



Status and Plan for FP7-NEU2012



the Accelerator Neutrino Network
in the EuCARD Integrating Activity

V. Palladino
Univ & INFN Napoli
86th Plenary ECFA
CERN Council Chamber
27-11-2009



NEu2012

Neutrinos for Europe in 2012

Council dixit

*..... to be in position to define the optimal neutrino program
..... in around 2012*



NEu2012 looks thus ahead to its closing date and final goals



NEu2012 (Apr 1 2009 →

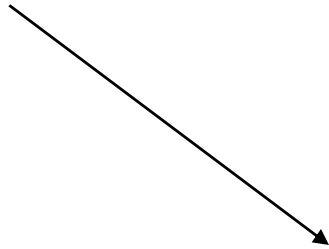
Apr 1 2013

ahead, after >10 years of initiative

ECFA Muon Study Groups (A. Blondel)

since 1998 in close collaboration with a **CERN NFWG** (H. Haseroth)

Neutrino Factory Working Group

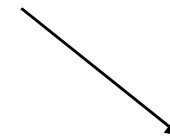


FP6 Network within CARE

BENE (V. Palladino)

Beams for European Neutrino Experiments

Jan 1, 2004 to Dec 31, 2008



NEu2012 (Apr 1 2009 →)

Apr 1 2013



ECFA Muon Study Groups

1999 1st Yellow Report
 first NuFact99 in Lyon
HARP R&D experiment
2001 the BetaBeam concept
 NNN02 CERN workshop
 birth of T2K Eu team
 NUFact02 in London
2003 MICE R&D experiment
 NuFact Summer Schools
 hundreds of NFWG notes
 recognition of the SPL potential
 connection to the EURISOL R&D
 and more

CERN Nu-Factory Working Group

“evaporated” in 2002

BENE

NB no CERN steam engine behind !!

May 04 MultiMegaWatt workshop
 Sep 04 Villars ... the “neutrino window “
MERIT R&D experiment
NF ISS (launched at NuFact05 in Frascati)
 2nd yellow report, input to
 2006 Council Strategy Group statements
 EMMA FFAG R&D experiment
2007 EUROnu proposal ... + Laguna proposal (Astroparticle)
2008 NEu2012 proposal, plus MICE-TA, ANAC/FFAG
 and more





back to NEu2012 final goals



a **platform for** consolidating the **European neutrino community**
enhancing **collaborative work** and exchanges
in view of **delivering** at the end of 2012 **an agreed programme** of neutrino experiments,

prepare, together with the EUROnu + LAGUNA Studies + the community at large

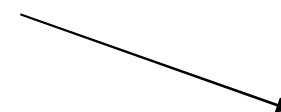
the formulation/proposal of

Eu participation to a optimal global accelerator neutrino program

based on upgrades of existing infrastructures and/or
on the proposal of a new one.

backed by the largest possible Eu accelerator neutrino community

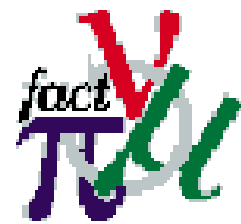
NEu2012



Apr 1 2013



NEu2012 and its connections in the EuCARD



FP7 Integrating Activity (EU Coordinated Accelerator R&D)



Project no. 227579
14 November 2008

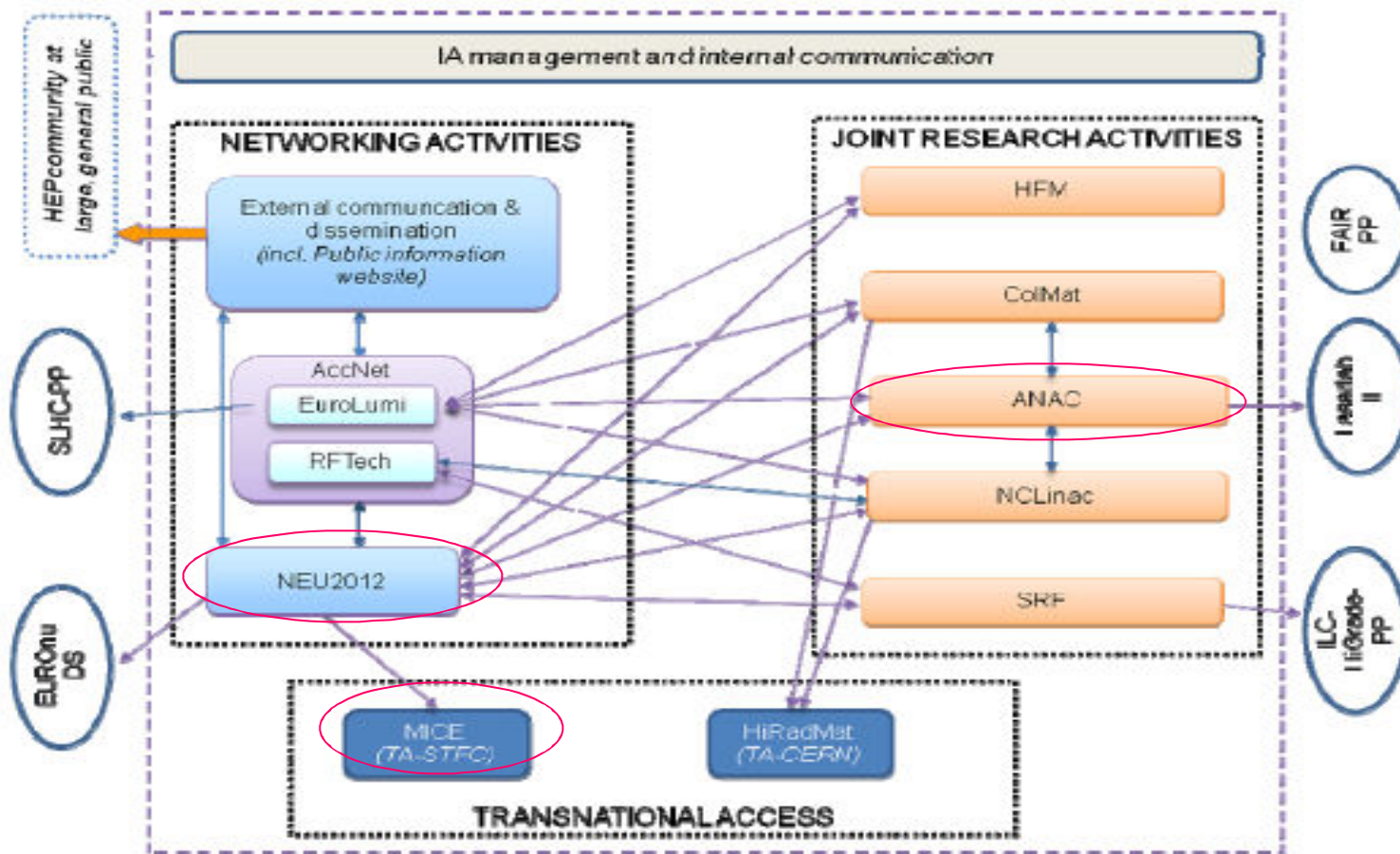


Figure 1. Diagram showing interdependencies



Work package 3 description: NEU2012: Structuring the accelerator neutrino community

Work package number	WP3		Start date or starting event:	M1			
Work Package title	NEU2012						
Activity type	COORD						
Participant id	INFN	CERN	UNIGE				
Person-months per beneficiary:	3.6	21.6	11.6				

possible future new facilities while surveying the coherence with the physics needs. It will conclude with recommendation for the choice of the next global accelerator neutrino facility, taking into accounts the technological risks and possible synergies with all other programmes worldwide.

The following Institutes have declared their strong interest in the NEU2012 activities: CEA (F), STFC (UK), CSIC (Spain), UCLN (Belgium), UniSofia (Bulgaria), CNRS-IN2P3 (F), CHIPP(CH), MPG-MPIK (D), Cracow U (Poland), UAM (Spain), Imperial (UK). Outside Europe, Osaka U. and KEK (J), FNAL/BNL/LBNL (USA), TIFR (India).

Objectives:

The "European Strategy for Particle Physics" emphasizes the importance of accelerator-based neutrino experiments, and sets the milestone for the next major undertaking in this field in 2012. The NEU2012 goal is to offer a platform for consolidating the European neutrino community and enhancing collaborative work and exchanges in view of delivering at the end of 2012 an agreed programme of neutrino experiments, based on upgrades of existing infrastructures and/or on the proposal of a new one.

Among the possibilities the following will be considered and evaluated:

- Upgrade of CNGS (cf Table B.1.1); understanding of the ultimate upgrade potential (neutrino flux, neutrino spectra, flux monitoring and far detector design and location).
- A new neutrino facility, including a ring, (beta-beam or a neutrino factory complex) offering much higher rate and purer flavour content, allowing for a more ambitious programme of complete determination of the physical quantities governing neutrino oscillations: mass splits, flavour mixings and charge-parity violating phase.

The NEU2012 network should be the forum where the community will discuss the results of the CNGS upgrade studies, the solutions proposed by EuroNu for its beam options, the outcome of international design studies in progress in Japan and USA and of the state of the art R&D projects in progress or being proposed, in particular, in the framework of EuCARD.

Deliverables of tasks	Description/title	Nature	Delivery month
3.1.1	NEU2012 Website operational	O	M6
3.1.2	Final NEU2012 guidelines for an accelerator neutrino experiments programme	R	M48
3.2.1	Performance analysis and physics potential of upgrades of existing neutrino facilities	R	M40
3.3.1	Proposal of the next global accelerator neutrino facility for Europe to build or help build.	R	M40

Mile-stone	Description/title	Nature	Delivery month	Comment
3.1.1.1	Calendar of workshops & conferences concerning NEU2012	O	M6	
3.1.2.1	Intermediate review of NEU2012 recommendations on neutrino experiments	R	M24	Road map for a programme of neutrino experiments
3.1.3.1	NEU2012 first annual workshop	O	M1	
3.1.3.2	NEU2012 second annual workshop	O	M24	
3.1.3.3	NEU2012 third annual workshop	O	M36	
3.1.3.4	NEU2012 final annual workshop	O	M48	
3.2.1.1	Intermediate review of NEU2012 recommendations on existing accelerator neutrino facilities.	R	M24	Road Map for upgrading existing accelerator neutrino facilities
3.3.1.1	Intermediate review of NEU2012 recommendations on new accelerator neutrino facilities.	R	M24	Road Map to new accelerator neutrino facilities

Description of work:

Task 1. NEU2012 Coordination and Communication
 The activities of this task are to oversee, co-ordinate the work and do the financial follow-up for all tasks in NEU2012. It shall ensure the consistency of the WP work according to the project plan and coordinate the WP technical and scientific tasks with the tasks carried out by the other work-packages when it is relevant. The coordination duties also include the organization of WP internal steering meetings, topical workshops, working sessions and reviews as necessary and contributions to the Annual Meetings. Participants from inside and outside the consortium will be invited.

In addition to the coordination work, this task will take responsibility for the production of a final document making the synthesis of the findings of the two other tasks, proposing an agreed programme of neutrino experiments, based on upgrades of existing infrastructures and/or on the proposal of a new one.

Task 2. Getting the most out of existing neutrino facilities
 This task will scrutinize the performance of operating neutrino facilities, i.e. of the CNGS in its international context: CNGS intensity limitation for future upgrades, figures of merit for upgrades (improved neutrino flux, neutrino spectra, flux monitoring abilities and far detector design and location).

Task 3. Road map to the next European accelerator neutrino facility
 This task will contribute to a synthesis on the European and worldwide research performed on

**Essentially one single
 "paramount deliverable"
 in April 2013**

**An accelerator neutrino
 experiments programme**

see next slide



Objectives:

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 of the state of the art **R&D** projects in progress or being proposed, **in particular**, in the framework of **EuCARD**.



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Few Contractors
 postdoc power
 with the charge
 of reaching out
 the entire community

Task 1. NEU2012 Coordination and Communication

Coordination: V.Palladino/INFN, S. Pascoli/UKNF

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Task 2. Getting the most out of existing neutrino facilities

CNGS Upgrade: I. Eftymiopoulos/CERN

This task will scrutinize the performance of operating neutrino facilities, i.e. of the CNGS in its international context: CNGS intensity limitation for future upgrades, figures of merit for upgrades (improved neutrino flux, neutrino spectra, flux monitoring abilities and far detector design and location).

CERN CNGS team + LNGS experimental teams

Task 3. Road map to the next European accelerator neutrino facility

Next Eu ν Facility: A. Blondel/UniGeneva

This task will contribute to a synthesis on the European and worldwide research performed on possible future new facilities while surveying the coherence with the physics needs. It will conclude with recommendation for the choice of the next global accelerator neutrino facility, taking into accounts the technological risks and possible synergies with all other programmes worldwide.

involving the largest possible Eu accelerator neutrino community

other beneficiaries

The following Institutes have declared their strong interest in the NEU2012 activities: CEA (F), STFC (UK), CSIC (Spain), UCLN (Belgium), UniSofia (Bulgaria), CNRS-IN2P3 (F), CHIPP(CH), MPG-MPIK (D), Crackow U (Poland), UAM (Spain), Imperial (UK).

Outside Europe, Osaka U. and KEK (J), FNAL/BNL/LBNL (USA), TIFR (India).



The Eu Community of Accelerator Neutrino Users besides NEu2012, EUROnu, NF-IDS

small teams at

NuMI

- MINOS
- MiniBoone
- SciBoone
- Minerva
- NOVA

≥ 2 experiments at

CNGS

- OPERA
- ICARUS, ModuLAr
- GLACIER

a large group at

JPARC

T2K

D-CHOOZ

Daya Bay

+ R&D experiments MuScat, HARP, NA61, MICE, MERIT, EMMA, **Laguna**, EuCARD ..

≈ 500 Users

+ comparable non Eu community

addressing
to some extent
also
the non-Accelerator
Eu Neutrino community

Writing the European Neutrino Oscillation Roadmap

Have agreed to contribute:

Theory

Manfred Lindner

John Ellis (POFPA) or Michelangelo Mangano

José Bernabeu

Experiments

André Rubbia (LAGUNA)

Antonio Ereditato (CHIPP-OPERA)

Carlo Rubbia et al (ICARUS)

Francesco Terranova (INFN-OPERA deputy)

David Wark (T2K International spokesperson)

Jenny Thomas (MINOS deputy spokesperson)

Hervé de Kerret (DCHOOZ)

Agnieszka Zalewska (SPC panel chair)

Marcos Dracos (IN2P3)

Marco Zito (DAPNIA-EUROnu SB)

Alessandro Baldini (MEG spokesperson) + Marco Grassi

will also include EUROnu (NF) (Long),

EUROnu (BB) (Lindros or other) EUROnu (Rob Edgecock)

+ Alain Blondel, Silvia Pascoli, Mauro Mezzetto and Fanny Dufour

NEU2012 18 March 2009 Alain Blondel



an Eu ν road map

calls for a **synthesis** among the options of

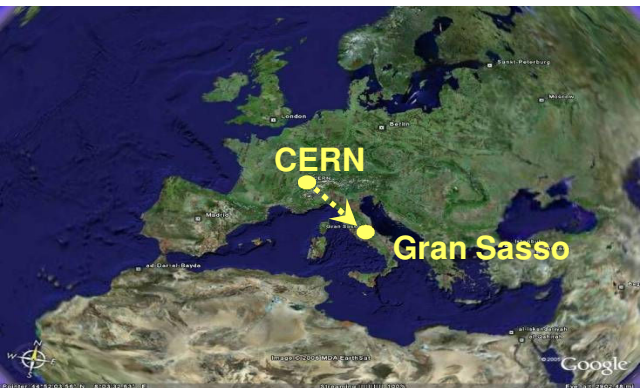
- Continuation of CNGS (if θ_{13} large)
- Pushing one novel Eu option (EUROnu)
 - SPL Superbeam
 - Betabeam which options are indeed realistic?
 - which baselines are ?
 - NuFact SPL to which underground lab ? \longrightarrow LAGUNA
 - is ISIS an option?
- Participation to International programs
 - JPARC superbeams beyond T2K
 - Fermilab superbeams: NuMI to DUSEL beyond MINOS and Nova
 - Fermilab muon program : NuFact rings before a collider

~1-2 slide each next, then conclusions

CONVENTIONAL v BEAMS: SPS with new injectors (4/4)

POT/year [10^{19}] for 200 days of operation with 80% machine efficiency

from M. Meddahi



SPS cycle length	6 s		4.8 s	
Injection Energy	14 GeV		26 GeV	
Beam sharing	0.45	0.85	0.45	0.85
Max SPS intensity @ 400GeV [$\times 10^{13}$]	4.8	5	9.4	
	5.7	5.9	11.1	
Future injectors (>2016) + SPS RF upgrade	7		9	17.1
Future injectors + new SPS RF system + CNGS new equipment design	10		12.9	24.5

An upgraded CNGS will require a re-classification and/or partial reconstruction of the neutrino beam-line infrastructure.

Beyond the CNGS: Two main physics strategies



use of the high neutrino rate ($>10^{20}$ /year) and energy (10-50 GeV) of
Neutrino Factory + LMD (“Hyper-MINOS”)

$\mu \Rightarrow \bar{\nu}_e + \nu_\mu$ detector of large but not huge mass (**50-100 Kt**),
necessarily magnetic
(a dense magnetized **Iron** detector,
or, possibly, Li-Argon),
a few **1000 Km** away.

use of the lower neutrino rate (10^{18-19} /year) and energy (sub-GeV) of
Betabeam + Megaton (“Hyper-Kamioka”)

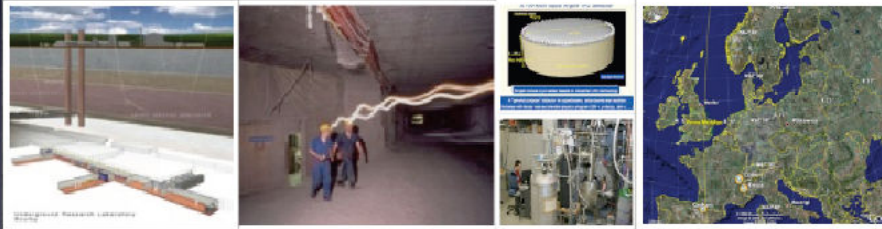
$\beta \Rightarrow \nu_e$ low density detector of very large mass (0.5-1 Mt)
and volume (0.5-1 Mm³)
non magnetic
(a **Water Cerenkov** detector,
or possibly, again Li-Argon),
a few **100 Km** away

The LAGUNA design study



A Larger Underground Cavern and Detectors are needed

Deep Underground Science Facilities for ν Physics & Proton decay
Prospects for a next generation ν observatory 100 kton - 1 Mton
Progress in Europe

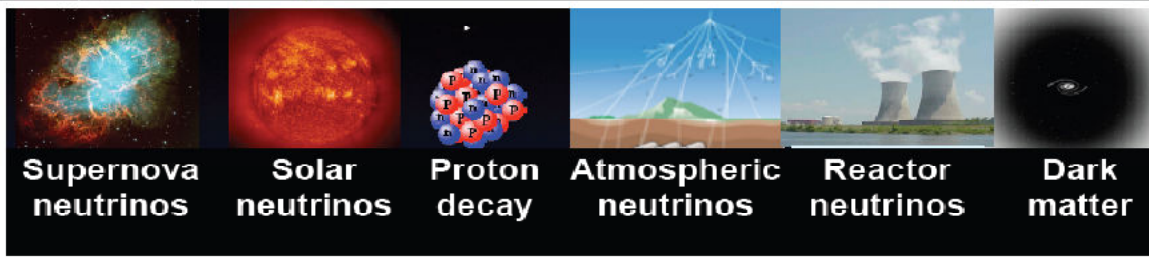


Big range of baselines possible

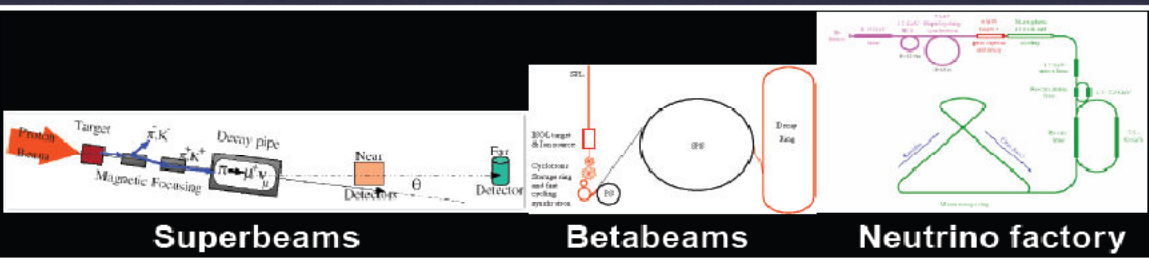


Science of LAGUNA

Particle Physics and Particle Astrophysics



Long baseline neutrinos with accelerators



Superbeam (high power conventional beams)

$$\pi \Rightarrow \nu_{\mu}$$

is less performing, per se

but does have **technical synergy with the NuFact**

largely coincides with **the front end of a Factory**

solving the technical challenges of a several MegaWatt proton driver and target & collection system, on the way to build a factory,

yields a superbeam facility essentially for free

(not its detector, however!)

and does have **scientific synergy with the Betabeam**

can use the same detector

combination has some truly unique features:

1) oscillation signal is $\nu_e \rightarrow \nu_{\mu}$ in the first,

$\nu_{\mu} \rightarrow \nu_e$ in the second,

one calibrates the signal (and background) of the other !

2) T-reversal and CPT asymmetries can be measured



may fit in both strategies



the two strategies



Betabeam + Megaton

and

NuFact + LMD

are complementary !!!!!!!!!!!!!

each has merits unaccessible to the other

(matter effects, CP, T , CPT violation, p decay, astroph. & cosmology ..)

! we could and should aim at having both type facilities !

we must push both very actively

catch opportunities wherever they emerge

seriously aim at building one in Europe in the “construction window”

between LHC and next LC

~all novel CERN options are based on

SPL construction, stage 3: JAERI and Fermilab do not aim anywhere close

HP-SPL (5 GeV)



- addition of klystrons,
- cavities from 4 to 5 GeV,
- replacement of all modulators,
- upgrade of electric/cryogenic infrastructure,
- possible high-power users: EURISOL, neutrinos, LHeC,
- possible start of operation: 2020

kinetic energy	5 GeV
beam power	3-8 MW
repetition rate	50 Hz
pulse length	up to 1.2 ms
average pulse current	0-40 mA
protons p. pulse	$1.5 (3) \times 10^{14}$
length (SC linac)	472 m

"SPL", SLHC public event 2009, F. Gerigk

great, so far unmatched, Eu asset

JAERI and Fermilab currently do not aim anywhere close

An ISIS option too, for Europe?



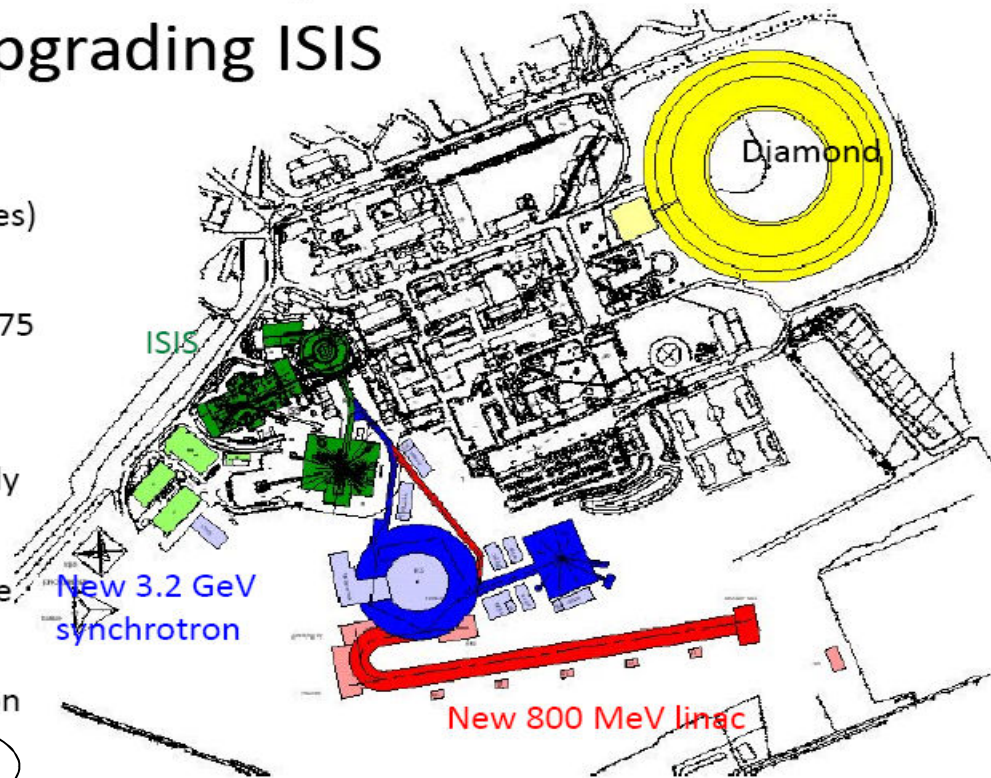
Science & Technology Facilities Council

ASTeC



Favoured Option for Upgrading ISIS

- I. Add new 3.2 GeV synchrotron
 - Bucket-bucket transfer (2 bunches) from ISIS
 - Simple energy increase gives ~ 0.75 MW to new neutron production target (40 Hz)
- II. Build new 800 MeV H^- linac; possibly decommission ISIS
 - Charge exchange injection, phase space painting
 - 5 bunches for neutron production
 - 2 MW at 30 Hz, ~ 5 MW at 50 Hz



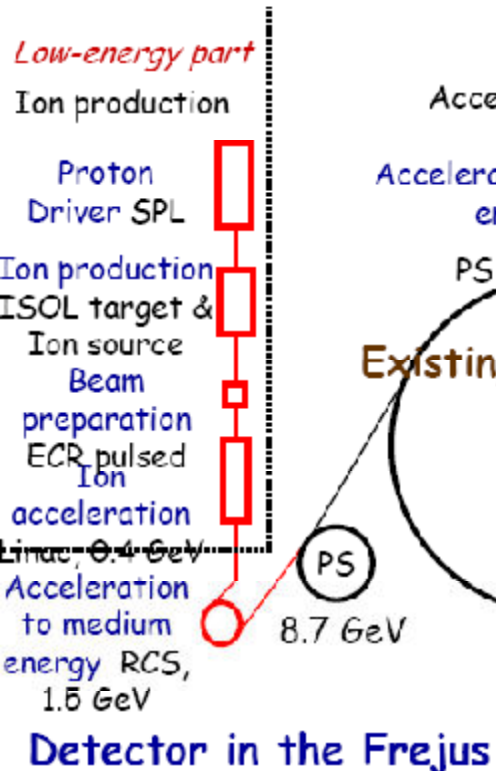
\.G.

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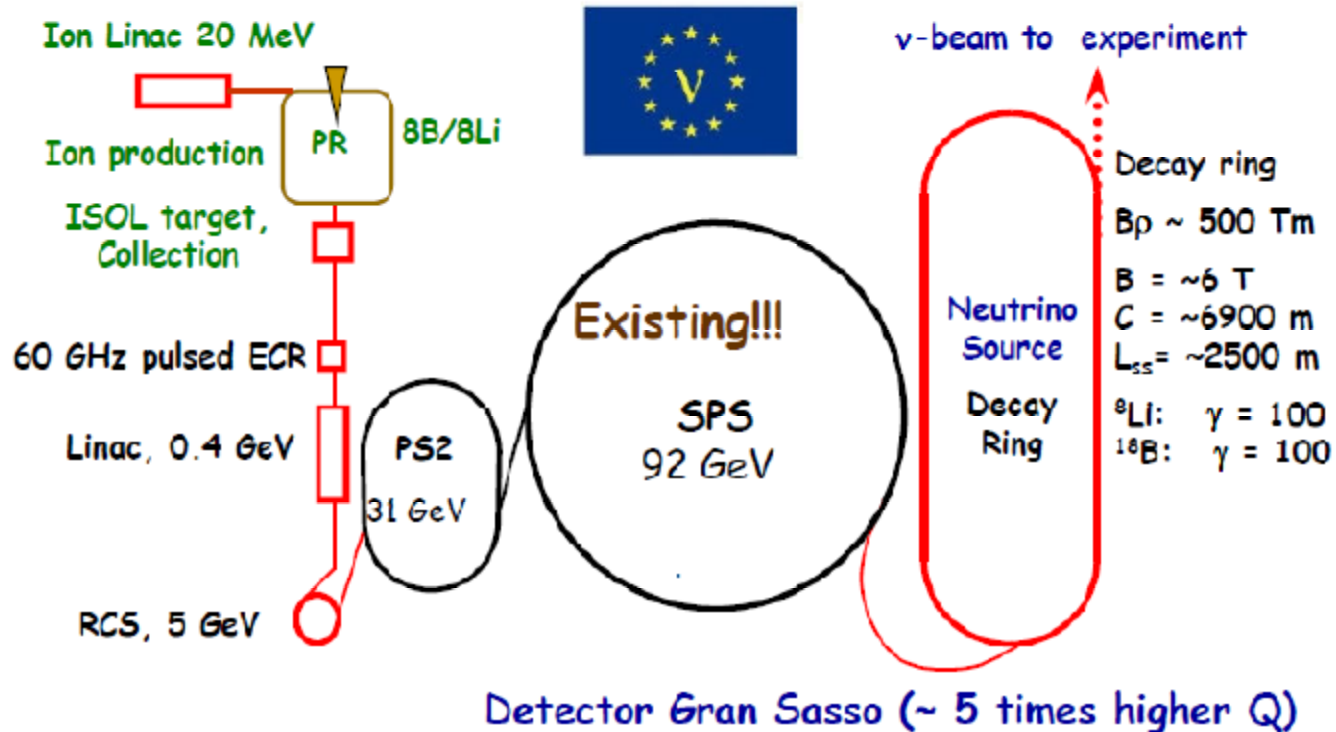
2 December, 2008

Enough rate from at least one betabeam option?

EURISOL Beta Beam scenario



Beta Beam scenario EUROnu, FP7

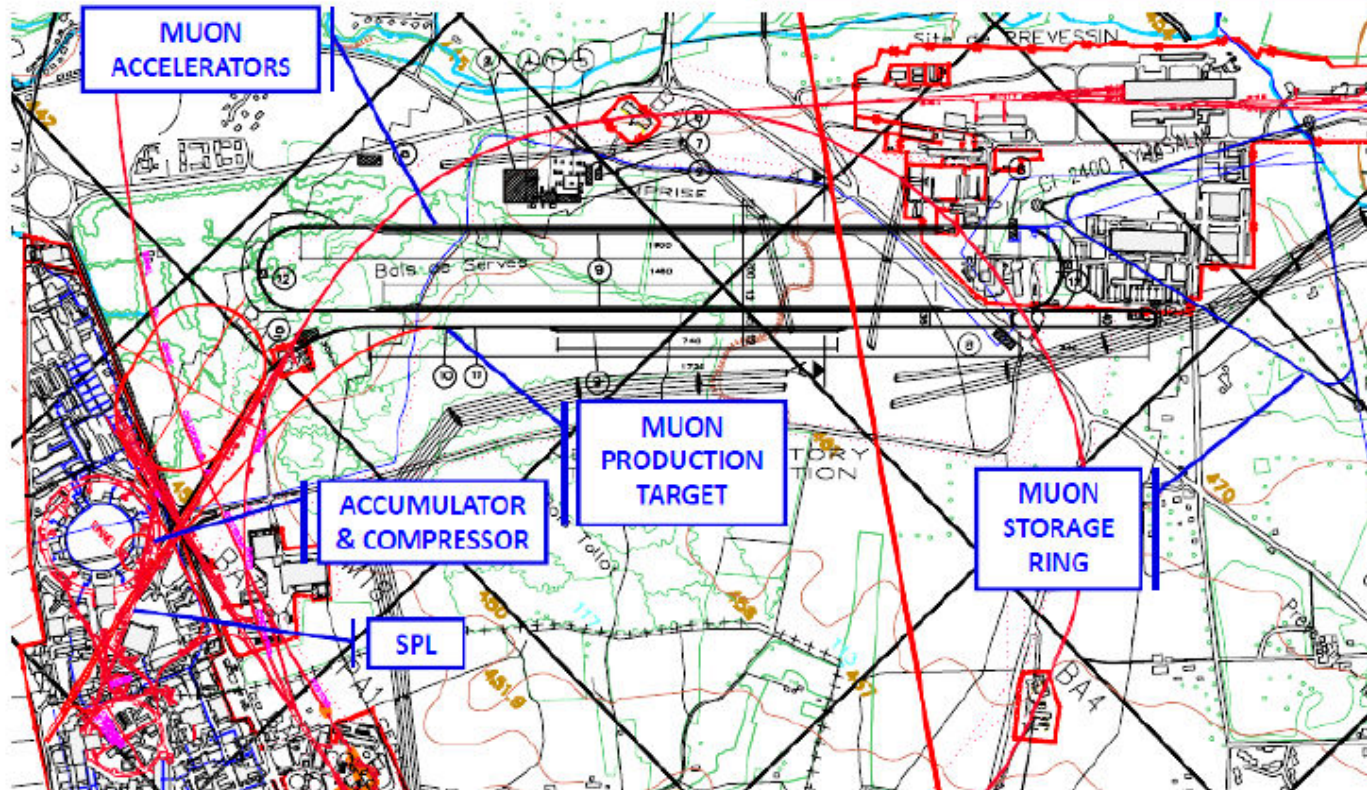


A drawing in need of update ... + extensive R&D to contribute to

Neutrino Factory at CERN

"Proof of principle" [obsolete v Factory design]

Neutrinos with the "High power" SPL



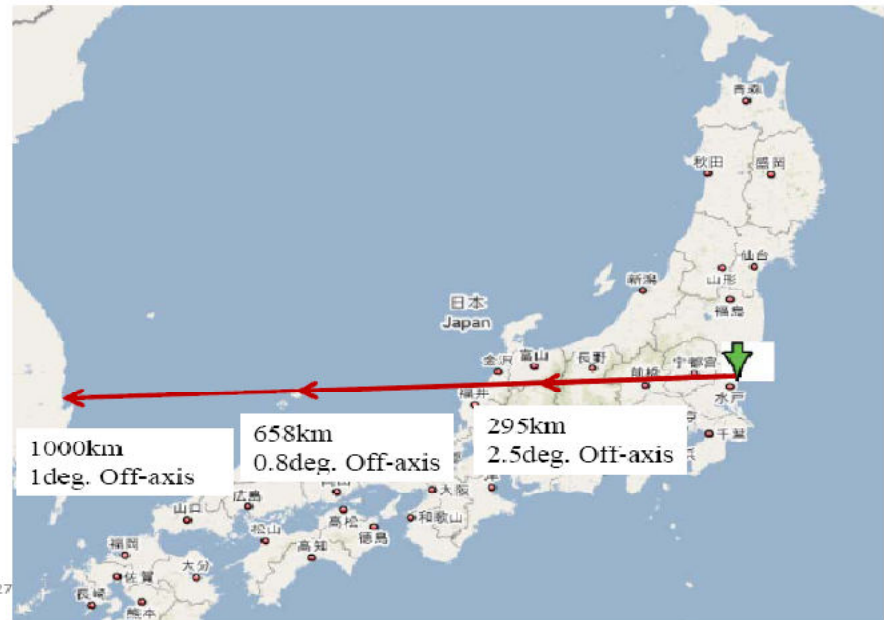
R.G. From R.Garoby talk

30

3/10/2009

Japanese
1/2 Megaton

choosing
a site



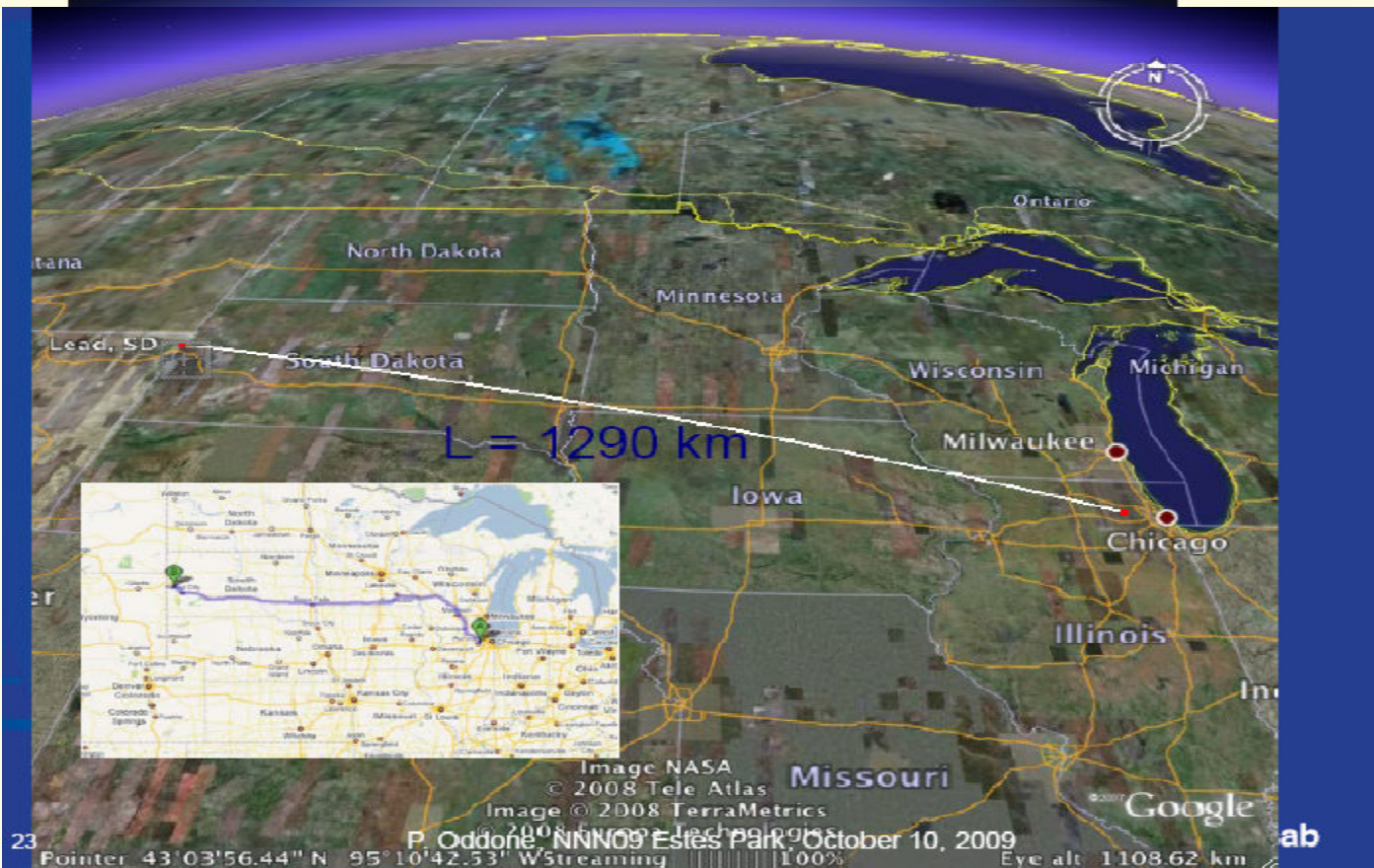
Technically Feasible MR Power Improvement S
— KEK Roadmap —

	Day1 (up to Jul.2010)	Next Step	KEK Roadmap	Ultimate
Power(MW)	0.1	0.45	1.66	?
Energy(GeV)	30	30	30	
Rep Cycle(sec)	3.5	3-2	1.92	
No. of Bunch	6	8	8	
Particle/Bunch	1.2×10^{13}	$<4.1 \times 10^{13}$	8.3×10^{13}	
Particle/Ring	7.2×10^{13}	$<3.3 \times 10^{14}$	6.7×10^{14}	
LINAC(MeV)	181	181	400	
RCS	h=2	h=2 or 1	h=1	

After 2010. plan depends on financial situation

Fermilab longer term superbeam

Fermilab to Homestake DUSEL (1290km)

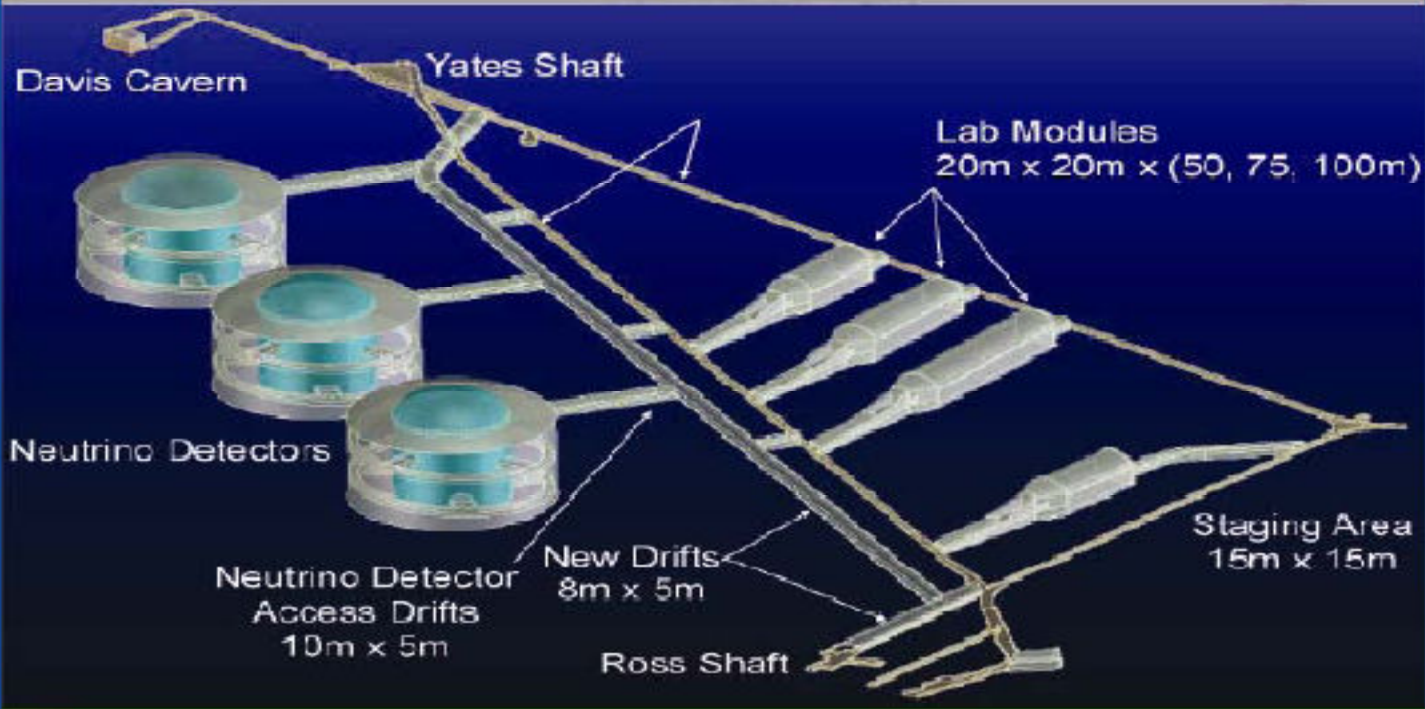


US 1/2 Megaton does have a site

Deep Underground Science and Engineering Laboratory at Homestake, S. Dakota

Intensity frontier: DUSEL

4850 Level Conceptual Layout



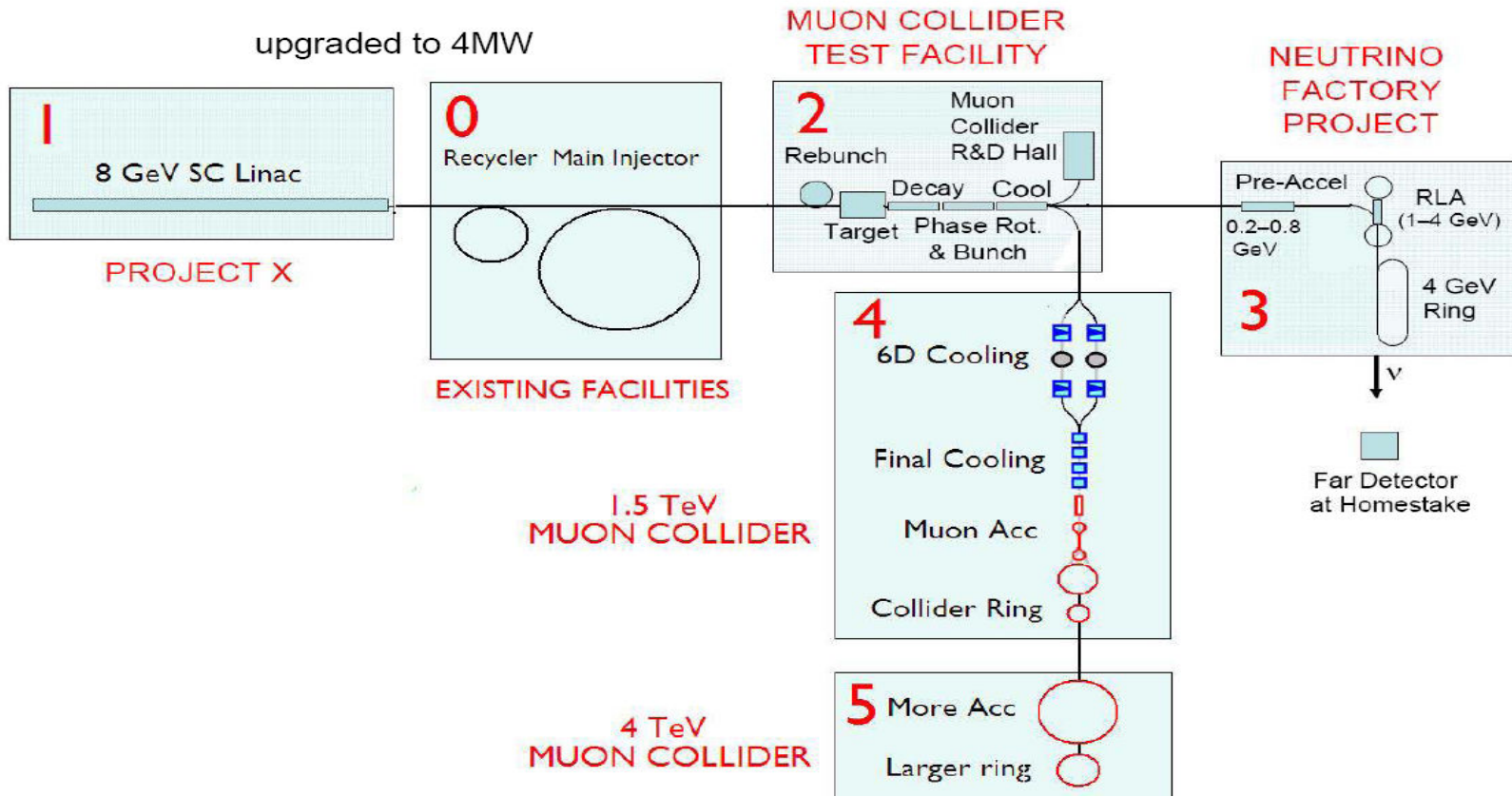
P. Oddone, NNN09 Estes Park, October 10, 2009



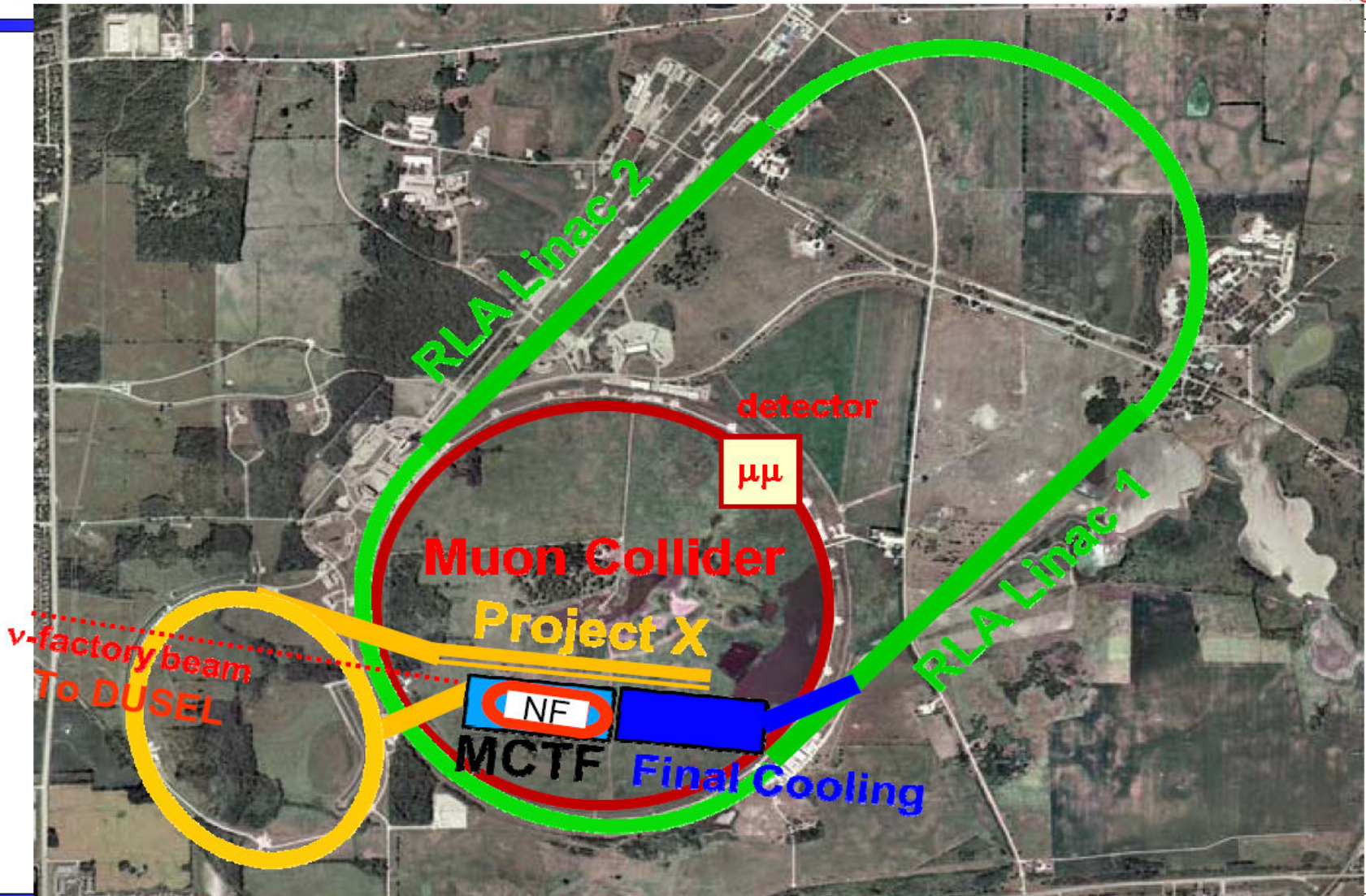
The Fermilab Muon Program



Illustrative Staging Scenario

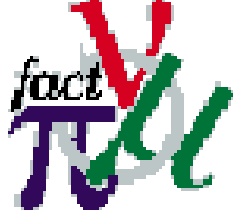


An Illustrative Muon Vision at FNAL





NEu2012 is setting up a forum



aiming at this necessary synthesis

One main meeting per year Spring 2010

first at RAL 13 April 2010

Spring 2011

Midterm Milestone Report(s)

Spring 2012

Spring 2013

Final Road Map Report

will need all the - brains

- support

- good will

available in Europe.

Legitimate national interests

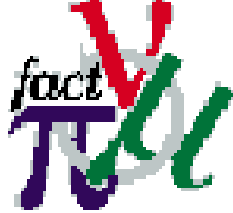
will have to be harmonized

achieving an

unprecedented level of coherence



NEu2012 so far



- moved on setting up its structure, bodies, tools
- convened its road map committee first on Mar 18
<http://indico.cern.ch/conferenceDisplay.py?confId=54880>
- provided some contributions to
 - The May Workshop on non LHC physics
- a large number of sessions and talks to
 - The October Neutrino Strategy Workshop
-
- is evaluating now the workshop outcome & follow up
- preparing its spring meeting
 - where the main points of the evolving road map draft document will be revisited
 - securing the involvement of the road map committee in its preparation

see you at RAL, Tue Apr 13 2010

PS2 superbeam
High Q beta beam
optimal baseline for superbeam+betabeam
tau detection in the neutrino factory
and more on the agenda



Thank you

