Update of FCC-ee IR

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for the FCC-ee MDI meeting

May 9, 2016

Outline

- Previous to do list
- Last SR study
- 100 m soft bend
- Reference Frame
- Summary
- Next to do list

Last MDI meeting and FCC week

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

What to do next

- **Backscatter at tt machine** ✓
- **Forward scatter at tt** ✓
- **Check what a higher field soft bend does**
  - Try this at the Z
- **Look at Z machine parameters** ✓
- **Look at Higgs machine parameters**
- **Look at 100 m soft bend** ←

Machine parameters used in following very Initial IR tt design

- 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.

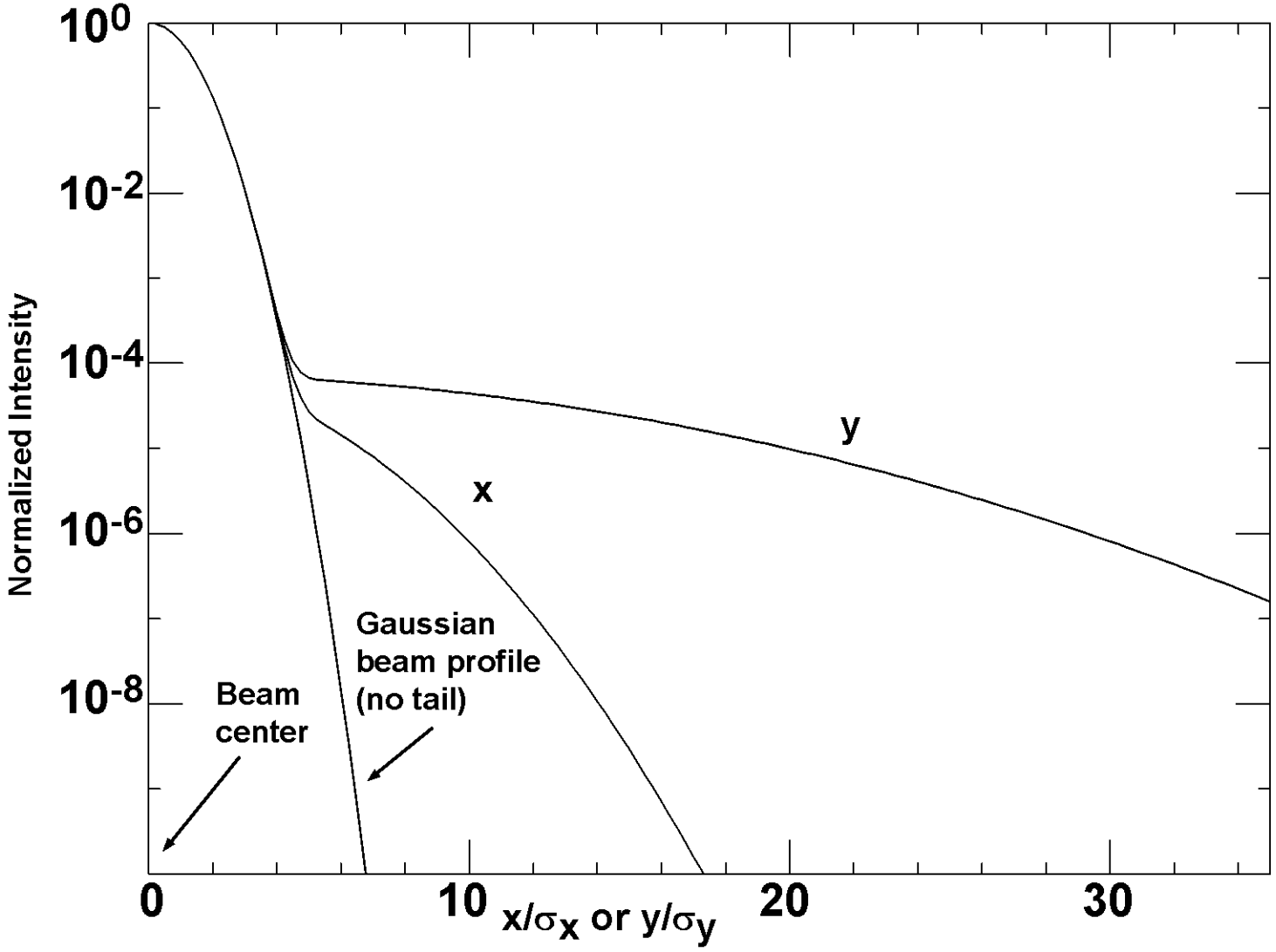
Last Soft Bend

- **In previous study the last soft bend was located at 42.33 to 91.89 m (49.56 m long)**
- **K. Oide has a new lattice with the last soft bend starting at 100 m (37 m long)**
  - The following bend is also soft (same field and sign)
- **Made a new beam line with new soft bend location at 100 m from the IP**

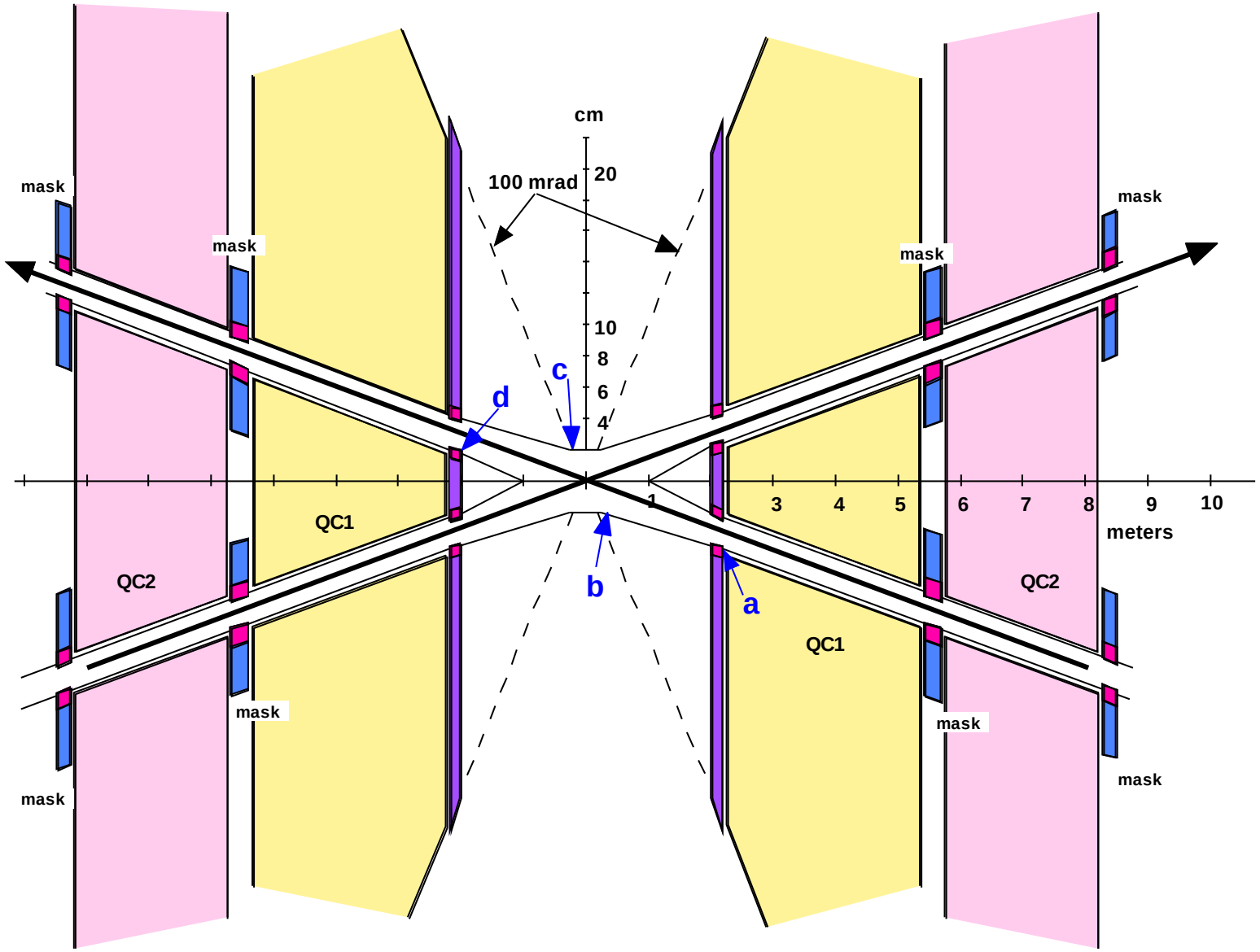
Final Focus SR study

- **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
  - 50 σ_y

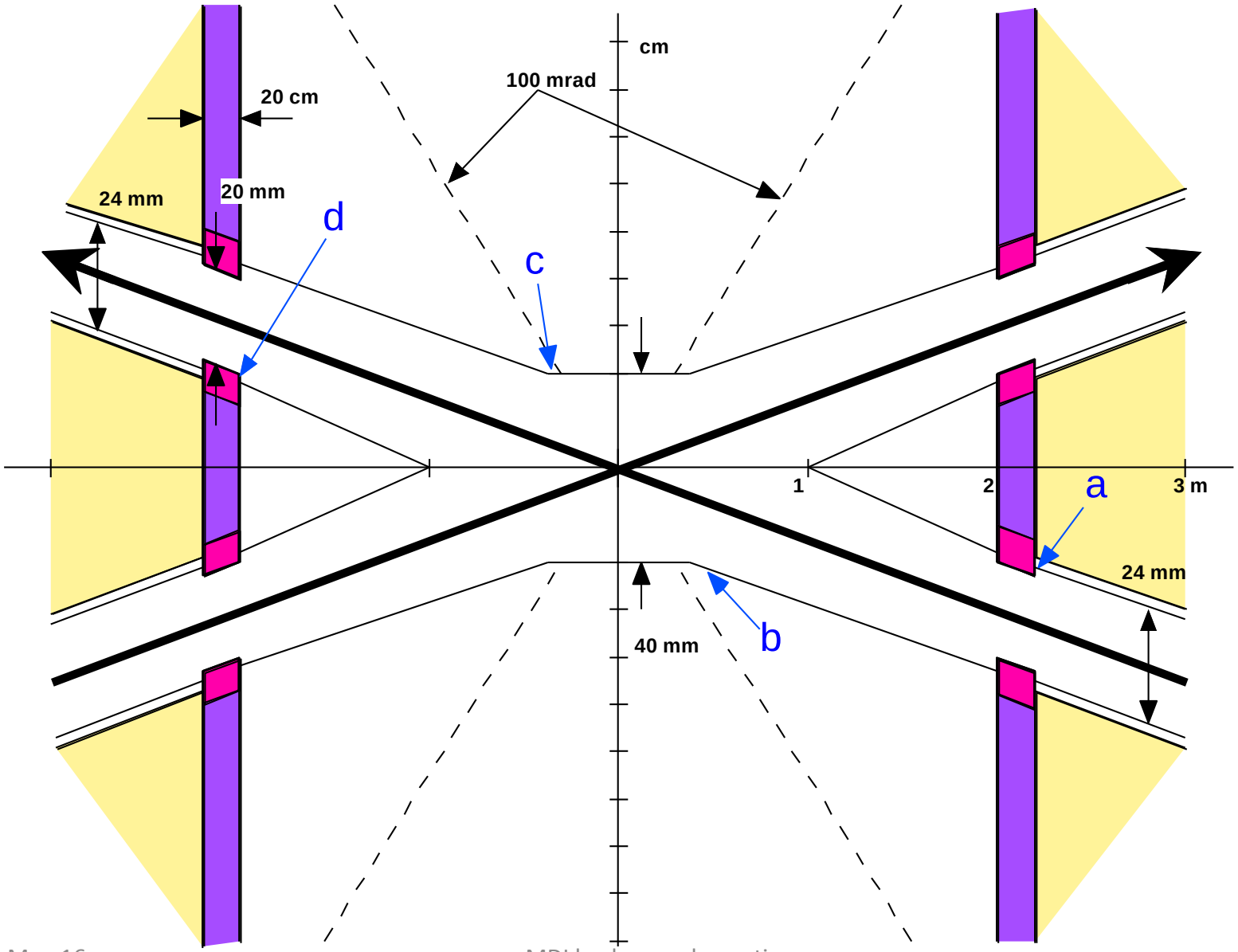
Beam tail distributions



IR Layout


cm
20
10
8
6
4
100 mrad
mask
mask
mask
mask
mask
mask
mask
mask
QC1
QC2
QC1
QC2
a
b
c
d
1
3
4
5
6
7
8
9
10
meters

Close up of IP Area



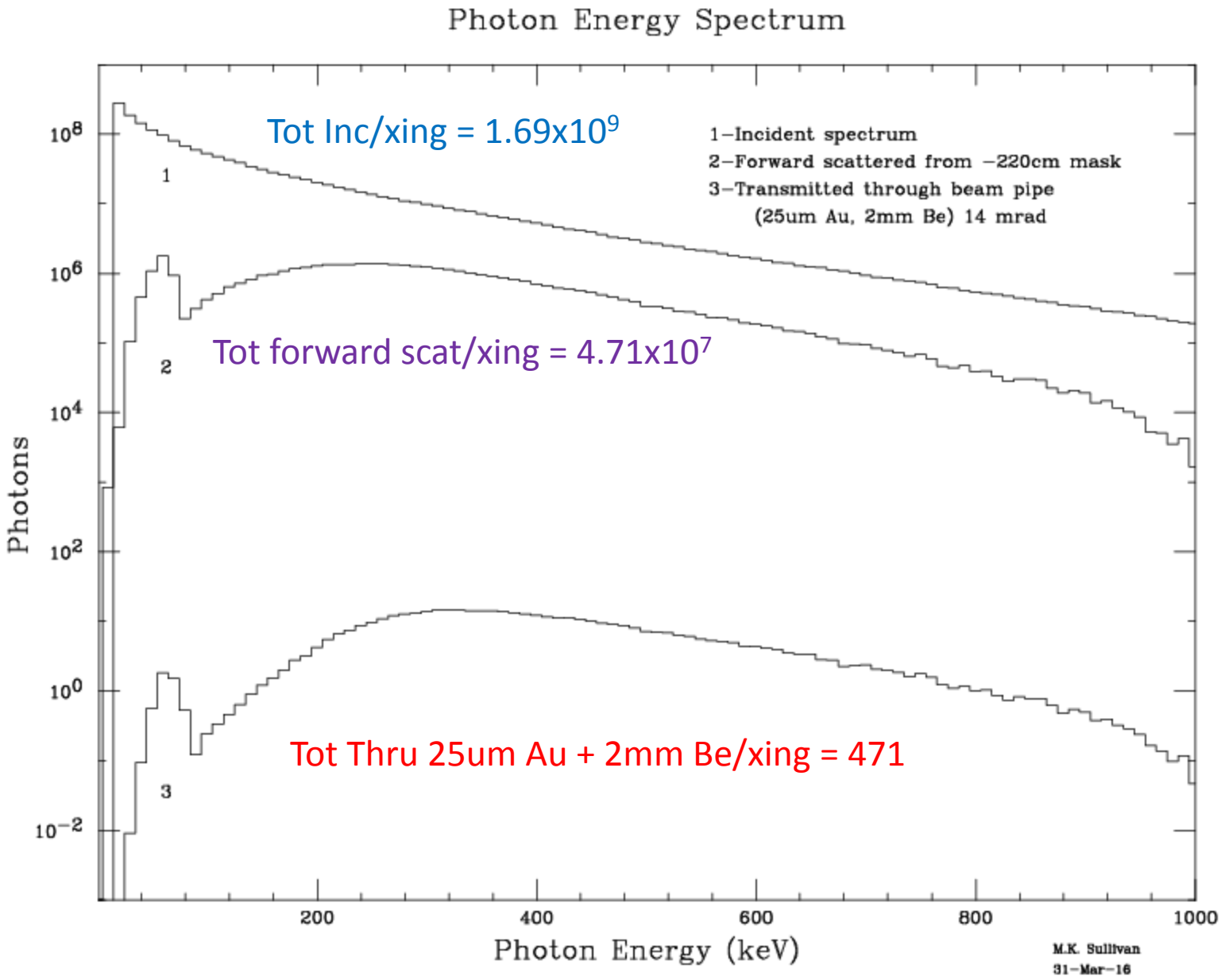
Hits/crossing FF + last bend

- Location Photons that hit each location
- Tot >1 keV >10 >50 >250 >1000
- a 1.79e9 4.86e8 3.66e8 2.26e8 6.62e7 2.90e6
- 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 2.12e9 5.95e8 4.49e8 2.77e8 8.12e7 3.56e6
  - Numbers are for 15 mm radius beam pipe
  - No quad radiation

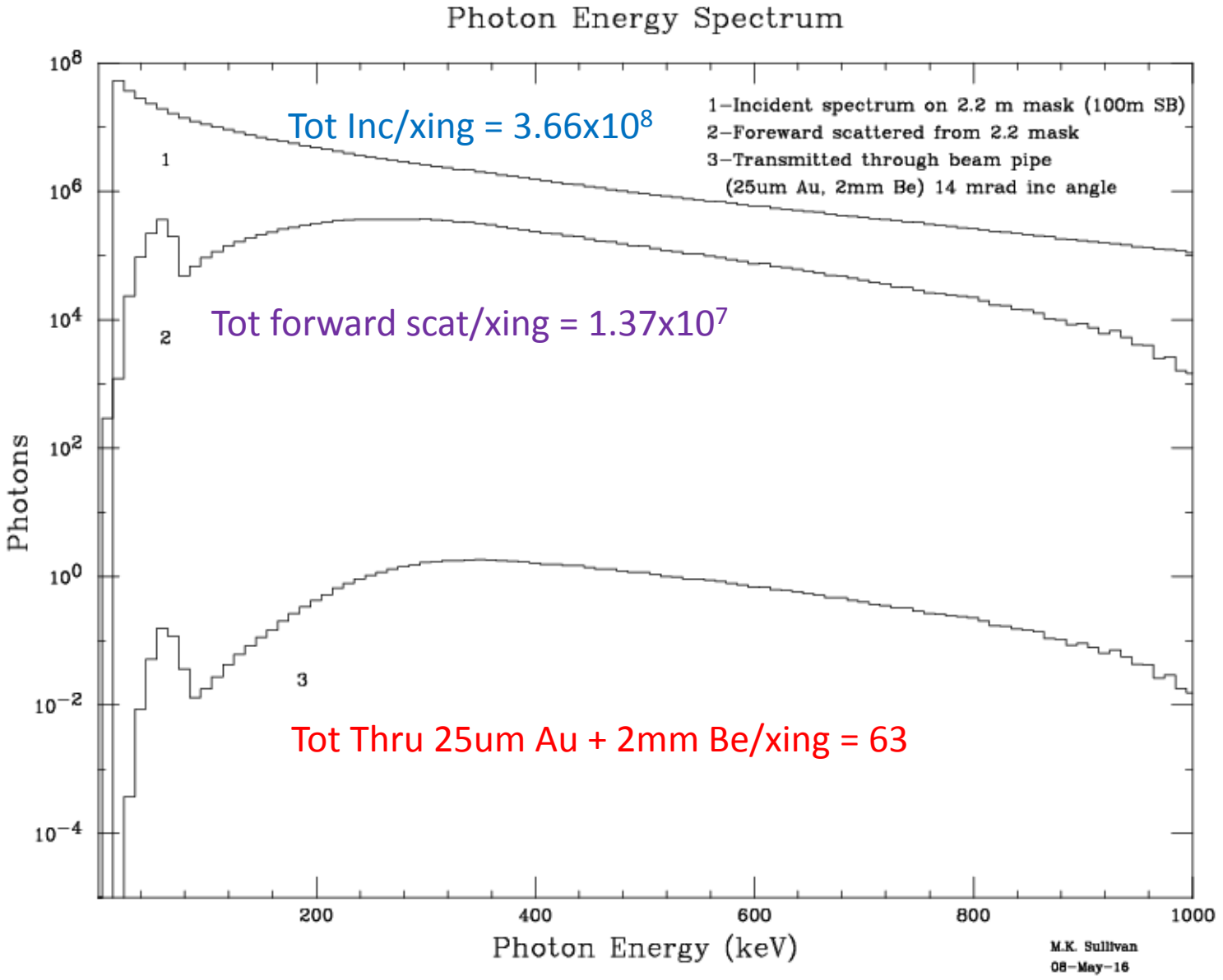
Upstream Mask of FF quad at 2.2 m

- **There are also enough hits on the upstream mask to cause a significant forward scatter rate to the IP beam pipe**
  - About 2.5% forward scatter
  - The SA fraction of the IP beam pipe from the quad face is about 1.93×10^{-5} for BP 2 cm rad ±25 cm long
  - The result is about 470 photons/crossing go through a 25um Au and 2 mm Be beam pipe with an average energy of 410 keV for each beam

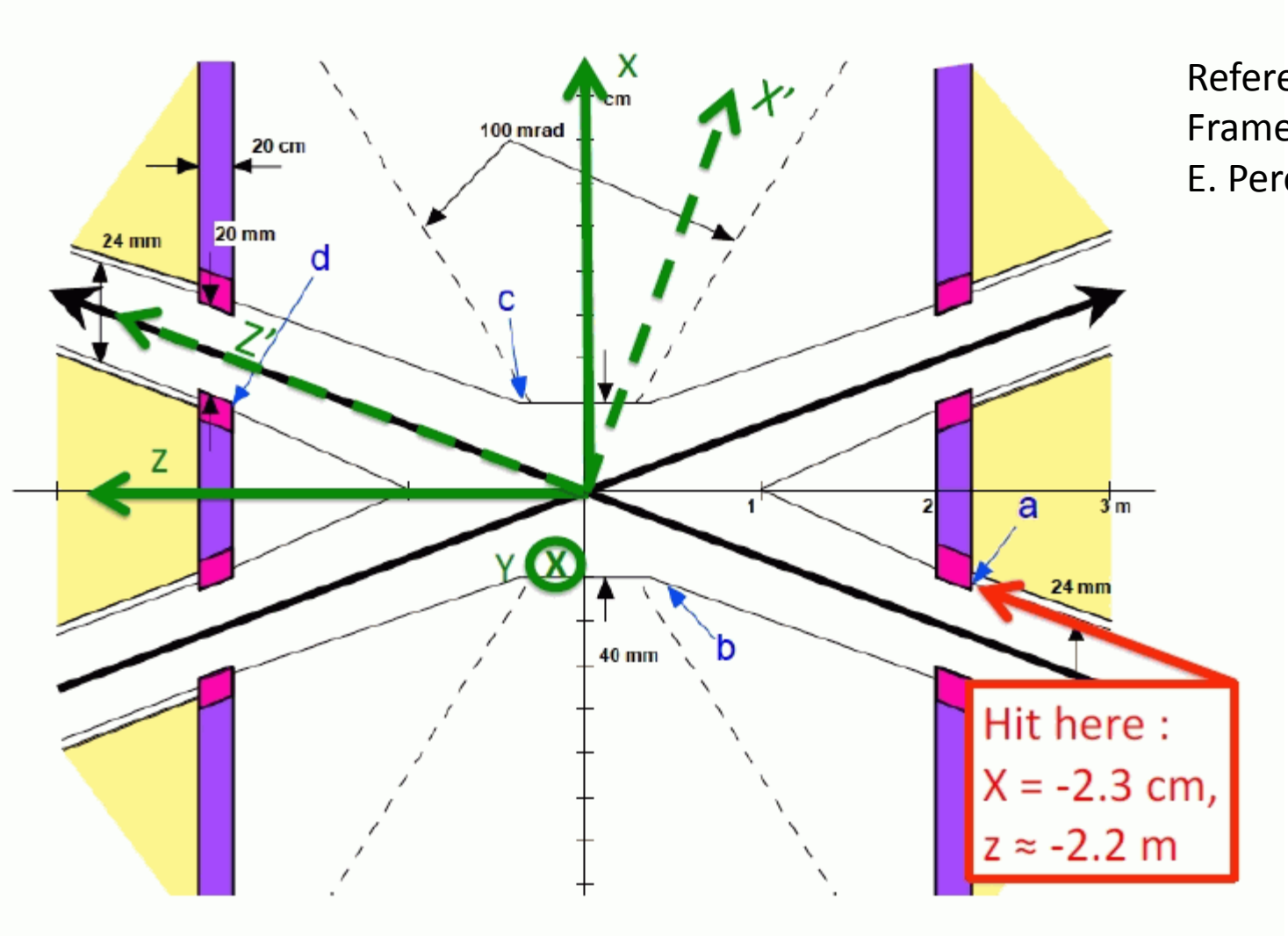
Forward Scattered



Forward Scattered (100m SB)



Reference Frame



Reference Frame from E. Perez

Summary

- **Quick look at 100 m Soft bend position for tt machine**
  - Checked backgrounds from forward scattered photons
  - Answer is that backgrounds are lower by at least 3
  - Multiply numbers shown by 2 to include both beams
- **Settled on a reference frame for the IR**

Next steps

- **Make a long file of photons from the**
  - Forward source from the tt machine
  - Backward source from the tt machine
- **Double check the Higgs machine**
  - Different IP also?
- **Go back to the Z machine and try to see how small the IP chamber can be**
  - Assume FF quads are the same but beam pipes between +/- 2.2 m can be different