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Thales Klystrons for Linacs

High gradient Day

31 January 2013

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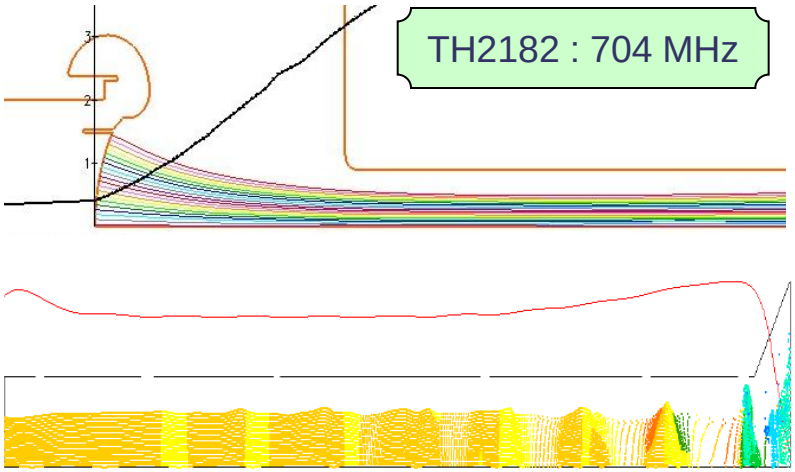
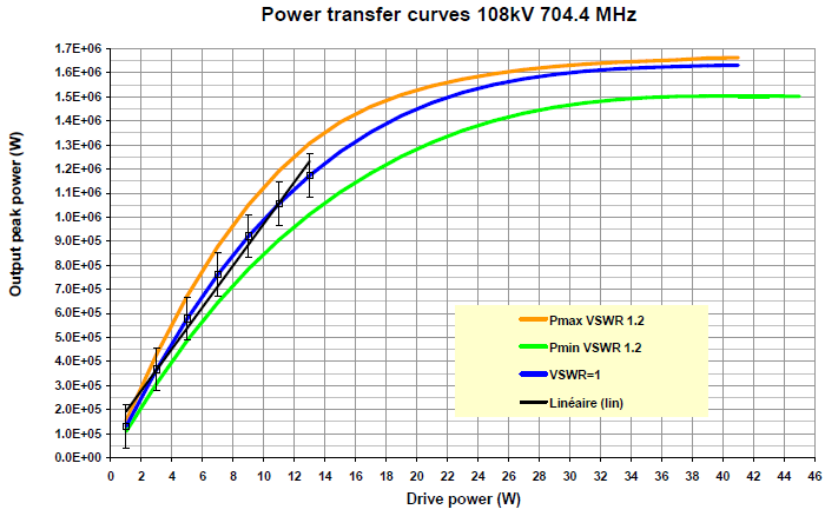
Current R&D Activities on Klystrons at Thales ED

R&D at Thales ED is currently focused on long pulse UHF klystrons

- **TH2179: 352 MHz 2.8MW 1.3 ms**
  First tube installed at CERN (Linac 4)
- **TH2181: 325 MHz 3.1MW 0.25 ms**
  Prototype in 2013
- **TH2182: 704 MHz 1.5MW 2 ms**
  Efficiency target: 65%. Prototype in 2013





108 kV 22A Ps = 1.6MW @ 704 MHz Efficiency > 65%

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Short Pulse Klystrons (< 10 µs)

S band klystrons:

- Strong heritage on 45 MW 20kW family (2856MHz and 2998 MHz)
- Demonstrated life time > 40000 hours
- Production > 25 klystrons / year
- TH2100L : 60MW 1.5µs 100 Hz operating at 350 kV 408A installed at PSI.

New Products in S band

- Increase of peak power up to 80MW 4µs 120Hz is achievable with conventional klystron technology.
- Development can be launched only for significant quantities.

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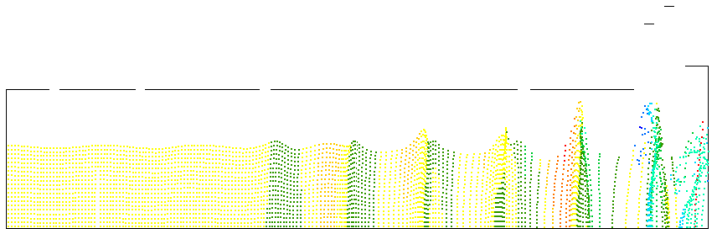
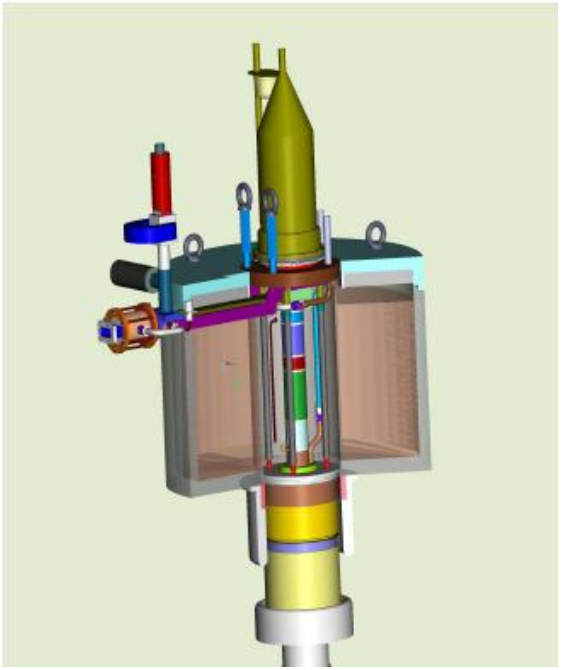
Short Pulse Klystrons (< 10 µs) in C or X band

KlysTop
Fo=5.7GHz Pe=120W Ps=50.5MW n=45%



C band : 5712 MHz 50MW 2.5µs 100 Hz

- Thales has an interest in developing such klystron, with the support of european labs and is open for collaboration.
- Design study is in progress.



X band : 11994 MHz 5MW 5kW

- Thales has performed a detailed design study of an X band klystron.
- The S band medical klystron technology is a strong basis for this development.
- Market size and perspectives to be confirmed.

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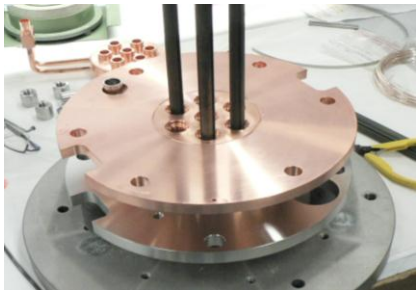
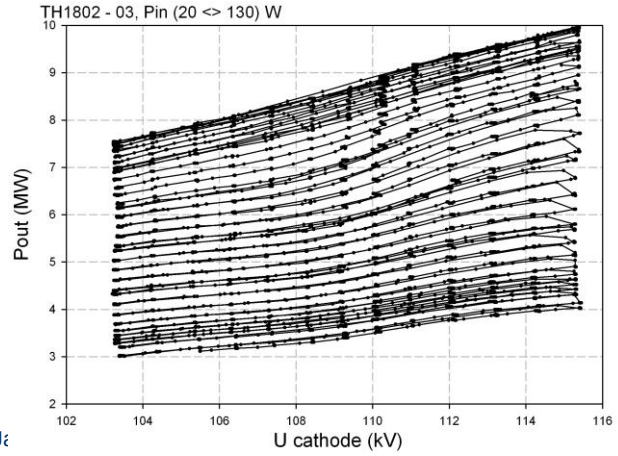
Long Pulse Klystrons : L band Multi Beam Klystron



TH1802: 1300 MHz 10MWp
150kWa Efficiency > 63%

- 22 tubes under production for E-XFEL (DESY)
- Industrial experience to produce high power MBKs at 1unit /month
- RF Windows under air (No SF6)
- Very stable operation
- Good baseline to address CLIC needs in L band



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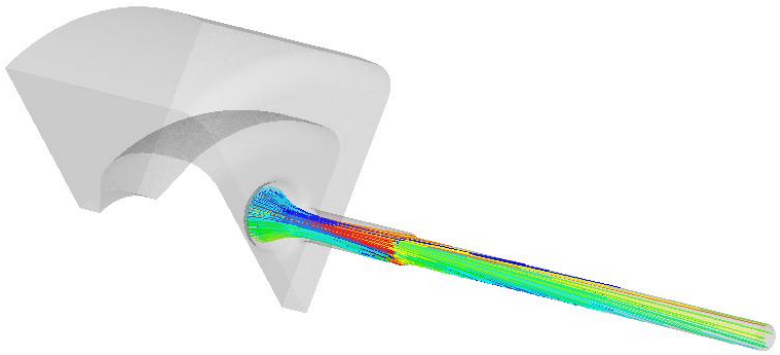
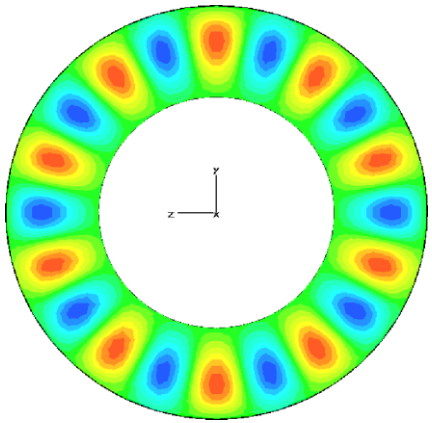
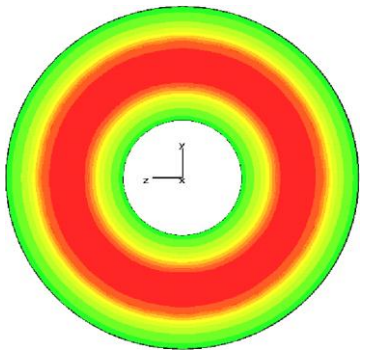
Efficiency increase on L band Multi Beam Klystron

It takes 10 years to develop and master a new technology.

- Thales is building on the MBK heritage to study a 1 GHz RF source for the CLIC drive beam. Efficiency target η = 70%.
- Increase of beamlets Nr (up to 20) → decrease of individual beam perveance (~ 0.2 µP) → high interaction efficiency (η = 78 - 0.16 x µP)
- Theoretical Feasibility already demonstrated
- Design studies to be pursued on beams optics, cavity geometry and interaction mode and RF stability.
- Collaboration frame: Hypernet







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Conclusions

- **Thales ED is involved on the long term in the scientific market and is willing to work with european labs to prepare the future needs.**
- **We think that new technologies have to be prepared well in advance (5 to 10 years) and this needs to be well coordinated and supported.**
- **Collaboration with labs is very important at several steps:**
  - Understanding of trends on RF needs to oriente properly our developments.
  - Work share and technical exchanges in the design phase.
  - In some cases, use of labs facilities to test the new prototypes.
- **New accelerator projects like CLIC will require efficient, reliable and affordable RF sources, due to the high number of units involved.**
  - the MBK technology is a promising solution for CLIC L band requirements and can benefit from the experience of E-XFEL program.
  - Thales ED intends to explore new MBK concepts in collaboration with CERN to achieve more than 70% efficiency with good reliability and lifetime.