APS_1269060

To: Rod Gerig
From: Glenn Decker
Subject: Double undulator small angle case tolerances
Date: June 23, 2000

In response to an action item of a recent review, I am including here a revised set of missteering tolerances for the small angle case together with a recommendation for the maximum allowable separation angle between undulators located in the same 5 meter straight section. The original tolerances were overconservative as a result of an error in thinking on my part.

Specifically, for the large angle case with an electromagnet between the undulators, one must consider the two insertion devices to be somewhat independent such that two independent missteering interlocks are necessary. Having said that, it becomes evident that the present method for beam position offset determination is no longer valid. With so many large steering elements inboard of the Q1's it is no longer possible to "connect the dots" to determine offsets for bpm's mounted on the small aperture insertion device chamber, as is presently done.

For the small angle case, I mistakenly applied this same logic, forgetting why this was not an issue for for the present double undulator installation which has an angle of 270 microradians between the insertion devices (ID's). Because the angle is small, and is produced by permanent magnets, it is clear that an interlock on the average trajectory through both undulators is sufficient. In fact we now interlock using the P1 bpm's whose offsets relative to adjacent Q1 quads is directly determined. Therefore, in place of a +/- 0.5 mm tolerance (amounting to +/- 0.5 mrad for 2 meter bpm separation), we can use +/- 0.5 mm with a 5 meter separation, or +/- 0.2 mrad, which is quite a significant difference. Although we can determine the bpm offset relative to the quad centers to better than 0.1 mm, we must take into account that the quad centers may be misaligned relative to the beamline by as much as .4 mm, giving the total +/- 0.5 mm absolute bpm offset tolerance. It is the increase in separation between the bpm's that accounts for the difference between the two cases.

The correct tolerance stack up is as follows (ref M. Borland email 5/30/00):

1) Radiation fan (K/gamma)	+/- 0.16 mrad	0.08
2) Beam angular size	+/- 0.10 mrad	
3) bpm absolute accuracy	+/- 0.2 mrad	±0.1
4) bpld beam missteering trip limit	+/- 0.4 mrad	.9
5) absorber alignment	+/- 0.13 mrad	
Total	+/- 0.99 mrad	1.49

Call it 1.0 mrad. The absorbers impose a horizontal angular acceptance of +/- 1.8 mrad. Thus an angle as large as 1.6 mrad between the undulators could in theory be tolerated (={1.8 - 1.0} x 2). I should point out however that the +/- 0.4 mrad bpld trip limit is less than half of the present horizontal limit and it needs to be verified that this is consistent with injection and top-up operation. Relaxing this requirement and allowing the present +/- 0.9 mrad trip limit would allow up to 1.1 mrad ID separation angle with almost assured operation.

With regard to the so-called Decker distortion, keep in mind that only distortions greater than half the ID separation angle provide any benefit in the reduction of x-bpm backgrounds. For example, if we were to use the present 1.0 mrad distortion with a 1.0 mrad angle between ID's, the clearance between the nearest source of stray radiation and the ID beam would be only 0.5 mrad instead of the full 1.0 mrad for the single ID case. I expect that this should still provide adequate reduction in stray radiation backgrounds. The diagram shown in Figure 1 illustrates this situation.

In summary, while it is conceivable that a separation angle between insertion devices as large as 1.6 mrad could be made to work, it is my recommendation that this angle be kept to 1.0 mrad or lower. By doing so we will assure that no new issues arise from changing the parameters associated with either the beam position limits detector or the Decker distortion.

CC: M. Borland, L. Emery

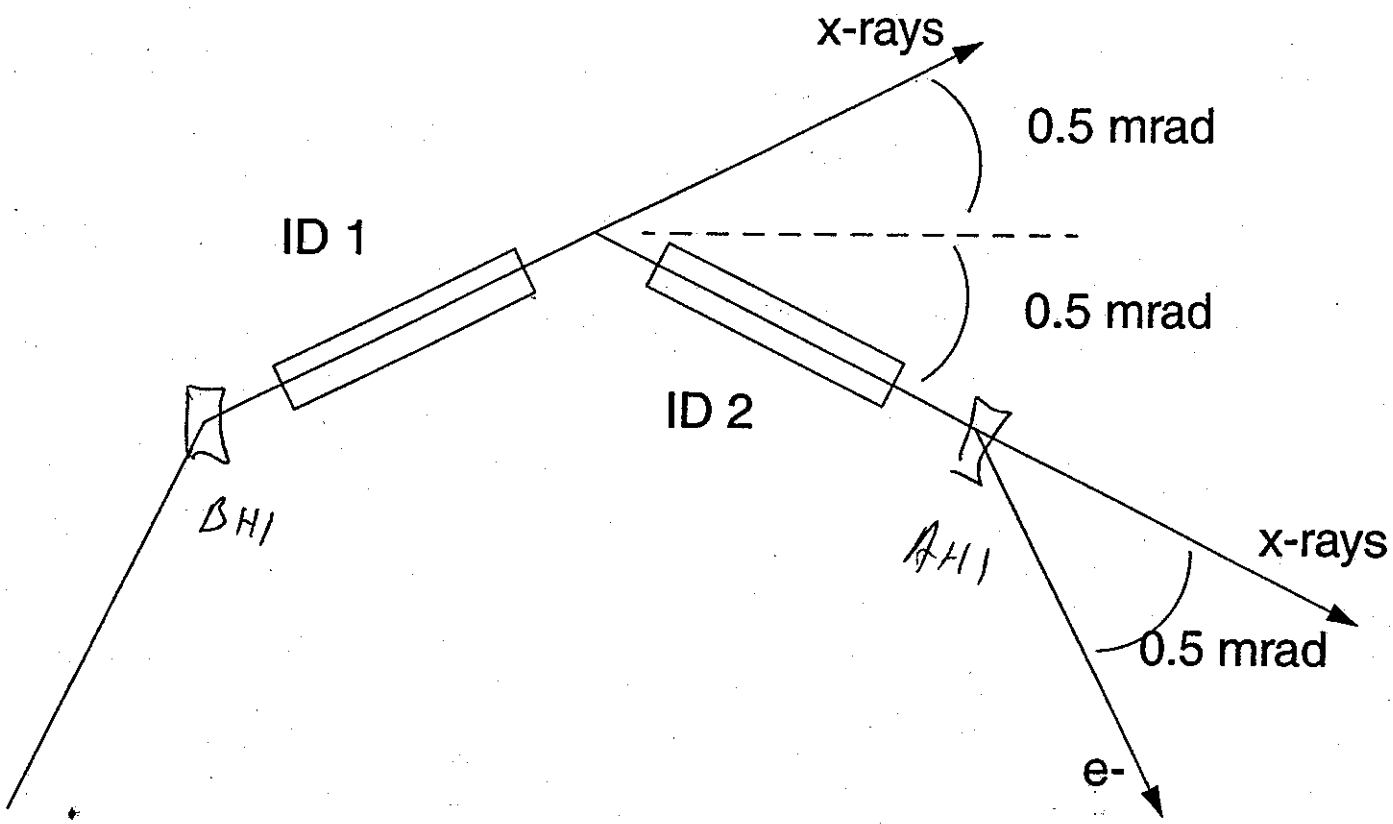


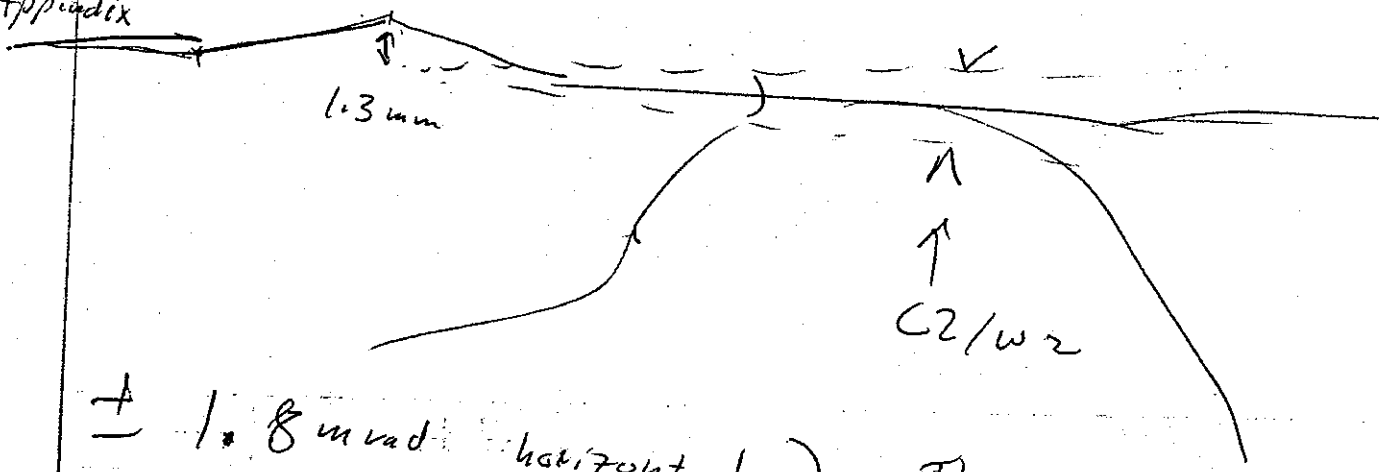
Figure 1. One mrad ID separation with 1 mrad distortion

V. Decker 10/2/01

Steve Devey

report on canted recess (1 mrad)

Appendix



± 1.8 mrad horizontal
± 1.0 mrad vertical
} This is when you hit metal

BPLD trip limit is ± 0.9 mrad H
± ~~0.5~~ 0.49 mrad V