NESSiE

Neutrino Experiment with SpectrometerS in Europe

...&...

Neutrino Experiment with SpectrometerS in FERMILAB

Strategia coordinata per neutrino beams in Europa (ESP) e USA (P5):

'R&D al CERN, esperimenti a FNAL'

Giugno 2014: *APPEC International Meeting for Large Neutrino Infrastructures*

➔ *CERN Council approva la "Neutrino Platform" – **stanziati 55 M CHF***

- **NESSiE @CERN:**

  Esperimento approvato WA104-NESSiE

  Report Apr. 2014 apprezzato da SpSC - MoU richiesto

  schedula: 2015-2017

  'Precision measurement of muon momentum & charge in the 0.5 GeV - 10 GeV range'

  R&D on Air Core Magnet Spectrometer / study magnetization of large volume Lar-TPC

- **NESSiE@Fermilab:**

  Physics Proposal a FNAL (PAC, Physics Advisory Committee, P-1057)

  possibile riutilizzo degli spettrometri di OPERA

  schedula: 2015-2019

  FNAL sta elaborando un piano strategico per **short baseline**

  esaminerà P-1057 **in autunno**

Bibliografia recente NESSiE:

- **An Appraisal of Muon Neutrino Disappearance at Short Baseline arXiv 1306-3455v2 AHEP 2013(2013) Id 948626**
- **The NESSiE concept for sterile neutrinos XV Workshop on Neutrino Telescopes - Venice 2013 arXiv:1312.1227v1 [hep-ph] 4 Dec 2013**
- **''WA104 – NESSiE R&D plan", CERN-SPSC-2014-14, SPSC-SR-133**
- **Prospects for the measurement of muon-neutrino disappearance at the FNAL-Booster Apr 9, 2014. 76 pp. e-Print: arXiv:1404.2521 [hep-p]**

All the major items for 2015 rquested as sub judice,
Waiting for definition of formal actions at CERN and FNAL

NESSiE

Summary

- CERN and USA, following the outcomes by ESP (European Strategy) and P5 (strategy in USA), agreed to make R&D for neutrino at CERN and experiments at FNAL
- NESSiE Collaboration has submitted a Technical Report to CERN-SPSC and a Physics Proposal to FNAL (PAC, Physics Advisory Committee, number P-1057)
- FNAL is undergoing a strategic plan for the Short-Baseline projects
- Our FNAL proposal will be scrutinized in autumn
- The CERN Neutrino Platform has been approved and funded last week at the CERN Council (≈ 55 MCHF)
- The approved experiments WA104-Icarus, WA104-NESSiE and WA105 will correspond to MoU's

Luca Stanco, CdS 15 July 2014

Many discussions/meetings in the last 12 months:

- All along CERN-CENF
- October 2013: visit of large group of representatives at FNAL
- November 2013: restricted meeting at CERN of Neutrino ref. people
- January 2014: ICFA-EU in Paris
- February 2014: LBNE meeting at FNAL, SBL meeting at CERN
- March 2014: visit to INFN HQ
- April 2014: SPSC meeting and presentation
- June 2014: APPEC International Meeting for Large Neutrino Infrastruct.

Paper work:

- MoU for WA104, SPSC request for human and financial resources
  CERN-SPSC-2014-15, SPSC-M-785, 25 April 2014.

- SPSC request for TDR for WA104-NESSiE:
  A. Anokhina et al., "WA104 – NESSiE R&D plan", CERN-SPSC-2014-14, SPSC-SR-133

- FNAL-Booster SBL proposal: A. Anokhina et al., " Prospects for the measurement of ν_μ disappearance at the FNAL–Booster", arXiv:1404.2521, P-1057, 10 April 2014

Consuntivo 2013

- 3 talks: Neutrino telescope (Venezia), La Thuile, IFAE
- 2 posters: Lake Louise e IFAE
- 1 articolo ISI su rivista
- 2 articoli non ISI (proceedings)
- 3 tesi triennali

From Marzio Nessi's Talk @ APPEC (June 2014)

Given the still vague/evolving road map on long baseline ν activities in Europe, Japan and US

CERN

CERN adopted (pragmatical) position is to support, on the short term, generic R&D on ν detectors & beams and to support physics related to a ν short baseline (steriles, cross-sections, calibration, event reconstruction, ….). The goal is to assist and foster collaboration in Europe among the various ν institutions, independently where a Long and/or Short ν baseline(s) will be implemented

CERN Neutrino Platform

CERN council last week has decided to implement the proposed Medium Term Plan (MTP) which for the first time (since years) contains an important allocation of resources in the next 5 years dedicated to the Neutrino CERN Platform

From Marzio Nessi's Talk @ APPEC

This will cover:

- Generic ν detector R&D including large prototypes
- Design and generic R&D on ν beams
- The construction of a new experimental hall dedicated to neutrinos (Nord Area extension : EHN1) with charged test beams capabilities
- The reinforcement of various Technical/Scientific groups at CERN (cryogenics, physics, ….) which will support the activities of the platform
- The support with detectors and components of the Short Baseline at FNAL
- Support to various design/feasibility studies on this field (nustorm, ESS beam, …..)

CERN Neutrino Platform

2014 -2018

Neutrino detectors R&D

Preparation of 5 MOUs addenda in progress

WA104: rebuild ICARUS T600 in bldg 185 and make it ready for a FNAL beam

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 prototypes

MIND : R&D on muon tracking detectors

LBNF : Test of a LBNE module inside the WA105 cryostat

From Marzio Nessi's Talk @ APPEC

In the pipeline : Argoncube-TPC, Hyper-Kamiokande EU prototypes, new 200t TPC, ...

Aims of the Project

Precision measurement of muon momentum & charge in the 0.5 GeV - 10 GeV range

- relevant to disentangle ν anomalies in ν / anti-ν channels

- relevant in LBL exps to limit ν / anti-ν related systematics

From Laura Patriziii's Talk @ SPSC

Proposed strategy

A) The "conservative" approach

Air Core Magnet spectrometer coupled to Iron Core Magnet spectrometer – Coupling to upstream LAr TPC

B) The advanced solution (R&D)

- Superconducting ACM spectrometer – Coupling to upstream LAr TPC

-Magnetization of Large Volume LAr-TPC

WA104 -NESSiE R&D program

- First step - construction and operation of 13/39 ACM coils

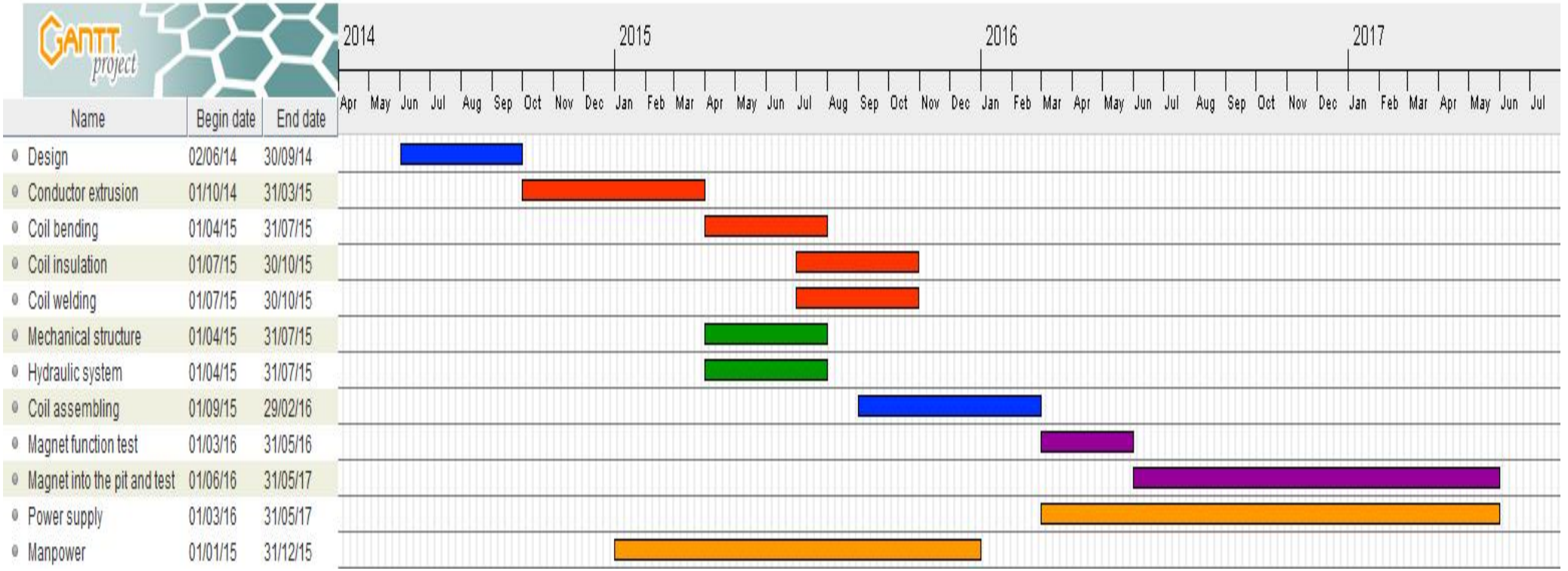
- R&D on Tracking Detectors in Magnetic Field
  - Scintillator bars + SiPM in analog and digital readout
  - Other tracking devices (RPC in analog readout)

- Charged beam tests
  - charge and momentum measurement
  - Test on LAr-TPC –ACM matching

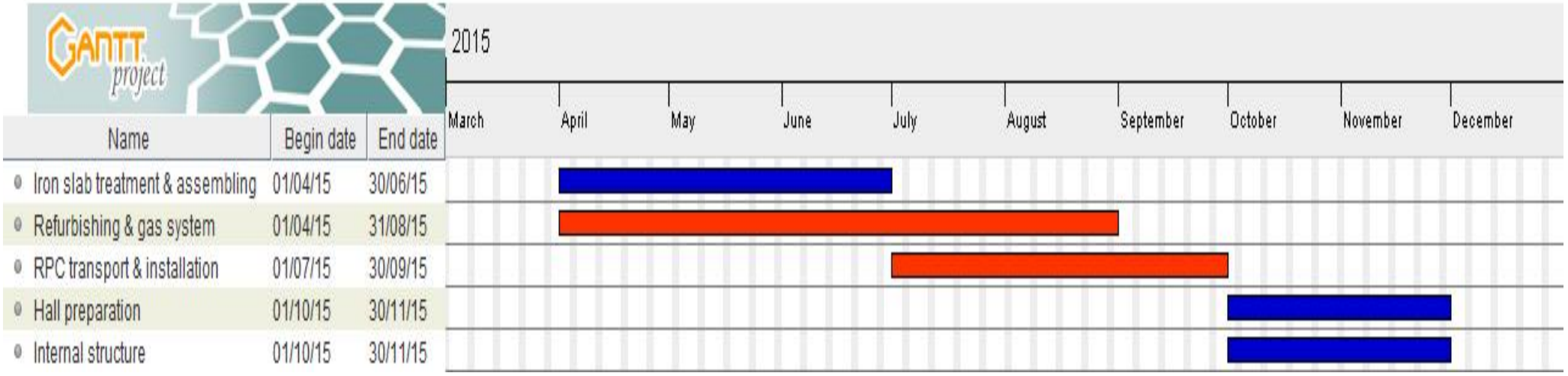
- Cold ACM in NbTi : design, simulation, demonstrator

- MgB2 Conductor: R&D actvity
  Synergy with LAr –TPC magnetization.

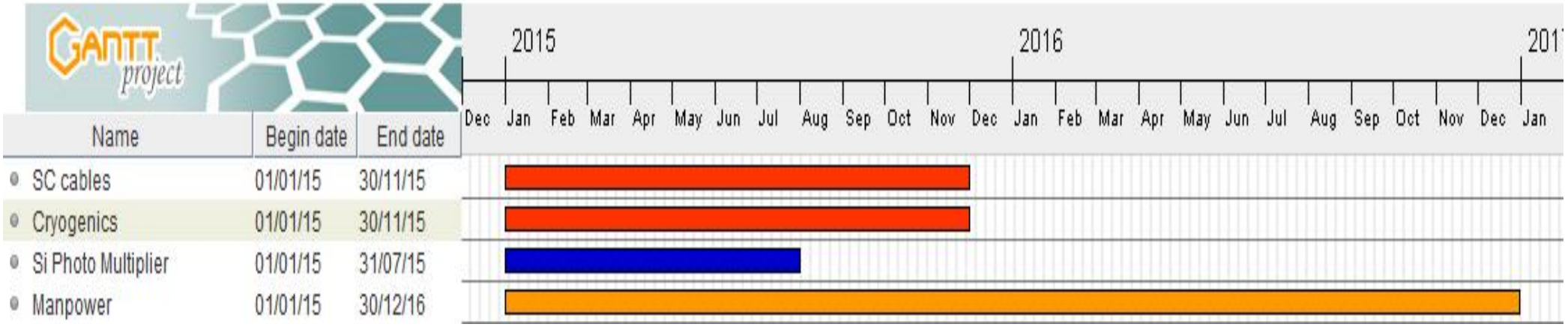
ACM construction



Return flux at CERN



R&D SuperConductor system

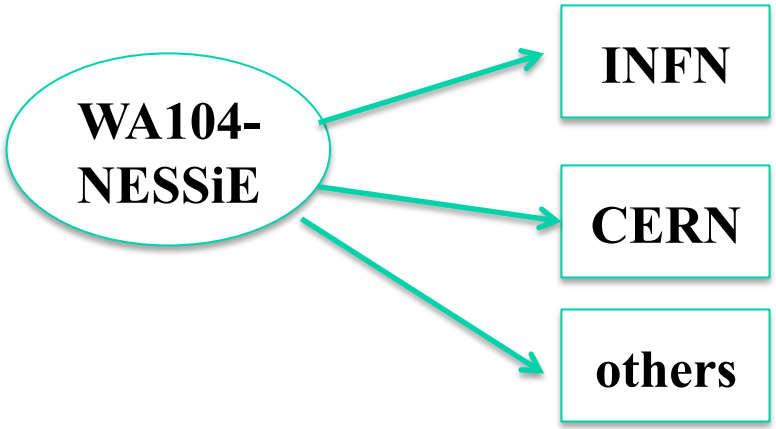


Outcome of CENR-SPSC, 10 April 2014

The SPSC **received with interest** the document describing the technical WA104-NESSiE programme (SPSC-SR-133-2014). The Committee **supports** the R&D on air core magnets and associated detectors that could be used for future neutrino projects, and **encourages** synergy with the Liquid Argon (LAr) R&D programmes.
The SPSC **requests** a document quantifying the human and financial resources needed for all aspects of the project, including the requests to CERN.

MoU

MoU for WA104-NESSiE



NESSiE:

Spokesperson: *Luca Stanco*
Chairperson Collaboration Board: *Laura Patrizii*
Technical Coordinator: *Paolo Bernardini*
Contact Person at CERN: *Stefano Dusini*
GLIMOS : *Giovanni Marsella*

ANNEX 3: List of Institutes, Funding Agencies and Representatives

NESSiE:

1. ***INFN**, Sezione di **Bari**, 70126 Bari, Italy,*
   represented by Saverio Simone;
2. *Dipartimento di Fisica, **Università** di **Bari**, 70126 Bari, Italy,*
   represented by Marilisa De Serio;
3. ***INFN**, Sezione di **Bologna**, 40127 Bologna, Italy,*
   represented by Laura Patrizii;
4. *Dipartimento di Fisica, **Università** di **Bologna**, 40127 Bologna, Italy,*
   represented by Maurizio Spurio;
5. *Rudjer **Boskovic** Institut, Bijenicka 54, 10002 **Zagreb**, Croatia,*
   represented by Mario Stipcevic;

NEW

6. ***CERN**, Geneva, Switzerland,*
   represented by Marzio Nessi;
7. ***INFN**,Laboratori Nazionali di **Frascati**, 00044 Frascati (Roma), Italy,*
   represented by Andrea Longhin,
8. ***Lebedev** Physical Institute of Russian Academy of Science, Leninskie pr., 53, 119333 Moscow, Russia, represented by Natalia Poluhina;*
9. ***INFN**, Sezione di Lecce, 73100 **Lecce**, Italy,*
   represented by Giovanni Marsella;
10. *Dipartimento di Matematica e Fisica, **Università** del Salento, 73100 **Lecce**, Italy,*
    represented by Paolo Bernardini;
11. ***Lomonosov** Moscow State University (MSU-SINP), 1(2) Leninskie goy, GSP-1, 119991 Moskow, Russia, represented by Tatiana Roganova;*
12. ***INFN**, Sezione di **Padova**, 35131 Padova, Italy,*
    represented by Stefano Dusini;
13. *Dipartimento di Fisica e Astronomia, **Università** di **Padova**, 35131 Padova, Italy,*
    represented by Riccardo Brugnera;
14. *Dipartimento di Fisica e Astronomia, **Università** di **Roma** "La Sapienza", 00185 Roma, Italy, represented by Giovanni Rosa.*

	cost KCHF	INFN (%)	Other FA (%)	CERN (%)
ACM construction				
TOTAL	**513**	**79% (403)**	**2% (12)**	**19% 98**
Return Flux at CERN				
TOTAL	**140**	**53% (74)**	**15% (21)**	**32% (45)**
R&D SC system				
TOTAL	**350**	**15% (52)**	**1% (3)**	**84% (295)**
Tracker system				
TOTAL	**275**	**195**	**20**	**60**
GRAN TOTAL	**1278**	**724**	**56**	**498**

MoU

Released yesterday, July 14th, by CERN Project Manager

Power Supply 10 kA by CERN: 620 KCHF in-kind loan for 1 year

FNAL-NESSiE

Prospects for the measurement of ν_μ disappearance at the FNAL-Booster

The NESSiE Collaboration

arXiv:1404.2521, P-1057

in case of a positive outcome from FNAL, we are fully open

- *either to accept any new USA Collaborator*
- *and to be part of the larger project for SBL at FNAL*

A. Anokhina[11], A. Bagulya[10], M. Benettoni[12], P. Bernardini[8,7], R. Brugnera[13,12], M. Calabrese[7], A. Cecchetti[6], S. Cecchini[3], M. Chernyavskiy[10], P. Creti[7], F. Dal Corso[12], O. Dalkarov[10], A. Del Prete[9], G. De Robertis[1], M. De Serio[2,1], L. Degli Esposti[3], D. Di Ferdinando[3], S. Dusini[12], T. Dzhatdoev[11], C. Fanin[12], R. A. Fini[1], G. Fiore[7], A. Garfagnini[13,12], S. Golovanov[10], M. Guerzoni[3], B. Klicek[15], U. Kose[5], K. Jakovcic[15], G. Laurenti[3], I. Lippi[12], F. Loddo[1], A. Longhin[6], M. Malenica[15], G. Mancarella[8,7], G. Mandrioli[3], A. Margiotta[4,3], G. Marsella[8,7], N. Mauri[6], E. Medinaceli[13,12], A. Mengucci[6], R. Mingazheva[10], O. Morgunova[11], M. T. Muciaccia[2,1], M. Nessi[5], D. Orecchini[6], A. Paoloni[6], G. Papadia[9], L. Paparella[2,1], L. Pasqualini[4,3], A. Pastore[1], L. Patrizii[3], N. Polukhina[10], M. Pozzato[4,3], M. Roda[13,12], T. Roganova[11], G. Rosa[14], Z. Sahnoun[3‡], S. Simone[2,1], C. Sirignano[13,12], G. Sirri[3], M. Spurio[4,3], L. Stanco[12,a], N. Starkov[10], M. Stipcevic[15], A. Surdo[7], M. Tenti[4,3], V. Togo[3], M. Ventura[6] and M. Vladymyrov[10].
(a) Spokesperson

1. INFN, Sezione di Bari, 70126 Bari, Italy
2. Dipartimento di Fisica dell'Università di Bari, 70126 Bari, Italy
3. INFN, Sezione di Bologna, 40127 Bologna, Italy
4. Dipartimento di Fisica dell'Università di Bologna, 40127 Bologna, Italy
5. European Organization for Nuclear Research (CERN), Geneva, Switzerland
6. Laboratori Nazionali di Frascati dell'INFN, 00044 Frascati (Roma), Italy
7. INFN, Sezione di Lecce, 73100 Lecce, Italy
8. Dipartimento di Matematica e Fisica dell'Università del Salento, 73100 Lecce, Italy
9. Dipartimento di Ingegneria dell'Innovazione dell'Università del Salento, 73100 Lecce, Italy
10. Lebedev Physical Institute of Russian Academy of Science, Leninskie pr., 53, 119333 Moscow, Russia.
11. Lomonosov Moscow State University (MSU SINP), 1(2) Leninskie gory, GSP-1, 119991 Moscow, Russia
12. INFN, Sezione di Padova, 35131 Padova, Italy
13. Dipartimento di Fisica e Astronomia dell'Università di Padova, 35131 Padova, Italy
14. Dipartimento di Fisica dell'Università di Roma "La Sapienza" and INFN, 00185 Roma, Italy
15. Rudjer Boskovic Institute, Bijenicka 54, 10002 Zagreb, Croatia

‡ Also at Centre de Recherche en Astronomie Astrophysique et Geophysique, Alger, Algeria

Key-points of the proposal:

1. The muon-neutrino disappearance is mandatory
   - either in case of null result on electron-neutrino
     (the sterile possibility might still be there due to interference modes and data mis-interpretation)
   - or in case of positive result
     (to address the correct interpretation of sterile, see current tension between appearance/disappearance)

2. Standalone measurement of muon-neutrinos
   (fully compatible with upstream LAr, or, in case, a small active scintillator target may be foreseen at Near-site for NC/CC and absolute rate control)

3. Interplay between systematic and statistical errors: optimized configuration for Near and Far sites

4. No R&D/refurbishing/upgrade: robustness of the program
   (80% of re-used well proven detectors, straightforward extension; < 100 kWatt needed for each site)

5. IDENTICAL near and far detector
   (the same iron slab will be cut in two pieces to be put corresponding in the Near and the Far)

Careful study of the FNAL-Booster neutrino beam,
based on previous knowledge from MiniBooNE, SciBooNE and data obtained by HARP and E910.

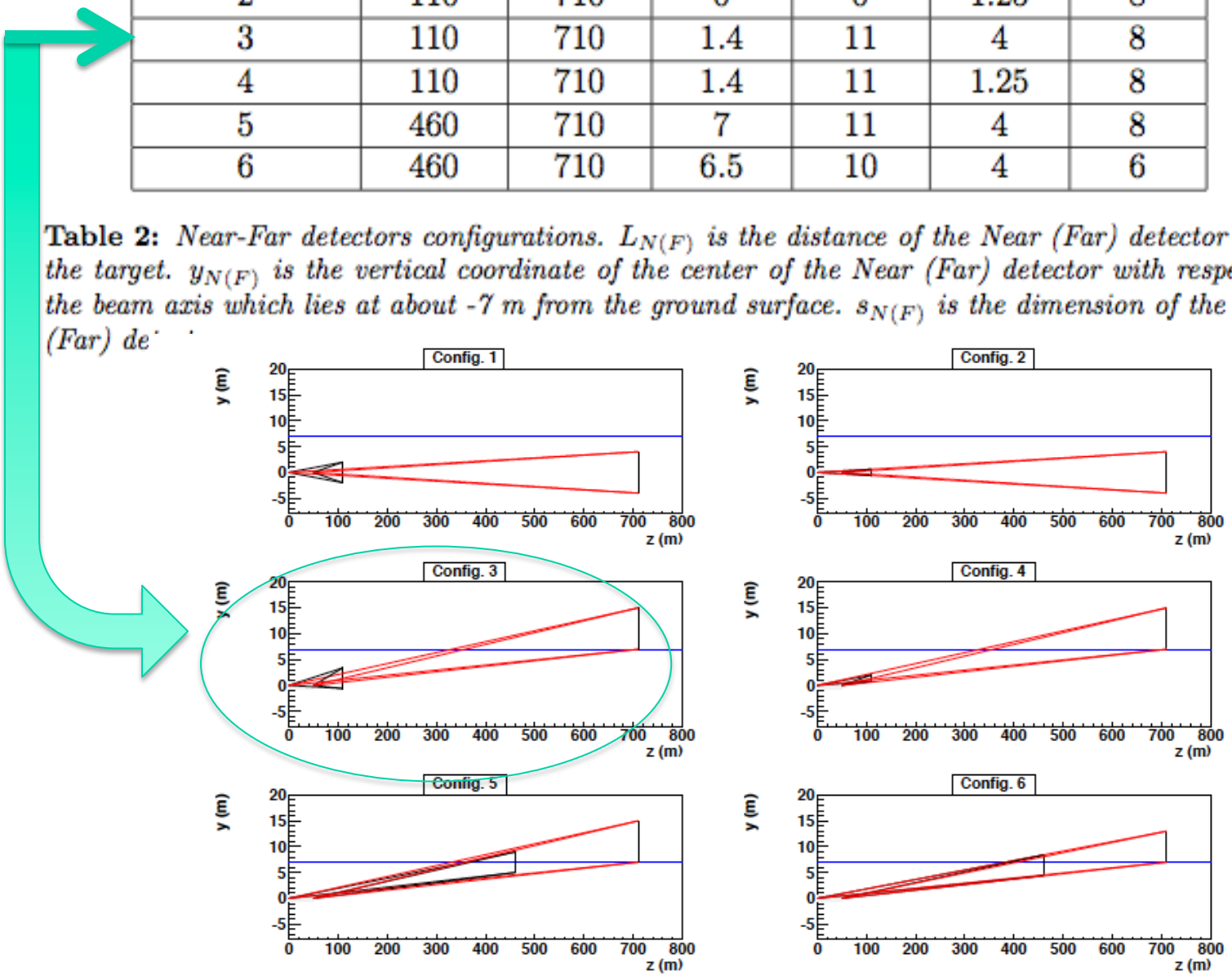
- full simulation of the beam with GEANT4 and FLUKA
  (from proton to neutrinos)

- detailed systematic error source analysis
  (use of Sanford-Wang parametrization)

- Several configurations analyzed, on/off-axis including MicroBooNE site and different detector sizes

configuration	L_N (m)	L_F (m)	y_N (m)	y_F (m)	s_N (m)	s_F (m)
1	110	710	0	0	4	8
2	110	710	0	0	1.25	8
3	110	710	1.4	11	4	8
4	110	710	1.4	11	1.25	8
5	460	710	7	11	4	8
6	460	710	6.5	10	4	6

Table 2: *Near-Far detectors configurations. $L_{N(F)}$ is the distance of the Near (Far) detector from the target. $y_{N(F)}$ is the vertical coordinate of the center of the Near (Far) detector with respect to the beam axis which lies at about -7 m from the ground surface. $s_{N(F)}$ is the dimension of the Near (Far) de*



Sanford-Wang

chosen configuration

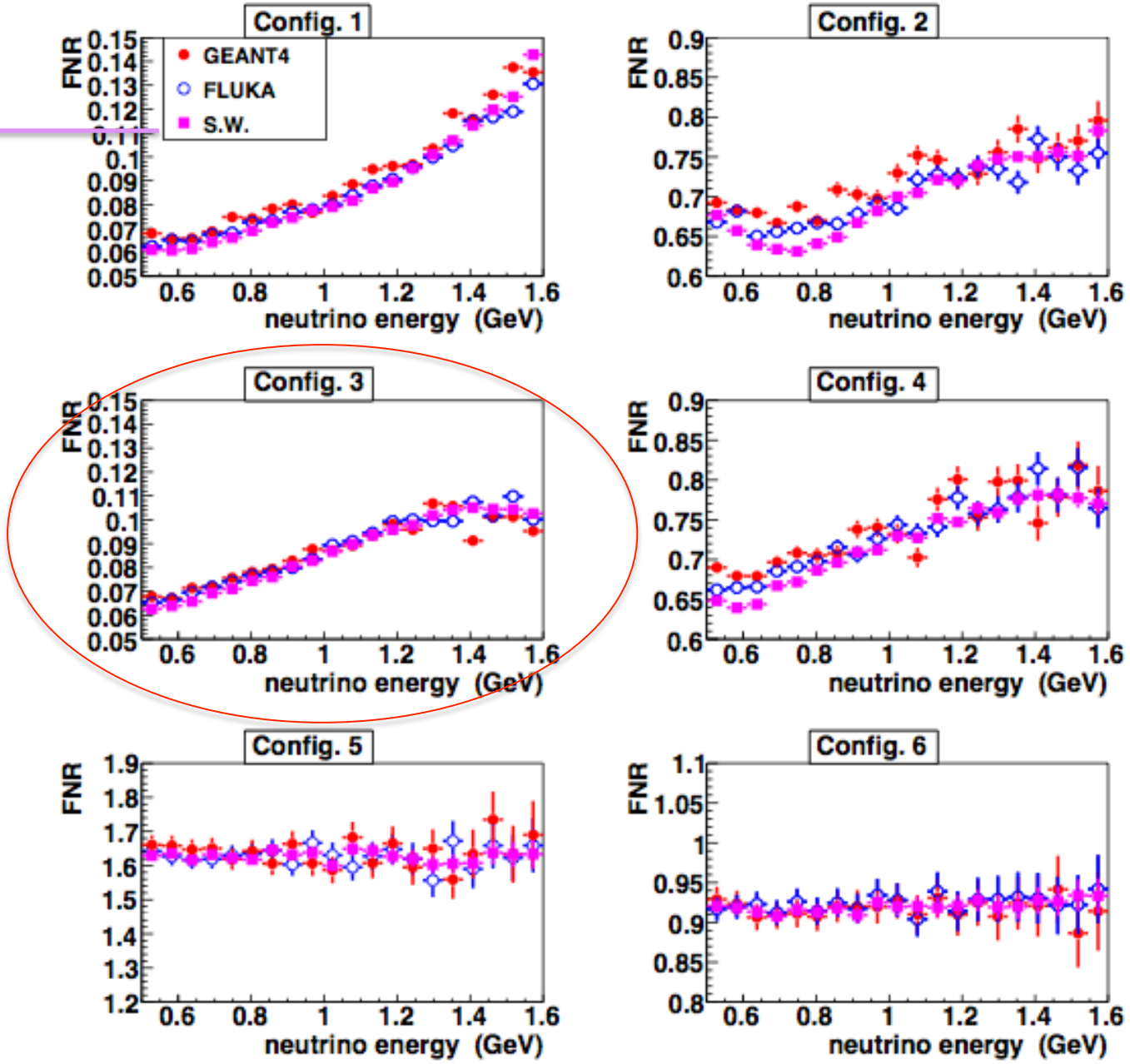


Figure 10: *Far-to-Near ratios for the six considered configurations. Comparison of FLUKA and GEANT4 for hadroproduction.*

Iron slabs thinner than those available by OPERA NOT worth

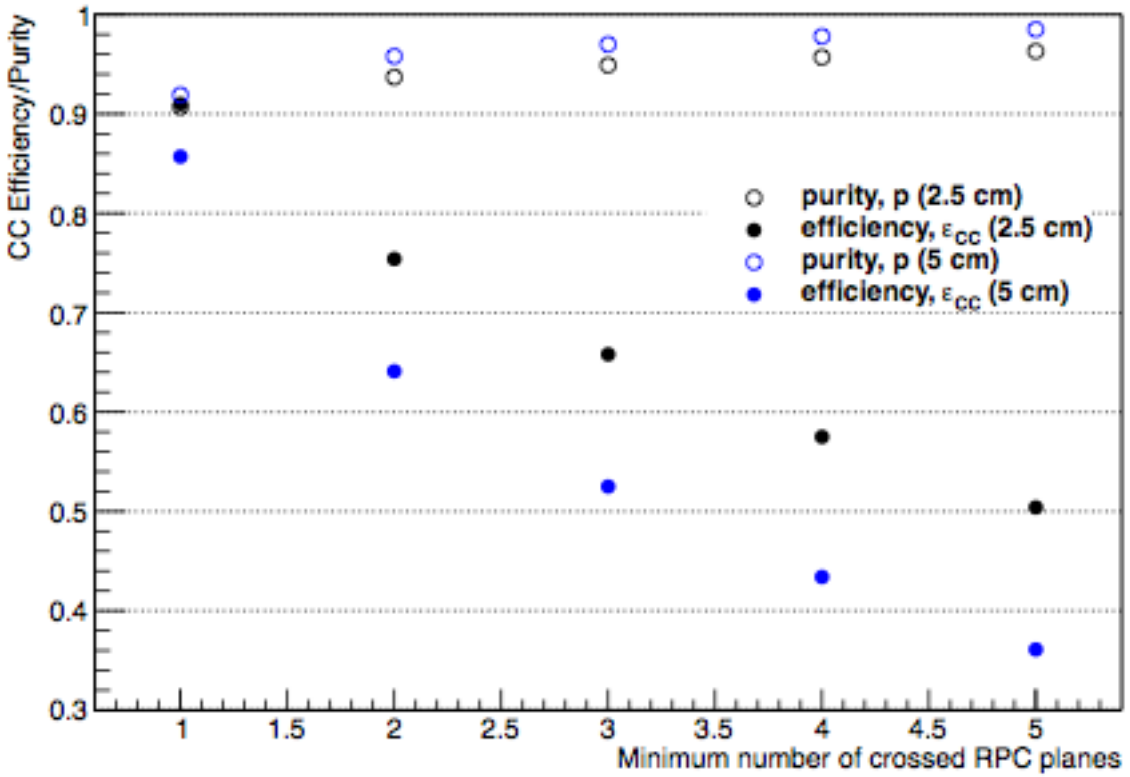
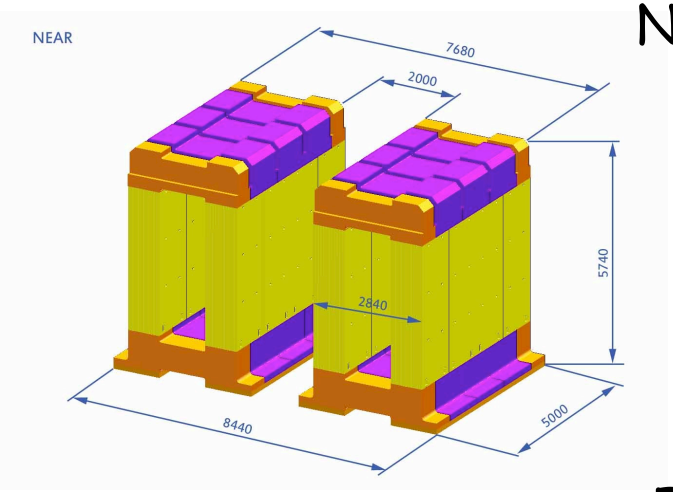
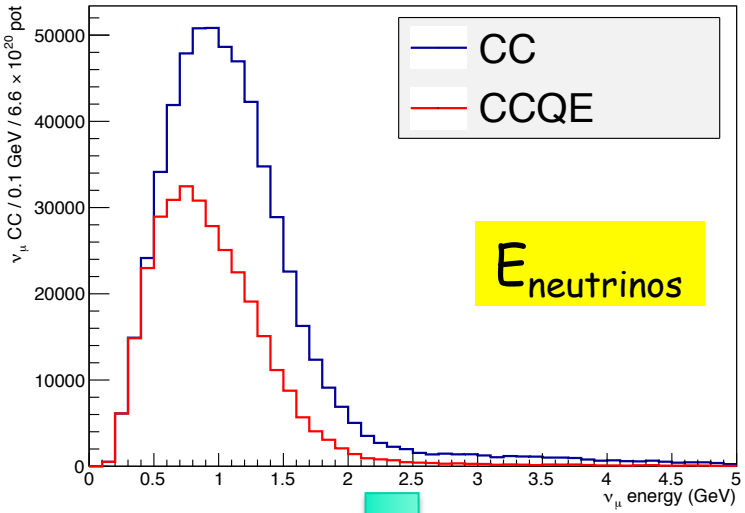


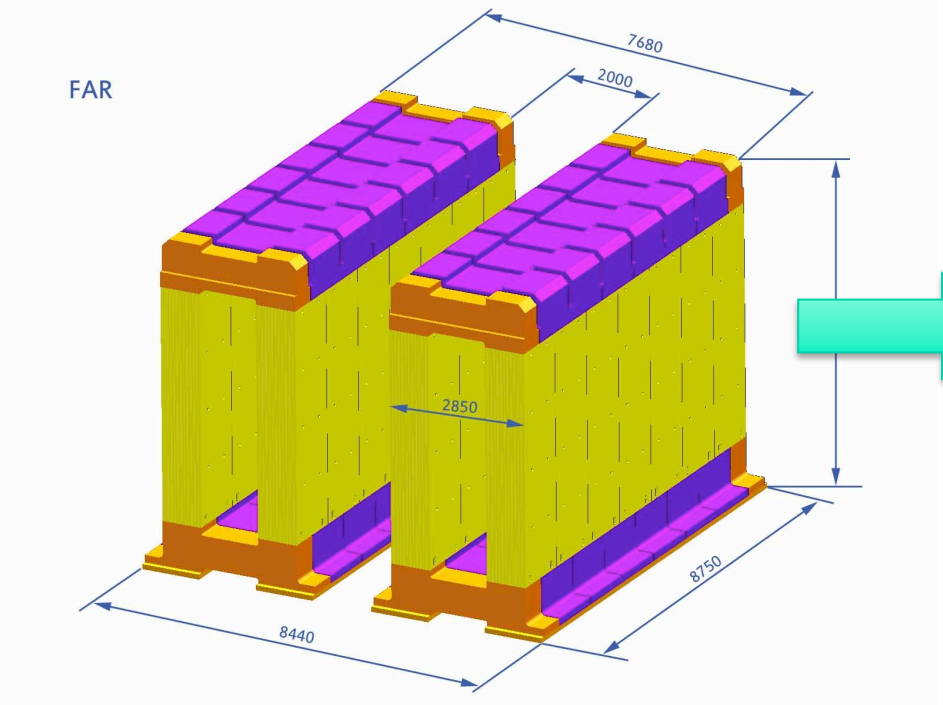
Figure 18: *CC efficiency (ε_{CC}, points) and purity (p, open circles) as a function of the minimum number of RPC planes for the two spectrometer geometries, 5 cm slabs (in blue) and 2.5 cm slabs (in black). For a given level of purity p the efficiencies for the two geometries are similar, therefore no advantage in statistics is taken requiring the same NC contamination suppression.*

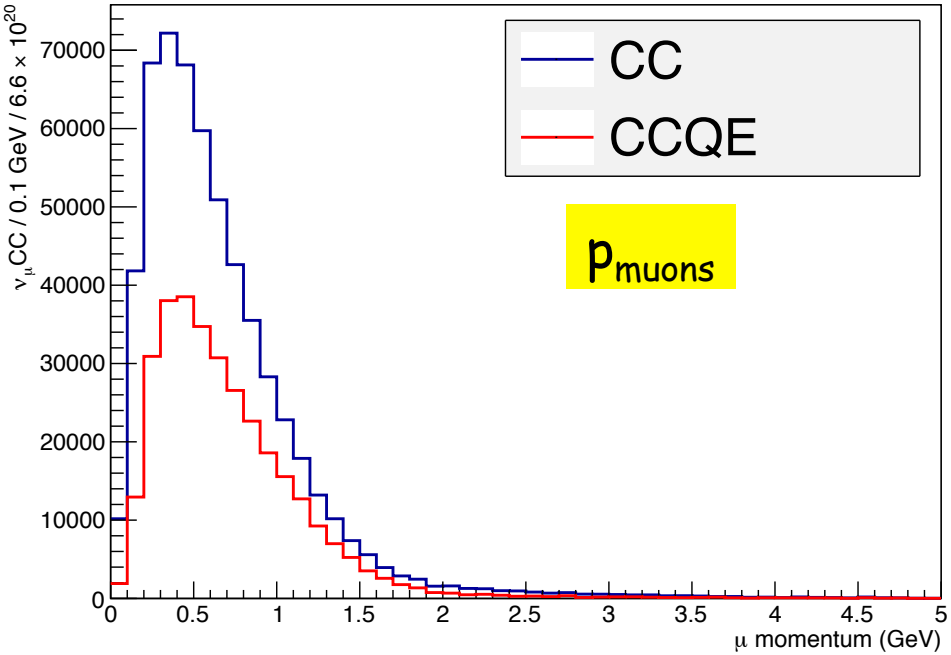
Near site





Far site

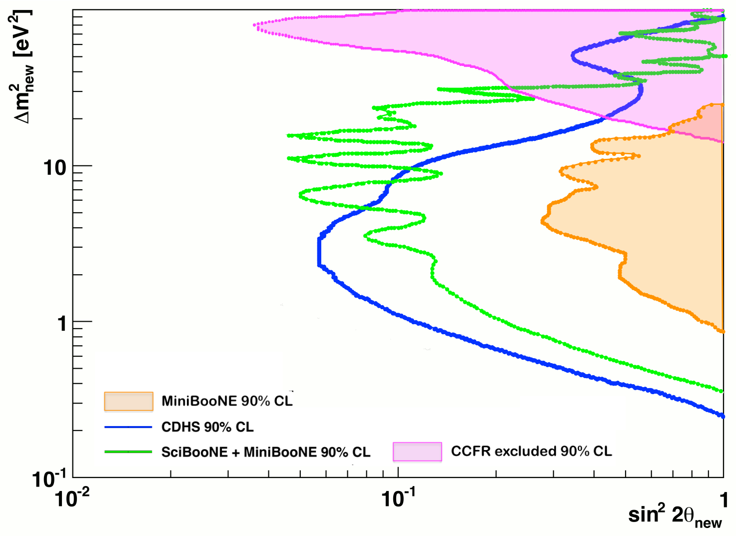


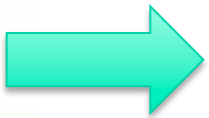


ABSOLUTE nb. interactions in fiducial volume Far, 3 years data taking

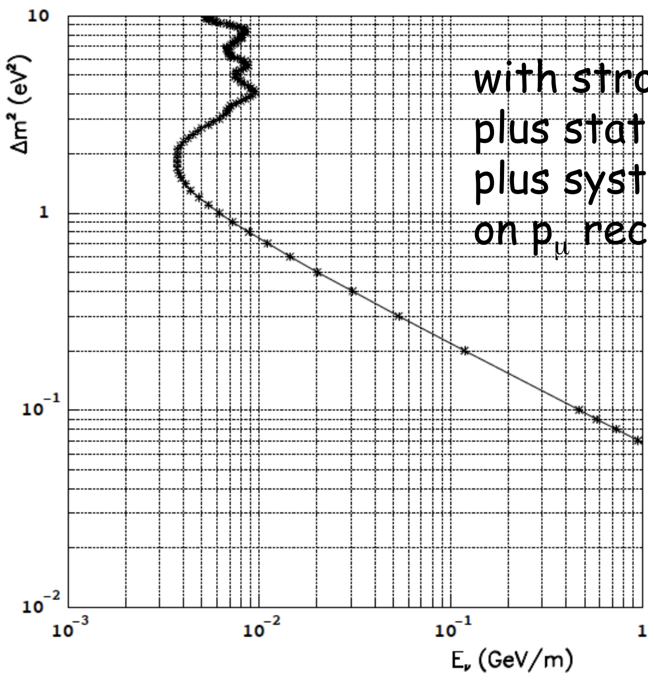
Sensitivity

from here (now)

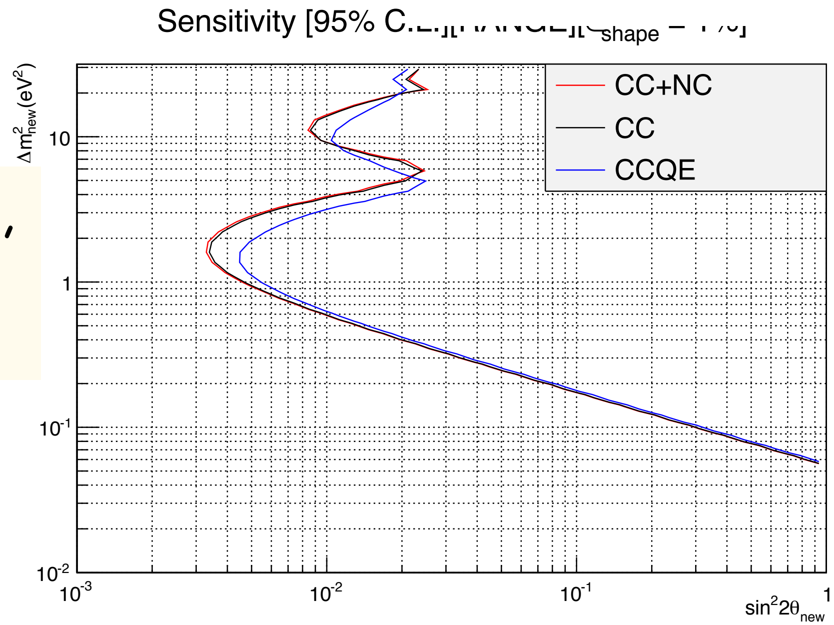




to here (NESSiE)



with strong cuts
plus statistical error
plus systematics only
on p_μ reconstruction



Three independent analysis, with different statistical approaches

Above conditions plus
a full simulation
and a careful treatment
of 1% systematics error

Schedule and Costs

A bit aggressive, but reliable schedule based on successful OPERA experience

Year(portion)	Action
1^{rst} half 2015	Define tenders/contracts
2^{nd} half 2015	Site preparation
	Setting up Detectors Test-stands
1^{rst} half 2016	Mechanical Structure construction
	Start Magnet installation
	Start detectors installation
2^{nd} half 2016	End installation
1^{rst} half 2017	Commissioning and Starting Run
2^{nd} half 2019	End Data Taking

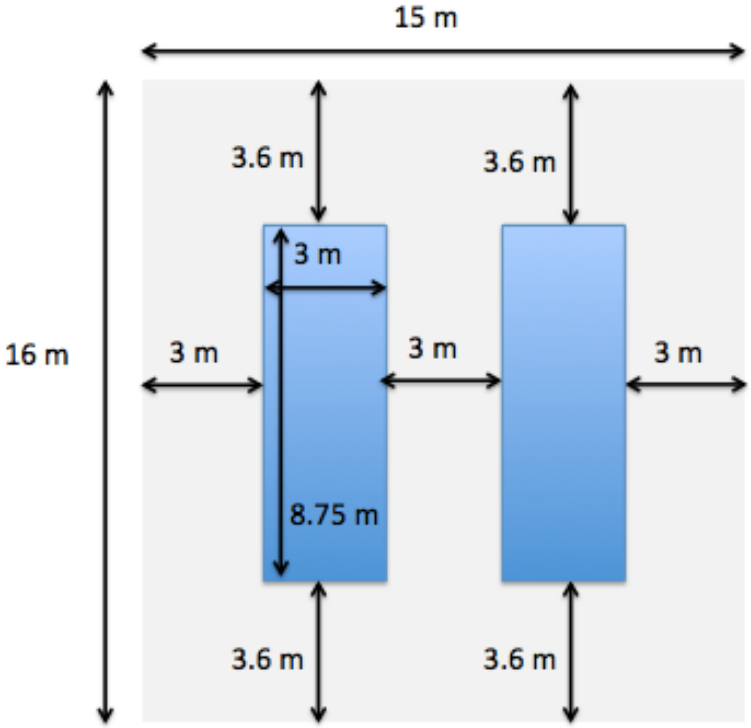
Both Near and Far

Item	Cost (in M €)
Far	
Magnet	2.5 (in–kind)
RPC detectors	0.8 (in–kind)
Strips	0.3 (in–kind)
New Electronics	0.2
Data Acquisition	0.1
Near	
Magnet	2.0 (in-kind)
Top/bottom yokes	1.0
Coils, Power Supplies	0.2
RPC detectors	0.6 (in–kind)
New detectors	0.2
Strips	0.2 (in–kind)
New Electronics	0.1
Data Acquisition	0.1
Transportation	0.6
Total	2.5 + 6.4 (in–kind)

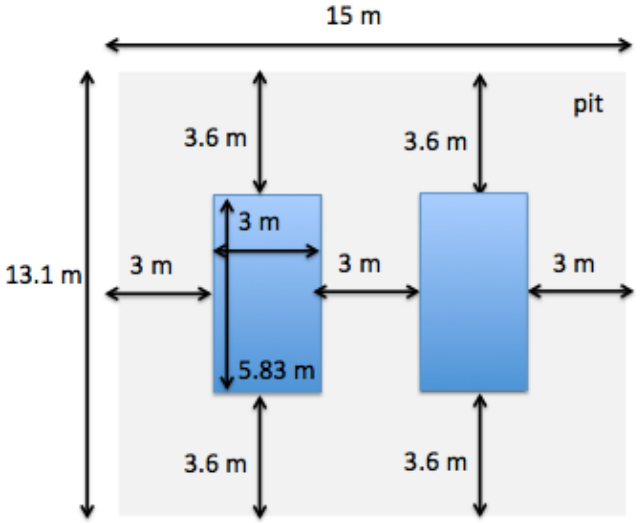
(new Electronics, new DAQ, 2 x coil number)

For an ease installation…

FAR site, on SURFACE



NEAR site, in the pit



Note: the detectors size is 6x6 m^2
In case business go on,
there is room for discussion

Status of FNAL-NESSiE, June 2014

Proposal well received by FNAL director.
PAC number attributed.
It will scrutinized in the next autumn.

Dear Prof. Stanco

Thank you for the proposal from the NESSiE Collaboration "Prospects for the measurement of ν_μ disappearance at the FNAL-Booster," to which we have assigned proposal number P-1057.

As you know, Fermilab is considering development of a Short-Baseline Neutrino (SBN) program utilizing the existing Booster Neutrino Beam, based on the approved MicroBooNE experiment, which will start running later this year, and possibly the ICARUS T600 and LAr1-ND detectors whose proposals were presented at the PAC meeting in January of this year. The program has been endorsed in the recently issued P5 report, which recommends: "Select and perform in the short term a set of small-scale short-baseline experiments that can conclusively address experimental hints of physics beyond the three-neutrino paradigm. Some of these experiments should use liquid argon to advance the technology and build the international community for LBNF at Fermilab."

The NESSiE proposal was submitted too late for consideration by the PAC in January, but it is well appreciated and in line with the P5 recommendations. Therefore we plan to consider it in future PAC meetings. The strategy for the SBN program, including multiple detectors, will be discussed at the July 23-25 PAC meeting, but specific experimental proposals will not be presented. A full review of the NESSiE proposal, which would be necessary to make a decision regarding it, will be scheduled for the following PAC meeting in the fall (exact dates to be determined).

Best regards,

Nigel Lockyer
Director of Fermilab

cc: Fernando Ferroni, President, INFN
Antonio Masiero, Vice-President, INFN

Then,

we are forced to undergo a “WAIT & WATCH” scheme:

- **very low FTE percentages**
- **major items requested as sub judice**

NESSIE Collaboration

ITALY

- Bari: 0.3 FTE/3
- Bologna: 1.5/7
- Frascati: 0.1/1
- Lecce: 1.5/4
- Padova: 1.6/10
- Roma1: 0.3/1

TOTAL: 5.3 FTE / 26 People

Richieste finanziarie 2015

Missioni: 118 K + 72 K (s.j.)
Consumo: 75 K + 487 K (s.j.)
Inventario: 5 K (s.j.)
Totali:193 K + 564 (s.j.)

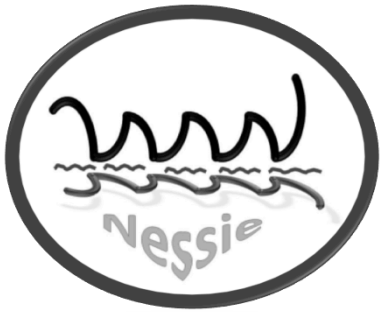
Richieste ai servizi PADOVA per il 2015:

Elettronica: t.b.d.

Meccanica: t.b.d

Uffico Tecnico: 4 m.u. per supporto valutazione siti CERN/FNAL

Thank you !



NESSiE at CERN

NESSiE at FNAL