Positioning of dispersion suppressor collimators around IR2

John Jowett

Ultraperipheral processes in Pb-Pb collisions

$$\text{BFPP1:}\quad {}^{208}\text{Pb}^{82+} + {}^{208}\text{Pb}^{82+} \longrightarrow {}^{208}\text{Pb}^{82+} + {}^{208}\text{Pb}^{81+} + e^{+},$$

$$\sigma = 281\ \text{b},\quad \delta = 0.01235$$

$$\text{BFPP2:}\quad {}^{208}\text{Pb}^{82+} + {}^{208}\text{Pb}^{82+} \longrightarrow {}^{208}\text{Pb}^{82+} + {}^{208}\text{Pb}^{80+} + 2e^{+},$$

$$\sigma = ??\ b,\quad \delta = 0.02500$$

$$\text{EMD1:}\quad {}^{208}\text{Pb}^{82+} + {}^{208}\text{Pb}^{82+} \longrightarrow {}^{208}\text{Pb}^{82+} + {}^{207}\text{Pb}^{82+} + n\ ,$$

$$\sigma = 96\ b,\quad \delta = -0.00485$$

$$\text{EMD2:}\quad {}^{208}\text{Pb}^{82+} + {}^{208}\text{Pb}^{82+} \longrightarrow {}^{208}\text{Pb}^{82+} + {}^{206}\text{Pb}^{82+} + 2n\ ,$$

$$\sigma = 29\ b,\quad \delta = -0.00970$$

Each of these makes a secondary beam emerging from the IP with rigidity change

$$\delta = \frac{1 + \Delta m / m_{\text{Pb}}}{1 + \Delta Q / Q} - 1$$

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Beam losses from ultraperipheral nuclear collisions between $^{208}\text{Pb}^{82+}$ ions in the Large Hadron Collider and their alleviation

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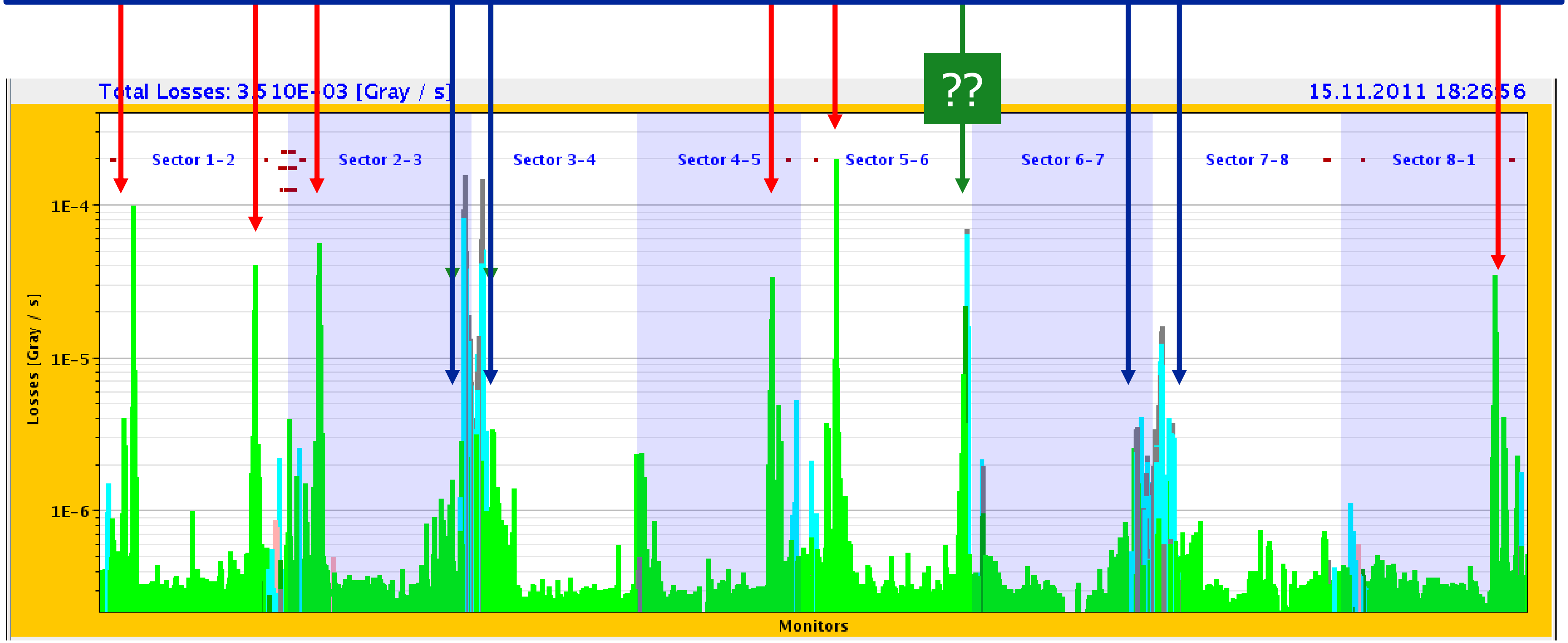
Losses during Pb-Pb Collisions in 2011

Bound-free pair production secondary beams from IPs

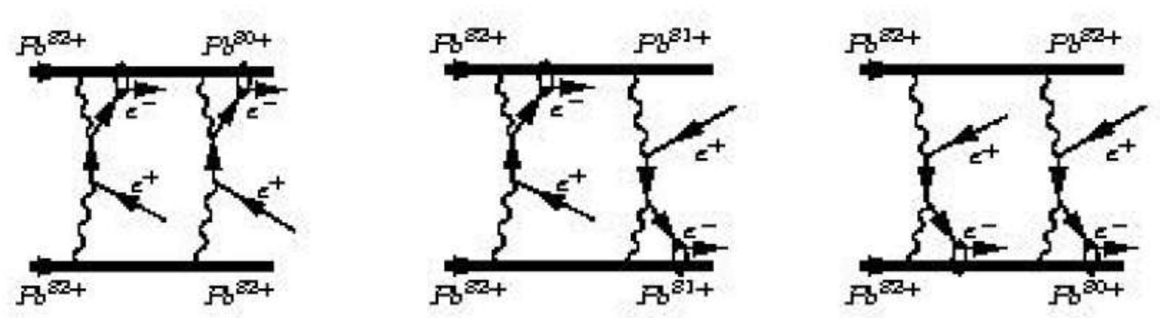
IBS & Electromagnetic dissociation at IPs, taken up by momentum collimators

Losses from collimation inefficiency, nuclear processes in primary collimators



Multiple pair production

- Multiple pair production (uncorrelated)



Pb(80+)Pb(82+) Pb(81+)Pb(81+) Pb(82+)Pb(80+)

σ(80+,82+) > 6 mb

ALICE@upgrade:
rate(min bias) = 50 kHz
rate Pb(81+) = 50 kHz x(260/7) ~ 1.8 MHz (either side)
rate Pb(80+) > 50 kHz x(0.006/7) ~ 42 Hz (either side)

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Open issues:

- size beam spots Pb(81+) and Pb(80+) ?
- Feasibility of simultaneous measurement of Pb(81+) and Pb(80+) ?
- Gas based detector ?
- Feasibility of simultaneous measurement of Pb(82+, 207) ? (neutron emitted, other side of Pb(81+,208))

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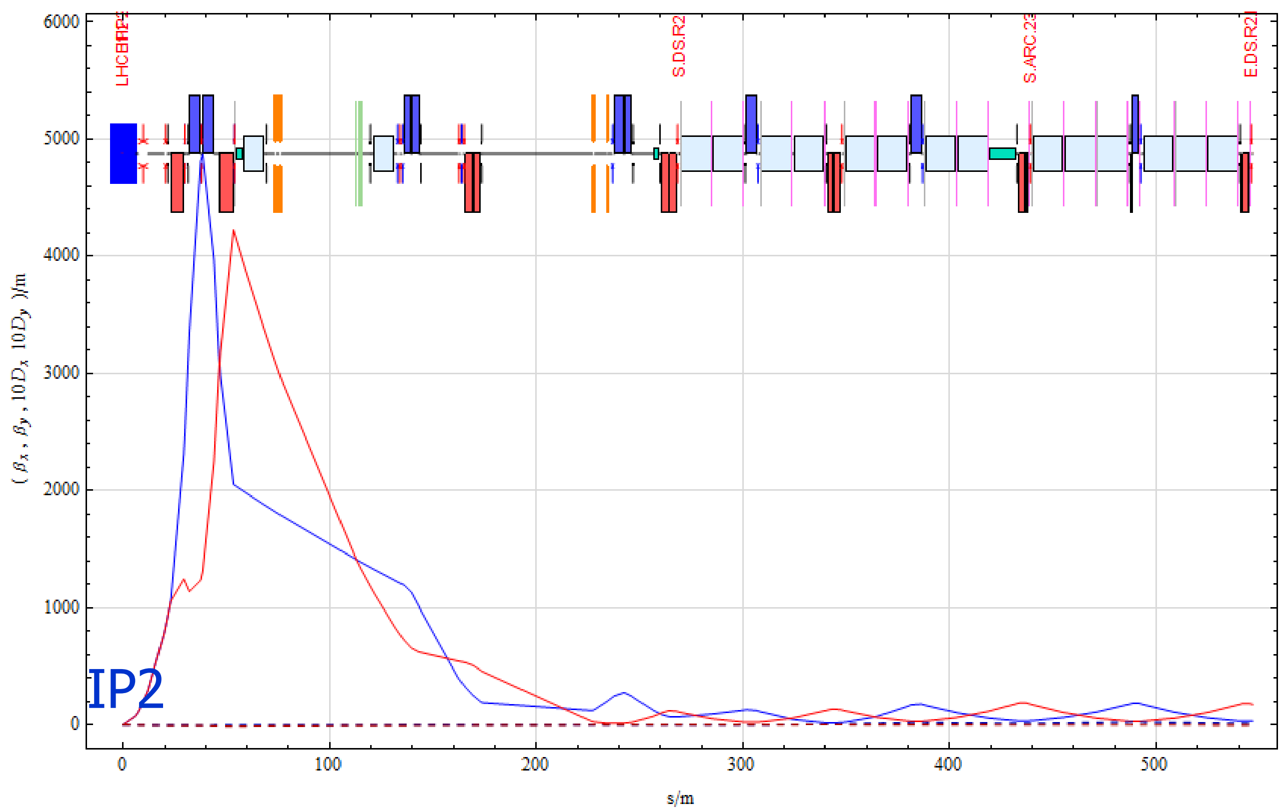
Parameters considered

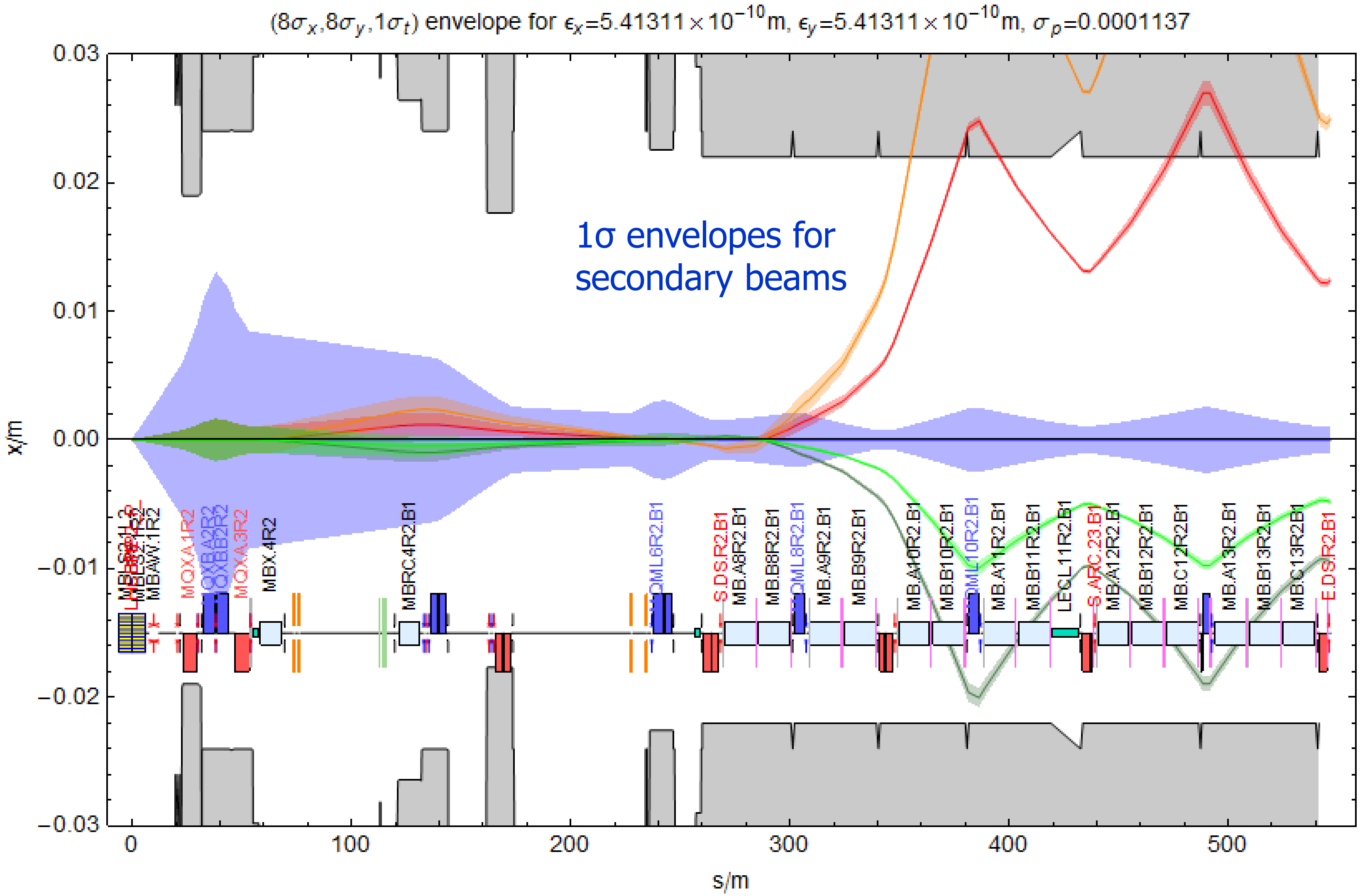
$E = 6.5\,Z$ TeV

$\beta^* = 0.5$ m (Nominal optics for 2019)

Half-crossing angle $p_y = 80\ \mu$rad



Secondary beams from Beam 1 in IR2

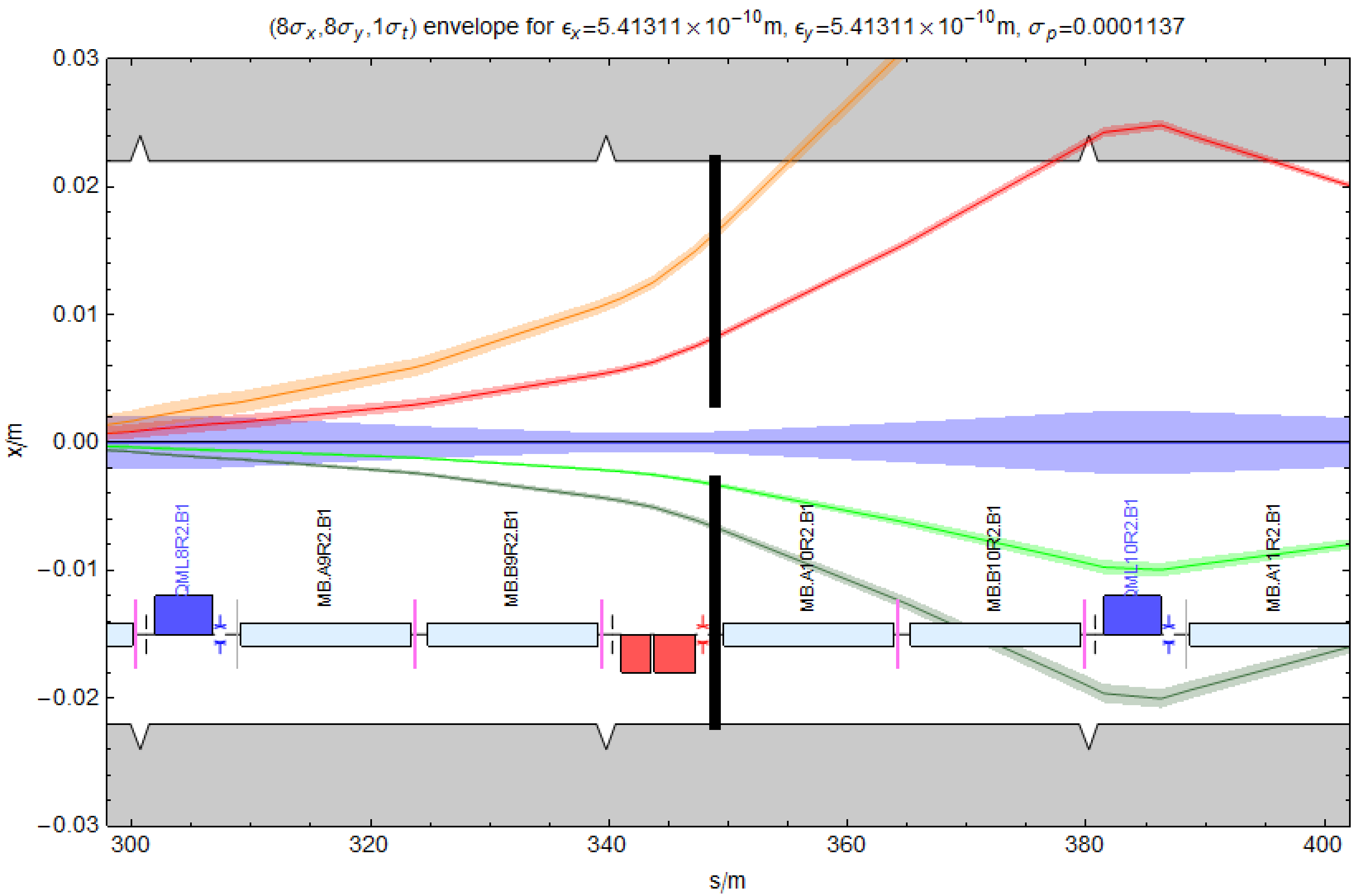


Cannot separate BFPP and main beam in warm area (eg by Roman pots a la TOTEM).

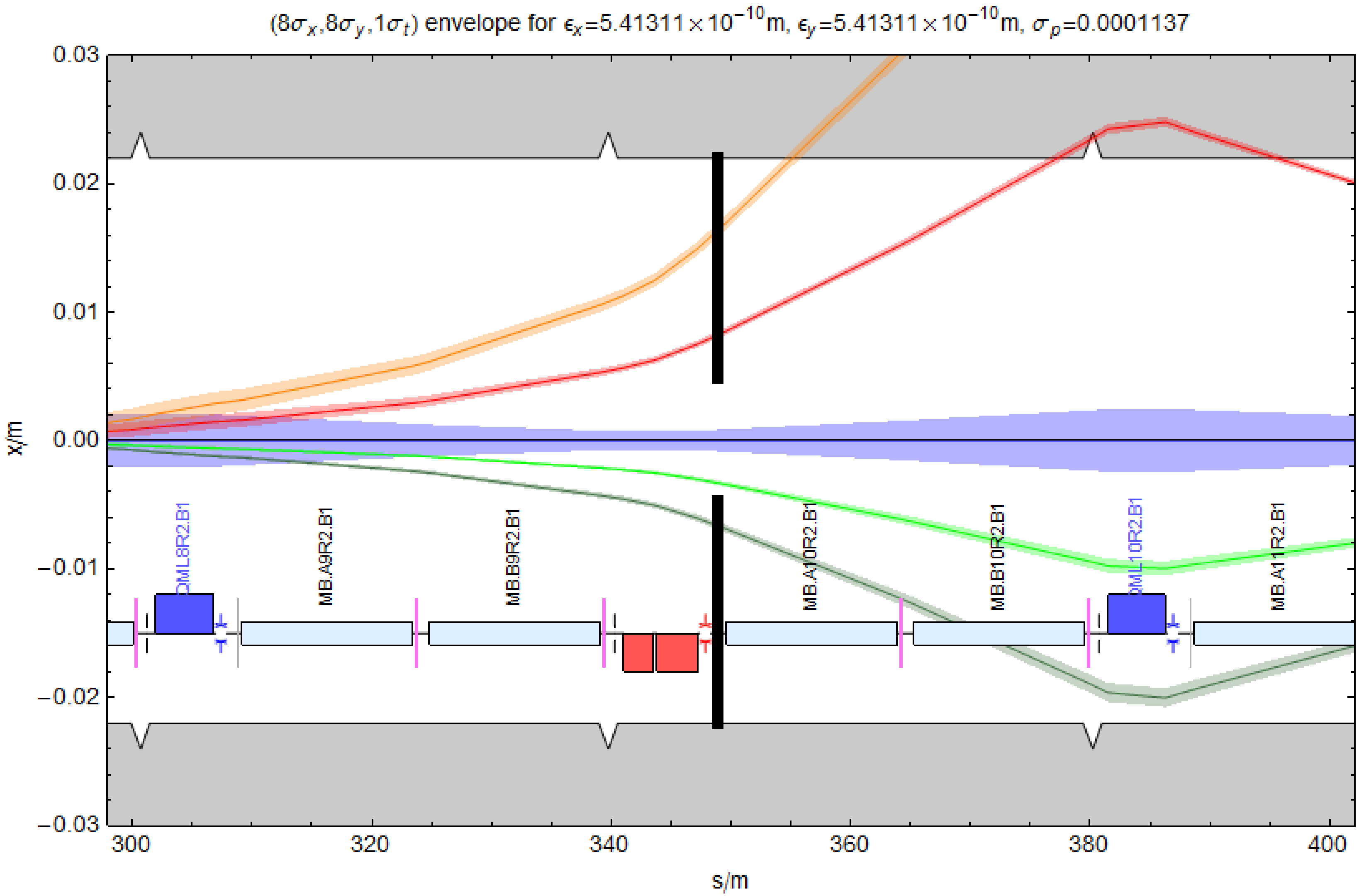
CDF version

- http://cern.ch/jowett/IR2/BFPP/DSCollimatorBFPP.cdf
- You might need to install a browser plug-in:
  - http://www.wolfram.com/cdf-player/

Optimum collimator position



Open gap so EMD1 passes (to IR3)



Further opening or local bumps allow other selections.

ATLAS and CMS ?

- ATLAS and CMS also take high-luminosity Pb-Pb
- The same problem of BFPP losses exists in the DSs around IP1 and IP5
  - Details of loss locations may be slightly different
  - Highest losses in 2011 were right of IP5
- Similar motivation to install DS collimators to avoid a peak luminosity limit from quenches and/or long-term radiation damage

Conclusions

- DS collimator for BFPP protection must be near Q9 in IR2
  - Unless perhaps we insert bumps?
- Detectors for BFPP ions must be located in cold section
  - Incorporate in DS collimators?
- Collimator gap can control selection of ultra-peripheral processes to control losses in IR3 and for physics purposes (possibly)