ILC IP SR and PEP-II

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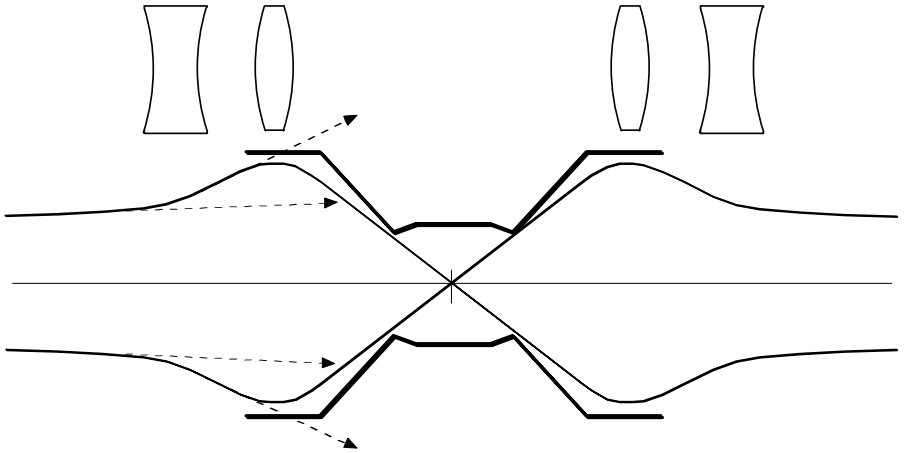
Outline

- General SR issues
- PEP-II design criteria
- ILC design
- Issues for consideration
- Summary

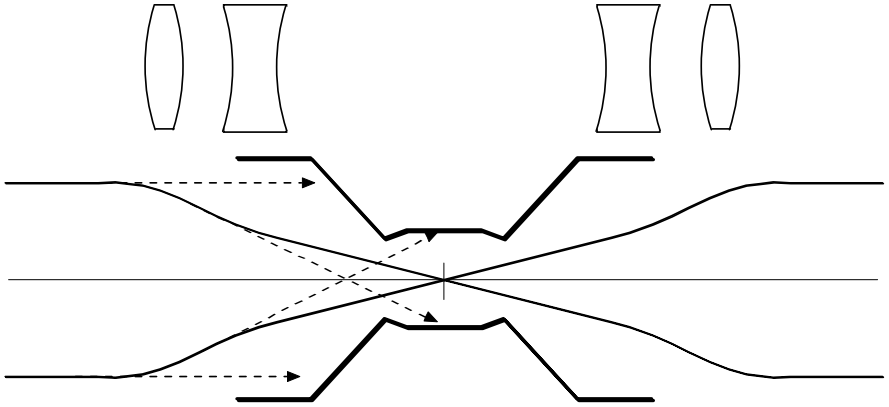
General SR Issues

- SR generated in the Final Focus
  - X plane is usually more difficult
  - Must keep track of the radiation from the last bend magnet
  - Tail or halo distribution
    - How many particles
    - How many sigma
  - Backscattered radiation from downstream surfaces

Cartoon of SR from the Final Focus Doublet

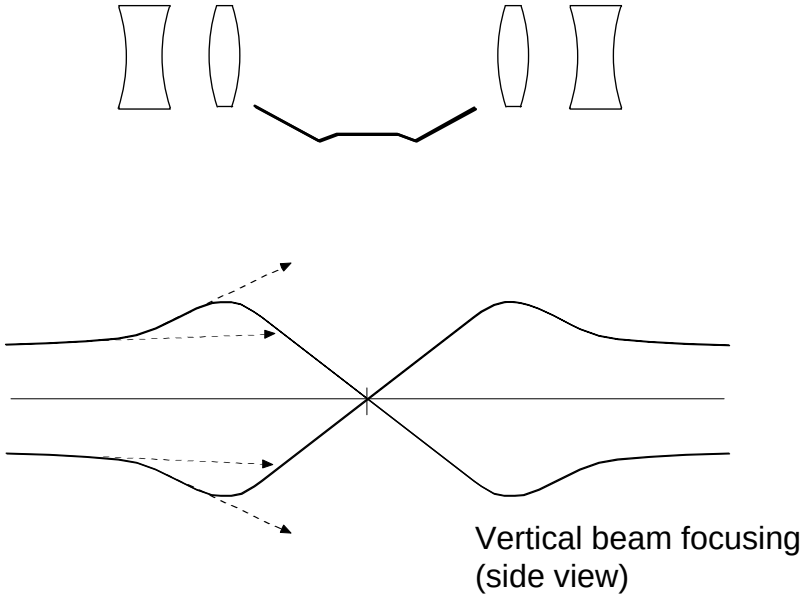


Vertical beam focusing
(side view)

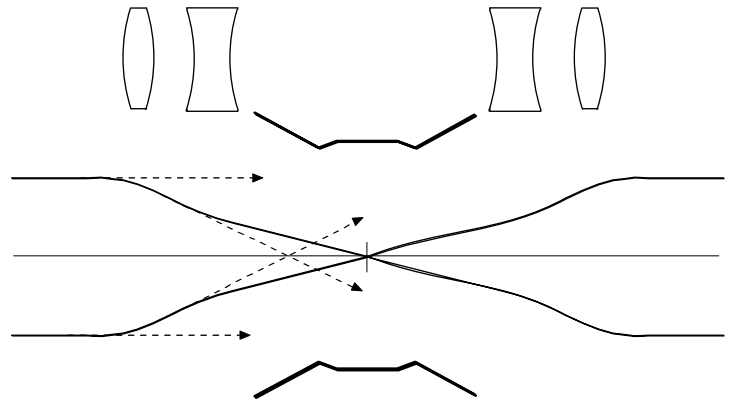


Horizontal beam focusing
(plan view)

Similar cartoon with low emittance beams (more like the ILC)



Vertical beam focusing
(side view)



Horizontal beam focusing
(plan view)

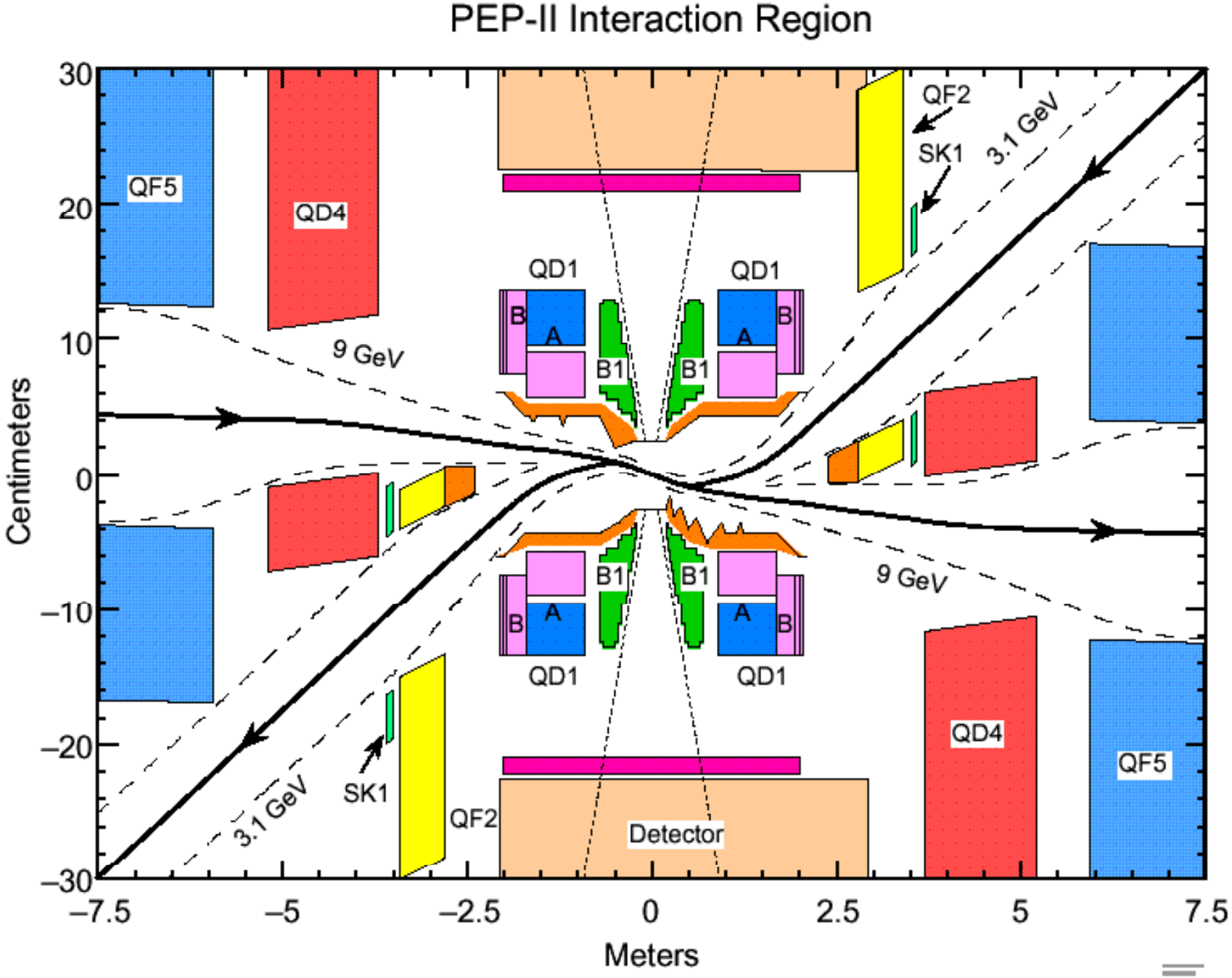
Other accelerators

- KEKB initially had trouble with upstream correctors getting too strong and sending SR fans onto the Be beam pipe. Cooked at least one silicon vertex detector.

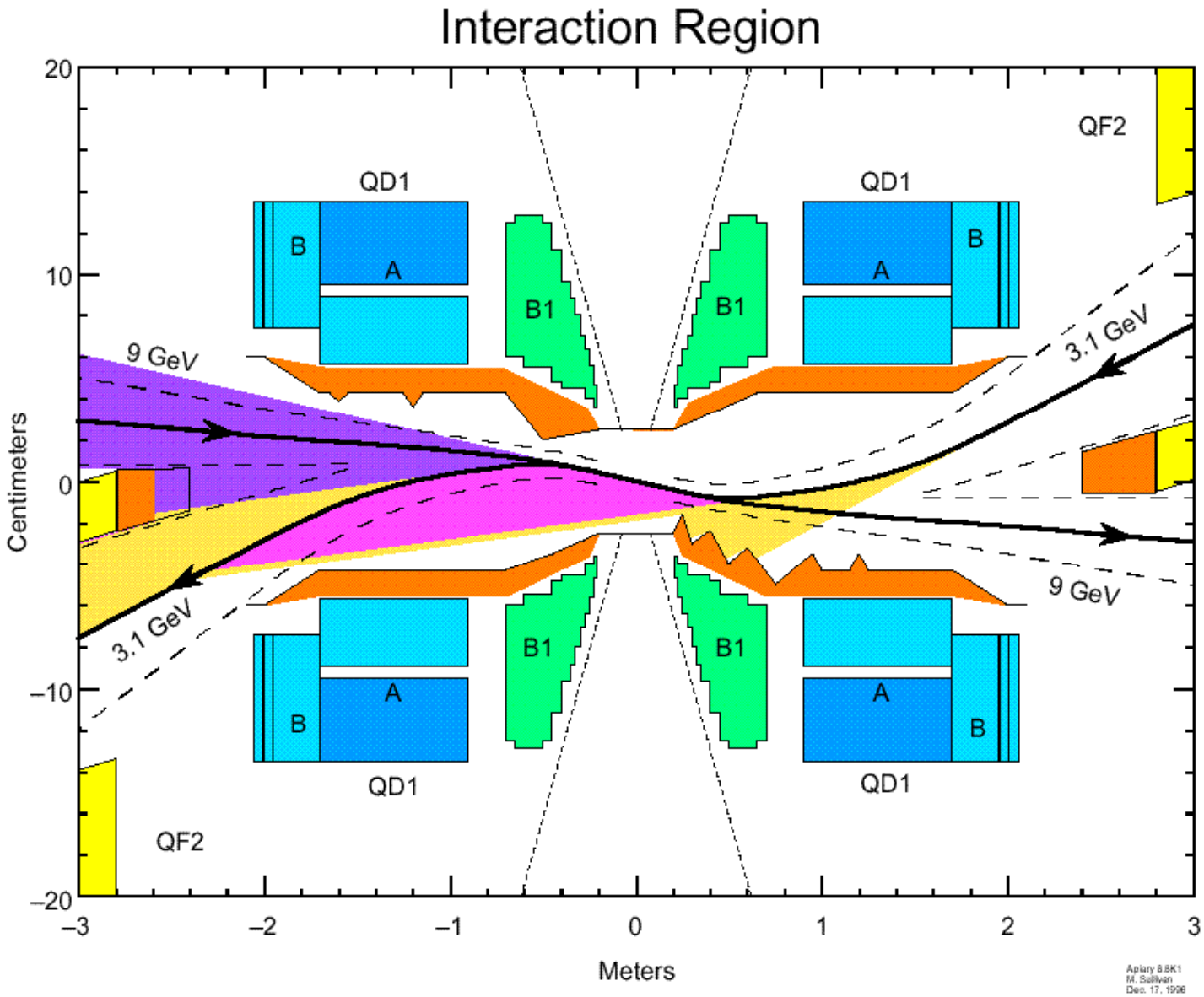
- HERA had overwhelming backgrounds from a surface about 10-20 m? downstream that was struck by SR and had to redesign the IP masking

PEP-II IR design

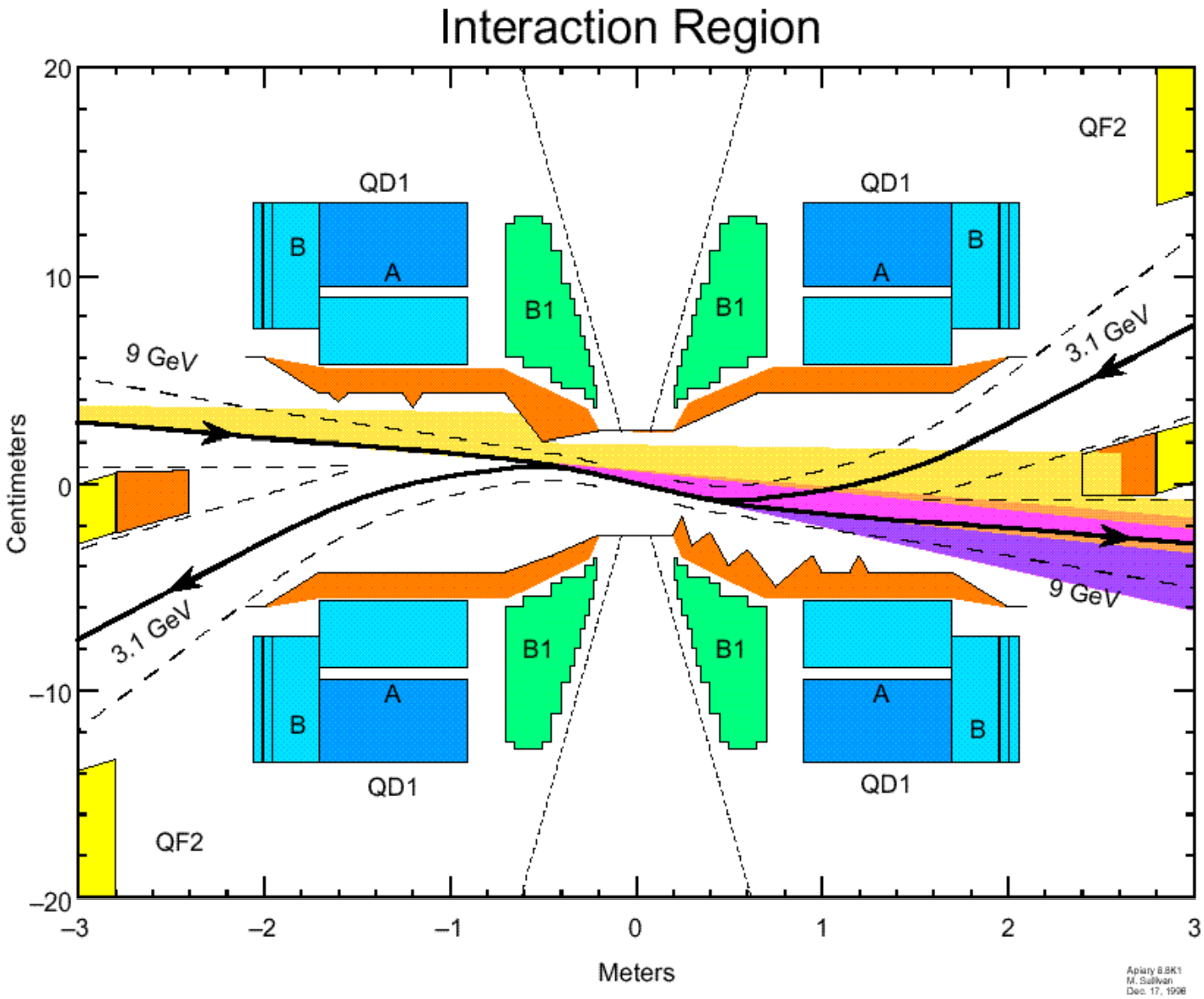
- No surfaces struck by SR have a view of the IP beam pipe (photons have to double bounce to hit the detector beam pipe)
- Photon energies are low (10-20 keV) so we used a high Z liner for the BE beam pipe (4 um Au)
- Tip scattering from nearby masks is the major source of background from SR
- Tail distribution was set conservatively high
- Design is insensitive to the tail distribution because of the local beam bending
- Masking design as open as possible in order to minimize HOM power buildup


PEP-II Interaction Region
QF5
QD4
QF2
SK1
3.1 GeV
9 GeV
QD1
B
A
B1
Detector
Centimeters
Meters
30
20
10
0
−10
−20
−30
−7.5
−5
−2.5
0
2.5
5
7.5

LER Synchrotron Radiation Fans



HER Synchrotron Radiation Fans



ILC Design

- Final focus SR passes through the IP
- Very soft final bend magnets
- Some numbers:
  - Total SR γs/bunch from the FF doublet is 1.37×10^{10}
  - Total SR γs/bunch from 6 B1 soft bends is 2.21×10^{10}
  - Total SR γs/bunch from 2 B2 bend magnets is 2.04×10^{10}
  - The field of the six soft bend B1 magnets is 124 G
  - The critical energy of the B1 magnets is 517 keV
  - The critical energy of the B2 magnets is 1.43 MeV
  - γs/bunch that strike the beam pipe upstream of the 49 m mask 3.15×10^{10}

ILC design considerations

- Apologies if these have been studied
  - Backscatter from downstream surfaces
    - This has been and is being looked at
  - Are there really NO photons from the upstream beam that strike near the IP?
    - One bounce from the soft bend radiation OK?
    - Skew quads. Need to see what turning them on does.
    - Sextupoles. What SR do they produce?
    - No upstream corrector magnets?
    - Octupoles?
    - Collision fast feedback elements
  - Out of plane radiation? (probably not)
    - At the critical frequency the out of plane angle is 1 urad

Design considerations (2)

- Need to model down to 10 keV
- Surface reflected scattering
  - At very small angles and very flat surfaces one can get total external reflection.
  - From Hobey I have for Cu the critical angle is 29 keV-mrad which (I believe) translates to 290 keV-100 urad. Need to look at this in more detail.
- Beam misalignment
  - Need to check what happens when the beam is misplaced by 1-2 mm (2-3 sigma X)
- Maximum beam emittance allowed?
  - If the beam emittance gets above a certain value the FF SR will start to strike near the IP
- What about partial collisions?
- Is the detector dead from SR if one train goes astray?
- Detector field and beam orbit. How to model?

Summary

- The IR design is starting to stabilize
- This allows for more thorough studies of background issues
- The ILC IR has several challenging issues
- More work still needs to be done to make sure the detector is protected under real running conditions