



NLC - The Next Linear Collider Project

**Intra-Pulse
Beam-Beam Scans
at the
NLC IP**

Steve Smith

SLAC

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Beam-Beam Scans

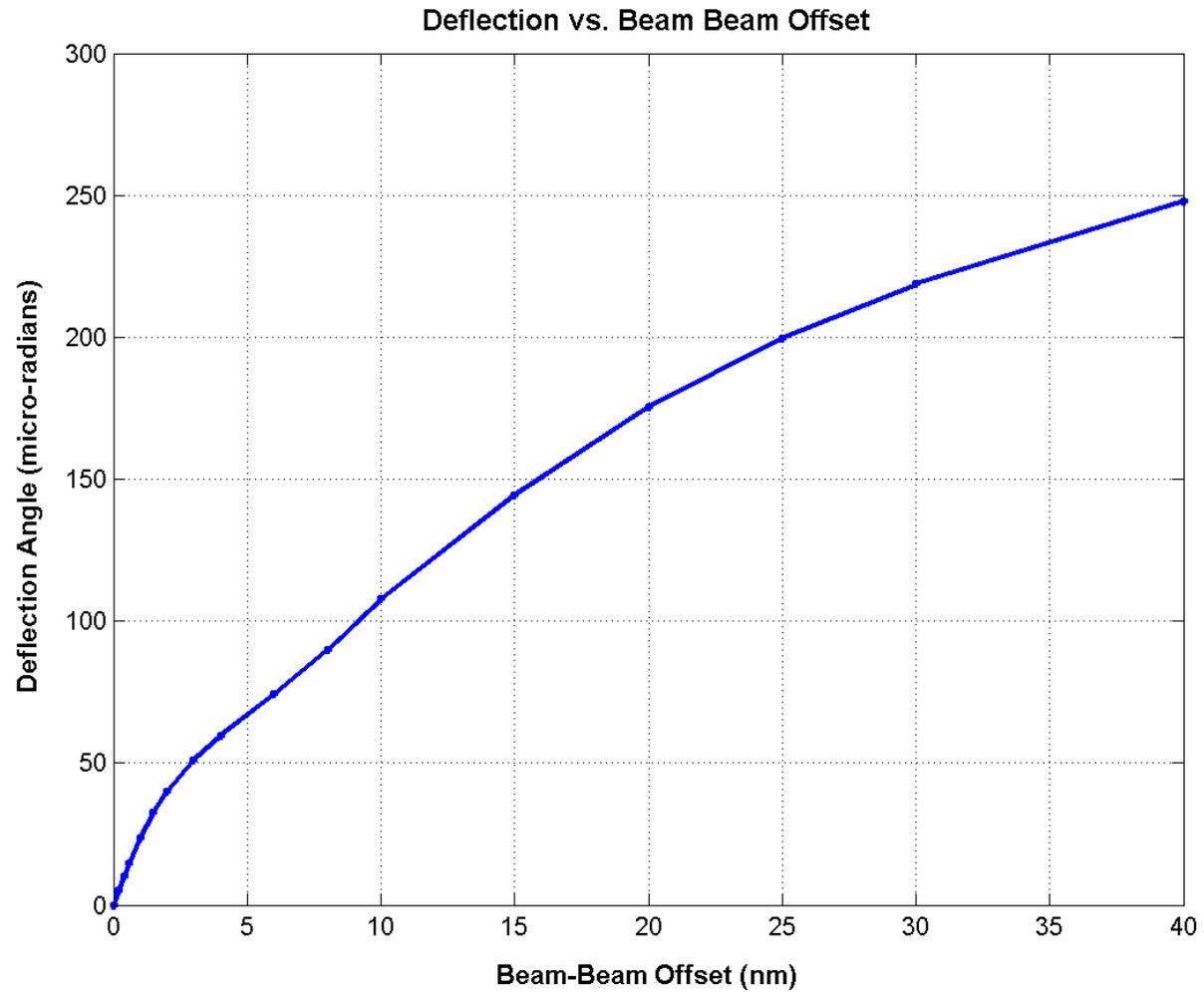
Next Linear Collider

- Important linear collider diagnostic
 - Spots sizes
 - Alignment
 - Waists
 - Etc. etc. etc...
- Some Limitations:
 - Takes lots of time at one measurement per pulse train
 - Sensitive to drifts over length of scan
 - *i.e.* low frequency noise, drift
 - Pulse-pulse jitter
- Can we do a scan in one bunch train?
 - Increase utility of diagnostic by increasing speed
 - Reduce sensitivity to drift and low frequency noise
- Yes
 - Assuming existence of intra-pulse IP feedback.



Beam-Beam Deflection

Next Linear Collider

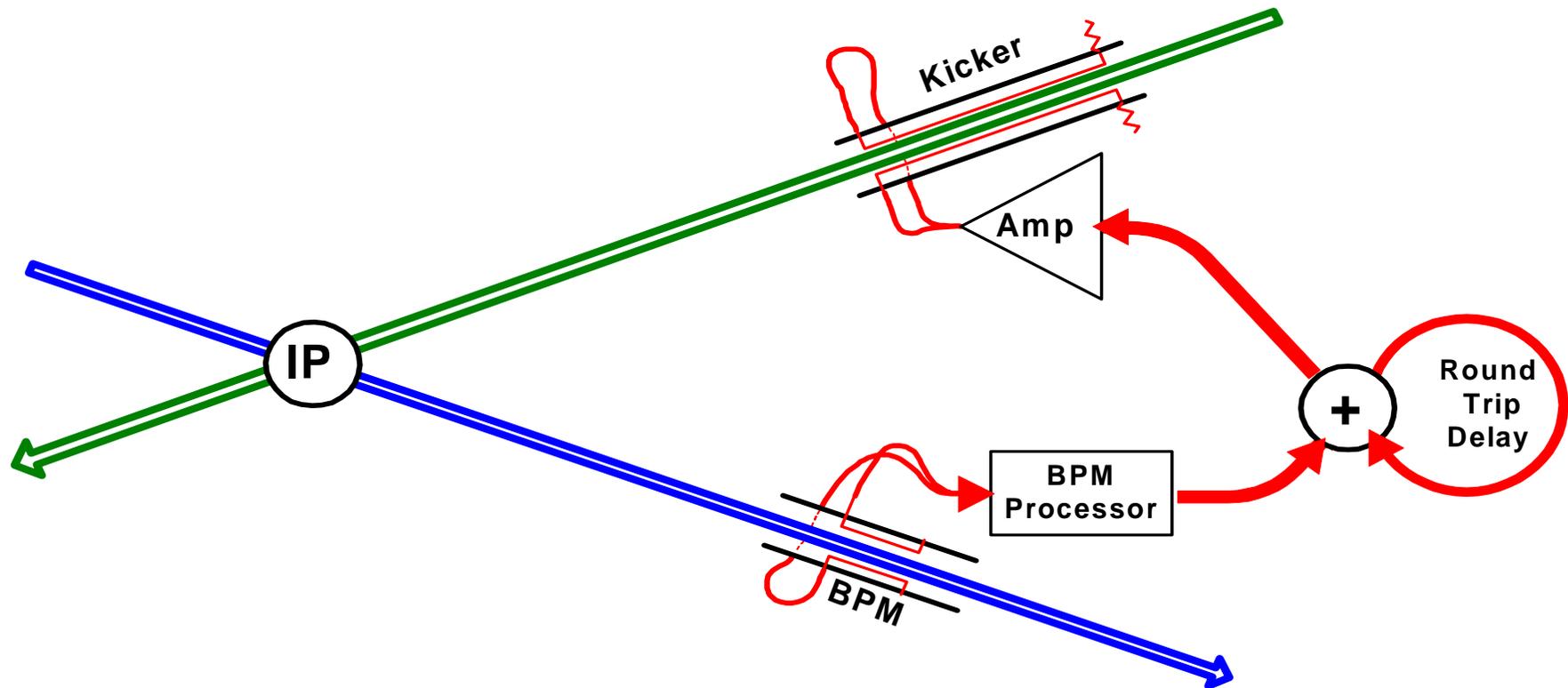


A. Seryi



Intra-Pulse Feedback

Next Linear Collider





Intra-pulse Feedback

Next Linear Collider

- Fix IP jitter within the crossing time of a bunch train (250 ns)
- BPM measures beam-beam deflection on outgoing beam
 - Fast (few ns rise time)
 - Precise (~micron resolution)
 - Close (~4 meters from IP?)
- Kicker steers incoming beam
 - Close to IP (~4 meters)
 - Close to BPM (minimal cable delay)
 - Fast rise-time amplifier
- Feedback algorithm to converge within bunch train.



Single-Pulse Beam-Beam Scan

Next Linear Collider

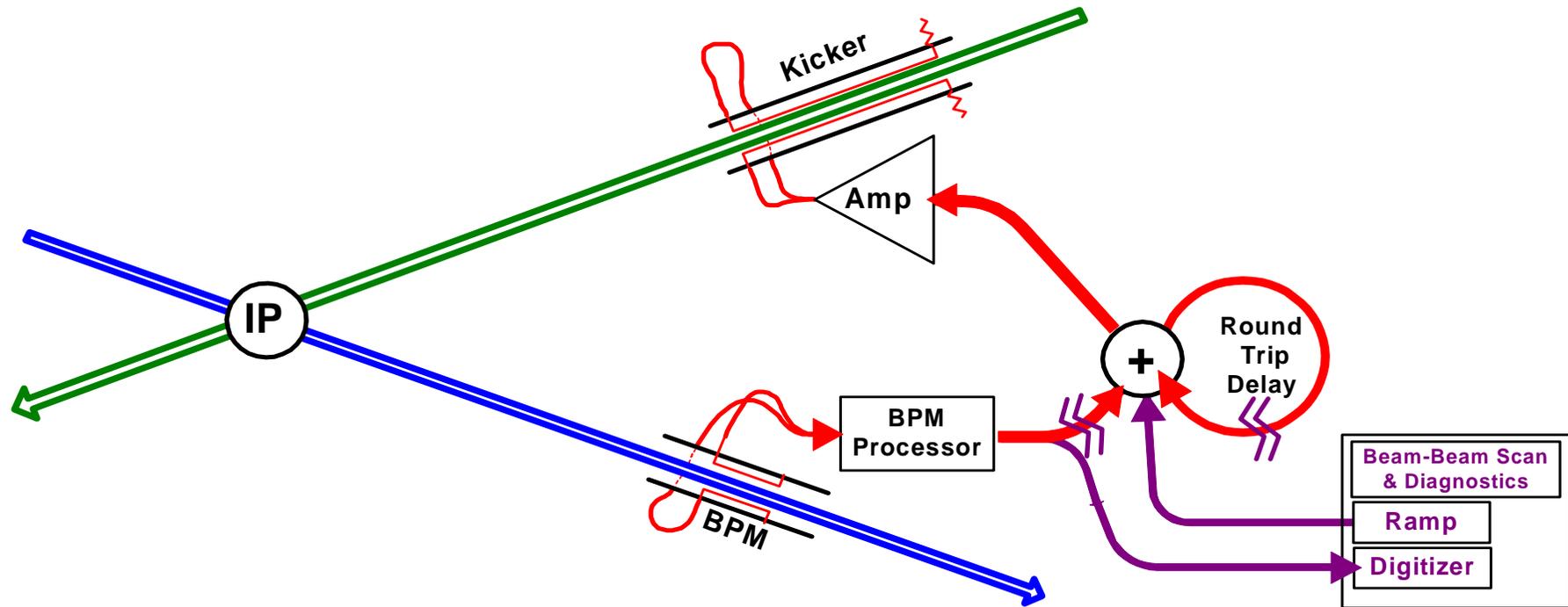
- Fast BPM and kicker needed for interaction point stabilization
- Open the loop and program kicker to sweep beam
- Digitize fast BPM analog output
- Acquire beam-beam deflection curve in a single machine pulse
- Eliminates inter-pulse jitter from the beam-beam scan.
- Use to
 - Establish collisions
 - Measure IP spot size
 - Waist scans.
 - What else?



Intra-Pulse Feedback

(with Beam-Beam Scan & Diagnostics)

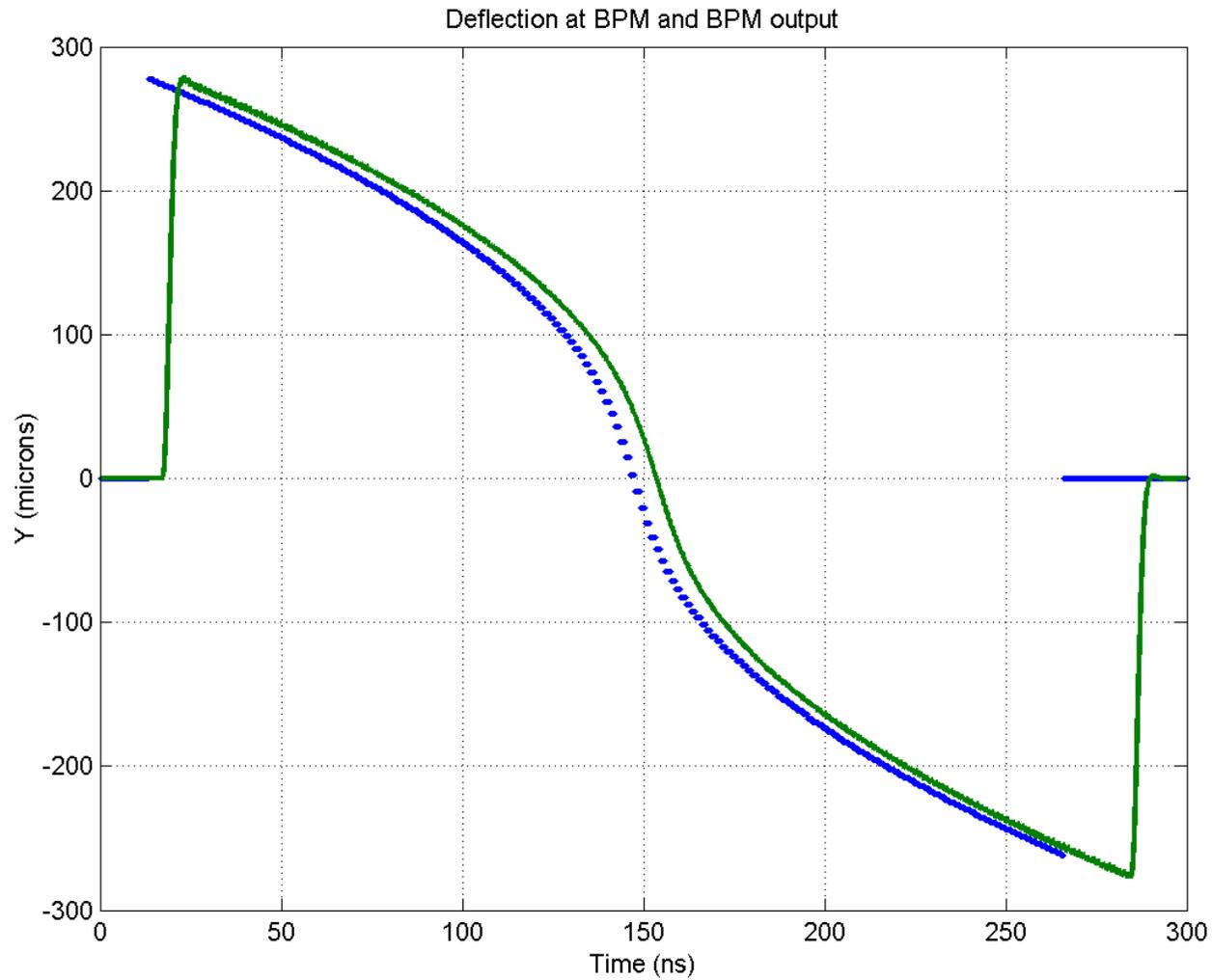
Next Linear Collider





Beam-Beam Scan

Next Linear Collider



Beam bunches at IP: blue points
BPM analog response: green line



Single Pulse Beam Scans

Next Linear Collider

- How much information in a scan?
 - Potentially 180 points per scan!
 - Feedback system needs 100 - 200 MHz bandwidth.
 - Can get possibly 50 to 100 nearly independent measurements in a pulse.
 - Depending on resolution required.
- Invasive/Non-invasive
 - Invasive for range $>$ luminosity height
 - Non-invasive range $<$ luminosity height (Beam dithering)
- Could operate concurrently with IP feedback closed loop
 - If you know the transfer function well enough.



Conclusions

Next Linear Collider

- Given Intra-Pulse Interaction Point Feedback, we have tools to perform beam-beam scans within the bunch train.
- Speeds up beam-beam scans by an order of magnitude or more.
- Optimize more parameters more often.
- Reduces low frequency noise in beam-beam scans
 - Machine drifts
 - Pulse-pulse jitter
 - $1/f$ noise
- Valuable
- Nearly free!