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# A Look at Zero Degree Extraction using a Kicker

The possibility of a 1-2 T·m kicker was raised at the January '05 MDI Workshop by Y. Iwashita so it begged the question of what the extraction line might look like.

**Compare ILC with the SLC zero degree crossing**:

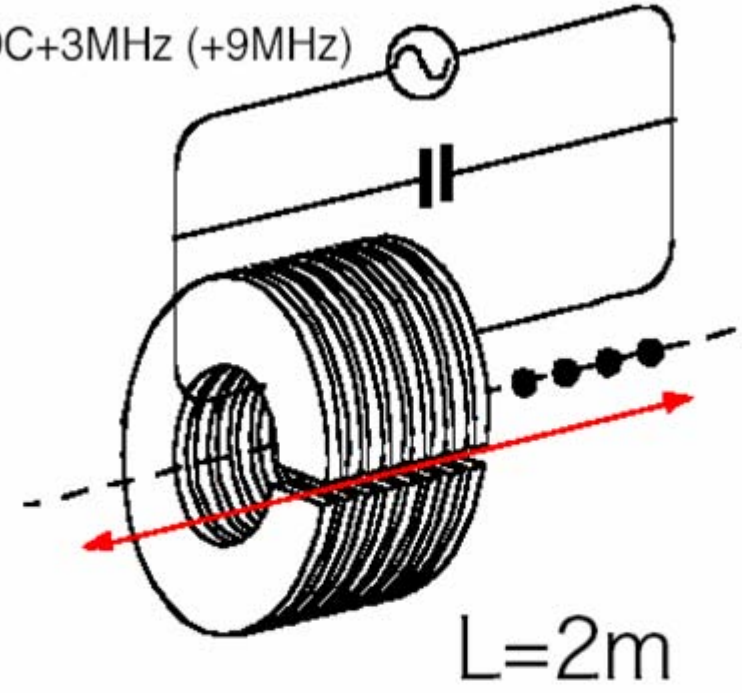
1. The SLC pulsed kicker was "easy", L=4.0 m, B=0.05 T, => $\int Bdl = 0.2$ T•m

2. The ILC disrupted beam has ~100x more power, much larger energy spread (up to -80% ΔE/E), and a large vertical average deflection angle (200 μrad) under some conditions.

3. The ILC has a 300-1000 kW beamstrahlung flame with non-negligible angular spread.

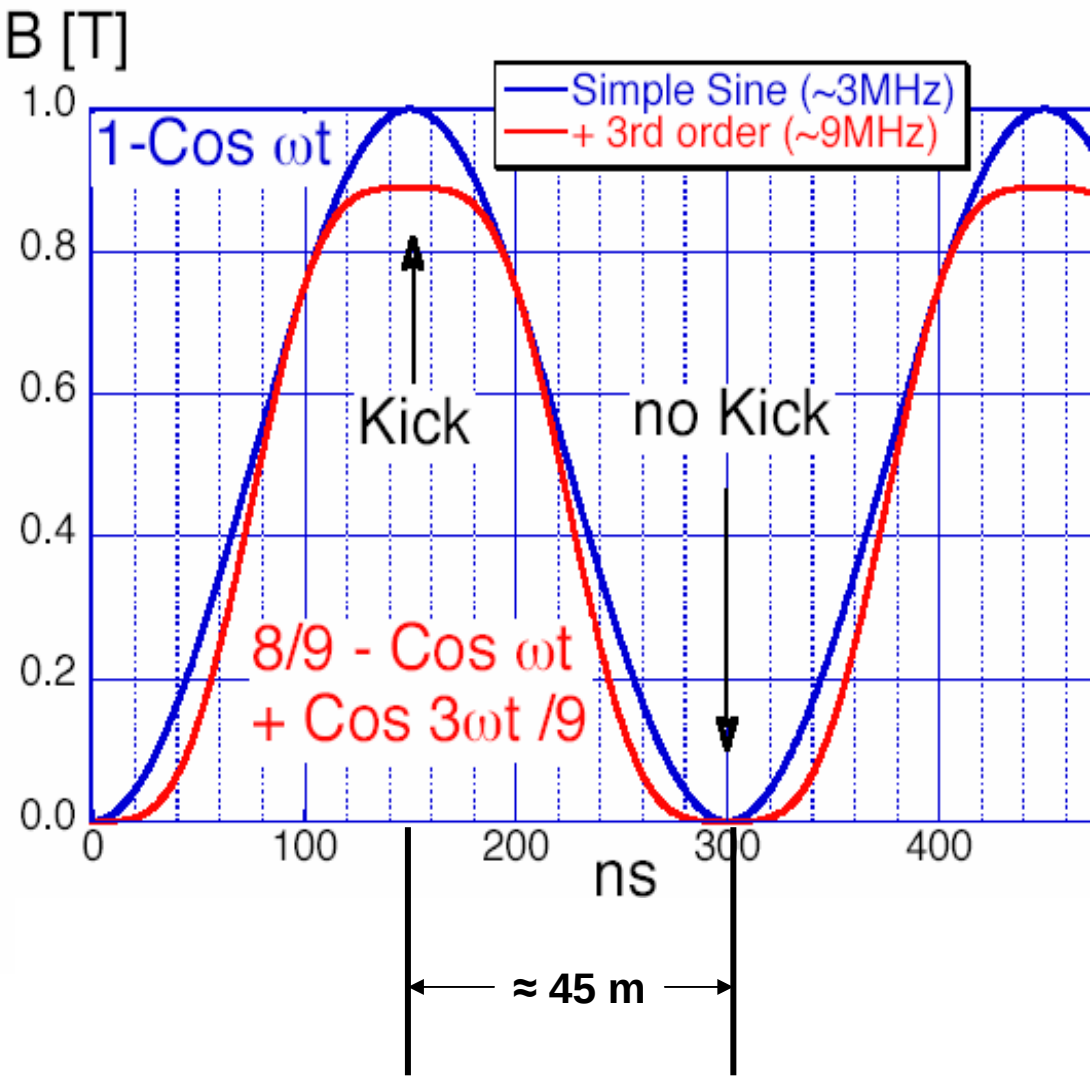
# RF Kicker Concept

**See Y. Iwashita talk at the MDI Workshop, Jan. 2005**




2cm x 6cm x 2m=0.0024m$^3$

Stored Energy W ~ 1200[J] @1T



# Assumptions and Constraints for ILC Head-on Collisions

1) **A stable and reliable RF kicker with $\int Bdl = 1.0$ T•m (1.2 mrad bend @ 250 GeV/c).**

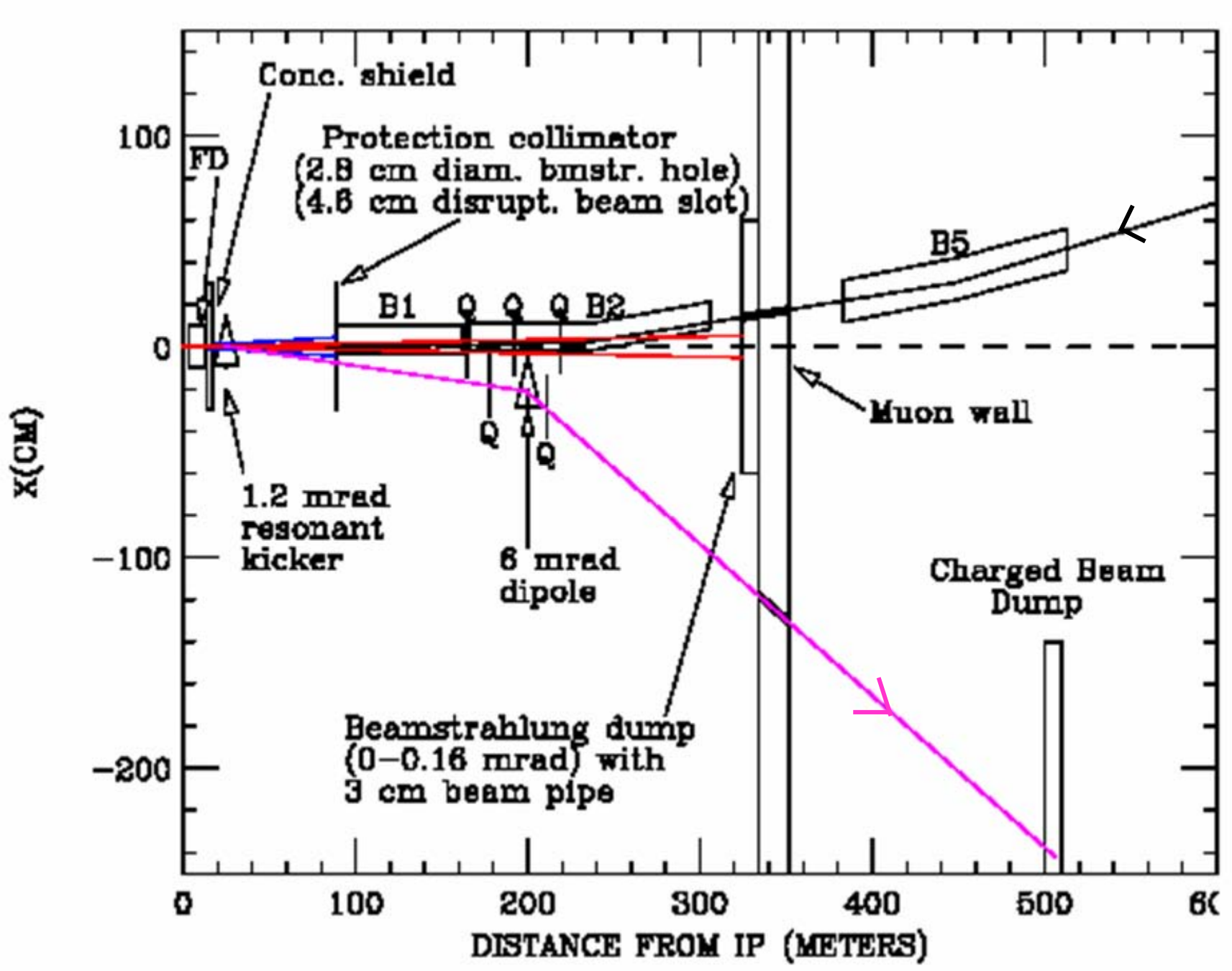
2) **NLC FF optics is needed to allow early separation of the outgoing beamstrahlung from the incoming beam as early as possible. The first soft bend starts about 90 m from the IP.**

3) **Assume final doublet apertures are as in NLC optics.**

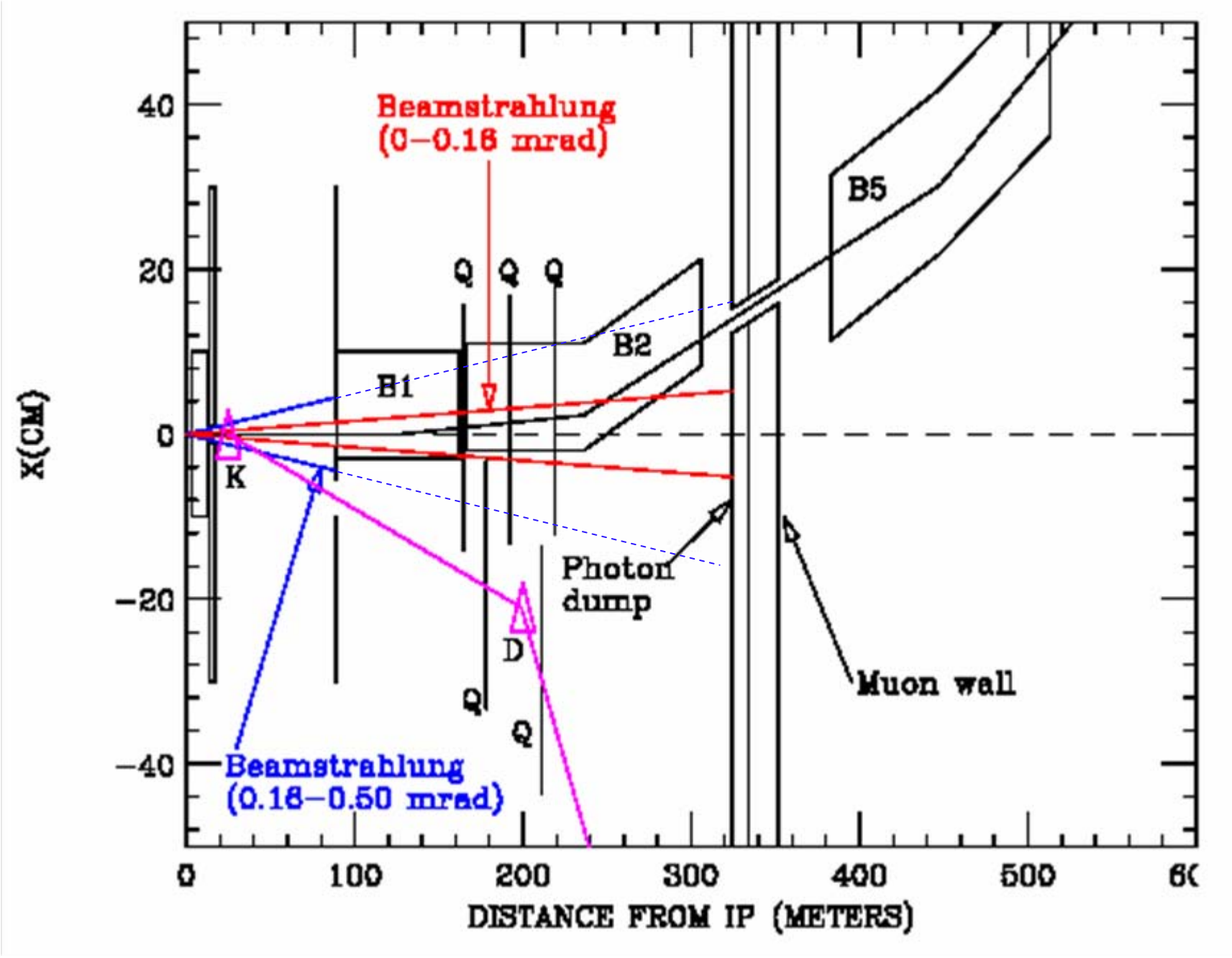
4) **No change in bunch spacing when upgrading to higher energy.**

5) **No attempt has been made to design extraction line optics for an energy or polarization measurement.**

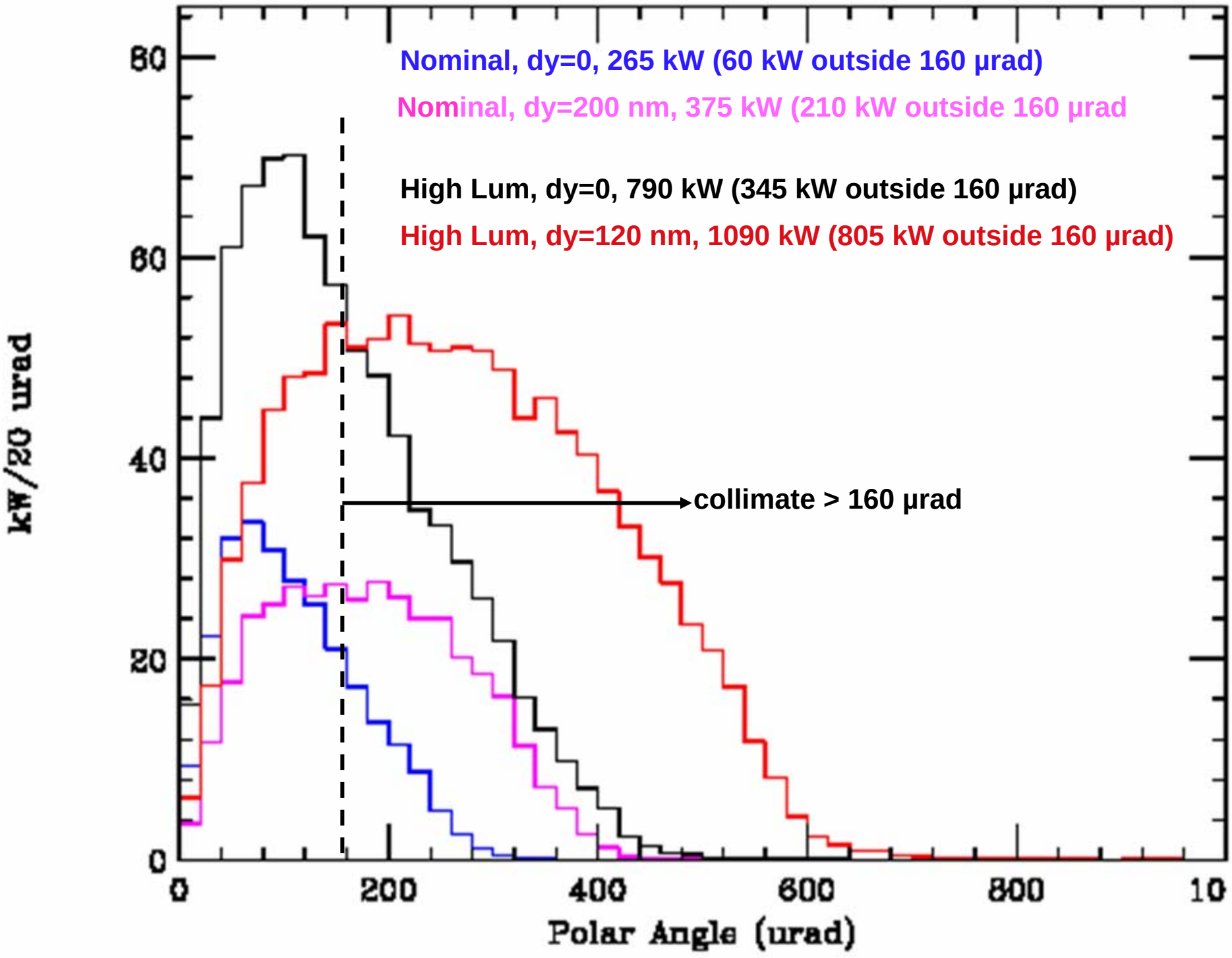
# Tunnel Layout for ILC Head-on Collisions – Zero Degree Extraction



# Tunnel Layout for ILC Head-on Collisions – Zero Degree Extraction



# Beamstrahlung Polar Angle for Two ILC parameter Sets and Two Bunch Crossing Positions



# Power Lost on Outgoing Beam Elements for Four Cases of Zero Degree Extracted Beam

## Parameter Sets– 500 GeV CM

| Beam Element | Z (m) | Nominal dx0-dv0 | Nominal dx0-dv200 | High Lum dx0-dv0 | High Lum dx0-dv120 | High Lum (Kicker 8 cm gap) dx0-dv120 |
|---|---|---|---|---|---|---|
| Kicker (2 cm gap) | 25 m | 0 kW | 5 kW | 3 kW | 450 kW | 30 kW |
| Horiz. slit 8 cm wide | 86 | 20 | 20 | 380 | 250 | 520 |
| Vert. slit 2.8 cm high | 86 | 0 | 175 | 10 | 1230 | 1380 |
| Beam-Strahlung | 86 | 60 | 210 | 345 | 805 | 805 |
| QF1ext | 175 | 0 | 0 | 4 | 2 | 2 |
| QF2ext | 208 | 0 | 0 | <1 | <1 | <1 |

**Notes:**

1. Must open soft bend synchrotron radiation mask at Z=12 m to 1 cm => IP beam pipe, 1.3 cm
2. Power losses shown on protection collimator at Z=86 m are additive
3. Collimate beamstrahlung for angles > 0.16 mrad
4. QF1 radius must be 2cm
5. SQ3FF radius must be 3 cm

# Machine Protection, Fault Examples

1) **Reduced kick of out-going bunch, => undisrupted bunches (380μ x 32μ) hit protection collimator, => 50 ˚C/bunch temp. rise in solid aluminum. May be OK in an aluminum plate/water collimator.**

2) **No kick, undisrupted bunches go backward through incoming line. If this happened in SLC, the incoming arc had an energy taper, so the backward bunch was lost in the arc and may have caused an ion chamber trip.**

3) **Kicker at wrong phase so the incoming bunch gets a kick (A. Seryi) => severe damage potential - see next slide.**

4) **Incoming dark current bunches see non-zero kicker field and hit elements in the IR (A. Seryi) => MPS trips and/or large backgrounds in the detector.**

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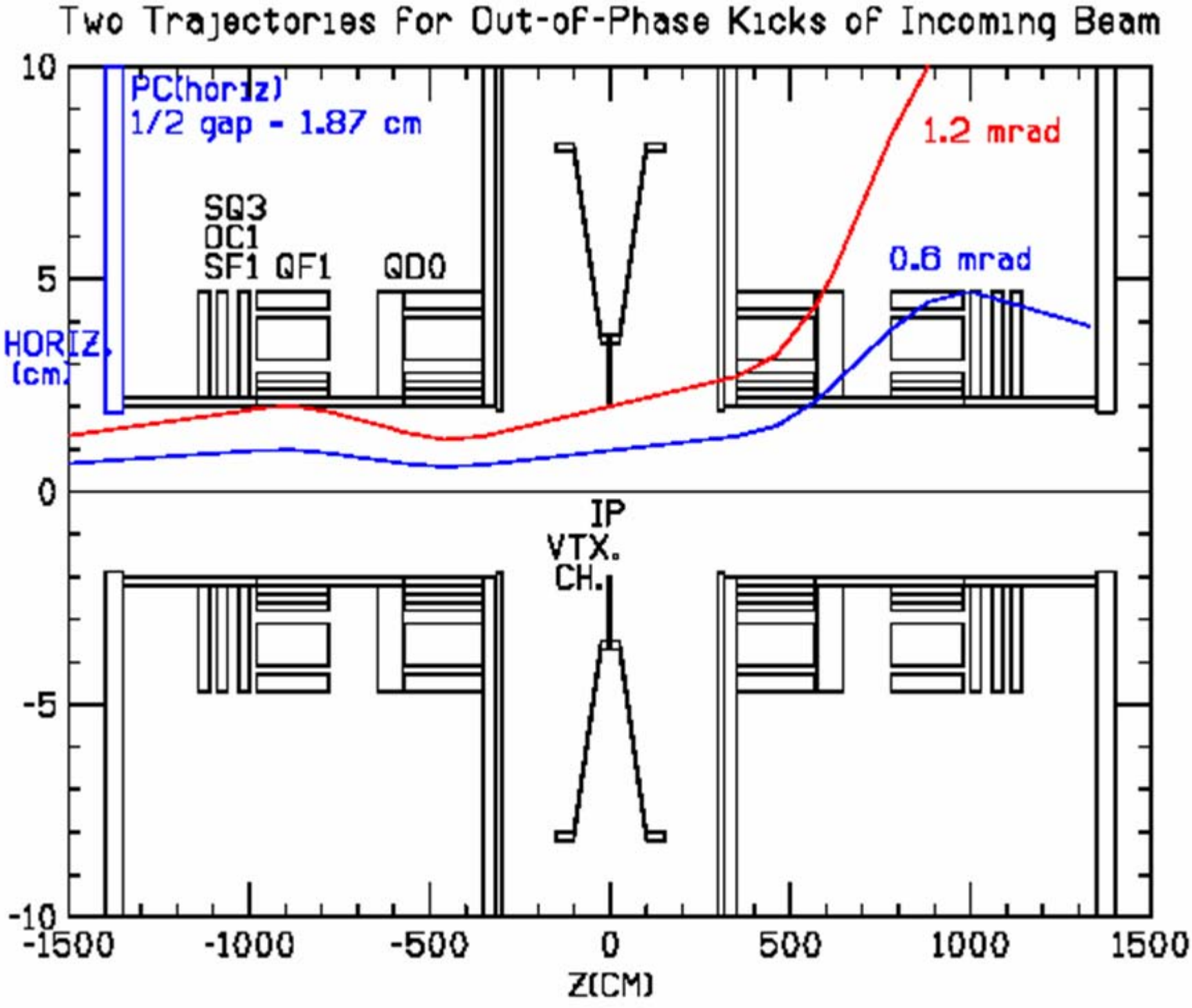
# Kicker out-of-phase for incoming main bunches or dark current bunches



# Summary of Requirements and Issues for Zero Degree Extraction

1) **Except for QD0, the final doublet magnets must have 2-3 cm radius bore.**

2) **Dipoles B1 and B2 must be C-magnets.**

3) **The three relatively weak quadrupoles within the B1 and B2 dipole strings must be narrow on one side.**

4) **Need a high power aluminum/water protection collimator at Z = 90 m for wide angle beamstrahlung and disrupted beam < 80% $E_{beam}$.**

5) **Need a ≈3 cm diameter beam pipe through the main beamstrahlung dump at Z = 320 m.**

6) **Neutron backgrounds to the detector from the protection collimator.**

7) **Non-zero kicker field at the time of the incoming bunches.**

8) **A number of machine protection issues and dark current background.**

9) **The "High Lum" parameter set requires a large vertical gap kicker (≈10 cm) to reduce power loss.**

10) **Haven't looked at 90 GeV CM or 1 TeV CM.**