Arguments and Requirements for an ILC “IPBPM”

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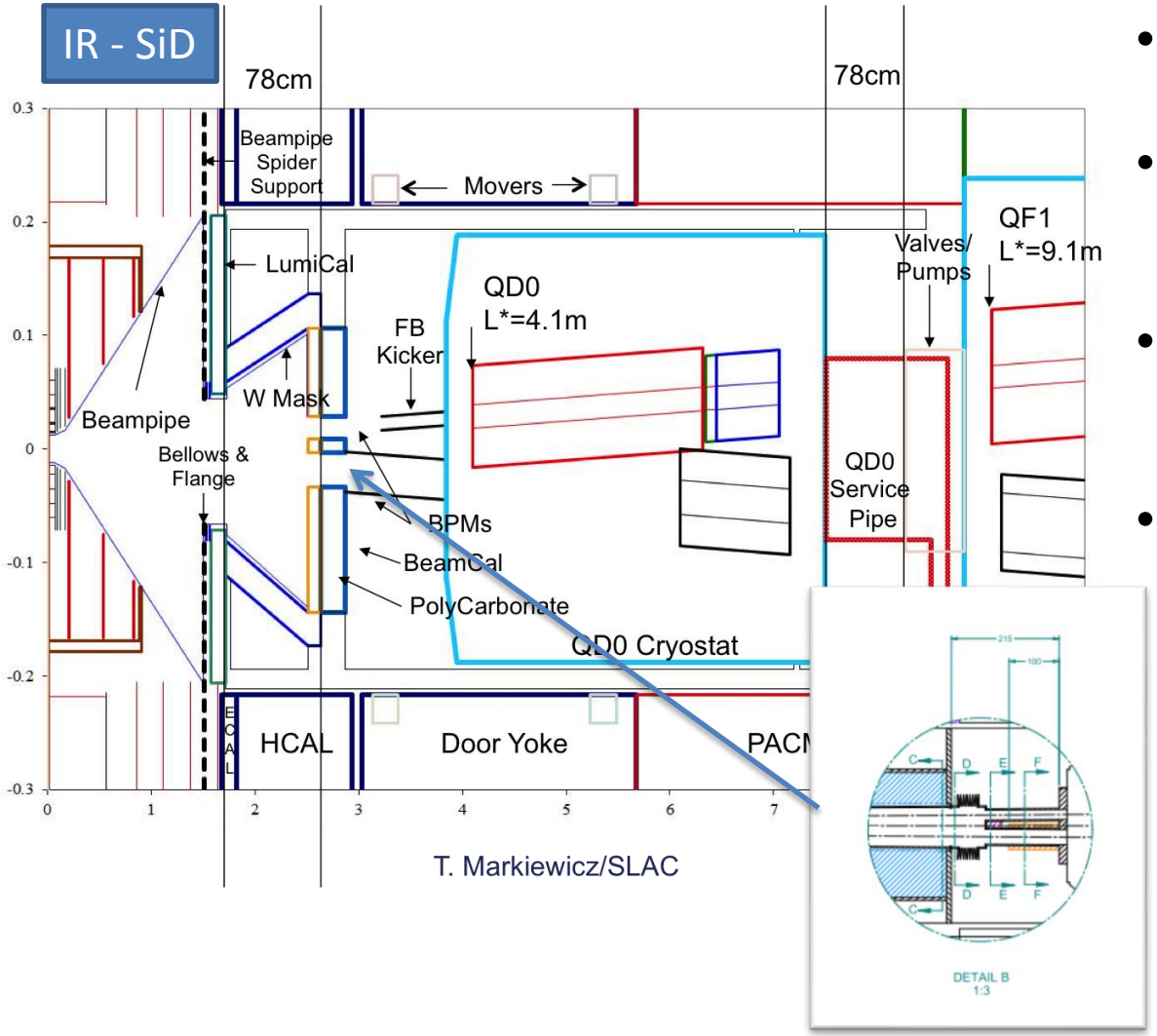
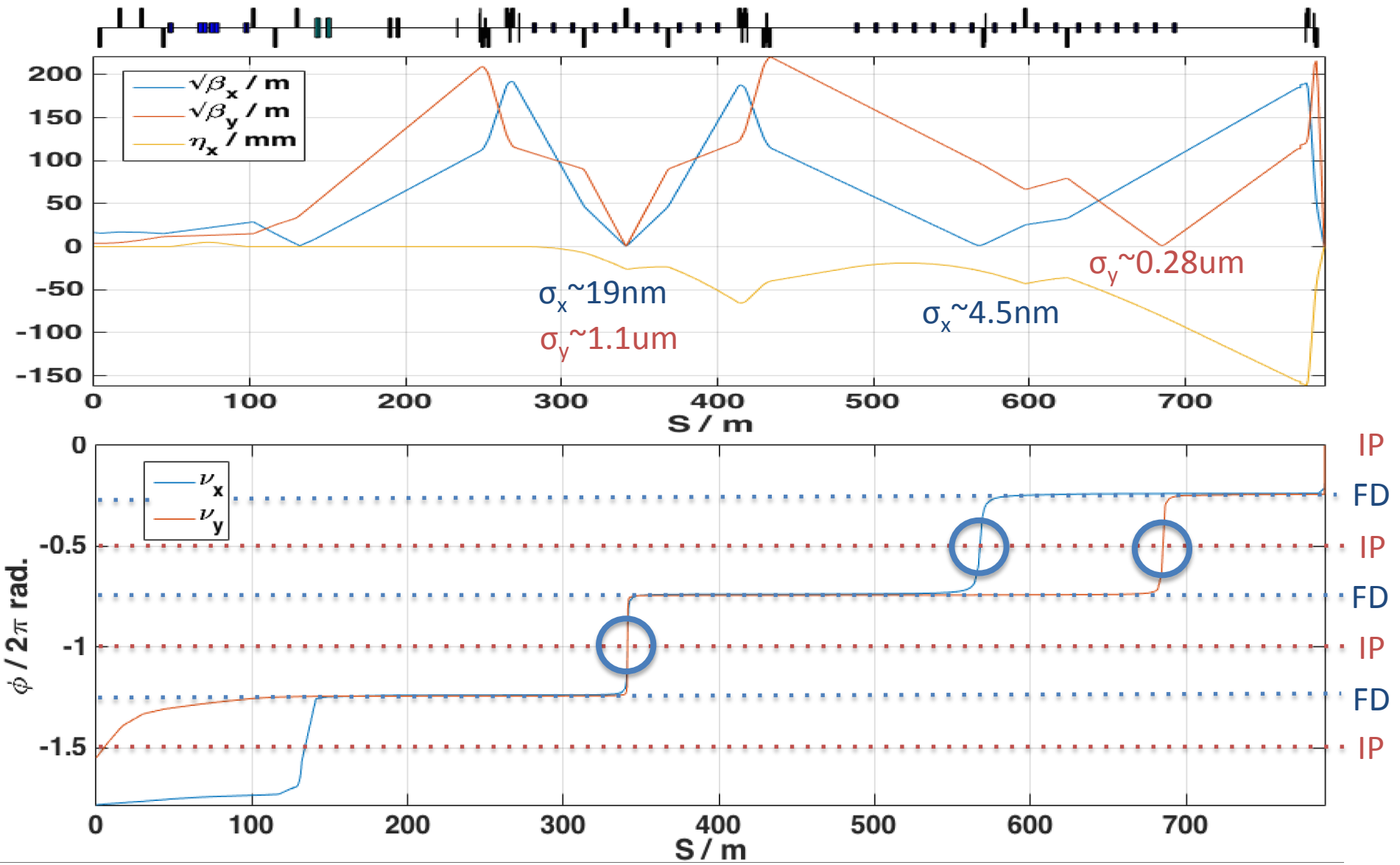
Q: Provide 1 or 2 BPMs inside of QD0's?



- Require IPFB BPM on outgoing beamline
- Another BPM on ingoing beamline after QD0?
- Provides IP position info by reconstructing IP trajectory
- "Trivial" for SiD, ILD has tighter space constraints-> need to justify.

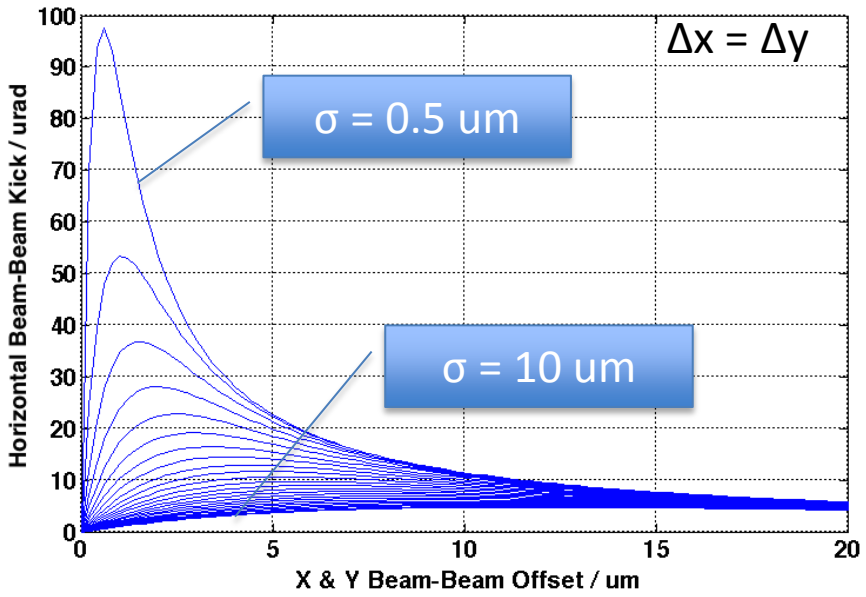
ILC FFS Optics (E_{CM}=500 GeV)

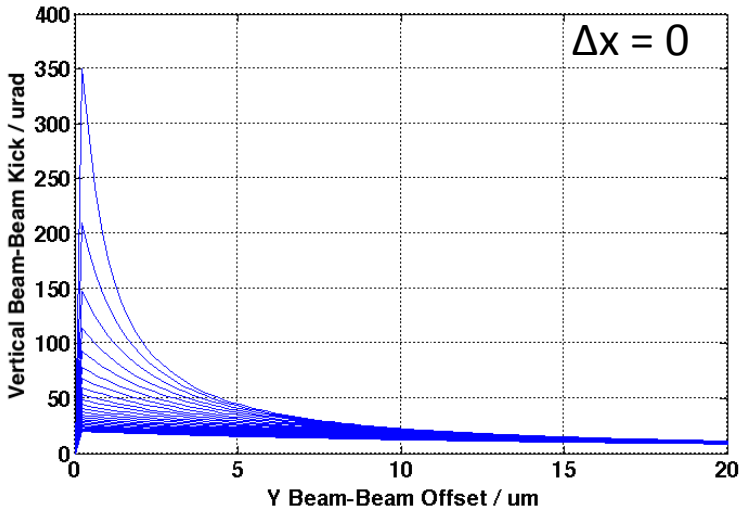


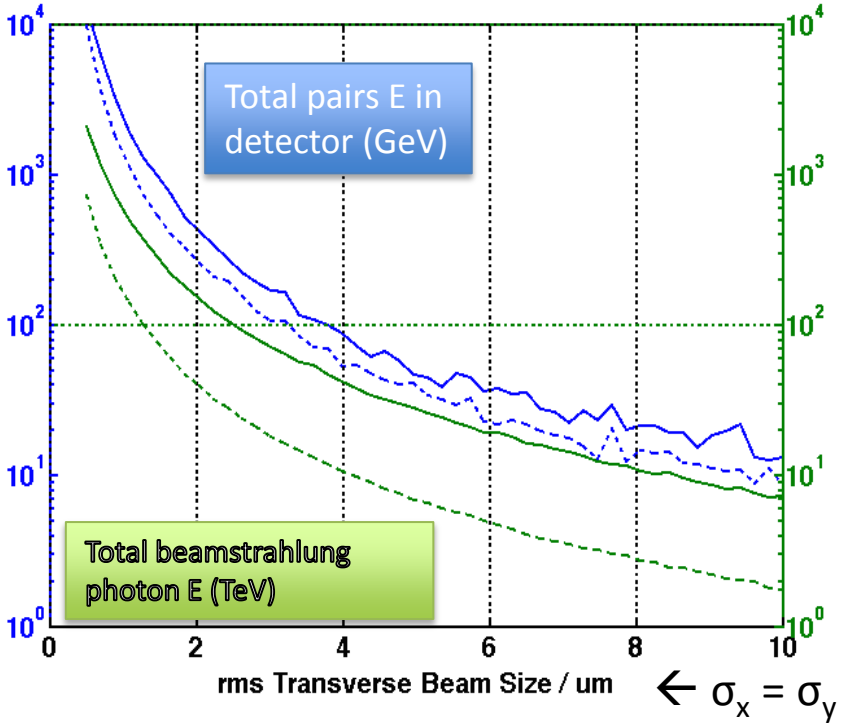
IPBPM Requirements Summary

- Recovery of IP collisions after push-pull or significant down-time
  - Recover collisions within beam-beam feedback capture range (10um)
  - Requires BPM resolution of similar scale to capture range requirement
  - BPM pair needs to be aligned with detector
  - Requires high quality gain tracking in electronics (cal tone)
- Tracking of IP position motion <1σ
  - Requires O(nm) resolution cavity BPM pair
    - Compatible with IPFB?
    - Dynamic range sufficient given IP angle jitter?
    - Gain sensitivity?
  - Beam-beam kick far more sensitive to relative IP offset, better to use that.
  - Need absolute tracking of IP position at this scale?
    - Probably only detector cares about this?
  - Provide information about FD jitter by comparison with u/s BPM systems
    - Again, beam-beam kick more sensitive for this purpose anyway
- Reconstruction of IP waist position?
  - Required resolution set by β_y^* ~ 500um
  - Best possible reconstruction accuracy by IPBPM pair ~ 2mm

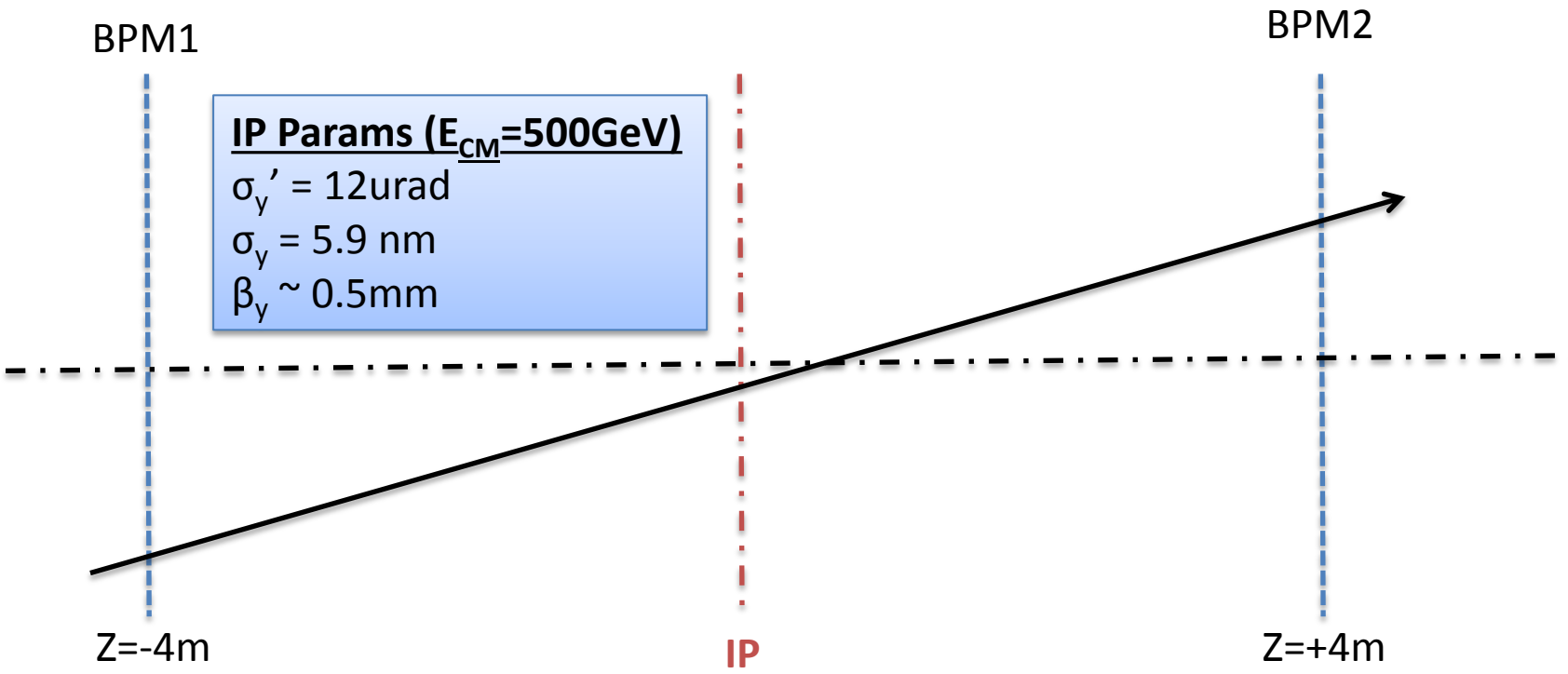
Beam-Beam Kick Feedback Capture Range
Δy ~<10um σ_y ~<10um







IP Position Reconstruction



Resolution Requirements

$$X_{IP} = X_1 + X'_1.L_1 \approx X_1 + \frac{(X_2 - X_1).L_1}{(L_2 - L_1)}$$

$$L_1 = L_2 \Rightarrow \sigma_{IP} \approx \sqrt{1/2}\,\sigma_{BPM}$$

Gain Requirements from ANG Jitter:

Assume ~0.1σ' jitter:

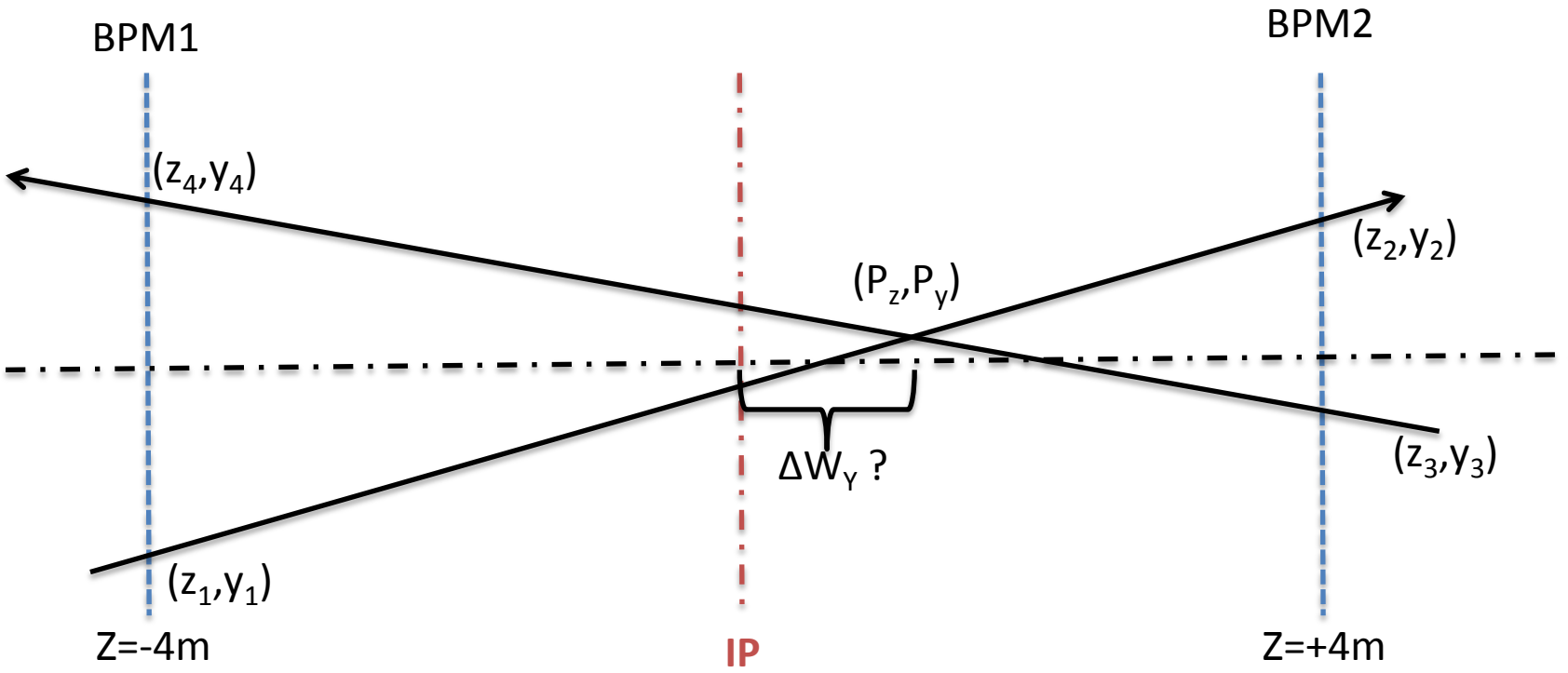
& Fast ANG feedback correct factor 10

$\Rightarrow |Y_1| \sim |Y_2| \sim 0.5$ um

Gain stability ~ 0.1%

=> $\Delta X_{IP} \sim (Y_2G_2+Y_1G_1)/2 \sim <$ **0.5nm**

IP Waist Z Location Reconstruction?



$$P_z = \frac{(z_1 y_2 - y_1 z_2)(z_3 - z_4) - (z_1 - z_2)(z_3 y_4 - y_3 z_4)}{(z_1 - z_2)(y_3 - y_4) - (y_1 - y_2)(z_3 - z_4)}$$

Min Error on reconstructed waist
Given by BPM dynamic range:

$$s_{P_z} \geq 2' (DynRange)_{BPM} = \frac{2 s_{BPM}}{|y_{BPM}|^{MAX}}$$

Realistic dynamic range <1:1000 => ΔW_Y = 2mm
(β_y^* = 0.48mm)