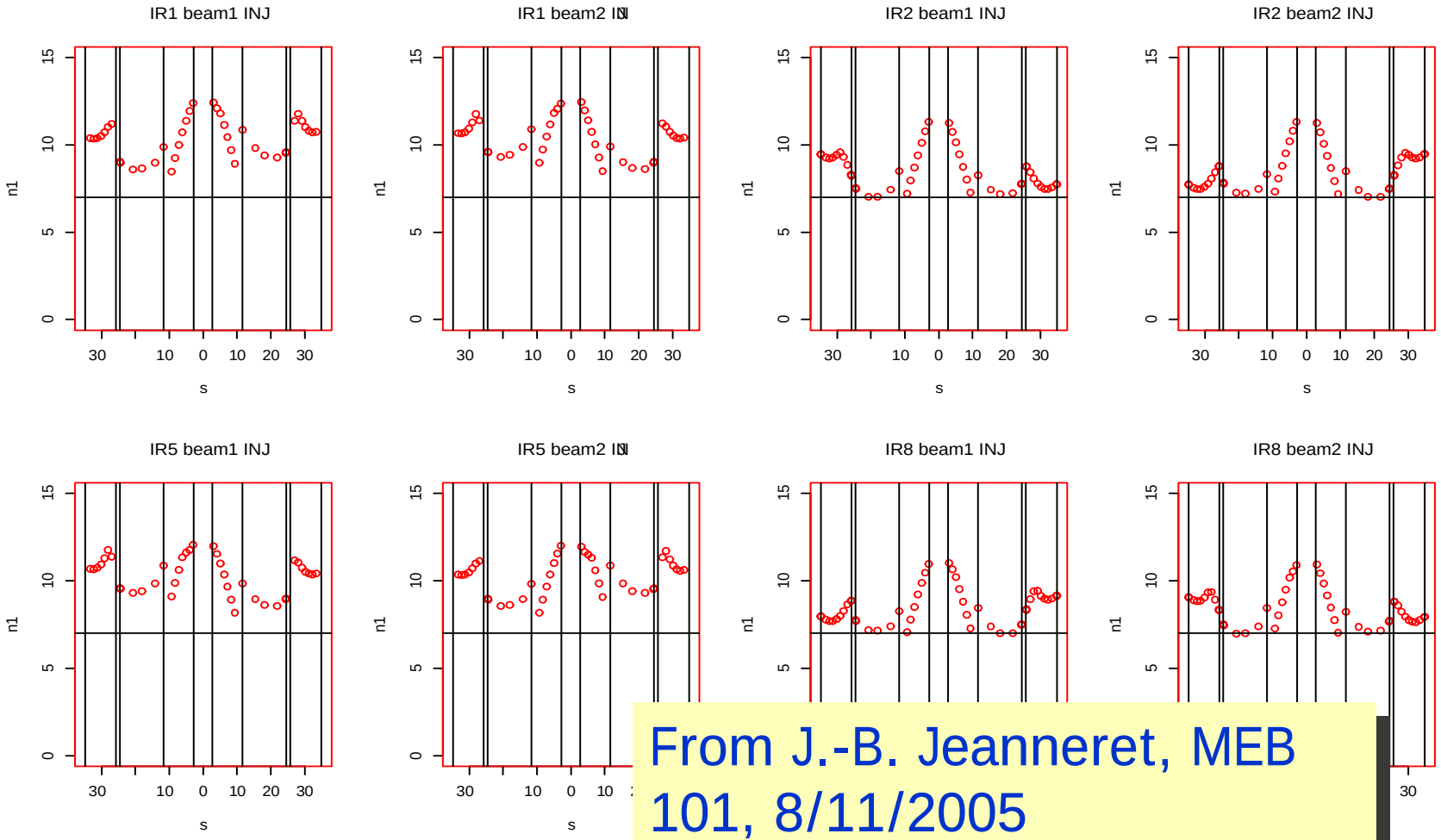
Displacement of IP2 at injection

- IP1 and IP5 have been displaced transversely in *collision* optics to gain aperture (S. Fartoukh)
- There is a similar aperture limitation in IR2 at *injection*
  - J.B. Jeanneret, see next slide
  - Cure with similar vertical displacement of IP2
- Conditions for study
  - V6.500 injection optics (default ALICE spectrometer off ?)
  - Also done with ALICE spectrometer on – reality, although not shown here
  - Latest aperture model used

Normalised aperture at injection

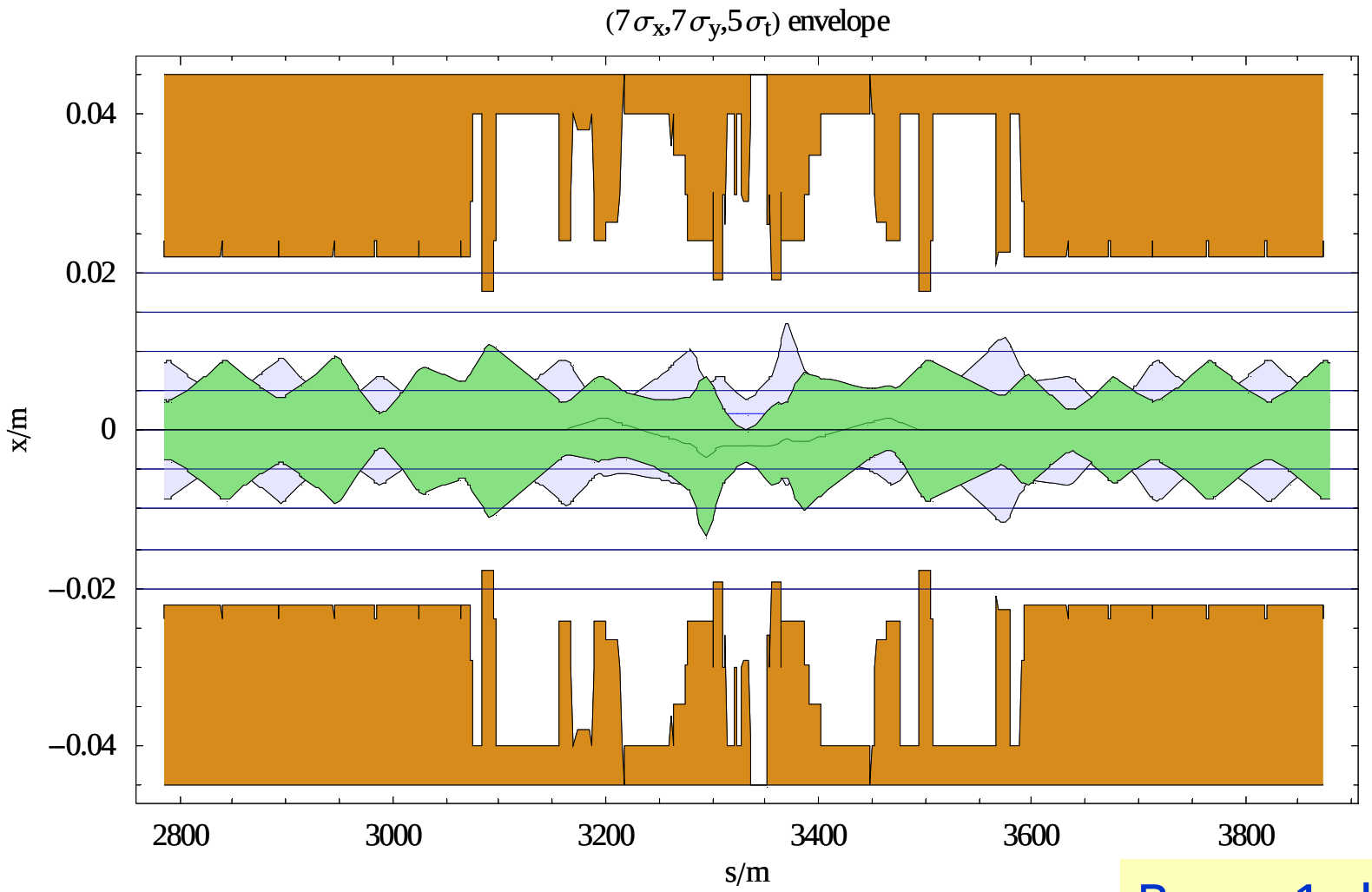
	IR1	IR2	IR5	IR8
beta*[m]	17	10	17	10
alfa [murad]	160	170	160	170

proton2



From J.-B. Jeanneret, MEB 101, 8/11/2005

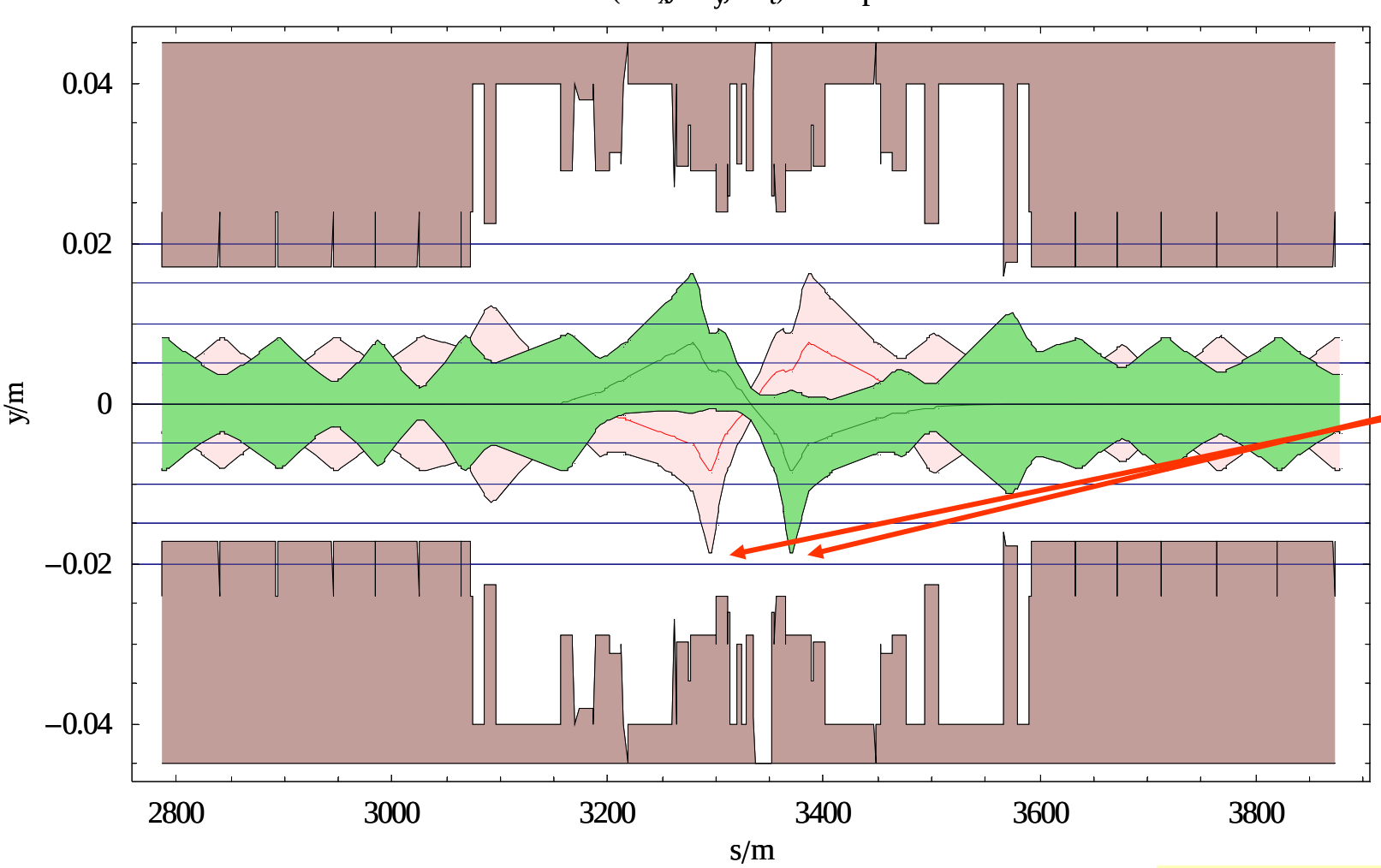
Horizontal Beam envelopes, V6.500 injection optics, IR2



NAME	s	x_c	p_{xc}	y_c	p_{yc}
IP2	3332.44	0.002	0	0	0.00017
IP2	3332.28	−0.002	0	0	−0.00017

Beam 1: blue
Beam 2: green

Vertical Beam envelopes, V6.500 injection optics, IR2



Aperture limit

NAME	s	x_c	p_{xc}	y_c	p_{yc}
IP2	3332.44	0.002	0	0	0.00017
IP2	3332.28	-0.002	0	0	-0.00017

Beam 1: pink
Beam 2: green

Matching

Strengths to be varied

(lxplus1) In[25]:=

```
strengthsIR2 =
 Cases[madLHCStrengthSettings[], MADsetDelayed[str_, val_ /; StringMatchQ[val, "*ON_X2*"]],
   Infinity] /. MADsetDelayed[str_, val_] → str
```

(lxplus1) Out[25]=

```
{ACBXV1.L2, ACBXV1.R2, ACBCV6.L2B1, ACBYVS4.L2B1, ACBYVS4.R2B1,
 ACBCVS5.R2B1, ACBYVS5.L2B2, ACBYVS4.L2B2, ACBYVS4.R2B2, ACBCV6.R2B2}
```

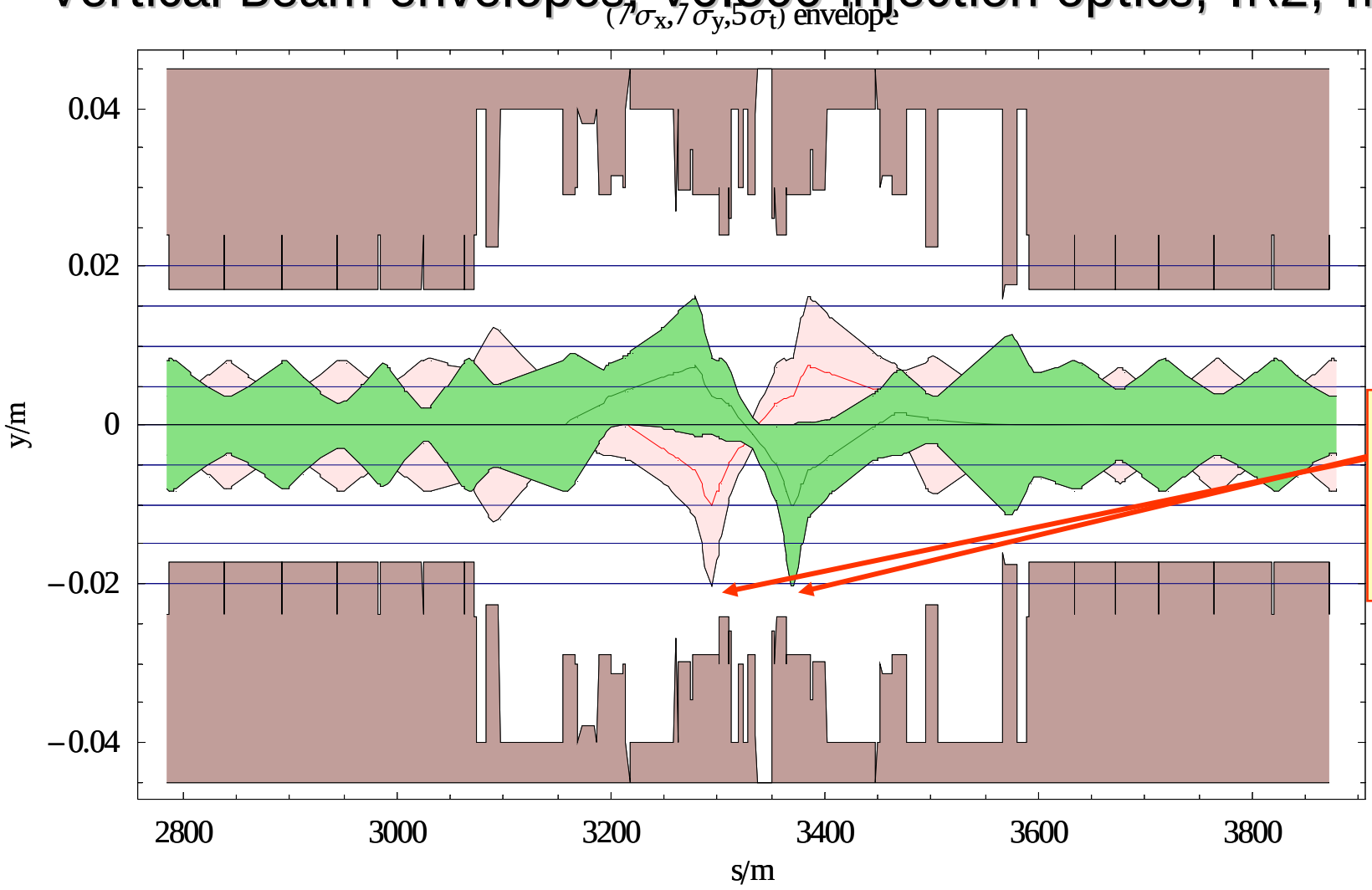
(lxplus1) In[27]:=

```
strengthsYIR2 = Select[strengthsIR2, Not@StringMatchQ[#, "ACBX*"] &]
```

(lxplus1) Out[27]=

```
{ACBCV6.L2B1, ACBYVS4.L2B1, ACBYVS4.R2B1, ACBCVS5.R2B1,
 ACBYVS5.L2B2, ACBYVS4.L2B2, ACBYVS4.R2B2, ACBCV6.R2B2}
```

Vertical Beam envelopes, V6.500 injection optics, IR2, IP2 at -1mm

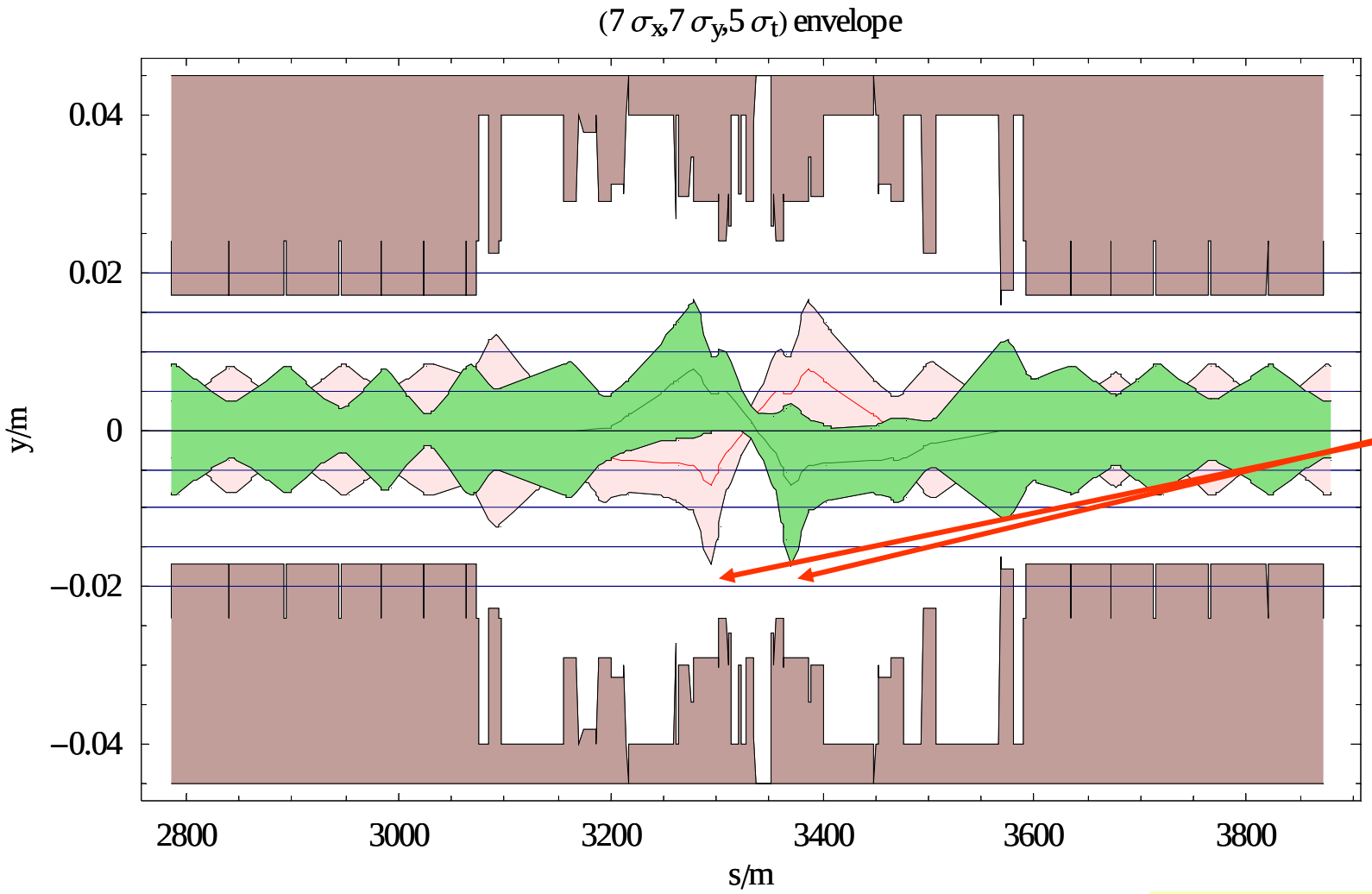


Aperture limit worse

NAME	s	x_c	p_{xc}	y_c	p_{yc}
IP2	3332.44	0.002	0	−0.001	0.00017
IP2	3332.28	−0.002	0	−0.001	−0.00017

Beam 1: pink
Beam 2: green

Vertical Beam envelopes, V6.500 injection optics, IR2, IP2 at +1mm



Aperture limit better, equal above and below

NAME	s	x_c	p_{xc}	y_c	p_{yc}
IP2	3332.44	0.002	0	0.001	0.00017
IP2	3332.28	−0.002	0	0.001	−0.00017

Beam 1: pink
Beam 2: green

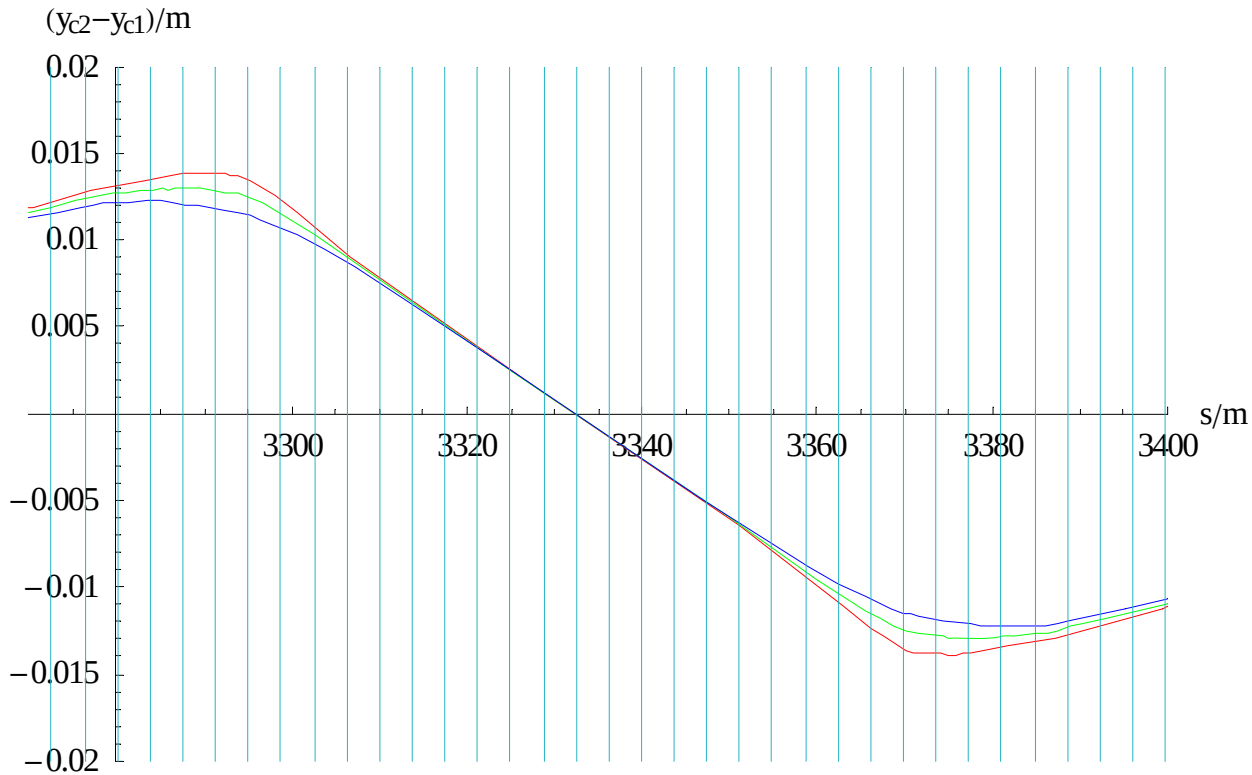
Matching results for +1 mm displacement of IP2

```
Strengths before matching:

ACBCV6.L2B1 =      -7.771488E-06 ;
ACBCV6.R2B2 =       -7.57375E-06 ;
ACBCVS5.R2B1 =      5.7337946E-05 ;
ACBYVS4.L2B1 =     -6.9601072E-05 ;
ACBYVS4.L2B2 =     -1.3481602E-05 ;
ACBYVS4.R2B1 =     -3.2639812E-05 ;
ACBYVS4.R2B2 =     -6.6937891E-05 ;
ACBYVS5.L2B2 =      4.5792594E-05 ;

Strengths after matching:

ACBCV6.L2B1 =   -2.581799457E-05 ;
ACBCV6.R2B2 =   -2.516107162E-05 ;
ACBCVS5.R2B1 =    3.276853315E-06 ;
ACBYVS4.L2B1 =   -7.589124947E-05 ;
ACBYVS4.L2B2 =    8.984852911E-05 ;
ACBYVS4.R2B1 =    8.875360852E-05 ;
ACBYVS4.R2B2 =   -6.704376334E-05 ;
ACBYVS5.L2B2 =    2.617020991E-06 ;
```

Vertical beam-beam separation

(lxplus1) In[129]:=

```
DisplayTogether[(beambeamSeparationPlots@@#)[[2]] &/@
  {{casem1, Red}, {case0, Green}, {casep1, Blue}}, bblinePlot,
 PlotRange→ {{3270, 3400}, {-0.02, 0.02}}]
```

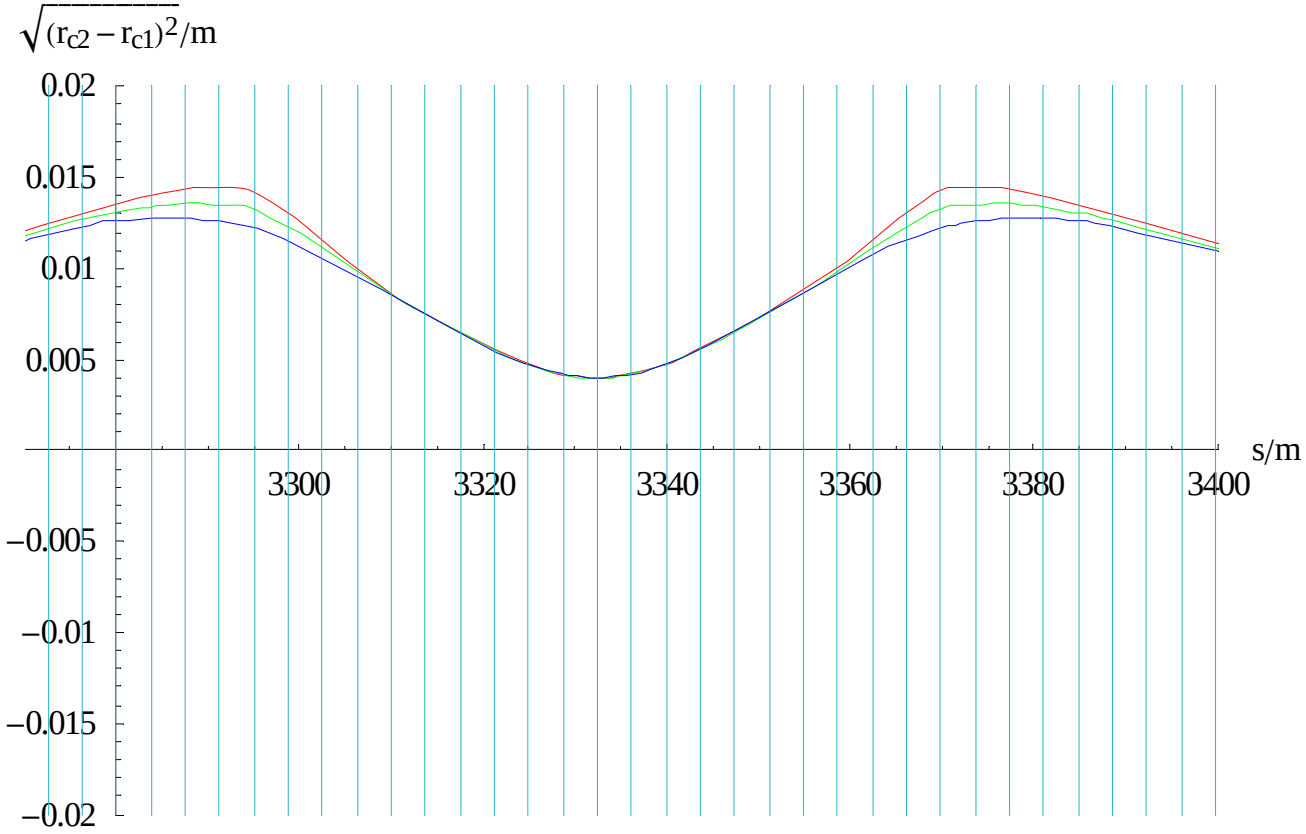


Some reduction in vertical separation in when aperture optimised (blue vs. green)

Vertical beam-beam separation

(lxplus1) In[128]:=

```
DisplayTogether[Last[beambeamSeparationPlots@@#] &/@
  {{casem1, Red}, {case0, Green}, {casep1, Blue}}, bblinePlot,
 PlotRange→{{3270, 3400}, {-0.02, 0.02}}]
```

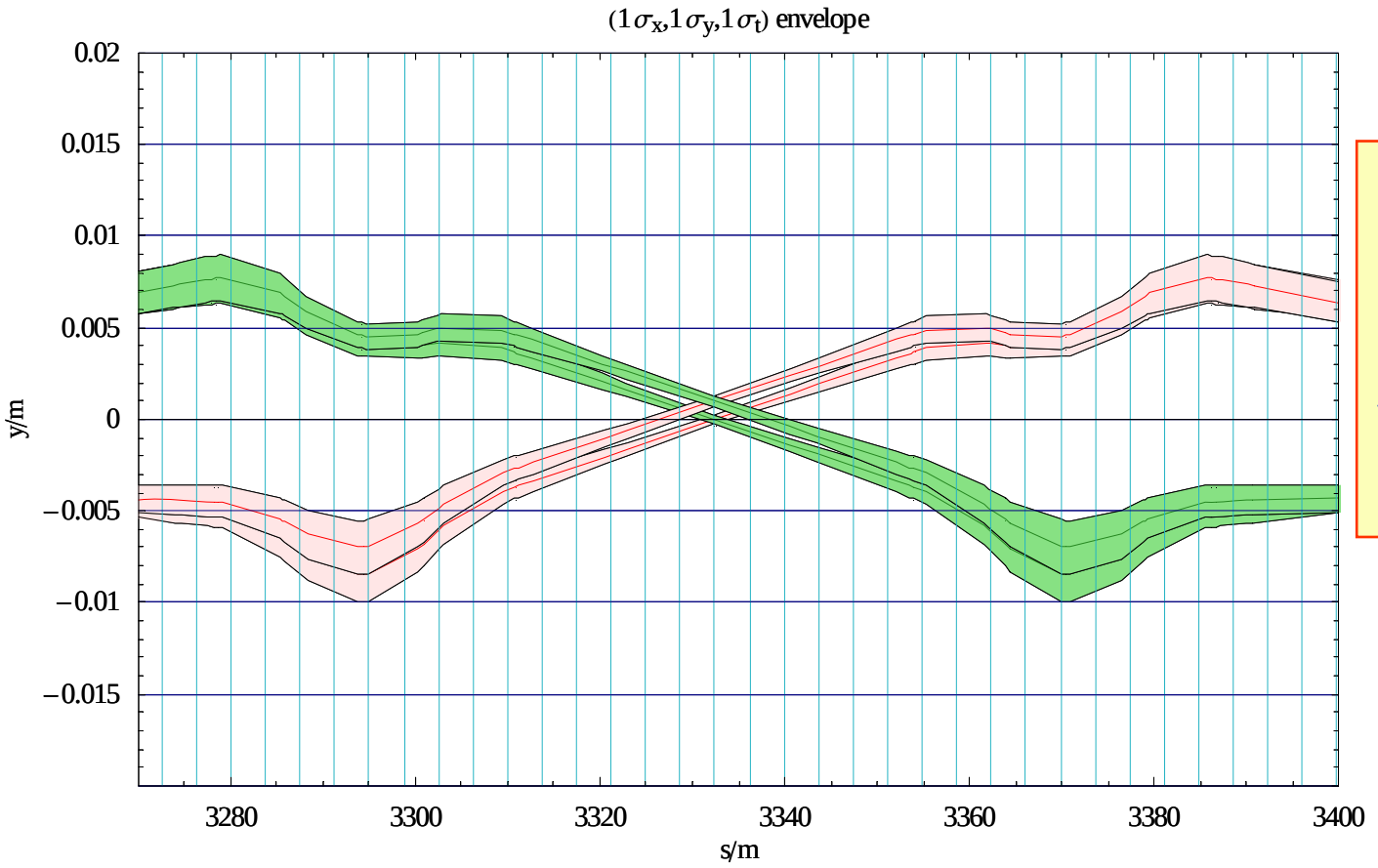


Some reduction in total separation when aperture optimised (blue vs. green)

Vertical beam-beam separation, 1 sigma envelopes

(lxplus1) In[135]:=

```
DisplayTogether[sigmaInAperturePlot[case0, "Y"], sigmaInAperturePlot[casep1, "Y"],
 bblinePlot, PlotRange→ {{3270, 3400}, {-0.02, 0.02}}]
```

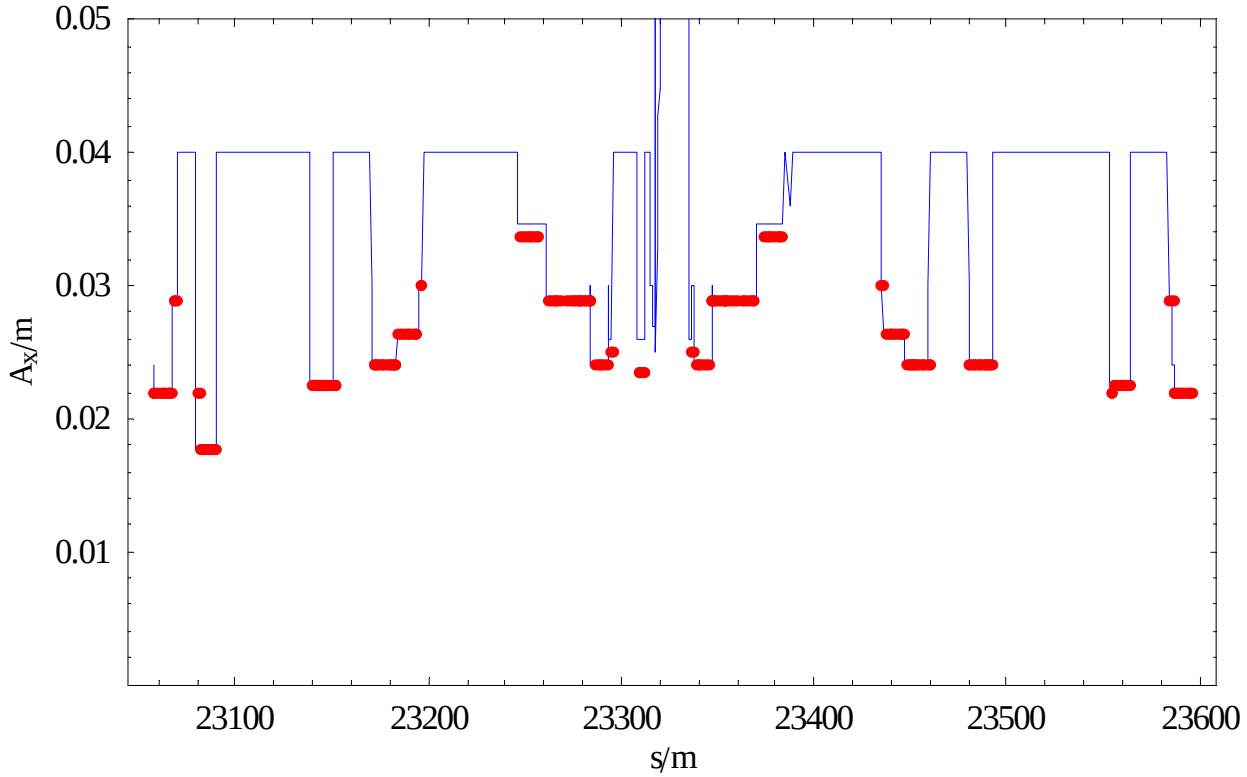


Some reduction in vertical separation when aperture optimised

Comparison of horizontal aperture models in IR2

(lxplus1) In[400]:=

```
DisplayTogether[apXcollPlot, apXseqPlot, FrameLabel → {"s/m", "Ax/m"}, Frame → True]
```



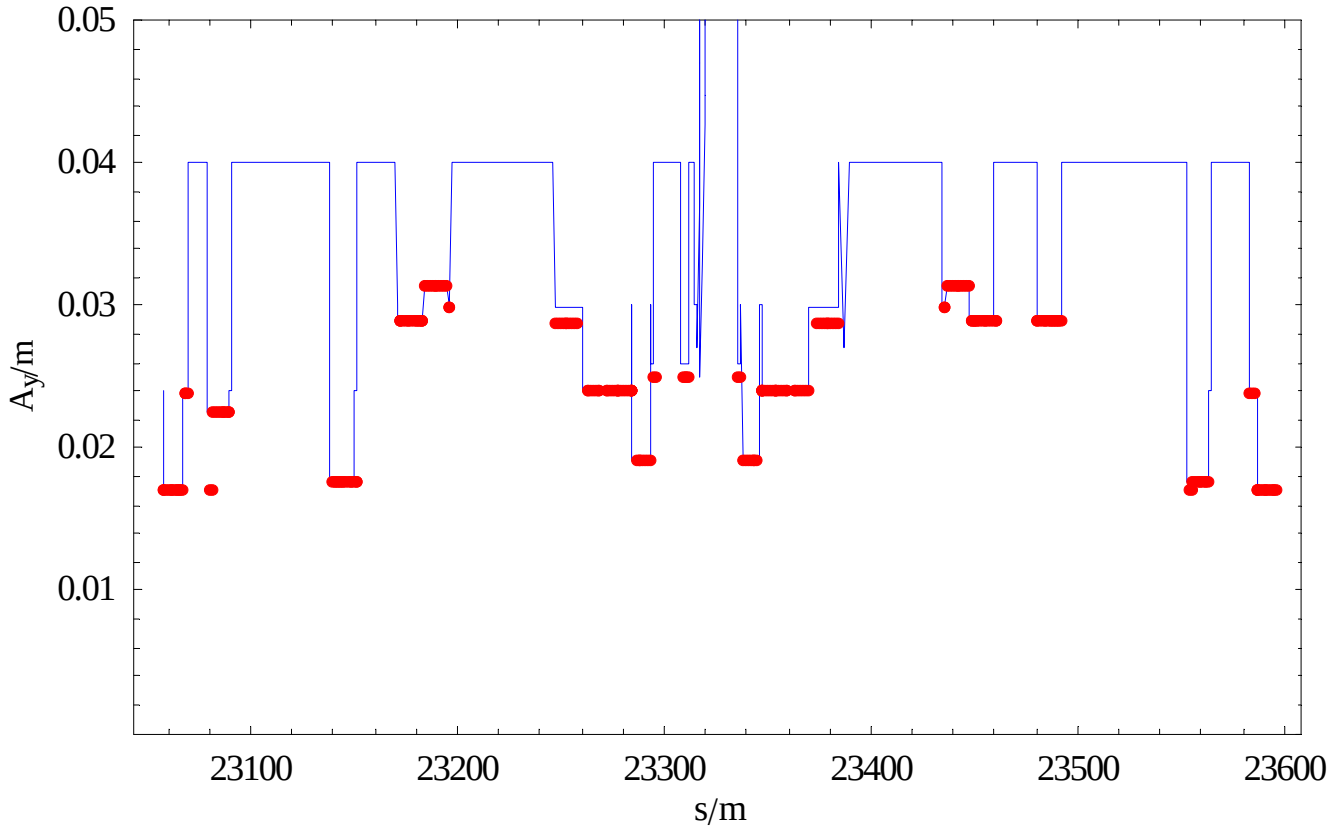
Latest minimal collimation model vs. aperture in special sequence file

“seq_sf”

Comparison of vertical aperture models in IR2

(lxplus1) In[401]:=

```
DisplayTogether[apYcollPlot, apYseqPlot, FrameLabel → {"s/m", "Ay/m"}, Frame → True]
```



Latest minimal collimation model vs. aperture in special sequence file

"seq_sf"

Conclusions

- Vertical displacement of IP2 by +1 mm provides optimum aperture at injection
  - With opposite sign of ALICE spectrometer, displacement should be -1 mm
- Switchgear in V6.500 strength file for injection not consistent with collision
- Technical points:
  - Found some “unexpected” (by me, anyway) behaviour of APERTURE command in MAD-X (not described here)
  - Differences in aperture details in seq_sf file
  - New aperture and envelope plots available in Madtomma (quite well documented with examples).