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LMJ - DP14 Neutron Pack Calibration

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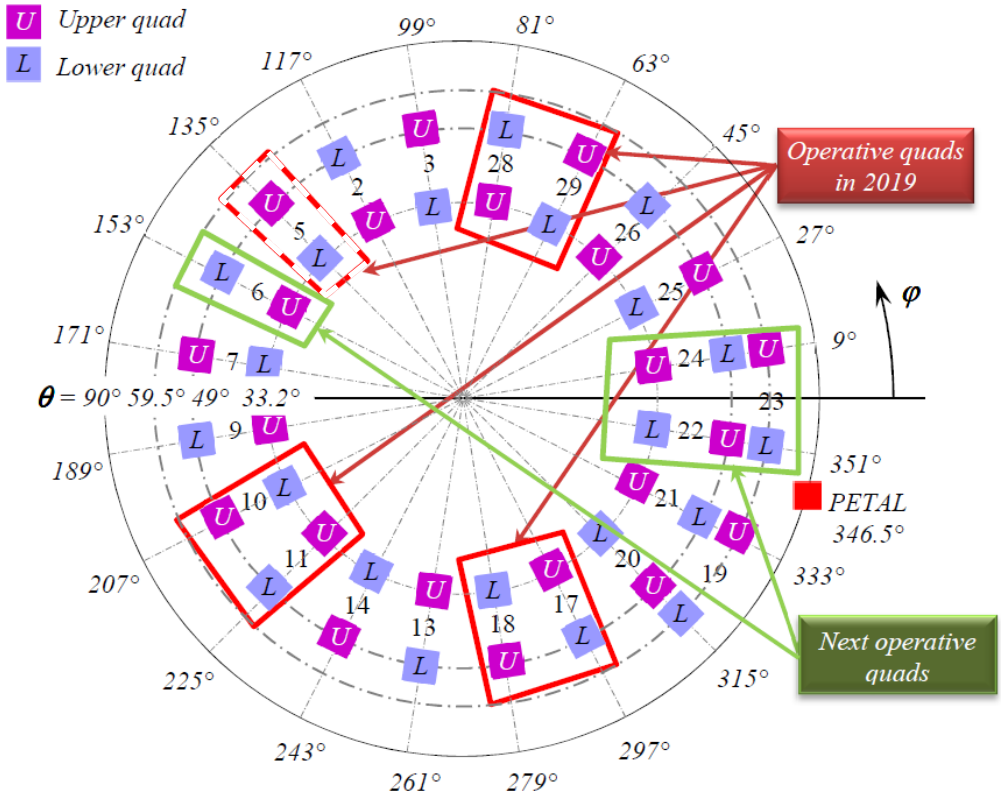
In 2019, first implosion of D_2 capsule with neutron production

At least 7 laser chains will be used for the implosion of D_2 capsule

Irradiation geometry of LMJ quads and PETAL beam.

The operative quads at the beginning of 2019 are indicated in red (Bundles # 5, 10, 11, 17, 18, 28 and 29).

The next operative quads are indicated in green (Bundles # 6, 22, 23 and 24)

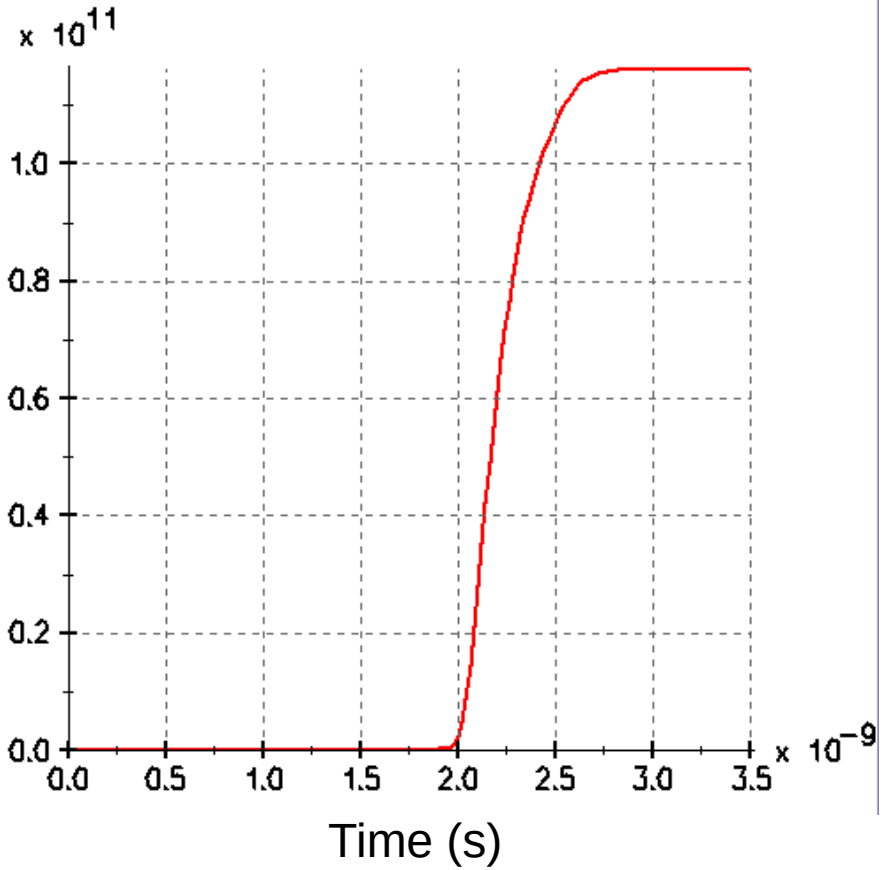


Beam Port	θ	φ	Beam Port	θ	φ	Beam Port	θ	φ	Beam Port	θ	φ
Quads operative in 2019											
28U	33.2°	81°	28L	131°	81°	29U	49°	63°	29L	146.8°	63°
17U	33.2°	297°	17L	131°	297°	18U	49°	279°	18L	146.8°	279°
10U	49°	207°	10L	146.8°	207°	11U	33.2°	225°	11L	131°	225°
5U	49°	135°	5L	146.8°	135°	PETAL	90°	346.5°			

Spherical coordinates of beam ports

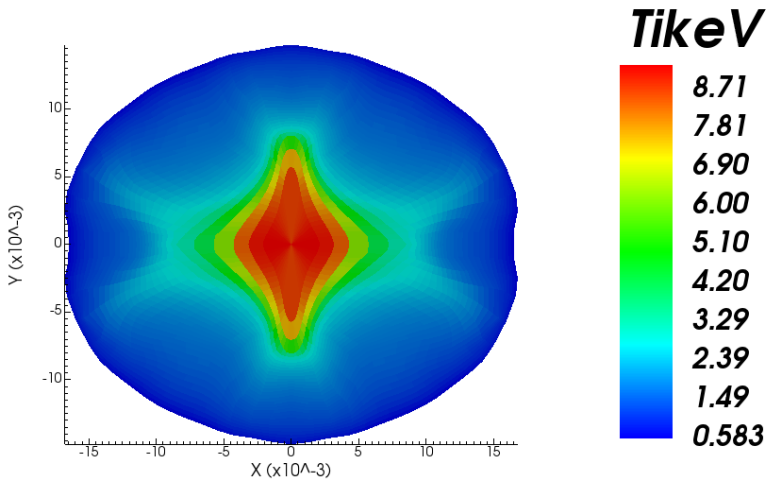
Expected Neutron Yield is about 10^{11} D_2 neutrons

n(t) = neutron yield



Ti_{max}= 1.85 keV

Map of the Ti @ t = 2.25 ns



Neutron yield estimation : **1.16 10^{11}** with 2D simulation
1.20 10^{11} with 1D simulation

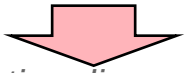
LMJ DP14 : Neutron pack

Goals :

- ***Neutron yield measurement*** *(Activation, PMT nTOF, CVD nTOF)*
- ***Ti measurement*** *(PMT nTOF, CVD nTOF)*
- ***Bang Time measurement*** *(PMT nTOF, CVD nTOF)*
- ***Anisotropy measurement****. (PMT nTOF, CVD nTOF)*

D_2 implosion for 2019 :

- *1 equatorial axis + 1 near polar axis(16°) is requested at minimum in 2019.*
- *Neutron yield prediction (1D et 2D)* $\approx 10^{11}$ *(*$\Rightarrow$ ***10^9 -10^{10} due to 3D effects****)*
  $\Rightarrow$ Neutron yield prediction is too low to use Indium diagnostic on LMJ in 2019
  (Threshold about 5.10^{11} *@ 50 cm from TCC)*



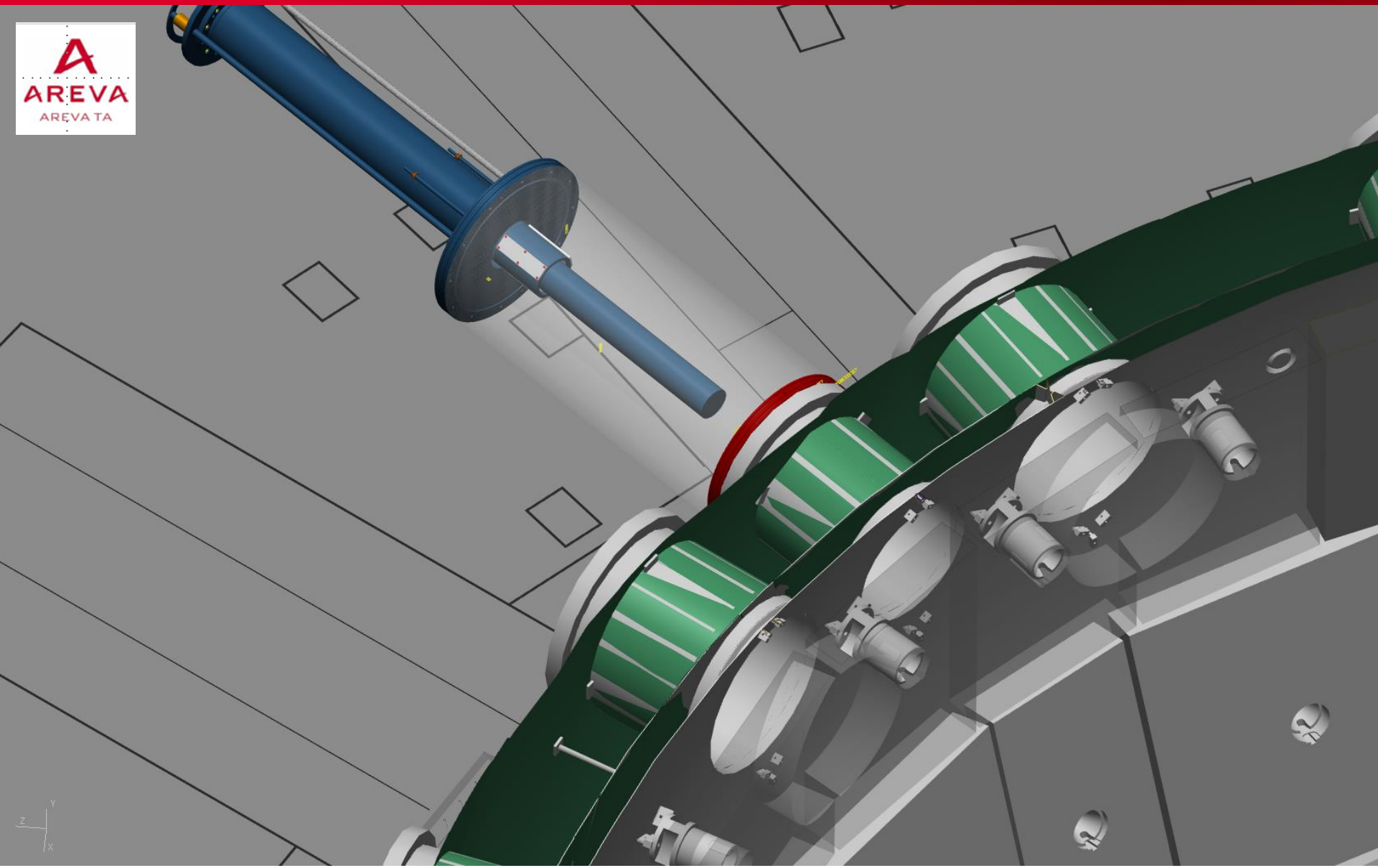
- *Impossible to use the activation diagnostic which is the reference for neutron yield calibration*
- *Impossible currently to use CR39*
- *Necessary to use PMT + scintillators inside the target chamber*
  $\Rightarrow$ go away from target chamber and protections to minimize downscattered γ and neutrons
  $\Rightarrow$ PMT nTOF calibration for D_2 and DT on OMEGA facility*.*

Development for 2019 - 2022: symmetry with 10 laser chains and more

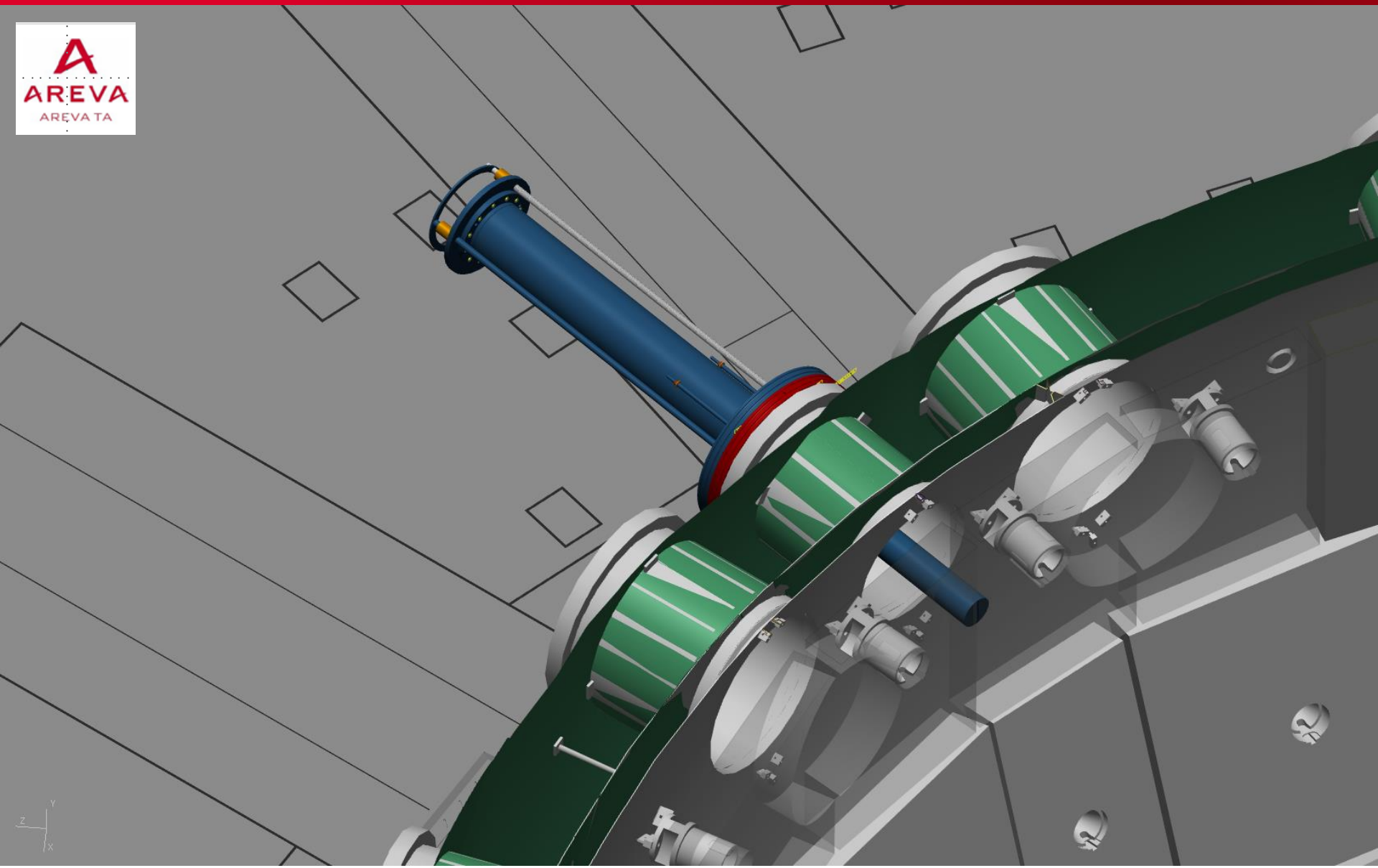
- *Activation diagnostic in D13 position + RTP.*
- *11 measurement locations are requested for the neutron pack.*

Goals:
- Use the same concept for all measurement location on the target chamber
- Try to anticipate evolutions after 2022

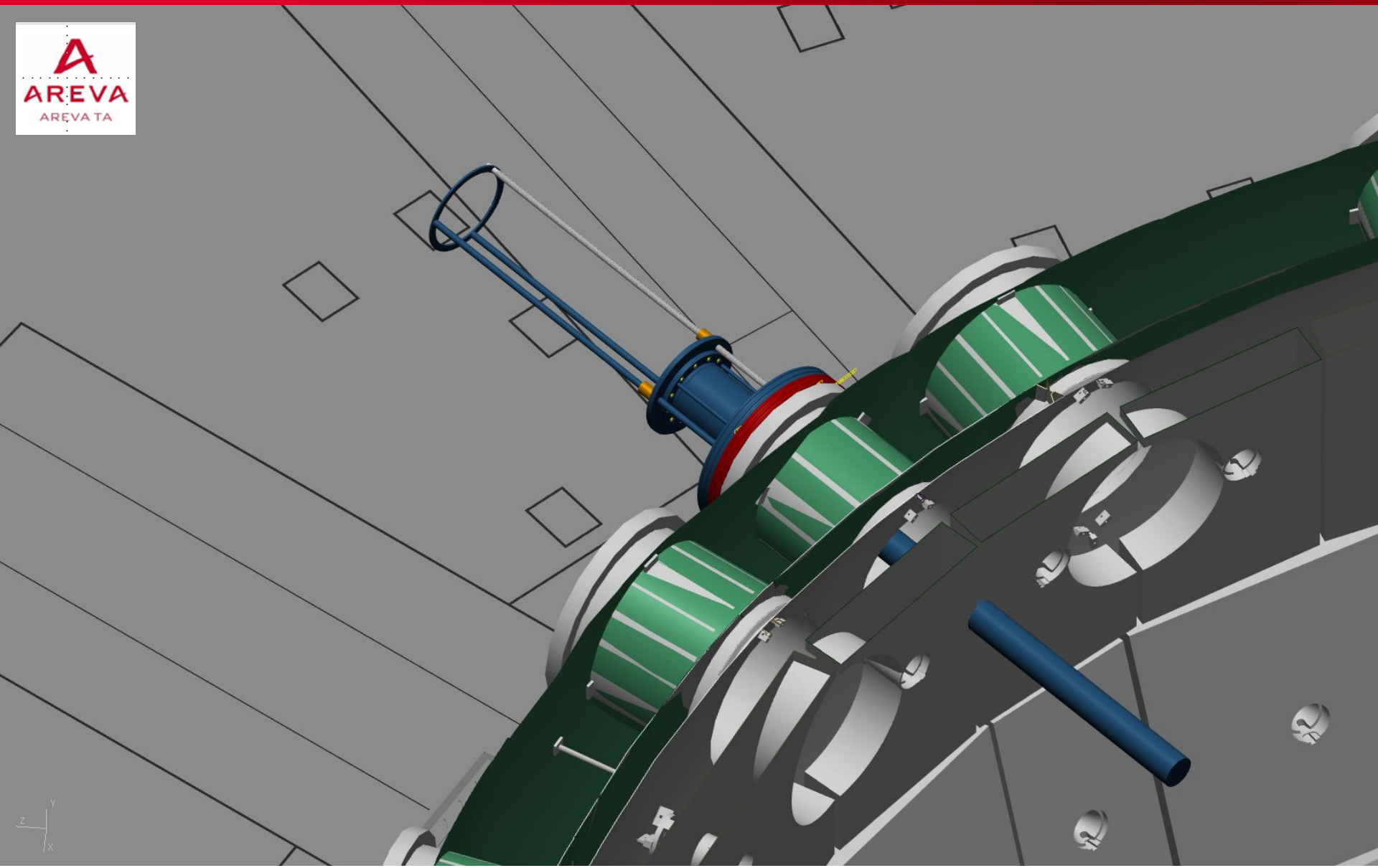
Draft model of DP14 re-entrant tube : fixing



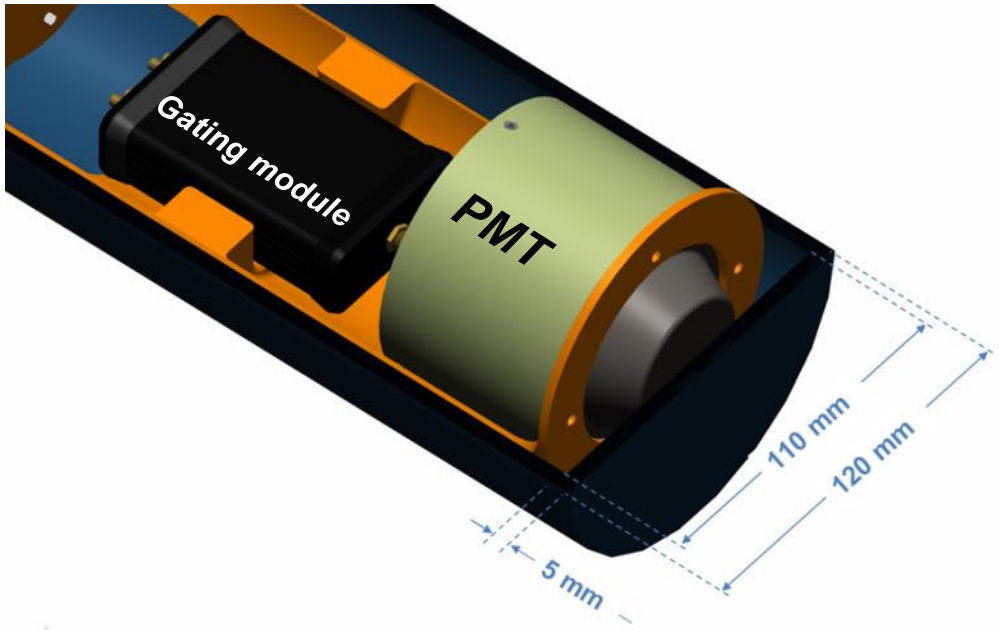
Draft model of DP14 re-entrant tube : maintenance

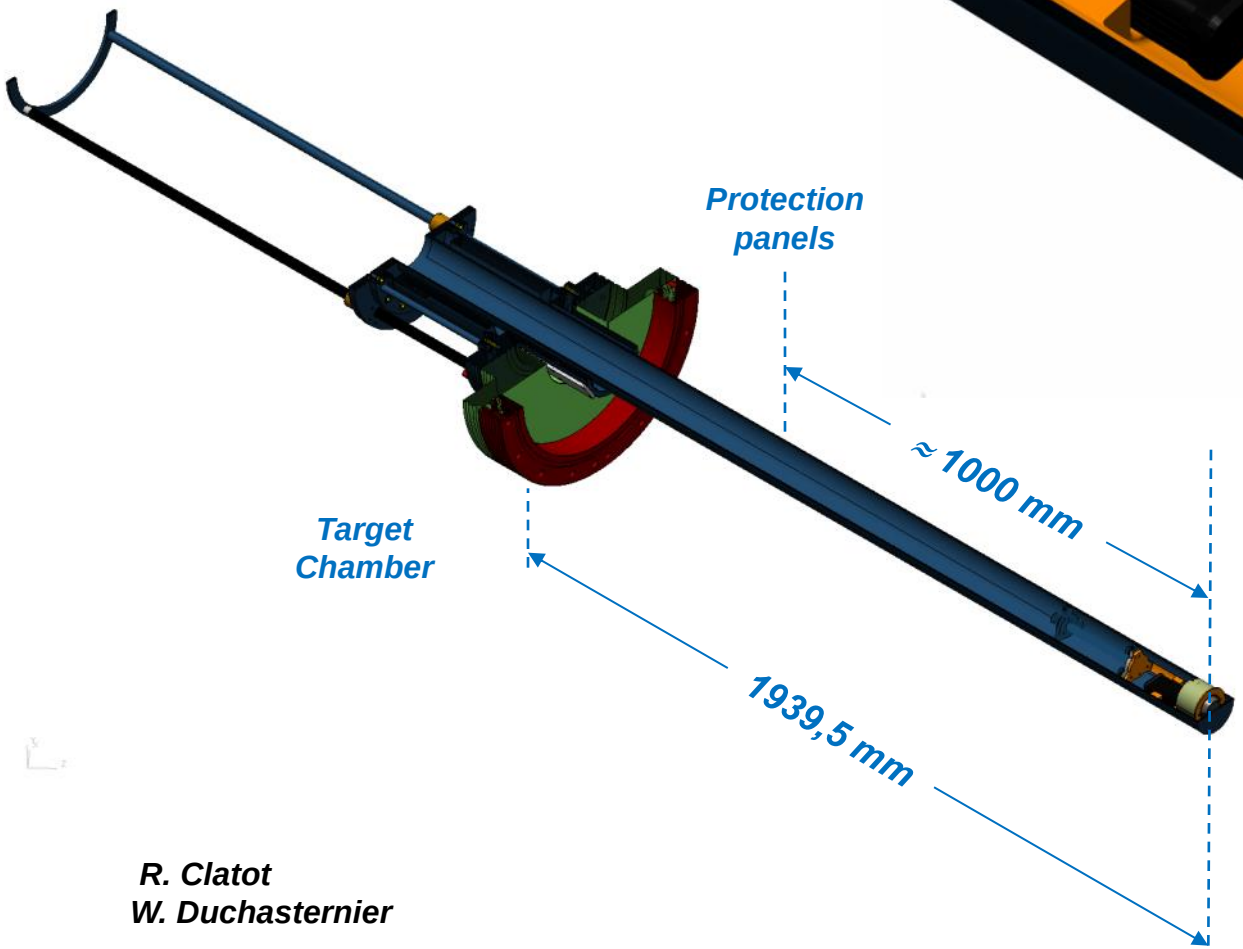


Draft model of DP14 re-entrant tube : operation



Draft model of DP14 re-entrant tube : operation



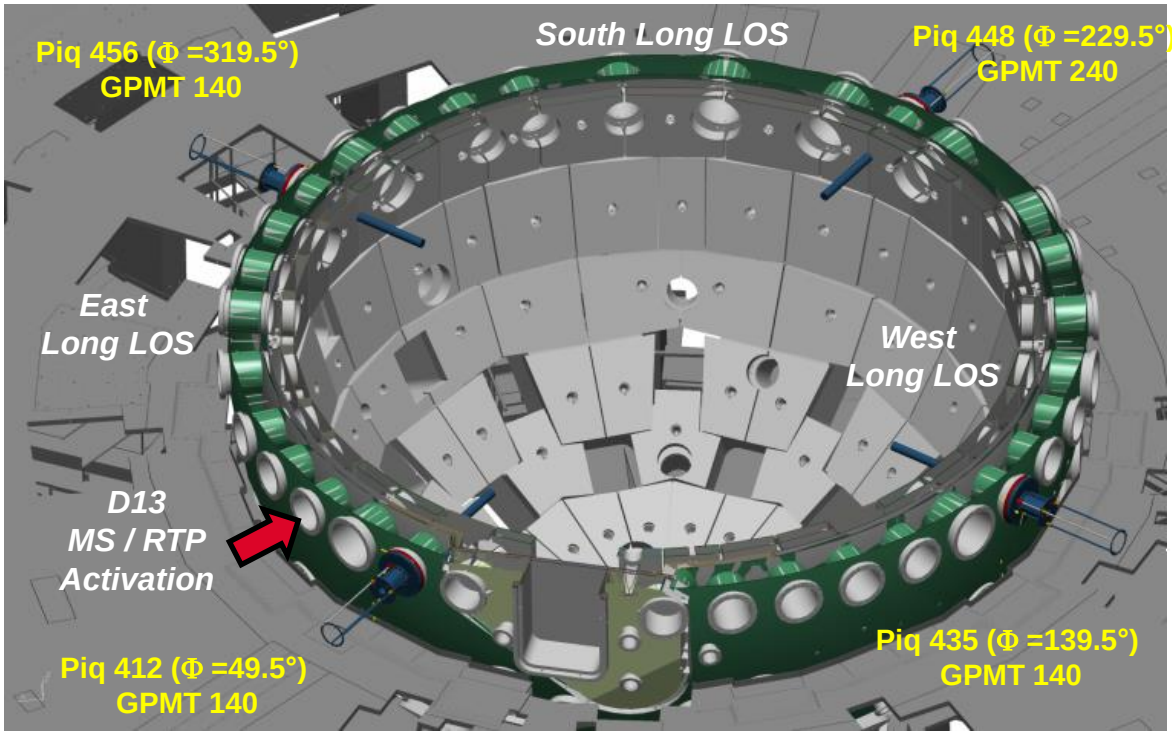


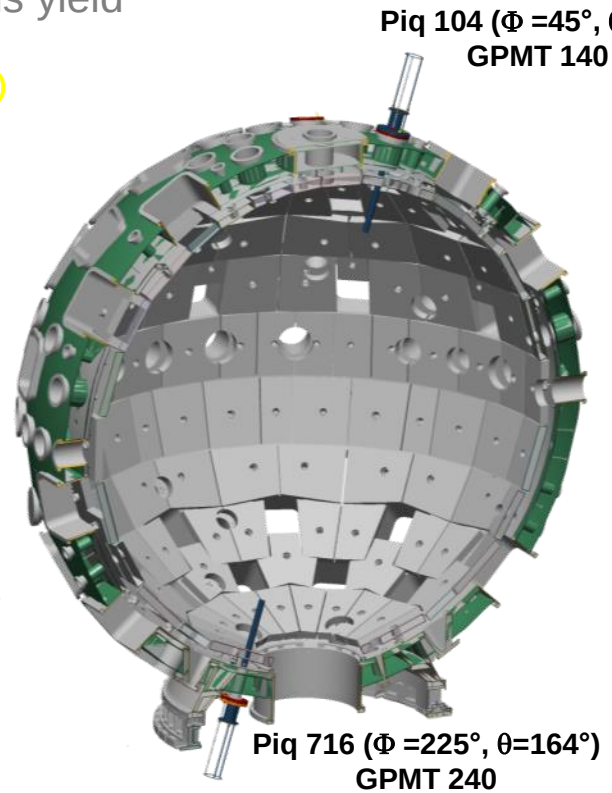
R. Clatot
W. Duchasternier

Overview – LMJ implosion of D_2 capsule in 2019

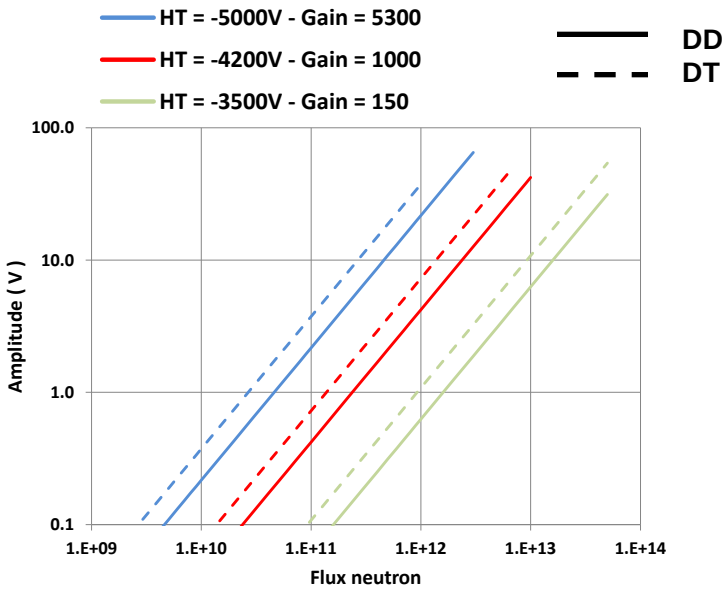
Summary:

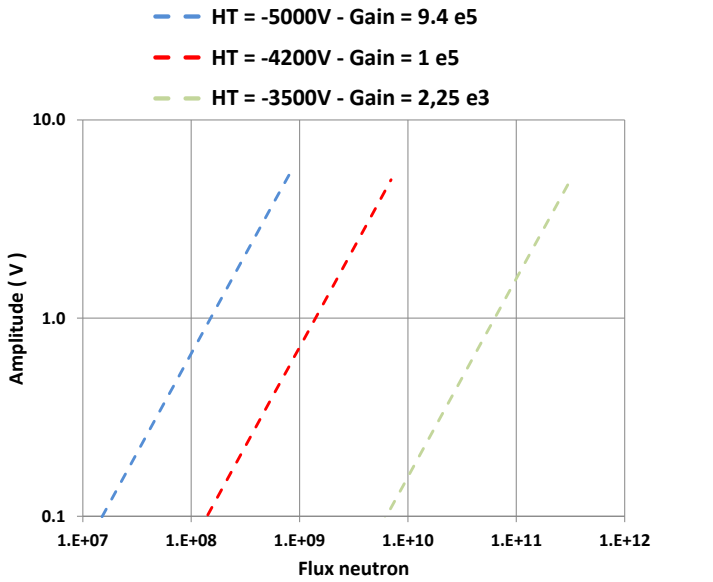
- *Simulations 1D & 2D: $\Phi_n = 10^{11}$ & $Ti_{max} = 1,85$ keV*
- ***PMT nTOF goal: D_2 $Y_n = 10^9$ -10^{10} & Ti = a few keV***
- *6 nTOF positions: 2 perpendicular equatorial axis + 1 near polar axis (16°)*
- *We will use both GPMT 140 (gain 10^3) et GPMT 240 (gain 10^6)*
  ⇒ allow us to measure Yn if prediction is overestimated
  ⇒ will allow us in future to measure secondary neutrons yield





LMJ nTOF range estimation using measurements made on OMEGA at 5.2 meters from TCC





D_2 primary neutrons

GPMT 140 + BC422Q(1 %)
ϕ = 40 mm x 10 mm
@ 3,6 m from TCC

DD range : 2 x 10^9 à 5 x 10^{13}
DT range : 10^9 à 5 x 10^{13}

Possibility to use 20 mm thick BC422Q

Secondary neutrons in D_2 shot

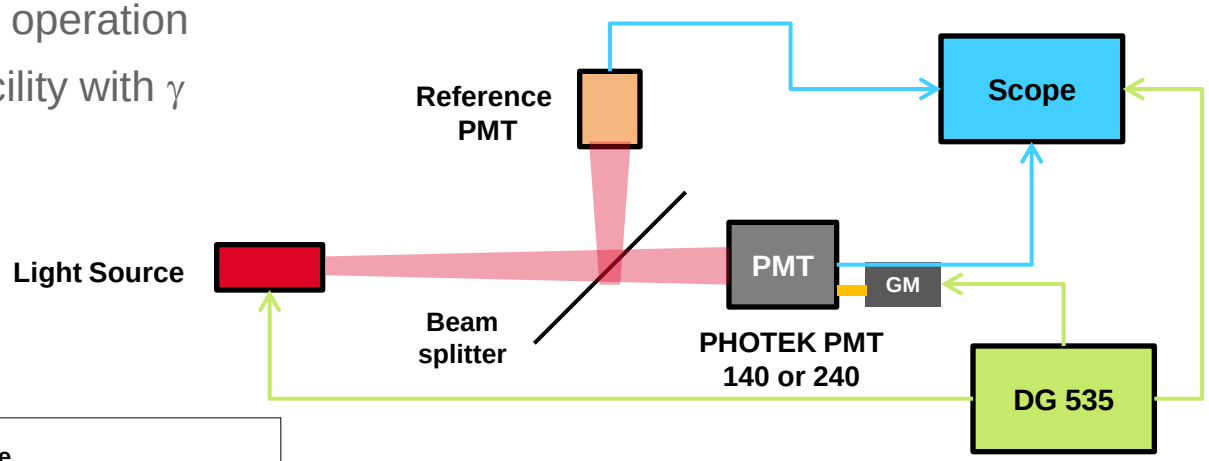
GPMT 140 + BC422Q(1 %)
ϕ = 40 mm x 10 mm
@ 3,6 m from TCC

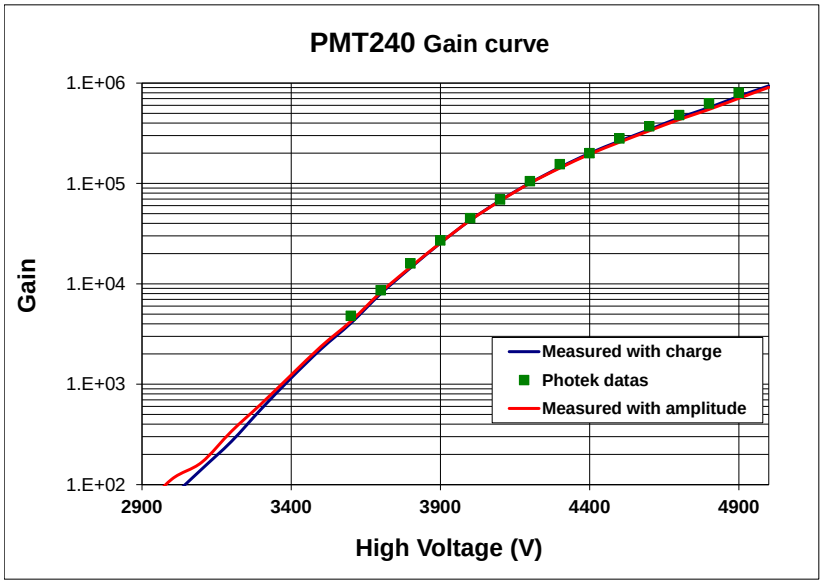
DT range : 10^7 à 5 x 10^{11}

The PMT commissioning will be made at CEA before calibration on OMEGA

Commissioning will be made at CEA :

- PMTs gain curve and linearity/gain using a light source
- Gating modules tests and operation
- IR measured on ELSA facility with γ





Two ways to make calibration on OMEGA

OMEGA :

- ***Is there free LOS or positions around the OMEGA target chamber ?***
- ***How many PMT can be installed at the same time ?***
- ***Can CEA PMT and acquisition system stay on OMEGA from 2017 to 2019?***

1st option:

- *Use PMT inside a re-entrant tube ⇒ Low yield.*

2nd option :

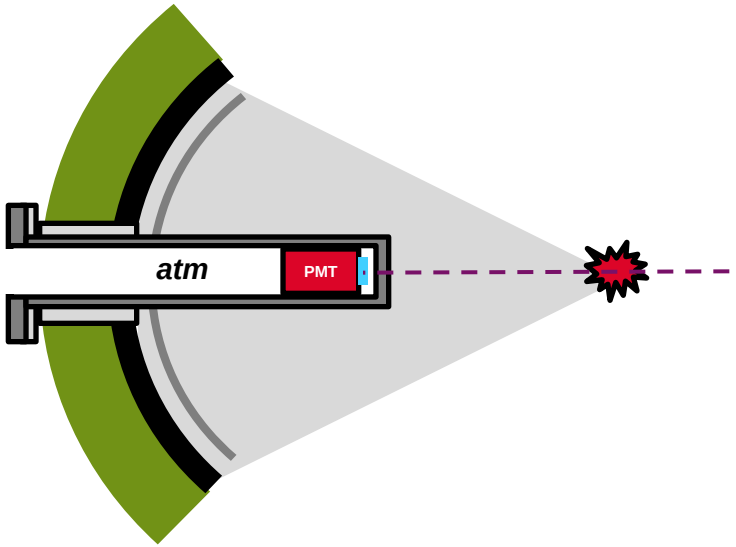
- *Use PMT outside the Target Chamber with a collimator.*

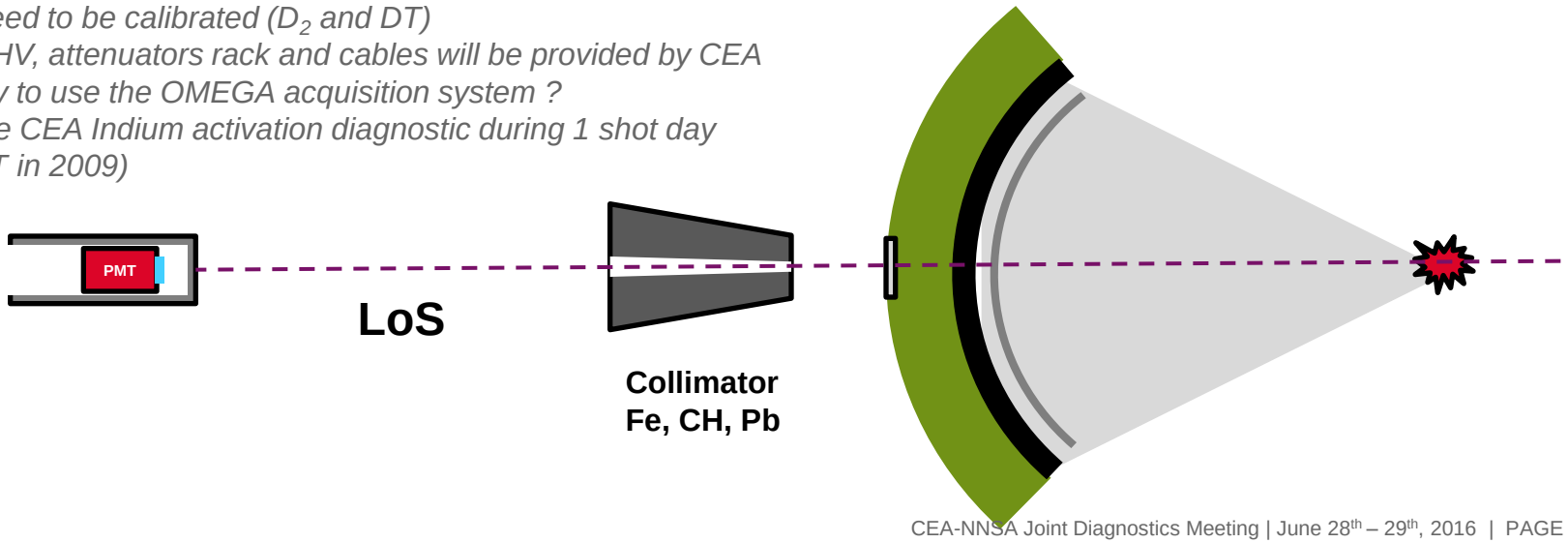
Shots days : low D_2 and DT yields

- *CEA D_2 shot day in September 2017 (FY18 and FY19 ?)*
- *Low DT yield on OMEGA ?*

Detectors & acquisition :

- *8 PMT need to be calibrated (D_2 and DT)*
- *Scopes, HV, attenuators rack and cables will be provided by CEA Possibility to use the OMEGA acquisition system ?*
- *Use of the CEA Indium activation diagnostic during 1 shot day (as for DT in 2009)*





Draft schedule for DP14 development and calibration

	2016	2017	2018	2019
Photek PMT	**Ordered and delivery**			
Scintillators	**Order and delivery**			
PMT receipt and qualification @ CEA	**to August 2017**			
IR test on ELSA facility with γ		**to August 2017**		
Diagnostic qualification for OMEGA	**to June 2017**			
Calibration on OMEGA (D_2 and DT)		**4th quarter FY17 (PI: F.Philippe)**	**From July 2017 to April 2019**	

LMJ shot

Conclusion

Scattering simulations need to be done to quantify geometry effects between OMEGA calibration and LMJ measurements

- ***LMJ PMTs (x8) need to be calibrated on OMEGA for D_2 :***

  ⇒ CEA will take D_2 shot day on OMEGA for FY17,18 and 19…

  ⇒ We would like to use CEA indium activation diagnostic during 1 shot day to compare calibrations (as made for DT in 2009)

- ***If LLE agrees, we need to find LOS or positions on the OMEGA target chamber to be able to calibrate several PMT during the same shot :***

  ⇒ Diagnostic qualification process

  ⇒ Can DP14 diagnostic stay several month on OMEGA ? : PMT in TB, scopes rack in La Cave

  ⇒ Can we use OMEGA acquisition system ?

- ***According to PMT positions, it should be fine to calibrate PMTs for low DT yield.***

- ***GOAL = start PMTs calibration during 2017, September 16th shot day (PI : F. Philippe).***

Five additional positions on meridian 333° could be used after 2019

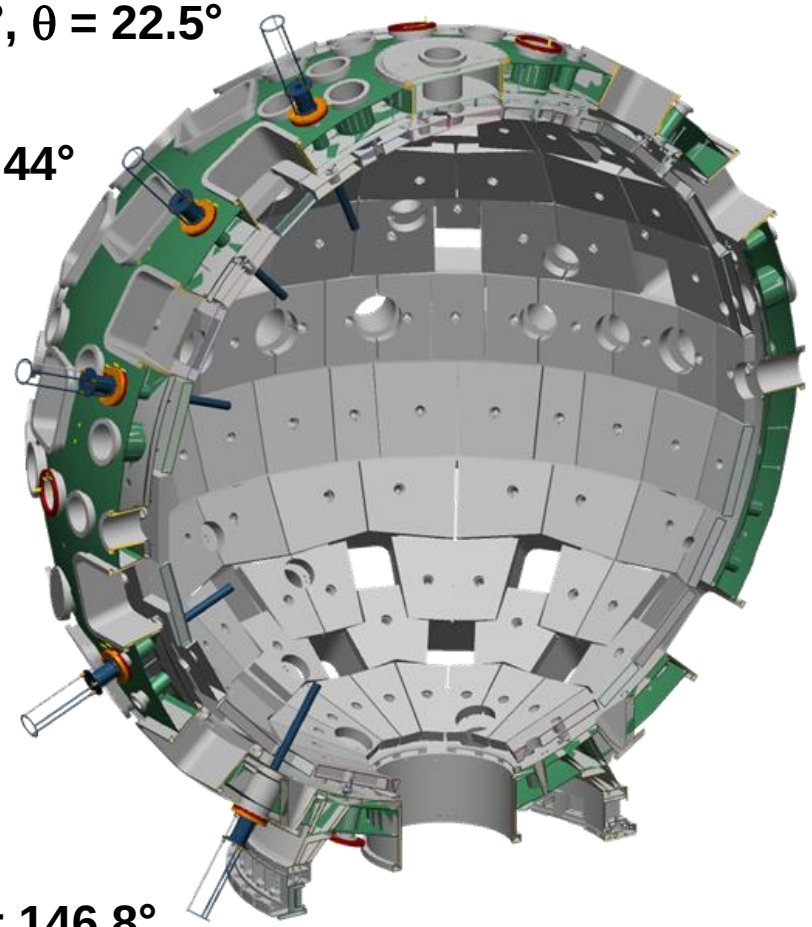
Piq 123 : Φ = 333°, θ = 22.5°

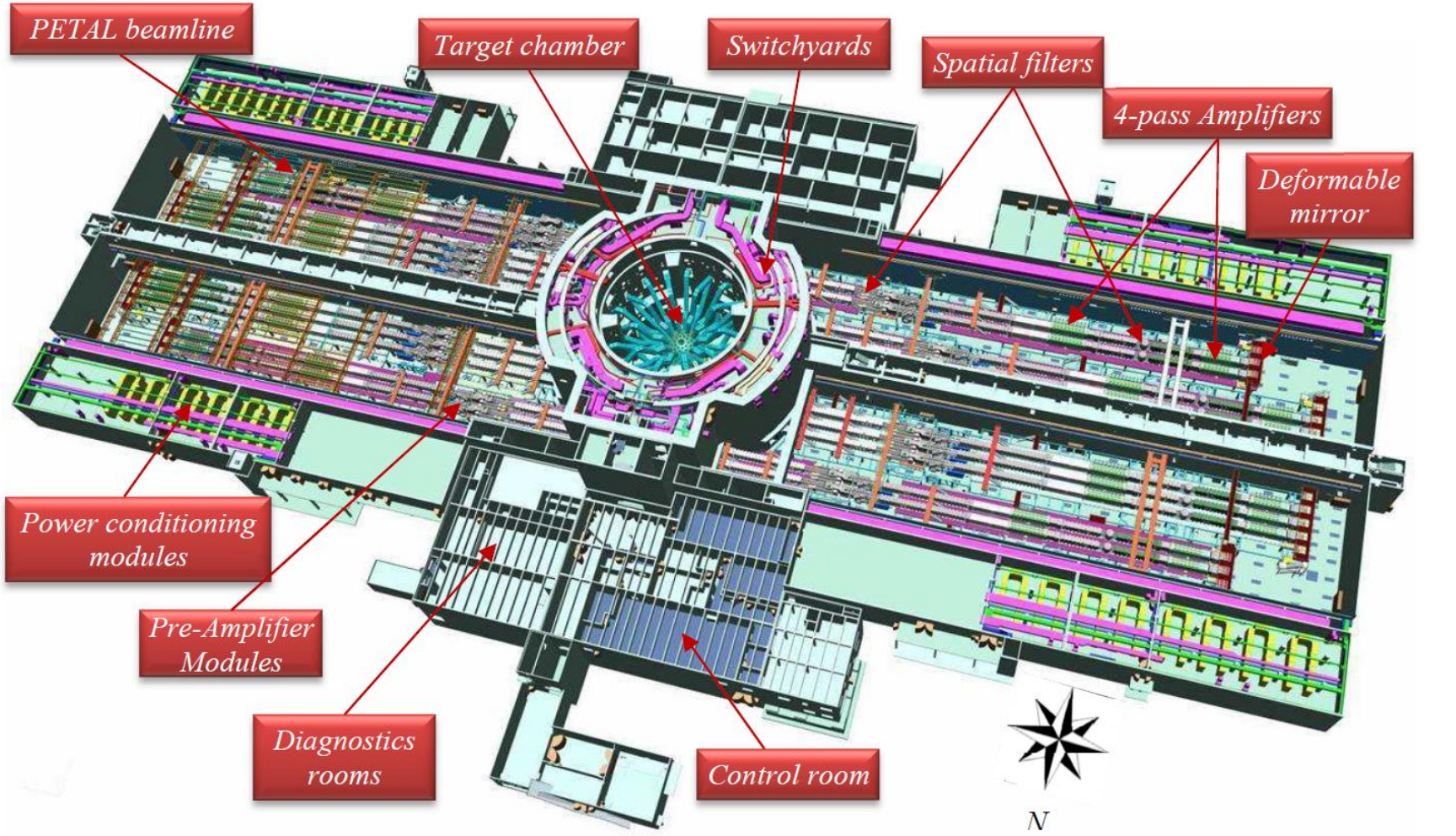
Piq 226 : Φ = 333°, θ = 44°

Piq 354 : Φ = 333°, θ = 70°

Piq 536 : Φ = 333°, θ = 112°

Piq 724 : Φ = 333°, θ = 146.8°




PETAL beamline
Target chamber
Switchyards
Spatial filters
4-pass Amplifiers
Deformable mirror
Power conditioning modules
Pre-Amplifier Modules
Diagnostics rooms
Control room
N