Design challenges for head-on scheme

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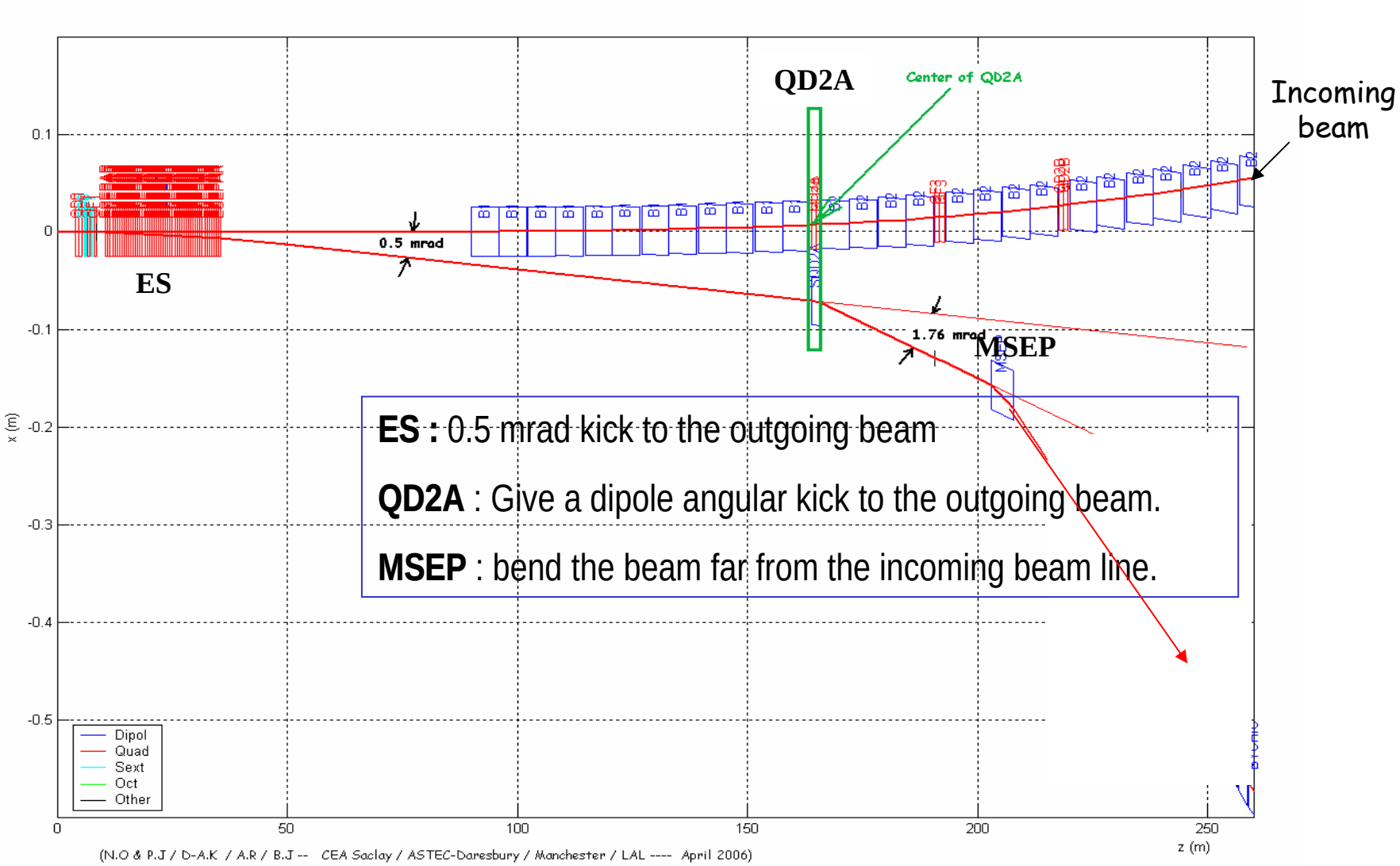
- This talk is mainly based on the design status at June 2006 (EPAC).
- Lew will cover some new design ideas to reduce cost of the extraction line.
- And will answer some of the questions raised in this talk.

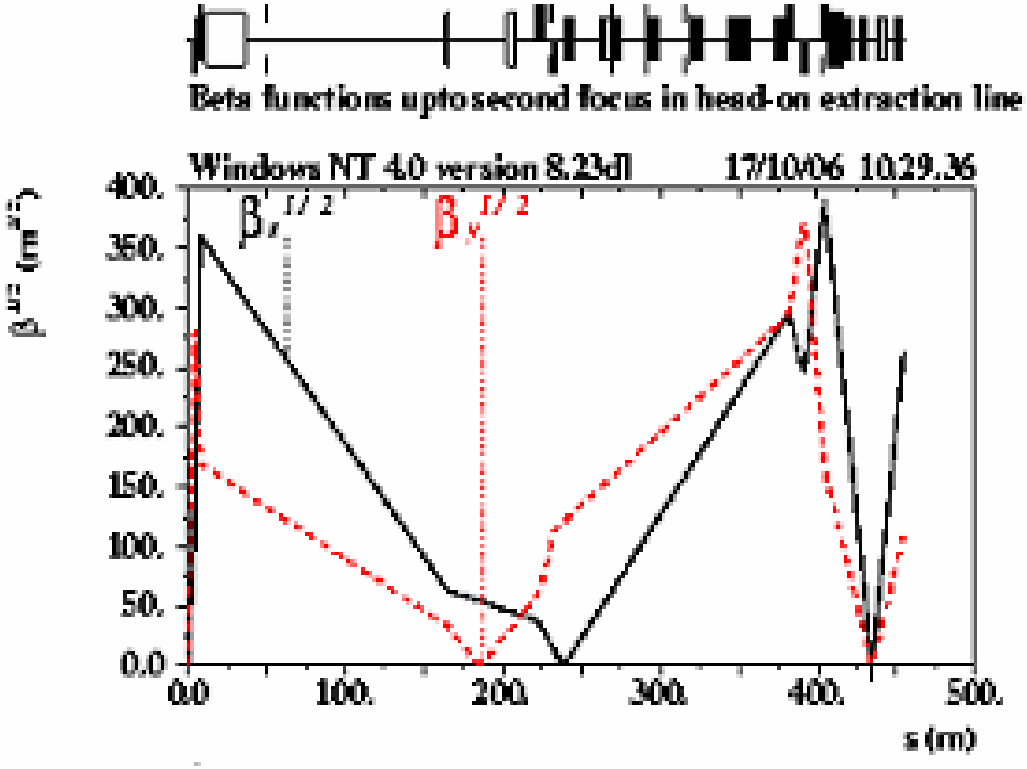

QD2A
Center of QD2A
Incoming beam
ES
0.5 mrad
1.76 mrad
MSEP
ES : 0.5 mrad kick to the outgoing beam
QD2A : Give a dipole angular kick to the outgoing beam.
MSEP : bend the beam far from the incoming beam line.
Dipol
Quad
Sext
Oct
Other
x (m)
z (m)
(N.O & P.J / D-A.K / A.R / B.J -- CEA Saclay / ASTEC-Daresbury / Manchester / LAL ---- April 2006)

Design (June 2006 – EPAC)

- Shorter Final Doublet:
  - Larger bore, shorter SC magnets result in smaller losses in FD.
  - Separator closer to IP results in acceptable parasitic bunch crossing spacing at 46 m.
- Separator Electric Field Reduced to Below LEP Operating Field:
  - Allows larger gap between plates resulting in smaller losses in the separator.
- Create Space for High Power Intermediate Dump:
  - Concentrates extracted beam and beamstrahlung losses mostly at one place and allows room for shielding to protect nearby components and the environment.
  - Incoming beam magnets QF3, QD2B, and B2 have smaller apertures.
  - This dump is modeled after the aluminum/water 2 MW energy slit in the SLAC A-line.
- Extraction line optics
- Similar to 2 mrad with downstream diagnostics – losses in the beam line were not estimated after MSEP

Optics presented at EPAC

- The initial strong focussing by the final doublet and need for Compton IP leads to increase the betatron amplitudes and orbits of low energy particles.
- This leads to high beam loss, (unless good collimation of the energy tail is designed).

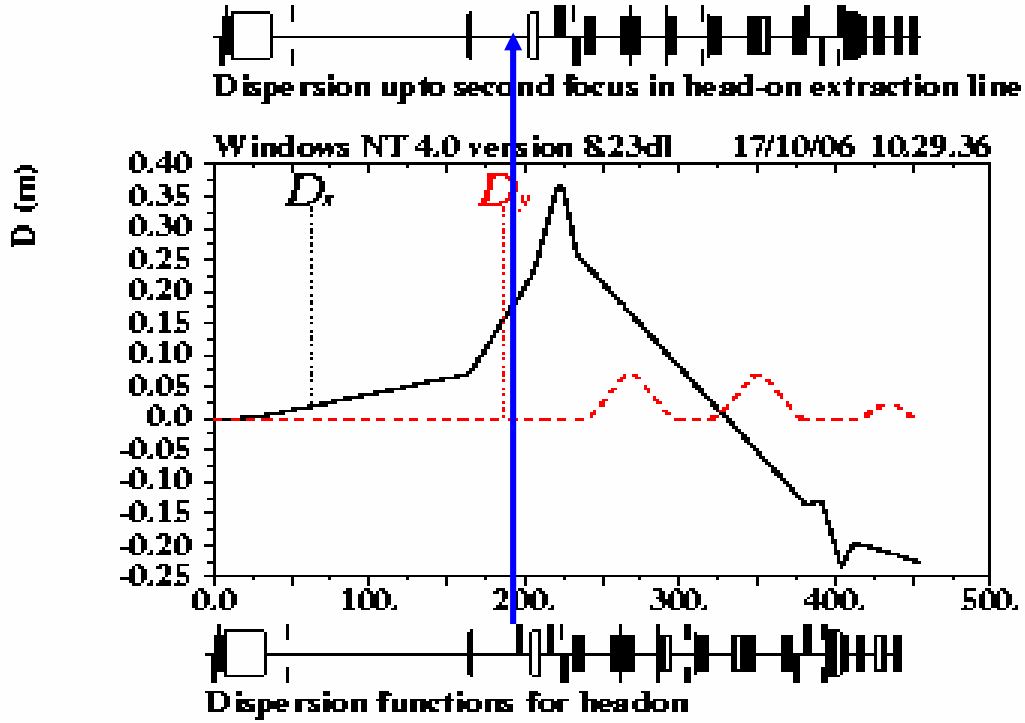


• Downstream diagnostics + vertical chicane for clean-up :

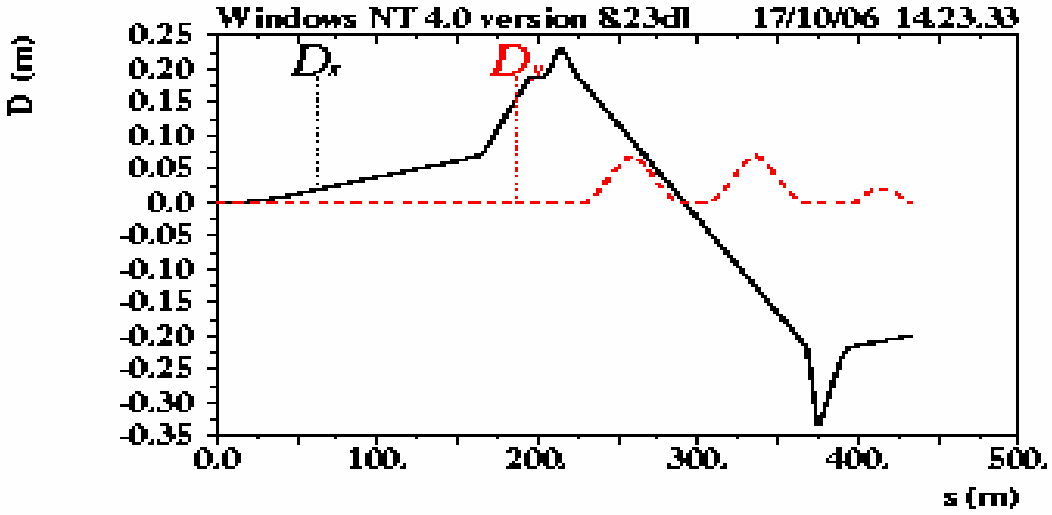
Distance up to second focus ~430m, need another 150-200m for creating transverse separation of 3.5m for the beam dump.

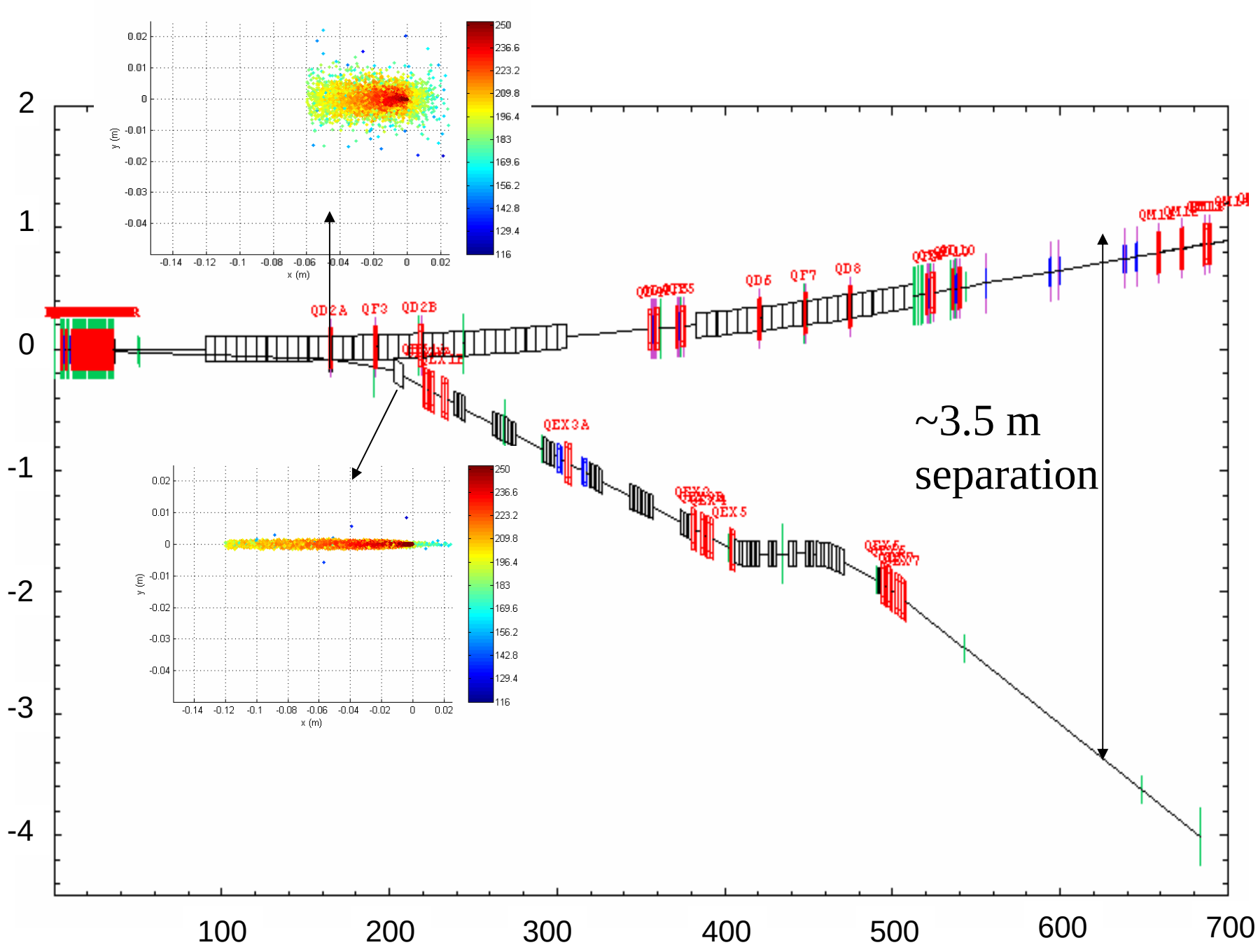
Optics presented at EPAC

- Dispersion control is bit tricky in this design due to long drift.
- Dispersion at Compton IP is ~ 0.2m. Needs further reduction to obtain 100 μm spot size with Δp/p=0.1%.



Tried to include quadrupole here by creating a space in the soft bends (after EPAC)




~3.5 m
separation
QD2A
QF3
QD2B
QD6
QF7
QD8
QEX3A
QEX5
x (m)
y (m)

Design Challenges for Head-on scheme

- Electrostatic separator : Maximum field, gap, breakdown during bunch train, Spent beam and radiative bhabha losses, SR hitting, vacuum requirements, Machine protection issues, Parasitic bunch crossings for all parameter sets
- Final focus – compact to accommodate the ES –separation between quads and quad-ES minimum
- Shared magnets with the incoming beam
- Common beam pipe for incoming+outgoing?
- Feedback kicker location and space required
- Losses in the extraction line, synchrotron radiation, diagnostics performance
- Location of beam dump
- Costs – CF&S for long extraction lines
- Magnet power and running cost?
- Maintenance of magnets (PCs) and radiation conditions near the collimators & beamstrahlung dump

- First quadrupole QD2A at distance of ~170m from the IP
- No optics in between!
- Losses on the face of QD2A
- Beamstrahlung cone needs larger apertures of incoming dipoles B1. These are low field dipoles → design is challenging specially at low energy operation
- QD2A and other septum quadrupole requirements
- Optics of extraction line – dispersion control?
- Requirement of downstream diagnostics – specially R22=-0.5 not possible, other preferred solution R22=+0.5 achieved but the optics is quite strong in this case and leads to very high beam sizes for off-energy particles.

- To keep the extraction line length reasonable and also to provide the required separation for the beam dump.
- Beam dump (+shielding needs clear separation of ~3.5m between incoming line and outgoing lines at the beam dump location, Lew will cover CF&S cost implications in his talk)
- Contradictory requirements :
  - Separation from incoming line to put independent magnets on the outgoing line
  - Second focus for polarimetry needs beam to be parallel to the IP → all the bends need to be compensated → SR due to all these bends becomes significant
- Few design approaches
  - Remove vertical clean-up chicane- saves ~50m + energy loss due to SR reduced.
  - Tried to remove MSEP, thus bend back by 5 mrad to make the beam parallel to the IP at the second focus also removed.

- Synchrotron radiation profiles at both ends of the electrostatic separator – T. Maruyama
  - With the Nominal parameter set (250 GeV), there are no losses on a 2 cm gap mask at the inboard end of the separator or on the 25 m long separator plates.
  - With the Low P parameter set, 115 Watts hit the 2 cm mask, but nothing hits the separator plates. This loss would be much reduced if the 2 cm mask was opened a few mm, and there would still be no losses on the electrodes. The 115W would result in a non-negligible number of back-scattered photons going backward through the IP, but is better than for a 2 mrad crossing angle because these photons pass through the IP without hitting the IP beampipe.

Feedback kicker location

- 2m gap between FD and separator is left for the feedback kicker.
- Feedback kicker location discussion in 20mrad and 2 mrad IR was discussed at SLAC, BDS meeting, October 2005.

  Upstream of SD0 : In this case the nonlinear effect due to orbit offset in the sextupole SD0 is minimized (the feedback range of 20sigmaX and 70sigmaY or more is possible)

  If closer to QF1, the nonlinear effect is larger, and the range of feedback is reduced (to about 5sigmaX and 10sigmaY). Another possible location of the kicker is inside of SD0 -- this needs further studies.
- S.Smith, Length of the kicker ~1m (four striplines-x,y-Unloaded stripline kicker) or Ferrite-loaded single-turn kicker (requires diff z for x,y). kicker aperture 20mm for 20 mrad and 180mm for 2mrad
- No clear space between QD0 and QF1 in case of head-on for 1m long kicker? Can we increase the 1.2m gap to accommodate the kicker and reduce the gap of 2m?

What do we need to consider more?

- Cost?
- ILC parameter space changes
- The BDS design for RDR now has
  - All curved paths with space for 1 TeV
  - Only few soft dipoles in FF at 250 GeV
  - Straight part will be at 250 GeV
- How does this affect the head on extraction scheme?
- L* = 4m → how much can be changed?
- Collimation depths
- Backgrounds
- Possible upgrade scenario for 1 TeV CM operation.
- Only 1 IR?
- R&D?