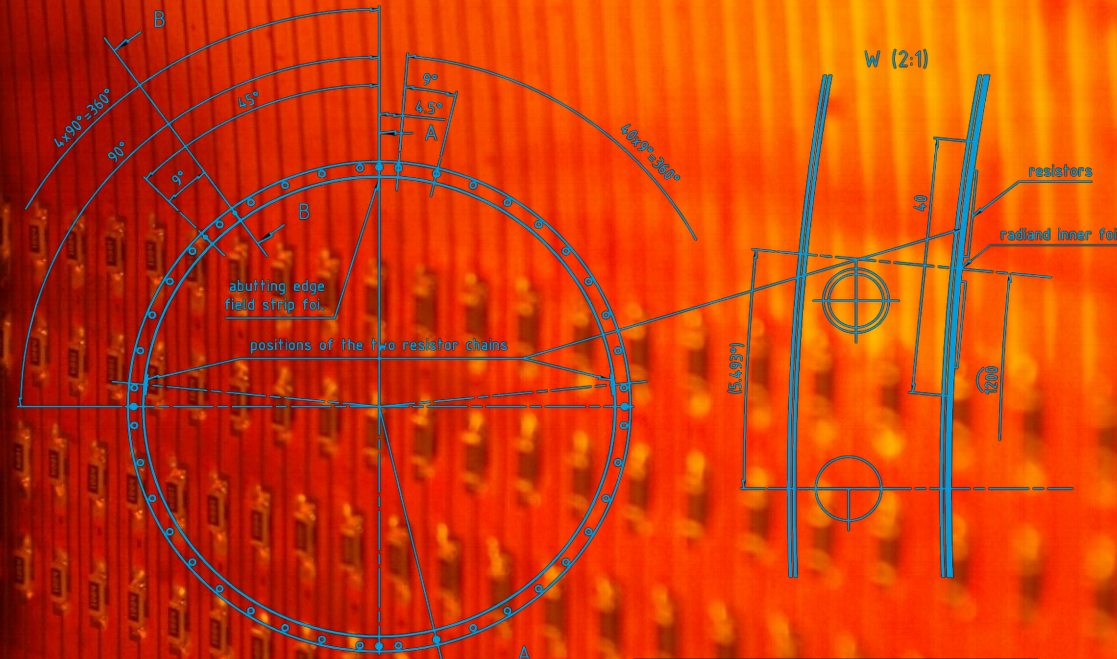
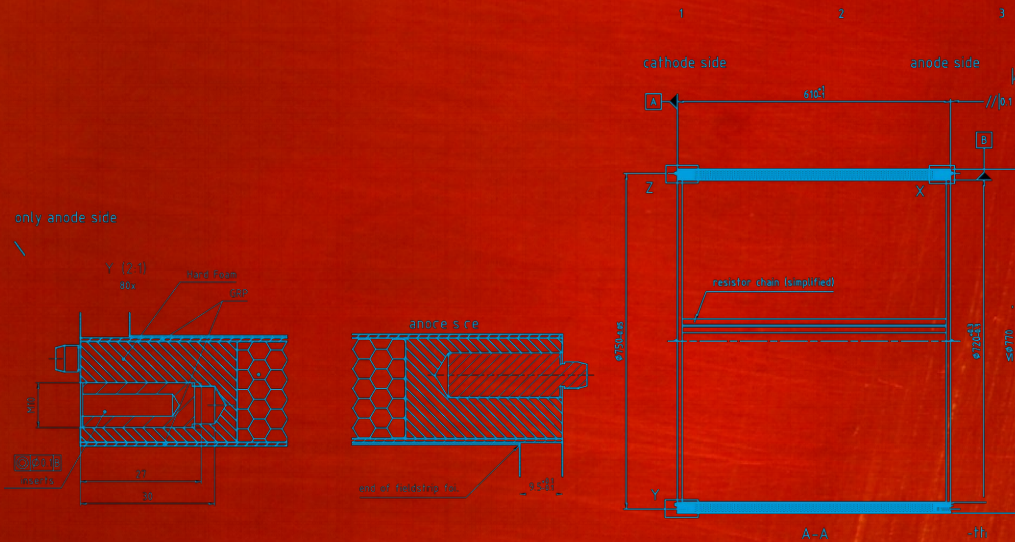


TPC R&D @ DESY

LCTPC Collaboration Meeting, 2021

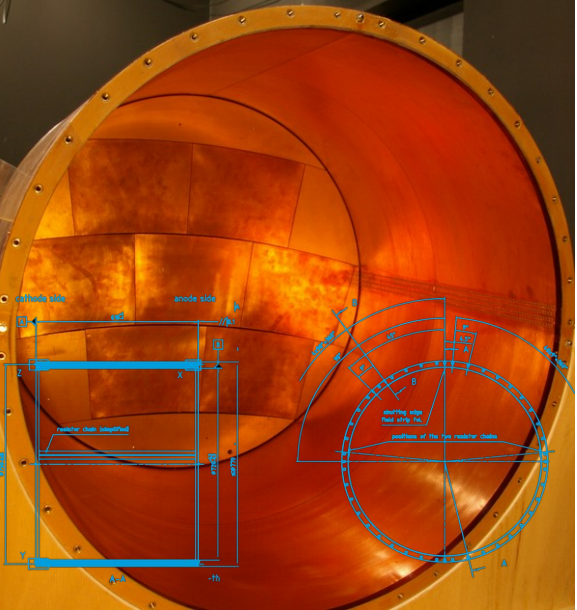
Ralf Diener



Project	Task	Phase	Status
TPC R&D	Field cage assembly	Design	Completed
TPC R&D	Field cage assembly	Production	In Progress
TPC R&D	Field cage assembly	Installation	Planned

Content

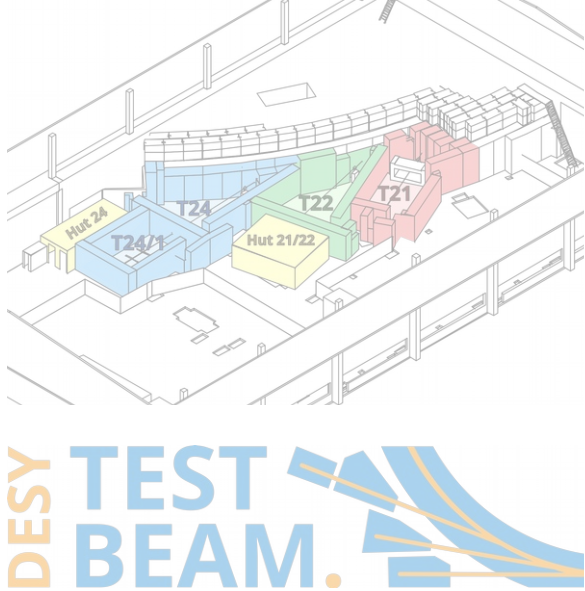
Field Cage



Group



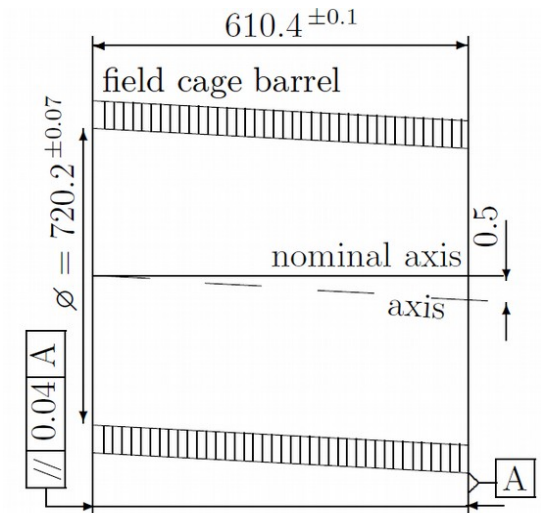
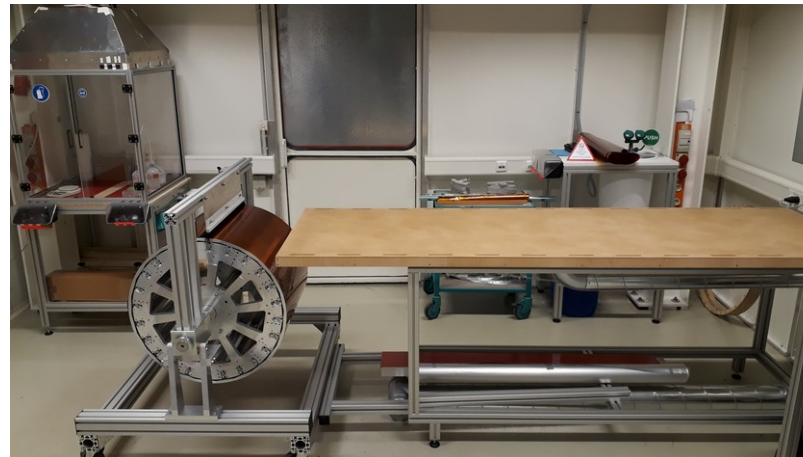
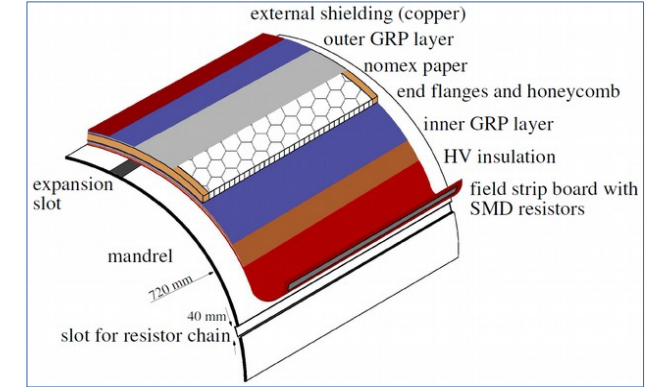
Test Beam



A year in the Life of a Field Cage

Starting Point

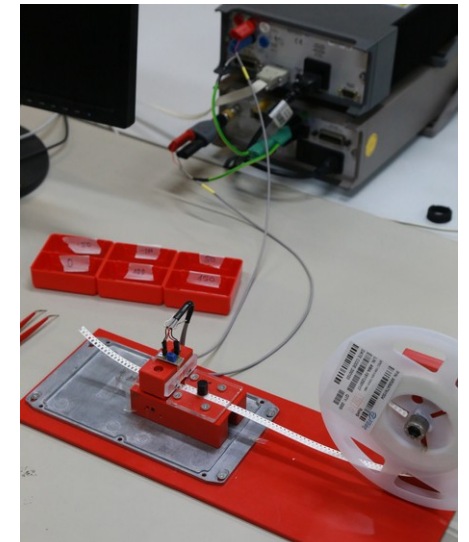
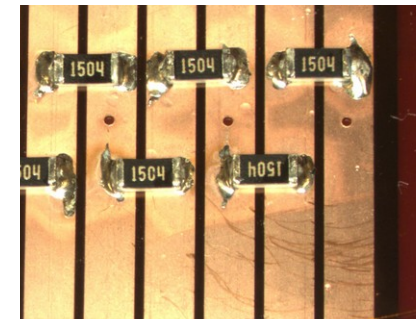
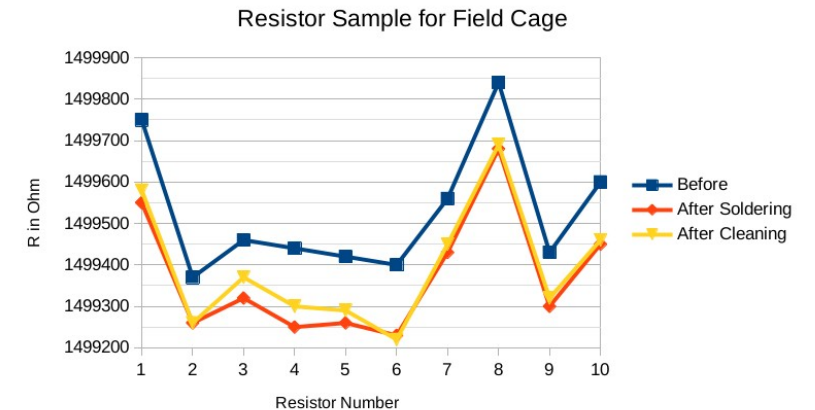
- Requirements
 - Integrated (gas vessel + field shaping + HV shielding)
 - High mechanical precision: order of $100\ \mu\text{m}$
 - HV stability $\geq 25\ \text{kV}$
 - Low material budget: $\sim 1\%$ X_0 per wall
- 1st iteration not mechanically as precise as required
- 2nd iteration under construction
 - Tooling basically ready
 - Many materials tested and procured



A year in the Life of a Field Cage

High Precision Resistors

- January: High precision resistors arrived,
 - Testing the tools to select 0.005 % precision out of the purchased resistors with 0.05 % precision
- March: Tests of resistivity change after soldering
→ resistivity changes, but all in the same direction and range
- April: Design / construction of SMD resistor measurement station started
- June/July: Improving resistor measurement setup
 - Calibration of Keithley electrometer
- October: Resistor measurements
 - Noticed (before soldering): offset in some of the measured resistors
 - Improved setup including “online” analysis to find such effects
 - Re-did measurements and sorting in daily batches
- November: Soldering on field strip foil by DESY ZE group



A year in the Life of a Field Cage

Construction, Gluing, HV and Shielding

- June: Investigating options for outer shielding foil
 - Previous: 10 μm Cu + 50 μm Kapton $\sim 0.09\%$ X_0
 - New: 2 samples PET/Al 23 μm /25 μm and 25 μm /12 μm , results in $\sim 0.03\%$ X_0 , foils arrived in July
- September: First dry run for gluing \rightarrow a few small improvements on tooling and processes
- October:
 - Last missing material arrived
 - HV test of some components
 - Complete wall sample holds 30 kV
 - Kapton significantly less HV stable than expected in long term tests
 - For better gluing Nomex layer replaced by Kapton:
more HV stability without increasing X_0
- November: First gluing test on mandrel



Field strip + Kapton foil
(in blue: release film)



... + peel ply + suction fleece

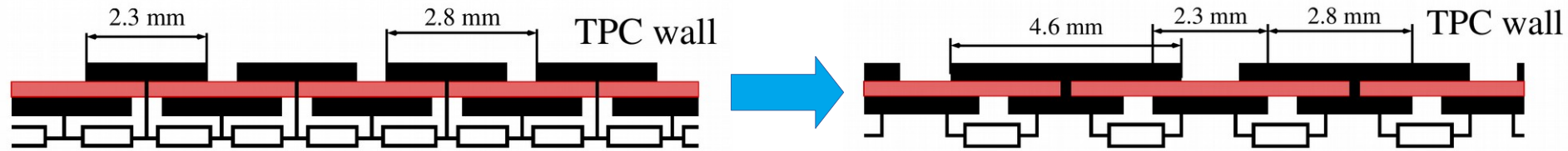


... put into vacuum bag \rightarrow pumping

A year in the Life of a Field Cage

Field Strip Foil

- February: field strip foil production at CERN started
 - New, simpler mirror strip layout (distortion reach from wall ~7 mm instead of ~5 mm)

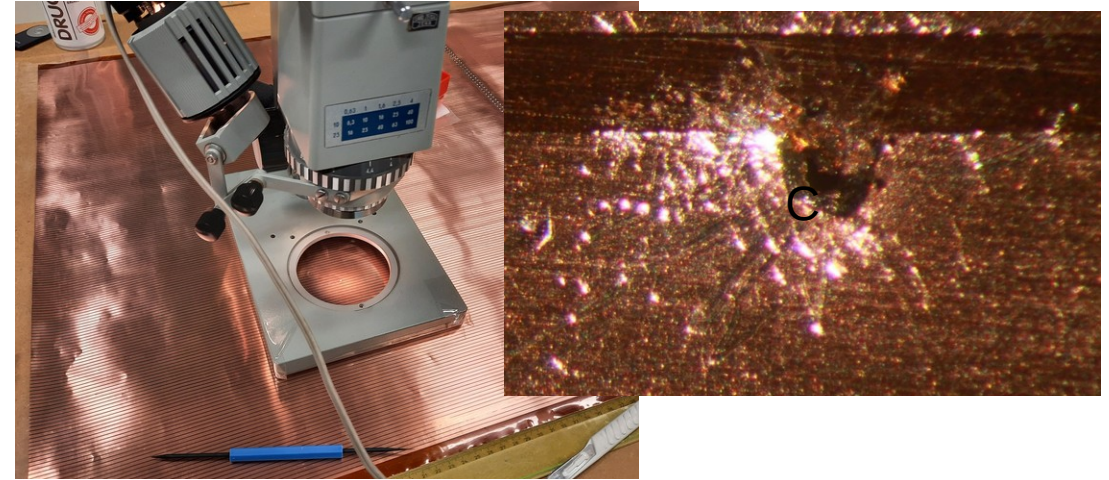


- New material: 50 μm Kapton with 17 μm copper on both sides (before 35 μm Cu): saving $\sim 0.25\%$ X_0
- June: Foil arrived and cutting investigated in more detail:
 - We need precise dimensions; goal: gap after wrapping around ~ 100 μm
- July: Cutting test at external company, in September more tests at DESY
- October: Final cutting and trimming of the edges
- November
 - Found after soldering a field strip pair with 650 k Ω instead of 750 k Ω resistivity

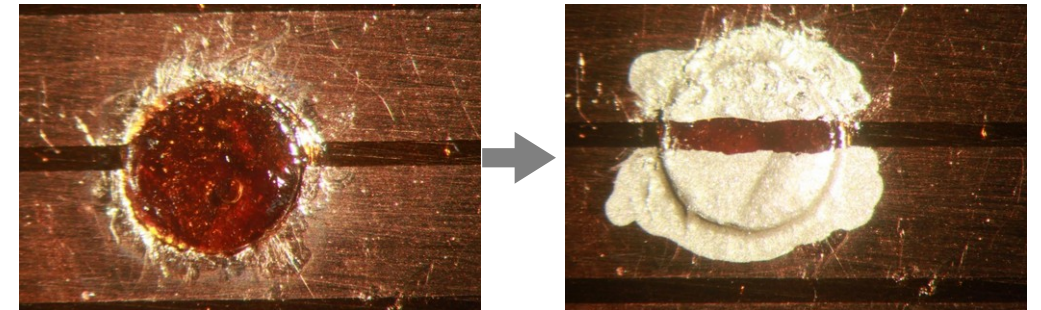
A year in the Life of a Field Cage

Field Strip Foil

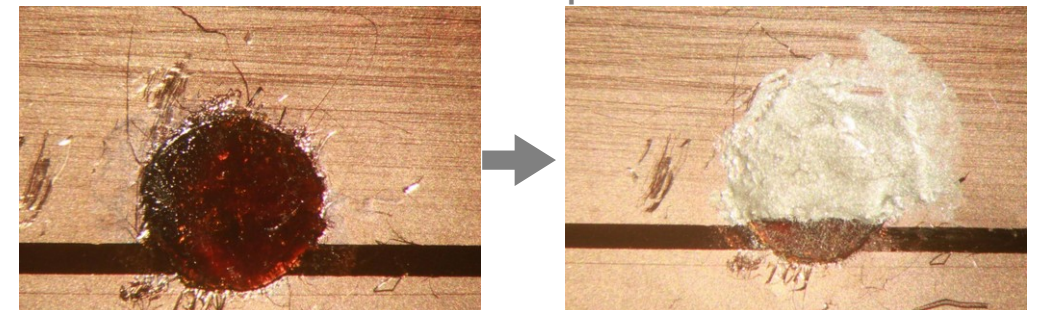
- December:
 - Investigating and fixing resistivity mismatch
 - Signal runtime measurements (reflectometry) lead to find a tiny hole to the mirror strip side
 - Carefully “cleaned” hole borders and removed copper
 - Closed by gluing in a Kapton patch
 - Re-painted conducting pattern on top
 - Resistivity after repair as expected
- December 16th: "We stay at home" rule
 - HV test of the repaired place planned
 - Final gluing delayed, no activity in workshop since



Field strip side

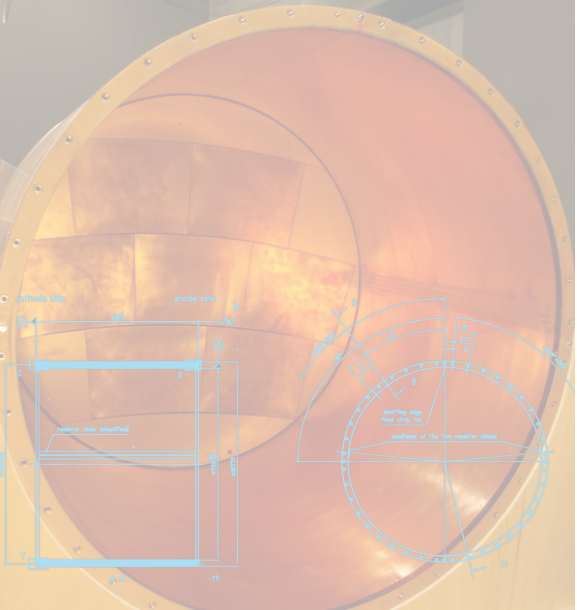


Mirror strip side



Content

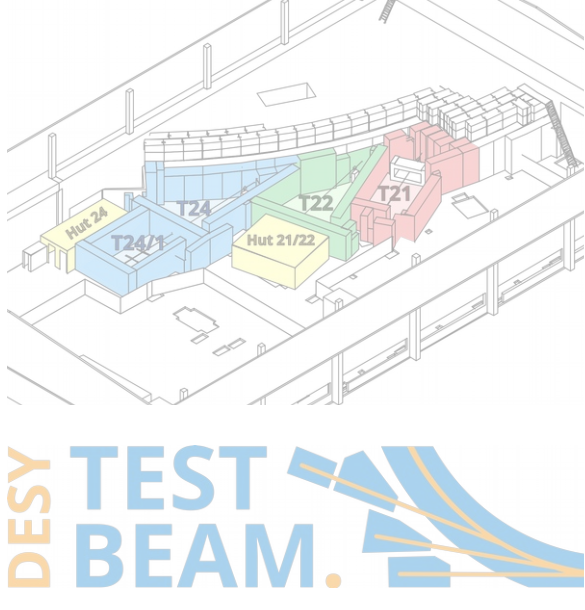
Field Cage



Group



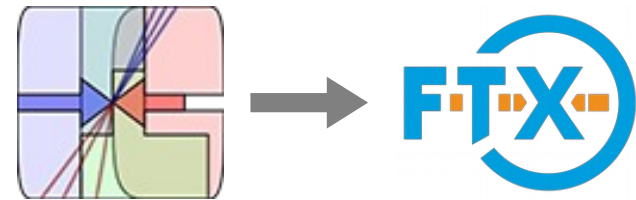
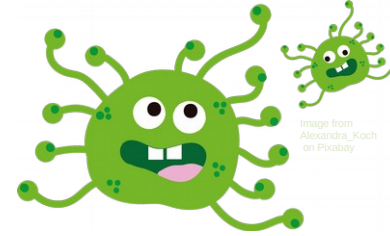
Test Beam



Group

Overview 2020 and Organization

- DESY basically shut down March to May, since then limited normal mode
 - Typical hygiene rules: distance, masks, limited room occupancy, etc.
- Since December 16th
 - “Lockdown”: only absolute necessary presence on-site
 - No user operations since end of December
 - Since today: some necessary work on-site, but very limited
- B. Beyer who was involved in nearly all our hardware projects in many ways did go into pension
- Group Organization
 - FLC was joined with FLA and test beam to form the FTX group
 - FLC TRK group (was officially only Oliver and me) included in the new Test Beam and Telescopes (TBT) group
 - 2021: Ties interim-director of FH at DESY

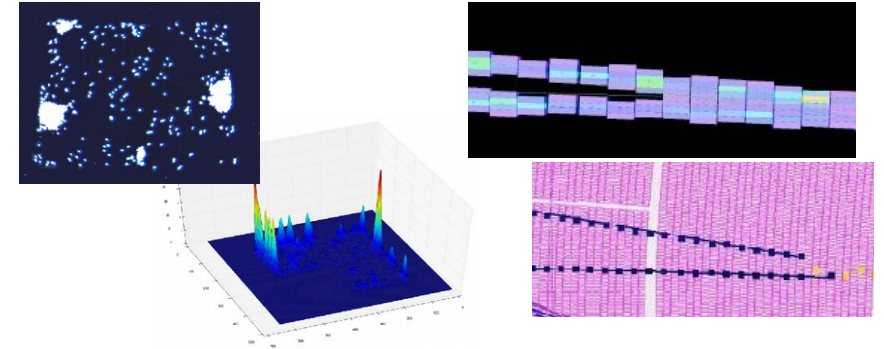


Group

PhD Students

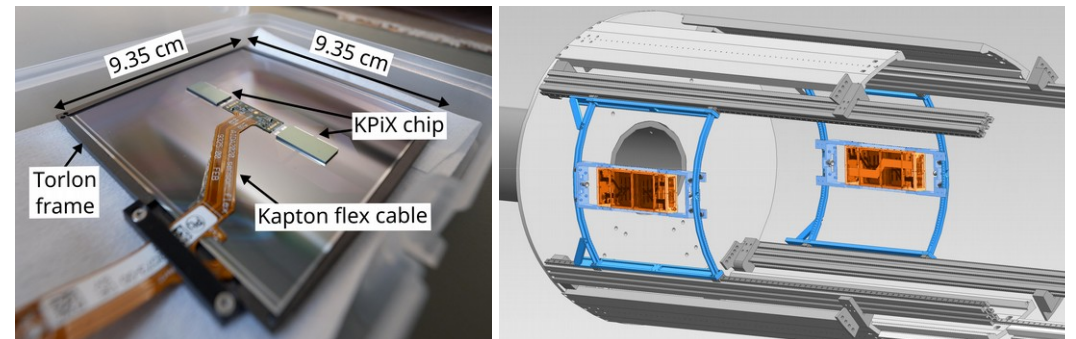
- 2 PhD thesis successfully completed in 2020 (*both unfortunately not yet online*)

- Oleksiy Fedorchuk
“Investigations of the long-term stability of a Gas Electron Multipliers and double hit resolution for the highly granular Time-Projection Chamber”



- Defense planned for March, re-scheduled 2 times due to Corona
- Successfully defended November 26th

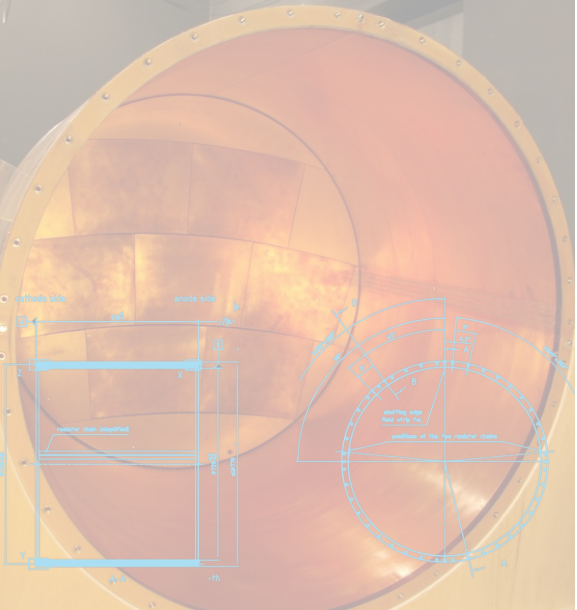
- Uwe Krämer
“A high resolution Silicon Strip Telescope and its application at the DESY II Test Beam Facility”



- Successfully defended December 15th
- Started his fellow in the TBT group
- 2 PHD thesis in the pipeline:
 - Paul Malek on GEM module R&D, beam test and dE/dx
 - Ulrich Einhaus on Ropperi, pad size optimization and dE/dx

Content

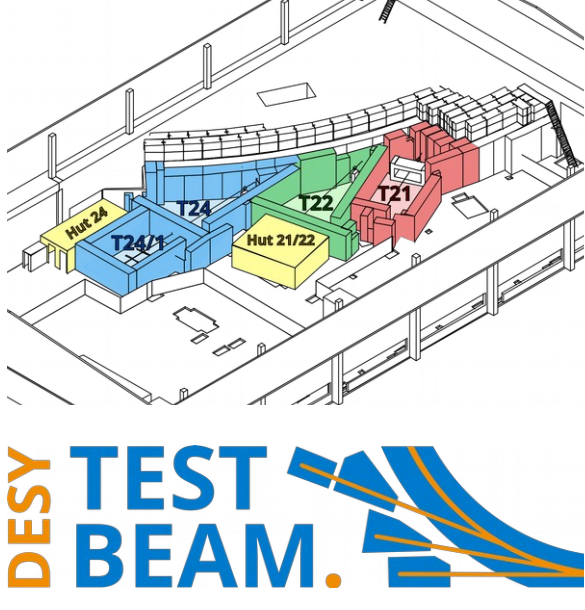
Field Cage



Group



Test Beam



Testbeam and Corona

Impact of Pandemic - Some Numbers

- Complete shutdown: 10 weeks (CW 12-21)
- lost 27 user weeks for 16 projects
- After Corona shutdown (fully booked: 72 weeks)
- 56 booked, 16 weeks completely free
- More than 10 projects had to cancel their beam time completely
 - Including all TPC test beam efforts
 - Only some Lycoris tests took place
- Several weeks used by local teams and re-scheduled groups affected by the shutdown
- Comparison 2019 / 2020
- Significant decrease in all numbers

Before

After



Year	2019	2020
User groups	80	60
Weeks used	114/120 (+ a few double bookings)	66/111 (incl. shutdown)
Number of users	702	345

Testbeam in 2020/2021

Looking Forward

- 2020: Hall windows replaced and new hall lights
- Winter shutdown
 - Usual cleaning up and tidying, interlock test & R-Weg interlock commissioning and test
 - New primary targets to be installed in DESY tunnel
 - Replacement due to spare parts running out
 - More carbon fibre spares / better maintainability
 - Current DESY “lockdown” hopefully has only minimal impact on the schedule
- First half year nearly fully booked
 - Including bookings by LCTPC-Pixel and T2K
- Call for 2nd half of 2021 soon
(when we can judge better impact on schedule of the first half year)

Week	TB21		TB22		TB24/1		TB24		
	DATE	DURATION	PCMAG	TELESCOPE PCMAG	ADIKRA				
4-Jan-21	1	Shutdown							
11-Jan-21	2								
18-Jan-21	3								
25-Jan-21	4	Startup		Startup		Startup			
1-Feb-21	5	CMS-Pixel-Phase2	X	Telescope Dev	X				
8-Feb-21	6	CMS-Pixel-Phase2	X	CALICE AHCAL	X				
15-Feb-21	7	EP Pixel R&D	X	DualReadout-FA					
22-Feb-21	8	HVMAPS	X	DualReadout-FA			BCGS+ DESY-HD Prep	X	
1-Mar-21	9	LHCb-Mightypix	X	ATLAS-HGTD	X		CEPC-ECAL	X	
8-Mar-21	10	MBI	X	ATLAS-HGTD	X		CEPC-ECAL	X	
15-Mar-21	11	MBI	X	ALICE-ITS3	X		TOTEM	X	
22-Mar-21	12	CMS-Pixel-Phase2	X	Bonn-CMOS	X		DESY-HD School	X	
29-Mar-21	13	CMS-Pixel-Phase2	X	Telescope Dev	X		CMS-OT-PS	X	
5-Apr-21	14								
12-Apr-21	15	EP Pixel R&D	X	ATLAS-ITk-Pixel	X		LHCb-ECAL		
19-Apr-21	16	Mu3e-Tile		Telescope Dev	X		LHCb-ECAL		
26-Apr-21	17	Mu3e-Tile		CALICE AHCAL	X		Mimosis		
3-May-21	18	CMS-Pixel-Phase2	X	CALICE-SIW-ECAL	X		CMS Outer Tracker	X	
10-May-21	19	CMS-Pixel-Phase2	X	CALICE-SIW-ECAL	X		CMS Outer Tracker	X	
17-May-21	20								
24-May-21	21	MBI	X	DMAPS	X		Timepix4/ALPIDE	X	
31-May-21	22	Mu3e-Tile		ATLAS-HGTD	X		Mimosis		
7-Jun-21	23	Mu3e-Tile		ATLAS-HGTD	X		ALICE-ITS3	X	
14-Jun-21	24	EP Pixel R&D	X	ATLAS-ITk-Pixel	X	LCTPC-Pix	X		
21-Jun-21	25	CMS-Pixel-Phase2	X	ATLAS-ITk-Pixel	X	LCTPC-Pix	X		
28-Jun-21	26	CMS-Pixel-Phase2	X	ATLAS-ITk-Strips	X	TZK			
5-Jul-21	27	JT-56	X	ATLAS-ITk-Strips	X	TZK			
12-Jul-21	28	Summer Shutdown							
19-Jul-21	29								

ANNOUNCED

