This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

IFAST WP7_Task 7.5: CompactLight Prototype Accelerating Structure

I.FAST 1st Annual Meeting, CERN May 2 -6, 2022

Gerardo D'Auria, Elettra - Sincrotrone Trieste

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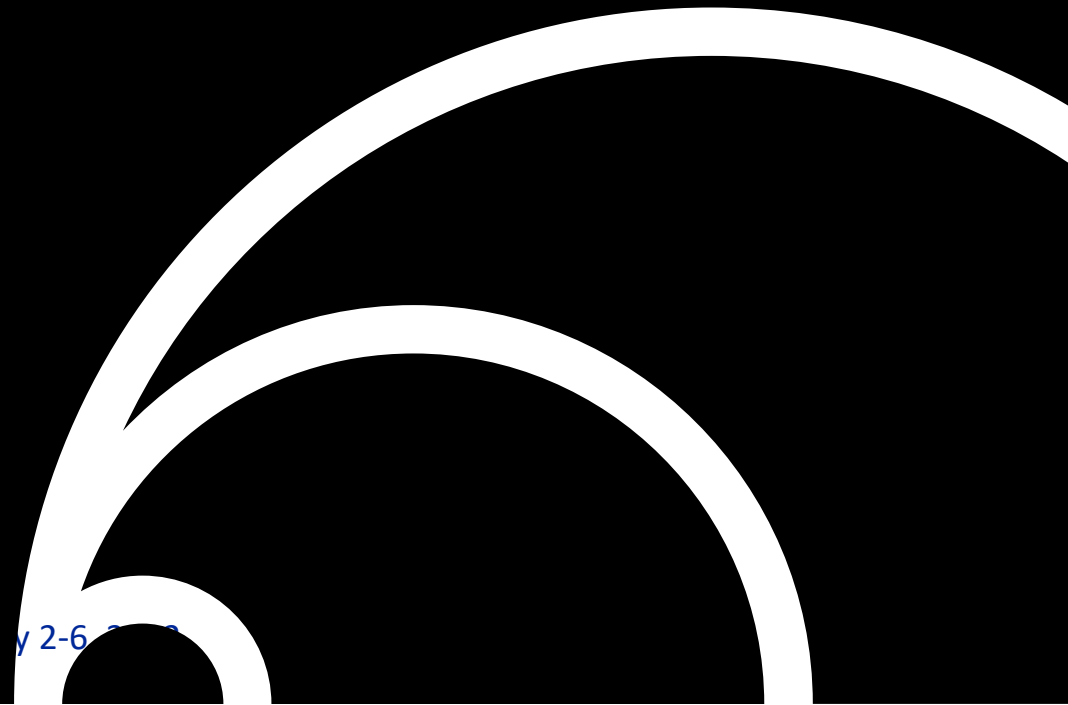


Task 7.5: CompactLight Prototype Accelerating Structures

Objective:

Build and test, at low and high RF power, two prototypes of the X-band (12 GHz) accelerating structure designed for the CompactLight (XLS) project, a new class of linac-driven FEL facilities, based on a Horizon 2020 Design Study. (http://www.compactlight.eu)

Task 7.5 Partners:

ELETTRA-ST **CERN** **INFN** **VDL-ETG** **COMEB** **TMD**

Activities and Deliverables

The two prototypes will be used to get a full validation of the XLS accelerating structure at two RF operating regimes:

a) high gradient/low pulse repetition rate (60 MV/m @100Hz);

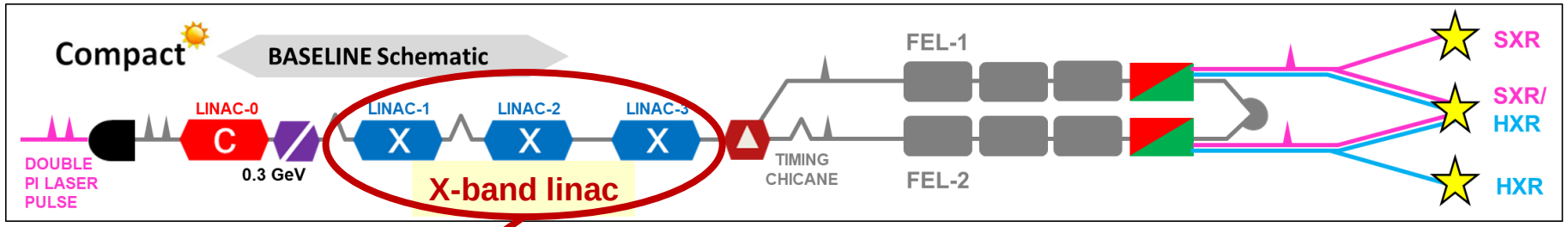
b) low gradient/high pulse repetition rate (30 MV/m up to 1KHz).

Two deliverables:

D7.5: Construction of the XLS accelerating structure pre-prototype.
Development of production process and RF tests of the pre-prototype (@TRL 6/7)_M32

D7.6: Construction of the XLS accelerating structure full prototype.
Production process analysis and validation, RF tests of the full prototype (@TRL 7)_M48

CompactLight Linac layout



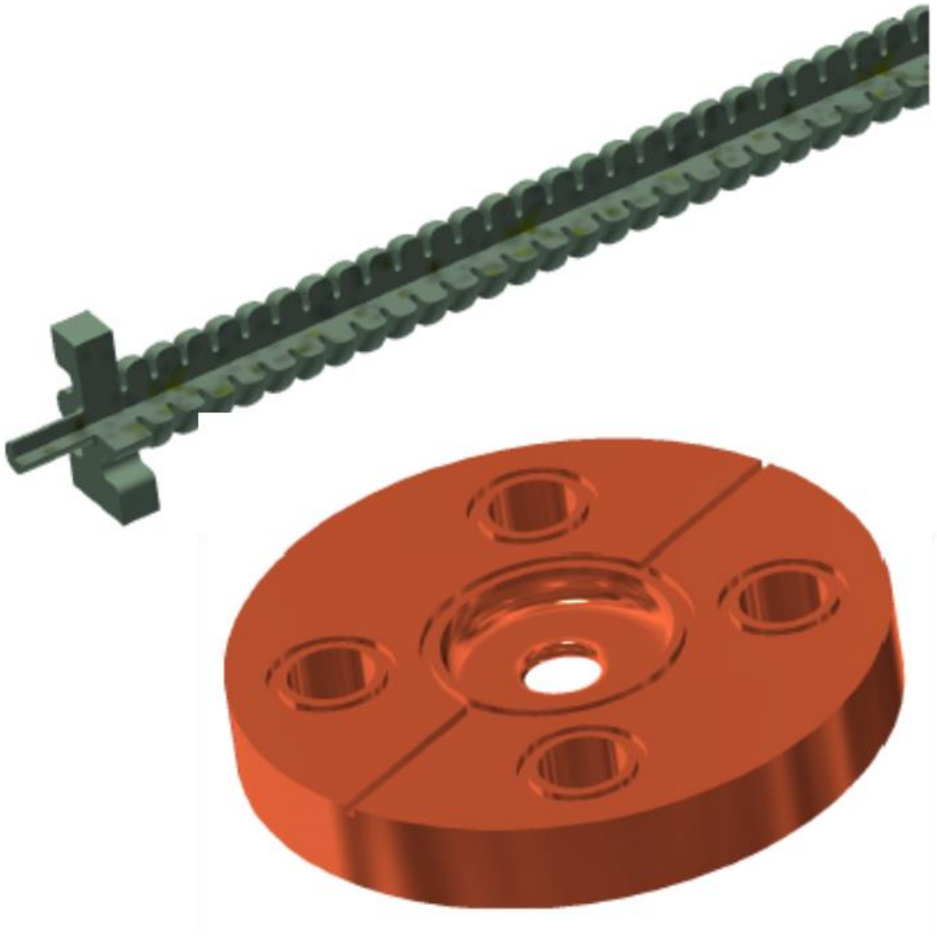
10 MW, 1.5 μs, @1 KHz

50 MW, 1.5 μs, @100 Hz

Parameter	Unit	Dual mode		Dual source	
Operating Mode		B		U1, U2	
Repetition rate	kHz	0.1	0.25	0.1	1
Linac active length	m	94			
Number of structures		104			
Number of modules		26			
Number of klystrons		26		26 + 26	
Peak acc. gradient	MV/m	65	32	65	30.4
Energy gain per module	MeV	234	115	234	109
Max. energy gain	MeV	6084	2990	6084	2834

Accelerating structure RF operating parameters

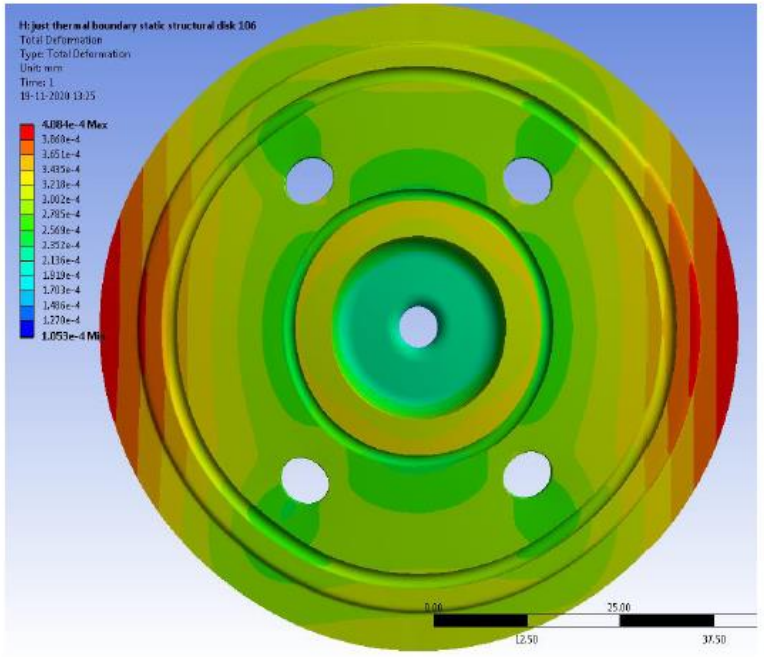
Parameter	Units	Value		
Frequency	GHz	11.994		
Peak klystron power (100 - 250 Hz)	MW	50		
Peak klystron power (1000 Hz)	MW	10		
RF pulse length (250 Hz)	μs	1.5 (0.15)		
Waveguide power attenuation	%	≈ 10		
Average iris radius a	mm	3.5		
Iris radius a	mm	4.3-2.7		
Iris thickness t	mm	2.0-2.24		
Structure length L_s	m	0.9		
Unloaded SLED Q-factor Q_0		180000		
External SLED Q-factor Q_E		23300		
Shunt impedance R	$M\Omega/m$	85-111		
Peak modified Poynting vector	$W/\mu m^2$	3.4		
Group velocity v_g/c	%	4.7-0.9		
Filling time t_f	ns	146		
Repetition rate	Hz	100	250	1000
SLED		ON	OFF	ON
Required klystron power	MW	44	44	9
Average accelerating gradient	MV/m	65	30	30



Courtesy M. Diomede

Thermo-mechanical design

- Optimization of the cooling geometry
- Iteration with RF on the deformation
- Choice for 4 cooling channels with a diameter of 6 mm (similar to CLIC)
- Cooling channels slightly asymmetrical to match the RF couplers



Courtesy M. van den Berg

Unexpected problems

Unfortunately, in mid-August, we were informed that our colleague, Mathieu Breukers, one of the founding fathers of the ultra precision machining activities at VDL-ETG, responsible for the XLS structure manufacturing, passed away.

For this reason, all the activities to prepare the disks manufacturing, the structure brazing, etc. have been stopped to allow VDL to review their work plans and to determine the way forward without the expertise and experience of Mathieu.

Restart of activities

The activity resumed at the end of January 2022 to complete the preparatory phase. Mari Van Der Linden was appointed by the VDL to continue the planned activities on Task 7.5

- **Establish the brazing procedure**
- **Organize a brazing test, on few cells, at TMD.**

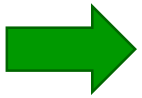
It was also decided to ask for a 12 months extension of Task 7.5:

- **From April 2024 up to April 2025** (end of project), staying within the four years project limit.

Activity status

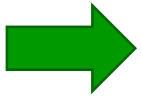
Preparatory phase:

- **Technical drawings for prototype production**
- **Thermo-mechanical analysis and temperature stabilization at different operating regimes**
- **Structure thermal simulations (INFN)**



Activities started in May 2021 and carried out up to mid of July 2021

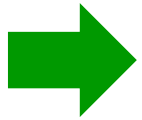
Brazing procedures



Activity started in Jan. 2022

Next steps

- **Brazing tests (three disks) at TMD:**
  - **one coupler**
  - **two discs and covers on both sides**
- **Allows for water and vacuum circuits**
- **Production process analysis and optimization**

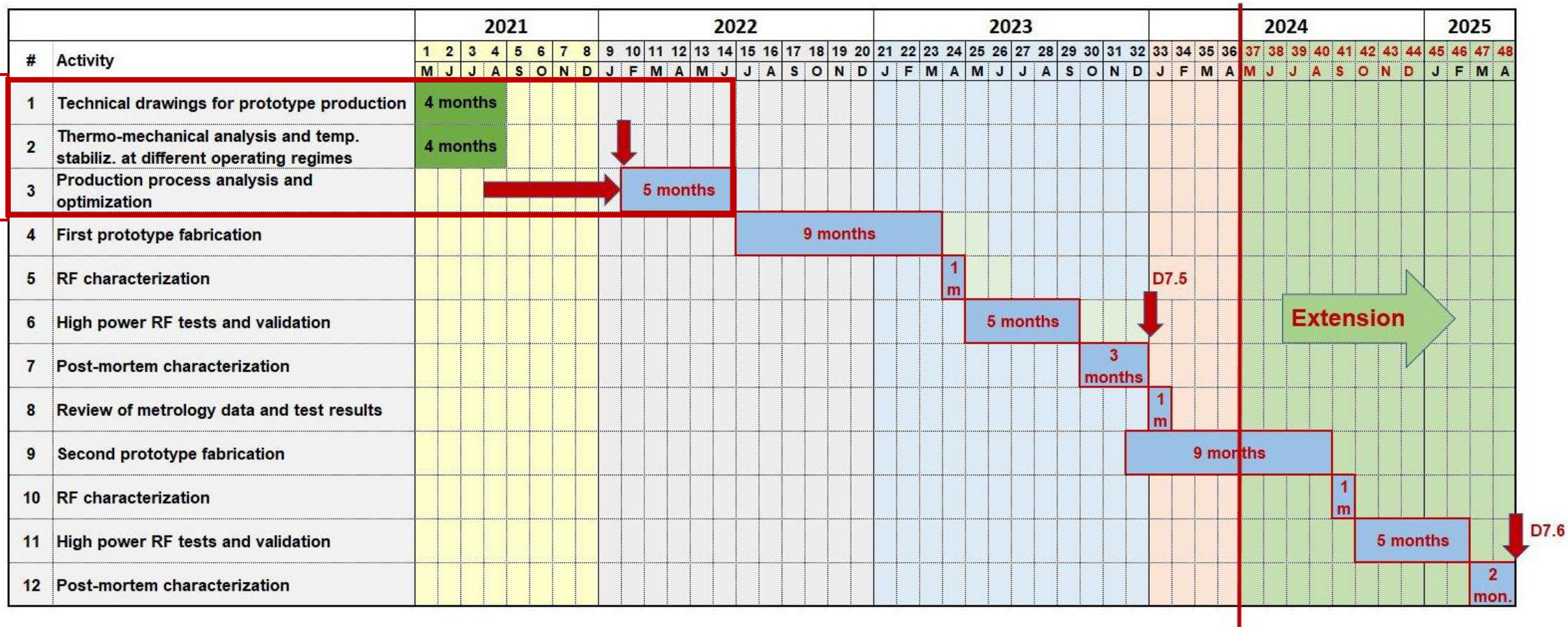


Activities to be completed by the end of June 2022

The first prototype fabrication will start in July 2022

Task 7.5 new time schedule

Preparatory phase for structure fabrication



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Thank you!

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