VMM and SRS - a guide for dummies
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VMM documentation and slides

https://cds.cern.ch/record/2309951/files/ATL-MUON-PROC-2018-003.pdf

https://indico.cern.ch/event/999799/contributions/4204329/attachments/2236311/3791411/Electronics%20for%20MPGDs.pdf

https://indico.cern.ch/event/757322/contributions/3425783/attachments/1842281/3021108/2_20190510_SRS_for_VMM_era_HW_Doro.pdf

https://indico.cern.ch/event/872501/contributions/3741500/attachments/1984534/3306263/Connecting_VMM_frontend_to_SRS_backend.pdf

Instructions for the software installation
https://gitlab.cern.ch/rd51-slow-control/vmm-doc

Setup: APV vs VMM
FEC: the same of the APV25, but with a dedicated firmware for the VMM3 chip
ADC: not present anymore, but there is a DVMM card now

CHIPS: 1 APV25 128 channels chip vs 2 VMM3 64 channels chip
As for APV, 1 HDMI mini cable per each hybrid -> 128 channels readout in both cases

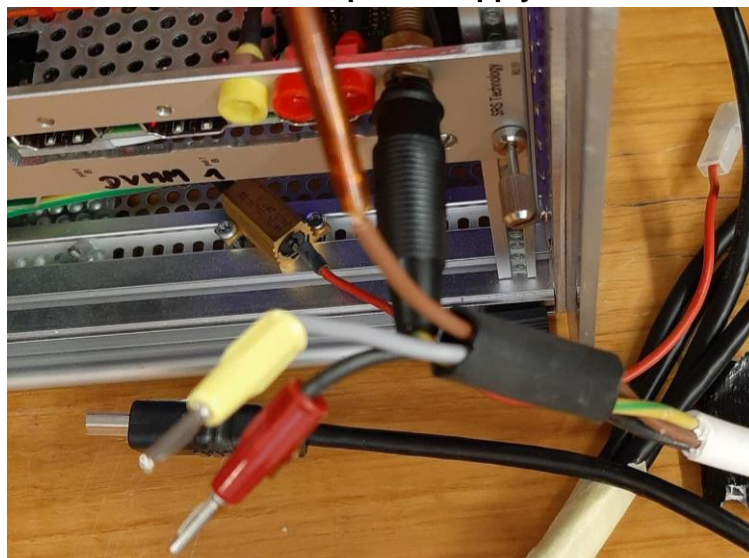**Power supply of the VMM hybrids**
Three different of power supply:
1 - Internal via HDMI cables
2 - External via DVMM card power supply ---> but not all the DVMM cards have the slots in the back
3 - External via an external power supply module

Picture referred to power supply mode n. 2

P1 ---> FPGA: between 3 V and 3.5 V (3.1 V the best)
P2 ---> VMM chip: between 1.75 V and 2.1 V (1.9 V the best)

P2 = min. 1.75V -> 4 LDO's 2x VMM (1.2V) ~ 1.5A
GND = low impedance cable
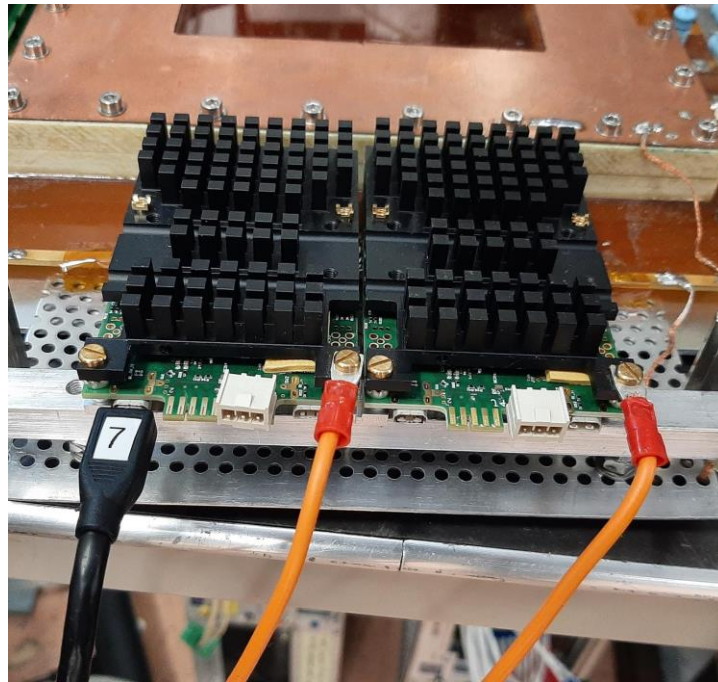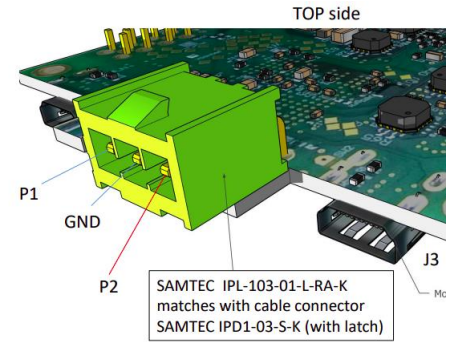P1 = min 3 V -> LDO FPGA/Flash/ADC (2.5V) ~ 0.15A

Check the low voltage applied to the hybrid using a tester!

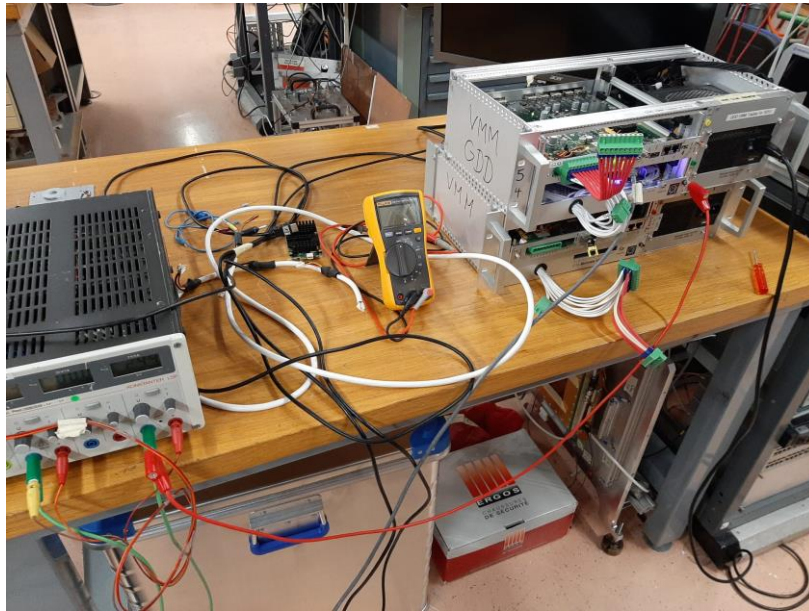Turn-on the HV of the detector only if the hybrid is powered!!!

Grounding
Two possibilities:
1 - via the power cable itself
2 - via an independent grounding cable plugged to one of the hybrid screws

If an external power supply is used, put the power supply module and the SRS crate at the same ground using a cable (there is a slot in the SRS crate for it)

Be careful with the grounding ---> the hybrid and the detector have to be at the same grounding ---> how to do that? copper tape?

Ubuntu network settings
Identity ---> MTU 9000 ---> very important for all used ports (ethernet and WiFi)
IPV4
Address 10.0.0.3 —> pc used for the DAQ
Netmask 255.255.255.0

10.0.0.2 is instead the FEC IP address

Ethernet connection
The name of the ethernet port has to be changed in essdaq/config/system_rhum.sh
The name can be found using ifconfig command

How to acquire data?

In order:

1 - Launch the VMM DCS (Slow Control)
2 - Launch kafka
3 - Launch the EFU (Event Formation Unit)
4 - Launch Daquiri
5 - Launch Wireshark

How?

1 - Slow control
./vmmsc/build/vmmdcs
OR the alias vmmsc

2 - kafka
./essdaq/kafka/start_kafka.sh

3 - EFU
./essdaq/detectors/gdgem/start.sh

4 - Daquiri
cd essdaq/detectors/gdgem
./daquiri.sh

5 - Wireshark
wireshark -X lua_script:/home/dateuser/vmmsc/vmm3a_plugin.lua
OR the alias essws

1 - Slow Control

From this panel we can set the acquisition ON or OFF. If we set the acquisition OFF, but data are still arriving to Daquiri, the reason is that we are reading older data from a buffer.

In order

1 - Load the configuration file from /home/dateuser/vmmsc/configs
If config file does not exist, select FECs, Hybrids and VMMs, save the config file and load it

p.s. The number of the hybrid MUST CORRESPOND TO the number of the DVMM card port used for that hybrid

2 - Open communication ---> all alive
3 - Send
4 - Link Status

Check data 5
Data, 5: 22222404 ----> good
Data, 5: 22222303 ----> not good

These 8 numbers identify the DVMM card port. They have to be read from right to left.

5 means that the port is in acquisition mode ---> should only be the case if the acquisition is on
4 means that port is connected properly to the hybrid and read for acquisition
3 means that the hybrid on the port is recognised, but the clocks are not synchronous. ---> Press "Warm Init FEC". This should solve the problem. Otherwise: improve grounding.
0 or 2 means that the connection is not working properly

5 - Check I2C Hybrid ID ---> click on read
    C0D6A000A000004E ----> ok
    0000000000000000 ----> not ok, but if the DVMM card is old, it could not support this functionality

6 - Acquisition ON to start the data-taking

From the VMMSC panel we can:
- Pulse and readout the analogue signal from each VMM channel (ST)
- Mask VMM channels (SM)
- Set threshold per each VMM channel (SD) -> w.r.t. the threshold set for the entire VMM, which is shown on the left side
- There are eight different gains of the preamplifier are available, from 0.5 up to 16 mV/fC. 6 mV/fC should be a reasonable value to set

Set acquisition OFF when settings (masked channels, gain, thresholds) need to be changed. Then, use the command SEND. The DAQ can complain if the acquisition is left ON.
Daquiri and EFU can be left running, instead.

In the configuration file -> fecID is not the ID but the last number of the IP address

1.1 - Calibrations

Calibrations under Calibration tab in the Slow Control panel
Offline ADC ---> Take Data
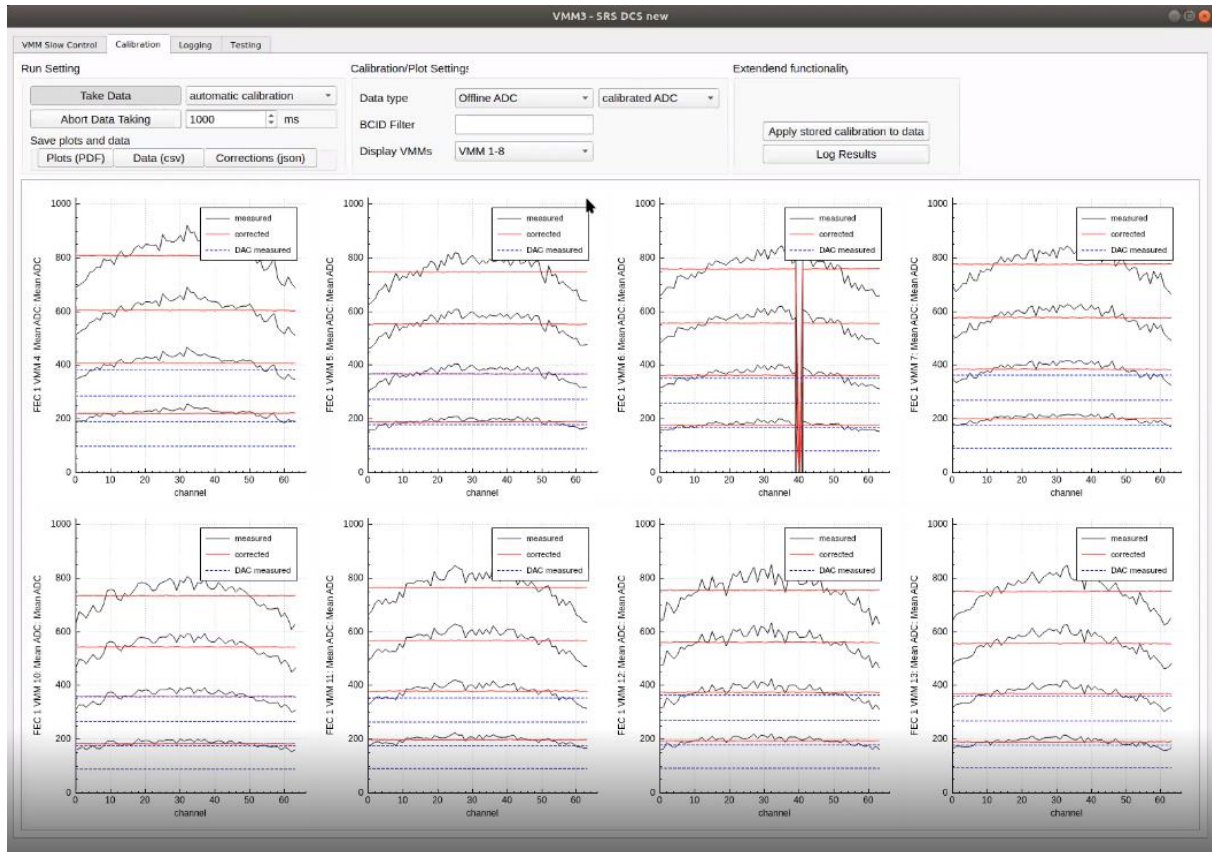Offline Time (BCID/TDC) ---> Take Data

Calibration will not work if EFU is running because the same port is used —> ./stop.sh

For the ADC calibration, each PAD is pulsed with 4 different signals of different amplitudes. The 4 distributions represent the mean value of the ADC distribution for each of the 64 VMM channels for each signal amplitude.

ADC calibration

Time calibration
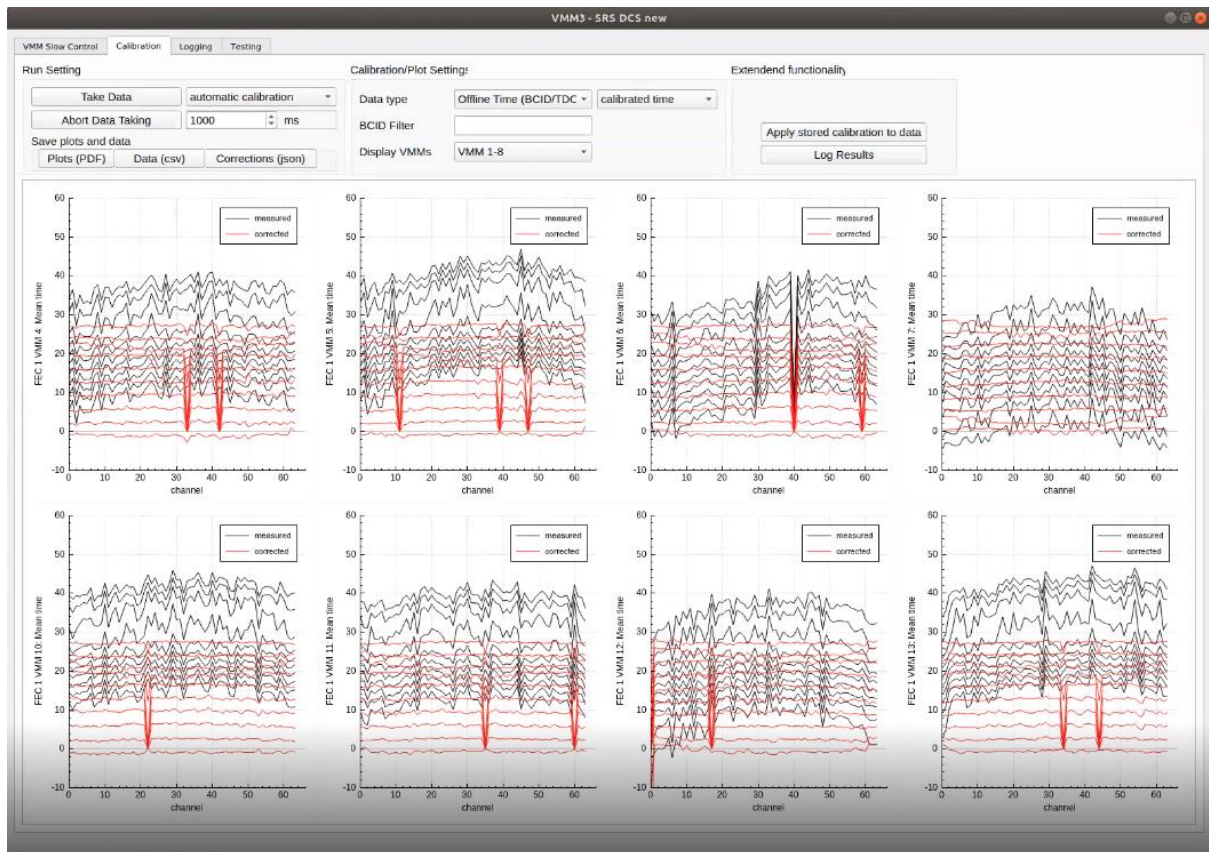
We will get one plot for each VMM chip. Indeed 64 channels are shown.

To create the calibration file, click on Correction (json)
ADC and time calibration will go to the same calibration file
If one of the calibration is not performed, we should observe only 0 for the offsets and 1 for the slopes

The calibration file will be created in vmmsc/build and has to be moved to essdaq/detectors/gdgem

There, please rename the calibration file according to the name specified in essdaq/config/mysystem.sh (only, if you want to apply the calibration online or if it should be saved as part of the HDF5 file, assuming you want to save your data as HDF5 and not as PCAPNG)

If I change hybrid or settings, I should re-run the calibration
If I add hybrids, besides the calibrations, I should also update the configuration file

2 - kafka

Kafka manages the communication between the EFU and Daquiri

cd ~/essdaq/kafka
./start_kafka.sh
./check_kafka.sh
./stop_kafka.sh

Sometimes it does not run immediately
If we check the status with ./check_kafka.sh, it could say "No local Kafka found"
In such a case, launch the start command again!
If we check again, it should say "Kafka running locally"

3 - EFU

Used to:
- receive detector data
- calculate detector position
- generate events
- forward events to scalable storage

cd essdaq/detectors/gdgem
./start.sh
./stop.sh

If the configuration file is changed, EFU has to be stopped and restarted

4 - Daquiri

From the same directory of Kafka (VMM/essdaq/detectors/gdgem), we can launch Daquiri

./daquiri.sh from gdgem

Be sure that kafka is running before launching Daquiri

NMX profile ---> Connect

If Wireshark shows a flux of data but the Daquiri histograms are empty, the problem could be that MTU = 9000 has not been set for all the ports used (WiFi and ethernet)

5 - WireShark

Wireshark is used to monitor the network communication and data transfer. It provides human readable information about the transfer of packages.

This could also be the second step
I can launch it once the acquisition is set to ON in the Slow Control

After launching go to "Capture options"
Input ---> select the correct ethernet interface ---> enx3c18a…….
Options ---> Select 100 packets only
Start

N.B. Read only few packages (~100), otherwise your RAM will be 100% full in short time

What can I observe?

The number close to FEC is the last part of the FEC IP
According to BCID, VmmID and channel number of the hits I can even visualize a cluster
ADC charge —> 1023 —> channel in saturation

Recording data

Command to use

sudo tcpdump -i enx3c18a07af6a9 -w rhum-at-gdd_2021-12-03_run01.pcapng udp port 6006

-i —> ethernetinterface
-w —> file name
udp —> network protocol
port 6006 —> port
We can launch the command from the directory where we want to store the data

N.B. The number of recorded events will not be shown!

Stop the process with CTRL+C

To specify to run for 60 seconds, use:
sudo timeout 60s tcpdump -i enx3c18a07af6a9 -w rhum-at-gdd_2021-12-03_run01.pcapng udp port 6006

In this case we cannot stop the process with CTRL+C

Once the acquisition is over and the .pcapng file is produced, we have to run a python script

./reconstruction.py

One root file containing three different trees will be created

Many options available in reconstruction.py

```python
#!/usr/bin/python

import os
import subprocess
import re
import sys

try:
        args = ['/home/daq/vmm-sdat/build/convertFile',
                '-f', '/home/daq/live-demo.pcapng',
                '-vmm', '[[1,0,2,4],[1,0,2,5],[1,0,2,6],[1,0,2,7],[1,1,2,10],[1,1,2,11],[1,1,2,12],[1,1,2,13]]',
                '-axis', '[[1,0],0],[[1,1],0]',
                '-bc', '40', '-tac', '60',
                '-th', '0',
                '-cs', '1', '-ccs', '3', '-mst', '0',
                '-dt', '100', '-spc', '500', '-dp', '100',
                '-save', '[[1],[1],[1]]',
                '-info', 'live-demo-test',
                '-df', 'SRS']
        subprocess.call(args)

except OSError:
        pass
```

General recommendations and errors

The MTU parameter of all the connections has to be set to 9000 (high value for jumbo frame).
Check the ethernet settings from Ubuntu network settings - Identity - MTU 9000.
Not found a way to change the WiFi MTU —> One solution is to turn-off WiFi connection.

EFU runtime_error ---> probably it is already running and you launched ./start.sh again.
It has to be stopped before!

The FEC has been changed
Two possibilities:
        1 - I can change the FEC ID (last number of the FEC ID) in the .json configuration
        and calibration file
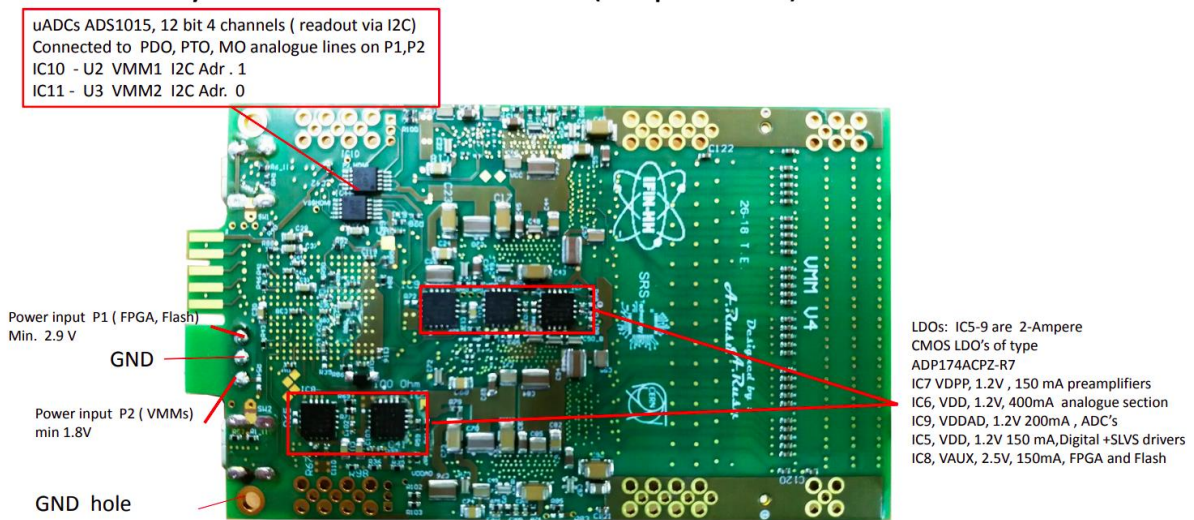   2 - I can change the FEC address from the Slow Control

Don't change gdgem directory. There are important files there to be used.

If the ethernet port changes, remember to modify UDP_ETH in
VMM/essdaq/config/system.sh

New aliases

alias vmmsc="~/vmmsc/build/vmmdcs"

alias essws='wireshark -X lua_script:/home/dateuser/vmmsc/vmm3a_plugin.lua'

uADCs ADS1015, 12 bit 4 channels (readout via I2C)
Connected to PDO, PTO, MO analogue lines on P1,P2
IC10 - U2 VMM1 I2C Adr . 1
IC11 - U3 VMM2 I2C Adr. 0

Power input P1 (FPGA, Flash)
Min. 2.9 V

GND

Power input P2 (VMMs)
min 1.8V

GND hole

LDOs: IC5-9 are 2-Ampere
CMOS LDO's of type
ADP174ACPZ-R7
IC7 VDPP, 1.2V , 150 mA preamplifiers
IC6, VDD, 1.2V, 400mA analogue section
IC9, VDDAD, 1.2V 200mA , ADC's
IC5, VDD, 1.2V 150 mA,Digital +SLVS drivers
IC8, VAUX, 2.5V, 150mA, FPGA and Flash

TOP side

P1

GND

P2

SAMTEC IPL-103-01-L-RA-K
matches with cable connector
SAMTEC IPD1-03-S-K (with latch)

J3

Molex 0467651001

MMCX-J-P-H-ST-TH1