Efficiency studies

- ✓**SOURCES**
- ✓**IN-BEAM**

AGATA week September 2017

Standard measurement during the preparation

$$\varepsilon_{1.4\ MeV} = \frac{N_\gamma}{Act \times \Delta T \times (1\text{-}DT) \times BR}$$

~2% uncertainties

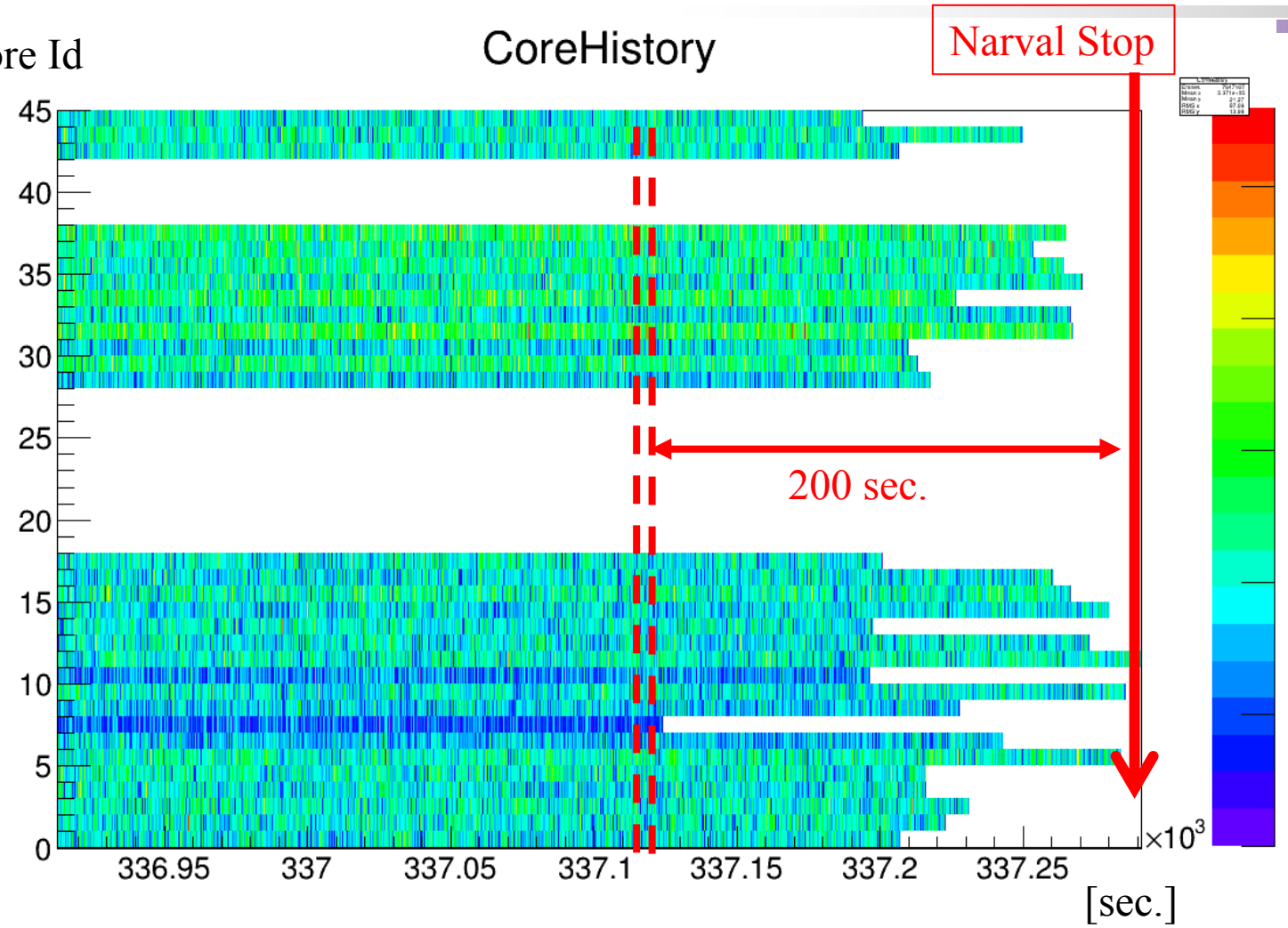
$$\varepsilon_{1.4\ MeV} = \varepsilon_{GEANT4}$$

Standard measurement during the preparation

$$\varepsilon_{1.4\ \mathrm{MeV}} = \frac{N_\gamma}{Act \times \Delta T \times (1\text{-}DT) \times BR}$$

AGATA is not in common dead time.
Each crystal is +/- in trigger less

^{60}Co run example

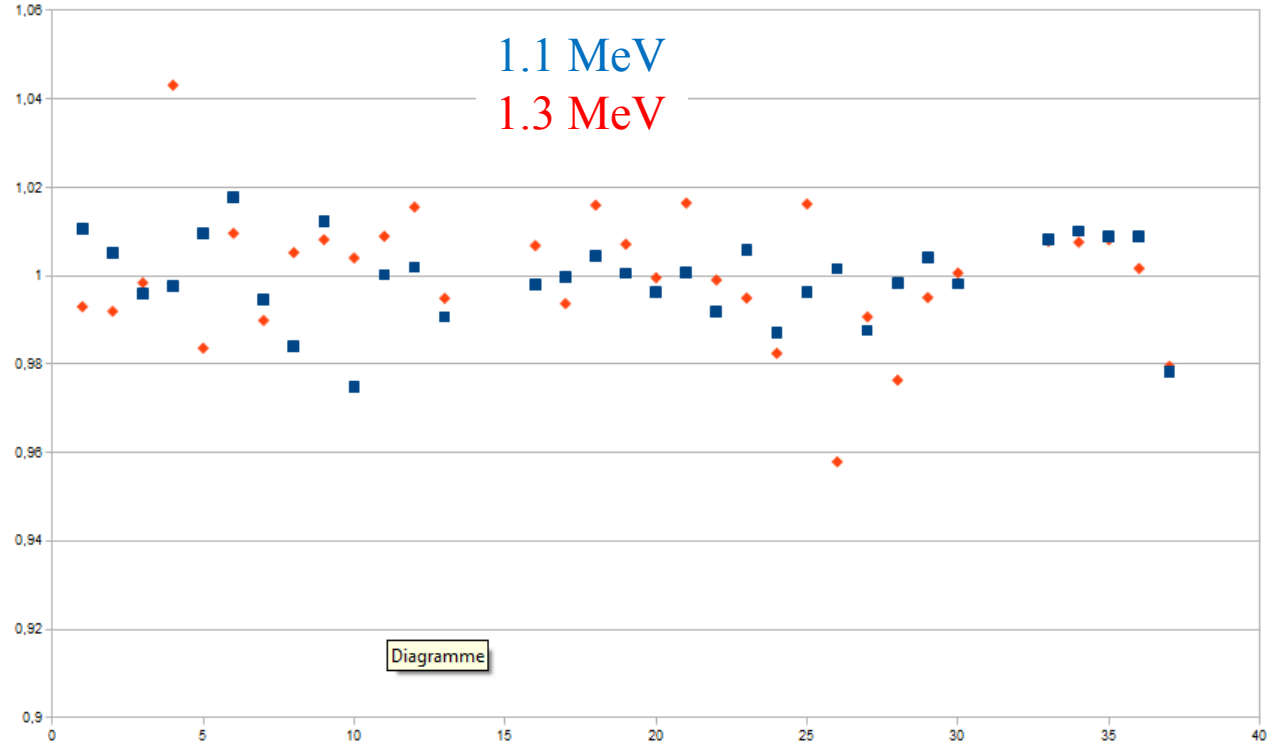


The writing on disk is asynchronous and the last buffer of each crystal is lost at the stop which takes ~2 sec. Go back to traces at least or cut in the ACQ Time

Standard measurement during the preparation

$$\varepsilon_{1.4\ \mathrm{MeV}} = \frac{N_\gamma}{\mathrm{Act} \times \Delta T \times (1 - DT) \times BR}$$

We usually correct for possible dead time using the GANIL electronic which has a much higher dead time and which can be quantified by running with the AGAVA triggered by the OrAGATA in ancillary.sh



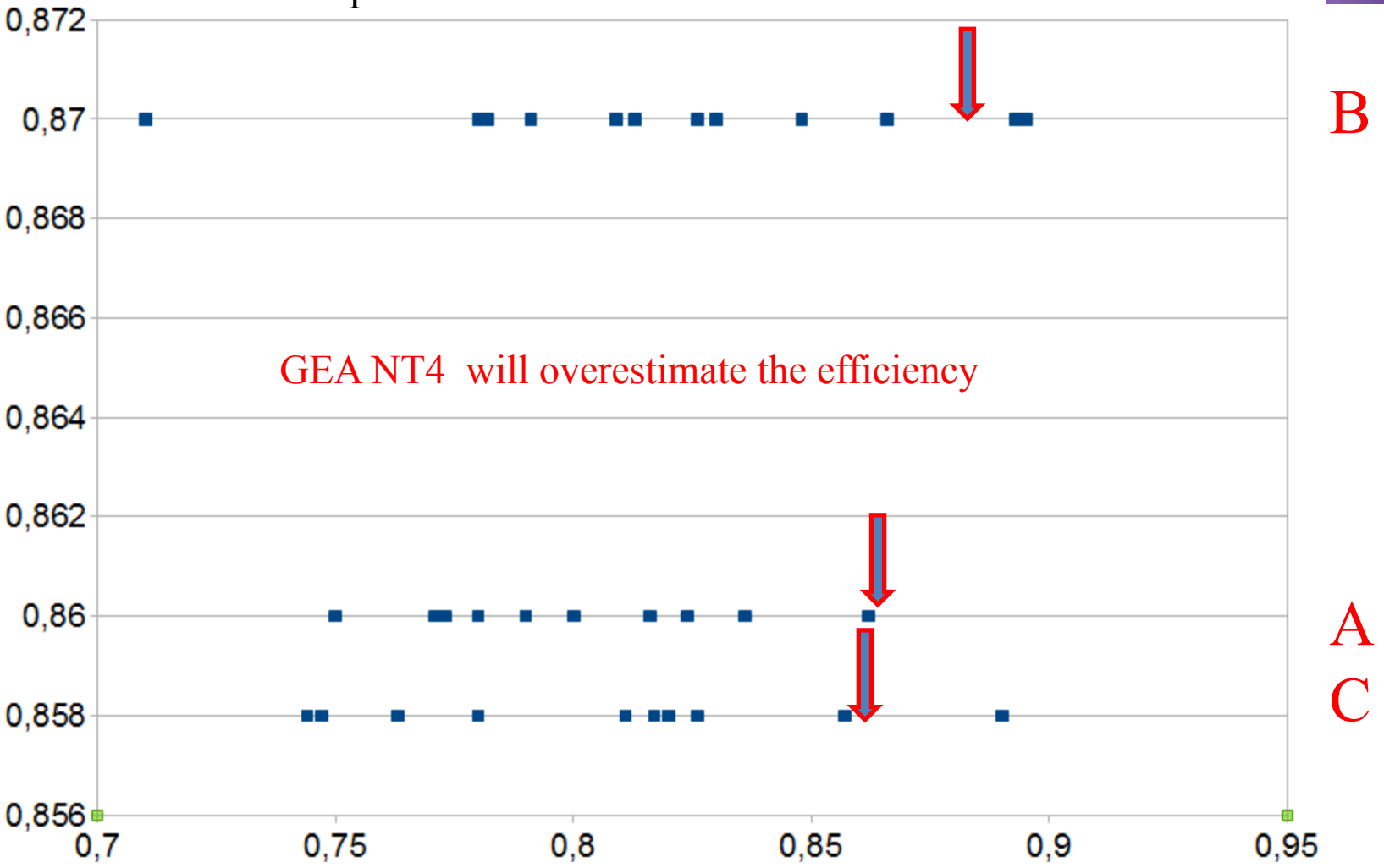
At low rate, the GTP or only the Root node has not effect on the measured efficiency

$$\varepsilon_{1.4\ MeV} = \varepsilon_{GEANT4}$$

In nominal : Crystal A-type = 0.106% = 86%
Crystal B-type = 0.117 % = 87%
Crystal C-type= 0.106 % = 85.8%

- The absolute efficiency is not a CAT criteria
- It is given in the CANBERRA technical sheet for each capsule delivered
- It is cross checked only in 30% of the CAT according to the reports. They often differ.

The 35 capsules in 2017



Canberra

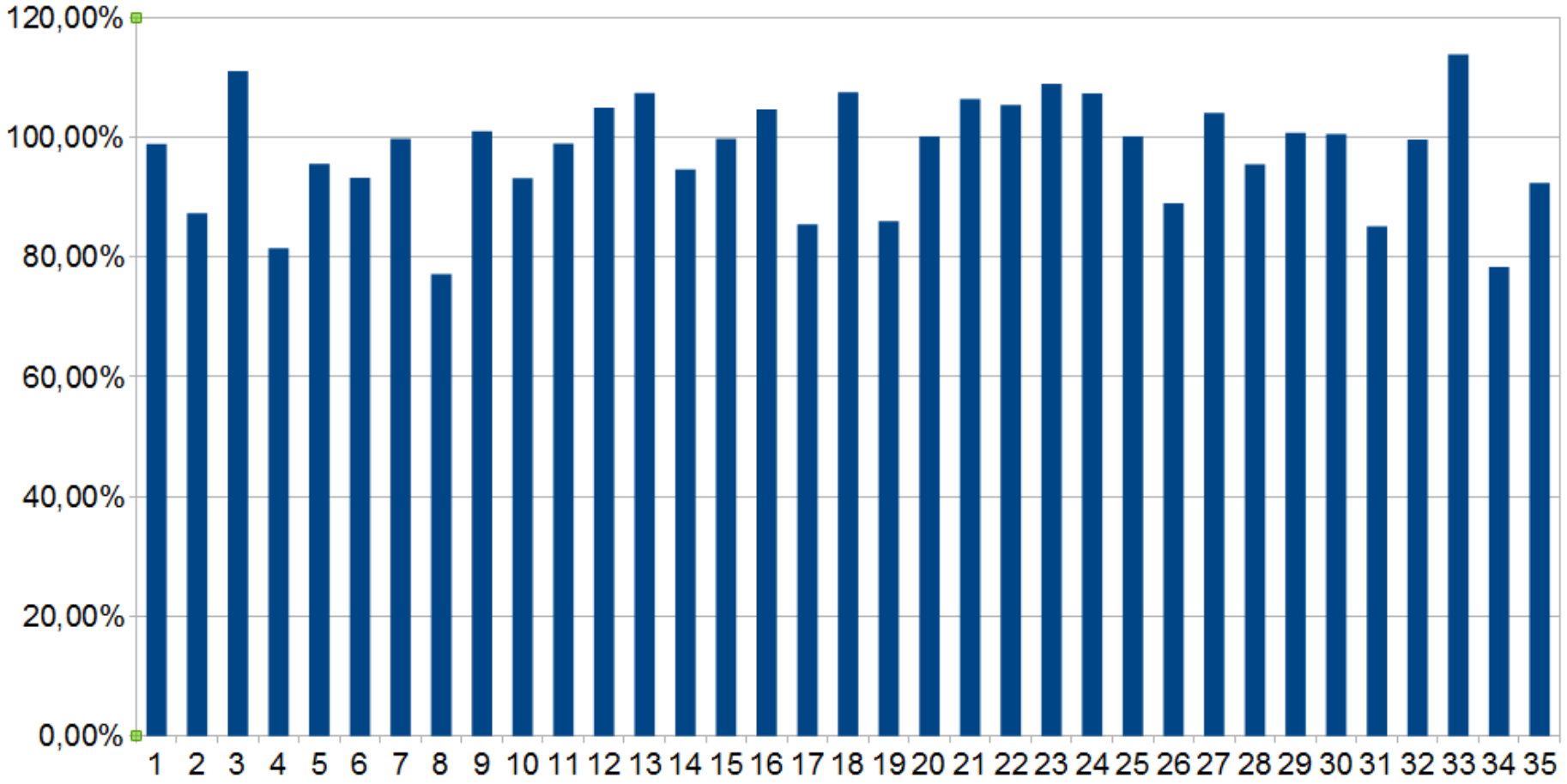
$$\varepsilon_{1.4\ MeV} = \varepsilon_{GEANT4} \rightarrow \varepsilon_{GEANT4\ cor}$$

Run 78 E706 (2017) 35 crystal in nominal
(no trace, no histo, no PSA, ancillary.sh)

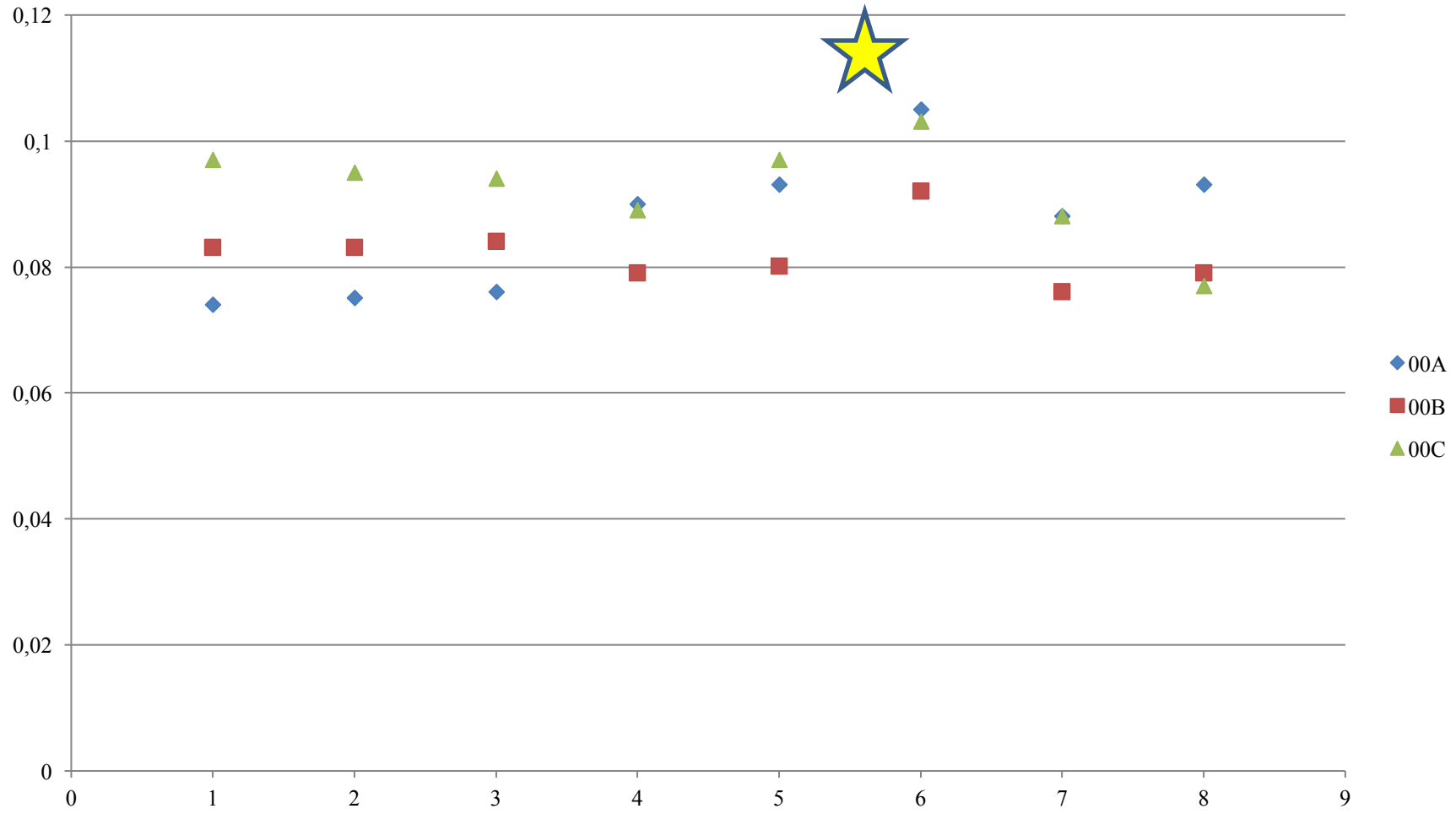
ε_{single} @1.4 MeV = 3.4(1)%

$\varepsilon_{single\ G4}$ = 3.8%

$\varepsilon_{single\ G4c}$ = 3.6%


120,00%
100,00%
80,00%
60,00%
40,00%
20,00%
0,00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35

Accidental GANIL black-out
All connections closed, reshuffle of the /agatadisks



The in-beam efficiency is hard to estimate because the reaction

σ is not known

Extrapolation from radioactive sources has no sense:

Multiplicity effect if nominal → compact
Pile-up effects in FEBEE
Unexpected/uncontrolled effects

Status Report e661 (juin 2016) Spectroscopy of fission fragments (32 capsules) in compact
02/02/2017
A. Lemasson et M. Rejmund

The gamma efficiency from γγ coincidence in [low activity ^{152}Eu]
using 344 keV - 778 keV, gated from above, is at 344 keV ~ 10.4 %
À 1.4 MeV, F=1.5

Experimental data :
(Doppler corrected and isotopically identified ^{100}Zr),
the gamma efficiency from the γγ coincidence 352 keV – 497 keV, gated from above, is at 352 keV ~ 5.6%.
A 1.7 MeV F=1

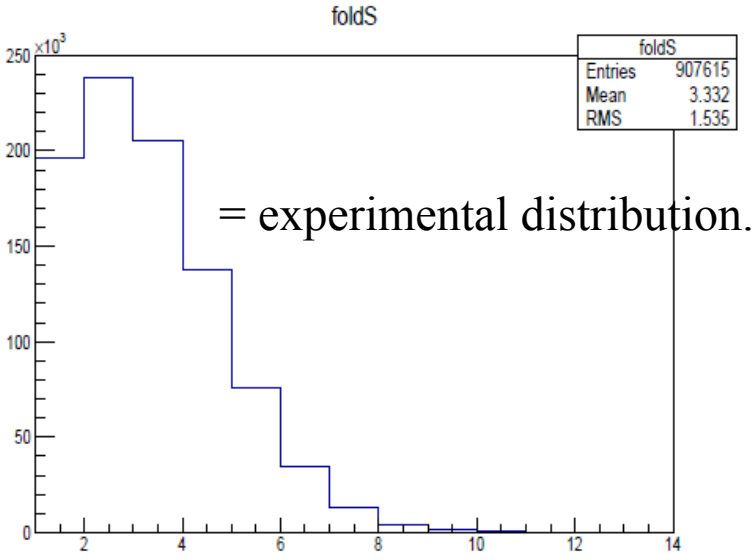
(cheap) fission source in GEANT4 + exact geometry

/Agata/generator/gamma/band 200 300 8

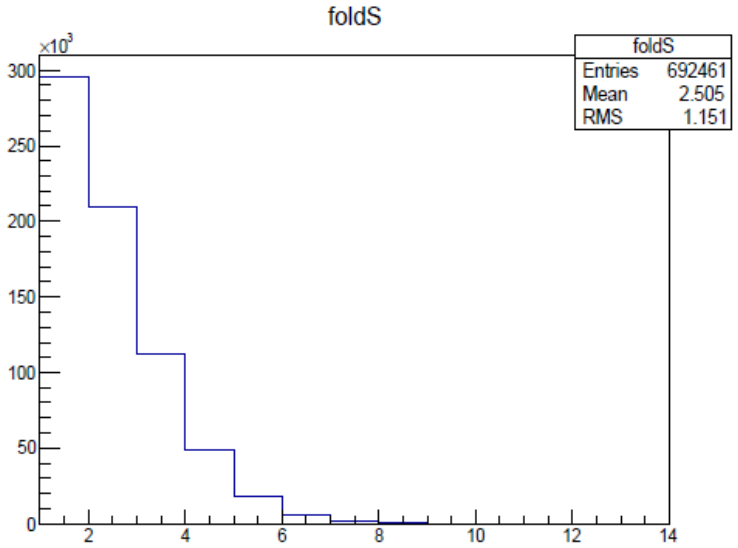
$\sim^{100}Zr$

Compact

Nominal



= experimental distribution.



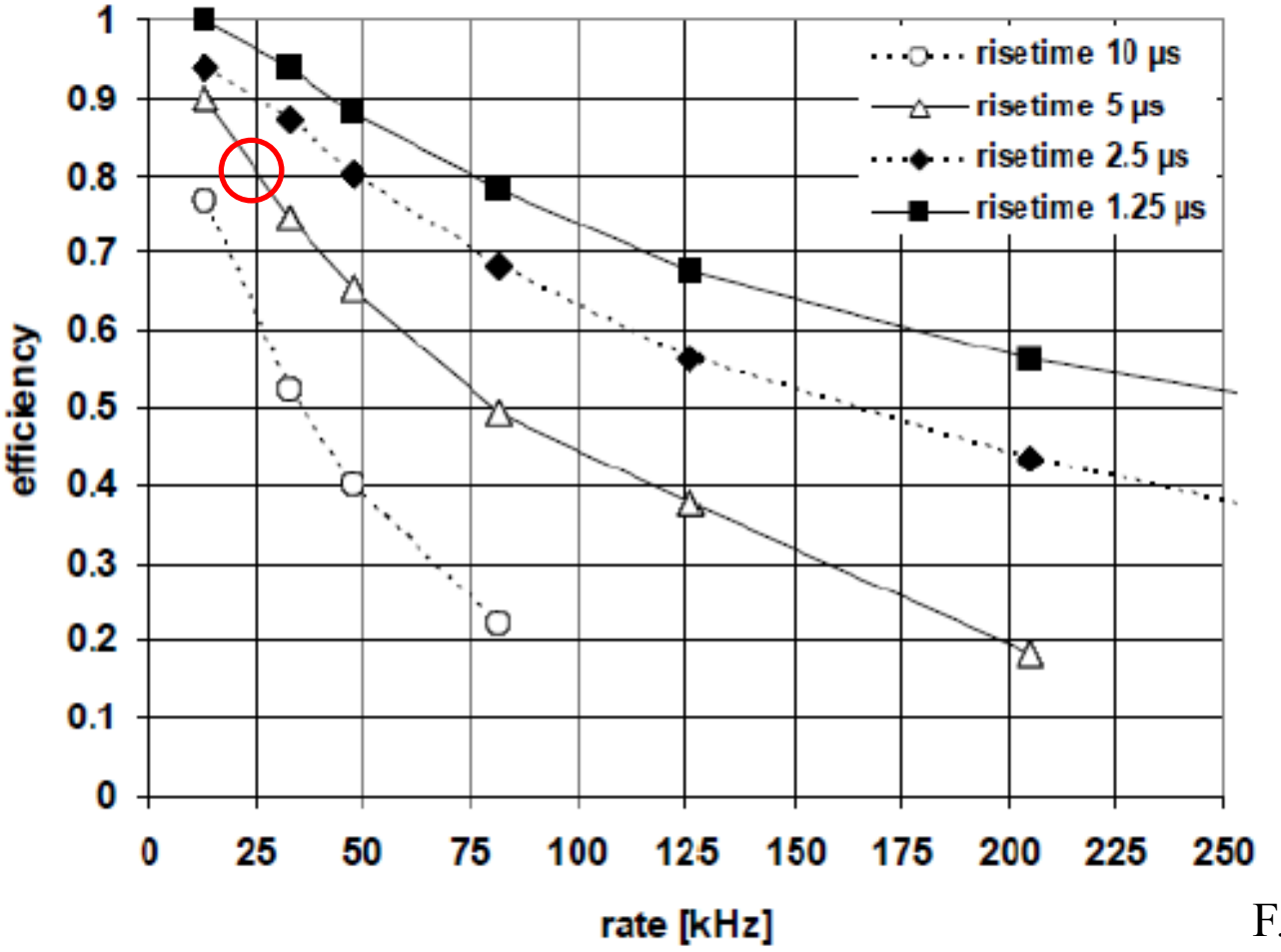
(cheap) fission source in GEANT4 + exact geometry

Table 11: Summary

Energy [MeV]	Config	Single	OFT (F)	MGT (F)
1.1	Nominal Mono Energy at Rest	4.4	6.1 (1.38)	6.2 (1.4)
1.1	Compact Mono Energy at Rest	8.1	11.3 (1.40)	11.4 (1.4)
1.1	Compact ^{60}Co at Rest	7.7	10.6 (1.37)	10. (1.33)
1.1	Compact Fission at Rest	7.5	9.6 (1.28)	8.1 (1.08)
1.1	Nominal Fission at Rest	4.2	5.7 (1.35)	5.1 (1.21)
1.1	Compact Mono Energy β=0.1	7.3	10.1 (1.38)	10.1 (1.38)
1.1	Compact Fission β=0.1	6.5	8.7 (1.26)	7.4 (1.07)
1.1	Compact Fission β=0.1 by $\gamma - \gamma$	6.1		

There is an obvious loss in compact configuration due to the multiplicity

- ε 7.7% → 6.5%
- F 1.37 → 1.26

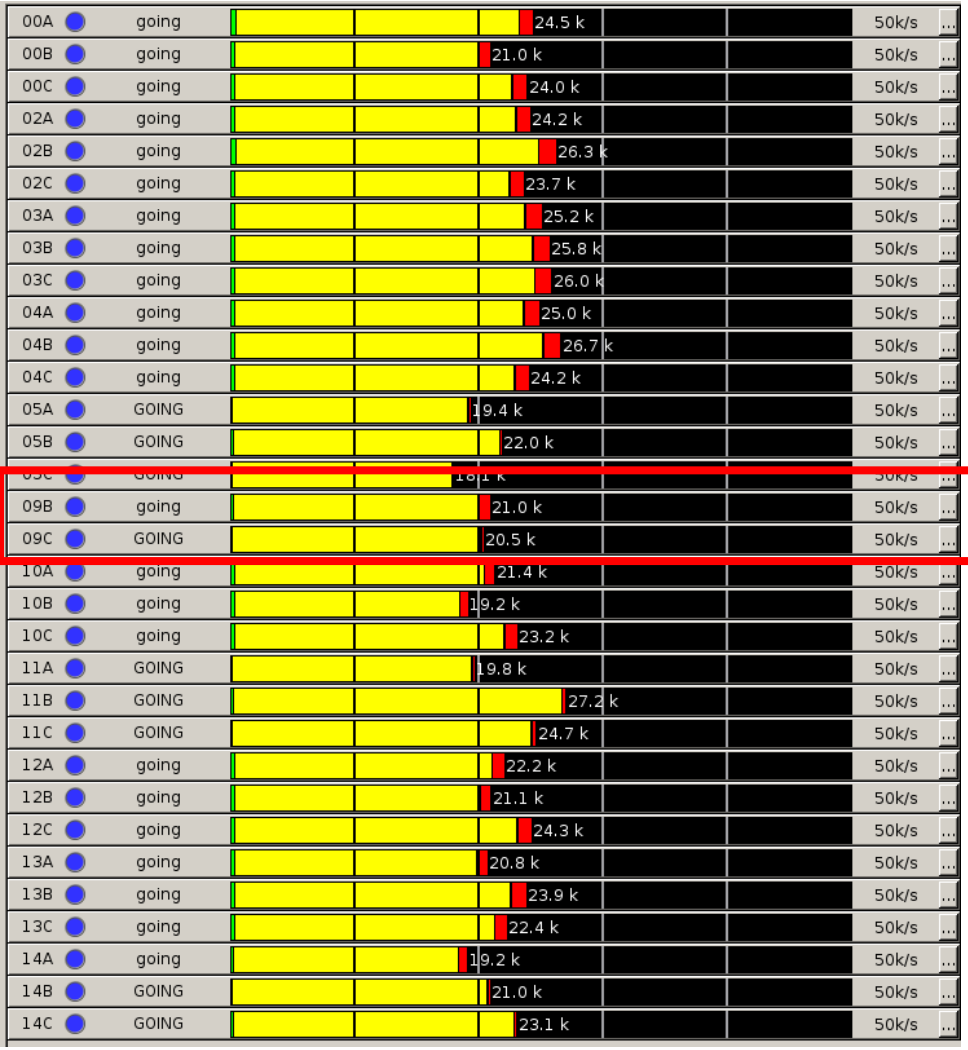


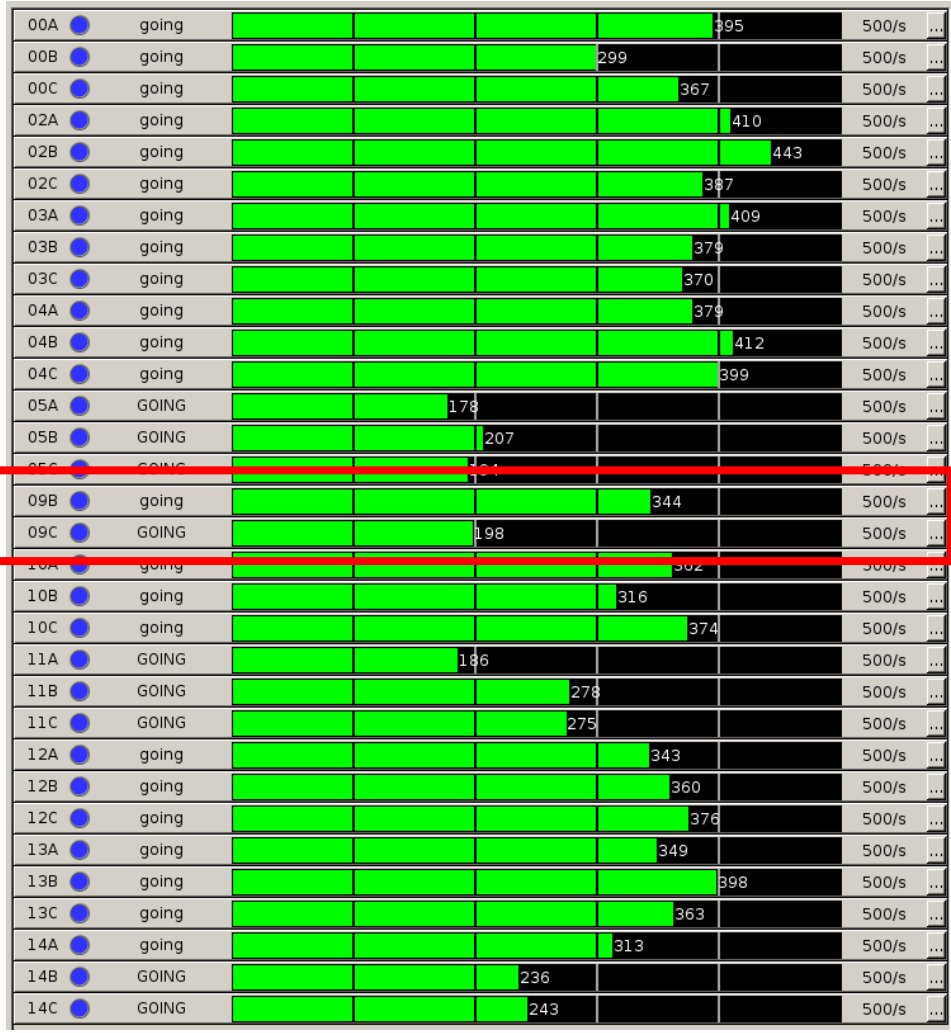
→ 20% loss

F. Recchia et al. LNL report

Back in 2016, we noticed a loss in validation for the GGP channels later explained by a too short TIMEOUT at the GTS block level with respect to the general latency of the GTS system at this load

Corrected since March 2017

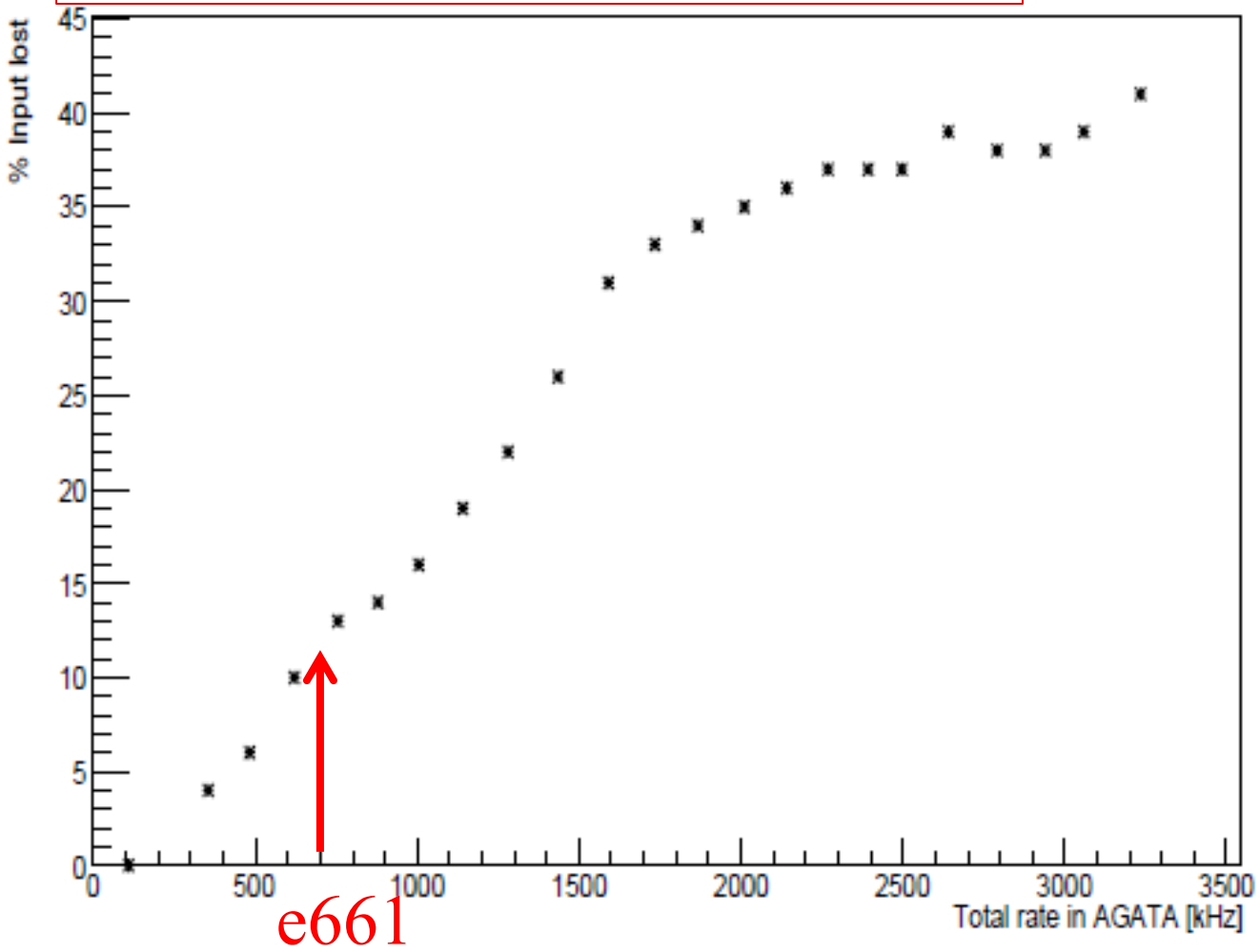




High rate effect

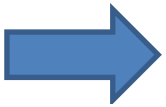
2017 GANIL MBq ^{60}Co source (32 crystals) ATCA + GGP

GTS limitation to be understood



All these effects participate to losses in the in-beam efficiency

AGATA crystals are not in common dead time.
As a consequence BOTH the total projection **AND** the γγ are affected



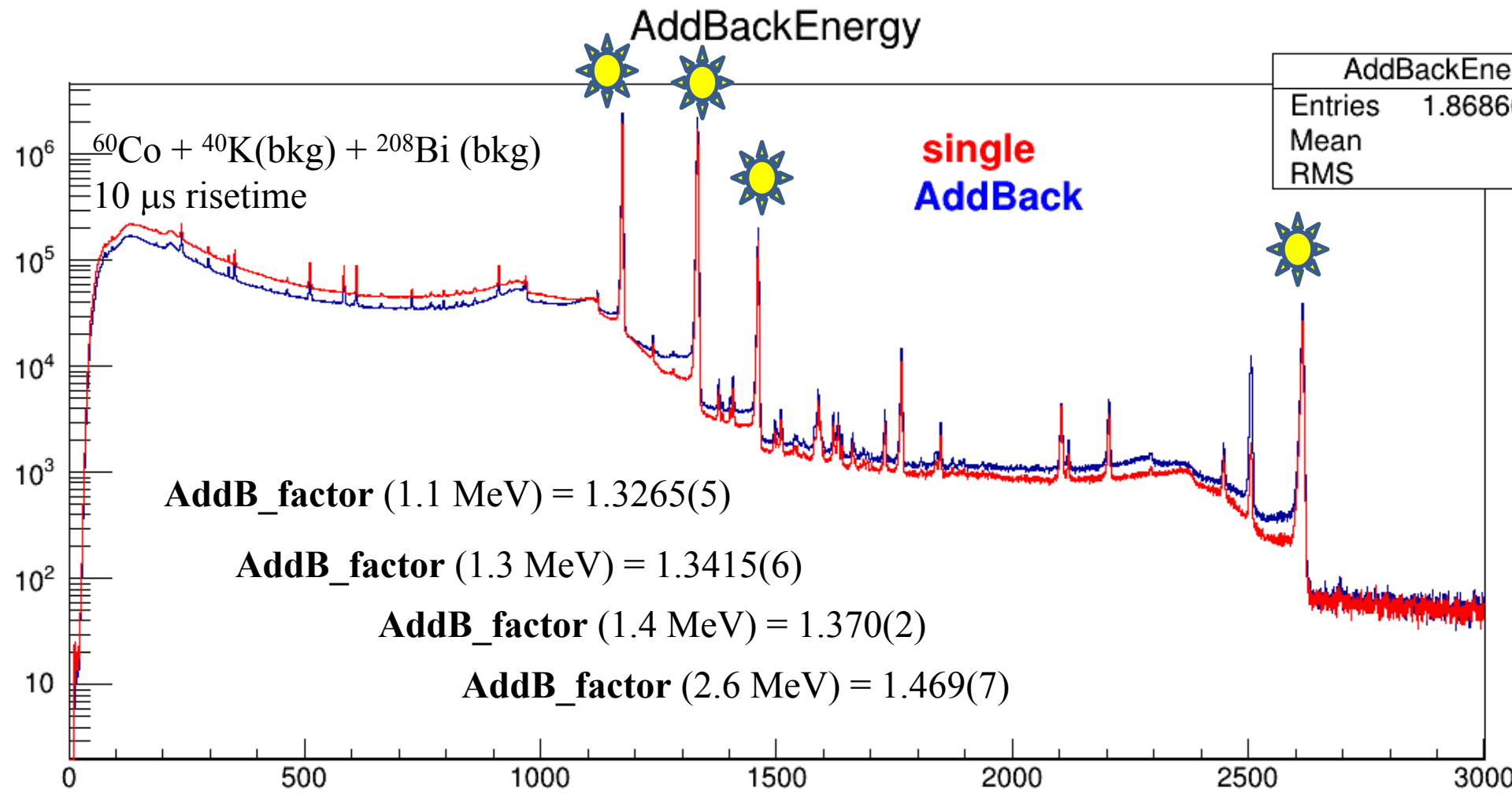
Including these losses in the G4 reading

Table 11: Summary

Energy [MeV]	Config	Single	OFT (F)	MGT (F)
1.1	Nominal Mono Energy at Rest	4.4	6.1 (1.38)	6.2 (1.4)
1.1	Compact Mono Energy at Rest	8.1	11.3 (1.40)	11.4 (1.4)
1.1	Compact ^{60}Co at Rest	7.7	10.6 (1.37)	10. (1.33)
1.1	Compact Fission at Rest	7.5	9.6 (1.28)	8.1 (1.08)
1.1	Nominal Fission at Rest	4.2	5.7 (1.35)	5.1 (1.21)
1.1	Compact Mono Energy β=0.1	7.3	10.1 (1.38)	10.1 (1.38)
1.1	Compact Fission β=0.1	6.5	8.7 (1.26)	7.4 (1.07)
1.1	Compact Fission β=0.1 by $\gamma-\gamma$	6.1		
1.1	Compact Fission+FEBEE β=0.1	4.0		
1.1	Compact Fission+FEBEE β=0.1 by $\gamma-\gamma$	3.5		

54% losses between low activity source and in-flight fission source at high multiplicity and high counting rate
Addback Factor 1.38 → 0.94
E661 → 46% measured losses, F ~1

Inappropriate RiseT vs AddBack factor



To make it easy : only core (E0) energies are considered. No Tracking but a simple AddBack procedure using neighboring cores **AddB_factor** = Int(AddB)/Int(Single)

AGATA crystals are not in common dead time

AGAVA

AGATA

^{60}Co MBq

Ancillary.sh { 100 Hz AGAVA }
Coincidence 2.2 us

100Hz Pulser

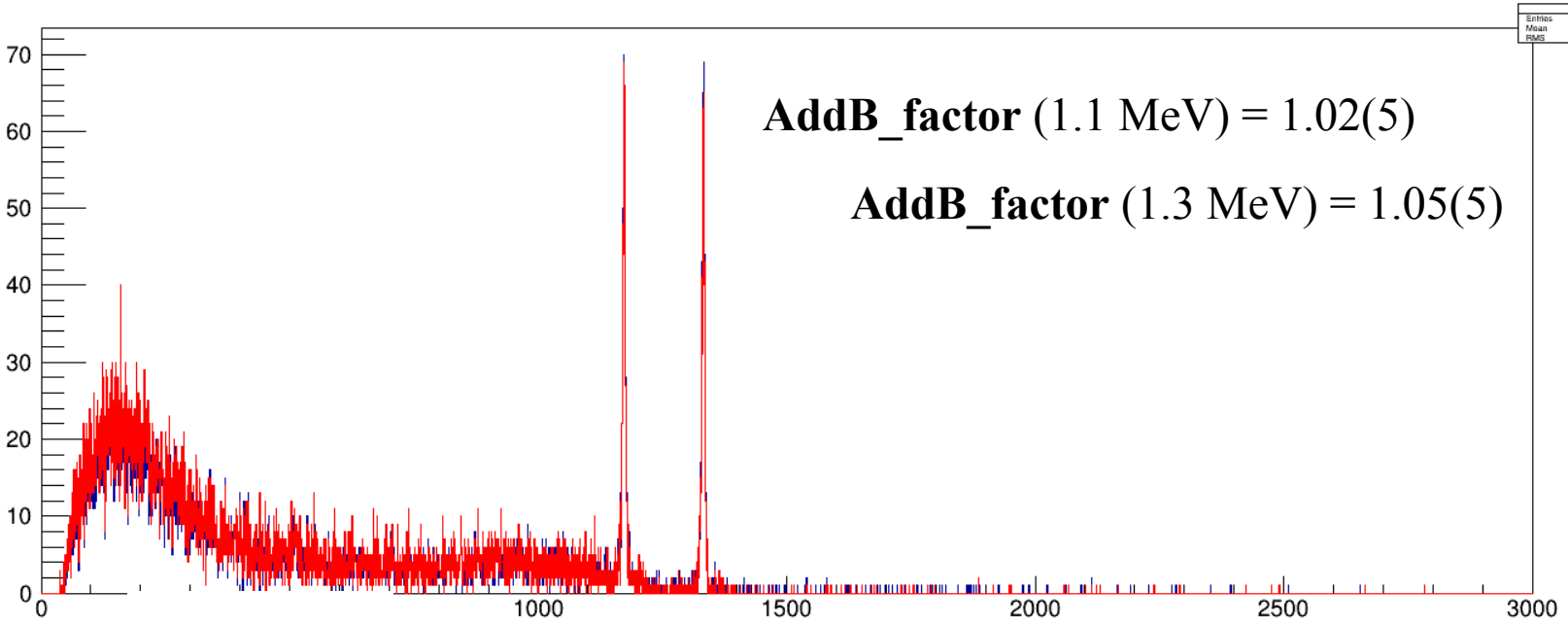
Ancillary.sh
Mult gamma>=1

>50kHz/core

10 µs RiseT Pile up will reject 60% of the requests

AddBackEnergy

Total input rate in GTP = 1.6 MHz



AddB_factor (1.1 MeV) = 1.02(5)

AddB_factor (1.3 MeV) = 1.05(5)

Survey of fission runs

//E680 – Fission run with [20-24] cores in compact configuration (-88.5 mm)
Rate was~36kHz/core RiseT =5us => 25% rejection expected
No GGP, No losses in the GTP from elog entries run 184,173
^{100}Zr → ε(351.9 keV) from γγ ,Tracked = 6.09(8)% Addback = 6.0(1) %
High multiplicity G4 says OFT=7.7% and AddB 8.1% → Can be explained only from pileup

//E669– Fission run with [21-24] cores in intermediate configuration (-52mm)
Rate was ~20kHz/core, RiseT =5us => 15% losses rejection expected
No GGP, No losses in the GTP from elog entries run 208, 193
^{86}Se → ε(868 keV) from γγ, Tracked = 4.5%
4 γ–rays cascade G4 says OFT=5.2% →Can be explained only from pileup

//E661 – Fission run with 32 cores in compact (-100 mm)
Losses explained with the compact configuration, pileup, GGP losses and GTP losses

//E706 – Fission run with 35 cores in nominal
Rate was 20kHz/core RistT = 5us =>15% losses rejection expected
GGP; measured losses are 11% from elog run126 (in agreement with the measurement in source)
^{100}Zr → ε(351.9 keV) from γγ ,Tracked = 5.8(6)%
High multiplicity G4 says OFT = 7.1% , Pile-up included => 6%, GTP included => 5.4%

Conclusion

✓ Source efficiency can be affected by hardware status
✓The efficiency measurement during the CAT should be a standard measurement if we want to understand our experimental efficiencies.
✓The G4 geometry must take this into account

In-beam with high rate

✓Brut force efficiency vs multiplicity effect should be look carefully in the choice of the nominal vs compact configuration
✓Pile-up rejection matters
✓The GGP time out has been corrected
✓Some GTS limitations at high load deserve more studies

There are additional backpressure effects when GGP are added to the ATCA for a validation rate > 1.5 kHz/core that need further investigations
→ This do not affect yet the in-beam/source data where run at ~200-300 Hz/core validation rate

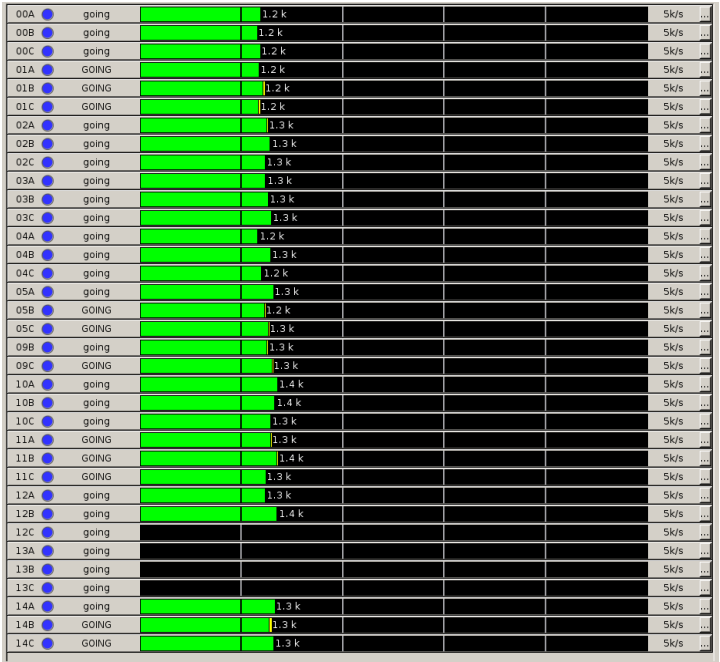
Everybody in GO and DrainON - ValidateALL

```
Aurora: CHANNEL UP       Input: RUN          Sort: RUN          t=100  k=0.9    V5          h: help

                clock ..... 15.909.187.014.154  100.00 M    event number ..... 3.984.188.218   30.24 K

          input trigger ..... 8.933.831.756     39.63 K     output reject ..... 1.244.442      8.13
            input idle ..... 1.128.493.529.204   7.09 M    output validate ..... 8.830.300.381  39.38 K

          sort trigger ..... 8.933.770.762     39.63 K
            sort idle ..... 626.577.538.457    3.94 M

         sumbus trigger ..... 8.831.544.823     39.38 K
           sumbus idle ..... 614.652.478.336    3.89 M
      sumbus under min ..... 0                  0.00          gate reject ..... 1.244.442      8.13
            transition ..... 7.926.244.222     30.24 K       gate validate ..... 8.830.300.381  39.38 K

  threshold not reached ..... 0                0.00
      threshold reached ..... 8.831.544.823    39.38 K     threshold equal ..... 7.926.244.222  30.24 K

         sumbus trigger ..... 0                0.00
           sumbus idle ..... 629.533.341.940   3.96 M
      sumbus under min ..... 0                  0.00          gate reject ..... 0              0.00
            transition ..... 0                  0.00        gate validate ..... 0              0.00

  threshold not reached ..... 0                0.00
      threshold reached ..... 0                0.00     threshold equal ..... 0              0.00
```

Is Equal to Sum CFD (39 kHz)

100% GTS validation

60Co source with 1.5 kHz/Core

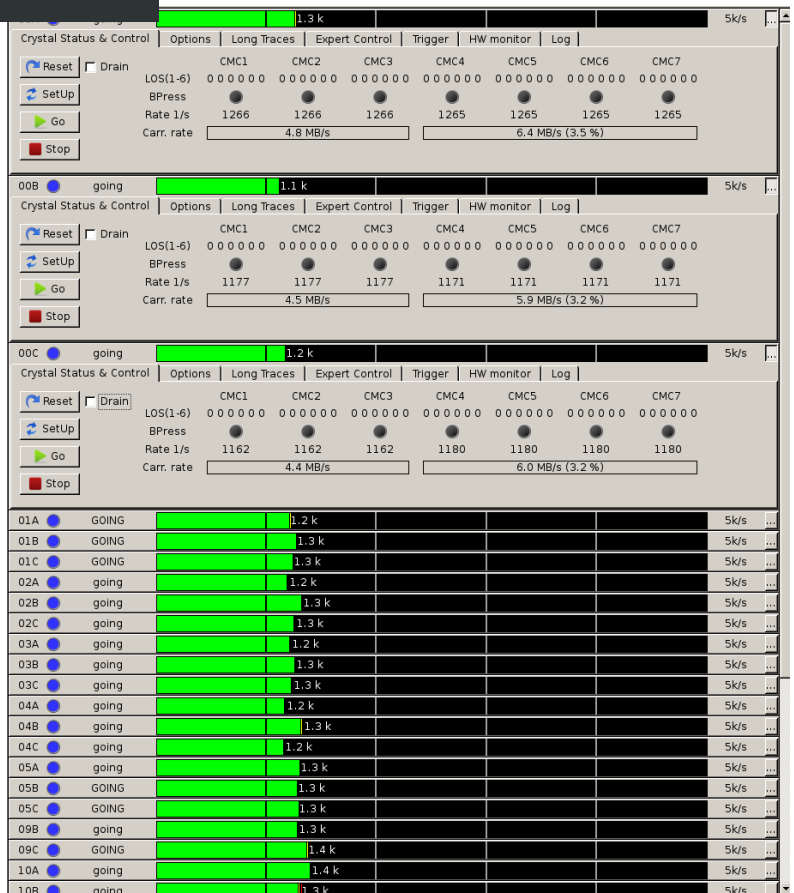


```
Aurora: CHANNEL UP       Input: RUN          Sort: RUN                t=100  k=0.9    V5                    h: help

                clock ........ 15.924.048.699.115  100.00 M      event number ............. 3.988.481.995   30.26 K

      input trigger ............. 8.939.448.724   39.75 K      output reject ................ 1.245.444    7.51
        input idle ......... 1.129.547.723.473    7.09 M      output validate ............. 8.835.871.008   39.40 K

       sort trigger ............. 8.939.387.648   39.75 K
         sort idle ........... 627.166.088.371    3.95 M

      sumbus trigger ............. 8.837.116.452   39.41 K
        sumbus idle ........... 615.233.016.559    3.89 M
     sumbus under min ........................... 0    0.00      gate reject ................ 1.245.444    7.51
          transition ............. 7.930.537.999   30.26 K      gate validate ............. 8.835.871.008   39.40 K

 threshold not reached ........................... 0    0.00
     threshold reached ............. 8.837.116.452   39.41 K      threshold equal ............. 7.930.537.999   30.26 K

      sumbus trigger ............................ 0    0.00
        sumbus idle ........... 630.123.021.806    3.96 M
     sumbus under min ........................... 0    0.00      gate reject ............................. 0    0.00
          transition ............................ 0    0.00      gate validate ........................... 0    0.00

 threshold not reached ........................... 0    0.00
     threshold reached ........................... 0    0.00      threshold equal ......................... 0    0.00
```

Is Equal to Sum CFD (39 kHz)

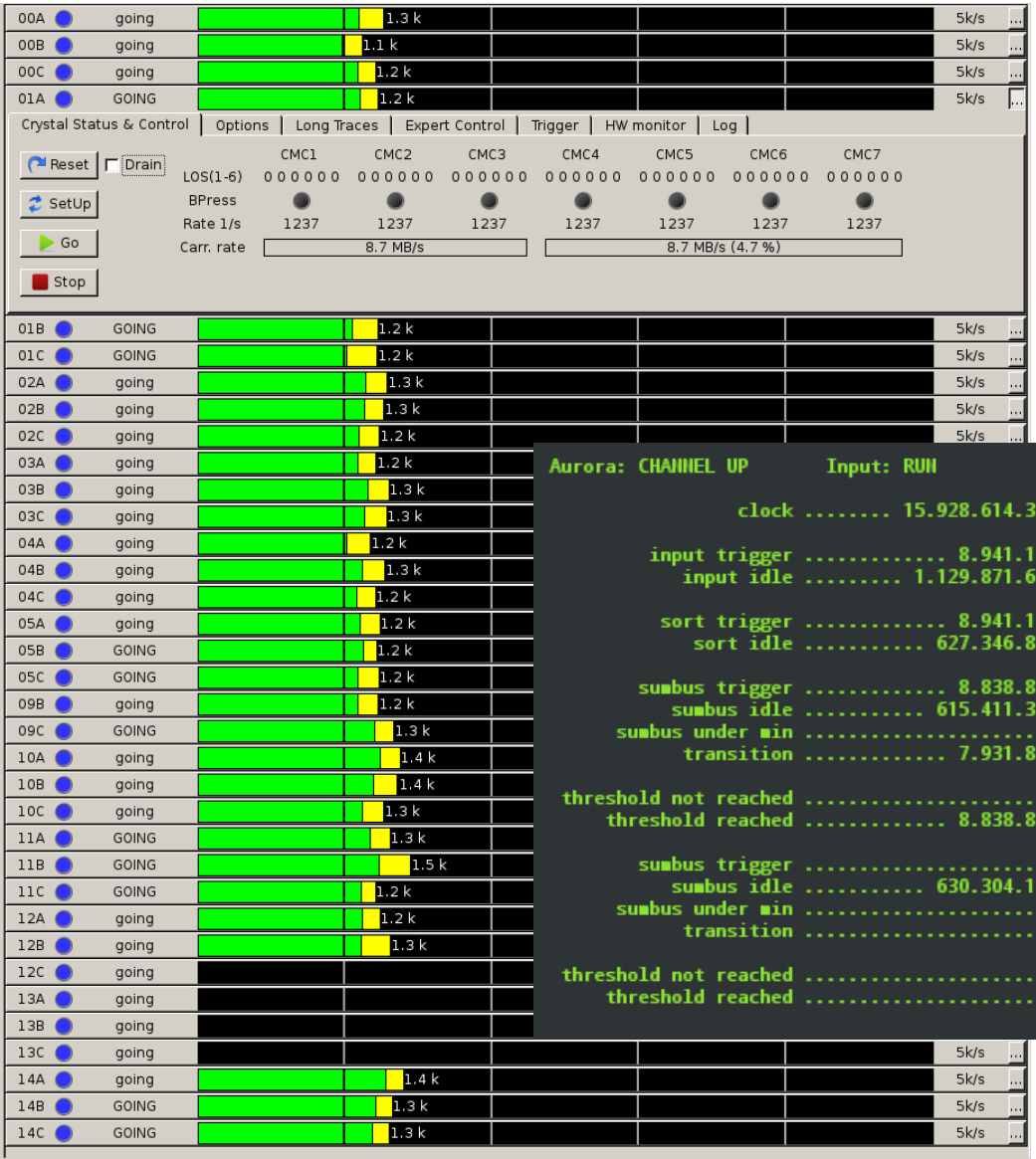
laboratoire commun CEA/DSM — Spiral2 — CNRS/IN2P3

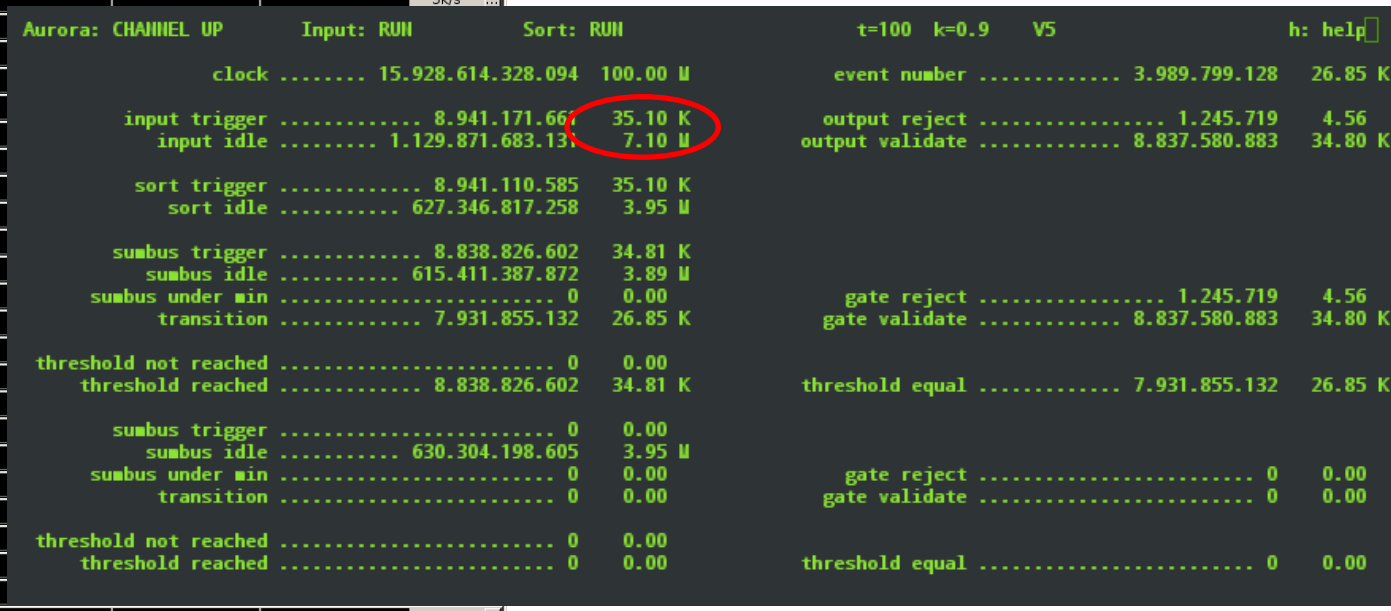
Everybody in GO and 3 ATCA Drain OFF – femul readout with cdat – bdat-No PSA – adf - histo



100% GTS validation

Everybody in GO and 1 GGP Drain OFF, All ATCA drain ON –femul readout with cdat – bdat-No PSA – adf -histo

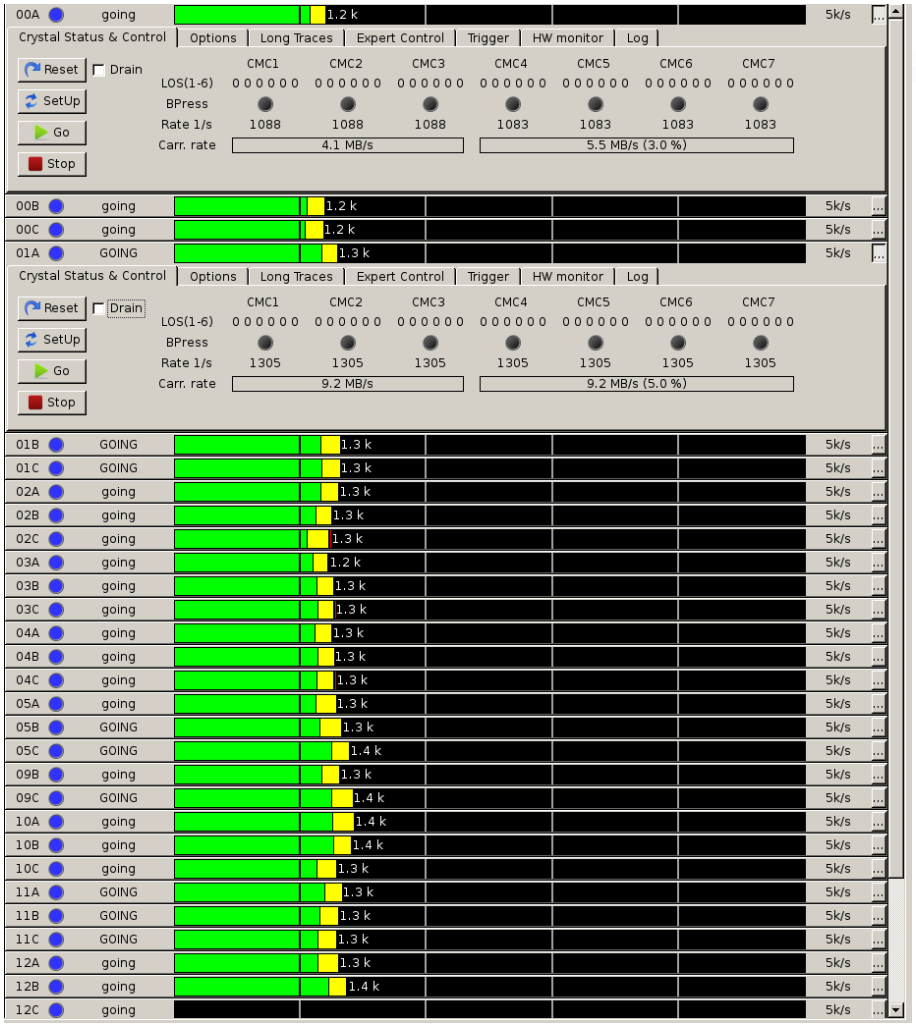




All channel have losses !!! GGP and ATCA

Less than Sum CFD (39 kHz) => Missing request to the Trigger Input

Everybody in GO and 1 GGP Drain OFF, 1 ATCA drain OFF –femul readout with cdat – bdat-No PSA – adf -histo



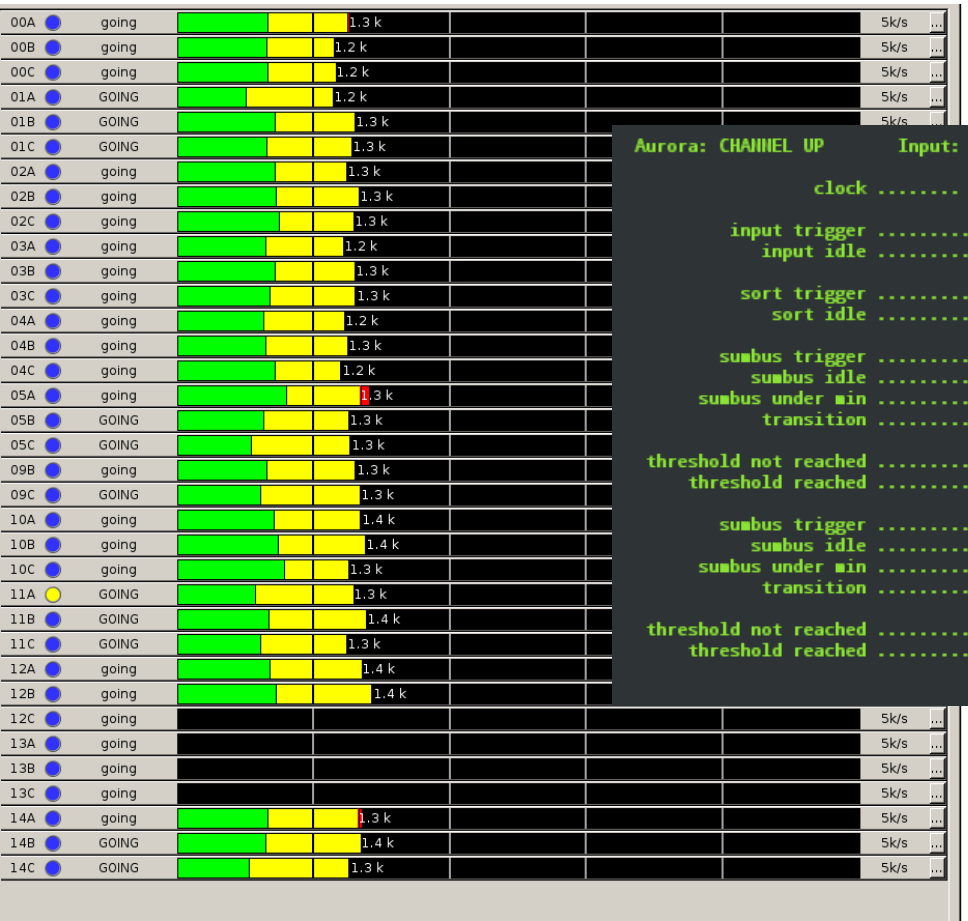
Same losses has before

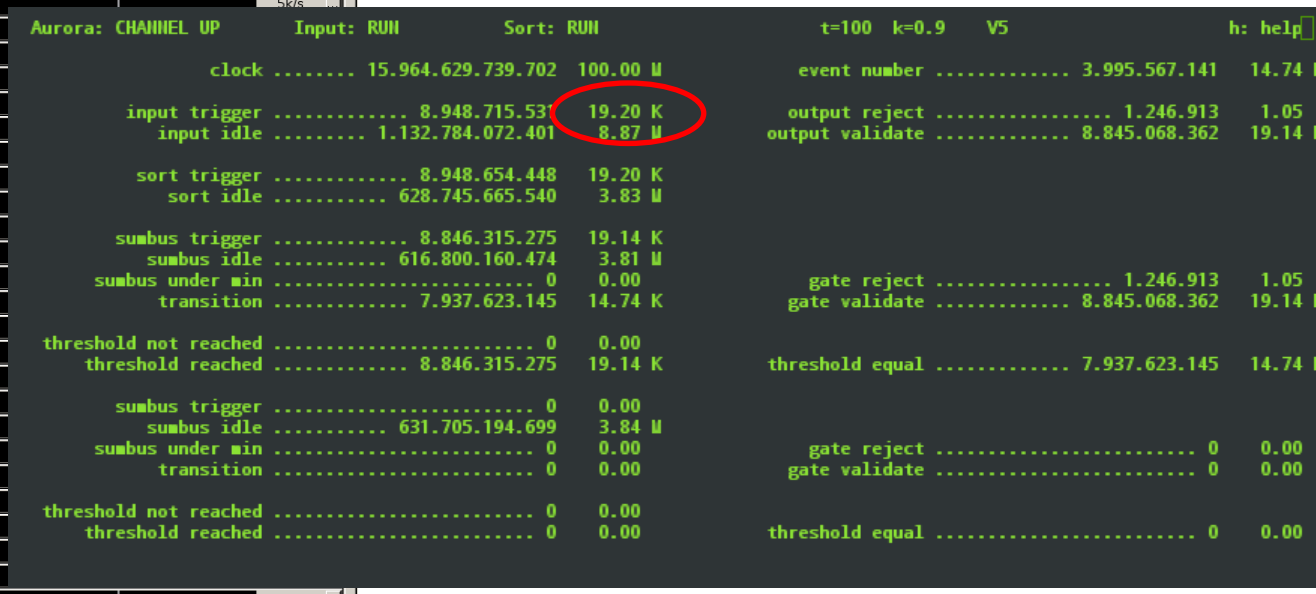
Everybody in GO and All channel drain OFF –femul readout with cdat – bdat-No PSA – adf -histo

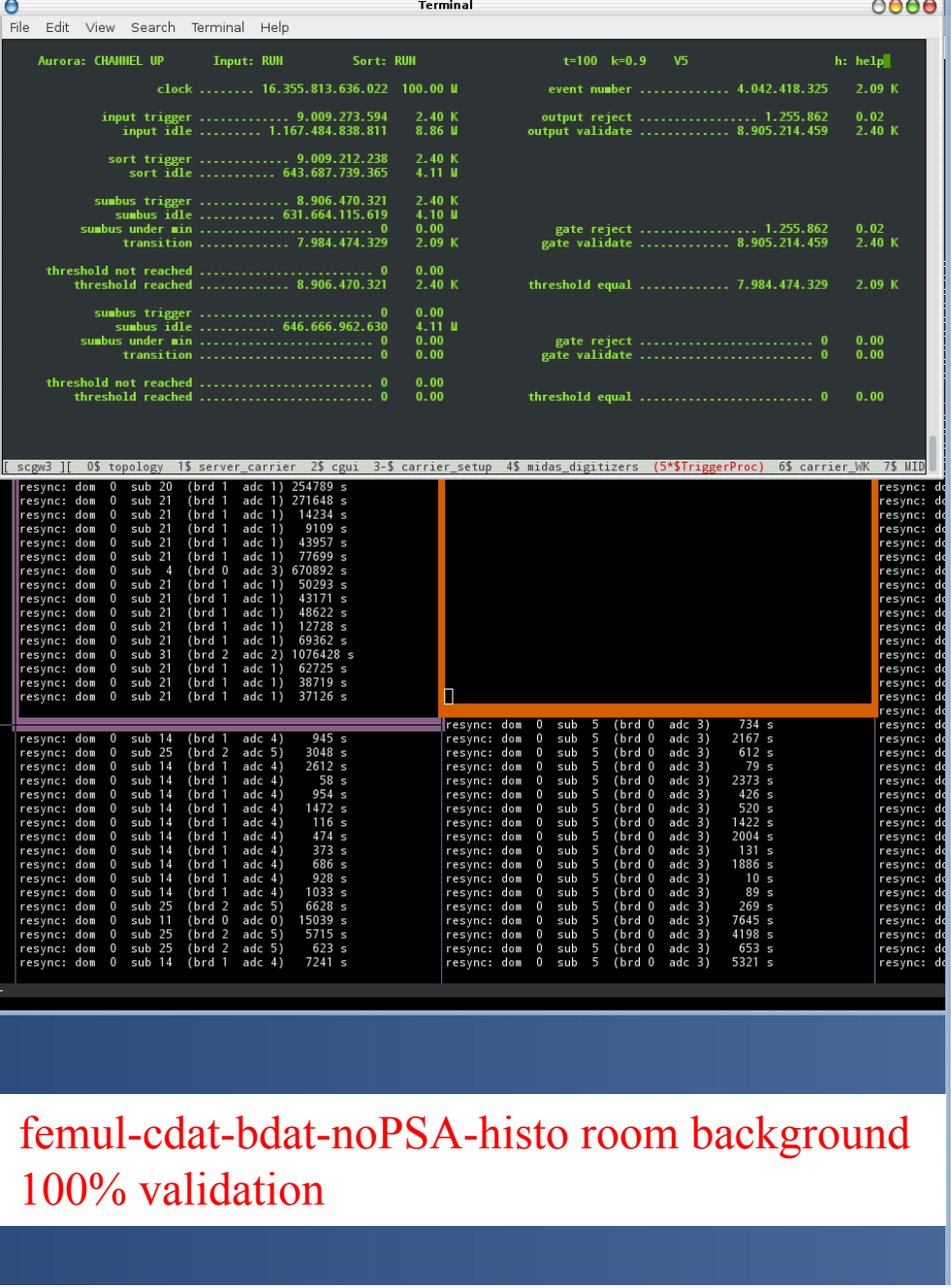
No rejection when All ATCA are drain off and all GGP drain ON
as soon as there is at least 1 GGP, we have losses in the GTS when rate > 1kHz validation

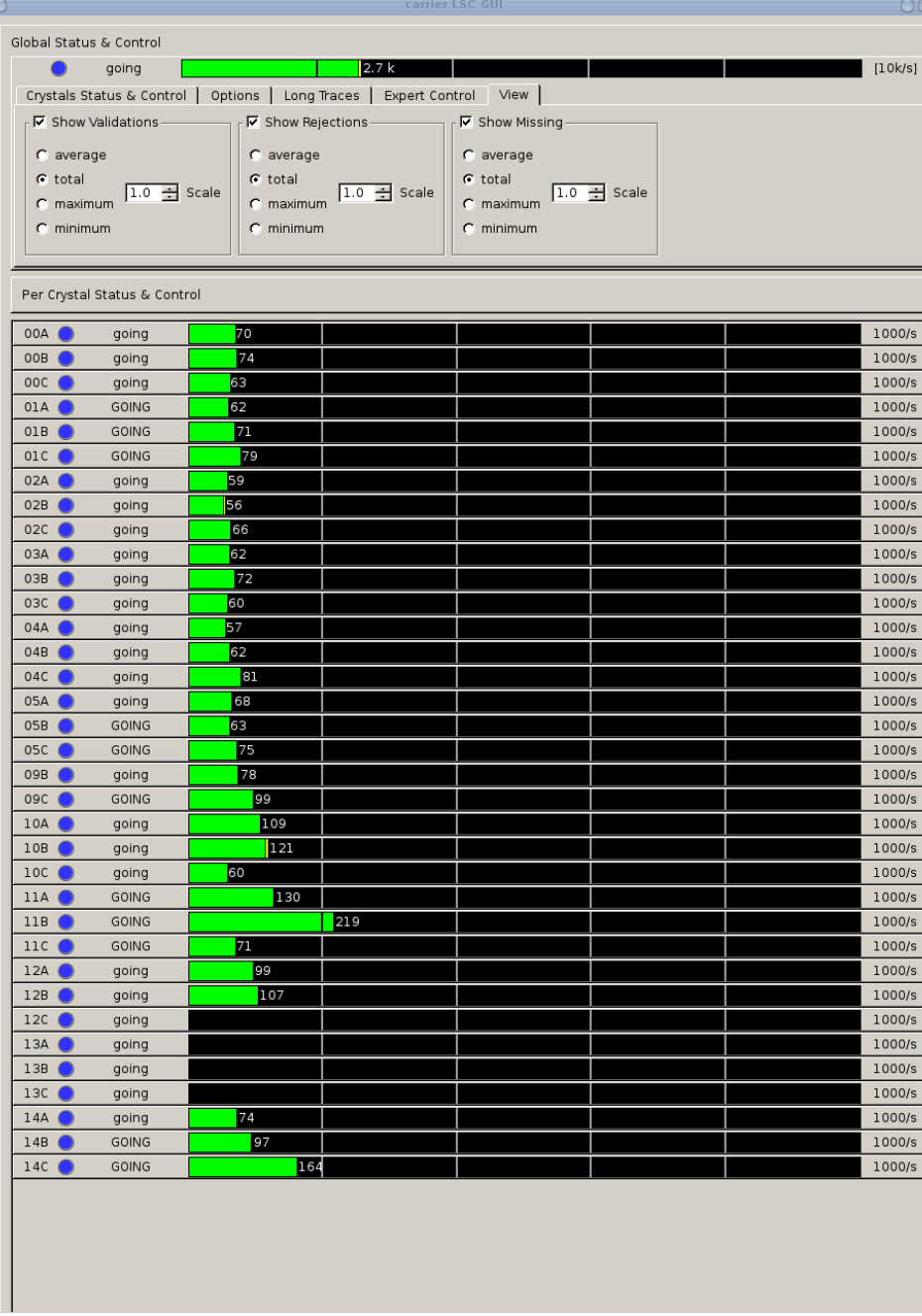
50 % rejection !!!!!! Half of the GTS request are not reaching the TP (CFD = 39 kHz)

Same result in exclude Trigger Processor.

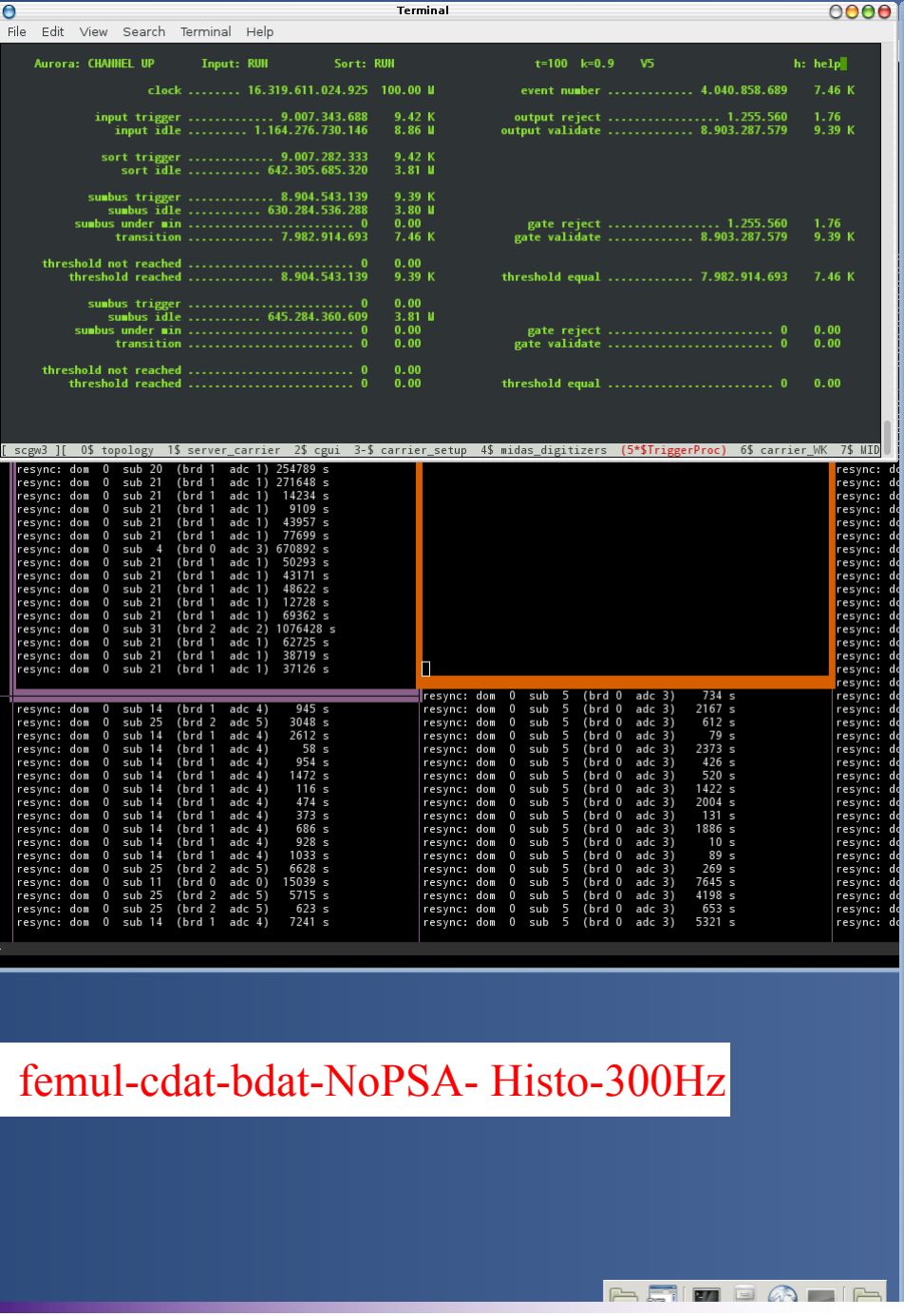


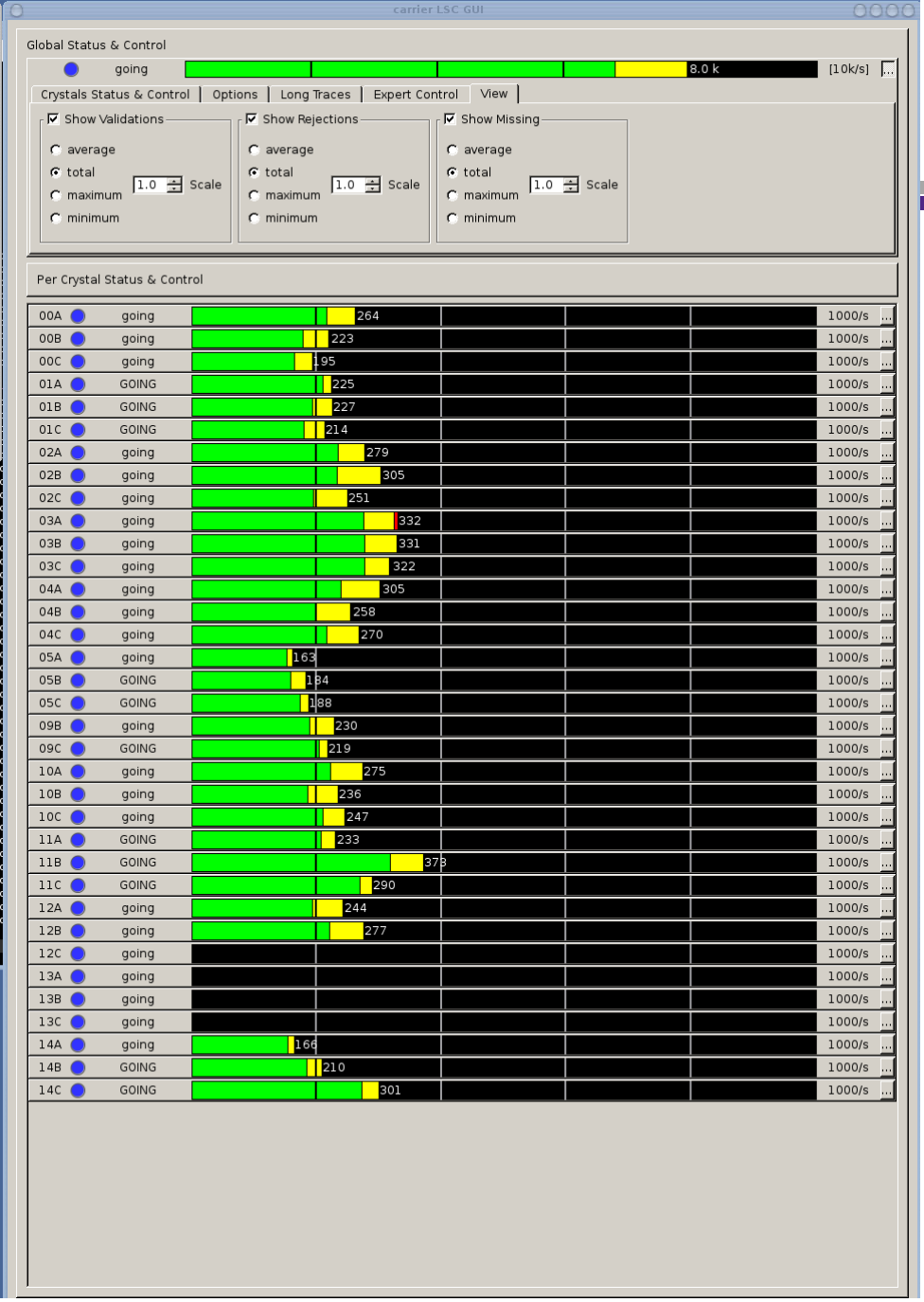




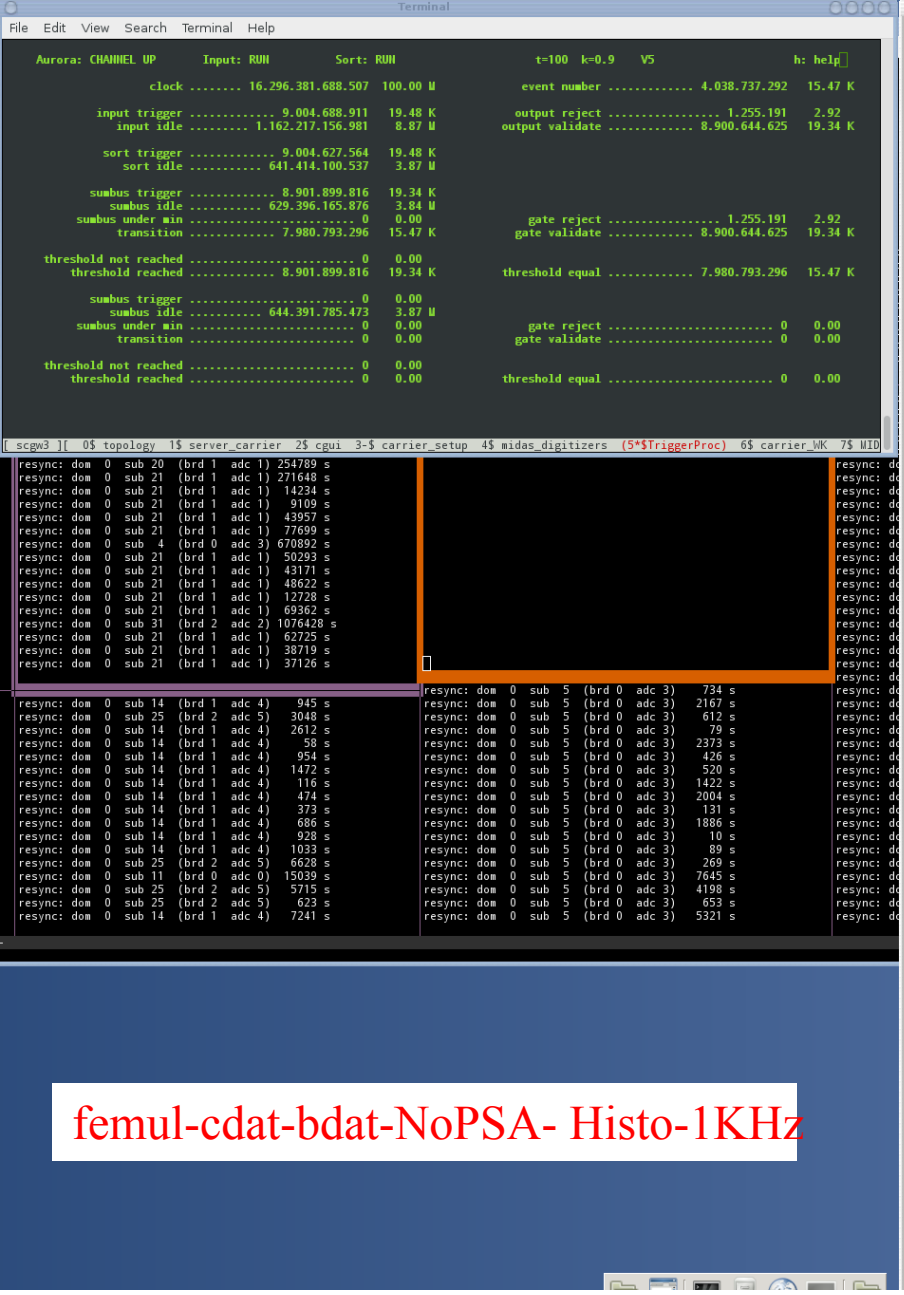


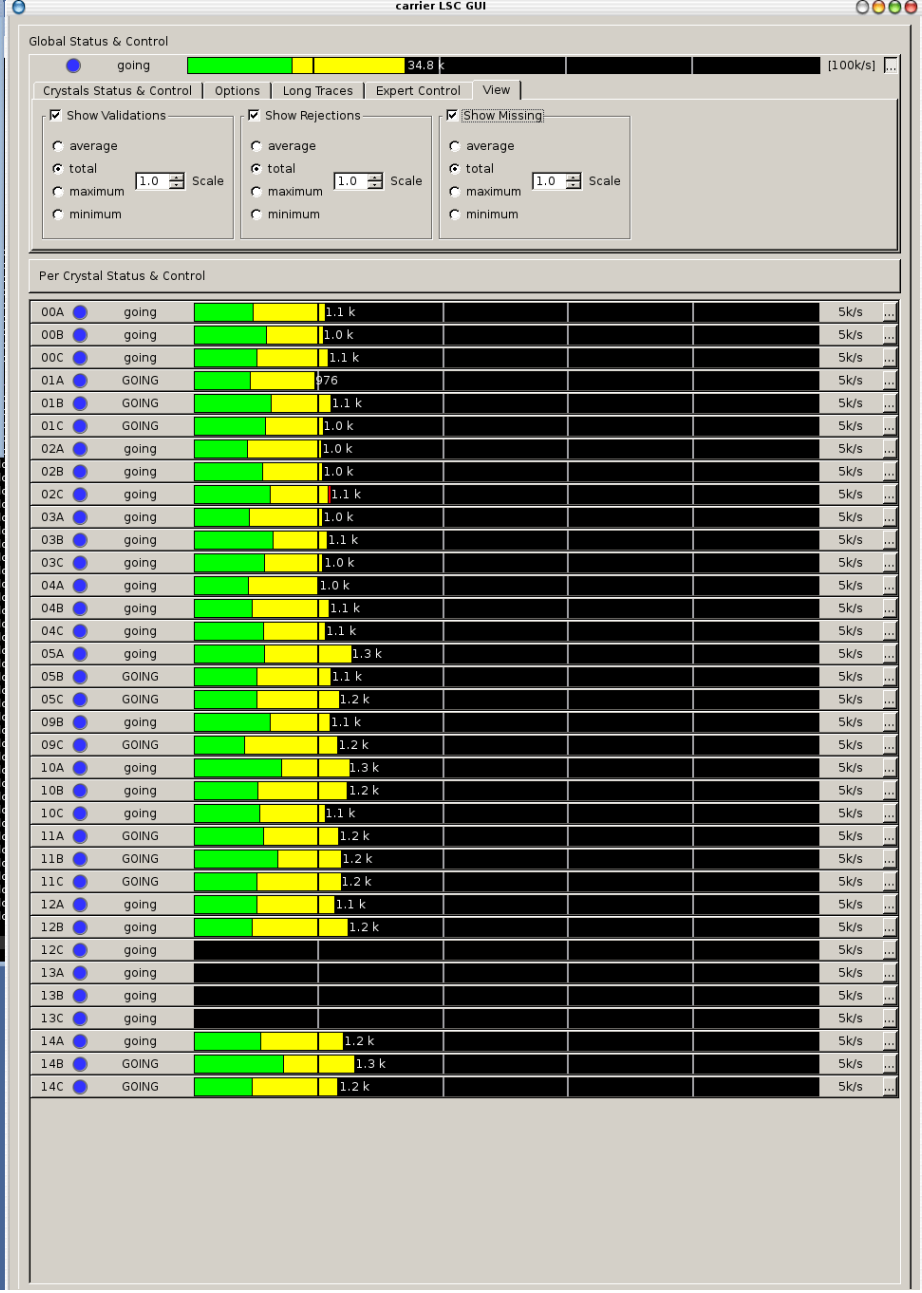
femul-cdat-bdat-noPSA-histo room background
100% validation



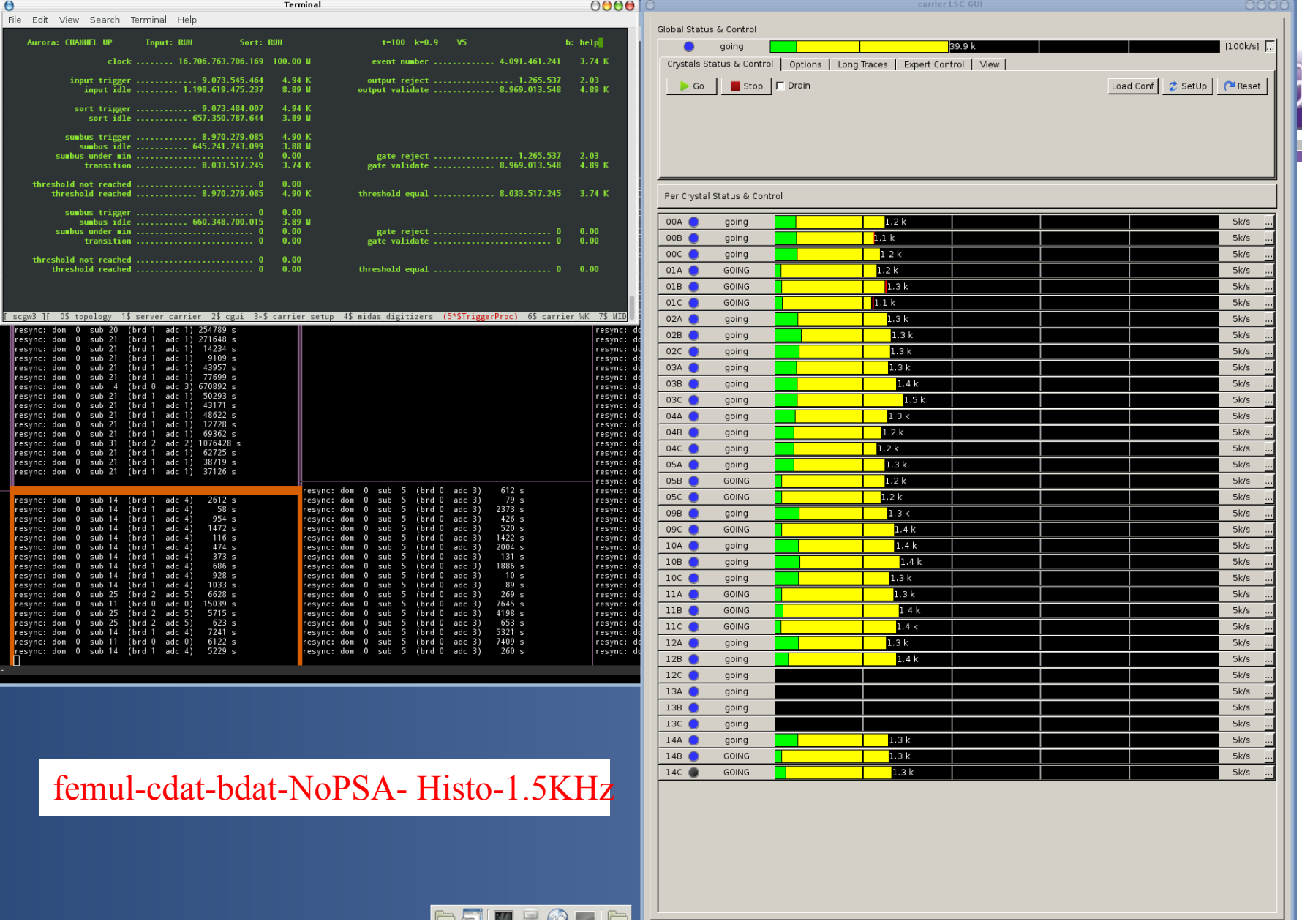


femul-cdat-bdat-NoPSA- Histo-300Hz



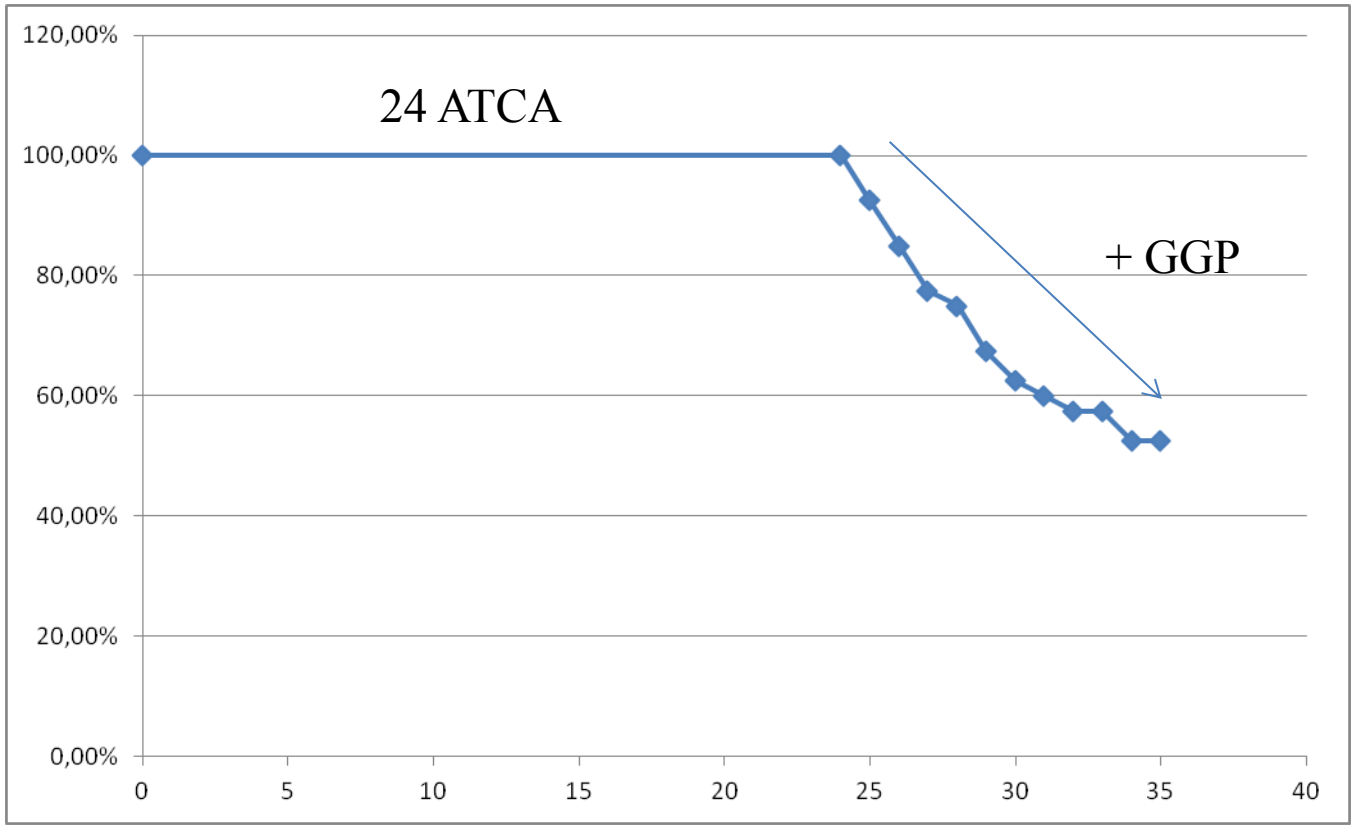


femul-cdat-bdat-NoPSA- Histo-1KHz



femul-cdat-bdat-NoPSA- Histo-1.5KHz

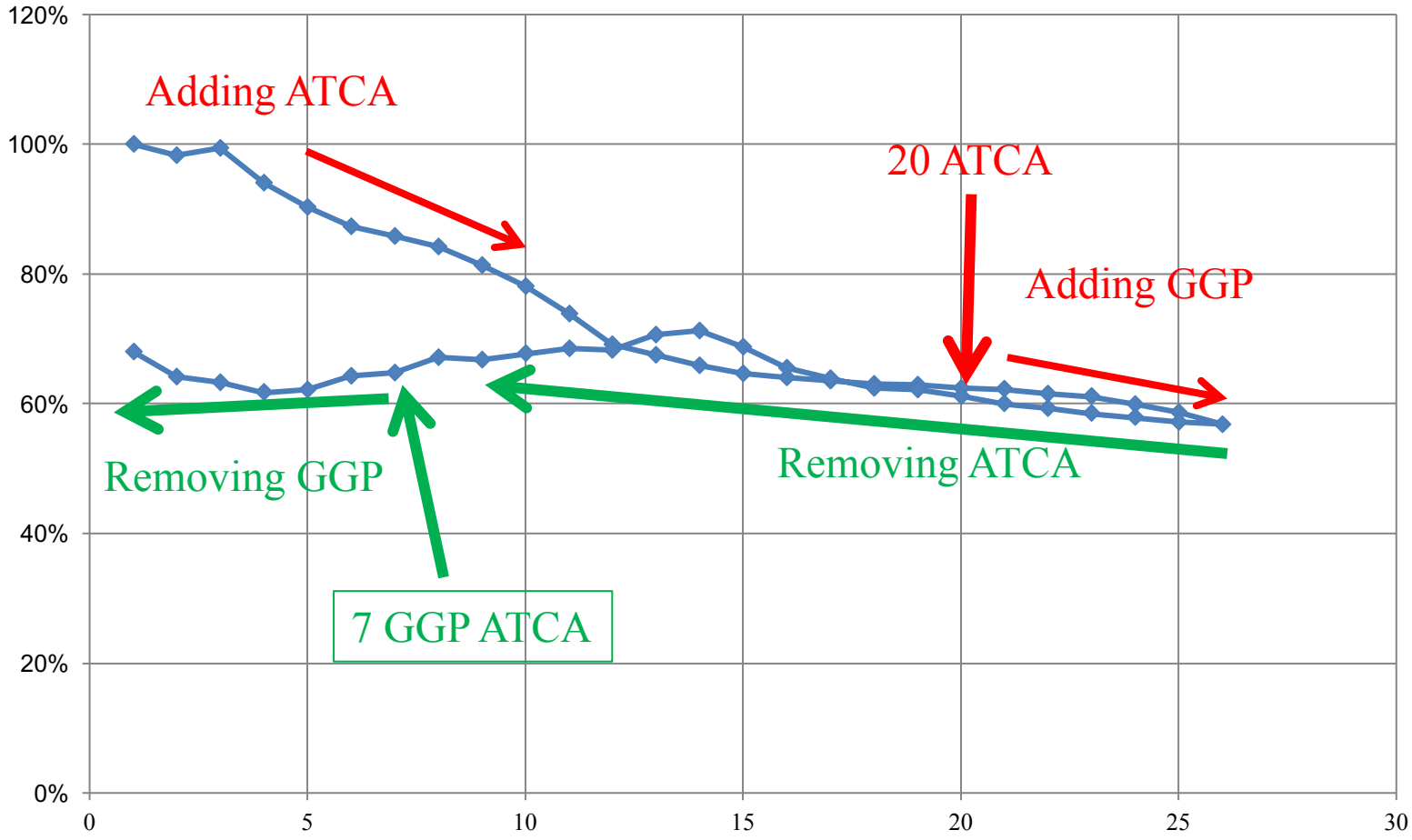
@1.5 kHz/core
Ratio Trigger Input / Sum CFD



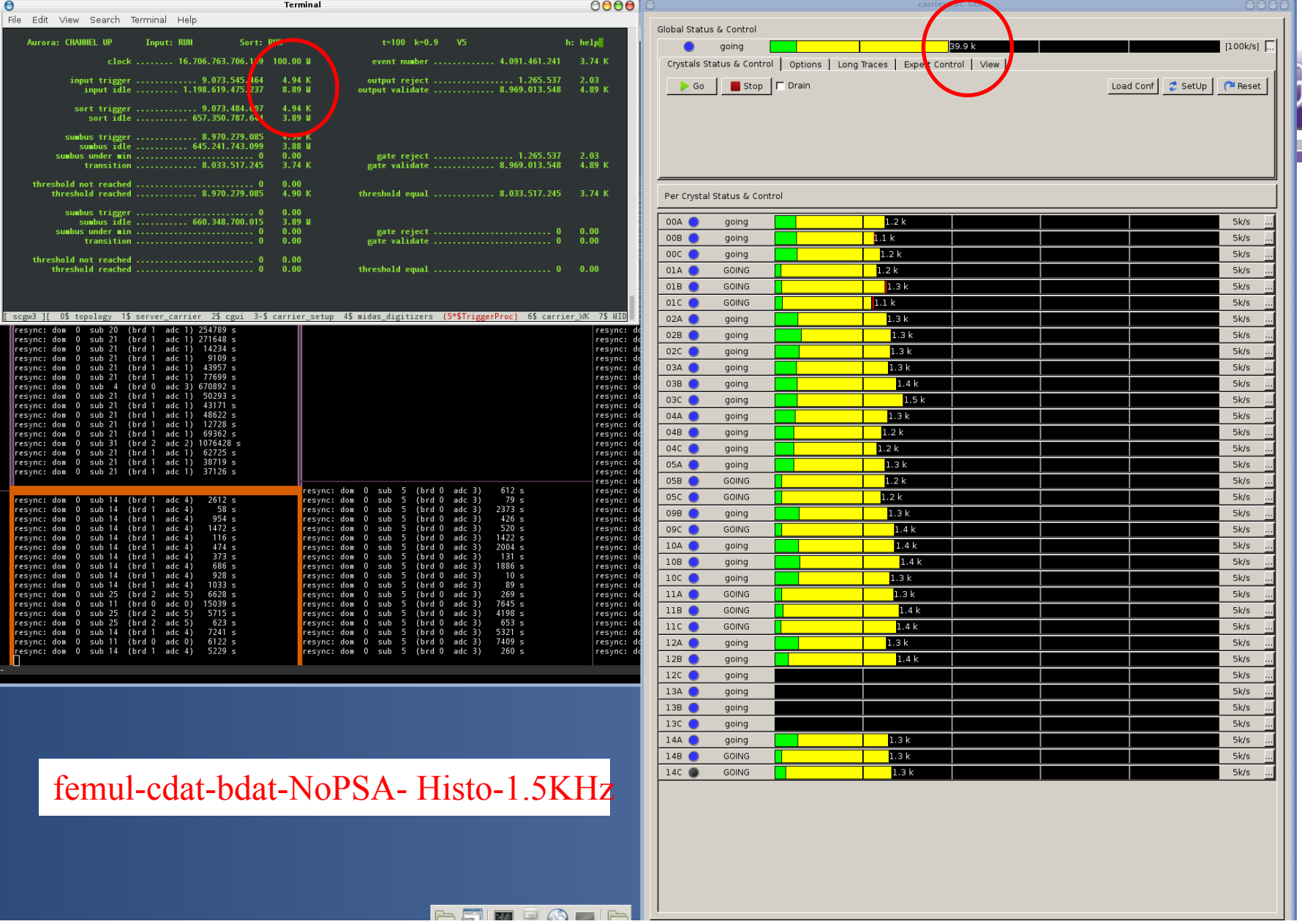
#Channel Drain OFF

~100 kHz/core, validateAll,

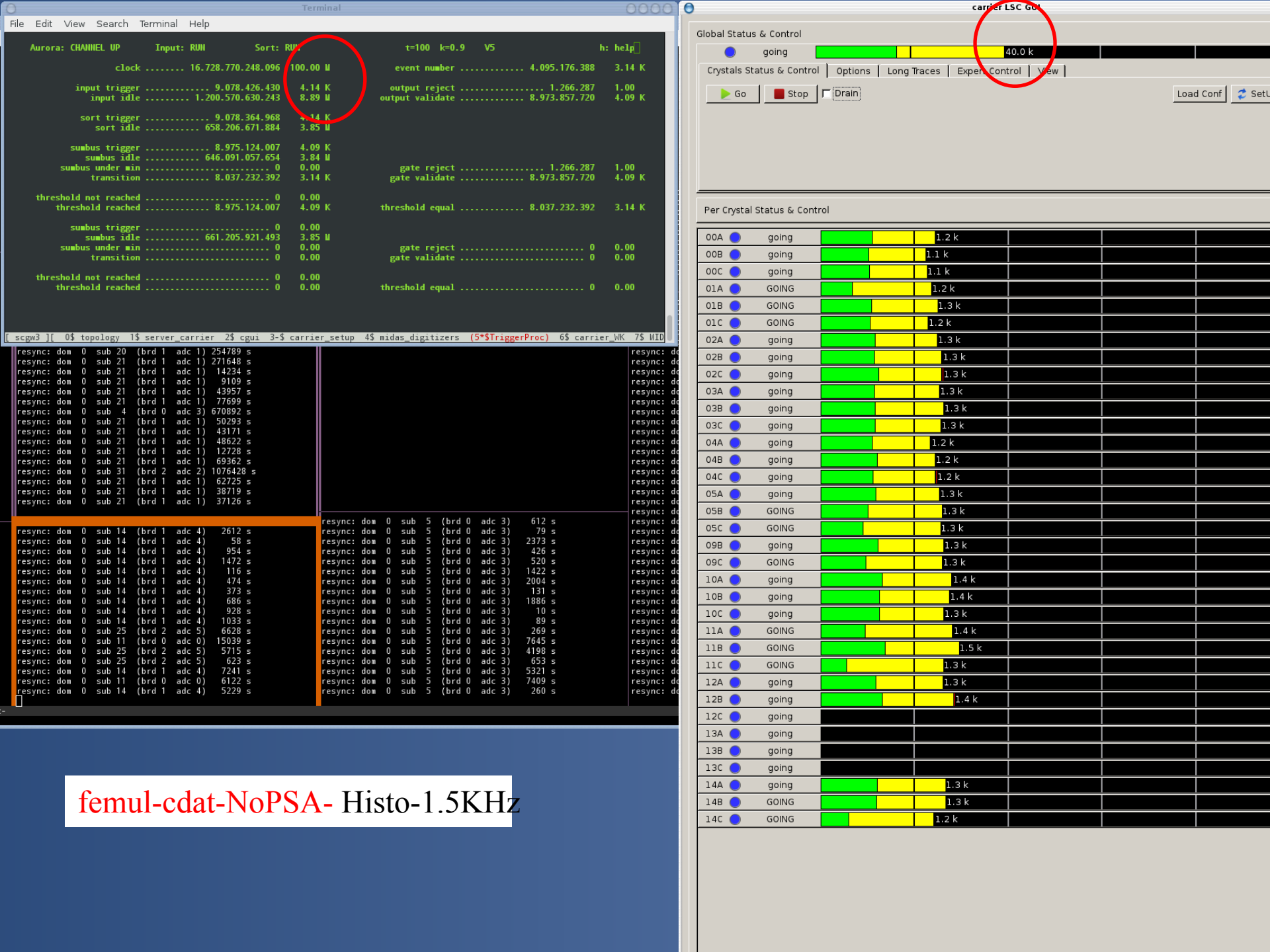
Input TP/ Sum CFD cgui

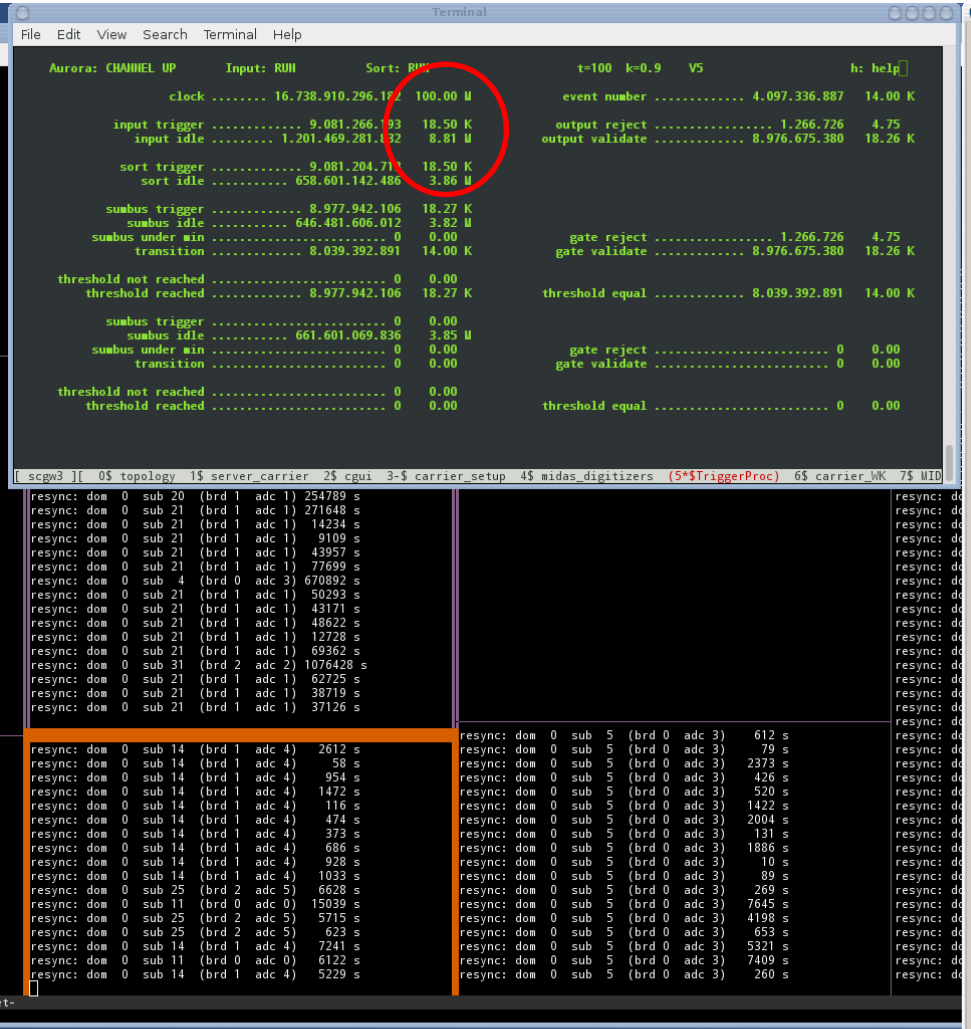


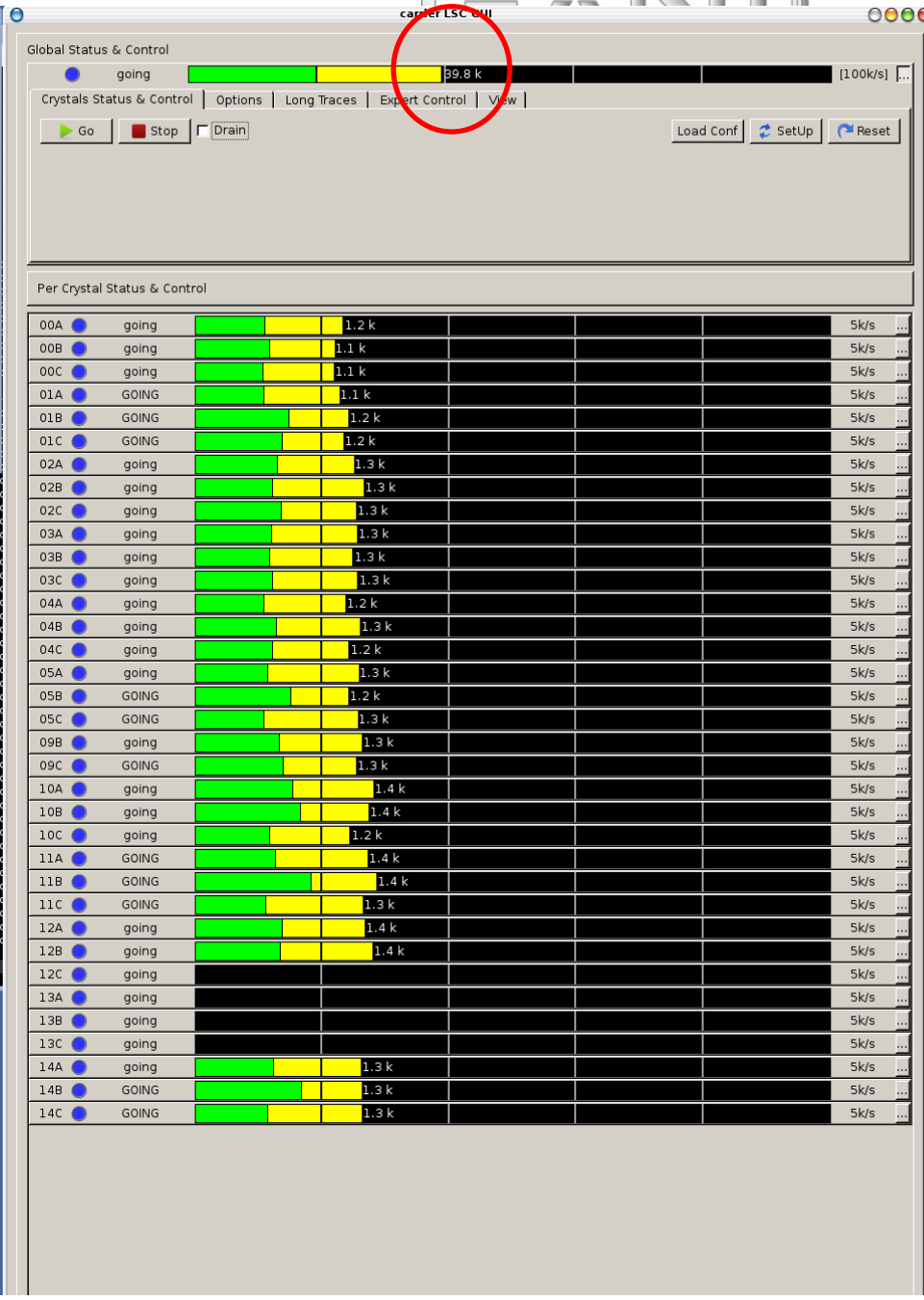
Keeping 1.5 kHz/core, changing the femul ouput



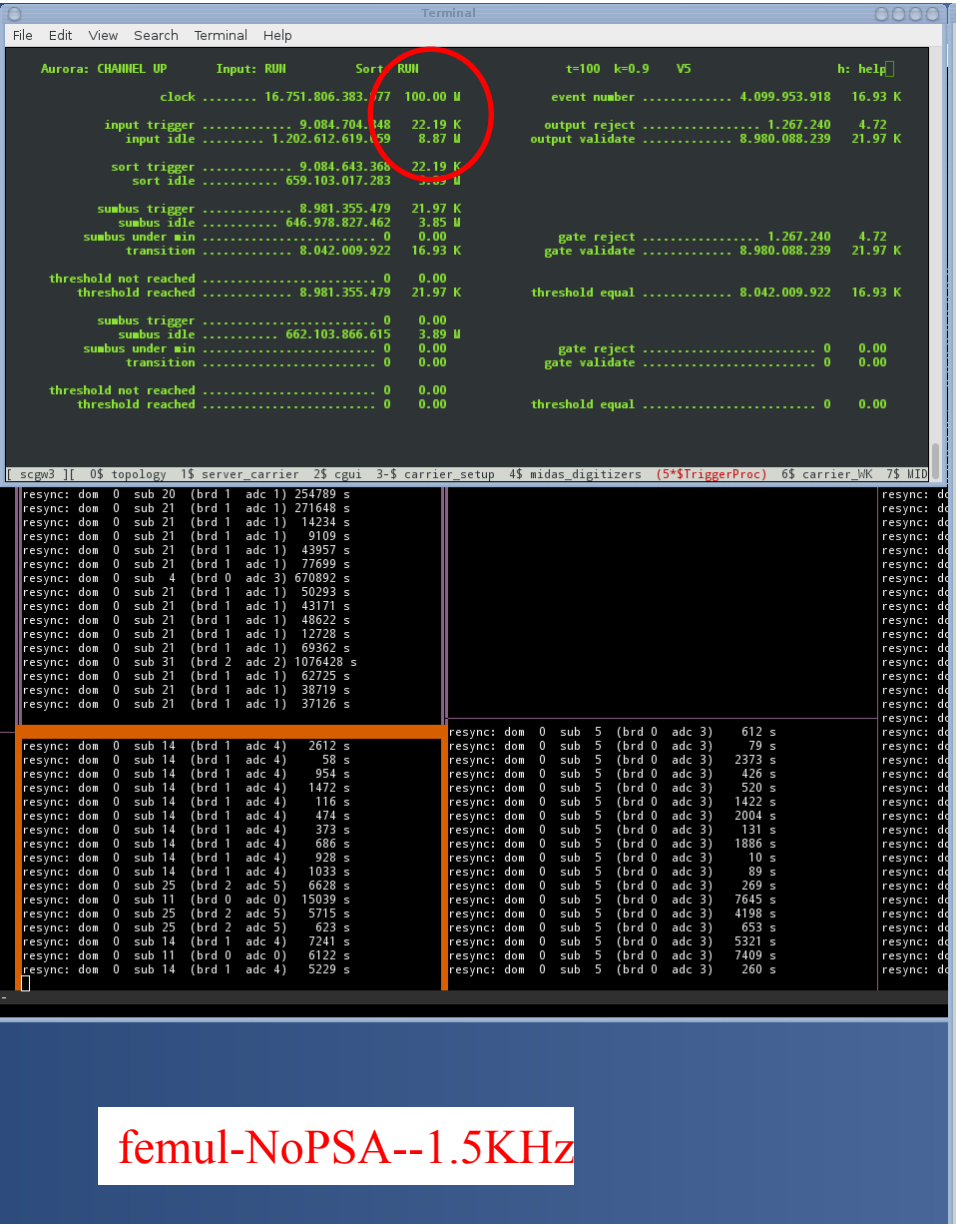
femul-cdat-bdat-NoPSA- Histo-1.5KHz


Terminal
File Edit View Search Terminal Help
Aurora: CHANNEL UP Input: RUN Sort: RUN t=100 k=0.9 V5 h: help
clock ..... 16.728.770.248.096 100.00 M
event number ..... 4.095.176.388 3.14 K
input trigger ..... 9.078.426.430 4.14 K
input idle ..... 1.200.570.630.243 8.89 M
output reject 1.266.287 1.00
output validate ..... 8.973.857.720 4.09 K
sort trigger ..... 9.078.364.968 4.14 K
sort idle ..... 658.206.671.884 3.85 M
sumbus trigger ..... 8.975.124.007 4.09 K
sumbus idle ..... 646.091.057.654 3.84 M
sumbus under min 0 0.00
gate reject 1.266.287 1.00
transition ..... 8.037.232.392 3.14 K
gate validate ..... 8.973.857.720 4.09 K
threshold not reached 0 0.00
threshold reached ..... 8.975.124.007 4.09 K
threshold equal ..... 8.037.232.392 3.14 K
sumbus trigger 0 0.00
sumbus idle ..... 661.205.921.493 3.85 M
sumbus under min 0 0.00
gate reject 0 0.00
transition 0 0.00
gate validate 0 0.00
threshold not reached 0 0.00
threshold reached 0 0.00
threshold equal 0 0.00
[scgw3][0$ topology 1$ server_carrier 2$ cgui 3-$ carrier_setup 4$ midas_digitizers (5*$TriggerProc) 6$ carrier_WK 7$ MID
carrier LSC GUI
Global Status & Control
going
40.0 k
Crystals Status & Control
Options
Long Traces
Expert Control
View
Go
Stop
Drain
Load Conf
SetU
Per Crystal Status & Control
00A going 1.2 k
00B going 1.1 k
00C going 1.1 k
01A GOING 1.2 k
01B GOING 1.3 k
01C GOING 1.2 k
02A going 1.3 k
02B going 1.3 k
02C going 1.3 k
03A going 1.3 k
03B going 1.3 k
03C going 1.3 k
04A going 1.2 k
04B going 1.2 k
04C going 1.2 k
05A going 1.3 k
05B GOING 1.3 k
05C GOING 1.3 k
09B going 1.3 k
09C GOING 1.3 k
10A going 1.4 k
10B going 1.4 k
10C going 1.3 k
11A GOING 1.4 k
11B GOING 1.5 k
11C GOING 1.3 k
12A going 1.3 k
12B going 1.4 k
12C going
13A going
13B going
13C going
14A going 1.3 k
14B GOING 1.3 k
14C GOING 1.2 k
femul-cdat-NoPSA- Histo-1.5KHz





femul-NoPSA- Histo-1.5KHz



femul-NoPSA--1.5KHz