CLIC MiniWeek

Pedro Morales Sanchez – CERN

12/12/2023

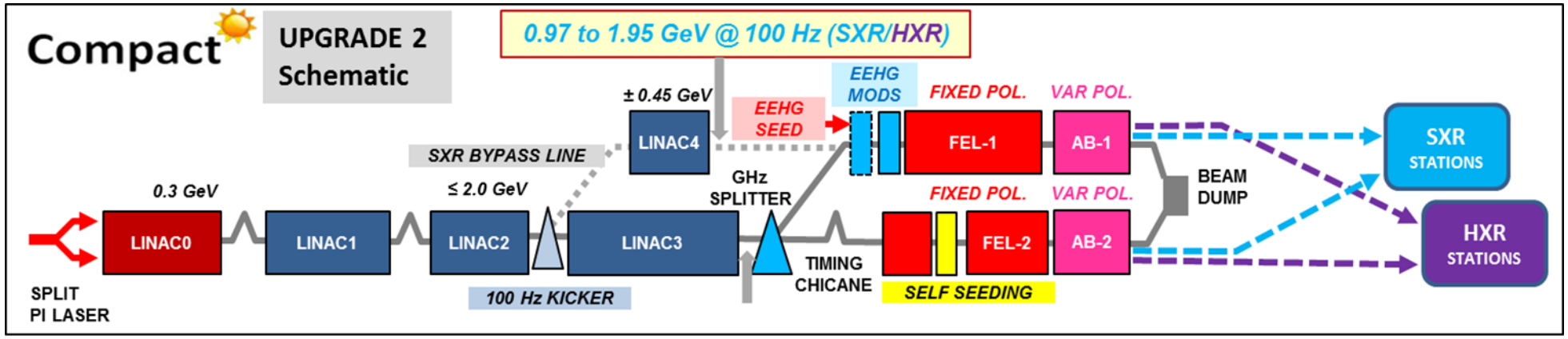
Contends

- CompactLight + iFAST
- iFAST prototype on going
  - Design
  - Mock-Up
  - Prototype
- Conclusion

Contends

- CompactLight + iFAST
- iFAST prototype on going
  - Design
  - Mock-Up
  - Prototype
- Conclusion

CompactLight + iFAST

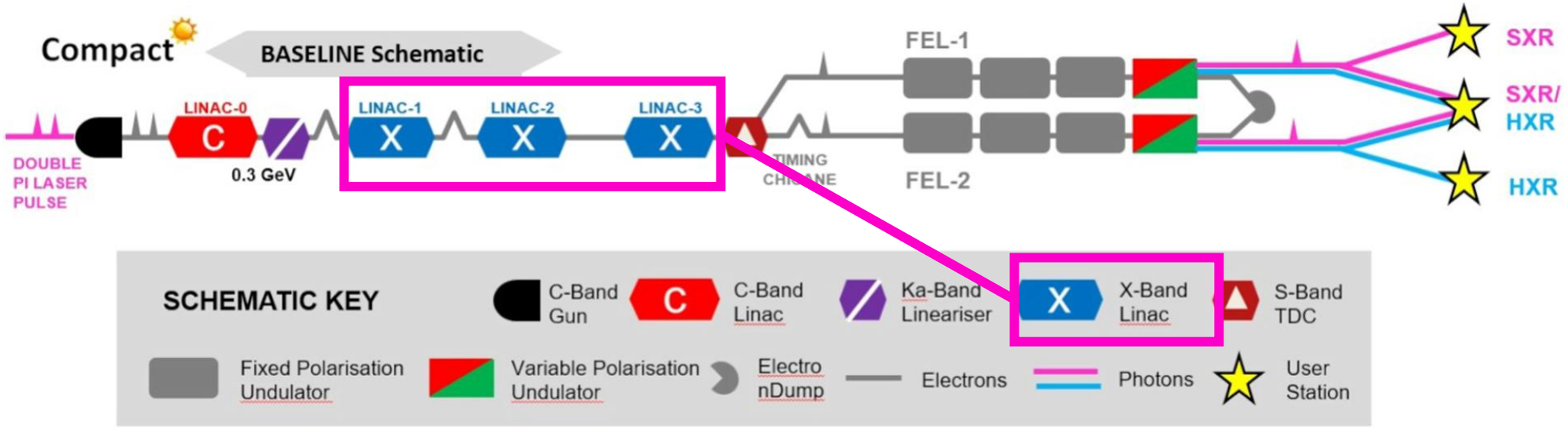


Objective of CompactLight: “The project aims at making X-ray FELs small and inexpensive enough to be within national and even university scale, yet with uncompromised scientific potential”.

Focus on Cost, Power consumption and Footprint.

EU Founded H2020 collaboration among 26 institutions

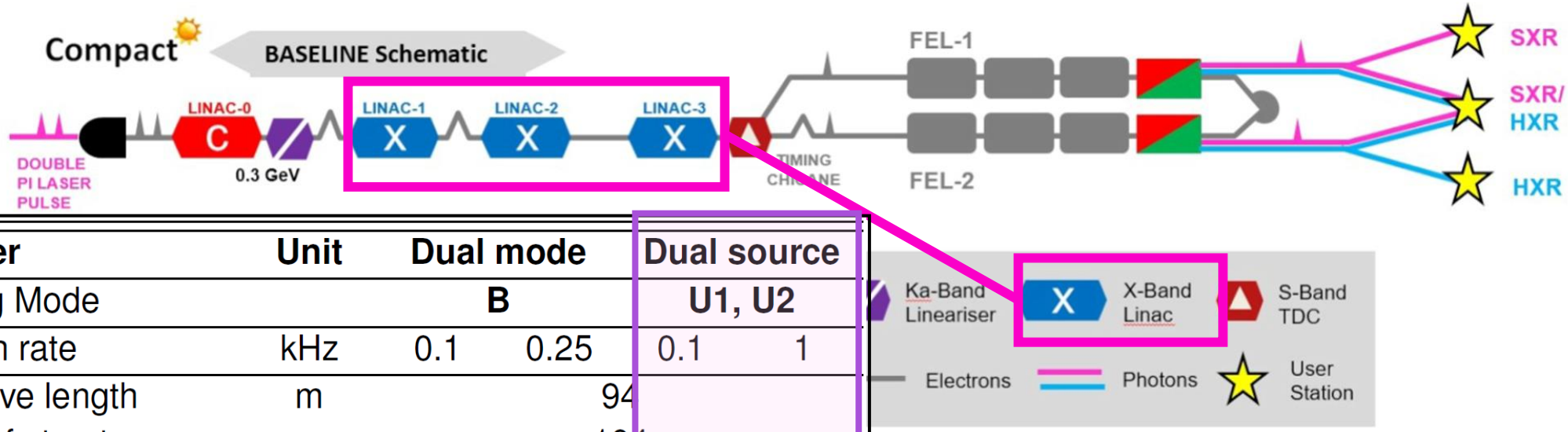
CompactLight + iFAST



10 MW, 1.5 μs, @1 KHz

50 MW, 1.5 μs, @100 Hz

CompactLight + iFAST



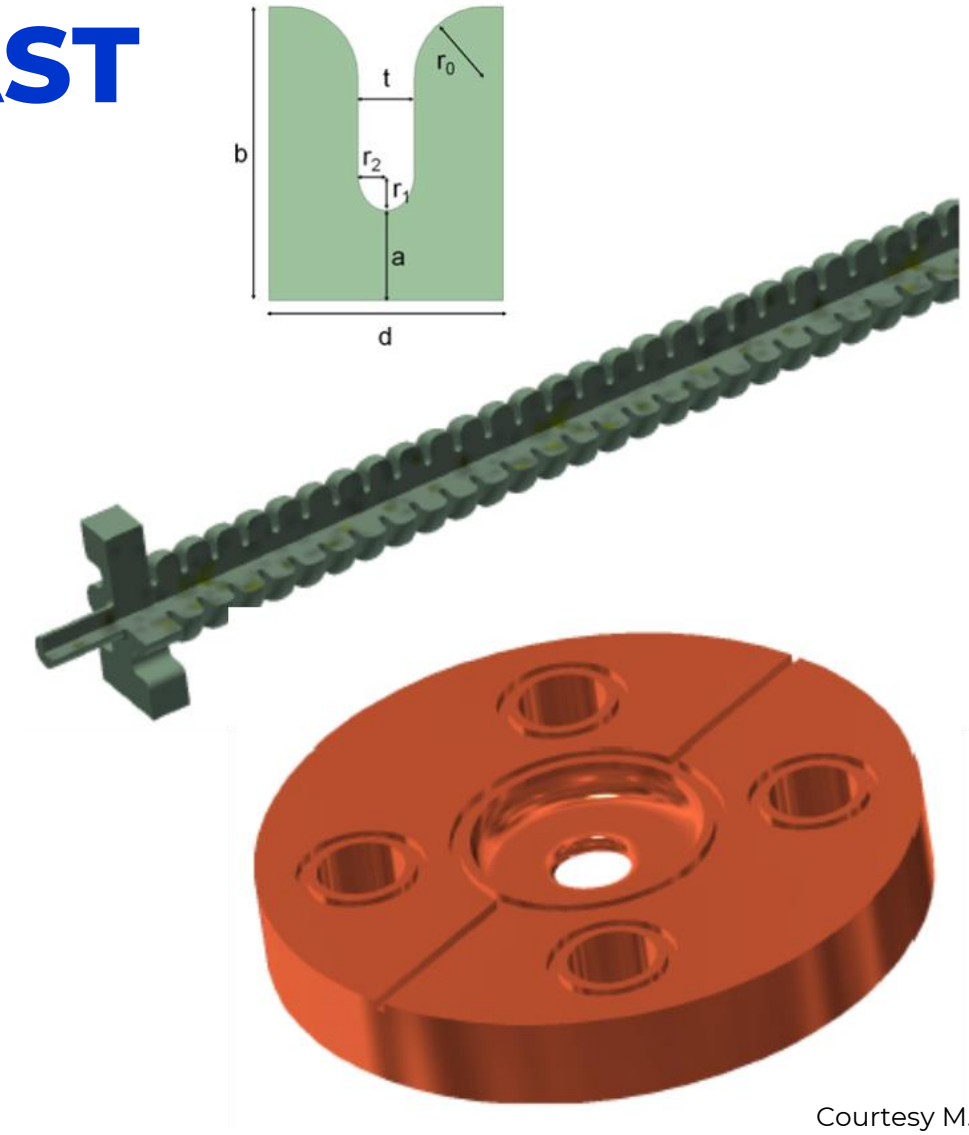
Parameter	Unit	Dual mode		Dual source	
Operating Mode		B		U1, U2	
Repetition rate	kHz	0.1	0.25	0.1	1
Linac active length	m	94			
Number of structures		104			
Number of modules		26			
Number of klystrons		26		26 + 26	
Peak acc. gradient	MV/m	65	32	65	30.4
Energy gain per module	MeV	234	115	234	109
Max.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

10 MW, 1.5 μs, @1 KHz

50 MW, 1.5 μs, @100 Hz

CompactLight + iFAST

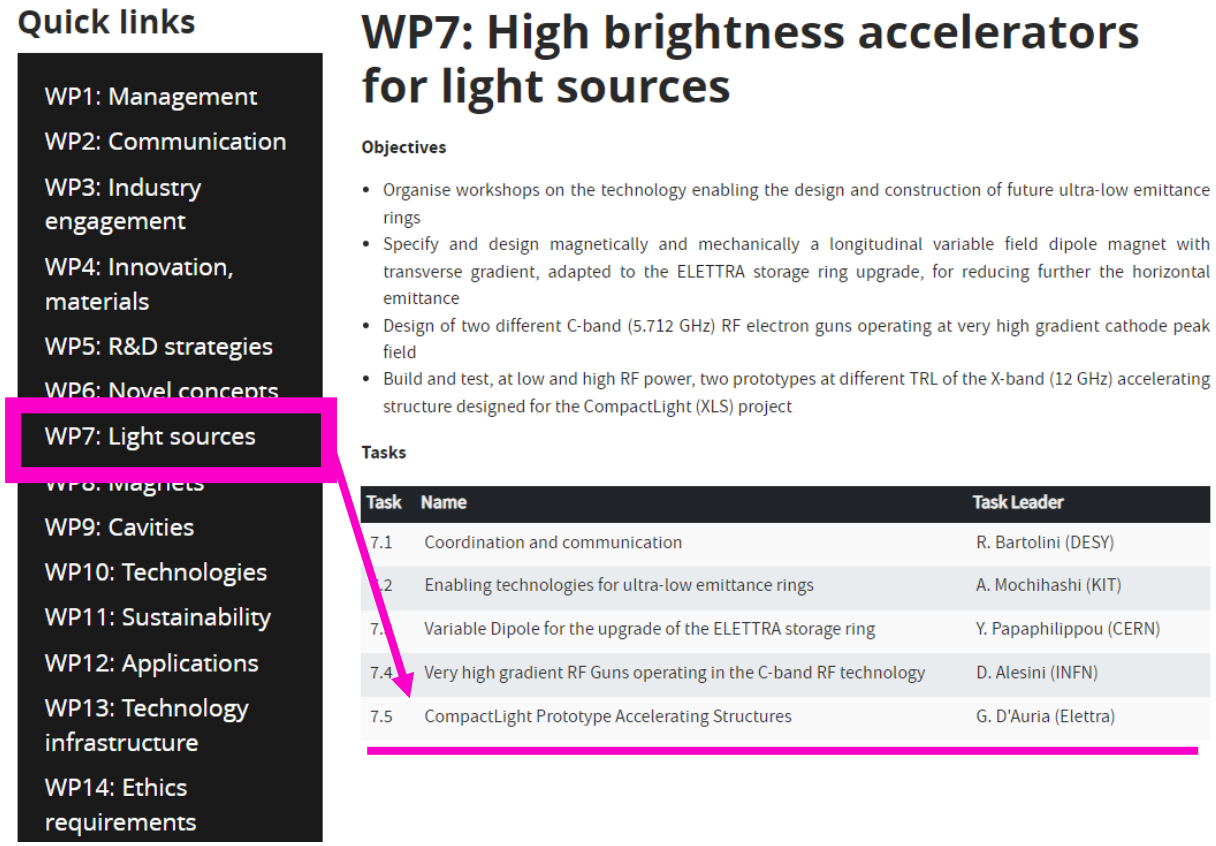
Parameter	Units	Value		
Frequency	GHz	11.994		
Peak klystron power (100 - 250 Hz)	MW	50		
Peak klystron power (1000 Hz)	MW	10		
RF pulse length (250 Hz)	μs	1.5 (0.15)		
Waveguide power attenuation	%	≈ 10		
Average iris radius a	mm	3.5		
Iris radius a	mm	4.3-2.7		
Iris thickness t	mm	2.0-2.24		
Structure 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

CompactLight + iFAST

Objectives: “I.FAST aims to enhance innovation in the particle accelerator community,[…]These include, among others, new accelerator designs and concepts, advanced superconducting technologies for magnets and cavities, techniques to increase brightness of synchrotron light sources, strategies and technology to improve energy efficiency, and new societal applications of accelerators”.



CompactLight + iFAST

Task 7.5: CompactLight accelerating structure prototype

Objective: Build and test, at low and high RF power, two prototypes of the X-band (12 GHz) accelerating structure designed for the CompactLight project.

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)_ Feb24
- **D7.6: Construction of the XLS accelerating structure full prototype.**
Production process analysis and validation, RF tests of the full prototype (@TRL 7)_Apr25

CompactLight + iFAST

Task 7.5 Partners

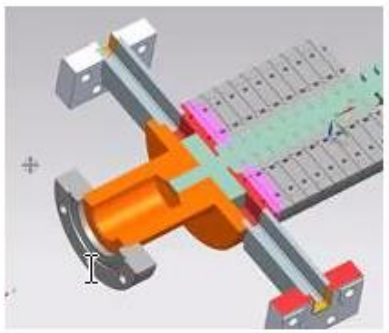
ELETTRA-ST	CERN	INFN	VDL-ETG	COMEB	TMD
- General coordination	- Consultancy - Metrology verification - RF measurements at low and high power	- Electro-magnetic design of the structure - RF measurements at low and high power	- Fabrication of cells and couplers	- Fabrication of cells and couplers	- Brazing

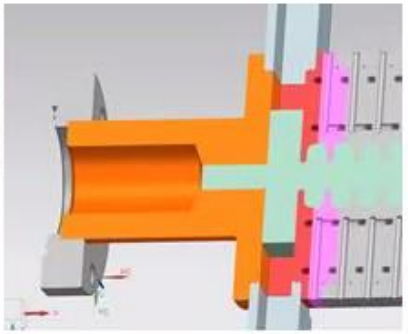
Contends

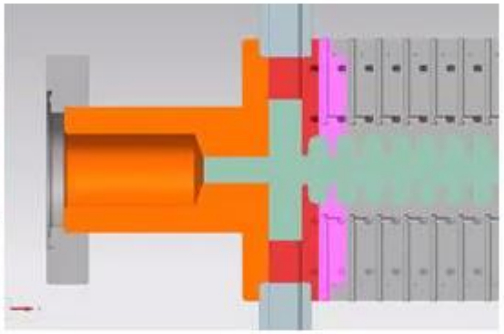
- CompactLight + iFAST
- iFAST prototype on going
  - Design
  - Mock-Up
  - Prototype
- Conclusion

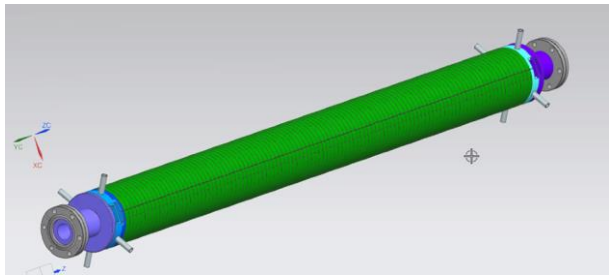
iFAST prototype on going - Design

RF accelerating structure







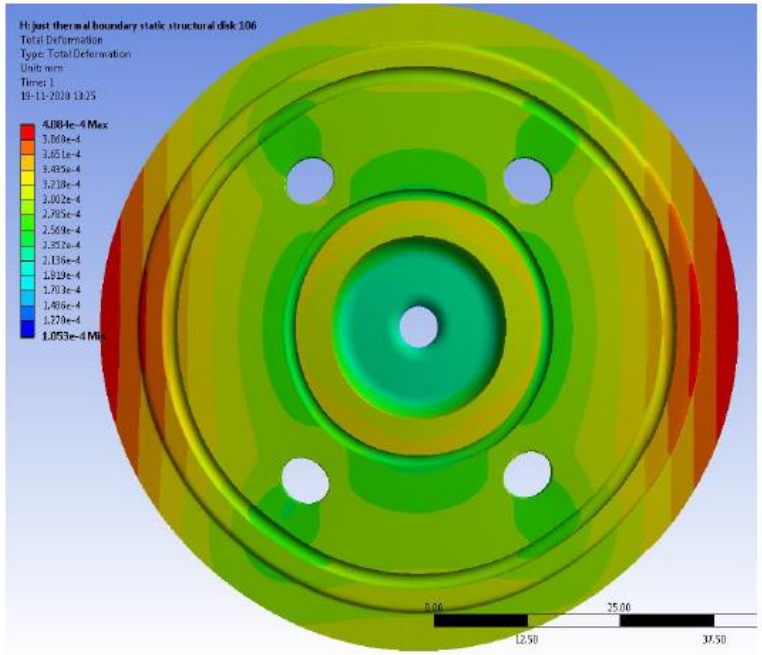


RF Structure
Input – Output RF couplers

iFAST prototype on going - Design

Thermo-mechanical simulations

- 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

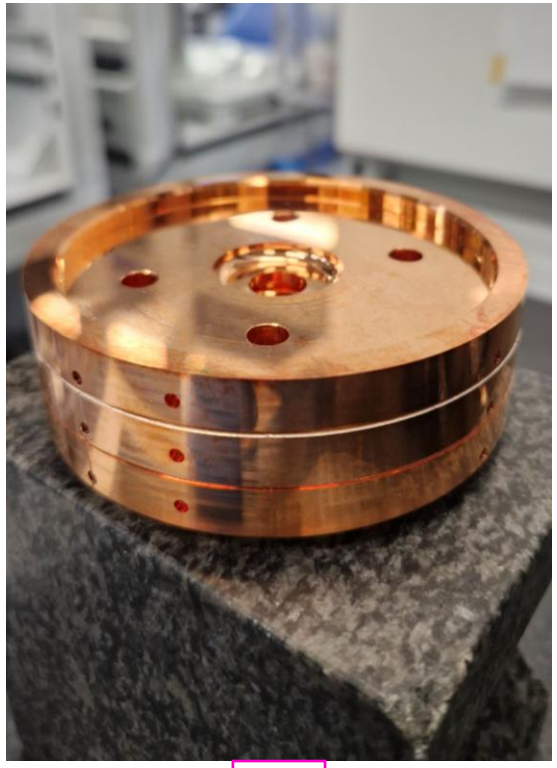


Courtesy M. van den Berg

Contends

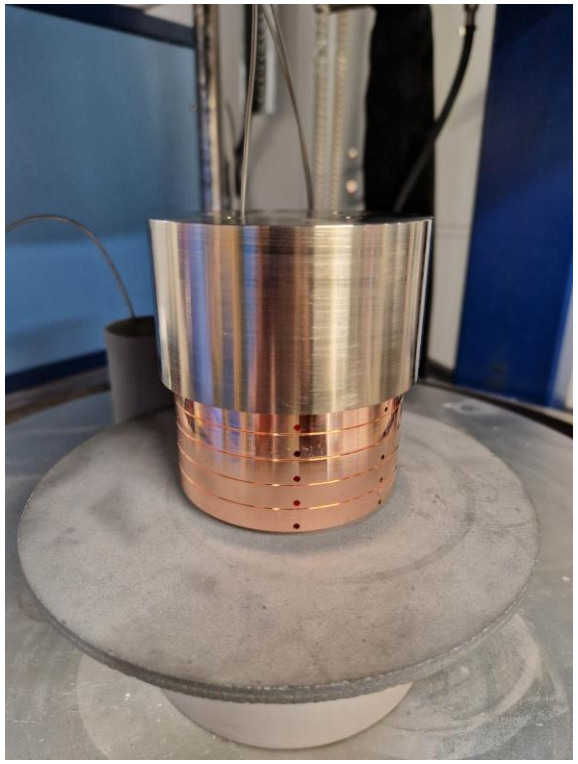
- CompactLight + iFAST
- iFAST prototype on going
  - Design
  - Mock-Up
  - Prototype
- Conclusion

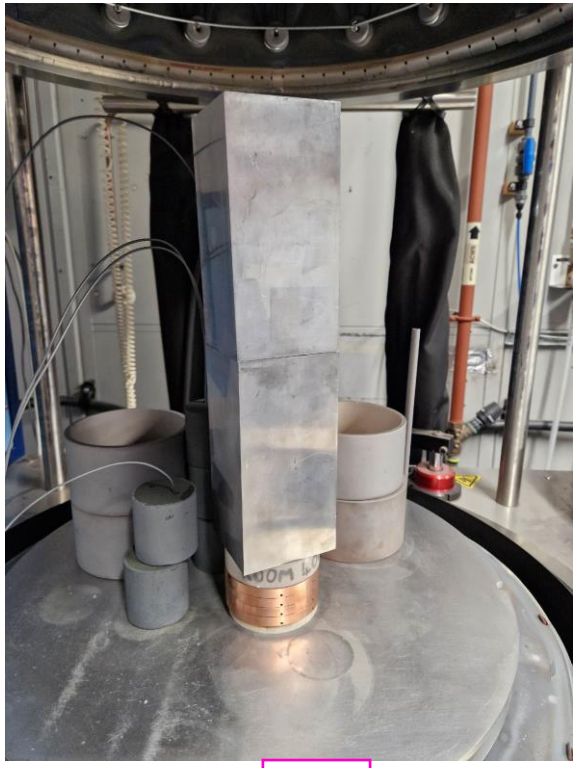
iFAST prototype on going – Mock-up



1st

2nd





3rd

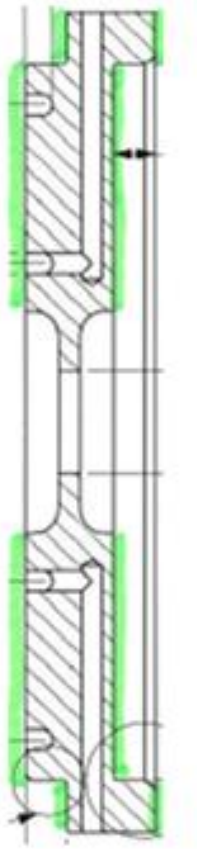
3 trials have been carried out with different conditions:

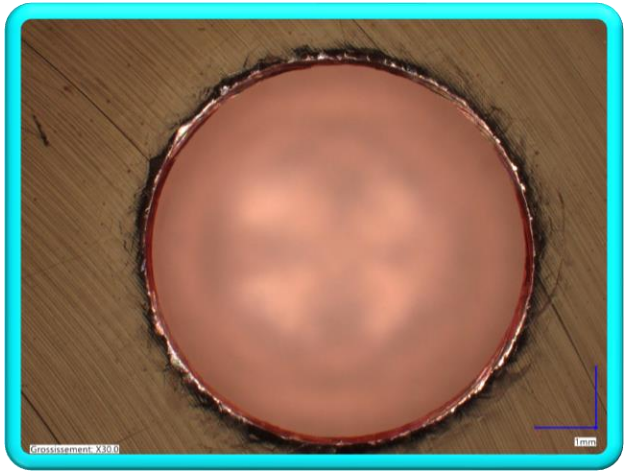
Machinability
Interlocking alignment
Brazing material
Leak tightness
Weight

iFAST prototype on going – Mock-up

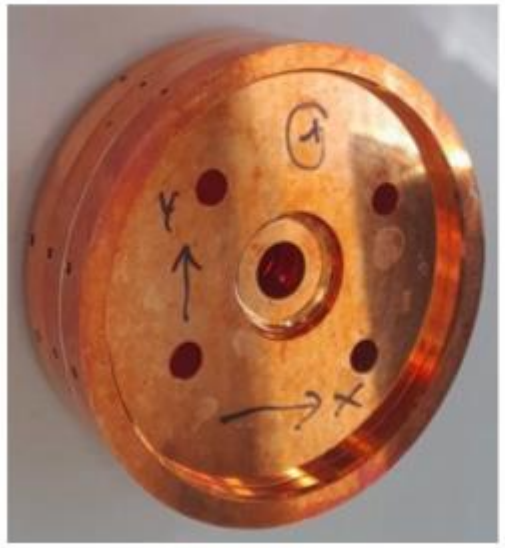
Courtesy COMEB

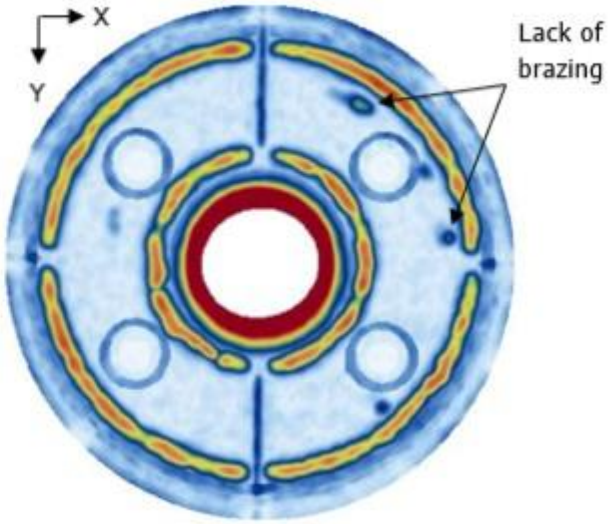
- 35um





iFAST prototype on going – Mock-up

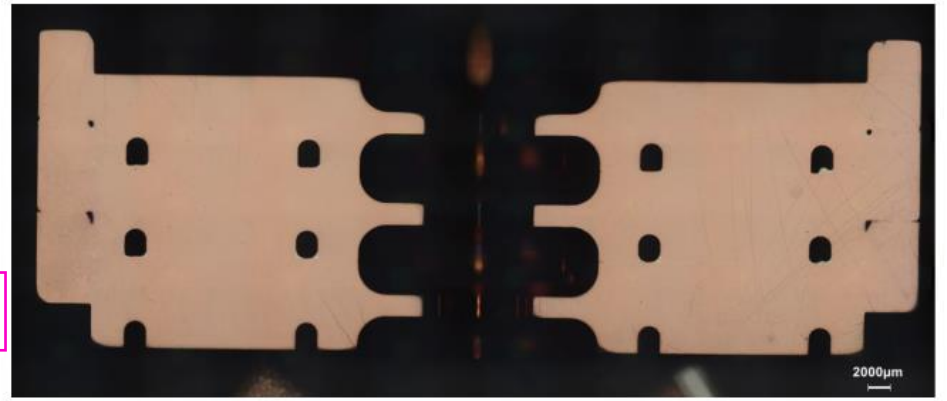




Performed UT analysis and microscopy afterward. BFM inspection

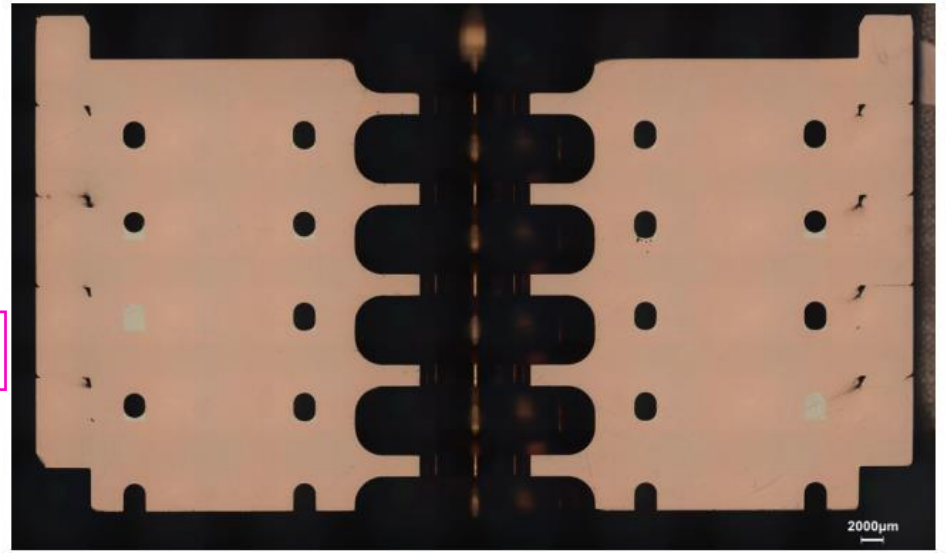
X3

1st

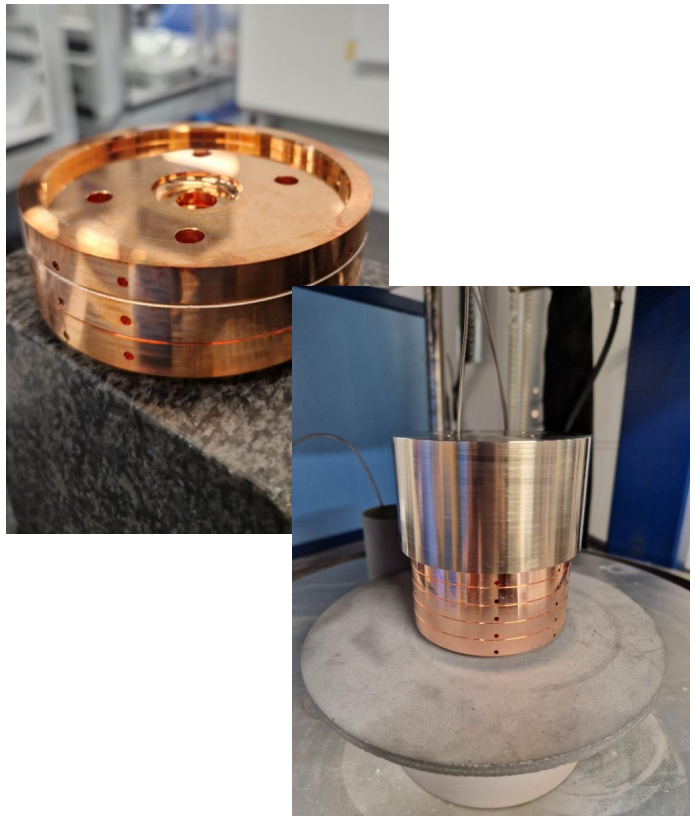


X5

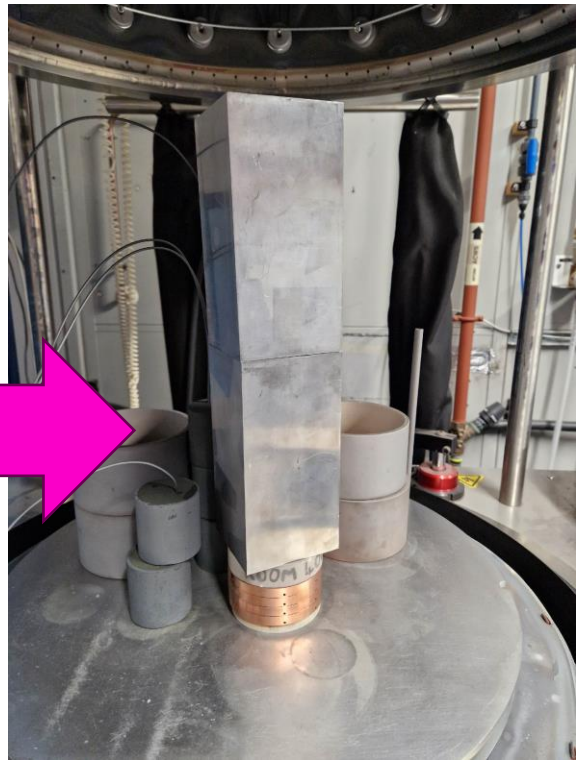
2nd



iFAST prototype on going – Mock-up



The alignment and flatness of the structure were kept as expected after the cycle with the 40kg on top. The BFM was not showing itself on the external surface and it was successfully tested under vacuum.



3rd

Pictures Courtesy TMD

Contends

- CompactLight + iFAST
- iFAST prototype on going
  - Design
  - Mock-Up
  - Prototype
- Conclusion

iFAST prototype on going – Prototype

Machining done at VDL

iFAST prototype on going – Prototype

ZEISS CALYPSO
7.6.0403

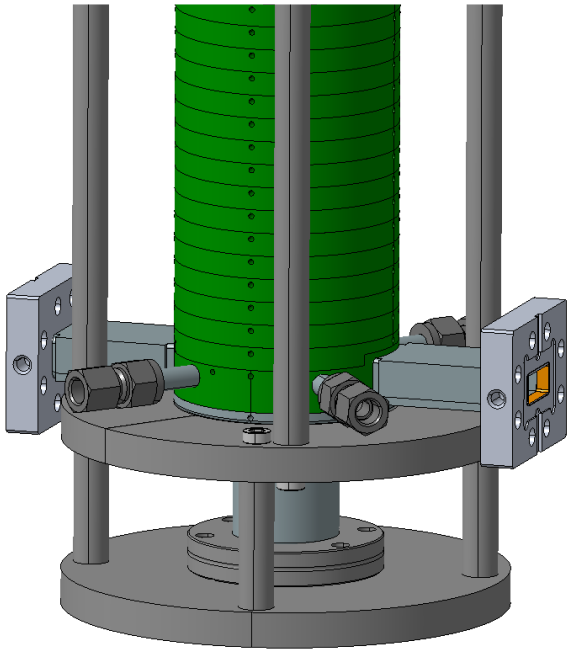
Metrology crosscheck

CERN-METROLOGY

iFAST xband disk 049

EDMS N°: 2977953

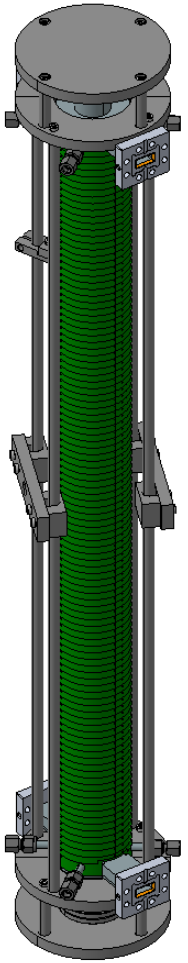
iFAST prototype on going – Prototype



Tooling fabrication is ongoing at TMD

The shipment is on its way from CERN to the UK

Assembly forecasted by January 2024



Contends

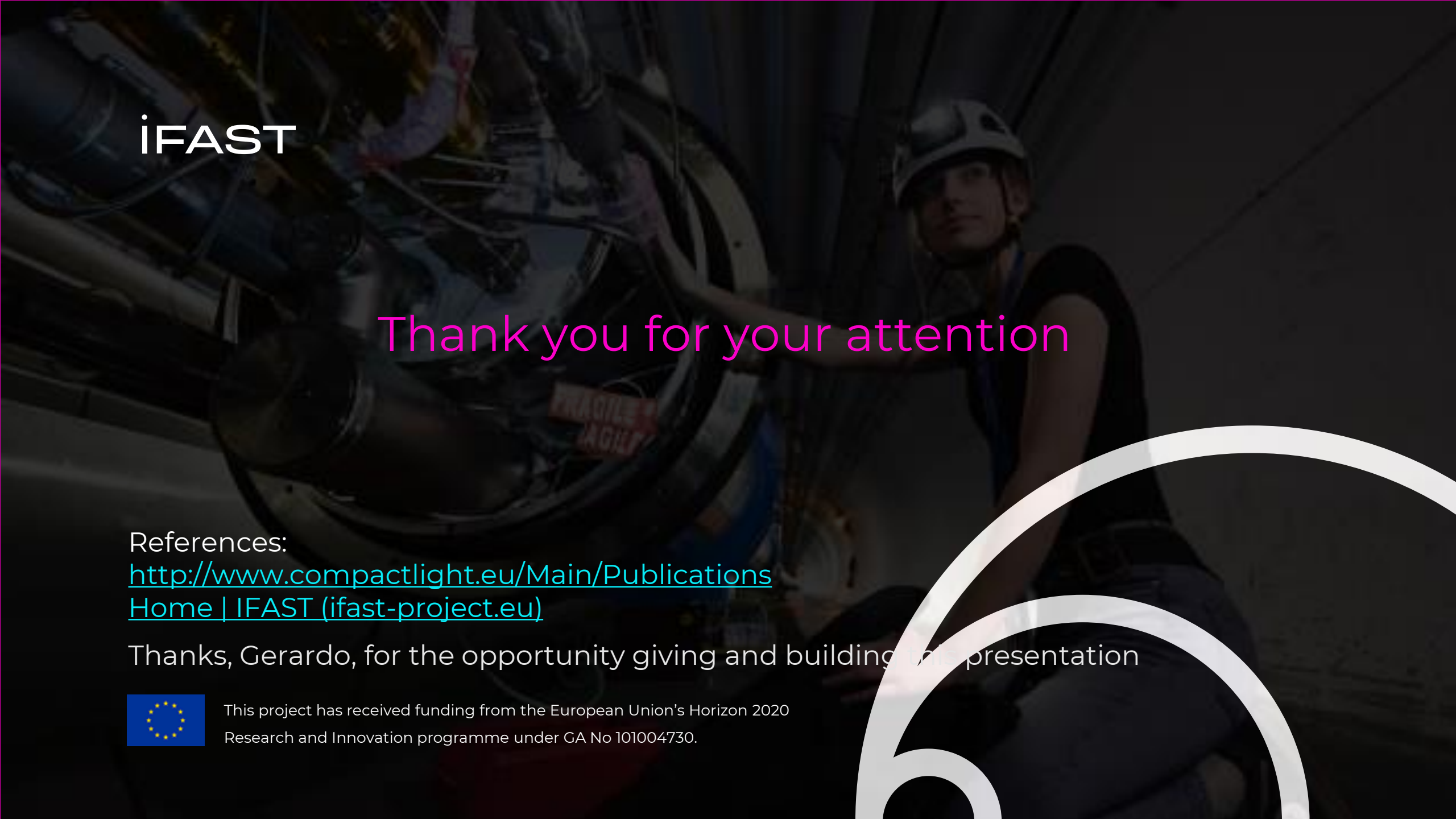
- CompactLight + iFAST
- iFAST prototype on going
  - Design
  - Mock-Up
  - Prototype
- Conclusion

Conclusions

- The work from CompactLight to develop cost-efficient and versatile X-Band linac has been a success story. We have been able to benefit from this in iFAST project.

- We have validated the assembly method at least in the mock-up phase and we are confident to have similar results in the final assembly.

- On track to deliver the first structure early next year and test it around February 2024.



iFAST

Thank you for your attention

References:
http://www.compactlight.eu/Main/Publications
Home | IFAST (ifast-project.eu)

Thanks, Gerardo, for the opportunity giving and building this presentation

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