# Beam summary data in MR Run42 (T2K Run3c)

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# Overview

- Apply the Good spill selection to the beam data in the MR Run42
  - Use improved fitting for horn current (by Suzuki-san)
  - Used data set : Beam line Run# **420022 (4/8) ~ 420212 (5/5)**
- Horn current setting in this period : **250kA**

# Spill selection

1. Physics run
   - "run_type" is "physic run" and all Horn ON
   - exclude spills for beam tuning, beam study
2. TriggerFlag is "Beam Trigger" (beam during MR operation)
3. Good GPS status
4. CT05 # of protons per spill > 1e11 in order to exclude spills which no beam in MR (due to machine interlock etc...)

**Quick spill selection**

5. Normal condition cut
   - exclude unusable spills (e.g. PV2 magnet unstable etc...)
6. Horn current cut
   - Nominal current ± 5 kA for all three horns
7. MUMON cut
   - beam angle within 1mrad (|Si fit X|<10cm & |Si fit Y|<10cm)
   - Si total Q / CT05 cut : mean of Q/CT05 ± 5%

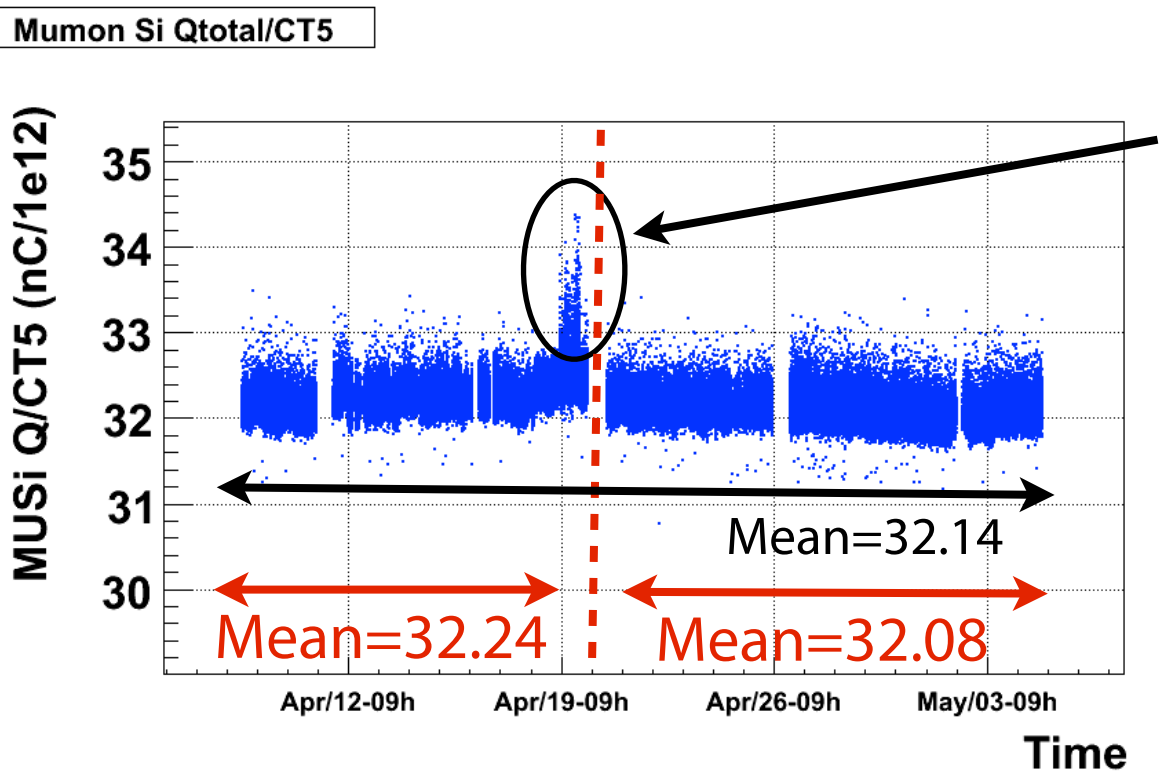
**Good spill selection**

# Horn & MUMON cut

- Horn current & MUMON Si Q /CT5 cut are defined as the followings table.
  - Horn cut : (Mean of three horns current in physics run) ± 5 kA
  - MUMON SiQ / CT5 cut : (Mean of this ratio in physics run) ± 5%
- Consider different threshold of MUMON SiQ/CT5 cut according to the period (→ next page)

| run# | Horn current setting | Horn current cut | MUMON SiQ/ CT5 cut |
|---|---|---|---|
| 420022~420136 | 250kA | 249.5 ± 5kA | 32.24 ± 5% |
| 420137~420212 | 250kA | 249.5 ± 5kA | 32.08 ± 5% |

# Threshold of MUMON SiQ / CT5




The ratio MUMON SiQ / CT5 of some spills is different from the mean. Distribution is continuous.

→ When this mean slightly change by including more data, some good spills around this region become 'bad'.

Because the good spills of the past beam data cannot be bad, the threshold of this cut is defined according time.

- By Apr/20 : 32.24 ± 5%
- From Apr/20 : 32.08 ± 5%

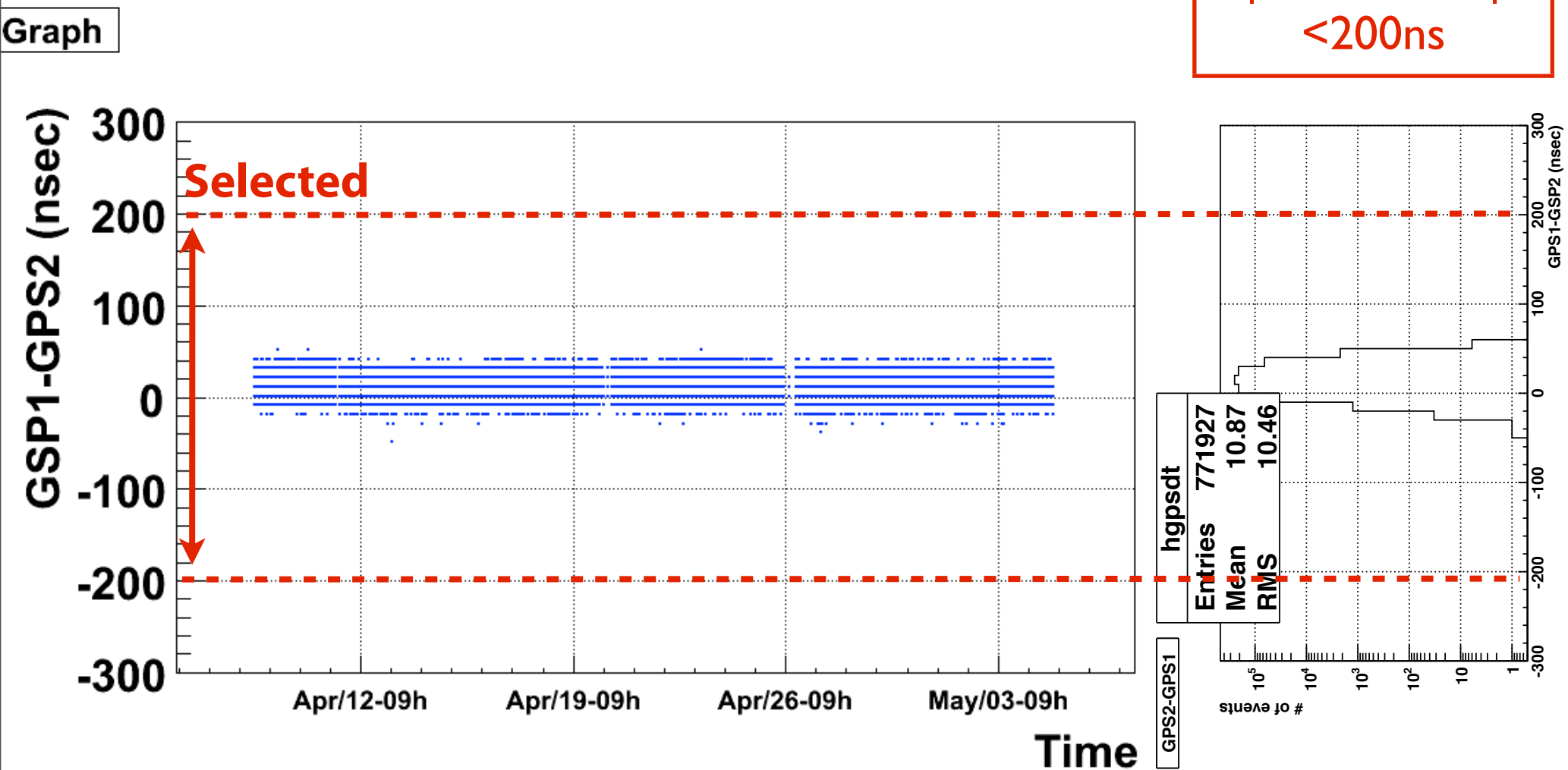
(Note: for past data in T2K RUN1-2, we define the separate threshold for specific the data)

# Normal condition cut

- Remove 1 spill by normal condition cut
  - Run#420189, Spill#3032400 : Neutrino BLM MPS

# GPS Status

|GPS1-GPS2|
<200ns



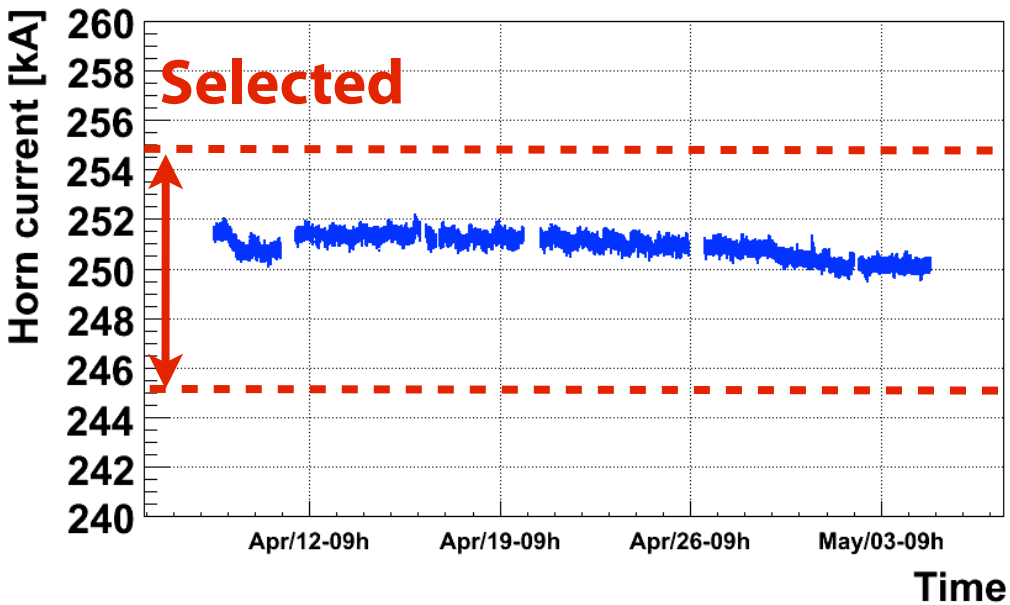

GPS1,2 status are good during this period

**No Bad spill**

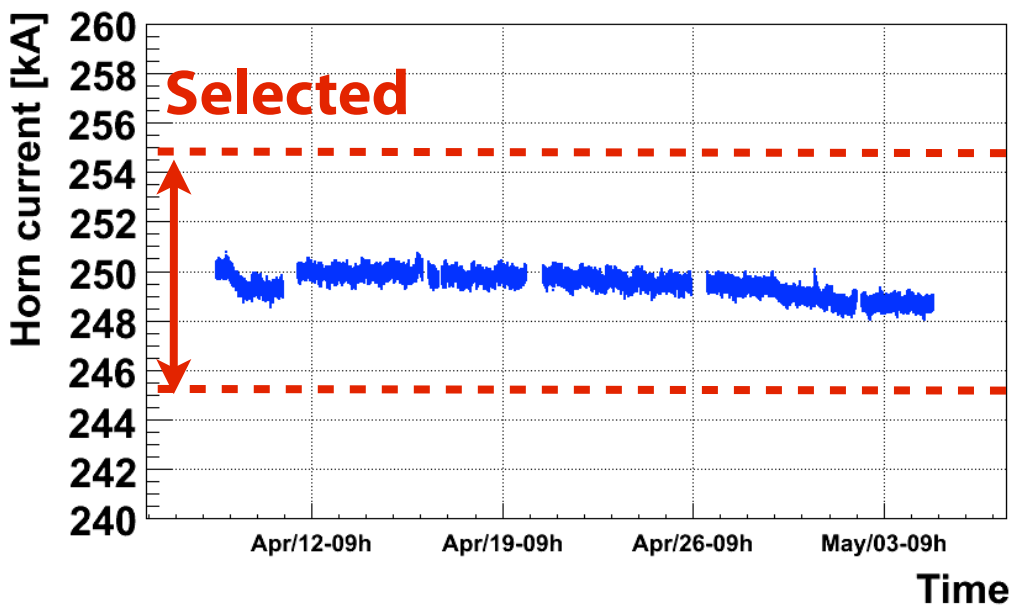
# Horn current

249.5 ± 5kA

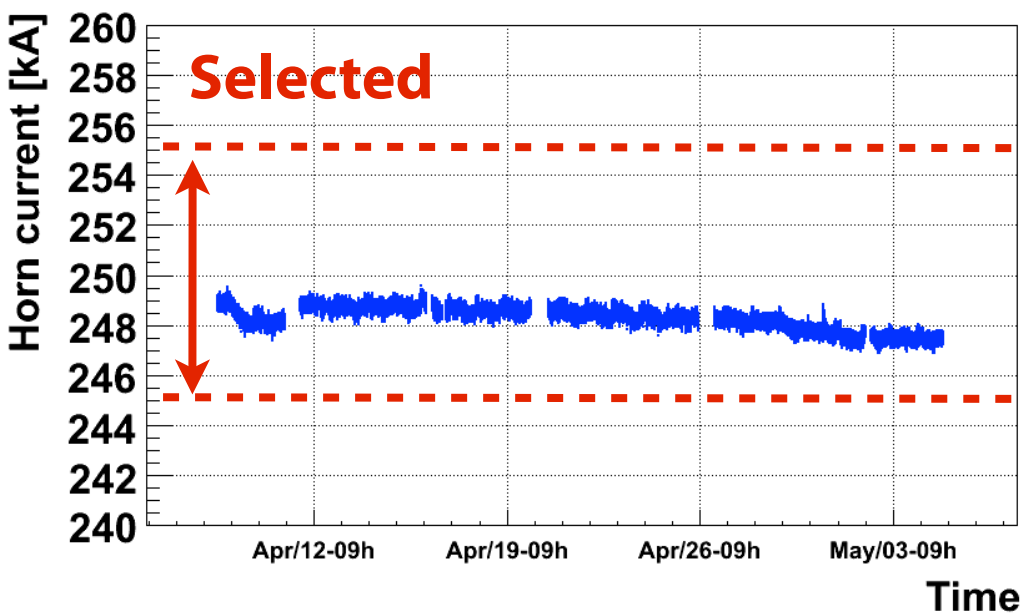
Horn1 current




Horn2 current

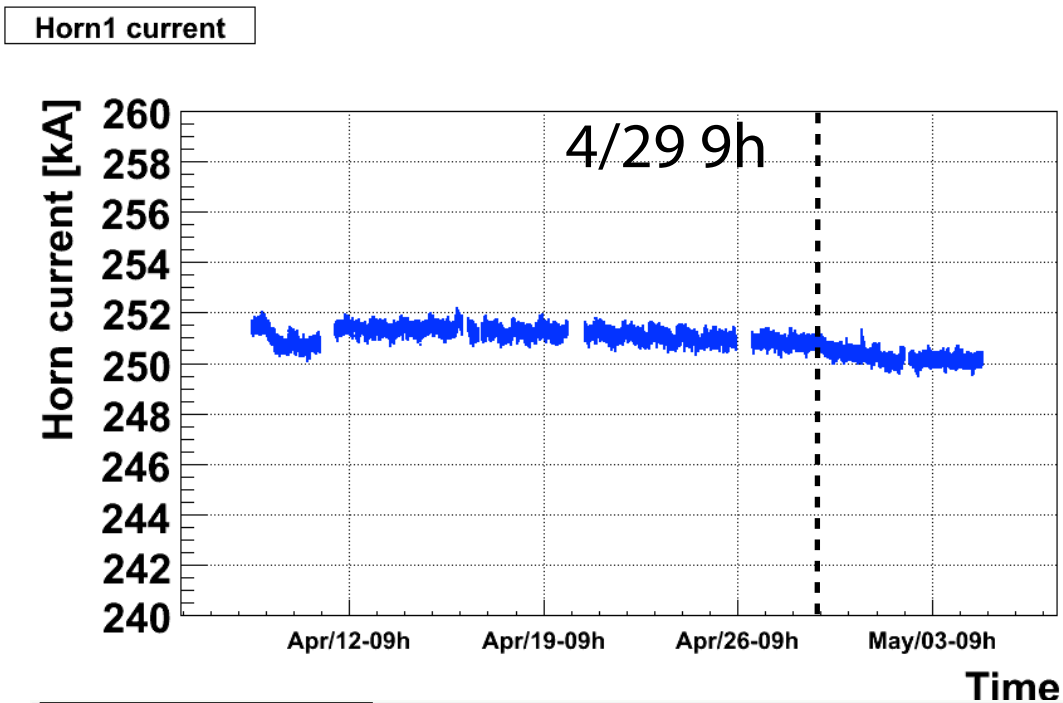



Horn3 current




- No bad spill, but horn current decreasing gradually (especially from Apr/29)
- But, current is stable from 5/3

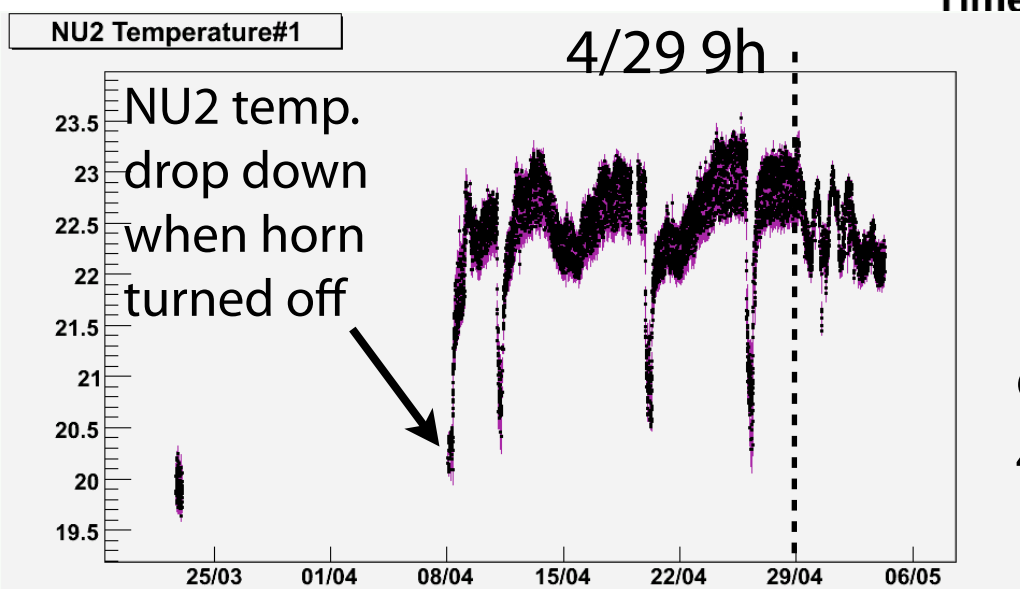
# Horn current decreasing




Waring for NU2 temperature at 4/2913:38 (from shift summary)

*NU2 temperature was slowly rising. Air conditioner setting was too high. The setting was adjusted. Now it is stable.*

Other troubles at 4/29 are shown on backup page.



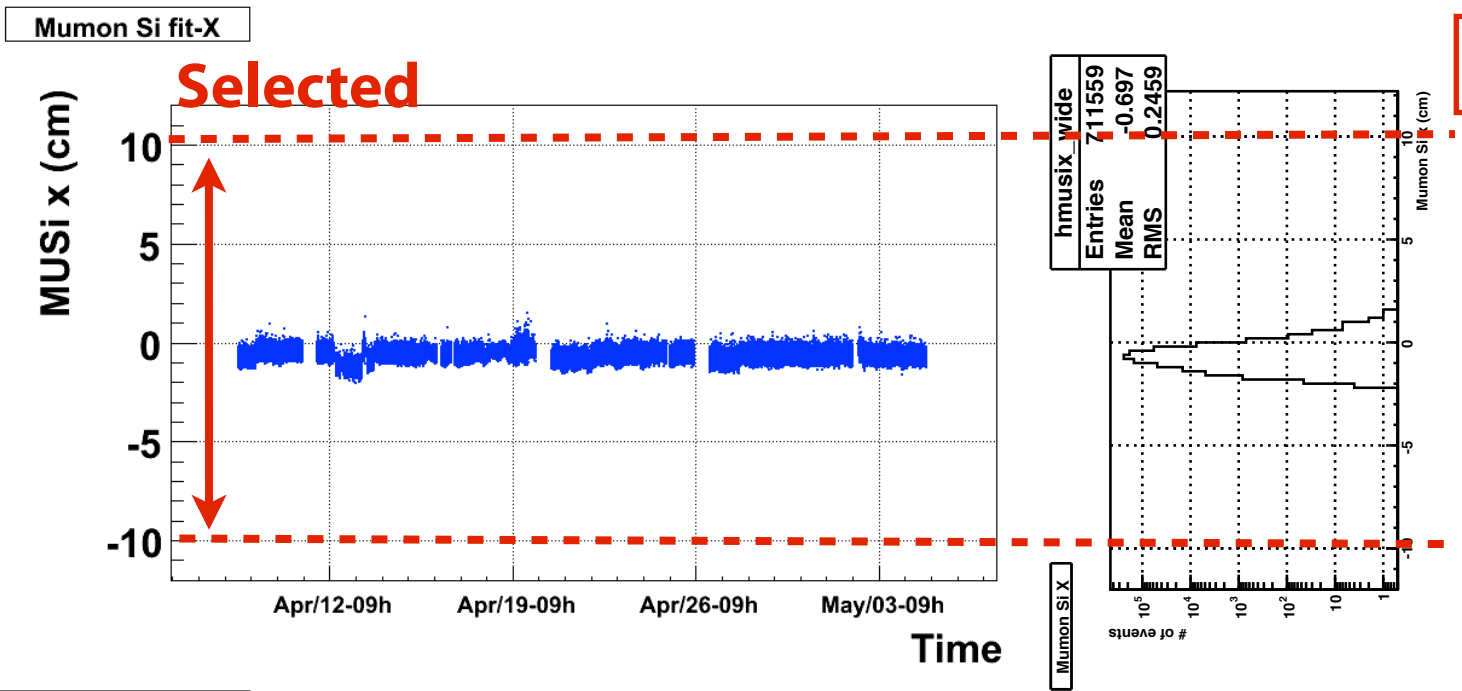

*This time scale is diff. from above plot **Day/Month**

Actually, NU2 temp. decreasing gradually from Apr/29

But, there seems to be no correlation b/w horn current and NU2 temp. in other time region(NU2 temp. rising in 4/22~4/26).

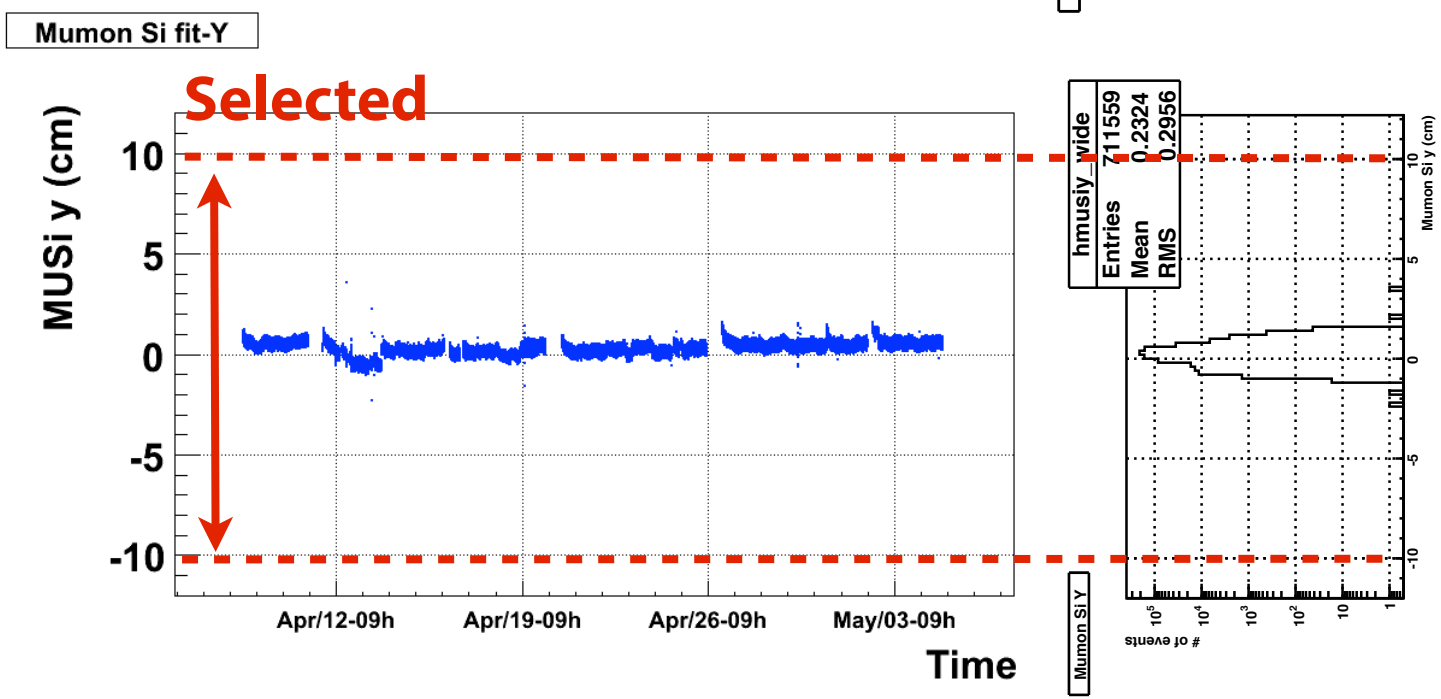
→ Other reason ? Anyway, be careful for horn current stability.

# MUMON Si fit center




|fit center| < 10cm

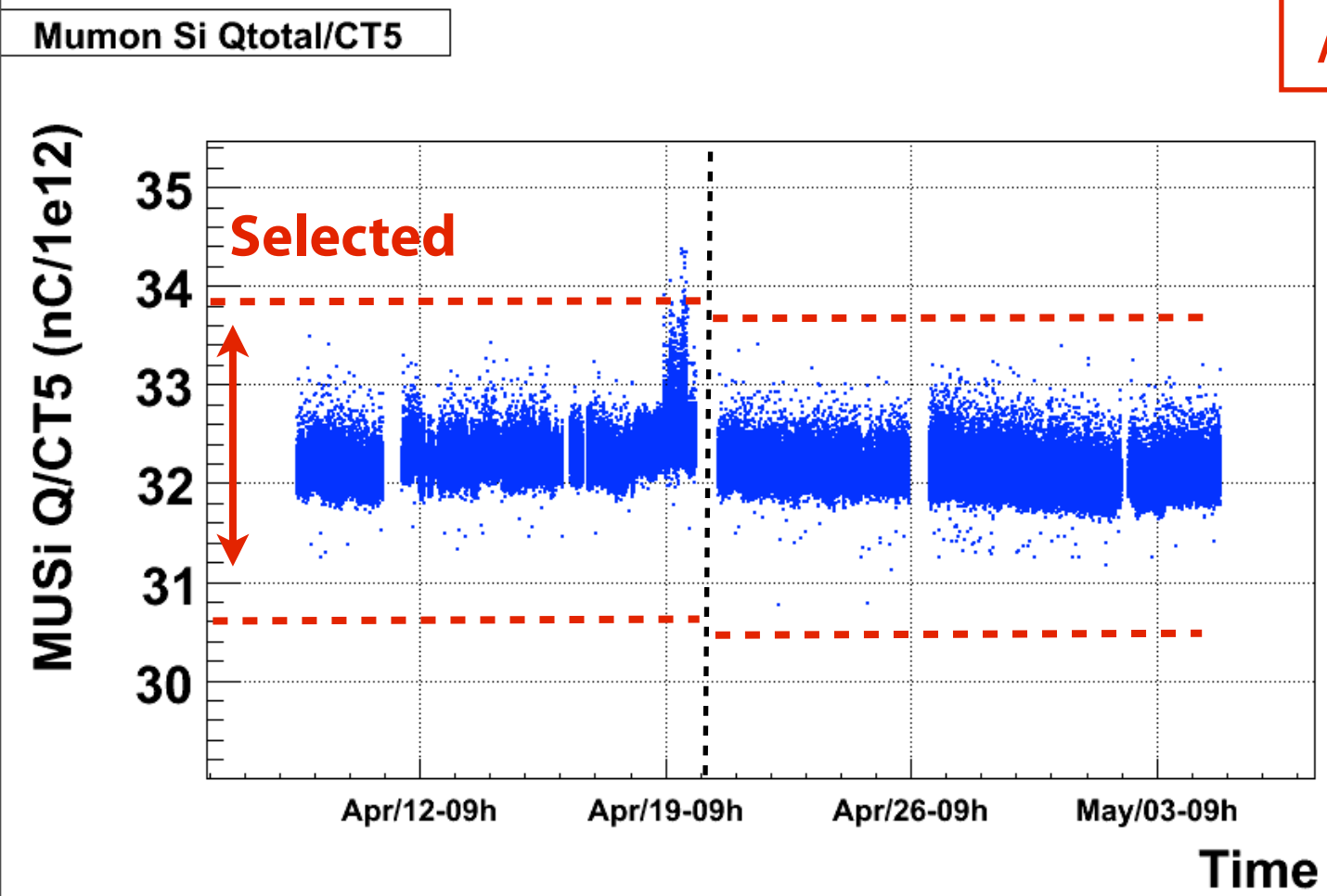
**No Bad spill**




After beam restart, MUSi-y was about 1cm larger than MUSi-y before beam stop and decrease

# MUMON Si Q / CT05

~Apr/20 : 32.24 ± 5%
Apr/20~ : 32.08 ± 5%




**15 Bad spill**

→ Still investigate the reason of bad spills

# Summary of Good spill selection (MR Run42)

## Run# 420022(4/8)~420212(5/5)

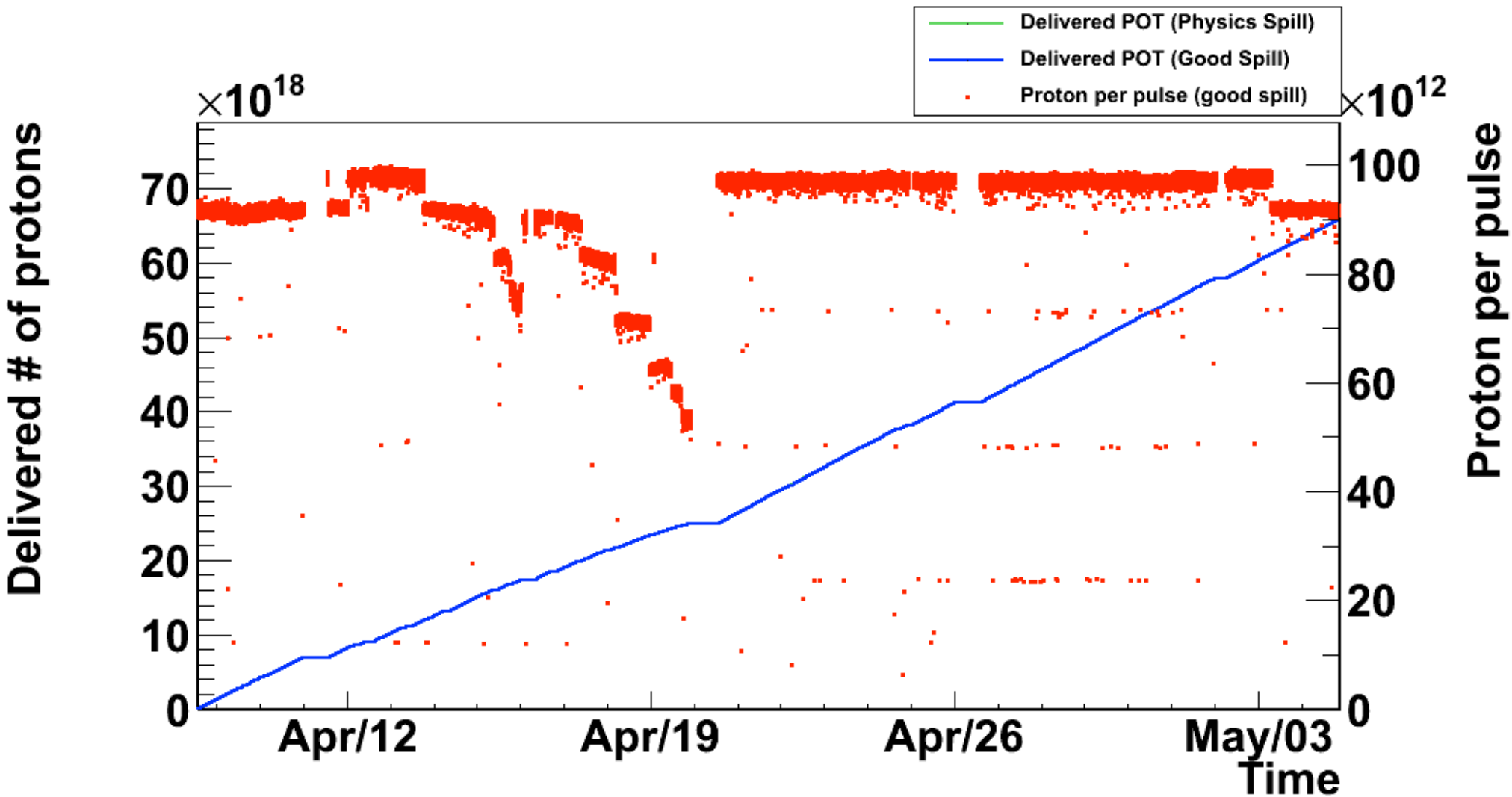
| | # of spills | Ratio |
|---|---|---|
| Physics spills | 720980 | 1 |
| Beam trigger | 712202 | 0.988 |
| Good GPS | 712202 | 0.988 |
| ppp(CT5)>1e11 | 711560 | 0.987 |
| Normal beam | 711559 | 0.987 |
| Horn cut | 711559 | 0.987 |
| MUMON cut | 711544 | 0.987 |

Bad spills during beam operation : **15** = **0.003%** of good spills

# of delivered protons (CT5) after Good spill selection :

**6.583 e+19**

# Integrated POT (MR Run42)



# Definition of Good spill flag

- In order to distinguish the Horn-off spill from the horn ON spill, the value of the good flag will be re-defined.
  - flag =0 : Not suitable data for physics analysis.
  - flag =1 : Good spill for Horn 250kA operation.
  - flag =100 : Good spill for Horn OFF.
  - flag = 2, 3 ... 99: Reserved for the other horn operation mode.
  - flag =-1,-2 ... -99: Reserved for the other horn operation mode with opposite polarity.

| horn current | 0 kA | 200 kA | 250 kA |
|---|---|---|---|
| good spill flag | 100 | 2 | 1 |

**T2K RUN1, 2, 3c : Flag = 1　T2K RUN3b : Flag = 2**

# Back up

# Neutrino Event/Trouble around 4/29 (from Shift summary)

4/26 Maintenance (10:00-21:00 MR injection Kicker)
[NU maintenance]
+ Horn CW: cover gas sampling, flushing
+ 32deg-CW: 4/20 by-pass of degasfier was open in TS-B2.
+ NU2 30deg CW:4/27 AM Change broken strainer by new one.
+ DAQ maintenance: Control network maintenance: done.
+ NU3 CW: Low flow rate:
+ Slow-monitor maintenance:

4/29
4:22 DAQ abort
MIDAS status had no error. it was known case written in the shift manual. Alert was rest and run was changed.
5:35 Online Mon.
"MAG,PH3" is larger value (12.8A) than threshold. In plot, error bar was very large (+/-2A), but center value is almost zero.
Alert was reset and run was changed.It was informed to Nakadaira-san and Fujii-san.
13:38 Slow alarm
NU2 temperature was slowly rising. Air conditioner setting was too high. The setting was adjusted. Now it is stable.

4/30 21:01 NU MPS Horn current balance
-> checked -> no problem
-> 21:47 Horn recovered
-> 21:53 beam is back
5/2 10:00-12:00 MR study

5/2 11:30 Horn CW He sampling
--> Stop horn operation during sampling work.

# Bad spills by mumon/ct cut

The list of 15 bad spills by mumon/ct cut

```
Run# Event# Spill# : MUMON SiQ / CT05 [nC/1e12 pot]
420129 399 2787394 : Bad spill due to si q/ct : 33.8941
420131 4245 2792766 : Bad spill due to si q/ct : 34.0369
420133 282 2802552 : Bad spill due to si q/ct : 34.3632
420133 365 2802635 : Bad spill due to si q/ct : 34.0714
420133 842 2803112 : Bad spill due to si q/ct : 34.3079
420133 1663 2803933 : Bad spill due to si q/ct : 33.9289
420133 2736 2805006 : Bad spill due to si q/ct : 34.3291
420133 3397 2805667 : Bad spill due to si q/ct : 34.2762
420133 3744 2806014 : Bad spill due to si q/ct : 34.1580
420133 3975 2806245 : Bad spill due to si q/ct : 33.9332
420133 4359 2806629 : Bad spill due to si q/ct : 33.8676
420133 4409 2806679 : Bad spill due to si q/ct : 34.2070
420133 5709 2807979 : Bad spill due to si q/ct : 34.0246
420133 5893 2808163 : Bad spill due to si q/ct : 34.0234
420133 6067 2808337 : Bad spill due to si q/ct : 34.3270
```

Now investigate the reason of these bad spills. At this moment, these spills are still “Bad”.