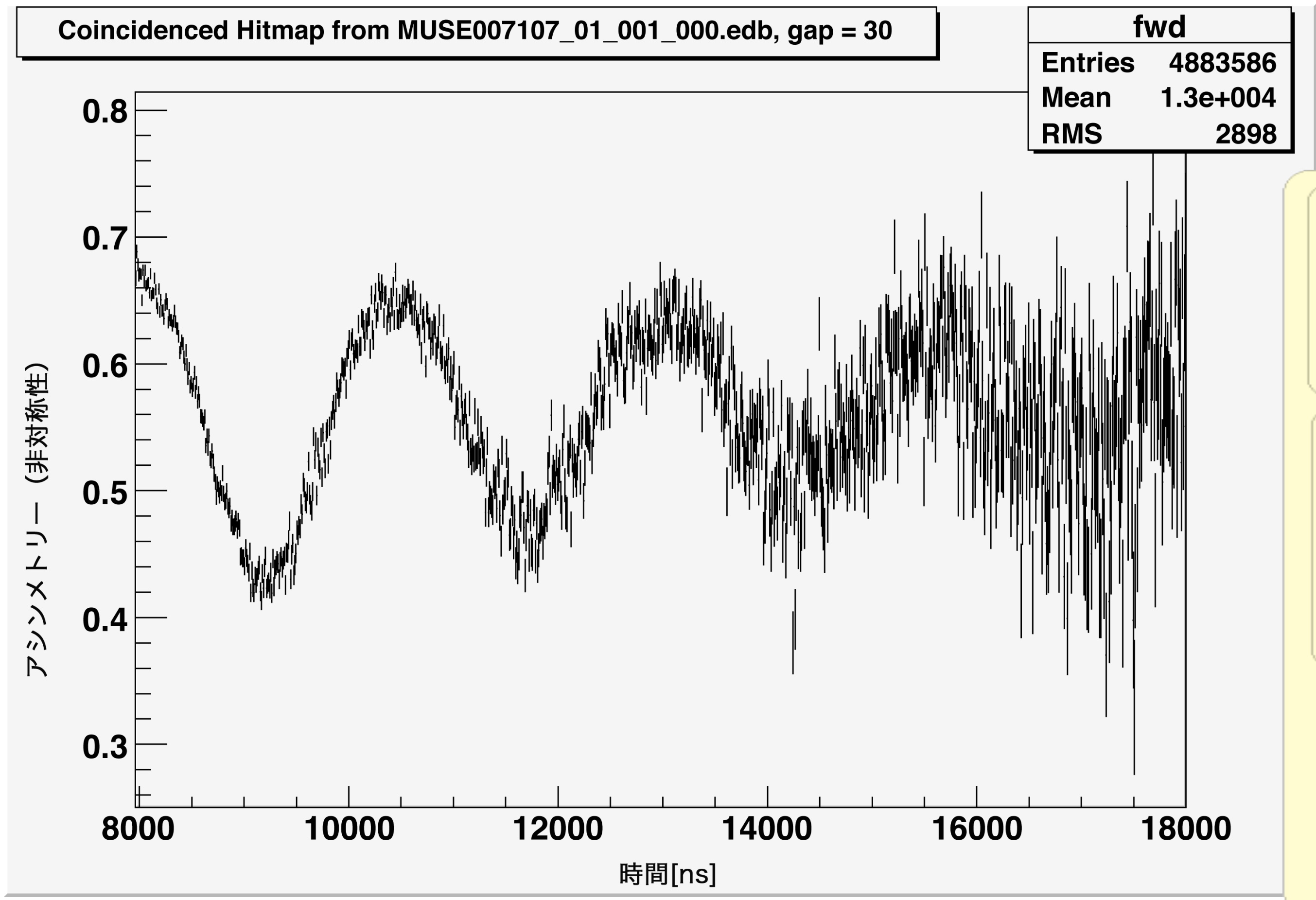


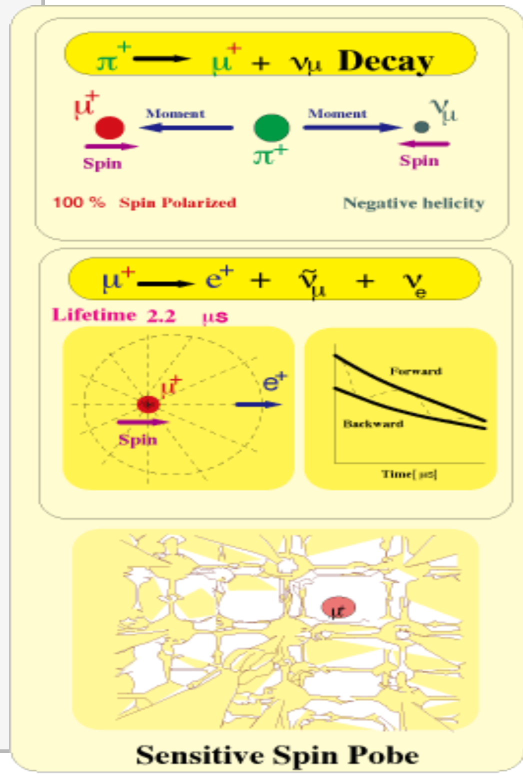


Prepared by
Takesita et al

128 x 2 telescopes

First surface muon μSR Spectrum obtained utilizing an Al plate as sample





μ^+ ; Light Hydrogen with Spin

Photo celebrating Muon DAY1 on September 26th, 2008

J-PARC MUSE Beam Intensity

So far, 20 kW Operation (from Sep. 2008)
Yield;   2 x 10^5 surface muons/s

From November,10th 2009, 120 kW
Yield; **1.8 x 10^6 surface muons/s**

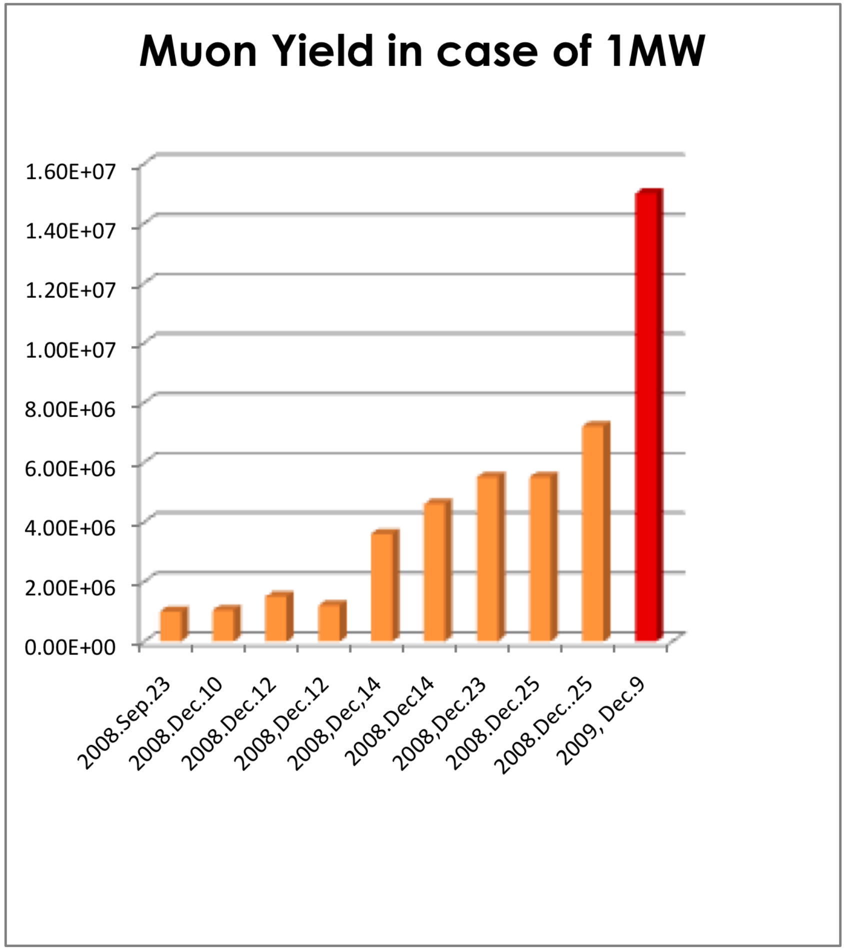
We achieved World strongest pulsed surface muon beam at J-PARC MUSE With 120 kW.

At December, 2009, 300 kW
Yield; **4.5 x 10^6 surface muons/s**

In future @1MW
1.5 x 10^7 surface muons/s

On Nov.2010's RUN, we succeeded in obtaining ~20 % more intense muon, by replacing old Qudrupole magnets with a narrower aperture.

November-December, 2009



Surface μ^+
(& Decay μ^+ (up to 120 MeV/c))

Press release

[The world-most intense pulsed muon beam achieved at J-PARC MUSE]

At the J-PARC Muon Facility (MUSE), the intensity of the pulsed surface muon beam was recorded to be 1.8×10^6/s on November 2009, which was produced by a primary proton beam at a corresponding power of 120 kW delivered from the Rapid Cycle Synchrotron (RCS). The figure surpassed that obtained at the Muon facility of Rutherford Appleton Laboratory in the UK, pushing MUSE to the world frontier of muon science. It also means that the unprecedentedly high muon flux of 1.5×10^7/s (surface muons) will be achieved at MUSE when the RCS proton beam power reaches the designed value of 1 MW within a few years.

科学新聞

22年4月2日朝・夕
第　版6頁

世界最高強度ミュオン発生

J－PARC実験で成功

ミュオン（ミュー粒子）は、湯川秀樹博士がその存在を予言したパイ中間子が崩壊してできる不安定素粒子。大強度陽子加速器施設（J－PARC、茨城県東海村）では、昨年12月10日に試験的に行った陽子ビーム高出力運転において、物質・生命科学実験施設（MLF）に設置したミュオン実験装置で発生したミュオン数を実測した結果、世界最高強度のパルスミュオンが発生していることを確認した。

10日の運転では陽子ビーム出力を300キロワットに上昇させ、ミュオン装置に導き、高強度パルスミュオンの発生を行うとともに、陽子ビームの120キロワットでの定常運転を実施した。その際、検出器を用いてミュオン数を実測したところ、1パルス当たり7万2000個のミュオンが実験エリアに飛来してきていることが確認できたとしている。また300キロワット運転時では約18万個のミュオン強度が得られた。これは英国の同種のミュオン源で得られた1パルス当たり約3万個を上回る、世界最高強度パルスミュオンの発生となった。

今後、陽子加速器の一層の高出力化のための整備・調整を進め、1メガワットにまで上昇させる計画で、これによりさらなるミュオン強度の上昇が見込まれている。

高強度のパルスミュオン発生により、物性物理学や原子分子物理学の基礎研究がより加速すると同時に、磁性材料、超伝導材料、燃料電池などの環境技術につながる研究開発をはじめとする応用分野への利用が期待される。

（第３種郵便物認可）　2010年(平成22年)３月１６日（火曜日）　讀賣新聞

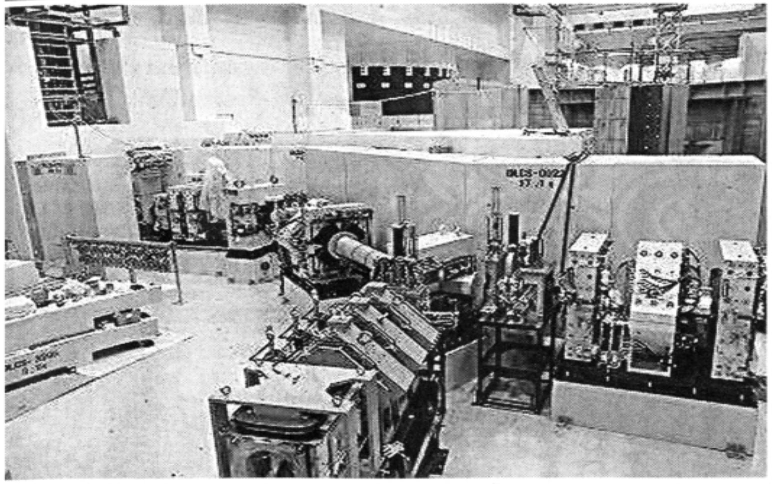
世界最高出力を達成

J－PARC「ミューオン」発生装置

東海村の大強度陽子加速器施設（J－PARC）物質・生命科学実験施設で、物質の微細な構造の測定などに使うミューオンの発生装置が昨年暮れ、世界最高の出力を達成していたことが、施設を運営するJ－PARCセンターの計測で分かった。

ミューオンは、光速近くまで加速した陽子を黒鉛に衝突させると発生する素粒子。磁気に敏感に反応するため、物質に当てることで、その物質内部の磁気がどうなっているかや、物質中に含まれる水素の状態などを、極めて高い精度で測定できる。新しい磁性材料をはじめ、超電導素材、燃料電池の材料開発などに威力を発揮すると期待されている。

ミューオンは断続的に発生するが、1回あたりの計測値は7万2000個に達しており、英国にある発生装置の2倍以上。高い効率での測定ができる。陽子加速器の出力を上げれば、同18万個のミューオンが得られることも確認。世界最高レベルの計測装置として、基礎科学や産業分野まで、幅広い利用が進みそうだ。

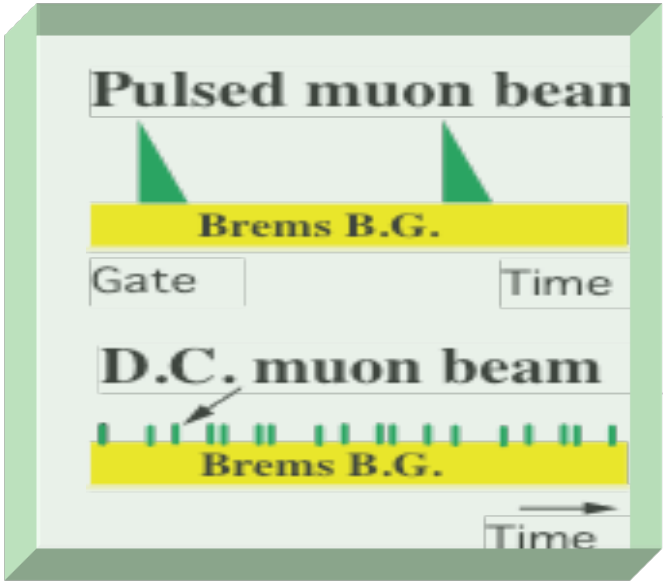


世界最高強度のミューオン発生が確認されたＪ－ＰＡＲＣの実験施設。左から延びるのがミューオンの通り道だ（Ｊ－ＰＡＲＣセンター提供。建設中の撮影）

What is Pulsed Muon compared with DC Muon *(Complementary)*

1. **Long time Measurement (in particular, slow relaxation)**
   The higher beam intensity, the better, since no pile up occurs.
   (muon decay or μSR)
2. **Synchronization with pulsed perturbation**
   Can be synchronized with pulsed RF or Laser
   →*Ultra Slow Muon Generation by Laser Resonant Ionization of Mu*
3. **Phase Sensitive Measurement**
   Even under a large white noise, muon related signal can be observed efficiently, such as μCF experiment under a large Bremstraulung from Tritium.
4. Time Resolution is determined by proton beam,
   to be as large as 100 ns.
   →*Development of Beam Slicer*
   →*Ultra Slow Muon Generation*
5. Instrument should be segmented!
   →*Expensive Spectrometer*

Complementary to Continuous Beams

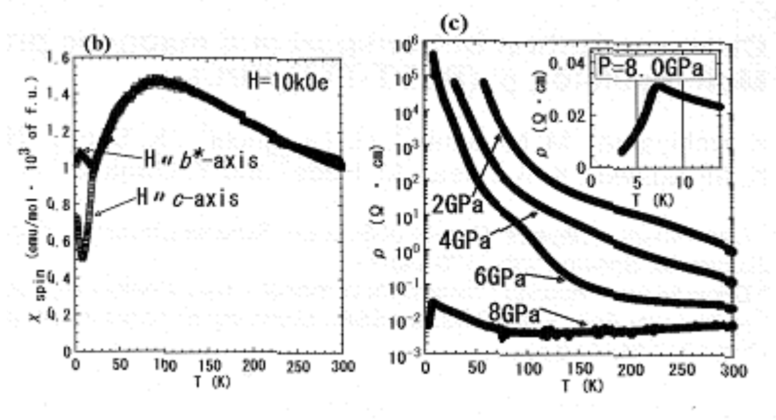


Studies explored at MUSE (2008B-2009)

1. Solid State Physics（Magnetism・Superconductor）
    1. *μSR Study of Organic Antiferromagnet β'-(BEDT-TTF)$_2$IBrCl*
    2. **μSR in Ironpnictide superconducto** *Phys. Rev. Lett.* 103 027002←The first PRL @J-PARC
    3. μSR evidence for magnetic ordering in $CeRu_2Al_{10}$ *J. Phys. Soc. Jpn. At May, 2010*
    4. **novel phase transition in f-electron system** *Phy.Rev. B, in press*
2. Material Science（Li Batteries、Alloy、Voids）
    1. Li_xCoO_2（Toyota） *Phy.Rev. B, to be published*
    2. $CaFe_2O_4$–type $NaMn_2O_4$ and $LiMn_2O_4$
    3. Li Diffusion in Li ion conductor
    4. Pre-martensitic phenomena of thermo elastic martensitic transformation in NiTi alloys studied by muon
    5. μSR in Finemet
3. Physical CHemistry
    1. Investigation of molecular effect in the formation process of muonic atom
    2. Mu(μ^+e^-) formation mechanism in condensed matters
4. Particle Physics
    1. $\mu^- + A(Z,N) \rightarrow e^- + A(Z,N)$ rare decay
5. Non–destructive analysis, Radiography
    1. Koban, Old coin *J. Phys.: Conf. Ser.s **225** (2010) 012040*
    2. Muon Radiography
6. Beam Development
    1. Slicer *J. Phys.: Conf. Ser. 225 (2010) 012012*
    2. Ultra Slow Muon

μSR Study of Organic Antiferromagnet β'-(BEDT-TTF)$_2$IBrCl

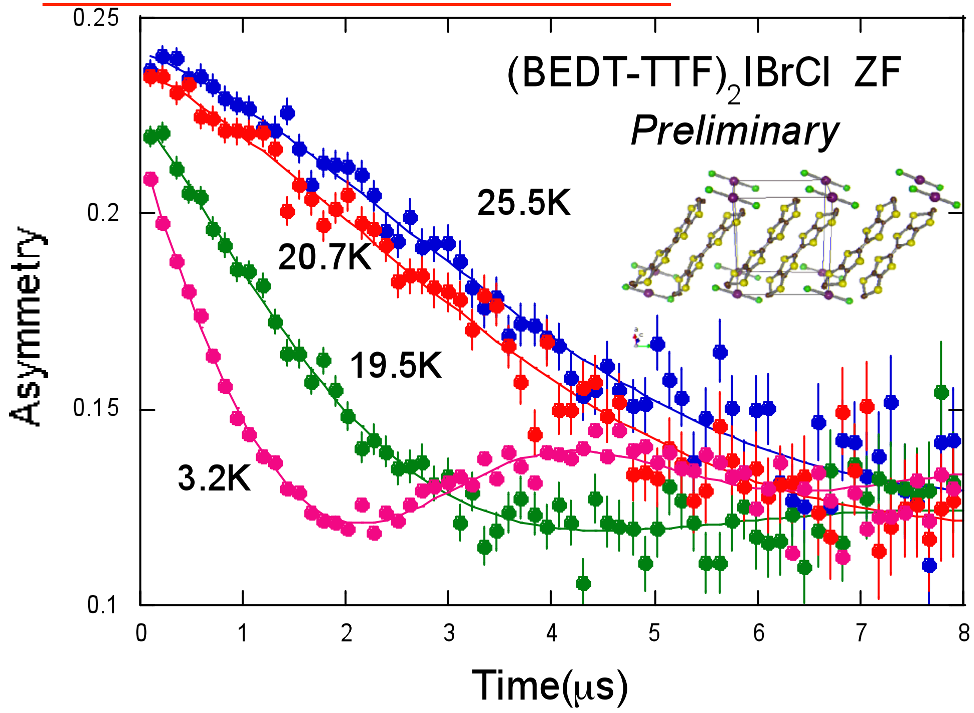
K.Satoh (Saitama), W.Higemoto(JAEA) et al.



Strong competition between superconductivity and magnetism was suggested from bulk measurement .

Microscopic study by using μSR to investigate a nature of the magnetic state.

Present result at MUSE-D1

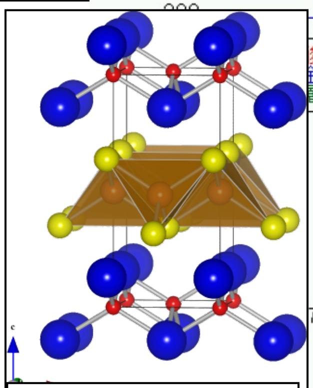


Spontaneous Muon Spin Precession was observed

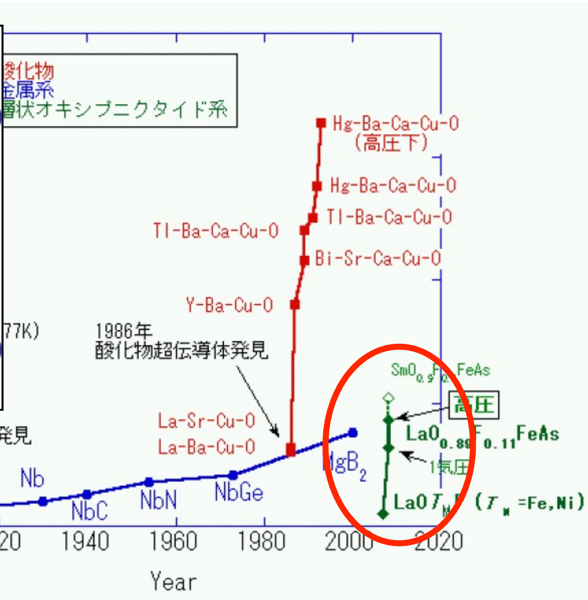
↓

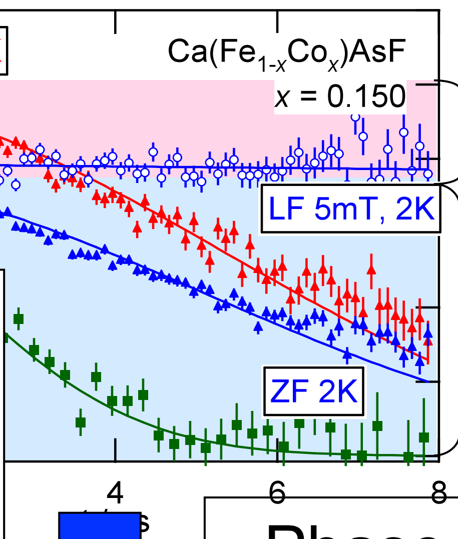
Evidence of Antiferromagnetic State below 20K.

μSR in Ironpnictide superconductor (Takeshita et al. *PRL* **103** 027002)



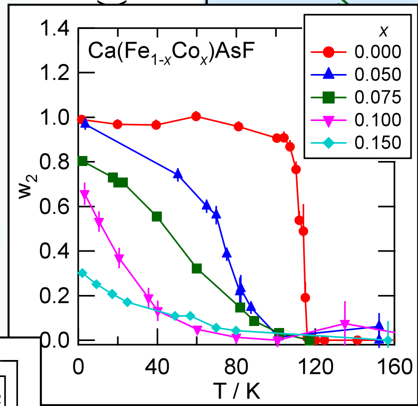
LaFeAs(O,F)



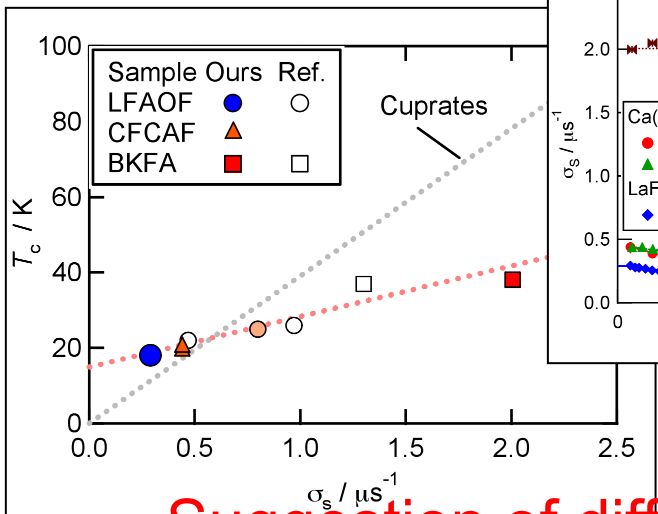


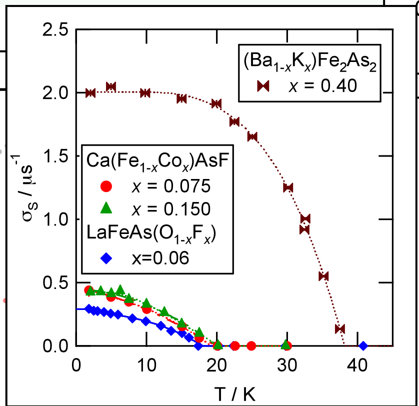
Mag.

SuperCond.

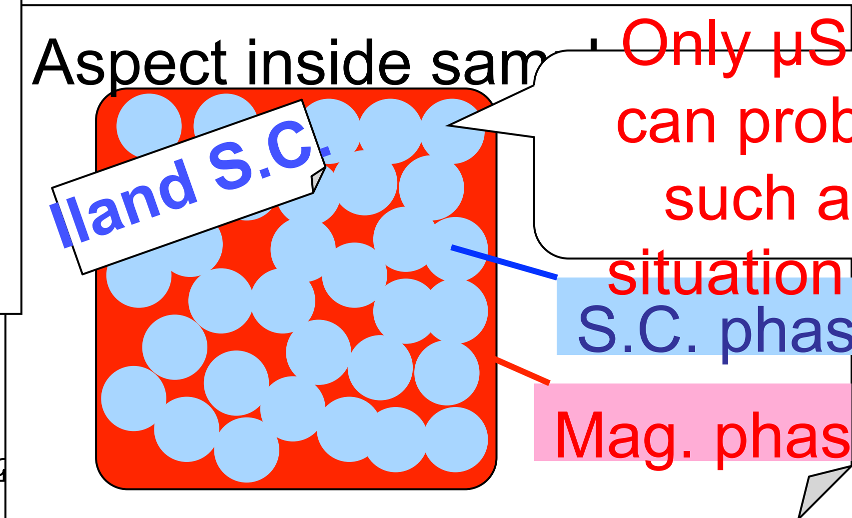


Phase separation





Suggestion of different mechanism from cuprate superconductor!



Only μSR can probe such a situation !

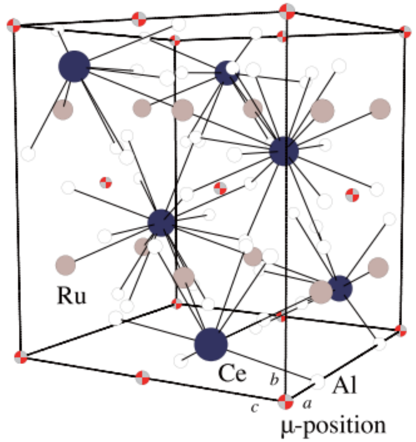
Iland Superconductor !

μSR evidence for magnetic ordering in $CeRu_2Al_{10}$

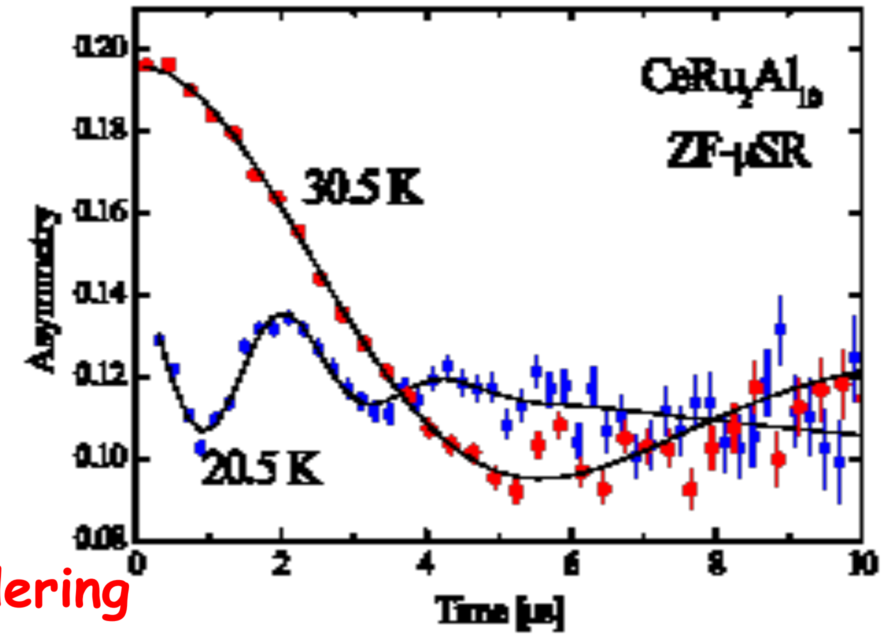
S. Kambe (JAEA-ASRC) et al.,

$CeRu_2Al_{10}$

- Orthorhombic crystal structure (*Cmcm*)
- Phase transition at T_0=27K
- No evidence for magnetic ordering by Al-NMR in ZF only quadrupolar splitting was observed below T_0.)



Ground state?
Magnetic or Nonmagnetic?



Zero Field μSR experiment

- Spontaneous muon spin precession was observed below T_0.

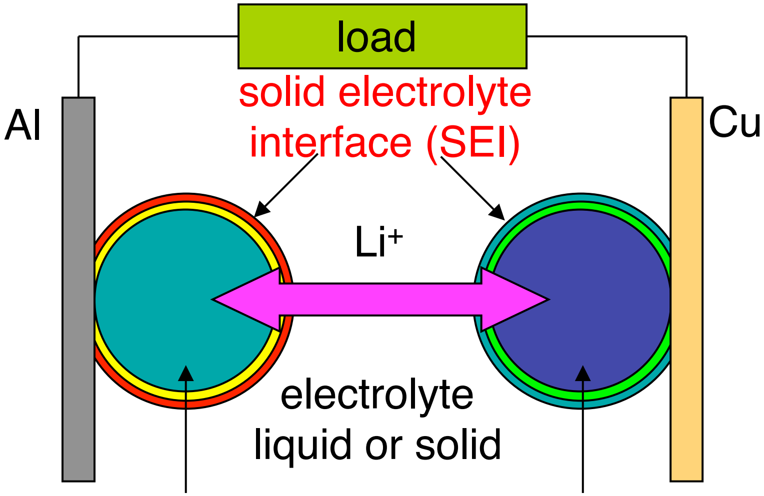
First clear evidence for magnetic ordering in $CeRu_2Al_{10}$!

submitted to J. Phys. Soc. Jpn.

TOYOTA CRDL, INC.

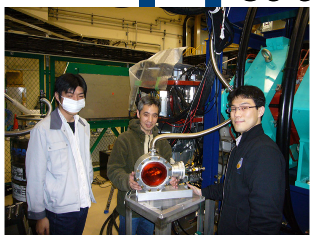
µSR experiment on Li-battery materials

schematic concept of Li-battery



cathode
$LiCoO_2$
$LiNiO_2$
$LiMn_2O_4$

anode
graphite
$LiTi_2O_4$

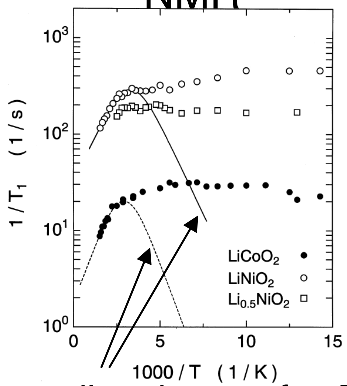


In order to know the Li diffusion (D_{Li}) in each component, we need a technique to measure D_{Li} for the materials including magnetic ions and for the interface with 10-20 nm thickness.

µSR, using surface and ultra-slow muons, is the only technique to provide such information.

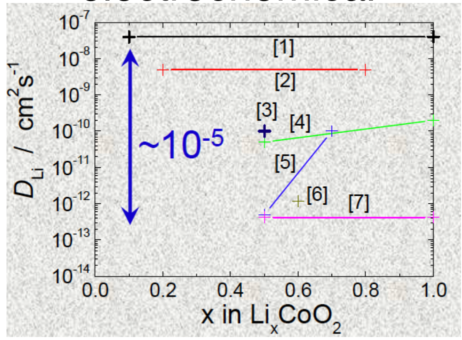
Past work for D_{Li} measurements

NMR

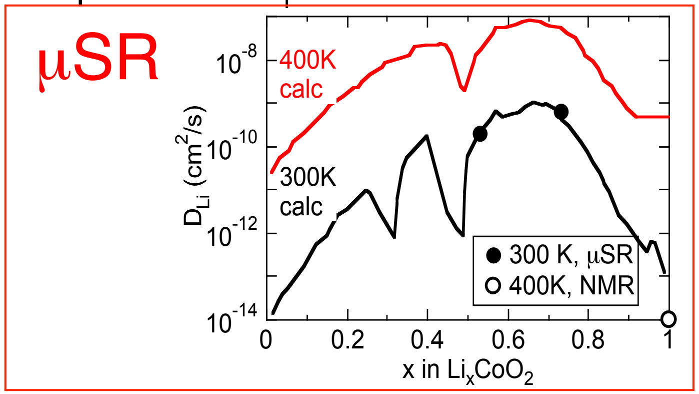


predicted curve for D_{Li}.
Co or Ni spins affect T_1.

electrochemical



D_{Li} strongly depends on how to measure it.



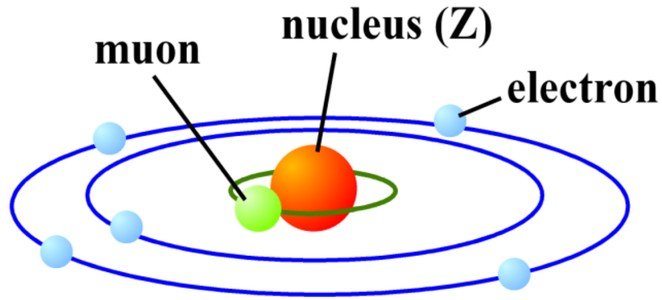
D_{Li} obtained by µSR is in good agreement with D_{Li}^{calc} predicted by a first principle calculation.
We are, thus, measuring D_{Li} for the Li-battery materials in order to make a database of D_{Li}.

Non Destructive Measurements using Negative Muon

What is negative muon (μ^-)

μ^- 200 times heavier electron

→ muonic atom



200 times larger binding energy

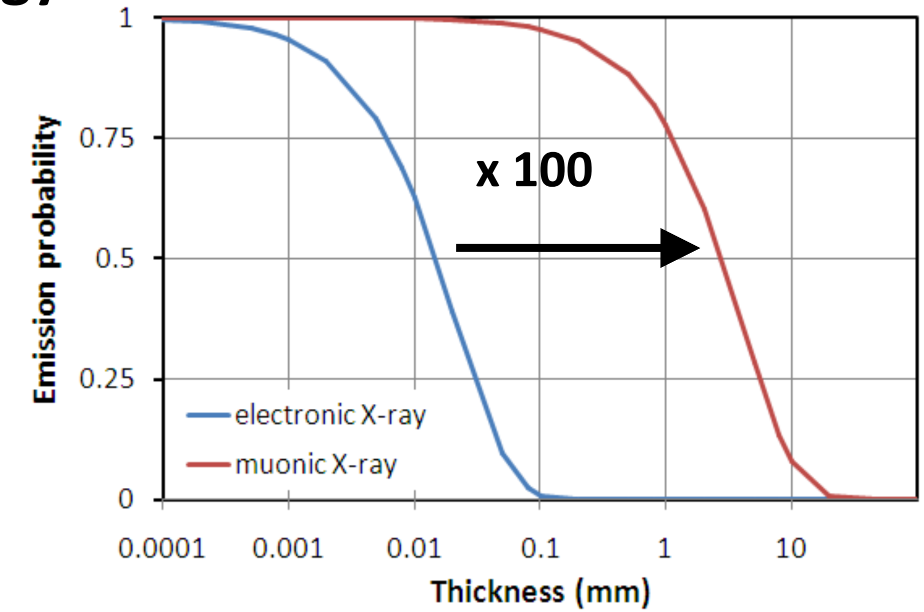
||

~ 200 times higher muonic X ray

Cu Kα X-ray
- Electron: 8 keV
- **Muon : 1.5 MeV**

||

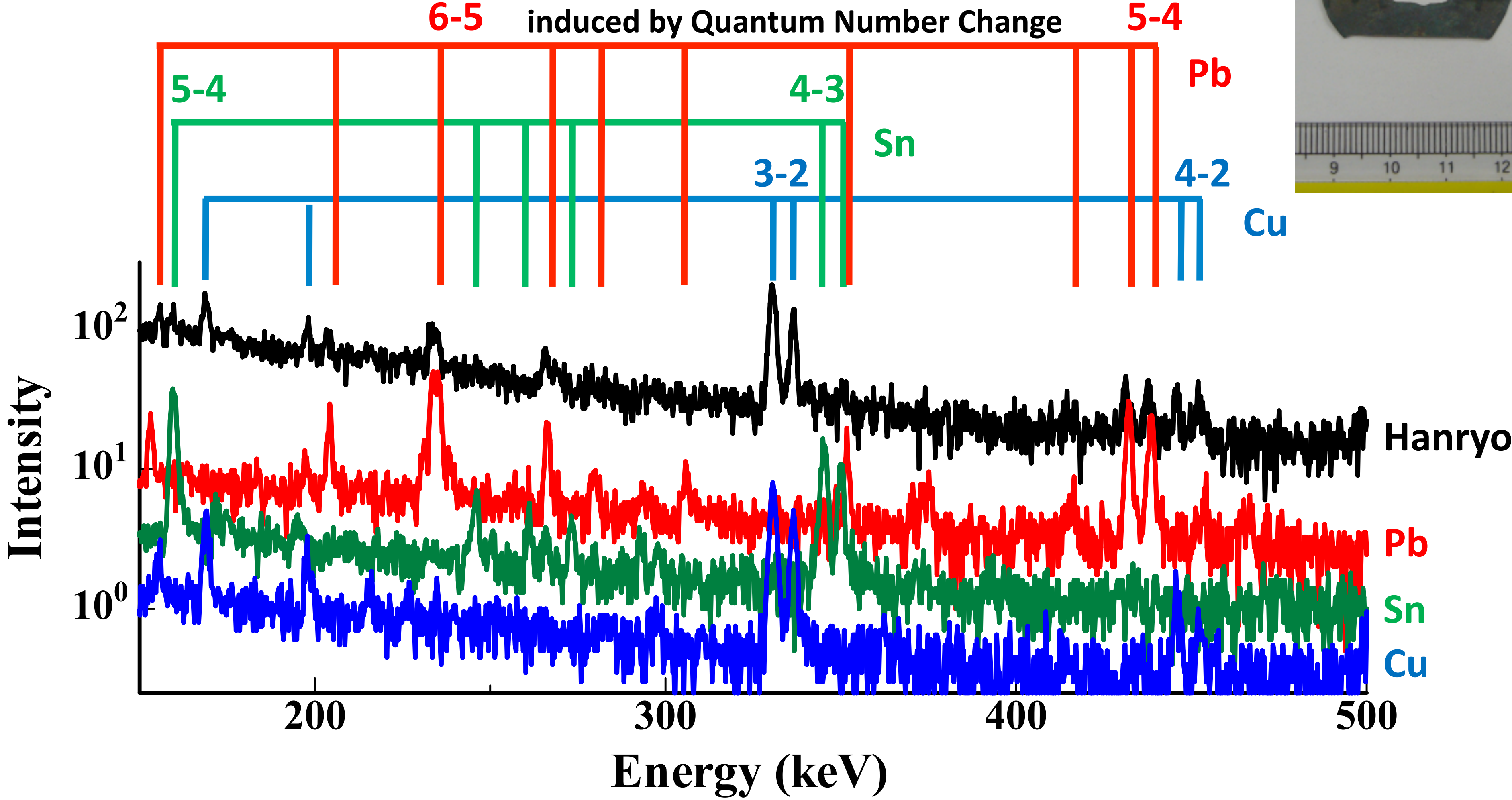
Deep penetration



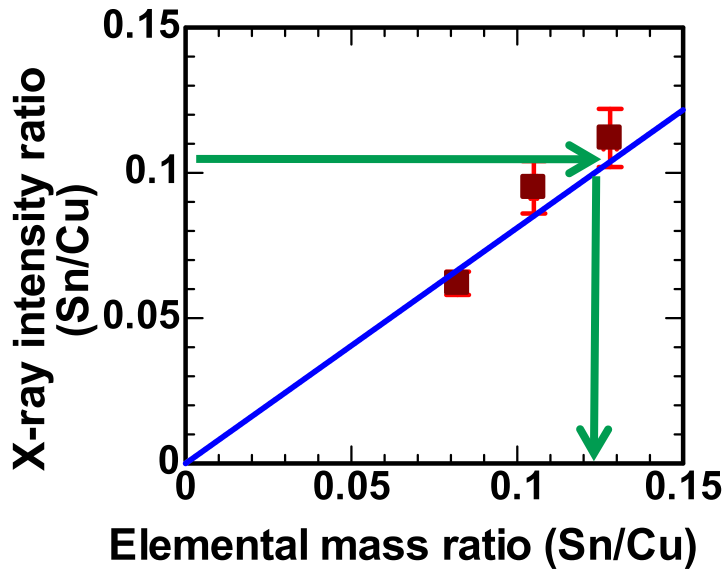
X ray absorption efficiency in Cu

Muonic X ray measurements

Old Chinese coin(Hanryo) consists of Cu, Sn, Pb etc



Analysis of Hanryo



Determined by muonic characteristic X rays

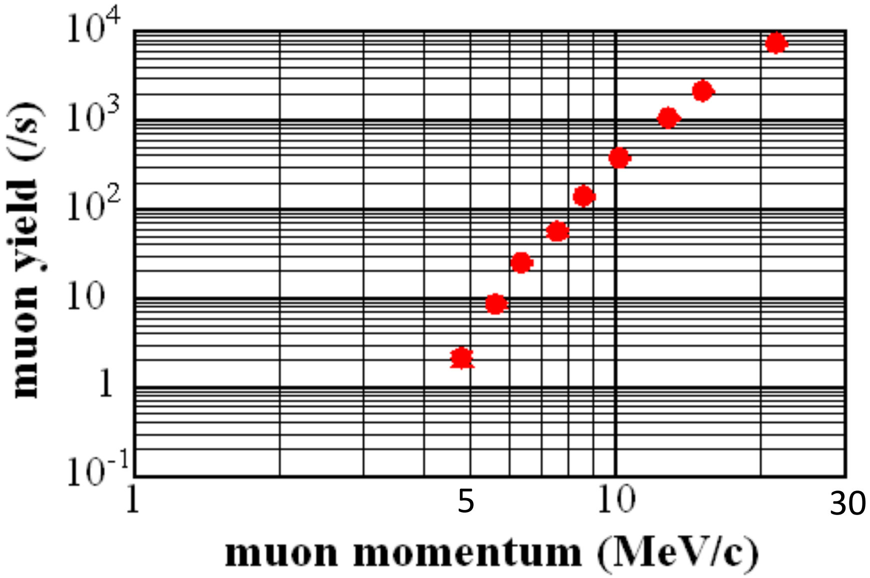
Components（weight ratio）
Cu:73±3%, Sn:10±1%, Pb:17±2%

- **Non destructive quantitative analysis was done at MUSE**
- **at MUSE muon beams (10 – 120 MeV/c) are available corresponding to 5 μm – 10 mm range**
- **Not only weight ratio, but also information on chemical state**

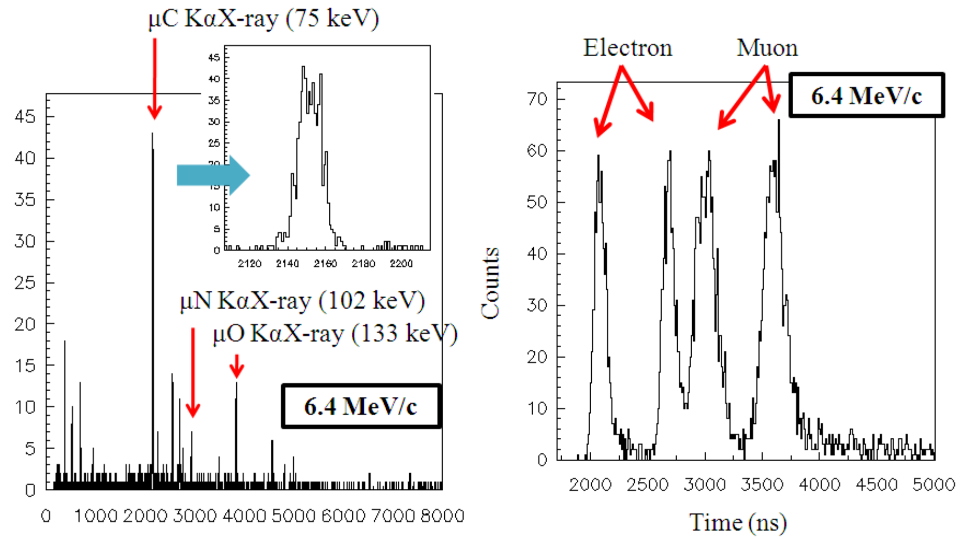
Negative Muon as low as 5 MeV/c

Experiment at D2 area

Observing muonic X-ray coming from stopped at the Kapton measured by Ninomiya et al.



Negative Muon Yield vs momentum (@120 kW)

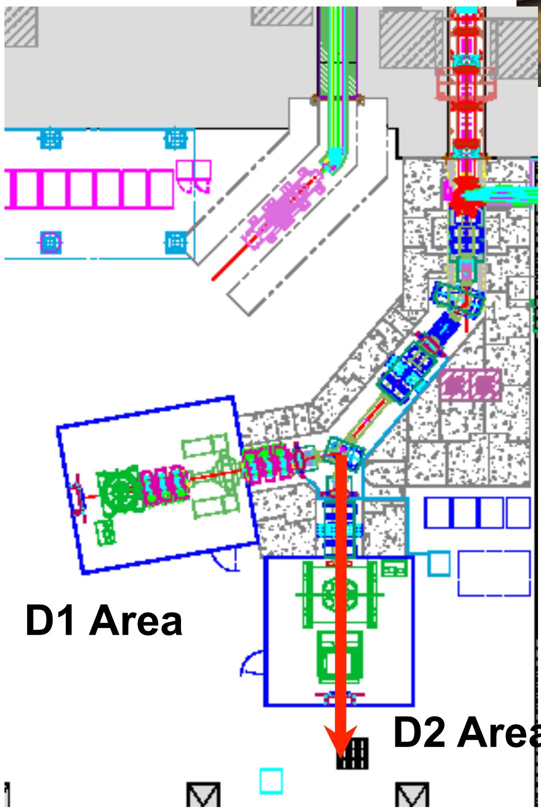


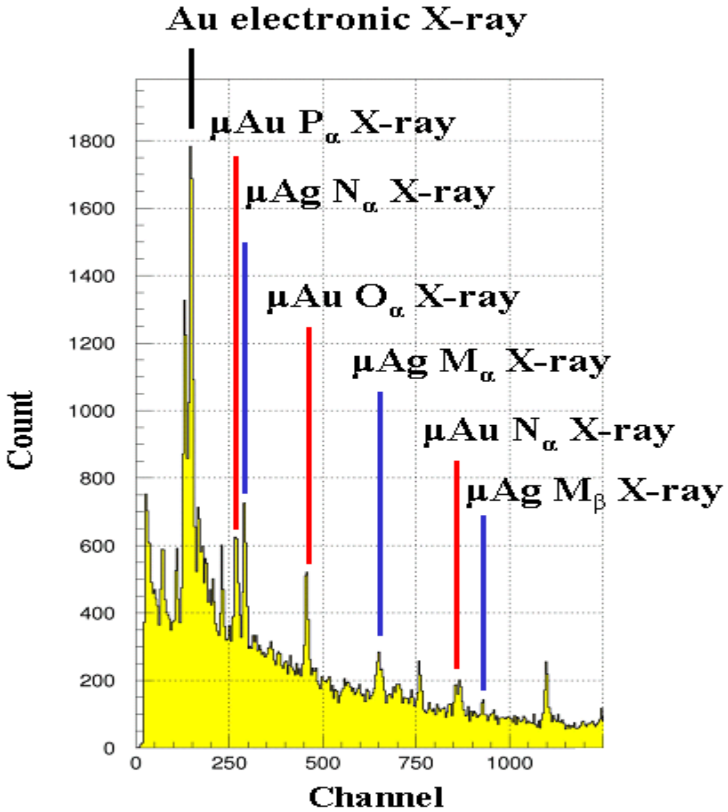
X-ray energy spectrum and timing spectrum（6.4MeV/c, 36000 s）

- Momentum can be also checked by TOF difference between muon and electron.
-

➡ Extraction of Low Momentum Muon

Decay Muon Extraction D2 area



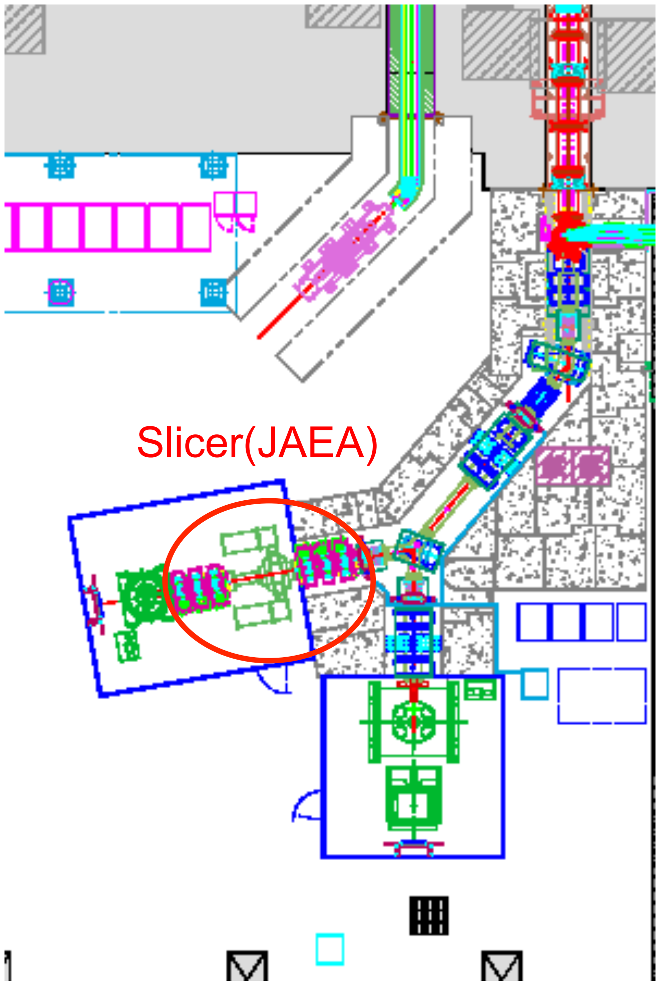


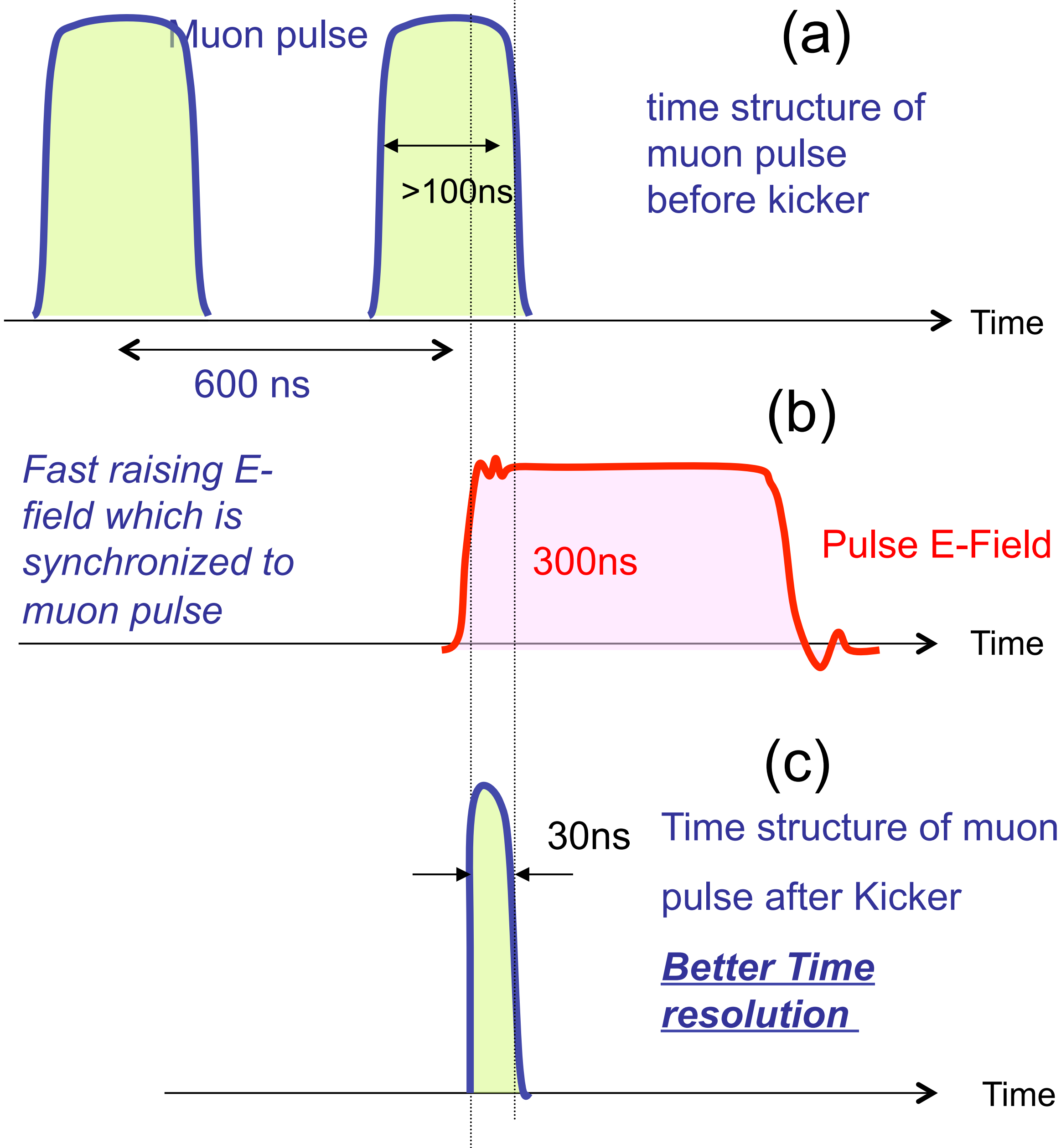
measured by Ninomiya et al

Photo preparing X-ray measurements using Ge detector at D2 area.A trial to test a non destructive measurement using Tempo KOBAN
(天保小判, 国立歴史民俗博物館・齋藤努先生 提供)

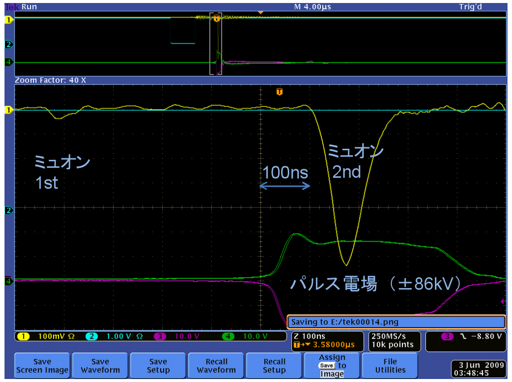
Beam Slicer and Kicker System

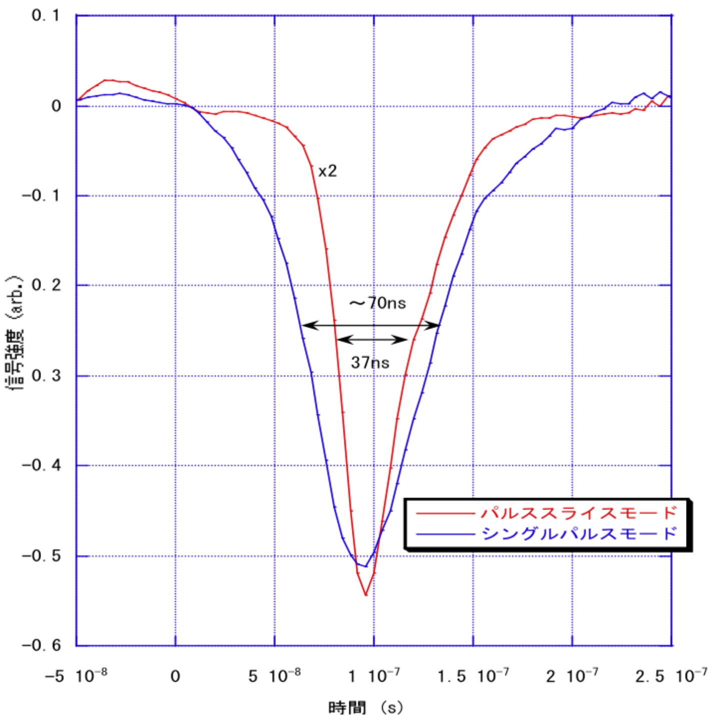
(*Prepared by Higemoto (JAEA-ASRC, Advanced Science Research Center)*)

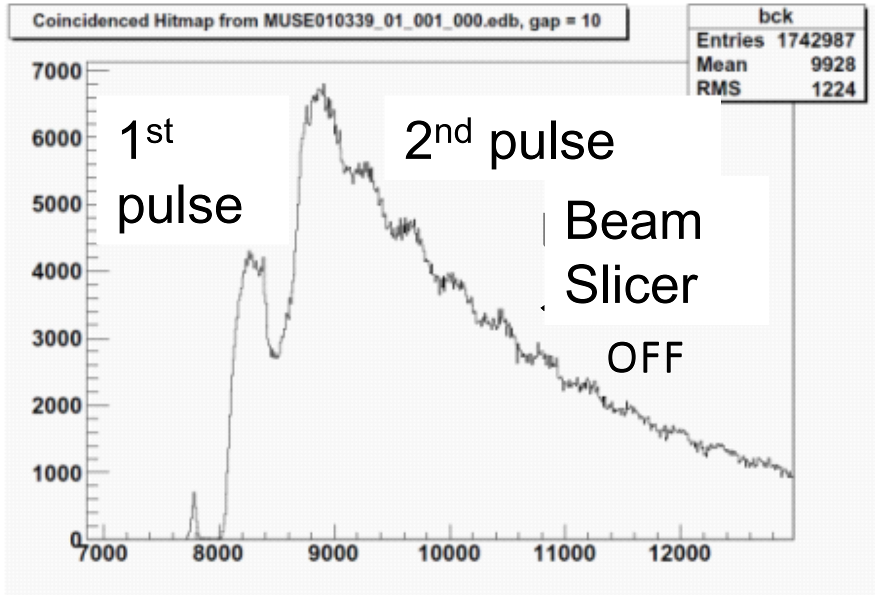


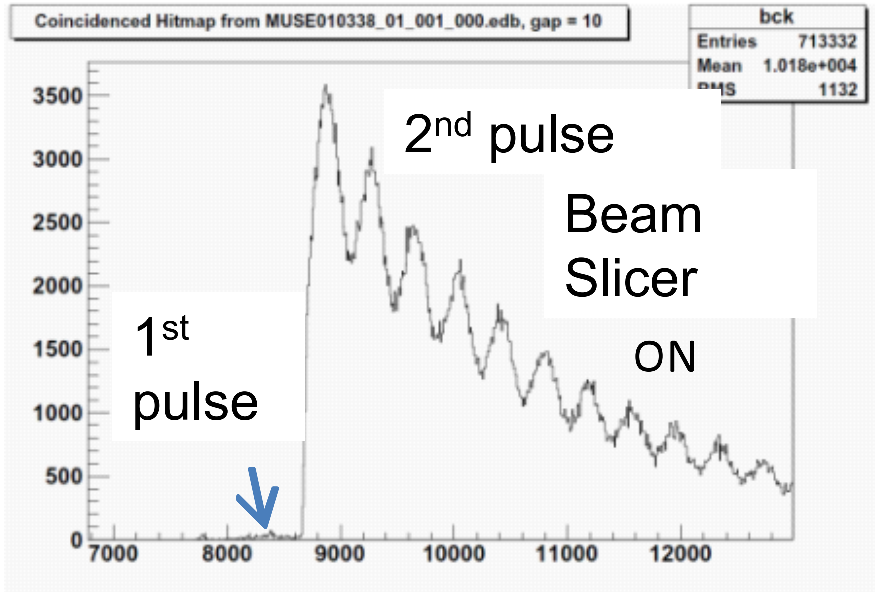


Beam Slicer for Single Bunching and Beam Slice by JAEA Higemoto et al.







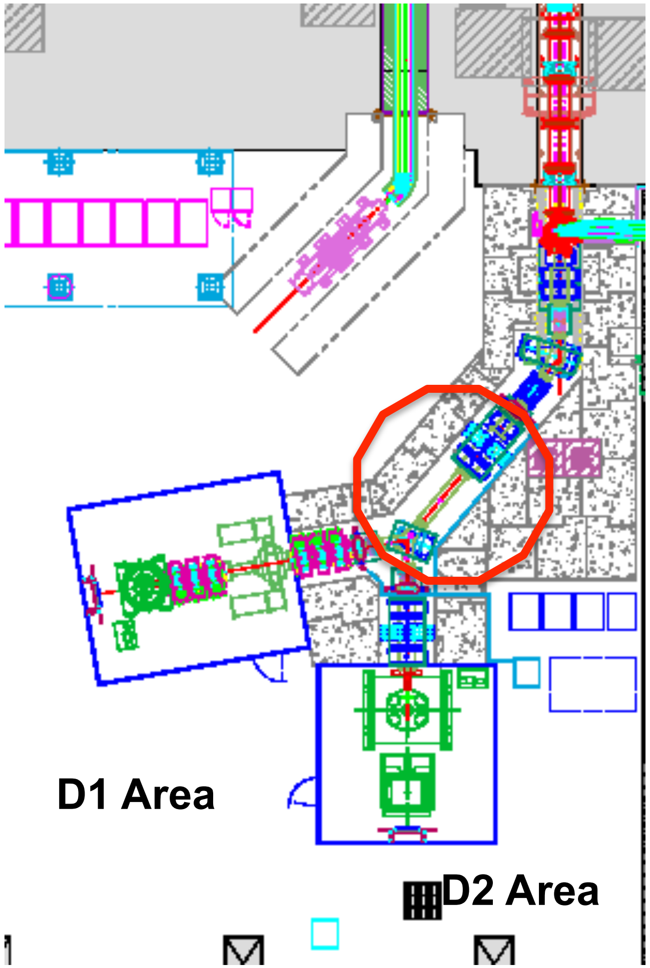


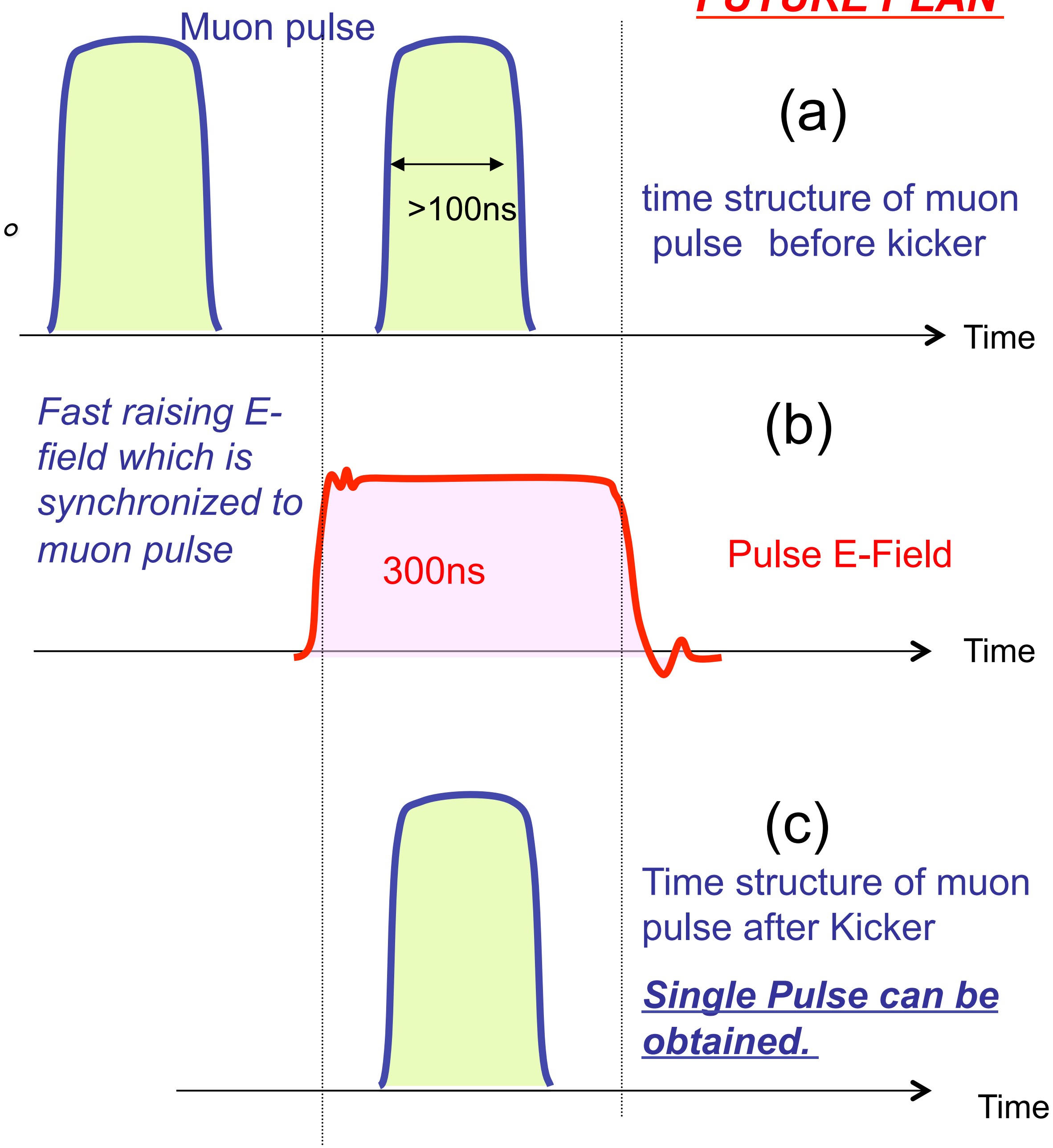
Future plans

Beam Kicker

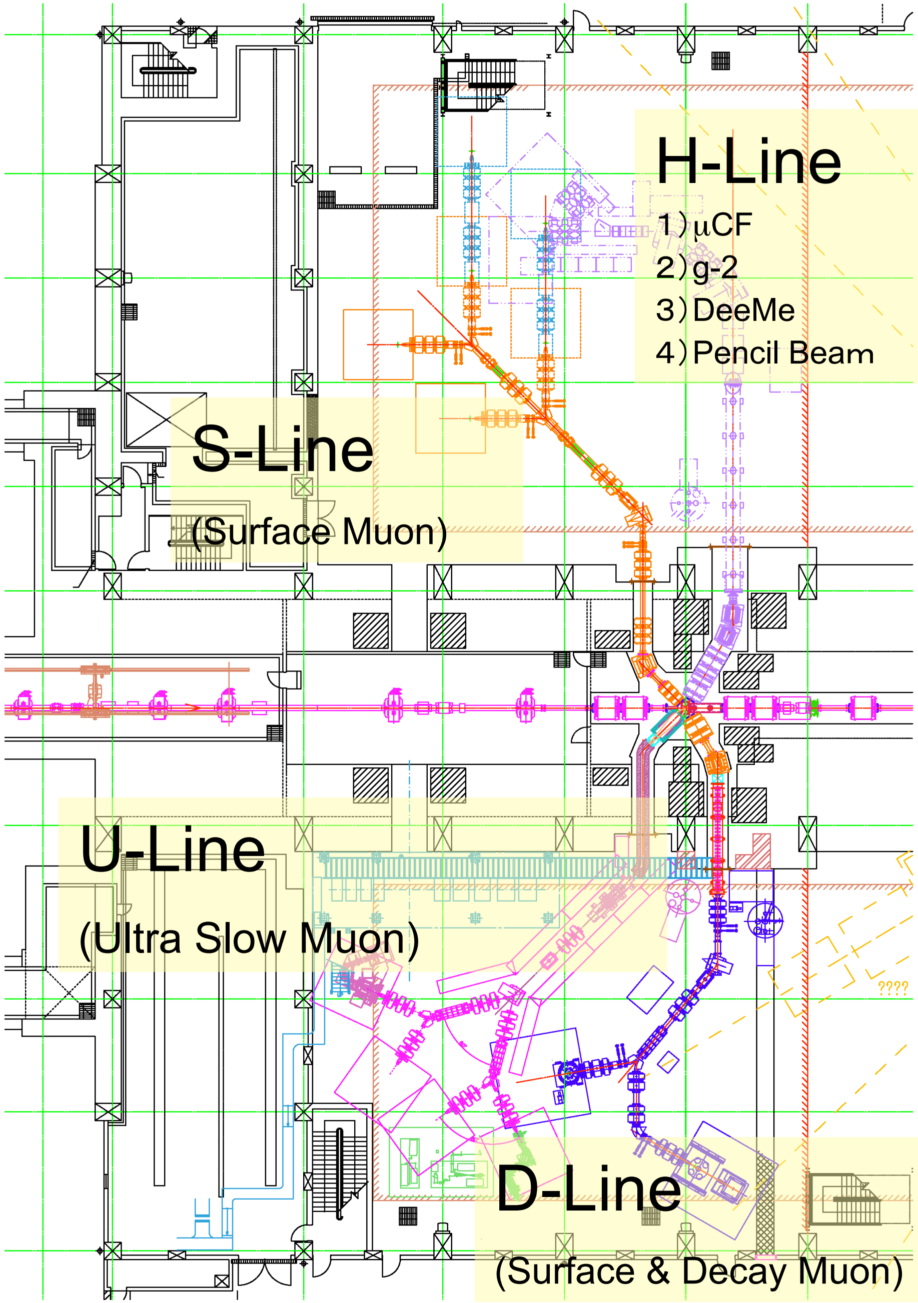
Short Range FUTURE PLAN

To separate double bunched beam to single, to D1 and D2 area at the same time! 。





Muon Beam available at J-PARC Muon



1) D-Line

	Surface Muon (μ^+)	Decay Muon (μ^+,μ^-)
Beam Energy	4.1MeV	5-50 MeV
Implantation Depth	~0.2 mm	1 mm - ~cm
Energy Distribution	~15%	~15%
Pulse Width	~100 ns	~100 ns
Beam Size	30 mm x 40 mm	70 mm x 70 mm
Intensity	3 x 10^7/s	10^{6-7}/s
Beam Port	2	2

2) S- Line

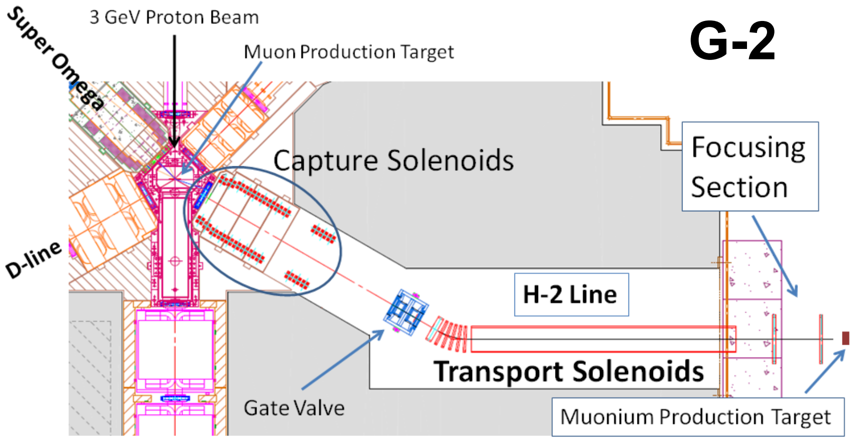
	Surface Muon (μ^+)
Beam Energy	4.1MeV
Implantation Depth	~0.2 mm
Energy Distribution	~15%
Pulse Width	~100 ns
Beam Size	30 mm x 40 mm
Intensity	10^{6-7}/s
Beam Port	4

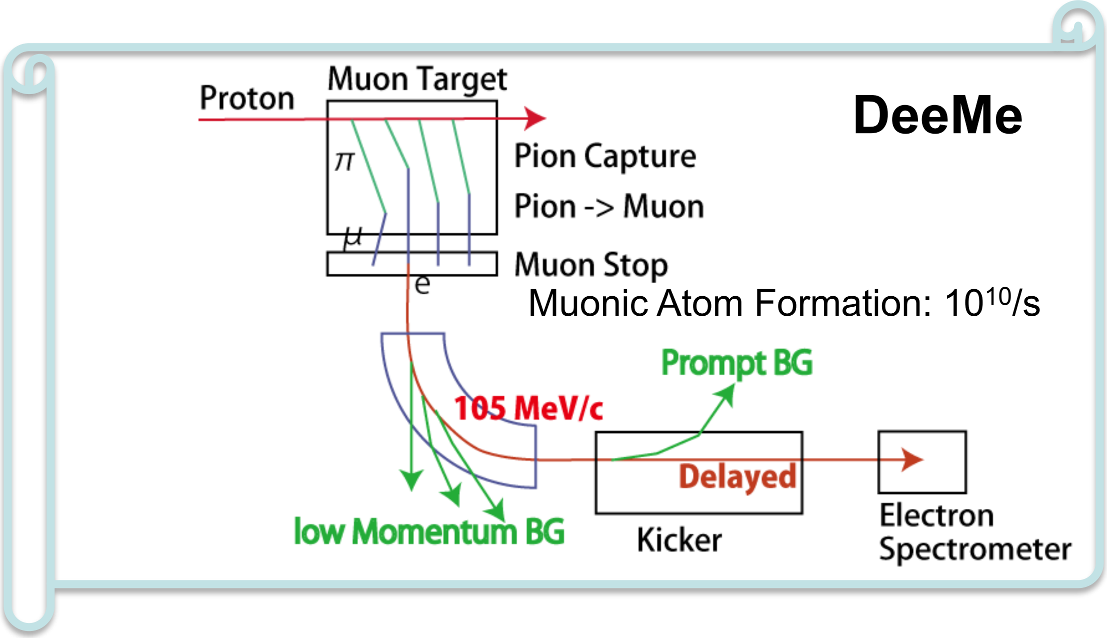
3) U- Line

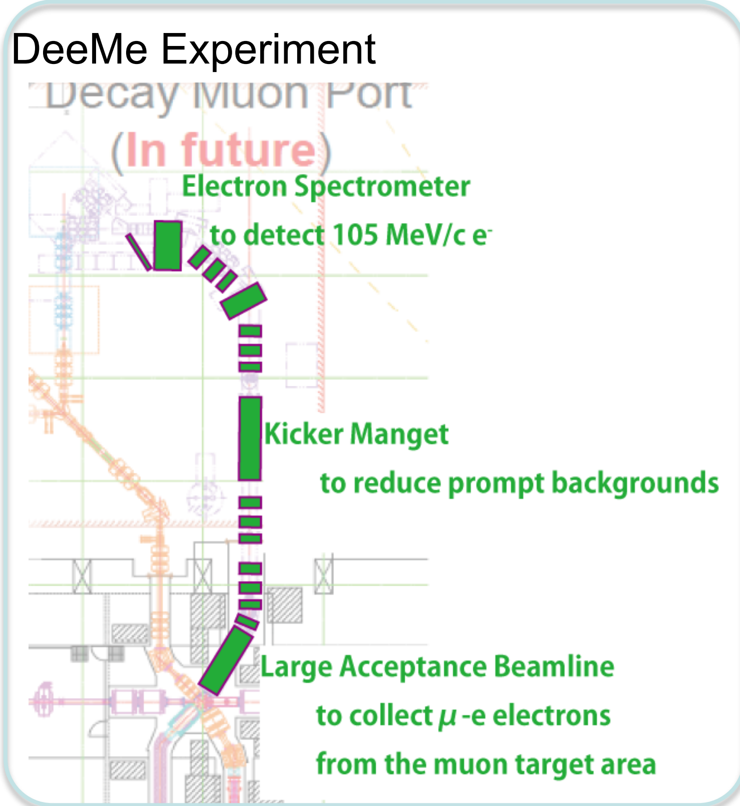
	Ultra Slow Muon (μ^+)	Cloud Muon (μ^-)
Beam Energy	50eV -30 keV	4 MeV
Implantation Depth	1 nm - 200 nm	?
Energy Distribution	<< 1 %	?
Pulse Width	8.3 ns(present) --> ns	~100 ns
Beam Size	3x4mm(present) --> 1 ϕ	?
Intensity	2-5 x 10^5/s	10^6/s
Beam Port	2	2

H-Line; High Momentum Muon Beam Line

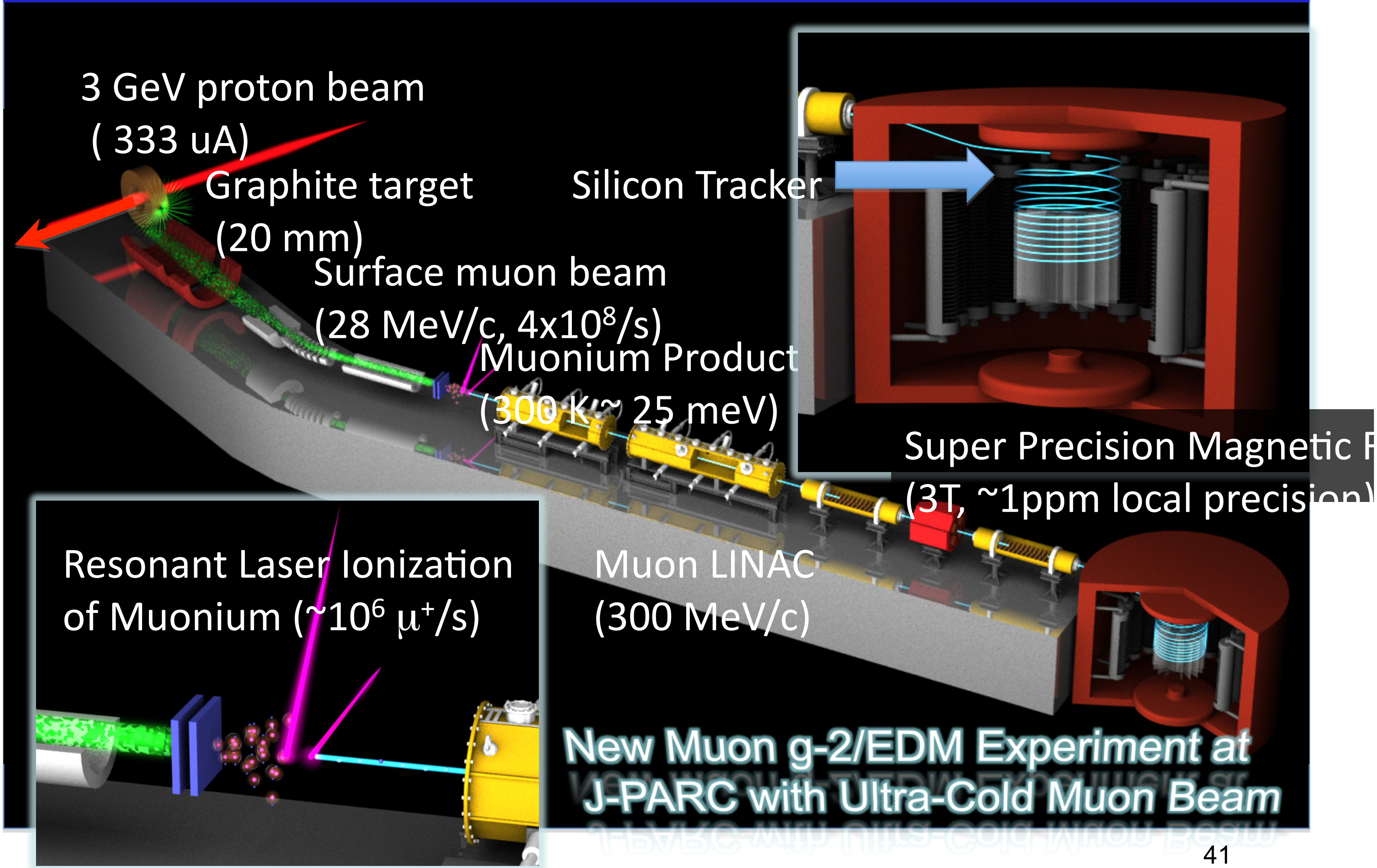
- High Pressure μCF Experiments using Muon High Momentum Muon
- G-2 experiment
- DeeMe (μ – e decay,
  regarded as **pre-COMET**)
- Pencil Beam Development







g−2 by Saito et al. Details by Ishida today



Search for $\mu^- + A(Z,N) \rightarrow e^- + A(Z,N)$, by Aoki et al.

Forbidden in the Standard Model of Particle Physics.

REALLY EXCITING if this process is found:

- Clear evidence of the physics beyond the Standard Model.
- Related to neutrino oscillation, physics in LHC etc.

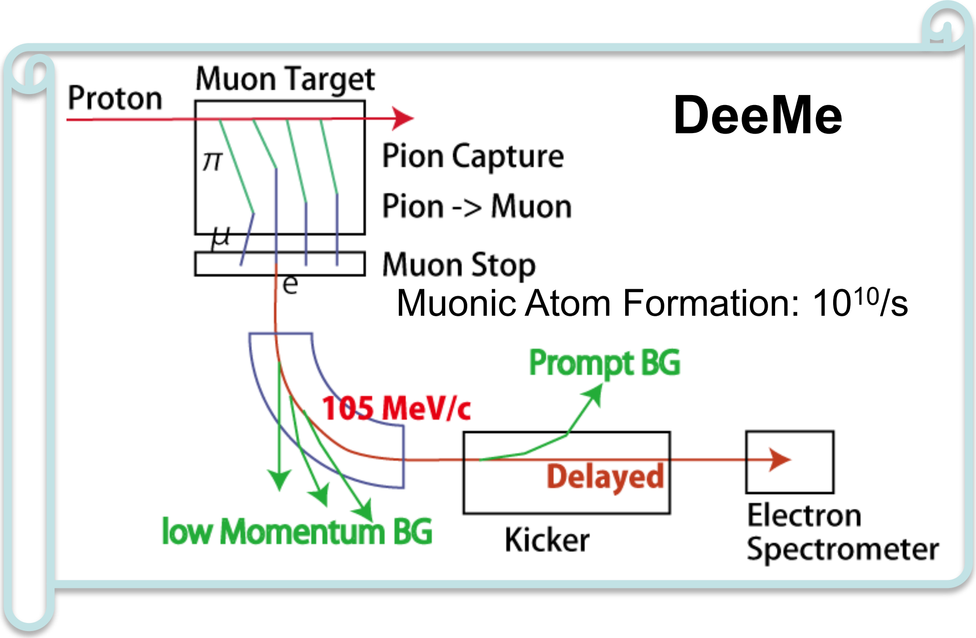
- Current Upper Limit (SINDRUM-II@PSI): BR < 7×10^{-13}
- Theoretical Predictions: BR = 10^{-14}~10^{-16}

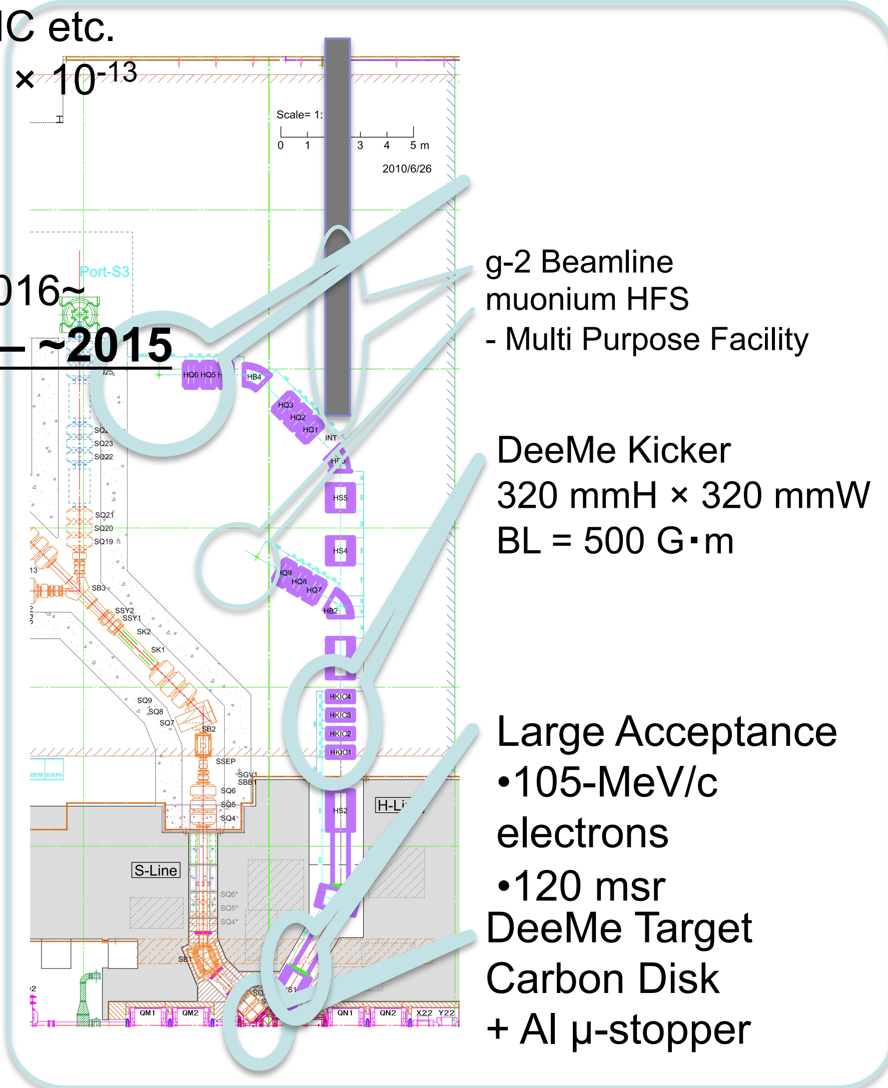
Experimental Activities in the world

- MEG(PSI): BR[$\mu \rightarrow e\gamma$] < 10^{-13} – ~2012
- COMET(J-PARC MR): BR[μ-e conv.] < 10^{-16} – 2016~

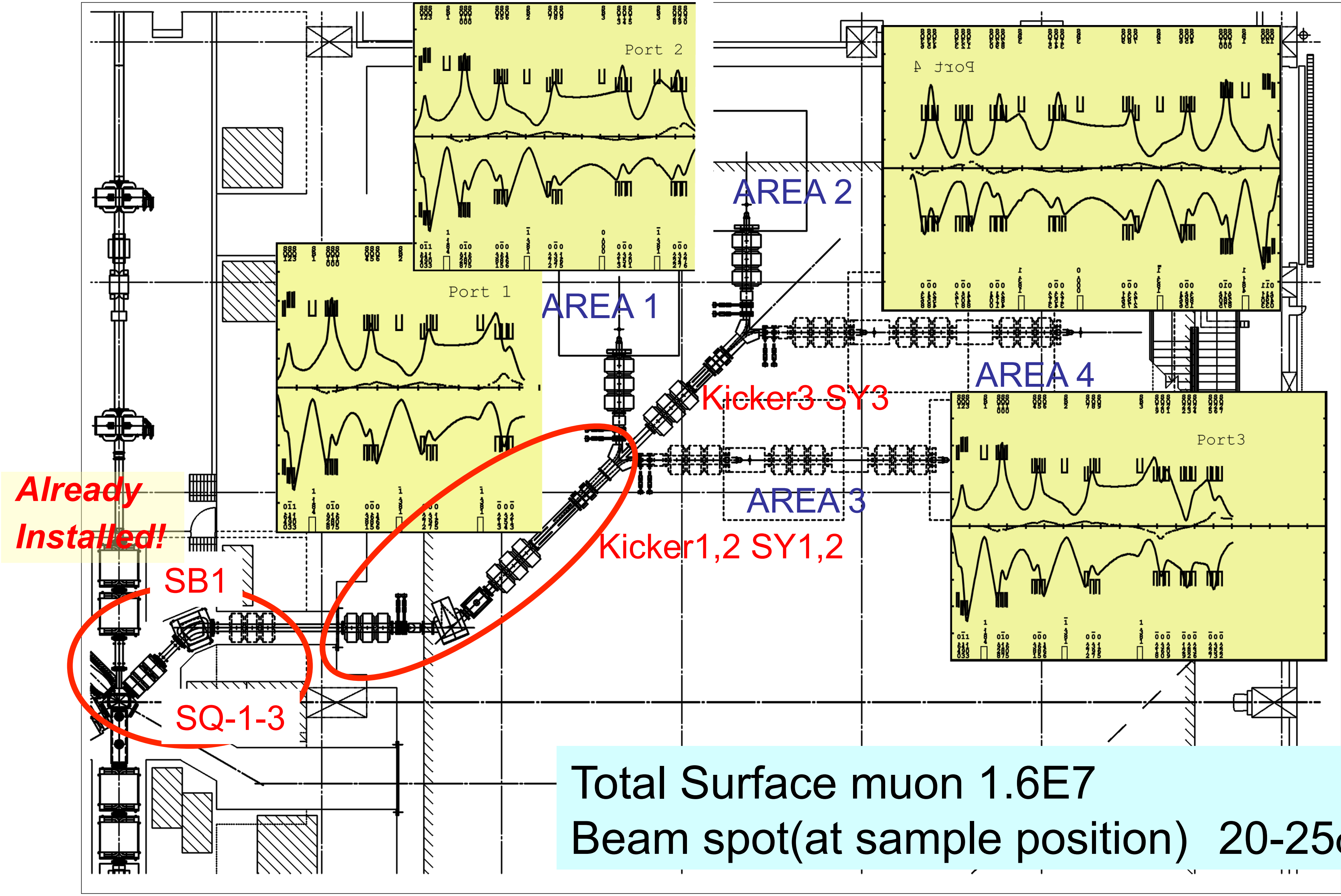
DeeMe(J-PARC MLF): BR[μ-e conv.] < 10^{-14} – ~2015

- Simple, Fast, Low Cost
- Staging: DeeMe → COMET





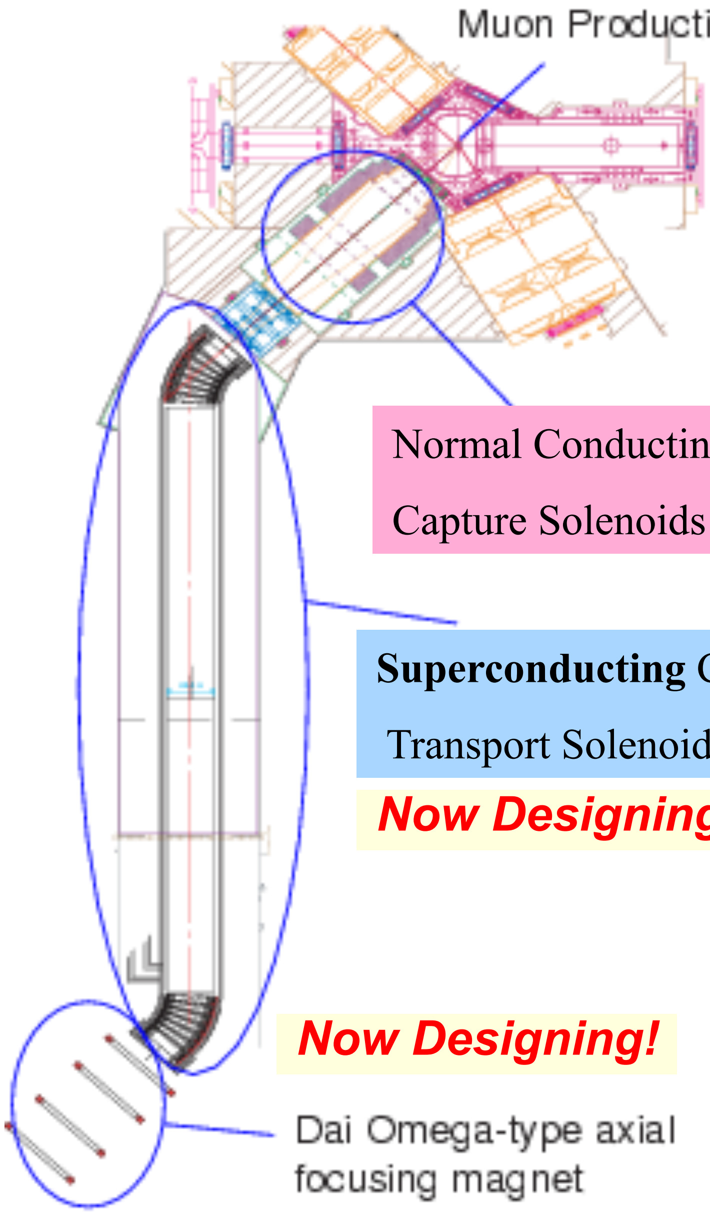
S-Line; Surface Muon Channel dedicated for Material Sciences



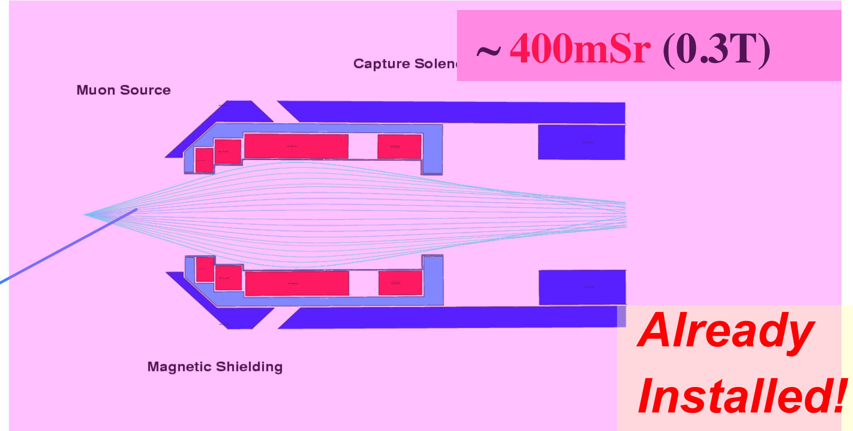
Total Surface muon 1.6E7
Beam spot(at sample position) 20-25ϕ

U-Line; Super-Omega Muon Beamline for Intense Ultra Slow Muons

Details by Dr. Ikedo



Normal Conducting(***MIC***) Capture Solenoids

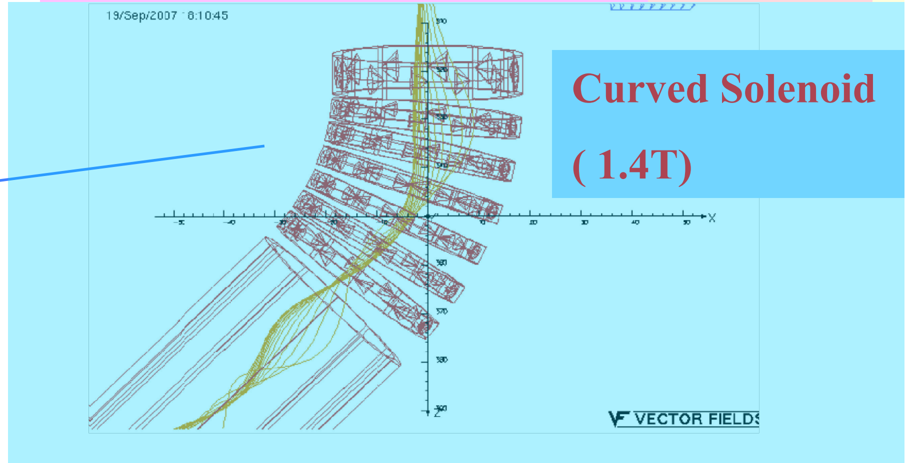


~ 400mSr (0.3T)

Already Installed!

Superconducting Curved Transport Solenoids,

Now Designing!



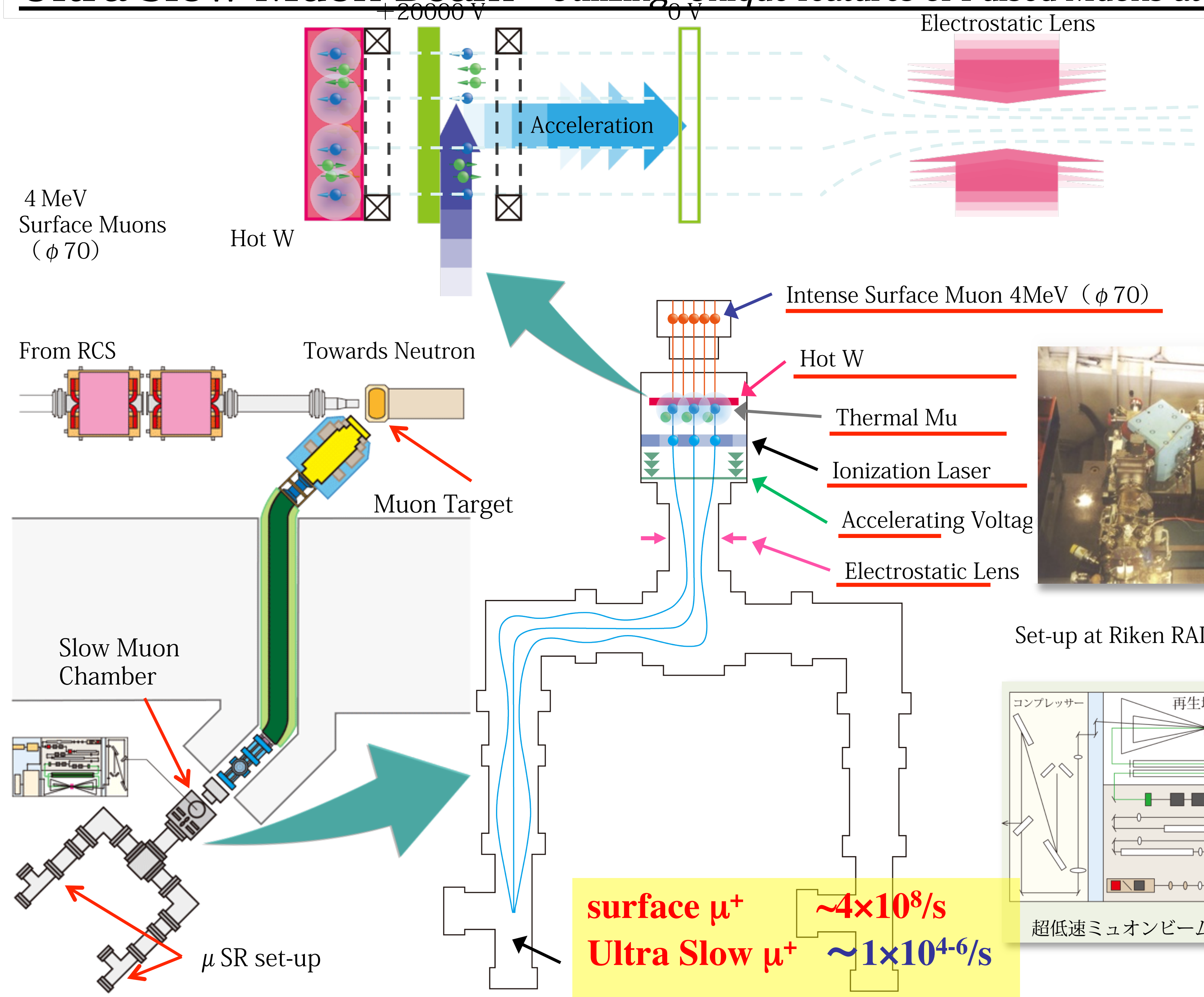
Curved Solenoid (1.4T)

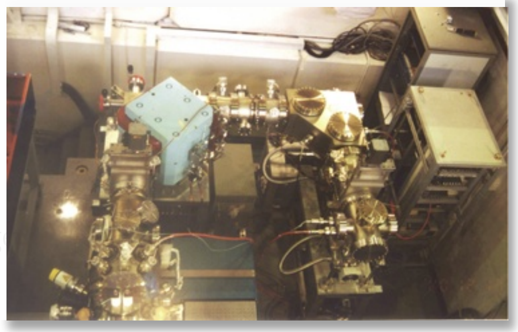
Now Designing!

Aim for the highest intensity pulsed surface muon beamline in the world

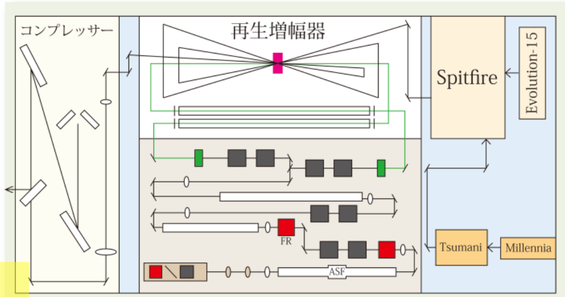
surface μ^+	**~4×10^8/s**
cloud μ^- (30MeV/c)	**~1×10^7/s**

Ultra Slow Muon Beam– *Utilizing Unique features of Pulsed Muons at J-PARC MUSE-*





Set-up at Riken RAL



超低速ミュオンビーム生成用最先端レーザー源

MUSE Schedule

Installig U–Line in the summer of 2012

Installing Rotating Target and Front end of H–Line and S–Line in the summer

Approved up to the focusing Solenoid

		2010	2011	2012	2013	2014	2015
U Line	Superconducting Curve Solenoid	5	3	3	3	3	3
	Installation		10,5,10				
	Superconcduting Focusing Solenoid		3	3,5,10	2		
	Mu chamber & VUV Laser		3	3,3,5	5	5	5
	Spectrometer			5	5	6	6
	RF acceleration				3	3,5,10	1
	Negative muon extraction			3	3	3,5,5	3
U–Line Man power		5	11	17	21	20	18

Fabricating in 2011 for all the Magnets in the M2 tunnel

		2010	2011	2012	2013	2014	2015
S–Line	SQ4–6+ Shield		3				
	Installation			5,5,5			
	Port1;TRIPLET、SpinRotator			3,5			
	Spectrometer			5	5	3	3
	Port2				5,5	5,5	5,5
S–Line Man Power			3	13	10	8	8

Fabricating in 2011 for all the Front-end MIC Magnets

		2010	2011	2012	2013	2014	2015
H–Line	MIC Solenoid		3				
	GV, Plug shield etc			5,10,10			
	Superconducting Solenoid				5,5,10	5,10,10	
	Shield				3	3	
	Infrastructure				2	2	
	Experimental set–up					5	5,5
H–Line Man Power			5	10	10	15	5

On going program

		2010	2011	2012	2013	2014	2015
D– Line	Spectrometer	3	6	6	6	6	6
	Kicker Device		2	1	1	1	1
	Superconducting solenoid	2,3	2,3	2,3	2,3	2,3	2,3
Man Power		5	10	9	9	9	9

Summary

- First Muon Beams was successfully delivered on Sep. 26th , 2008, standing as the only muon source in Asia region.
- Phase1 construction of J-PARC muon facility MUSE (World strongest pulsed muon source on Nov., 2009) was completed!
- We have only one muon beamline at present!
- We started construction of the U-line for Ultra slow muon

Welcome to J-PARC MUSE,

for your participation !