1 degree IR layout and optics

Rob Appleby
Luke Thompson
CERN/Cockcroft Institute
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This is a brief status update

Luminosity and Acceptance of the IRs

Luminosity and acceptance very much depend on physics program

=> Possible scenario two different interaction region setups
= 10^{33} cm^{-2} s^{-1}, 10° < θ < 170°
= 10^{31} cm^{-2} s^{-1}, 1° < θ < 179°

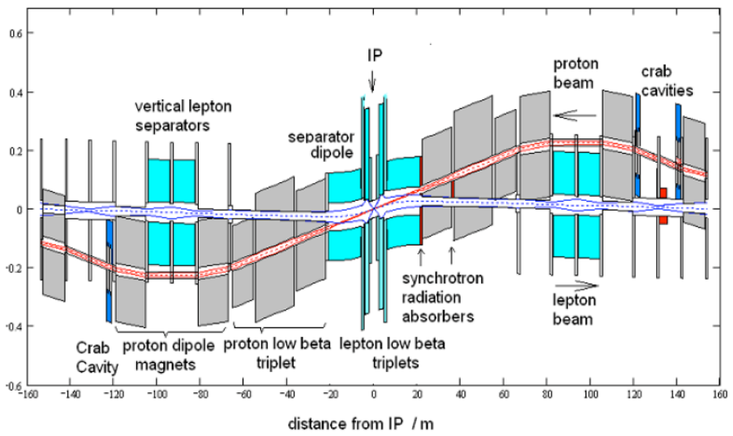
10 degree IR has been studied, with a optics and separation scheme worked out
but work needed for the 1 degree (low lumi) IR

Interesting design and optics challenges
Interplay between optics, SR production and beam-beam interaction

Design dominated by separation scheme (well known)

Linked with the detector layout and design

10 degree IR layout



spectrometer effect: use dipole fields to separate the beams according to their momentum.

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→ quadrupole triplet offset

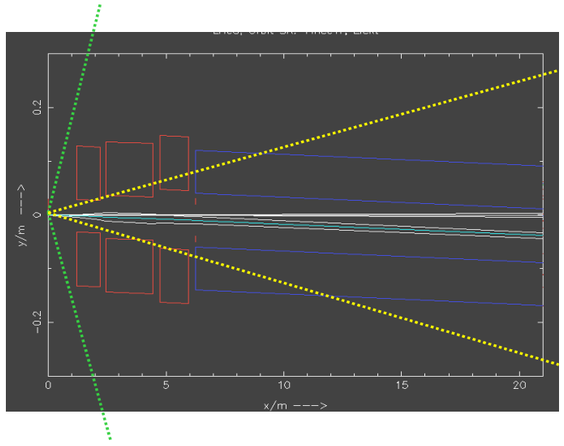
LHC bunch distance: 25 ns
1st parasitic crossing: 3.75m
first e-quad positioned at 1.2m
... too far for sufficient beam separation

separation has to start at the IP, support the off-centre-quadrupole separation scheme by crossing angle (≈1.5 mrad) at the IP. Betx=12.7 cm, Bety=7.1 cm

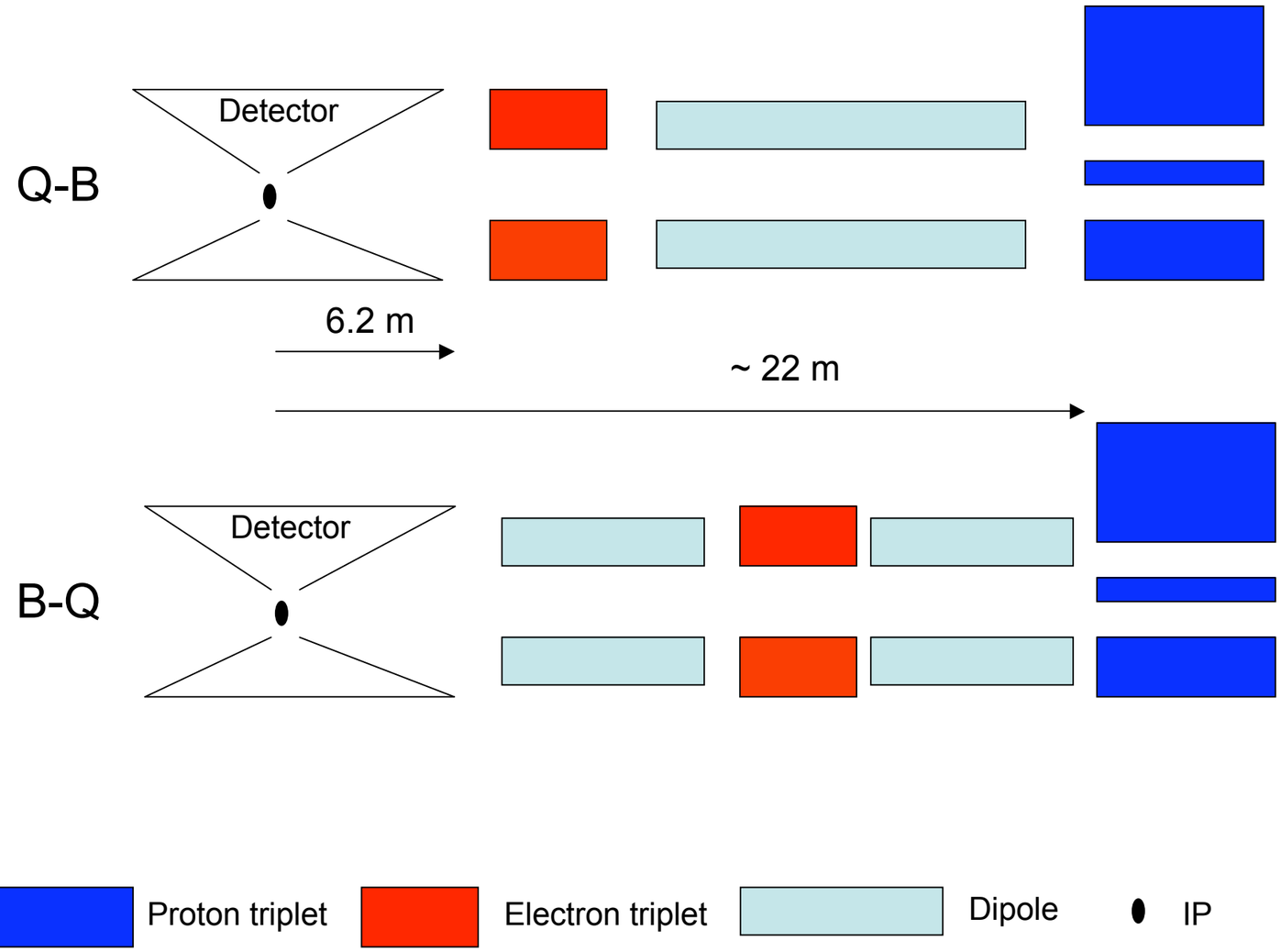
Overall SR power in IR is 60 kW. SR controlled with smooth bending. Masked needed

Turning to the 1 degree IR (needed for physics programme)…

Machine elements (quad) in forward region sit within the 1 degree cone, so a new design (and concept?) is needed
(Q1E has 21 cm outer radius)



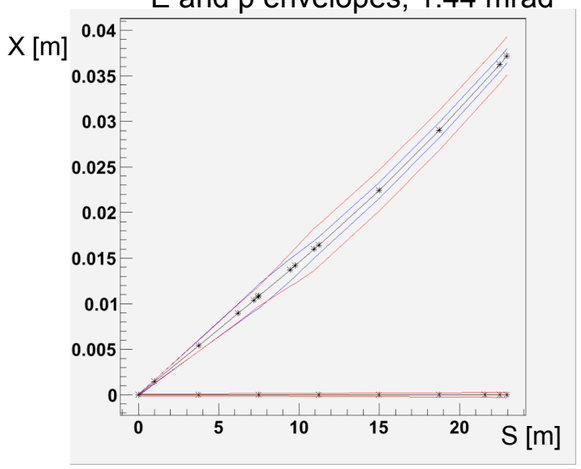
1 degree conceptual layouts



The Q-B layout

- Electron optics: betx*=0.63 m, bety*=0.35 m, E=70 GeV
  - Head-on lumi 1.5E32 (assuming matched proton optics, partially done)
- Achieve smooth bending with electron quad and dipole separator
  - Bending radius of 26000 m (3060 m for LHC dipoles), matched for quads and dipole (smooth)
  - Offset of electron quad is small in this scheme (~ 1/10 mm)
- Separation criteria
  - 5 sig_e + 5 sig_p (absolute minimum)
  - Exploit common proton half-quad with 10 degree, so need 37 mm separation
  - First two parasitic nodes before electron quad, so need to supplement separation with beam crossing angle

E and p envelopes, 1.44 mrad



Crossing angle of 1.44 mrad meets separation criteria

- Well in excess of 5 + 5 criteria before electron quad (e optics)
- About 50% lumi drop (to be checked)
- Separation quite easy…we just need to bend more if the beam-beam is problematic……interplay between optics, SR production and beam-beam

CDR plans for 1 degree IR

- Separation achieved with smooth bending radius of offset quads and dipole, but major contribution to separation achieved with crossing angle
- We'll need to iterate on the optics and layout after SR calculations
  - Finish Q-B layout and begin calculations of the SR with a set of prototype parameters
  - Study the B-Q layout (probably beneficial)
  - Iterate on optics and SR loads
  - Study both for CDR
- Could we integrate dipoles into the detector?
- Match optics into e ring optics
- Make some new calculations of SR load, with a tilt towards studying the SR backgrounds
  - CI expertise in background calculations and optics