

# Beam losses in coast from recent SPS MDs

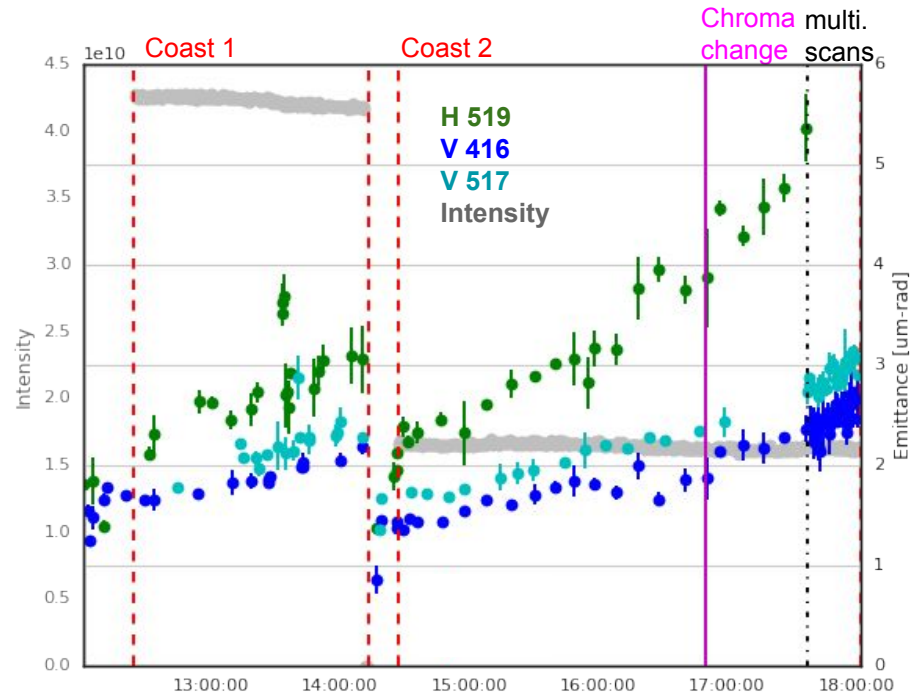
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# Motivation

- The **crab cavity test** with proton beams will take place in the SPS in 2018
  - Once the CC is installed only limited time of dedicated MDs will be available
  - We need to be prepared so that we can use the MDs with the CC in the SPS in the most efficient way
  - **HLLHC-UK collaboration**
- Previous studies: Emittance evolution in coast in the SPS
- ◆ Similar behaviour for H and V until 2012 @ 120 GeV and 270 GeV
  - ◆ Visible difference between the two planes from 2015 and after
  - ◆ 2 dedicated MDs in 2016

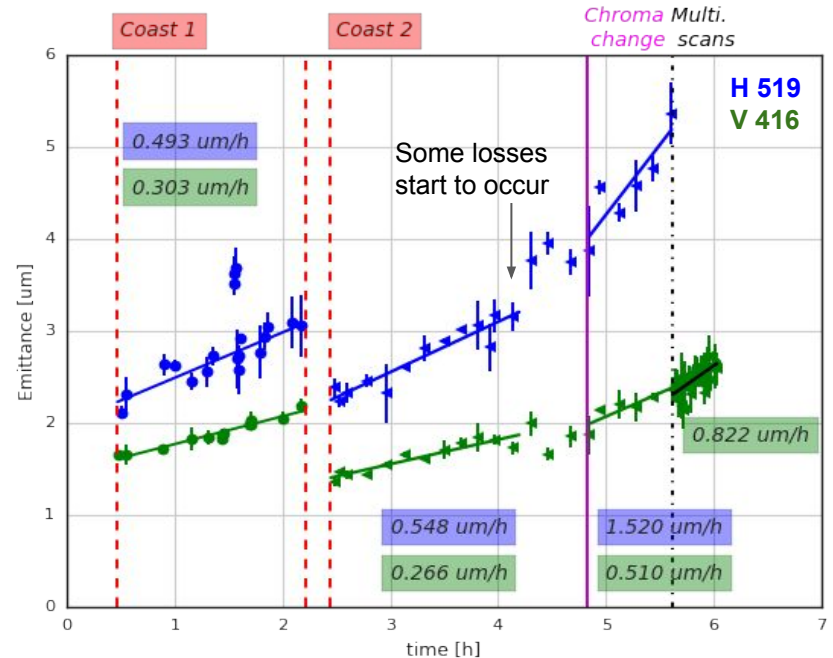
# Emittance evolution in coast MD: 7 Dec. 2016

- From 2015 visible difference between the two planes was observed
  - MD conditions:
    - Energy of 270 GeV
    - **Two different intensities**
      - Coast 1:  $4.2 \times 10^{10}$
      - Coast 2:  $1.6 \times 10^{10}$
    - Chroma H/V: 0.5/1
    - Wire scanners used: 519H, 416V, 517V
- Chroma change by 2 units performed after 2 hours in coast 2
- Multiple wire scans performed the last 15 min. of the MD

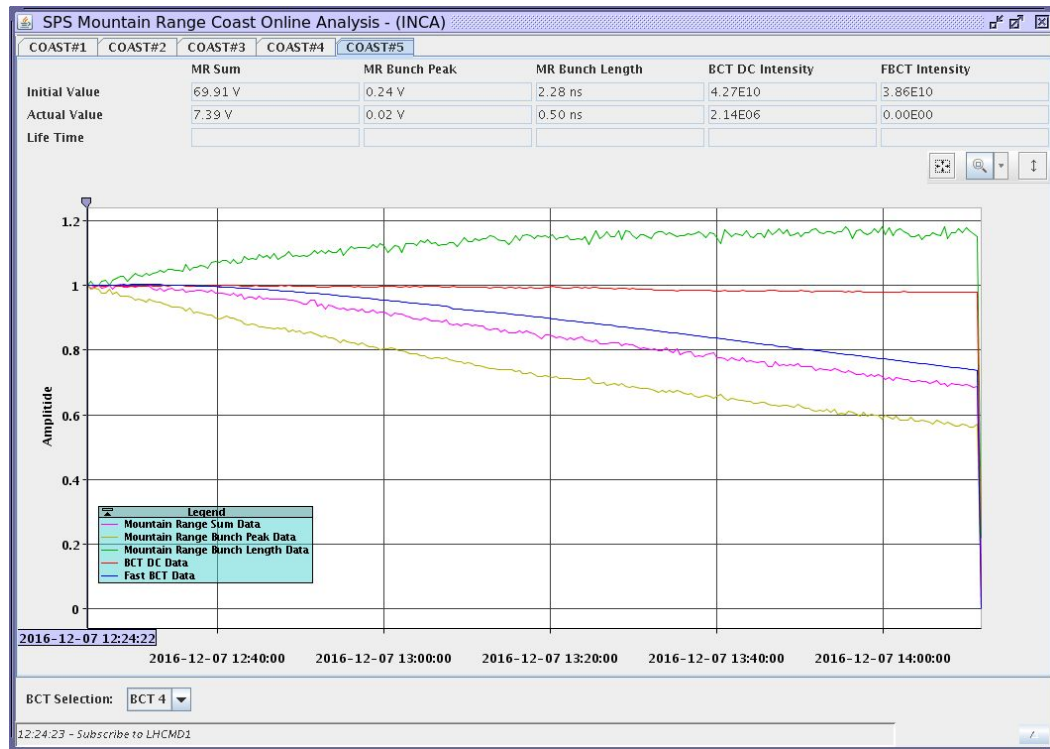


# Emittance evolution along the MD

- Linear fit applied for 4 different cases:
  - a. Coast 1
  - b. Coast 2 before chroma change and for same time-window as in coast 1
  - c. Coast 2 after chroma change
  - d. Coast 2 during the multiple WS
- Clear **slope increase** after the **chroma change** in both planes
- Slope increase during the multiple scans, however the spread is also large

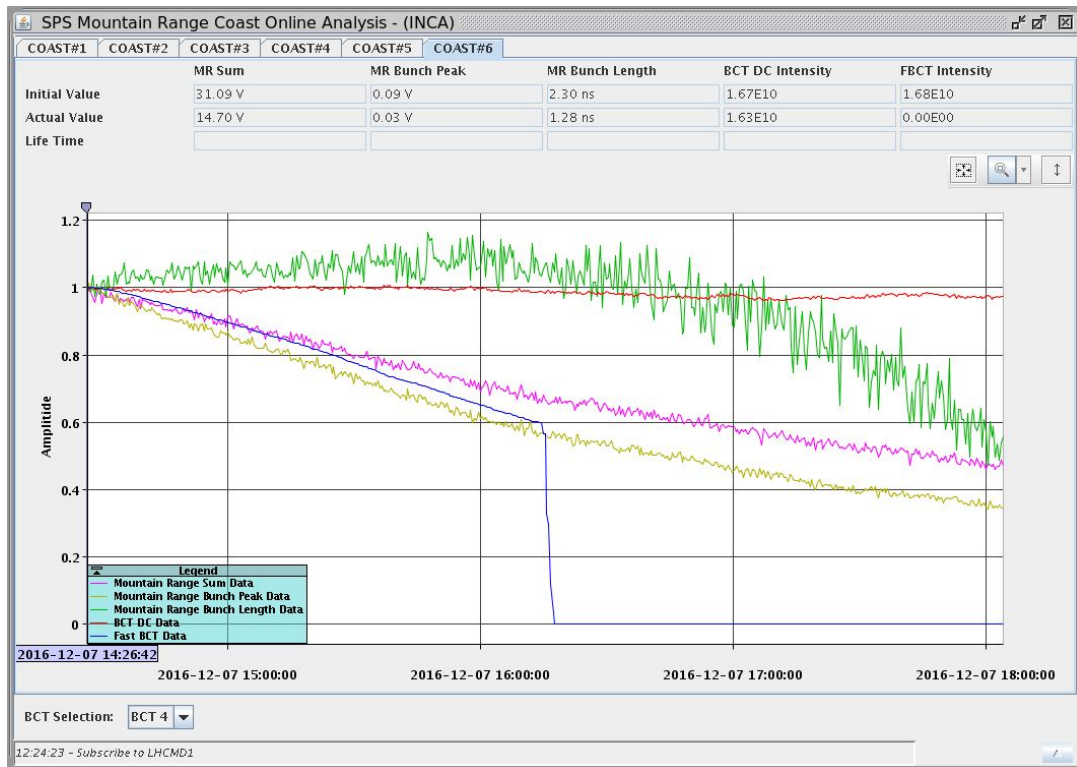


# 07 Dec 2017 coast 1



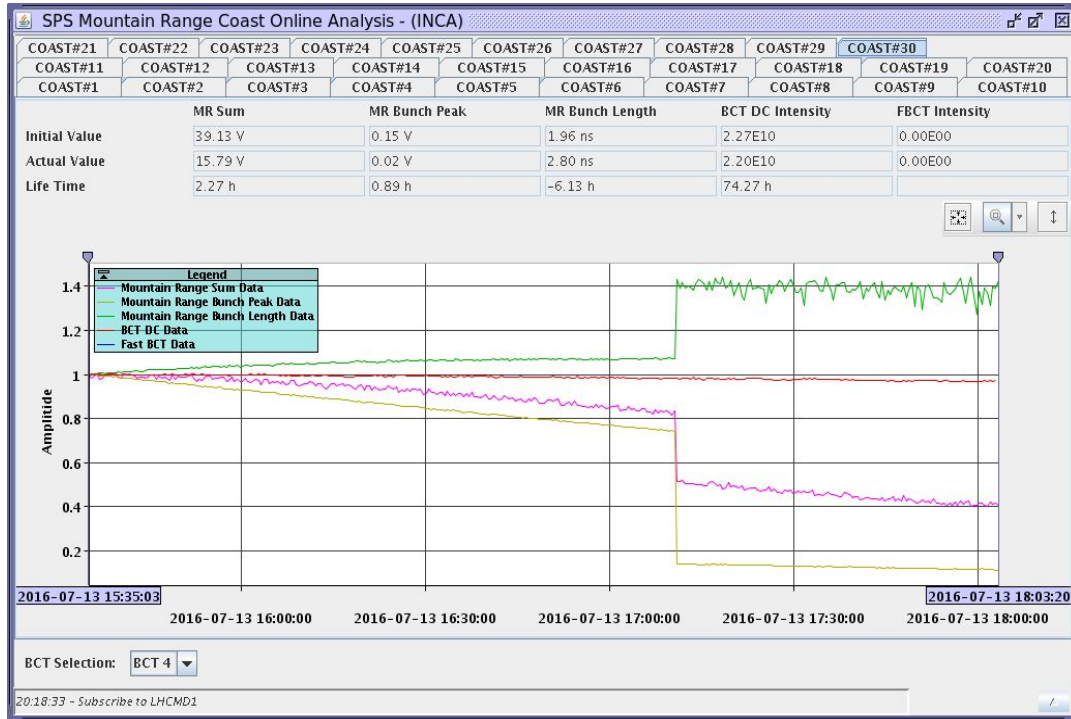
- Intensity:  $4.2e10$
- bunch length 2.28ns
- $V_{rf} = 2MV$
- $emit_{H/V} = 2.0/1.9 \text{ um}$
- Losses: 25% in 1.8h
- Bunch length blow up  
~ 20%
  - IBS predicts ~10%

# 07 Dec 2017 coast 2



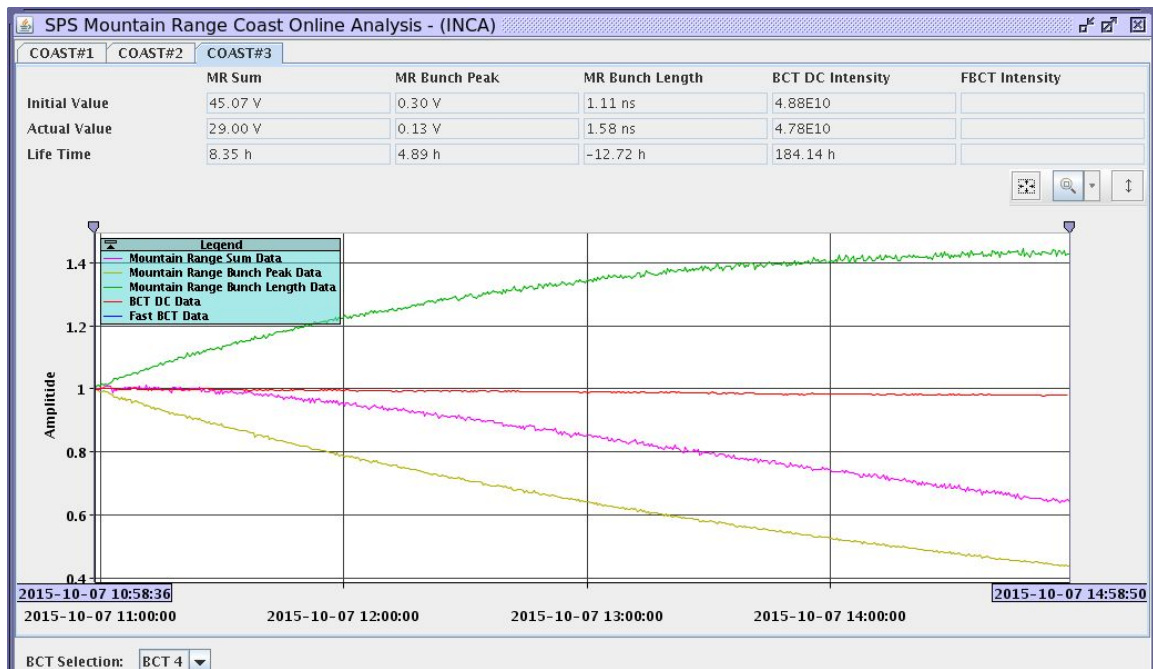
- Intensity:  $2.2e10$
- bunch length 2.3ns
- $V_{rf} = 2MV$
- $emit_{H/V} = 2.0/1.7 \text{ um}$
- Losses: 30% in 1.8h
- Bunch length blow up ~10%
  - IBS predicts ~ 5%

# 13 July 2016



- Intensity:  $2.2e10$
- bunch length: 1.96ns
- emitH/V = 2.8/2.1 um
- Losses: 20% in 1.7h
- Bunch length blow up ~10%
  - IBS predicts ~5%

# 07 Oct. 2015



- Intensity:  $4.8e10$
- bunch length 1.11ns
- $V_{rf} = 5MV$
- $emit_{H/V} = 2.8/2.1\mu m$
- Losses:  $\sim 40\%$  in 4h
- Bunch length blow up  $\sim 40\%$ 
  - IBS predicts 40%



# MD on coast: 10 May 2017

## → MD settings:

- ◆ Energy: 270 GeV
- ◆ Intensity:  $\sim 2 \times 10^{10}$
- ◆ Low chroma

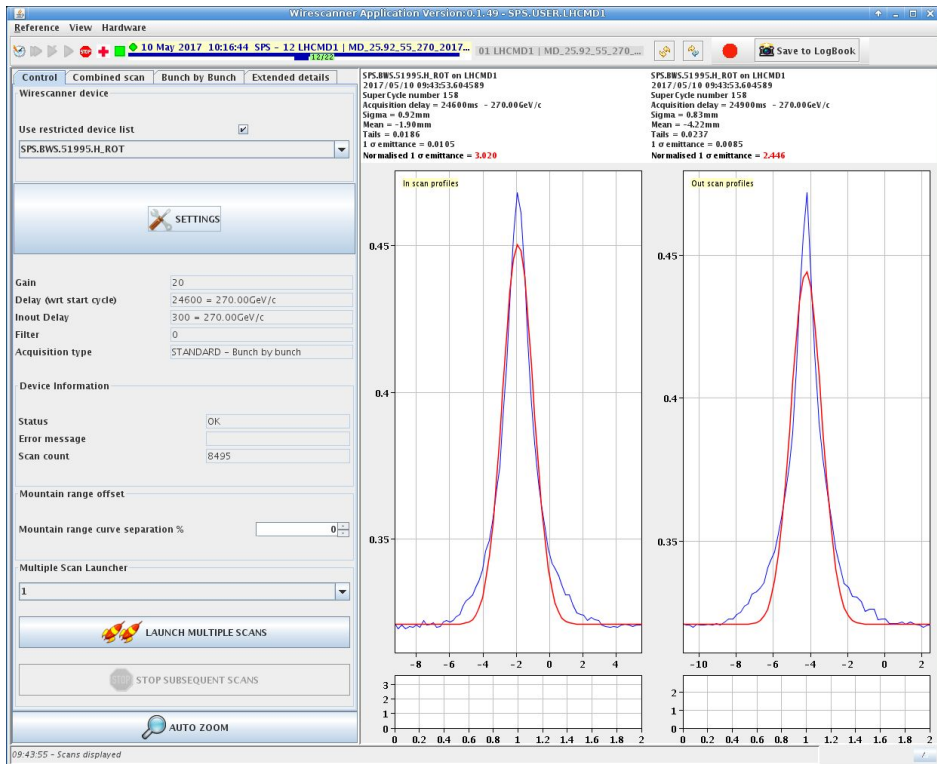
## → MD goal:

- ◆ Follow up the transverse emittance evolution under similar conditions as in December 2016
  - We asked to have the first MD of the year, expecting to have worse vacuum levels → interested on the impact on the transverse emittance evolution
- ◆ Understand the off-bucket losses we observed in previous MDs

## → Finally...

- ◆ The transverse profiles were not very nice and we observed large tails
- ◆ Gave time for setting up the WS
- ◆ Concentrated mostly on the off-bucket losses
- ◆ 3 different RF voltages were studied: 2, 4 and 5 MV

# MD on coast: 10 May 2017



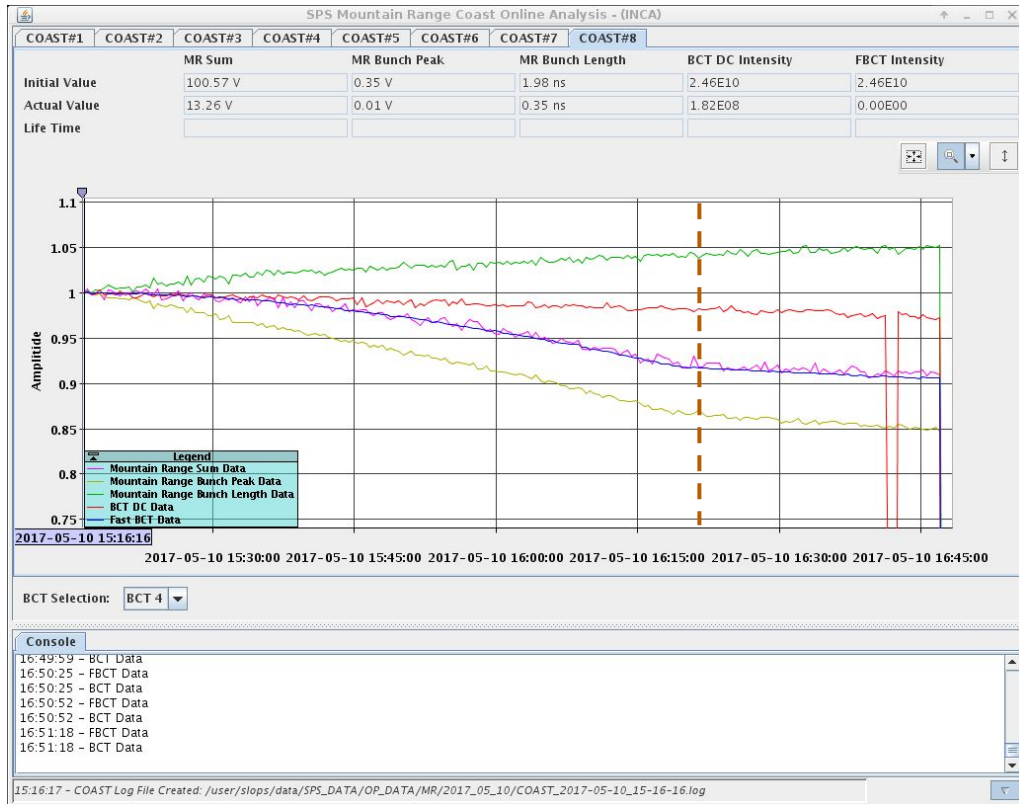
- An example of the transverse profiles
  - Large tails
  - Large hor. Emittance
  - The emittance is coming from the PS already with large tails

# 10 May 2017



- Mountain range data for coast 7 with  $V_{rf} = 5\text{MV}$ 
  - Very similar for the previous coasts as well
- Similar behaviour as previous MDs until

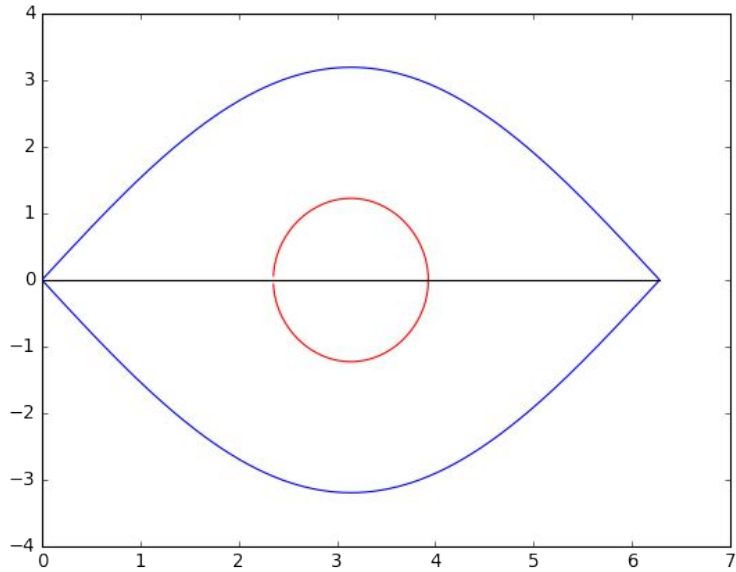
# 10 May 2017



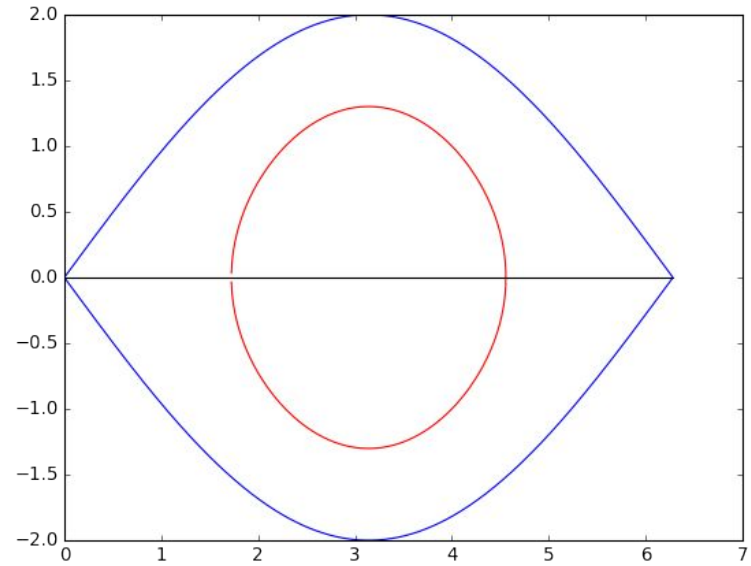
- Thomas switched off the RF feedback around 16:17 → Clear change of slope in losses!
- Not clear change in bunch length evolution
- At the last 30 minutes of the MD the RF phase loop was also switched off → The bunch got unstable

# Summary

- During coast MDs, losses out of the bucket were observed in all MDs of 2015 and 2016
  - An MD in coast was performed yesterday (10 May 2017) under similar conditions as in Dec. 2016
    - Same observations as in past MDs with respect to losses
    - Switching off the RF feedback led to big improvement!
    - Switching off the RF phase loop as well → bunch got unstable
- ❖ **Many thanks to the RF team for their great help yesterday!!**



- $V_{rf} = 2\text{MV}$
- Bunch length: 2.3 ns
- Long. emit.: 0.18 eV.s



- $V_{rf} = 5\text{MV}$
- Bunch length: 1.2 ns
- Long. emit.: 0.35 eV.s

# Summary table

	Emit. H/V [ $\mu\text{m}$ ]	Nb [ $1\text{e}10$ ]	Chroma H/V	H growth [ $\mu\text{m}/\text{h}$ ]	V growth [ $\mu\text{m}/\text{h}$ ]	Time [h]	Number of linear WS scans	V growth per scan [nm]
Coast 1	2.23/1.61	4.25	0.5/1	0.49	0.30	1.8	17	31.2
Coast 2 before chroma change	2.25/1.41	1.65	0.5/1	0.55	0.27	1.8	10	63.5
Coast 2 after chroma change	4.0/1.98		2.5/3	1.52	0.51	0.8	1	-
Coast 2 during WS multi-scans	-/2.3		2.5/3	-	0.82	0.4	24	14.3

- No difference between the two intensities ( $1.6\text{e}10$  and  $4.2\text{e}10$ )
- Clear correlation with chroma
- No clear correlation between the emittance increase and the number of wire-scans
  - Need to repeat for longer time interval to verify the observations of F. Roncarolo