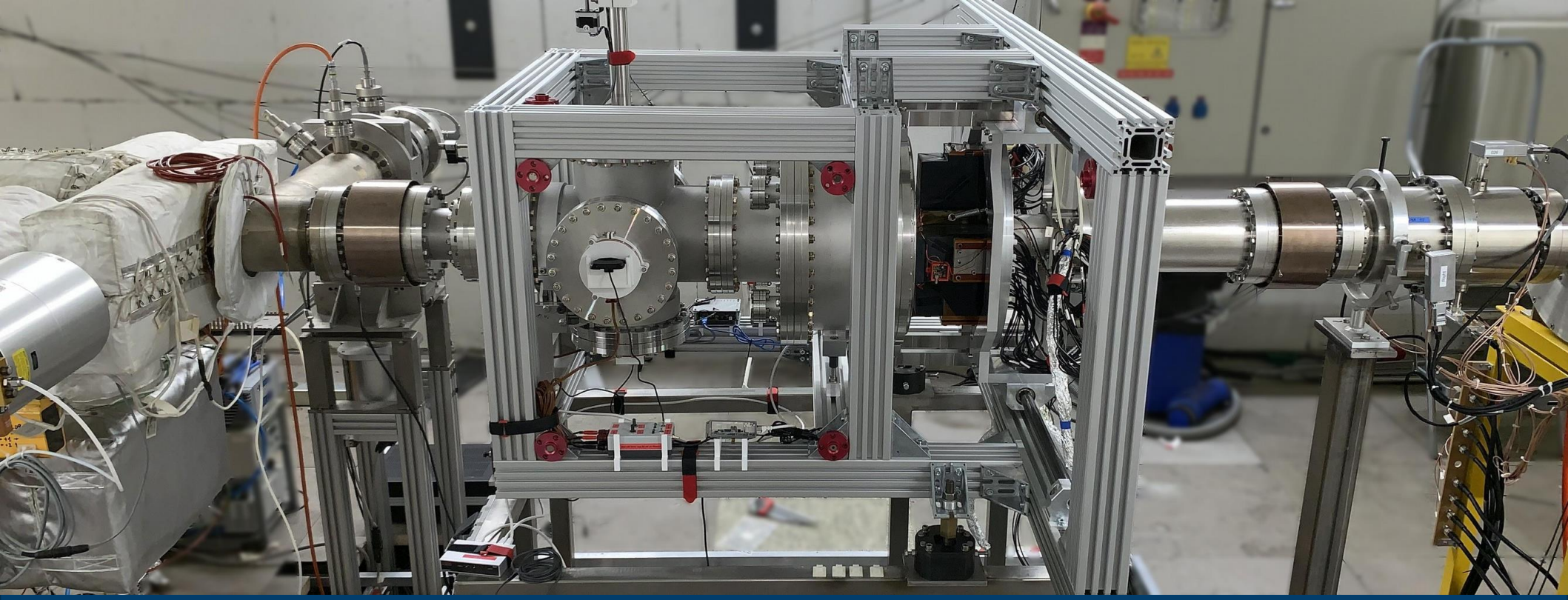


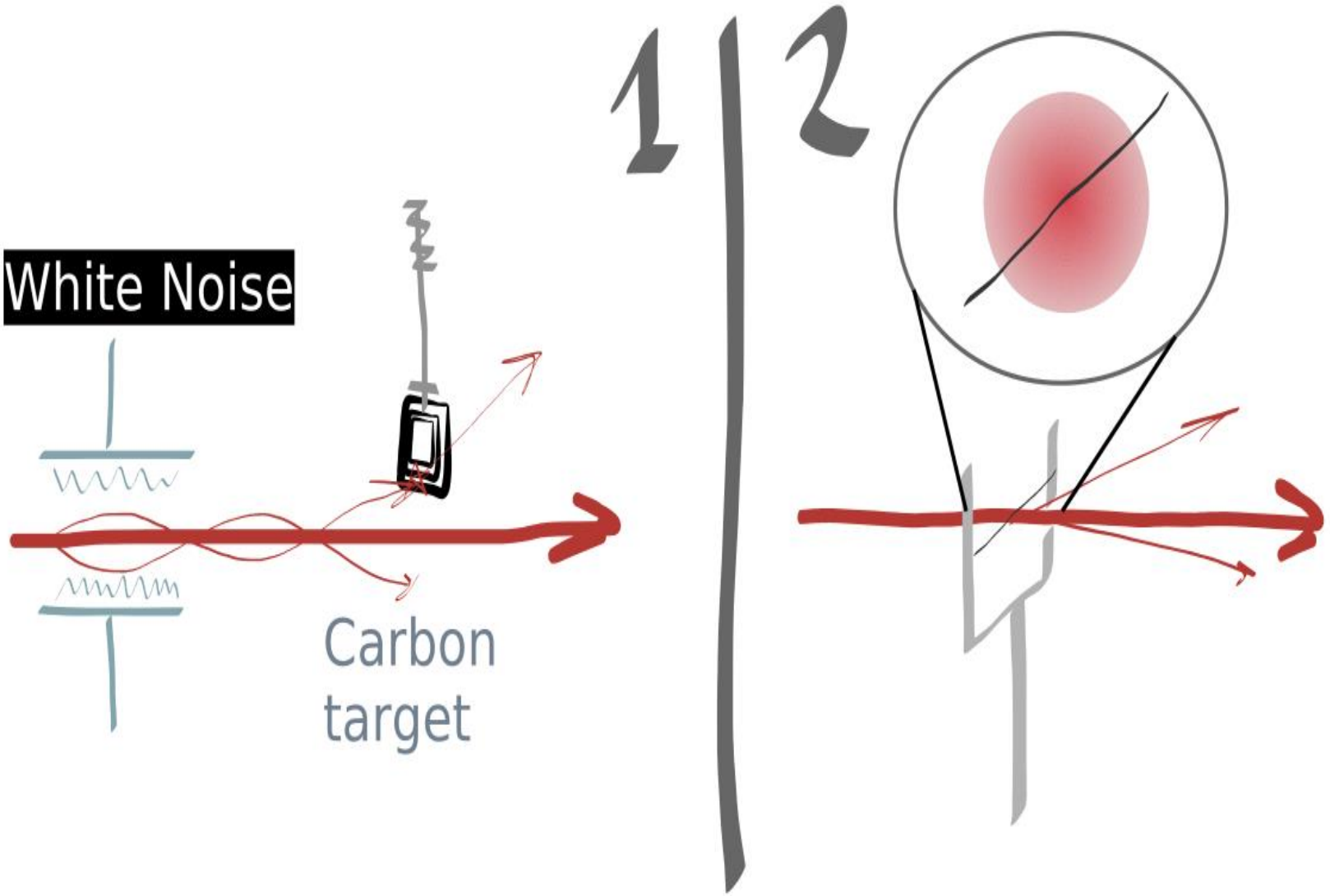
Pellet target development

31.03.2020 Otari Javakhishvili

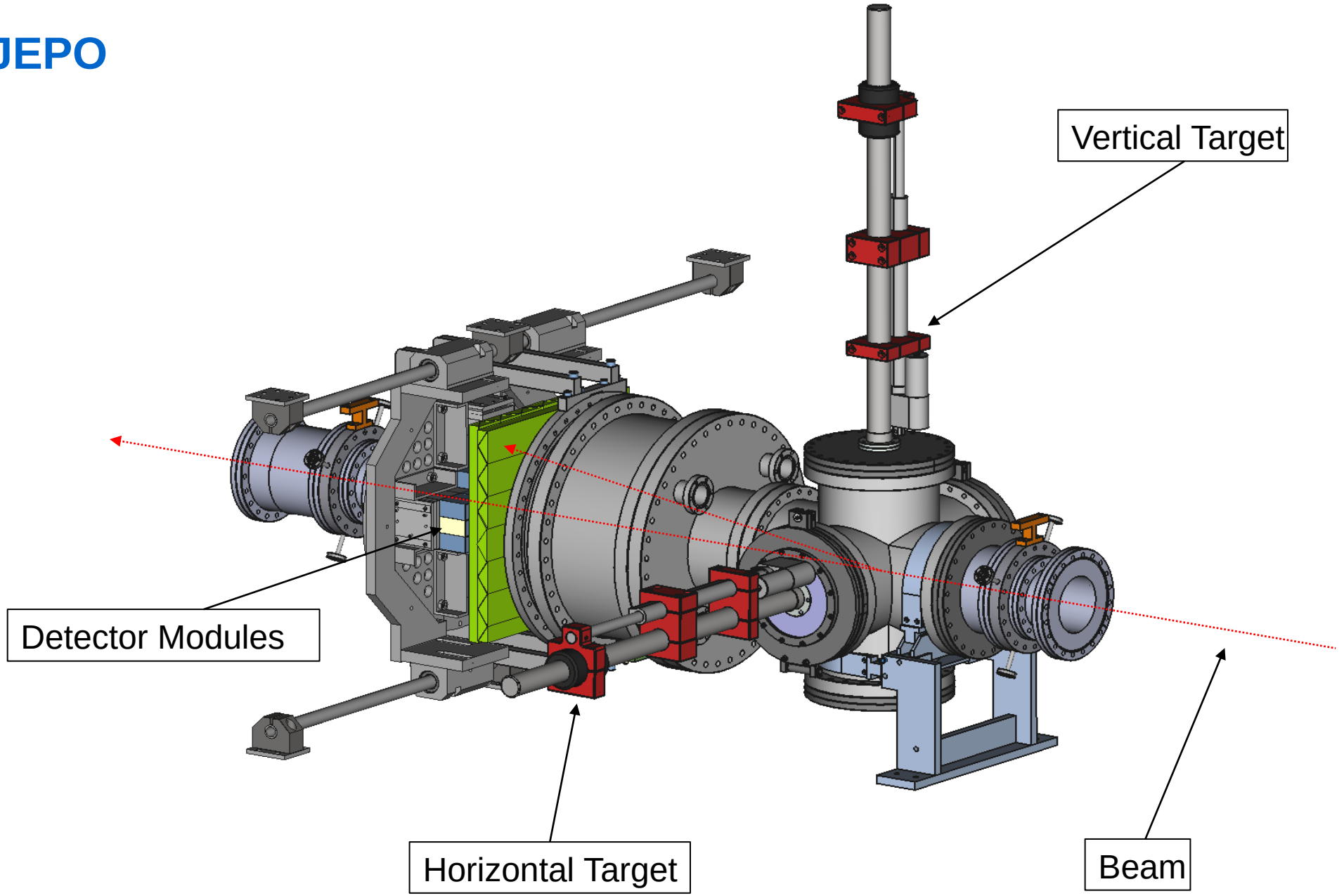
Requirements

- Minimal influence on the beam
- Minimal influence on vacuum system of the storage ring
- Frequency and speed of the target must be variable
- Must have precise triggering and TOF measurement
- Must be able to be synchronized with other parts of the detector

Different Target Systems

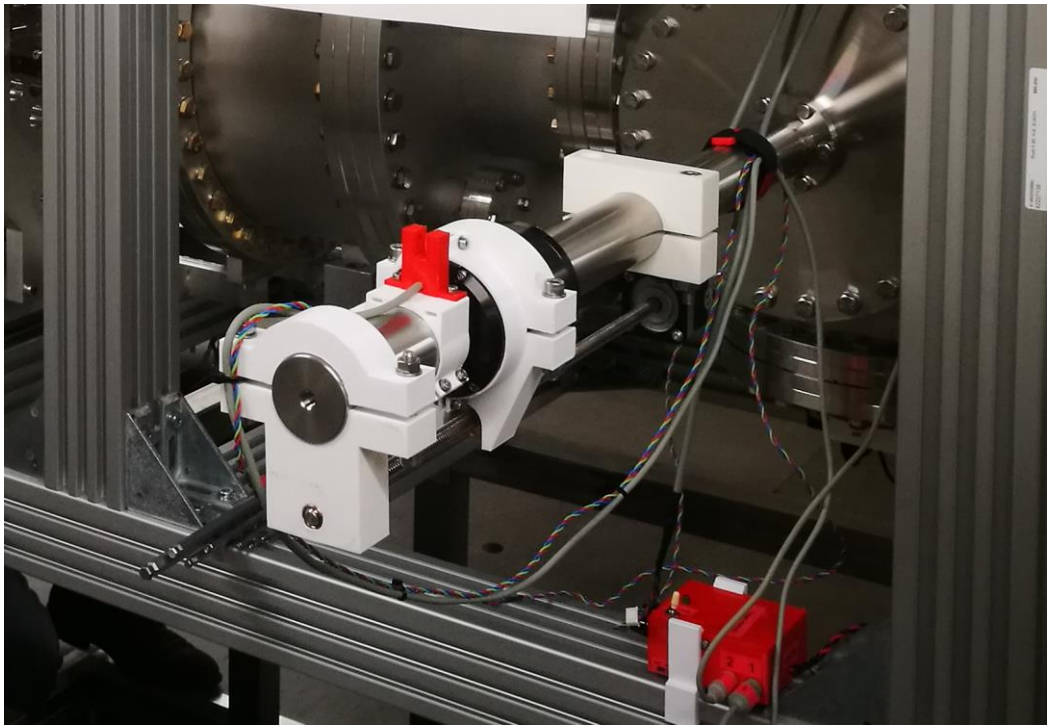


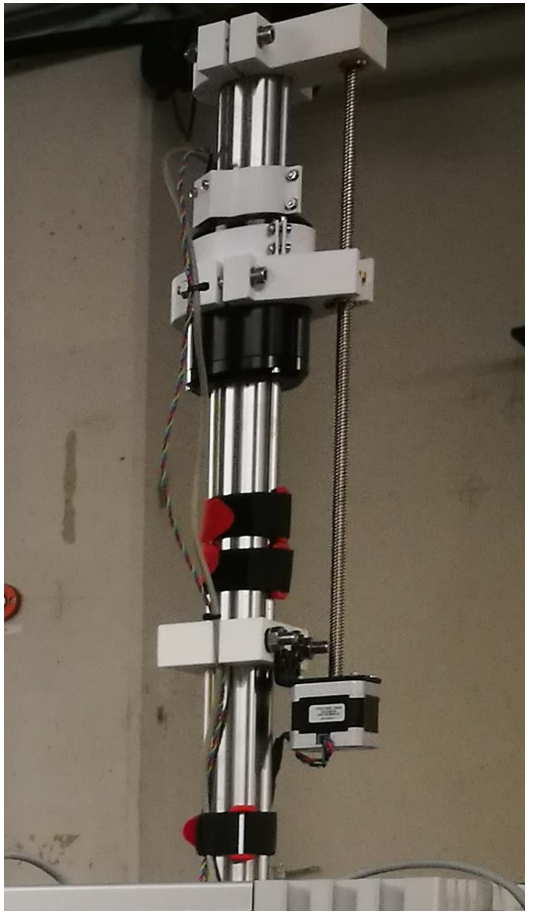
JEPO



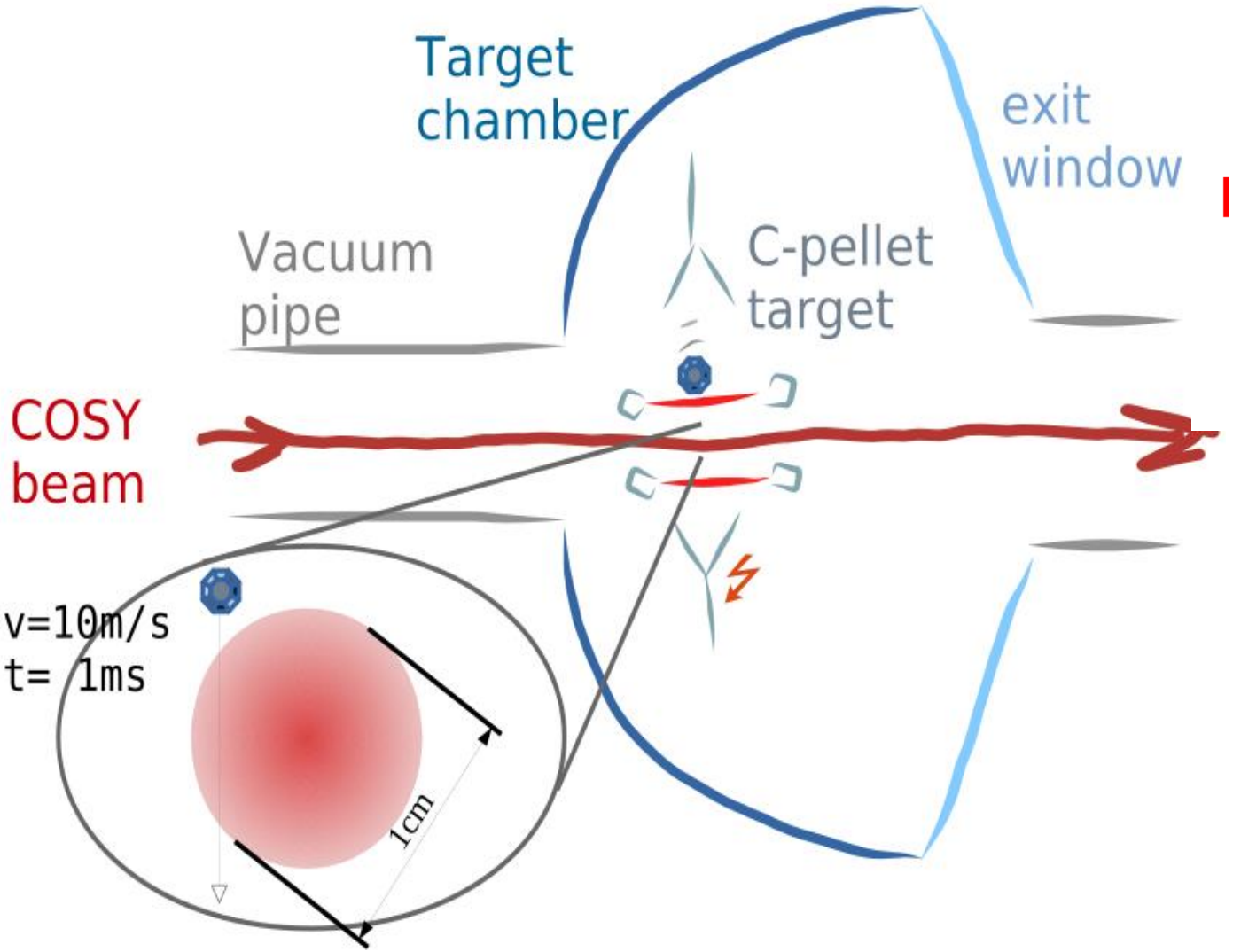
Block Target System

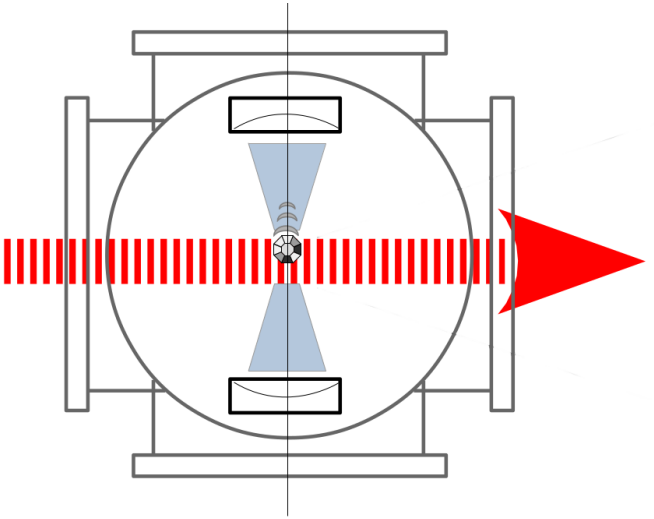
- Horizontal and vertical targets
- Linear actuator using stepper motors
- Software and hardware interlock systems
- Industry standard instructions using G-Code



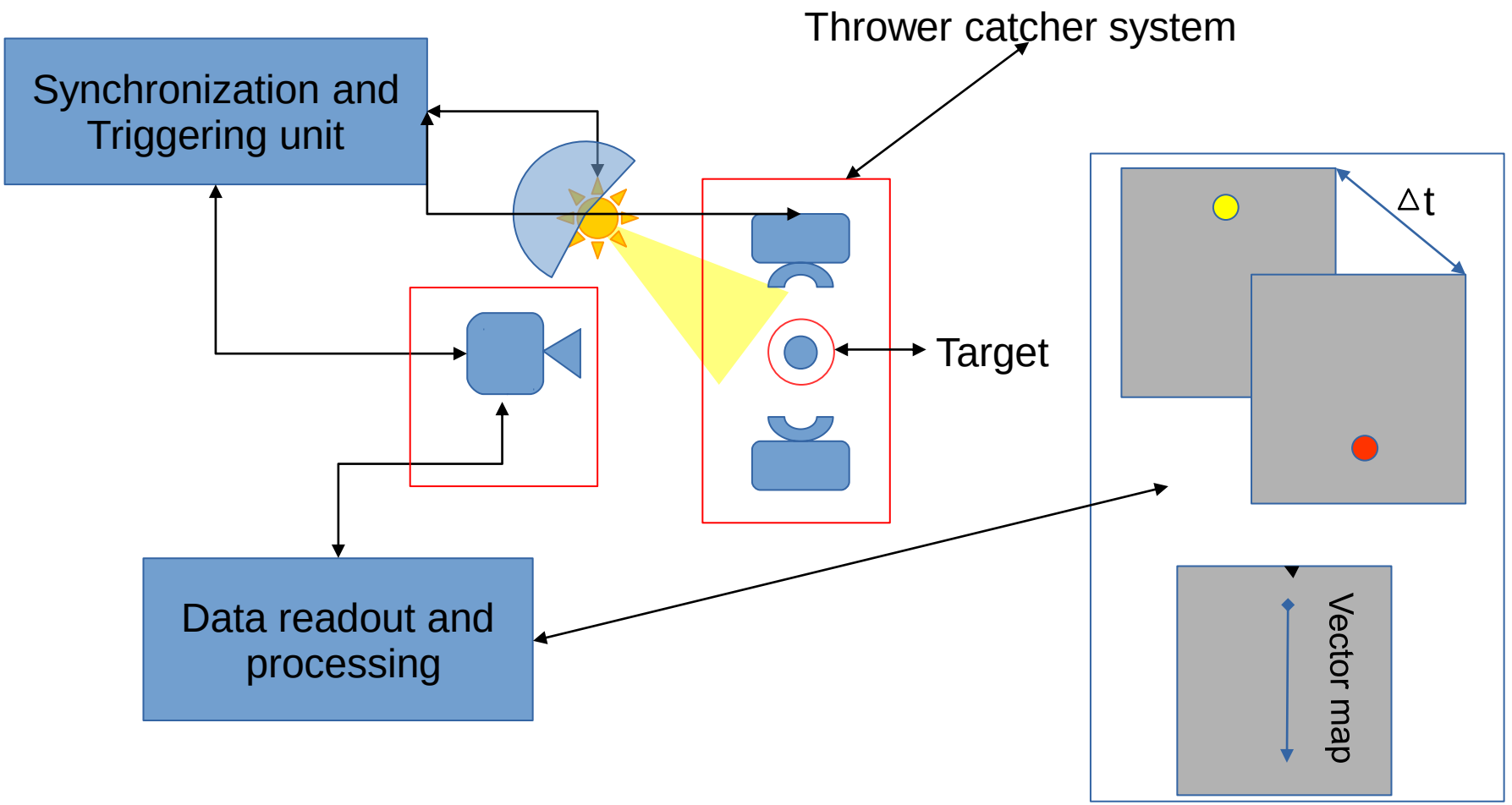


Ballistic pellet target system

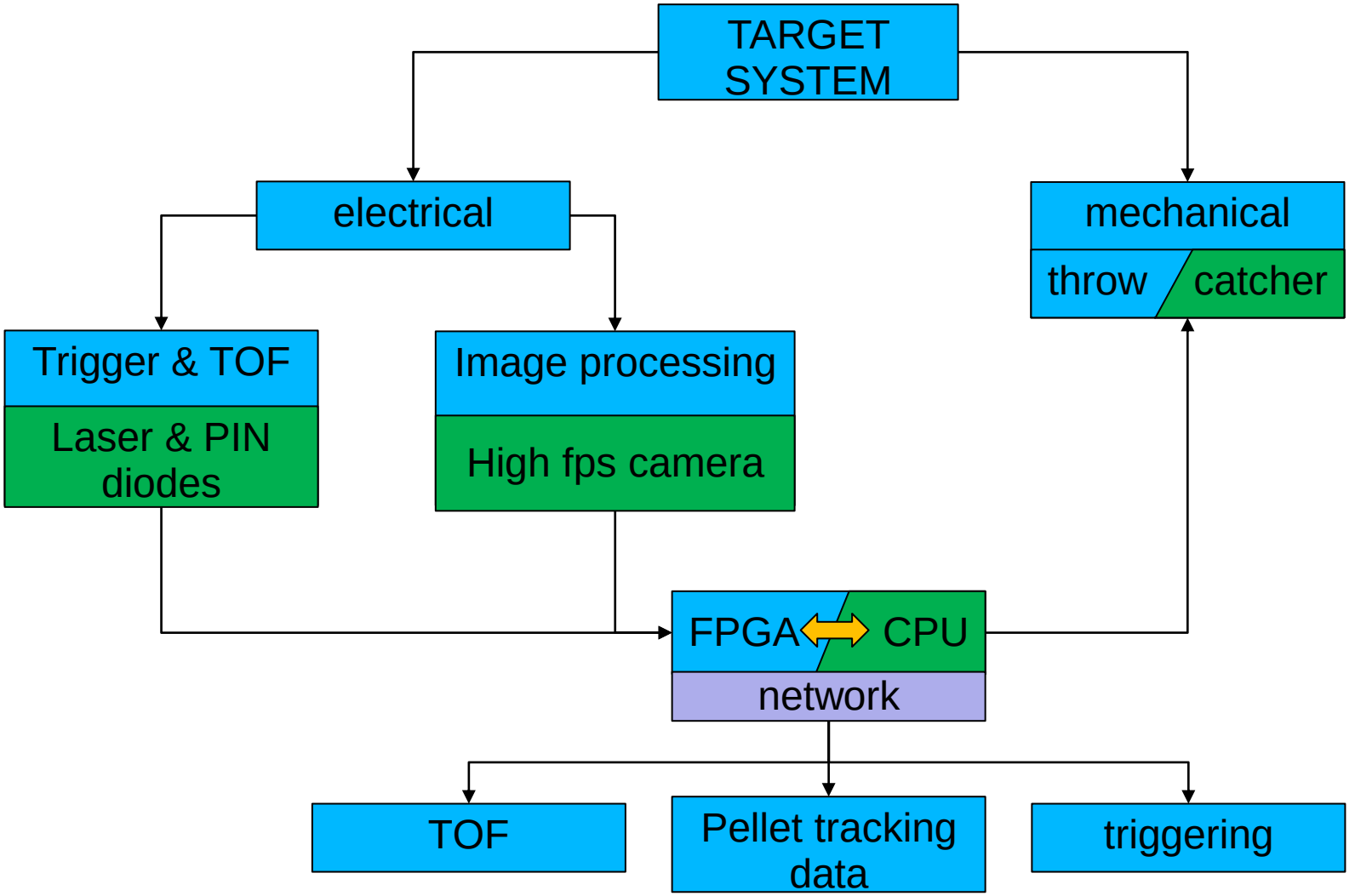




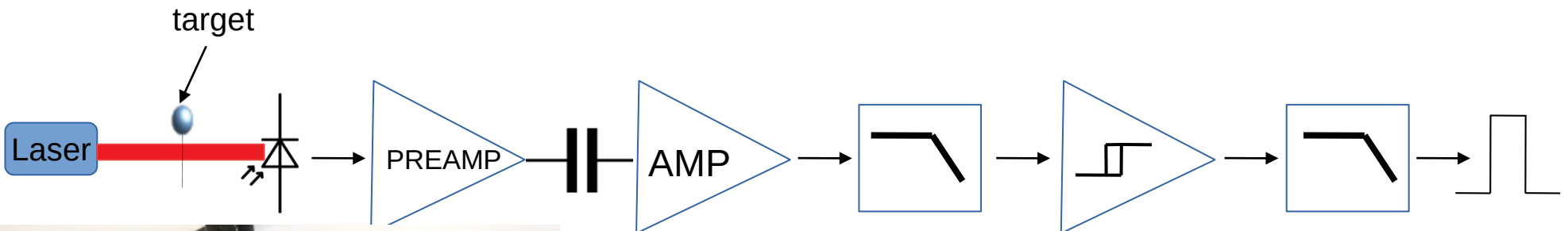
Pellet target system working diagram

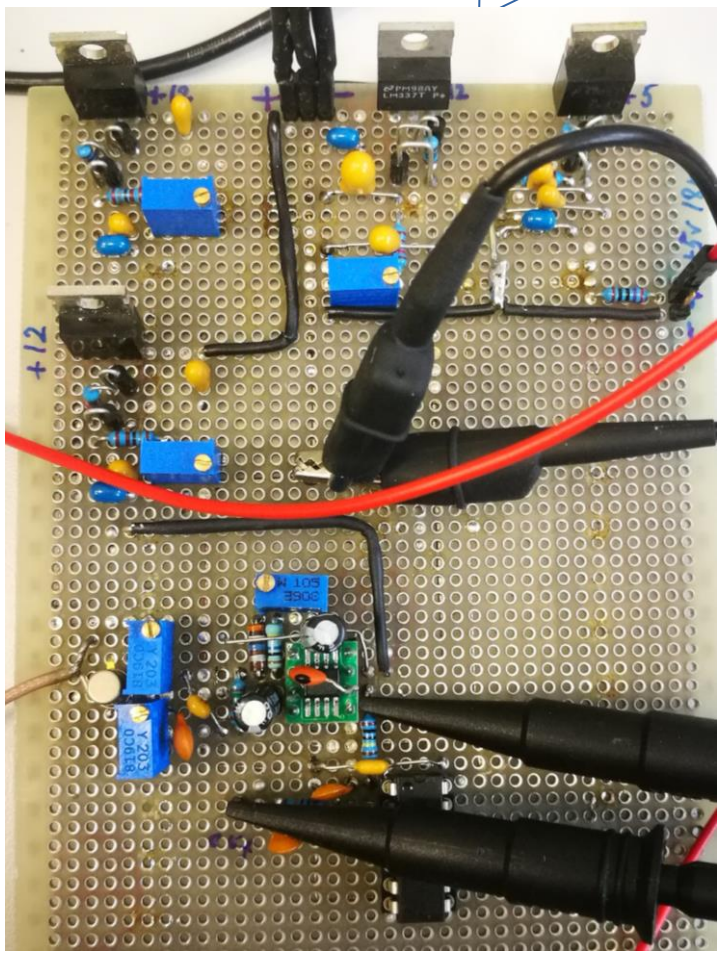


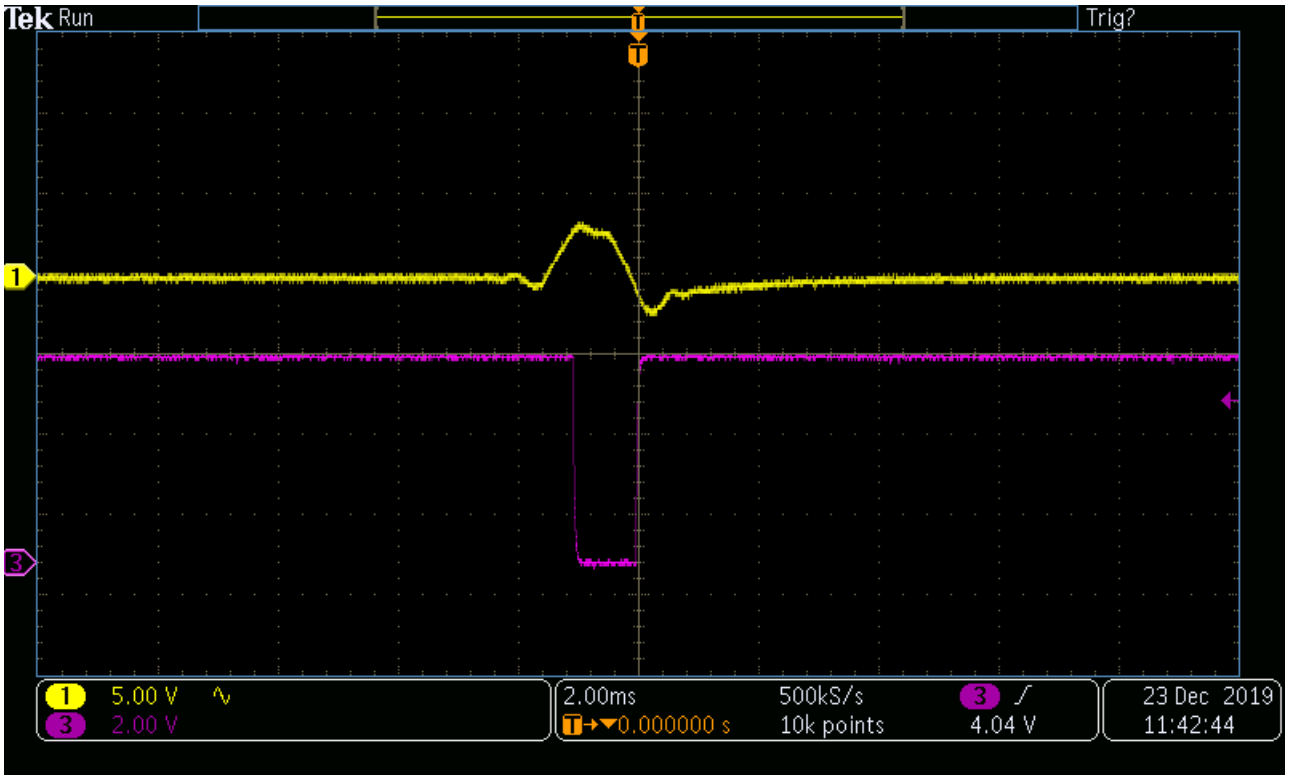
SYSTEM DESIGN



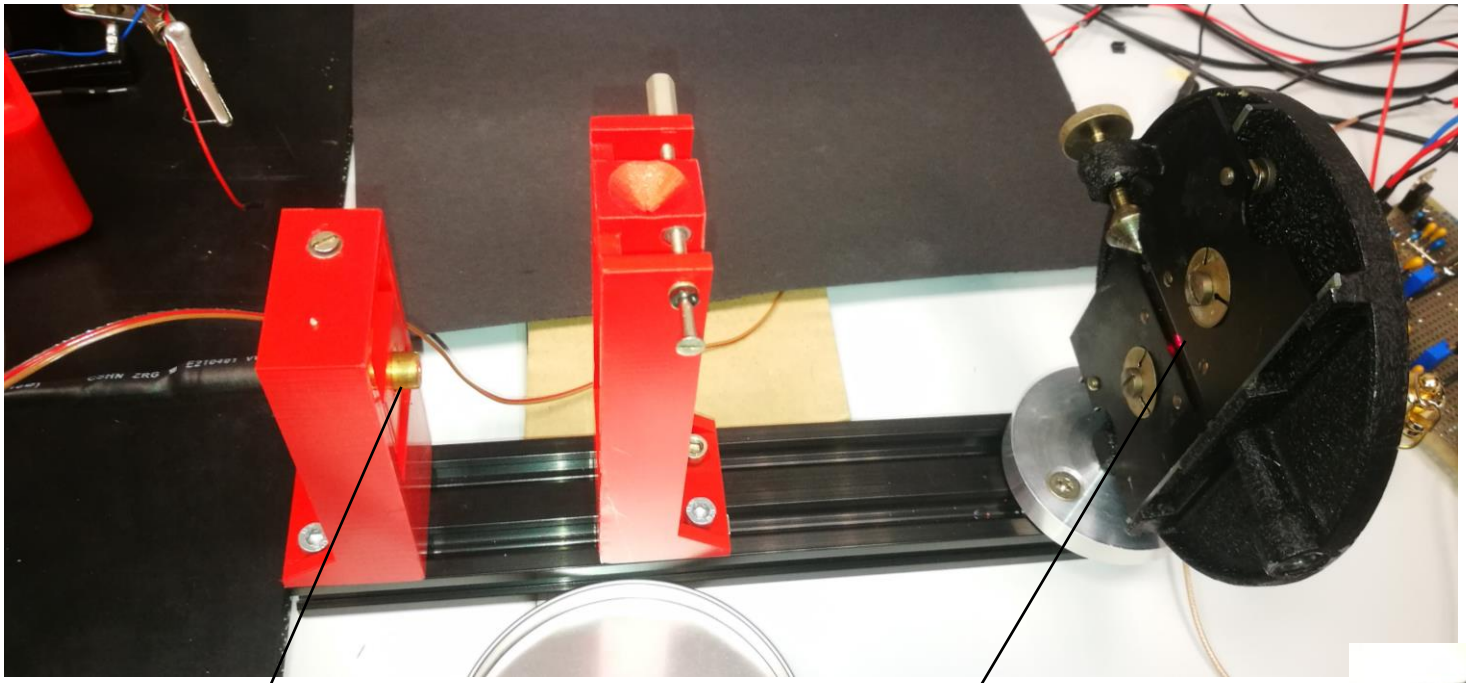
Triger system

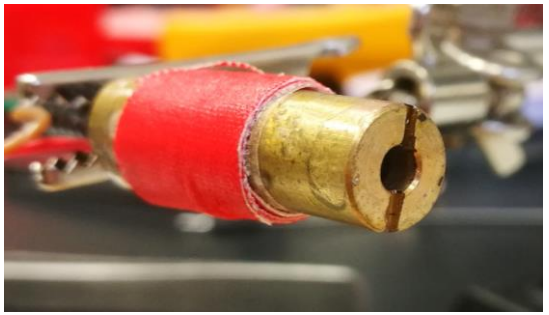


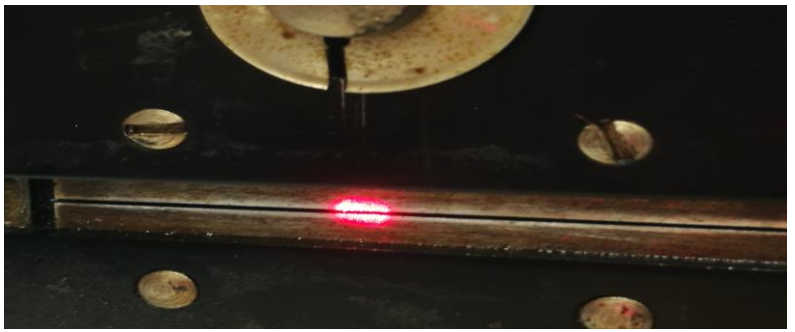


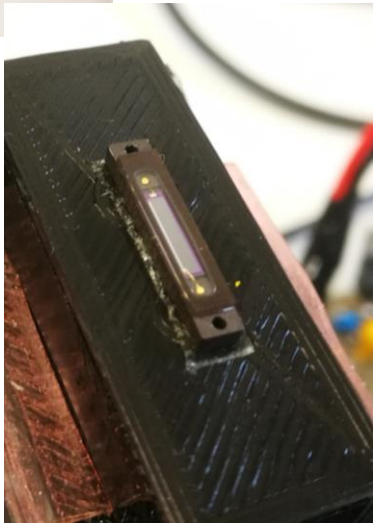


Triger system testbench









FPGA Image processing

5MP – CMOS image sensor

MIPI CSI-2 interface

Resolution - QSXGA@15Hz, 1080p@30Hz, 720p@60Hz, VGA@90Hz and QVGA@120Hz

Formats - RAW10, RGB565, CCIR656, YUV422/420, YCbCr422, and JPEG

667 MHz dual-core Cortex-A9 processor

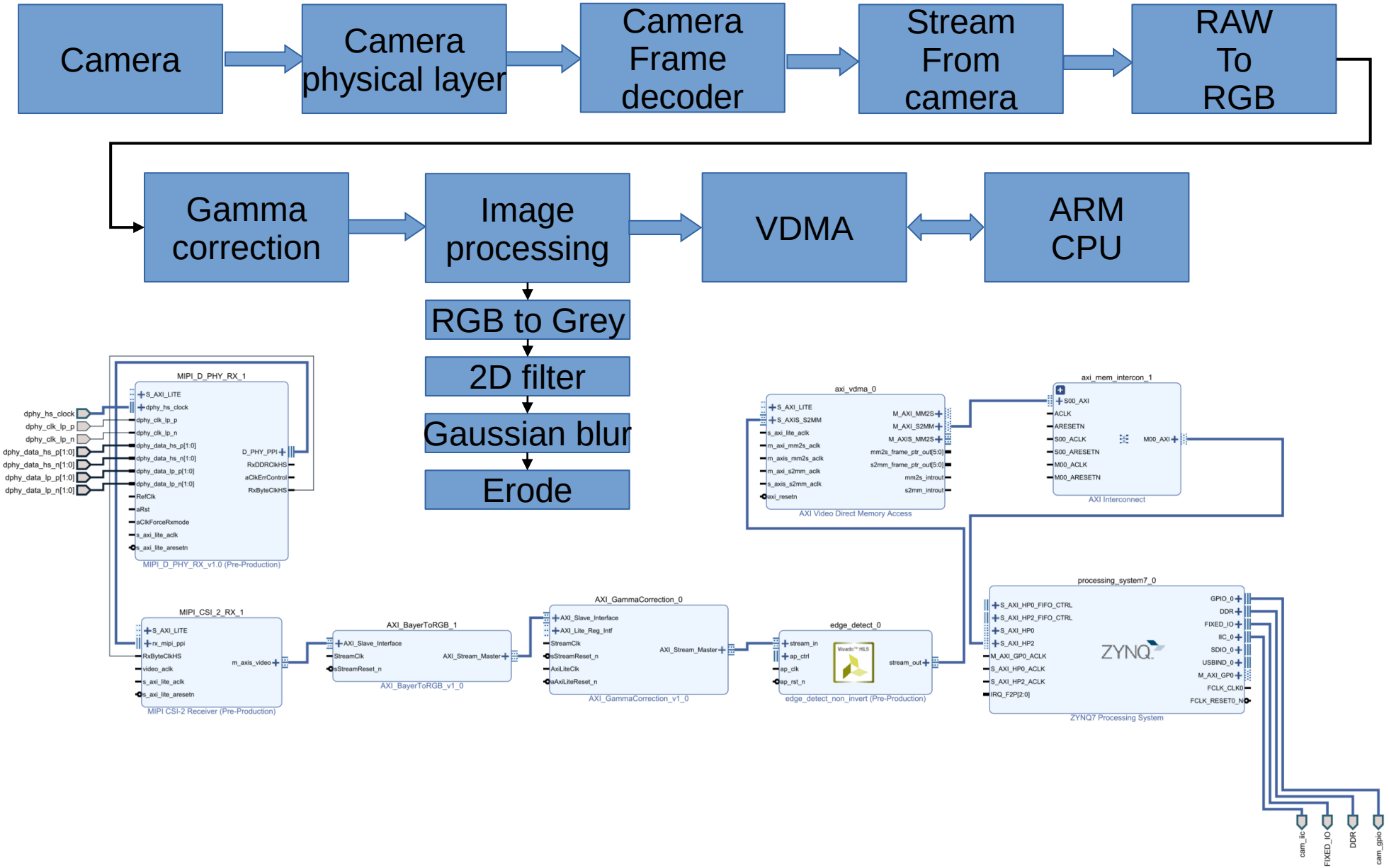
1G Ethernet, USB 2.0, SDIO

1 GB DDR3L RAM

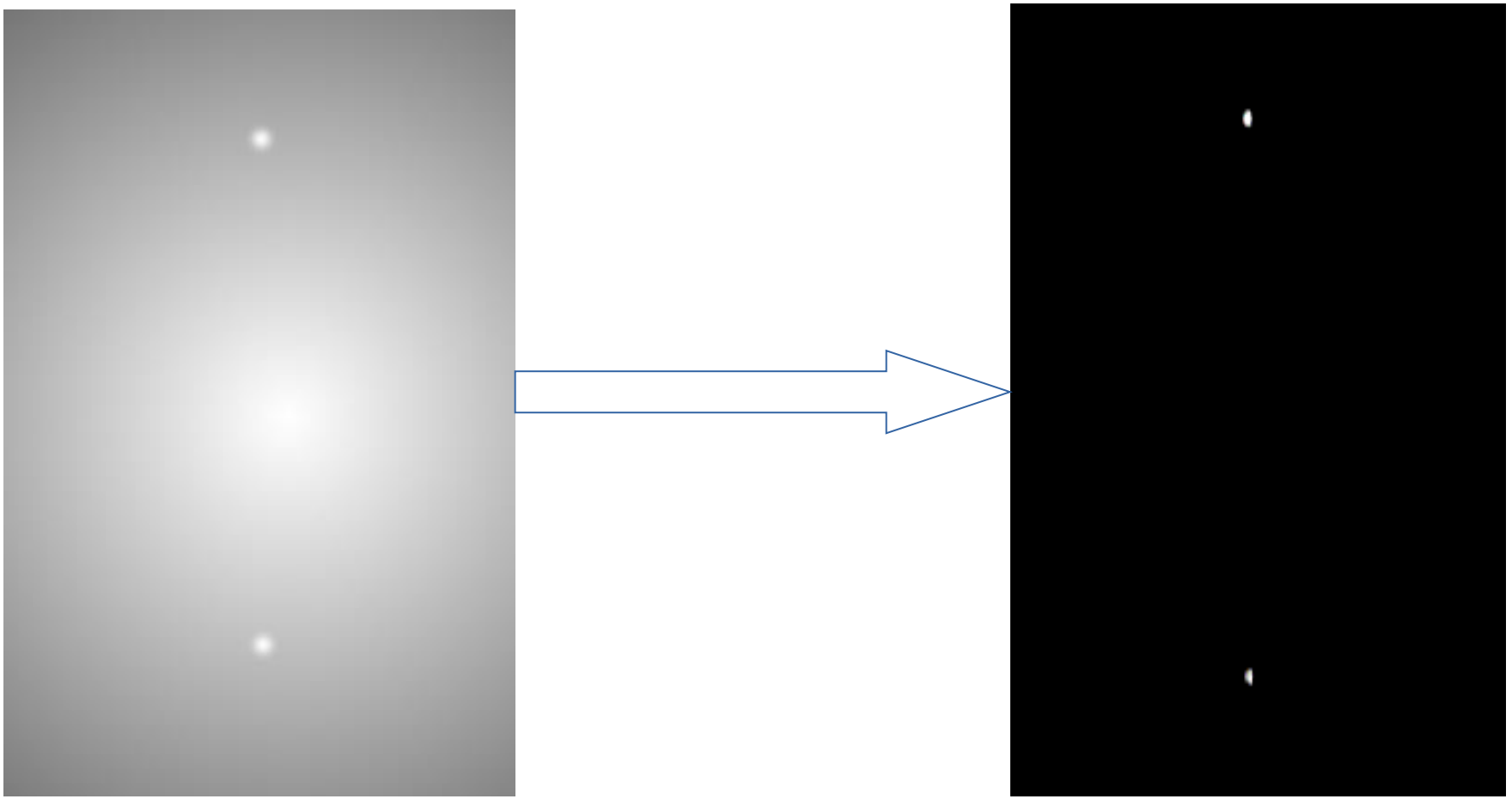
FPGA – XC7Z020-1CLG400C

- Look-up Tables (LUTs) 53,200
- Flip-Flops 106,400

FPGA Image processing



Vivado HLS IP development



Camera and image processing test

Image from custom linux
Running on FPGA board

Image processing test using
color invert and Sobel filter

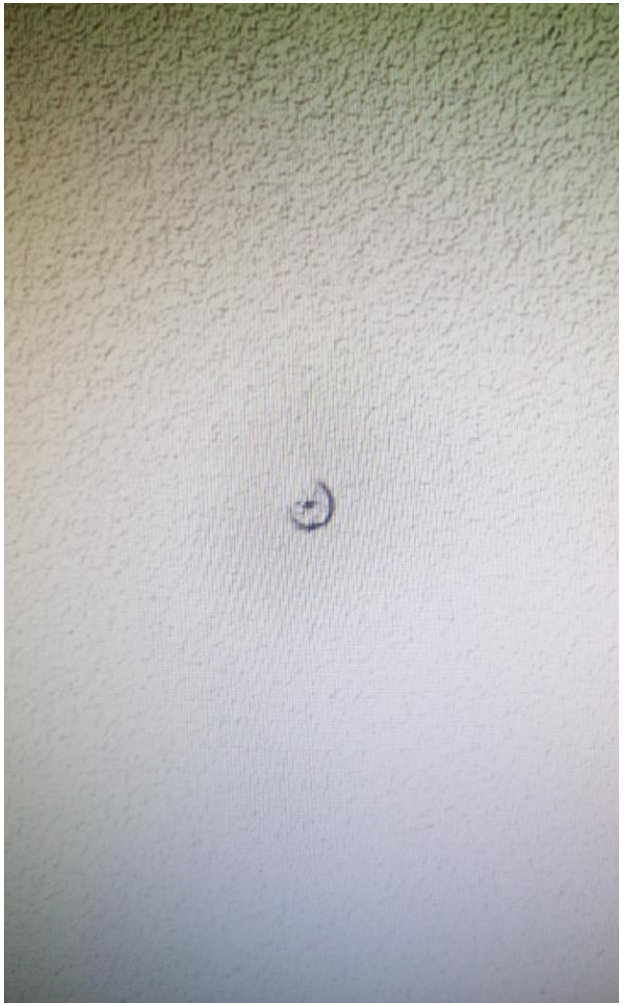
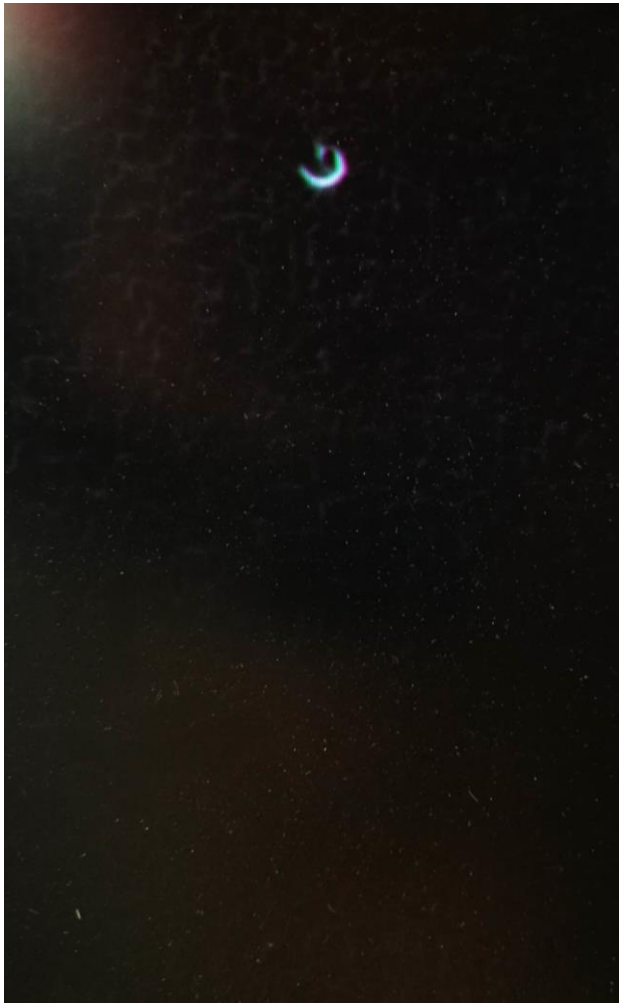


Image processing test using
Pewitt filter



Summary

- First prototype of triggering system has ben developed and tested with 400 µm ball.
- First camera tests were made on FPGA
- Test image processing IP has been developed
- Custom Linux distro was built with working programming, network, GPIO and camera interfaces

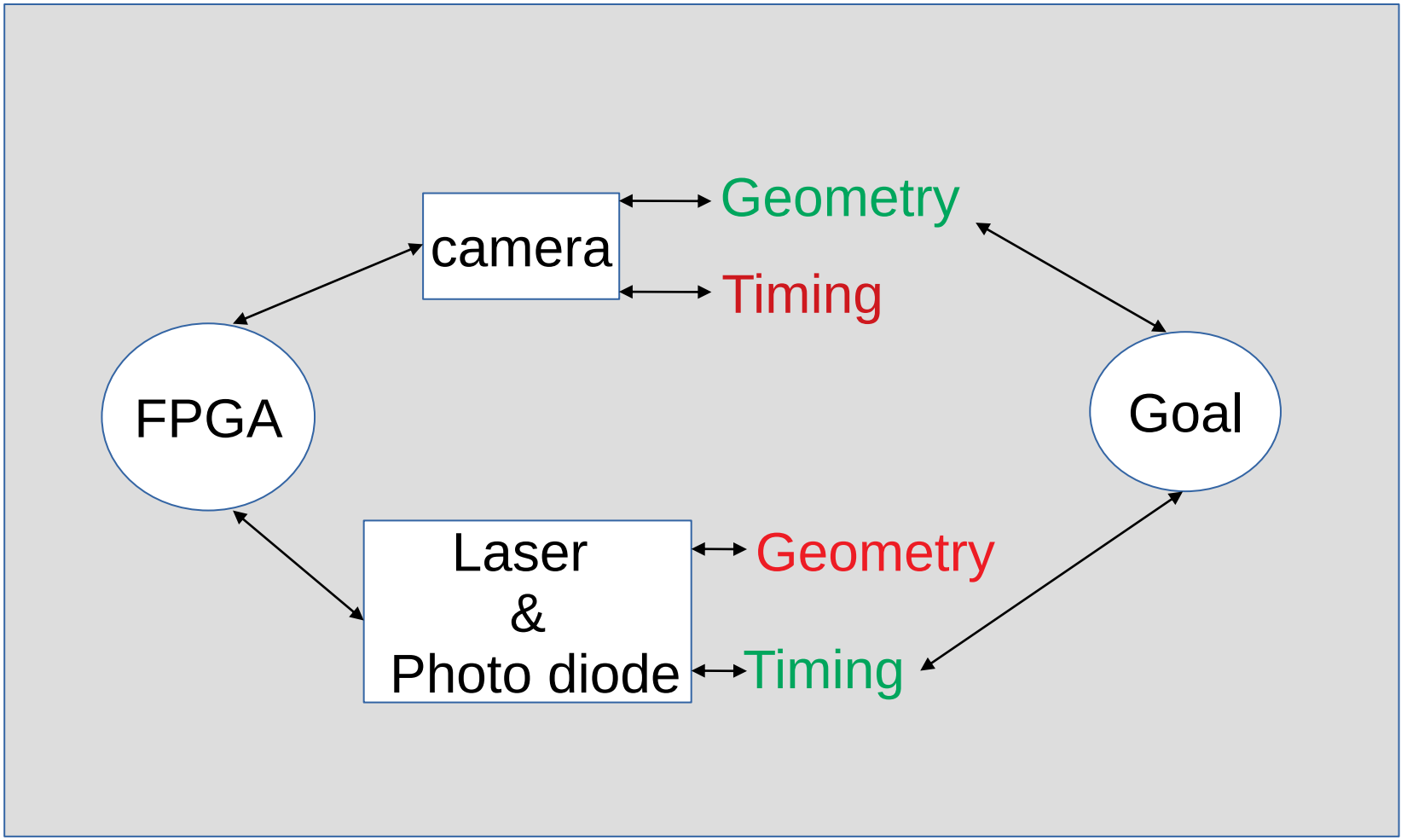
Outlook

- Automatized mechanics should be developed for target tests (dropper/catcher system)
- Another trigger system must be assembled dedicated mechanical system should be developed for two trigger system to test TOF.
- AXI control interface should be implemented in image processing IP to control some parameters from CPU
- Developing a stroboscopic system for image capturing
- New system design must be created with image processing IP cores and implemented in Linux

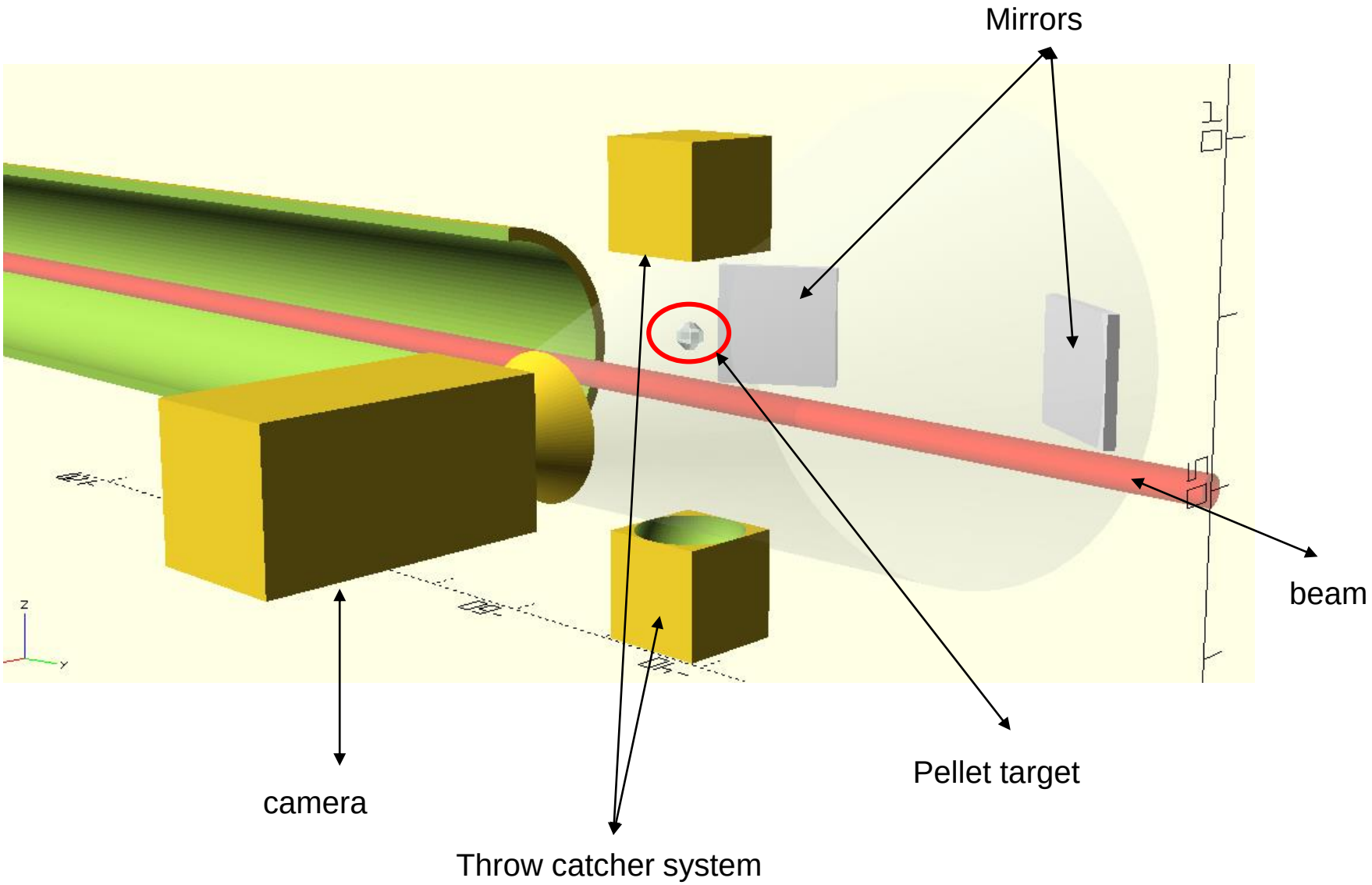
THANK YOU

Appendix

ოპტიმალური სისტემების შერჩევა

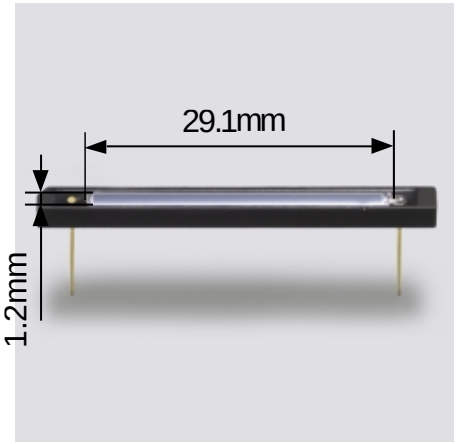


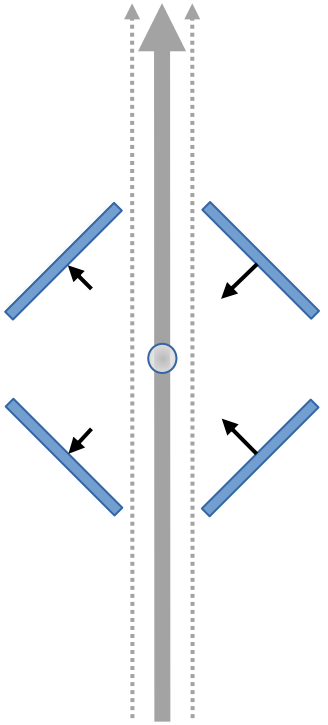
გრანულიანი სამიზნის 3D სქემა

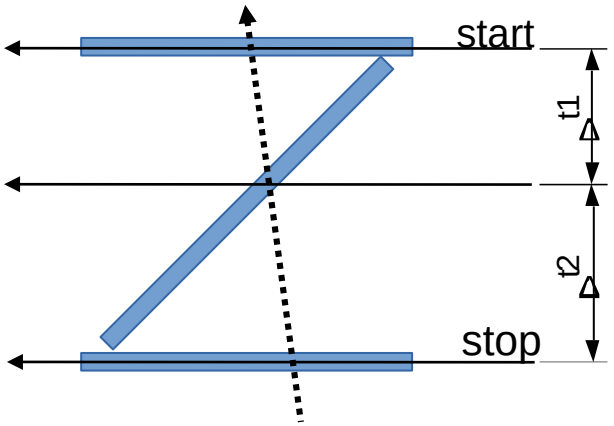


სამიზნის ფრენის დროის გაზომვა

- Triggering
- Position reconstruction







Camera requirements

Minimum camera characteristics with window size 1x4 cm and pellet diameter 100µ:

- Minimum 26 fps to get 2 points (free fall)
- Minimum 400 pixels

Pco - pco.dimax HS4
Fps = 2277 @ 4Mpix (2000x2000) or 7039 @ 1MPix (1000x1000)

Interfaces: USB 3.0, GigE/USB 2.0, Camera Link

exposure time range 1.5 µs - 40 ms

Ximea - CB019MG-LX-X8G3

Fps = 2500+ @ 2Mpix (1920x1080)

Interfaces: PCI Express (PCIe) Gen3

exposure time range = 1µs – 1sec