



# The IR and THz Free Electron Laser at the Fritz-Haber-Institut

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The IR and THz FEL at the FHI is designed to deliver radiation from  $\sim 4$  to 500 microns. A single-plane-focusing undulator combined with a 5.4 m long cavity is used in the mid-IR ( $< 50$  micron), while a two-plane-focusing undulator in combination with a 7.2 m long cavity with a 1-D waveguide for the optical mode, will be used for the far-IR. The S-band electron accelerator includes a gridded thermionic electron gun and twin accelerating structures which are separated by a chicane to deliver the required performance over the 15 - 50 MeV energy range. Key aspect of the accelerator performance is low longitudinal emittance,  $< 50$  keV-psec, at 200 pC bunch charge. "First Lasing" of the MIR system was achieved in 2012. User operation is scheduled to start in fall 2013.

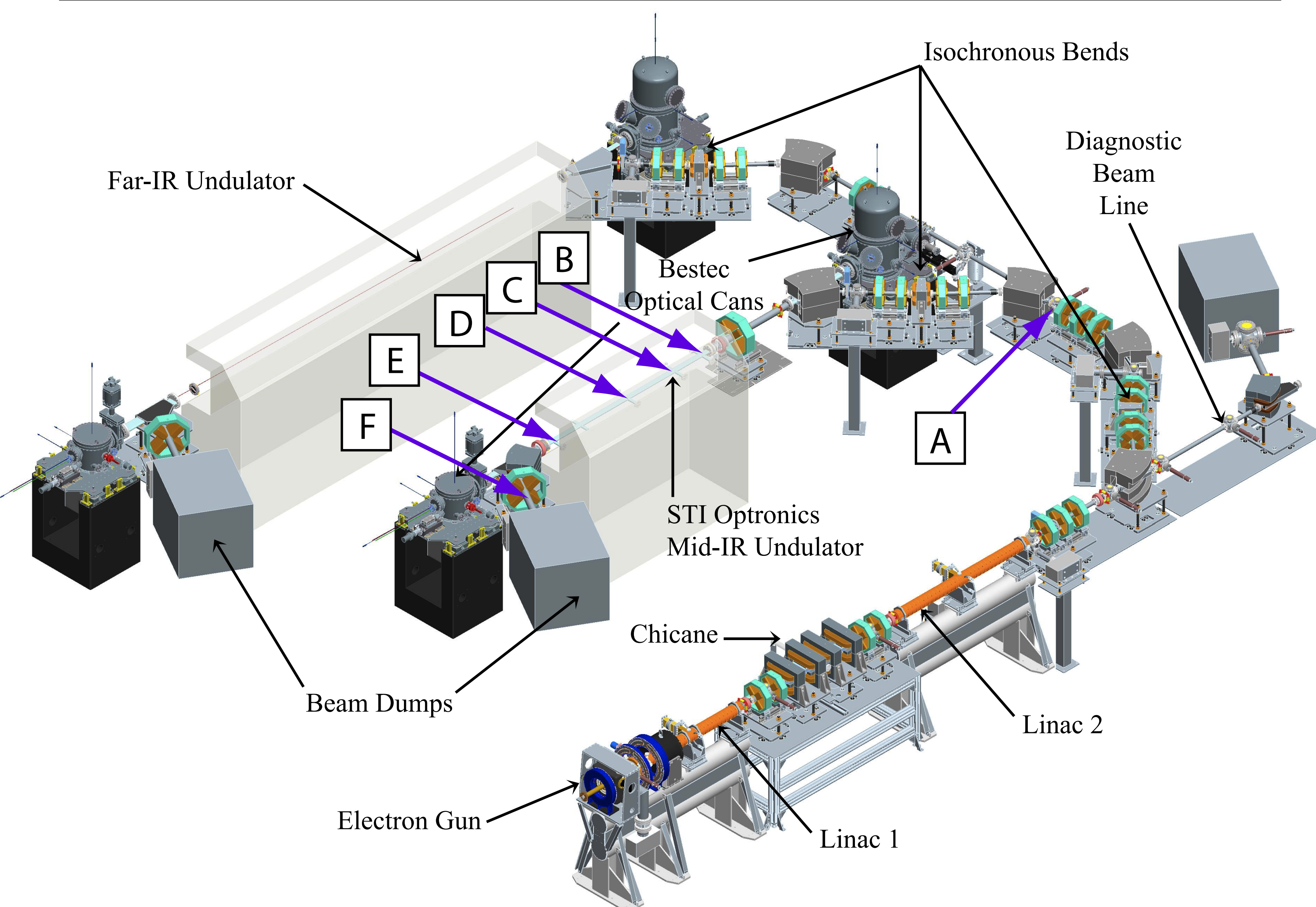
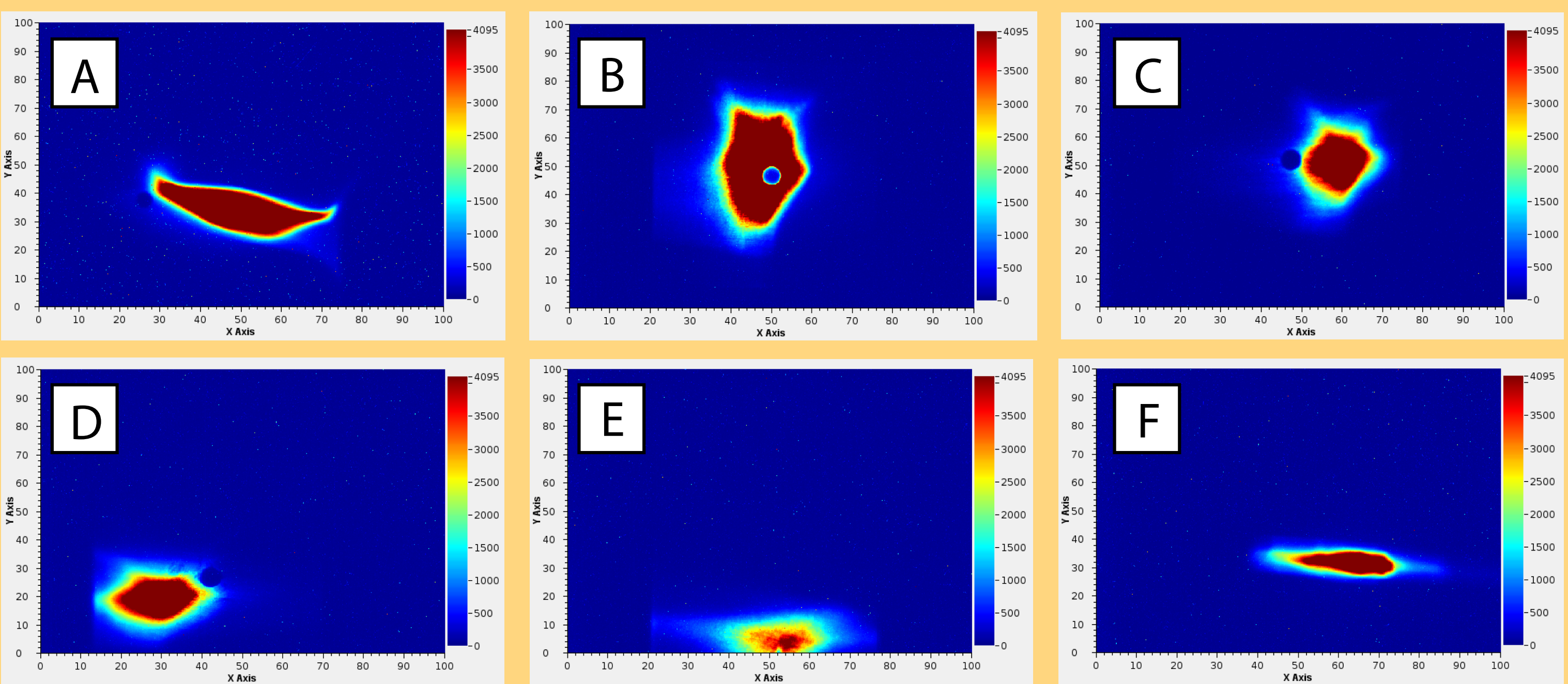
## Status as of August 2013:

- Installation of linacs and e-beam line complete (except FIR branch)
- Linac and e-beam line commissioning nearly complete
- MIR undulator and cavity commissioned
- 5 MIR user beam lines commissioned
- FIR undulator and cavity in planning
- User operation to start before end of 2013

Thermionic gun from a commercial IOT tube (CPI Eimac K2) with dispenser cathode. Photographs show the gridded cathode when cold (left) and when hot (right).



## OTR view screen images of e-beam along FEL beam line at $\sim 35$ MeV, 190 pC



## Electron Beam Parameters

### Normal-conducting S-band linac:

manufacturer:	Advanced Energy Systems
RF frequency:	3 GHz
micropulse rep. rate:	1 GHz (and fractions thereof)
electron energy:	15 - 50 MeV
macropulse length:	15 $\mu$ s
macropulse rep. rate:	10 Hz (max 20 Hz)
bunch charge:	200 pC (max 300 pC)
bunch length:	1-5 ps
energy spread:	50 keV
energy drift:	$< 0.1\%$ per hour
norm. transverse emittance:	$20 \pi$ mm mrad

## Klystron



3 GHz, 20 MW,  
20  $\mu$ sec  
2 x Thales 2130

## MIR Undulator:

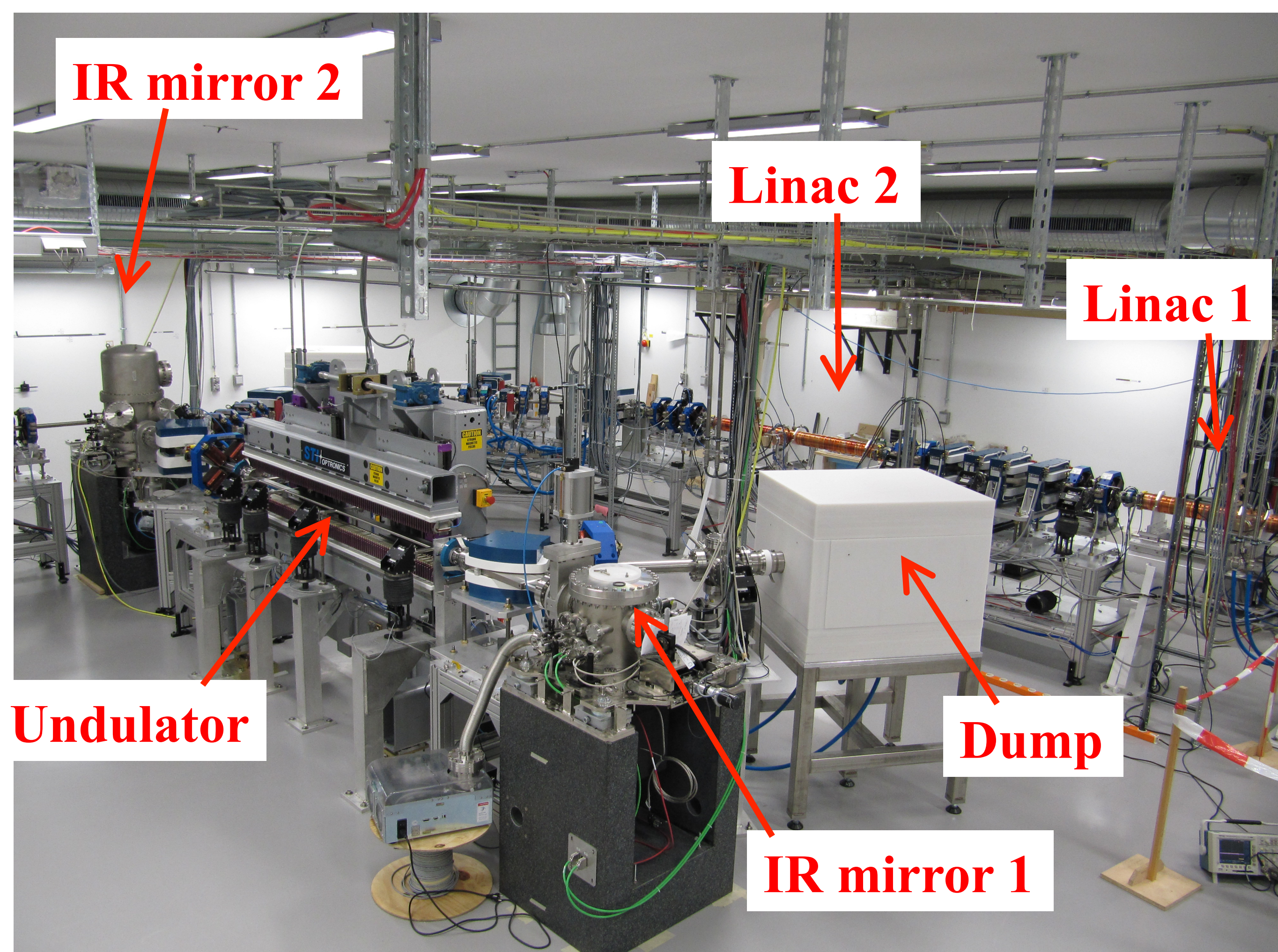
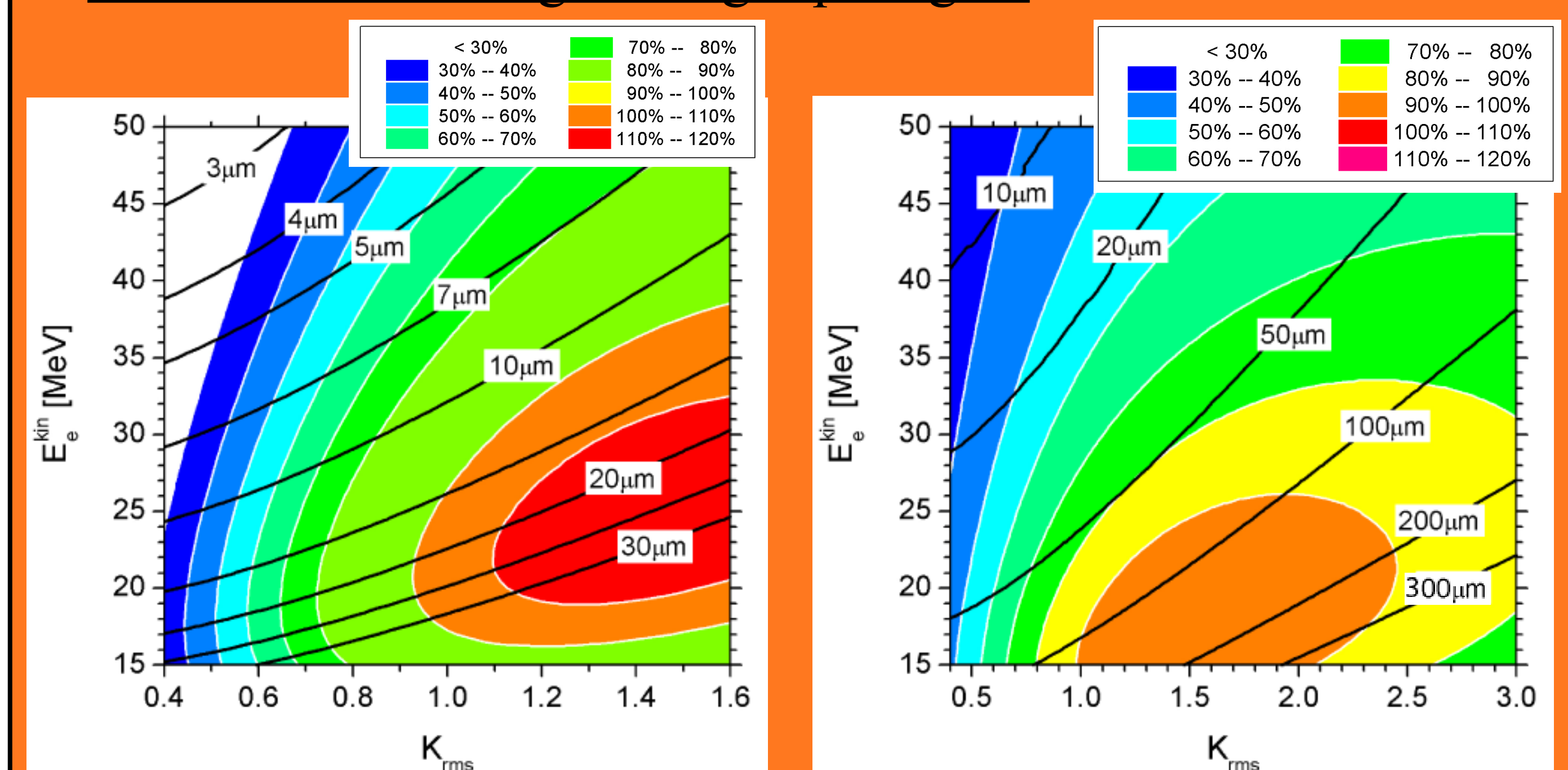
type: planar hybrid  
material: NdFeB  
period: 40 mm  
number of periods: 50  
length: 2 m  
min gap: 16.5 mm  
K (rms): 0.5 - 1.6  
made by STI Optronics



## MIR-cavity:

wavelength: 4 - 40  $\mu$ m,  
length: 5.40 m, no waveguide, outcoupling-holes in cavity mirror: 0.75, ..., 3.5 mm,  
made by BESTEC GmbH

## Calculated small-signal single-pass gain



## IR macropulse energies at 25 MeV electron energy

