RP Insertions at Low β* in 2016

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2015 Run: RP Positions and Diffractive Mass Acceptance Limits

2015: successful RP insertions to ~25 σ at lumi up to 5 x 10^{33} cm^{-2} s^{-1}
→ optimistic expectations for 2016

$\sqrt{s}$ = 13 TeV, β^* = 0.8 m, α_X = 290 μrad, ε_n = 3.5 μm rad

$\xi_{min} = x_{min} / D$

	Horizontal RP	$\sigma_{x,beam}$	D_x	Detector edge position now: 20.7 σ + 0.5 mm + 0.5 mm (window + gap)	ξ_{min}	Removing 0.5mm margin: 20.7 σ + 0.5 mm (window + gap)	ξ_{min}
Sector 5-6 (Beam 1)	XRPH.C6R5.B1	165 μm	-85 mm	4.416 mm	**0.052**	3.916 mm	**0.046**
	XRPH.D6R5.B1	117 μm	-79 mm	3.422 mm	0.043	2.922 mm	0.037
	XRPH.E6R5.B1	102 μm	-77 mm	3.111 mm	0.040	2.611 mm	0.034
Sector 4-5 (Beam 2)	XRPH.C6L5.B2	168 μm	-86 mm	4.478 mm	**0.052**	3.978 mm	**0.046**
	XRPH.D6L5.B2	121 μm	-81 mm	3.505 mm	0.043	3.005 mm	0.037
	XRPH.E6L5.B2	106 μm	-78 mm	3.194 mm	0.041	2.694 mm	0.035

Minimum diffractive mass in central diffraction: 2 surviving protons (double arm measurement in C & D & E):

$M = \sqrt{\xi_1 \xi_2 s}$

M > 676 GeV

M > 598 GeV

Scenarios for 2016

A: β*=65 cm

- 160 µrad half Xing (11 σ BB)
- Remove 2 σ additional margin from 80cm

Collimator	Setting
TCP IR7	5.5
TCSG IR7	8.0
TCSG IR6	9.1
TCDQ IR6	9.6
TCT IR1/5	11.5
P. Aperture	13.4
C. Aperture	13.8

B: β*=50 cm

- Use tighter IR7/6 hierarchy, 10 σ BB (165 µrad), better orbit in 2015

Collimator	Setting
TCP IR7	5.5
TCSG IR7	7.5
TCSG IR6	8.3
TCDQ IR6	8.3
TCT IR1/5	10.0
P. Aperture	11.5
C. Aperture	11.9

C: β*= 40 cm

- In addition to 50 cm rely on phase
- 185 µrad half Xing (10 σ BB)

Collimator	Setting
TCP IR7	5.5
TCSG IR7	7.5
TCSG IR6	8.3
TCDQ IR6	8.3
TCT IR1/5	9.0
P. Aperture	9.9
C. Aperture	10.2

2015

13.7

XRP: Vertical: 14.5 sigma
Horizontal: 17 sigma
+ orbit margin (0.5 mm ?)

2016 Optics: RP Positions and Diffractive Mass Acceptance Limits

Relative to 2015:

- Beams thicker: RPs further away for given number of sigmas
- Dispersion smaller (due to larger crossing-angle) → bigger $\xi_{min} = x_{min} / D$

Positions proposed so far:

$\sqrt{s}$ = 13 TeV, β^* = 0.4 m, α_X = 370 μrad, ε_n = 3.5 μm rad

	Horizontal RP	$\sigma_{x,beam}$	D_x	Roman Pot position: 17 σ + 0.5 mm	Detector position: 17 σ + 0.5 mm + window + gap	ξ_{min}
Sector 5-6 (Beam 1)	XRPH.C6R5.B1	213 μm	-74.9 mm	4.121 mm = 19.3 σ	4.421 mm = 20.7 σ	**0.059**
	XRPH.D6R5.B1	144 μm	-71.7 mm	2.948 mm = 20.5 σ	3.248 mm = 22.6 σ	0.045
	XRPH.E6R5.B1	120 μm	-70.6 mm	2.540 mm = 21.2 σ	3.040 mm = 25.3 σ	0.043

$M = \sqrt{\xi_1 \xi_2 s}$

M > 767 GeV

→ Strategy in collaboration with machine:

- Try to increase the dispersion by ~ 20 mm
- Investigate how close the RPs can safely approach the beam
  (try to be less conservative but still safe)

Production Rapidity in Central Diffraction

Production rapidity y of a central diffractive state
is determined by momentum asymmetry of the two surviving protons in central diffraction:

$$y = \frac{1}{2} \ln \frac{\xi_1}{\xi_2}$$

$$M^2 = \xi_1 \, \xi_2 \, s$$

minimum M and y = 0 only for $\xi_1 = \xi_2$
wider ξ range → larger visible phase space → more acceptance

Central production of the possible resonance at ~750 GeV:

$$y_{max} = \ln \frac{M}{\xi_{min} \sqrt{s}}$$

with M = 750 GeV, √s = 13 TeV

goal: y_{max} ~ 0.5 with full double arm

Limiting RPs for acceptance: C6R5, C6L5 (i.e. 210-N)

$$d_{RP} = d_{detector} - 0.3\text{mm} = D\xi_{min} - 0.3\text{mm}$$

assuming full acceptance at d + 0.3 mm (window + gap)

β* = 0.4 m, α_X = 370 μrad, D_x = -74.9 mm (without improvement)

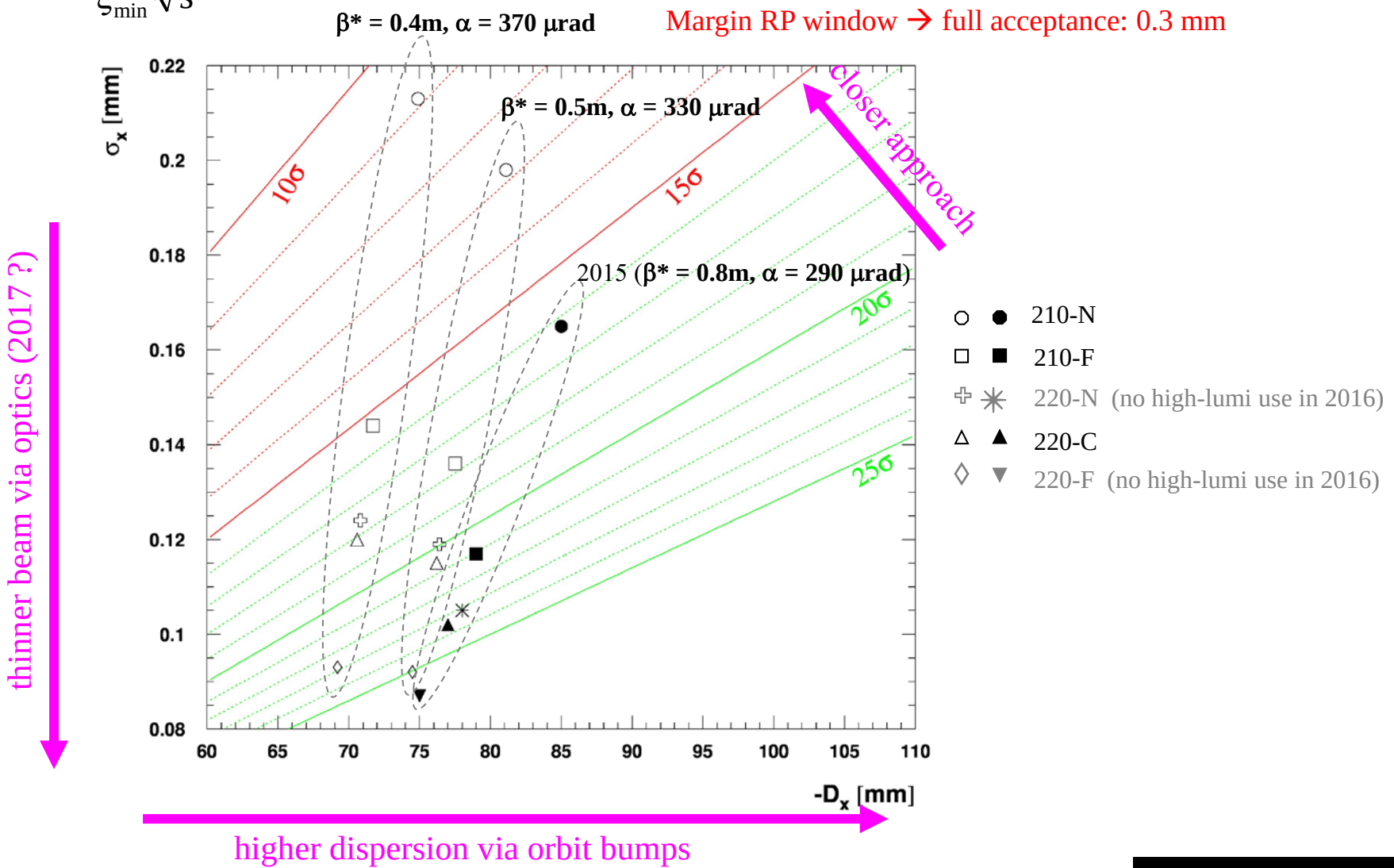
d_{RP} (210-N)	$d_{detector}$	ξ_{min}	y_{max}
19.3 σ	20.8 σ	0.059	--
17.8 σ	19.2 σ	0.055	0.05
16 σ	17.4 σ	0.049	0.16
15 σ	16.4 σ	0.047	0.21
11 σ	12.4 σ	0.035	0.50
5.6 σ	7.0 σ	0.02	1
1.4 σ	2.8 σ	0.008	2

unrealistically close

Phase Space of RP Approach

Horizontal RP approach to N σ_x needed to reach $\xi_{min} = 0.035$ or rapidity $y_{max} = 0.5$

$$y_{max} = \ln \frac{M}{\xi_{min}\sqrt{s}}$$ with M = 750 GeV, $\sqrt{s}$ = 13 TeV



Backup

Rapidity and ξ Acceptance vs. Dispersion

$$y_{max} = \ln \frac{M}{\xi_{min}\sqrt{s}}$$ with M = 750 GeV, √s = 13 TeV

β* = 0.4m, RP 210-N (i.e. fixed $\sigma_{x,beam}$ = 0.213 mm)