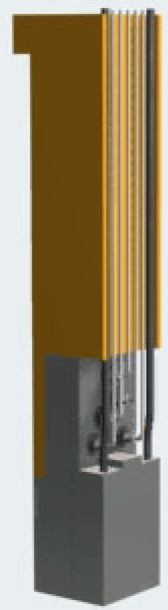
Luminosity Monitor Status



From LBNL

John Byrd

Bill Turner

Peter Denes

Massimo Placidi

Alex Ratti

Stefano De Santis

Jean-Francois Beche

Jim Greer

Marco Monroy

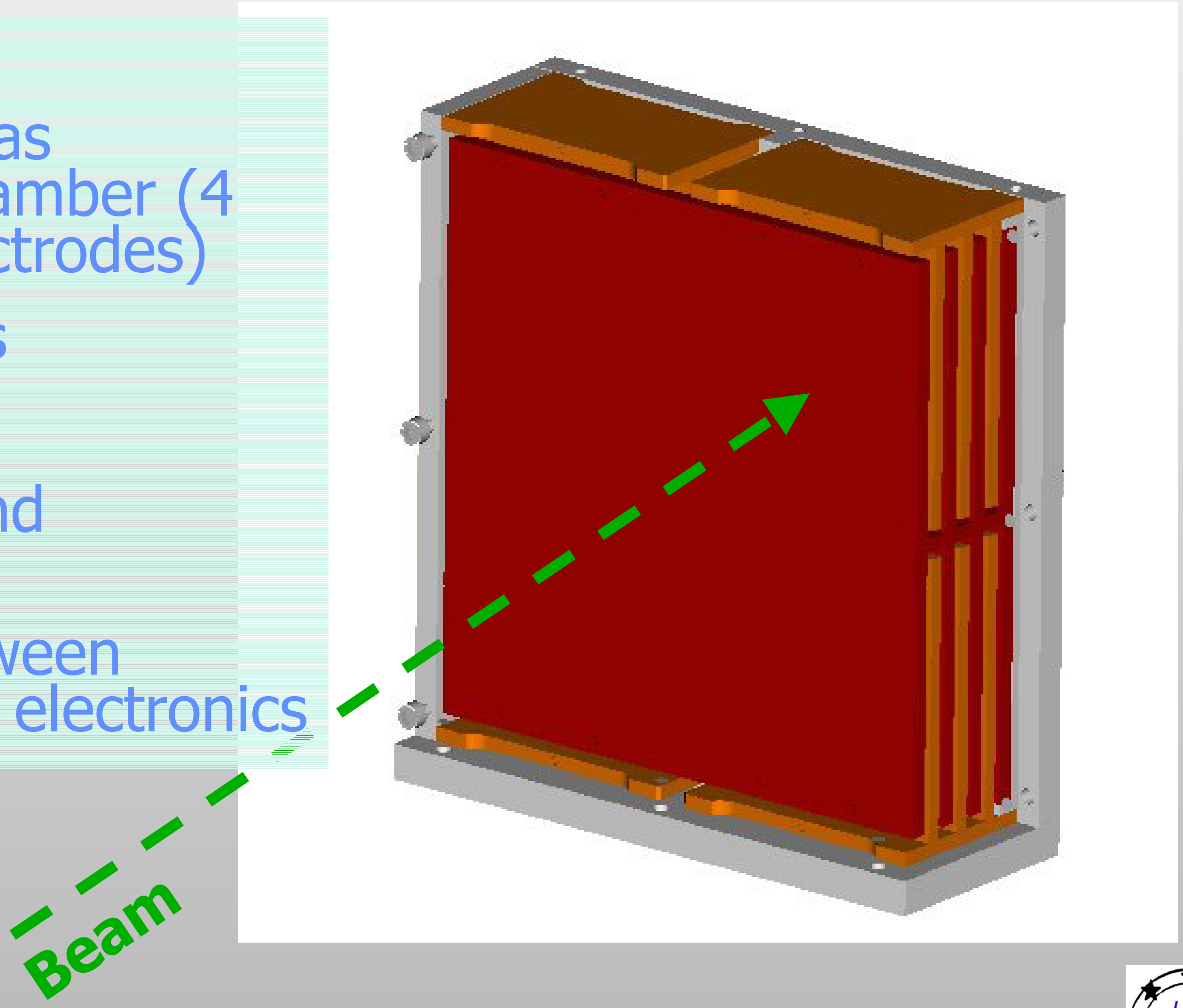
Max Zolotorev

Mostly concerning
Ionization chamber
Some CdTe as well

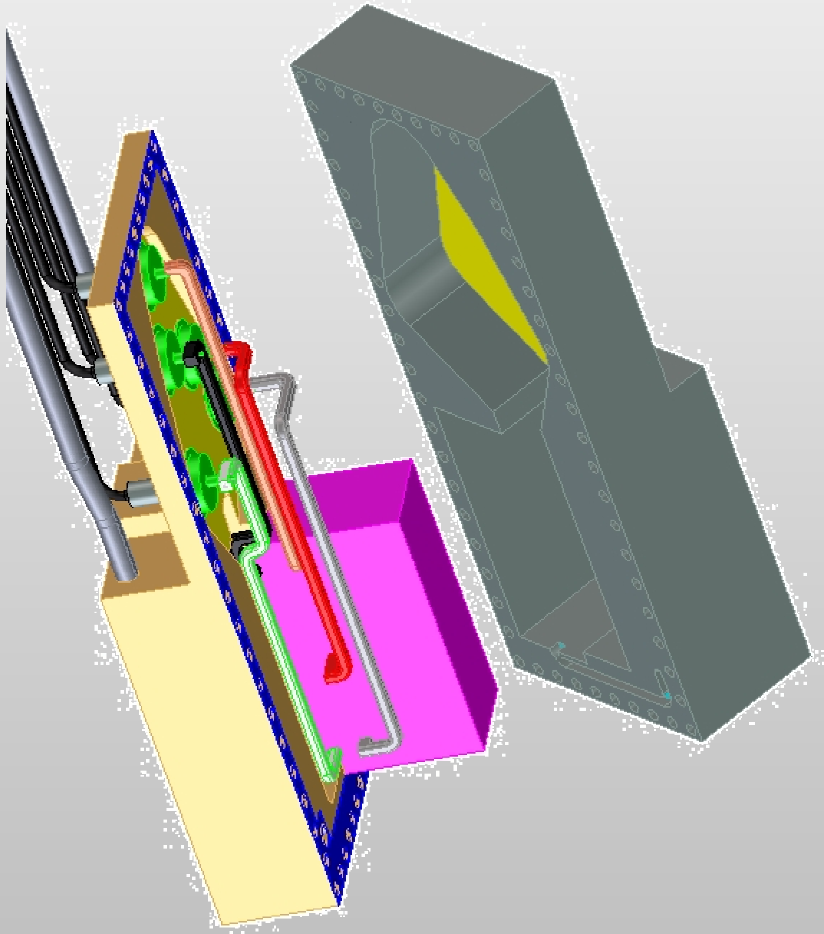
Ionization Chamber

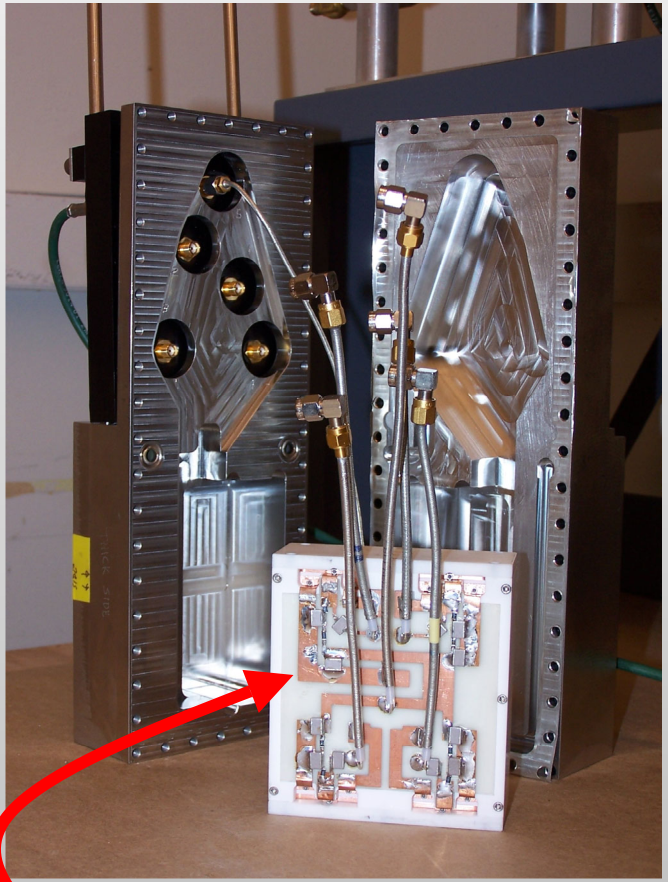
Reminder

- 4 quadrant gas ionization chamber (4 quadrant electrodes)
- 6x1 mm gaps
- Ar + N_2
- Central ground structure
- 3m coax between chamber and electronics



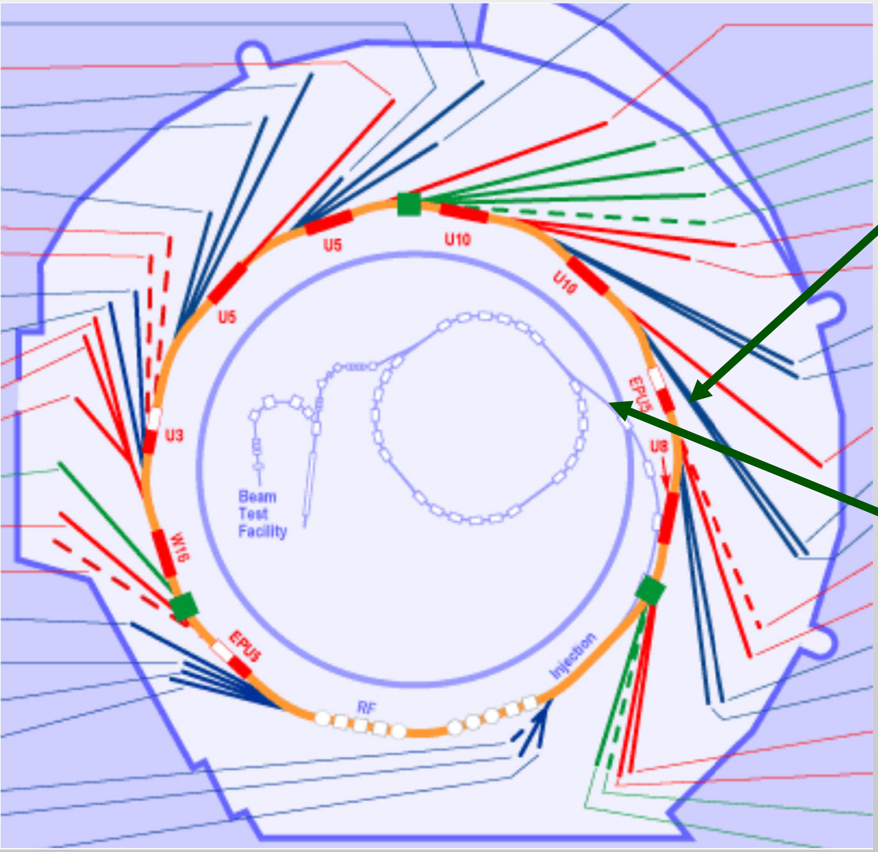
Detector





Metalized MACOR
- Component attach
- Strain relief

Beam Tests at the ALS



Storage Ring spill:

- 1.5 GeV e- with variable spacing
- 30 psec pulse length
- intensity of a few e-
- weekly access

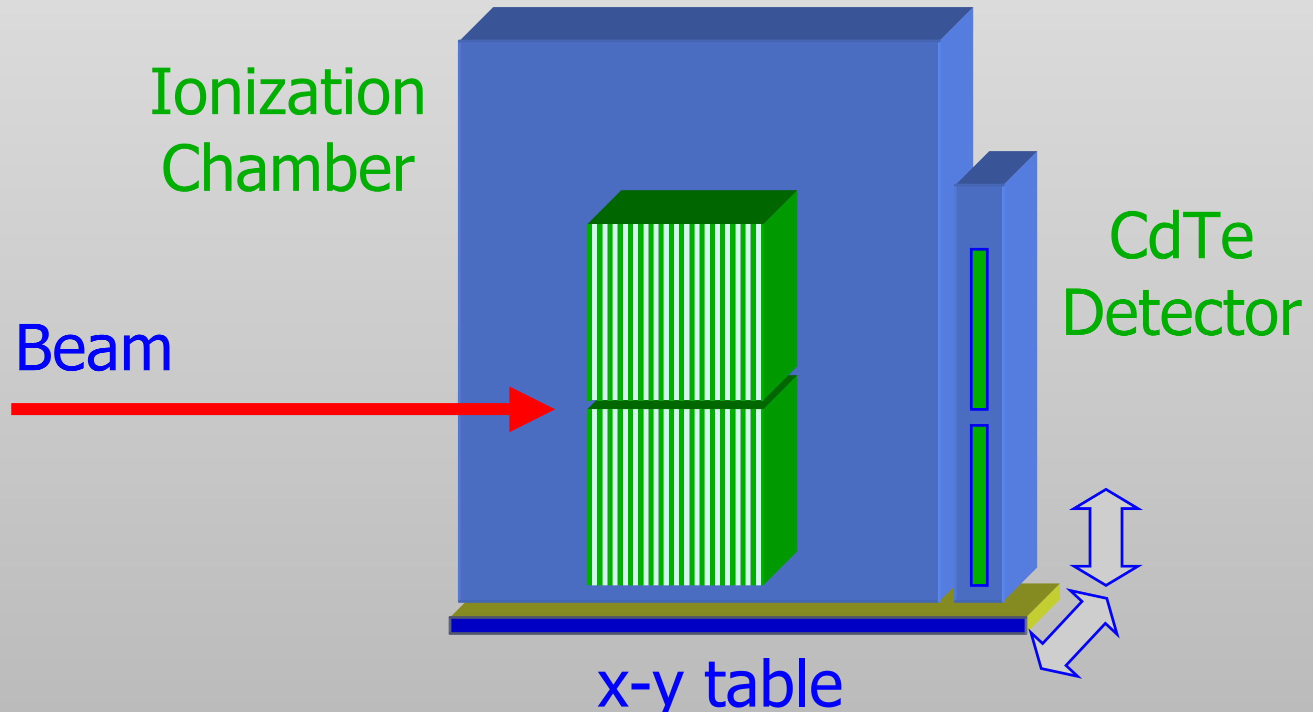
Booster-To-Storage Ring spur:

- 1.5 GeV e- at 1 Hz rate
- 30 psec pulse length
- intensity from 1 to 1e9 e- (1e3 typical)
- daily access and availability

BTS: Detailed performance
Ring: "40 MHz" test

ALS Booster Tests

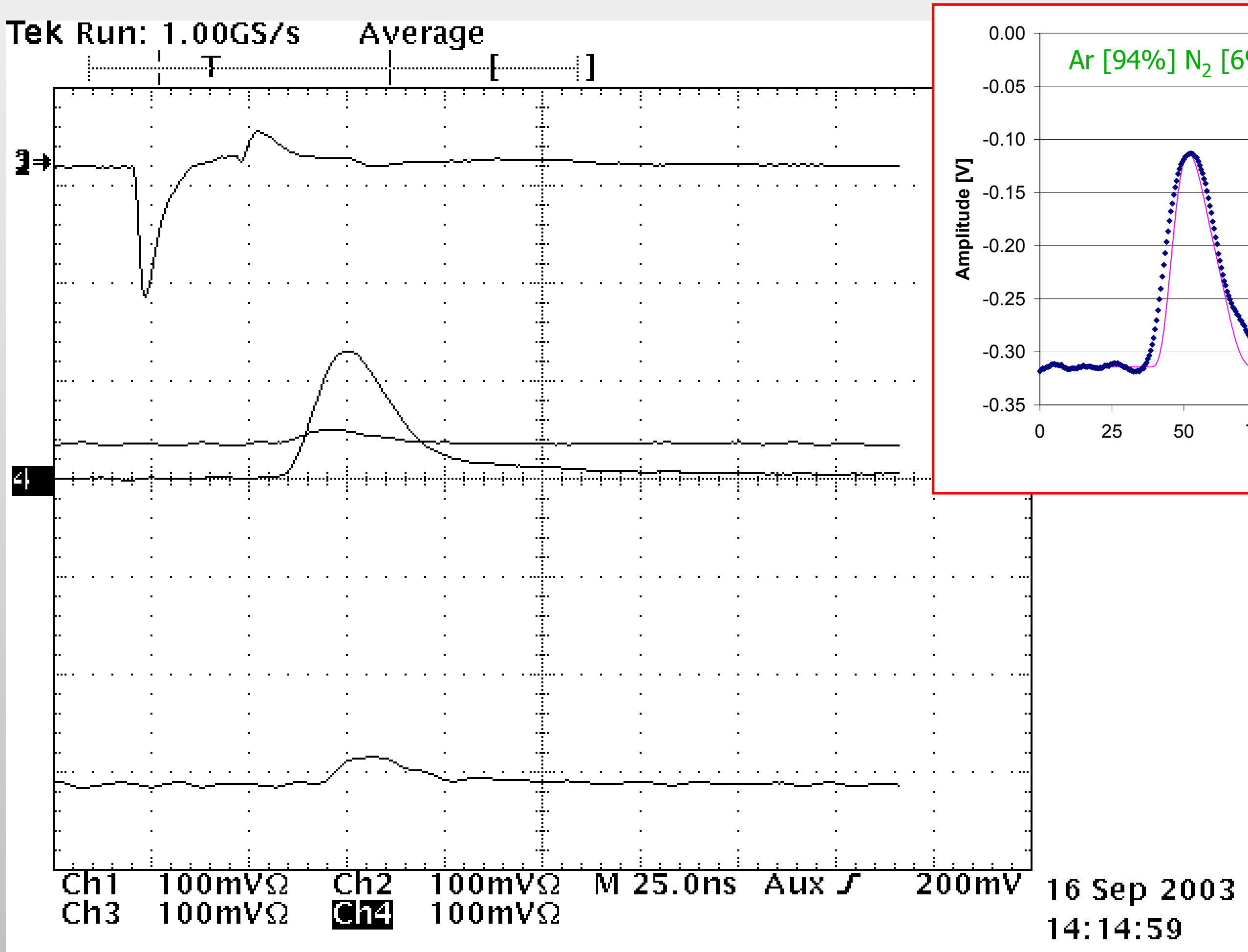
- "δ-function" e^- beam (50 ps); 1.5 GeV; 1 Hz
- Adjustable intensity (typically ran at 20 pp interaction equivalent ± 50%)

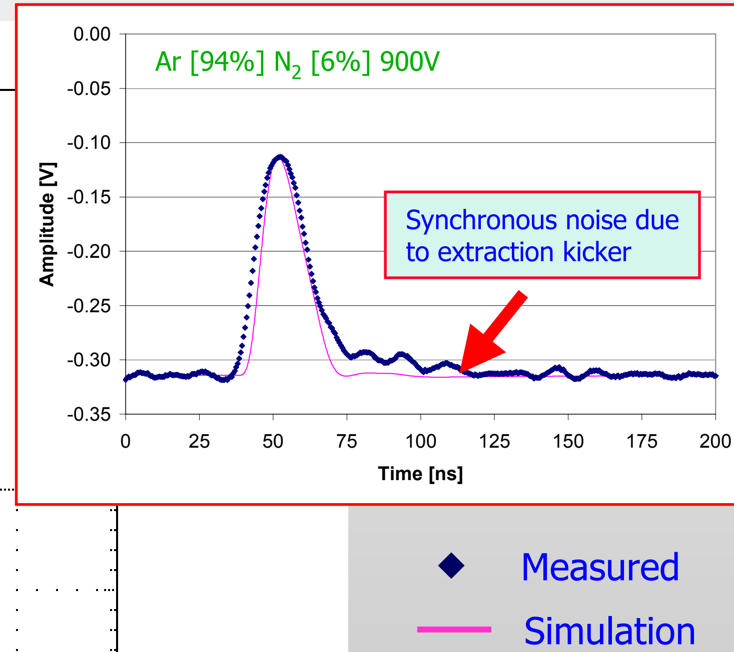


Waveforms at BTS

CdTe

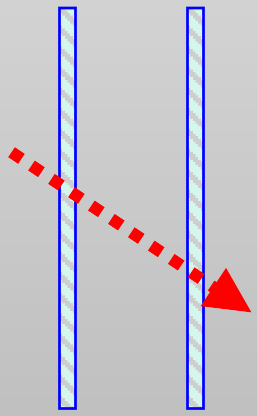
Gas Quadrants

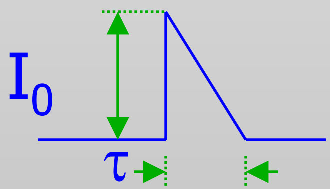




Gas Tests

- Chamber uses Ar (100-*x* %) + N_2 (*x* %)
- Design was based on Monte Carlo calculations of gas properties
- Drift velocity is key parameter (determines speed)





$\tau = x_{GAP}/v_D$

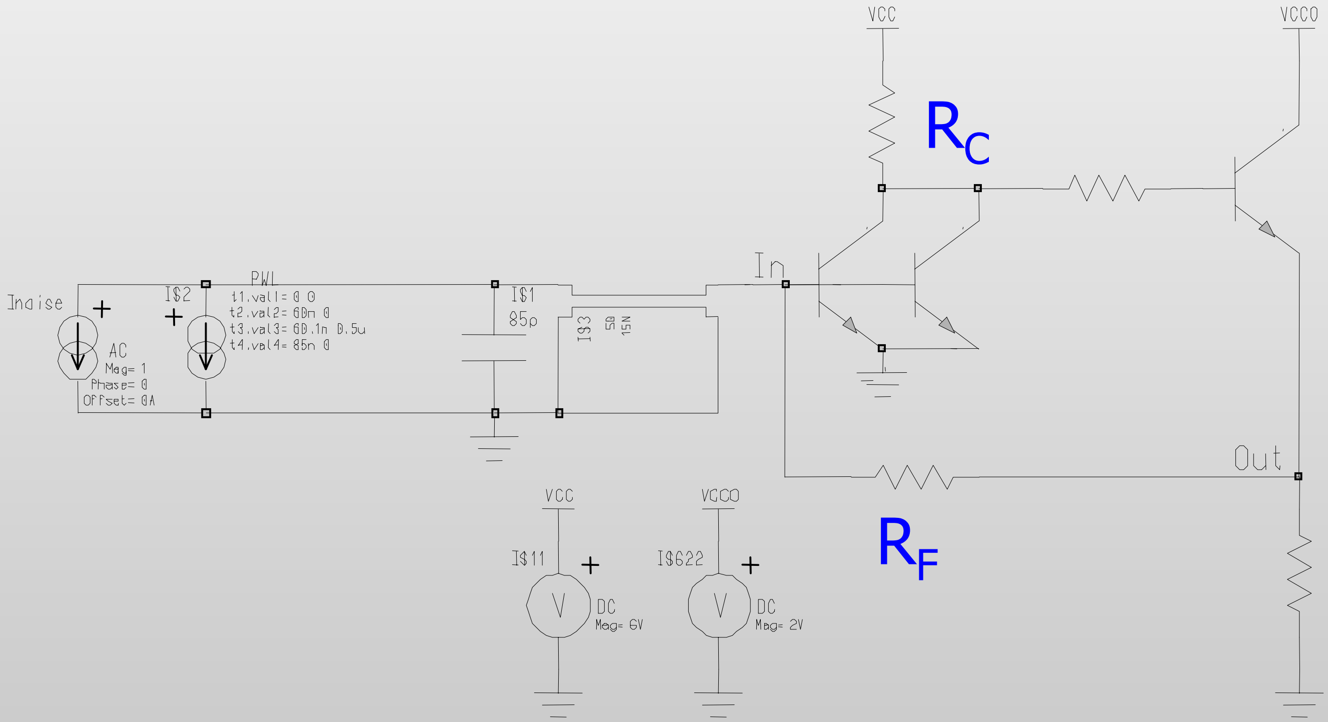
$$Q = \int_0^{\tau} I(t)dt = \frac{1}{2} I_0 \tau$$

charge/proton = Q_0 x x_{GAP} x P [Atm] x N_{GAP}

N_1 e^-/*MIP*/mm x N_2 *MIP*/p

$I_0 = 2\, Q_0 v_D P N_{GAP}$

Test System Performance with Simple Trans-Resistance Amplifier

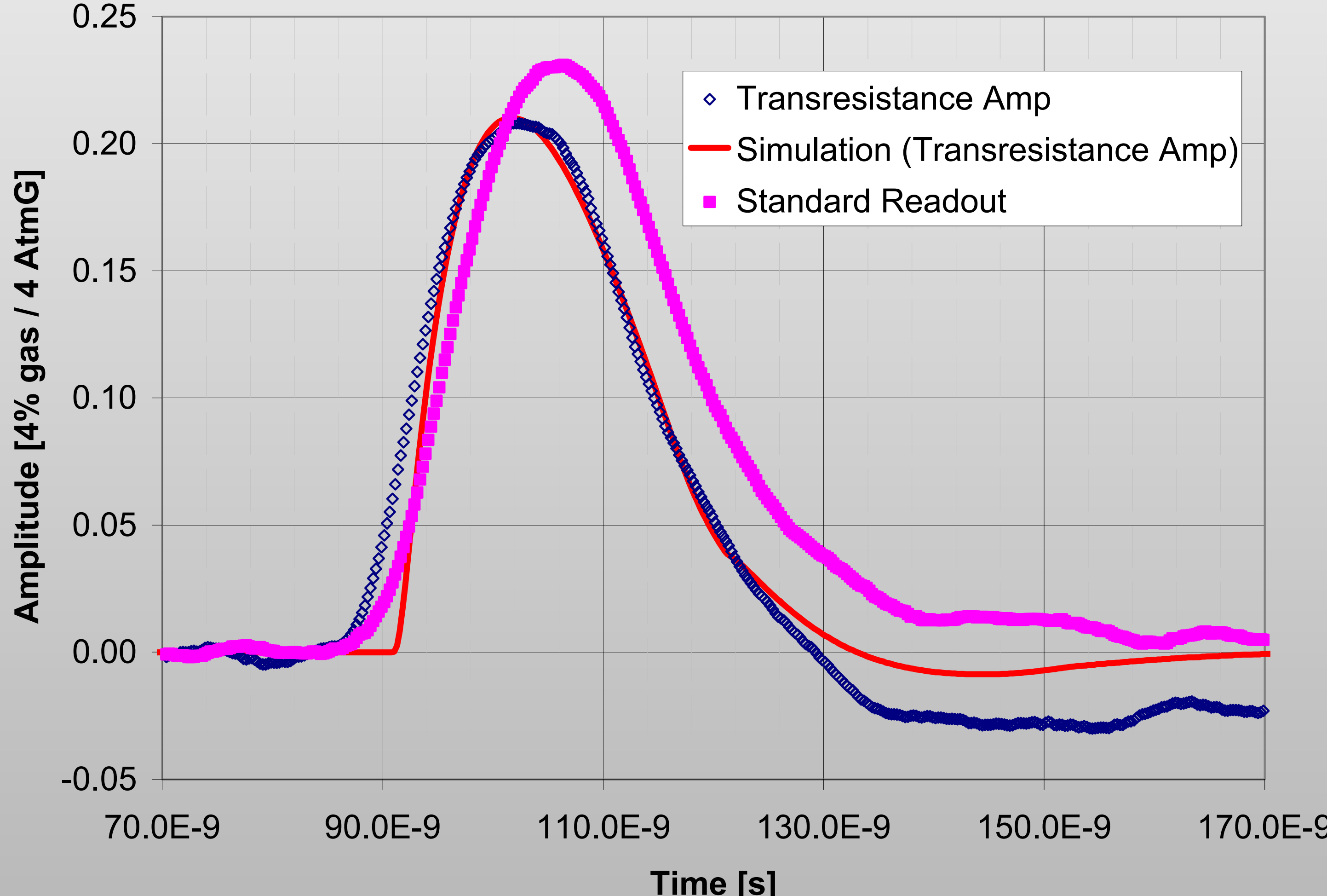


$$Z = R_F/(1+g_mR_C)$$
$$V_{OUT} = R_FI_{IN}$$

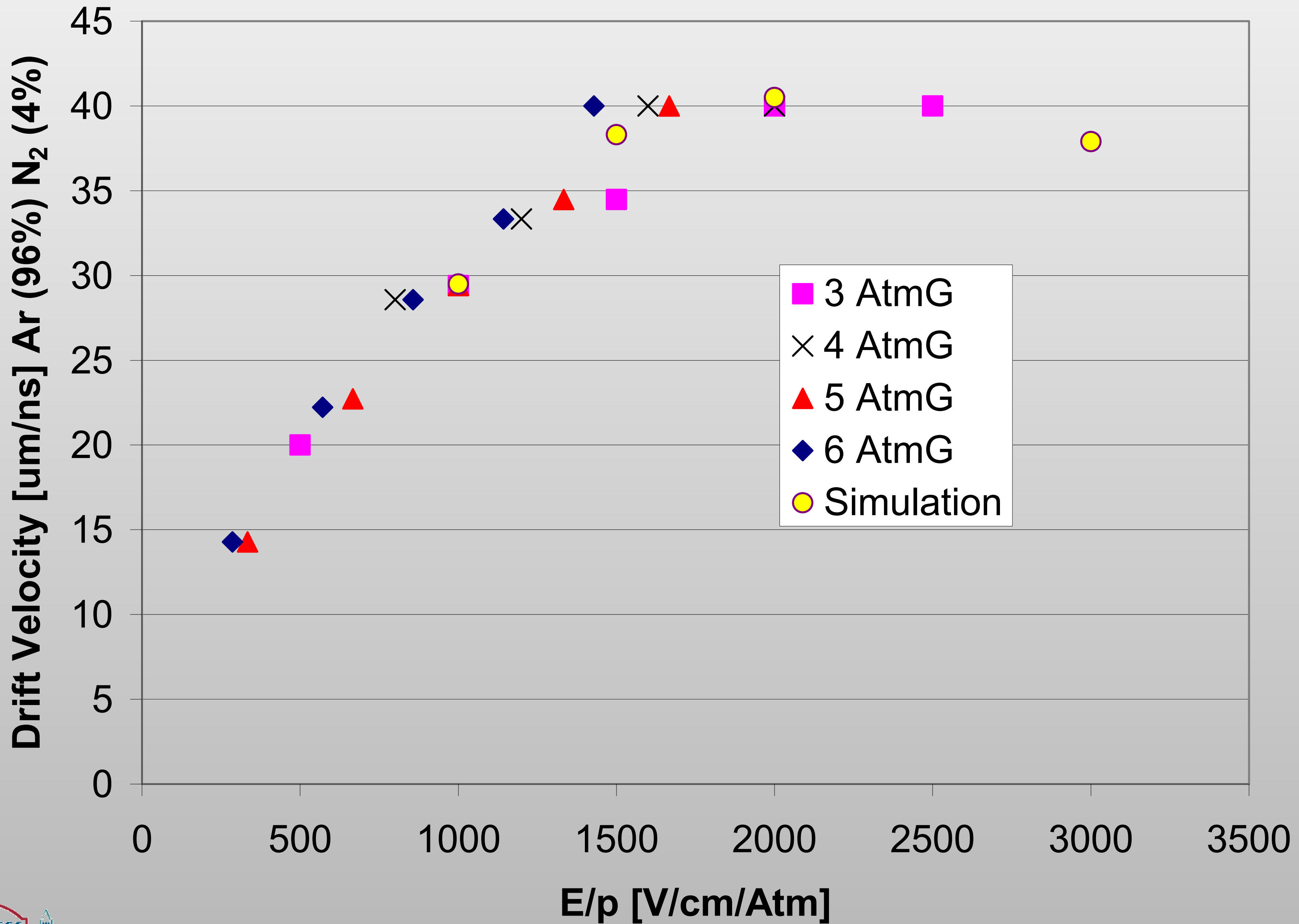
Avoids need to deconvolve shaping

Modified Electronics for Gas Tests

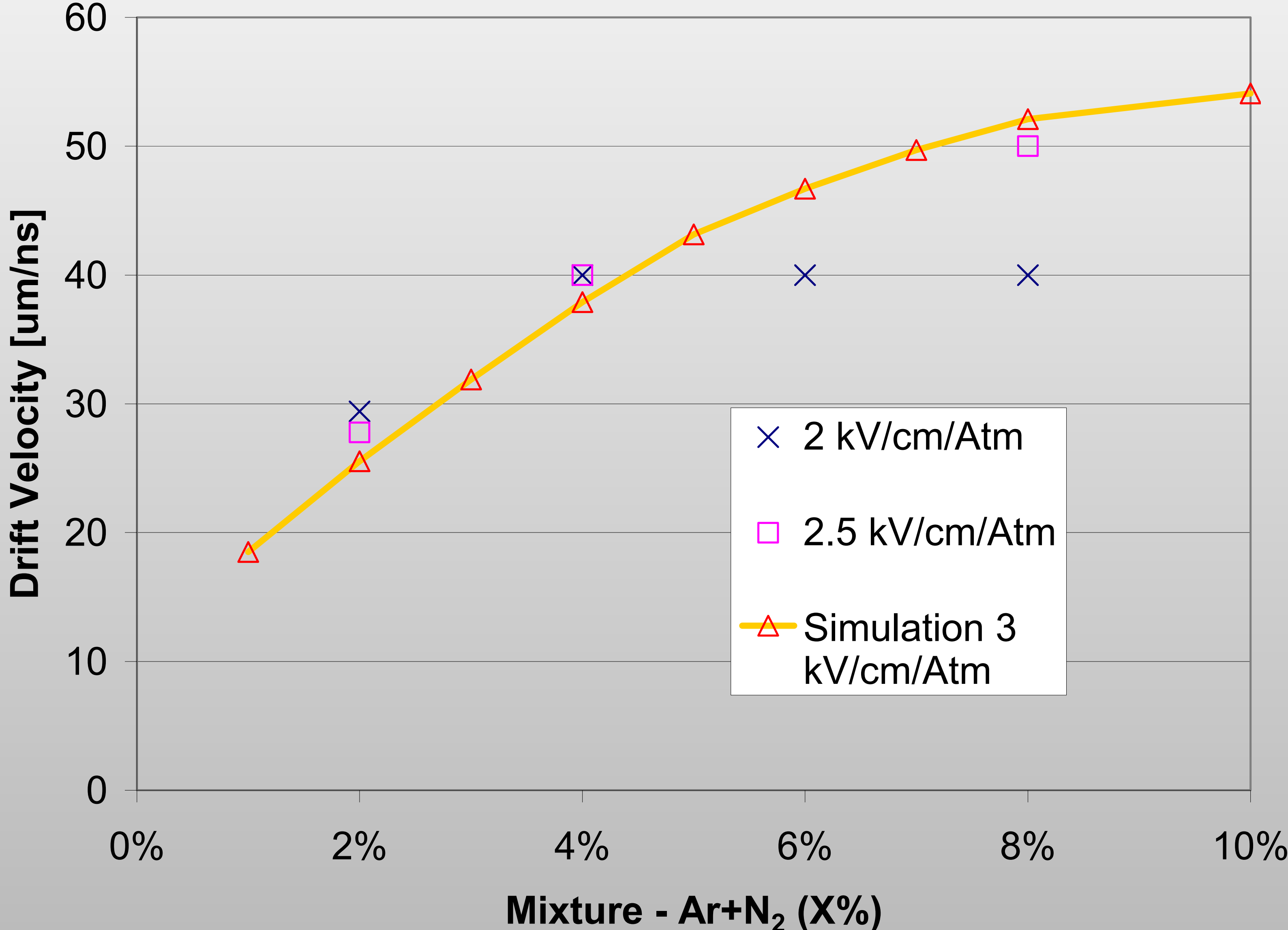
For these tests, use transresistance amp (no shaping)
Fit measured waveform(P, % N_2) to simulation with T_D



Nominal Mix – vary V, p and measure v_D

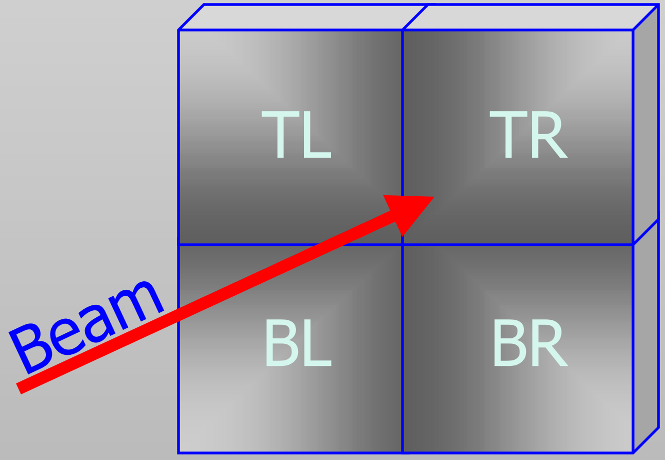


vs. N_2 Content – vary mix and measure v_D



Position Scans

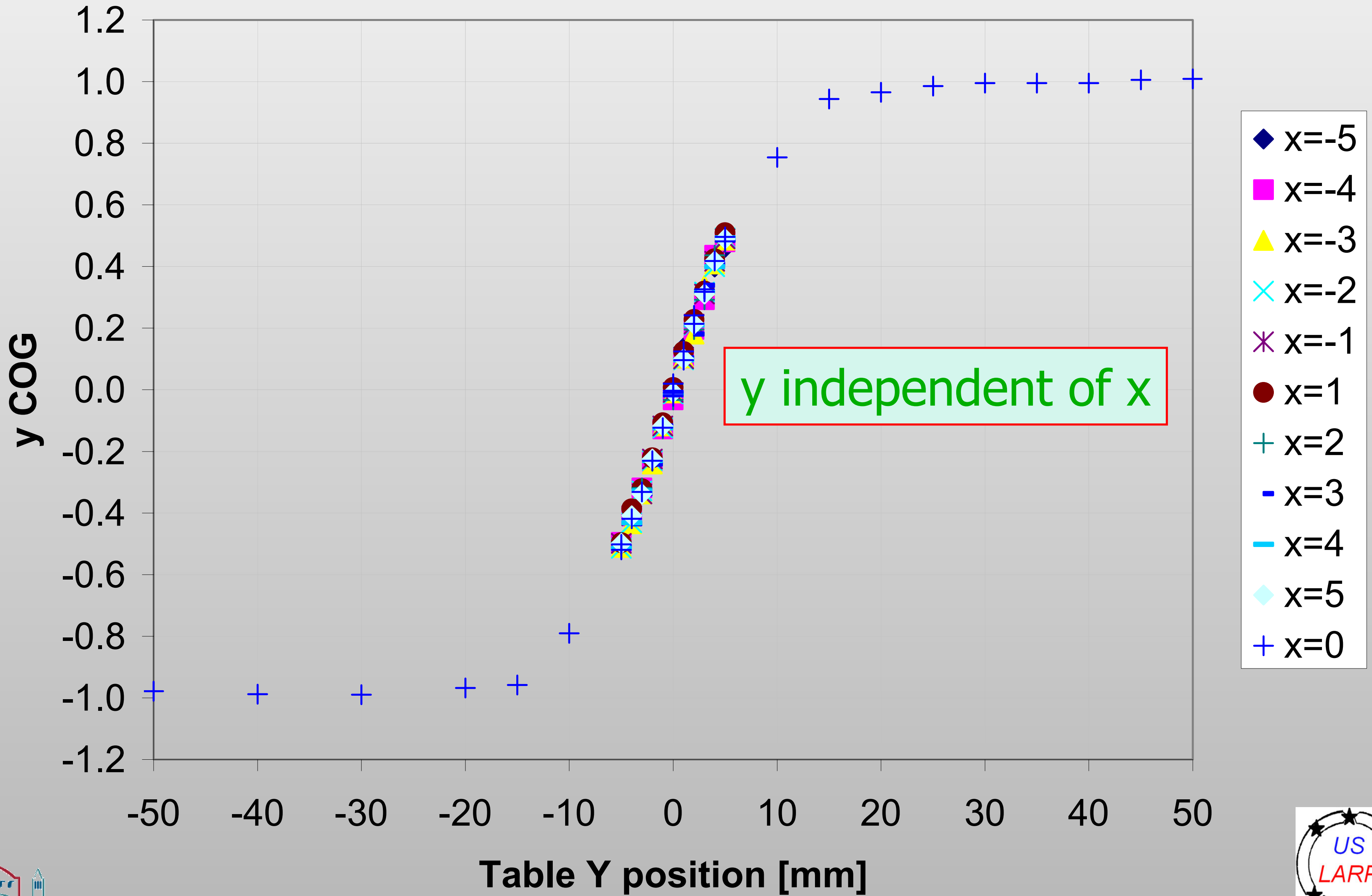
- "Raster scan" e– beam across chamber (by moving x-y table with respect to beam)
- Record pulse heights of the 4 quadrants (note: primitive DAQ → relatively large error bars on measurements)
- Measure COG (center-of-gravity) coordinates vs. known table position



$$x = \frac{(TR + BR) - (TL + BL)}{TR + BR + TL + BL}$$

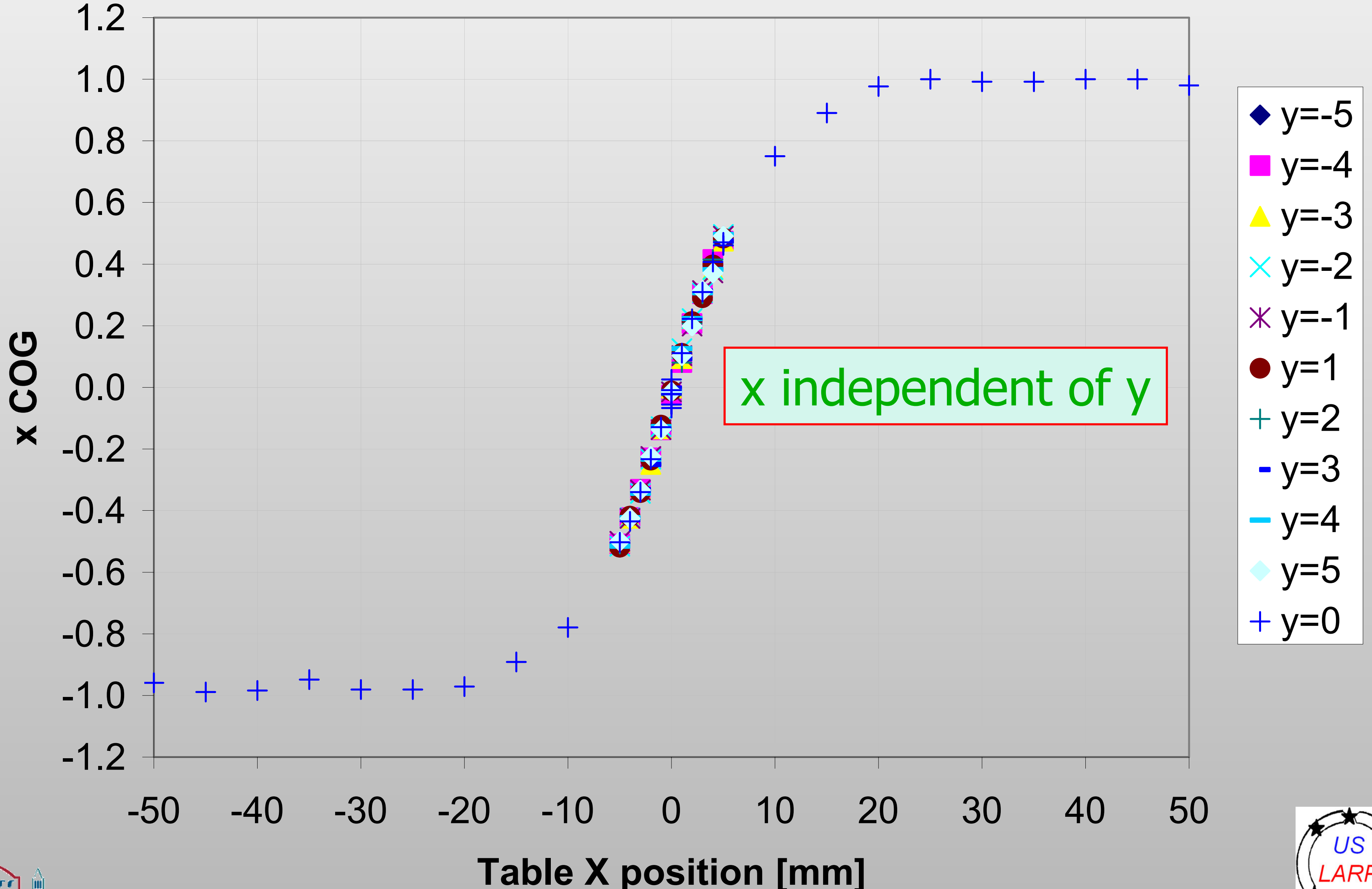
$$y = \frac{(TR + TL) - (BR + BL)}{TR + BR + TL + BL}$$

Scan – y Results at Different x
(Narrow beam)

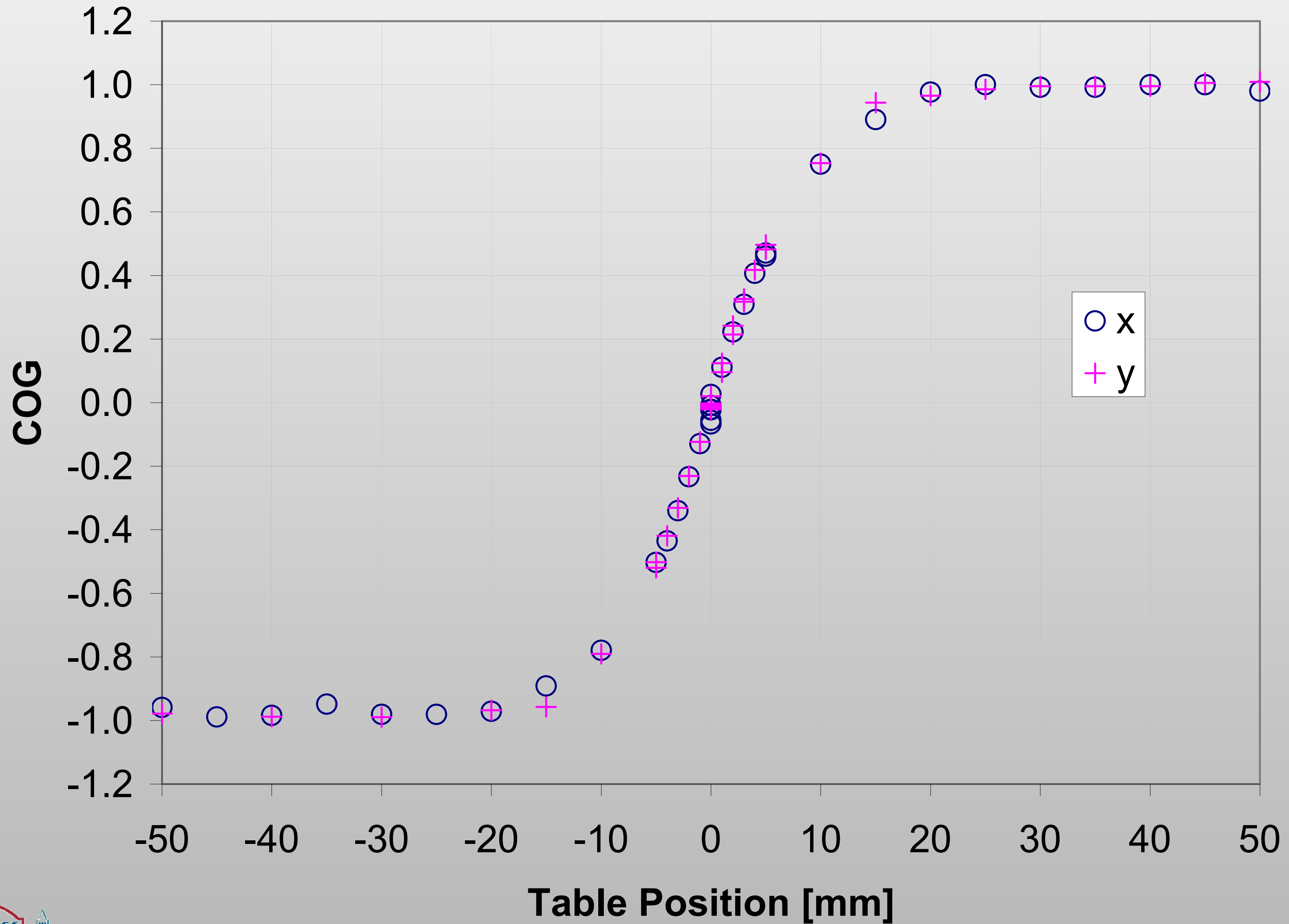


Scan – x Results at Different y

(Narrow beam)

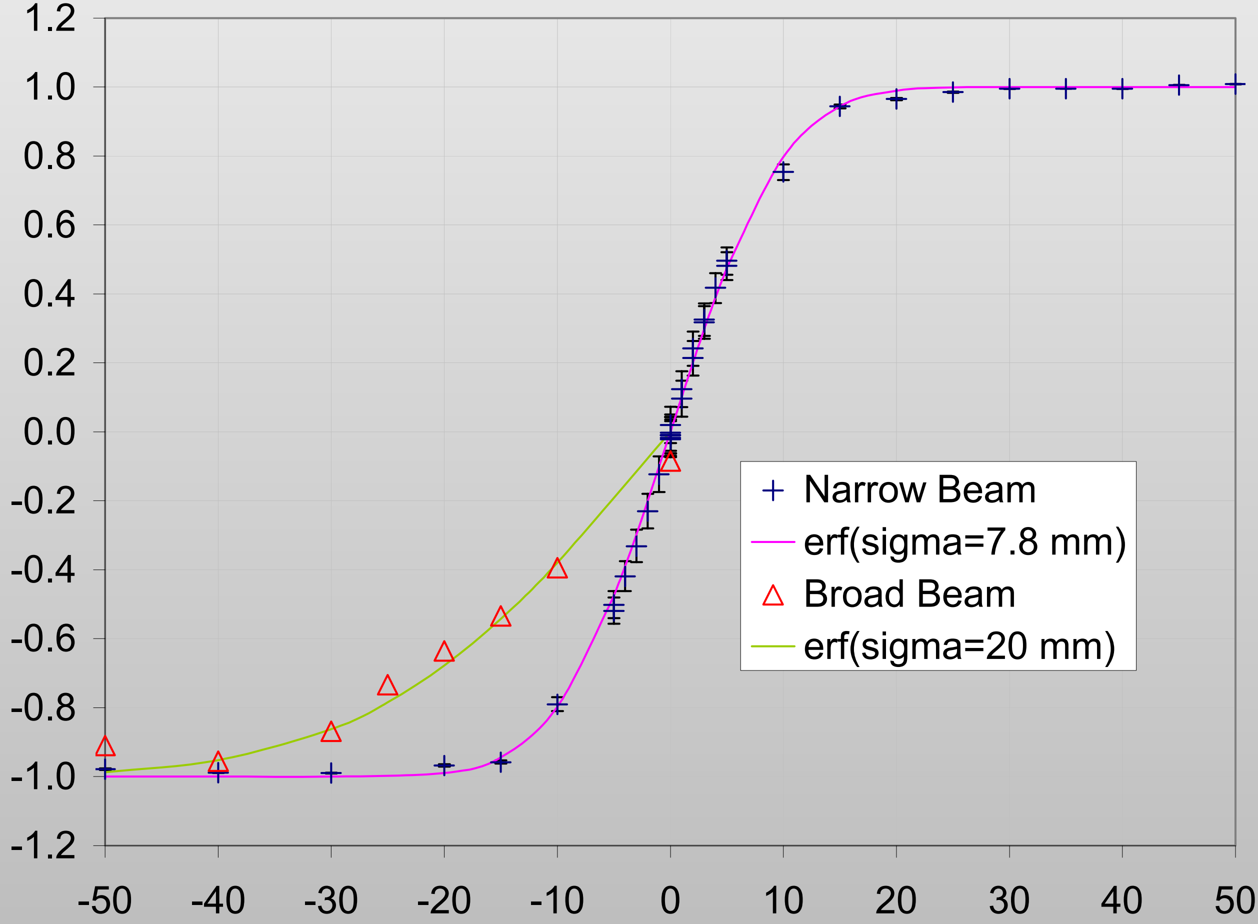


Symmetric x and y Response



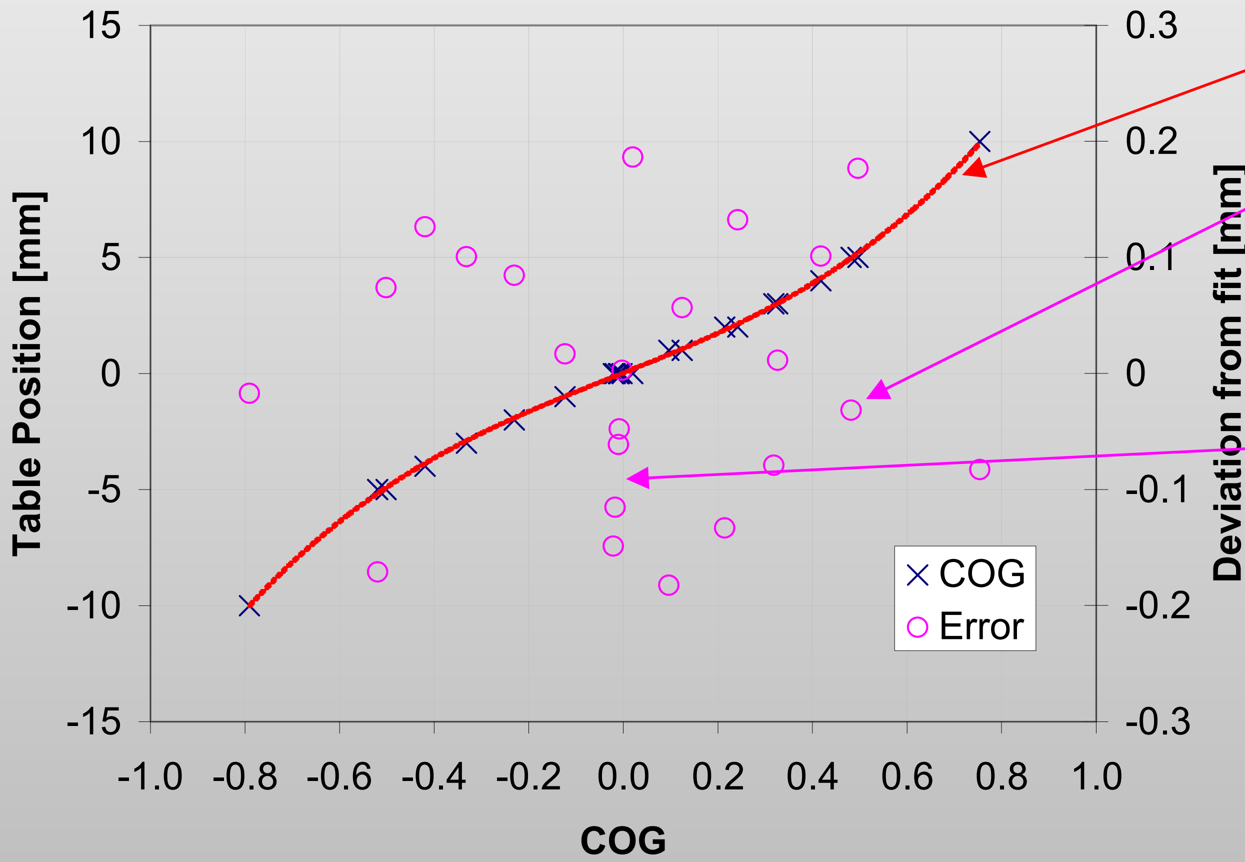
Beam Size

Most scanning done with narrow beam



Assume gaussian beam profile ⇒ COG fits to *erf* ()
⇒Narrow beam has σ ~ 8 mm
⇒ Broad beam has σ ~ 20 mm

Position Resolution



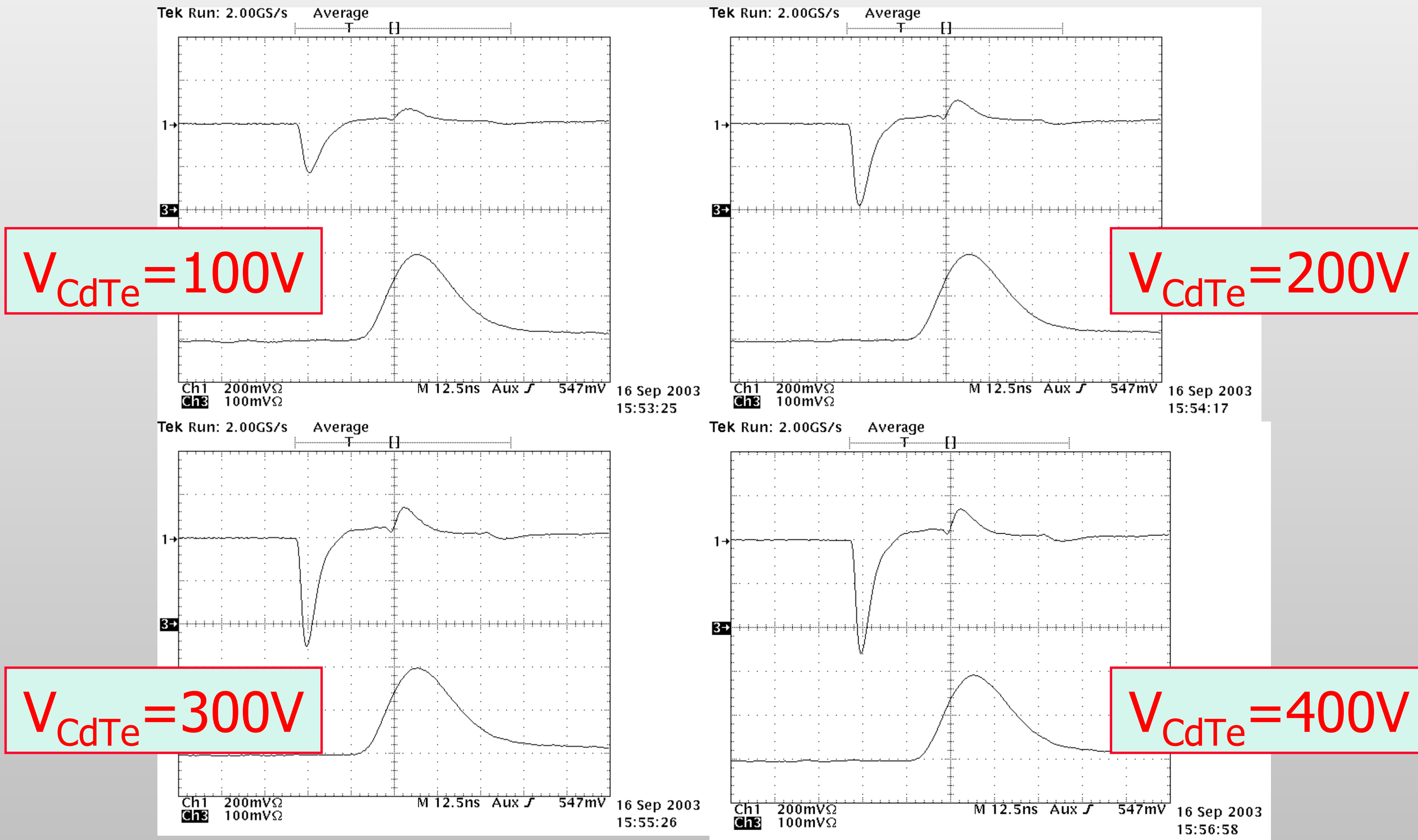
Fit COG vs position to polynomial.

Error is deviation from fit ($\sigma \sim 110\ \mu m$)

Primitive DAQ: Estimate measurement error from reproducibility ($\sigma \sim 110\ \mu m$)

Resolution is better than current measure-ment precision

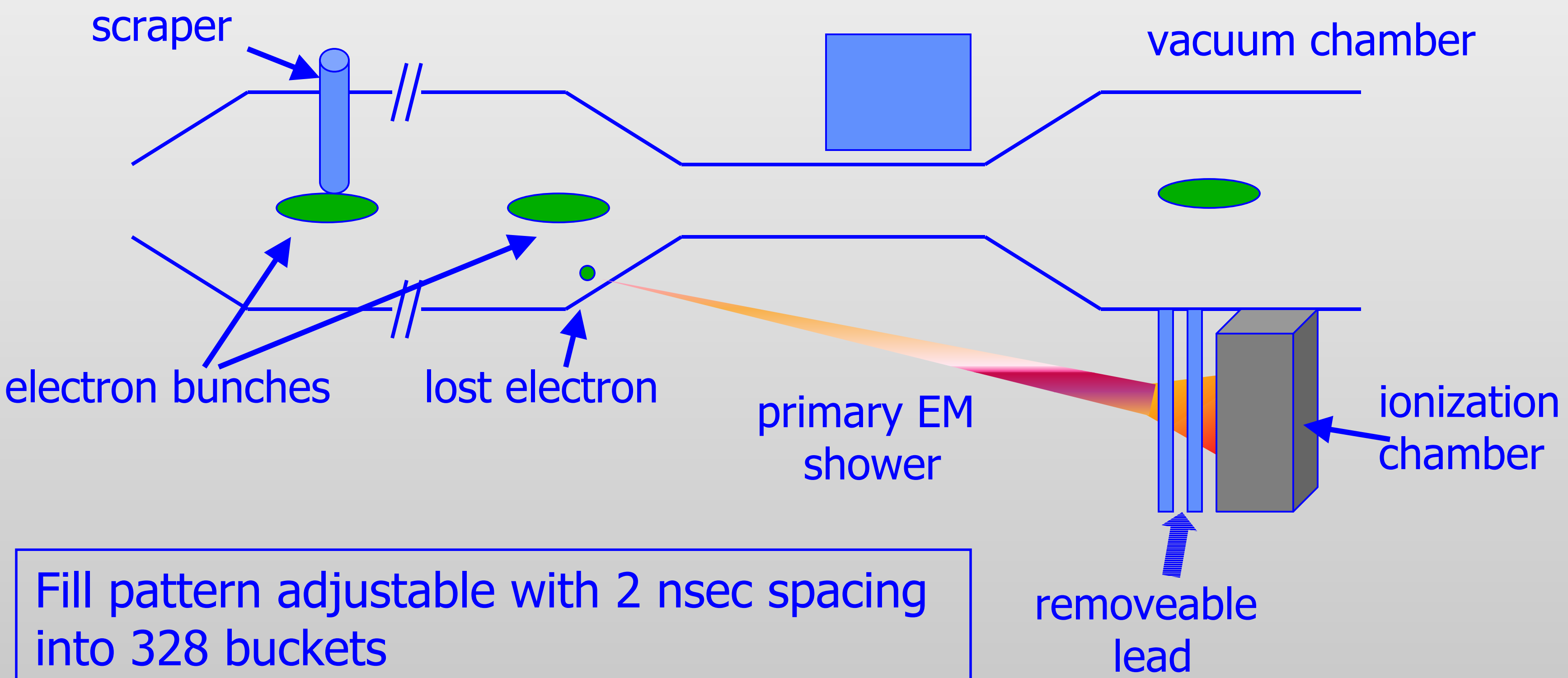
CdTe Signal vs. Bias Voltage



BTS Conclusions

- Simulated performance = measured performance
- Drift velocities of > 45 μm/ns (i.e. collection time < 25 ns) attained (factor of 2 improvement over previous mixture)
- Ionization chamber works as a true 4-quadrant detector ("obvious", but 1st time chamber worked as a 4-quadrant detector)
- x and y are independent
- Position resolution (across quadrant boundaries) is better than we can currently measure (need to improve our DAQ!) i.e. < 110 μm

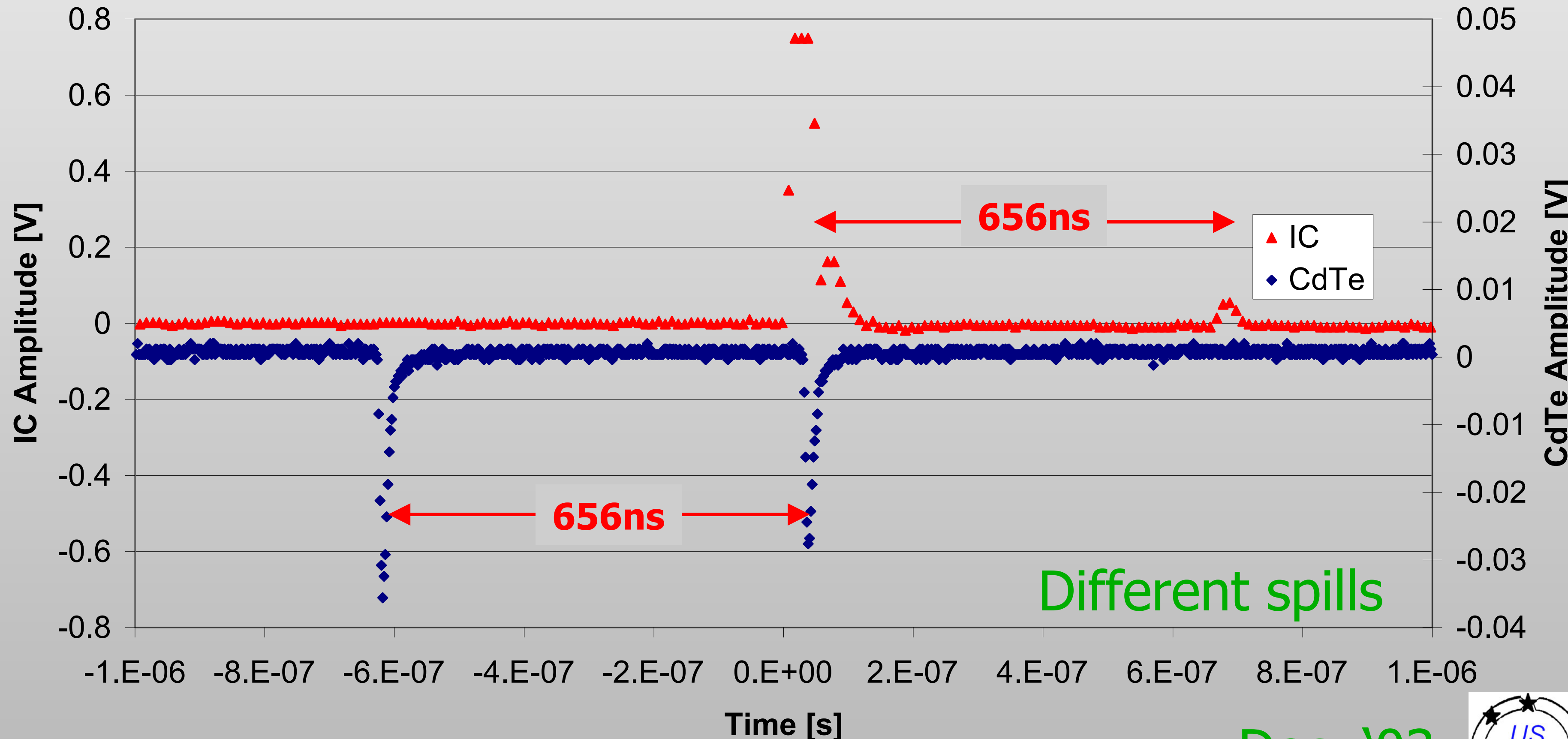
ALS Ring Tests



Fill pattern adjustable with 2 nsec spacing into 328 buckets
For example:
24 ns ⇒ 41.7 MHz, max 27 bunches
26 ns ⇒ 38.5 MHz, max 25 bunches
LHC conditions: 25 ns ⇒ 40 MHz

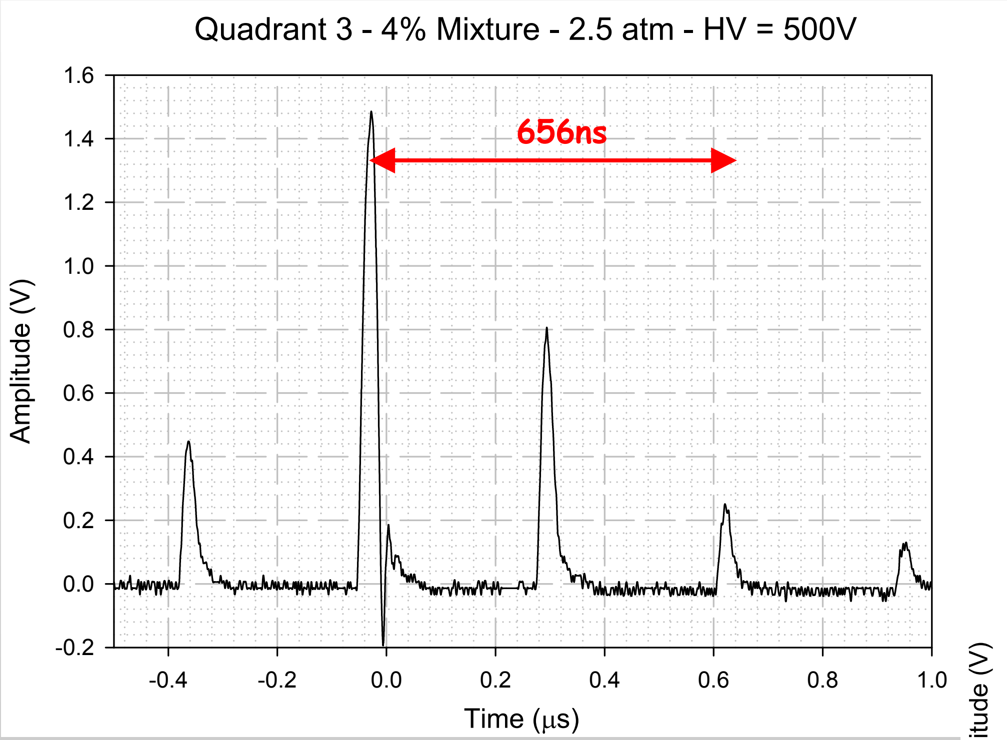
Does it work?

- Fill pattern = 1 bunch

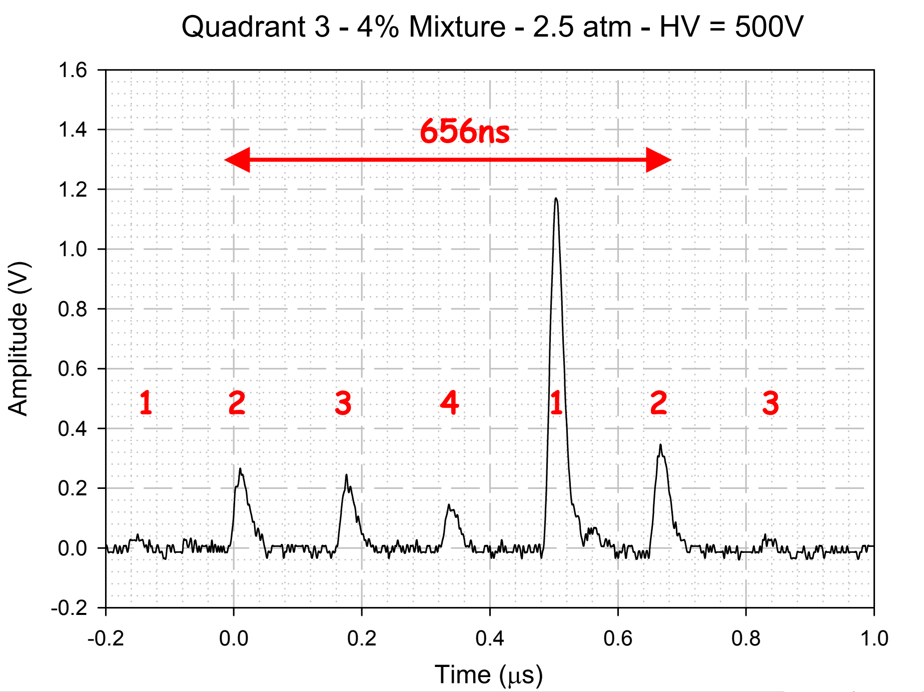


Dec. '03

Increase the Number of Bunches



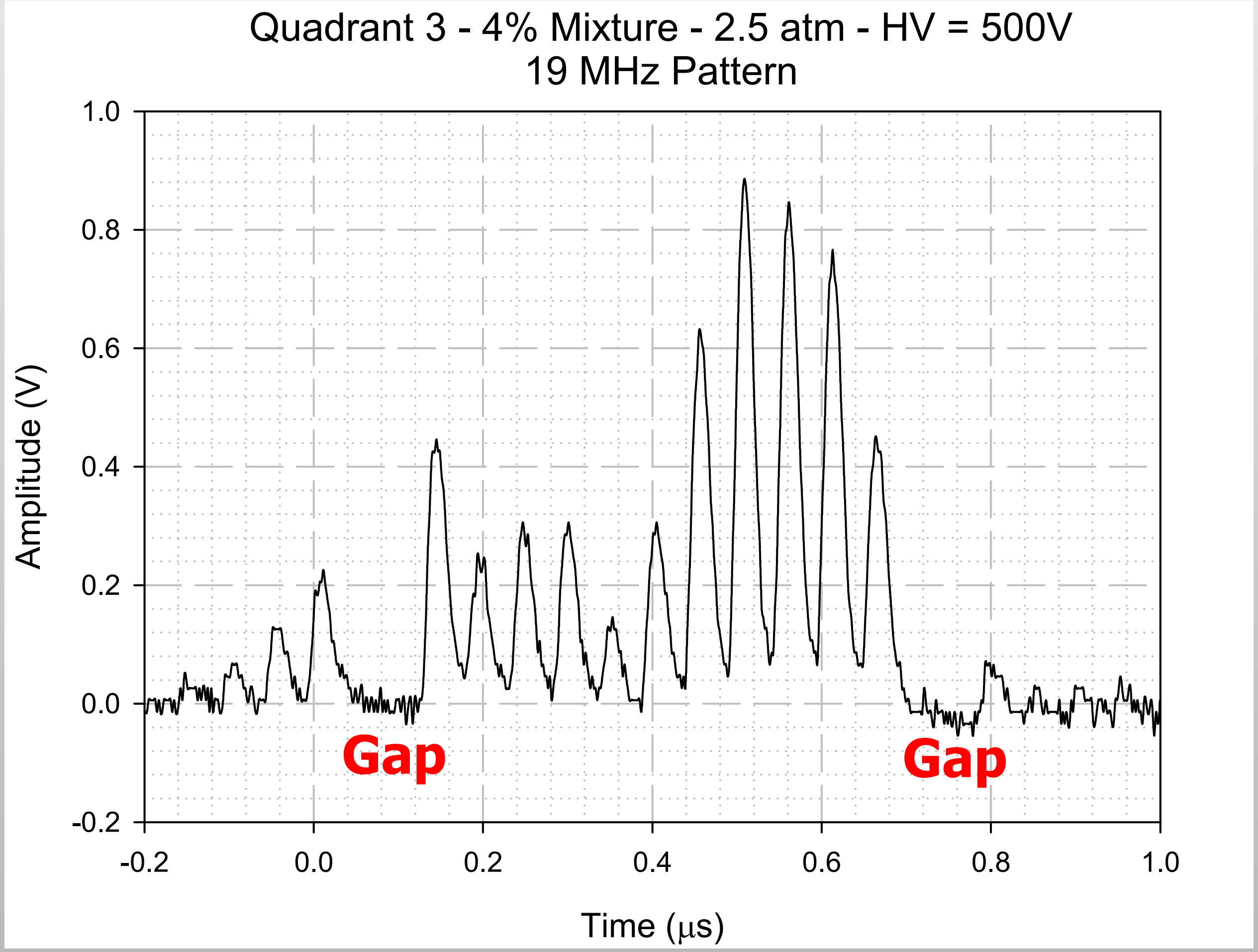
2 bunches



4 bunches

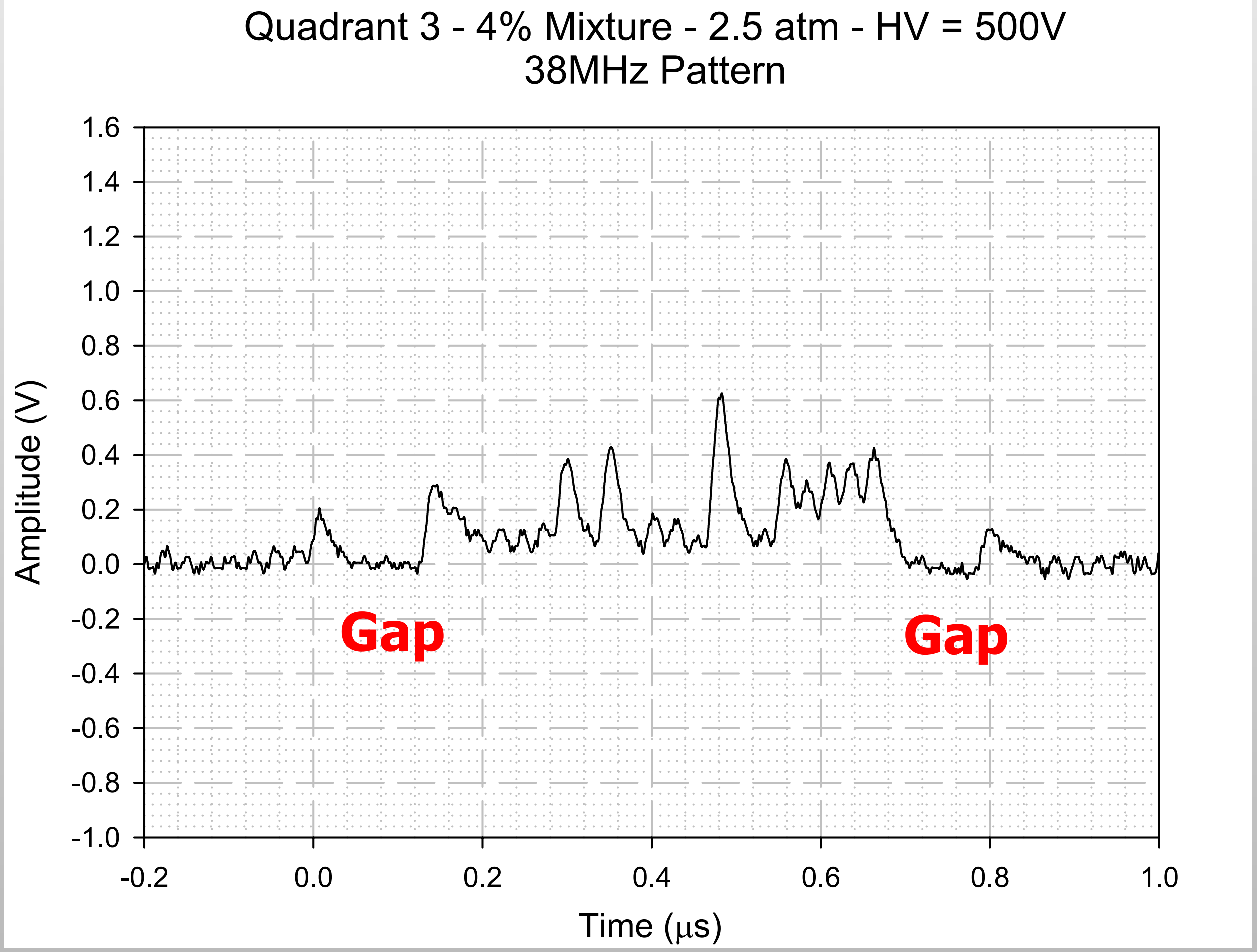
19 MHz

- Fill pattern = 11 bunches – 52 ns between bunches
- 84 ns gaps



38 MHz

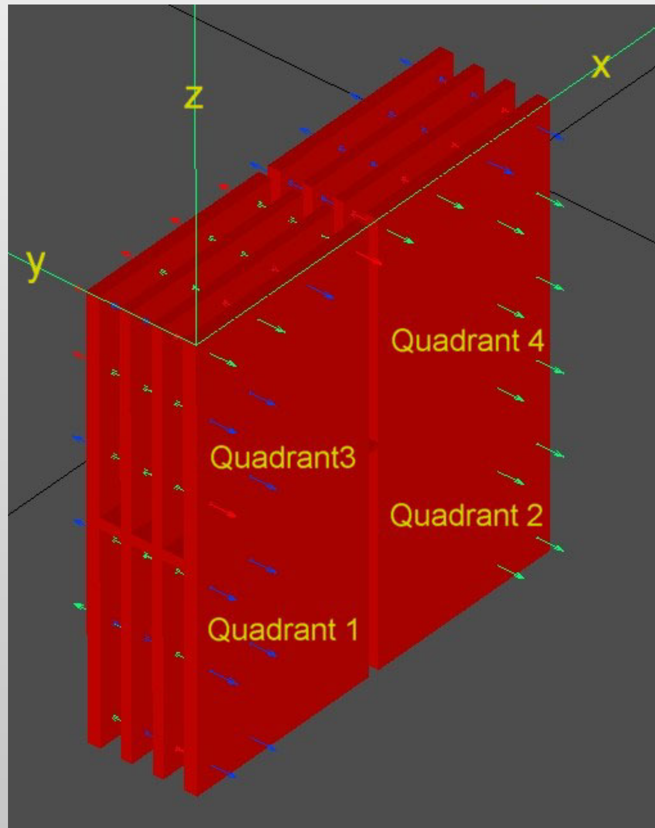
- Fill pattern = 22 bunches – 26 ns between bunches
- 84 ns gaps

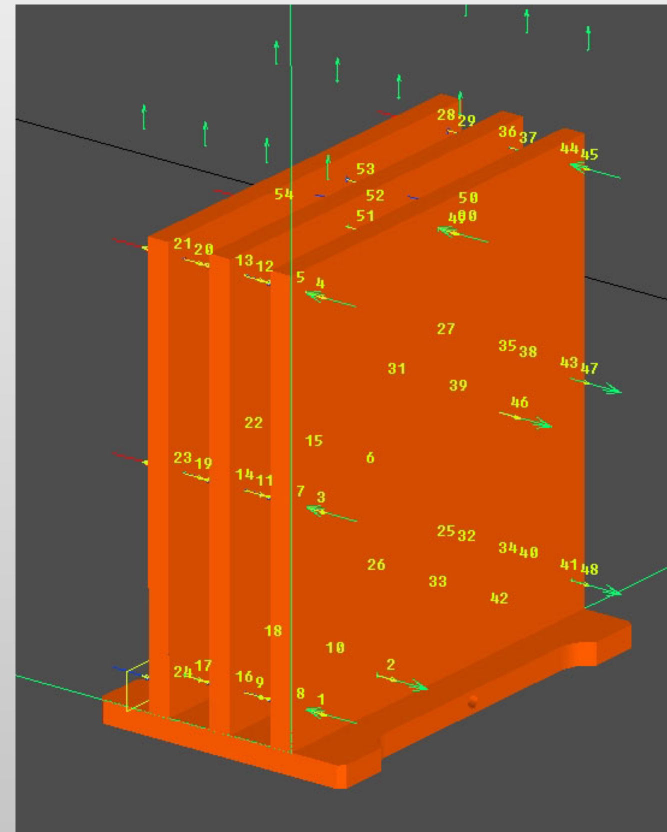


Performance Summary and Next Steps

- Chamber + TAN insert designed and built
- Operates as predicted, works as 4-quadrant detector with no cross-talk
- Gas pressure and voltage behavior as simulated
- ALS BTS setup established for precise tests (need DAQ improvement in order to determine ultimate position resolution – currently ~100 μm, but systematics limited)
- ALS ring setup for 40 MHz test
  - Leaky capacitor required removal/repair of chamber late December. Re-install next Tuesday
- Proceed to final mechanical design issues (see next slides)
- Electronics integration
- Intended radiation test at RTF abandoned

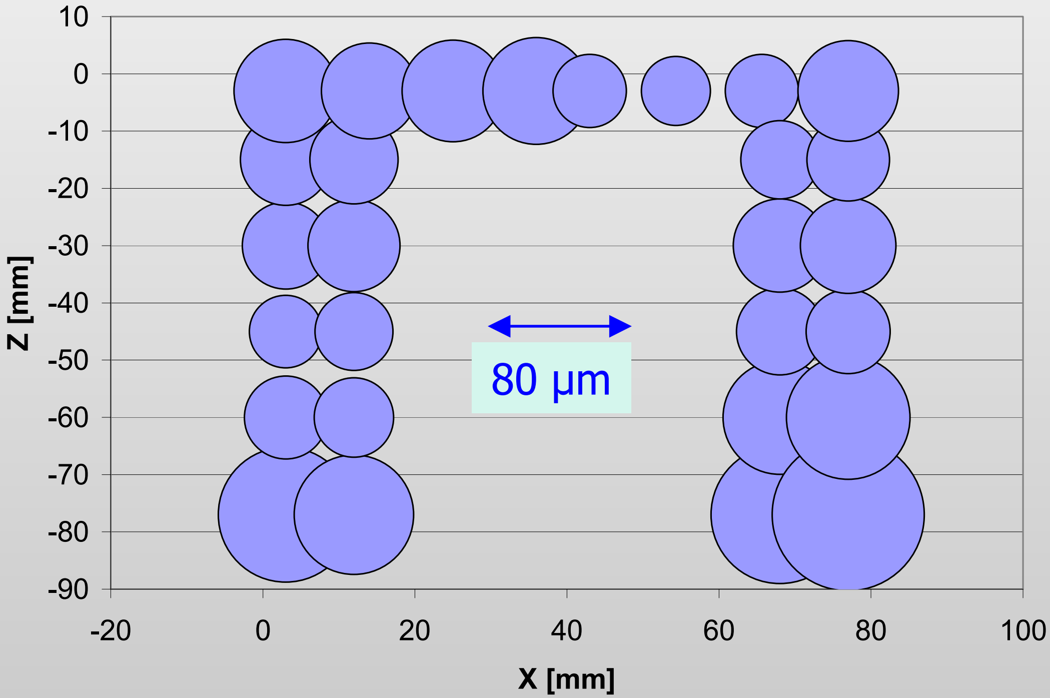
Machining Issues (1)



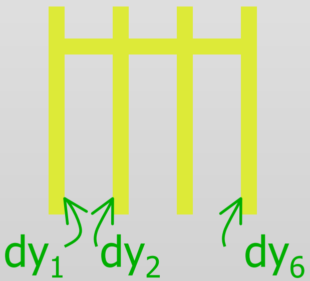


Survey ground plane and each “comb”

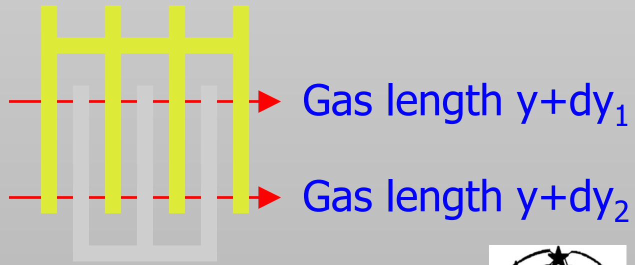
Machining Issues (2)



Ground plane RMS vs position. Avg=35 µm

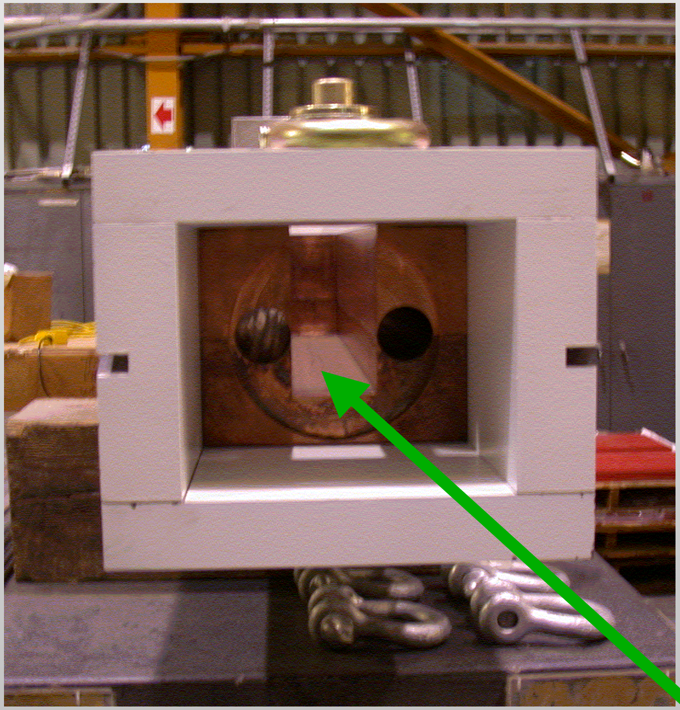


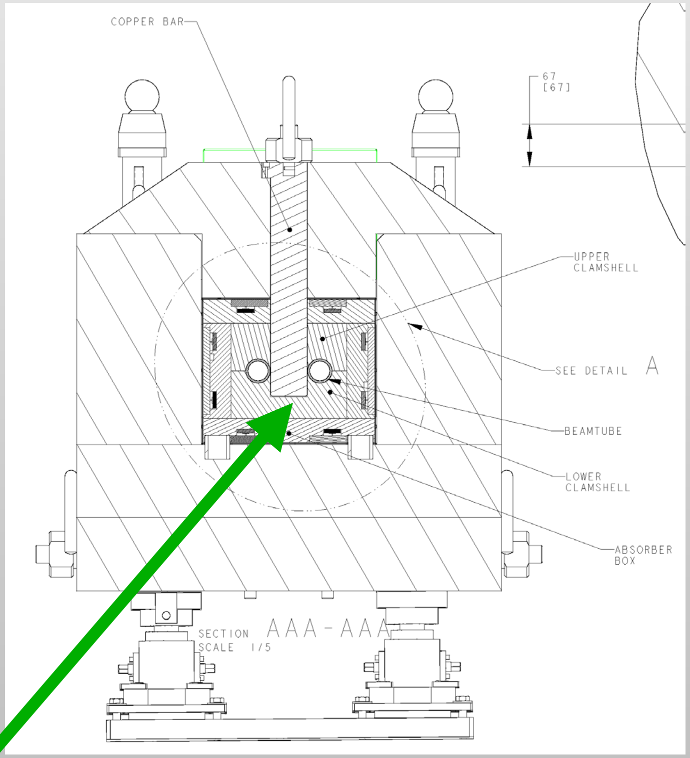
Resolution: dy=const. (indep. of x,z)



Need to Design Manipulator

- Shielded manipulator for removing TAN insert





Instrumentation slot

Proposed Test at FNAL RTF

>100 MGy/year (>0.1 **T**Rad for 10 year operation)