

# *EUROnu Super Beam Work package*

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For the WP2 team

Third EuroNu Annual Meeting  
Rutherford Lab  
January 19 2011



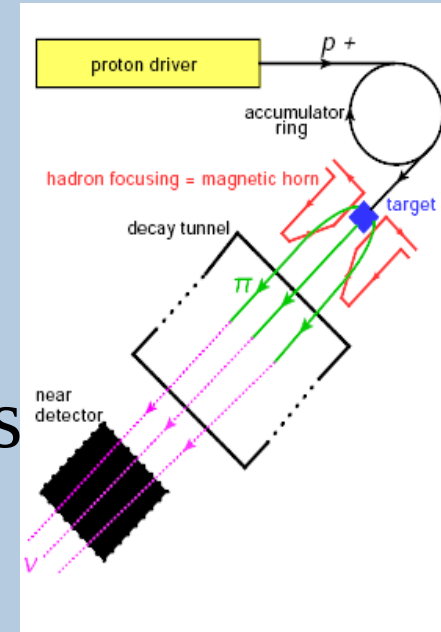
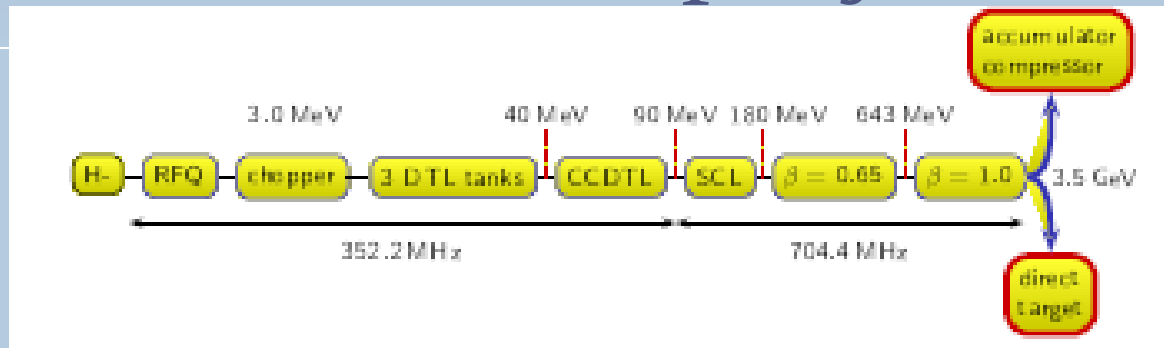
# *The WP2 team*

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

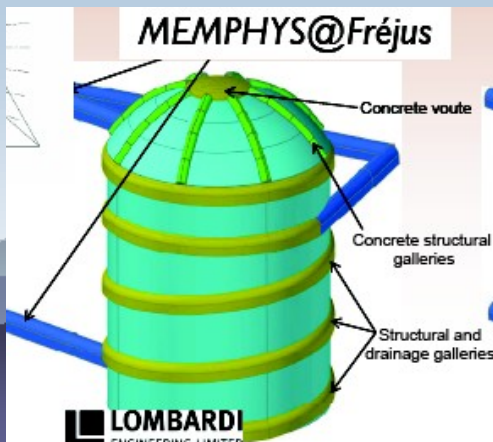


- ◆ O. Besida, C. Bobeth , O. Caretta , P. Cupial , T. Davenne , C. Densham, M. Dracos ,M. Fitton , G. Gaudiot, M.Kozien ,B. Lepers, A. Longhin, P. Loveridge, F. Osswald , M. Rooney ,B. Skoczen , A. Wroblewski, G. Vasseur, N. Vassilopoulos, V. Zeter, M. Zito

# The project



- Design of the CERN to Fréjus Super Beam based on SPL
- 4 MW
- 130 km baseline
- 5 GeV k.e. proton beam
- Focus on a solution for the target+collector



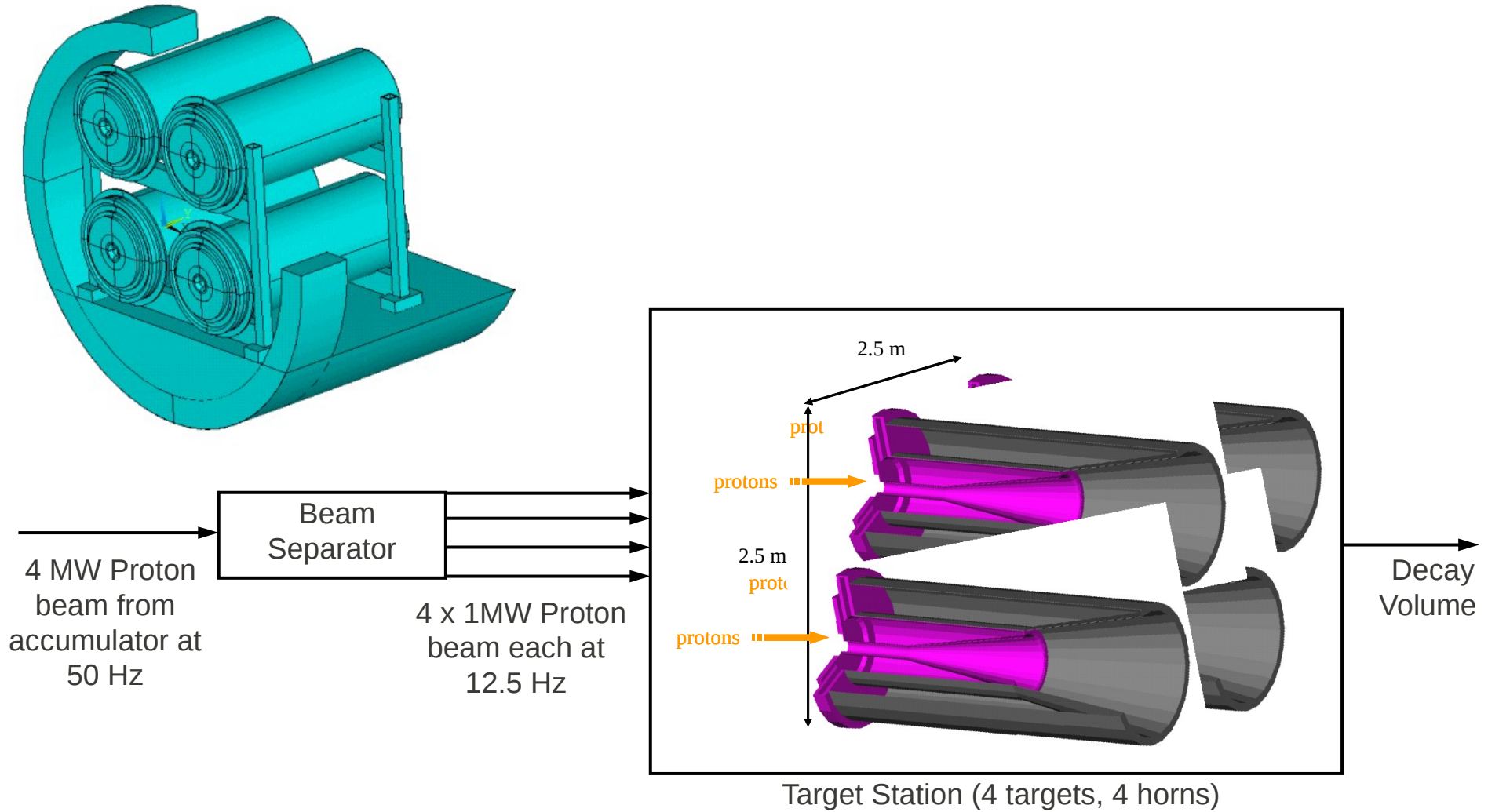
# *Activities*

- ♦ Beam simulation and optimization, physics sensitivities (Saclay)
- ♦ Beam/target interface (RAL)
- ♦ Target design (RAL, Strasbourg)
- ♦ Horn design (Strasbourg, Cracow)
- ♦ Target horn integration (Strasbourg, Cracow)
- ♦ Target station (RAL)
- ♦ Regular phone meetings + one face to face meeting in Cracow since last plenary

# *Important steps forward*

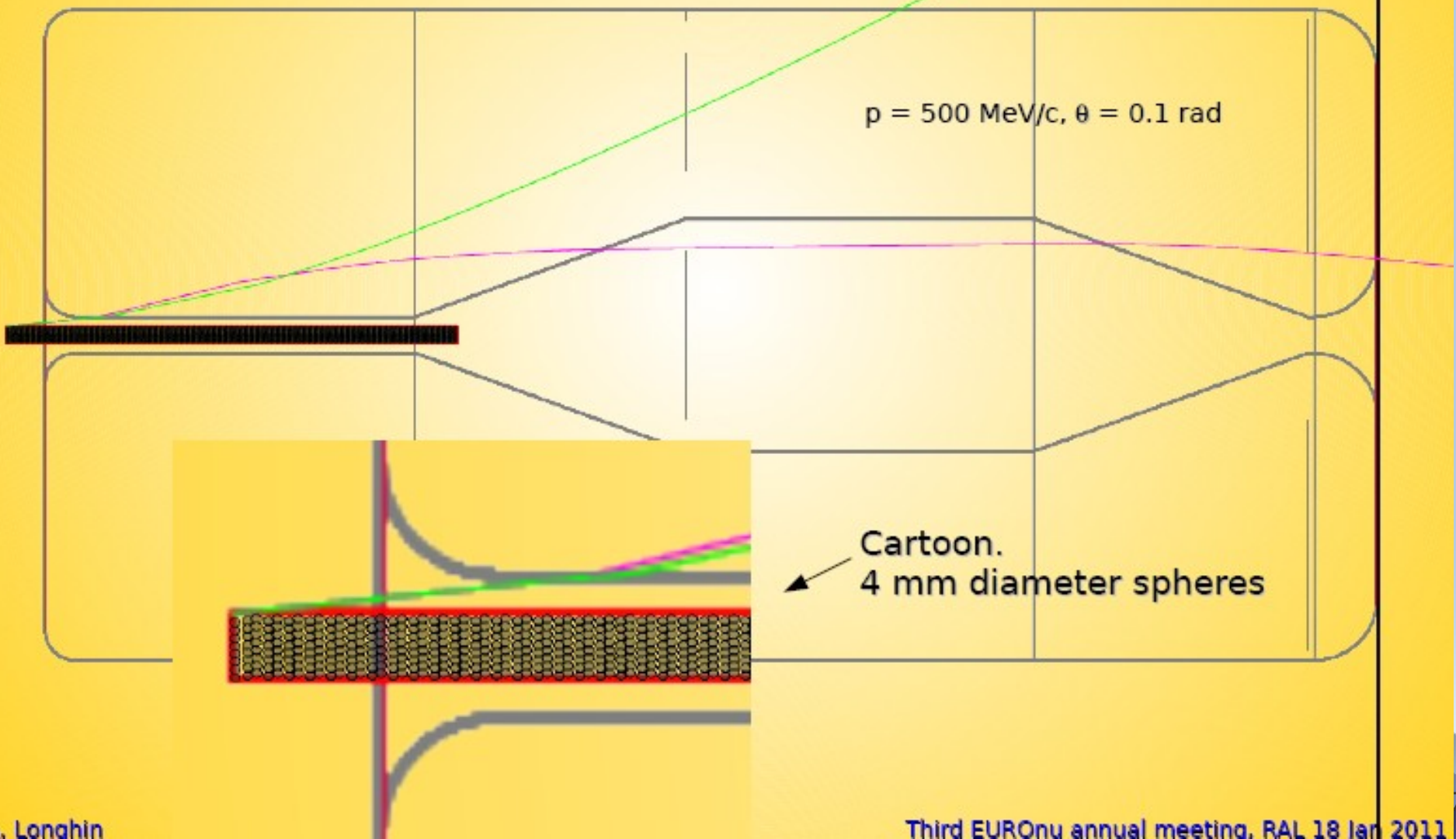
- ◆ Solid static target
- ◆ Use multiple (4) targets+collectors
- ◆ Each pulsed at 12.5 Hz
- ◆ Use single horn (no reflector)
- ◆ Optimization of horn shape → Miniboone shape
- ◆ A lot of progress towards a working solution, at constant (or improved) physics performance

# Overall configuration



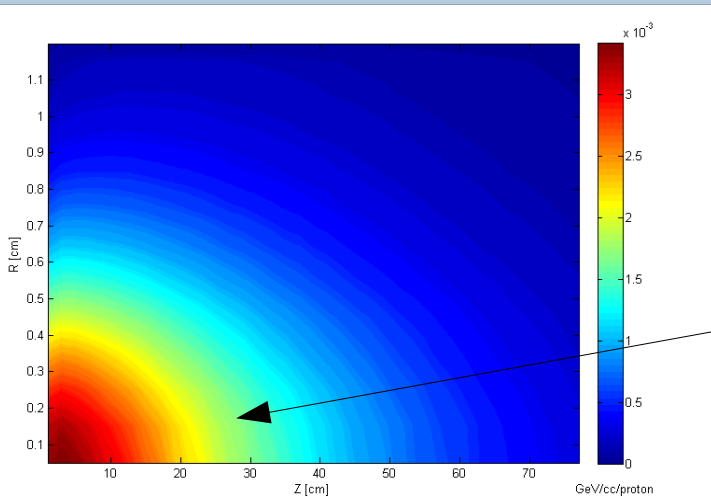
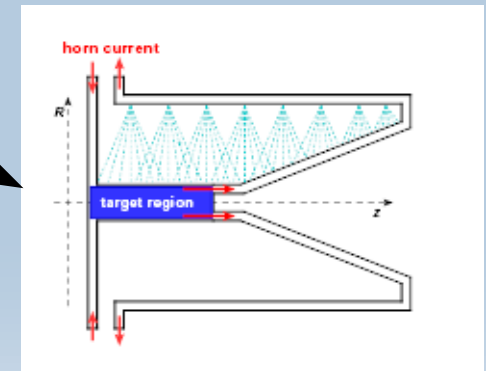
# Focusing

Target needs to be separated.  
 $R = 3\text{cm} + 3\text{ mm Al thickness.}$



# Target studies and baseline

- In the past months we have focussed on the target design
- We have considered:
  - A solid static low-Z target cleverly shaped
  - A one-piece (embedded) target+horn (conducting target)
  - A pebble bed target



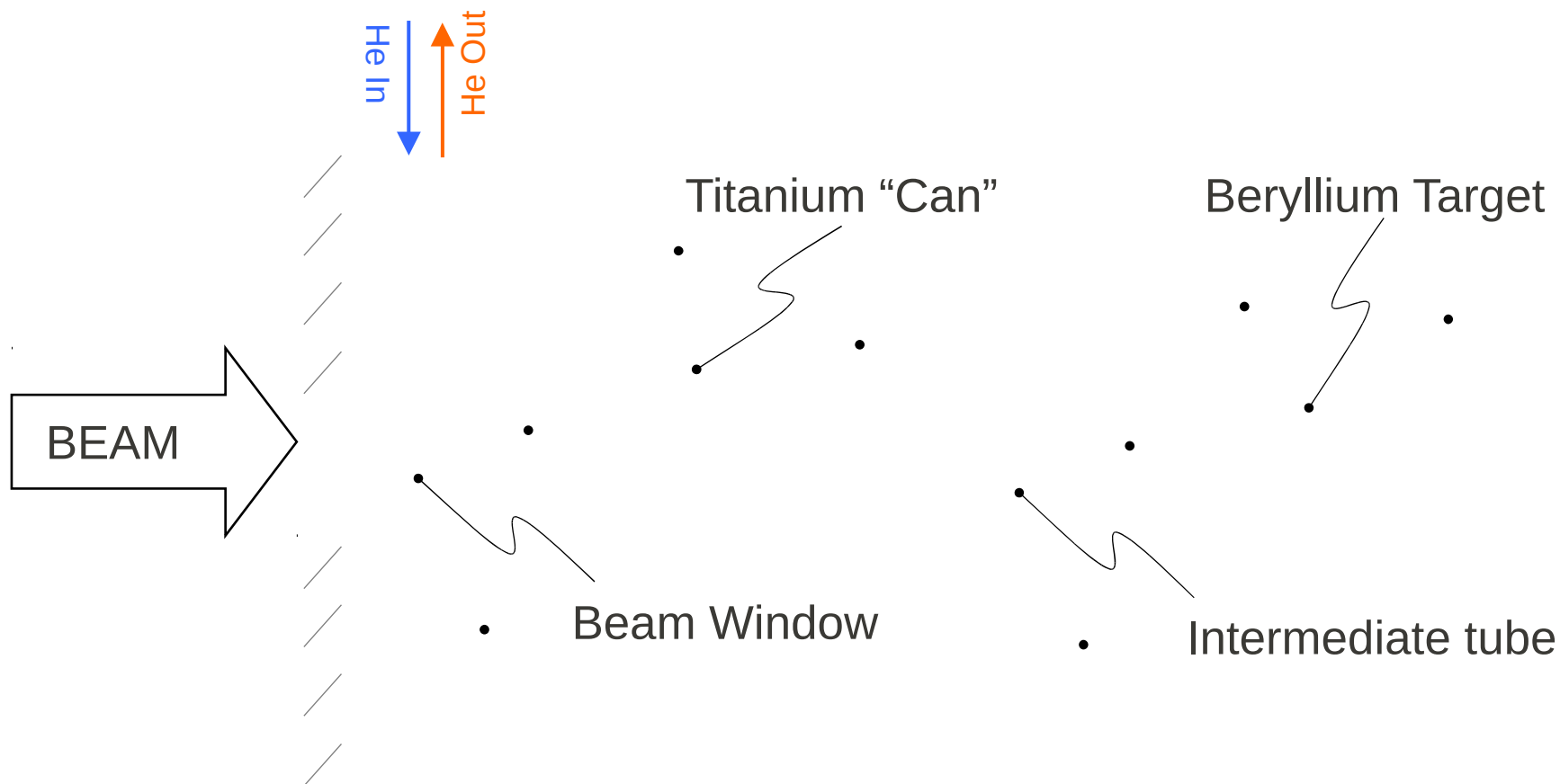
A critical issue: very high power density in the upstream central volume



# “Pencil” Target Concept Design

- Pencil shaped Beryllium target contained within a Titanium “can”
- Pressurised Helium gas cooling, outlet at 10 bar
- Supported as a cantilever from the upstream end

P. Loveridge

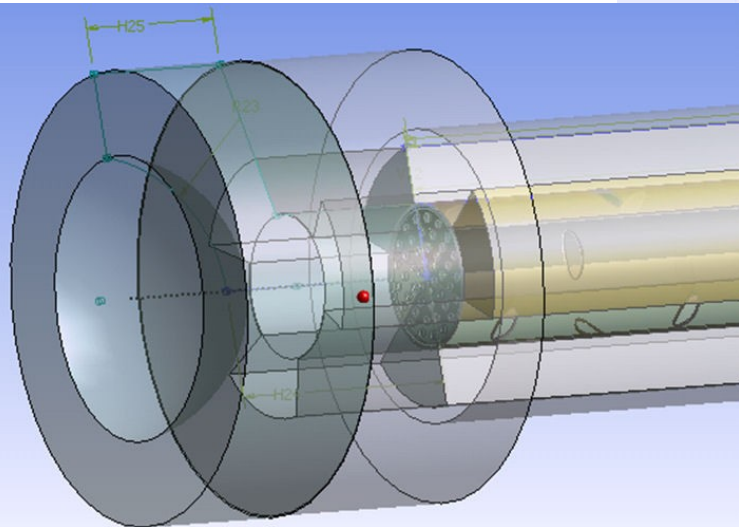


*Drawing not to scale!*

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

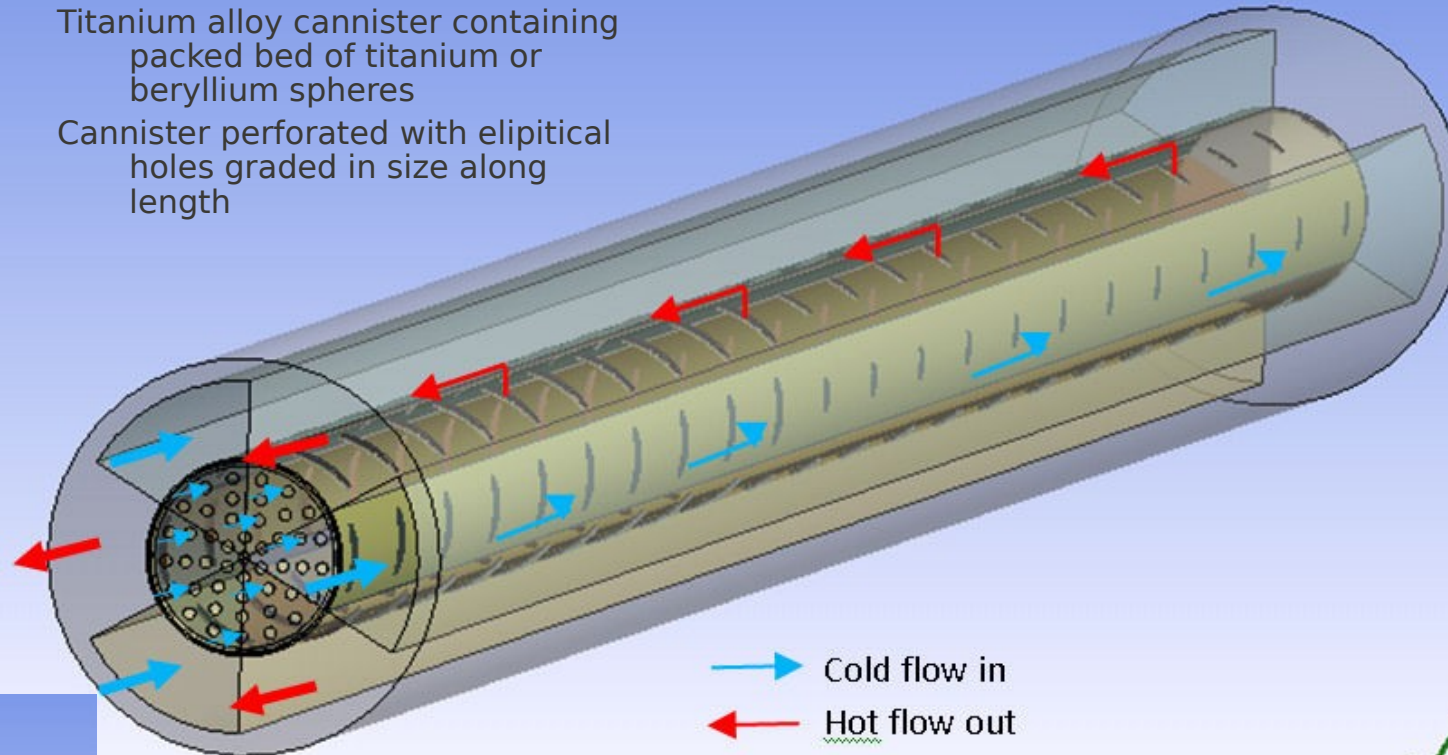
Packed bed cannister in  
parallel flow configuration

Packed bed target front  
end



Titanium alloy cannister containing  
packed bed of titanium or  
beryllium spheres

Cannister perforated with elipitcal  
holes graded in size along  
length



→ Cold flow in  
← Hot flow out

## 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

# *Towards the target baseline*

After these studies we have concluded that

- ◆ The pebble bed target appears to be the best candidate (capable of multi-MW ??)
- ◆ The solid static target is feasible, pencil shape solution
- ◆ The embedded target is disfavored

# Horn

Baseline :

- ♦ Miniboone shape
- ♦ Aluminum
- ♦ Cooled with internal water sprays
- ♦ Pulsed with 300-350 kA

## GEOMETRY

Parameters	value [mm]
$L_1, L_2, L_3, L_4, L_5$	589, 468, 603, 475, 10.8
$t_1, t_2, t_3, t_4$	3, 3, 3, 3
$r_1, r_2$	108
$r_3$	50.8
$R^{10}$	12
$L^{10}$	780
$z^{10}$	68
$R_2, R_3$	191, 359
$R_1$ integrated	12
$R_1$ non integrated	12 + 28 = 40

TABLE: Horn geometric parameters.

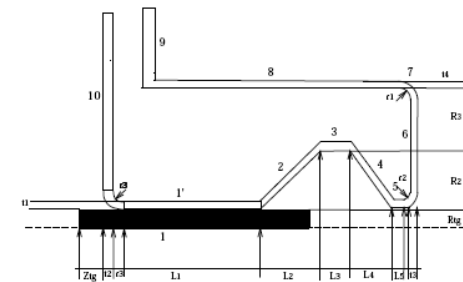
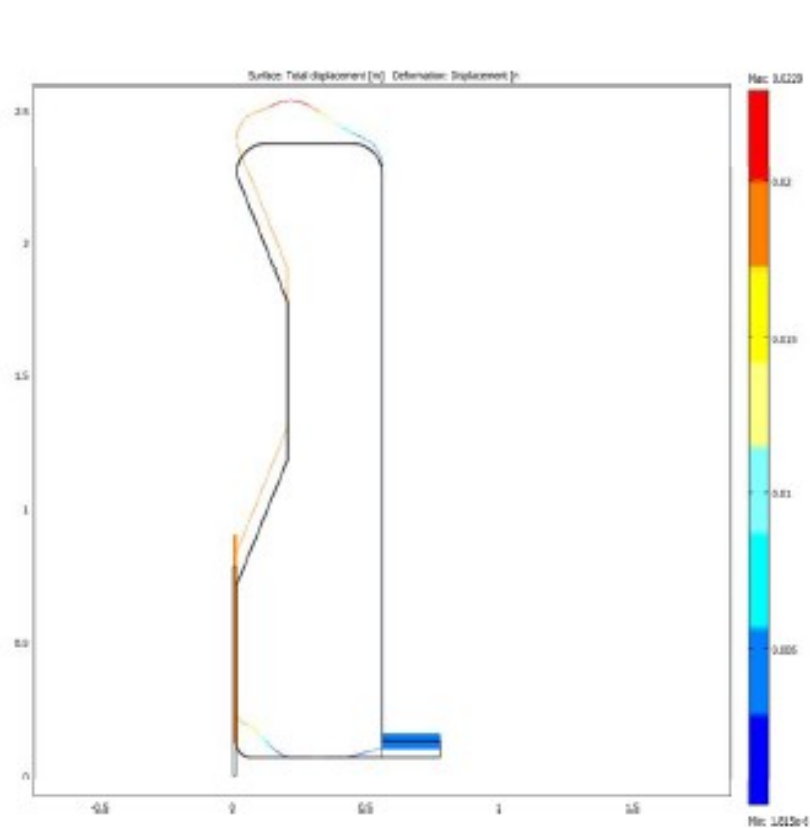


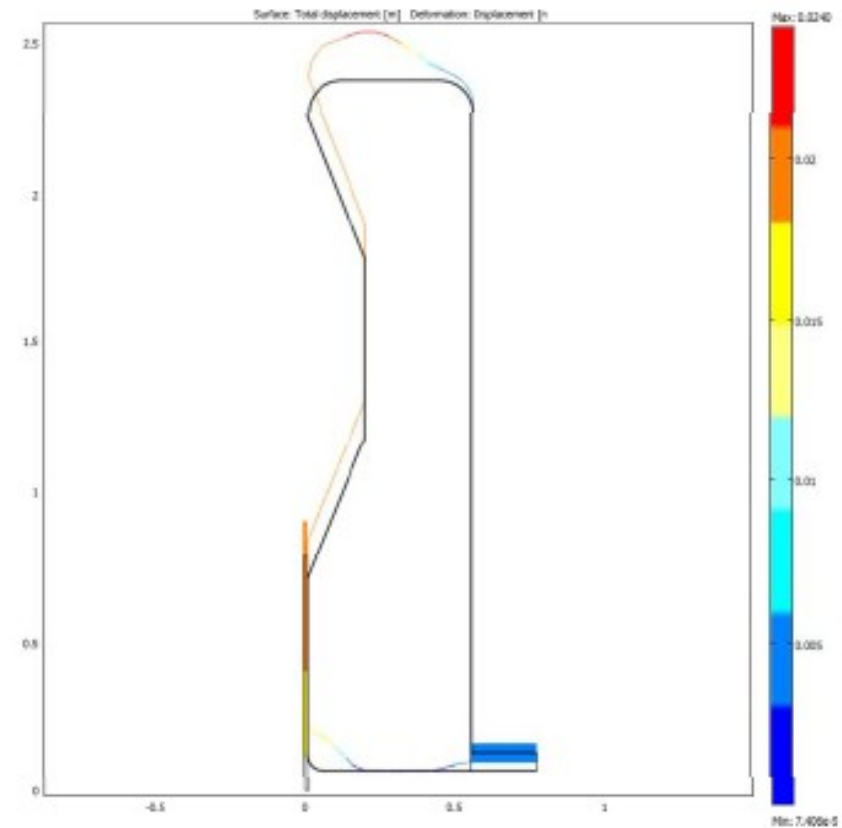
FIGURE: Horn parameters.

# DISPLACEMENT FIELD, $t = 3$ mm

B. Lepers



a)

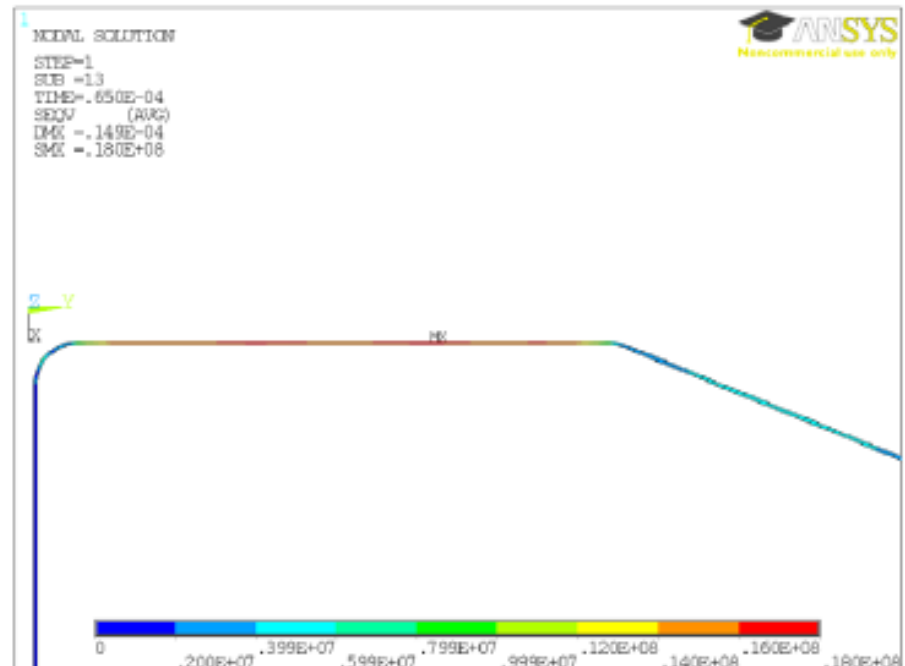
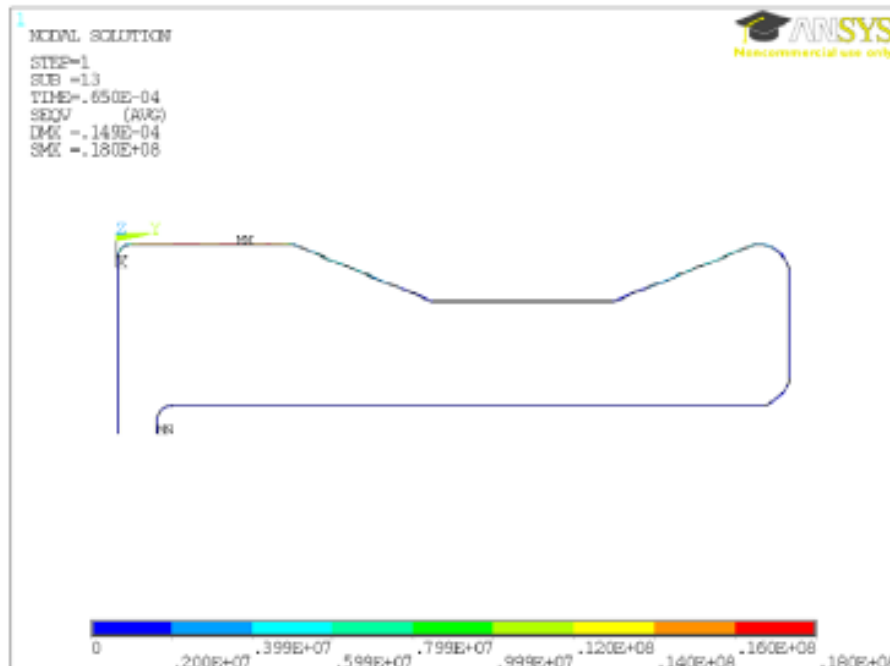


b)

**FIGURE:** Displacement field for the horn with thickness  $t = 3$  mm, magnetic pressure  $u_{max} = 23$  mm a) and magnetic pressure + thermal dilatation  $u_{max} = 24$  mm b) for cooling scenario 2

# Response to magnetic pulses

P. Cupial



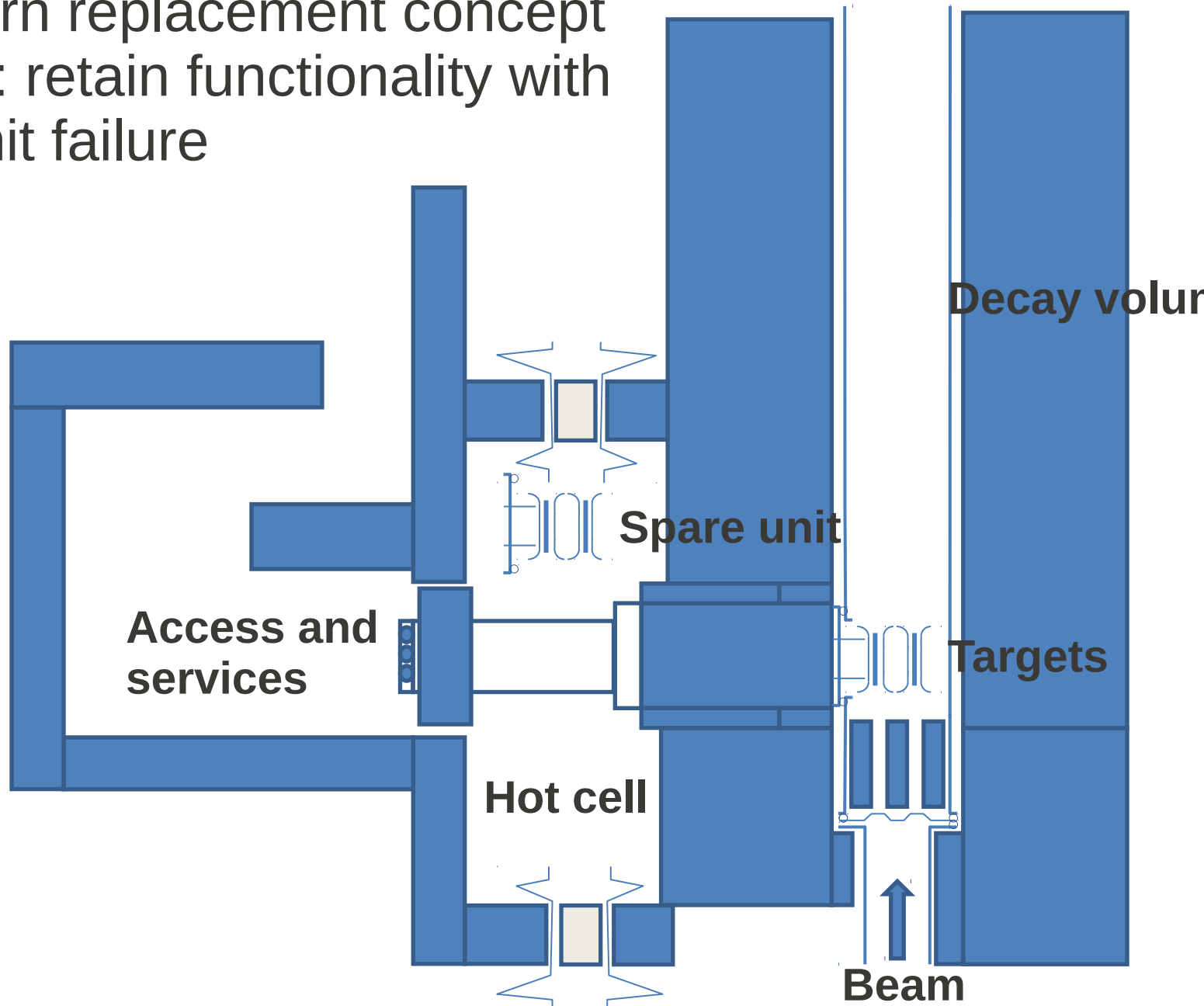
Maximum von Mises stress due to magnetic pulses = 18 MPa (at 300 kA)

= 24.5 MPa (at 350 kA)

# TARGET STATION CONCEPT

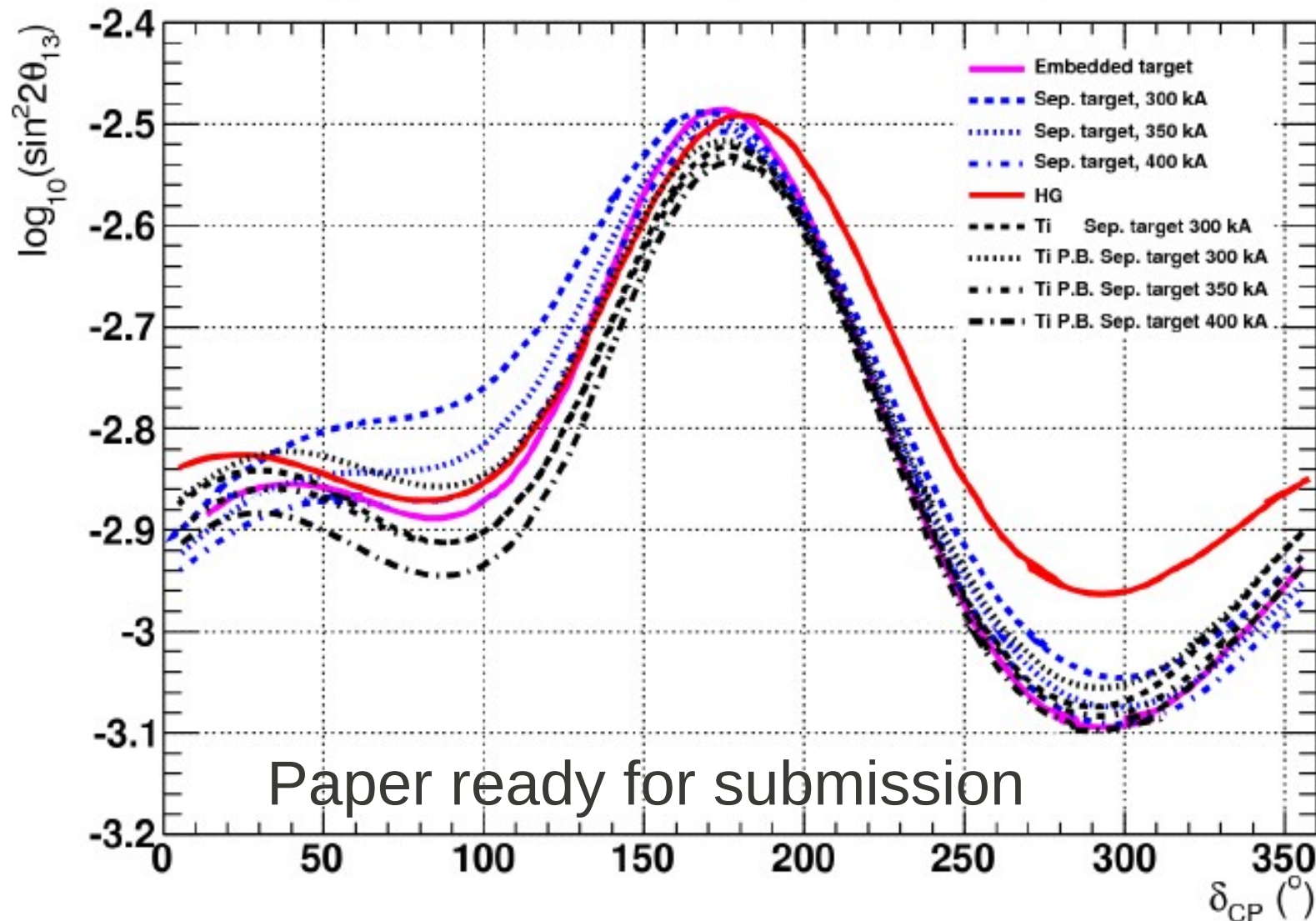
C. Densham

Target and horn replacement concept  
Requirement : retain functionality with  
1 (out of 4) unit failure  
1.3 MW each



# $\theta_{13}$ discovery potential

$\theta_{13}$  discovery at  $3\sigma$  ( $\Delta\chi^2 = 9$ ). 5% sys.



Paper ready for submission



# *Next steps*

- ♦ Report on preliminary design to be completed by the end of the month
- ♦ Then finalize the baseline design, the working parameters, the drawings and the physics performances
- ♦ Next deliverable target and collection design report (March)

# Deliverables

Deliverable	Delivery date (months)	
Requirements for proton driver	6	Completed
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	Completed
Prel. Design of Target and Collection	24	
1st Target and Collection integration drawings	24	
1st Est. of Nu Beam Intensity	24	Completed
Final Target and Collection integration drawings	36	
Design of target station	40	
Report on Nu Beam Intensity	42	