LINAC 4
Laser Emittance meter

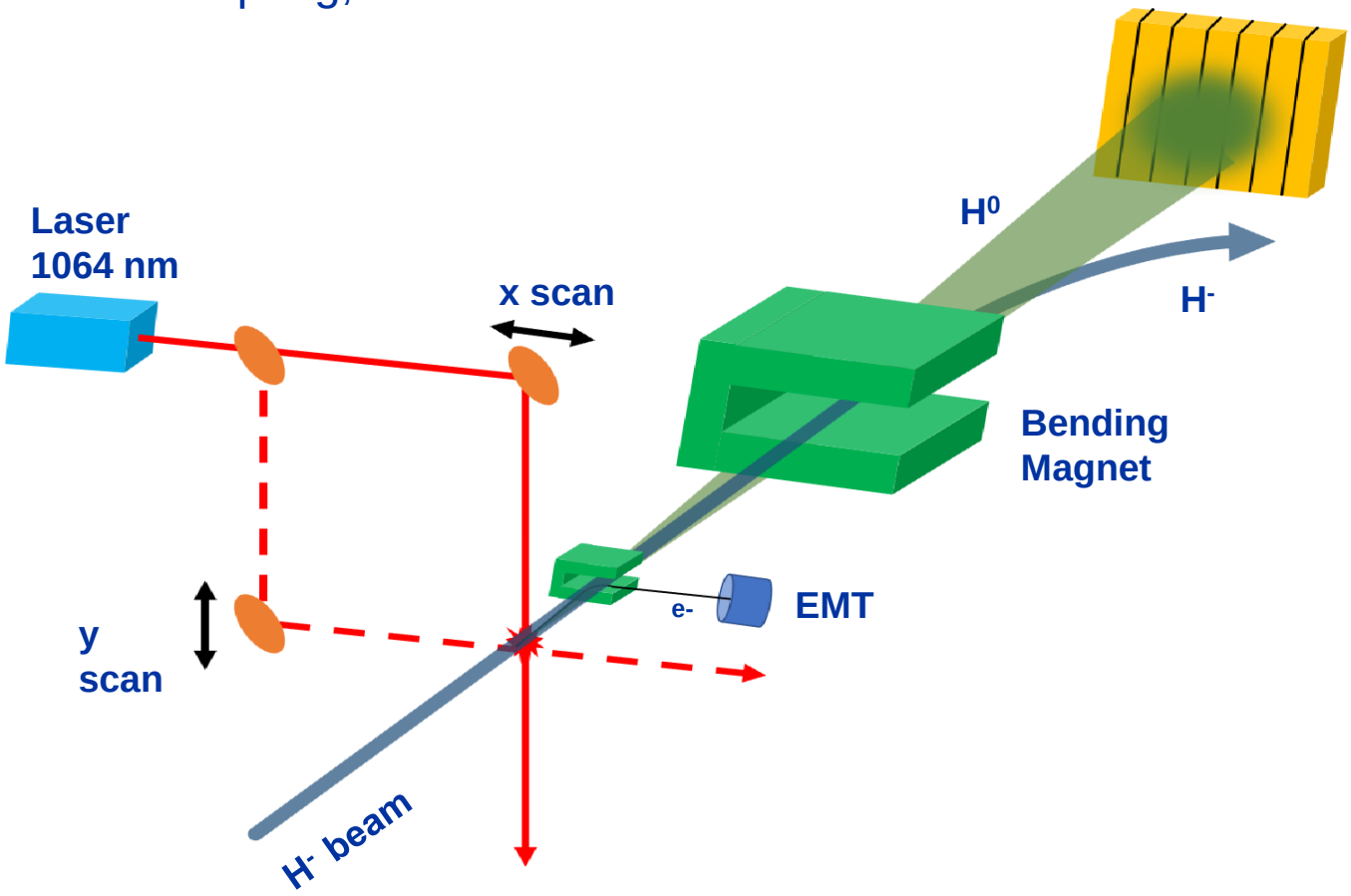
Aurélie Goldblatt

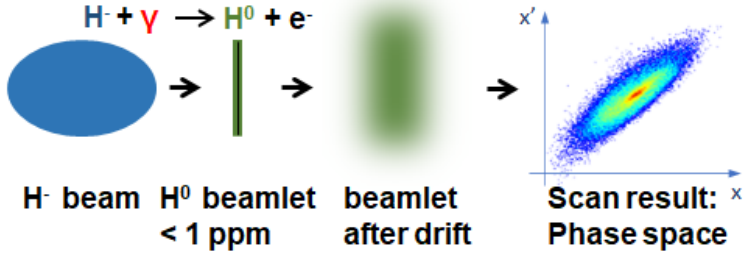
13.04.2022

CONCEPT

Photo-detachment: e^- stripping from photon interaction

Non intercepting, no beam limitation





Design production and installation (2018)

Thomas HOFMANN

in collaboration with G.E. Boorman,

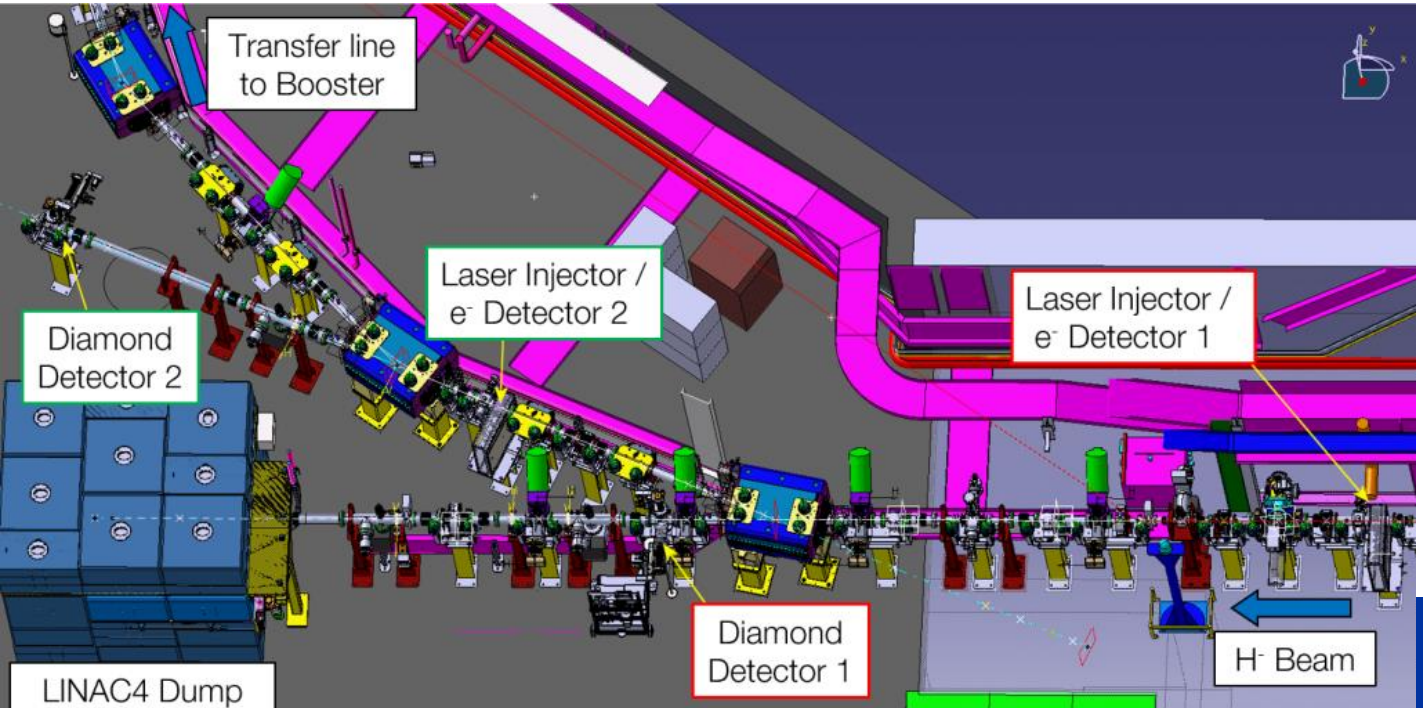
A. Bosco, S.M. Gibson

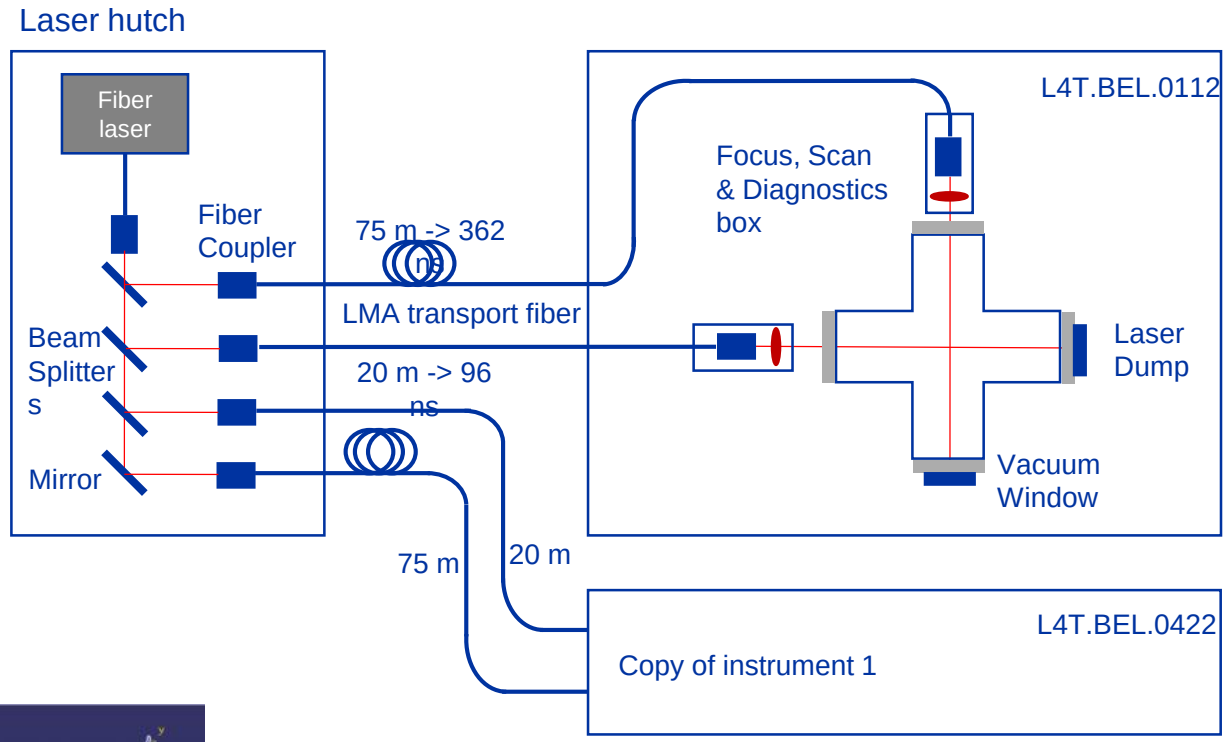
John Adams Institute at Royal Holloway

HARDWARE

System 1 : in the straight line towards the dump
-> emittance wo dispersion

System 2 : between two dipole magnets
-> low H0 background level





Short pulsed fiber laser (Ytterbium 1064nm) tunable power, freq and pulse width

Large mode area transport fibers with special end facet

constraints:
- constant laser diam @ interaction point
- sustainable power density for fibers

DIAGNOSTICS

Diamond Detectors:

- Polycristalline chemical vapor deposition (pCVD)
- Radiation tolerant
- Big detector size and long drift to avoid cross talk
- 28 channels, pitch 0.34mm, 2 different shapes
- Stepping movable stages

Additional:

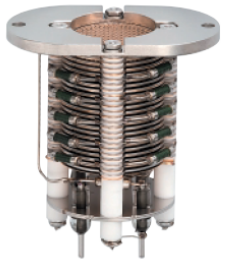
- 5GHz photodiodes
- Energy meters
- Cameras

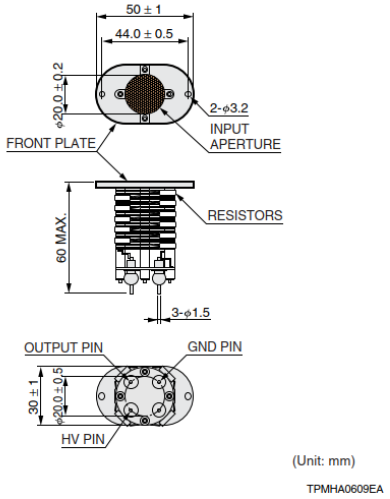
Electron multiplier tube (EMT)

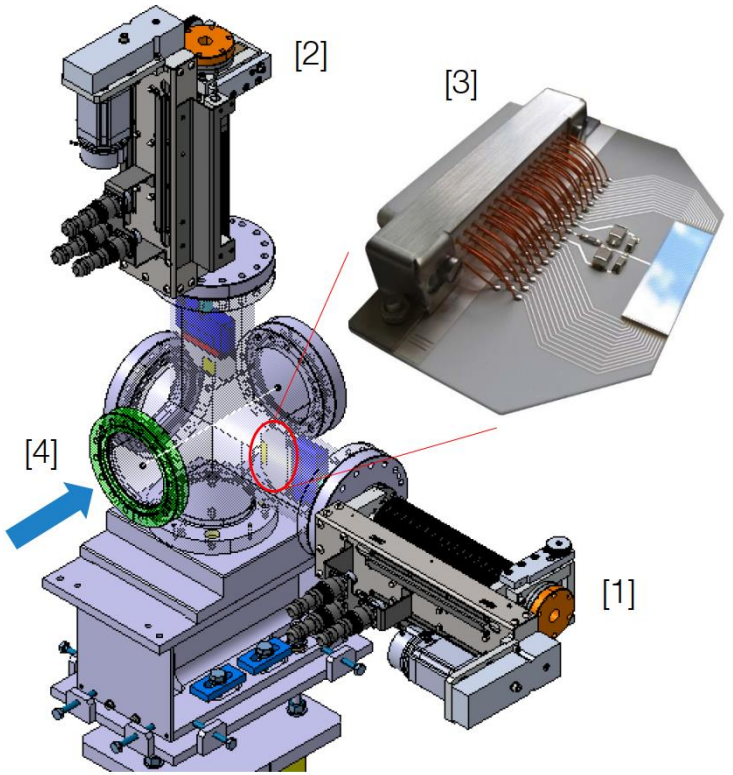
R2362

■**Features**
Wide detection area

Mounting plate potential
Front plate: -HV







DAQ & CONTROL

NI PXIe Controller (running LabVIEW RT 2017)

Digitizer/FPGA cards

timing/synchronization card

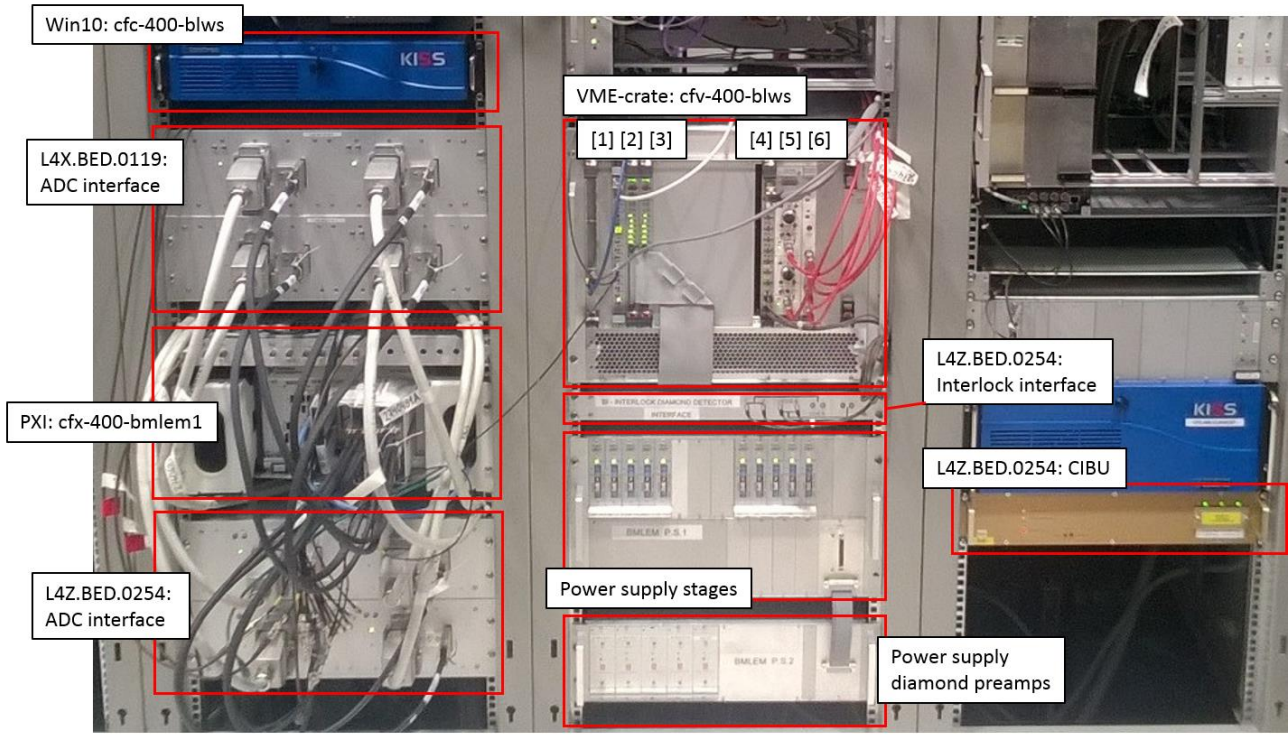
general-purpose DAQ card

Preamplification cards in tunnel (diamond)

control and readout code runs on controller

CMW server providing access to relevant parameters (virtual FESA class)

Sampling frequency diamond 50MHz, PDEMT 120MHz



SYNCHRONIZATION

LINAC 4 macropulse divided in 4 rings of ~150 us

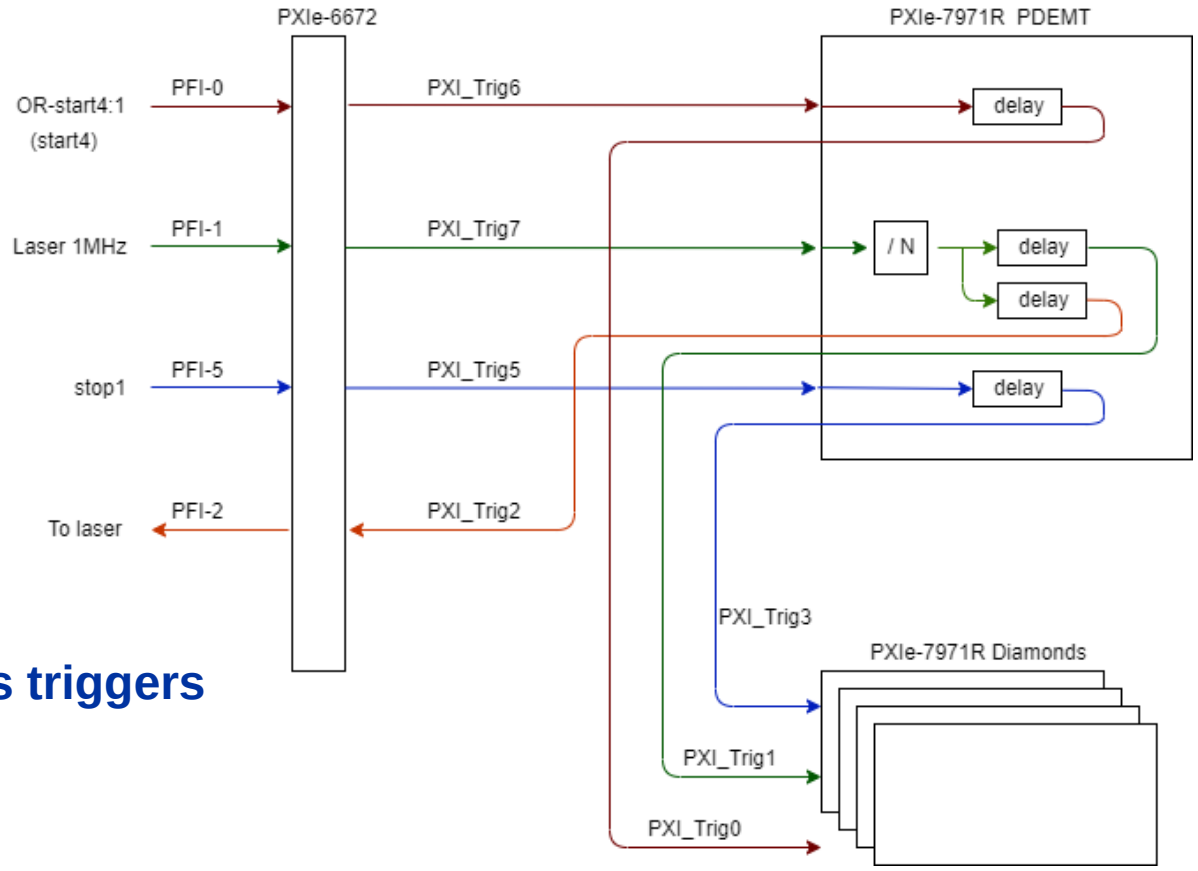
beam chopped into 1us buckets (PSB freq)

1us period reconstructed with LINAC4 RF of 352 MHz

Laser synchronized with PSB 1MHz timing

tunable division factor, typically used 500kHz

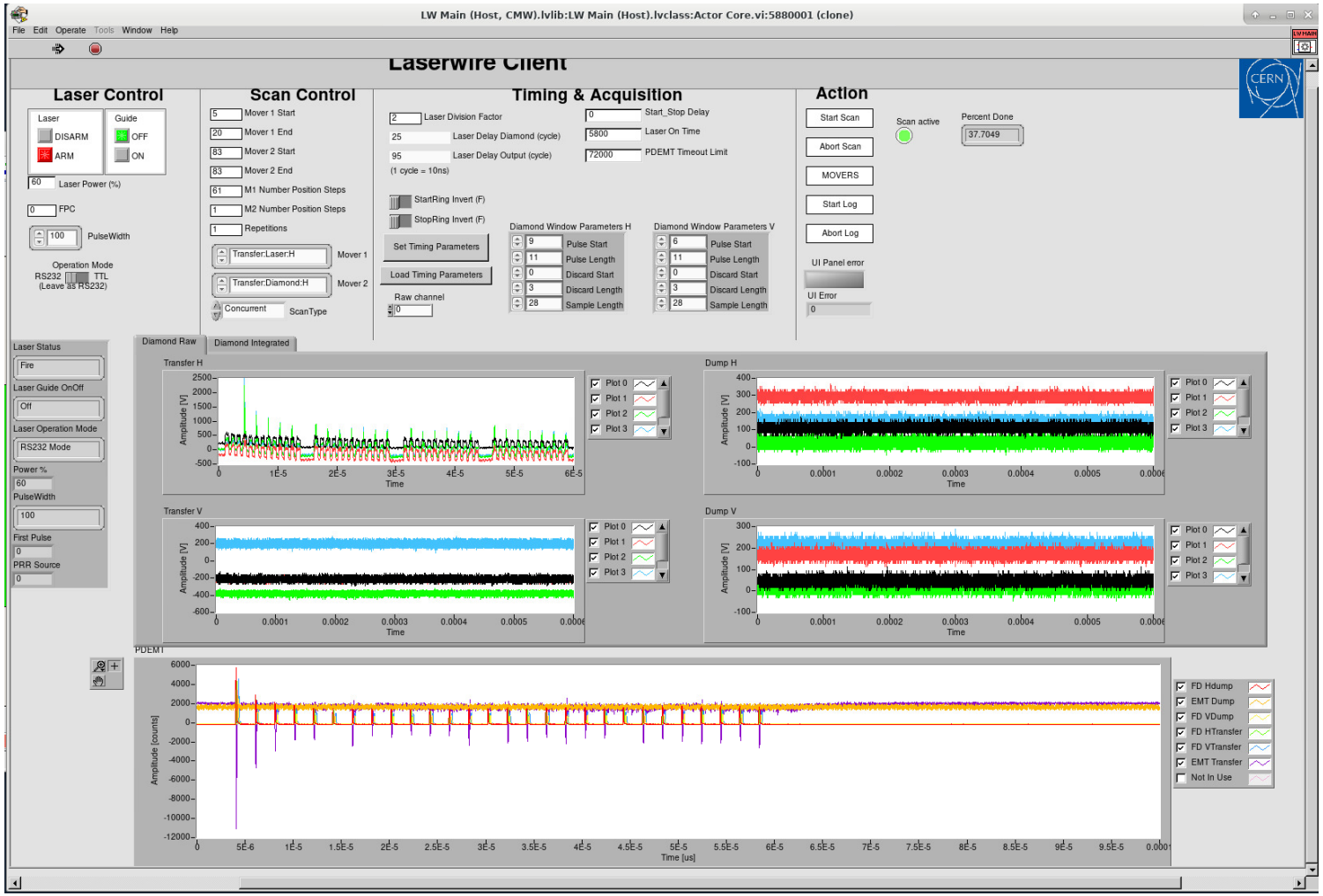
Acquisition synchronized with Start and Stop rings triggers



TOOLS

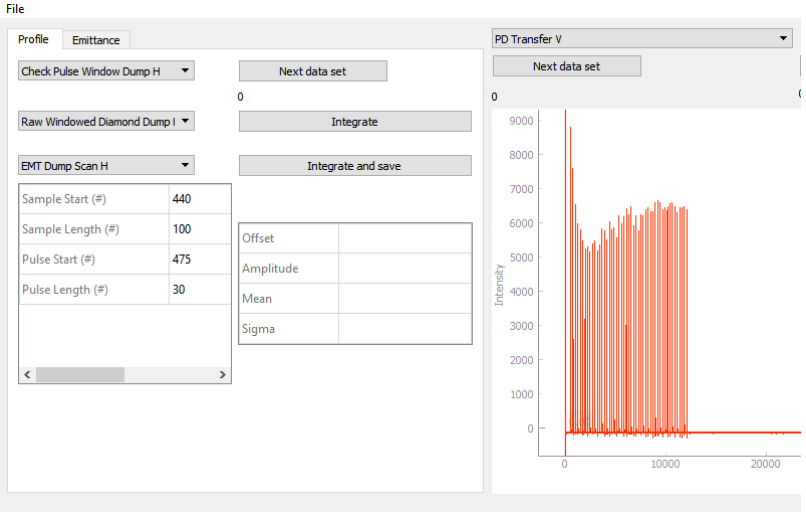
Laser operation

LabView GUI



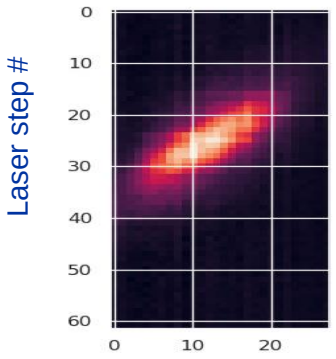
Debugging and testing:

tdms files, PyQT GUI

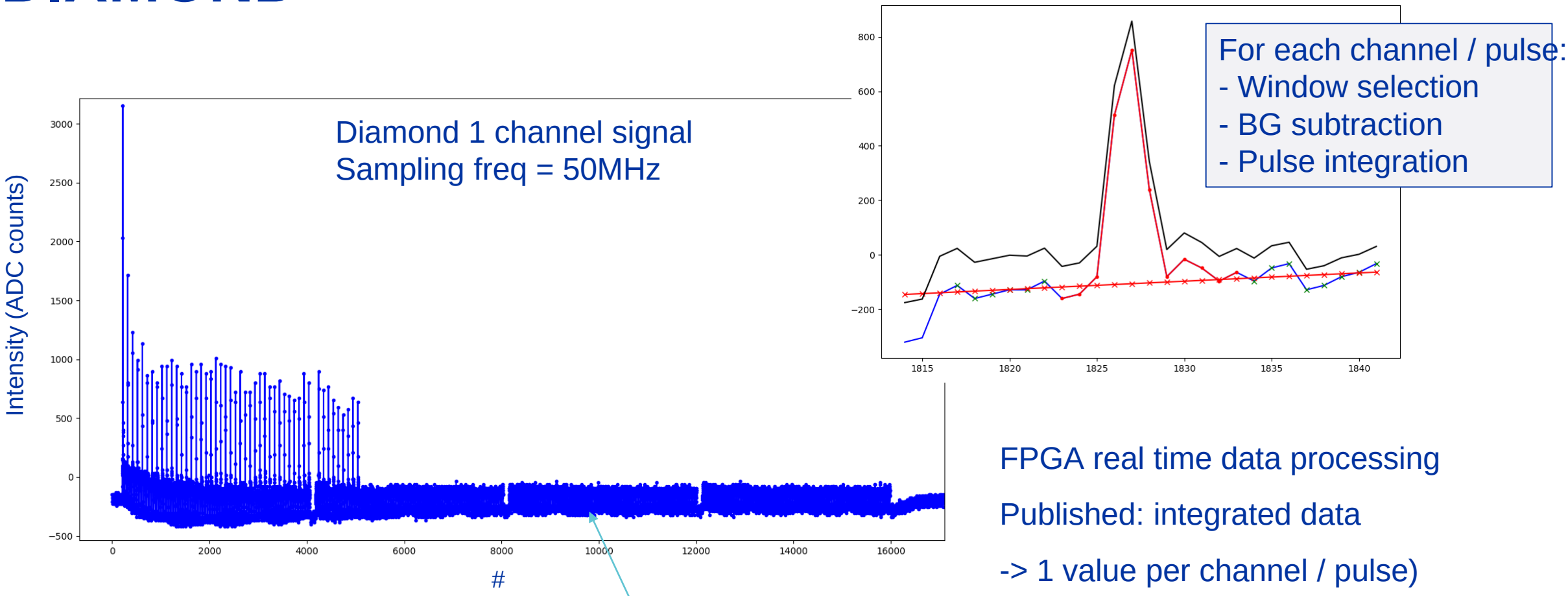


Online analysis:

CMW data, PyJapc



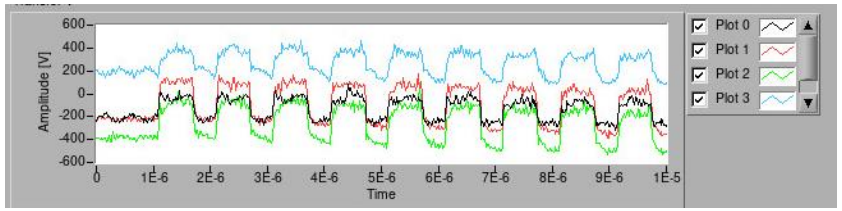
DIAMOND



FPGA real time data processing

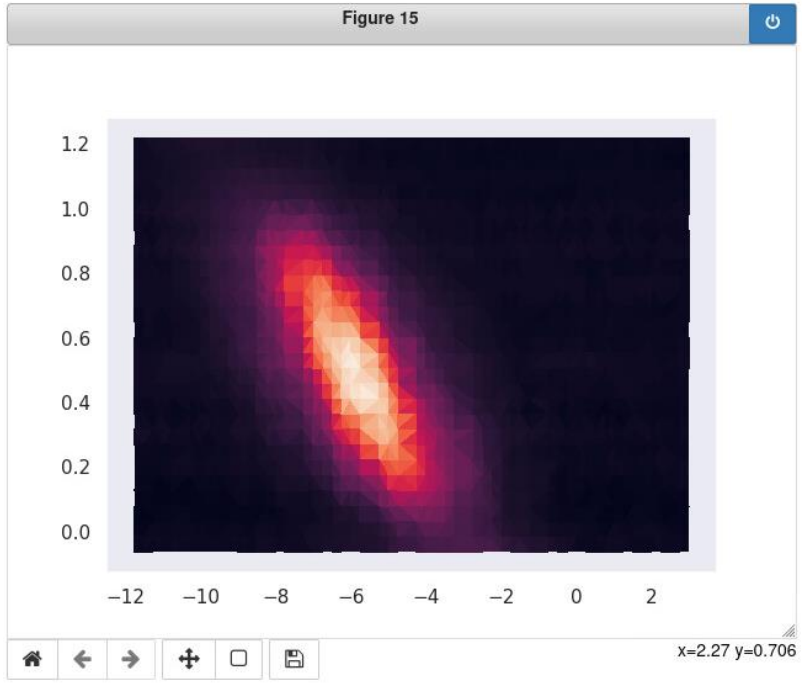
Published: integrated data

-> 1 value per channel / pulse)

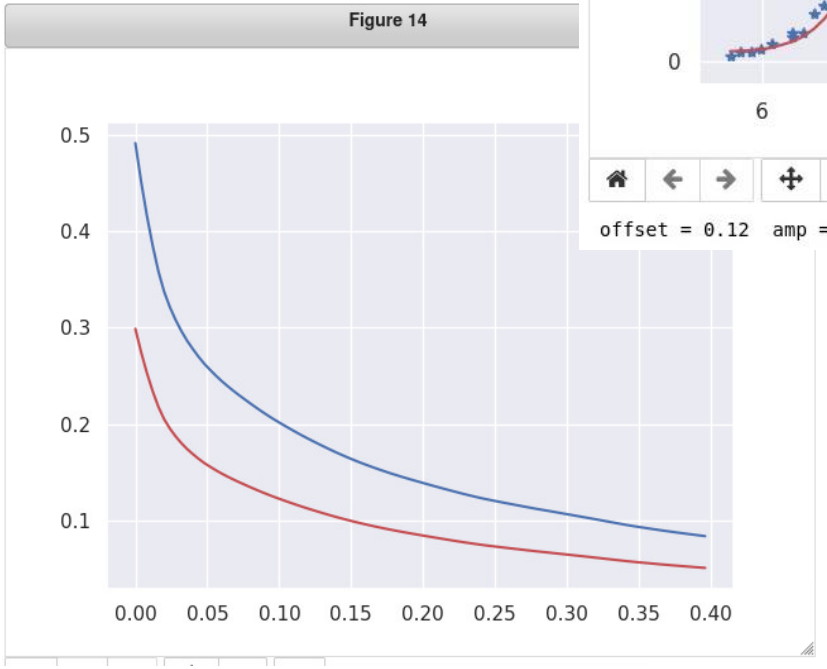


all bunches visible even wo laser (H^0 BG)

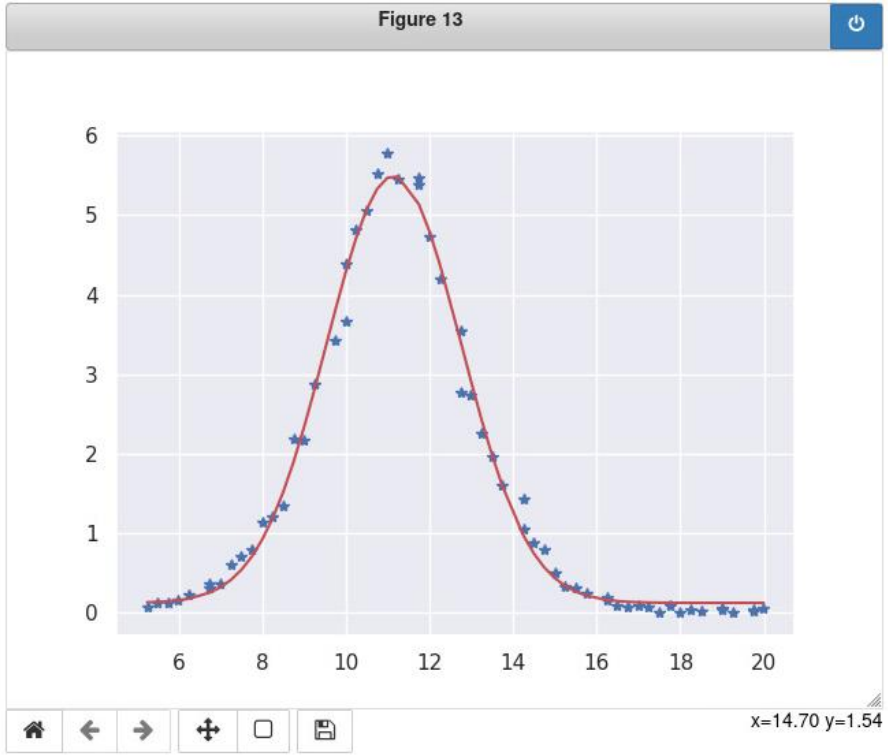
EMITTANCE & PROFILE



Phase space (angles vs pos)



Emittance vs threshold of 1 pulse

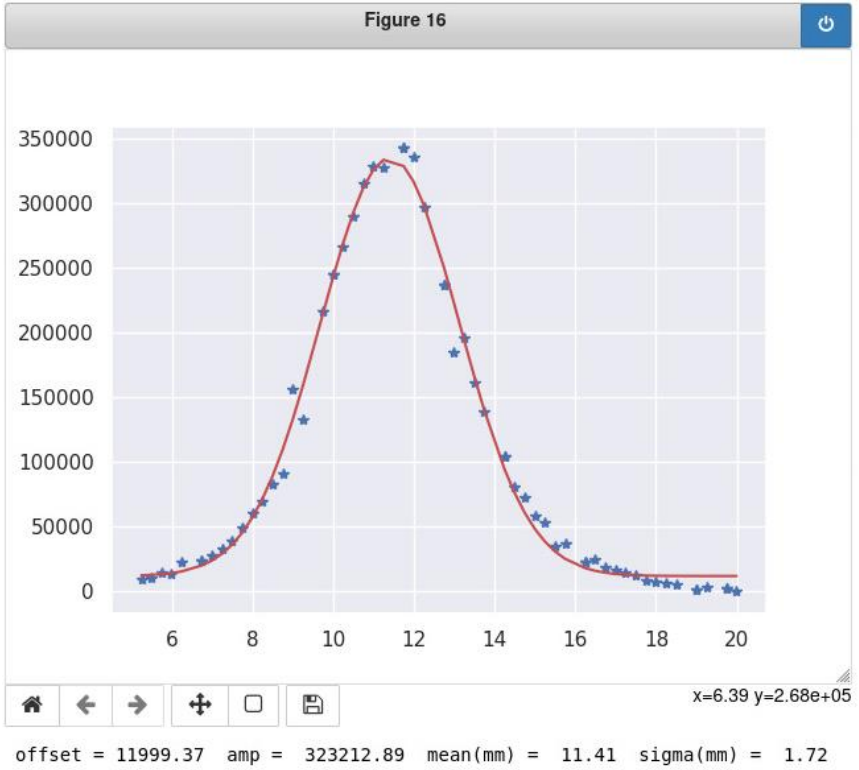


1 pulse profile

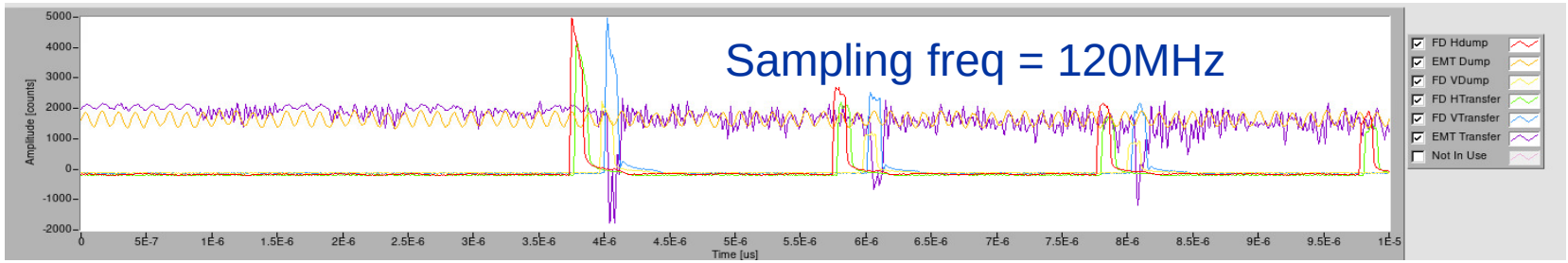
EMT

Same data processing than diamond

but not implemented in FPGA



1 pulse profile

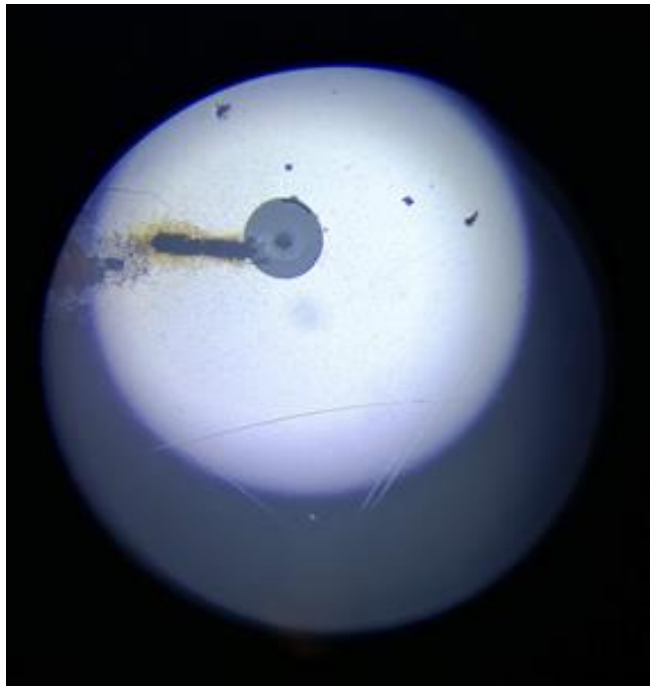


GUI display

ISSUES & MITIGATIONS / HARDWARE

Extreme : burned fibers (happened once or twice)

Expected : fibers transmission degradation

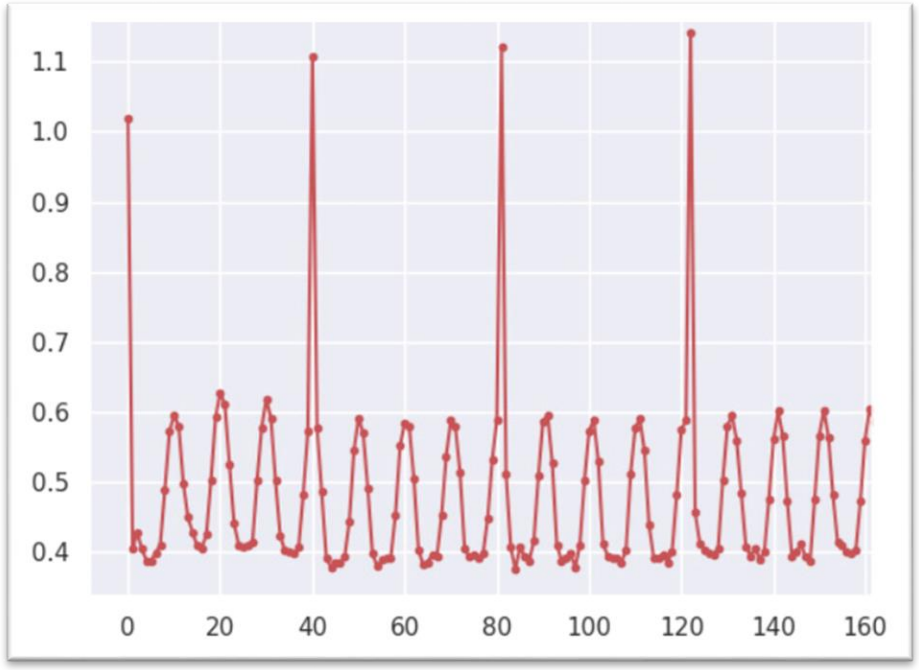


- New spare fibers pulled last year
- Alignment and transmission check (IST)
- PD signals check at all time
- No fiber degradation observed within a year

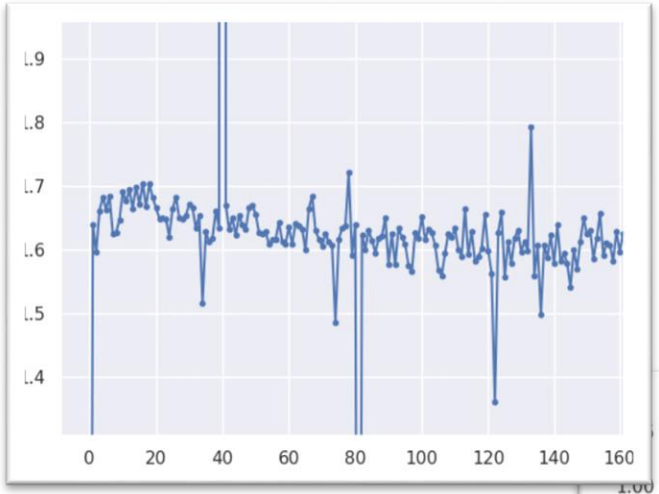
ISSUES & MITIGATIONS / NOISE

pulse spacing 2us

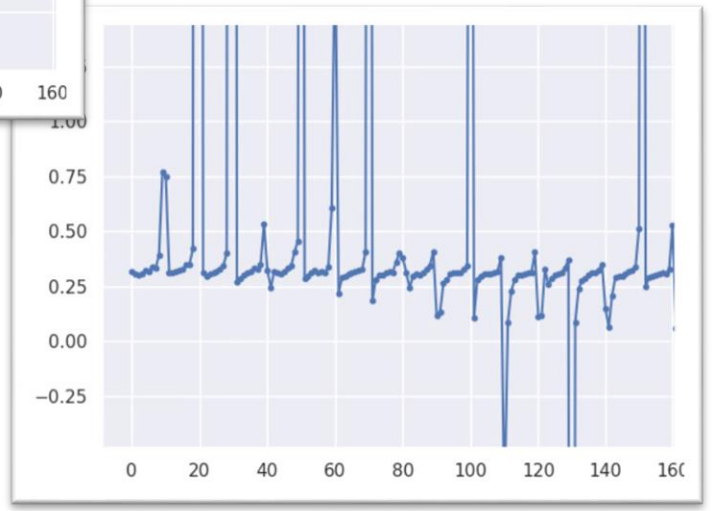
oscillation period 10 points -> 50kHz



Emittance along train



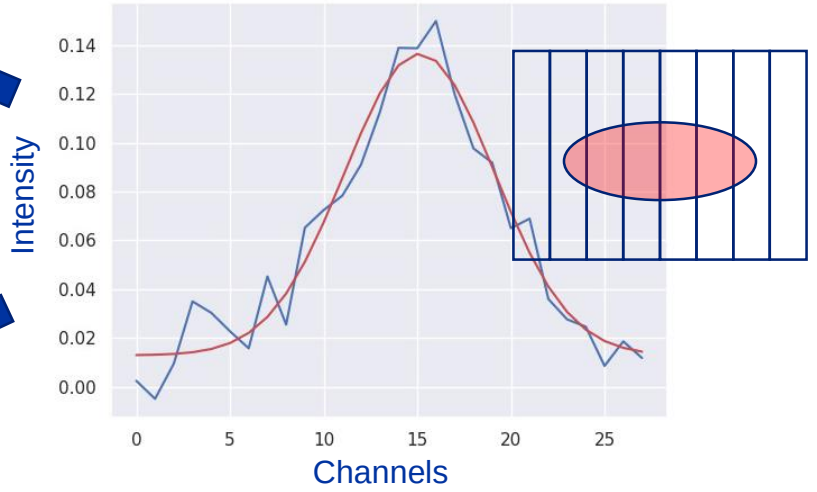
sigma profile along pulse



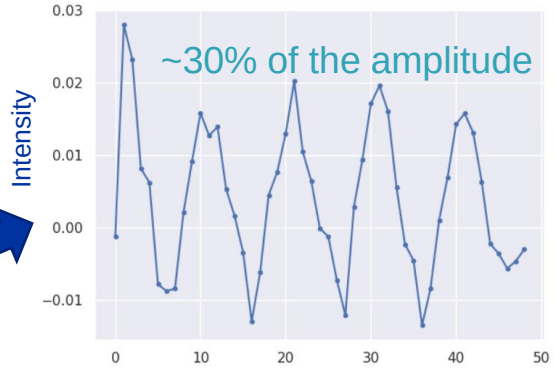
sigma angles projection along pulse

ISSUES & MITIGATIONS / NOISE

mean along pulse

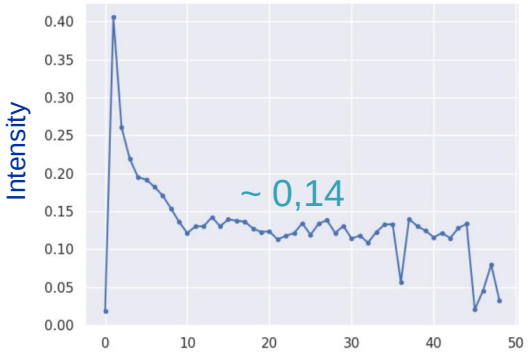


Diamond integrated data, single shot, 1 pulse



offset along pulse

sigma along pulse



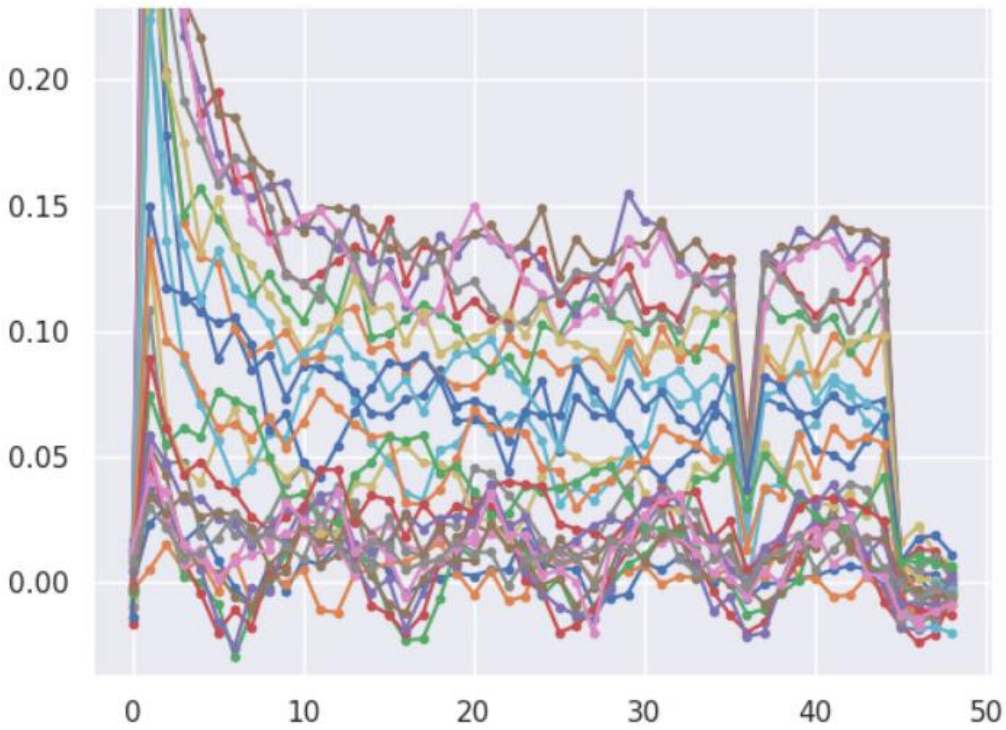
amplitude along pulse

More impact on low int channels
-> affects offset and sigma

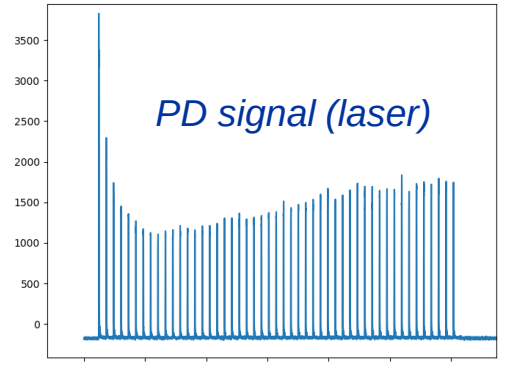
Laser seems excluded

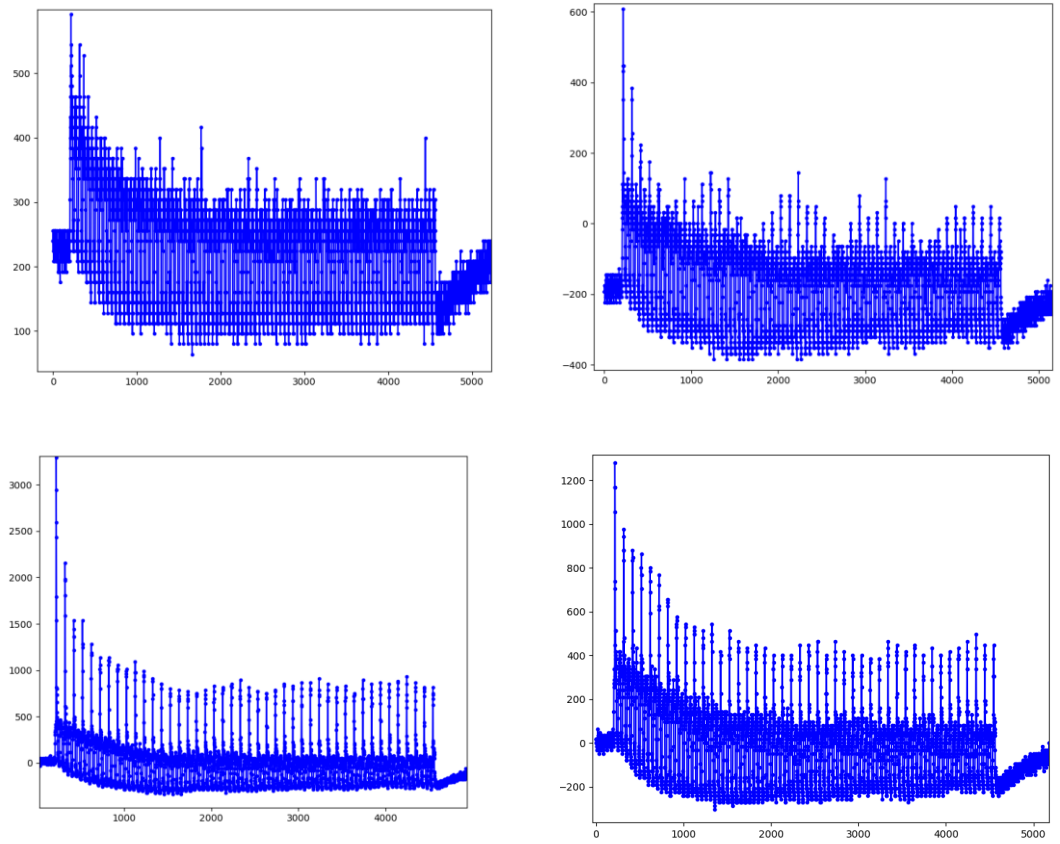
ISSUES & MITIGATIONS / NOISE

Oscillation 50kHz, amp up to 25-30%
Not the same phase for all



Integrated data per channel along pulse (single shot)





Raw diamond signals

ISSUES & MITIGATIONS / NOISE

Periodical noise on diamond channels ~ 2MHz, disappears if far from beam timing
Is that noise responsible?

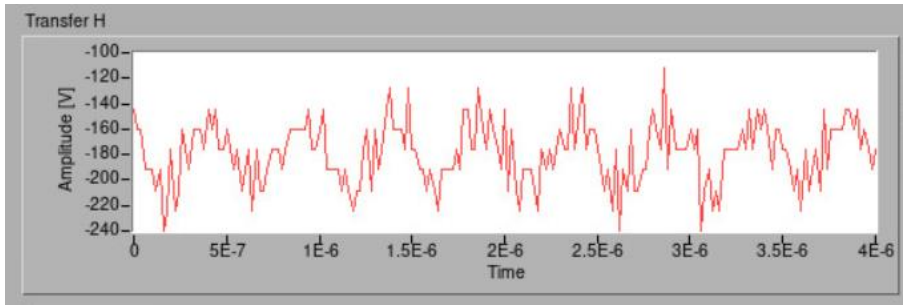
Tried to put ferrites on some cables, no change

Test proposed by Jean (tunnel access needed)

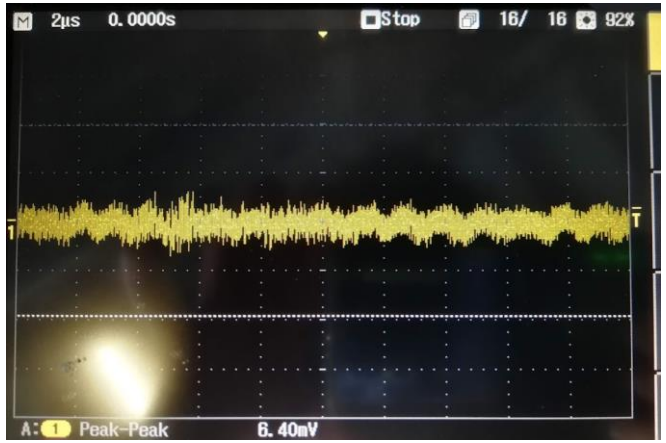
1. disconnect one channel at detector level

2. Disconnect one channel at preamp level

-> see if noise disappears



Diamond row signal, GUI display



Current clamp: noise ~ 1MHz

STATUS

After a year of debugging, all the functionalities work

Many measurements made with Transfer laser station on the first pulses to:

- Implement cmw data processing
- Find good settings (laser, diamond pulse window, scans)

Hardware reliable and stable

Excellent support from the LabView team

Started measurement of the macropulse few weeks ago

-> discovered periodical noise along the pulse, investigation ongoing

-> use of digital notch filter

Next step: comparison with SEM & WS

LINKS

https://wikis.cern.ch/display/BEBI/L4+Laser+EM

https://www.findlight.net/front-media/products/datasheet/VGEN-ISP-POD-20-Fiber-Laser.pdf