Results from beam-beam tracking campaign 2005

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Questions:

- **Dynamic aperture in collision with head-on and long range beam-beam interactions**
- **Difference between alternating of non-alternating crossing planes in IP1 and IP5**
- **Difference betwen Nominal and PACMAN bunches**
- **Effect of triplet errors**

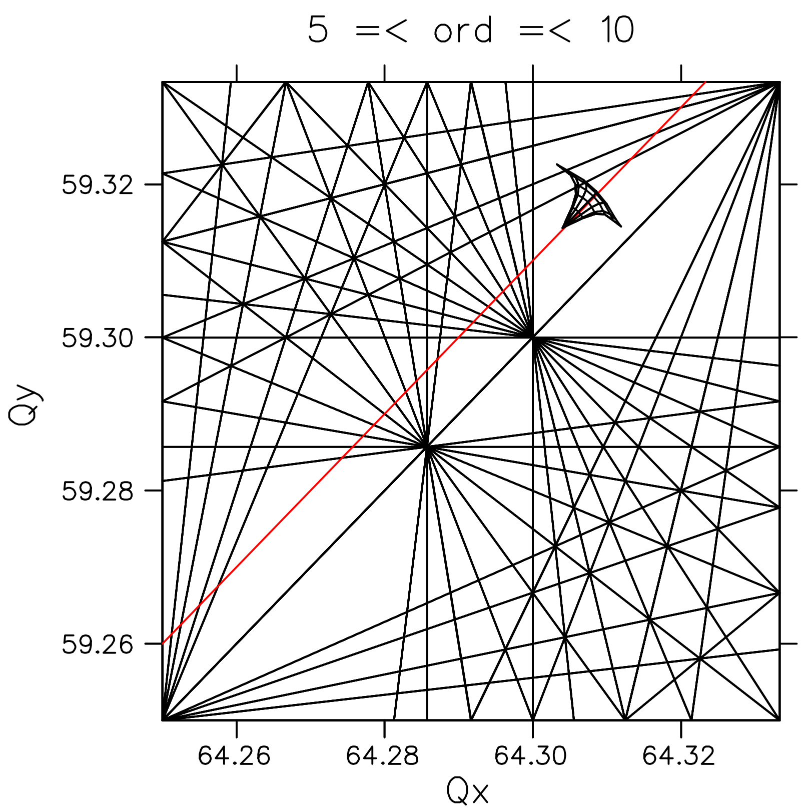
Procedure (1):

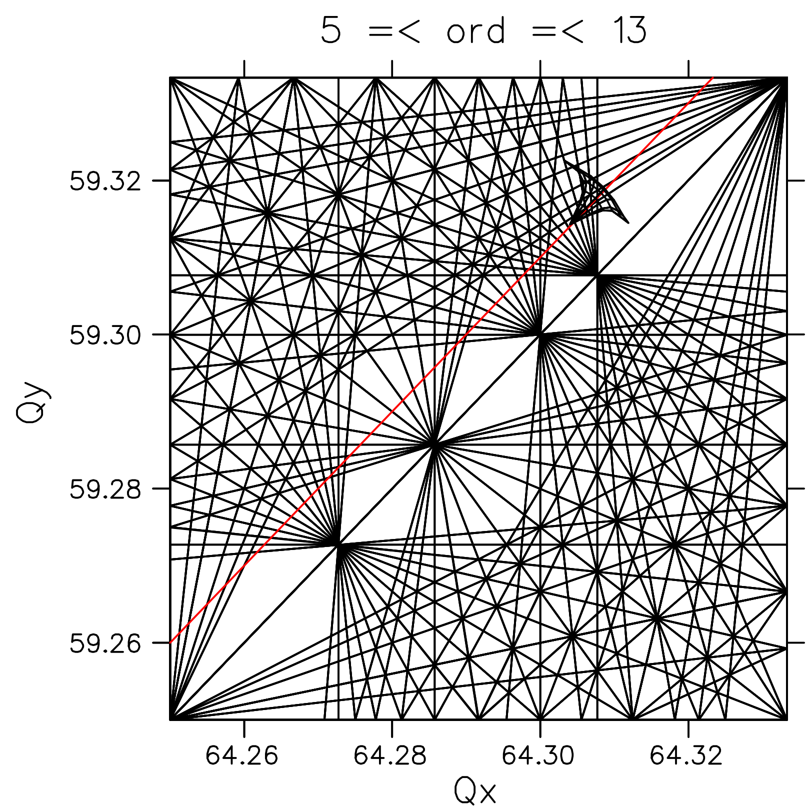
- V6.4 and $\beta^* = 0.55$ m
- Head-on and long range beam-beam interactions
- Triplet errors corrected
- Horizontal-Vertical and Horizontal-Horizontal crossings in IP1 and IP5
- Nominal and PACMAN bunches separate

Procedure (2):

- All angles between 0^0 and 90^0 in x-y plane
- Error table 2210
- Preparation with MADX
- Tracking with SIXTRACK
- Tracking up to 10^6 turns with 20 seeds for triplet errors
- Use of LHC@home

Working diagram



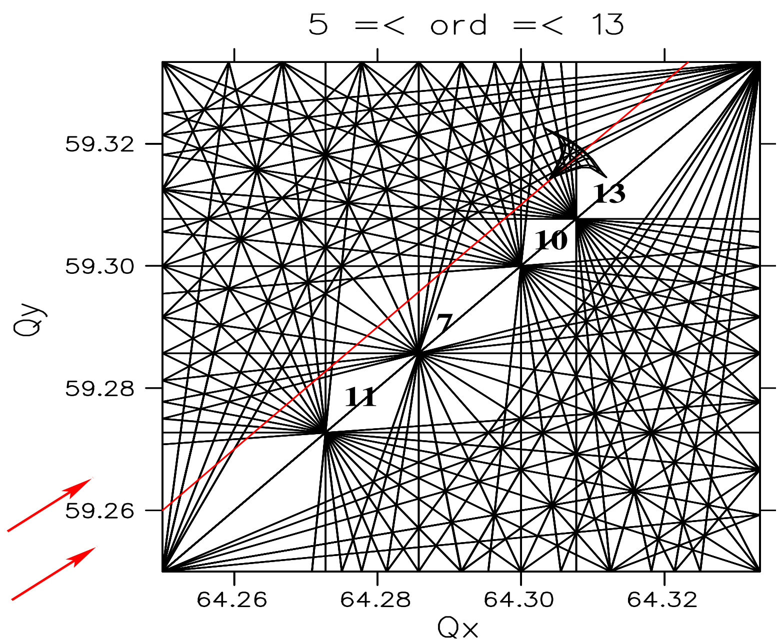


Tune scan with split 0.01 and 0.02, step of 0.001

tunescan lines
(step 0.001)

split 0.02

split 0.01



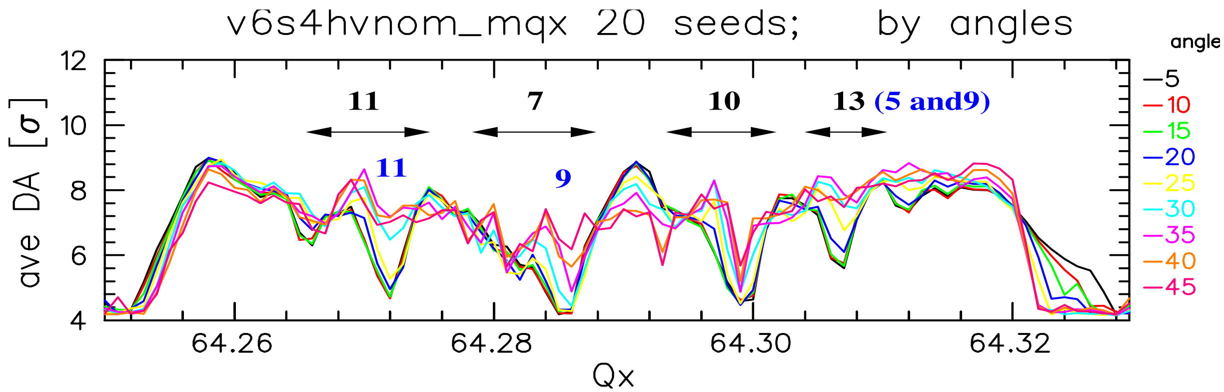
Average Dyn. Aperture (DA), 10^6 turns

20 seeds triplet errors and corr. nominal bunch hor.–vert. crossing IP1 and 5

shown angles 0 – 45 deg

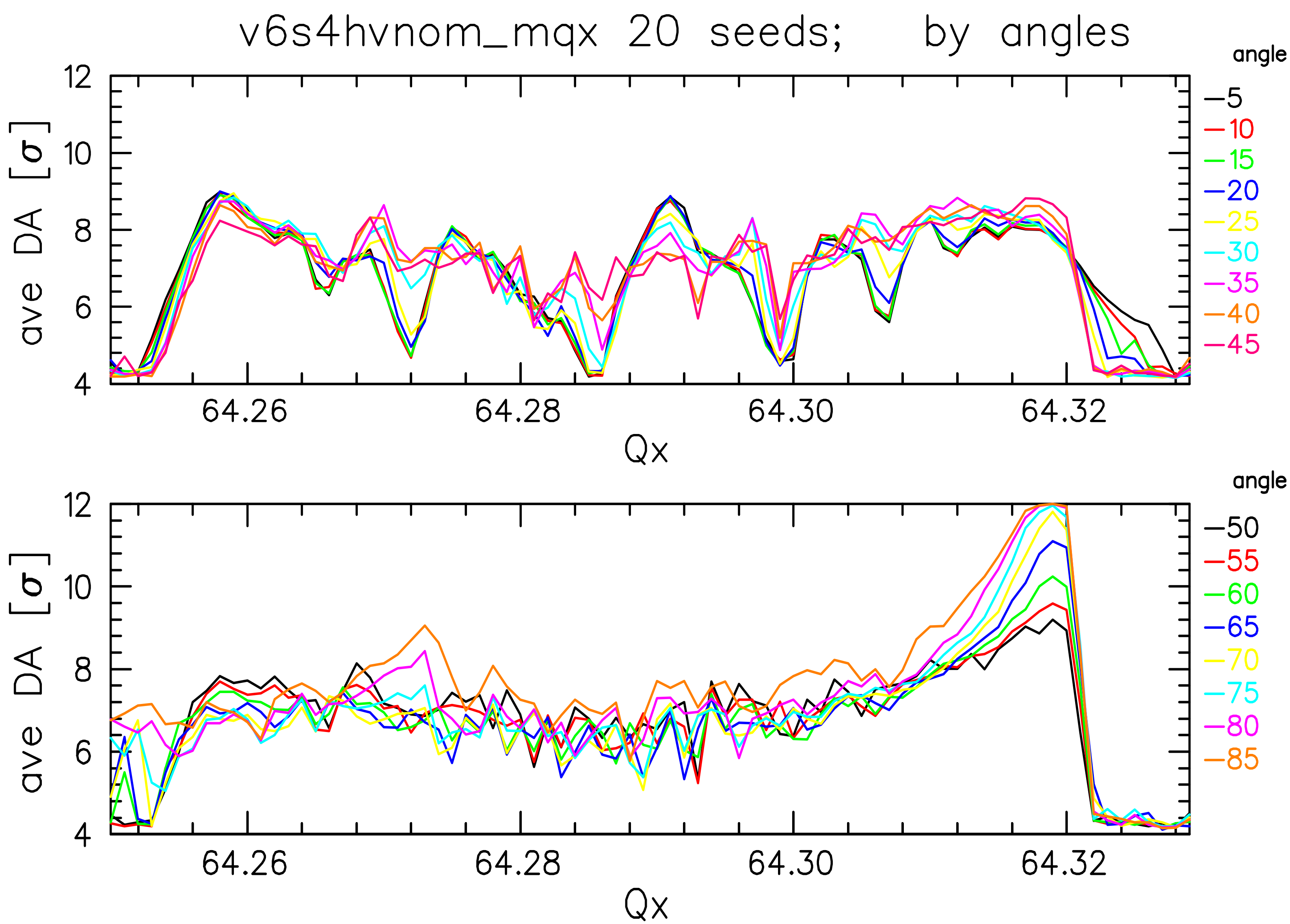
split 0.01

HV Nom

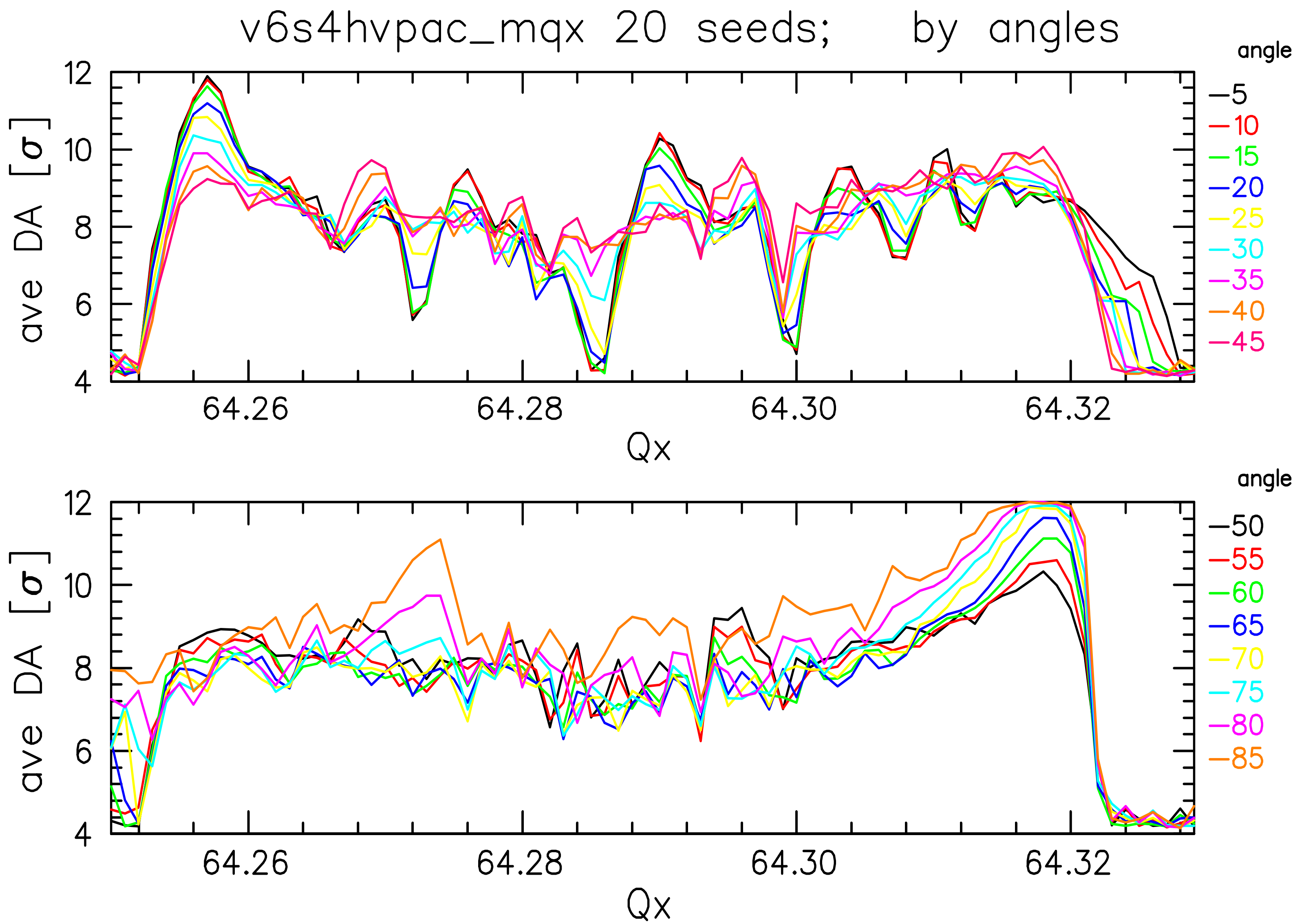


unperturbed (by bb) tune

Ave. dynamic aperture (HV triplet errors, NOMINAL)

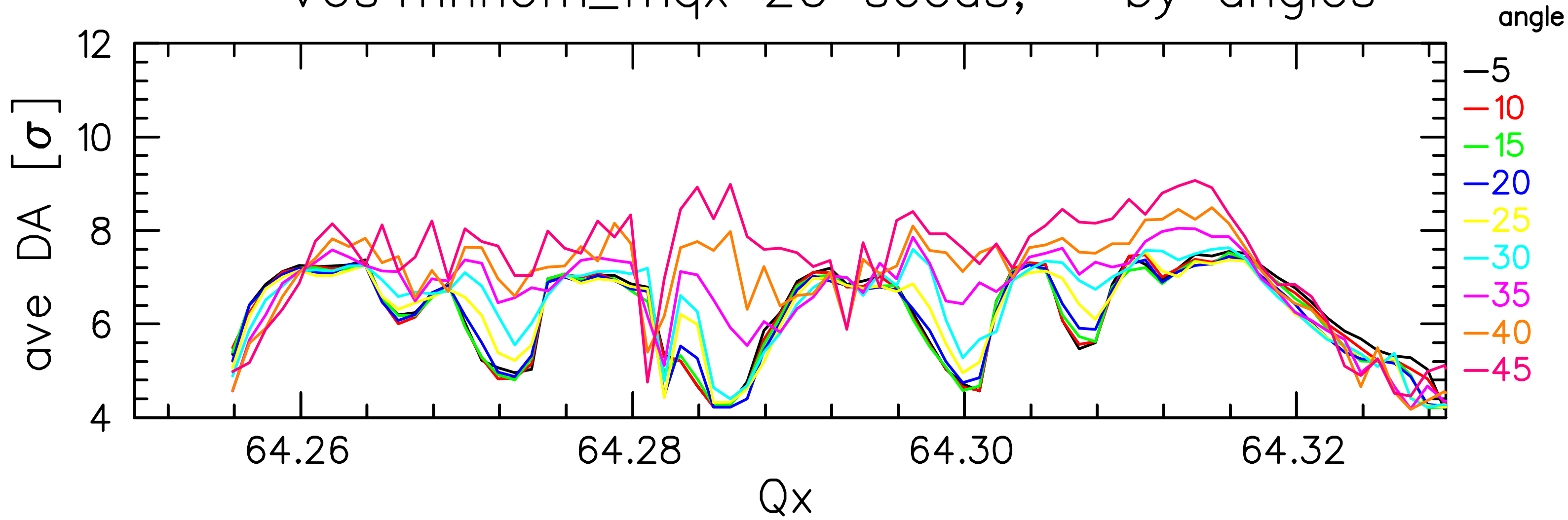


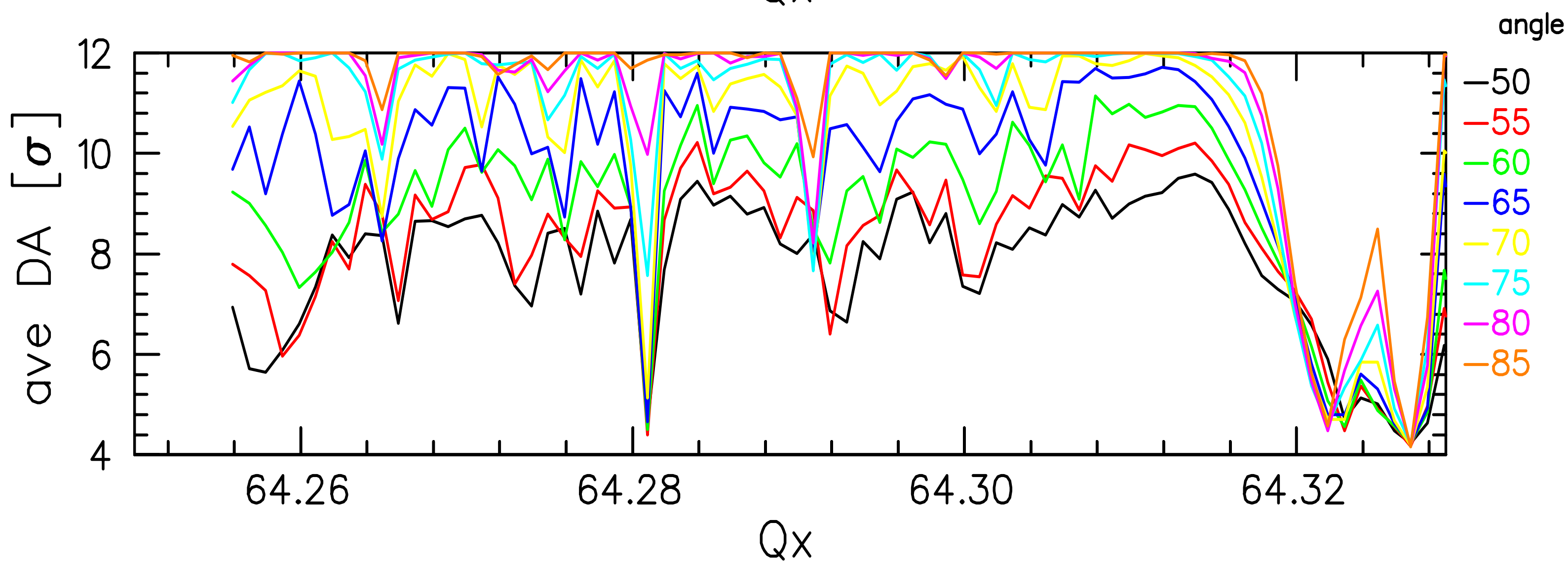
Ave. dynamic aperture (HV triplet errors, PACMAN)



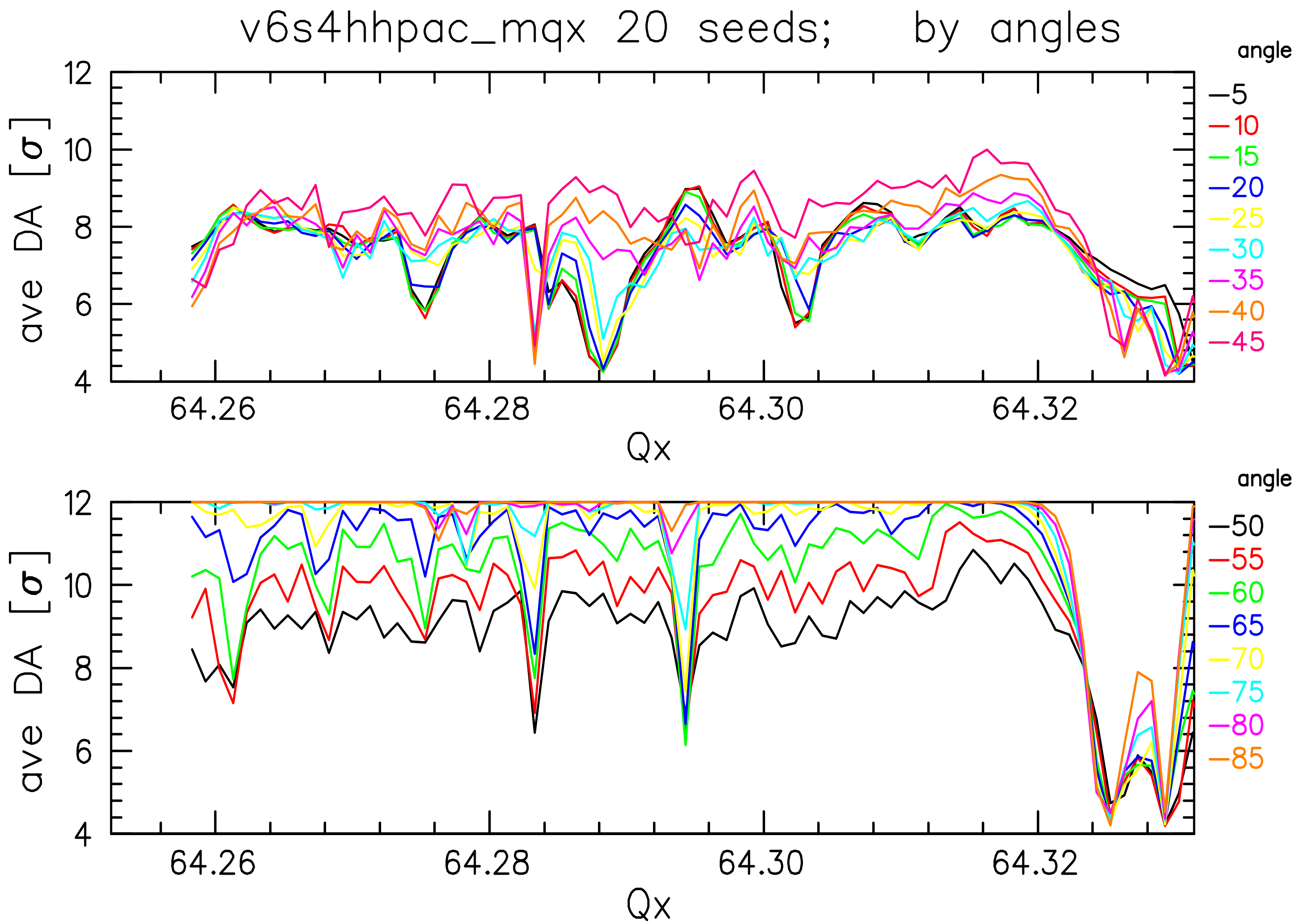
Ave. dynamic aperture (HH triplet errors, NOMINAL)

v6s4hhnom_mqx 20 seeds; by angles

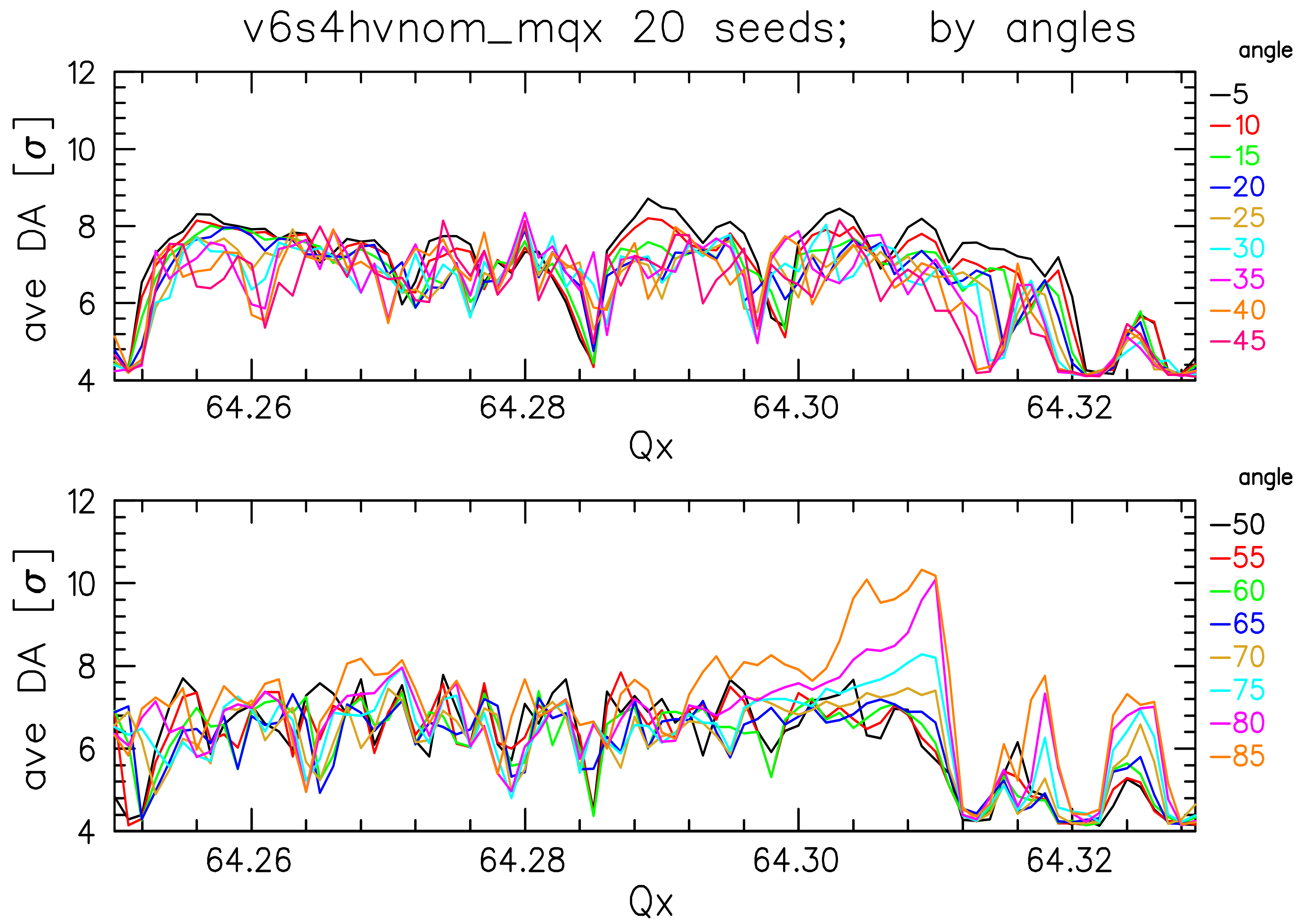




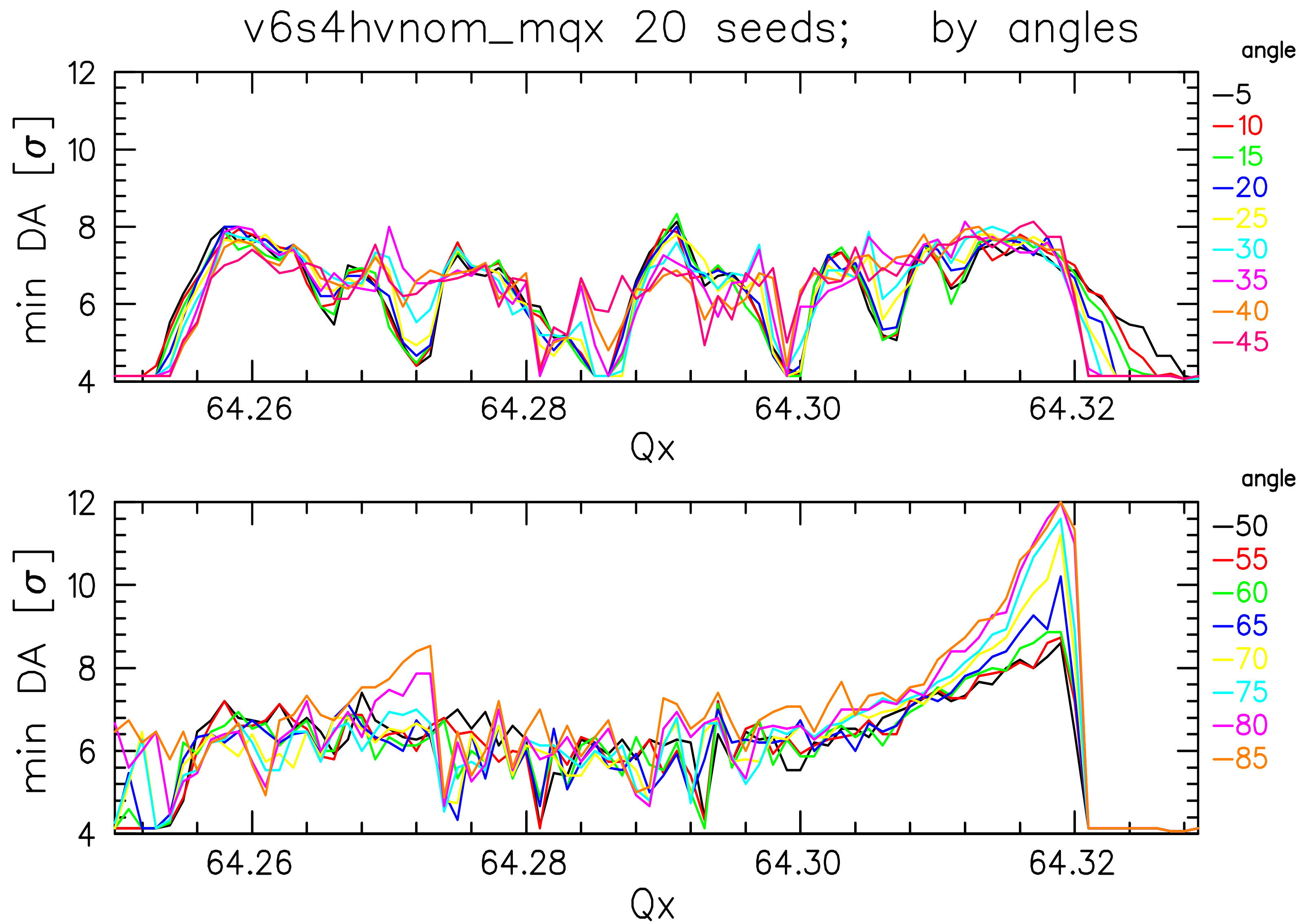
Ave. dynamic aperture (HH triplet errors, PACMAN)



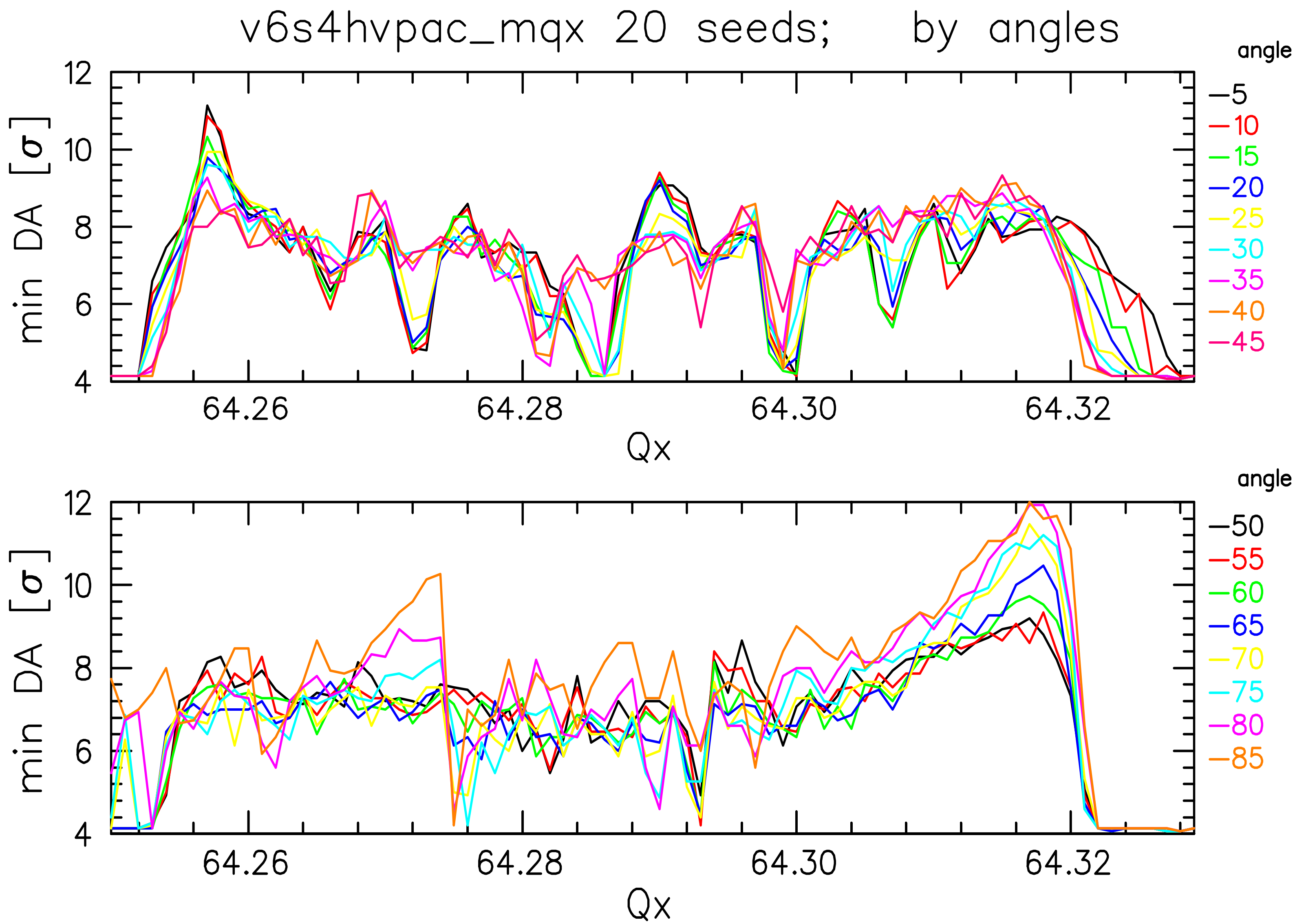
Ave. dynamic aperture (HV triplet errors, split 0.02)



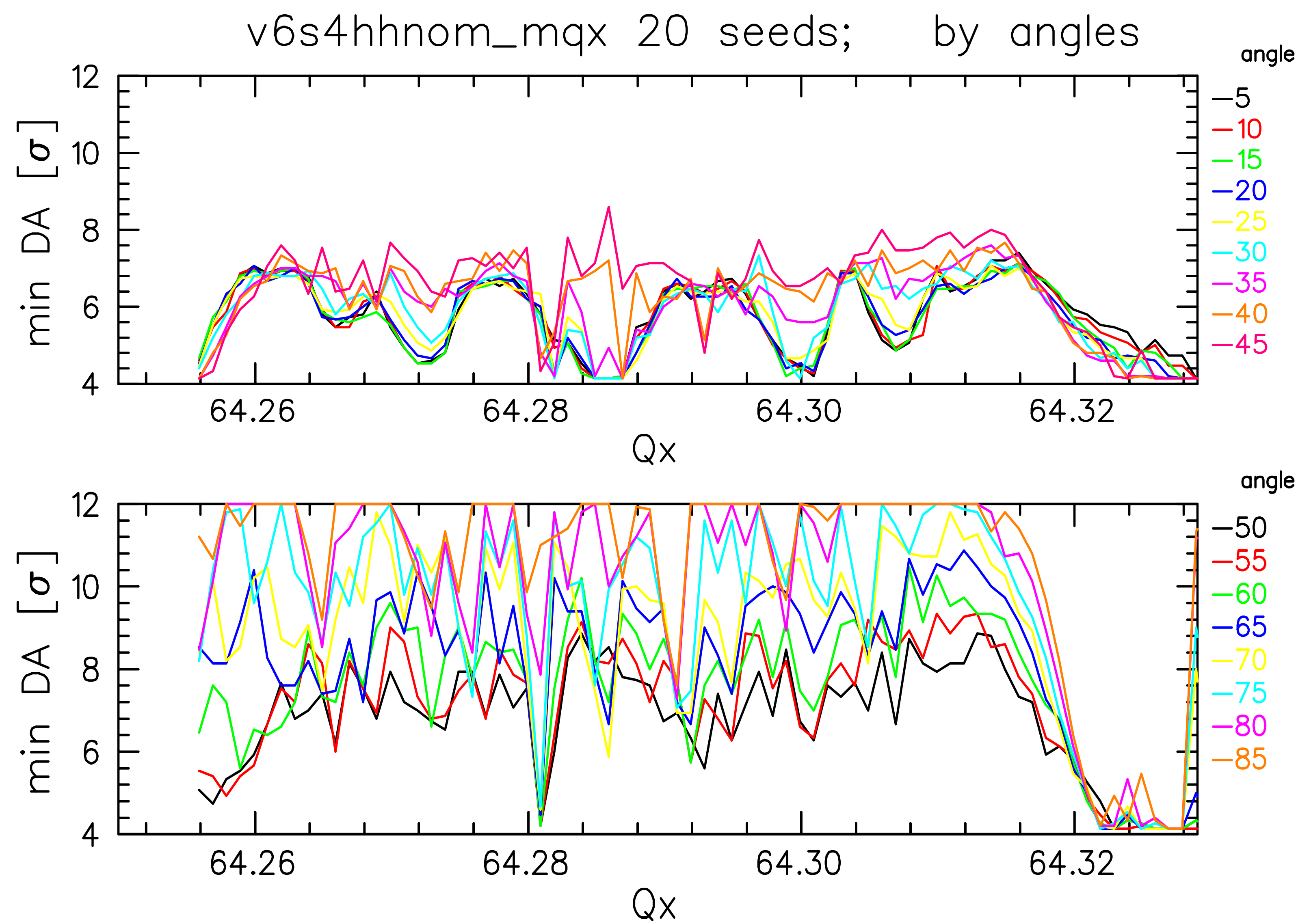
Min. dynamic aperture (HV triplet errors, NOMINAL)



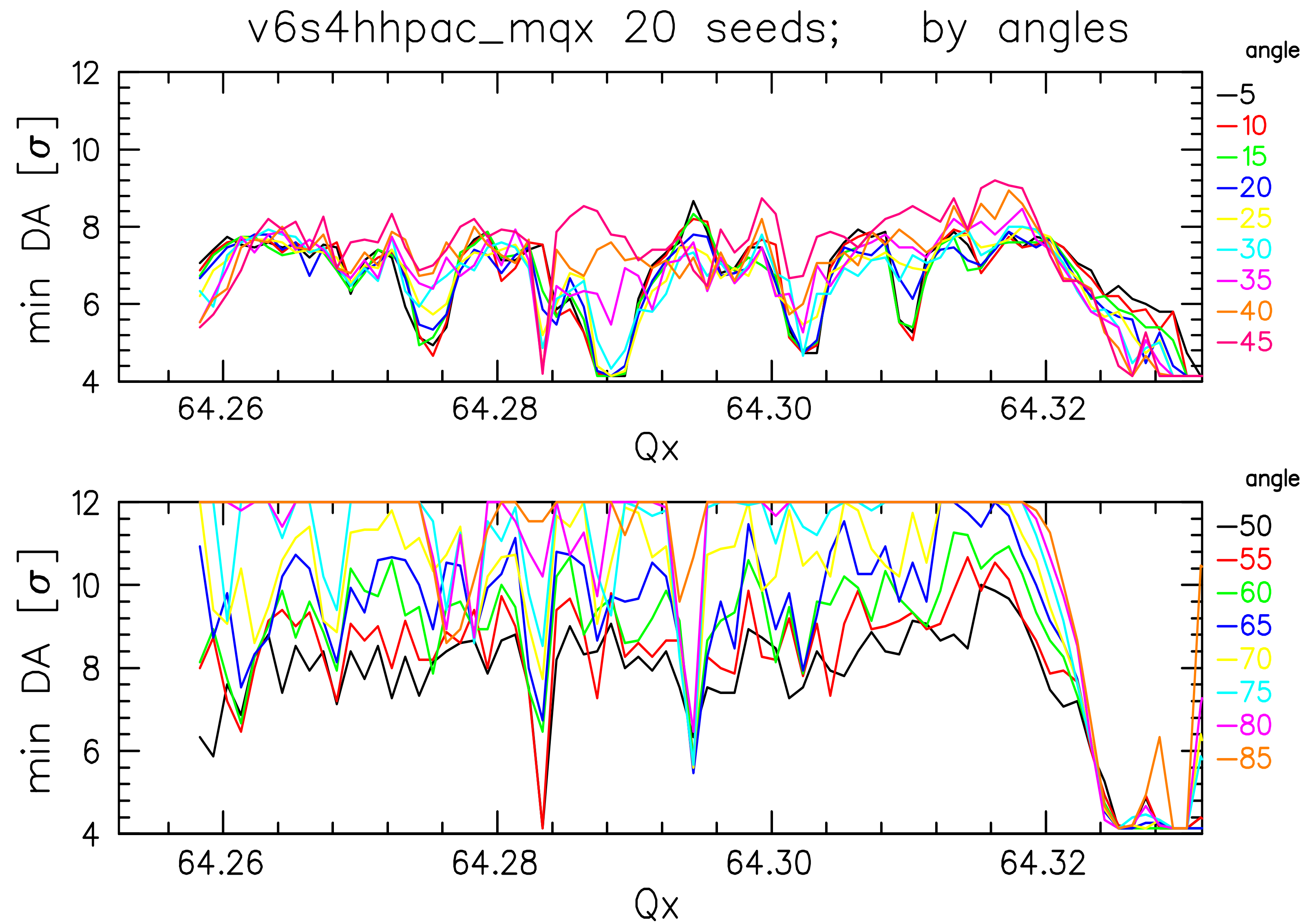
Min. dynamic aperture (HV triplet errors, PACMAN)



Min. dynamic aperture (HH triplet errors, NOMINAL)

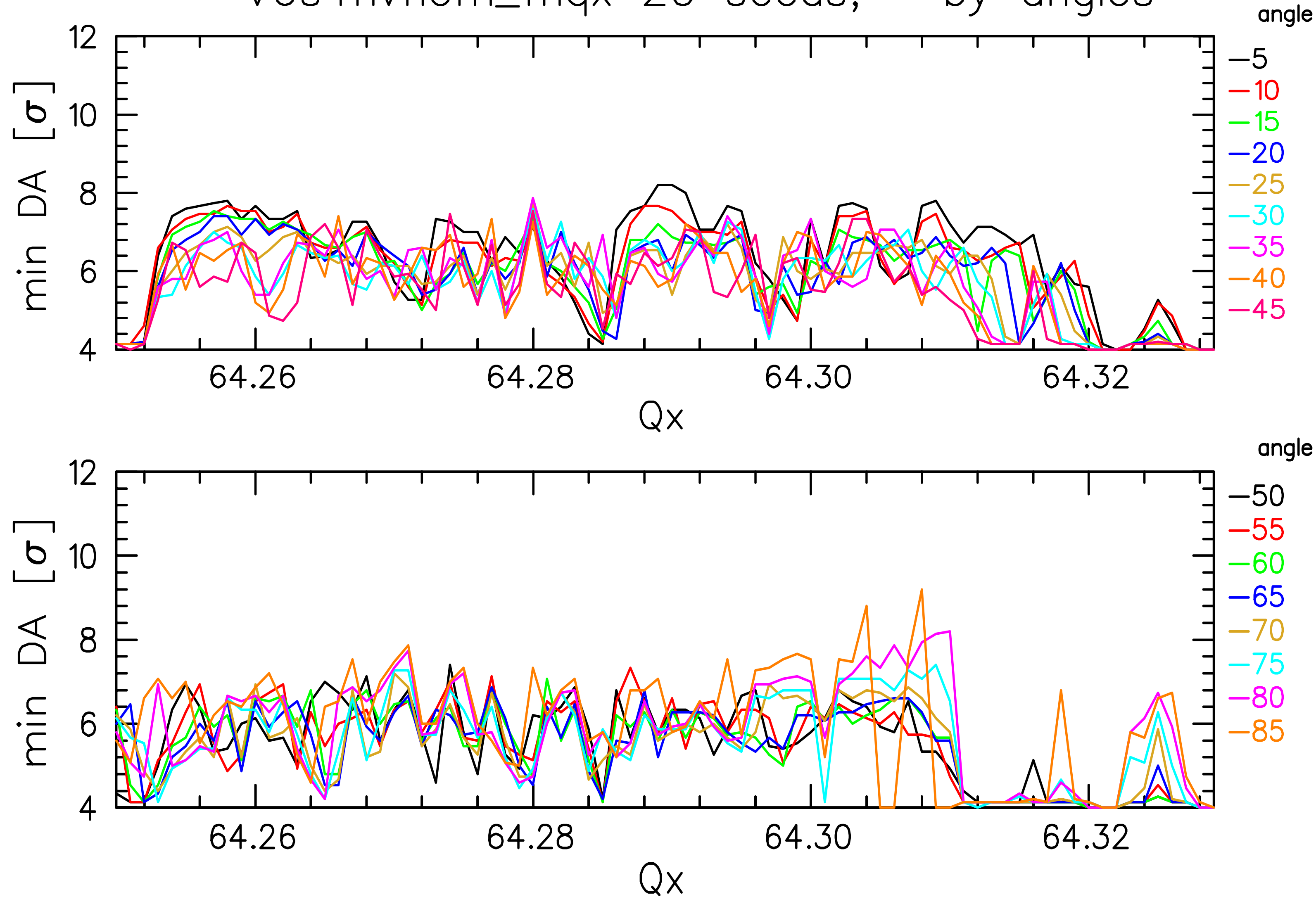


Min. dynamic aperture (HH triplet errors, PACMAN)

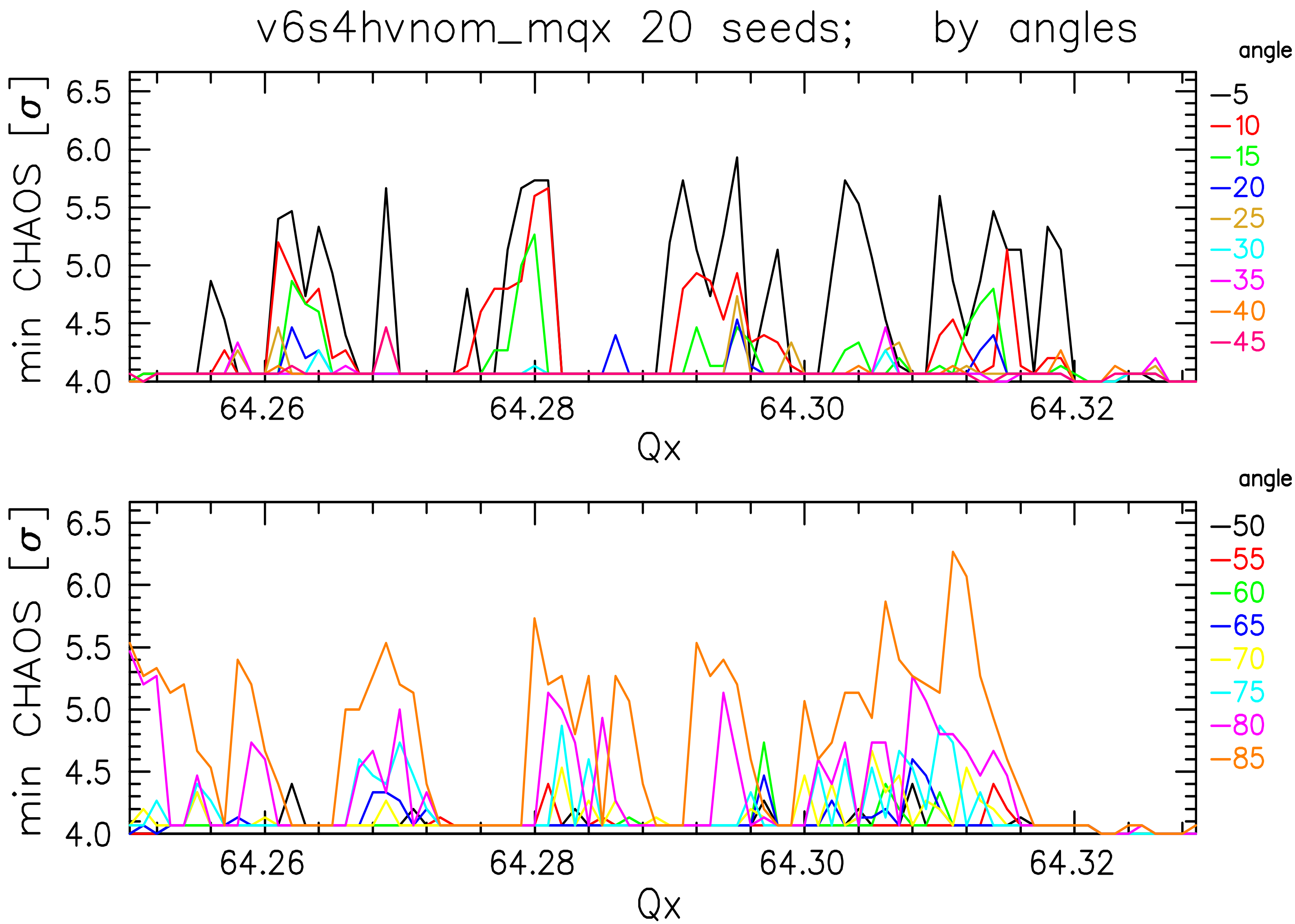


Min. dynamic aperture (HV triplet errors, split 0.02)

v6s4hvnom_mqx 20 seeds; by angles

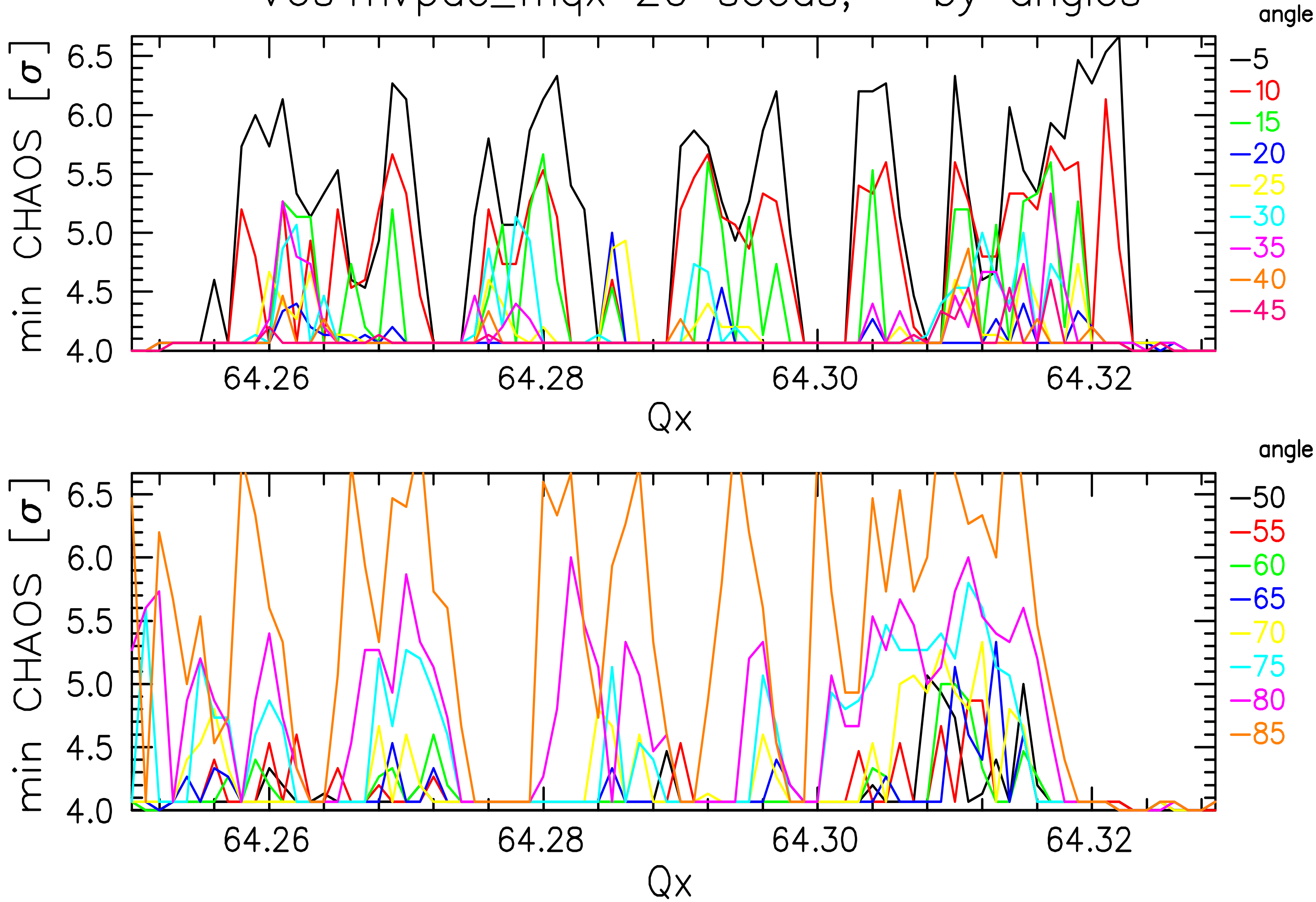


Chaotic border (HV triplet errors, NOMINAL)

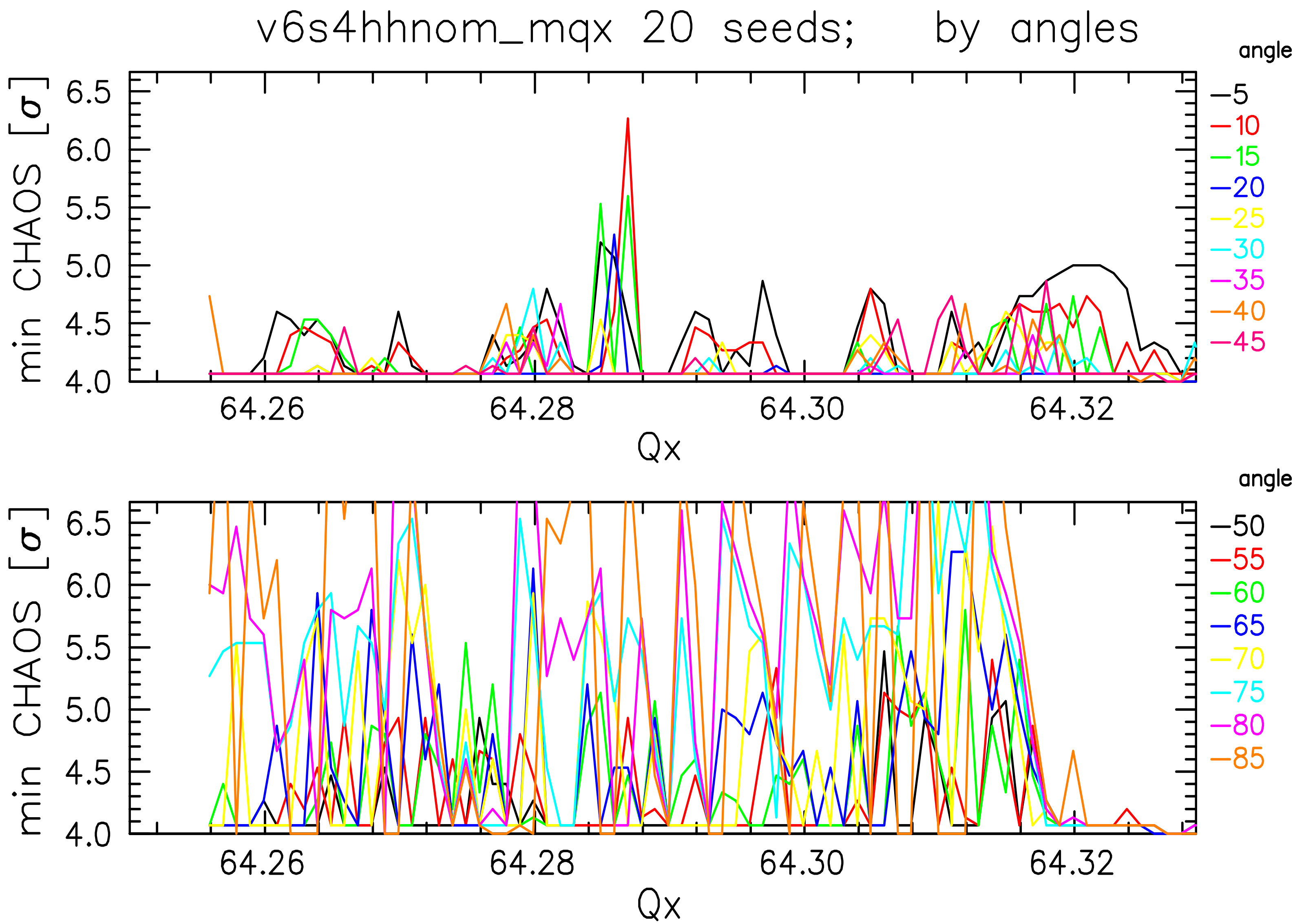


Chaotic border (HV triplet errors, PACMAN)

v6s4hvpac_mqx 20 seeds; by angles

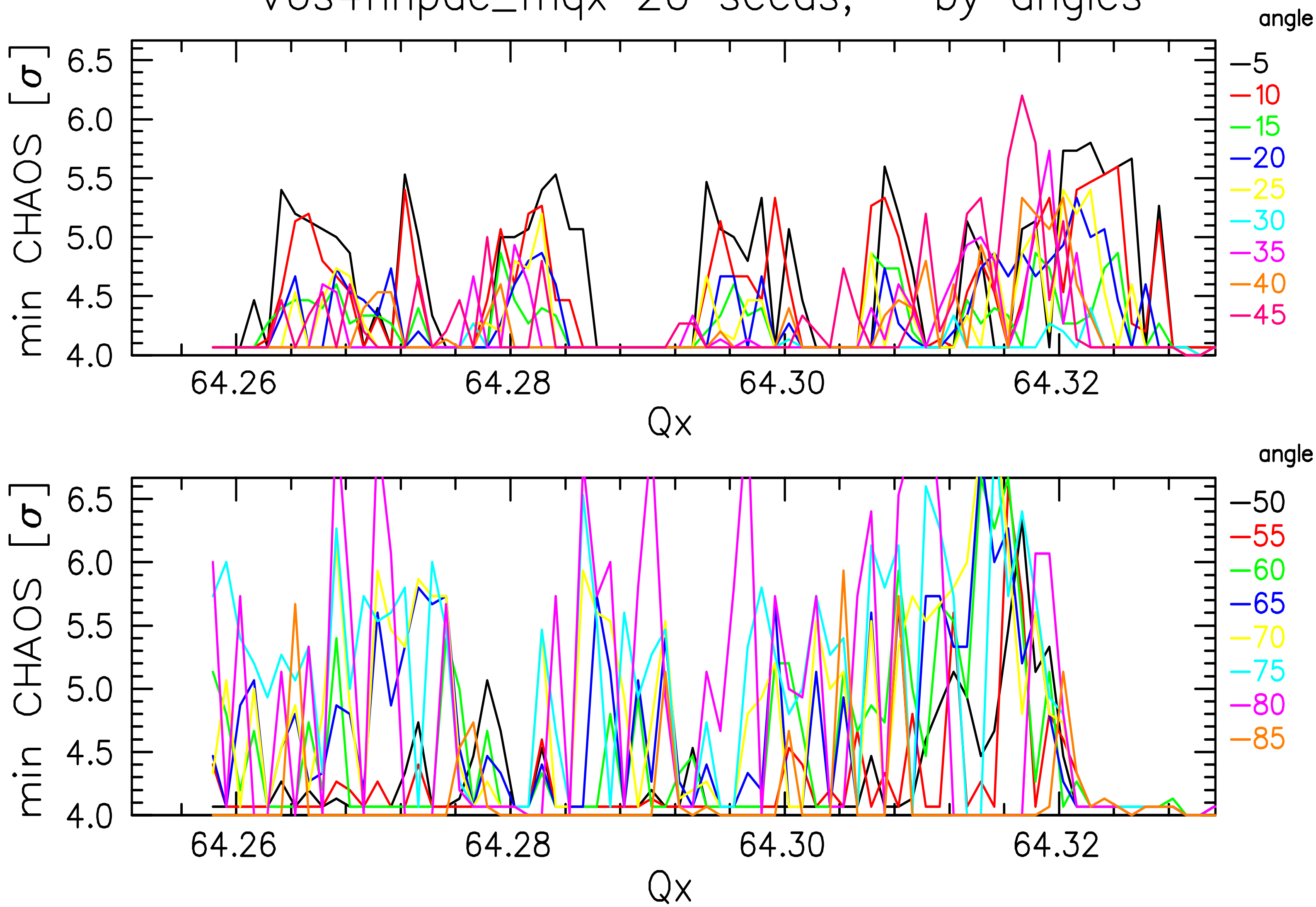


Chaotic border (HH triplet errors, NOMINAL)

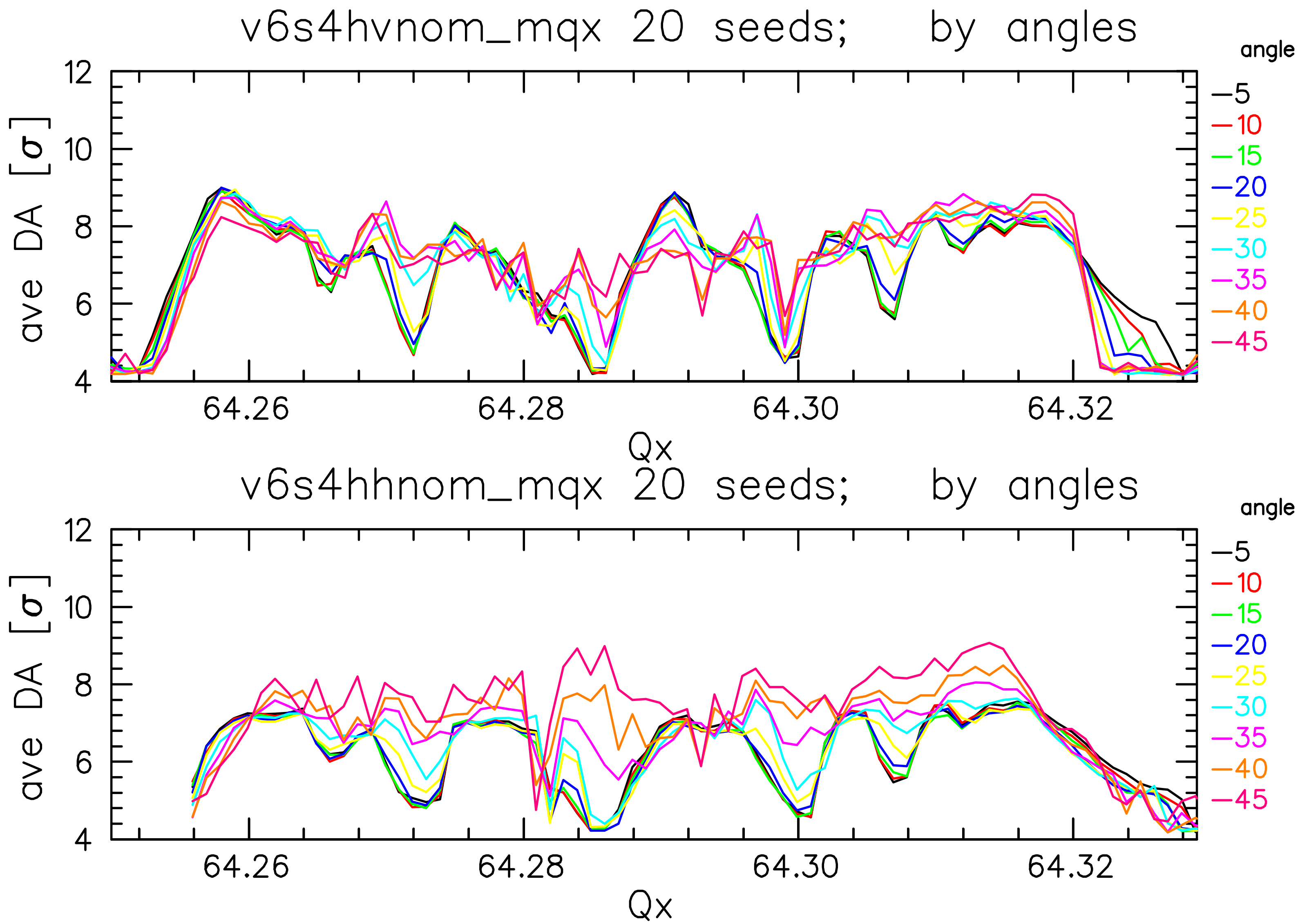


Chaotic border (HH triplet errors, PACMAN)

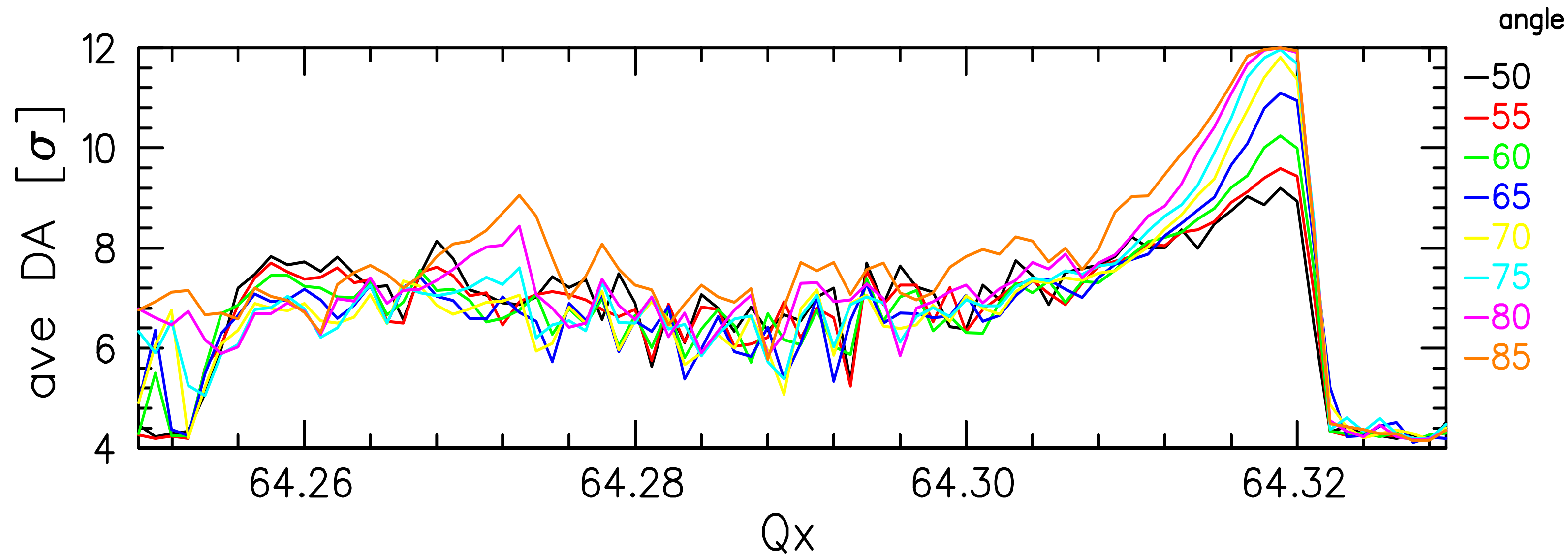
v6s4hhpac_mqx 20 seeds; by angles

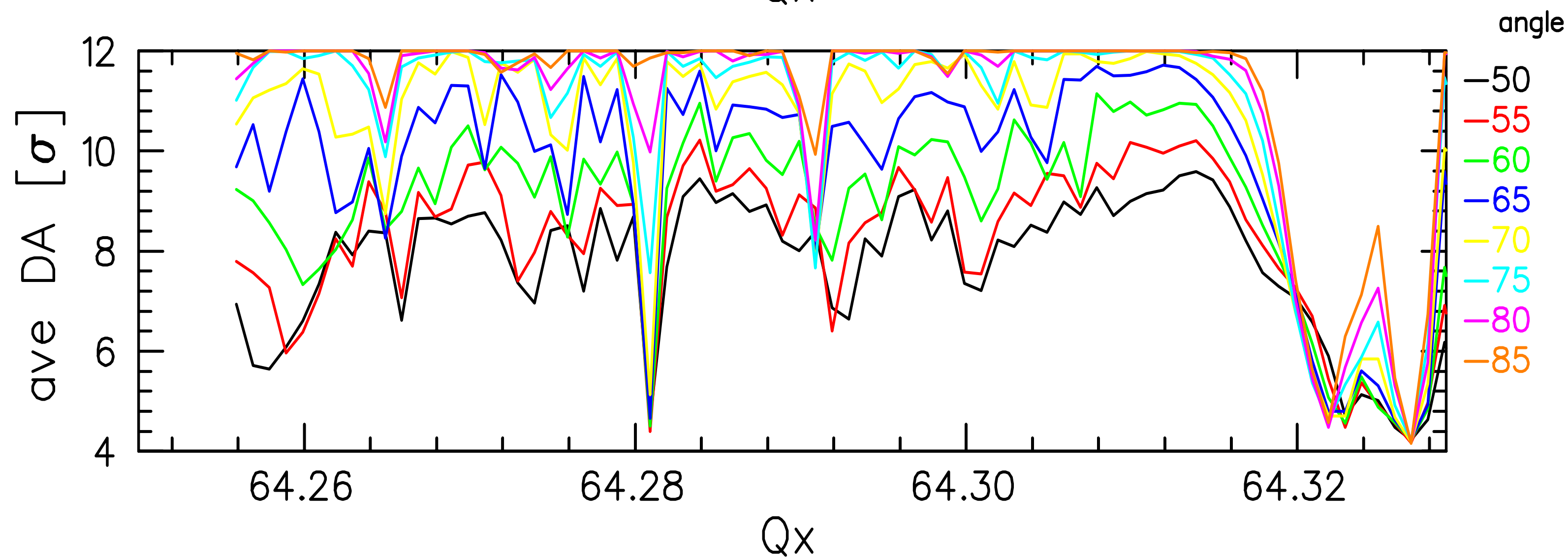


HV versus HH, average, small angles

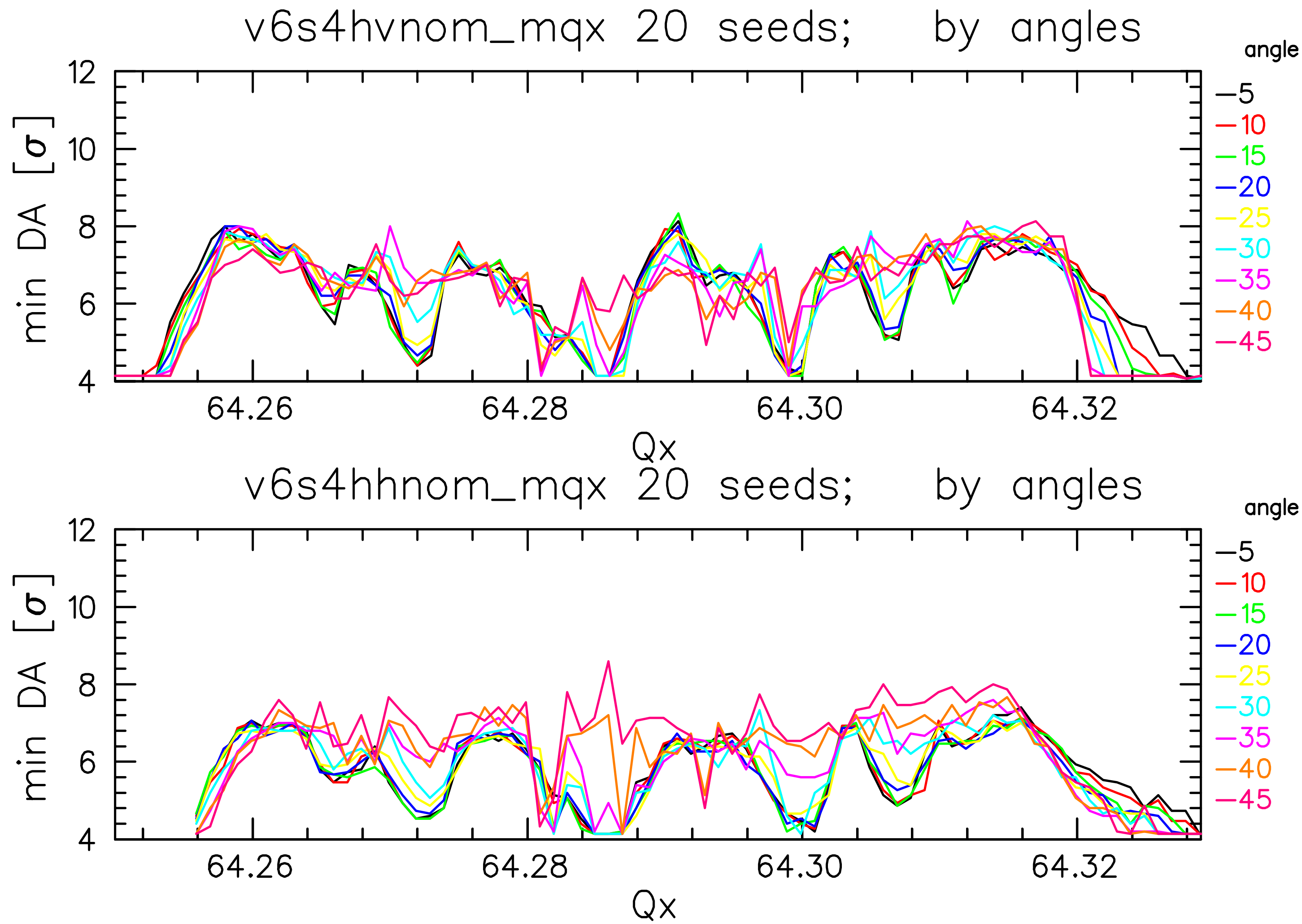


HV versus HH, average, large angles

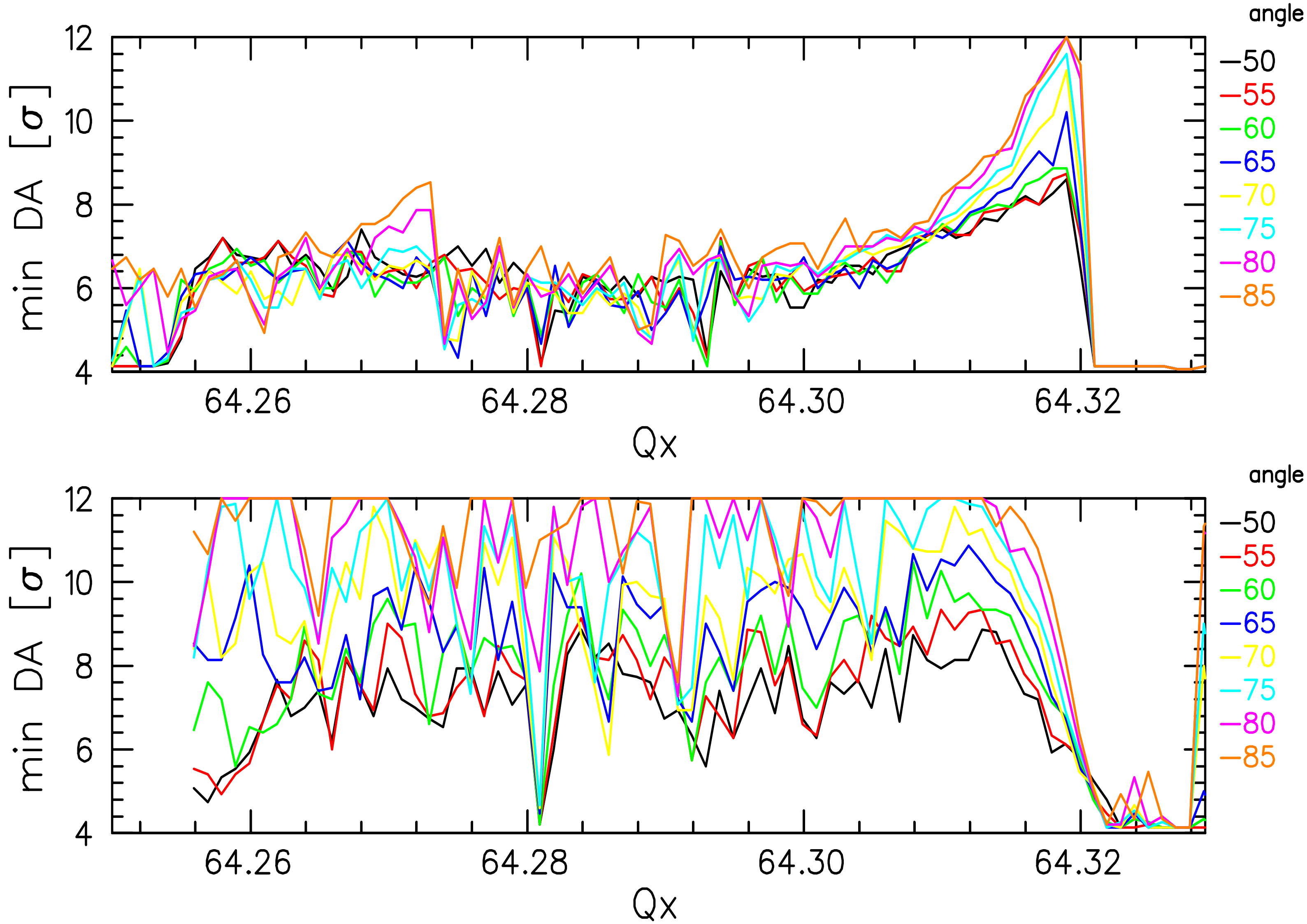




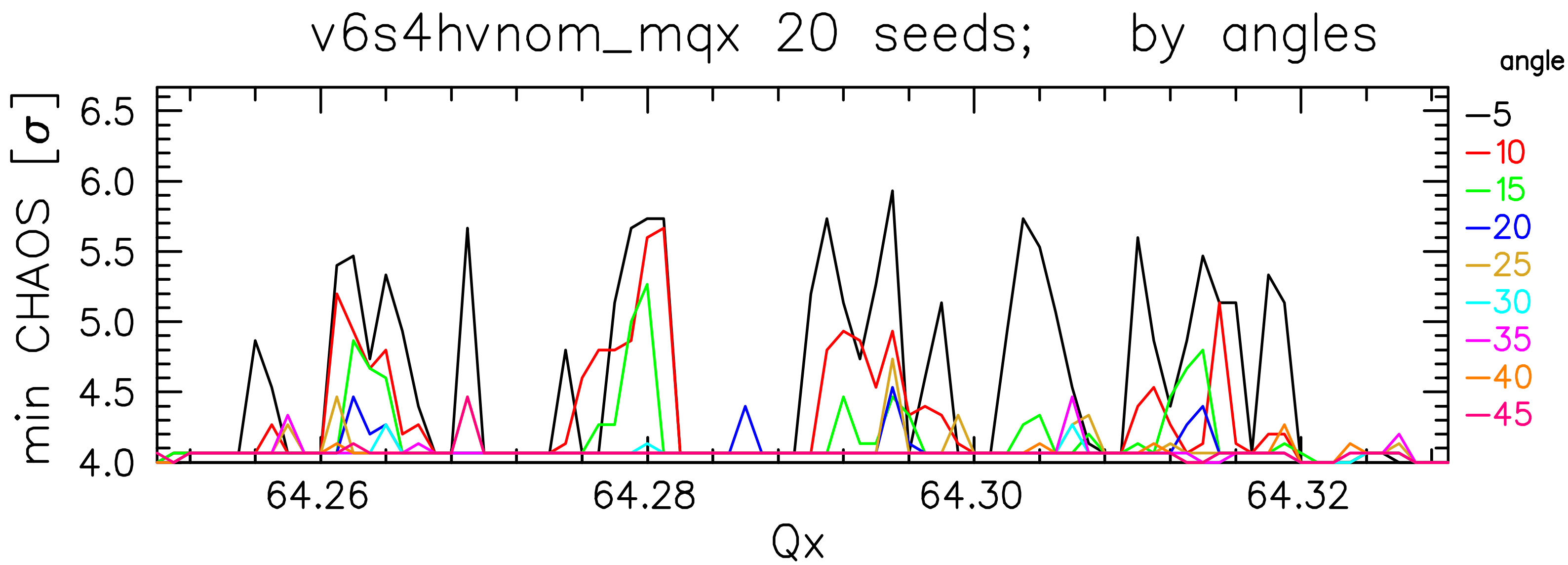
HV versus HH, minimum, small angles

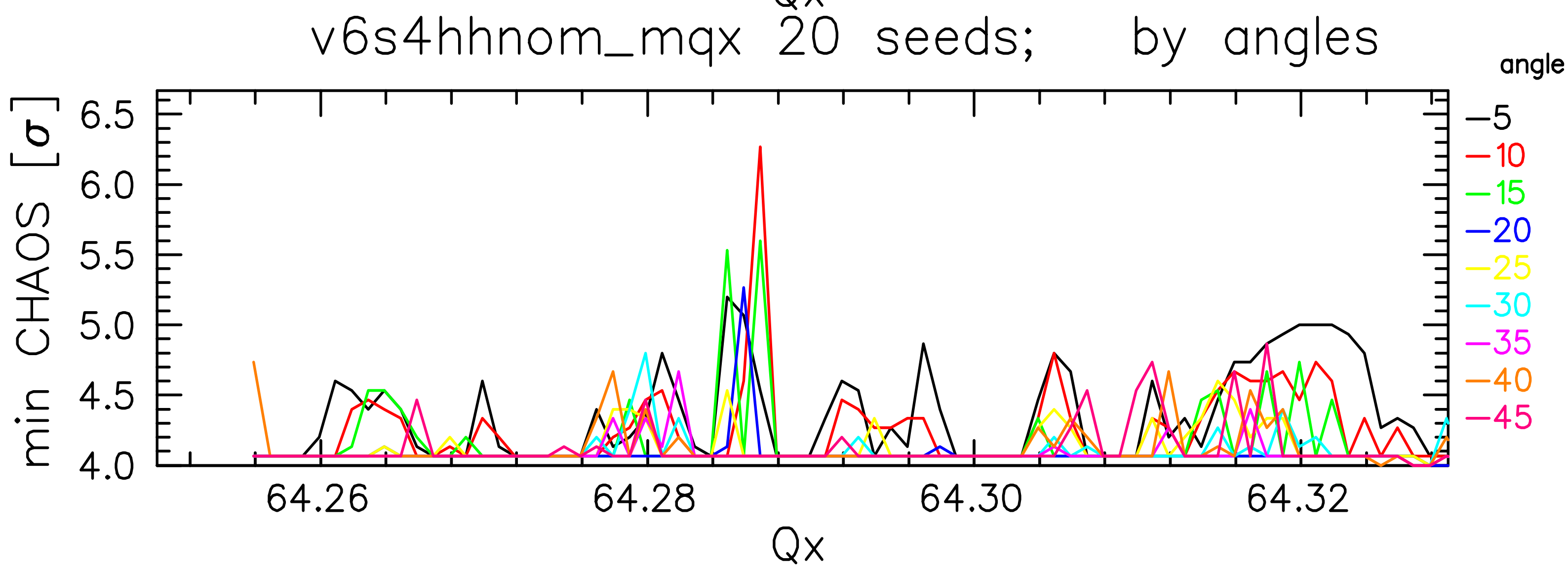


HV versus HH, minimum, large angles

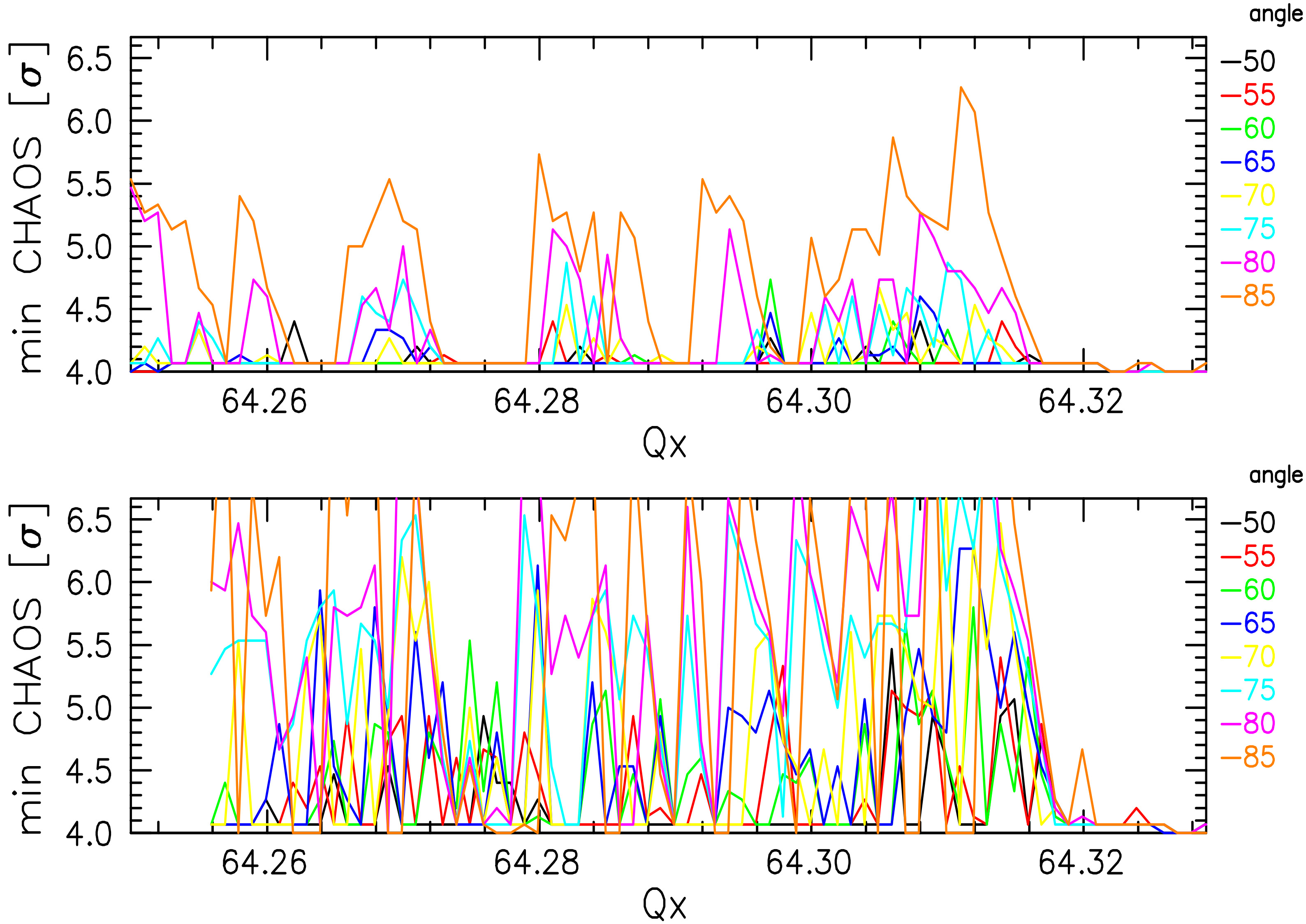


HV versus HH, chaos border, small angles)





HV versus HH, chaos border, large angles)



Observations:

- For corrected triplet errors, tune dependence dominated by beam-beam effects
- Strong angular dependence in HH case, better in vertical plane
- Dynamic aperture: small difference between HV and HH considering the full angular range, HH about 0.5 to 0.7 σ lower minimum
- Chaos border: for HH significantly lower below 45 degrees
- Tune split of 0.02 made things worse
- No alternative working point for HH case

Summary (1):

- Dynamic aperture interval for full angular range
- Values in tune range $Q_x \in [0.308, 0.312]$

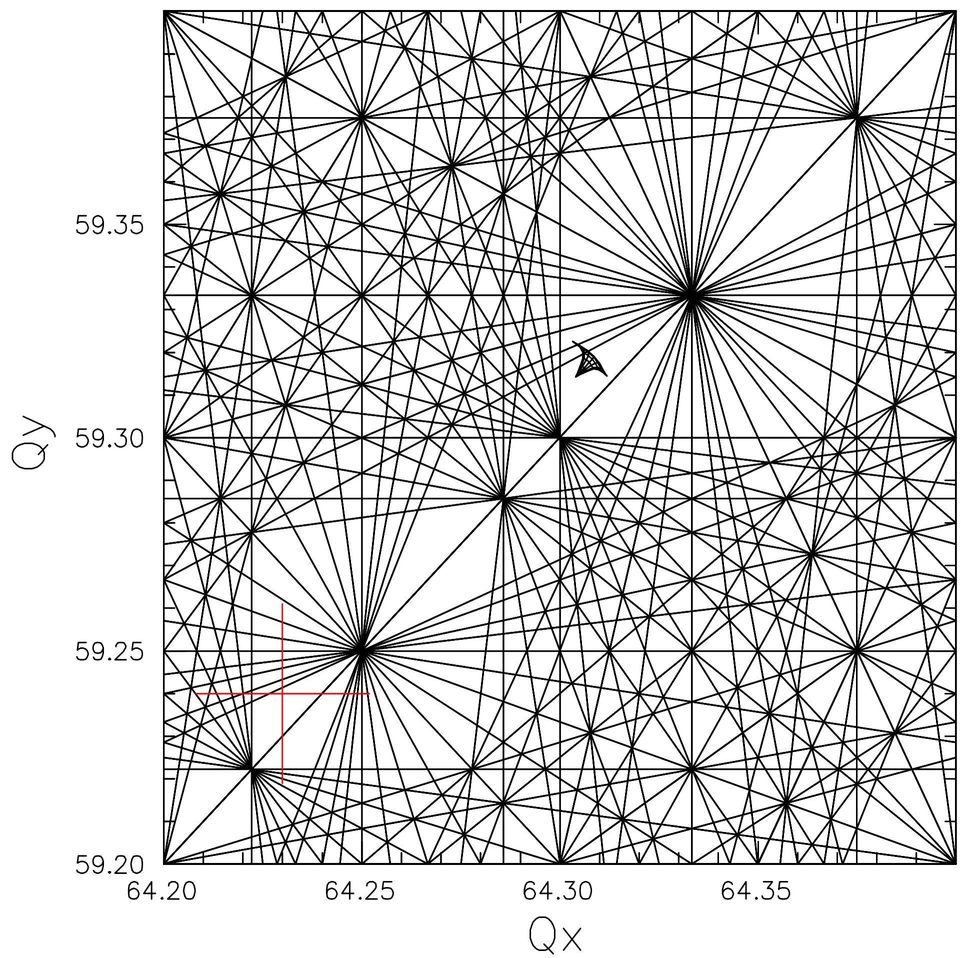
case	average dynamic aperture	minimum dynamic aperture
HV, nominal	6.9 - 9.5	6.0 - 9.0
HV, PACMAN	7.4 - 11.0	6.4 - 10.5
HH, nominal	5.6 - 12.0	5.2 - 12.0
HH, PACMAN	7.4 - 12.0	5.0 - 12.0

Summary (2):

- **Dynamic aperture interval for full angular range**
- **Values for best sliding window $\Delta Q_x \leq 0.002$**
- **Within tune range $Q_x \in [0.300, 0.320]$**

case	average dynamic aperture	minimum dynamic aperture
HV, nominal	8.0 - 12.0	7.2 - 12.0
HV, PACMAN	8.6 - 12.0	7.8 - 12.0
HH, nominal	7.2 - 12.0	6.8 - 12.0
HH, PACMAN	8.0 - 12.0	7.4 - 12.0

Other working points



Proposed studies:

- **Triplet errors uncorrected**
- **Triplet errors partially corrected**
- **Other working point**
- **V6.5 and $\beta^* = 2$ m, no correction of triplet errors**
- **Vertical-vertical crossing**