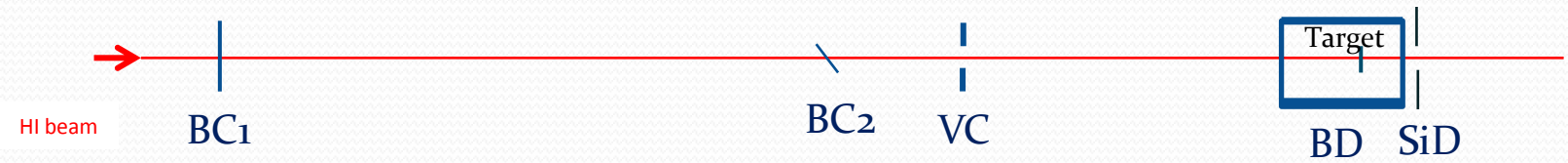
Trigger system of BM@N experiment

D.Bogoslovski, V.Rogov, S.Sergeev, V.Yurevich

Outline

- Requirements
  - Beam line + equipment
  - Architecture choice
- Hardware
  - Architecture
  - Motherboard and Mezzanine cards
- Software
  - Architecture
  - Control and monitoring

Requirements -> Beam line



Scintillation Detector	Photodetector	Scintillator	Operation in magnetic field
BC1	XP2020	Plastic scintillator D150x3 mm	No
BC2(To)	MCP-PMT PP2365E	Plastic scintillator D20x0.8 mm Angle 45°	Yes
VC	XP2020	Plastic scintillator D100x10 mm hole D27 mm	Yes
BD	SiPMs (Sensl) 6 x 6 mm	BC-418 plast. scintillator 150x7x7 mm 40 units	Yes
SiD	64 radial strips	Silicon D86x0.3 mm hole D32 mm	Yes

Requirements->Detectors I

To detector (BC2)

Photodetector
18mm MCP-PMT

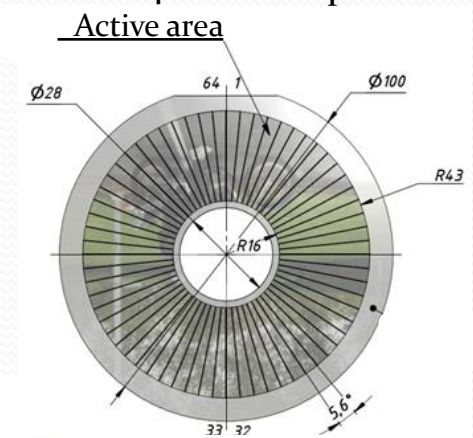
TYPE
PP0365G

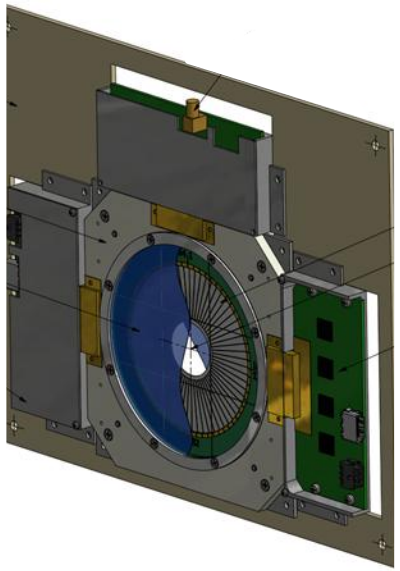
Barrel detector

40 scintillation strips
with SiPM readout

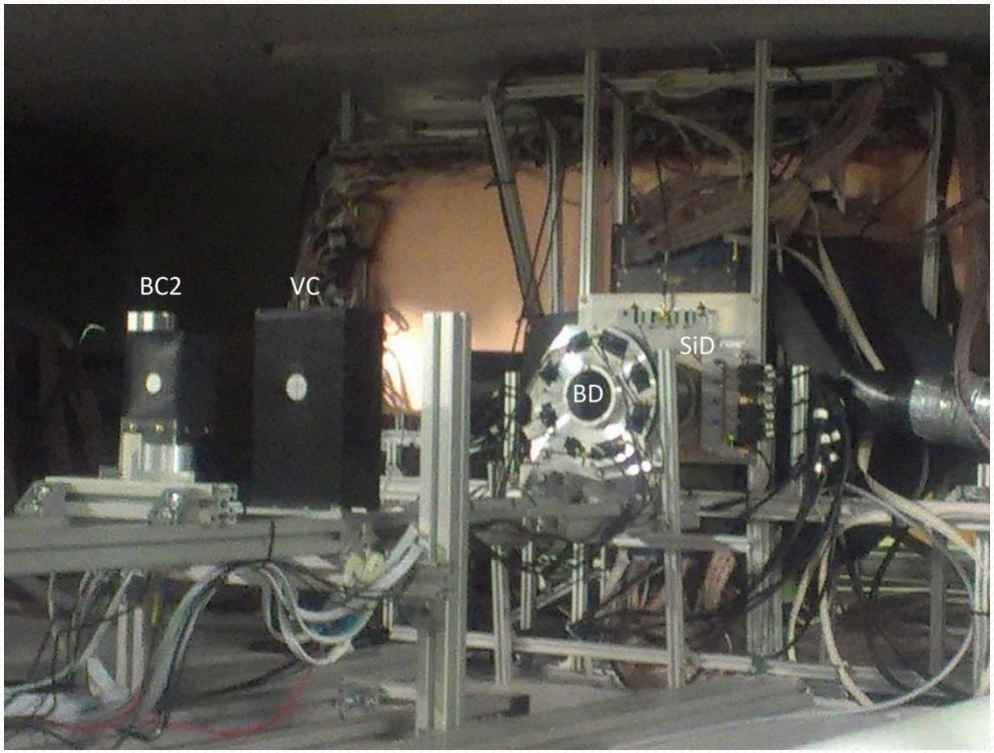
Si detector

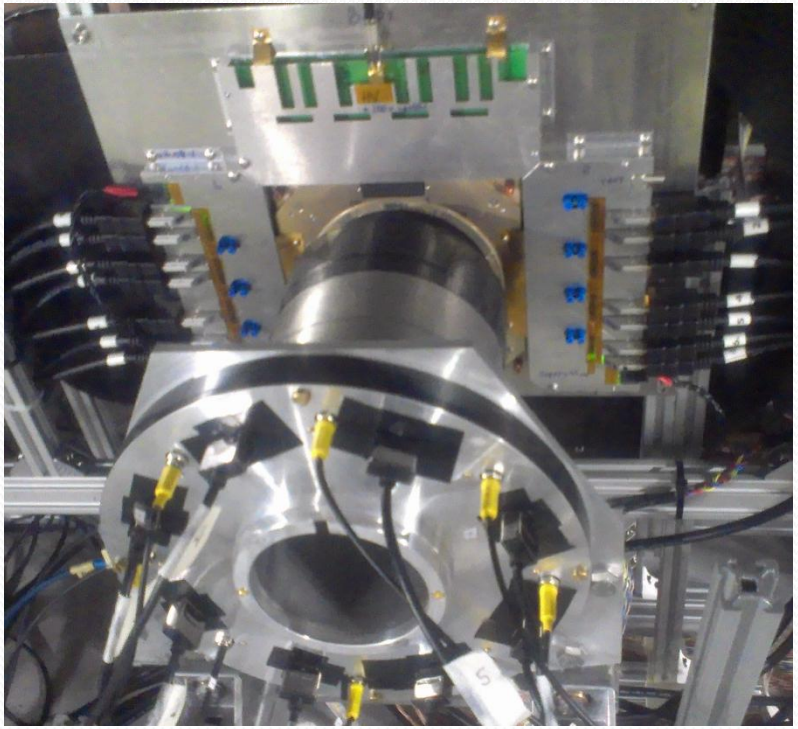
64 radial strips





Requirements -> Detectors II





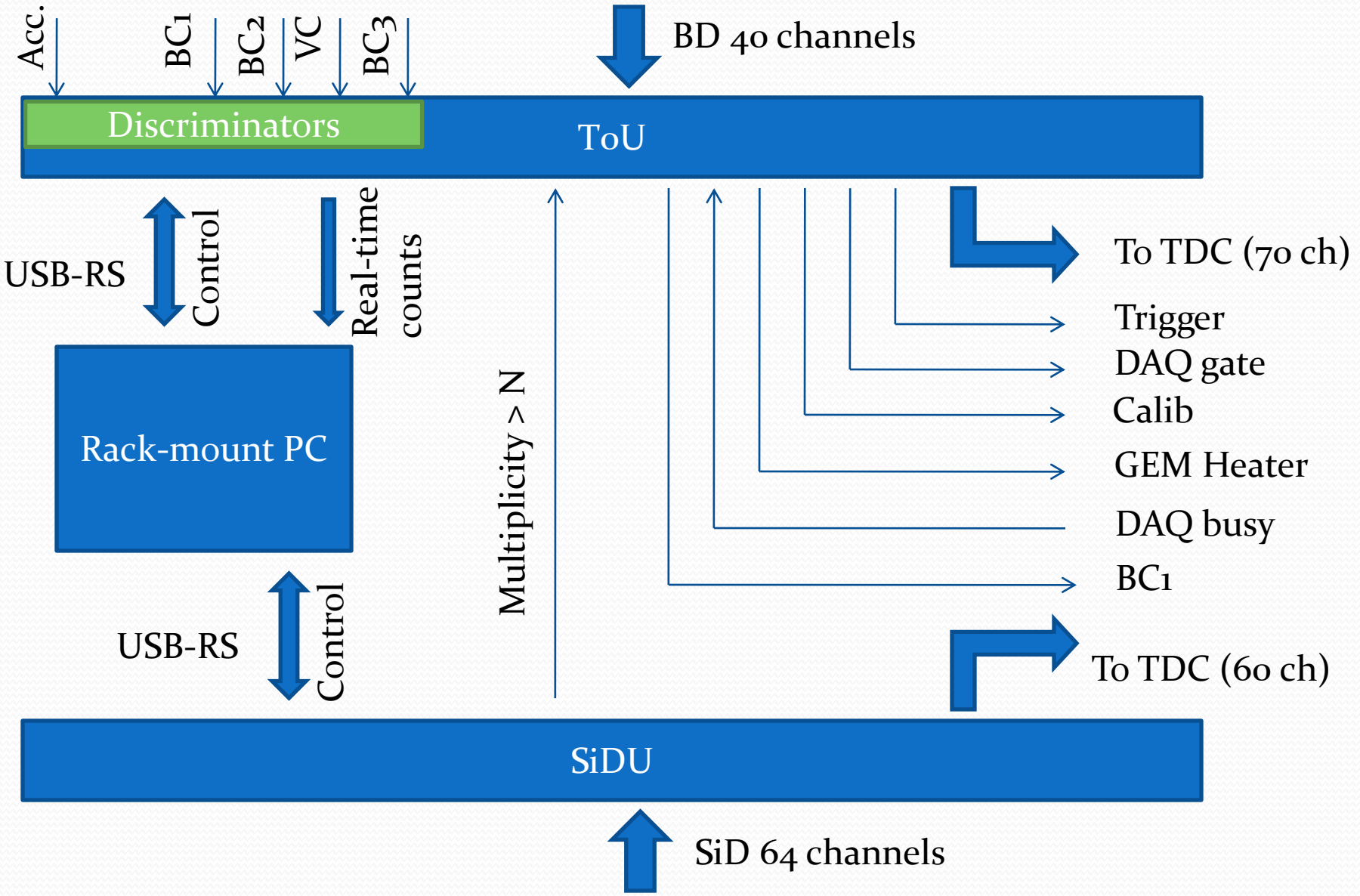
Requirements I

- We have to use short cables
- The trigger units should be installed in the restricted access area
- Adjustments and control should be done remotely
- Trigger system should generate a trigger signal based on particle multiplicity in the Barrel Detector and Si detector
- We should use two trigger units – ToU and SiDU connected by LVDS
- The rack contains NIM crate with extra equipment
- The control PC is a rack-mount industrial PC located in the trigger system rack

Requirements II

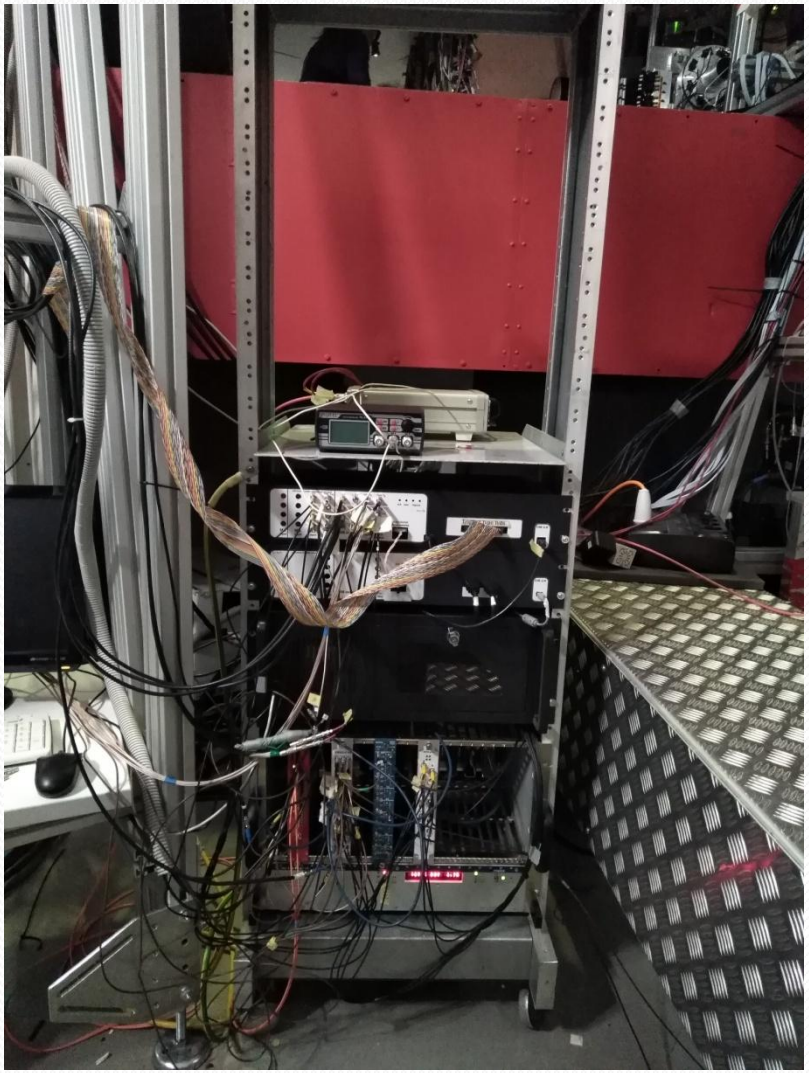
- All input signals should be sent to TDC to get event timing
- Trigger unit should generate gate and trigger signals to subsystems
  - Spill gate
  - LED calibration gate
  - LED flash signal
  - GEM Heating signal
- Trigger unit should generate beam/calibration event flag signal to DAQ
- Trigger system contains PMT HV power supply (by HVSys, Dubna) and SiPMT BV power supply (self-maid)

Requirement->Architecture



Requirements->realization

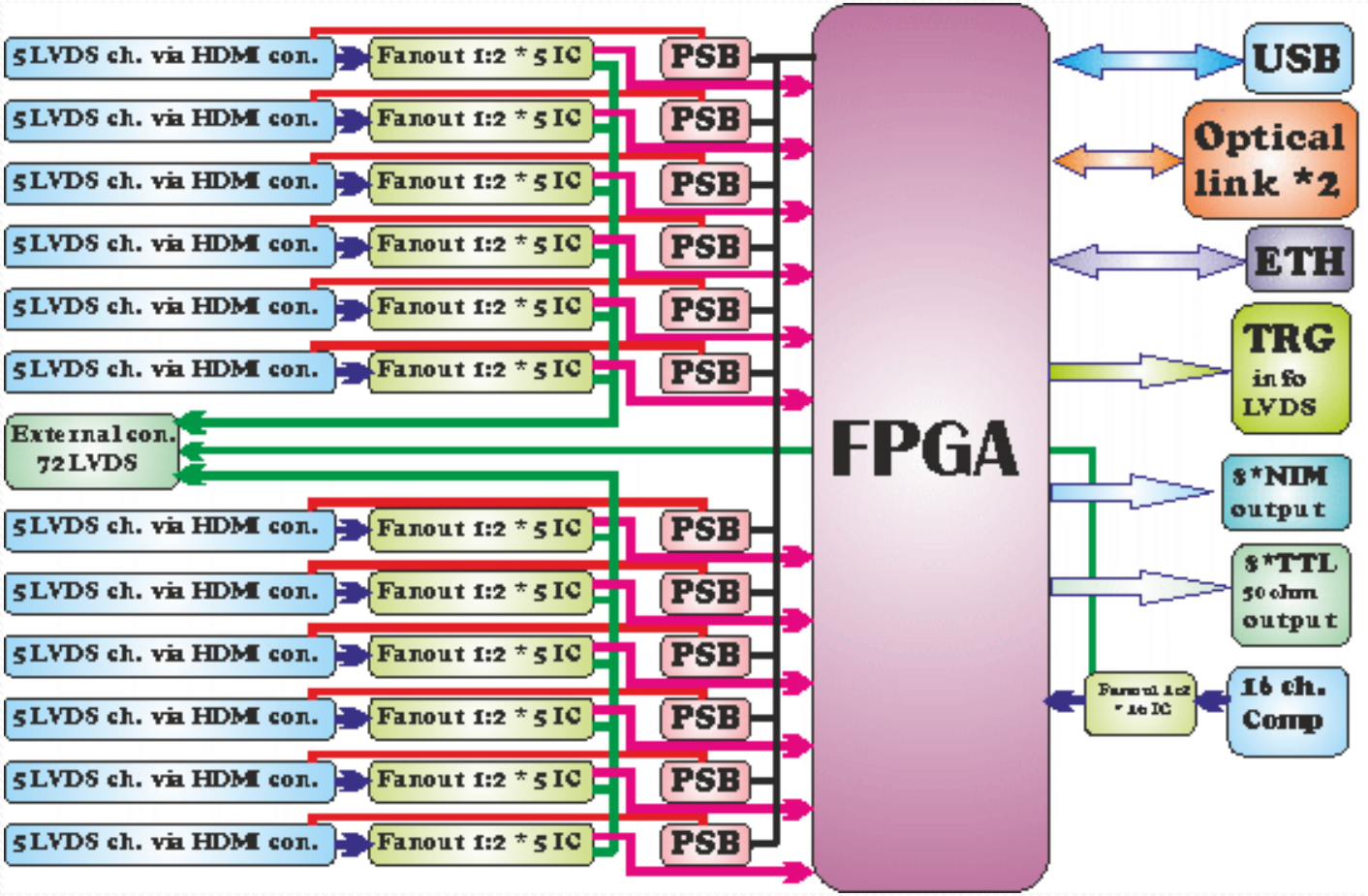
- Trigger system rack located near the magnet
- No magnetic field influence observed
- No radiation damage or SEU observed



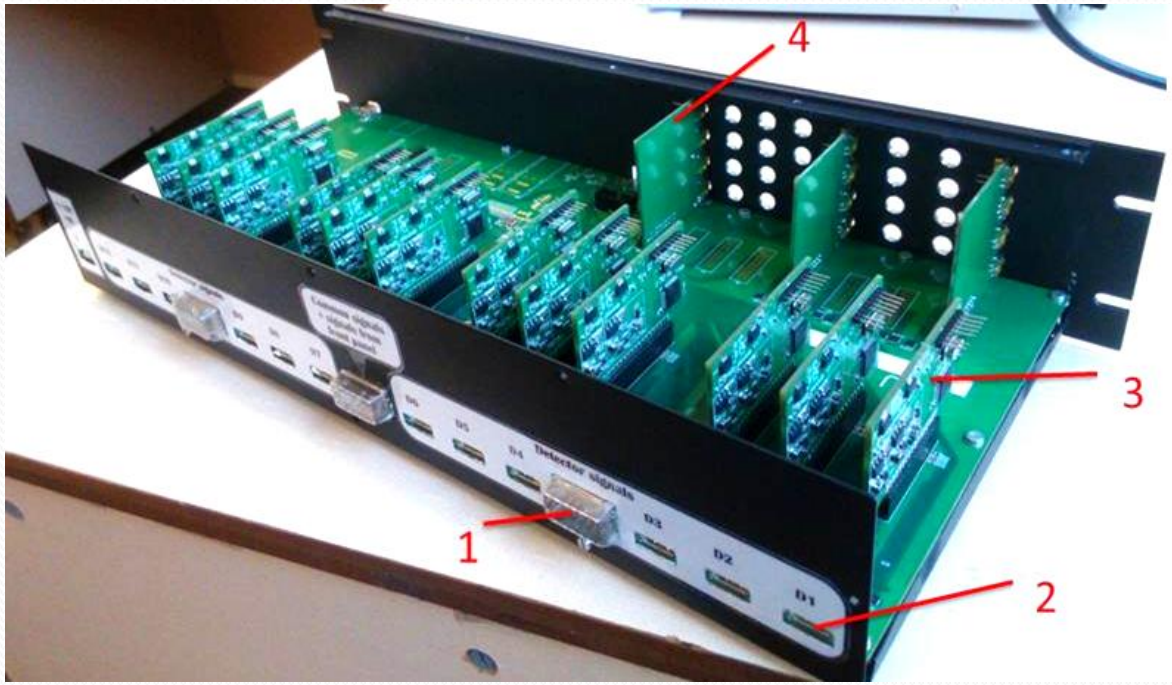
Hardware I

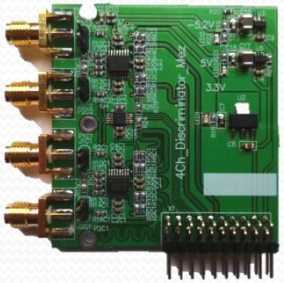
- Trigger unit consists of
  - Mother board containing
    - FPGA Altera Cyclon5
    - Low jitter signal splitters
    - USB, Ethernet and Optical link interfaces
  - Mezzanine boards
    - 4 Input boards with discriminators, 4 channels each
    - 4 Output boards – NIM signal, 4 channels or
    - 4 Output boards – 50 Ohm TTL , 4 channels
    - 12 LV power supplies, +8V adjustable ,+8V adjustable, -7.2V fixed
    - LVDS output buffer

Hardware II

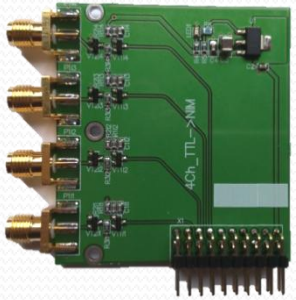

5 LVDS ch. via HDMI con.
Fanout 1:2 * 5 IC
PSB
External con. 72 LVDS
FPGA
USB
Optical link *2
ETH
TRG info LVDS
8*NIM output
8*TTL 50 ohm output
16 ch. Comp

Hardware III

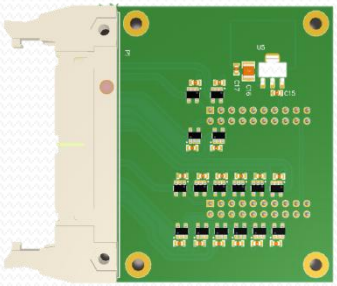




Input module



Output NIM module

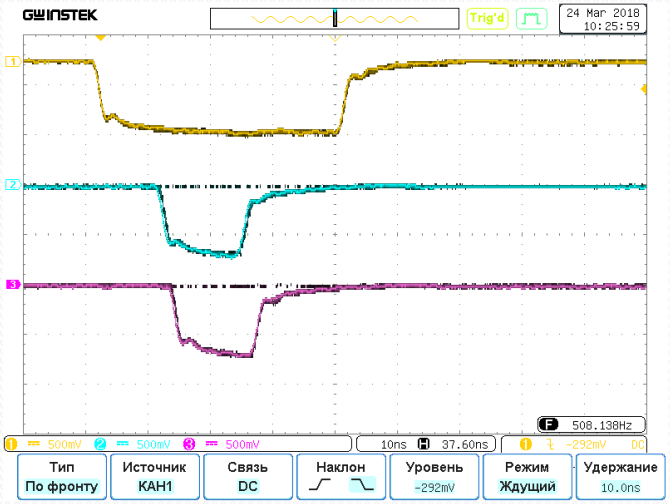


Output LVDS module

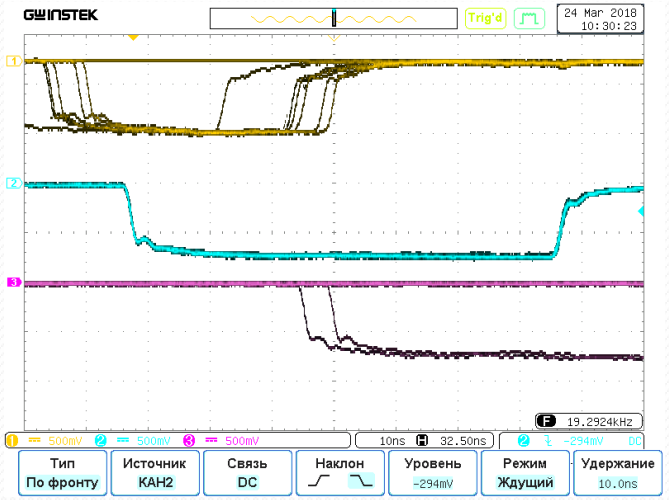
Output 50 Ohm TTL module

Hardware IV -> features

- ToU Logics contains up to 12 adjustable delay lines and shapers
- Delay and shaper settings could be adjusted with ~0.7 ns step
- ToU contains 4 multiplexers providing connection to the logics key points for simple trigger adjustment



BC1, BC2 and Beam_Trigger



BC1, SiD and DAQ_Trigger

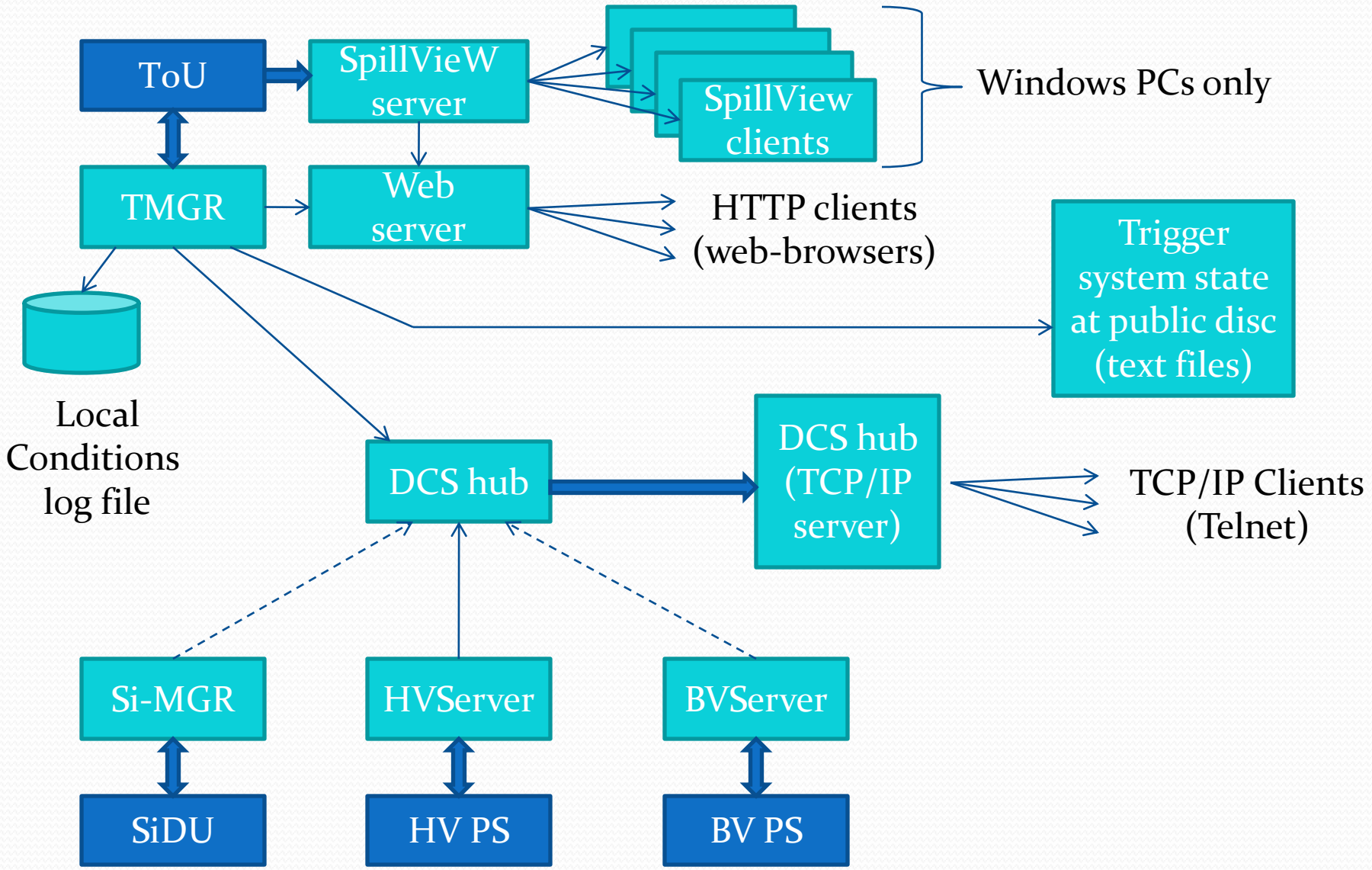
Hardware -> Summary

- Developed in 2015
- Used in experiments BM@N and SRC
- No electronics failures observed
- Mechanically damaged Molex connectors -> replaced

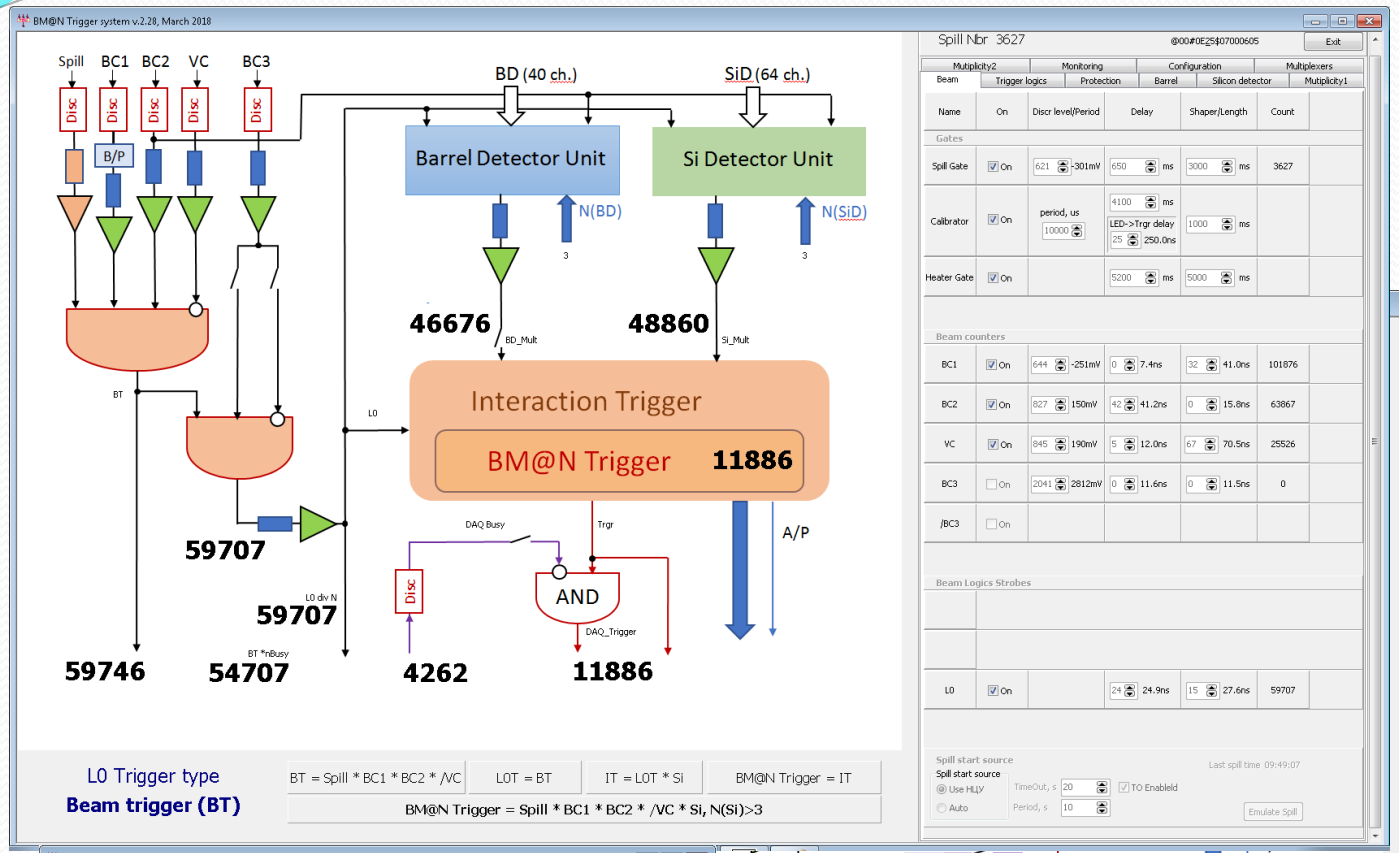
Software -> requirements

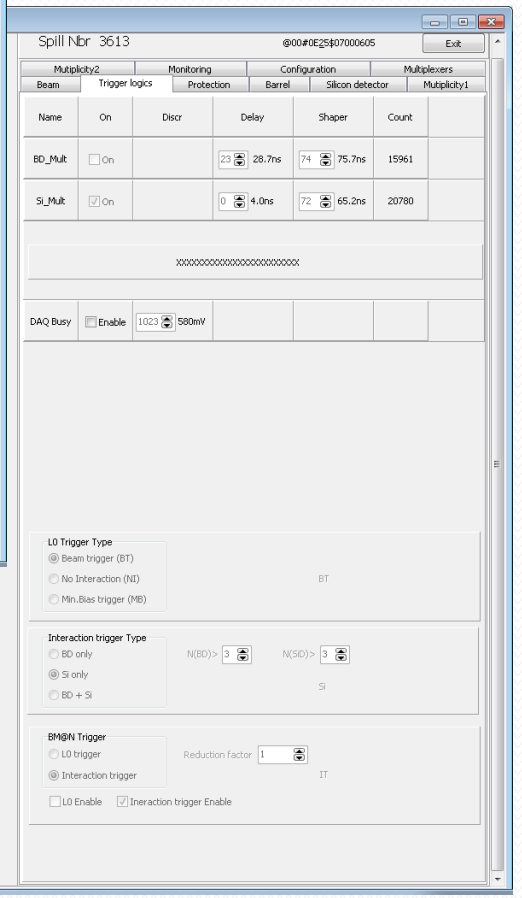
- Software should allow to the shifters to select a trigger type in a simple way
- ToU hardware has > 100 controls => software should have extended GUI
- The spill data information should be presented to the BM@N shifters and to the accelerator shifters => client/server architecture
- The actual trigger system state should be sent to the MN@N DCS

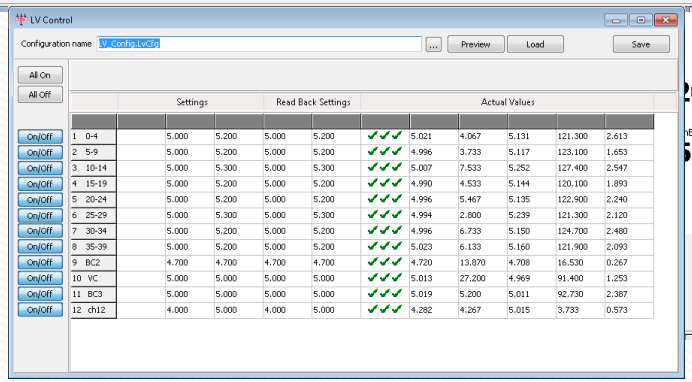
Software -> architecture

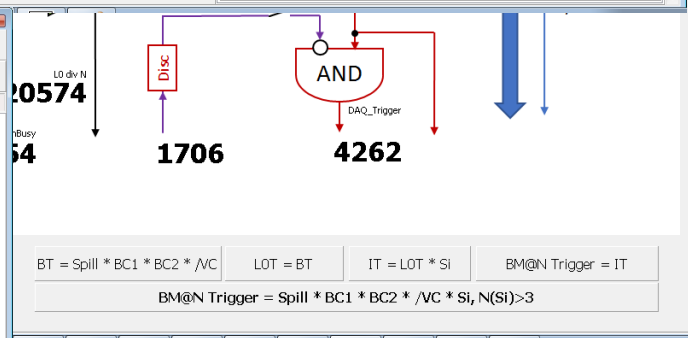


Software -> ToU manager I

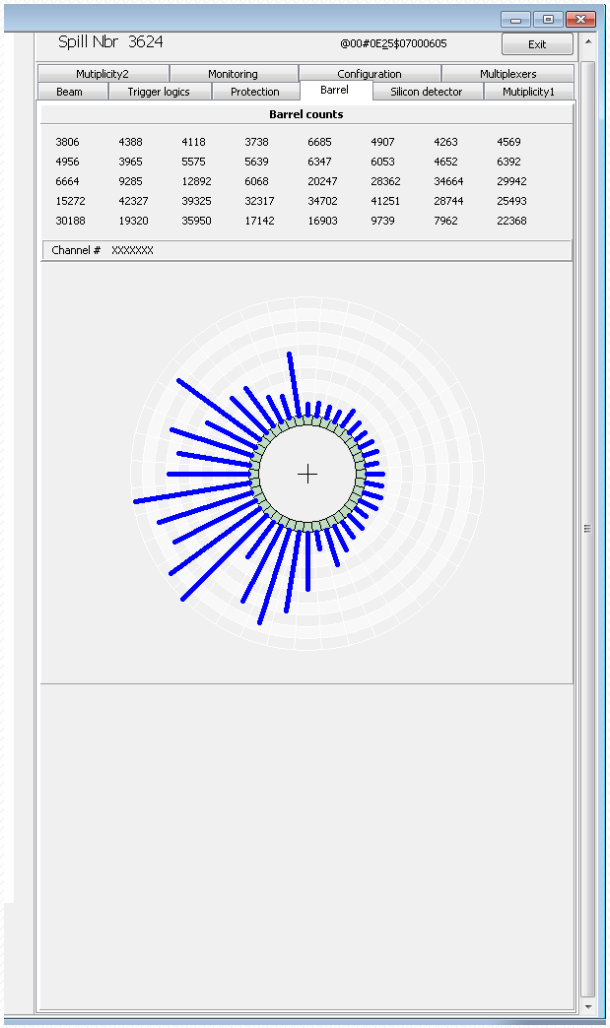


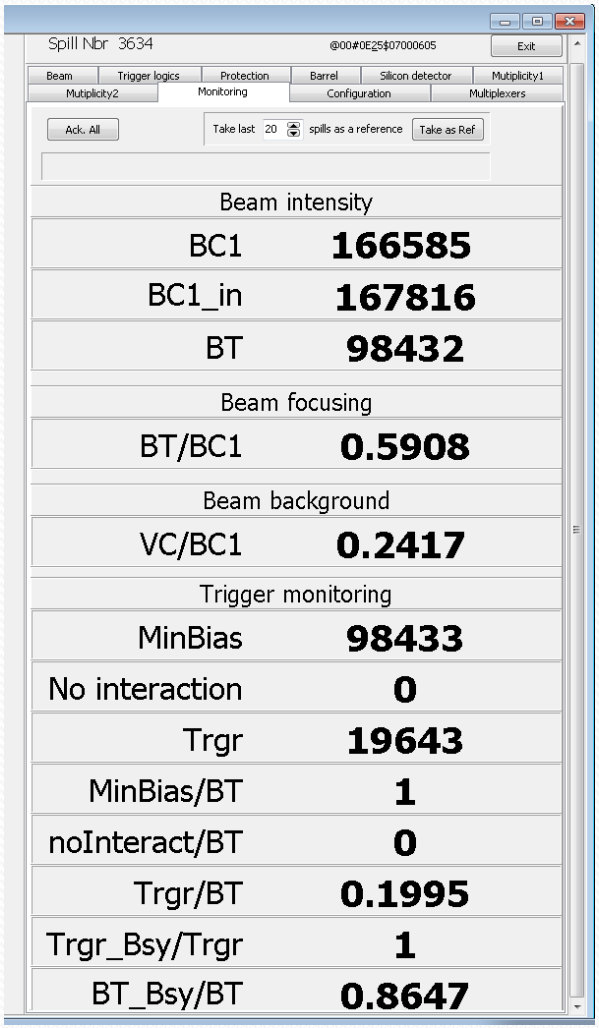


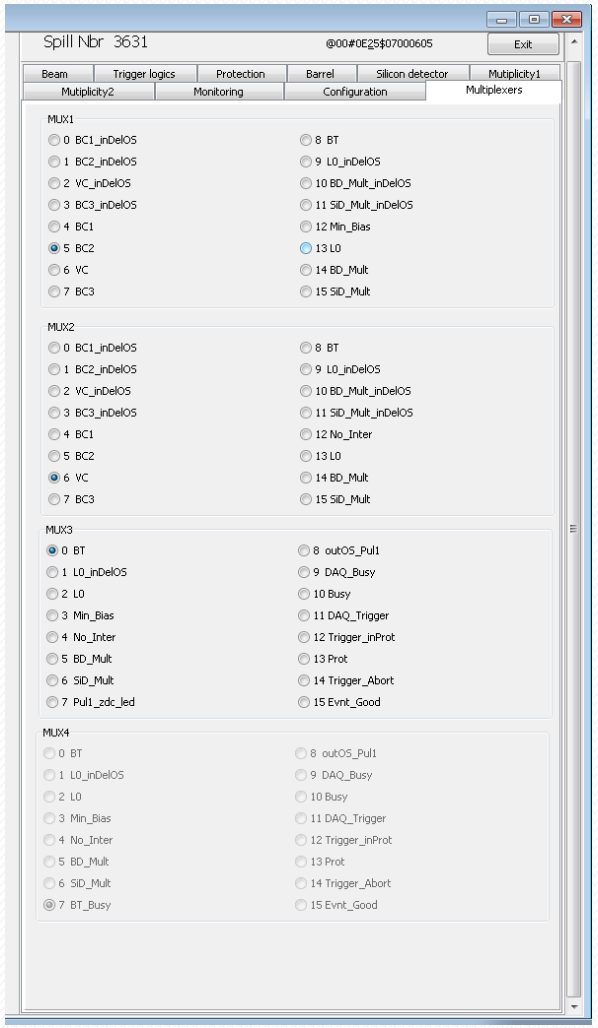




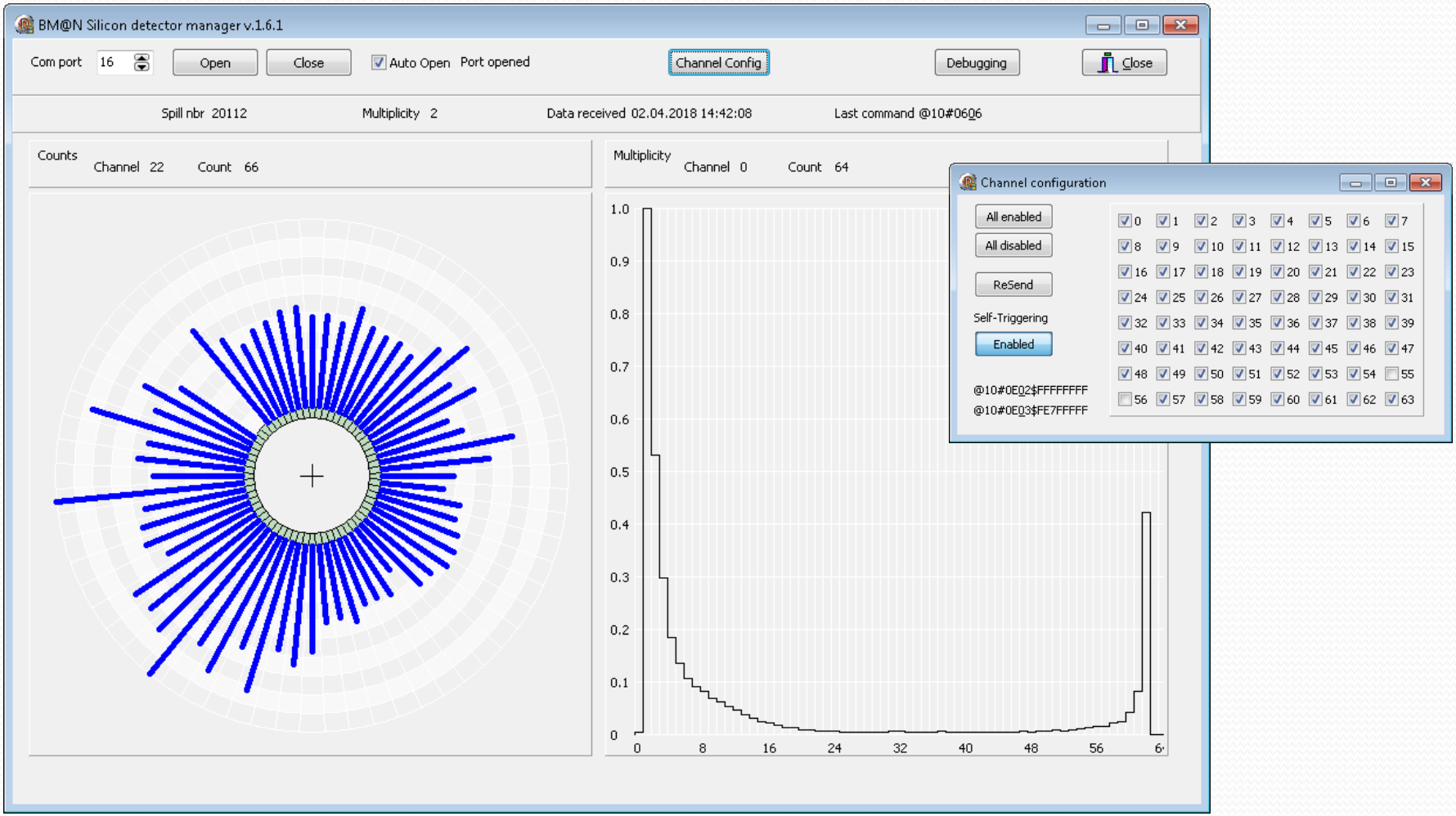
Software -> ToU manager II



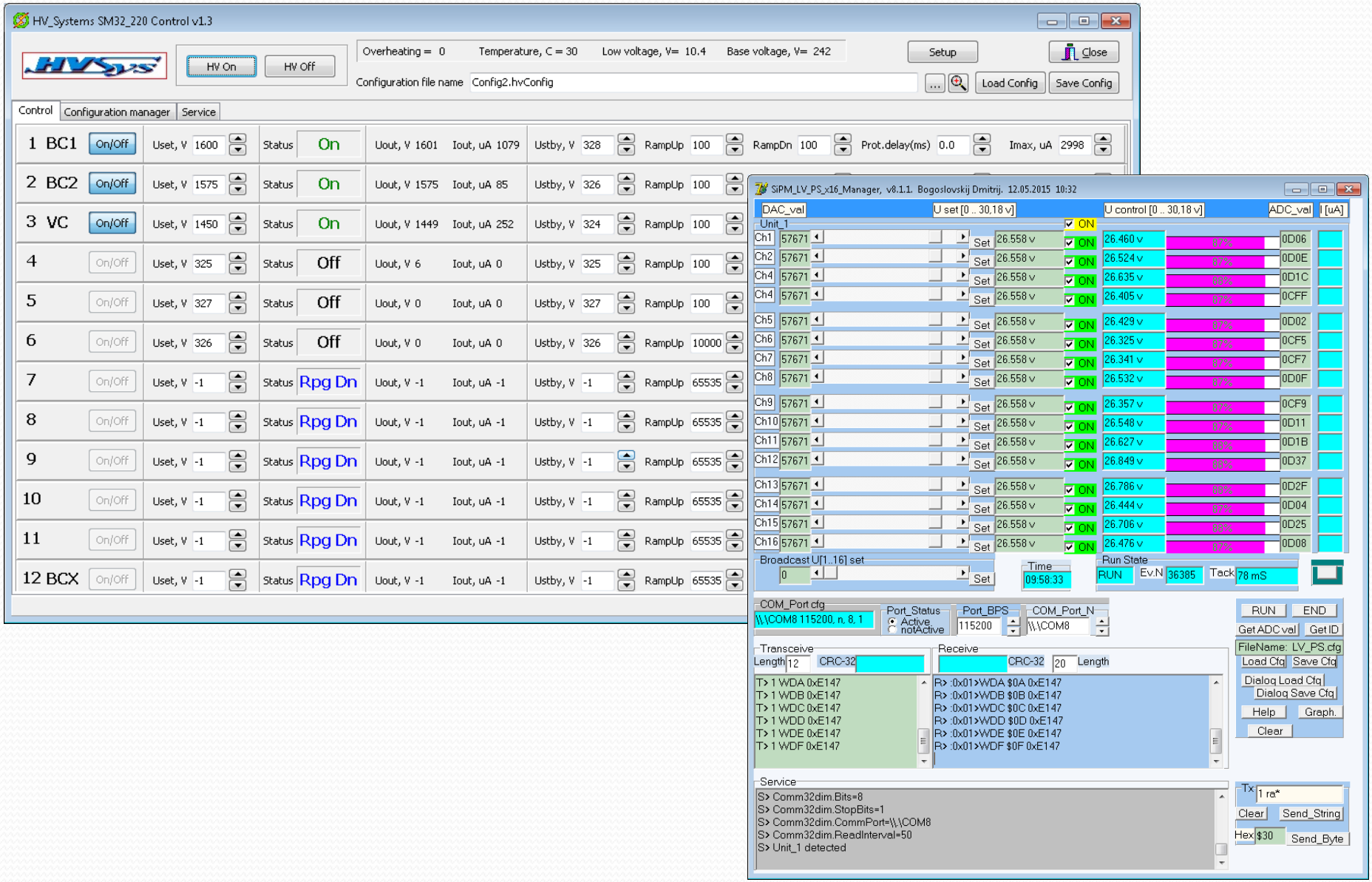




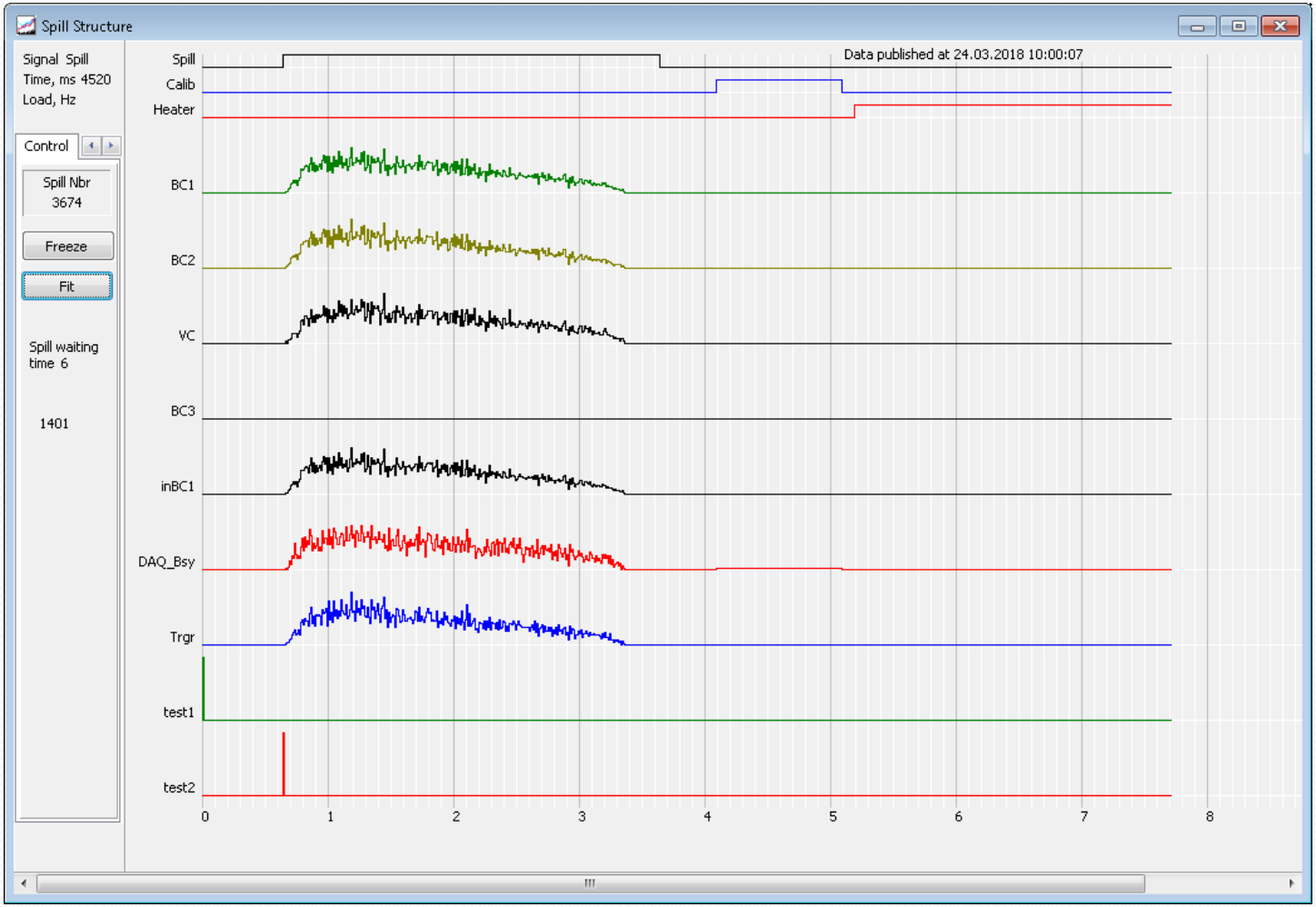
Software -> SiDU manager



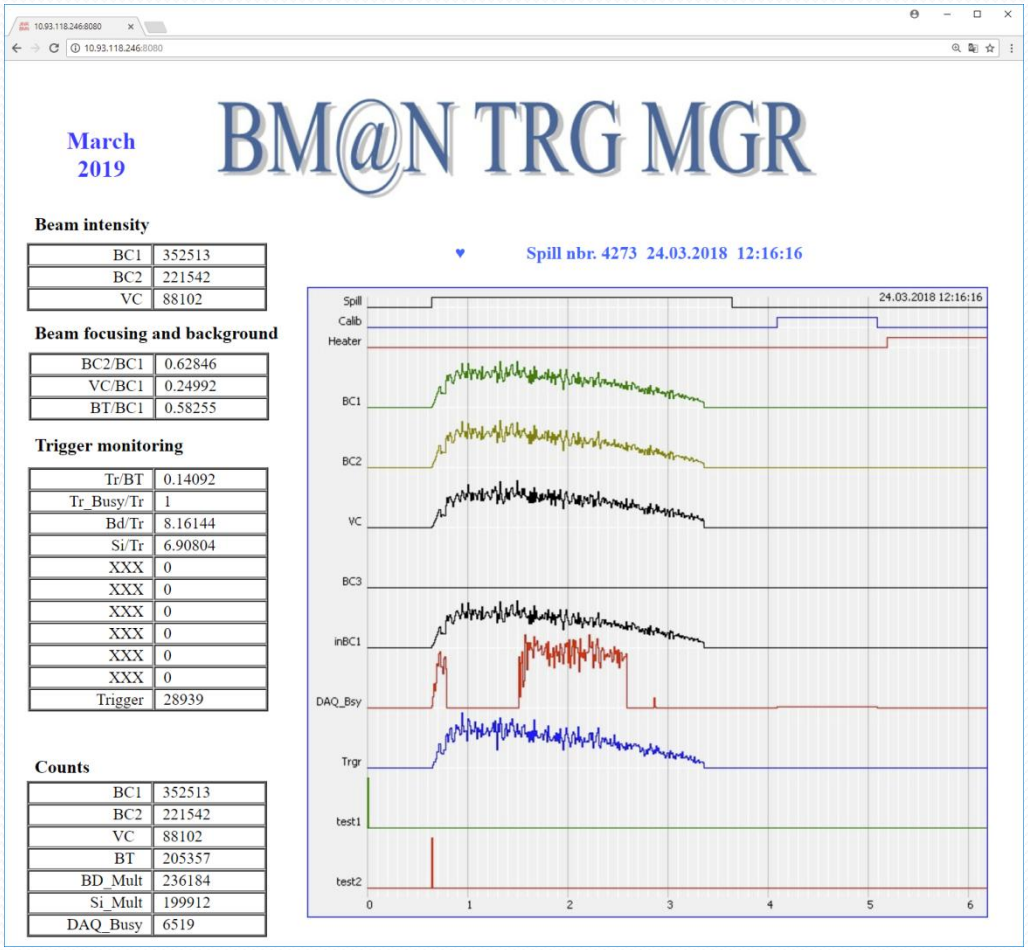
Software->HV & BV managers



Software -> SpillView server



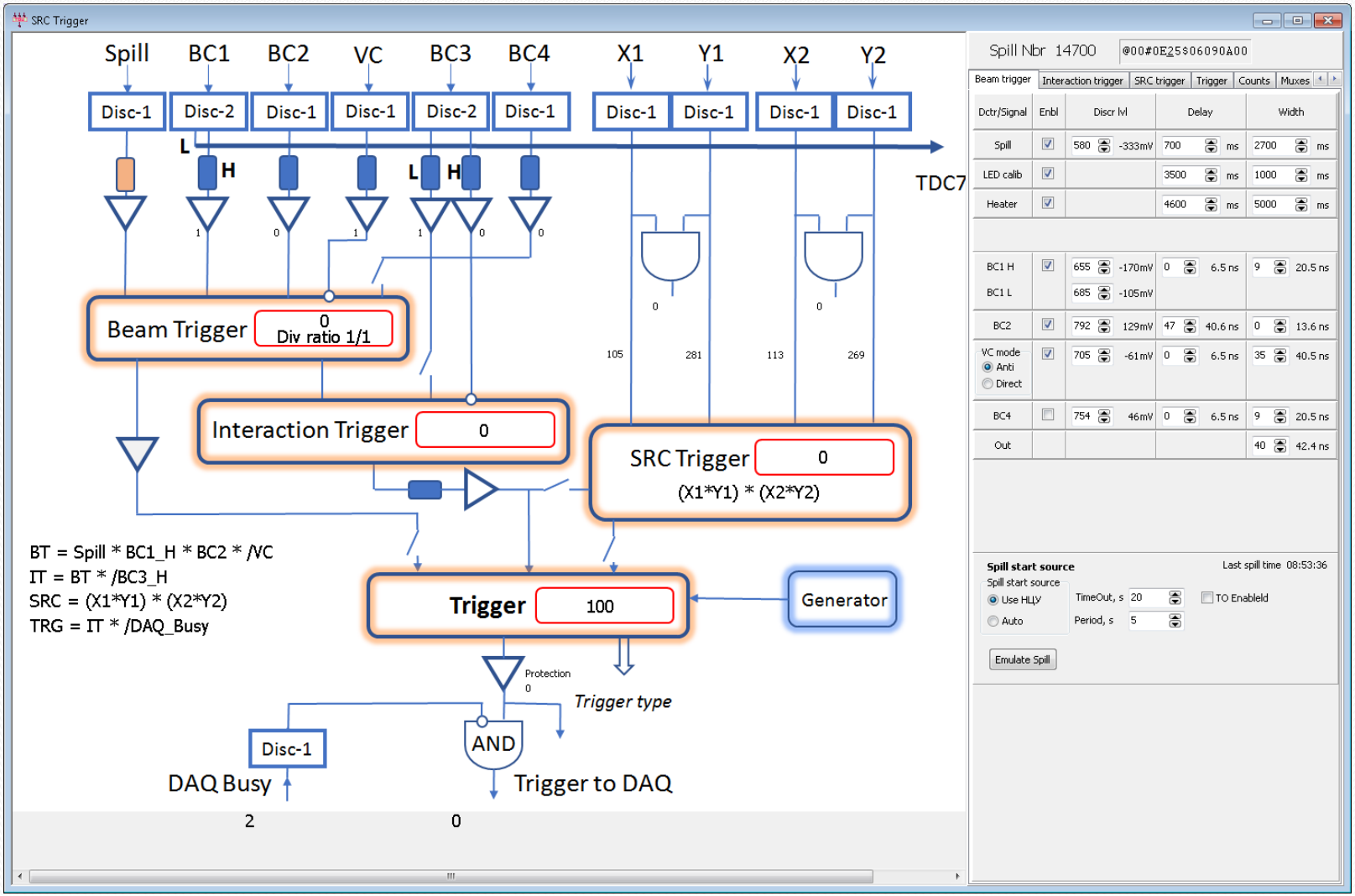
Software -> Web server



Conclusion

- Trigger system works since 2015. It provides comfortable and user-friendly GUI
- Five modules have been manufactured
- Used in two experiments – BM@N and SRC
- No electronics failure observed. We met only “external” problems – bad 220V power and mechanical damage of a Molex TDC cable connector
- The system has been interfaced to the DCS system (no DCS commands accepted, the Trigger State transfer only)
- Almost all FPGA recourses have been used. Further ToU extension requires a motherboard redevelopment

Software -> SRC experiment



Software -> SRC experiment