Tagger beam pipe collimation of low-energy electrons

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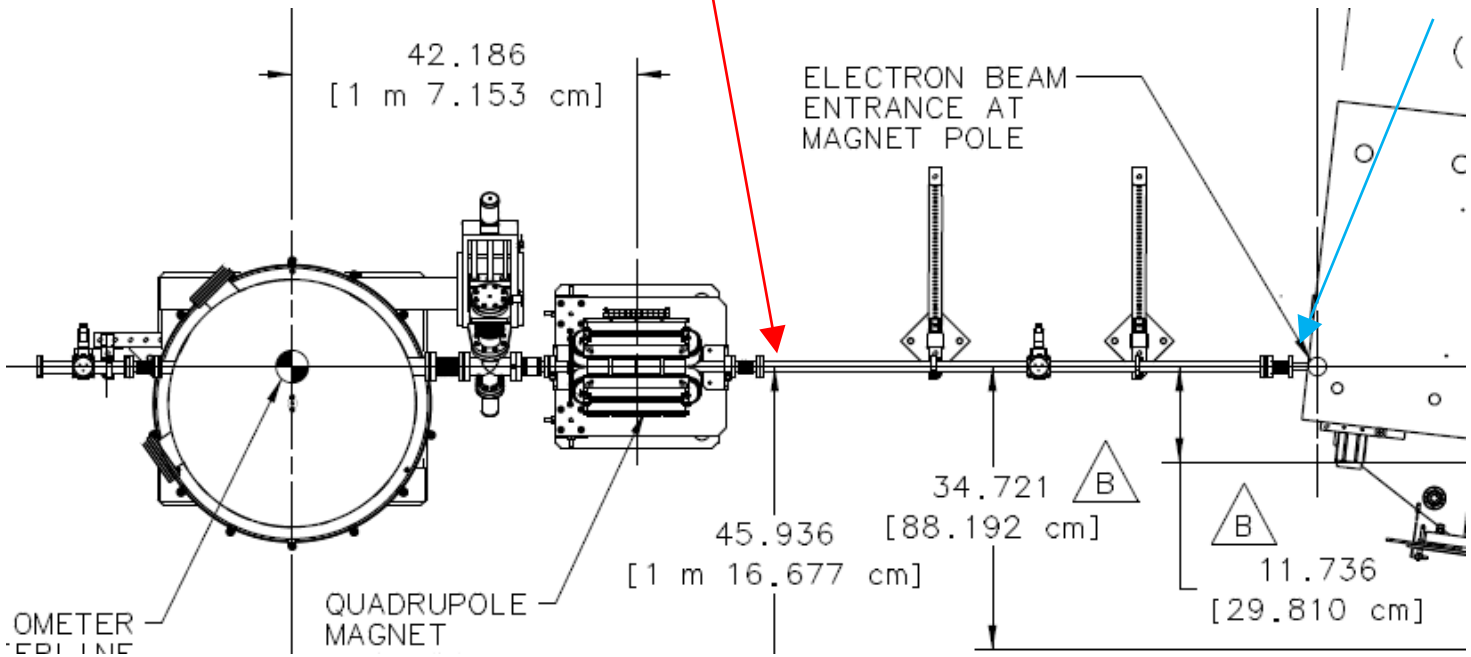
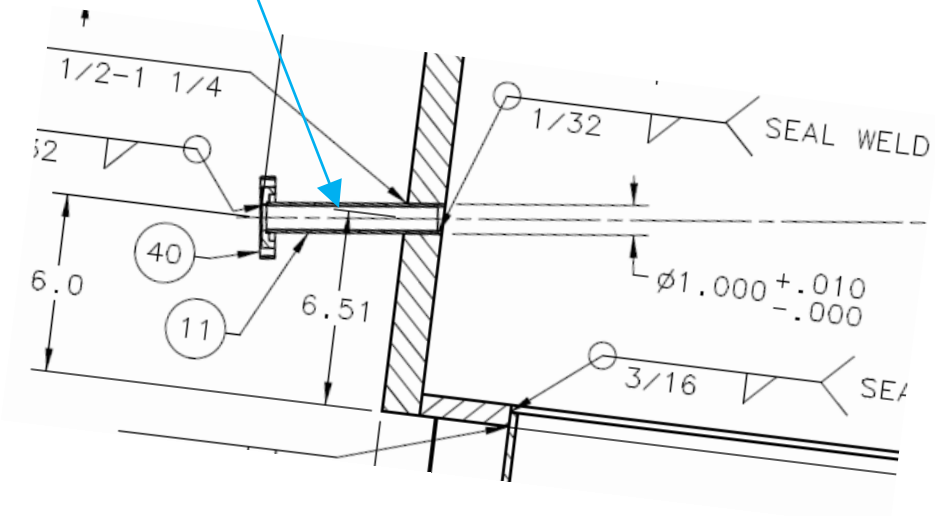
In my previous note on the efficiency of the TAGH hodoscope, I neglected the collimating effects of the beam pipe between the goniometer and the tagger vacuum chamber.

Quad to dipole vacuum flange
28 mm I.D.

Flange to vacuum chamber
20.5 mm I.D.



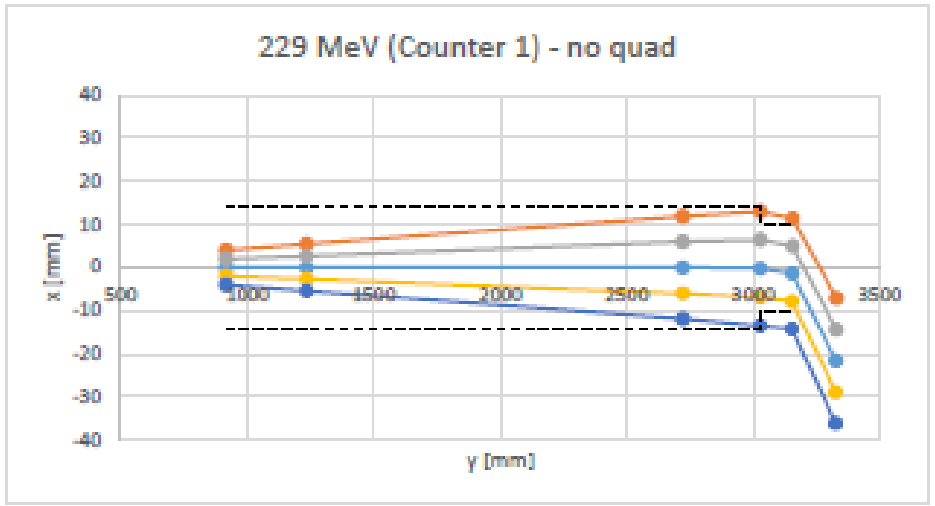


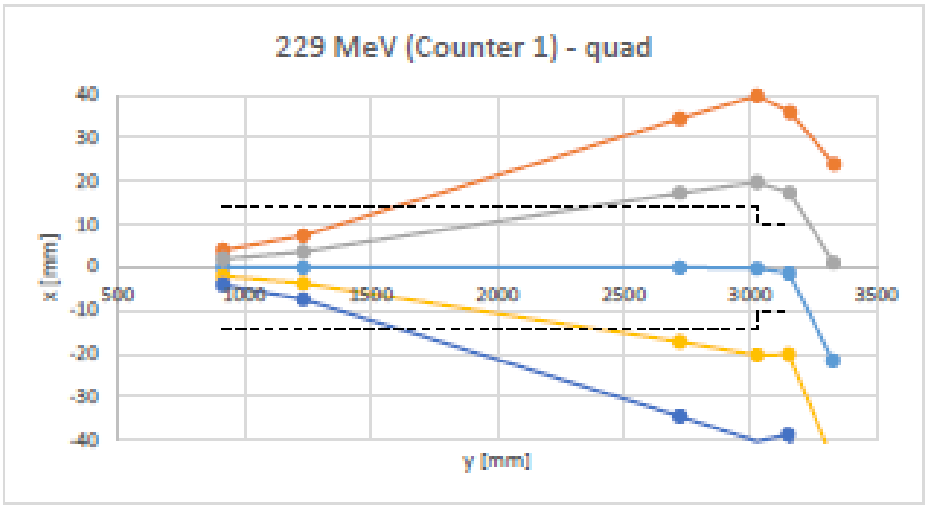
From drawings D…0000-4002-RevB.pdf, p. 5
and D-…1900-1013-C.pdf, p. 3

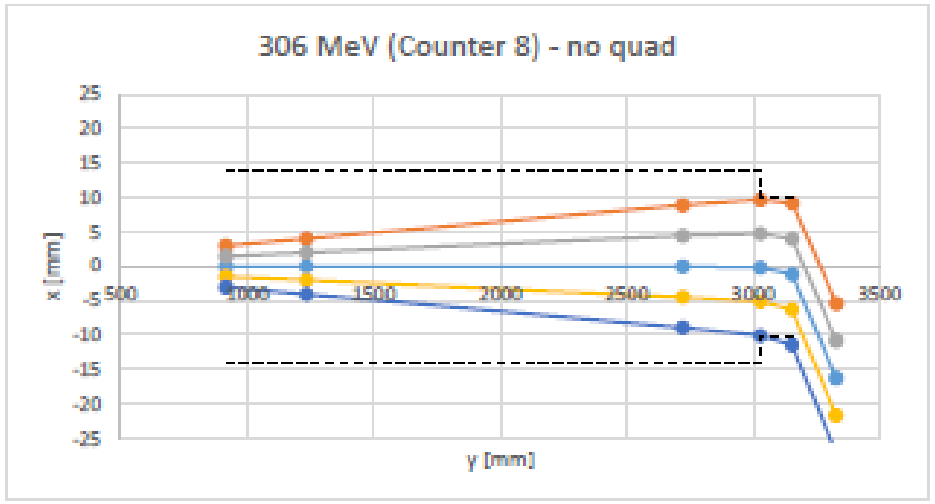
Based on alignment surveys and drawings …1013 and …4002, I have used endplanes at the following distances along the beamline:

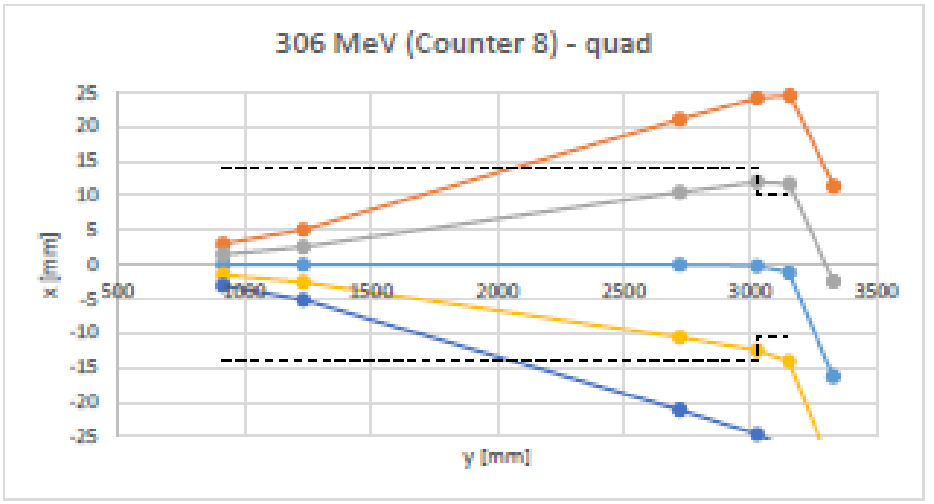
		Endplane	B[Tesla]
Goniometer center	0	0	
Start of quadrupole	0.9162 m	1	
End of quadrupole	1.2342 m	2	
Start of fringe field (“ENTRY” field box)	2.7200 m	3	.0010
Dipole entry flange	3.0275 m	4	.038
Dipole vacuum chamber	3.1533 m	5	.245
Pole root (effective field boundary)	3.1922 m	-	.478
Start uniform field (“MAIN” field box)	3.3287 m	6	1.50

Without and with quadrupole: low-E rays with horizontal angles 0, ±θce, ±2θce:
Horizontal positions at quad entry, quad exit, fringe entry, flange, vacuum chamber, main box entry.
(Dashed lines = vacuum pipe inner radius)









As a function of electron energy E, calculate (in units of θ_{ce})

maximum and minimum horizontal angles – solid curves

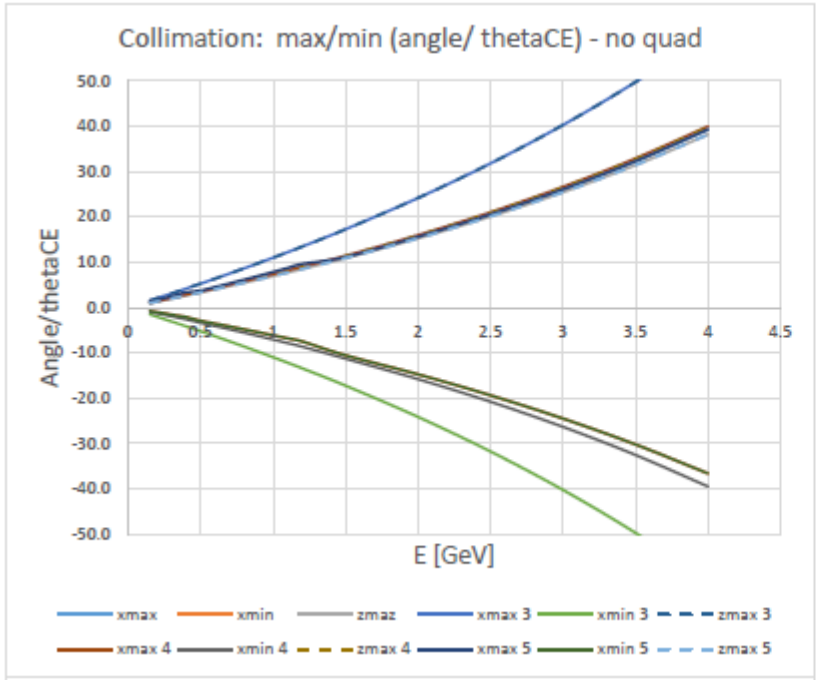
maximum vertical angle (symmetric) – dashed curves

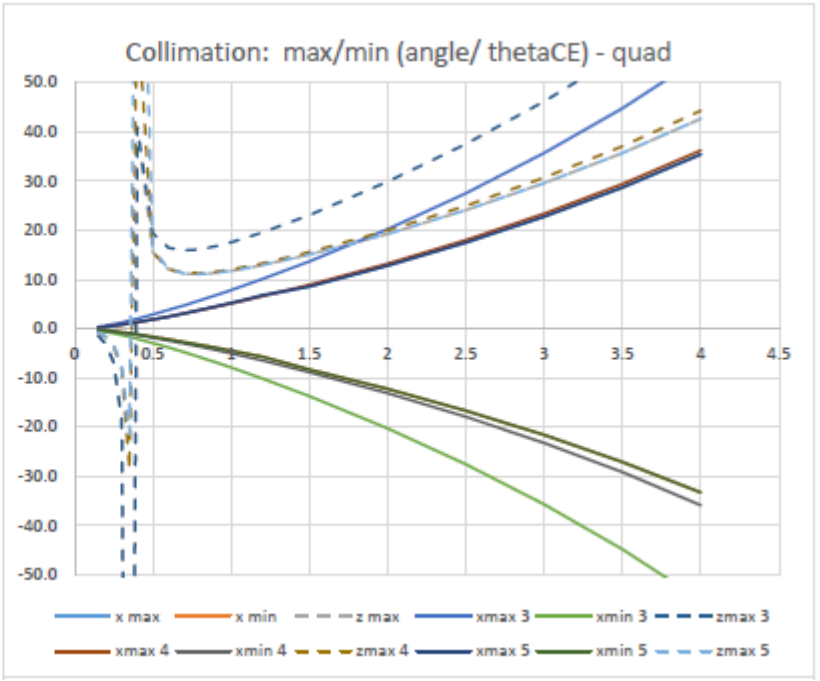
which passes inside the vacuum pipe at each of

endplane 3 start of dipole fringe field

endplane 4 dipole entry flange

endplane 5 dipole vacuum chamber (usually the limiting aperture)



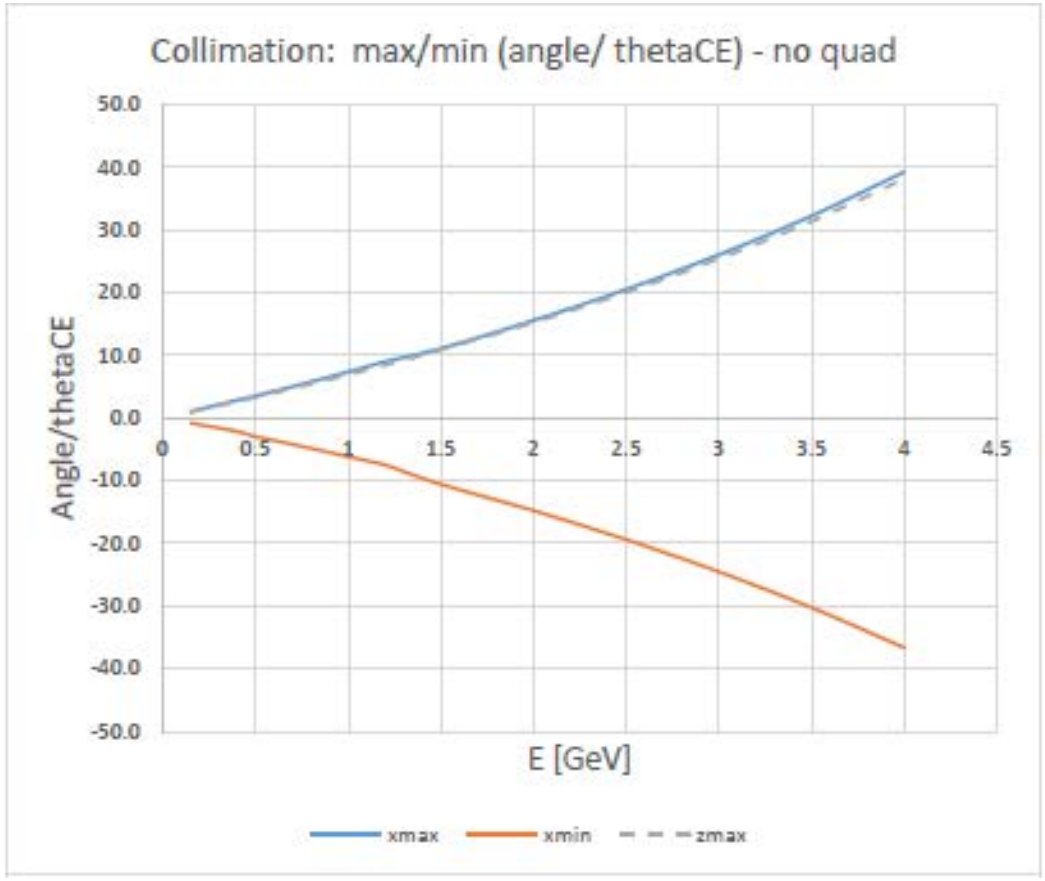


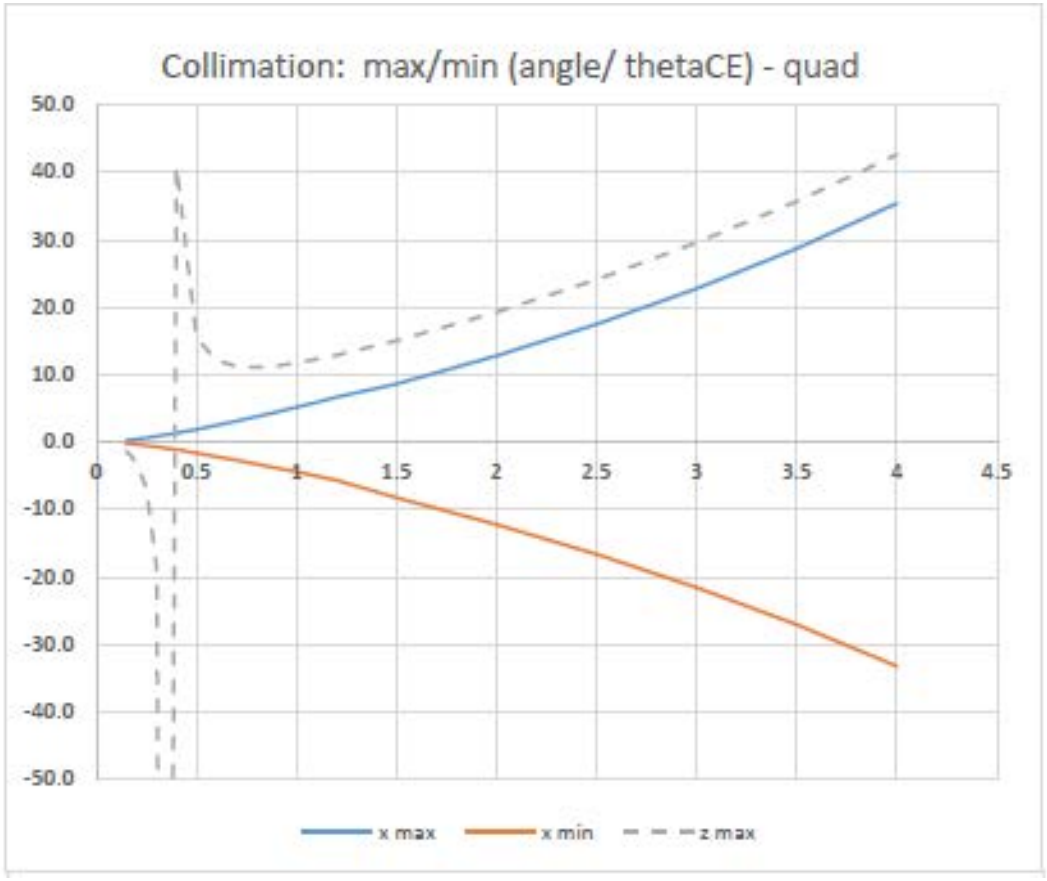
Limiting horizontal (solid) and vertical (dashed) angles versus electron energy

x and –x are slightly asymmetric because of dipole fringe field

Structure in vertical angle at ≈400 MeV is due to quadrupole vertical focusing, which causes low-energy rays to cross the horizontal midplane.

Angle limits > 10 θ_{ce} are insignificant. Next slide shows a more informative angle scale …





Collimation effects are	No quad	With quad
substantial for $\|\theta\|_{max} < \theta_{ce}$:	n.a.	$E_e < 0.4$ GeV (counter 19)
negligible for $\|\theta\|_{max} > 3\theta_{ce}$:	$E_e > 0.4$ GeV (counter 19)	$E_e > 0.8$ GeV (counter 33)