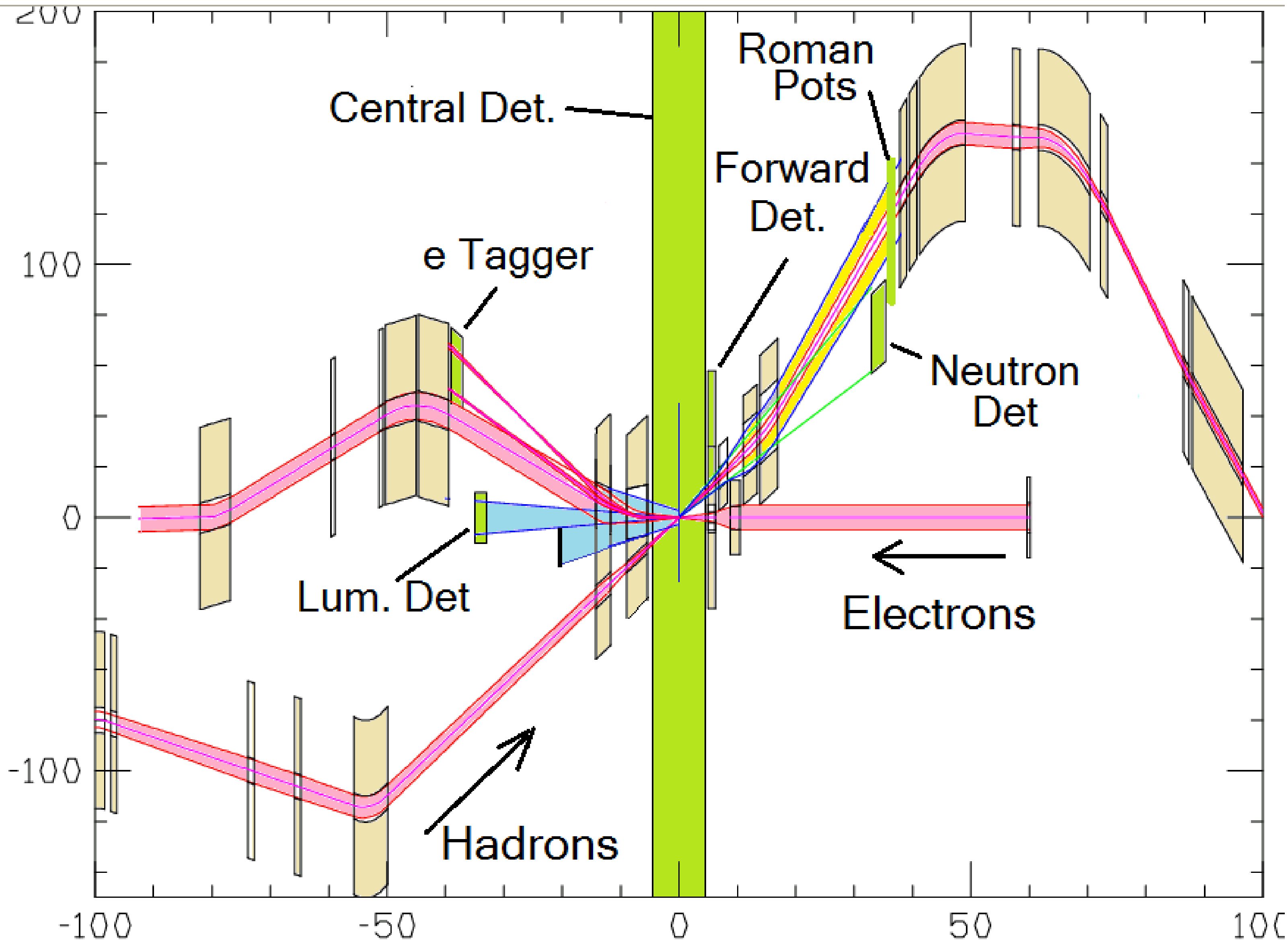
Dec IR Update 12/22/17

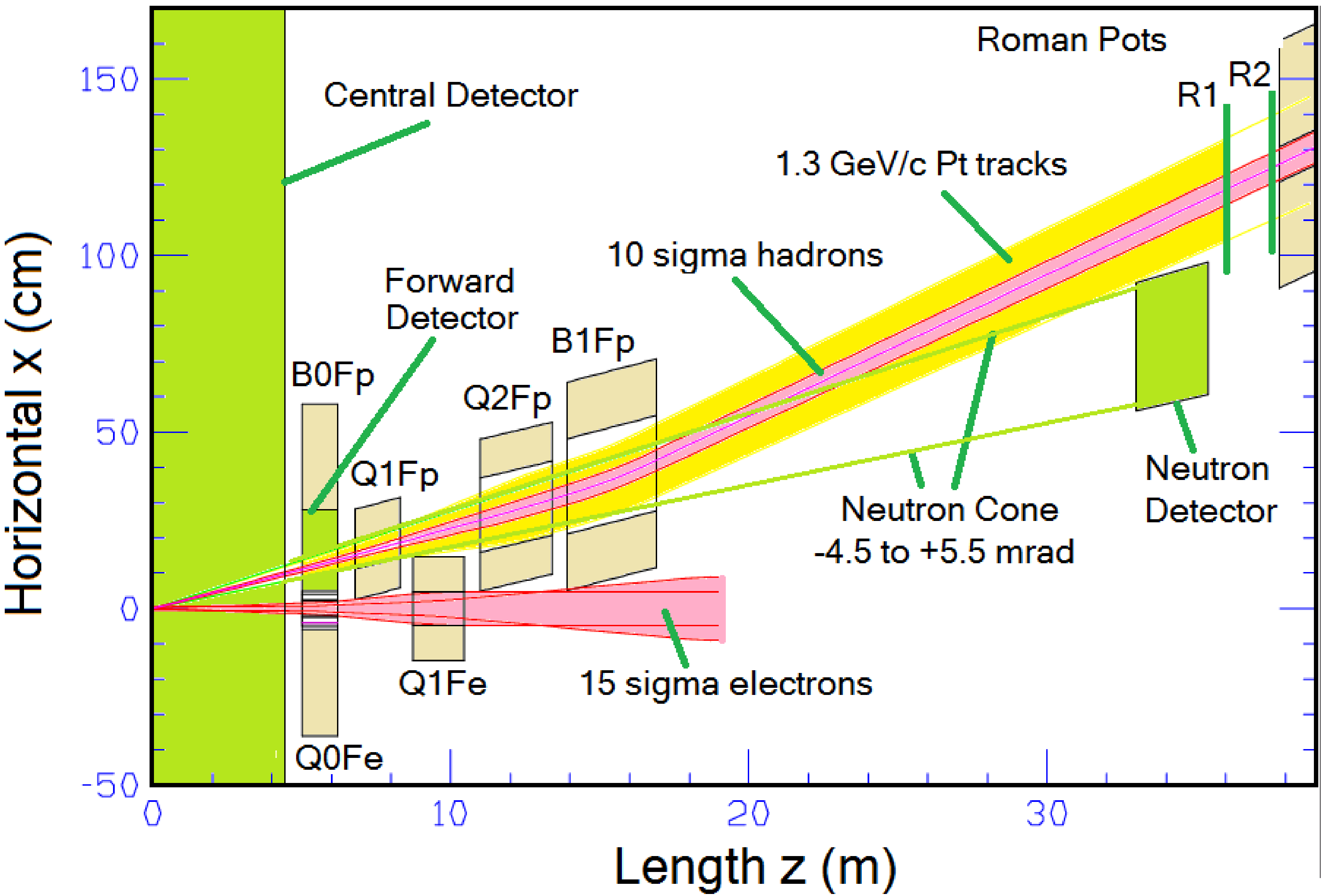
Bob Palmer

Contents

1 Introduction



1.1 Forward Layout



Hadron Forward Magnet Parameters

Hadron 275 GeV

		L1	DL	gap	x	θ	IR	OR	B	Grad)
		m	m	m	cm	mrad	cm	cm	T	T/m
B0	3	5.00	1.20	0.60	11.0	0.00	17.00	47.0	1.26 (1.3)	0.000
Q1	5	6.80	1.50	2.70	15.4	22.00	4.20	12.8	5.641	-131.0 (134.3)
Q2	7	11.00	2.40	0.50	26.4	20.00	10.50	21.5	4.622	44.1 (44.0)
B1	9	13.90	3.00	20.90	34.6	22.00	13.50	29.5	4.574 (4.574)	0.000

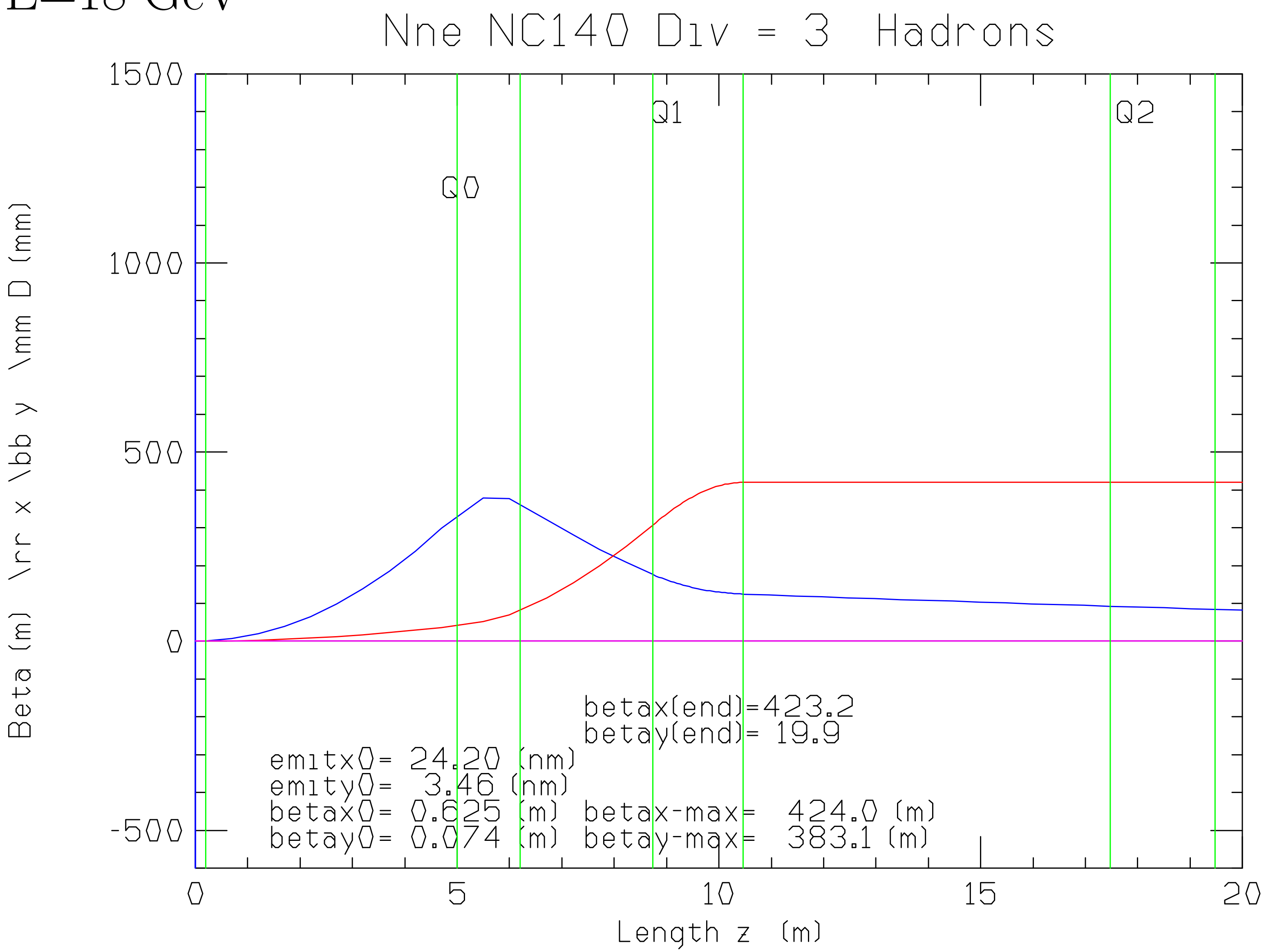
Red=Guillaume   parentheses on values used in initial design

Electron 18 GeV

		L1	DL	gap	x	θ	IR	OR	B	Grad)
		m	m	m	cm	mrad	cm	cm	T	T/m
Q0	3	5.00	1.20	2.54	0.0	0.00	2.20	5.0	0.309	-14.061
Q1	5	8.74	1.72	7.02	0.0	0.00	4.85	14.7	0.282	5.996

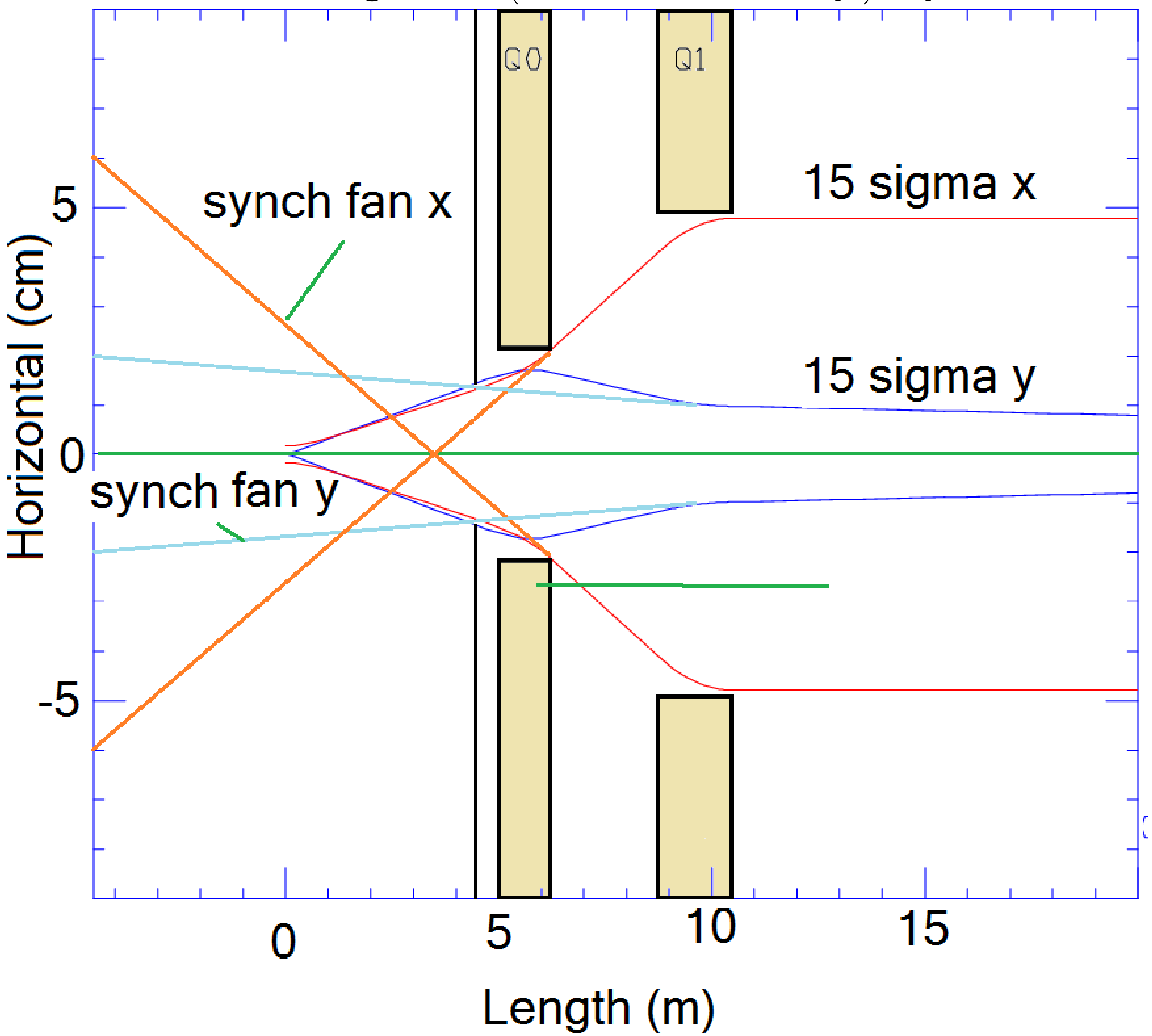
Forward electrons betas

E=18 GeV

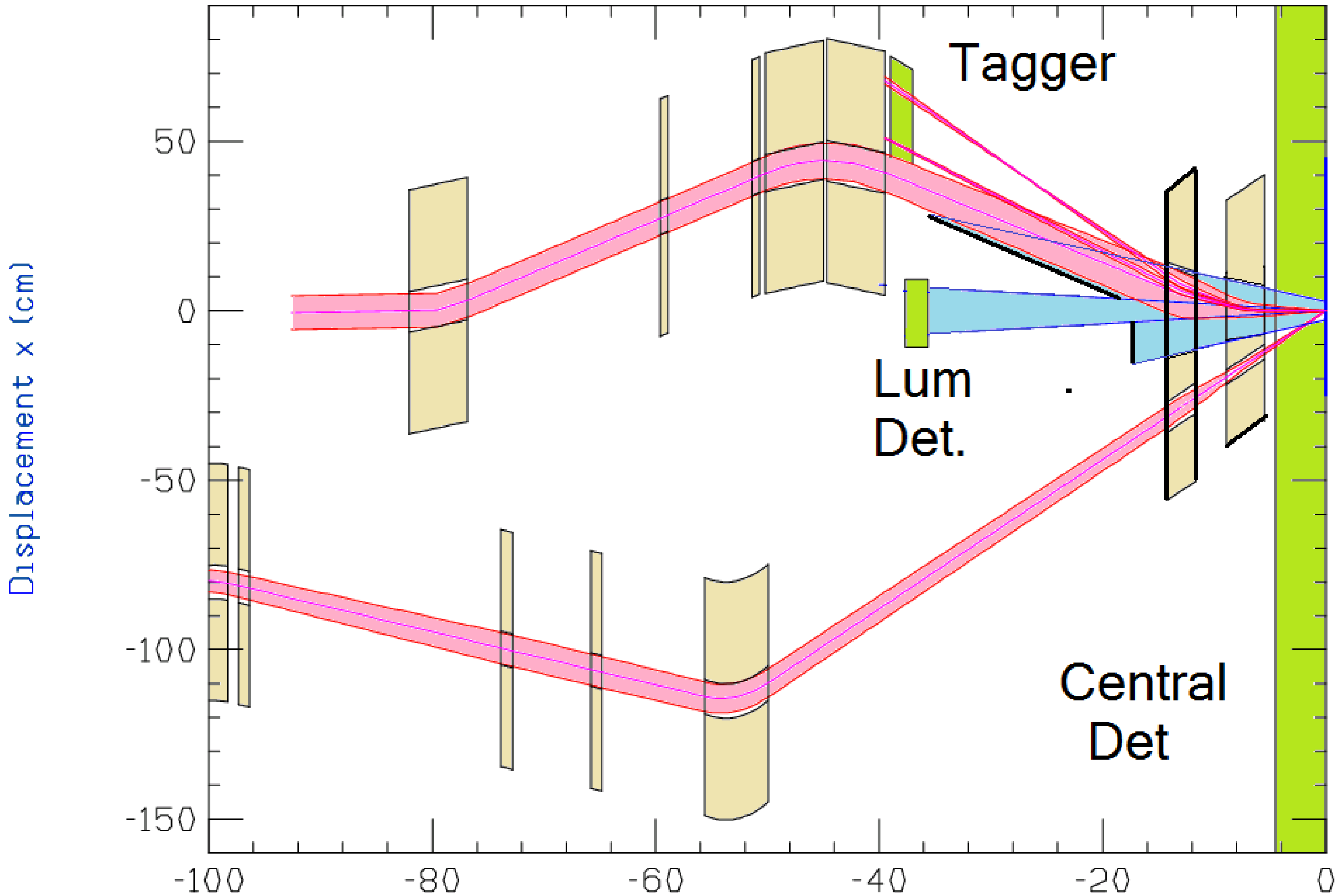


Electron amplitudes & Synchrotron Fan

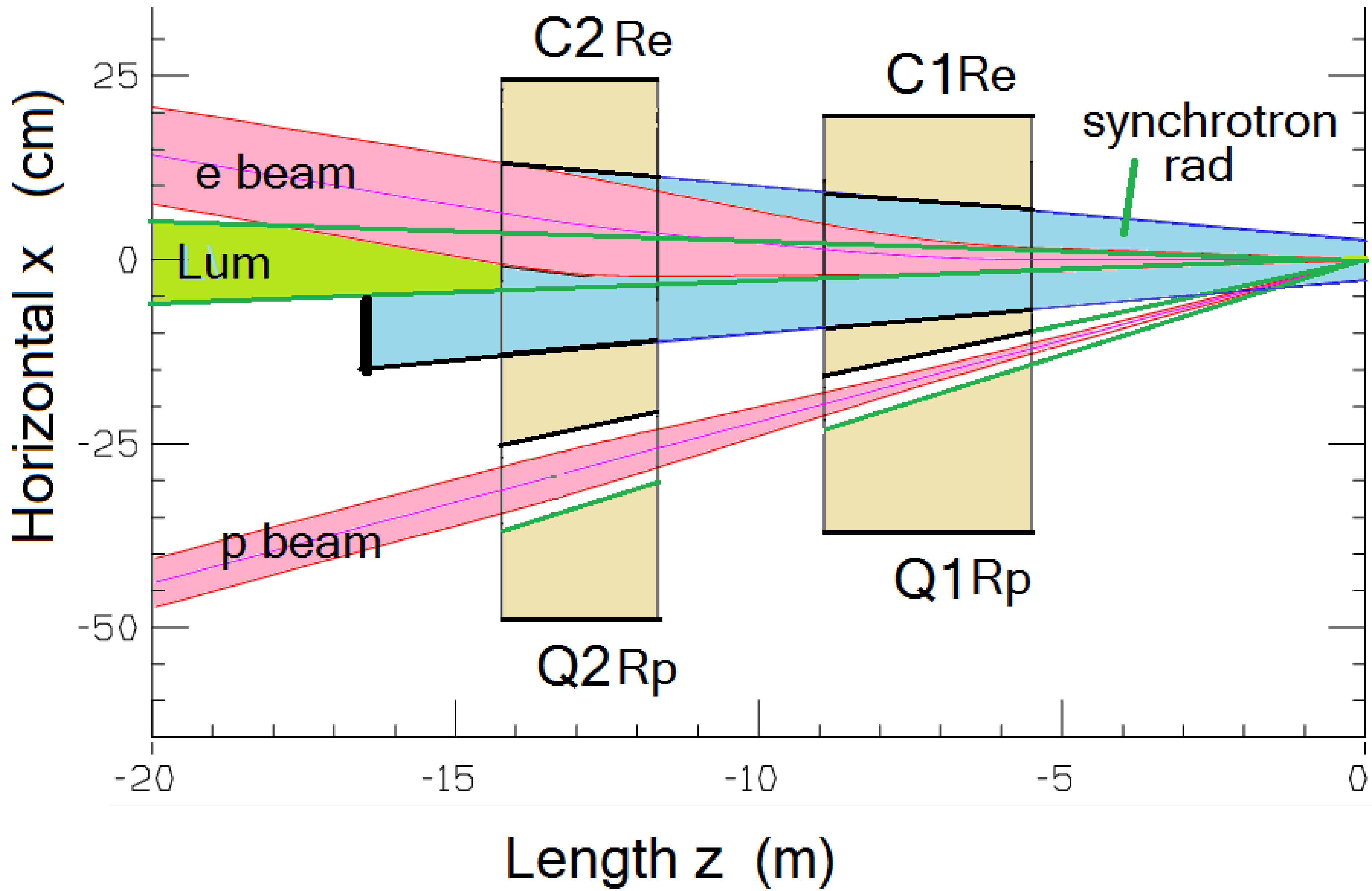
Shown at 15 sigmas (red=x blue=y) synch fans also shown



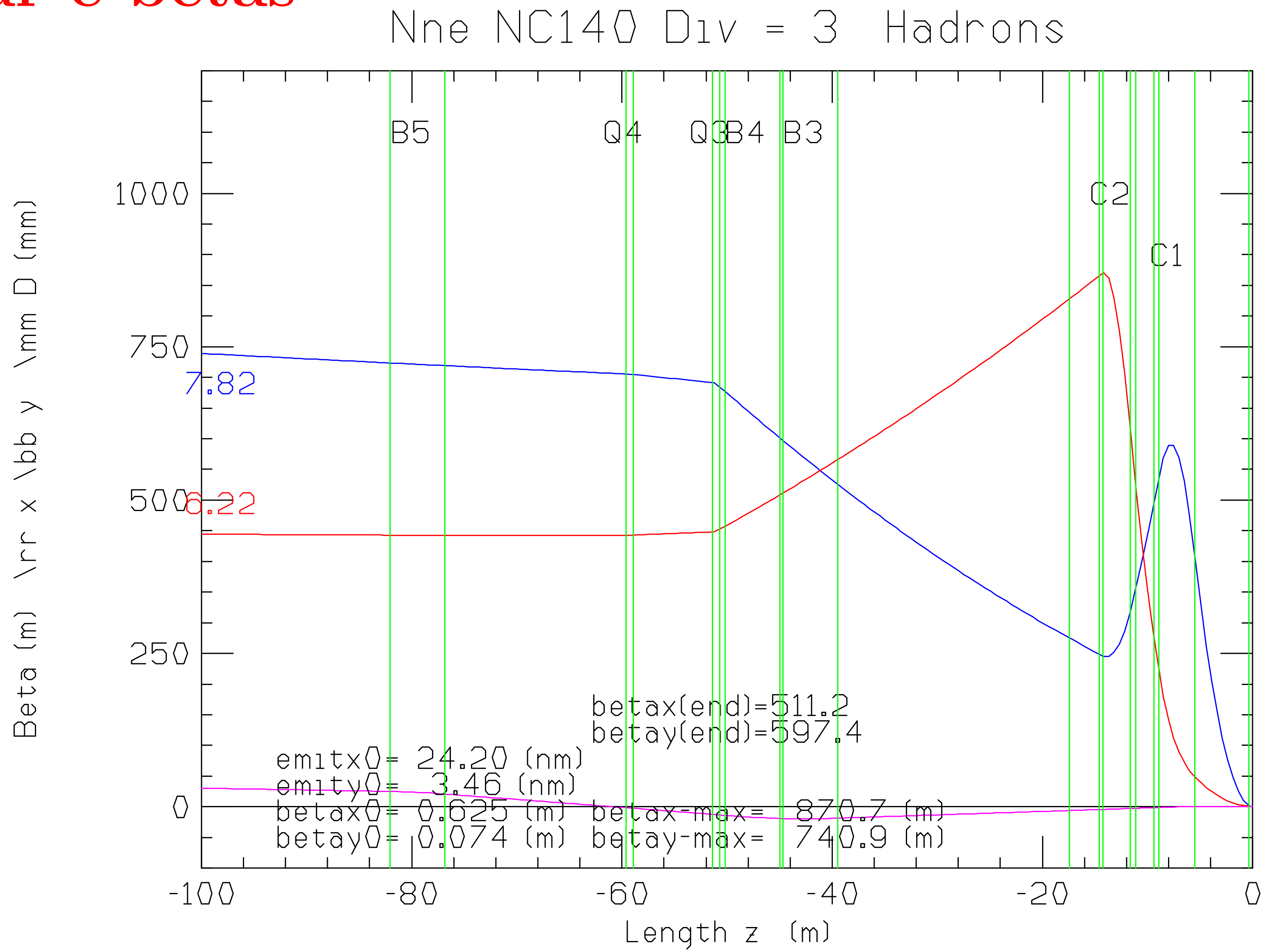
1.2 Rear Side layout



Rear Layout Detail



Rear e betas


Nne NC140 Dıv = 3 Hadrons
B5
Q4
Q3B4 B3
C2
C1
1000
750
500
250
0
7.82
6.22
Beta (m) \rr x \bb y \mm D (mm)
betax(end)=511.2
betay(end)=597.4
emıtx0= 24.20 (nm)
emıty0= 3.46 (nm)
betax0= 0.625 (m) betax-max= 870.7 (m)
betay0= 0.074 (m) betay-max= 740.9 (m)
-100
-80
-60
-40
-20
0
Length z (m)

Rear Magnet Parameters

Hadrons mom = 275 GeV

mnnp3Rw.tab

		L1	DL	gap	x	θ	IR	OR	B	Grad)
		m	m	m	cm	mrad	cm	cm	T	T/m
Q1	3	5.50	3.42	2.75	-12.1	-22.00	2.08*	52.2	1.394	-63.375
Q2	5	11.67	2.57	2.69	-25.8	-22.00	4.50*	64.5	1.931	42.900

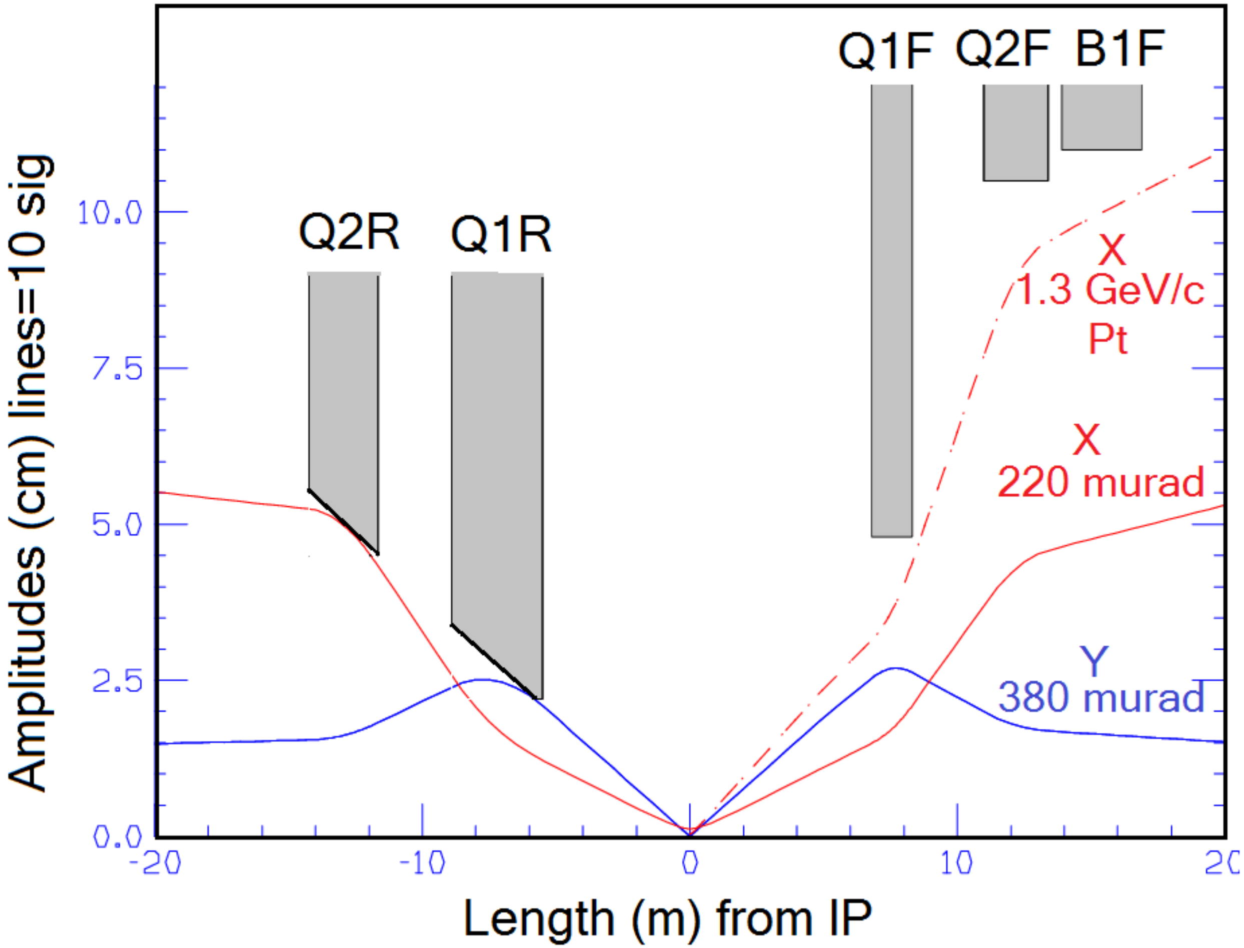
Electrons mom = 18 GeV

mnne3Rv.tab

		L1	DL	gap	x	θ	IR	OR	B	Bpt	Grad)
		m	m	m	cm	mrad	cm	cm	T	T	T/m
C1	3	5.50	3.42	2.75	2.8	-7.30	9.50*	9.5	0.137	0.390	-4.107
C2	7	11.67	2.57	0.37	3.5	10.00	7.50*	7.5	0.137	0.242	3.227

Note*: Dimensions nearest IP and tapered $\propto$ abs. dist from IP

Limiting hadron apertures

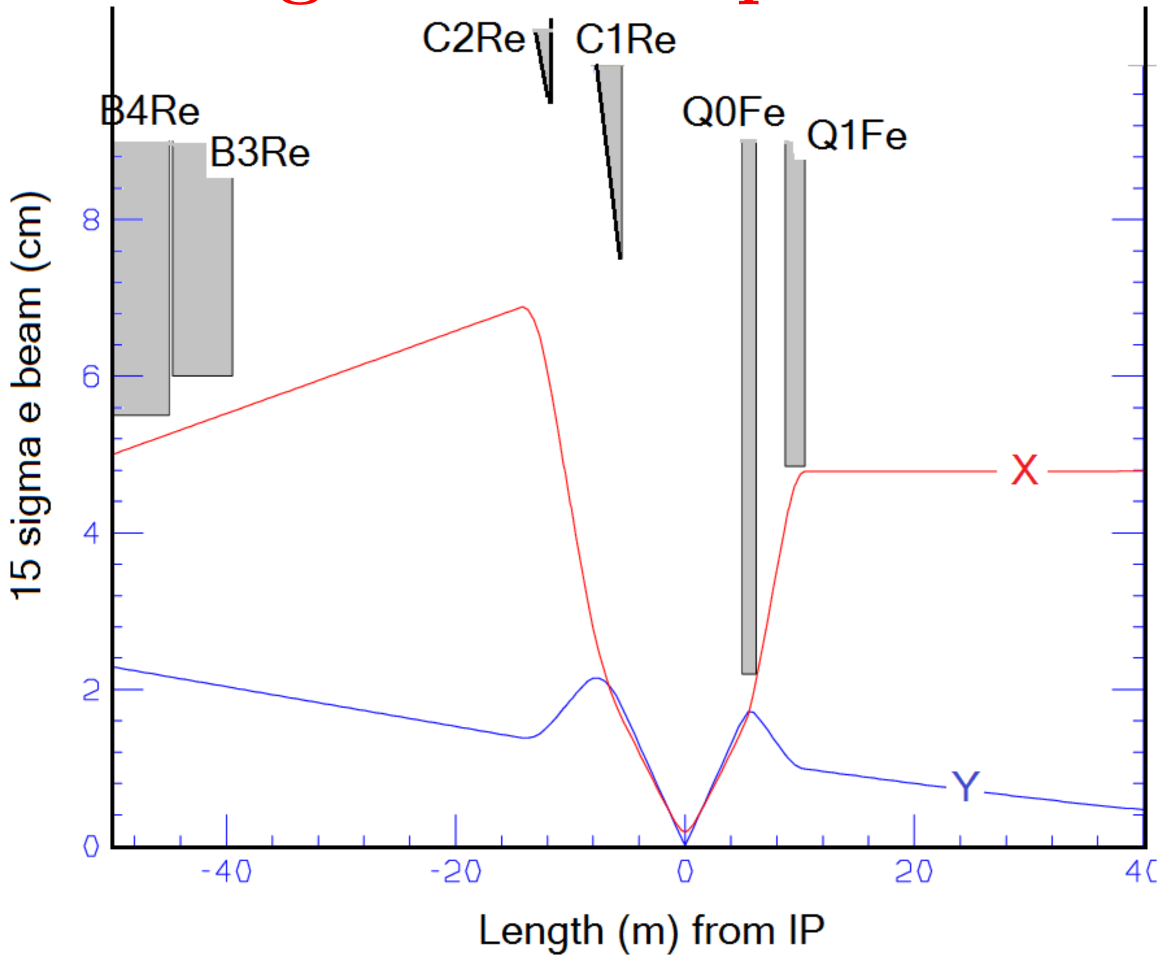


Forward apertures set for 1.3 GeV/c Pt

Rear Q1Rp apertures set for 10 σ of 380 μrad divergence in y

Rear Q2Rp apertures set for 10 σ of 220μrad divergence in x

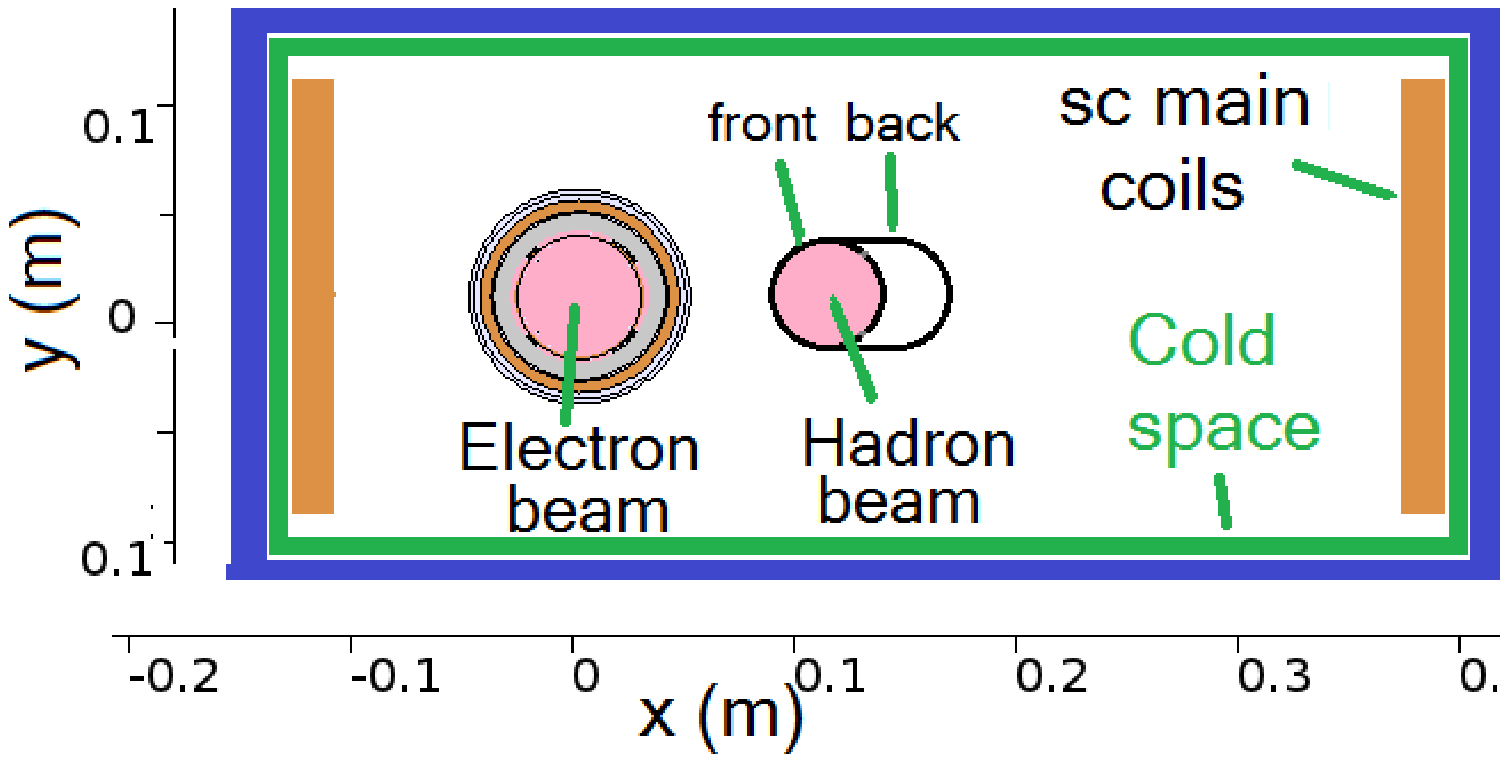
Limiting electron apertures



Q0Fp and Q1Fe set for 15 σ of 380 μrad divergence in x
Rear C1Re and C2Re set for 15 sigma synchrotron radiation

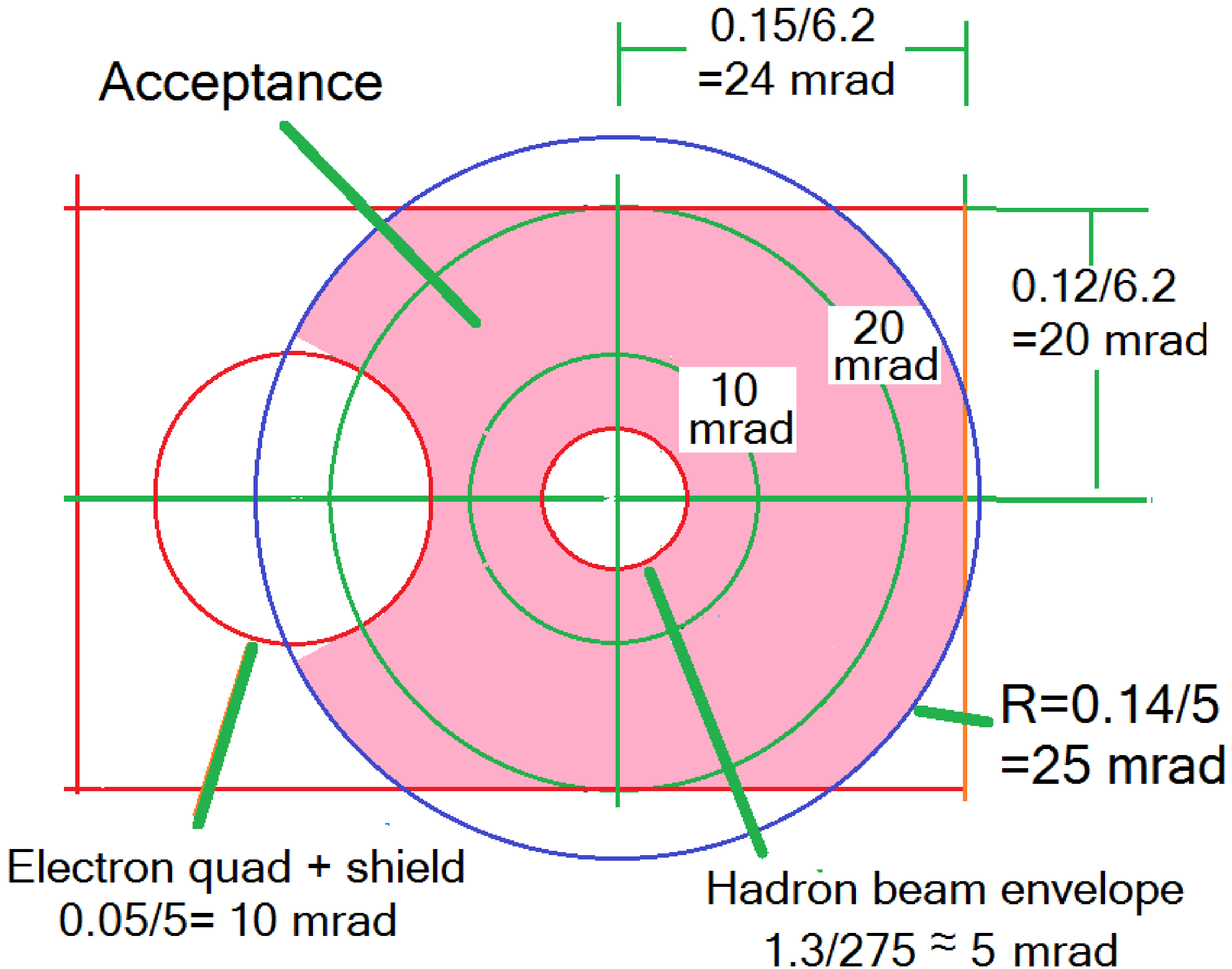
2 Detectors

2.1 Forward Spectrometer

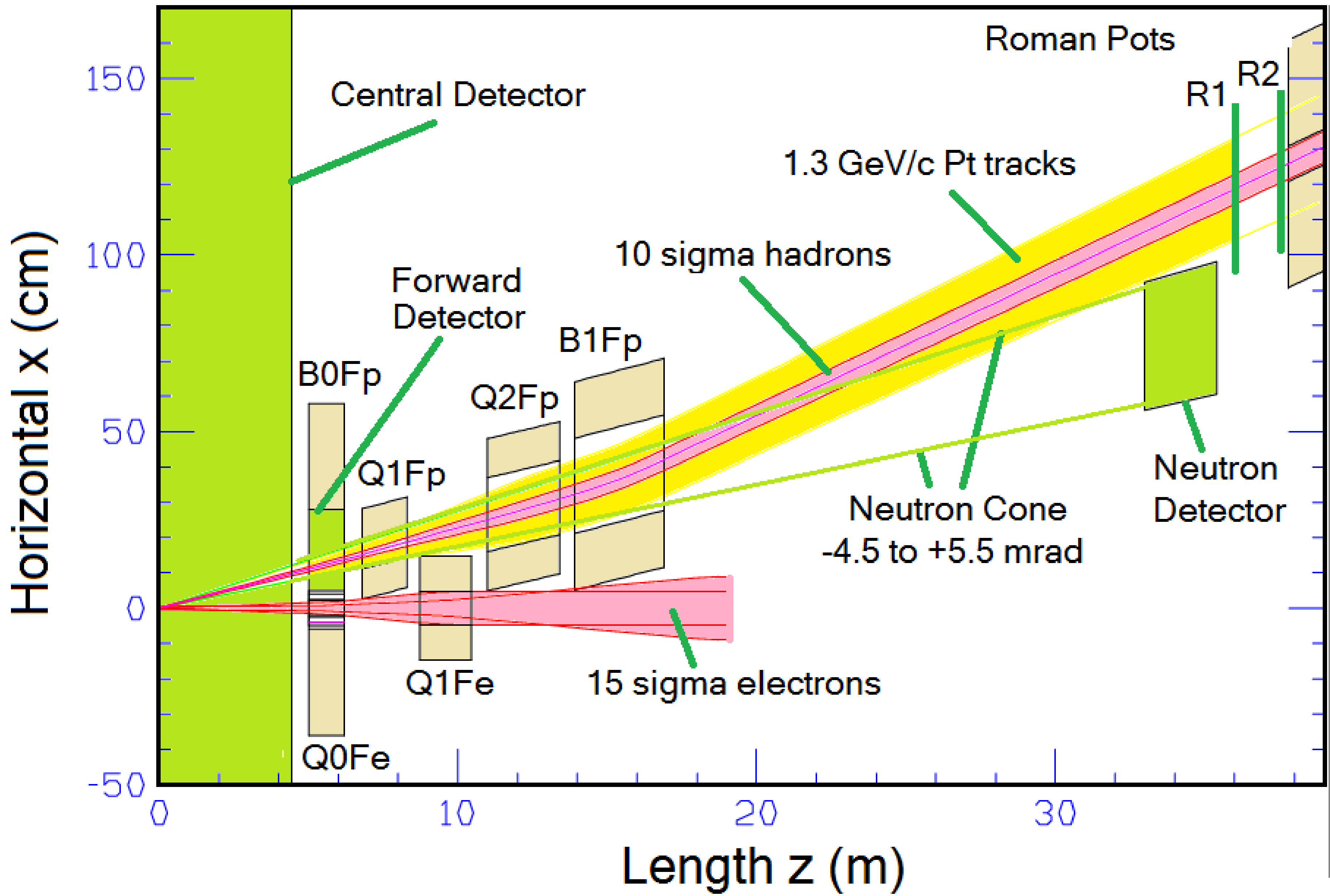


The spectrometer detectors inside their magnet will run cold (4 K or 77 K) to minimize the needed space between them and the magnets surrounding the electron beam

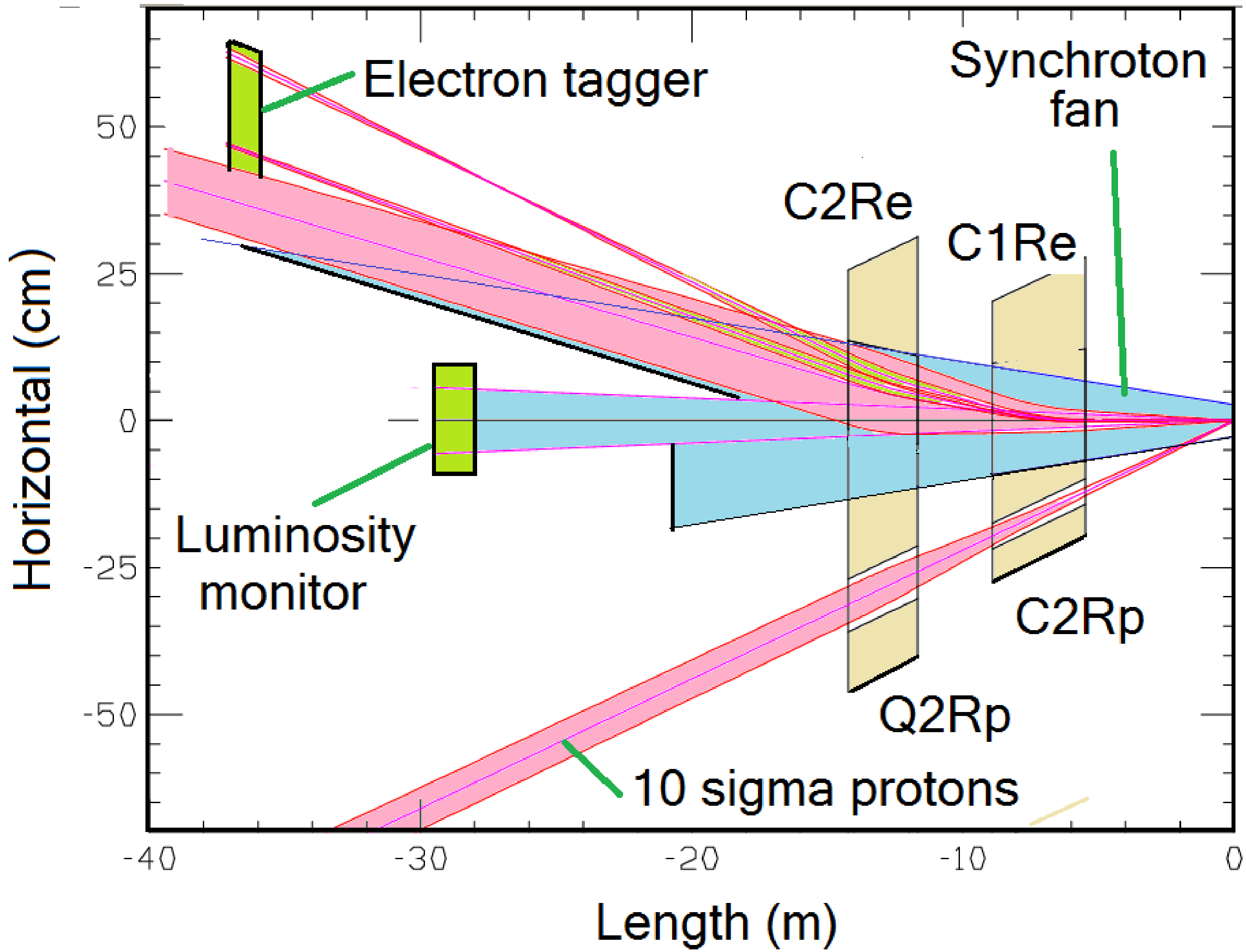
Projected angular acceptance



2.2 Other Forward Detectors



Rear Detectors



3 Magnets

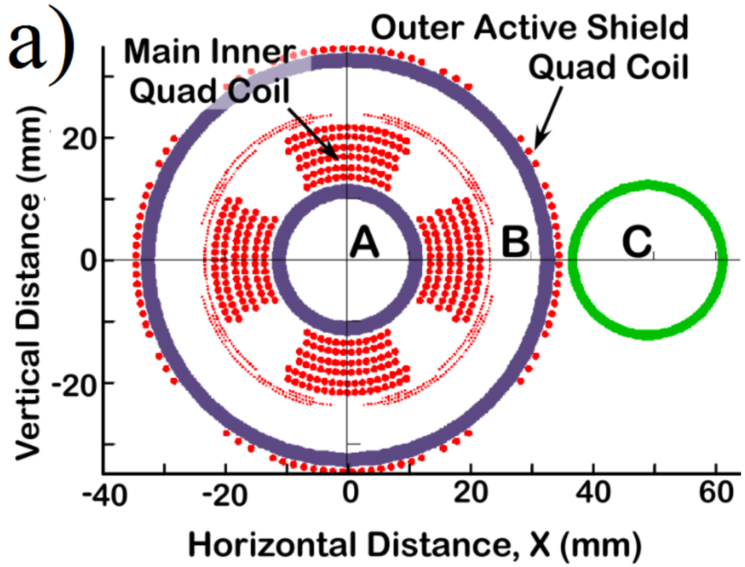
3.1 Active shield Concept

For many of the IR hadron magnets it is necessary to provide a shield to avoid excessive synchrotron radiation. Since the space between the two beams is so close, there is often too little space to introduce enough iron to achieve this. Instead, either the electron beam, or the hadron beam can be dynamically shielded by a coil that exactly cancels the stronger hadron magnet's field on the electrons.

In the case of the forward spectrometer the hadron dipole surrounds the electron beam, and a bucking dipole around the electrons cancels it. In the following hadron focusing quadrupole is close to the electron beam and is shielded by a bucking (anti-) quadrupole surrounds the primary quadrupole cancelling its stray field outside it.

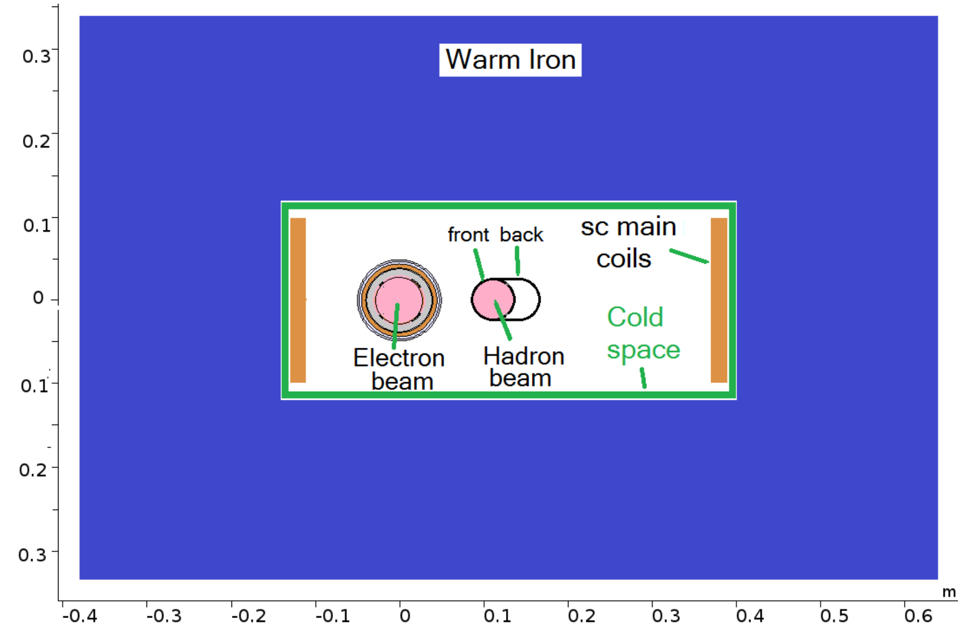
Example of dynamic shielding

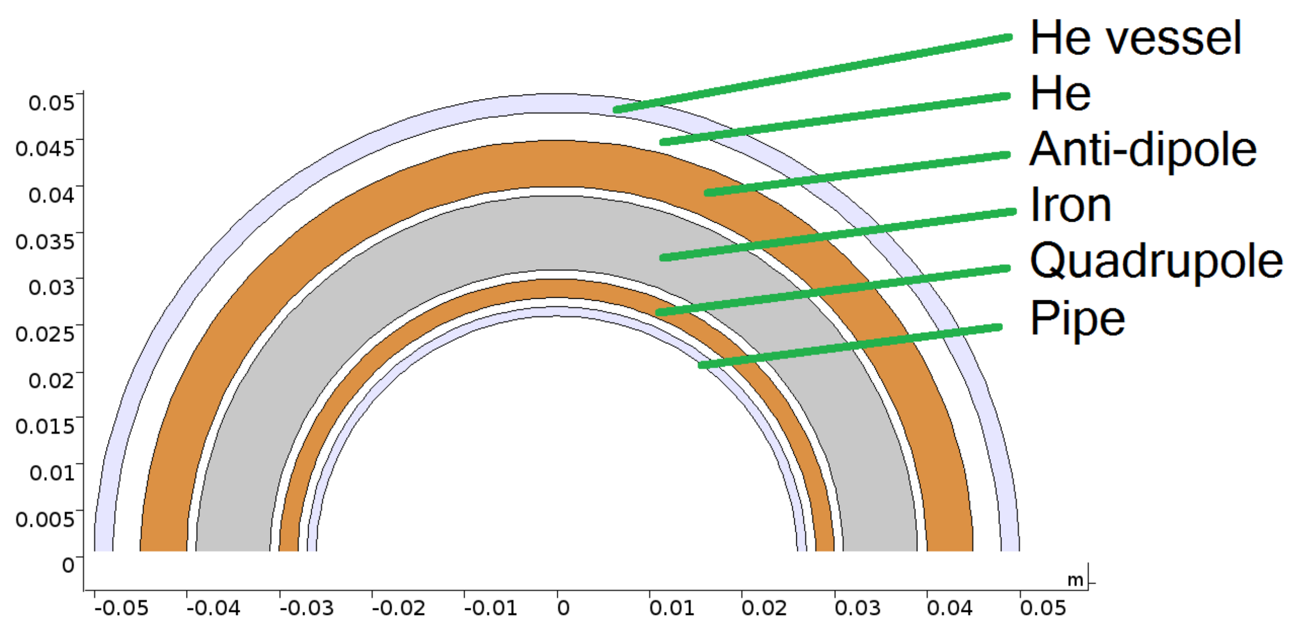
Built, for another project, and tested at BNL.



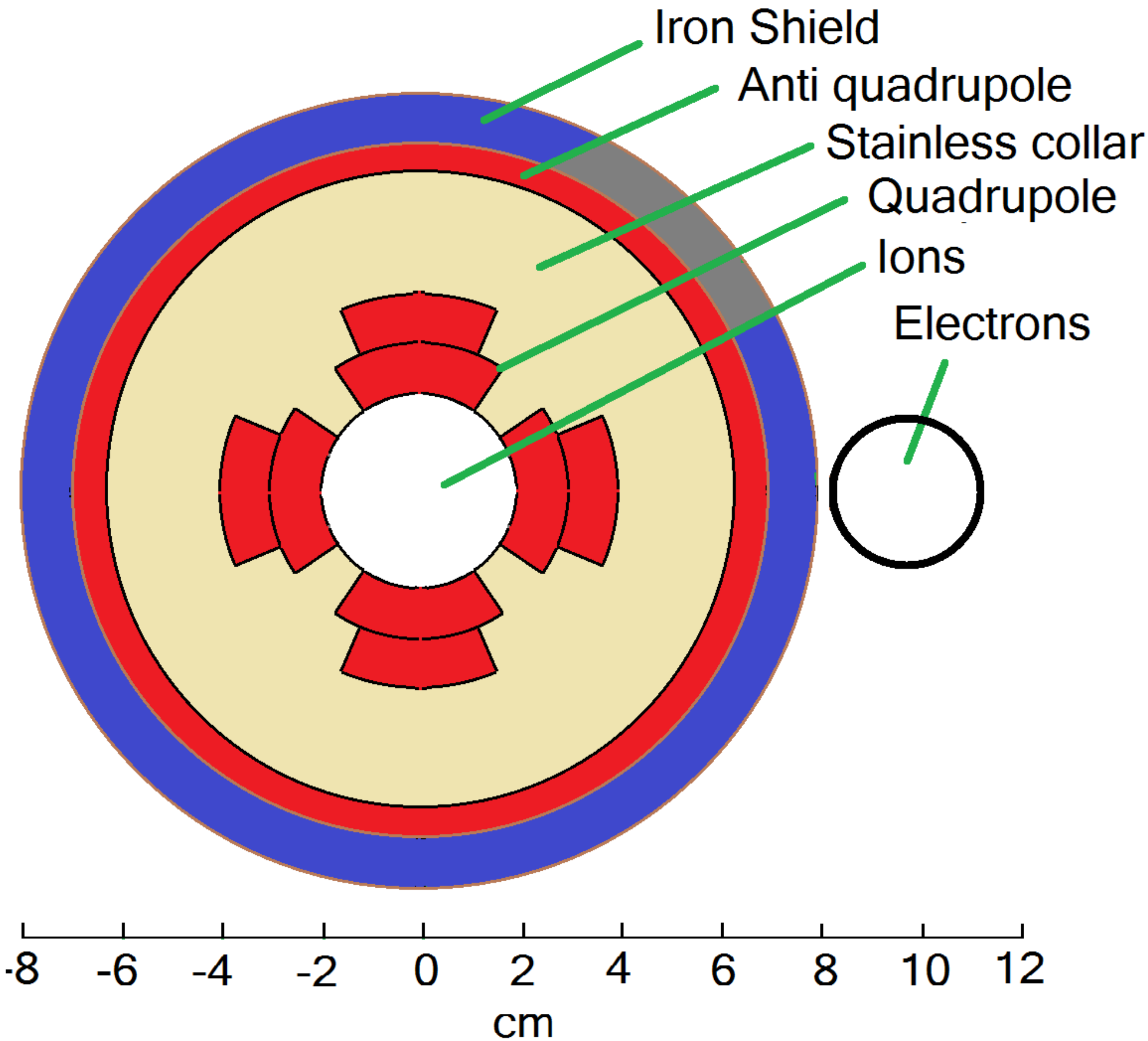
3.2 Forward Spectrometer (B0pf) and Q0Fe

The spectrometer magnet in the forward hadron beam is a 1.3 T bending magnet that contributes to the dog leg that takes the beam clear of the forward neutron detector.



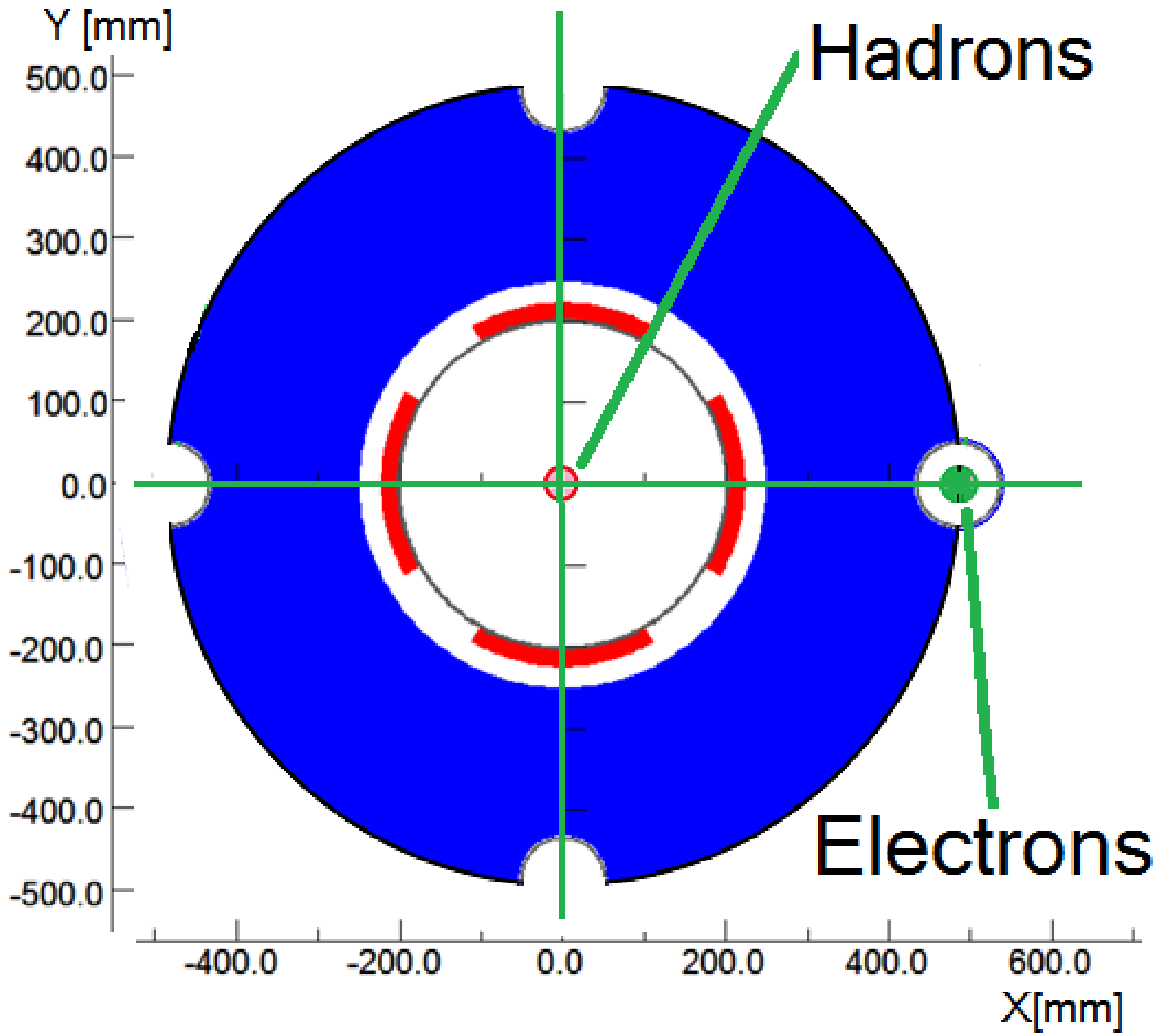


First Forward Hadron Quad: Q1Fp

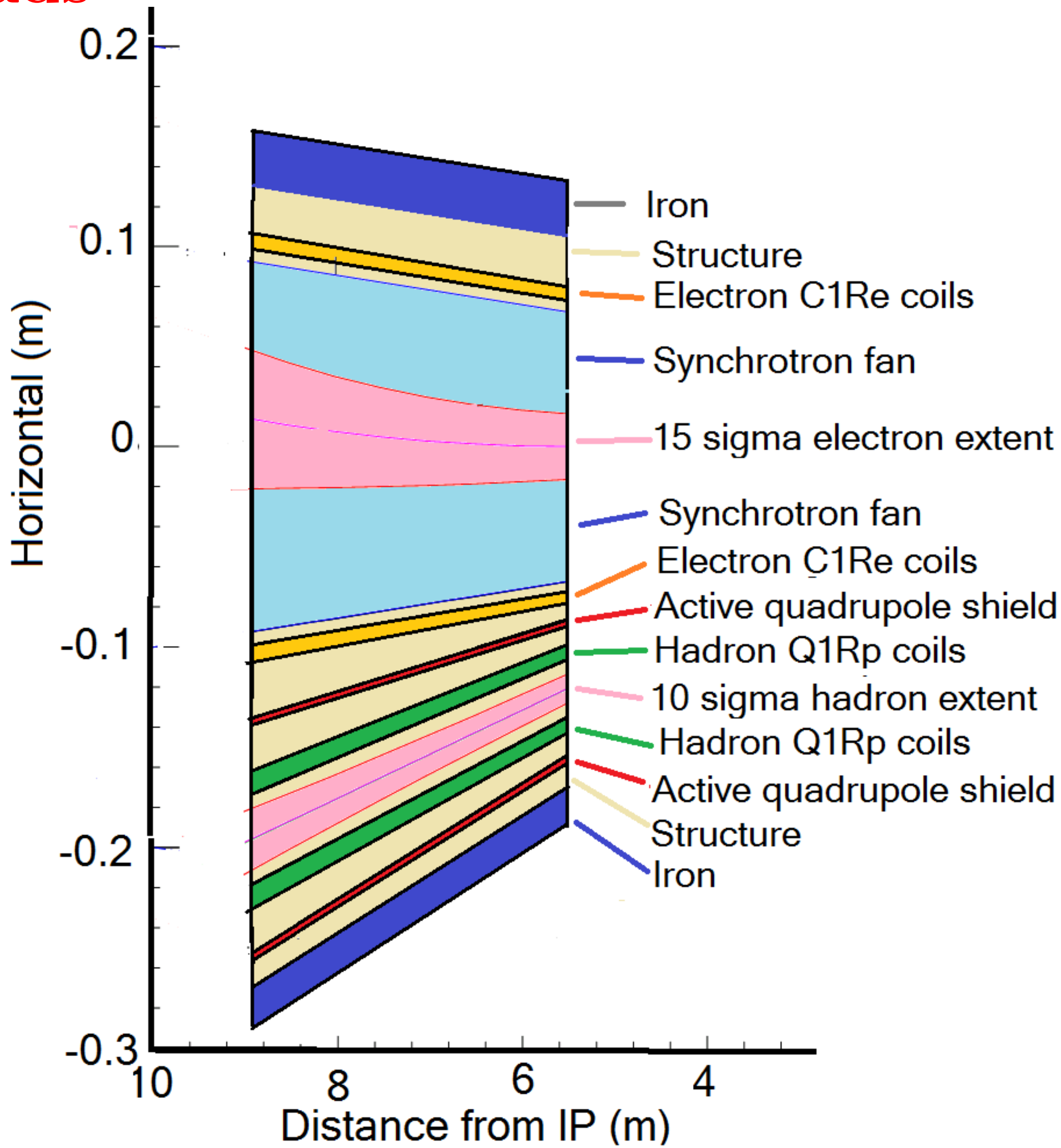


3.3 Second Forward Hadron quad Q2Fp

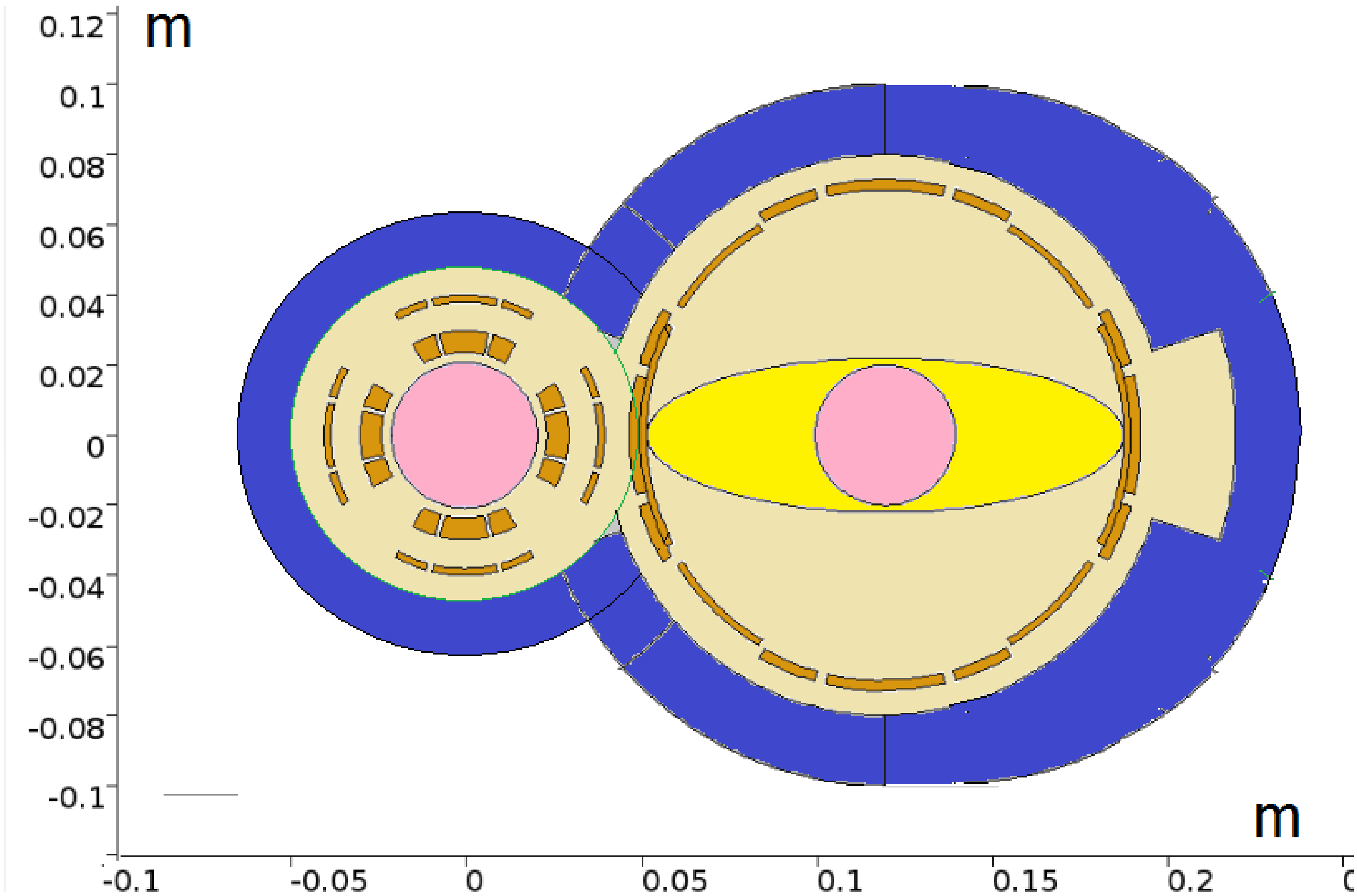
Could use active shielding as in Q1pF, or :



3.4 First Rear Quads C1Re & Q1Rp



Section



There is also a slotted Iron design.

Holger Witte's Comment

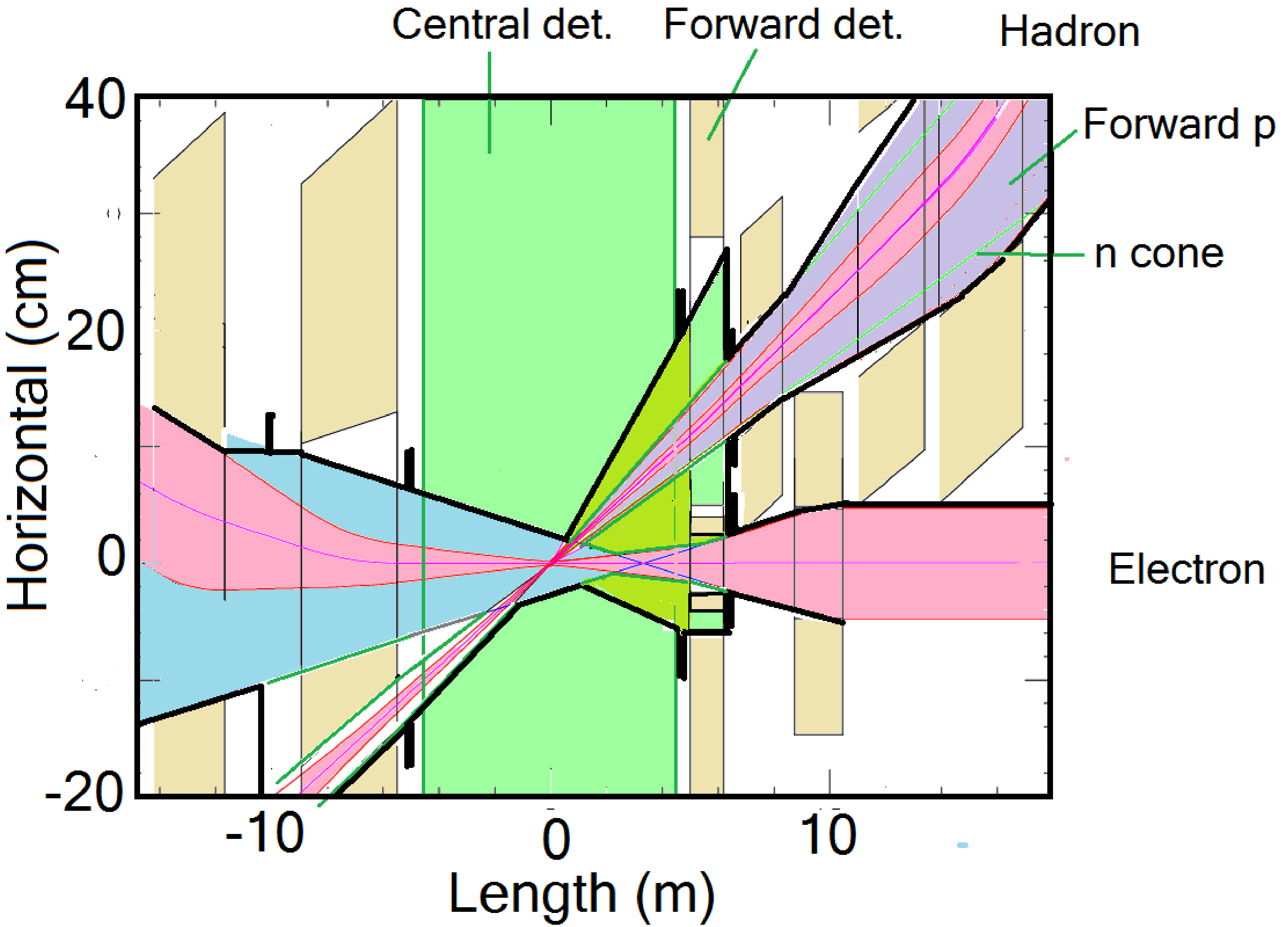
"The design looks challenging - on paper this is ok at the moment, but my concern is that when we start to look into this in detail it will fall apart."

In this case we can lower the temperature to 2 K, as is probably also needed for Q1Fp.

3.5 Second Quads: C2Re & Q2Rp

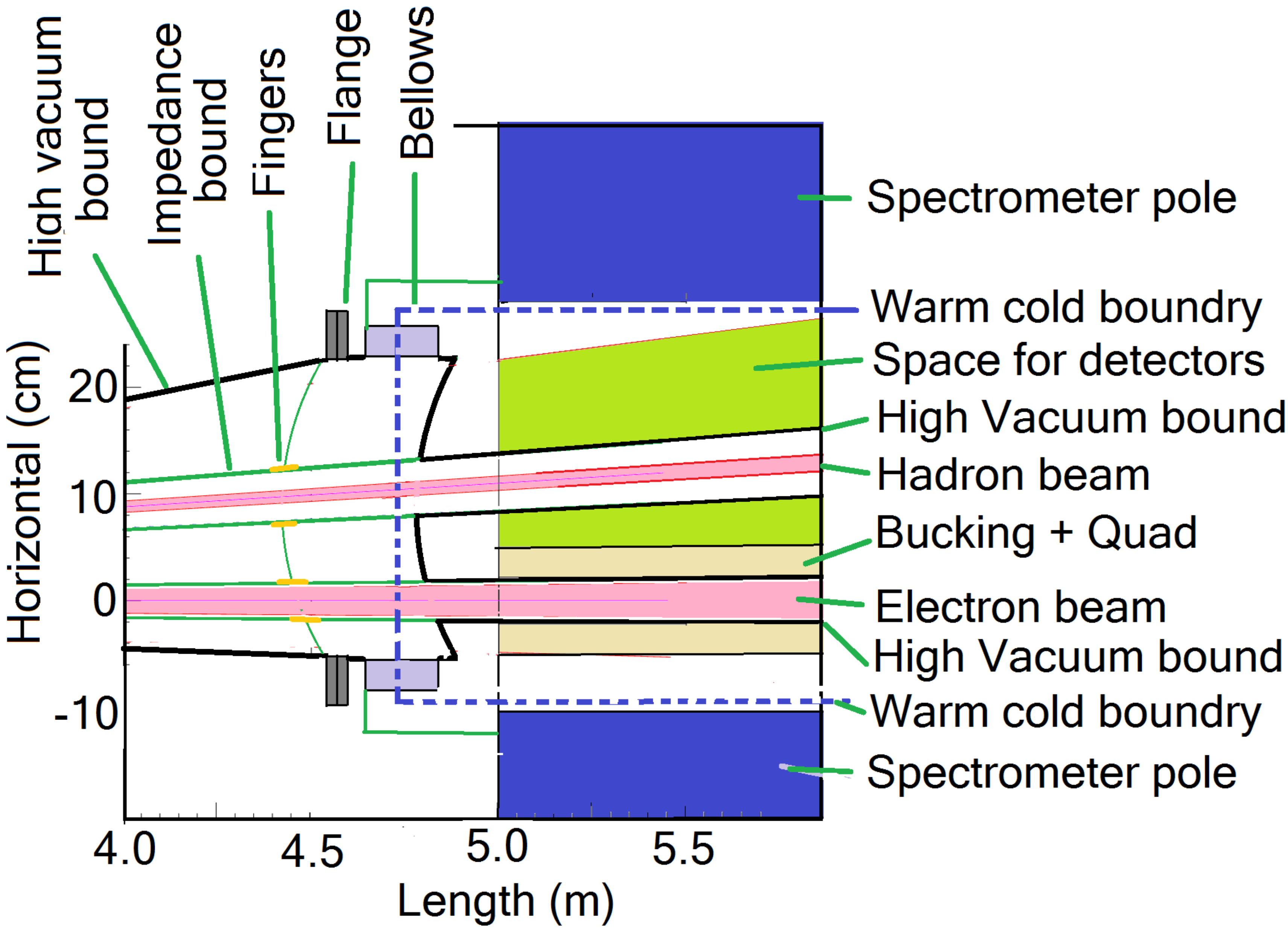
Could be similar to C1 but with more space between beams, it may not need to be tapered

4 Vacuum

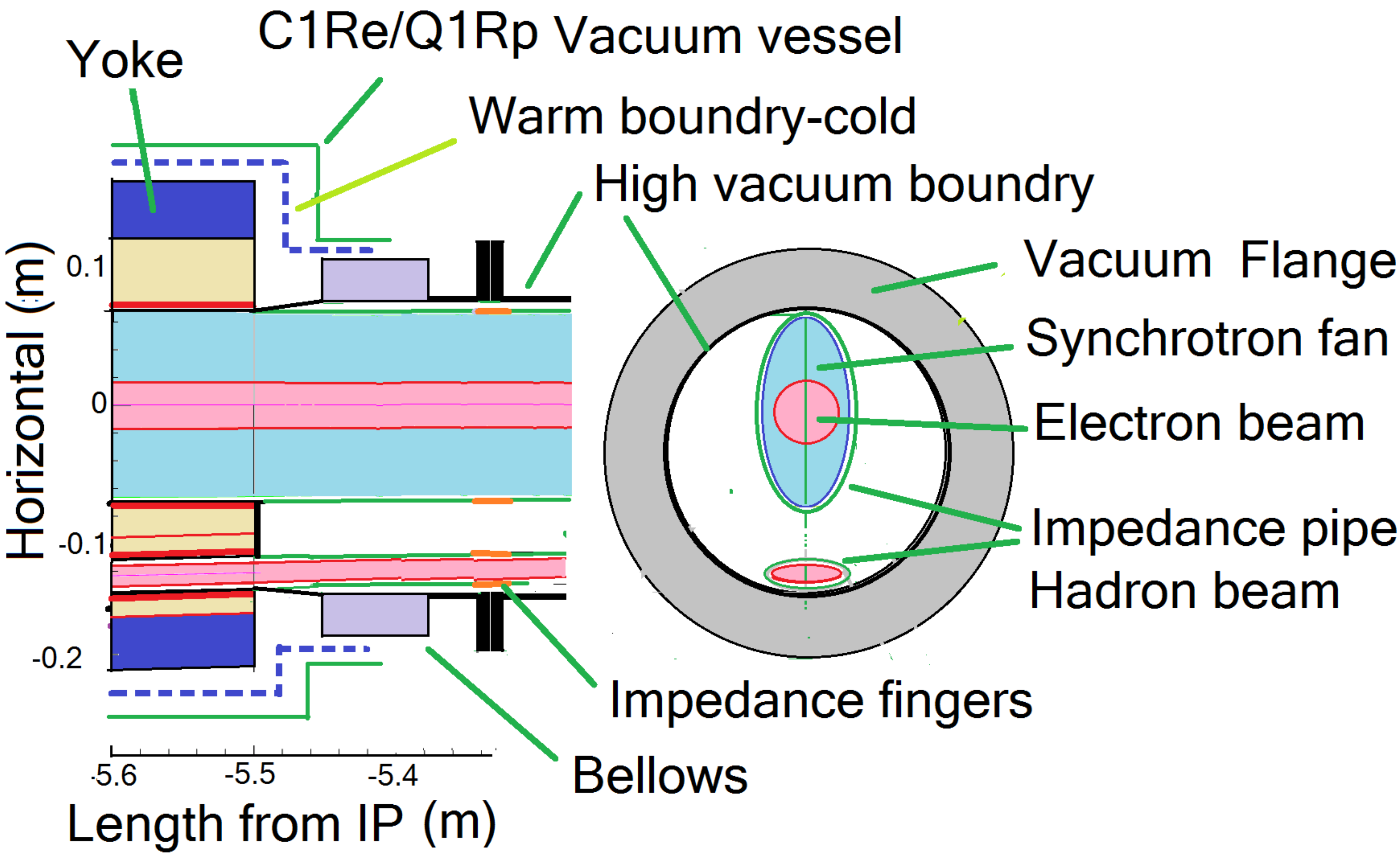


detail-IR-2c

Forward Flange & Bellows



Rear Flange & Bellows



December 22, 2017 High Divergence forward hadrons at 275 GeV/c

```
## using Palmer's file is bet87h labelled nnp3h.tex
## The detector solenoid is not included
## note that these values are not identical to those in the current lattice (see page 5 above)
## ----------------------------------------------------------
## Initial conditions at IP
##
## beta*_x  beta*_y  g emit_x g emit_y  angle_x  angle_y
##  [m]      [m]      [nm]     [nm]     [mrad]   [mrad]
##
  0.9440   0.0420     16.1000    6.1000      22      0
## -----------------------------------------------------------
## magnet parameters
##
##name  center_z center_x center_y radius   length   angle      B      gradient
##           [m]      [m]      [m]      [m]      [m]    [mrad]     [T]      [T/m]
##
  B0pf    5.599  -0.0132    0.00   0.1700    1.200   -22.00   -1.300      0.00
  Q1pf    7.548   0.0040    0.00   0.0420    1.500     0.00    0.000   -134.32
  Q2pf   12.197   0.0201    0.00   0.1050    2.400    -2.00    0.000     44.02
  B1pf   15.396   0.0400    0.00   0.1350    3.000     0.00   -4.574      0.00
## x=0, z=0, y=0 is at the center of the IP
## The z axis is aligned with the initial mean hadron direction
## Only the magnets close to the IP are given, those further away must come from the
## lattices
## ------------------------------------------------------------------------------
##
## parameters at the Roman Pots for HA2
##
##loc     Z      beta_x   beta_y   adv_x    adv_y    Disp
##       [m]    [m]      [m]      rad/pi    rad/pi   {m}
##
  R1    36.00   1105.2   197.73   0.488    0.53    0.343
  R2    39.00   1188.7   174.19   0.489    0.54    0.387
##
##===============================================
## 10 sigma beam outlines and magnet apertures for 275 GeV protons in above HD case
## These numbers use the above initial values, rather than the current lattice
##
## name(i)  thetax    L(m)  cenx(cm)  ceny topx(cm) botx  topy(cm)  boty betax(m)  betay   magc(cm) top(cm) bot(cm)
  B0( 3 )   0.0000    5.0    0.00   0.00    0.66   -0.66    1.90   -1.90    0.66    1.90     0.00    17.00   -17.00
  gap      1.7018    6.2    0.11   0.00   0.92   -0.71    2.32   -2.32    0.82    2.32     0         0        0
  Q1( 5 )   1.7018    6.8    0.21   0.00    1.10   -0.69    2.53   -2.53    0.90    2.53     0.40     4.60    -3.80
  gap      1.5466    8.3    0.45   0.00   1.70   -0.80    2.63   -2.63    1.25    2.63     0         0        0
```

```
  Q2( 7 )   1.5466   11.0    0.86   0.00    3.08   -1.36    2.00   -2.00    2.22    2.00     2.25    12.75    -8.25
  gap      3.1347   13.4    1.42   0.00    4.17   -1.32    1.69   -1.69    2.75    1.69      0        0        0
  B1( 9 )   3.1347   13.9    1.58   0.00    4.36   -1.20    1.67   -1.67    2.78    1.67     4.00    17.50    -9.50
##
```