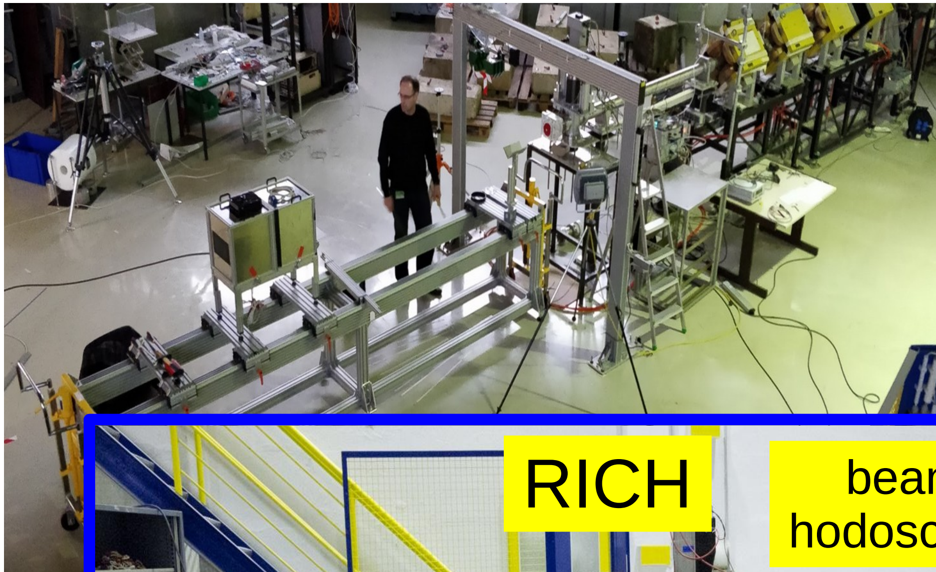
COSY CBAC meeting #7
proposal D004.x: status report

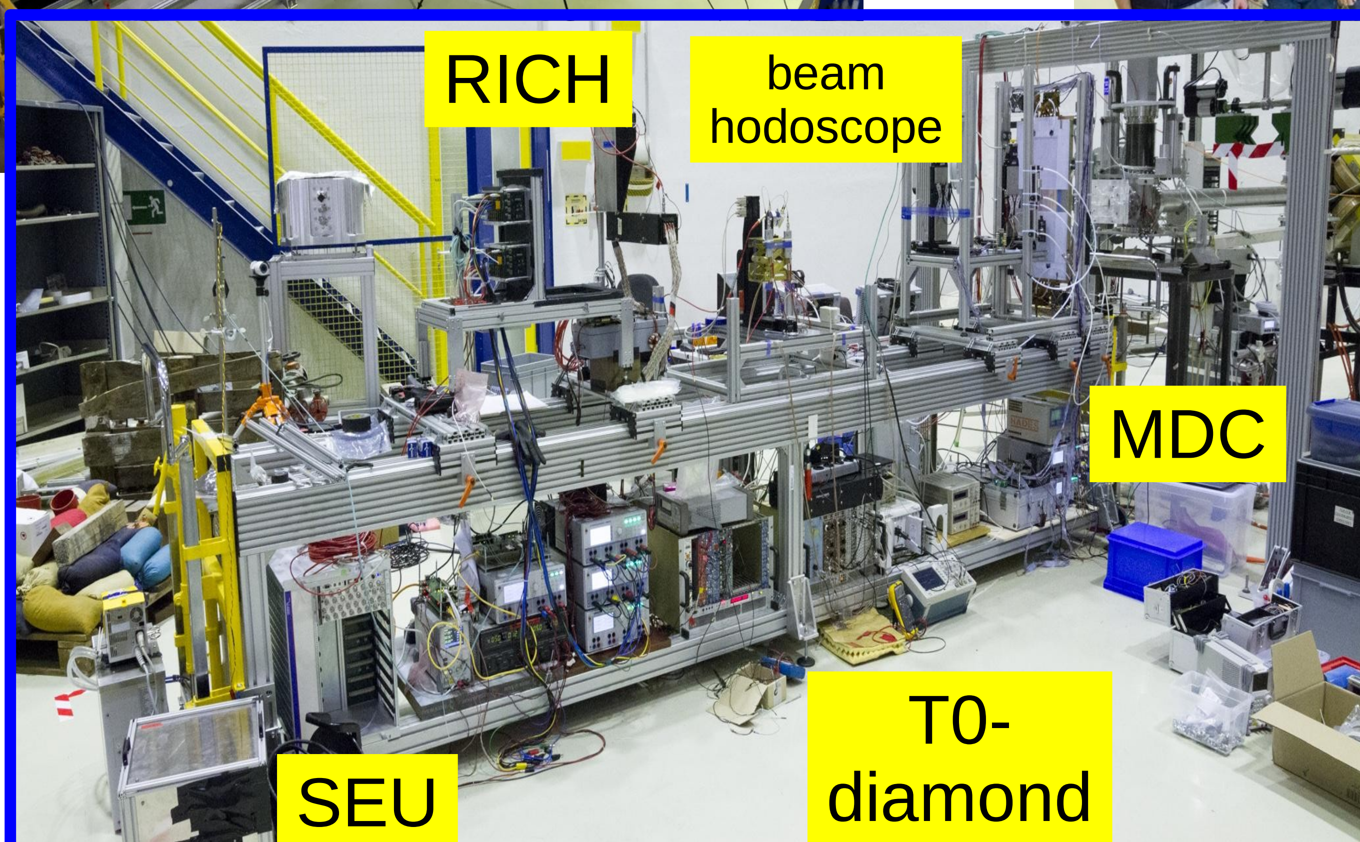
- Review of recent “CBM“ testbeam Oct/Nov 2017
- Upcoming test beam Feb/Mar 2018
  - plans and goals
  - status of preparation
- Future plans

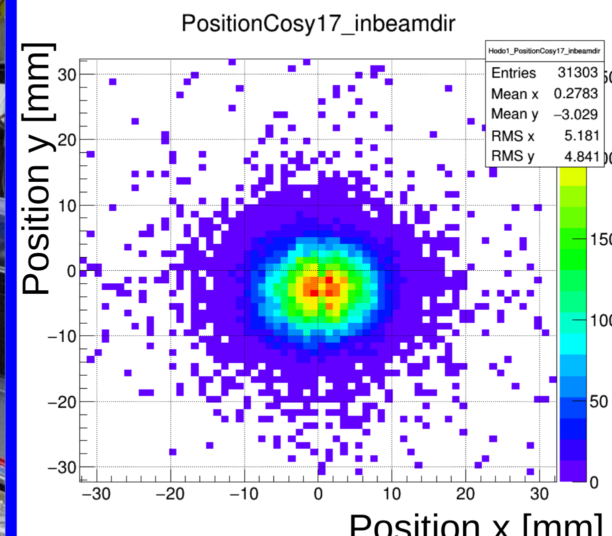
Testbeam Oct/Nov 2017

- Very successful testbeam from 28.10. - 05.11. 2017
- **Users from several subdetector groups, independent setups**
  - More than 15 people actively involved, complex setup
  - First time using Big Karl cave!
- **Main user: CBM/HADES RICH**
  - first beam test of newly developed DIRICH readout chain for MAPMTs (and MCPs)
  - test of wavelength shifting coating (WLS)
  - new prototype setup for use in further beam tests
- **Several additional groups:**
  - diamond T0 start detectors for HADES / CBM
  - HADES MDC, comparison between old ASD8 and new PASTTREC readout
  - SEU (single event upset) test of new readout controller
- Original main user: CBM-STS
  - could not use beam due to delays in new STS-XYter hardware production
  - looking forward now to upcoming beamtime Feb 2018

Impressions from test beam, Oct/Nov 2017
BIG KARL cave





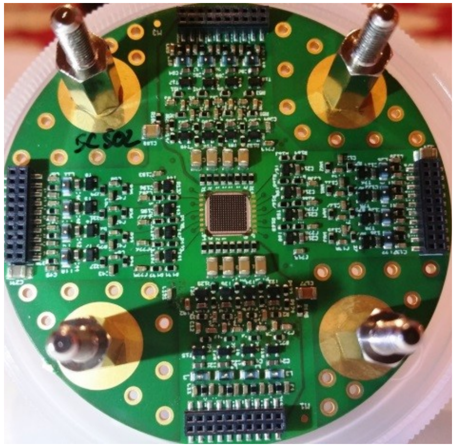


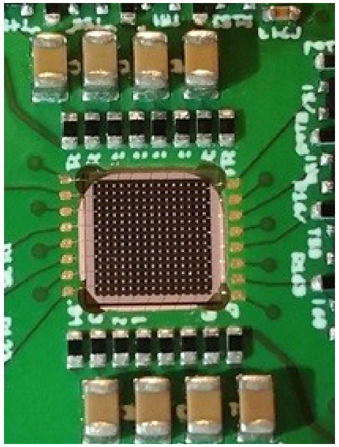
Beam spot at RICH
from hodoscope

HADES diamond T0 detector upgrade

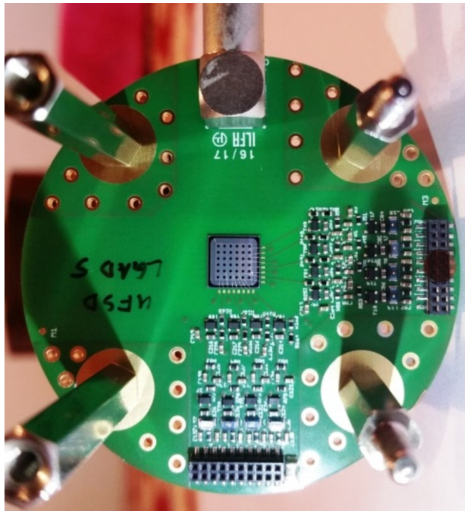
Double-sided, single crystalline scCVD diamond for Minimum-Ionizing Particles (MIPs)

- 16 strips, 300um pitch, on each side → 256 pixel equivalent,
- active area: 4.3 mm x 4.3 mm



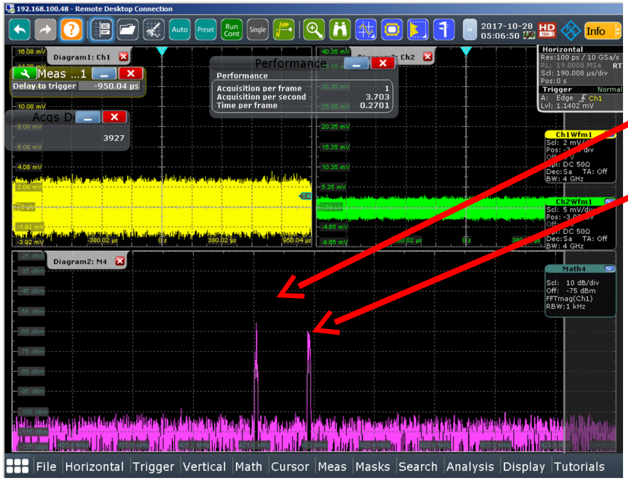


New, cheaper technology R&D: UFSD - Ultra Fast Silicon Detectors

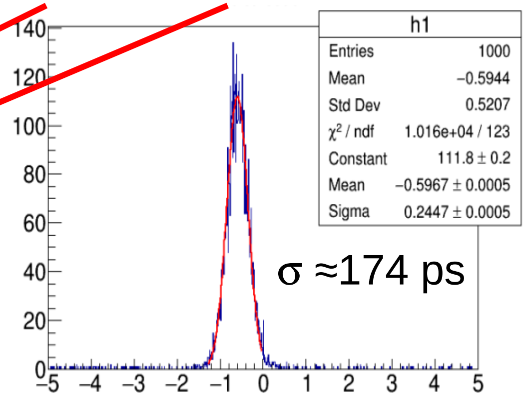


- Developed for CERN LHC
- Prototype ready:
  - 36 pixels,
  - Active area: 4.5 mm x 4.5 mm
- Can be used for timing
  - Precision below 100ps

Results from last beam time



Strong pickup signal seen in the readout electronics: 421.6 MHz / 422 MHz



Goals for Feb. beam time:

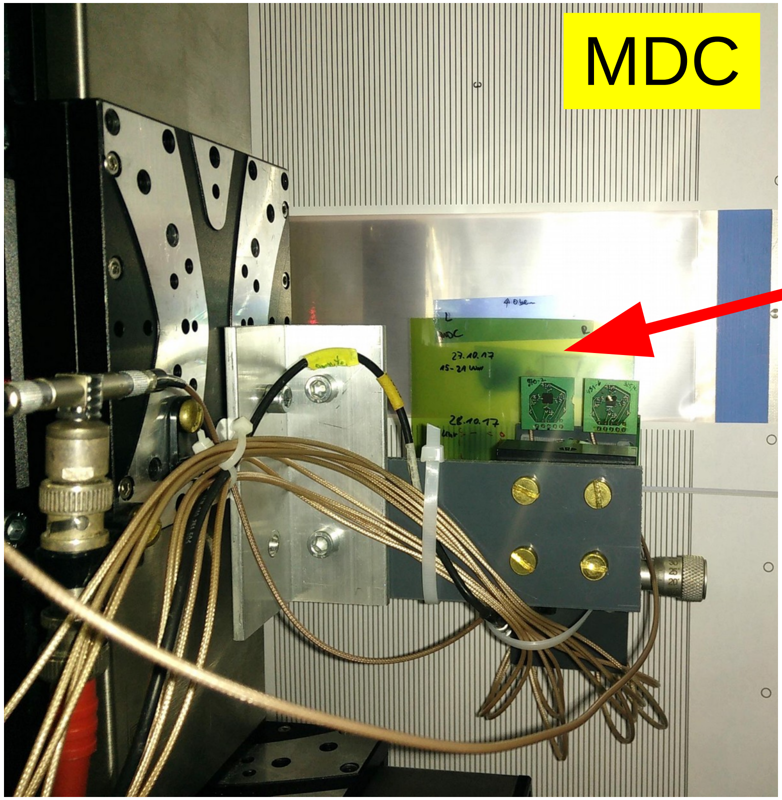
- Further performance studies of diamond based, segmented detectors
  → expected time precision below 100ps
- performance study of UFSD
  → expected time precision below 100ps

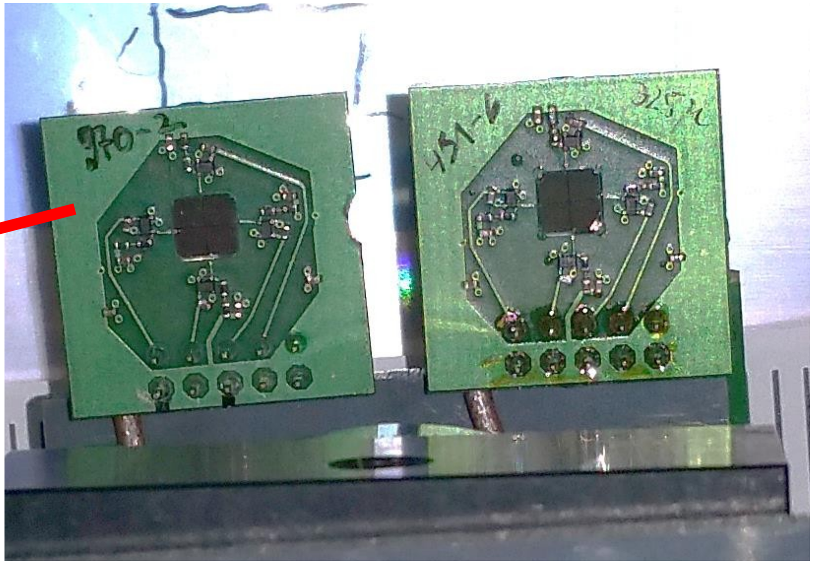
Setup:

- Several detectors in beam
- Scope and TRB3 based readout
- Setup mounted on a 2dim linear stages – remote control

HADES Multiwire Drift chambers – readout upgrade

- Study prototype MDC drift chamber for future HADES MDC upgrade (timing and position < 100mum – charge sharing method)
- Precision measurement of drift velocity in dependence of location inside a drift cell
- **Compare "old" ASD8 readout ASIC versus new PASTTREC readout**

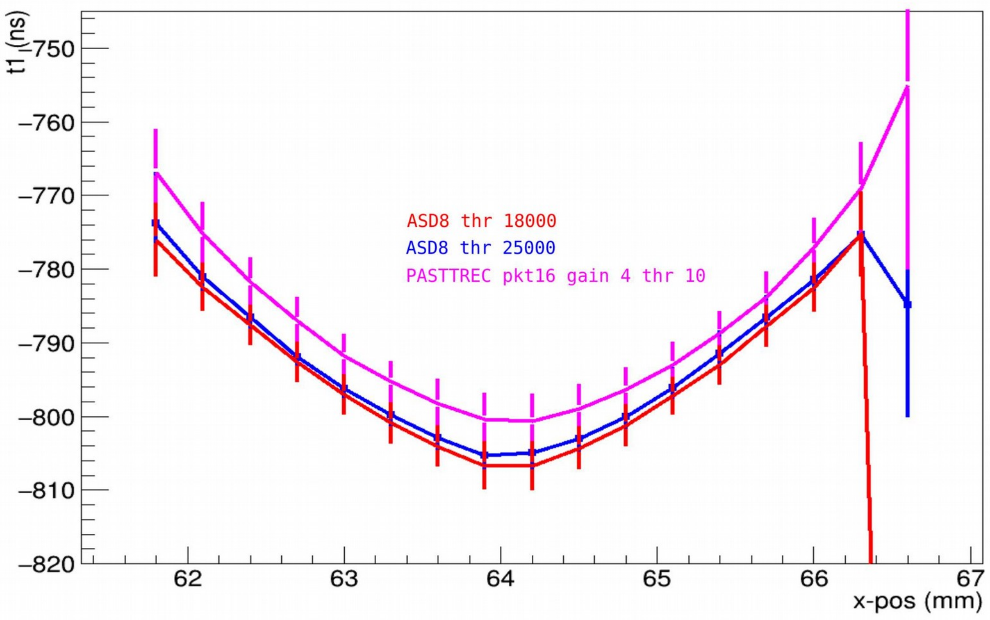




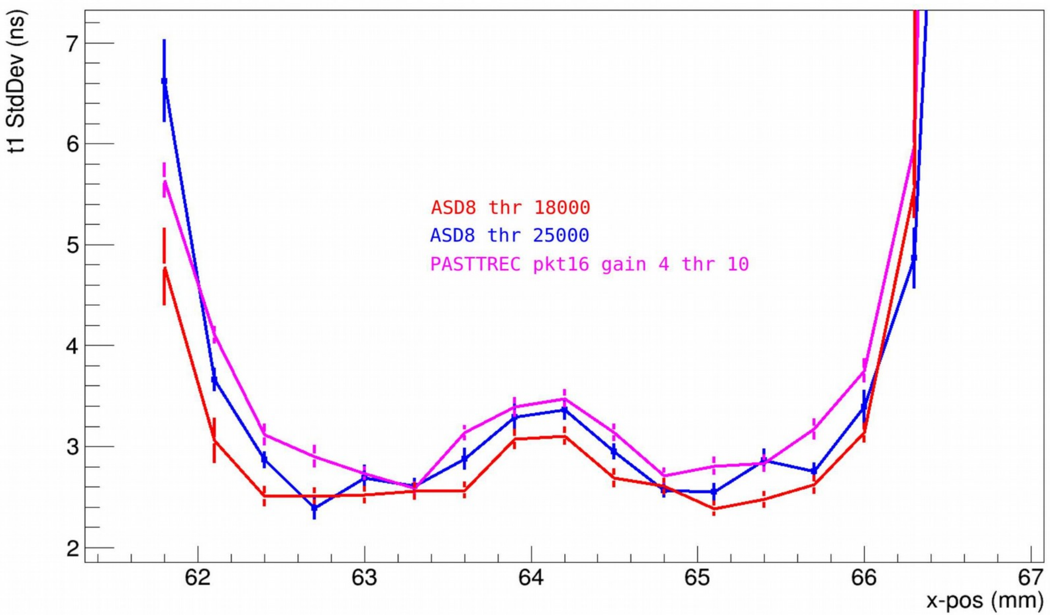
reference diamond T0 detectors
mounted on linear stage (mum precision)
in front of MDC as "start" detector

MDC results: drift time and precision comparison ASD8 vs PASTTREC

- Both ASICs show compareable precision and absolute mean drift time measures
- Drift velocity distribution across the drift cell is found to be smooth



drift time [ns] versus position within cell [mm]



drift time precision [ns sigma]
as function of position within cell [mm]

RICH setup and goals

- RICH group is building CBM RICH detector, upgrading HADES RICH detector sharing same MAPMTs Hamamatsu H12700

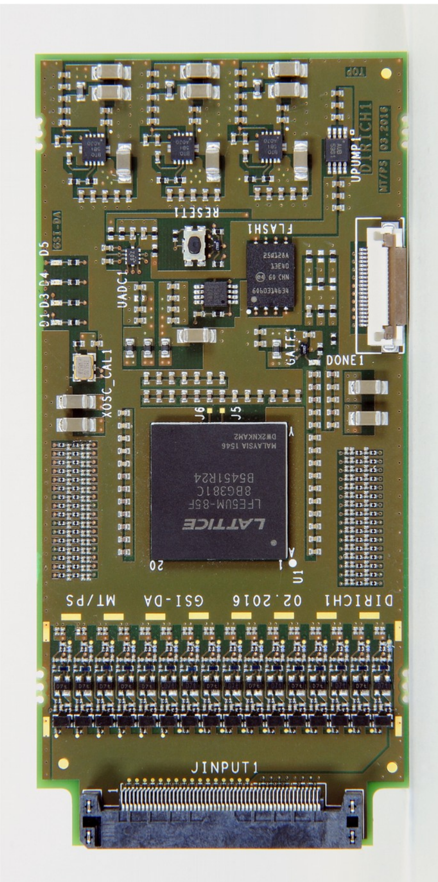
- New electronic readout chain DIRICH for MAPMTs and MCPs being developed
  - FPGA TDC based, excellent timing precision
  - Only timing and Time-over-Threshold, no amplitude measurement
  - Analog signal discrimination inside FPGA

- **Main goal: Qualify DIRICH readout chain for production**
  - Prototypes available since 12 months for lab tests
  - Upcoming HADES beamtime in August 2018
  - October 2017 beamtest was “final test”
  - Efficiency, Timing precision, rate capability, functionality

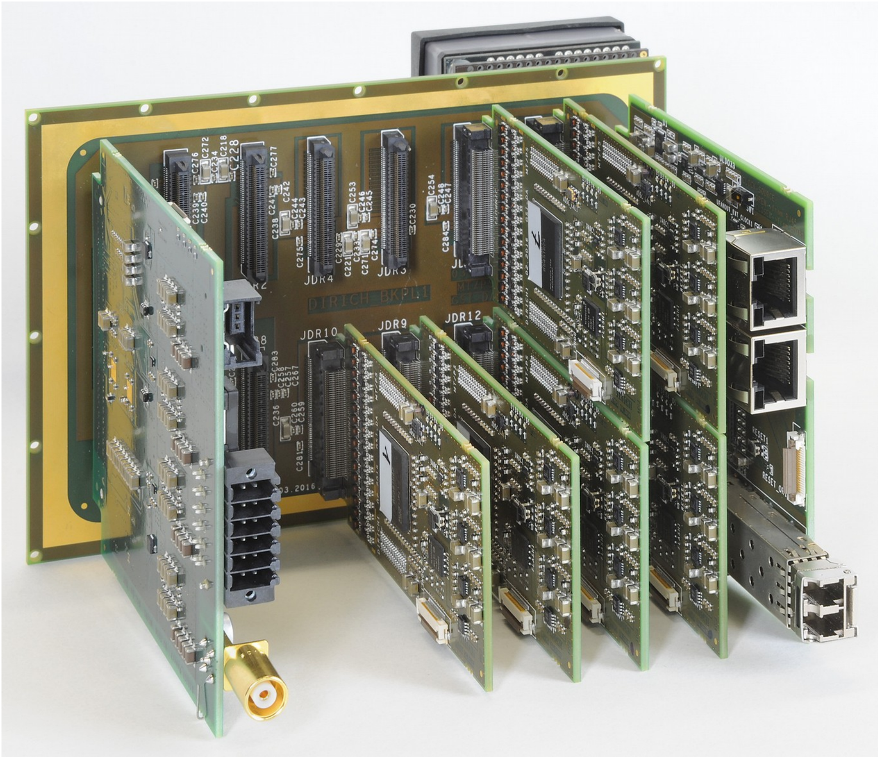
- Small RICH prototpye developed for electronic tests at COSY and GSI

The DIRICH family

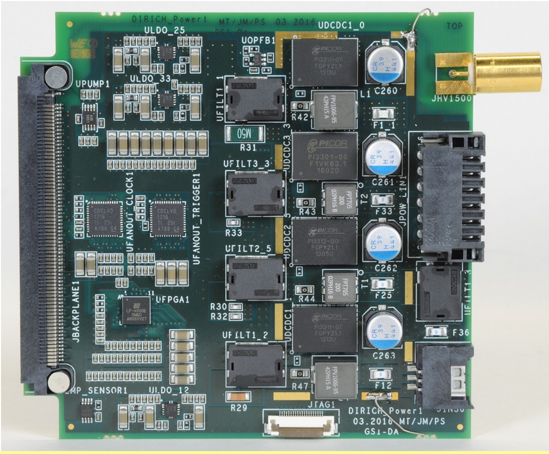
M. Traxler, C. Ugur, J. Michel, P. Skott, BuW, and many more (TRB collab.)



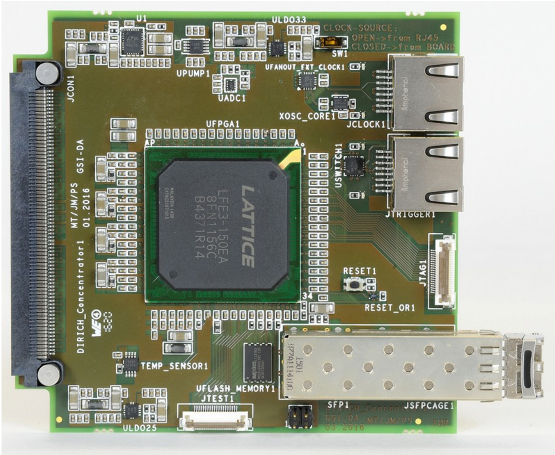
32ch DIRICH
frontend module



3x2 MAPMT readout module
384 channels, 12x DiRICH
(with few modules equipped)

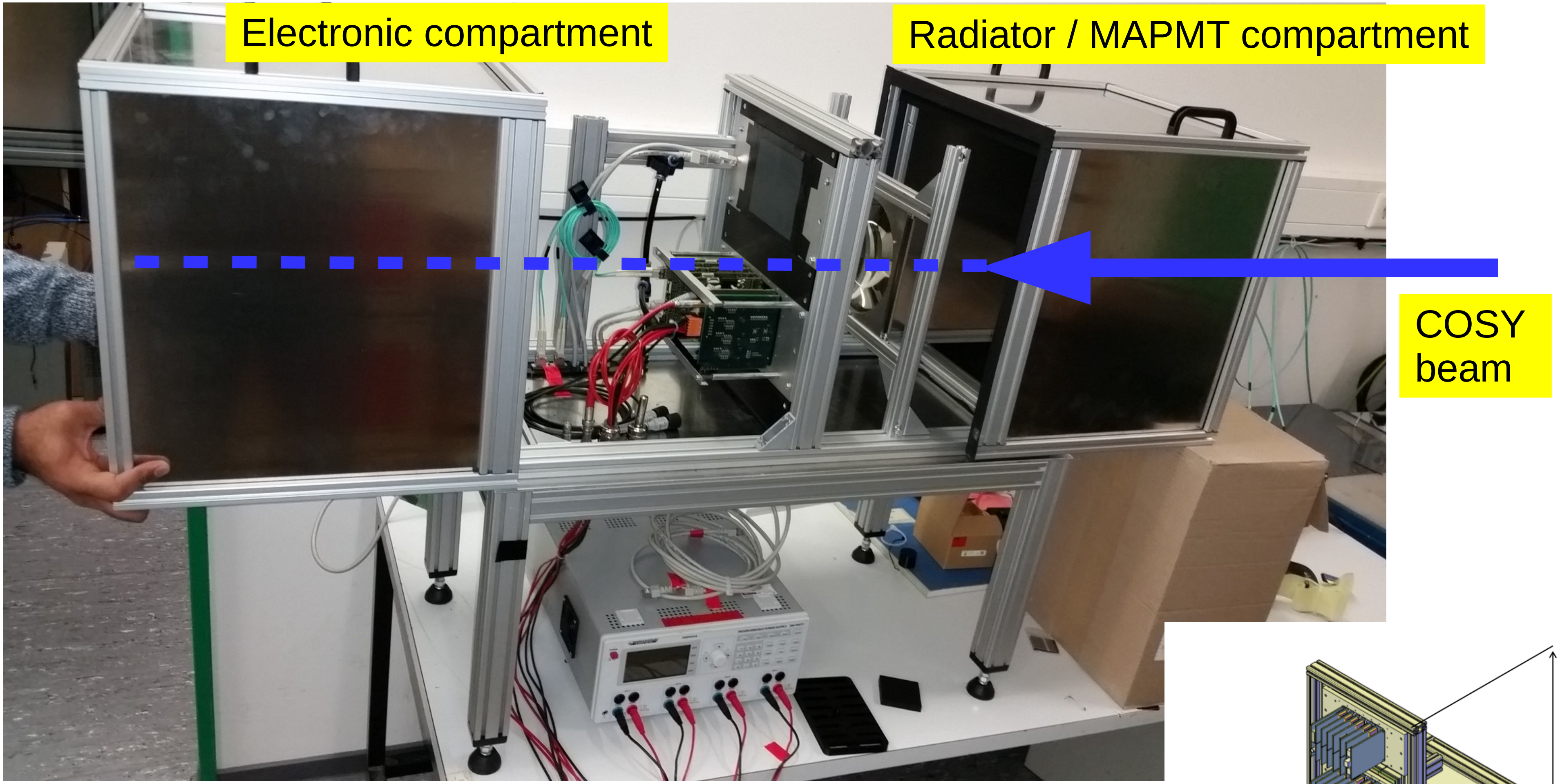


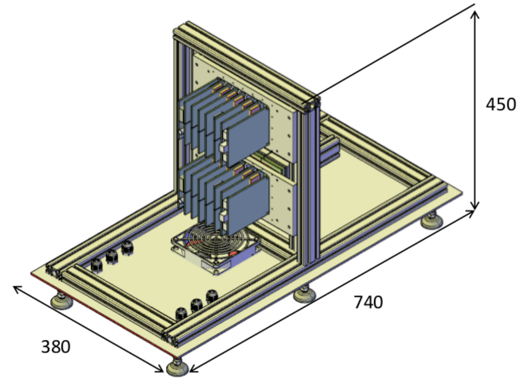
DIRICH-Power module
(LV + HV supply, DCDC)



DIRICH-Combiner module

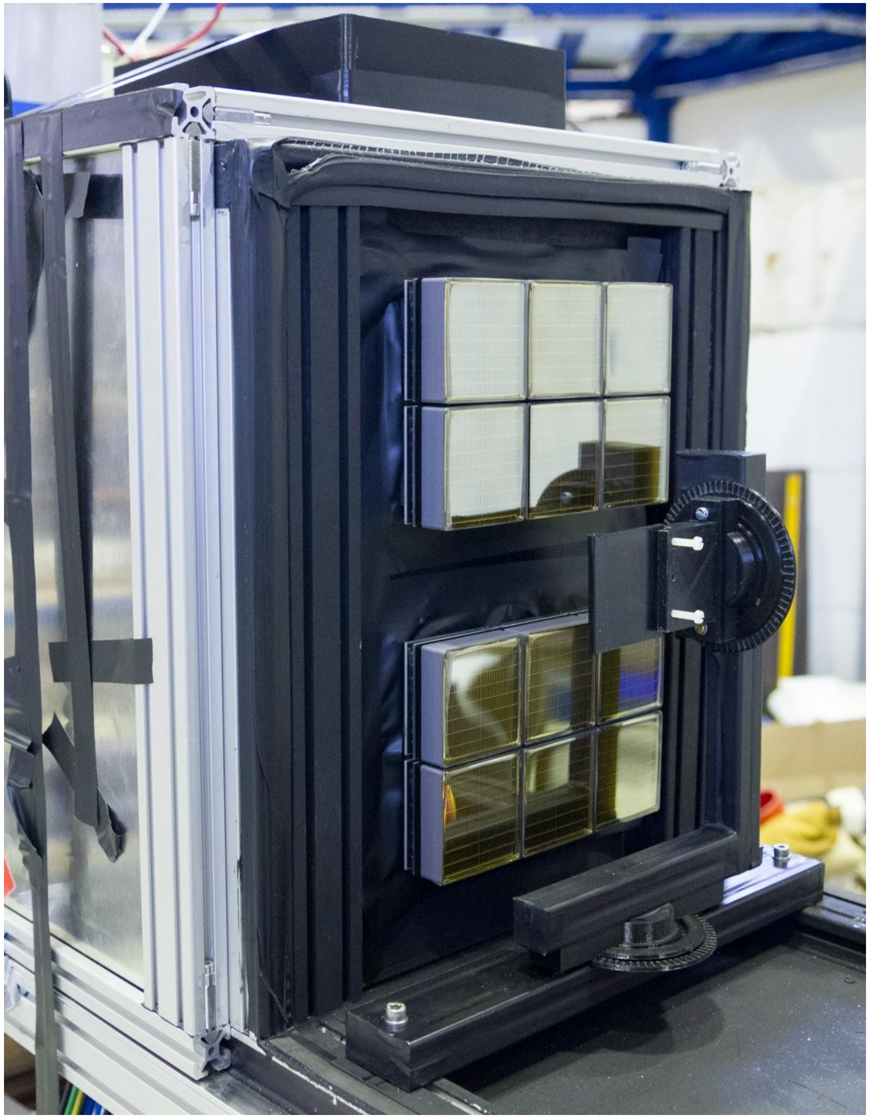
RICH@COSY prototype

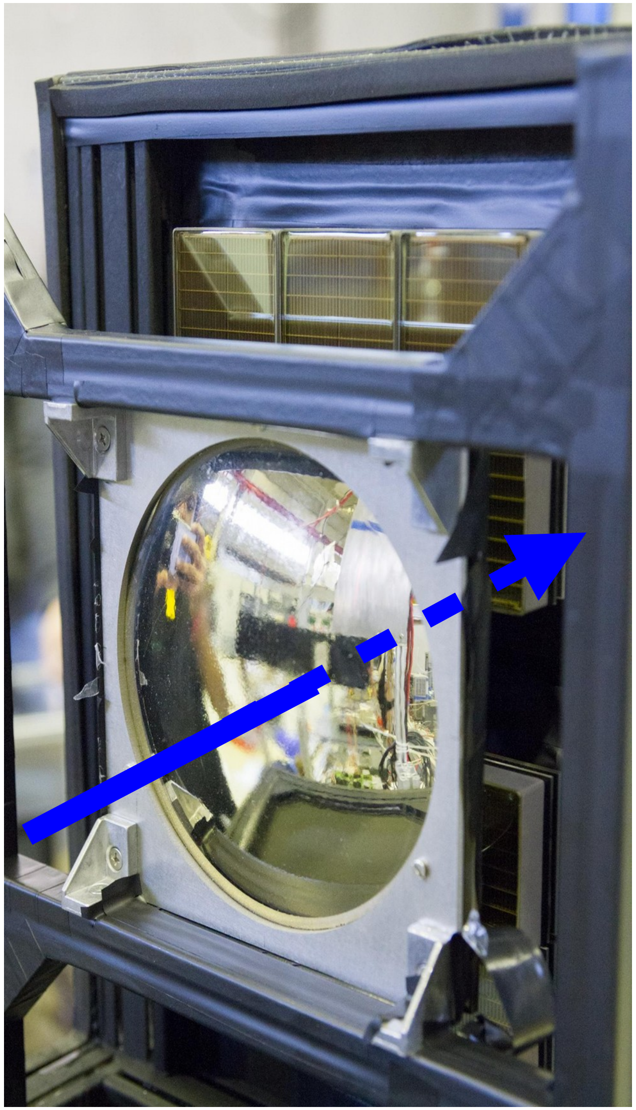


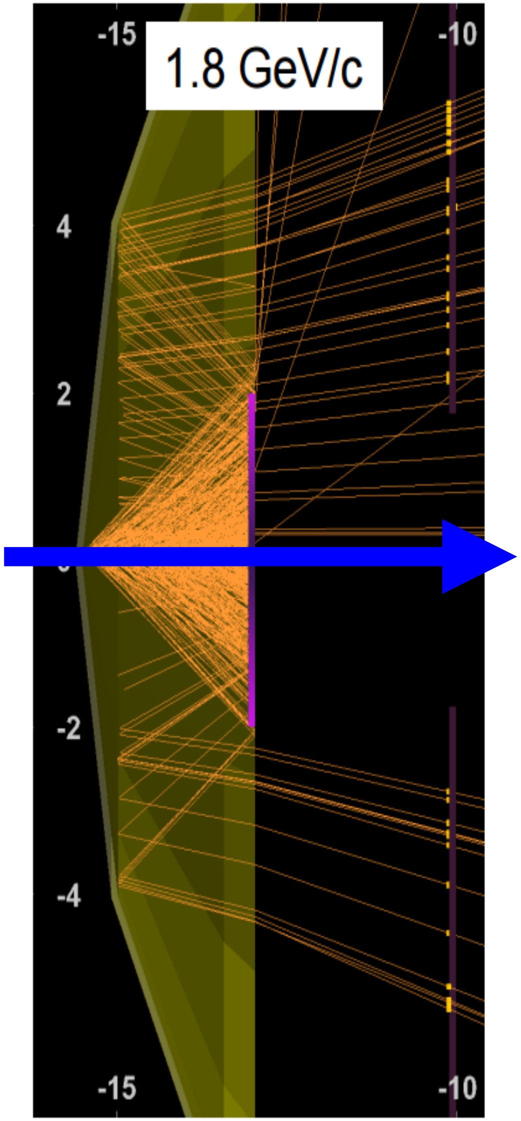


Main motivation:
Test MAPMTs and electronics with real Cherenkov photons

RICH prototype – radiator configurations



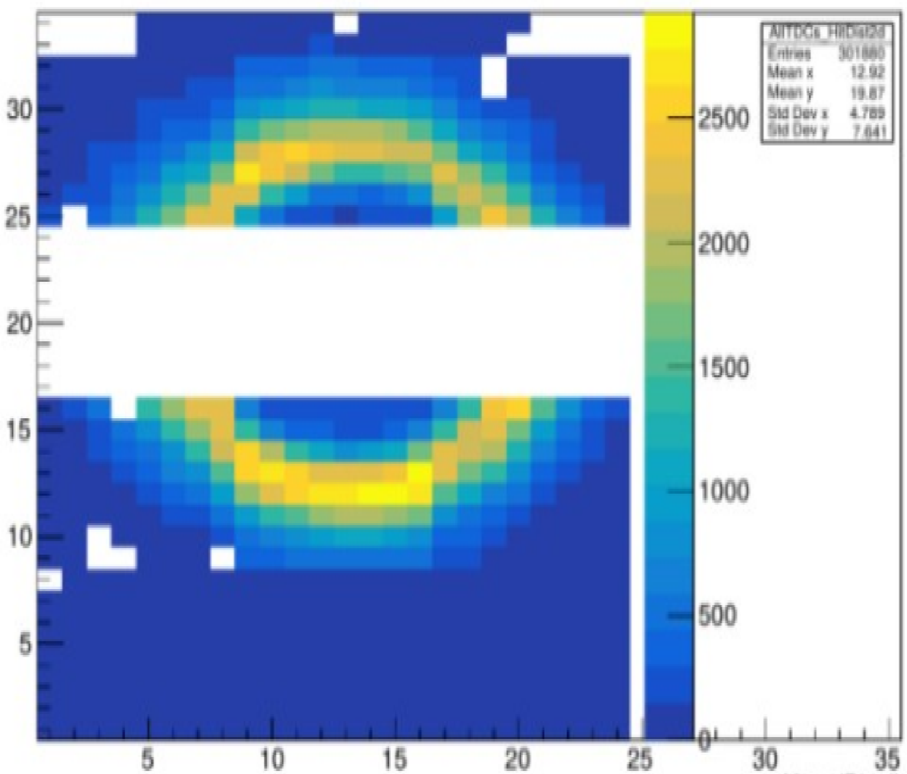




setup 1: proximity focussing setup
3mm quartz glass radiator

setup 2: focussing setup using borosilicate lense
with mirror coating as radiator and focussing mirror

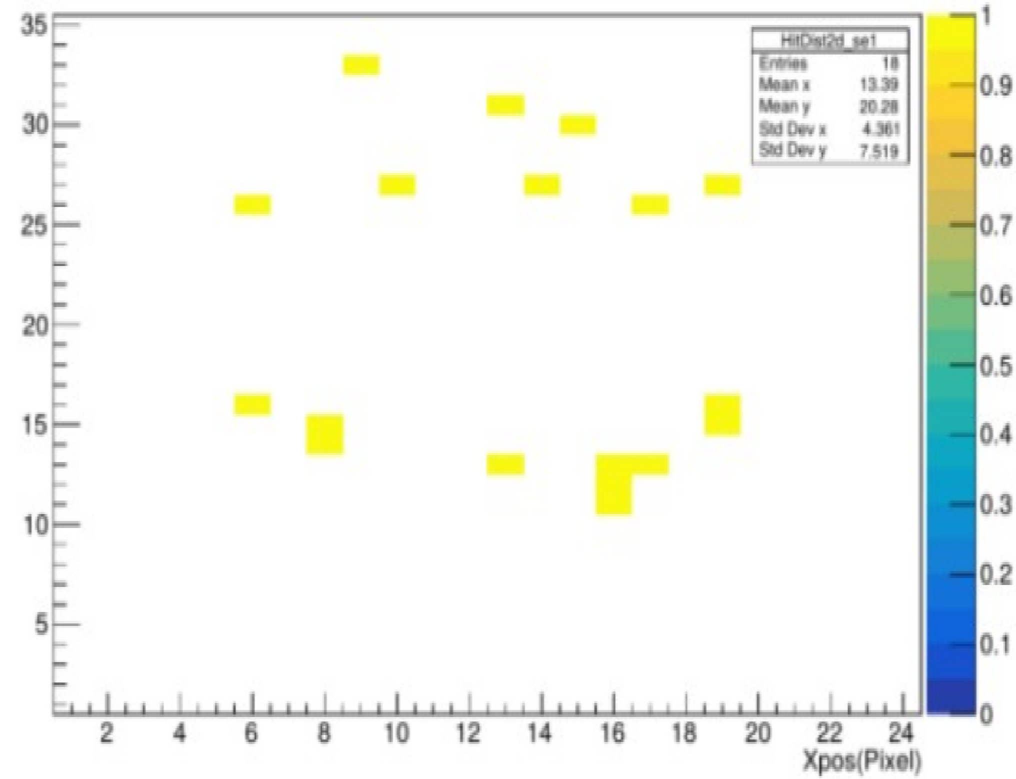
First impression - proximity focusing setup 600 MeV proton(s) in quartz radiator



Integrated Cherenkov ring image

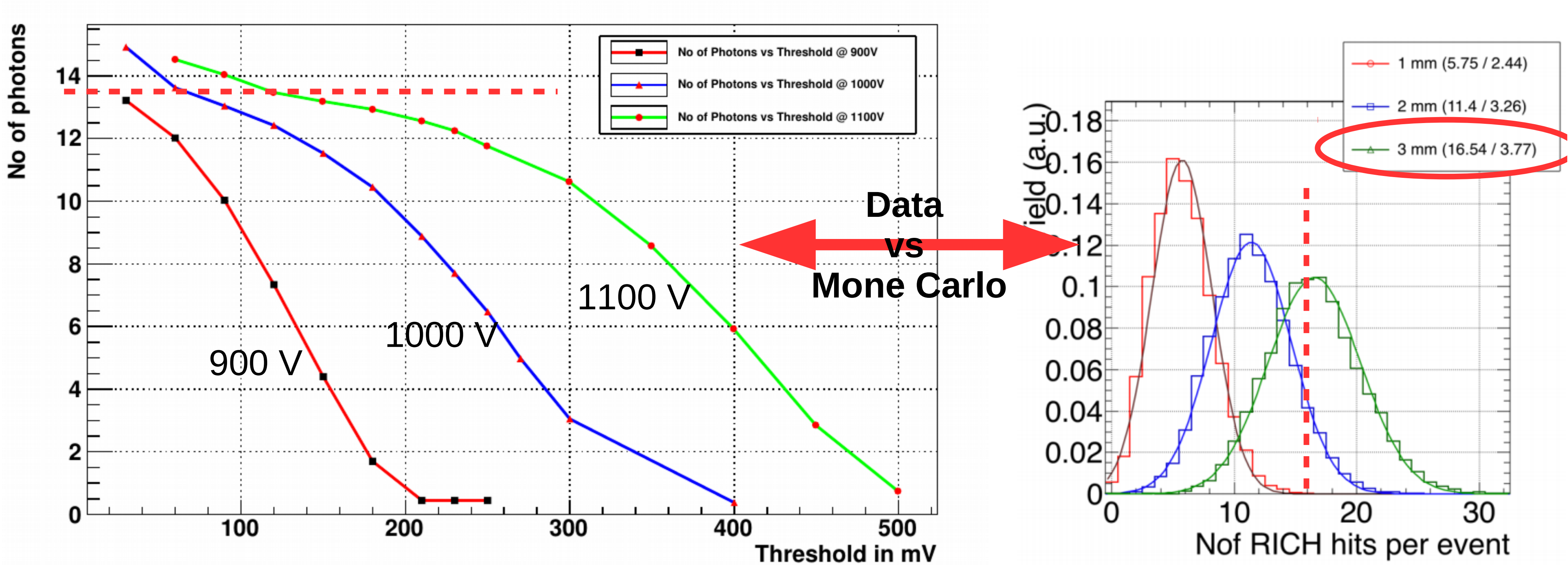
- ring image clearly visible
- fairly homogeneous population

- "blurred" due to proximity focusing



Typical single proton event
(here: 17 photons detected)

Photon detection efficiency - Number of hits per ring / proton



Measured number of detected hits/Cherenkov ring
as function of threshold, for different PMT HV

Realistic GEANT Monte Carlo
Spectral quantum efficiency
(collection efficiency 100 %)

- Up to ~14 detected photoelectrons measured
- Around 16 detected photons expected from simulation (assuming 100% coll. Efficiency)

- **Preliminary result: good agreement !**

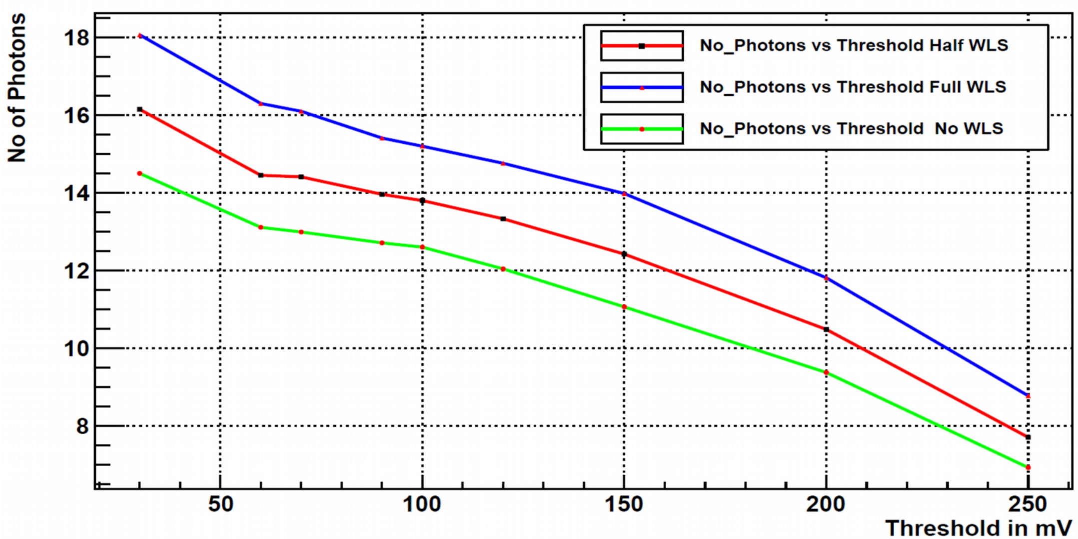
Effect of WLS on efficiency

- Both HADES and CBM will use **gaseous radiator : C_4F_{10} / CO_2**
  → **most Cherenkov photons produced in UV** range
  → Cherenkov photon yield THE critical parameter when building a RICH

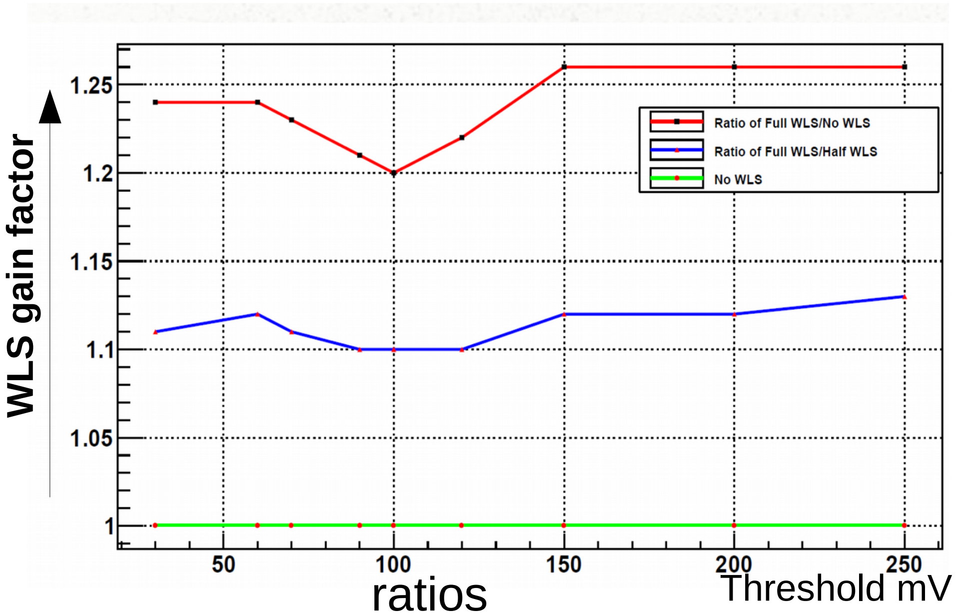
- WLS coating of PMT glass window to enhance UV sensitivity

Measurement during COSY test beam:

- Initially all PMTs coated with WLS
- WLS layer removed in two consecutive steps
- **precise determination of Cherenkov photon yield**
- influence of WLS on photon timing



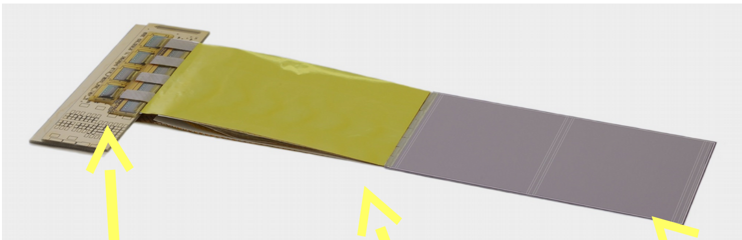
Photons per ring for full / half / none WLS coating



ratios

Preparation for upcoming CBM beamtime: CBM Silicon Tracking System STS

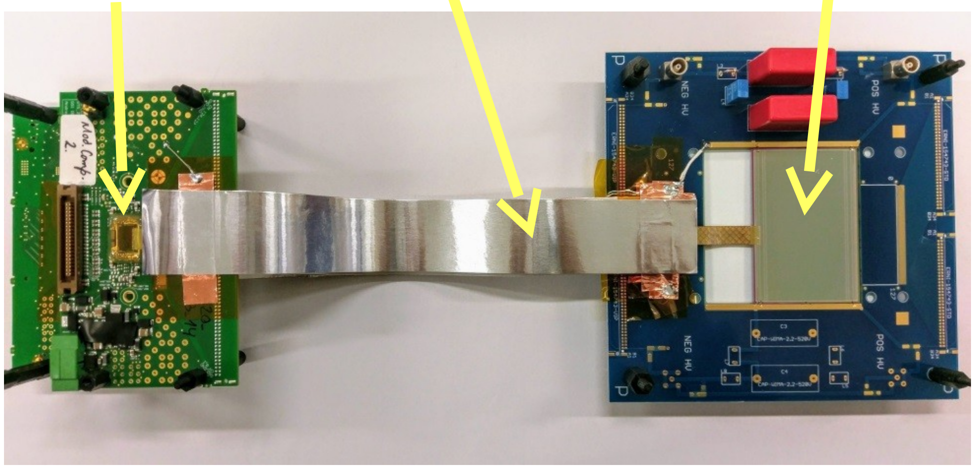
prototype detector module



STS-XYTER v2.0 ASIC on FEB

microcable

silicon microstrip sensor



Aim of the test:

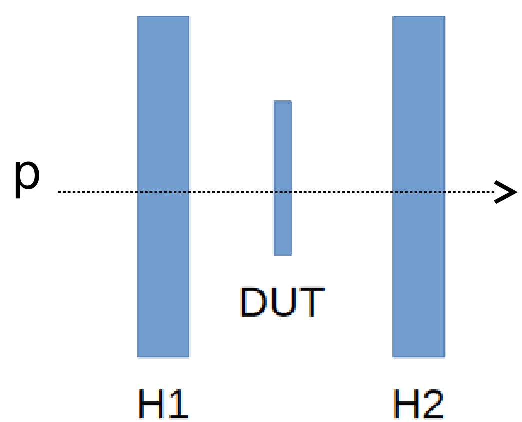
Determination of
- Signal-to-noise ratio
- Detection efficiency

Importance:

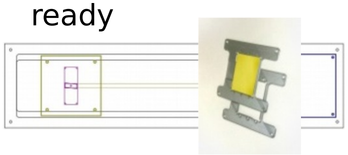
final test before full module is applied to mSTS in mCBM (Aug-Oct. 2018, Aug. – Nov. 2019), and production readiness (Q4/2018)

Status:

objects ready, set-up under assembly



beam hodoscopes ready

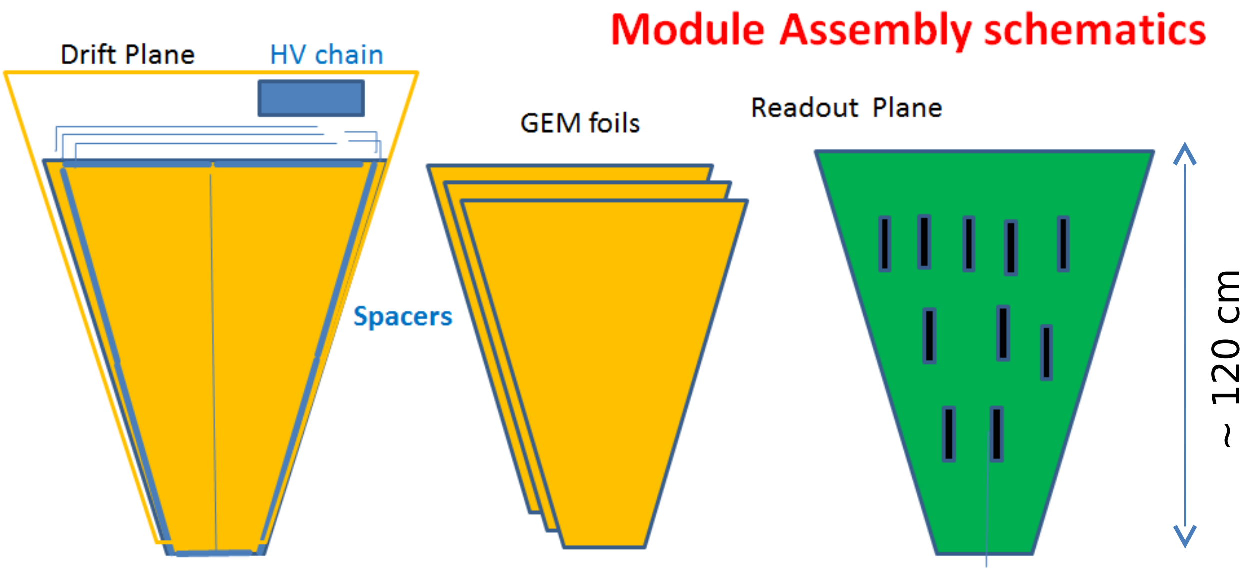


module holder construction

Preparation for upcoming CBM beamtime: GEM detectors for CBM MUCH

Full-size prototype "M2"

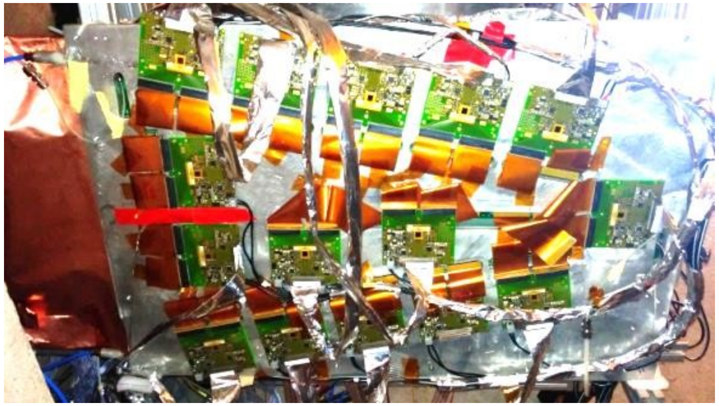
- CERN-made GEM foils
- **with new HV configuration;** biasing network laid out for high st… under pulsed current; involving opto-coupler switches
- with full-fledged controlled cooling
- with full 18 FEB–B read-out
- and latest DAQ

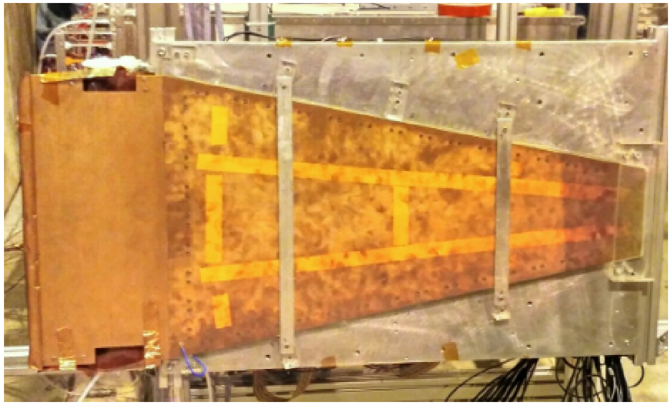


Triple-GEM test detector (as reference)

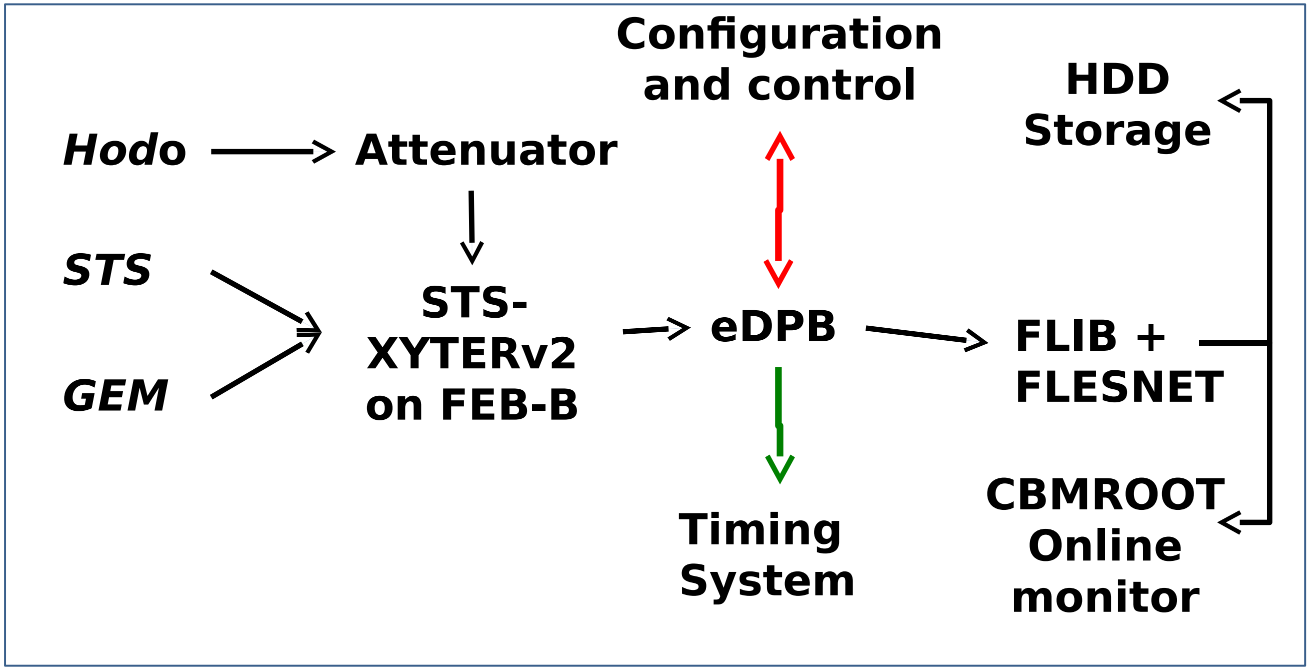
- *Indian-made GEM foils*
- *10 cm x 10 cm and/or*
- *30 cm x 30 cm*

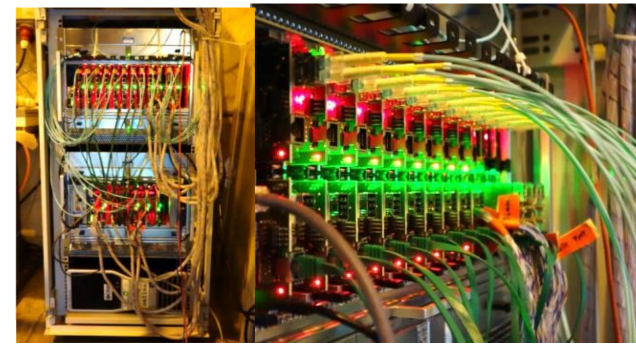
Prototype M1 under test at CERN-SPS (12/2016)





Common free-streaming DAQ system prototype for (m)CBM DAQ



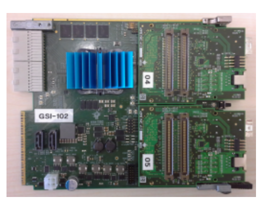


mFLES

on detector

STS-XYTER
FEB-B

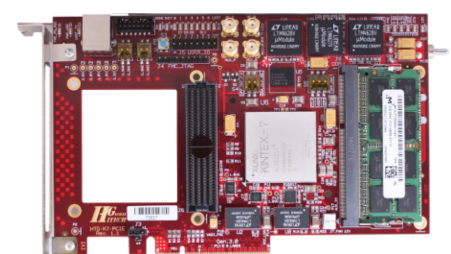
on/near detector



eDPB

in µTCA crates

eDPB/MUCH
gDPB
tDPB



PCs with FLIBs for time-slice building from the incoming data stream

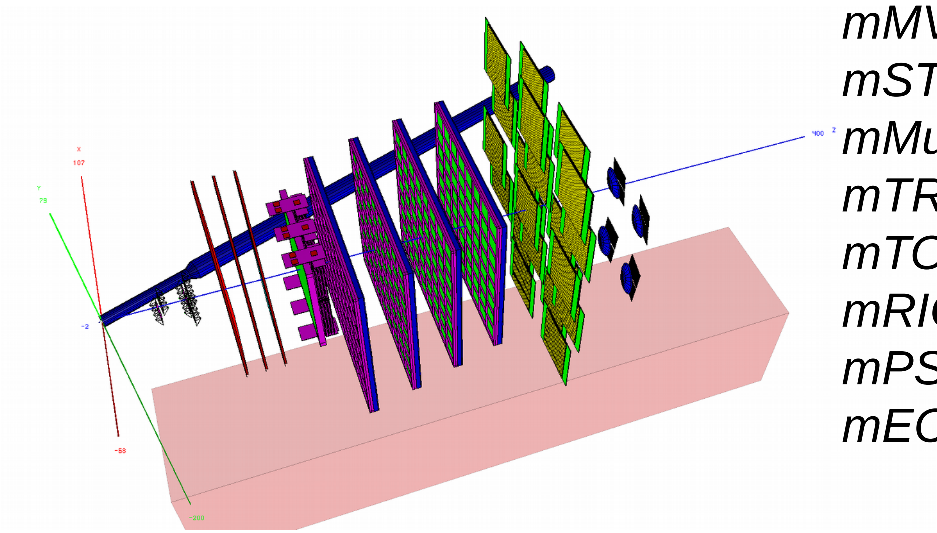
COSY beamtime Q1/2018 requirements

Total number of particles type of beam (p, d, polarization)	Momentum range (MeV/c)	Intensity Minimum (particles per second)	Maximum
protons	p ~ 2700	~ 10^4	10^6
Experimental area	**Safety aspects (if any)**	**Earliest date of installation**	**Total beam time (No. of shifts)**
Big Karl, or JESSICA cave	None	week #9 2018 26 Feb 2018 detector tests: prototype	7 days around the clock (installation of equipment during the beamtime week is sufficient)

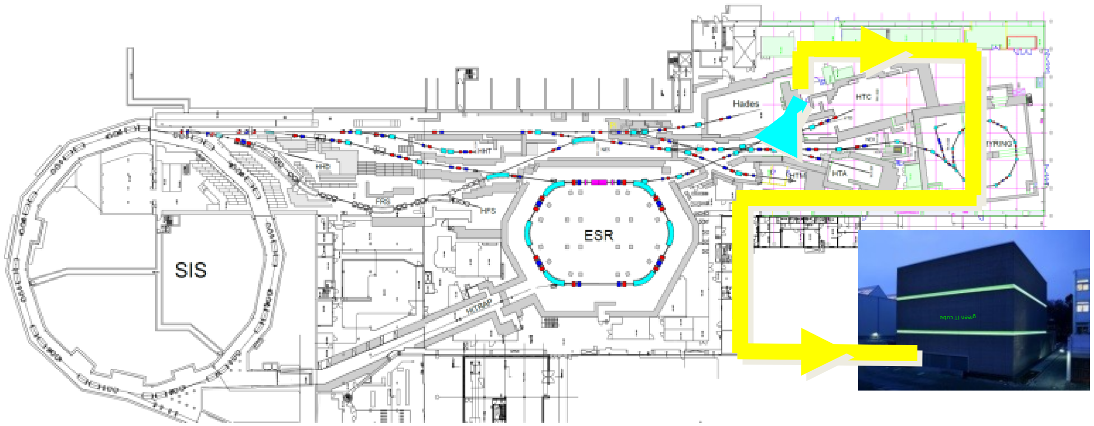
- The **setup would fit both into Big Karl or JESSICA cave**
- **last beamtime MDC group badly suffered from FZJ “Betriebsfunk” in Big Karl** (due to close antenna)
- **If this can not be solved → We would prefer JESSICA cave**

Future beam test plans 2018 / 2019

- From mid 2018 and in 2019, effort will be concentrated at GSI:
  test of detector systems, DAQ and on-line analysis in “mini CBM” (mCBM) at SIS-18.



mMVD
mSTS
mMuch
mTRD
mTOF
mRICH
mPSD
mECAL



www.fair-center.eu/fileadmin/fair/experiments/CBM/documents/mcbm-proposal2GPAC-WebVersion0619-SVN7729.pdf

- However, further corroborating detector tests may be required.
- SEU tests of electronics (e.g. the final STS-XYTER ASIC) may be necessary.

- **Additional Beam time at COSY may be applied for at a later time.**

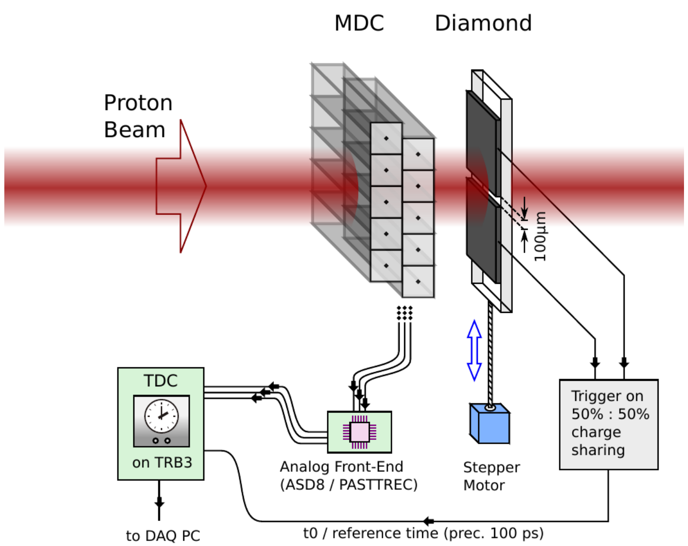
summary

- **Test beams at COSY are** (and have already proven to be in the past!) **essential for FAIR detector development** (here: CBM and HADES, …)
- **Interesting and important results from Oct 2017 test beam**
  - could not have been obtained in lab measurements alone !
  - Without Nov 2017 beam test, HADES RICH would probably have lost >=1 week of upcoming production run at GSI in autum 2018 ...
- **Preparations for upcoming CBM-STS test beam in Feb 2018 well on track**
- We would like to thank the whole COSY (and IKP) crew for the extremely supportive and friendly atmosphere we experienced during Nov 2017 test beam
- See you in February / March 2018 !

spares

Preparation for upcoming COSY testbeam HADES T0 diamond and MDC

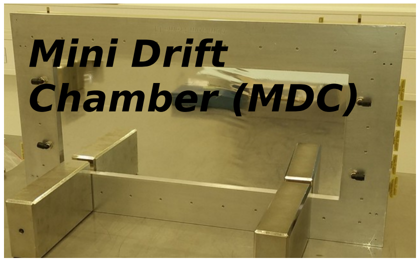
3. T0 – Diamond detector

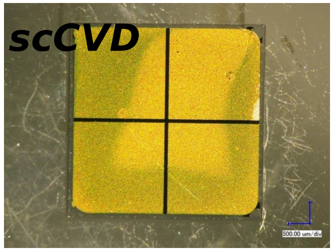


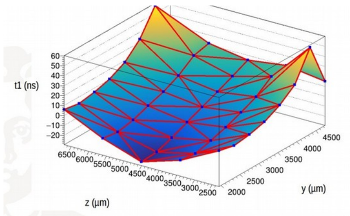
Goals:

- Study drift velocity map inside drift cell, gas mixture dependency
- Compare precision of old & future HADES analog ASICs
- Measure spatial resolution of full system: MDC + analog + digital electronics with standalone DAQ

Setup:
- Mini Drift Chamber (MDC)
  - 50x20 cm² active area
  - 2 drift cell layers,
  - each 40 cells (5x5 mm²)
- reference / tracking by Diamond (scCVD) detector:
  - 4 channels, 100µm gap
  - time precision < 100 ps
  - movable (µm step precision)

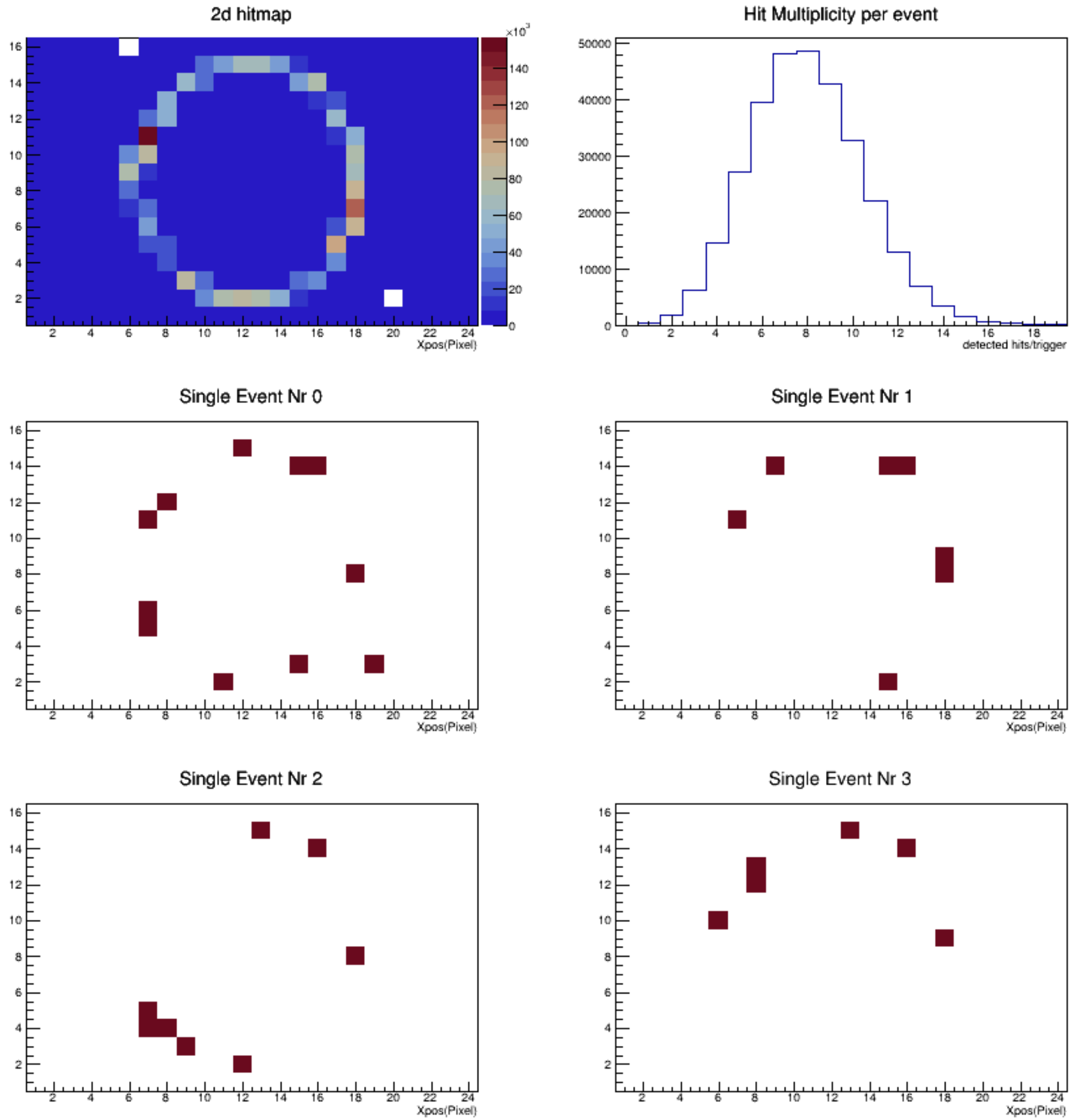




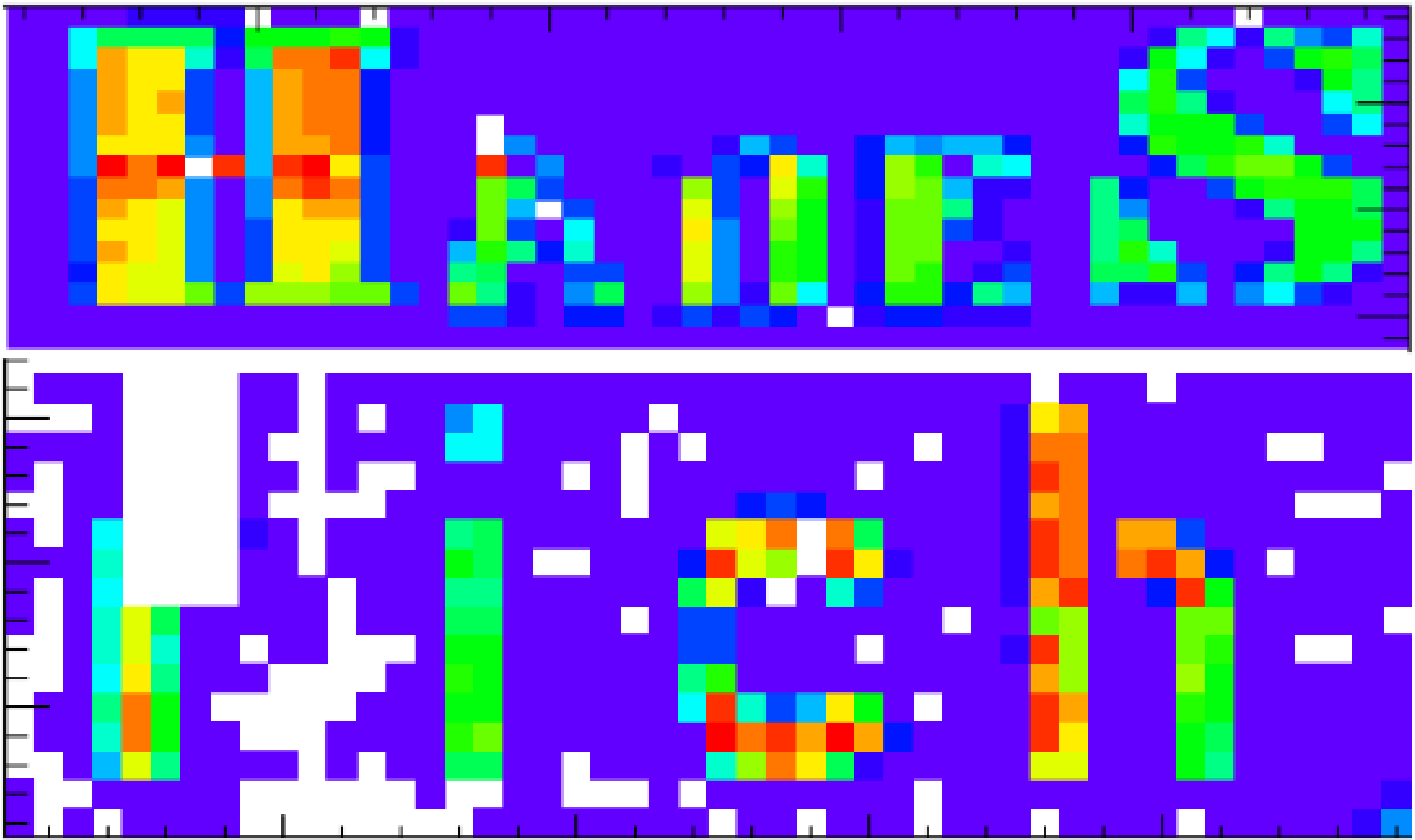


drift time map inside a single drift cell (measured by laser ionization @ HZDR)

First rings with DiRICH readout



some fun with DiRICH...



new MDC drift chamber, Feb 18