Alternative Low Voltage Power Source

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<u>Outline</u>

Requirements for ILC RF Source

2 Tunnels or 1 Tunnel

Elimination of Pulse-Transformer

Basic Scheme for RF Source without PT

KEK’s Plan for Klystron R&D

Direct Switching Modulator

Summary

Requirements for ILC RF Source

- About 700 klystrons are installed in Ecm = 500 GeV ILC plan
  - Highly reliable machine is required
  - Easy maintainability is required

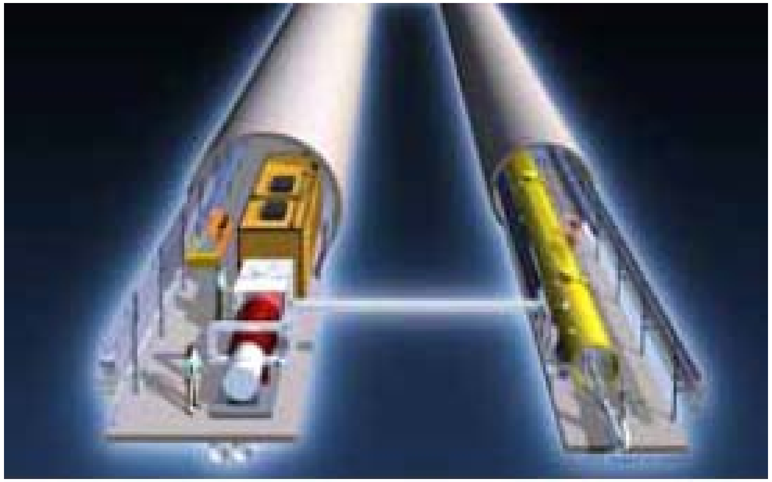
    ->Quick repair of the RF Source
  - Safety machine is desirable

    ->Large quantity of insulation oil?

    ->SF6 gas filling?

2 tunnels or 1 tunnel?

2-tunnel plan is favorable from the view point of RF maintenance



-> Possibility to repair failed parts (klystron, SW device, etc.) during operation
-> Each component must be compact to replace them easily in the tunnel

• Horizontally mounted klystron installed in the atmosphere is easily replaced
• Modular units of the modulator are installed to be replaced the failed module easily

Elimination of Pulse-Transformer

- Current design of the rf source includes the pulse-transformer, but is it possible to eliminate it?

Merit of pulse transformer elimination

1. ¼ cost of the modulator comes from pulse transformer and we can save it
2. Large amount of insulation oil in the long tunnel is not desirable from the fire problem
3. Pulse transformer is large and it is not easy to replace it

Basic Scheme for RF Source without Pulse Transformer

- Multi-Beam Klystron
  - many small beam-lets of about 40
  - operation voltage of about **50-kV** which enables us to use insulation ceramic without oil tank
- Direct Switching Modulator

  50-kV IGBT (IEGT) Switching Circuit is directly connected to the klystron

KEK's Plan for Klystron R&D

- KEK is planning to develop a 10 MW multi-beam klystron operating at low voltage of 45-50 kV
  - First step -> C band small MBK for super-KEKB plan

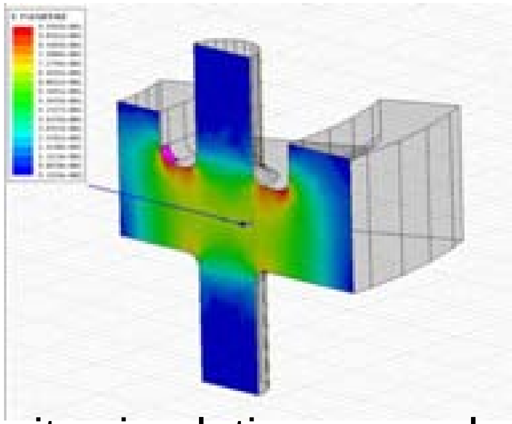
  →X-band MBK for medical purpose (difficult)

  →Another L-band MBK for ILC (not difficult)
- Seeking budget source

C-band 100 kW MBK for Driving 50 MW Klystron

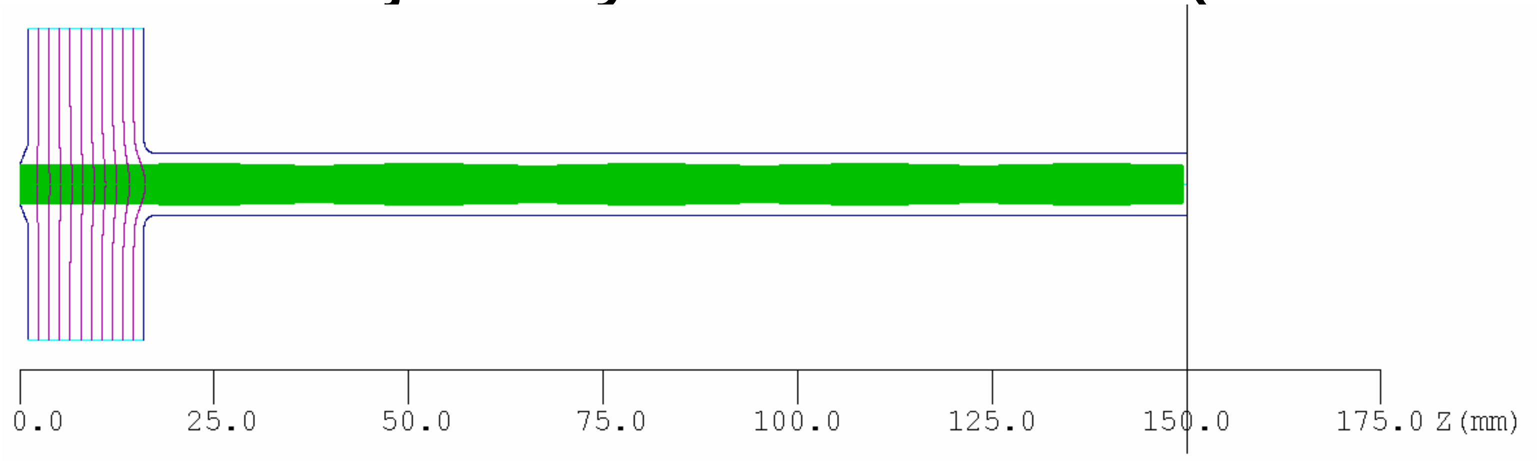
- Preliminary design was performed by V. Teryaev, M. Yoshida and S. Fukuda
- Aiming to drive 16 C-band 50-MW klystrons for super-KEKB project
- Immersed flow with non-convergent gun
- 8 beam-lets with the same heater assembly
- Beam-cavity interaction with rod-loaded if necessary → This design and experience are applied to L-band MBK
- → *Cathode assembly diameter is too large to use the existing furnace if 40 beam-lets are stacked in one filament assembly (to be solved)*

		C-band Sub-boostr	L-band MBK
Output power	MW	0.2	10
Applied Voltage	kV	30	50
Number of beam-let		8	36
Perveance of a beam let		0.253	0.75
Total perveance		2.02	27
Expected efficency	%	75	65
Cathode loading	A/cm2	6	8
Catode diameter	cm	0.46	1.17
Conversion ratio		1	1

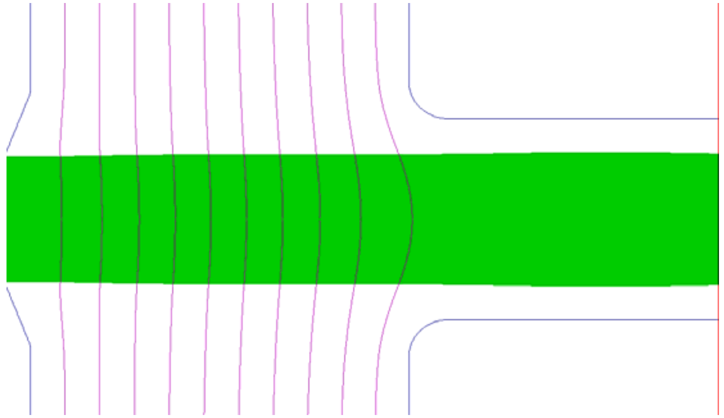


Cavity simulation example of C-band MBK

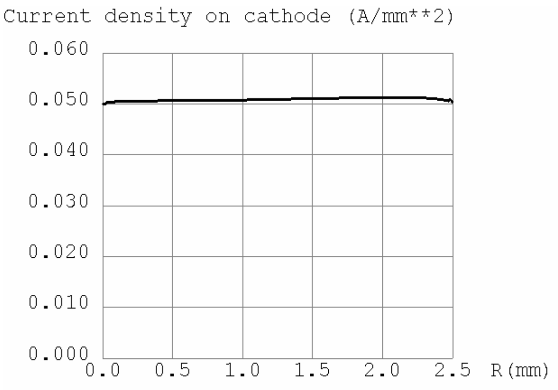
Simulation Example
- beam trajectory of a beam-let (C-band MBK)



Beam trajectory (complete immersed flow design)



Vicinity of the cathode



Cathode loading

Direct Switching Modulator

- Output specification

  Vo=50kV, Ipulse=310A, assuming the efficiency of 65%.
- No pulse transformer
- Insulation ceramic of the klystron is durable in atmosphere (see popular thyratron)
- Candidate IGBT

  ex. 8 series of six 3.3kV-800A IGBTs are planned
- Crowbar is also eliminated
- DC power supply is also expensive and is divided into 2 categories → Fixed DC section (for several modulators) and regulated local charging power supply

Summary

- Alternative low voltage power source is proposed
- This proposal comprises a 50 kV,10 MW MBK and a direct 50 kV switching modulator
- Elimination of pulse transformer is very attractive
- KEK will construct TESLA type RF source using 5 MW klystron for STF Phase-1, but R&D for the alternative will be considered during the STF-1 construction