

Orbit analysis, proposal for 2022 BPM interlock settings and staging

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Thanks to D. Mirarchi, J. Wenninger

Joint meeting: 224th Machine Protection Panel – 263rd LHC Collimation Working Group

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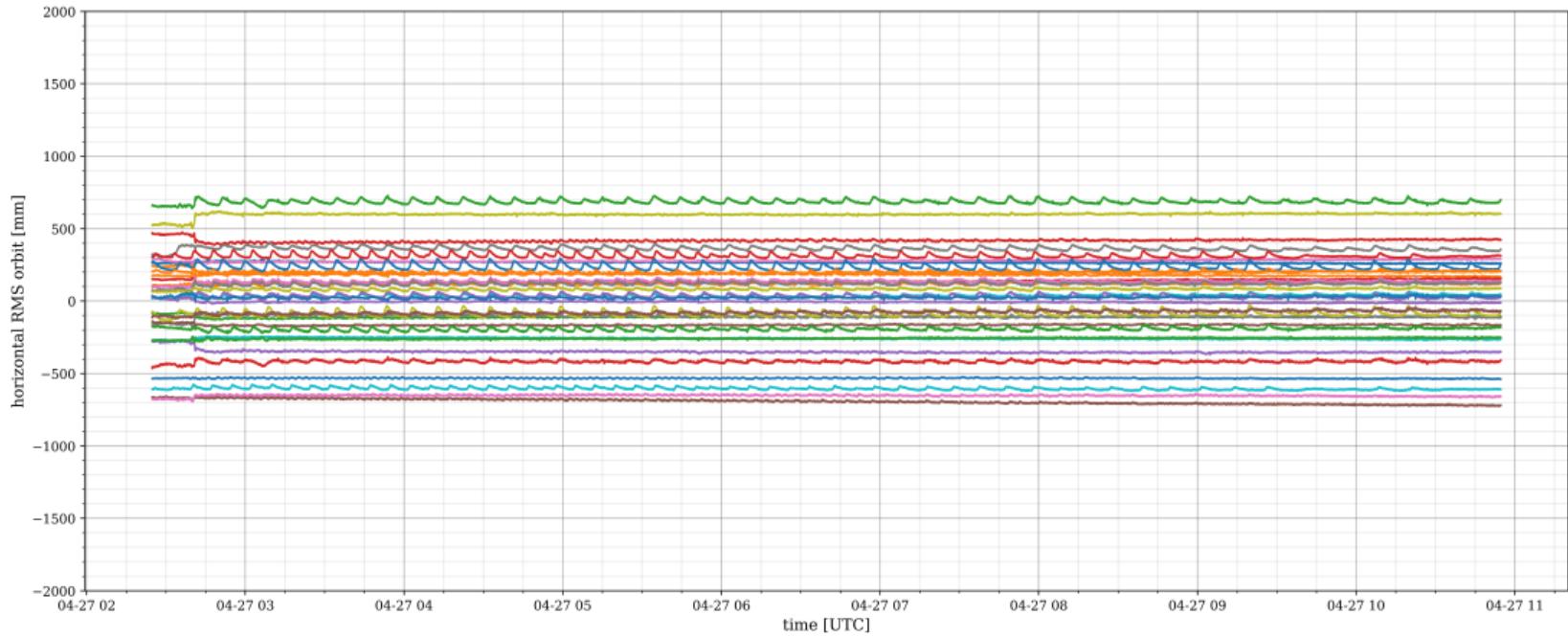
Introduction

- New Mo-coated TCSPMs installed in LS2 must be protected against primary beam losses
- All new collimators have in-jaw BPMs that can be used for interlocking
 - Interlock strategy?
 - Thresholds?
 - Impact on availability?

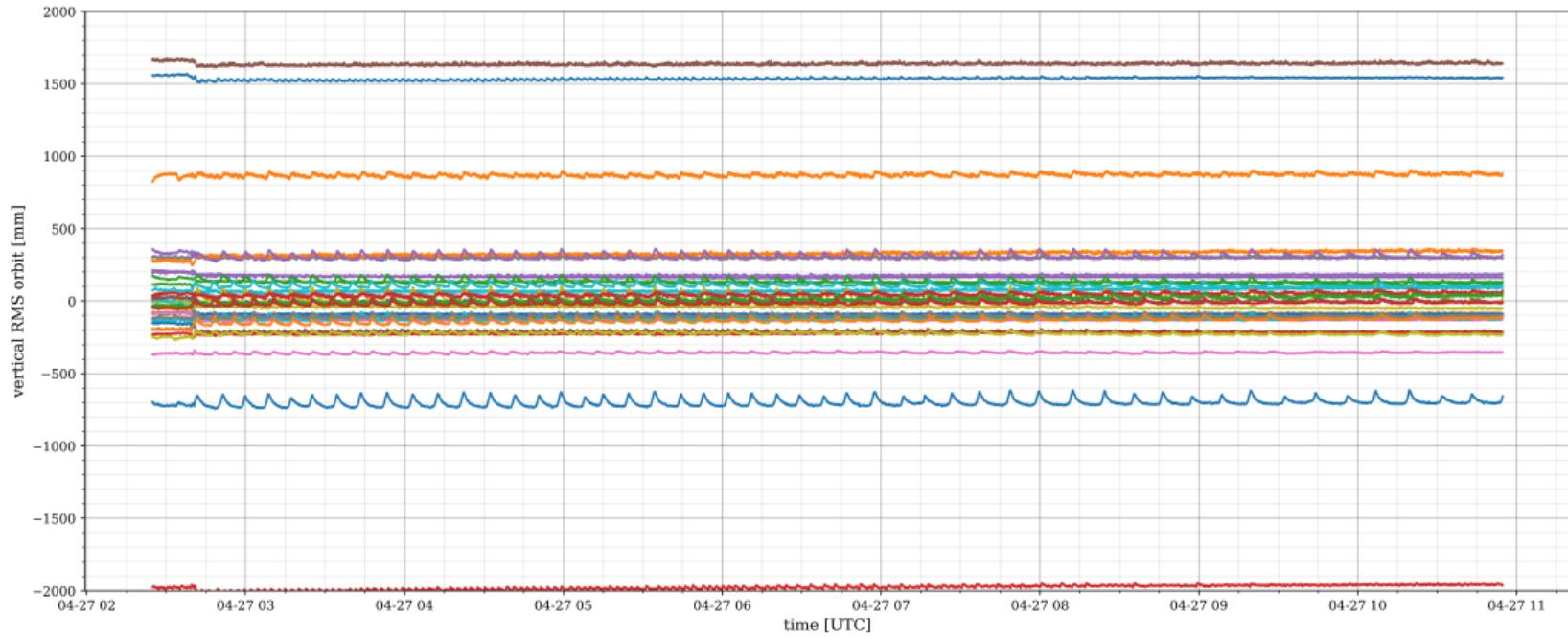
Run II – IR7 orbit statistics

- Individual IR7 BPM readings
 - Cells +-9
- Collimator BPM readings
 - TCP.C6L7.B1
 - TCSPM.D4R7.B2
 - TCSP.A4R6.B1
 - TCSP.A4L6.B2
- 5 second windows to filter out spikes
- For normal IR7 BPMs, used first fill of 2018 as the reference orbit
- Focused on FT / SB
- Fill-to-fill stability?
- Variation within fills?

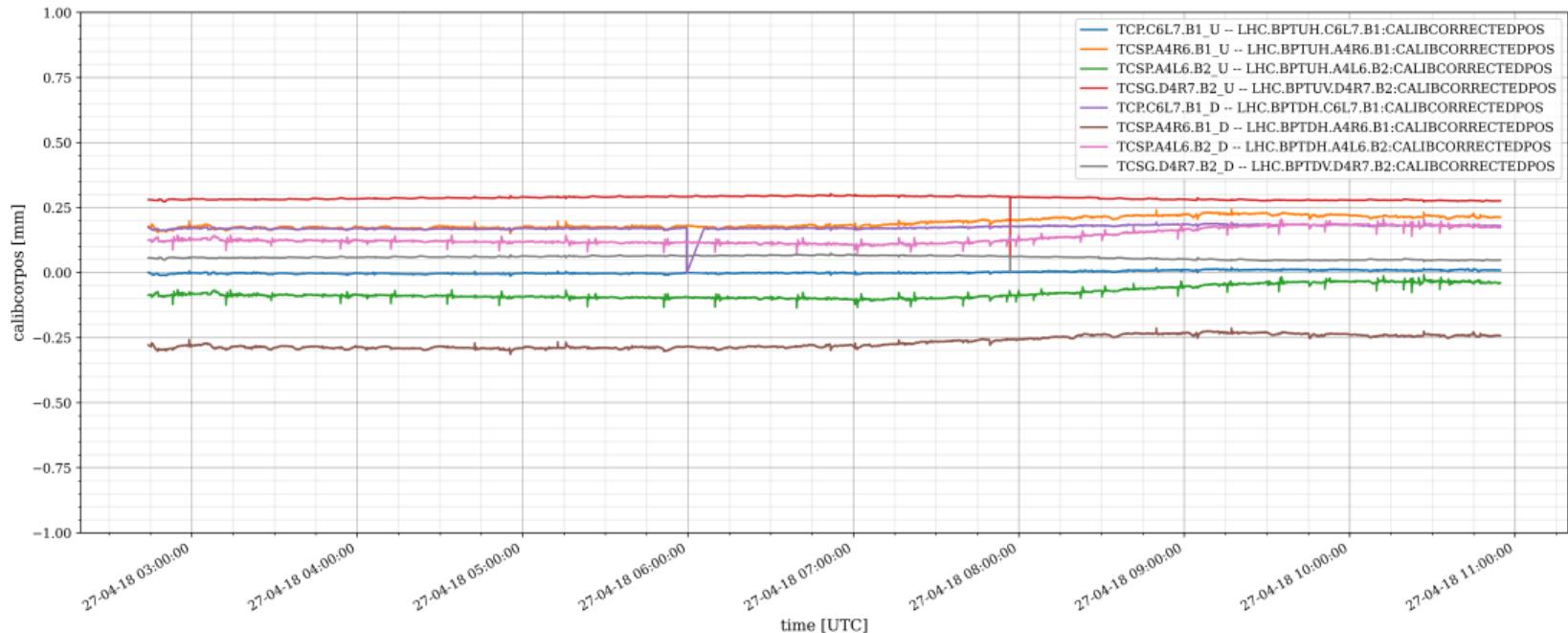
IR7 readings – first fill 2018 – hor. (FT->SB)



IR7 readings – first fill 2018 – ver. (FT->SB)

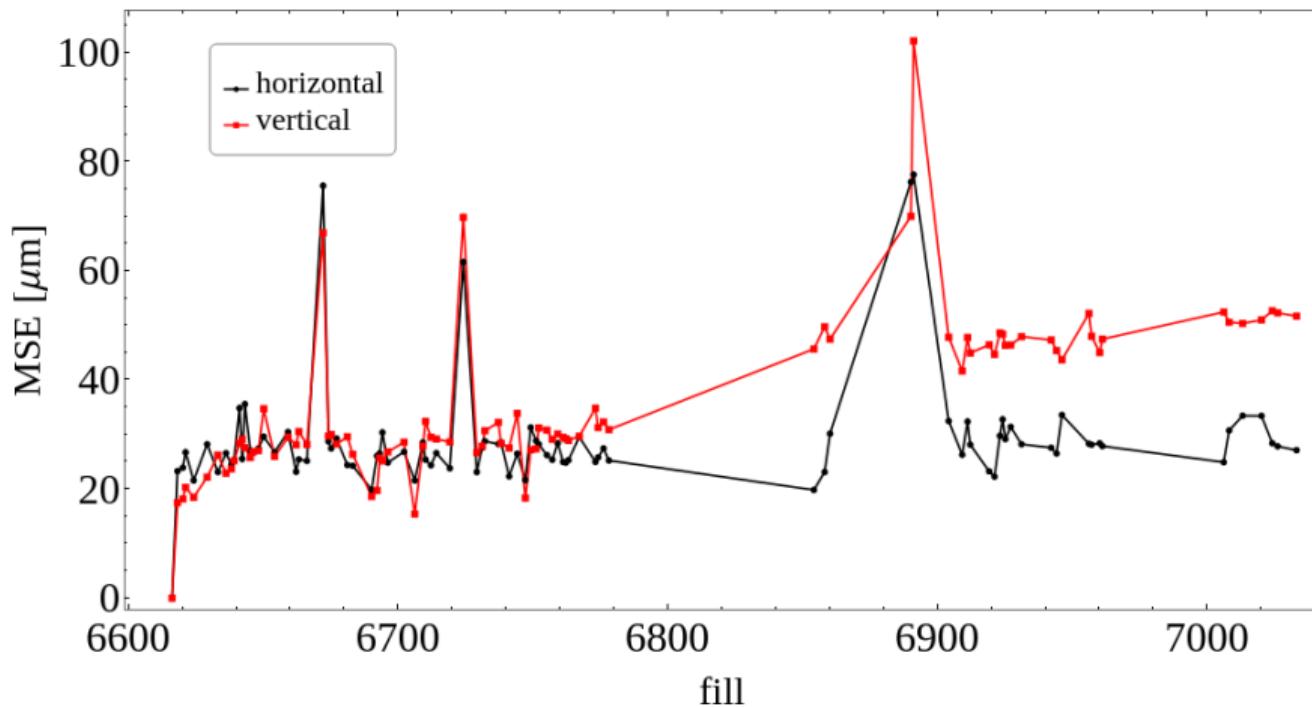


Collimator readings – first fill 2018 (SB)



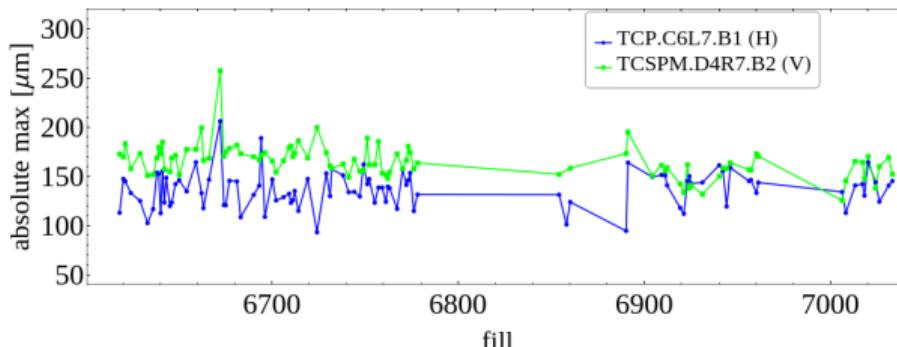
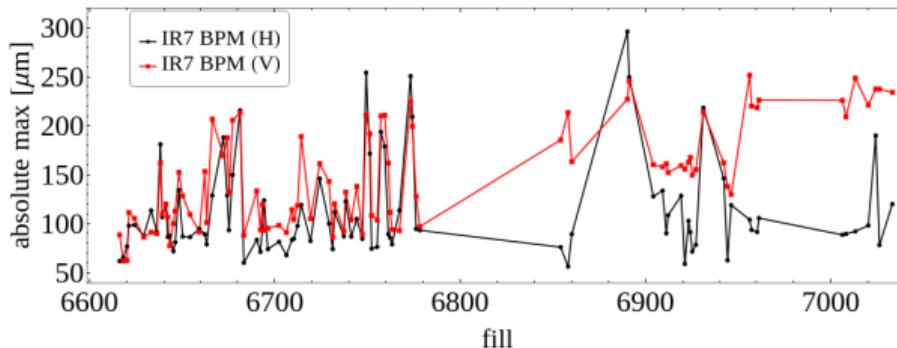
Evolution of Mean Squared Error over 2018

MSE of IR7 BPMs in each fill compared to the reference fill



Evolution of Max variation within each fill

Absolute maximum offset compared to the reference fill average orbit



Orbit stability (FT->SB)

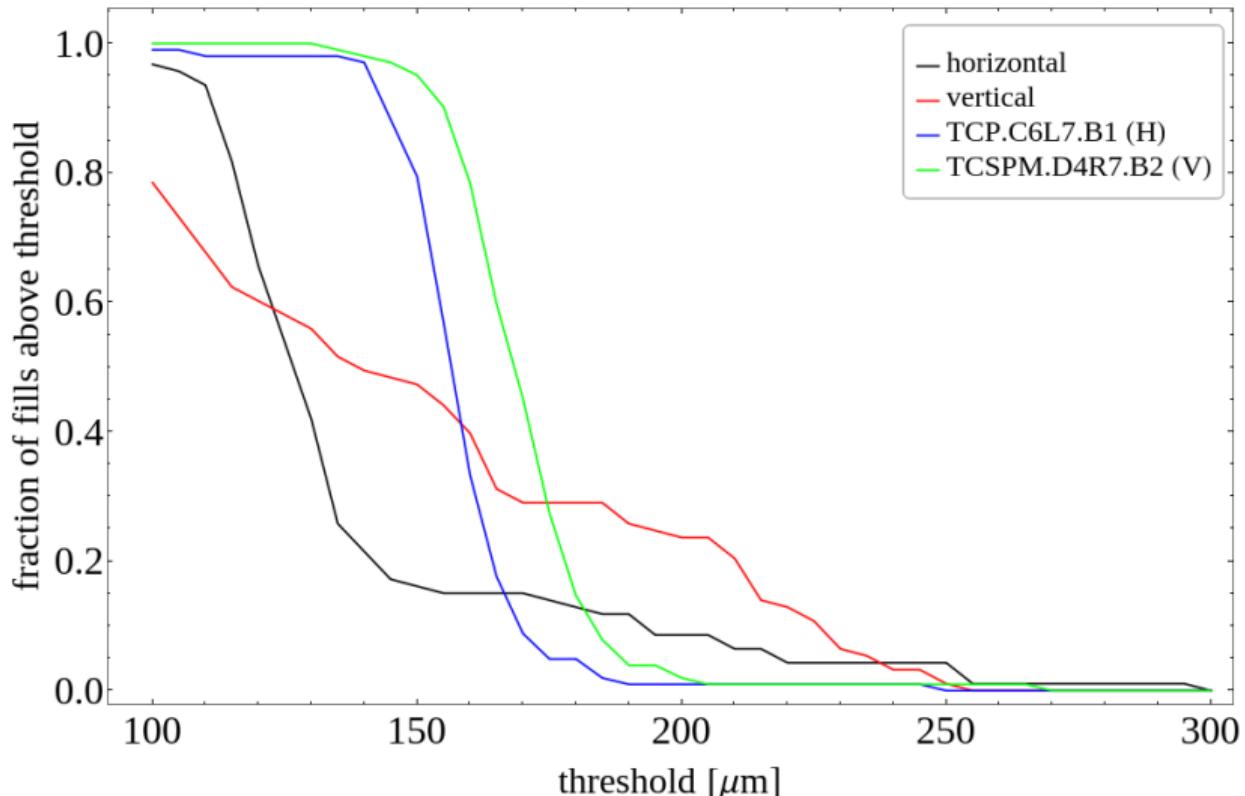
fill-to-fill	offset (mean / std)	min (mean / std)	max (mean / std)
IR7 (H) [μm]	42/8	-126/21	117/42
IR7 (V) [μm]	38/14	-99/29	143/57
IR7 (H) [σ]	0.18/0.16	-0.61/0.19	0.64/0.27
IR7 (V) [σ]	0.18/0.17	-0.57/0.18	0.65/0.25

Orbit stability (FT->SB)

fill-to-fill	offset (mean / std)	min (mean / std)	max (mean / std)
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fill-to-fill	offset (mean / std)	min (mean / std)	max (mean / std)
TCP.C6L7.B1 (H) [μm]	127/18	111/20	157/16
TCSPM.D4R7.B2 (V) [μm]	155/17	144/18	169/15
TCSP.A4R6.B1 (H) [μm]	1/67	-45/65	72/64
TCSP.A4L6.B2 (H) [μm]	-3/64	-47/58	45/71
TCP.C6L7.B1 (H) [σ]	0.46/0.07	0.39/0.07	0.60/0.06
TCSPM.D4R7.B2 (V) [σ]	0.85/0.09	0.77/0.09	0.94/0.08
TCSP.A4R6.B1 (H) [σ]	0.01/0.12	-0.09/0.12	0.18/0.12
TCSP.A4L6.B2 (H) [σ]	-0.01/0.12	-0.12/0.11	0.11/0.14

fraction of fills above threshold



TCP - TCS hierarchy margins

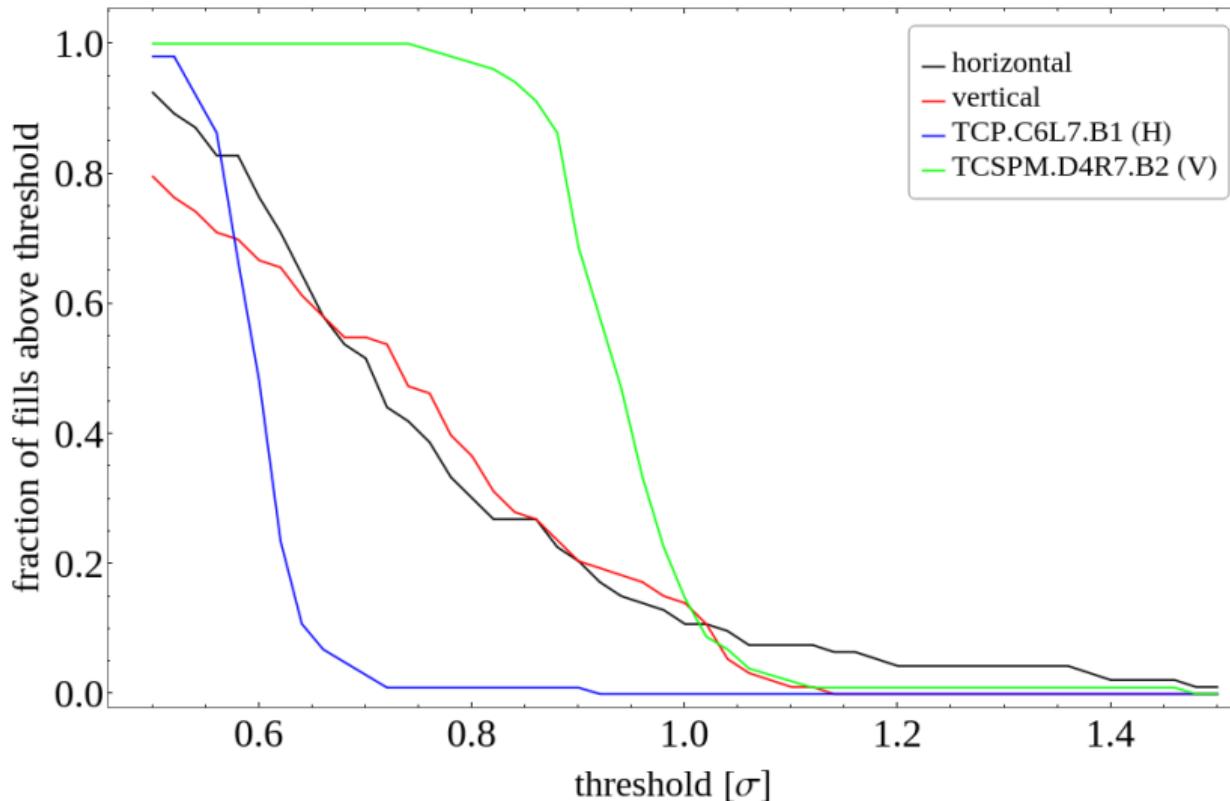
collimator	β [m]	σ [μm]	gap [σ]	β beat [σ]	margin [σ]	margin [μm]
TCP.C6L7.B1 (H)	140.9	257	5.0	0.23		
TCSP.A4R6.B1 (H)	523.9	496	7.4	0.34	1.82	904
TCSPM.6R7.B1 (H)	293.6	371	6.5	0.30	0.97	358
TCSPM.B4L7.B1 (H)	134.1	251	6.5	0.30	0.97	242
TCP.D6L7.B1 (V)	71.4	183	5.0	0.23		
TCSG.D4L7.B1 (V)	68.8	180	6.5	0.30	0.97	173
TCP.B6L7.B1 (S)	134/79.5	224	5.0	0.30		
TCSPM.E5R7.B1 (S)	256/126	299	6.5	0.30	0.97	289
TCP.C6R7.B2 (H)	140.9	257	5.0	0.23		
TCSPM.6L7.B2 (H)	293.4	371	6.5	0.30	0.97	358
TCSPM.B4R7.B2 (H)	145.6	261	6.5	0.30	0.97	252
TCP.D6R7.B2 (V)	71.5	183	5.0	0.23		
TCSPM.D4R7.B2 (V)	65.4	175	6.5	0.30	0.97	169
TCP.B6R7.B2 (S)	134/79.6	224	5.0	0.30		
TCSPM.E5L7.B2 (S)	256/126	299	6.5	0.30	0.97	289

Conclusions

- MSE of average orbit in IR7 BPMs increased over the year, no similar worsening seen in the collimators
- IR7 BPMs reach above $200 \mu\text{m}$ in several fills
- IR7 collimator fluctuations small ($20 \mu\text{m}$)
 - Margin is eaten up by overall offset
- With 10 % beta beating, hierarchy margin is 0.97σ
 - In TCSG.D4L7 / TCSG.D4R7 margin is 173 / 169 μm
- **Proposal:**
 - Activate interlock with tentative, relaxed threshold ($300 \mu\text{m}$)
 - Continuously check new collimator BPMs during commissioning
 - Tighten threshold if deemed possible
 - Consider using BPMs for collimator alignment – allows for tighter thresholds

Extra slides

fraction of fills above threshold – σ



Collimator readings – first fill 2018 – FT

