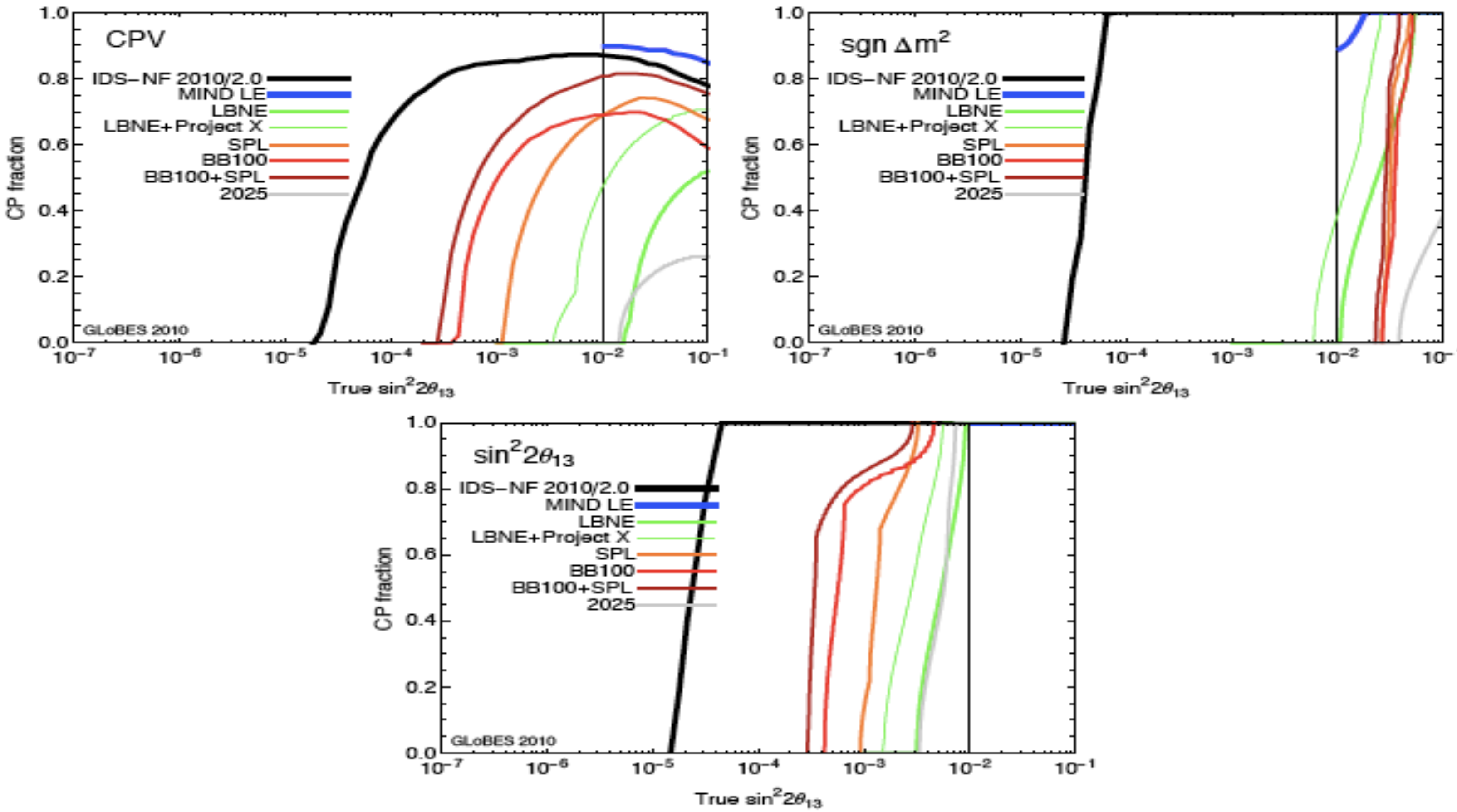
ECFA Review Panel for future accelerator based neutrino facilities



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Charge to the ECFA Review Panel for future accelerator based neutrino facilities:

to review

• **EUROnu Mid-term Report** and **IDS-NF Interim Design Report**

• concerning: scientific case, technical feasibility, risk and necessary R&D, cost and planning, organization
and to deliver

• concise written report by the end of July 2011

• oral presentation by the panel chair at ECFA-EPS joint session on European Strategy Document Update, Grenoble, 23 July 2011 in the afternoon

ECFA neutrino review
Comparison tables

		Comprehensive-ness of work done so far [1]	Technical feasibility	R&D still necessary [7]	Contingent upon	Scale of planning to make happen	related research elsewhere- not reviewed here	Likely effort to obtain safety approval	Physics reach	Likely cost
Superbeam — CERN	overall	incomplete	Challenging		CERN policy	regional			Good cf. now [11]	!
Proton driver (4 MW)		Sufficient [12]	Feasible	Considerable			FNAL, J-PARC	Probably manageable		
Target		incomplete	Challenging	Considerable						
Horn		incomplete	Very challenging	V. extensive [10]						
Decay tunnel		Sufficient	Feasible	limited						
Dump		Sufficient	Feasible	limited						
Detector - as beta beams										
Beta beam — CERN	overall	incomplete	More challenging	V. extensive [6]	CERN policy	interntional			Better [11]	! !
Proton driver (incl. SPL)		Sufficient	Feasible	Considerable				Probably manageable		
Ion sources		incomplete	Challenging	Very extensive			Canfranc, Fréjus, Gran Sasso, Umbria			
Linac		incomplete	Feasible	limited						
RCS		incomplete	Feasible	limited						
PS		incomplete		Beam dynamics						
SPS		incomplete	Need to modify machines [4]	Beam dynamics						
Decay ring		incomplete	Challenging [9]	Beam dynamics						
detector - water cherenkov		sufficient	feasible	limited		international	SuperKamiokande, LBNE	managable	good (energy)	
Detector										
Neutrino factory — CERN/FNAL/RAL	overall	Sufficient	Very challenging			global	J-PARC		Best [11]	! ! !
Proton driver (4 MW, linac+compress. or synch.)		Prob. sufficient	Challenging	extensive				considerable		
Target		incomplete	Very challenging	Very extensive						
Buncher		Prob. sufficient	Challenging	Considerable						
Rotator		Prob. sufficient	Challenging	Considerable						
Cooling channel		Prob. sufficient	Challenging	Extensive	MICE results [2]					
Linac		Sufficient	Feasible	limited						
RLAs		Sufficient	Feasible	limted						
FFAG		incomplete	V. challenging [5]	Very extensive						
Decay ring		incomplete	V. challenging [3]	Extensive [8]						
Detectors, far										
MIND		sufficient	established	limited		international	Minos, Nova	managable	good	
LArTPC		incomplete	Very challenging	extensive		international	Icarus, Argonut. Laguna	considerable	best	
TASD		incomplete	Challenging	considerable		international	Borxino, Kamland,Laguna	considerable	good	
Detector, near										
option A (silicon +scifi)		Prob. sufficient	Challenging	limited		regional	Opera, Nomad,	managable	good	

[1]For purpose of producing a plausible outline design report.
[2]Detailed results from MICE experiment may come too late for use in Neutrino Factory Reference Design Report.
[3]Deep and steeply sloping.
[4]Particularly challenging for γ = 350.

[5]Several orders of magnitude extrapolation from present state of the art.

[6]Some parts of the scheme still relatively sketchy.

[7]Before well informed decision could be taken as to whether practical to build or not.
[8]Need to accommodate both beam diagnostics and engineering considerations.

[9]RF system hardware for decay ring very demanding.
[10]Including materials compatibility and pulsed power issues.

[11] subject to parameter values, especially theta13
[12]no end-to-end design

what is in the table?

comprehensiveness of work done so far/ technical feasibility/ R&D still necessary/ contingent upon/ scale of planning to make happen/ related research elsewhere (not reviewed)/ likely effort to obtain safety approval/ physics reach/ likely cost

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Super-beam/ Beta-beam/ Neutrino Factory/ detectors evaluation expressed in the table is explained by the core text of the report

report will be submitted to the community for comments via

→ Ken Long (Imperial College)
→ Rob Edgecock (Rutherford)

A rich research program in neutrino physics exploiting particle-astrophysics, accelerator and reactor experiments has made rapid progress possible; it is vibrant to date. The pioneering phase characterized by the remarkable physics return of relatively modest experiments is concluding; increasingly complex facilities are required to fill in many aspects of our still incomplete picture of neutrino physics.

The European program should aim for neutrino physics beyond the determination of θ_{13}, the angle connecting the solar and atmospheric oscillation. It will be determined or significantly limited by present experiments. An outstanding goal is the discovery of CP-violation in the lepton sector. This requires a big step in technical improvements and should not avoid the challenges of introducing new concepts in accelerator, beam and large detector.

Even though it is premature to motivate future facilities on the basis of present indications (which include recent T2K and MINOS results as well as intriguing low statistics hints for new physics from short-baseline experiments and reactor data), the recent developments underscore the possibility of unexpected discoveries supporting the construction of neutrino facilities with the widest science reach.

From Super-beam to Beta-beam and Neutrino Factory, it seems reasonably clear that cost, complexity and risk all increase together in this order. It is also reasonably clear that the physics reach of the three schemes increases in the same order — so that, for example, while the Neutrino Factory would be the most expensive, complex and risky, it would also provide the most experimental information.

It may appear that extending the presently available technologies (of accelerator, beam and large detector) looks faster and easier than introducing new concepts. However, to improve mature technologies substantially may need much more work than introducing new technologies.

The Super-beam and Neutrino Factory proposals require high intensity, relatively low-energy proton accelerators. A common challenge for these proposals is the difficulty to handle large beam intensities with correspondingly severe high energy losses. These create thermal dissipation and material irradiation problems for different components such as vacuum windows, targets, focusing horns or solenoid magnets.

The Beta-beam requires further development beyond the source whose design was presented. The realization of such a project is attractive from the point of view that its science reach is adequate in the presence of a large θ_{13} mixing angle and can be matched with a water Cherenkov detector that is also favored by a community of particle astrophysicists.

The Neutrino Factory presented an end-to-end long-term research and development program.
It is to the advantage of both Super-beam and Beta-beam projects to develop a complete end-to-end conceptual design that can be confronted with the reality of CERN policy. This is especially the case for the Beta-beam, for which the focus of the where the focus of the presentations was the ion source.

The European neutrino-beam physics program should have synergy with astroparticle physics because of the common goal of commissioning massive detector for progress in

both fields.

Merci !

No matter how it is implemented, this neutrino program presents challenges and risks that are very significant, but the scientific rewards in terms of new physics are potentially even greater.