Libera

Evaluation of a new 500 MHz digitizer at Elettra

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Instrumentation Technologies

Content

- **Description of the new digitizer**
- **Measurement results:**
  - **Fill pattern**
  - **Bunch-by-bunch position**
- **New HTTP API for Libera instruments**

No time for the »Peter's project« update on the weather station – it's in the backup slides!

Libera Digit 500 AC/DC

- Based on the CavityBPM → flexible analog front-end

- 500 MHz 14-bit ADCs

- 1 second per channel storage (4 GB total)

- Sampling clock locked to REF input

- Dynamic range 90 dB

- Bandwidth:
  - ➢ AC coupled: 1 MHz to 2 GHz
 - ➢ DC coupled: DC to 250 MHz

www.i-tech.si
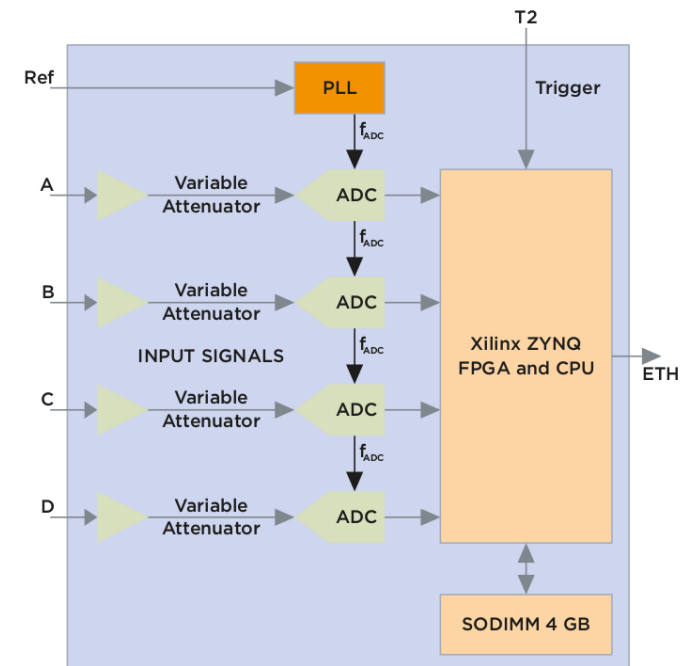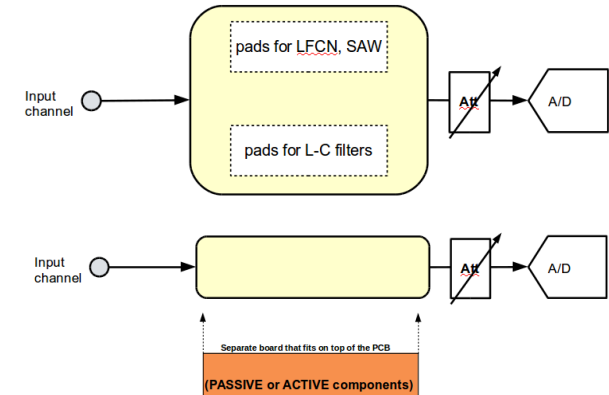
Test with ICT at FERMI

- DC coupled version, installed at FERMI

- Pulse width: few nanoseconds

- Test on a bench: a pulse injected to a ICT, readback with Digit 500

- Test with beam

- Results comparable with

  oscilloscope reading
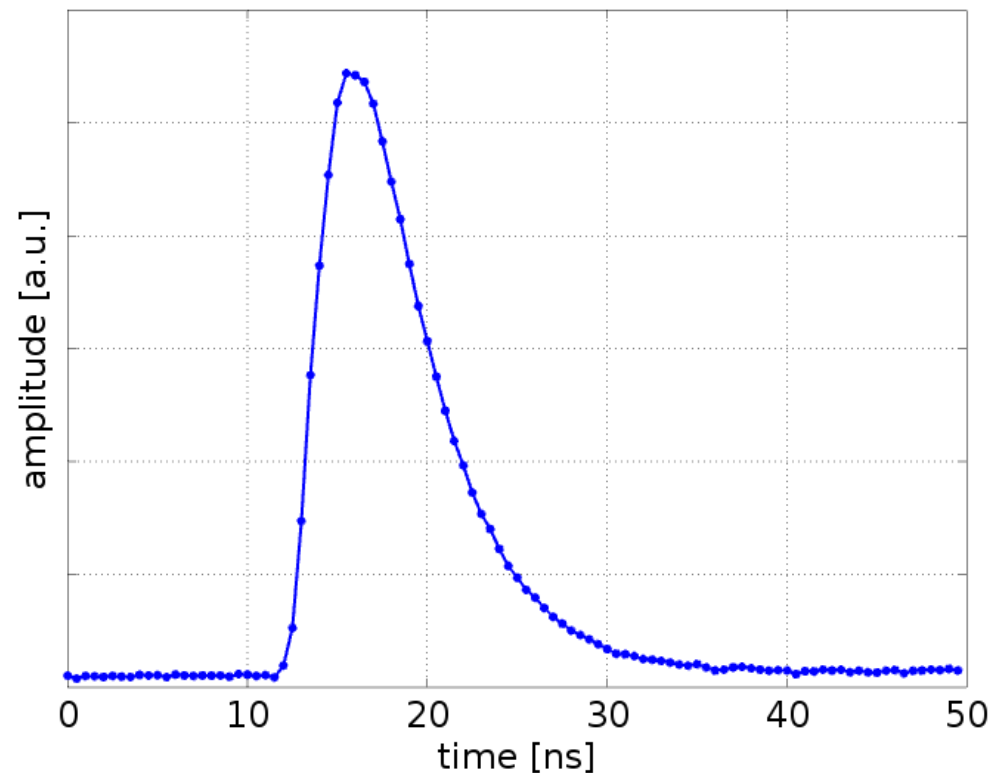
Fill pattern measurement – first try

- AC coupled version, installation at Elettra storage ring

- Signal from spare pickup (not button)

- Channel-to-channel phase difference

- Shape not as expected

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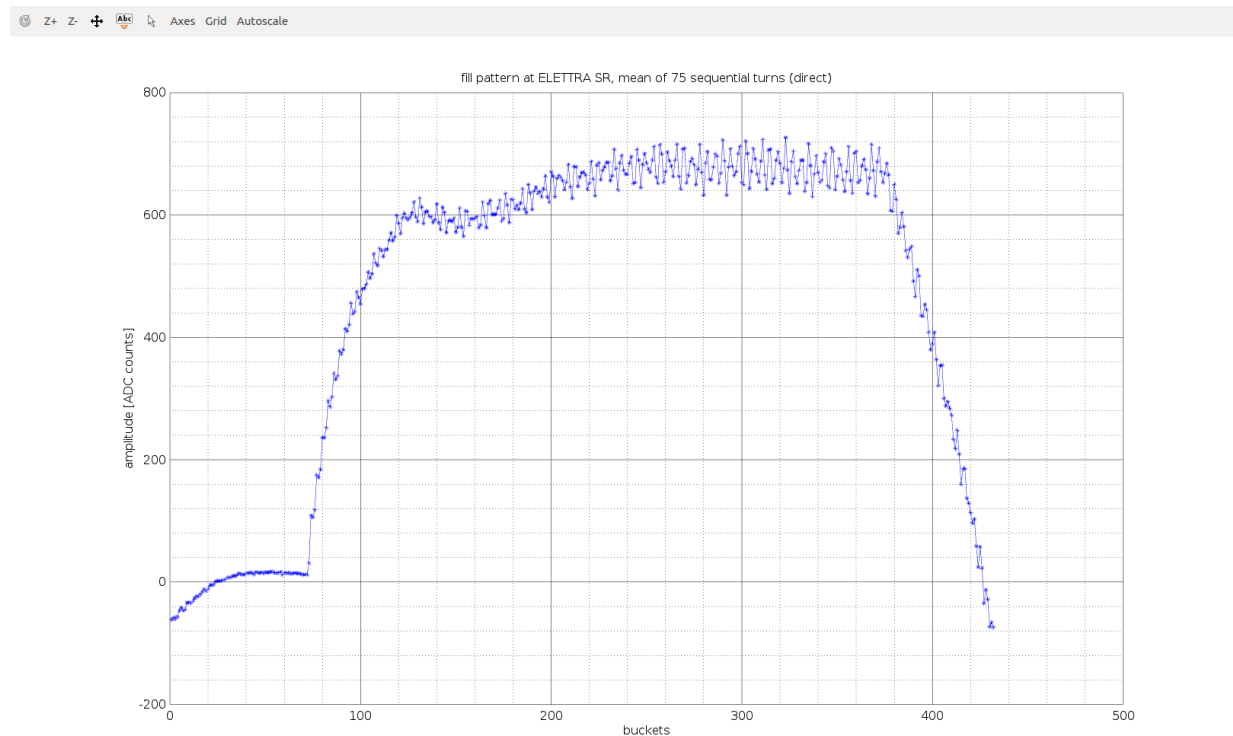
Bunch flat-top

- Measured with 8 GS/s oscilloscope – the flat-top region was estimated **10-15 ps**

- High order harmonics (~1.5 GHz) present in the signal, most probably due to splitter's frequency response

- Sensitive to phase differences in cables & reference clock phase

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Fill pattern measurement – before second try

- Used external filters to condition the signal

- Compare response to single bunch with:

  - ➢ Direct (no filter)

  - ➢ 570 MHz LPF with 0.5 dB insertion loss

  - ➢ 500 MHz BPF with 15 dB insertion loss and 54 MHz bandwidth
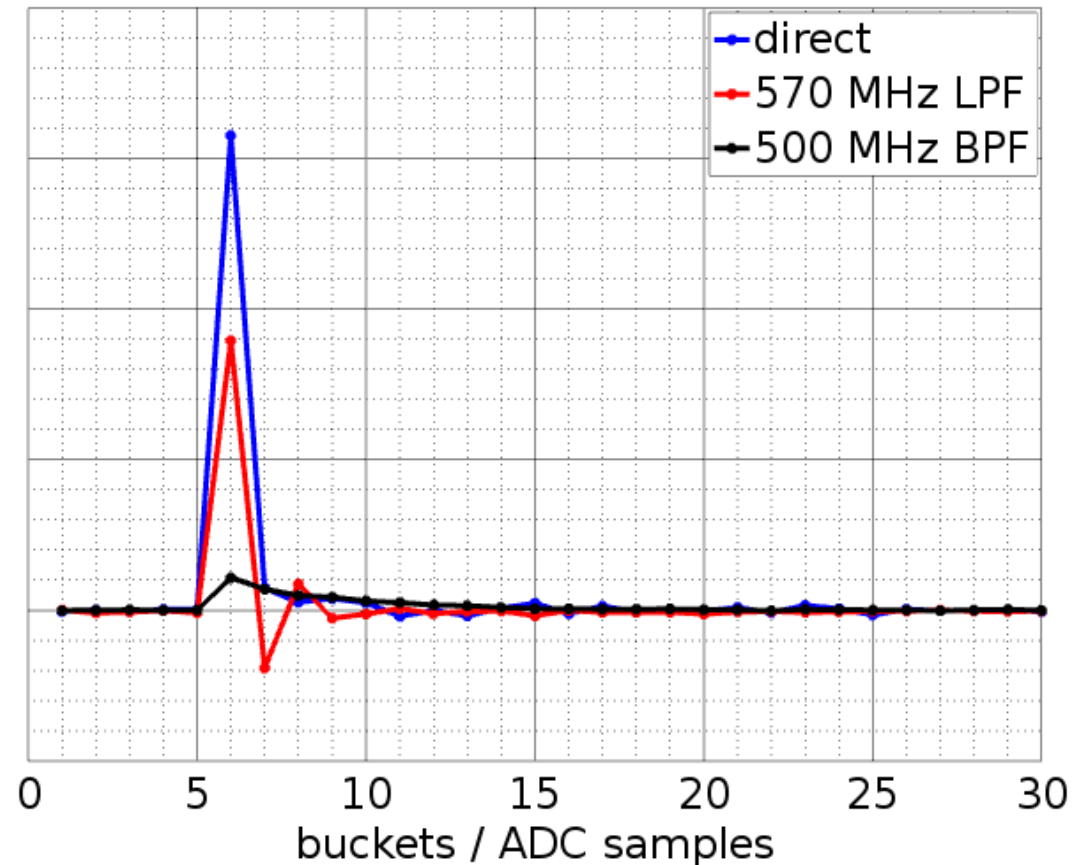
Fill pattern measurement – second try

- Manual REF clk phase adjustment

- 1 standard button pickup split to 4

- No filters used

- Much better results
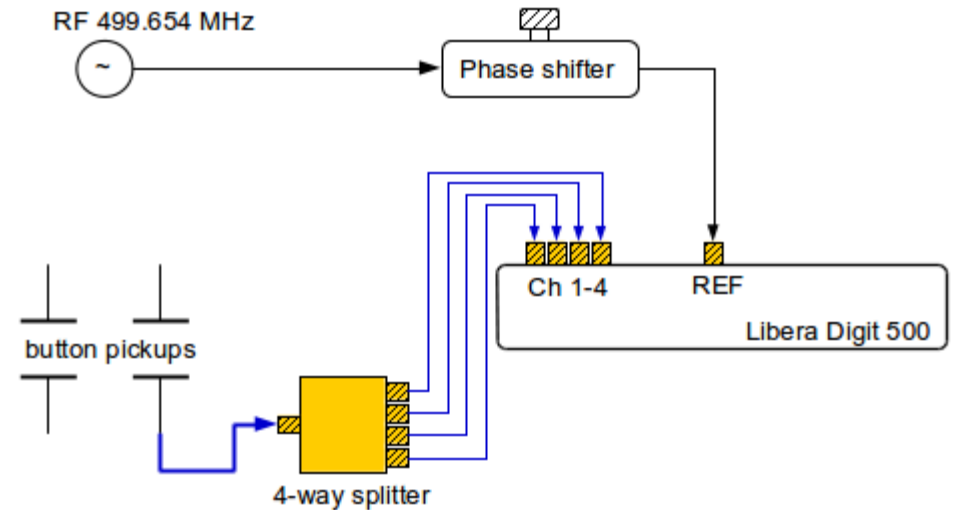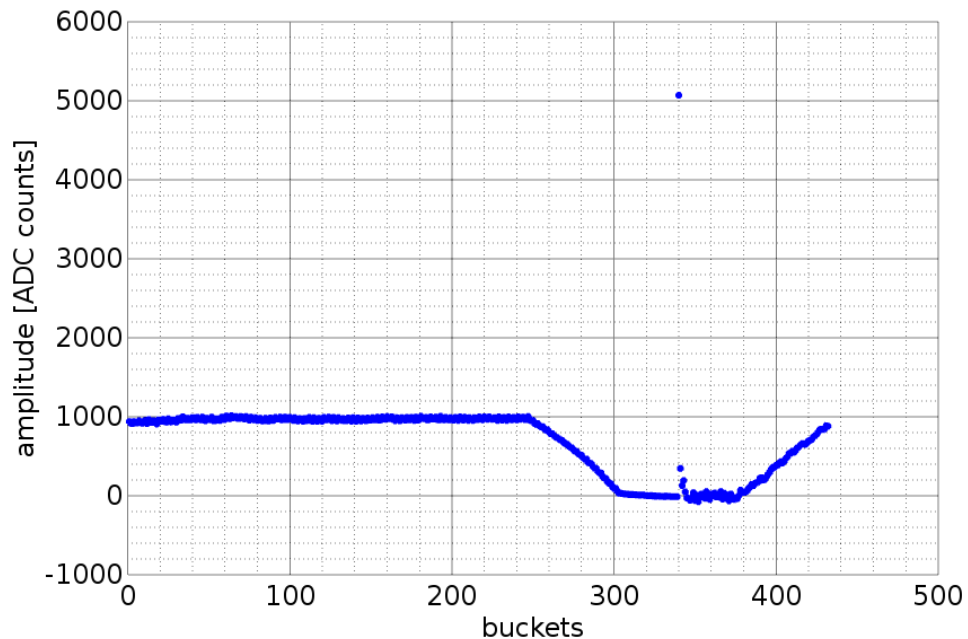
- Hybrid fill pattern: ~250 bunches with 1 mA/bunch followed by a gap and a 3 mA single bunch

- Matches with oscilloscope reading
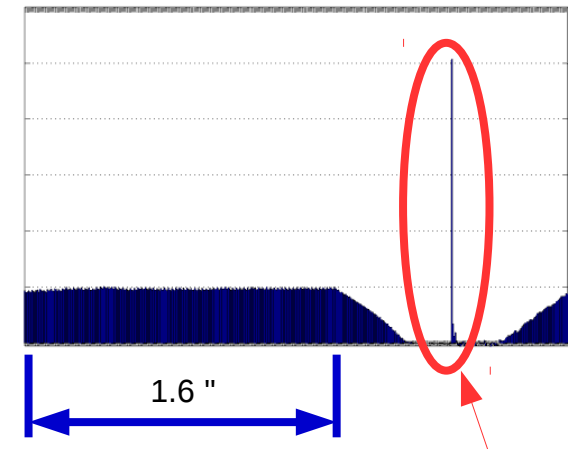
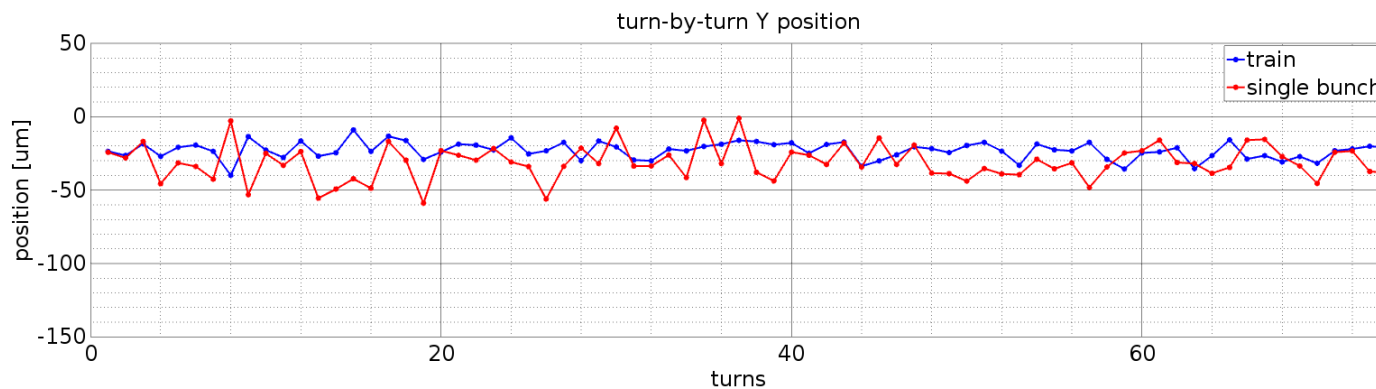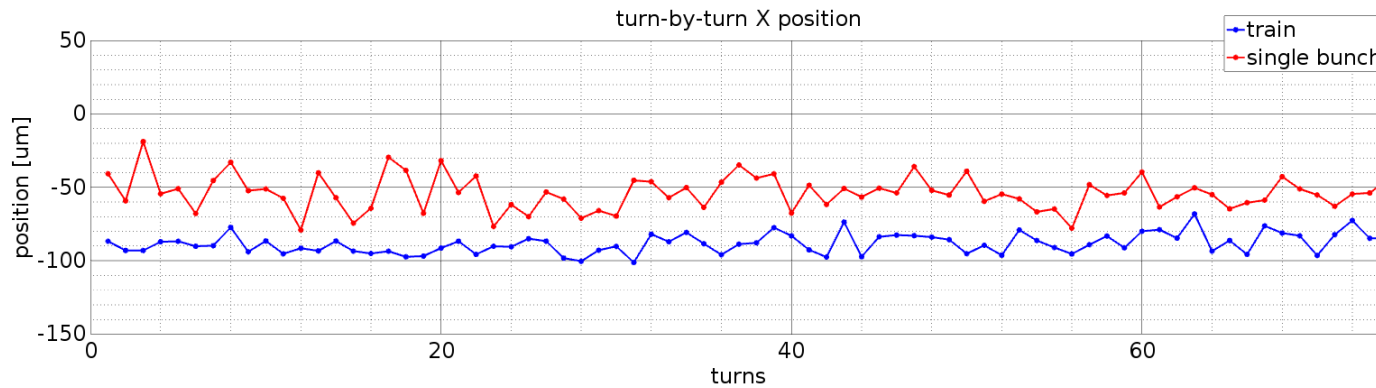- Current after a single bunch is real

Bunch-by-bunch position measurement

- Data from a hybrid fill mode, position calculated off-line (delta-over-sum, 10 mm Kx/Ky)
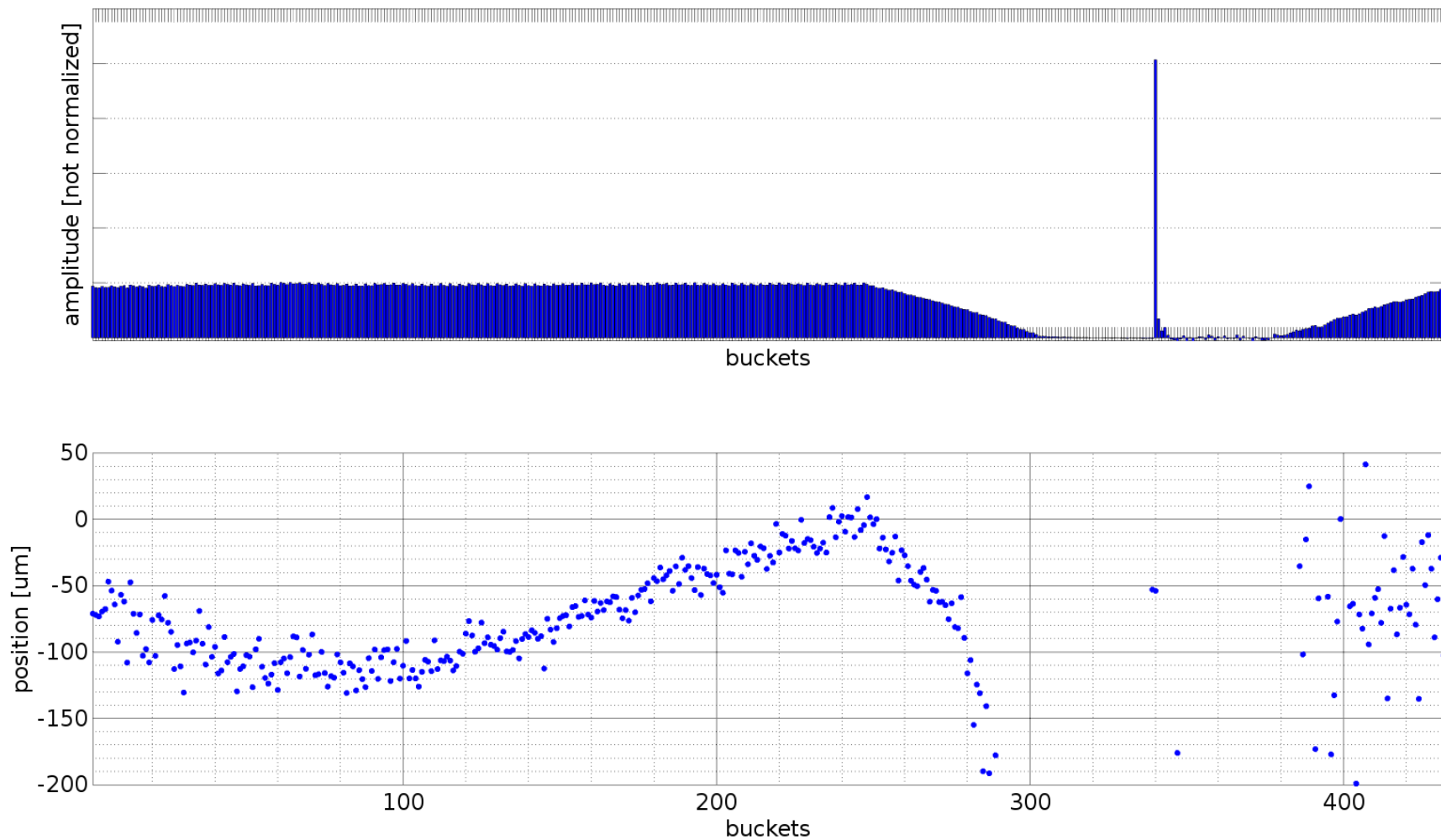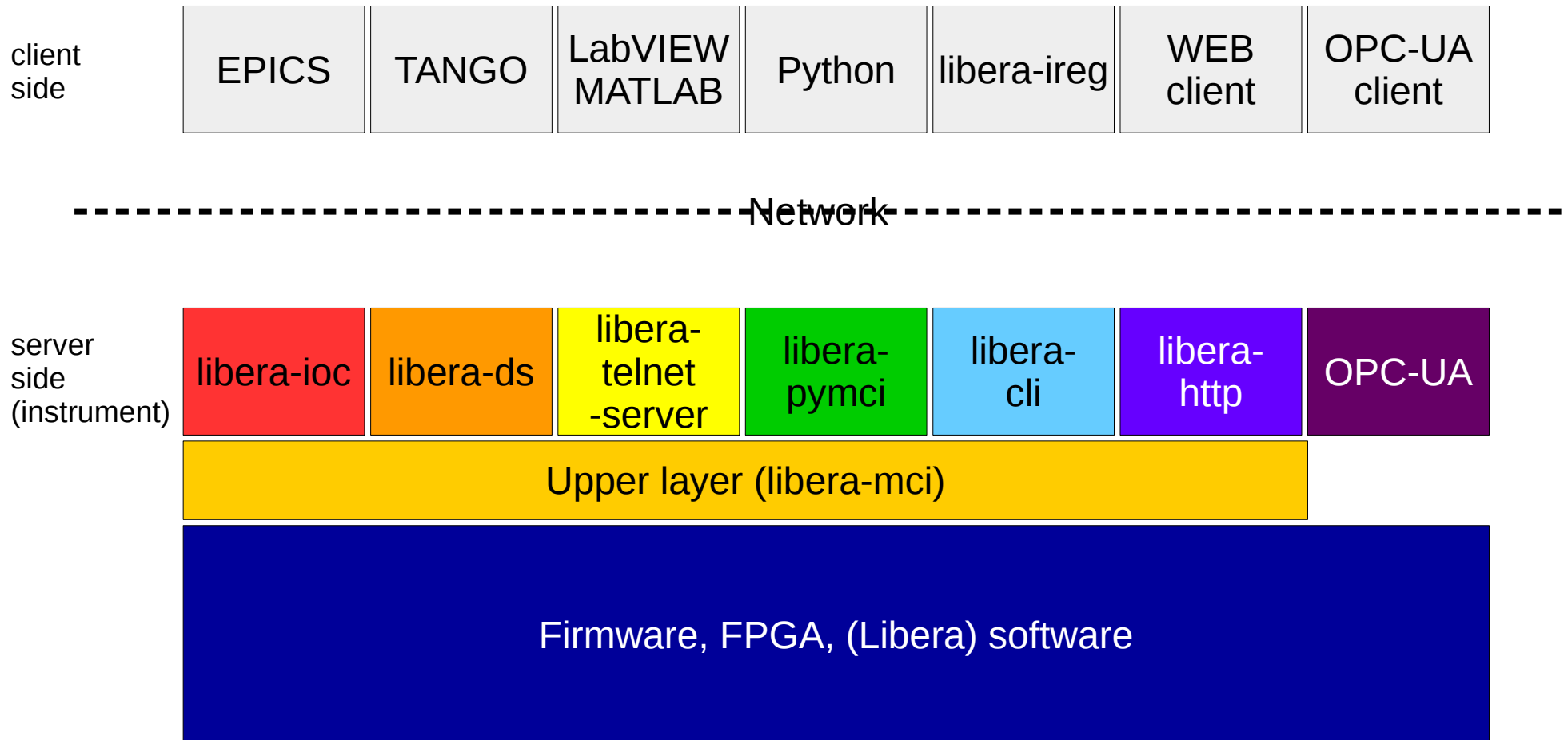
Bunch-by-bunch position evaluation

- Average position from 250 bunches over 75 turns (blue curve)

- Position from a single bunch for every of the 75 turns (red curve)

Interface updates – a rainbow

client
side

| EPICS | TANGO | LabVIEW MATLAB | Python | libera-ireg | WEB client | OPC-UA client |

-------------------------------- Network --------------------------------

server
side
(instrument)

| libera-ioc | libera-ds | libera-telnet-server | libera-pymci | libera-cli | libera-http | OPC-UA |

Upper layer (libera-mci)

Firmware, FPGA, (Libera) software

HTTP API – May 2019

- Read parameter:

  ```
  curl -X POST <IP_address>:8080/api/ -d '{"path":"my_parameter","cmd":"get"}'
  ```

- Set parameter:

  ```
  curl -X POST <IP_address>:8080/api/ -d '{"path":"my_parameter","cmd":"set"}'
  ```

- Server in the instrument, example `index.html` contains simple JSON code

- Using **`w3.css`** and **`vue`** scripts for example interfacing, **`plotly`** for plotting

Example for Libera Digit 500

Example for Libera BLM
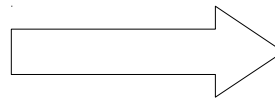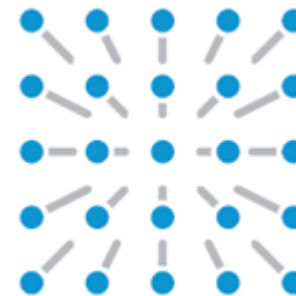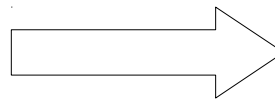
Conclusion

- Possible applications:

  - Fill pattern monitor

  - Bunch-by-bunch position monitor

  - General purpose digitizer

- Future outlook:

  - programmable REF phase offset

  - Signal processing scheme

  - (raw) data streaming
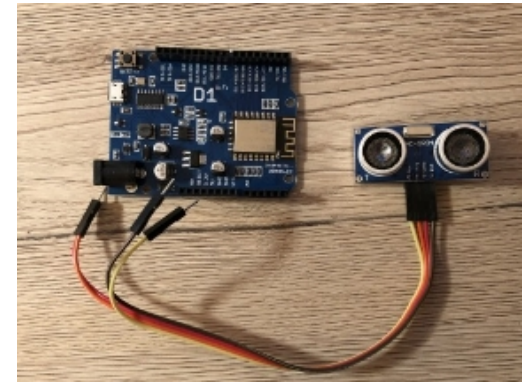
Thank you for your attention!

Backup slides – non Libera

Peter's project update since DEELS 2017 (1)

SDS011: A better PM2.5 and PM10 detector

HC-SR04: ultrasonic distance sensor for snow depth measurement

Webcam with day/night configuration
1 hour & 1 day auto time-lapse videos
Video storage

ADS-B receiver: follow aircraft over my town. Maximum range:
~58 nm with low-cost antenna
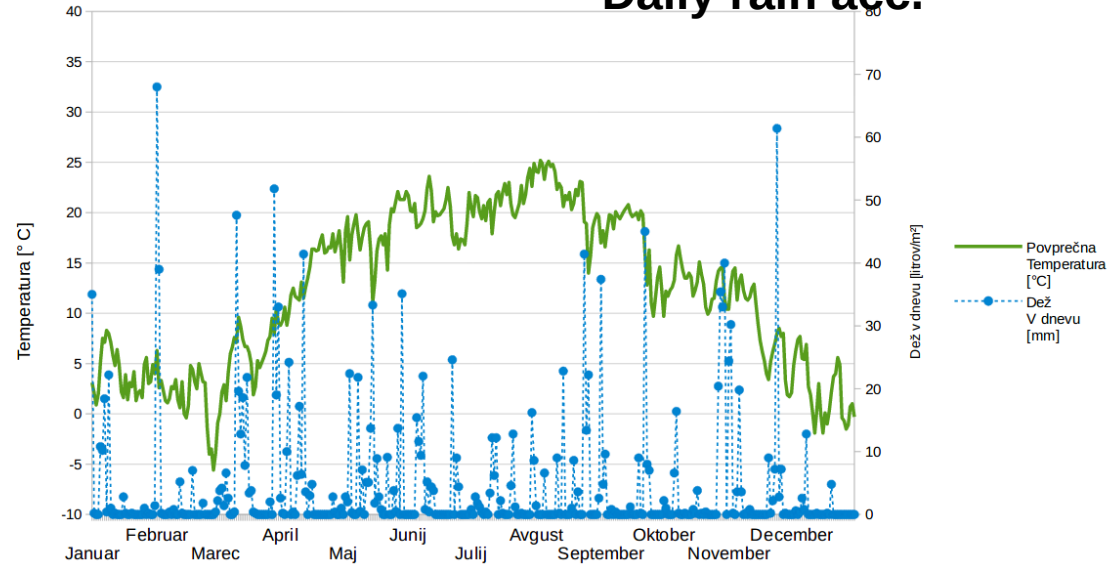
Peter's project update since DEELS 2017 (2)

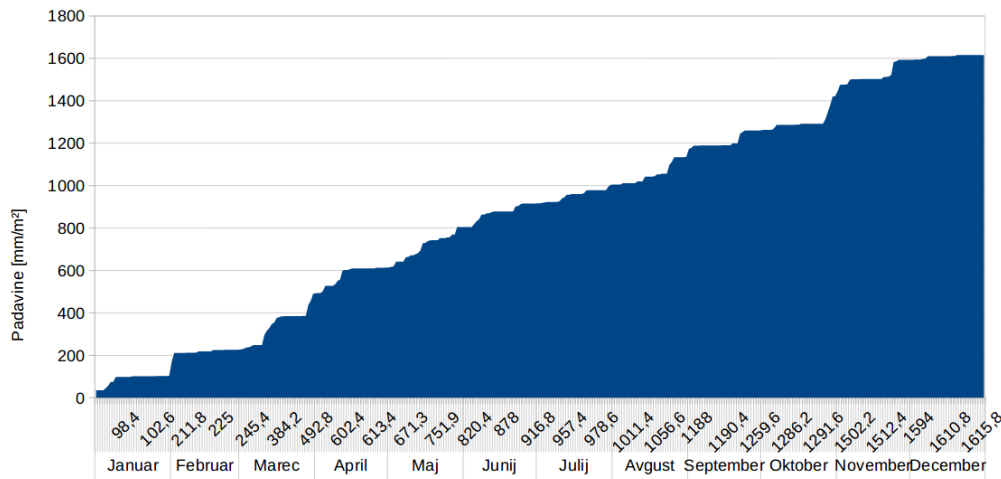**Avg.temperature & Daily rain acc.**

Performance over y.2018
- **Data acquisition on-line: ~99.7%**
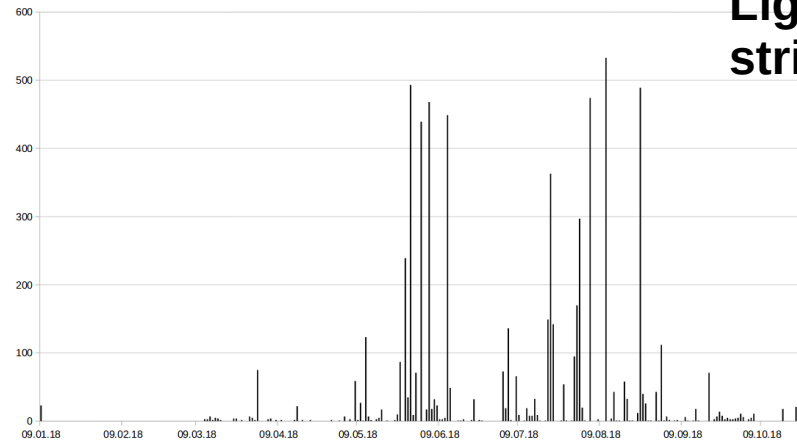- **Fresh web data availability: ~99%**
- **Data logged in database: 100%**

Issues:
- **Work on electrical network**
- **Windows updates**

Rain accumulation

Lightning strike counter

Peter's project update since DEELS 2017 (3)

New weather station!
- **Ultrasonic wind detector**
- **Haptic rain sensor**
- **Temperature, humidity, lightning strike, barometer**

Data in real-time (3-sec update)
from 920 m above sea level