LASER MEGAJOULE TARGET CHAMBER DIAGNOSTIC MODULE

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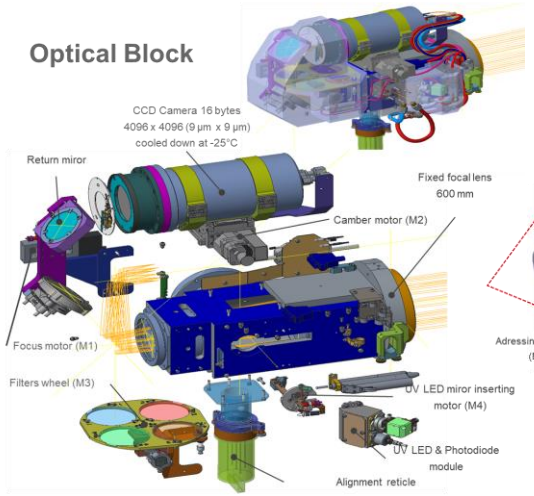
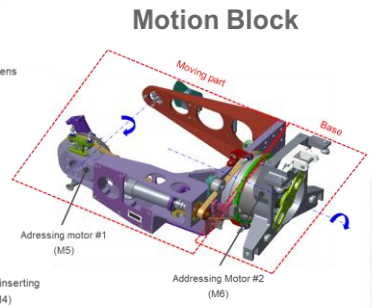
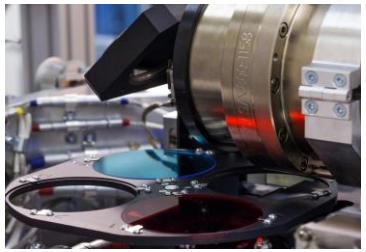
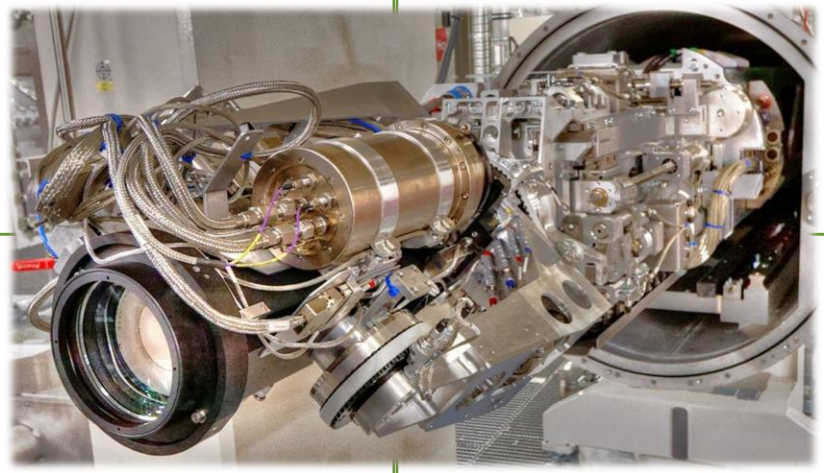
Equipment Presentation

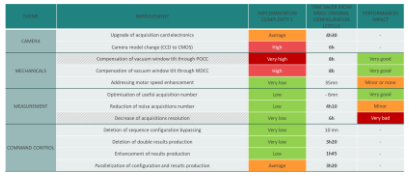








Timeline Improvement Impletentation Plan



Phase 0
2020 Summer

THEME	IMPROVEMENT	IMPLEMENTATION STATE
COMMAND CONTROL	Deletion of sequence configuration bypassing	Achieved in 2020
	Deletion of double results production	Achieved in 2020

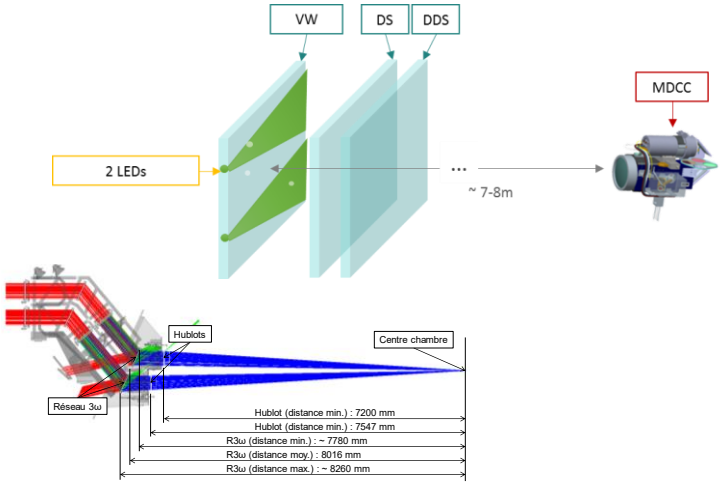
Phase 1
2021 Summer

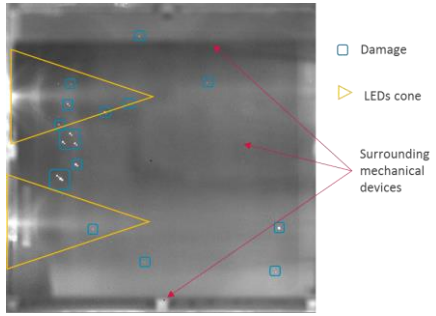
THEME	IMPROVEMENT	IMPLEMENTATION STATE
CAMERA	Upgrade of acquisition card electronics	Achieved in 2021
MESURE	Optimisation of useful acquisition number	Achieved in 2021
	Reduction of noise acquisitions number	Achieved in 2021
COMMAND CONTROL	Enhancement of results production	Achieved in 2021

Phase 2
2024 Summer

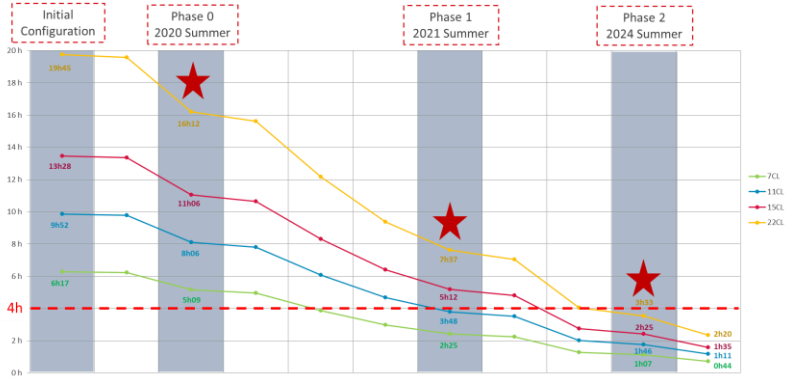
THEME	IMPROVEMENT	IMPLEMENTATION PLANNING
CAMERA	Camera model change (CCD to CMOS)	2024-2025
MECHANICALS	Addressing motor speed enhancement	2022
	Compensation of vacuum window tilt through MDCC	2024
COMMAND CONTROL	Parallelization of configuration and results production	2024

Damaging Measurement Process





Timeline Evolution & Conclusion



FUNCTIONS AND PERFORMANCES

One system for 3 measurements

- **Measurement of optical component damages at the end of laser bundle**
  - Vacuum windows
  - 3w gratings
- **Measurement of vacuum windows transmission rate**
- **Measurement of spatial energy distribution (near field) at the end of laser bundle**

Performances

- 100 µm resolution
- 50 µm damage detection
- Autonomous functioning by night

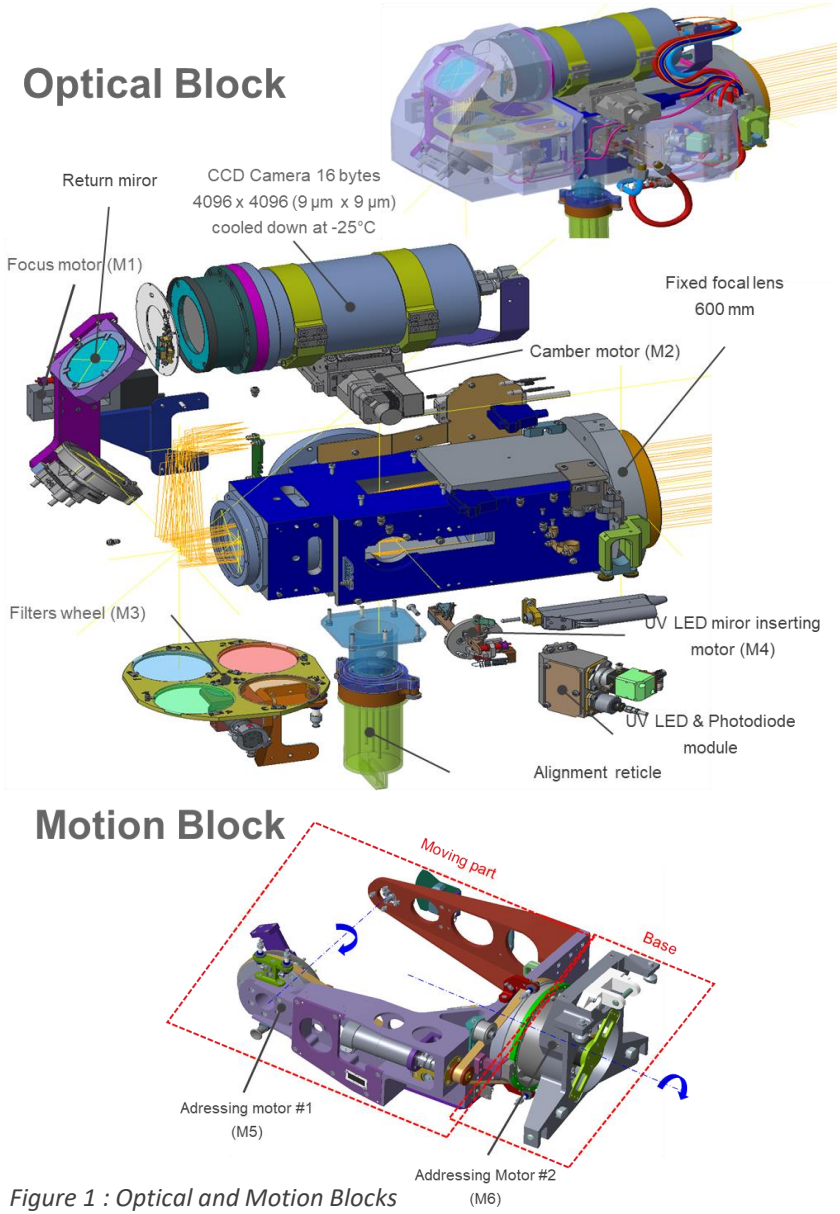


Figure 1 : Optical and Motion Blocks

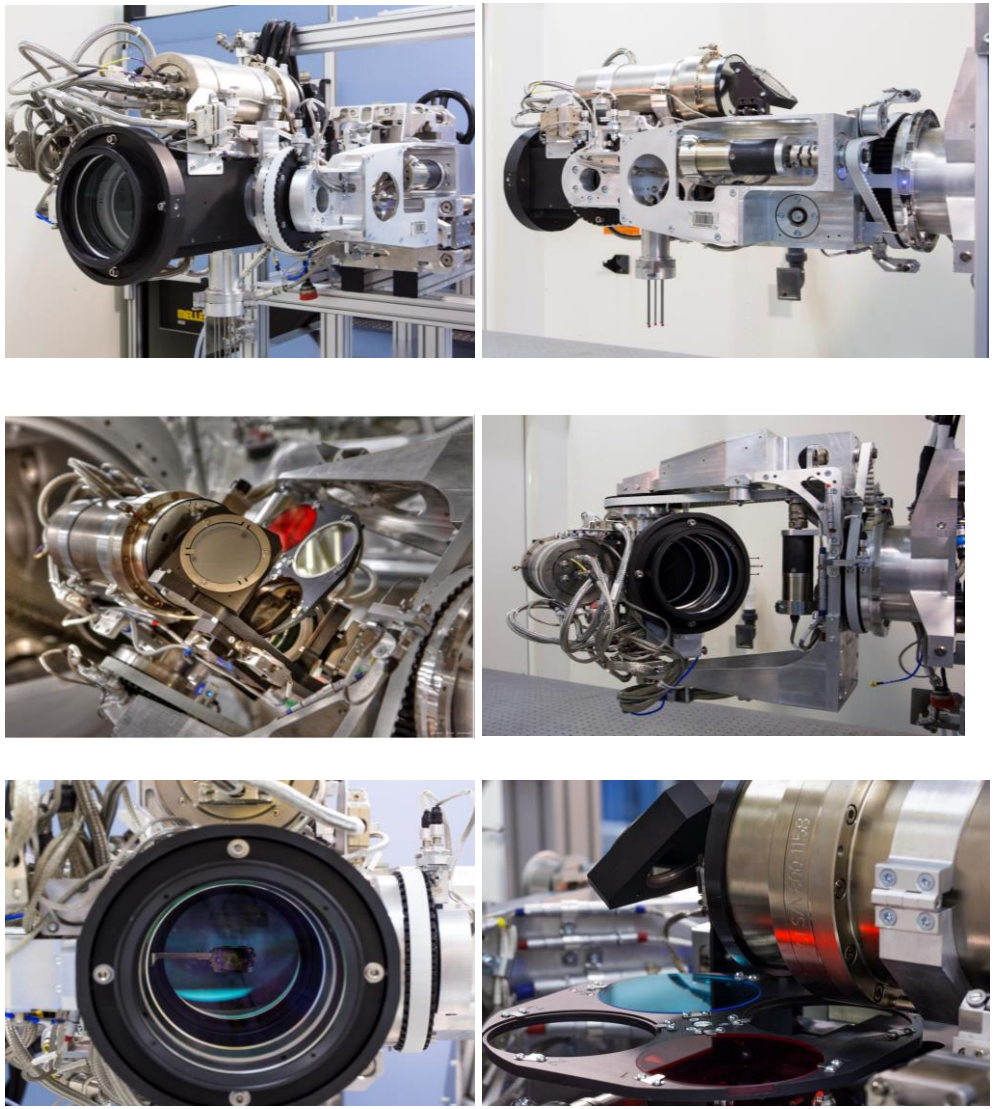


Figure 2 : MDCC Pictures (from qualification laboratory)

VACUUM WINDOW DAMAGING MEASUREMENT

1 VACUUM WINDOW ADDRESSING

- **MDCC positionning in front of the vacuum window observed**

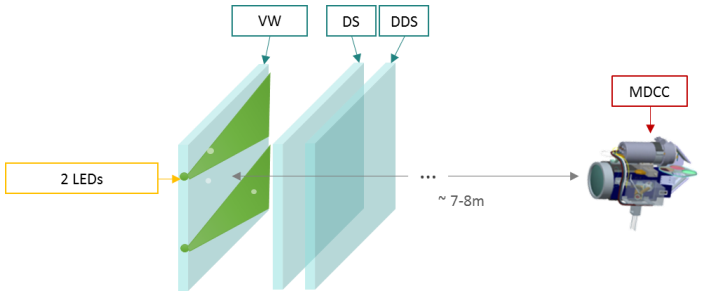


Figure 3 : MDCC Adressing

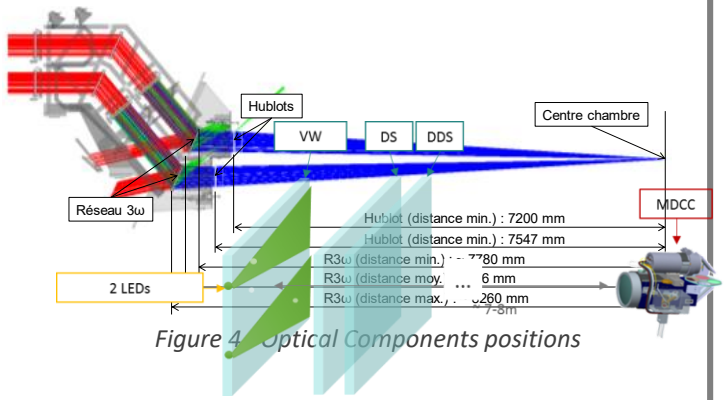


Figure 4 : Optical Components positions

- **Camera camber correction**

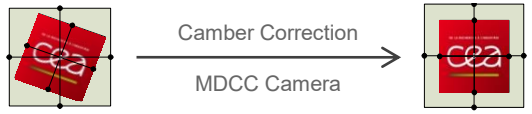


Figure 5 : Camera camber correction

2 DATA ACQUISITION

- **2 to 7 acquisitions LEDs on (at various focus, depending of vacuum windows inclination)**
- **1 acquisition LEDs off**

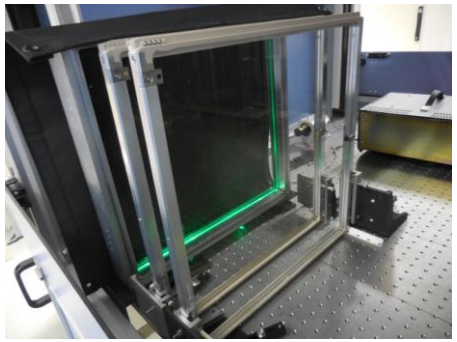


Figure 6 : Vacuum window illumination through green LEDs

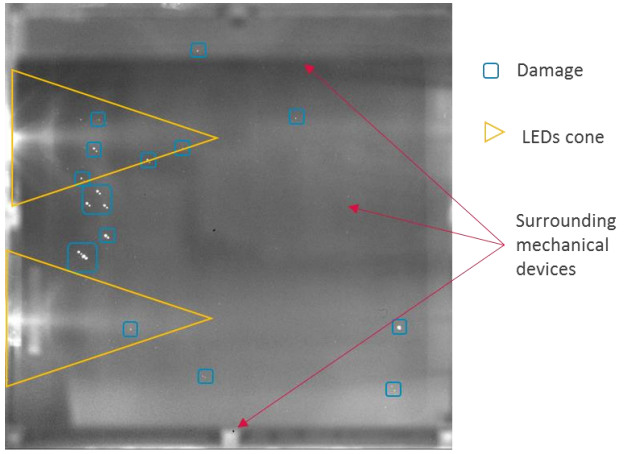


Figure 7 : MDCC acquisition

3 MEASUREMENT STAKES

- **Ensure installation safety**

  2 safety criteria for vacuum windows

  C1 criteria → total damaged surface

  Damaged surface proportion on the component < 10%

  C2 criteria → local damaged surface

  Damaged surface proportion on a 2x2 cm² sub-aperture < 60%

- **Enhance optical components durability**

  To limit costs and because of production and maintenance capability

  - Damage growth stop thanks to spot blockers
  - Recycle loop possible if damage size < 750 µm (reminder : MDCC resolution = 100 µm)

Figure 8 : Blockers seen from start (left) and end (right) of laser bundle

- **Predict damaging**
  - Damage laws knowledge for laser performances
  - Short term (maintenance) and long term (planification) prediction

DAMAGING MEASUREMENT SEQUENCE TIMELINE IMPROVEMENTS

- **Autonomous damage measurement sequence run by night**
- **Sequence duration with MDCC original configuration (at integration end of 2018)**
  - 6mn45s for a beam (1 vacuum window)
  - 54mn for a laser bundle (8 vacuum windows)
  - (By extrapolation) 19h45mn for all the LMJ installation (22 laser bundles, 176 vacuum windows)
- **Sequence timeline incompatible with installation timeline**
- **Search for solutions to fit the 4 hours time slot allocated in the targeted installation timeline**

THEME	IMPROVEMENT	IMPLEMENTATION COMPLEXITY [1]	TIME SAVER FROM MDCC ORIGINAL CONFIGURATION (22 CL) [2]	PERFORMANCES IMPACT
CAMERA	Upgrade of acquisition card electronics	Average	**4h30**	-
	Camera model change (CCD to CMOS)	High	**6h**	-
MECHANICALS	Compensation of vacuum window tilt through POCC	Very high	**8h**	Very good
	Compensation of vacuum window tilt through MDCC	High	**8h**	Very good
	Addressing motor speed enhancement	Very low	35mn	Minor or none
MEASUREMENT	Optimisation of useful acquisition number	Low	- 6mn	Very good
	Reduction of noise acquisitions number	Low	**4h10**	Minor
	Decrease of acquisitions resolution	Very low	**6h**	Very bad
COMMAND CONTROL	Deletion of sequence configuration bypassing	Very low	10 mn	-
	Deletion of double results production	Very low	**3h20**	-
	Enhancement of results production	Low	**1h45**	-
	Parallelization of configuration and results production	Average	**3h20**	-

[1] Cost/Time compromise
[2] Improvements combination reduce timesaver compared to sum of individual improvement timesavers

Figure 9 : Timeline Improvements

Phase 0 Mid 2020

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Phase 1 Mid 2021

THEME	IMPROVEMENT	IMPLEMENTATION STATE
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Phase 2 Mid 2024

THEME	IMPROVEMENT	IMPLEMENTATION PLANNING
CAMERA	Camera model change (CCD to CMOS)	2024-2025
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Figure 10 : Improvement implementation plan

- **3 phases of implementation planned between 2020 to 2024**
- **Expectation of sequence timeline reduction of more than 50% after the first 2 improvement phases**
- **Challenging last phase with most complex improvements (mechanicals and camera change)**

DAMAGING MEASUREMENT SEQUENCE TIMELINE EVOLUTION

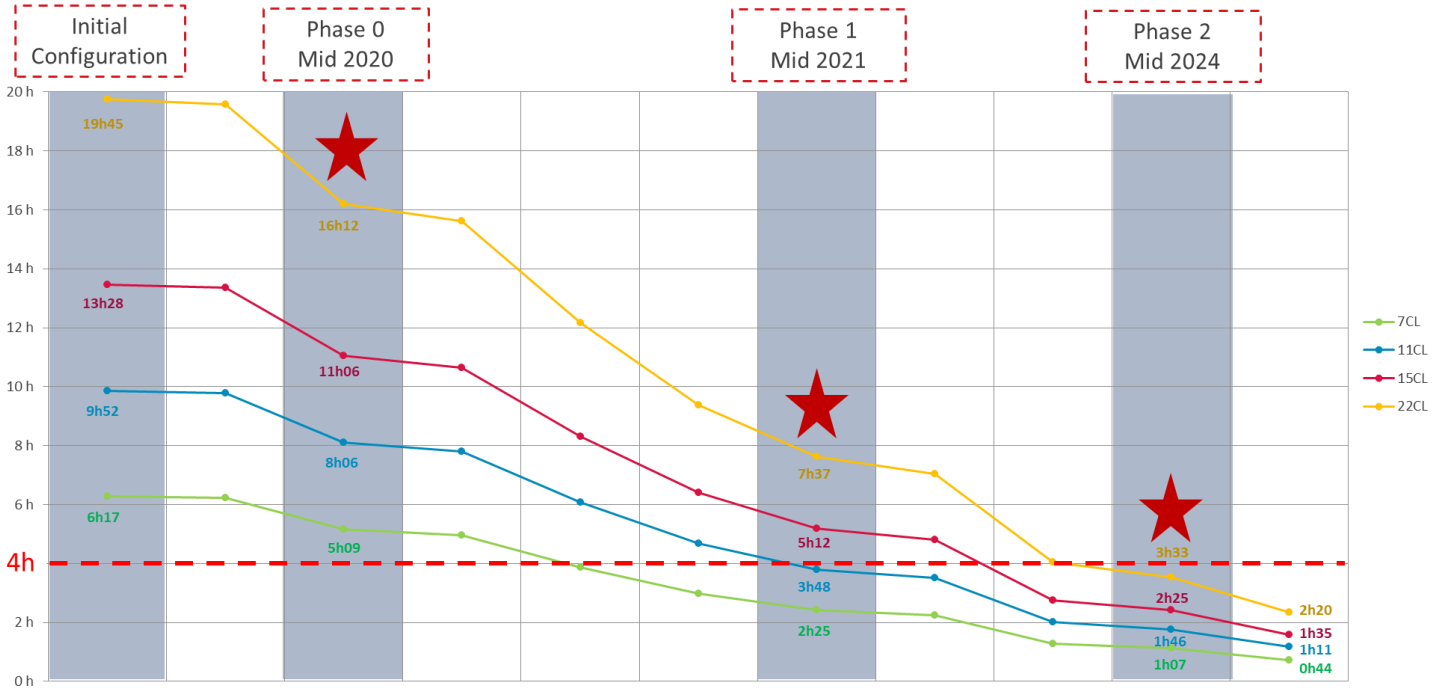

Figure 11 : Evolution of damaging sequence timeline

- Thanks to Phase 1 damaging measurement sequence run in less than 4 hours for 11 laser bundles, next LMJ milestone in 2022
- Phase 2 is a prequisite for the next milestones (15 and 22 laser bundles)
- Expectation of hardly 2 hours and 20 minutes for LMJ nominal configuration

ZOOM ON TRANSMISSION RATE MEASUREMENT

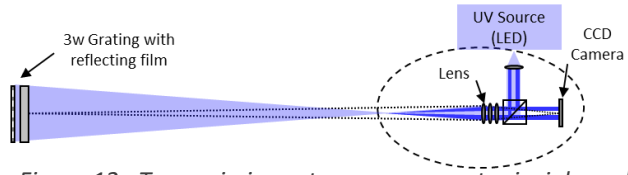

Figure 12 : Transmission rate measurement principle

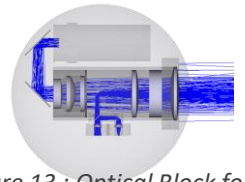

Figure 13 : Optical Block focus

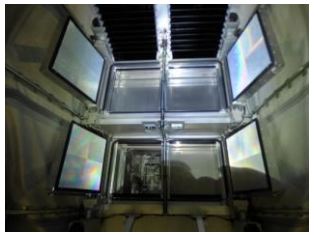

Figure 14 : 3w grating reflecting film

Comparison of UV LED emission signal and reflected signal acquired

Figure 15: Redirection mirror

SUMMARY

- One autonomous laser diagnostic for 3 measurements
- Measurement of vacuum window damaging most critical
- MDCC ensures installation safety and enhances optical components durability
- Warning on duration of damaging measurement sequence
- Various improvements identified and implemented or to come
- Evolution of sequence timeline promising to fulfill the needs and expectations