TRD
GAS Refill
Version 5, 16th December 2015

B. Beischer, Th. Kirn, Th. Siedenburg, S. Zeissler

TRD-ACC-TAS SHIFTER:
TRD-Gas-Expert Phone Numbers

Gas Expert Telephone Numbers:

TRD Mobile: 16 9779 (from outside CERN: +41 76 487 9779)

Thorsten Siedenburg: Office: +49241 80 27186; Private: +49 241 4002544;
Mobile: +49 157 88464495

Stefan Zeissler: cell +41 76 4876254

Valery Zhukov: Office: +41 (0)22 767 8188 Mobile: +41 76 487 6537

TRD Gas Refill - Preparation

For each Gas Refill a log file has to be created and filled in by hand.

The log files are stored in ~/Gas_Refills

Create a new directory with name: yyyy_mm_dd, e.g.

trd@pcpoc25 Gas_Refills$ mkdir 2013_01_23

trd@pcpoc25 Gas_Refills$ cd 2013_01_23

Follow instructions of automated worksheet for TRD Gas Refill

(still separate in the moment, calculation by hand described on pages 5-11, continue on page 12!)

Take care, not to change the number of lines by adding or deleting text.

TRD Gas Refill - Preparation

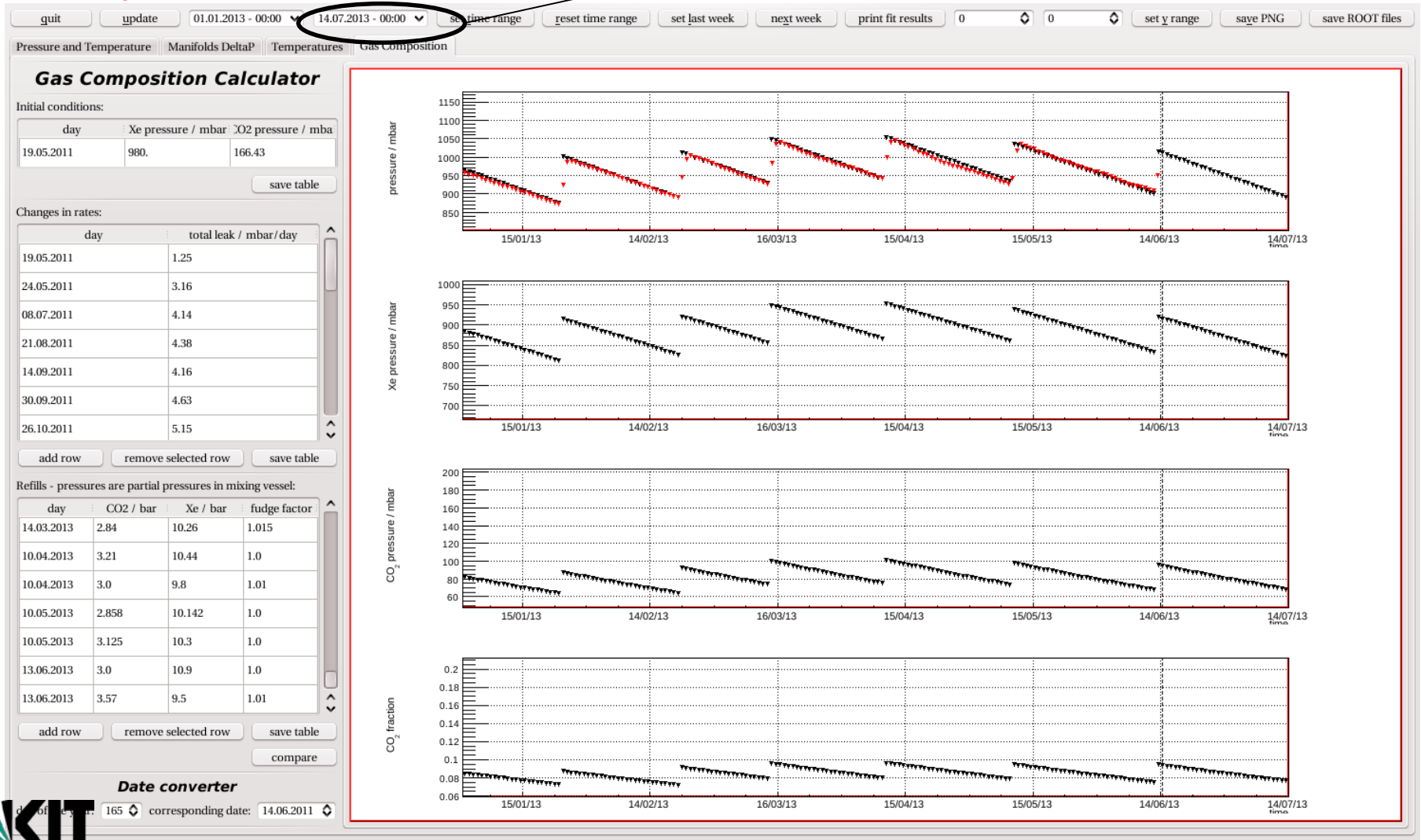
Calculate the amount of gas to be filled; check actual gas composition in

TRD-PressureMonitor and in text file

~/RUN/COMMANDING/TRDGAS/Gas_Refills/gas_composition_history.txt

Example: 13th June 2013:

Set the date to the one of day 2 of Refill



TRD Gas Refill - Preparation

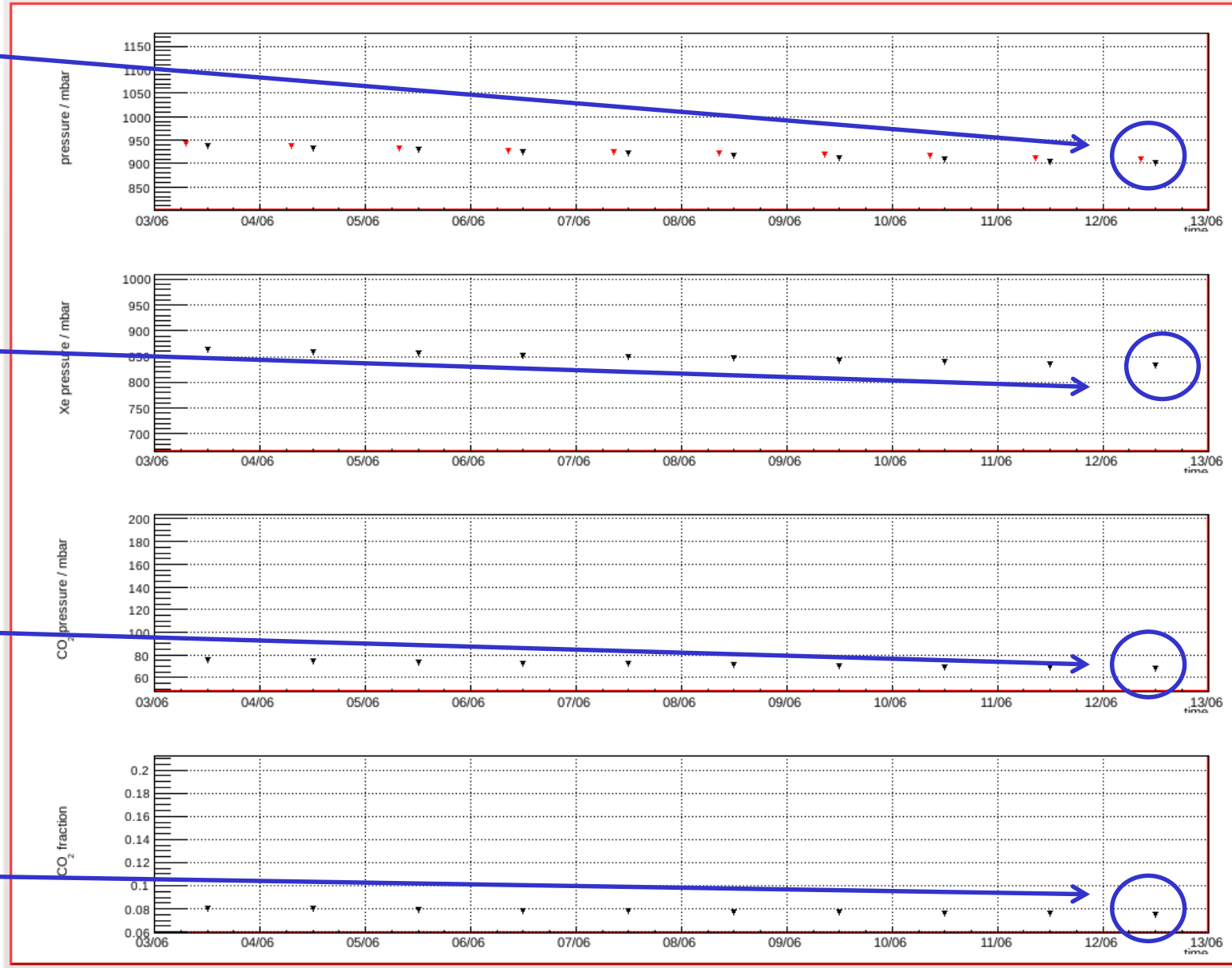
TRD-PressureMonitor: check actual gas composition; Example: 13th June 2013:

Measured total pressure: 905 mbar

Xe @ 835 mbar, (in TRD, calculated)

CO_2 @ 68 mbar, (in TRD, calculated)

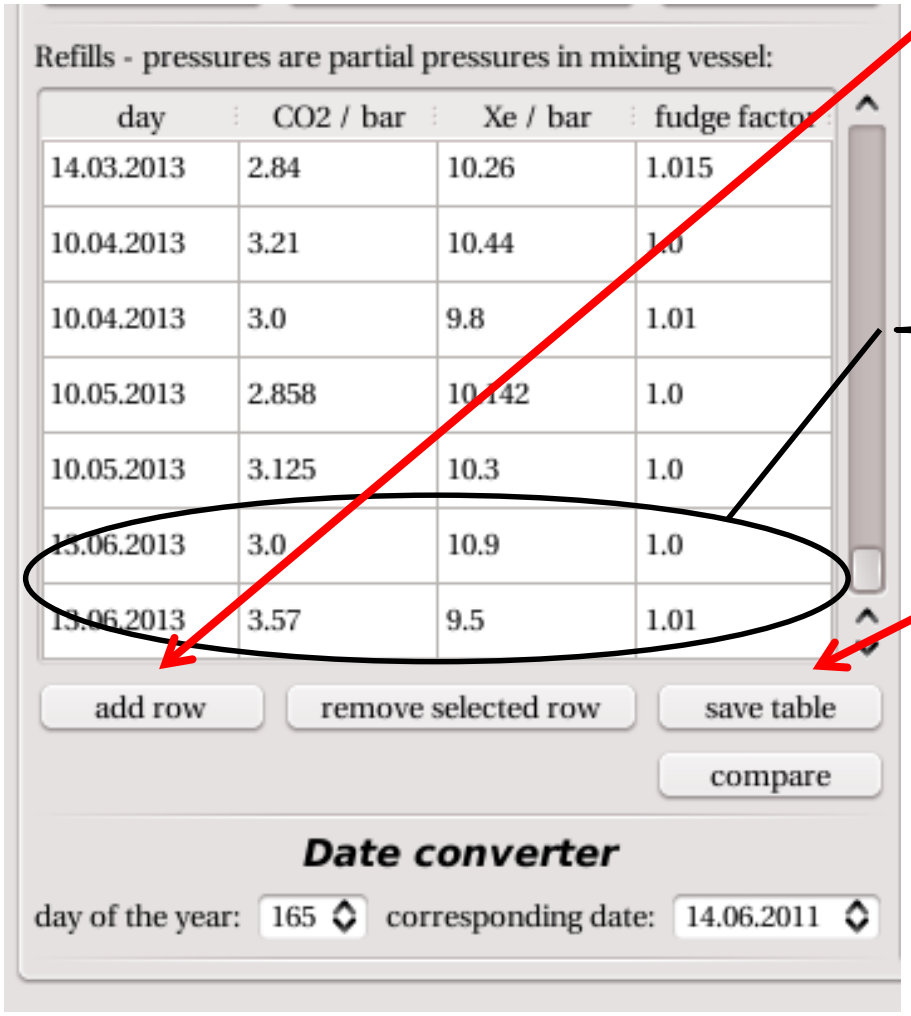
7.51% CO_2 (in TRD, calculated)



TRD Gas Refill - Preparation

Calculate the amount of gas to be filled using TRD-PressureMonitor

Example: 13th June 2013:



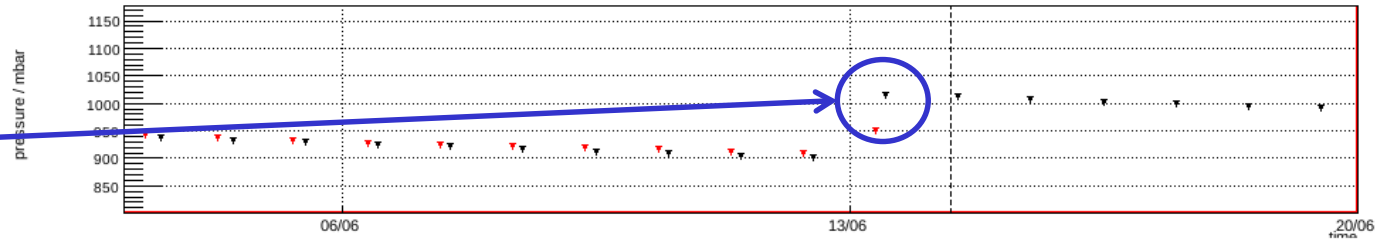
- Add two rows
- Edit rows to date of injections
- Edit CO_2 / Xe to target values (usually 3/10)
- Edit fudge factor to be 1.0 for first injection and 1.01 for second (to make black curve match red one)
- Save table
- Use updated predicted values (black points) in plots to find new partial pressures (like on previous slide for actual status)

TRD Gas Refill - Preparation

Example: 13th June 2013: Use updated predicted values (black points) to find new partial pressures

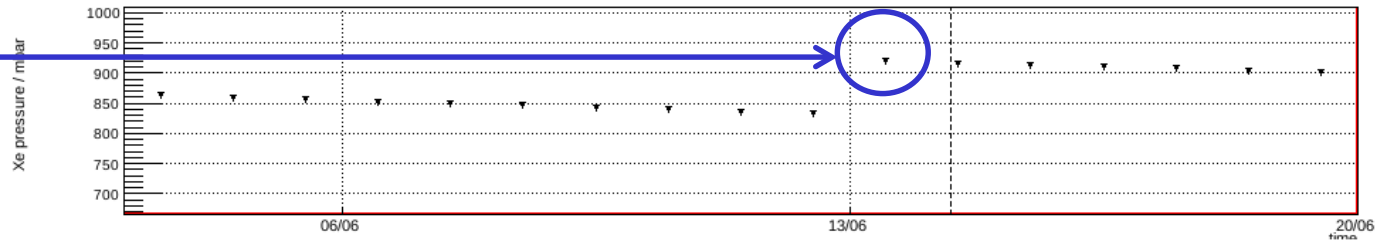
Predicted total pressure:

1019 mbar



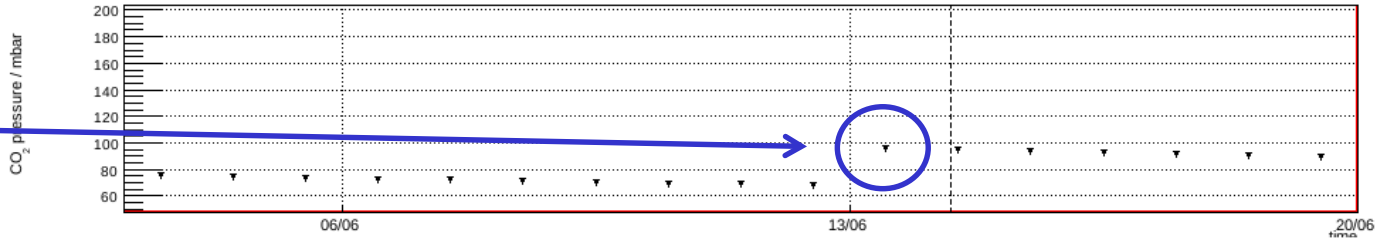
Xe @ 927 mbar,

(in TRD, calculated)



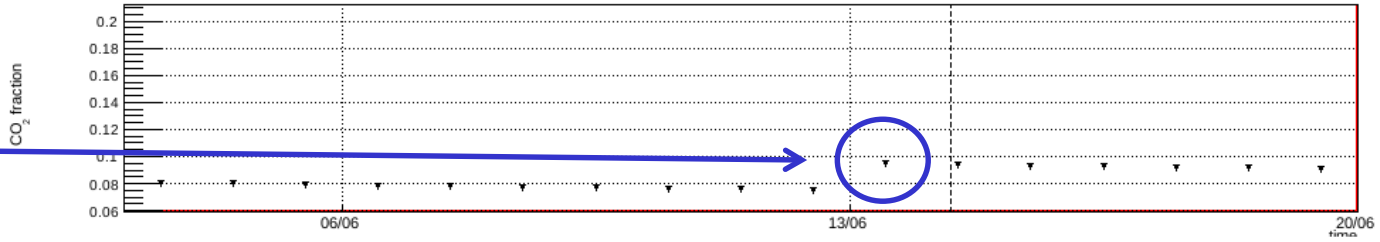
CO_2 @ 92 mbar,

(in TRD, calculated)



9.03% CO_2

(in TRD, calculated)



TRD Gas Refill - Preparation

TRD-PressureMonitor: Example: 13th June 2013:

Total pressure in TRD 905 mbar @ 7.51% CO_2 (Xe @ 835 mbar, CO_2 @ 68 mbar)

- Using previous slide, find new partial pressures:

  Xe @ 927 mbar, CO_2 @ 92 mbar → 1019 mbar @ 9.03 % CO_2 in TRD

- How to get the predicted values in TRDPressureMonitor Calculator:

  For each injection:

  Xe = Fudge Factor · (target P_{Xe} – (Xe-fraction · P_{tot} in $V_{mix,Vess}$ after injection))

  / (V_{TRD} + $V_{Mix,Vess}$)

  Xe = 1.15 (10000 mbar – ((10/13)·1000 mbar)) / (230 + 1) L = 46 mbar

  CO_2 = (target CO_2 pressure – (CO_2 -fraction · P_{tot} in $V_{mix,Vess}$ after injection))

  / (V_{TRD} + $V_{Mix,Vess}$)

  CO_2 = (3000 mbar – ((3/13)·1000 mbar)) / (230 + 1) L = 12 mbar

  Amount to be transferred in 2 refills: Xe = (835 + 2 · 46) mbar = 92 mbar,

  CO_2 = (68 + 2 · 24) mbar = 24 mbar

TRD Gas Refill - Preparation

TRD-PressureMonitor: Example: 13th June 2013:

- Get CO_2 fraction out of total pressure in mixing vessel after last refill:

  CO_2 fraction = 23.3 % in V_{MixVes} (see page 4 of previous refill worksheet day 2)

  Calculate rest partial pressures in V_{MixVes} before starting mixing

  10th May 2013: Total pressure in V_{MixVes} = 1300 mbar (use TRDGas-M)

  → Xe: 1300 mbar · (1.0 - 0.233) = 997 mbar,

  CO_2: 1300 mbar · 0.233 = 303 mbar

  Want 10 bar of Xe and 3 bar CO_2 to be injected twice, so need to add,

  13th June 2013:

  Xe: (10000 – 997) mbar = 9003 mbar

  CO_2: (3000 – 303) mbar = 2697 mbar

- If target values reached after first injection and end up with 1000 mbar in the mixing vessel, → Xe: 10/13 (1000 mbar) = 769 mbar; CO_2: 3/13 (1000 mbar) = 231 mbar

  To reach again 10 / 3 ratio in the mixing vessel, the amount of Xe & CO_2 pressure:

  Xe: (10000 – 769) mbar = 9231 mbar

  CO_2: (3000 – 231) mbar = 2769 mbar

TRD Gas Refill - Preparation

- In reality target values will never be reached, so after first injection recalculate everything using actual values. Example: 13th June 2013

  Xe: (997 + 9900) mbar = 10897 mbar; CO_2: (303 + 2700) mbar = 3003 mbar

  → CO_2 fraction = 21.6 % and P_{MixVes} = 1000 mbar

  → Xe: 784 mbar; CO_2: 216 mbar

  Amount which was transferred to the TRD:

  Xe = 1.15 (10897 mbar – 784 mbar) / (230 + 1) L = 50 mbar

  CO_2 = (3003 mbar – 216 mbar) / (230 + 1) L = 12 mbar

  The goal was to transfer 10/3 + 10/3, in first mixing got 10.897/3.003 so for next injection it is needed:

  Xe: (20000 – 10897) mbar = 9103 mbar

  CO_2: (6000 – 3003) mbar = 2997 mbar

  Since gas still remains in the mixing vessel, the amount to be added is:

  Xe: (9103 – 784) mbar = 8319 mbar

  CO_2: (2997 – 216) mbar = 2781 mbar

TRD Gas Refill - Preparation

- In reality target values will never be reached, so after 2nd injection re-calculate everything using actual values for record keeping purposes.

Example: 13th June 2013

Xe: (784 + 8700) mbar = 9484 mbar; CO_2: (216 + 3350) mbar = 3566 mbar

→ CO_2 fraction = 27.3 % and P_{MixVes} = 1075 mbar

→ Xe: 782 mbar; CO_2: 294 mbar

Amount which was transferred to the TRD:

Xe = 1.15 (9484 mbar – 782 mbar) / (230 + 1) L = 43 mbar

CO_2 = (3566 mbar – 294 mbar) / (230 + 1) L = 14 mbar

So after both mixings/injections, the total amount in TRD was:

Xe: (835 + 50 + 43) mbar = 928 mbar

CO_2: (68 + 12 + 14) mbar = 94 mbar

→ 1022 mbar @ 9.2 % CO_2 total in the TRD

TRD Gas Refill - Preparation

The name of the text file you generated should look like this:

TRD_Refill_##_Day#.txt. Below, {filename} = ##_Day#

E.g. April 1 2014: TRD_Refill_26_Day1.txt

Transform the text file into postscript format with

trd@pcpoc25 yyyy_mm_dd $ ../refill2ps {filename}

Check the result with ghostview (is paging o.k.?)

trd@pcpoc25 yyyy_mm_dd $ gv TRD_Refill{filename}

Print the file and fill in where marked during the refill process.

On the following pages the actions are described, too.

If any deviation appears between the file TRD_Refill{filename}

and this description, call expert.

If no expert is available stick to the file TRD_Refill{filename}.

TRD Gas Refill – Step 0

TRD-Gas: Preparation of Gas Refill

Requirements:

TRD-SidePanel and Box-C Temperature > 5°C

| TXe vessel - Tmix vessel | < 5 degrees C

(Note: TXe vessel is plot 90, red/magenta, Tmix vessel is plot 94, brown)

Call Thorsten (phone ##s on pg. 2)

Step 0:

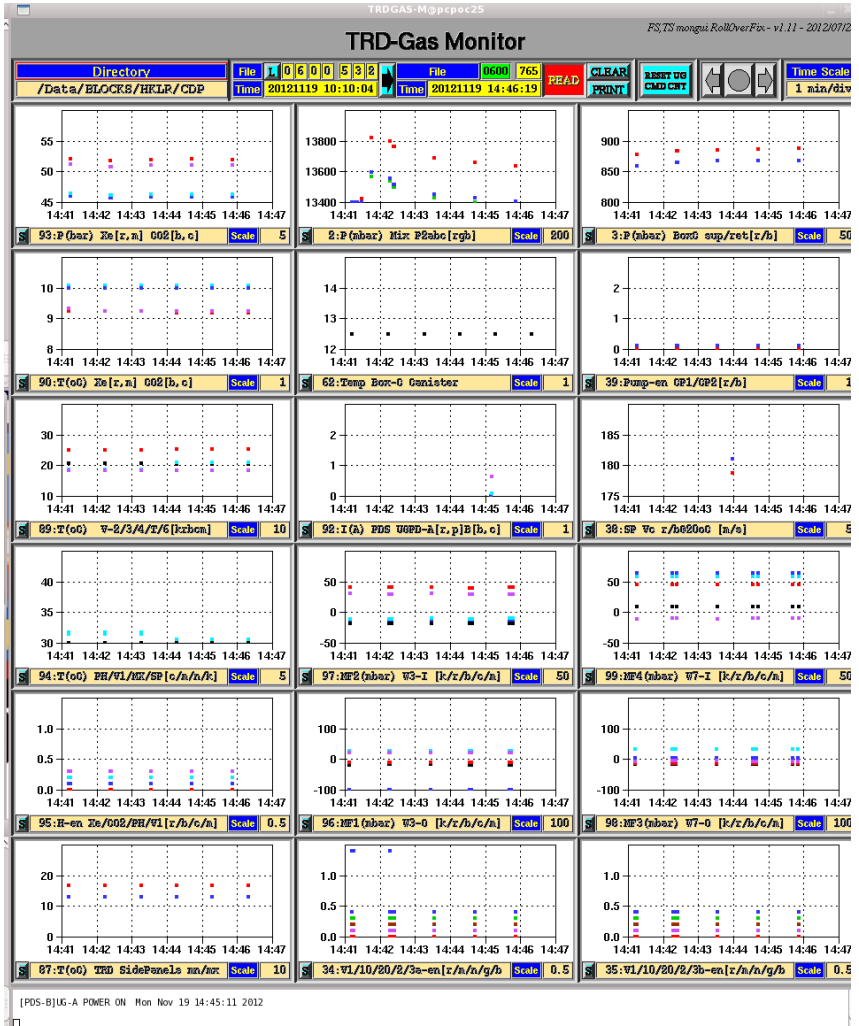
- Prepare Commanding for TRDGAS from GUI (TRDGAS-C)
  - [trd@pcppc24 example_dir] cd ~/RUN
  - [trd@pcppc24 example_dir] Gas_Refill_Start.sh
  - DO NOT TOUCH THE MOUSE OR KEYBOARD UNTIL IT'S FINISHED!!!

  This will start all the programs you need. However, the next few pages show the individual commands in case something fails.

TRD Gas Refill: Screenshot right screen

- Start TRDGAS-M with option “C” (“C” forces command file replies to ~/RUN/OUTPUT/TRDGAS-M/UGcmdLog/UnixTime_CmdFile.log)
  - trd@pcpoc25 RUN$ TRDGAS-M-GasRefill C

  Check (ls –l) that TRDGAS-M-GasRefill is writing CmdFile replies to ~/RUN/OUTPUT/TRDGAS-M/UGcmdLog/UnixTime_CmdFile.log



TRD Gas Refill – Step 0

Start TRDGAS-C:

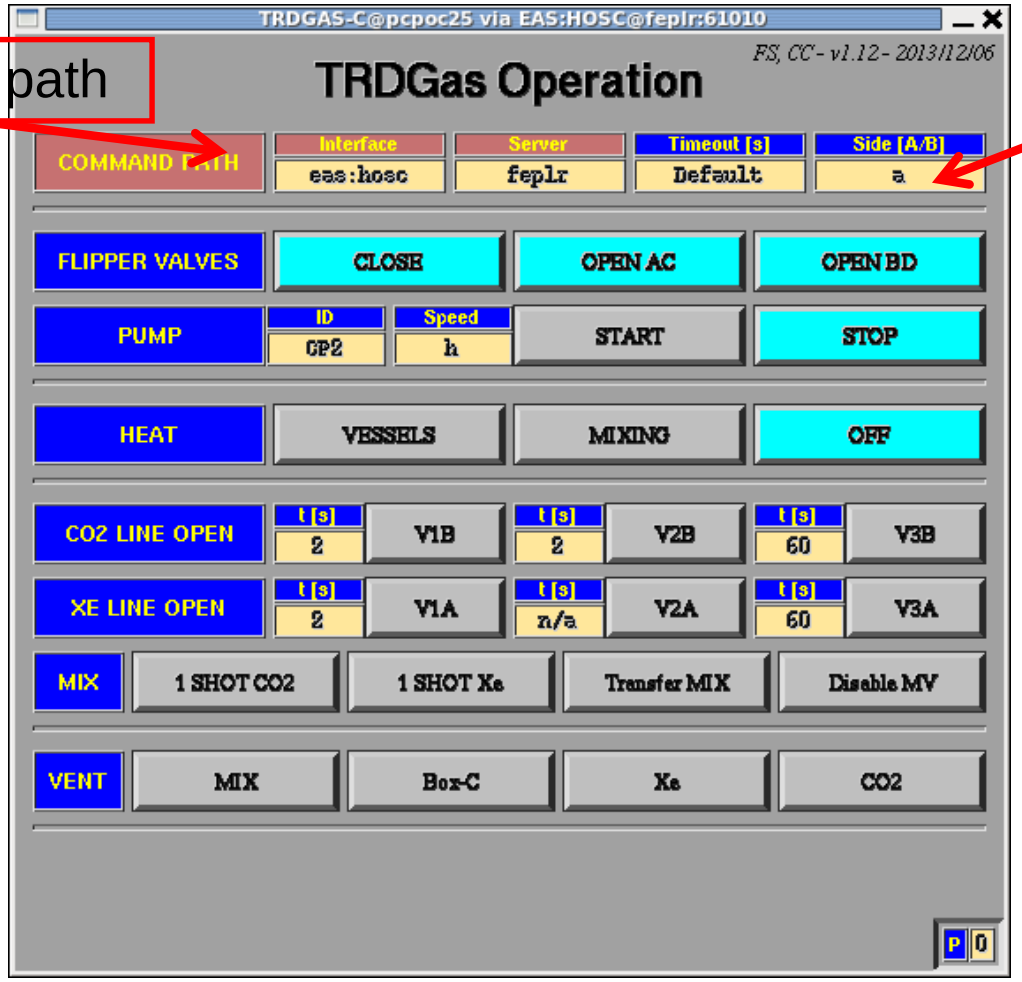
trd@pcpoc25 ~$ cd RUN

trd@pcpoc25 RUN$ set-command-path eas:hosc feplr

trd@pcpoc25 TRDGAS$ TRDGAS-C eas:hosc feplr

Ask LEAD to get commanding from TRD station for TRD refill

Check command path



Set UG-Side to A

TRD Gas Refill – Step 0

TRD-Gas: Preparation of Gas Refill

Prepare 4 terminals for commanding and monitoring

1st terminal (this terminal is used for commanding you need to do during refill):

trd@pcpoc25 ~$ cd ~/COMMANDING/TRDGAS/

2nd terminal (to watch all commands sent to JMDC affiliated with the refill):

trd@pcpoc25 ~$ cd ~/COMMANDING/TRDGAS/

trd@pcpoc25 TRDGAS$ cmds_mon –m hosc | grep “TAG:F7A”

3rd terminal (to watch all ground commands sent to JMDC):

trd@pcpoc25 ~$ cd ~/COMMANDING/TRDGAS/

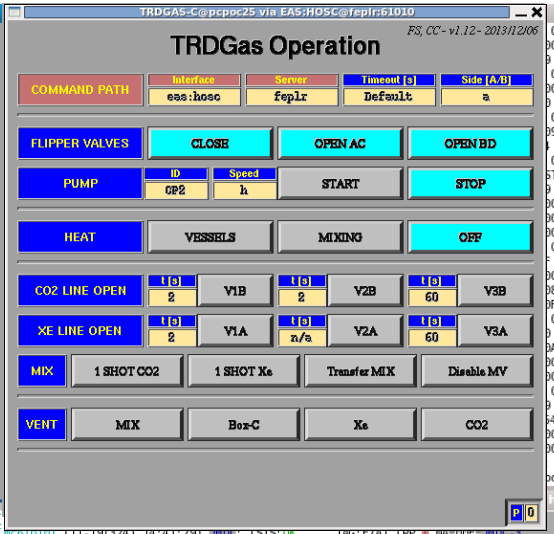
trd@pcpoc25 TRDGAS$ cmds_mon –m hosc –g

4th terminal (to watch for replies):

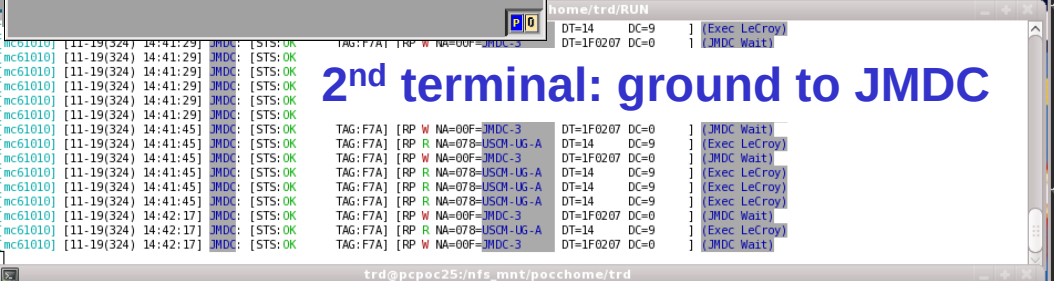
trd@pcpoc25 ~$ cd ~/COMMANDING/TRDGAS/

trd@pcpoc25 TRDGAS$ tail –f ~/RUN/OUTPUT/TRDGAS-M/UGcmdLog/UnixTime_CmdFile.log

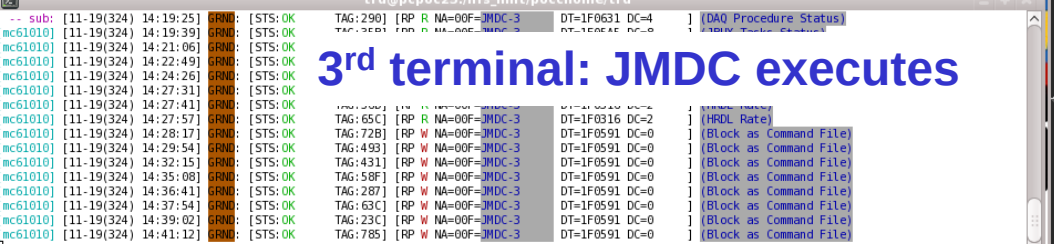
TRD Gas Refill: Screenshot right screen



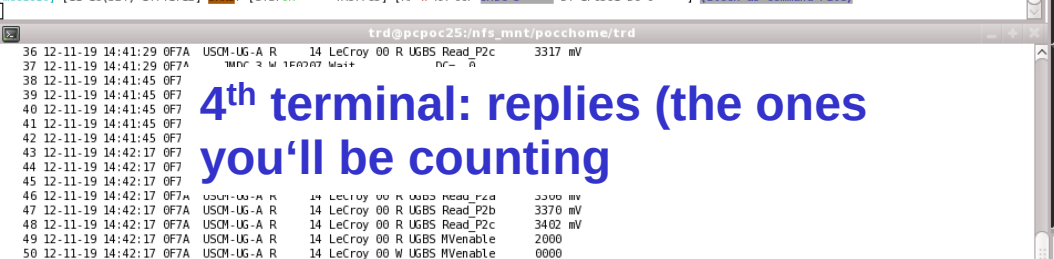
1st terminal: workspace



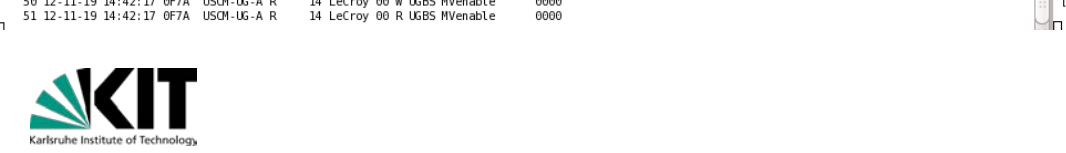
2nd terminal: ground to JMDC

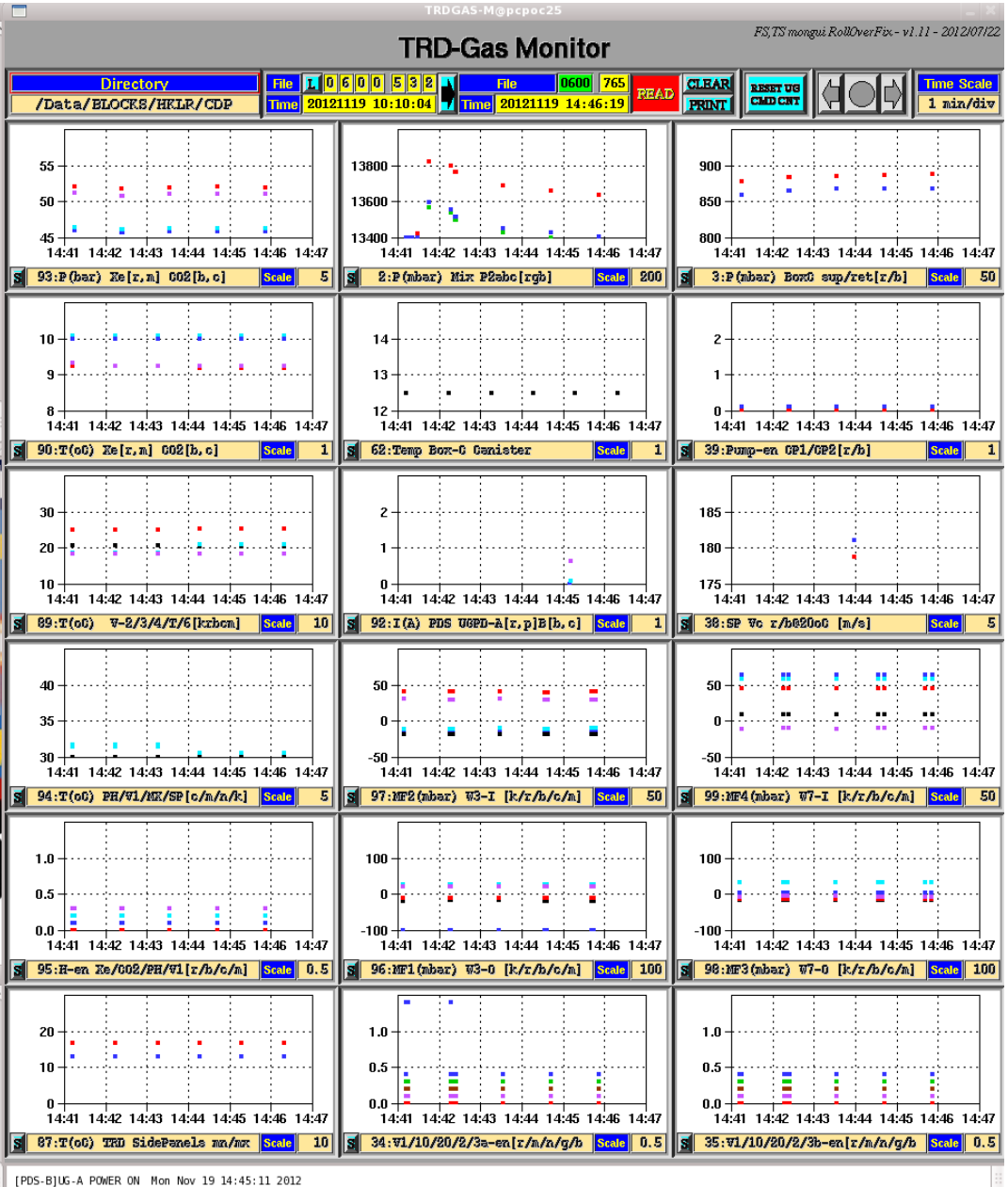


3rd terminal: JMDC executes



4th terminal: replies (the ones you'll be counting





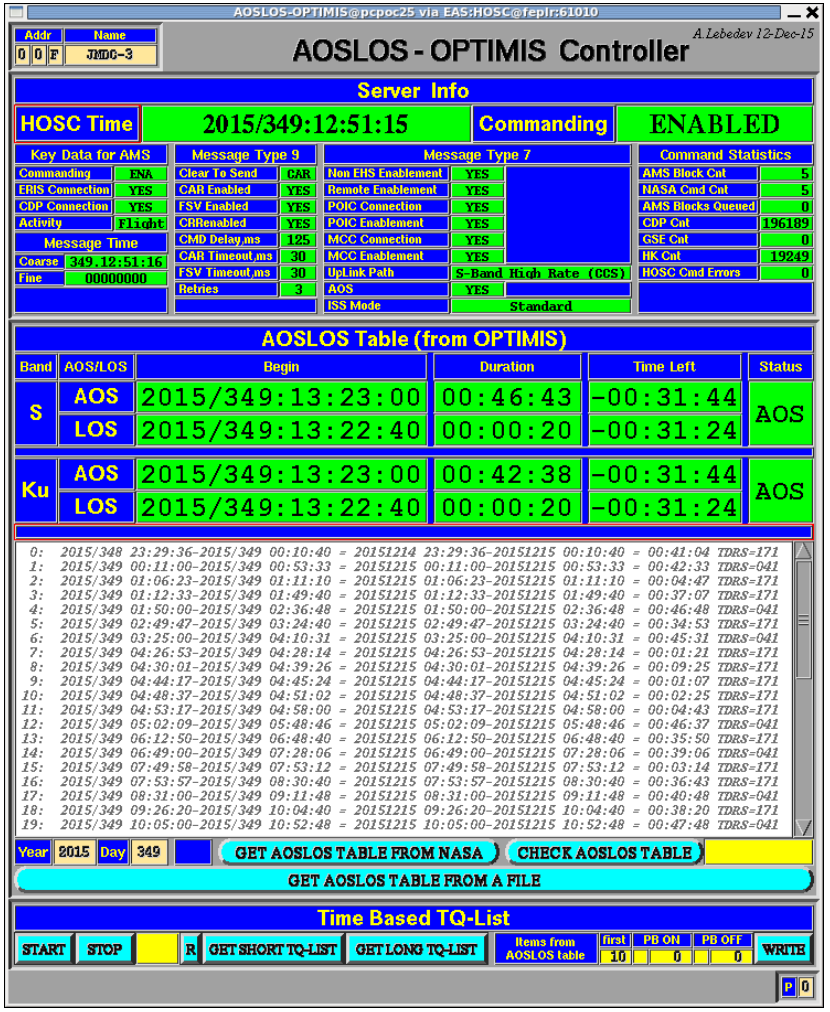
TRD Gas Refill – Step 0

Continue Step 0: Open AOSLOS monitor on left-hand screen:

- To start the AOSLOS monitor:

  cd ~/RUN

  trd@pcpoc25 RUN$ AOSLOS-OPTIMIS eas:hosc feplr

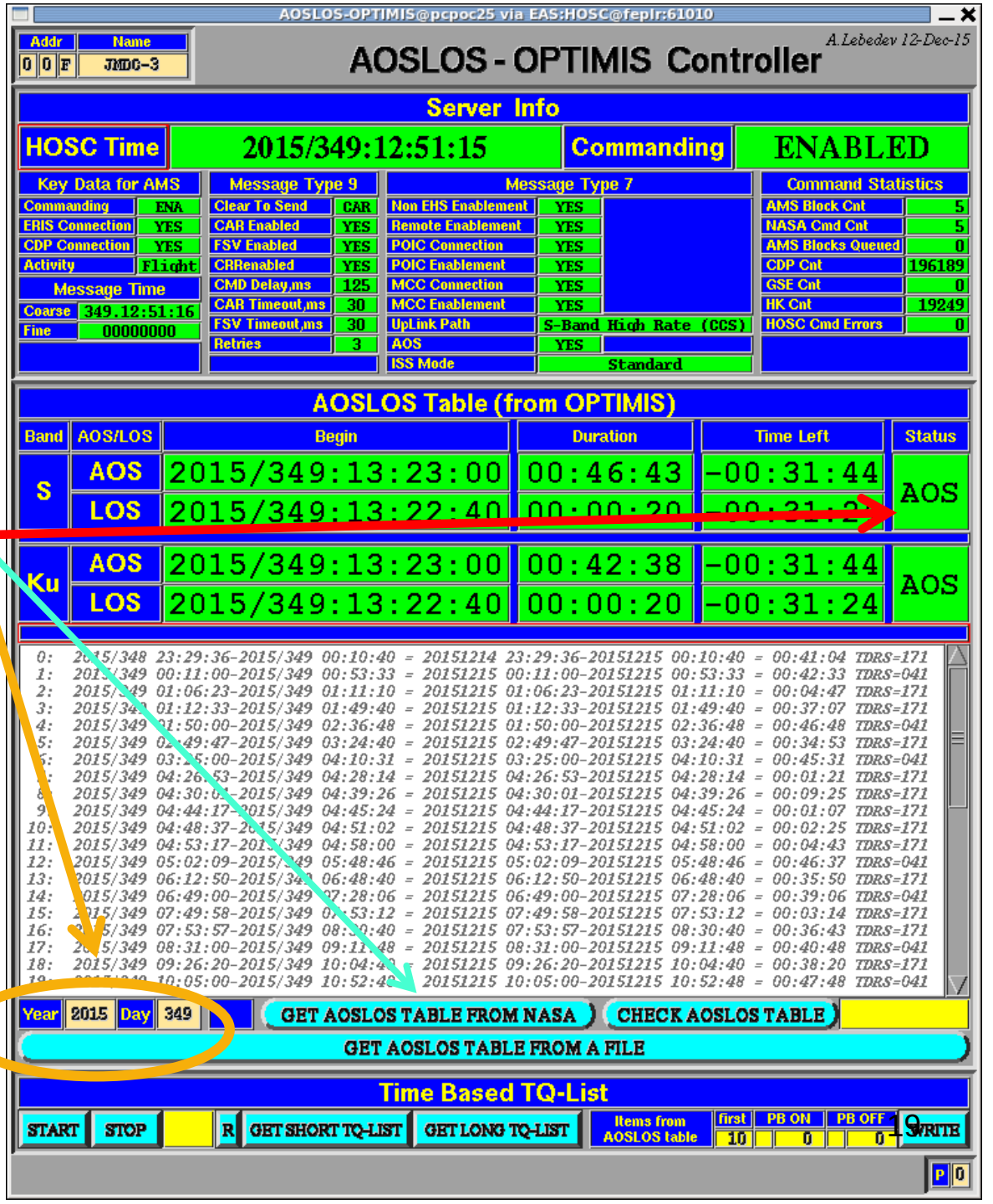


TRD Gas Refill – Step 0

Click until you have the proper year and GMT day and click [GET AOSLOS TABLE]

If you have ANY kind of LOS (KU band or S band) as indicated by the RED squares.
Do not send commands for the gas refill.

Once you have the proper table loaded:
MOVE THE AOSLOS Controller **DOWN** in the desktop until just the top half is visible to **AVOID PUSHING EXTRA BUTTONS! THIS WOULD BE VERY BAD!!!**



TRD Gas Refill – Step 1

Step 1: Heat PreHeater to prepare gas-mixing

Requirement: +35°C for Mixing Operation to satisfy NASA safety thermal interlock implemented in USCM-UG

(if temperature falls below +35°C, commands will fail with a reply that says ABORT)

PreHeater temperature limited to +54°C by thermostats

Time to reach +35°C from +20°C is approx. 30 minutes

Heat during steps 2-6 to reduce overall time for operations

TRD Gas Refill – Step 1

Step 1: Heat PreHeater to prepare gas-mixing

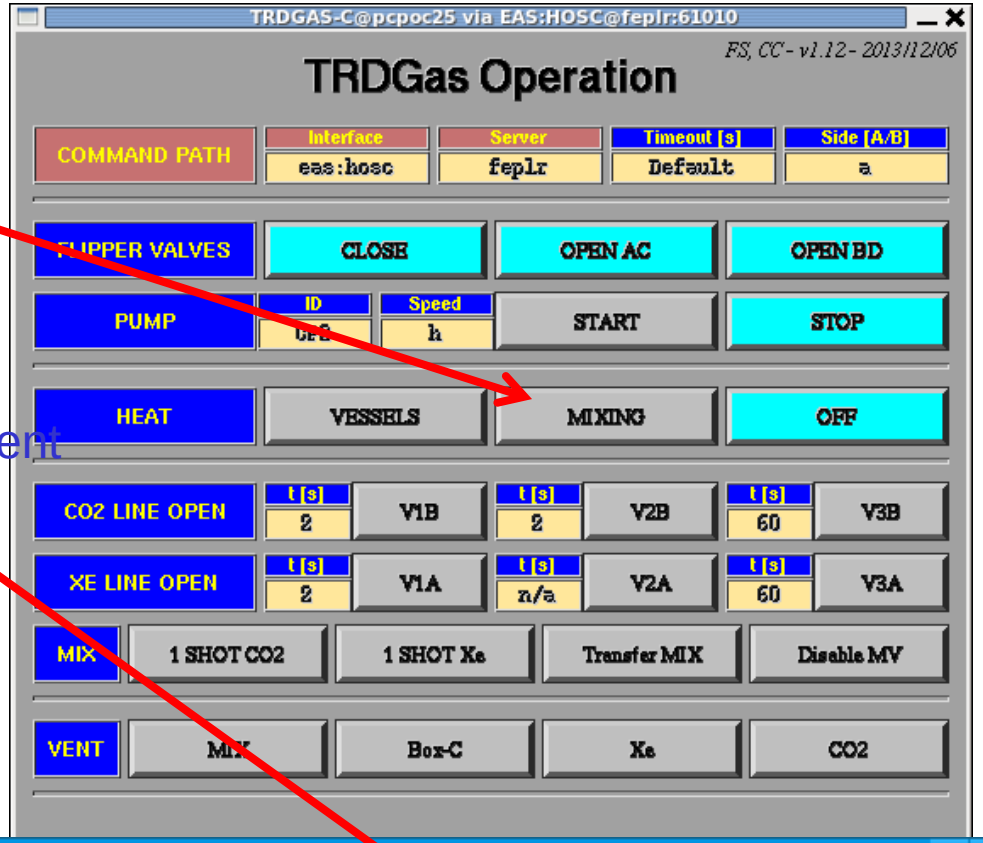
TRDGAS-C: Switch on Heaters for Mixing

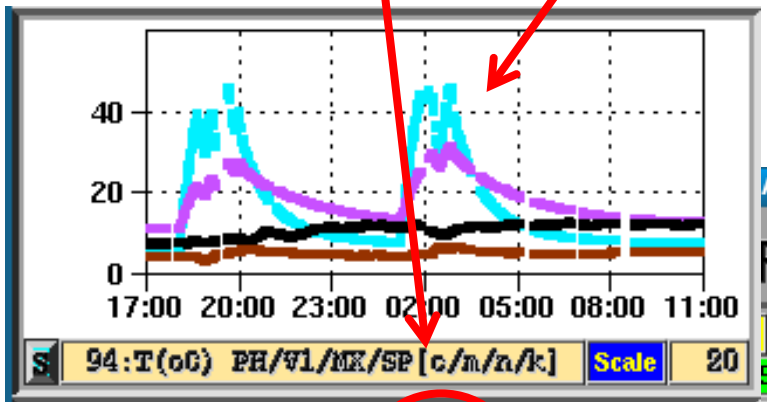
4th terminal: UGcmdLog: **Check for 9 replies in 1s**

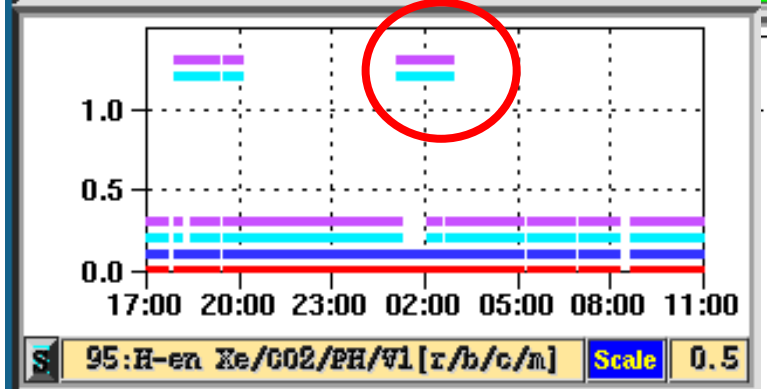
TRDGAS-M: **Reset UG CMD CNT after 9 replies**

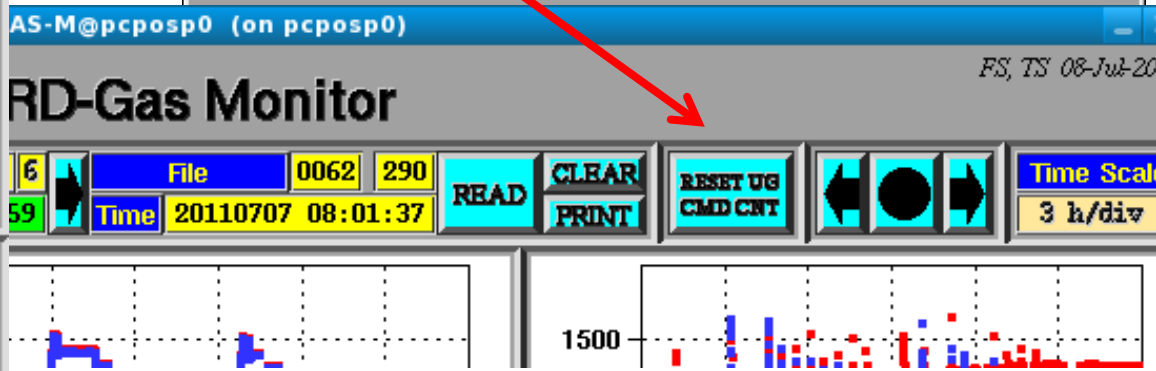
94: Temp. PH & V1 (cyan/magenta) rise from ambient

95: H-En PH & V1 from 0 to 1









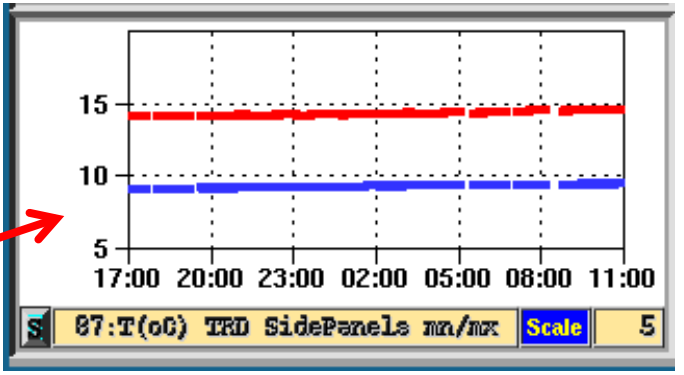
TRD Gas Refill – Step 2

Step 2-5: Assure that Flipper Valves are open:

(Flipper valves see p. 73-76, TRD-ACC-TAS-Shifterguide)

Step 2: Open AC Flipper Valves

TRDGAS-M: 87: TRD SidePanel Temperatures > 0°C

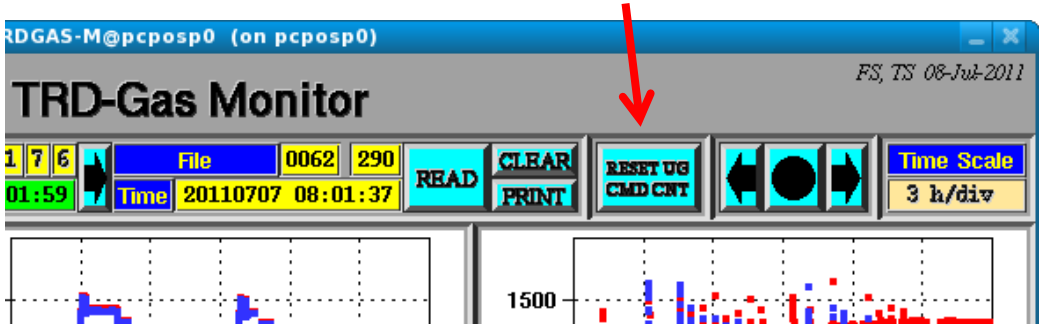


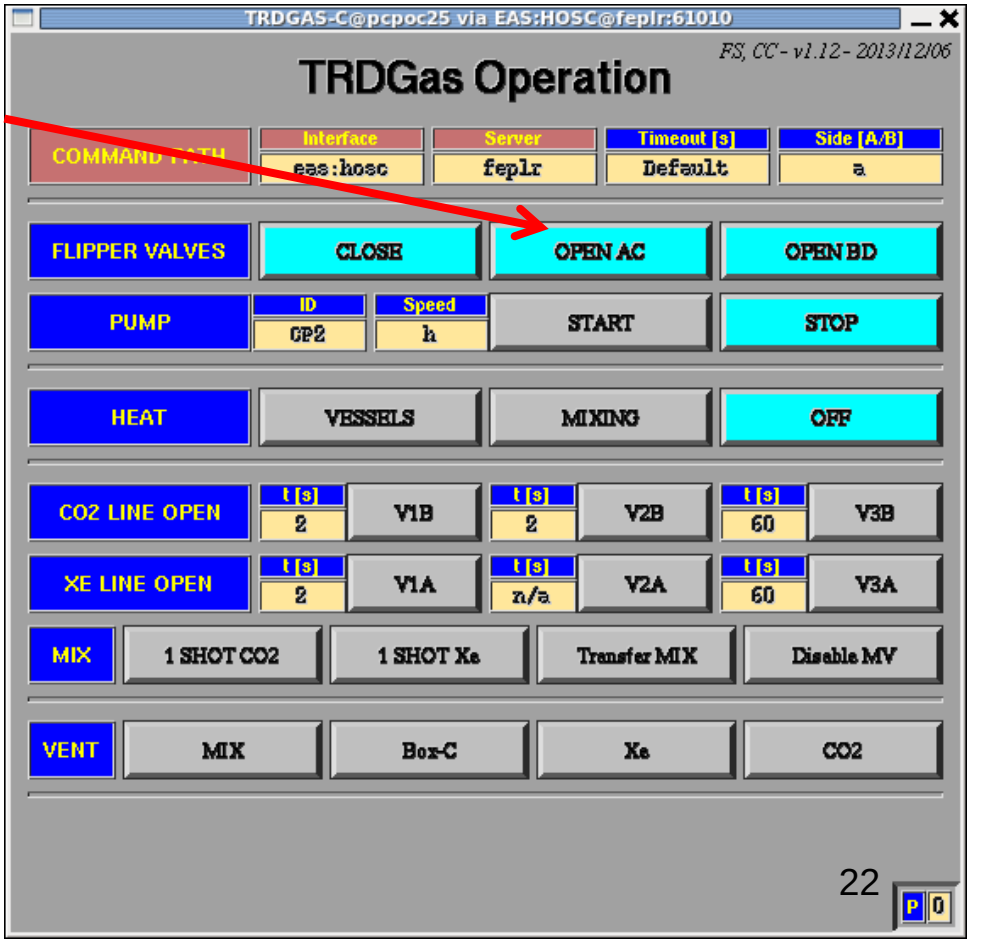
TRDGAS-C: FLIPPER VALVES: [OPEN AC]

4th terminal:

UGcmdLog: **Check for 77 replies in 6s**

and TRDGAS-M: **Reset UG CMD CNT**



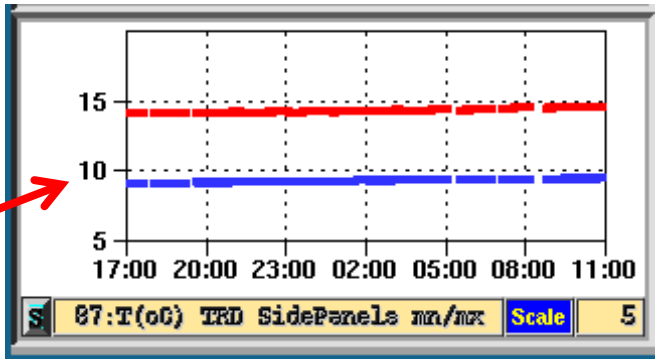


TRD Gas Refill – Step 3

Step 3: Open BD Flipper Valves

(Flipper valves see p. 73-76, TRD-ACC-TAS-Shifterguide)

TRDGAS-M: 87: TRD SidePanel Temperatures > 0°C

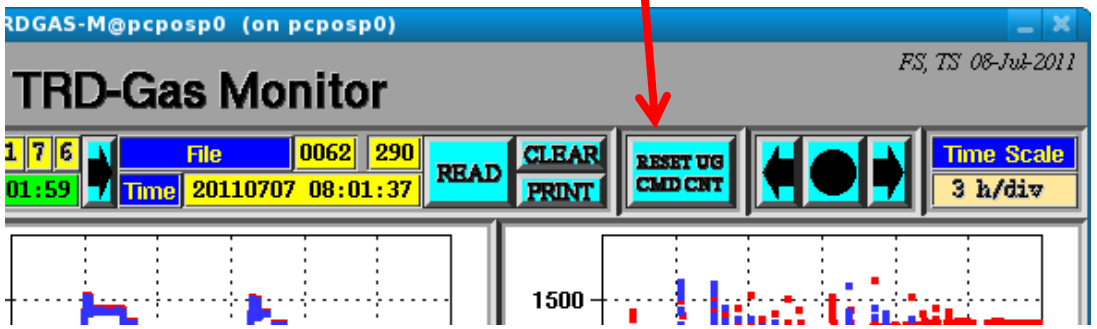


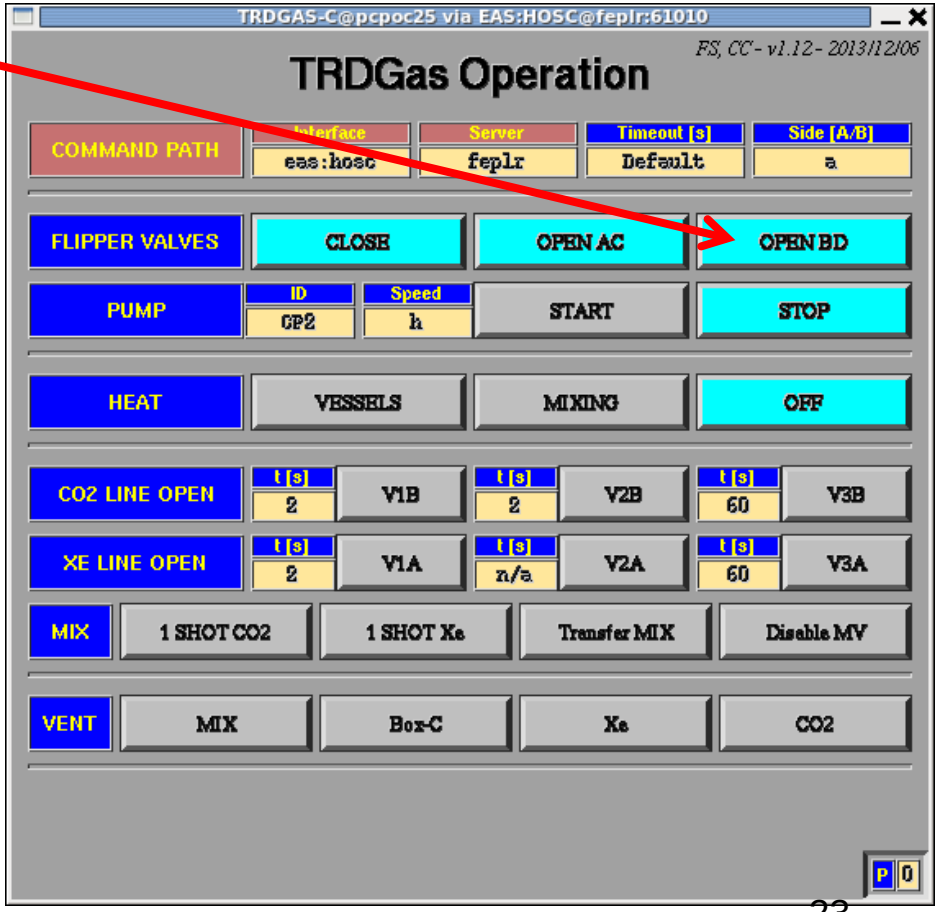
TRDGAS-C: FLIPPER VALVES: [OPEN BD]

4th terminal:

UGcmdLog: **Check for 77 replies in 6s**

and TRDGAS-M: **Reset UG CMD CNT**





TRD Gas Refill – Step 4

Step 4: Start Circulating Gas to verify all FVs are open

TRDGAS-M: 94: Spiro Temperature > +5°C

TRDGAS-C: PUMP: {CP2} {h} [START]

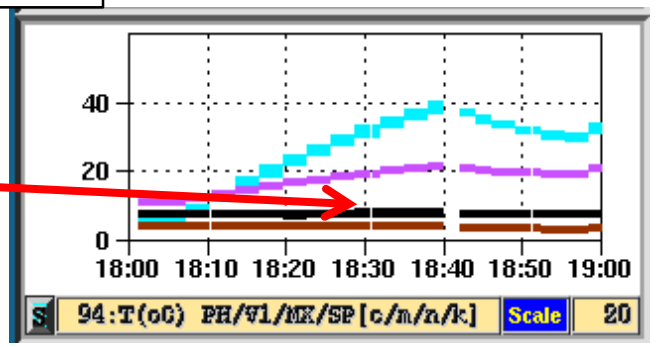
(Pump @ Half Speed)

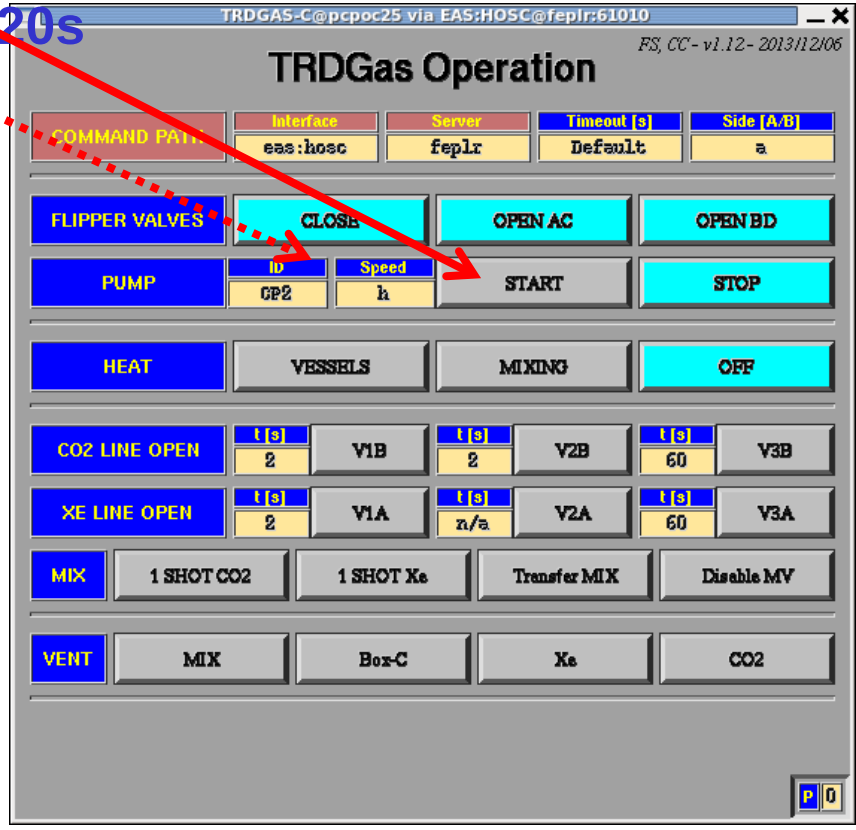
4th terminal: UGcmdLog: **Check for 58 replies in 20s**

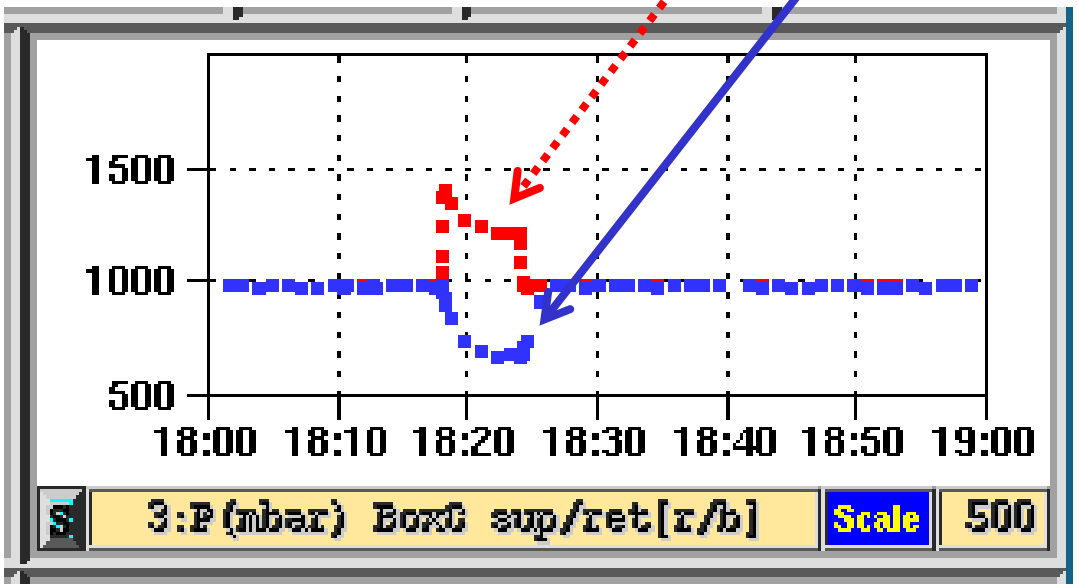
TRDGAS-M: **Reset UG CMD CNT**

3: Psup increase by 250 mbar

3: Pret decrease by 250 mbar







TRD Gas Refill – Step 4

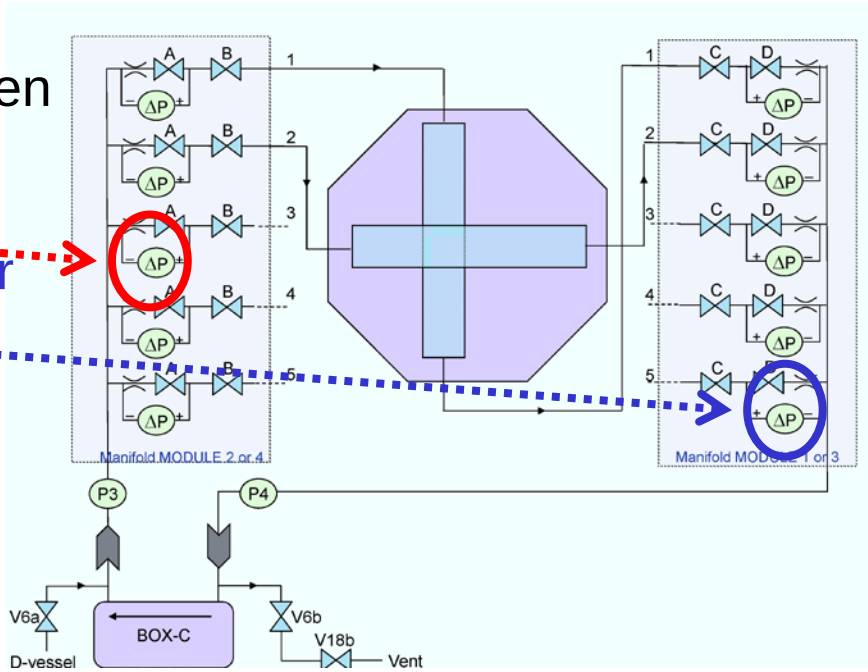
Step 4: Start Circulating Gas to verify all FVs are open

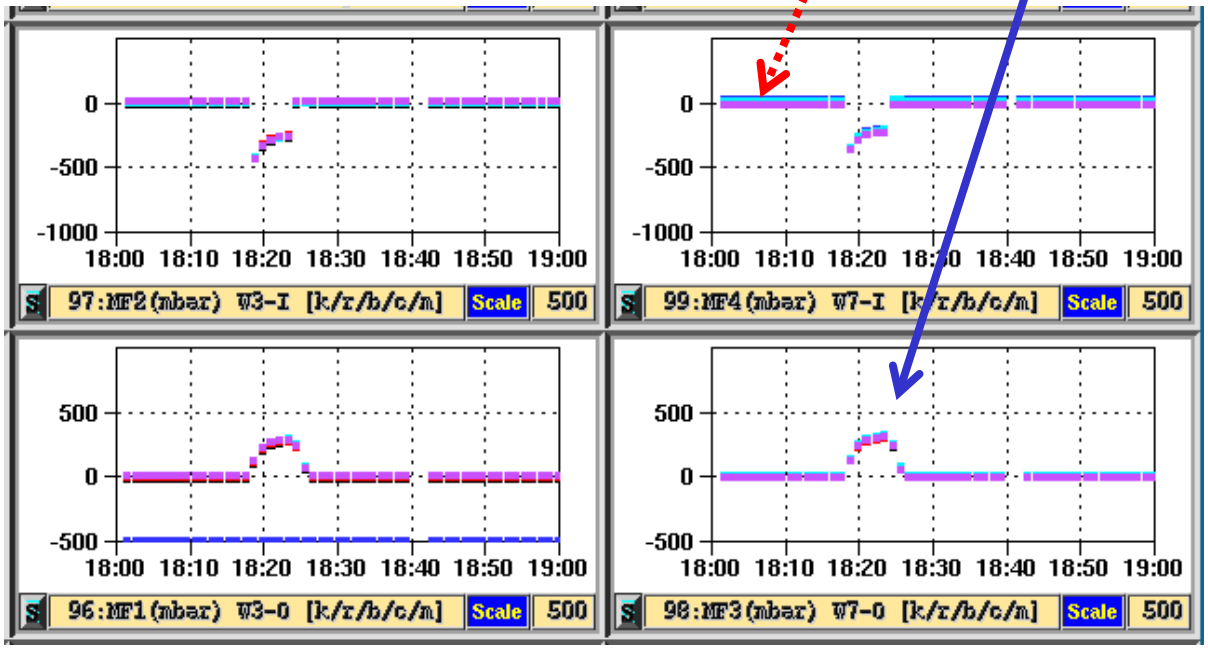
TRDGAS-M: 97, 99: Inlet MFdPs drop to -250 mbar

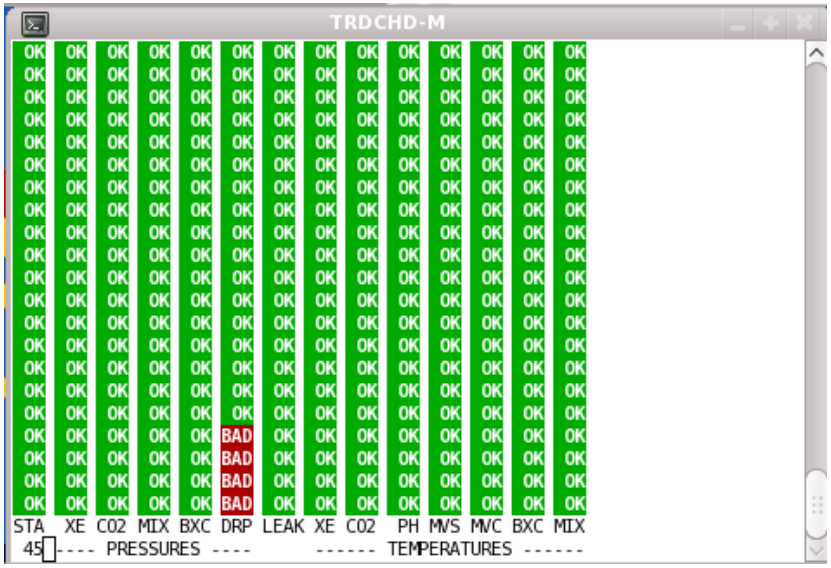
96, 98: Outlet MFdPs rise to +300 mbar

Wait until pressure stable (5-10 minutes)

TRDCHD-M: DRP will turn red “bad” until pressure stable







TRD Gas Refill – Step 5

Step 5: Stop Circulating Gas

TRDGAS-C: PUMP: [STOP]

4th terminal:

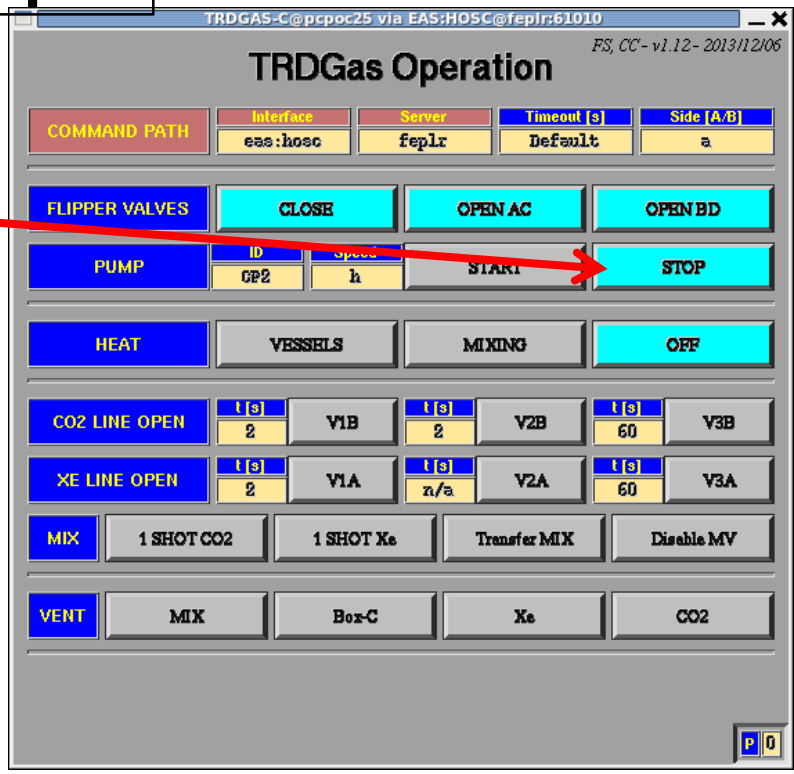
UGcmdLog: **Check for 60 replies in 20s**

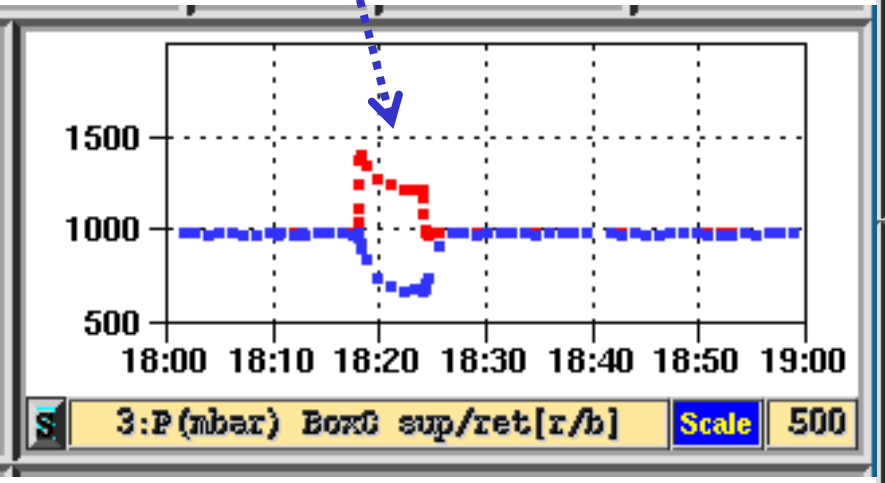
TRDGAS-M: **Reset UG CMD CNT**

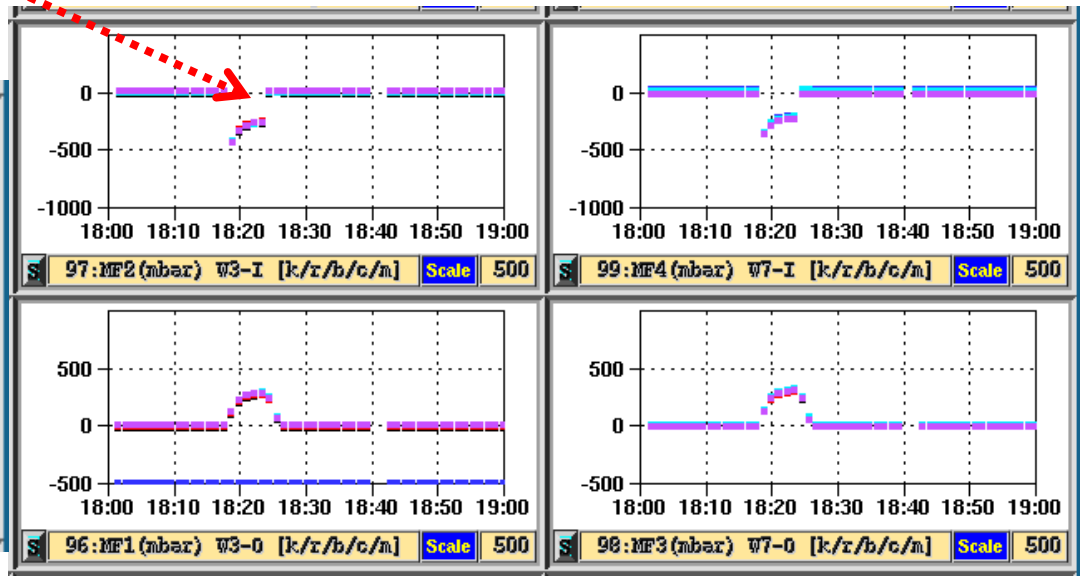
3: Psup, Pret back to values before pumping

96, 97, 98, 99: all MFdPs back to 0 (± 50) mbar

TRDCHD-M: DRP will turn red "bad" until pressure stable







TRD Gas Refill – Step 6

Step 6: Heaters for Mixing

<u>If Temp.PH has dropped below 35 DegC</u>

Heater ON: TRDGAS-C: HEAT: [MIXING]

UGcmdLog: **Check for 9 replies in 1s**

Heater OFF: TRDGAS-C: HEAT: [OFF]

UGcmdLog: **Check for 3 replies in 1s**

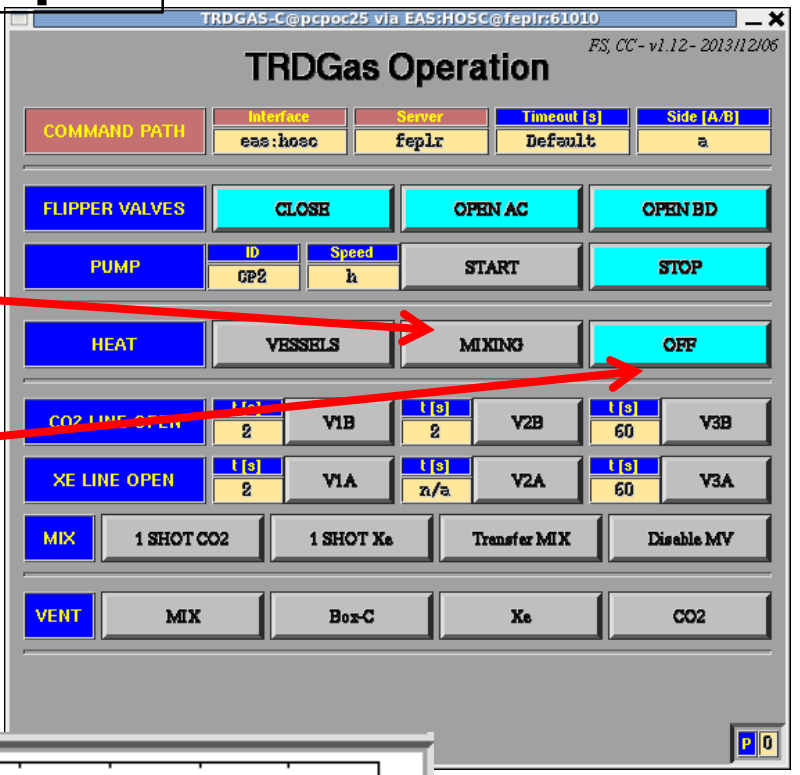
TRDGAS-M: **Reset UG CMD CNT**

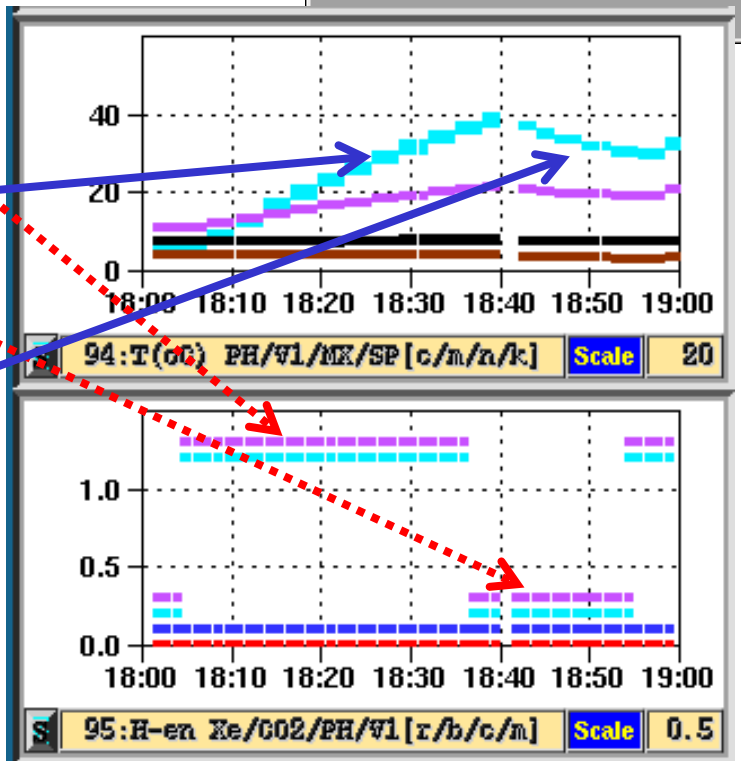
ON: 95: H-En PH & V1 from 0 to 1

94: Temperatures PH & V1 rise

OFF: 95: H-En PH & V1 from 1 to 0

94: Temperatures PH & V1 drop





TRD Gas Refill – Step 7

Step 7: Filling of Mixing Vessel with Xe & CO_2

There are two ways to fill the mixing vessel:

a) Use the GUI

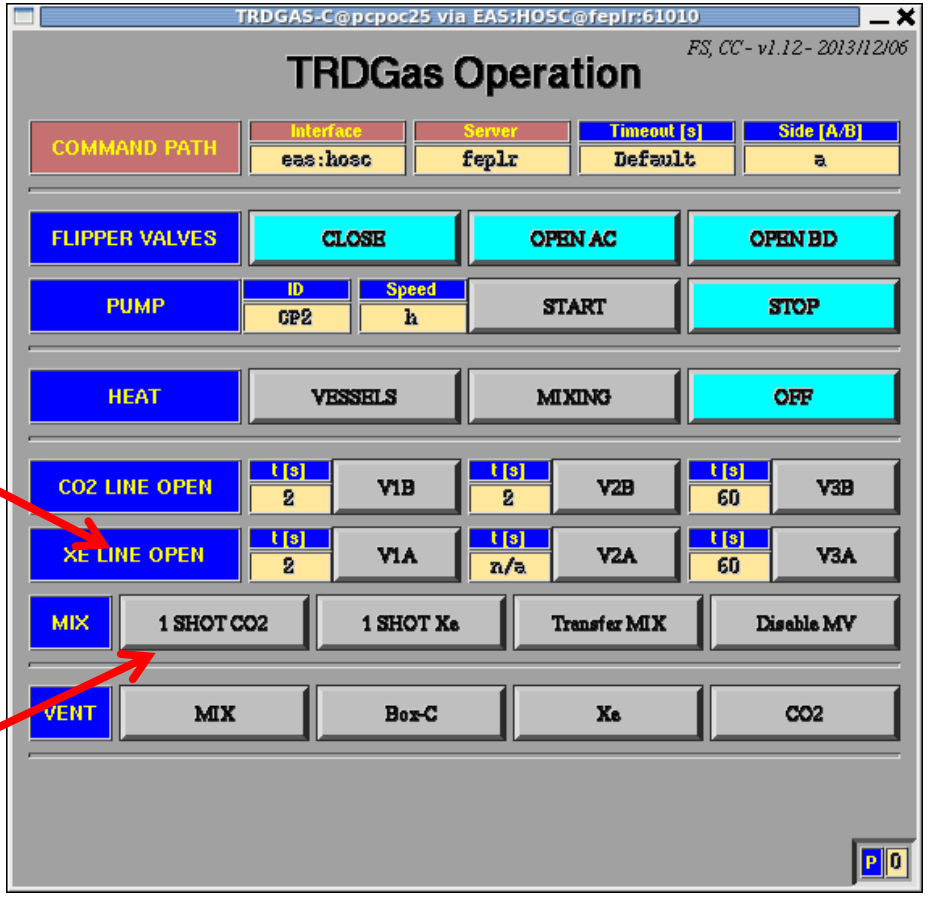
for Xe use: fill buffer volume

Half Shot {2} [V1A] {10} [V3A]

{60} [V3A]

Long Shot {10} [V1A] {10} [V3A]

{60} [V3A]



for CO_2 (Full Shot) use

for CO_2 (Half Shot) use commands, see next page

TRD Gas Refill – Step 7

Step 7: Filling of Mixing Vessel with Xe & CO_2

b) Send commands (BETTER TO USE THE GUI):

> cd ~/RUN/COMMANDING/TRDGAS

> set-command-path eas:hosc feplr

For CO_2:

> ./UG_EXEC.csh A HSHC_20S (half shot)

Only for completeness, only needed if there is no GUI

> ./UG_EXEC.csh A 1SHC_60S (full shot)

> ./UG_EXEC.csh A OV1B_2S (open first valve for 2 s)

> ./UG_EXEC.csh A OV2B_2S (open second valve for 2 s)

> ./UG_EXEC.csh A OV3B_60S (open third valve for 60 s)

For Xe (remember, the second valve is stuck open→**don't touch it! Use the GUI!**):

> ./UG_EXEC.csh A OV1A_2S (open first valve for 2 s)

> ./UG_EXEC.csh A OV3A_3S (open third valve for 3 s)

> ./UG_EXEC.csh A OV3A_10S (open third valve for 10 s)

> ./UG_EXEC.csh A OV3A_60S (open third valve for 60 s)

With Xenon we usually start with a shot of 2--3-60, and then continue with shots of 2--60, until the end.

TRD Gas Refill – Step 7

Step 7: Filling of Mixing Vessel with Xe & CO_2

Using the GUI:

a) Start with CO_2:

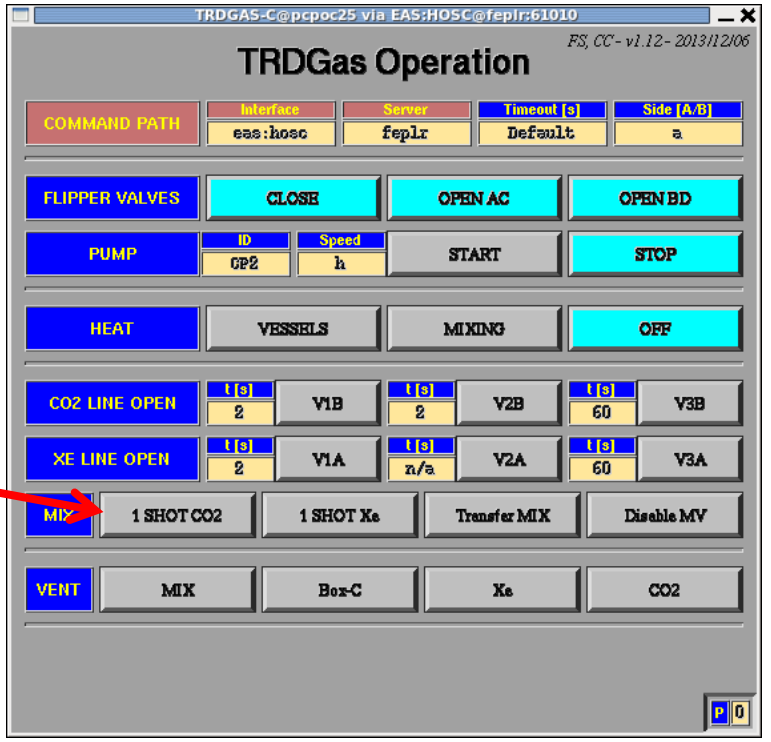
1 Shot CO_2

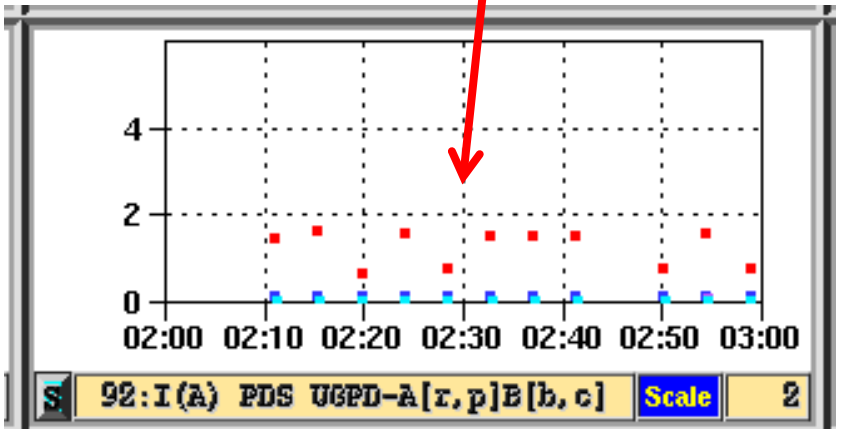
Pmix increases from value before mixing till desired value. Example 23rd January 2013:

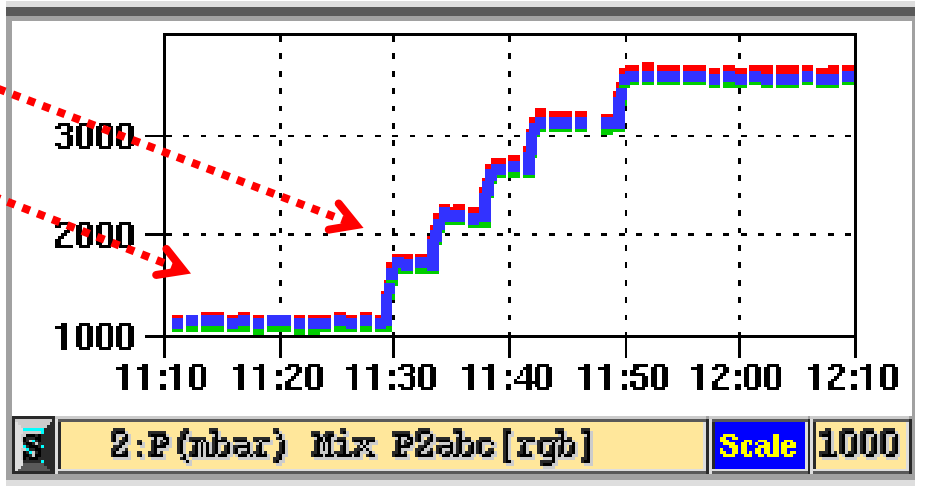
TRDGAS-M:

2: Pmix increase from 1 bar to 1.8 bar

92: PDS-UGPD at 1.5 A (only read every 5 min)







TRD Gas Refill – Step 7

CO_2 mixing:

Repeat Step 7a) until Pmix at desired value and document steps in log file:

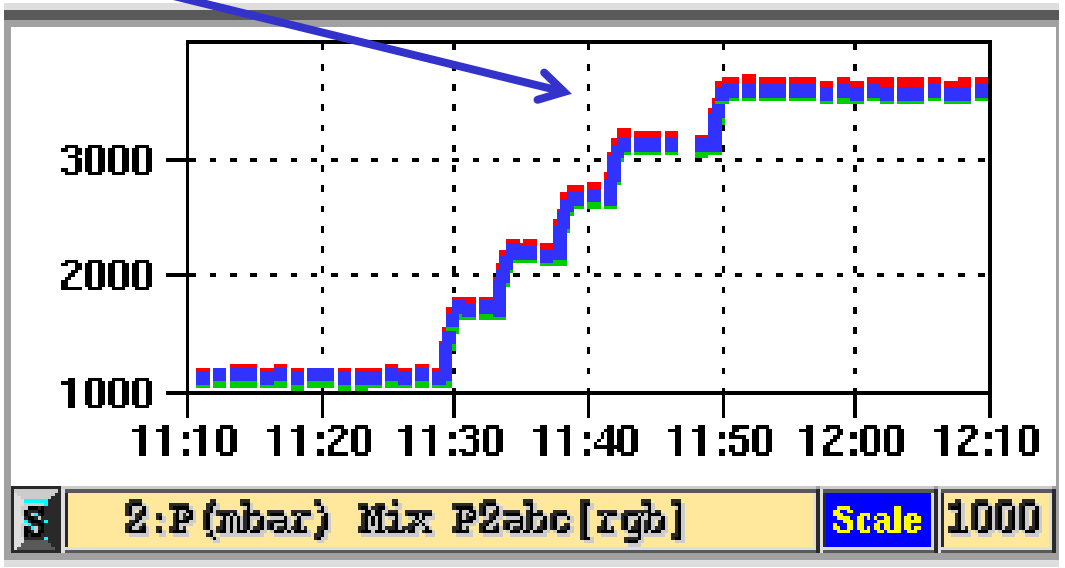
Example 23rd January 2013:

$Pmix_{CO2}$ = 3.5 bar after 5 times 1 Shot CO_2

TRDGAS-M:

2: Pmix increase from 1.8 bar to 3.5 bar

92: PDS-UGPD at 1.5 A



TRD Gas Refill – Step 7

Step 7: b) Filling of Mixing Vessel with Xe

(Vessel valves see p. 75-76, TRD-ACC-TAS-Shifterguide)

Using the GUI :

Use only valve V1A and V3A due to the problem of valve V2A (stuck open)

1st step: Open V1A for 2s

2nd step: Open V3A for 10s and then for 60 s

For bigger steps (cold case), open V1A for 10 s and V3A for 10s followed by 60s.

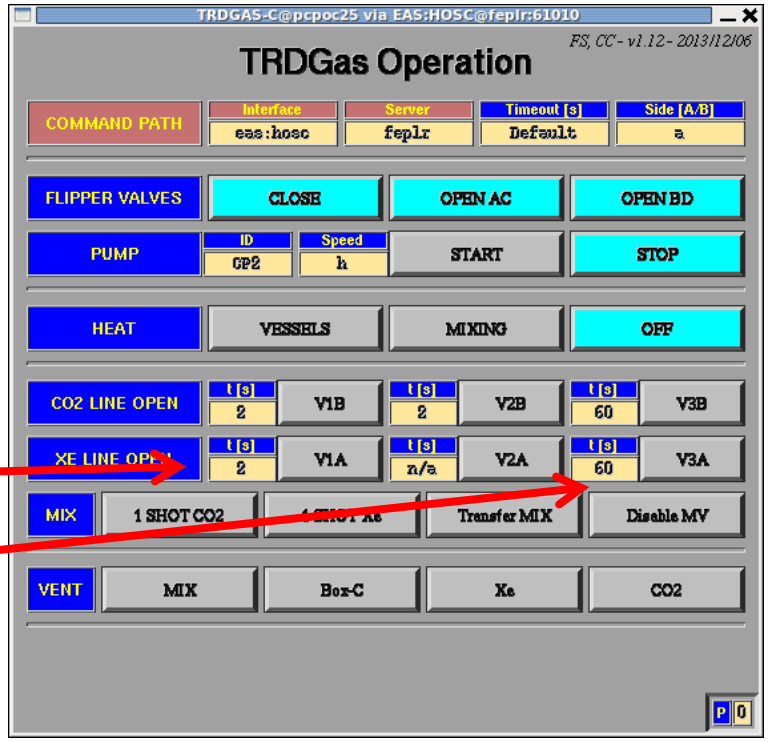
Pmix increases from value before mixing till desired value. **DO NOT EXCEED 14 bar!!!**

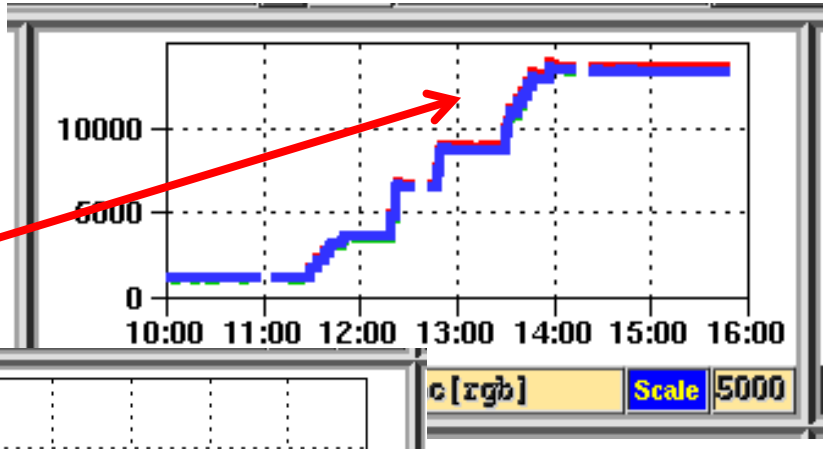
Example 23rd January 2013:

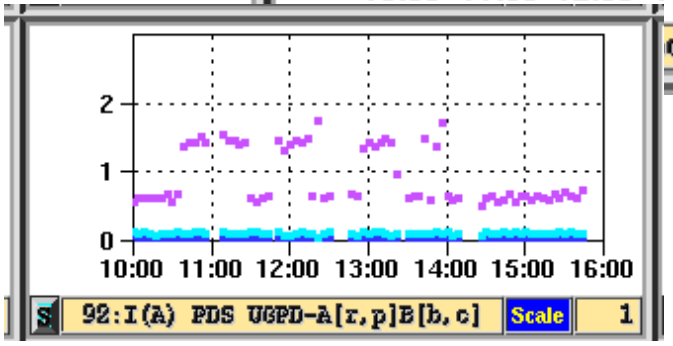
TRDGAS-M:

2: Pmix increase from 3.5 bar to 13.5 bar

92: PDS-UGPD at 1.5 A







TRD Gas Refill – Step 7

Xe mixing:

Repeat Step 7b) until Pmix at desired value and document steps in **log file**:

Example 23rd January 2013:

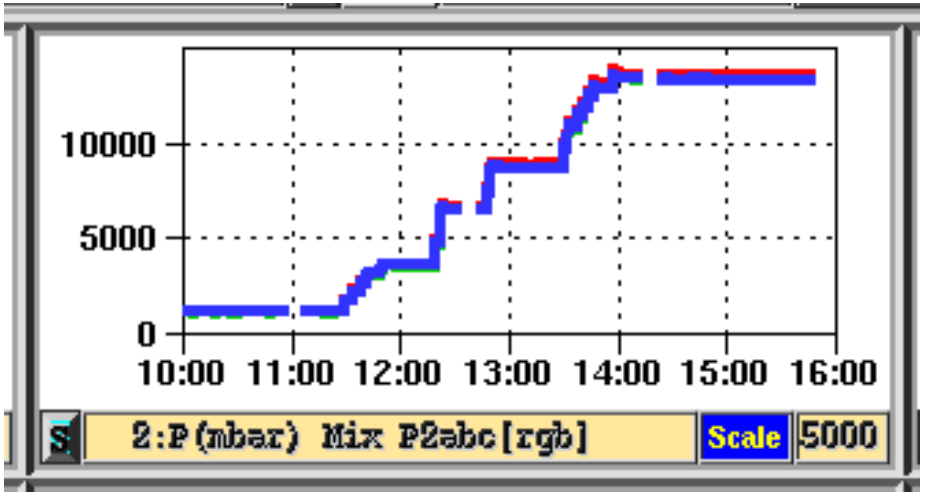
$Pmix_{Xe}$ = 13.5 bar after

3 times: V1A open for 10 s and

V3A for 10s followed by 60s

2 times: V1A open for 2s, V3A open for 10s followed by 60s

1 times V1A open for 2s, V3A open for 10s



TRD Gas Refill – Step 7

Fill in the log file:

```
 initial              Xe: _____      CO2: _____       ______  ______  ______

Rpt  Gas  P/bar    VLV-OPEN-TIME/s, Exec-Time         ----P-MIX/mbar-----    CMD Replies
                     V1          V2          V3        P2a     P2b     P2c

# 1  ___  _____   ___,_____  ___,_____  ___,_____   ______  ______  ______  _____________
# 2  ___  _____   ___,_____  ___,_____  ___,_____   ______  ______  ______  _____________
# 3  ___  _____   ___,_____  ___,_____  ___,_____   ______  ______  ______  _____________
.
.
```

Calculate the final partial pressures:

```
CO2  __________ + ___________ = __________ bar

Xe   __________ + ___________ = __________ bar
```

And update history file:

~/COMMANDING/TRDGAS/Gas_Refills/gas_composition_history.txt

And update ELOG and Pressure Monitor

TRD Gas Refill – Step 8

Step 8: Initiate Transfer Sequence

Ask LEAD to Get JMDC flash directory (“Get Directory” button in JMDC-C controller).

Terminal Output from TRDGAS-M:

```
==========================================================================

JMDC-0F Flash-Directory UG-entries from Sat Apr 30 14:44:22 2011
BoF   --FileName--            Length  crc
    39 UGA_GCCL.cmd     1744  +
   102 UGB_GCCL.cmd     1744  +
   121 UGA_HVXE.cmd      100  +
   131 UGA_TMX0.cmd     1320  +
   186 UGA_TMX4.cmd     1320  +
   239 UGA_TMX7.cmd     1320  +
   276 UGA_TMX2.cmd     1320  +
   277 UGA_TMX3.cmd     1320  +
   311 UGA_TMX5.cmd     1320  +
   373 UGA_TMX6.cmd     1320  +
   382 UGA_HVES.cmd      112  +
   393 UGA_TMX9.cmd     1848  +
   453 UGA_TMX1.cmd     1320  +
   471 UGA_HMIX.cmd      112  +
   485 UGA_TMX8.cmd     1320  +
```



```
==========================================================================
```

TRD Gas Refill – Step 8

Step 8: Initiate Transfer Sequence

a) (this step can be skipped when you are sure that JMDC is ok, i.e. if UGA command files exist -- see previous page)

Upload Command-Files to JMDC-MCT-Flash (one by one):

trd@pcpoc25 TRDGAS$ Write_UG_CmdFile_to_MCT_JMDC_Flash.csh A TMX#

(where this command must be issued 10 times, replacing # with the corresponding number 0..9)

trd@pcpoc25 TRDGAS$ Write_UG_CmdFile_to_MCT_JMDC_Flash.csh A HMIX

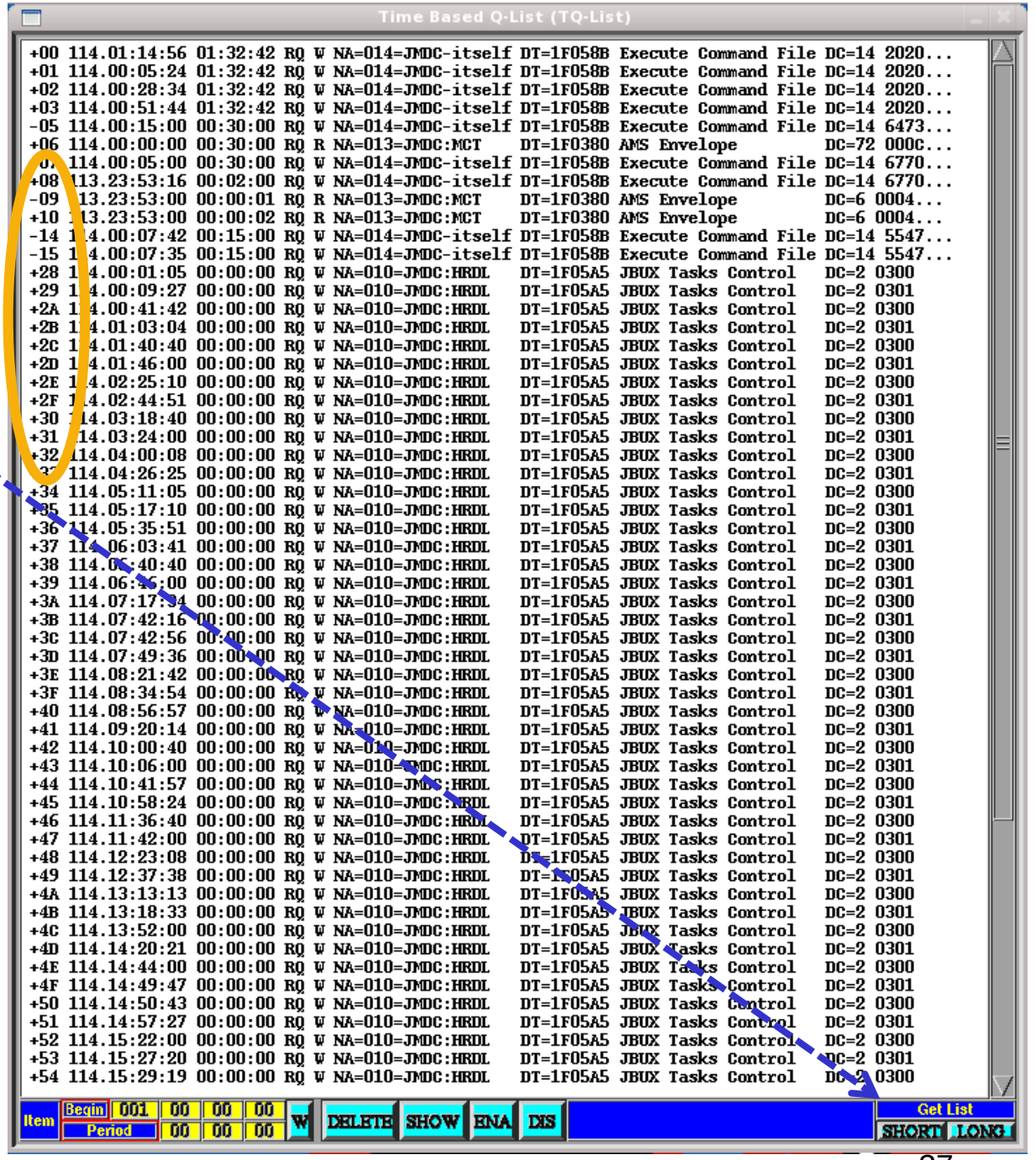
Check to make sure that the command files ended up in the JMDC flash (see previous slide)

TRD Gas Refill – Step 8

b) Ask LEAD to “Get Short TQ-List” to read content of Time-Based-Qlist on JMDC-MCT:

When there is AOS, ask LEAD to “Get the SHORT TQ LIST”. They will push the [SHORT] button in the bottom right and this list will update.

What you want to check is if the items 20-35 are already taken. The item number is on the far left side. In this example, 28+ are used, so we would have to use different item numbers. The point is to be careful not to write over something which is currently scheduled.



TRD Gas Refill – Step 8

c) Choose a command file that does not overlap with the currently used item numbers. The current options are (where the item numbers will be 20-35, 40-55, etc):

UGA_TRD_REFILL_TQ_20_35_HMIX.cmd

UGA_TRD_REFILL_TQ_40_55_HMIX.cmd

UGA_TRD_REFILL_TQ_60_75_HMIX.cmd

UGA_TRD_REFILL_TQ_80_95_HMIX.cmd

UGA_TRD_REFILL_TQ_A0_B5_HMIX.cmd

UGA_TRD_REFILL_TQ_C0_D5_HMIX.cmd

UGA_TRD_REFILL_TQ_E0_F5_HMIX.cmd

Note that for the second injection we don't use the steps to turn the heaters on, so those options are:

UGA_TRD_REFILL_TQ_20_31.cmd

UGA_TRD_REFILL_TQ_40_51.cmd

UGA_TRD_REFILL_TQ_60_71.cmd

UGA_TRD_REFILL_TQ_80_91.cmd

UGA_TRD_REFILL_TQ_A0_B1.cmd

UGA_TRD_REFILL_TQ_C0_D1.cmd

UGA_TRD_REFILL_TQ_E0_F1.cmd

TRD Gas Refill – Step 8

d) Upload Commands into Time-Based_QList:

TRDGAS-M: 94: Spiro Temperatures > +5°C

Ask LEAD to:

-stop the Run

-set RunTag for “TRD Non-Nominal”

-restart the Run

trd@pcpoc25 TRDGAS$ UG_EXEC.csh A TRD_REFILL_TQ_20_35_HMIX

(or for second injection: trd@pcpoc25 TRDGAS$ UG_EXEC.csh A TRD_REFILL_TQ_20_31)

Write down T0: T0 is time when TRD-REFILL was sent

TRD Gas Refill – Step 8

d) Check if all 18 items are entered

Correctly in TBQL:

ASK LEAD to “Get Short TQ-List”

to read content of Time-Based-Qlist on

JMDC-MCT

In this case we asked for Items: 17 … 28 with

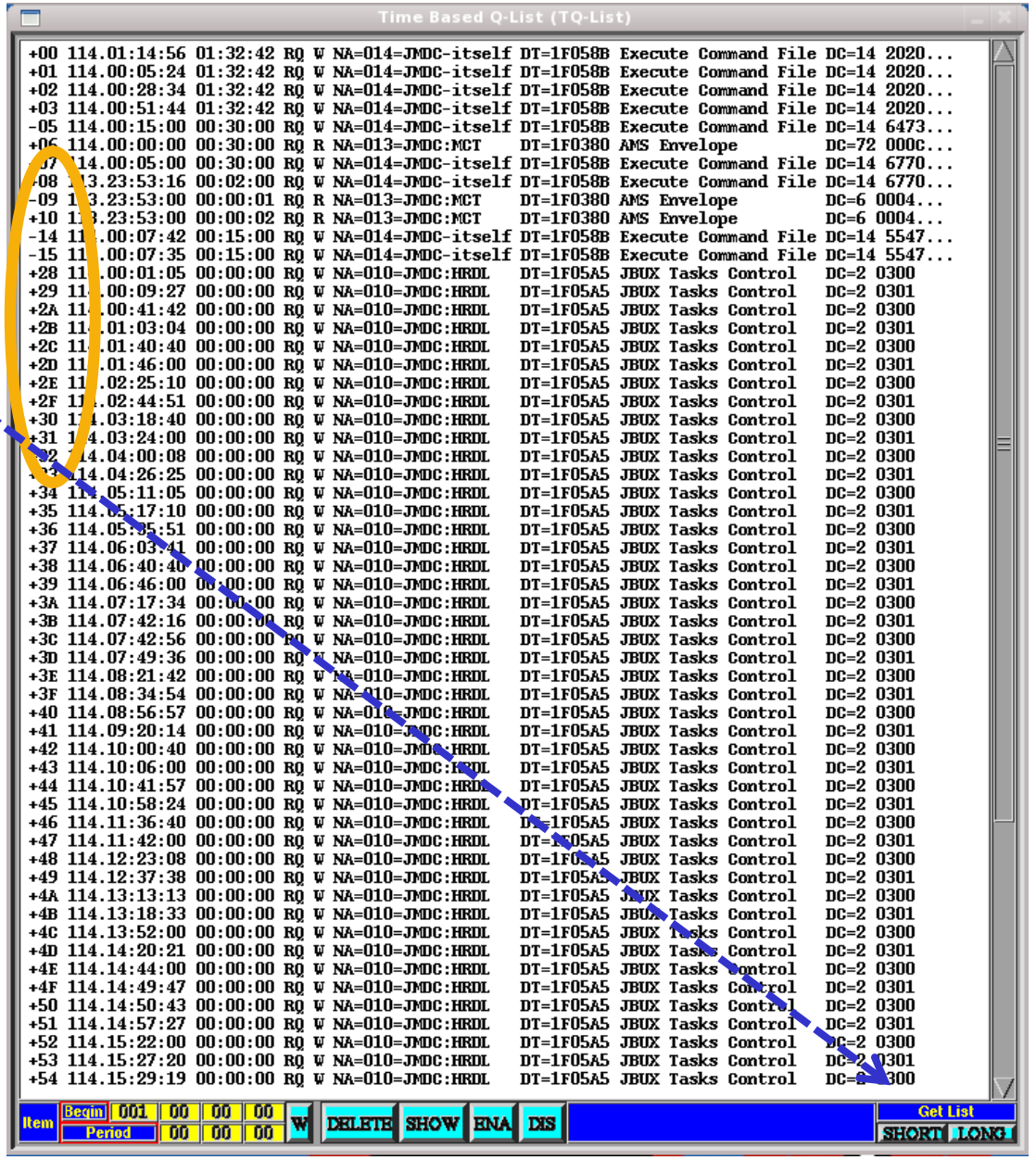
Start-Times +10 min, +22 min, … ,

+3h 22 min

If entries are not correct ask LEAD to

delete them and repeat

from Step 8c

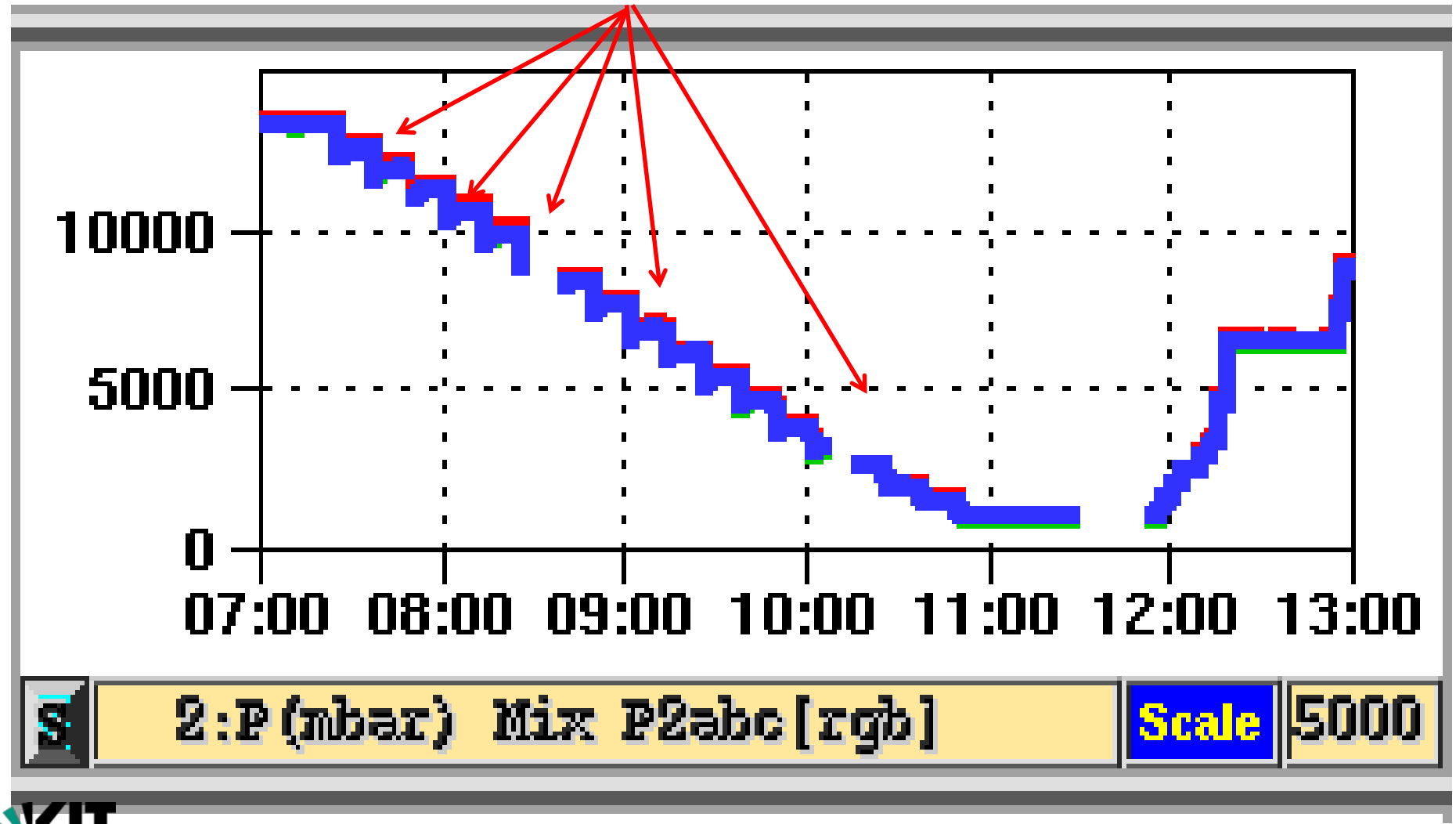


TRD Gas Refill – Step 8

Watch the pressure drop in the mixing vessel with

TRDGAS-M: 2: Pmix decreasing

(18 Transfers)



TRD Gas Refill – Step 9&10

Step 9: Hand back control to LEAD for next 3.5h

Step 10: Check replies (every 12 min 110 CommandFile replies for TMX0…..8; 154 for TMX9)

If pressure drop is less than required, repeat step TMXi manually

> UG_EXEC.csh A TMXi with “i” replaced by 0..8

Pmix has to be below 1.8 bar before Step TMX9 (last one) is executed,

(if not, have LEAD disable TMX9 and repeat TMX8 by hand then do TMX9)

CMD	Time	#Replies	Pmix	Ref. Val. (bar)	
			_____	13.7	
TMX0	_____	_____	_____	13.0	reset UG CMD CNT
TMX1	_____	_____	_____	12.2	reset UG CMD CNT
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
TMX9	_____	_____	_____	0.9	reset UG CMD CNT

TRD Gas Refill - Step 11

Step 11: Increase TRD HV

Increase TRD HV by XXX V and check Gain Stability

Calculate HV step for signal adjustment (the worksheet does this automatically now, but for reference we'll keep this here):

HV adjustment: 1000 mbar / 880 mbar = +13.6 % Density increase

→ Gain / (1.04)^(13.6) = Gain / 1.74

CO2 – fraction +1.2%

→ Gain / (1.08)^(1.2) = Gain / 1.10

Total Gain drop: 1.88 → HV: ln(1/1.88)/ln(0.99) = 62.8 V

NOTE: the 0.99 is because you get 1% per Volt, the 1.04 is for 1% density change, and 1.08 is for 1% CO_2 fraction change.

So if the calculated adjustment is ~63V, one then needs to adjust that number by two things:

(a) +8 for the pump running at half speed (since we will leave the pump on overnight)

(b) X, which is whatever the normal HV adjustment would be at that moment (use the GainMonitor to fit the plot, as usual: (let's use -2Vhere, just for example).

So the HV adjustment by 62.8 V + (8 V -2 V)= 68.8 V

(For Step 15) When the pump is turned off on Day 2 we subtract the same (8-2)V – ZV where Z is however much the adjustment is at THAT point (like step b)—there have been at least 12h since the previous adjustment. So for example say the new adjustment is now -1V, we'd adjust by -(8-2)V -1V = -7V.

TRD Gas Refill – Second Mixing and transfer

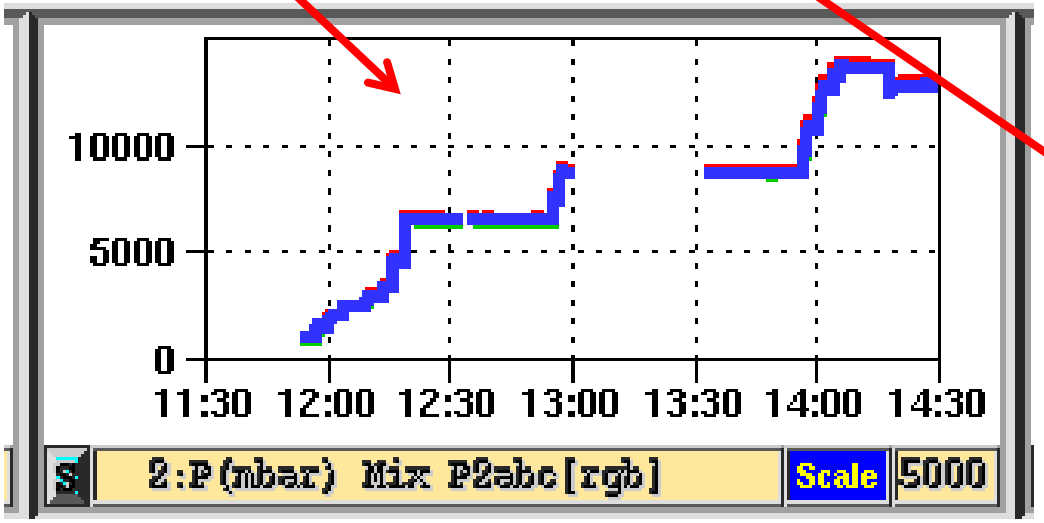
After first Mix & Transfer:

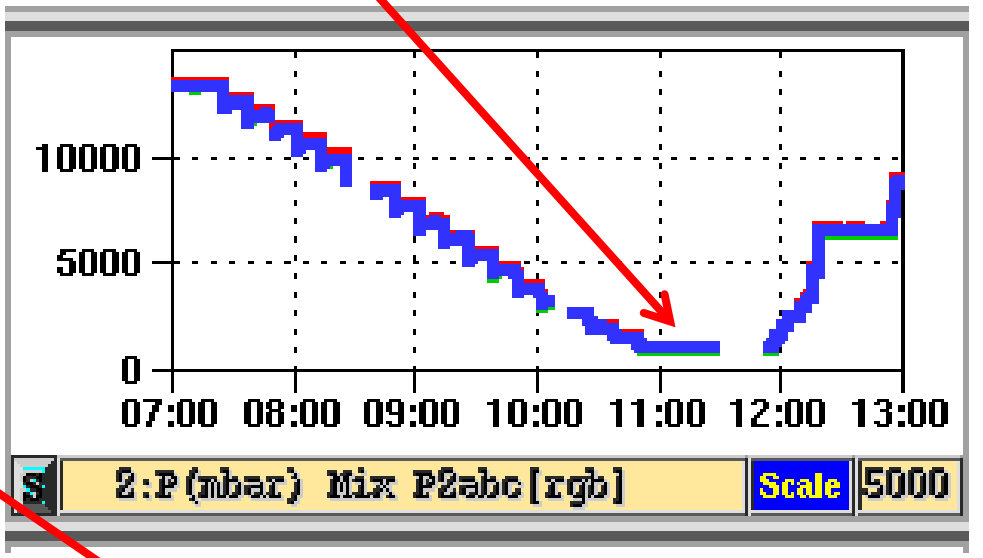
For second Mix & Transfer wait for 12 minutes of pumping after TMX9

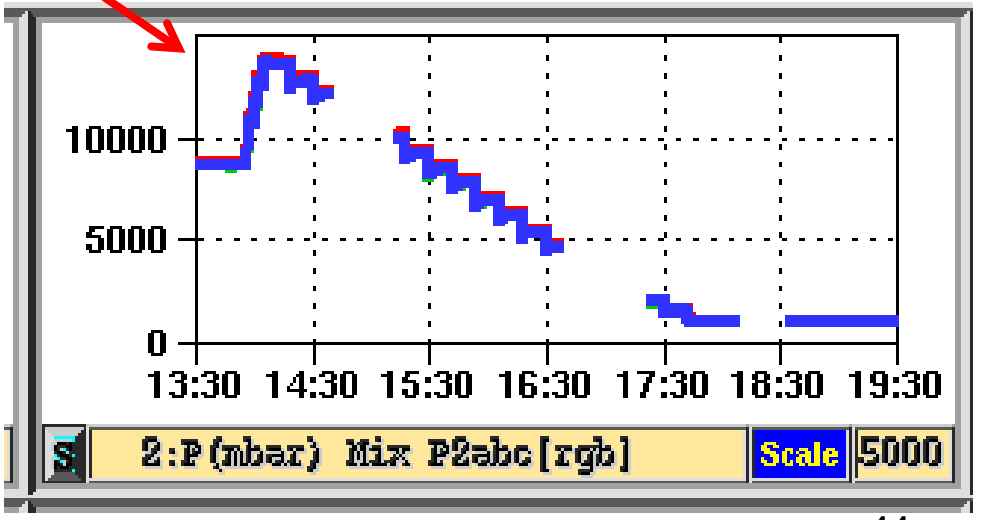
REPEAT Step 5 – 10

Transfer of x liters

2nd Mixing **2nd transfer**







After second Mix & Transfer continue

with step 12

TRD Gas Refill – Step 12

Step 12: Circulate gas at full speed to assure closing of BoxC-Relief-Valve, Wait until pressure is stable (5 min)

TRDGAS-M: 94: Spiro Temperature > +5°C

TRDGAS-C: PUMP: {CP2}{f}{START}

4th terminal:UGcmdLog: check for

58 replies in 20s

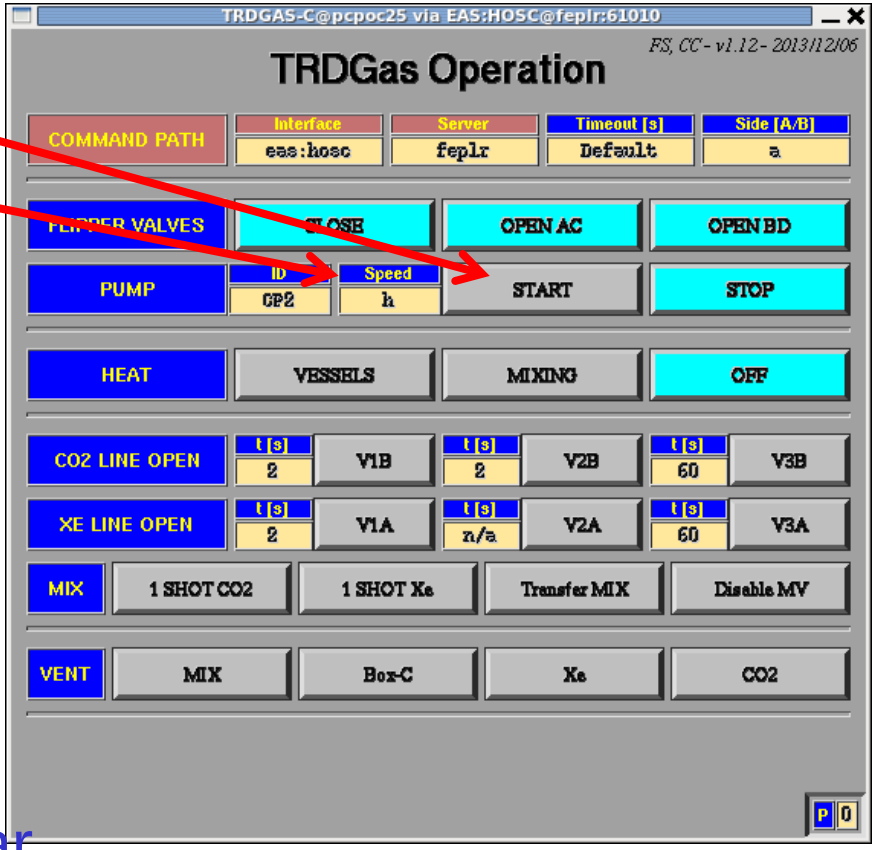
TRDGAS-M: Reset UG CMD CNT

3: Psup increase by 300 mbar

3: Pret decrease by 400 mbar

97,99 Inlet: MFDPs drop to -300 mbar

96,98 Outlet: MFDPs increase to 400mbar



TRD Gas Refill – Step 13

Step 13: Continue gas circulation at half speed for 12h to homogenize gas gain

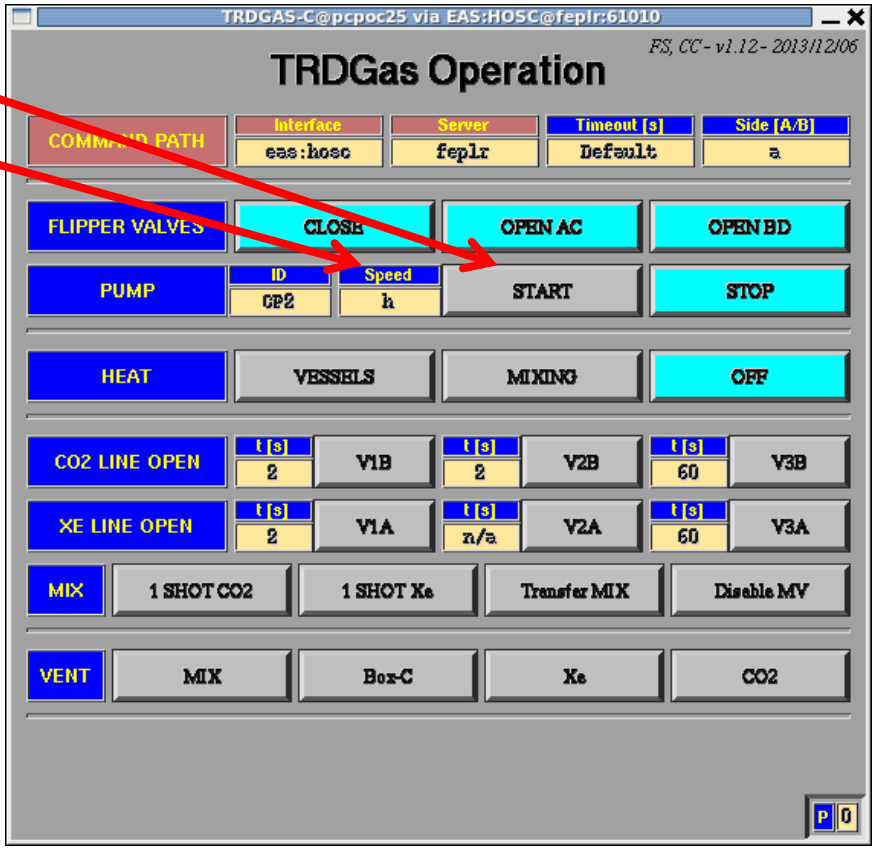
TRDGAS-M: 94: Spiro Temperature > +5°C

TRDGAS-C: PUMP: {CP2}{h}{START}

4th terminal:UGcmdLog: check for

58 replies in 20s

TRDGAS-M: Reset UG CMD CNT



TRD Gas Refill – Step 13

Step 13: Continue gas circulation at half speed for 12h

to homogenize gas gain

TRDGAS-M: Reset UG CMD CNT

3: Psup increase by 200 mbar

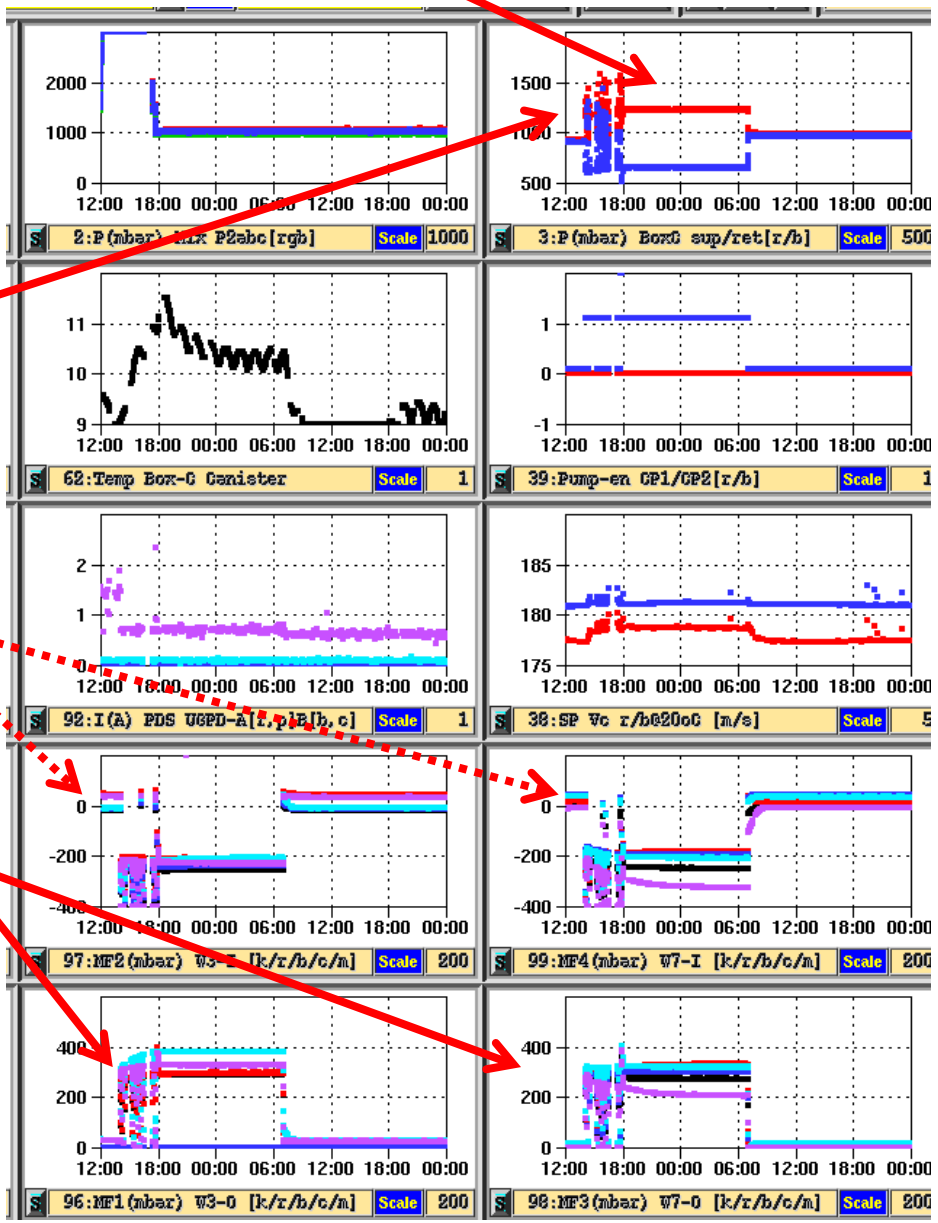
3: Pret decrease by 300 mbar

97,99 Inlet:

MFDPs drop to -200 mbar

96,98 Outlet:

MFDPs increase to 300mbar



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TRD Gas Refill – Step 14

Step 13 cont.: Inform LEAD that TRD Gas Refill commanding is complete,

RunTag to be changed to “Science Run (with pump on)”

Circulation of gas will continue (pump running @ half speed)

for ≈ 12h

Step 14:

Update information in file

~/COMMANDING/TRDGAS/Gas_Refills/gas_composition_history.txt

TRD Gas Refill – Step 15

Step 15: Stop Gas-Circulation

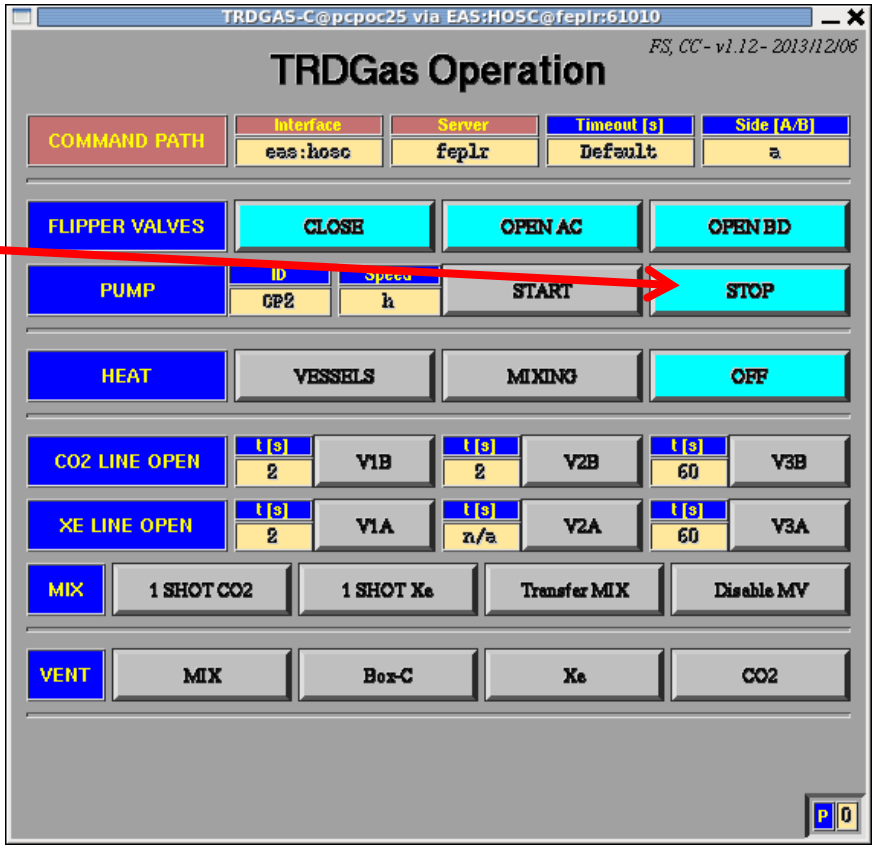
TRDGAS-C: PUMP: [STOP]

4th terminal: UGcmdLog:

Check for 60 replies in 20s

TRDGAS-M:

Reset UG CMD CNT



3: Psup, Pret back to values before pumping

96, 97, 98, 99: all MFdPs back to 0 (± 50) mbar

TRDCHD-M: DRP will turn red “bad” until pressure stable

TRD Gas Refill – Step 15

Step 15: Stop Gas-Circulation

3: Psup, Pret back to values before pumping

96, 97, 98, 99: all MFdPs back to 0 (± 50) mbar

TRDCHD-M: DRP will turn red “bad” until pressure stable

adjust HV by ~ -7 V (See pg 43, step 11) so that MPV ≈ 60 ADC

When turning DAQ back on after HV adjustment, ASK LEAD to increment RunTag to “Science Run (nominal)”

Inform LEAD that TRD Gas Refill commanding is complete