

# UFO type 2

## Analysis of beam loss signature and explanation of related hypothesis

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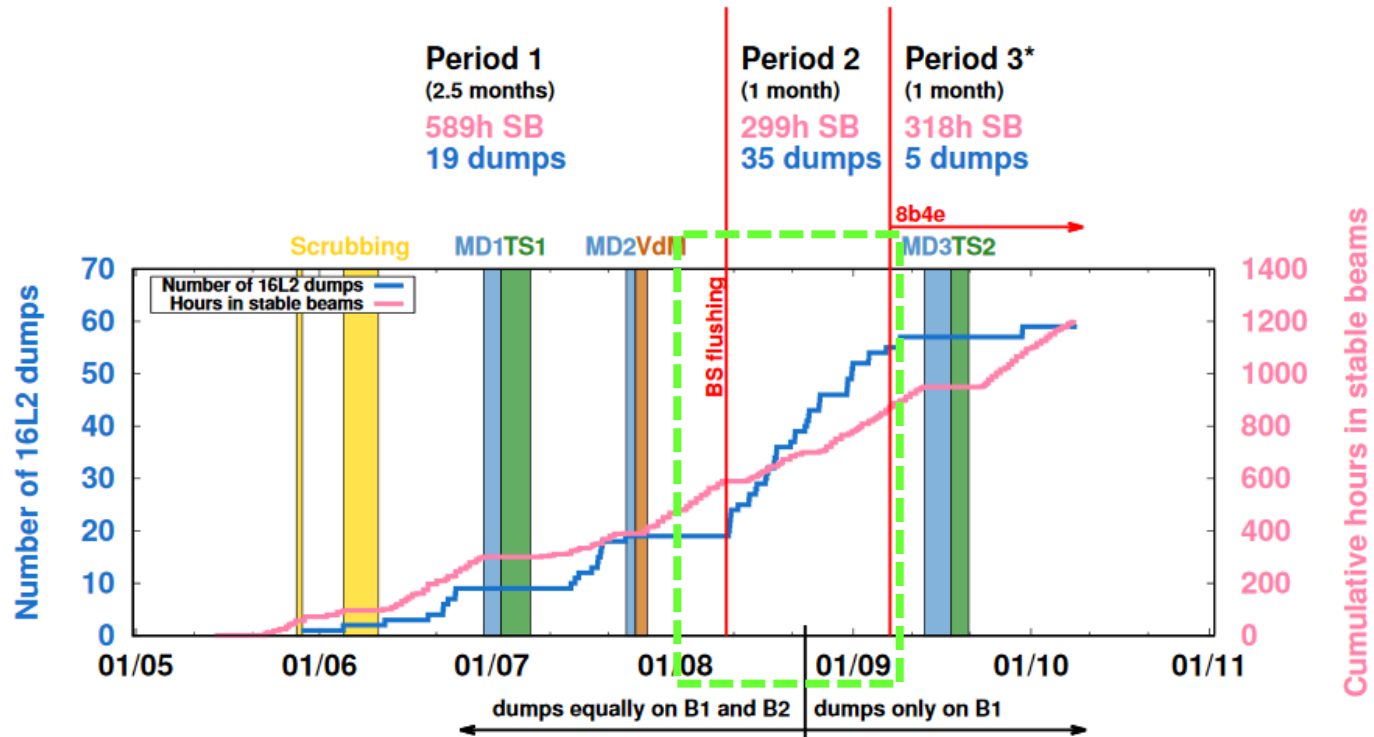
# Brief overview of 16L2 issues

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# Recap: Impact of 16L2 events in 202017

## Dumps and quenches related to losses in 16L2

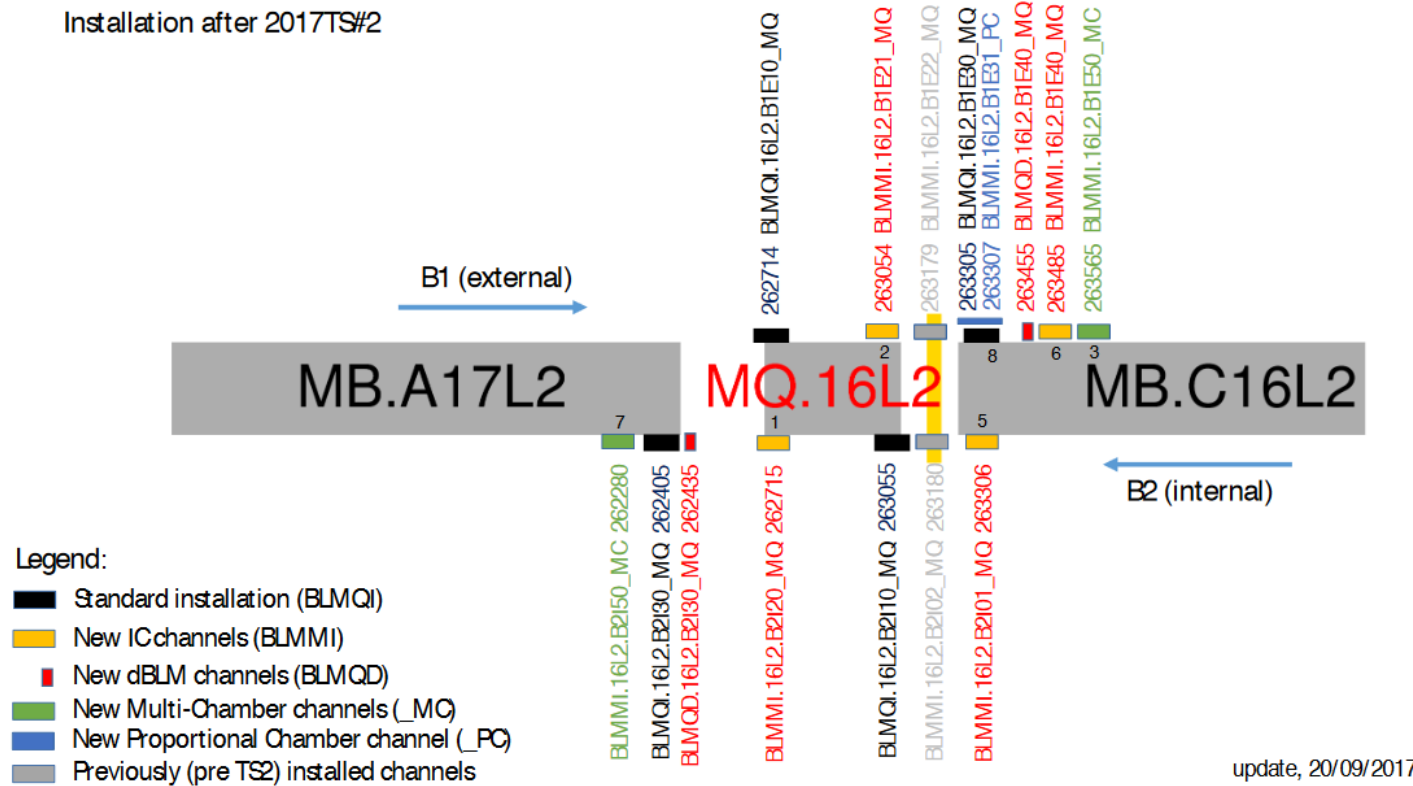
**59 dumps** ( $39 \times B1$ ,  $20 \times B2$ ), including 1 quench on the 12/08:



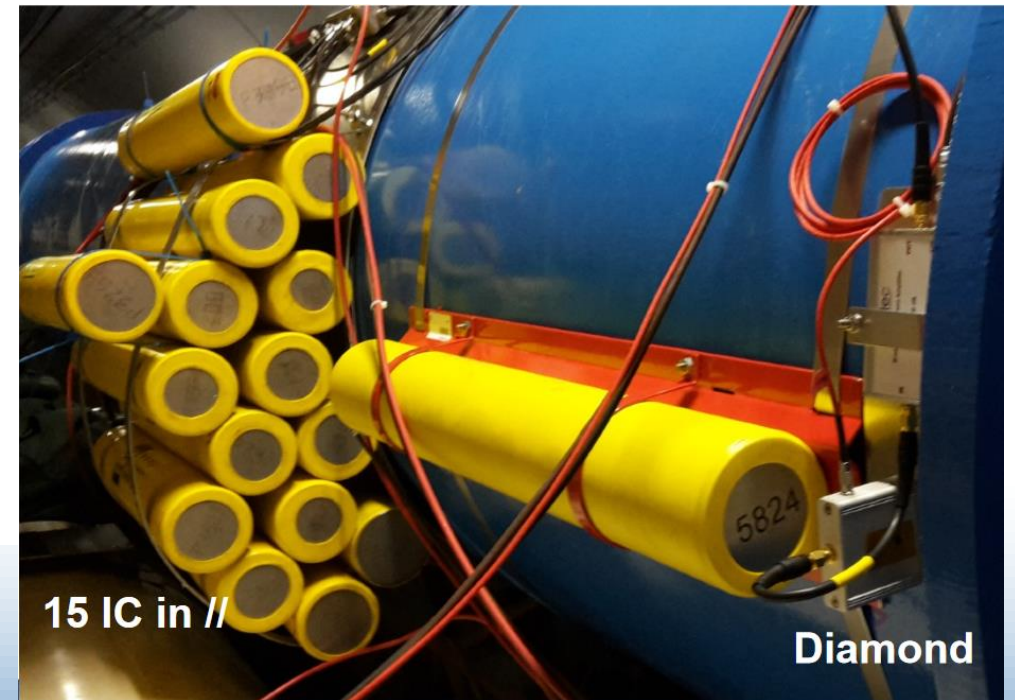
\*as of 09/10/2017

# Recap: BLMs in 16L2 after TS2

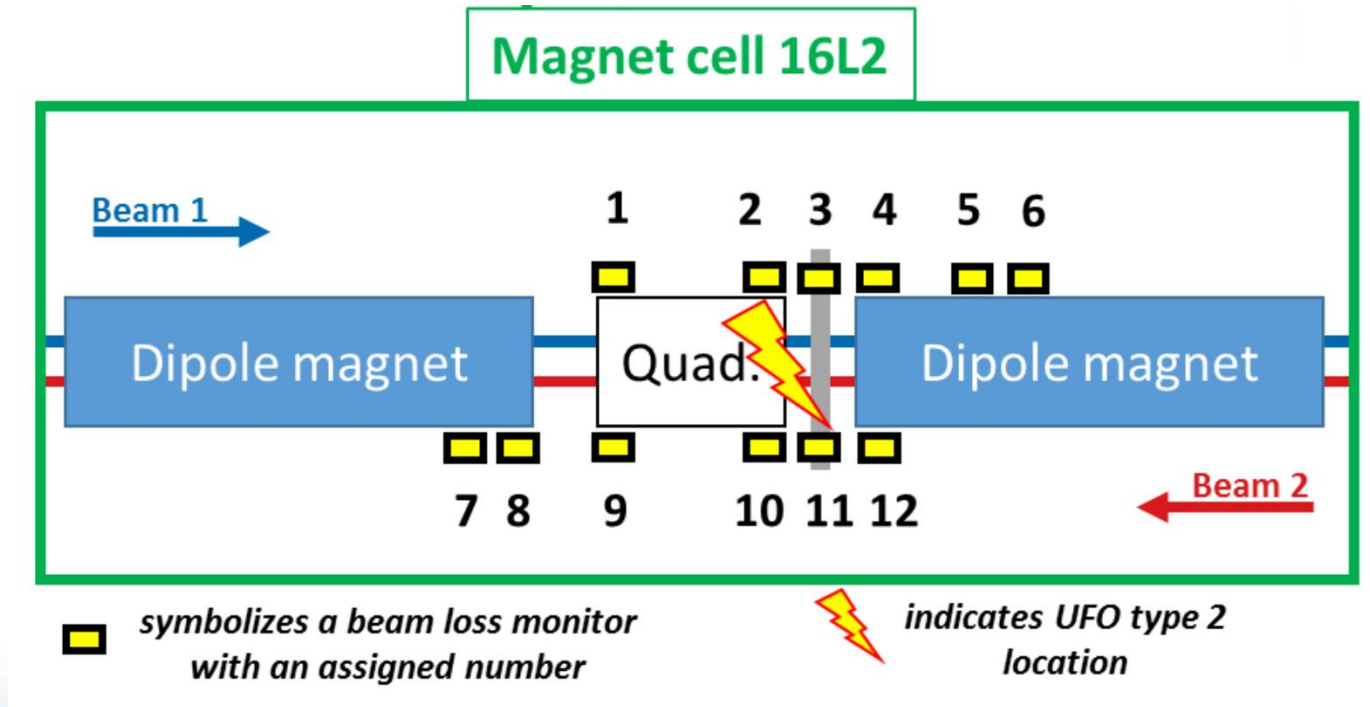
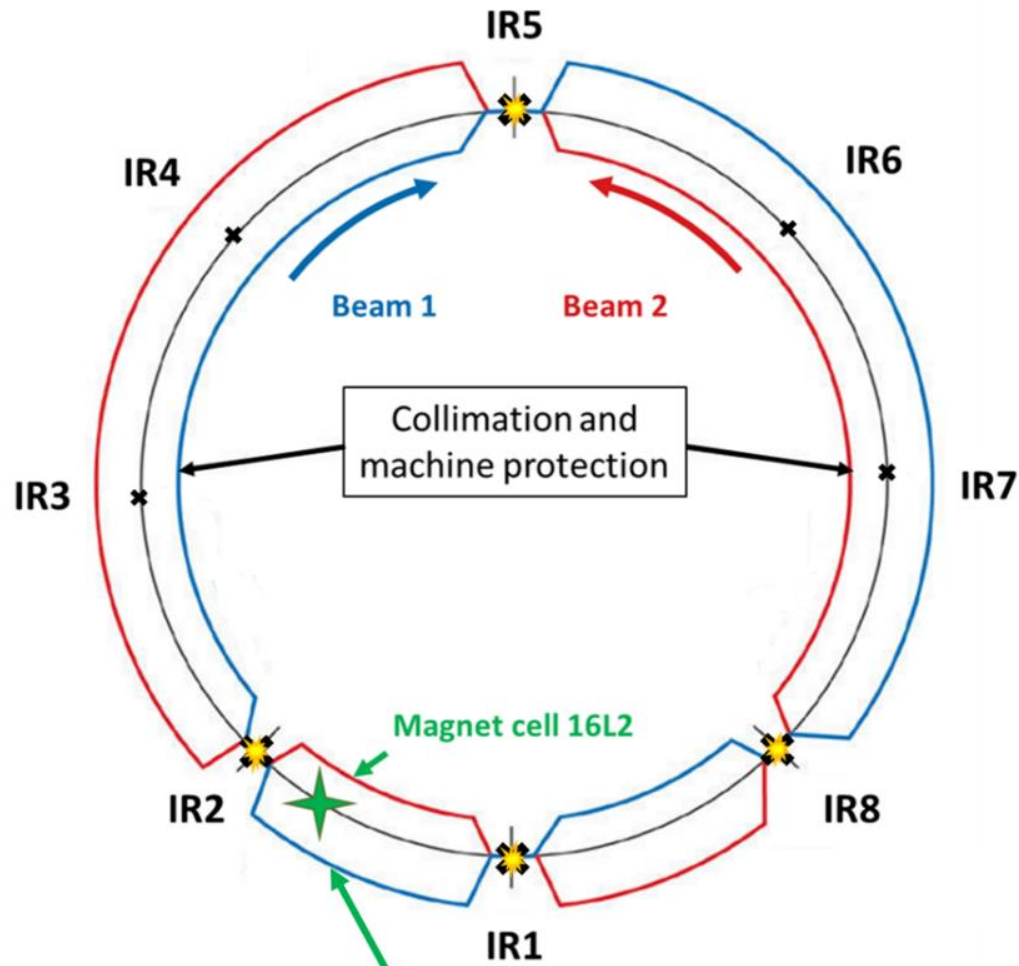
Installation after 2017TS#2



From [morning meeting](#)



# Illustration of loss location



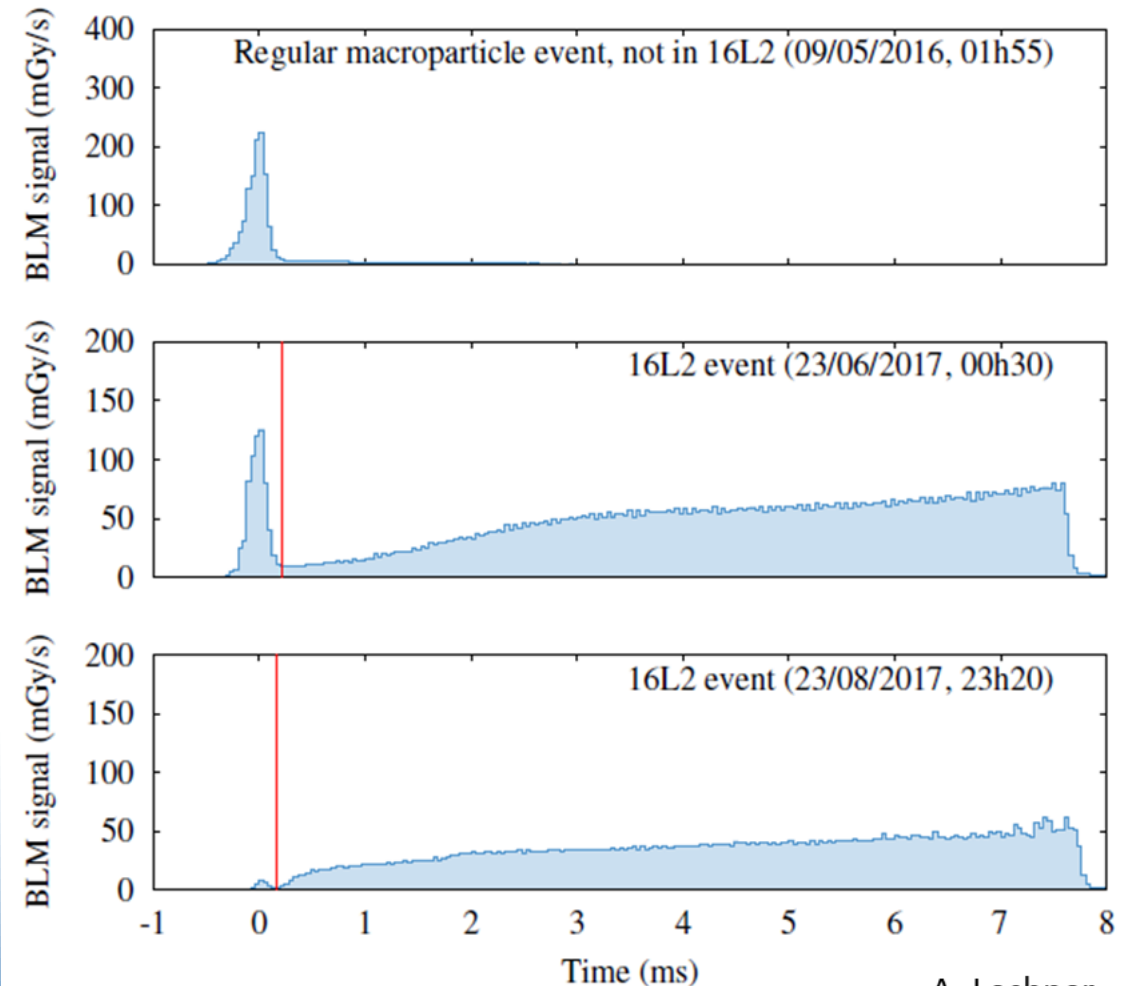
# General observations

In 16L2:

- Sometimes peak as seen in regular UFO type 1
- Sometimes no initial peak
- After  $\sim 1$  ms losses increase continuously

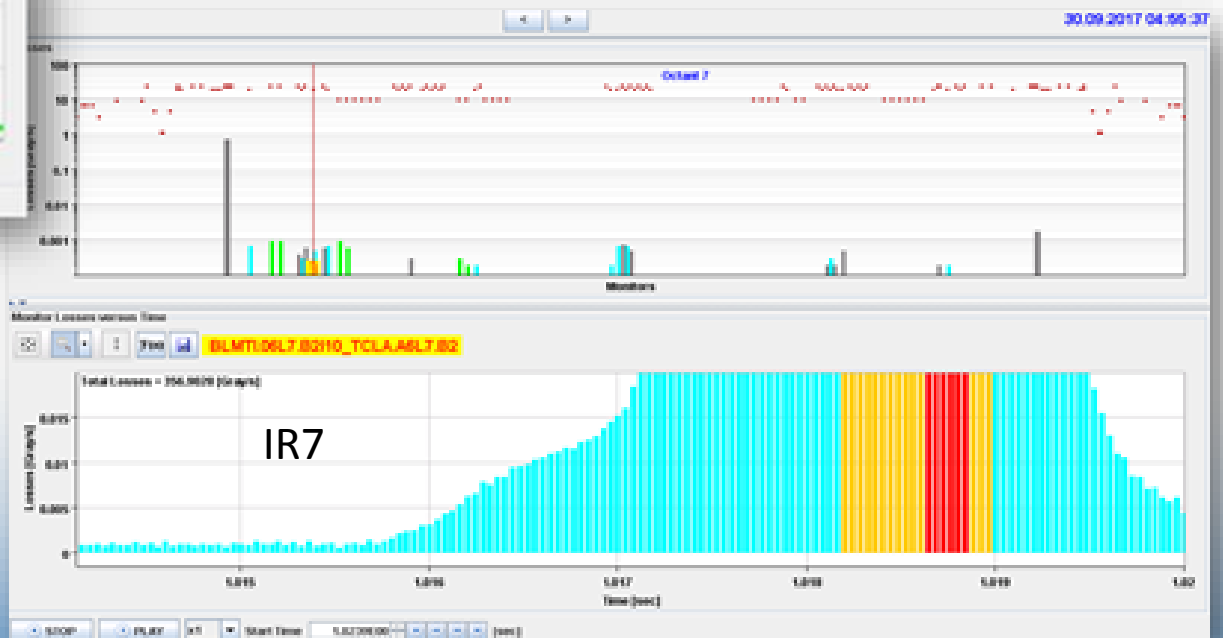
In IR7 – insertion cleaning:

- Negligible elastic losses
- Sometimes reduced losses (UFO acts as collimator!)
- Steap rising of losses due to beam instability
- Sometimes slow rinsing, oscillating losses
- IR7 triggers the dump



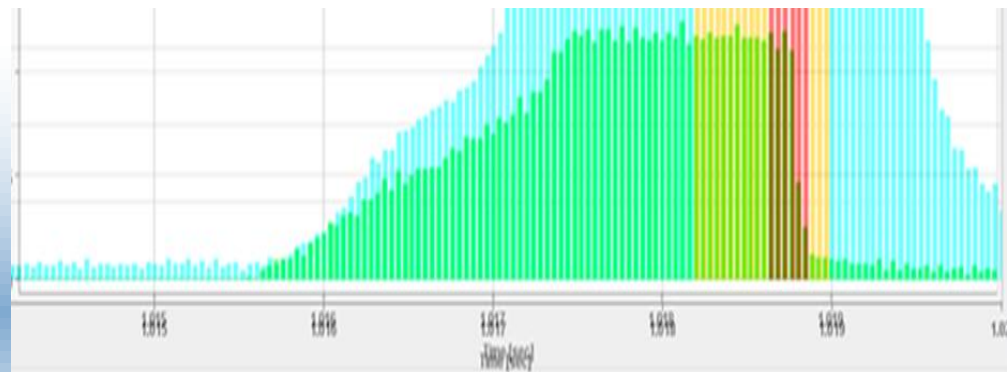
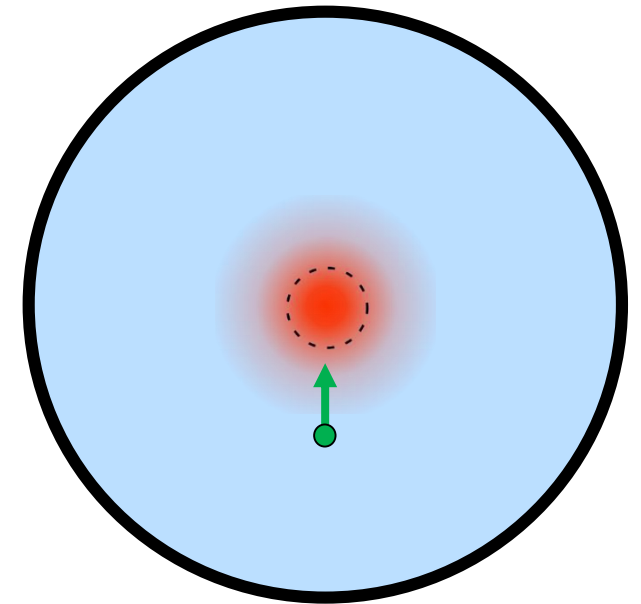
A. Lechner

# UFO Type 2 in post mortem interface



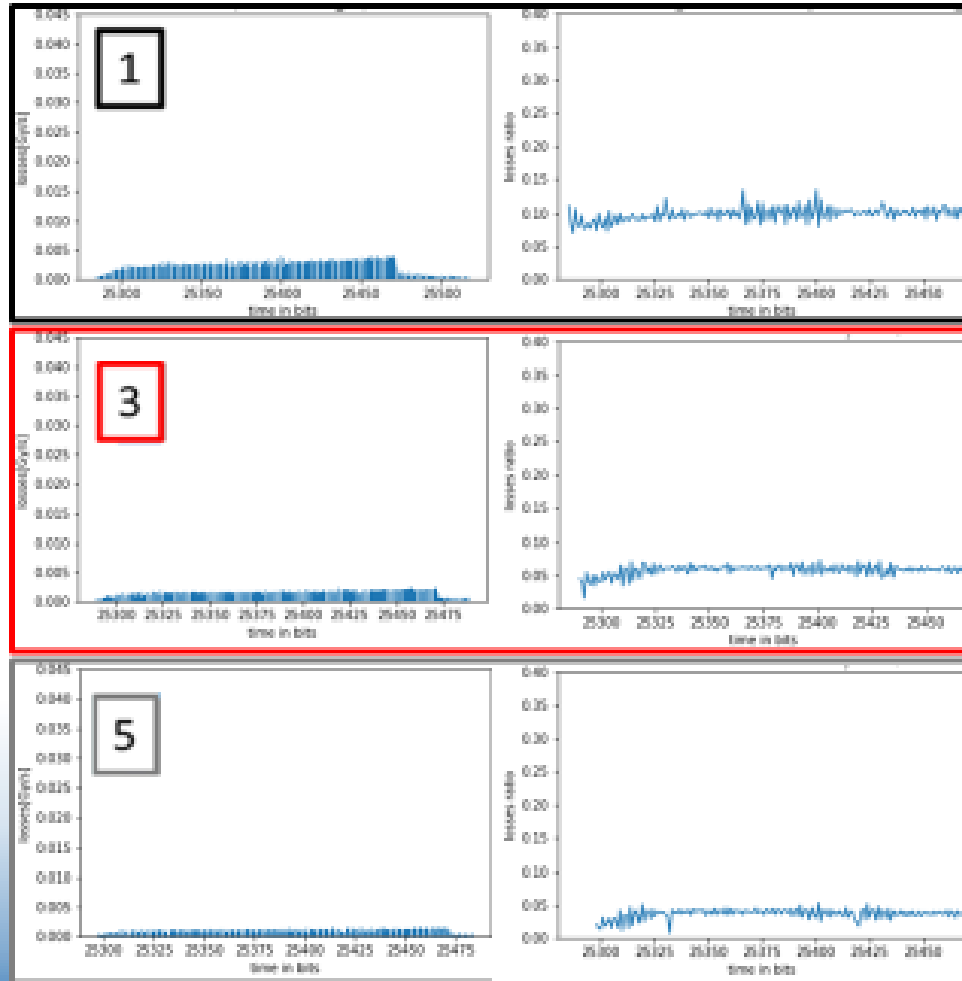
# UFO Type 2 in cell 16L2: Hypothesis

- Solid macroparticle of low melting point enters beam halo
- As in UFO type 1 it gets bombarded by protons
- It gets (at least partially) vaporized
- Part of the gas atoms remain in the beam
- Hadronic showers by inelastic scattering
- Ionization of the neutral gas atoms
- This creates a plasma → influences the beam dynamics





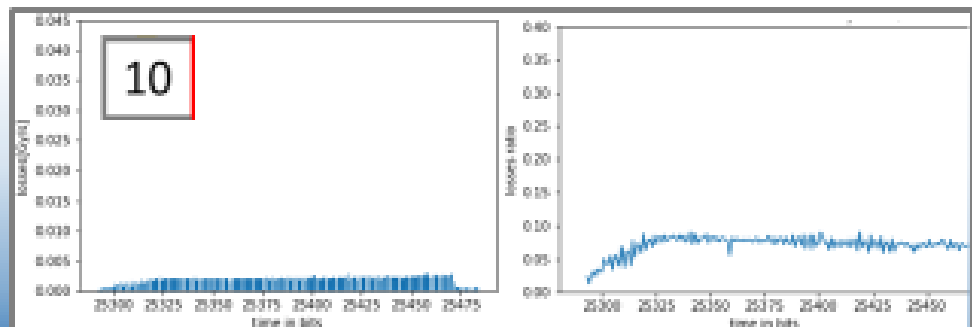
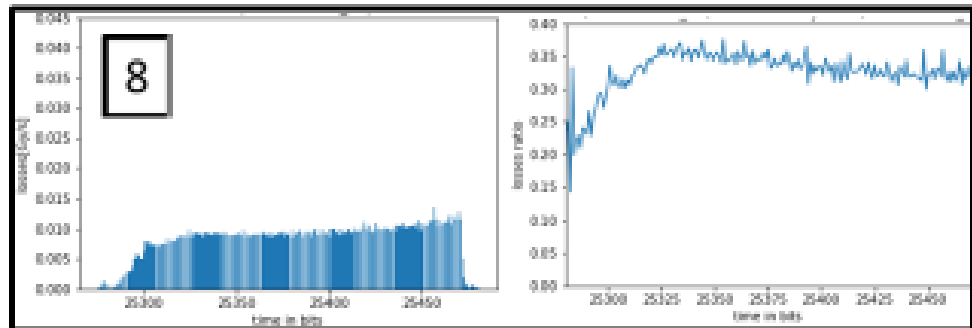
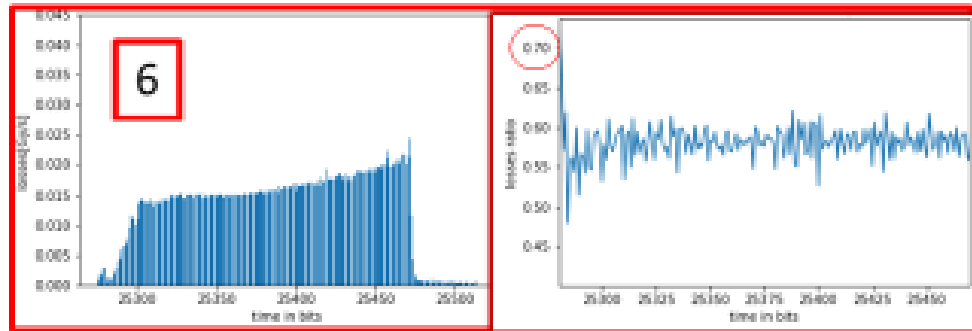
# Recap: local losses of 2 events indicate expansion



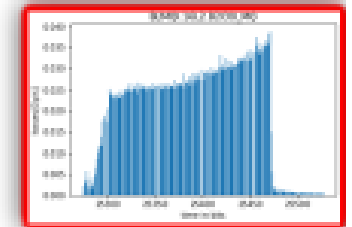
Normalized loss signatures in B1 monitors



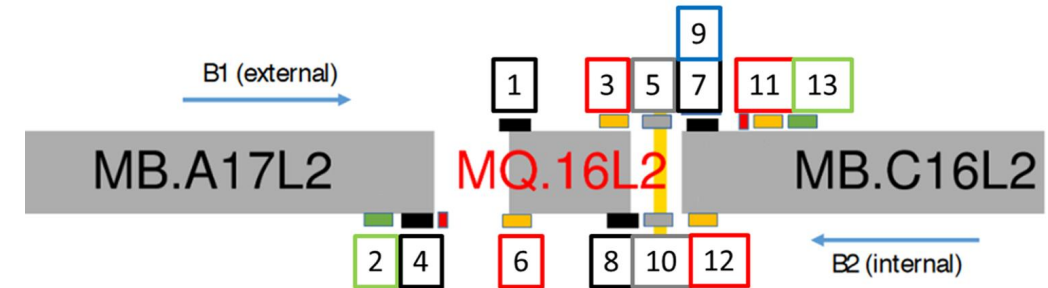
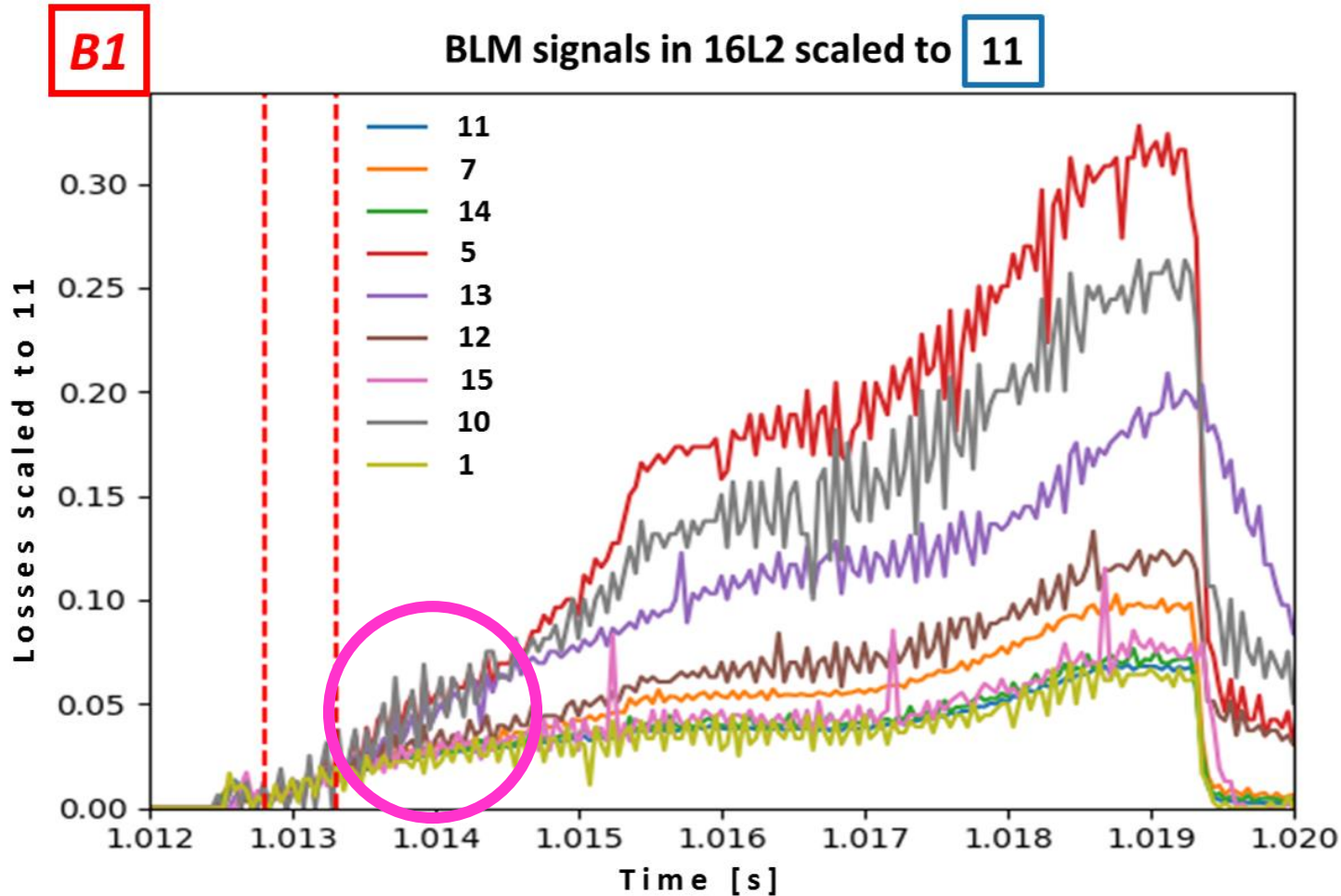
# Recap: local losses of 2 events indicate expansion



Normalized loss signatures in B2 monitors

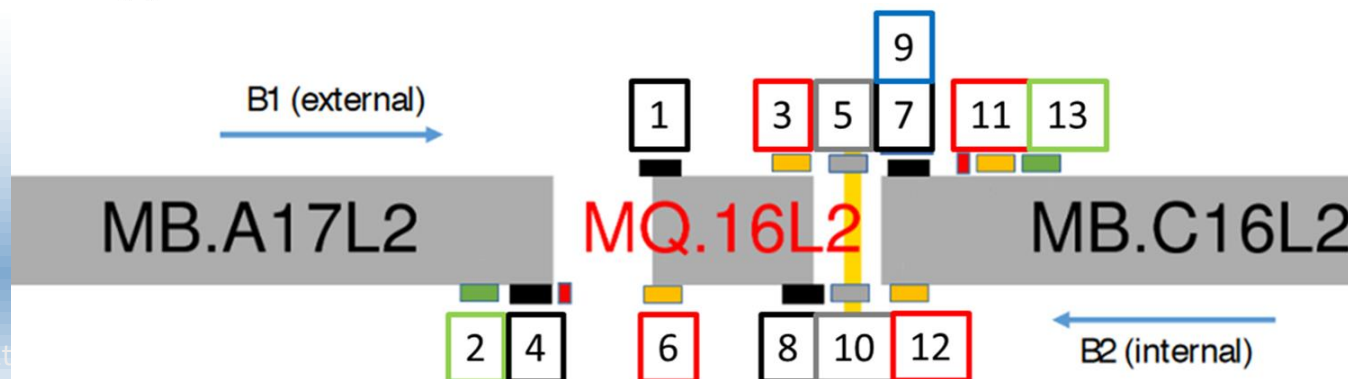
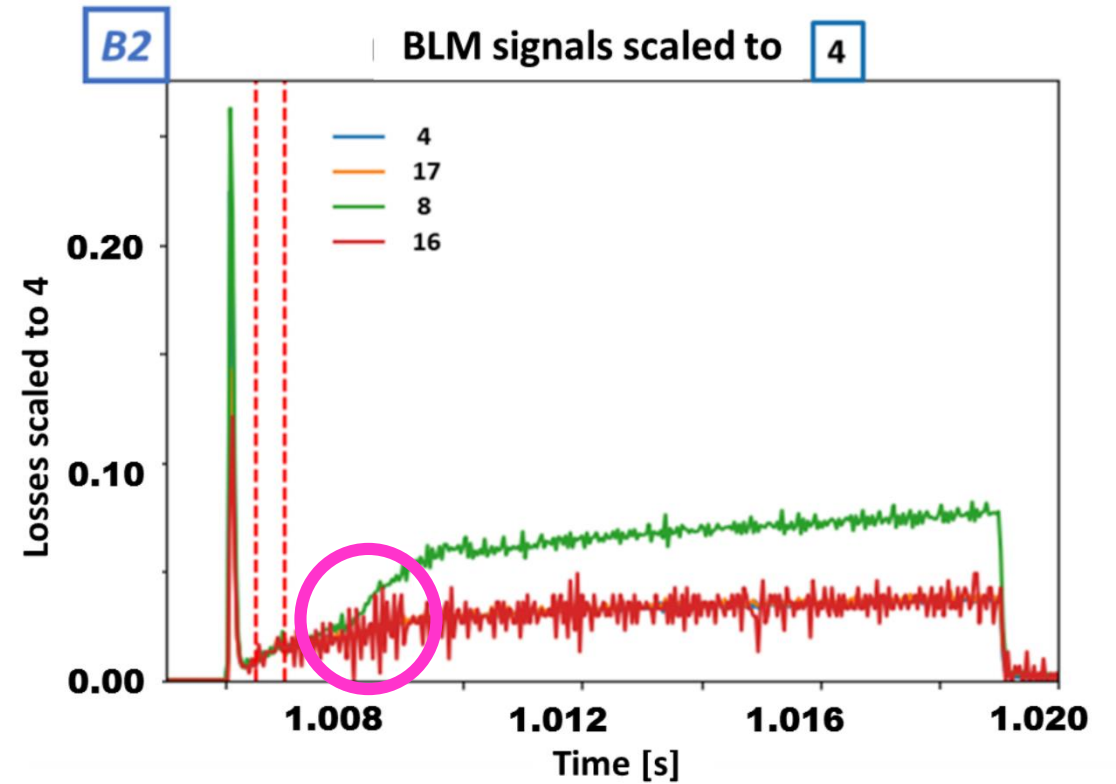
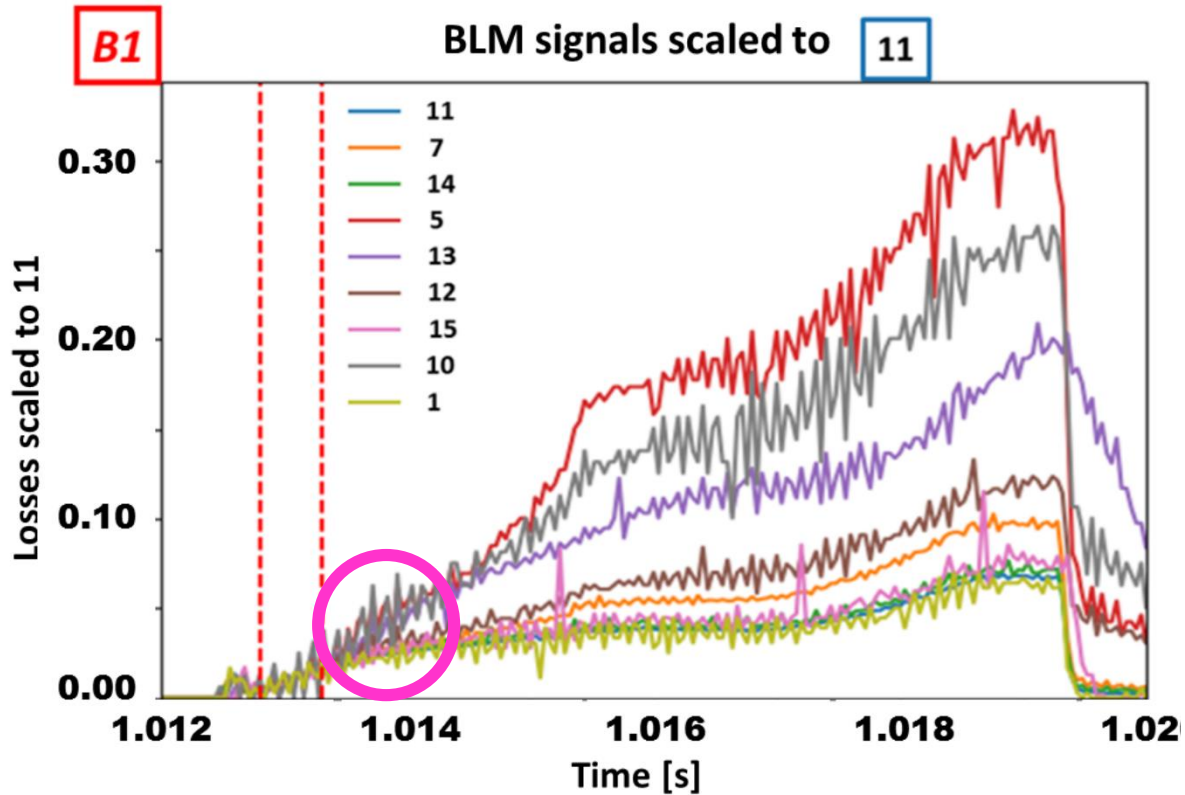


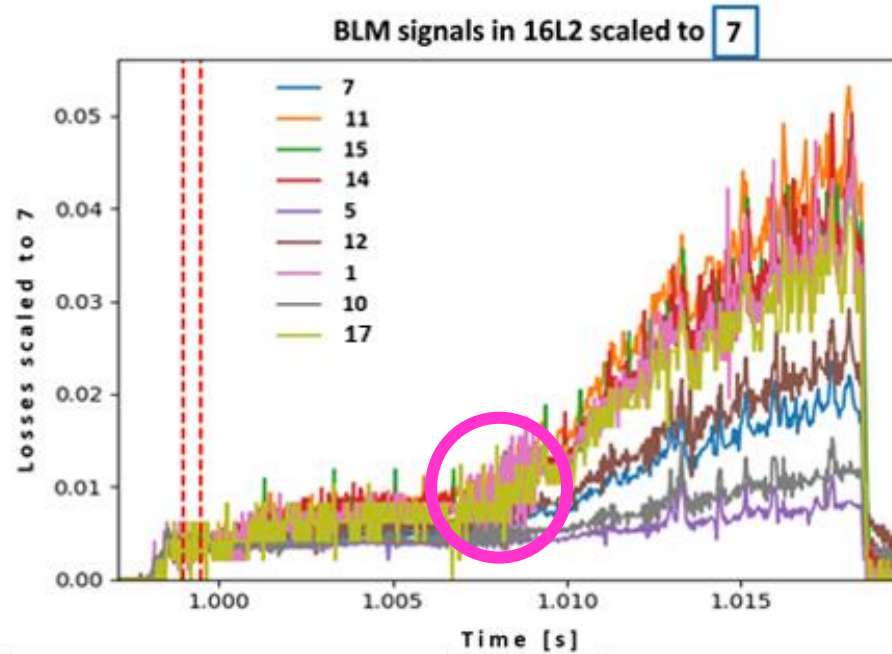
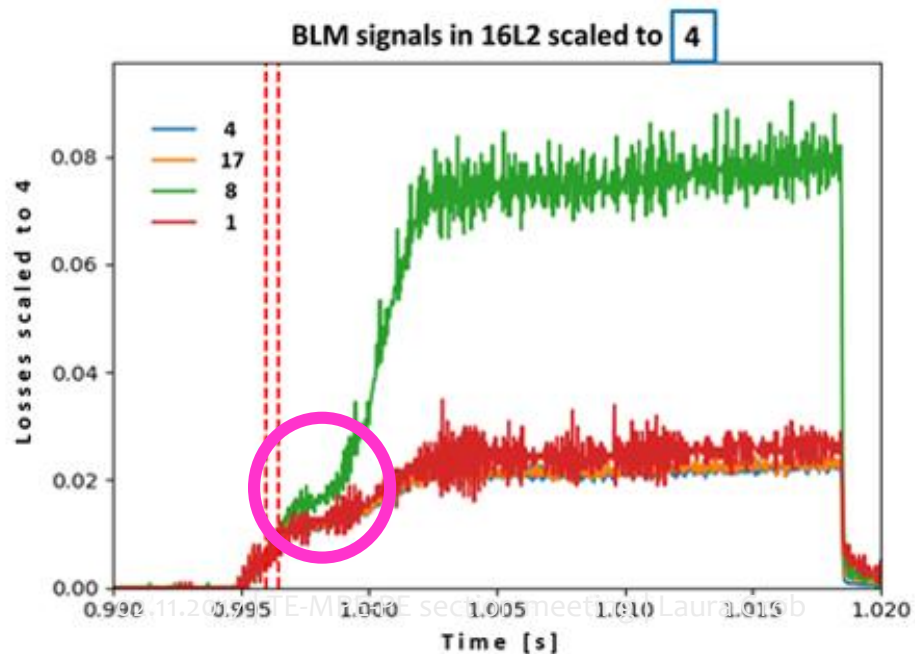
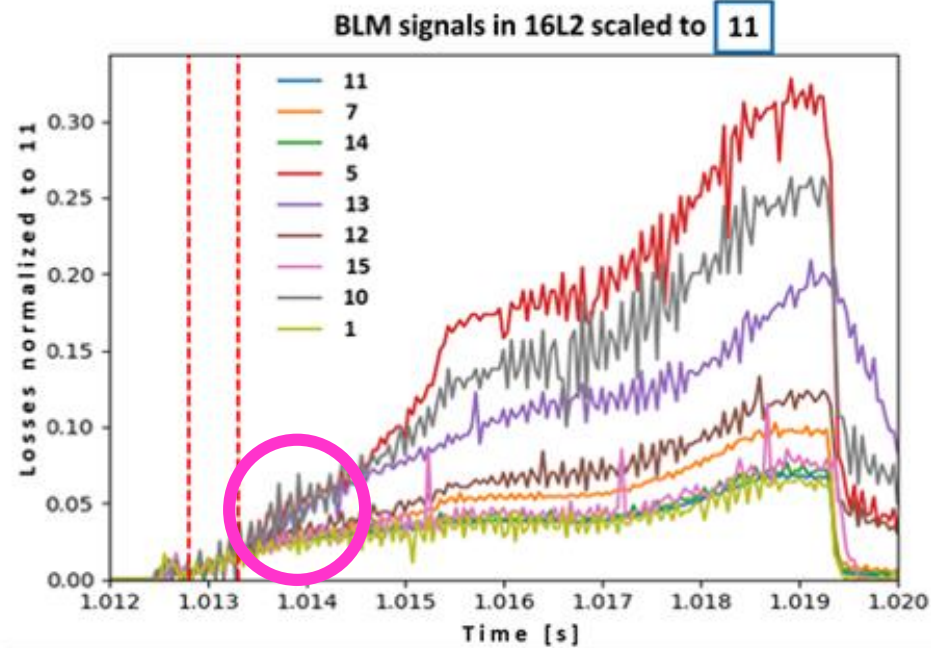
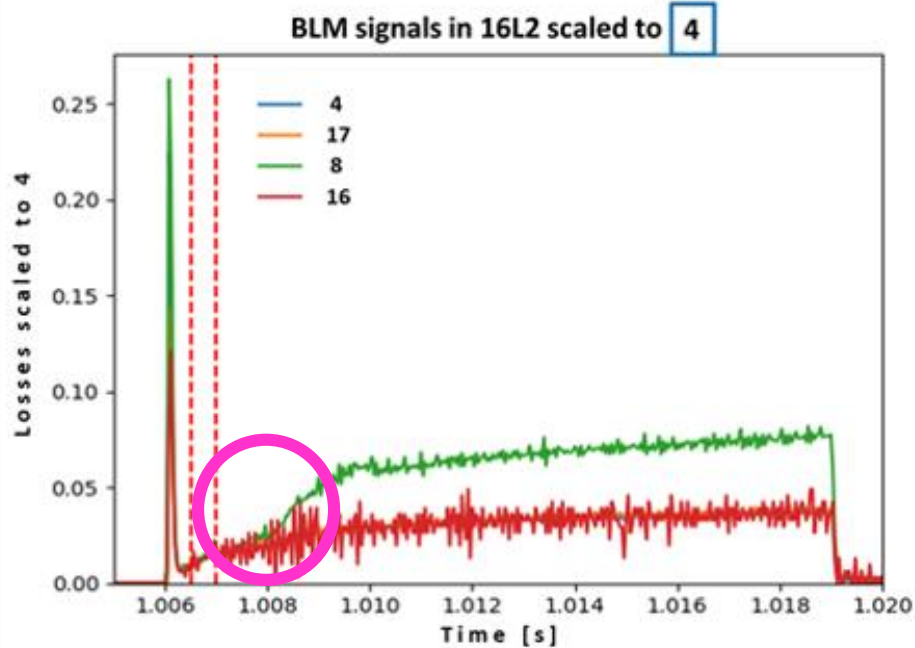
# Closer analysis of 16L2 dumps in 2017



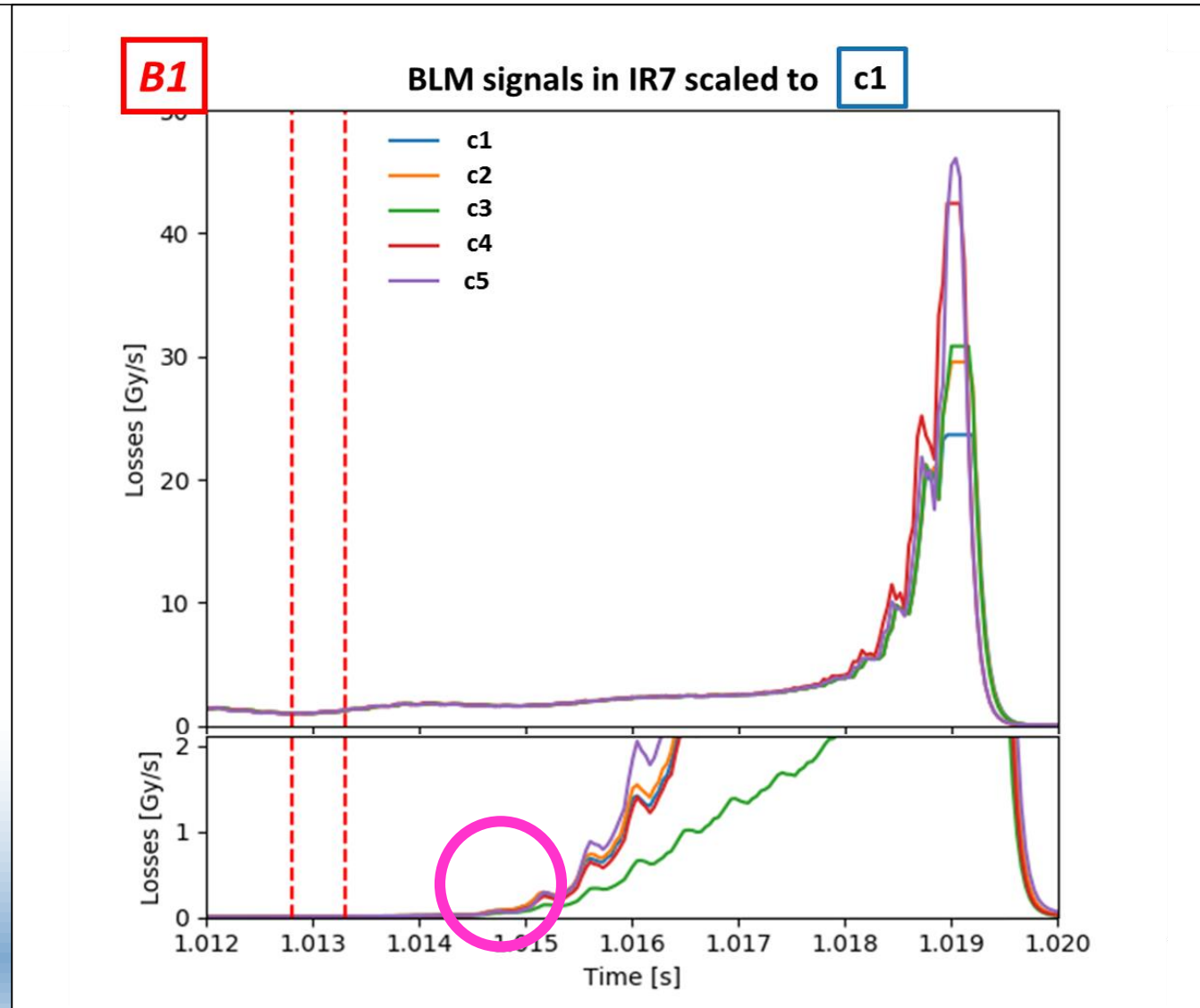
Divergence at  $\approx 1.0135$  s

# 16 L2 signatures: B1 and B2 comparison



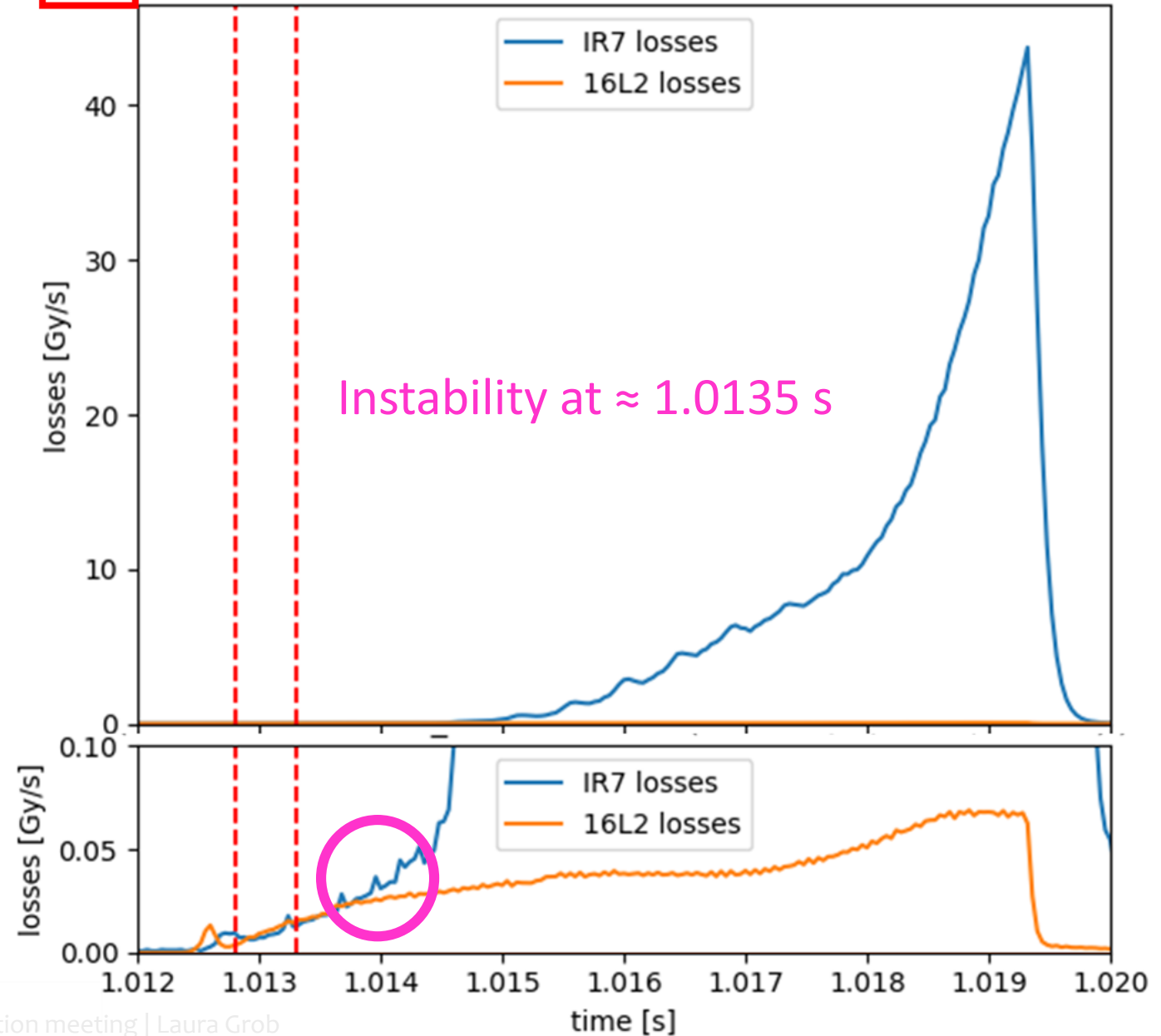


# IR7 losses at collimators



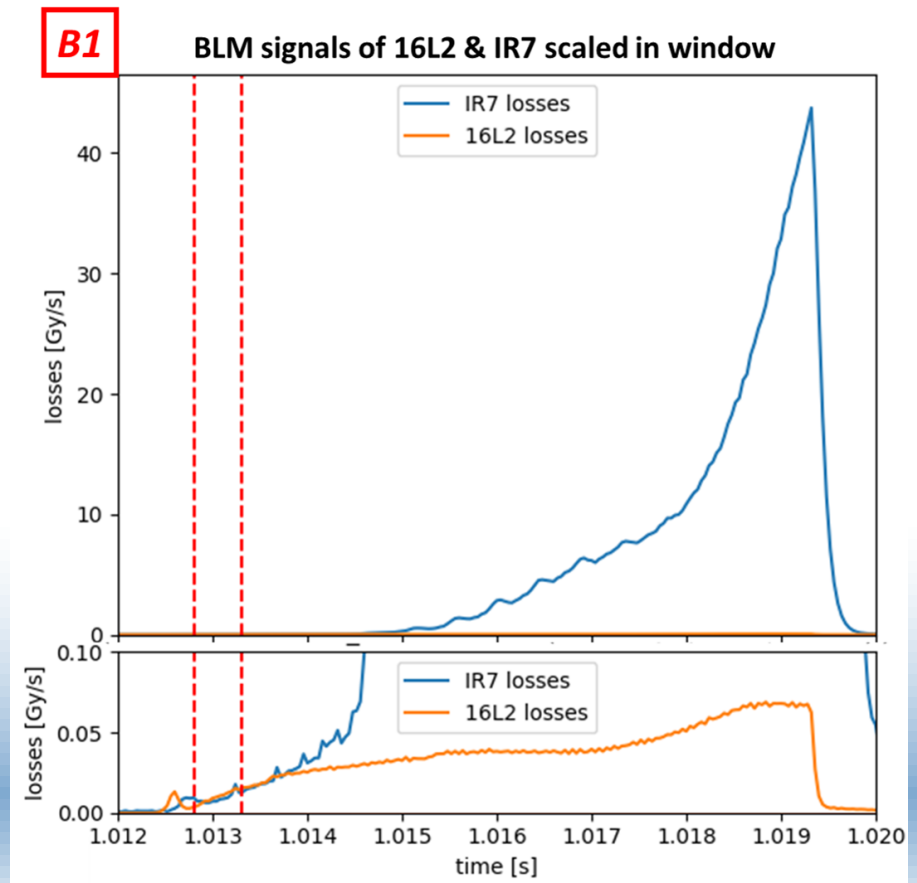
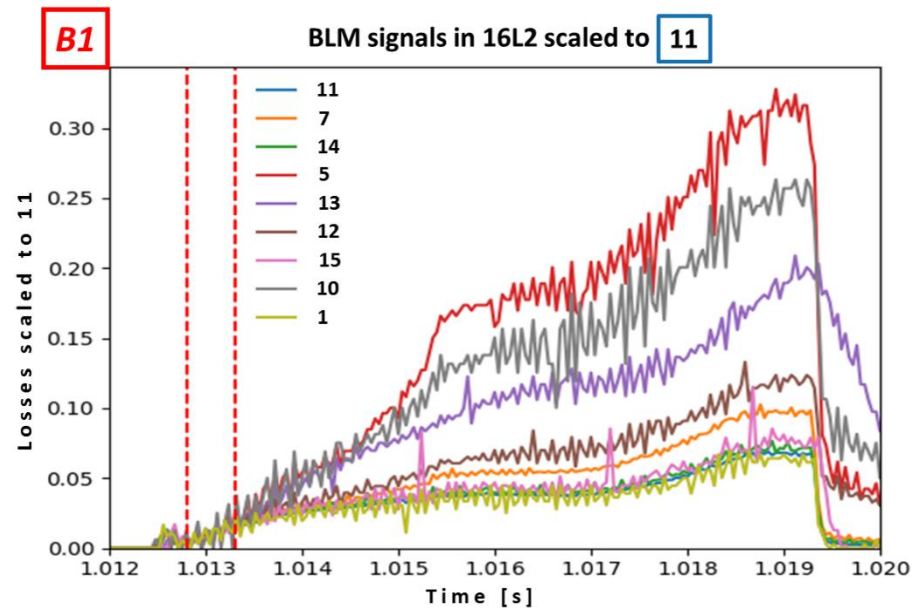
**B1**

### BLM signals of 16L2 & IR7 scaled in window



# Interpretation of observed behavior

- Neighboring BLMs show losses
- Losses increase with time wrt BLM with highest signal
- This could indicate longitudinal expansion of source
- Can be explained by evaporation
- This supports theory of UFO type 2

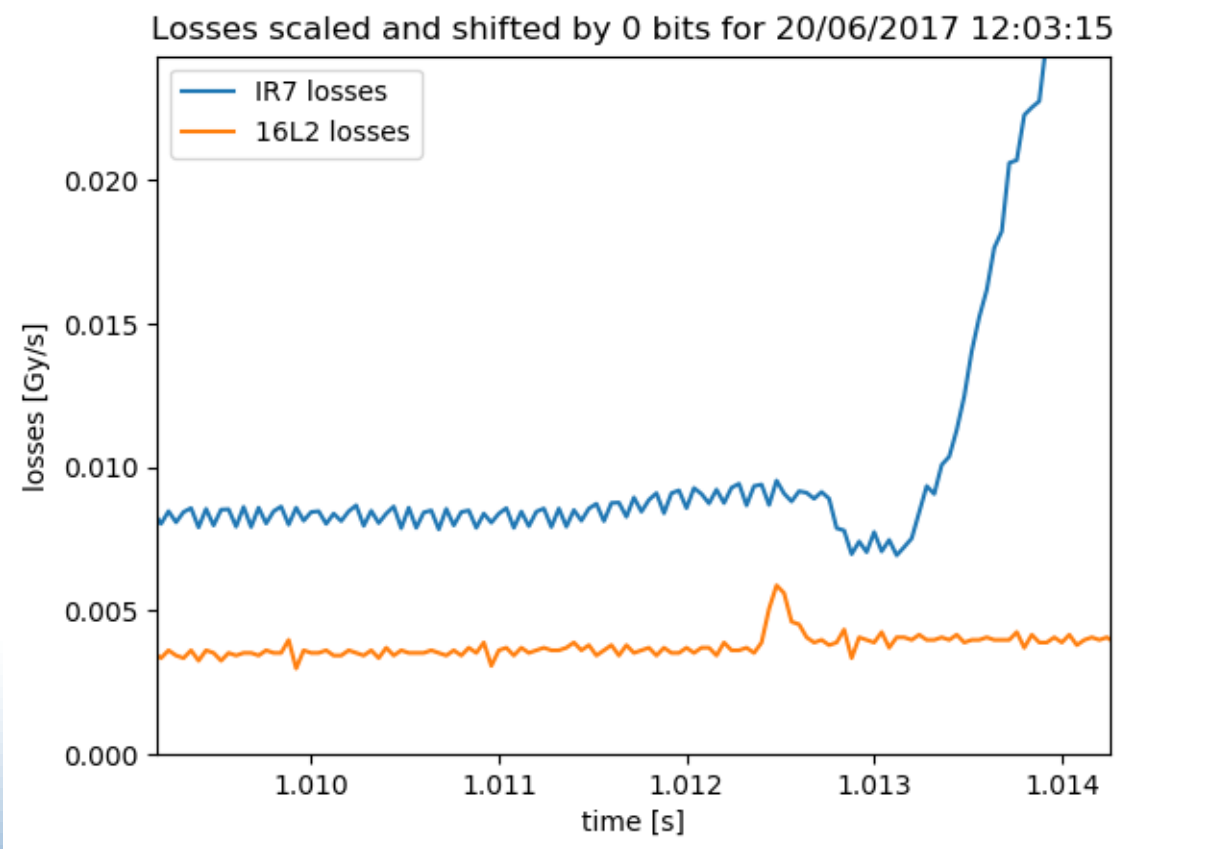


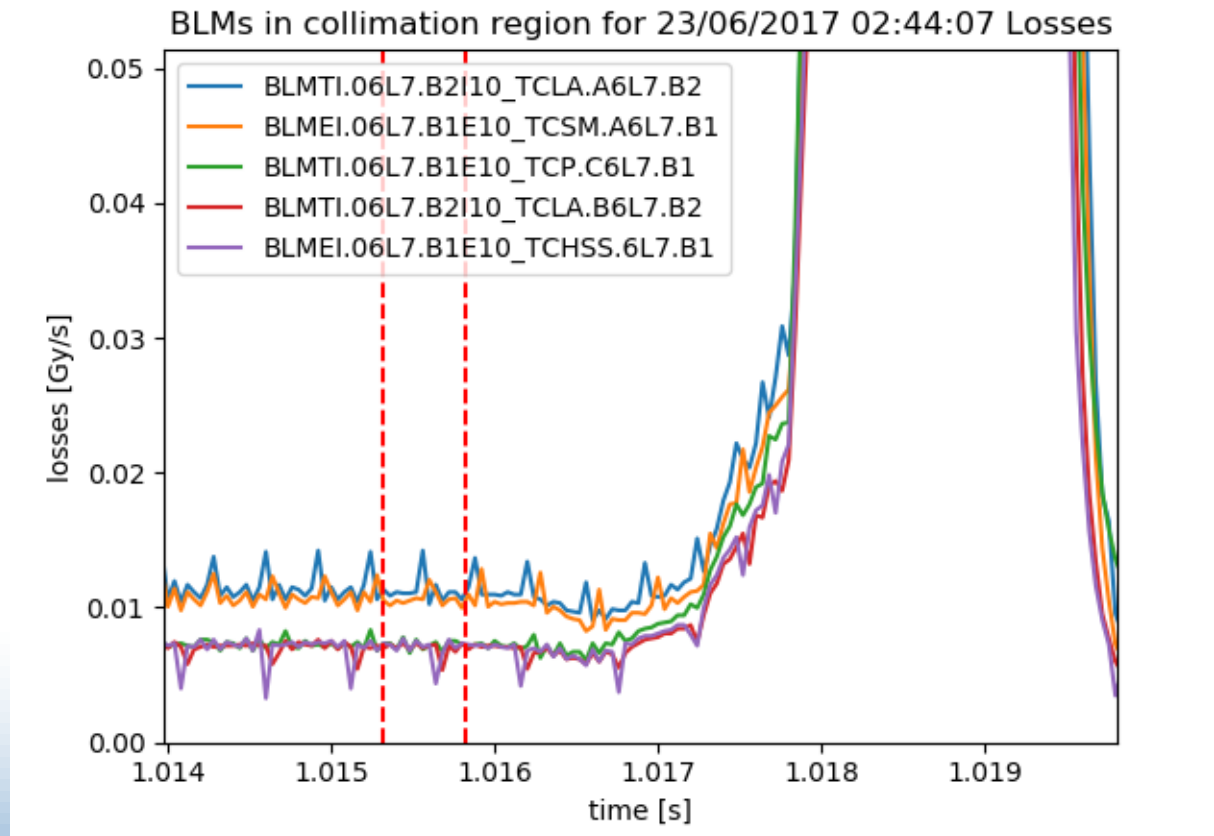


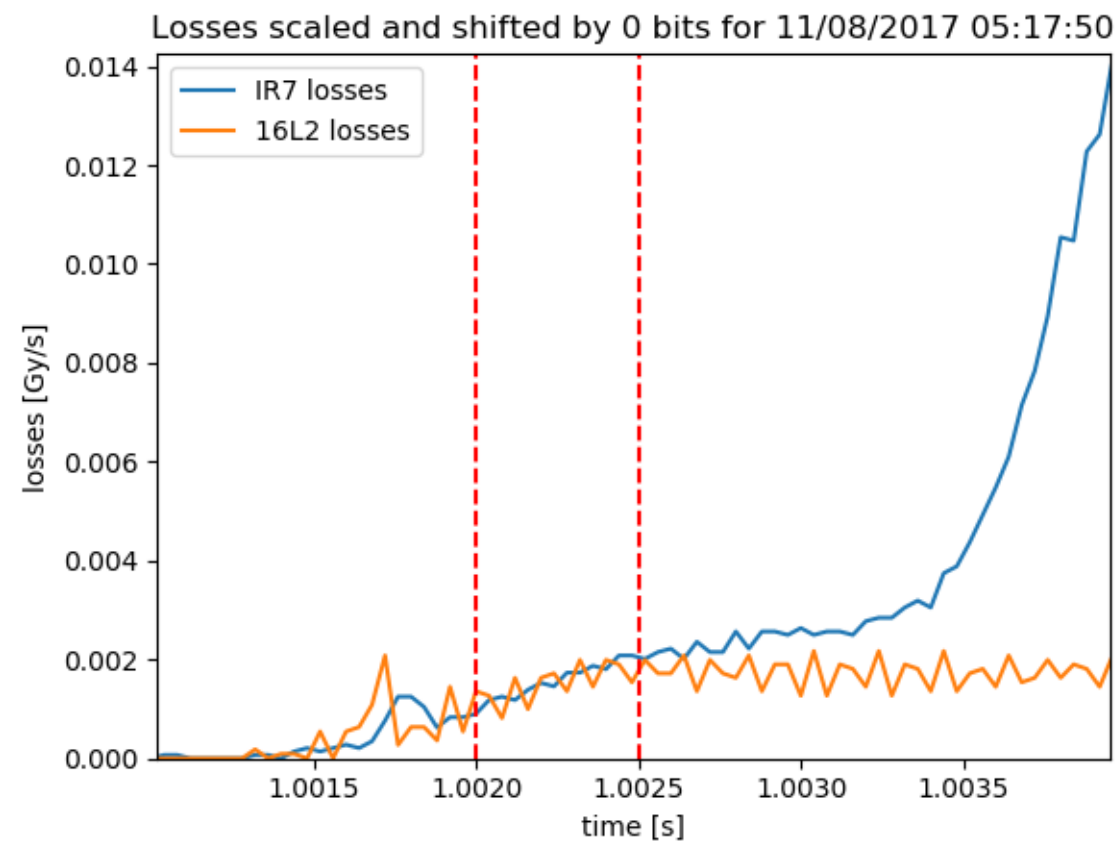
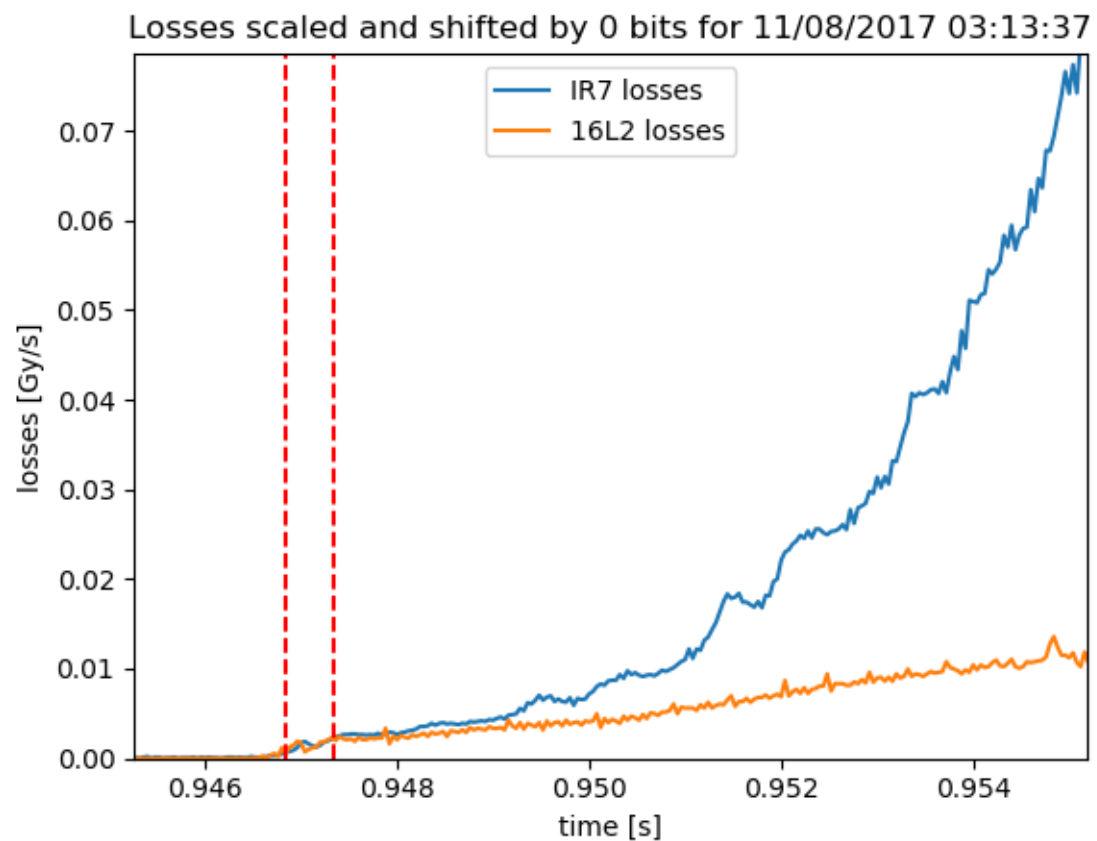
**THANK YOU FOR YOUR ATTENTION!**



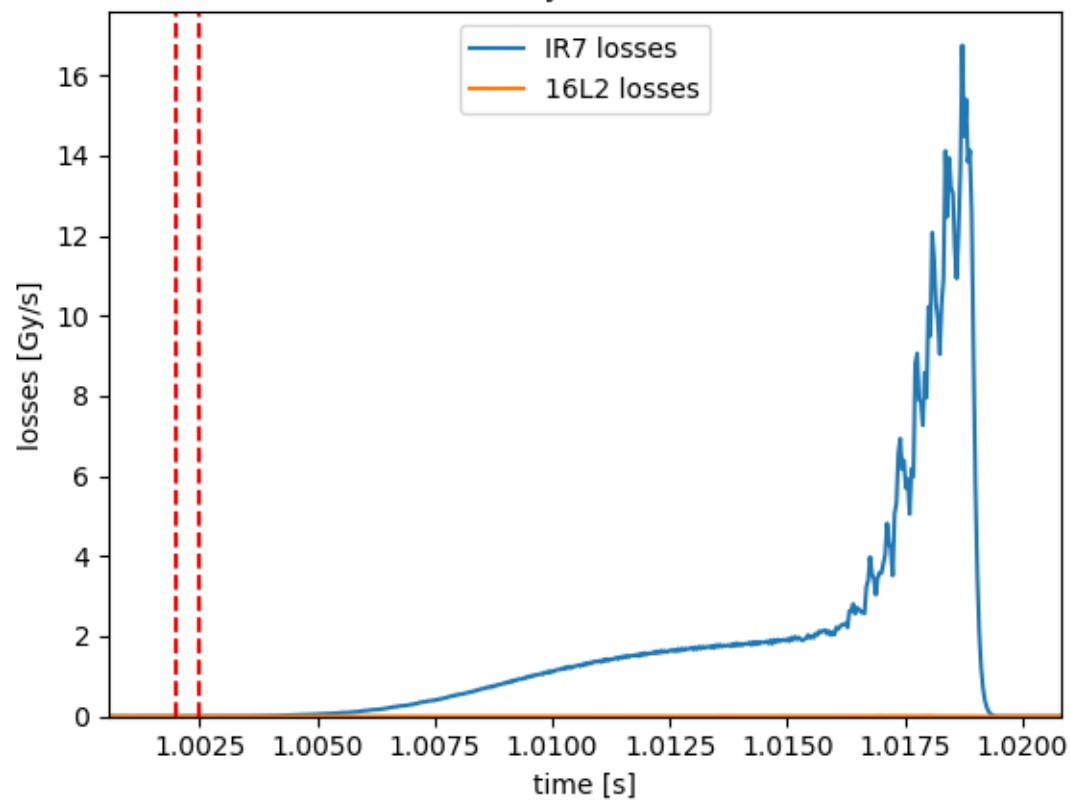




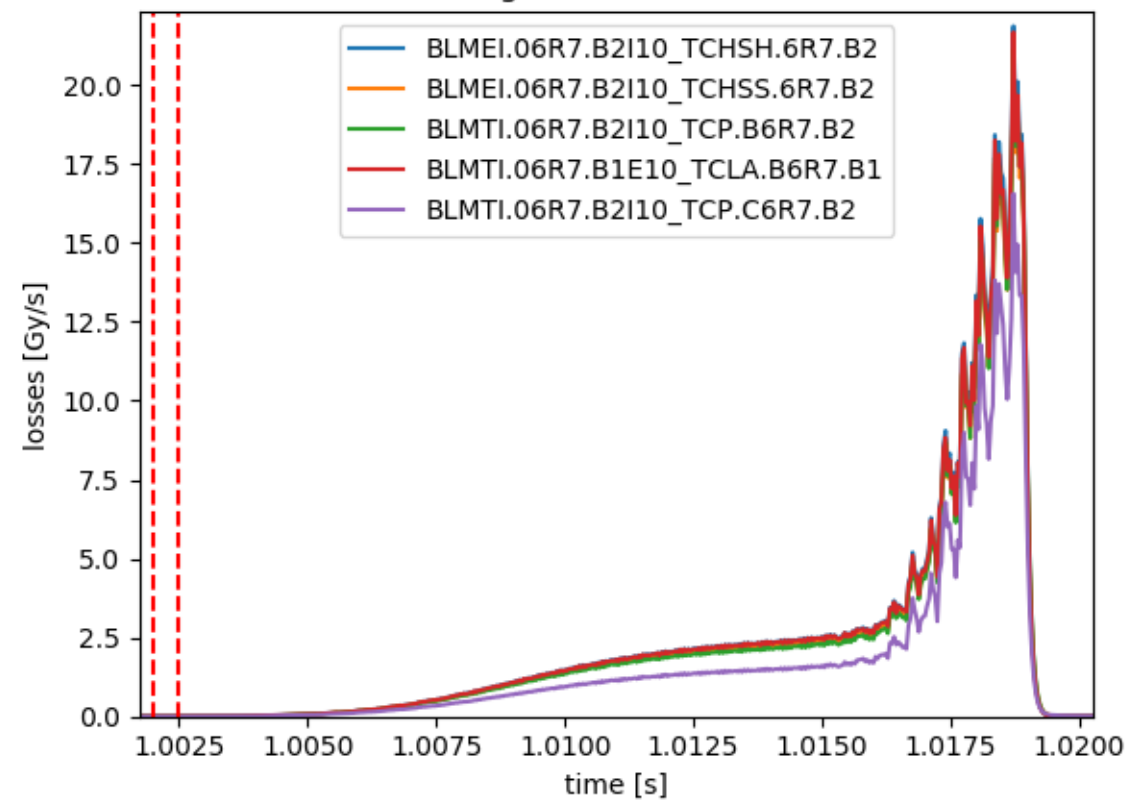




Losses scaled and shifted by 0 bits for 11/08/2017 05:17:50



BLMs in collimation region for 11/08/2017 05:17:50 Losses



# Longitudinal expansion I

Analysis of 16L2 beam loss signatures showed unexpected behavior.

Considering a point source, the losses in the different BLMS should be proportional with a fixed scaling factor.

The 2 events previously shown in the section meeting (ref) showed a dis-proportional increase of losses seen by BLMs close to the UFO location, whereas BLMs further away don't see this.

This led to the believe that the scattering source expands longitudinally and creates losses closer to the respective BLMs.

Here I should show the previous slide

# Longitudinal expansion I

Since the topic received much attention a bigger post-mortem analysis of the 68 16L2-beam dumps was performed, employing an improved version of Martynas UFO-Buster Analysis Tool.

Comparative plots with scaled losses revealed the same observations but moreover showed the onset of the beam instability in the collimator BLMs as well as the local UFO signature.

One can see that the change of slope in 16L2 coincides with the first oscillations leading to the instability.

Although the oscillations seem to vary a lot in the different events. Some do not have this „pre-lude“ at all

Here I should show the plots from the IPAC paper.

Intelligent ordering to show above mentioned behavior

More cases!



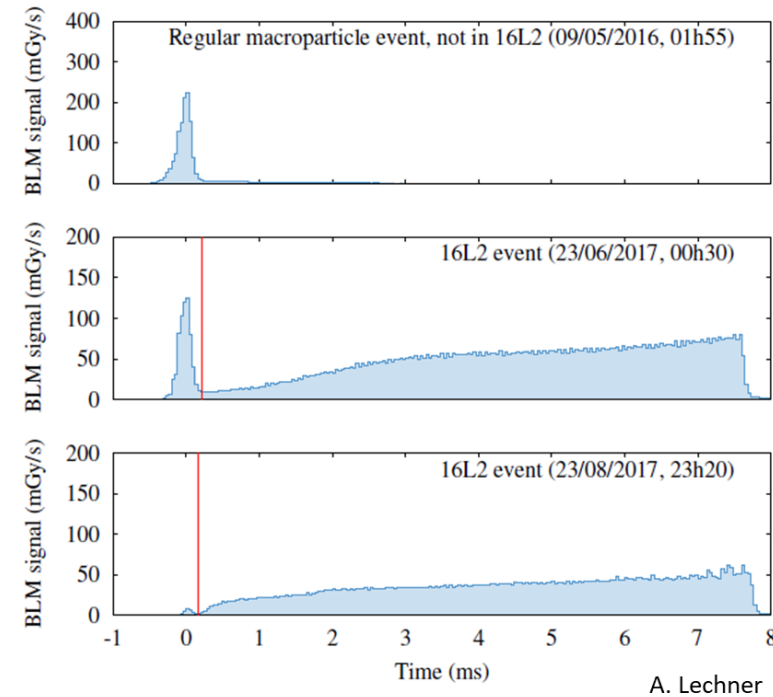
# General observations

In 16L2:

- Sometimes peak as seen in regular UFO type 1
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In IR7 – insertion cleaning:

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- Sometimes reduced losses (UFO acts as collimator!)
- Steep rising of losses due to beam instability
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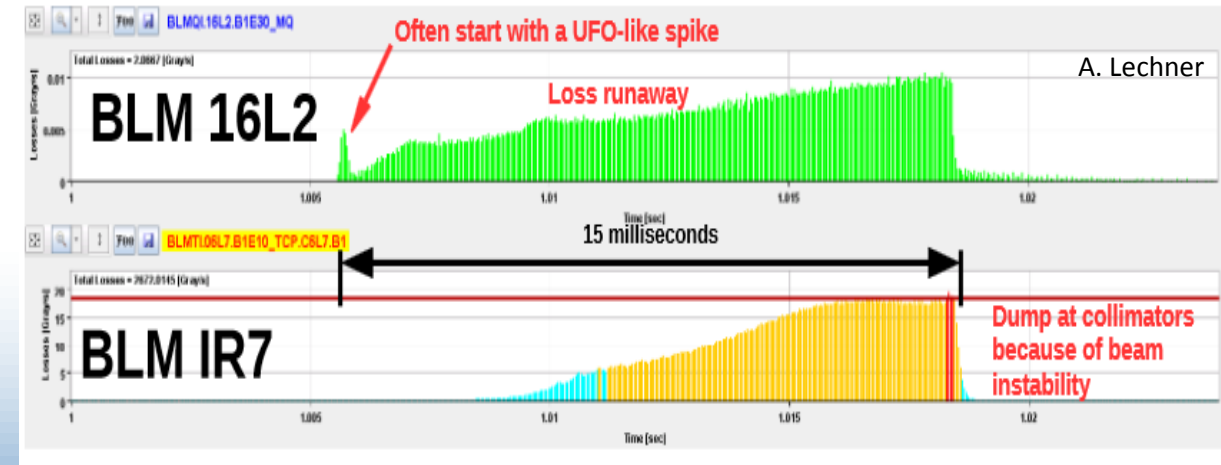
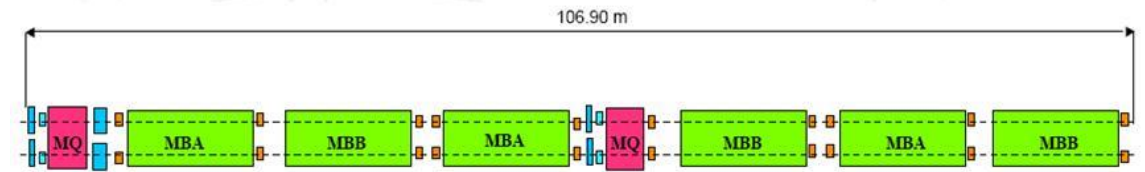




# What is „16L2“

After sector 12 intervention in EYETS 16/17:  
Multiple problems observed in one FoDo cell:

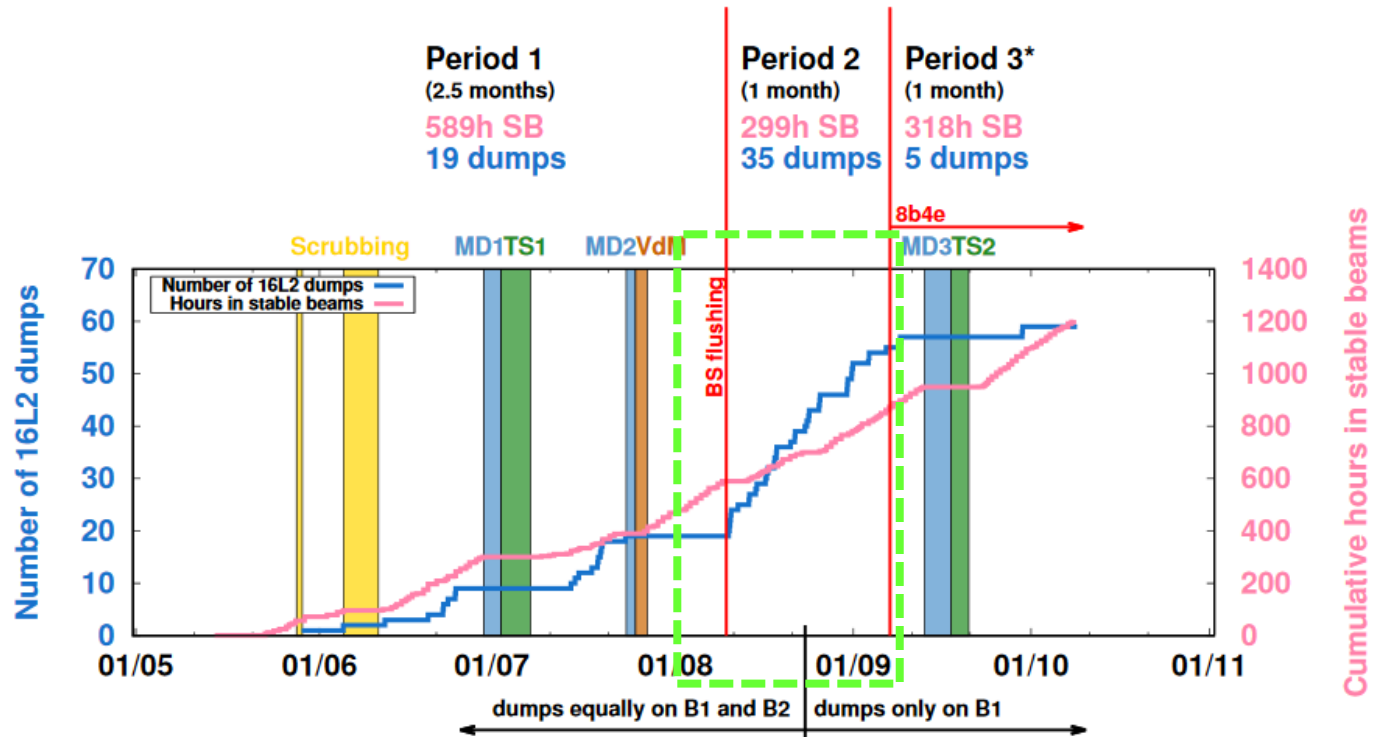
- Higher steady state losses in cell 16L2
- Repeated fast losses:
  - Local collisions in 16L2 causing inelastic/elastic losses
  - Fast rising instability causing losses in IR7 which dump
- More than 60 dumps only from 16L2 events!
- Mechanism still unclear



# Evolution of 16L2 events

## Dumps and quenches related to losses in 16L2

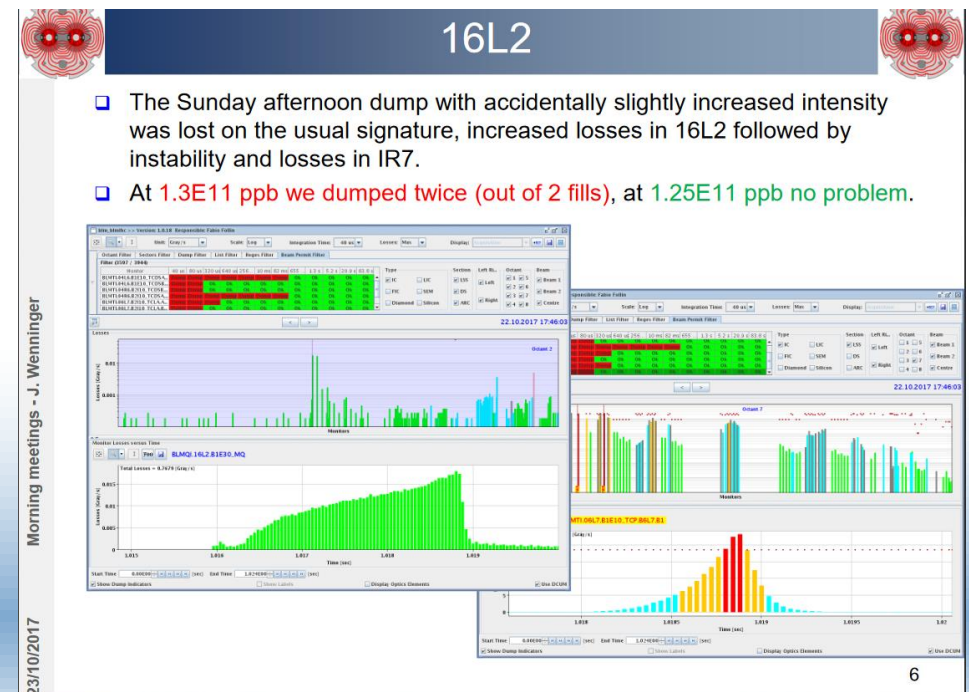
**59 dumps** ( $39 \times B1$ ,  $20 \times B2$ ), including 1 quench on the 12/08:



\*as of 09/10/2017

# Different steps to reduce 16L2 impact

- Warm up of beam screen supposed to remove condensed gas:
  - Steady state losses reduced, but significant increase of 16L2 dumps
- Optimization of magnetic field
  - Small change of field in corrector magnet
- Installation of solenoid and additional BLMs
- Change of bunch pattern
- Bunch intensity is critical parameter!



# Bunch-by-bunch losses

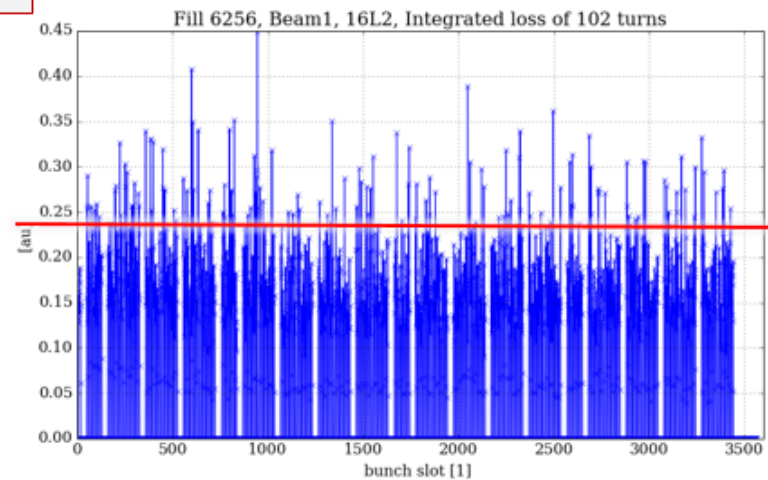
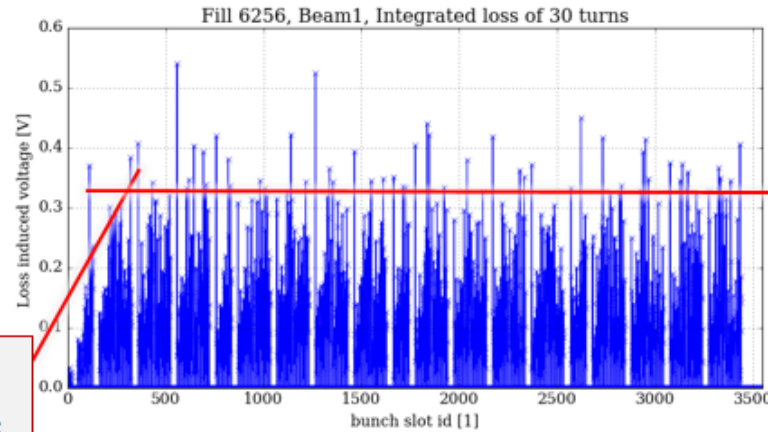
## Integrated losses

Fill 6256, 30/90  
6.5 TeV,  
8b4e scheme

dBLMs @ TCP

Rising slope after AG +  
some 30b LHC INJ gaps

dBLMs @ 16L2



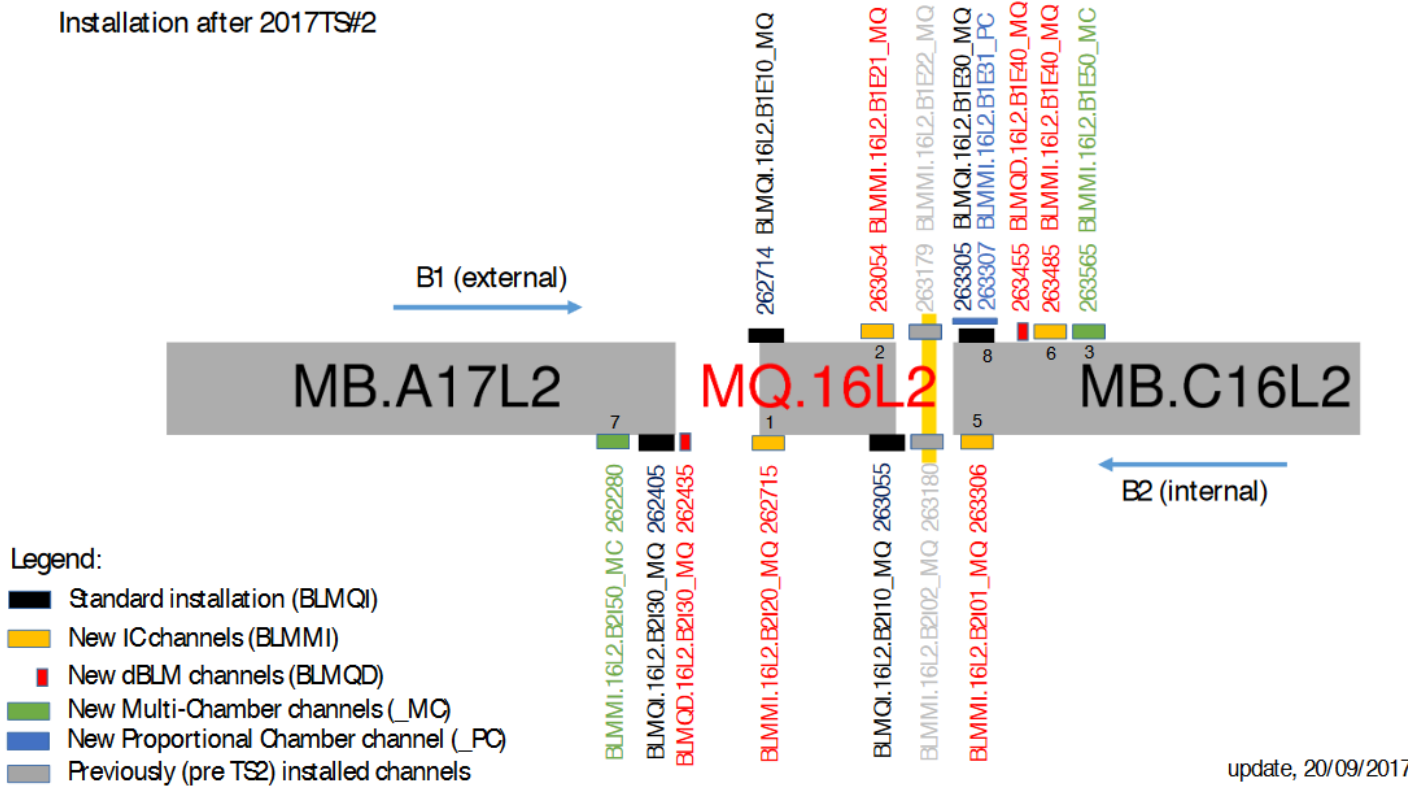
# Analysing the losses in 16L2

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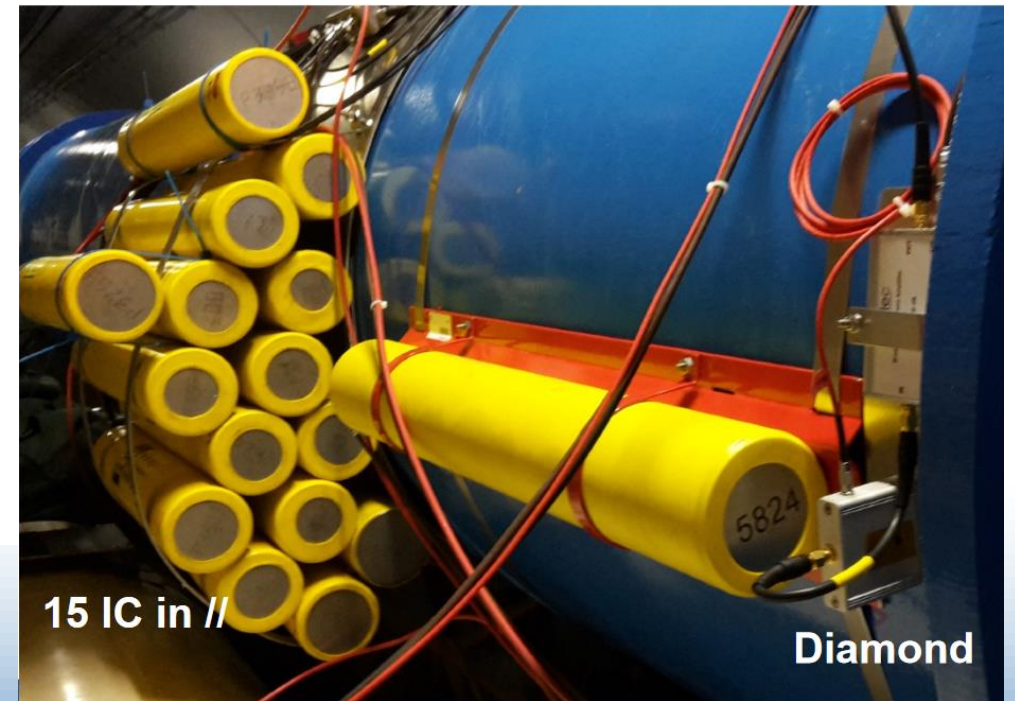


# BLMs in 16L2 after TS2

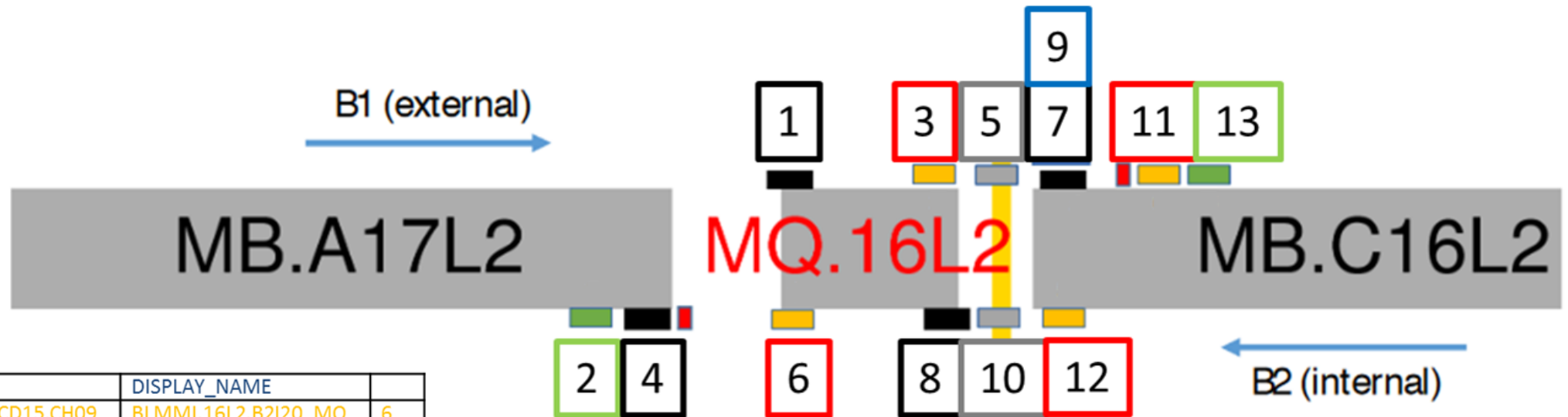
Installation after 2017TS#2



From [morning meeting](#)



# Simplified BLM layout

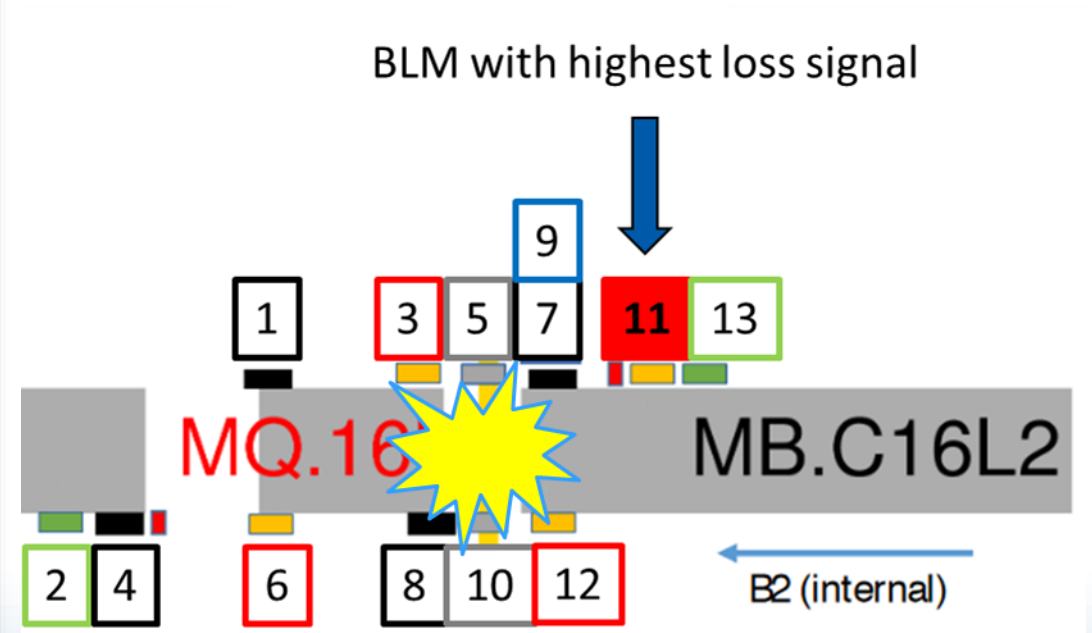
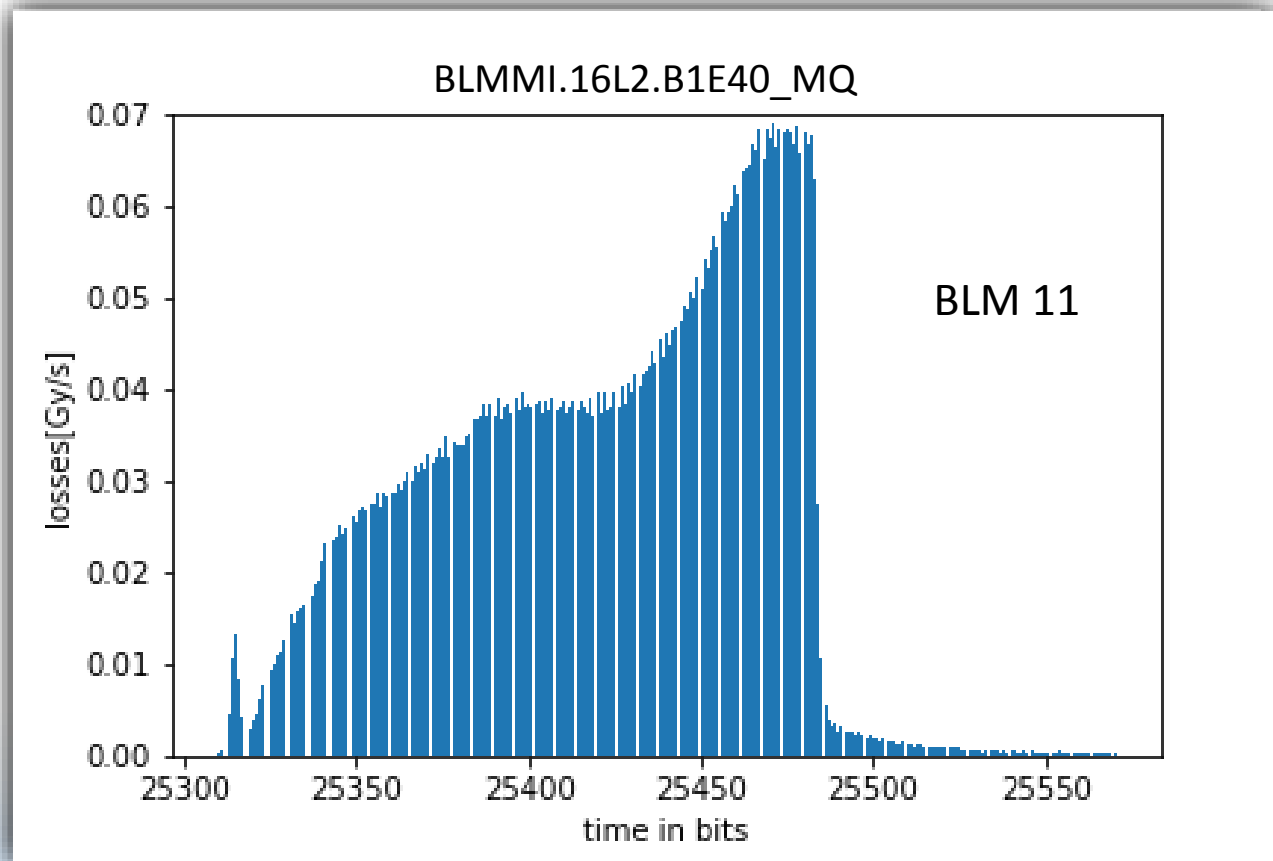


BLM_MOBILE_NAME	DISPLAY_NAME	
BLMM.HC.BLM.SR2.C.CD15.CH09	BLMMI.16L2.B2I20_MQ	6
BLMM.HC.BLM.SR2.C.CD15.CH10	BLMMI.16L2.B1E21_MQ	3
BLMM.HC.BLM.SR2.C.CD15.CH11	BLMMI.16L2.B1E22_MQ	5
BLMM.HC.BLM.SR2.C.CD15.CH12	BLMMI.16L2.B2I02_MQ	10
BLMM.HC.BLM.SR2.C.CD15.CH13	BLMMI.16L2.B2I01_MQ	12
BLMM.HC.BLM.SR2.C.CD15.CH14	BLMMI.16L2.B1E40_MQ	11
BLMM.HC.BLM.SR2.C.CD15.CH15	BLMMI.16L2.B2I50_MC	2
BLMM.HC.BLM.SR2.C.CD15.CH16	BLMMI.16L2.B1E50_PC	13
	BLMQI.16L2.B2I30_MQ	4
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	BLMQI.16L2.B1E30_MQ	7

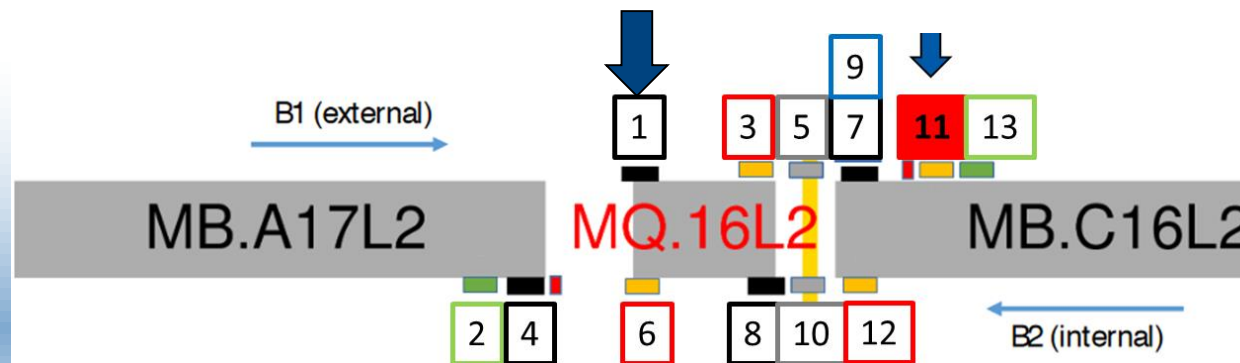
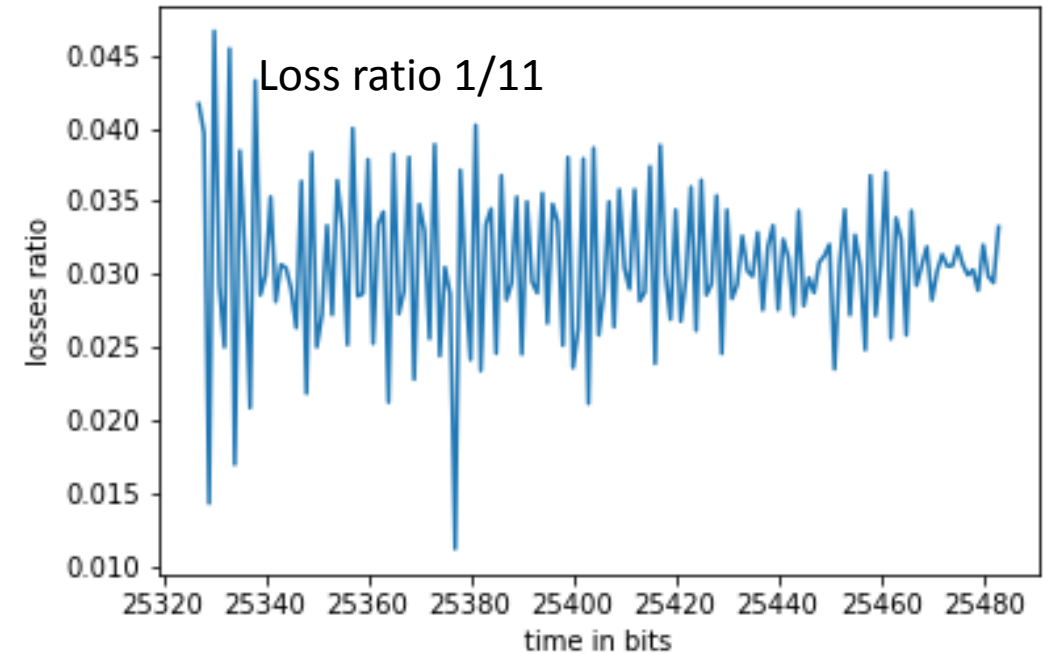
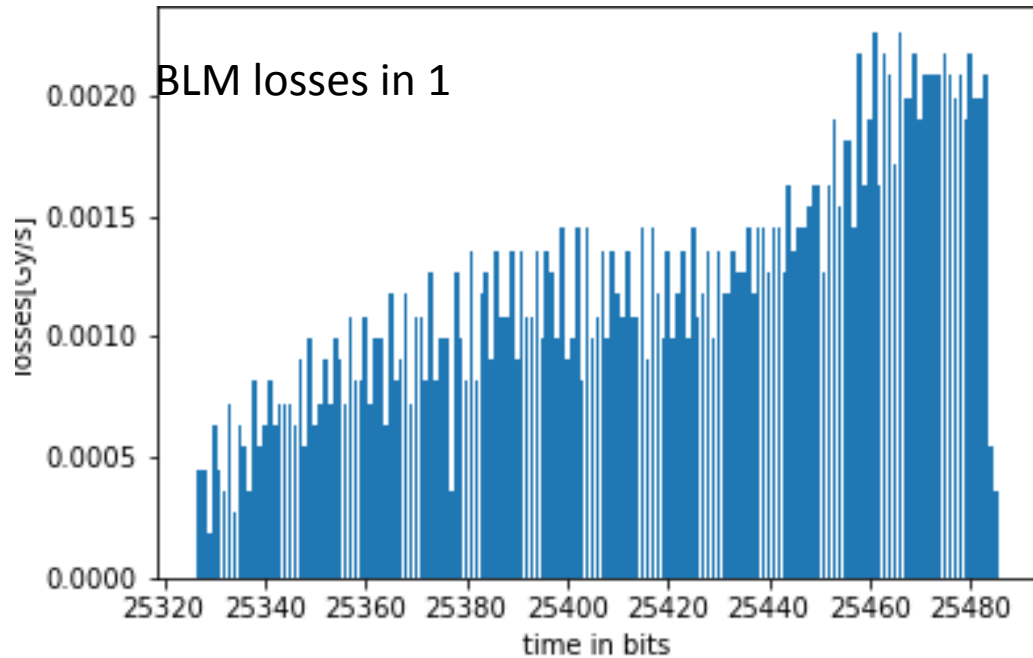
# Idea for loss analysis

- Get Post Mortem BLM data
- Find BLM with highest losses
- Correlate the losses of other BLMs to this BLM
- See relative time structure of losses

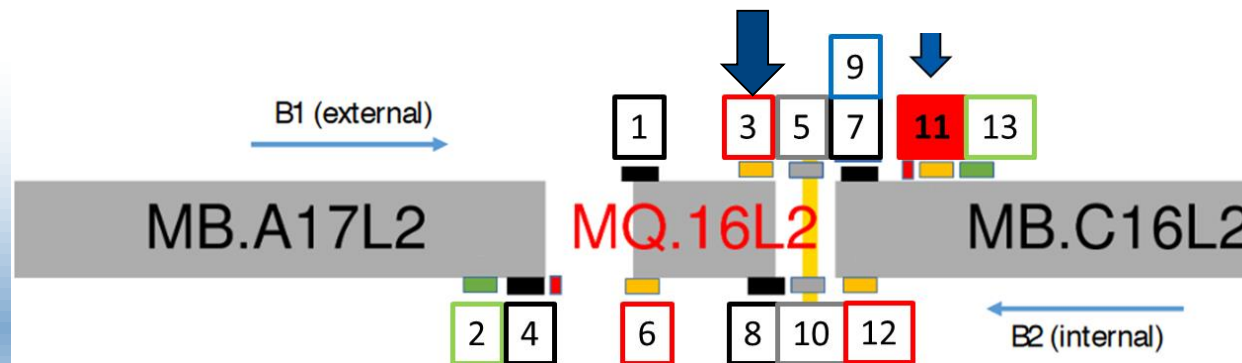
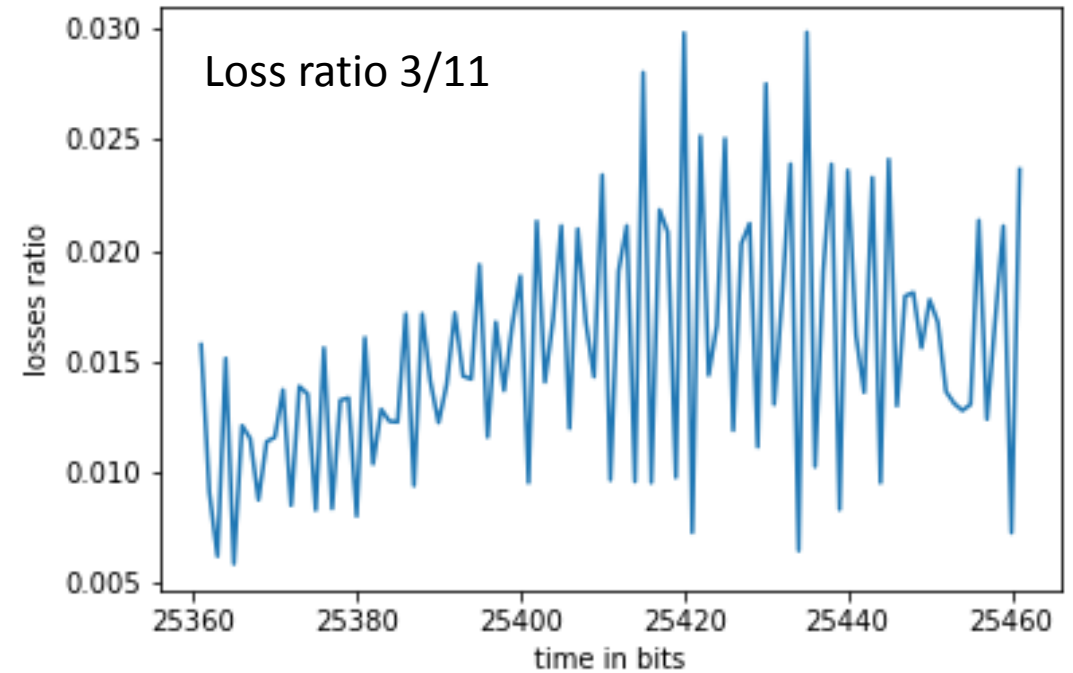
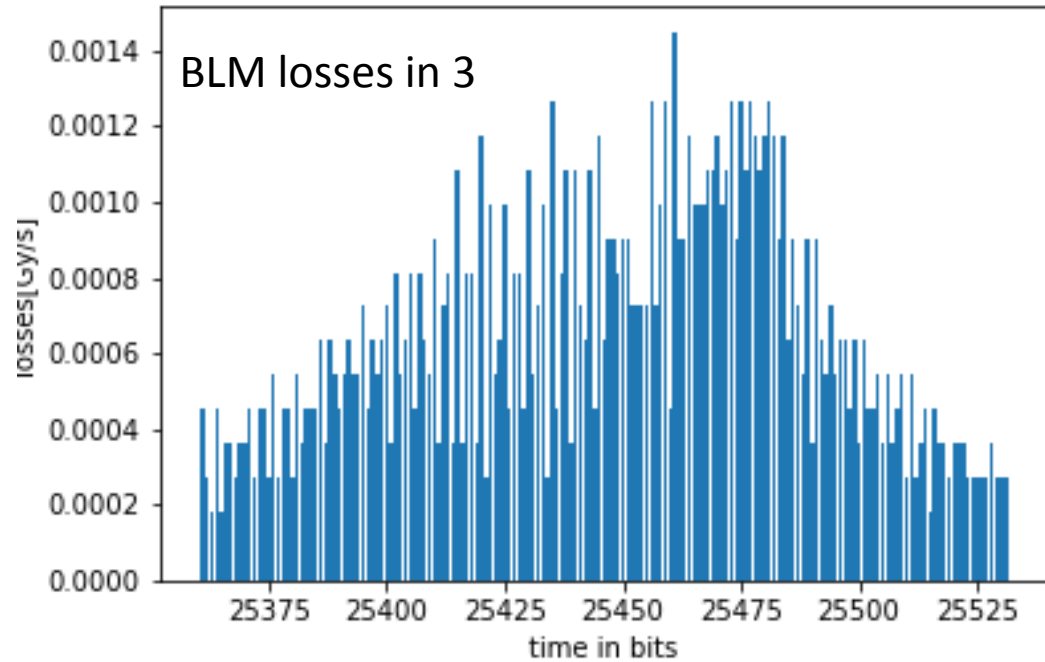
# 16L2 dump 1: 06-09-2017, 20:19, B1 UFO



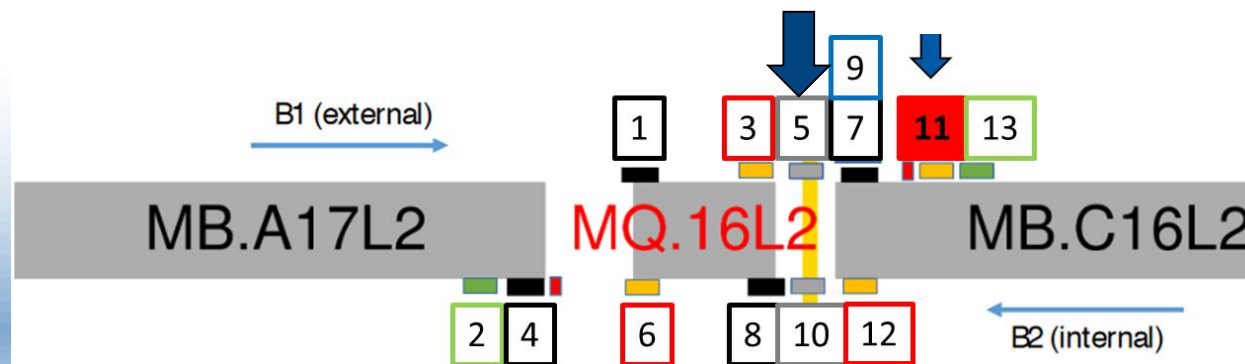
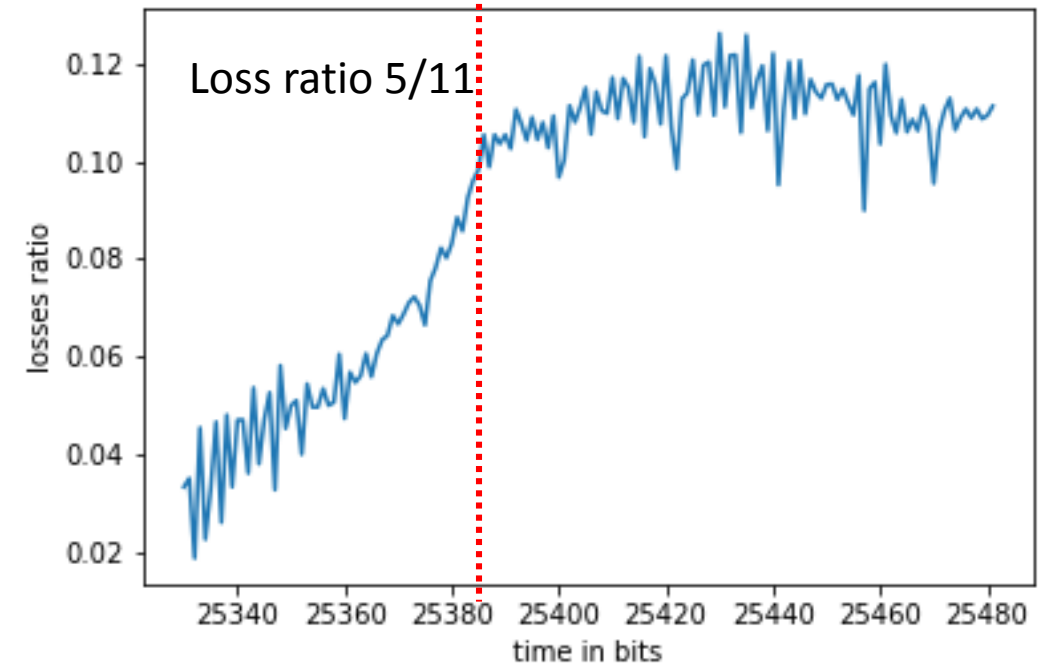
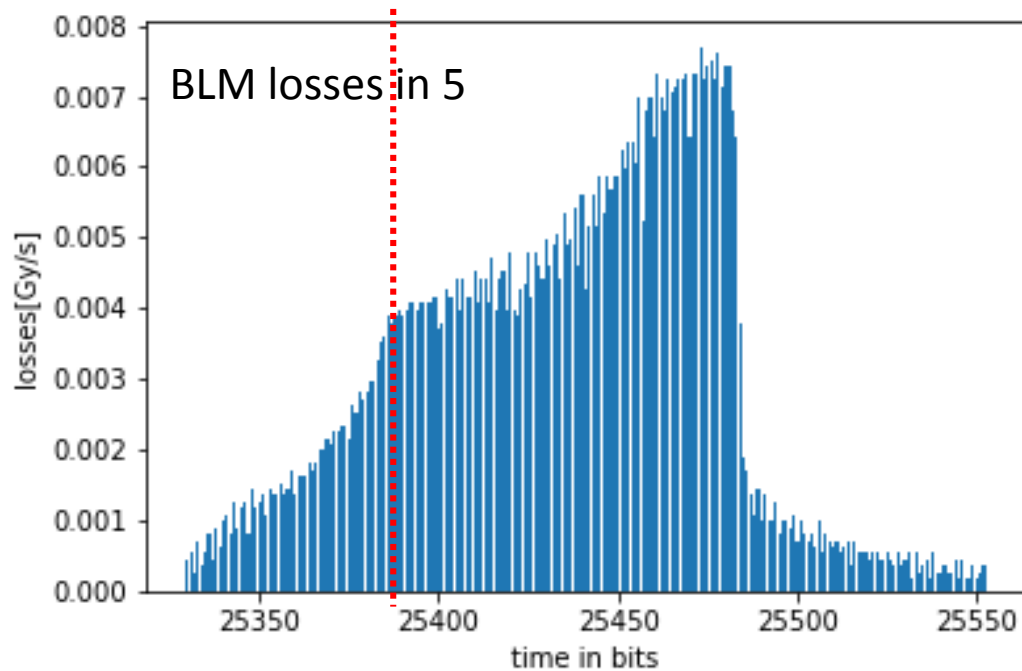
# Ratio of BLM 1/11



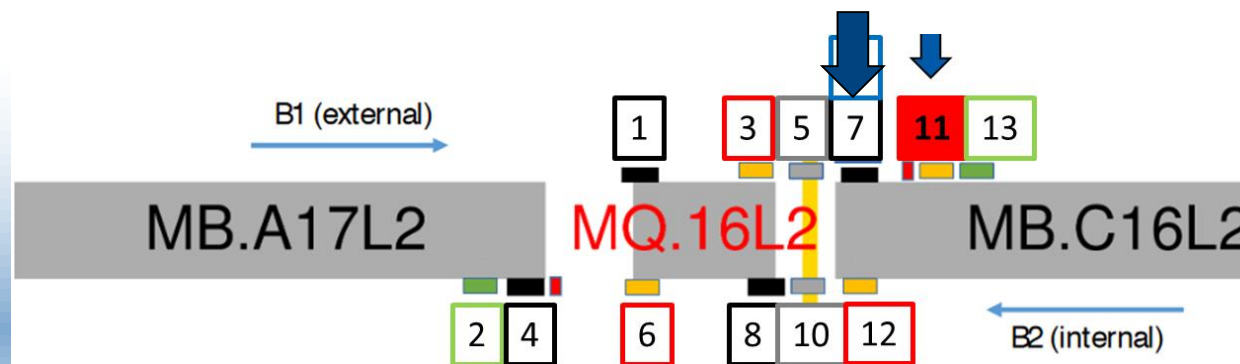
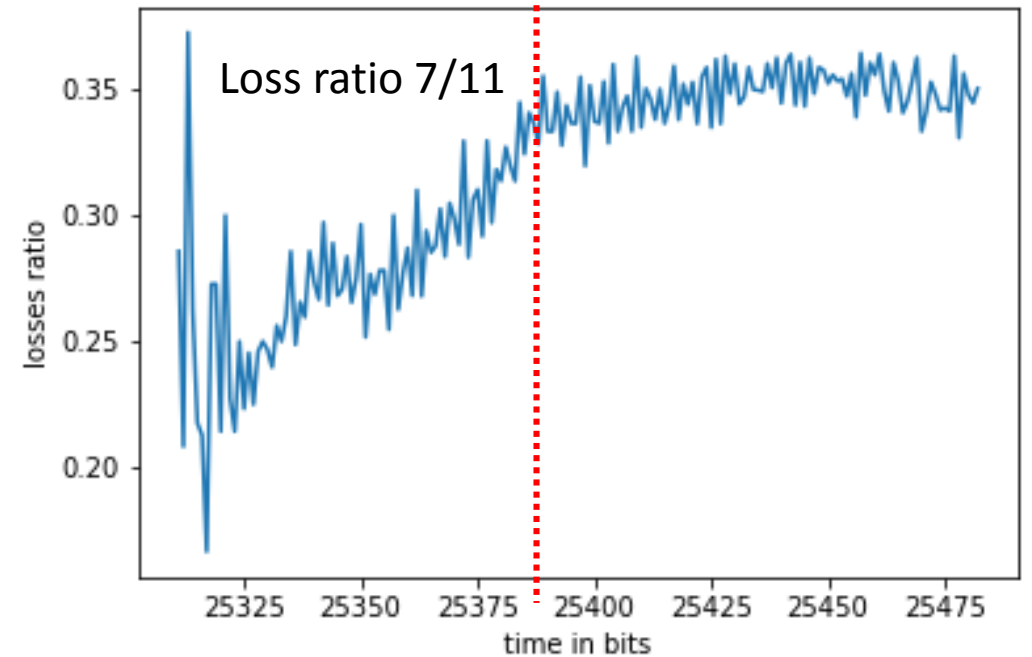
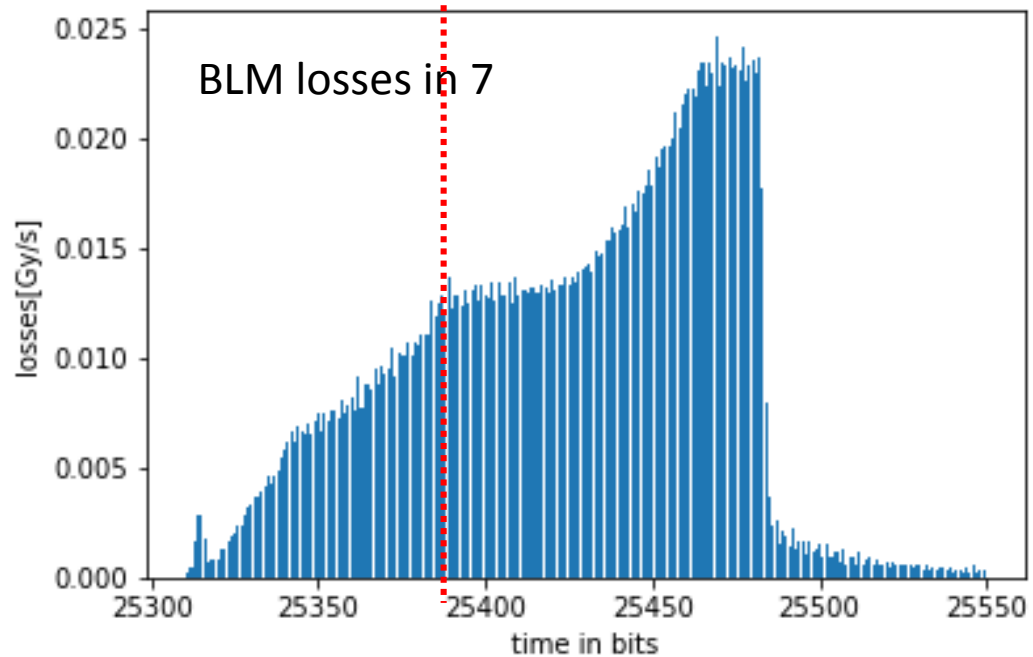
# Ratio of BLM 3/11



# Ratio of BLM 5/11

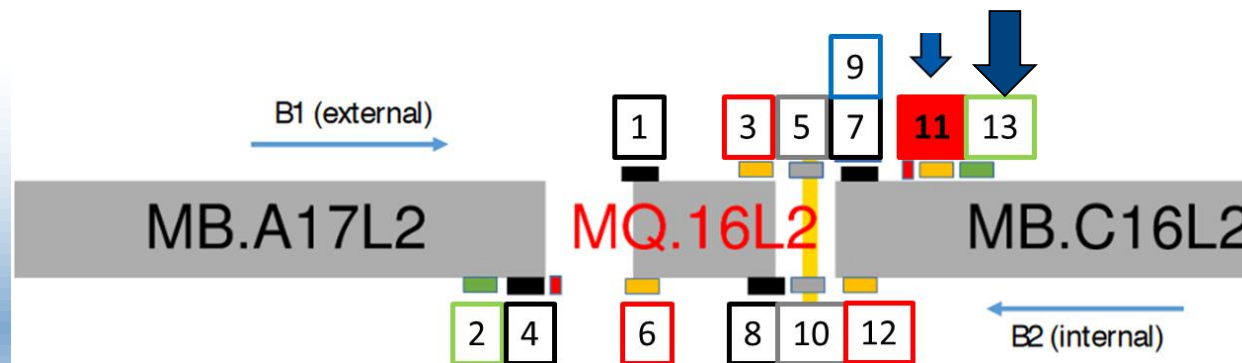
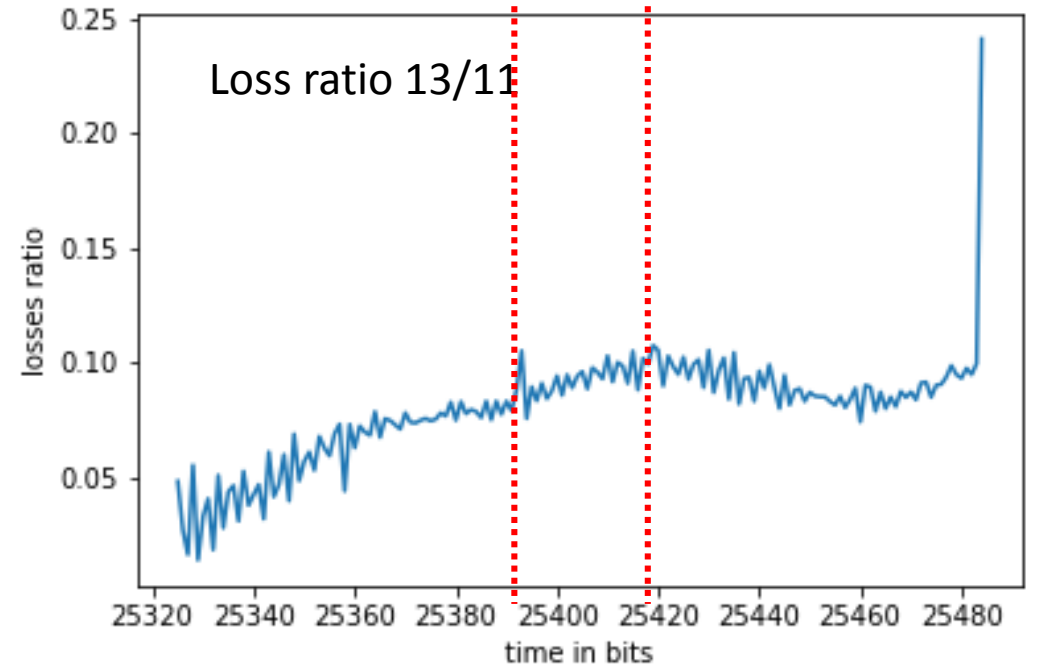
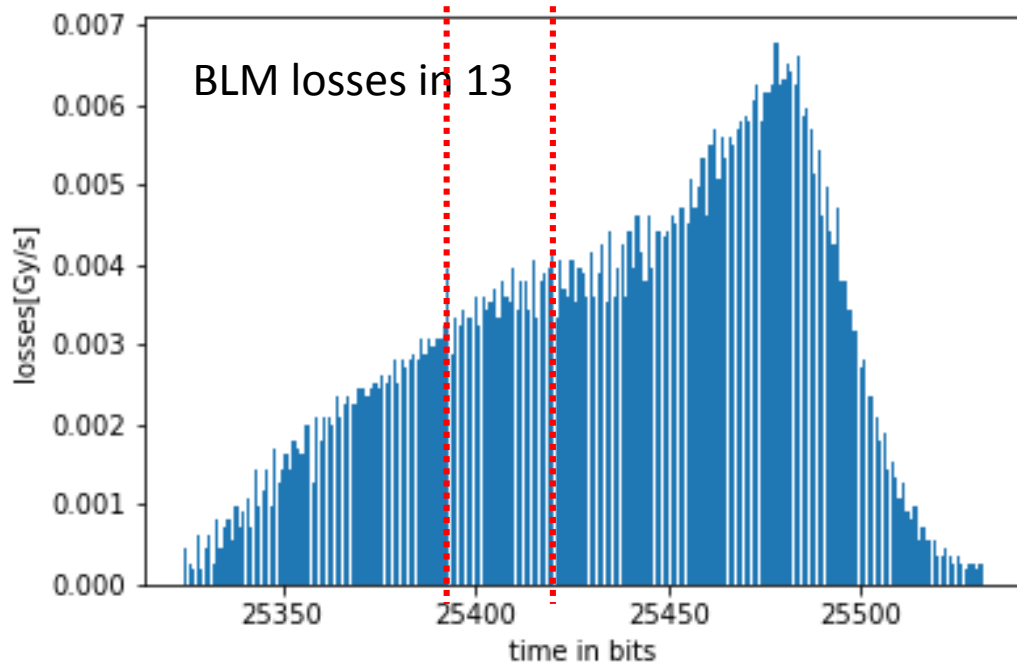


# Ratio of BLM 7/11

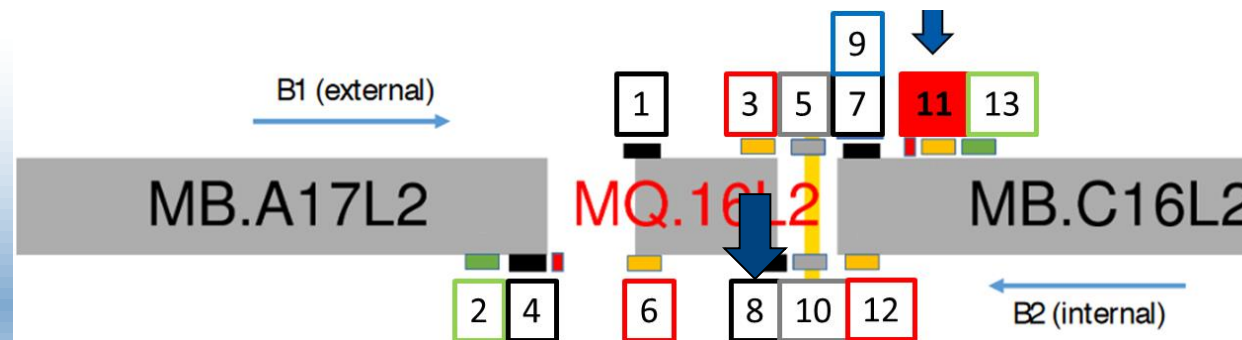
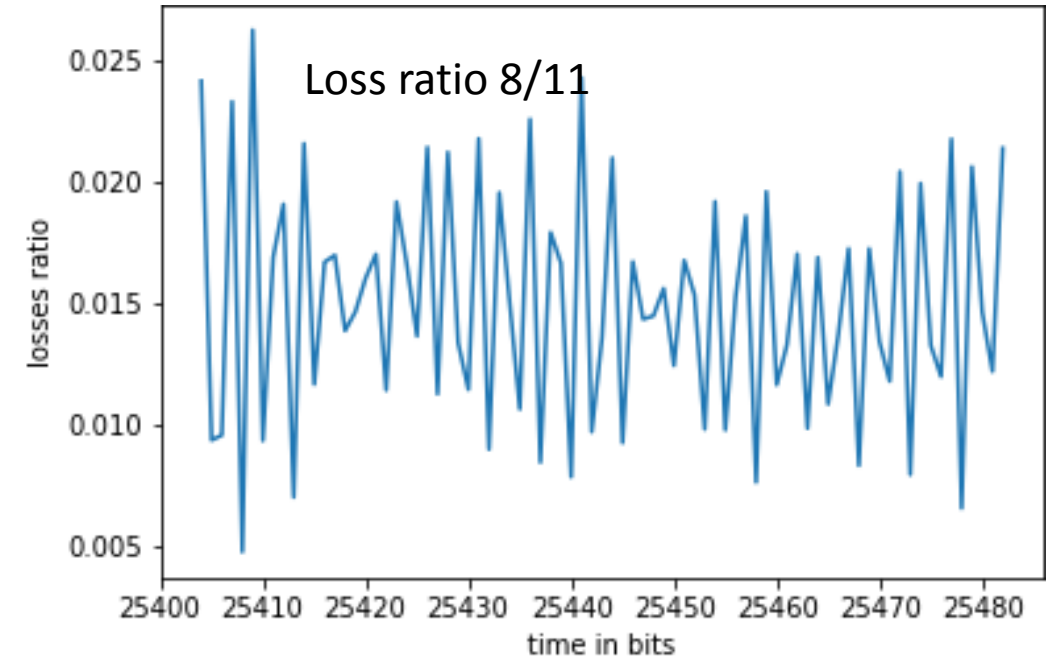
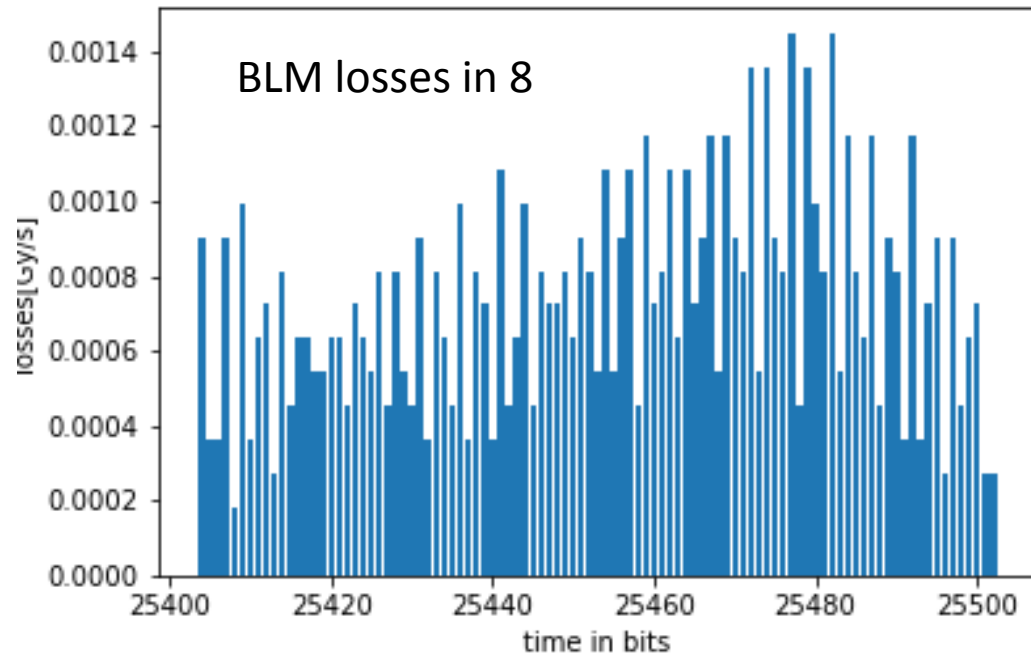




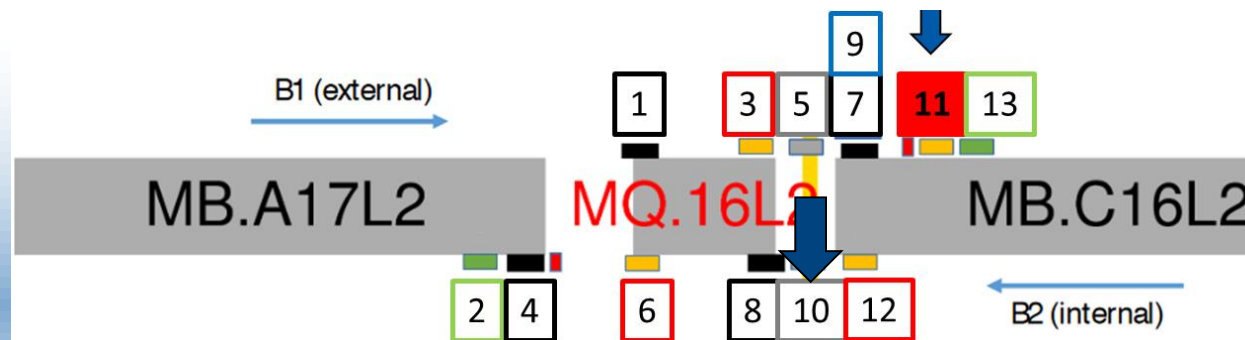
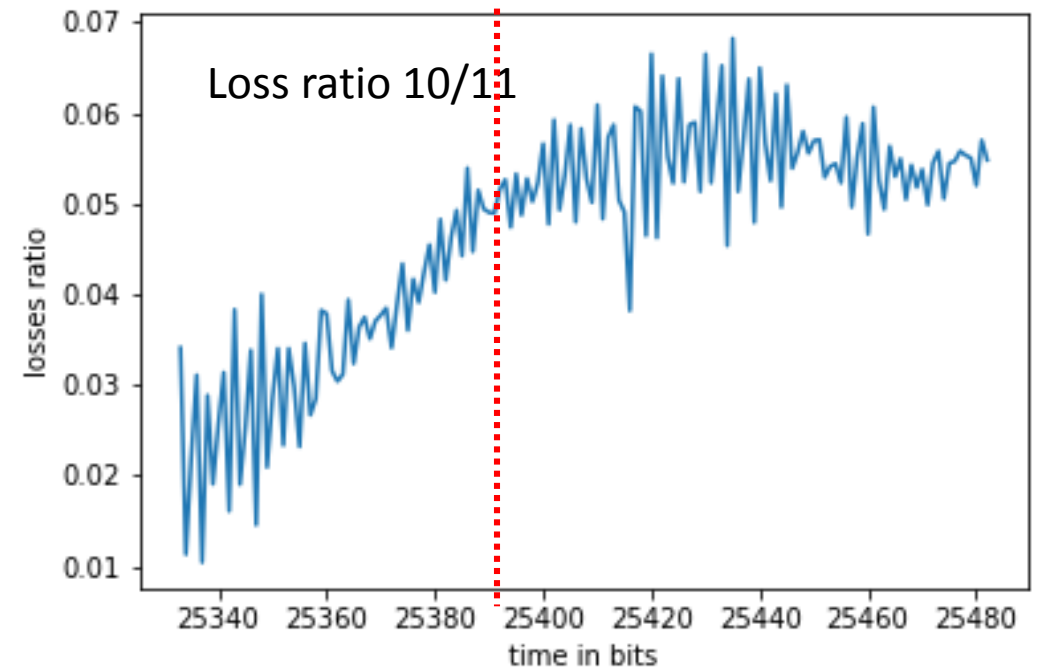
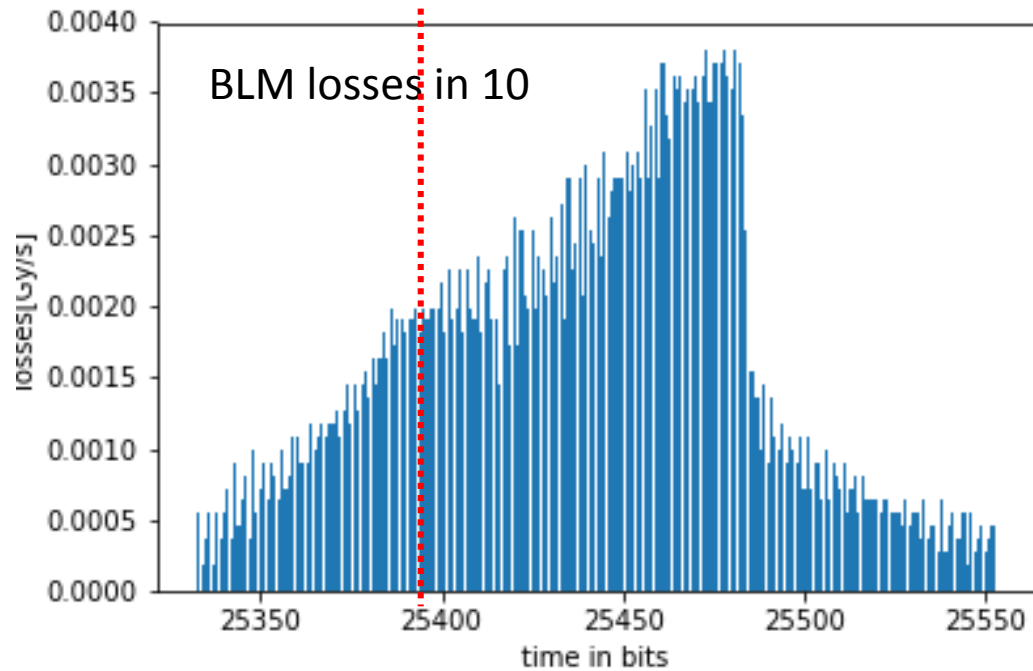
# Ratio of BLM 13/11



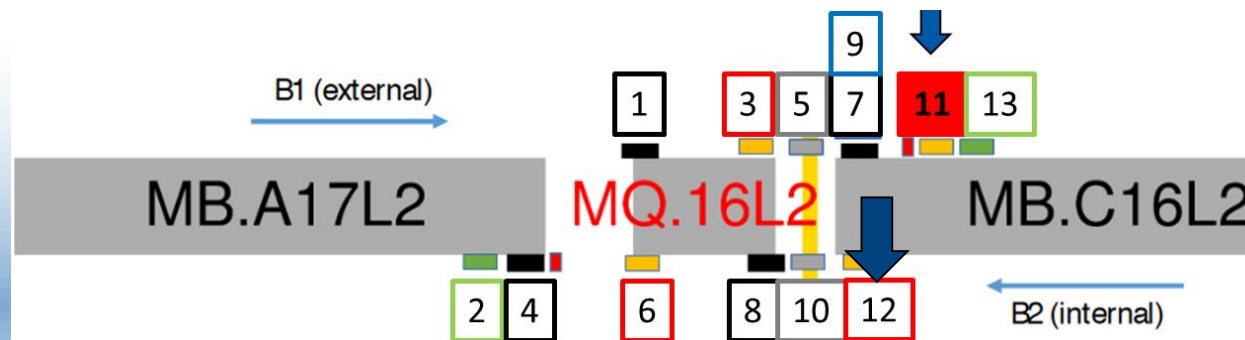
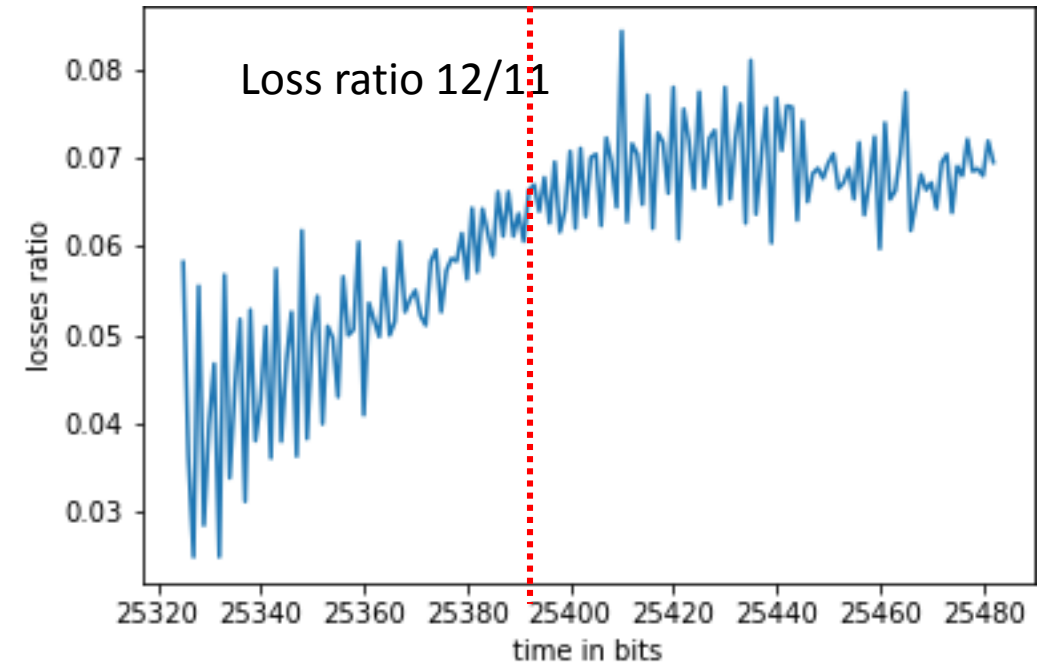
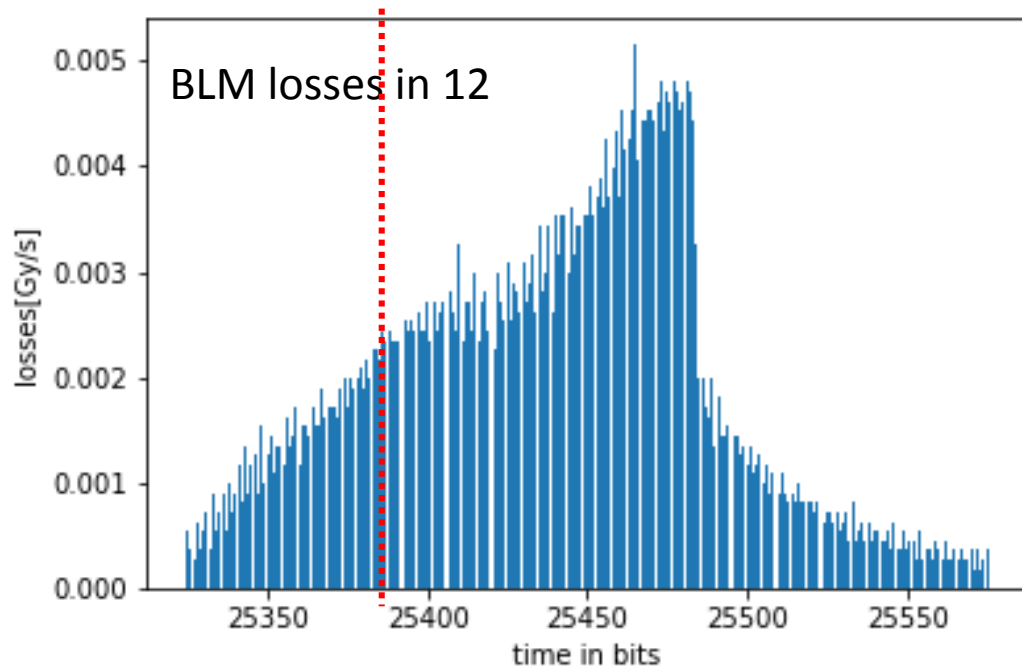
# Ratio of BLM 8/11



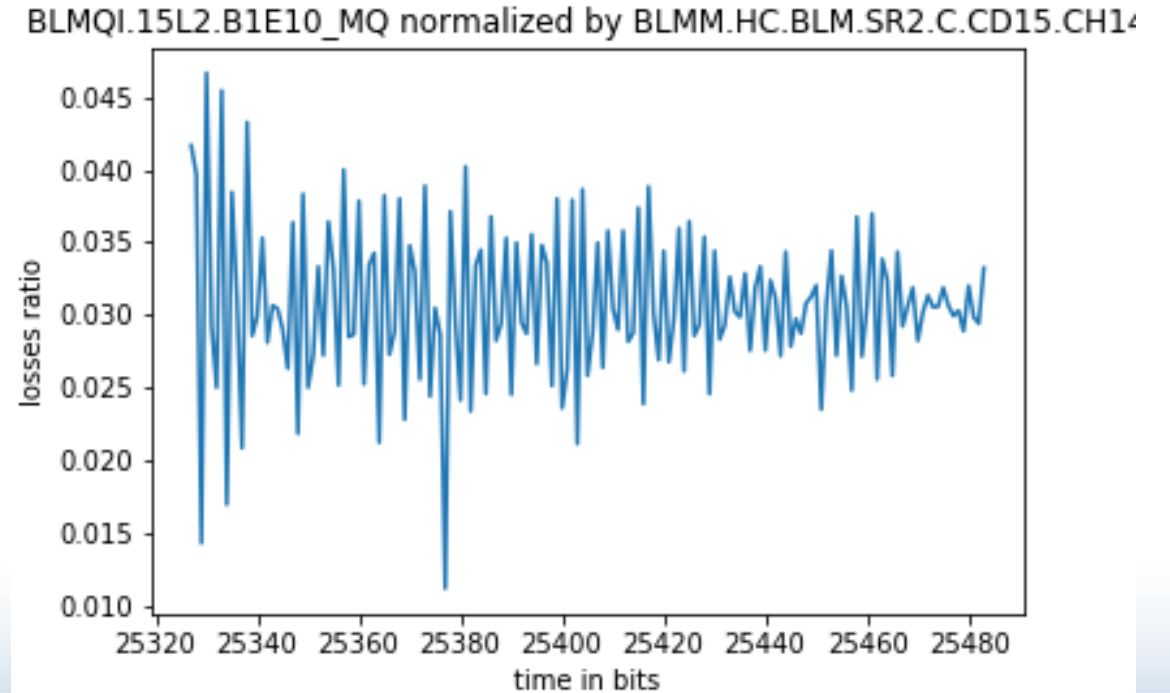
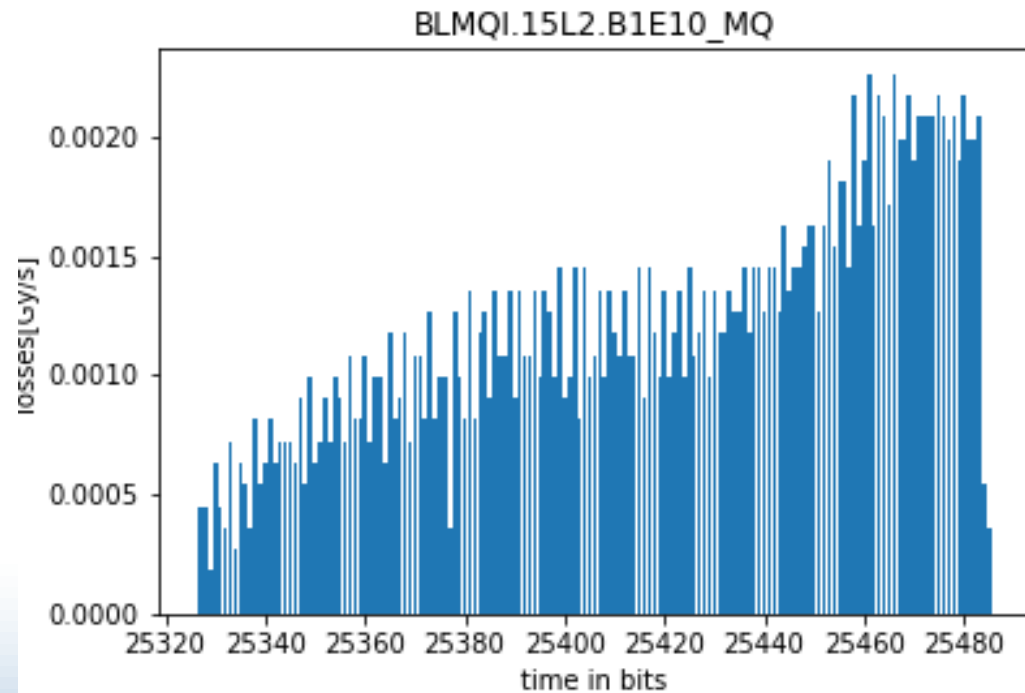
# Ratio of BLM 10/11



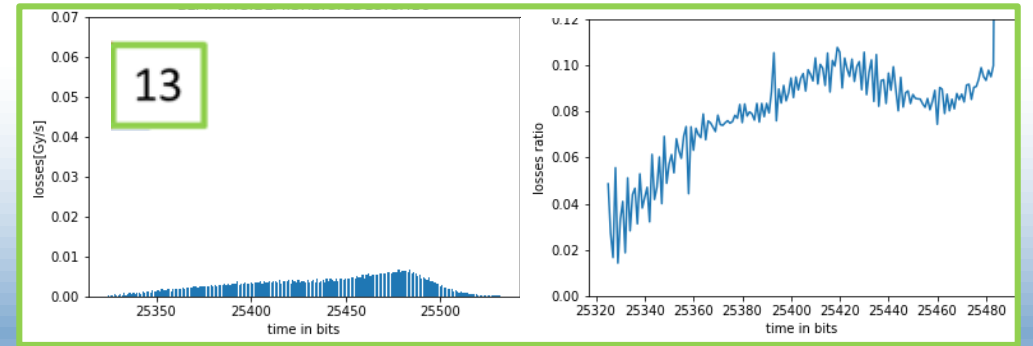
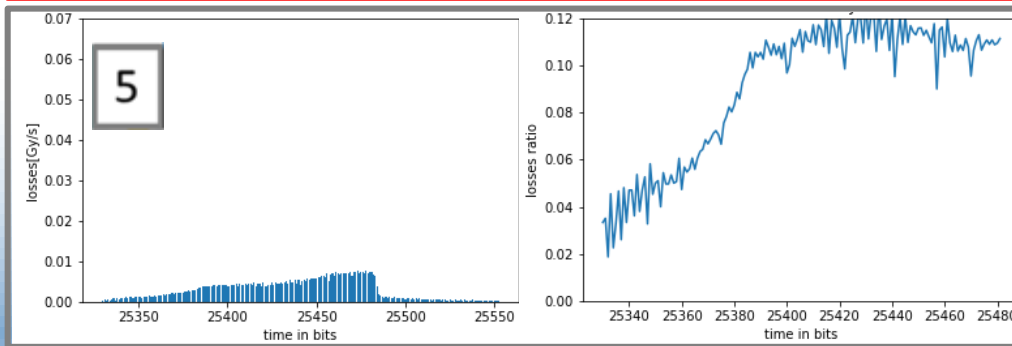
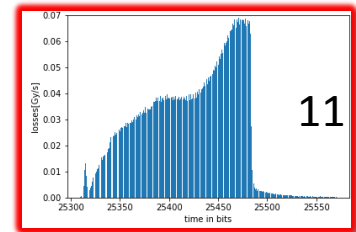
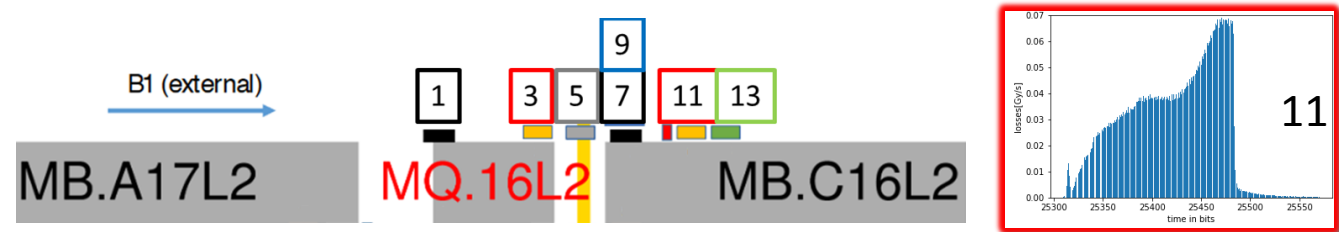
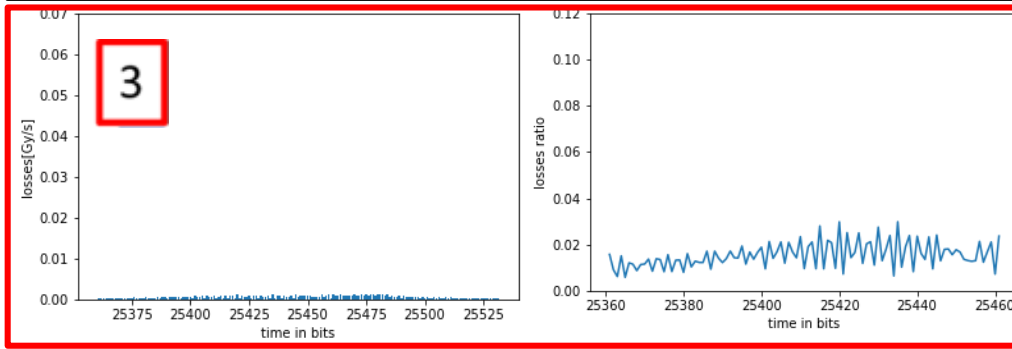
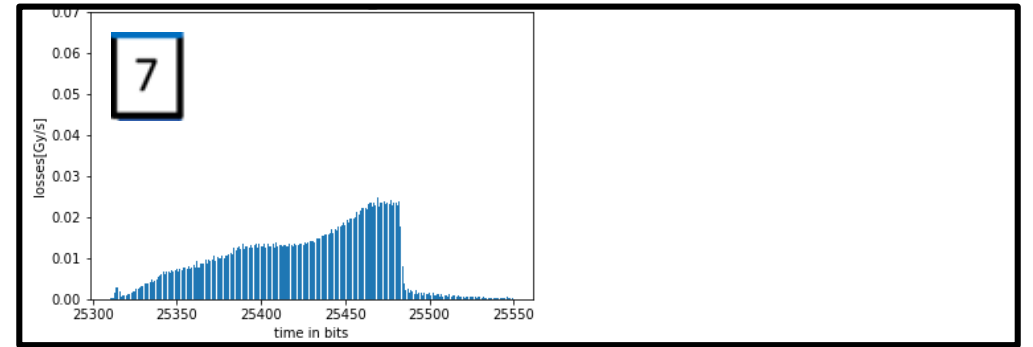
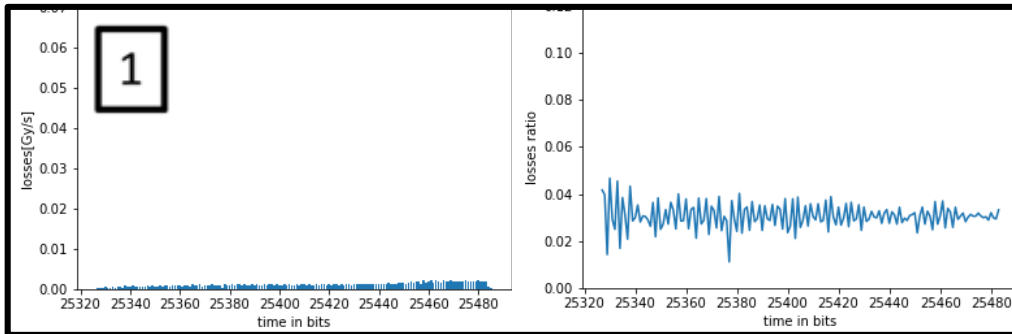
# Ratio of BLM 12/11



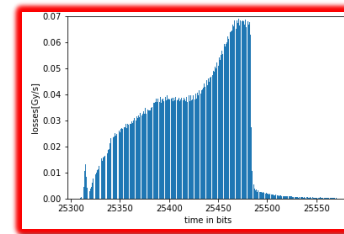
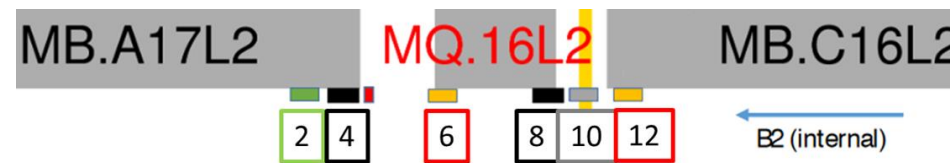
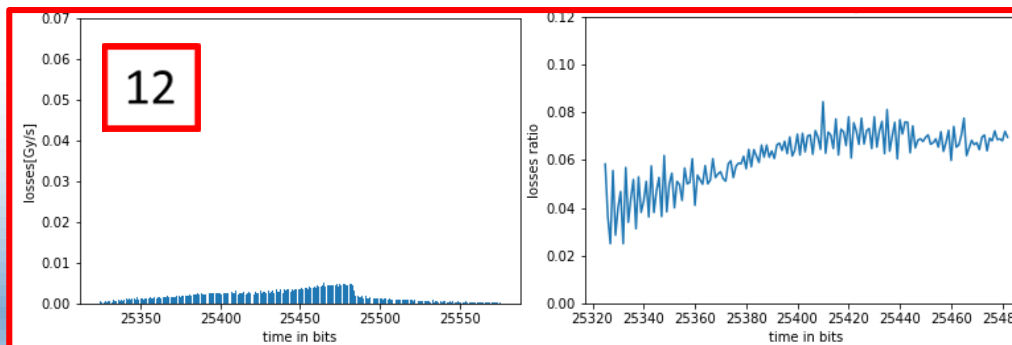
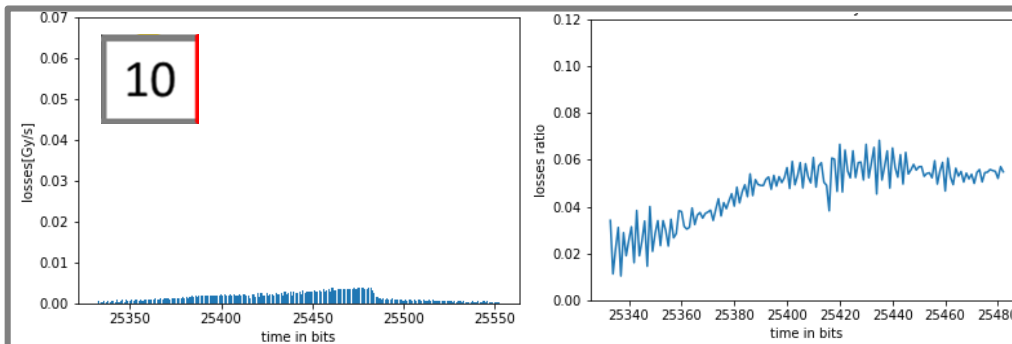
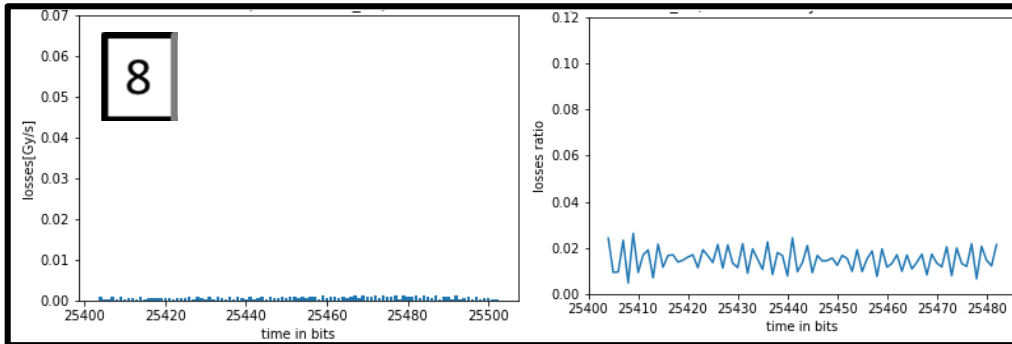
# In addition: signal in BLMQI.15L2.B1E10\_MQ



# Comparison on same axes for B1

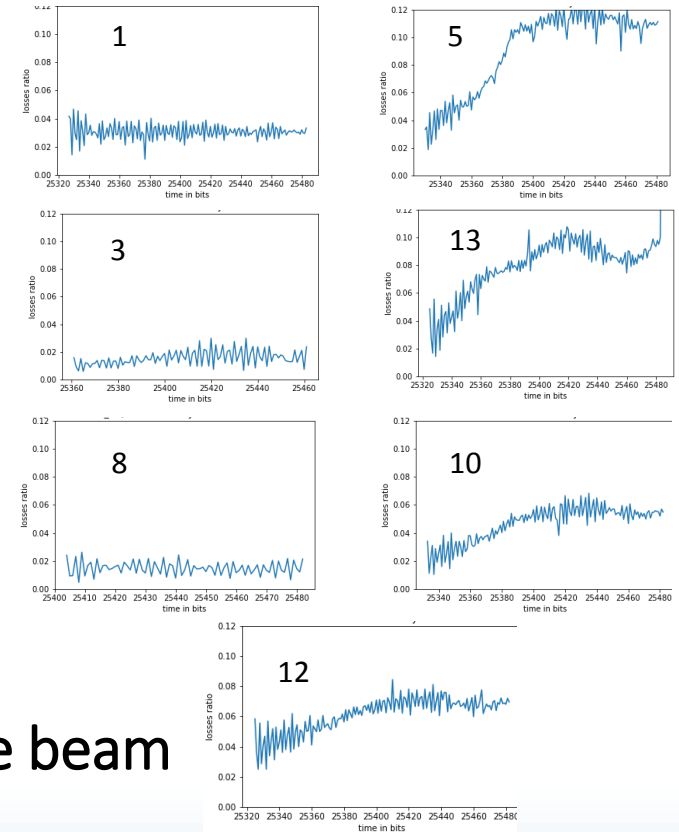


# Comparison on same axes for B2



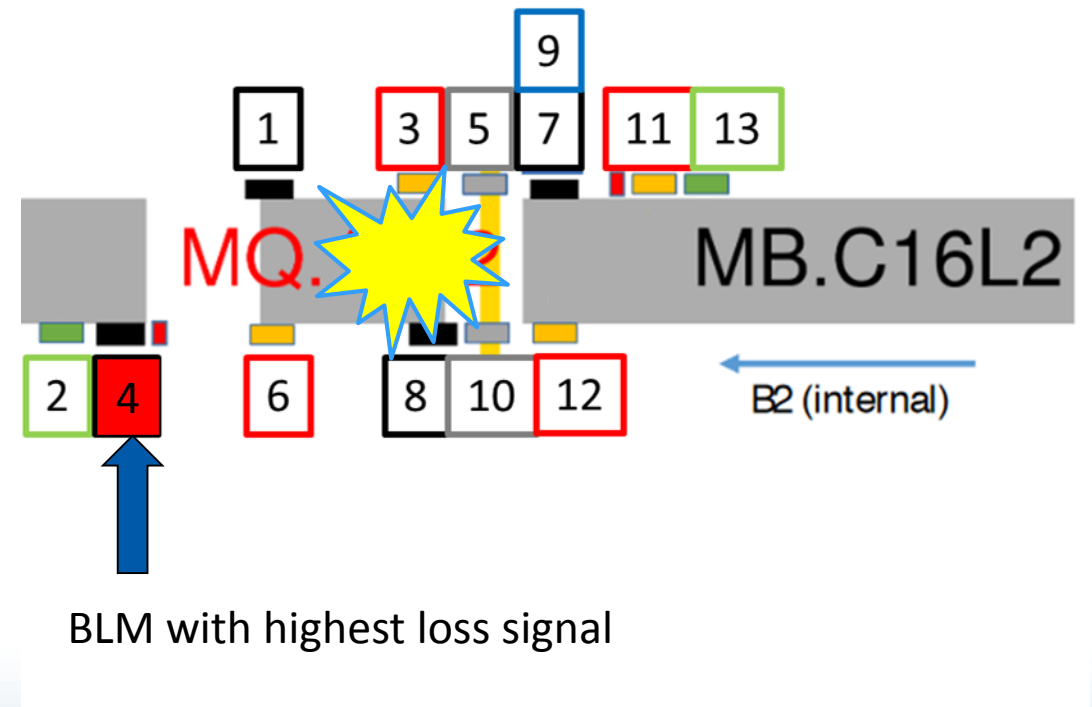
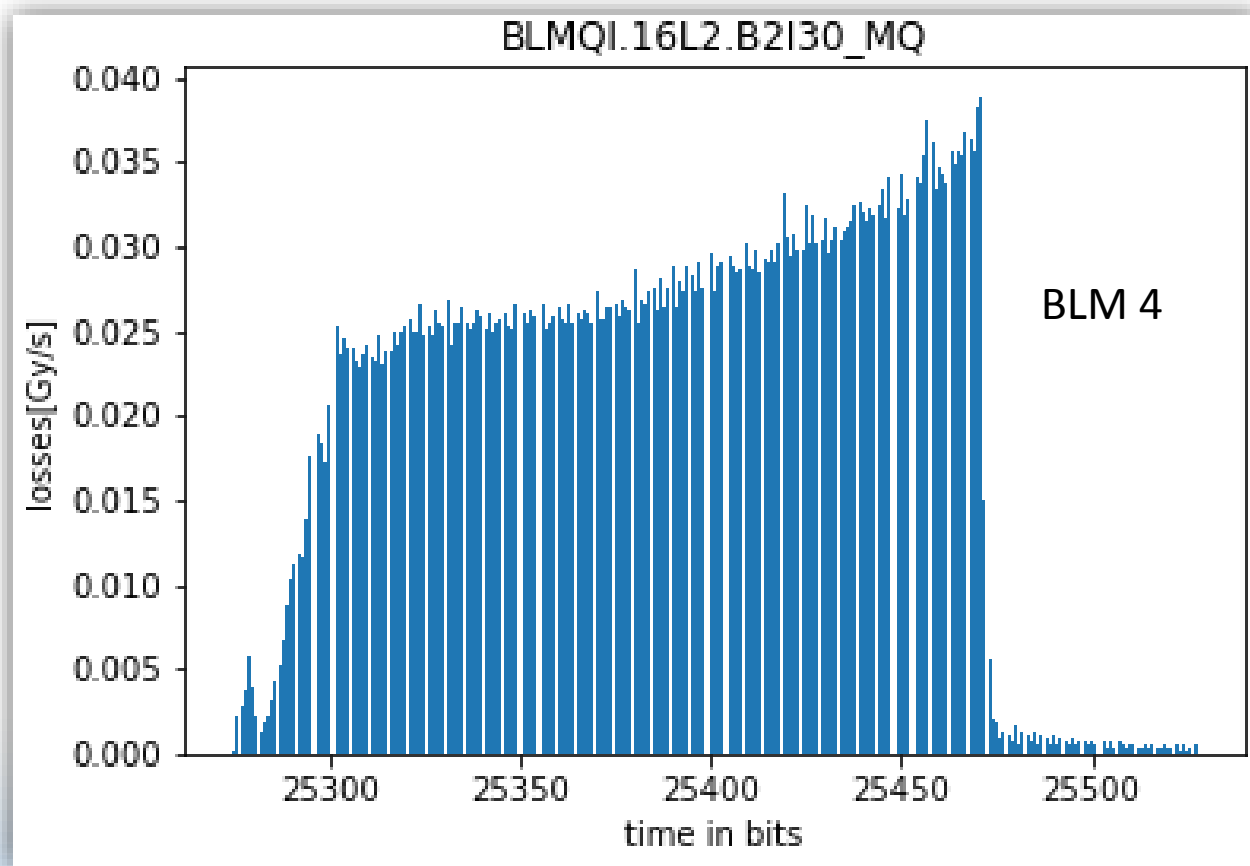
# Observation from first dump:

- Neighboring BLMs show losses
- The **ratio is rising** for many of the neighboring BLMs
- This means that the **losses increase with time wrt BLM 11**
- This could indicate **longitudinal expansion of matter into the beam**
- This **supports theory of UFO type 2** (maybe caused by evaporation/explosion/atom cloud)

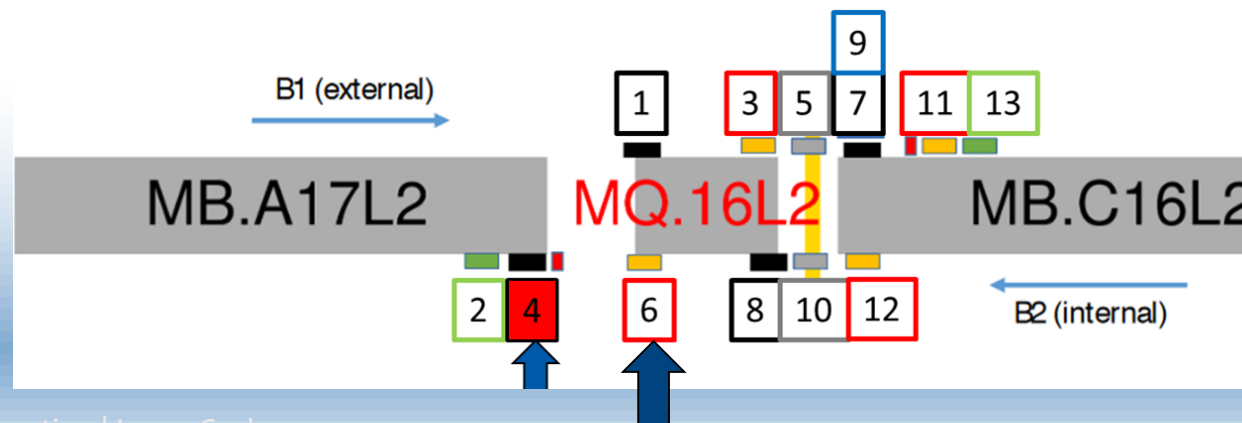
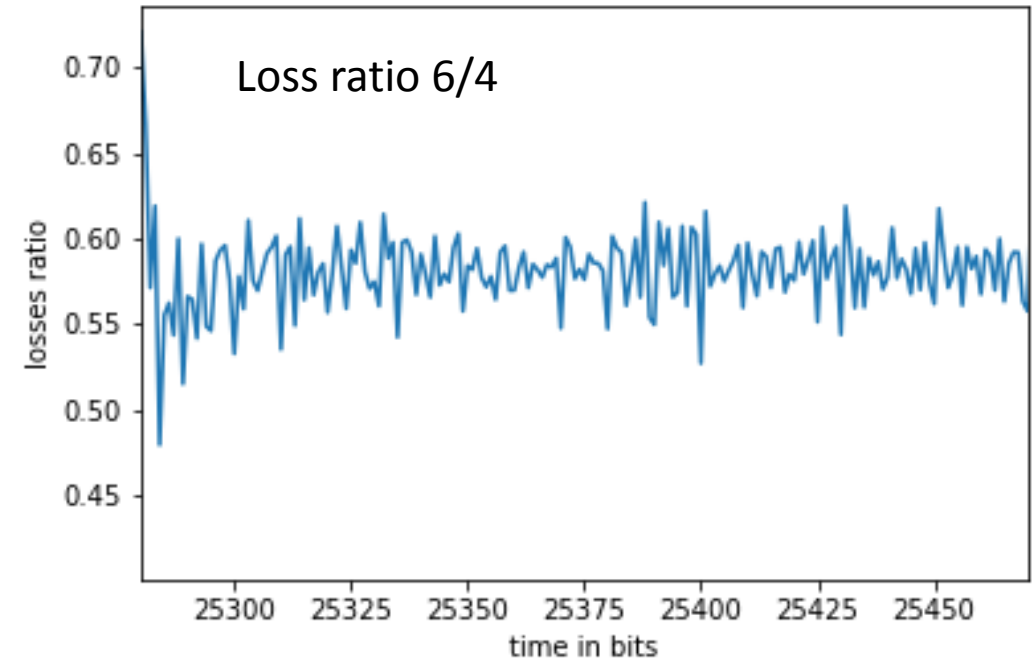
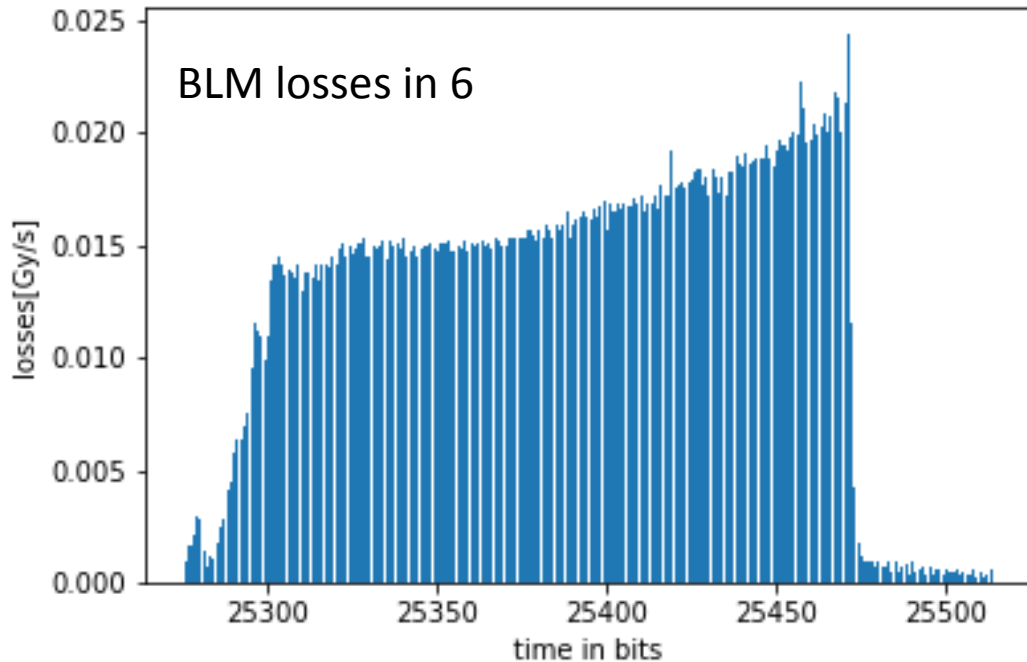




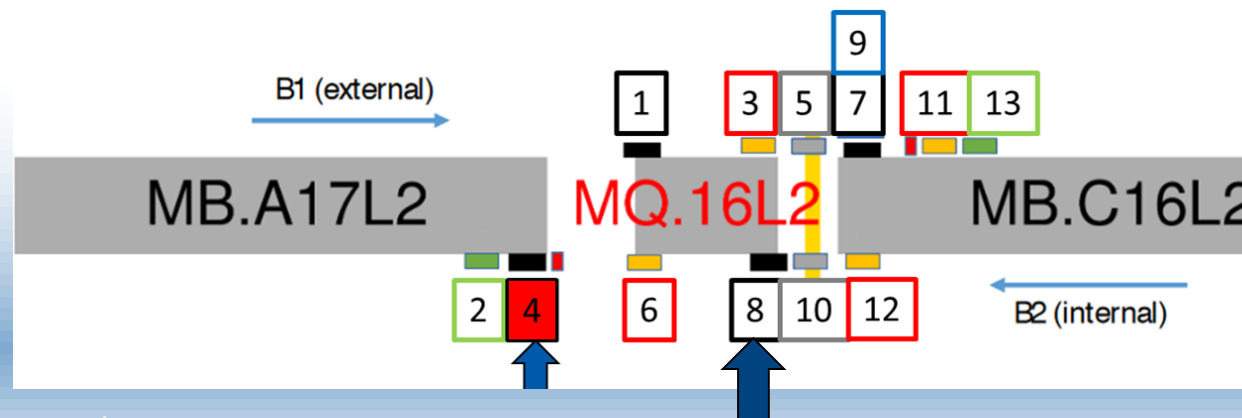
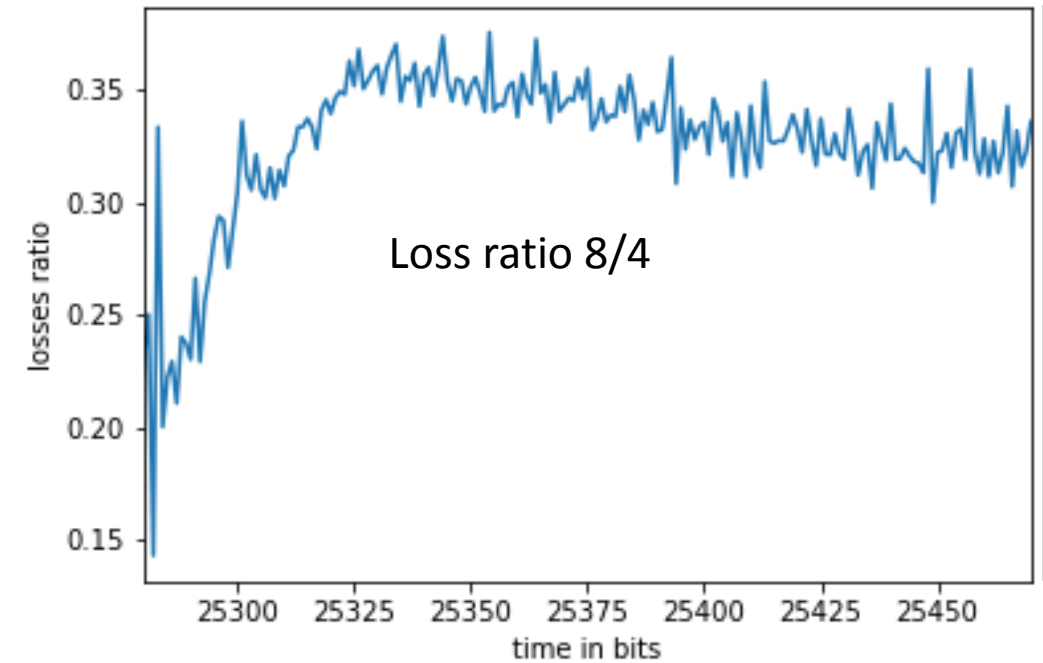
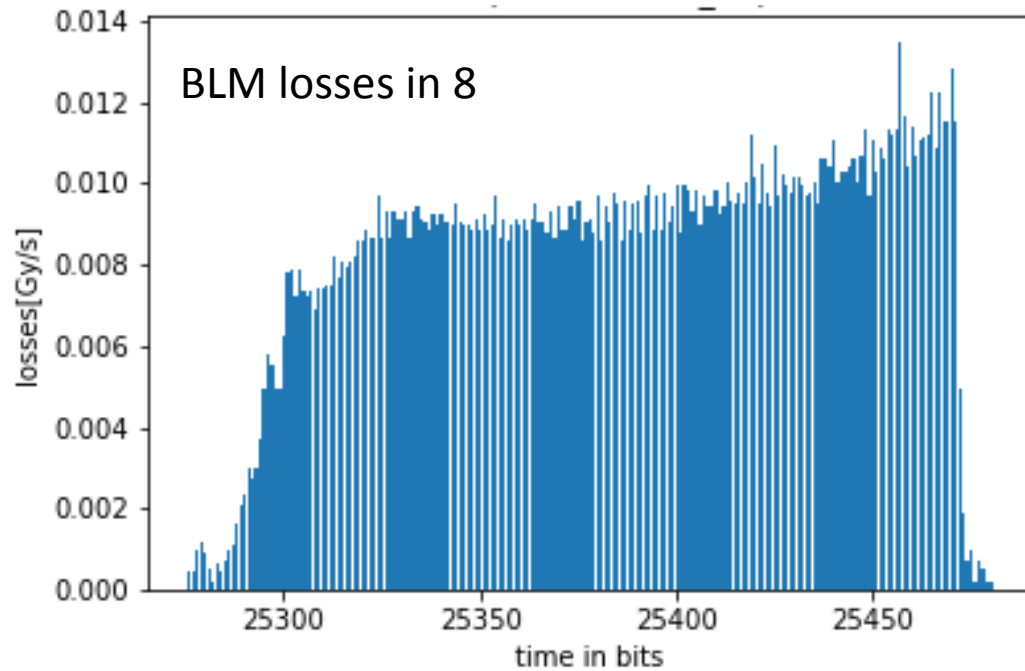
# 16L2 dump 2: 17-08-2017, 05:03, B2 UFO



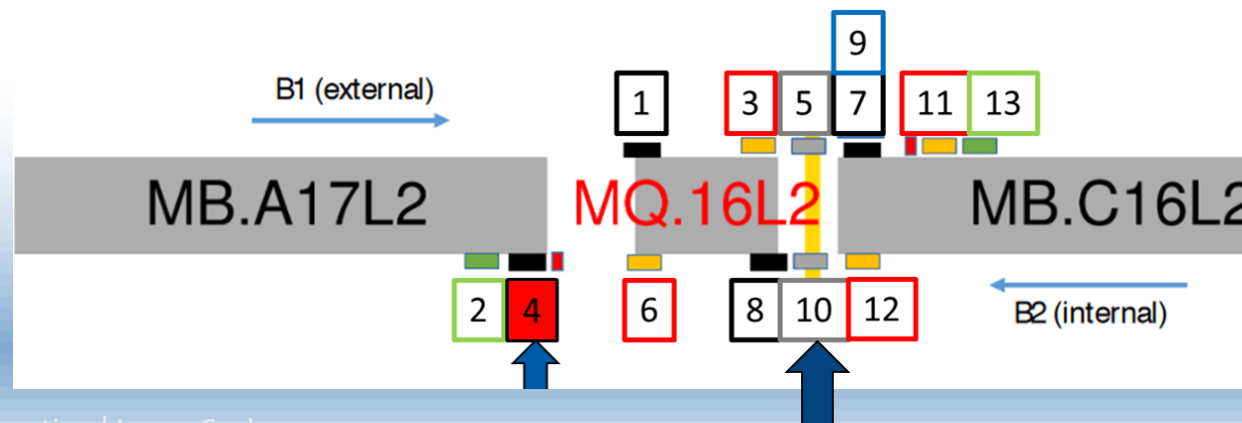
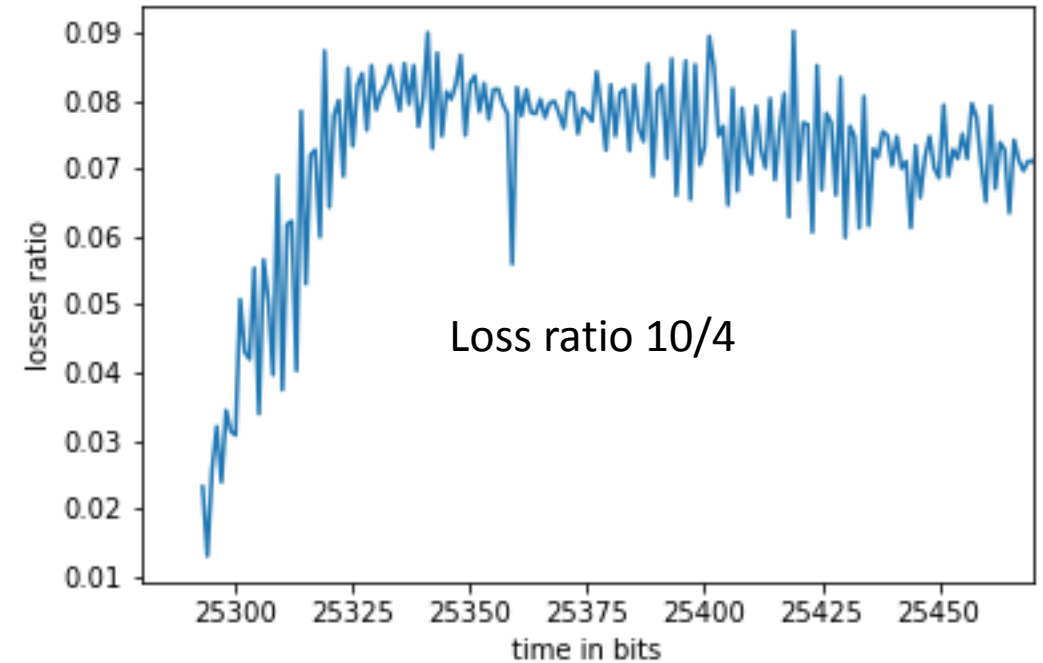
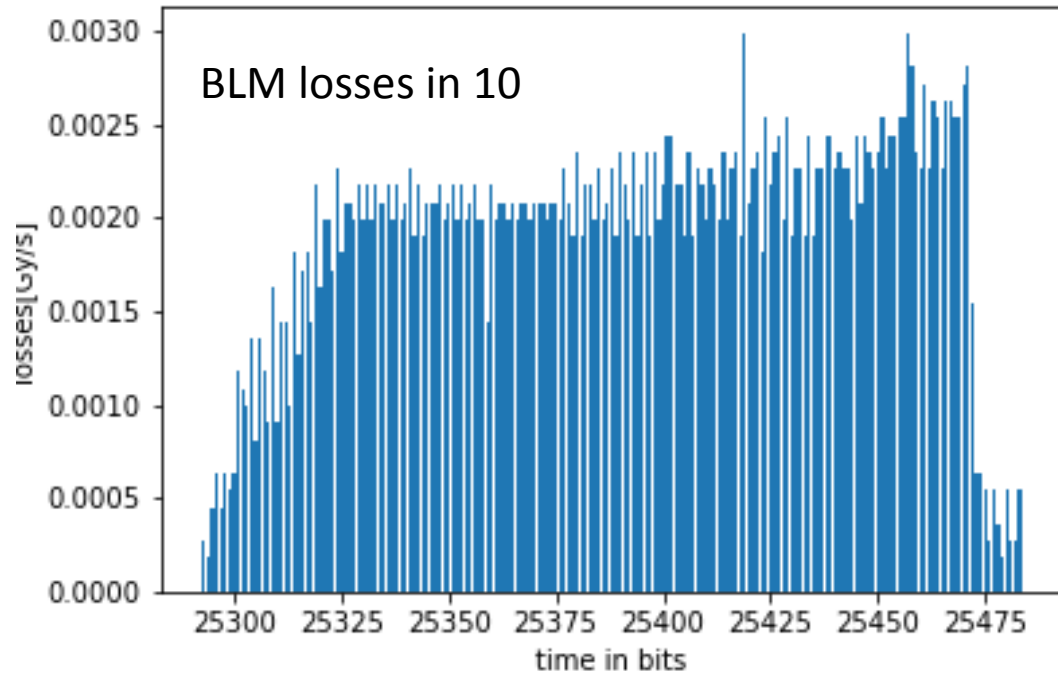
# Ratio of BLM 6/4



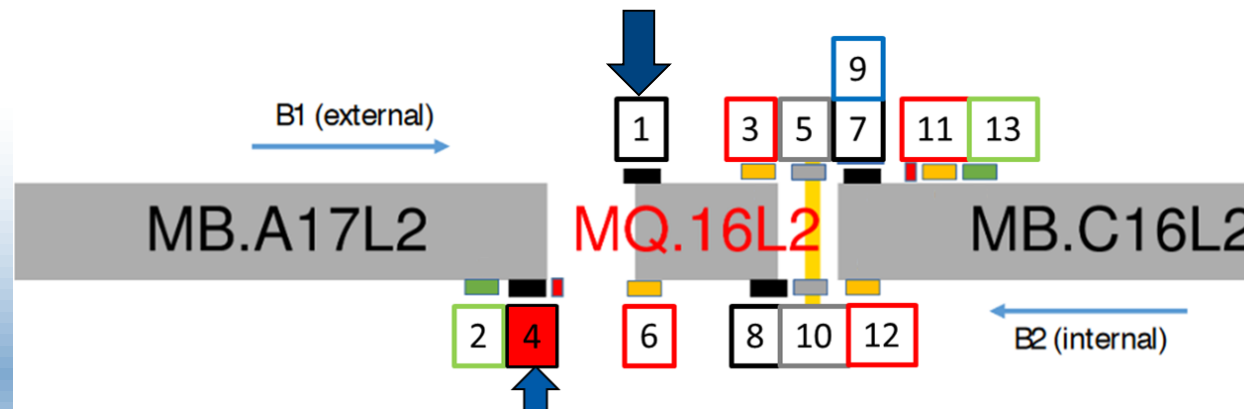
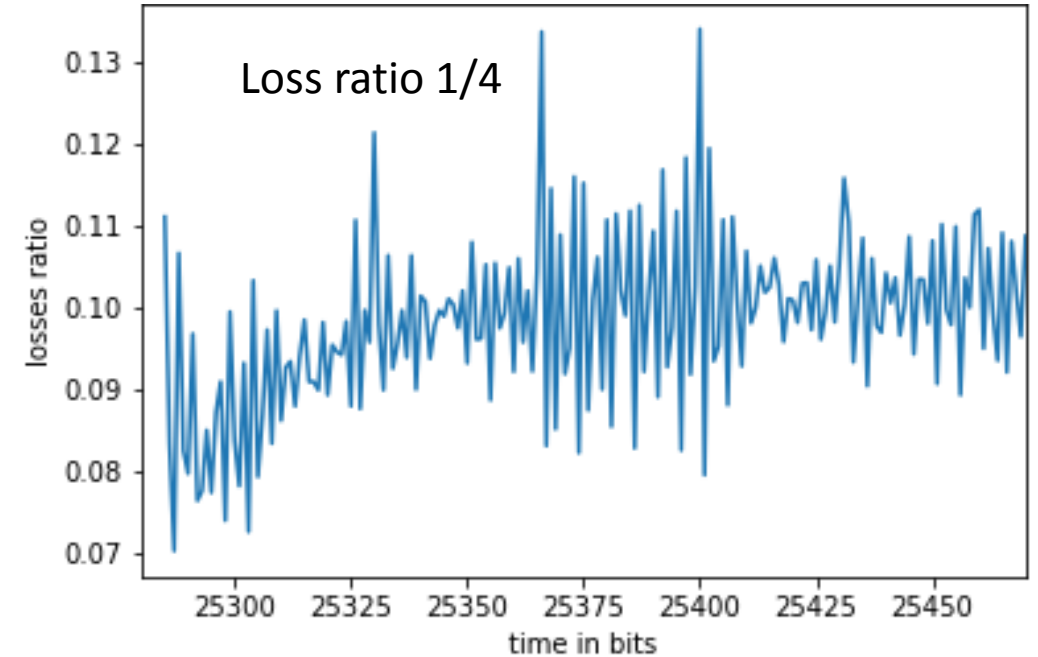
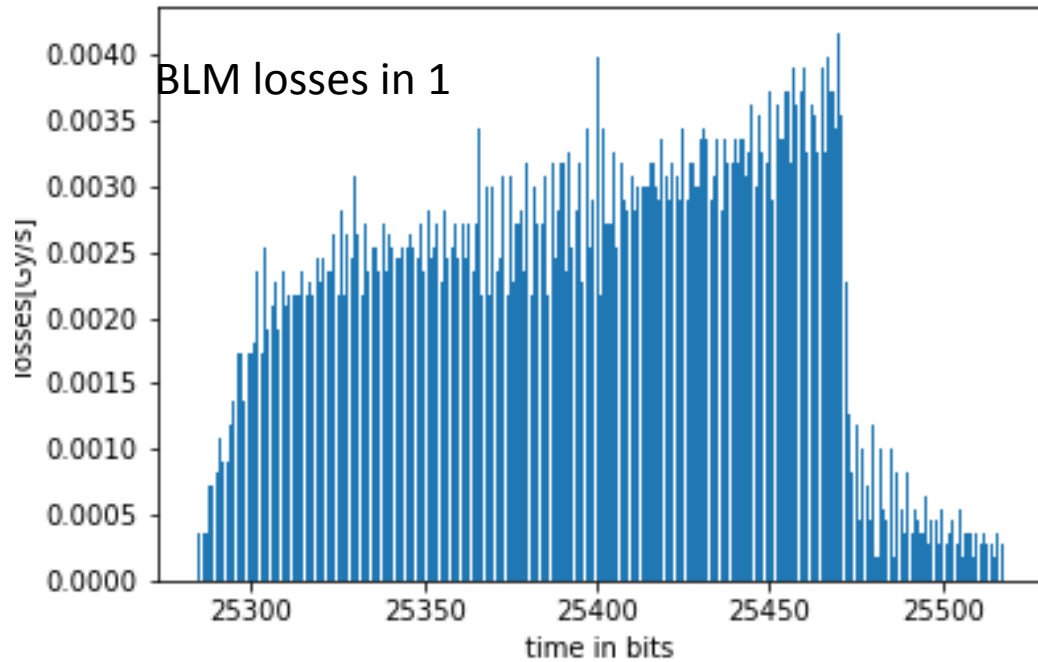
# Ratio of BLM 8/4



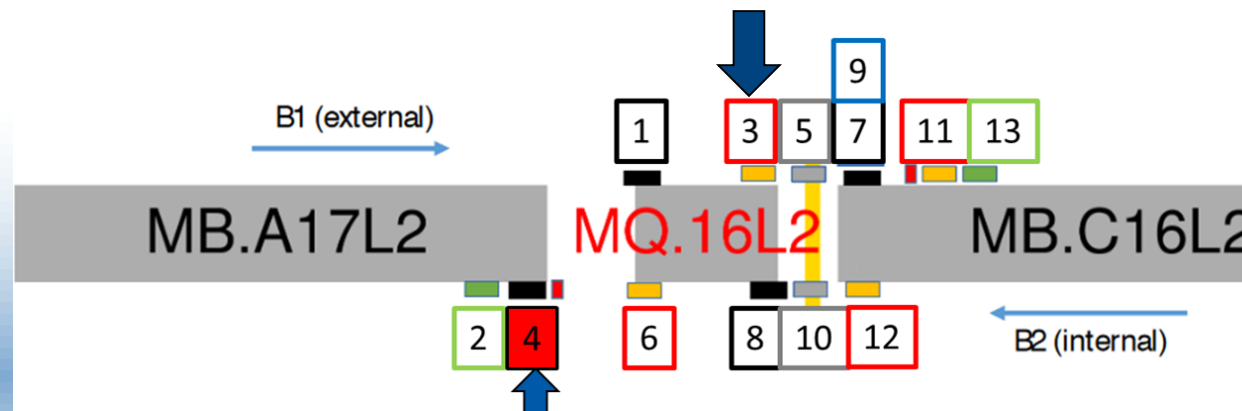
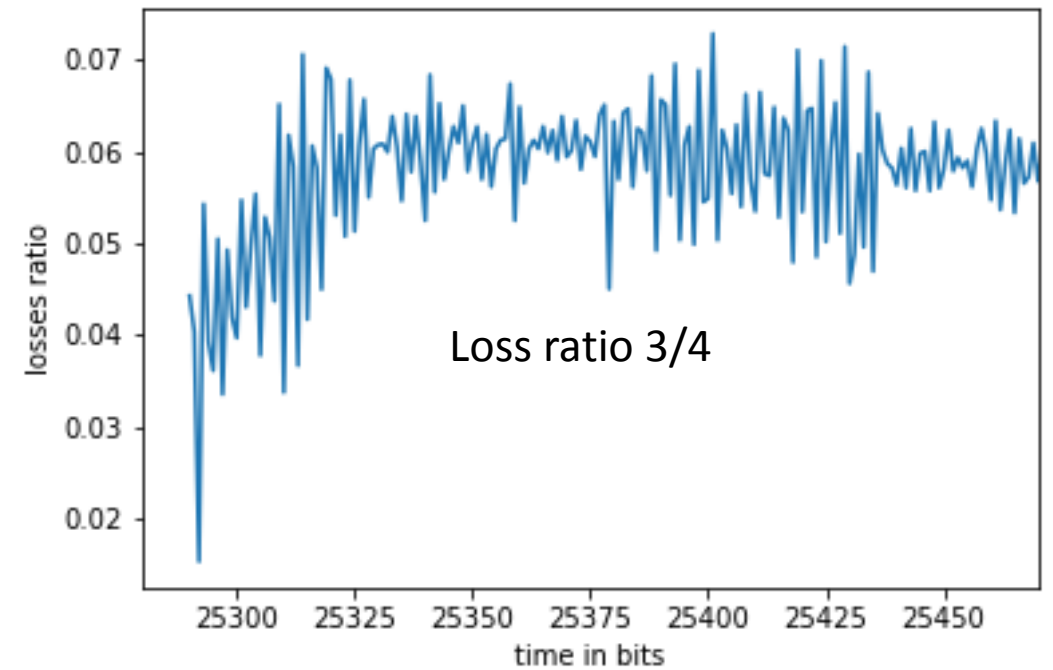
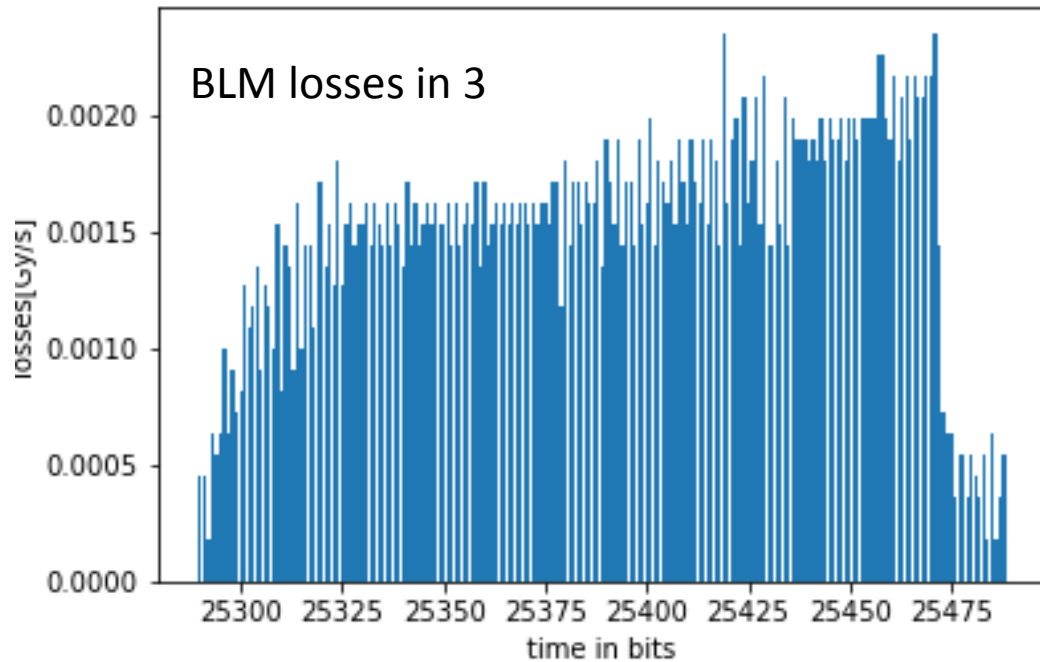
# Ratio of BLM 10/4



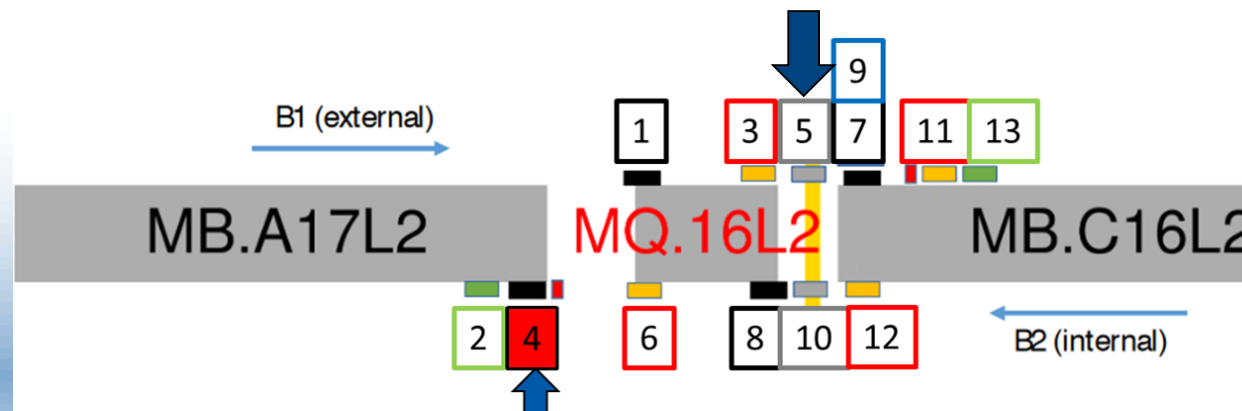
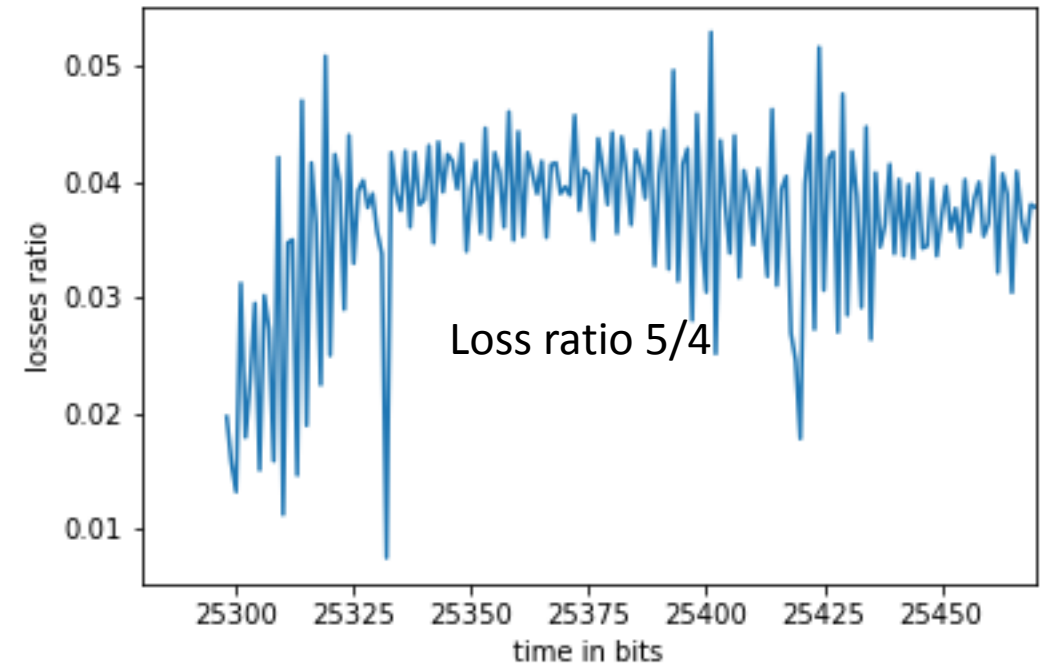
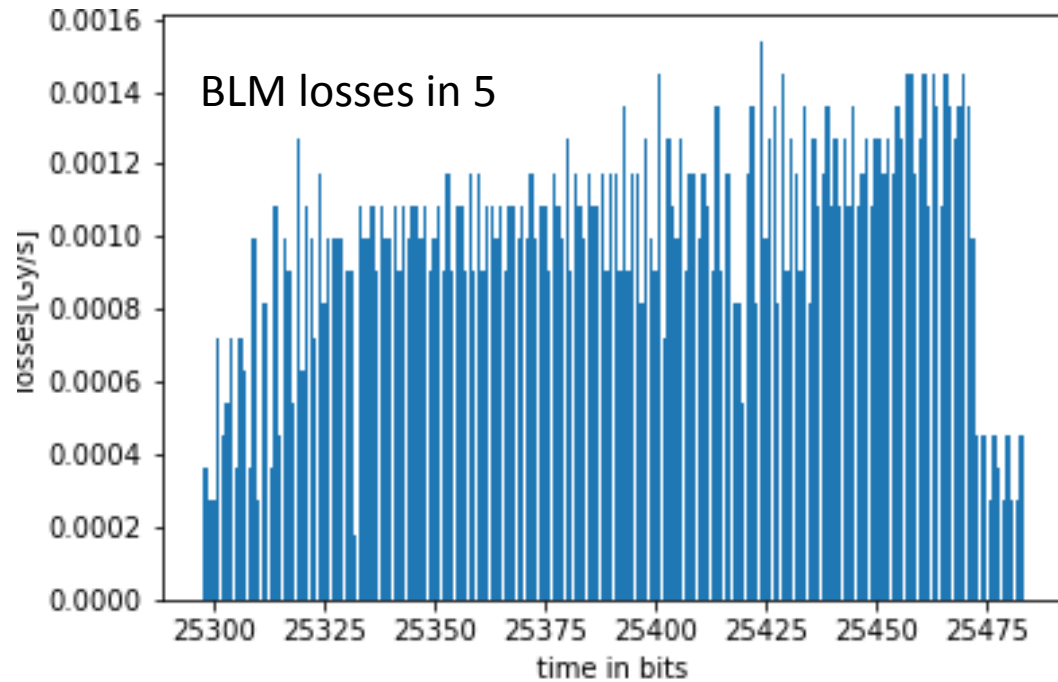
# Ratio of BLM 1/4



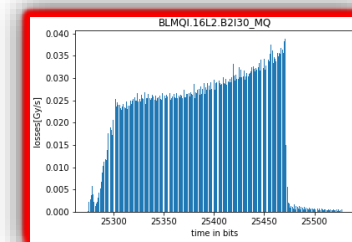
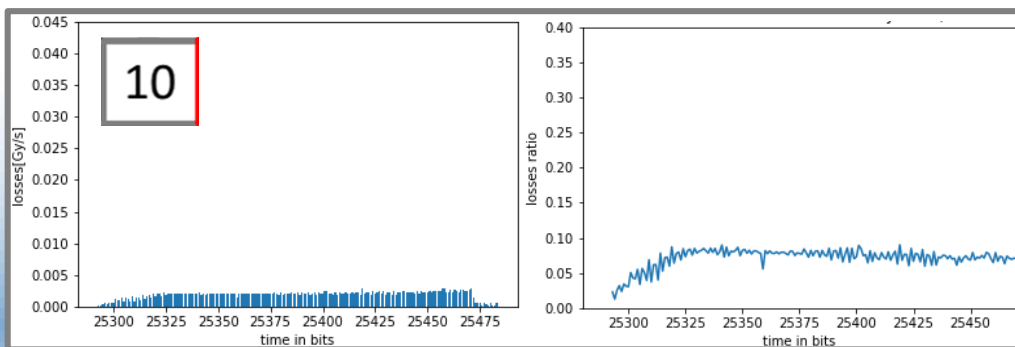
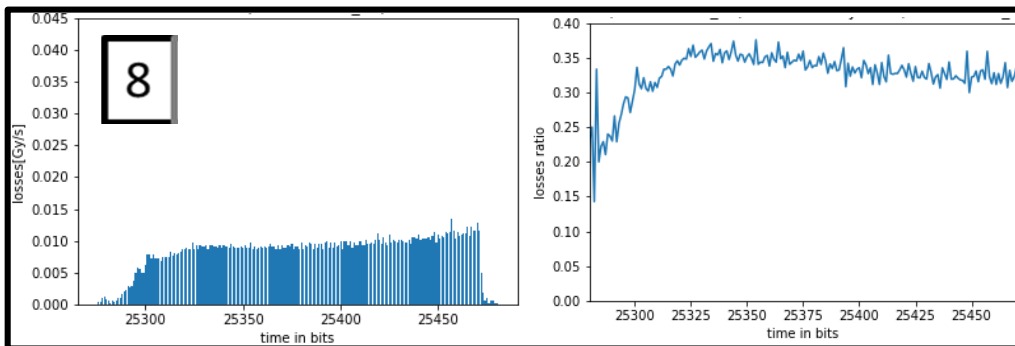
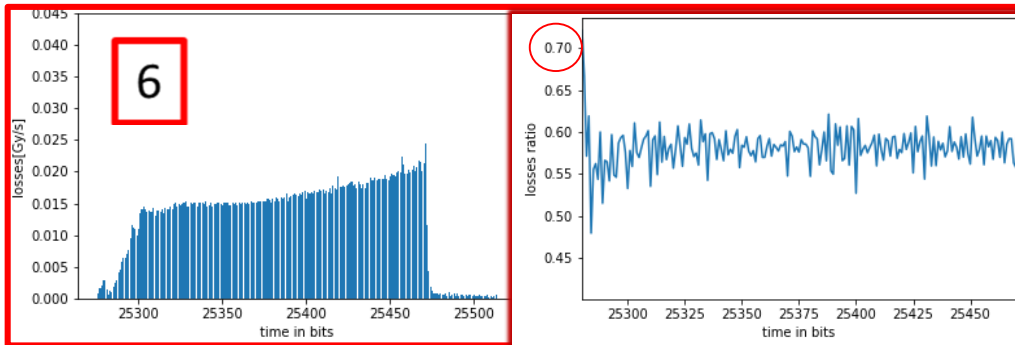
# Ratio of BLM 3/4



# Ratio of BLM 5/4

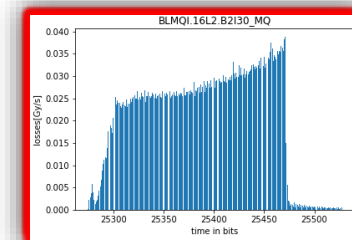
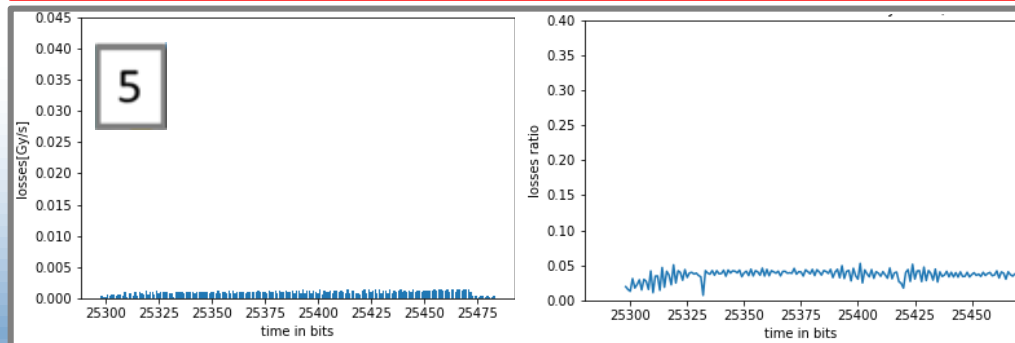
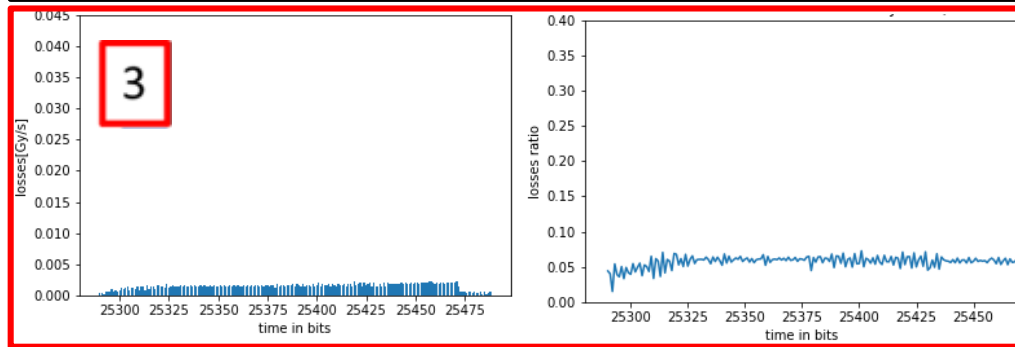
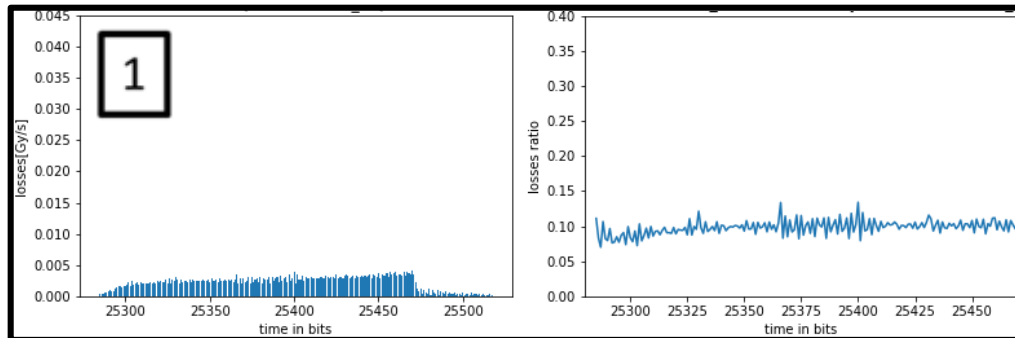


# Comparison on same axes for B2





# Comparison on same axes for B1



## Observation of loss patterns from first dump confirmed by second dump:

- Neighboring BLMs show losses
- The **ratio is rising** for many of the neighboring BLMs
- This means that the **losses increase with time wrt BLM with highest signal**
- This could indicate **longitudinal expansion of matter** into the beam
- This **supports theory of UFO type 2** (maybe caused by evaporation/explosion/atom cloud)

**THANK YOU FOR YOUR ATTENTION!**



# 16L2 PM data ratio plots

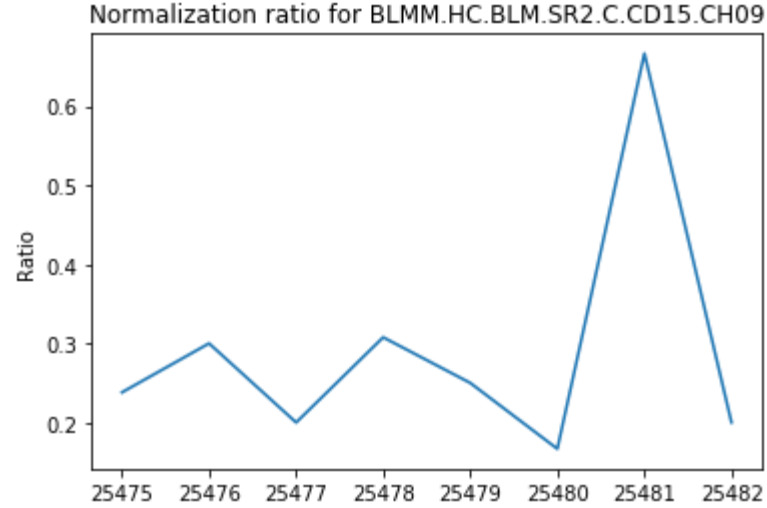
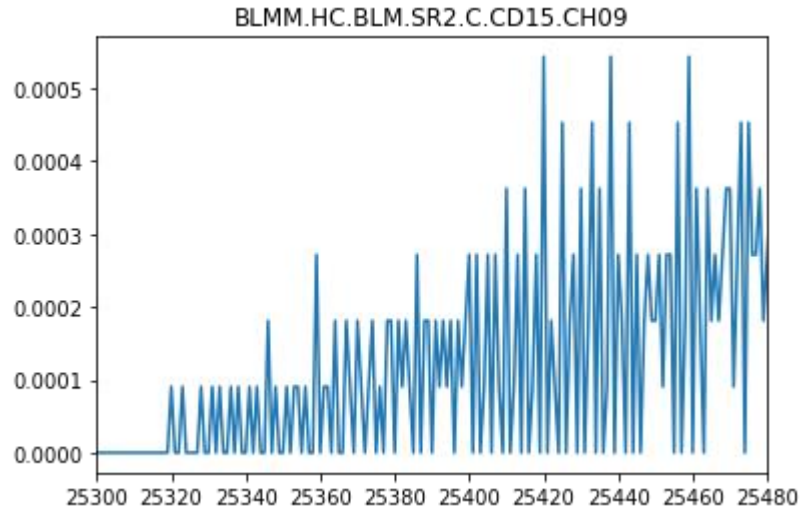
By Martyna Dziadosz

06-SEP-2017

20.19.55.45

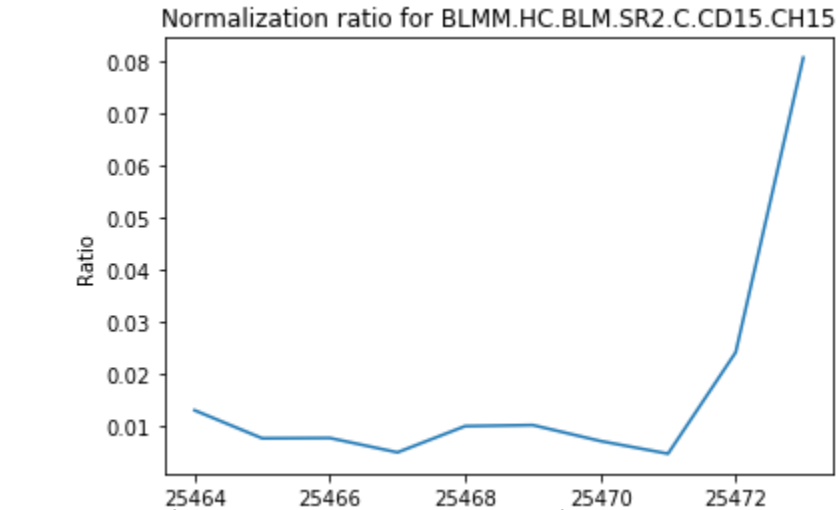
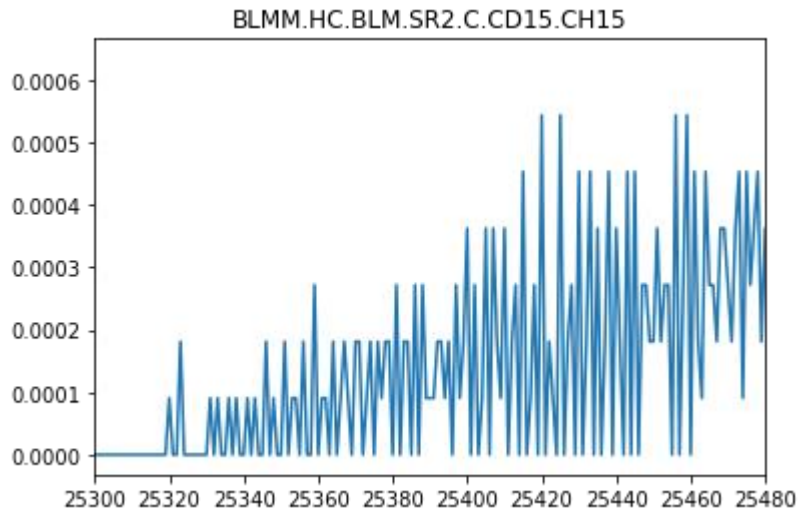
B1 losses

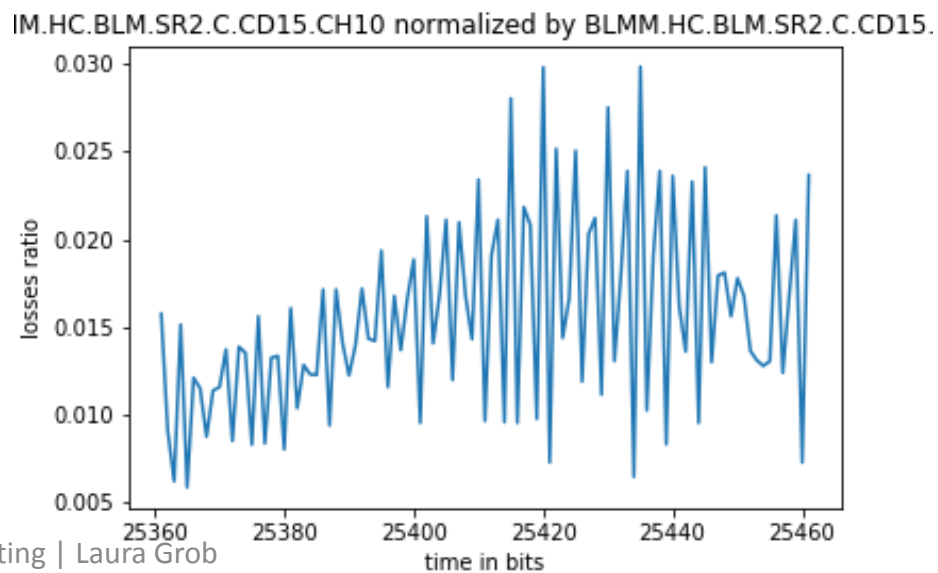
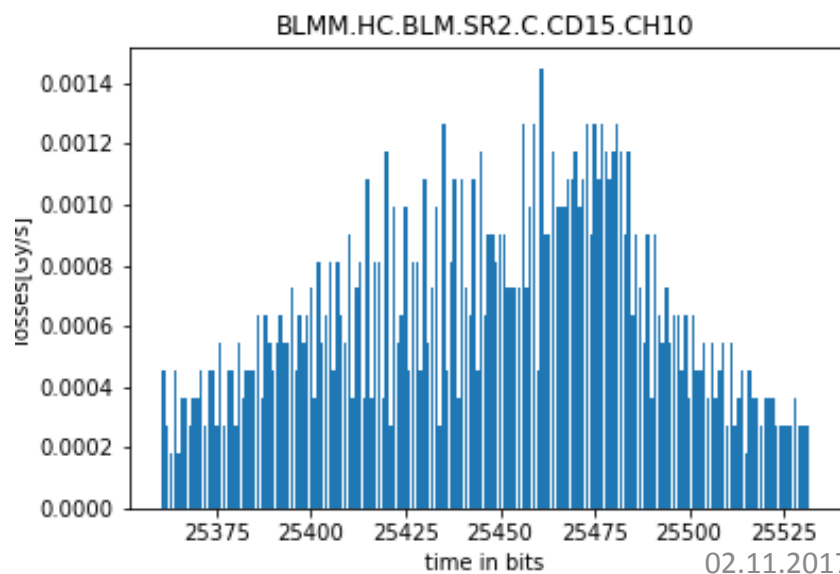
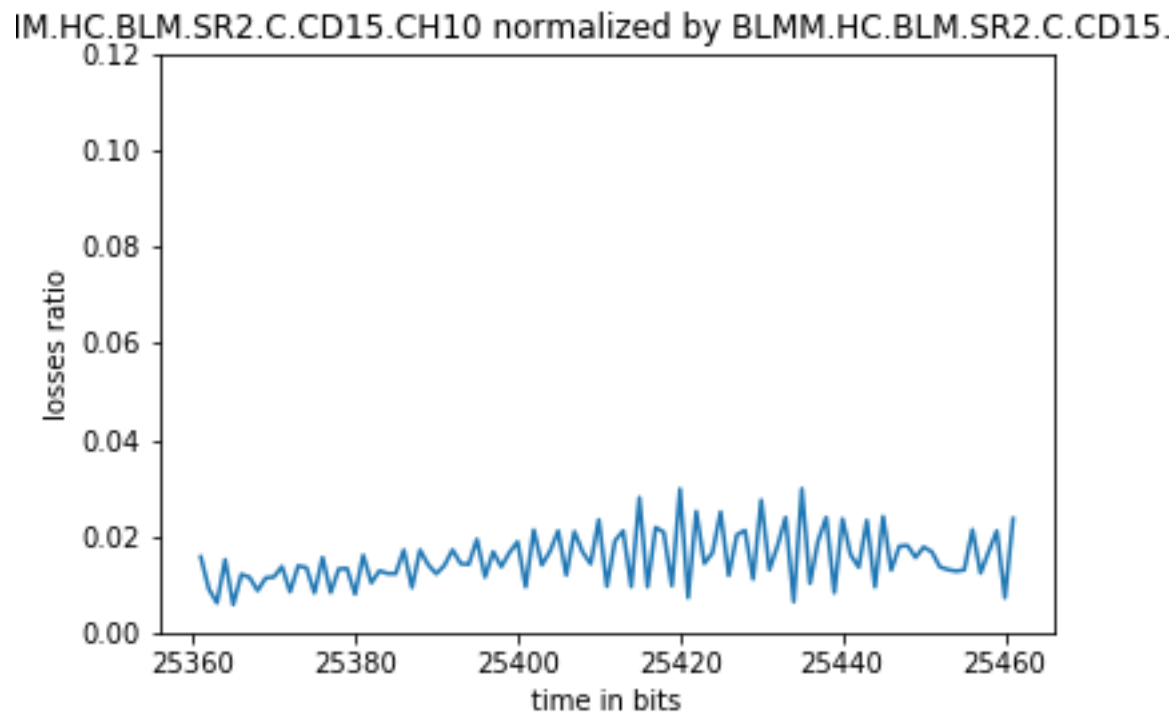
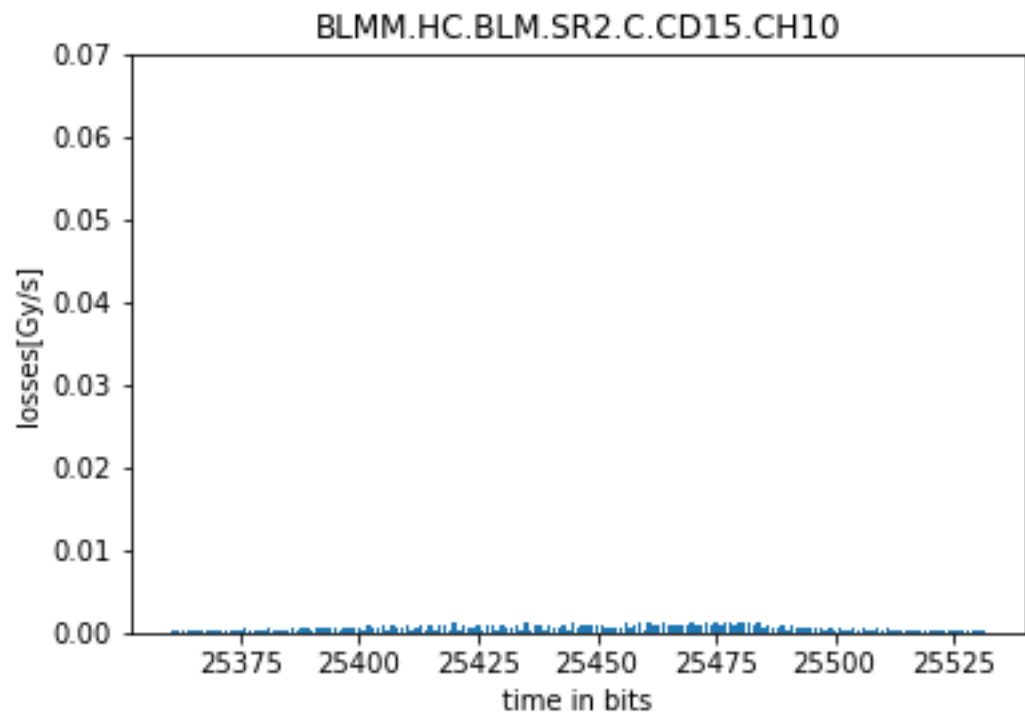
# BLMM.HC.BLM.SR2.C.CD15.CH09

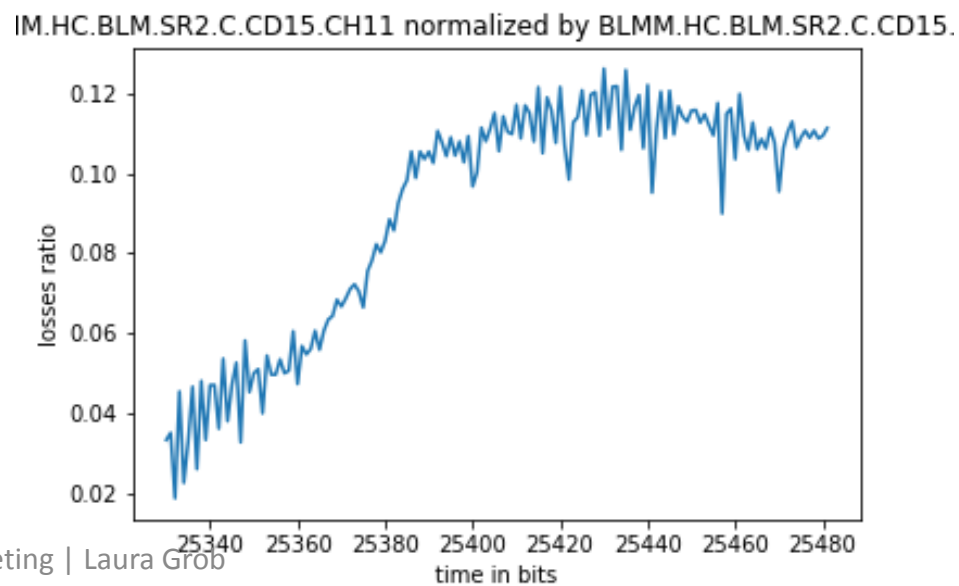
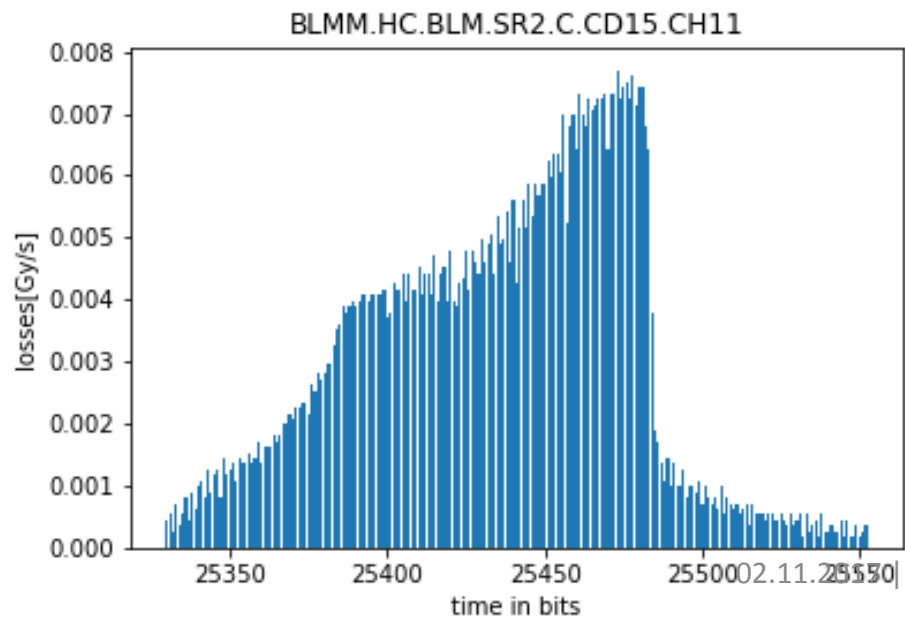
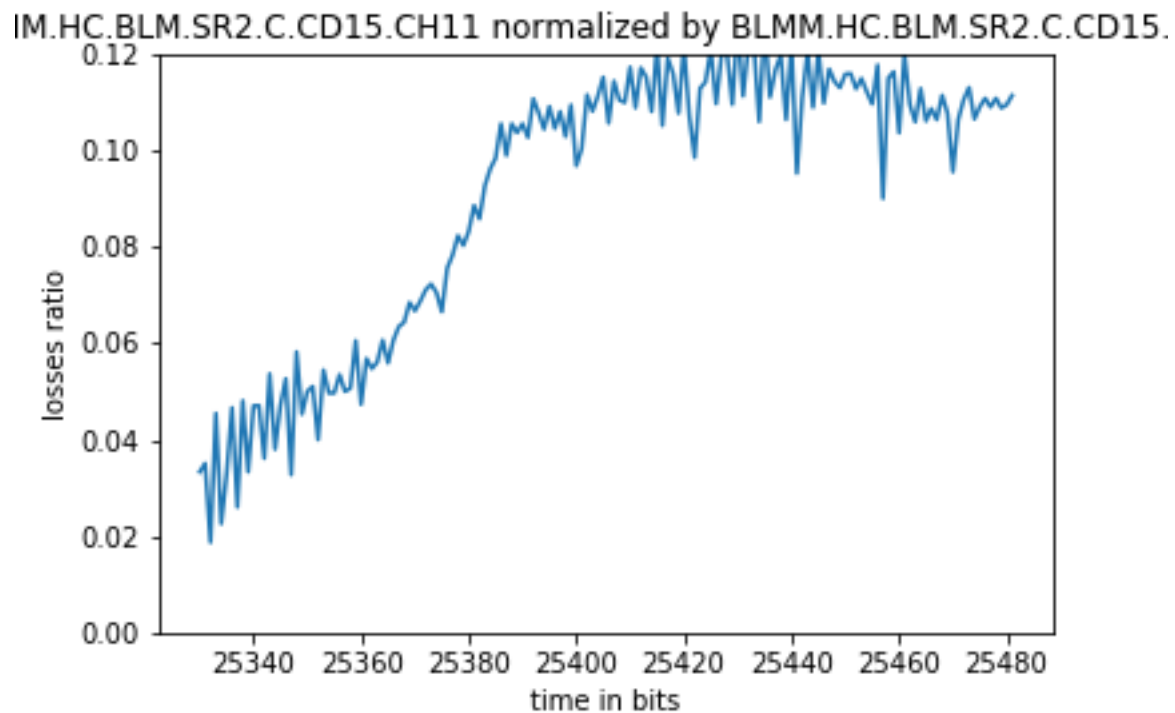
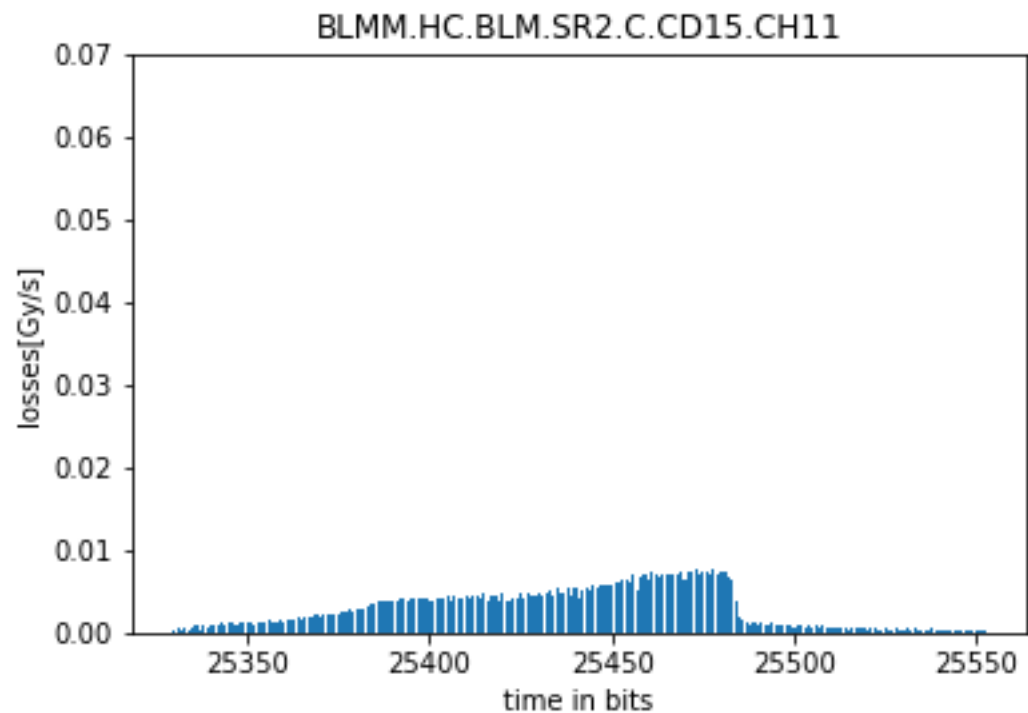


**MISSING  
PLOTS**

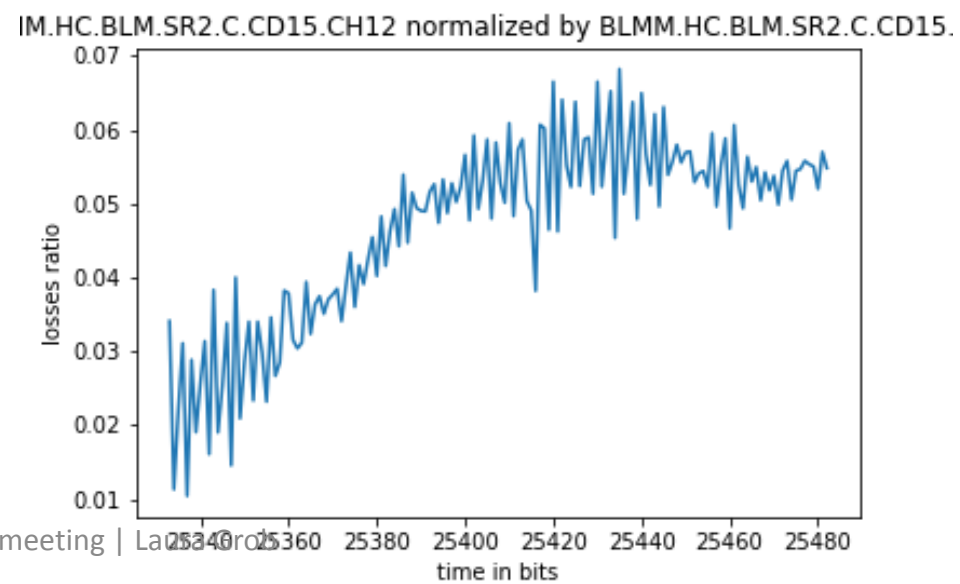
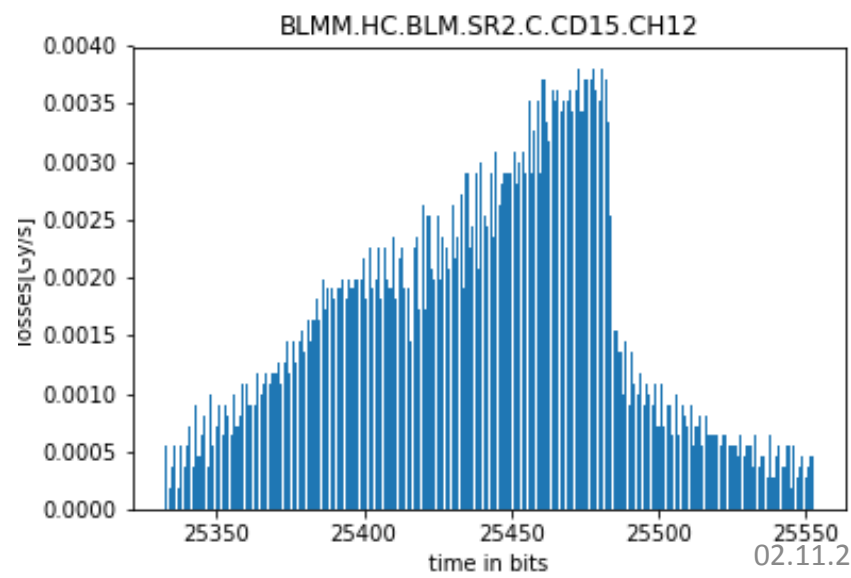
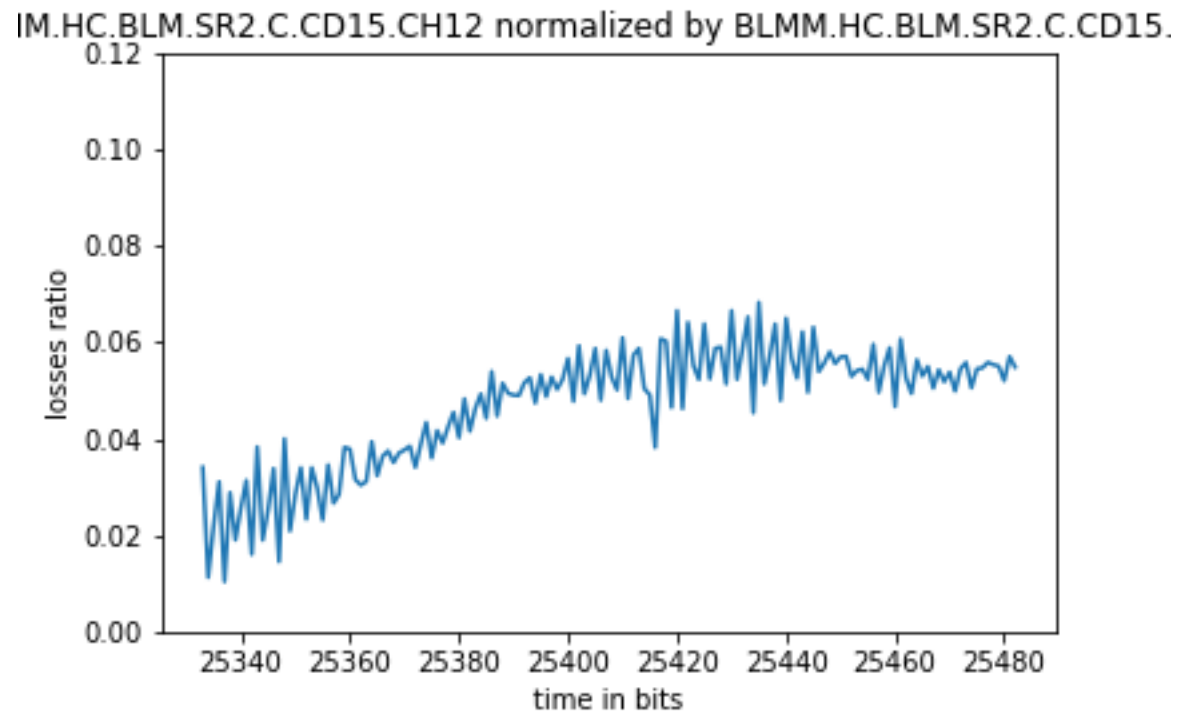
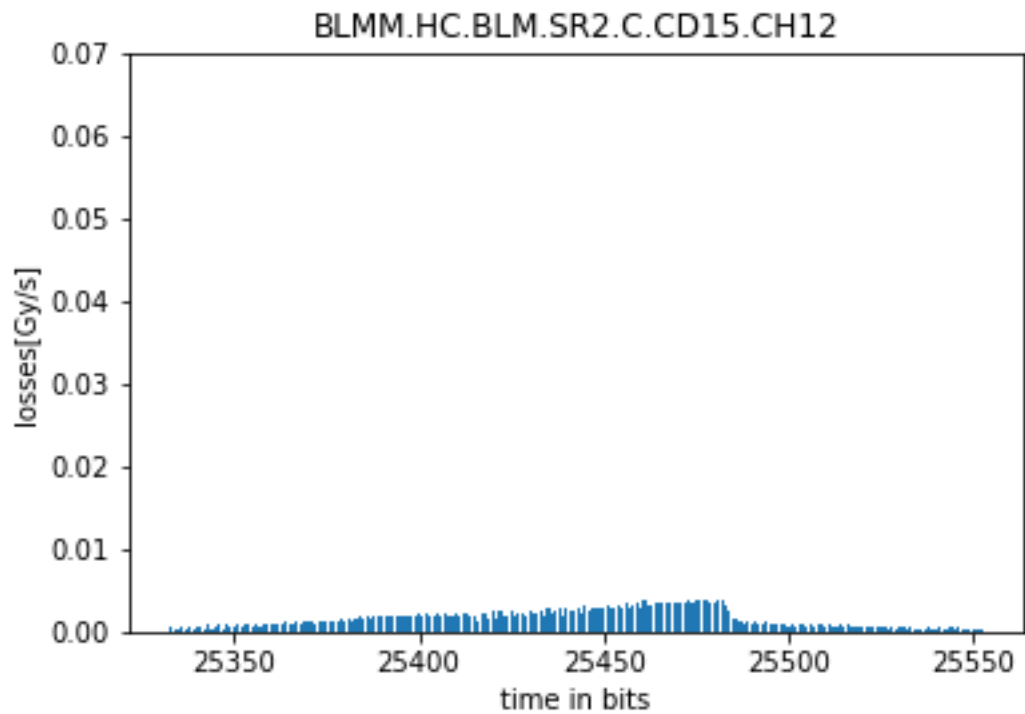
# BLMM.HC.BLM.SR2.C.CD15.CH15CH15

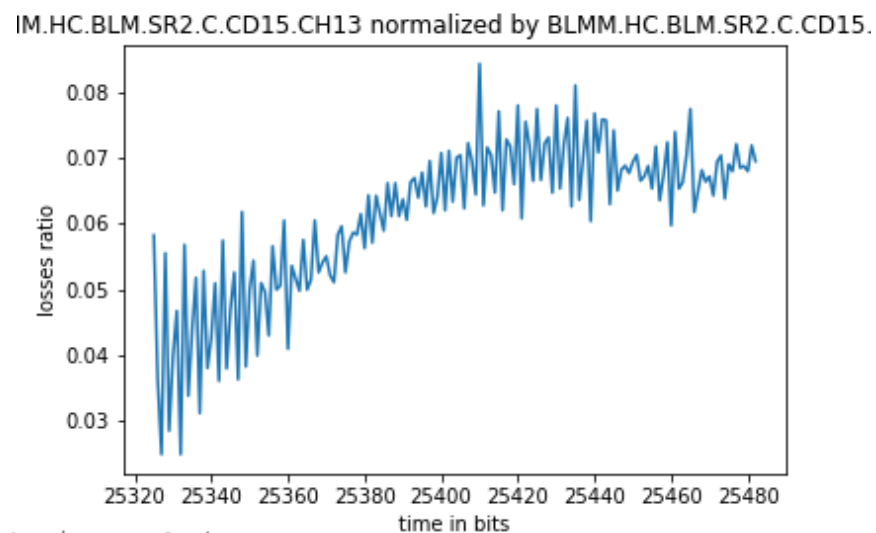
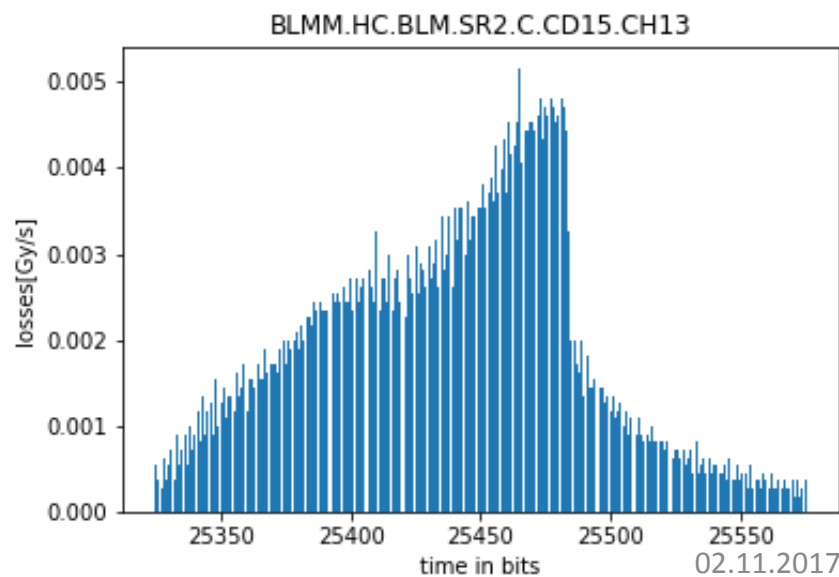
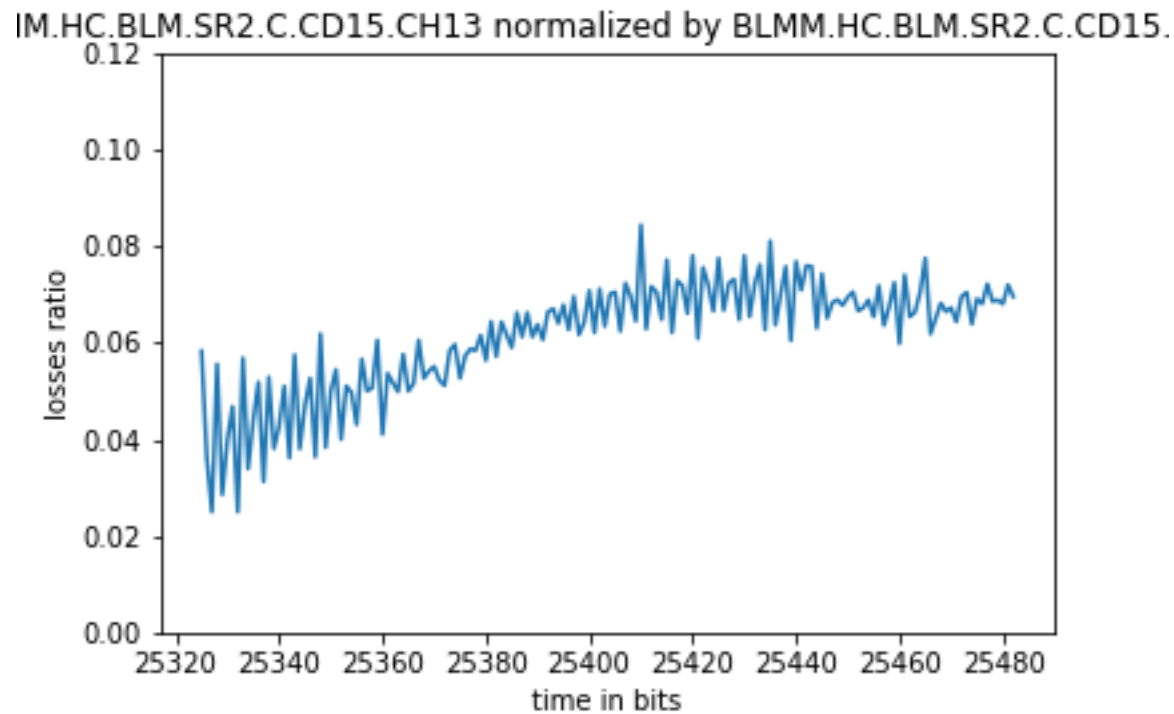
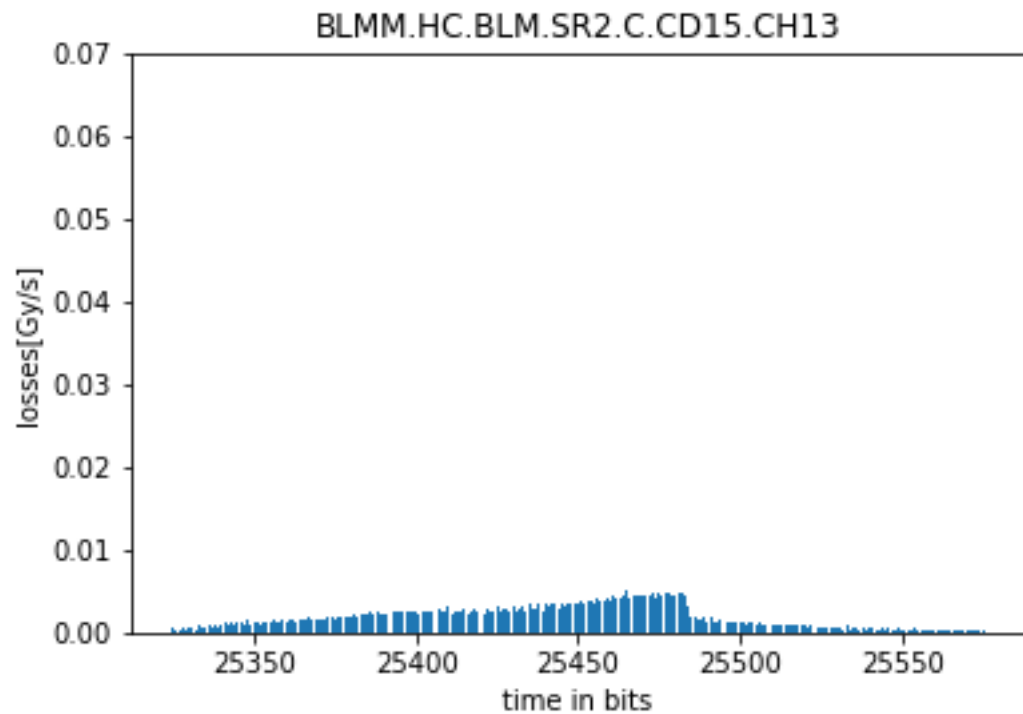


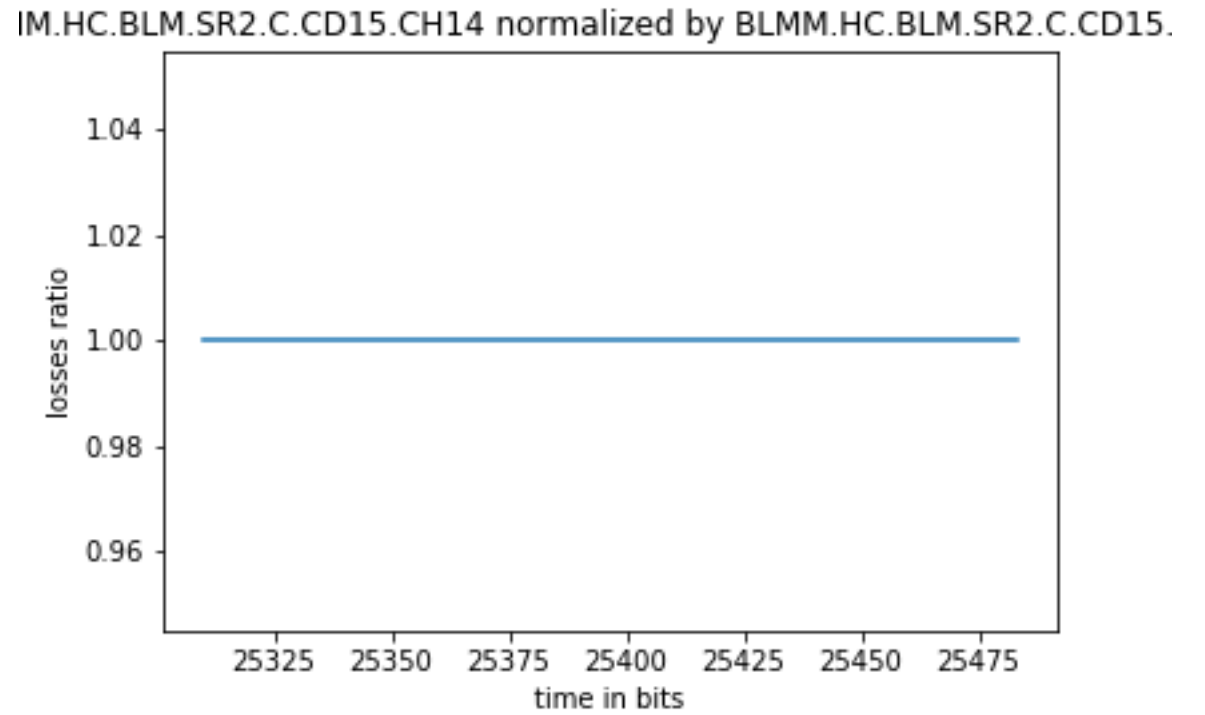
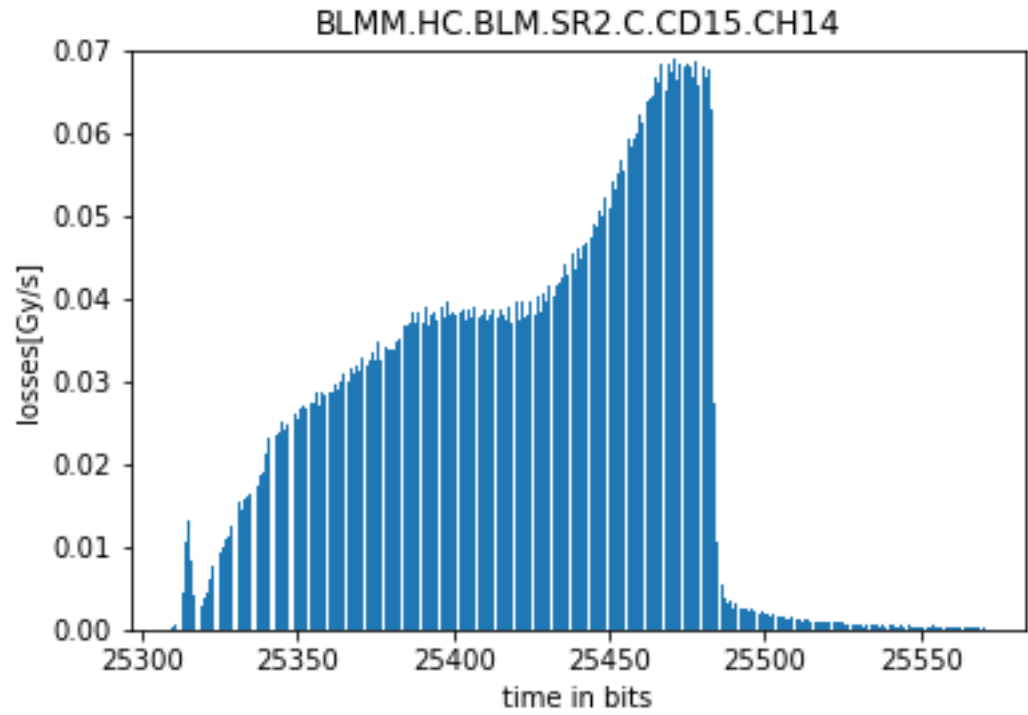




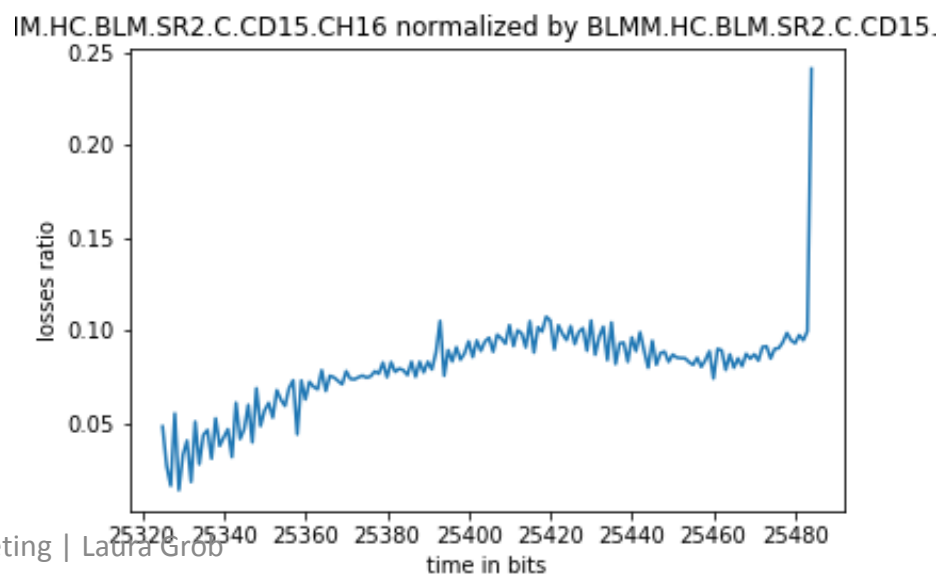
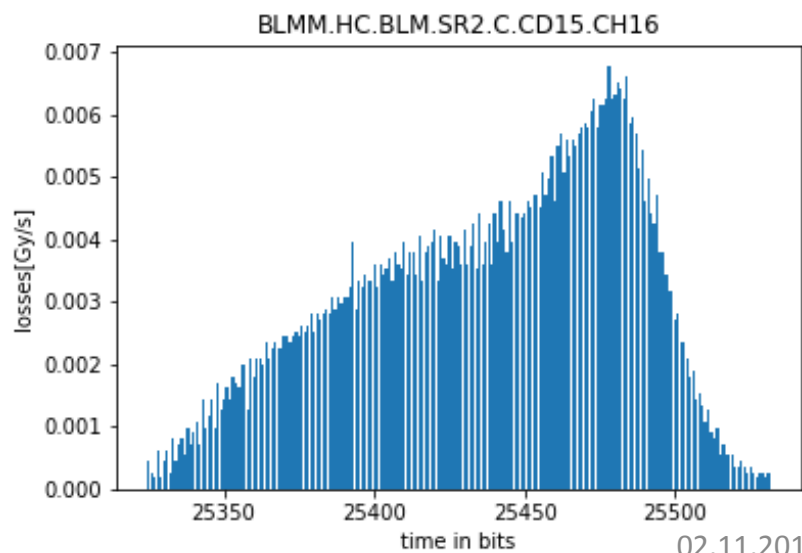
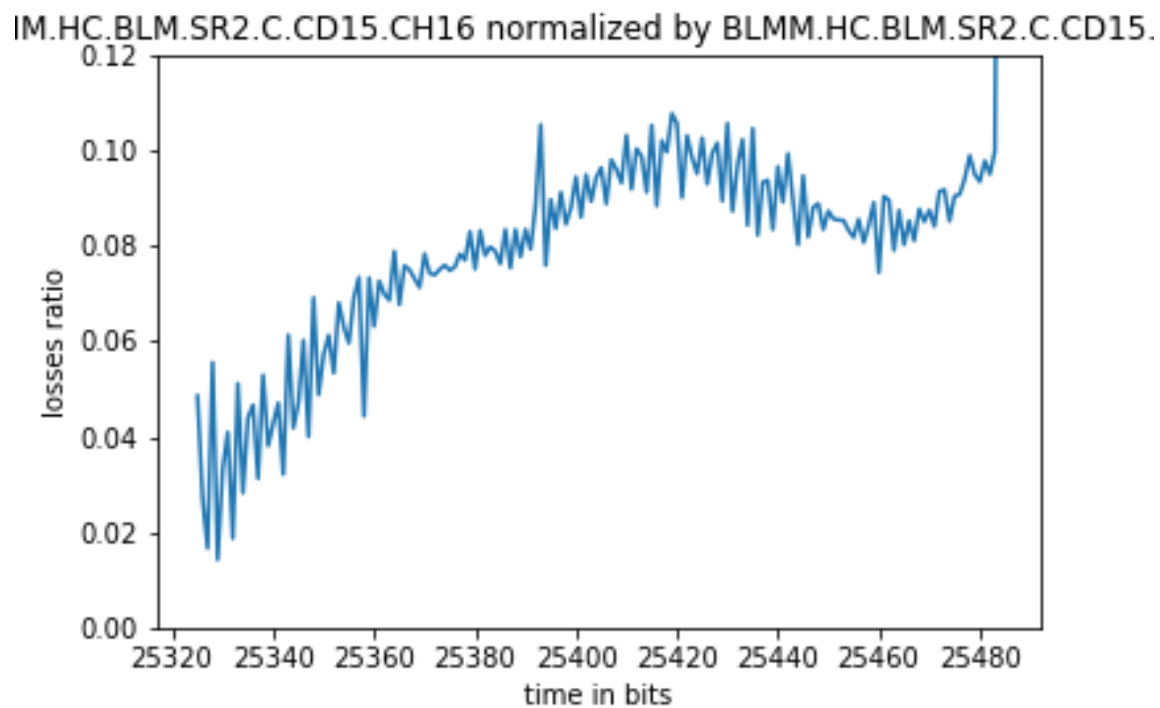
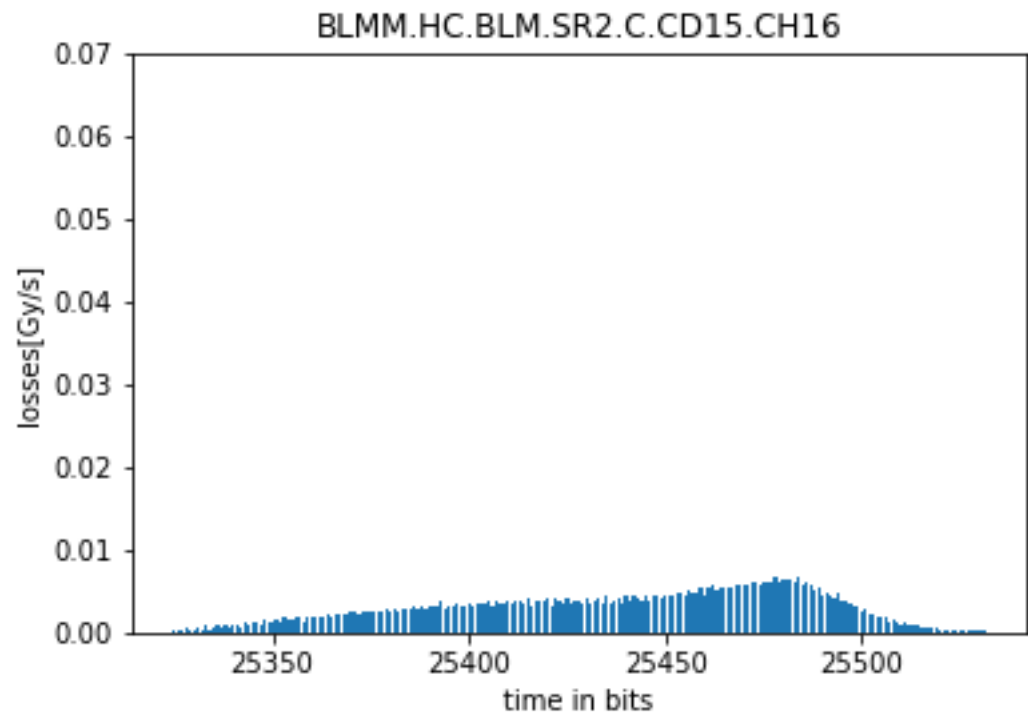


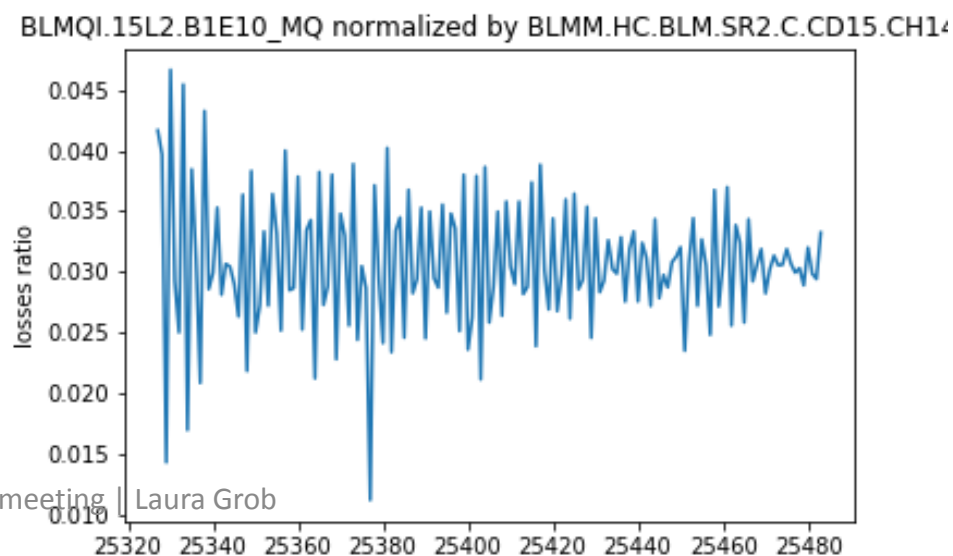
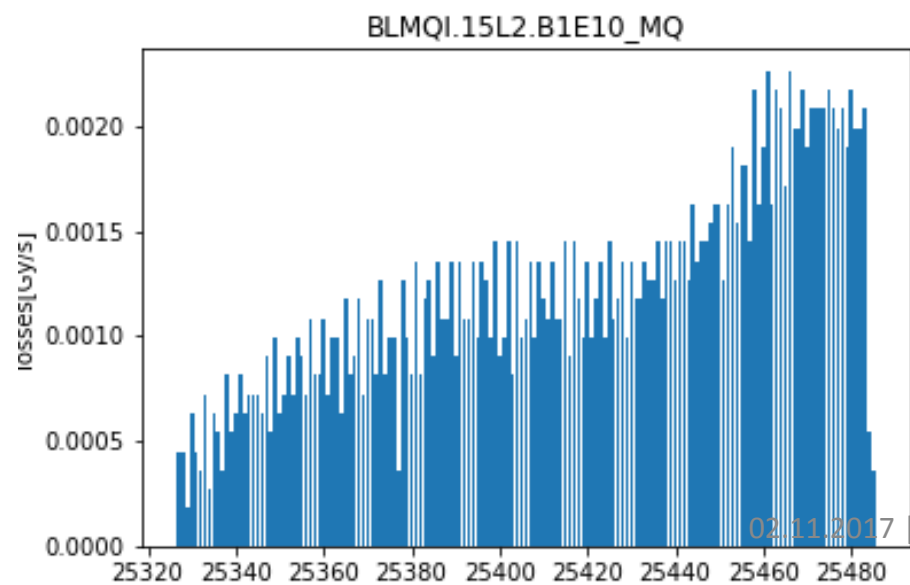
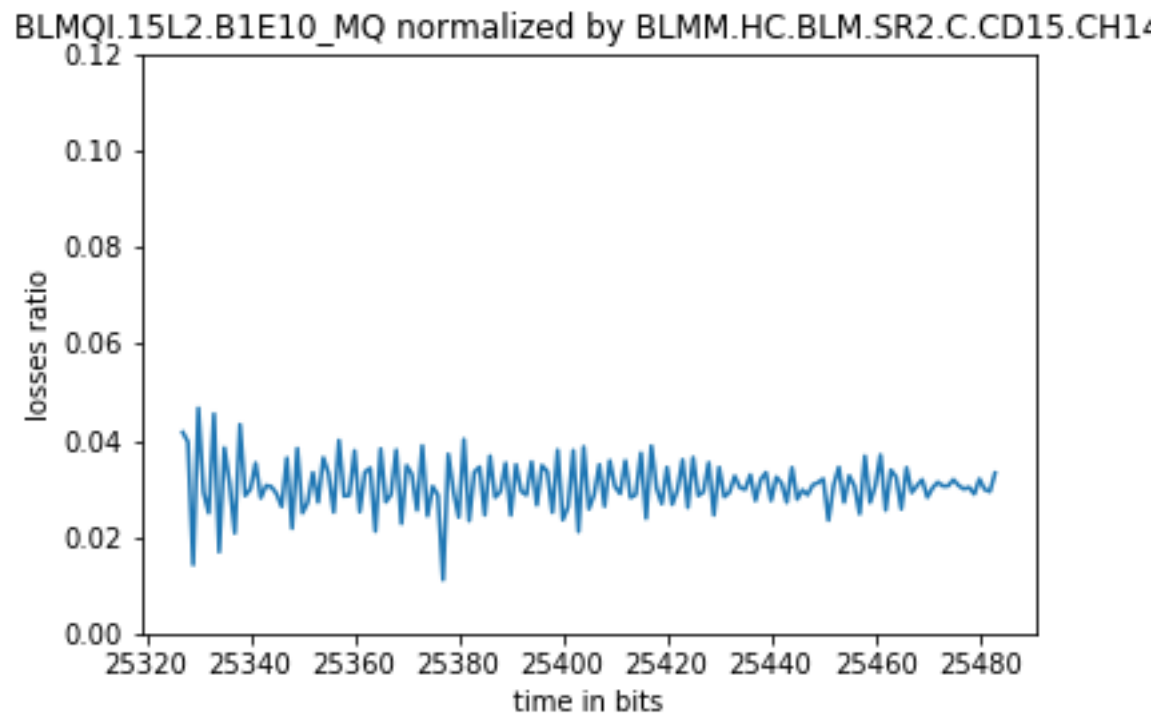
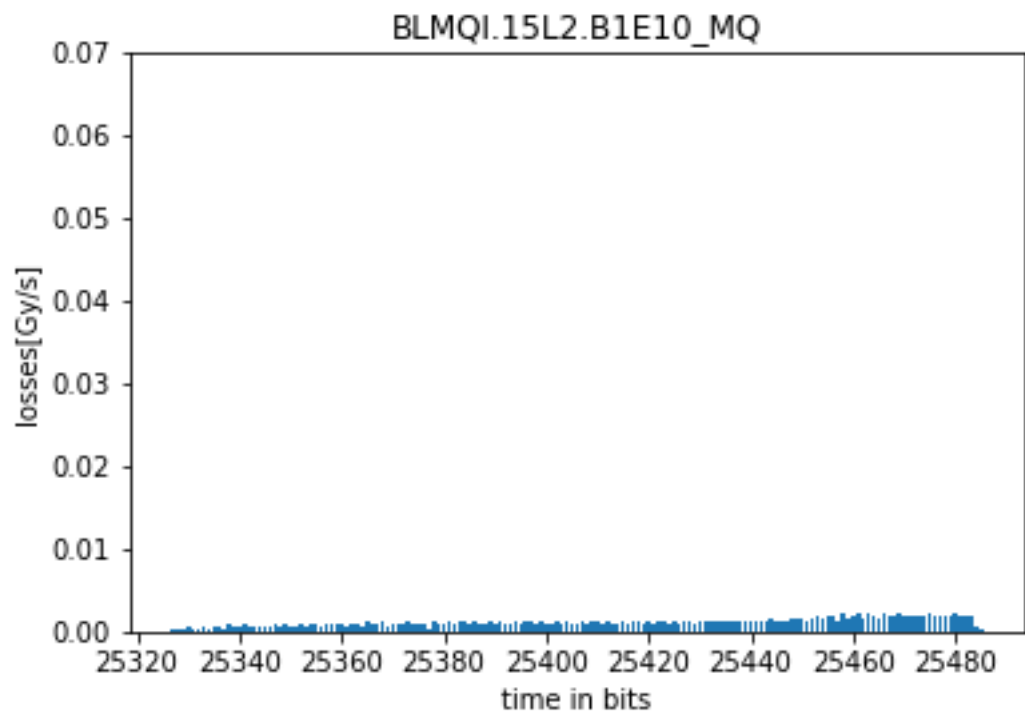


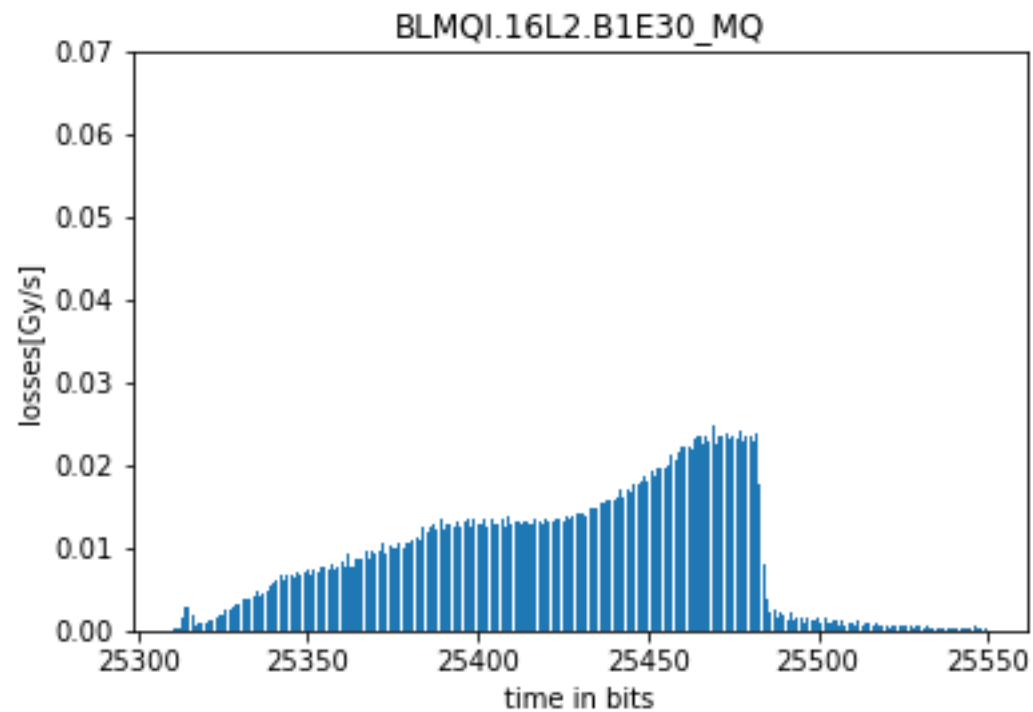




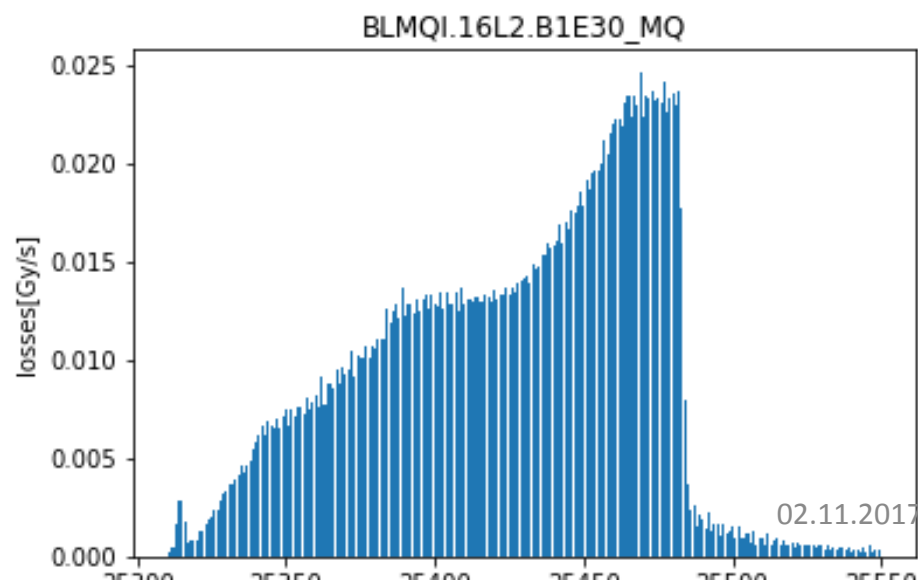
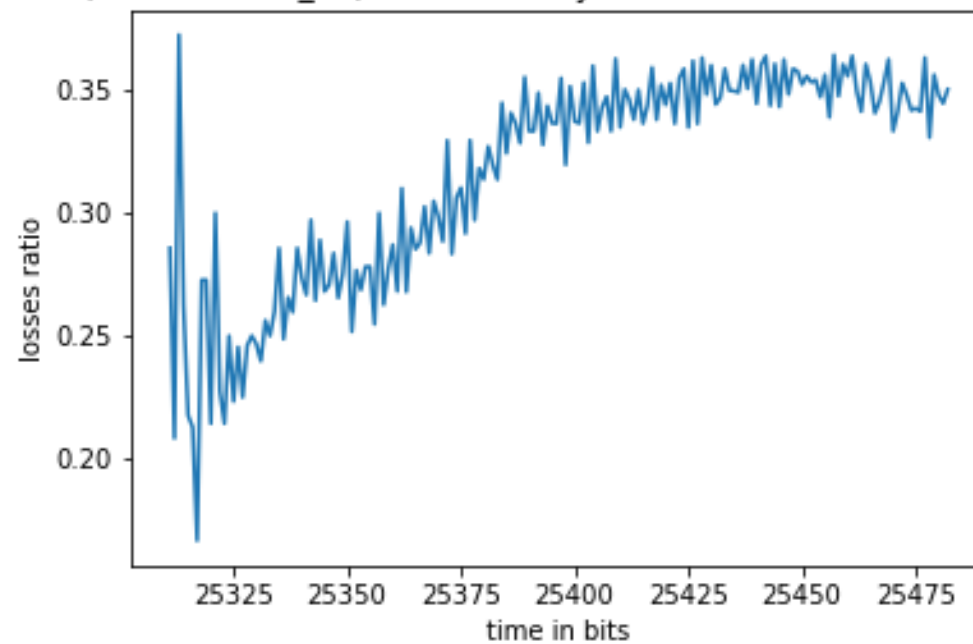
**NORMALIZATION**  
**BLM !!!**

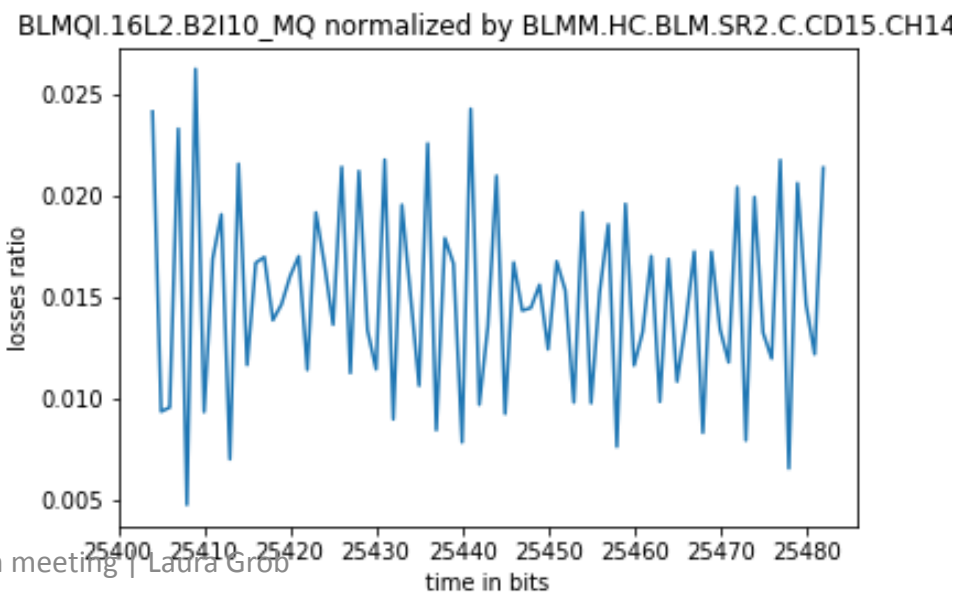
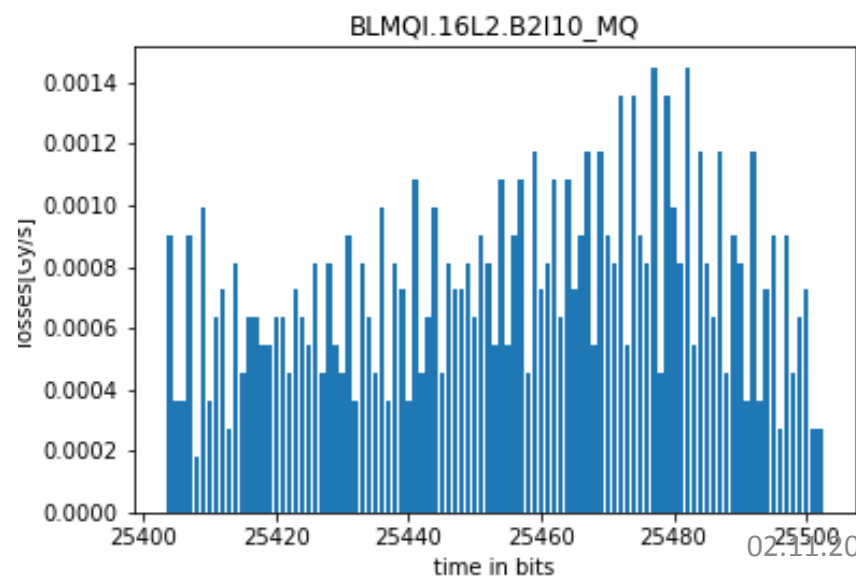
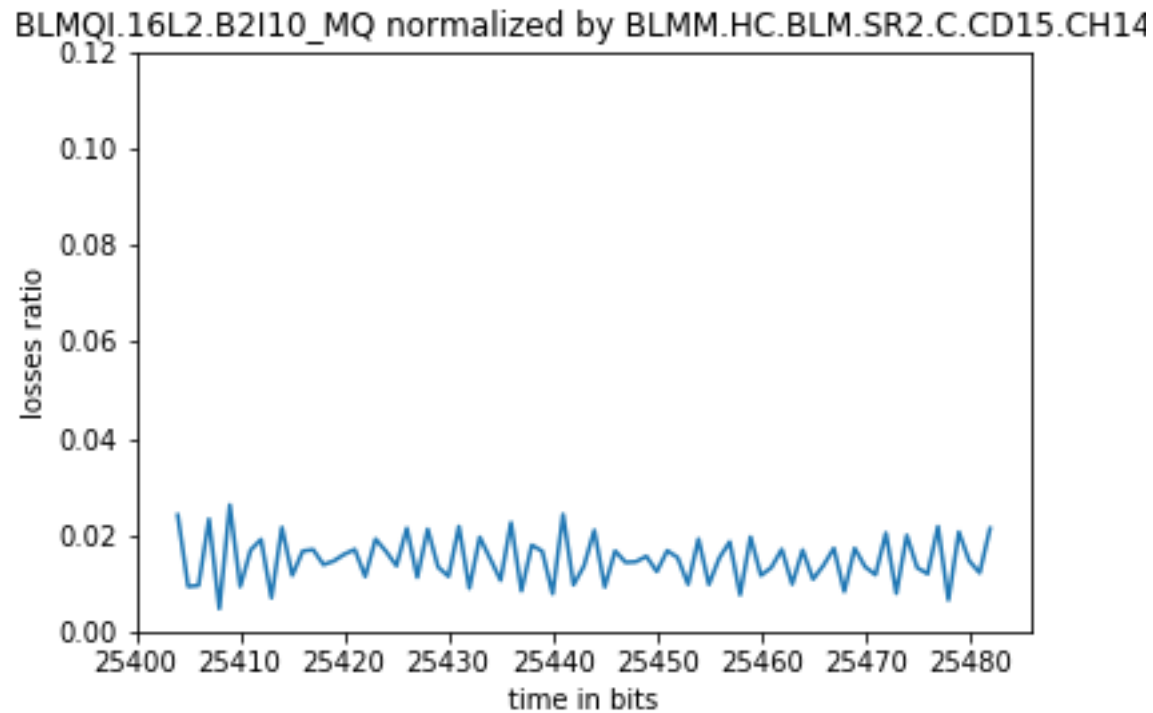
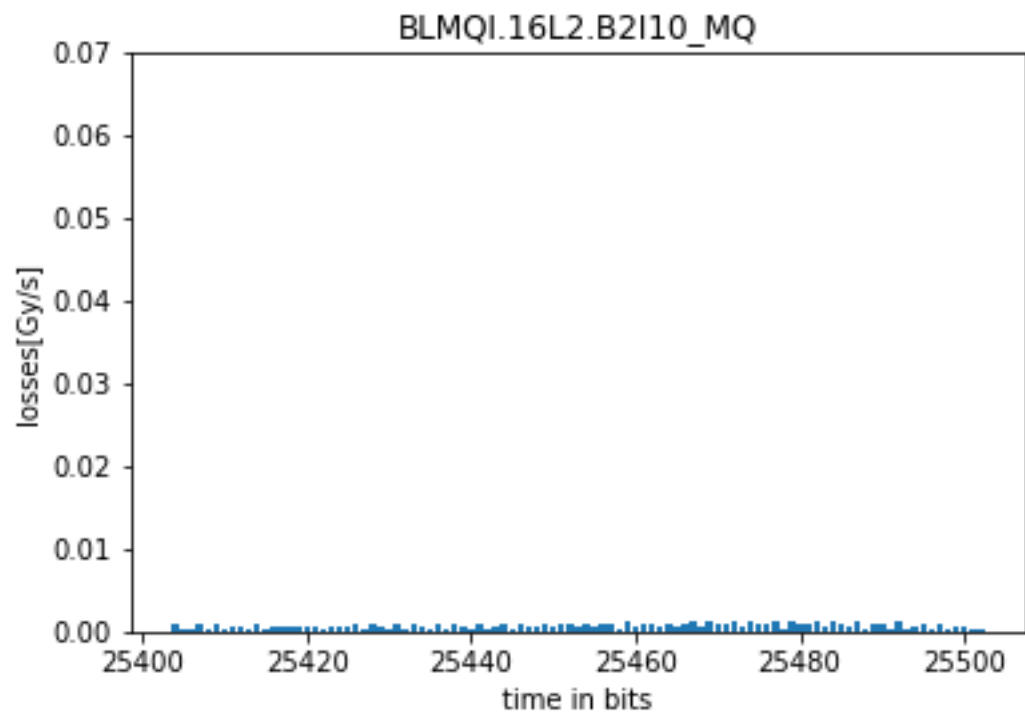






BLMQI.16L2.B1E30\_MQ normalized by BLMM.HC.BLM.SR2.C.CD15.CH14

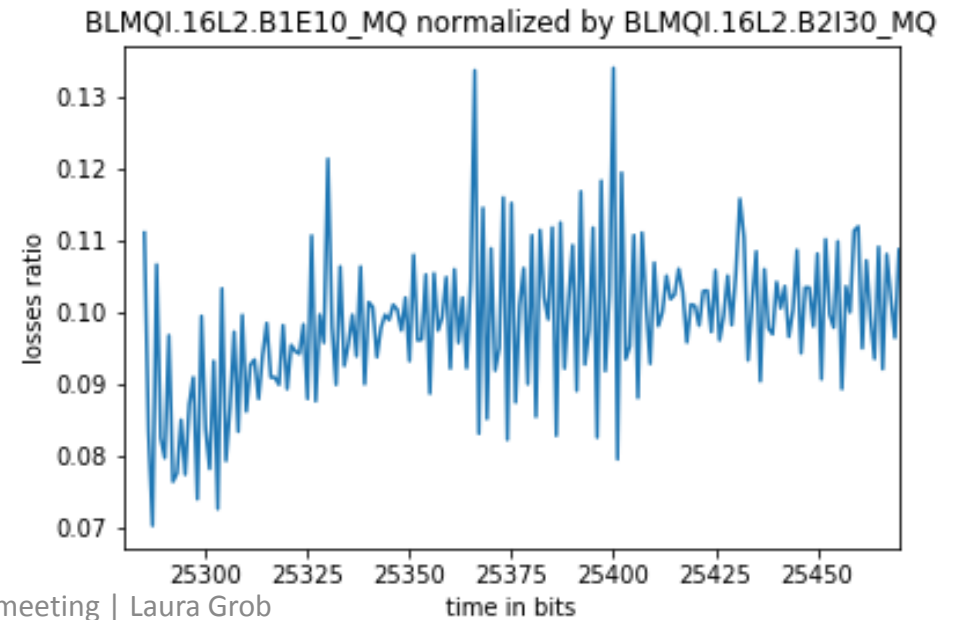
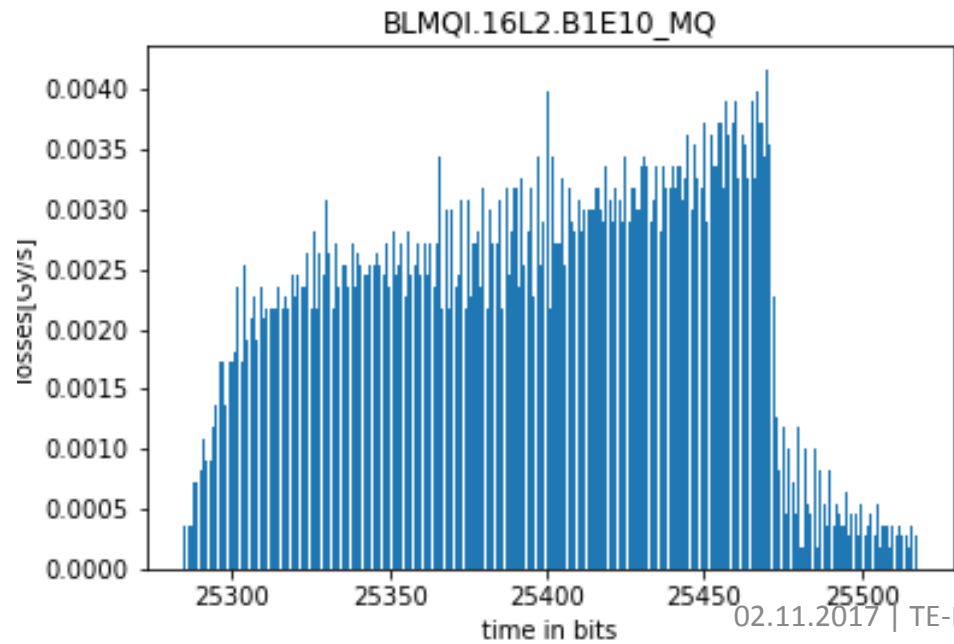
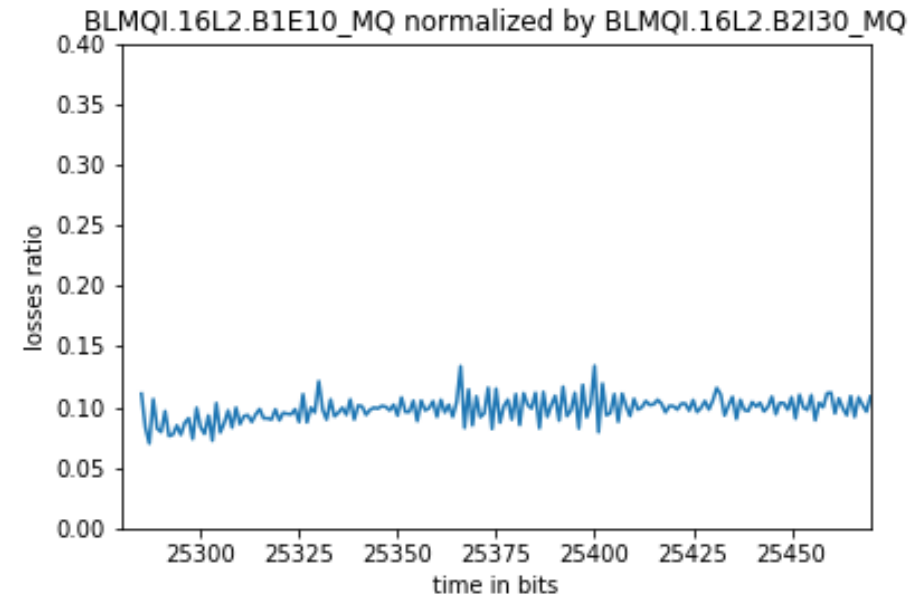
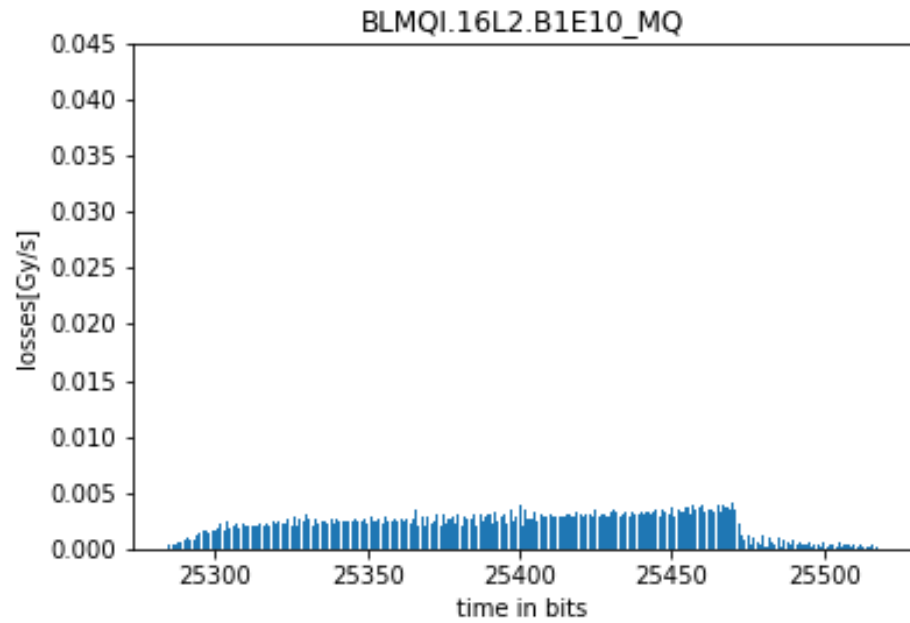


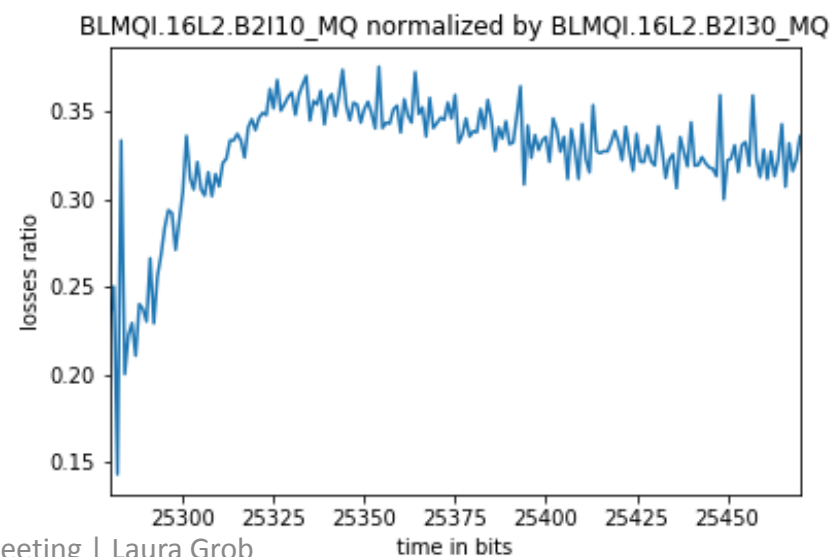
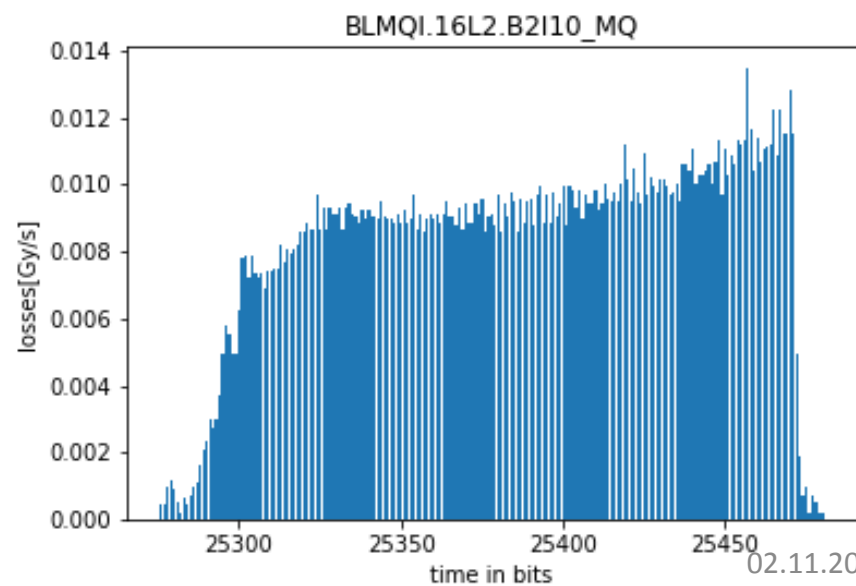
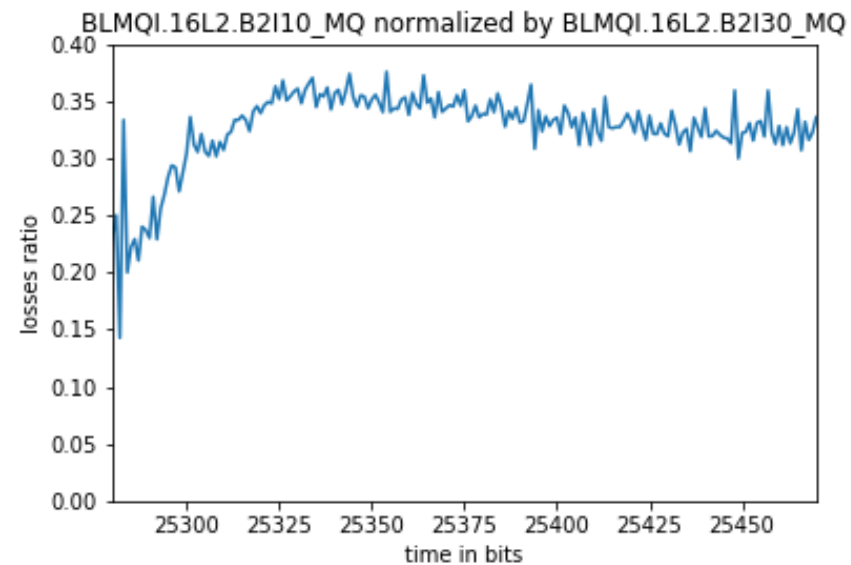
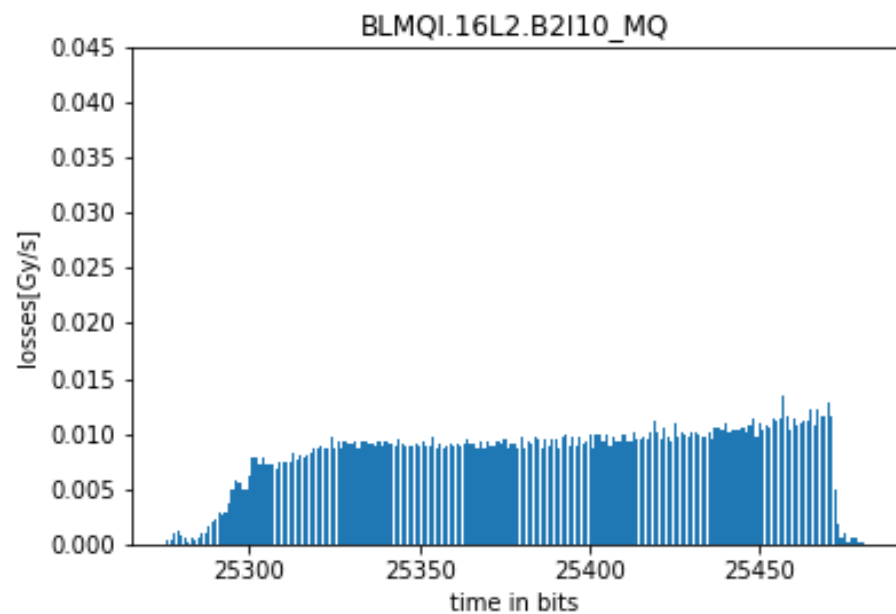


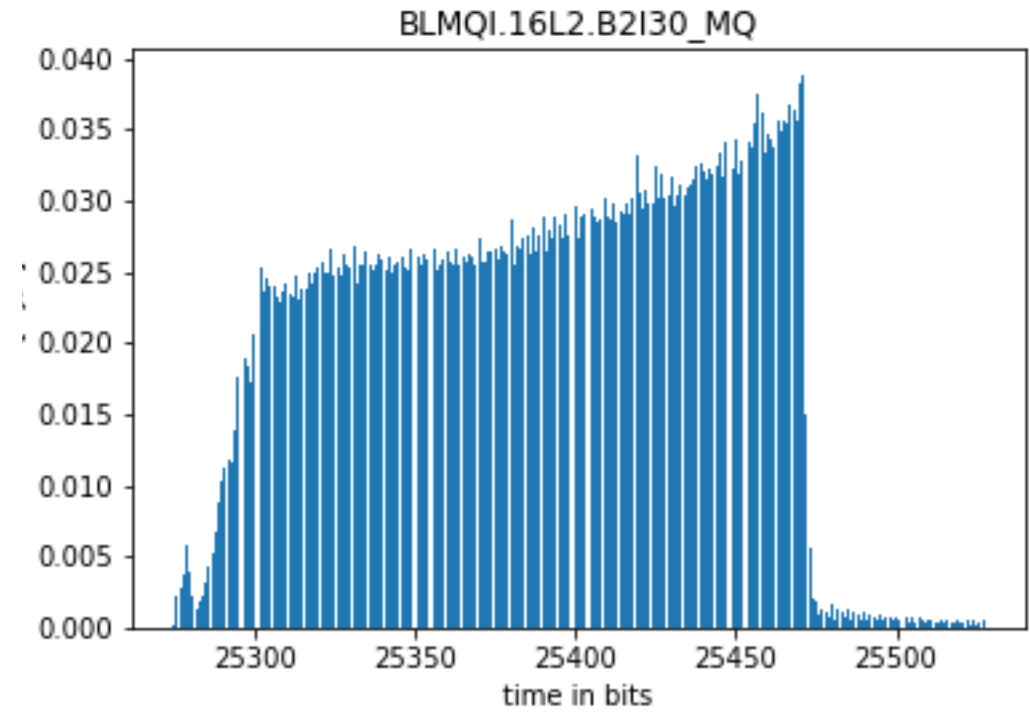
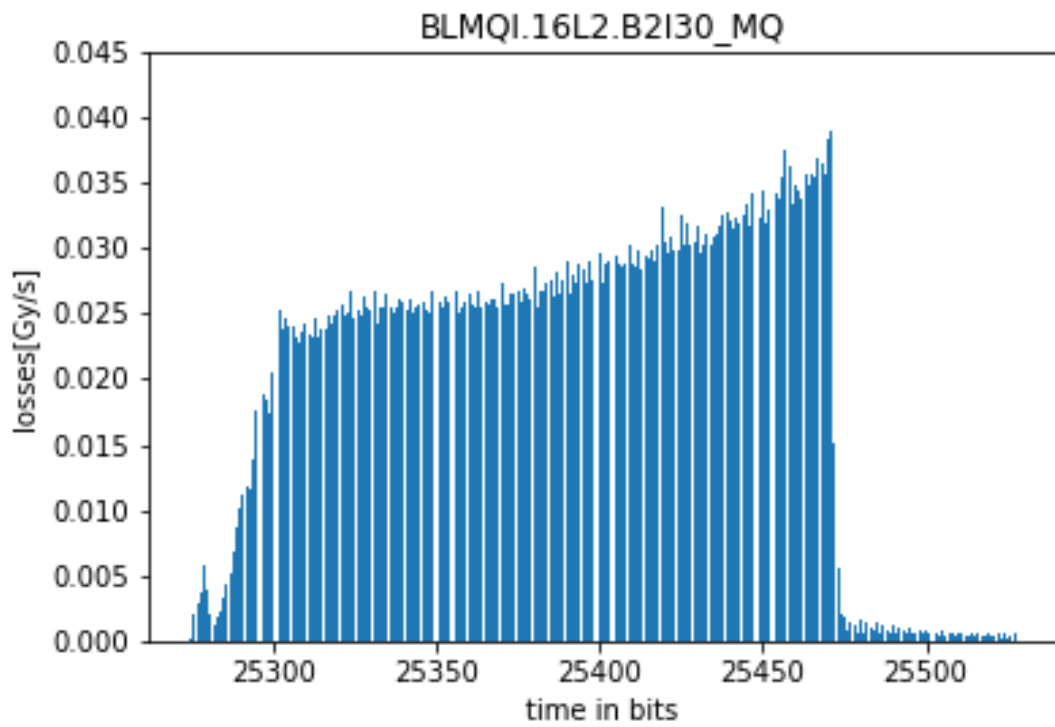
17-AUG-2017

5.03.55.45

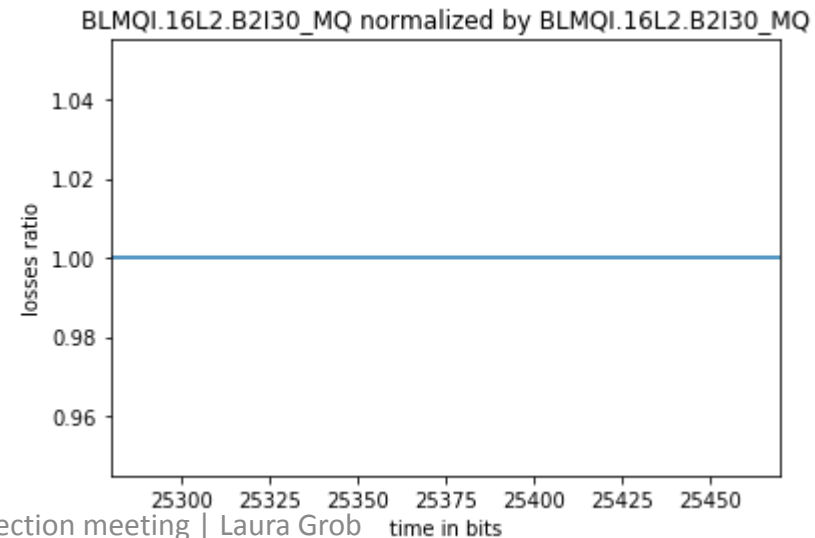


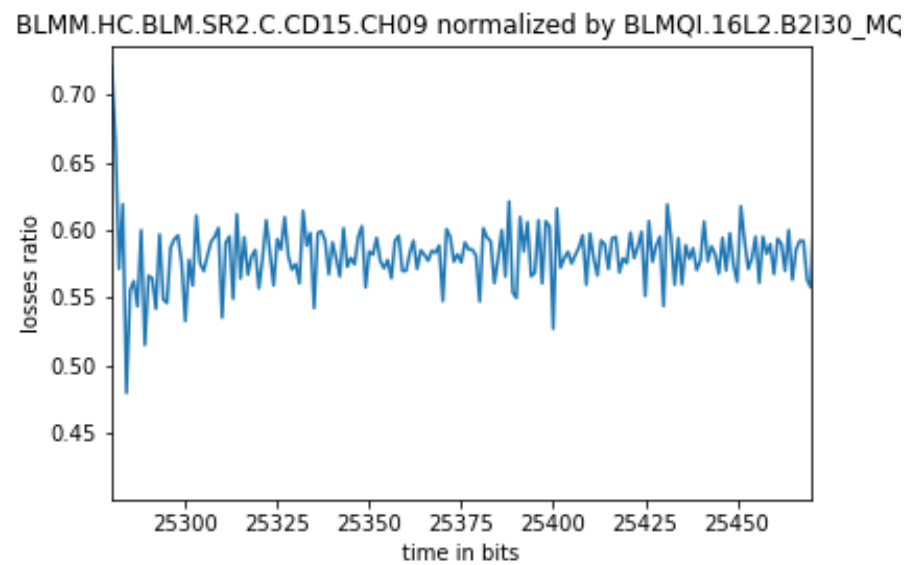
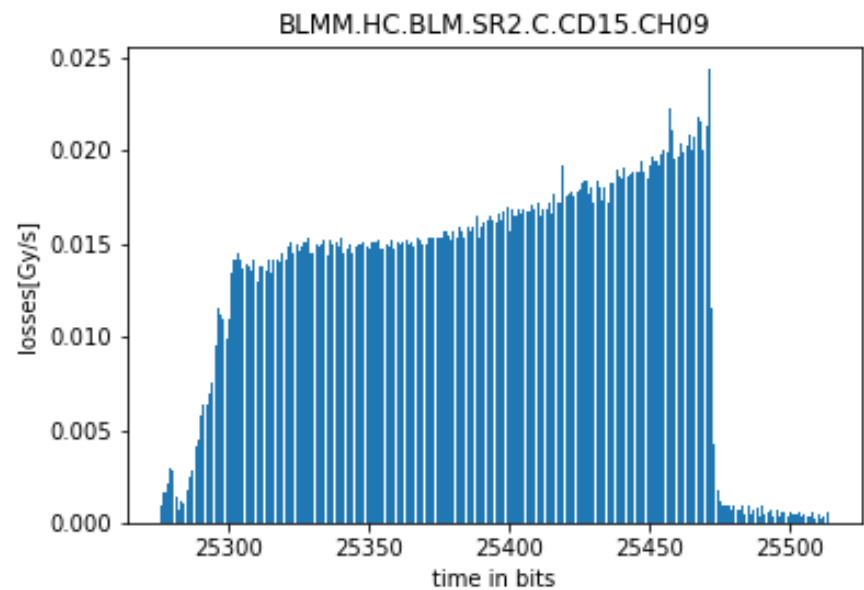
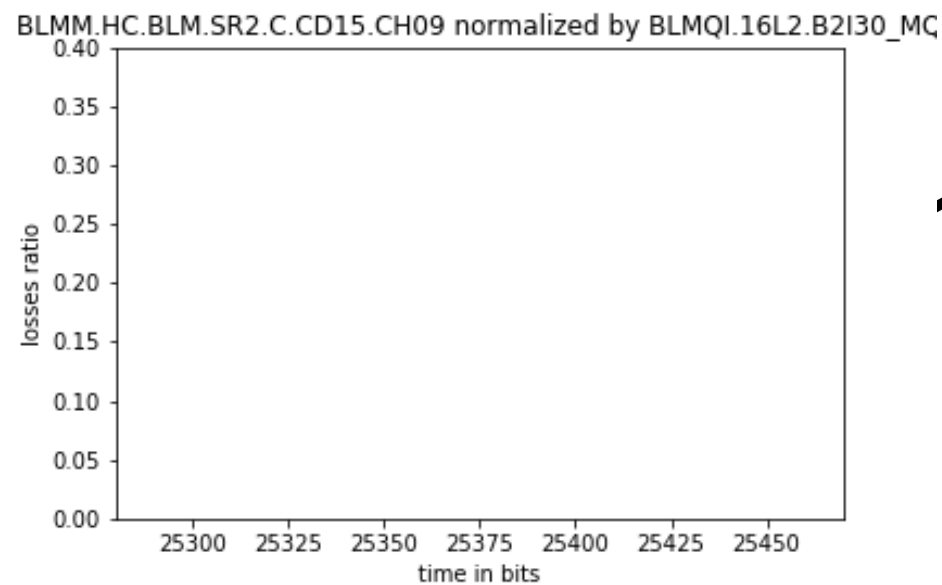
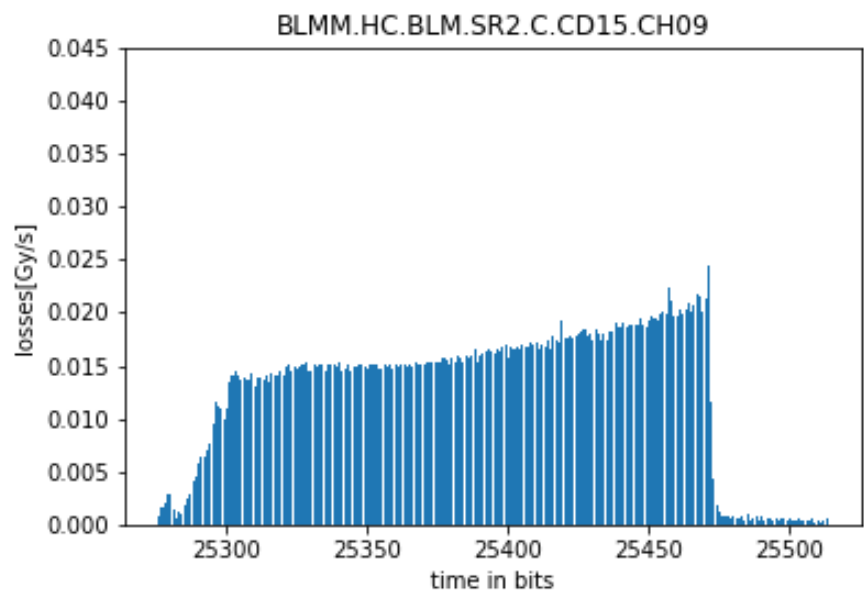


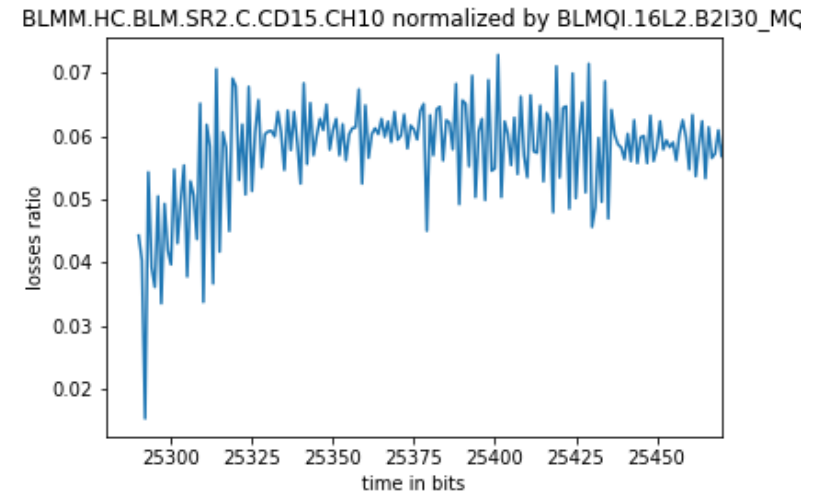
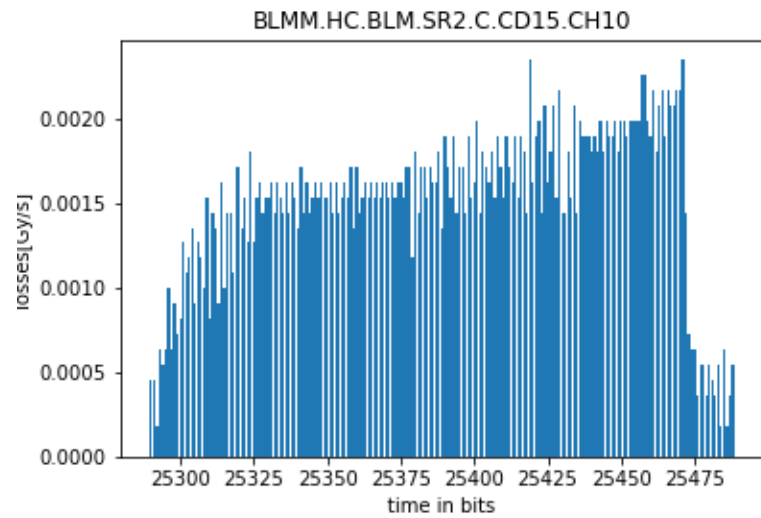
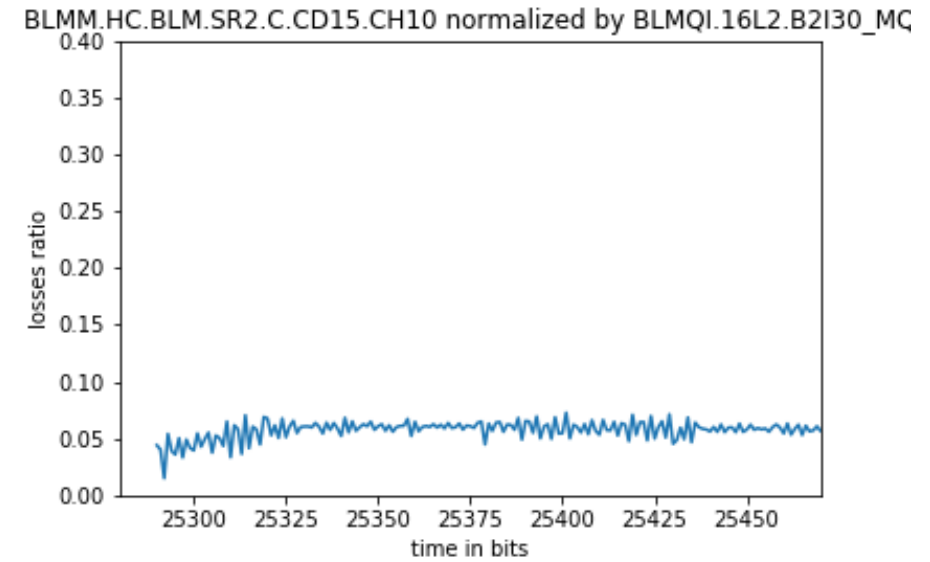
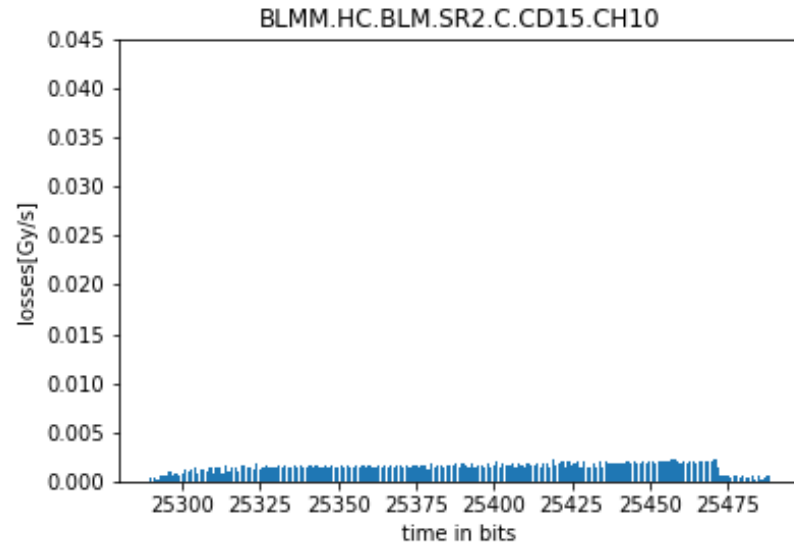


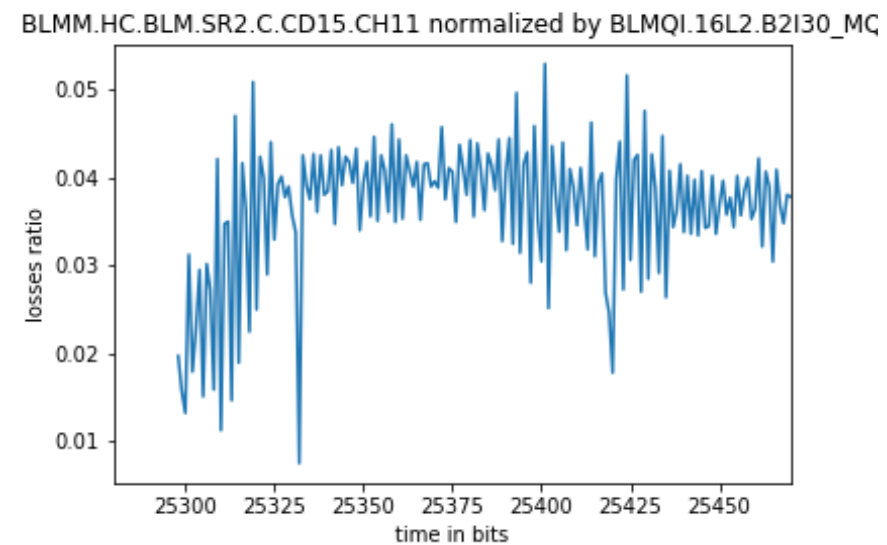
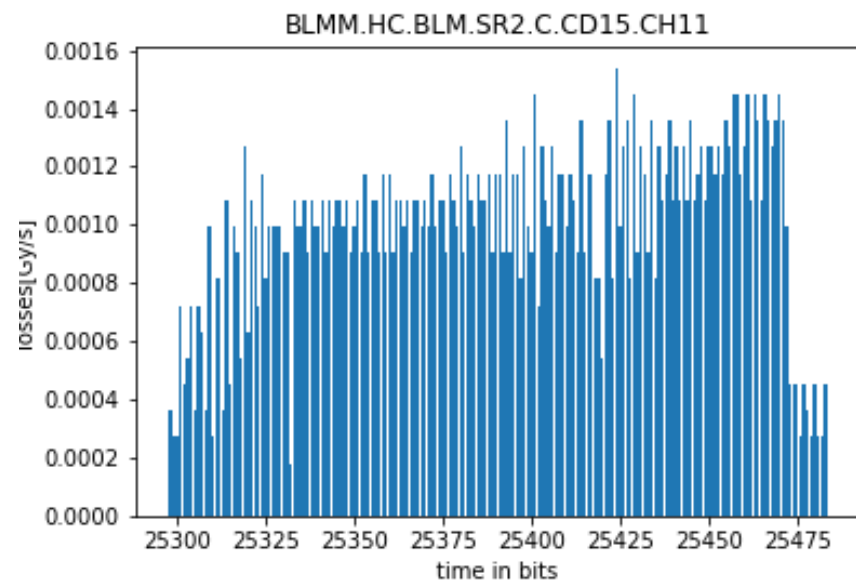
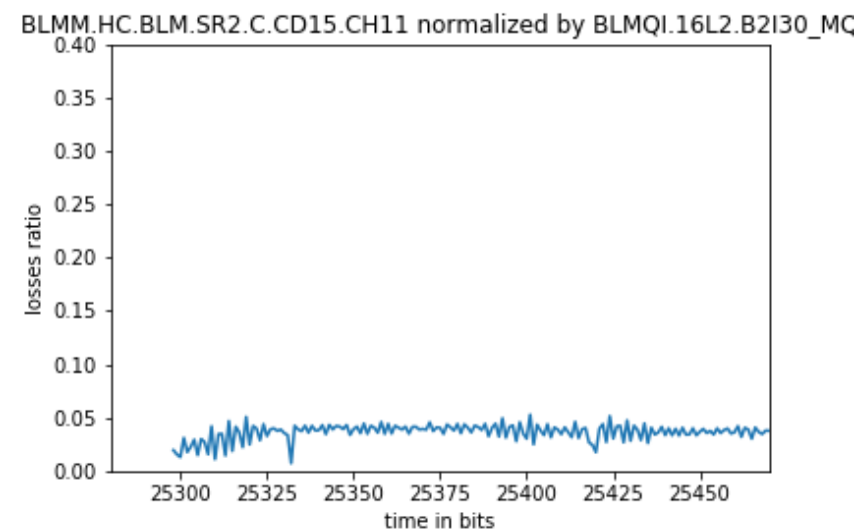
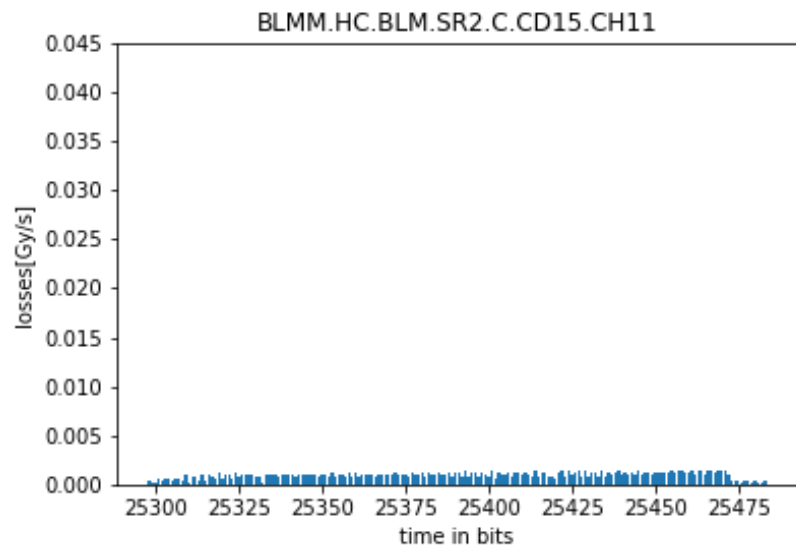


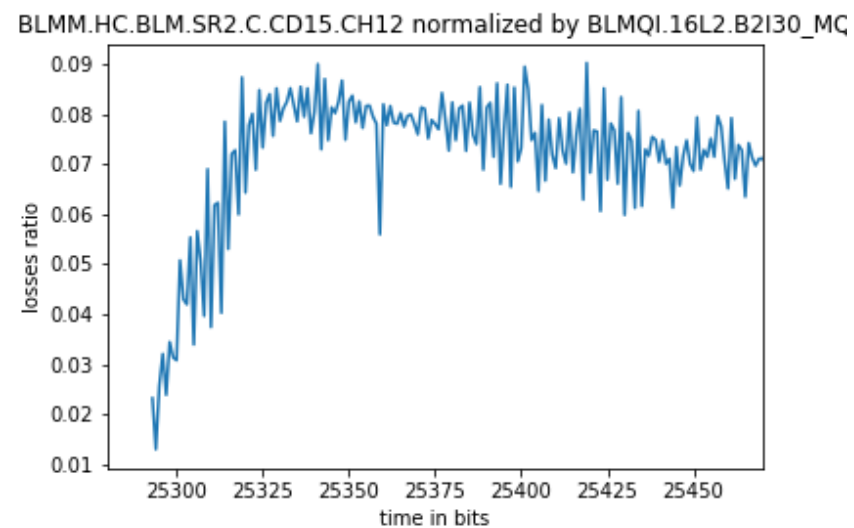
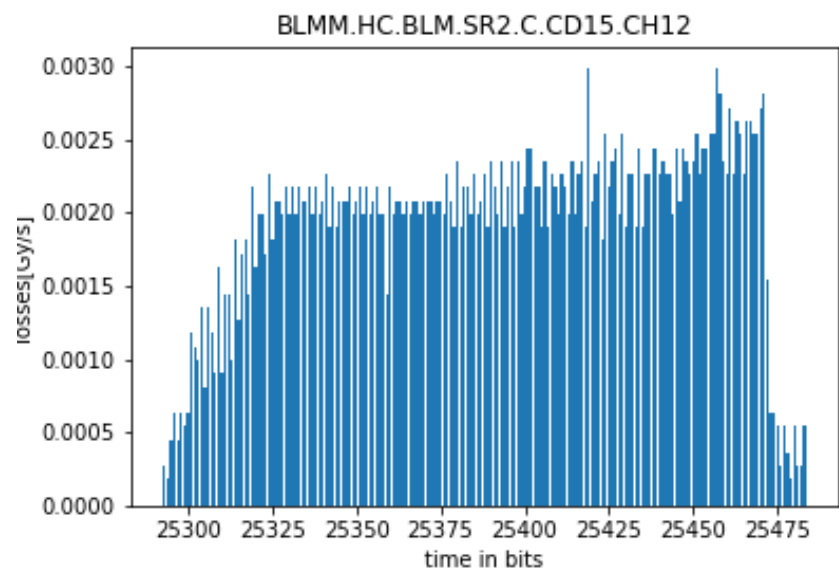
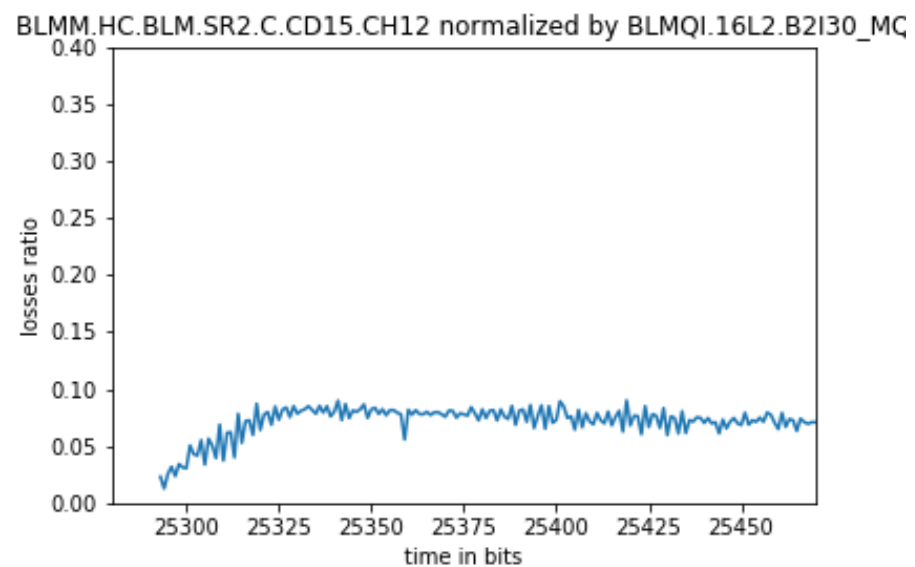
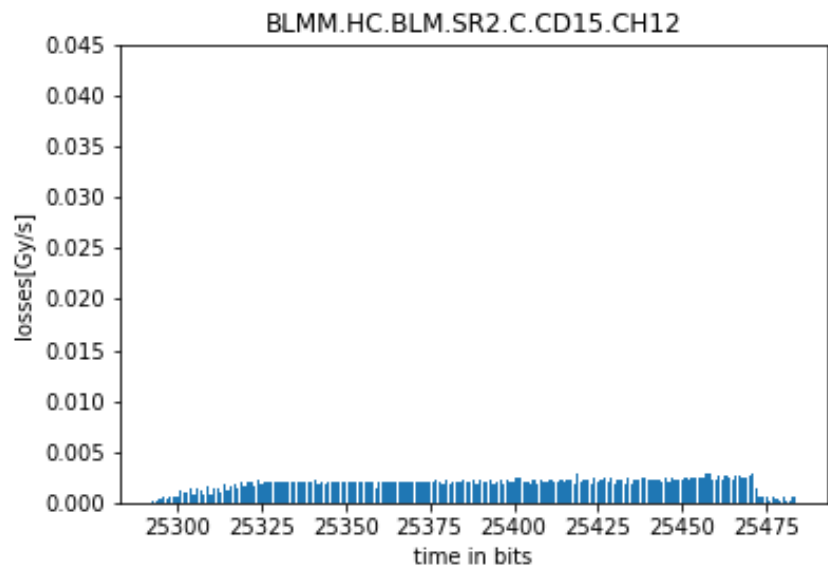
**NORMALIZATION  
BLM !!!**



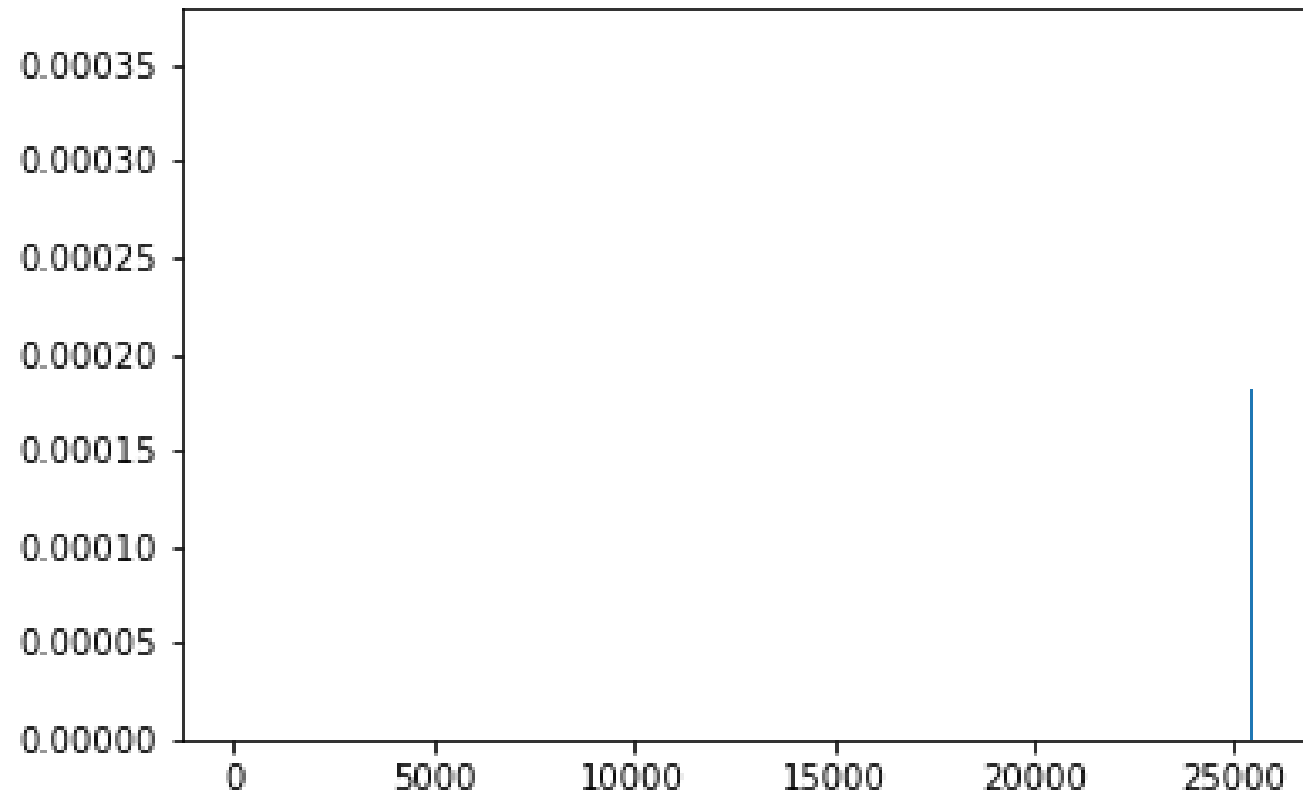






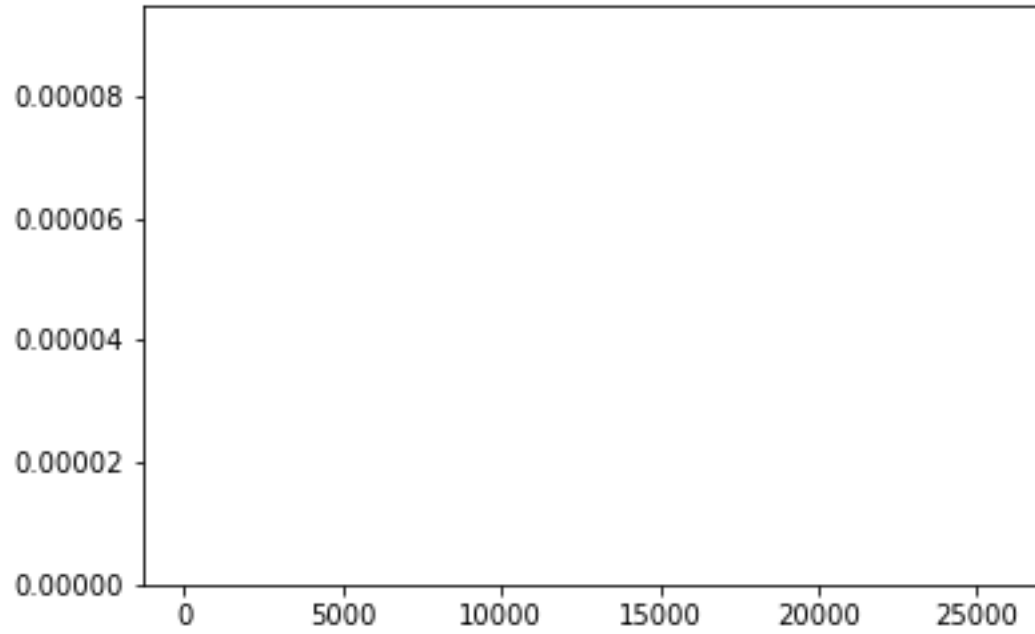


BLMM.HC.BLM.SR2.C.CD15.CH14

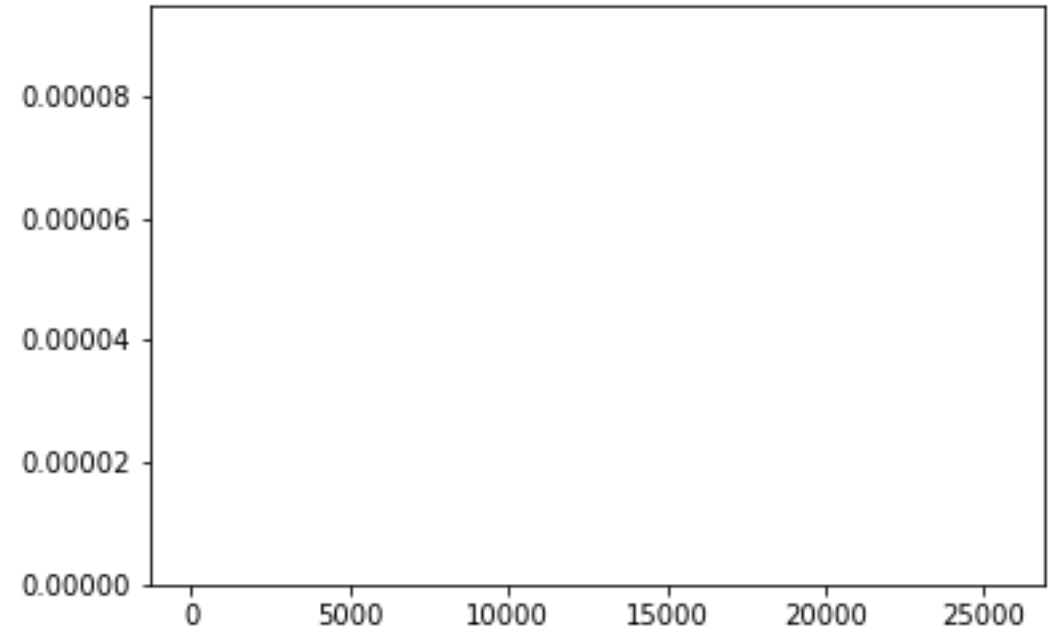




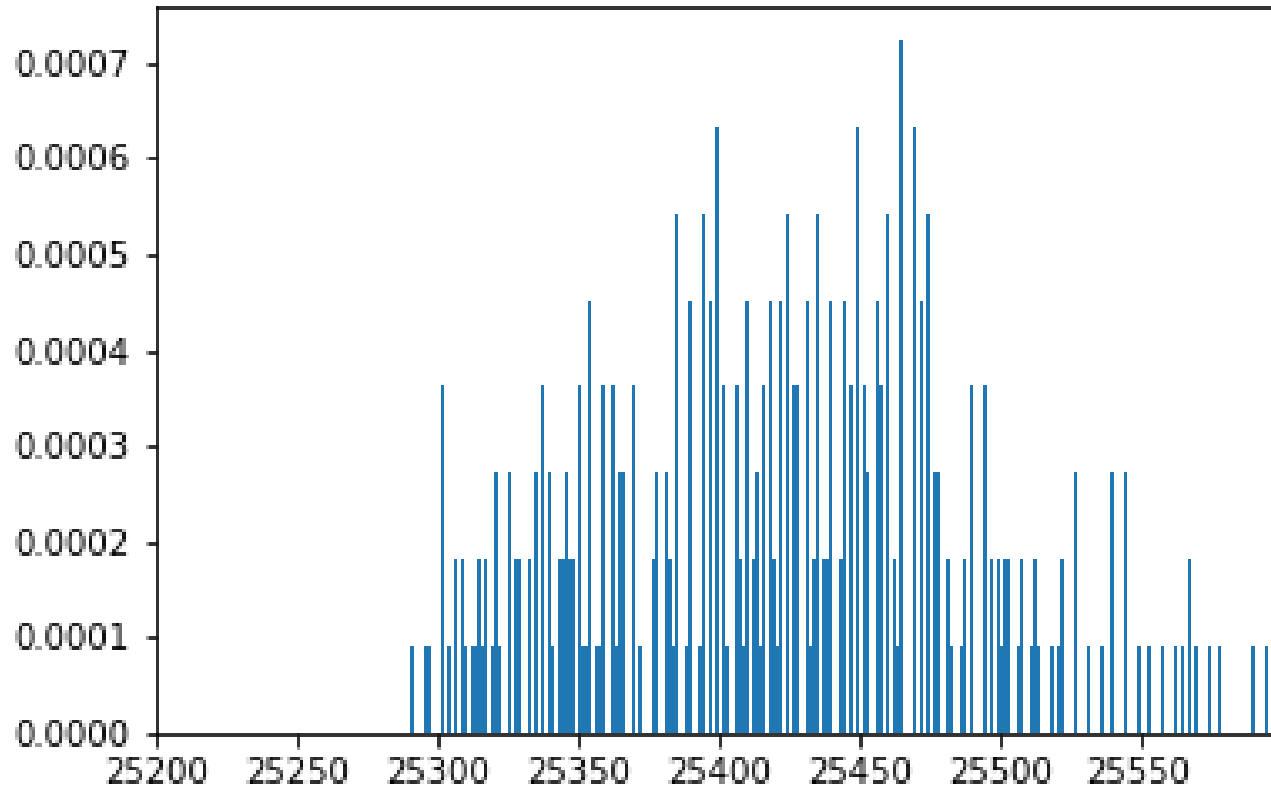
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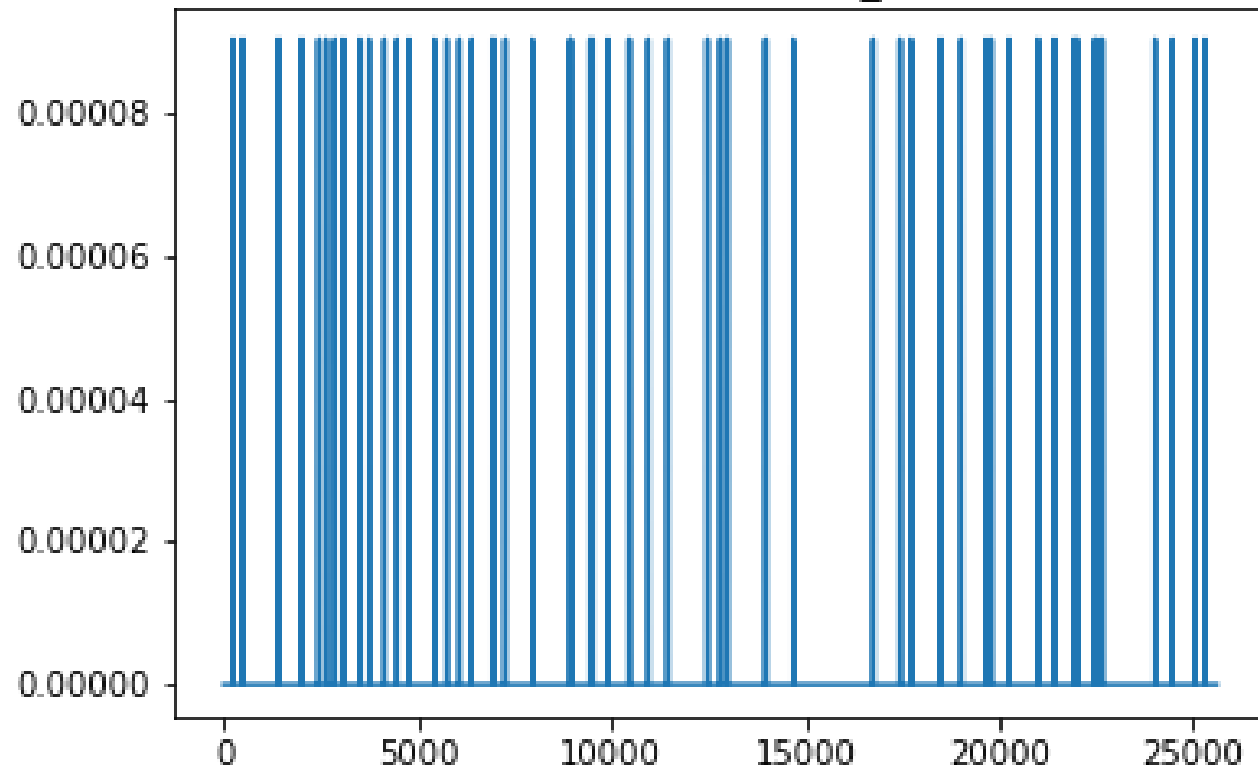
BLMM.HC.BLM.SR2.C.CD15.CH16



BLMQI.16L2.B1E30\_MQ



BLMQI.15L2.B1E10\_MQ



BLMQI.15L2.B2I30\_MQ

