EUROnu Super-Beam work package

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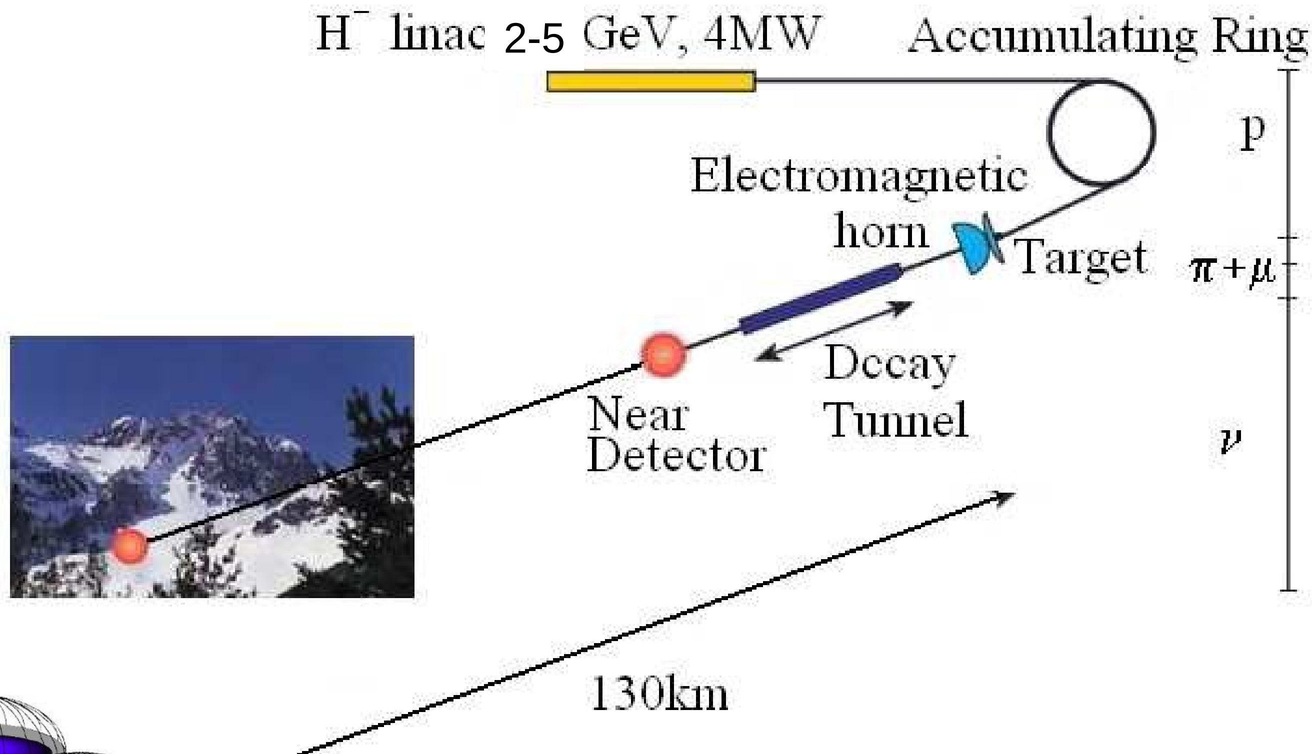
Irfu-Saclay

On behalf of the SB WP2 team

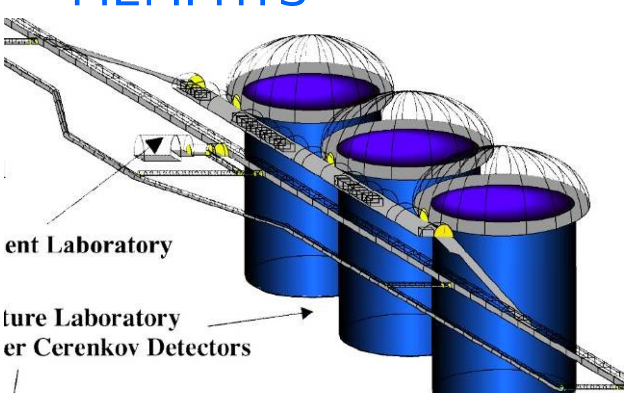
Euroν 29/9/2009

What Euroν DS Superbeam is about-1

- We start from the SPL to Frejus concept



MEMPHYS

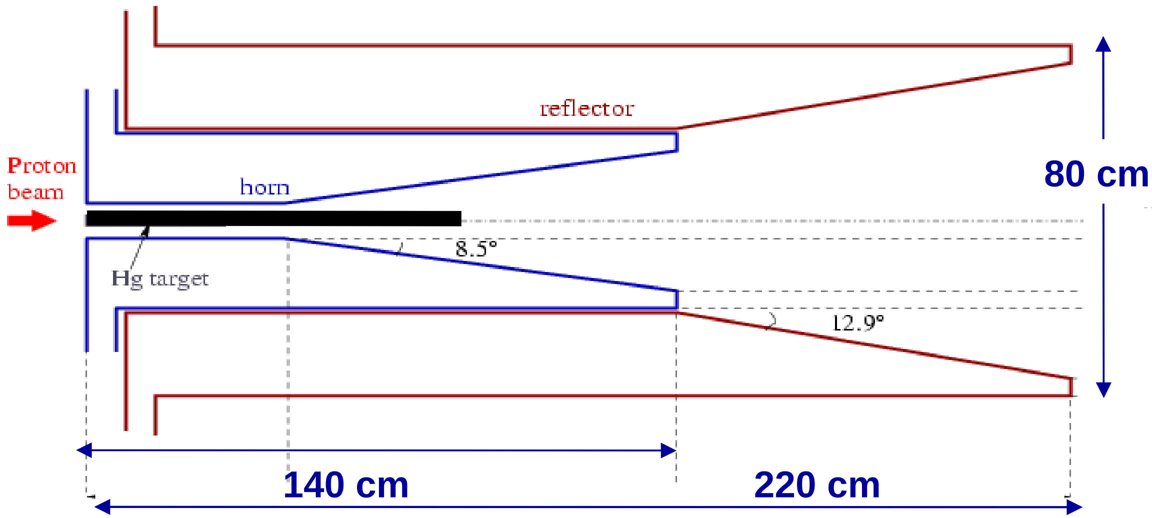


<u>Far detector feasibility, excavation, engineering is covered by the Laguna DS</u>

Proton driver

- Advanced CDR for SPL at CERN.
- We take SPL as our baseline proton driver
- Changes to this proton-driver design only from the optimization of the target and collection or from the physics and detector studies

The focus of this WP



- The target and collector system is a challenging problem
- No off the shelf solution
- Difficult to scale up from other beam setups

Activities

- We held two face to face meetings and three phone meetings
- Plus several informal meetings (NUFACT, MEMPHYS-LAGUNA, Saclay-Strasbourg ...)
- We started to work on all components of the problem:
  - The beam simulations
  - The target
  - The collector
  - Beam-Target interface and requirements
- Two internal notes
- Outreach :
  - Two talks at NUFACT
  - Talk + poster at the CERN workshop
  - Talk at HPT
  - Fruitful contacts with LAGUNA people

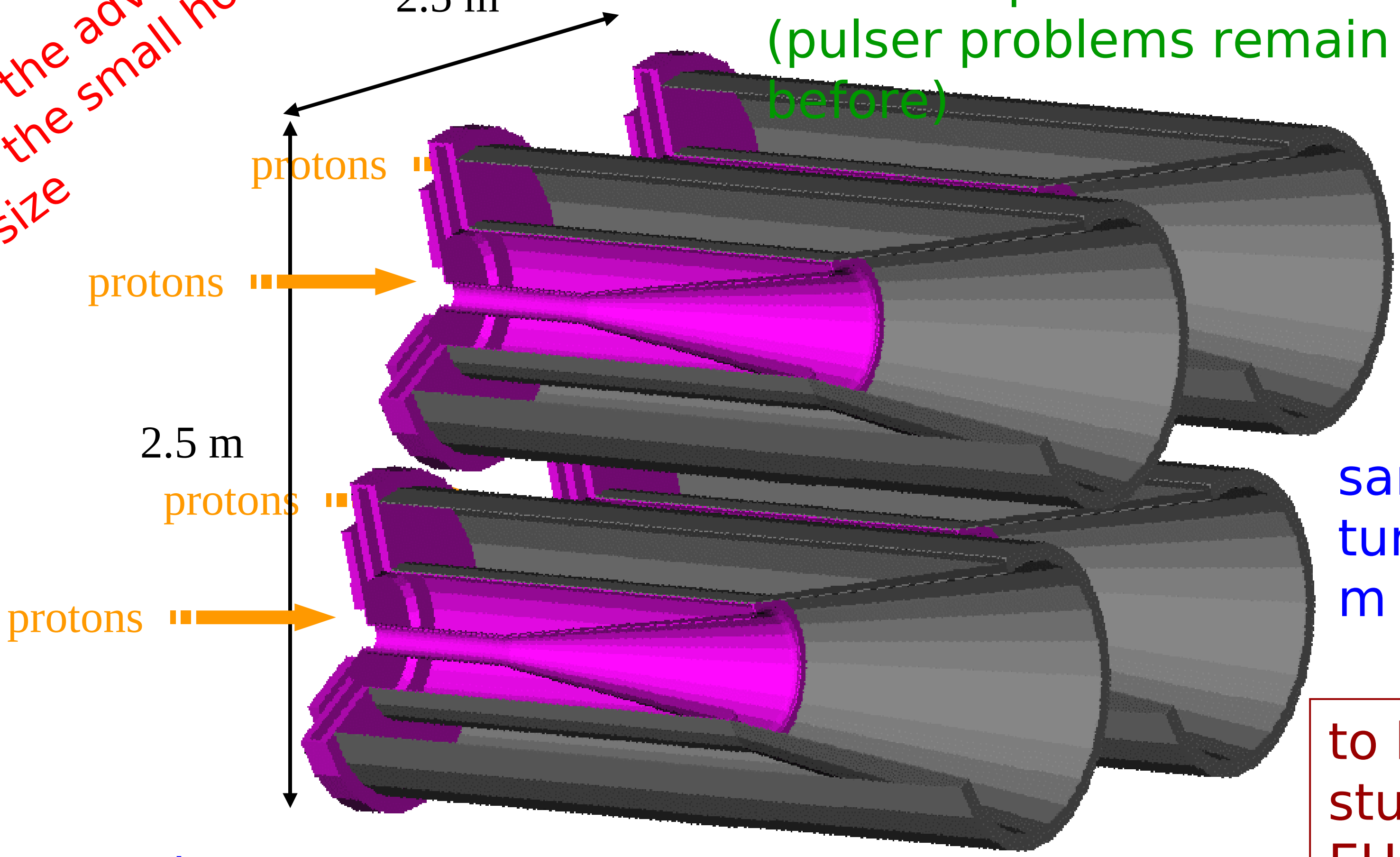
The emerging concept

- Target-Collector: adopt multiple (4) target+collector systems to mitigate the difficulties
- Target: explore the feasibility of a static solid target
- Keep pebble-bed and powder jet as more advanced solutions
- Collector: use as a baseline the CERN NF prototype and then optimize further

New ideas

use the advantage of the small horn size

minimize power dissipation and radiation problems
(pulser problems remain as before)

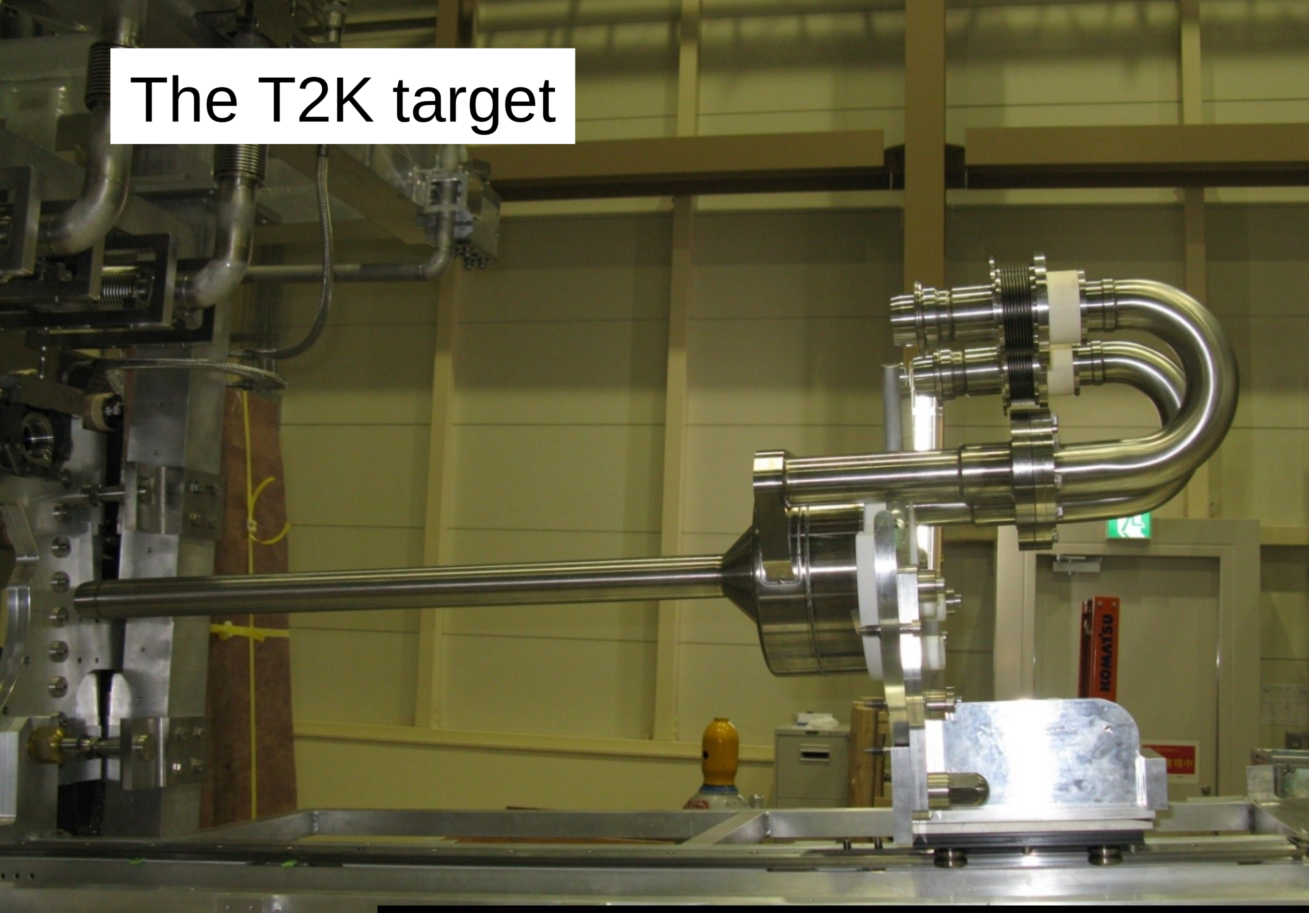


same decay tunnel Ø 3 m

to be studied in EUROν

2 options:
- send at the same time 1 MW per target/horn system
- send 4 MW/system every 50/4 Hz

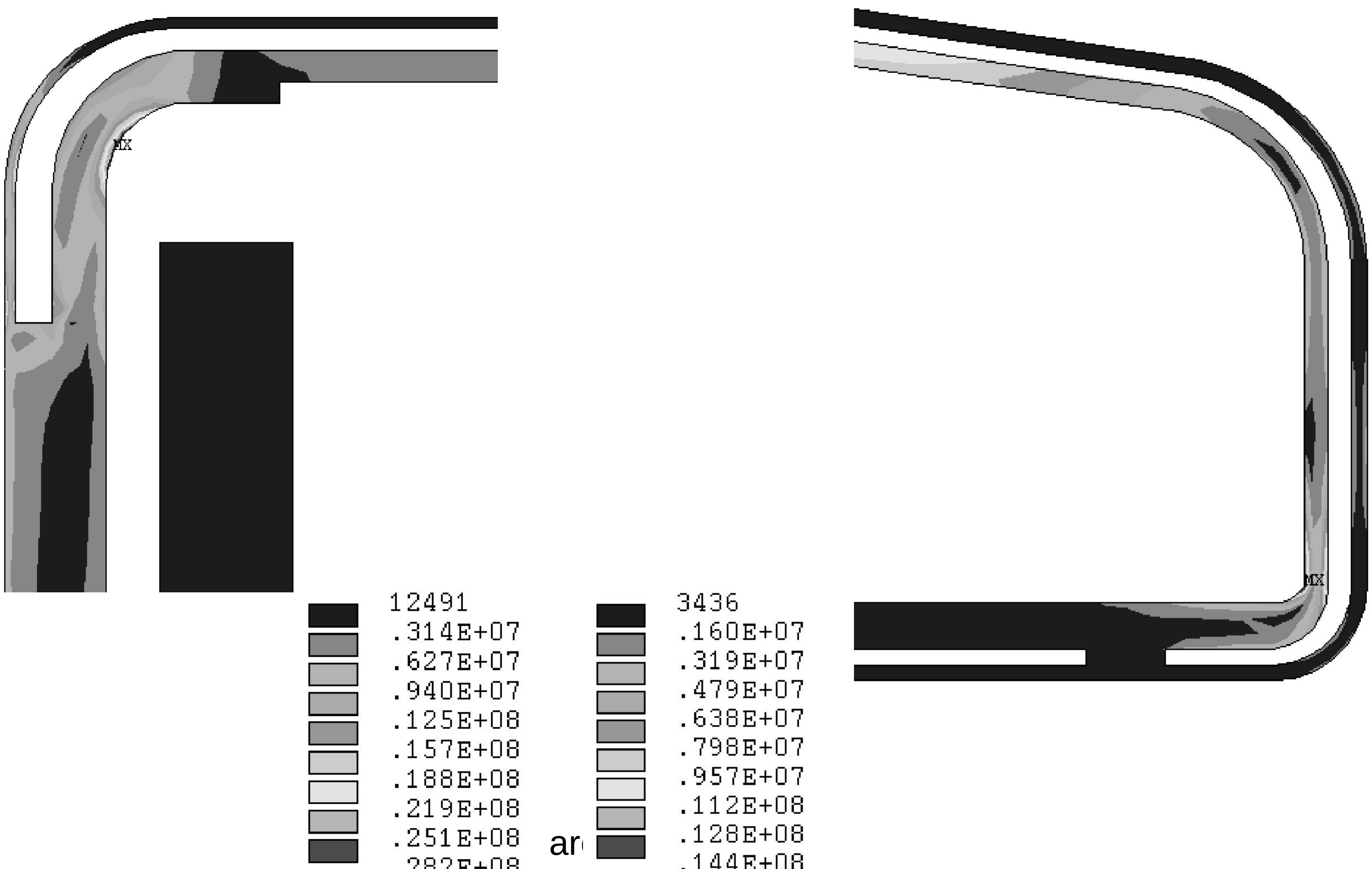
→ possibility to use solid target?



C. Densham,
M. Fitton, O. Caretta

P. Cupial

MAXIMAL TRESCA EQUIVALENT STRESS
/ 30 MPa /



On our to do list:

- Feasibility of a static carbon target:
  - Dimensions
  - Deposited energy
  - Radiation dose
  - Heat exchange system
- Optimization of the horn
- Lifetime of target and horn
- Beam window
- Integration
- for a detailed workplan see http://indico.in2p3.fr/conferenceDisplay.py?confId=1586

Overall schedule concept

2009: establish viable baseline

2010: preliminary conceptual design

2011: integrated conceptual design

3 sigma sensitivity C-Hg comparison

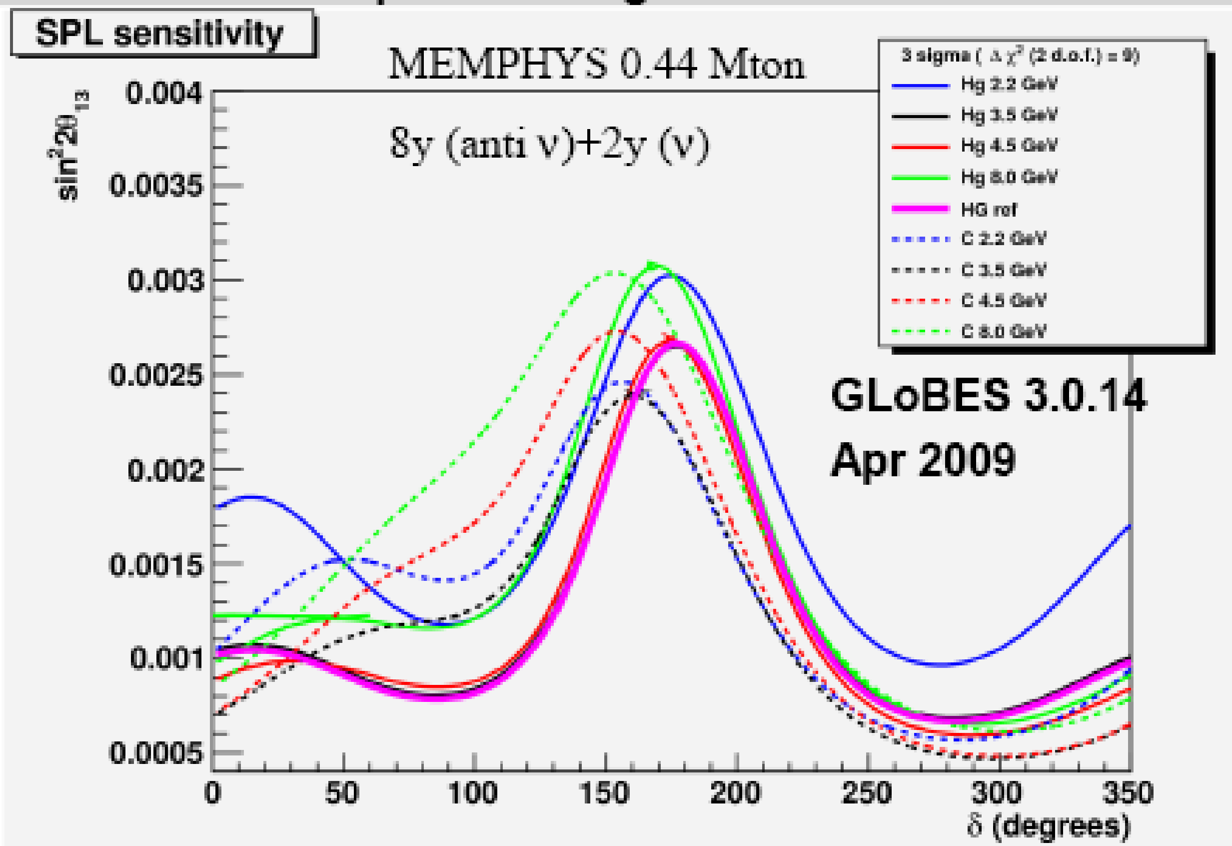
A. Longhin

Carbon (- - - - - - -) Mercury (———)

Color codes: proton energies

Presented at NUFACT09 in July

“Minimal change” scenario i.e. same horn and simulation (geant3) 78 cm long graphite target in place of 30cm mercury



Carbon limit (dashed) more δ dependent than for Mercury (continuous). Nevertheless quite competitive.

AEDL file SPL.glb developed by M.Mezzetto et al.

A. Longhin

GEANT4

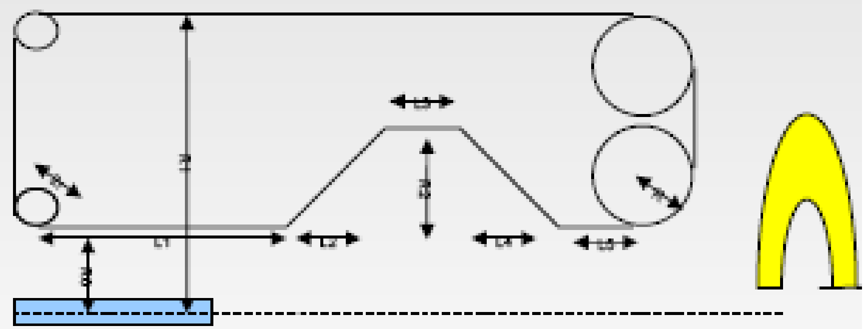
- GEANT4: modern, updated tool (C++)
- more flexible in view of the wish of studying many different geometries and optimize horn for a longer target

- A tool for "exploring" interesting geometries has been developed within G4:

Parametric model implemented in GEANT4 simulation (MINIBOONE inspired) with 9 parameters

In general with this shape better wrong charge pion rejection (more "forward closed") but conversely higher mean energy is obtained

Flexible enough to reproduce also standard conical geometry



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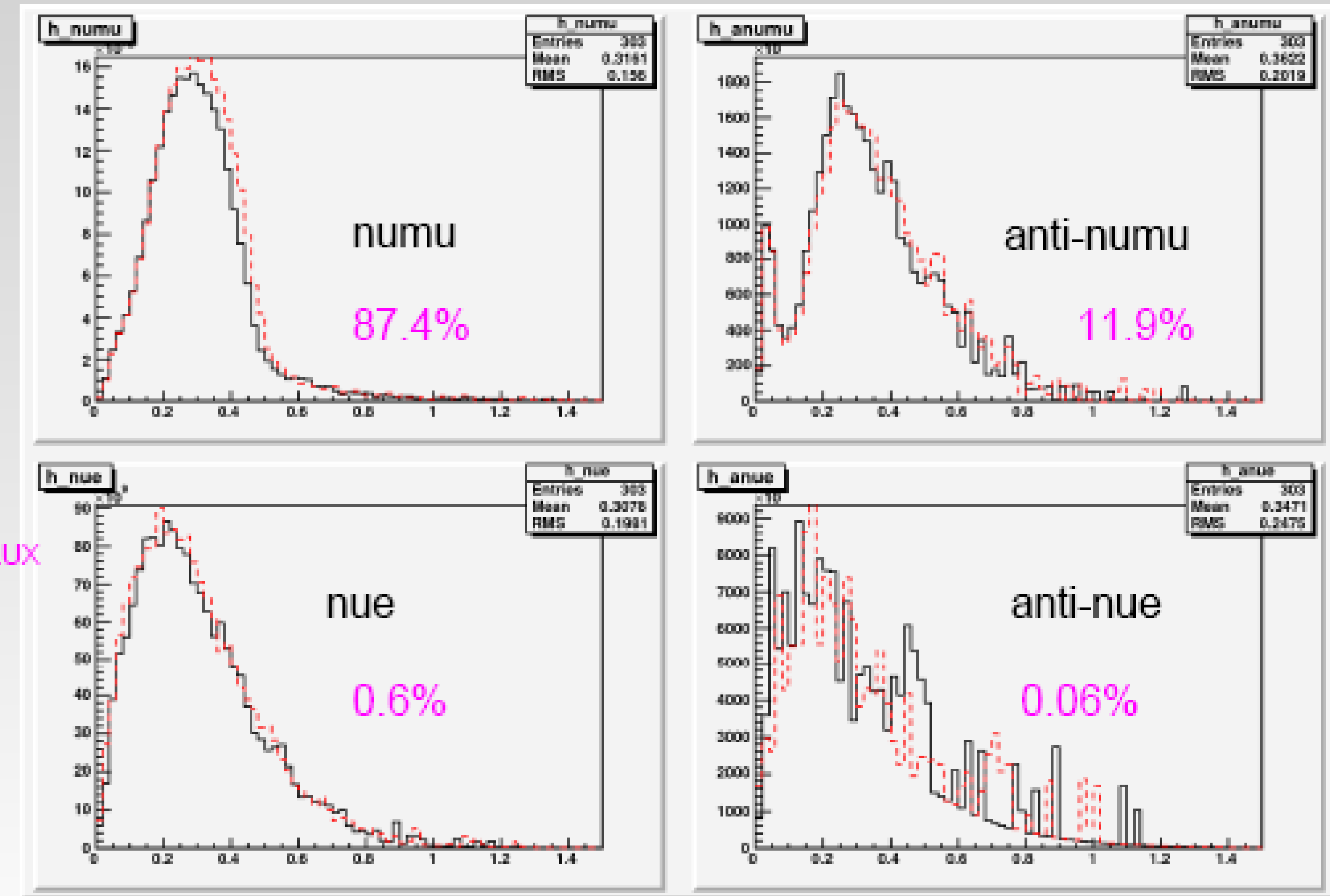
GEANT 4-3 "mature" comparison: total fluxes

GEANT3 (dashed)
GEANT4

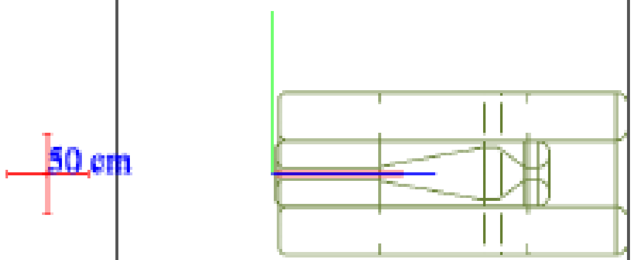
% TOT FLUX (G4)



Ek(p) = 4.5 GeV

A. Longhin

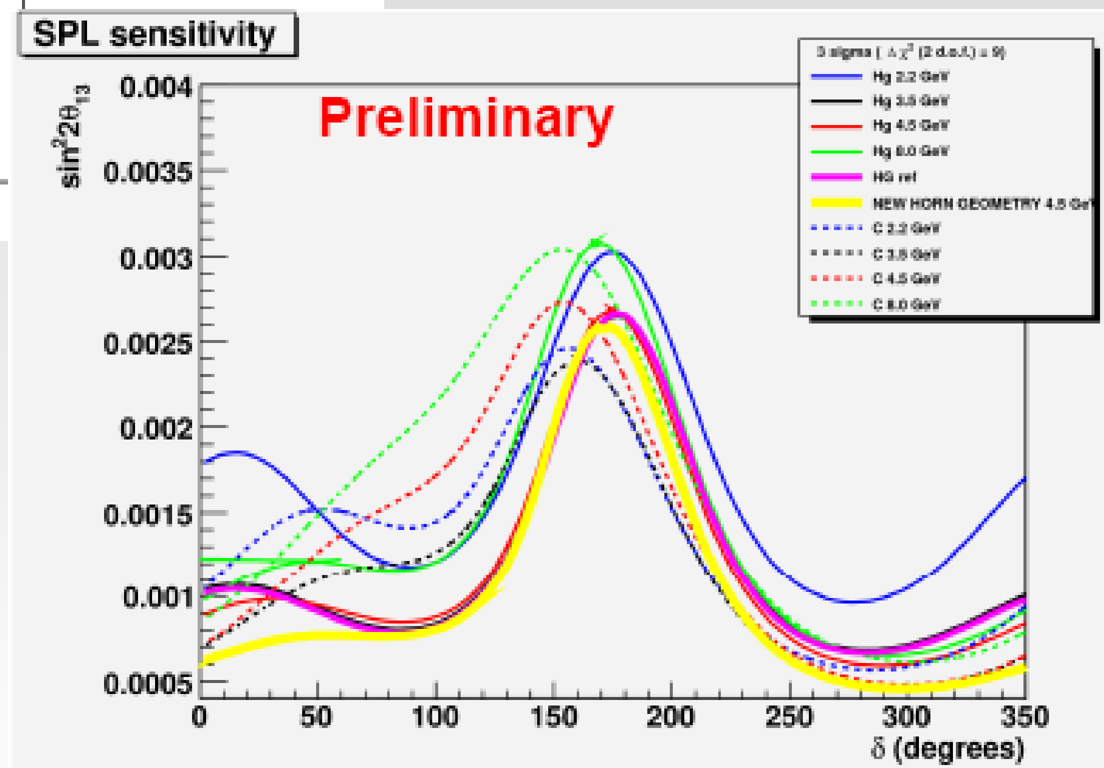
Preliminary sensitivity with a new horn shape



Reflector thicker by 10cm, ~same length

Usual 300/600 kA for Horn/Reflector

more "closed", lower antinumu contamination



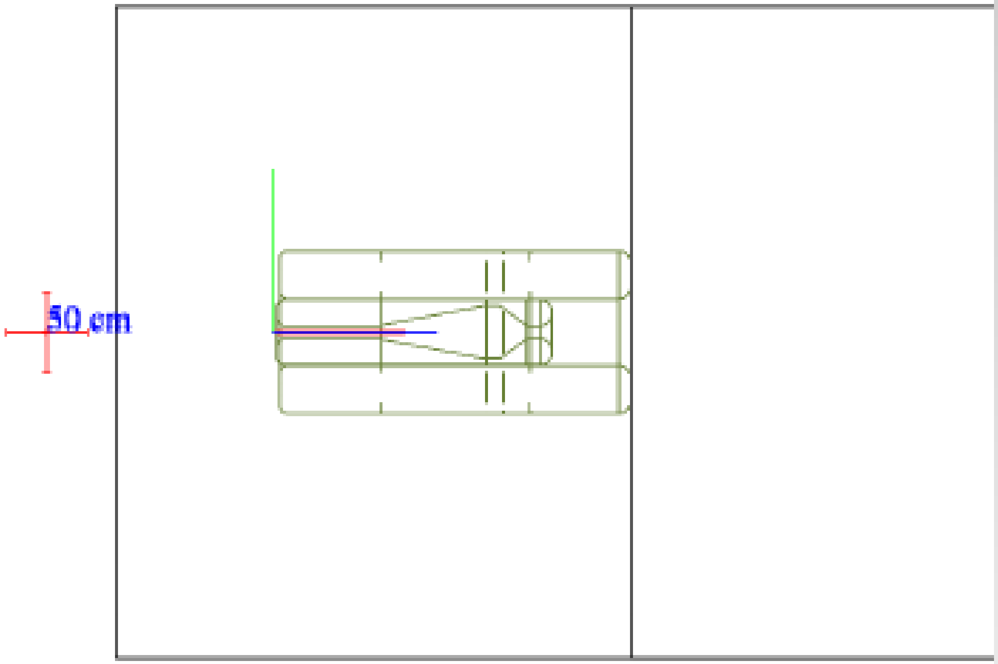
Caveats.

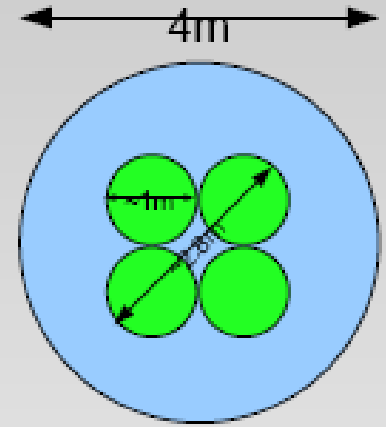
no aluminum cage at present

nu_e almost but not completely reproduced with g4

Conclusions and Outlook (I)

A. Longhin





GEANT4 simulation reproduces quite well previous results, some refinements still needed. Work in progress ...

TODO after GEANT4 setup validation:

* finalize characterization of a new shape for the horn

* Implement multiple-horn configuration and study the impact on fluxes and sensitivities. Expected effects:

- each horn sees an "off-axis tunnel (~on axis with lower effective radius)

  interference among horns for high angle tracks in terms of material (and B field depending from proton injection-horn pulsing strategy)

Comments and questions from IAP

While the Superbeam concept is the most technically advanced, an integrated approach to its design was not evident. The various subsystems should be considered together, and environmental protection should be an important design consideration from the outset. [WP2]

It was not clear from what was presented that 130 km is an optimal Superbeam baseline. Having options for other baselines, to be identified in discussions with WP6, would be prudent. [WP2]

- Implications of the proposed “4-horn” system should be evaluated in detail before adopting this as the baseline configuration. [WP2]

- For both WP2 and WP3, the choice of a 4 MW proton driver needs firmer justification. [WP2 & 3]

Comments and questions from IAP

- proton driver: a discussion of these requirements now exists in the note of WP2 (first deliverable).

- integrated approach. Considered from the start. Need to mention the environmental approach (from T2K studies)

- optimality of 130 km ? Need to discuss with WP6. Need to mention mass hierarchy from atmospherics (Maltoni)

- four targets/horns system. Study needed for the efficiency of the system

- 4 MW for proton driver ? Studied. Sensitivity scales as expected as 1/sqrt(power)

Deliverables

Deliverable	Delivery date (months)	
Requirements for proton driver	6	
Target and Collection design report	30	
Target and Collection integration	36	
Beam characteristics	36	
Final report	48	

Milestones

Milestone	Delivery date (months)	
Proton driver report	12	
Prel. Design of Target and Collection	24	
1st Target and Collection integration drawings	24	
1st Est. of Nu Beam Intensity	24	
Final Target and Collection integration drawings	36	
Design of target station	40	
Report on Nu Beam Intensity	42	

Conclusions

- SuperBeam work package of the Euronu is focusing on the key issues for this project
- A first year with intense activity and new results
- We are converging on a realistic baseline
- Replies to IAP in progress
- Next steps: from baseline to conceptual design

CERN direction, SPC and Council

CERN-AB-2007-014-PAF

After the publication of the comparison report:

- The CERN direction has accepted the (LP)SPL as an integral part of the future complex of injectors,
- The SPC review panel has removed his objection to the linac.
- **The SPC has therefore agreed with the CERN management and accepted the (LP)SPL as the baseline option for the future injector of PS2.**

SPL type	full-power	low-power
E [GeV]	5	4.0
Pbeam [MW]	4	0.192
f_{rep} [Hz]	50	2
I_{av} [mA]	40	20
t_{pulse} [ms]	0.4	1.2
$n_{protons}/_{pulse}$ [10^{14}]	1.0	1.5
Max. filling time PS2 [ms]	0.6	1.2
$n_{klystron}$ (Linac4 + SPL)	19+53	19+24
$n_{SC\ cavities}$	234	194
inst. $P_{RF(peak)}$ [MW]	220	100
$P_{facility}$ [MW]	38.5	4.5
P_{cryo} [MW]	4.5	1.5
T_{cryo} [K]	2	2
length [m]	534	459

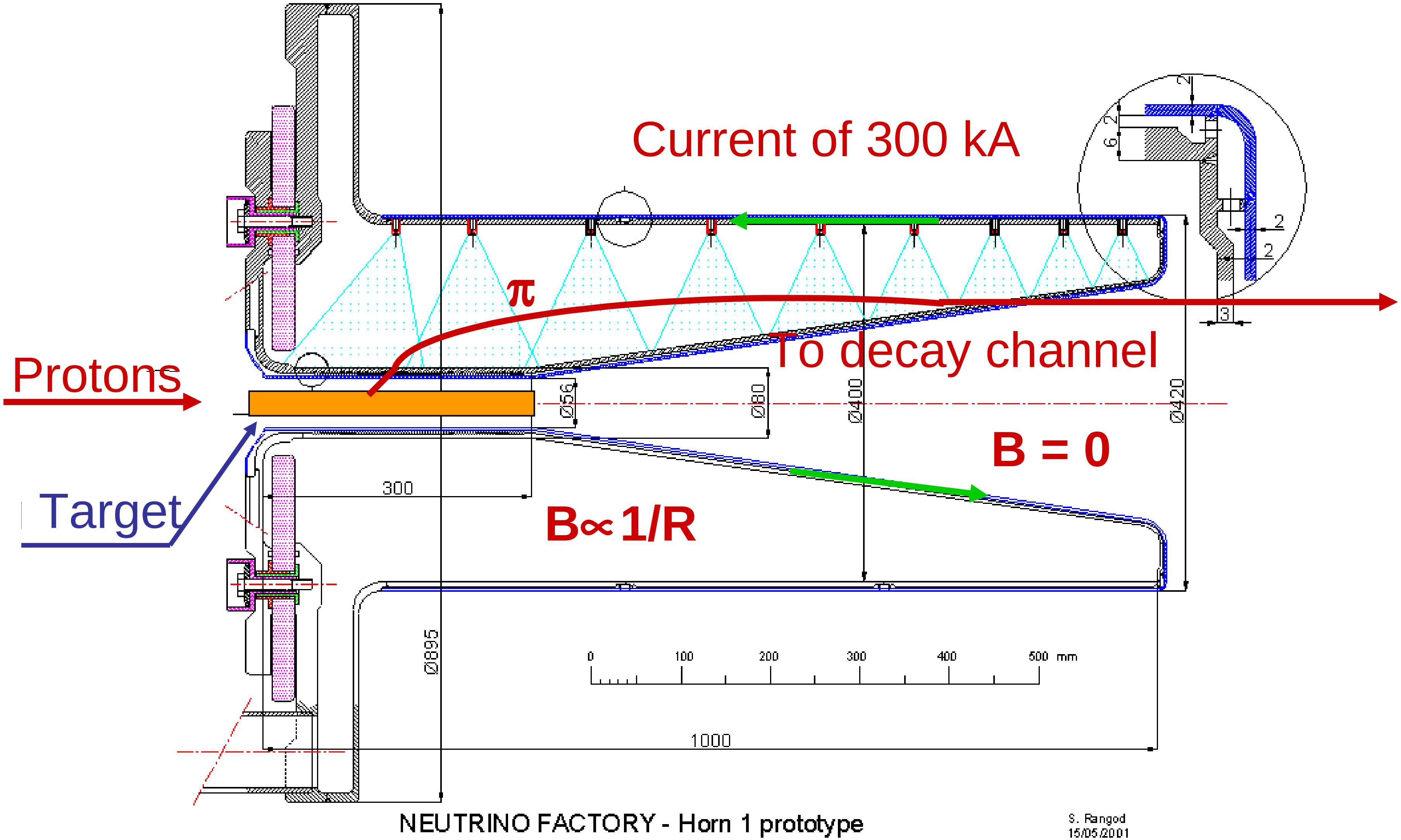
"The low-power SPL", PS2 meeting, 20. June 2007, F. Gerigk

Collector

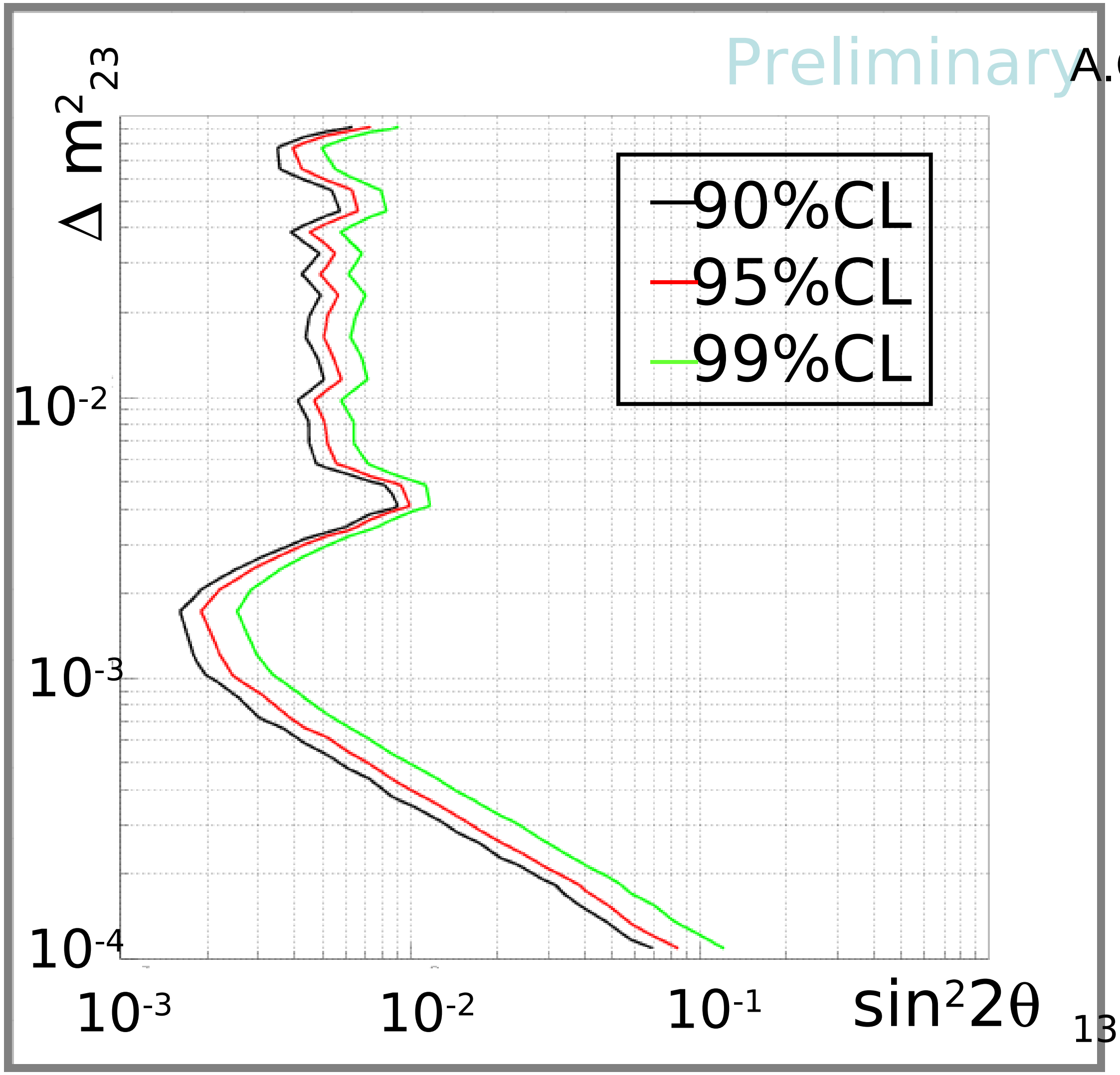
- Main challenges:
  - design of a high current pulsed power supply (300 kA/100 μs/50 Hz),
  - cooling system in order to maintain the integrity of the horn despite of the heat amount generated by the energy deposition of the secondary particles provided by the impact of the primary proton beam onto the target,
  - definition of the radiation tolerance,
  - integration of the target.

Focusing system: magnetic horn

M. Dracos



Sensitivity 3.5GeV



Minimum:
$\theta_{13} = 1.2°$
(90%CL)