IR Update

M. Sullivan

for the 3rd SuperB workshop

SLAC June14-16, 2006

Outline

- IR parameters and constraints
- First design attempt
  - SR shielding and SR backgrounds
- Second attempt
- Third attempt
- Fourth concept
- Radiative bhabhas and other factors
- Summary

Detector Constraints

- **±300 mrad physics acceptance from the nominal beam axis**
- **Smallest possible beam pipe radius (1 cm)**
- **Thinnest possible beam pipe wall**
- **Solenoidal detector magnetic field (1.5T)**
- **Low SR backgrounds**
- **Low BGB backgrounds**
- **Low Radiative Bhabha backgrounds**

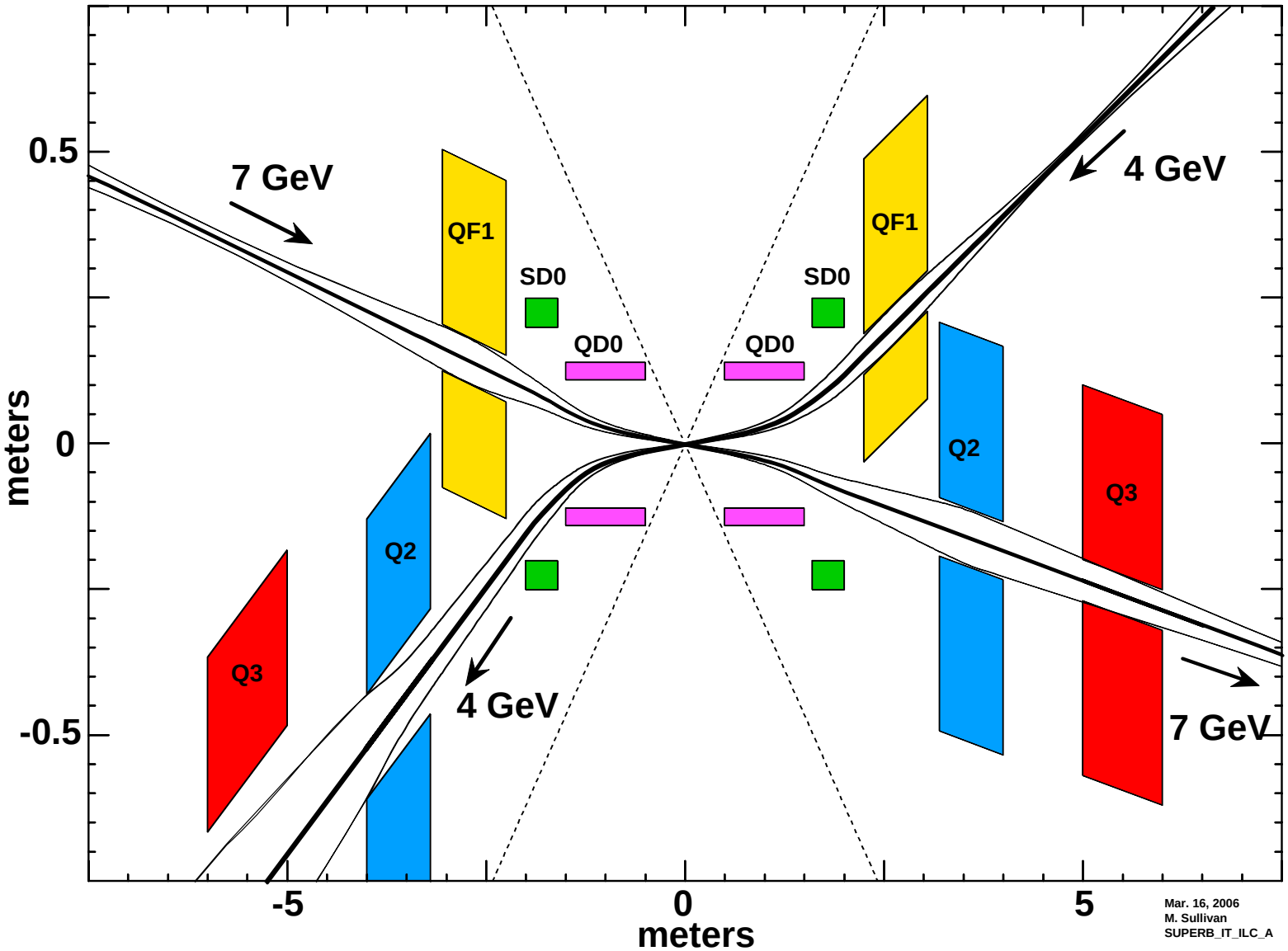
Accelerator IR Parameters

- **Very small spot size at IP (1 μm x 12 nm)**
  - **Beta functions (beam size) grow very rapidly away from the collision point**
  - **Small emittances are important**
  - **Last quad before the IP must be close (50 cm)**
- **Shared quadrupole**
  - **The last quad must be shared (at 50 cm the beam centers are 25 mm apart for ±25 mrad xing angle)**
  - **The beam envelopes (15 sigma) are 17 mm apart at 50 cm from the IP**
  - **A shared quad means the radiative bhabha bkgd has to be carefully studied**

Accelerator IR Parameters (2)

- **Shared sextuple**
  - The shared quad can be set for only one of the beams (or in between the two beam energies)
  - With a shared sextupole just outside of the shared quad and with the beams separated one can adjust the sextupole strength and offset so that the LER receives less total focusing and the HER receives more total focusing (Raimondi's idea)
  - This greatly helps in maintaining control of the beta functions and hence beam sizes)

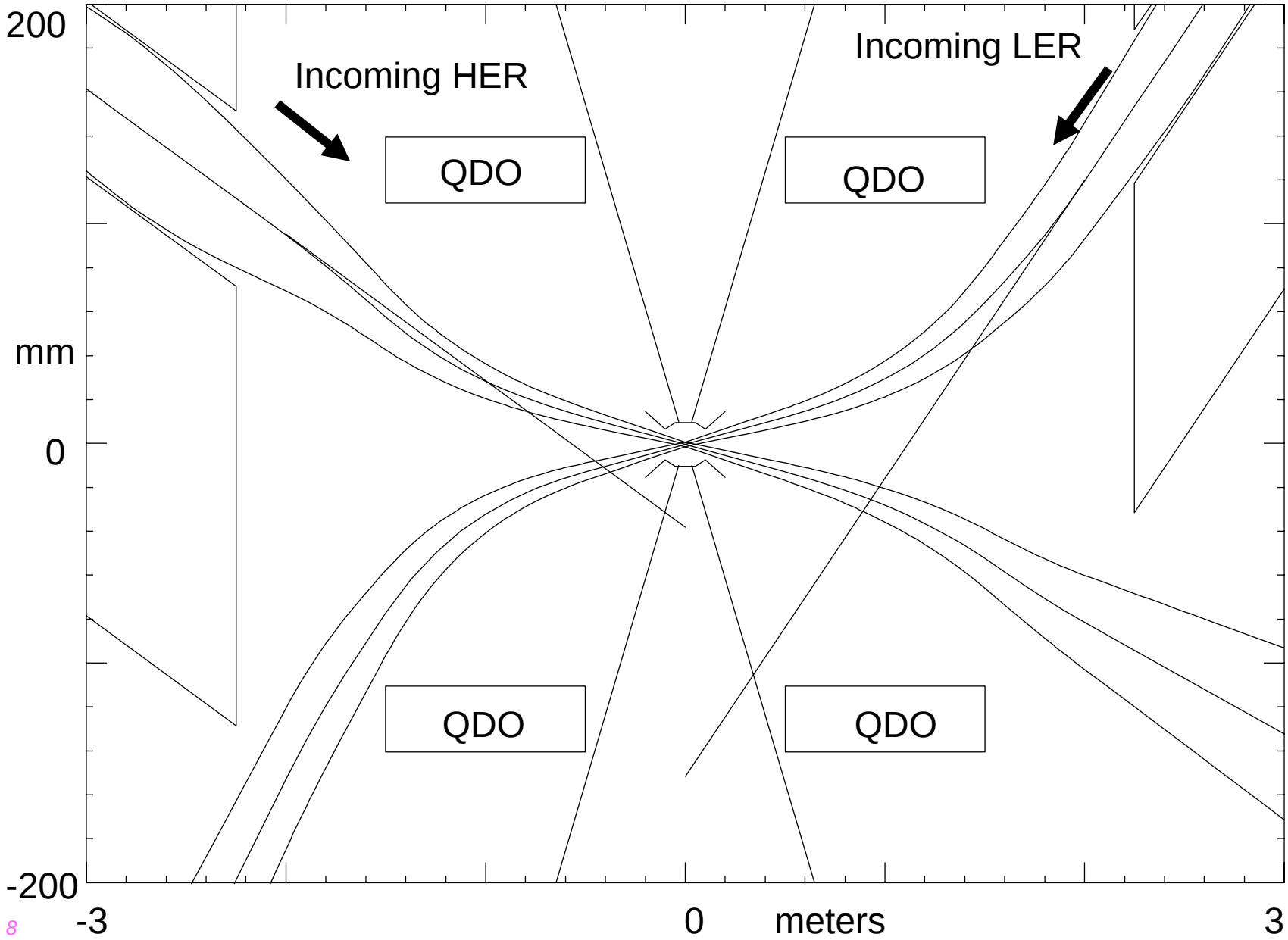
IR design from March Workshop



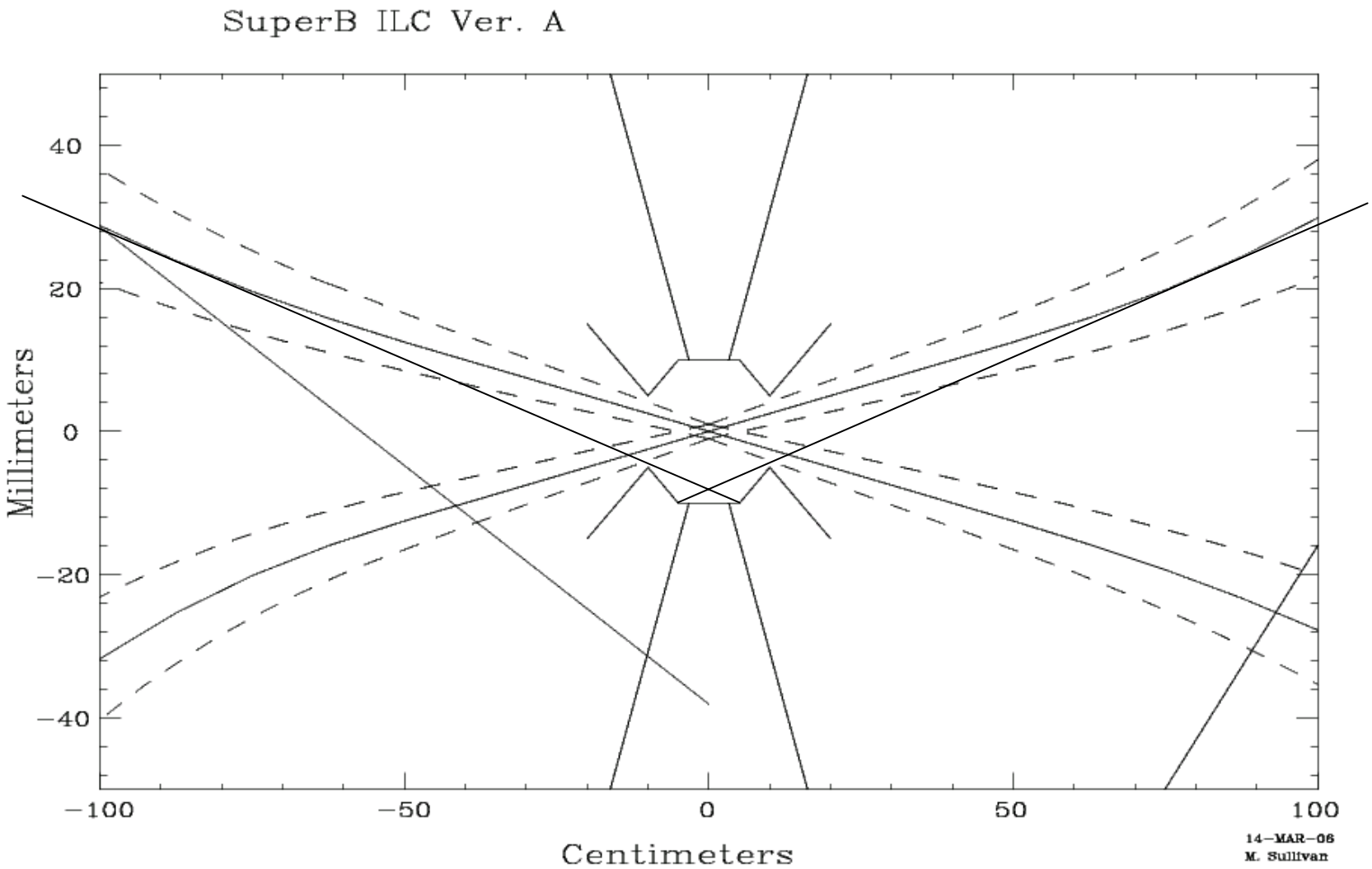
SR from the Initial Design

- **Both beams emit fans of SR on the same side of the beam pipe**
- **These fans are fairly strong (100s of W)**
- **These fans strike close to the detector beam pipe and strike the mask surfaces on the downstream side of the detector beam pipe**

Close up of March IR design



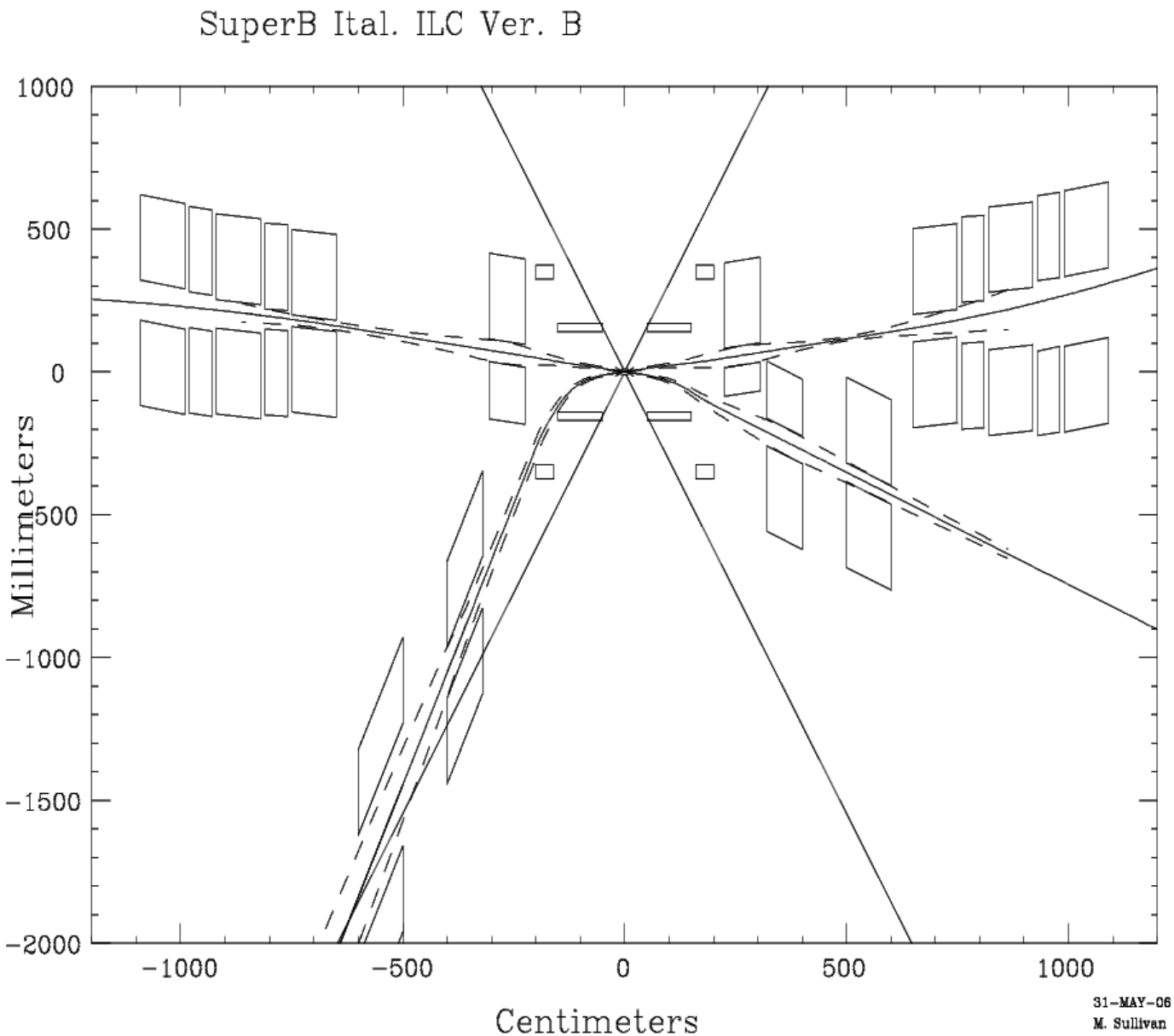
Even closer…


SuperB ILC Ver. A
40
20
0
−20
−40
Millimeters
−100
−50
0
50
100
Centimeters
14−MAR−06
M. Sullivan

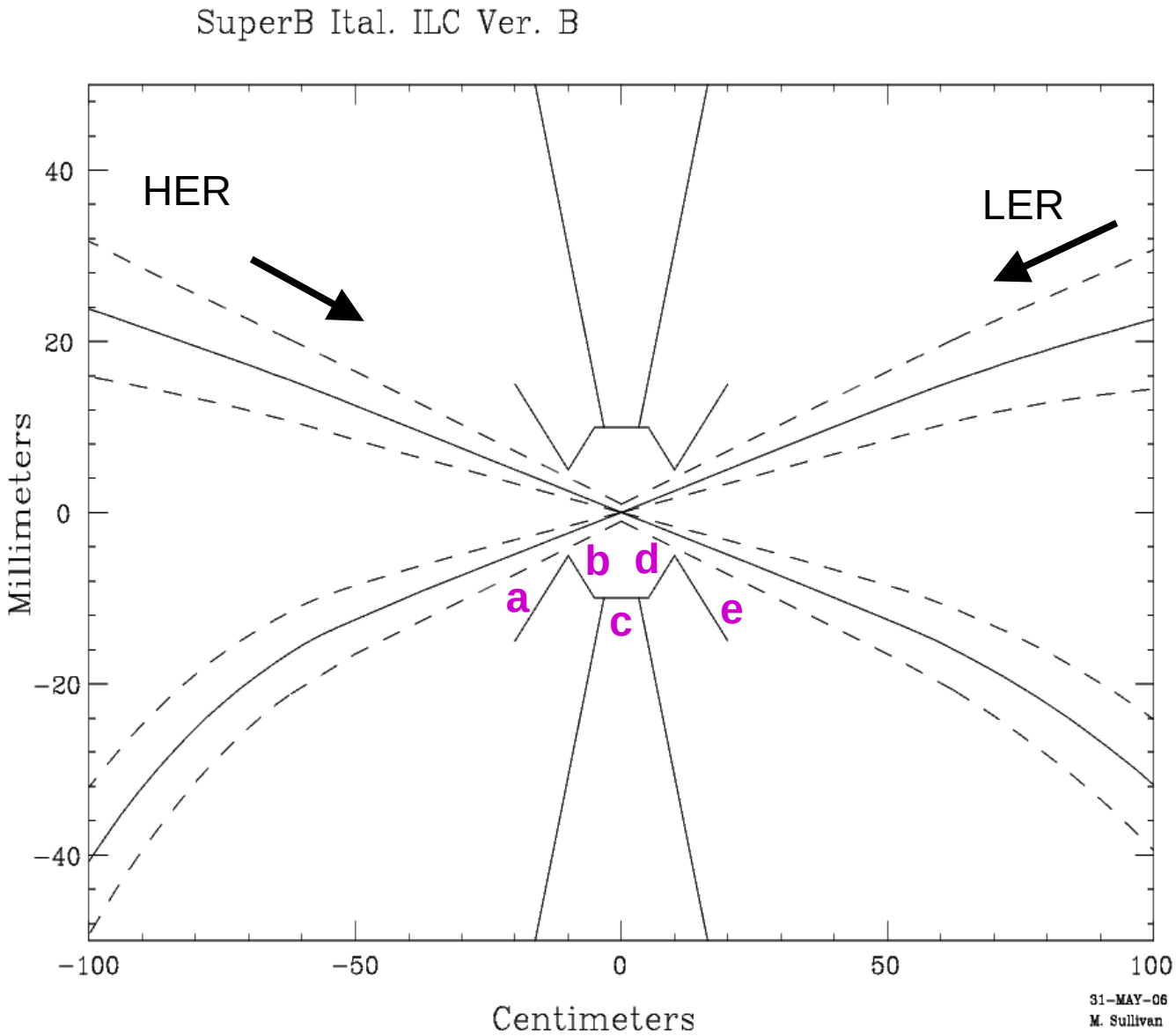
Second Attempt

- **Incoming beams as straight as possible**
- **Still difficult to shield detector beam pipe**
- **Masking has to move down to a 5mm radius**
- **Radiative bhabha background gets worse because outgoing beams are more off-axis in QD0**
- **LER outgoing is bent rather severely and the QDO radius has to increase to let the LER escape**

Second Attempt



Second Attempt (close up)



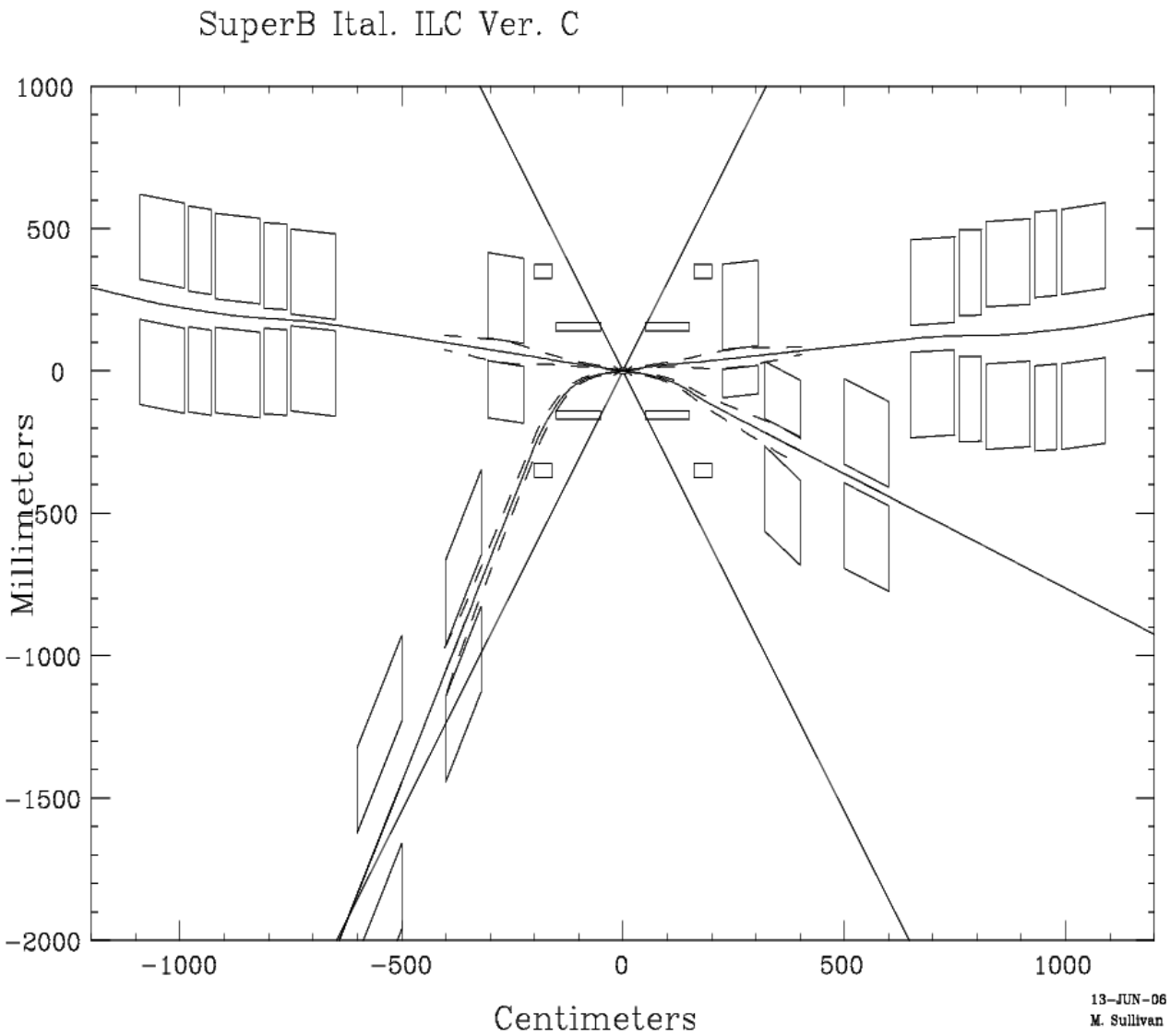
SR in the second attempt

- **Still get direct hits on the detector beam pipe**
- **Still get too many photons hitting the downstream masks (see summary table)**
- **Exiting beam line for LER is very close to the physics acceptance of the detector**
- **QDO radius had to increase to allow LER to exit. It also intrudes into detector acceptance**

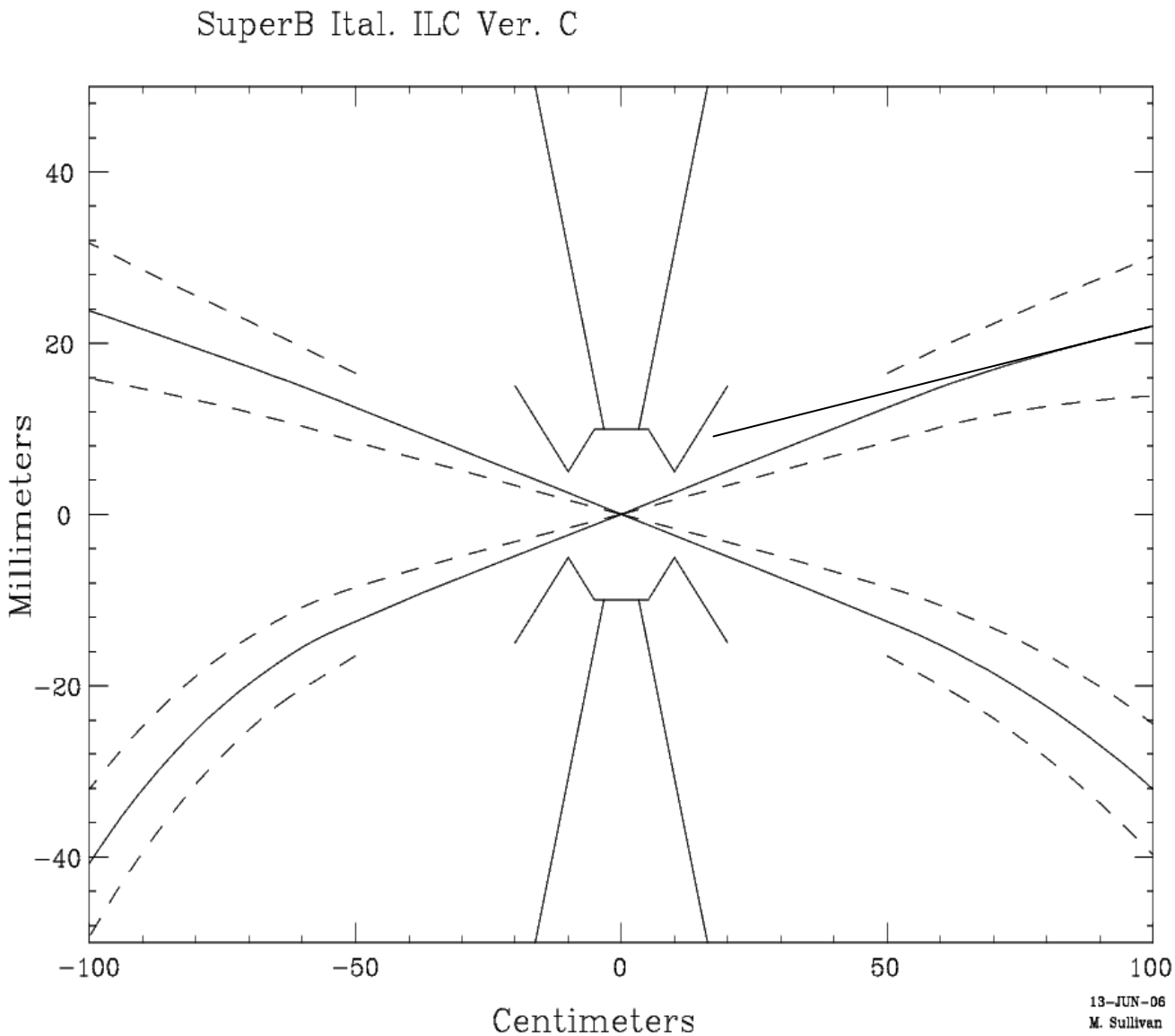
Third Attempt

- **Move incoming LER off-axis to redirect QF1 SR away from the detector beam pipe**
- **Outgoing HER even more off-axis**
- **Direct SR on detector beam pipe fixed**
- **High power still on downstream masks**

Third Attempt



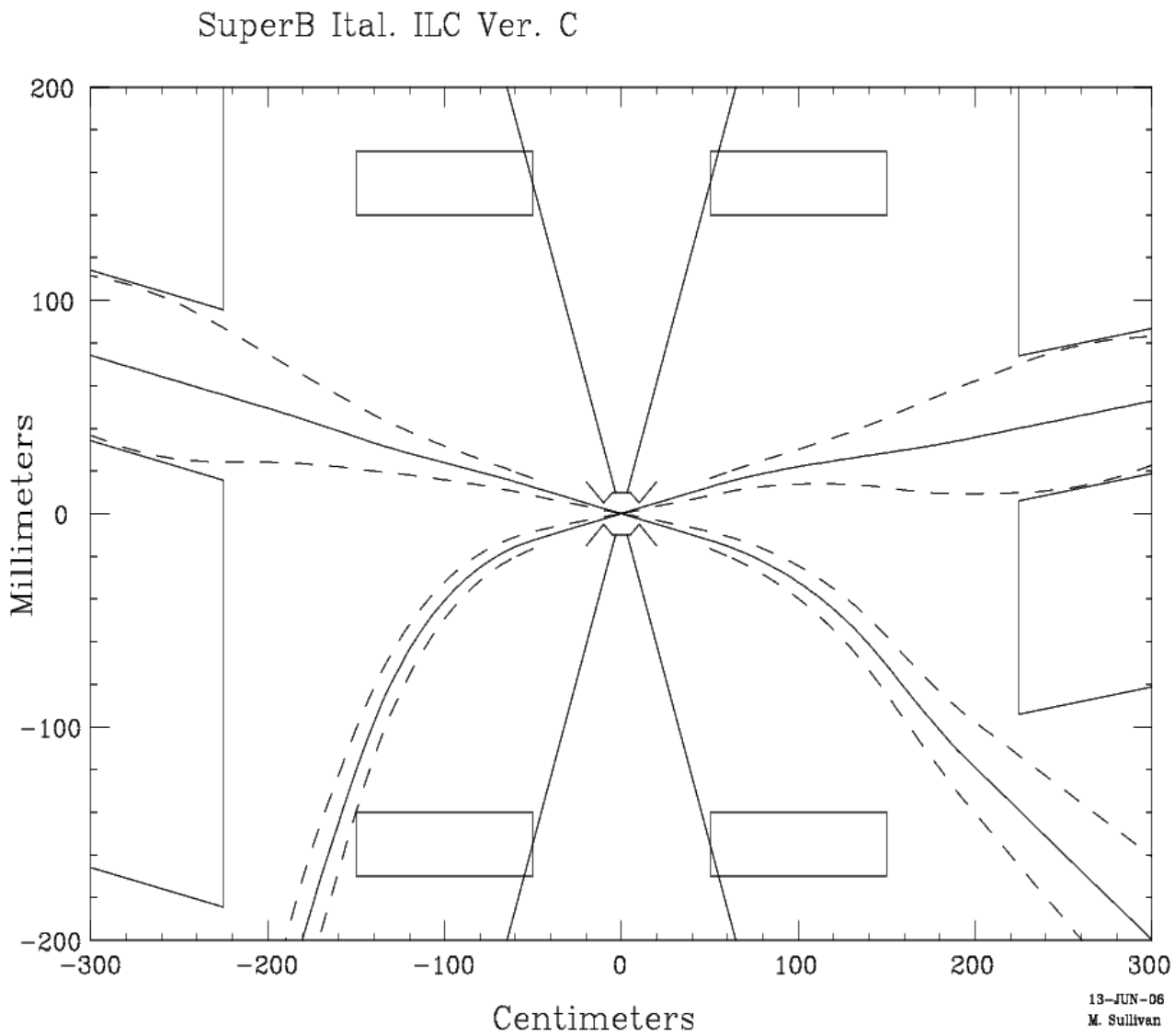
Closeup of 3rd Attempt



Better, but…..

- We no longer hit the beam pipe directly
- We still have too many photons striking the inside surfaces of the masking
- With the masking this close there is no gain from solid angle effects– half of the scattered photons will hit the detector beam pipe
- The best one can probably do to suppress backscatter from the mask surfaces is maybe 1%
- More typical backscatter rates are 5%

3rd Attempt showing SR sources



Summary Table

γ/xing >4 keV
(PEP-II 10/xing)

(Version)	HER a	LER b	Det. IP c	HER d	LER e
			Surface		
(B) with 7 mm mask Centered incoming beam	3.7e10 20 kW	3.2e8 400 W	0 HER 1.6e7 19 W	1.6e8 100 W	5.8e8 670 W
(B) with 5 mm mask Centered incoming beam	3.7e10 20 kW	4.1e8 405 W	0 HER 2882 1.4 mW	1.7e9 2 kW	7.0e8 810 W
(C) with 7 mm mask Offset incoming LER	3.7e10 20 kW	2.0e7 27 W	0 HER 26,700 16 mW	1.6e8 100 W	2.4e9 1.9 kW
(C) with 5 mm mask Offset incoming LER	3.7e10 20 kW	3.2e5 14 W	0 HER 0 LER	3.5e9 2.1 kW	1.5e8 1.9 kW

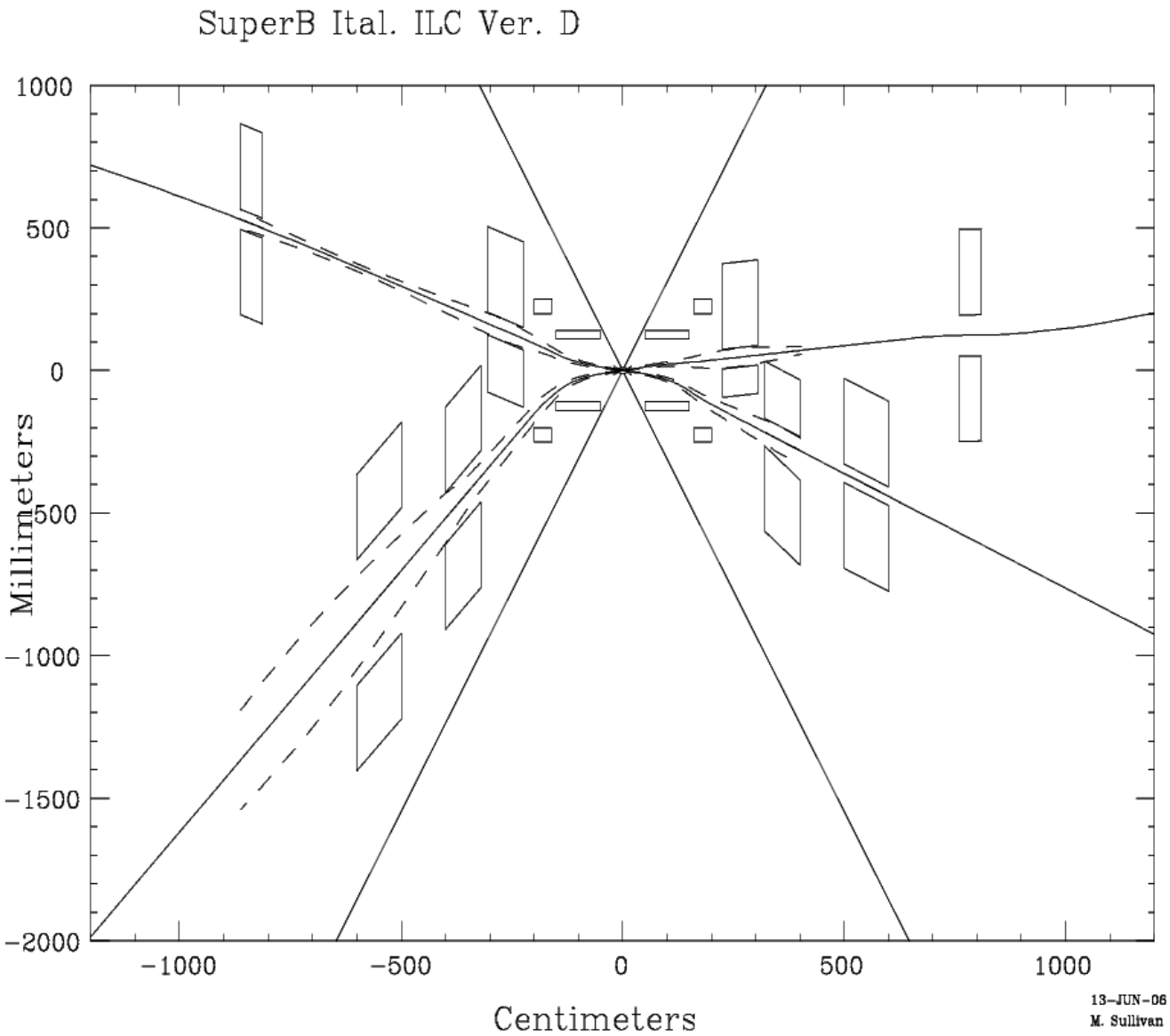
Fourth Concept

- **Try to follow the successful PEP-II design by attempting to get the SR masking for the two beams decoupled**
- **If we can to do this then the masking on the downstream side of each beam can be eliminated where the SR rate is still too high**
- **No results yet--- just thought of it**

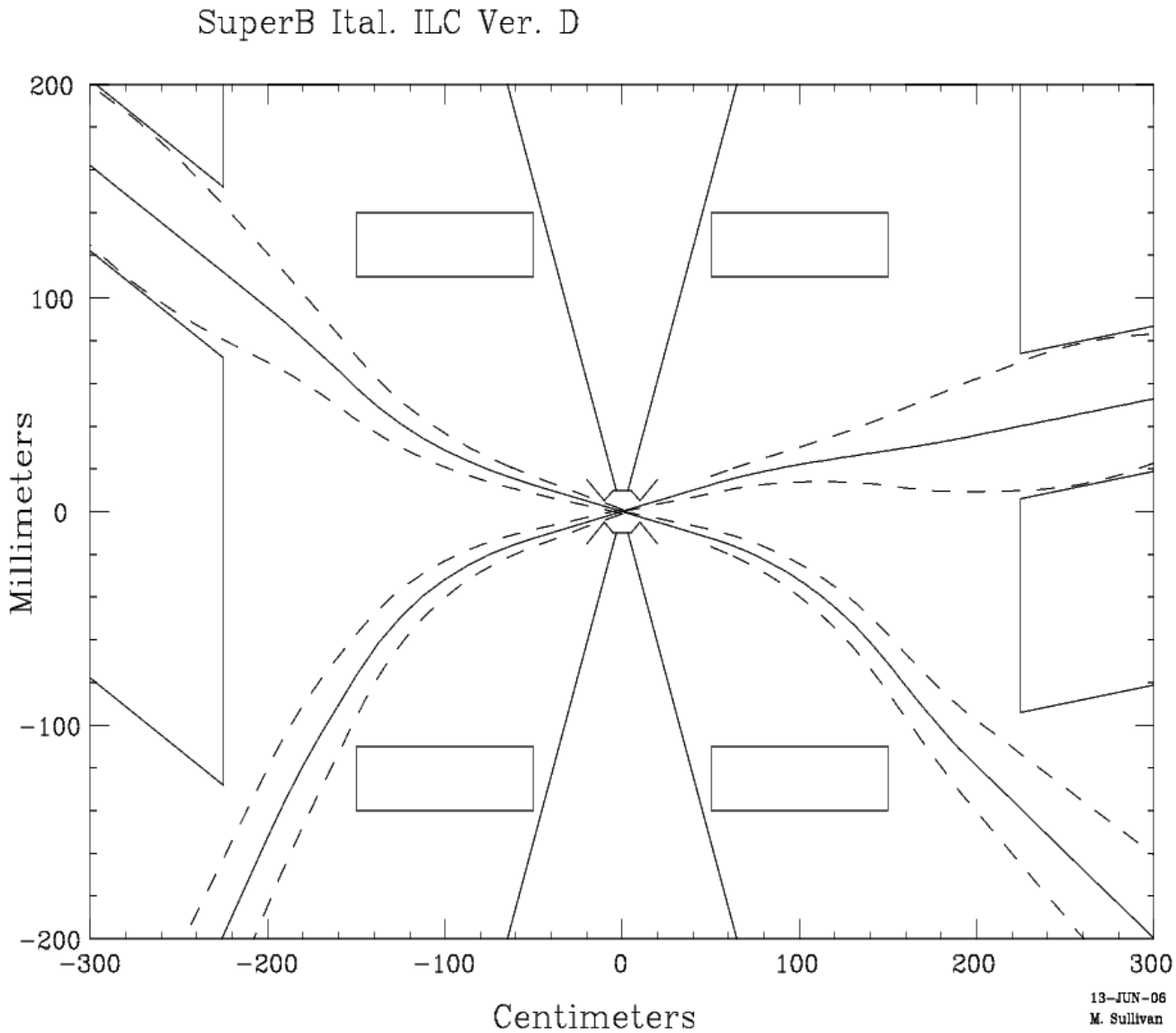
4^{th} Idea Features

- **Move the incoming HER side back to the first IR attempt orbit**
- **This moves the outgoing LER beam away from the detector and allows us to reduce the diameter of QDO**
- **It also directs the incoming HER SR to the bottom part (in the picture) of the masking on the incoming side**
- **If we can redirect the LER radiation away from the downstream mask (the HER upstream mask) then the masking of the beam pipe opens up**

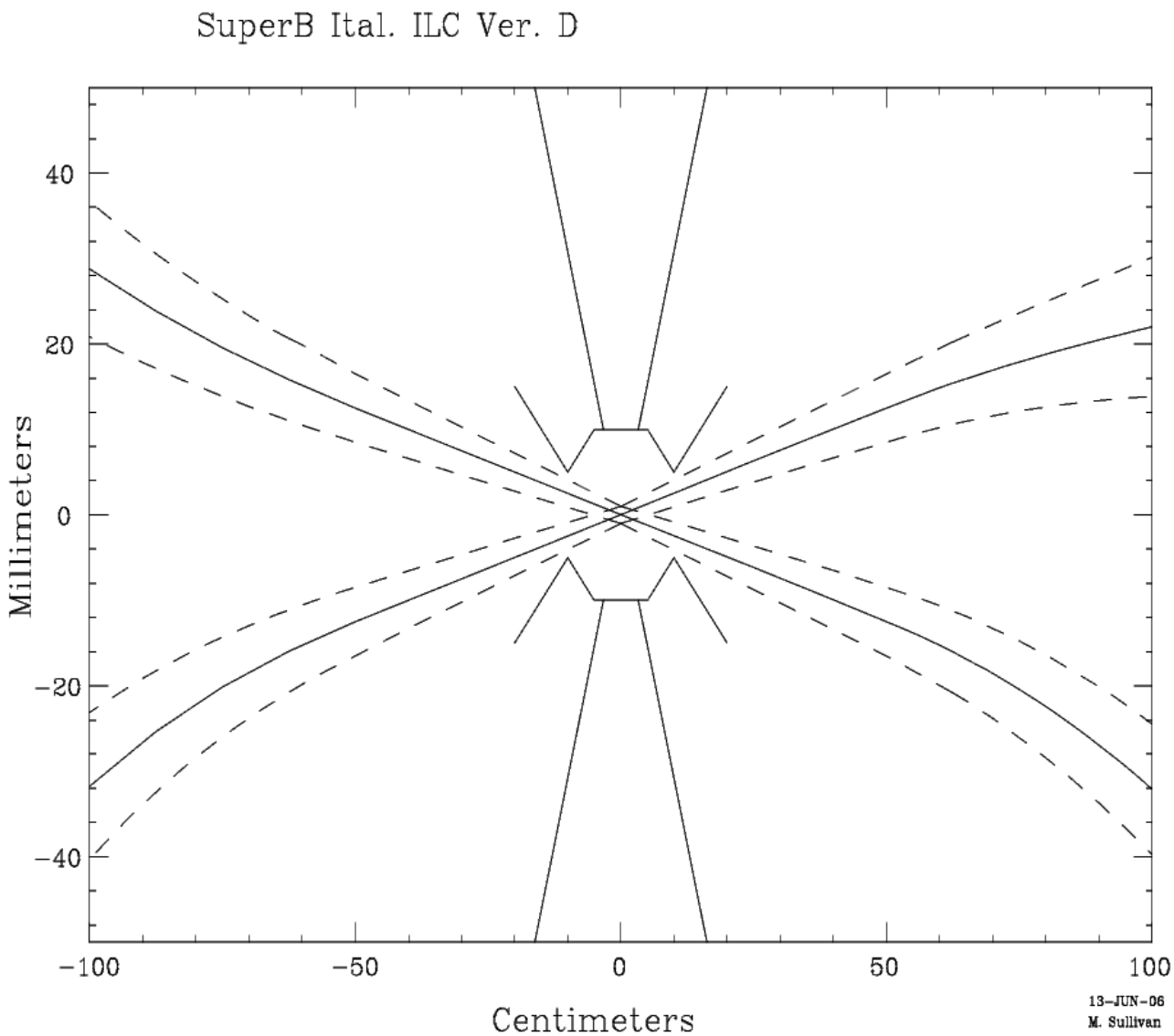
Fourth IR Concept



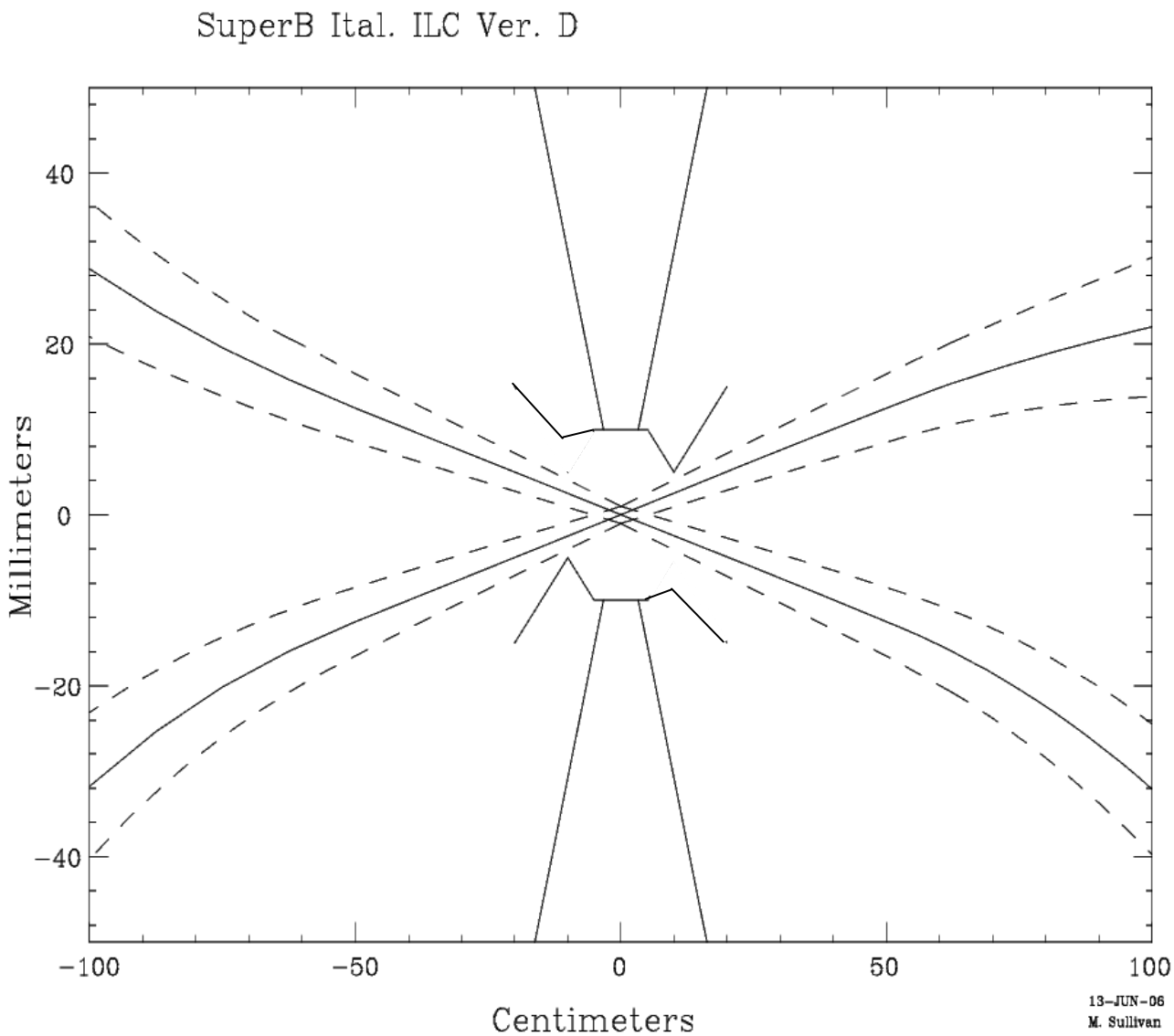
Close up of the 4th Idea



Still closer…



Still closer…



Masking is more open. This improves HOM power issues.

Radiative bhabhas and other stuff

- The 4th idea improves the radiative bhabha background
- Shielding the detector from radiative bhabha bkgds will be a challenge (J. Va'Vra and neutrons)
- Need to get the beamlines under a little better control. Some of the outgoing quads need to get closer
- Does extra bending get some of the radiative bhabhas further away from the detector?

Summary

- This is a first look at SR bkgds
- Not hopeless yet for a 1 cm radius beam pipe
- The small emittances give us a chance
- Beam pipe heating will have to be studied in light of the small radius and thinness of the wall (still true)
- Want to find a solution that also works from a HOM point of view
- More work to do, but looks possible so far…