

# ACTIVITIES AT IMID

**Aneta Zatočilová, Ing. Ph.D.**

Institute of Machine and Industrial Design  
Faculty of Mechanical Engineering  
Brno University of Technology

Brno, 29.5.2019



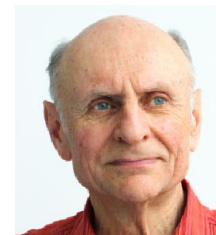
INSTITUTE OF MACHINE  
AND INDUSTRIAL DESIGN

# INTRODUCTION

- Introduction
- VAV activities
- Contractual Research
- Education
- Future plans

# RIAT

Josef Nevrlý Jan Brandejs David Paloušek



## SLM Technology

David Paloušek Daniel Koutný Radek Vrána



Jan Suchý

Malý Martin

Ondřej Vaverka

Ondřej Červinek



Vít Šreibr

## Optical measurement

Tomáš Koutecký Aneta Zatočilová



Jakub Hurník



External - Pavel Loučka (Doc. Štarha ÚM)

## 3D Robotic printing

David Škaroupka



Martin Krčma



Arnošt Vespalec



Petr Krejčířík

# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽĐAS

- 2010 – 2015 dissertation thesis A.Z.
  - 2016 – 2017 diploma thesis J.H.
  - 2018 – 2019 Zéta
  - 2020 – 2023 Trend?
- } 2018 – 2023  
dissertation J.H.

## AIM:

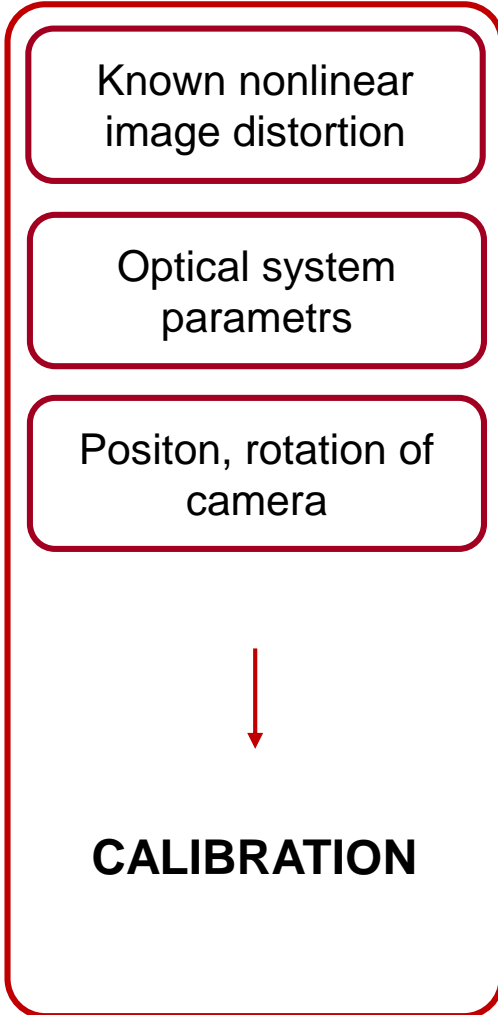
- automation of measurement of forgings during production -> saving production time and manpower
- first step for automation of forging process



# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽĐAS

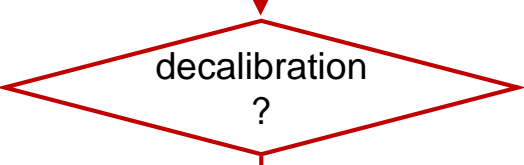
3D MODEL

2+ images  
in one c.s.



in advance, external

At measurement place

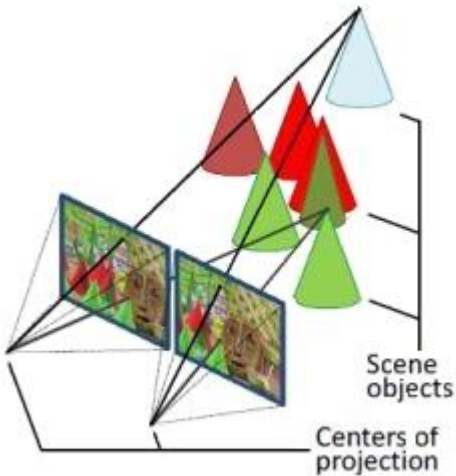
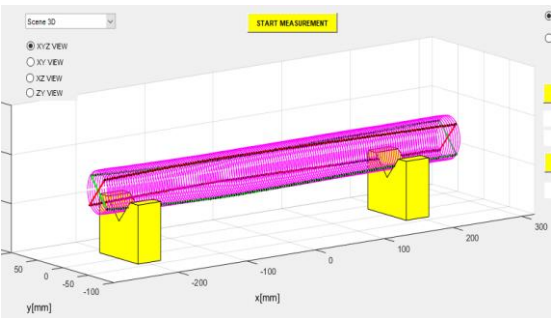


yes

no

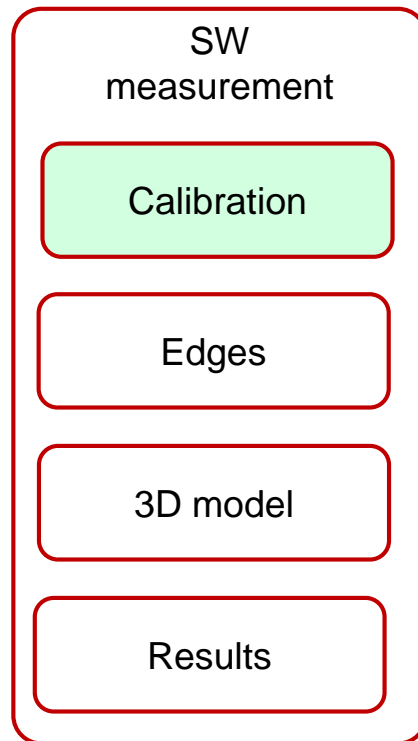
Repetitively

Once – prior to installation



# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽĐAS

- 2018 – 2019 Zéta

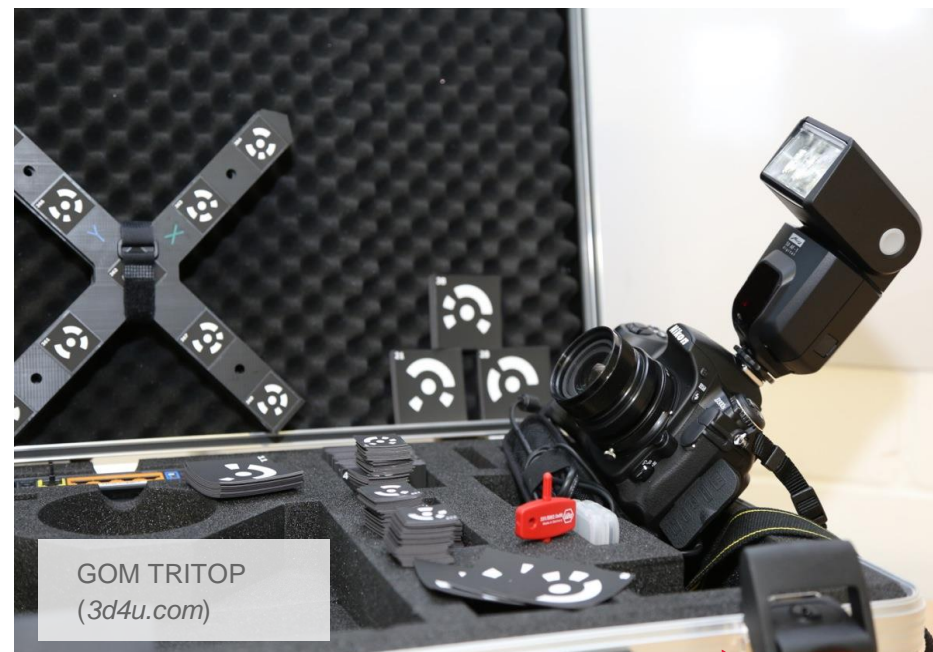


# OPTICKÝ SYSTÉM PRO MĚŘENÍ ROTAČNÍCH VÝKOVKŮ

Nonlinear distortion,  
Parameters of optical  
system

Flexible calibration field  
– must be measured  
by Tritop (GOM)

Recognition of coded  
markers and their  
2D-3D alignment

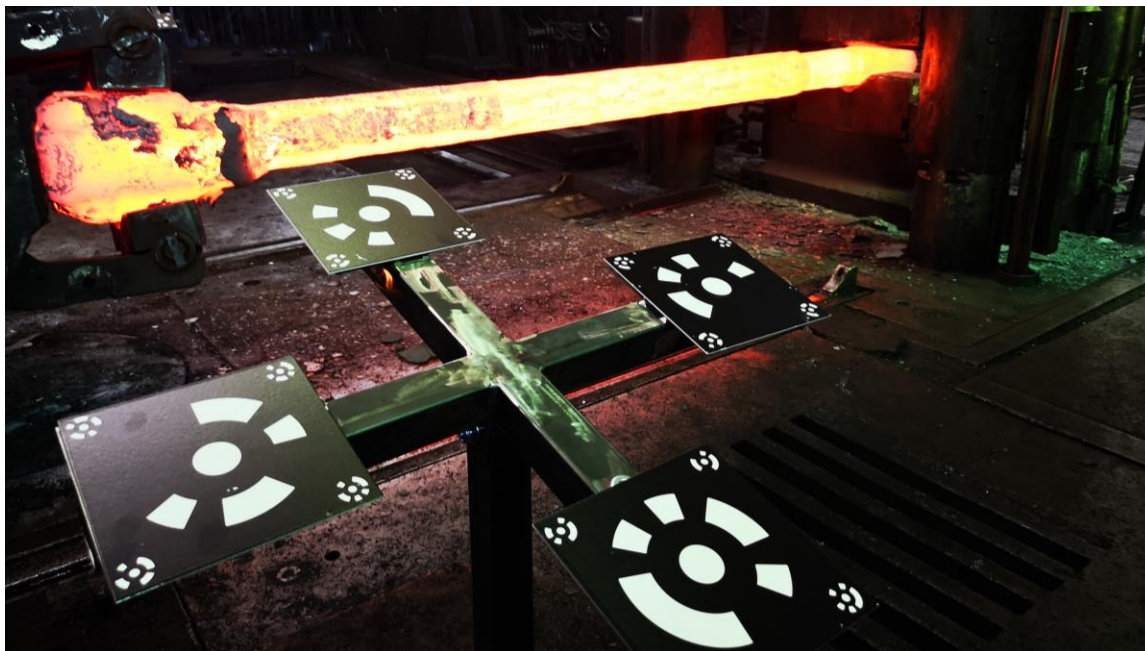


# OPTICKÝ SYSTÉM PRO MĚŘENÍ ROTAČNÍCH VÝKOVKŮ

Position and  
orientation of cameras

Only 4+ markers  
must be measured by  
Tritop (GOM)

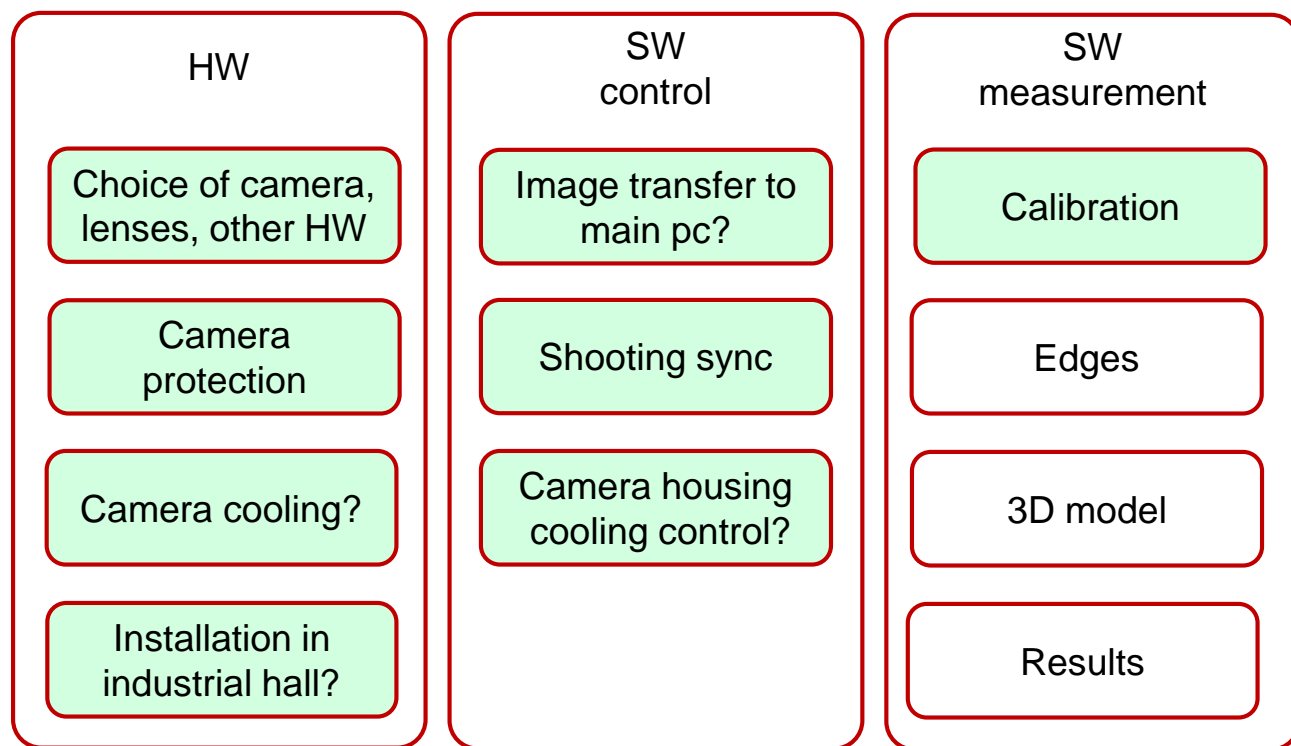
Recognition of coded  
markers and their  
2D-3D alignment





# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽĐAS

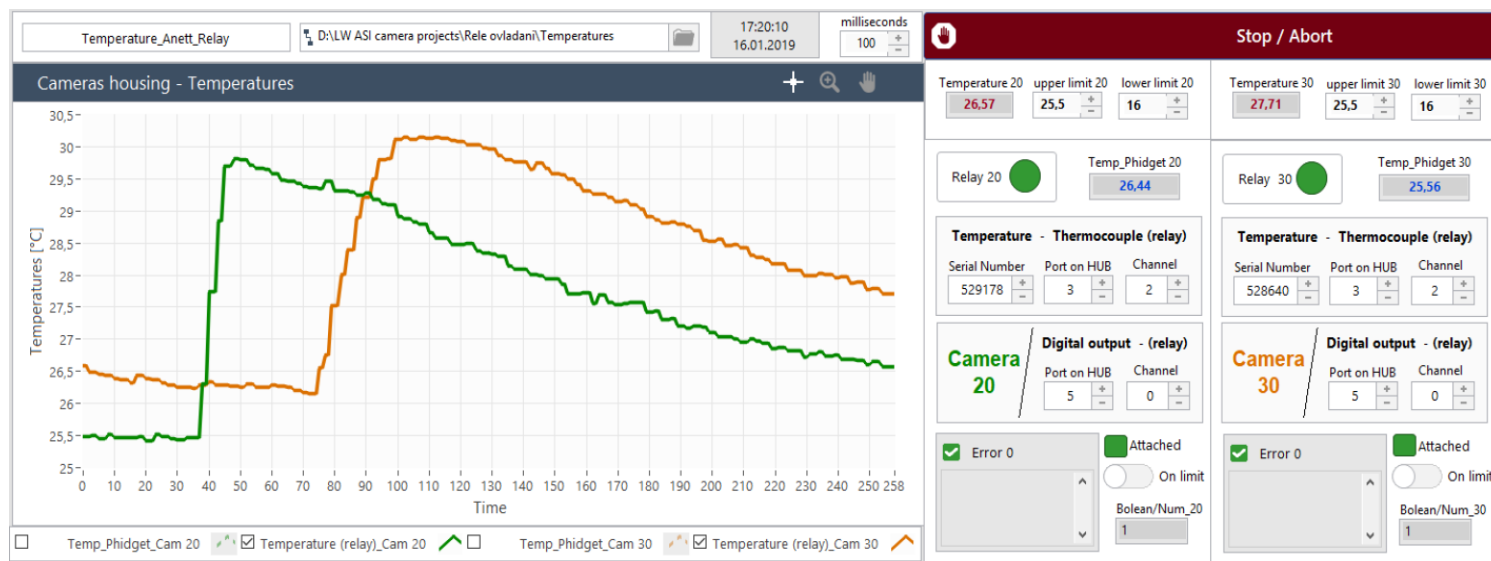
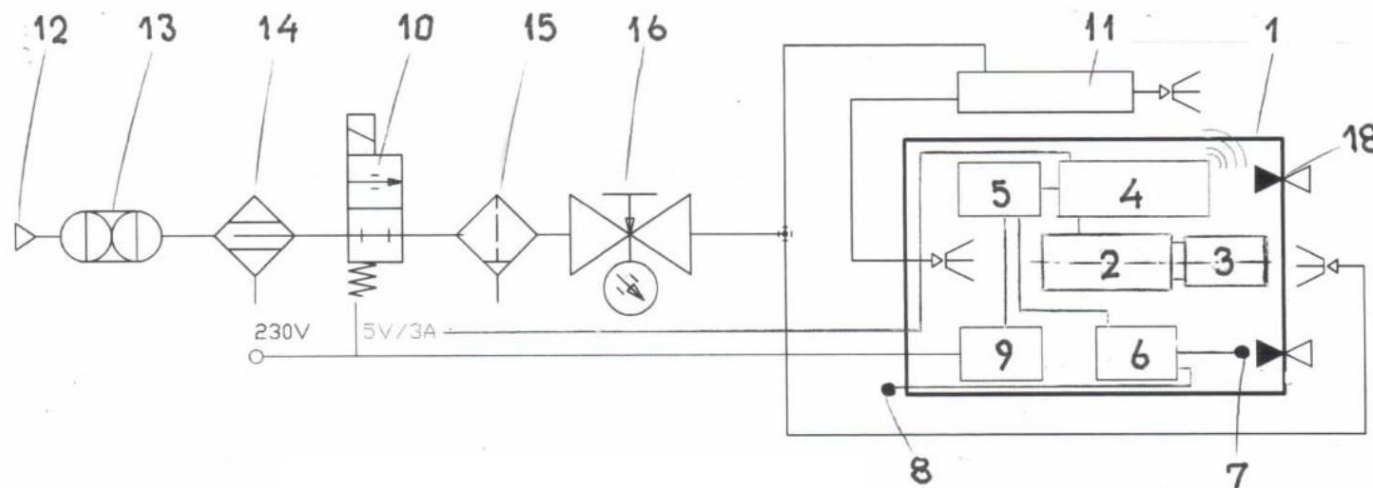
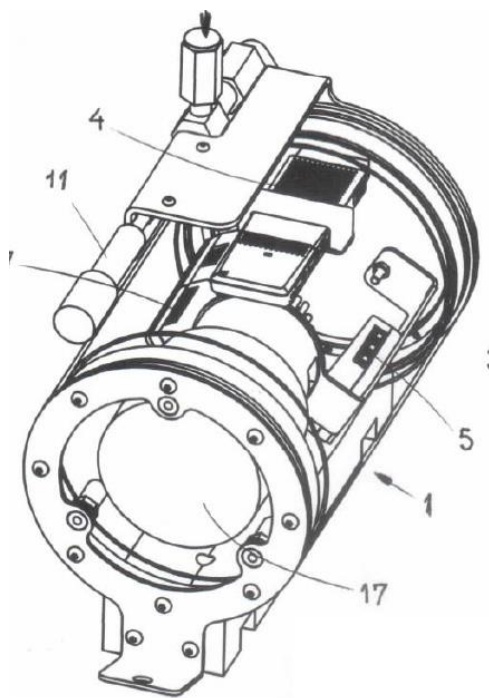
## ▪ 2018 – 2019 Zéta

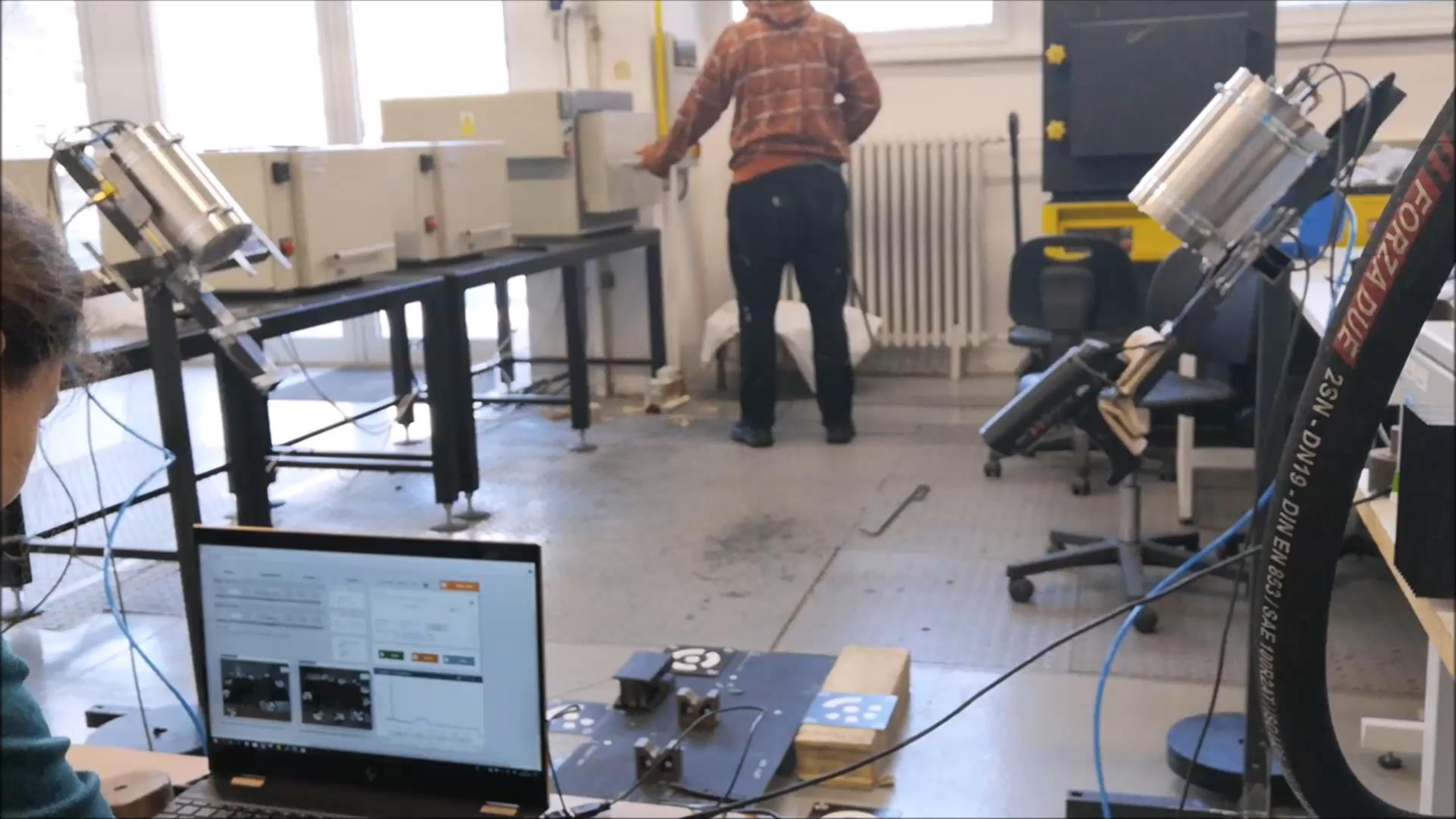


# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽĎAS

## Camera housing + autonomous cooling

- wifi or cable communication

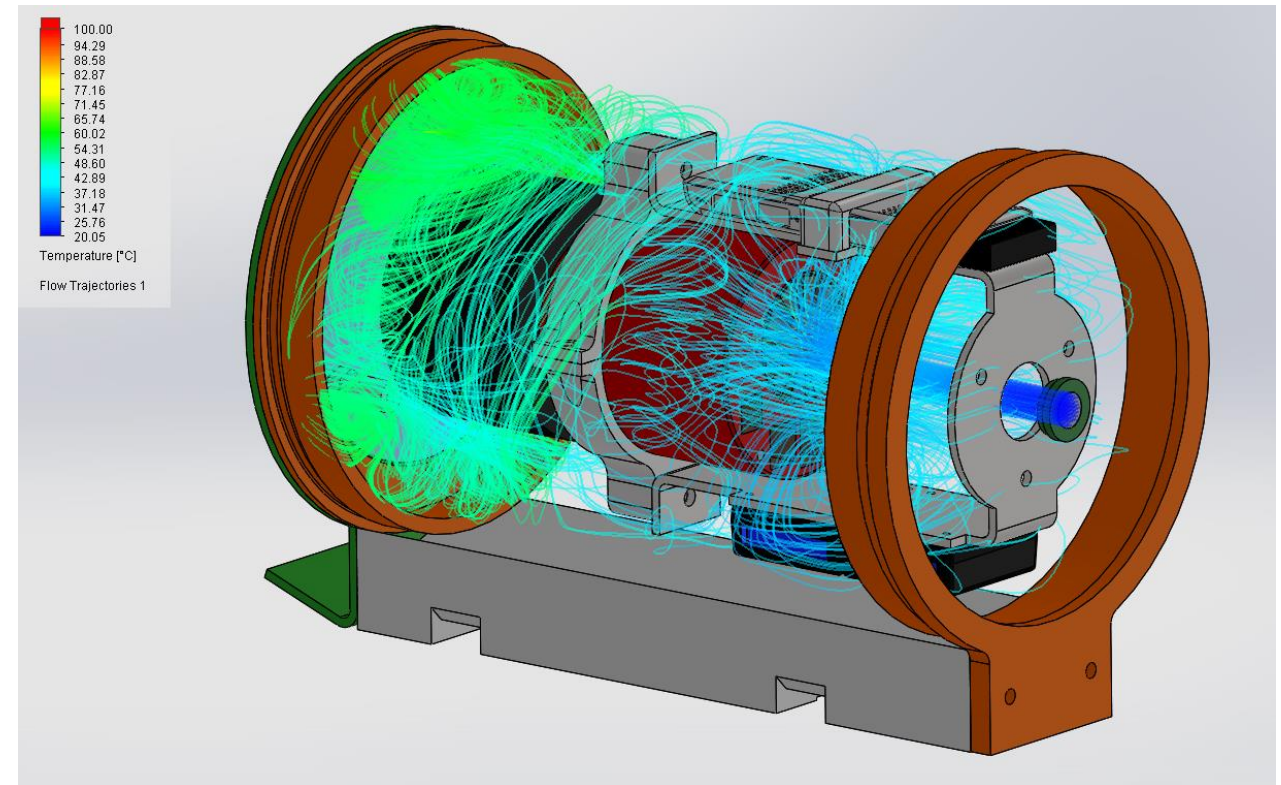




# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽĎAS

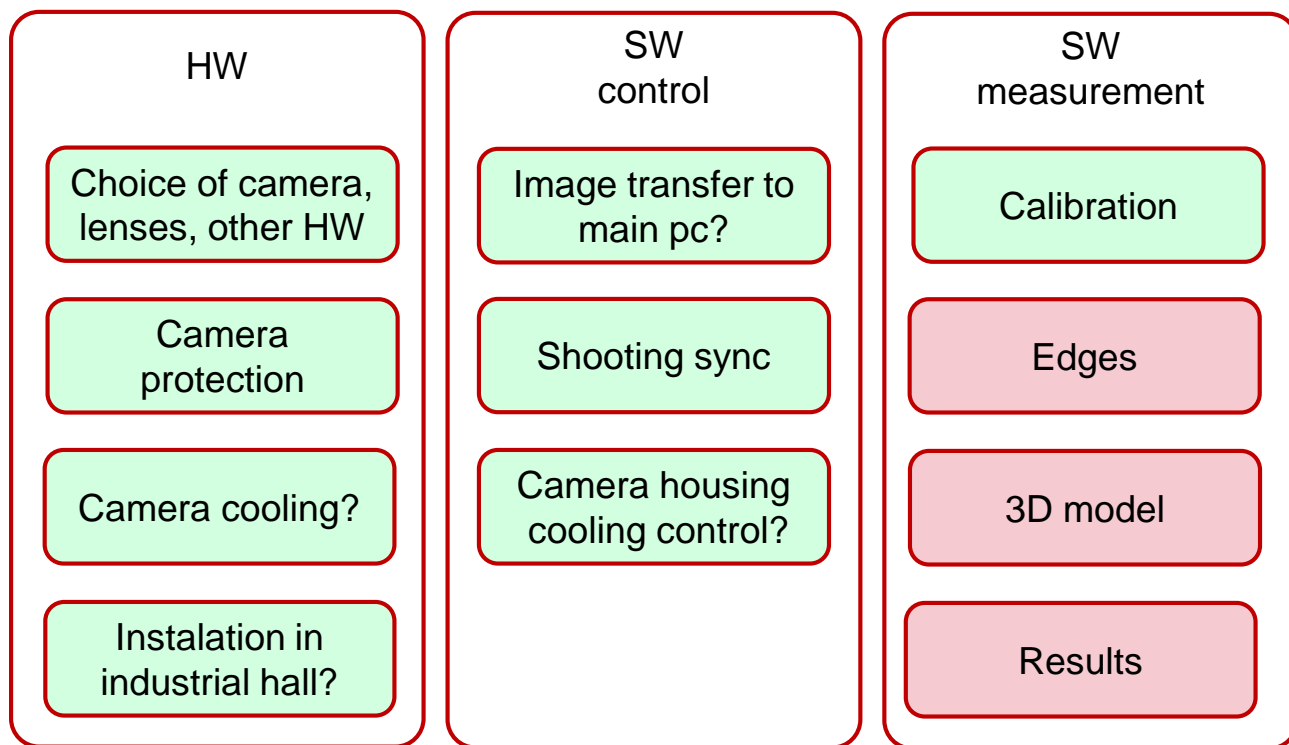
## ZKP - Camera housing for 3. camera without Vortex cooling - simulation

- Input air:**
- speed 10 m/s
  - temperature 20 °C
- Output air:**
- pressure 101,325 kPa
  - temperature 40 °C
- Heat sources:**
- forging 1150 °C (13 m distant)
  - camera 45 °C
- Resulting Temp.:**
- front of the housing 85 °C
  - front of the lens 45,5 °C
  - back of the camera 35 °C



# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽĐAS

## ▪ 2018 – 2019 Zéta



## Currently

- Test of new sw. for camera control (Delphi), which is independent of the connection type, **and** number of cameras (wifi, USB...)
- Installation of 3. camera and measurement in Žďas, testing
- TAČR Trend project planning
- July - SPIE optical metrology
- June - Dec. – edge detection, 3D model, evaluation -> Gfunk

# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽŽAS

Figures were excluded from  
online version of presentation

# DEVELOPMENT OF OPTICAL SYSTEM FOR ŽĎAS

- ✓ Gužit - Camera housing
- ✓ Gfunk - Prototype optical system
- ✓ Jimp - Generation and identification of photogrammetric circular code targets
- ✓ Jsc - Camera calibration method of optical system for large field measurement of hot forgings in heavy industry. Spie optical Metrology 2019. Munich

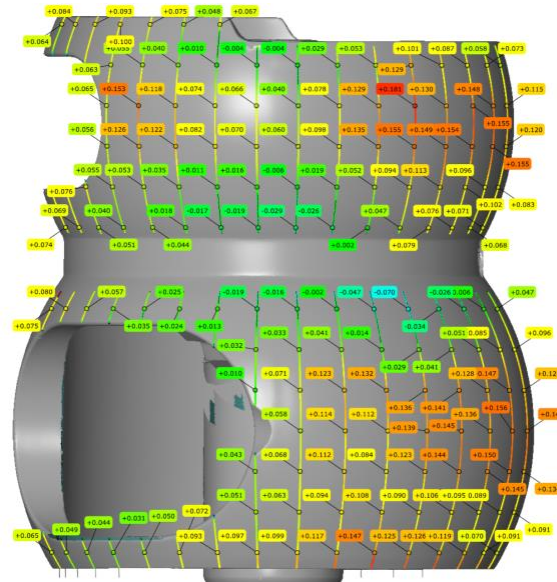
## Other publication:

Tomáš Zikmund, Jakub Šalplachta, Aneta Zatočilová, Adam Břínek, Libor Pantělejev, Roman Štěpánek, Daniel Koutný, David Paloušek, Jozef Kaiser, Computed tomography based procedure for reproducible porosity measurement of additive manufactured samples, NDT & E International, Vol. 103, 2019, p. 111-118, ISSN 0963-8695. **IF 2,78**

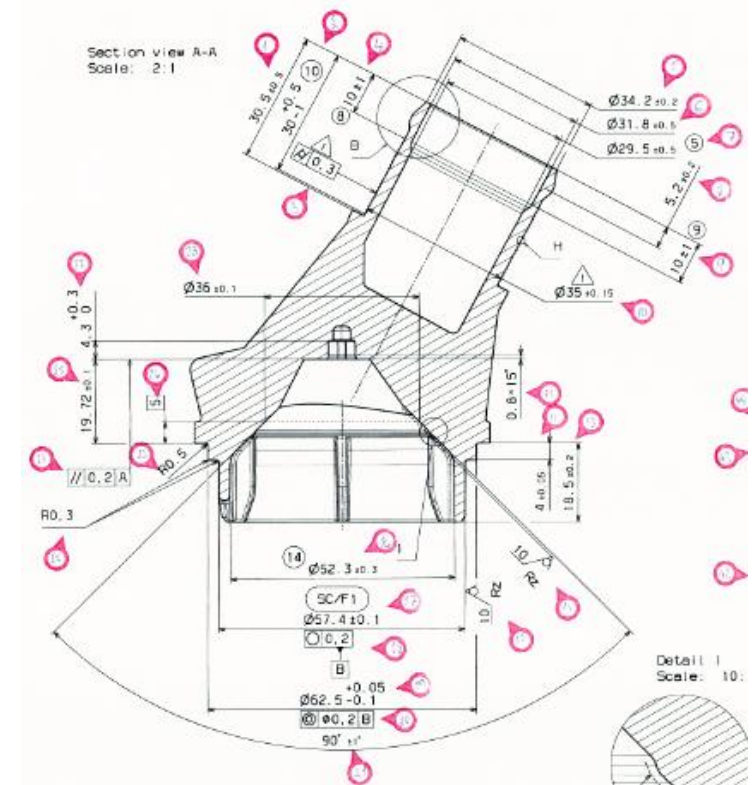
# CONTRACTUAL RESEARCH

## ITW PRONOVIA

- GD&T
- Dimensional inspection
- Reverse engineering



Element	Property	Nominal	Actual	Tol -	Tol +	Dev	Check	Out
DIM 21.∠XZ	∠XZ	+90.00°	+88.63°	-1.00°	+1.00°	-1.36°	<input type="checkbox"/>	-0.36°
DIM 28.∅	∅	+36.00	+35.96	-0.10	+0.10	-0.04	<input checked="" type="checkbox"/>	
DIM 68 - Plane X profile 1	⤿	+0.00	+0.03	+0.00	+0.30	+0.03	<input checked="" type="checkbox"/>	
DIM 68 - Plane X profile 2	⤿	+0.00	+0.15	+0.00	+0.30	+0.15	<input checked="" type="checkbox"/>	
DIM 68 - Plane Y profile 1	⤿	+0.00	+0.06	+0.00	+0.30	+0.06	<input checked="" type="checkbox"/>	
DIM 68 - Plane Y profile 2	⤿	+0.00	+0.05	+0.00	+0.30	+0.05	<input checked="" type="checkbox"/>	





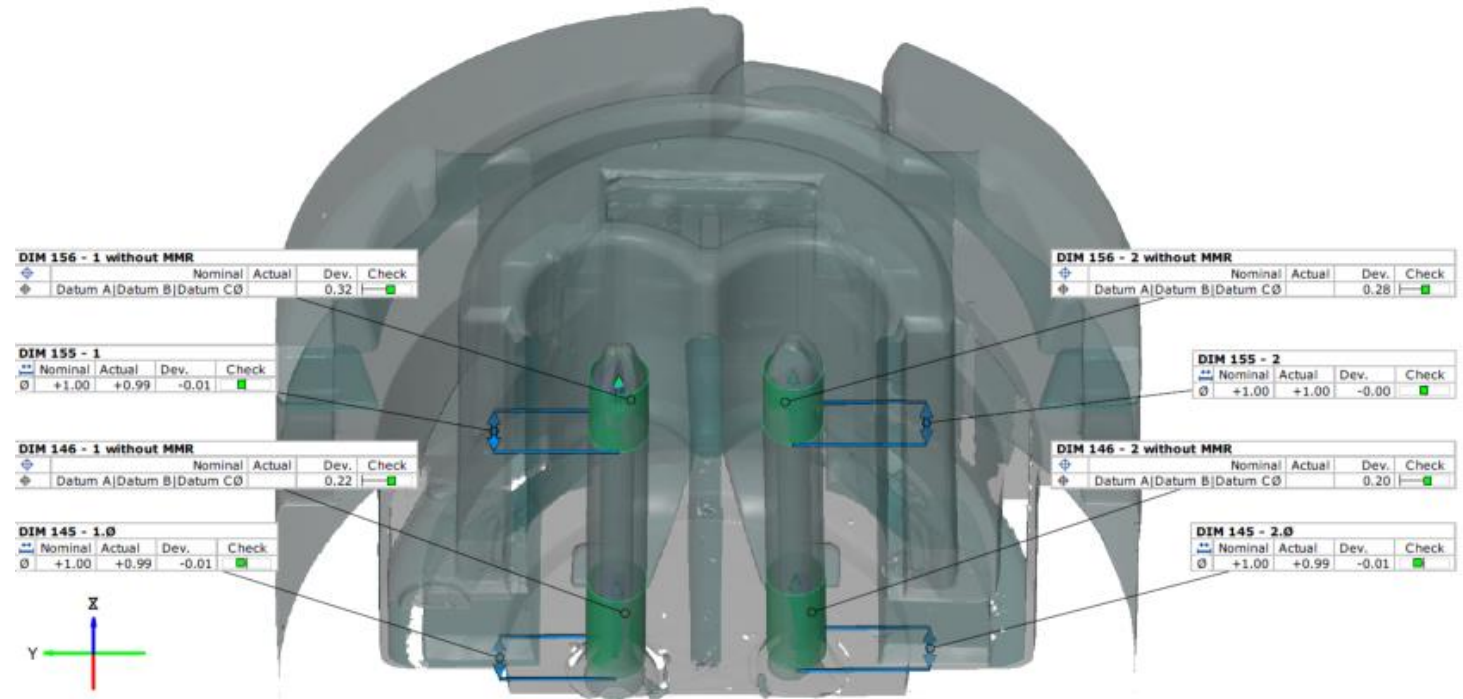
# CONTRACTUAL RESEARCH

## CEITEC – laboratory of tomography

TRW Automotive GmbH

- GD&T
- Dimensional inspection

Figures were excluded from  
online version of presentation



# TEACHING ACTIVITIES

## WINTER

- ZRI-A – 3D optická digitalizace a inspekce strojních dílů (+Kotecký, Hurník)
- 3CD – CAD (Inventor)
- ZRS – Řízení projektu (+ Koutný)
- (ZKP – Týmový projekt)
- RS1 – 3D digitální technologie a CAD (Mechanika těles) (+Koutecký)

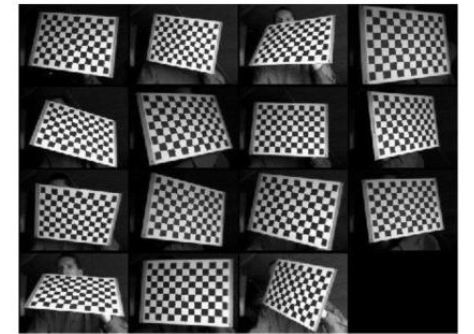
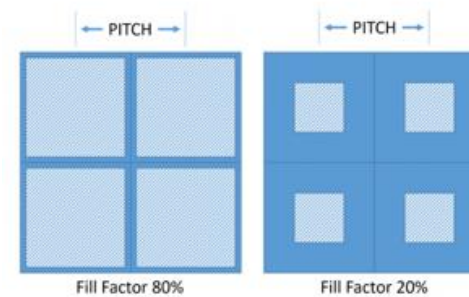
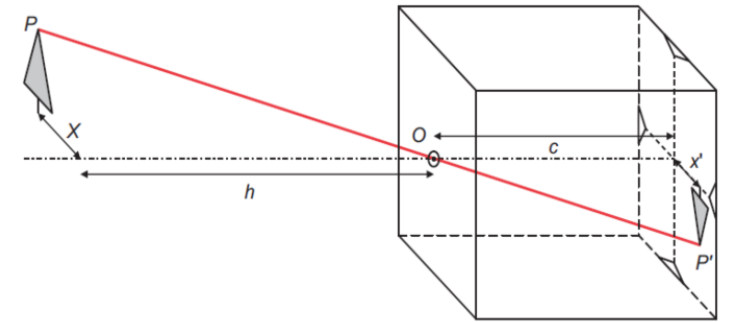
## SUMER

- (ZIP – Konstrukční projekt)
- 6KM – Solidworks a 3D tisk

# TEACHING ACTIVITIES – ZRI-A

## ZRI-A NEW LECTURES

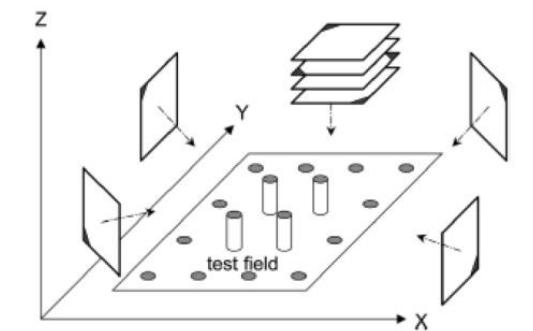
- Basic components of camera
- Optical aberrations
- Calibration of photogrammetry system
- Histogram and intensity transformations
- **Inspiration:** Tomas Luhman book and Cyrill Stachniss YT video lectures of Photogrammetry I and II



2D metric calibration using chessboard

$$f(x, y) = g(x, y) * h(x, y)$$

$$h_1(x, y) = \frac{1}{9} \cdot \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$



Imaging configuration for 3D test field

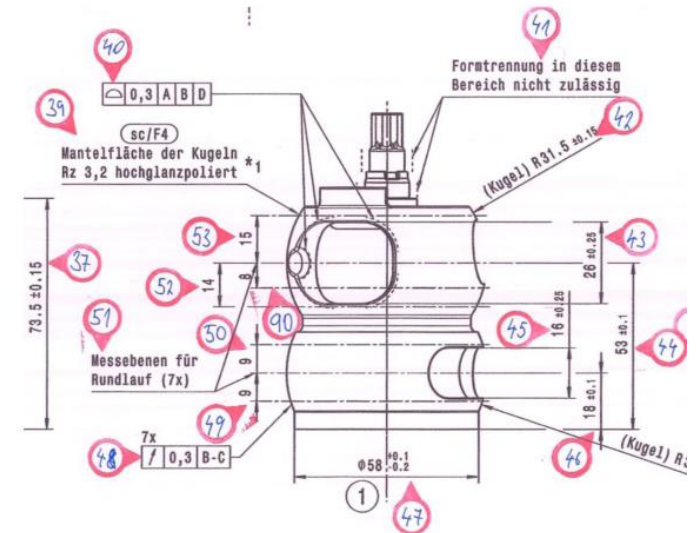
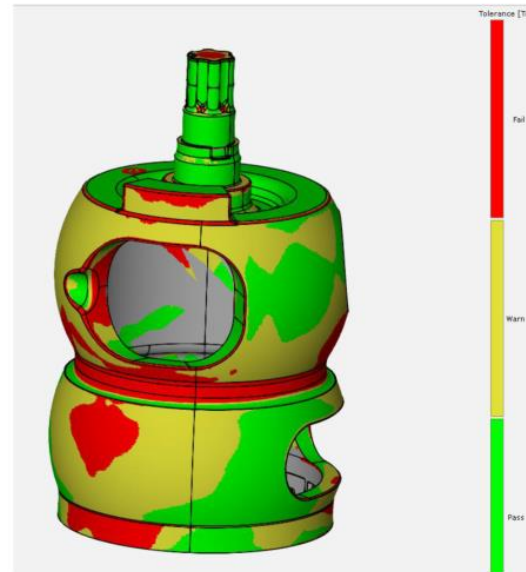
# ZRI-A (INTEREG PROJECT – FABLAB)

- Inspection of Kugelement part (ITW Pronovia) according to the drawing
- New manual for orientation in GOM inspect workflow (35 pages)
- Created for independent work under supervision of lecturer

Students comments (Apollo):

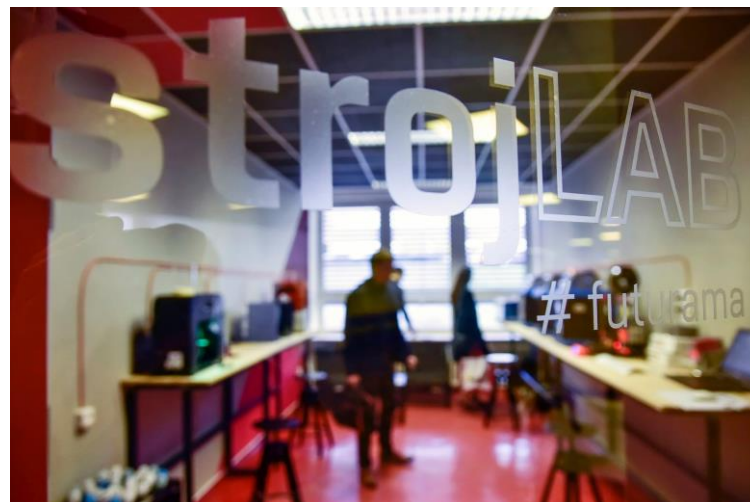
Úplně zrušit samostatnou práci na cvičeních a řešit výuku pouze step-by-step

Vedení cvičení dle manuálu od Gom Inspect je dle mého na vysokou školu nedostačující, protože se pouze jde dle manuálu a nedělalo se nic navíc.



# FABLAB NET

- Festival Prototyp
- Autodesk academia design
- FabFest
- Roll out strategy report



# FUTURE PLANS

- TAČR Trend – Žďas 2020 – 2023
- TAČR Zéta – Mico 2020 – 2022
- Improve ZRI-A lectures, solve the problem with hw demands of GOM inspect sw
- Teaching internship on INSA de Lyon (1 - 2 weeks)
- Research internship (University of Bonn)???

# THANK YOU FOR YOUR ATTENTION

**Aneta Zatočilová, Ing. Ph.D.**

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