HIGH-RATE VMM3 TESTBEAM @ MAMI

MAINZ ER SUPERCONDUCTIVE ACCELERATOR

Multi-turn, superconducting ERL

Energy recovery mode

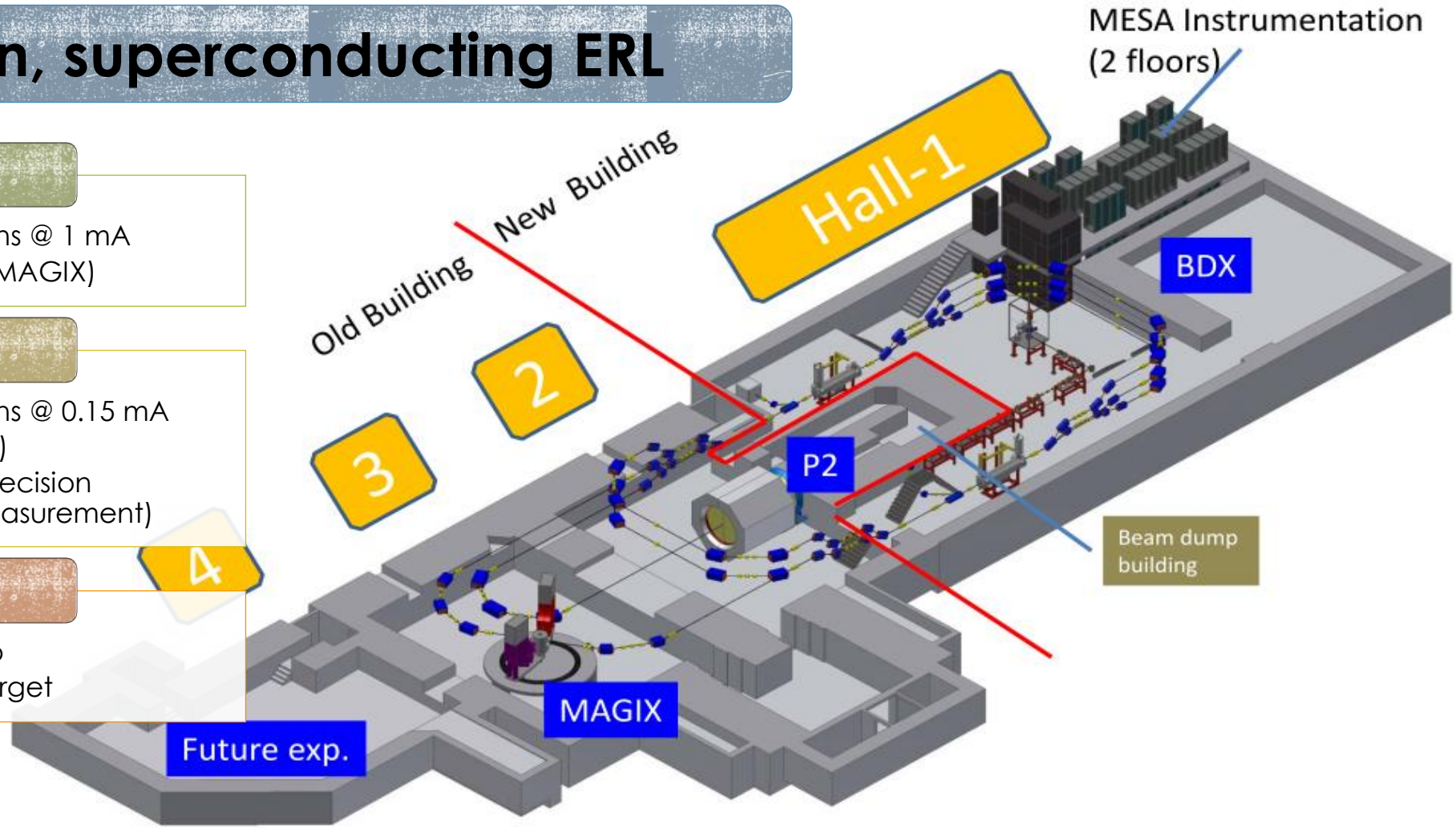
- 105 MeV polarized electrons @ 1 mA
- Internal target scattering (MAGIX)

External beam

- 155 MeV polarized electrons @ 0.15 mA
- Dedicated experiment (P2)
- Electroweak asymmetry precision measurement (10000 h measurement)

Beam dump experiment

- Behind the P2 beam dump
- About 10^{23} electrons on target



THE MAGIX SETUP

A high-precision multi-purpose experimental setup

Internal Gas Target

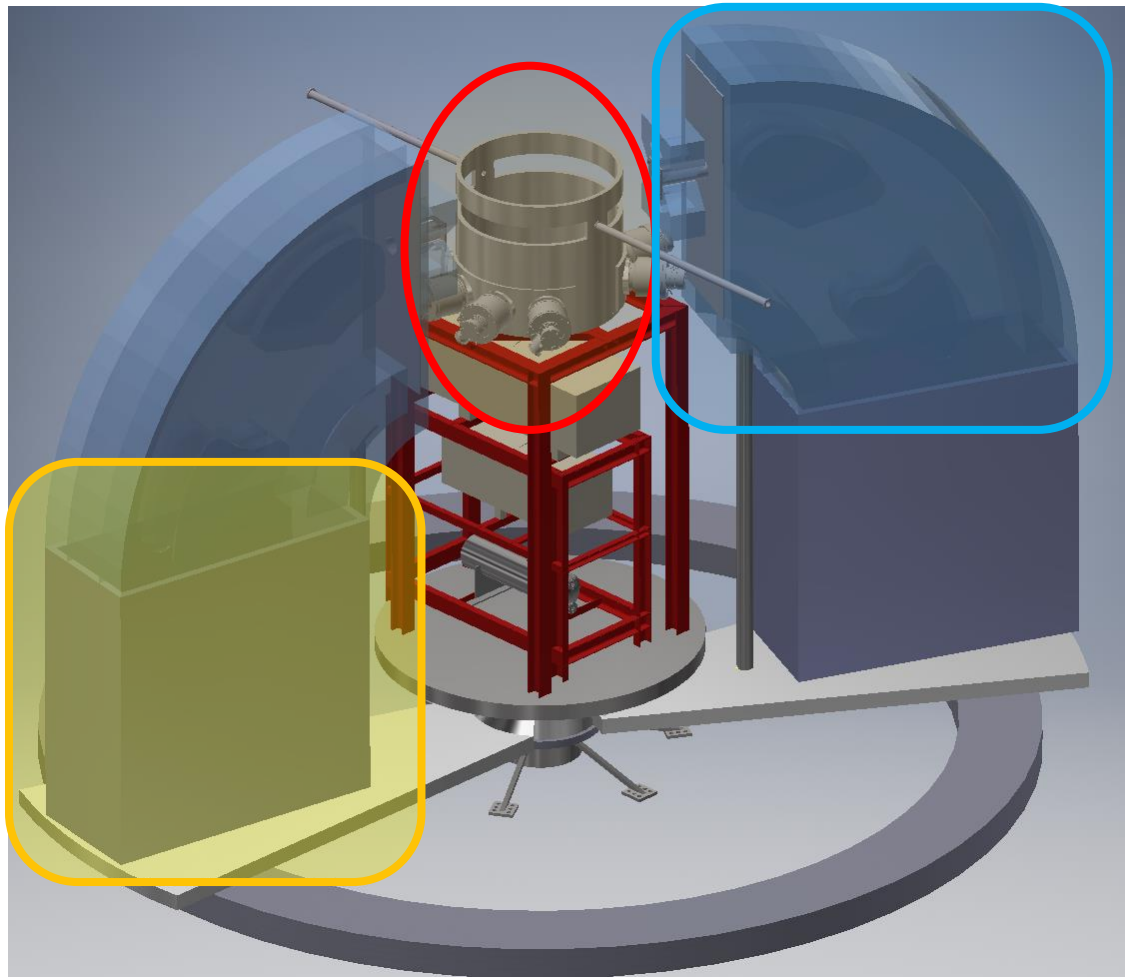
- Windowless gas target
- Integrated recoil silicon detectors
- Forward luminosity monitors

Spectrometers

- Twin Arm Dipole Spectrometer
- Zero-degree tagger spectrometer

Focal Plane Detectors

- GEM-based TPC tracker
- Timestamping trigger



TPC BASELINE DESIGN

Geometry

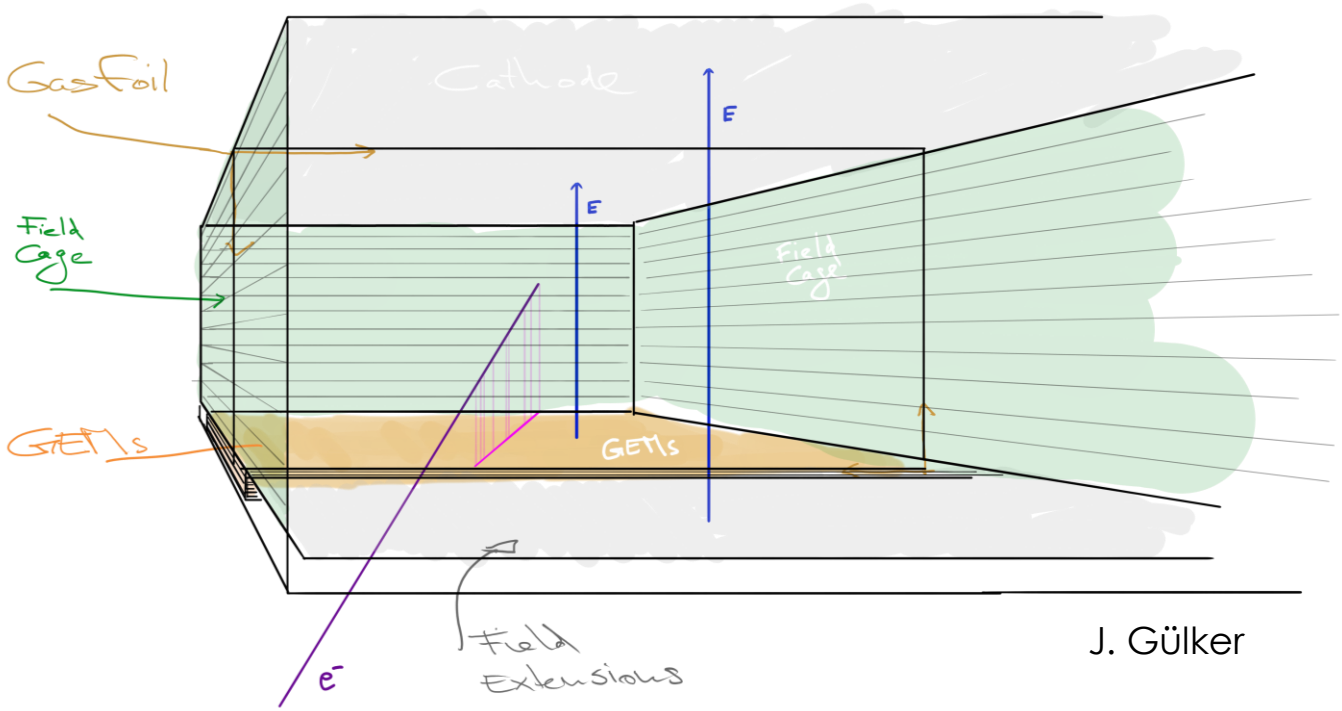
- 150 mm drift length
- 1000 * 160 mm^2 sensitive surface
- 2 * 8 mm^2 pads laid out in rows

Fields and amplification

- Open field cage with extension plates in the spectrometer vacuum
- 3 or 4 GEM amplification setup

Electronics

- ~ 10k channels per detector
- Maximum design rates: 100 -1000 kHz events on <100 channel per event
- VMM3a frontend with SRS-based DAQ



J. Gülker

Schedule and milestones

- Complete the design by June 2019
- Purchase the most expensive components in summer
- GEM and electronics are the two main items

VMM3-SRS VALIDATION PROGRAM

Operate them

- Verify the basic operational parameter: electronic parameters, data bandwidth, SRS integration, reliability.
- Using the APV setup to cross-check and validate

Measure high-rate performances

- Measure the basic characteristics at rates up to a few MHz
- Measure with increasing number of channels per event
- Measure double hit separation capability

Evaluate in a TPC prototype

- All of the above in TPC prototypes of different sizes

VMM3 TESTBEAM @ MAMI

Schedule

- M. Lupberger and VMM3 setup arrived on 07 Nov
- Lab measurement on 07 Nov with iron sources
- Installation at the test-beam on 08 Nov
- Running until the 11 Nov

MAMI detector test beam line

- 195-855 MeV electrons with tight focus
- Currents up to a few nA due to the radiation protection limitations

Detectors

- Small TPC prototype not ready on time due to delayed deliveries
- Standard double strip "CERN detector" – 0.4 mm strip pitch, 512 channels
- Double connection drift chamber – 28 pads connected to APV and VMM at the same time
- Triple GEM readout, Ar-CO_2 70-30

ELECTRONICS SETUP

Frontend

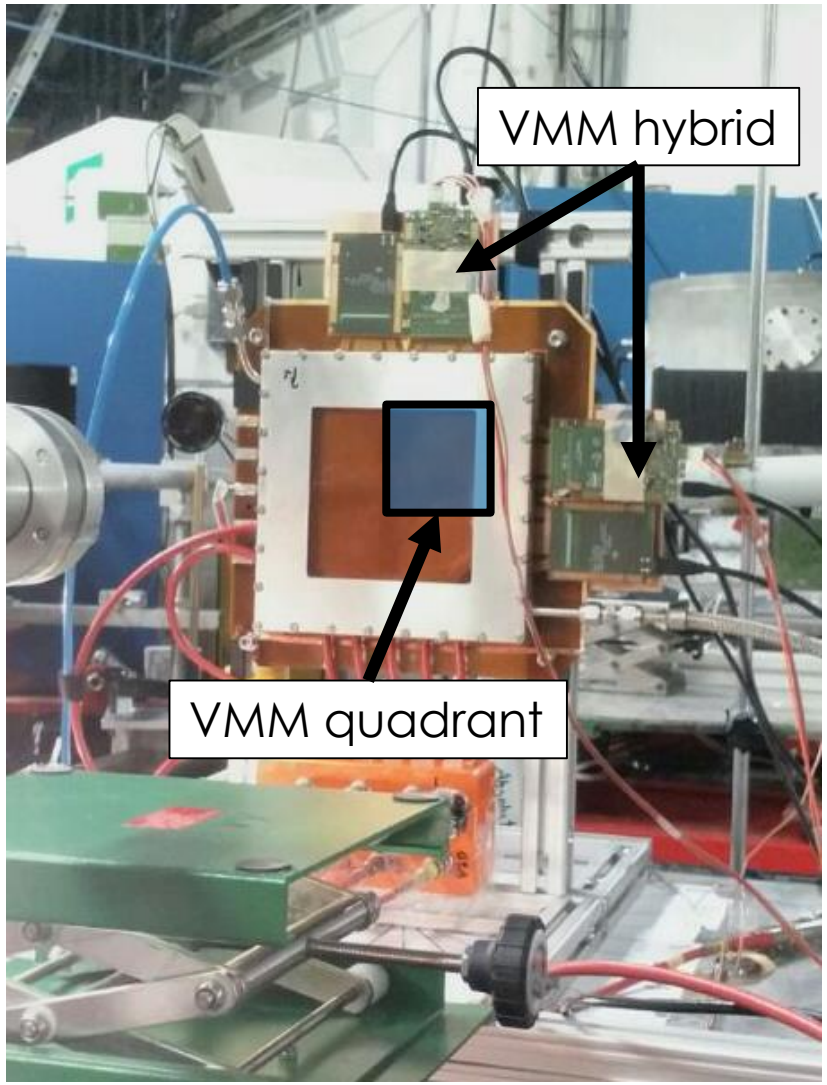
- 2 VMM3a hybrids, 1 hybrid per coordinate, 256 channels
- 2 APV hybrids, 1 hybrid per coordinate, 256 channels
- 1 quadrant (5 x 5 cm^2) all VMM, 1 quadrant all APV, 2 mixed readout

DAQ system

- CERN mini-computer with ESS software
- USB 3.1 RAID storage device

Slow control

- ESS software for the VMM
- EPICS based slow control for the local equipment



RESULT SUMMARY

Datasets

- Iron spectra from the laboratory before the test-beam
- Full scan of the amplification parameters (gain and shaping time) with and without neighboring logic
- Scanning of shaping times and readout frequencies for rates up to 3 MHz
- Angular scan from 0 to 75 degrees at rates from 2 KHz to 3 MHz to hit as many channels as possible.
- Drift velocity scan at 3 MHz
- APV-VMM parallel runs with the 28 channels drift chamber.
- ~700 runs, 2.7 TB data acquired, uncompressed CSV format

General observations

- Nothing was damaged during the TB (besides one GEM foil)
- The connection between the DAQ and the VMM was sometimes problematic. Often we had to power cycle the system to recover
- When running the system seemed very solid and reliable (software included)

FIRST ANALYSIS

Understand and decrypt

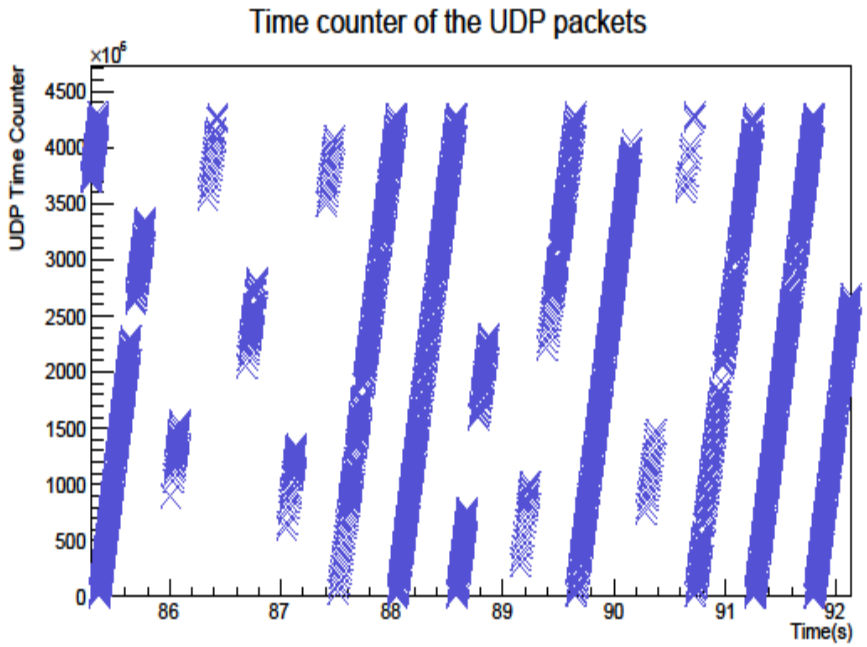
- Data stored in plain CSV format, not very efficient but useful to look in the data
- Bookkeeping system to sort and process the datasets
- Currently performing a basic statistical analysis of the acquired data – acquisition bandwidth and efficiency
- The raw hits need to be sorted and arranged in event-like structures for a functional and physics analysis

Data rates

- Data reception rate ~3.9M hits per second @ 2.7 MHz
- Data writing rate capped at about 500k hit per second, ~35 Mb/s
- ~88% of UDP packets were not processed and written to disk
- Need to switch to binary storage and more efficient processing

Data corruption

- Some inconsistencies detected in the data that were written to disk
- Notified Dorothea that spotted a bug in the DAQ code



OUTLOOK

Complete and test the small TPC

- This week the detector should be finished.
- Will be tested locally with the APV but needs to be tested with VMM
- If no equipment is yet available for delivery, maybe we can test it at CERN

Complete the new DAQ system

- Improve acquisition efficiency
- Readout both VMM and APV simultaneously
- It's really important to have the VMM hardware locally to progress

Complete the analysis

- Complete the event reconstruction and apply the physics reconstruction algorithm that we already use for the APV
- Validate the performances of the VMM at high-rates according to plan

CONCLUSIONS

Successful test-beam

- Considering the quality and quantity of data obtained
- Considering the quality of the collaboration between us and Michael/RD-51 collaborators

Analysis to complete

- Plenty of data to work with.
- If you have some benchmark quantity you think could be useful to extract from the data let me know

More progress to come

- The first TPC prototype is almost ready and it will need to be tested with the VMM
- Some VMM hardware to use will be very welcome and will make any progress much faster
- DAQ and analysis software under development will be included in the new SRS DAQ for VMM

SFB 1044

PRISMA

THANK YOU FOR YOUR ATTENTION!

http://magix.kph.uni-mainz.de

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University of Ljubljana

Westfälische Wilhelms-Universität Münster

Johannes Gutenberg Universität Mainz

JG|U