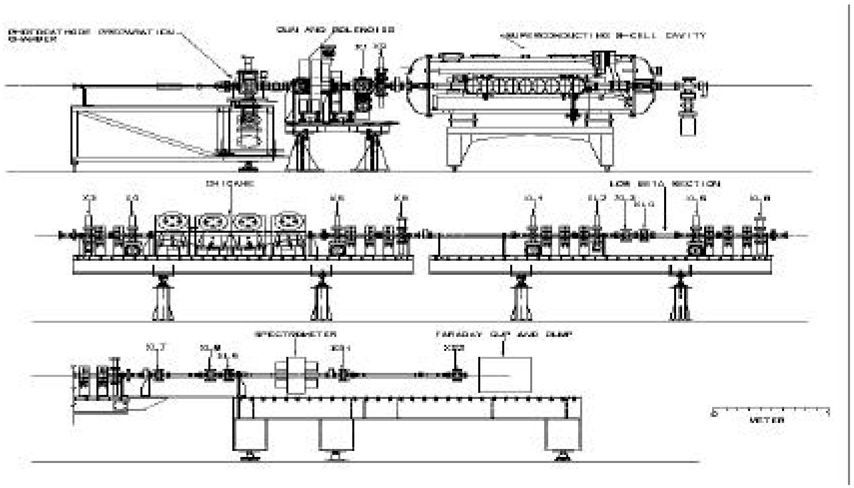
NICADD/NIU Accelerator R&D Proposal*

Two Component Program **:**

- **Benchmark flat-beam simulation codes vs. FNPL experiments.**
  - **Only facility presently configured for flat-beam generation**
- **Develop electron-beam diagnostics:**
  - **Single-shot interferometer w/ 3.3mm to 20 mm range.**
  - **Electro-optic crystal with low-wakefield vacuum chamber.**

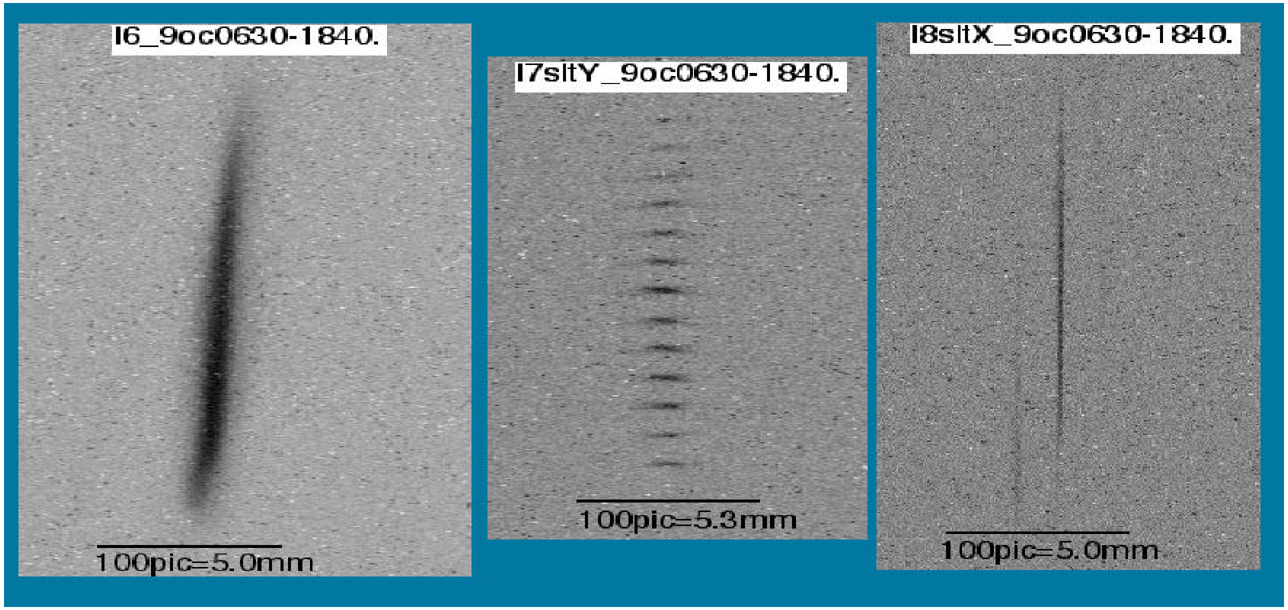


***For Court Bohn**

Jerry Blazey
NICADD/NIU

Flat Beam

***Goal*: Eliminate e- damping ring : $e_y/e_x \sim 100$ with $e_{geom} \sim 1$ µm/nC.**
Achieved to date: $e_y/e_x \sim 50$ with $e_{geom} \sim 6$ µm/nC.



***Key Question*: How to optimize beam quality with flat-beam transformation? Simulations are needed to guide improvements!**

Jerry Blazey
NICADD/NIU

Challenges for Simulations

- **Complication: Space charge, rf focusing "ruin" the linear round-to-flat transformation by introducing nonlinear forces.**

- **Codes that include these nonlinear forces are, e.g.,: PARMELA, ASTRA, HOMDYN.**

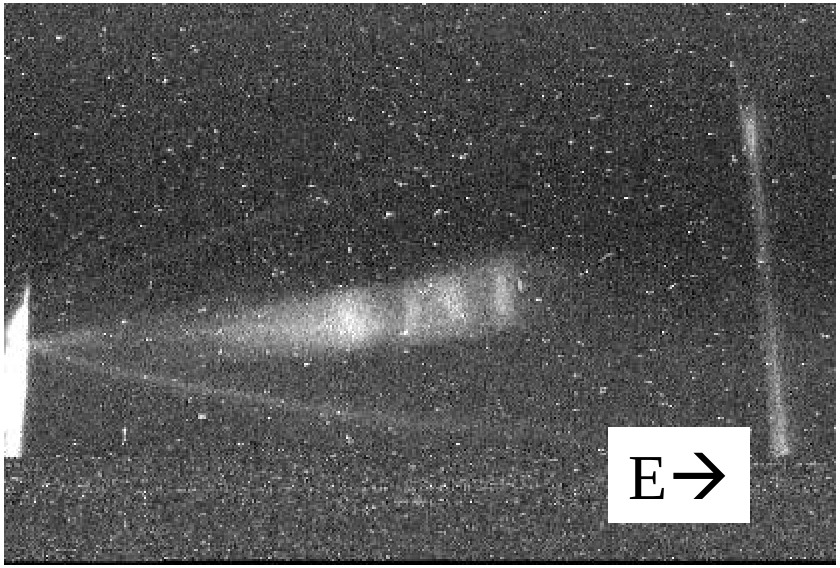
- **Canonical simplification: cylindrical symmetry . codes must be generalized. Authors of ASTRA, HOMDYN are working on generalizations.**

NIU proposes to benchmark generalized codes against FNPL experiments.

Jerry Blazey
NICADD/NIU

Studies of Bunch Compression

- Coherent synchrotron radiation and other wakefields complicate bunch compression, e.g., microbunching can arise:



Energy fragmentation of compressed bunch as seen in FNPL:
Beam Energy ~ 15 MeV
Bunch Charge ~1 nC

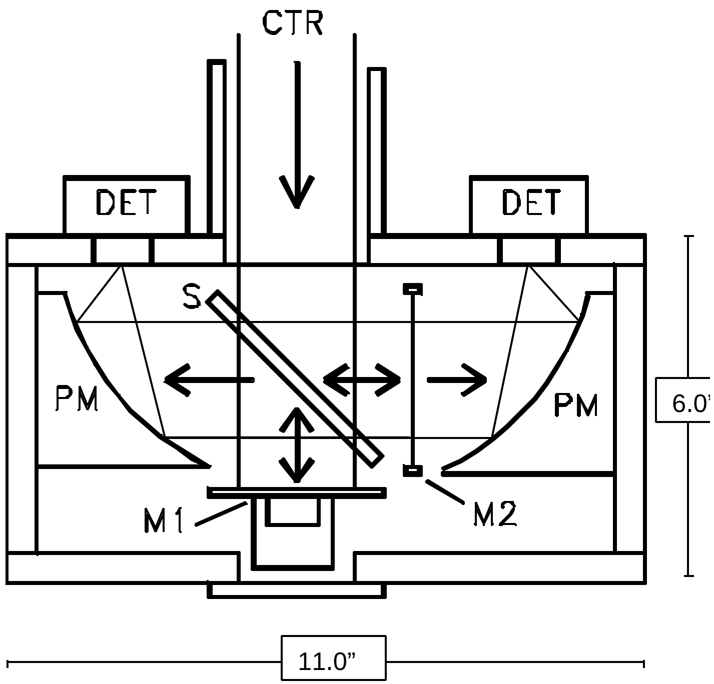
- Dynamics are sensitive to phase space input to the bunch compressor
- Careful measurement of input & output longitudinal phase space needed
- One viable option: far-infrared interferometer to measure coherent synchrotron from thin film transition radiation

Jerry Blazey
NICADD/NIU

NICADD/NIU/Georgia*
Procuring New Interferometer

Woltersdorff beamsplitter, purged, reference detector

Optics diameter:	**75 mm**
Dimensions:	**30cm x 15 cm x 15 cm**
Frequency range:	**3 cm^{-1} to 500 cm^{-1} (3.3 mm to 20 mm).**
Translation stage:	**20 mm travel, 2 mm accuracy.**



CTR: Coherent Transition Radiation
S: Beamsplitter
M1: Mirror on Translation Stage
M2: Fixed Mirror, Semi-Transparent
PM: Off-Axis Parabolic Mirror
DET: Detector Module

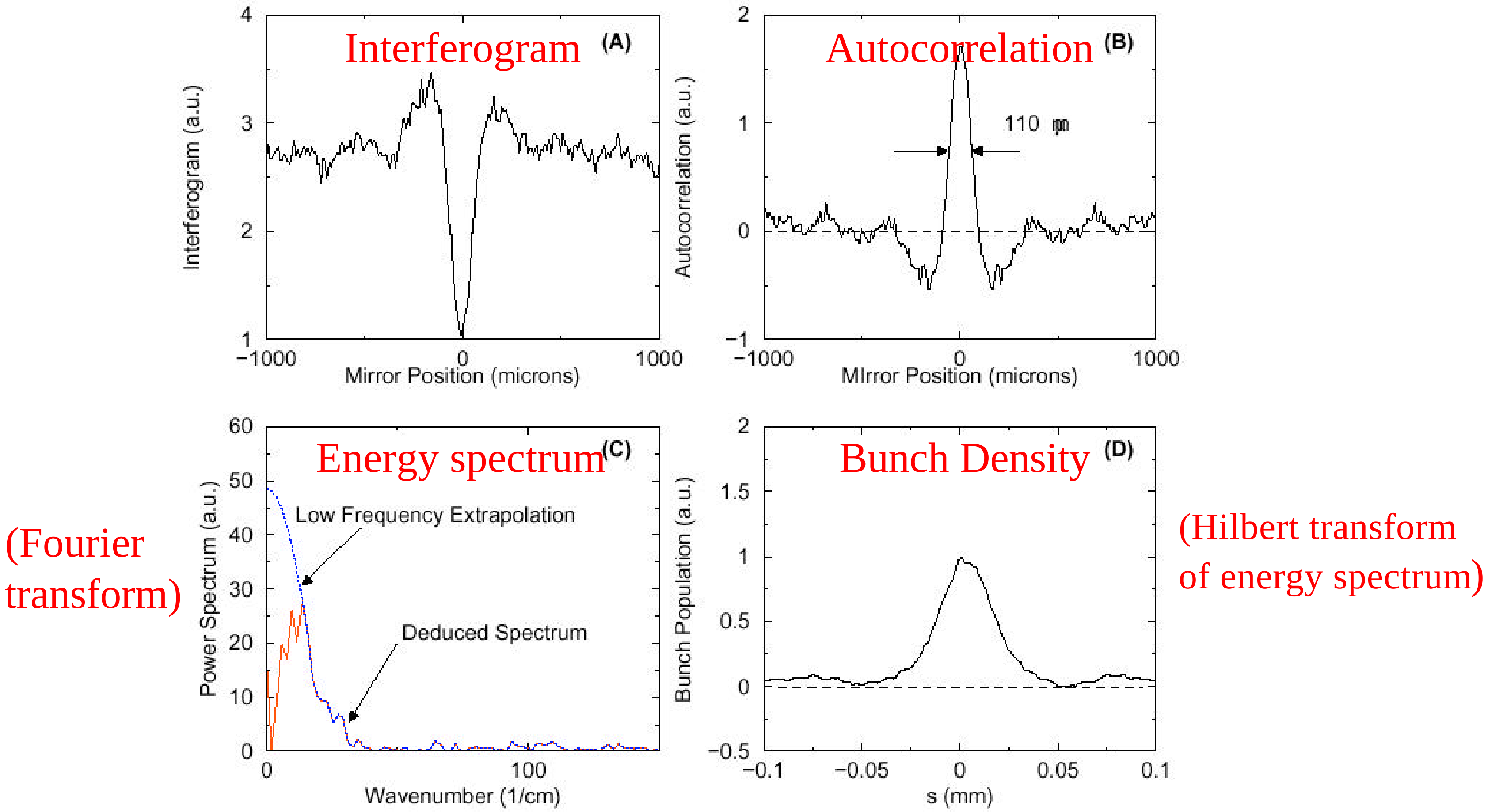
***Uwe Happek**

UCLC

Jerry Blazey
NICADD/NIU

What Does an Interferometer Provide?

[P. Piot, et al., Proc. PAC'99, 2229 (1999)]



- **Resolution of fine structure requires access to short wavelengths,**
- **Existing interferometers average over many bunches, *not* single shots.**

Proposal for Future Interferometry

- **<u>Develop single-shot capability</u> with U. Georgia:**
  - multichannel detector based on mirage effect (heated air above detector is probed by laser beam);
  - preserve compact size (existing FIR multichannel detectors are large).

- **Possibly procure second Michelson interferometer for simultaneous input/output phase-space measurements.**

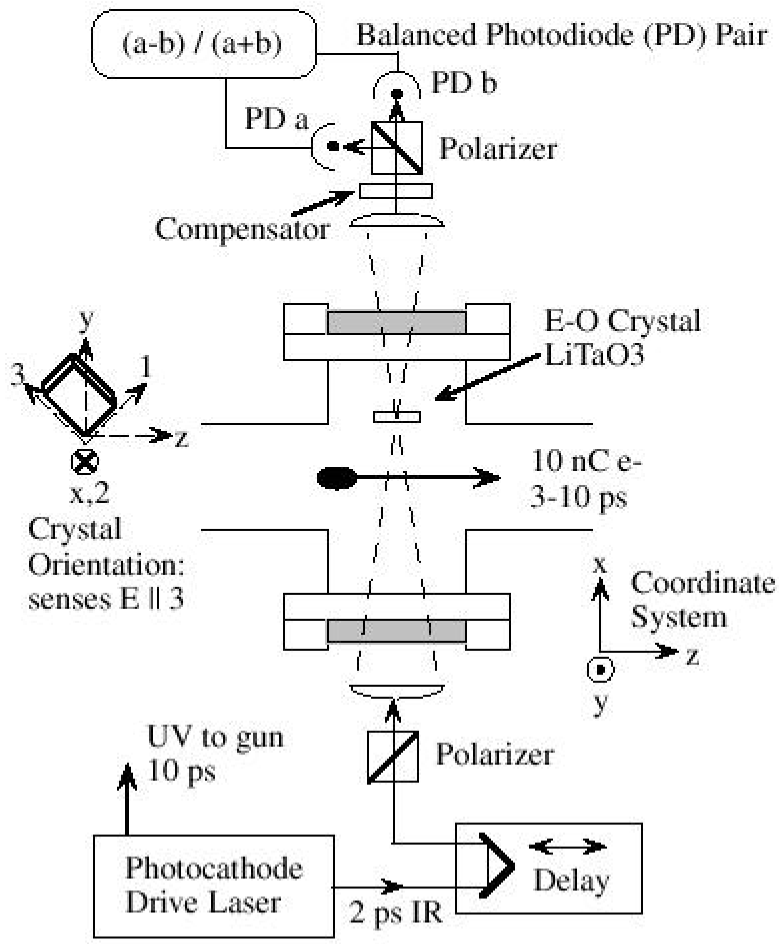
Jerry Blazey
NICADD/NIU

A SECOND ALTERNATIVE: ELECTRO-OPTIC DIAGNOSTIC

[M.J. Fitch, *et al*., *Phys. Rev. Lett.* **87**, 034801 (2001)]

- **Major Advantage: Noninvasive (Does not intersect beam.)**
- **Works via Pockels effect:**
  - **Electric field modifies dielectric tensor;**
  - **Laser beam monitors the modifications.**
- **Potential: Direct time-domain observation of beam field,**
- **But chamber wakefield must be small!**

<u>NIU proposes to build and implement a low-wakefield chamber.</u>



UCLC

Jerry Blazey
NICADD/NIU

- **Personnel:**
  - Court Bohn, Nick Barov
  - Daniel Mihalcea, Yang Xi, Simulations Post-doc TBD
  - Two Graduate students
- **Facilities & Computing Resources:**
  - FNPL: Photoinjector, new interferometer
  - NIU: System Operator, 16 Node 1.4 GHz Farm
- **Budget:**

– Grad student, simulations, 9 mo.	$18,000
– Grad student, optics, 9 mo.	$18,000
– Hardware	$15,000
– Total	$51,000