

E-Beam Scanner R&D

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Project X Collaboration Meeting

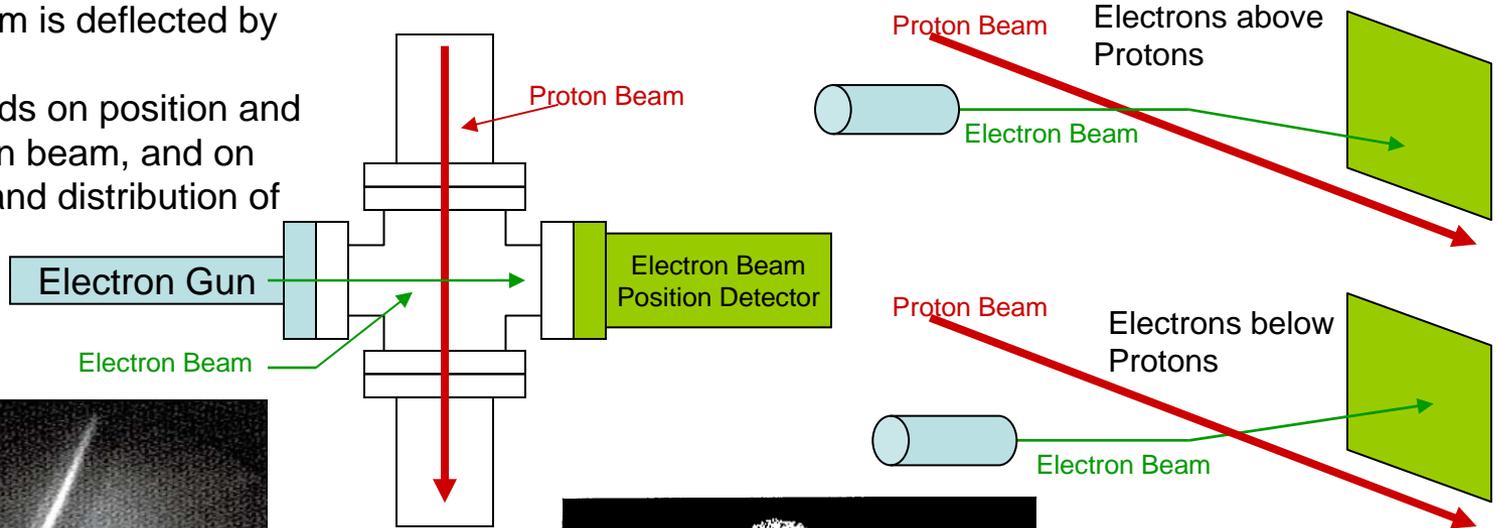
September 11-12, 2009

Project X Beam Profile Measurements



- Currently ~200 KW beam power to NUMI
- Upgrade to 400 KW for NOVA and ultimately 2 MW for Project-X
 - Flying wires (i.e. things that touch the beam) won't survive (??)
 - Laser wires don't work with protons
 - Ionization Profile Monitor works
 - Gas Jet "Wires"
 - **Electron beam scanner**

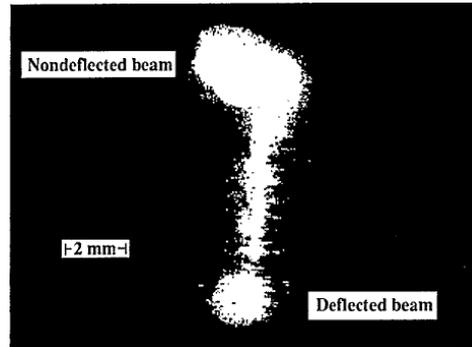
- The electron beam is deflected by the proton beam
- Deflection depends on position and energy of electron beam, and on the total charge and distribution of protons



Deflection of ion beam curtain observed at CERN SPS

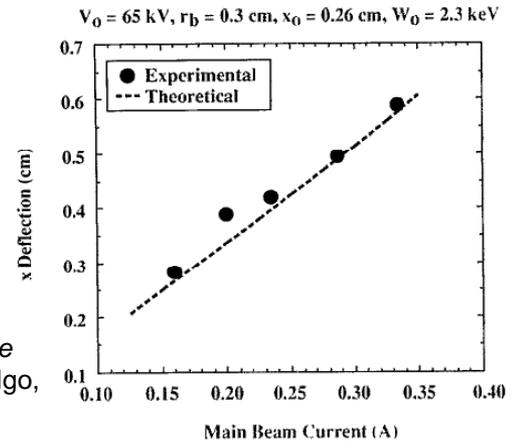
- *Transverse profile monitor using ion probe beams.* J.Bosser, et.al. CERN-PS-2000-071-BD, Nov 2000. 28pp.

- W. Nexsen et al., SSCL-631, May 1993.
- E. Tsyganov et al., Proc. 1993 PAC.

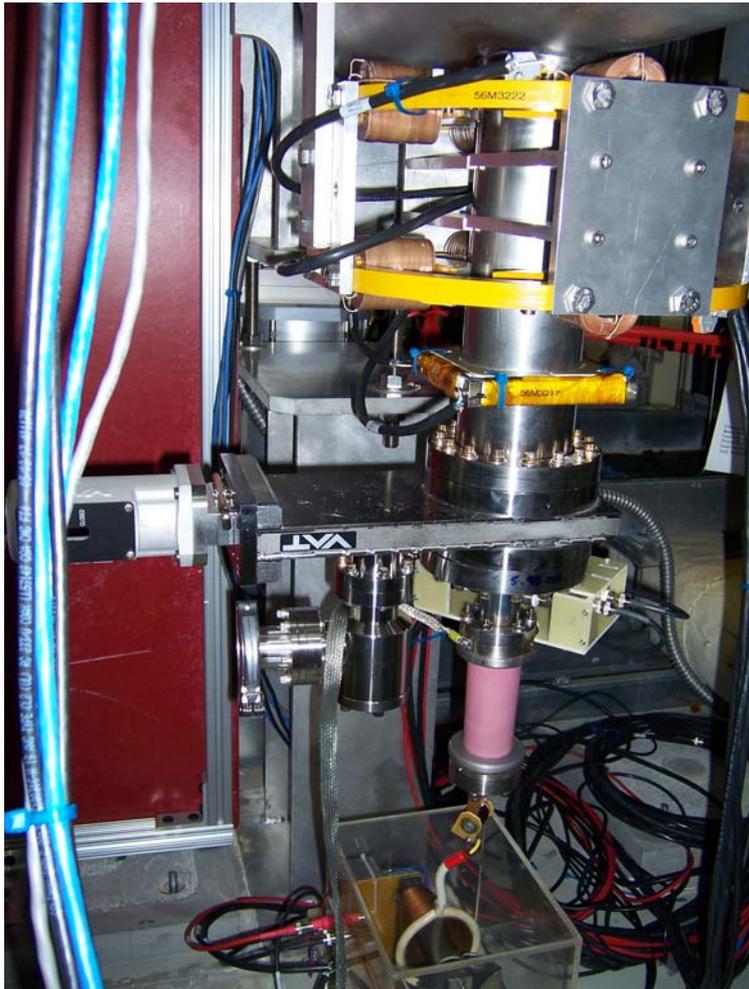


Deflection of ~2 keV e⁻ beam by 65 keV e⁻ beam

- *Nonperturbing electron beam probe to diagnose charged-particle beams.* J.A.Pasour and M.T.Ngo, Rev. Sci. Instrum. **63** (5), May 1992.



SNS Electron Beam Profile Scanner

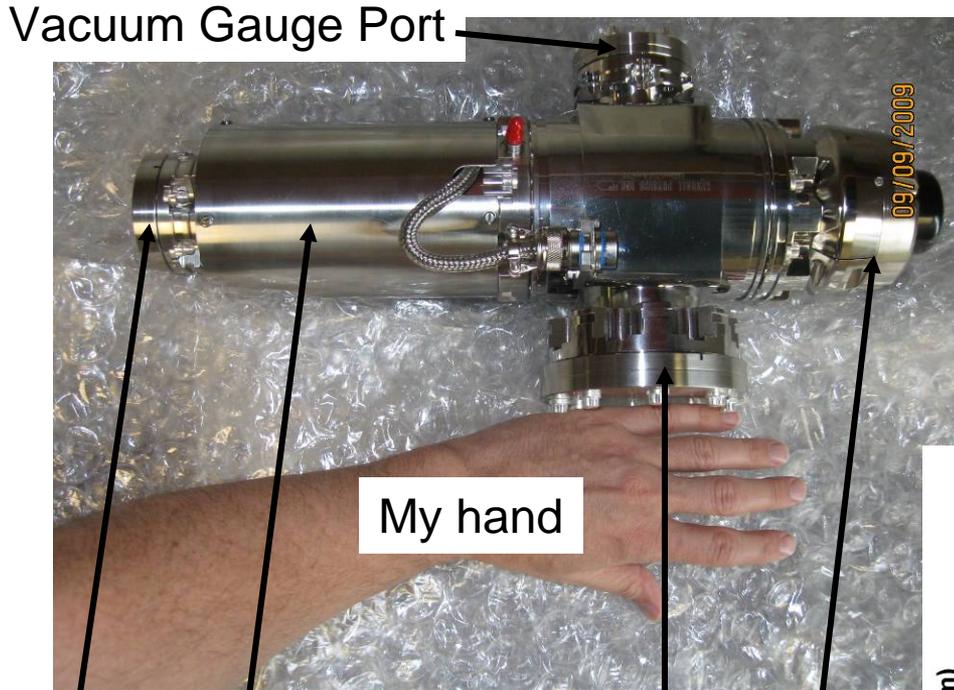


- SNS version built with Russian collaborators
 - e gun built from scratch because no commercial device available that satisfied requirements
- 60 KeV, 2 mA

SNS - MI Intensity Comparison

Parameter	SNS	Project X (MI)
Design Beam Intensity	1.4E14 (1.4 MW 60 Hz)	2E14
Ring Length (μ s)	1	11
Charge density (particles / cm)	5.4E9	0.6E9
RMS Bunch Length (ns)	---	1.5
Transverse Beam Size	~ few centimeters	~1 mm
Peak Charge Density (particles / cm)	5.4E9	4E9

Commercial Electron Gun



Business End

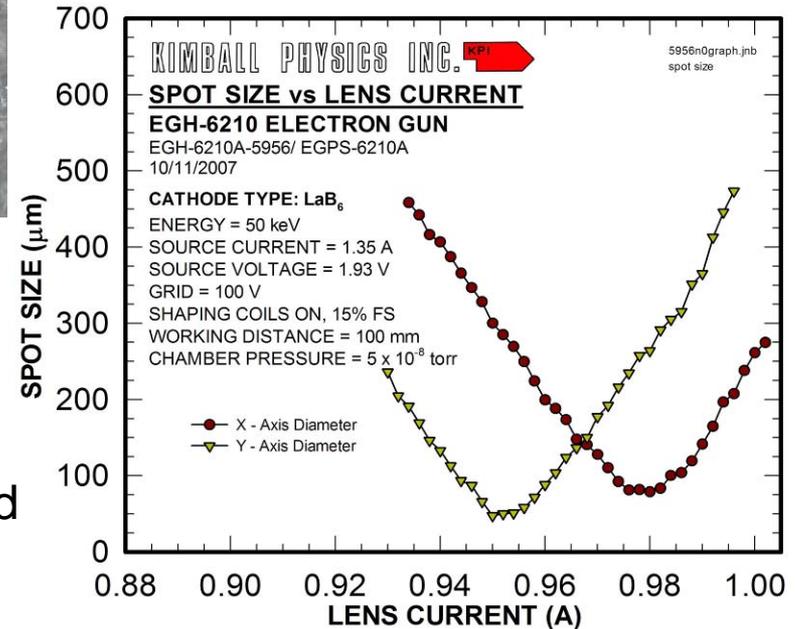
Steering / Focusing Elements

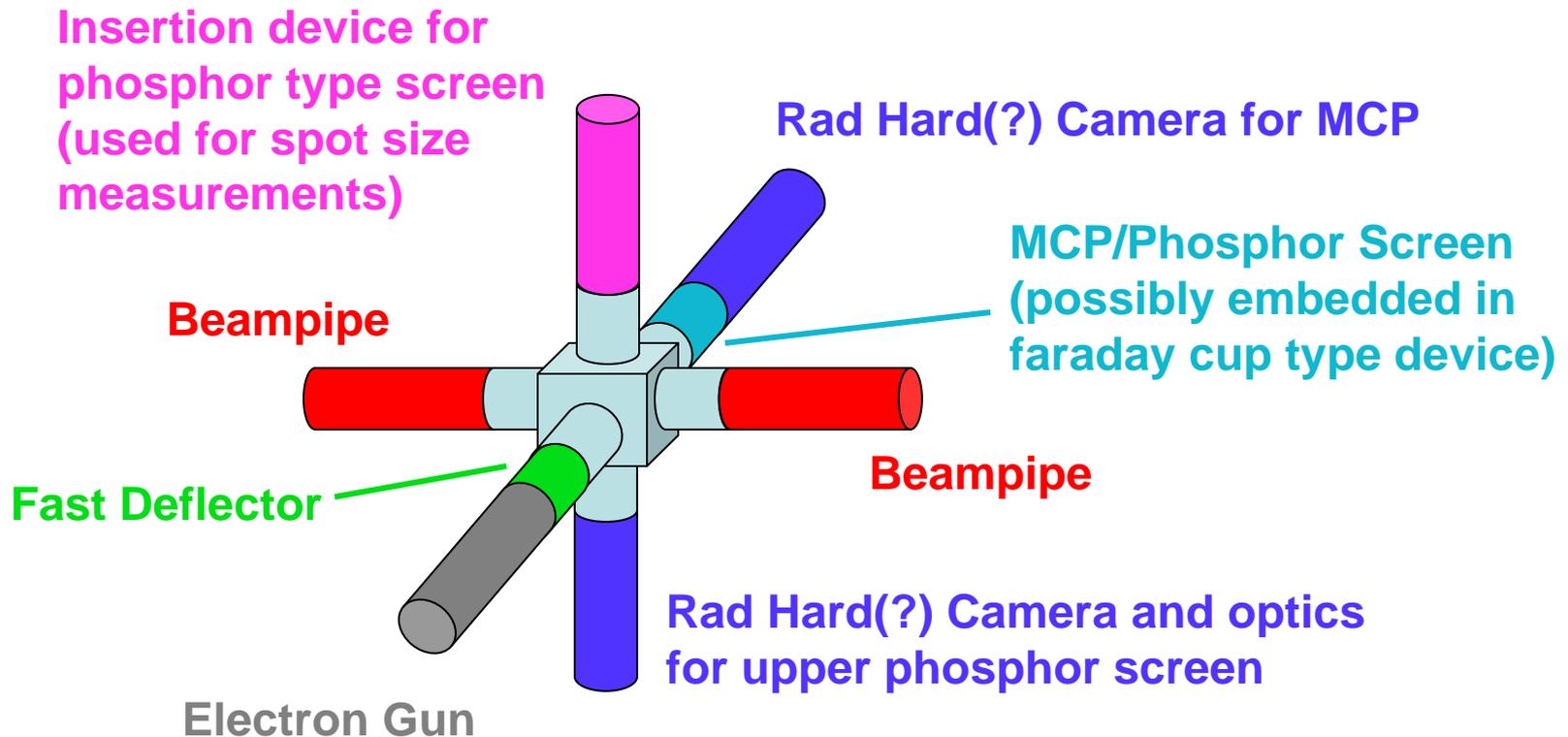
Vacuum Pump Port

Cathode End

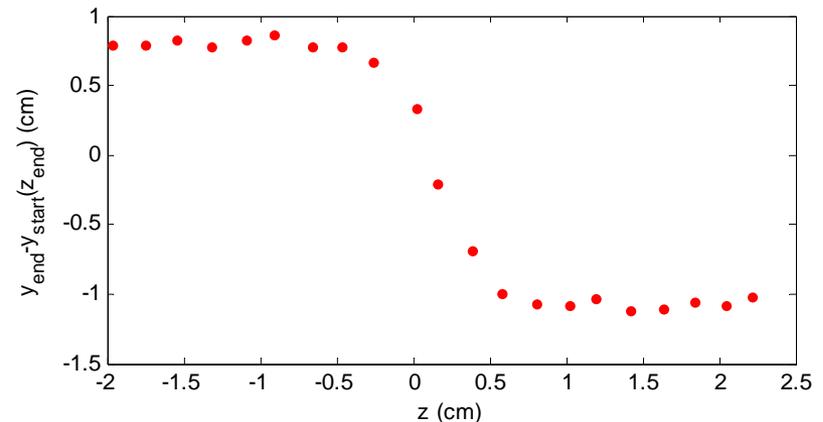
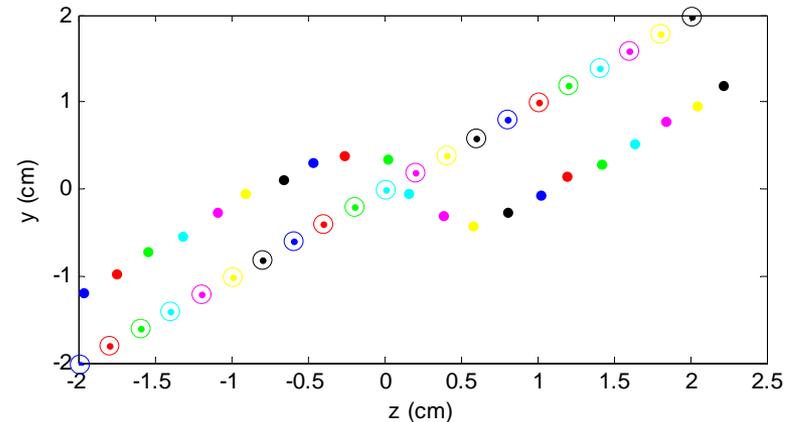
Kimball Physics

- 1 – 60 KeV
- Up to 6 mA
- Pulseable
- 100 μm spot size

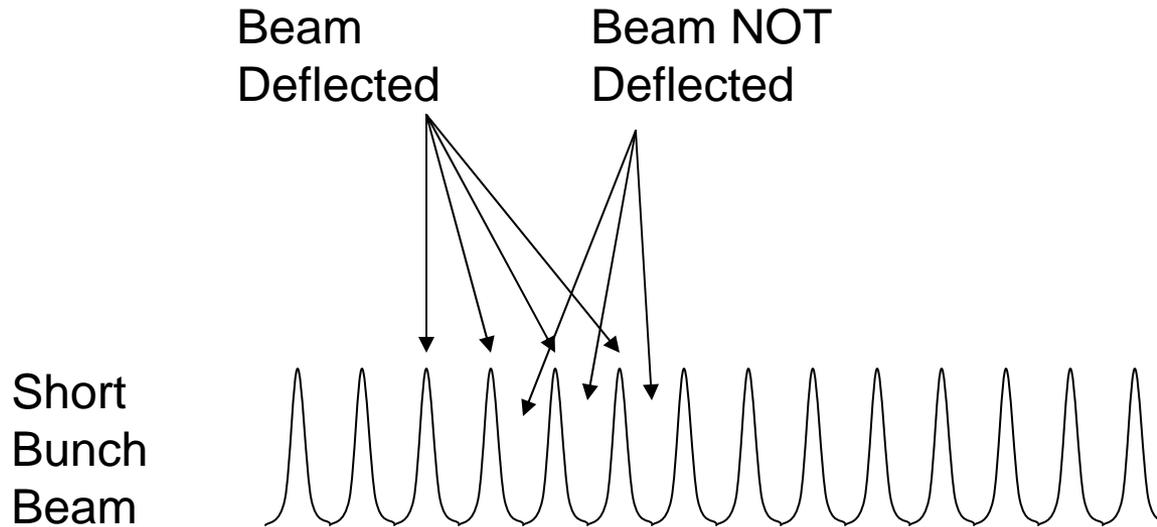
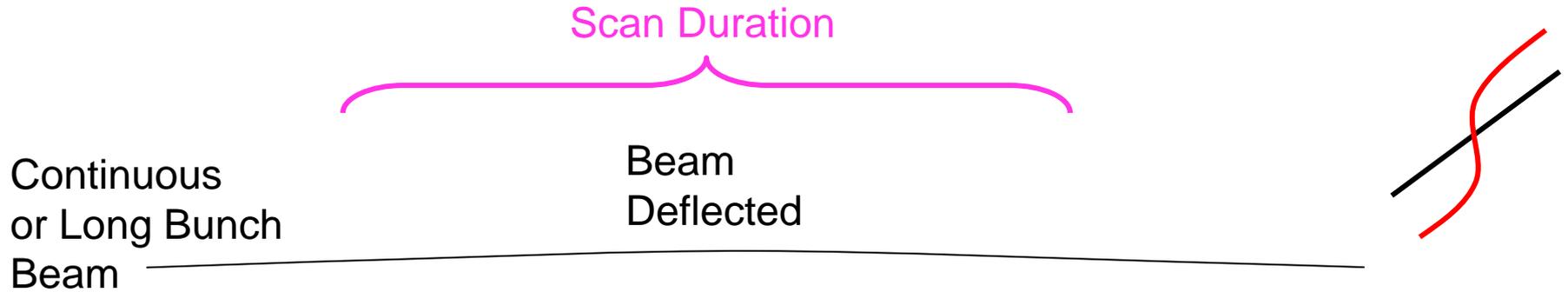




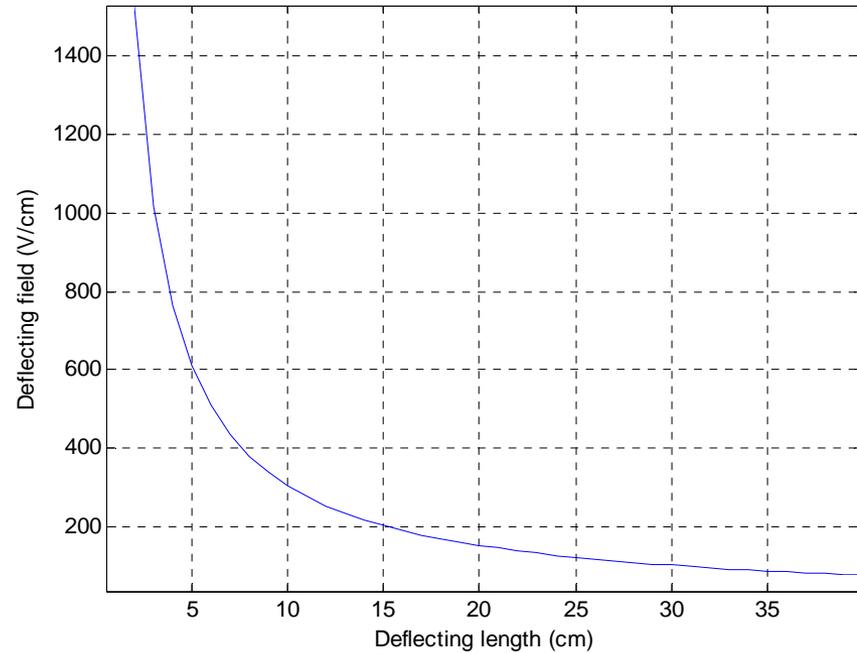
- Scan electron beam across proton beam and measure deflection
 - Works for continuous beam
 - Bunched beam complicates things



Bunched vs. Continuous Beam



- Add a fast deflector to sweep the e beam within a bunch
 - ~1ns time frame
- Requires some design effort



Other Items

- Concerns about radiation damage to power supplies (Kimball Physics says < 5 m from gun)
- R&D Possibility with NUMI / NOVA