EUROν Super-Beam work package

Marco Zito

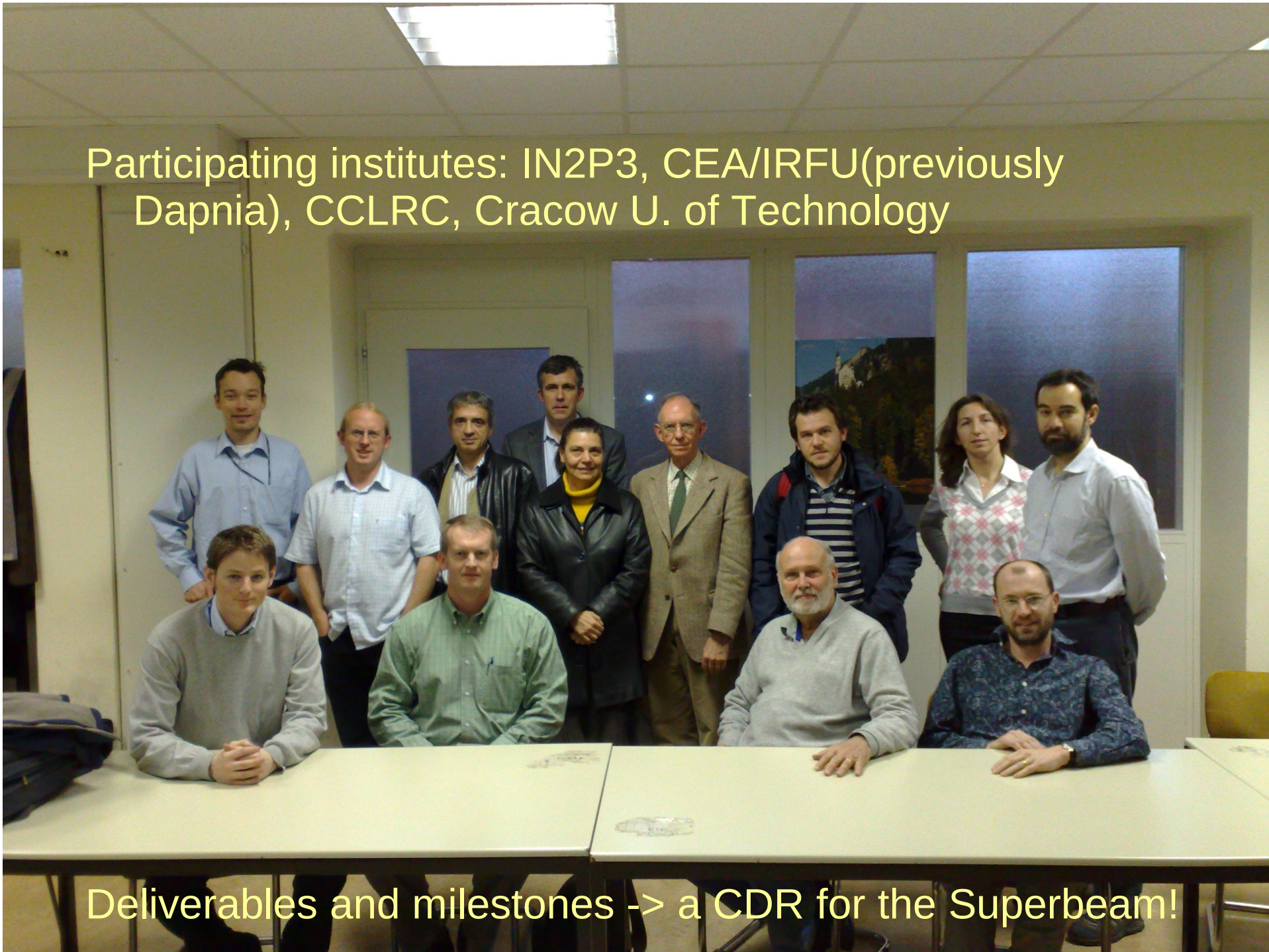
Irfu-Saclay

On behalf of the SB WP2 team

Euroν 25/3/2009

Outline

- Overview of this work-package
- The critical issues
- Status and activities
- Schedule and deliverables

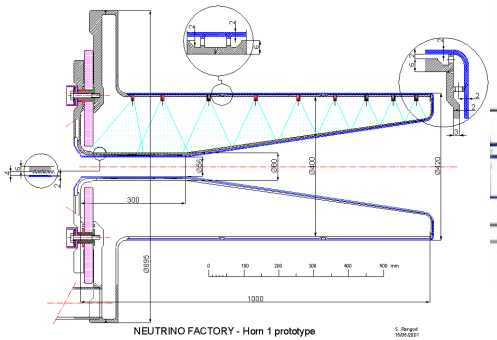

Participating institutes: IN2P3, CEA/IRFU(previously Dapnia), CCLRC, Cracow U. of Technology
Deliverables and milestones -> a CDR for the Superbeam!

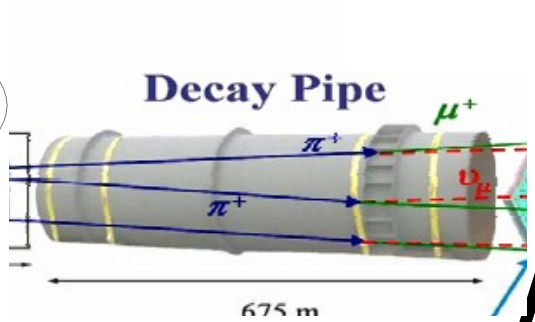
Super-Beam

Multi MW
Proton
Driver

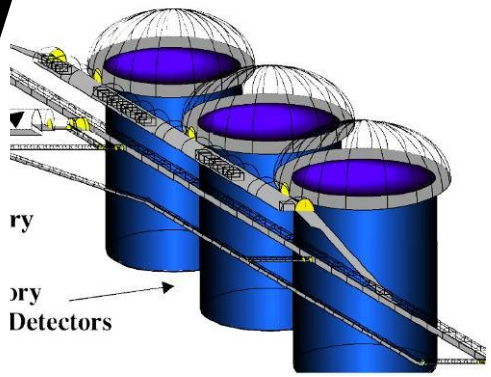
P

Target+Collector





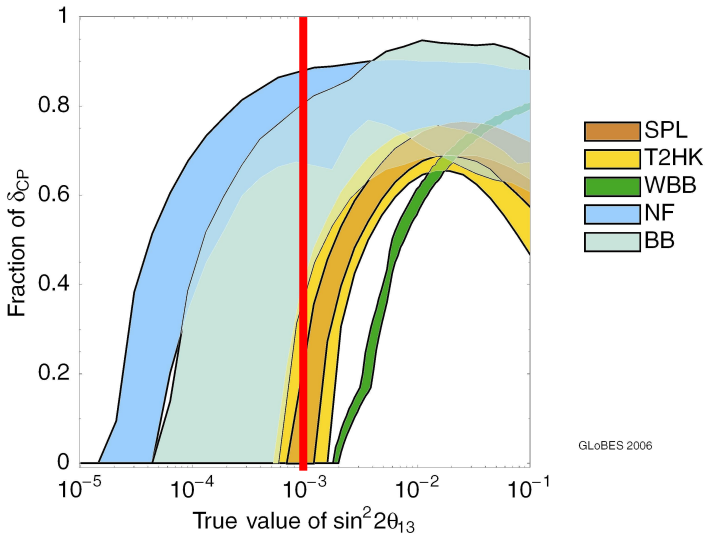
Far detector



Once we have an intense (multi MW) proton beam
Target+collector+decay volume give a NeutrinoSuper-Beam

Several SB projects around the world!

Super Beam features

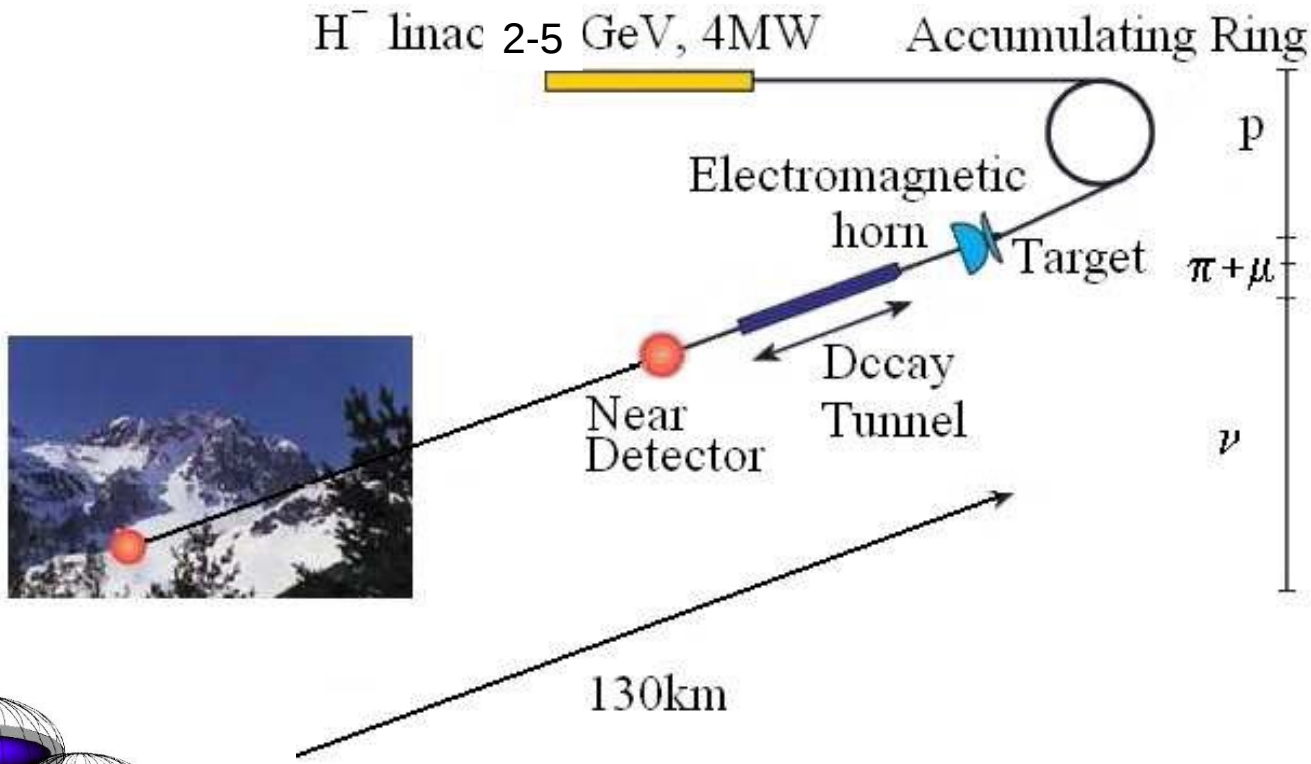


- "Conventional" technology
- Moderate investment
- Shorter schedule
- Competitive CP sensitivity down to $\sin^2(2\theta_{13})\sim 10\text{-}3$

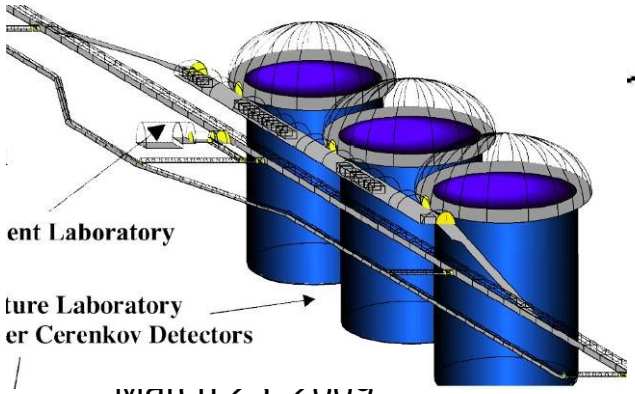
First indications about $\sin^2(2\theta_{13})$ by 2010-2011 (T2K+...) eagerly expected!

What Eurov DS Superbeam is about-1

- We start from the SPL to Frejus concept



MEMPHYS



Far detector feasibility, excavation, engineering is covered by the Laguna DS

Proton driver

- Tremendous effort for the NF proton driver: need to fully exploit this synergy
- Advanced CDR for SPL at CERN. Important and very positive developments (see presentation from R. Garoby)
- We take SPL as our baseline proton driver
- Ongoing work by dedicated team
- Refinements, R/D, further studies in other frameworks
- Changes to this proton-driver design only from the optimization of the target and collection or from the physics and detector studies

SPL

CERN–2006–0
12 July 2006

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIR

CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCI.

Conceptual design of the SPL II

A high-power superconducting H⁻ linac at CERN

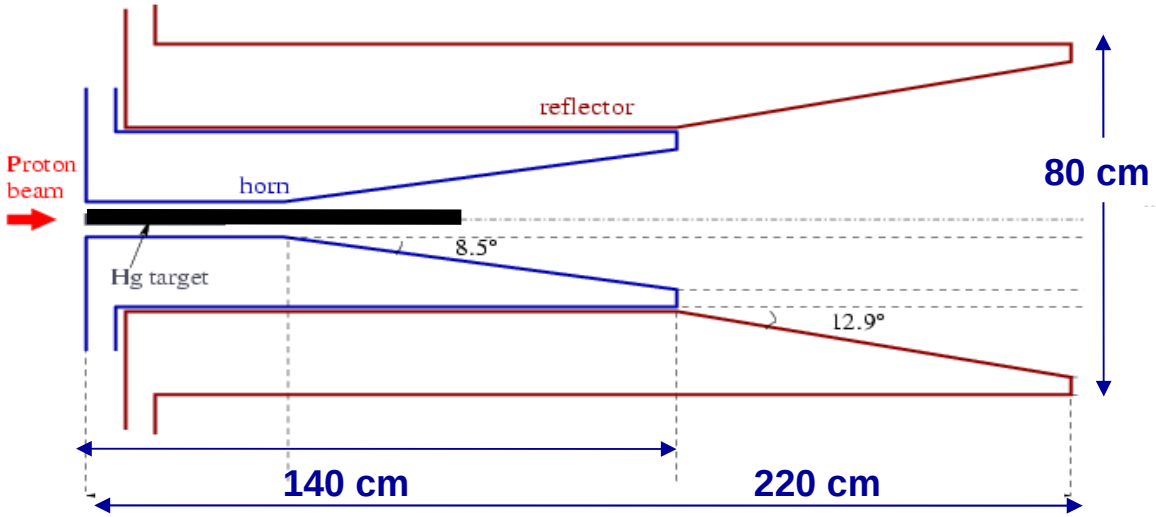
F. Gerigk (Editor), M. Baylac[1], E. Benedico Mora, F. Caspers, S. Chel[2], J.M. Deconto[1], R. Duperrie
E. Froidefond[1], R. Garoby, K. Hanke, C. Hill, M. Hori[3], J. Inigo-Golfin, K. Kahle, T. Kroyer,
D. Kuechler, J.-B. Lallement, M. Lindroos, A.M. Lombardi, A. López Hernández, M. Magistris,
T.K. Meinschad, A. Millich, E. Noah Messomo, C. Pagani[4], V. Palladino[5], M. Paoluzzi, M. Pasini
P. Pierini[4], C. Rossi, J.P. Royer, M. Sanmarti, E. Sargsyan, R. Scrivens, M. Silari, T. Steiner,
J. Tückmantel, D. Uriot[2], M. Vretenar

Figure 1: Layout of the new proton injector complex at CERN.

Table 1: Parameters of the "nominal" SPL and of the low-power LP-SPL.

	unit	*SPL*	*LP-SPL*
Energy	[GeV]	5.0	4.0
Beam power (for ν factory)	[MW]	4.0	0.192
Repetition rate	[Hz]	50	2
Average pulse current	[mA]	40	20
Peak pulse current	[mA]	64	32
Chopping ratio	[%]	62	62
Beam Pulse length	[ms]	0.6	1.2
Protons per pulse for PS2	[10^{14}]	1.5	1.5
Beam duty cycle	[%]	2.0	0.24
Number of klystrons (LEP)		14	14
Number of klystrons (704 MHz)		57	28
Peak RF power	[MW]	219	100
Average power consumption	[MW]	38.5	4.5
Cryogenics av. power consumption	[MW]	4.5	1.5
Cryogenic temperature	[K]	2.0	2.0
Length	[m]	534	459

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 one EVO meeting
- We started to work on all components of the problem:
  - The beam simulations
  - The target
  - The collector
  - Beam-Target interface and requirements

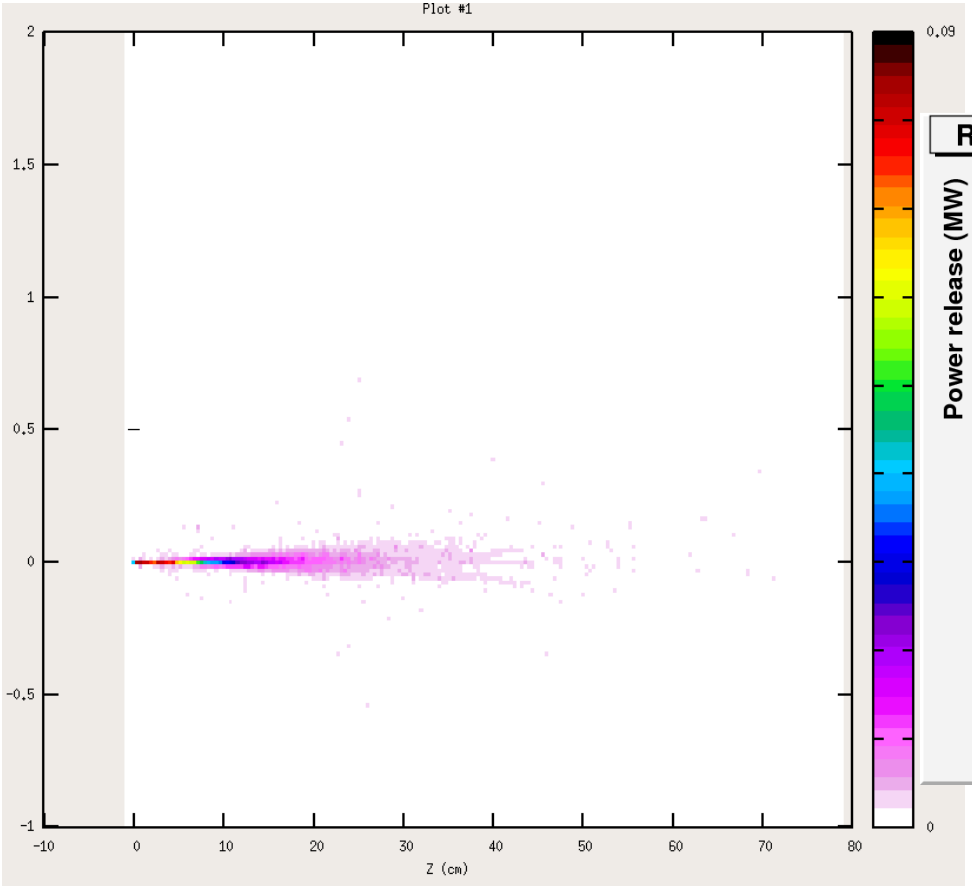
First face to face meeting Dec 15-17

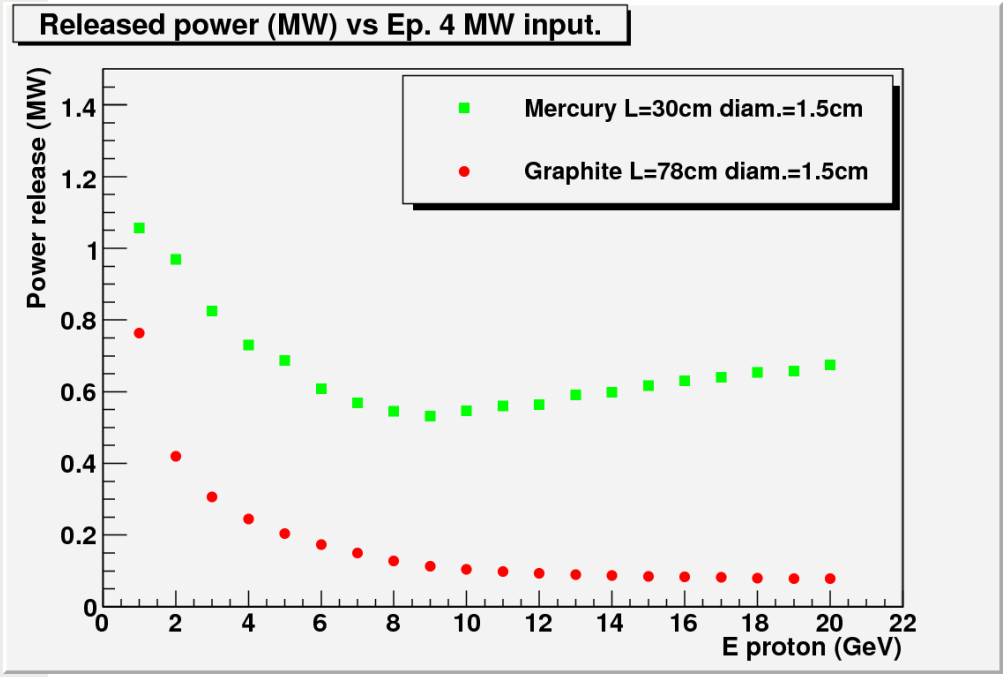
- http://indico.in2p3.fr/conferenceDisplay.py?confId=1586
- Tuesday 16 December 2008
- 09:00 CERN Proton Drivers (30') (files Slides ppt file) M. Martini (CERN)
- 09:30 Beam stability in the SPL-based accumulator: issues and planned studies (30') E. Benedetto
- 10:00 Harp Results on Hadroproduction (45') (files Slides ppt file) G. Catanesi
- 11:30 SPL neutrino spectra (30') (files Slides ppt file) Antoine Cazes (IPNL-IN2P3)
- 12:00 Discussion (30') All
- 14:00 Dusel neutrino spectra (30') (files Slides pdf file) M. Bishai
- 14:30 Princeton/Oxford Meeting (45') (files Slides pdf file) Kirk Mc Donald (Princeton University)
- 15:15 CERN Target Test Area (45') (files Slides ppt file) Ilias Efthymiopoulos (CERN)
- 16:00 T2K Target (45') (files Slides ppt file) Chris Densham
- 16:45 Solid Target R&D (45') (files Slides ppt file) Roger Bennett
- 17:30 Powder Jet development (45') (files Slides ppt file) O. Caretta
- Wednesday 17 December 2008 toptop
- 09:00 Target Imbed in Horn (45') (files Slides ppt file) Nikolaos Simos (BNL)
- 09:45 SPL Collection system (45') (files Slides ppt file) Marcos Dracos (IPHC-IN2P3/CNRS)
- 10:30 Design and Operational Features of a Mercury Target Facility (45') Van Graves
- 11:15 Hg Beam Dump issues (45') (files Slides ppt file) T. Davenne
- 12:00 Muon Production efficiency (45') (files Slides ppt file) Harold Kirk (BNL)
- 14:00 Workplan and summary (2h00')
-

Neutrino beam simulation

From received wisdom to state of the art tools: Fluka, GEANT3->GEANT4+...

Big help from A. Cazes

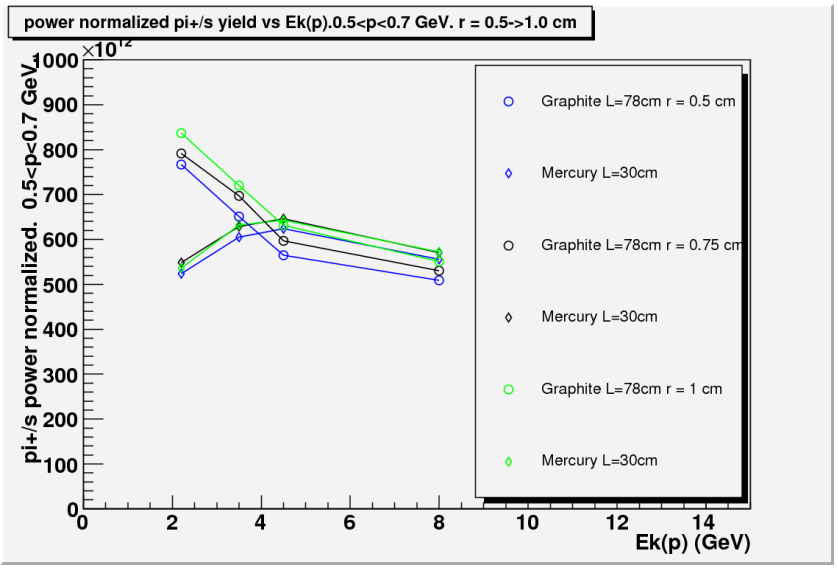


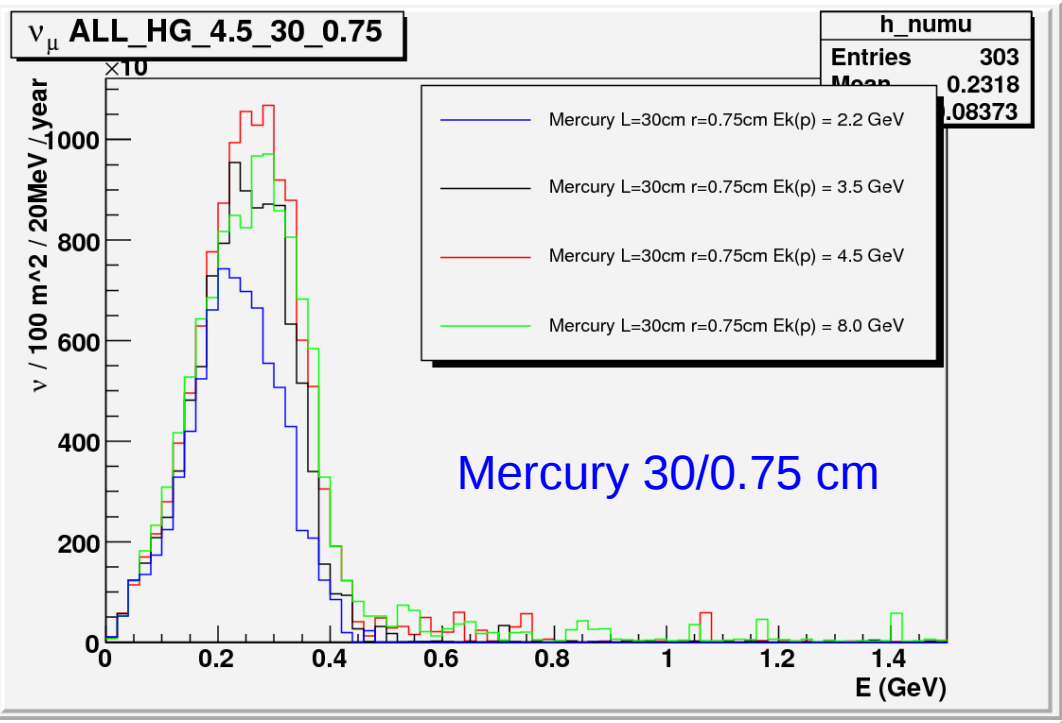


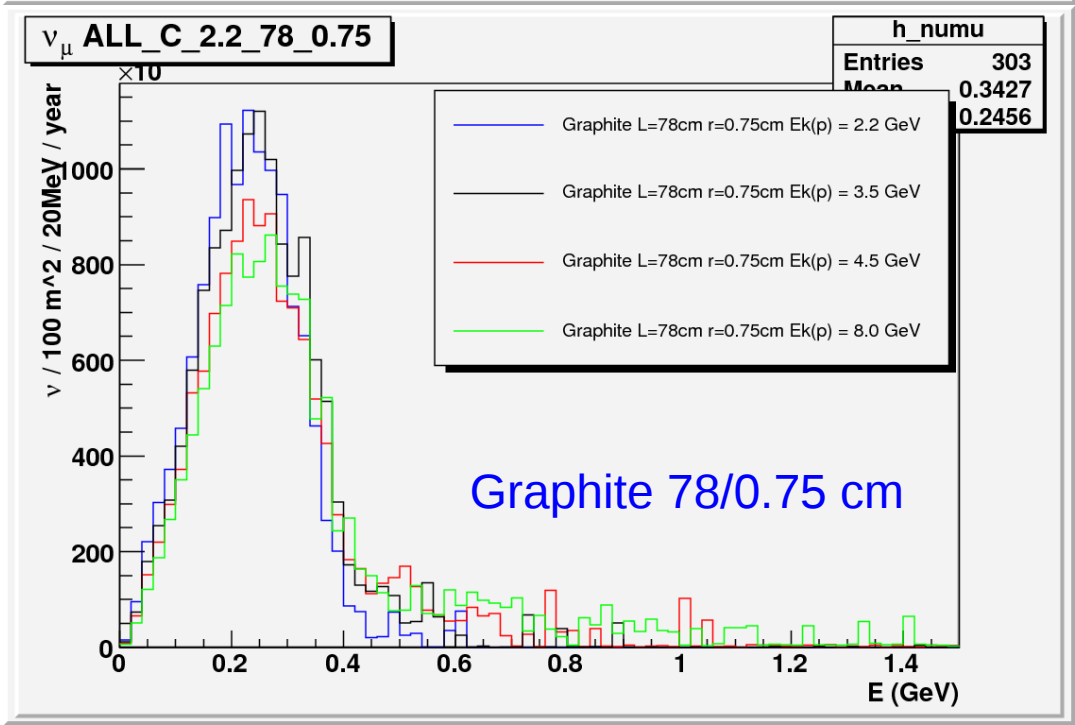
ν_μ fluxes: Mercury-Graphite

A. Longhin

- pion yield trends are reflected in fluxes despite non optimized focusing for long Graphite target
- Fluxes intensities are similar
- Slightly higher high energy tail for Graphite (most likely cured with optimized focusing)







The emerging concept

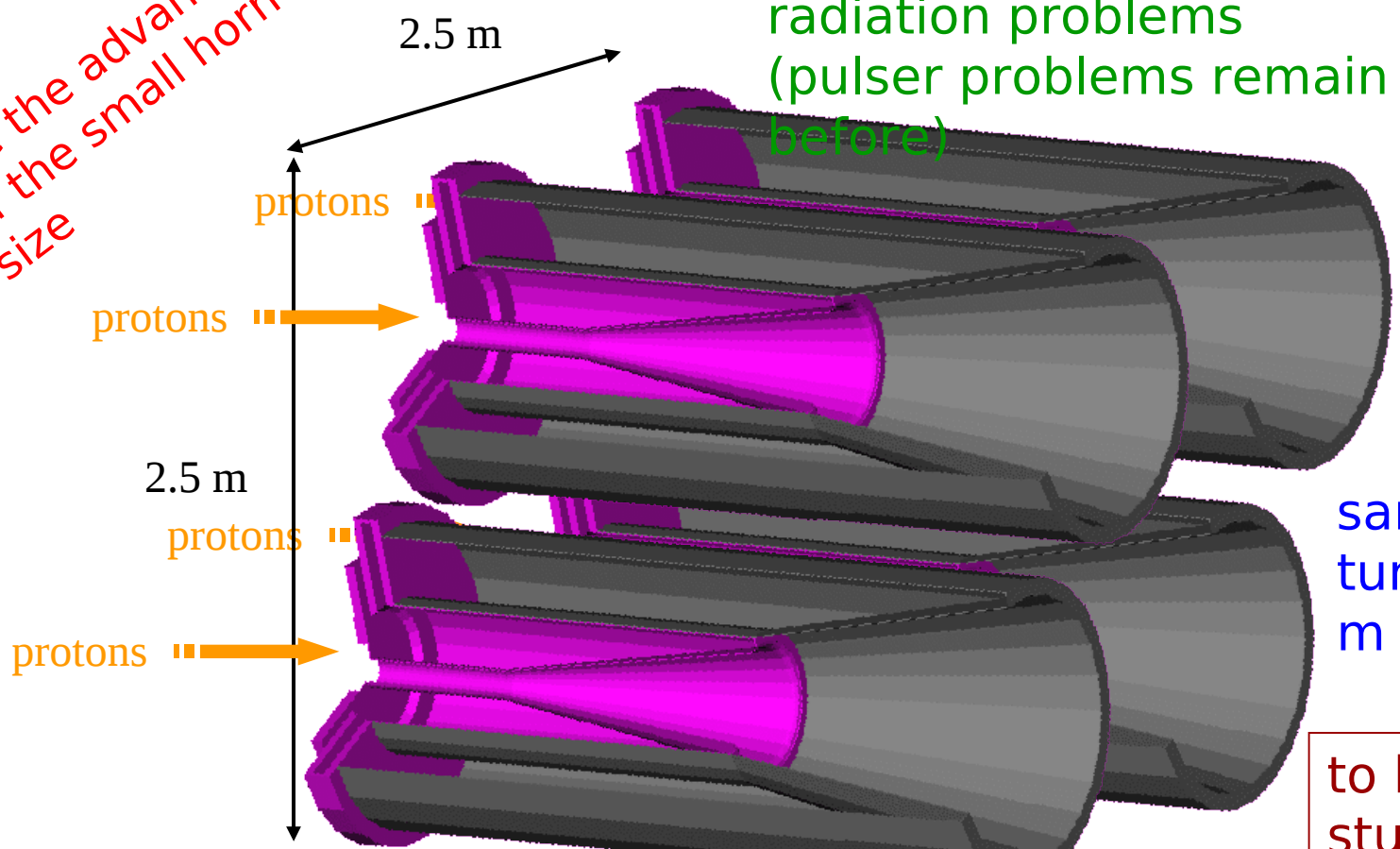
- Target-Collector: adopt multiple (4) target+collector systems to mitigate the difficulties (M. Dracos idea)
- Target: explore the feasibility of a static solid target
- Keep pebble-bed and powder jet as more advanced solutions
- Collector: use as a baseline the CERN NF prototype

M. Dracos

New ideas

use the advantage of the small horn size

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

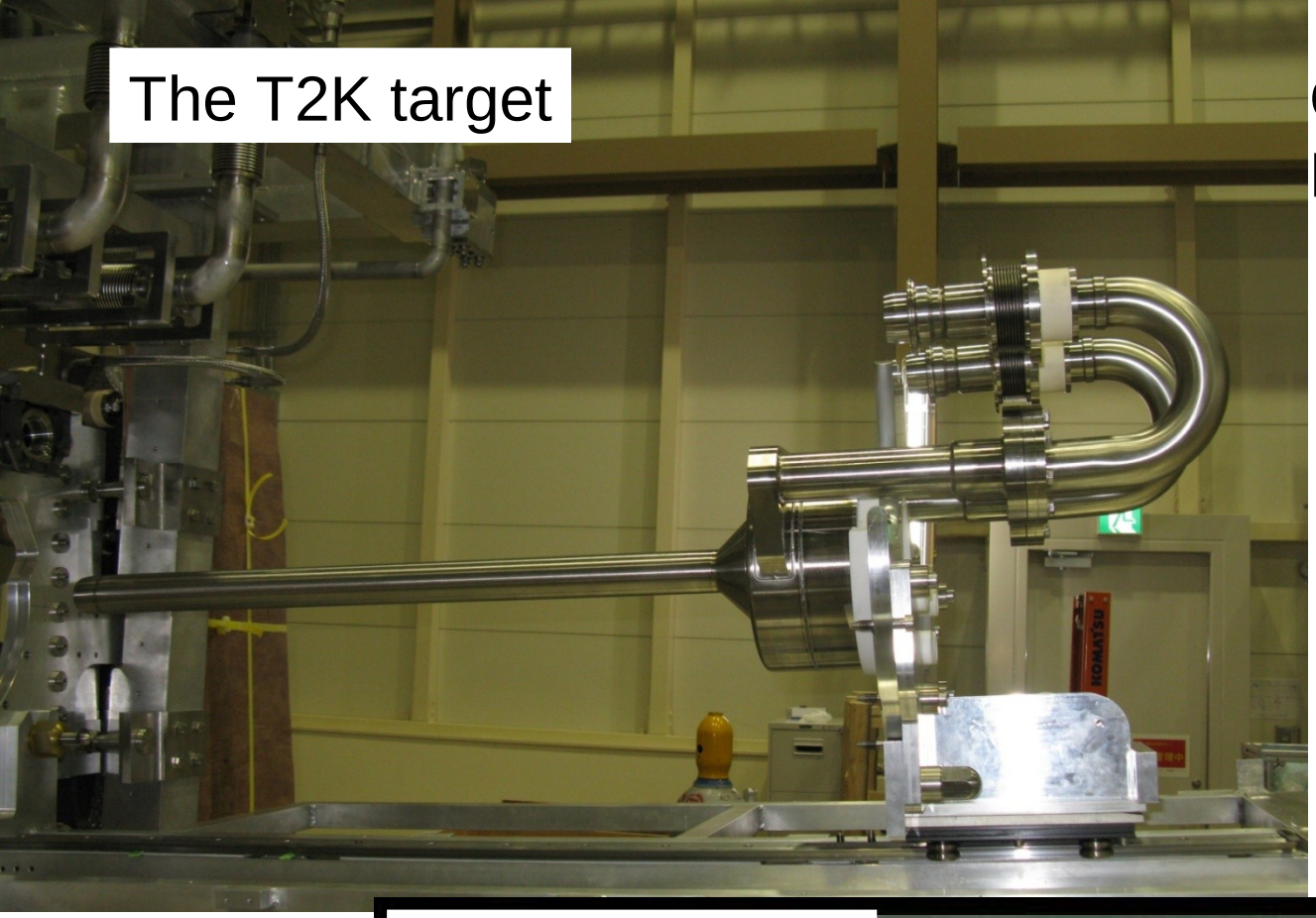


same decay tunnel Ø 3 m

to be studied in EUROν

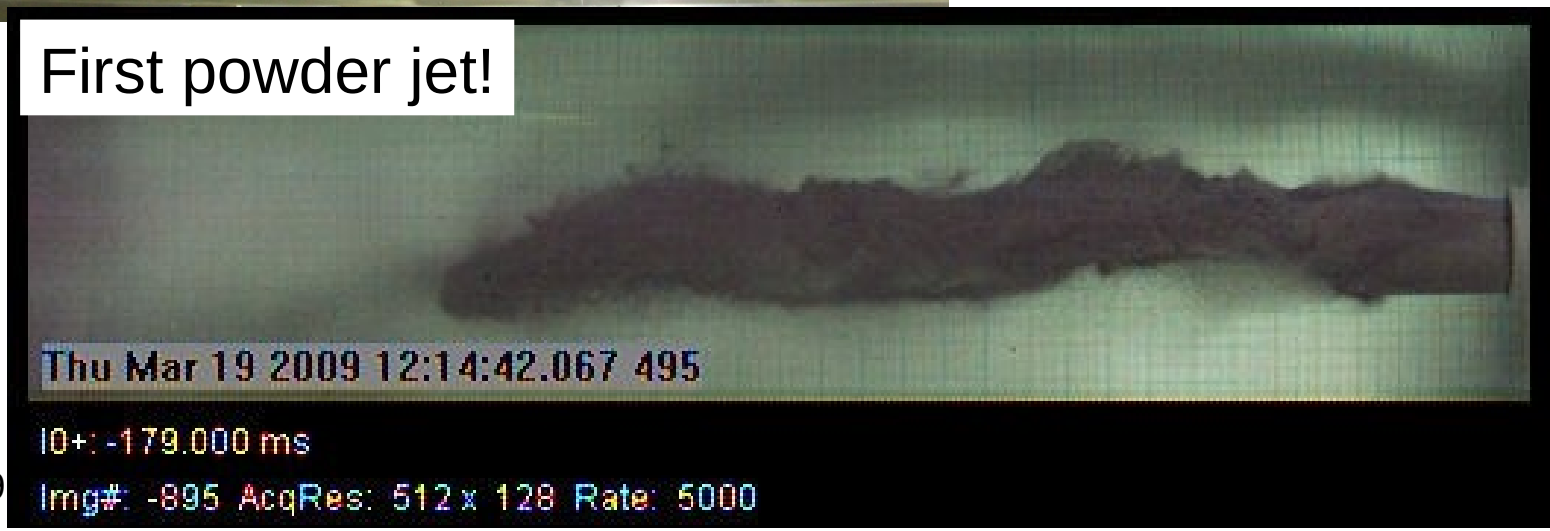
2 options:
- send at the same time 1 MW per target/horn system
- send 4 MW/system every 50/4 Hz → possibility to use solid target?

The T2K target



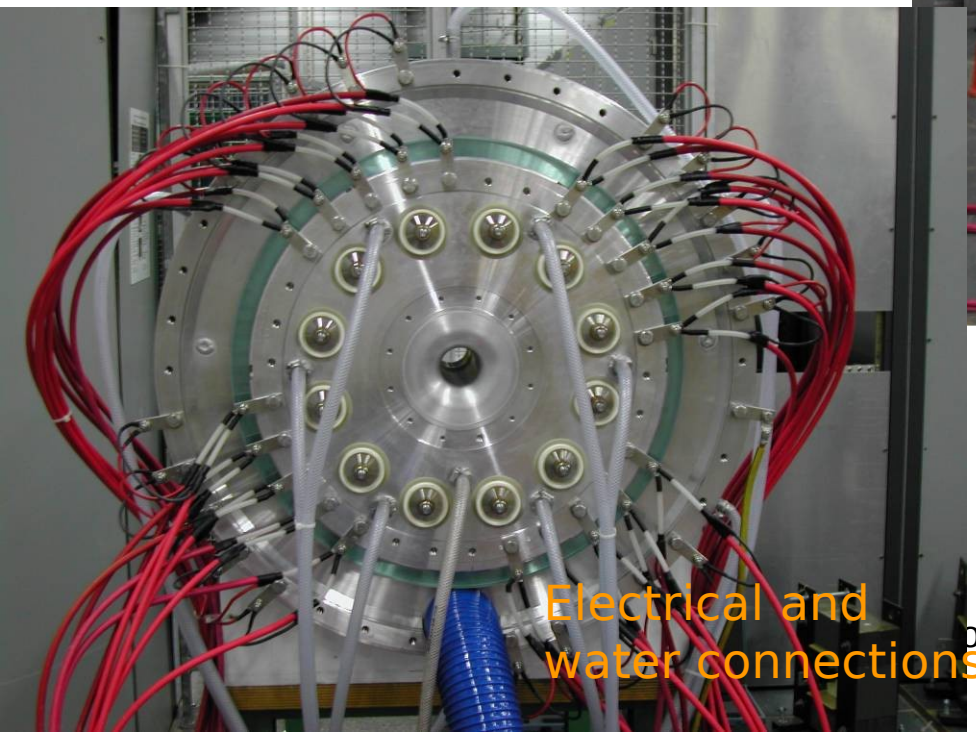
C. Densham,
M. Fitton, O. Caretta

First powder jet!



Horn prototype

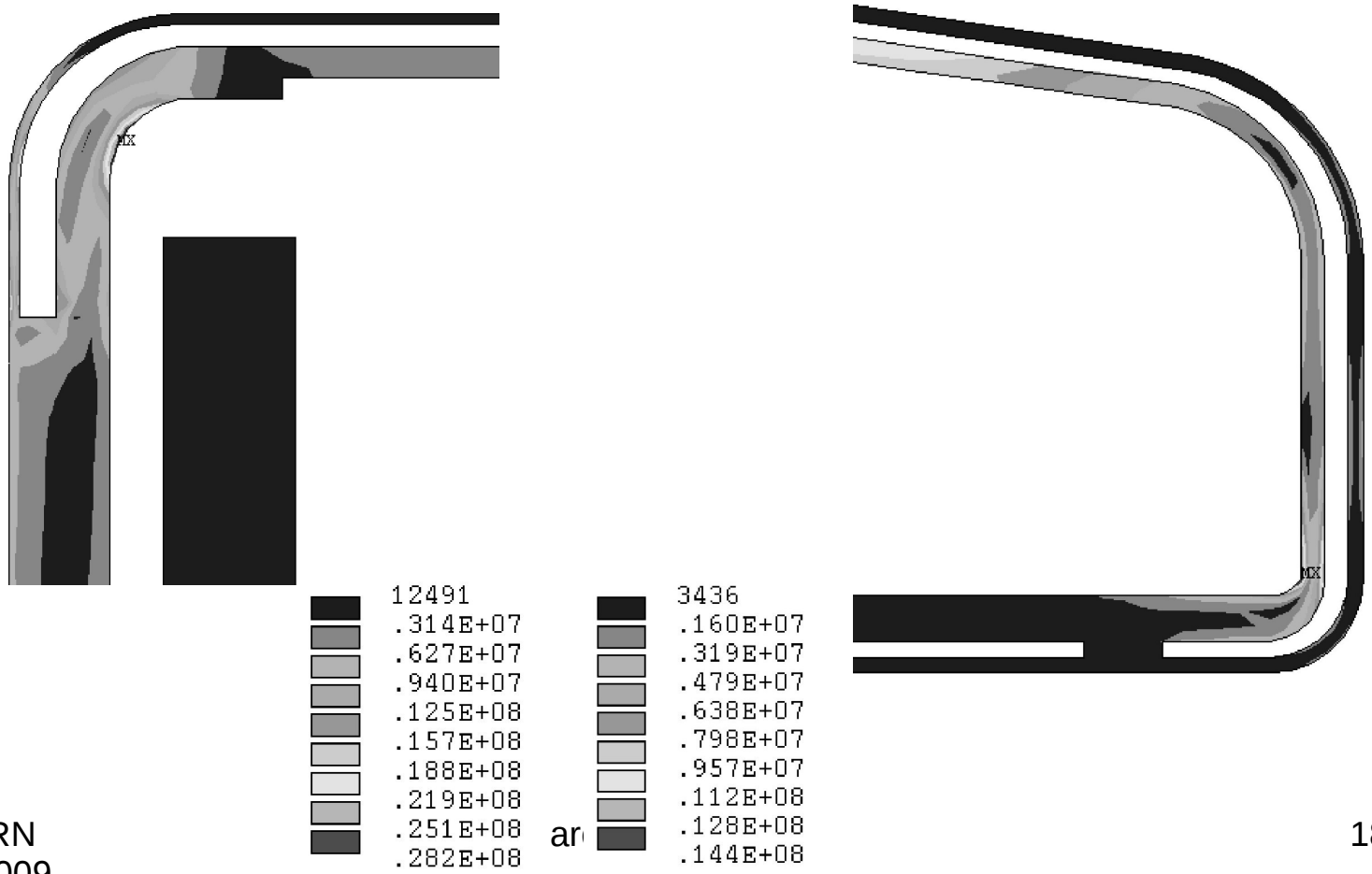
- **For the horn skin AA 6082-T6 / (AlMgSi1) is an acceptable compromise between the 4 main characteristics:**
  - Mechanical properties
  - Welding abilities
  - Electrical properties
  - Resistance to corrosion
  - Same for CNGS



- tests done with: 30 kA and 1 Hz, pulse 100 μ s long
- new tests to be done with 50 Hz

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

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 Euroν is focusing on the key issues for this project
- A lot of activity is ongoing in the different labs
- We have prepared a detailed work plan
- We are quite confident that we have the forces, the competence and the plan to develop the conceptual design of a competitive neutrino facility for the discoveries of the next decade

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

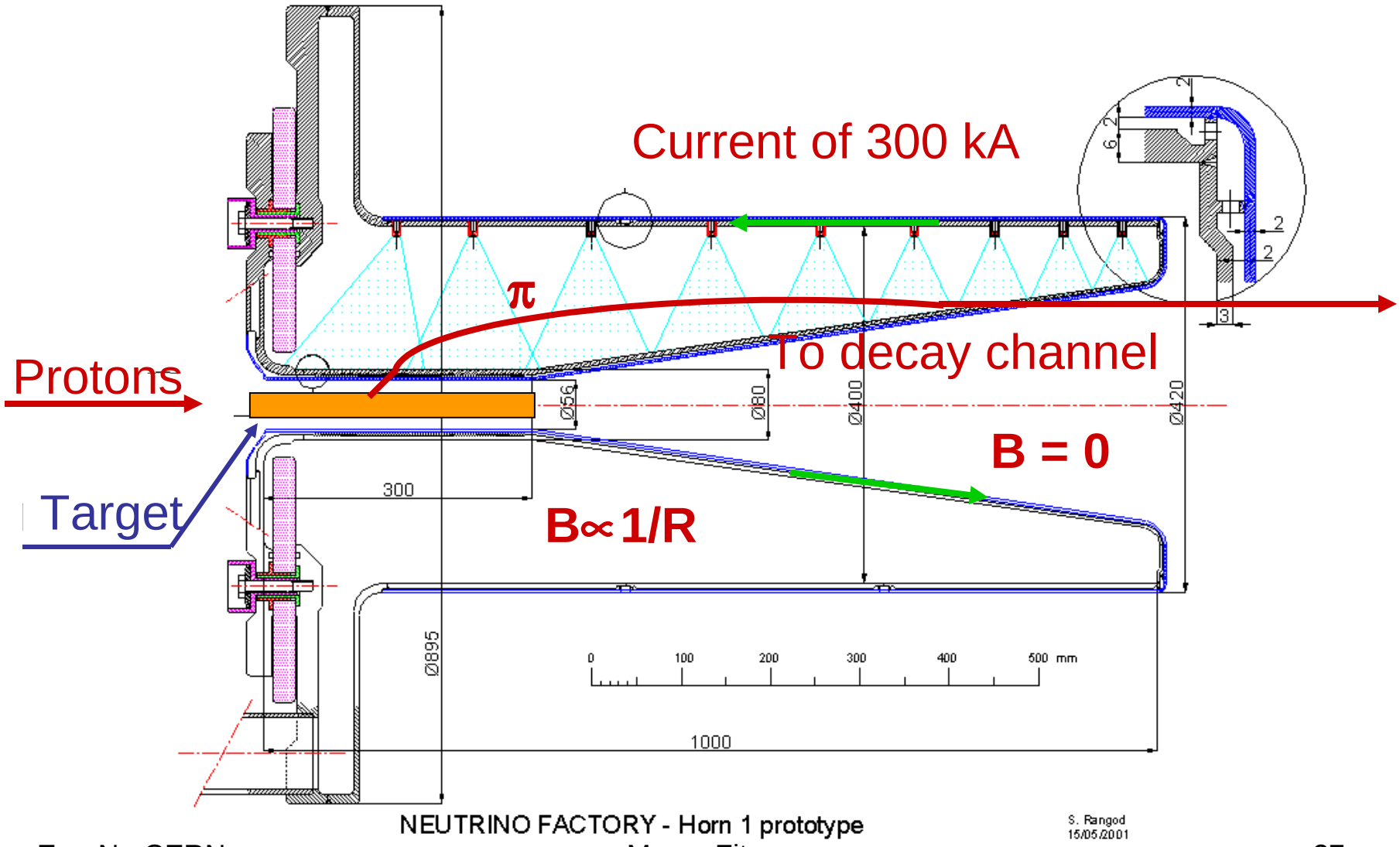
"The low-power SPL", PS2 meeting, 20. June 2007, F. Gerigk

Collector

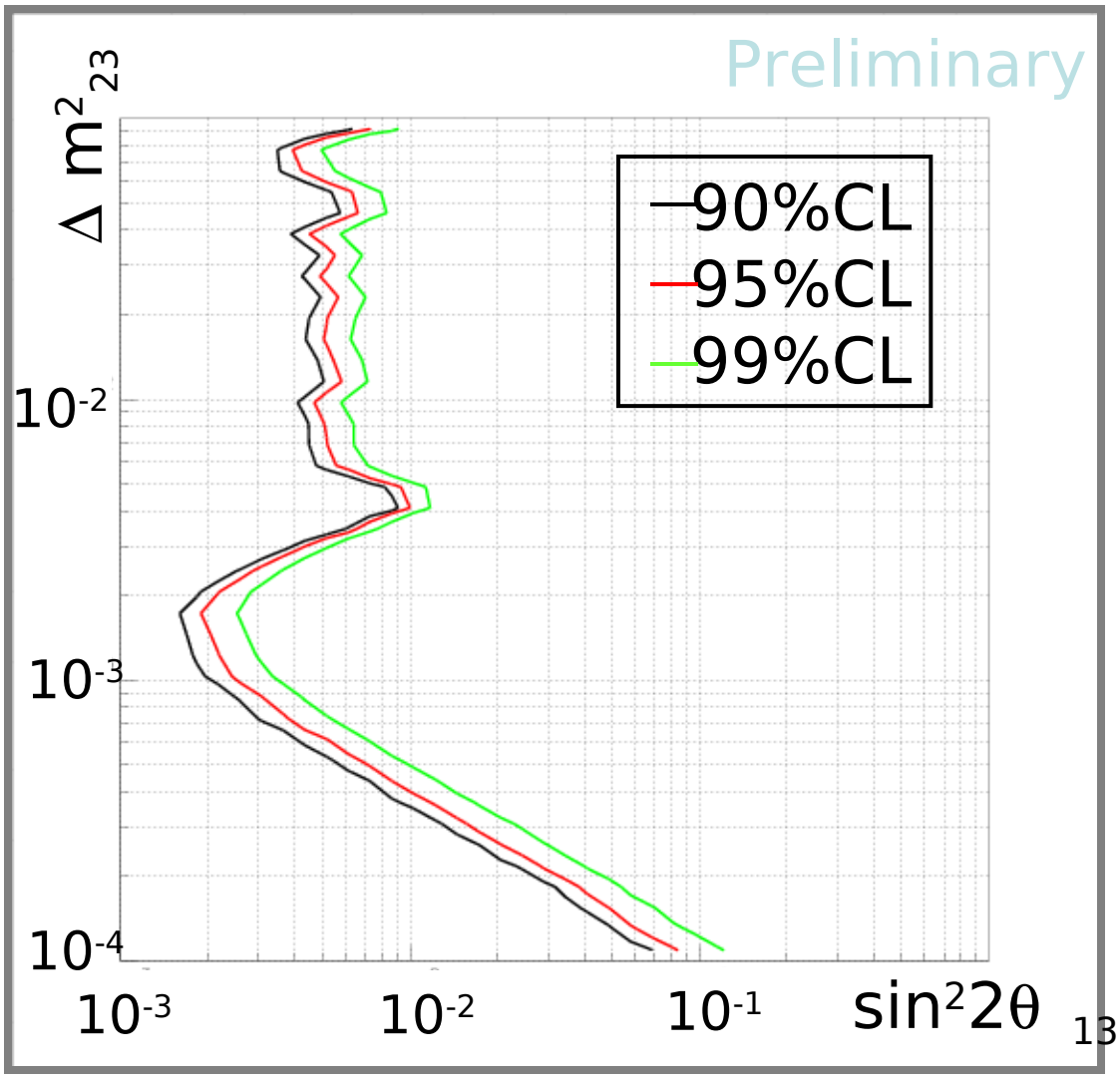
- Main challenges:
  - design of a high current pulsed power supply (300 kA/100 μs/50 Hz),
  - cooling system in order to maintain the integrity of the horn despite of the heat amount generated by the energy deposition of the secondary particles provided by the impact of the primary proton beam onto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

Focusing system: magnetic horn

M. Dracos



Sensitivity 3.5GeV



A.Cazes thesis

Minimum:
$\theta_{13} = 1.2°$
(90%CL)