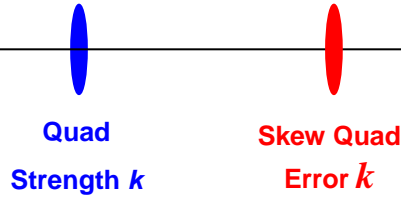
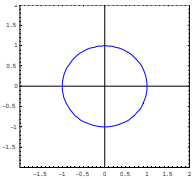


Tiny XY coupling can cause major uncorrectable blowup under near-singular transport

$$\alpha_x = 0, \beta_x = \gamma_x = 1$$



OBSERVE HERE

Quad=0 Skew=0 Emittance=1.0

Quad=5 Skew=0 Emittance=1.0

Near singular; Can be restored

Quad=0 Skew=0.05 Emittance=1.03

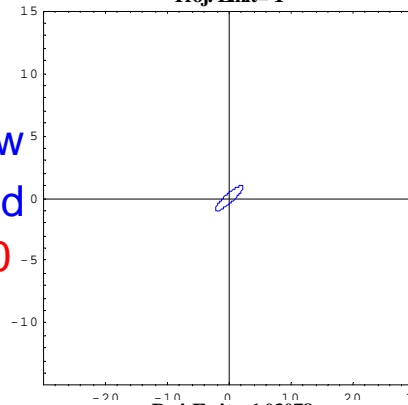
Slight emittance increase

Quad=5 Skew=0.05 Emittance=5.25

Major blowup; Cannot be restored

Quad $K=0$

Proj. Emit= 1



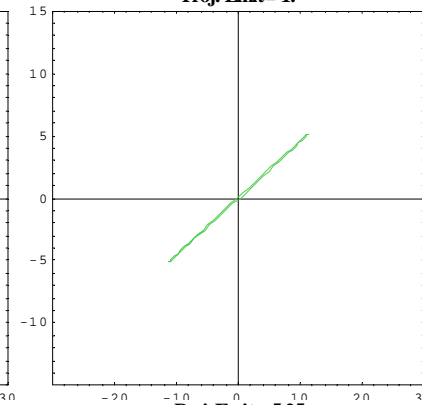
Skew

Quad

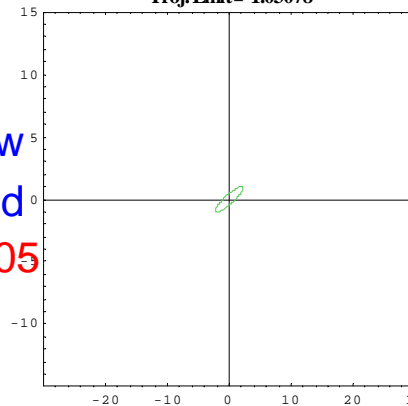
$K=0$

Quad $K=5$

Proj. Emit= 1.



Proj. Emit= 1.03078

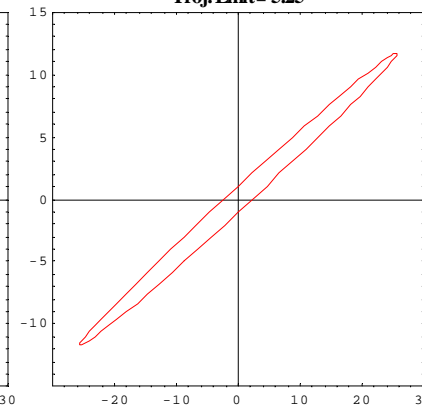


Skew

Quad

$K=0.05$

Proj. Emit= 5.25



$$\mathcal{E}_{X \text{ Final}}^2 - \mathcal{E}_{X \text{ Initial}}^2 = \langle XX \rangle \langle YY \rangle k^2 = \beta_x \beta_y \epsilon_x \epsilon_y k^2$$

Observation of Damping (or Lack thereof) - 100 keV to 60 MeV

■ Propagation of PZT (spot motion on cathode) orbit through Injector

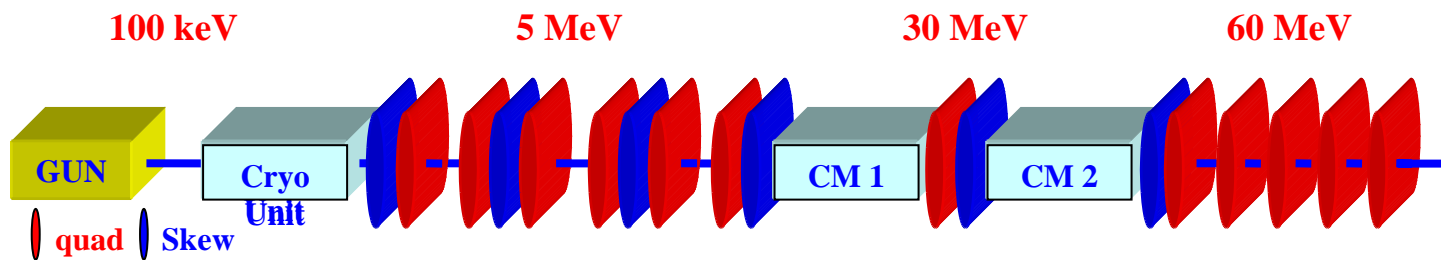
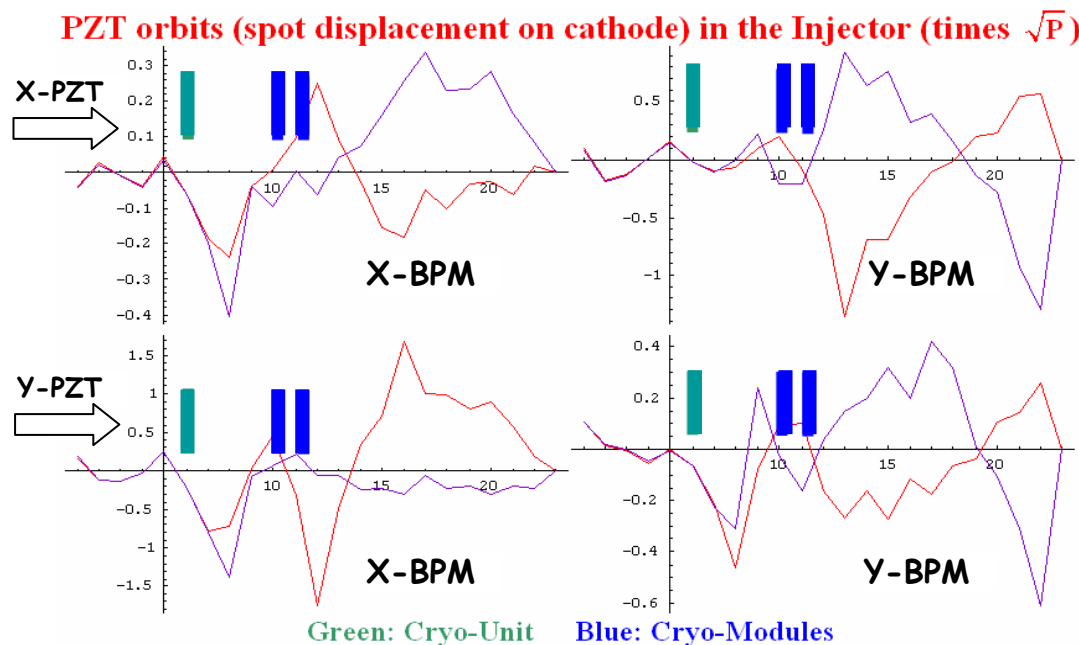
indicates **orbit blowup**.

■ Blowups coincide with SRF components (Cryo-modules).

■ XY coupling from HOM couplers

■ Near singular transport from imperfect low energy modeling.

⇒ **A Potent Combination!**



CEBAF Injector 100 keV-60 MeV