8th BM@N Collaboration Meeting (3-8 October, 2021)

Trigger detectors and trigger system

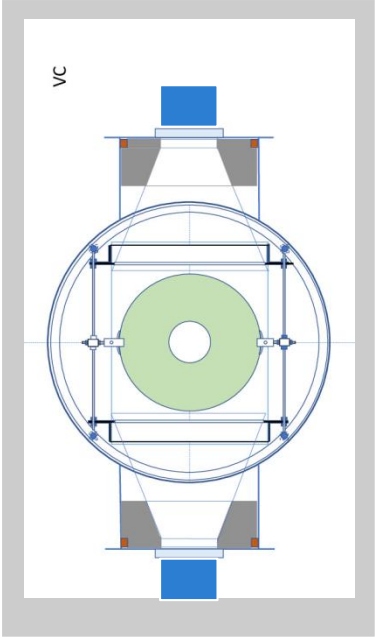
Trigger group

BC1 and VC

Vacuum components
- major components (boxes, quartz windows, PMT holders) ready ✓
- minor items (O-rings, clamps, etc.) supplied (double-check needed)

PMT and bases
- PMT Hamamatsu R2490-07 available ✓
- PMT sockets Hamamatsu E678-21C available ✓
- new base designed, PCBs are ordered, prototype is being tested
- housing designed, all parts are produced ✓

Scintillators
- 100x100x0.25mm^3 (BC1) and Ø100x10mm, hole Ø27mm (VC) available ✓
- scintillator mounts tentative design done, production planned for Oct-Nov



Electronics
- cables, HV and signal, HV power supply available ✓
- additional linear fan-out modules produced ✓
- amplifier CAEN N979 ordered
- TQDC, TDC, CAEN digitizer N6742 available ✓

Ongoing and planned commissioning tests
- gain change at high beam intensity ongoing tests with LED and laser
- gain change in magnetic field (VC) will be tested on site (after installation ?)

Overall status: some delays in design and production of mechanical parts due to pandemic, but so far no major setbacks or points for extra concern

BC2

Vacuum components
- major components (boxes, quartz windows, PMT holders) ready ✓
- minor items (O-rings, clamps, etc.) supplied (double-check needed)

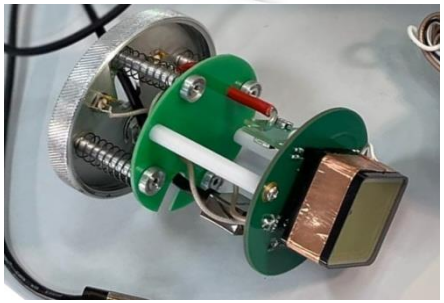
PMT and FEE
- MCP-PMT XPM85112/A1-Q400 (Photonis) available ✓
- FEE designed, all parts produced, first PMT is being tested
- housing designed, all parts are produced ✓

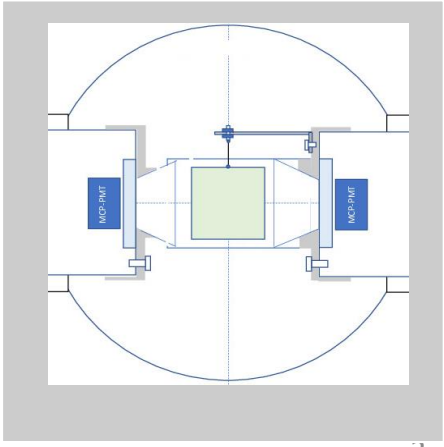
Scintillators
- BC400B 30x30x0.15mm^3 available ✓
- scintillator mounts tentative design done, production planned for Oct-Nov.

Electronics
- cables, HV and signal, HV power supply available ✓
- additional linear fan-out modules produced ✓
- TQDC, TDC, CAEN digitizer N6742 available ✓

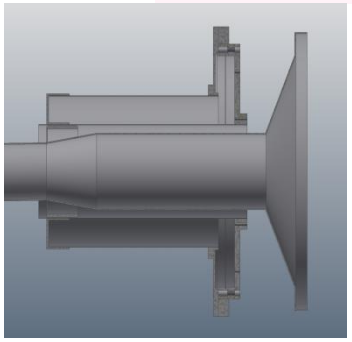
Ongoing and planned commissioning tests
- time resolution ongoing tests with laser
- gain change at high beam intensity ongoing tests with LED and laser
- gain change in magnetic field will be tested on site (after installation ?)
- the same PMTs, FEE and read-out chain are being prepared for the SRC T0 counters, performance will be checked in the SRC run

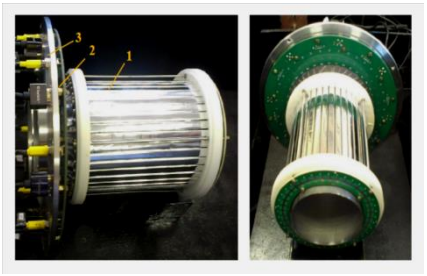
Overall status: similar to BC1, VC – i.e., some delays, but not major





BD upgrade (I)



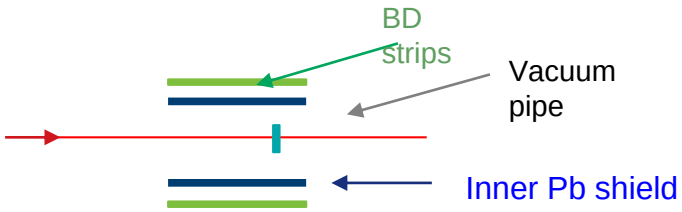


upgrade is finished ✓

New FEE board

- less noise, more flexibility to set thresholds
- increased pulse width >12 ns
- additional inputs for test pulses

tests with cosmics planned for Nov-Dec.



fixed ✓

Inner Pb shield

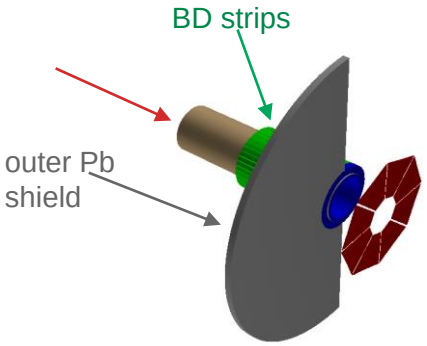
(cylinder 15 cm long, 4 mm thick)

inner dia. of the shield is 70 mm

i.e., radial gap between the shield and vacuum pipe is 2 mm,

4 mm of Pb leaves 1 mm gap for support material

design in progress, production scheduled for Nov.



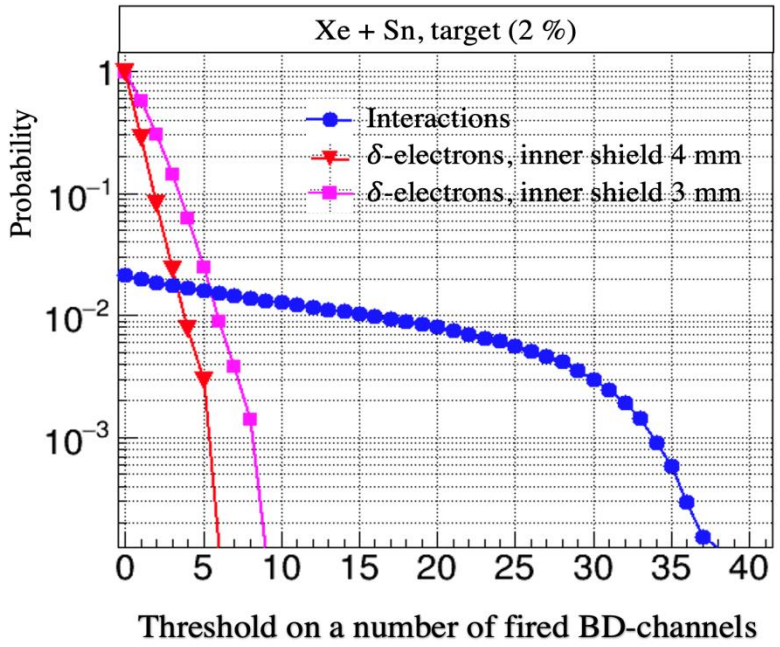
Outer Pb shield

(half-disc R=25 cm, 1 cm thick)

production scheduled for Nov.

Overall BD upgrade status: on schedule, design and production of the Pb shields is now given more attention

BD upgrade (II)



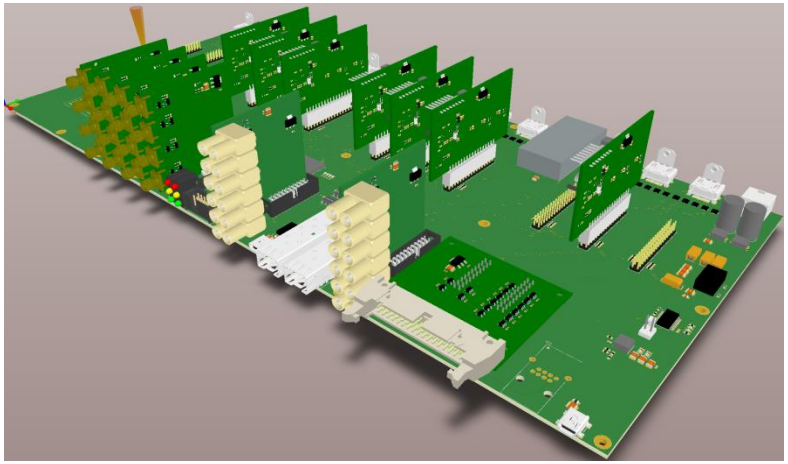
Simulation of δ-electron background for different thickness of inner shield

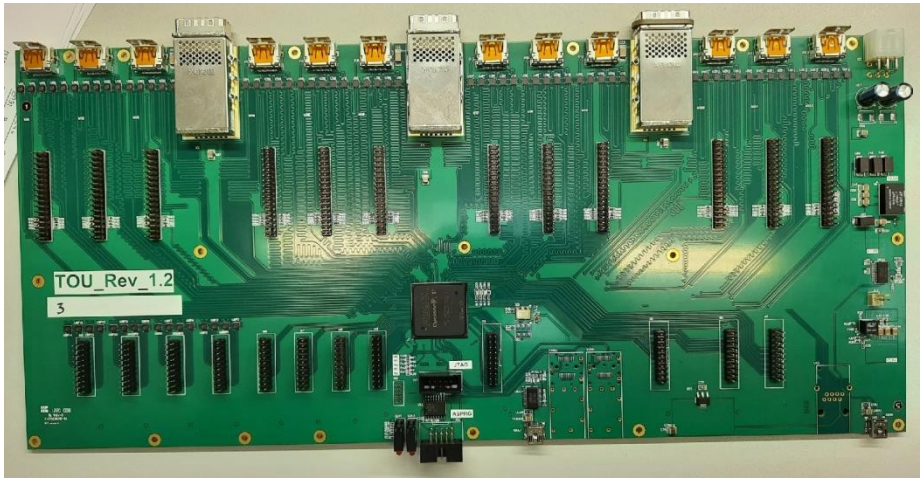
Trigger 0-level Unit (T0U) I

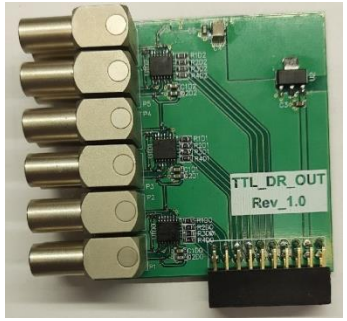
- New design
  - Increased input/output line number
    - Extra TTL-50 Ohm input or output lines
    - Extra LVDS input or output lines
  - Completely new firmware (100% Verilog)
  - New server

Trigger 0-level Unit (TOU) (II)

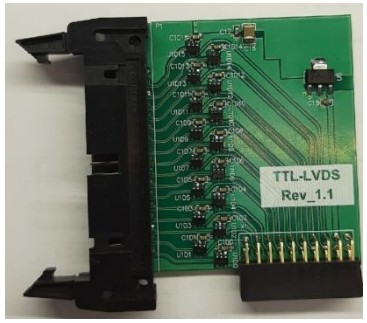
New boards – manufactured and checked.



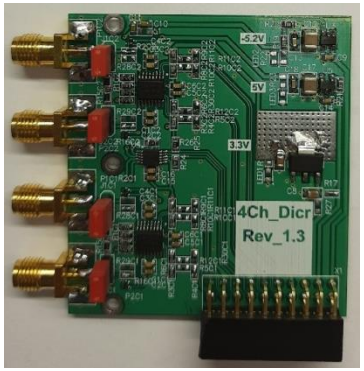




12-channel 50 Ohm TTL input or output board



16-channel LVDS input or output board



4-ch. Input discriminators

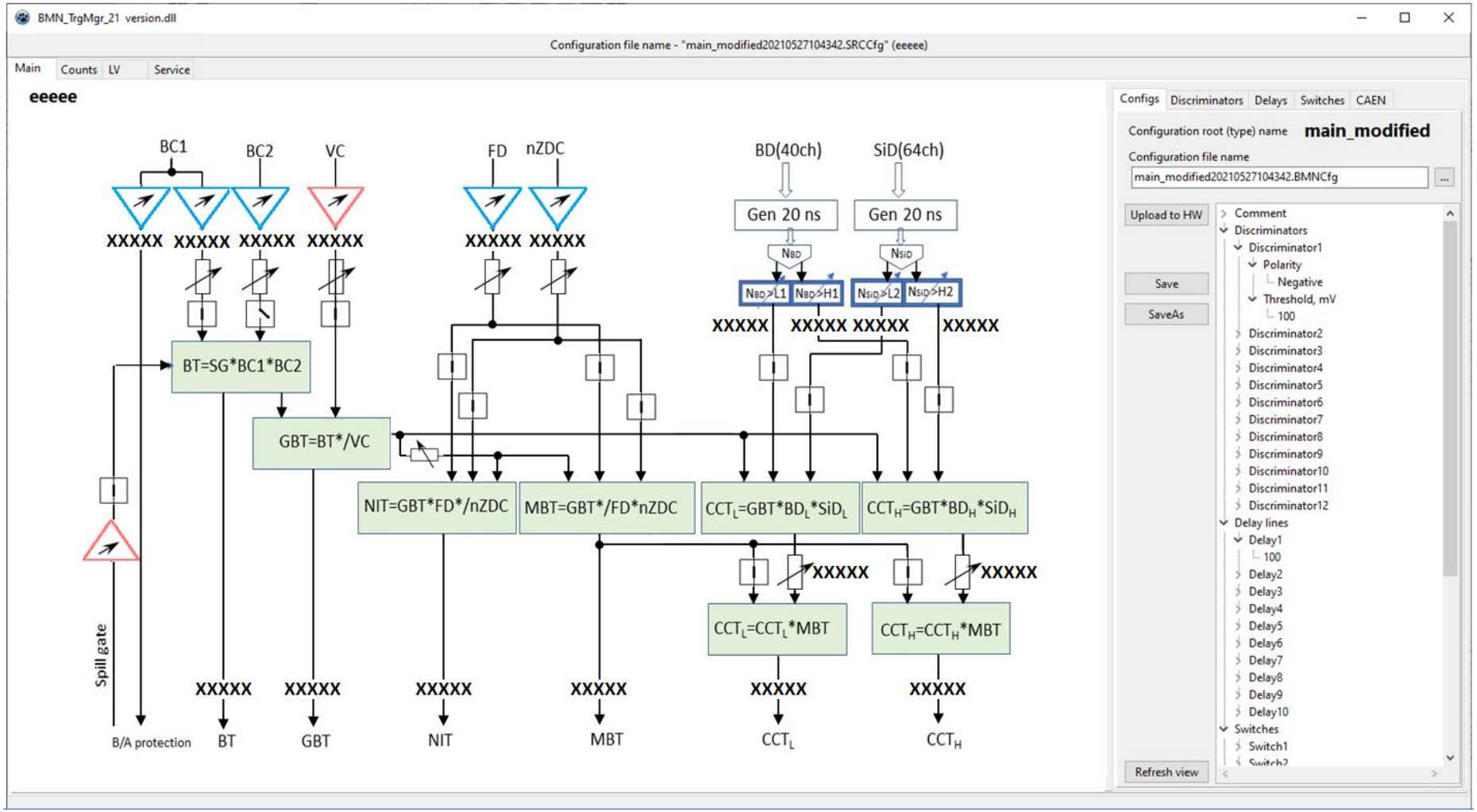
-2 to 2V input

Threshold 5mV step

1.5 GHz equivalent input rise time bandwidth

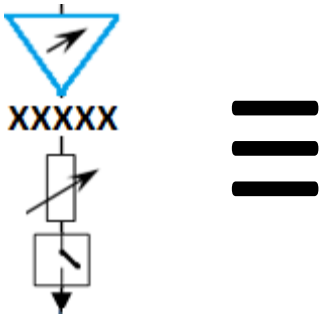
Ready ✓

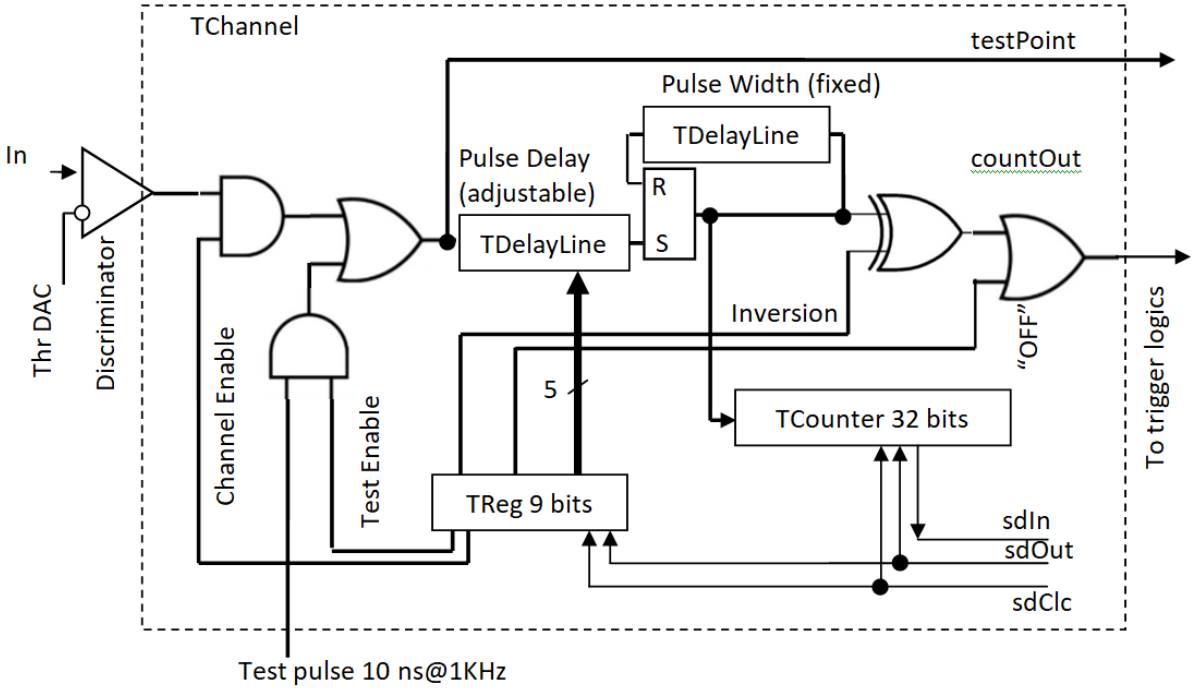
TOU Server (I)


BMN_TrgMgr_21 version.dll
Configuration file name - "main_modified20210527104342.SRCCfg" (eeeee)
Main
Counts
LV
Service
eeeee
BC1
BC2
VC
FD
nZDC
BD(40ch)
SiD(64ch)
Gen 20 ns
Gen 20 ns
XXXXX
BT=SG*BC1*BC2
GBT=BT*/VC
NIT=GBT*FD*/nZDC
MBT=GBT*/FD*nZDC
CCT_L=GBT*BD_L*SiD_L
CCT_H=GBT*BD_H*SiD_H
CCT_L=CCT_L*MBT
CCT_H=CCT_H*MBT
Spill gate
B/A protection
BT
GBT
NIT
MBT
CCT_L
CCT_H
Configs
Discriminators
Delays
Switches
CAEN
Configuration root (type) name
main_modified
Configuration file name
main_modified20210527104342.BMNCfg
Upload to HW
Save
SaveAs
Refresh view
Comment
Discriminators
Discriminator1
Polarity
Negative
Threshold, mV
100
Discriminator2
Discriminator3
Discriminator4
Discriminator5
Discriminator6
Discriminator7
Discriminator8
Discriminator9
Discriminator10
Discriminator11
Discriminator12
Delay lines
Delay1
100
Delay2
Delay3
Delay4
Delay5
Delay6
Delay7
Delay8
Delay9
Delay10
Switches
Switch1

Input channel

- Input discriminator range +3V..-2V (new +2V..-2V), step ~5 mV
- Input Signal could be inverted
- Channel contains adjustable delay line and fixed shaper



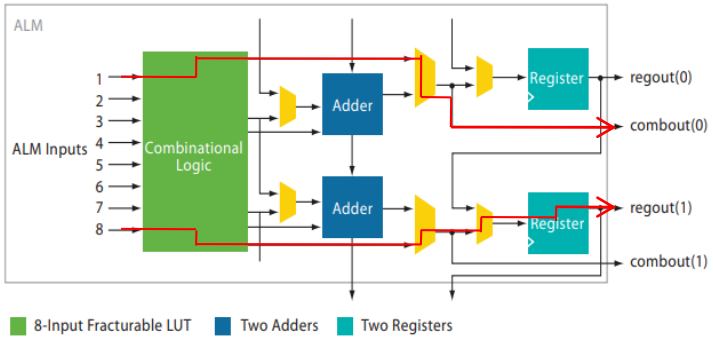


Delay lines

- Delay lines are **asynchronous** for ordinary channels with short delay and **synchronous** for channels with long delay
- **Asynchronous** delay is built using FPGA element propagation delay. **Very resource consuming.** Not longer than 45 ns
- **Synchronous** delay uses FPGA 100 MHz internal clock counting therefore introduces jitter +/- 5 ns
- Synchronous delays used in circuits with delay longer than 50 ns

Asynchronous delay

- Used FPGA Cyclone 5 contains ~29 000 elements (ALM – Adaptive logical unit)
- One delay cell consumes 1 ALM
- One input channel uses ~200 ALMs
- We expect to use >30% of FPGA resources



A - Delay via LUT +Mux (as a single gate) = ~ ¼ ns

B - Delay via LUT+2Muxs+reg (as a D-trigger) = ~3/4 ns

TOU Server (II)

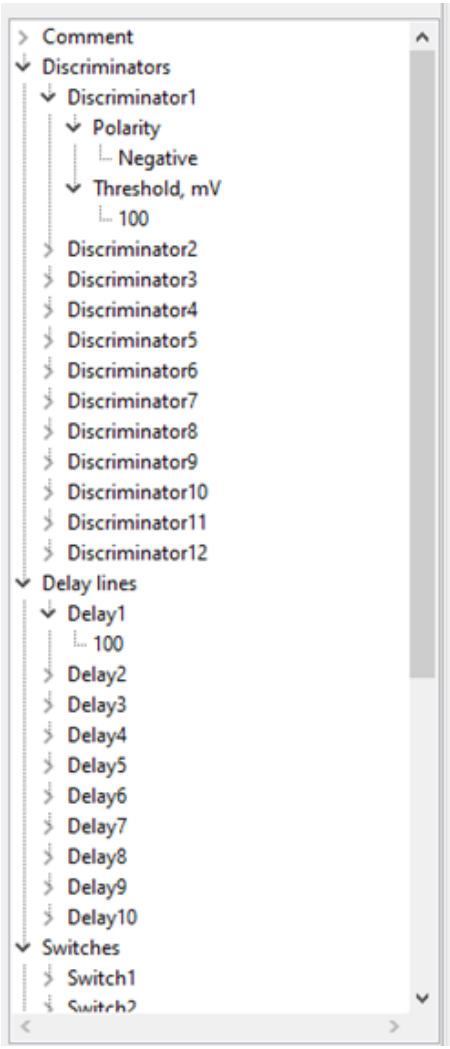
- What's new:
  - Interactive trigger components (click-sensitive)
  - All modifications are saved to "configuration file" in text format.
  - Old configuration files **are not** deleted
  - Non-experts are allowed to upload **only predefined set of configurations** corresponding to the run type

T0U Server (III)

- What's new (continued):
  - Configuration file name consists of a name itself + creation time, for example "**gold_gold**20210527104342.BMNCfg"
  - T0U server is able to **receive** commands from the Run Control System (RCS) to upload a configuration according to the run type using Trigger System Configuration manager.
  - Trigger System Configuration manager **distributes commands** to the HV and T0U **servers** For example if RCS sends command "gold_gold" then all trigger system servers will upload configuration "gold_gold" with the latest time-stamp

Configuration file

- T0U Configuration file is a text file with tree-like structure
- The system assumes to use the **Trigger System Global Configuration**. This file also has a tree-like structure with subsystem Configuration file names for in tree leafs
- Not clear if the Trigger System Global Configuration manager is needed in 2022 Beam run => could be omitted



Communication interface (I)

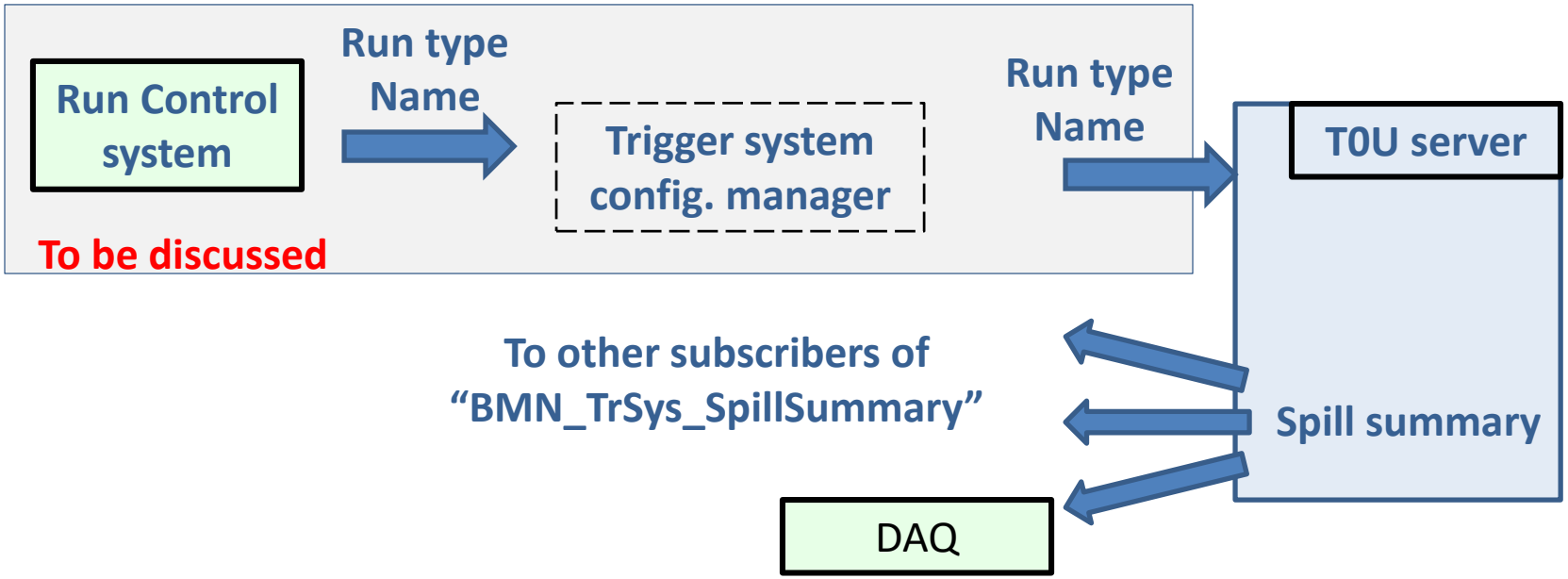
- To communicate to higher level system and inside Trigger system we use DIM protocol, see **https://dim.web.cern.ch/**
- Why DIM:
  - Client/server architecture
  - Based on TCP/IP, fast, uses service logical name addressing
  - Developed at CERN in 80-s for LEPP experiments
  - Will be supported for LHC experiments
  - Recommended by CERN JCOP as an interface for home made software to SCADA systems
  - Open source
  - Is very simple + has a lot of debugging stuff
  - Has both Client and Server managers for WinCC OA (PVSSII)

Communication interface (II)

- T0U server publishes **BMN_TrSys_SpillSummary** DIM-Service data block for **each spill** as follows (expected to be written to the data stream)
  - Counts in BD, 40 integers
  - Multiplicity in BD, 41 integers
  - Counts in T0U, 20 integers
  - Service information (Trigger DCS PC actual time etc.) ~20 integers
  - Loaded configuration file name (ASCII text)
  - Set of logic logics for T0U nodes (ASCII text)

Communication interface (III)

- T0U server receives **BMN_TrSys_RunTypeComd** command to DIM Command Service containing a run type name or a full configuration file name



The end

Thank you for attention

Distributed Information Management System (DIM)

DIM, is a portable, light weight, package for information publishing, data transfer and inter-process communications. Like most communication systems, is based on the client/server paradigm.

The basic concept in the DIM approach is the concept of "service". Servers provide services to clients. A service is normally a set of data (of any type or size) and it is recognized by a name - "named services". The name space for services is free.

Services are normally requested by the client only once (at startup) and they are subsequently automatically updated by the server either at regular time intervals or whenever the conditions change (according to the type of service requested by the client).