PANDA

MVD Session at GSI - ZEA-1 Status

05. NOVEMBER 2019 I

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F. BECKER | IKV-AACHEN

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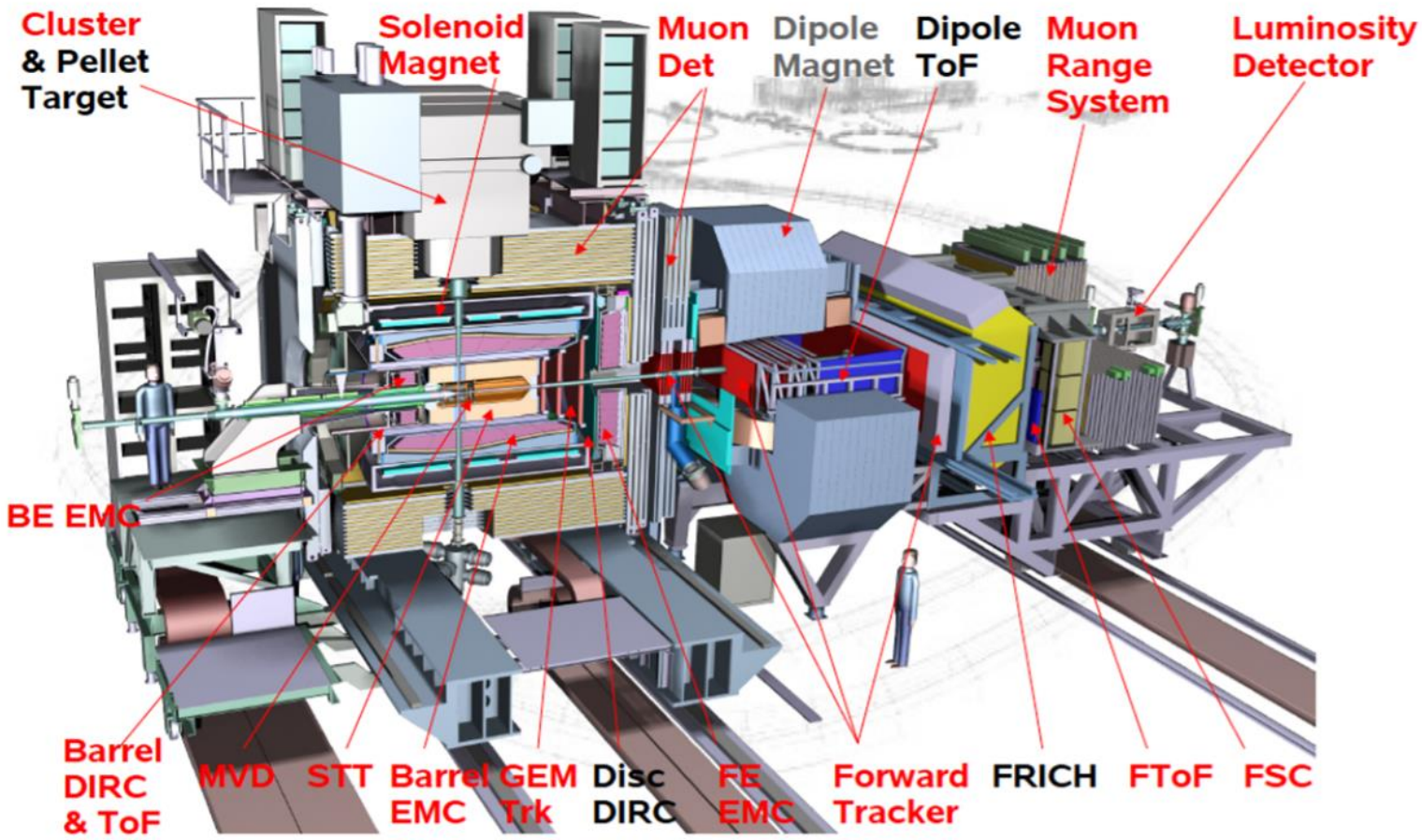
The PANDA detector (start/full setup)

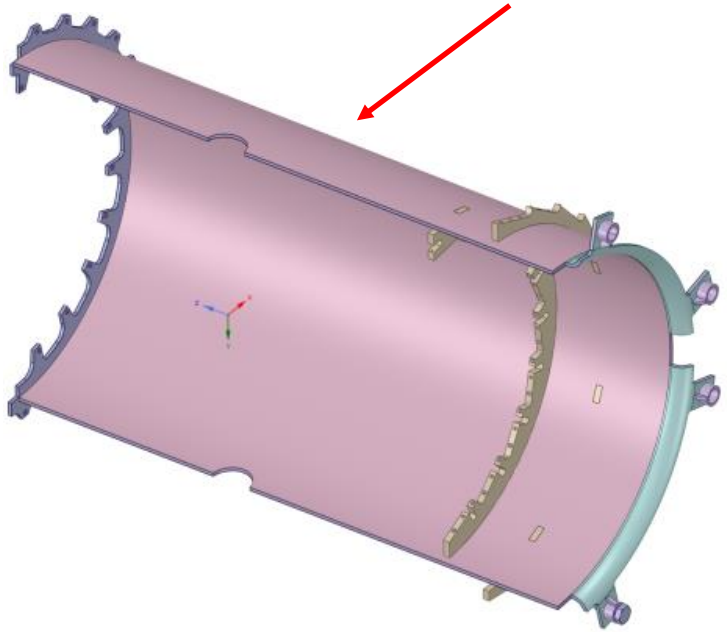


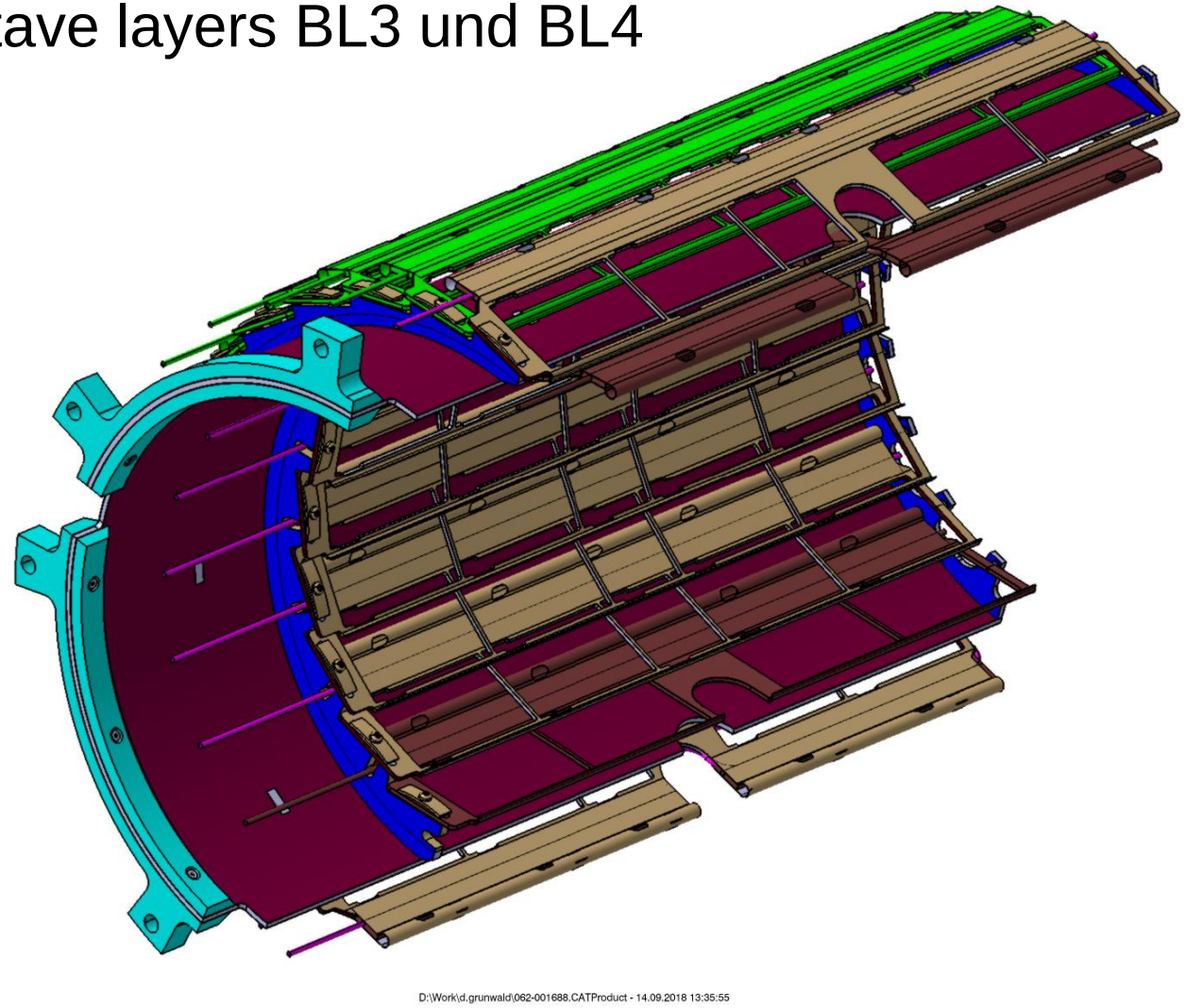
Quelle: https://panda.gsi.de/system/files/user_uploads/dbeyssi%40ipno.in2p3.fr/TA-CON-2017-057_0.pdf

Prototype MVD half-shell with flange and stave layers BL3 und BL4

Remark:
The combination half-shell and aluminium flange, as shown in the CATIA-model right, is going to be substituted by a part manufactured of carbon fibre reinforced plastic (CFRP) completely.
Presently IKV Aachen provides the form for that component.

FEM already calculates with this model.





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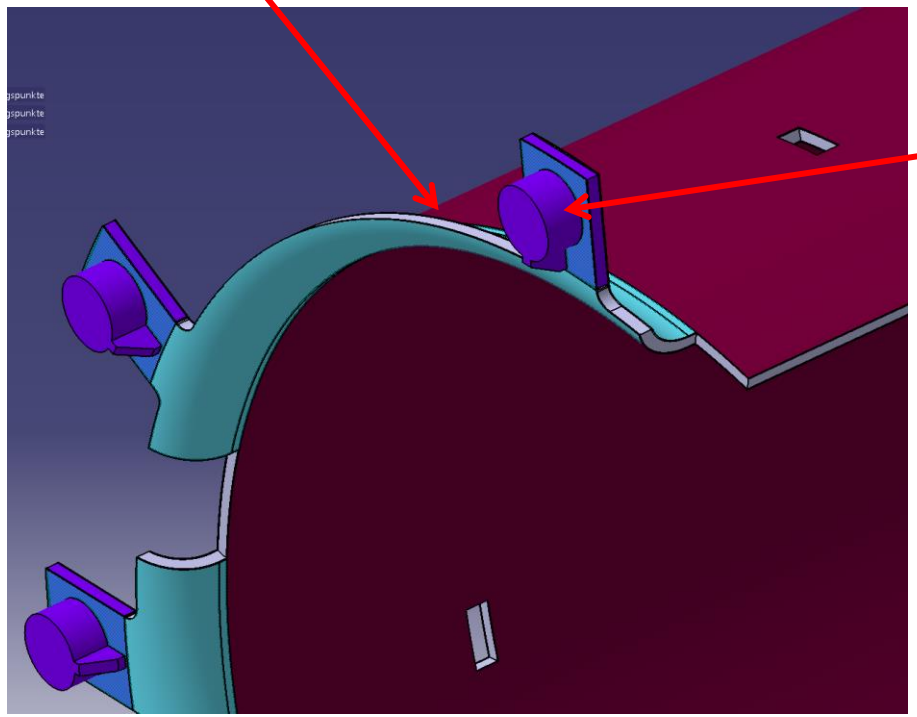
PROTOTYPE MVD

MVD half-shell and flange out of CFRP

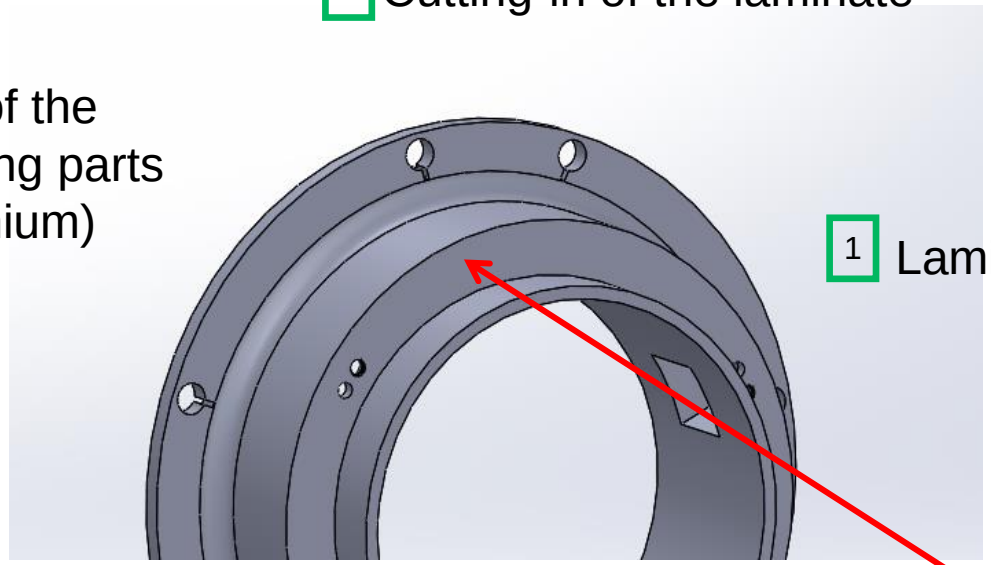
Transition half-shell to flange, both out of CFRP



Order of the manufacturing of the transition half-shell to flange

2 Cutting-in of the laminate

3 Insert of the load-bearing parts (aluminium)



1 Laminating

4 Curing in the autoclave

5 Dismantling

0 Preparation of the form

Source: „19_08_13_Laminiervorrichtung Versionen“ from Fabian Becker, IKV-Aachen

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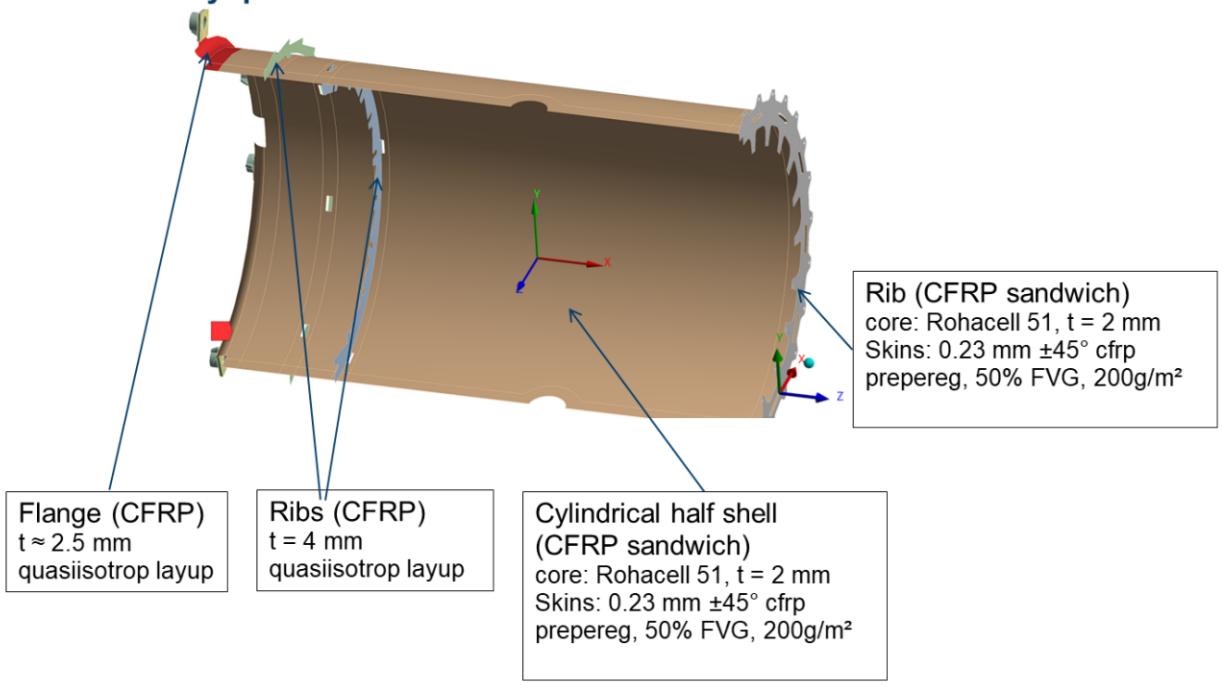
FEM-analysis of the half-shell with flange

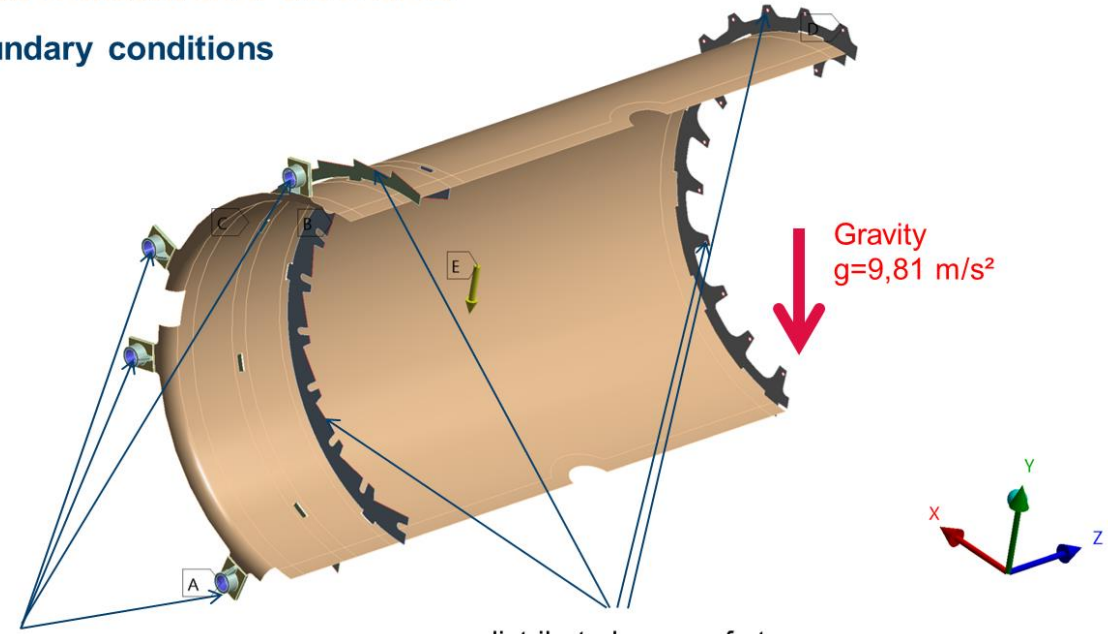
Calculation Model

Laminate Layup



Calculation Model

Boundary conditions



fixed support at mounting points **=> means, that is the best case.**
$u_x=u_y=u_z=0$

distributed mass of staves (red)

Source: „062-PPT-20190829-SSchoenen-Stiffness_cylindrical_half_shell_CFRP_Flange_V1.0 “ from Stephan Schoenen, ZEA-1

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PROTOTYPE MVD

FEM-analysis of the half-shell with flange

Results

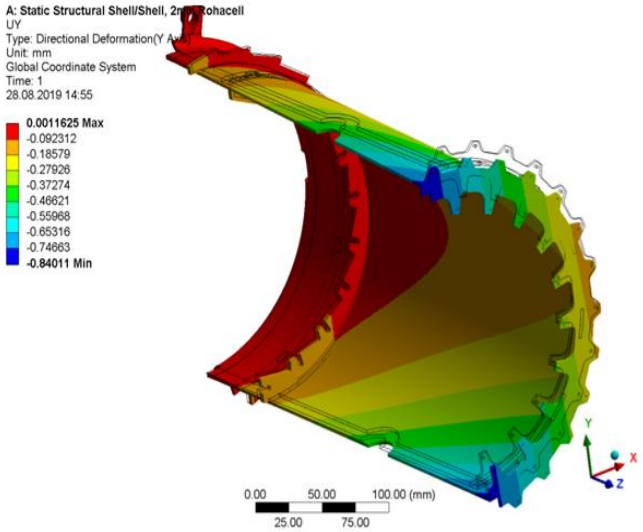
Investigation of simple improvements

CFRP & Rohacell with Al-Inlays

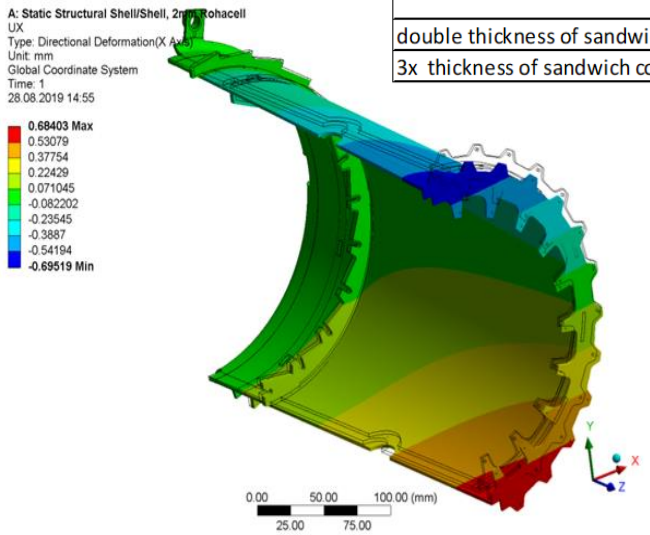
	Skin		Core		Displacements			Mass
Modification	**Layup**	**Thickness**	**Material**	**Thickness**	**vertical**	**relative**	**lateral**	**in g**
reference	-45/45	0.23	Rohacell	2	-0.84	100%	+/-0.69	188
	0/90	0.23	Rohacell	2	-1.18	140%	+/-0.95	188
	0/90-45/45	0.23	Rohacell	2	-1.1	131%	+/-0.9	188
double thickness of sandwich skin	-45/45	0.46	Rohacell	2	-0.55	65%	+/-0.45	274
	0/90/-45/45	0.46	Rohacell	2	-0.65	77%	+/-0.54	274
double thickness of sandwich core and skin	-45/45	0.46	Rohacell	4	-0.19	23%	+/-0.15	317
3x thickness of sandwich core and 2x of skin	-45/45	0.46	Rohacell	6	-0.11	13%	+/-0.07	354

Results

Current design - displacements



vertical displacement
max. absolute value: uy=-0.84 mm



lateral displacement
max. absolute value: u_x=0.69 mm

Source: „062-PPT-20190829-SSchoenen-Stiffness_cylindrical_half_shell_CFRP_Flange_V1.0 “ from Stephan Schoenen, ZEA-1

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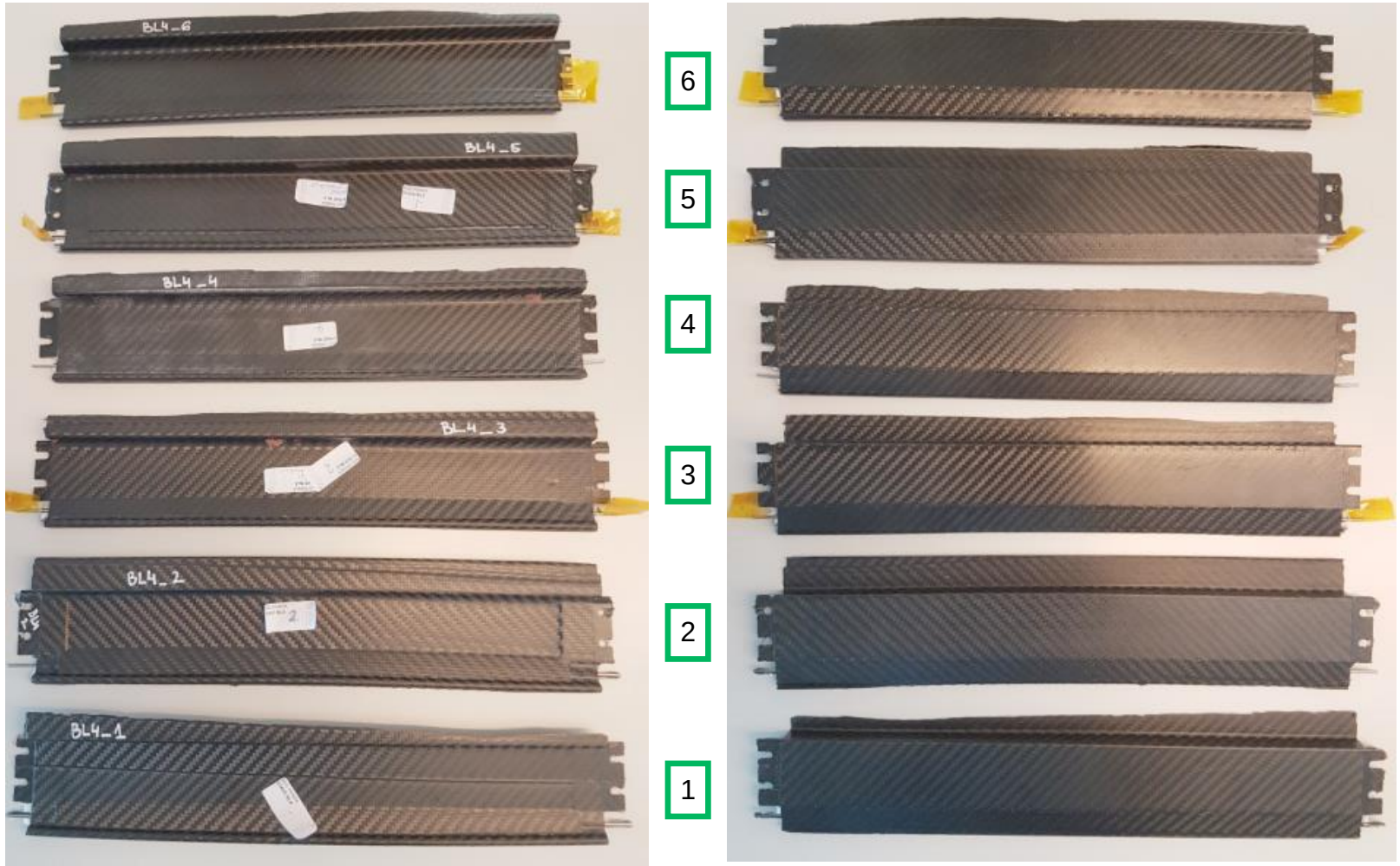
PROTOTYPE MVD

Staves BL4 number 1 to 6 are manufactured at IKV-Aachen

Backside

“Chip”-side



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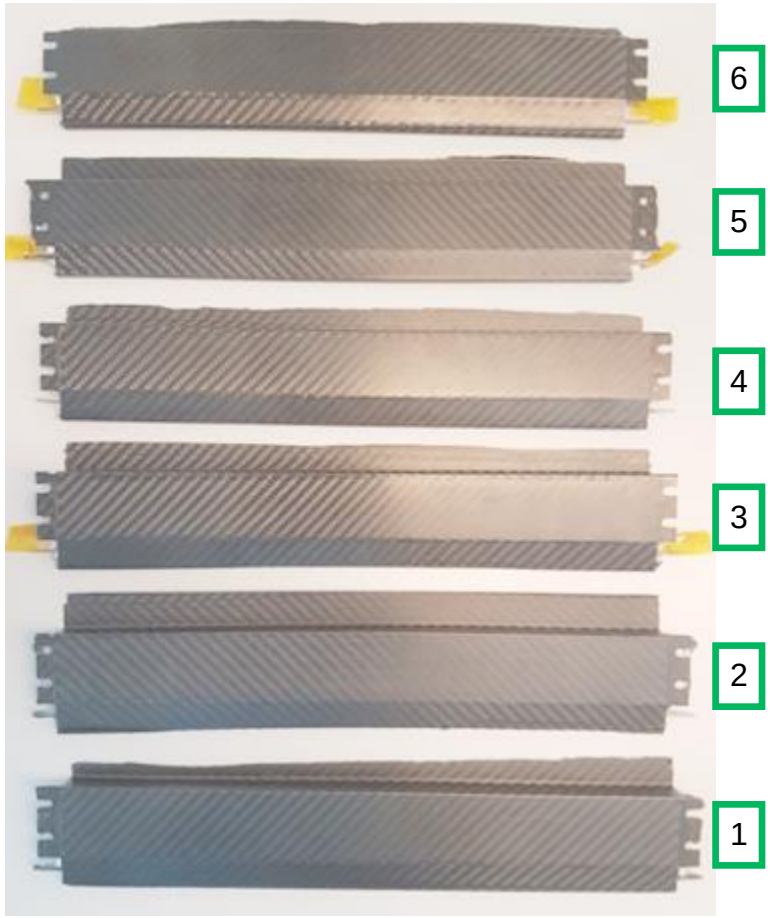
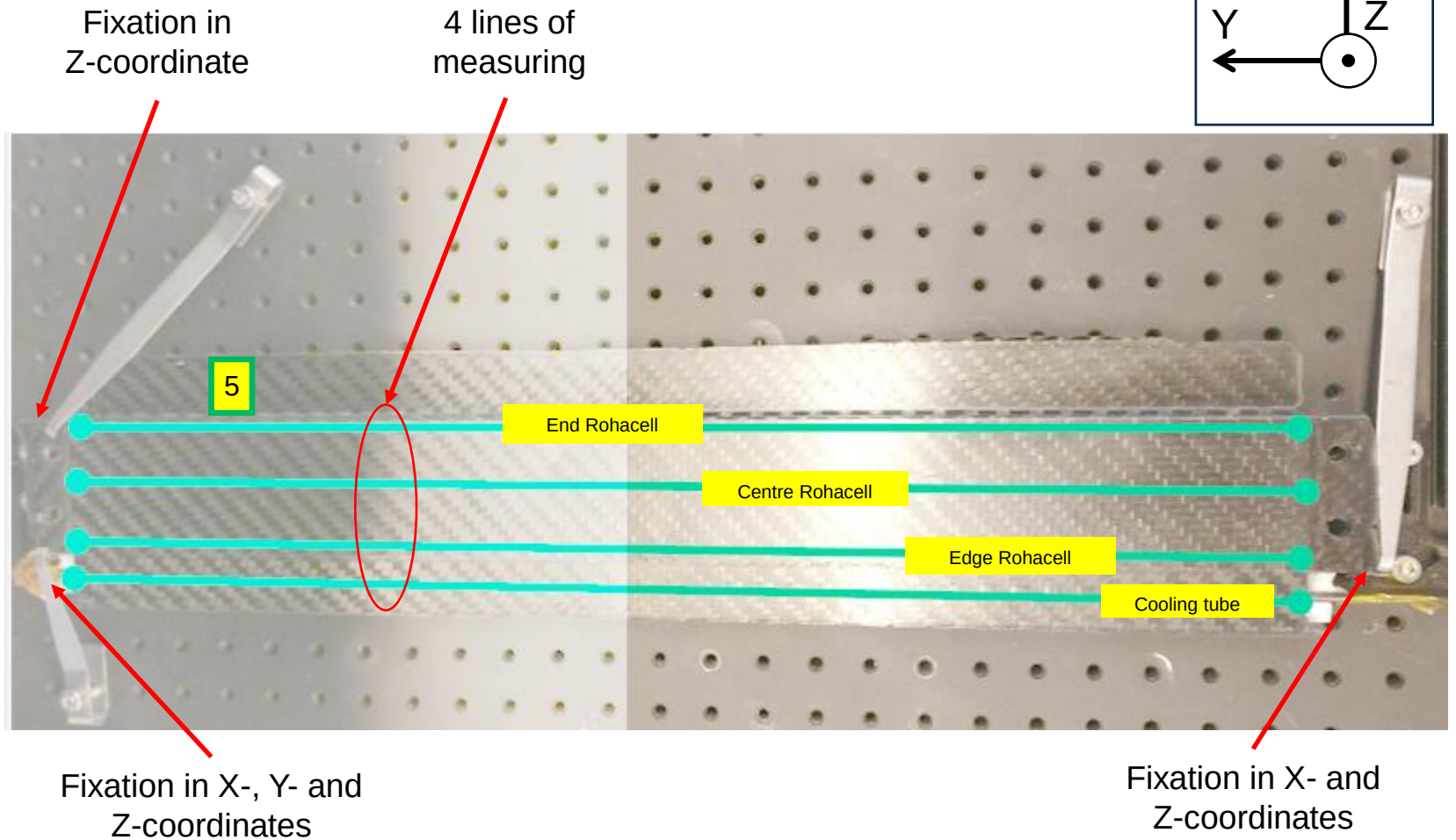
PROTOTYPE MVD

Staves BL4 number 1 to 6 are measured at IKV-Aachen





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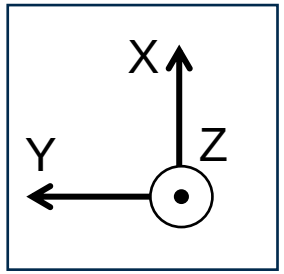
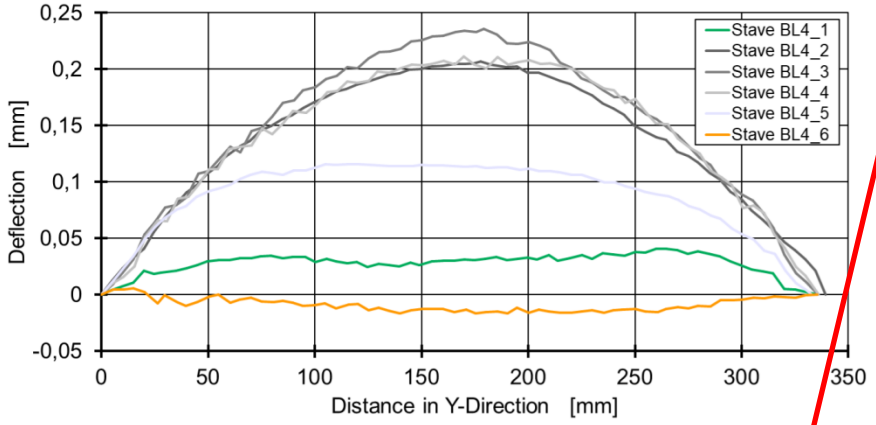
PROTOTYPE MVD

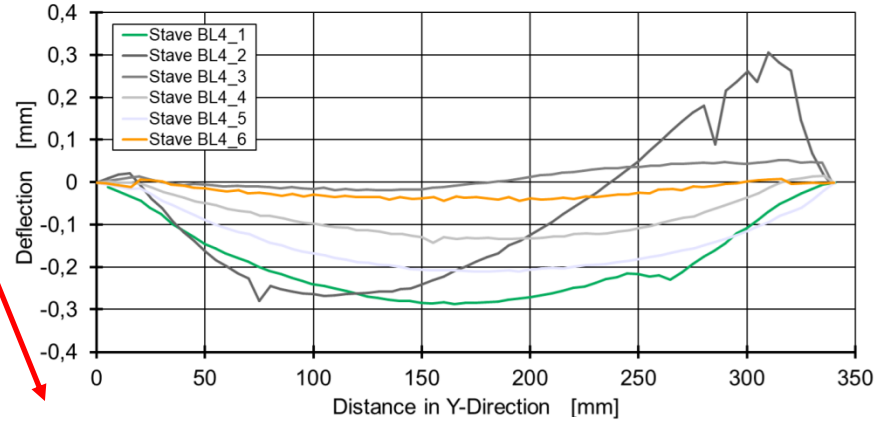
Staves BL4 number 1 to 6 are measured at IKV-Aachen



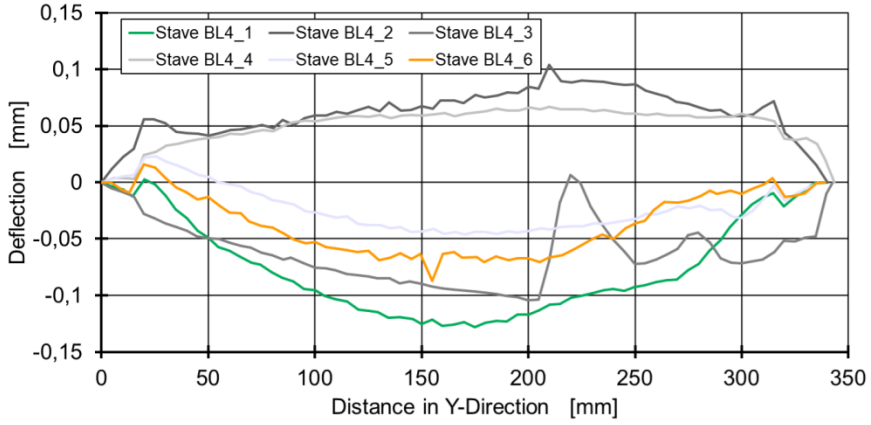
Comparison in Deflection End Rohacell



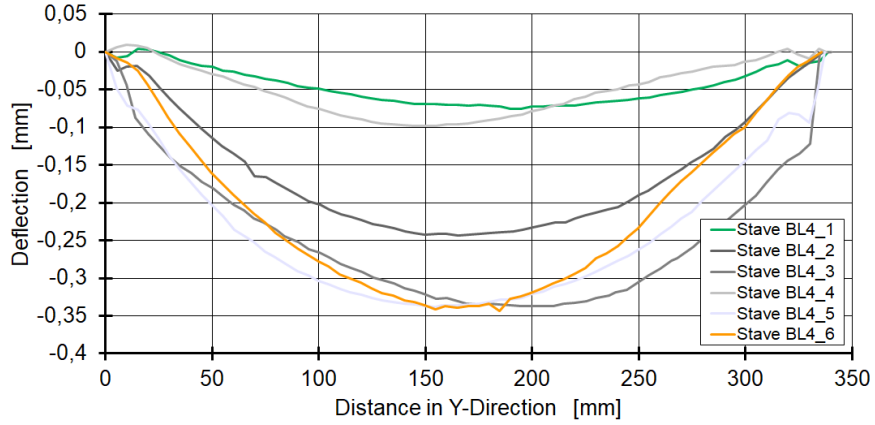
Comparison in Deflection Edge Rohacell



Comparison in Deflection Center Rohacell



Comparison in Deflection Cooling Tube



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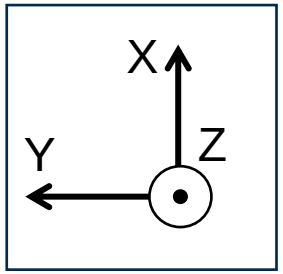
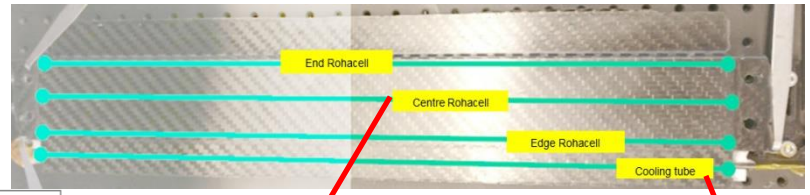
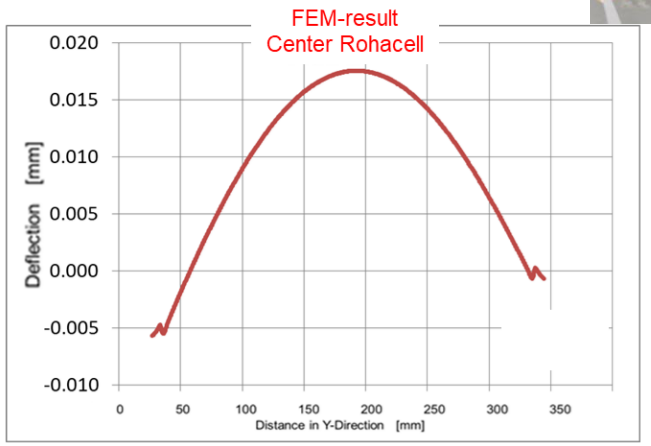
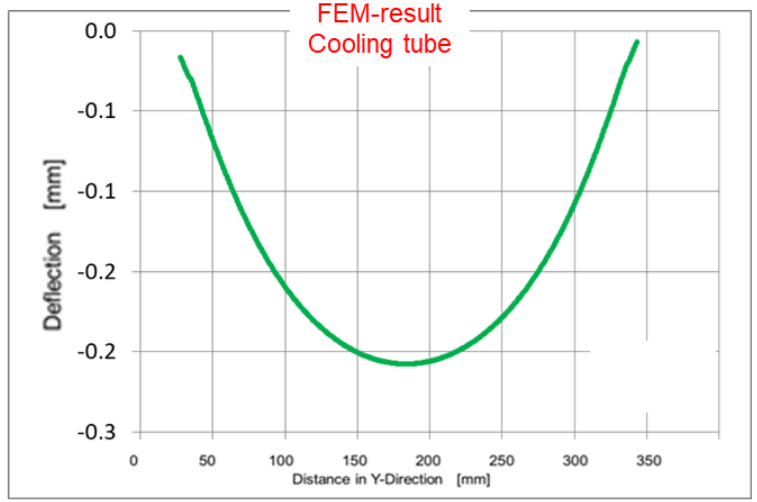
PROTOTYPE MVD

Measurement results at IKV-Aachen compared with FEM-results



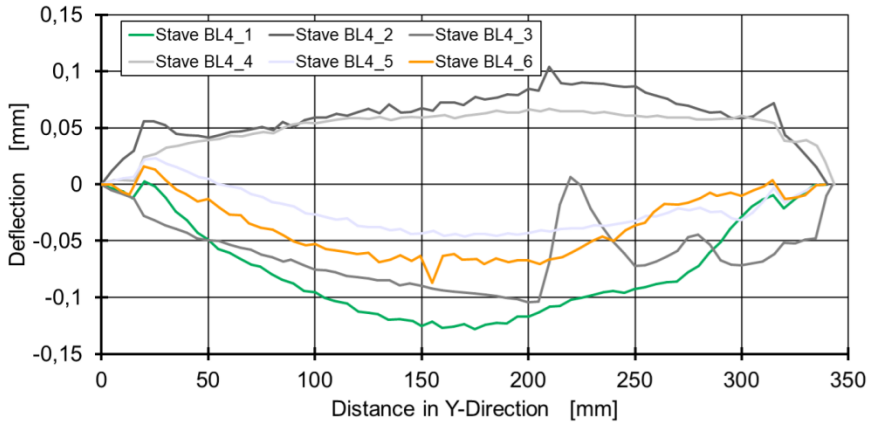




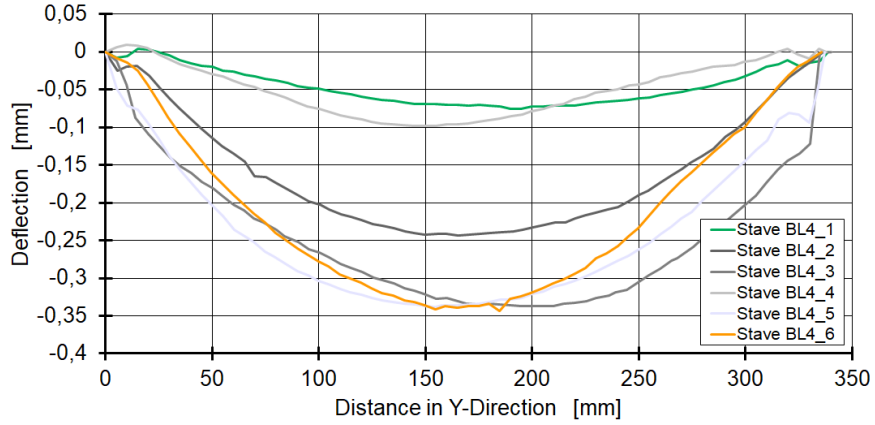


Source: „062-PPT-20190311-SSchoenen-Thermo_mechanische _Berechnung_Stave_V1.4 “ from Stephan Schoenen, ZEA-1

Comparison in Deflection Center Rohacell



Comparison in Deflection Cooling Tube



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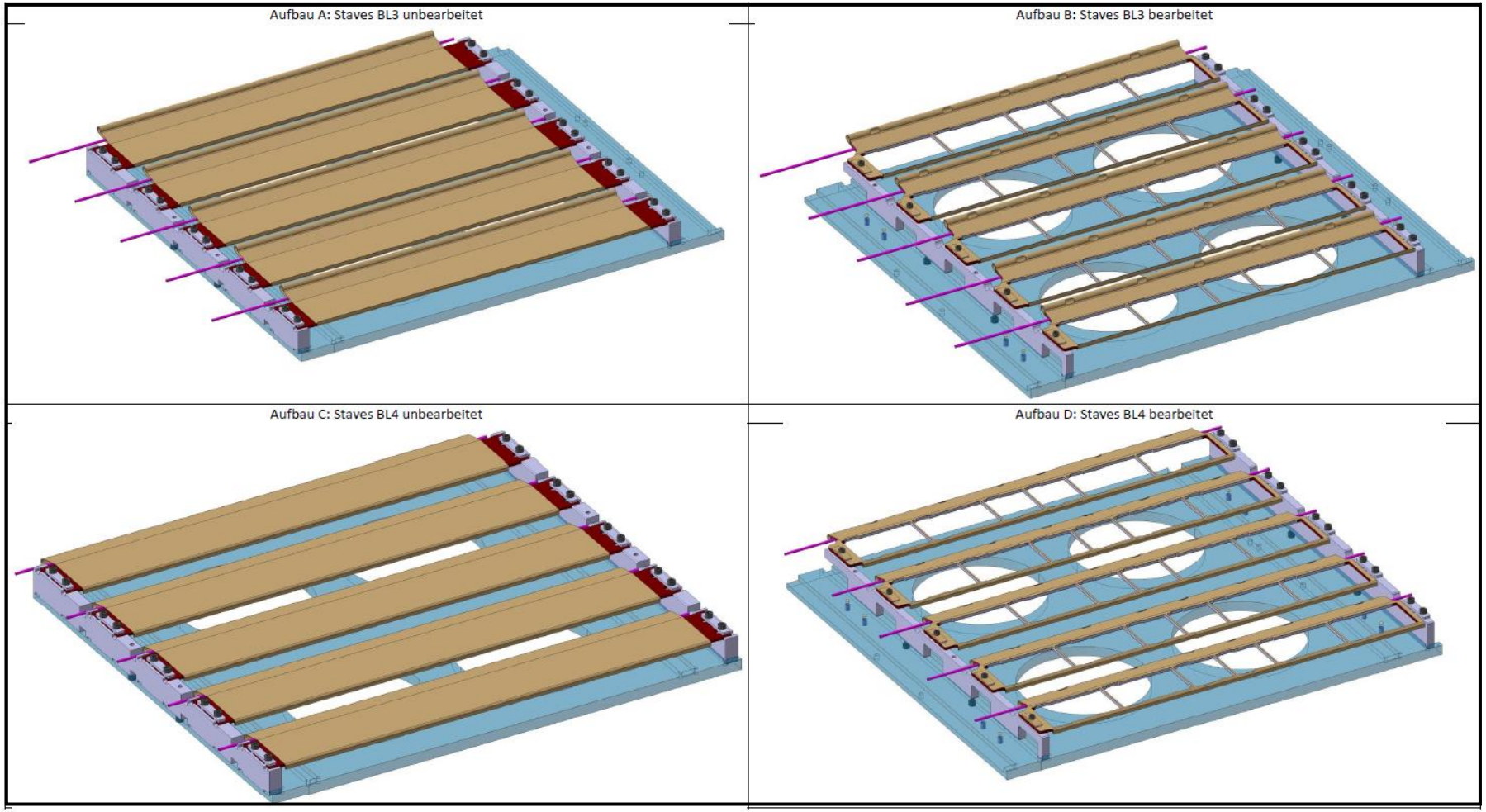
Presently under construction is the ZEA-1 measurement device for staves BL3 und BL4



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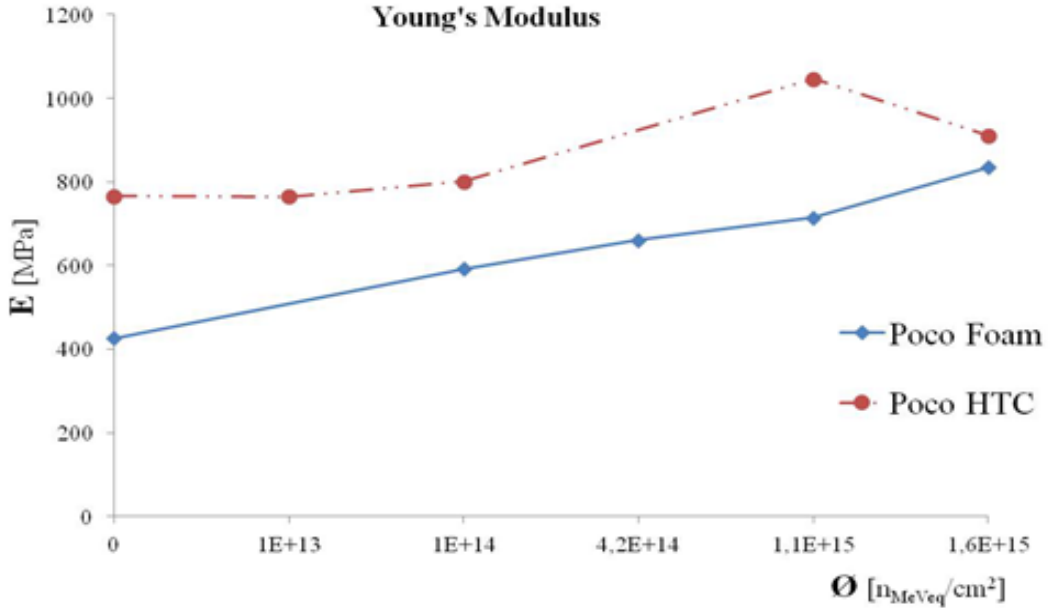
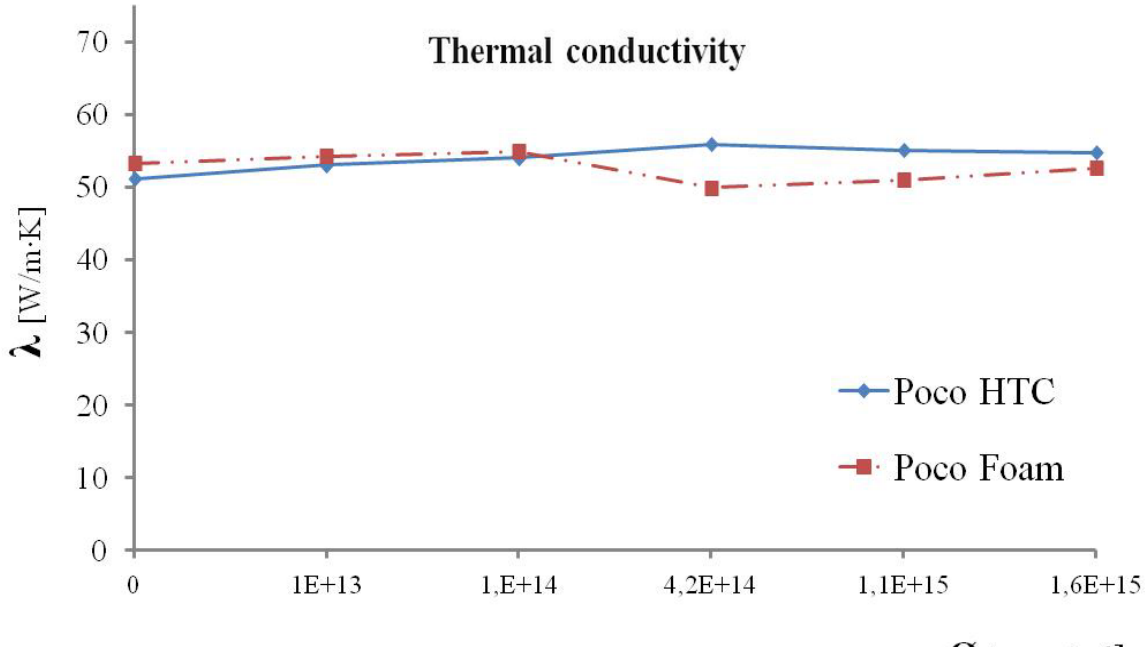
PROTOTYPE MVD

Info from „Thermal performance of carbon foams used as heat sink for the pixel MVD PANDA" with the www-link:
„https://iopscience.iop.org/article/10.1088/1748-0221/6/12/C12015"

This study has been performed with
neutrons taking into account the "foreseen" fluence in PANDA, 1x10e14 n [1MeVeq/cm2] for ten years of data taking, 50% duty cycle, with **antiproton-proton annihilations** at 15 GeV/c beam momentum (5x10e14 n [1MeVeq/cm2] for ten years of data taking, 50% duty cycle, with **antiproton-Xe annihilations** at 15 GeV/c beam momentum).

Specimens with a **15 mm x 50 mm area and 5 mm thick** of the two carbon foam.





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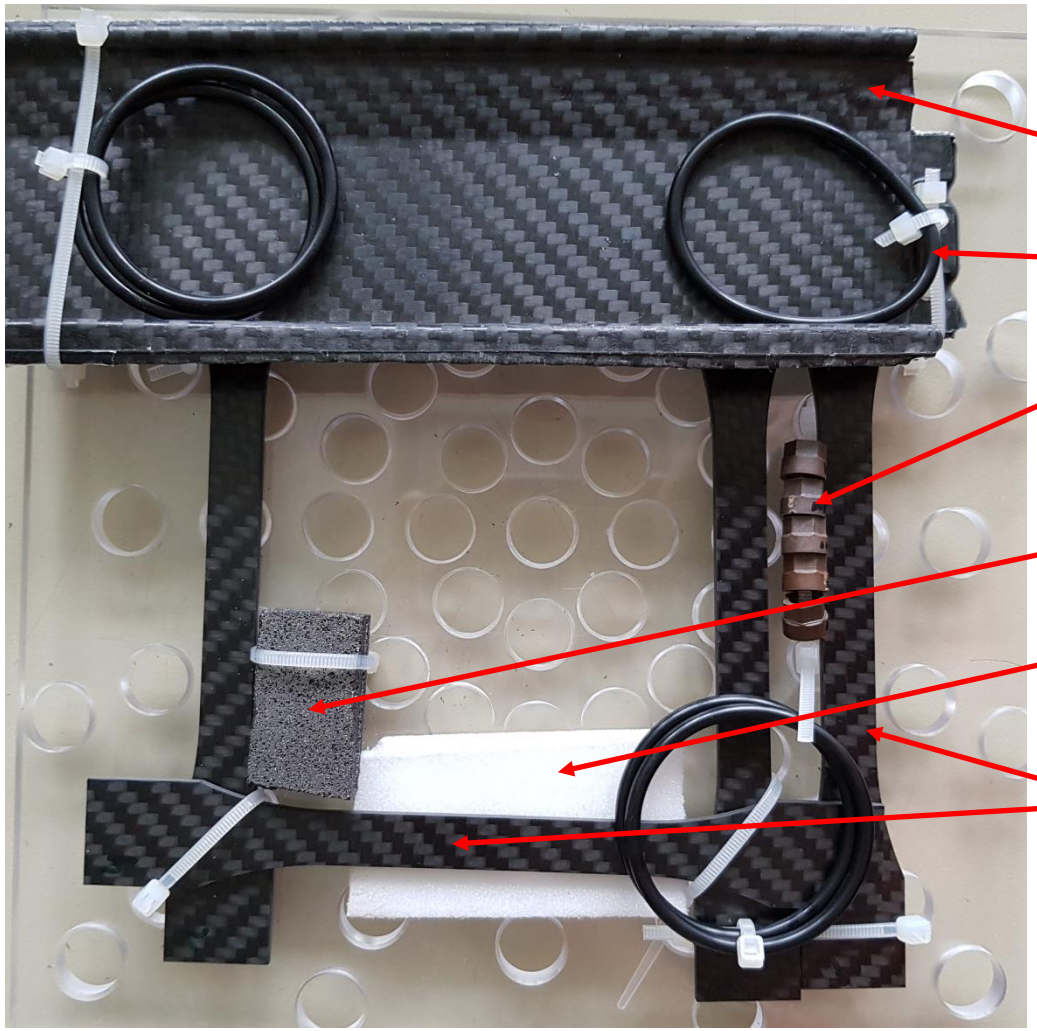
Some probes are exposed to radiation in the cyclotron at IKP-1 in Forschungszentrum Jülich presently



Part of a stave

O-ring

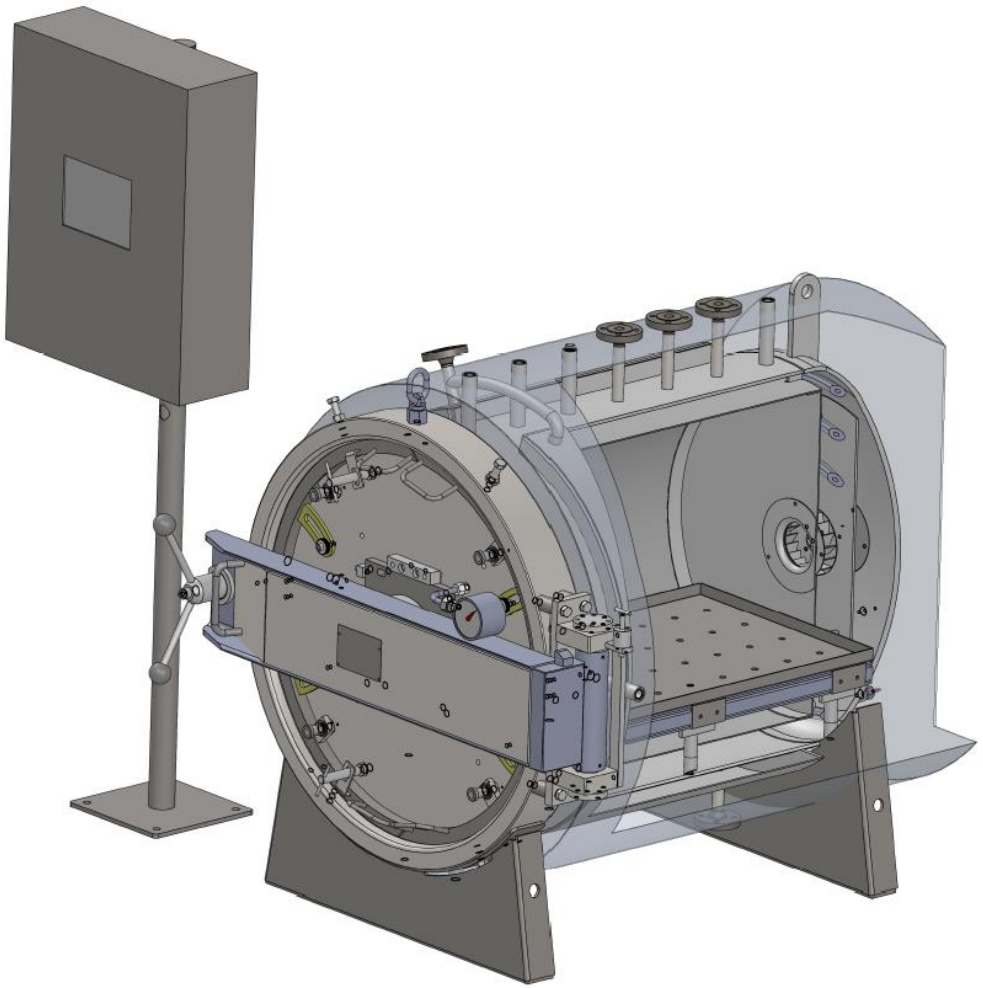
Nuts form the cooling pipe, made of plastic

Foam POCO HTC

Foam ROHACELL

Form parts cut from staves for tensile tests

Autoclave ordered for the manufacturing/production of CFRP components at ZEA-1



Dimensions

	Overall	Telescopic slide-out
Length:	1500 mm	1000 mm
Width:	1400 mm	600 mm
Height:	1400 mm	30 mm (space 450 mm)

Masses

empty:	1450 kg
Load:	200 kg (Telescopic slide-out)

Date of delivery: week 51 in 2019

Siegfried Kempe GmbH • Enriemat ® • Kemflex • Kemlock • Kemtight
Apparate- und Maschinenbau • D-74193 Schwaigern / Württ.

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kempe

Kunde:			Datum	Name	Benennung: Autoklav DN900 PN15 Mit Segmentverschluss P265GH	Revision: 0
Vorlage:		bearbeitet:	29.07.2019	Ribeiro		
Ver.	Änderung / Datum	geprüft				
01		normgepr.:				
02		Blattgröße: A1	Maßstab: 1:7		Zeichnung-Nr.: B-0900-015-201/1	Herstelljahr / Herstell-Nr.: 2019 / 10007
03			Datei: 10007-Zusammenbau			Blatt / von: 1 / 1

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Conclusions and plans for 2020

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PROTOTYPE MVD

Conclusions

- 6 Staves BL4 are ready for the final machining (cut-outs for the sensor-plates, drilling of the holes for fixing the staves)
- The measurements on the four Y-lines at each stave show displacements in a Range from -0.35 mm to +0.30 mm.
  - => Concerning construction and measurement methods some questions are still open
  - => Nevertheless, these parts are useable for further processing
  - => BUT, the reproducibility has to be improved !

Plans for 2020

- Examination and reporting of the properties of the probes (foams, o-rings, CFRP) which have been exposed to radiation in the cyclotron at IKP-1 in the Forschungszentrum Jülich

- At ZEA-1 building-up and commissioning of the hardware for the construction of CFRP components
- Establishing of the manufacturing of staves at IKV-AC and at ZEA-1

- Measuring of the existing 6 staves BL4 at ZEA-1 BEFORE final machining
- Final machining of the 6 staves BL4 at ZEA-1
- Measuring of the 6 staves BL4 at ZEA-1 AFTER final machining

- Construction of a prototype “half-shell with flange and stave layers BL3 and BL4” out of CFRP at IKV-Aachen
- Testing of the properties of this prototype with thermal load
  - => Ask for information about the electronic-parts (chips) on the staves, means: Definition of size and power dissipation

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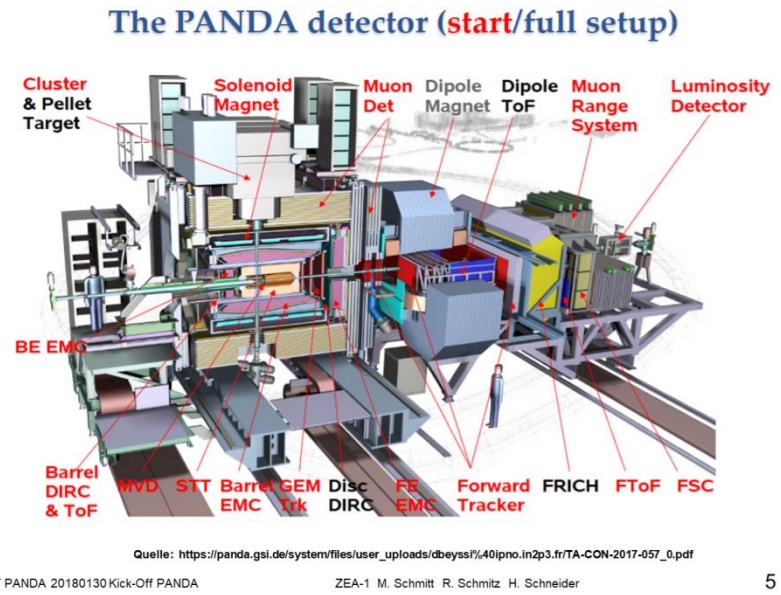
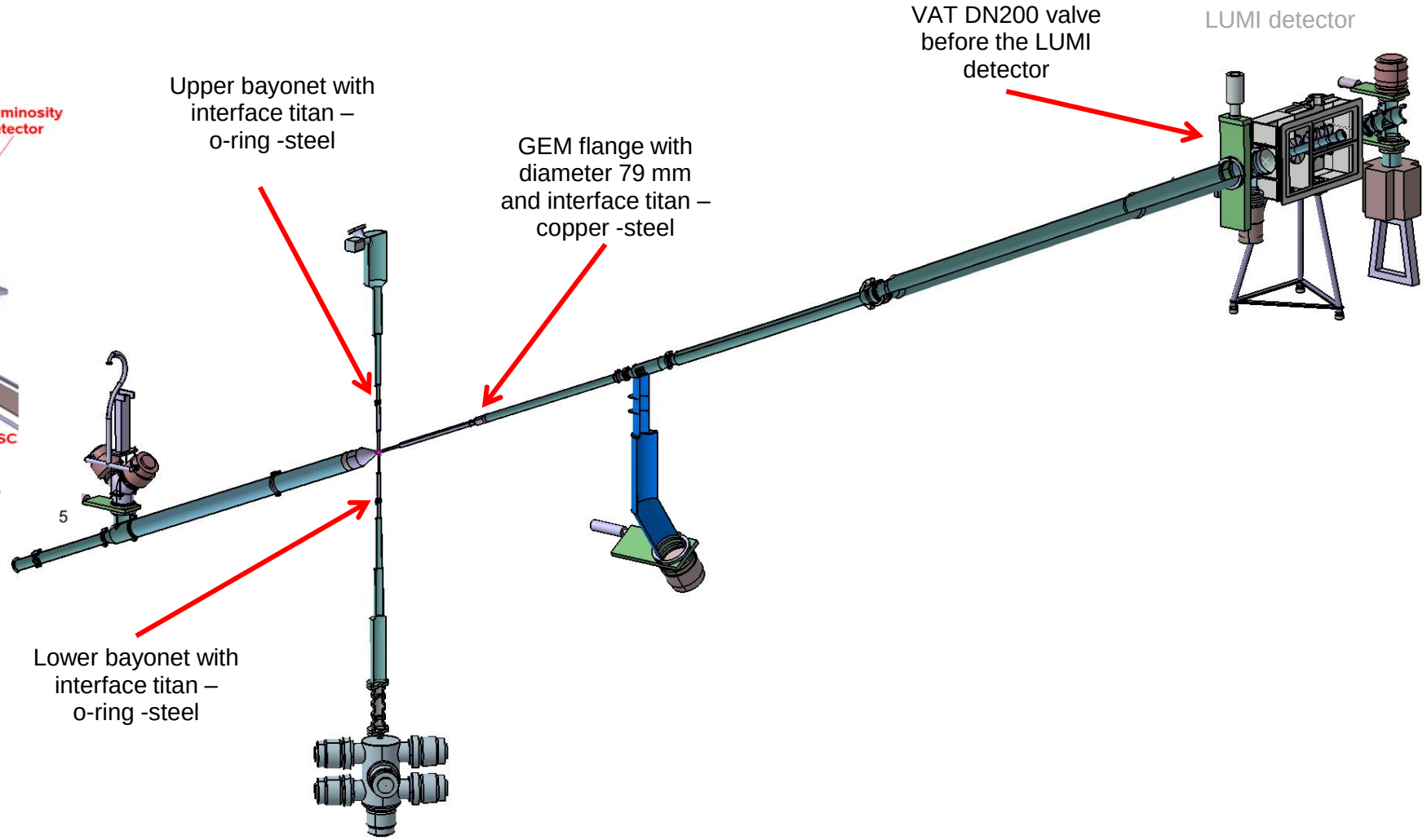
Vacuum system PANDA





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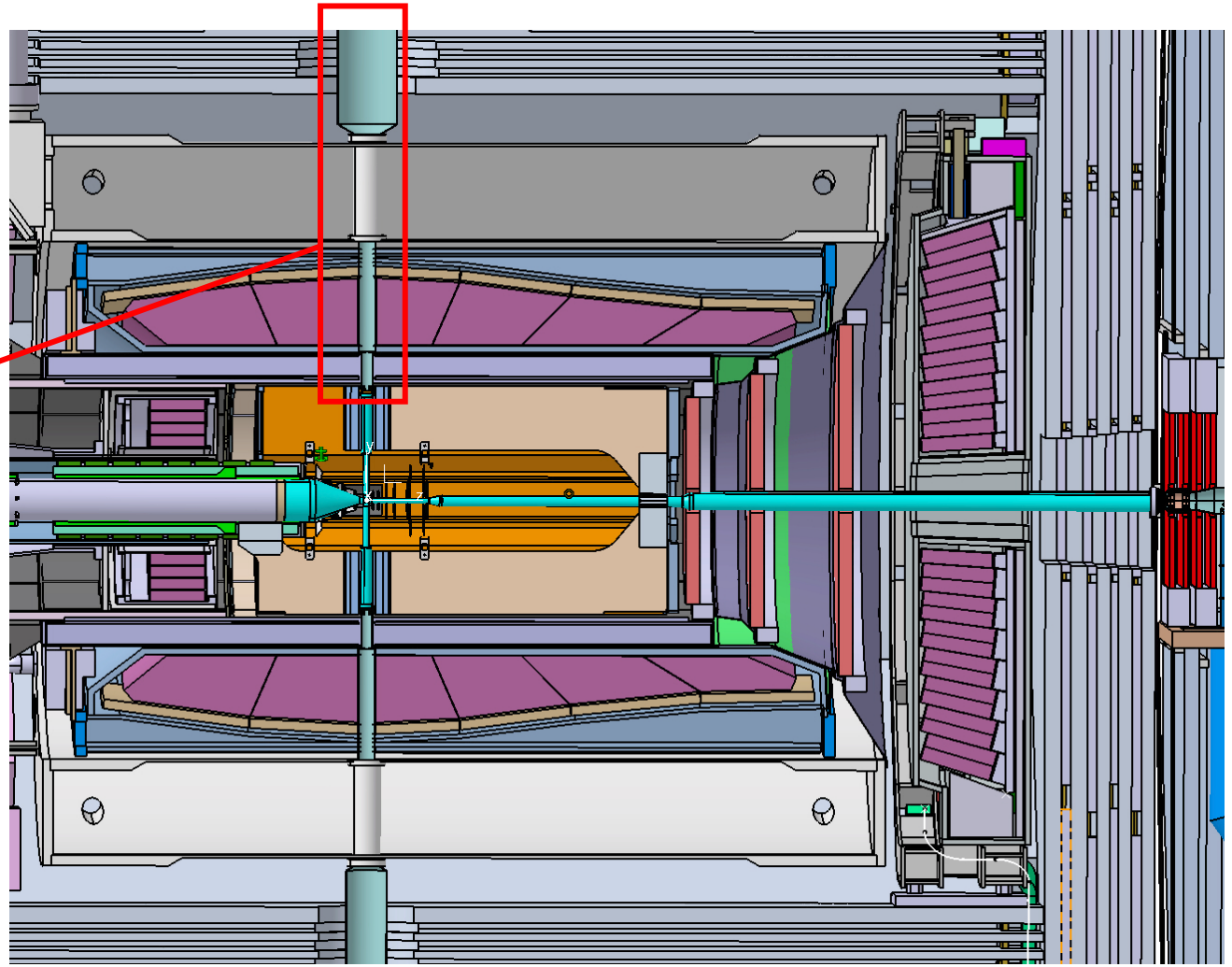
Target-BL-prototype



Target-BL in PANDA

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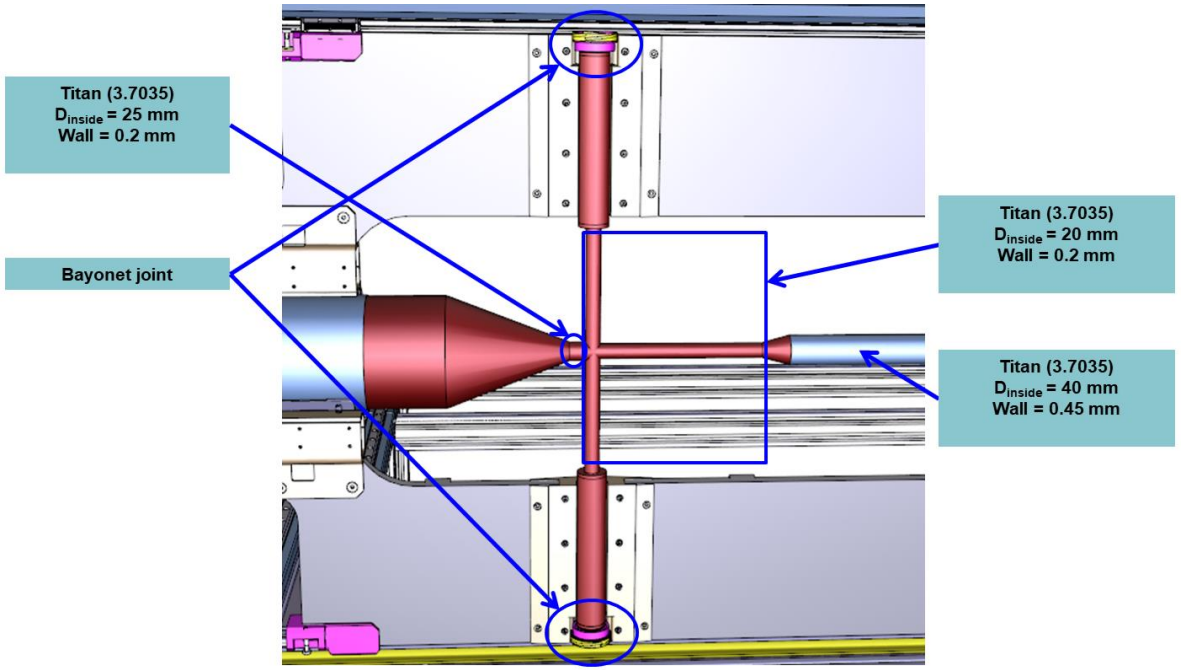

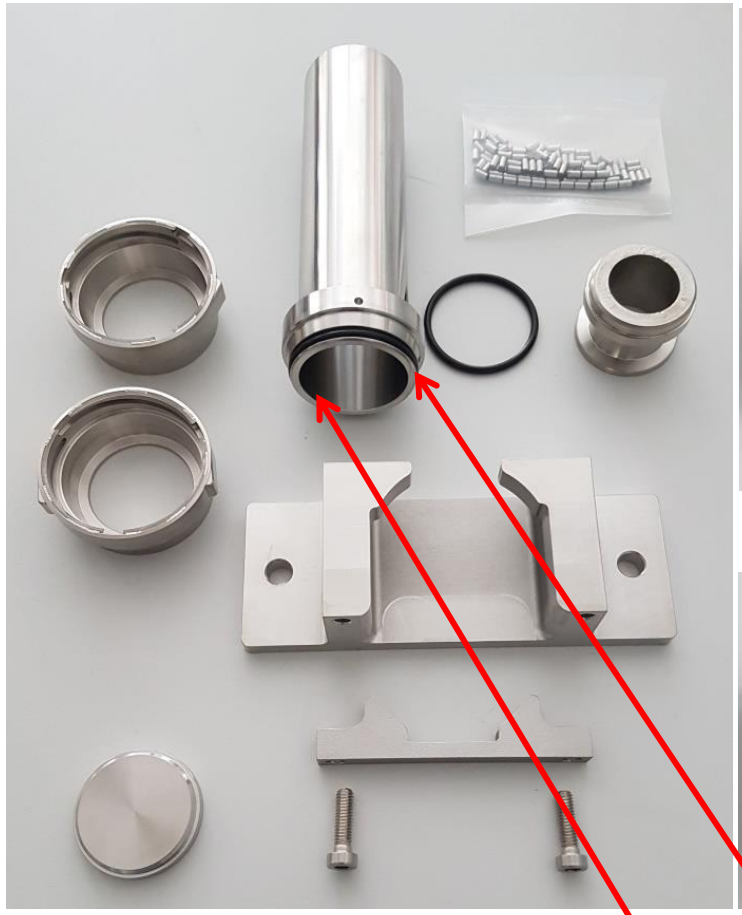

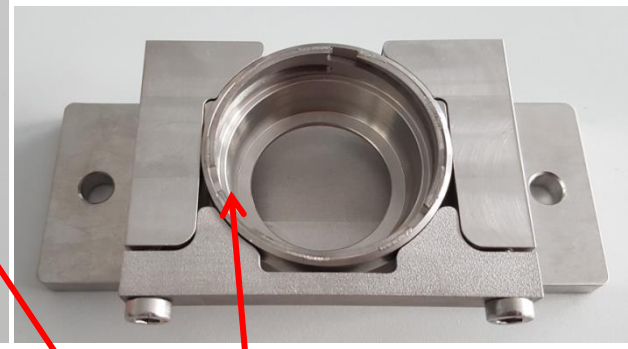

Prototype bayonet joint with interface steel – o-ring – titan
For the o-ring two materials are in the test:
NBR (Acrylnitril-Butadien Kautschuk or Perbunan N)
EPDM Schwefel 70 (ethylen-propylen-copolymer with sulfur cross-link)

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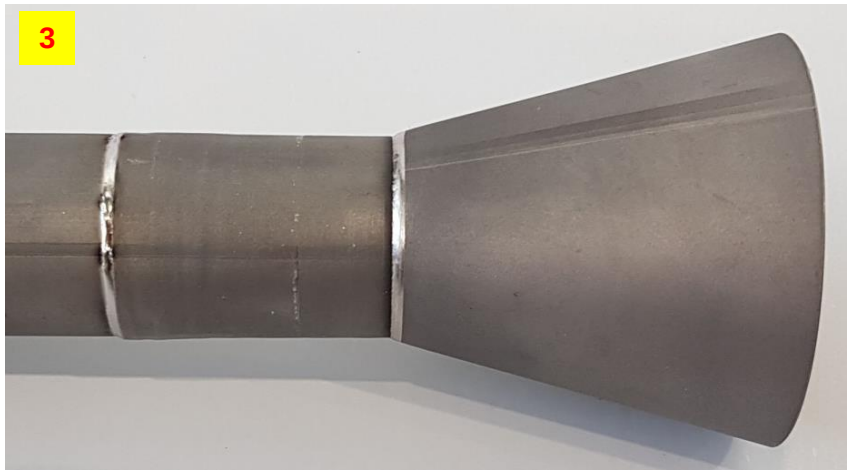
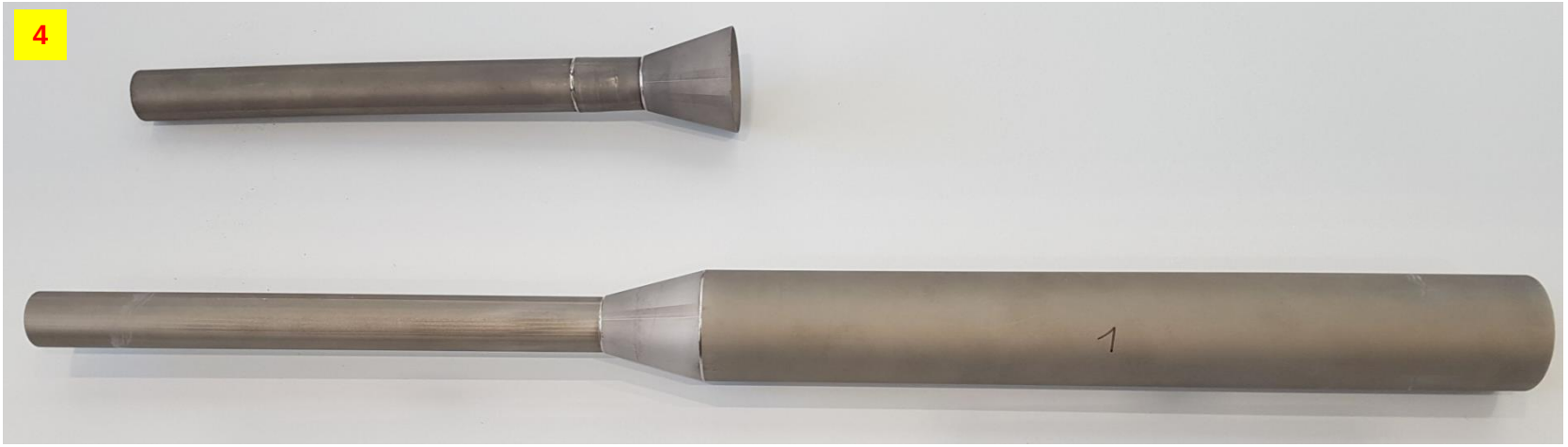
Pre-prototype titan-pipe 20-cone-40
Parts before final welding

Pre-prototype titan-pipe 20-cone-40

with	length	diameter	wall in mm:
Pipe	211	20	0.20
Cone	36	20-40	0.43
1/3 Pipe	297	40	0.45





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PROTOTYPE VACCUM

Pre-prototype titan-pipe 20-cone-40 Measurement results

Pre-prototype titan-pipe 20-cone-40

with	length	diameter	wall in mm:
Pipe	211	20	0.20
Cone	36	20-40	0.43
1/3 Pipe	297	40	0.45

Wall-thickness of the pipes 0.2 mm

Pipes are measured at 4 different circumferences with 4 points each

pipe 1:	0.214 mm	+0.011 mm	-0.014 mm
pipe 2:	0.213 mm	+0.007 mm	-0.013 mm

Wall-thickness of the cones 0.43 mm

cones are measured at 20th and 40th circumferences with 4 points each

cone 1 and 2:	at 20er	0,41 mm	at 40er	0,45 mm

Wall-thickness of the pipes 0.45 mm

Pipes are measured at 4 different circumferences with 4 points each

pipe 1:	0.465 mm	+0.045 mm	-0.060 mm
pipe 2:	0.449 mm	+0.021 mm	-0.021mm
pipe 3:	0.445 mm	+0.030 mm	-0.030 mm
pipe 4:	0.459 mm	+0.031 mm	-0.029 mm
pipe 5:	0.454 mm	+0.046 mm	-0.054 mm
pipe 6:	0.440 mm	+0.045 mm	-0.030 mm

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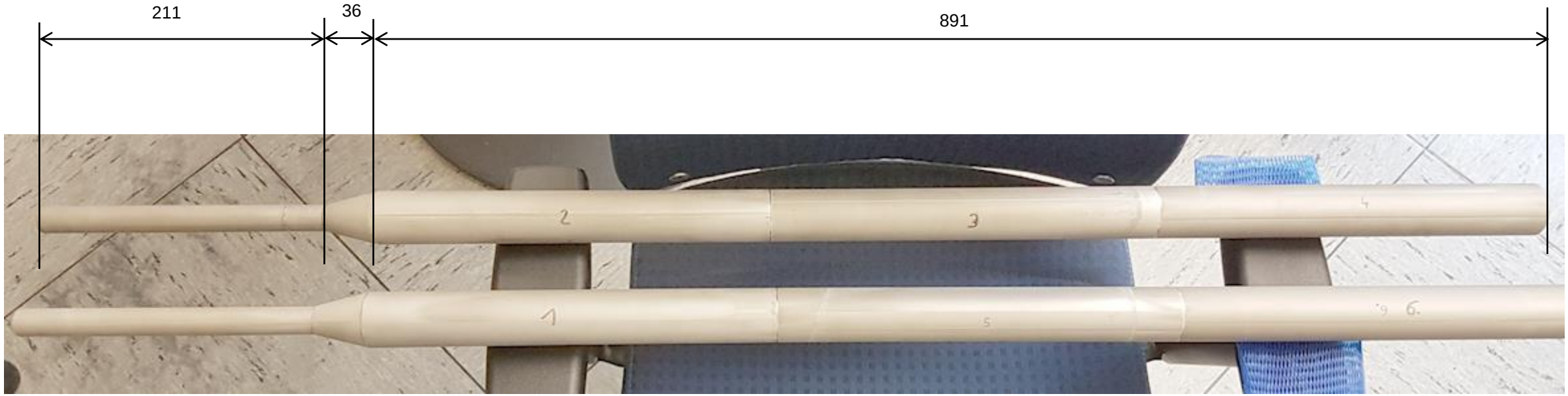
PROTOTYPE VACCUM

Pre-prototype titan-pipe 20-cone-40
Final welding is done
Length 1138 mm

Pre-prototype titan-pipe 20-cone-40

with	length	diameter	wall in mm:
Pipe	211	20	0.20
Cone	36	20-40	0.43
Pipe	891	40	0.45



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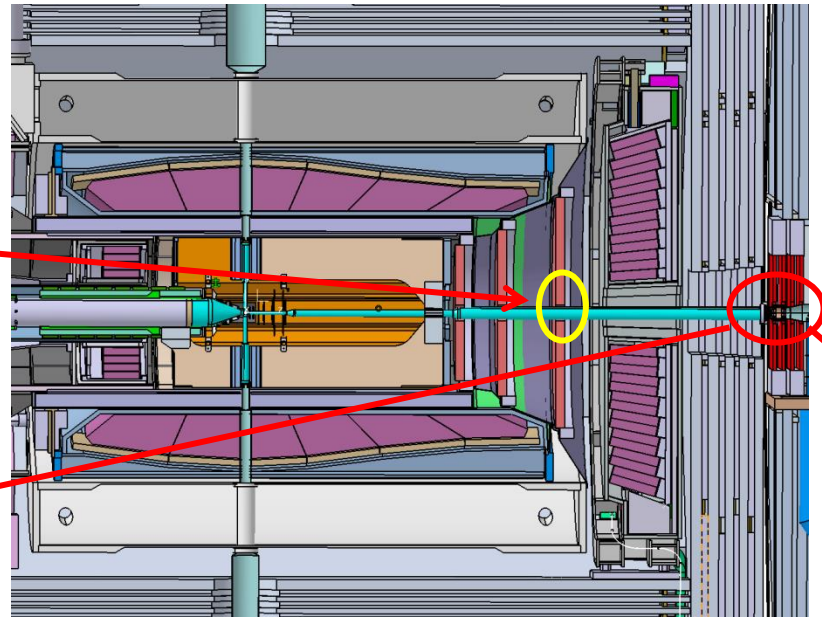
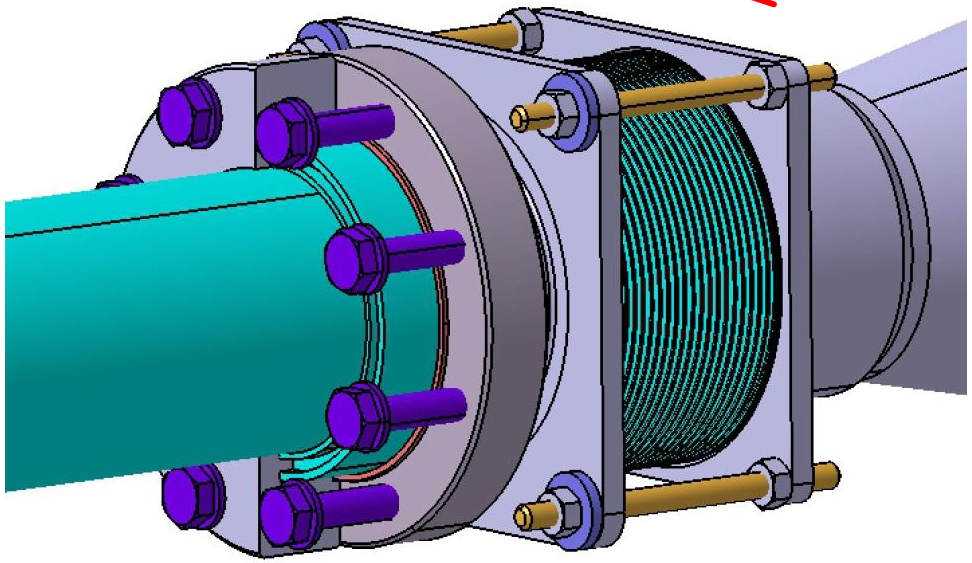
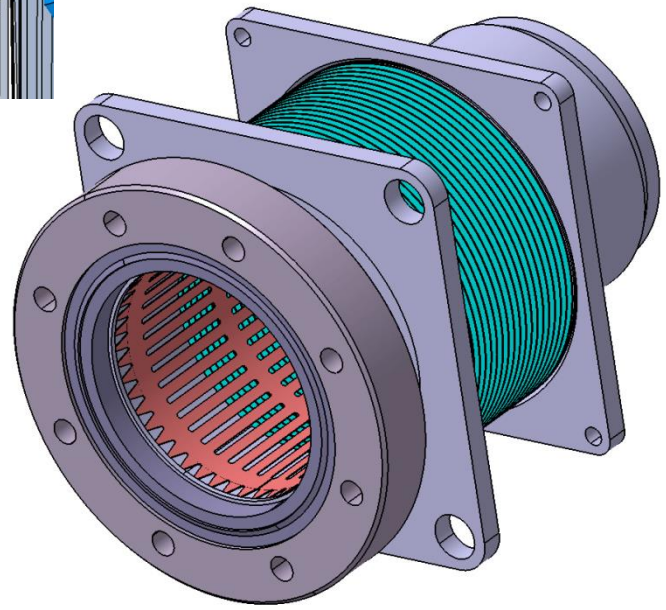
GEM detector diameter 79 mm





GEM flange with diameter (79 mm) adapted to the GEM detector and with two half-shells for the bolting



GEM flange with RF grid and bellow

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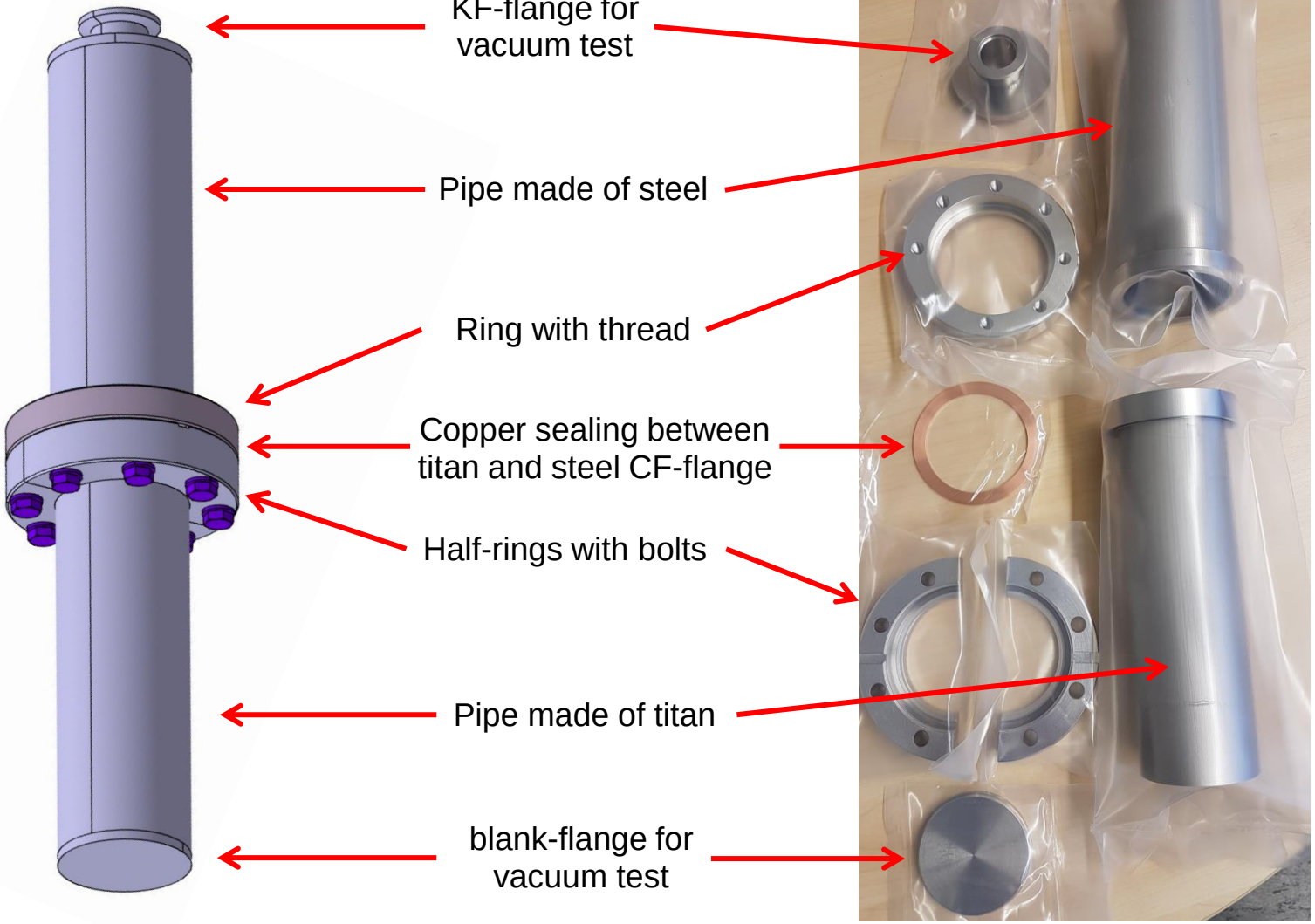
Prototype of the GEM flange with diameter (79 mm)



Conclusions and plans for 2020

Conclusions

- The construction of the 3 prototypes (titan pipes with wall thickness from 0.2 to 0.45 mm, target-BL with bayonet and GEM-flange) is finished

- The VAT-valve DN200 for the LUMI-detector is ordered

- For the adapter/interface of the bayonet in the central space frame (CSF) a **vertical AND horizontal form fit** is strongly recommended

Plans for 2020

- Measuring of the geometry of the 2 pre-prototypes titan pipes after the welding-process

- Vacuum testing with all prototypes and reporting of the results (titan pipes, GEM-flange, target-BL with bayonet)

- Construction of the target-cross with wall thickness of 0.2 mm

- Designing of a mounting and transport frame for the complete prototype PANDA vacuum chamber (length ca. 6000 mm)