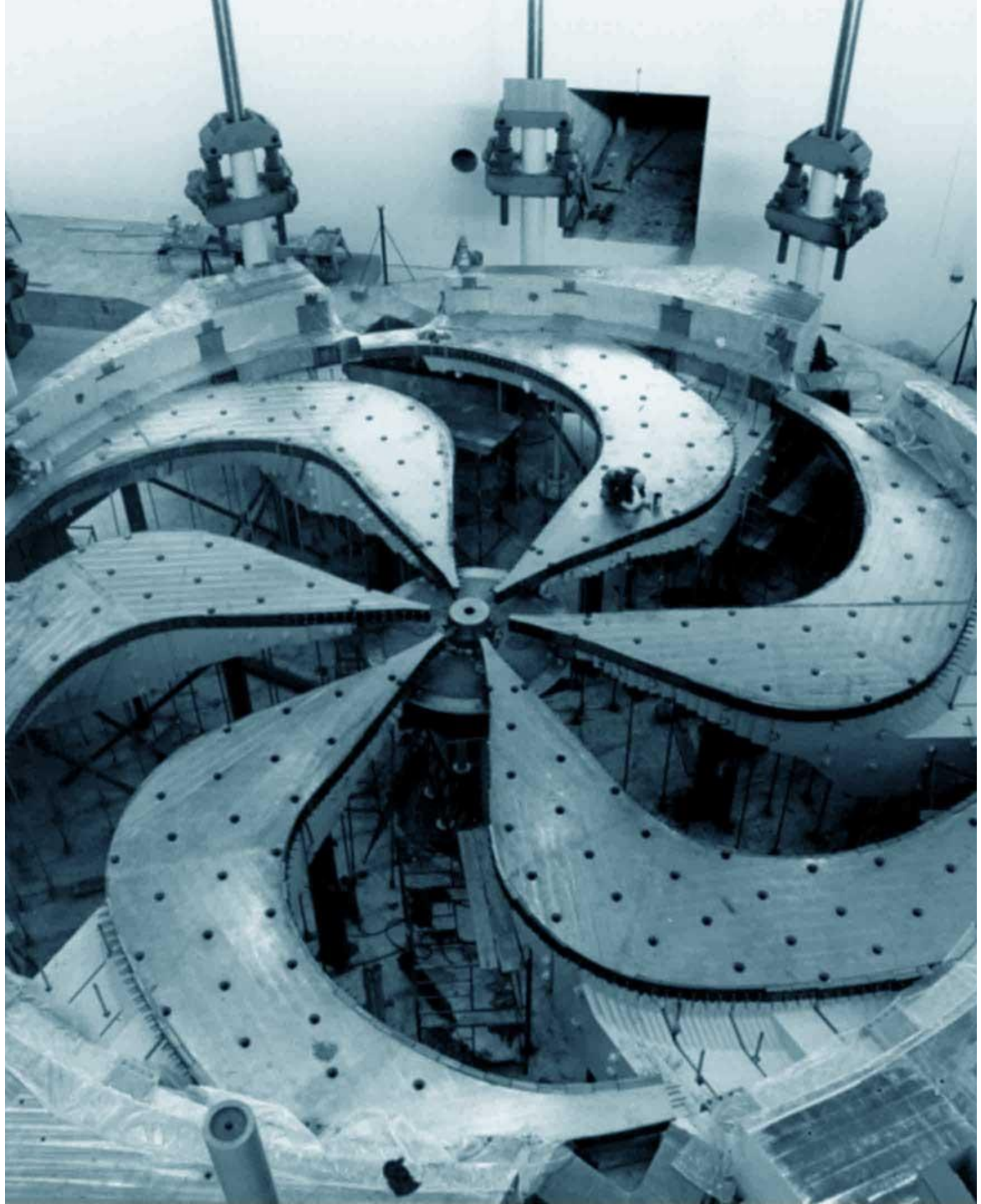
The electron gun for the THZ radiation project

Friedhelm Ames

FEL Canadian Research collaboration workshop

March 19, 2024



Electron source requirements

- For THZ operation:
  - Bunch charge 50-200 pC
  - Bunch length 50 ps for dc gun, <20 ps for rf gun
  - Pulse repetition frequency < 100 kHz
  - Beam energy > 500 keV

- For RIB production
  - Average current up to 3 mA (> 3000 hours of operation per year)
  - Bunch length 130 ps
  - Pulse repetition frequency 650 MHz
  - Macro pulse structure with duty factor up to 100 %
  - Beam energy > 300 keV

- Parallel operation should be possible →low maintenance to minimize downtime

Presently used electron source at TRIUMF

- DC gun operated at 300 keV with thermionic cathode
  - Rf modulation at grid

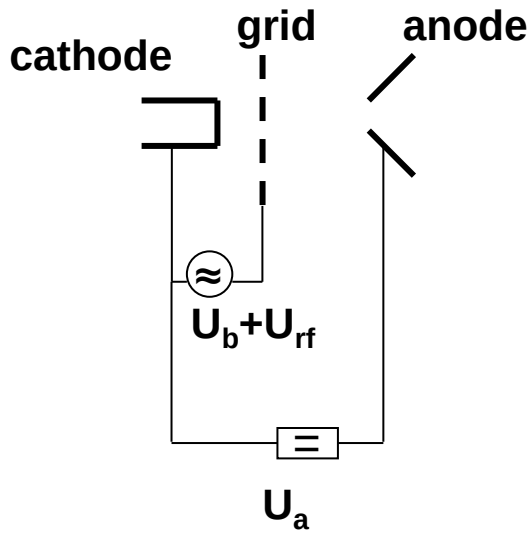
  - Average current up to 10 mA
  - Bunch length < 130 ps
  - Bunch charge < 15 pC
  - Pulse repetition frequency 650 MHz
  - Duty factor up to 100 %
  - Beam energy 300 keV

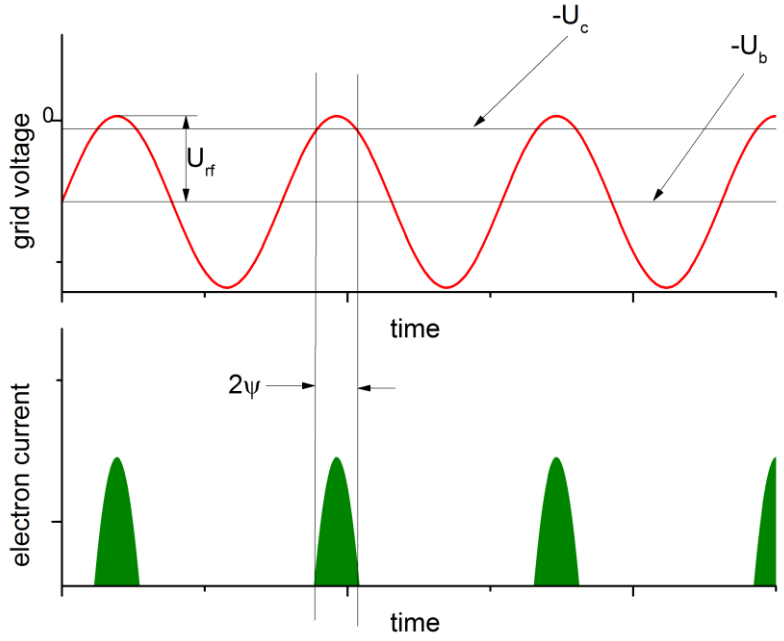
CPI

thermionic dispenser cathode with grid

model Y-845

Cathode area 0.5 cm^2





Dc photo gun versus (S)RF photo gun

	DC gun	SRF gun
Beam energy	Up to 500 keV State of the art at KEK, Cornell	Typically, 2-5 MeV
Bunch charge	200 pC	200 pC
Bunch length	Difficult to transport pulses shorter than 50 ps or >50 pC due to low energy	Shorter pulses possible
footprint	May require larger footprint for high voltage power supply	Less footprint, rf supply can be separated
cost	High >2 M$	High >2 M$ can be lower if rf and cryogenics infrastructure of the linac can be used
risk	High risk (500 keV is presently limit of technology)	Low risk (proven to deliver requirements, ex. ELBE)

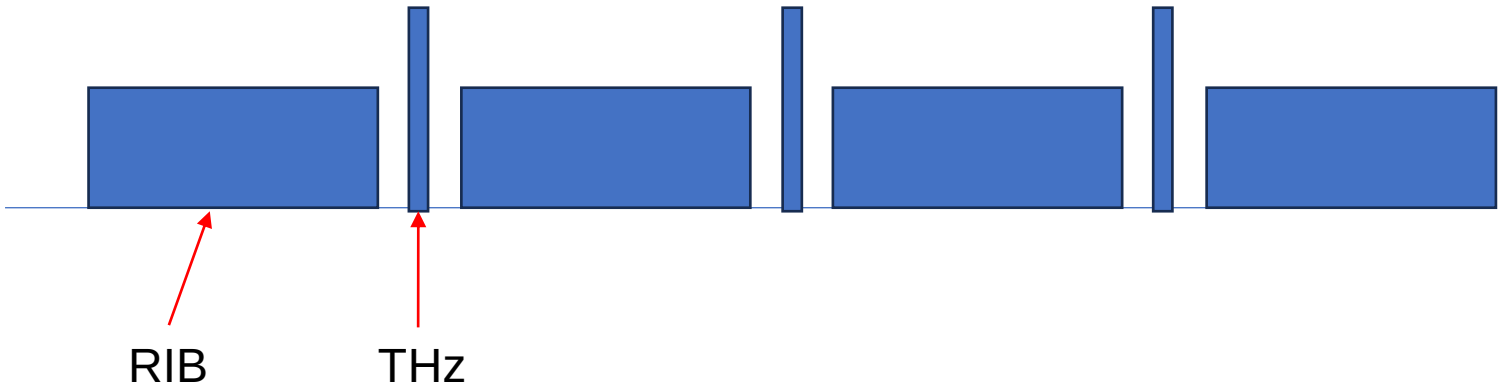
Cathode material

	QE (%) typical	Laser wavelength (nm)	lifetime	production/handling
Cs_2Te	5-10	260	~10 days	Complex production Very sensitive to vacuum
K_2CsSb	4-10	520	~10 days	Complex production Very sensitive to vacuum
Mg	0.2	260	Very long, can be prolonged by in situ UV cleaning	Easier production More robust in operation
Cu	0.02	260	Very long, can be prolonged by in situ UV cleaning	Easier production More robust in operation

Lifetimes are very much depended on operating conditions (vacuum)

Parallel operation

- 2 laser systems
- For THZ operation:
  - 10-100 kHz repetition frequency
- For RIB production
  - ~130 MHz up to 90% duty factor



Thank you
Merci

www.triumf.ca

Follow us **@TRIUMFLab**

Discovery, accelerated