Transition Radiation Energy and Spectrum measurements (2022 run)

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Proposed FAST Beam parameters

- Beam energy ~45 MeV
- Beam emittance (rms, n) ~ 4 um (depends on a bunch charge)
- Bunch charge 0.1 – 2 nC (~1 nC)
- Bunch length (rms) ~6 mm (at 1 nC) → 10-20 ps rms
- Desired peak currents: 7 - 15 A

	FAST	**EIC (100 GeV)**	**EIC (275 GeV)**
Electron beam energy	50 – 300 MeV	50 MeV	137 MeV
Bunch charge	0 – 3 nC	1 nC	1 nC
Emittance (norm, rms)	~3 μm (at 1 nC)	2.8 μm	2.8 μm
Bunch length	0.3 – 20 mm	14 mm	7 mm
Drift section (amplifier)	80 m	100 m	100 m

Bunch length

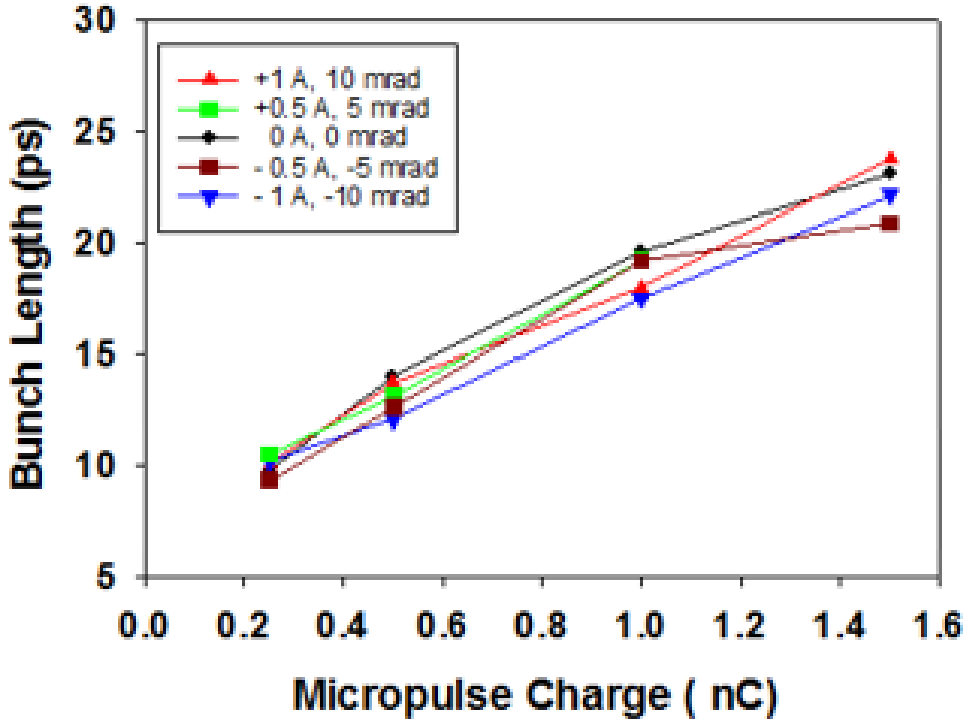
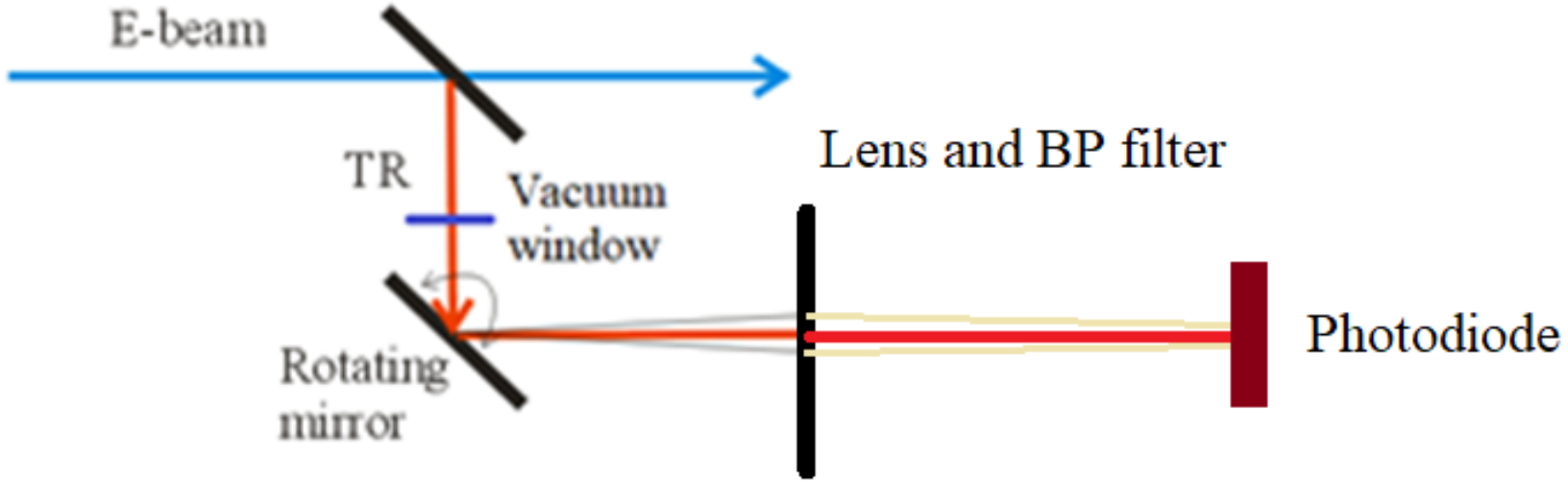


Figure 4: Streak camera bunch length versus charge results during the V101 corrector scan from -1.0- to +1.0-A values. At 4.5 MeV, a 1-A current change corresponds to a 10-mrad angular change into CC1. The transverse laser spot is ~ 0.5 mm in x and y in this case.

X121 cross

https://journals.aps.org/prab/abstract/10.1103/PhysRevAccelBeams.23.054401

Proposed setup at x121



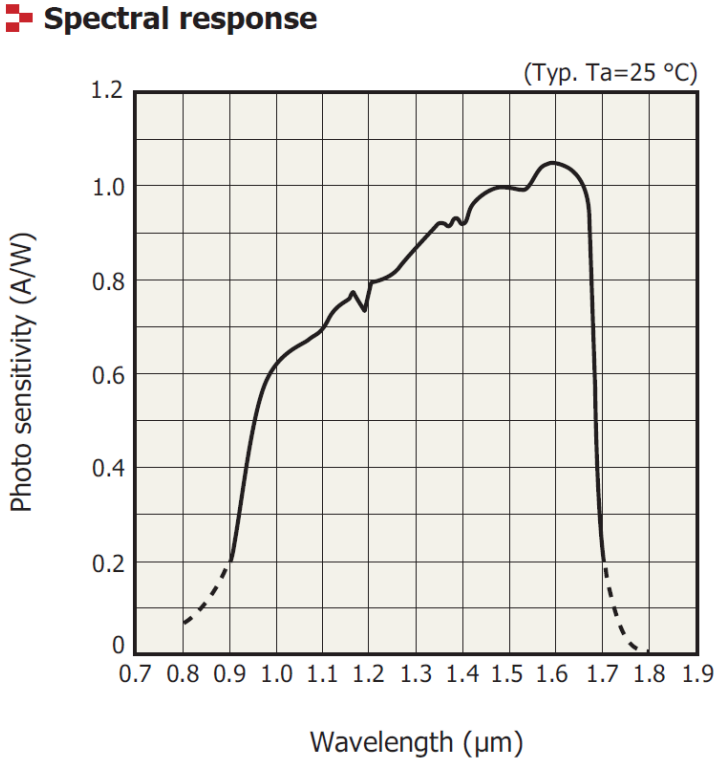
- Proposed optical band: 0.5 - ~2 um (measure in ~100 nm steps)

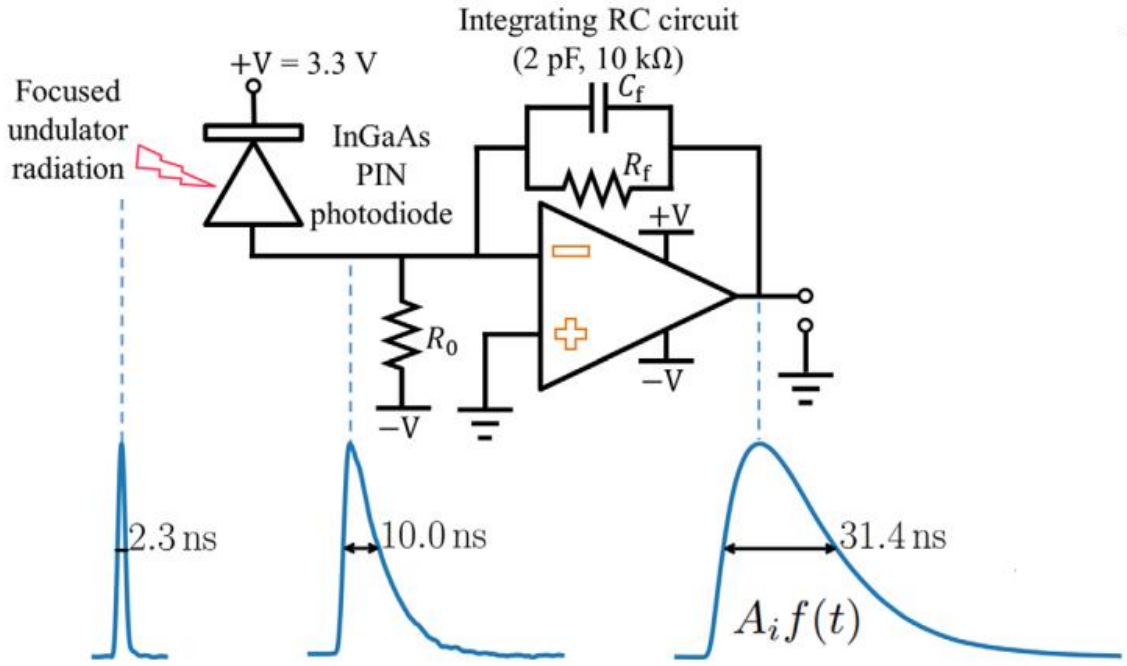
Example of schematic

InGaAs PIN photodiode

G11193-10R

Sensitive area: Ø1mm
Quantum efficiency at 1.16 µm: 80%





- Our previously used design may not work directly because the TR pulse length is only ~10 ps
- We may have to slow the pulse down to ~2 ns

Signal levels (estimate)

$$\lambda 1 := 1 \cdot 10^{-6} \cdot m \qquad \lambda 2 := 1.1 \cdot 10^{-6} \cdot m$$

$$d\omega := 2 \cdot \pi \cdot c \cdot \left(\frac{1}{\lambda 1} - \frac{1}{\lambda 2} \right)$$

$$W := \frac{Z \cdot q^2 \cdot N_b \cdot d\omega}{4 \cdot \pi^2} \cdot \left[\left(\frac{1}{\beta} + \beta \right) \cdot \operatorname{atanh}(\beta) - 1 \right]$$

$$W = 2.452 \times 10^{-12} J \qquad k_d := 1 \cdot \frac{C}{J}$$

$$C_d := 10^{-10} \cdot F \qquad Q_d := W \cdot k_d$$

$$\frac{Q_d}{C_d} = 0.025 V$$

- Beam: 1 nC, 45 MeV