Klystrons for Linear Colliders

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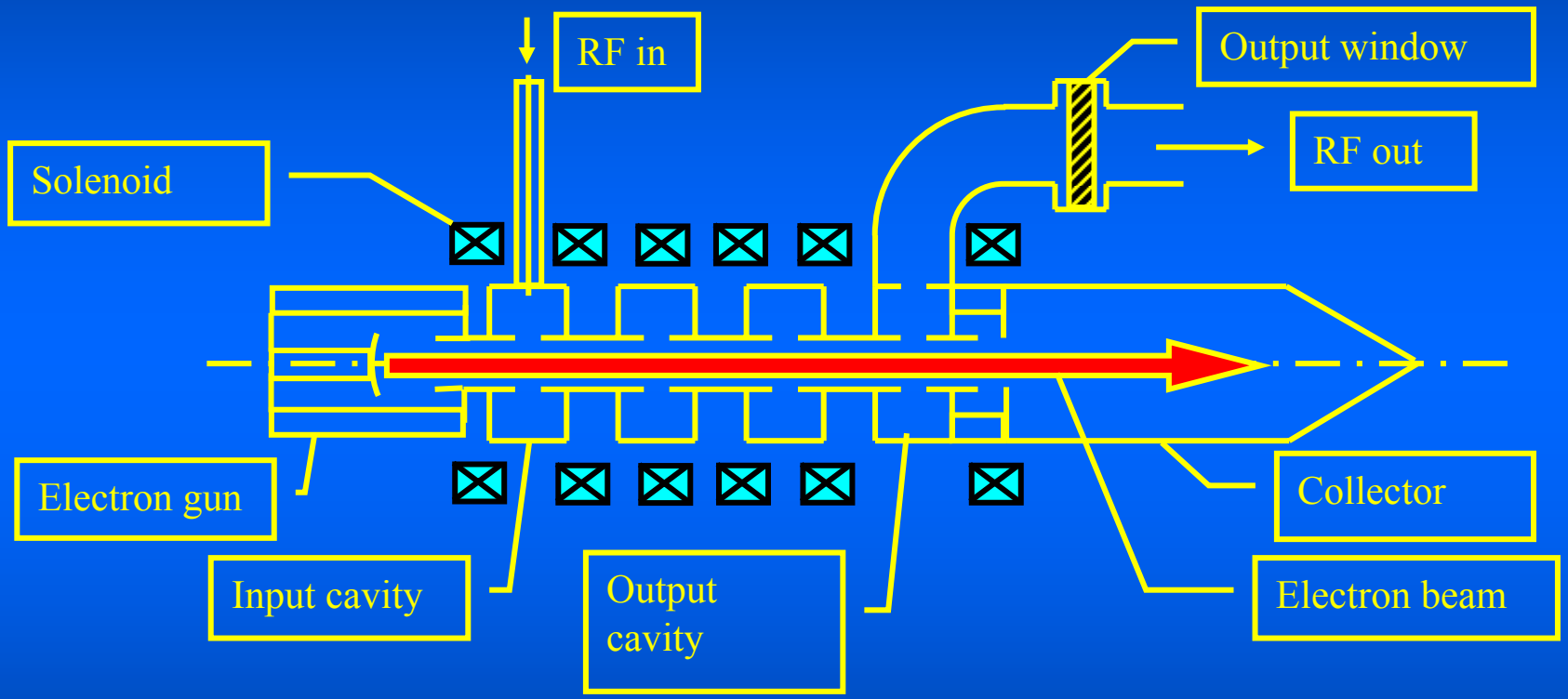
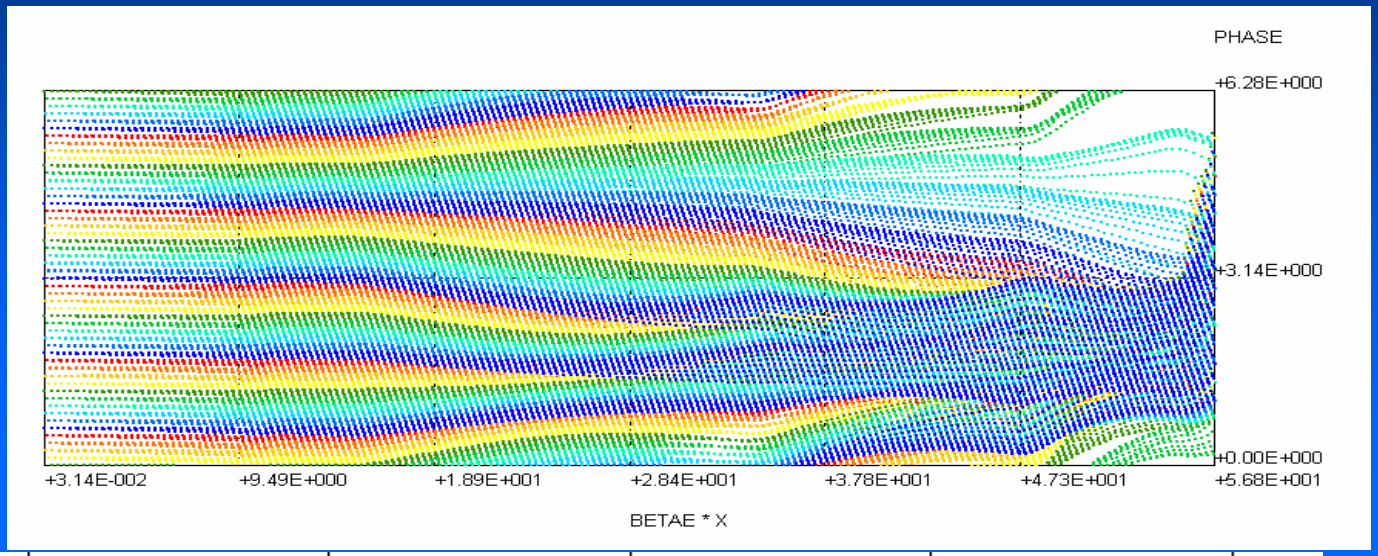
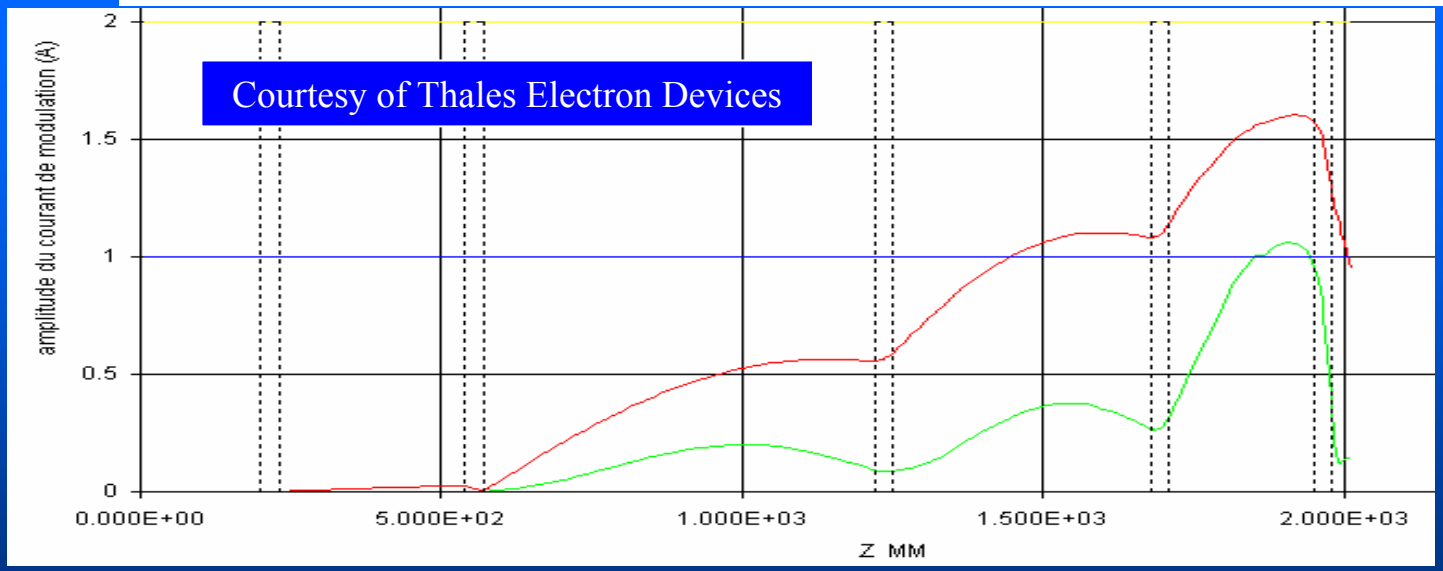
Single-beam klystron



Klystron Applegate diagram





Linear Collider Klystron Requirements

Design issues:

- High peak power
  - High voltage and current
- High efficiency
  - High voltage and low current
  - Low solenoid power
- High reliability
  - Low voltage – to avoid gun and output cavity breakdown
  - Low cathode loading – for long cathode life
  - Low peak power – to avoid output window failure and waveguide arcs

Klystron Development - State of the art (1)

NLC Klystron

Type	SBK
Frequency	11.4 GHz
V_0	490 kV
I_0	260 A
Power	75 MW pk
Efficiency	55 %
Number required	8256

Multiple Beam Klystron

- Several electron beams in one vacuum envelope
- Reduced beam voltage
- Increased efficiency

BUT

- More difficult and expensive to make

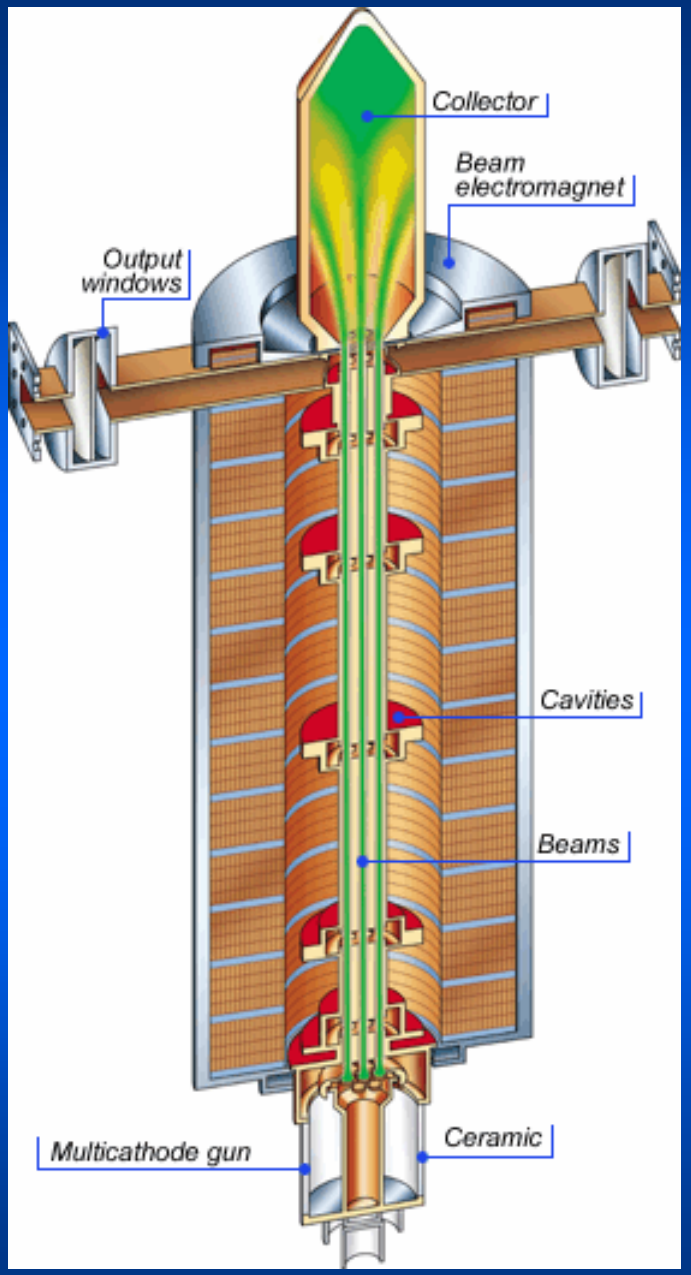


Diagram courtesy of Thales Electron Devices

Klystron Development - State of the art (2)

MBK for TESLA

Frequency	1300 MHz
V_0	115 kV
I_0	133 A
Power	9.8 MW pk
Efficiency	64 %
Beams	6
Number required	572

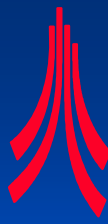
Courtesy of Thales Electron Devices

Klystron Development - State of the art (3)

Klystron problem areas

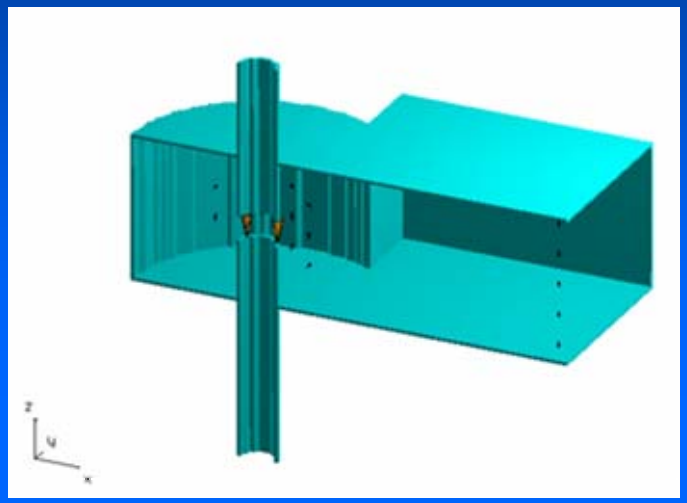
- Reliability (including rate of RF trips)
  - Voltage breakdown in gun and output cavity
  - Window failure
  - Waveguide arcs
- Efficiency
  - Electronic efficiency
  - Solenoid power consumption
- Cost
- Industrial capacity

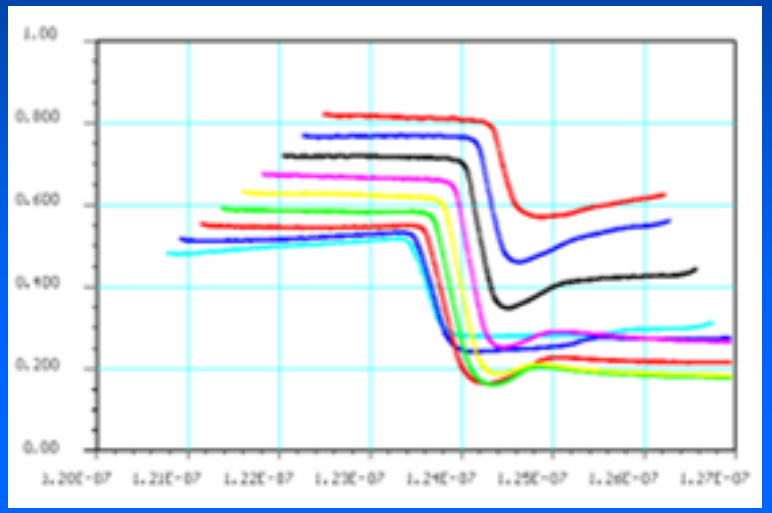
Future Linear Collider Klystron Study

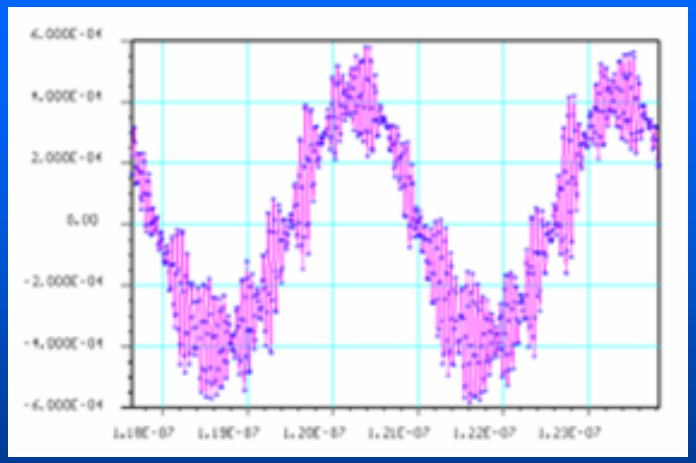


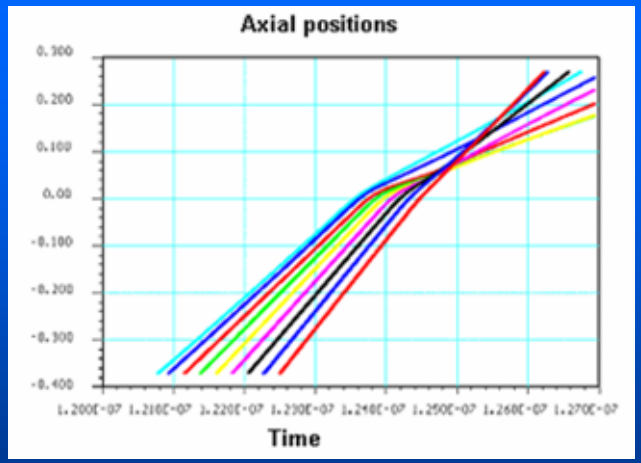
- June 2001 to June 2003
- Funded by PPARC (£82k)
- Research Associate: Dr Feng Jinjun
- Collaborators
  - CERN
  - DESY
  - ASTeC
  - e2v technologies Ltd
  - TMD Technologies Ltd

MAFIA model of a klystron output cavity

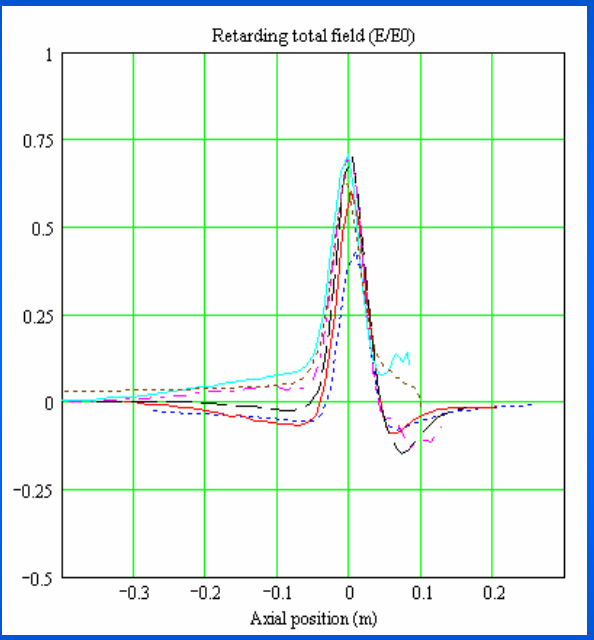


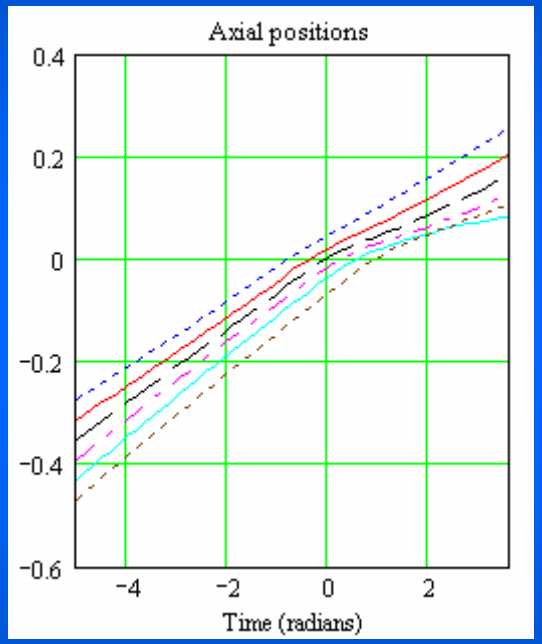


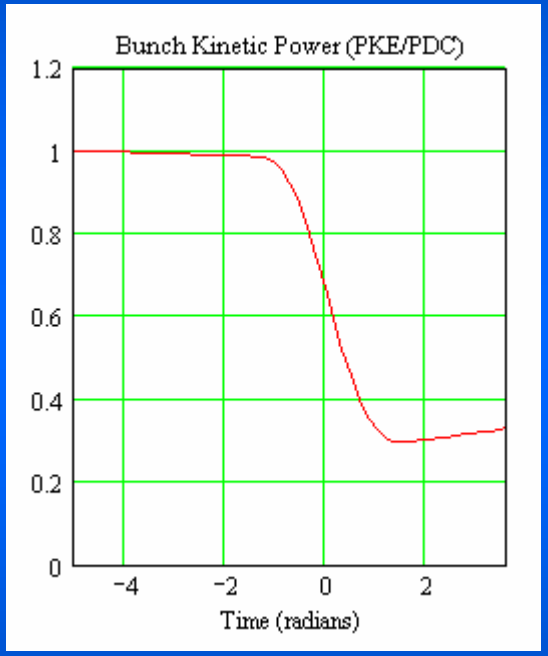




MathCad model of a klystron output cavity

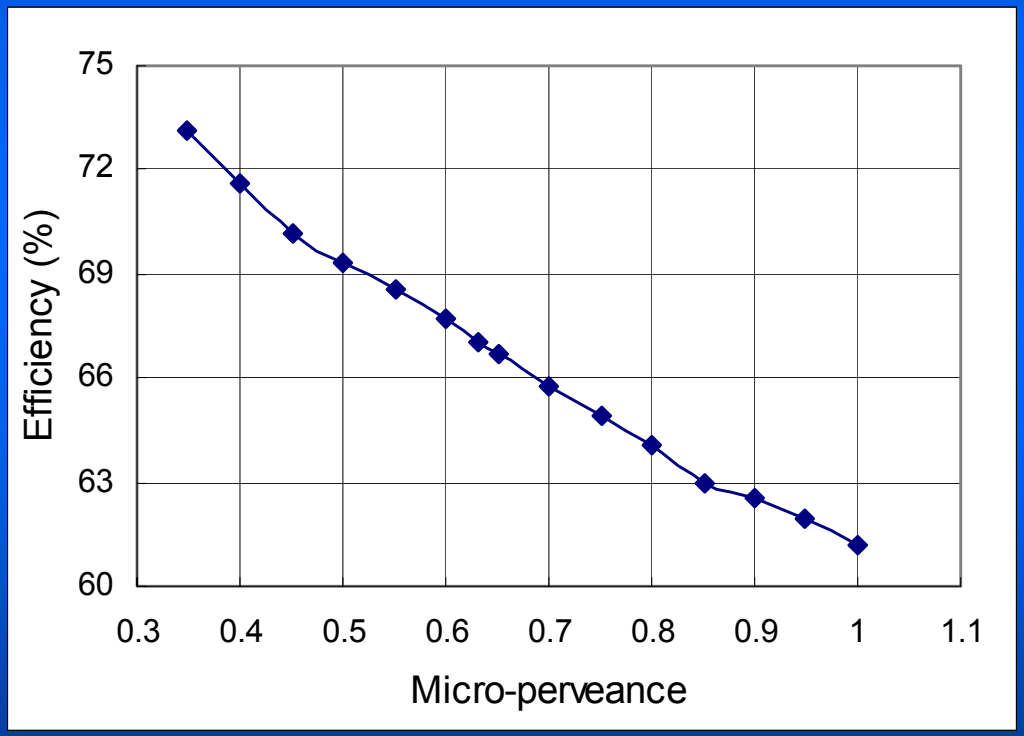




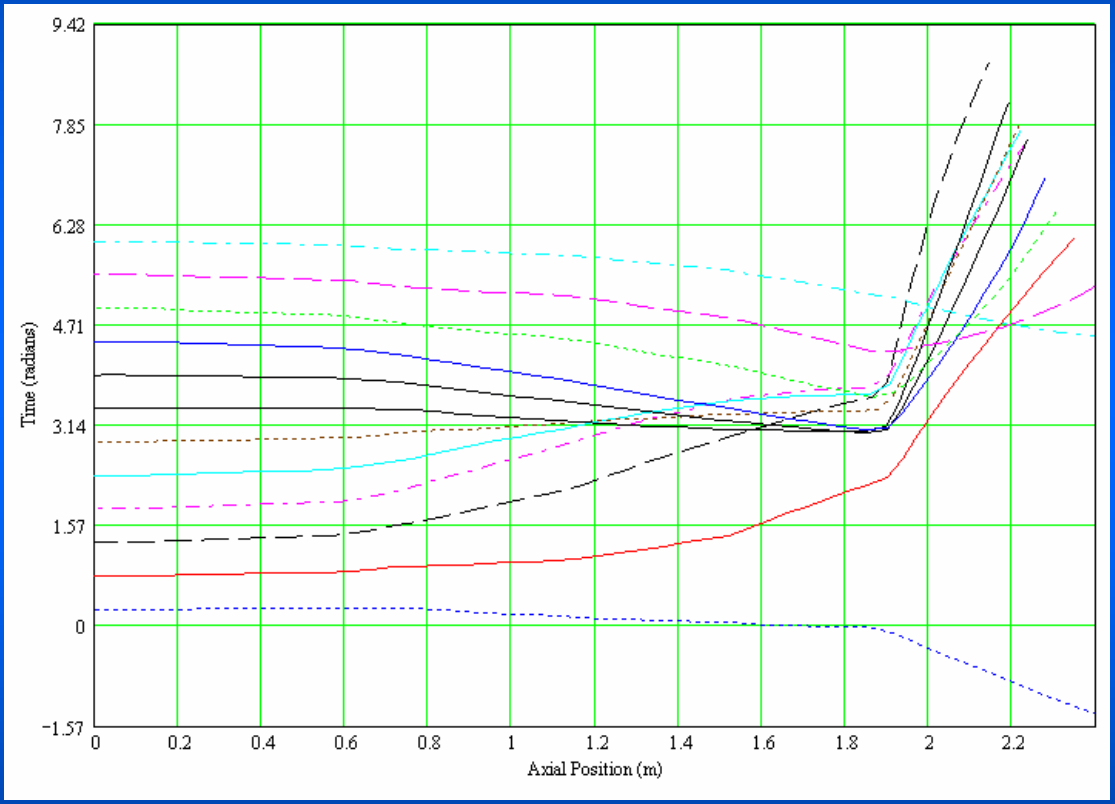


Klystron Efficiency

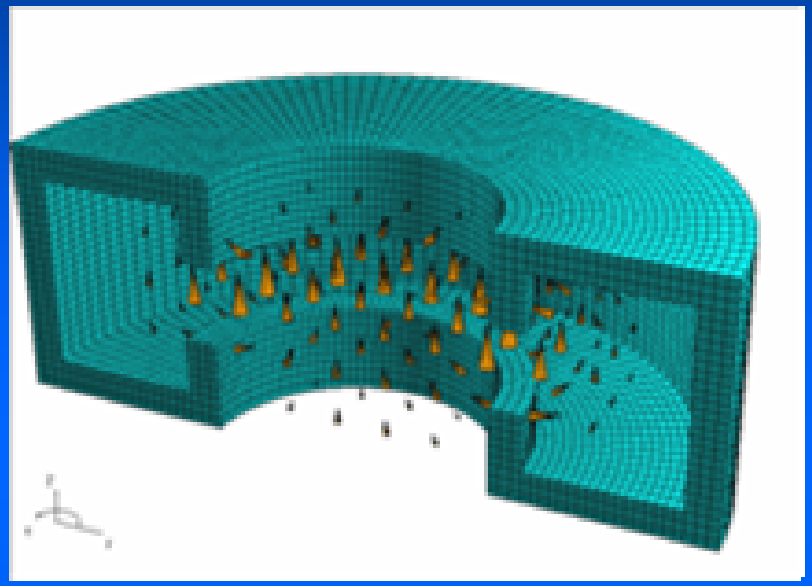
- Perveance = $I / V^{3/2}$

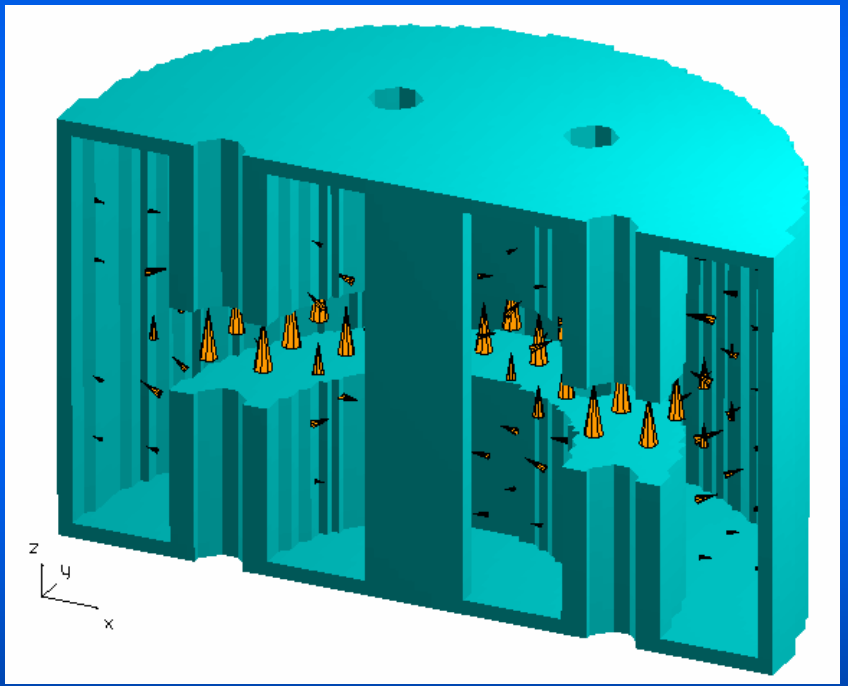


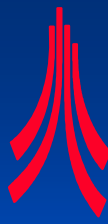
MathCad model of klystron bunching



Models of klystron output cavities







Achievements

- Improved design tools,
- Novel cavity geometry,
- Conceptual MBK designs for TESLA and CLIC