Update of FCC-ee SR studies

M. Sullivan

for the FCC-ee IR workshop

Ja. 16-27, 2017

Outline

- Last SR study
- 100 m soft bend
- Reflected radiation from soft bend
- Vacuum pumps and HOM absorbers
- Summary
- Next to do list

Summary of Last SR study

- **Results for Backward scattering at tt**
- **Results for small beam pipe < 1.5 cm**
  - Final Focus quadrupole SR in MeV energy range
  - Preferred 2 cm radius beam pipe for now
- **Results for forward scattering at tt**
- **First look at Z running**

Machine parameters used in IR tt SR studies

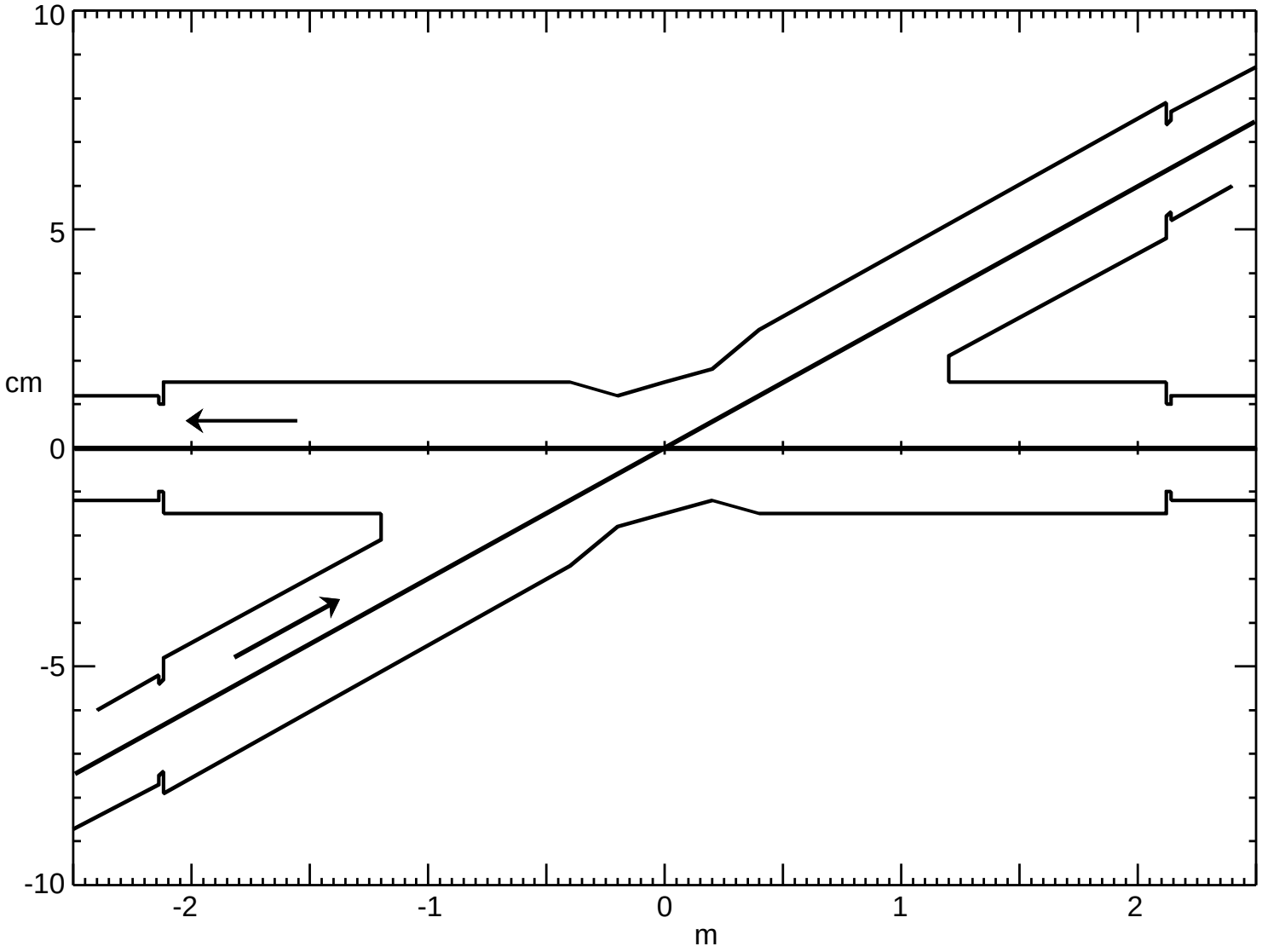
- Beam Energy — 175 GeV
- β_x^*/β_y^* — 1000/2 mm
- $\varepsilon_x/\varepsilon_y$ — $1.3\times10^{-9}/2.5\times10^{-12}$ m-rad
- σ_x/σ_y — 36 μm /71 nm
- L* — 2.2 m
- Crossing angle — ±15 mrad
- Beam current — 6.632 mA
- e/bunch — 1.71×10^{11}
- # bunches — 81

Final Focus parameters

Magnet	L (m)	Z face (m)	G (T/m)
Q1C1	1.6	2.2	97
Q1C2	1.6	3.8	97
Q2C1	1.25	5.7	61.5
Q2C2	1.25	6.95	61.5

- Beam pipe aperture 24 mm dia.
- SR masks 20 mm dia.

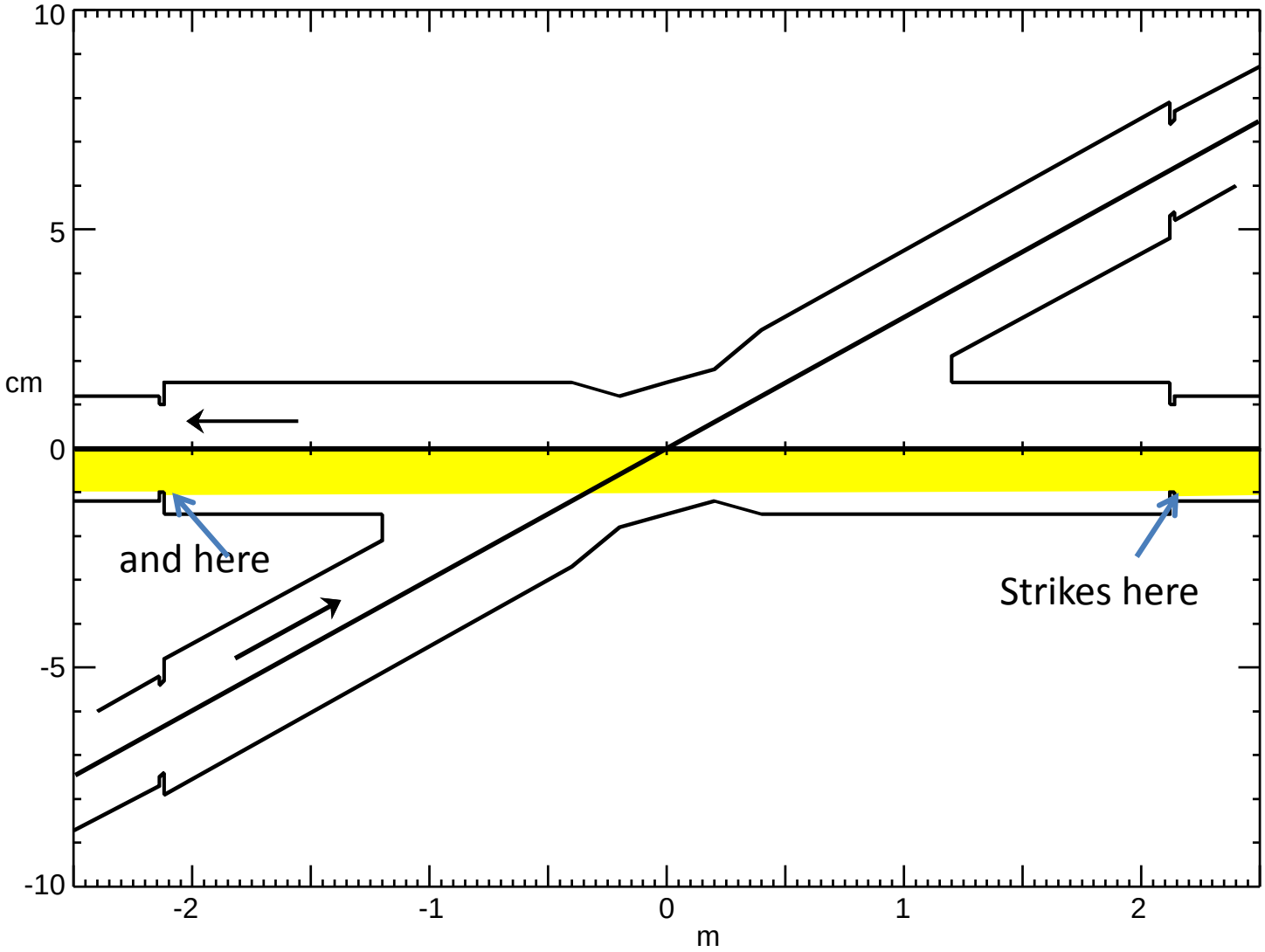
IR cartoon centered on the incoming beam



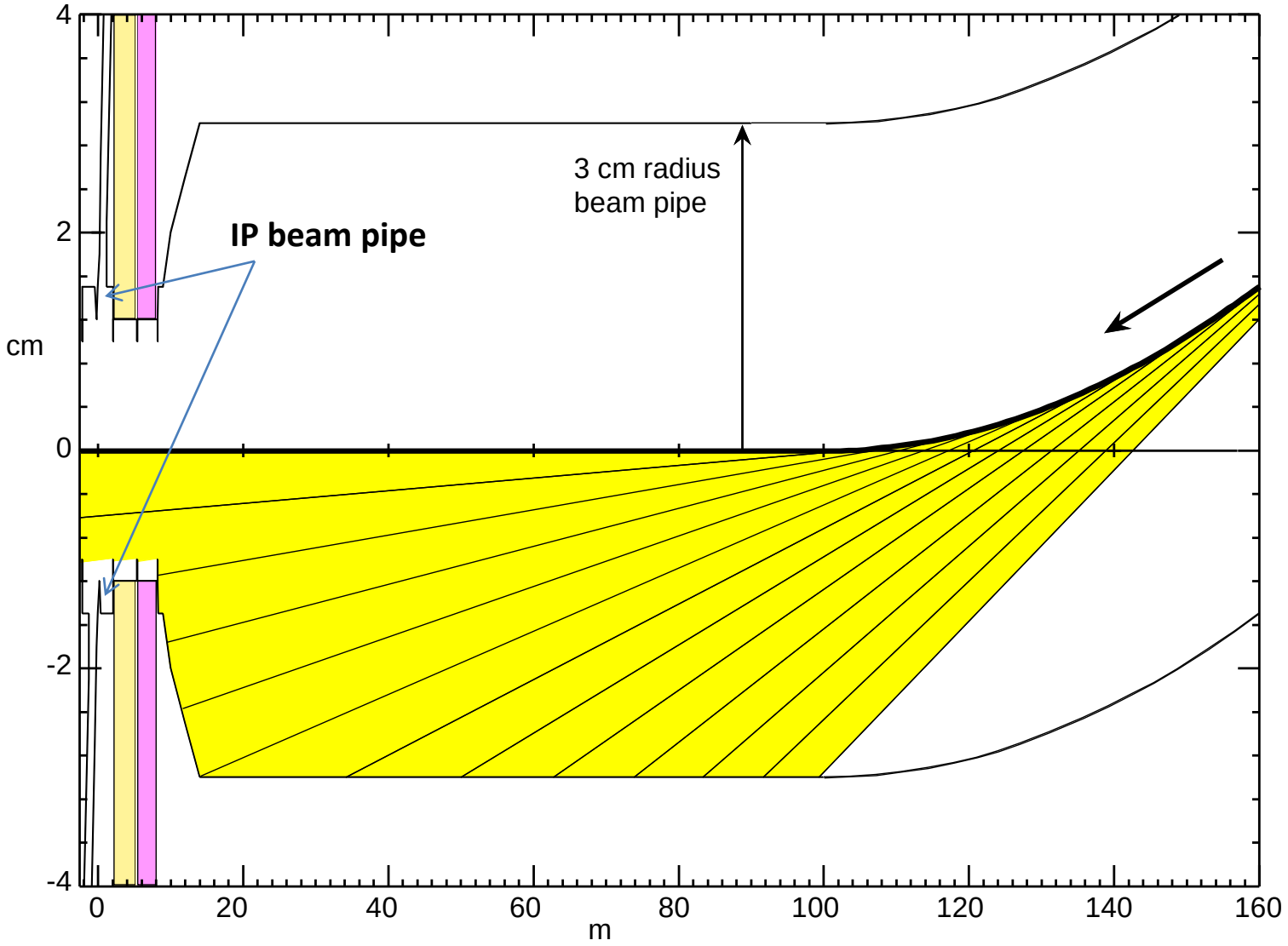
Last Soft Bend

- K. Oide-san has a lattice with the last soft bend starting at 100 m (55 m long)
- The following bend is also soft (same field and sign)
- Made a new beam line with new soft bend(s) starting location at 100 m from the IP

Upstream soft bend radiation



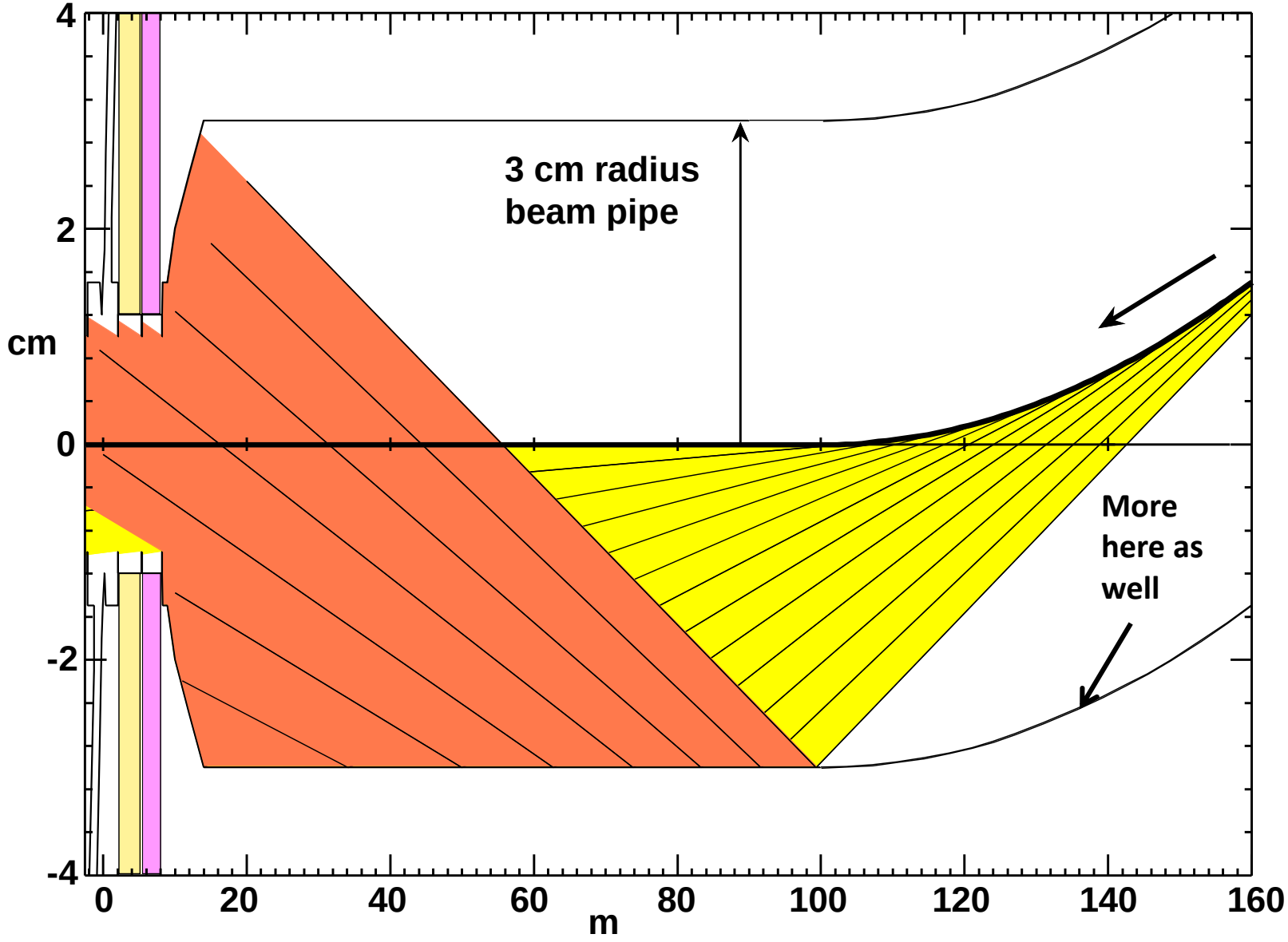
Soft bend radiation fan



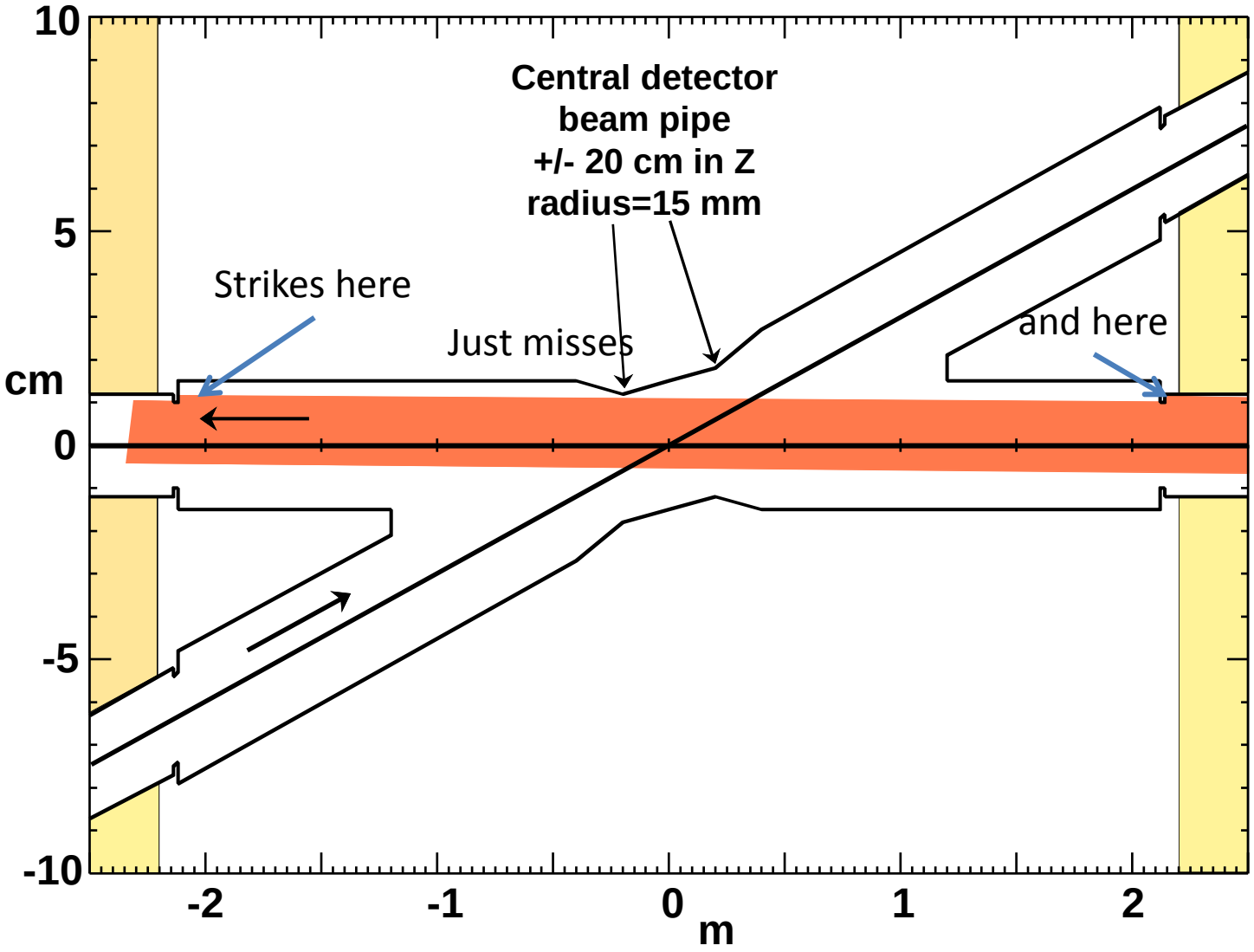
Reflected SR from the soft bend

- Have taken a first look at the possibility that some of the soft bend radiation will directly reflect from the inside beam pipe wall
- 53% of the photons are below 0.1 of the critical energy (<10 keV for the soft bend)
- The softer the photon the more easily it can reflect
- Only 4% of the total energy of the SR is in the <10 keV photons
- The angle of incidence is 0.35—0.69 mrad which is quite small (the smaller the angle the more likely to directly reflect the SR)

Reflected Upstream SR



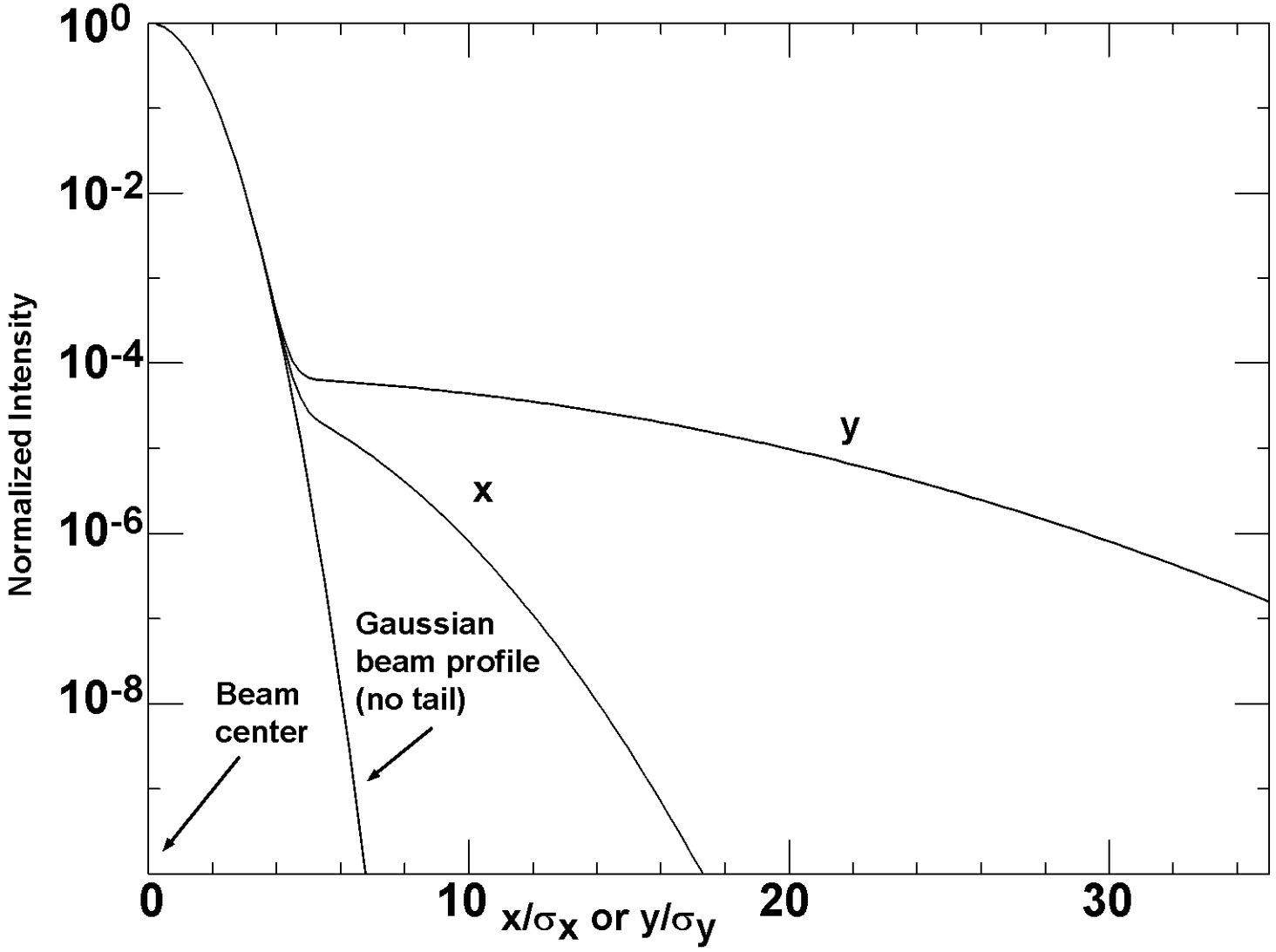
Reflected upstream SR in the IR



Final Focus SR study

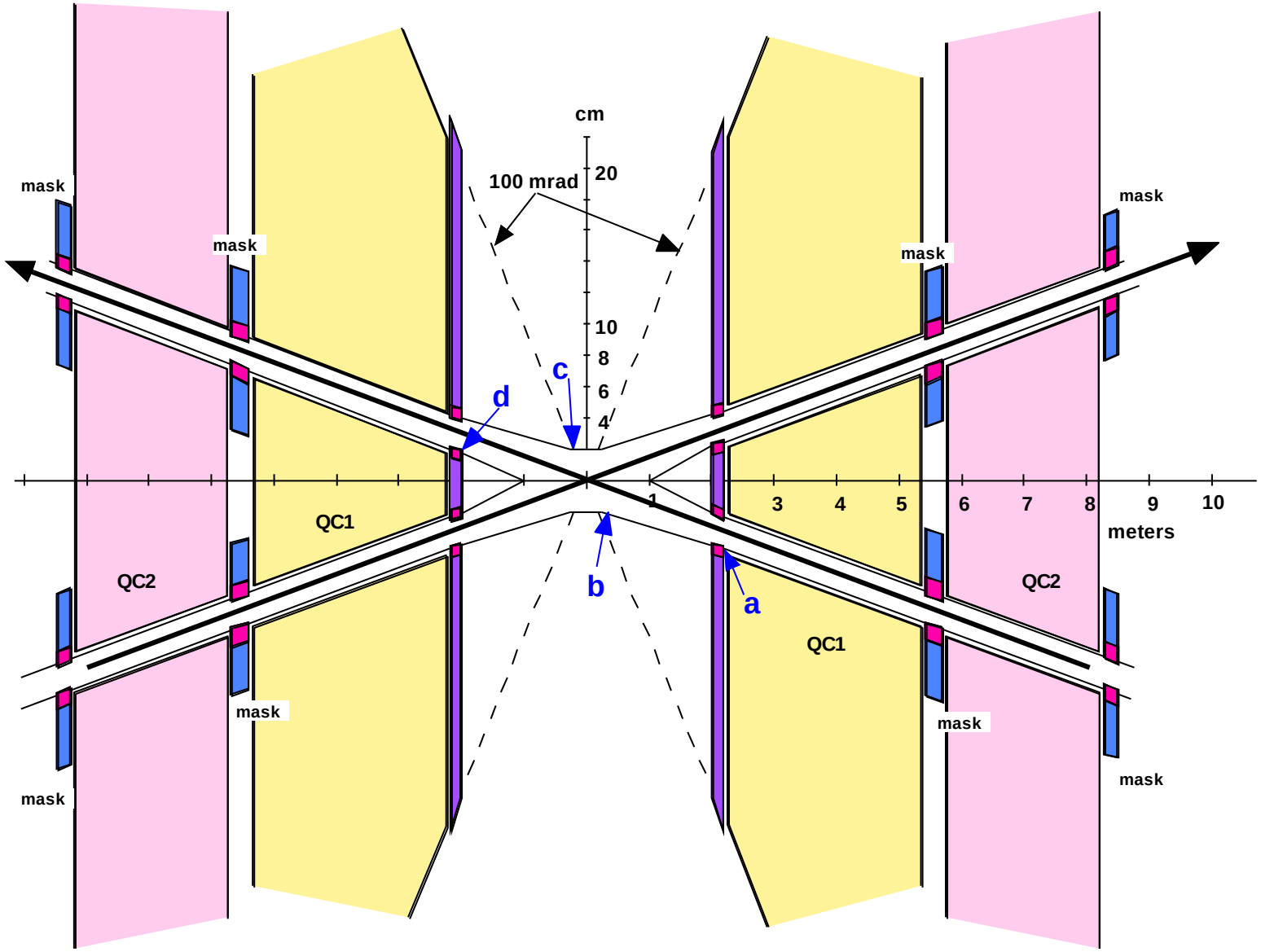
- **BSC used in FF (half aperture)**
  - 20 σ_x (about 11 mm at back end of QC2)
  - 60 σ_y (about 5 mm in middle of QC1)
    - B factories had ½ ε_{tot} x β_y x 10 (>20 mm)
- **Beam tail distribution (halo)**
- **Ray tracing out to (half aperture):**
  - 15 σ_x
  - **40** σ_y

Beam tail distributions

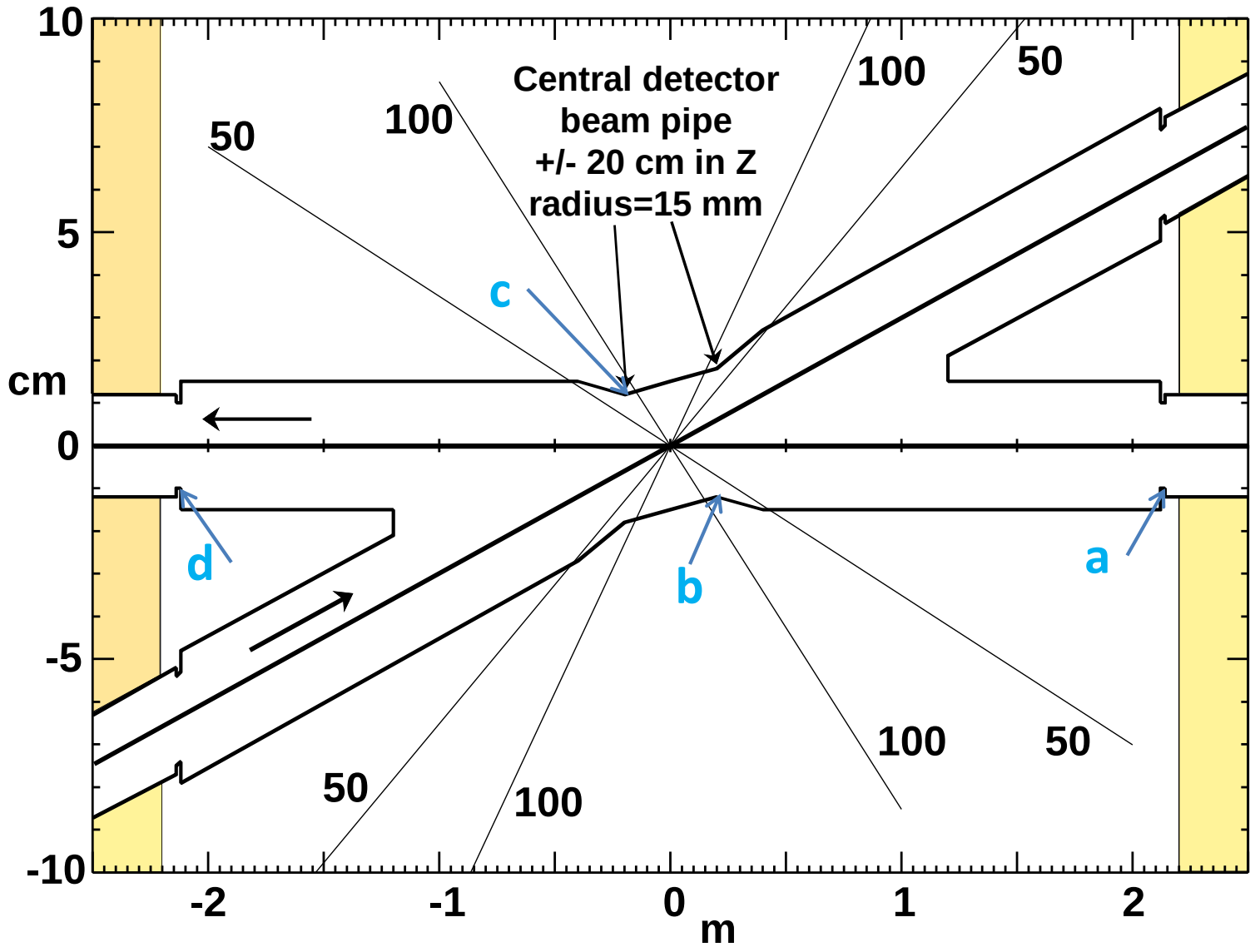


IR Layout

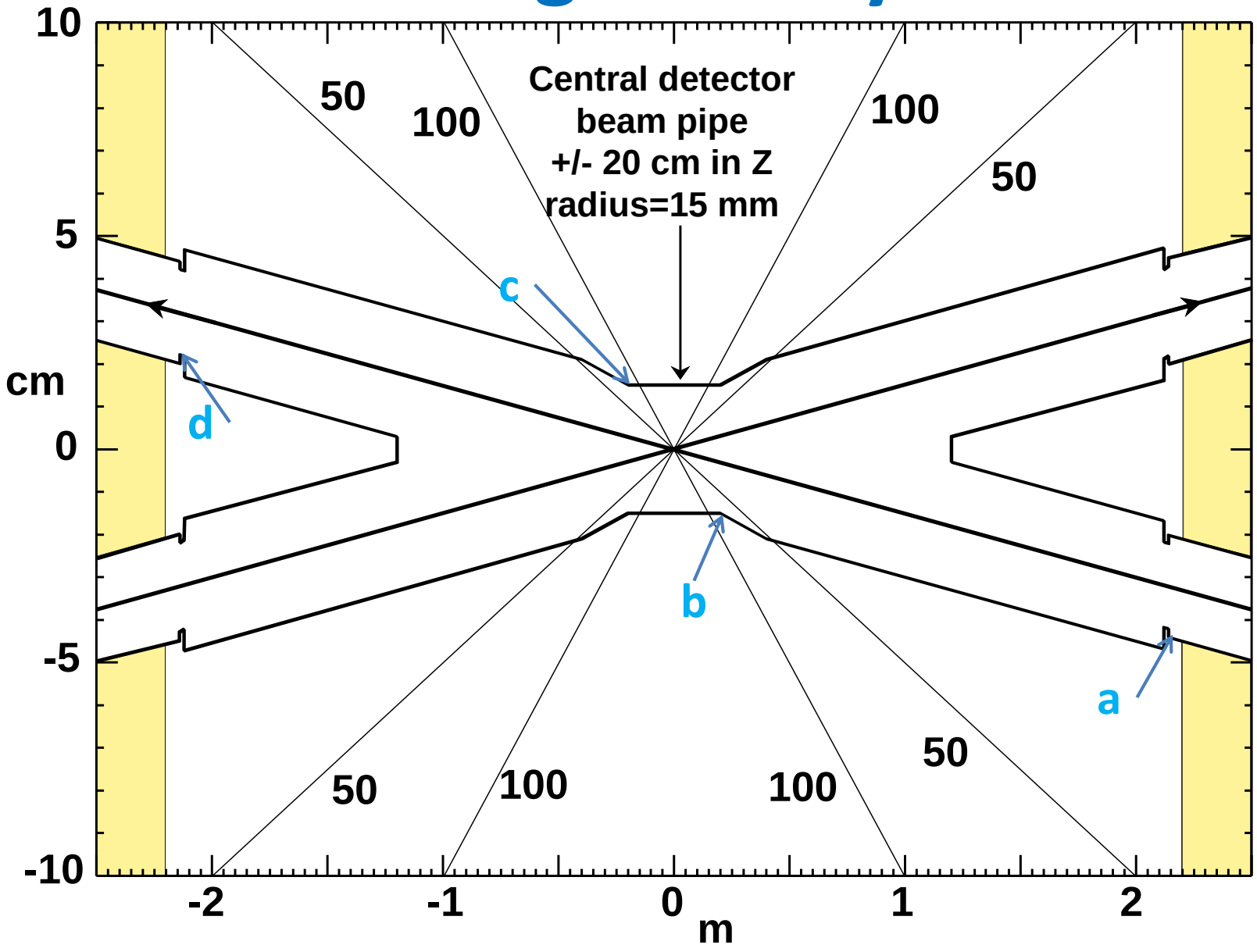
Central chamber is 40 mm in this picture
(did not get updated)



Close up of IP Area



Detector geometry view



Hits/crossing FF + last bend

- Location Photons that hit each location

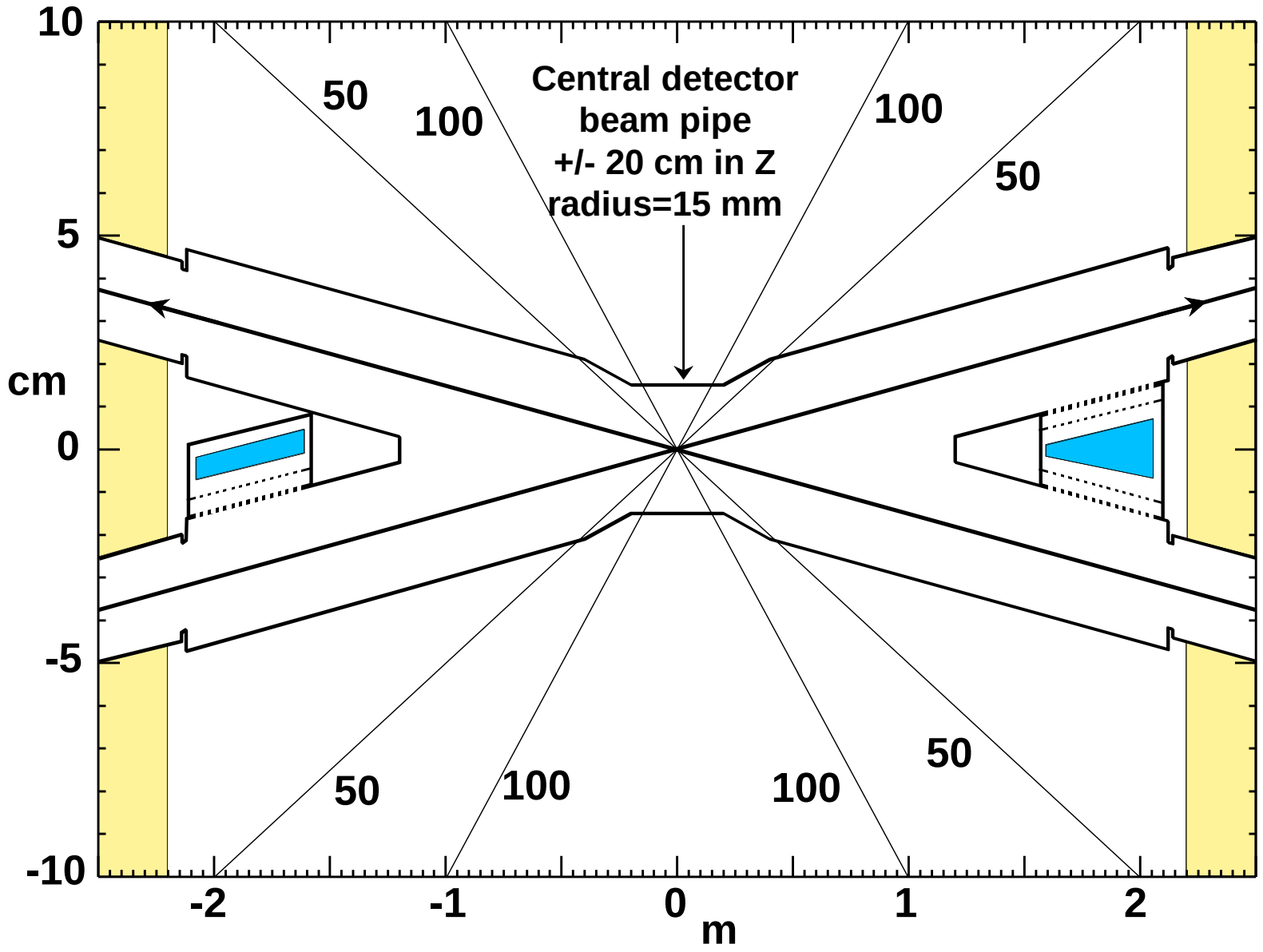
	Tot	>1 keV	>10	>50	>250	>1000
a	1.87e9	3.33e8	2.64e8	1.80e8	7.21e7	7.94e6
b	0.0	0.0	0.0	0.0	0.0	0.0
c	0.0	0.0	0.0	0.0	0.0	0.0
d	2.21e9	3.96e8	3.13e8	2.13e8	8.45e7	9.43e6

  - Numbers are for 15 mm radius beam pipe
  - No quad radiation

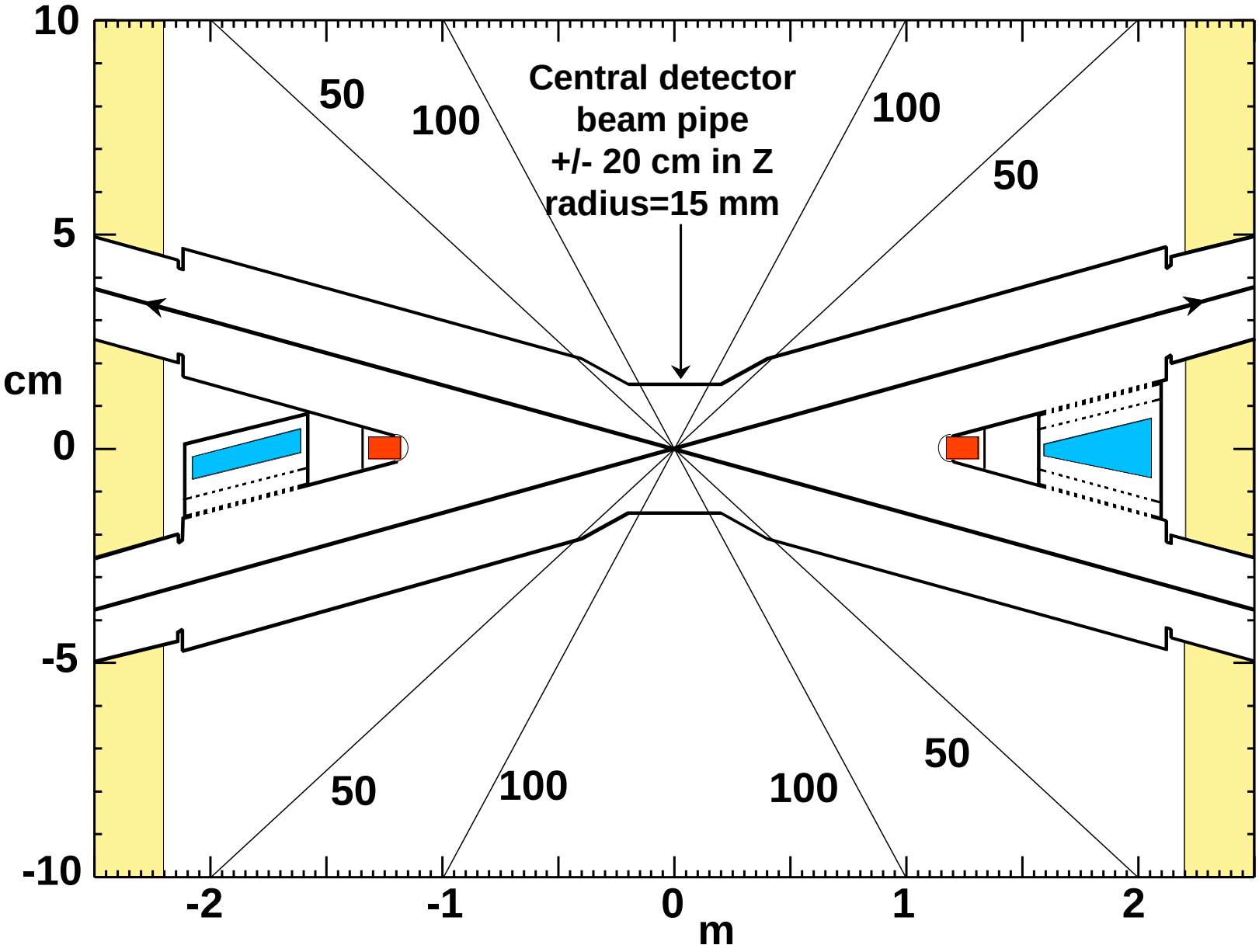
Upstream Mask of FF quad at 2.1 m

- **There are enough hits on the upstream mask to cause a significant forward scatter rate to the IP beam pipe**
  - About 3.9% forward scatter ($7.23e10^{7}$)
  - The SA fraction of the IP beam pipe from the quad face is about 2.55×10^{-6} (BP 1.5 cm rad ±20 cm long)
  - The result is about 1844 photons/crossing are incident on the central beam pipe

Possible vacuum pump positions



Possible HOM absorber locations



Summary

- **Soft bend radiation for tt machine dominates SR backgrounds**
  - 20 sigma X beam particles start to add photons to the mask tips
  - Checked backgrounds from forward scattered photons
  - Have estimate for #photons incident on central chamber – can do better (this week)
  - Multiply numbers shown by 2 to include both beams

Summary (2)

- **Looked at reflected photons from soft bend**
  - No direct hits on the central beam pipe
  - Adds photons to the mask tips
- **Initial guess for NEG vacuum pump locations**
- **Initial guess for HOM absorbers**

Next steps

- **Study the Z machine in much greater detail**
  - Power levels on mask tips OK?
  - Can we absorb almost all of the incident photons?
    - Very low critical energy
  - Probably Au layer on the central chamber will block all scattered photons
  - Can 5 cm beta* X work?
- **Improve program part that calculates the incident rate on the central chamber from forward/back scattered photons (this week)**