DE LA RECHERCHE À L'INDUSTRIE

LMJ program
&
Diagnostics plan

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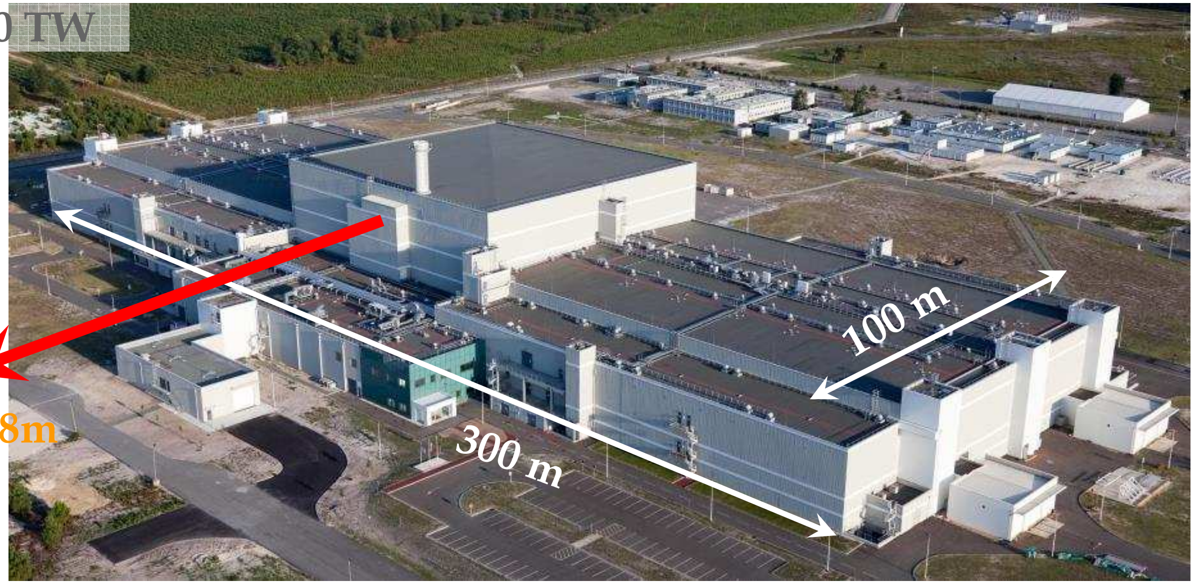
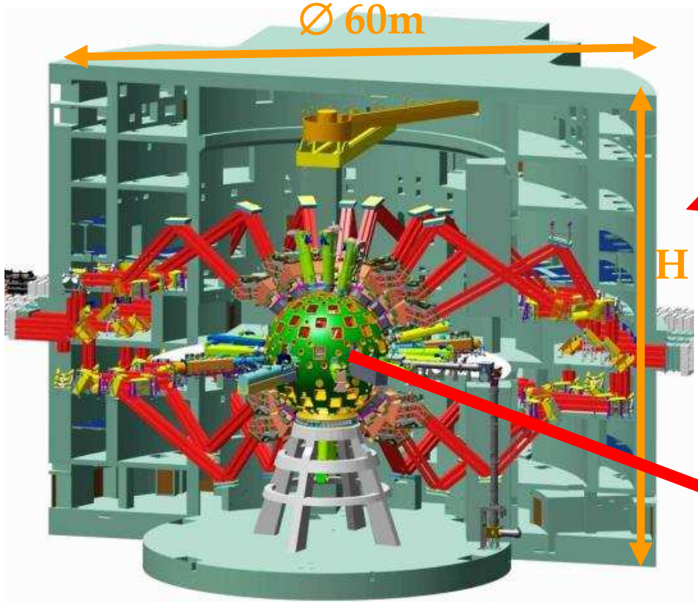
Laser MegaJoule main characteristics

4 Laser bays

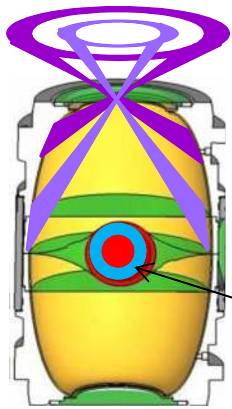
- Glass Neodymium laser, frequency tripled : $\lambda = 0.35\ \mu m$
- Designed for 240 beams, 176 will be installed
- Laser energy ~ 1.5 MJ, Power ~ 400 TW
- Pulse duration : from 0.7 to 25 ns





Target bay

- Biological protection : 2 m thick concrete
- Target chamber Ø 10 m
- 200 ports for laser beams and diagnostics



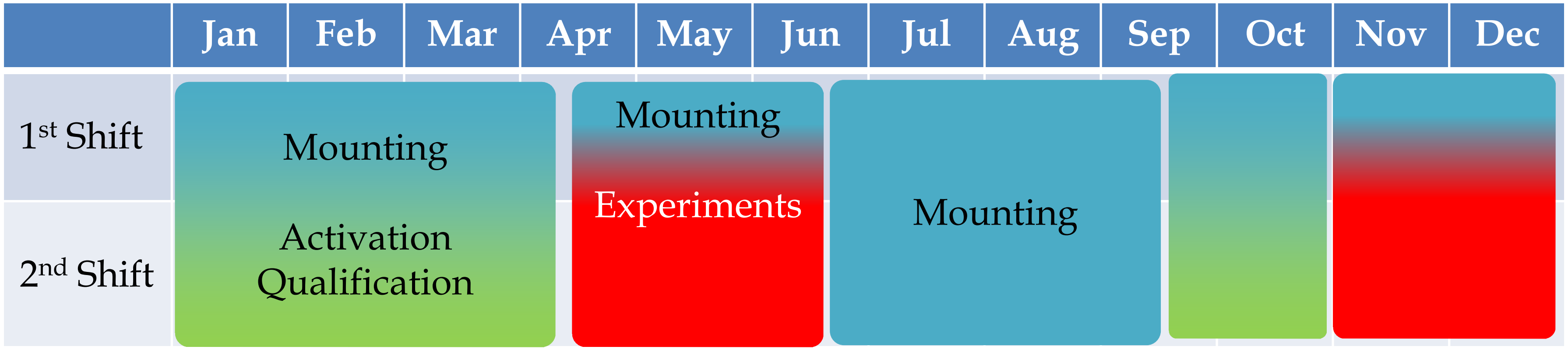
Ignition target

- 2 X 2 cones irradiation : 33° & 49°
- Hohlraum length ~ cm
- Capsule Ø ~ 2 mm

LMJ Schedule : the "3 thirds rule"

Three main activities are performed during the year

- Mounting of new bundles
- Activation / qualification of the previous mounted bundles
- Plasma experiments



Only one shift is dedicated to experiments => 1 shot/day during less than 4 months

- **50 Physics shots + 30 preparation shots (Diagnostic qualification, pointing, synchro, ...)**

Other activities can impact the schedule :

- **Preparation for maintenance of activated equipment**
  - Due to high energy particles generated by PETAL shot in 2017

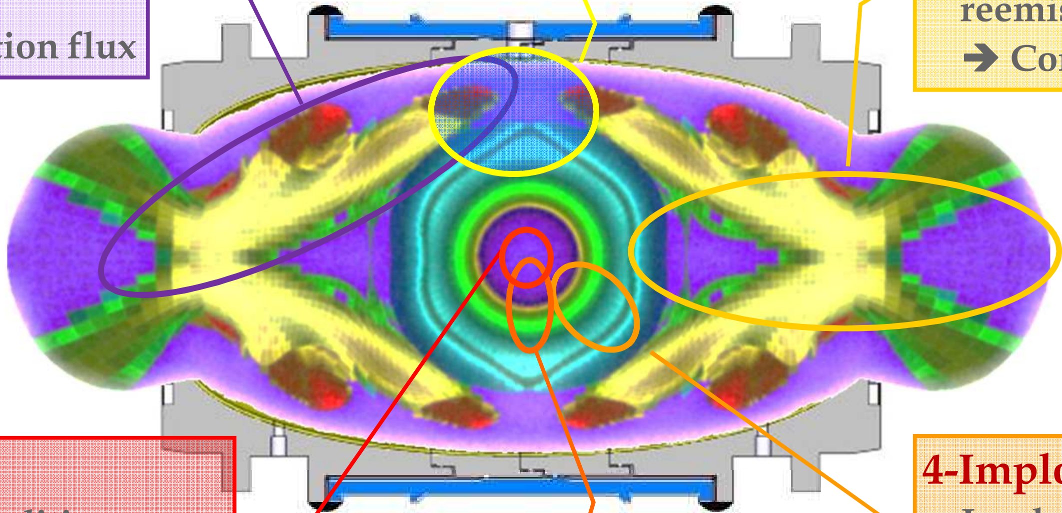
=> no experiments at the end of 2016

The 8 experimental topics of the Simulation Program

2-Fundamental data
EOS, Opacities…
➔Control of matter's behavior under HP and HT

1-Hohlraum energetics
Laser plasma interaction,
X-ray conversion
➔Control of radiation flux

3-Radiation transport
X-ray absorption, loss, reemission
➔ Control of energy transport



6-Fusion
Thermodynamic conditions, initiation of fusion reactions
➔ Control of ignition conditions

5-Hydrodynamics Instabilities
Instabilities growth, turbulence
➔ Control of mixing

4-Implosion hydrodynamics
Implosion velocity, Shock tuning
➔ Control of compression

7-Ignition
Study of different kind of ignition targets
➔ Control of DT burning

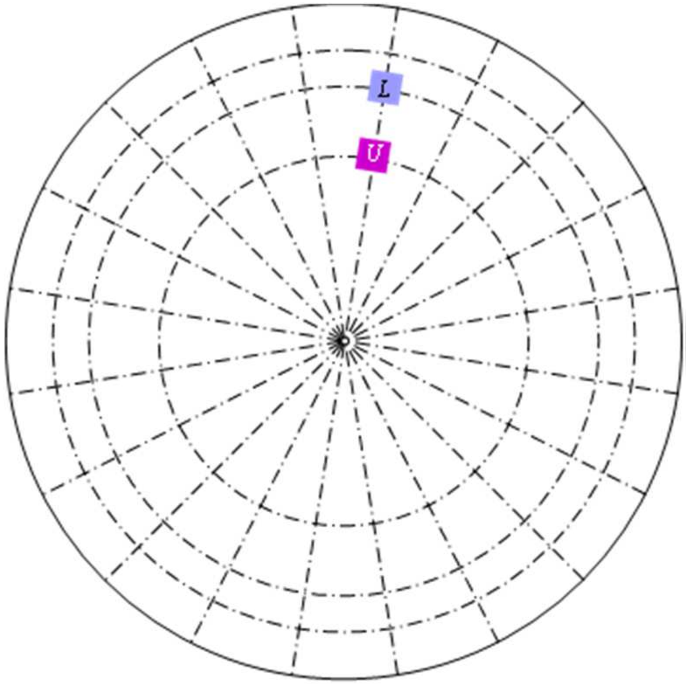
8-Applications
Coupling of an ignition target with another target
➔ Control of complex powerful system

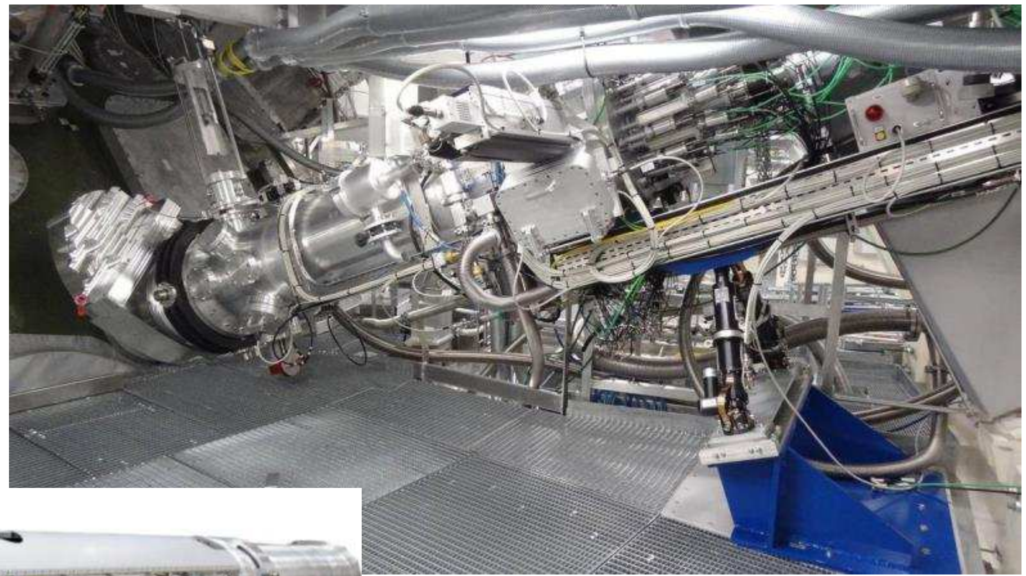
The 6 experimental configurations of Laser MegaJoule

1st configuration: 1 laser bundle
2 SID
4 diagnostics

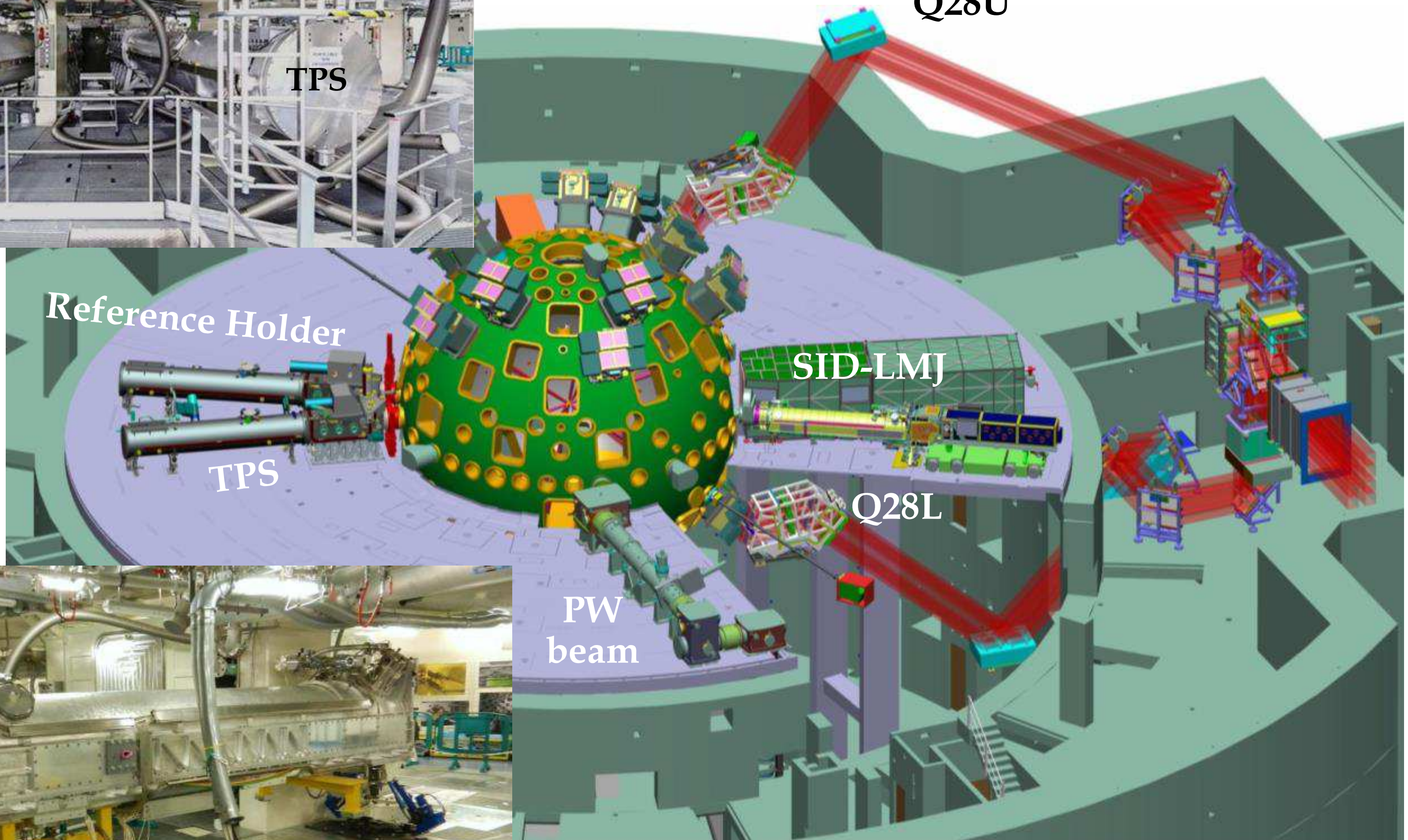
Total Energy = 25 kJ

X-ray Diagnostics		Optical Diagnostics	Particles Diagnostics
Imagers	Spectro.		
GXI-1	DMX		
GXI-2	miniDMX		





Target bay : 1st configuration equipment (today)



The 6 experimental configurations of Laser MegaJoule

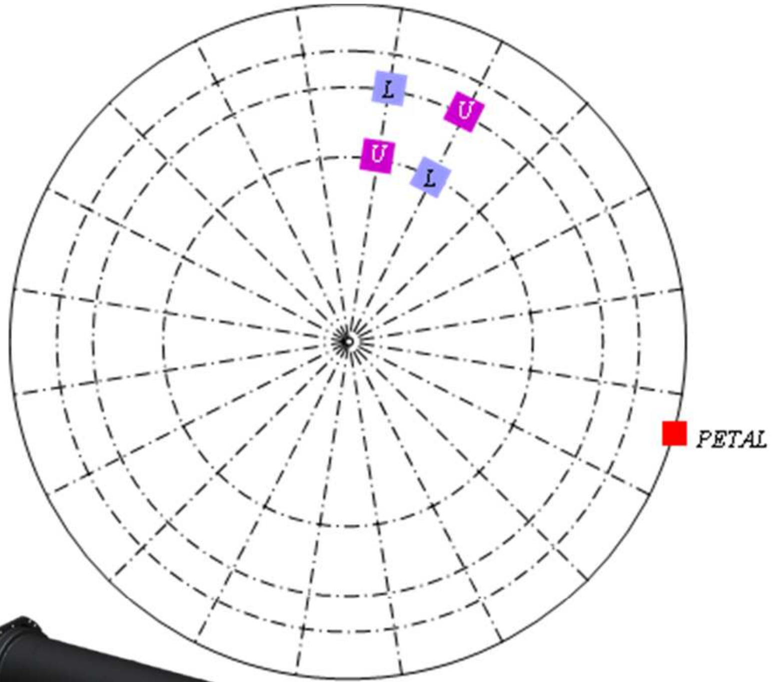
2nd configuration: 2 laser bundles (+ PETAL)

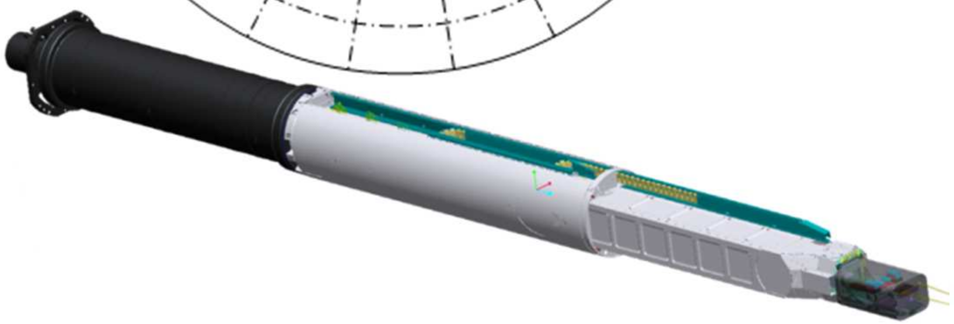
Total Energy = 60 kJ

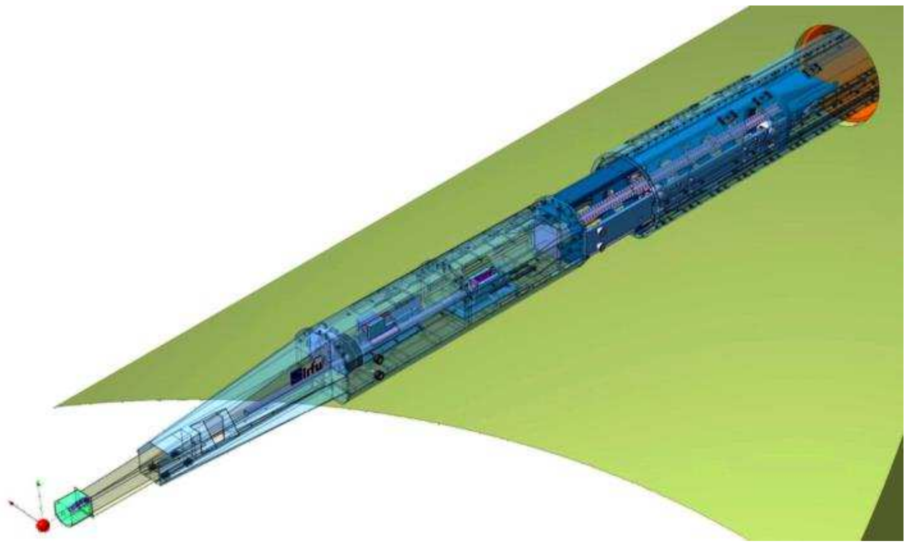
3 SID

9 diagnostics

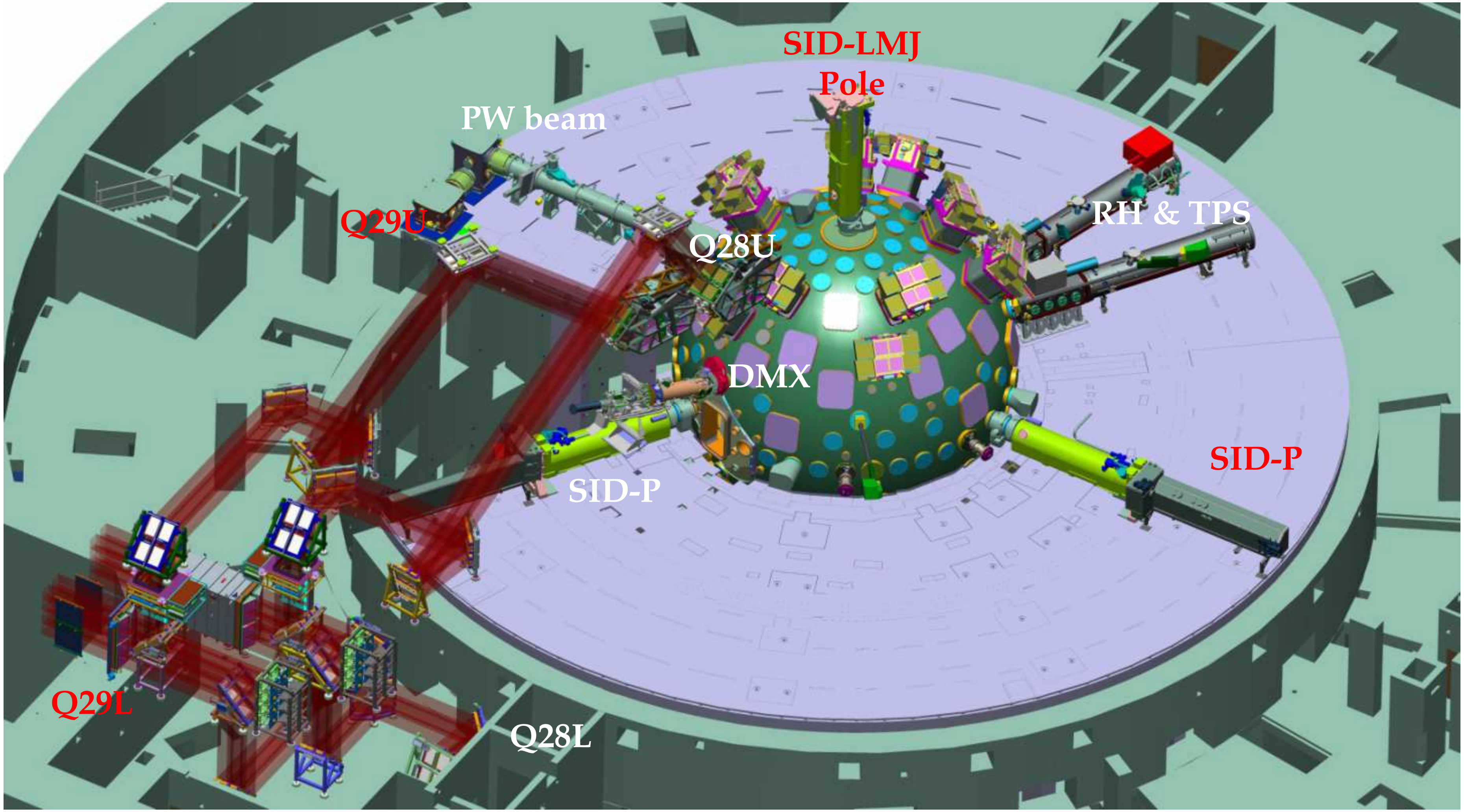
X-ray Diagnostics		Optical Diagnostics	Particles Diagnostics
Imagers	Spectro.		
GXI-1	DMX		SESAME
GXI-2	miniDMX		SEPAGE
SHXI	SPECTIX		
SSXI			







Target bay : 2nd configuration equipment - 2017

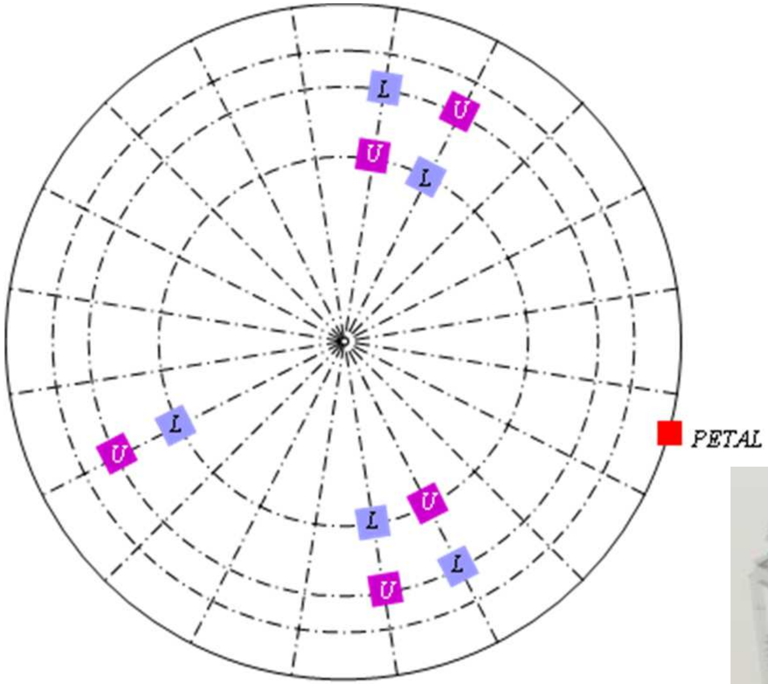


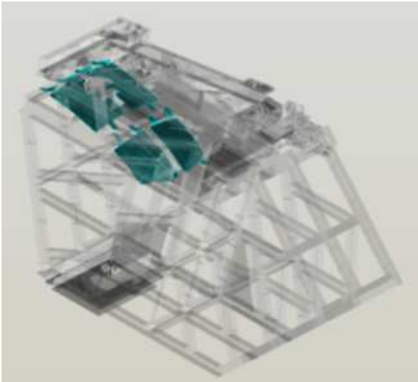
The 6 experimental configurations of Laser MegaJoule

3rd configuration: 5 laser bundles (+ PETAL)
4 SID
13 Diagnostics

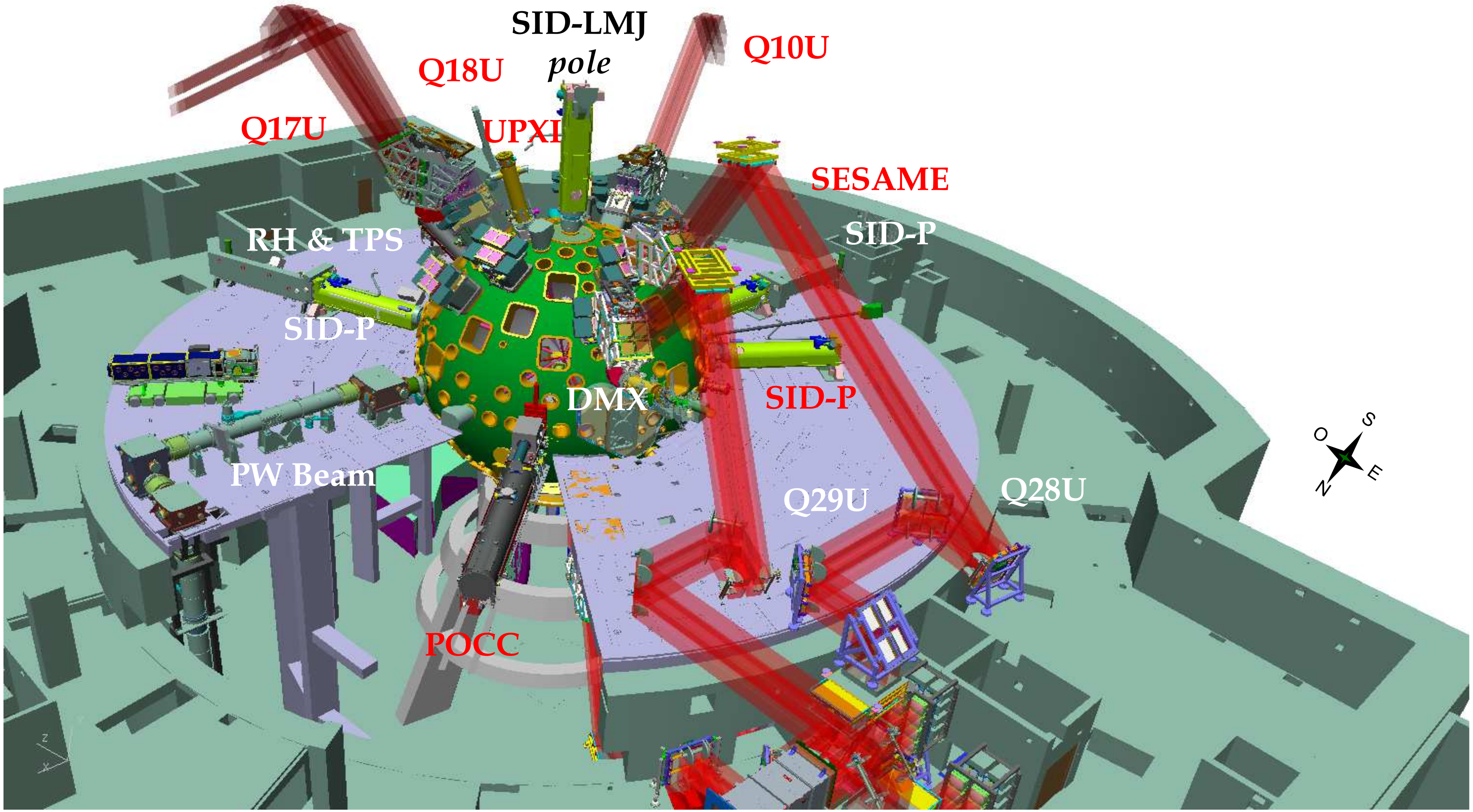
Total Energy = 150 kJ

X-ray Diagnostics		Optical Diagnostics	Particles Diagnostics
Imagers	Spectro.		
GXI-1	DMX	FABS1	SESAME
GXI-2	miniDMX	EOS pack	SEPAGE
SHXI	SPECTIX		
SSXI			
ERHXI			
UPXI			





Target bay : 3rd configuration equipment - 2018



The 6 experimental configurations of Laser MegaJoule

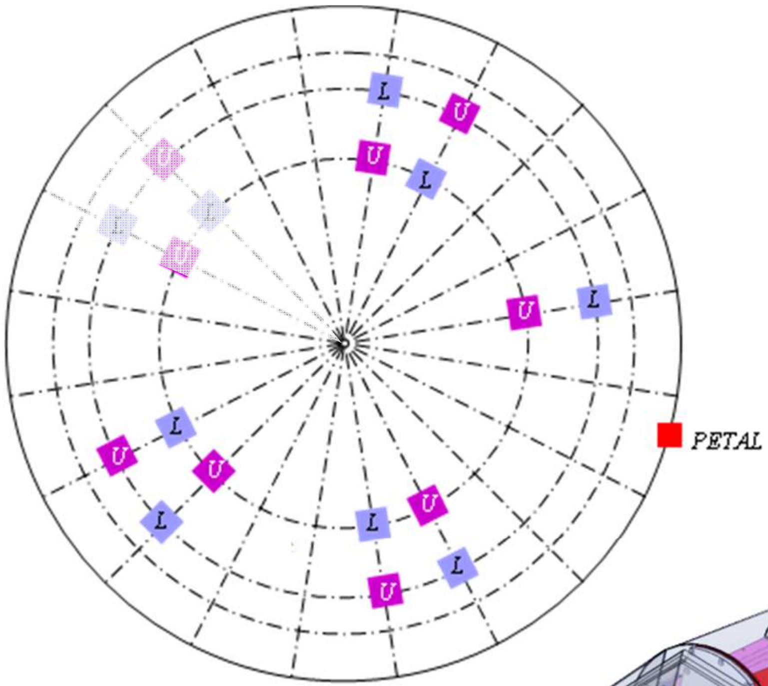
4th configuration : 7 to 9 laser bundles (+ PETAL) Total Energy = 250 to 320 kJ

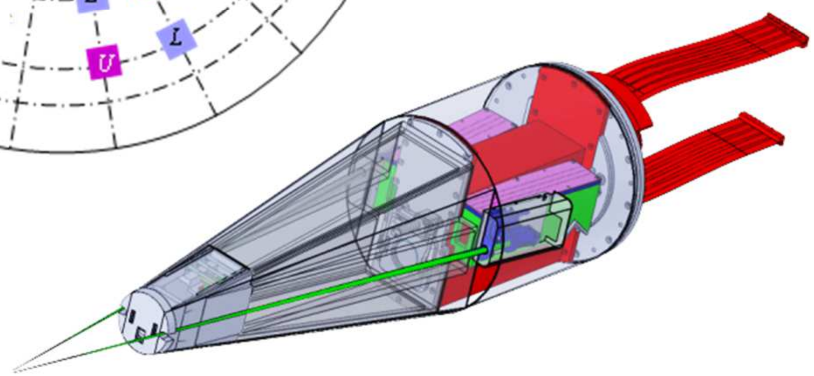
- 3rd order « symmetry » (then 4th) => First Implosion (D_2/Ar gas) and neutron production

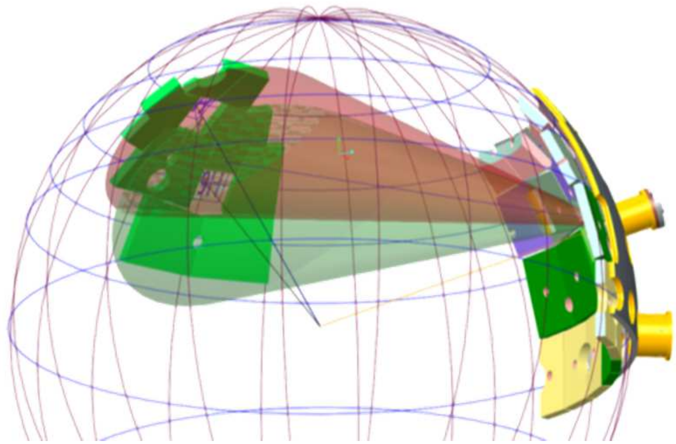
5 SID

19 Diagnostics

X-ray Diagnostics		Optical Diagnostics	Particles Diagnostics
Imagers	Spectro.		
GXI-1	DMX	FABS1&2	SESAME
GXI-2	miniDMX	NBI	SEPAGE
SHXI	SPECTIX	EOS pack	Neutron pack
SSXI	HRXS		
ERHXI			
UPXI-LPXI			
GSXI			







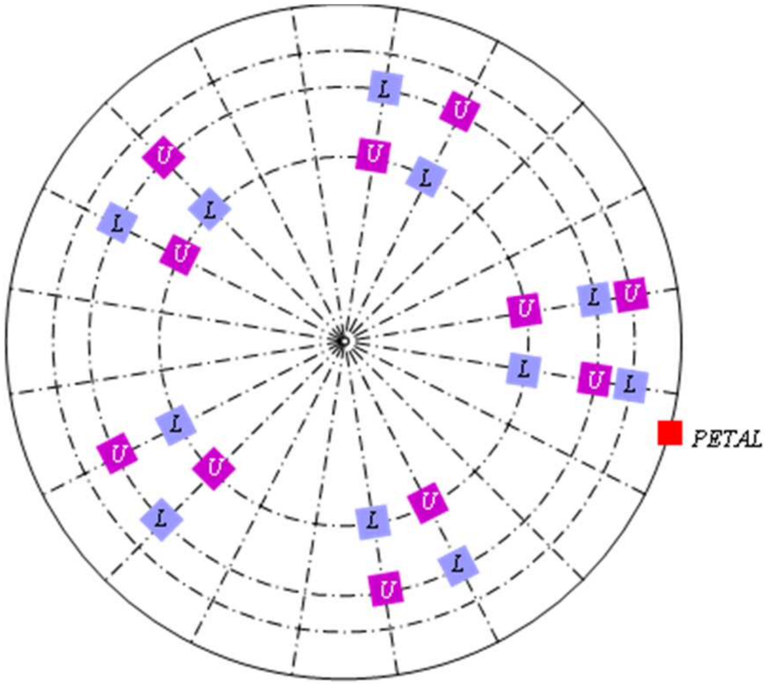
The 6 experimental configurations of Laser MegaJoule

5th configuration : 11 to 21 laser bundles (+ PETAL) **Total Energy = 530 kJ to 1 MJ**

- Low Temp. target positioning system, 5th order axial symmetry => Ignition preparation

6 SID

26 Diagnostics



X-ray Diagnostics		Optical Diagnostics	Particles Diagnostics
Imagers	Spectro.		
GXI-1	DMX	FABS1&2	SESAME
GXI-2	miniDMX	NBI	SEPAGE
SHXI	SPECTIX	EOS pack	Neutron pack
SSXI	HRXS	Thomson Scattering	Neutron pack 2
ERHXI	SRSXS		
UPXI-LPXI	miniDMX2		
GSXI	SRHXS		
SHXI-2			
GXI-3			

The 6 experimental configurations of Laser MegaJoule

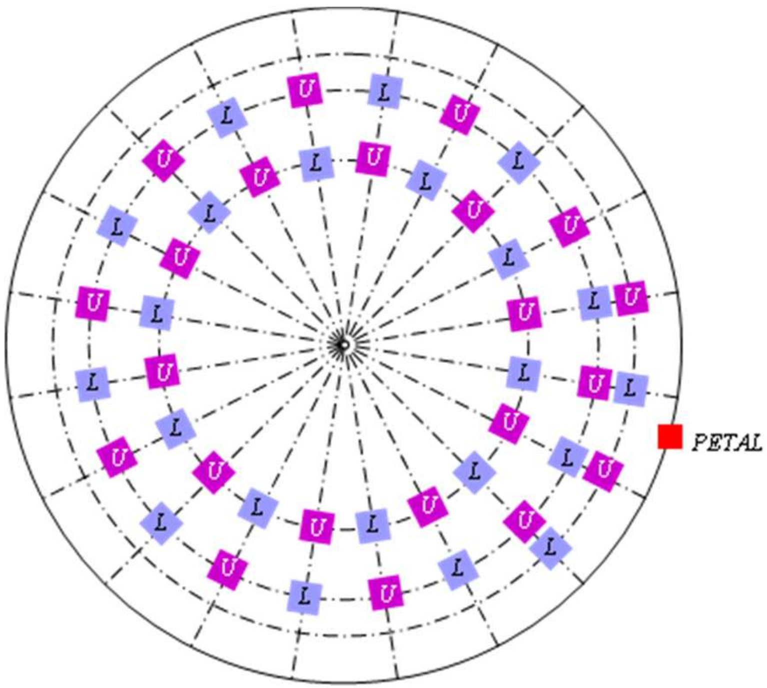
6^{th} configuration : 22 laser bundles (+ PETAL)

Total Energy = 1,5 MJ

- Cryogenic target positioning system, Full axial symmetry => Ignition Milestone

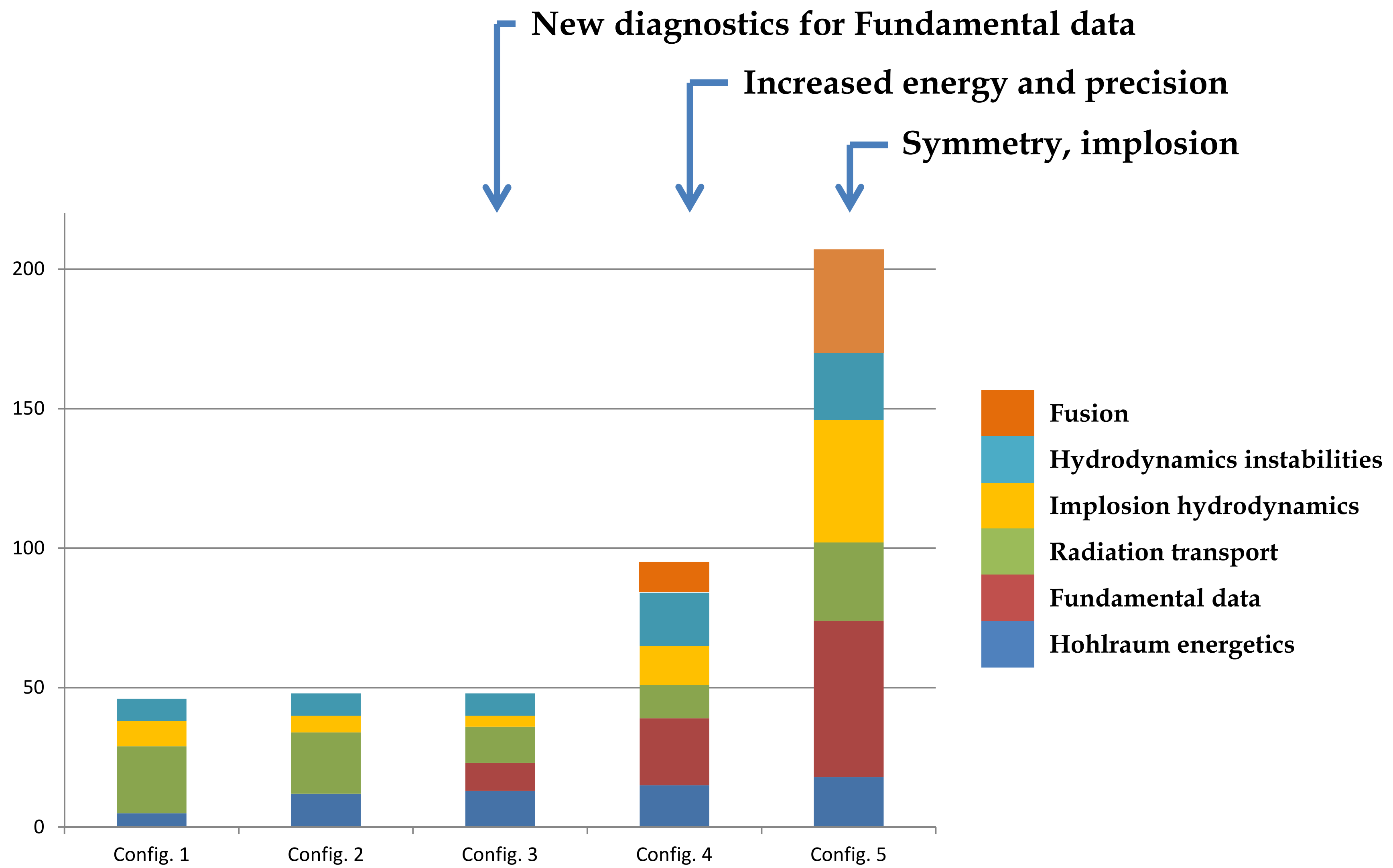
Up to 10 SID

26+ Diagnostics



X-ray Diagnostics		Optical Diagnostics	Particles Diagnostics
Imagers	Spectro.		
GXI-1	DMX	FABS1&2	SESAME
GXI-2	miniDMX	NBI	SEPAGE
SHXI	SPECTIX	EOS pack	Neutron pack
SSXI	HRXS	Thomson Scattering	Neutron pack 2
ERHXI	SRSXS	…	…
UPXI-LPXI	miniDMX2		
GSXI	SRHXS		
SHXI-2	…		
GXI-3			

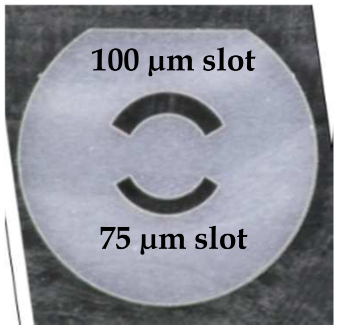
The experimental program on LMJ



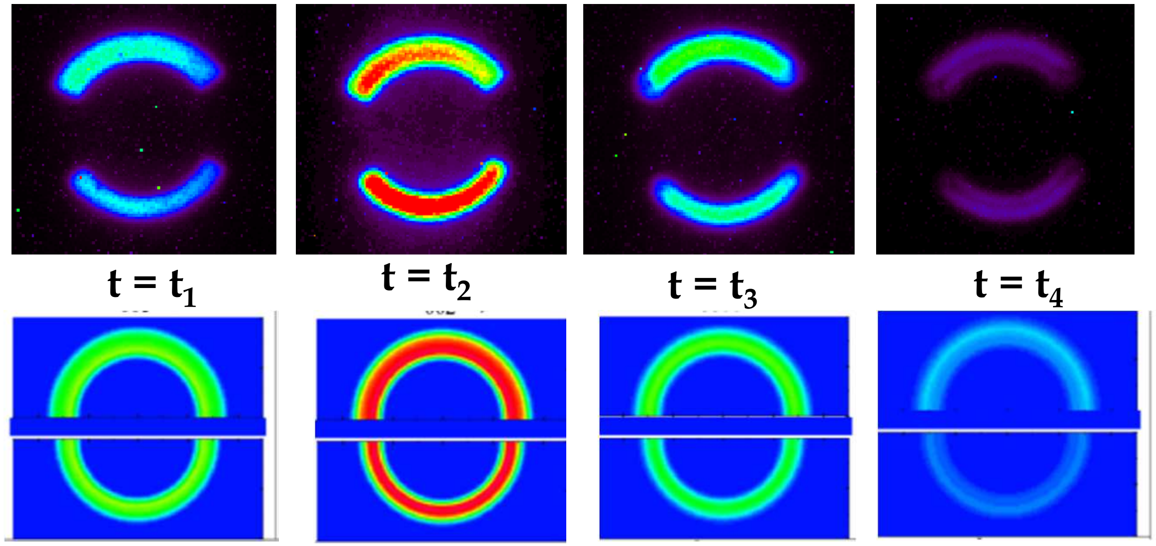
Dynamics of slot closure

Demonstrate LMJ abilities to perform experiments for Simulation program

- Slot dynamics is diagnosed by auto-radiography
- First shot with Ta_2O_5 aerogel sample, 200 µm thickness

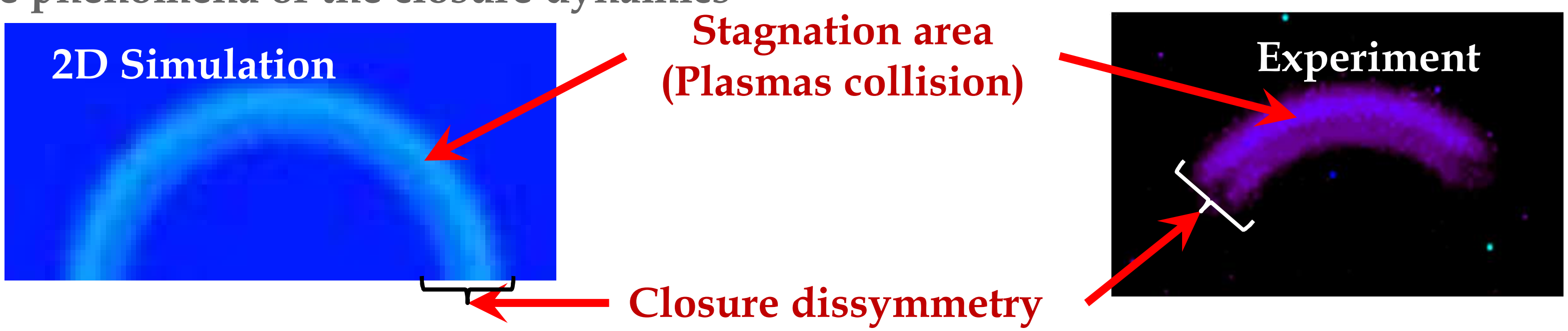


2D simulations before shot

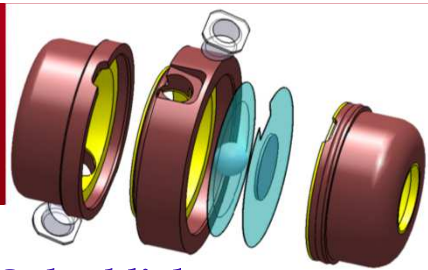


Details of the phenomena are well predicted by simulations

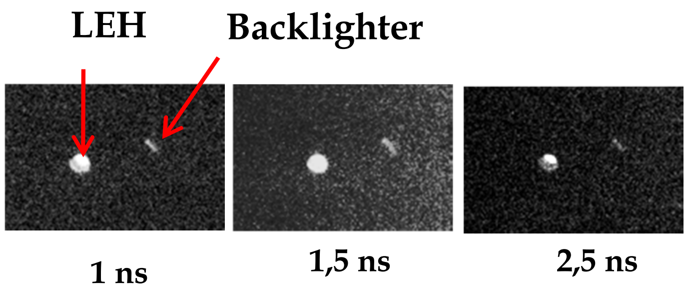
- Late phenomena of the closure dynamics

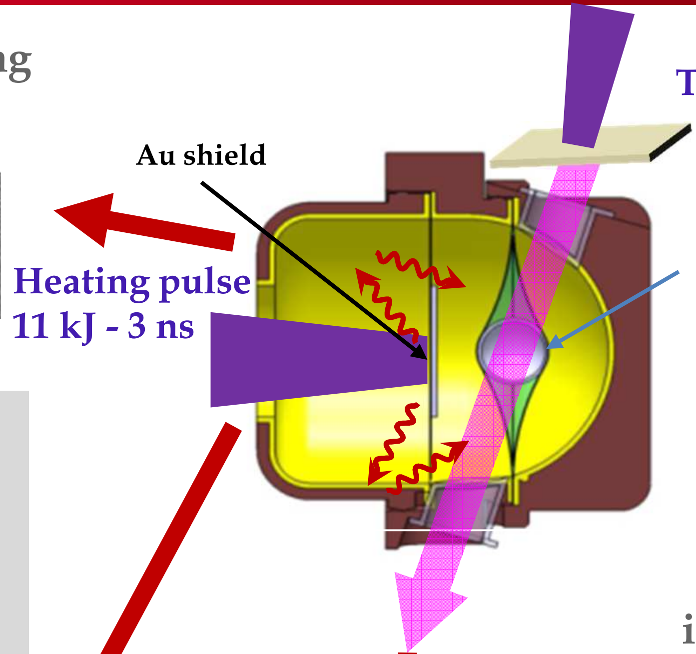


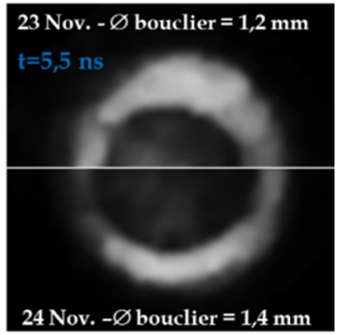
2015 - Asymmetrical implosion
Variations in capsule position and shield size



GXI-2: Beams pointing monitoring

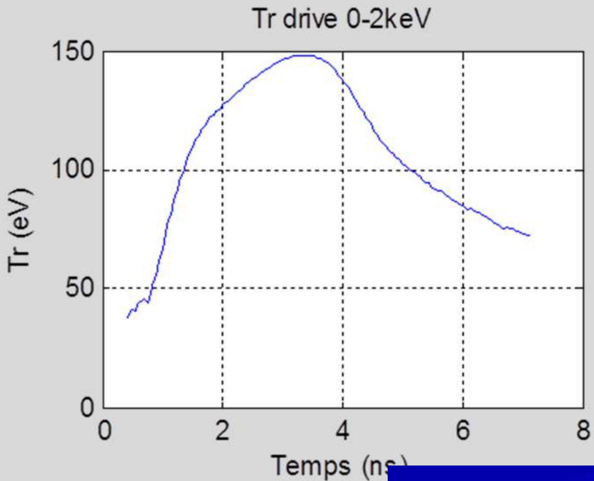




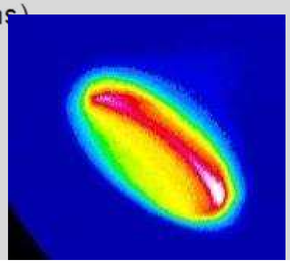


GXI-1: less convergent implosion with big shield

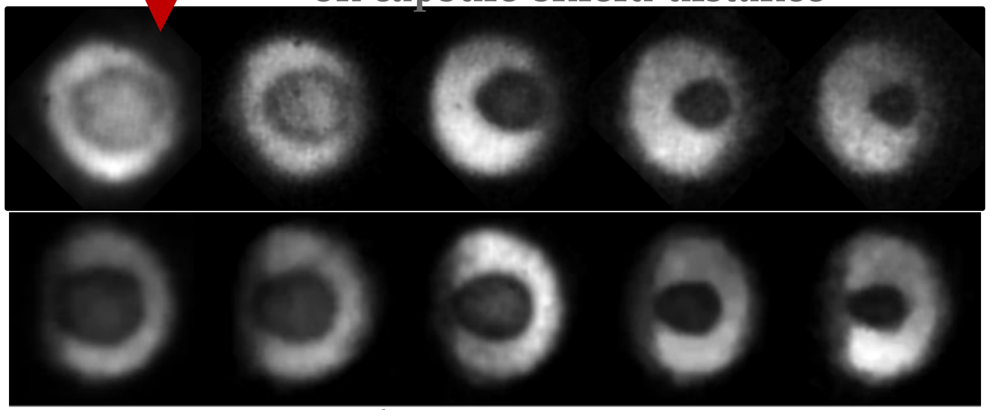
DMX: Rad. Temp. measurement



DMX: LEH time integrated picture



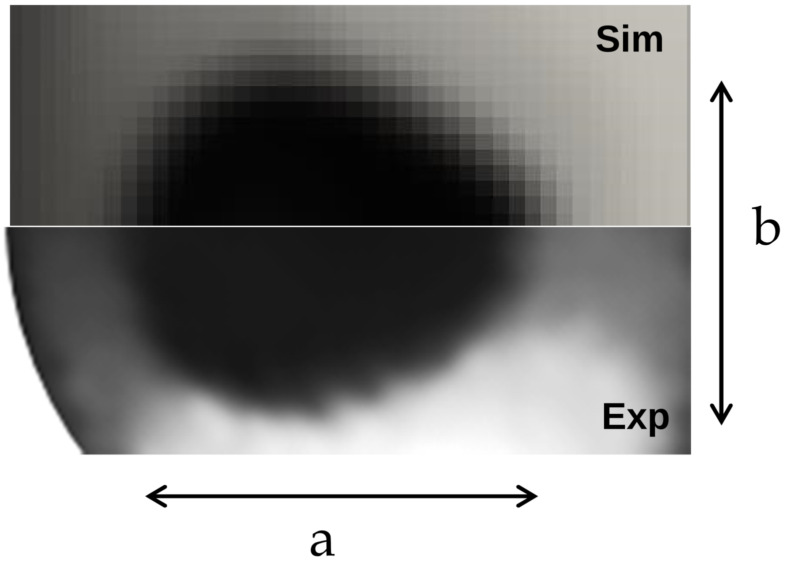
GXI-1: Implosion geometry depending on capsule-shield distance

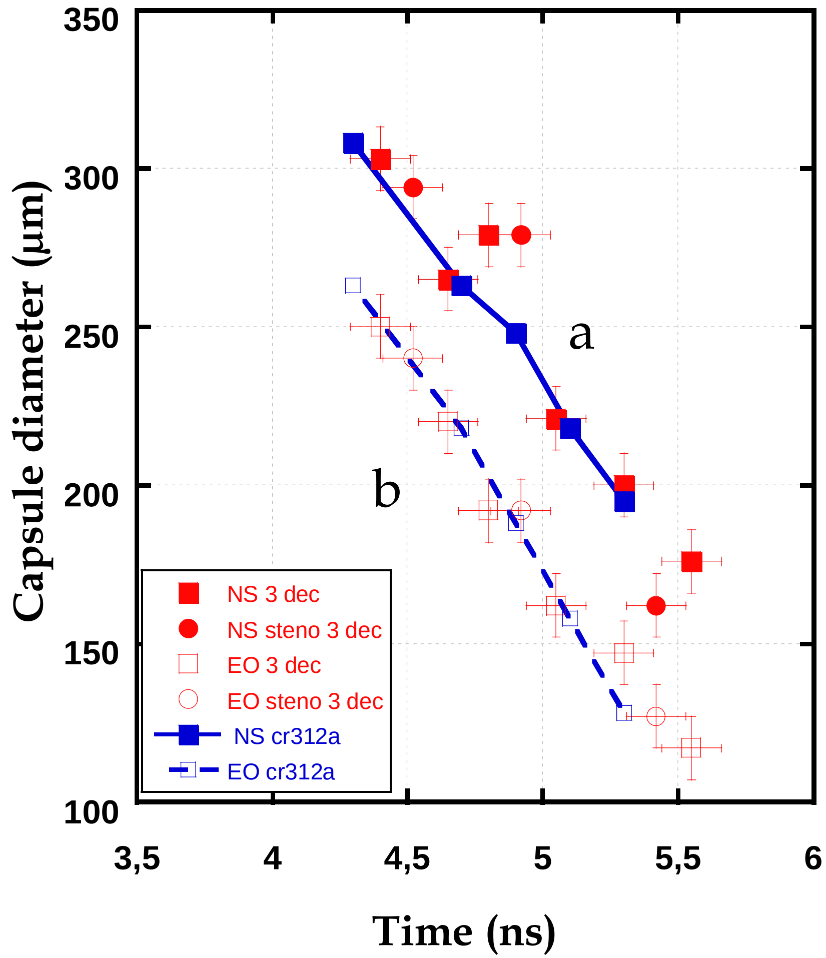


2015 - Asymmetrical implosion

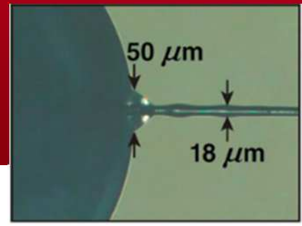
The egg shape, predicted by simulation, is due to the anisotropic distribution of the drive around the capsule.

Comparison Experiment / Simulation at 5.1 ns



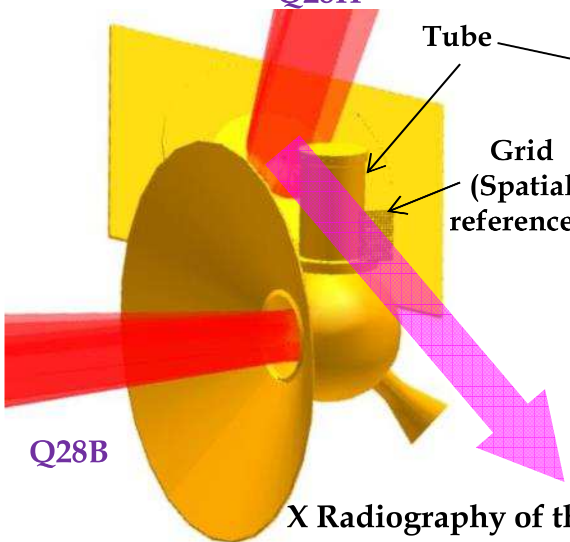


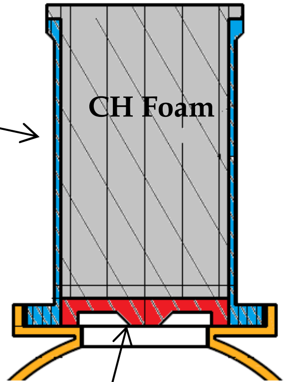
2015 – Technological Singularity

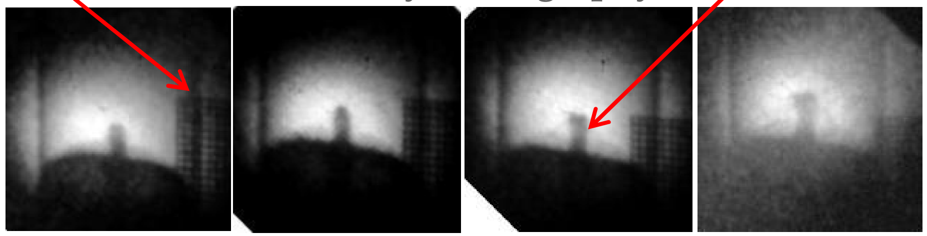


Effect of a technological singularity present on a laser target

- Shock propagation in Ta_2O_5 disk (radiographic contrast) including the singularity.
- Shocks coalescence and inversion of the defect, which leads to a jet of material in a foam.
- Multi-time late radiography of the jet.



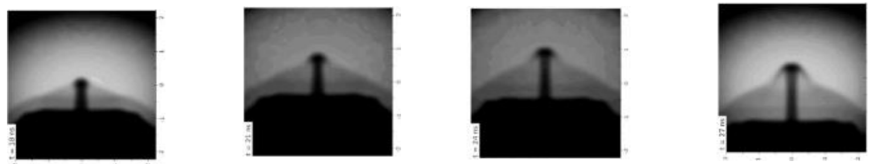




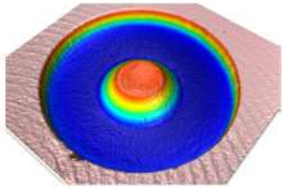
Grid

X-ray Radiography

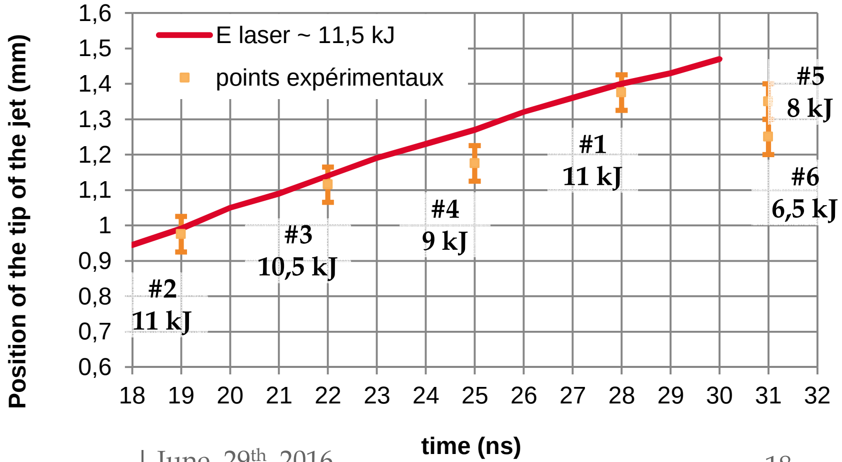
Jet



Δt = 18 ns | 21 ns | 24 ns | 27 ns



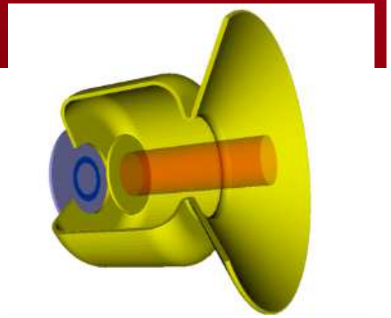
Simulation

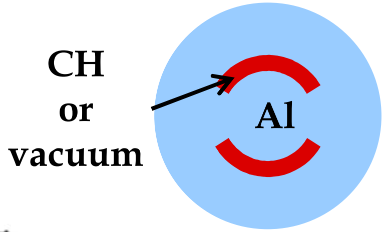


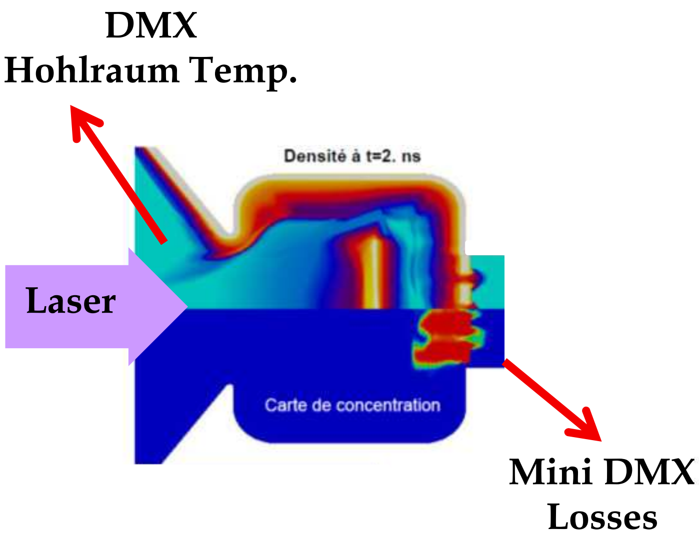
2016 - Radiative losses

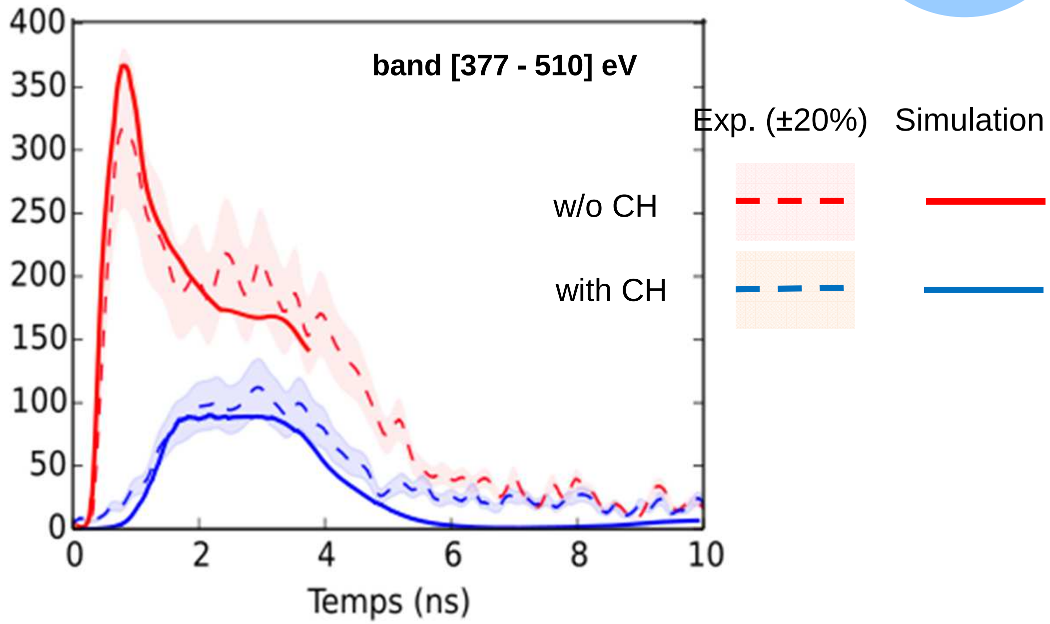
Continuation of dynamics of slot closure, with quantification of losses through the slot.

- X-ray conversion in a gold hohlraum with shield
- Measurement of radiation temp. in hohlraum and losses through the slots
- Samples with empty slots or filled with CH (delayed closure)









High sensitivity to the sample characteristics (thickness, slot width, …)

Continuation of the program

Radiation transport

- Radiative balance in hohlraums - 2016
- Radiative propagation in a close sub-sonic regime – 2017
- Radiative propagation in inhomogeneous media -2017
- Rosseland opacities - 2017

Hohlraum energetics

- Characterization of magnetic fields – 2017 (Academic access)
- X-ray conversion on the rear face of target – 2018
- Laser-Plasma Interaction in gas hohlraum – 2019

EoS

- Reference materials (Quartz, Al, diamond) and low-Z materials (B, HLi) – 2019

Implosion hydrodynamics

- Corrected asymmetrical implosion - 2017
- 1D planar hydrodynamics – 2018
- D_2 capsule implosion (neutron production) - 2019

Hydrodynamics Instabilities

- Turbulence in shock tube - 2018

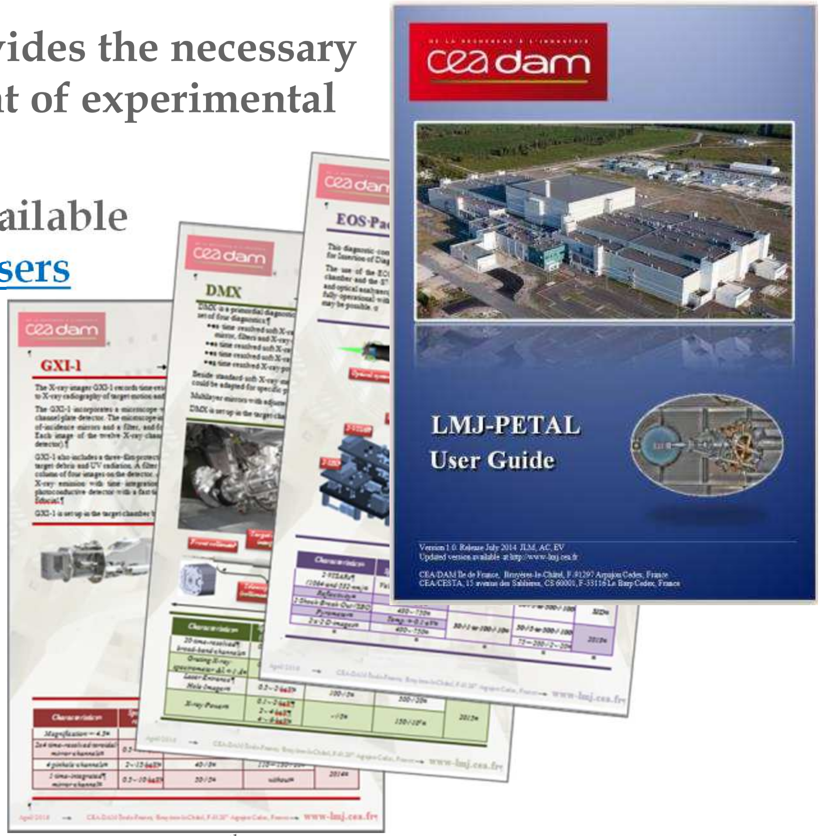
Access of the Academic Community to LMJ-PETAL

Opening policy

- The CEA-DAM has promoted for several decades collaboration with national and international scientific communities
- Between 2005 and 2014, access to the LIL facility has been given to the scientific community

With the LMJ and PETAL facilities, the CEA-DAM is once again in a position to welcome national and international teams.

- LMJ-PETAL User Guide (+ Diagnostic forms) provides the necessary technical references for the writing of Letter of Intent of experimental proposals to be performed on LMJ-PETAL.
- Regularly updated version of this User guide is available on LMJ website at : http://www-lmj.cea.fr/en/ForUsers
- Academic access and selection of the proposals are coordinated by Institut Laser & Plasmas (ILP) with the help of the International Scientific Advisory Committee of PETAL.



A direct access to LMJ-PETAL is also possible through NNSA-CEA collaboration

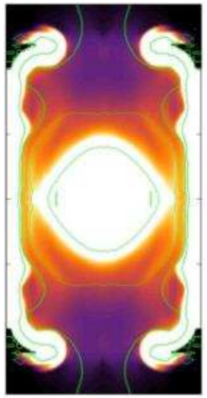
Academic experiments

First call for experiments:

- The first configuration (end 2016) includes 4 quads and the PETAL beam

4 experiments selected (2017-2018) among 16 proposals

- Amplification of B fields in radiative plasmas : Magnetogenesis and turbulence in galaxy
  - PI : Prof G. Gregori Department of Physics, University of Oxford
- Interacting radiative shock : an opportunity to study astrophysical objects in Laboratory
  - PI : Dr M. Koenig – LULI, Ecole Polytechnique
- Study of the interplay between B field and heat transport in ICF conditions,
  - Dr R. Smets – LPP Ecole Polytechnique
- Strong Shock generation by laser plasma interaction in presence or not of laser smoothing
  - PI : Dr. S. Baton – LULI, Ecole Polytechnique ; X. Ribeyre – CELIA, Univ. Bordeaux



Second call: launched on April 2016

- First selection by experts of the ISAC-P (International Scientific Advisory Committee of PETAL), organized by the Institute Lasers et Plasmas (ILP) : September 2016.
- After this pre-selection, the deposit of the full proposals will be asked for December 2016.

➔ The experiments will take place in 2019 and 2020, with 14 quads and 16 diagnostics.

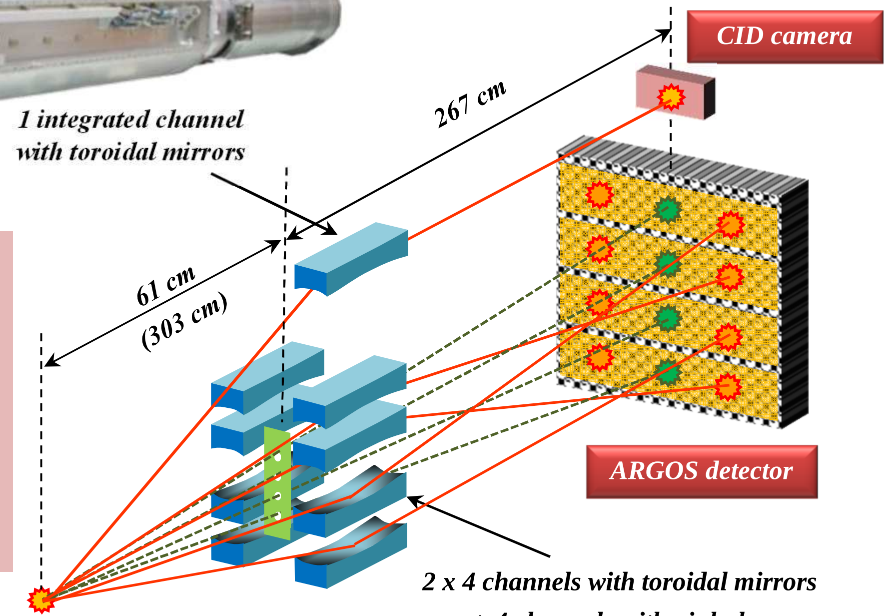
Plasma diagnostics installed on LMJ

Name	Characteristics	Needs	Position
GXI-1	Gated hard X-ray imager, Space resolution = 35 µm Field of view: 3 mm	2D X-ray image	SID
GXI-2 (GXI-1 like)	Gated hard X-ray imager, Space resol. = 150 or 50 µm Field of view: 15 mm or 5 mm	Beams pointing monitoring	SID
DMX	Broad-band X-ray spectrometer, temporally resolved	Primary hohlraum radiative temp.	MS D9 (D8 in 2018)
Mini-DMX	Mini Broad-band X-ray spectrometer, temporally resolved	Secondary hohlraum radiative temp.	SID

GXI-1 (and 2) , Gated X-ray Imager 1 (and 2)

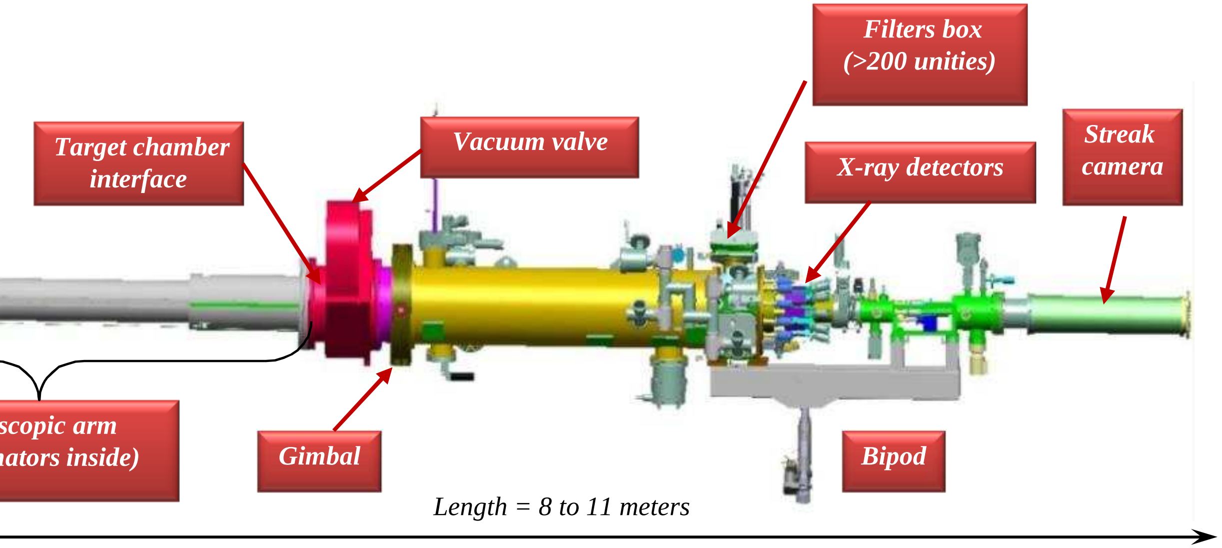
Characteristics	*Spectral range*	*Spatial resolution (µm) / Field of view (mm)*	*Time resolution (ps) / Dynamic (ns)*
Magnification = 4.3 (0.9)			
2x4 time-resolved toroidal mirror channels	*0.5 - 10 keV*	*35 / 3 (150/15)*	*110 - 130 / 20*
4 pinhole (refractive lenses) channels	*2 (6) - 15 keV*	*40 / 3 (150/15)*	*110 – 130 / 20*
1 time-integrated mirror channel	*0.5 - 10 keV*	*50 / 5 (140/20)*	*without*

- Dedicated to X-ray radiography (Pointing monitoring)
- Microscope with large source-to-optic distance and a large size gated micro channel plate detector.
- Three-film protective holder to protect optical components from damages caused by target debris and UV radiation.



DMX, Broad-band X-ray Spectrometer

Characteristics	Spectral range (resol. E/ΔE)	Spatial resol. (µm) / Field of view (mm)	Time resol.(ps) / Dynamic (ns)
20 time-resolved broad-band channels	0.03 - 20 keV (5)	- / 5	150 / 10^5
Grating X-ray spectrometer Dl < 1 Å	0.1 - 1.5 & 1.5 - 4 keV		17 / 2 to 120 / 25
Laser Entrance Hole Imager	0.5 - 2 keV	100 / 5	500 / 20
X-ray Power	0.1-2 , 2-4 & 4-6 keV	- / 5	150 / 10^5



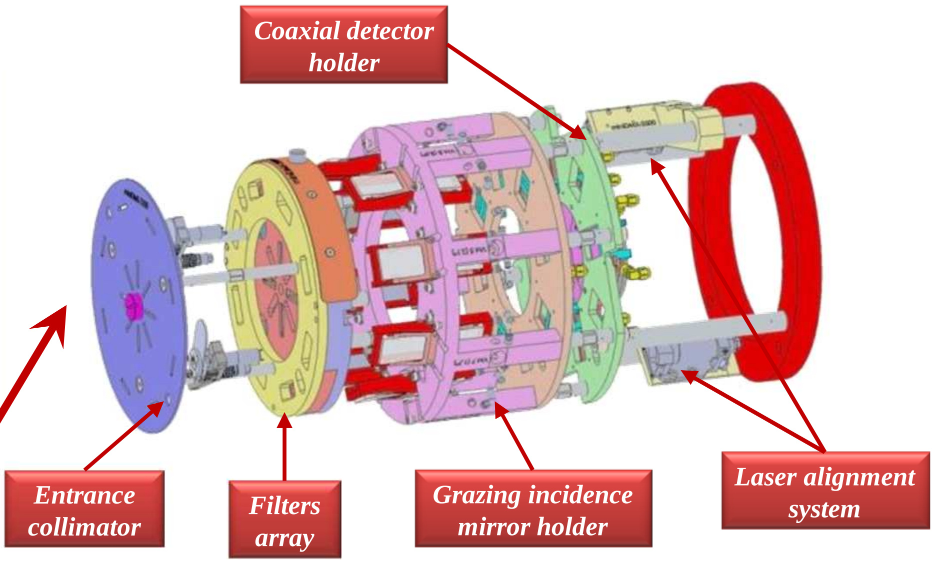
- a time resolved soft X-ray broad-band spectrometer (20 channels combining mirror, filters, X-ray diodes)
- a time resolved soft X-ray spectrometer (gratings and streak camera)
- a laser entrance hole imaging - time resolution planned
- a time resolved X-ray power measurement spectrally integrated.

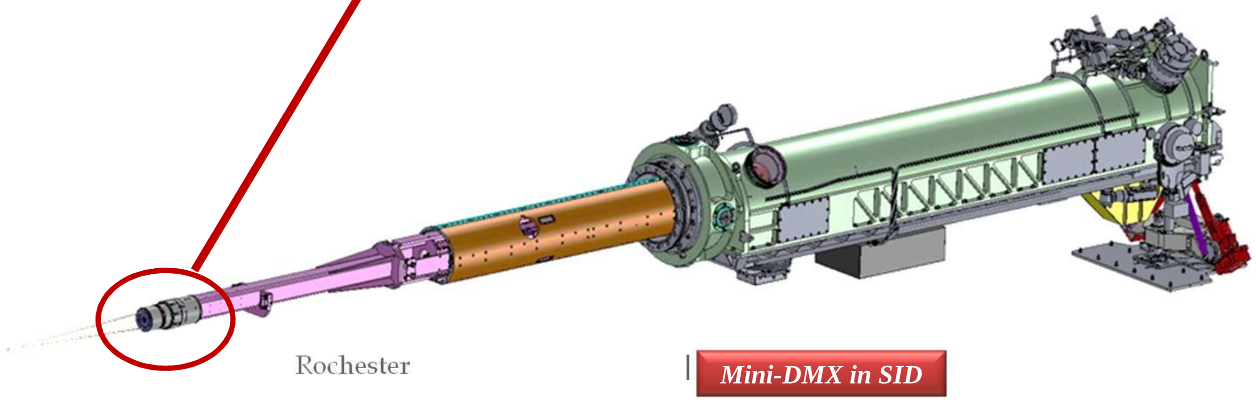
Mini-DMX, Mini-Broad-band X-ray Spectrometer

Characteristics	*Spectral range (resol. E/ΔE)*	*Spatial resol. (µm) / Field of view (mm)*	*Time resol. (ps) / Dynamic (ns)*
16 time-resolved broad-brand channels	*0.03 – 7 keV (5)*	*- / 5*	*150 / 10^5*

- Second hohlraum energetic performance measurements axis on the LMJ facility.
- Composed of 16 broadband channels combining filters, mirrors and coaxial detectors
- Positioned at its working distance (1000 mm or 3500 mm) by a SID,

This diagnostic, like DMX, is absolutely calibrated





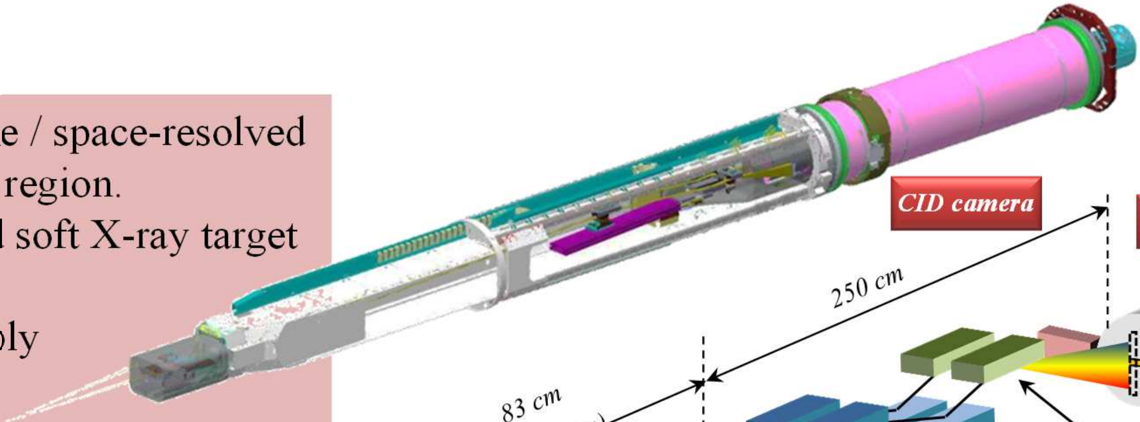
Plasma diagnostics in progress

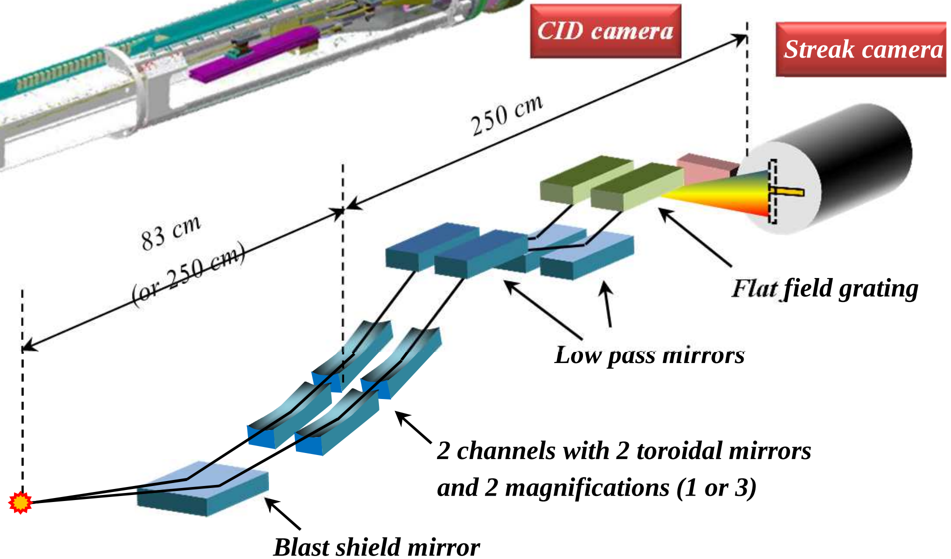
Name	Characteristics	Needs	Position	Planned
SSXI	Streaked soft X-ray Imager, Space resol. = 30 or 50 µm Field of view : 5mm or 15mm	Rosseland Opacities Radiative Transfer	SID	2017
SHXI	Streaked hard X-ray imager Space resol. = 150 µm Field of view: 15 mm	1D X-ray image	SID	2017
EOS Pack	VISAR, SBO, Pyrometer, Reflectivity	EOS Shocks propagation	SID + analysis table	2019

SSXI, Streaked Soft X-ray Imager

Characteristics	*Spectral range*	*Spatial resolution (µm) / Field of view (mm)*	*Time resolution (ps) / Dynamic (ns)*
Magnification = 1 or 3			
1 time-resolved bi-toroidal mirror channel	*0.05 – 1.5 keV*	*30 / 5 or 50 / 15*	*17 / 2 to 120 / 25*
1 time-integrated bi-toroidal mirror channel	*0.05 – 1.5 keV*	*30 / 5 or 50 / 15*	*without*
Spectral selection by grating			

- Time-resolved 1D image or time / space-resolved spectra in the soft X-ray spectral region.
- Analysis of radiative waves and soft X-ray target emission.
- Association of an optics assembly and a spectral selection device (blast shield which large flat mirror, with grazing incidence, and an X-ray microscope with two channels).
- The spectral selection is provided by two low-pass mirrors combined with a reflective flat field grating.

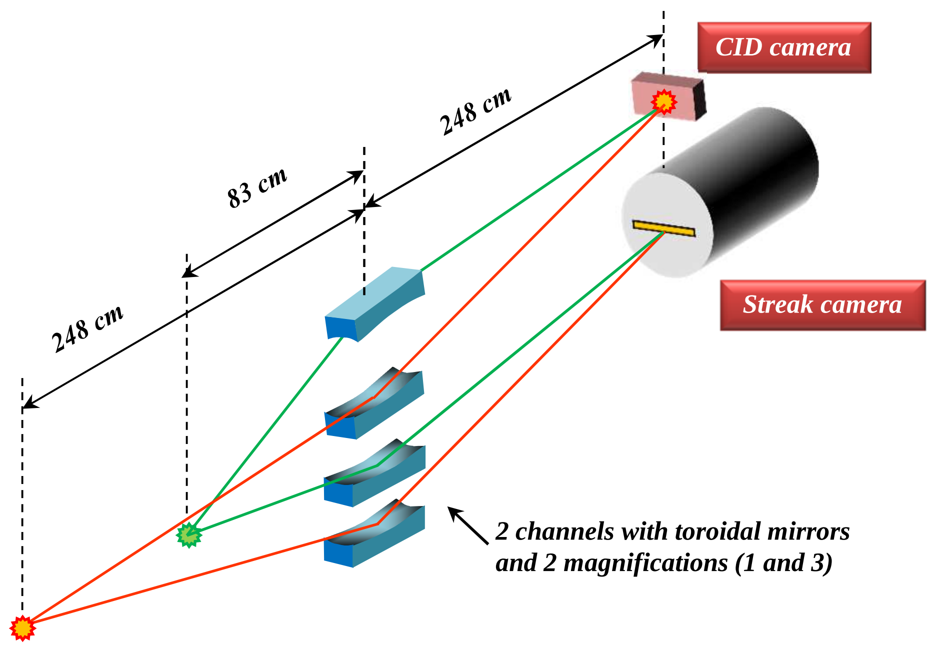




SXHI, Streaked Hard X-ray Imager

Characteristics	*Spectral range*	*Spatial resolution (µm) / Field of view (mm)*	*Time resolution (ps) / Dynamic (ns)*
Magnification =1 or 3			
1 time-resolved toroidal mirror channels	*0.5 - 10 keV*	*150 / 15 or 50 / 5*	*17 / 2 to 120 / 25*
1 time-integrated mirror channel	*5 - 10 keV*	*130 /20 or 50 / 6.5*	*without*

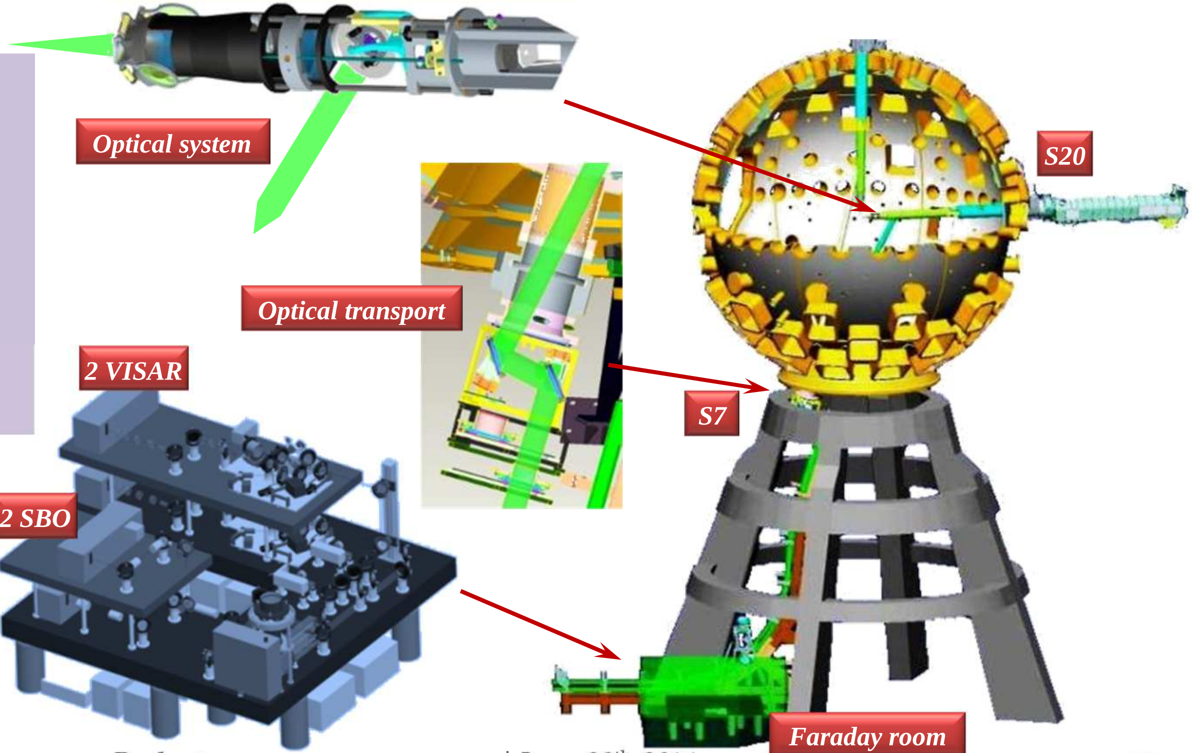
- Time-resolved 1D image in the hard X-ray spectral region.
- X-ray radiography and hard X-ray target emission.
- Two X-ray channels per magnification (grazing angle-of-incidence toroidal mirrors and a filter).
- One image of them produced on the streak camera while the other formed on a time integrated detector (CID).
- A protective holder contains three films to protect optical components.



EOS Pack, Diagnostics set for EOS experiments

Characteristics	*Measurement or Spectral range (nm)*	*Spatial resol. (µm) / Field of view (mm)*	*Time resol. (ps) / Dynamic (ns)*
2 VISARs (1064 and 532 nm)	*Velocity 0.5 - 200 km/s*	*30 / 1 to 50 / 5*	*50 / 5 to 500 / 100*
Reflectivity	*R > 0.1*		
2 Shock Break Out (SBO)	*490 - 750*	*30 / 1 to 100 / 10*	*50 / 5 to 500 / 100*
Pyrometer	*Temp. > 0.1 eV*		
2 x 2 D images	*490 - 750*		*75 – 200 / 2 - 20*

- Optical system, positioned close to the target (SID),
- Optical transport system
- Analysis table.
- Laser and optical analyzers will be hardened and protected against EMP inside Faraday cages.



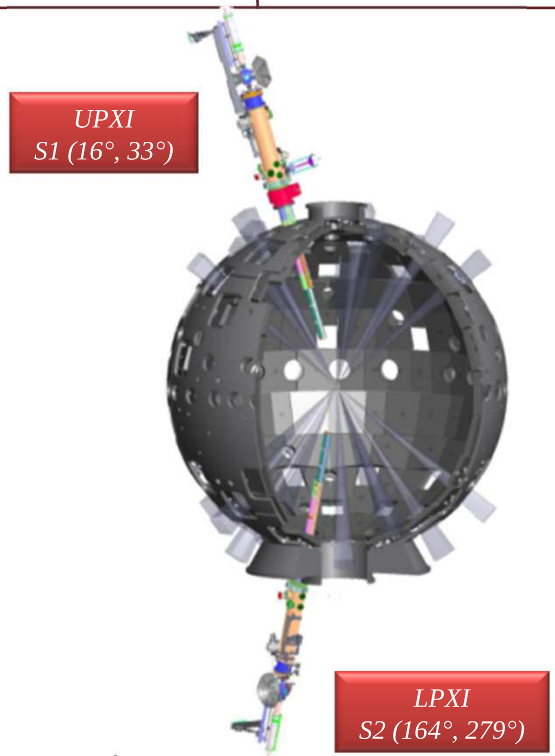
Plasma diagnostics under study

Name	Characteristics	Needs	Position	Planned
UPXI - LPXI	Hard X-ray imagers, upper and lower polar	LEH images in polar irradiation	Specif. Mechanics	2018-2019
FABS	Full aperture backscattering system (Raman-Brillouin spectrometer), Q28H	Energy Balance Interaction	Focusing system	2019
NBI	Near Backscatter Imager (analysis of backscattered light outside Q28H & Q29H)	Energy Balance Interaction	Chamber	2019
ERHXI	Enhanced Resolution Hard X-ray Imager, Spatial resolution: 7 to 20 µm Field of view 0.5 or 1.5 mm	Imploded core image	SID	2019
HRXS	High Resolution X-ray Spectrometer, Spatial resolution: 10 or 100 µm Field of view 0.5 or 5 mm	NLTE spectroscopy Spectral opacities	SID	2019
Neutron Pack	Neutron Counting, flying time for Ti, bang time	First fusion reactions	Chamber	2019

UPXI – LPXI, Upper – Lower Polar X-ray Imagers

Characteristics		*Spectral range*	*Spatial resolution (µm) / Field of view (mm)*	*Time resolution (ps) / Dynamic (ns)*
1 pinhole channel		*> 3 keV*		
Passive detector Magnif. = 2 to 5	*CID detector*		*80 / 12 to 65 / 5*	*without*
	Image Plate		*80 / 50 to 65 / 25*	
Optional camera Magnif. = 6	*Streak camera*		*65 / 2*	*17 / 2 to 120 / 25*
	Framing camera			*110 - 130 / 20*

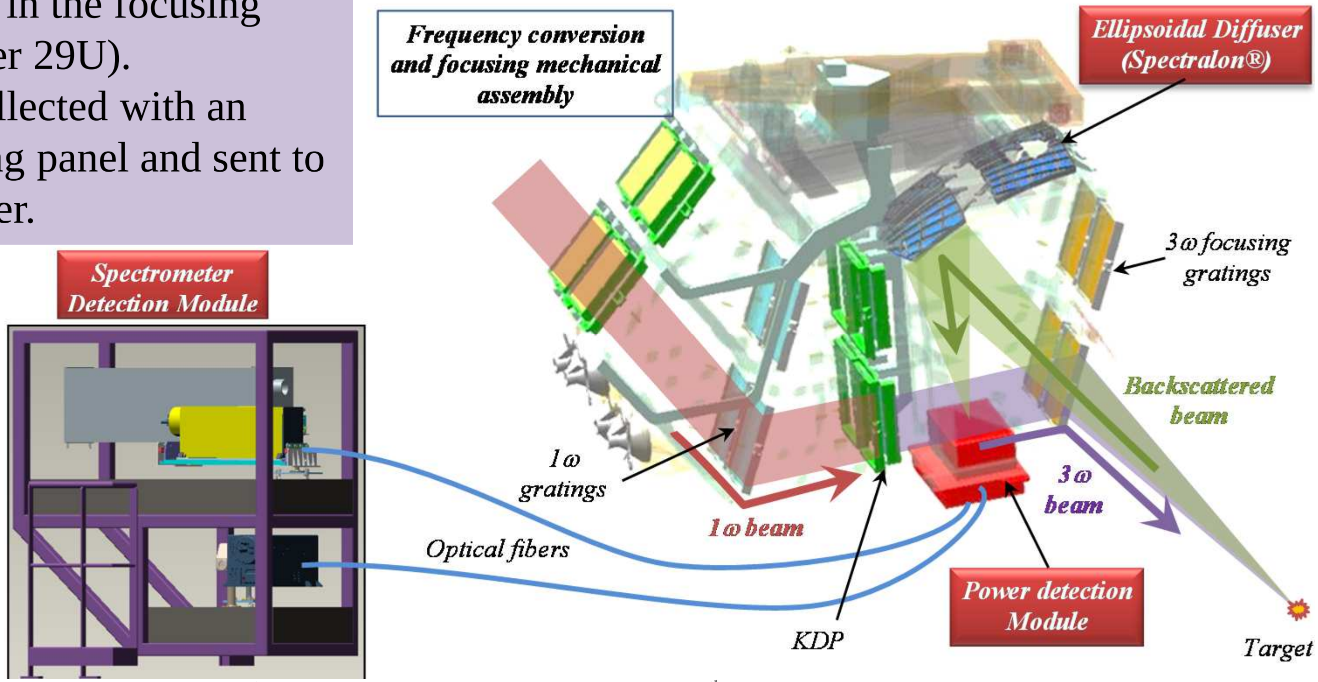
- Time-integrated 2D image, or optionally time-resolved 2D or 1D image, in the hard X-ray spectral region.
- Dedicated to pointing precision of LMJ laser beams
- The image is accomplished with a single 50 µm diameter pinhole laser drilled into a tantalum foil. The maximum target to pinhole distance is 250 cm (minimum is 150 cm) for a magnification of 2 (5 or 6).
- Available with time-integrated detectors and time-resolved detectors (X-ray streak camera operating with a temporal resolution of 50 ps or ARGOS framing camera).



FABS, Full Aperture Backscattering System

Characteristics	*Measurement or Spectral range (nm)*	*Spatial resol. / Field of view*	*Time resol. (ps) / Dynamic (ns)*
Brillouin spectrometer $\Delta\lambda < 0.05$ nm	*346 - 356*	*without*	*50 / 5 to 250 / 25*
Raman spectrometer $\Delta\lambda < 5$ nm	*375 - 750*		
Time integrated calibration spectrom.	*350 - 700* *375 - 750*		*Without / 5 to 25*
3 Brillouin power channels	*< 360*		*250 / 25*
2 Raman power channels	*350 - 750*		
1, 2, 3w power channels	*1053, 526, 351*		*500 / 25*

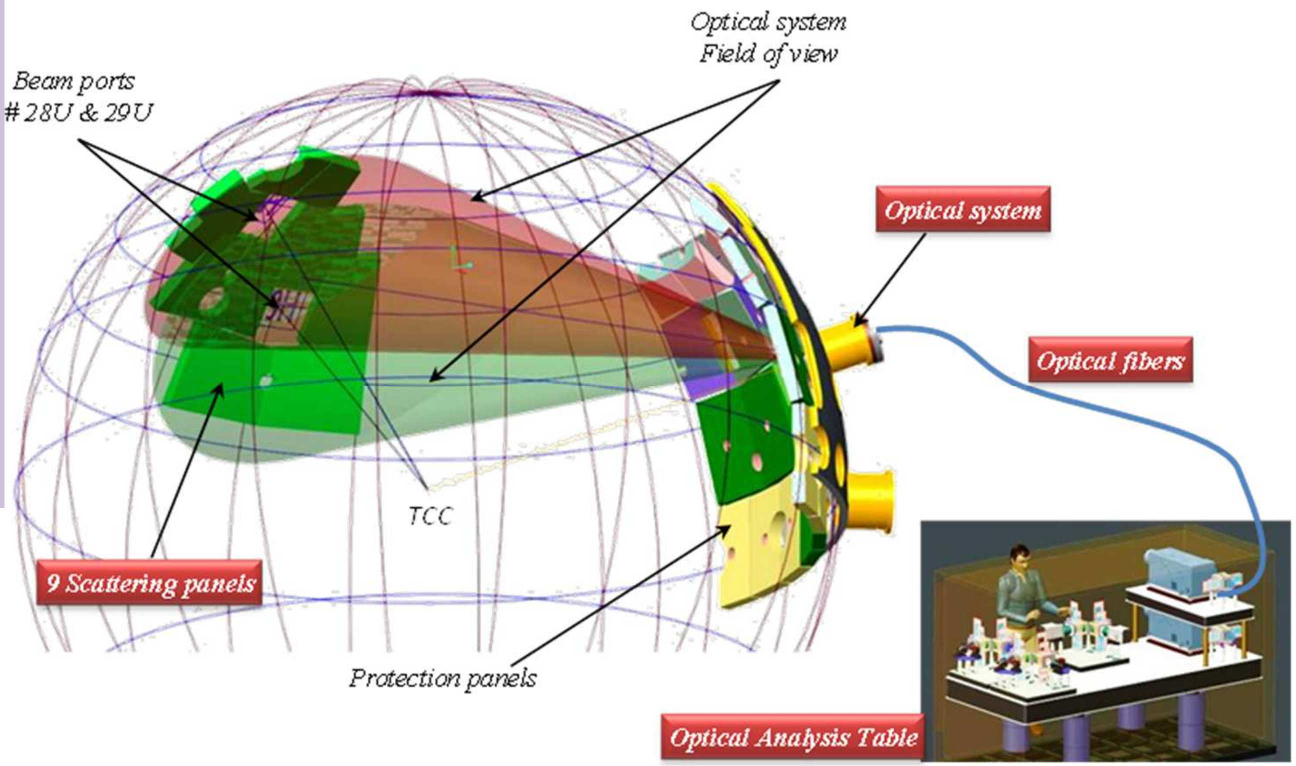
- Analysis of backscattered light in the focusing cone of quadruplet 28U (and later 29U).
- The backscattered energy is collected with an ellipsoidal Spectralon® scattering panel and sent to the Raman-Brillouin spectrometer.



NBI, Near Backscatter Imager

Characteristics	*Spectral range (nm)*	*Spatial resol. (µm) / Field of view (mm)*	*Time resol. (ps) / Dynamic (ns)*
2 Brillouin power channels	*346 - 356*	*without*	*250 / 25*
2 Raman power channels	*375 - 750*		
Brillouin image	*346 - 356*	*Angle: 2° / 16°*	
Raman image	*375 - 750*	*Angle: 2° / 16°*	

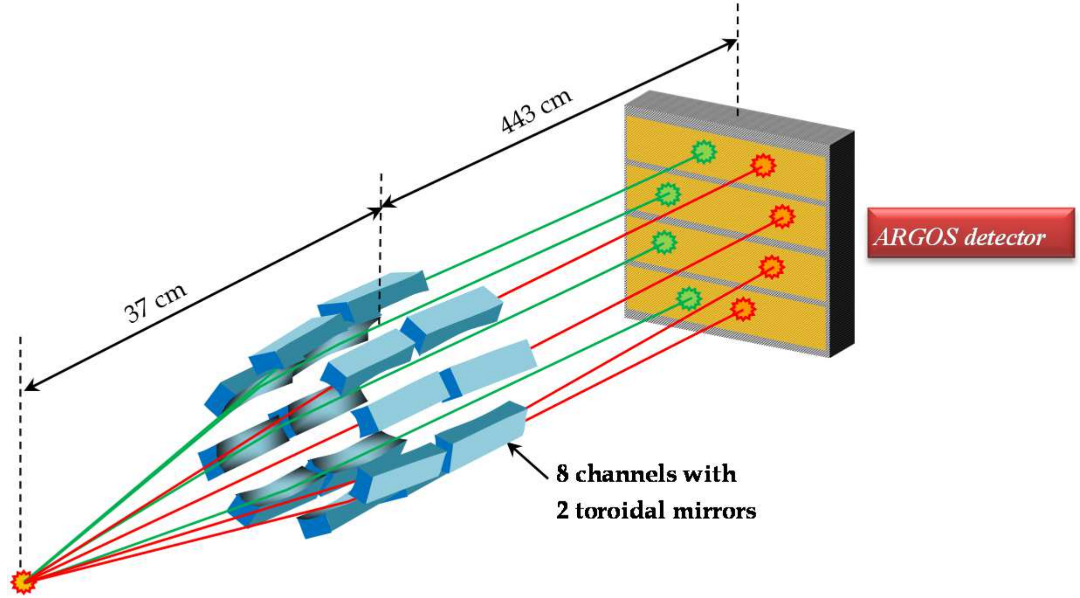
- Analysis of backscattered light outside the focusing cones of quadruplet 28U and 29U.
- The backscattered energy is collected by an optical system looking at Spectralon® scattering panels inside the chamber, and send to an optical table where Raman and Brillouin ranges are analyzed.



ERHXI, Enhanced Resolution Hard X-ray Imager

Characteristics	*Spectral range*	*Spatial resolution (µm) / Field of view (mm)*	*Time resol. (ps) / Dynamic (ns)*
Magnification = 12			
8 time-resolved bi-toroidal mirror channels	*0.5 - 11 keV*	*7 / 0,7*	*50/ 20*

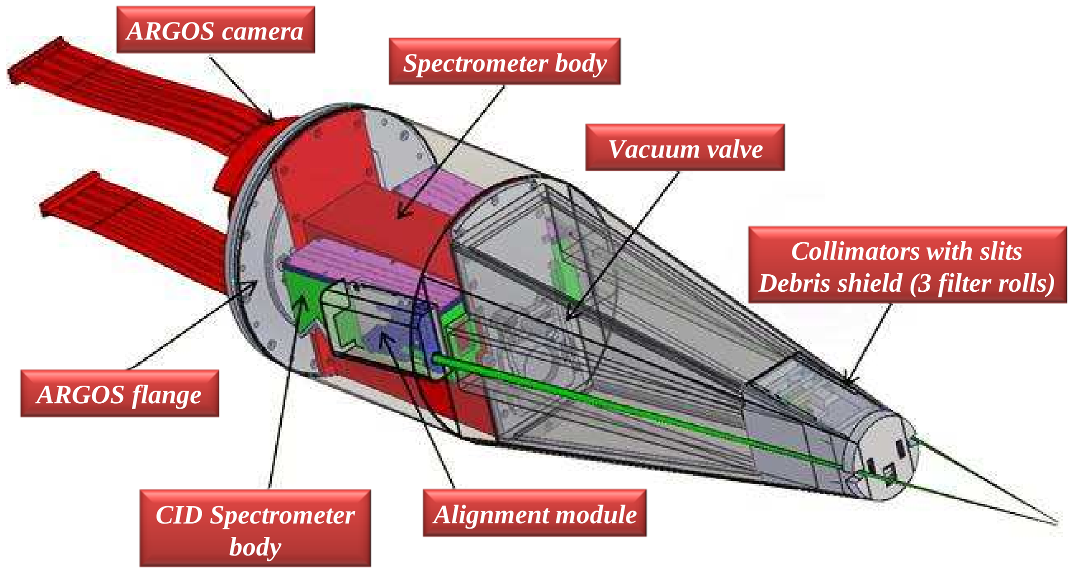
- Time-resolved 2D image in the hard X-ray spectral region with a high spatial resolution.
- Microscope with large source-to-optic distance and a new gated MCP (new ARGOS detector).
- The microscope includes eight X-ray channels, each consisting of 0.6° grazing angle-of-incidence bi-toroidal mirrors and a filter.
- This imager must include a film protective holder to protect optical components from damages



HRXS, High Resolution X-ray Spectrometer

Characteristics	*Spectral range (resol. E/ΔE)*	*Spatial resol. (μm) / Field of view (mm)*	*Time resolution (ps) / Dynamic (ns)*
Slit magnification = 3	*1 – 15 keV (~ 500)*	*70 (1D) / 5*	
4 time-resolved crystal channels			*110 - 130 / 20*
2 x 3 time-integrated crystal channels (CID)			*without*

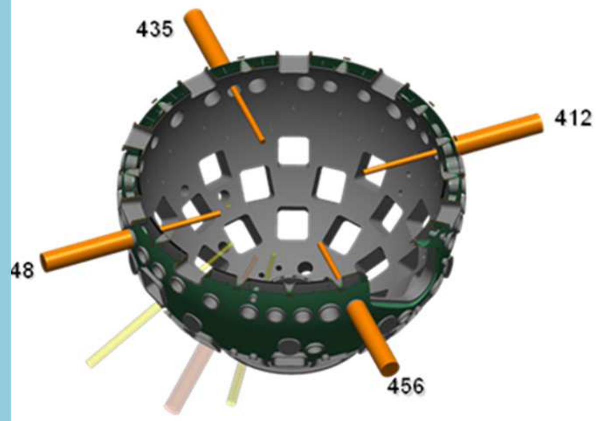
- Atomic physics (NLTE spectroscopy and opacity measurements). The central body is associated with the framing camera ARGOS (4 channels).
- Can be outfitted with one broad cylindrical concave crystal in order to get four frames at 4 different times in one spectral range or with two crystals in order to get 2 frames on each crystal and two different spectral ranges.
- The front end of the spectrometers includes a snout with collimation slits and a debris shield made of three filter rolls.

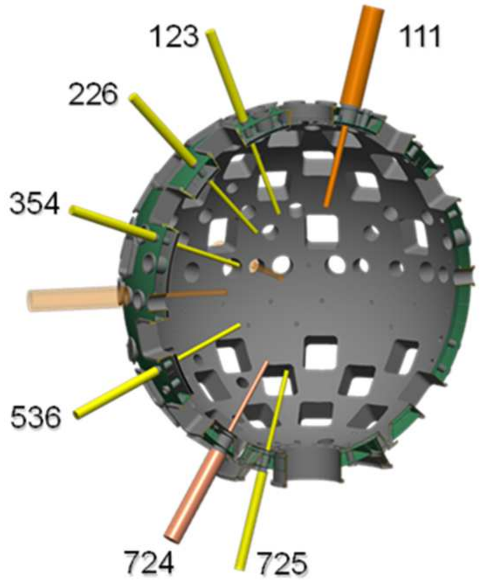


Neutron Pack, Activation and nTOF diagnostics

Characteristics	*Yield (neutrons)*	*Spatial resolution / Field of view*	*Time resolution (ps)*
Activation	*D_2 : 10^9 to 10^{15}* *DT : 10^9 to 5.10^{18}*	*without*	*without*
Gated PMT + scintillator			*50 (Timing accuracy)*
Photodiode			
CVD diamonds			

- Neutron yield, ion temperature, neutron bang time and ratio of secondary to primary neutron reactions during D_2 and DT implosions.
- Several neutron Time of Flight detectors (nTOF: Gated photomultiplier tubes and scintillators, photodiodes, CVD diamonds) and activation (indium, copper, zirconium, etc.).
-These diagnostics will be installed in several stages.





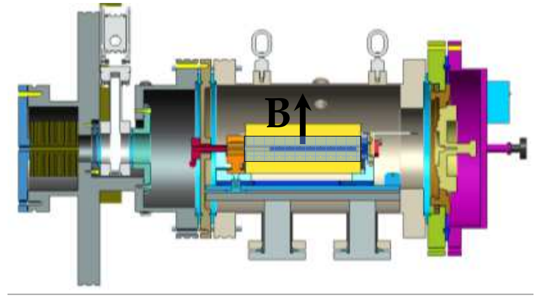
Plasma diagnostics planned after 2019

Name	Characteristics	Needs
GSXI	Gated Soft X-ray imager, medium field	Radiation transport
SRSXS	Spatially Resolved Soft X-ray spectrometer	Spectral opacities
2nd miniDMX	2nd MiniDMX adapted to measures of secondary cavities in nuclear environment	Tr secondary cavity Radiation transport:
FABS Q29H	Full Aperture Backscatter System on Quad29	Energy balance Interaction
SHXI-2	Streaked Hard X-ray Imager 2	Implosion dynamics
Thomson scattering	4 or 5ω probe beam	Characterization of plasma conditions in a cavity
GXI-3	Gated X-ray Imager 3 High resolution, improved temporal resolution	Implosions final phase
SRHXS	Spatially Resolved Hard X-ray Spectrometer Improved temporal resolution	Final implosion conditions analysis Mixing effects
Neutrons Pack 2	Neutron production history Directional measures	Neutron measurements enrichment rho-r / n(t) asymmetry

PETAL+ Project: Plasma Diagnostics for PETAL experiments

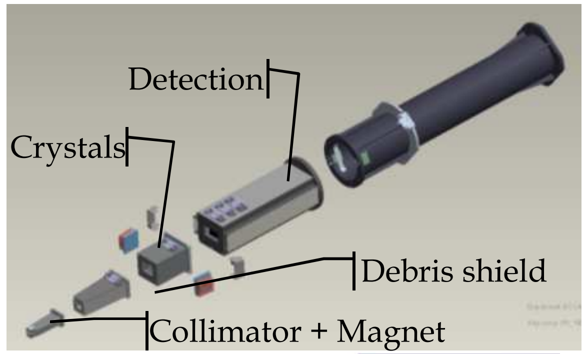
Inserters :

- Derived from LMJ SID (diagnostics compatibility)
- The first one is qualified



Electron spectrometer

- Magnetic spectrometer : 5 - 150 MeV
- Two modules on the chamber wall (0° and 45° /PETAL)
- Delivery : 2016

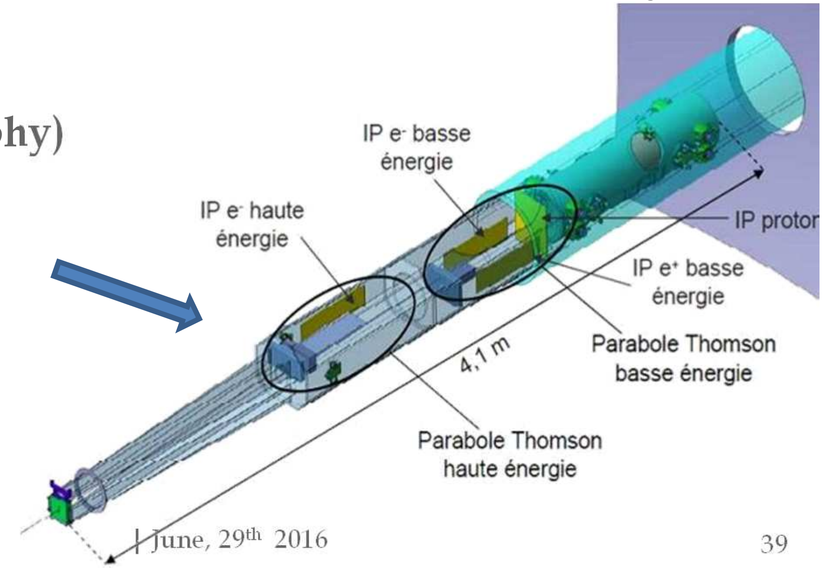


Hard X-ray spectrometer

- Transmission crystals (x2 : Quartz, LiF) : 15 – 100 keV
- Shielding : high energy X-ray and particles (magnets)
- Delivery : 2016

Charged particles diagnostic

- Proton spectroscopy & Imaging (proton-radiography)
  - 100 keV-200 MeV
- Electron spectroscopy
  - 100 keV – 150 MeV
- Two Thomson parabolas + Image Plate
- Delivery : 2017



2nd European Conference on

Plasma Diagnostics

Bordeaux, France

18th – 21st April 2017

Topics and Scientific Committee

Magnetic Confinement Fusion:
Angelo A. Tuccillo (chair), Liqun Hu, Mikhail Kantor, Michael Walsh

Beam Plasma & Inertial Fusion:
Dimitri Batani, Jean-Luc Miquel, Keisuke Shigemori

Low Temperature & Industrial Plasmas:
Dietmar Block, Walter Gakelman, Svetlana Ratynskaia

Basic & Astrophysical Plasmas:
Marco Feroci, Jan-Willem den Herder, Olivier Limousin

Local Organising Committee

Dimitri Batani (chair), Pauline Aussel, Eric Cormier, Sophie Heurtebise, Katarzyna Jakubowska, Jean Lajzerowicz, Didier Mazon, João Jorge Santos, Emmanuelle Volant

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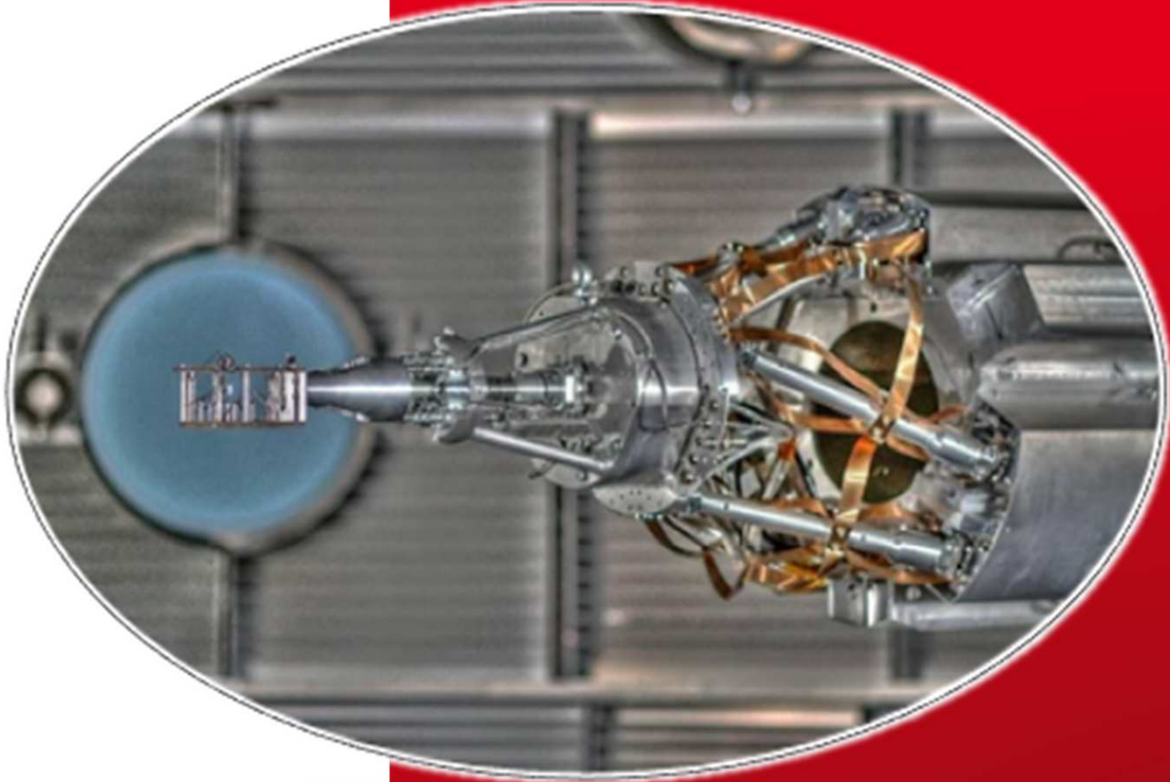
EPS endorsement pending

More information available at
https://ecpd2017.sciencesconf.org



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The PETAL Project

Petal PETAWATT AQUITAINE LASER

PETAL is a part of the opening policy of CEA

- It will be dedicated to the scientific community

INSTITUT LASERS ET PLASMAS

PETAL was supported by

REGION AQUITAINE

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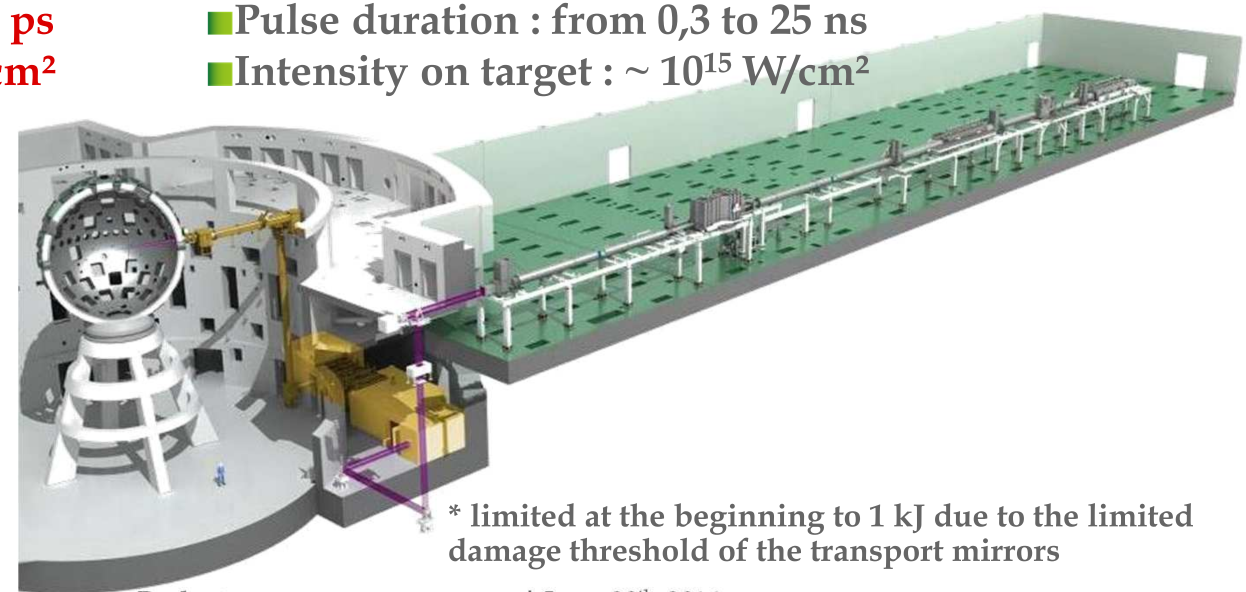
The coupling of PETAL with LMJ is an opportunity to study a wider field of physics

PETAL goals

- Energy : up to 3 kJ *
- Wavelength : **1053 nm** (526 nm option)
- Pulse duration : **from 0,5 to 10 ps**
- Intensity on target : **~ 10^{20} W/cm²**
- Power contrast : 10^{-7} at -7 ps
- Energy contrast : 10^{-3}

LMJ (1 beam)

- Energy : up to 7.5 kJ (x 176 = 1,3 MJ)
- Wavelength : 351 nm
- Pulse duration : from 0,3 to 25 ns
- Intensity on target : ~ 10^{15} W/cm²

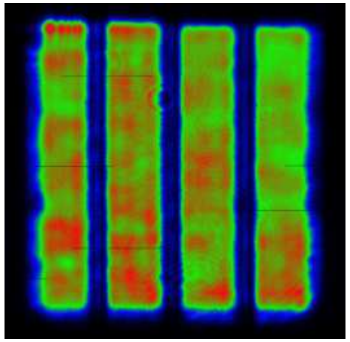


* limited at the beginning to 1 kJ due to the limited damage threshold of the transport mirrors

First high energy shots in May 2015 : 1,2 PW - 846 J / 700 fs

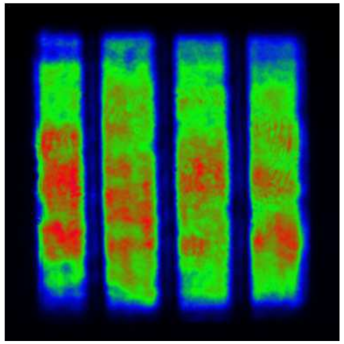
Experimental results May 29th

PAM output profile



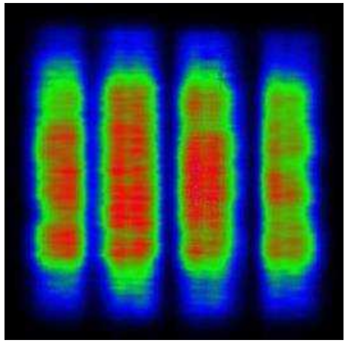
20,3 mJ

Amplifier output



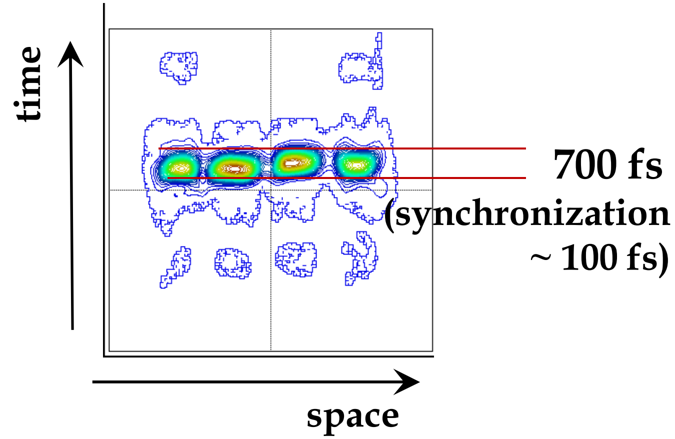
1,24 kJ

Compressor output



846 J

Spatio-temporal profiles at compressor output



=> 1.2 PW record

Qualification is going on :

- Compression optimization : 570 fs ☺
- New diagnostics installed :
  - Contrast, focal spot, phase, …
  - First contrast measurements : 10^{-6} @ -200 ps 😐 => 2w option to be considered
- Wave front correction (toroidal mirror) => better focal spot
- Spatial uniformity will be upgraded
- The filling of sub-aperture will be improved

The LMJ beamlines : most of the components have been qualified on the LIL prototype

- Square shape 37 cm x 35 cm
- 4 pass amplification
- Converted to 351 nm (3w)
- Focusing by gratings