Feasibility Study for employing the uniquely powerful ESS linear accelerator to generate an intense neutrino beam for leptonic CP violation discovery and measurement

Design Study

TIARA meeting, CERN, 2nd of March 2017

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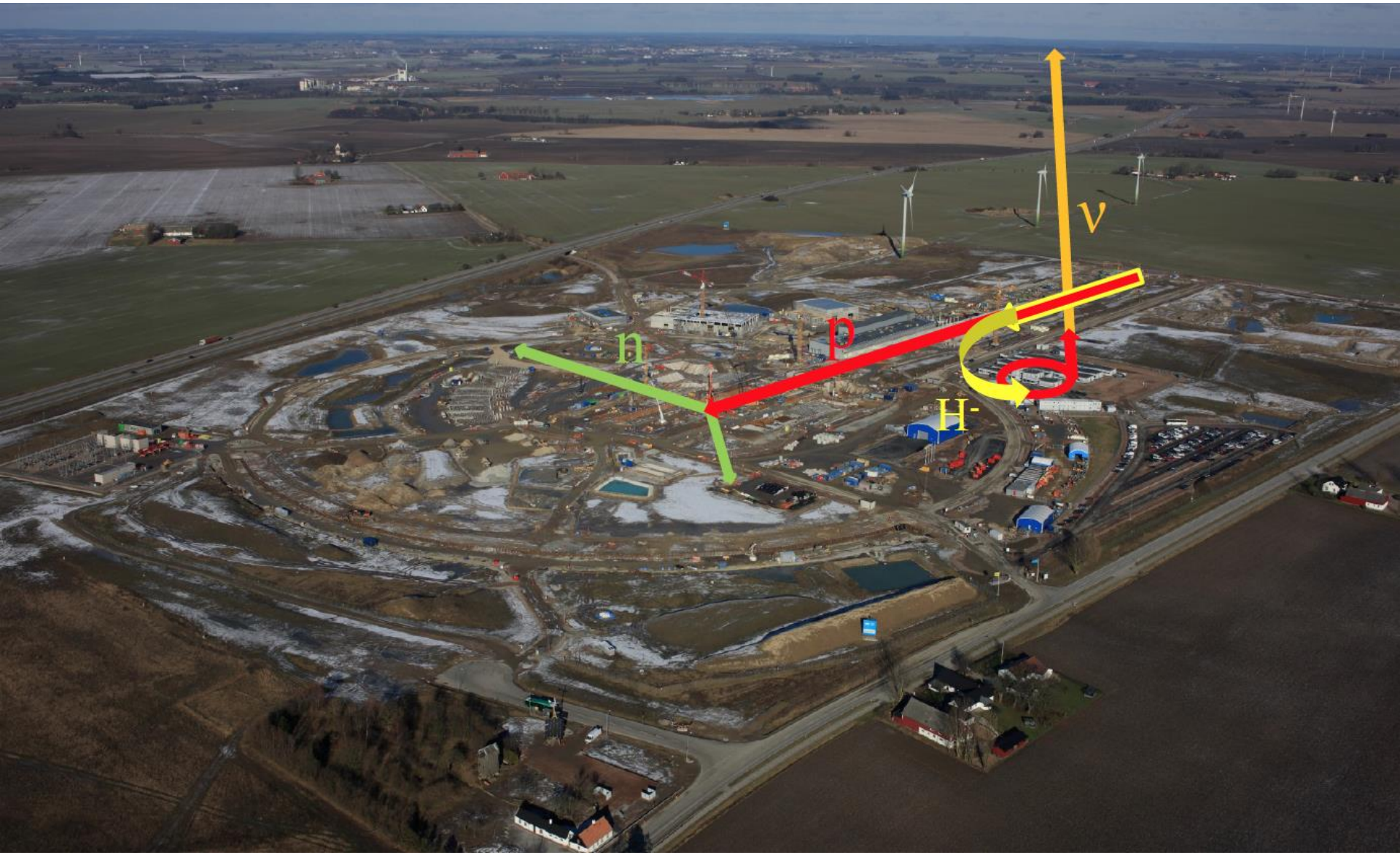
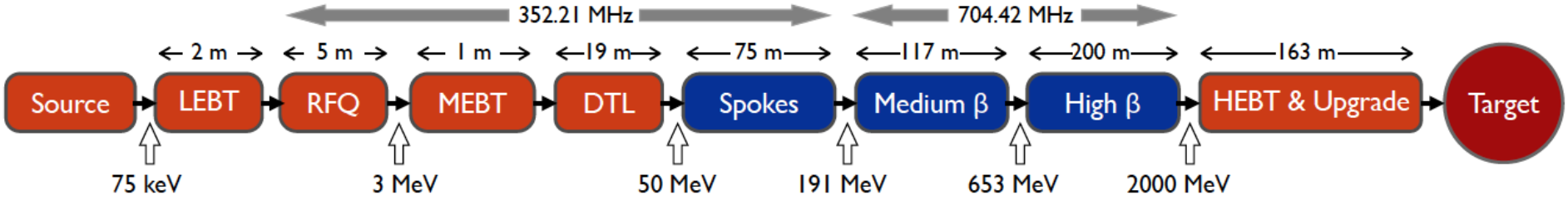
IPHC-IN2P3-Strasbourg

Why this project?

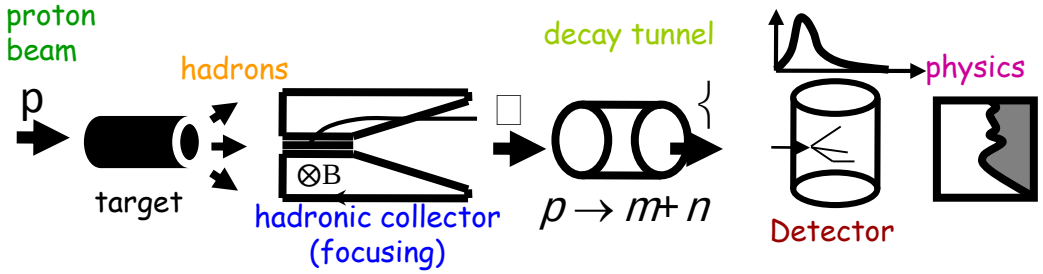


Having access to a powerful proton beam…



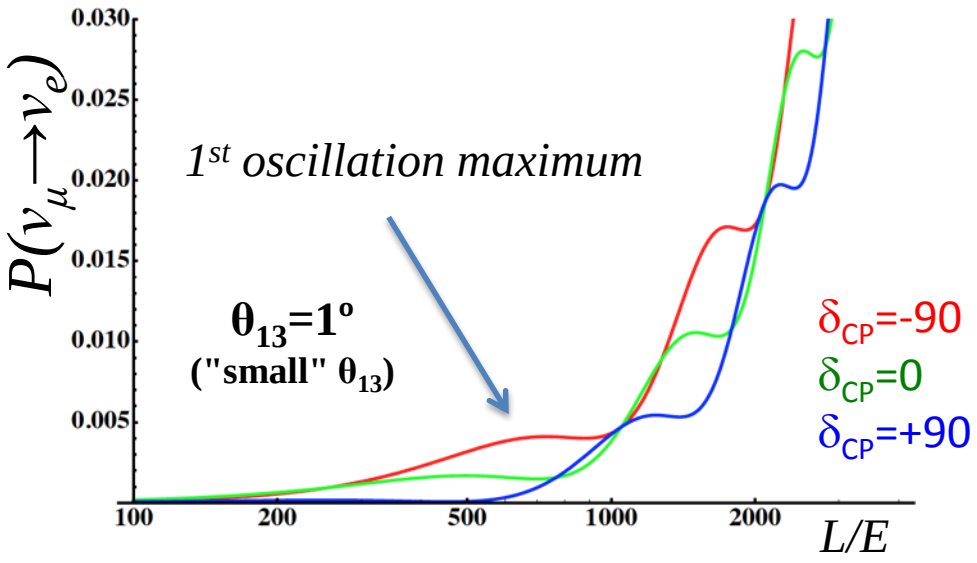
What can we do with:

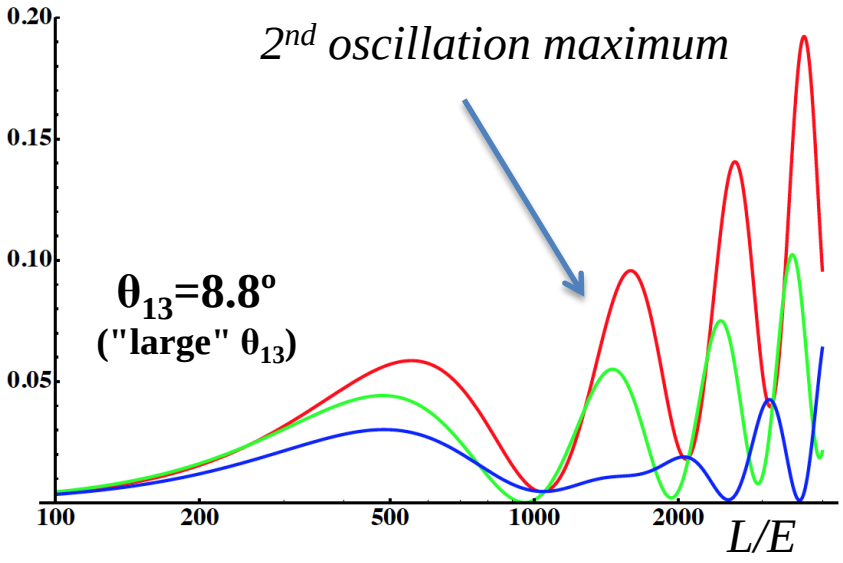
- 5 MW power
- 2 GeV energy
- 14 Hz repetition rate
- 10^{15} protons/pulse
- >2.7×10^{23} protons/year



conventional neutrino (super) beam

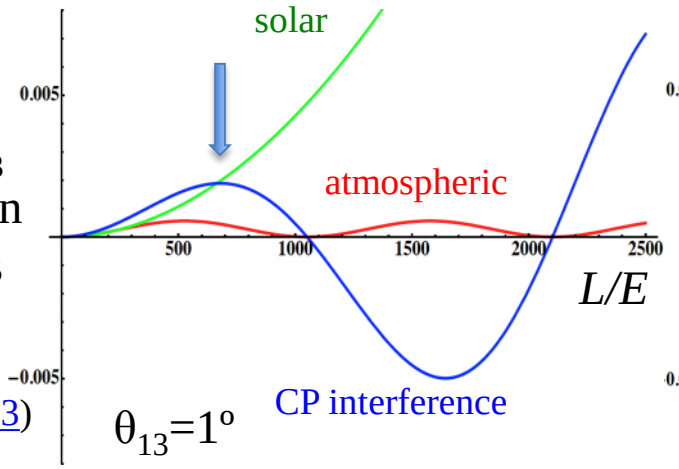
Neutrino Oscillations with "large" θ_{13}

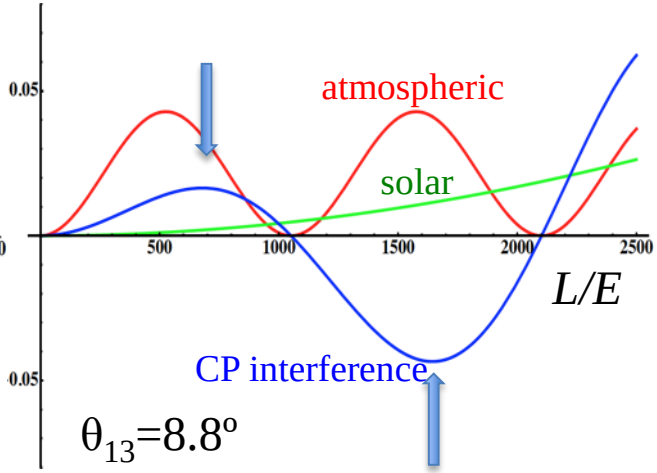




for small θ_{13} 1st oscillation maximum is better

(arXiv:1110.4583)





for "large" θ_{13} 1st oscillation maximum is dominated by atmospheric term

- 1st oscillation max.: $A=0.3\sin\delta_{CP}$
- 2nd oscillation max.: $A=0.75\sin\delta_{CP}$

more sensitivity at 2nd oscillation max.

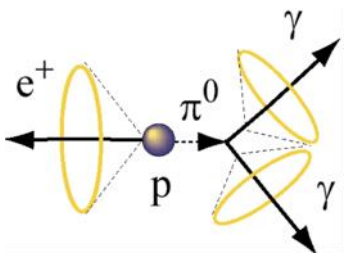
(see arXiv:1310.5992 and arXiv:0710.0554)

Can we go to the 2nd oscillation maximum using our proton beam?

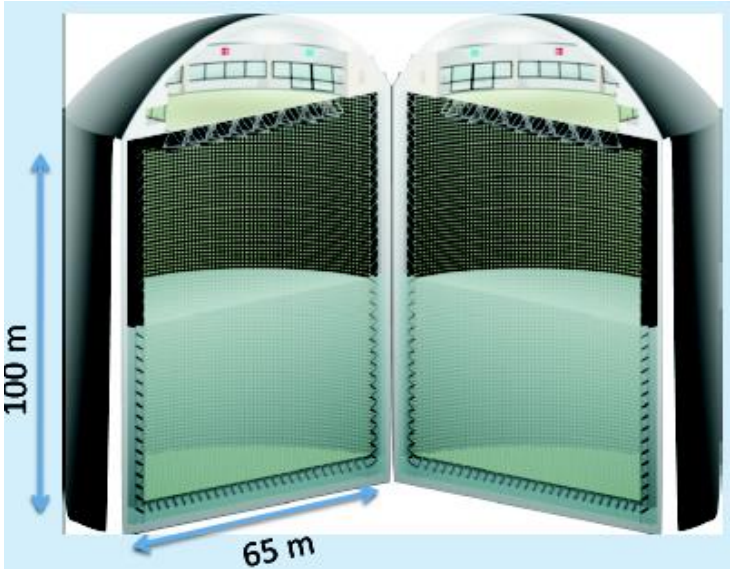
Yes, if we place our far detector at around 500 km from the neutrino source.

MEMPHYS Cherenkov detector
(MEgaton Mass PHYSics studied by LAGUNA)

(arXiv: hep-ex/0607026)

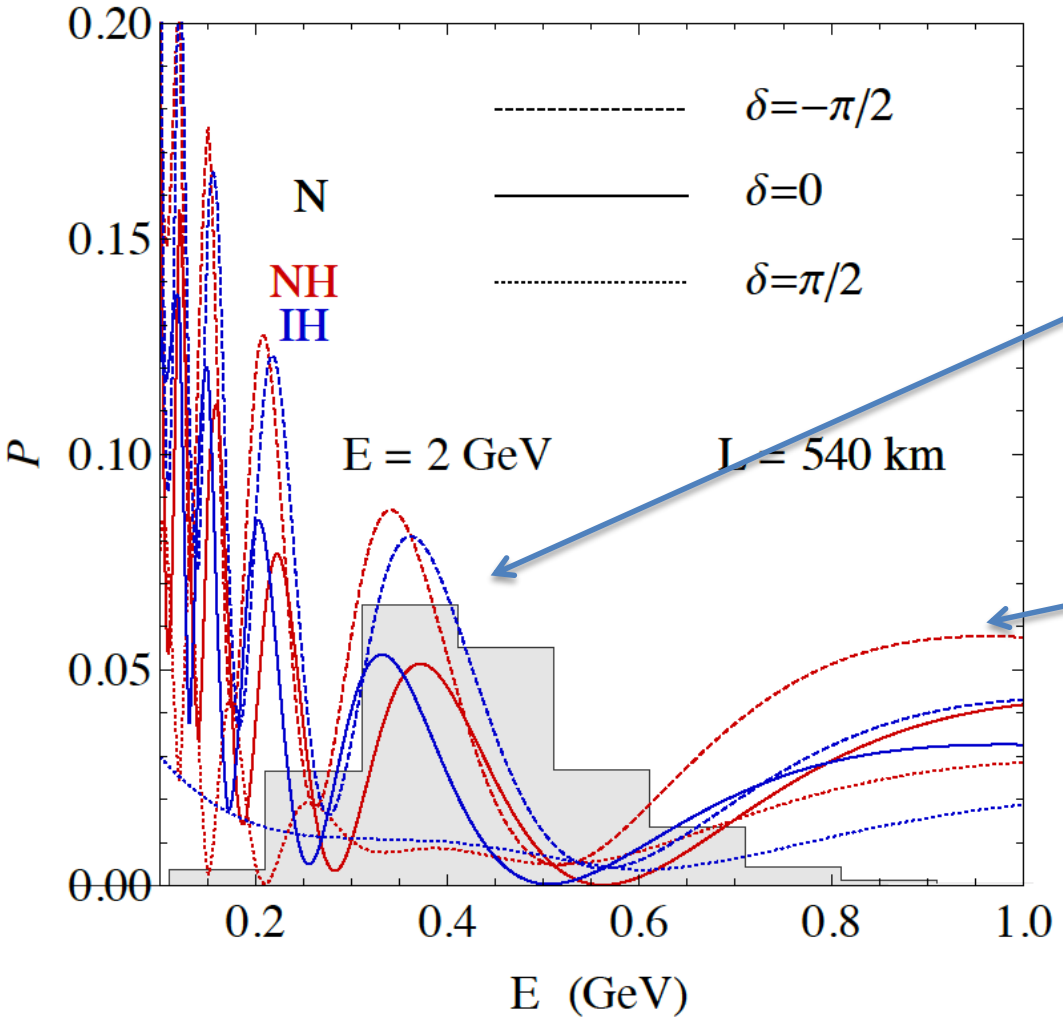


- **Neutrino Oscillations (Super Beam, Beta Beam)**
- **Proton decay**
- **Astroparticles**
- Understand the gravitational collapsing: galactic SN
- Supernovae "relics"
- Solar Neutrinos
- Atmospheric Neutrinos



- 500 kt fiducial volume (~20xSuperK)
- Readout: ~240k 8" PMTs
- 30% optical coverage

2nd Oscillation max. coverage

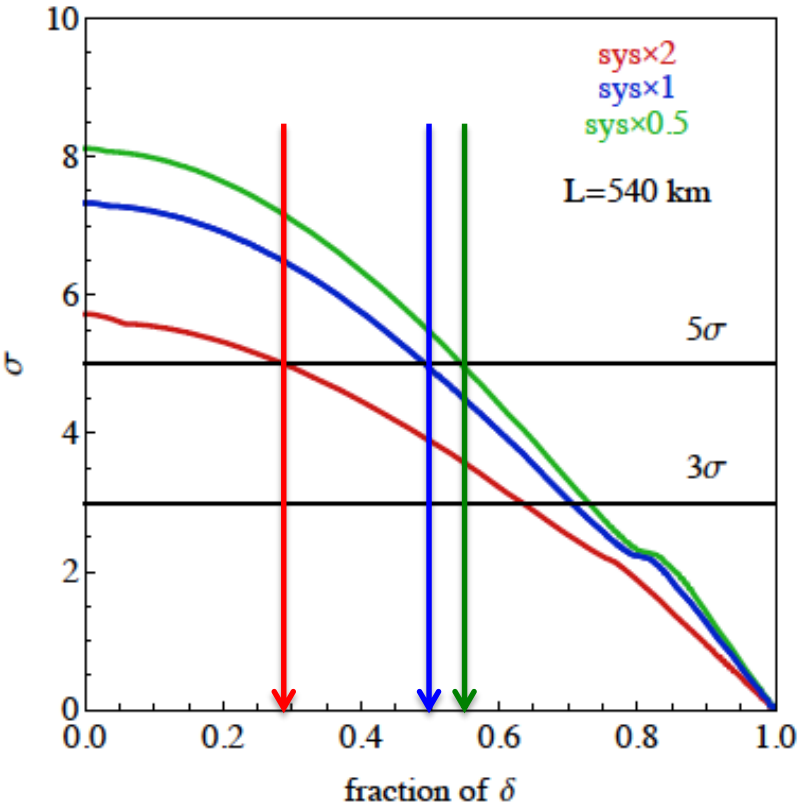


2nd oscillation max. well covered by the ESS neutrino spectrum

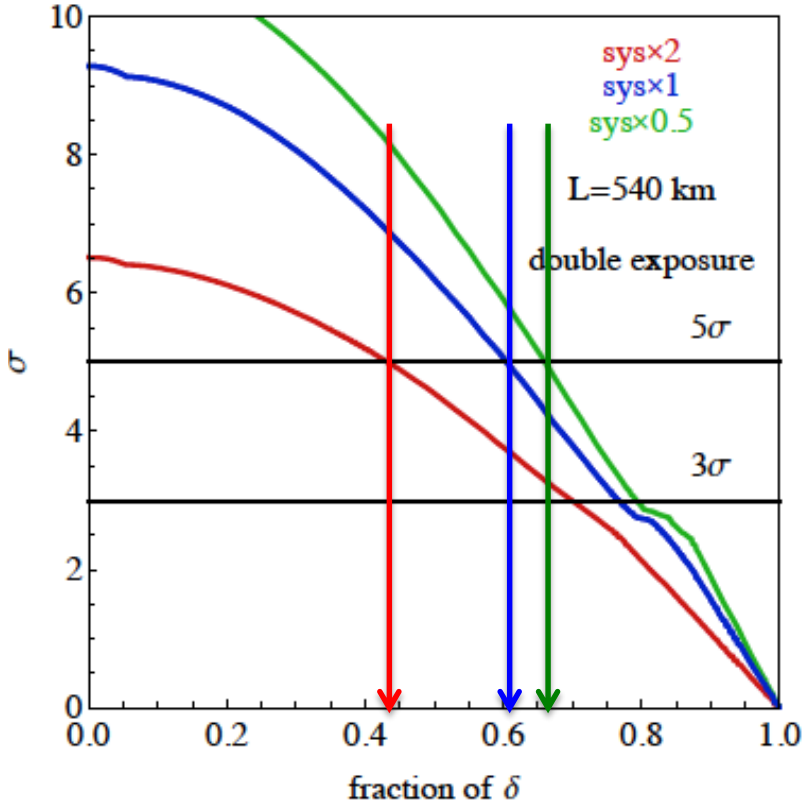
1st oscillation max.

δ_{CP} coverage

CPV (2 GeV protons)



after 10 years



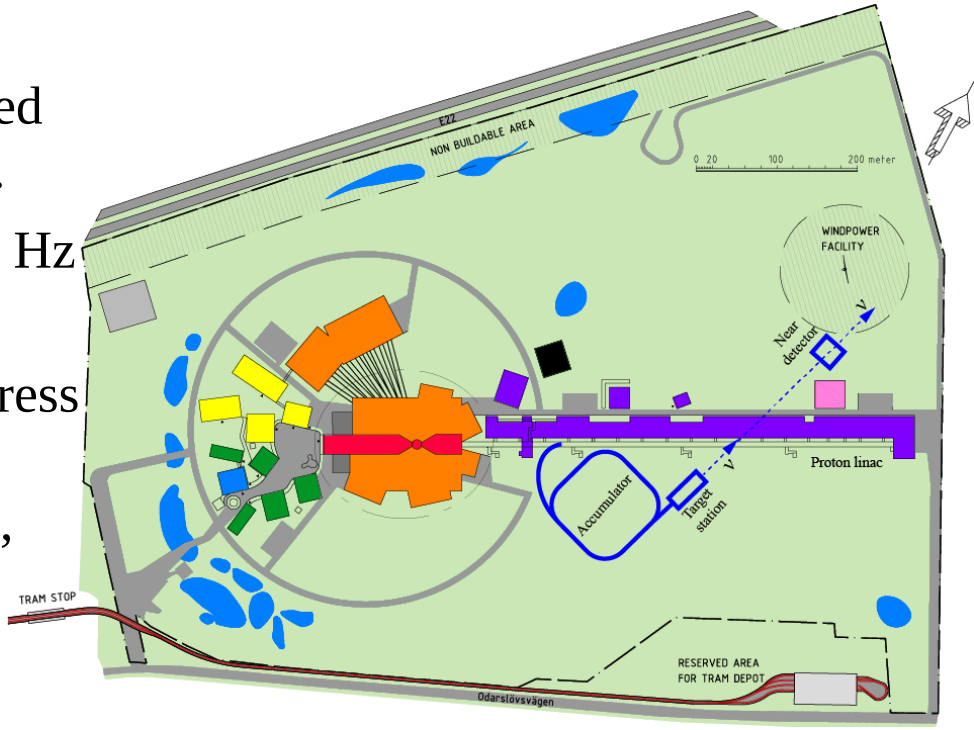
with 2 times more statistics

systematic errors (nominal values): 5%/10% for signal/background

more than 50% δ_{CP} coverage using reasonable assumptions on systematic errors

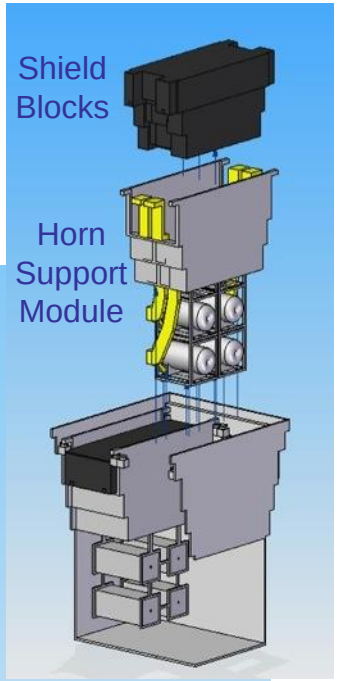
How to add a neutrino facility?

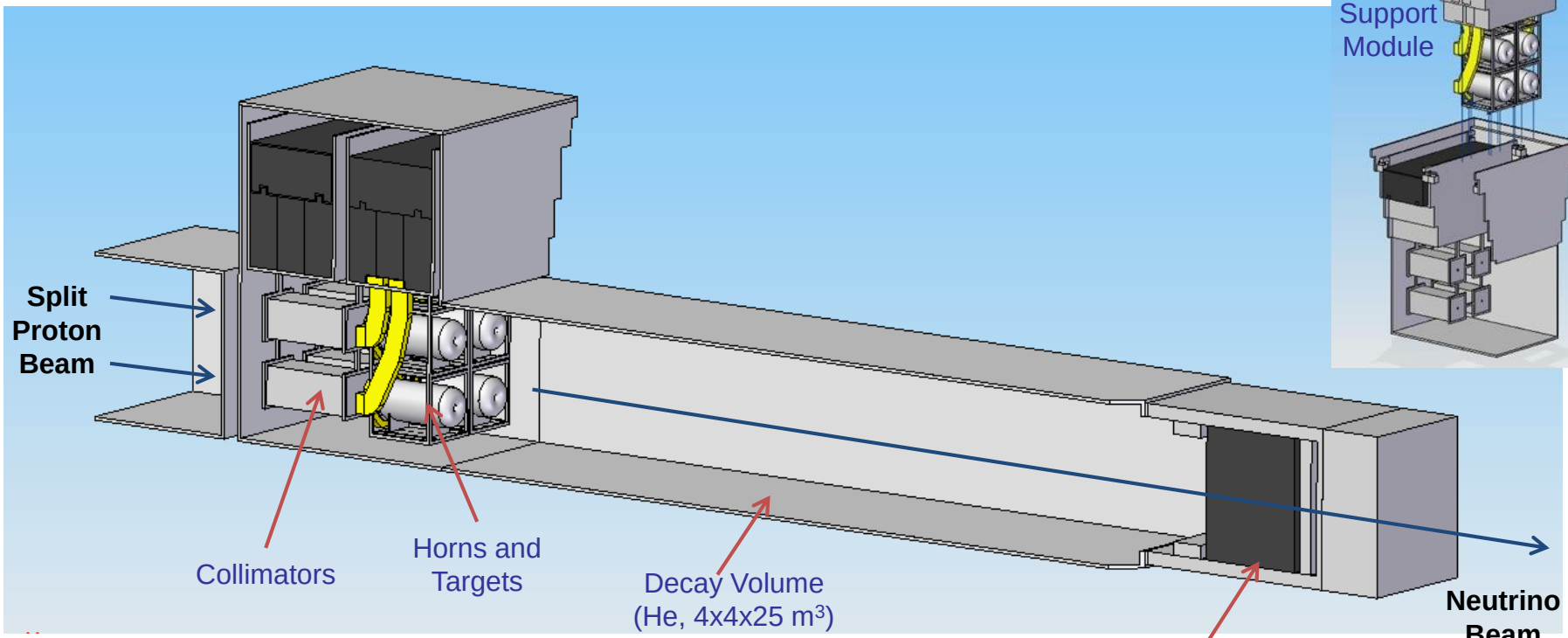
- The neutron program must not be affected and if possible synergetic modifications.
- Linac modifications: double the rate (14 Hz → 28 Hz), from 4% duty cycle to 8%.
- Accumulator (ø 143 m) needed to compress to few μs the 2.86 ms proton pulses, affordable by the magnetic horn (350 kA, power consumption, Joule effect)
  - H^- source (instead of protons)
  - space charge problems to be solved
- ~300 MeV neutrinos.
- Target station (studied in EUROν).
- Underground detector (studied in LAGUNA).
- Short pulses (~μs) will also allow DAR experiments using the neutron target.

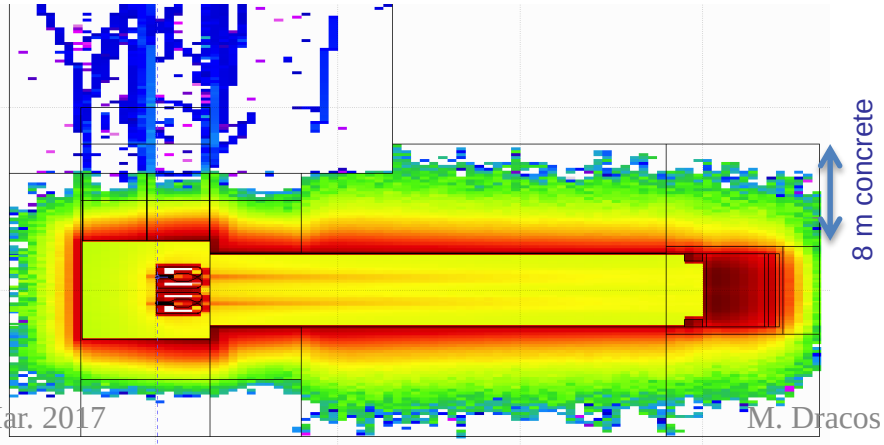


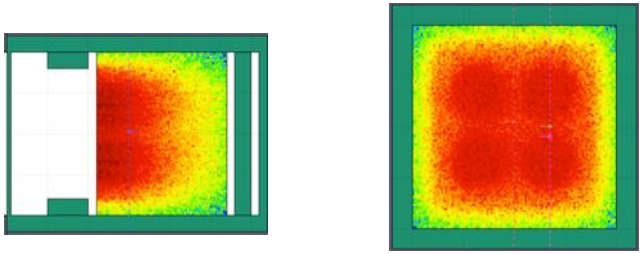
General Layout of the target station

(copied from EUROnu)



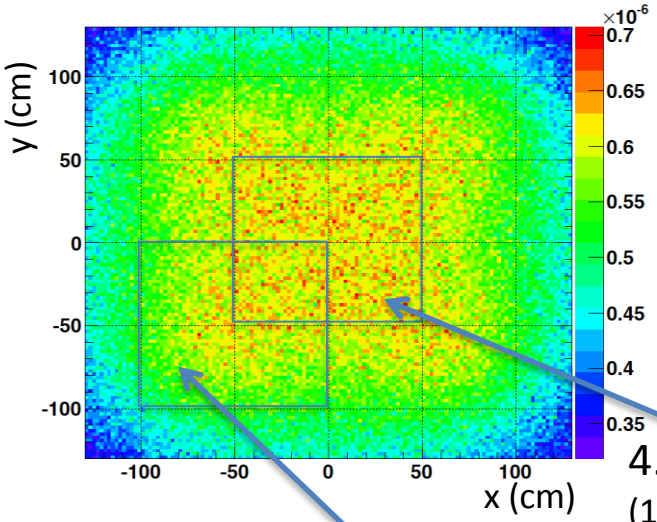






Muons at the level of the beam dump

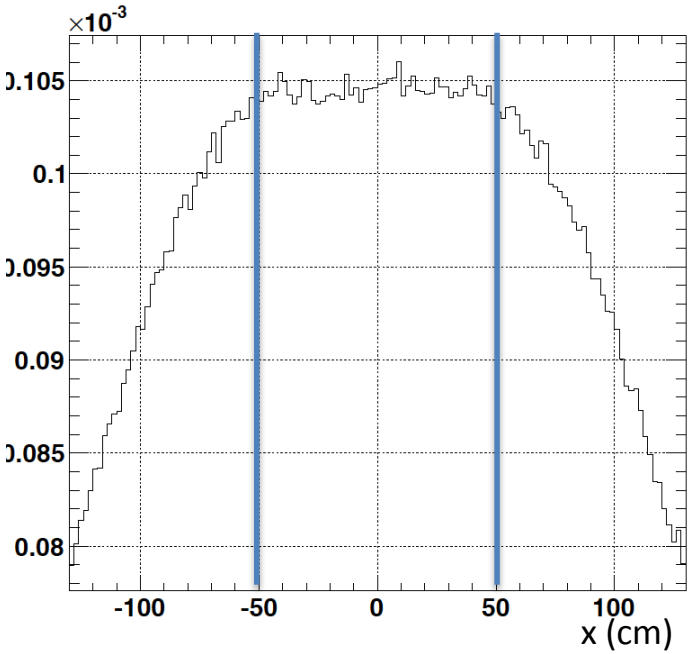
2.7x10^{23} p.o.t/year

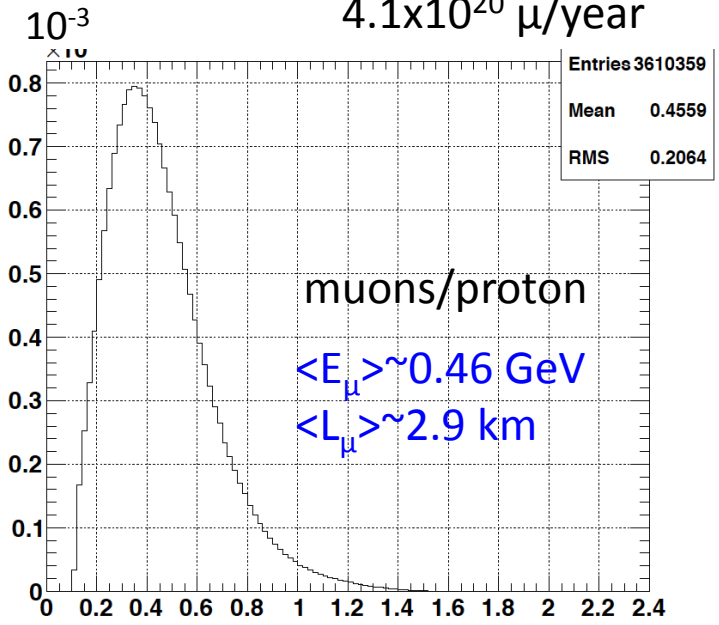


muons at the level of the beam dump (per proton)

4.2x10^{20} μ/year
(16.3x10^{20} for 4 m^2)

4.1x10^{20} μ/year





muons/proton

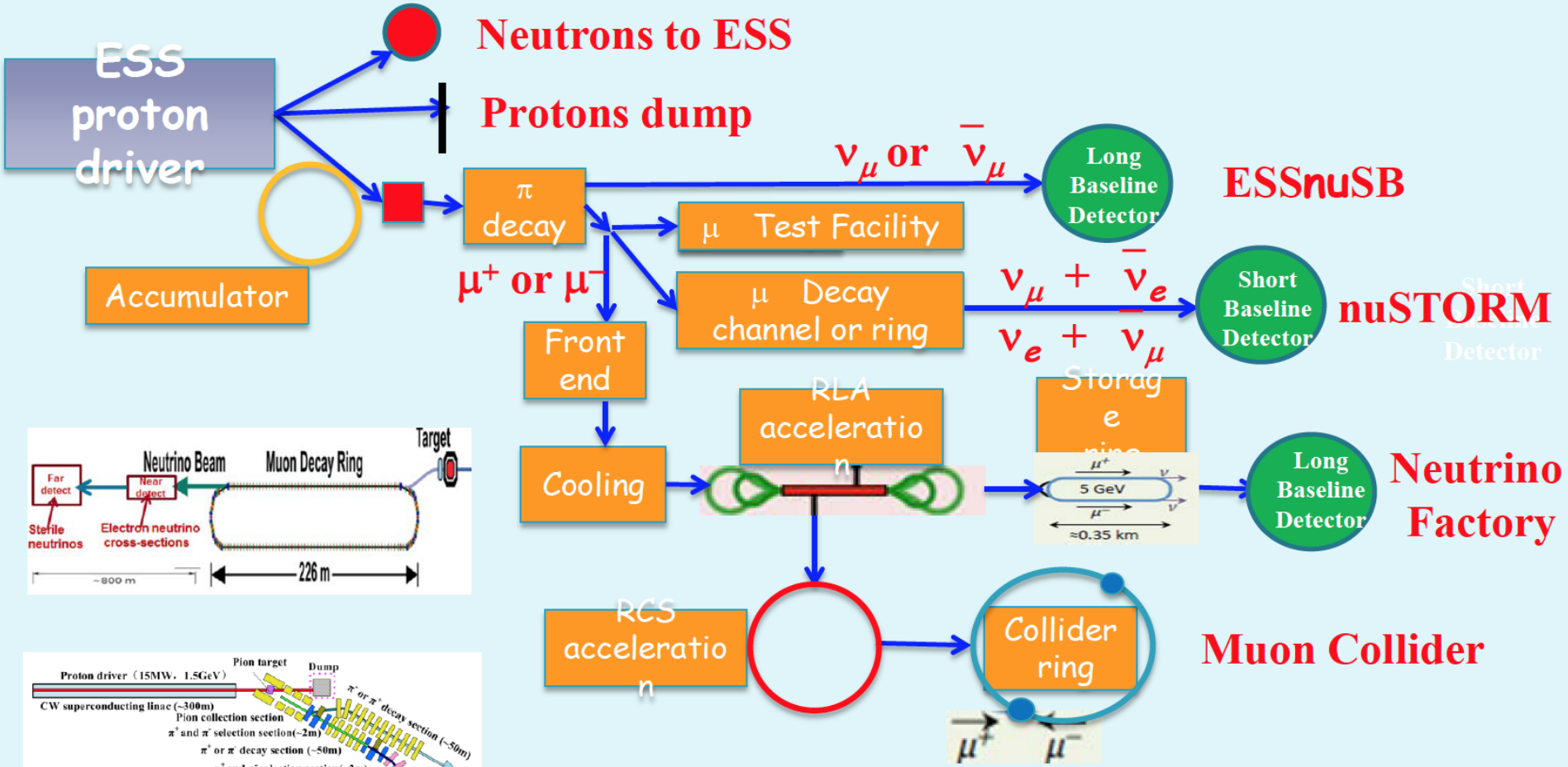
<E_μ>~0.46 GeV

<L_μ>~2.9 km

- input beam for future 6D μ cooling experiments (for muon collider)
- good to measure neutrino x-sections (ν_μ, ν_e) around 200-300 MeV (low energy nuSTORM)

Muon at the level of the beam dump

ESS neutrino and muons facility built in stages (or some of them) with increasing complexity



JP.Delahaye/CERN

EURONUDET COST workshop (15/10/2016)

A Design Study is needed
Which H2020 call?

Developing New World-Class research Infrastructures

(H2020-INFRADEV-01-2017: Design Studies)

- **Developing new world-class research infrastructures**.
  - Facilitate and support the implementation and long-term sustainability of the research infrastructures identified by the European Strategy Forum on Research Infrastructures (ESFRI) as well as of other world-class research infrastructures.
  - These will help Europe respond to grand challenges in science, industry and society.
  - In addition, the next generation of new research infrastructures can be identified through design studies. Support will be provided to:
    - Conceptual and technical design of new research infrastructures, which are of a clear European dimension and interest, through a bottom-up approach.
- Type of Action: **Research and Innovation Action**

Opening: 08 Dec 2016			
INFRADEV-01-2017 (RIA)		20.00	29 Mar 2017

H2020-INFRADEV-01-2017
Design Studies

- Type of action: RIA (Research Infrastructure Activities)
- Specific challenge:
  - **New leading-edge research infrastructures** in order to remain at the forefront of the advancement of research.
  - The aim of this activity is to support the **conceptual and technical design** and preparatory actions for new research infrastructures, which are of a clear European dimension and interest.
  - **Major upgrades of existing infrastructures** may also be considered if the end result is intended to be equivalent to a new infrastructure.
- Scope:
  - Design studies should address all key questions concerning the technical and conceptual feasibility of a new or upgraded fully fledged user facilities (proposals considering just a component for research infrastructures are not targeted by this topic).
  - Design studies lead to a CDR showing the maturity of the concept and forming the basis for identifying and constructing the next generation of Europe's and the world's leading research infrastructures.
  - CDRs will present major choices for design alternatives and associated cost ranges.

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- Scope: The activities that could be performed in a Design Study proposal include:
  - **Scientific and technical work**, i.e.:
    - the drafting of concepts, architecture and engineering plans for the construction,
      - taking into due account the creation of prototypes when relevant,
    - scientific and technical work to ensure that the beneficiary scientific communities exploit the new facility from the start with the highest efficiency.
  - **Conceptual work**, i.e.:
    - plans to coherently integrate the new infrastructure into the European landscape of related facilities;
    - the estimated budget for construction and operation;
    - plans for an international governance structure;
    - the planning of research services to be provided at international level,
    - procedure and criteria to choose the site of the infrastructure.
- **The main output of the design study will be the conceptual design reports for a new or upgraded research infrastructure of strategic importance for Europe**.

The Commission considers that proposals requesting a contribution from the EU of between **EUR 1 and 3 million** would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

H2020-INFRADEV-01-2017

- **Expected impact**:
  - Funding bodies for research infrastructures become aware of the strategic and funding needs of the scientific community.
  - Policy bodies at the national level, at European level and internationally have a sound decision basis to establish long-range plans and roadmaps for new research infrastructures of pan- European or global interest.
  - The technical work carried out under this topic will contribute to strengthening the technological development capacity and effectiveness as well as the scientific performance, efficiency and attractiveness of the European Research Area.
- **Eligibility conditions**: At least three legal entities. Each of the three shall be established in a different Member State or associated country. All three legal entities shall be independent of each other.
- **Funding rate*: up to* 100%**

Evaluation

Excellence	Impact	Quality and efficiency of the implementation
Clarity and pertinence of the objectives; Soundness of the concept, and credibility of the proposed methodology; Extent that the proposed work is **beyond the state of the art**, and demonstrates **innovation potential** (e.g. ground-breaking objectives, novel concepts and approaches, new products, services or business and organisational models). Appropriate consideration of interdisciplinary approaches and, where relevant, use of stakeholder knowledge.	The extent to which the outputs of the project would contribute to each of the expected impacts mentioned in the work programme under the relevant topic; Any substantial impacts not mentioned in the work programme, that would enhance innovation capacity, create new market opportunities, strengthen competitiveness and growth of companies, address issues related to climate change or the environment, or bring other important benefits for society; Quality of the proposed measures to: • Exploit and disseminate the project results (including management of IPR), and to manage research data where relevant. • Communicate the project activities to different target audiences.	Quality and effectiveness of the work plan, including extent to which the resources assigned to work packages are in line with their objectives and deliverables; Appropriateness of the management structures and procedures, including risk and **innovation management**; Complementarity of the participants and extent to which the consortium as whole brings together the necessary expertise; Appropriateness of the allocation of tasks, ensuring that all participants have a valid role and adequate resources in the project to fulfil that role.

Document Structure and limitations

- The template is given and **must** be followed.
- The cover page and sections 1, 2 and 3, together should not be longer than **70 pages**.
- Please, do not consider the page limit as a target! It is in your interest to keep your text as concise as possible, since experts rarely view unnecessarily long proposals in a positive light.
- The reference font for the body text of H2020 proposals is Times New Roman (Windows platforms), Times/Times New Roman (Apple platforms) or Nimbus Roman No. 9 L (Linux distributions).
- The minimum font size allowed is 11 points. Standard character spacing and a minimum of single line spacing is to be used.
- The page size is A4, and all margins (top, bottom, left, right) should be at least 15 mm (not including any footers or headers).

Document Structure

Title of Proposal

List of participants

Participant No *	Participant organisation name	Country
1 (Coordinator)		
2		
3		

Document Structure

1. **Excellence**
    1. **Objectives**
    2. **Relation to the work programme**
    3. **Concept and approach**
    4. **Ambition**
2. **Impact**
    - ***a) Dissemination and exploitation of results***
      Provide a draft '**plan for the dissemination and exploitation of the project's results'**. Please note that such a draft plan is an **admissibility condition**.
    - ***b) Communication activities***
3. **Implementation**
    1. **Work plan — Work packages, deliverables**
    2. **Management structure, milestones and procedures**
        - ***Please provide a table with critical risks identified and mitigating actions (table 3.2b).***
    3. **Consortium as a whole**
    4. **Resources to be committed**
4. **Members of the consortium** (this section is not covered by the page limit)
    1. **Participants (applicants)**
    2. **Third parties involved in the project (including use of third party resources)**

2014 Application

Horizon 2020

Call: H2020-INFRADEV-1-2014-1

Topic: INFRADEV-1-2014

Type of action: RIA

Proposal number: 653428

Proposal acronym: ESSnuSB

3 years ago

2014 Application

N.	Proposer name	Country	Total Cost	%	Grant Requested	%
1	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	FR	805,696	22.28%	357,167	19.47%
2	UPPSALA UNIVERSITET	SE	724,934	20.04%	485,891	26.49%
3	EUROPEAN SPALLATION SOURCE ESS AB	SE	493,133	13.63%	274,865	14.99%
4	EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH	CH	549,909	15.20%	324,237	17.68%
5	KUNGLIGA TEKNISKA HOEGSKOLAN	SE	170,439	4.71%	36,761	2.00%
6	UNIVERSIDAD AUTONOMA DE MADRID	ES	70,219	1.94%	62,667	3.42%
7	AKADEMIA GORNICZO-HUTNICZA IM. STANISLAWA STASZICA W KRAKOWIE	PL	247,675	6.85%	60,475	3.30%
8	SOFIISKI UNIVERSITET SVETI KLIMENT OHRIDSKI	BG	79,375	2.19%	39,063	2.13%
9	LUNDS UNIVERSITET	SE	405,463	11.21%	170,392	9.29%
10	UNIVERSITY OF DURHAM	UK	28,928	0.80%	10,500	0.57%
11	ISTITUTO NAZIONALE DI FISICA NUCLEARE	IT	41,035	1.13%	12,195	0.66%
	Total:		3,616,806		1,834,213	

2014 Application (evaluation)

Criterion 1 - Excellence

Score: **5.00** (Threshold: 3.00/5.00 , Weight: 100.00%)

Note: The following aspects will be taken into account, to the extent that the proposed work corresponds to the topic description in the work programme. If a proposal is partly out of scope, this must be reflected in the scoring, and explained in the comments.

Clarity and pertinence of the objectives

Credibility of the proposed approach

Soundness of the concept, including trans-disciplinary considerations, where relevant

Extent that proposed work is ambitious, has innovation potential, and is beyond the state of the art (e.g. ground-breaking objectives, novel concepts and approaches)

The objectives of ESSnuSB are very clear and pertinent and the proposed approach is credible. The concept is very sound, in particular the synergy with the future ESS facility. The concept also enhances opportunities for trans-disciplinary research and advanced exchange of knowledge also linked to the nature of the technical works to be undertaken on site. The proposed design study is very ambitious and clearly advances the state of the art under the relevant topic.

2014 Application (evaluation)

Criterion 2 - Impact

Score: **4.50** (Threshold: 3.00/5.00 , Weight: 100.00%)

Note: The following aspects will be taken into account, to the extent to which the outputs of the project should contribute at the European and/or International level:

The expected impacts listed in the work programme under the relevant topic

Enhancing innovation capacity and integration of new knowledge

Strengthening the competitiveness and growth of companies by developing innovations meeting the needs of European and global markets, and where relevant, by delivering such innovations to the markets

Any other environmental and socially important impacts

Effectiveness of the proposed measures to exploit and disseminate the project results (including management of IPR), to communicate the project, and to manage research data where relevant

The proposal answers the expected impacts in the topic's work program very well: a prospective ESSnuSB RI will strengthen the technological development capacity and effectiveness as well as the scientific performance, efficiency and attractiveness of the European Research Area. The challenges linked to the development of the ESSnuSB infrastructure will also be very positive in terms of know-how transfer between academia and industry.

The ESSnuSB answers one of the priorities defined in the European Strategy for Particle Physics.

Communication and dissemination measures are adequate. However, some specific details are lacking: e.g. the proposal states that special seminars for the public will be organized at the ESS. However, how many seminars are planned and how they are going to be covered is not presented and only information and figures on the final workshops are included. The question of IPR is not sufficiently addressed.

2014 Application (evaluation)

Criterion 3 - Quality and efficiency of the implementation

Score: **4.00** (Threshold: 3.00/5.00 , Weight: 100.00%)

Note: The following aspects will be taken into account:
Coherence and effectiveness of the work plan, including appropriateness of the allocation of tasks and resources
Complementarity of the participants within the consortium (when relevant)
Appropriateness of the management structures and procedures, including risk and innovation management

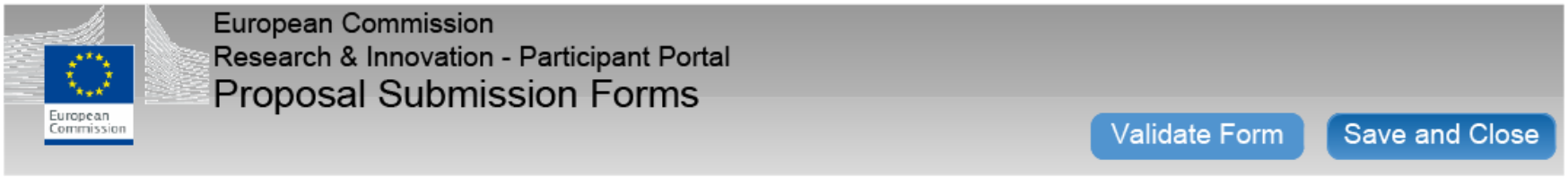
The work plan is coherent and sufficiently effective.
Each work package (WP) contributes to a clear objective and the work plan includes coordination tasks to ensure a coherent final design.
The allocation of tasks and resources is appropriate.

The consortium has the required competences to carry out the design study successfully.

The management structures and procedures are well defined, including identification of critical risks and mitigation measures, with the exception of the ESS linac modifications (WP 2) and design of the accumulator ring (WP 3) for which a proper SWOT analysis is lacking. In particular risk (and cost) associated with the interaction with the ESS have not been considered in sufficient detail.

Conflict resolution mechanisms and innovation management are only sketchily addressed.

ESSnuSB



Horizon 2020

Call: H2020-INFRADEV-2016-2017

(Development and long-term sustainability of new pan-European research infrastructures)

Topic: INFRADEV-01-2017

Type of action: RIA

(Research and Innovation action)

Proposal number: SEP-210411783

Proposal acronym: ESSnuSB

Deadline Id: H2020-INFRADEV-2017-1

ESSνSB Participants

Meeting last Saturday at CERN to finalise the application (thanks to COST).

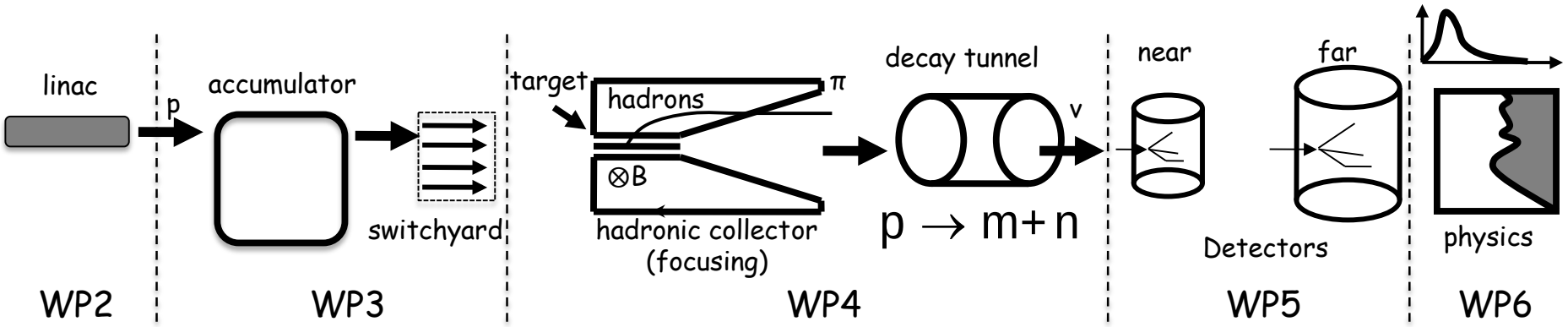
ESSνSB Participants

Title of Proposal: Discovery and measurement of leptonic CP violation using an intensive neutrino Super Beam generated with the exceptionally powerful ESS linear accelerator

Duration: 4 years

Participant no.	Participant organisation name	Part. short name	Country
1 (Coordinator)	Centre National de la Recherche Scientifique	CNRS	France
2	Uppsala University	UU	Sweden
3	European Spallation Source ERIC	ESS	Sweden
4	European Organisation for Nuclear Research	CERN (!)	IEIO
5	KTH Royal Institute of Technology	KTH	Sweden
6	Universidad Autonoma de Madrid	UAM	Spain
7	AGH, Krakow	AGH	Poland
8	Sofia University St. Kliment Ohridski	UniSofia	Bulgaria
9	Lund University	LU	Sweden
10	University of Durham	UDUR (!)	UK
11	Istituto Nazionale di Fisica Nucleare	INFN	Italy
12	Rudjer Boskovic Institute	RBI	Croatia
13	NCSR 'Demokritos', Athens	Demokritos	Greece
14	Cukurova University, Adana	CU	Turkey
15	University of Geneva	UNIGE	Switzerland
16	University of Oslo	UO	Norway

WP Description

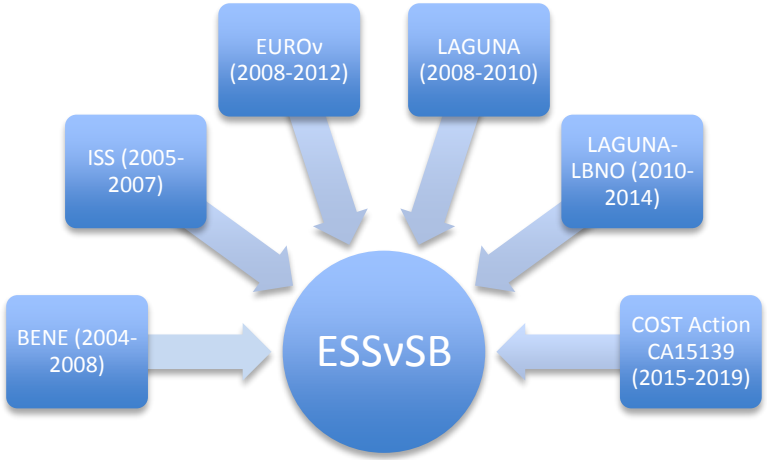


WP Description

- **WP1: Management**
  - General management and dissemination
  - Preparatory actions, with scientific communities, ESS, CERN and Swedish government
  - CDR, cost and safety
- **WP2: Linac**
  - H- source and Linac Beam-Line modifications
  - RF Power and Cooling upgrade
  - Energy Upgrade
- **WP3: Accumulator**
  - Accumulator and transfer lines design
  - Injection stripping of H^-
  - Layout and civil engineering of accumulator
- **WP4: Target Station**
  - Target/collector Station Design and civil engineering layout
  - Target
  - Horn collector and alternatives
- **WP5: Detector**
  - Far and Near Detector; cross-section measurements
  - Underground site location, access and test measurements
  - Cavern shape, excavation, reinforcement and services infrastructures
  - Relation to the Garpeneberg Mining Company and its concurrent mining activity
- **WP6: Physics Performance**
  - Performance for CPV as primary project goal
  - Performance for additional goals: MH, Proton lifetime, and cosmological neutrinos

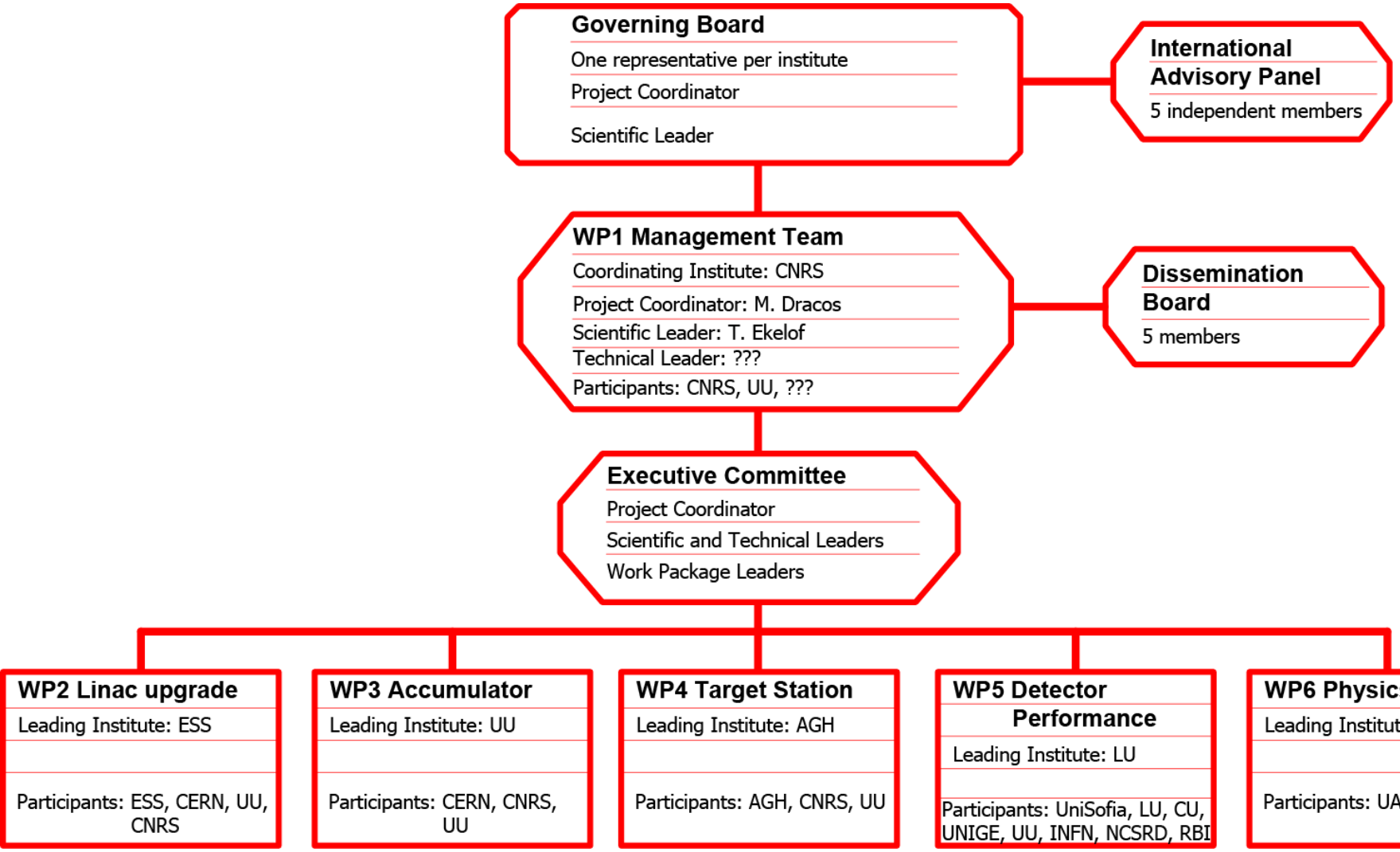
Recommendations/Limitations
(experience from previous application)

- **Experience from previous Design Studies**:
  - WP2 and WP3: ESS, SNS
  - WP4 from EUROv
  - WP5 from LAGUNA-LBNO and EUROv
  - WP6 from LAGUNA-LBNO
- **Main effort on WP2, WP3 and WP4**
- **Do not exceed 3 M€!**
  - traveling cost: ~2 k€/pers/year.
  - limited budget for mine subcontracting: 10 k€/year
- **Our proposal for EU budget:**
  - **pay all postdocs**
  - **pay all travelling expenditures**
  - **pay 25% overheads**
  - **money for salaries of permanent staff ???**



Design Study Structure

(preliminary)



Deliverables

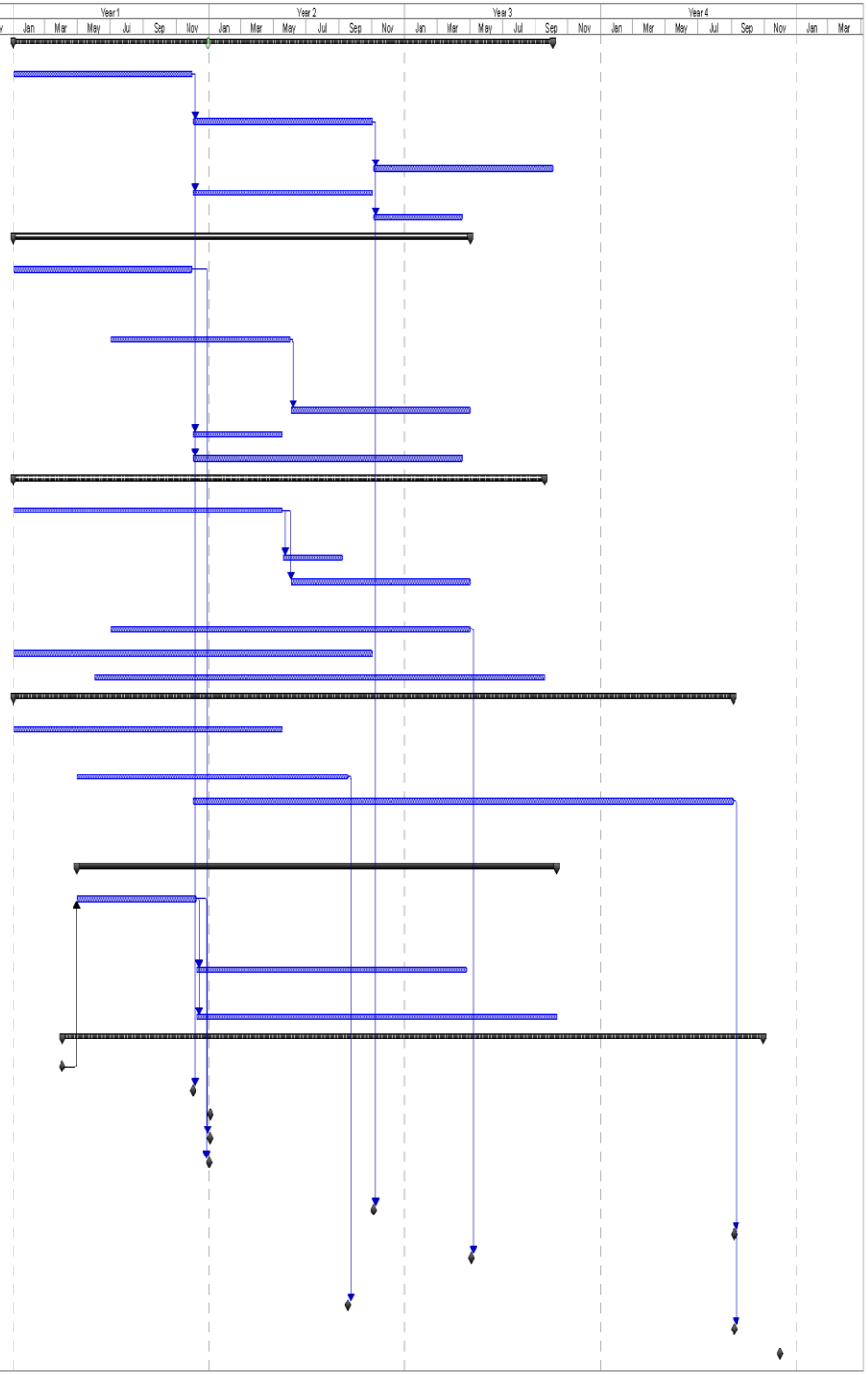
Del. no.	Deliverable name	WP no.	lead part.	Type	Dissemination level	Delivery date (in months)
1.1	Data Management Plan	1	CNRS	R	PU	6
1.2	Initial facility parameters	1	CNRS	R	PU	8
2.1	Requirements for the linac	2	ESS	R	PU	6
5.1	Near detector requirements	5	LU	R	PU	8
1.3	Report on 1st year activities	1	CNRS	R	PU	12
6.1	Physics Performance according to initial parameters	6	UAM	R	PU	12
3.1	Accumulator operation scheme, layout and optics	3	UU	R	PU	18
2.2	H^- source design, integration into ESS (optics and hardware), beam losses and activation, simulated performance for protons and H^-, beam chopping	2	ESS	R	PU	24
5.2	Mine evaluation and choice of the far detector site	5	LU	R	PU	24
1.4	Interim report	1	All	R	PU	24
4.1	Optimized design of the horn, requirements for pulse generator according to the beam frequency.	4	AGH	R	PU	24
4.2	Design and simulation of a continuous-current superconducting solenoid plus dipole hadron collector.	4	AGH	R	PU	24
6.2	Physics Performance after first optimizations and recommendation for the baseline	6	UAM	R	PU	24
6.3	Physics Performance and comparison with other proposals, after a second optimization	6	UAM	R	PU	32

Deliverables

Del. no.	Deliverable name	WP no.	lead part.	Type	Dissemination level	Delivery date (in months)
2.3	Conceptual design of the ESS RF power upgrade, powering and cooling schemes, integration into the existing system, 36 months.	2	ESS	R	PU	36
3.2	Transfer lines layout, injection system design and efficiency, control of beam losses and activation, space charge and beam dynamics, extraction lines, switchyard.	3	UU	R	PU	36
4.3	Design of the pulse generator, cooling system for the horn and pulse generator.	4	AGH	R	PU	36
5.3	Design of near detector, layout of its installation and performance.	5	LU	R	PU	36
1.5	Performance, cost and safety evaluation of the facility	1	CNRS	R	PU	42
5.4	Final design of far detector	5	LU	R	PU	42
6.4	Final Physics Performance	6	UAM	R	PU	42
4.4	Design of the target station/tunnel/beam dump	4	AGH	R	PU	42
1.6	Final report	1	All	R	PU	48

Gantt Chart

ID	Task Name	Resource Names	Duration
1	**Linac Studies**		**36 mons**
2	Modifications to the operation of the proton driver	CERN,ESS	12 mons
3	H- source choice and installation study	ESS	12 mons
4	Acceleration of the H- beam	ESS,CERN,CNRS	12 mons
5	Power doubling	ESS,UU	12 mons
6	Stripping of H- ions	CERN,ESS	6 mons
7	**Accumulator**		**30,5 mons**
8	Study of the operation scheme, optics and collimators of the accumulator	CERN,UU	12 mons
9	Location of the accumulator and design of its transfer line from the linac to the accumulator	CERN,ESS,UU	12 mons
10	Study of H- ion stripping	CERN,UU	12 mons
11	Ring kickers	CERN,CNRS	6 mons
12	Design of the beam switchyard	CNRS	18 mons
13	**Target Station**		**35,45 mons**
14	Adapt the EUROv design target station to the ESSvSB requirements	AGH,CNRS	18 mons
15	Target integration	CNRS,AGH	4 mons
16	Optimization of the horn type hadron collector	AGH,CNRS	12 mons
17	Horn current pulse generator	CNRS	24 mons
18	Alternative hadron collector	UU	24 mons
19	Simulation of the neutrino beam	CNRS	30 mons
20	**Detector Performance**		**48 mons**
21	Performance of the far Water Cherenkov detector	UU,LU	18 mons
22	Near detector design	CERN,LU,UniSofia	18 mons
23	Organization and subcontracting of the engineering studies of the underground detector location	UU	36 mons
24	**Physics Performance**		**32 mons**
25	Determination of the optimal baseline and initial physics performance	KTH,UAM	8 mons
26	Optimization of the physics performance	KTH,UAM	18 mons
27	Other physics subjects	KTH,LU,UDUR	24 mons
28	**Main intermediate reporting**		**46,75 mons**
29	Initial facility parameters	All	1 mon
30	Requirements for the linac	CERN,CNRS,ESS,UU	2 mons
31	Near detector specifications	LU,UniSofia	2 mons
32	Accumulator layout and optics	CERN	2 mons
33	Physics performance according to initial parameters	KTH,UAM	3 mons
34	H- source design	CERN,ESS	2 mons
35	Mine studies and choice of baseline	KTH,UAM,UU	2 mons
36	Collector optimisation and power supply	CERN,CNRS,AGH	2 mons
37	Design of near detector	LU,UniSofia,CNRS	2 mons
38	Final design of far detector	UU	2 mons
39	**Final report including costing**	**All**	**4 mons**



Milestones

No	Milestone Name	Related WP(s)	Estimated date (months)	Means of verification
1.1	Review of 1st year milestones, deliverables & costs	All	12	Report reviewed by GB
2.1	Linac report	2	12	Parameters reviewed by external experts
6.1	Update physics potential	6	12	Report reviewed
3.1	Evaluation of accumulator requirements	3	12	Report reviewed by external experts
4.1	Design of the hadron collection device	4	24	Report reviewed by external experts
3.2	Accumulator lattice design	3	24	Optics qualified by external experts
1.2	Review on interim milestones, deliverables & costs	All	24	Report reviewed by GB
4.2	1st estimation of neutrino beam intensity	4	24	Report qualified by external experts
2.2	Specification of H^--beam handling system complete	2	32	Report reviewed by external experts
6.2	Review of systematic errors.	6	32	Report reviewed
6.3	Physics performance with update of fluxes	6	32	Report reviewed
1.3	Review of 3rd year milestones, deliverables & costs	All	36	Report reviewed by GB
4.3	Final target/hadron collector integration drawings	4	36	Drawings qualified by external experts
3.3	Full simulation of the accumulation ring	3	36	Simulation results reviewed
5.1	Choice of optimal baseline scenario	5,6	42	Report reviewed
4.4	Design of target station	4	42	Report reviewed by external experts
1.4	**Cost and performance evaluation complete**	**All**	**48**	Report reviewed by external experts

Critical risks for implementation (has to be improved) Give a real SWOT analysis???

Description of risk (indicate level of likelihood: Low/Medium/High)	WP(s) involved	Proposed risk-mitigation measures
Change of management team personnel during the project	WP1	The many competent ESSvSB project members warrants that suitable replacements of any management team member can be found within the consortium if and when needed.
Unilateral withdraw of key partner(s).	WP1	Other partners will take over responsibility and, ultimately, the remaining participants will find the necessary resources to compensate. The net effect will be some delay.
Incompatibilities with the present ESS linac layout.	WP2	Evaluation of the cost to overcome this obstacle.
Too high radiation levels at the location of the target station non-compatible with the local regulations.	WP4	Study how to improve the overall shielding.
Impossibility of locating the near detector inside the already allocated ESS area.	WP5	Evaluate the extra cost to increase the ESS surface.
Mine studies, Garpenberg mine seems not to be the adequate place due to rock quality.	WP1	Investigate other mines like Zinkgruvan or Kongsberg in Norway.
Unable to better estimate the systematic errors better.	WP6	Chose the most pessimistic case for the physics performance evaluation.

Manpower
(preliminary)

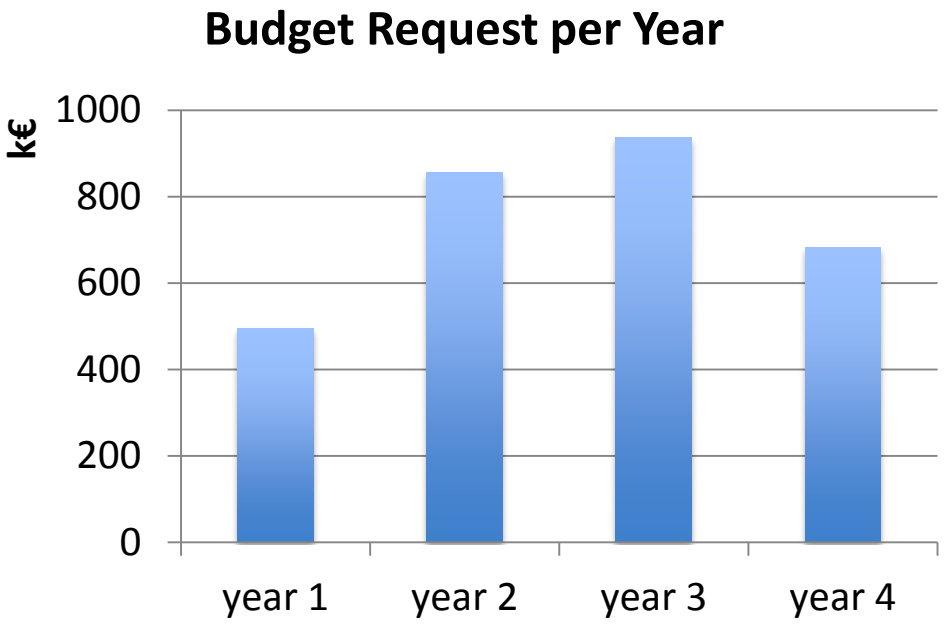
Tot manpower	Cost Category	Months WP1	Months WP2	Months WP3	Months WP4	Months WP5	Months WP6	Months Total	%
Direct Costs:	*Personnel:*								
	Senior Staff	20	48	58	90	114	42	372	59.6%
	Post docs	**48**	**36**	**36**	**48**	**36**	**48**	**252**	**40.4%**
	Total Personnel:	68	84	94	138	150	90	624	100.0%

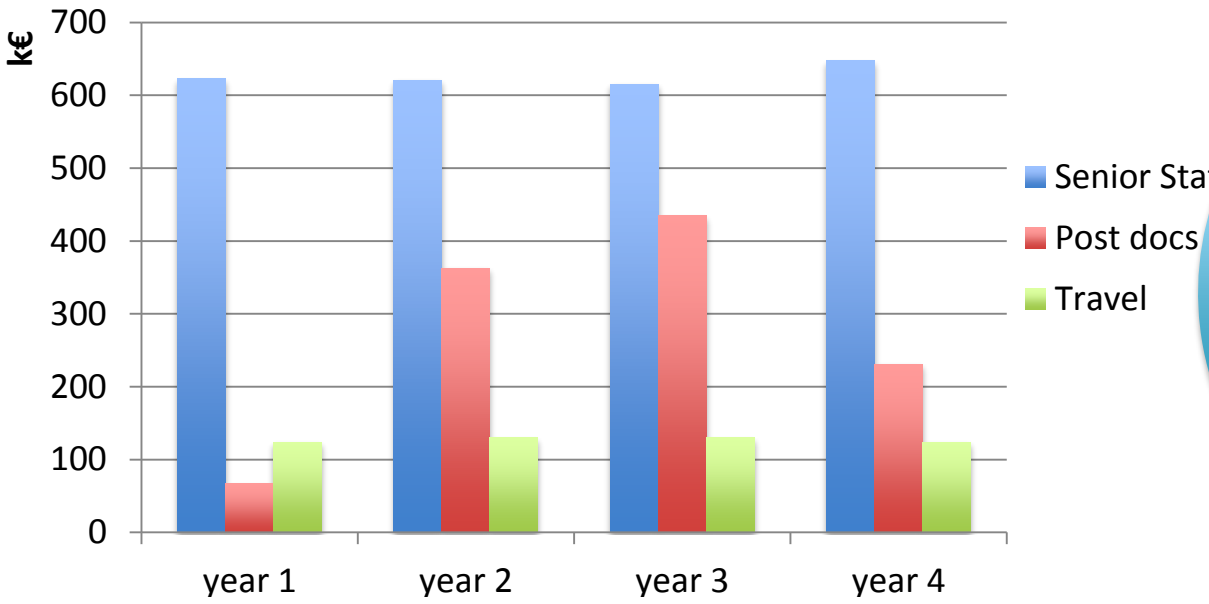
Total Cost

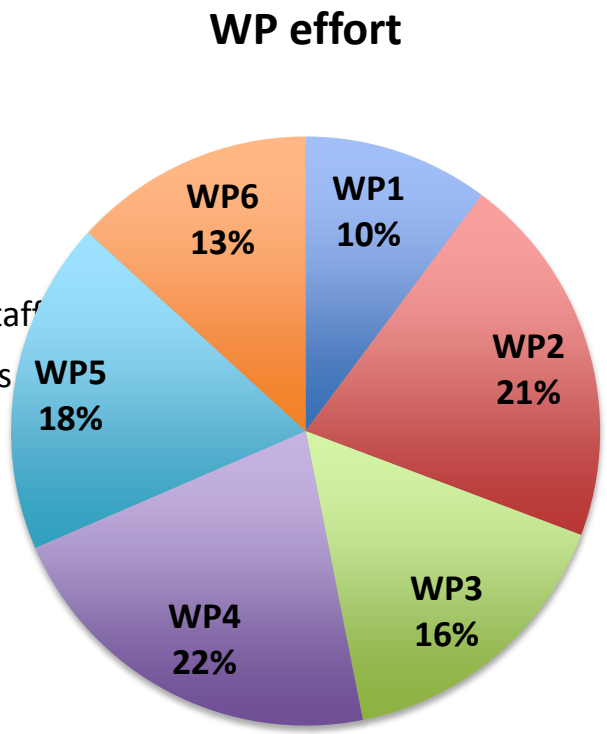
(preliminary)

All participants	Cost Category	Months 1-12	Months 13-24	Months 25-36	Months 37-48	Total (48 months)	
Direct Costs:	*Personnel:*						
	Senior Staff	623176	620692	615681	647464	2507014	48.3%
	Post docs	67353	363035	434842	231320	1096549	21.1%
	Other	0	0	0	0	0	0.0%
	Total Personnel:	690529	983727	1050523	878784	3603563	69.4%
	Other Direct Costs:						
	Consumables	0	0	0	0	0	0.0%
	Travel	124000	130000	130000	124000	508000	9.8%
	Publications, etc	2000	2000	2000	2000	8000	0.2%
	Other	0	0	0	0	0	0.0%
	Total Other Direct Costs:	126000	132000	132000	126000	516000	9.9%
	Total Direct Costs:	816529	1115727	1182523	1004784	4119563	79.4%
Indirect Costs (overheads):	Max 25% of Direct Costs	204132	278932	295631	251196	**1029891**	**19.8%**
Subcontracting Costs:	(No overheads)	10000	10000	10000	10000	40000	0.8%
Total Costs of project:	(by year and total)	1030661	1404658	1488154	1265980	**5189453**	100.0%
Requested Grant:	(by year and total)	495451	856195	937396	682585	**2971627**	**57.3%**

Cost/WP
(preliminary)







Just an exercise with what is known now

Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	© Direct costs of sub-contracting/€	(F) Indirect Costs/€ (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs/€	(H) Total estimated eligible costs/€ (=A+B+C+D+F+G)	(I) Reimbursement rate (%)	(J) Max. grant/€ (=H*I)	(K) Requested grant/€	B/A
CNRS	FR	990792	152000	0	285698	0	1428490	100%	1428490	788907	15.3%
UU	SE	643111	64000	40000	176778	0	923888	100%	923888	461522	10.0%
ESS	SE	513024	32000	0	136256	0	681280	100%	681280	444736	6.2%
CERN	CH	136130	40000	0	44033	0	220163	100%	220163	84033	29.4%
KTH	SE	205000	16000	0	55250	0	276250	100%	276250	136250	7.8%
UAM	ES	109333	16000	0	31333	0	156667	100%	156667	140000	14.6%
AGH	PL	291385	24000	0	78846	0	394231	100%	394231	288539	8.2%
UniSofia	BG	65000	32000	0	24250	0	121250	100%	121250	100750	49.2%
LU	SE	364916	32000	0	99229	0	496144	100%	496144	221410	8.8%
INFN	IT	17703	16000	0	8426	0	42129	100%	42129	24426	90.4%
UDUR	UK	22856	8000	0	7714	0	38570	100%	38570	15714	35.0%
RBI	HR	57867	20000	0	19467	0	97333	100%	97333	87173	34.6%
NCSRD	EL	41121	24000	0	16280	0	81402	100%	81402	60841	58.4%
CU	TR	47942	16000	0	15985	0	79927	100%	79927	55956	33.4%
UniGe	CH	83333	12000	0	23833	0	119167	100%	119167	35833	14.4%
AUTH	EL	14050	12000	0	6513	0	32563	100%	32563	25538	85.4%
Total		3603563	516000	40000	1029891	0	5189453		5189453	2971627	14.3%

Local (ESS) support?

FEB 23, 2017

Royal Visit. The European Spallation Source was the site of a roundtable discussion featuring King Carl XVI Gustaf of Sweden, the Governor General of Canada, and the research ministers of the two nations. The focus was on collaboration between Canada's and Sweden's science, industry and research infrastructures.

Yes!!!

EUROPEAN SPALLATION SOURCE

To whom it may concern – ESSnuSB project

The European Spallation Source (ESS) is now well into its construction phase and all indications are positive. The ESS is naturally concentrating on delivering first neutrons and achieving full specification such that we can deliver the transformational science that such a powerful source will enable. This is our top priority. At the same time we are aware of the future potential of the ESS laboratory. There are a number of future pathways and among them is the possibility, being explored by the very imaginative ESSnuSB project to deliver high intensity beams of neutrinos. Neutrinos offer a window to the fundamental structure of the universe which is totally independent and complementary to high energy colliders such as CERN. The ESSnuSB project is coming together around an increasingly credible science case and has assembled a strong international scientific collaboration with members from 12 European countries now organized as a EU COST Association, of which ESS is an associate member.

The ESSnuSB collaboration is currently studying how the average power of the ESS linear accelerator could eventually be increased from 5 MW to 10 MW by doubling the duty cycle from 4% to 8% with the goal of producing the highest flux neutrino-beam in the world. The primary scientific aim of the study is to specify how such a high flux neutrino beam would be produced and explore what new ground breaking neutrino physics would then become possible. The discovery of matter-antimatter asymmetries in the neutrino sector is especially tantalizing, as it could explain the observed preponderance of matter over antimatter in our universe. The exceptionally high power possible in an eventual ESS neutrino beam would allow for the neutrino measurements to be made at the second neutrino oscillation maximum, where the CP signal is three times larger than at the first maximum. This provides a clear advantage over the current generation of neutrino projects planned in US and Japan, respectively. The ESSnuSB project also opens up the possibility, at a future stage, of making use of the intense flux of muons generated concurrently with the neutrinos and to enable the generation of high-brightness short-pulse neutron beams.

It is now important for the ESSnuSB project to embark upon a sustained design phase so that its feasibility can be properly judged when the time comes. For the reasons given above I have no hesitation in fully endorsing the application for INFRADEV support so that a professional Design Report and an outline costing can be available by 2020 when ESS will be operational and its future development pathways can be assessed.

Lund, February 13, 2017

John Womersley
Director General

Conclusion

- The physics case of the application is very strong:
  - Significantly better CPV sensitivity at the 2nd oscillation maximum.
  - ESS will have enough protons to go to the 2nd oscillation maximum and increase its CPV sensitivity.
  - CPV: 5 σ could be reached over 60% of δ_{CP} range (ESSνSB)
  - large potentiality (muons…).
- Our application is inline with the INFRADEV/Design Study call.
- 15 institutes will participate to this application.
- The total requested EU budget for 4 years will be around 3 M€ for a total cost of ~5.2 M€.
- The application documents are now in final stage.

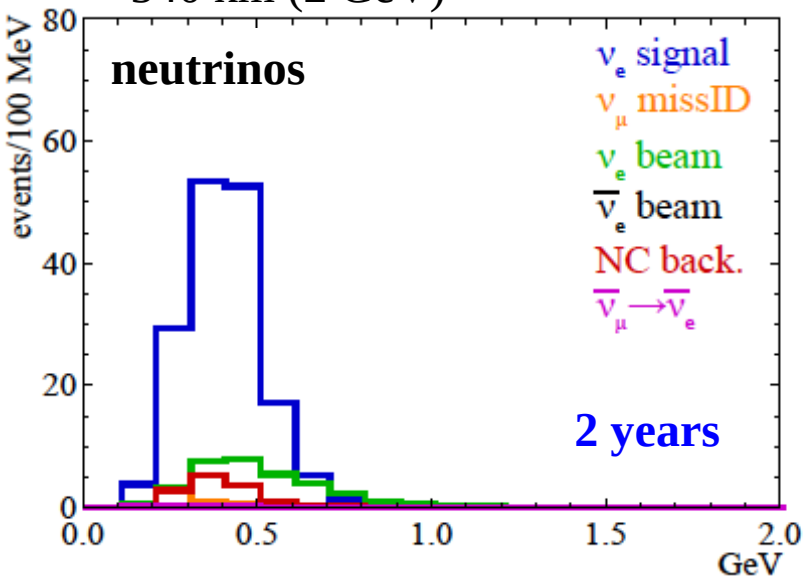
Thanks

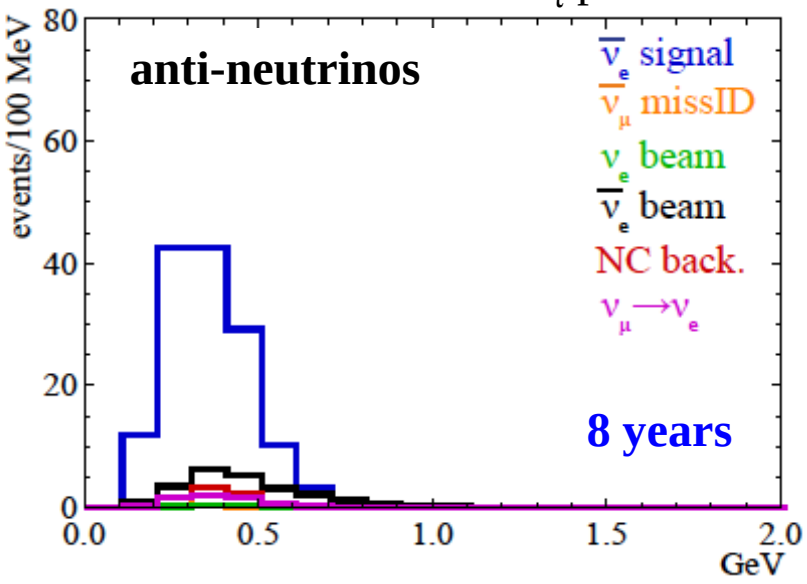
Neutrino spectra

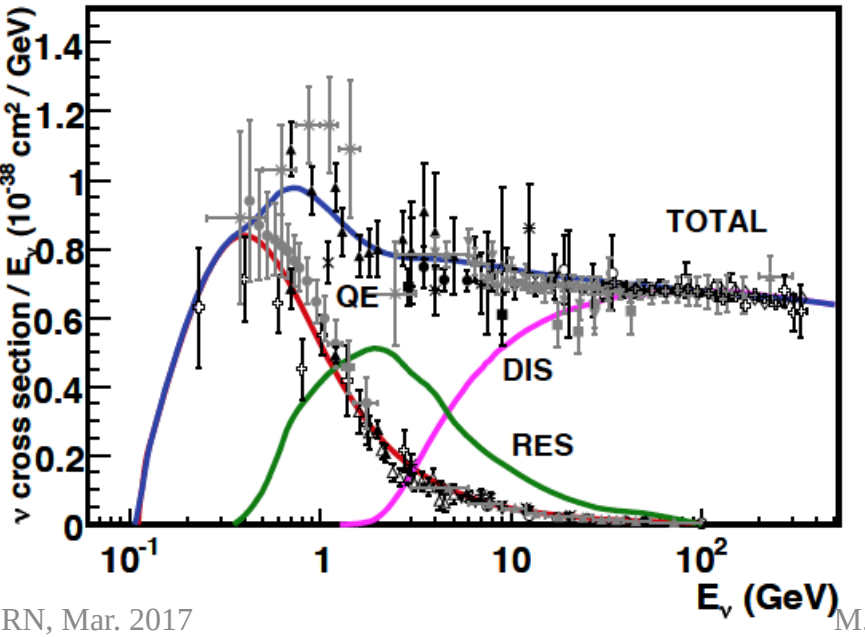
540 km (2 GeV)

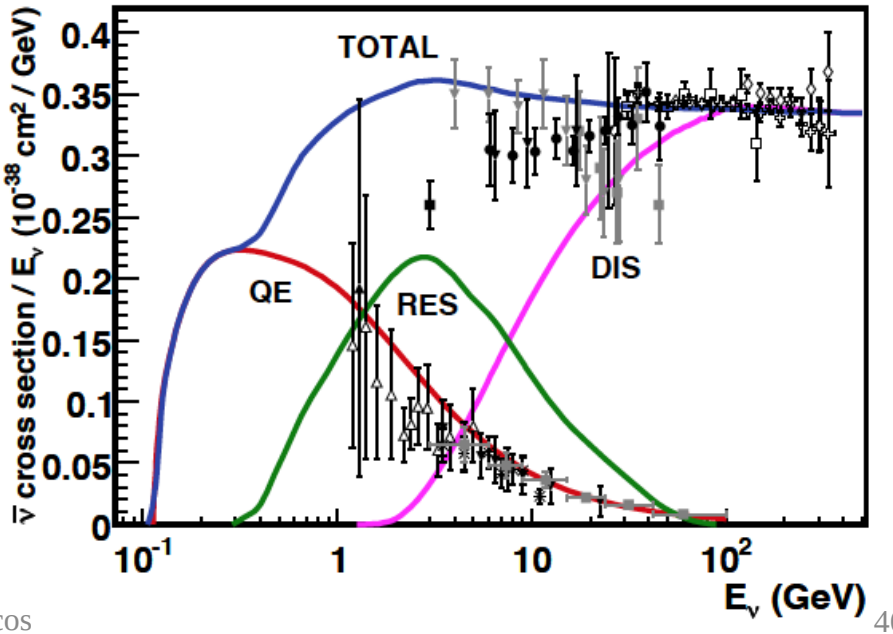
below ν_τ production

$\delta_{CP}=0$









Manpower

(preliminary)

Participant	WP1	WP2	WP3	WP4	WP5	WP6	Total
CNRS	62	6	27	71	0	0	**166**
UU	6	17	65	2	6	8	**104**
ESS	0	59	0	0	0	0	**59**
CERN	0	2	2	0	0	0	**4**
KTH	0	0	0	0	0	26	**26**
UAM	0	0	0	0	0	32	**32**
AGH	0	0	0	65	0	0	**65**
UniSofia	0	0	0	0	52	0	**52**
LU	0	0	0	0	37	0	**37**
INFN	0	0	0	0	0	2	**2**
UDUR	0	0	0	0	0	2	**2**
RBI	0	0	0	0	20	12	**32**
NCSRD	0	0	0	0	7	5	**12**
CU	0	0	0	0	22	0	**22**
AUTH	0	0	0	0	3	1	**4**
UniGe	0	0	0	0	3	1	**4**
Total	**68**	**84**	**94**	**138**	**150**	**90**	**624**

Postdoc sharing

(very preliminary)

Participant	WP1	WP2	WP3	WP4	WP5	WP6	Total
CNRS	48	0	0	24	0	0	**72**
UU	0	0	36	0	0	0	**36**
ESS	0	36	0	0	0	0	**36**
CERN	0	0	0	0	0	0	**0**
KTH	0	0	0	0	0	12	**12**
UAM	0	0	0	0	0	24	**24**
AGH	0	0	0	24	0	0	**24**
UniSofia	0	0	0	0	24	0	**24**
LU	0	0	0	0	12	0	**12**
INFN	0	0	0	0	0	0	**0**
UDUR	0	0	0	0	0	0	**0**
RBI	0	0	0	0	0	12	**12**
NCSRD	0	0	0	0	0	0	**0**
CU	0	0	0	0	0	0	**0**
AUTH	0	0	0	0	0	0	**0**
UniGe	0	0	0	0	0	0	**0**
Total	**48**	**36**	**36**	**48**	**36**	**48**	**252**

CERN participation in 2014

CERN (PIC: 999988133)	year 1	year 2	year 3	year 4	tot.		WP1	WP2	WP3	WP4	WP5	WP6
Elena Wildner	2.0	0.0	0.0	0.0	2.0		0.00	0.00	2.00	0.00	0.00	0.00
Bernhard Holzer	0.6	0.6	0.6	0.0	1.8		0.00	0.00	1.80	0.00	0.00	0.00
Ioannis Papaphilippou	0.6	0.6	0.6	0.0	1.8		0.00	0.00	1.80	0.00	0.00	0.00
Eric Montesinos	0.6	0.6	0.6	0.0	1.8		0.00	0.90	0.90	0.00	0.00	0.00
Frank Gerigk	0.6	0.6	0.6	0.0	1.8		0.00	0.90	0.90	0.00	0.00	0.00
Marzio Nessi	0.6	0.6	0.6	0.0	1.8		0.00	0.00	0.00	0.00	1.80	0.00

Export Edit View Member Assign MC1 candidates Email to selected

#	CTRY	Title	Firstname	Lastname	Group	Position	Institution
1	n/a	Dr	Marcos	Dracos	MC Members	MC Chair	IN2P3
2	n/a	Prof	Joakim	Cederkall	MC Members	MC Vice-Chair	Lund University
3	ES	Dr	Enrique	Fernandez-Martinez	MC Members	MC Member	Universidad Autónoma de Madrid
4	FR	Dr	Sebastien	BOUSSON	MC Members	MC Member	CNRS/IN2P3
5	FR	Dr	Elian	Bouquerel	MC Members	MC Member	CNRS/IN2P3
6	UK	Prof	Silvia	Pascoli	MC Members	MC Member	Durham University
7	EL	Dr	Georgios	Fanourakis	MC Members	MC Member	NCSR 'Demokritos'
8	HR	Mr	Budimir	Klicek	MC Members	MC Member	Rudjer Boskovic Institute
9	IT	Prof	Francesco	Terranova	MC Members	MC Member	Universita' di Milano Bicocca
10	IT	Dr	Mauro	Mezzetto	MC Members	MC Member	INFN
11	NO	Prof	Farid	Ould-Saada	MC Members	MC Member	University of Oslo
12	PL	Prof	Piotr	Cupial	MC Members	MC Member	AGH University of Science and Technology
13	SE	Prof	Joakim	Cederkall	MC Members	MC Member	Lund University
14	SE	Prof	Tord	Ekelof	MC Members	MC Member	Uppsala Univerity
15	TR	Prof	Yamac	Pehlivan Deliduman	MC Members	MC Member	Mimar Sinan Fine Arts University
16	TR	Prof	Aysel	Kayis Topaksu	MC Members	MC Member	Cukurova University
17	BG	Prof	Roumen	Tsenov	MC Members	MC Member	Faculty of Physics-Sofia University
18	CH	Prof	Alain	Blondel	MC Members	MC Member	University of Geneva
19	EL	*Prof*	*Spyros*	*Tzamarias*	*MC Members*	*MC Member*	
20	FR	Dr	Eric	Baussan	MC Members	MC Substitute	CNRS/IN2P3
21	SE	Prof	Tommy	Ohlsson	MC Members	MC Substitute	KTH Royal Institute of Technology
22	CH	Dr	Alessandro	Bravar	MC Members	MC Substitute	University of Geneva
23	SE	*Dr*	*Mattias*	*Blennow*	*MC Members*	*MC Substitute*	
24	n/a	*Prof*	*Jingyu*	*Tang*	*MC Observers*	*COST International Partner*	
25	n/a	Dr	Mats	Lindroos	MC Observers	International Organisations	European Spallation Source ESS AB
26	n/a	Dr	elena	wildner	MC Observers	European RTD Organisatior	CERN
27	n/a	Dr	Jean-Pierre	Delahaye	MC Observers	European RTD Organisatior	CERN