



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

WP 11.2

“High-Efficiency Klystron Industrial Prototype”

I.FAST Kick-off meeting, 4-May-2021

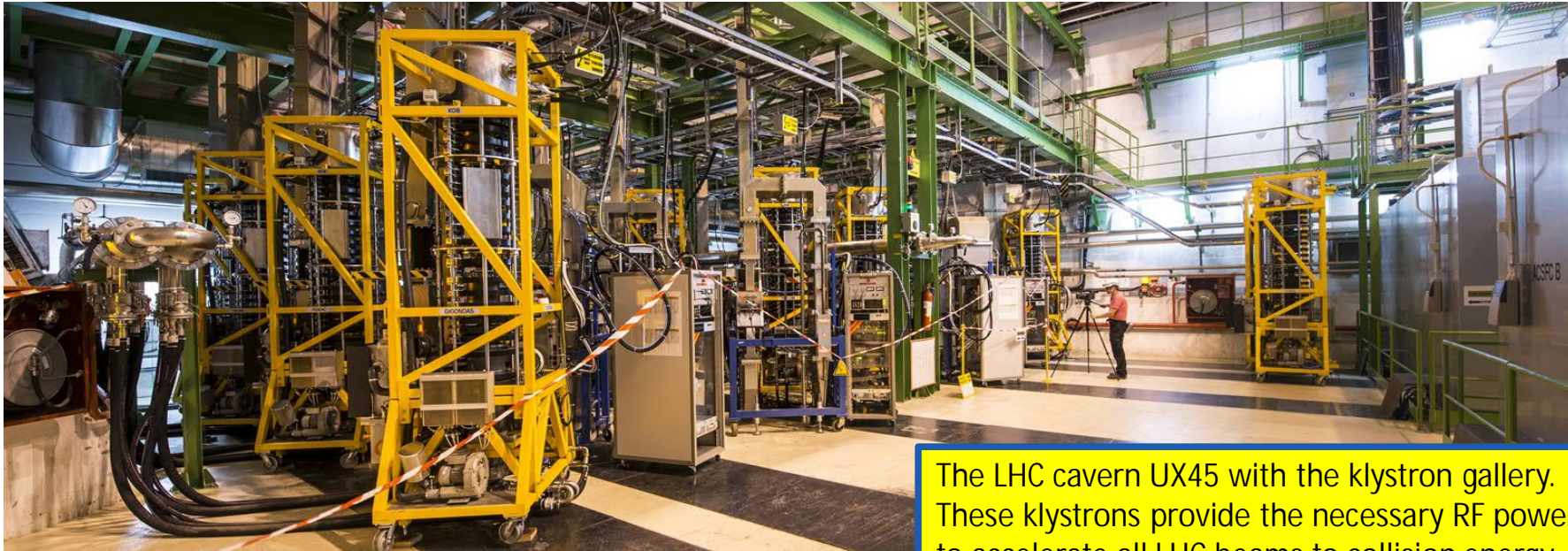
O. Brunner & E. Jensen/CERN



What?

Lucio: There is nothing better for Industry than to do the real thing!

- Fabrication and tests of industrial prototypes of High Efficiency Klystron to be used in LHC. “*TH2167 HE*”.
- “Drop-in” replacement of the present LHC klystron “*TH2167*”; this allows to reuse the existing infrastructure and subassemblies of the existing tubes.



The LHC cavern UX45 with the klystron gallery. These klystrons provide the necessary RF power to accelerate all LHC beams to collision energy.

Why?

- Higher energy efficiency *is a must* to all future accelerator projects.
- Careful and detailed paper studies for higher efficiency klystrons exist, from conceptual to detailed PIC simulations. Results are very promising & encouraging.
- The step from a paper study to an industrial prototype is particularly difficult and very important for success. This step is subject of I.FAST 11.2.
- Operating the LHC, the World's flagship High-Energy Collider for years to come, with higher efficiency versions of its klystrons will allow to 1) reduce the electricity bill and the environmental impact 2) increase the operational margin when operating with higher intensities ("HL-LHC").
- Once demonstrated, this technology is relevant for ILC, CLIC, FCC or any other future particle accelerator.

Who?



- CERN (N. Catalan, I. Syrathev, O. Brunner, E. Jensen ...)

- Igor has been the driving force for HE Klystron development for many years. Olivier is the head of the klystron section inside SY-RF and has relevant experience of the LHC klystrons and ancillaries. Nuria is leading the HE klystron effort @ CERN. Erk is on his way out – last working day in 4 weeks!



Nuria Catalan



Igor Syrathev



Olivier Brunner



- Thales AVS France SAS (A. Beunas, S. Bethuys, ...)

- Thales (formerly Thomson) is the only European supplier for high-power klystrons for science – the others are Canon/Japan and CPI/USA. They have the required expertise and facilities.



Armel Beunas



Stéphane Bethuys

- University Lancaster (G. Burt, J. Cai)

- University of Lancaster, part of the Cockcroft Institute, is particular strong in engineering for accelerators and has been a productive and reliable player in European collaborations. Graeme is Associate Director and Professor. Jinchi, formerly CERN fellow, has developed an advanced klystron simulation code (KLyC) and is key player in the HE klystron development.



GRAEME BURT
Lancaster University
BBC BREAKFAST

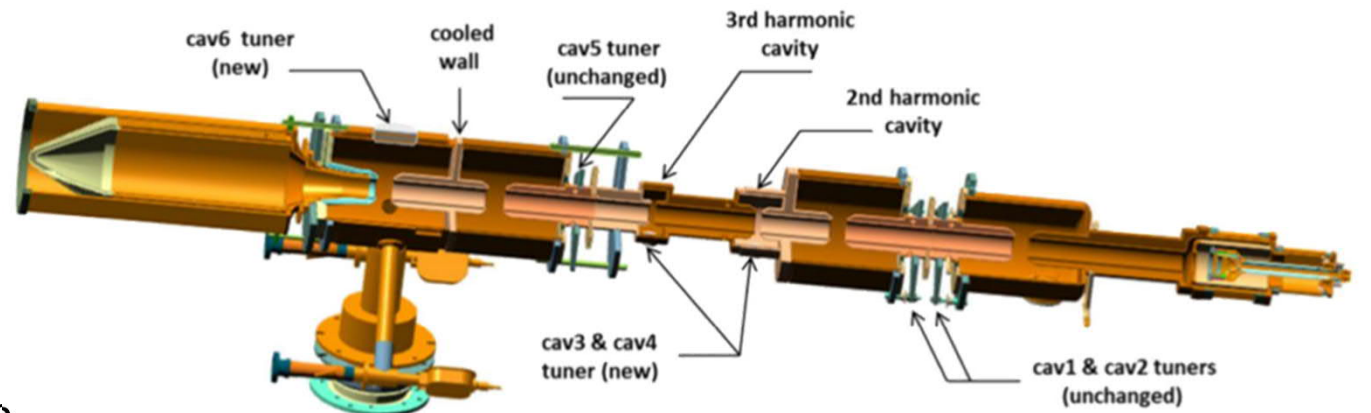


Jinchi Cai



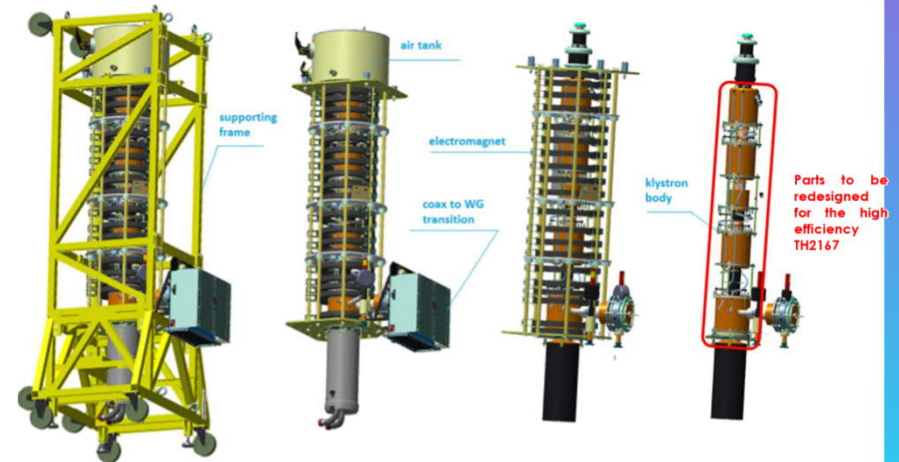
How?

- Sixteen 400 MHz, 300 kW CW klystrons *TH2167* presently provide RF power to the LHC.
- Key is the replacement of the interaction region of the klystron to apply the novel idea of the chosen “core stabilisation method” (CSM).
- To reduce cost and risk, but also to take centre stage in case of success, we opted for modifying the existing, reliable tube. This is constraining the design, but still allows to demonstrate feasibility.
- The *TH2167 HE* should produce 350 kW RF instead of 300 kW, supplied by the same modulator, with the same wall-plug power as presently the *TH2167*.
- See also <https://indico.cern.ch/event/727555/contributions/3452823/>!



THALES

Re-using frame, electron gun and solenoid



Where do we stand?

- A collaboration agreement*) CERN/Thales was elaborated and signed – it goes well beyond the needs of I.FAST, but is a useful frame contract.
- Work has started and is advancing well.
- The partners have signed the Grant Agreement.
- Thales' signature of the Consortium Agreement took some time with lawyers – but is now imminent.

*) KE-4924/BE



Thanks!

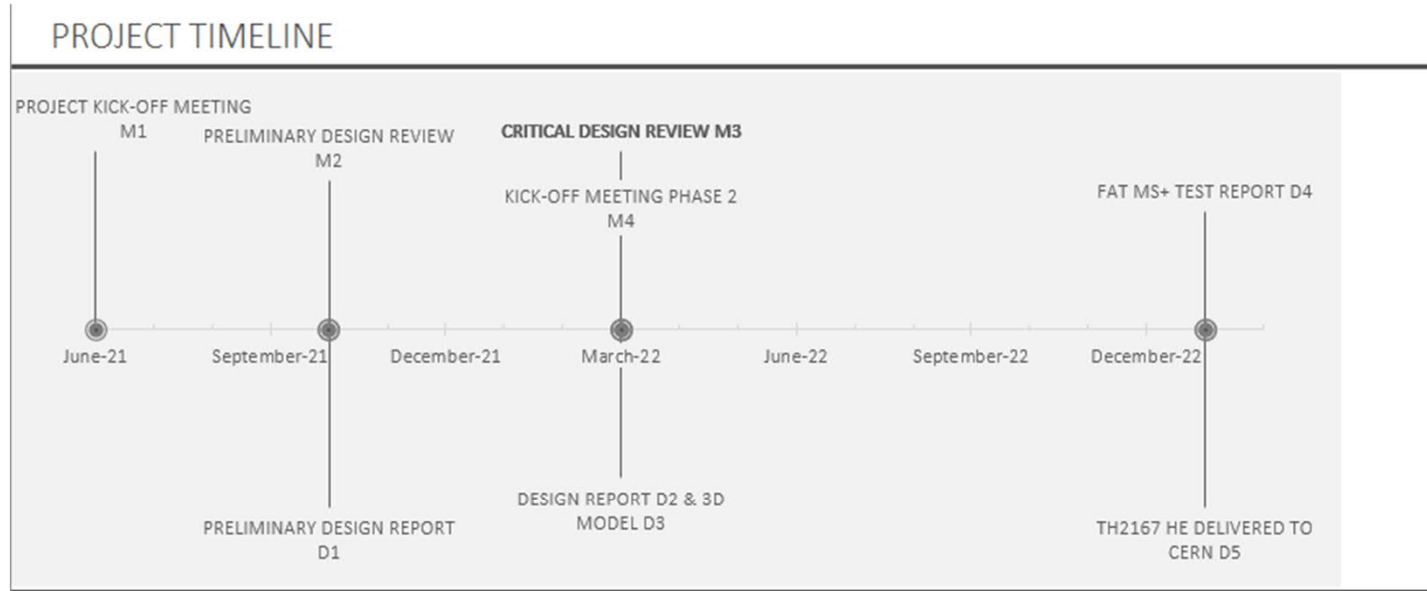


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Spare slide 1: Milestones and Deliverables

Number	Title	Type	Due date (month #)
MS 55	Design review		12
D 11.2	Klystron prototype completed and validated	Demonstrator	45

Spare slide 2: Internal planning and deadlines



PROJECT DETAILS

DATE	MILESTONE	POSITION	BASELINE	Position Adjusted	Date adjusted
1-Jun-21	Project kick-off meeting M1	30	0	30	1-Jun-21
15-Oct-21	Preliminary design review M2	25	0	25	15-Oct-21
15-Oct-21	Preliminary design report D1	10	0	-30	15-Oct-21
1-Mar-22	Critical design review M3	-10	0	30	1-Mar-22
1-Mar-22	Design report D2 & 3D model D3	-20	0	-25	1-Mar-22
1-Mar-22	Kick-off meeting Phase 2 M4	20	0	15	1-Mar-22
1-Jan-23	FAT MS+ Test report D4	-20	0	20	1-Jan-23
1-Jan-23	TH2167 HE Delivered to CERN D5	-25	0	-30	1-Jan-23

= I.FAST MS55

= I.FAST D 11.2 (with substantial margin)