WP2 report

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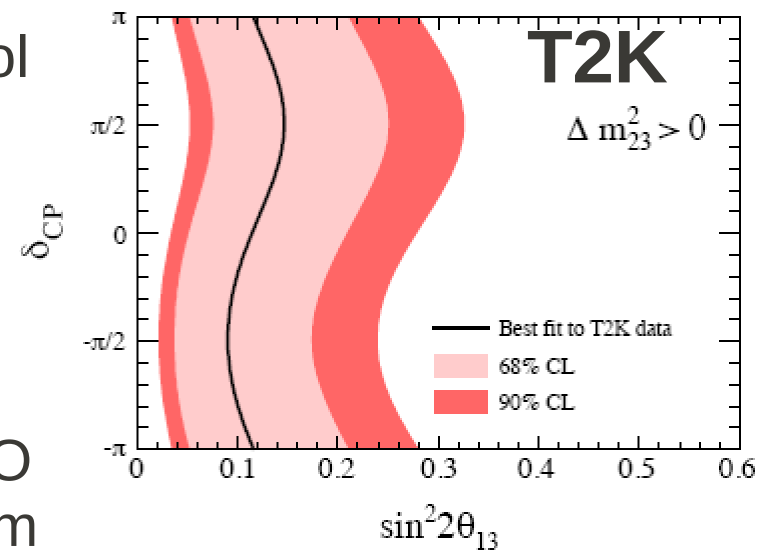
On behalf of the EUROnu WP2 team

EUROnu Meeting Paris June 13 2012

Motivation

(assum

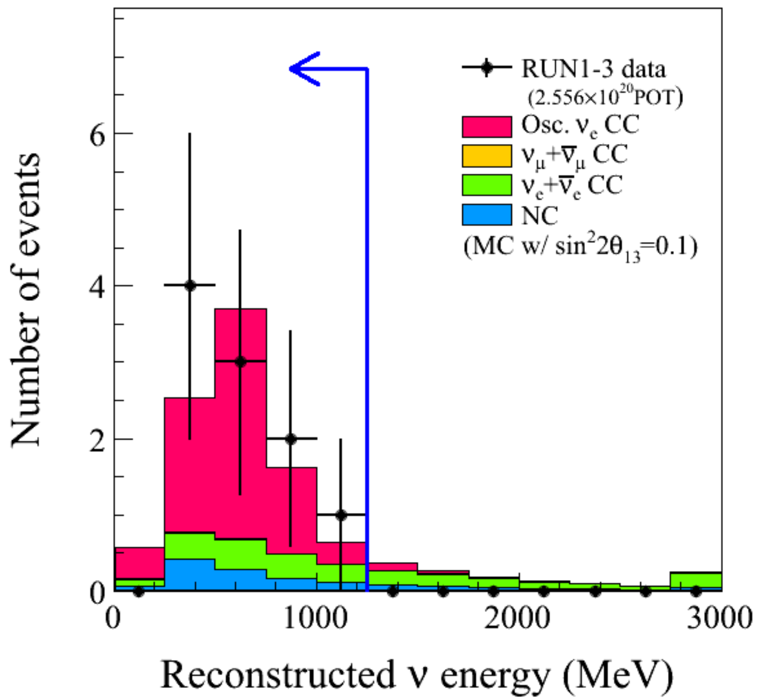
- Conventional neutrino beams are a powerful tool for the study of neutrino oscillations
- Currently several large scale HEP experiments using this technology: MINOS, OPERA, T2K
- The recent indications by T2K (and MINOS), spectacularly confirmed by Daya Bay and RENO point to the large θ_{13} region where a Super Beam has a good sensitivity

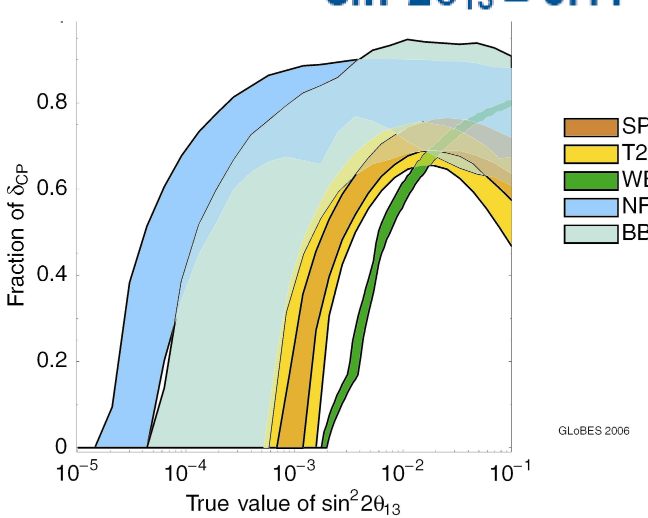


90% C.L. interval & Best fit point (assum

$0.03 < \sin^2 2\theta_{13} < 0.28$

$\sin^2 2\theta_{13} = 0.11$

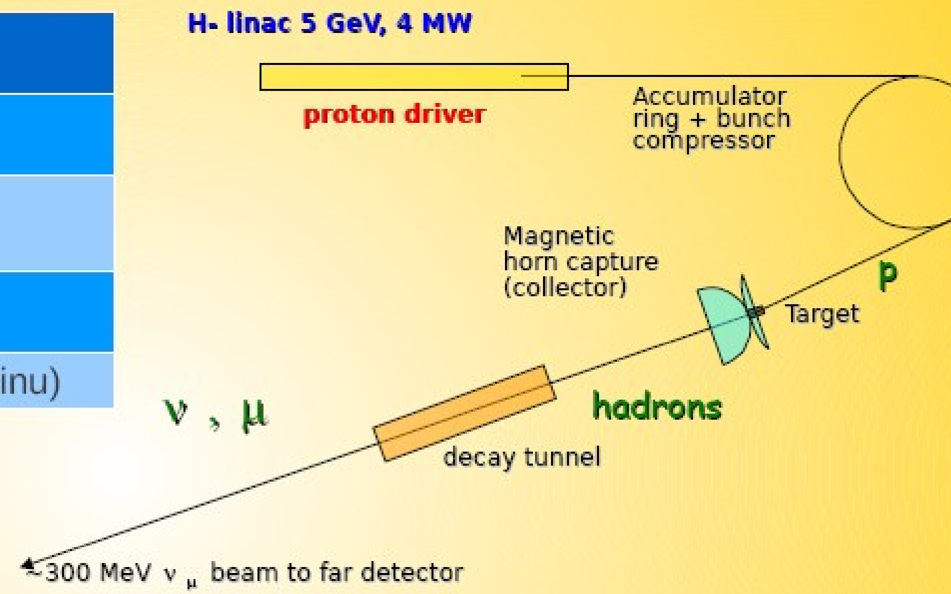


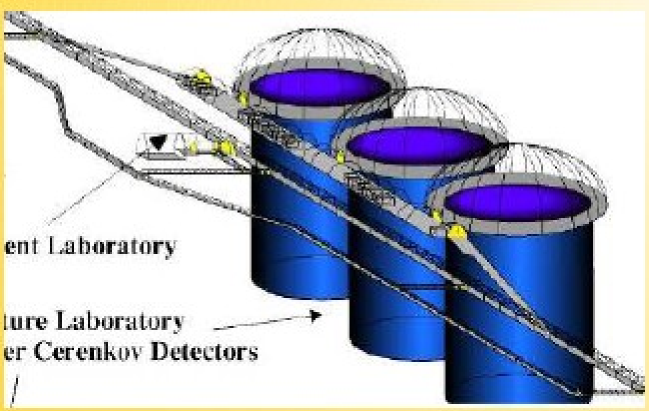


CERN to Fréjus

Basic scenario (detector, proton energy) is well defined

Beam Energy	5 GeV
Baseline	130 km
Far detector	MEMPHYS
Mass	440 kton
Running mode	2 y (nu) + 8y (antinu)





Proton beam

Energy	5 GeV
Beam Power	4 MW
N. beam lines	4
Rep. rate	12.5 Hz
Pulse dur.	5 μs
beam gauss width	4 mm

At the start of the project, no feasibility study of the neutrino beam

The WP2 team

- Cracow University of Technology
- STFC RAL
- IPHC Strasbourg
- Irfu-SPP, CEA Saclay

- E. Baussan, O. Besida, E. Bouquerel, C. Bobeth , O. Caretta , P. Cupial , T. Davenne , C. Densham, M. Dracos ,M. Fitton , G. Gaudiot, M.Kozien ,B. Lepers, A. Longhin, P. Loveridge, F. Osswald ,P. Poussot, M. Rooney ,B. Skoczen ,B. Szybinsky, G. Vasseur, N. Vassilopoulos, D. Wilcox, A. Wroblewski, V. Zeter, M. Zito

Overview

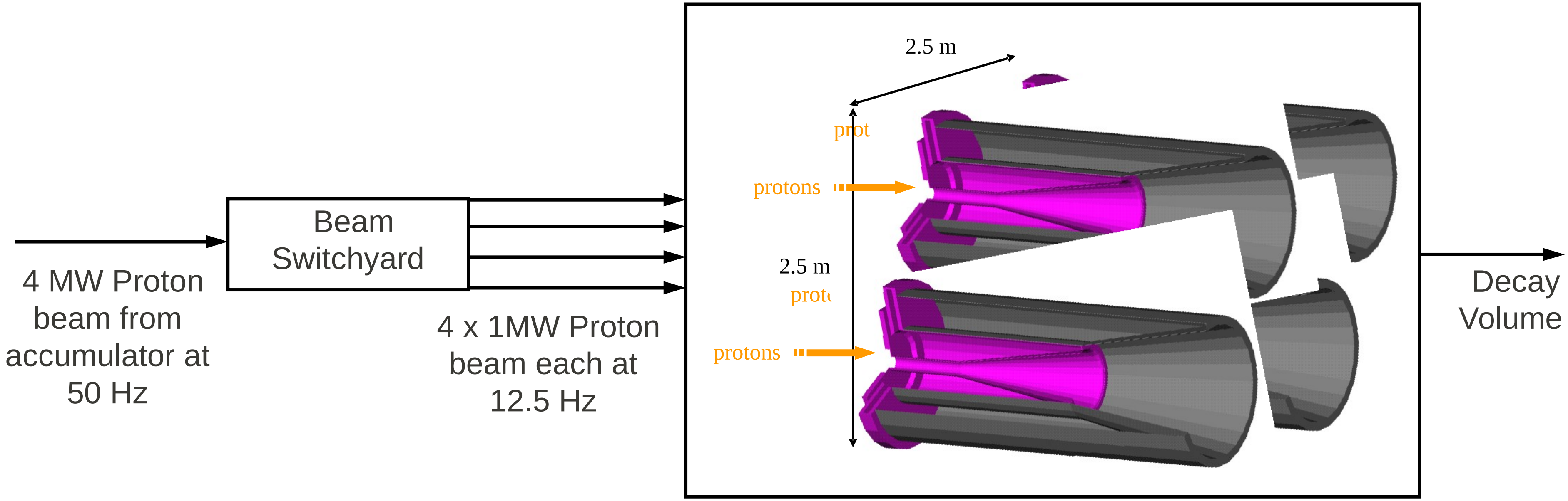
- We have successfully met our milestones and produced the conceptual design of the Super Beam facility
- This has been reported in our preliminary design report EUROnu-WP2-11-01 (last year)
- We have further refined and completed this design and this is what will be presented today

Important steps for the design

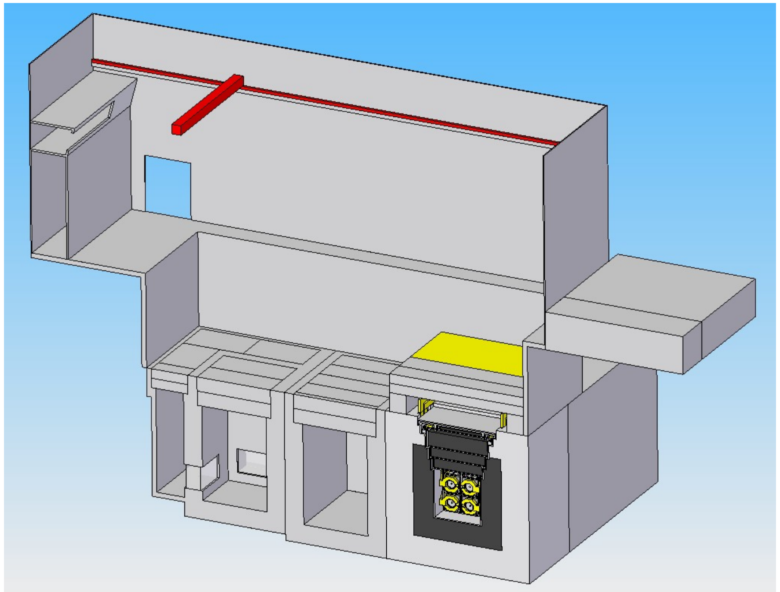
- Solid static target
- Use multiple (4) targets+collectors
- Each pulsed at 12.5 Hz
- Use single horn (no reflector)
- Optimization of horn shape → Miniboone shape

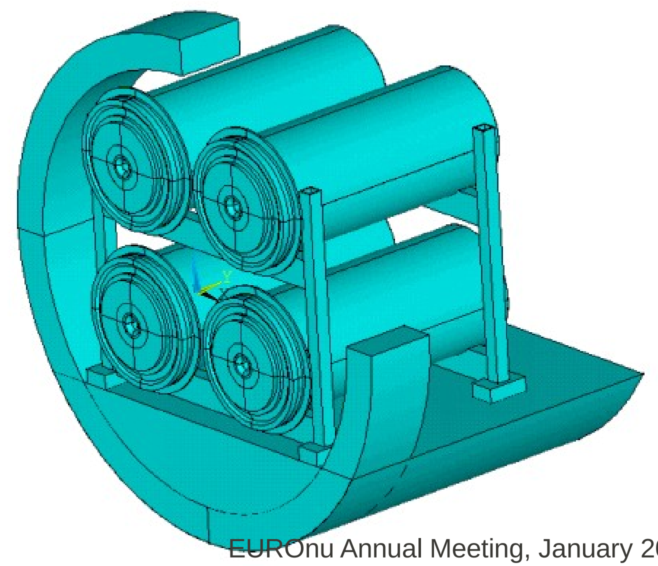
  → talk by N. Vasilopoulos
- A lot of progress towards a working solution, at constant (or improved) physics performance

Overall configuration



Target Station (4 targets, 4 horns)





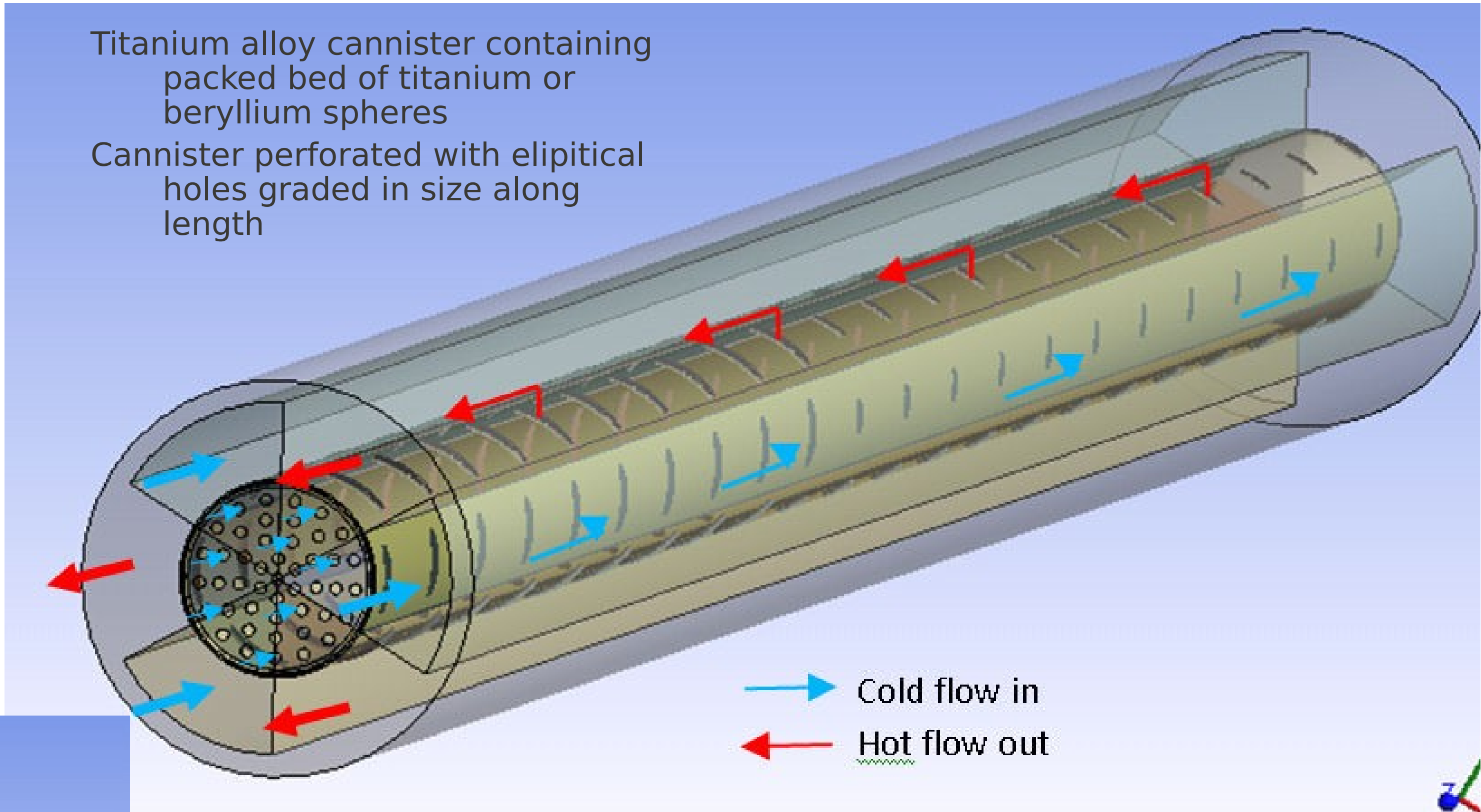
Proposed by Pugnat and Sievers

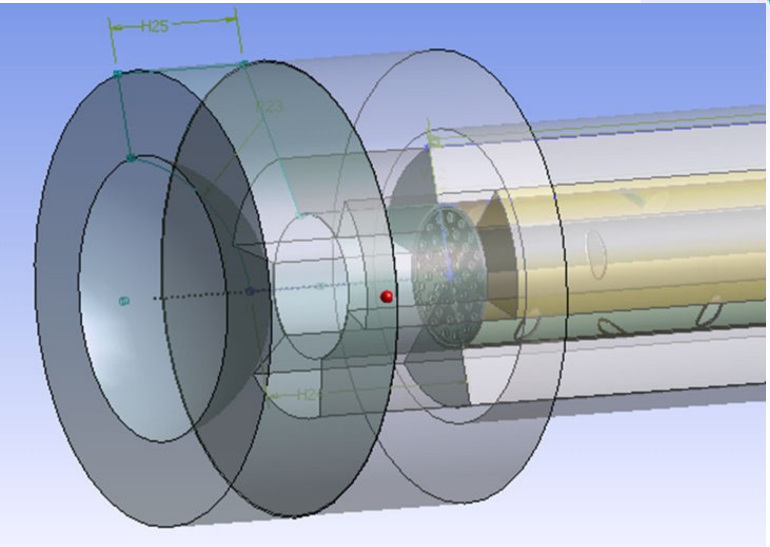
C. Densham, T. Davenne

Packed Bed Target Concept for Euronu (or other high power beams)

Packed bed cannister in parallel flow configuration

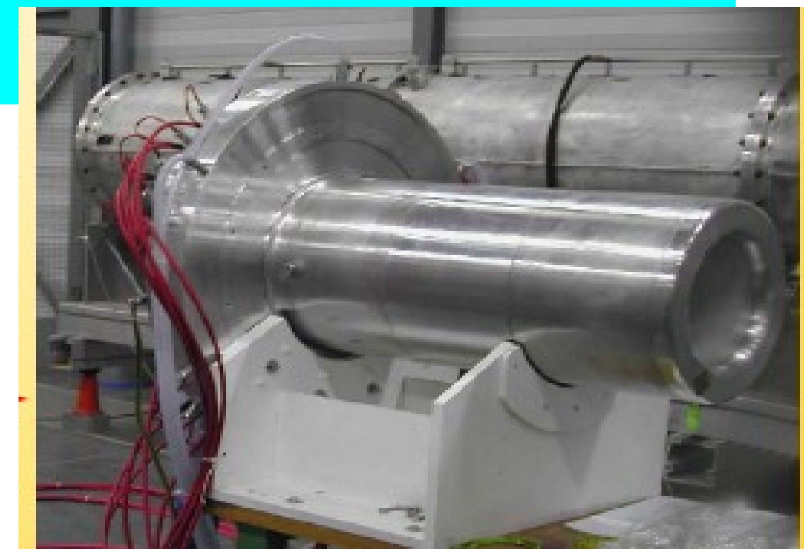
Packed bed target front end





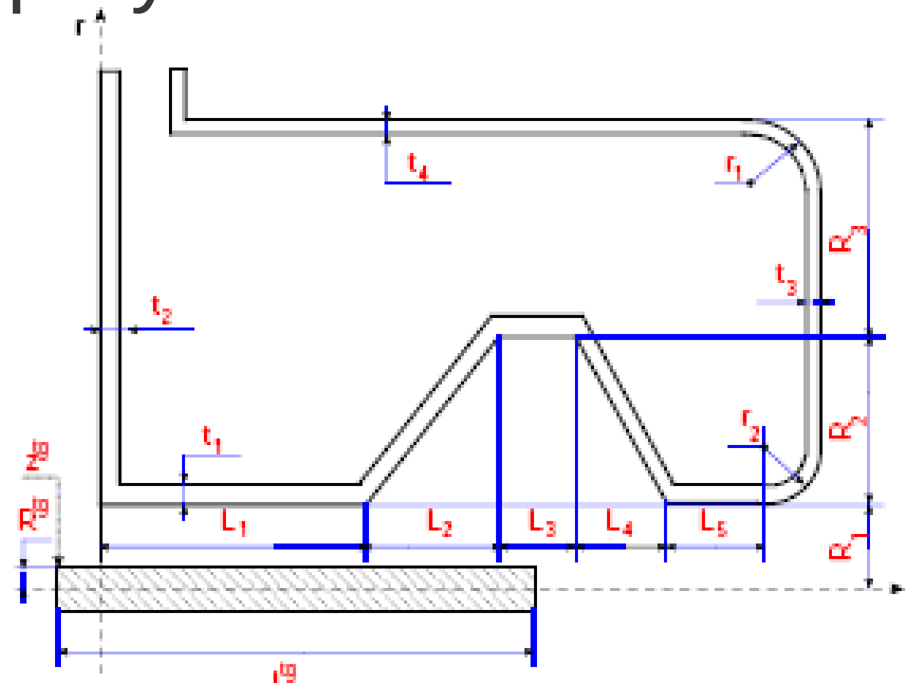
Model Parameters
Proton Beam Energy = 4.5GeV
Beam sigma = 4mm
Packed Bed radius = 12mm
Packed Bed Length = 780mm
Packed Bed sphere diameter = 3mm
Packed Bed sphere material : Beryllium or Titanium
Coolant = Helium at 10 bar pressure

Horn



Baseline :

- Miniboone shape
- Aluminum
- Cooled with internal water sprays
- Pulsed with 350 kA



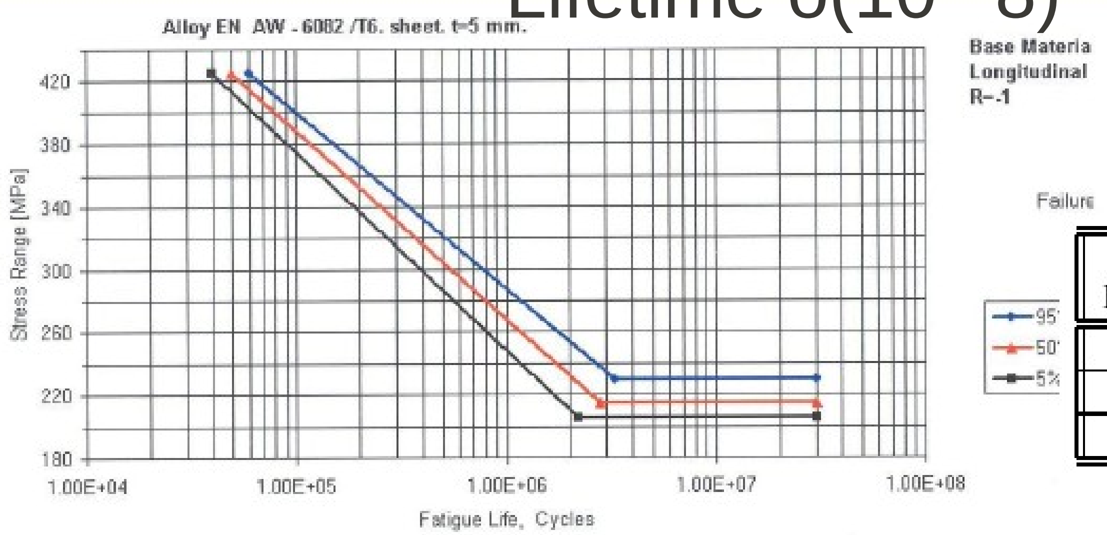
M. Kozien

Horn response under pulse magnetic forces

SINGLE PULSE with static thermal stress SVM=102.5 MPa and maximal magnetic stress SMAX=41 MPa – estimated life time

S-N curve - probability	Life time [s]		
	Rayleigh	Dirlik	Benasciutti-Tovo
95%	2.7076e+007	8.6147e+007	7.9627e+007
50%	6.0195e+006	1.8589e+007	1.7026e+007
5%	2.1816e+006	6.5918e+006	6.0132e+006

Lifetime o(10**8)~1 year



NUMBER OF PULSES

Dirlik model

f = 12.5 Hz

S-N CURVE PROBABILITY	LIFE TIME [s]	NUMBER OF PULSES
95 %	$8.6 \cdot 10^7$	$1.08 \cdot 10^9$
50 %	$1.9 \cdot 10^7$	$2.38 \cdot 10^8$
5 %	$6.6 \cdot 10^6$	$8.25 \cdot 10^7$

A.Niesłony

Further studies

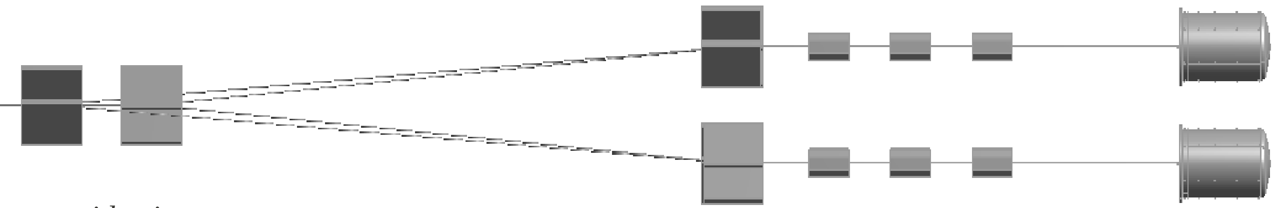
- Beam switch-yard and transport line
- Target station design
- Irradiation and contamination studies ->shielding
- Target-horn integration

All these studies are completed or very close to be completed !

Presentations in this session

- Elian Bouquerel Beam switchyard and transport
- Tristan Davenne Target studies
- Dan Wilcox Target station
- Nikos Vassilopoulos Horn studies
- Bogdan Szybinsky Target-Horn Integration

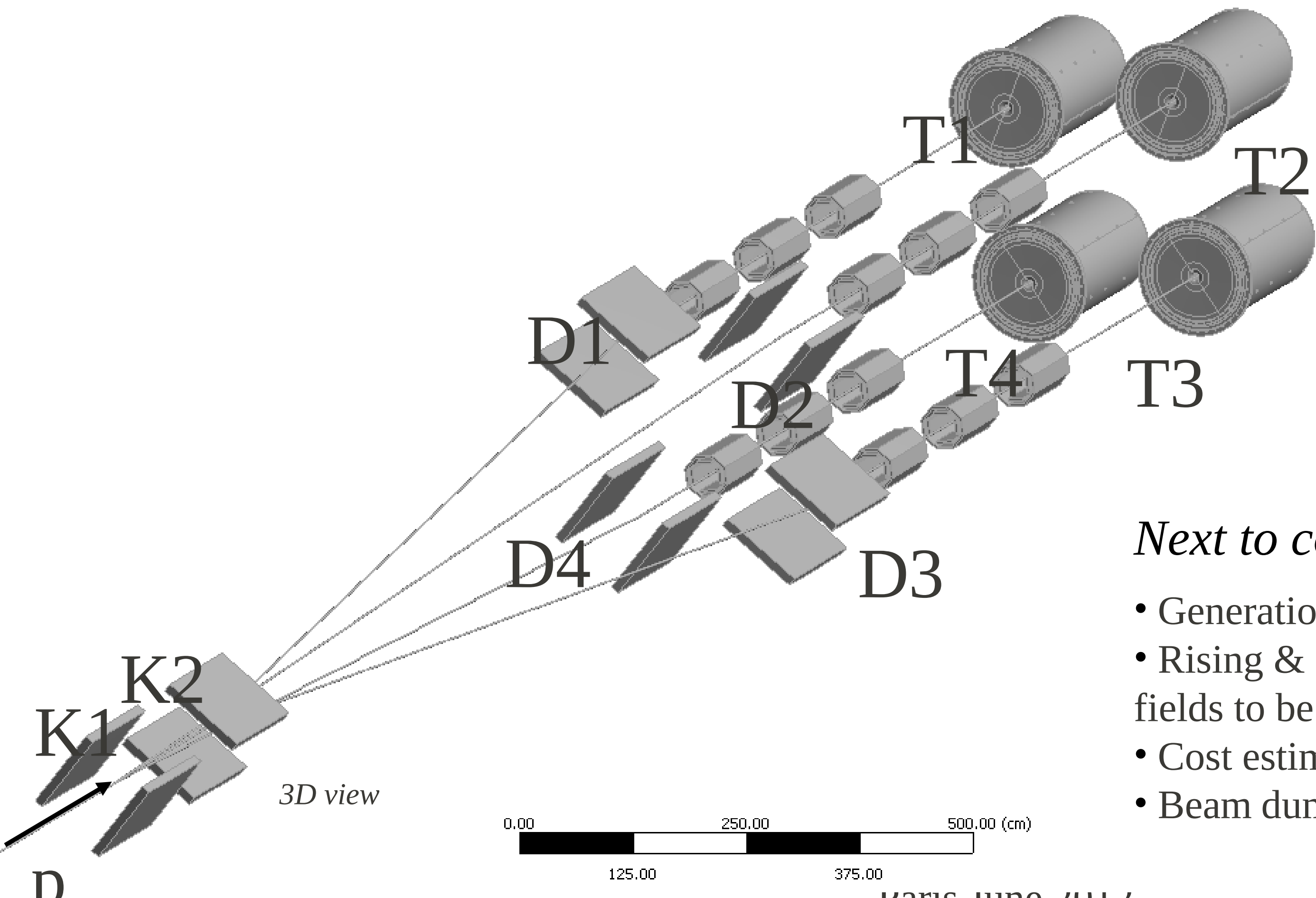
Beam focusing E. Bouquerel, IPHC



Layout of configuration 3

If quadrupoles after the compensating dipoles
-> possibility of having a **beam dump** between the second kicker and the compensating dipoles

Use of **collimators** to suppress eventual halo from the beam and avoid any particles from hitting the outside of each target (1.5cm radius)



Next to come…

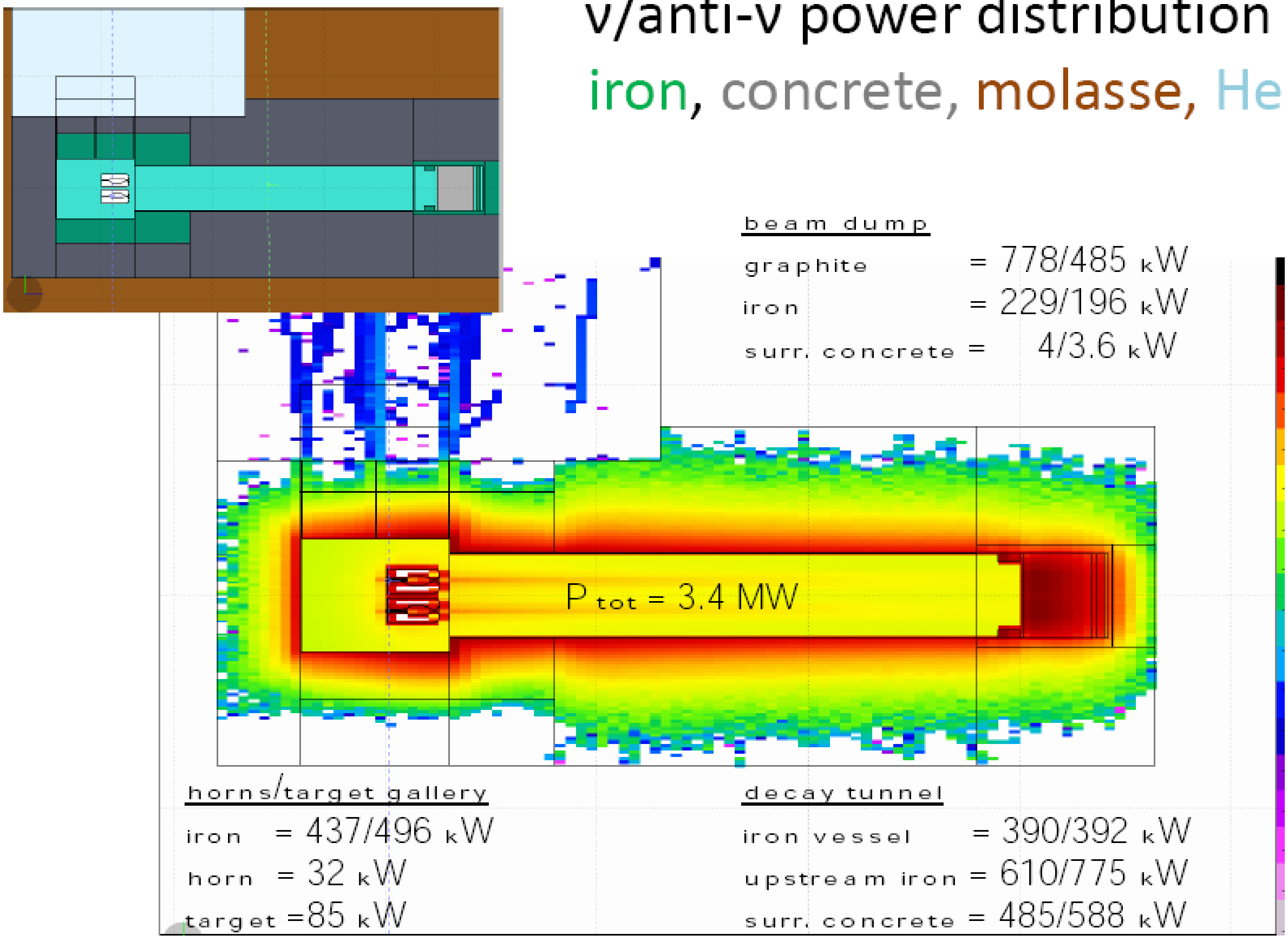
- Generation of magnetic field maps
- Rising & falling times of the magnetic fields to be defined
- Cost estimations
- Beam dumps…

Under progress…

N. Vassilopoulos, IPHC

ν/anti-ν power distribution

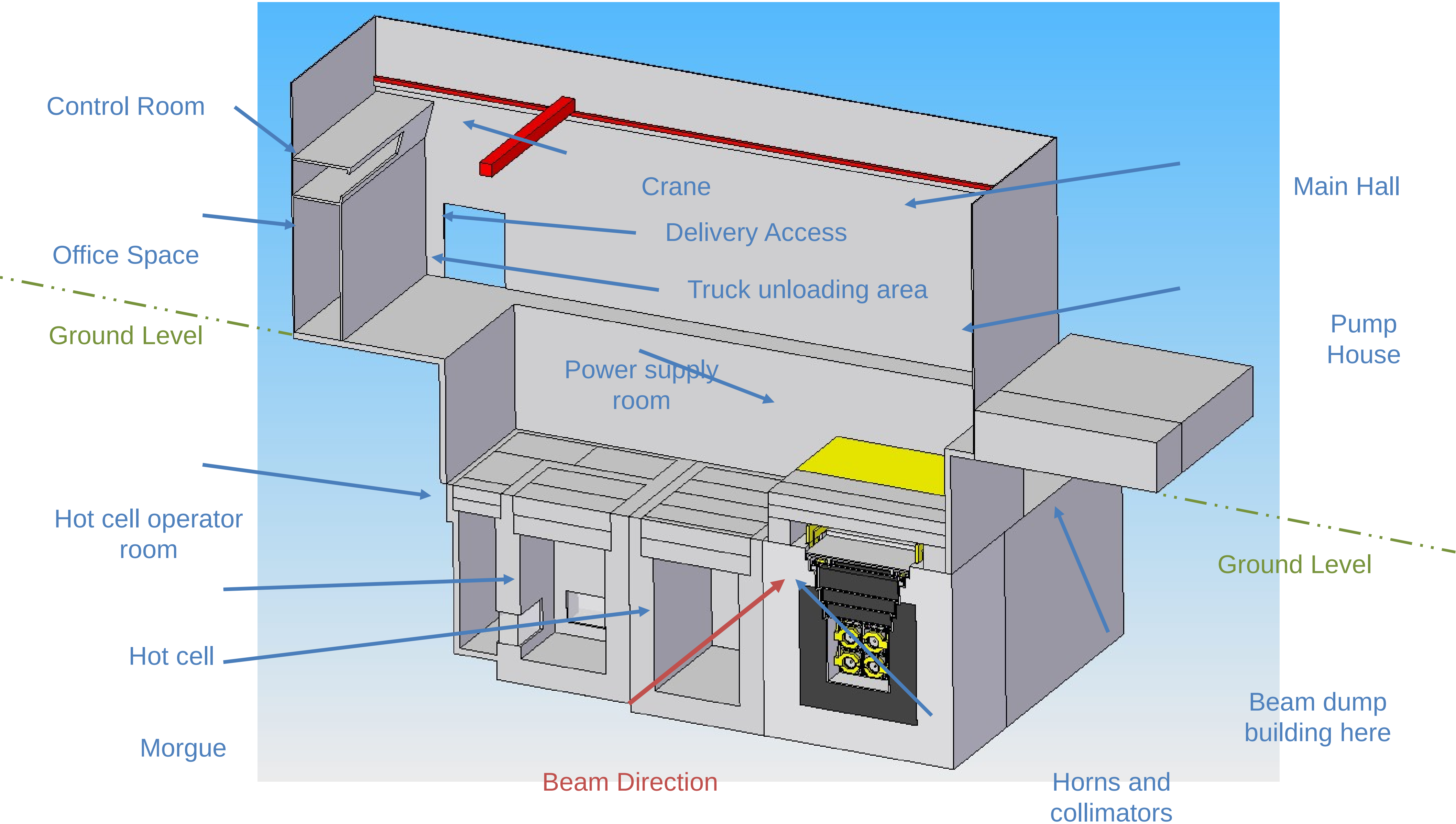
iron, concrete, molasse, He



IPHC Strasbourg, EUROnu - 03/2012 *thanks* 12

Overview

D. Wilcox, RAL



Fluxes and sensitivity

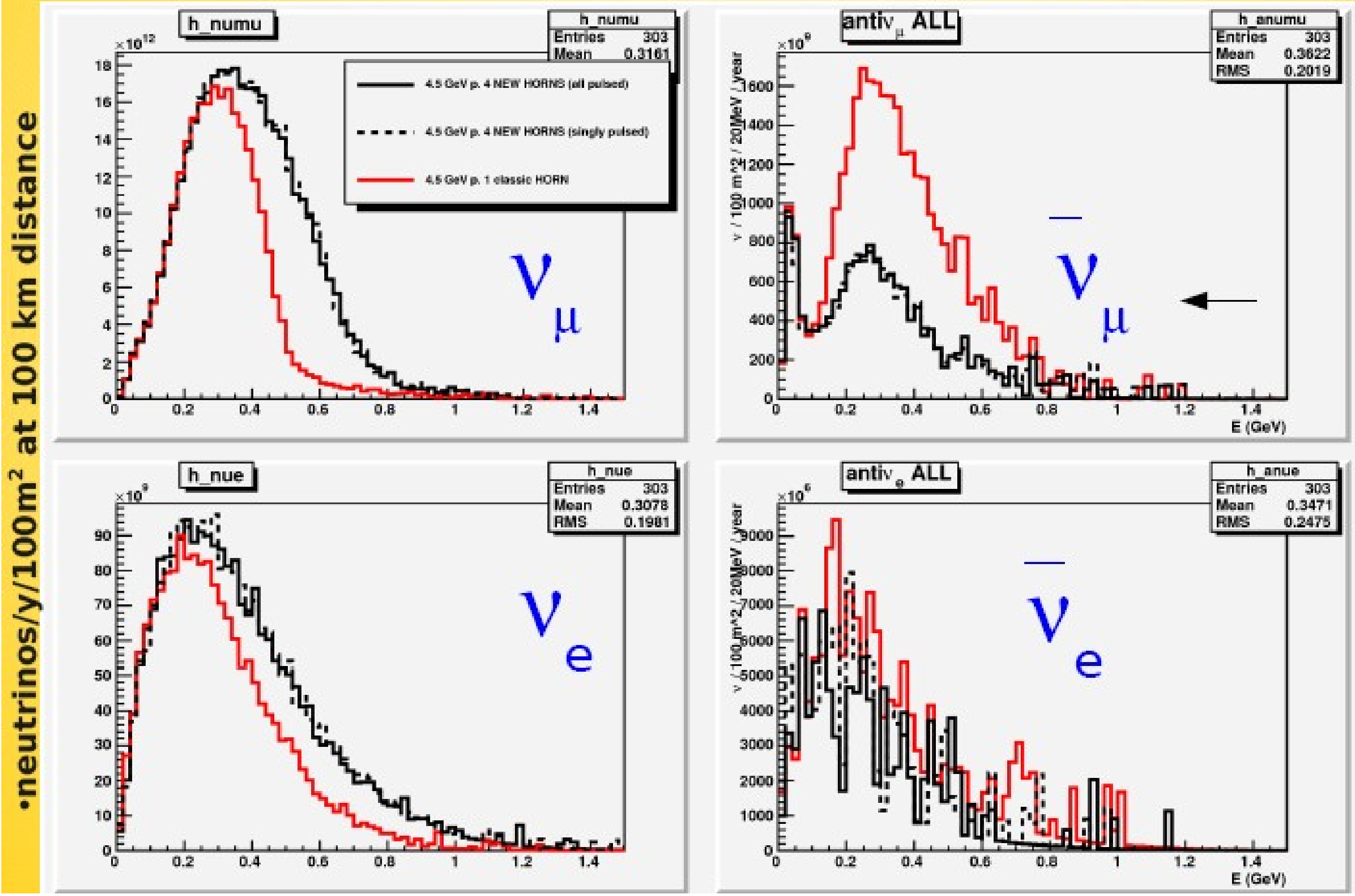
All the following results are summarized in

http://arxiv.org/abs/1106.1096 by A. Longhin

Fluxes: new VS old horn

Carbon target
new horns / old horn

- gain ν_μ at higher energies
- Effectively suppressed contributions from wrong charge pions (more than a factor 2 less anti-ν_μ, lower anti-ν_e +c.c.)

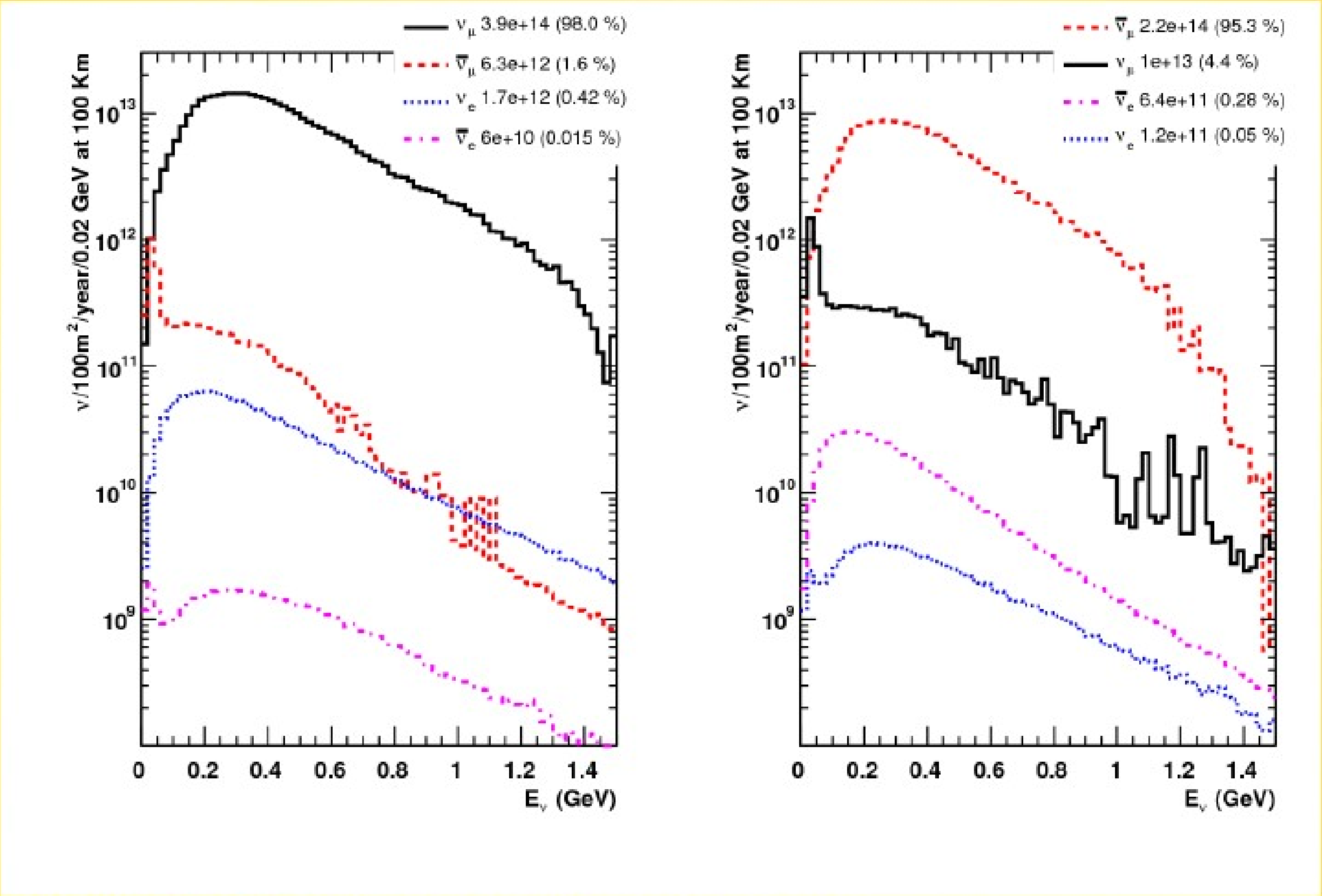


GEANT4

@ 4.5 GeV positive focusing

	OLD (%)	NEW (%)
+ FOCUSING		
ν_μ	88.9	-> 95.55
$a\nu_\mu$	10.5	-> 3.9
ν_e	0.6	-> 0.56
$a\nu_e$	0.052	-> 0.025
- FOCUSING		
ν_μ	26.1	-> 11.2
$a\nu_\mu$	73.4	-> 88.4
ν_e	0.17	-> 0.09
$a\nu_e$	0.34	-> 0.35

Optimised horn: fluxes

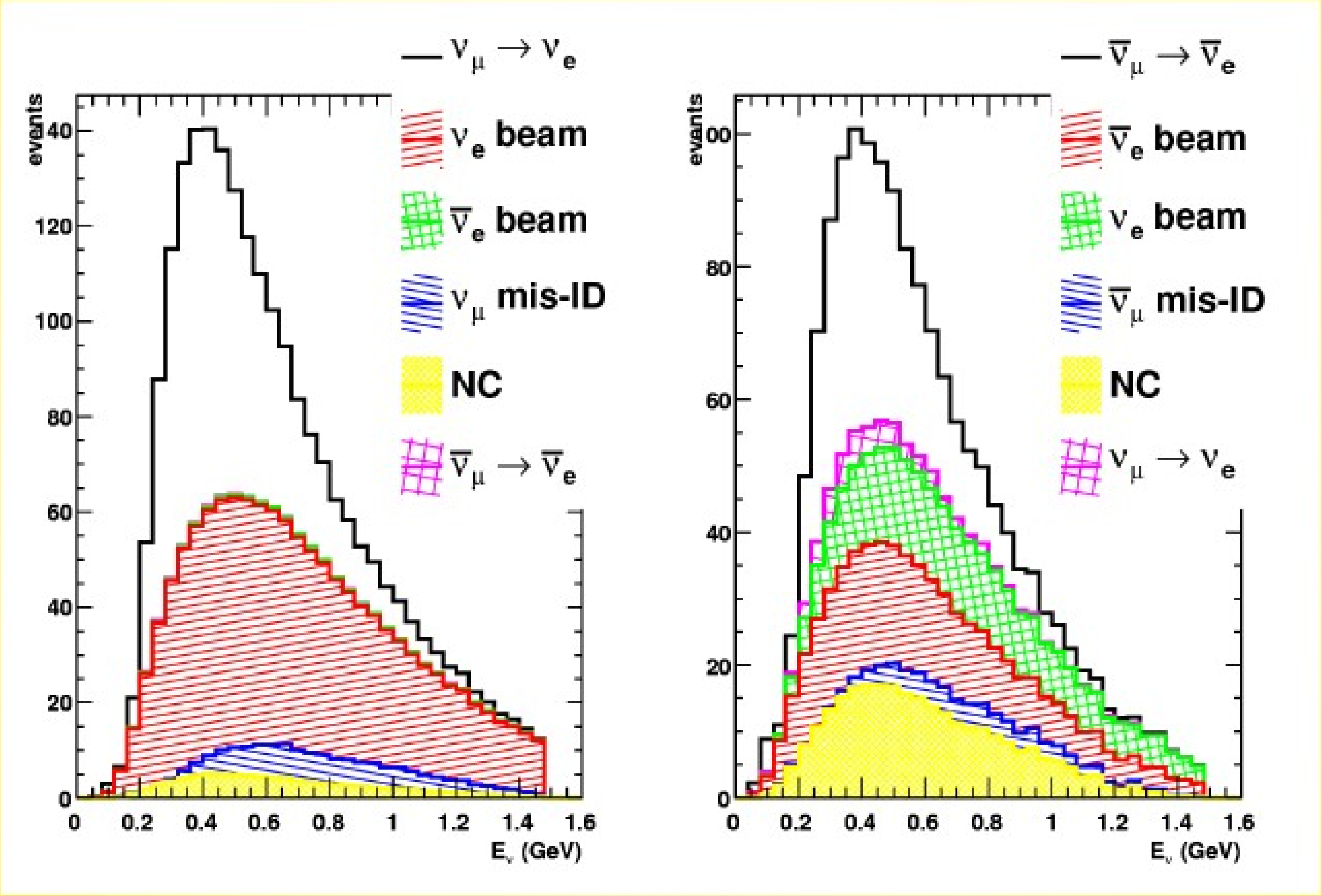


Fluxes in GloBES format are available online here:

http://irfu.cea.fr/en/Phocea/Pisp/index.php?id=54

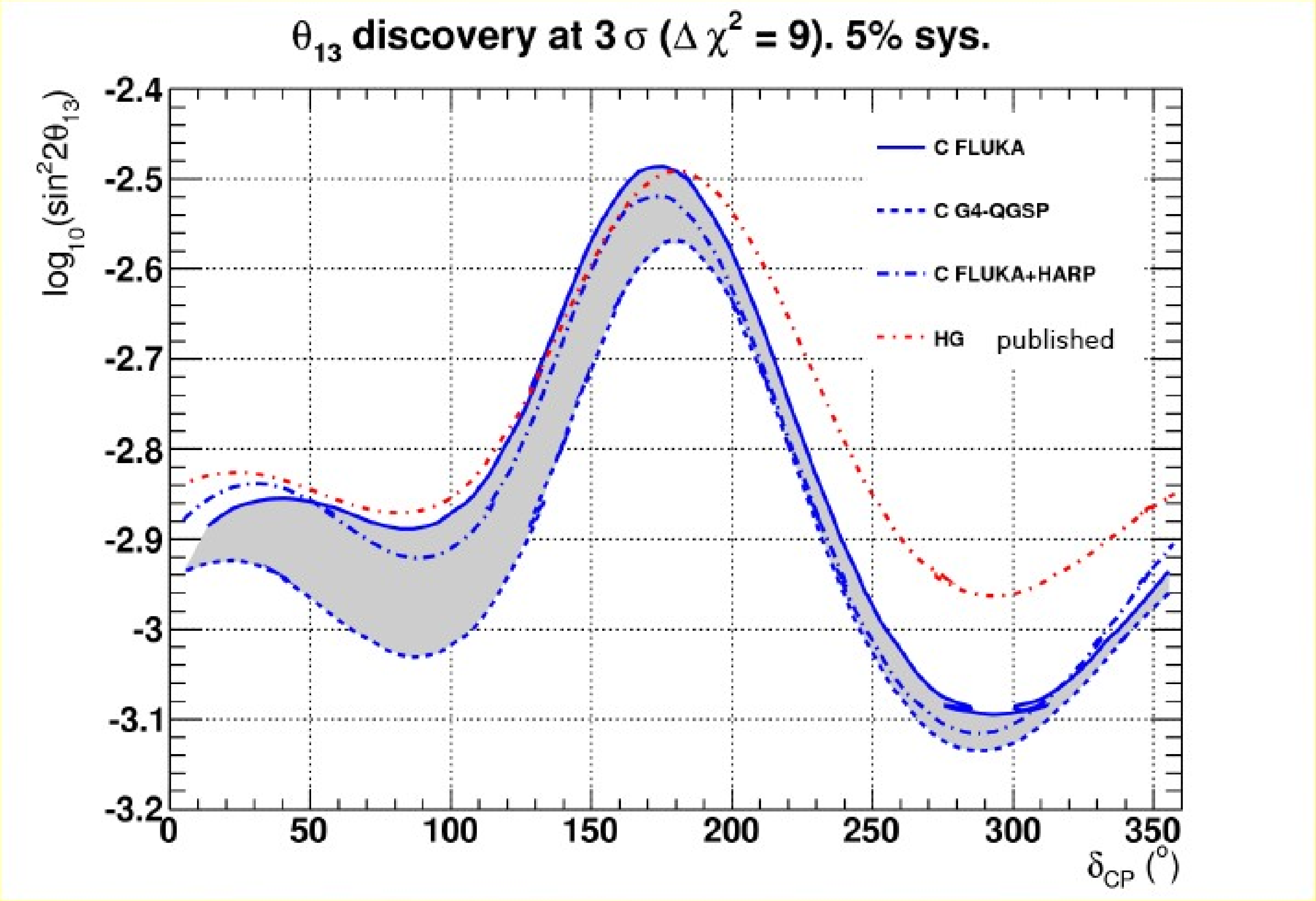
Event rates in MEMPHYS

$\sin^2 2\theta_{13} = 0.01,\ \delta_{CP} = 0$



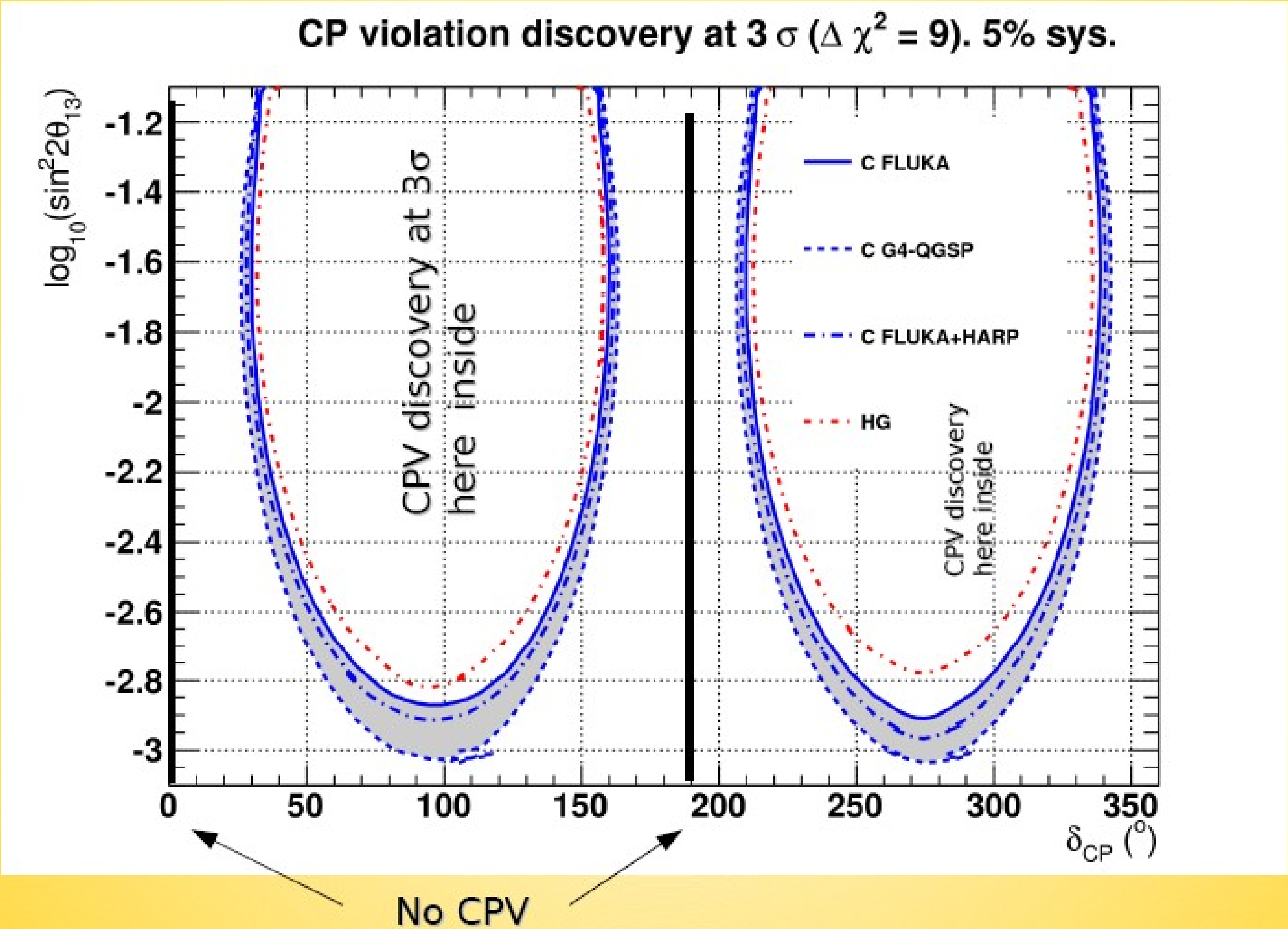
Based on the public MEMPHYS parametrization (AEDL) distributed with GLoBES
Bulk of the background from intrinsic beam electron component

Discovery of $\theta_{13} \neq 0$



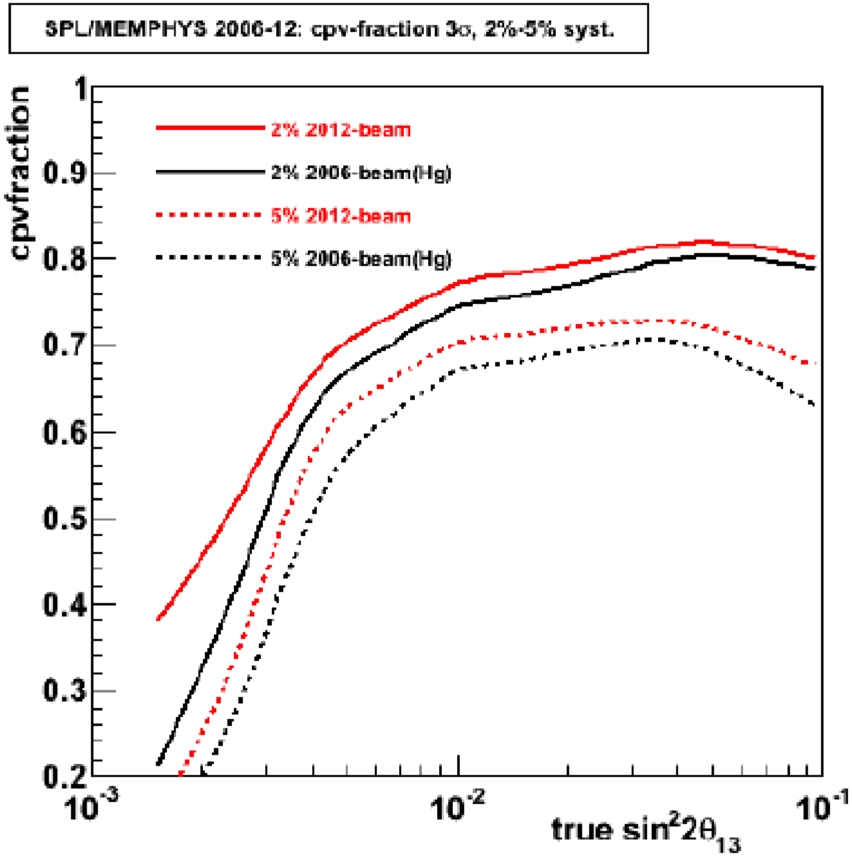
Using GEANT4 for p-target interactions or reweighting FLUKA to HARP data yields better limits

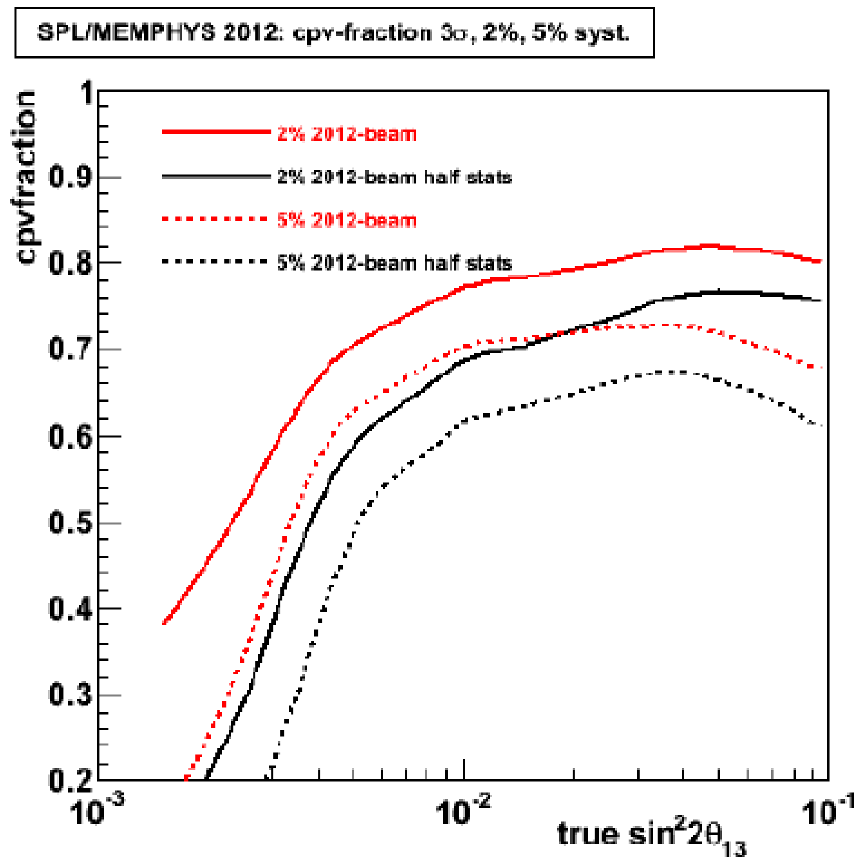
Discovery of CP violation



physics: cpv-fraction space vs systematics & statistics

N. Vassilopoulos





- assuming 2% syst., the beam could be run with half stats (@half power)
- better fatigue & radiation control for horns & beam elements
- mass hierarchy with atmospherics data in MEMPHYS *hep-ph/0603172*

Next steps

- Complete the WBS for the costing
- Write final report : aim at a preliminary version for the summer

Summary of main parameters

Parameter	Value
Beam Power	4 MW
Beam energy	4.5 GeV
Target length	78 cm
Target radius	1.2 cm
Decay tunnel radius	2m
Decay tunnel length	25m