

The Planar GEM-Tracker



...current status and future perspectives

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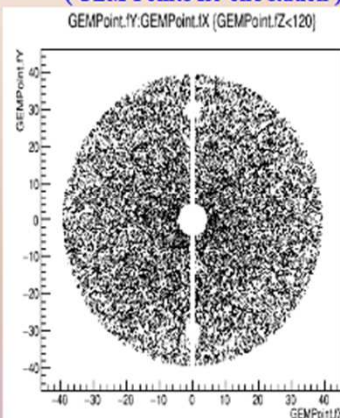
- GEM-Tracker System in PANDARoot & Performance
- GEM-Tracker / GEM-DISCs
 - ‚Cable‘ Conduit Thermal feasibility test
 - GEM-Frame winding tools & process
- GEM2D Demonstrator
 - GEM-Structures & -QA on TECHTRA GEM-Foils
 - Mechanics, PadPlane
- GEMEX Front-End Readout System Revision
- *Summary Status & Resources*
- *Open Points & Discussions & Comments to the Scrutiny Report*

Summary of Geometry Updating for PANDA GEM-Tracking System on the Root by Nazila

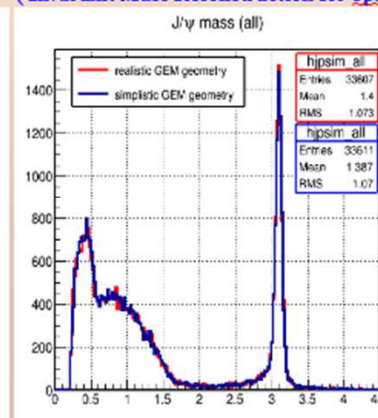
(realistic GEM geometry on the ROOT)



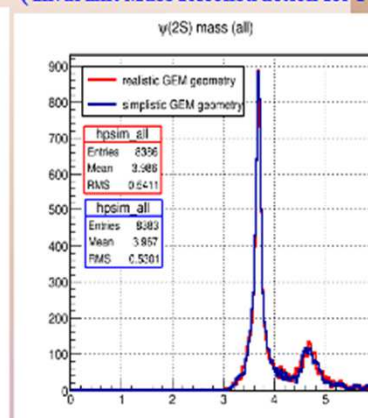
(GEM Points for one station)



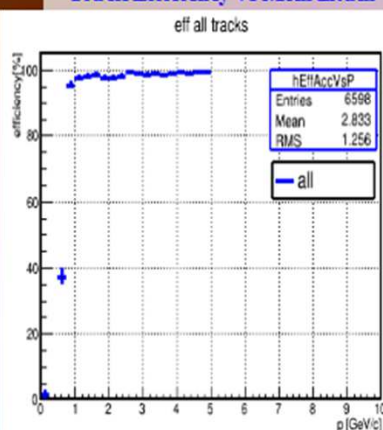
(Invariant Mass Reconstruction for J/psi)



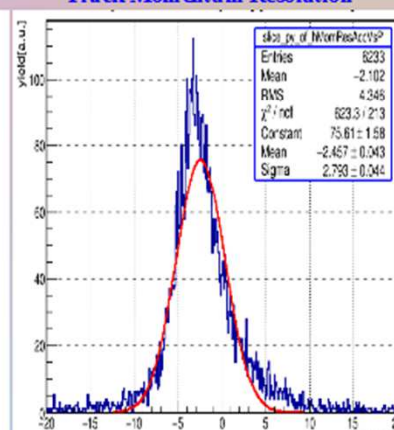
(Invariant Mass Reconstruction for Psi)



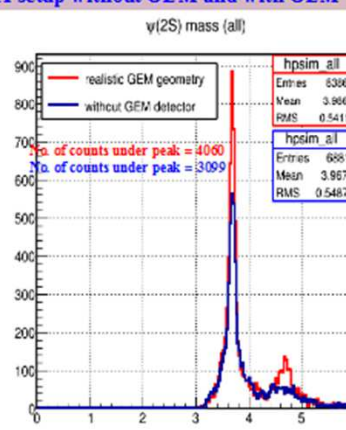
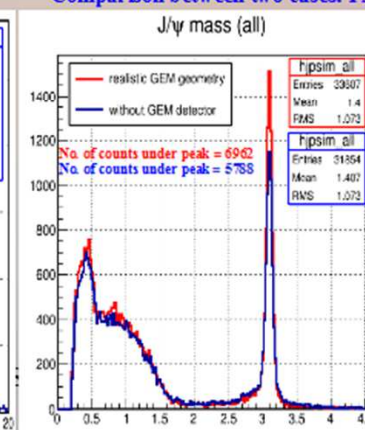
Track Efficiency vs Momentum



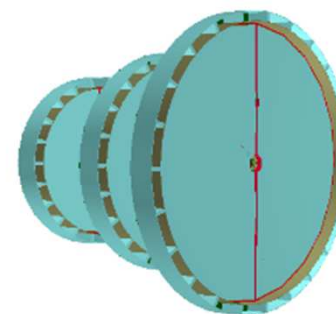
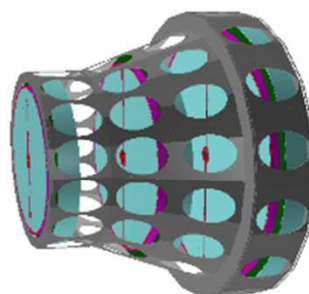
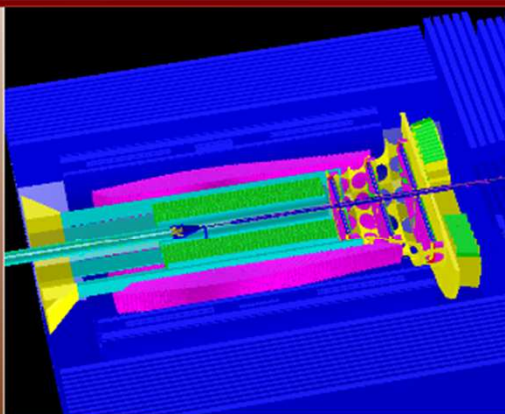
Track Momentum Resolution



Comparison between two cases: PANDA setup without GEM and with GEM



Summary of Geometry Updating for PANDA GEM-Tracking System on the Root by Nazila

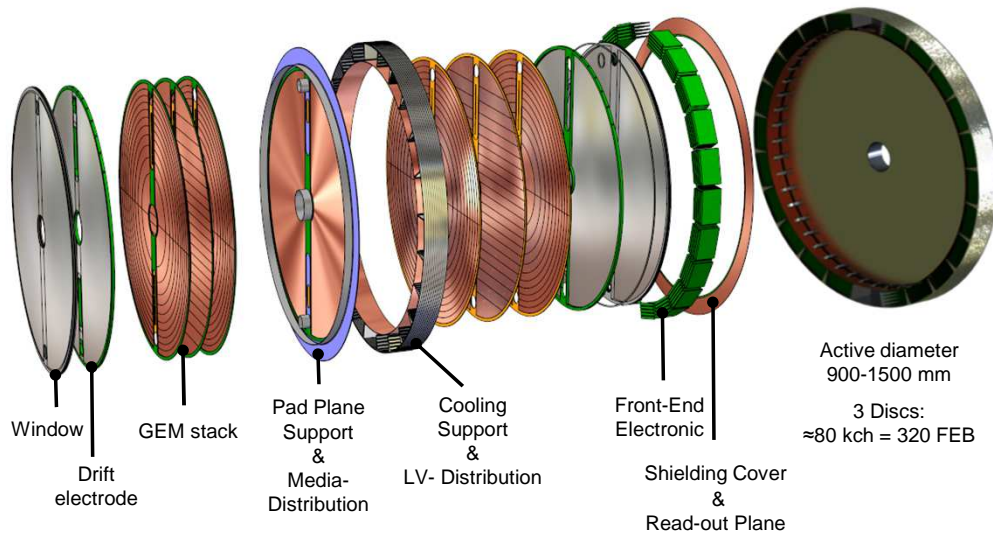


- The realistic geometry of GEM for PANDARoot is almost ready
- To be added; electronics devices, cables and connectors
- Materials for supporting structures and cooling devices do not increase background in the invariant mass reconstruction
- With realistic GEM geometry, mass resolution and tracking efficiency are improved, however, more detailed studies are required and in progress
- In the tracking class PndSttMvdGemTracking, tracking only with MVD and GEM is not implemented, and it will be done in near future

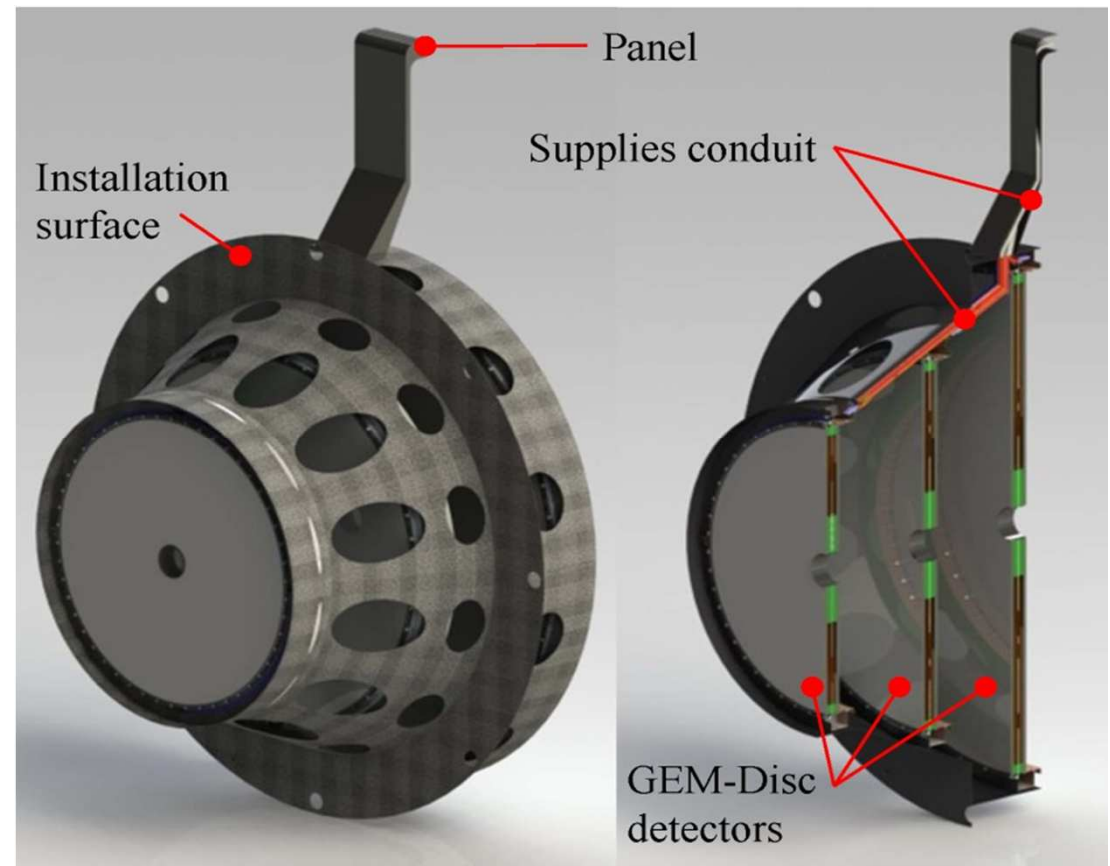
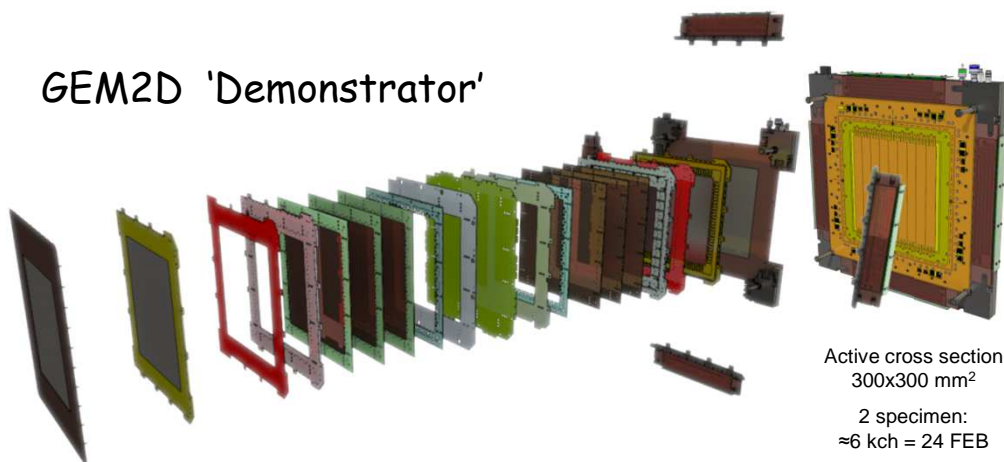
N.Divani - GSI & HIM

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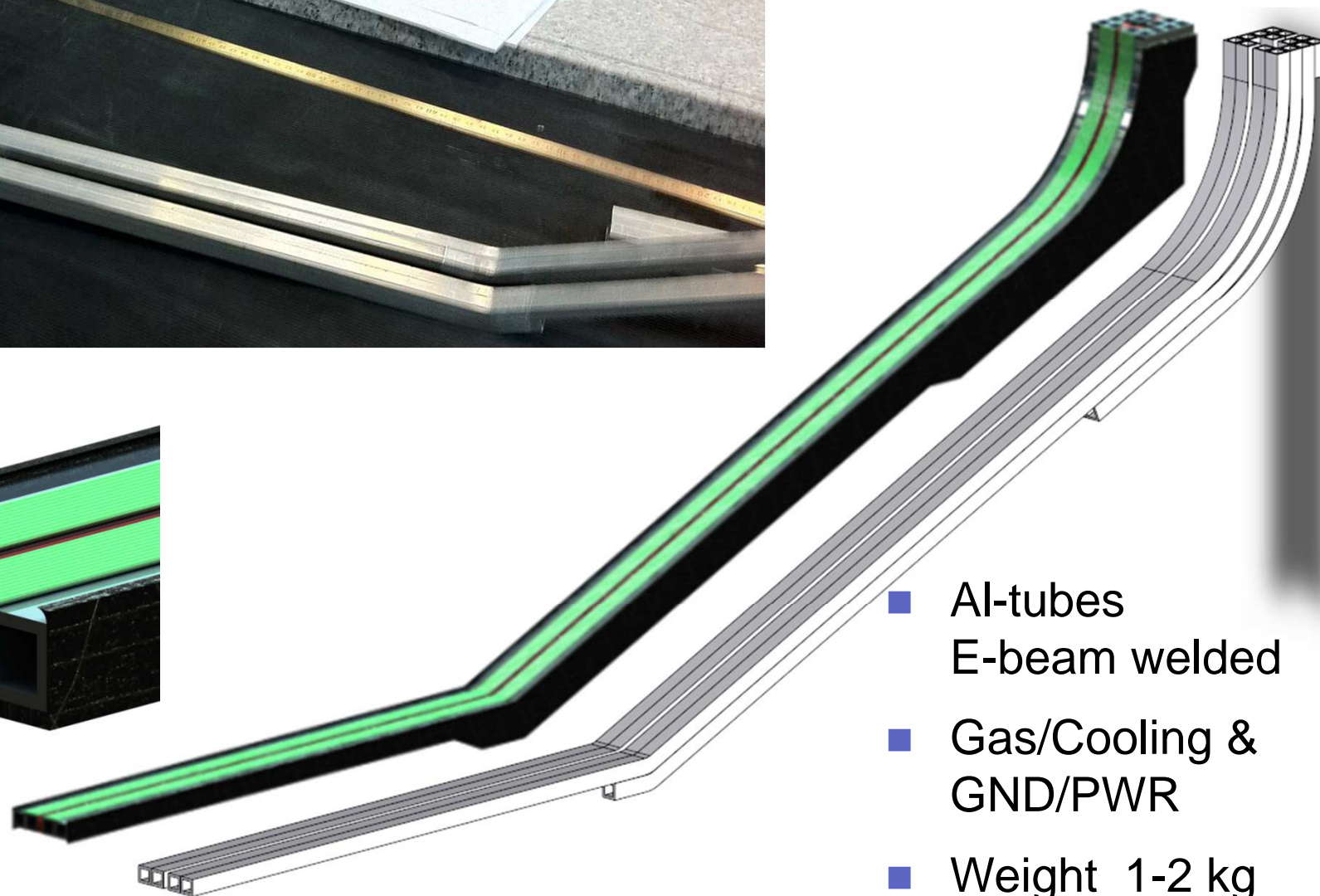
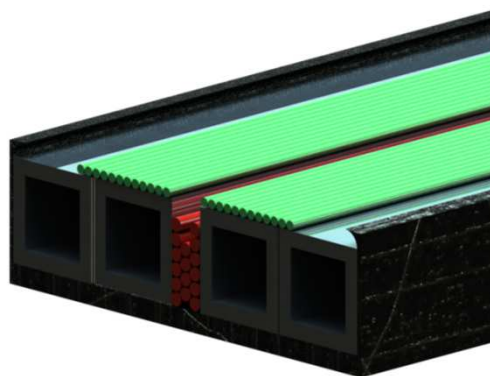
GEM-Disc 'Original'



GEM2D 'Demonstrator'

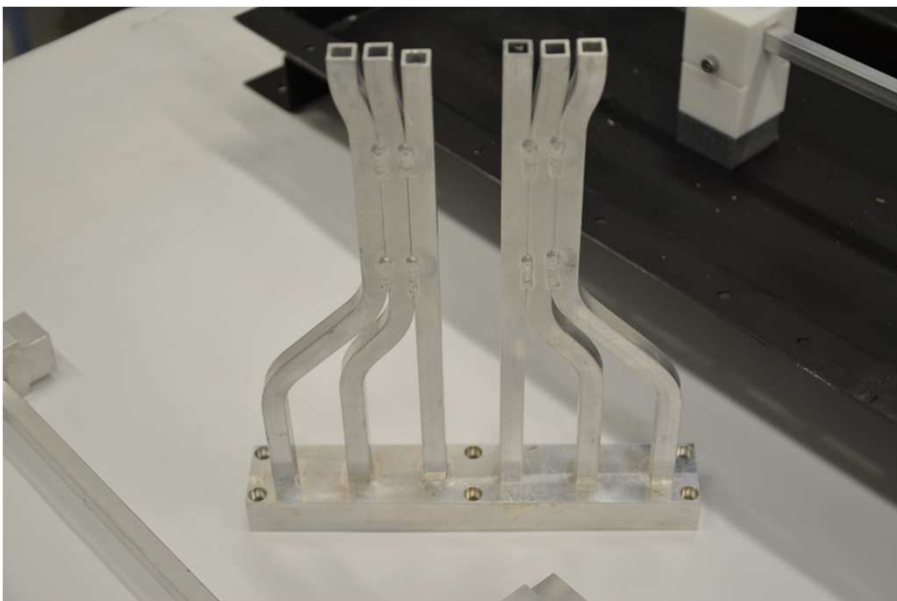
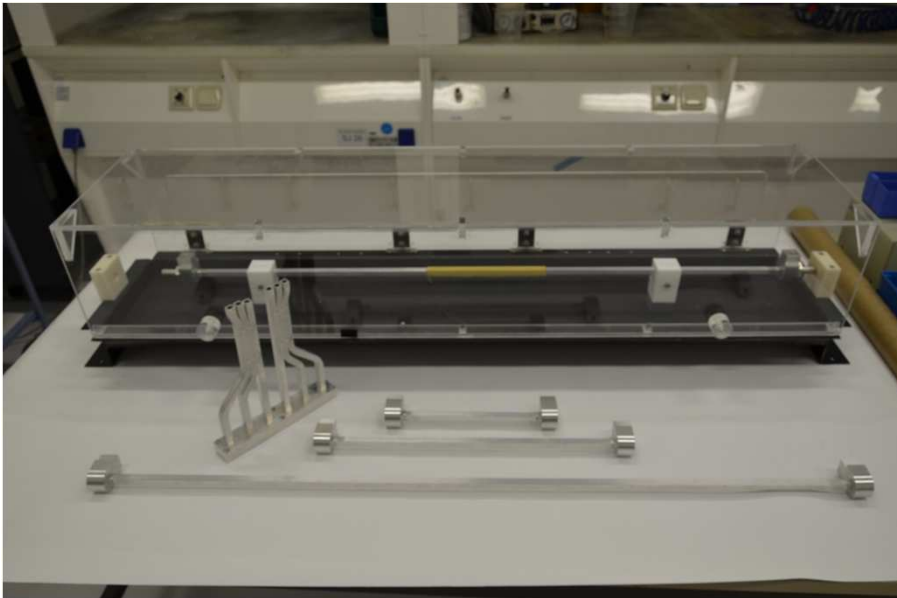


- Shape conformal solution too ambiguous for early-stage R&D
- Rectangular shape demonstrator GEM2D chosen in 2012

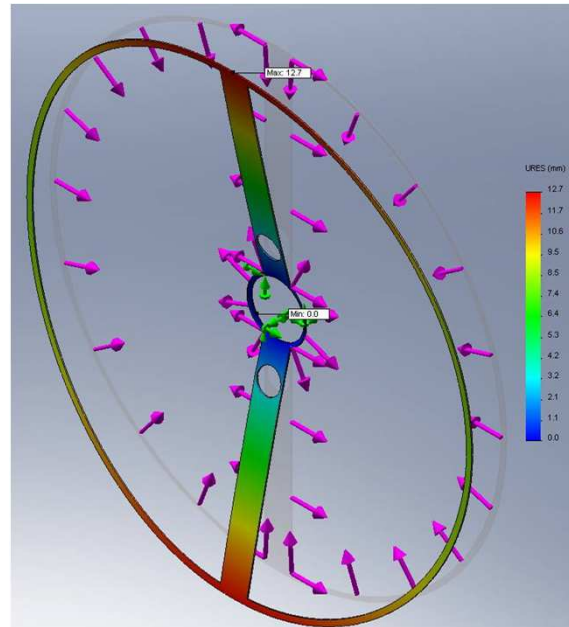
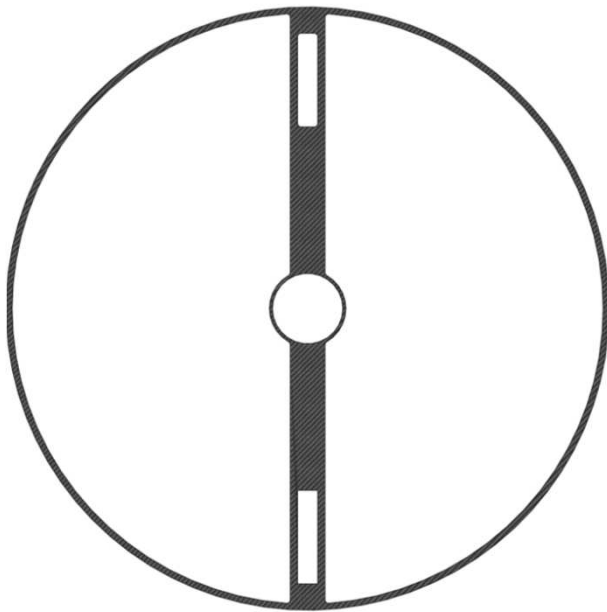


- Al-tubes
E-beam welded
- Gas/Cooling &
GND/PWR
- Weight 1-2 kg
- Size 46x52x1000mm³

Tests for feasibility (Current / temperature raise) required



- Test samples operated under realistic conditions (currents) with fluid cooling
- Temperature raise well below the 30°C design goal
- Optimization of the flex-parts pending

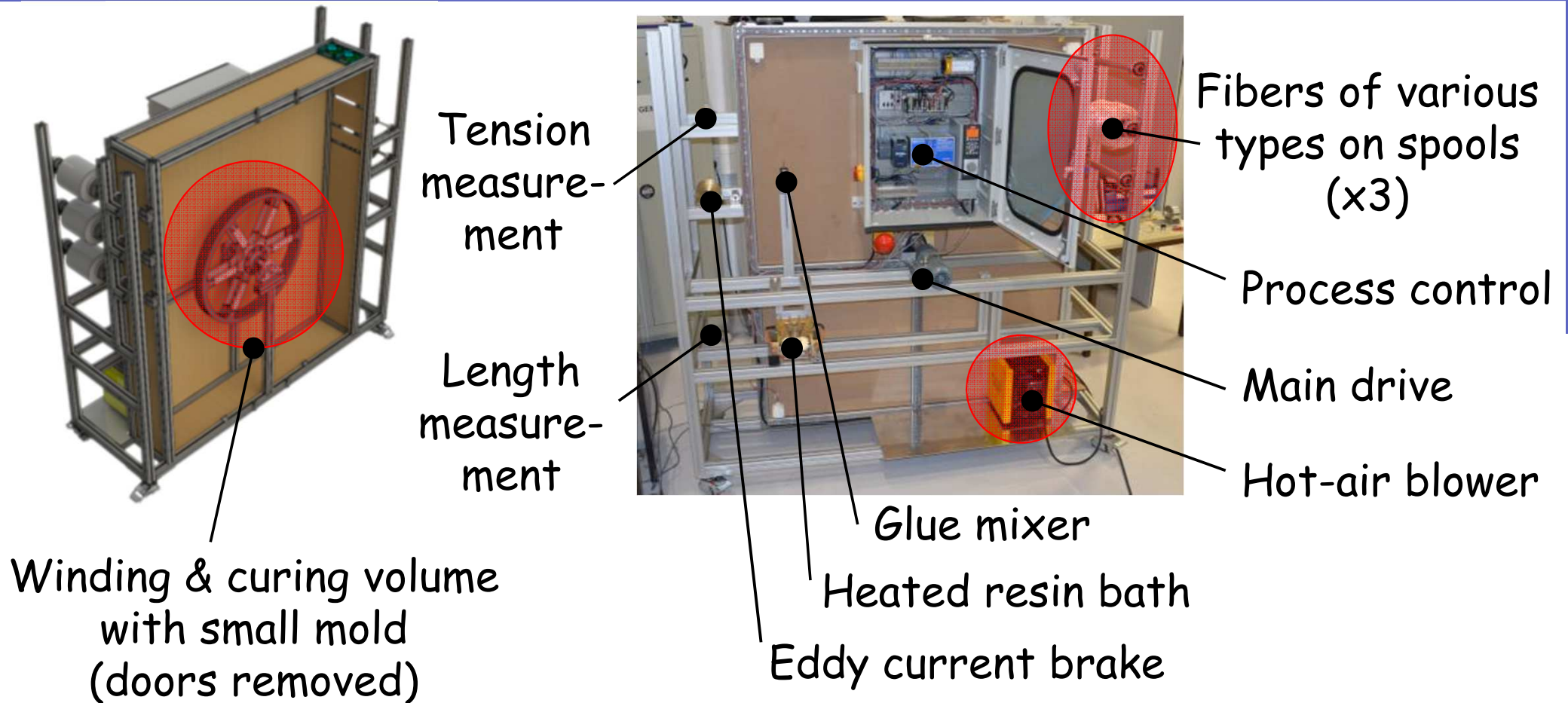


Maximum deformation (mm)
with planar foil stretching
and a 1mm thick frame

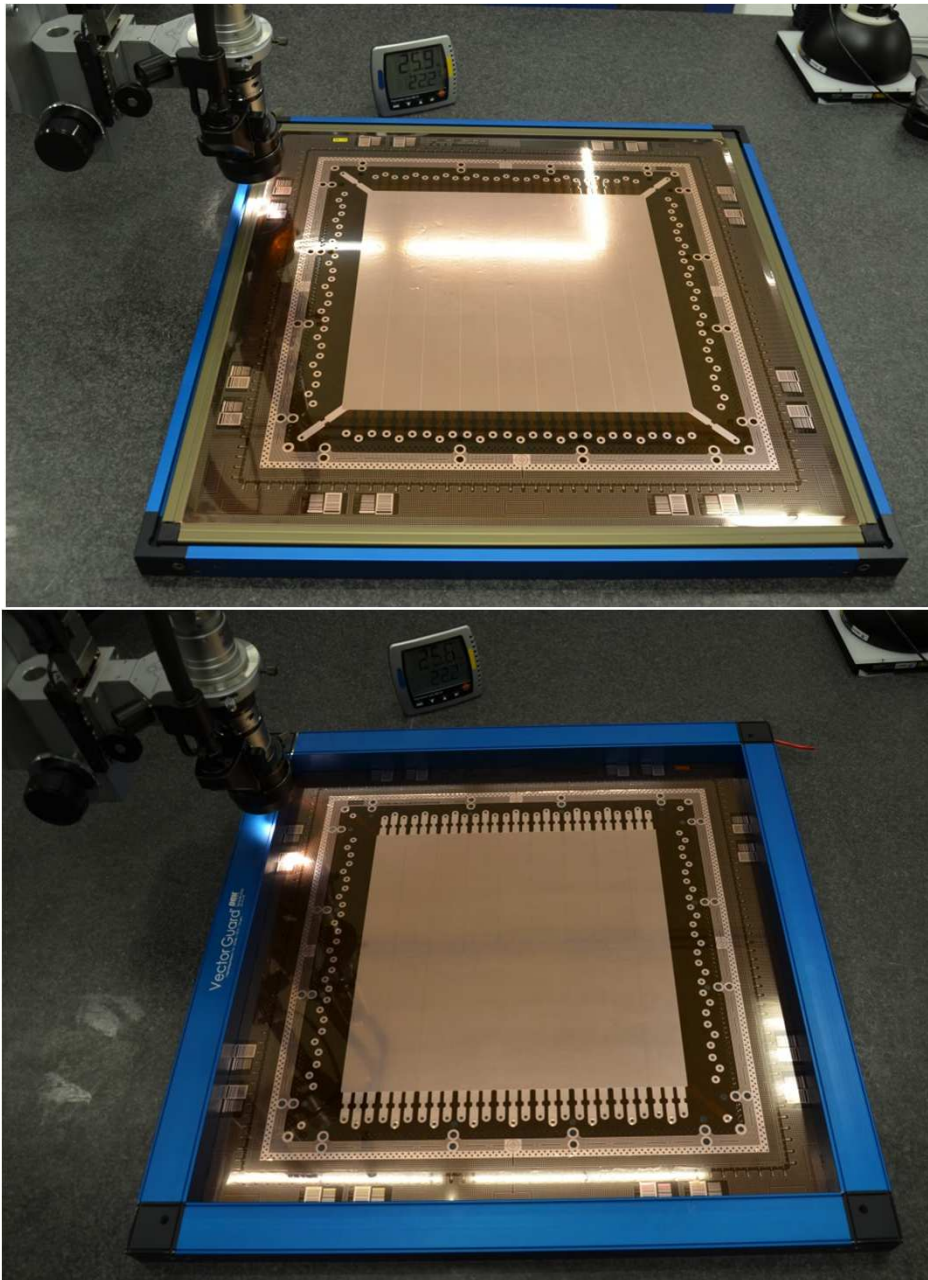
U_x	U_y	U_z	U_{res}
$\pm 1,5$	$\pm 0,24$	12,7	12,7

- Needs optimized fiber orientation and resin/matrix composition
- ⇒ In-house production of rings
0,5..10 mm thicknesses
various diameters up to 1.5 m
- Machinery required
- Mold Waiting to be applied since 08/2011

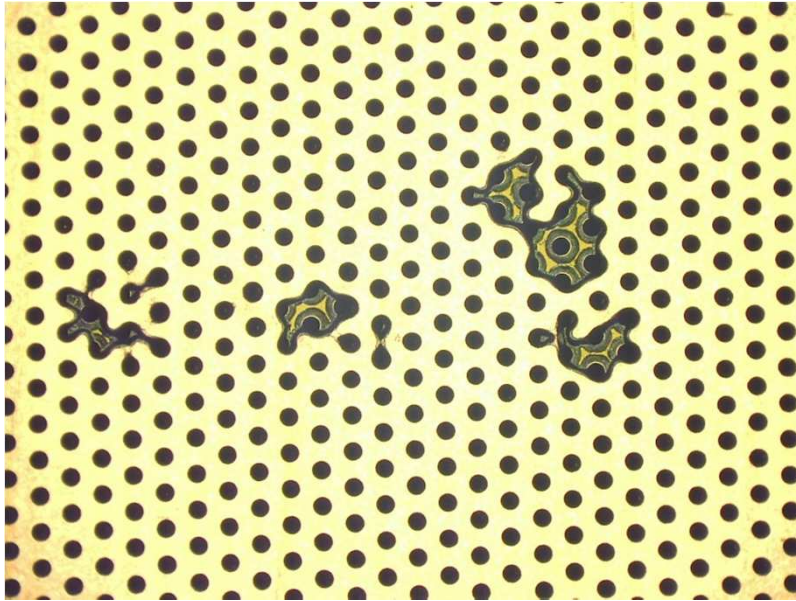




- High-quality winding of fibers of various (mixed) types
- Set up by 6 (8) students from neighboring universities
- Expected run-up in Q3/2016



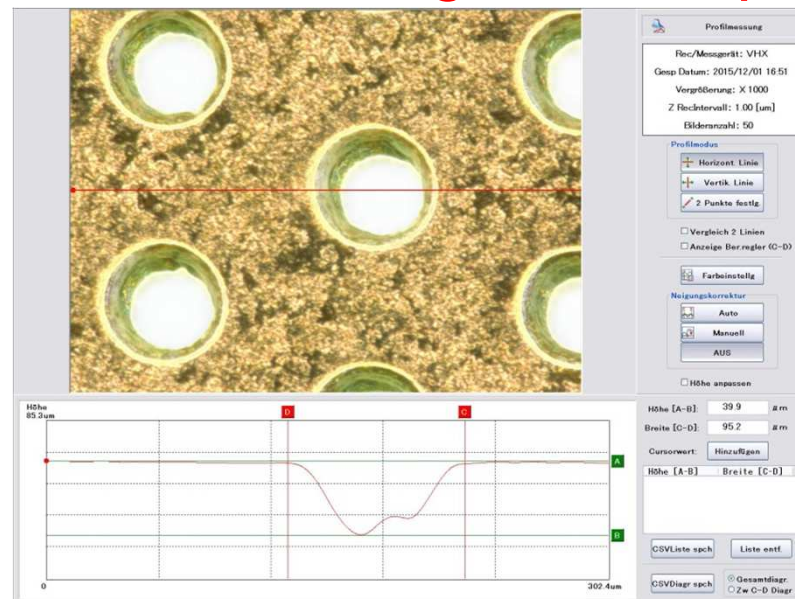
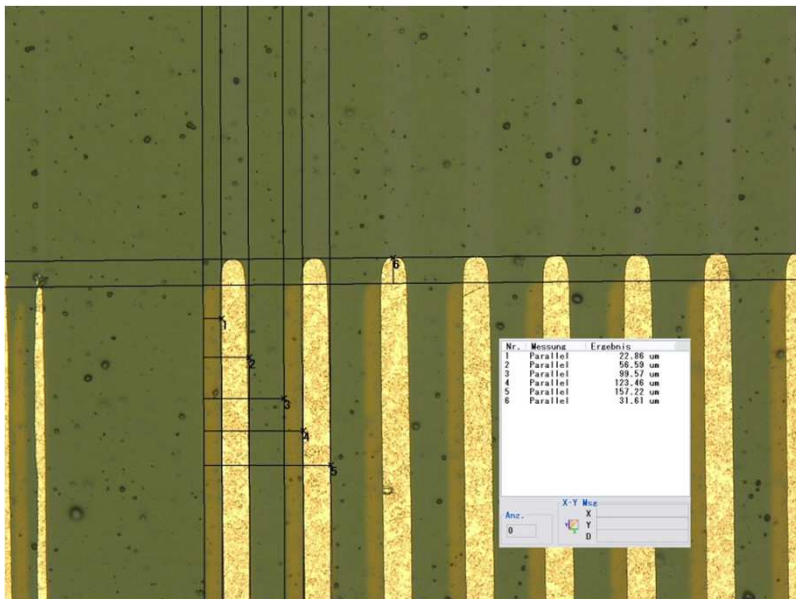
- 2 foils delivered by Techtra realizing GEM2D design
300x300mm² active area
9 sectors with identical layout
(>1,5 year delivery time)
- Max. 10nA@600V for 12 s
in free air at 1amt & 'normal'
humidity:
Several shorts in one sector
- Subjective impression
of optical homogeneity: **OK**
- 'Light' area < 1 mm²: **OK**



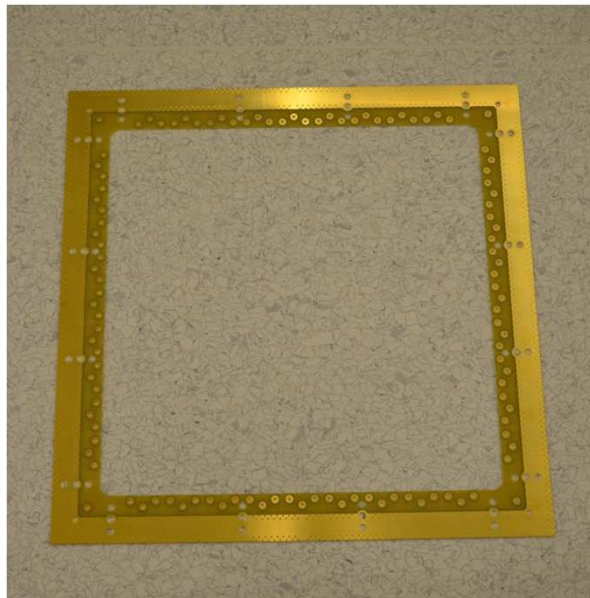
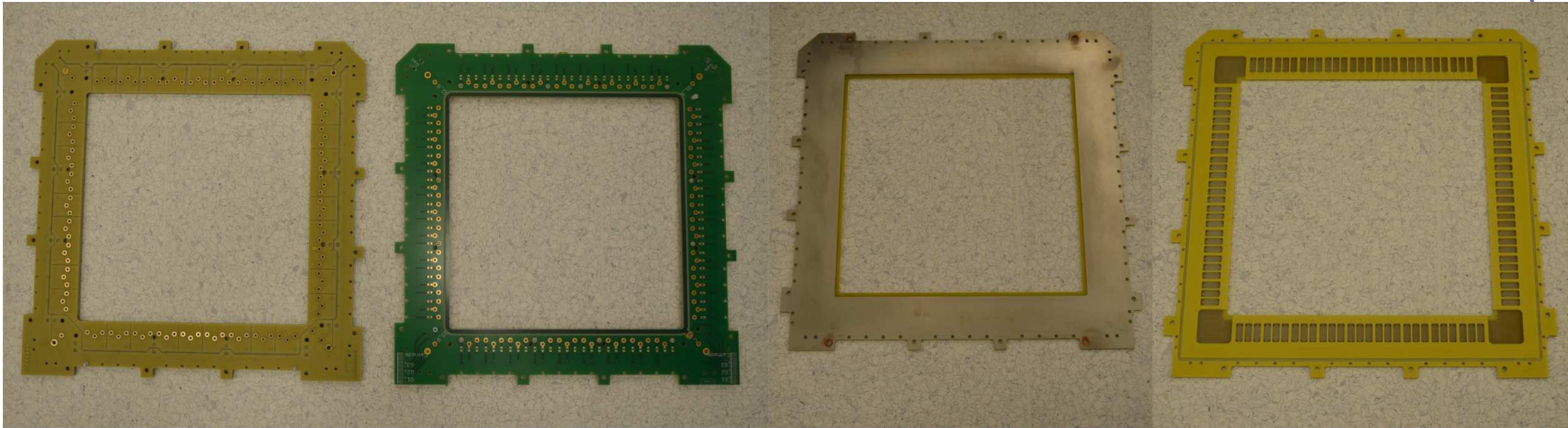
- **Max. 2 defects** with $<1 \text{ mm}^2$
- Polyimide hole & Copper rim:
 - $70 \pm 2 \text{ } \mu\text{m}$ & $50 \pm 2 \text{ } \mu\text{m}$ within a single GEM foil
 - $65\text{-}75 \text{ } \mu\text{m}$ & $35\text{-}55 \text{ } \mu\text{m}$ in a batch from foil to foil

- **Misalignment top/bottom masks**

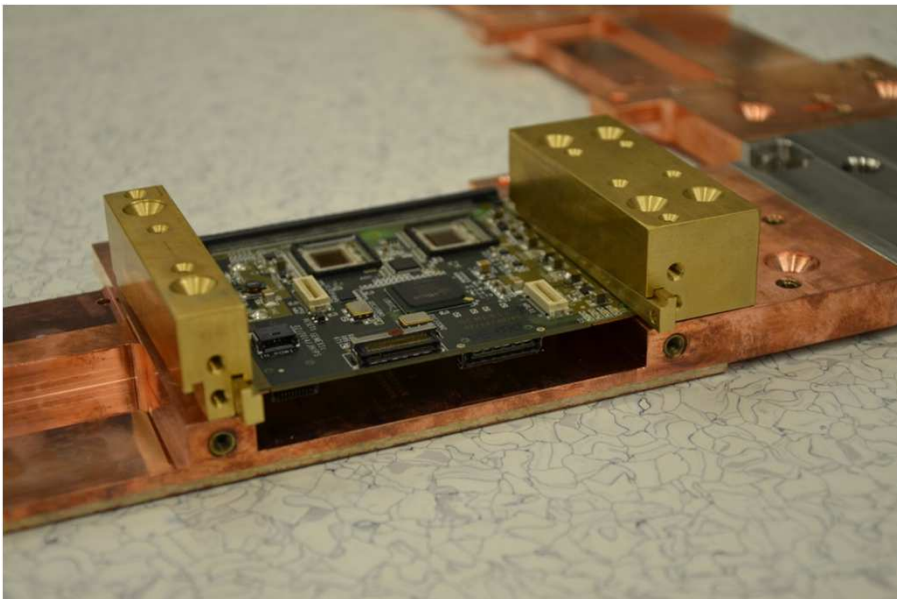
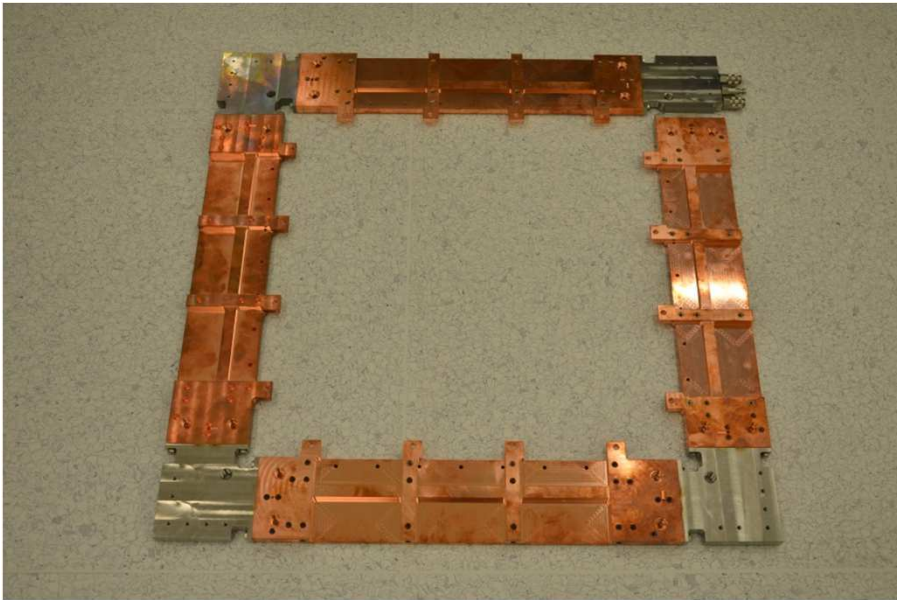
→ non-concentric holes



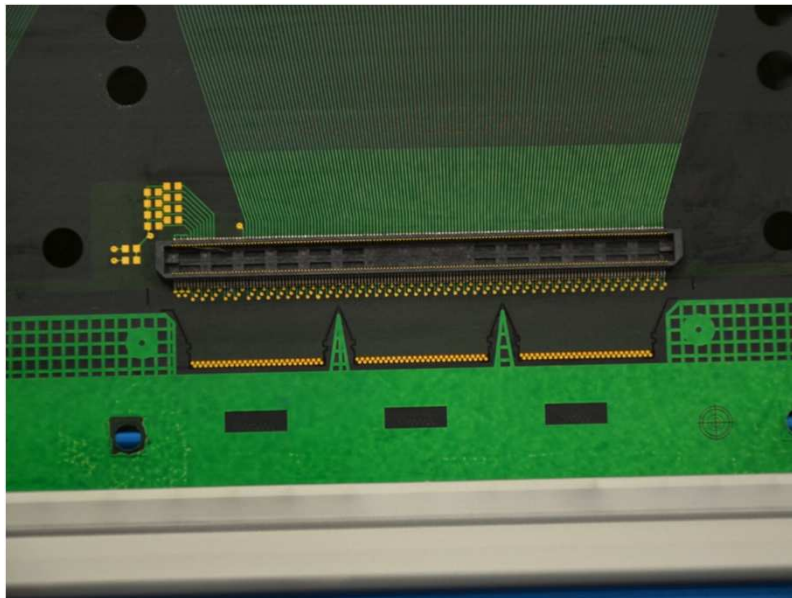
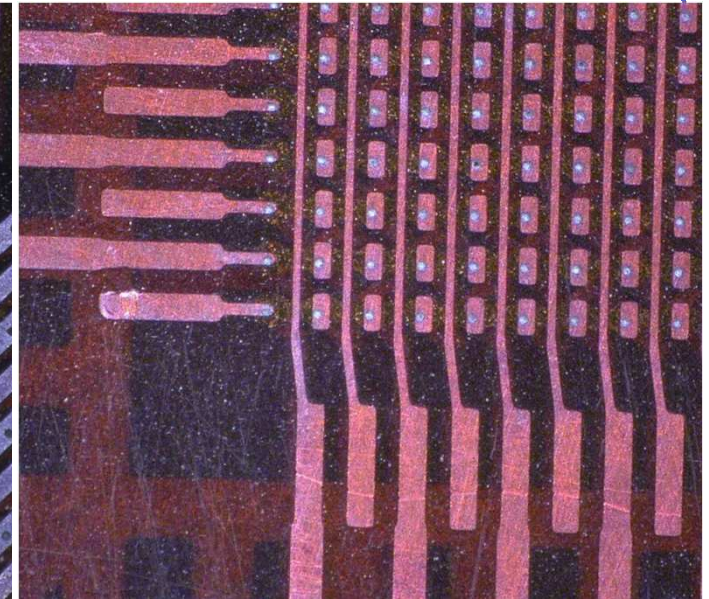
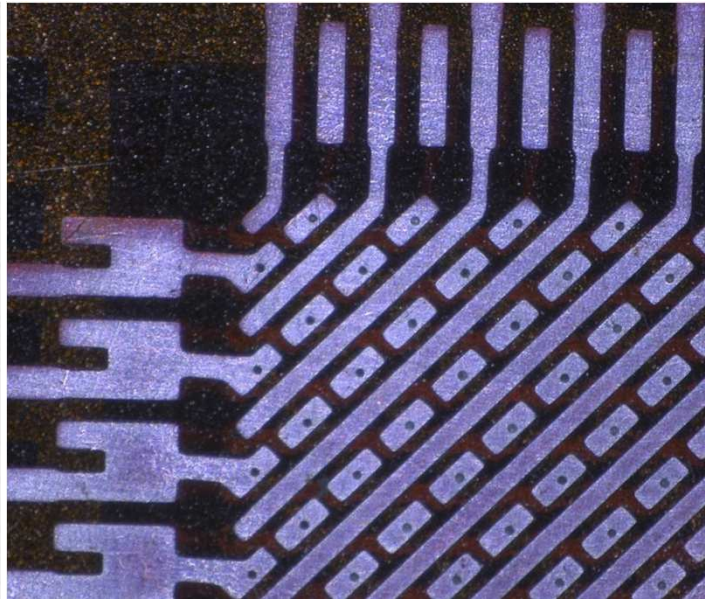
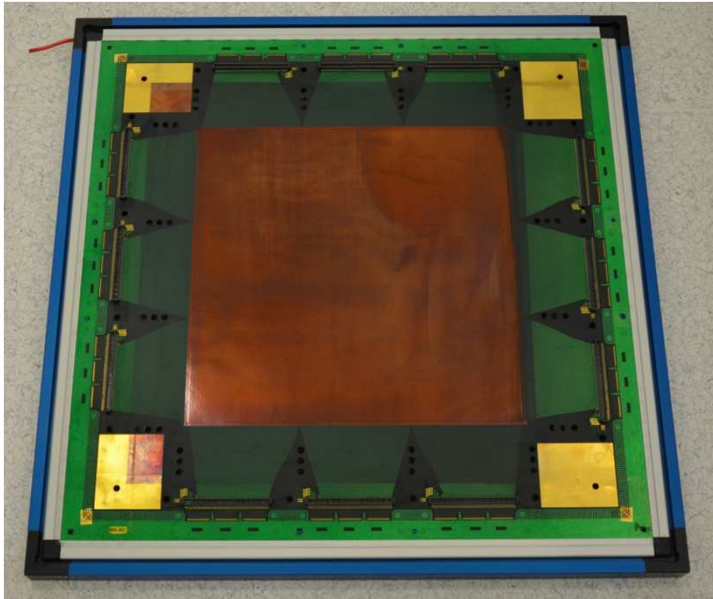
- **Single-mask foils will be better later on**



- All frames delivered
(shielding, cathode, GEMs, PadPlane stiffener)
for a set of two GEM2D demonstrator
detectors
- Assembly is pending

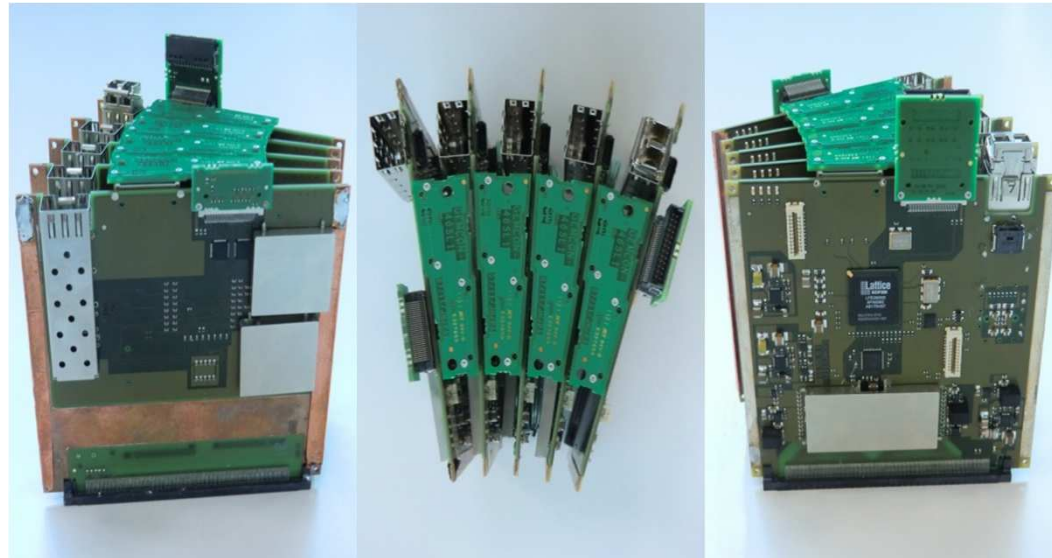
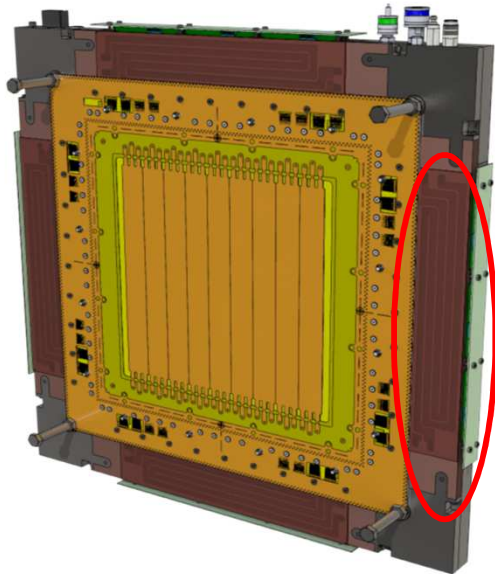


- Cooling 'main' structures fabricated at GSI (took month's)
- Successfully tested for leak-tightness under pressure
- GEMEX (V1C) readout front-end cards mountable

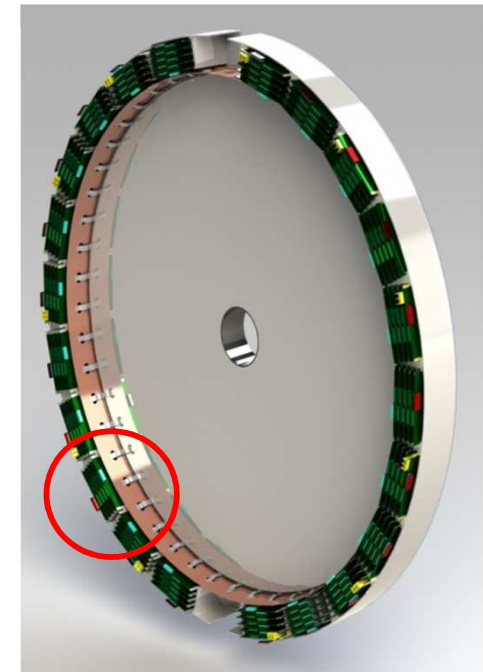


- PadPlane: Cartesian & 45°tilted strips
 - 450/150 μm width/gap, 250 μm thin flex
 - requires 1Mio μ -vias & <100 μm routing
- 1 out of 3 produced & part-mounted by CERN 1 short + 1 cut strip out of 3072 lines
>1,5 years delivery time

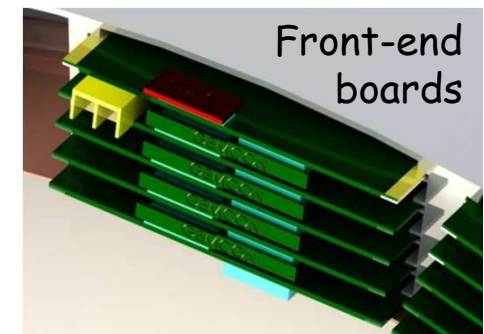
Medium-sized
Square-shaped
GEM2D
demonstrator
(3 kch)



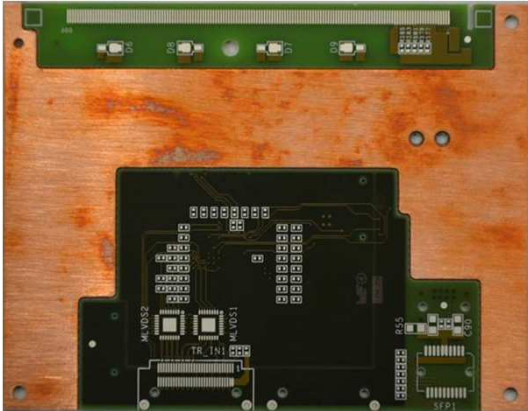
Large-sized
Circular-shaped
GEM-Disc detector
(20..45 kch)



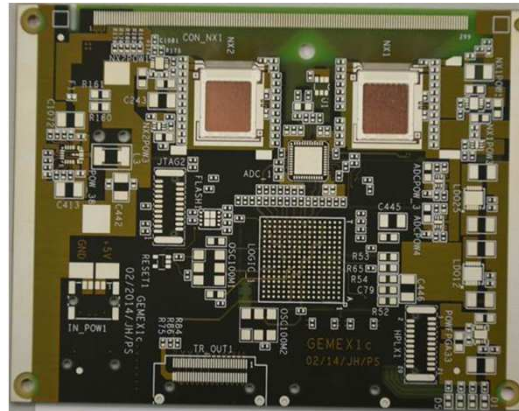
- High-density front-end boards with local intelligence
- 6 (80) kch, 24 (320) FEBs operated in groups with common supply, control, optical link
- Development at GSI synergies with other FAIR projects (SuperFRS, BioMat, ACC...)



Back-



Front-side view

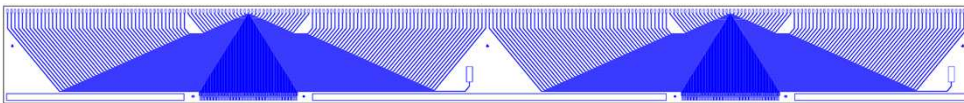


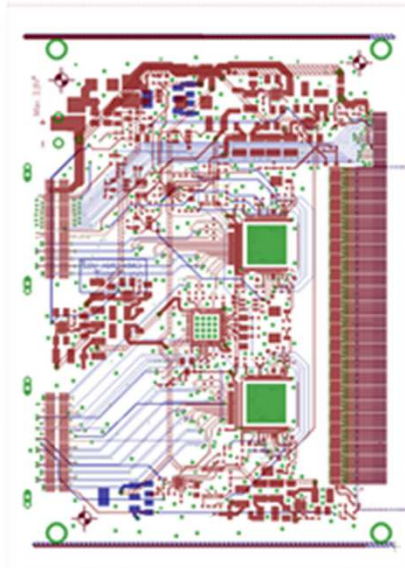
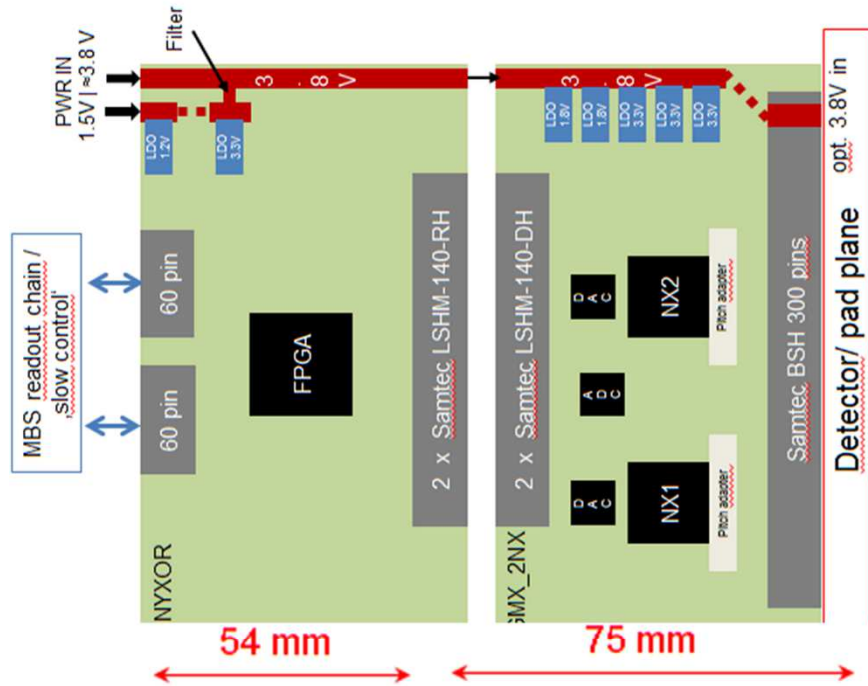
■ Revision 1C failed in 2014

- Too low yield due to $(50 \rightarrow 100) \mu\text{m}$ bonding structures on PCB
- Too high noise values during beam-tests at GSI (powering scheme)

■ Change of concept:

- Easier debugging & maintenance (interfaces accessible)
- Make use of pitch adapters
- Analog/digital parts split/modular
- Timing scheme adaptable (self-triggered, white (grey) rabbit, SODA, ...)





- XILINX Spartan 6
FPGA-based board
(offering more building blocks)
- Digital part under lab-test
- Analog part in part-mounting
expected back in 02/2016
- Intense in-lab test pending
- In-beam application of the system
planned for 06/2015 at GSI

- At all time we found the solutions required or are on the way technically and with respect to simulation (SR) it just takes time
- So far there is no major problem with the budget (SR) but rather with the way we spend it at GSI
- No show-stopper to be faced so far, nevertheless...
 - The project isn't driving full throttle, support in general is moderate
 - We are behind schedule by at least $\approx 2,5$ years
 - Time line is 'floating', no quantification is possible
 - TDR writing can start only if general problems are solved
 - We may catch up, but only if there will be more support, faster decisions, more enthusiasm
- There is hope that with the new structure of GSI's internal organization we might go on faster



GEM-Tracker (50) 'Alumni' members & tasks

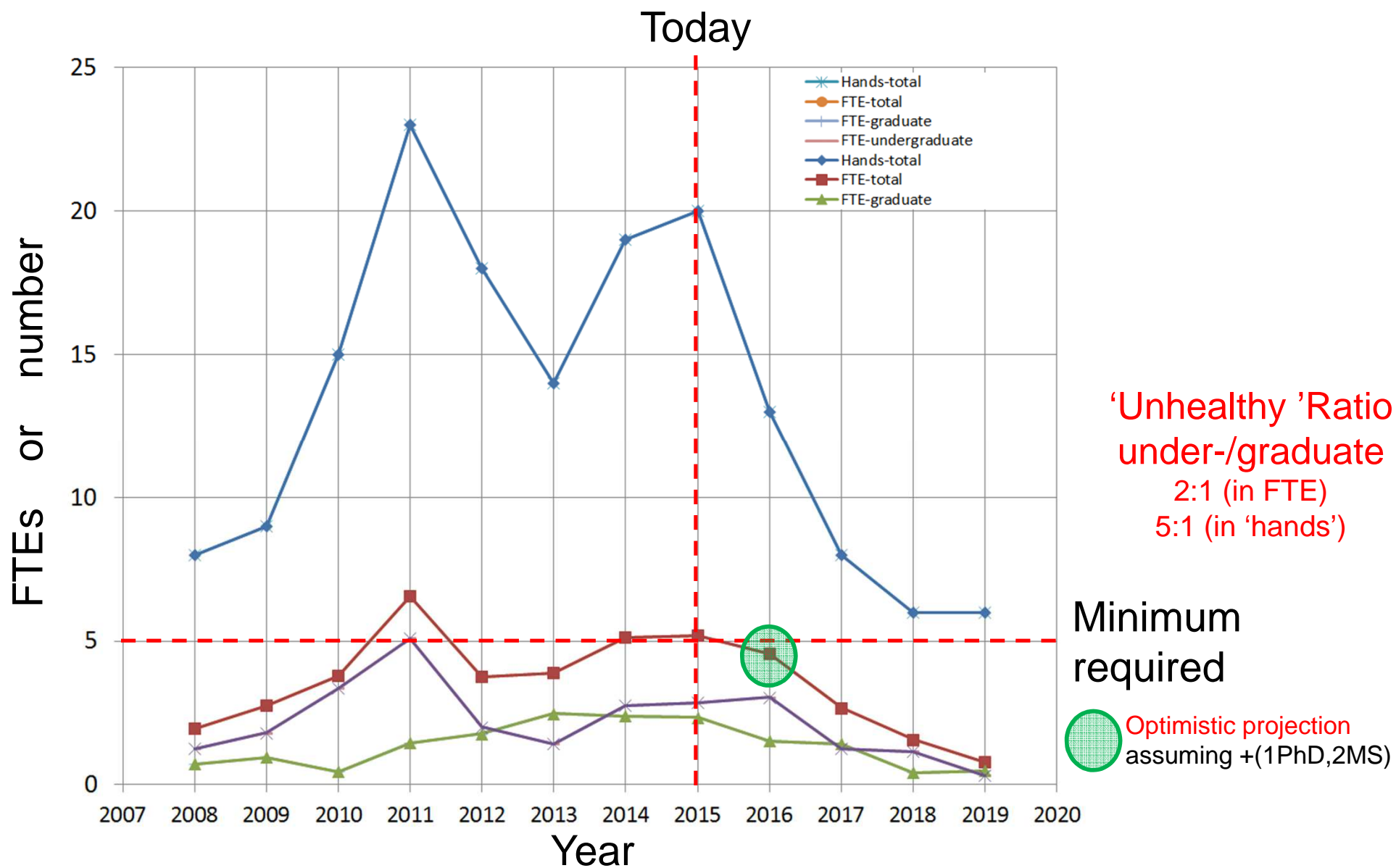
Yannick Ahouannou		GEM-Frame Wickelvorrichtung
Dirk Auer		Moulds, FEM simulations
James Bailey		GEM-QA
Farsane Baraki		Electronics, Testumgebung
Olga Bertini	(HIM)	Phys.-Simulations (setup-wise, PANDARoot)
Patrick Breckner		Electronics Part Mounting
Philipp Castorph		T-Sensors
Armstrong Djoumessi		FEE, Testing
Nico Donaera		Electronics
Lukas Dritschler		GEM-QA, Prozessteuerung
Mouhssine El Hayani		GEM-Frame Wickelvorrichtung
Mohamed El Khallali		GEM-QA
Sebastian Fesissow		General supplies
Atif Fouad		GEM-Frame Wickelvorrichtung
Mario Gagulic		GEM-stretching
Siavash Ghasemzadeh-Asl		FEE, Testing
Daniel Glaab		GEM-Frame
Andrii Gromliuk		Design (GEM2D), Det.-Simulations, Electronics
Andreas Heinz		PadPlanes, GEM generals, Sensors, WebInfo
Markus Henske		Sensors, Cooling, Purchase
Isidore Kameni		GEM-QA, Prozesseinrichtungen
Ingo Kaufeld		General mechanics
Can Kaya		Supplies Conduit, set-up & functional tests
Eugen Kramer		Electronics
Jochen Kunkel		General mechanics, drawings, assembly

Mathias Lieb		Electronics
Mohamed Maataga		GEM-Frame Wickelvorrichtung
Dima Melnichuk	(NCBJ)	Det.-Simulations (GEM/PadPlane, Garfield)
Witali Merker		Electronics
Robin Molatta		Electronics, Sensors
Milad Nuri		Supplies Conduit, set-up & functional tests
Rouven Plewe		GEM-Design
André Remers		Riddle, Moulds (outer)
Bodowin Renner		Electronics
Jörg Reuss		Riddle
Jörg Reuss		Riddle-mould, Handyman
Nami Saito	(HIM)	GEM-QA, data analysis
Sarah Schütz		Support & Insertion tool
Marco Seibert		Electronics
Ivan Fernando Soriano Osornio		Electronics, Partmounting
Daniel Soyk		Simulations
Clavel Janvon Tchatcho Bitchou		Electronics
Eldrige Tchoua Yamedji		GEM-Disc Moulds, Fasteners
Jessica Tischer		Support
Eduard Traut		GEM generals, Moulds (outer & inner)
Elena Traut		Cabling & Infrastructure
Mirabelle Tsadjeu Tsamo		Electronics
Jan Voss		General mechanics, GEM generals
Tobias Weick		Moulds



GEM-Tracker (14) 'Active' crew members & tasks

Maher Bouzayene		GEM-Frame winding
Christoph Cäsar		Front-end electronics, Testing
Nazila Dami Vreis	(HIM)	Phys.-Simulations (setup-wise, PANDARoot)
André Ehret		General mechanics & FEM simulations, Supplies, Conduit, GEM(-QA, Framing, Processing)
Houssem Jmour		GEM-Frame winding
Volker Kleipa		Analog electronics
Andrea Neeb		Relief person, gofer
Yves Moriaz Ngassa Tchangang		GEM-Frame, Processrealization
Sandra Schwab		CAM
Carmen Simons		Bonding
Bernd Voss		Project, 'All & nothing'
Joachim Weinert		CAM
Takehiko Saito	(HIM)	Project
Bogdan Zwieglinski	(NCBJ)	Project
&... the GSI-DL & central infrastructure (mainly mechanical & electronics workshop)		



- We suffer from a substantial drain in permanent man-power in the past 4 years
- Man-power in specialized engineering & 'hands-on' work is required
- Enforcement would be well appreciated in the fields of...
 - Mechanical design
 - (Data Acquisition) & Analysis
 - Cooling
 - Detector Control System