DE LA RECHERCHE À L'INDUSTRIE

LMJ Facility Status - 2021

October 22th 2021

H.Cortey

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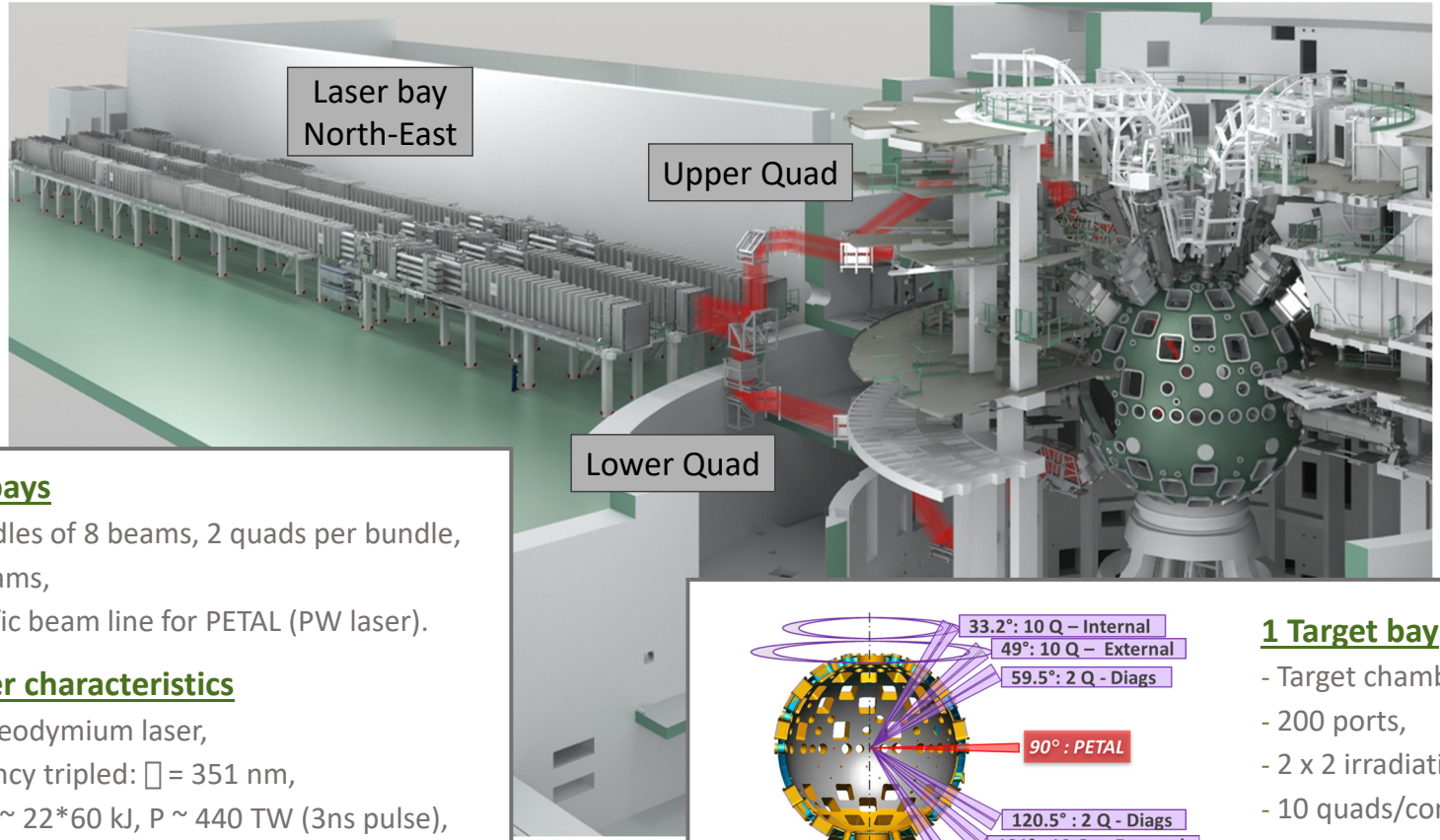
Laser MegaJoule main characteristics



4 Laser bays

- 22 bundles of 8 beams, 2 quads per bundle,
- 176 beams,
- 1 specific beam line for PETAL (PW laser).

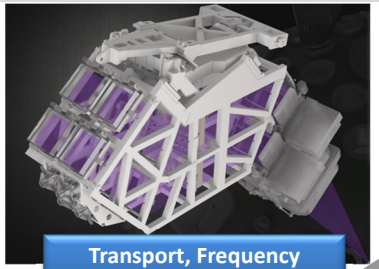
LMJ Laser characteristics

- Glass Neodymium laser,
- Frequency tripled: □ = 351 nm,
- Laser E ~ 22*60 kJ, P ~ 440 TW (3ns pulse),
- Pulse duration: from 0.7 to 25 ns.

1 Target bay

- Target chamber Ø 10 m,
- 200 ports,
- 2 x 2 irradiation cones,
- 10 quads/cone,
- 4 quads for Diagnostics.

LMJ Beamline Architecture



PEPC
(Plasma Electrode
Pockels Cell)

Deformable
mirror
M1

Amplification
Section

Spatial Filters

Angular
multiplexing

7 slabs

4 pass
amplifiers

9 slabs

Main oscillator

PAM regenerative
cavity

1 nJ

10 mJ

PAM
PreAmplifier

Front end

500 mJ

15 kJ

Argon

Transport, Frequency
conversion and focusing

Frequency conversion
& focusing system

1 & 2ω
beam dump

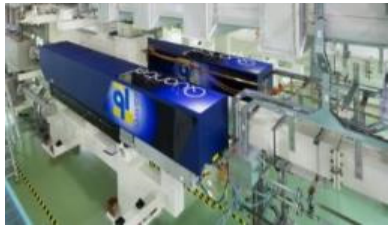
7.5 kJ UV

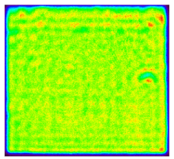
Window +
debris shields

Target
Chamber

Phase
plate

Transport
mirrors



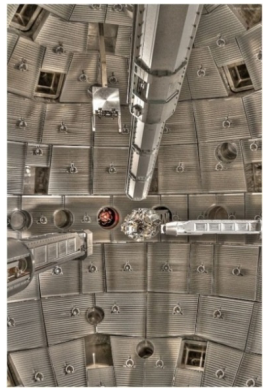


Square beam 35 x 35 cm²

Grouped by 4 = Quadruplet

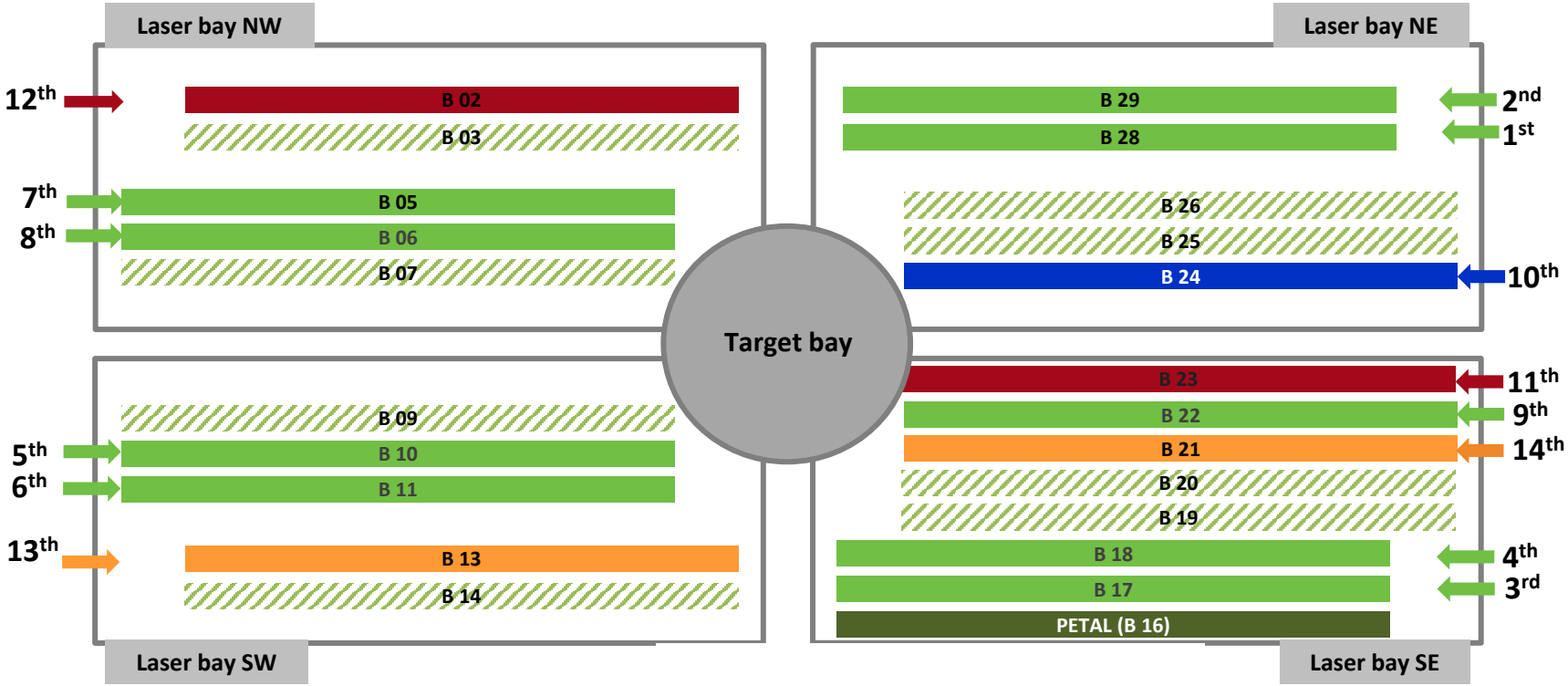
1 LMJ bundle = 2 quadruplets

1 PAM for 2 beams



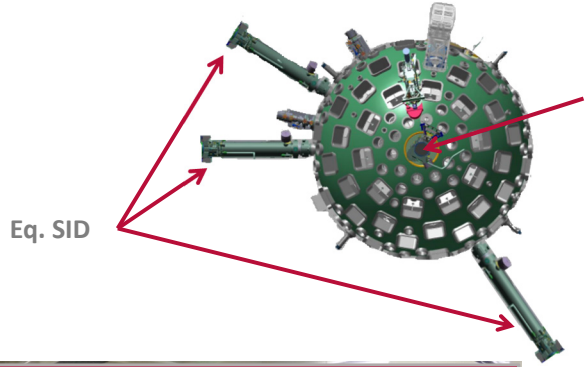
LMJ bundle status

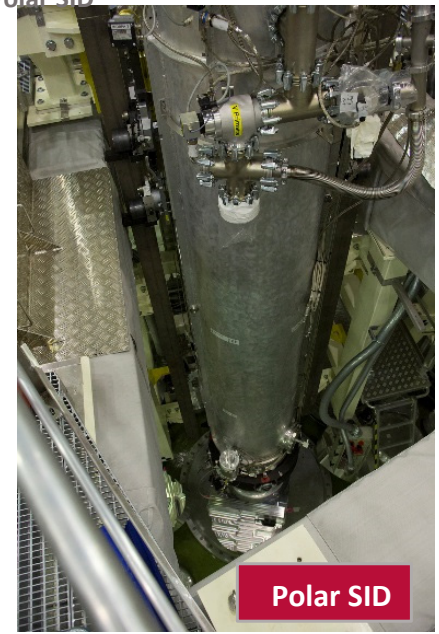
9 LMJ bundles are operational (B28, B29, B17, B18, B10, B11, B05, B06, B22) + PETAL,
1 LMJ bundles is being commissioned (B24) → end 2021,
2 LMJ bundle are already assembled (B02, B23)
2 LMJ bundles are being assembled: PAM, PEPC, transport mirrors, SCF (B13 et B21).



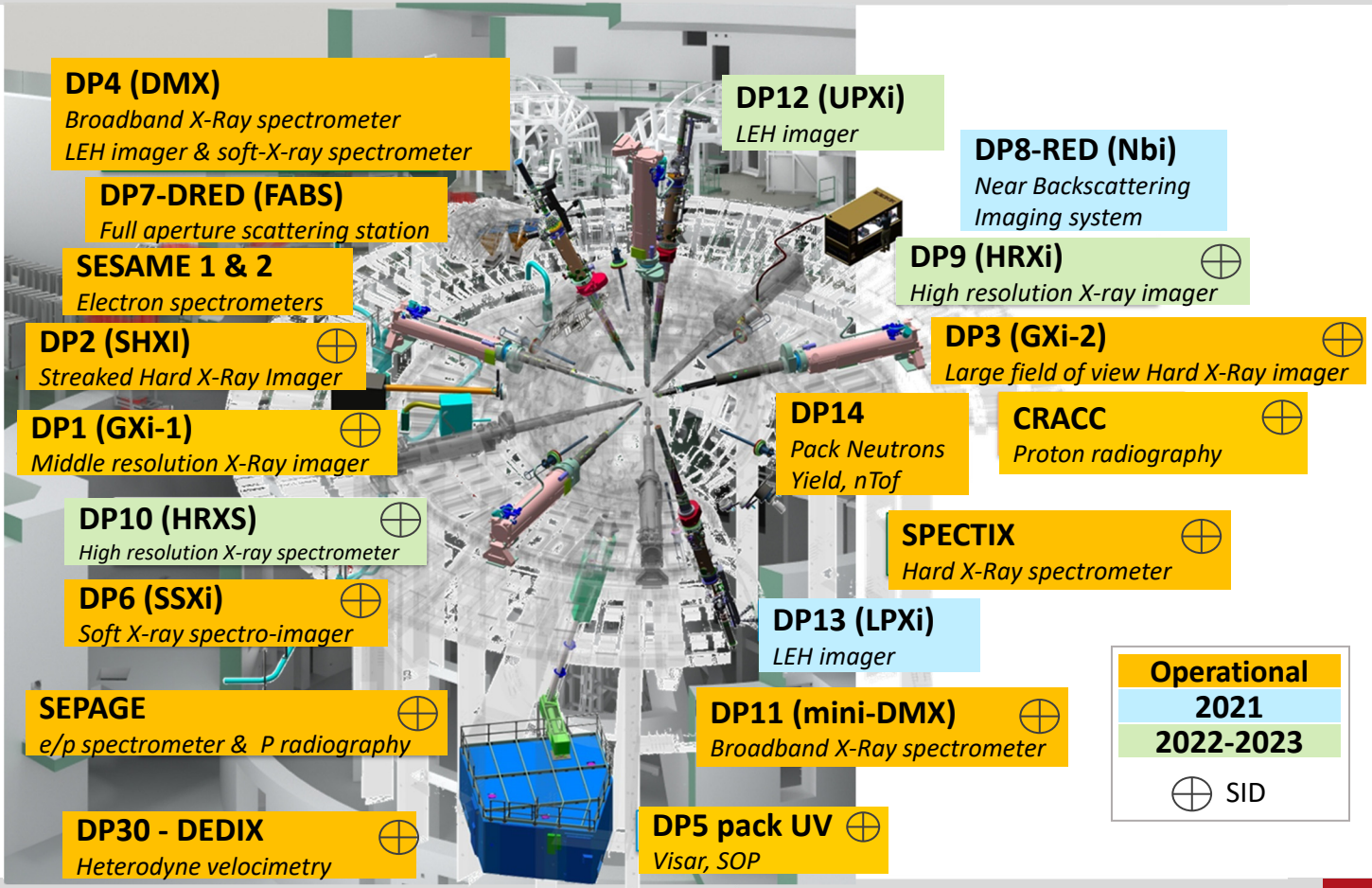
4 Systems for Diagnostic Insertion (SID) are available around the target chamber

- 3 equatorial SID (4 possible locations)
- 1 polar SID
- 3 more equatorial SID are coming (end of 2021, 2022 & 2023)





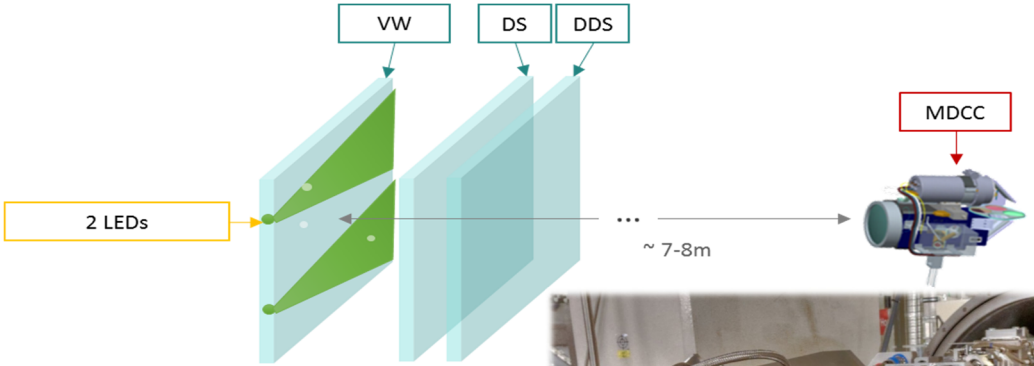
14 target diagnostics are operational for LMJ/PETAL

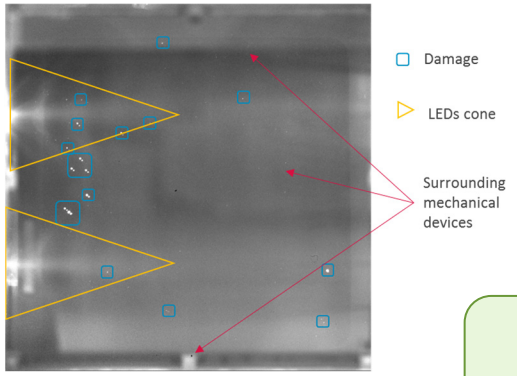


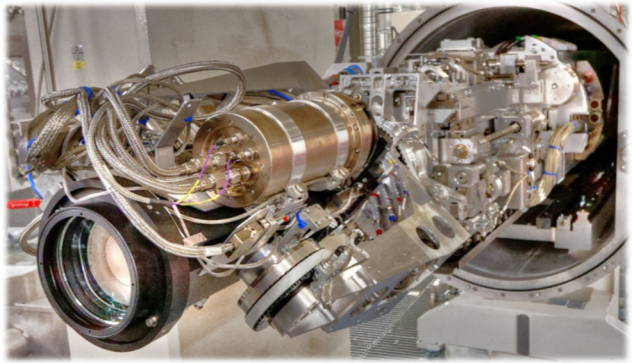
FINAL OPTICAL COMPONENT DAMAGE

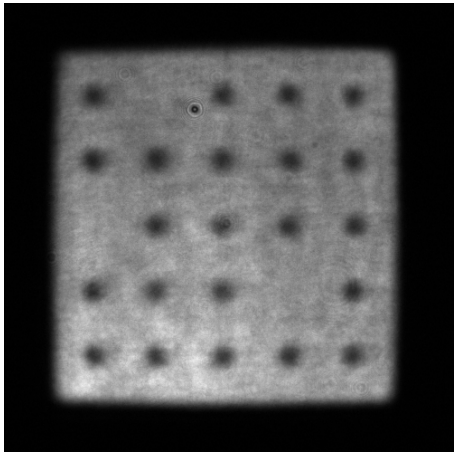
2 mains goals
Lifetime ➔ > 50 µm (initiation/growth)
Safety limit (*C2*)< Largest damage = 60% of any 2x2cm² sub-aperture

Shot-to-shot MDCC Vacuum Window images to track damage initiation & growth and verify safety limit









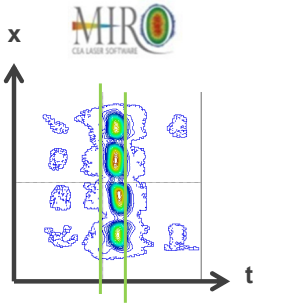
Spot blockers are being implemented to offer « manual » blocking capabilities on LMJ in 2020

ICALEPCS 2021
THE LASER MEGAJOULE TARGET CHAMBER DIAGNOSTIC MODULE
R.Clot - October 20th – 14h50 pm

CURRENT PETAL PERFORMANCE

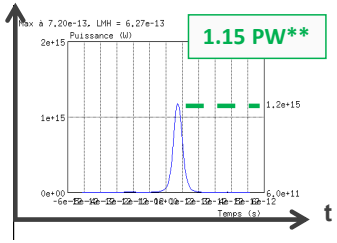
→ 2015 : 1.15 PW @ 700 fs @ 850 J*

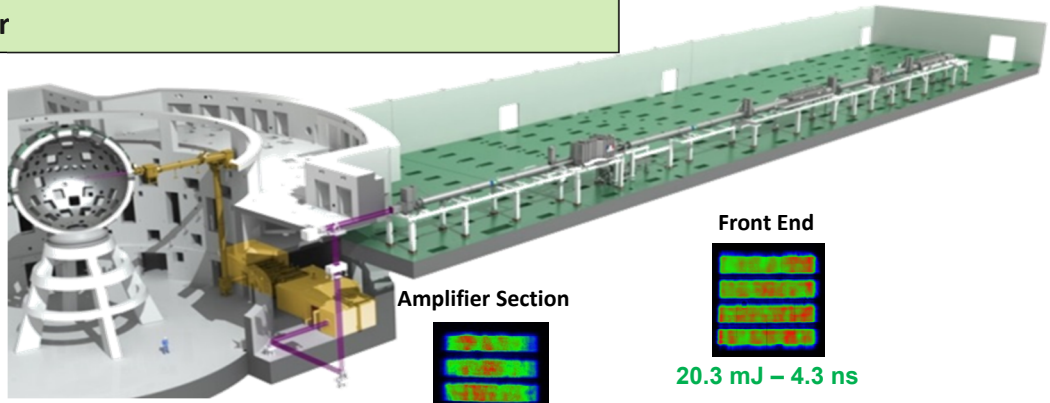
→ 2015 : shots at 1 kJ @ 1 ps in the compressor



≈ 700 fs @ 850 J

Maximal Power





Front End

20.3 mJ – 4.3 ns

Amplifier Section

1.24 kJ – 2 ns

→ 2016 : optimization of the pulse compression → 570 fs @ 219 J

→ 2017/2018 : commissioning of the facility on target and 1st campaigns → 7.9 1018 W/cm² (409 J @ 660 fs)

→ 2019 / 2020 : 2nd campaign and 3rd campaign

Improvement of the focal spot : 0.9 1019 W/cm² (358 J @ 690 fs)

Shot on a 25 µm wire with an elliptic focal spot of 1018 W/cm²

* **N. BLANCHOT** *et al.,* "1.15 PW–850 J compressed beam demonstration using the PETAL facility", *opt*. Express, **25**, 16957 (2017).

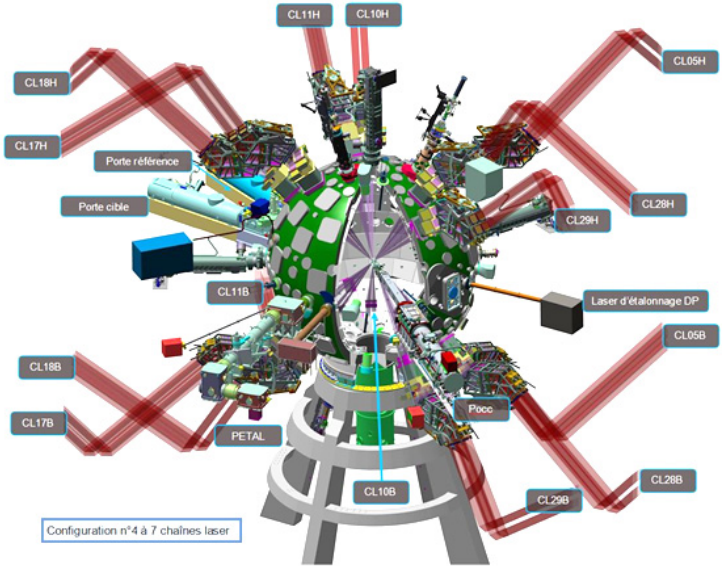
** **H. COIC** *et al.,* "Modeling of the petawatt PETAL laser chain using Miró code", *Applied Optics,* **56**, No. 34, 9491 (2017).

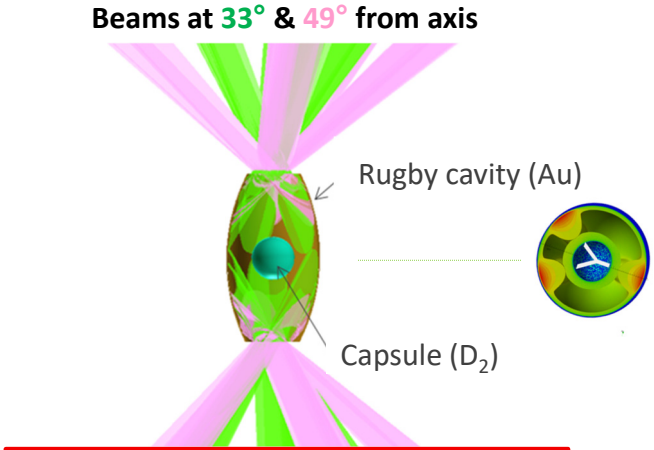
MAJOR MILESTONE : « Fusion milestone »

« Fusion milestone » - October 2019

First DD fusion experiments in cavity with 6 laser bundles

- **GOAL :**
  - Thermonuclear fusion by implosion of a D_2 capsule in a cavity,
  - Measurement of produced neutrons,
  - Design robust to laser illumination asymmetry (6/20 laser bundles).



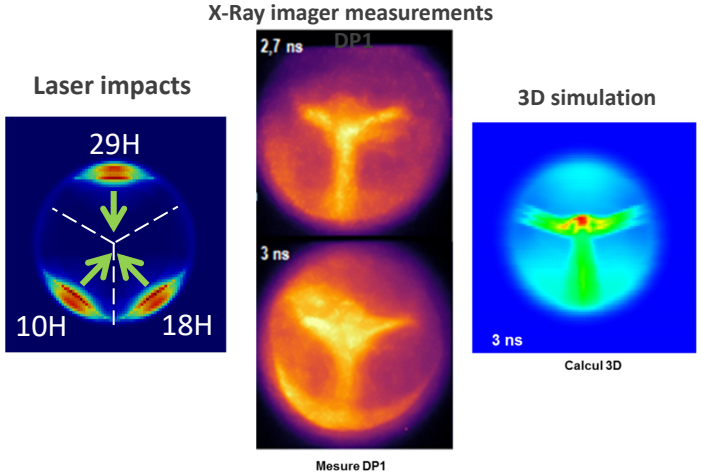


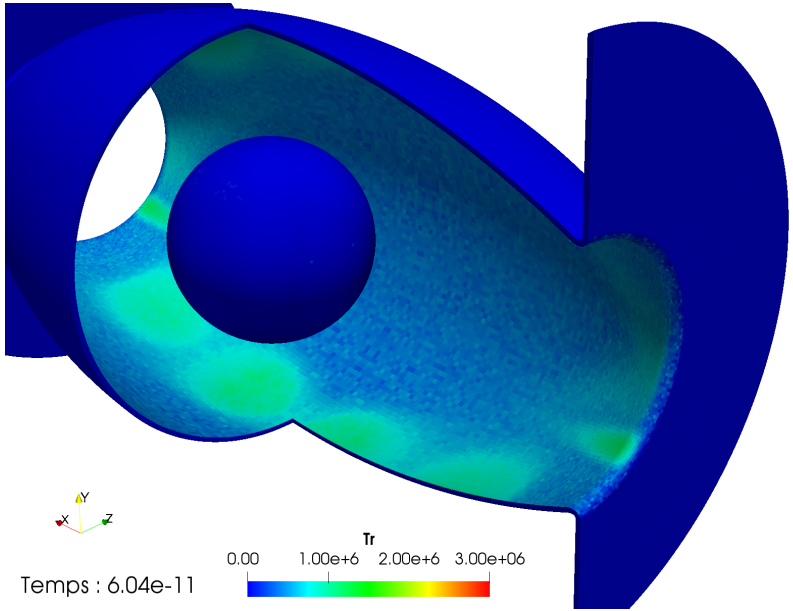
10 experiments using 12 quads (more than 150 kJ on target)

3D configuration simulation movie (D2 capsule and cavity)

Qualification of the simulation codes :

1. Neutron yield close to prediction,
2. Neutron yield variation with capsule size & laser illumination level: observed, close to prediction,
3. Neutron yield variation with deuterium pollution (Ar): observed, close to prediction.





3D configuration simulation movie (D2 capsule and cavity)


Thank you for your
attention !