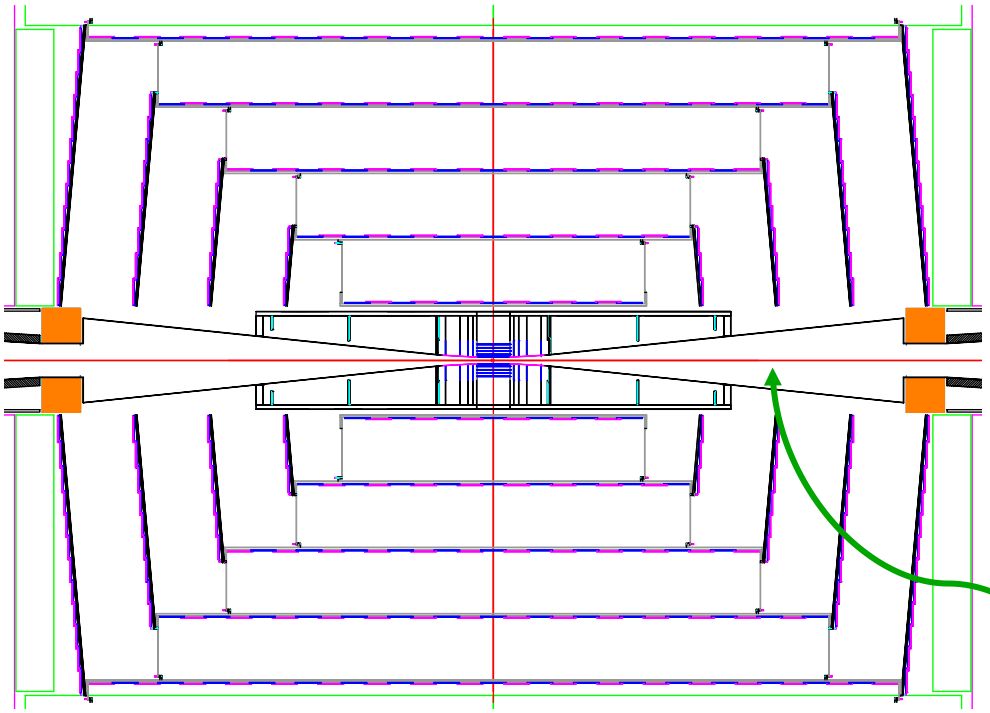
Q0 – Detector interface

- **Question:**
  - What is an acceptable position for the last quadrupole Q0 ?
    - To minimize interference with the detector performance
      - Interference with tracking
      - Interference with calorimetry

- **Disclaimer**
  - All slides, statements and conclusions are, at best, very preliminary

Interference with tracking ?

- Typical tracker volumes for an e^+e^- detector (here SiD)
  - Angular coverage all the way to 10 degrees from the beam axis
    - 15 degrees would still be acceptable (most of the physics is central in e^+e^- collisions)



Typical dimensions
(for the momentum precision)
R = 1.20 m, z = 1.65m

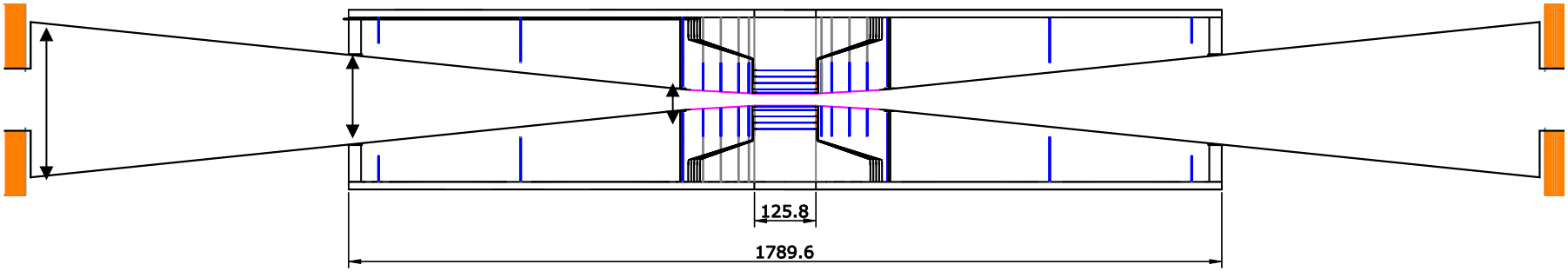
Barrel Region	R (cm)	Length of sensor coverage (cm)	Number of modules in ϕ	Number of modules in z
Barrel 1	21.95	111.6	20	13
Barrel 2	46.95	147.3	38	17
Barrel 3	71.95	200.1	58	23
Barrel 4	96.95	251.8	80	29
Barrel 5	121.95	304.5	102	35
Disk Region	**z_{inner} (cm)**	**R_{inner} (cm)**	**R_{outer} (cm)**	**Number of modules per end**
Disk 1	78.89	20.89	49.80	96
Disk 2	107.50	20.89	75.14	238
Disk 3	135.55	20.89	100.31	438
Disk 4	164.09	20.89	125.36	662

- A priori, the final quadrupole Q0 could fit in here,

Interference with tracking

- **Constraints on the dimensions (here for a blind cone of 10 degrees)**
  - **… and with a vacuum chamber radius of 2cm**

z=1.65m 90 cm 20cm



L= 60 cm 35 cm 11cm

  - **For a blind angle of 15 degrees, these numbers become**
    - **90 cm, 50 cm, and 14 cm**

- **Quid of synchrotron radiation induced by Q0, Q1 ?**
  - **Needs to be studied carefully**

Barrel	R	z_{max}	
Layer 1	14	63	
Layer 2	22	63	
Layer 3	35	63	
Layer 4	48	63	
Layer 5	60	63	
Disk	R_{inner}	R_{outer}	z_{center}
Disk 1	14	71	72
Disk 2	16	71	92
Disk 3	18	71	123
Disk 4	20	71	172
Forward Disk	R_{inner}	R_{outer}	z_{center}
Disk 1	28	166	207
Disk 2	76	166	541
Disk 3	117	166	832

For the record: dimensions of the vertex detector in SiD

Interference with calorimetry

- **Forward calorimetry principally needed for luminosity measurement**
  - As well as to cover the acceptance missed by tracking
    - In ALEPH, SiCal extended from 24 to 58 mrad (i.e., from 1.4 to 3.3 degrees)
      - ➨ Ensures large enough Bhabha cross section for Z pole measurements
    - Plus LCAL coverage to about 10 degrees
      - ➨ Ensures detector hermeticity.
  - Lumi Calo Geometry more complicated due to the possible beam crossing angle
    - Outgoing $e^{\pm}$ will have similar angles too.
      - ➨ Probably requires the Lumi calorimeter to be placed in front of Q0
    - Typical dimensions of the Lumi calorimeter
      - ➨ Length ~ 20 cm

        Excludes a Q0 placed at 20 cm from the IP
      - ➨ Radius (or transverse size)

        from 2.4 cm to 5.8 cm at 1 m from the IP

        from 4.8 cm to 11.6 cm at 2 m from the IP

        (ALEPH SiCAL : from 6 to 15 cm)
    - Question (not solved): can we measure EM shower position with precision with such small size for the lumi calorimeter ?

Preliminary conclusion on the Q0 position

- **The size of the lumi calorimeter is the limiting factor**
  - Together with the size of the Q0 system istself
    - Putting the Q0 system at 2m from the IP looks reasonable
      - ➨ Outside the tracker would help tremendously anyway
    - 1 m would be (very) challenging
      - ➨ but may not be totally impossible from the detector point-of-view
    - Closer than 1 m is not practical.
- **More studies are, of course, needed.**
  - Interference with tracking if Q0 is inside the tracker
  - Effect of synchrotron radiation
  - Geometry of the luminosity calorimeter in case of large crossing angle – may it help ?
  - Etc.