Two Bunch Compression Studies

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Motivation

- We can control the compression of B2 "semi-indepedently" of B1.
- Typically the setup for B2 is rather empiric
  - compression targets are often not reproducible from day to day and
  - sometimes there are even "jumps" in performance and compression targets need to be adjusted "on the fly" to recover
  - In BC1 the compression monitor shows only very small changes in signal and we wanted to know if this really has a big impact on the B2 compression
  - In BC2 very small changes of the compression target (+-20) for B2 have a big impact on the FEL performance whereas for B1 you can change +-200 without a very large effect on the B1 FEL performance

Measurements done

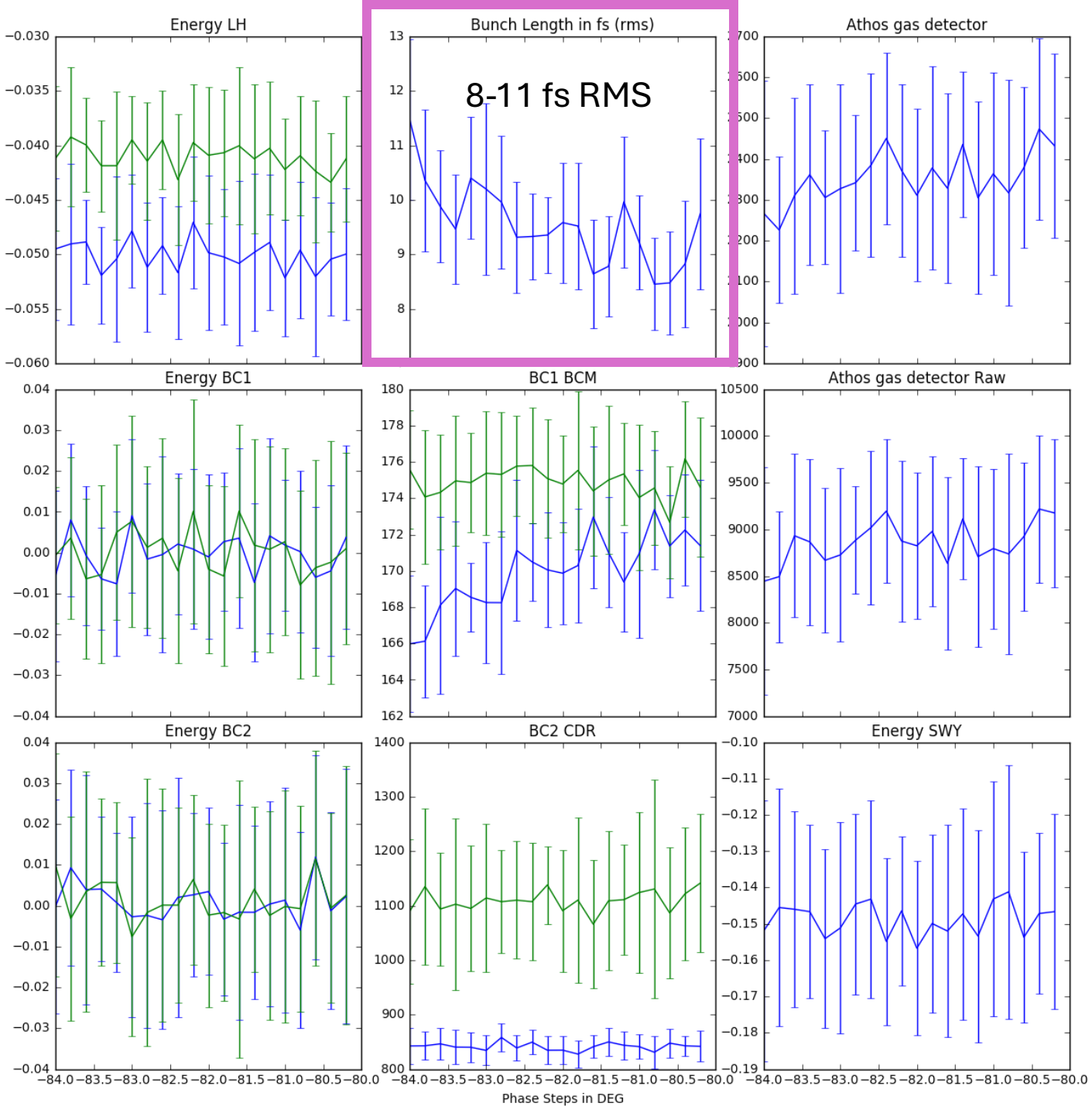
- 16.3.24 -> initial scans of the SINSB03/04 phase steps while measuring the bunch length with SATMA02 (energy and compression FBs were OFF). -> at first it looked like the BCM signal for B2 would not change, but this was due to a channel mixup 32854
- 19.5.24 -> repeated the phase step scans & scanned the compression target
- 25.5.24 -> more scans
  - BC1 compression target
  - BC2 compression target
- 26.5.24 Taking a quick look at the energy spread in the dogleg

19.5.24 Strongly compressed setting

Scanning the phase of SINSB03/04 phase steps from -84 to -80 DEG.
All beam feedbacks are enabled apart from BC1 B2 Compression
Measuring the bunch length with SATMA02.

Bunch 1
Bunch 2

Even though BC2 compression FB is enabled for B2 we do see a change in bunch length -> performance changes also slightly



19.5.24 Strongly compressed setting

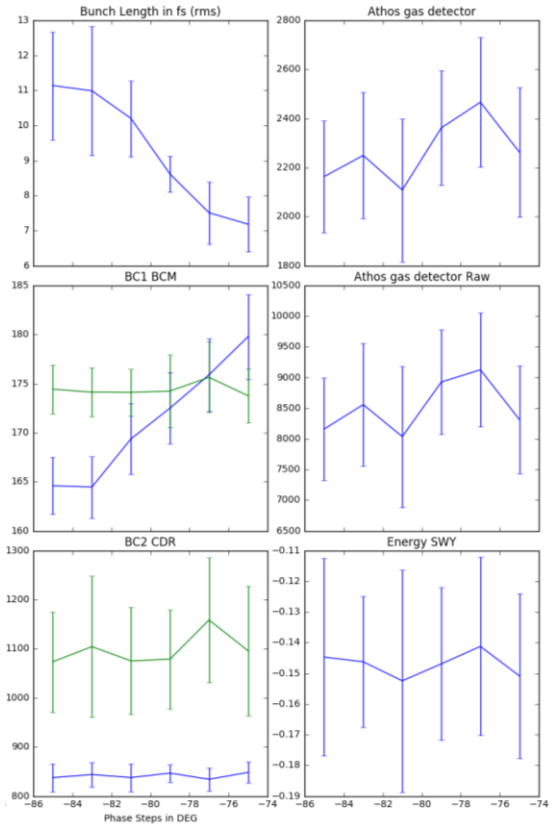
7-12 fs RMS

Larger range: Scanning the phase of SINSB03/04 phase steps from -86 to -74 DEG.
BC1 B2 Compression FB is disabled
Measuring the bunch length with SATMA02.

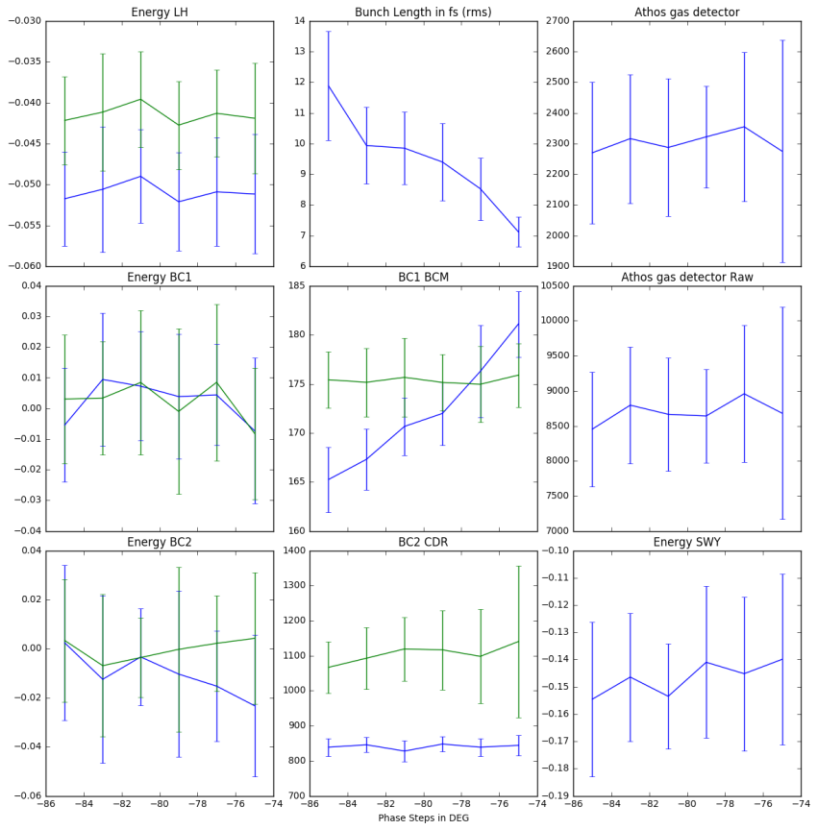
Bunch 1
Bunch 2

For comparison, same scan over a larger range with the compression BC2 FBs open and closed

With BC2 FBs closed



With BC2 FBs open



You see the energy change a bit, but the bunch
length change is still kind of the same, performance seems to be a bit more constant

With BC2 FBs closed

With BC2 FBs open

19.5.24 Strongly compressed setting

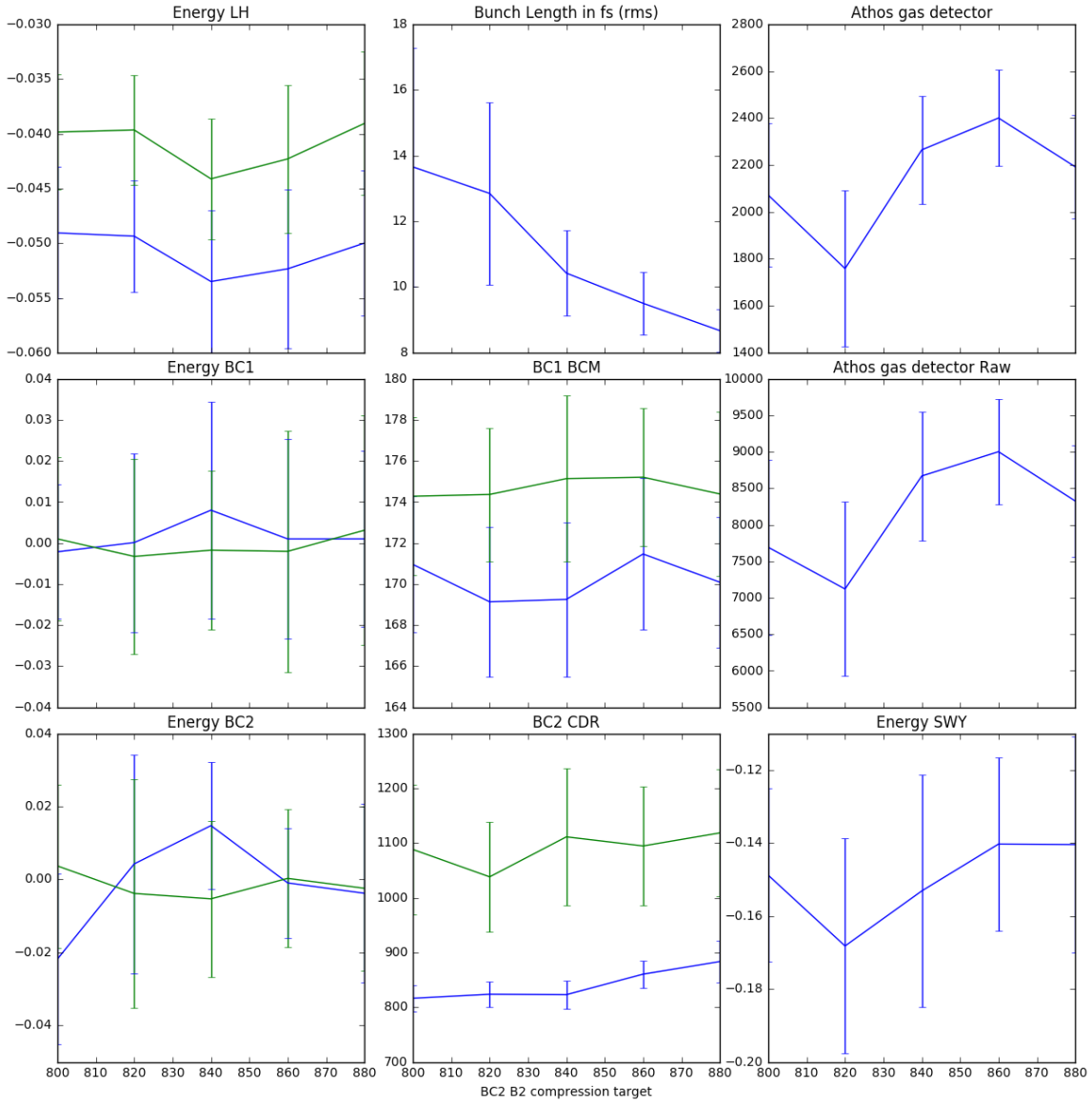
9-14 fs RMS

Scanning the BC2 compression target from 800 to 880 (energy FBs are enabled)

Bunch 1

Bunch 2

Bunch length changes from 14 to 9 fs RMS
Pulse energy changes quite a bit and actually losses are also a problem for high compression (not visible on plots)

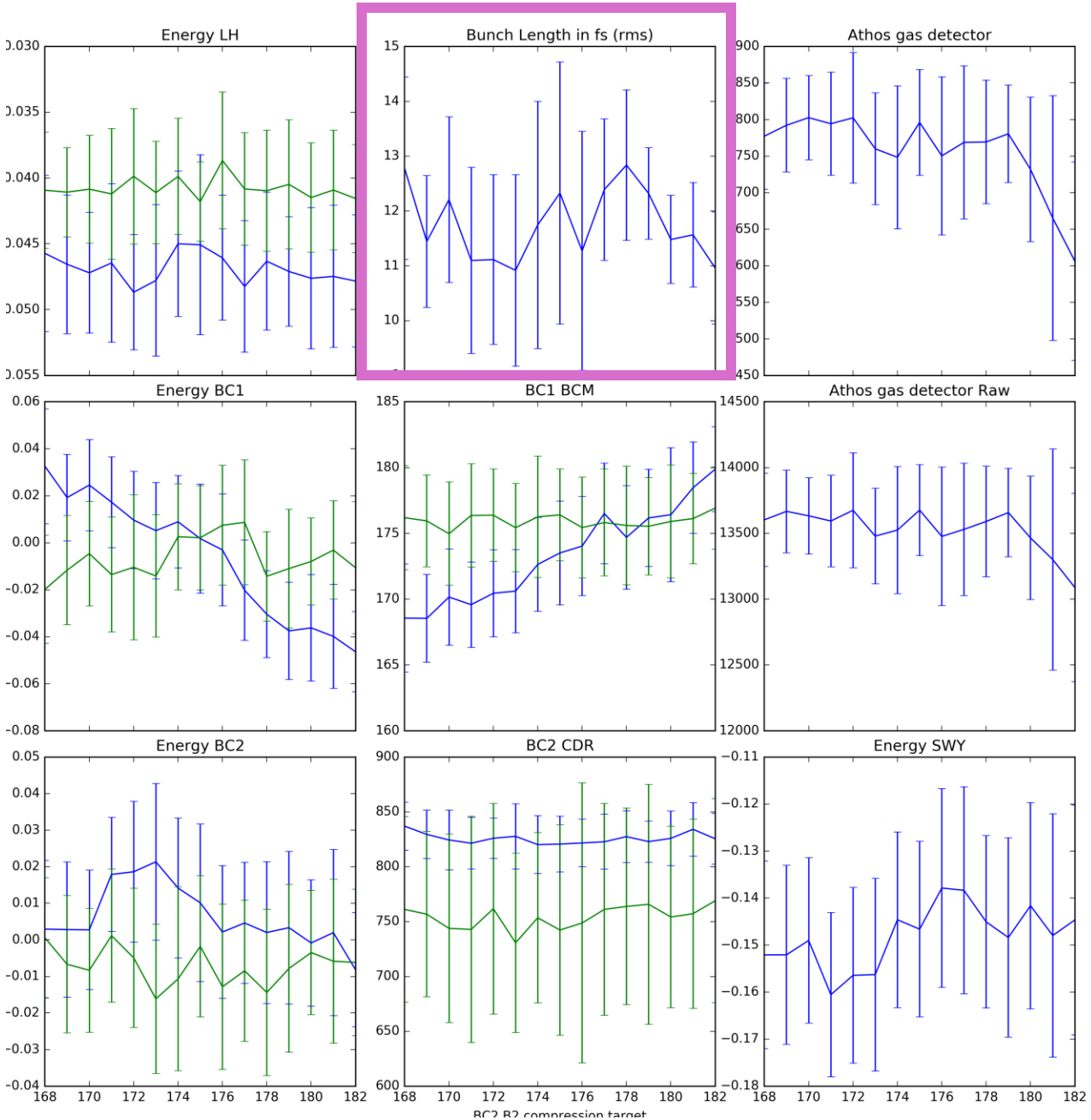


25.5.24 Less compressed setting

Scanning BC1 compression target
Measuring the bunch length with SATMA02.

Bunch 1
Bunch 2

For the settings of today the bunch length stays more constant when scanning the BC1 target, the performance only drops at the end of the range when the target is higher than for B1



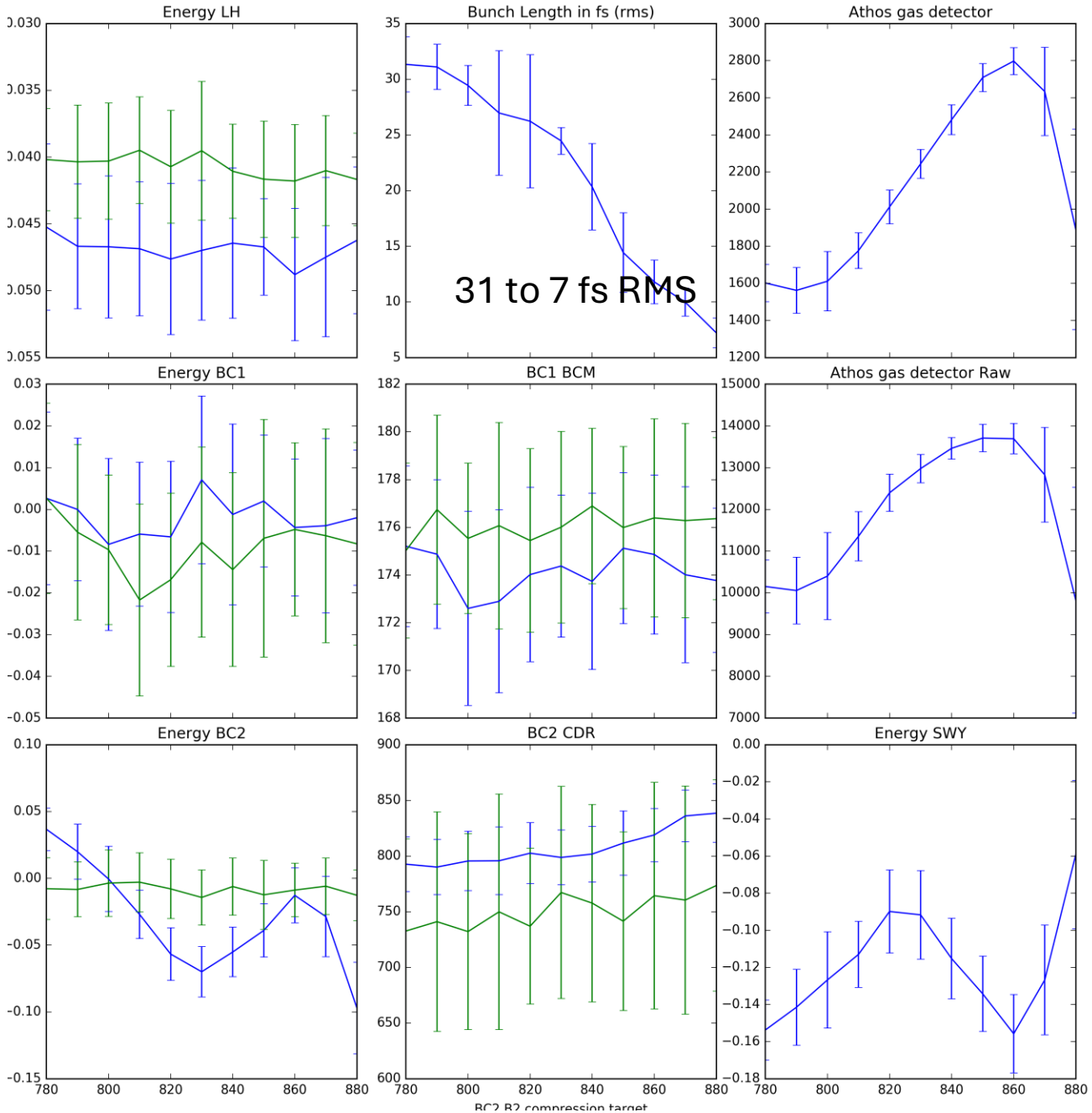
25.5.24 Less compressed setting

Scanning BC2 compression target
BC1 at "norminal" setting of 176
Measuring the bunch length with SATMA02.

Bunch 1
Bunch 2

Bunch length varies from 31 to 7 fs for target changes of 780 to 880 -> pulse energy also varies greatly

Best performance:
BC1 176
BC2 860
12 fs RMS

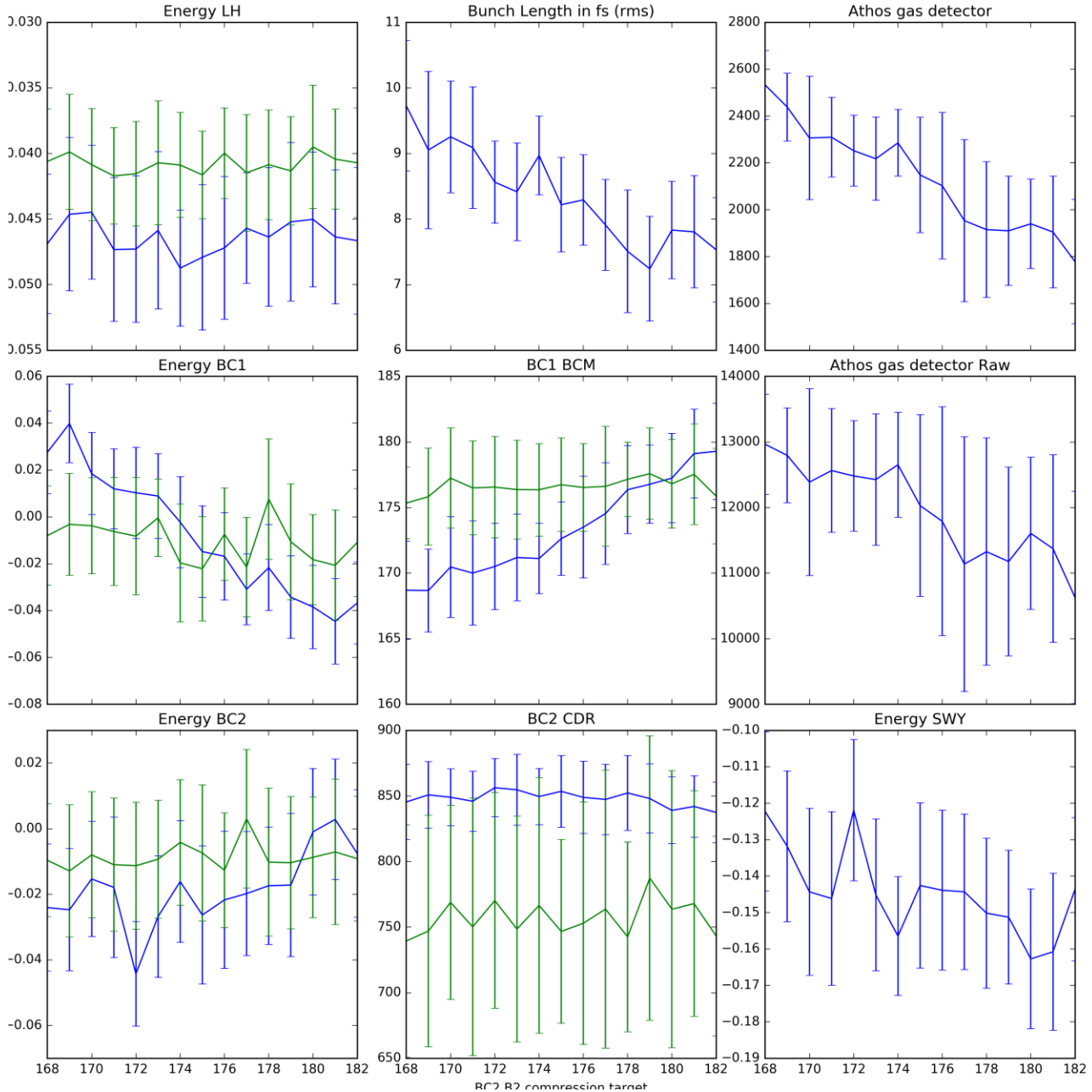


25.5.24 Less compressed setting

Scanning BC1 compression target
Keeping BC2 at 850
Measuring the bunch length with SATMA02.

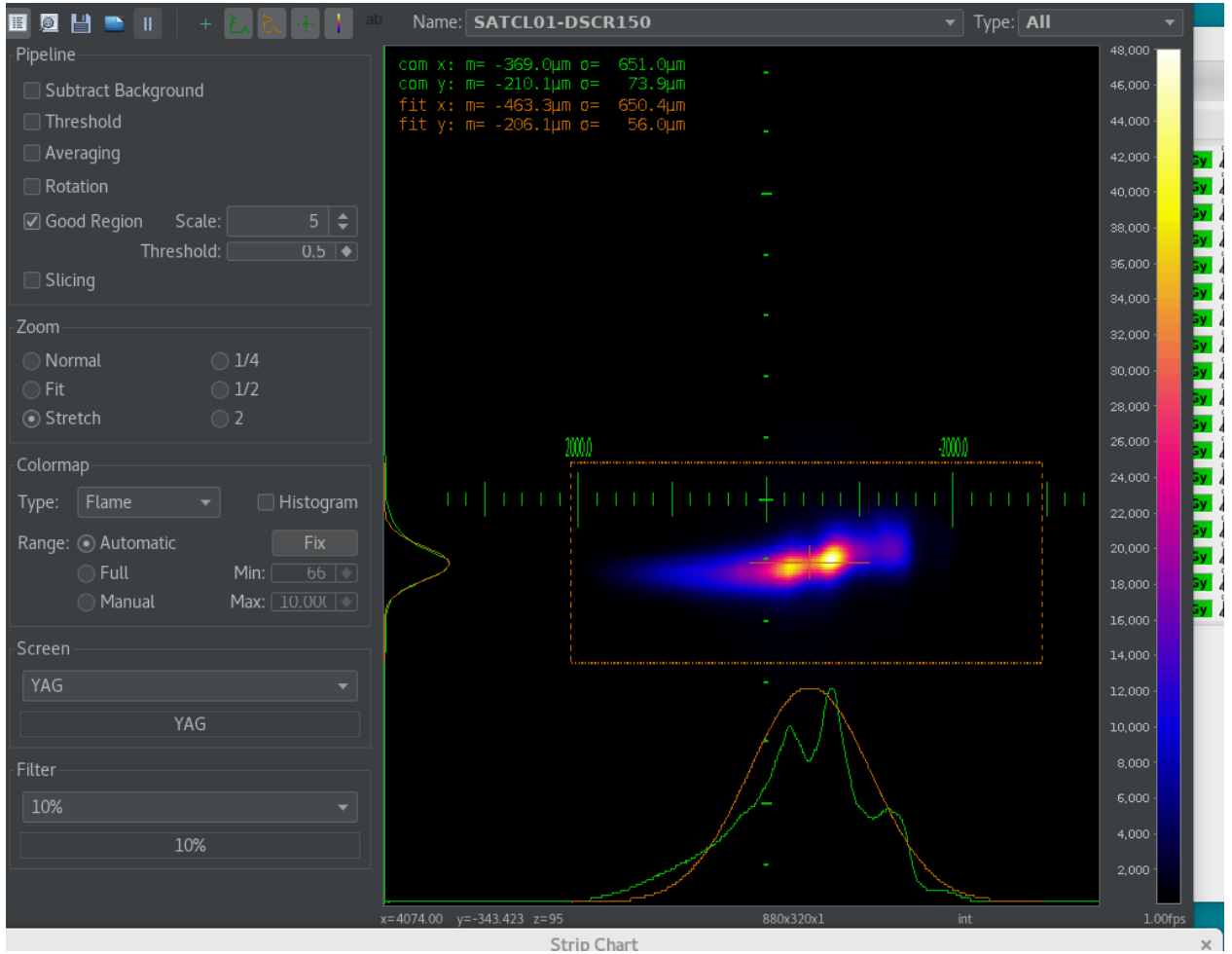
Bunch 1
Bunch 2

Bunch length varies from 9.5 to 7.5 fs for target changes from 168 to 182.
Performance is best for less compression



26.5.24 Looking at the energy spread in SATCL01

- 33786
- BC1 compression target:
  - Target 164: beam width 700 um
  - Target 174 (regular): beam width 650 um
  - Target 184: 610 um
  - For BC1 more compression leads to a lower energy spread -> less residual chirp?
- BC2 compression target :
  - Target 800 (regular): beam width around 660 um
  - Target 840: beam width around 690 um
  - For BC2 more compression leads to a slightly higher energy spread -> more residual chirp?



Conclusions

- Athos compression setup is not trivial with the dogleg compression depending on the residual chirp
- Needs further studies