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IFAST WP7_Task 7.5: CompactLight Prototype Accelerating Structure

IFAST kick-off meeting, May 04th, 2021

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Task 7.5: CompactLight Prototype Accelerating Structures

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

Objective:

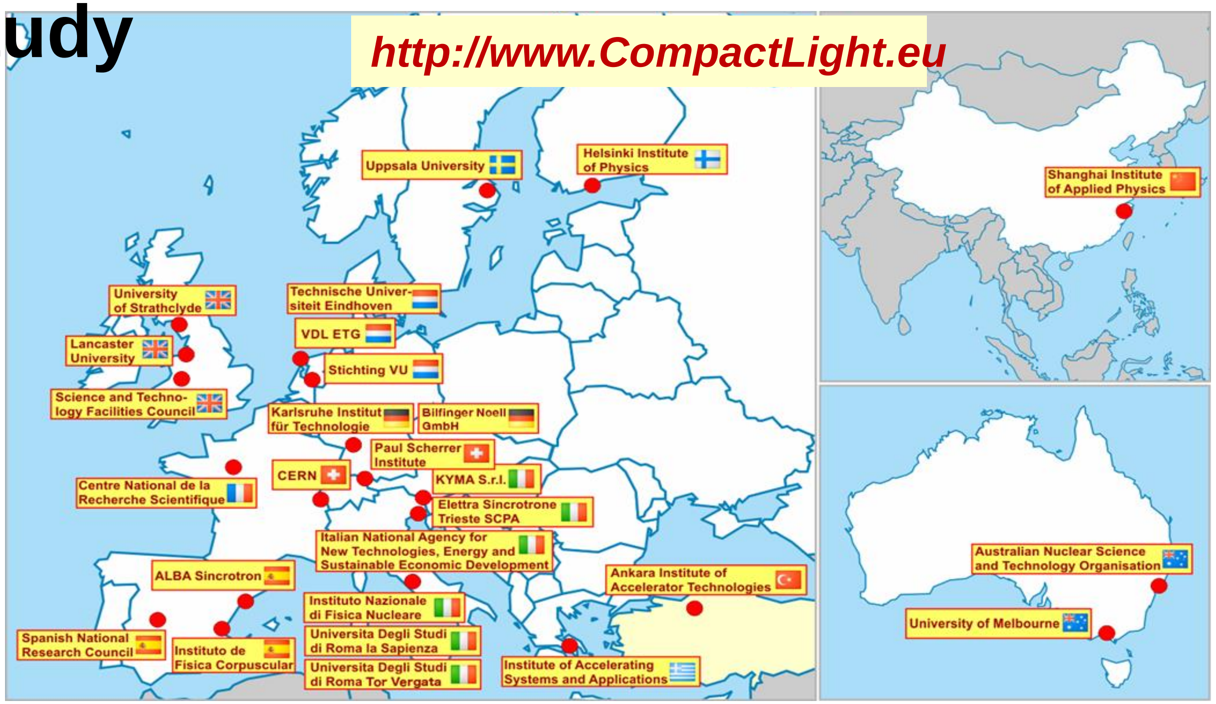
Build and test, at low and high RF power, two prototypes of the X-band (12 GHz) accelerating structure designed for the CompactLight (XLS) project, a new class of linac-driven FEL facilities, based on a Horizon 2020 Design Study.

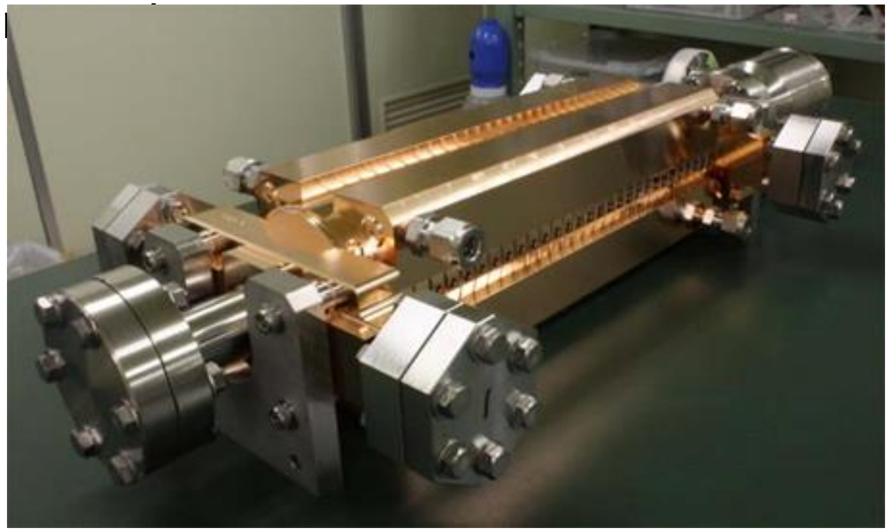
The CompactLight (XLS) design study

- The XLS Collaboration gathers several International Laboratories and Industries (26) with the aim to promote the design and construction of the next generation FEL based photon sources with innovative accelerator technologies.

- The objective is the design of a 5.5 GeV X-band linac, based on the CLIC technology, to drive a FEL facility with soft and hard X-

http://www.CompactLight.eu





Our aim is to facilitate the widespread development of X-ray FEL facilities across Europe and beyond, by making them more affordable to construct and operate through an optimum combination of emerging and innovative accelerator technologies:

- High brightness electron photoinjectors
- Very high gradient accelerating structures
- Novel short period undulators

XLS Partners

Participant		Organisation Name	Country
1	ST (Coord.)	Elettra – Sincrotrone Trieste S.C.p.A.	Italy
2	CERN	CERN - European Organization for Nuclear Research	International
3	STFC	Science and Technology Facilities Council – Daresbury Laboratory	United Kingdom
4	SINAP	Shanghai Inst. of Applied Physics, Chinese Academy of Sciences	China
5	IASA	Institute of Accelerating Systems and Applications	Greece
6	UU	Uppsala Universitet	Sweden
7	UoM	The University of Melbourne	Australia
8	ANSTO	Australian Nuclear Science and Tecnology Organisation	Australia
9	UA-IAT	Ankara University Institute of Accelerator Technologies	Turkey
10	ULANC	Lancaster University	United Kingdom
11	VDL ETG	VDL Enabling Technology Group Eindhoven BV	Netherlands
12	TU/e	Technische Universiteit Eindhoven	Netherlands
13	INFN	Istituto Nazionale di Fisica Nucleare	Italy
14	Kyma	Kyma S.r.l.	Italy
15	SAPIENZA	University of Rome "La Sapienza"	Italy
16	ENEA	Agenzia Naz. per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile	Italy
17	ALBA-CELLS	Consorcio para la Construccion Equipamiento y Explotacion del Lab. de Luz Sincrotron	Spain
18	CNRS	Centre National de la Recherche Scientifique CNRS	France
19	KIT	Karlsruher Institut für Technologie	Germany
20	PSI	Paul Scherrer Institut PSI	Switzerland
21	CSIC	Agencia Estatal Consejo Superior de Investigaciones Científicias	Spain
22	UH/HIP	University of Helsinki - Helsinki Institute of Physics	Finland
23	VU	VU University Amsterdam	Netherlands
24	USTR	University of Strathclyde	United Kingdom
25	UniTov	University of Tor Vergata	Italy
26	USTR	Bilfinger Noell GmbH	Germany
Third Parties		Organisation Name	Country
AP1	OSLO	Universitetet i Oslo - University of Oslo	Norway
AP2	ARCNL	Advanced Research Center for Nanolithography	Netherlands
AP3	NTUA	National Technical University of Athens	Greece
AP4	AUEB	Athens University Economics & Business	Greece
AP5	KyTe	KYMA TEHN. DOO	Slovenia

Italy	6
Neth.	3+1 Ass. Part.
UK	3
Spain	2
Australia	2
China	1
Greece	1+2 Ass. Part.
Sweden	1
Turkey	1
France	1
Germany	2
Switz.	1
Finland	1
Norway	1 Ass. Part.
Slovenia	1 Ass. Part.
Internat.	1

Activities and Deliverables

The two accelerating structures prototypes will be used to get a full validation at two RF operating regimes:

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

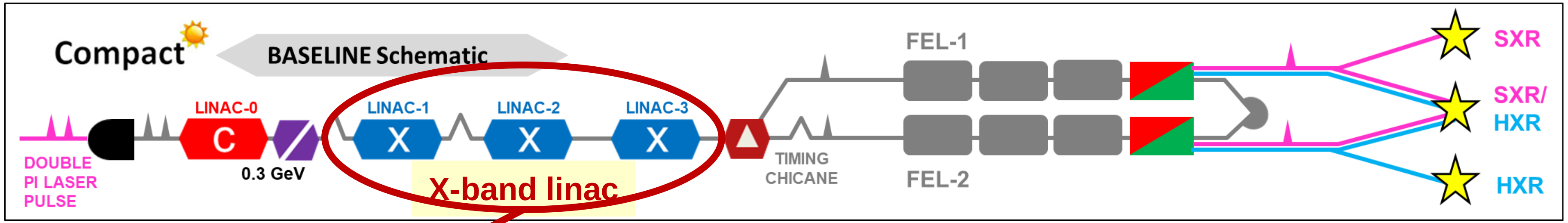
b) low gradient/high pulse repetition rate (30 MV/m up to 1KHz).

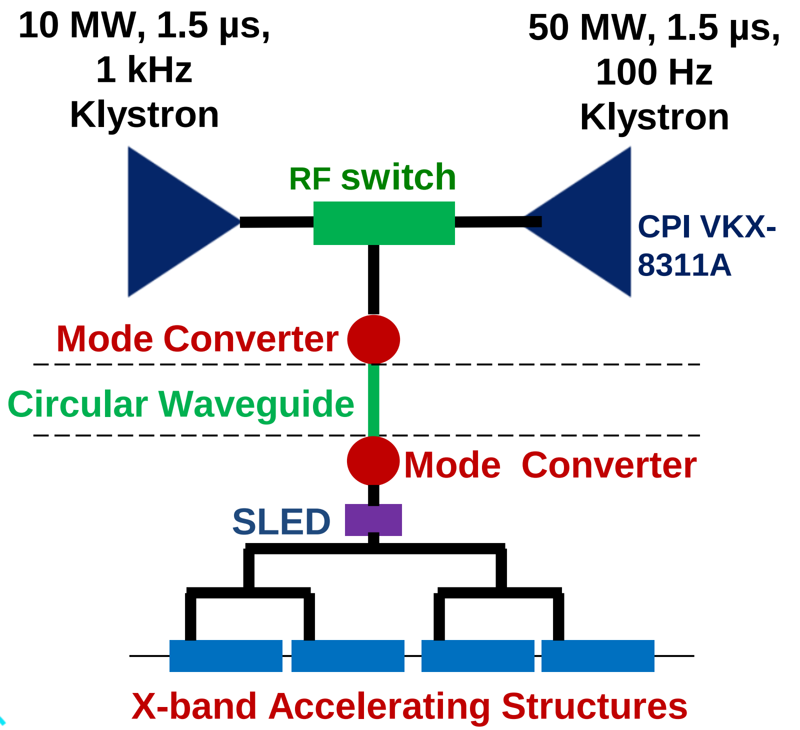
Deliverables:

D7.5: Construction of the XLS accelerating structure pre-prototype.
Development of production process and RF tests of the pre-prototype (@TRL 6/7)_M24

D7.6: Construction of the XLS accelerating structure full prototype.
Production process analysis and validation, RF tests of the full prototype (@TRL 7/8)_M36

CompactLight Linac layout

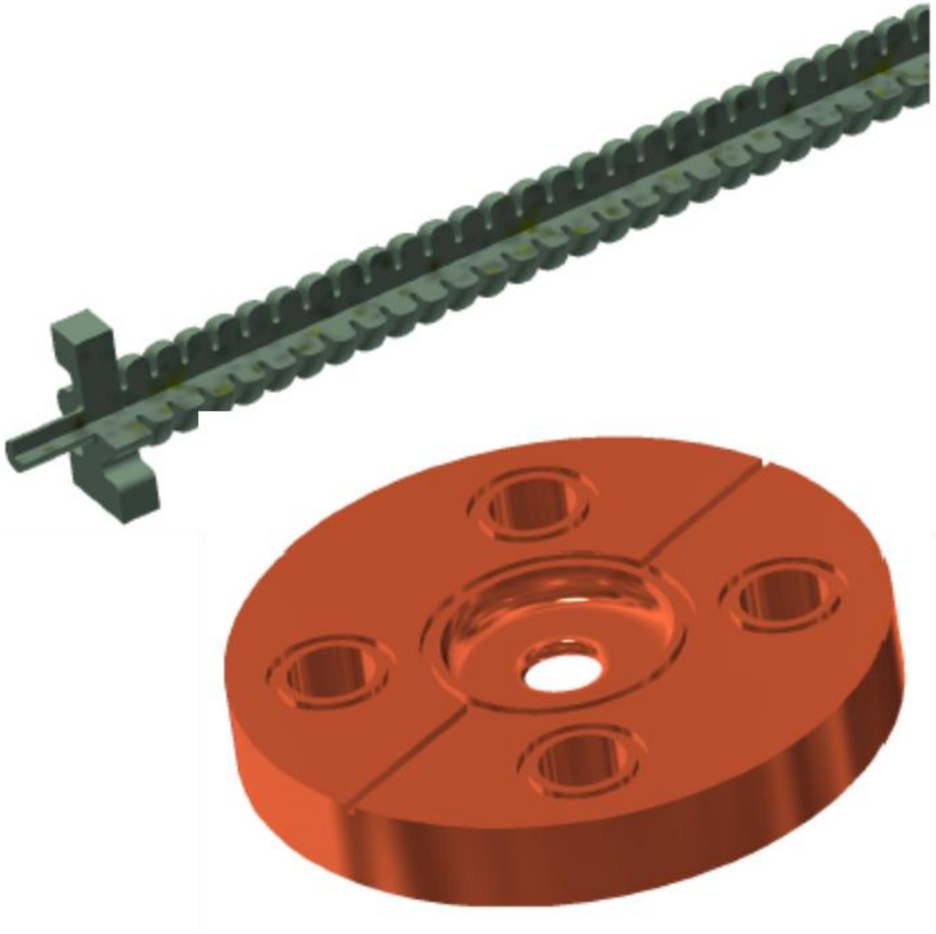




Parameter	Unit	Dual mode		Dual source	
Operating Mode		B		U1, U2	
Repetition rate	kHz	0.1	0.25	0.1	1
Linac active length	m	94			
Number of structures		104			
Number of modules		26			
Number of klystrons		26		26 + 26	
Peak acc. gradient	MV/m	65	32	65	30.4
Energy gain per module	MeV	234	115	234	109
Max. 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	$\mathrm{M}\Omega/\mathrm{m}$	85-111		
Peak modified Poynting vector	$\mathrm{W}/\mu\mathrm{m}^2$	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



Task 7.5 outline plan

		2021								2022												2023												2024			
#	Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
1	Technical drawings for prototype production	4 months																																			
2	Thermo-mechanical analysis and temperature stabilization at different operating regimes	4 months																																			
3	Production process analysis and optimization				3 months																																
4	First prototype fabrication							9 months																													
5	RF characterization																1m																				
6	High power RF tests and validation																	6 months																			
7	Production process analysis and optimization																			4 m																	
8	Second prototype fabrication																							9 months													
9	RF characterization																																1m				
10	High power RF tests and validation																																	4 months			

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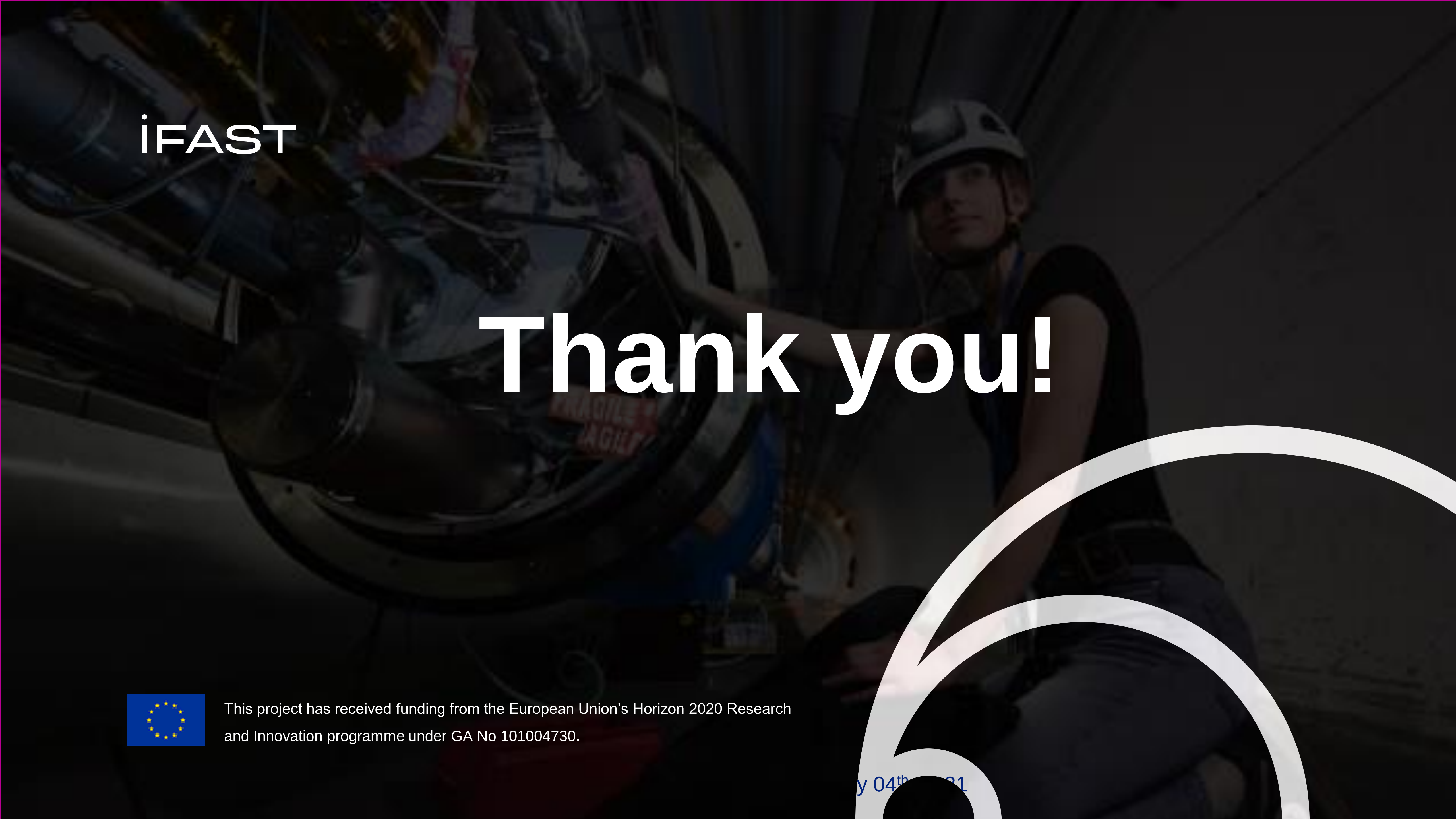

Thank you!

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