Positioning of IR2 collimators to intercept secondary beams from bound-free pair production and electromagnetic dissociation at the ALICE interaction point

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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

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

PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS
12, 071002 (2009)

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

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(Received 13 May 2009; published 29 July 2009)

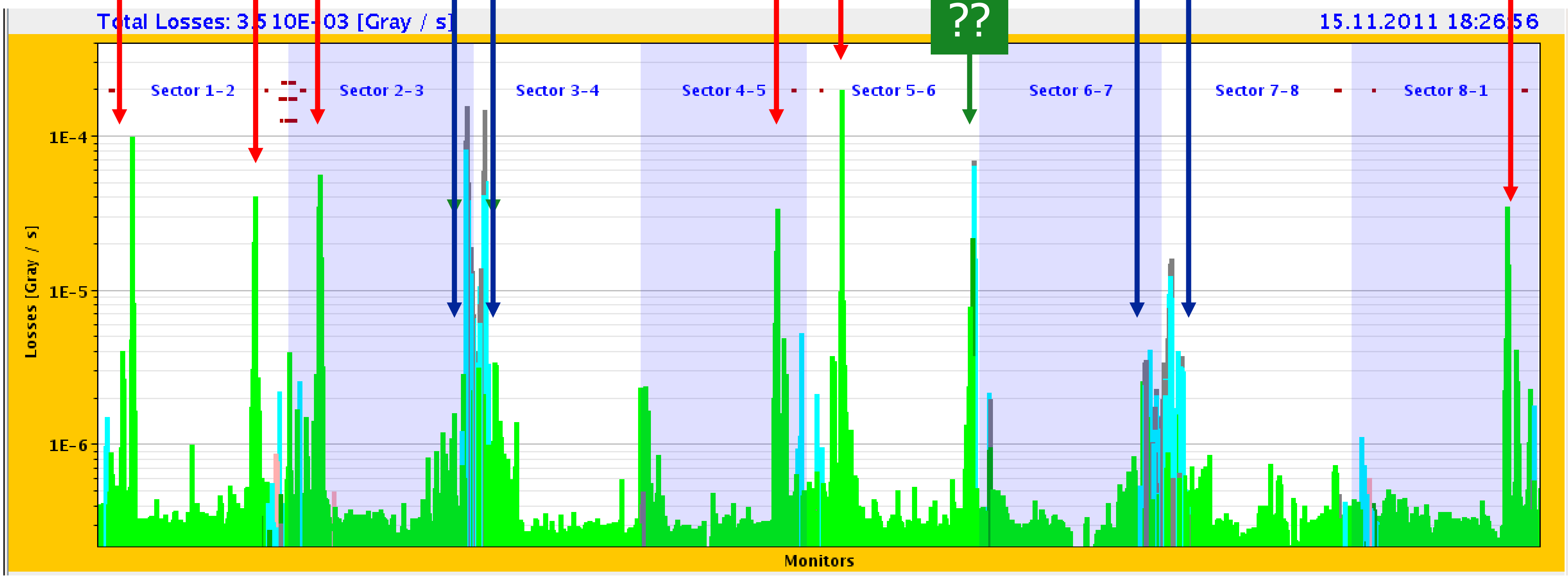
Losses during Pb-Pb Collisions in 2011

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

??

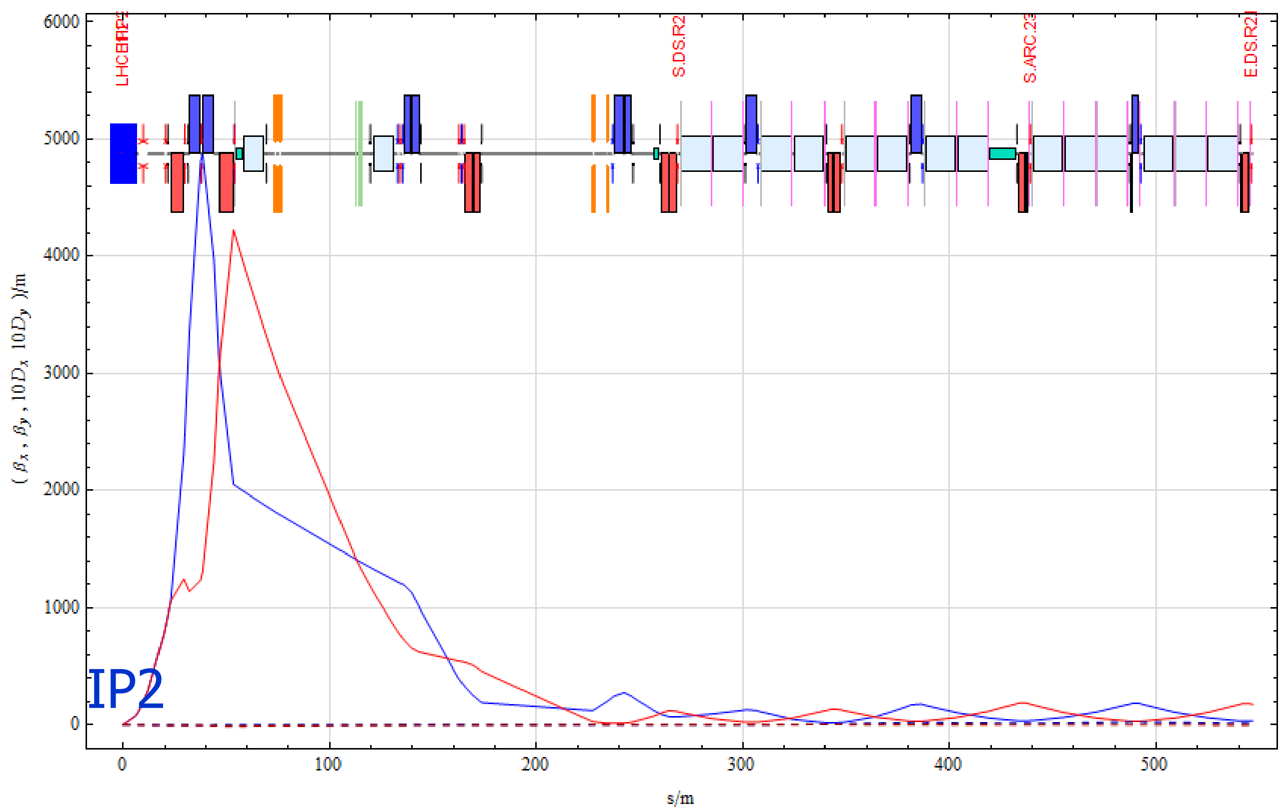


Parameters considered

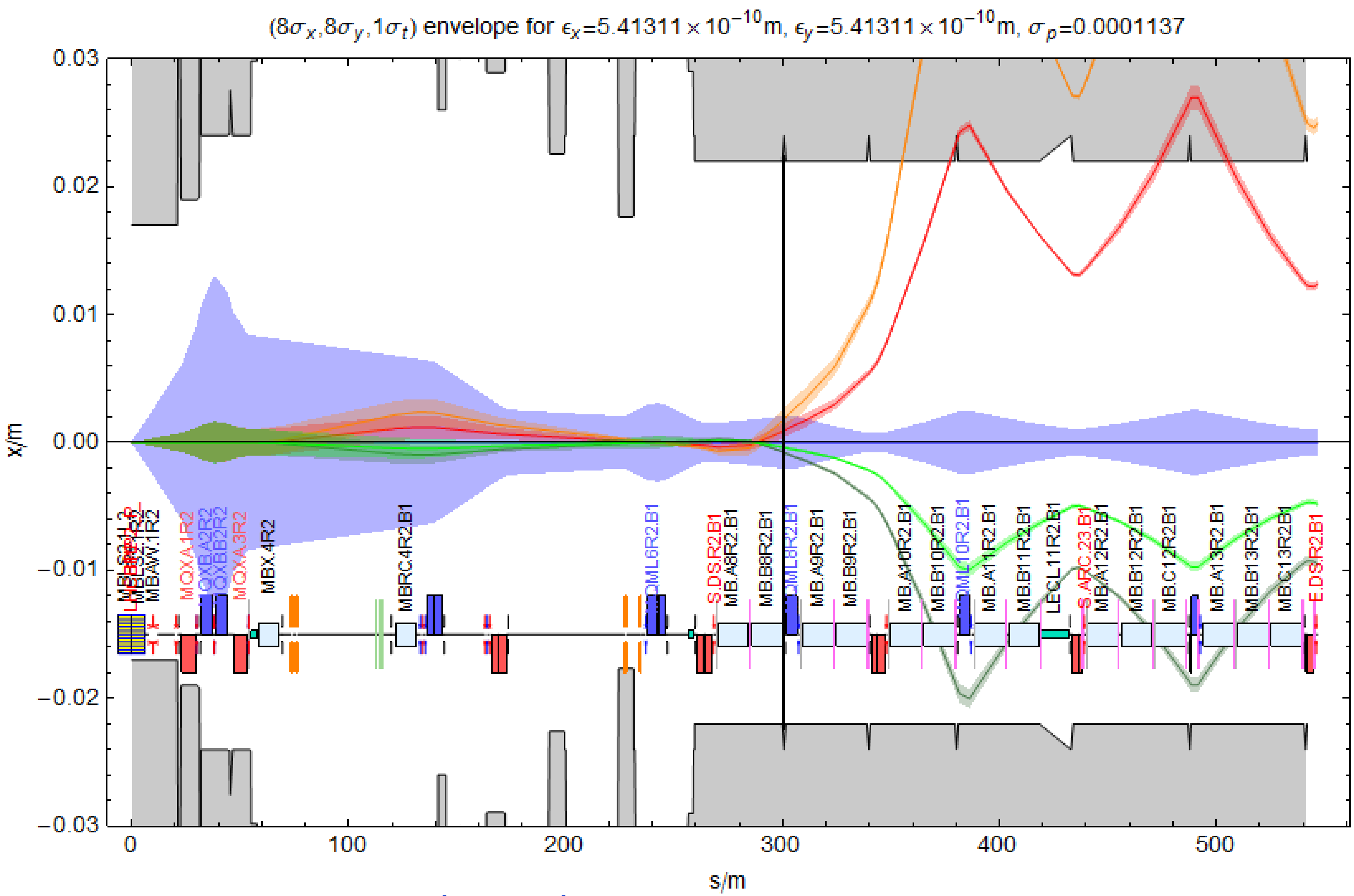
$E = 6.5\,Z$ TeV

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

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

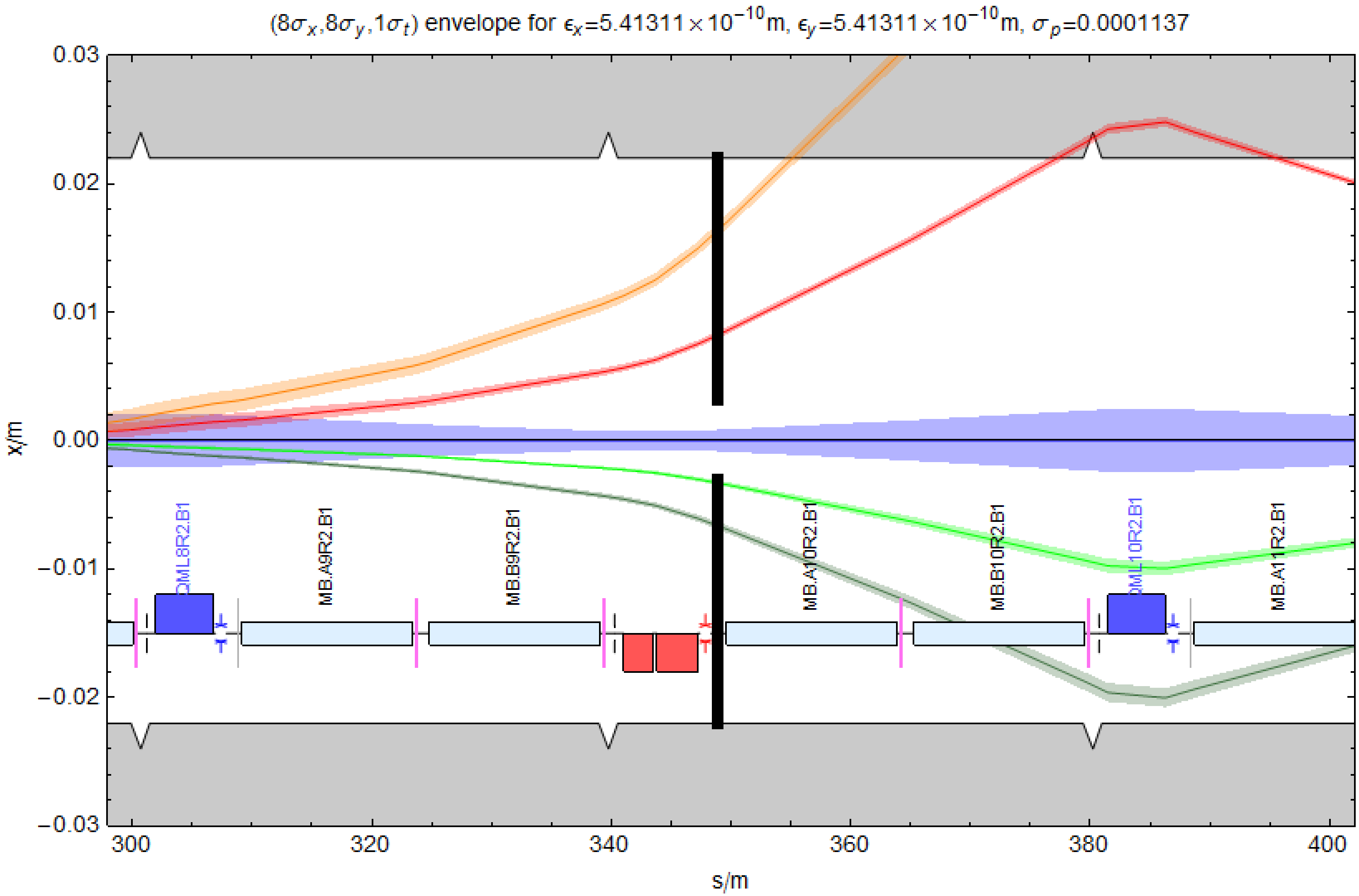


Secondary beams from Beam 1 in IR2

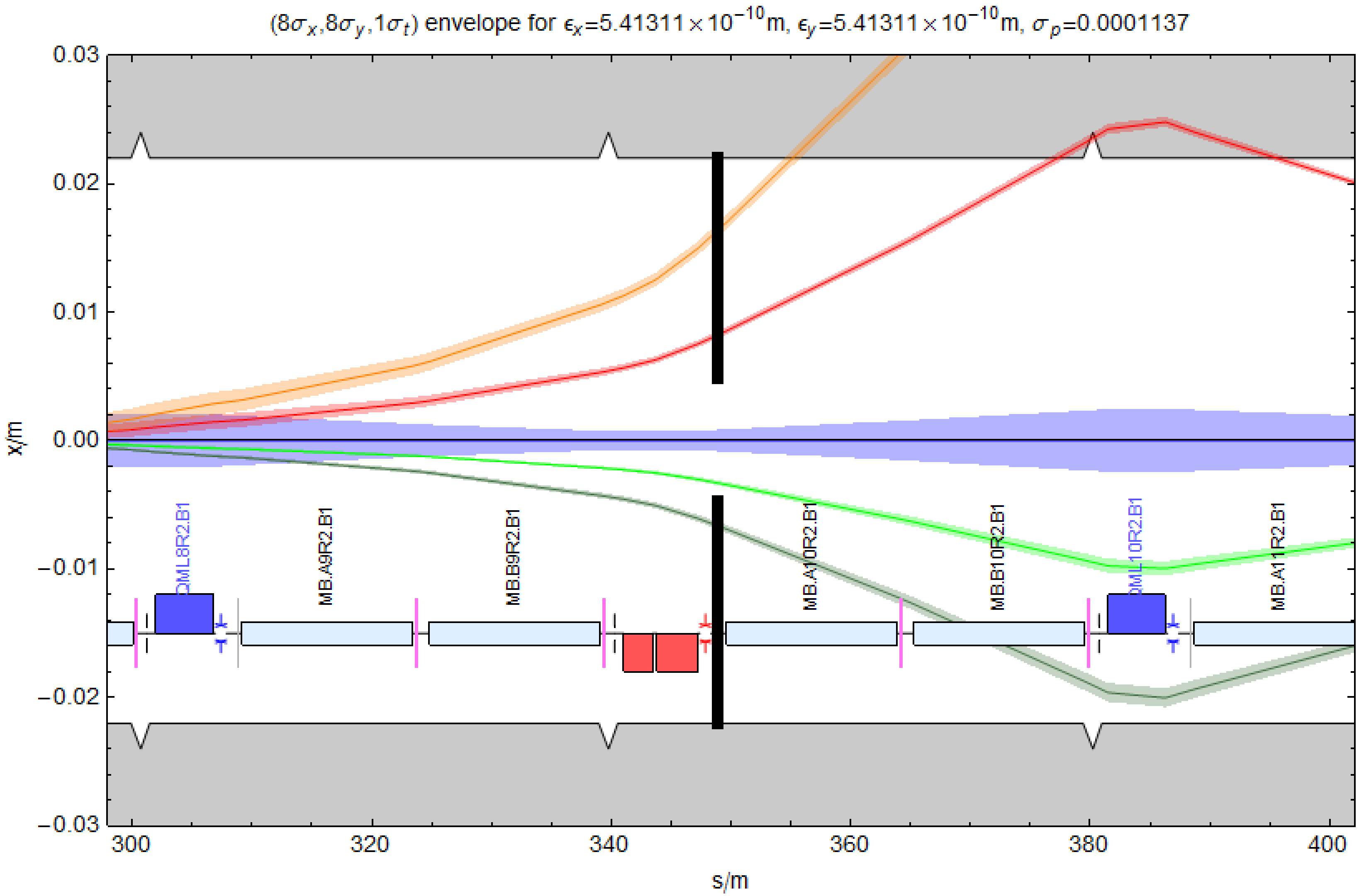


Cannot separate BFPP and main beam in warm area
(eg by Roman pots a la TOTEM).

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 for physics purposes