WG4
Injector and beam manipulation concepts (low emittance e+ and e- sources, emittance exchange, reduction and preservation approaches, ...)

John Power and John Sheppard

Special assistance from Martin Paraliev and Ray Flliller

Requirements for Injectors

TABLE 1). Major parameters of the sources.

Parameters	ILC	CLIC	Laser-Dielectric	PWFA	coaxial_DLA	LWFA
Particle Type	e-,e+	e-,e+	e-,e+	e-,e+	e-,e+	
Particles Per μbunch	$2x10^{10}$	$6x10^{9}$	$6x10^{4}$	1e10	2.5e7 (4pC)	
Number Of μbunch	2625	312	100-300	125	45e3	
Width Of μbunch	1 ns (~ps)	100 ps(~ps)	100 attosec	33 fs	30 ps	
Time Between μbunches	360 ns	500.2 ps	6.7 fs	4 ns	330 ps	
Peak Current of μbunch	4.8 A	9.6 A	67 A	45 kAmps?	0.12 A	Peak Current of μbunch
Width Of Macropulse	1 ms	156 ns	1 ps	500 ns	15 us	
Macropulse Repetition Rate	5 Hz	50 Hz	25 MHz	100 Hz	50 Hz	
Charge Per Macropulse	12600 nC	300 nC	1.6 pC	187 nC	180 nC	
Macropulse Current	12.6 mA	1.9 A	0.7 A	0.38 A	0.012 A	
Polarization (e-)	>80%	>80%	>80%	injector can provide it, but can plasma preserve it	80%	
Norm. Emittance, injected	$1x10^{-3}$	$1x10^{-3}$	no damping required for e-, problem for e+!		?	
Norm. Emittance, delivered (x/y)	$1x10^{-5}$ / $4x10^{-8}$	$6x10^{-7}$/ $2x10^{-8}$	$1x10^{-10}$/ $1x10^{-10}$	$0.2x10^{-5}$ / $5x10^{-8}$	?	
Power Source Wavelength	23 cm	2.5 cm	2 micron	200 um (not quite sine, nonlinear)	10 cm	
charge per second	42 uC	15 uC	40 uC	20 uC	9 uC	
others??						

*All schemes still need similar beam power:
polarization and e+ still needed at the same level

Novel Concepts with Potential Benefits

- Sources for microwave accelerators
  - Development of GaAs in SRF guns
  - Development of high-voltage pulsed DC guns
  - Emittance exchange
  - Robust GaAs
  - Field Emitter Array cathode
- Sources for optical accelerators
  - Single tip tungsten laser assisted
  - Pyroelectric crystal e- source

Lower emittance

Stable operation

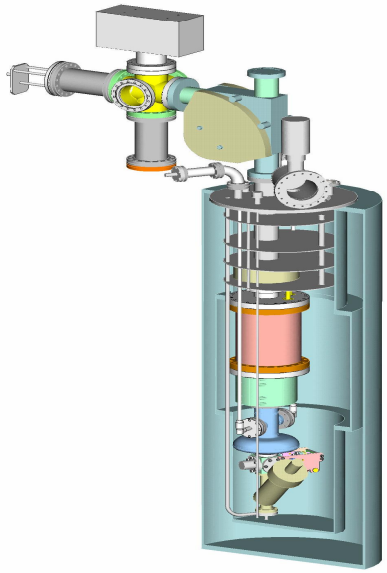
New injectors to match
Into optical accelerators

Concepts to lower emittance

Benefits: ease or eliminate damping ring

GaAs in SRF guns

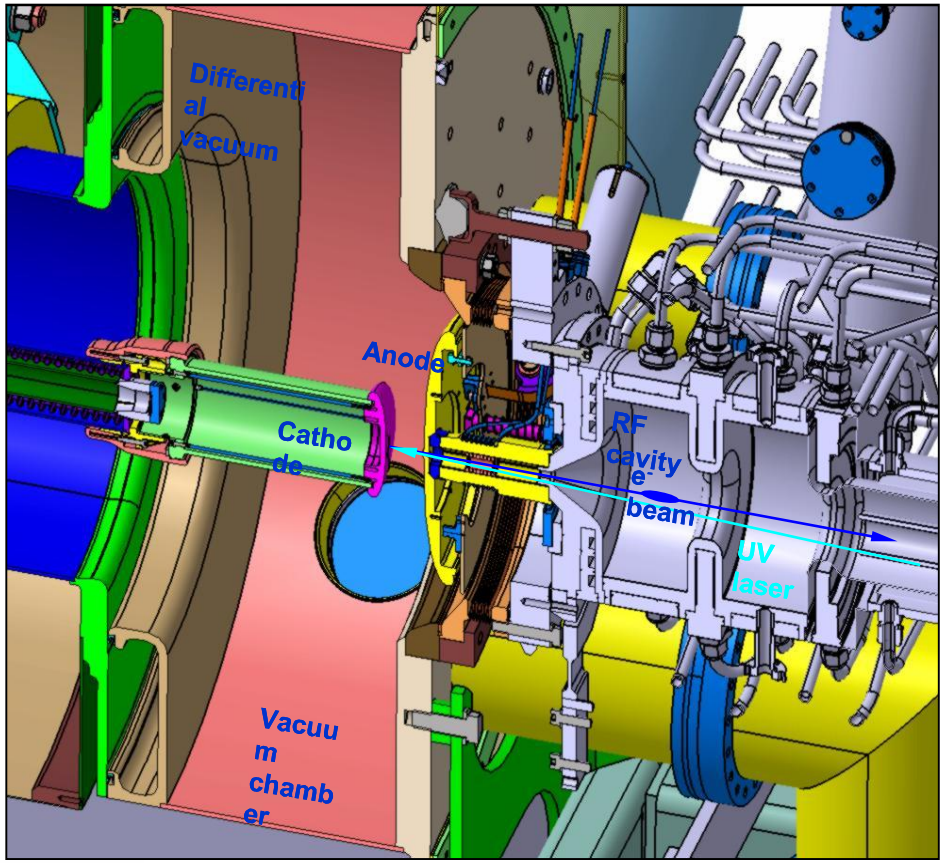
- –Polarization
- –QE ~ 0.5%
- –eN ~ 0.3 um
- –Test scheduled for next month



high-voltage pulsed DC guns

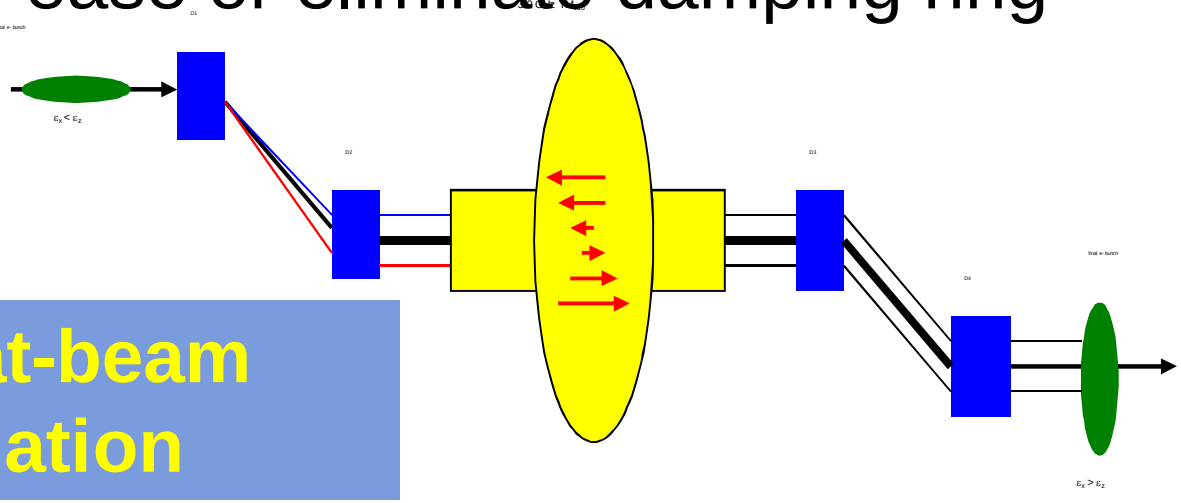
-500 kV

-lower eN possible (0.5um?)



Concepts to lower vertical emittance

Benefits: ease or eliminate damping ring



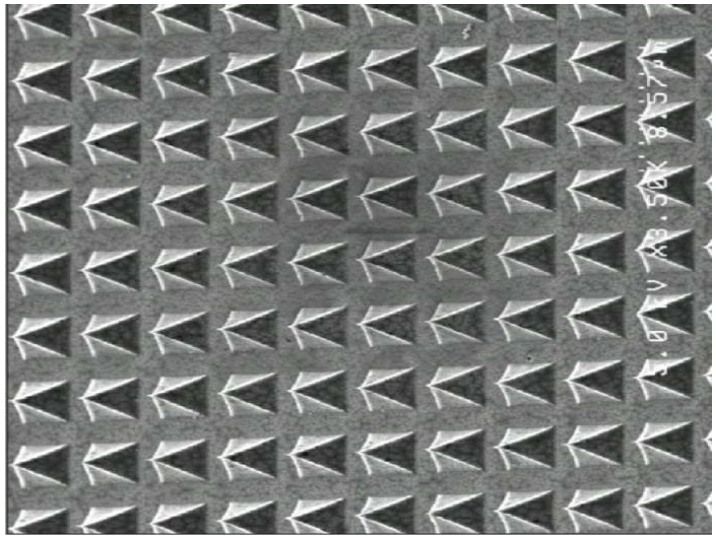
round-to-flat-beam transformation

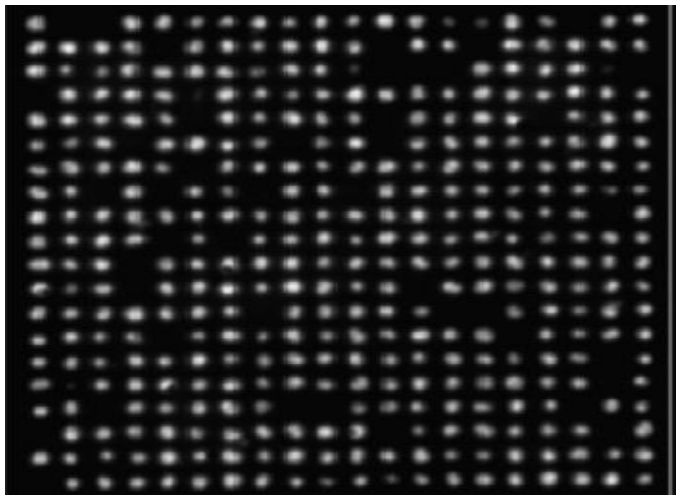
(5, 5, 8) → (1250, 0.02, 8) → (8, 0.02, 1250)

Emittance exchange

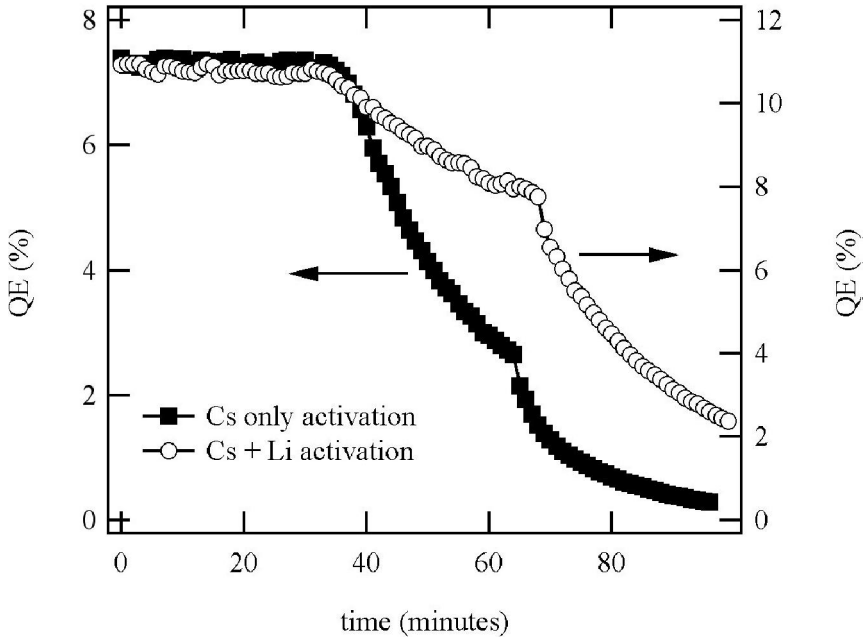
Concepts to stability
Benefits: lower cost

Field Emitter Array cathode
-eliminate the need for the laser
-potential for lower emittance

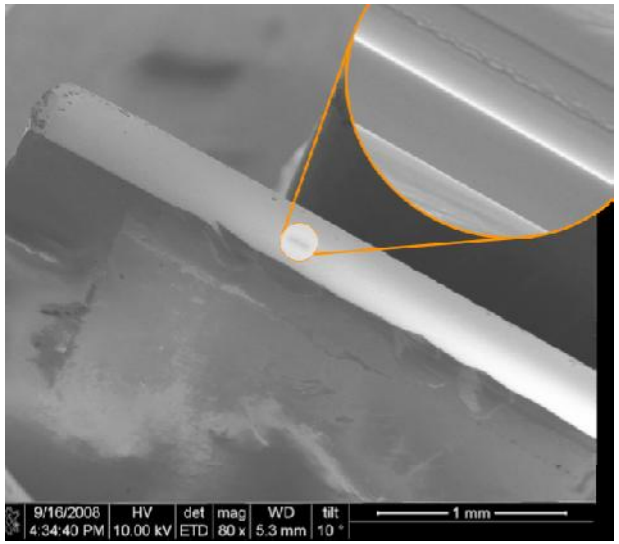




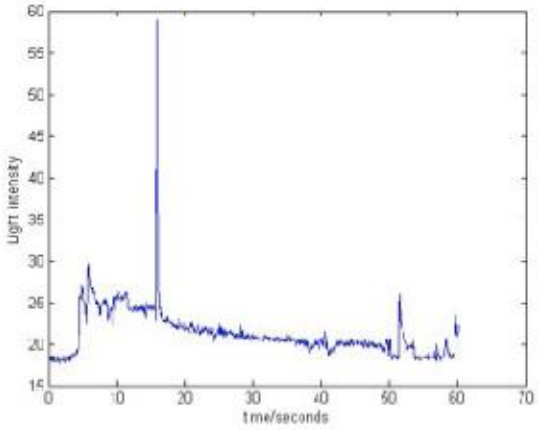
Robust GaAs
-longer lifetime x2?

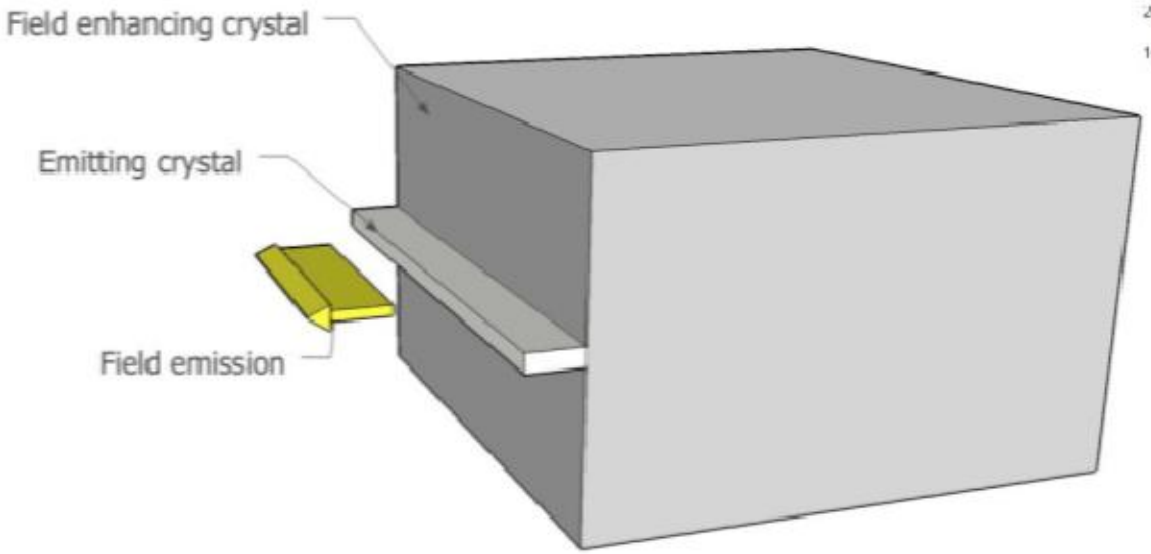


Concepts for optical wavelength injectors



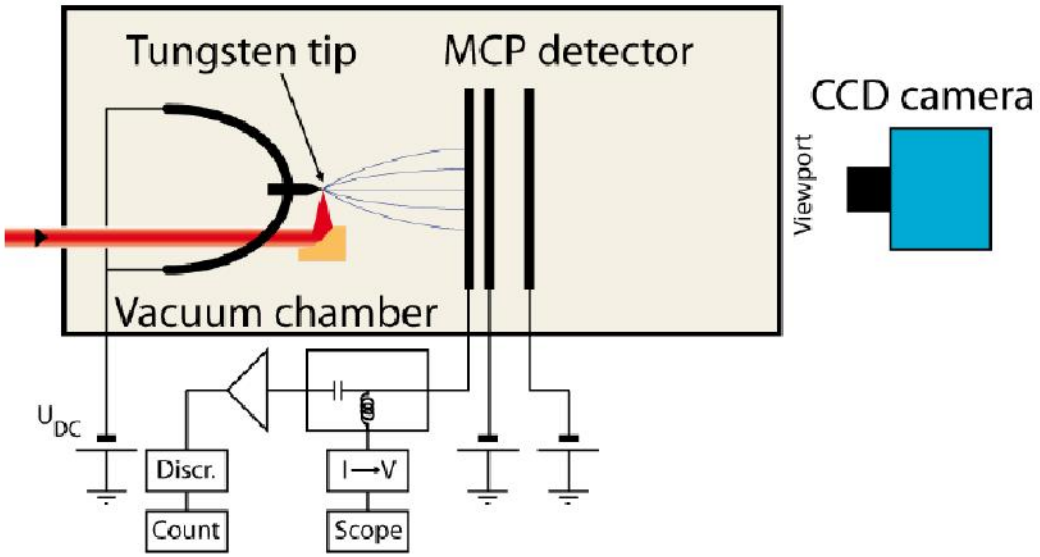
Pyroelectric crystal
-100 um emitter

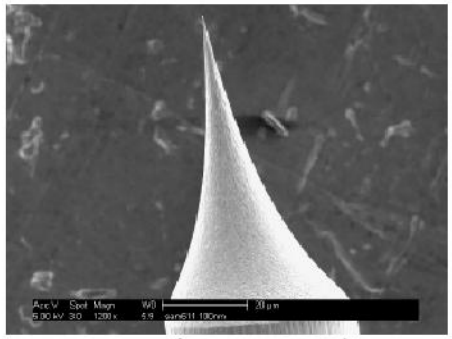


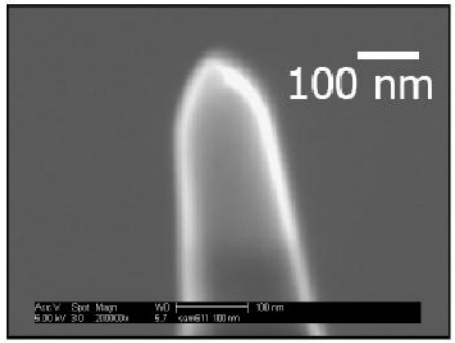


Concepts for optical wavelength injectors

Experimental setup



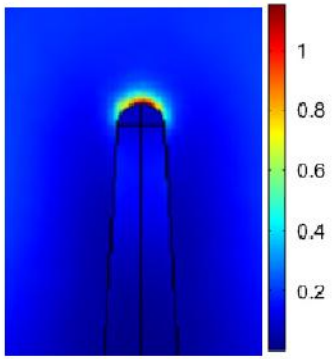




- Ti:Sa oscillator: ~780nm, 500mW, 6fs, 150MHz
- Spot radius on tip ~ 3 μm ($1/e^2$)

→ Peak elec. field up to 5GV/m w/o field enh.

r=50 nm W tip,
780 nm light



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