Categorization of aborts based on patterns of BOR/BCM data

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Acknowledgements:

S. Terui, and SuperKEKB KCG and BCG

MDI task force meeting

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1. Motivation

➤ **Aborts during SuperKEKB operation**

- **The beam dynamics before beam aborts should be well understood**
- **The turn-by-turn (t-b-t) data provide direct information of beam dynamics before aborts**
- **The t-b-t data from BOR/BCM can be used to categorized the abort events**
- **The analysis is based on the abort list recorded (started from Feb. 27, 2021) on:**

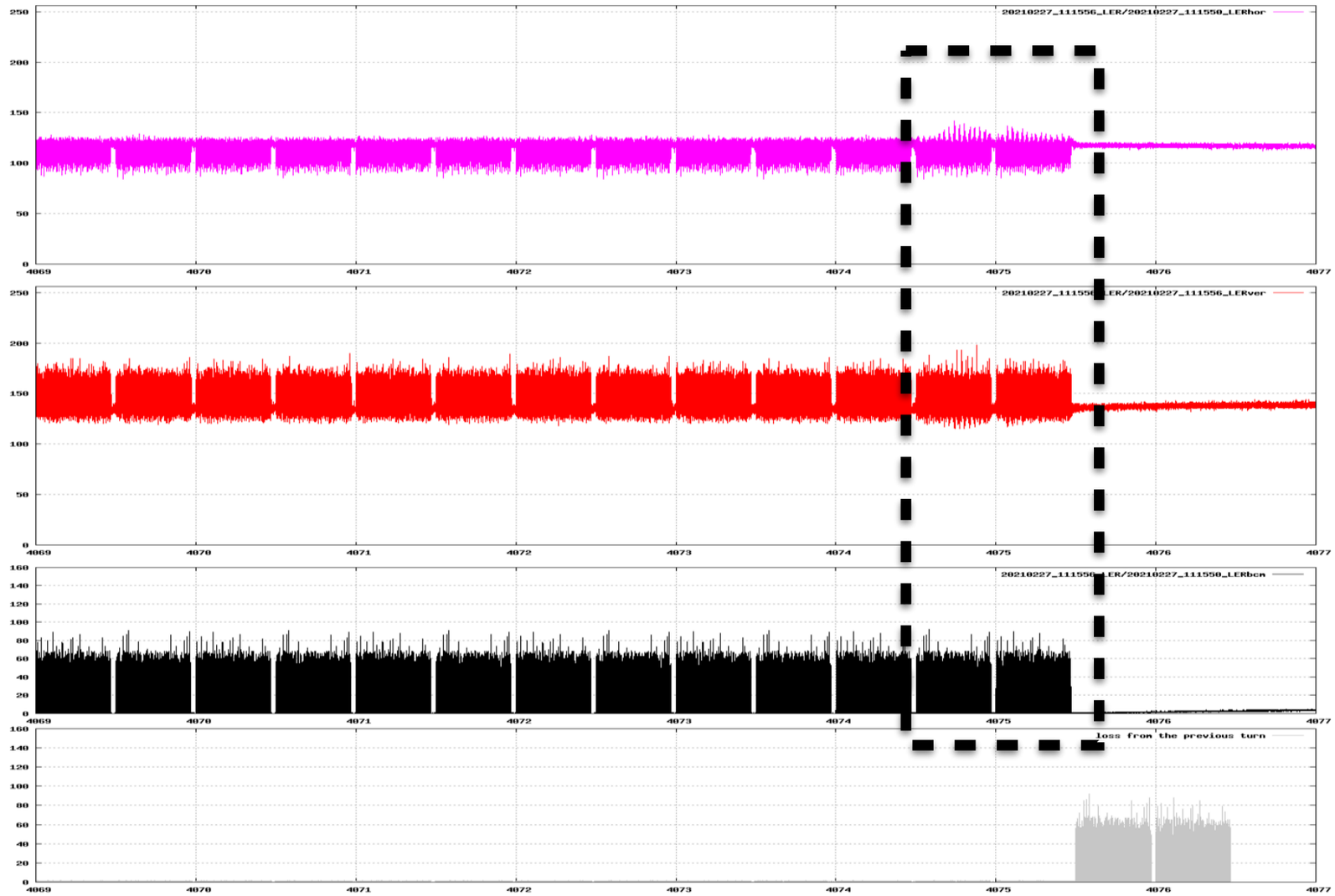
  http://kekb-co-web.kek.jp/doc/Image/BELLE/abort_summary/web/abortlist.html

➤ **This is a very preliminary phenomenon analysis, further quantitative analysis with joint efforts is necessary**

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-A**
  - * No obvious beam loss from BCM t-b-t data
  - * Obvious oscillation in BOR t-b-t data (starting from the -1 turn)



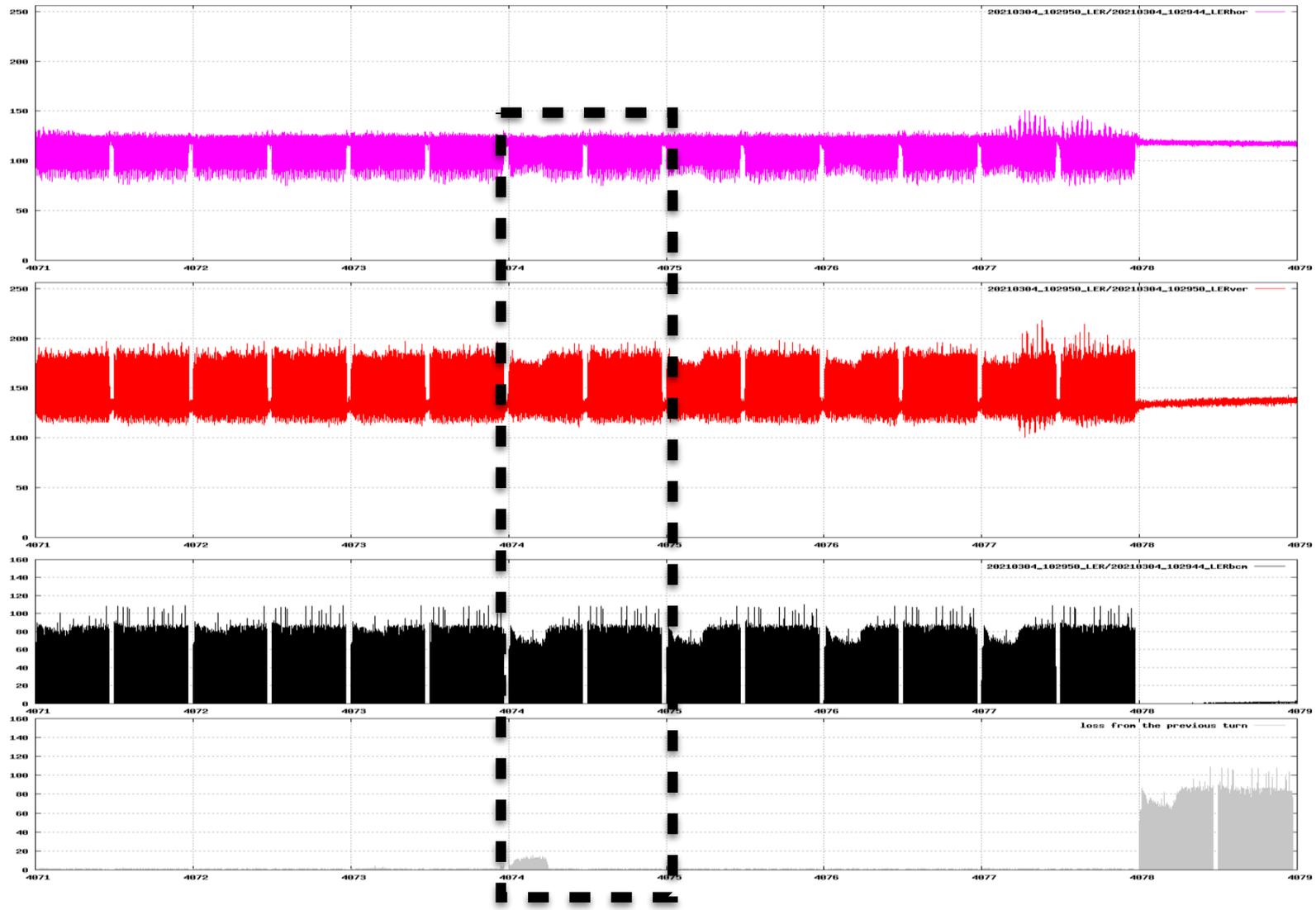
2021/02/27 11:15:50	Abort LER	CCG D6	209+358mA 978 bunch	5+3mRad/s												RFgun -1s		ccg -23s (D06_L12) (D06V1collimator)

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-B-1**

  *** Sudden beam loss in a single turn**

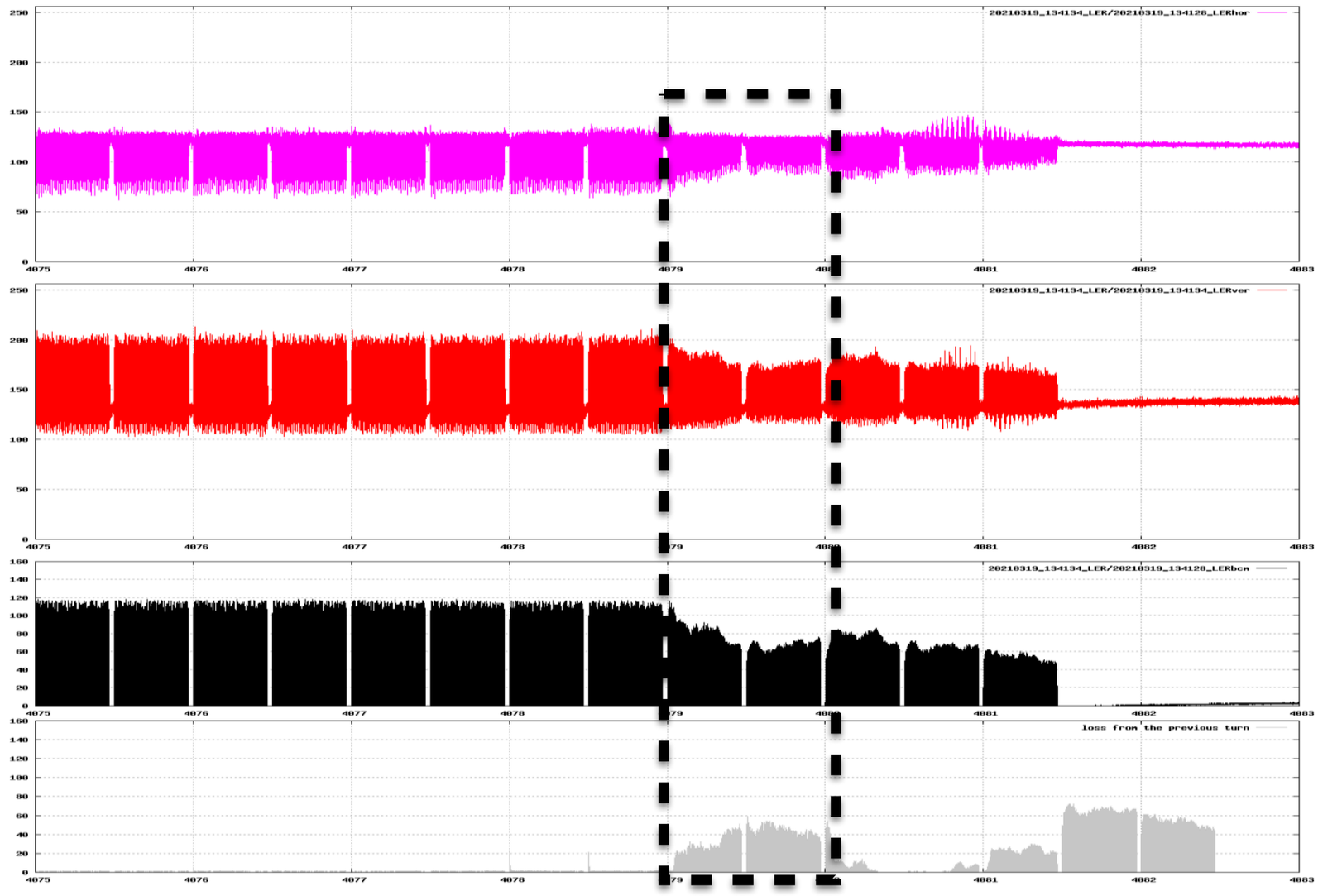


2021/03/04 10:29:44	Abort both	Belle2 VXD diamond	369+504mA 978 bunch (no Belle HV)	3+128mRad/s	8mRad												

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-B-2**
  - *** Sudden beam loss in a single turn**

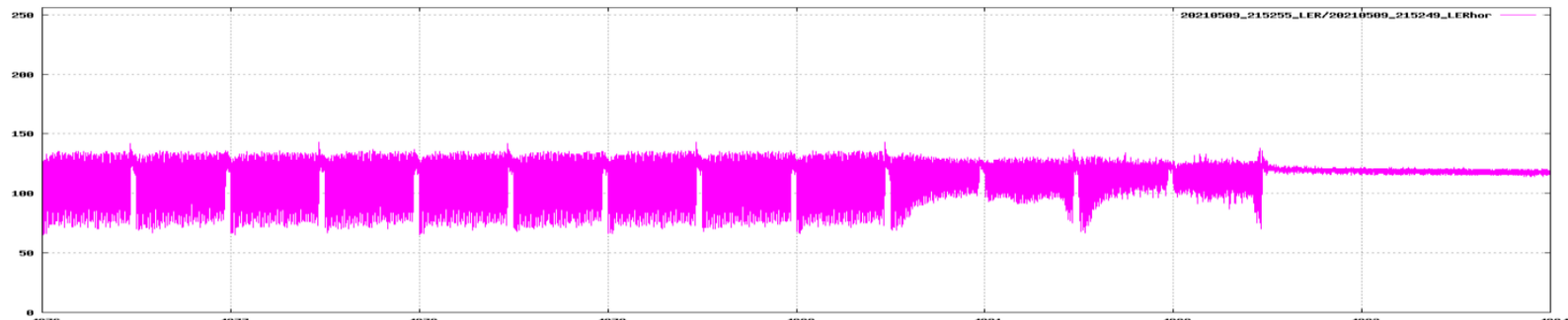


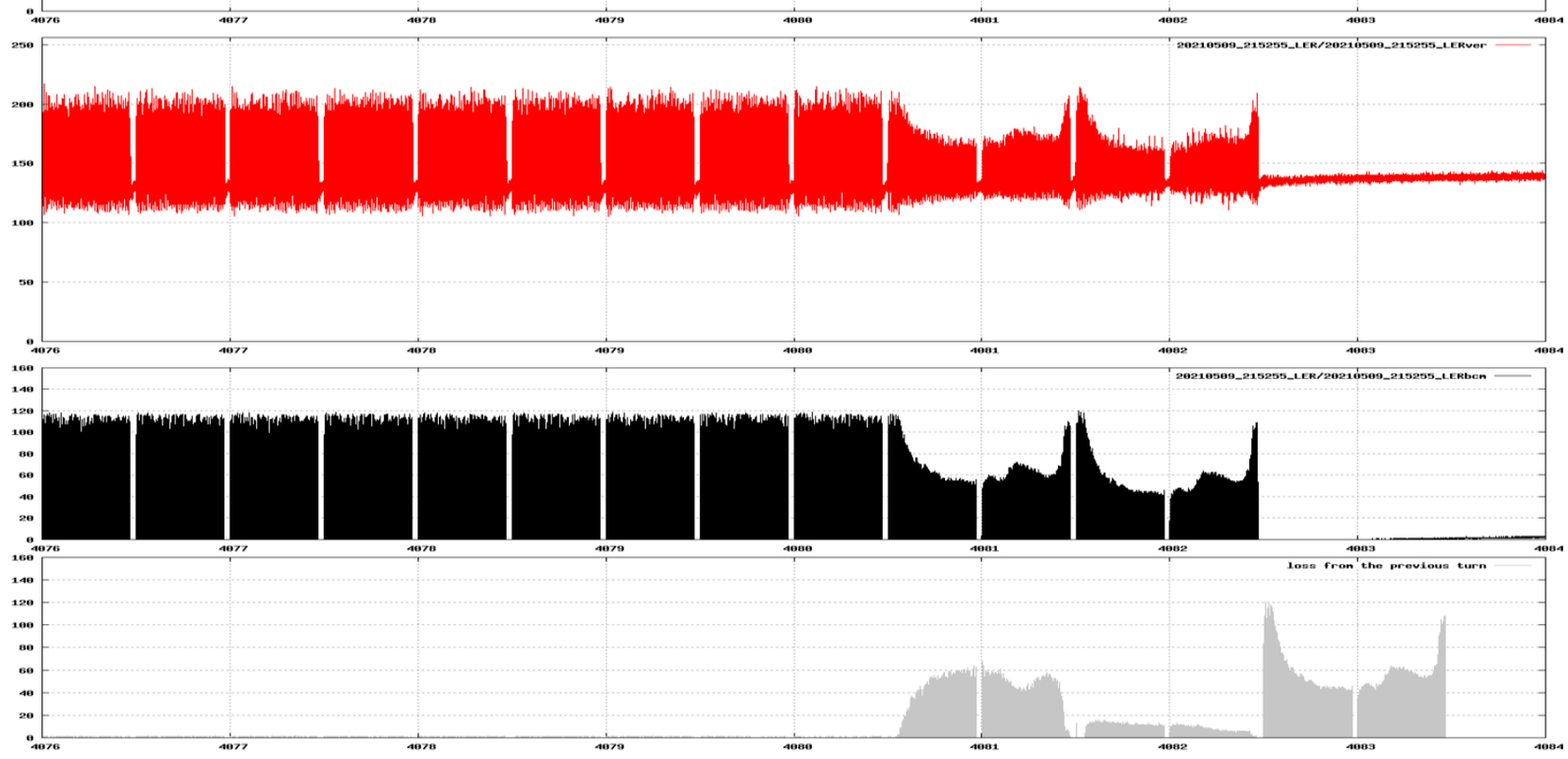
2021/03/19 13:41:28	Abort both	Loss Monitor D7-1 +diamond	468+693mA 978 bunch	16+198mRad/s	255mRad												ccg -15s (D06_L12) (D06V1collimator)

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-B-3**
  - *** Sudden beam loss in a single turn**





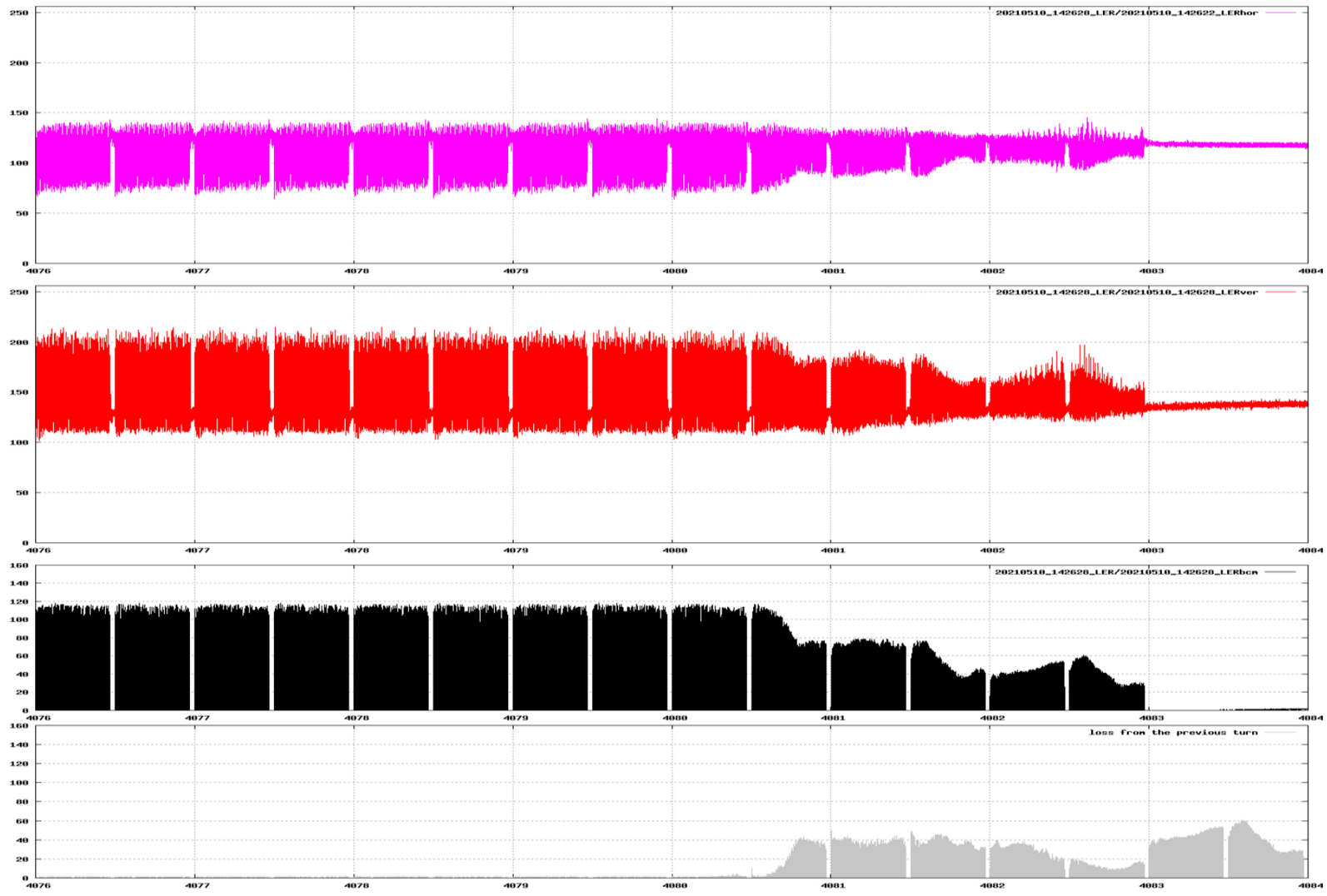
2021/05/09 21:52:49	Abort both	RF D5-F +diamond	679+836mA 1174 bunch	12+31mRad/s	130mRad											ccg -26s (D06_L12) (D06V1collimator)

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-B-4**

  *** Sudden beam loss in a single turn**



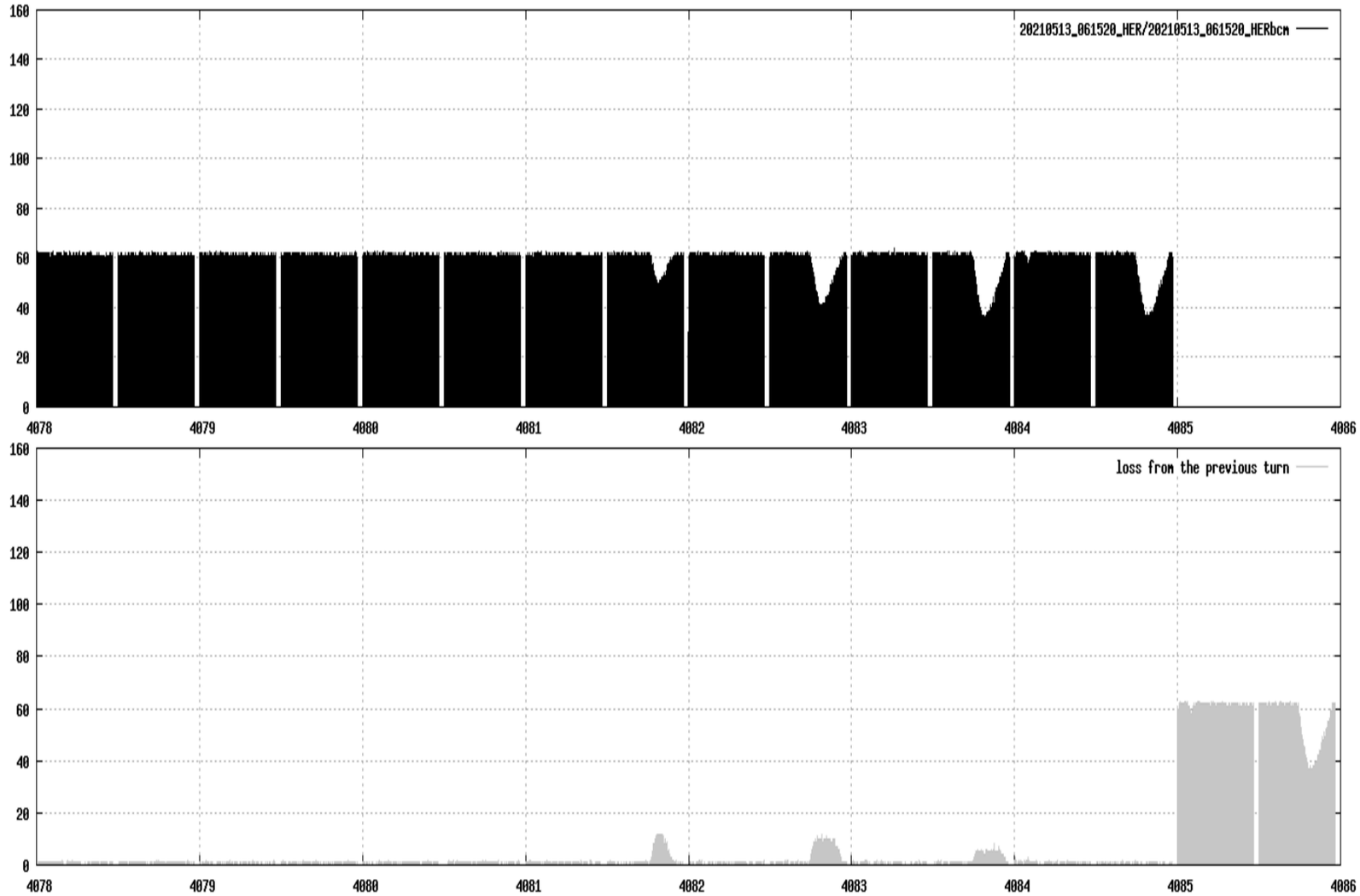
2021/05/10 14:26:22	Abort both	Belle2 VXD diamond	726+906mA 1272 bunch	176+346mRad/s	1756mRad												ccg -30s (D02_L18) (D02V1collimator/GV(D02_L03))

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-B-5**

  *** Sudden beam loss in a single turn**

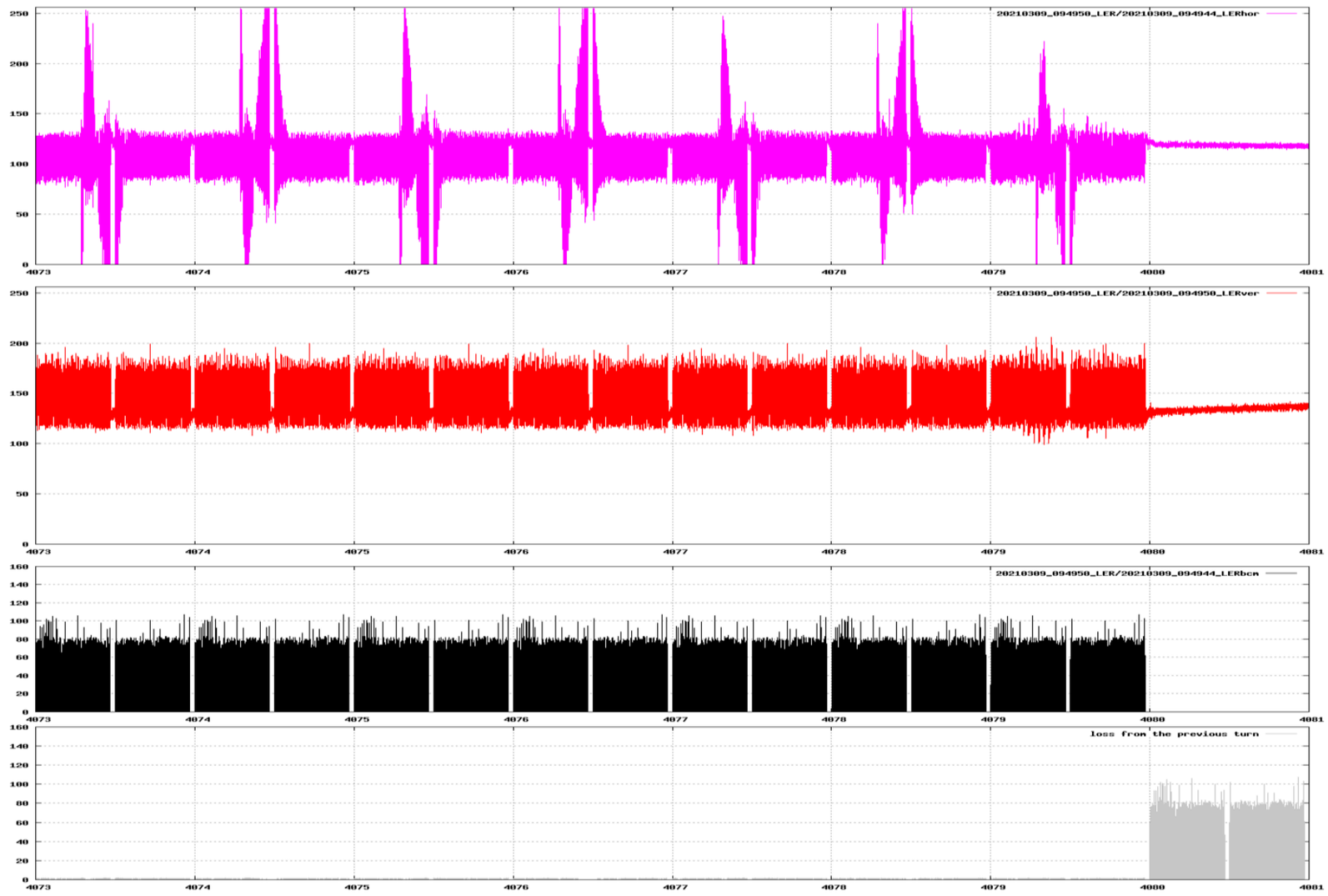


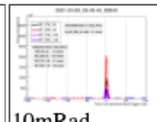
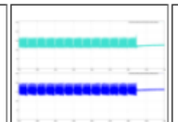
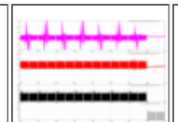
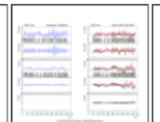
2021/05/13 06:15:20	Abort both	Loss Monitor D10-2 +diamond +D10-3	644+796mA 1174 bunch	232+24mRad/s	252mRad												

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-C**
  - * Large oscillation of bunches in part of the bunch train
  - * Oscillation appears only in x-direction

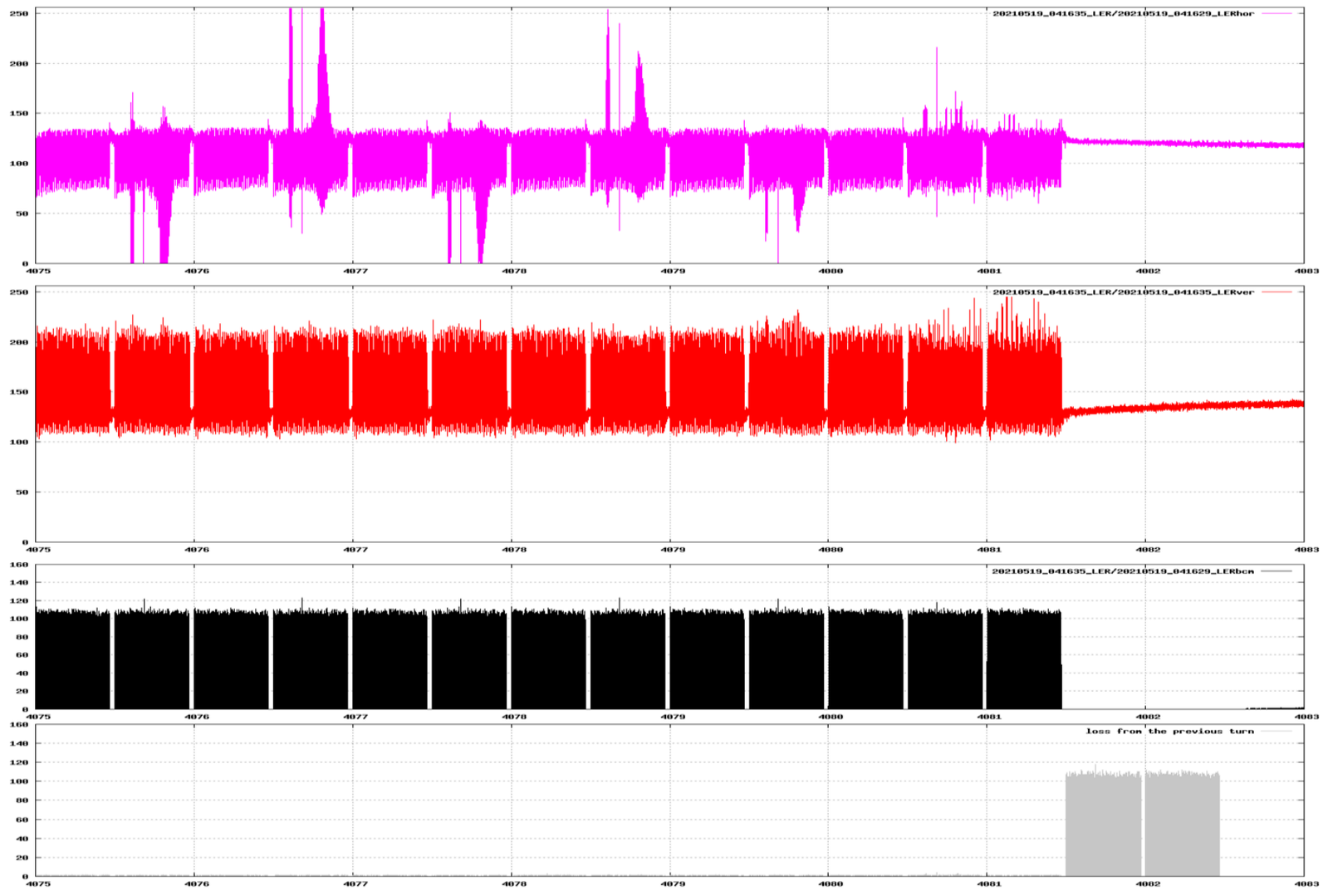


2021/03/09 09:49:44	Abort both	Belle2 VXD diamond	518+744mA 1565 bunch	3+97mRad/s	 10mRad						-55 us					

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-C**
  - *** Large oscillation of bunches in part of the bunch train**
  - *** Oscillation appears only in x-direction**

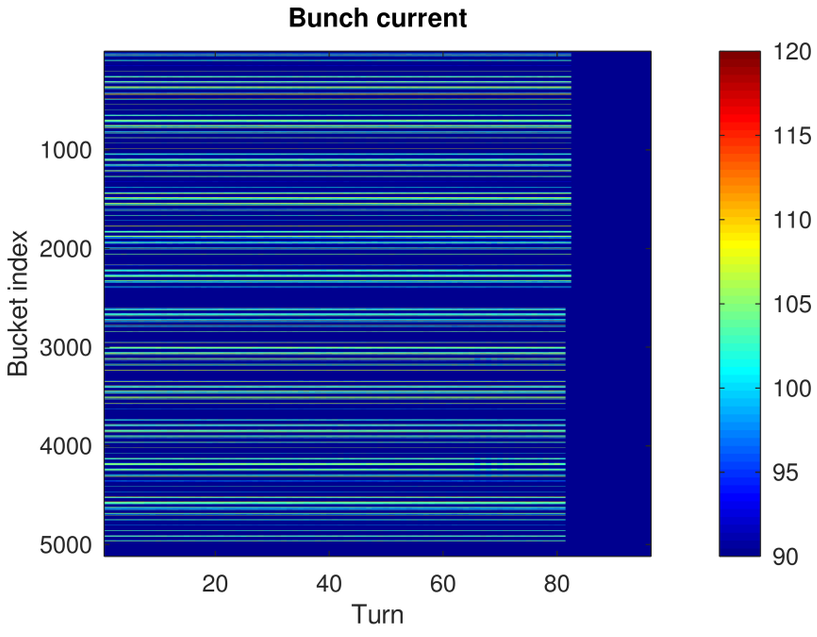


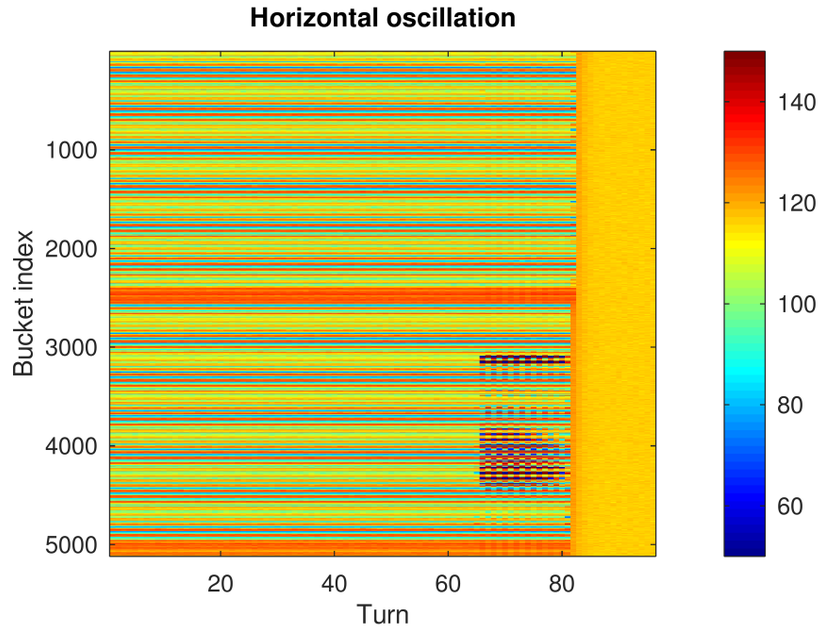
2021/05/19 04:16:29	Abort LER	RF D5-F	645+838mA 1174 bunch	5+41mRad/s							-105 us					

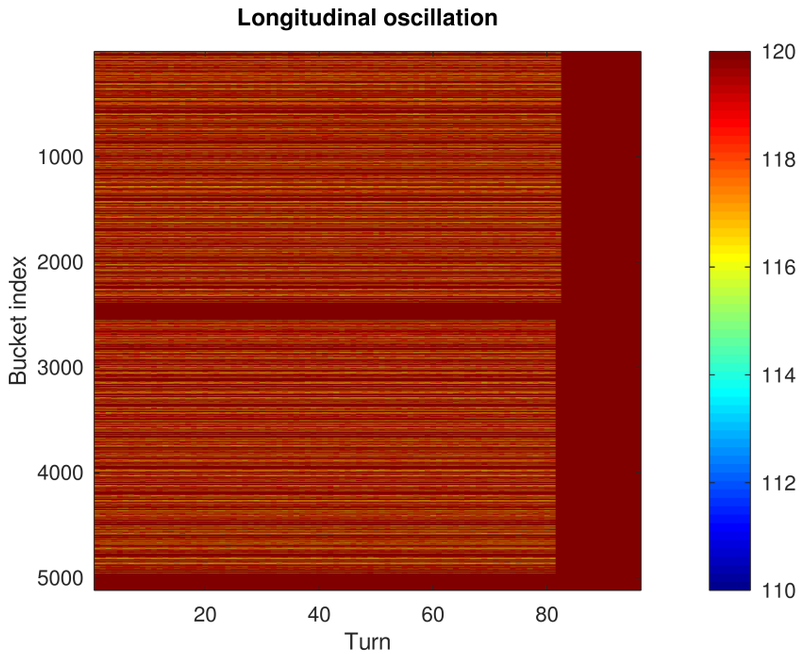
2. Patterns of BOR/BCM data

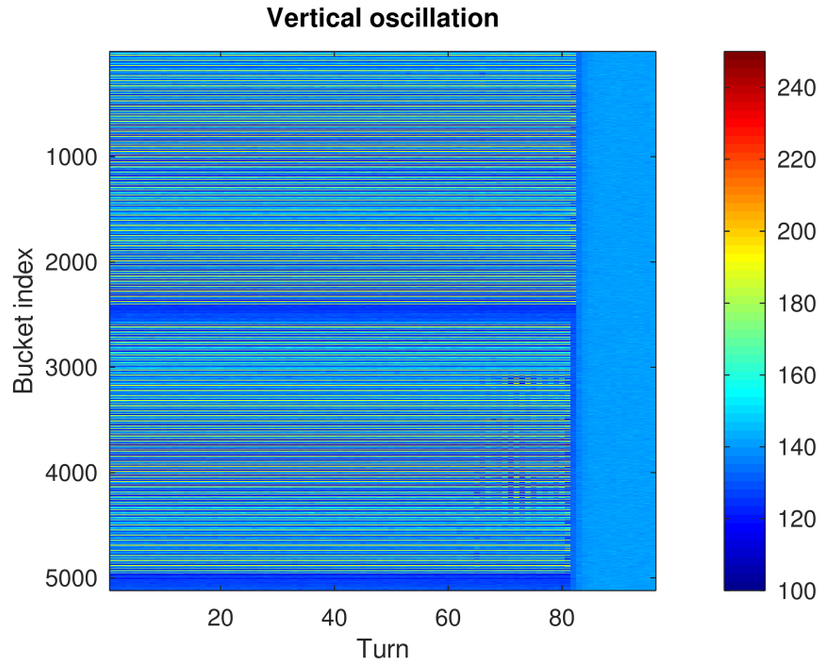
➤ Patterns of LER BOR/BCM data

- **Pattern LER-C**
  - * Large oscillation of bunches in part of the bunch train
  - * Oscillation appears only in x-direction





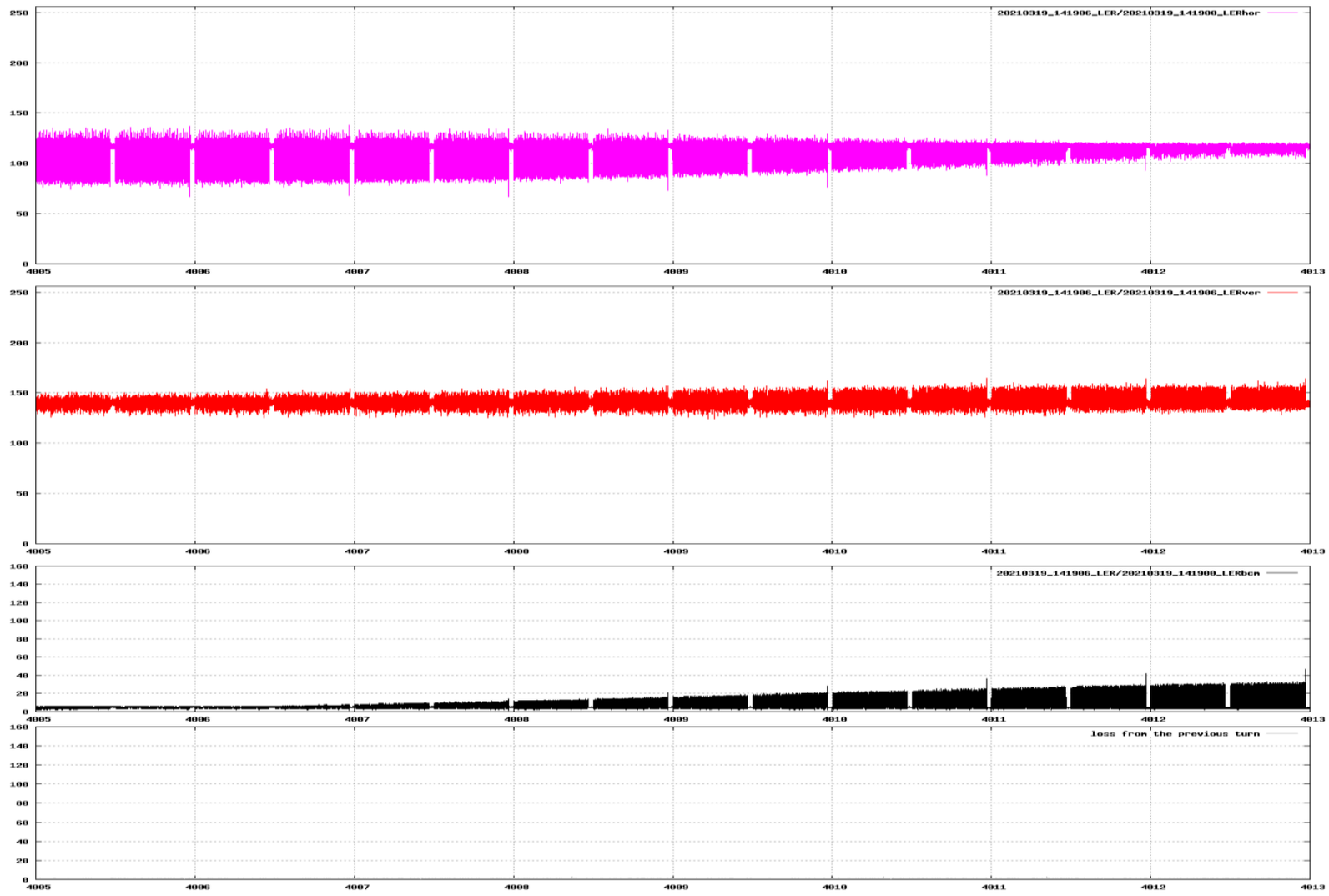




2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-D**
  - *** Gradual increase in BCM data?**

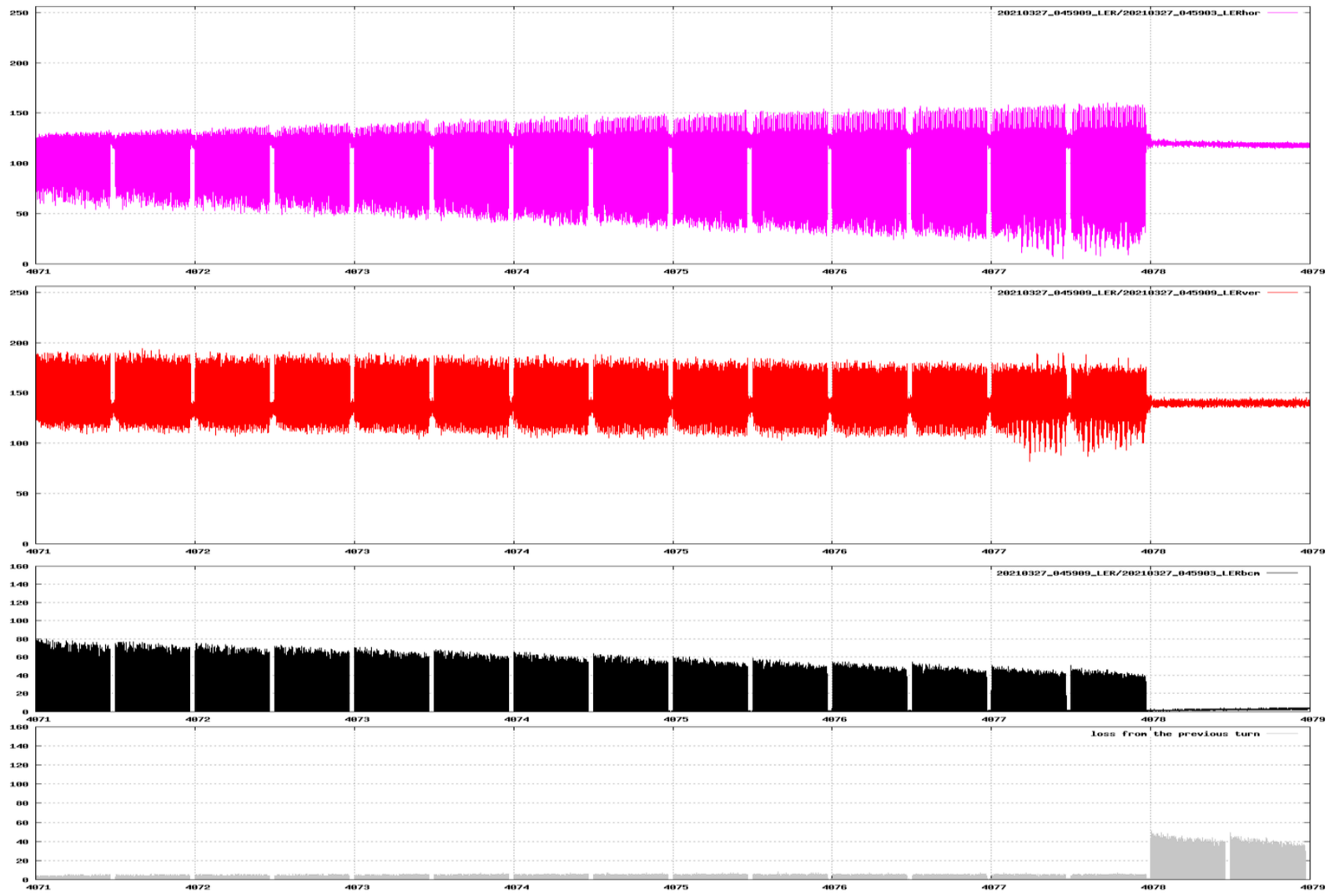


2021/03/19 14:19:00	Abort LER	Loss Monitor D7-1	218+78mA 978 bunch (no Belle HV)	26+127mRad/s													

2. Patterns of BOR/BCM data

➤ Patterns of LER BOR/BCM data

- **Pattern LER-E**
  - *** Gradual decrease in BCM data**

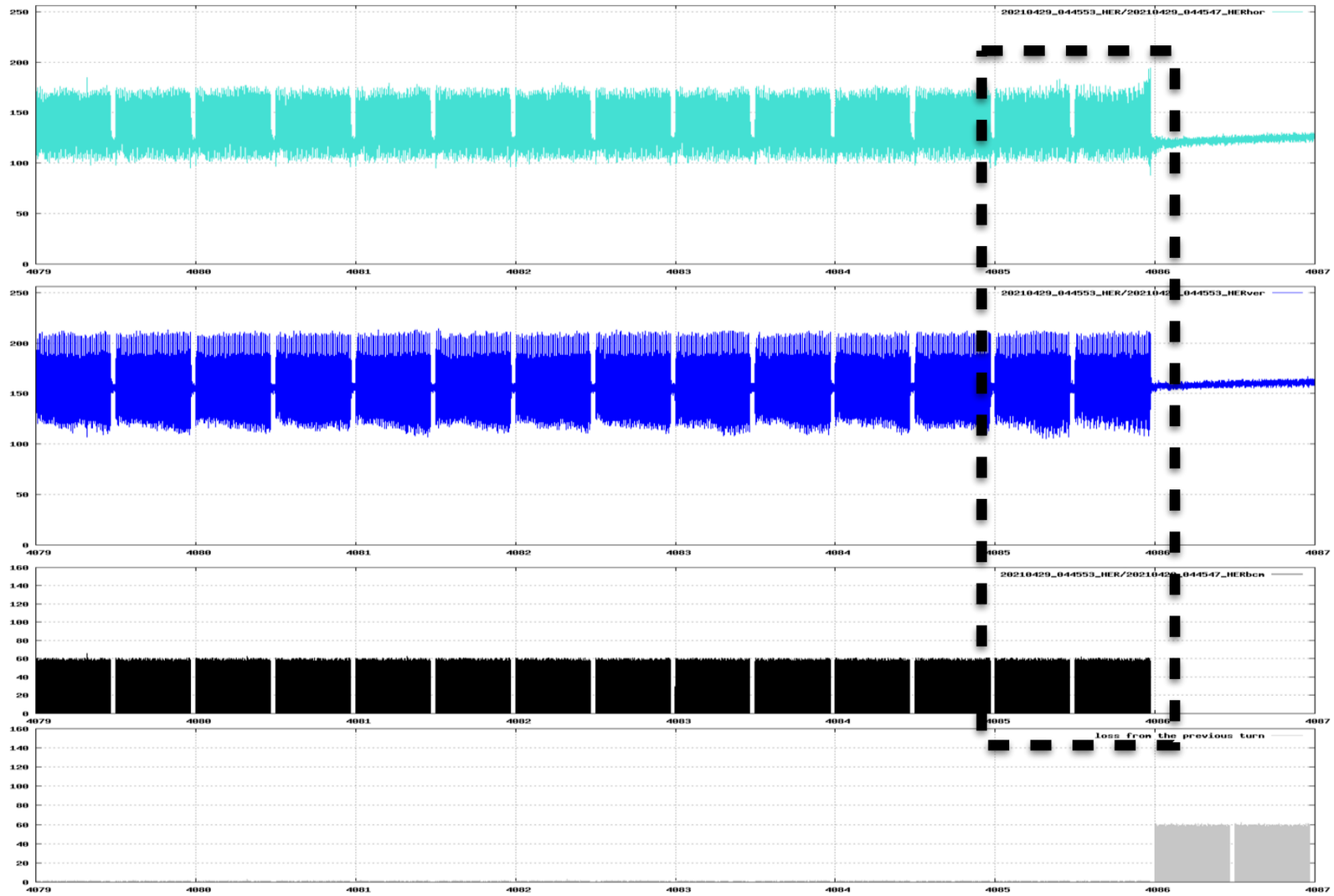


2021/03/27 04:59:03	Abort LER	RF Beam Phase D7	428+536mA 978 bunch	1+32mRad/s													

2. Patterns of BOR/BCM data

➤ Patterns of HER BOR/BCM data

- **Pattern HER-A (HER BCM data available from Apr. 28, 2021(to be confirmed))**
  - *** No obvious beam loss from BCM t-b-t data**
  - *** Obvious oscillation in BOR t-b-t data (starting from the -1 turn)**

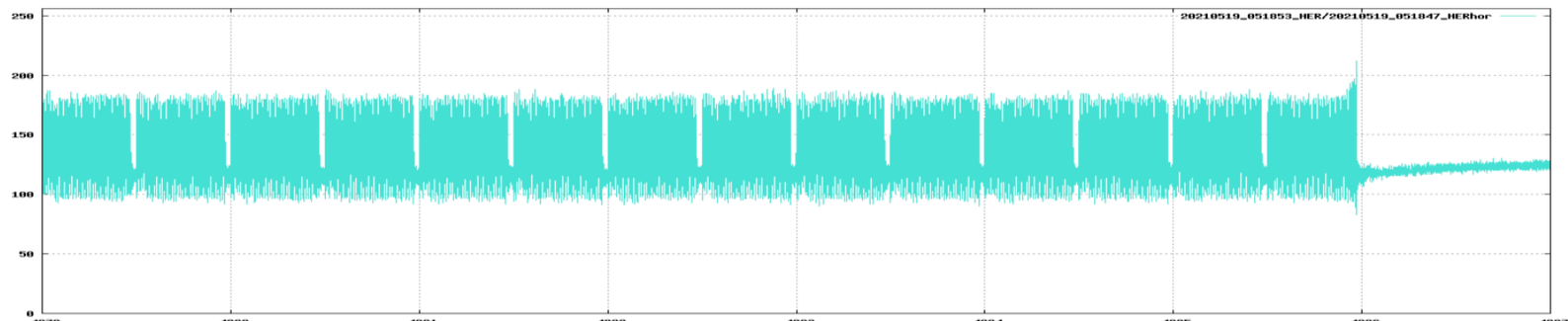


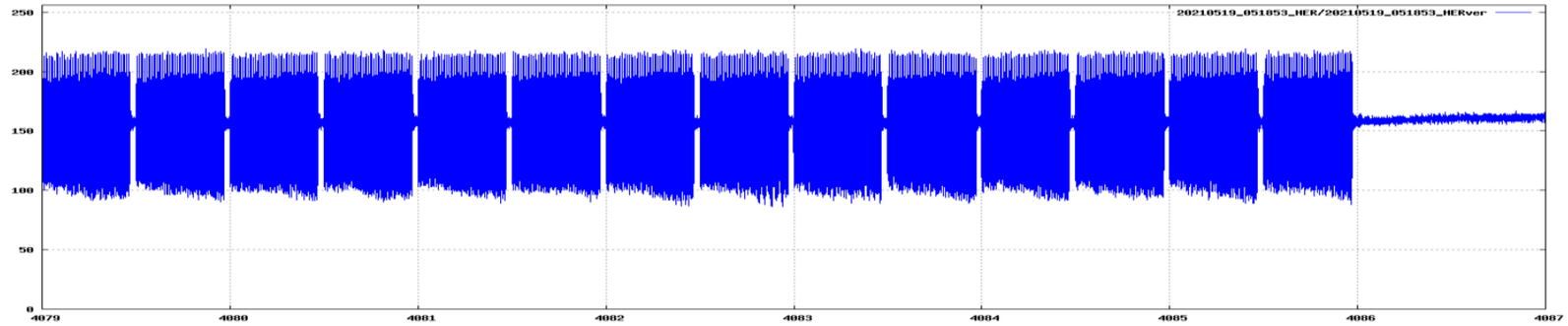
2021/04/29 04:45:47	Abort both	Belle2 VXD diamond	668+829mA 1272 bunch	12+47mRad/s	4mRad												

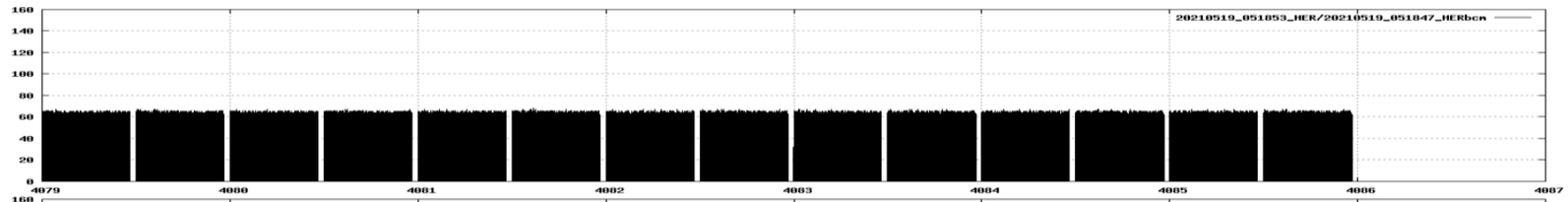
2. Patterns of BOR/BCM data

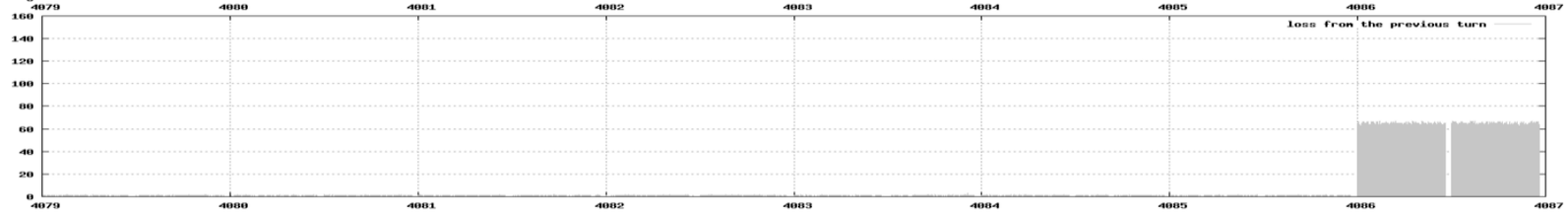
➤ Patterns of HER BOR/BCM data

- **Pattern HER-A (May 19, 2021)**
  - * No obvious beam loss from BCM t-b-t data
  - * Obvious oscillation in BOR t-b-t data (starting from the -1 turn)







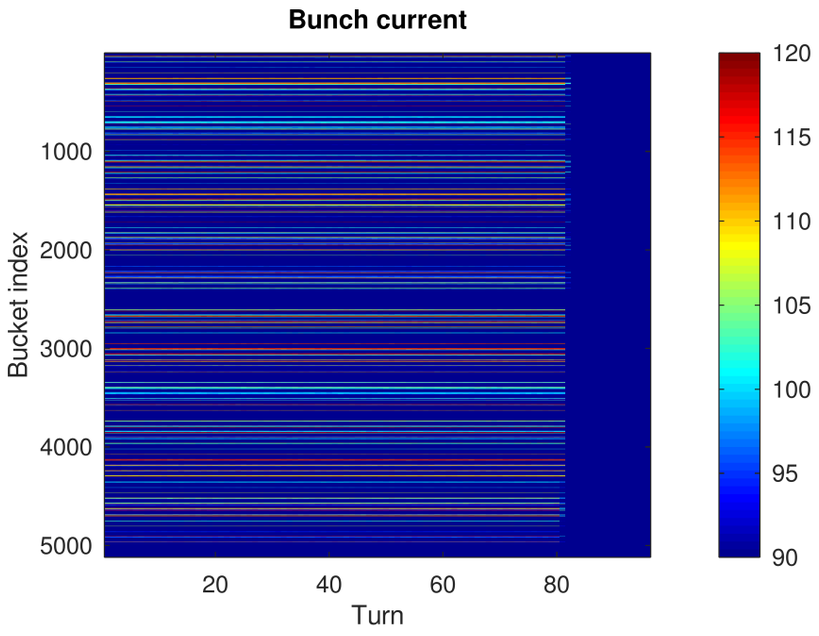


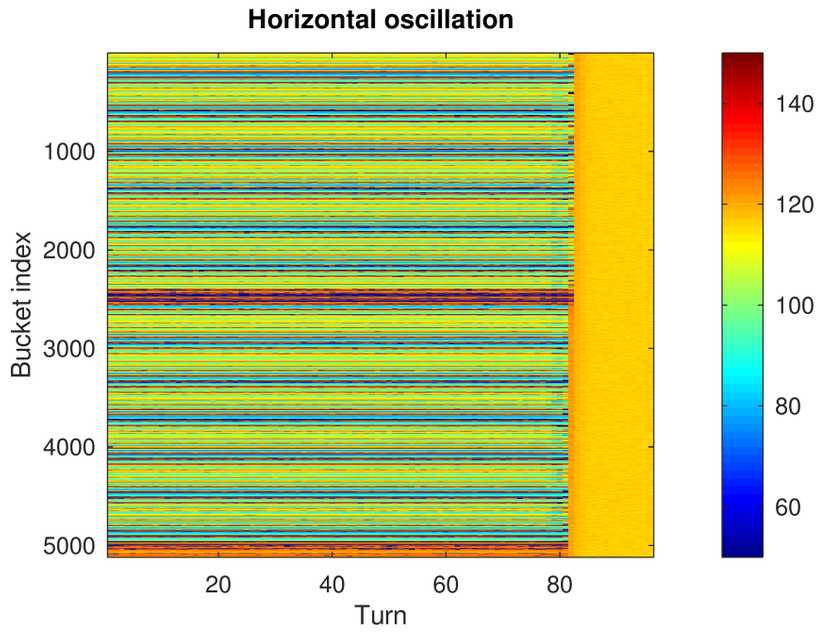
2021/05/19 05:18:47	Abort both	RF D5-F +diamond	679+837mA 1174 bunch	4+191mRad/s	50mRad											

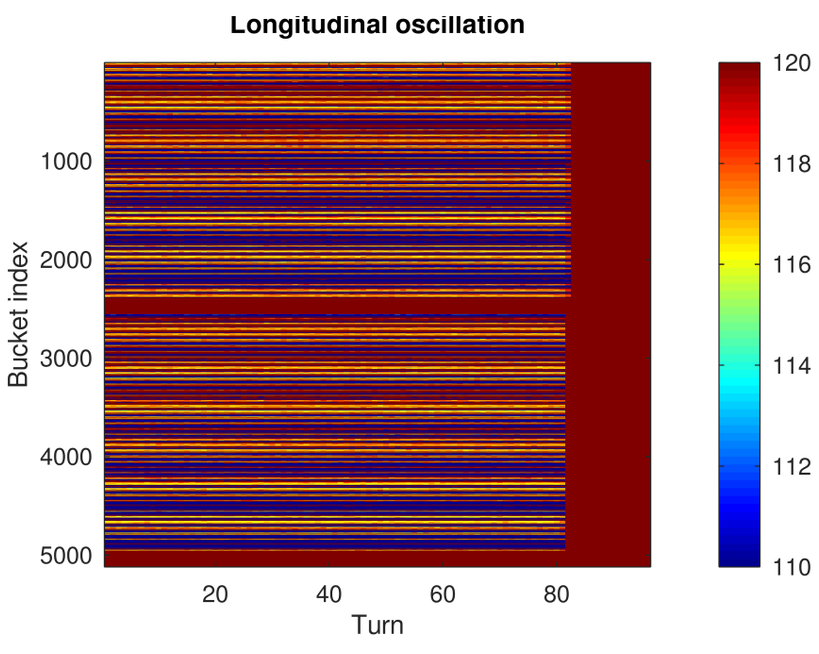
2. Patterns of BOR/BCM data

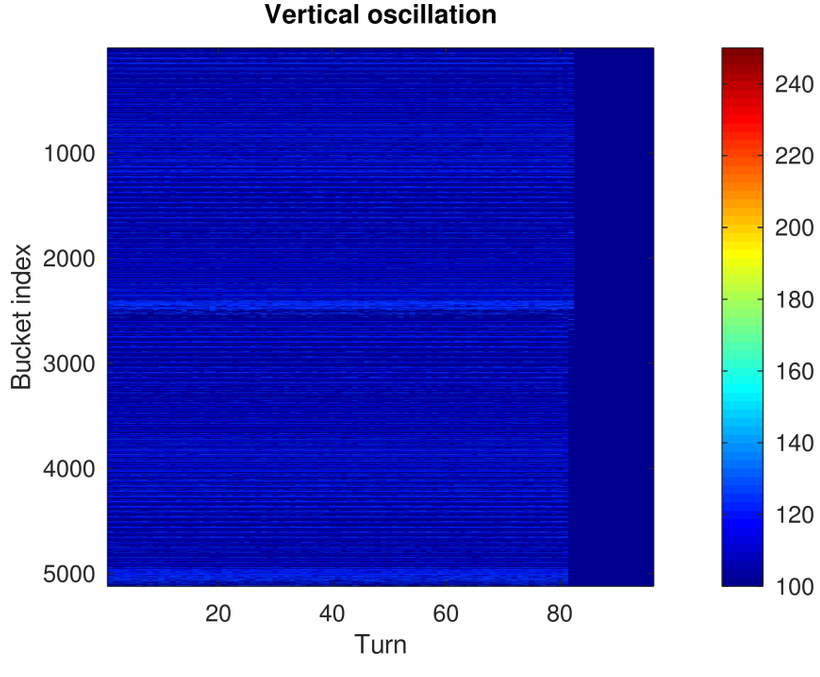
➤ Patterns of HER BOR/BCM data

- **Pattern HER-A (May 19, 2021)**
  - *** No obvious beam loss from BCM t-b-t data**
  - *** Obvious oscillation in BOR t-b-t data (starting from the -1 turn)**





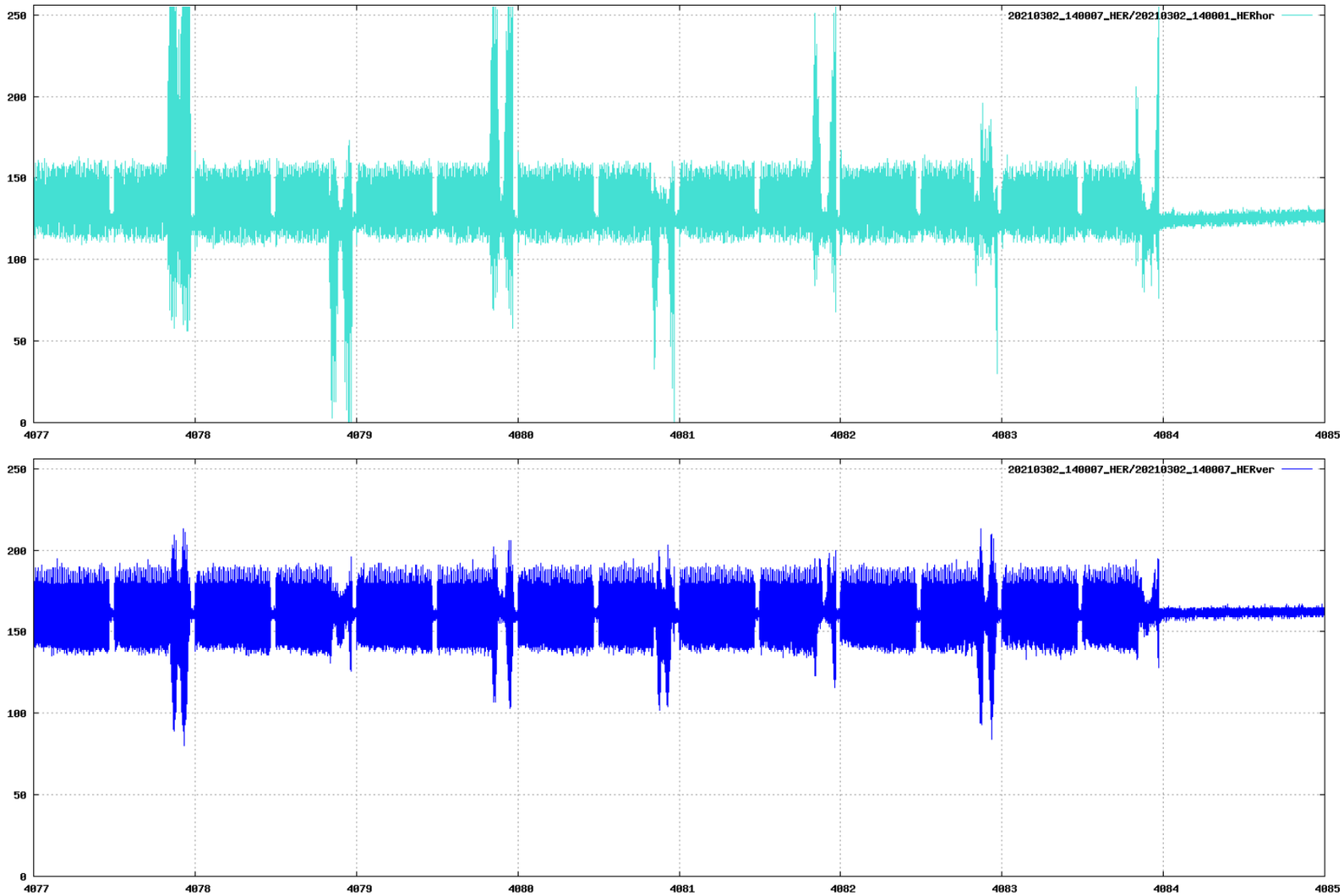


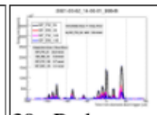
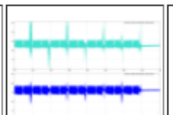
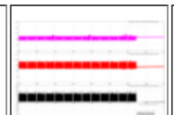


2. Patterns of BOR/BCM data

➤ Patterns of HER BOR/BCM data

- **Pattern HER-B (Only observed on Mar. 02,2021)**
  - *** Large oscillation of bunches in part of the bunch train**
  - *** Oscillation appears in both x- and y-directions**

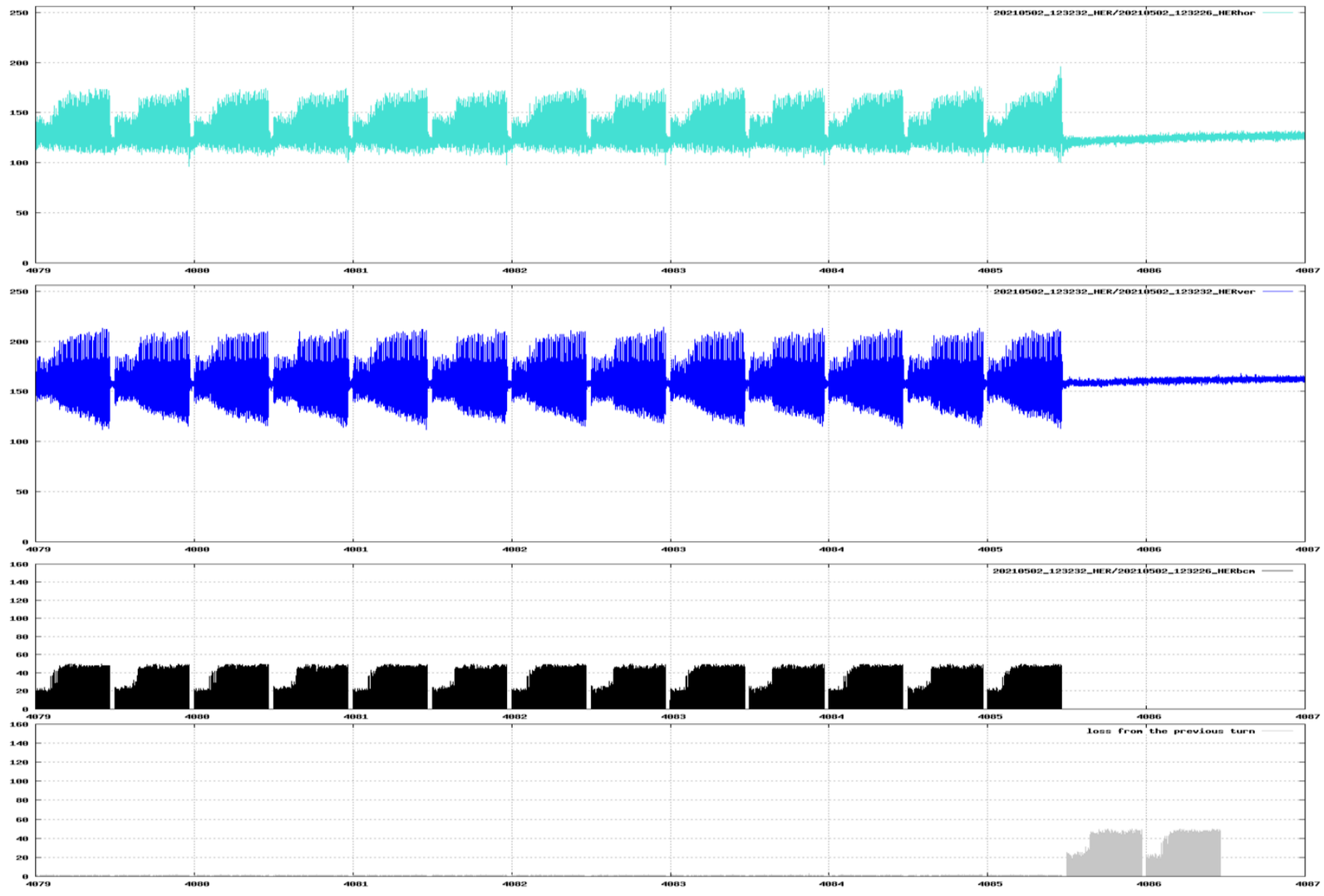


2021/03/02 14:00:01	Abort both	Belle2 VXD diamond	268+466mA 978 bunch	204+9mRad/s	 20mRad												

2. Patterns of BOR/BCM data

➤ Patterns of HER BOR/BCM data

- **Pattern HER-C-1**
  - *** Sudden beam loss in a single turn**

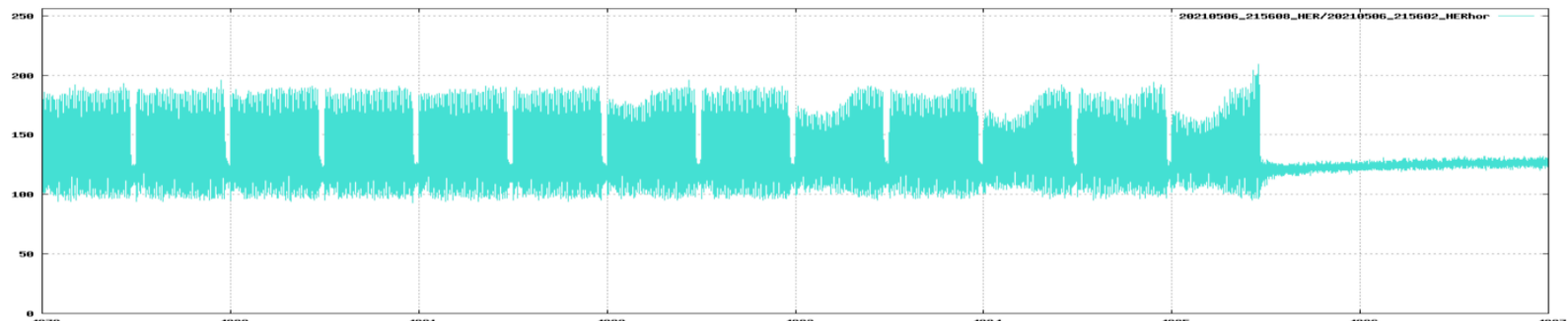


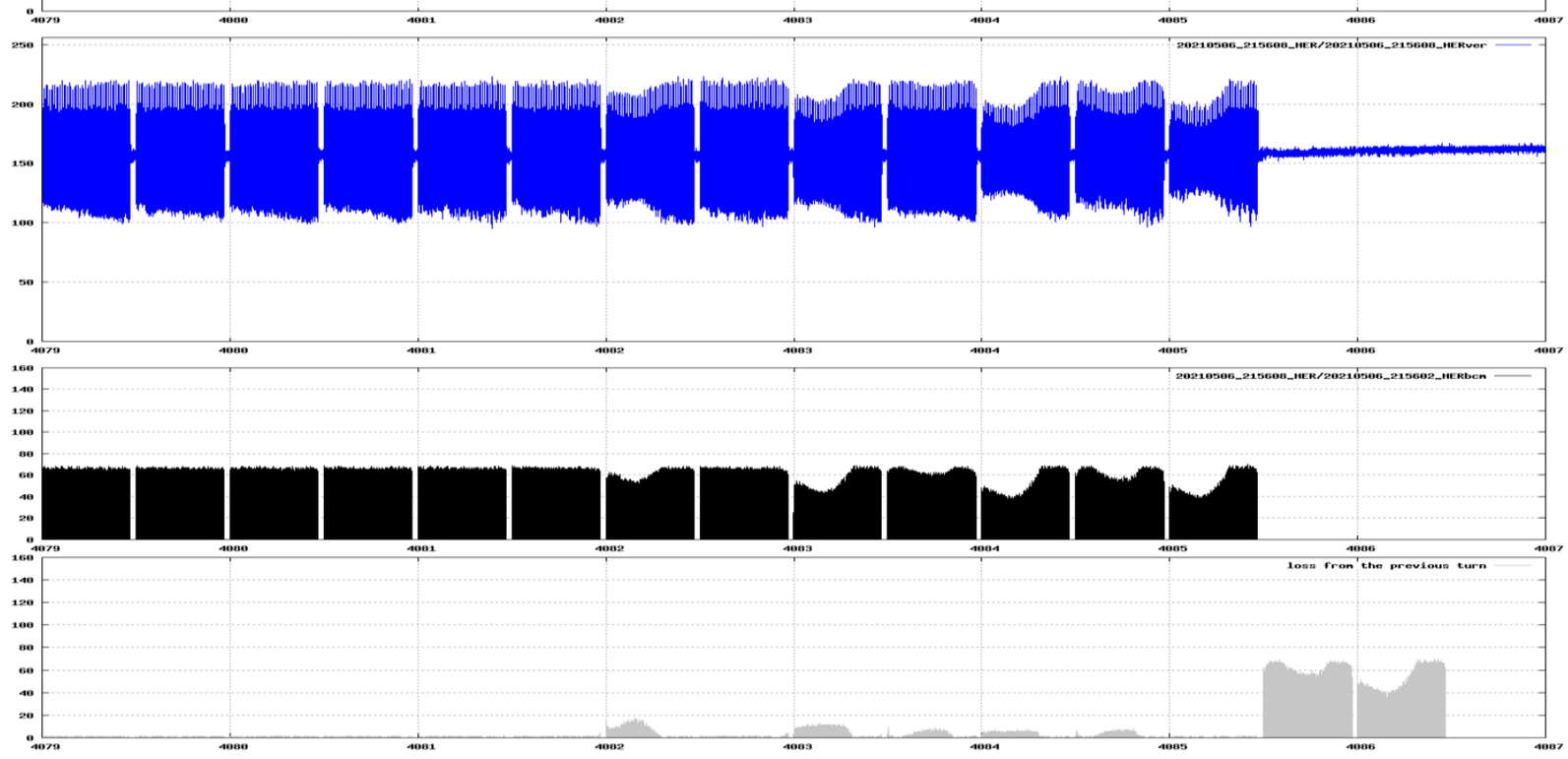
2021/05/02 12:32:26	Abort HER	Loss Monitor D10-3	679+498mA 1565 bunch	375+10mRad/s												

2. Patterns of BOR/BCM data

➤ Patterns of HER BOR/BCM data

- **Pattern HER-C-2**
  - *** Sudden beam loss in a single turn**



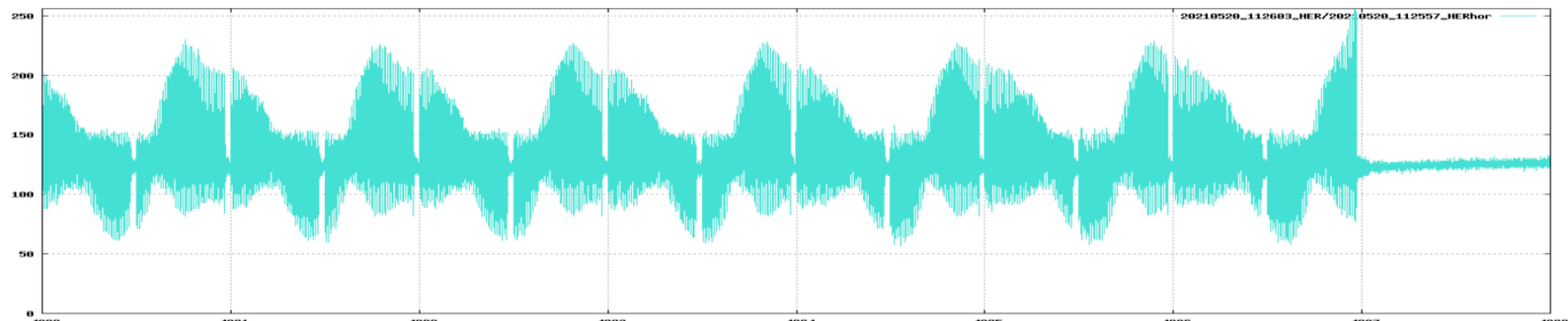


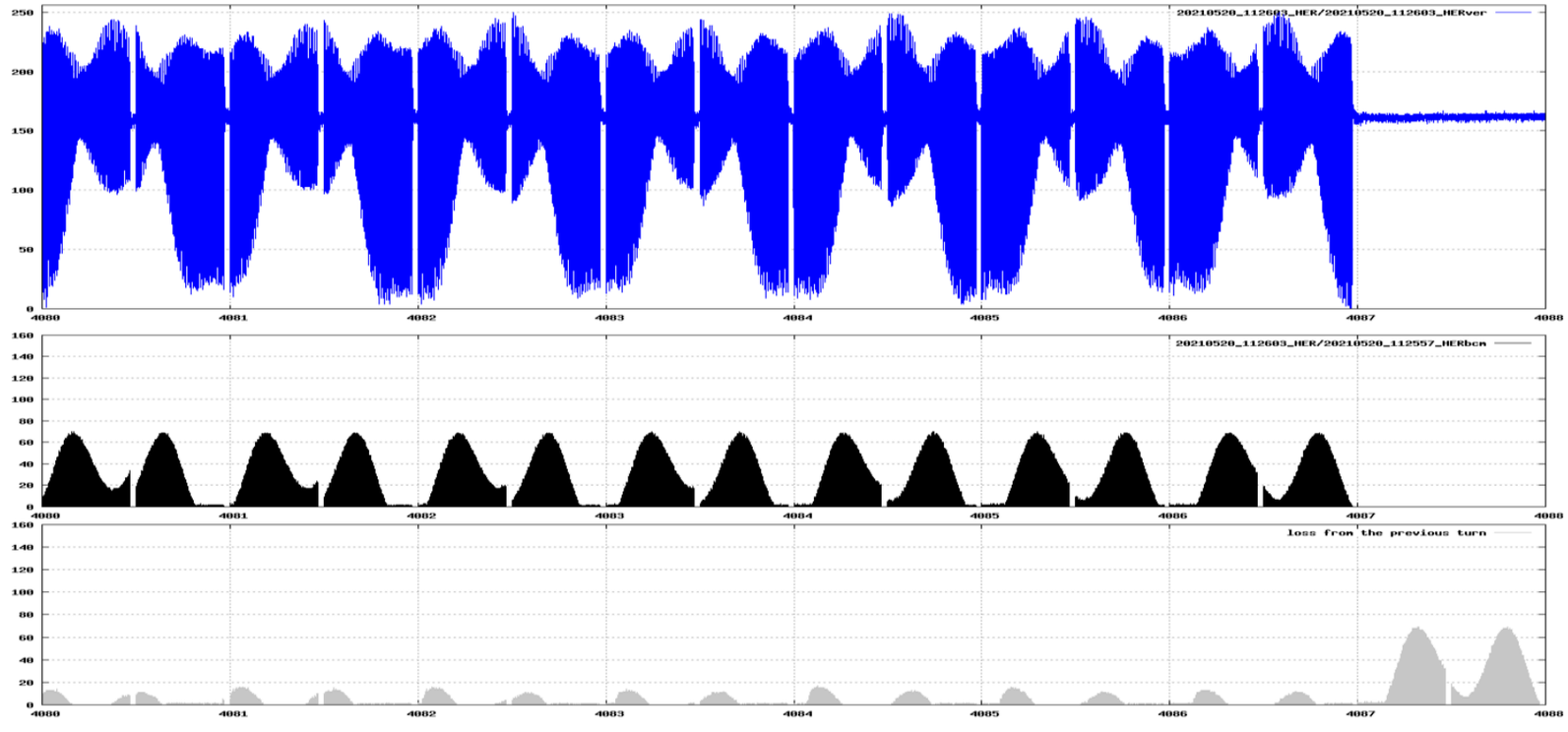
2021/05/06 21:56:02	Abort both	Belle2 VXD diamond +D10-3	626+767mA 1076 bunch	6+17mRad/s	501mRad												ccg 18s (D07_L00) (FBT_kicker/GV(D08_L06))

2. Patterns of BOR/BCM data

➤ Patterns of HER BOR/BCM data

- **Pattern HER-D**
  - *** Beam loss every turn (New phenomenon on May 20, 2021)**



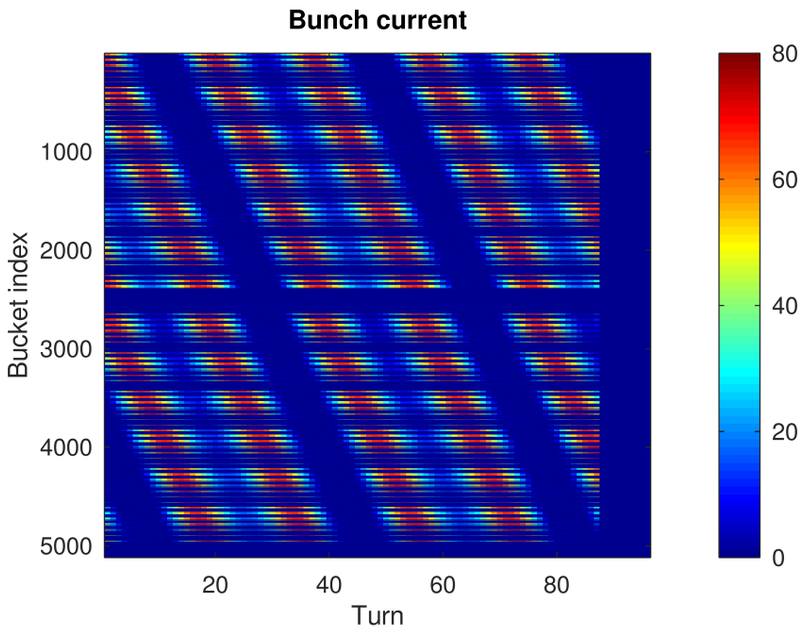


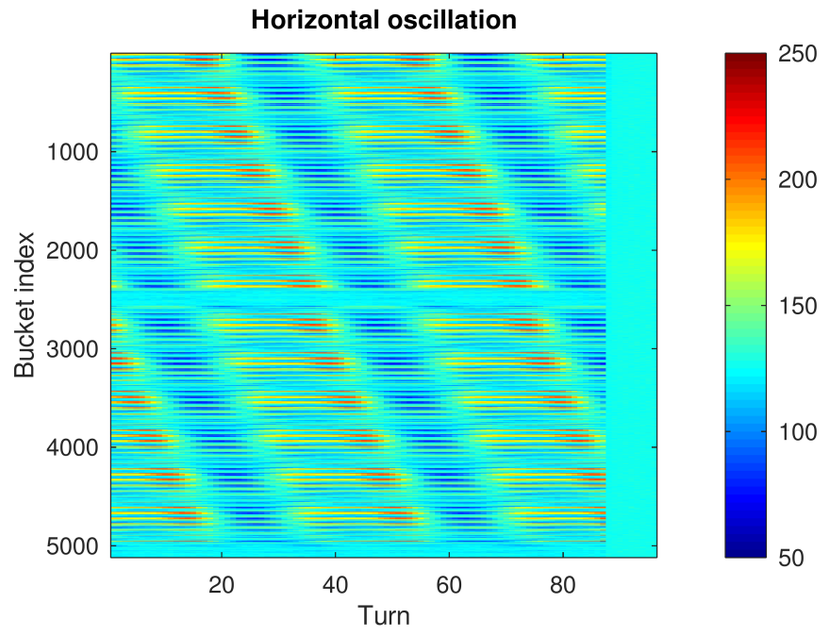
2021/05/20 11:25:57	Abort HER	Loss Monitor D10-3	678+837mA 1174 bunch	11+19mRad/s													

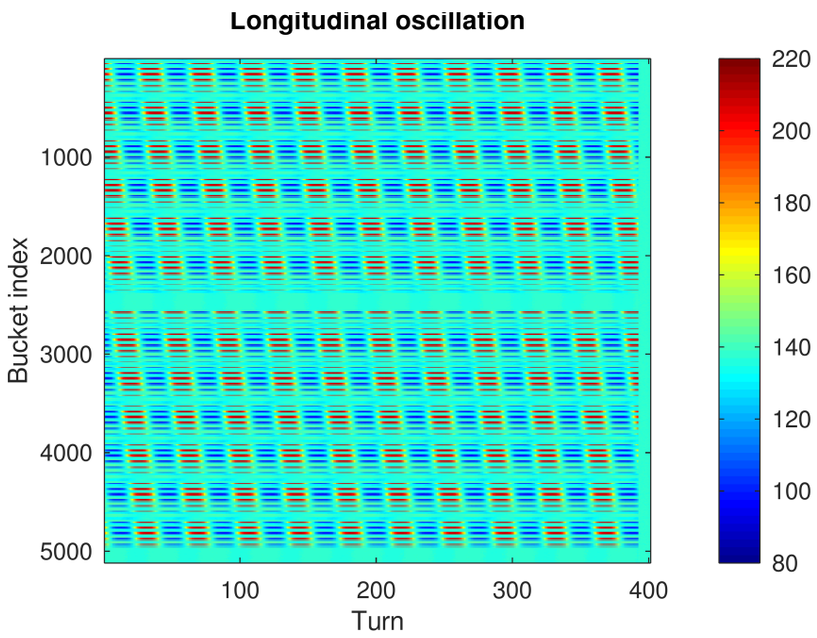
2. Patterns of BOR/BCM data

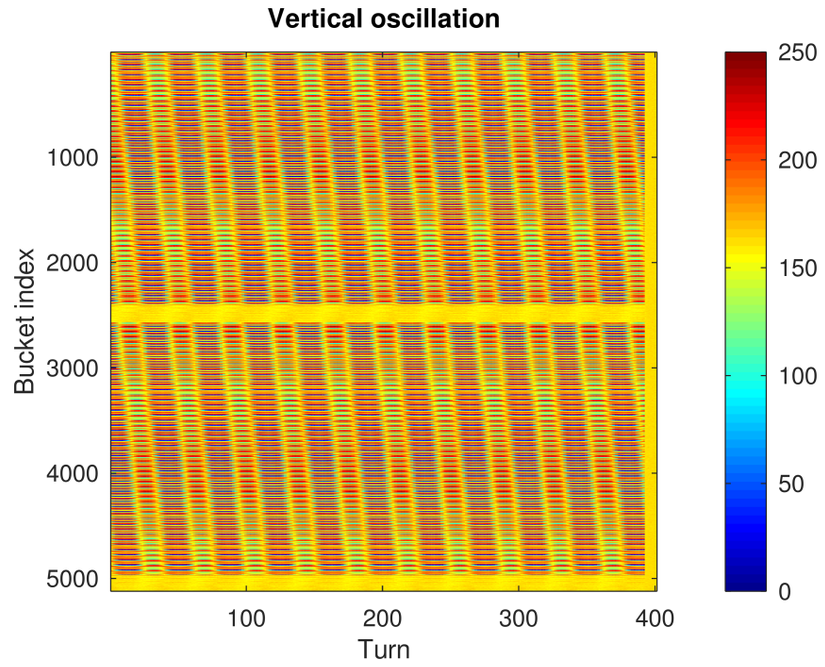
➤ Patterns of HER BOR/BCM data

- **Pattern HER-D**
  - *** Beam loss every turn (New phenomenon on May 20, 2021)**









2. Patterns of BOR/BCM data

➤ Summary

- Most of the “Abort LER”, “Abort HER”, and “Abort both” events contain both “Pattern LER-A” and “Pattern HER-A”
- The head-tail motion (related to TMCI) cannot be monitored by the BOR(?)
- Fourier analysis of BOR/BCM data is ongoing
- Turn-by-turn beam sizes might provide more information about beam dynamics before beam aborts