# Beam Separation with the Addition of IR Mini Separators

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Approximately 72.8" of additional space for separators can be created each side of the B0 & D0 IR's by removing the 2 now-defunct 55.19" Q1 low-β quadrupoles at B0 & the Roman pots at D0. This leaves the accompanying P-spools installed at B0 to maintain adequate IP beam control & diagnostic capabilities. (It would probably also be sensible to restore P-spools at D0 in place of the currently installed, shorter, H-spools and regain the HBPM's at the C49 & D11 locations).

The discussion of beam-beam separation obtainable by lengthening all 12 of the IR separators by ~24" each has been presented elsewhere [1]. That study reported that both the average ring-wide separation & separation at the first parasitic crossings could be increased by 19% over current Run II values. A less elegant, but simpler (cheaper), option is to fill each of the 4 liberated spaces with a single "mini" separator. With ~16" of dead space each end of the module allocated for connections, whatever, this leaves ~40.5" of actual electrode length.

In each of the four 3-bumps used to keep the beams separated through the short & long arcs during collisions one of the component gradients is always set to its maximum attainable value (*assumed* here to be 40 kV/cm). Ideally, the mini-separators would be installed to augment the kick from these maxed-out separators; thereby allowing gradients in the 3-bumps to be increased overall. This implementation is not entirely possible in the short arc. Both the horizontal & vertical B11 separators are fixed at 40 kV/cm, but there is room for just 1 mini-separator. With *only* the addition of mini-separators the greatest separation gains are obtained by putting a vertical mini-separator at B11, while the horizontal separation remains essentially unchanged by the mini-separator at C49 [2].

The separator configuration & gradients with mini-separators, and the corresponding increases in beam separation are summarized in the accompanying tables & figures. The average ring-wide σ increase in separation of 16.6%, and the 13.8% separation increase in $r$ at the 1st parasitic crossings is not quite as impressive as the 19% figures achieved with uniformly longer IR separators, but definitely represents the lion's share of possible gains.

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[1] elsewhere : not here.

[2] the optimum configuration of B11/C49 mini-separators is not immediately apparent if additional arc separators are also installed at B48. Whether horizontal or vertical separators are preferable at B48 will best be determined by studies of the 150 GeV injection helix.

## Collision Gradients

| Current Separators | | | | + Mini (40.5") Separators | | | |
|---|---|---|---|---|---|---|---|
| Horizontal MV/m | | Vertical MV/m | | Horizontal MV/m | | Vertical MV/m | |
| B11 | 4.000 | B11 | -4.000 | B11 | 4.000 | B11 | -3.515 |
| | | | | | | b11 mini | -3.515 |
| B17 | -1.904 | | | B17 | -1.906 | | |
| | | C17 | 2.435 | | | C17 | 2.951 |
| C49 | 3.707 | C49 | -3.280 | C49 | 2.670 | C49 | -4.000 |
| | | | | c49 mini | 2.670 | | |
| D11 | -3.466 | D11 | 4.000 | D11 | -4.000 | D11 | 3.571 |
| | | | | | | d11 mini | 3.571 |
| D48 | -0.592 | | | D48 | -0.638 | | |
| | | A17 | -1.635 | | | A17 | -2.100 |
| A49 | 4.000 | A49 | -3.269 | A49 | 3.338 | A49 | -4.000 |
| | | | | a49 mini | 3.338 | | |

## Ring-Wide Beam Separation @ Collision

[ $20\pi$ μm & $\delta p_{95} = 3.375E\text{-}4$ ]

Current Separators + Mini (40.5") Separators

| B-B Separation | σ's | σ's | % Increase |
|---|---|---|---|
| Average | 9.86 | 11.50 | 16.6 |
| Maximum | 12.63 | 14.86 | 17.7 |
| Minimum | 5.83 | 7.06 | 21.0 |

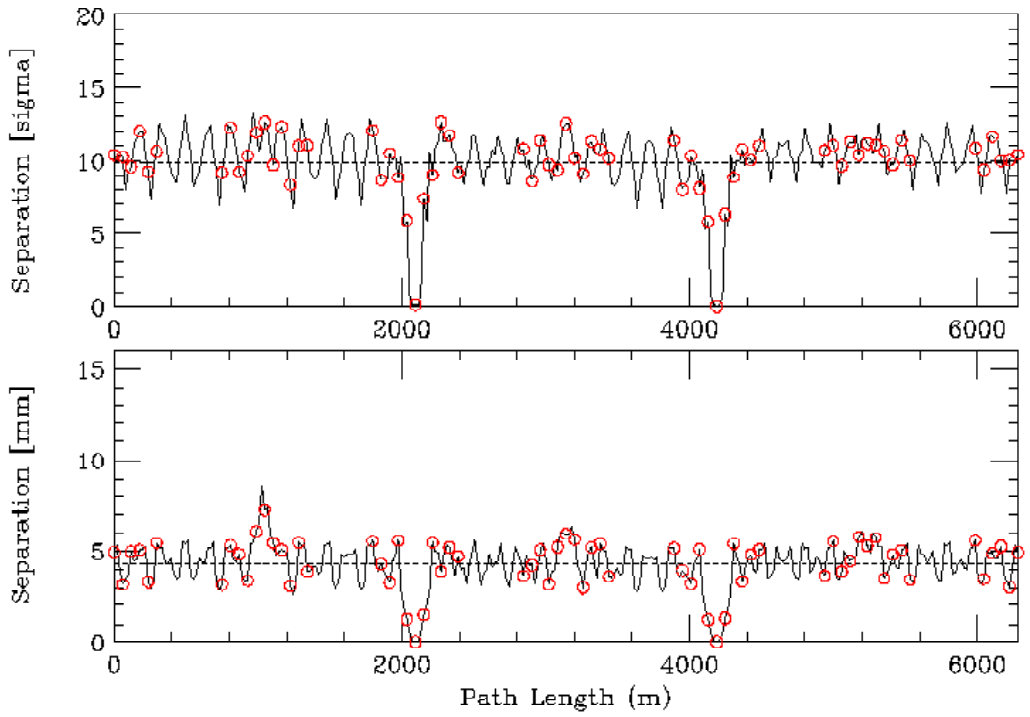
## Separation @ 1st Parasitic Crossings

[ $20\pi$ μm & $\delta p_{95} = 3.375E\text{-}4$ ]

Current Separators + Mini (40.5") Separators

| Site | r mm | σ's | r mm | σ's | % σ Increase |
|---|---|---|---|---|---|
| B0 u/s | 1.27 | 5.89 | 1.53 | 7.23 | 22.7 |
| d/s | 1.49 | 7.36 | 1.54 | 7.38 | 0.2 |
| D0 u/s | 1.23 | 5.83 | 1.44 | 7.06 | 21.1 |
| d/s | 1.31 | 6.31 | 1.52 | 7.26 | 15.2 |
| | | | Average r Separation Increase = 13.8% | | |

Current Separators




4 Mini Separators @ IR's