



Future Neutrino Beams in Europe & Japan

- Developments in Japan
- The European scene
- CERN: LHC injector upgrade
- UKNF
- Design Study EUROv
- Infrastructure proposals, EUCARD, DEVDET



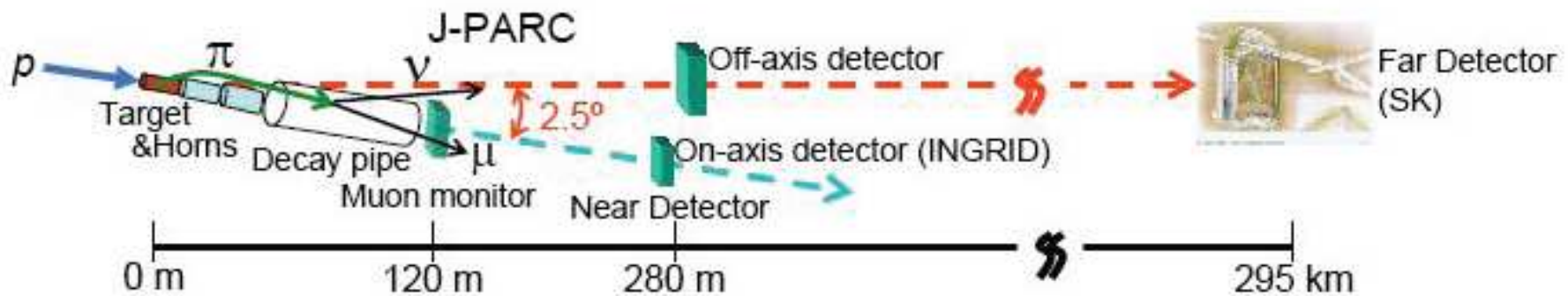
In the forefront: T2K



Super-Kamiokande
(ICRR, Univ. Tokyo)



J-Parc Main Ring
(KEK-JAEA, Tokai)



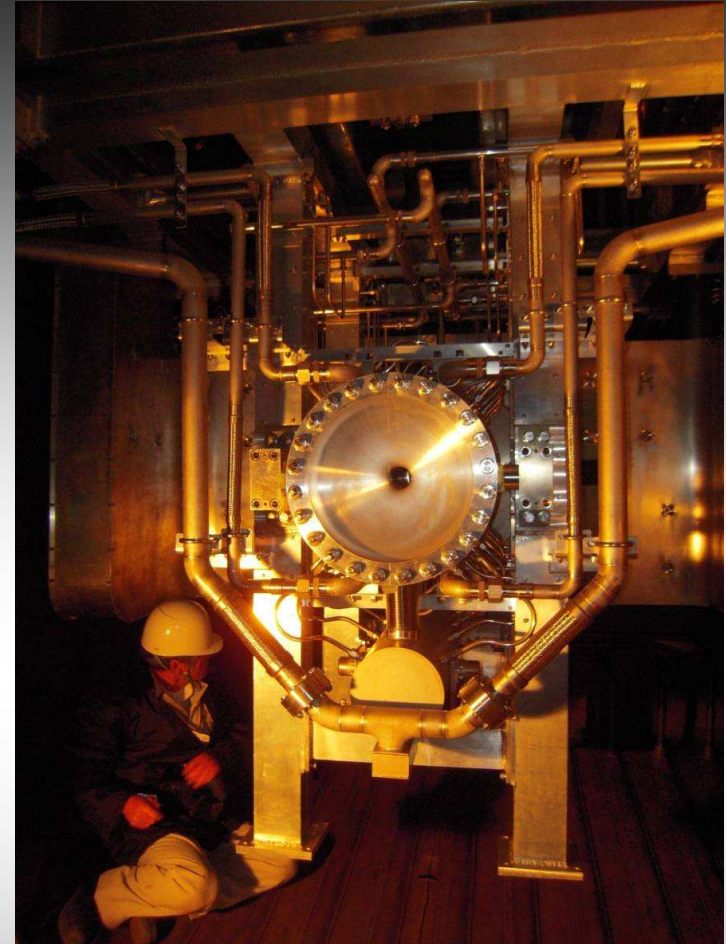


Status of T2K

30 GeV proton beam accelerated 23Dec08!



neutrino beam line SC magnets
installed and tested at 30 GeV



1st horn and target installed

1st beam on target (low power) April-May 2009

Far detector (Super KamiokaNDE) ready now (new electronics)

Near detector ND280 under completion. Operational end 2009

1st physics run: end 2009 - 2010 ==> $\sin^2 2\theta_{13}$ sensitivity ~ 0.06



Future plans develop around T2K beamline

1.66MW in 2015

Giant WC or Larg (no date)



Neutrino Intens

Quest for the Origin of Matter Dominated Universe

One of the Main Subject of *KEK Roadmap*

T2K (2009~)

Discover ν_e app.

Neutrino Anti-Neutrino meas.

Intensity Upgrade

Detector R&D

Tech. Choice

Huge det. Construction

CPV search Proton decay



Possible Timeline

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Linac(400MeV)	4	4	4	4	4	4	4	4	4	4
T2K		?			?	→ 400MeV				
MR Intensity Upgrade					?		?	→ 1.66MW		
Detector R&D										

Presented by KEK DG at KEK Roadmap Review Committee 9,10-March 2008

MUTAC09





Developments towards Intense Muon beams in Japan

aim at using High power JPARC for rare muon processes
e.g. $\mu N \rightarrow eN$ conversion
(low pion contamination, low muon energy spread)

Slides from Y. Kuno (Osaka U.)

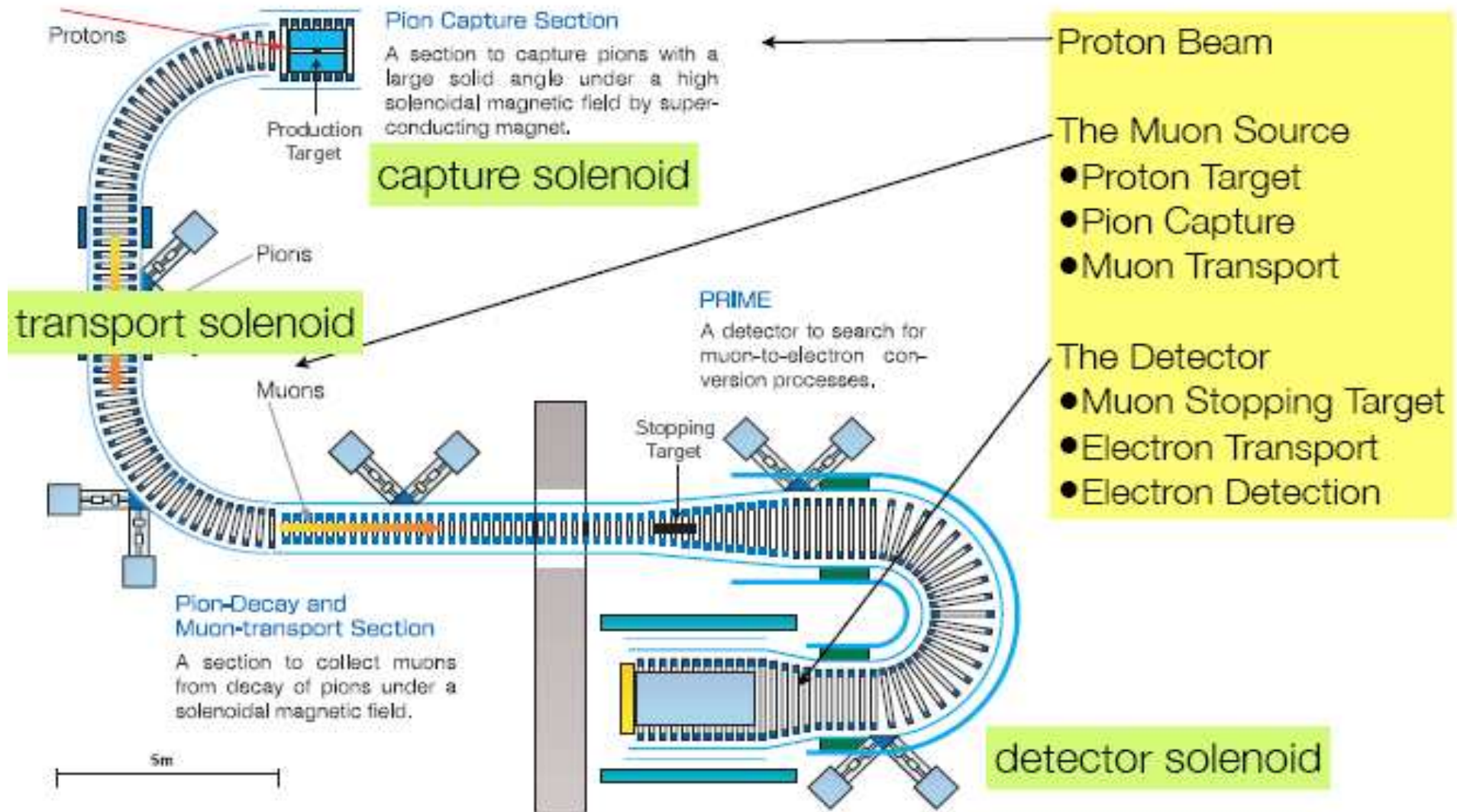


Japanese R&D

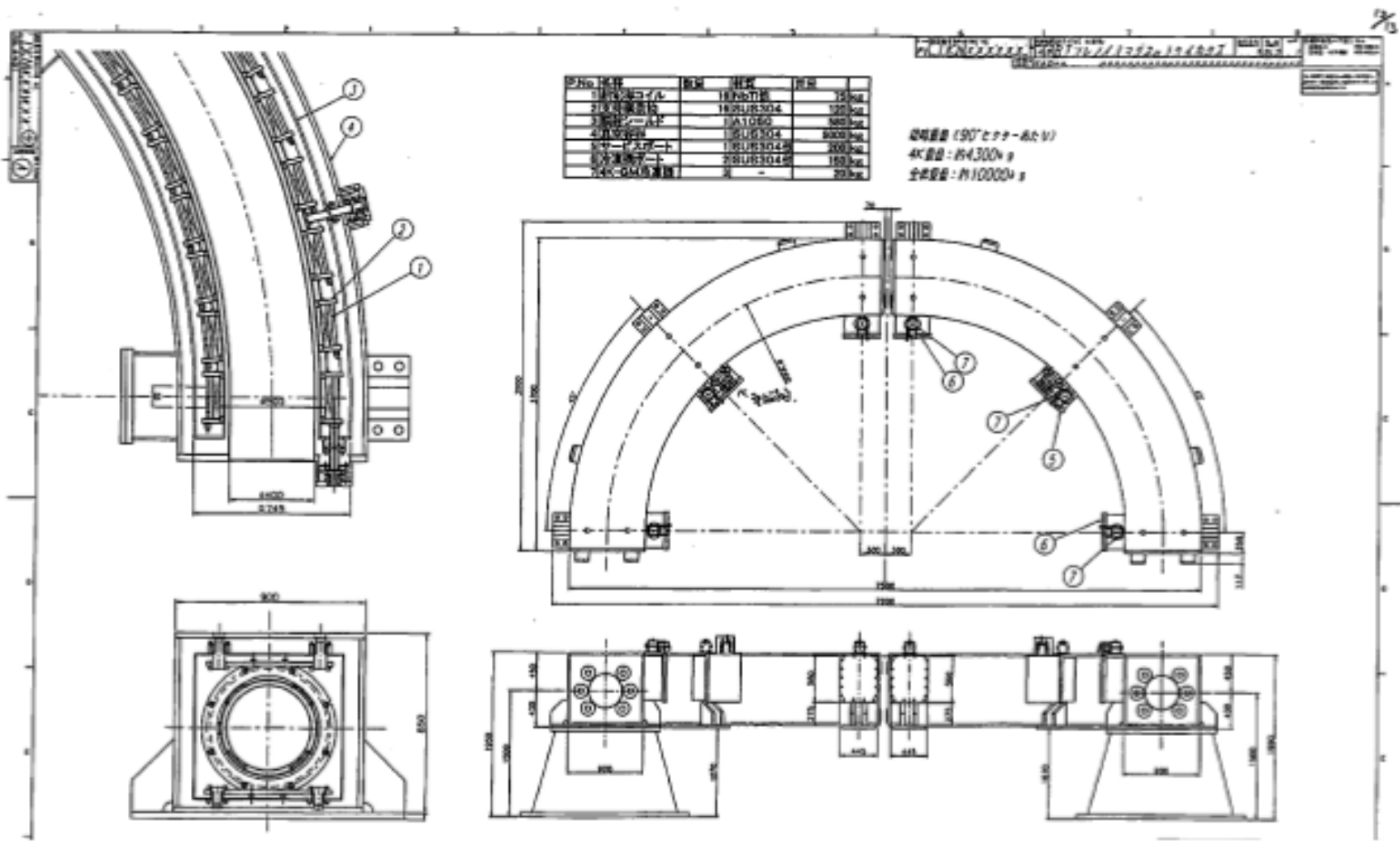
- **COMET R&D**
 - Design of superconducting solenoid magnets is underway.
 - pion capture system , muon transport system, detector system
 - Prototyping of solenoid coils for the muon transport section has been made by March, 2009.
- **PRISM FFAG R&D**
 - Muon storage ring R&D based on FFAG (PRISM-FFAG)
 - The 6-cell FFAG ring has been tested by using alpha-particles from a radioactive source.
- **MUSIC R&D**
 - The MUSIC project is a project to construct a high-intensity muon source at Research Center of Nuclear Physics, Osaka University.
 - The pion capture solenoid system has been funded. The construction will be completed by March, 2010.
 - The first beam is expected at April, 2010.



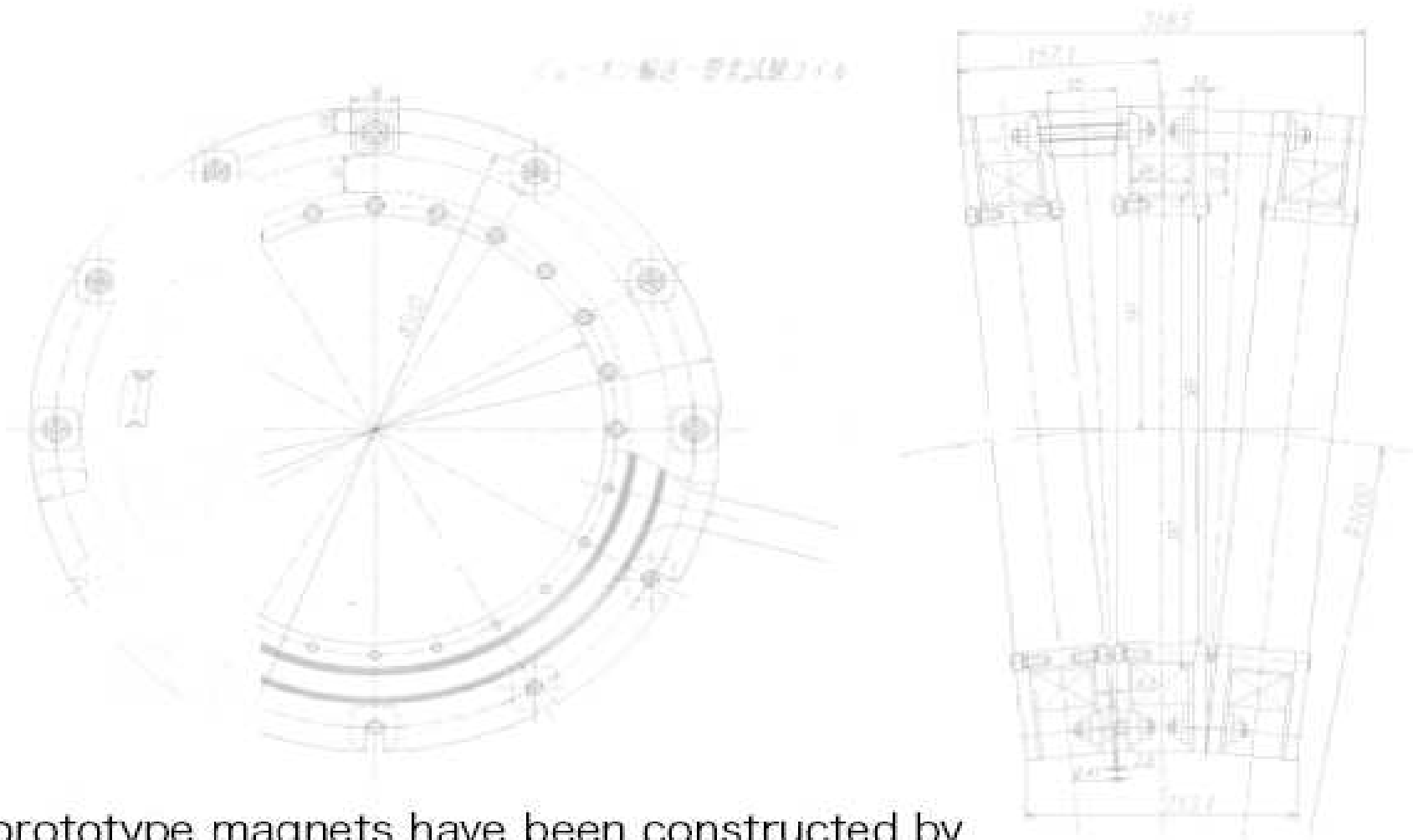
Layout of the COMET Experiment (COherent Muon to Electron Transition)



COMET Transport Solenoid Design



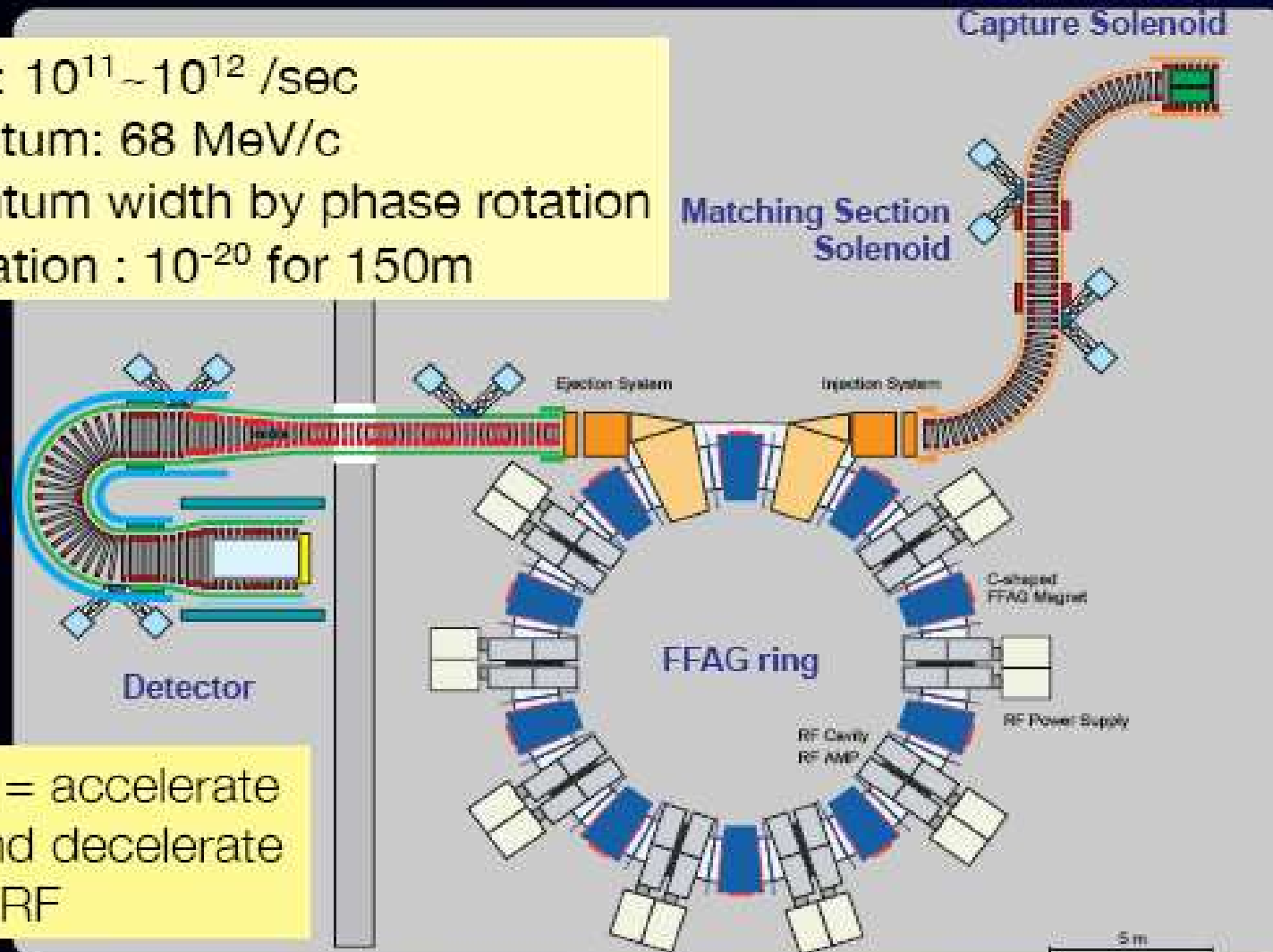
Prototyping of the Muon Beam Transport Solenoid Magnets



3 prototype magnets have been constructed by March, 2009.

PRISM Muon Beam

muon intensity: $10^{11} \sim 10^{12}$ /sec
central momentum: 68 MeV/c
narrow momentum width by phase rotation
pion contamination : 10^{-20} for 150m

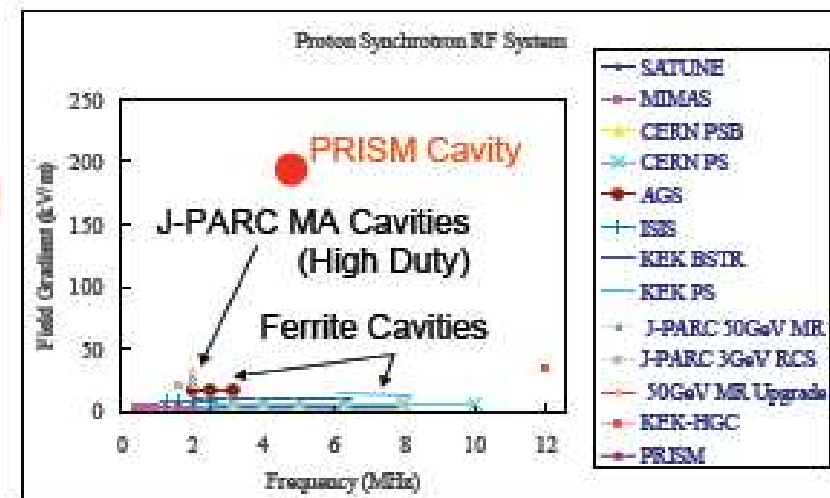


Phase rotation = accelerate
slow muons and decelerate
fast muons by RF

PRISM-FFAG R&D : Achievements and Plans



- Design of Muon Storage Ring based on FFAG : **completed**
- Construction of Large acceptance FFAG : **completed**
 - 6 FFAG magnets : **completed**
 - magnetic field measurements : **completed**
- Beam optics Study Based on One Cell : **completed**
- Development of High Gradient RF : **completed** 170kV/m sinusoidal @ 5MHz
- Beam Monitor R&D : **completed**
- High Saw-tooth RF : **completed**
- Construction of 6-cell ring : **completed**
 - commissioning : **completed**
 - test of phase rotation : **underway**

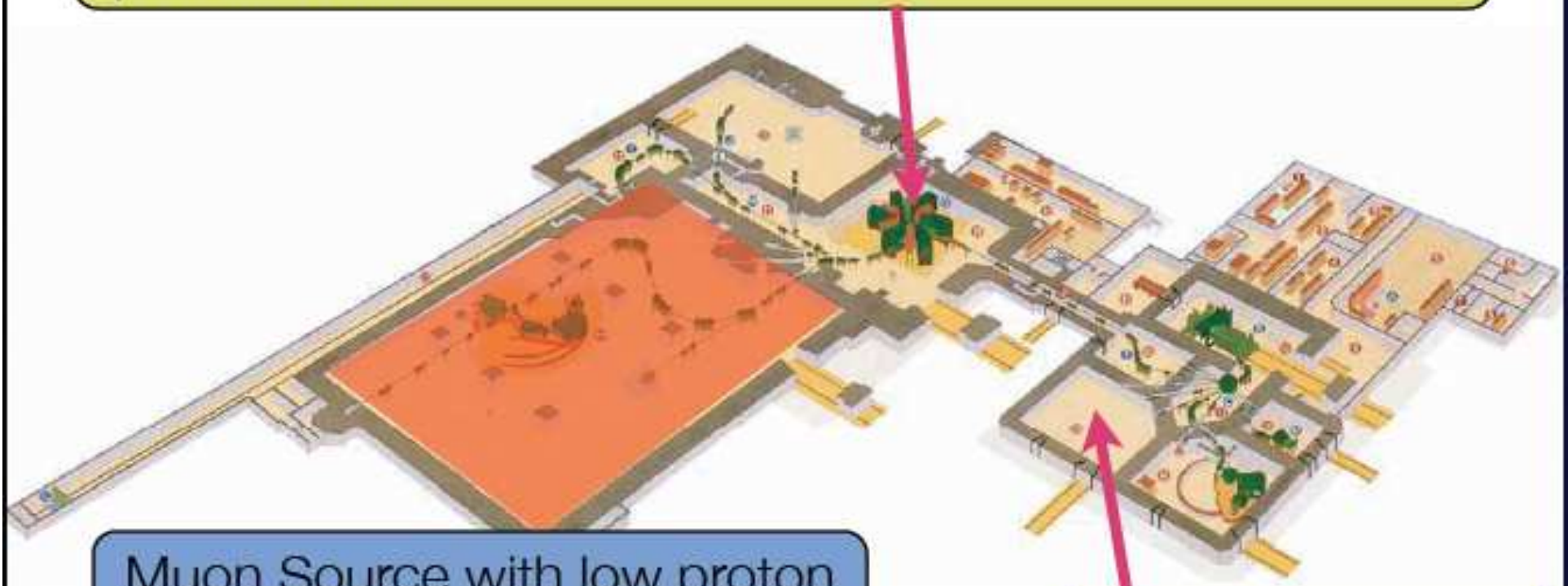


R&D on the PRISM Muon Storage (FFAG) Ring at Osaka University



Research Center for Nuclear Physics (RCNP), Osaka University

Research Center for Nuclear Physics (RCNP), Osaka University has a cyclotron of 400 MeV with 1 microA. The energy is above pion threshold.



Muon Source with low proton power at Osaka U.?

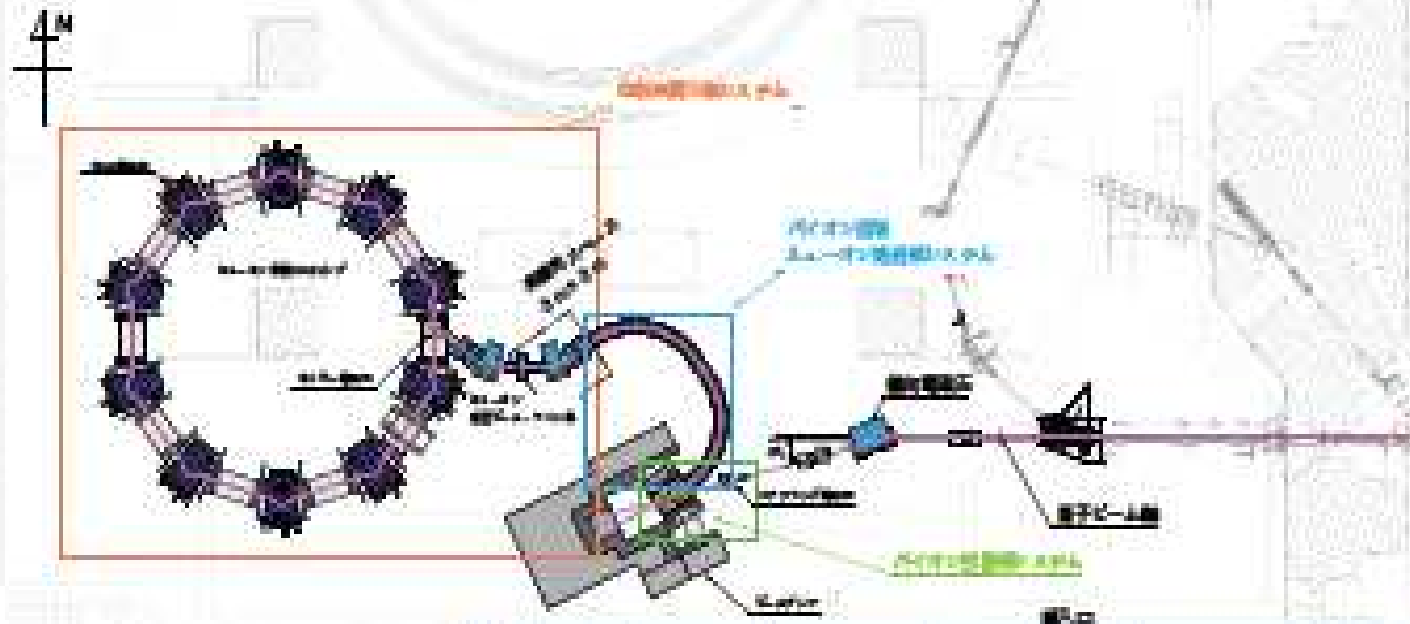
PRISM-FFAG R&D

MUSIC (=MUon Science Innovation Complex)

muon yield estimation

50 kW : 10^{11} muons/sec (for COMET)

0.4 kW : 10^9 muons/sec (for MUSIC)



The pion capture system has been approved in the 2008 supplementary government budget.



The European scene

High Energy Frontier:

- LHC about to turn on (first beams in September-October09)
- Two linear collider projects ILC, CLIC
- Activity on muon collider is limited
- sLHC includes upgrade of injectors
 - approved for R&D, opportunities for high intensity programme
- need for wider programme acknowledged

Neutrinos:

- CNGS program (OPERA, future? ICARUS → MODULAR?)
- strong EU involvement in T2K, OsBB expts, D-CHOOZ
- Strategy secretariat of CERN council has recognized EUROnu and NEU2012

Future (some coordination, BENE(CARE) → NEU2012 (EUCARD

- UKNF
- EU Design study program EUROv has started
- LAGUNA has started
- EU Infrastructure EUCARD NEU2012
- others: DEVDET for detector development will be resubmitted





EUROnu

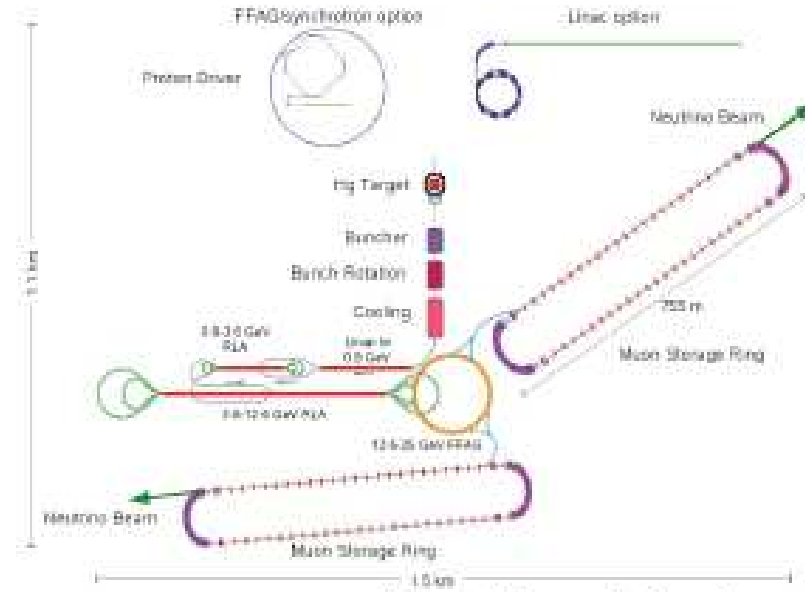
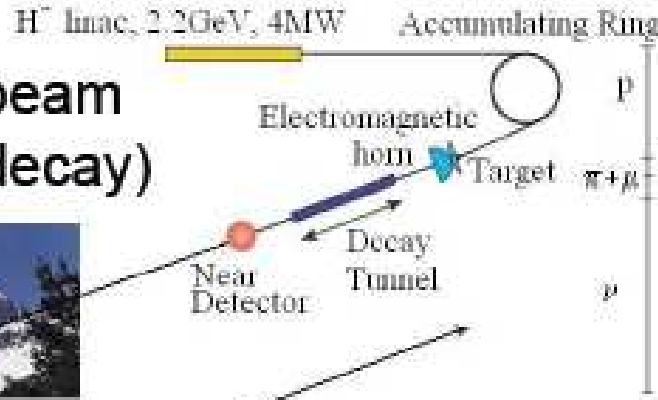
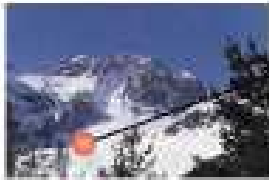
**A 13.5 M€ program over 4 years. 4M€ from Europe.
Deliver in 2012 three Design reports
(Superbeam, Betabeam, Neutrino factory)
+ studies of Detectors and physics performance comparisons.**





EURO_v

superbeam
(pion decay)



Neutrino Factory
(muon decay)



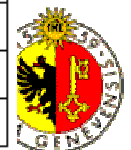
Beta-beam
ion decay ${}^6\text{He}$, ${}^{18}\text{Ne}$ or ${}^8\text{Be}$, ${}^8\text{Li}$

key question for us:
can any of this be at CERN?



Partners

Participant no. *	Participant organisation name	Part. short name	Country
1 (Coordinator)	Science and Technology Facilities Council	STFC	UK
2	Commissariat à l'Energie Atomique	CEA	France
3	European Organisation for Nuclear Research	CERN	Switzerland
4	University of Glasgow	Glasgow	UK
5	Imperial College of Science, Technology and Medicine	Imperial	UK
6	Consejo Superior de Investigaciones Cientificas	CSIC	Spain
7	Centre National de la Recherche Scientifique	CNRS	France
8	Cracow University of Technology	CUT	Poland
9	University of Durham	UDUR	UK
10	Istituto Nazionale di Fisica Nucleare	INFN	Italy
11	Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. (Max-Planck-Institut für Kernphysik, Heidelberg)	MPG	Germany
12	The Chancellor, Masters and Scholars of the University of Oxford	UOXF.DL	UK
13	Sofia University St. Kliment Ohridski	UniSofia	Bulgaria
14	University of Warwick	Warwick	UK
15	Université Catholique de Louvain	UCL	Belgium





Associates

- **Some funding available for travel**
- **Meetings possible at associates**
 - **Argonne National laboratory, USA**
 - **Brookhaven National Laboratory, USA**
 - **Fermilab National Accelerator Laboratory (FNAL), USA**
 - **Institute of Applied Physics in Nizhny Novgorod, Russia**
 - **Joint Institute for Nuclear Research, Dubna, Russia**
 - **TRIUMF Laboratory, Canada**
 - **University of Geneva, Switzerland**
 - **US Neutrino Factory and Muon Collider Collaboration**
 - **Virginia Polytechnic Institute, USA**

 - **Aachen, Germany**
 - **Weizmann Institute, Rehovot, Israel**
 - **GANIL**
 - **etc**





Structure

Work package No	Work package title	Type of activity	Lead participant No	Person-months	Start month	End month
1	Management and Knowledge Dissemination	MGT	1	92	1	48
2	Super-Beam	RTD	2	333	1	48
3	Neutrino Factory	RTD	5	282	1	48
4	Beta Beam	RTD	3	295	1	48
5	Detector Performance	RTD	4	199	1	48
6	Physics Reach	RTD	6	206	1	48
	TOTAL			1407		



First EUROnu meeting was held at CERN March 23-27 2009

Selected Highlights:

-- CERN injector chain and synergy with LHC (Garoby)

All three programs are consistent with High power SPL

+ accumulator for superbeam (microseconds)

+ compressor for neutrino factory (nanoseconds)

(NB: Not clear that Muon collider would be)

HOWEVER: New CERN management is asking the question

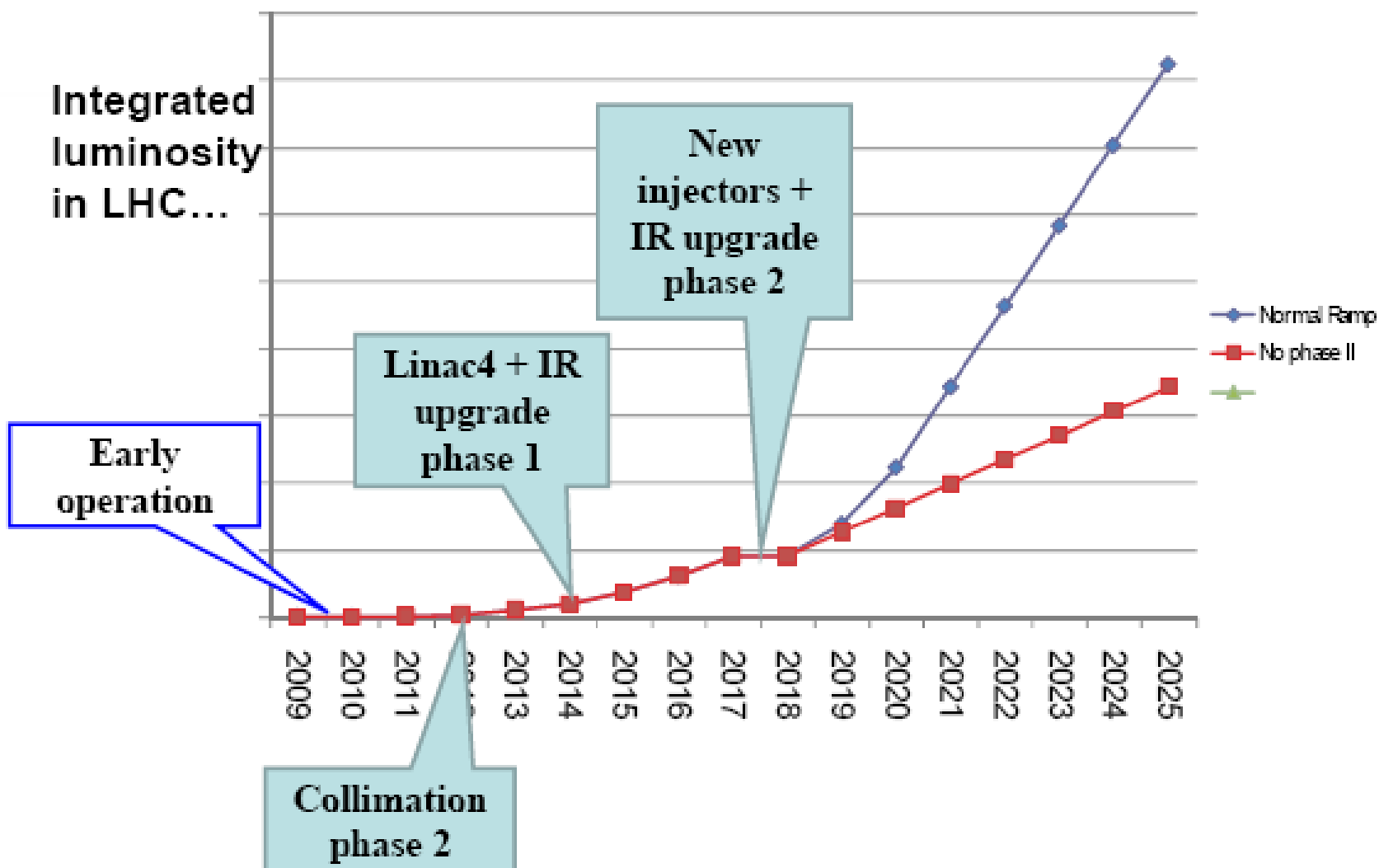
-- \$\$\$\$ for SPL HighPower-compatible wrt just LHC?

-- main requesters: neutrino community! (+ low energy muons)



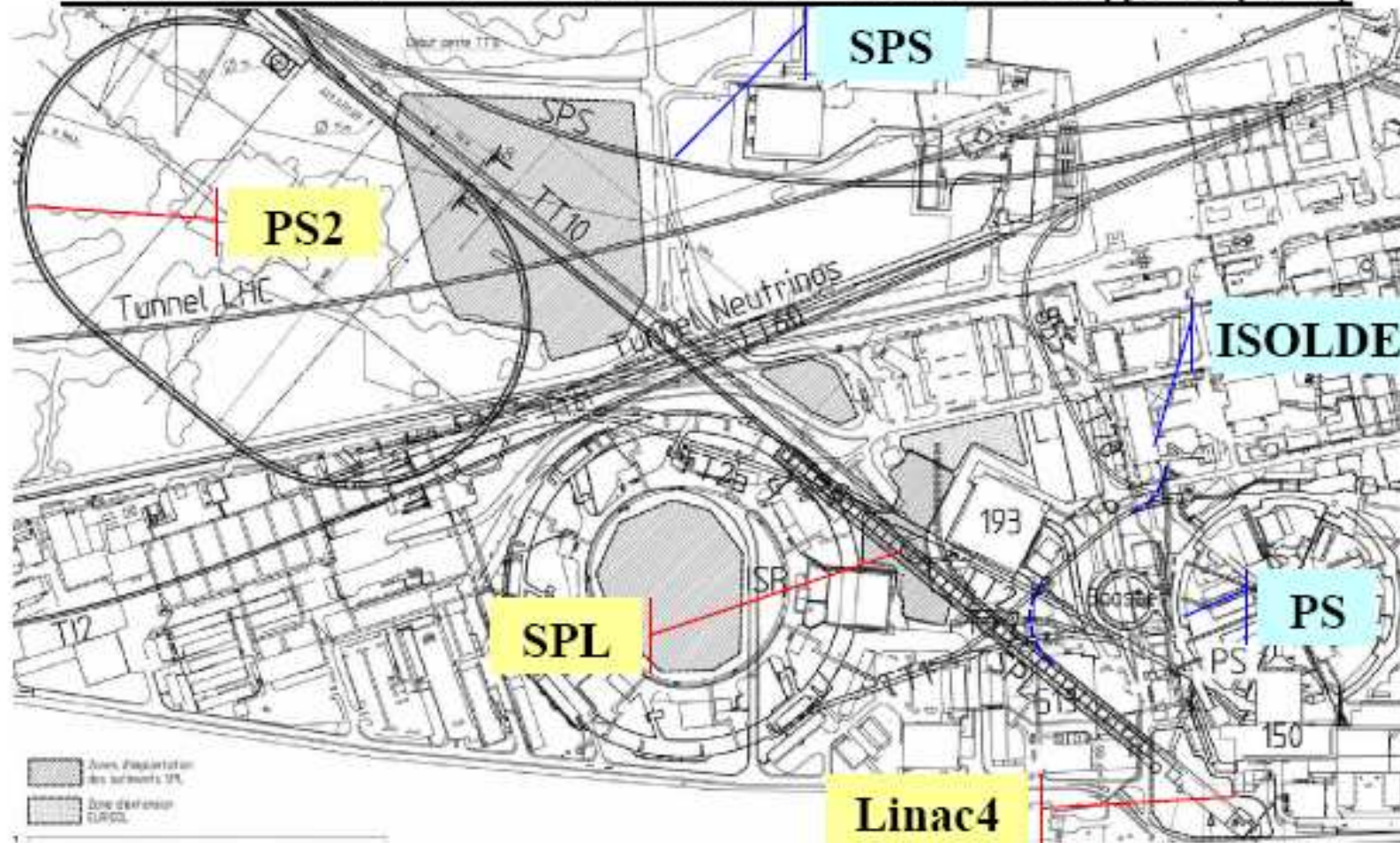


PLANS FOR FUTURE INJECTORS: Stage 2 (3/5)

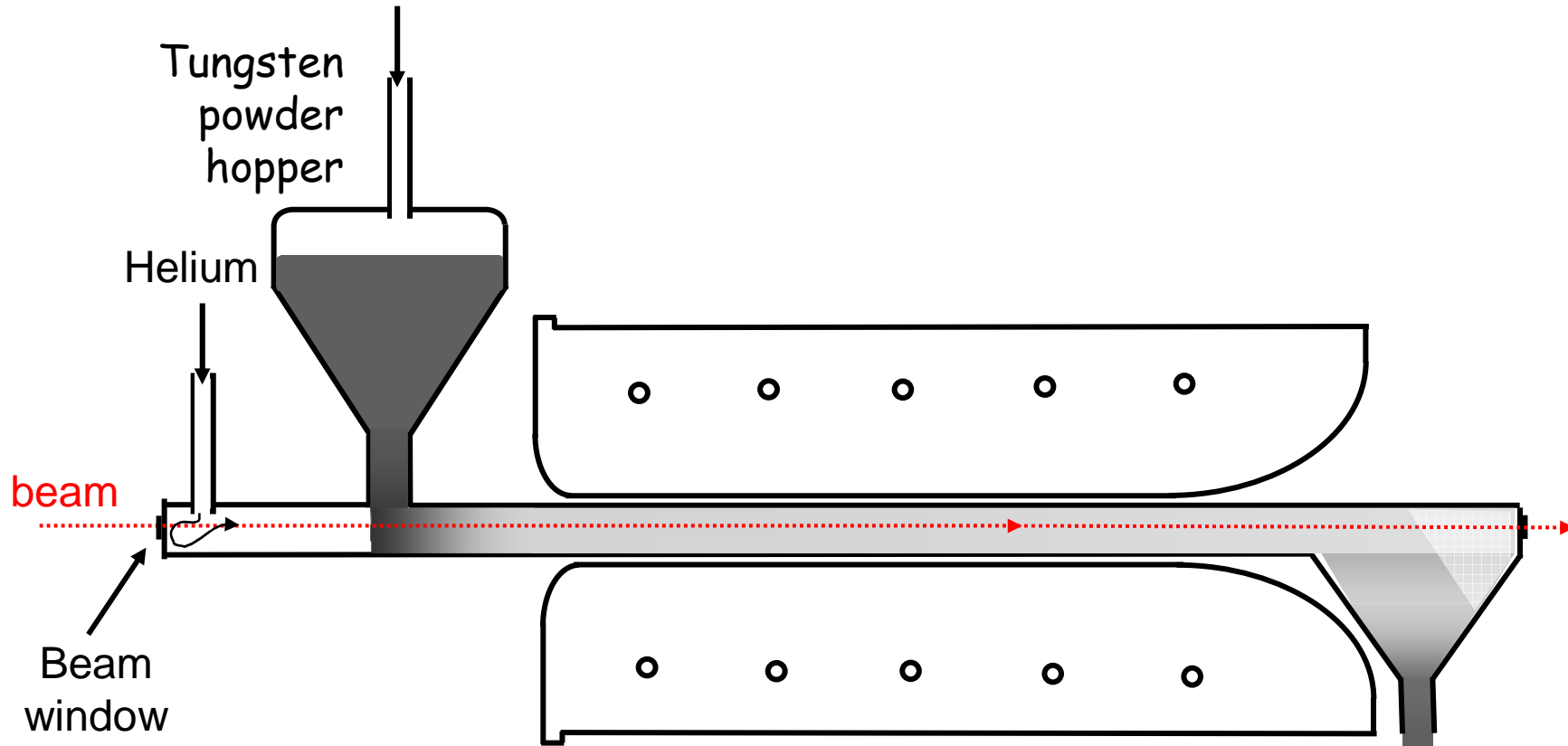




PLANS FOR FUTURE INJECTORS: Stage 2 (4/5)



A flowing powder target for a Superbeam or Neutrino Factory?





New powder test rig at RAL – first results from last week



What next at CERN?

-- Workshop on

New Opportunities in the Physics Landscape at CERN

May 11-13 at CERN: will concentrate on other uses of CERN

Complex than LHC. No neutrinos but proton driver discussion

-- Neutrinos will be addressed in a dedicated workshop

October 1-3 at CERN.

**-- SPC review panel will collect information and come up with
recommandations on neutrino physics at CERN**

Involvement in program abroad (T2K, Fermilab)

Detector R&D

**What to do to leave door open (or not) for an
accelerator- based program?**



Conclusions

- 1. Neutrino physics is recognized as an important part of the future of HEPP in Europe**
- 2. R&D on accelerator and detector technologies declared important by European Strategy Document to prepare 2012**
- 3. EUROv has started with aim to deliver design reports by 2012**
- 4. Some opportunity has been prepared with LHC injector upgrade at CERN, (SPL) this defines the time scale for high intensity as post-2017.**
- 5. Roadmap will be prepared within NEU2012 (successor of BENE)**
- 6. World wide coordination is seen as necessary and beneficial!**

