
"Wisdom is the child of wonder"
Happy New Year
2014!

Experimental and theoretical study of neutrino oscillations: exploring new physics beyond the Standard Model of Elementary Particles

Enhancing the leadership of Switzerland in neutrino physics through a coherent and coordinated action among researchers

January 2012

Applicants: Prof. S. Antusch, Prof. A. Blondel (PI), Prof. A. Ereditato, Prof. A. Rubbia (PI), Prof. M. Shaposhnikov

NB: It is not all about 'oscillations', actually

Since then (but we kind of knew):

the Daya Bay and θ_{13} revolution

the Higgs

less easy to anticipate:

the European strategy

The main objectives of the next three years will be as follows:

1. Exploitation and analysis of T2K and NA61/SHINE data (UniBe, ETHZ, UniGe)

2. Contribution to the LAGUNA-LBNO design study and preparation of a proposal: near and far detector design, physics studies, detector R&D (UniBe, ETHZ, UniGe).

3. Study of the impact of measurements of neutrino mixing parameters, in particular the neutrino mass hierarchy, on model building beyond the Standard Model (BSM) (UniBs)

4. Sterile neutrino search, study of possibilities at the CERN LBNO facility, and comparison with other proposed facilities (EPFL).

The total request amounts to 3.2 MCHF over three years, mostly dedicated to support of researchers and students working in close collaboration on the project.

awarded: 1.8 MCHF

T2K common fund, travel to shifts and T2K work

Manpower to all groups (fraction of 3 years for one person)

From the first year SINERGIA report to SNF in fall 2013.

Here is a brief account of the global achievements of the collaboration and how it was enhanced by the SINERGIA program. In general the collaboration has been both inspirational and practical.

1. The Swiss groups have collaborated intensely at several levels, starting with a prominent role in the definition of a strategy for future neutrino experiments in Europe [6] and a coherent long baseline proposal for a long baseline neutrino oscillation experiment in Europe[5].

2. In the T2K and NA61 experiment, the experimental groups of Bern, Geneva and ETHZ have actively collaborated on the elements of the cross-section measurements, first with the determination of the hadron production in the T2K target (NA61 experiment [2][4][16][18]), through the implementation of the NA61 in the T2K beam Monte-Carlos and in the subsequent neutrino flux determination [1][7][8][17] and by an leading role in the determination of cross-sections in T2K [9][10]. The flux determination plays an essential role in the neutrino disappearance oscillation analyses [3][13], and is instrumental in the recent discovery of the $\nu_\mu \rightarrow \nu_e$ transition [11][19]. In the context of T2K and NA61 the junior Swiss researchers have organized several internal meetings.

3. Inspired by the theoretical work of the Lausanne group, the ETHZ group has been very active in the search the effect of sterile neutrinos in a short baseline oscillation at T2K.(see section 2.2.1). The Bern group has joined the micro-BooNE experiment at Fermilab, which has the mid-term perspective to contribute to the study of low mass sterile neutrinos.

4. The EPFL group has continued the investigation of the possibility that the right handed (sterile) partners of the (left handed and active) neutrinos could provide a solution to the dark matter puzzle as well as to the matter and anti matter asymmetry of the Universe through baryogenesis, and came to possible, working solution and published the resulting parameter space.

5. Meanwhile the Basel group has made fundamental contributions in the exploration of the possible origin in deeper particle physics symmetries, of the CP and mass hierarchy parameters, which the LBNO project has for main objective to discover.

A short recall of where we stand

External events:

the Daya Bay and θ_{13} revolution
the Higgs
the European strategy and the ICFA neutrino panel

Internal events

T2K cross-section paper, 5 sigma appearance, disappearance
sterile analysis

NA61/SHINE : 2007 papers , 2009 analysis almost finished for tT, LT

LBNO status : EOI submitted, WA105 «approved»

Sterile neutrino search experiment at CERN submitted

First EU-HyperK meeting

Also FCC study (relationship to neutrinos to be investigated)

CERN Neutrino Platform

2014 -2018

Neutrino detectors R&D

MOUs preparation in progress

WA104: rebuild ICARUS T600 in bldg 185

WA104: R&D on a new Large LAr TPC (ICARUS T150)

WA104: R&D on an AIR core muon detector (NESSiE) or eventually integrate a solenoid in the main TPC

WA105: R&D on 2 phases large LAr TPC prototype

MIND : R&D on muon tracking detectors

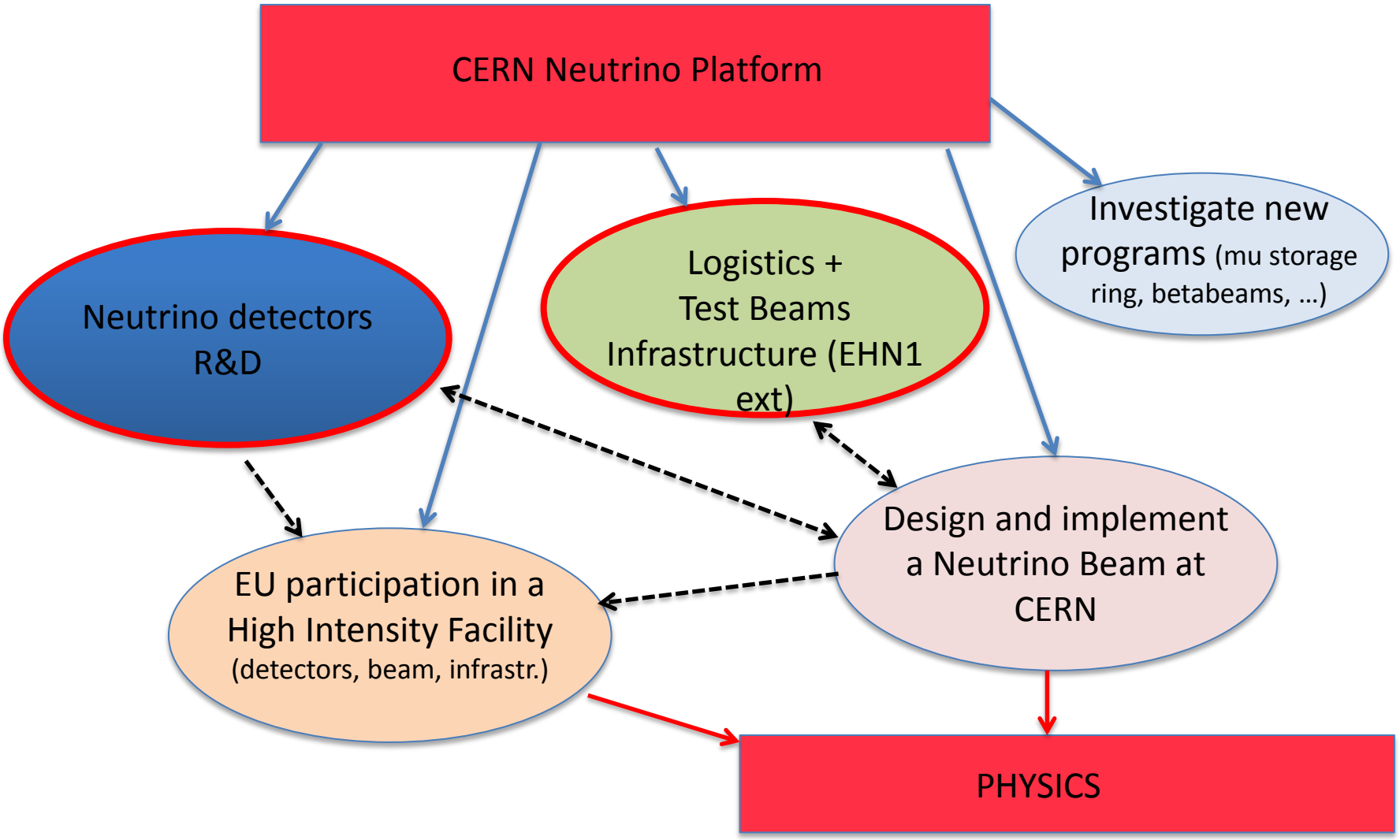
USA : Start a common R&D effort with US groups and EU groups for a LBN type of experiment ?

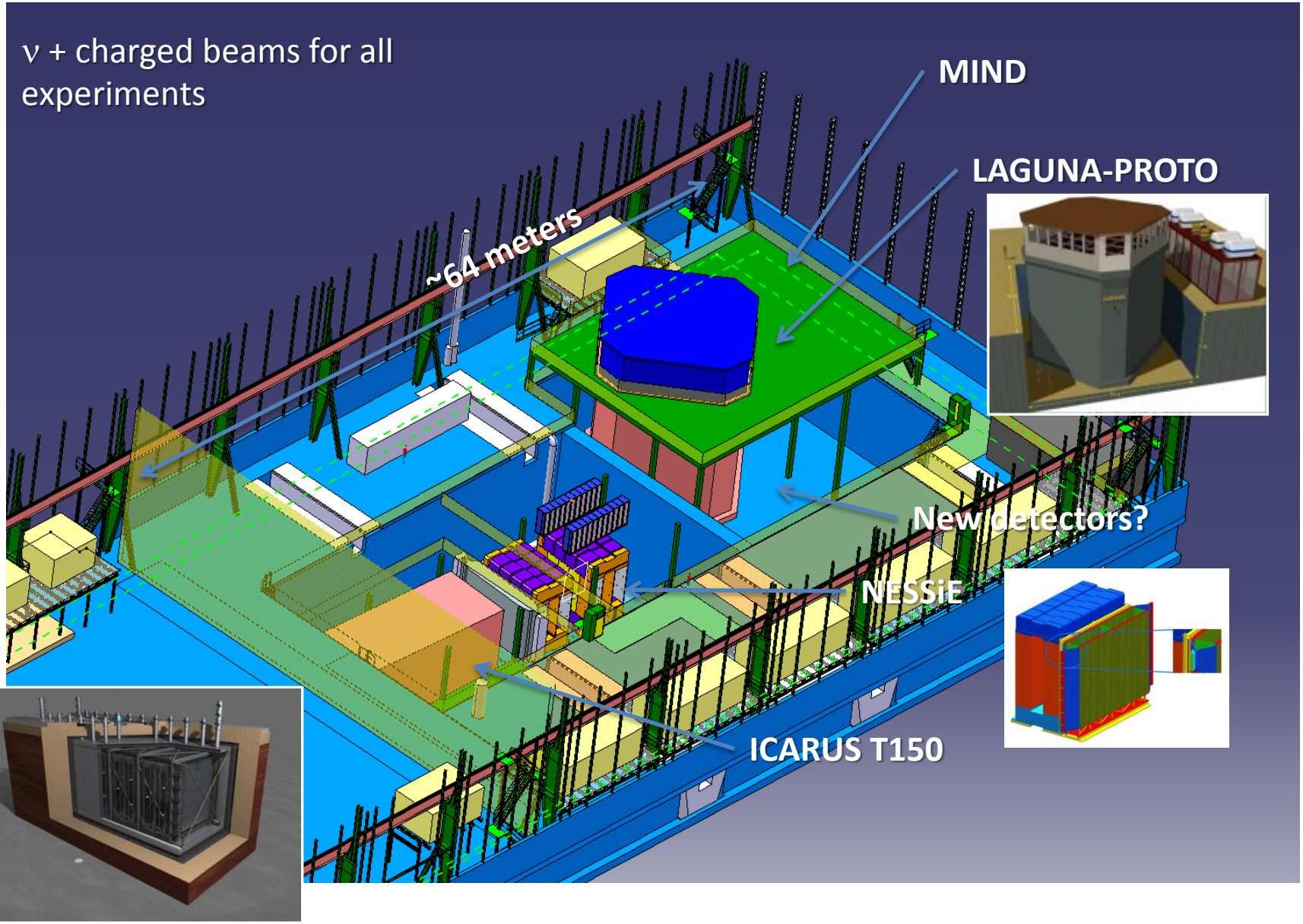
CERN Neutrino Project

…….

CERN should develop a neutrino program to pave the way for a substantial European role in future long-baseline experiments.

Europe should explore the possibility of major participation in leading long-baseline neutrino projects in the US and Japan.”




ν + charged beams for all experiments
MIND
LAGUNA-PROTO
~64 meters
New detectors?
NESSiE
ICARUS T150

Expression of Interest:
Proposal to search for Heavy Neutral Leptons at the SPS

(CERN-SPSC-2013-024 / SPSC-EOI-010)

On behalf of:

W. Bonivento[1,2], A. Boyarsky[3], H. Dijkstra[2], U. Egede[4], M. Ferro-Luzzi[2], B. Goddard[2], A. Golutvin[4], D. Gorbunov[5], R. Jacobsson[2], J. Panman[2], M. Patel[4], O. Ruchayskiy[6], T. Ruf[2], N. Serra[7], M. Shaposhnikov[6], D. Treille[2 (‡)]

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[2] *European Organization for Nuclear Research (CERN), Geneva, Switzerland*
[3] *Instituut-Lorentz for Theoretical Physics, Universiteit Leiden, Niels Bohrweg 2, Leiden, The Netherlands*
[4] *Imperial College London, London, United Kingdom*
[5] *Institute for Nuclear Research of the Russian Academy of Sciences (INR RAN), Moscow, Russia*
[6] *Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*
[7] *Physik-Institut, Universität Zürich, Zürich, Switzerland*
(‡) *retired*

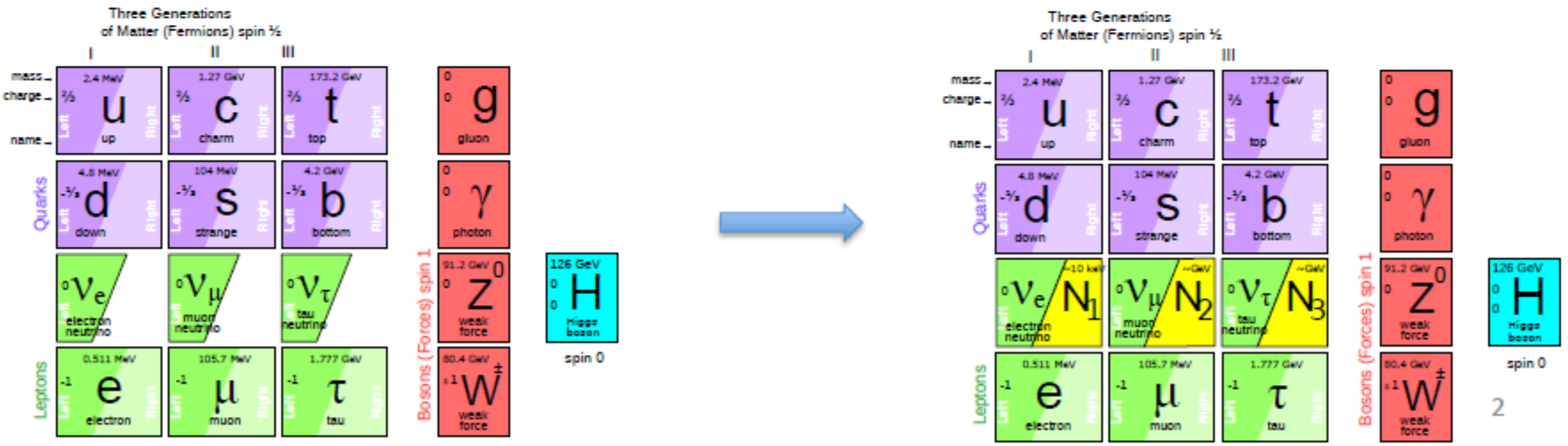
Theoretical motivation

- *Discovery of the 126 GeV Higgs boson → Triumph of the Standard Model*
  The SM may work successfully up to Planck scale !

- *SM is unable to explain:*
  - *Neutrino masses*
  - *Excess of matter over antimatter in the Universe*
  - *The nature of non-baryonic Dark Matter*

- *All three issues can be solved by adding three new fundamental fermions, right-handed Majorana **H**eavy **N**eutral **L**eptons (HNL): **N_1, N_2 and N_3***

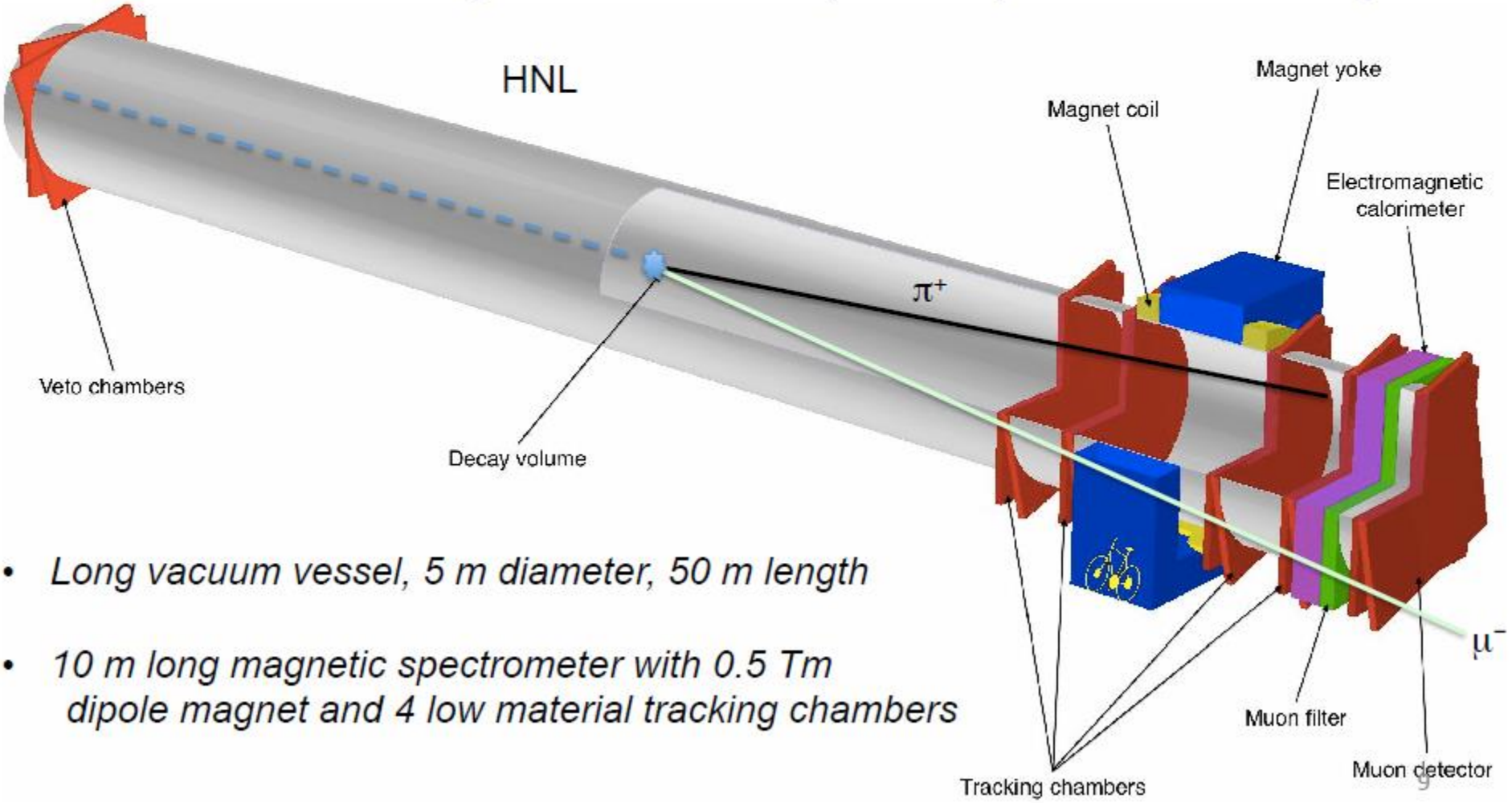
***νMSM**: T.Asaka, M.Shaposhnikov PL **B620** (2005) 17*



Detector concept

- *Reconstruction of the HNL decays in the final states: $\mu^-\pi^+$, $\mu^-\rho^+$ & $e^-\rho^+$*

  Requires long decay volume, magnetic spectrometer, muon detector and electromagnetic calorimeter, preferably in surface building

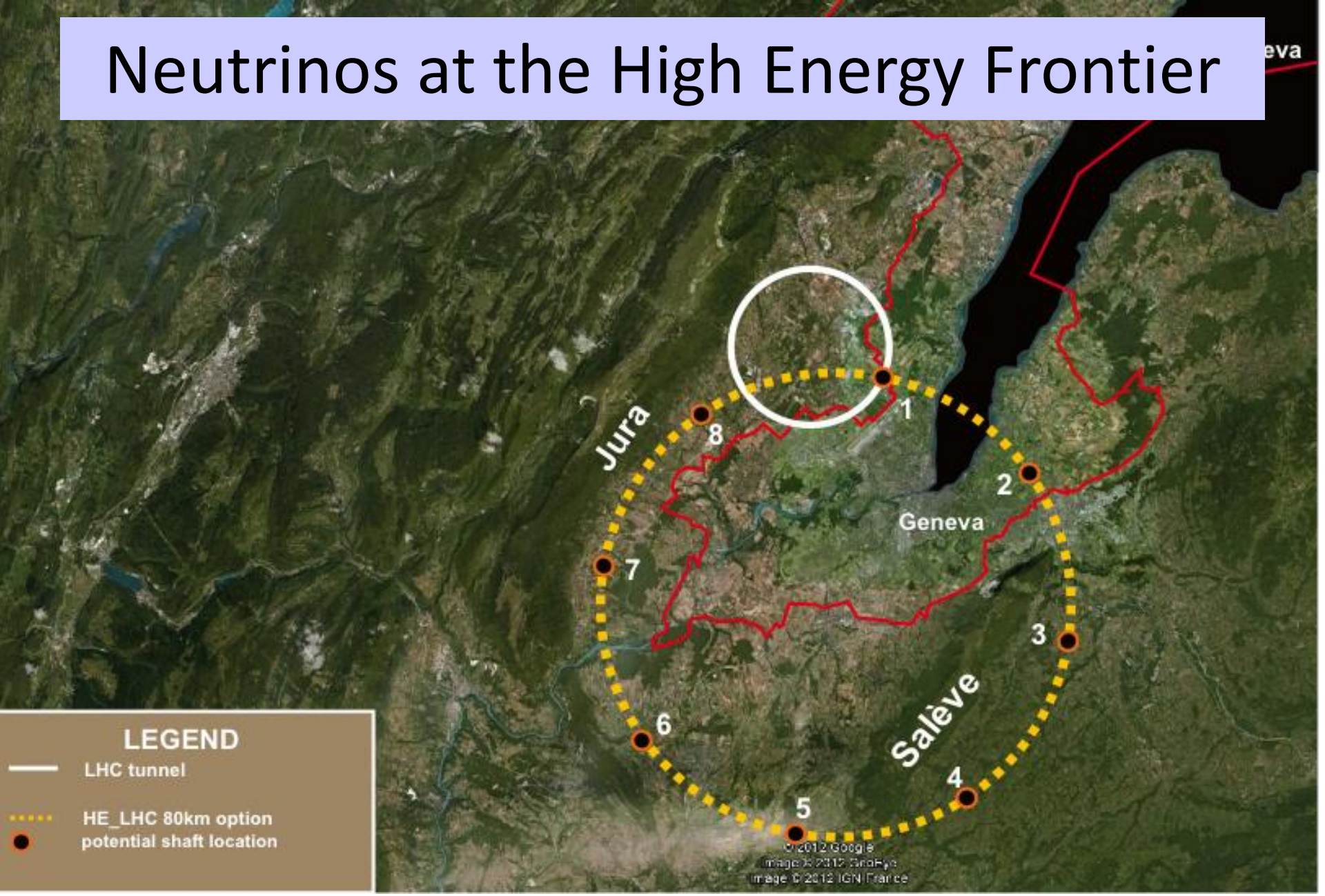


- *Long vacuum vessel, 5 m diameter, 50 m length*
- *10 m long magnetic spectrometer with 0.5 Tm dipole magnet and 4 low material tracking chambers*

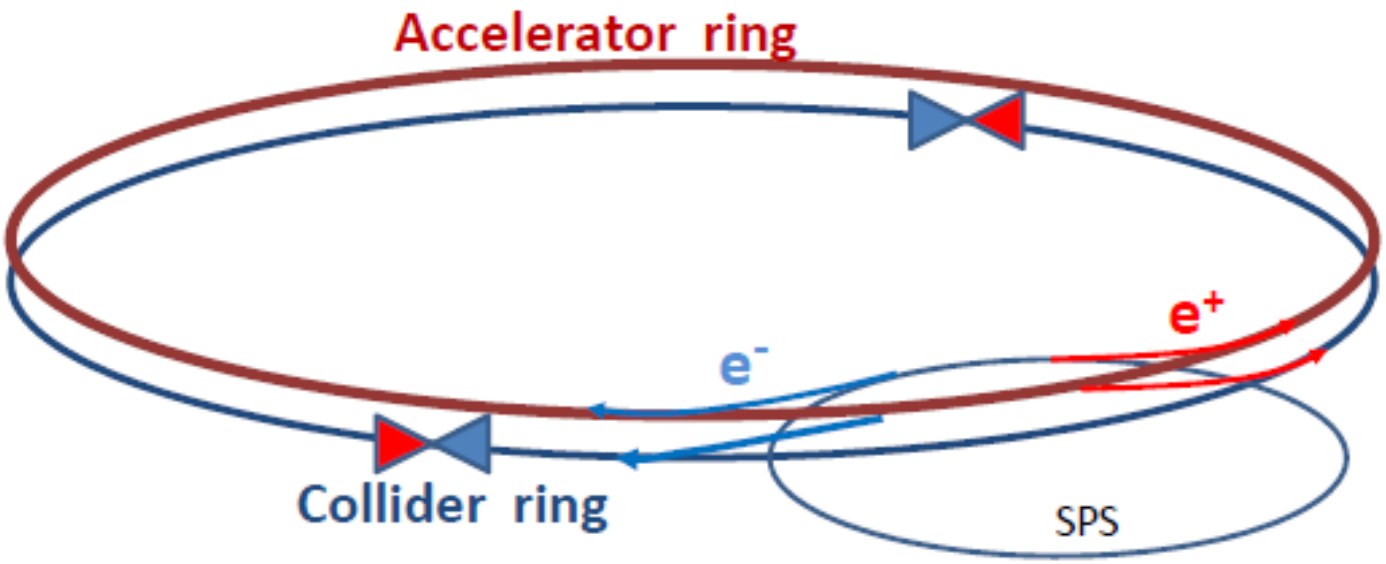
Being discussed with:

	European Organization for Nuclear Research (CERN)
France:	*CEA Saclay, APC/LPNHE Universite Paris-Diderot*
Italy:	*Instituto Nazionale di Fisica Nucleare (INFN)*
Netherlands:	*National Institute for Subatomic Physics (NIKHEF, Amsterdam)*
Poland:	*Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Sciences (Kracow)*
Russia:	*Institute for Nuclear Research of Russian Academy of Science (INR, Moscow),* *Institute for Theoretical and Experimental Physics ((ITEP, Moscow),* *Joint Institute for Nuclear Research (JINR, Dubna)*
Sweden:	*Stockholm University,* *Uppsala University*
Switzerland:	*Ecole Polytechnique Federale de Lausanne (EPFL),* *University of Zurich,* *University of Geneva*
UK:	*University of Oxford,* *University of Liverpool,* *Imperial College London,* *University of Warwick*

Neutrinos at the High Energy Frontier



Back to the future



30 years later and with experience gained on LEP, LEP2 and the B factories we can propose a Z,W,H,t factory of 1000 times the luminosity of LEP2

CERN is launching a 5 years international design study of Circular Colliders
100 TeV pp collider (VHE-LHC) and high luminosity e+e- collider (TLEP)
-- kick-off meeting 12-15 February 2014 in Geneva --

IPAC'13 Shanghai

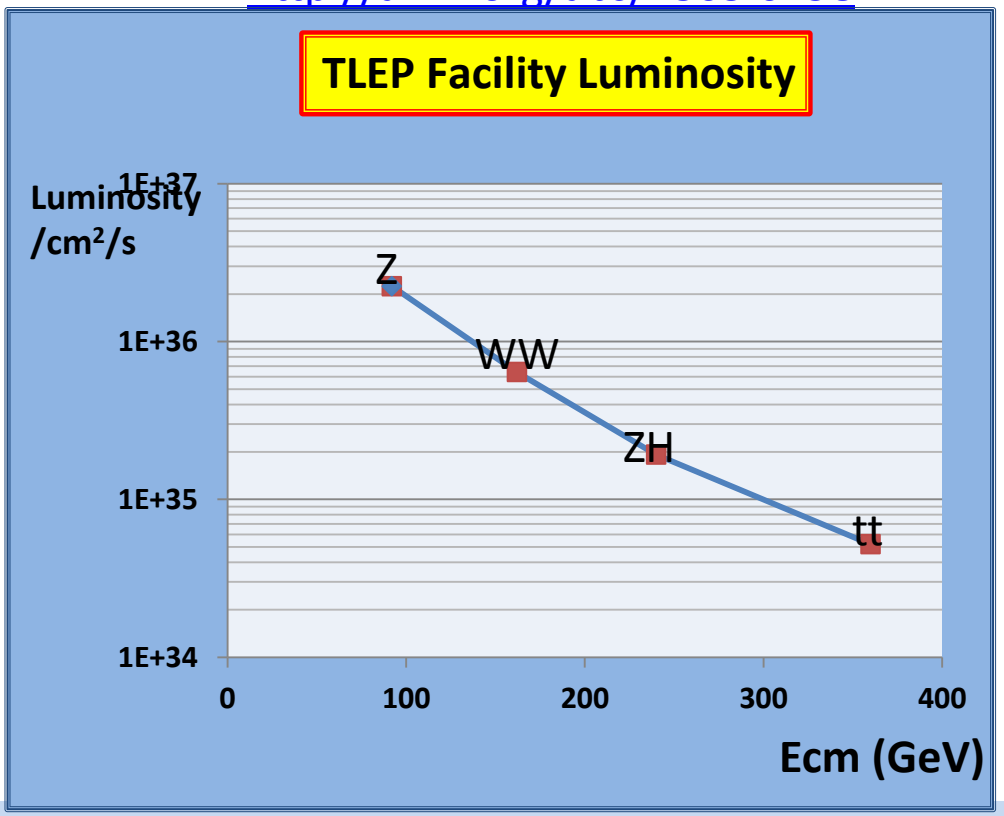
TLEP: A HIGH-PERFORMANCE CIRCULAR e^+e^- COLLIDER TO STUDY THE HIGGS BOSON

M. Koratzinos, A.P. Blondel, U. Geneva, Switzerland; R. Aleksan, CEA/Saclay, France; O. Brunner, A. Butterworth, P. Janot, E. Jensen, J. Osborne, F. Zimmermann, CERN, Geneva, Switzerland; J. R. Ellis, King's College, London; M. Zanetti, MIT, Cambridge, USA.

Table 1: TLEP parameters at different energies

	TLEP Z	TLEP W	TLEP H	TLEP t
E_{beam} [GeV]	45	80	120	175
circumf. [km]	80	80	80	80
beam current [mA]	1180	124	24.3	5.4
#bunches/beam	4400	600	80	12
#e^-/beam [10^{12}]	1960	200	40.8	9.0
horiz. emit. [nm]	30.8	9.4	9.4	10
vert. emit. [nm]	0.07	0.02	0.02	0.01
bending rad. [km]	9.0	9.0	9.0	9.0
κ_ε	440	470	470	1000
mom. c. α_c [10^{-5}]	9.0	2.0	1.0	1.0
$P_{loss,SR}$/beam [MW]	50	50	50	50
β^*_x [m]	0.5	0.5	0.5	1
β^*_y [cm]	0.1	0.1	0.1	0.1
σ^*_x [μm]	124	78	68	100
σ^*_y [μm]	0.27	0.14	0.14	0.10
hourglass F_{hg}	0.71	0.75	0.75	0.65
E^{SR}_{loss}/turn [GeV]	0.04	0.4	2.0	9.2
V_{RF},tot [GV]	2	2	6	12
$\delta_{max,RF}$ [%]	4.0	5.5	9.4	4.9
ξ_x/IP	0.07	0.10	0.10	0.10
ξ_y/IP	0.07	0.10	0.10	0.10
f_s [kHz]	1.29	0.45	0.44	0.43
E_{acc} [MV/m]	3	3	10	20
eff. RF length [m]	600	600	600	600
f_{RF} [MHz]	700	700	700	700
δ^{SR}_{rms} [%]	0.06	0.10	0.15	0.22
$\sigma^{SR}_{z,rms}$ [cm]	0.19	0.22	0.17	0.25
$\mathcal{L}$ /IP[10^{32}cm^{-2}s^{-1}]	5600	1600	480	130
number of IPs	4	4	4	4
beam lifet. [min]	67	25	16	20

http://arxiv.org/abs/1305.6498.



CONSISTENT SET OF PARAMETERS FOR TLEP TAKING INTO ACCOUNT BEAMSTRAHLUNG

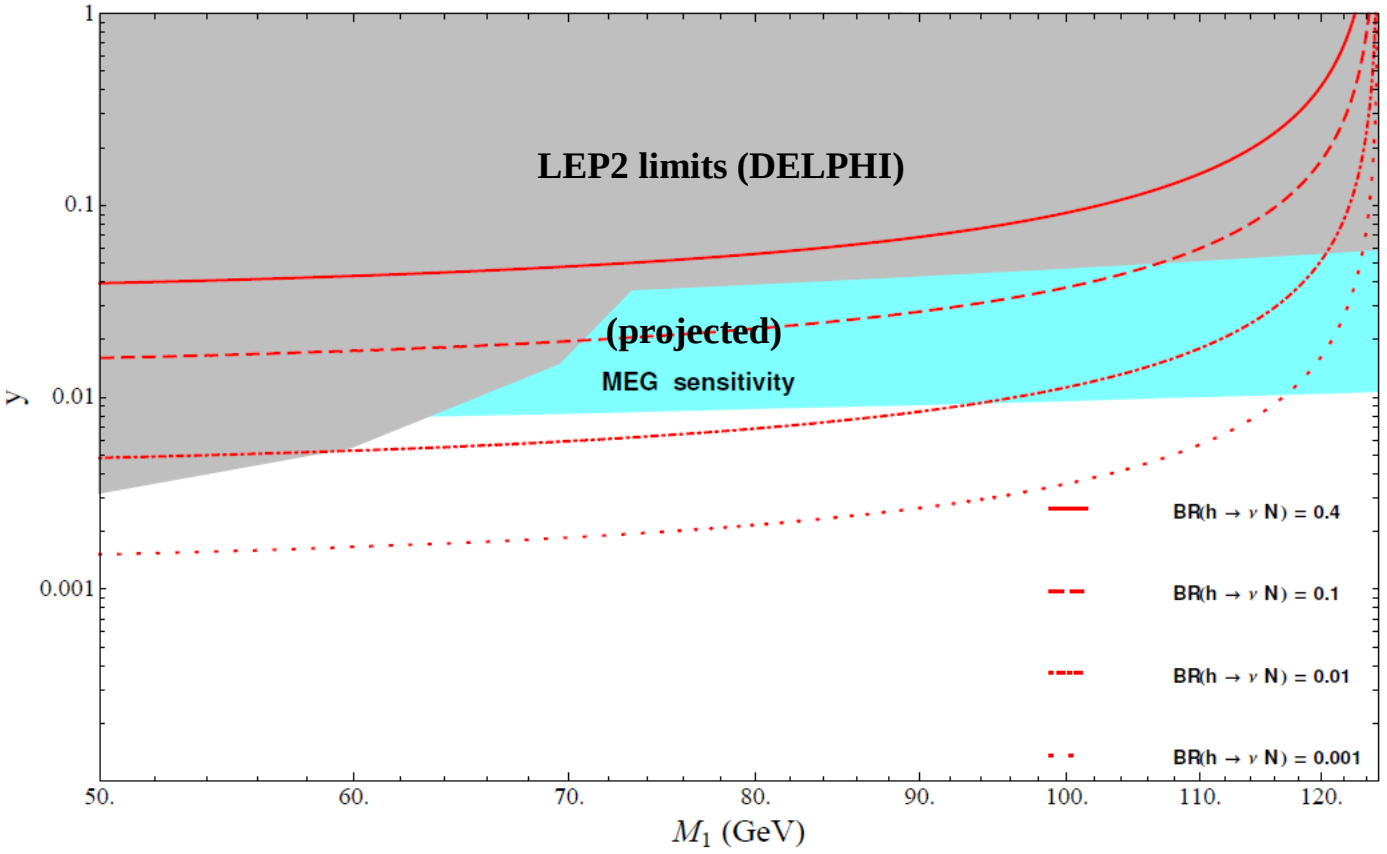
Will consider also : x10 upgrade with e.g. charge compensation?
(suppresses beamstrahlung and beam-beam blow

FLAVOUR(267104)-ERC-23 TUM-HEP 850/12 SISSA 25/2012/EP CFTP/12-013

arxiv:1208.3654

Higgs Decays in the Low Scale Type I See-Saw Model

C. Garcia Cely[a)], A. Ibarra[a)], E. Molinaro[b)] and S. T. Petcov[c,d)] [1]



ICFA neutrino panel

https://indico.in2p3.fr/conferenceOtherViews.py?view=standard&confId=8974

-- The main reason for the SINERGIA meeting to take place today

-- European town meeting takes place 8-10 January

-- common policy wrt panel questions?

This consultation of the European neutrino community is organised by the newly formed ICFA Neutrino Panel to collect input from the community and to receive reports from the regional planning activities. Similar meetings are organised and will take place in the two other world regions (the Americas and Asia).

As a reminder, the International Committee for Future Accelerators, ICFA, set up a Neutrino Panel in 2013 composed of 16 members from Asia, Europe and the Americas to promote international cooperation in the development of the future accelerator-based neutrino oscillation programs. In this context the Panel is organizing those consultation meetings as first steps to get a clear picture of the physics case and the experimental and theoretical planned activities around the world.

we should have a reasonable representation of the views from SWISS physicists

object of discussion part.

SINERGIA Swiss neutrino strategy meeting, January 2014

Tuesday, 7 January 2014 from **11:00** to **17:00** (Europe/Zurich)
at **CERN (6-2-004)**

Description A meeting of the Swiss neutrino groups

Tuesday, 7 January 2014

11:00 - 11:10	Welcome and introduction *10'* Speaker: Alain Blondel (Universite de Geneve (CH))	
11:10 - 11:30	MicroBooNE *20'*	
11:30 - 11:50	Minnerva *20'* Speaker: Sandro Bravar (Universite de Geneve (CH))	
11:50 - 12:10	T2K long term perspectives *20'* Speaker: Akitaka Ariga (Universitaet Bern (CH))	
12:10 - 12:30	T2HyperK *20'* Speaker: Mark Alastair Rayner (Universite de Geneve (CH))	
12:30 - 14:30	Lunch break	
14:30 - 14:50	Liquid argon detectors and LBNO *20'* Speaker: Sebastien Murphy (Eidgenoessische Tech. Hochschule Zuerich (CH))	
14:50 - 15:10	Magnetized iron detectors at LBNO *20'* Speaker: Etam Noah Messomo (Geneva university)	
15:10 - 15:30	LBNE *20'*	
15:30 - 15:50	Future perspectives on neutrino physics *20'* Speaker: Prof. Stefan Antusch (University of Basel)	
15:50 - 16:00	Tea break	
16:00 - 17:00	Discussion	