nuSTORM meeting

chaired by Kenneth Long (Imperial College London), Elena Wildner (CERN)

from Tuesday, March 26, 2013 at **12:30** to Wednesday, March 27, 2013 at **19:00** (US/Central)
at **CERN**
866-2-D05 & 864-1-C02

The NESSiE concept for Sterile Neutrinos

1) The Sterile Neutrino Issue with SPS beam at CERN

2) Which Detector(s) ?

Luca Stanco (INFN-PD)

March 27, 2012

INFN Istituto Nazionale di Fisica Nucleare

Proposal SPSC-P347 (March 2012)
(ICARUS + NESSIE)

1. Physics ground & Different Scenarios
2. Latest Beam & new simulation
3. Spectrometers
4. CERN Schedule disantengling

"Tensions" in the Standard Model between Quark and Lepton sectors:

- ***No right handed neutrino (in classical SM)***
- ***Neutrinos are neutral***
- ***Majorana masses*** *(the HIERARCHY problem)*
- ***Very different from quarks: large mixings and tiny masses*** *(the FLAVOUR puzzle)*
- ***Non coherent picture: discrepancies at ≈ 3-4 sigma level, in several measurements…***

As Higgs is going to be where expected and with expected properties …

As many open questions stay (e.g. Dark Matter)…

Neutrinos are an excellent place for looking Beyond Standard Model

Neutrino oscillations have established a picture through a large number of experiments consistent with the mixing of three physical neutrino ν_e,ν_μ and ν_τ with mass eigenstates ν_1,ν_2 and ν_3.

BUT

Anomalies appear in neutrino data in the region of $\Delta m^2 \sim eV^2$

Predominantly from single detector experiments…

Are they measurement "errors" or are they due to unaccounted oscillations between EW active neutrinos and other non-active neutrinos ?

Sterile neutrinos

- The possible presence of oscillations into sterile neutrinos was proposed by B. Pontecorvo, *(JETP, 53, 1717, 1967)*, but so far without conclusion.
- "Sterile" means "No Standard Model Interactions"
(i.e think to anti-ν_R, light neutrinos which can oscillate with "active" neutrinos)
- Smoking Gun: Neutral Current Deficit
- Counterchecked Smoking Gun: NC/CC ratios

- Two distinct classes of anomalies have been analyzed, namely
  - the apparent ***disappearance signal*** in the anti-ν_e events detected from (1) near-by nuclear reactors and (2) the from Mega-Curie k-capture calibration sources in the Gallium experiments to detect solar ν_e
  - observation for ***excess signals*** of anti-ν_e electrons from neutrinos from particle accelerators (LNSD/MiniBooNE)

- At least a fourth non-standard neutrino state can oscillate at small distances, $\Delta m^2_{new} \approx 1$ eV^2 (➔ **SHORT BASELINE projects)**

PHYSICS

What do you want to **discover** ?

What do you need/want to **disprove** ?

What do you need to **measure** ?

different answers to different questions:

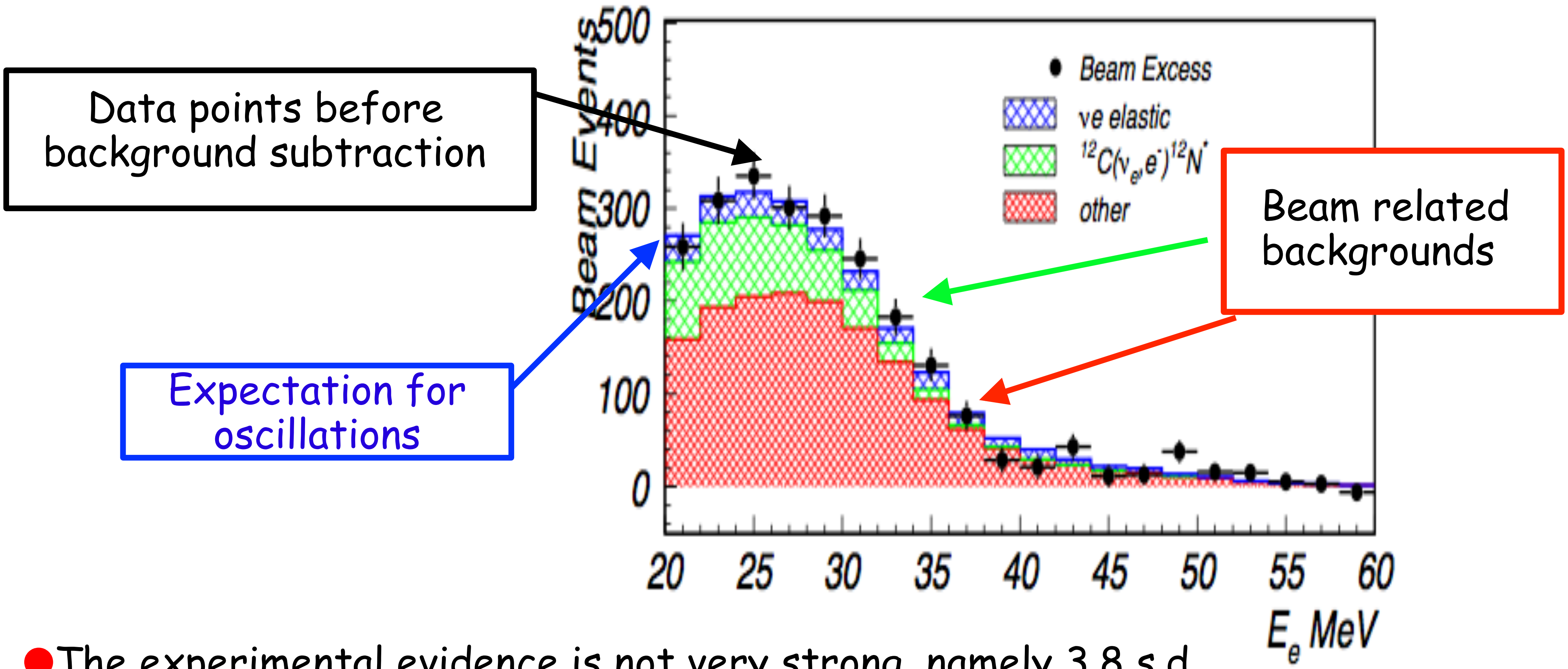
You want to discover **New Physics**

You want to outcome **Negative Physics**

You want to use **New Technologies**

LSND: Evidence for ($\nu_\mu \rightarrow \nu_e$)

Excess of events: 87.9 ± 22.4 ± 6.0



- The experimental evidence is not very strong, namely 3.8 s.d.
- **The experimental result so far has not been challenged experimentally**

MiniBooNE (USA, 15 years of work/money/people) was inconclusive

Going on and next Future

ANOMALIES/Steriles

Radioactive sources
Reactors
Beams

None of these experiments can be considered the definitive one:, which is

*- measure ν and **anti-ν**, **muons** ed **electrons***
- in different sites (≥ 2)
- provide a 5 sigma result

We need a Superior Class Experiment: 3 Kton Fe + 1 Kton LAr

The ultimate 3+1 experiment !

CERN

- CERN, towards creating an infrastructure (actually a MULTI-structure) at **North Area** for beams/R&D/multi-experiments

- **Underway**

- **Multistep project**
  Begin with SBL and R&D neutrino detectors,
  proceed with nuStorm and LBNO

- **What** ? (decide on tecnology)
  we are proposing LAr+Fe

Mandatory: measure ν-muon disappearance
(see yesterday Stephen Parke presentation and following discussion)

CERN DG requested a detailed document in November, ready on February 7th.

Letter of Intent for the New CERN Neutrino Facility

Draft 0 - v1.

January 11, 2013

Neutrinos CERN Community

ABSTRACT:
The nature and characteristics of neutrinos still represent one of the most intriguing questions of modern particle physics. This Letter of Intent presents a plan to build at CERN a Short Baseline Neutrino Facility capable to meet this challenge. The new beam line will make use of the SPS beam, it will be located in the CERN North Area of the Prevessin site and will comprise in a first step 2 experimental halls (far and near) which will host the detector facilities. The beam layout will be compatible with a long neutrino baseline which might be constructed in a second stage.

KEYWORDS: Neutrino, Short-baseline, Long-baseline, Sterile Neutrinos, ICARUS, NESSIE, LAGUNA, LBNO, CERN.

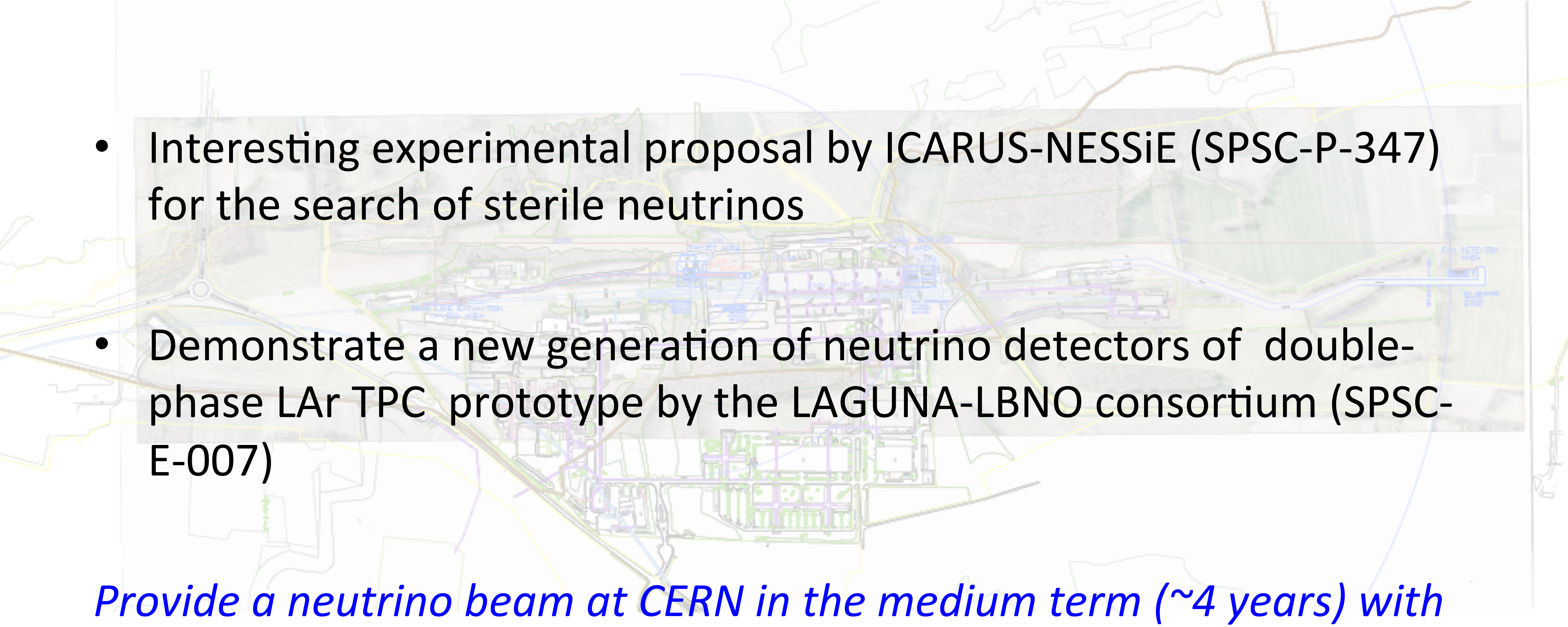
Leader Project:
Marzio Nessi (Cern)

Deputy:
Rende Steerenberg (Cern)

- **200 pages for 5 Work-Packages,**
- **a TDR for Beam, Infrastructures and Experiments**

M. Nessi©

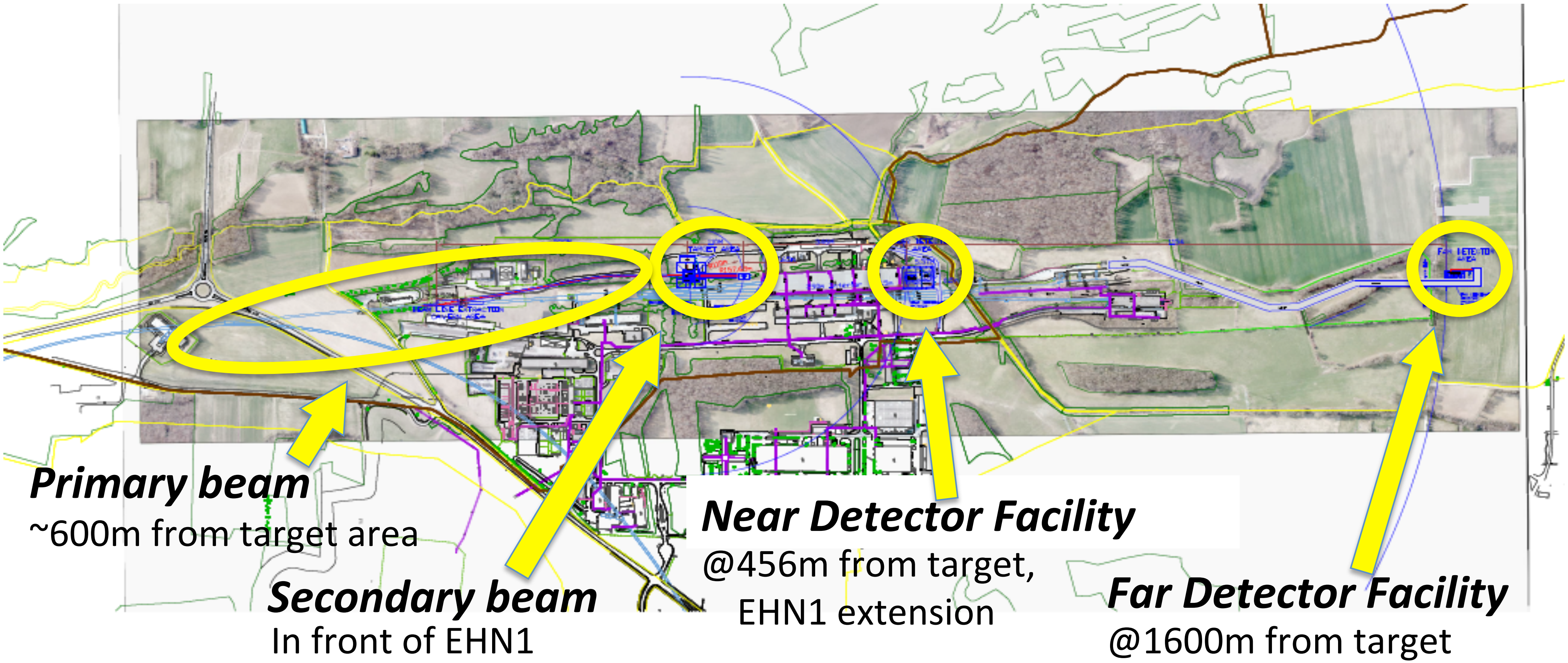
In practice (existing requests)

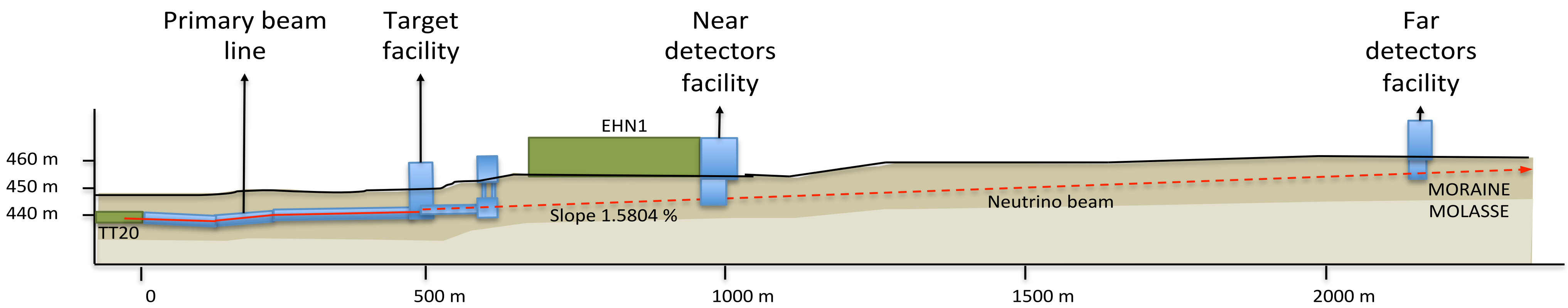


- Interesting experimental proposal by ICARUS-NESSiE (SPSC-P-347) for the search of sterile neutrinos

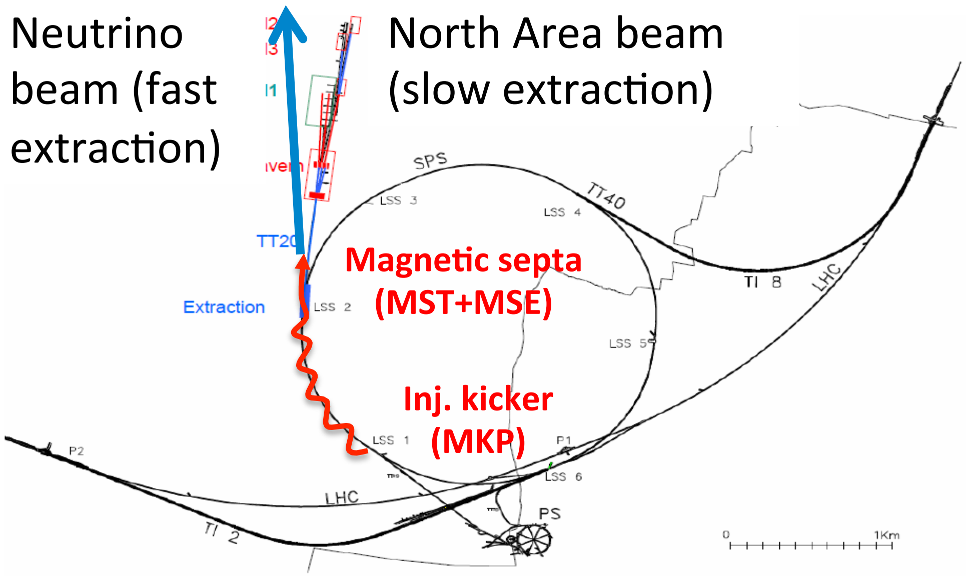
- Demonstrate a new generation of neutrino detectors of double-phase LAr TPC prototype by the LAGUNA-LBNO consortium (SPSC-E-007)

Provide a neutrino beam at CERN in the medium term (~4 years) with 2 experimental facilities (near and far). Satisfy the existing requests and allow new detectors/ideas to come forward


Primary beam
~600m from target area
Secondary beam
In front of EHN1
Near Detector Facility
@456m from target,
EHN1 extension
Far Detector Facility
@1600m from target


Primary beam line
Target facility
Near detectors facility
Far detectors facility
EHN1
460 m
450 m
440 m
TT20
Slope 1.5804 %
Neutrino beam
MORAINE
MOLASSE
0
500 m
1000 m
1500 m
2000 m

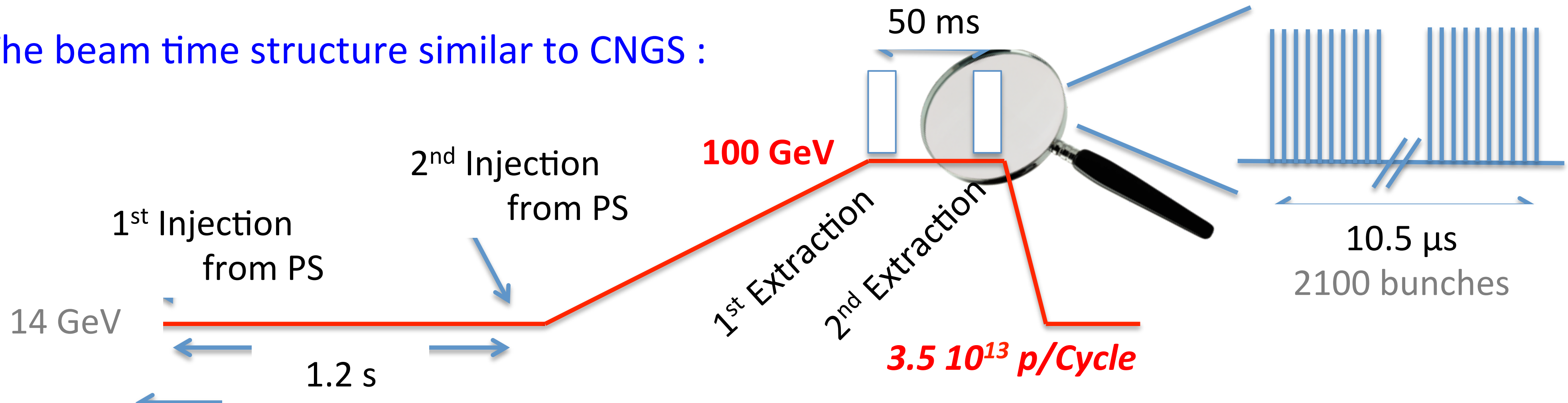
Which type of beam can CERN offer?



Fast extraction

- Beam excitation via injection kicker in LSS1 + extraction in LSS2 via existing septa *(incompatibility with simultaneous north area slow extracted beam !)*
- *Solution tested for low intensities during recent beam tests*

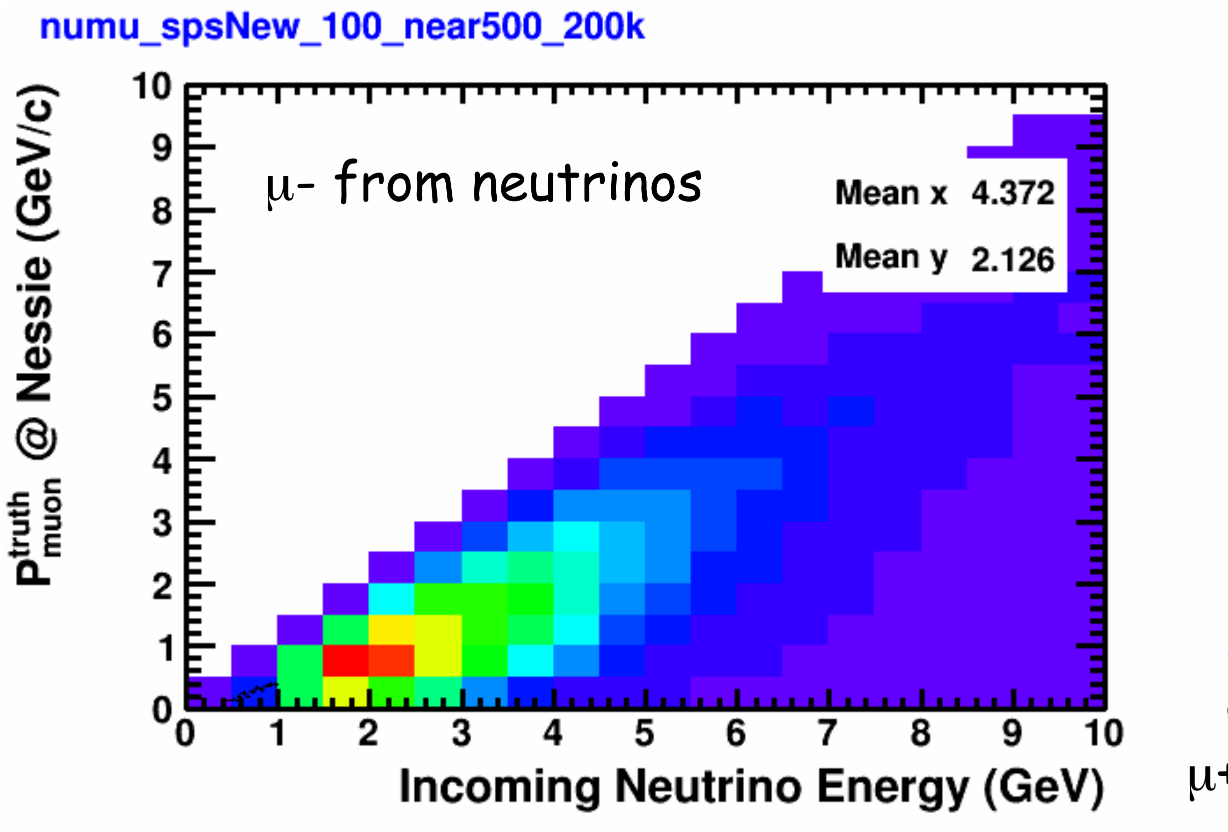
The beam time structure similar to CNGS :

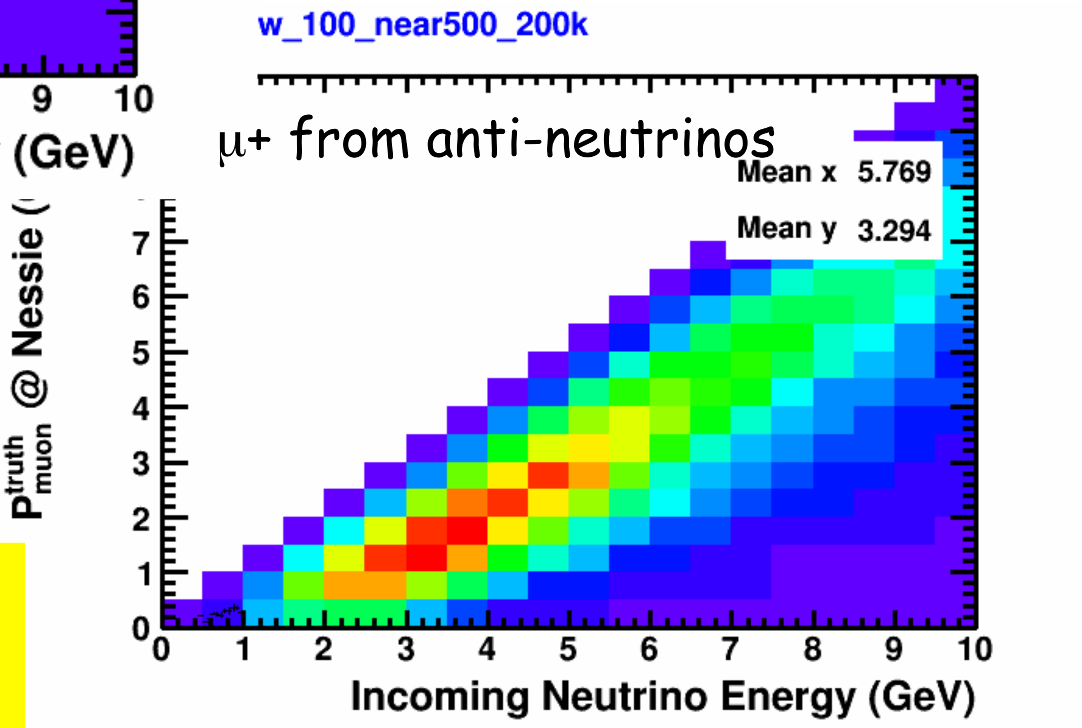


Cycle / Pulse 3.6 sec. (every 6 seconds)

→ 4.5×10^{19} pot/yr

POSITIVE FOCUSSING



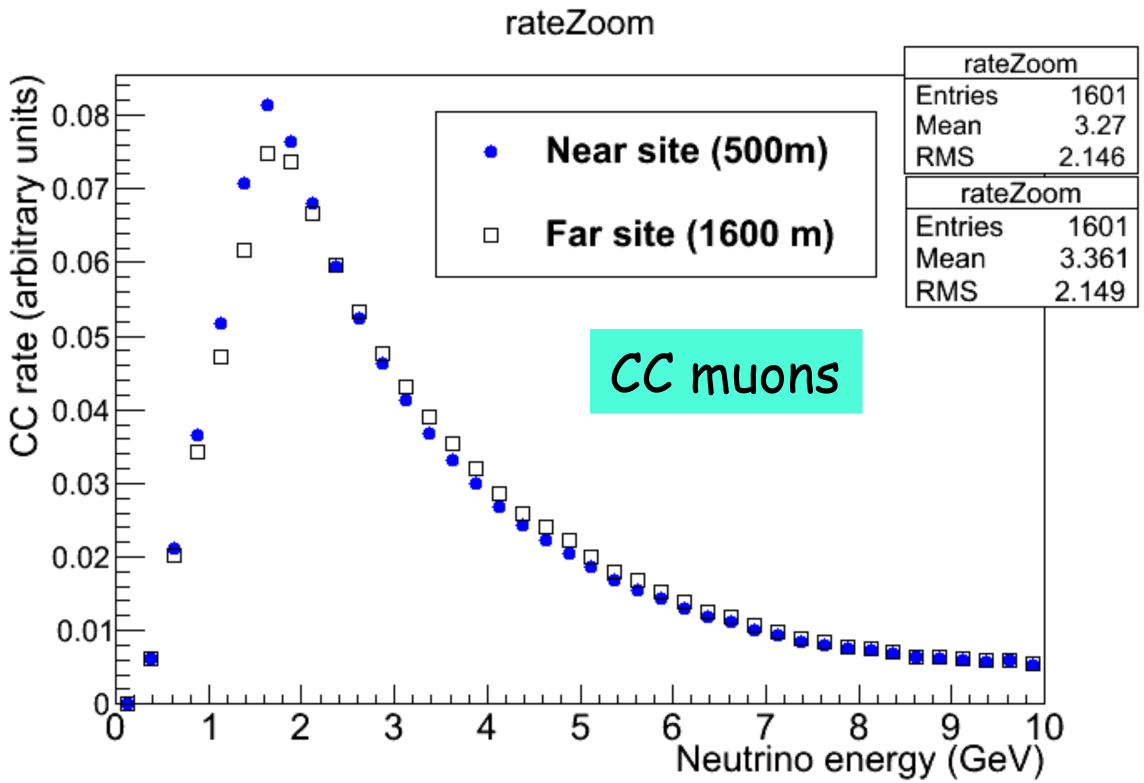


up to 30% ν_μ in anti-ν_μ beam (negative focussing)

Latest Beam Studies at SPS

- 100 GeV proton, Fast Extraction (10.5 μs), Luminosity as at CNGS

On-axis configuration Event rates 4.5 10^{19} pot (≈1 year)



Unoscillated ν_e fluxes are ~ identical → N/F deviations = oscillations

The oscillated signals are clustered below 6 GeV of visible energy

Scenario **defined** for DATA Taking: 2 years of anti-ν followed by 1 year ν

Start of the game: this year *(OR NOT VALUABLE)*

The project has to be approved this year,
so to allow CERN to start construction

MANDATORY FOR US

Search for "anomalies" from neutrino and anti-neutrino oscillations at $\Delta m^2 \approx 1eV^2$ with muon spectrometers and large LAr–TPC imaging detectors.

Technical proposal.

(CERN-SPSC-2012-010 and SPSC-P-347)

2 collaborations
30 institutions
~140 people

arXiv:1203.3432

ICARUS Collaboration

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NESSiE Collaboration

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The ICARUS-NESSiE P-347 proposal at the CERN-SPS

SPSC-P-347 (arXiv:1203.3432)

- L/E oscillation path lengths to ensure appropriate matching to the Δm^2 window for the expected anomalies
- **NEAR and FAR sites**
- **"Imaging" LAr-TPC detector capable of identifying unambiguously all reaction channels**
- **Magnetic spectrometers to determine muon charge and momentum**
- Interchangeable ν and anti-ν beams
- High rates due to detector large masses , in order to record relevant effects at the percent level ($>10^6\ \nu_\mu$, $\sim 10^4\ \nu_e$)
- Both initial ν_e and ν_μ components cleanly identified.

Couple the Best and Biggest Lar-TPC presently working with a relatively cheap but essential Muon detector

Charge and **momentum** measurements in Neutrino Interactions for the Charge Current mode: **essential** and **challenging**

Essential because:

- increase the active target mass by measuring the muon momentum
- increase the range of Δm^2 (at higher values, especially in the eV^2 range)
- calibration of the beam with a clean muon measurement at high p
- normalization point for the NC/CC rates

- clean separation of ν and νbar interactions
- disentangle the ν and νbar reverse contaminations in the beams

Challenging because:

- find best compromise between passive and active materials

GOALS/CAVEATS

Perform a DESIGN STUDY for a two-module Detector

- cheap
- almost no R&D
- fast
- fully compatible with the LAr proposal(s)
- standalone
- maximizing the physics output

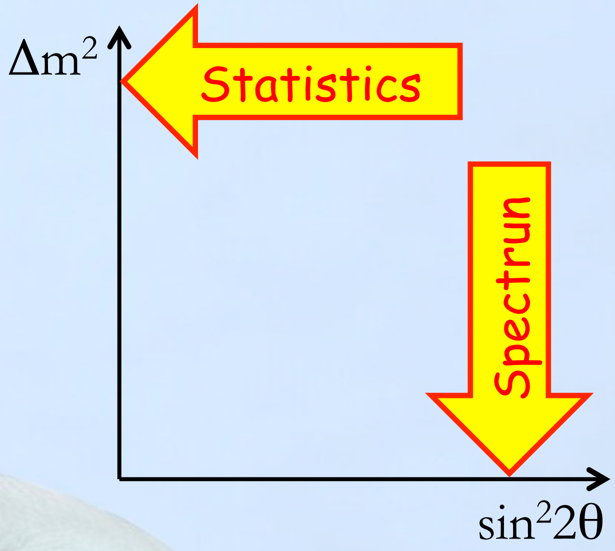
SpectrometerS *are essential to allow*

- *full Charge ID*
- *systematics and calibration controls*
- *clean separation* ν *and anti-*ν

NESSiE detector concept

NESSiE (Neutrino Experiment with SpectrometerS in Europe)

- **Goal:**
  - Allow charge separation and momentum measurement of as many muons as possible escaping from LAr (large statistics ↔ low $\sin^2 2\theta$)
  - Go as low as possible in muon momentum (low momenta ↔ low Δm^2)
  - Possibility to also study (NESSiE) internal events (coarser resolution w.r.t. LAr)



- **Solution:**
  - Air-core magnets for low momentum muons escaping from LAr ($E_\mu < 0.5$ GeV/c in NESSiE ↔ $\langle E_\nu \rangle < 1$ GeV in LAr)
  - Downstream massive iron dipolar magnets for higher momenta extension

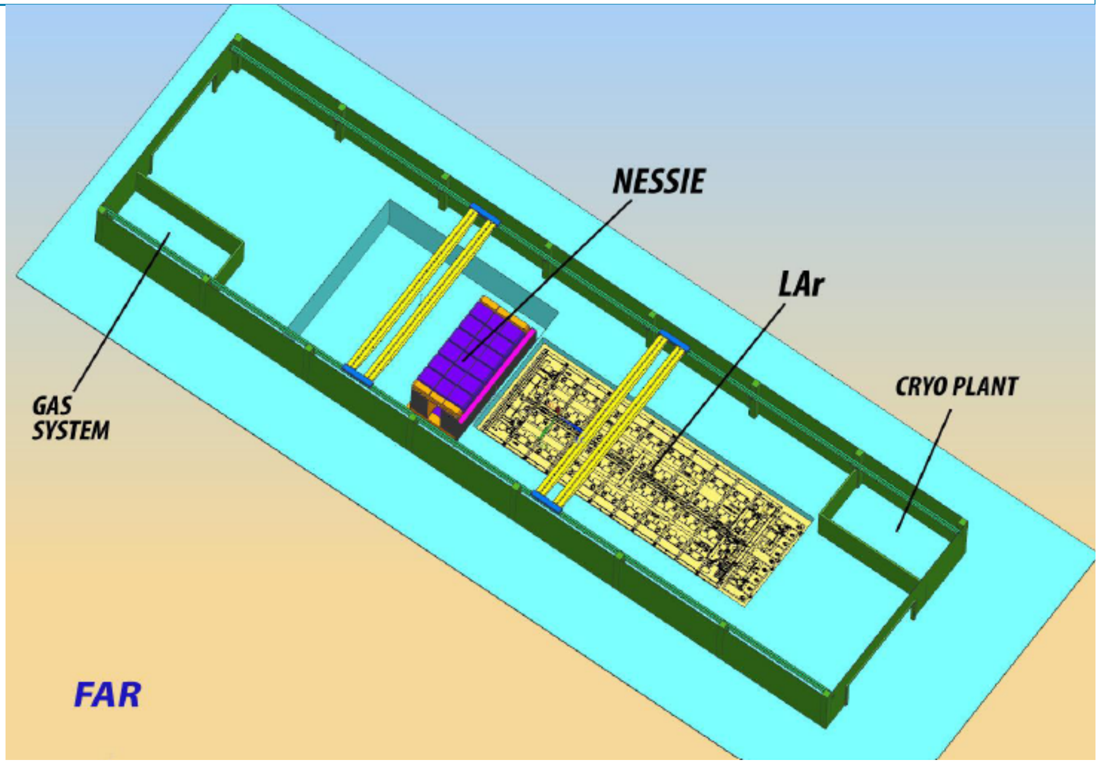
ICARUS-NESSiE

A coupled system of LAr detectors and Muon Spectrometers

NEAR SITE @300 m :
LAr mass = 119 t
Iron magnet mass = 840 t
5 interactions/spill

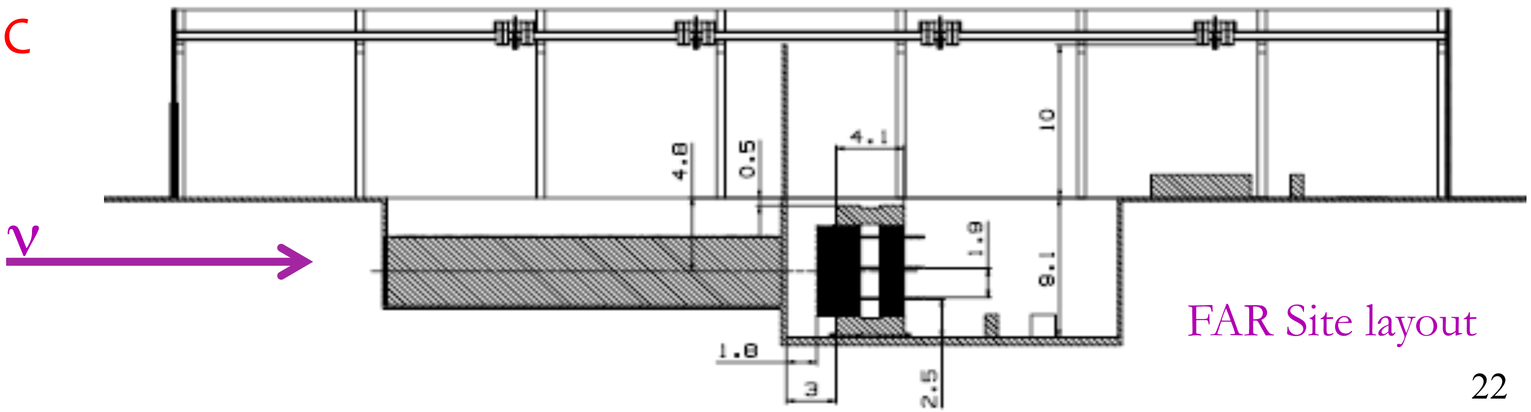
$2\cdot10^{13}$ p/spill (with "+" polarity)

FAR SITE @1600 m:
LAr mass = 476 t
Iron magnet mass = 1515 t
0.65 interactions/spill



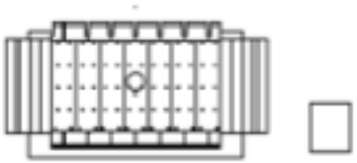
Observation ν_μ, ν_e CC, NC channels

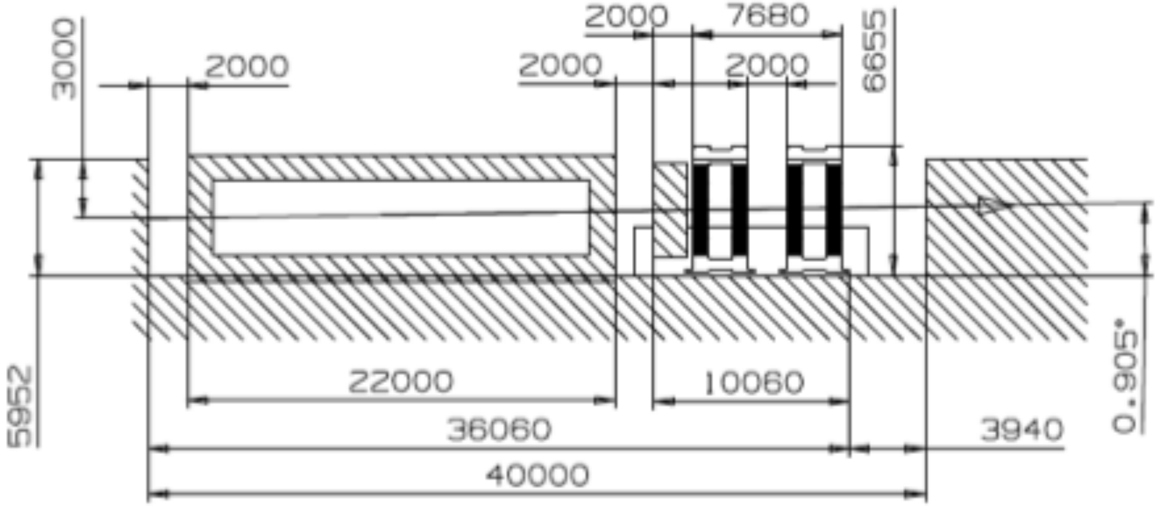
Charge separation and muon momentum



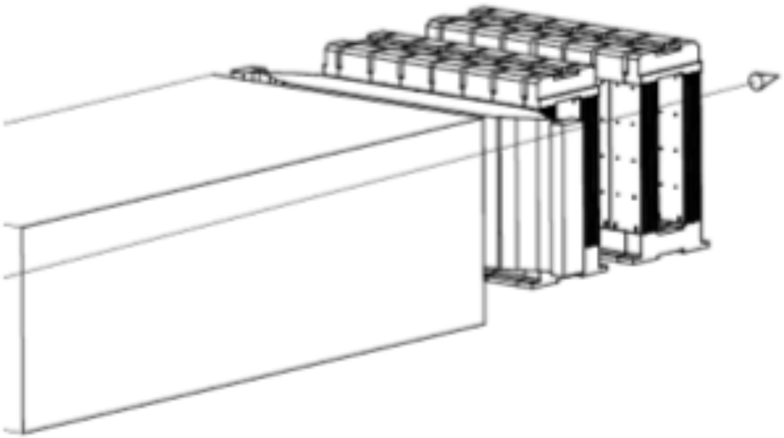
FAR Site layout

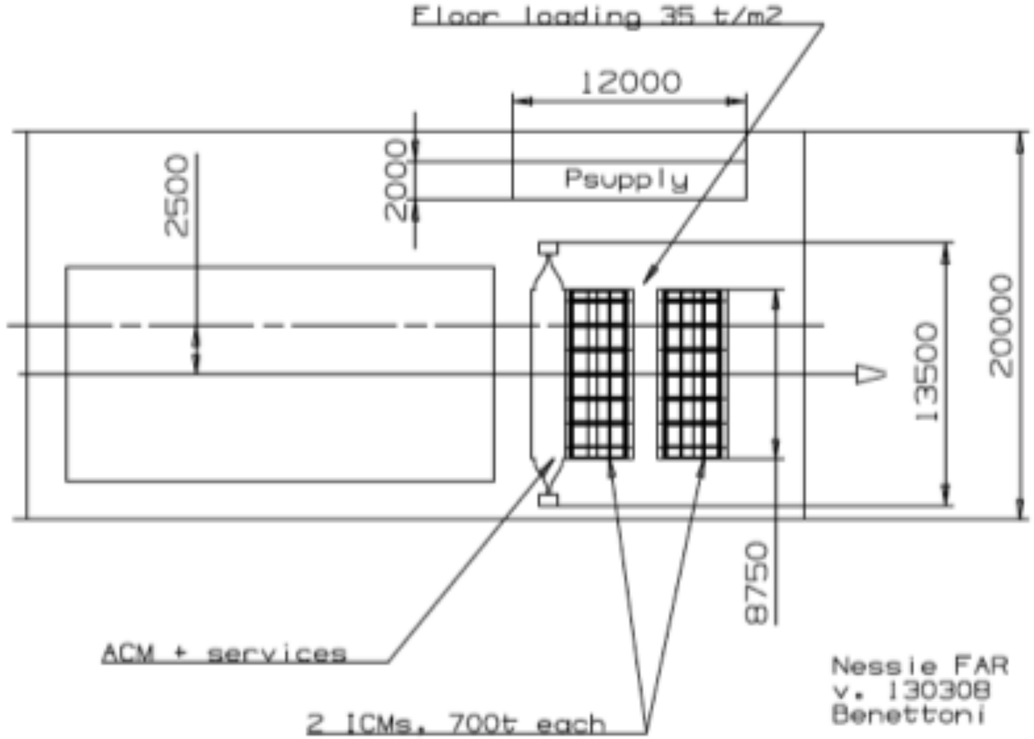
FAR site





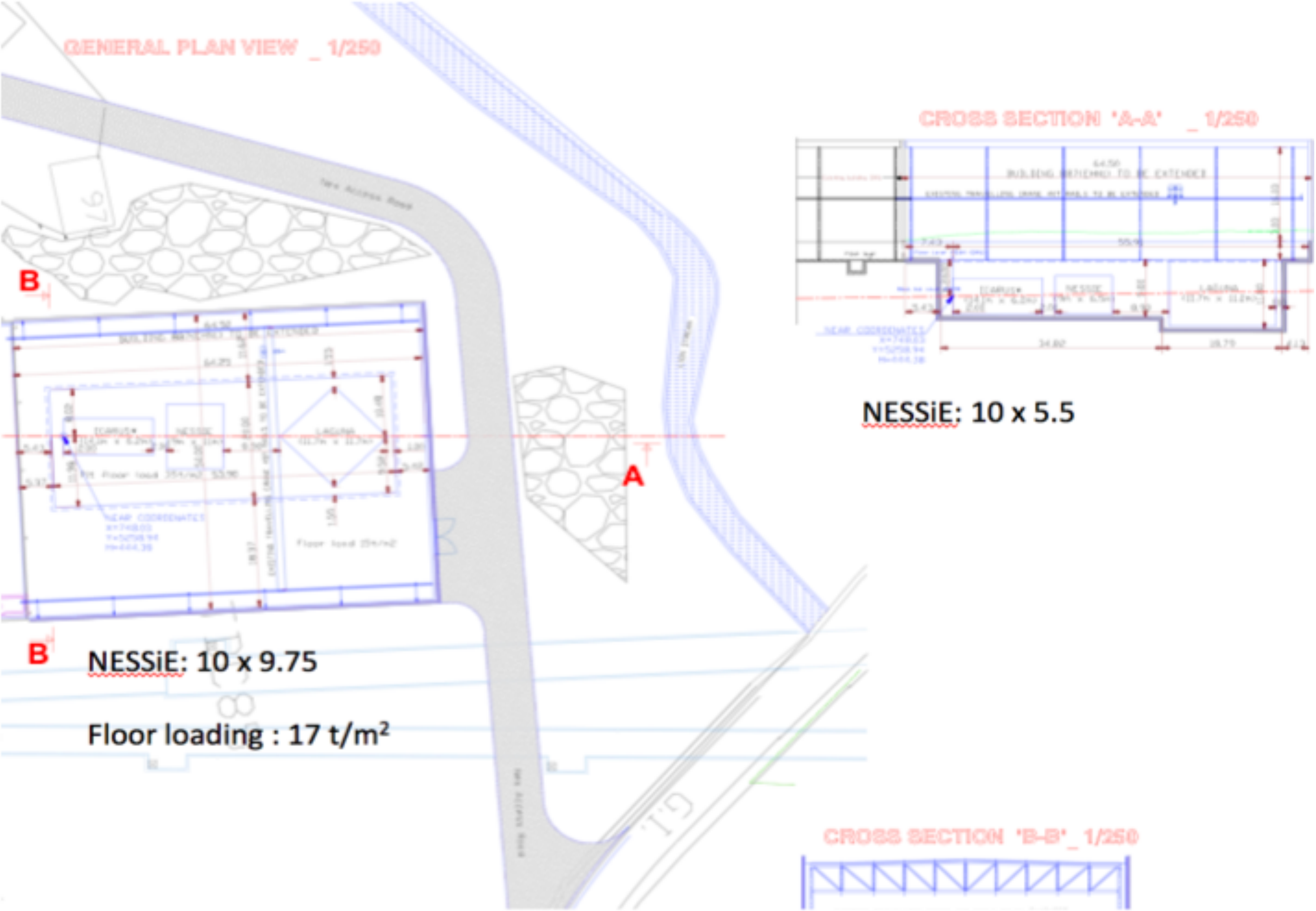
3000
2000
2000
2000
7680
2000
6655
5952
22000
10060
36060
3940
40000
0.905°





Floor loading 35 t/m2
12000
2500
2000
Psupply
13500
20000
8750
ACM + services
2 ICMs, 700t each
Nessie FAR
v. 130308
Benettoni

NEAR site



NESSiE: 10 x 5.5

NESSiE: 10 x 9.75

Floor loading : 17 t/m²

e.g. Expected Events in 1 year of Running (ν_μ or ν_μ–bar)

To reconstruct: 5.3 M muons in LAr (Near), 0.67 M muons in Lar (Far)
pos.foc. 5.2 M muons in Nessie (Near), 0.42 M in Nessie (Far)
(with factor 2 in overhead of triggers, positive focussing)

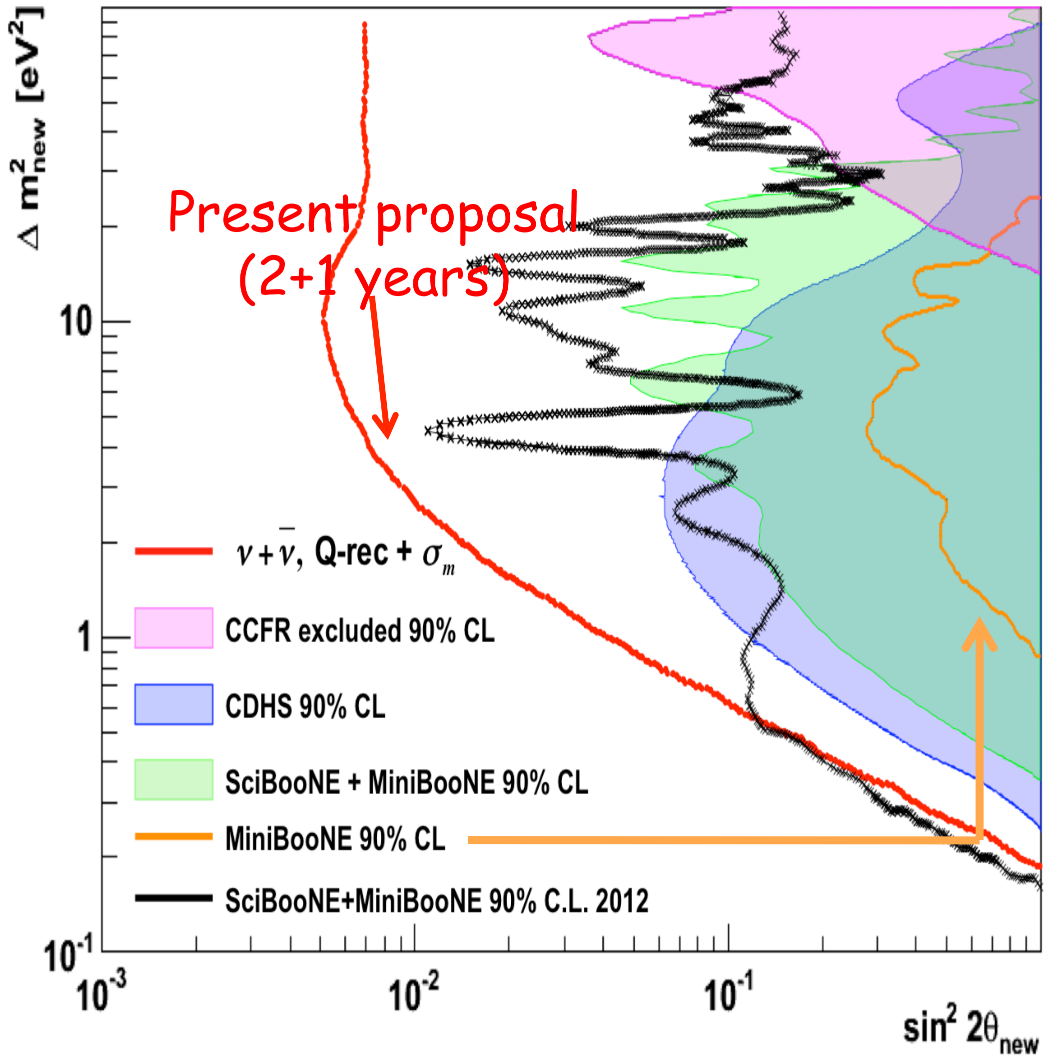
		NEAR (ν–bar)	NEAR(ν)	FAR(ν–bar)	FAR(ν)
produced	$\nu_e + \nu_e$–bar (LAr)	35 K	54 K	4.2 K	6.4 K
	$\nu_\mu + \nu_\mu$–bar (LAr)	2000 K	5250 K	270 K	670 K
	Appear. test point	590	1900	360	910
detected	ν_μ (LAr+NESSiE)	230 K	1200 K	21 K	110 K
	ν_μ (NESSiE)	1150 K	3600 K	94 K	280 K
	ν_μ–bar (Lar+NESSiE)	370 K	56 K	33 K	6.9 K
	ν_μ–bar (NESSiE)	1100 K	300 K	89 K	22 K
	Disappear. test point	1800	4700	1700	5000

NOTE: ν "contamination" in anti-ν negative polarity beam

- Values for Δm^2 (sterile model) around 2 eV^2 are reported as example

Sensitivity to ν_μ disappearance

90% C.L. sensitivity for 2 years anti-ν + 1 year ν
Exclusion limits :
CCFR, CDHS, SciBooNE + MiniBooNE



(only LAR+NESSiE events)

Nessie (initial design)

- Two Iron spectrometers (**ICM**), 1500 + 800 t, composed by:
- 48 yoke blocks, , 4.5 x 0.6 x 1 m, 25t
- 480 slabs, 2 – 3 t, 1.25m x 3.5–6 m
- 1800 + 700 m^2 of RPC
- «sandwich style» assembly to be made in situ, one piece per time

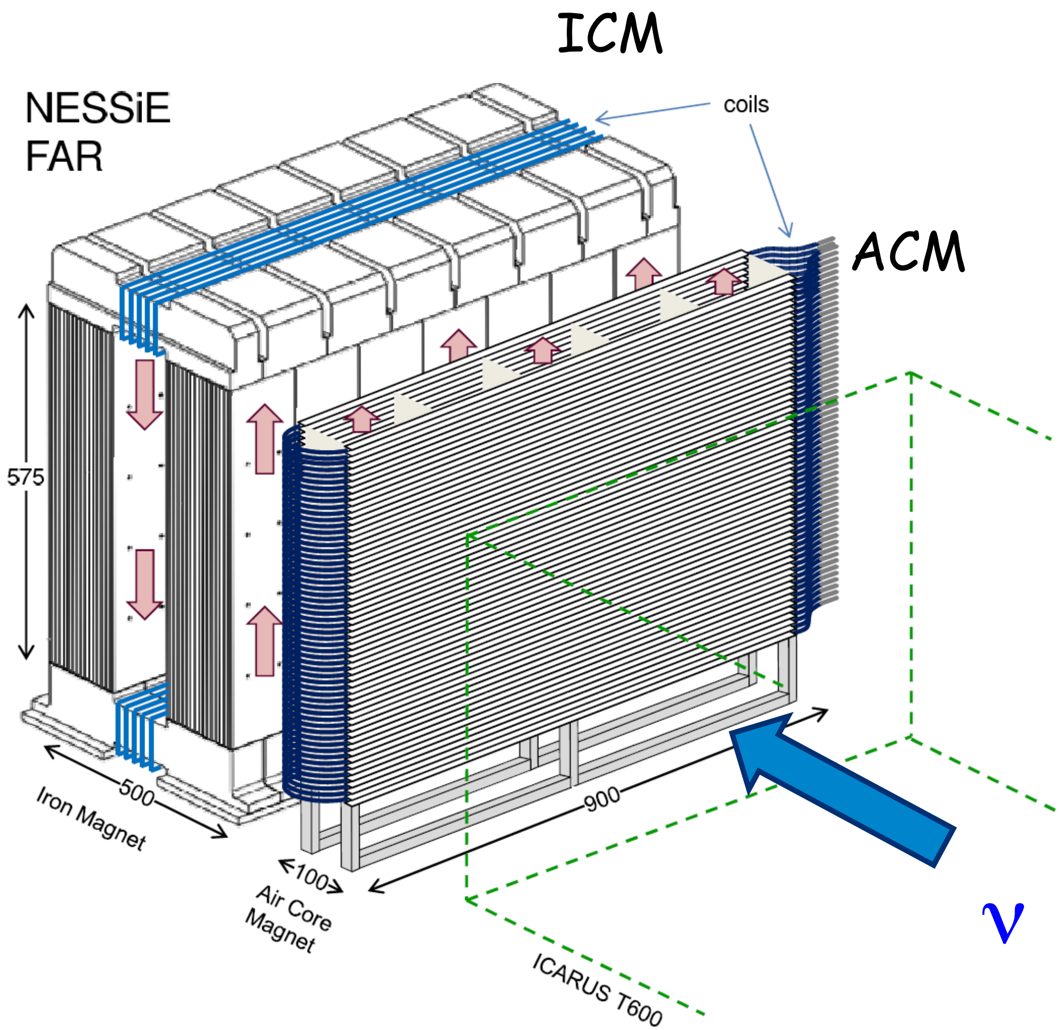
- 20,000+12,000 digital channels

- Two **ACM** preassembled and installed in one shot
- Precision Trackers preassembled and installed in one shot

- Near Nessie movable aside on air-pad

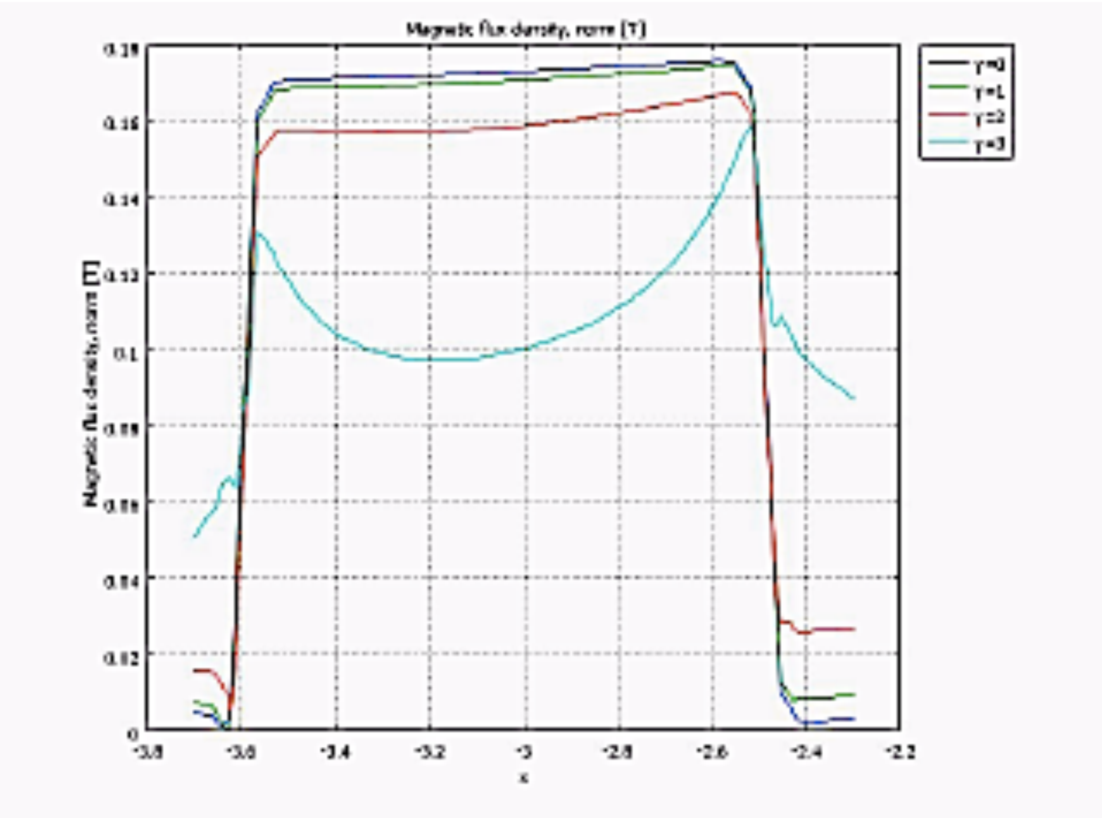
- 1 + 0.5 MW , 10 kA, power (summed up for ACM and ICM)

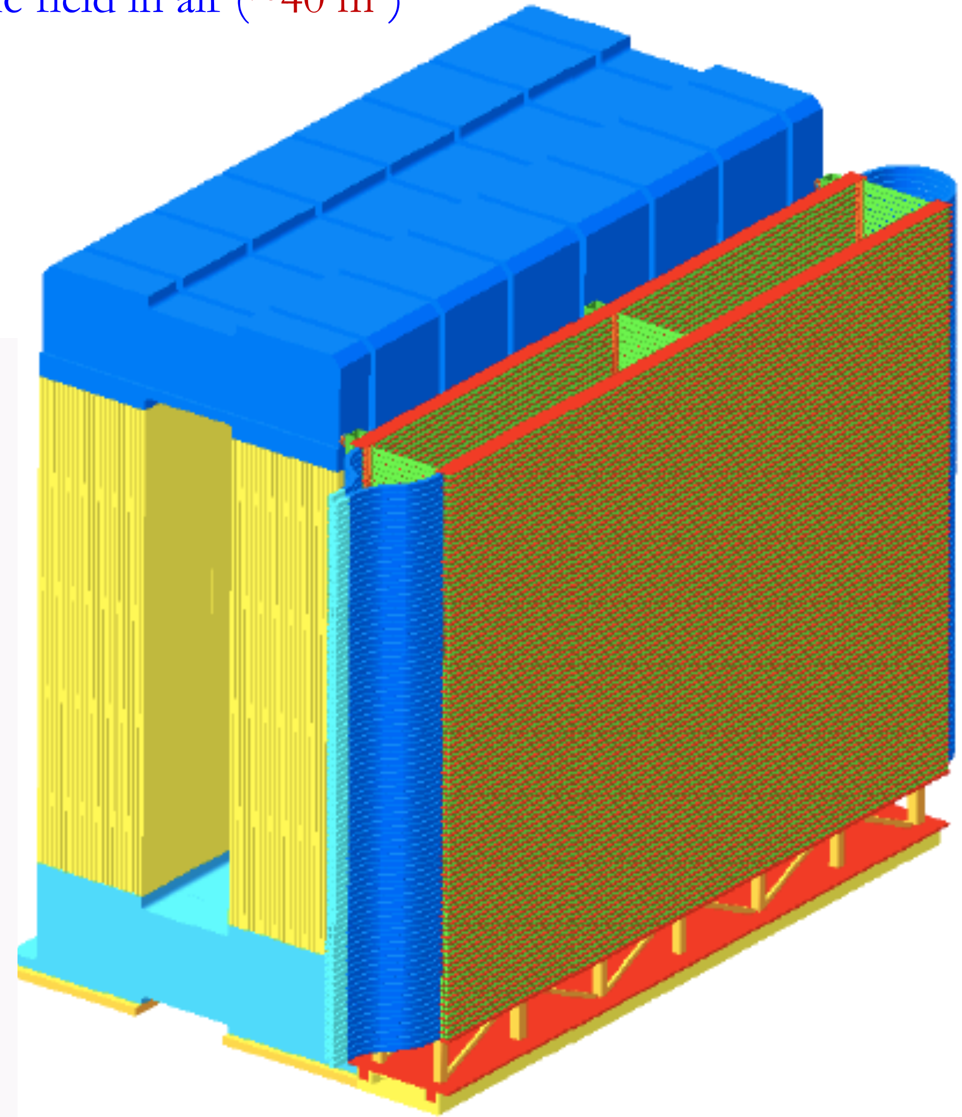
Optimized ! Reduced by almost a factor of 2 !!!



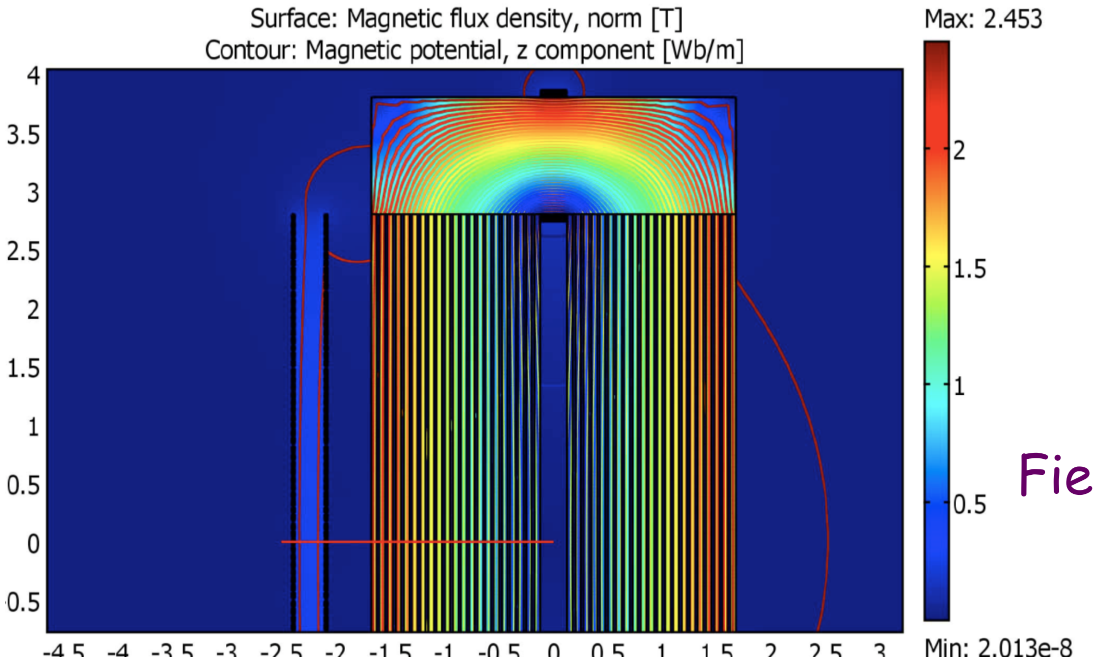
Air-core magnet (initial design)

- New concept for a large transverse area magnetic field in air (~40 m^2)
- B = 0.17 T
- Power < 2 MW
- To be coupled to a mm resolution detector (different possibilities under study)

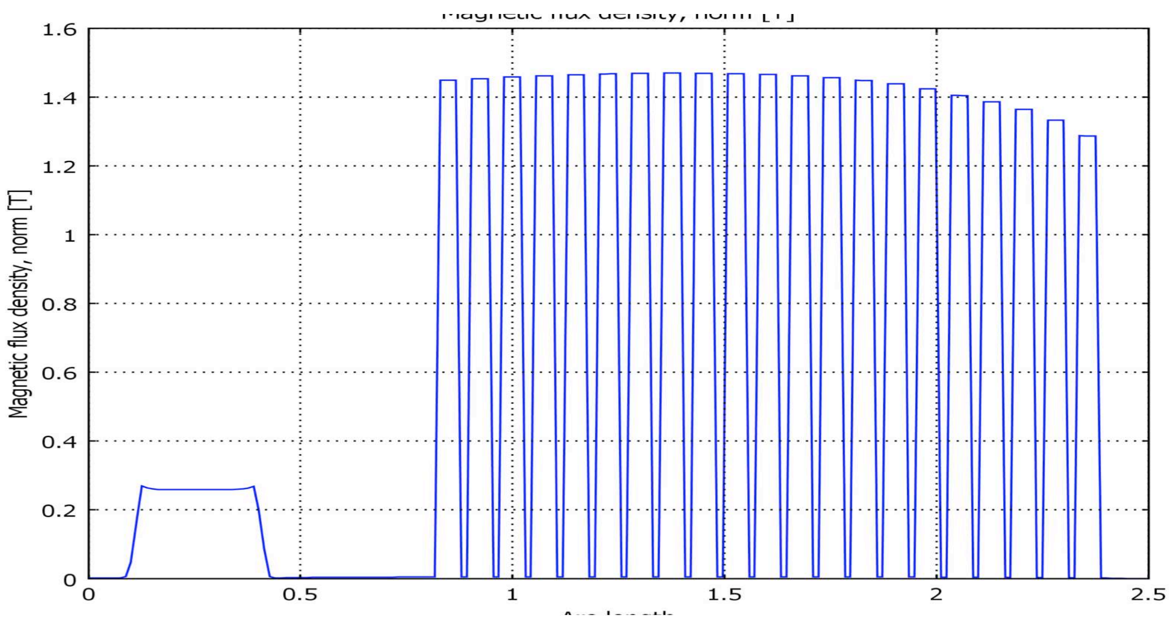




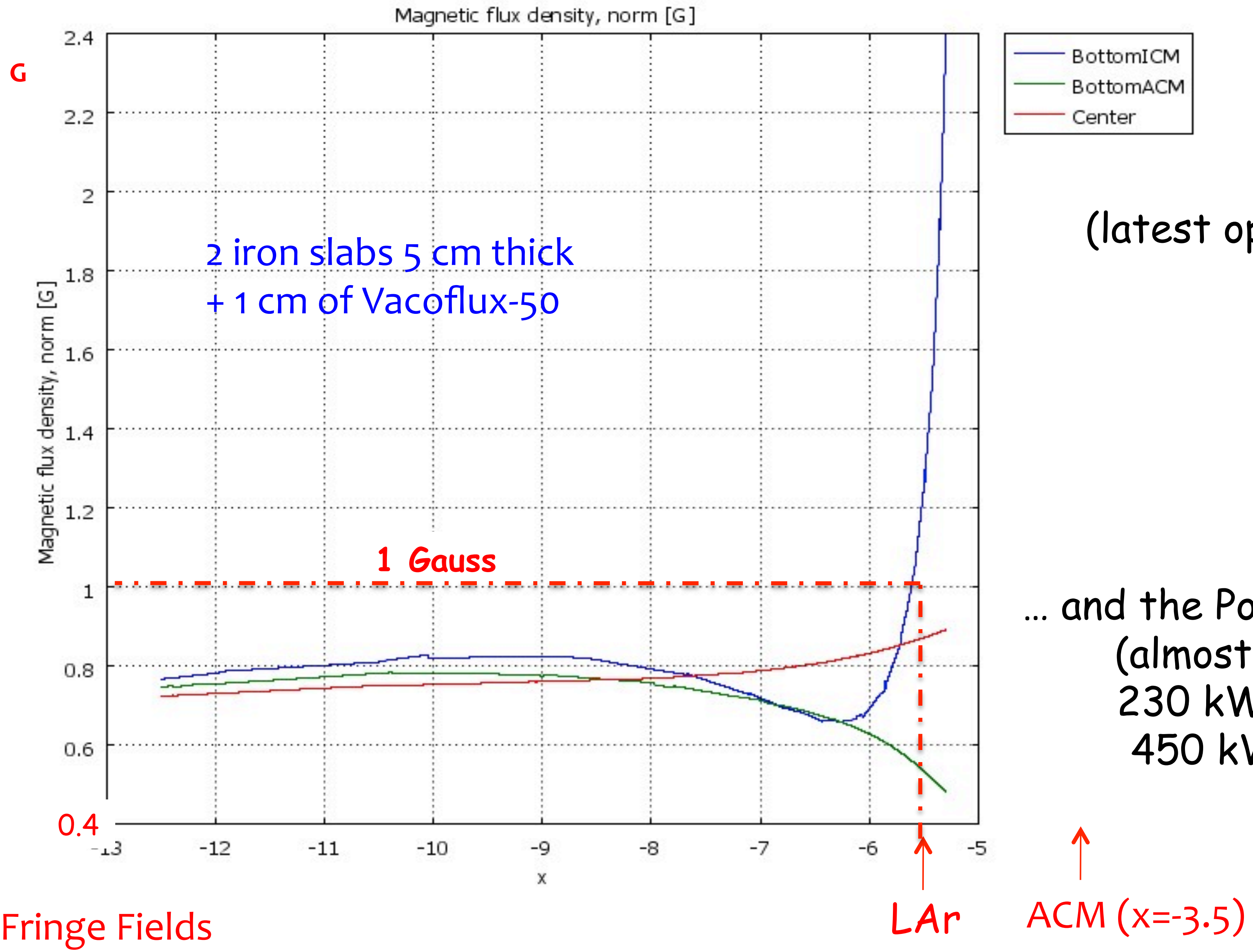
Magnetic Field Simulation



Field in Iron and in Air (2-D)



… and the fringe field is under control

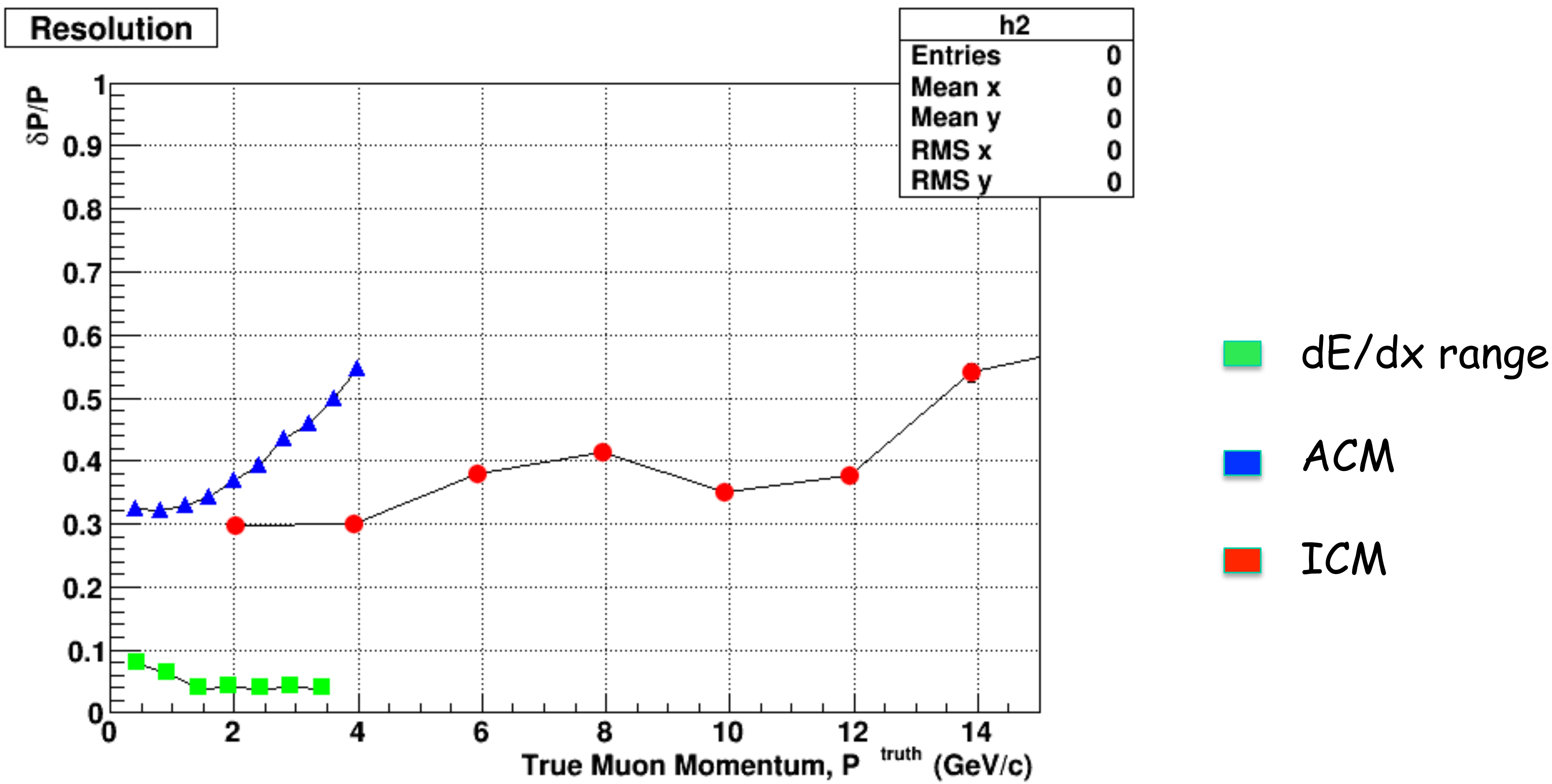


(latest optimization)

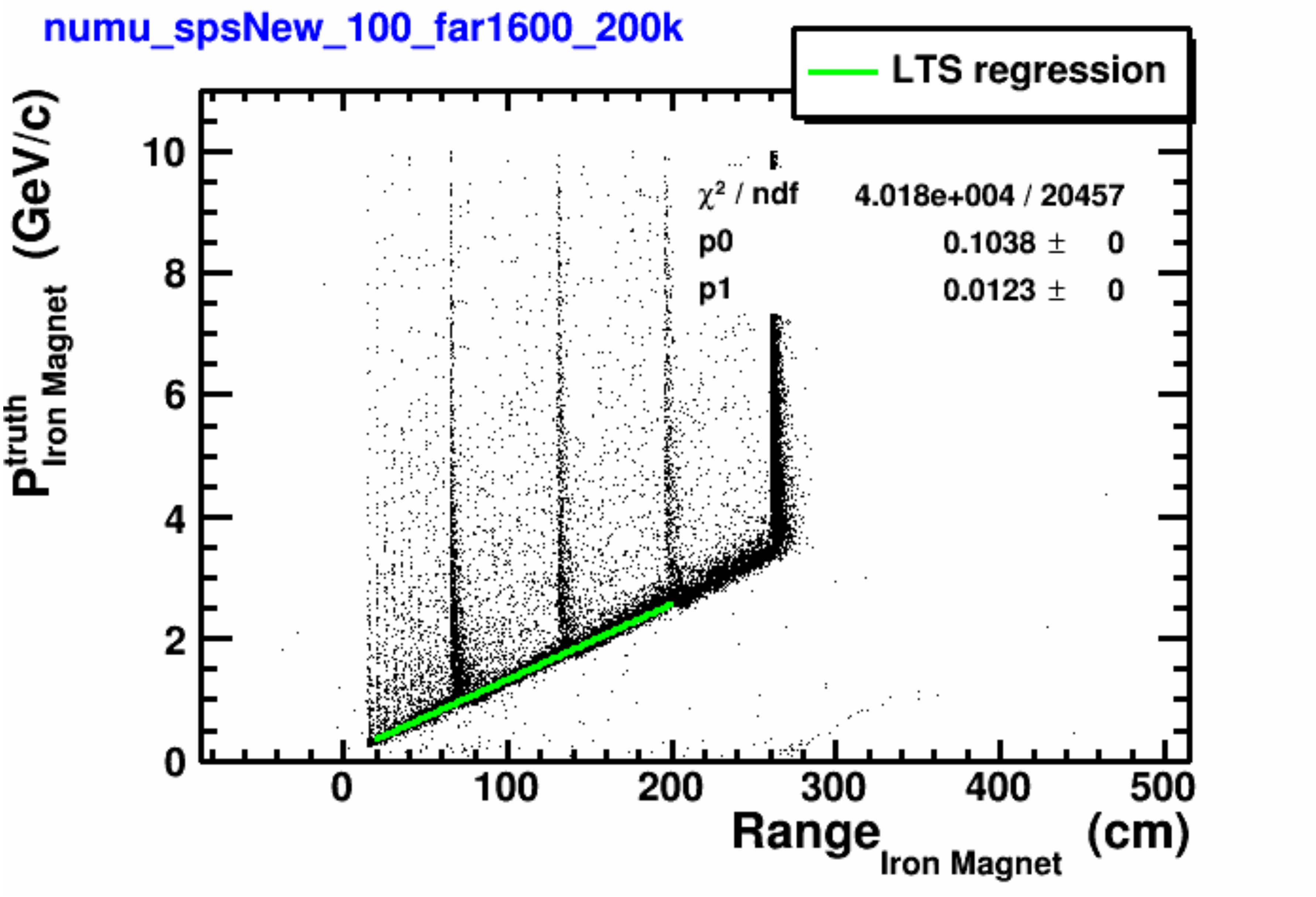
… and the Power Supplies (almost) as well:
230 kW (Near)
450 kW (Far)

Fringe Fields

Momentum measurement at 4% with dE/dx up to 3.5 GeV
At 30% with Prec.Tracker above 3 GeV
At 30% with ACM below 1.5 GeV

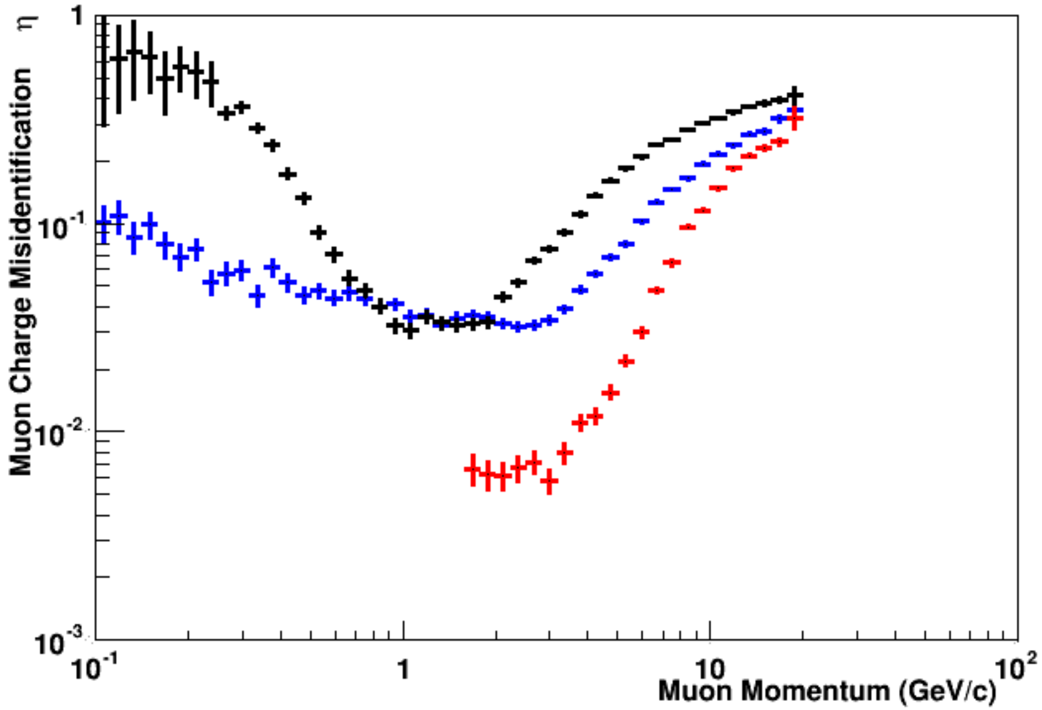


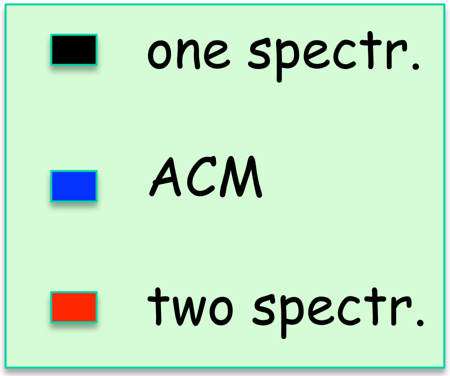
Latest configuration (OPERA-2), algorithms not optimized …



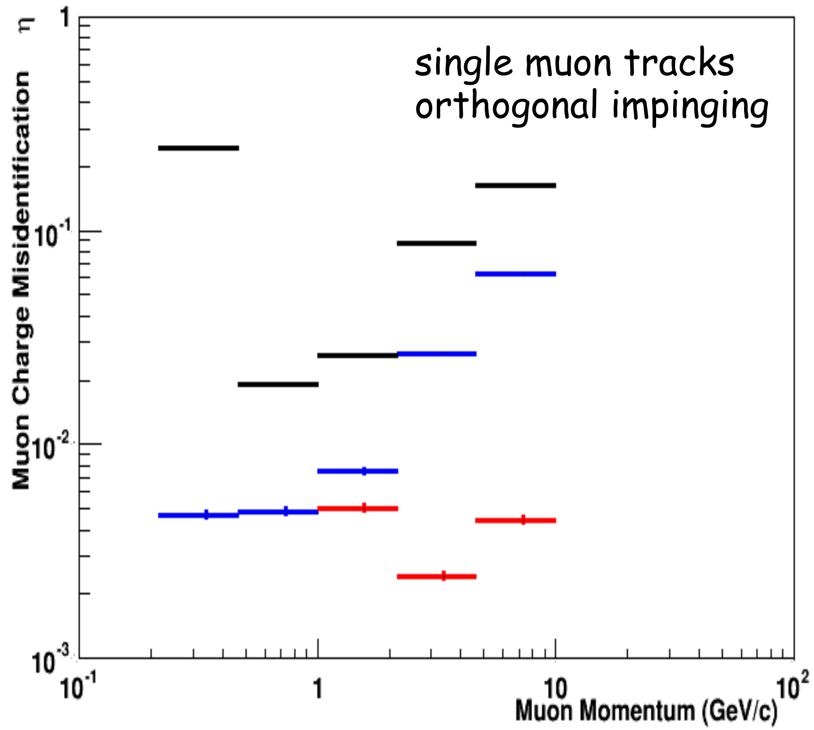
ν interaction in the LAr, measured by dE/dx-range in the Spectrometer

Muon mis-ID





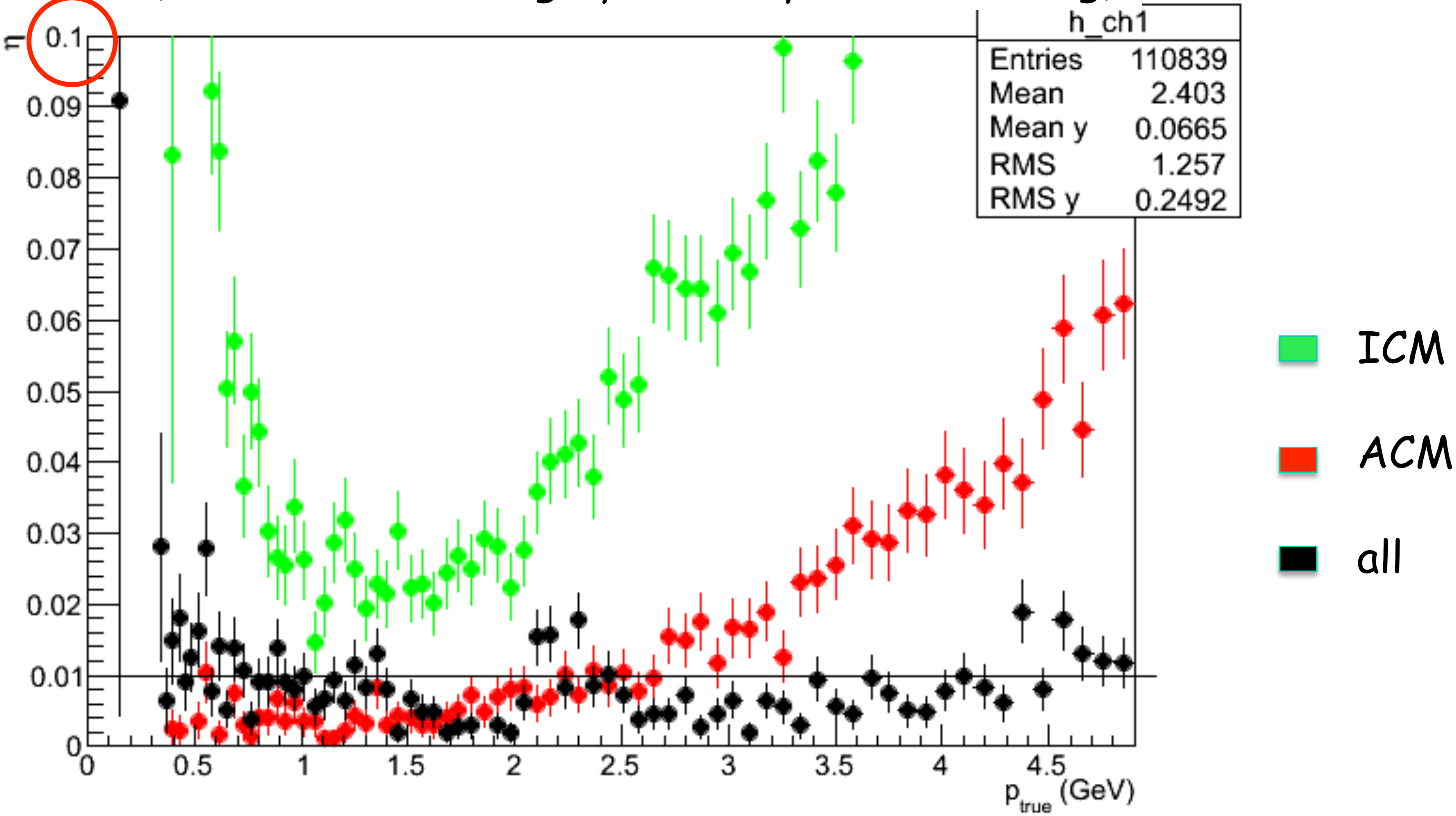
Charge mis-reconstruction at few percent level in all dynamical range of interest (full simulation including selection, efficiency and reconstruction)



Muon mis-ID

(with some "cleaning-up" and improved tracking)

10%



(no way without ACM)

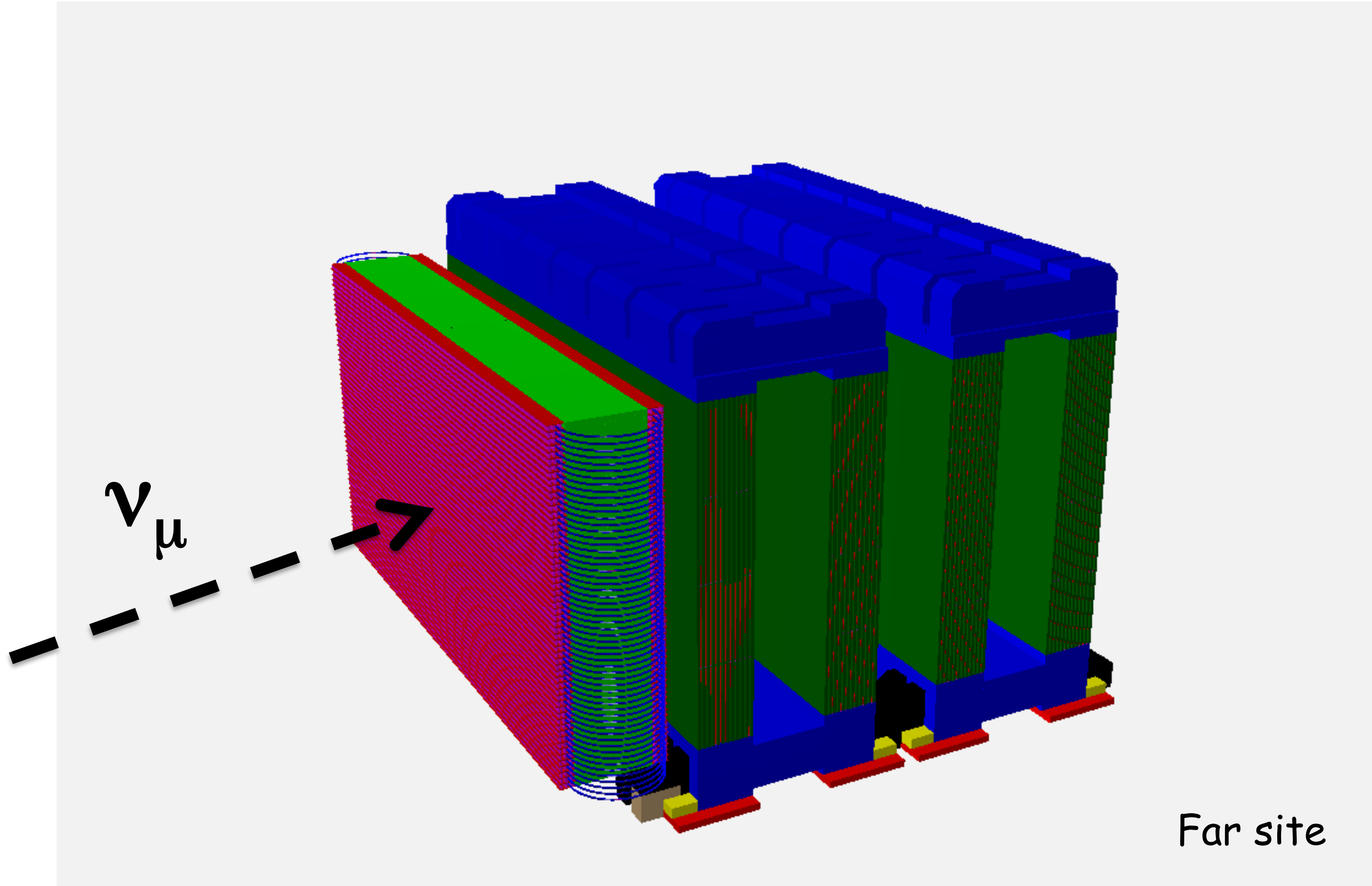
Opera re-use

- 2 Spectrometers "available", with Detectors and Servicing
- Possibility to full re-use for Far AND Near ICM
- Need two new sets of Yokes (Top & Bottom)
  new Electronics for RPC
  Mechanical Tools
  PT detectors
  Scintillators
- Other: ACMs

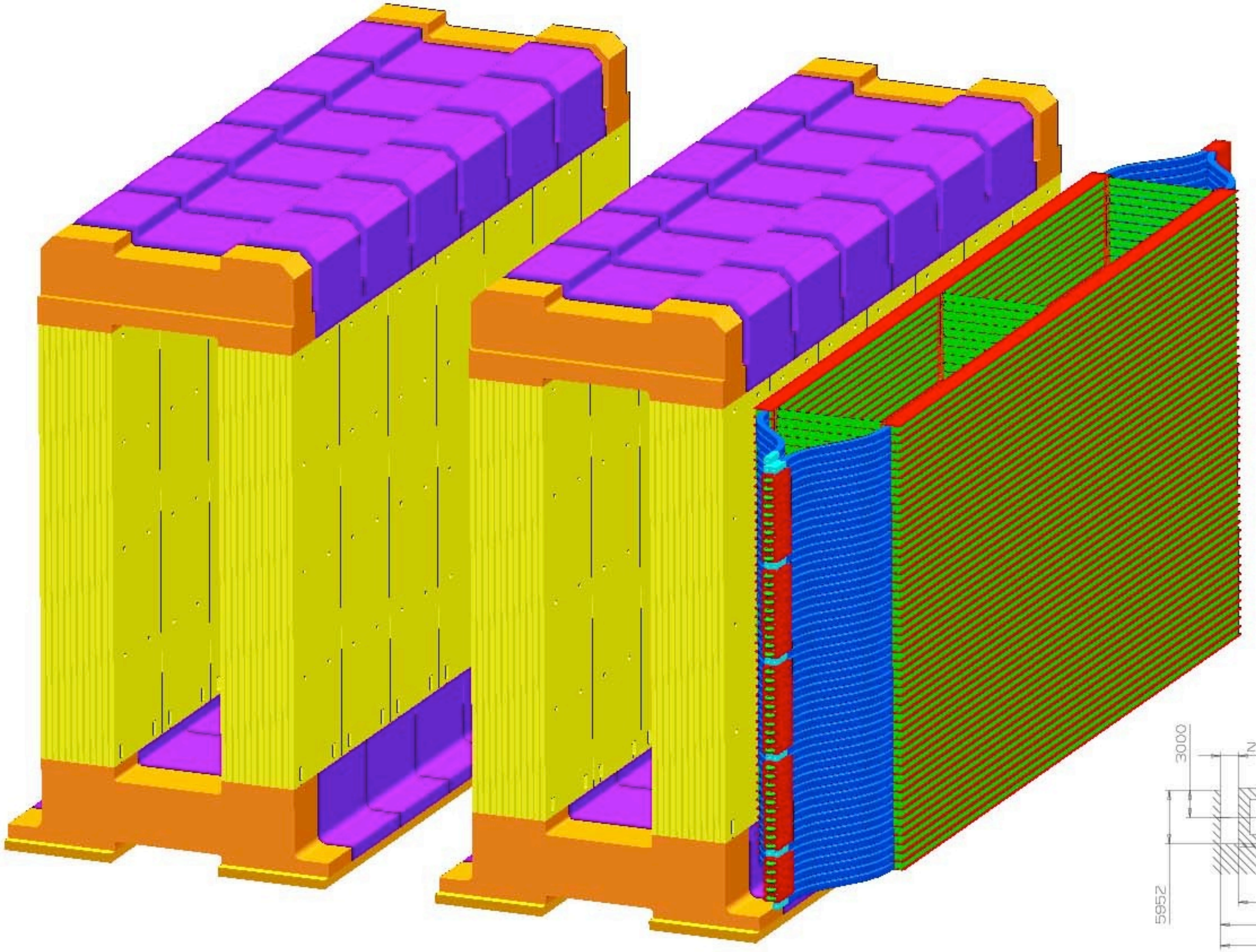
T0 availability for dismantling
and transportation at CERN: Autumn 2014

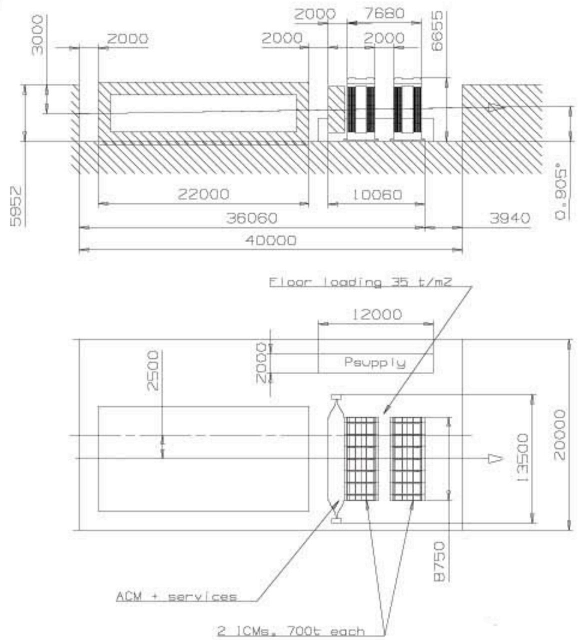
OPERA discussion:
possible start dismantling July-December 2014

Arrangement with OPERA Spectrs

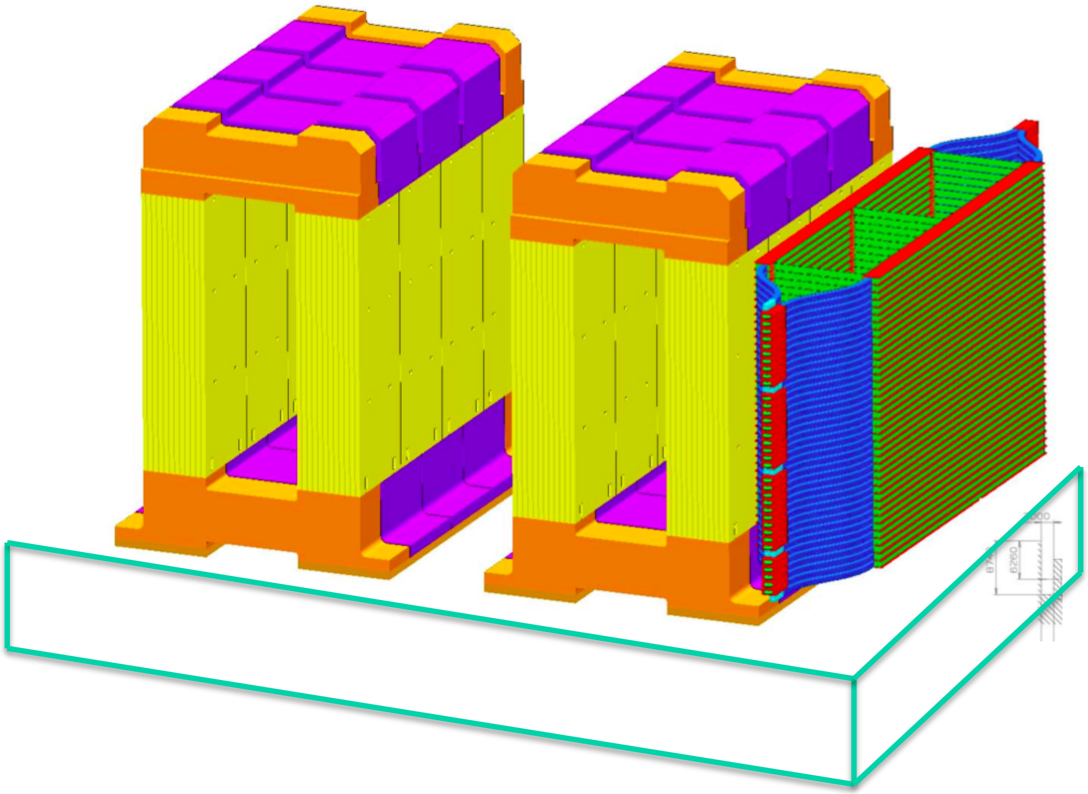


Far site

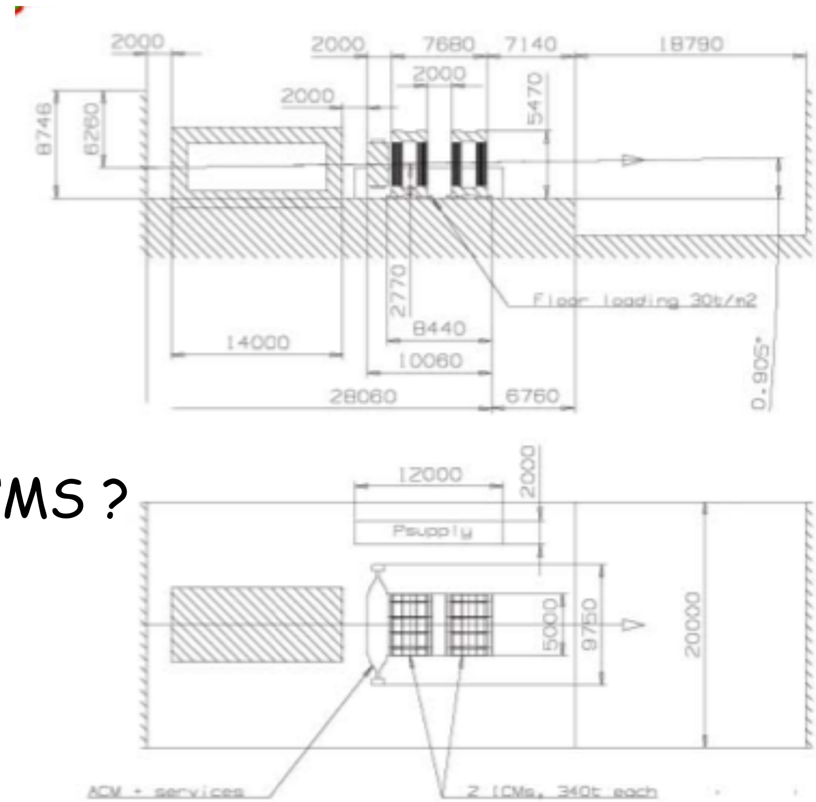



2000
7680
3000
2000
2000
2000
6655
22000
10060
36060
3940
40000
5952
0.905°
Floor loading 35 t/m2
12000
2000
Psupply
2500
13500
20000
8750
ACM + services
2 ICMs, 700t each

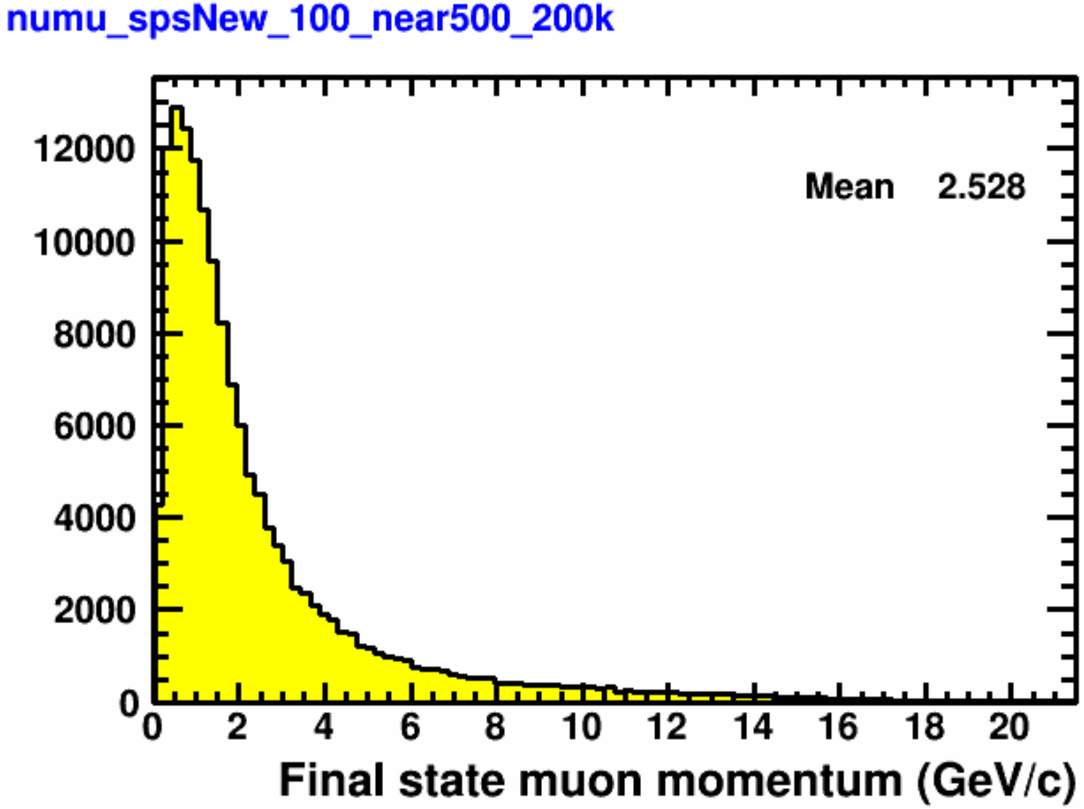
Near site

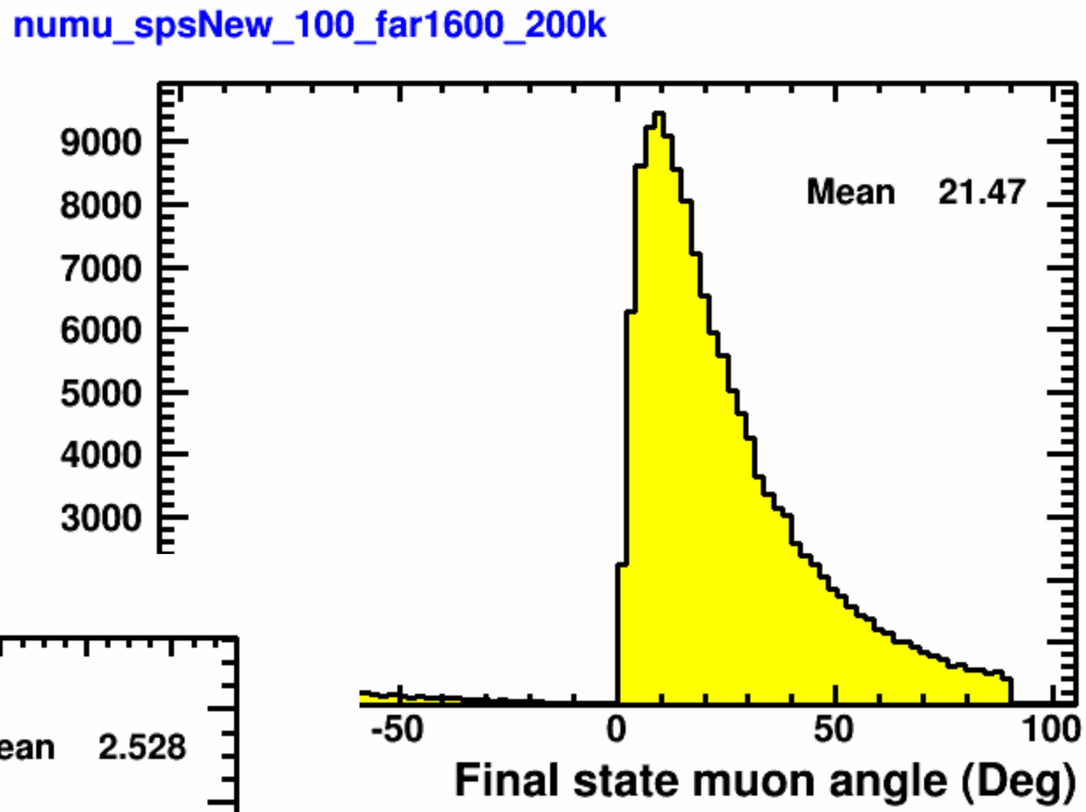


movable platform with air-pads à la ATLAS/CMS ?



Muon momentum



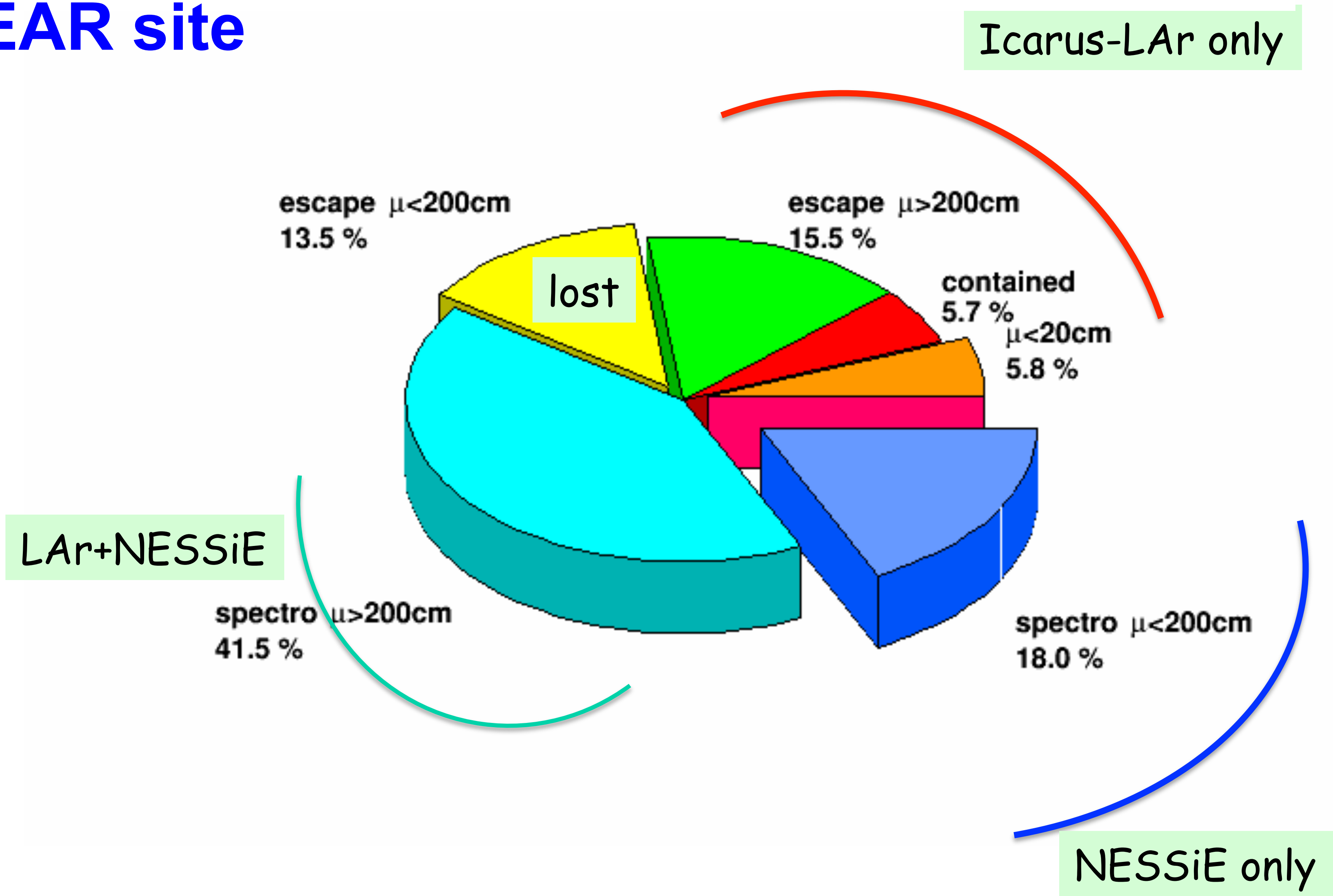


Muon angle

Neutrino Interactions in the Liquid Argon

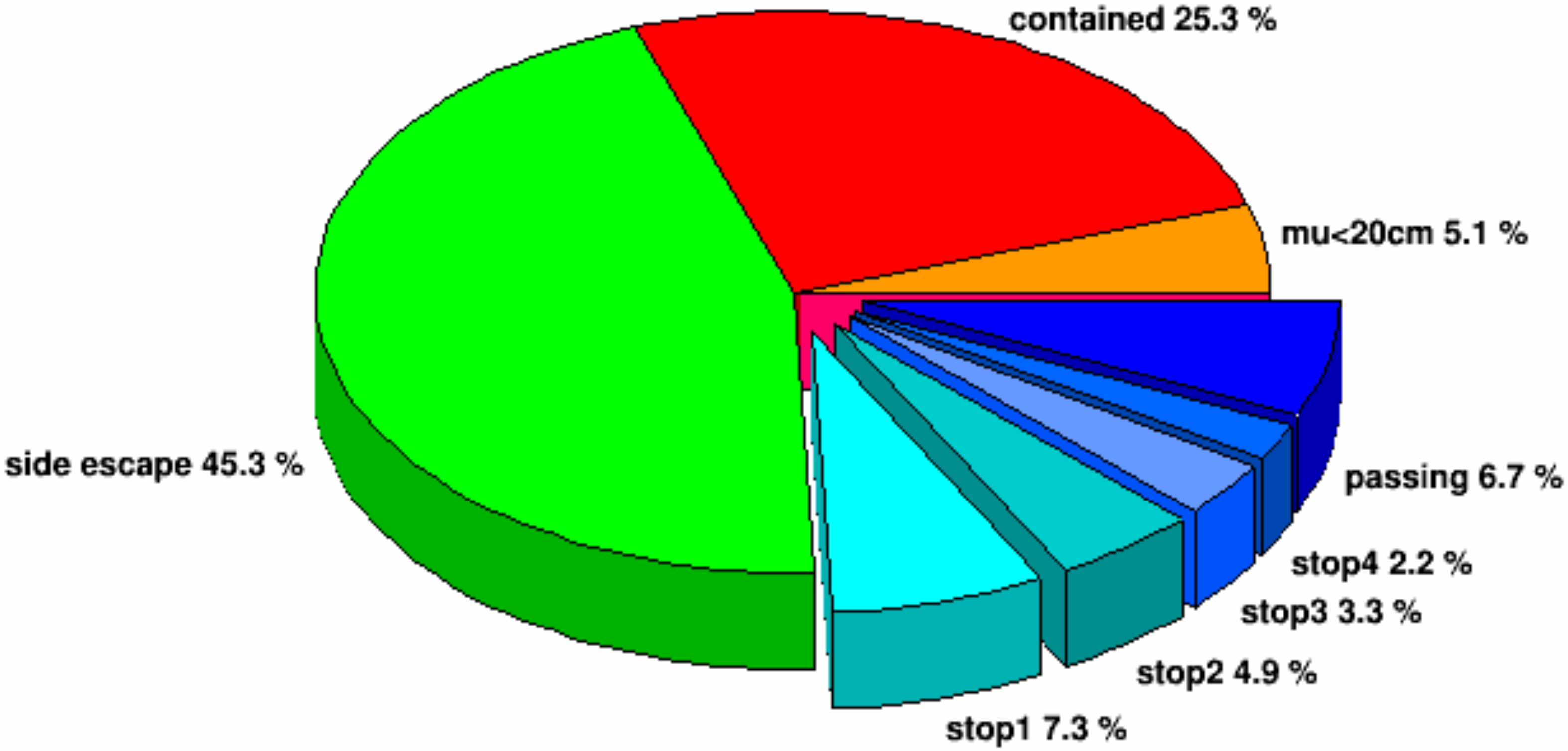
(accepatances)

NEAR site



muon stopping in the iron spectrometer

FAR site



IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 51, NO. 3, JUNE 2004 975

The OPERA Magnetic Spectrometer

M. Ambrosio, R. Brugnera, S. Dusini, B. Dulach, C. Fanin, G. Felici, F. Dal Corso, A. Garfagnini, F. Grianti, C. Gustavino, P. Monacelli, A. Paoloni, L. Stanco, M. Spinetti, F. Terranova, and L. Votano

TWO spectrs with:
12+12 Iron walls
(instead of 21+21)

***Abstract*—The OPERA neutrino oscillation experiment foresees the construction of two magnetized iron spectrometers located after the lead-nuclear emulsion targets. The magnet is made up of two vertical walls of rectangular cross section connected by return yokes. The particle trajectories are measured by high precision drift tubes located before and after the arms of the magnet. Moreover, the magnet steel is instrumented with resistive plate chambers that ease pattern recognition and allow a calorimetric measurement of the hadronic showers. In this paper, we review the construction of the spectrometers. In particular, we describe the results obtained from the magnet and RPC prototypes and the installation of the final apparatus at the Gran Sasso laboratories. We discuss the mechanical and magnetic properties of the steel and the techniques employed to calibrate the field in the bulk of the magnet. Moreover, results of the tests and issues concerning the mass production of the resistive plate chambers are reported. Finally, the expected physics performance of the detector is described; estimates rely on numerical simulations and the outcome of the tests described above.**

***Index Terms*—Gas detectors, neutrinos, particle measurements, particle tracking.**

I. Introduction

OPERA is a long-baseline neutrino experiment currently under construction at the Gran Sasso underground laboratories (LNGS) [1]. Its aim is the observation of $\nu_\mu \rightarrow \nu_\tau$ oscillations in the parameter region indicated by Super-Kamiokande [2] through direct observation of ν_τ charged current interactions. The detector design is based on a massive lead/nuclear emulsion target (ECC) complemented by electronic detectors (scintillator bars) that allow the location of the event and drive the scanning of the emulsions. This

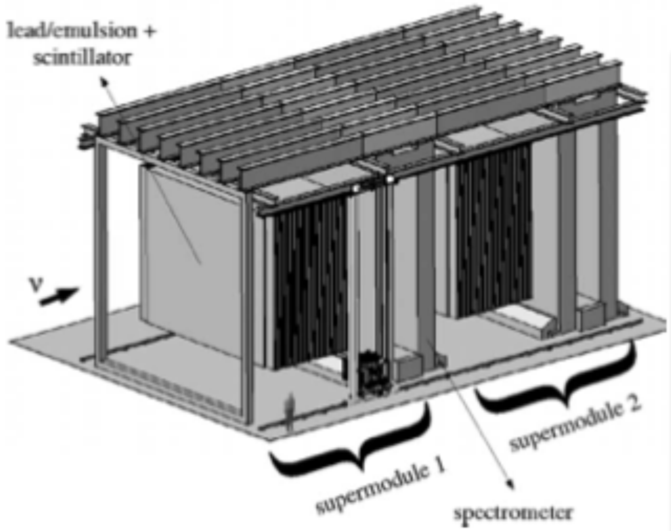
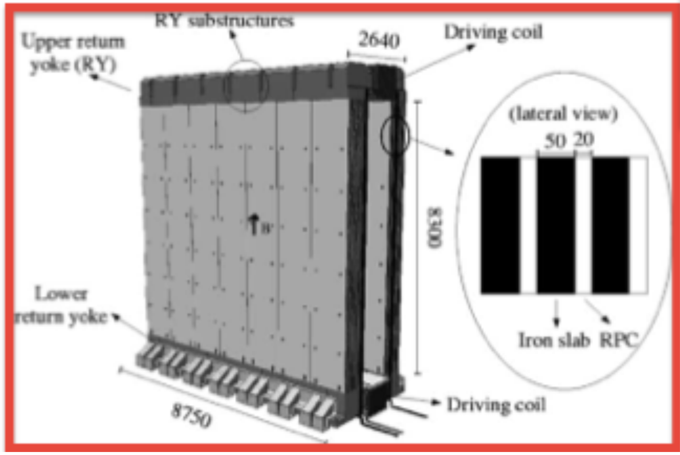


Fig. 1. The OPERA experiment at LNGS.



7 rows 3-RPC
(instead of 5)
➔ use 4 rows for FAR
3 rows for NEAR

7 vertical slabs:
➔ ok for FAR
➔ use 4 for NEAR

Need:
new NEAR Yokes

Sandwiches of Iron walls (7 vertical slabs) and RPC (7 rows x 3 chambers)

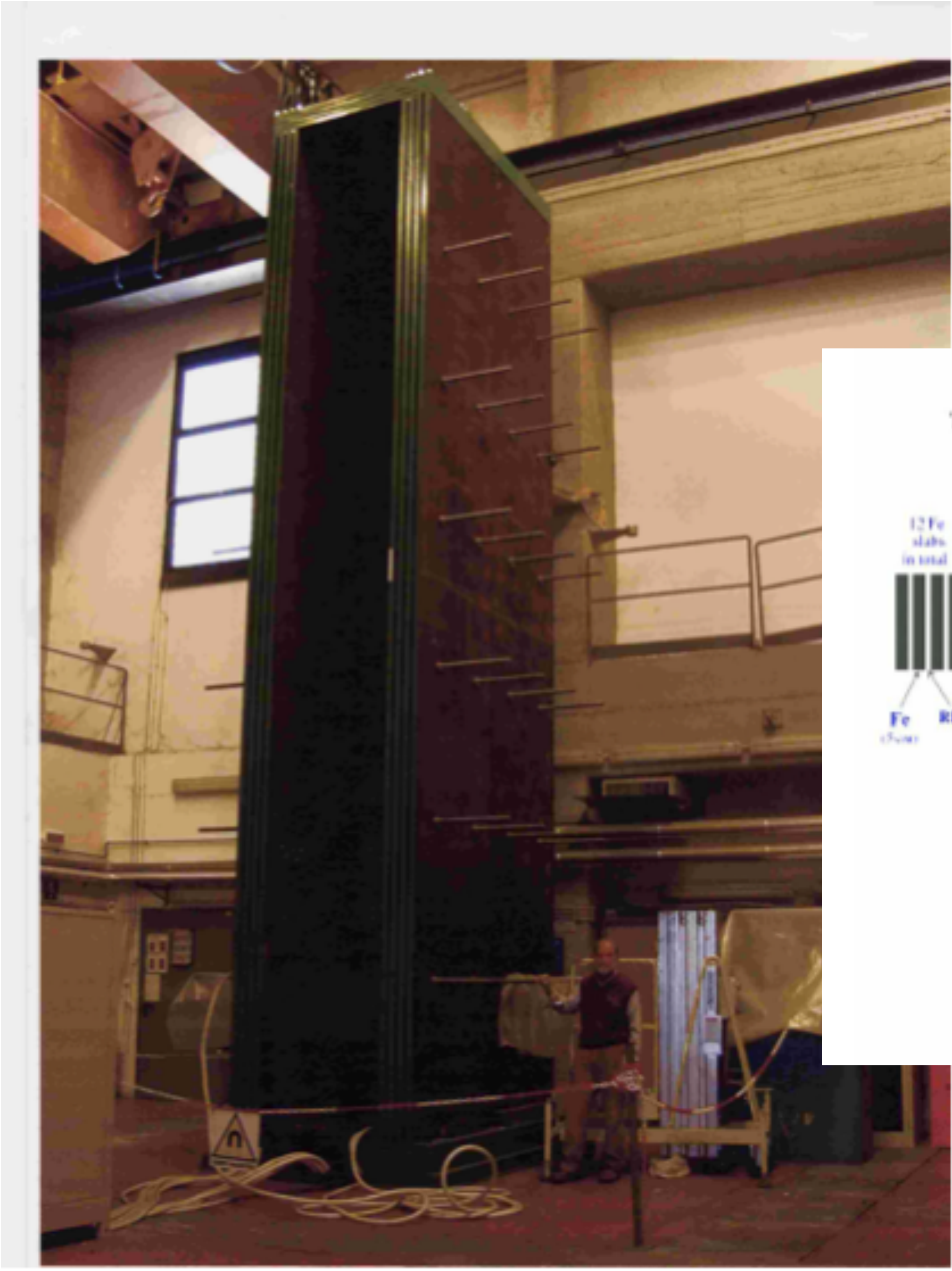
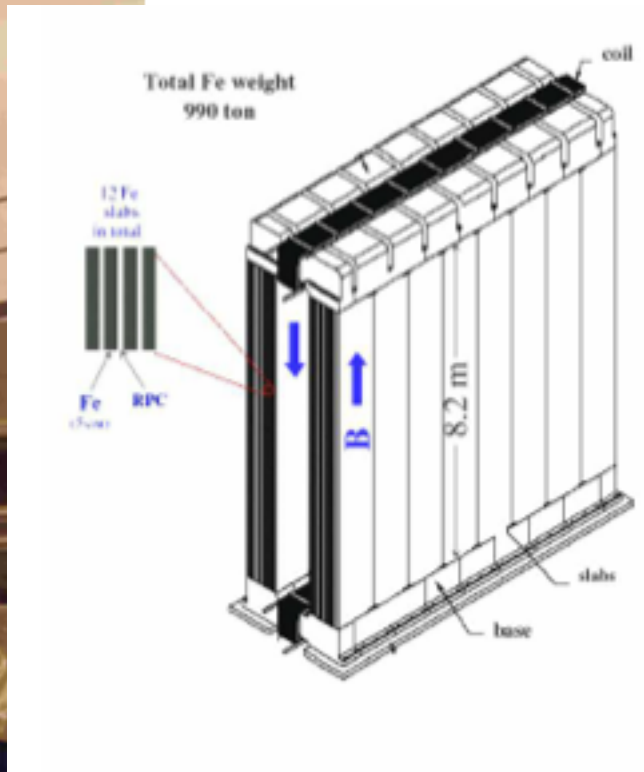
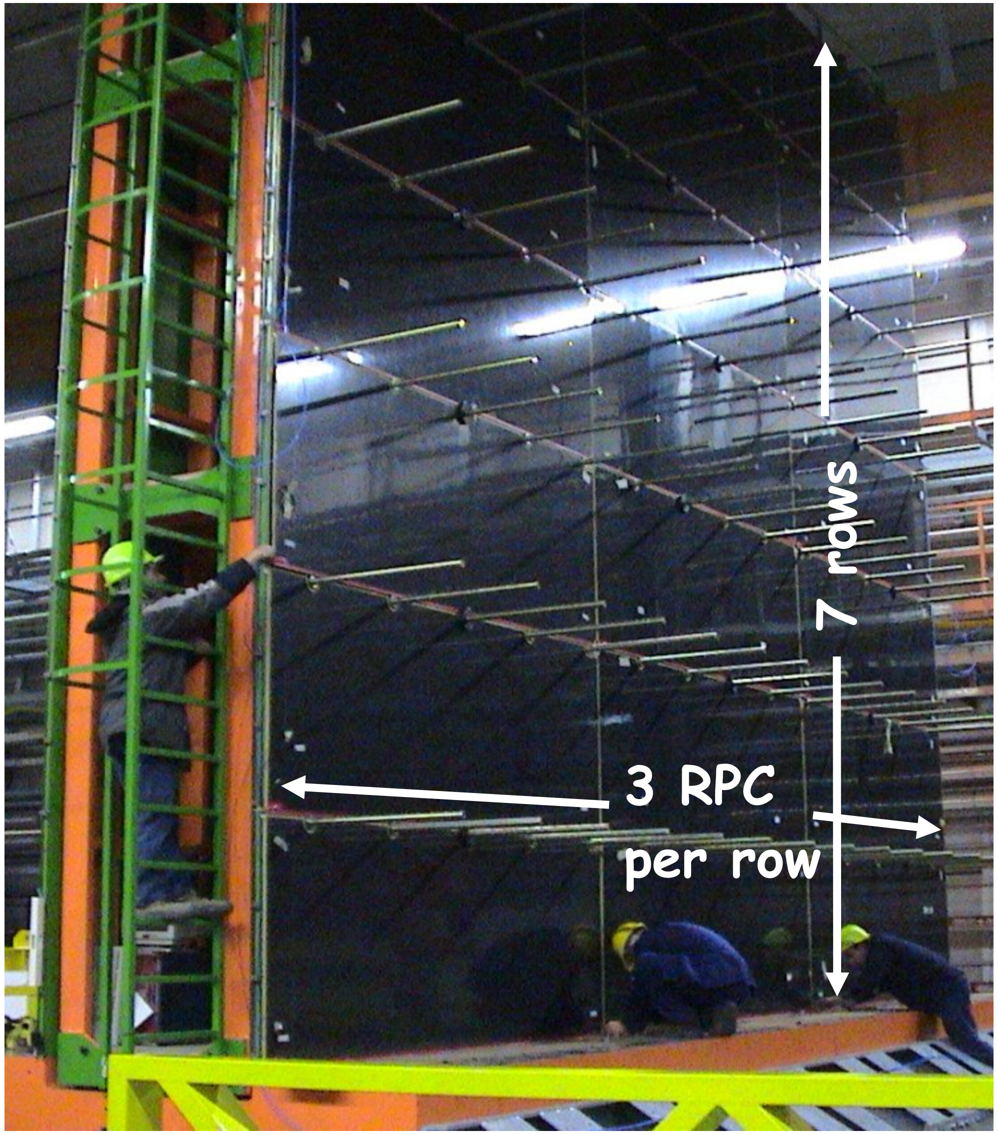


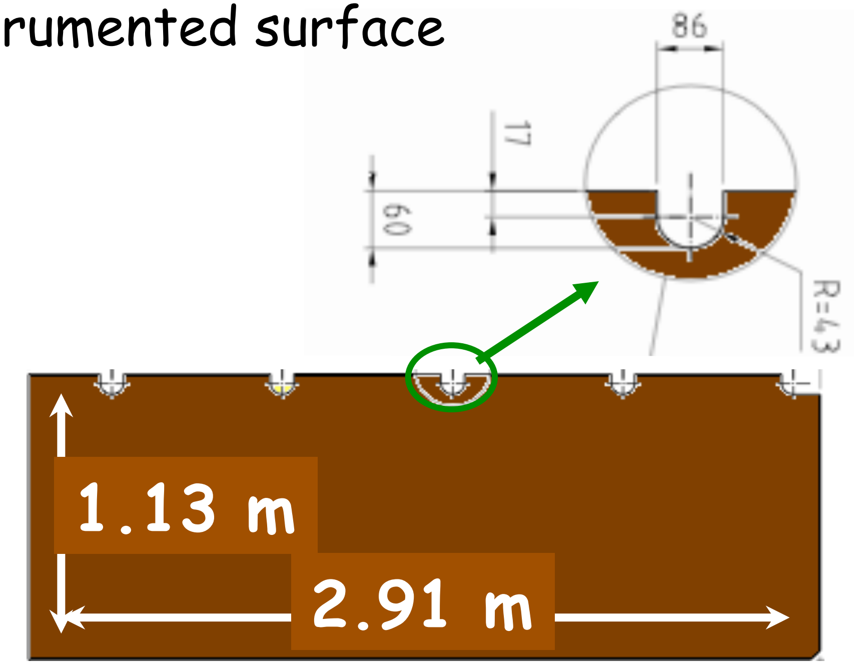
Figure 1: The OPERA dipolar magnet prototype.



RPC mechanical structure



- 3 x 7 RPC per plane
- ~ 70 m^2 instrumented surface per plane
- plane geometrical acceptance ~ 96%
- 22 + 2 RPC planes per spectrometer
- 1008 RPC for a total of ~ 3200 m^2 instrumented surface



RPC strips

Vertical strips (2.6 cm pitch) and Horizontal strips (3.5 cm pitch)

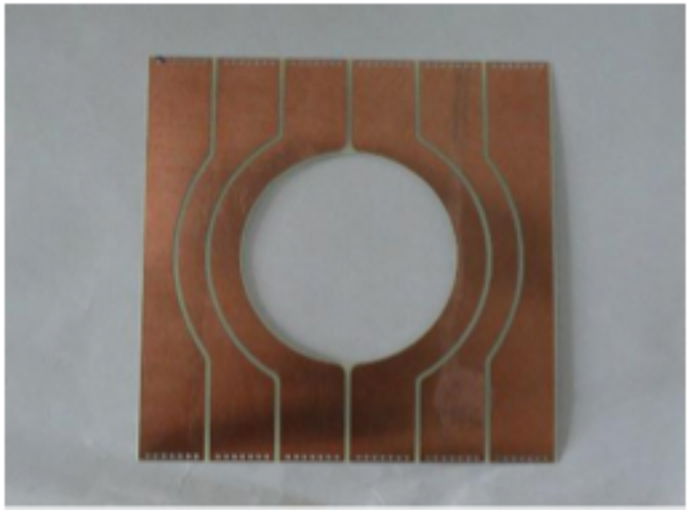
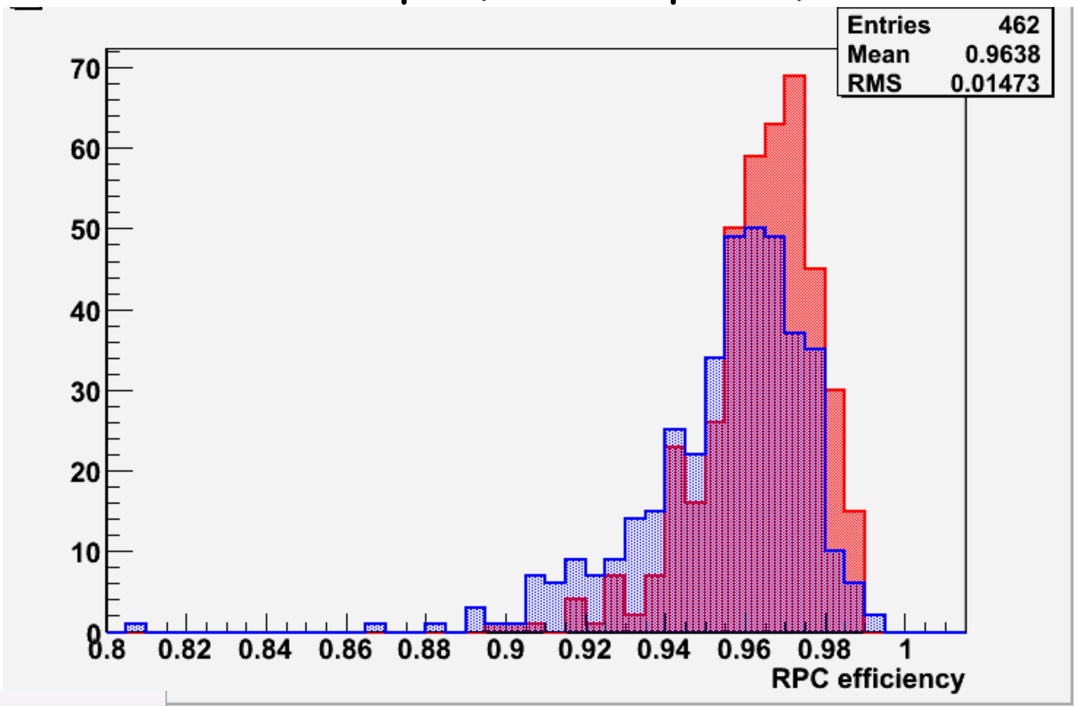
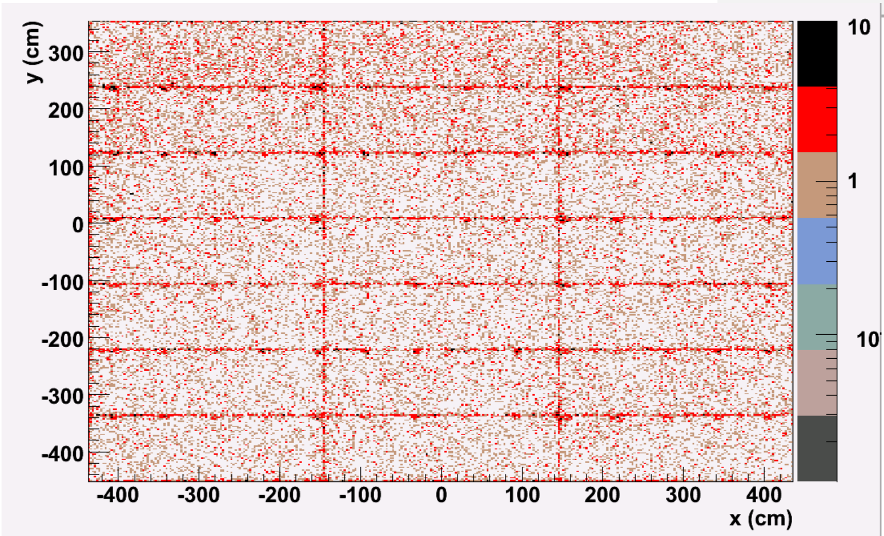


Fig. 6. Readout strips near the bolt.





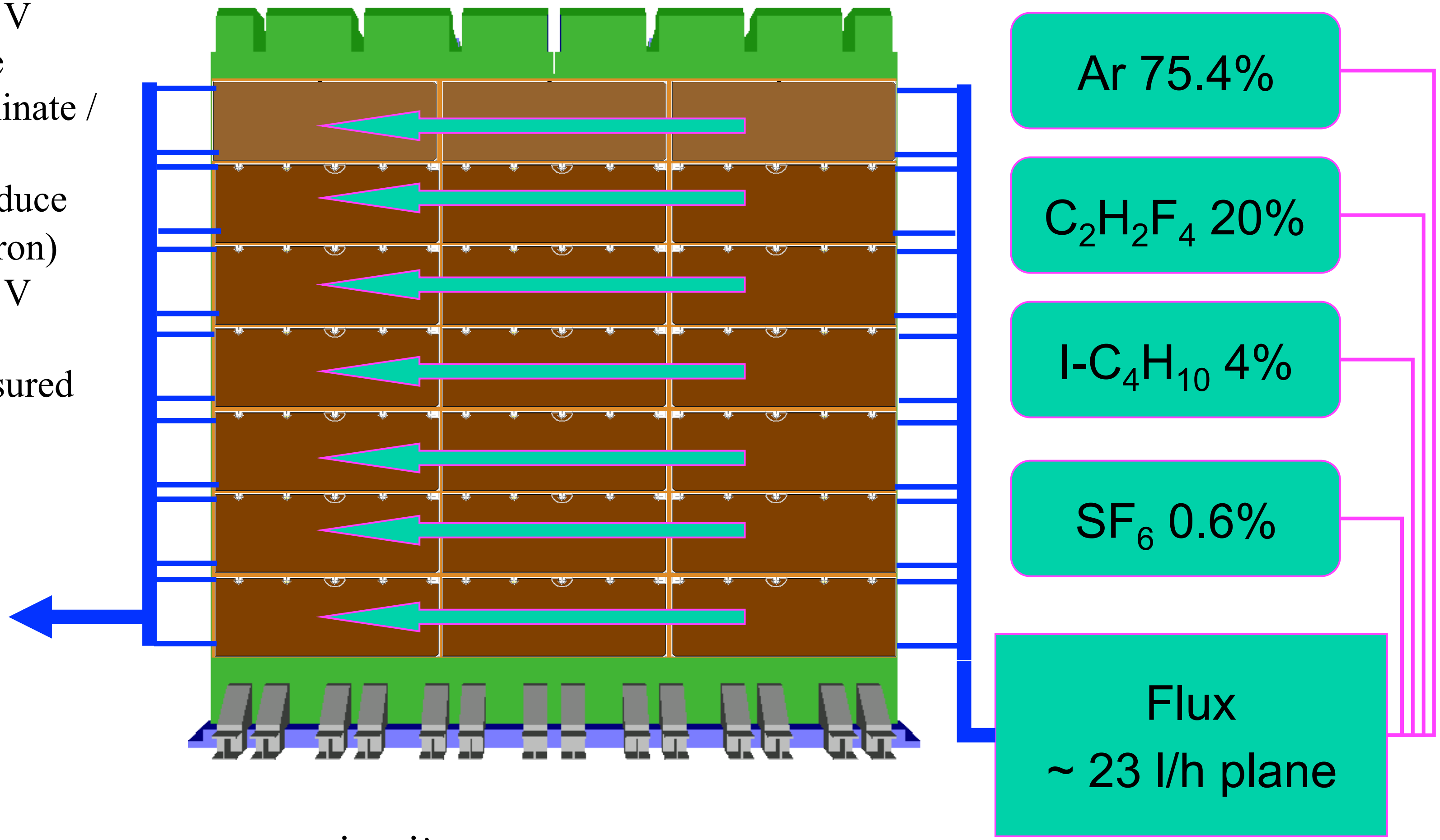
inefficient points
(summed over all the
planes)

RPC HV and gas system

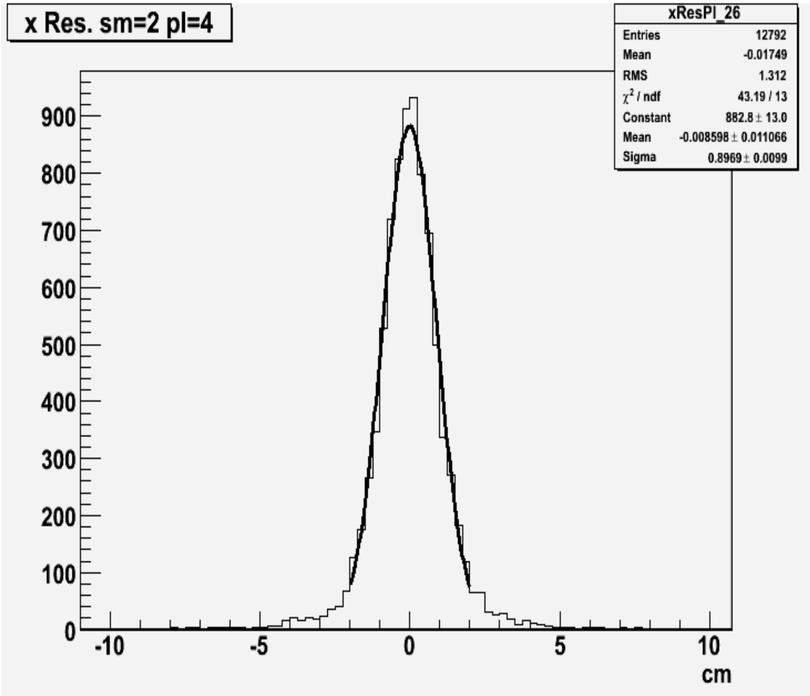
HV:

- running at about 5800 V
- 2 mm gap between the electrodes (plastic laminate / "bakelite")
- opposite polarity to reduce discharge to ground (iron)
- running at about 5800 V
- 144 HV channels
- RPC row current measured with nA resolution

gas system:

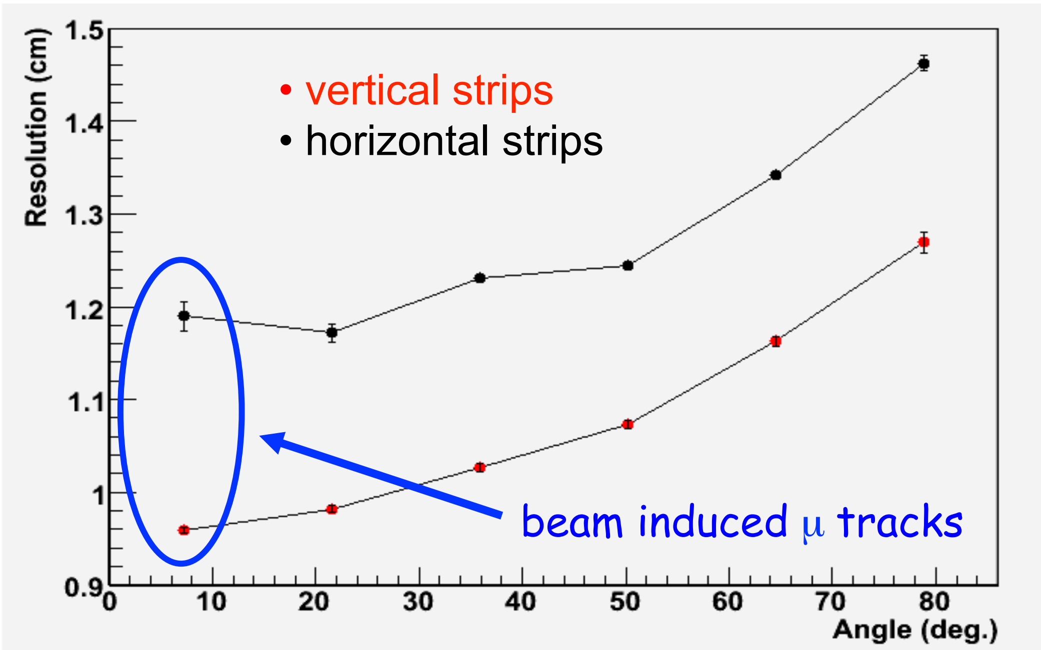


- open circuit
- RPC rows flushed in parallel with needle at the input to equalize the flux and bubbler on the output line
- in total ~ 1 m^3/h



RPC tracking resolution

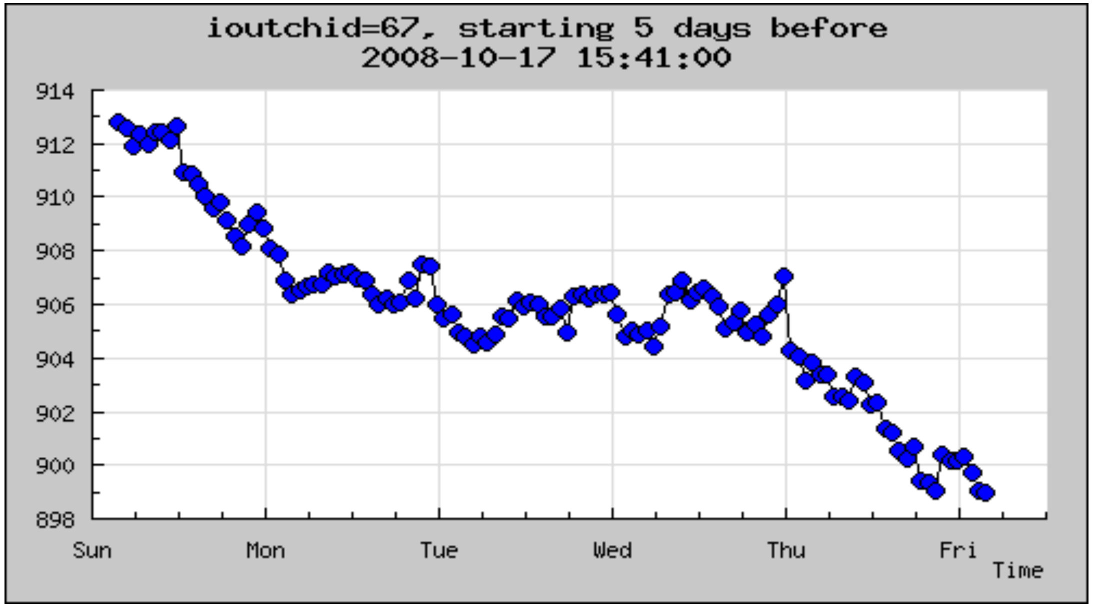
- tracks residuals for a typical plane
- mean well centered at 0 cm hence alignment is fine
- RMS = 1.3 cm
- σ = 0.9 cm

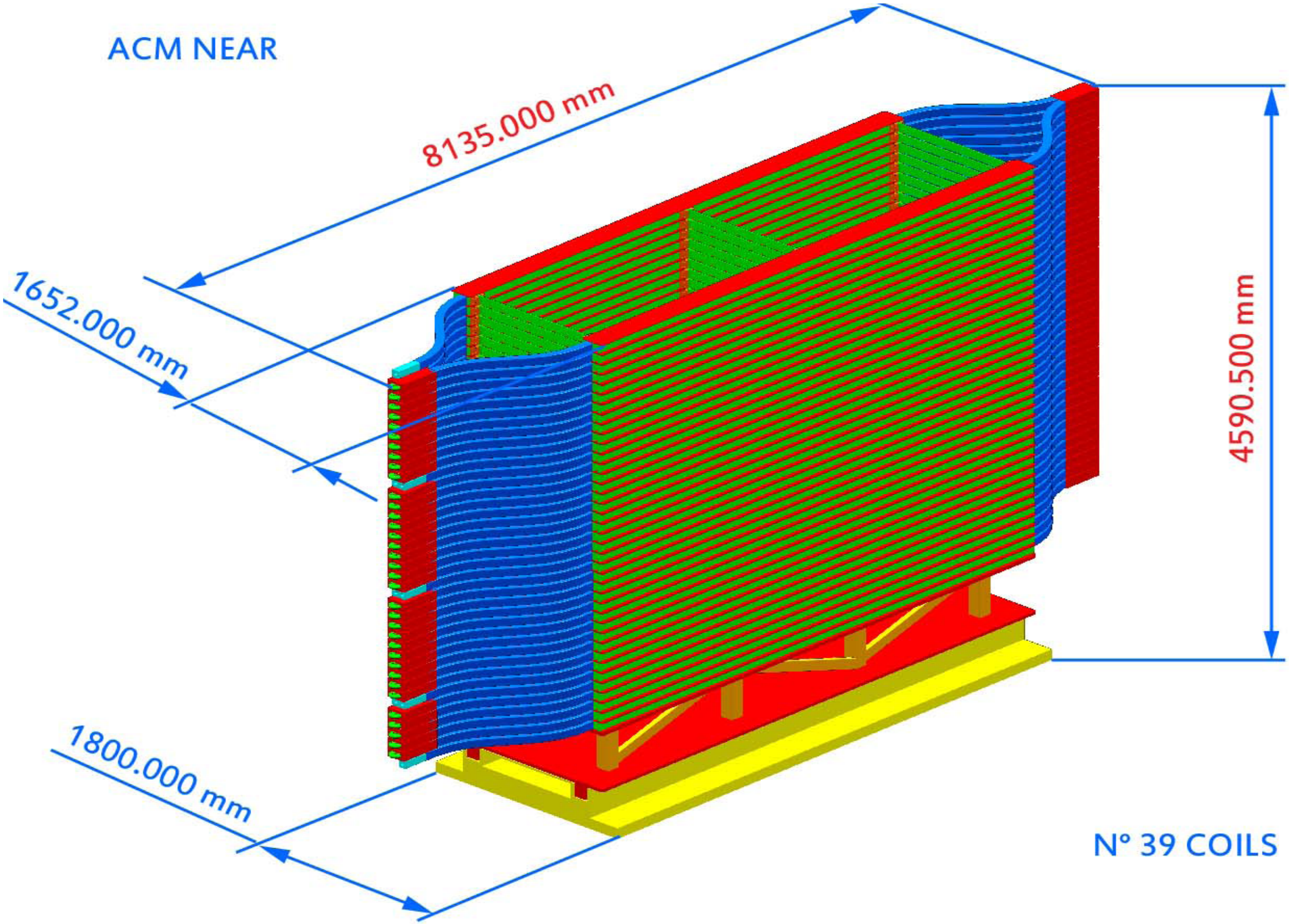


- resolution averaged over all 44 RPC planes
- higher resolution of the vertical view (lower strips size)
- better resolution of orthogonal tracks

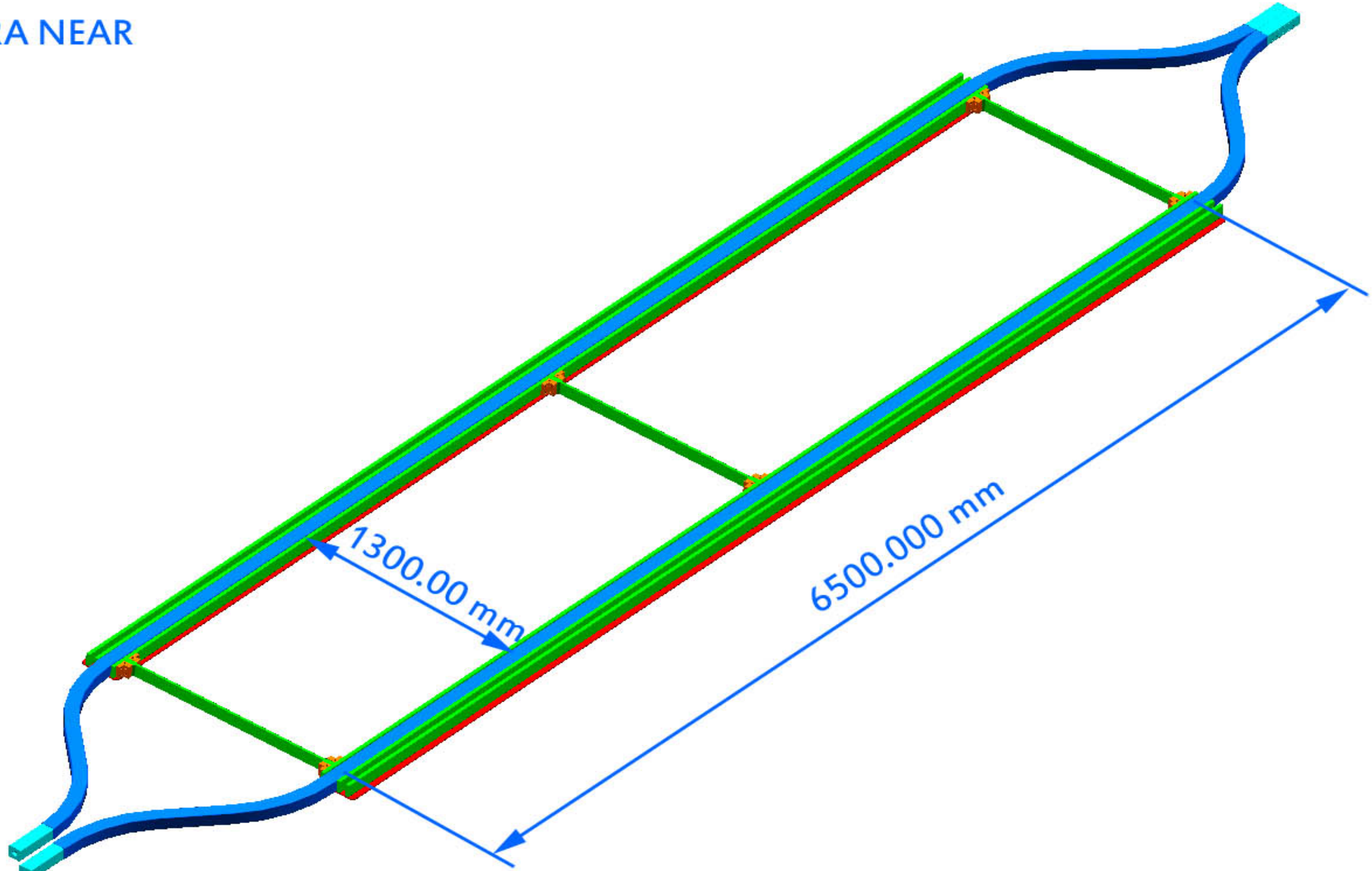
RPC monitoring

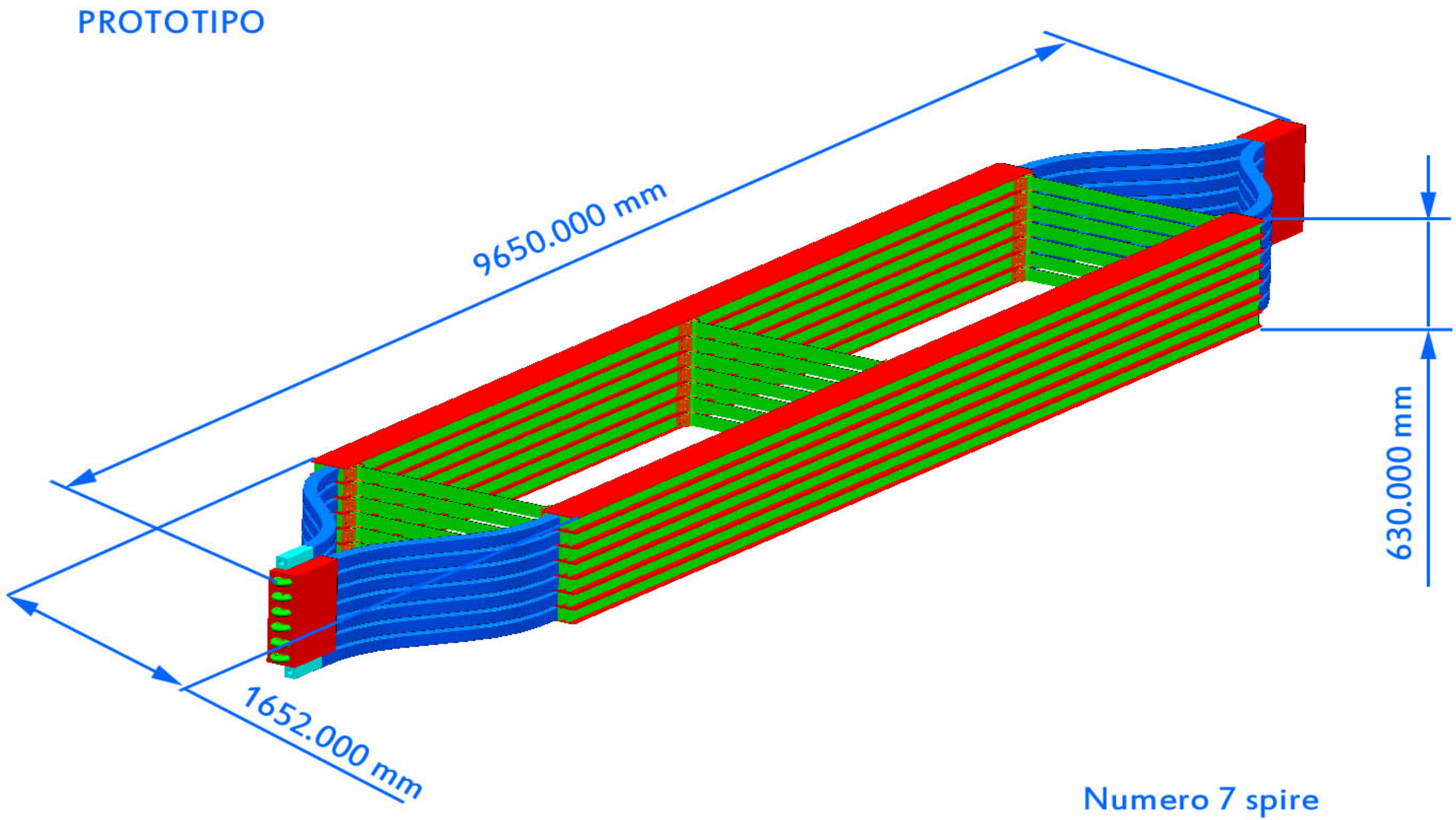
- operating pressure and temperatures recorded and shown via a web interface, HV adjusted accordingly
- HV and currents, at the single channel level, recorded and shown via web interface
- running conditions monitored via web interface
- running conditions can be monitored / changed via vcn-viewers
- alarm conditions on HV / currents / running conditions broadcasted to the relevant experts automatically via e-mail and sms messages




ACM NEAR
8135.000 mm
1652.000 mm
4590.500 mm
1800.000 mm
N° 39 COILS

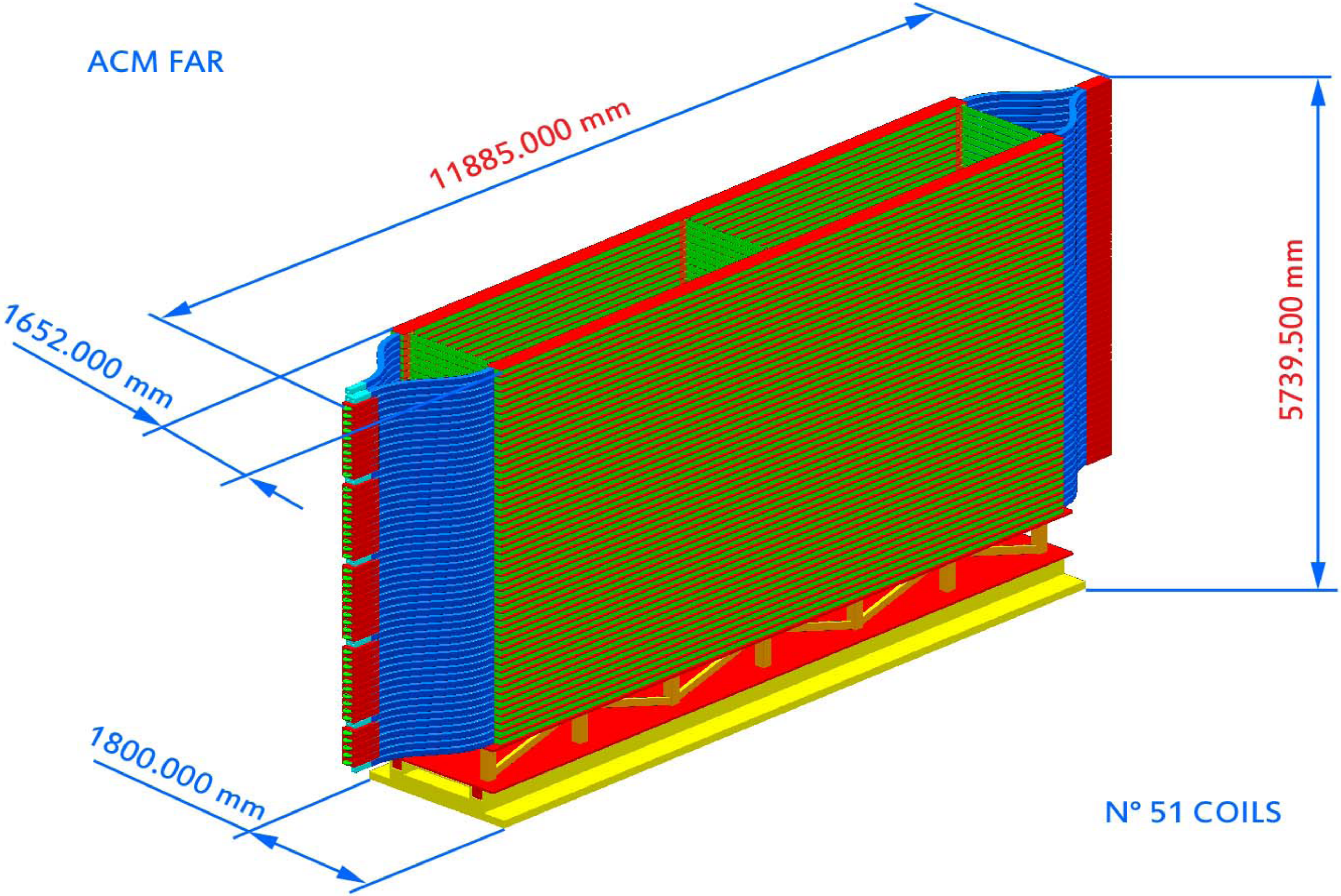
SPIRA NEAR





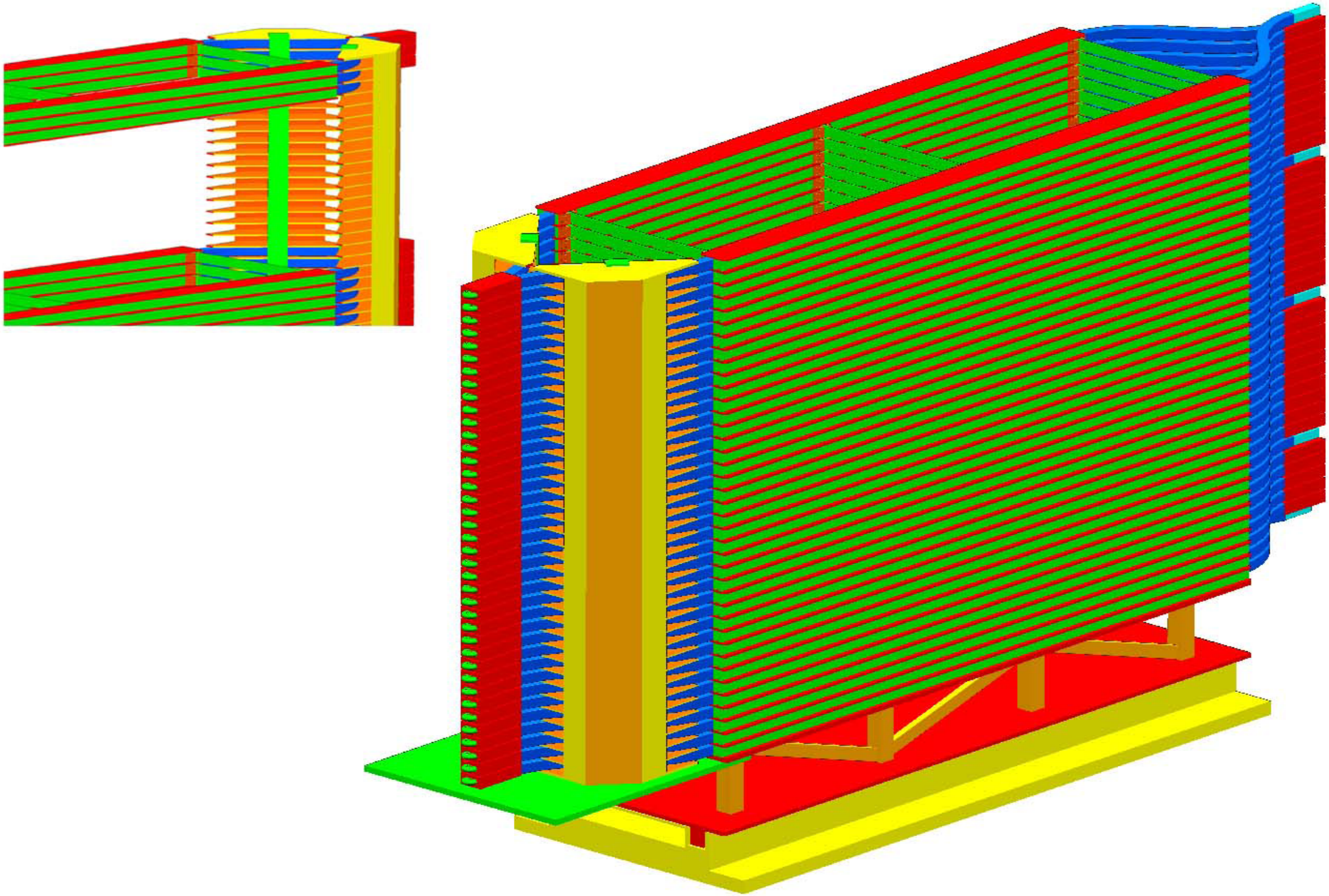
PROTOTIPO
9650.000 mm
630.000 mm
1652.000 mm
Numero 7 spire

ACM FAR



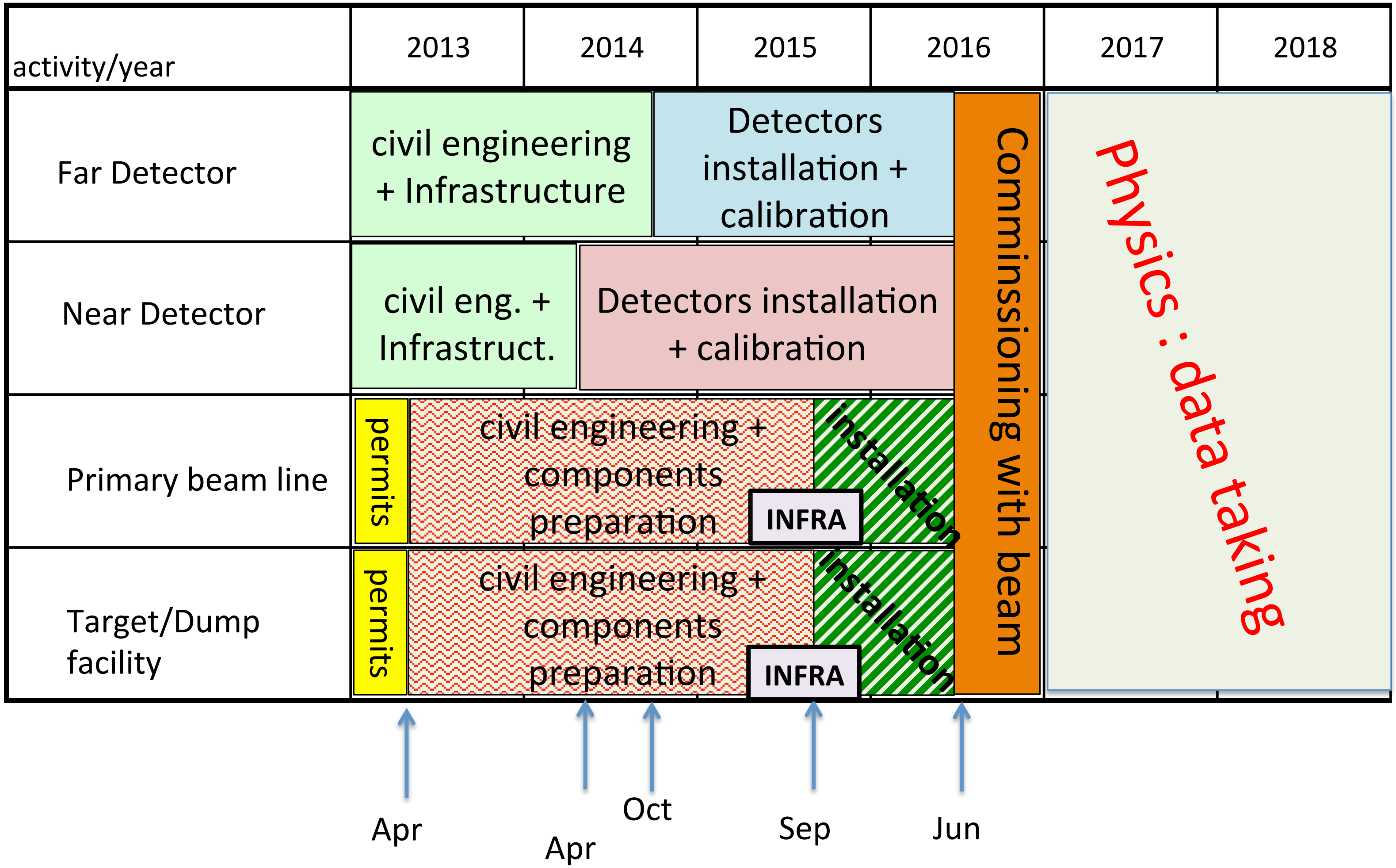
N° 51 COILS

Sudy of supporting edges



CERN Schedule

Overall Planning Proposal (nord area)



Nessie Schedule

2013:	ACM prototype construction, iron SM, ACM, HPT and ancillaries design
2013 - end:	start tenders process
2014 - early:	issue tenders for production/modification (copper. yokes, slabs, rpc, strips, tools/frames)
2014:	parts and tools production/modification
2014 – end:	first deliveries at Cern (copper coils, yokes, slabs, strips, tools/frames, RPC)
2015 - early:	start assembly
2016 - mid:	finish assembly
2016 – fall:	commissioning and start of data taking

Table 1. Detailed breakdown of installation operations.

operation	work days min	work days max	weeks (average)	crane 5 t occupancy	crane 40 t occupancy	crane drivers	
Measuring , tracking, drilling , stud bolts fixing with resins	15	20	4			0	
Bottom Copper coil, lower bars + thermal shield installation	5	5	1	50		0	
internal formwork - preparation	1	2	0	50		0	
Bottom Jokes installation	10	15	3		100	3	
jokes delivery and lowering inside pit							
Jokes preparation							
Jokes mounting on the stud bolts							
Checks, leveling, bolt tightning							
external formwork - preparation	1	2	0	20		0	
self-leveling concrete deposal	1	2	0	20		0	
#3 provisional carpentries delivery, installation, test	5	10	2	20	50	11	
personnel platforms delivery,installation, test:	5	10	2	20	50	11	
Mounting of studs on central support carpentry	1	2	0	20		0	
SLABS/STRIPS/RPCs sandwich installation	100	200	30	100	20	26	
2? Slabs Stacks (14 slabs, 40t) delivery + ancillaries							
First slab layers Installation, checks, fixing							
Delivery of RPCs, strip planes, foam lining							
Slabs, rpc strips preparation							
20+20 Slabs and RPC +strip sandwich installation							
Upper Copper coil, lower bars delivery, installation	3	5	1	50		0	
Top yokes delivery, preparation, installation, fixing	15	20	4		100	4	
jokes delivery and lowering inside pit							
Jokes preparation							
Jokes mounting							
Checks, leveling, bolt tightning							
Upper Copper coil, upper bars delivery, installation	5	15	2	50		0	
Structural checks	1	1	0			0	
Provisional carpentries removal, extracting aside	5	5	1		100	1	
Structural test and checks	1	1	0			0	
Bottom Copper coil, upper bars + thermal screen delivery, installation	20	20	4	50		0	
tools dismantling	5	10	2	50		0	
mount personnel scaffolding aside/inside	5	10	2	50		0	
ICM coils 50 kW cooling and power connections, test	10	15	3			0	
ICM FINISHED	214	370	58				
HPT detector intermediate position delivery, insertion,	10	20	3	50		0	
ACM coil delivery, insertion, fixing, connection, checks, tests	5	20	3		50	1	unless mobil
HPT detector for ACM delivery, insertion, fixing, checks, test?	5	20	3	50		0	
(Mounting of platform on top of Nessie)	5	15	2		50	1	
Detectors PS and electronics installation	15	20	4	50		0	
Detectors cabling, piping, test	15	25	4			0	
ACM and SERVICES	55	120	18				
OVERALL	54	98	76			57	

Status of approval and further steps

At CERN

- *Group established by CERN in order to realize SPS based new short-baseline ν beam in the North Area (project leader M. Nessi)*
- *Scientific Approval (SPSC) middle of January 2013*
- *Feasibility document submitted to CERN Directorate on February 7th 2013*
- *Research Board evaluation on March 4th 2013*
- *SPC*
- *CERN Council*

INFN: Currently Major contributor to the experiments (not beam)

- *Scientific approval*
- *Under evaluation by the Technical Scientific Committee (CTS) as for costs, manpower*
- *In-Kind contribution of Opera Spectrometers*

MONEY estimation

Iron magnets: in-kind value 5940 K€ (from OPERA MoU)
Cost for transportation to CERN and refurbishing: 3000 K€
In-kind value of Precision Tracker: 1900 K€
possible refurbishing: 700 K€
In-kind value of Scintillators: 1900 K€
possible refurbishing: 300 K€
Cost ACM: 700 (Near) + 1800 (Far)

TOTAL: 3+1+1+2 = 7 M€

→ *might be staged at 2nd phase (after LS2)*

Conclusions

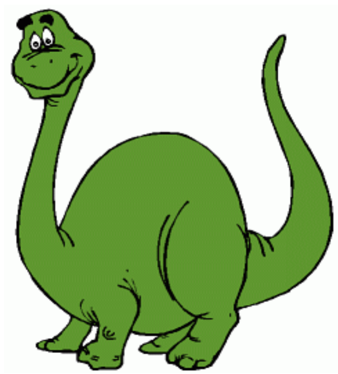
Possibility of exciting discoveries of BSM Physics with vast consequences or a complete clarification of present anomalies.

Favorable time scale thanks to the use of existing/running detectors (or reasonable extensions).

Opportunity for a revival of neutrino activity in Europe.

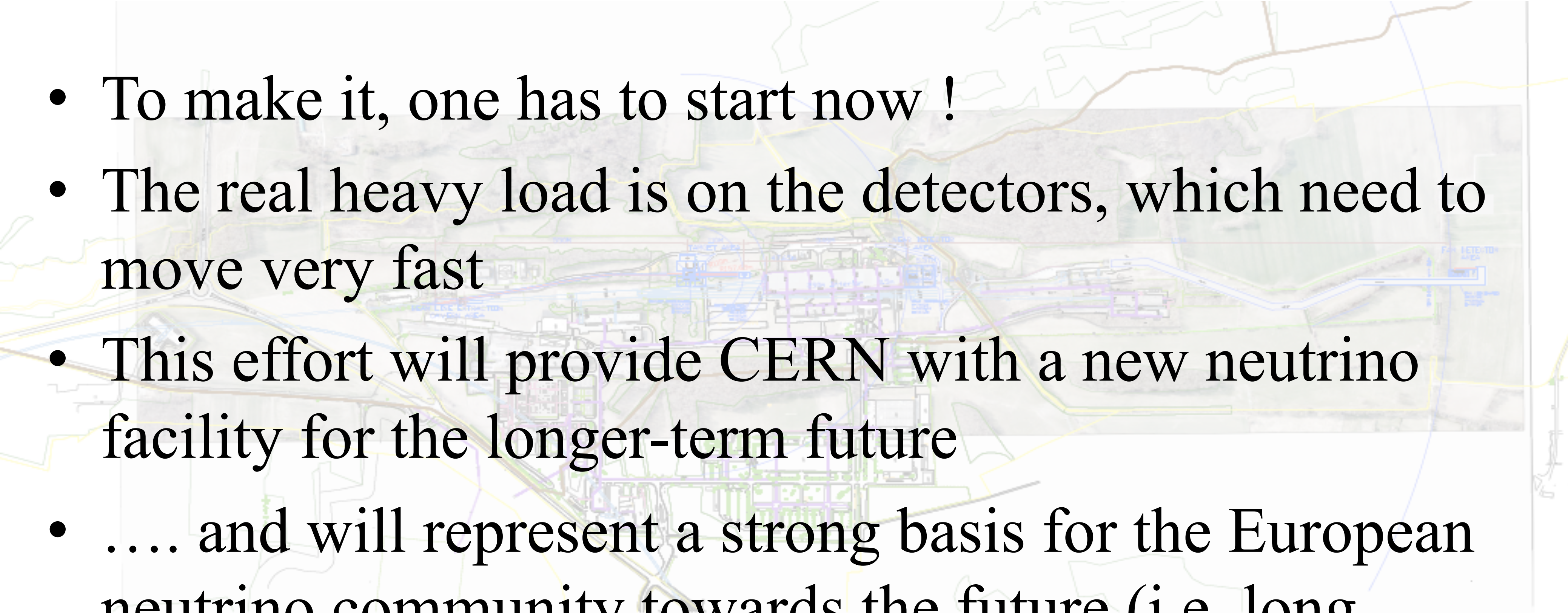
Possible synergies with the other 3ν and R&D programs.

Large room and availability for contributions in NESSiE



M. Nessi©

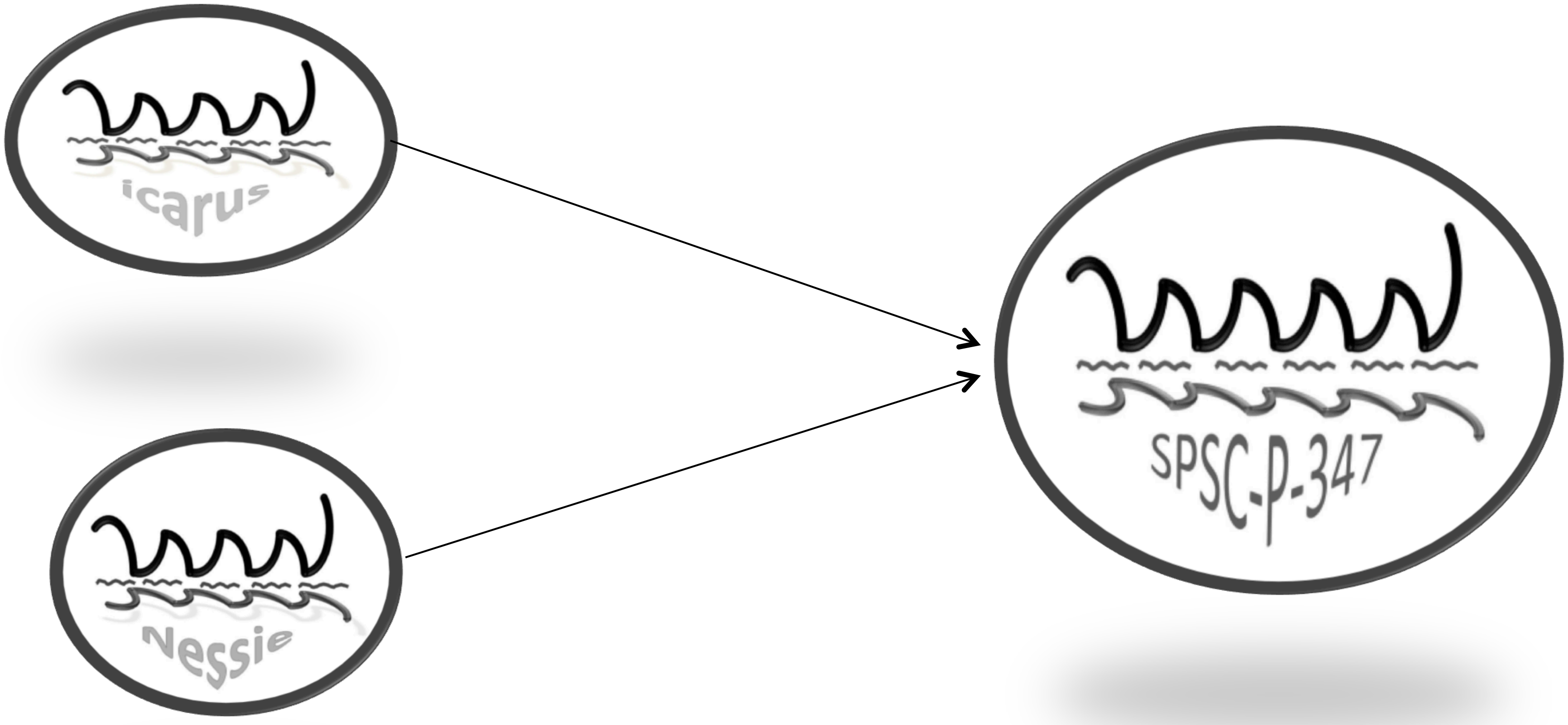
Summary



- To make it, one has to start now !
- The real heavy load is on the detectors, which need to move very fast
- This effort will provide CERN with a new neutrino facility for the longer-term future
- …. and will represent a strong basis for the European neutrino community towards the future (i.e. long baseline in or outside Europe)

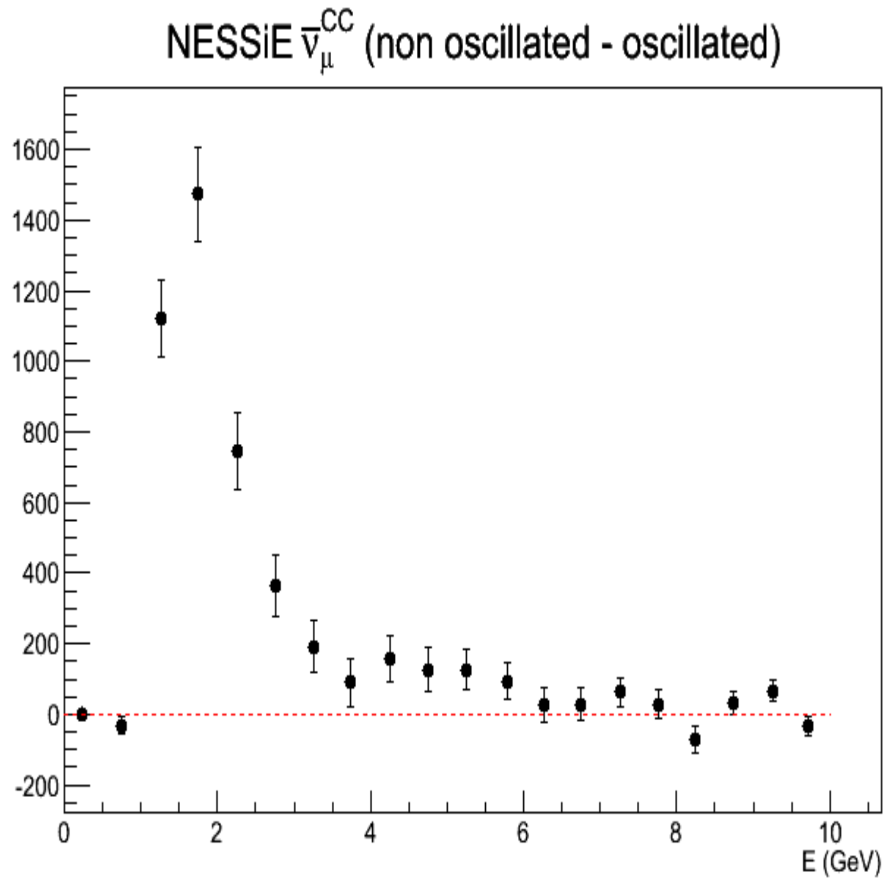
Let's not loose this momentum !!!

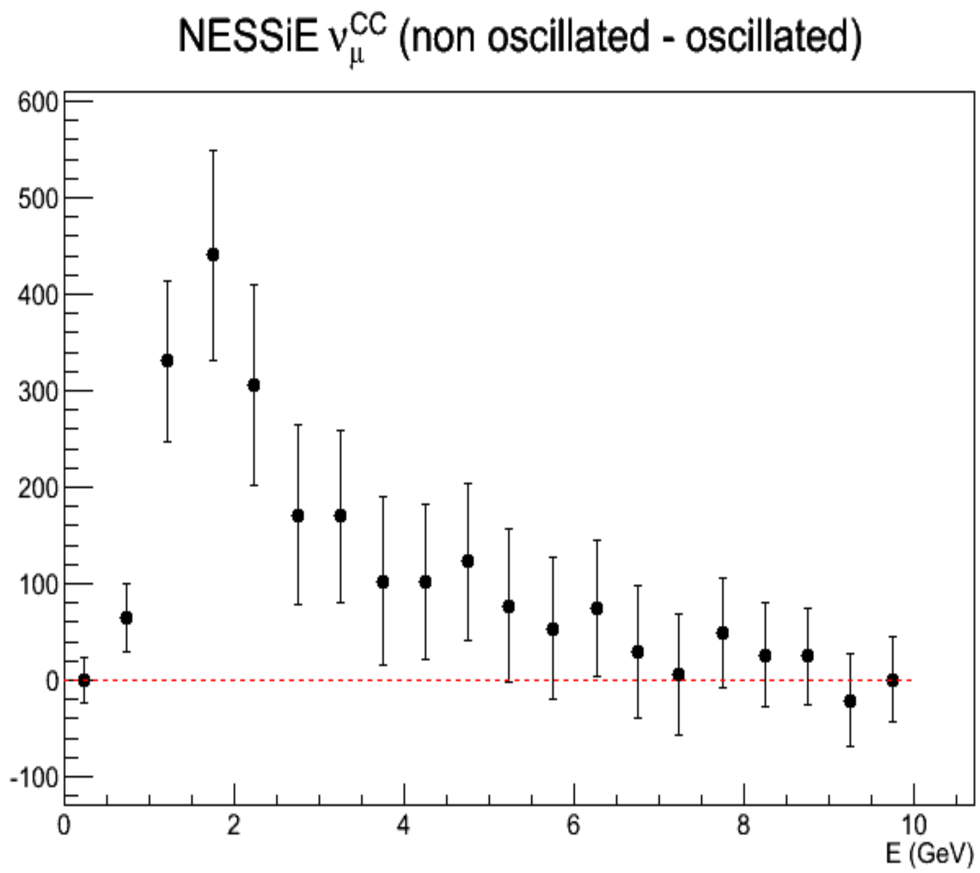
Thank you !



Backup slides

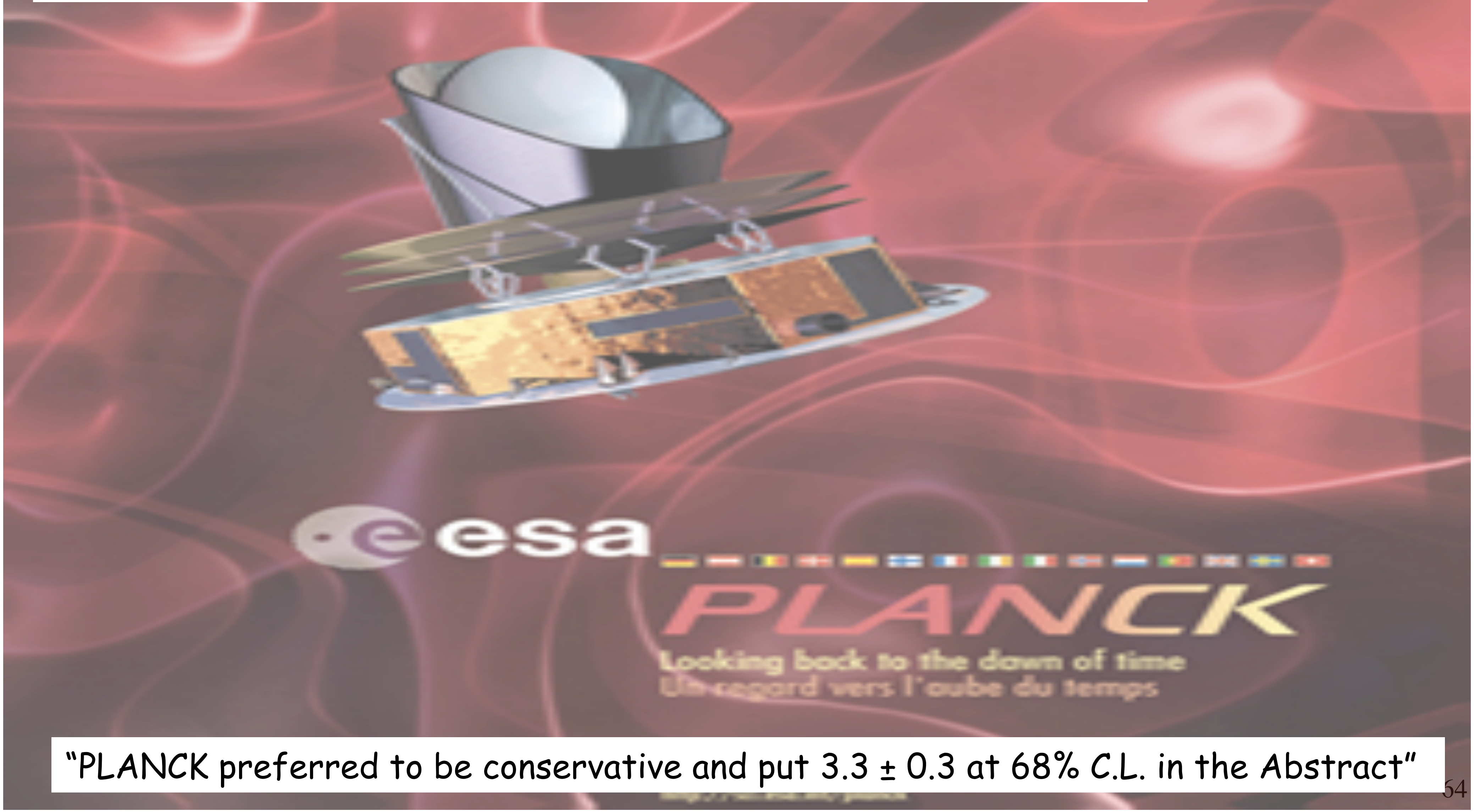
Muon disappearance signal





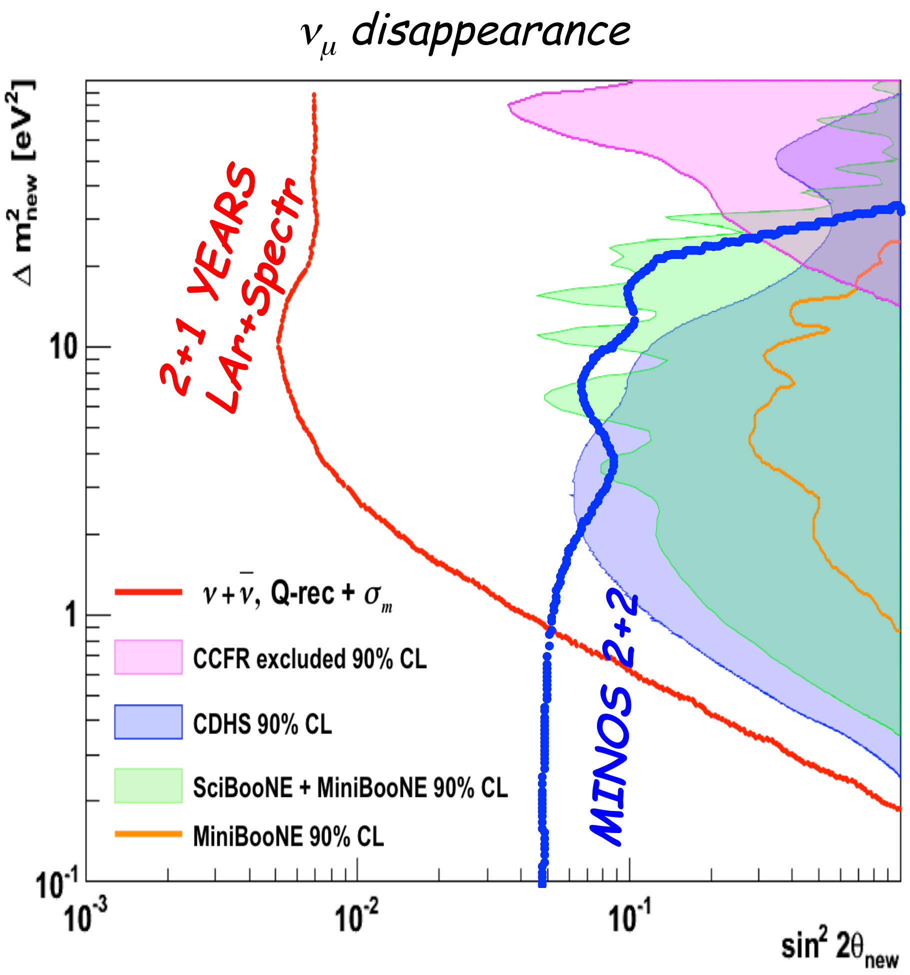
1 year of anti-neutrinos !

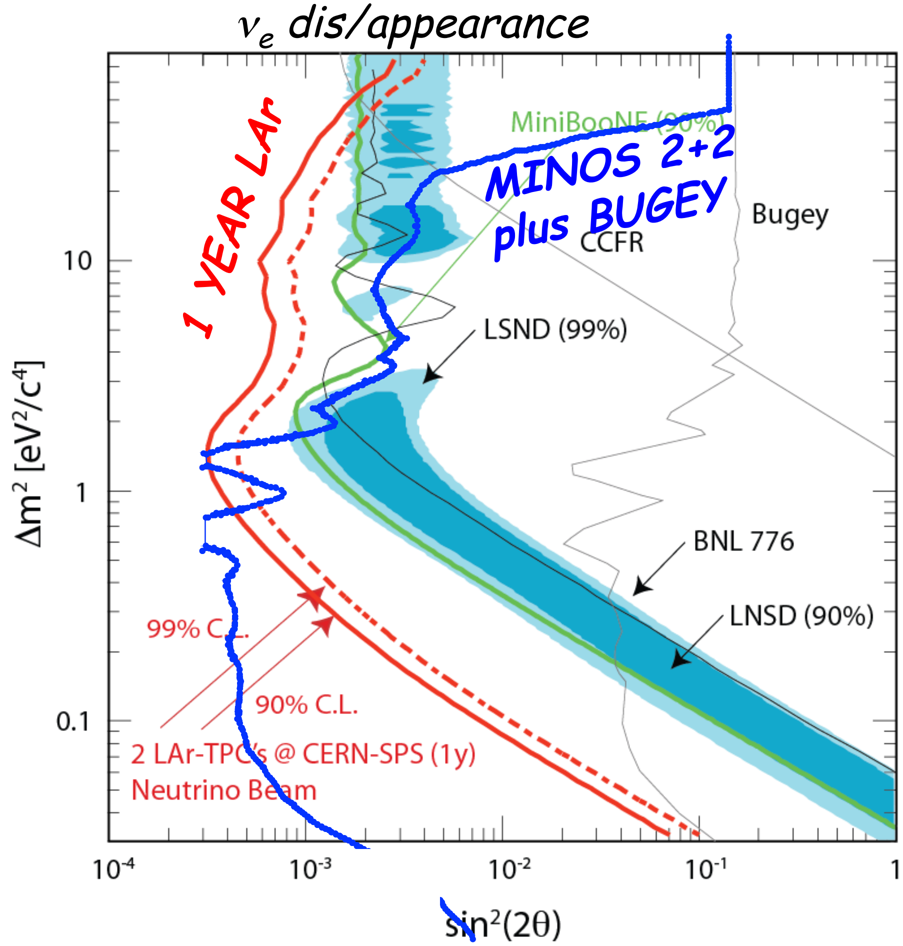
" A sterile neutrino is perfectly consistent with the Planck data.
If you actually look at the real numbers here:
http://www.sciops.esa.int/SYS/WIKI/uploads/Planck_Public_P/3/32/Grid_limit95.pdf
Planck alone gives Neff=4.5 ± 1.4 at 95% C.L.,
while Planck + HST 3.7 ± 0.5 at 95% C.L. "

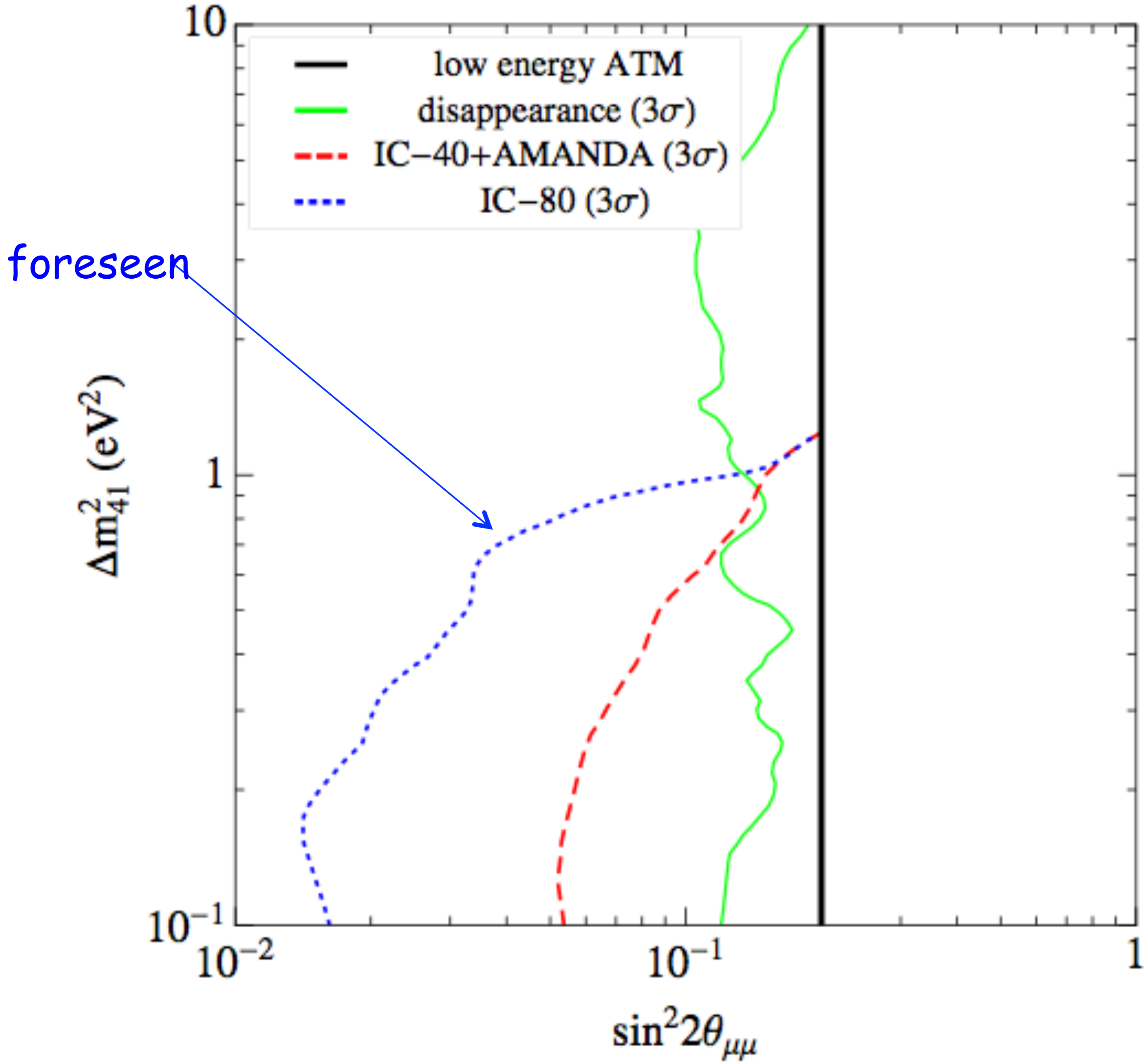


"PLANCK preferred to be conservative and put 3.3 ± 0.3 at 68% C.L. in the Abstract"

Comparison with MINOS+ limits







JCAP11(2012)041

(not sign by the whole collaboration)

Nessie FAR vs Icarus acceptance