High-power RF generation using a planar lasertron

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Outline:

- Lasertron concept
- Technological advances in lasers/photocathodes
- Sheet beam geometry cavities
- Conclusion and future work

History of the device:

- Lasertron idea conceived at Los Alamos, 1982
- Experimental tests at SLAC and KEK, 1986
- Work at NIU/FNAL and DULY Research, Inc. resulted in the submission of a Phase I SBIR in 2003 on the Planar Lasertron (which did not get funded; however, a related Phase II SBIR did get funded)

The SLAC experiment:

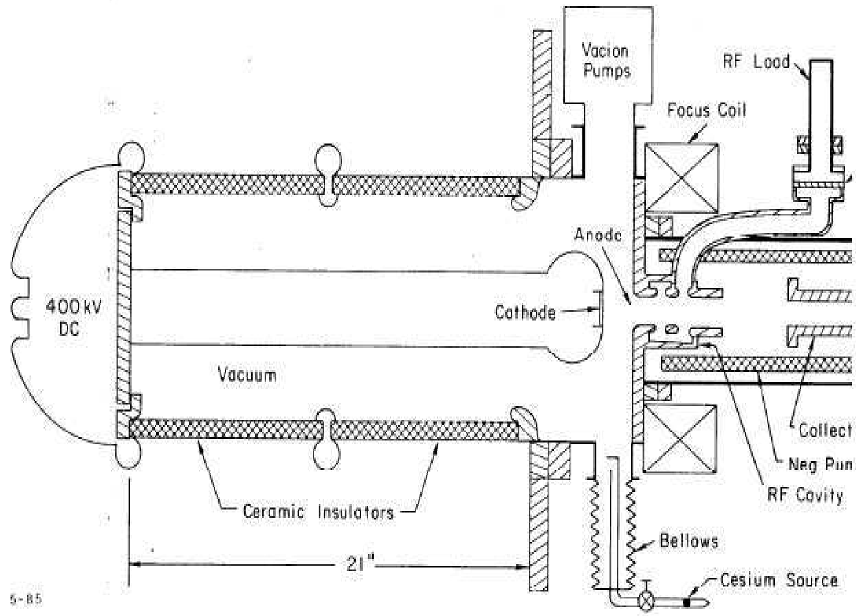
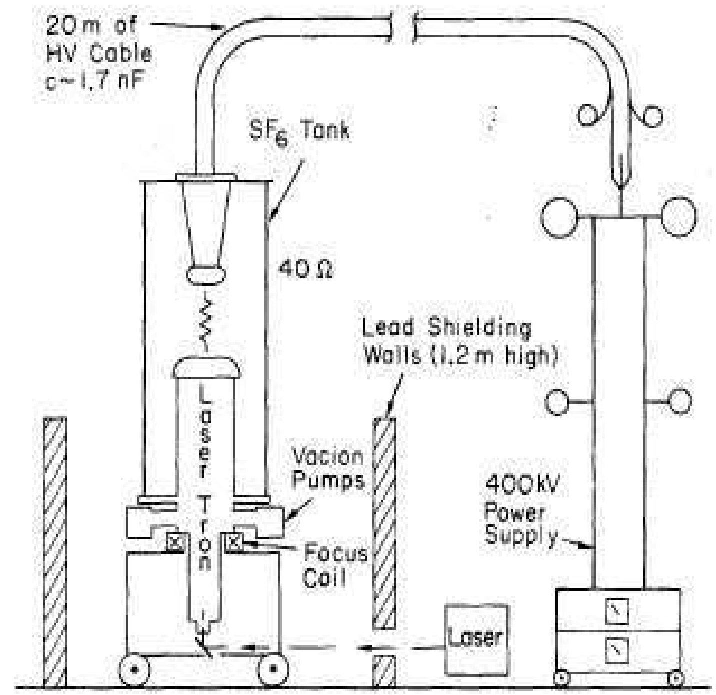


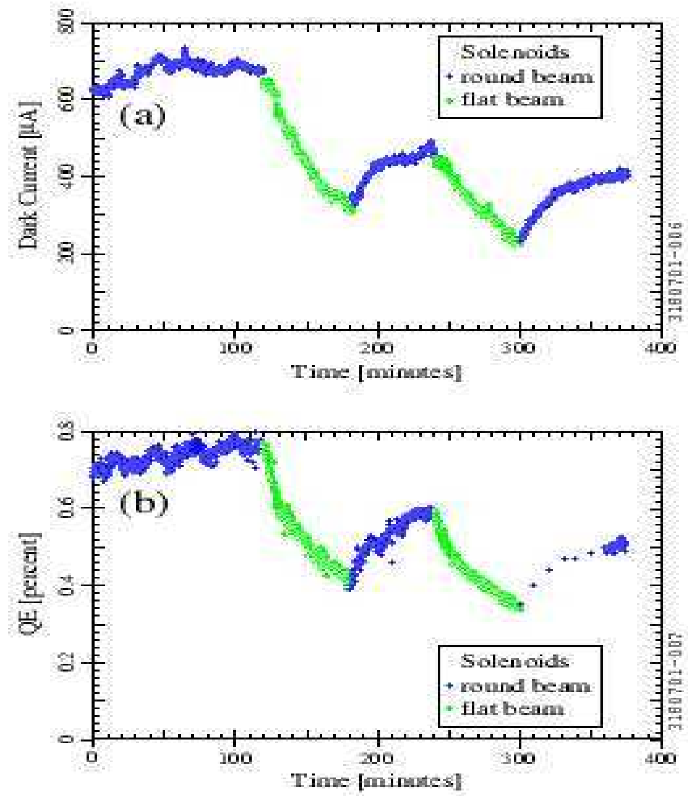
Fig. 1. A schematic view of the SLAC lasertron.



- Performance was limited due to poisoning of Gallium Arsenide cathode and mismatched coupling
- Device produced 2 kW
- Similar experiments carried out at KEK

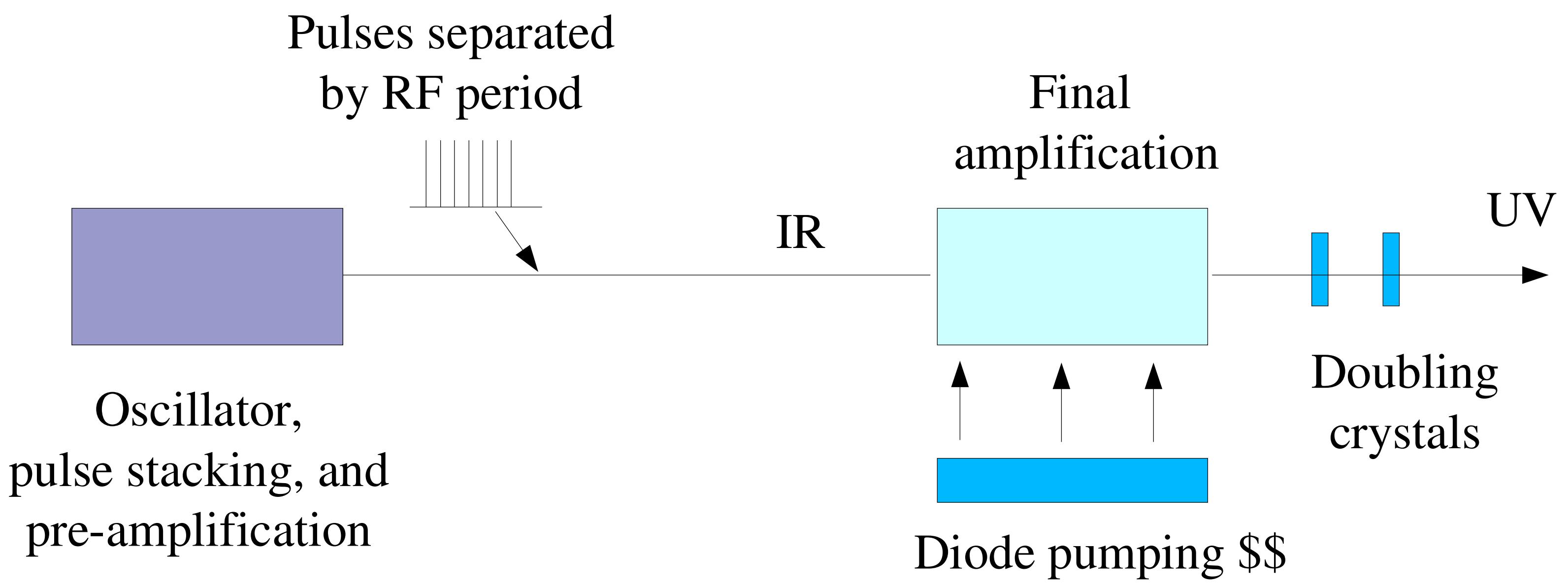
Cesium Telluride photocathodes are used at DESY TTF and A0 Photoinjector:

- QE is 10% after coating and can stay at ~1% for years of operation in an RF gun at 35 MeV/m.
- Dark current at the same gradient is between 0.03 and 1 mA.
- Dark current for a gradient of 12-15 MeV/m (DC) should be well below 1 µA (0.5 W of wasted power at 500 kV)



Results from W. Hartung et al., PAC 2001 Proceedings.
(35 MeV/m RF gun gradient)

Laser System

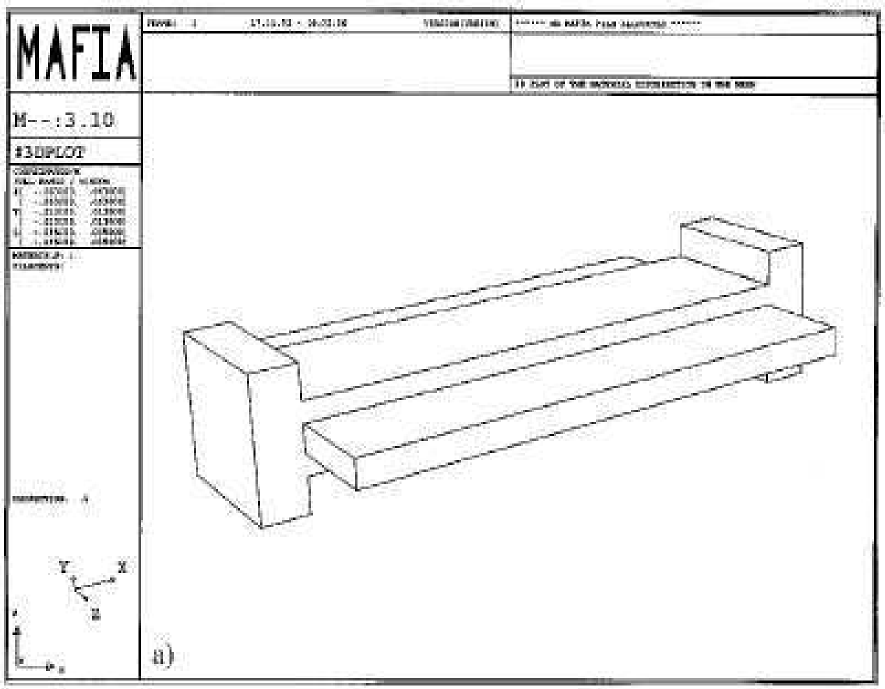


Efficiency:	
Wall power to pump light:	50 %
Pump light to IR:	10 %
IR to UV:	20 %
→ Overall:	1 %

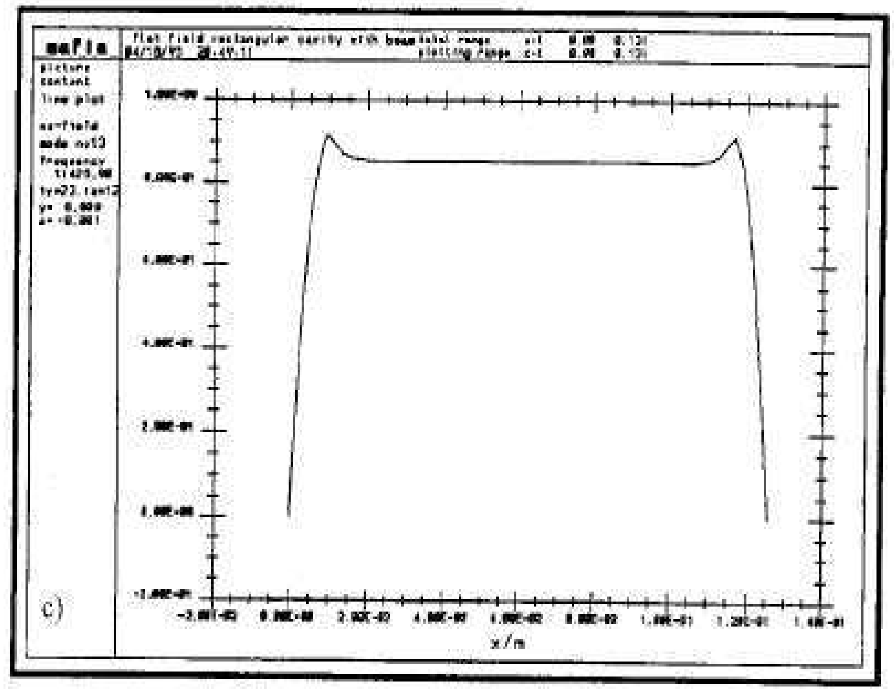
Example: (NLC-like application)	
Tube voltage:	500 kV
Cathode QE:	1%
Tube efficiency:	70%
Tube avg. power:	14 kW
→ Laser avg. wallplug power:	2 kW

Planar, or sheet beam geometry “barbell” cavities:

- Reduced space-charge forces (or micropurveance)
- Better field flatness (long and short dimensions)



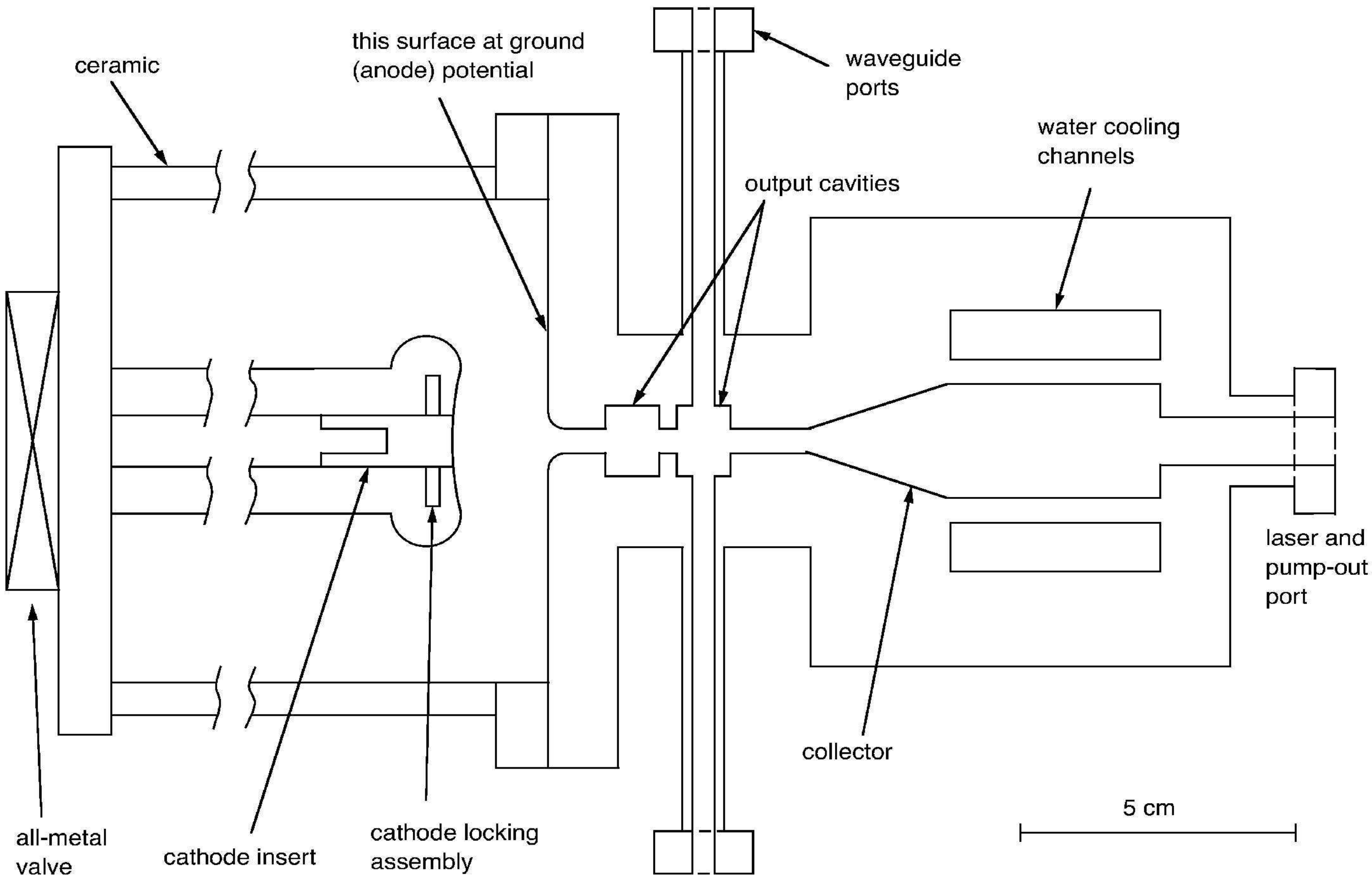
Isometric view, including beam pipe



Field profile (E_z) along wide dimension.

One possible design for a 11.4 GHz planar lasertron. Cavity “long” dimension is out of the page.

- 160 MW may be possible
- Short beam path suppresses instabilities



Conclusions/future work:

Given enough development, a planar lasertron might be a suitable replacement for a conventional klystron.

More detailed physics and engineering issues will be explored with the help of 2-D and 3-D PIC simulations of the device.

Concept can be extended to a THz source with a beat-wave laser system.

DULY Research is working on planar photonic bandgap cavities (Phase II SBIR has been funded).