3D - Printing for High Vacuum Applications

CAGR and Market Volume in 3D-Printing until 2030

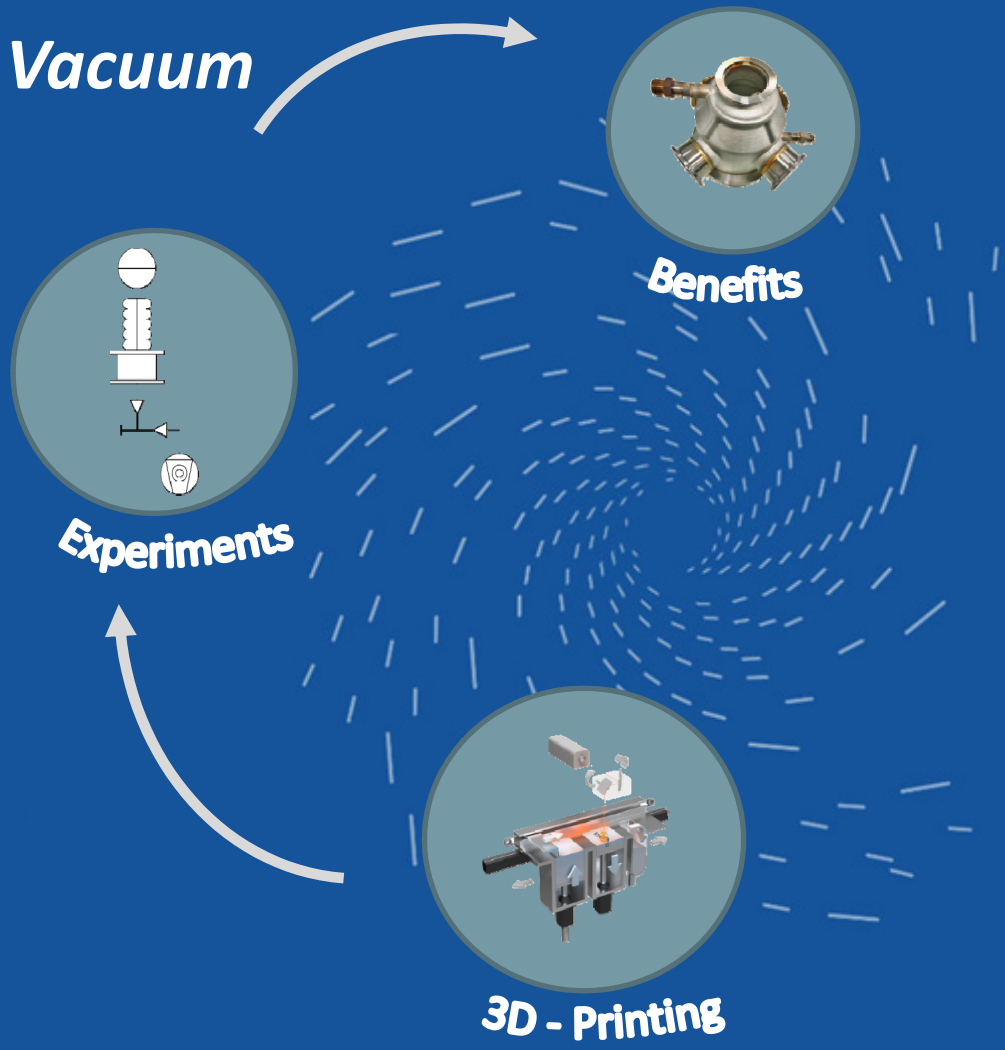
Business	CAGR until 2030	Market Volume 2015 in Billion €	Market Volume 2030 in Billion €
Aerospace	23%	0.43	9.59
Medicine	23%	0.26	5.59
Automotive	15%	0.34	2.61
Industry	14%	0.44	2.98
Retail Trade	13%	0.30	1.89
Vacuum Tech.	???	???	???

https://www.strategyand.pwc.com/

3D - Printing for High Vacuum Applications

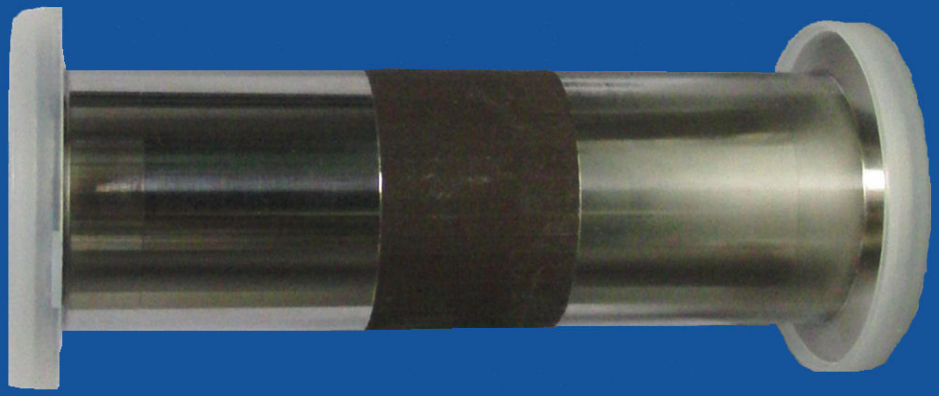
Overview

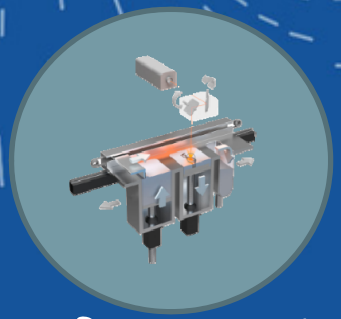
- 3D - Printing
- Experiments
- Benefits



3D - Printing for High Vacuum Applications

- *3D - Printing and its Problems*
  - ➢ *Components*





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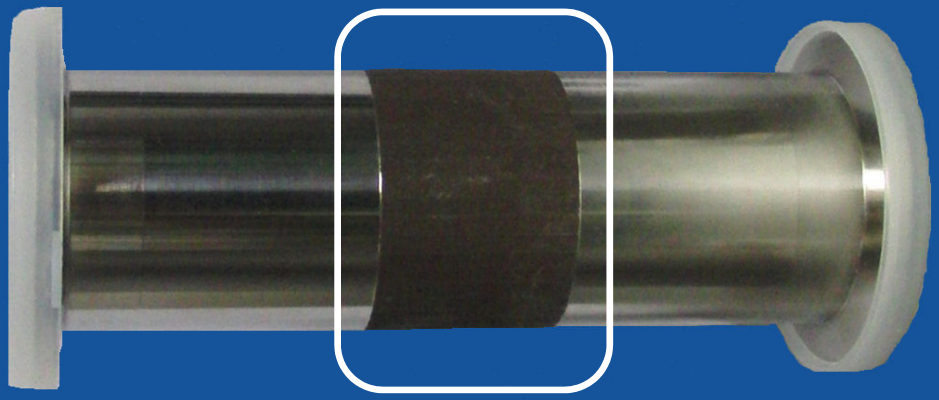
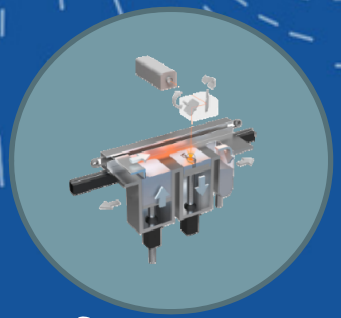
- *3D - Printing and its Problems*
  - ➢ *Roughness*





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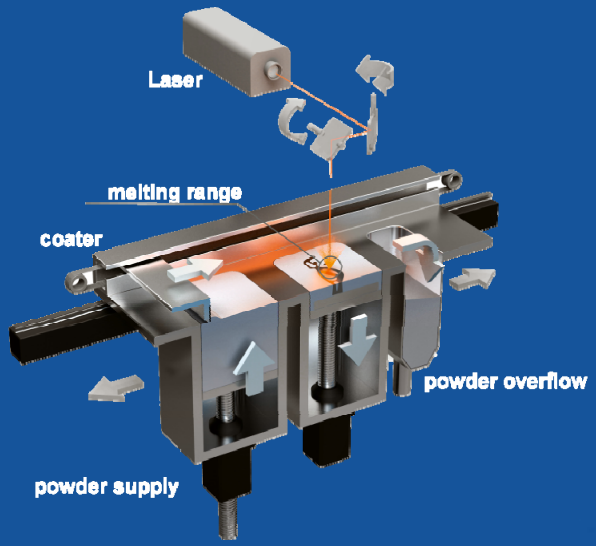
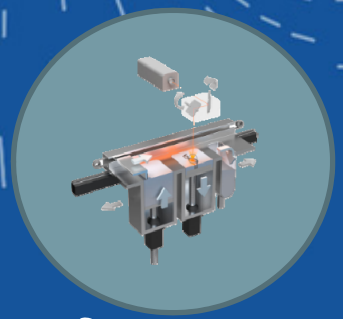
- *3D - Printing and its Problems*
  - ➢ *LaserCusing*





https://www.concept-laser.de/technologie.html

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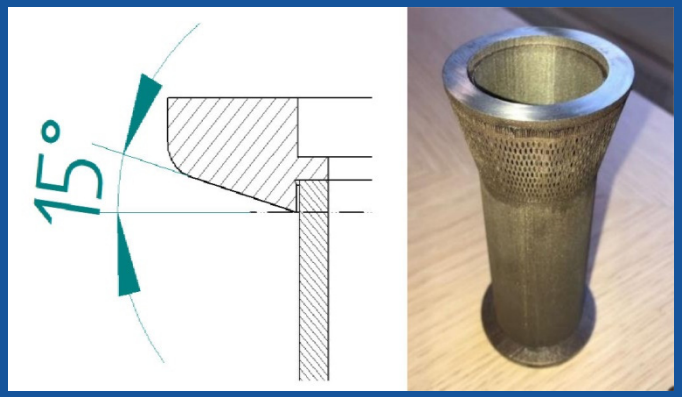
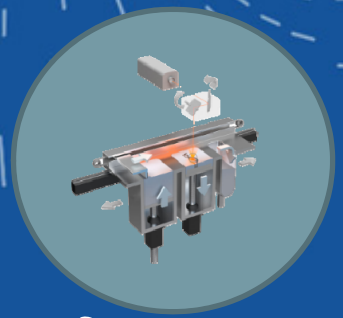
- *3D - Printing and its Problems*
  - ➢ *Support Structures*





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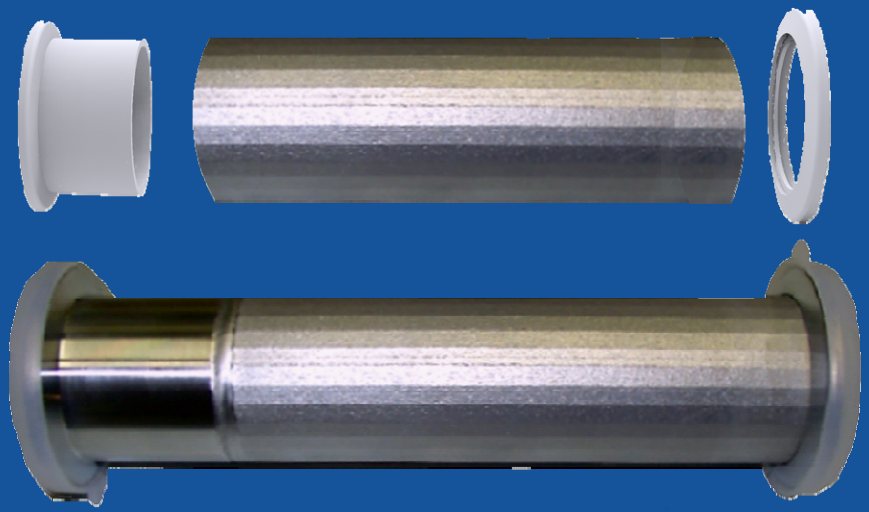
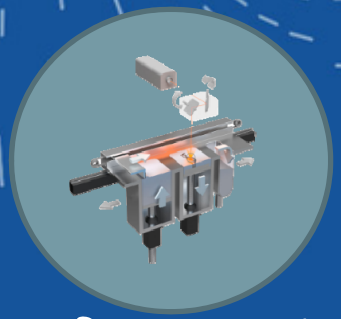
- *3D - Printing and its Problems*
  - ➢ *The Welded Connector*

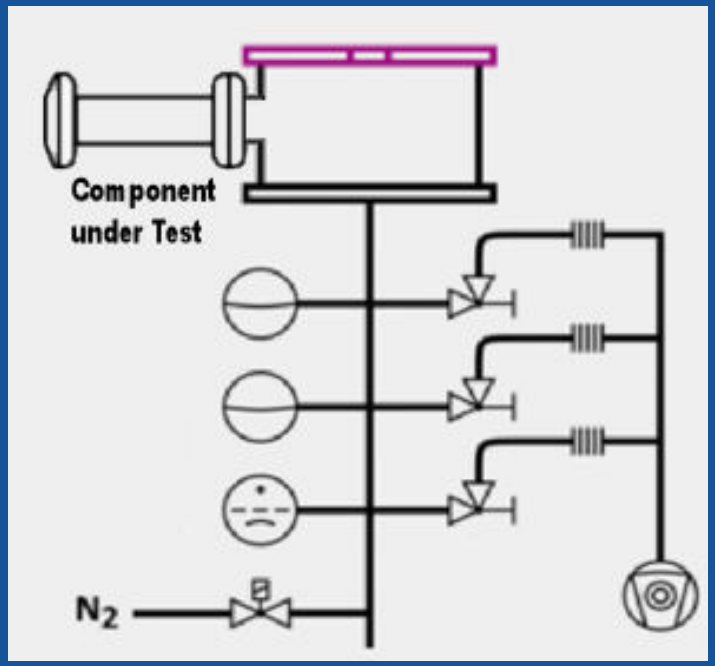




3D - Printing

3D - Printing for High Vacuum Applications

- ***Experiments - Setup***



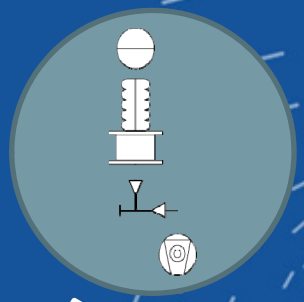
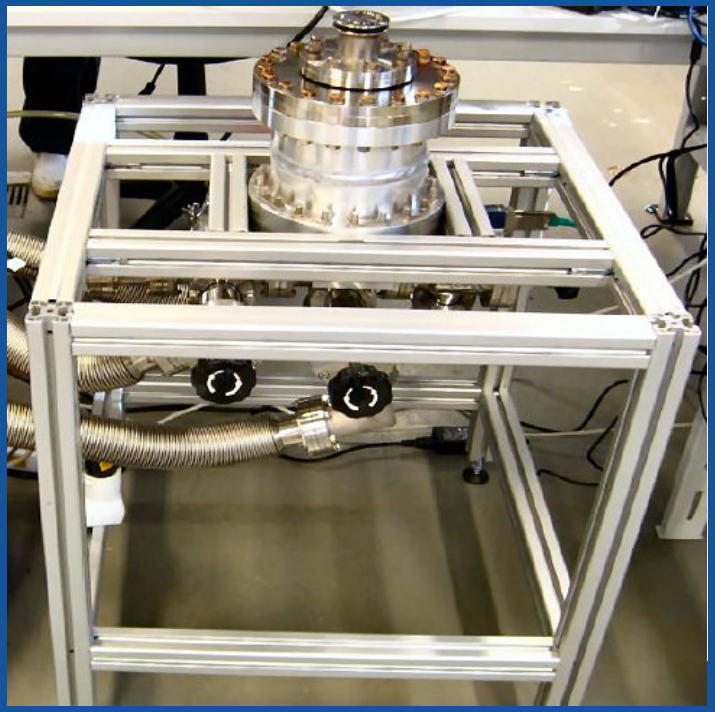


Photo coutesey of VACOM GmbH

3D - Printing for High Vacuum Applications

- ***Experiments - Setup***



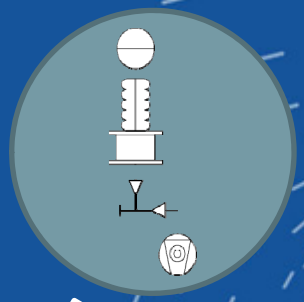
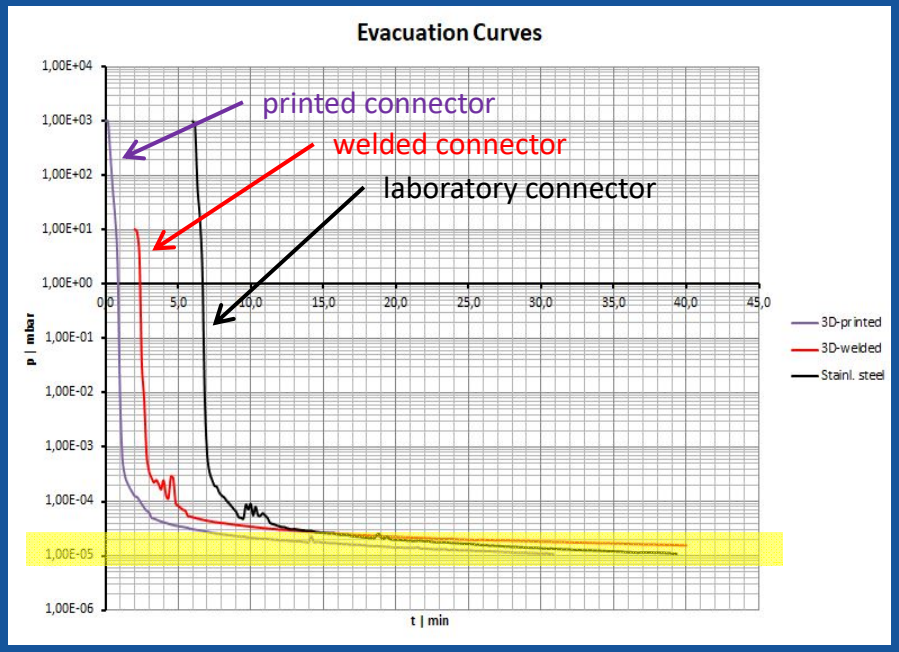
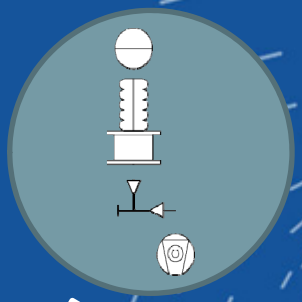


Photo coutesey of VACOM GmbH

3D - Printing for High Vacuum Applications

- *Experiments - Results*





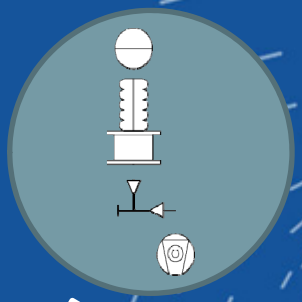
3D - Printing for High Vacuum Applications

- ***Experiments - Leakage Rate***

Leakage rate :

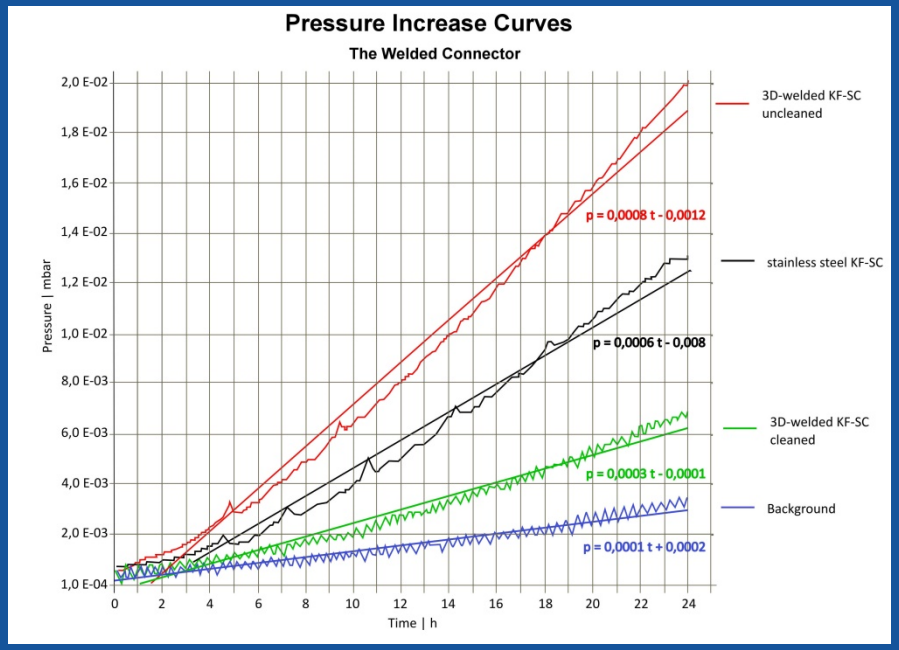
$$Q_o = \frac{\Delta p}{\Delta t} \cdot V_o$$

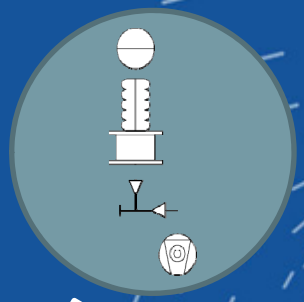
$$Q_{Component} = \frac{\Delta p}{\Delta t} \cdot V_o - Q_{Background}$$



3D - Printing for High Vacuum Applications

- *Experiments - Results*

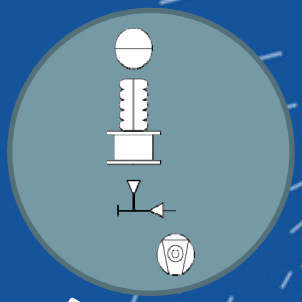




3D - Printing for High Vacuum Applications

- ***Experiments - Leakage Rate***

Component	Pressure Increase $\frac{\text{mbar}}{\text{s}}$	Leakage Rate $\frac{\text{mbar} \cdot l}{\text{s}}$
Background	$2.78 \cdot 10^{-8}$	$1.00 \cdot 10^{-7}$
3D Welded Connector uncleaned	$2.22 \cdot 10^{-7}$	$7.39 \cdot 10^{-7}$
Laboratory Connector	$1.67 \cdot 10^{-7}$	$5.25 \cdot 10^{-7}$
3D Welded Connector cleaned	$8.33 \cdot 10^{-8}$	$2.15 \cdot 10^{-7}$



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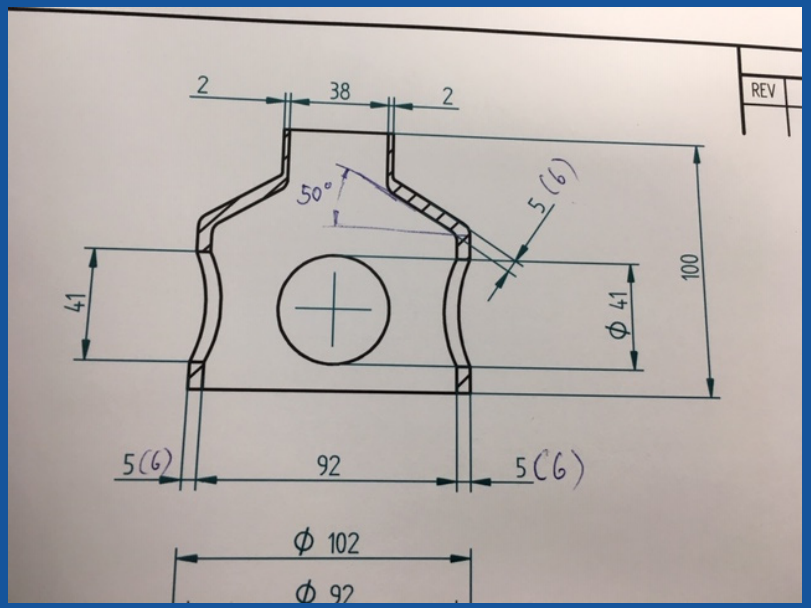
- *Benefits*



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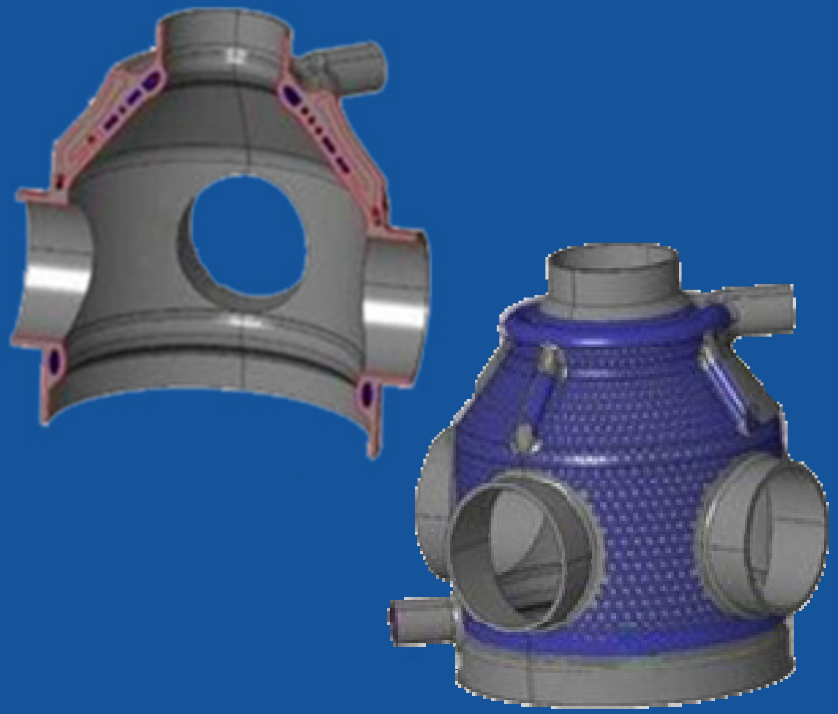
- *Benefits*



3D - Printing for High Vacuum Applications

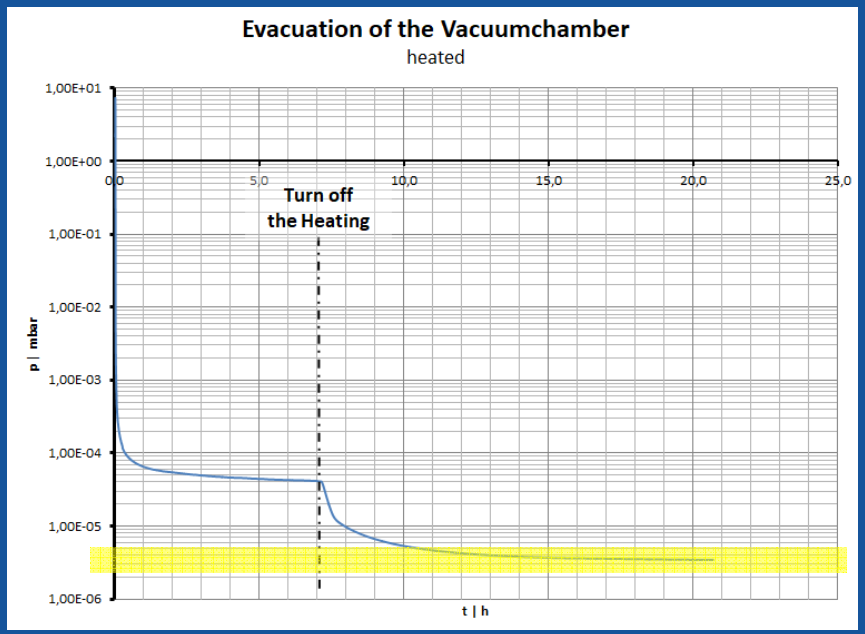
- *Benefits*
  - *Geometric freedom*
  - *Near net shape*
  - *Green technology*

3D - Printing for High Vacuum Applications

- *Benefits*

3D - Printing for High Vacuum Applications

- *Benefits*



3D - Printing for High Vacuum Applications

Conclusion

- *3D-printed components are suitable for high vacuum*
- *Welding with metals guarantees high flexibility*
- *Geometric freedom enables integration of functionality*

- *Surface roughness and support structures require reworking*

International Conference on Cyclotrons and their Applications (CYC2019) Cape Town

CYC 2019 22-27 SEPTEMBER CAPE TOWN

3D - Printing for High Vacuum Applications

Our Team :

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Fabian Beck
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IHR MÖGLICHMACHER

Michael Dinkel

10^{-n} mbar
VACOM®

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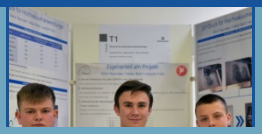

Leopold
Fabian
Vikto

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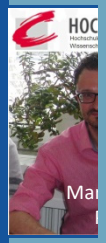

Thank you for your attention