# *ILC polarized Electron Source R&D*
## *Update*

## *LCWS 2008*

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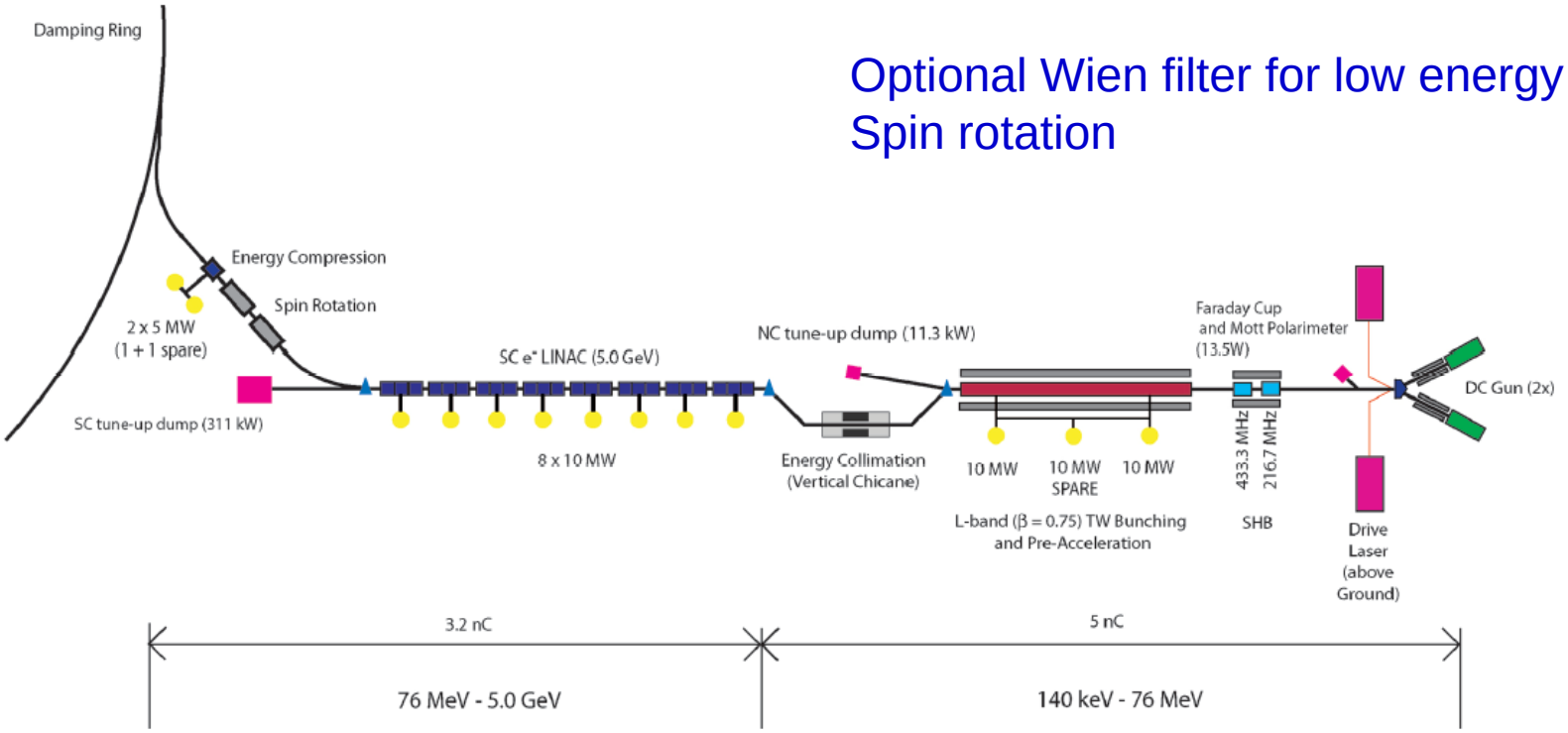
# Outline

- Reminder: Parameters and Layout
- Source Drive Laser System R&D
- DC Gun R&D
- Polarized Cathode R&D
- Other relevant R&D

# Parameters

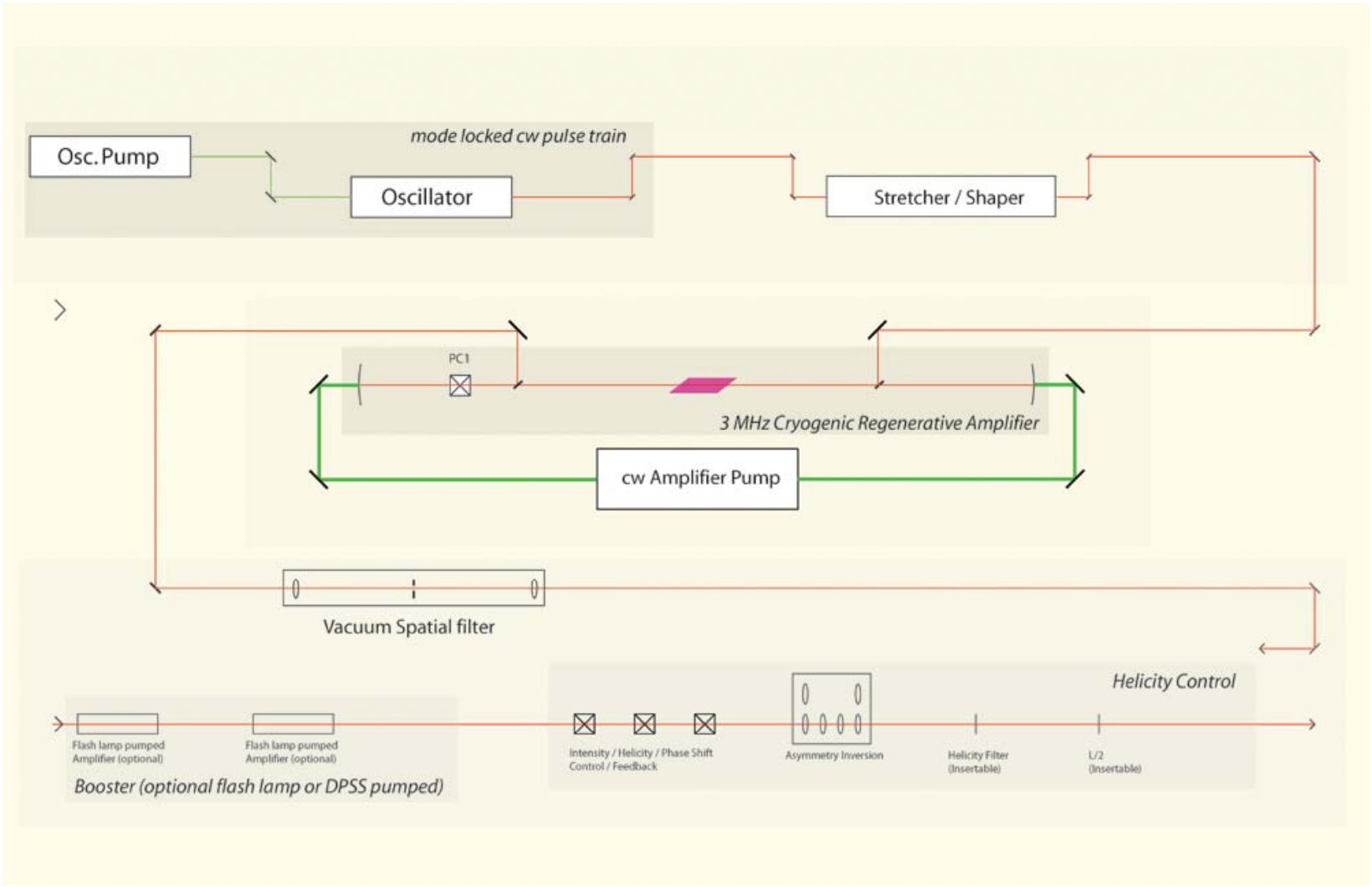
| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Electrons per bunch (at gun exit) | $n_e$ | $3*10^{10}$ | Number |
| Electrons per bunch (at DR injection) | $n_e$ | $2*10^{10}$ | Number |
| Number of bunches | $N_e$ | ~ 3000 | Number |
| bunch repetition rate | $F_{\mu b}$ | 3 | MHz |
| bunch train repetition rate | $F_{mb}$ | 5 | Hz |
| bunch length at source | $\Delta t$ | 2 | ns |
| Peak current in bunch at source | $I_{avg}$ | 3.2 | A |
| Energy stability | S | < 5 | % rms |
| Polarization | Pe | 80 (min) | % |
| Photocathode Quantum Efficiency | QE | 0.5 | % |
| Drive laser wavelength | $\lambda$ | 780-810 (tunable) | nm |
| single bunch laser energy | E | 5 | µJ |

# 5 GeV Electron Source Systems

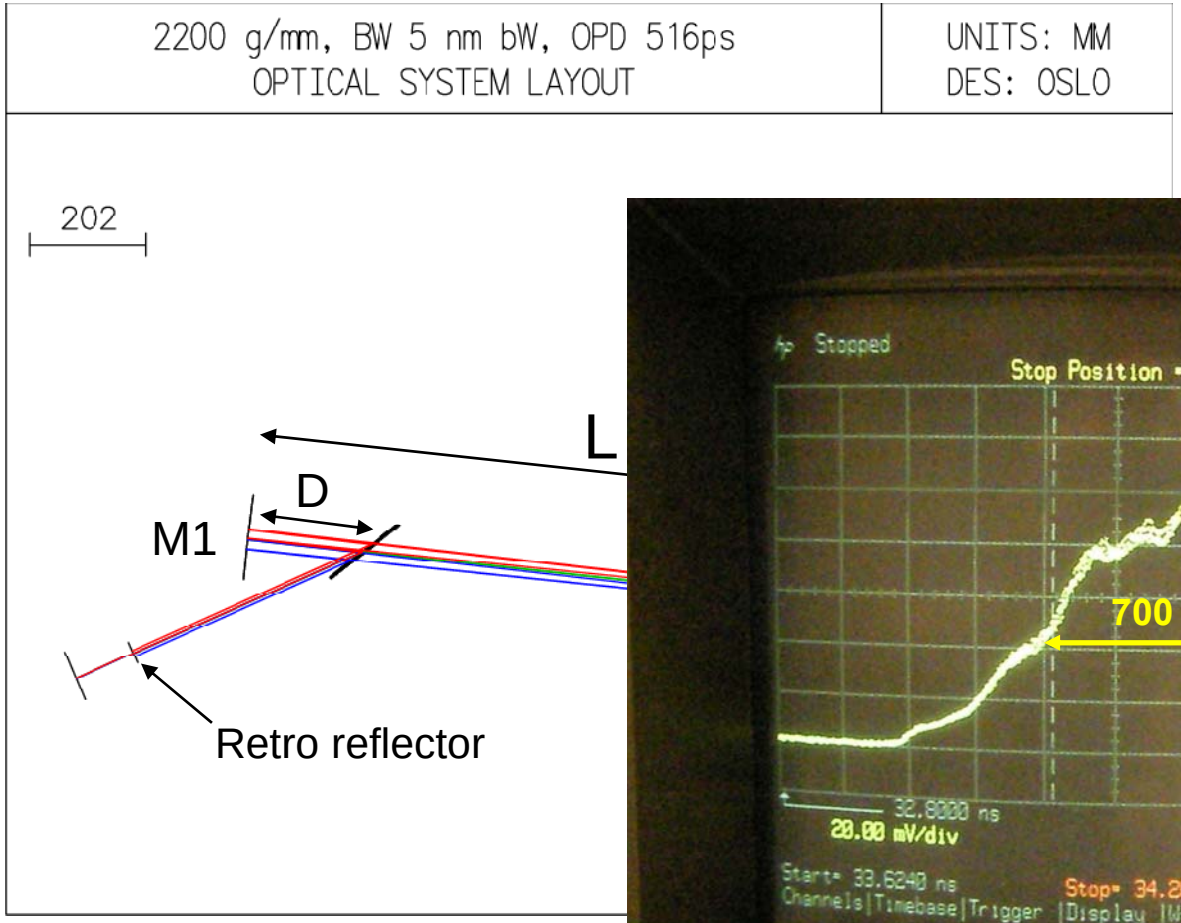


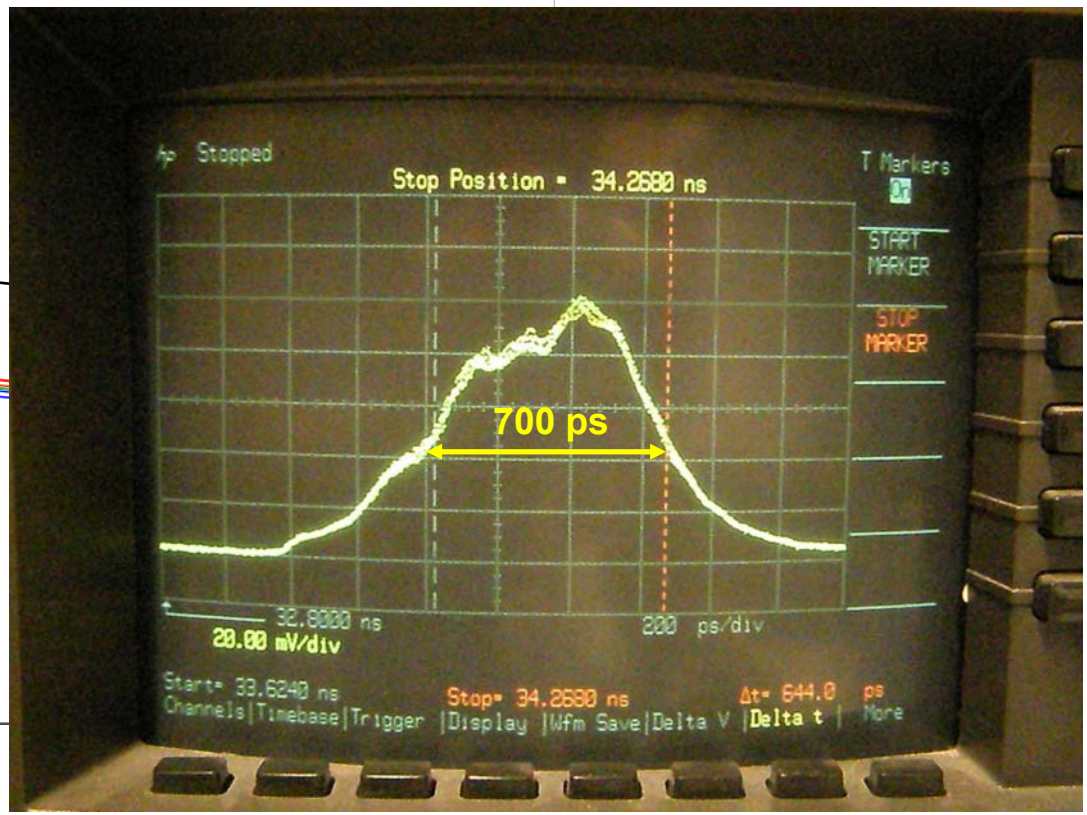

Optional Wien filter for low energy Spin rotation

# Source Drive Laser R&D

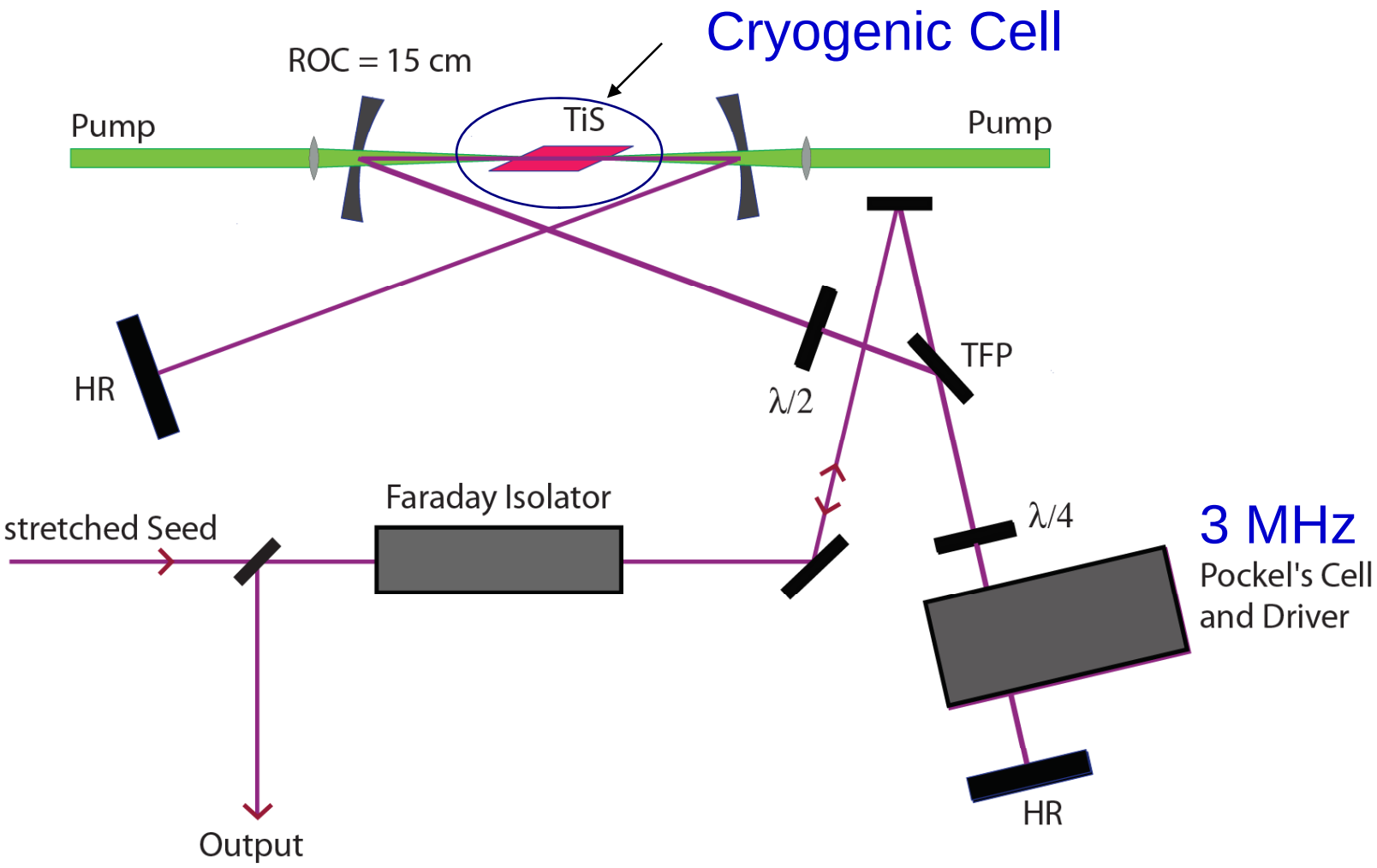


# Pulse stretcher 250 fs → 500 … 1000 ps



# Cryogenic Regenerative Amplifier



# Pockel's Cell Issues

- Electro optic crystals are also piezo - electric crystals!

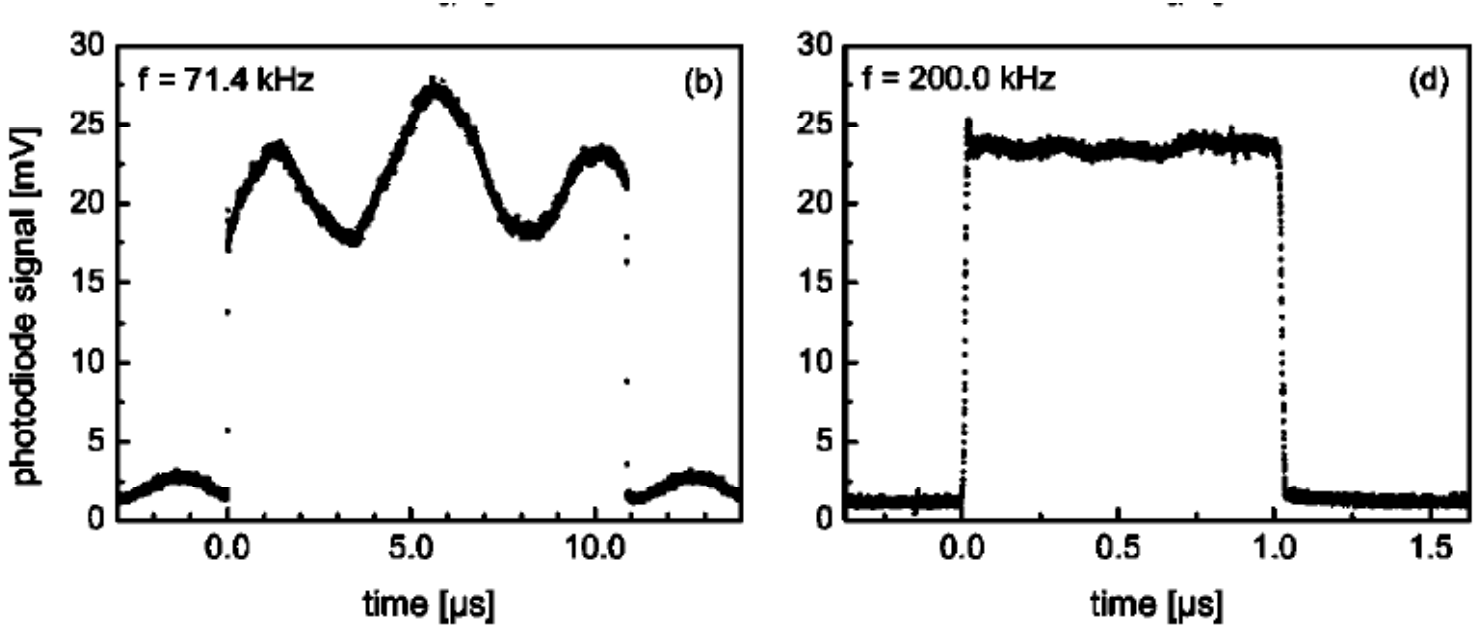
$$\Delta\phi = \left( \frac{2\pi L}{d} / \lambda \right) [-n^3 r_3 / 2 + (n-1) d_{13}] E_3$$

electro-optic coefficient

inverse piezo-electric coefficient

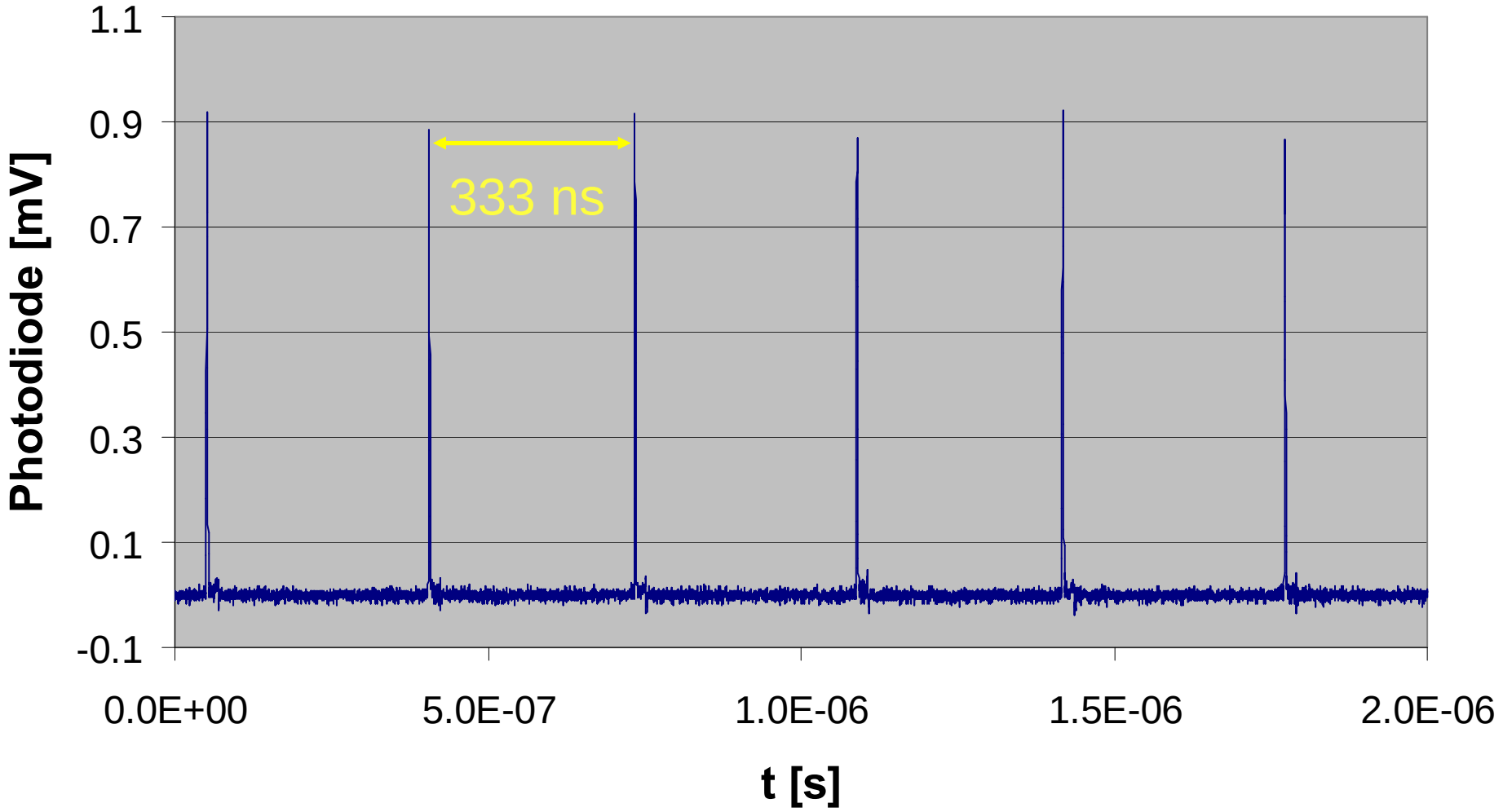
- At high kHz to MHz rates, piezo-electric resonances occur
  - Resonance at the 'wrong' frequency leads to unusable Pockel's cell
  - Catastrophic damage of crystal itself

# Piezo-electric ringing




Nickel et al., Rev Sci Instr. 76, 033111 (2005)

# Successful 3 MHz pulse switching



# DC Gun Development at Jlab

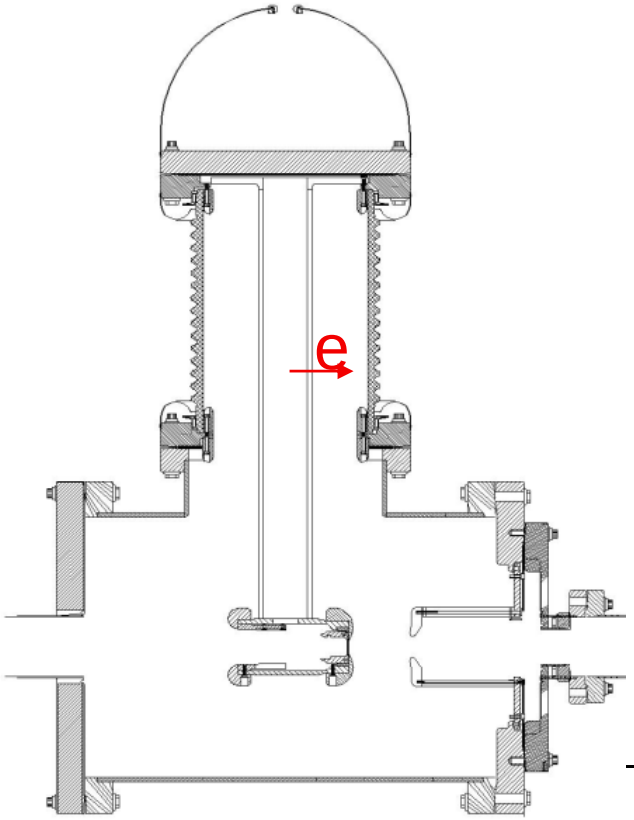
**Currently developing a 200kV gun**

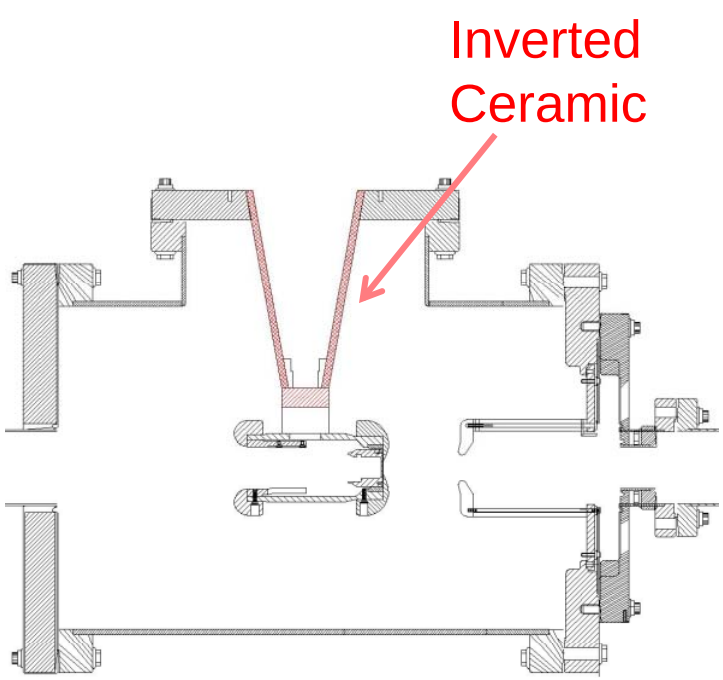
**Joint with ILC (CEBAF synergy)**

**Inverted ceramic insulator**

**medical x-ray technology, no exposed HV, no SF6,**

**field emission not likely to accumulate on insulator**



# ILC e-Gun Deliverables

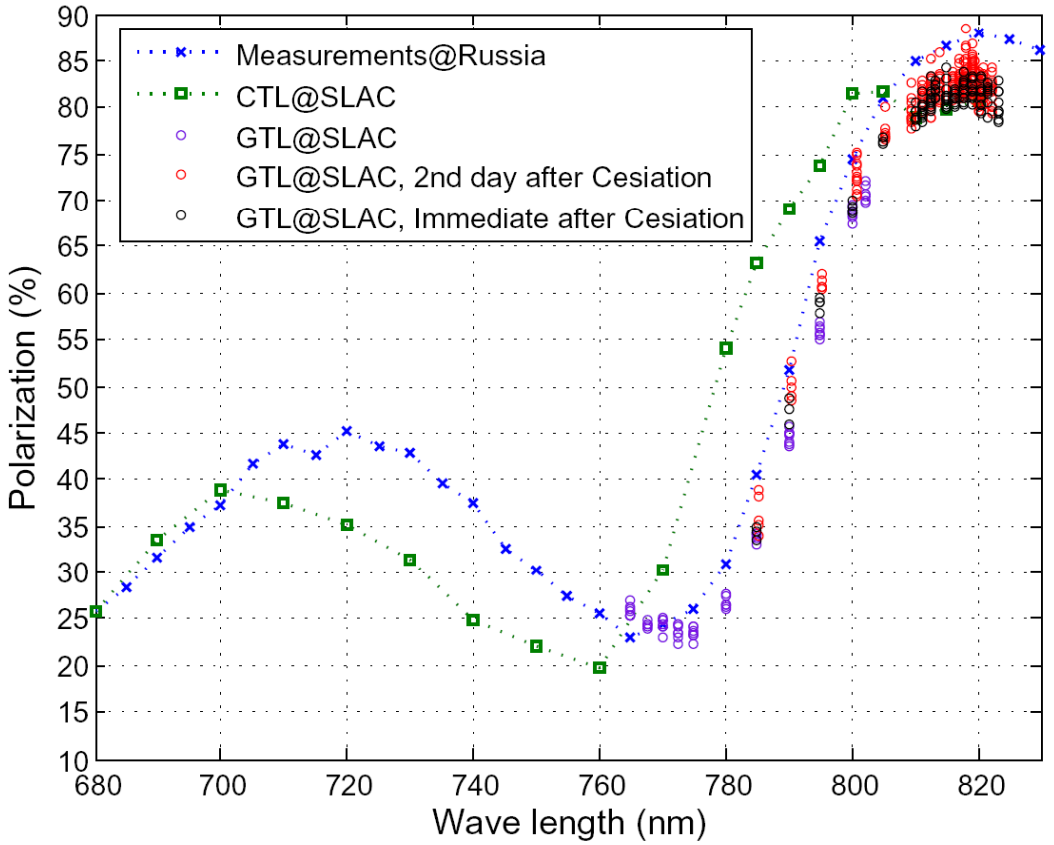
- 2009 – Reliable 200kV load locked gun
  - Tested at high average current at Injector Test Cave
  - Installed at CEBAF, schedule willing
  - Cathode/anode optic designed for low bunch charge.
- 2010 – Progress towards ~ 350kV design
  - There is at least one 350kV gun in operation…
  - Clear road map identifying technological challenges that must be solved, e.g., field emission, insulator high voltage breakdown
  - Build electron-optic model of ILC “front end” (Parmela and/or GPT), suitable cathode/anode design for high bunch charge with reasonable match to subharmonic buncher(s) and warm-RF injector

# ILC e-Gun Deliverables

- 2011 – Reliable ~ 350kV load locked gun…
  - Operating at ILC beam specifications at Injector Test Cave (laser from SLAC?). Verify adequate lifetime and beam quality.
  - Fine-tune gun/injector design using technique of multivariate optimization, for beam to the end of the 6GeV injector, perhaps to the damping ring

# Photocathode R&D

## InAlGaAs/AlGaAs – ~85% Spin Polarization




See talk by F. Zhou 'Polarized Cathode R&D update and PESP2008 Summary'

# Other relevant work

- Polarized RF gun developments (partially SBIR projects)
  - SC polarized RF gun (BNL)
  - PWT gun (Duly Research)
- Cathode R&D SBIR's
  - Innovative activation techniques (SAXET surface science, SLAC)
- Laser System development SBIR(II)
  - Kapteyn-Murnane Labs

# Summary

- R&D is being carried out despite funding challenges
  - Laser system development
  - Cathodes
  - Guns
- Proof of principle of ILC source is anticipated within ~ 2 years.