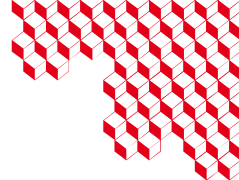


The Laser Megajoule Full Automated Sequences

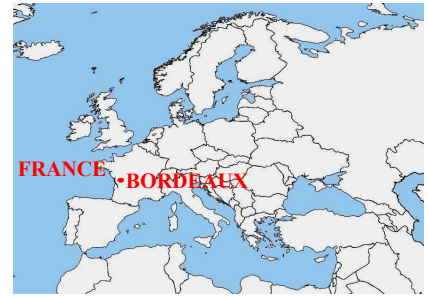
Authors : Yves Tranquille-Marques, Jean-Philippe Airiau, Pierre Baudon, Irwin Issury, Alain Mugnier (CEA, LEBARP cedex)



LMJ: LASER MEGA JOULE



- LMJ is a 176-beam laser facility developed by the French Nuclear Science directorate CEA, located at the *CEA CESTA site near Bordeaux
- Part of the French Simulation Program, it is designed to deliver about 1.4 MJ of energy on targets, for high energy density physics experiments, including fusion experiments
- Since 2022, the LMJ facility aims at carrying out experiments with 13 bundles of 8 laser beams and 20 target diagnostics.
- In order to achieve daily shots including all the preparatory steps, the LMJ performs night activities without operators. These sequences work on vacuum windows inspection and beam alignment. They are scheduled automatically one after the other.

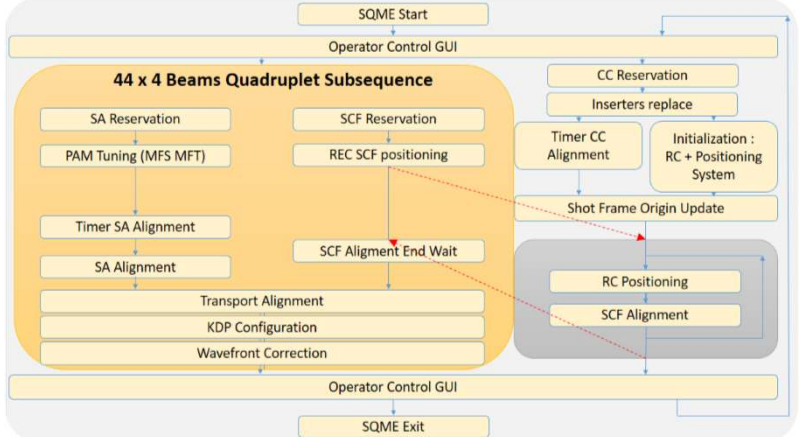
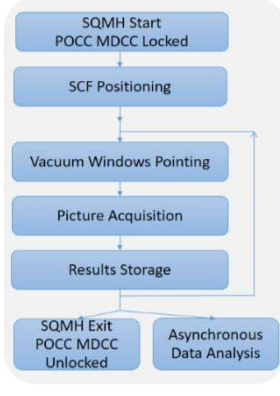
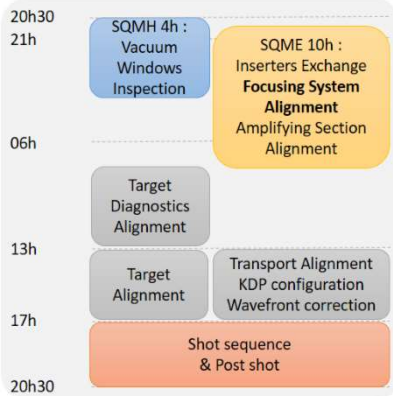


*CEA: Commissariat à l'Energie Atomique et aux Energies Alternatives

LMJ Automated Night Sequences

As prerequisites to shots, two sequences are performed during the night **without operator control** :

- vacuum windows damage inspection (**SQMH** sequence)
- alignment of laser beams (**SQME** sequence)



SHOT DAY SEQUENCE
 SQMH comes first and SQME waits. When SQMH ends, reservation mechanism unlocks SQMH resources for SQME use.

SQMH SEQUENCE
 Full automated sequence :
 • Exit against all constraints
 • Let SQME work during SQMH data analysis

SQME SEQUENCE
 SQME parallel scheduling and re-initialization availability improve success probability. They allow processing PAM tuning and SA reservation while SQMH is running.

Control GUI

The screenshot shows the 'SEQME : Séquence de préparation d'un tir de puissance' interface. It includes a 'Synthèse de l'étape / Réglages' section on the left with various sequence steps like 'Alignement CC', 'Alignement SA', and 'Alignement SCF'. The main area displays a 'VUE SYNTHÈSE ALIGNEMENT LASER + RESULTATS SQME' table with columns for sequence steps, coordinates, and status indicators.

Sequence	XYZ	Consignes SQME	Point visé en SCA (mm)	Position (Rc-mm)	SCF (mm)	SA	ST	KDP	PRECO
Reserver SA	20:56:12								
Reserver CC	22:48:34								
Inserters/Retirer REA	06:10:15	0.00 0.00 5.16 20:54:47	-0.02 -0.01 5.55	20:20:26	0.00 0.00 5.16	24:20:42	-0.02 -0.01 5.15	24:50:51	20:50:26
Inserters/Retirer REC	06:10:15	0.00 0.00 5.16 20:54:47	0.00 0.00 5.16	20:20:26	0.00 0.00 5.16	24:20:42	0.01 0.00 -0.04	24:50:51	20:50:26
Insertion TEI	06:10:15	0.00 0.00 5.16 20:54:47	0.01 -0.01 5.55	20:20:27	0.00 0.00 5.16	24:20:42	0.20 0.00 5.36	24:50:51	20:50:26
Regler/Retirer	06:10:15	0.00 0.00 5.16 20:54:47	0.02 -0.02 5.97	20:20:29	0.00 0.00 5.16	24:20:42	0.15 -0.25 5.32	24:50:52	20:50:26
Solliciter/Retirer	06:10:15	0.00 0.00 5.16 20:54:47	0.02 -0.02 5.87	20:20:29	0.00 0.00 5.16	24:20:42	0.03 -0.01 5.30	24:50:51	20:50:26
Retrait Pocc	20:55:22								
Retrait Pocc	20:55:20								
Insertion Pr	23:20:19	0.00 0.00 5.16 20:54:47	0.00 0.00 5.16	20:20:29	0.00 0.00 5.16	24:20:42	0.01 0.00 5.01	24:50:51	20:50:26
Automat SOPAC	23:20:42								
Démontage SOPAC	23:20:49	0.00 0.00 5.16 20:54:47	-0.01 -0.01 5.16	20:20:22	0.00 0.00 5.16	24:20:42	-0.01 -0.01 5.16	24:50:52	20:50:26
Arrêt RC	23:20:59								
Démontage RC	23:23:11								
Positionner en 0.0.0	04:07:08								
Faunim/PositionRc n°1	04:10:17								
Actualiser	04:13:20								
Faunim/PositionRc sulvaux	05:26:16	0.00 0.00 5.16 20:54:47	-0.01 -0.01 5.57	20:20:45	0.00 0.00 5.16	24:20:42	-0.01 -0.01 5.15	24:50:52	20:50:26

SQME GUI :

- Displays actions that are carried out by the sequence in a single windows
- Details an indicator for each function of 4 beams bundle granularity
- Indicates alignment function states : running, successful or not
- Enables to set parameters : perimeter, alignment actions and SA SCF alignment start times

ALIGNMENT SYNTHESIS GUI :

- Based on control points and success date
- Overview of all SQME steps results with time-stamping
- Highlighting not matching SCF/RC set up, RC position and SCF position

Enhancements

LAST IMPROVEMENTS :

- SQME Reservation Check
- SQMH Error Resilience
- Inserters Anticollision Control
- Positioning System Availability

FUTURE DEVELOPMENT :

- Anticollision : Target Diagnostic Position Checking
- Alignment : Target Diagnostic Integration to RC Alignment

