Fachhochschule Graubünden
University of Applied Sciences

# SwissPhotonics Workshop 2024

## «3D reconstruction with multi-view structured light»

Philipp Roebrock

graubünden Education and Research

# 3D structured light scanner: High accuracy for static objects


Keyence VR6000

Zeiss ATOS 5

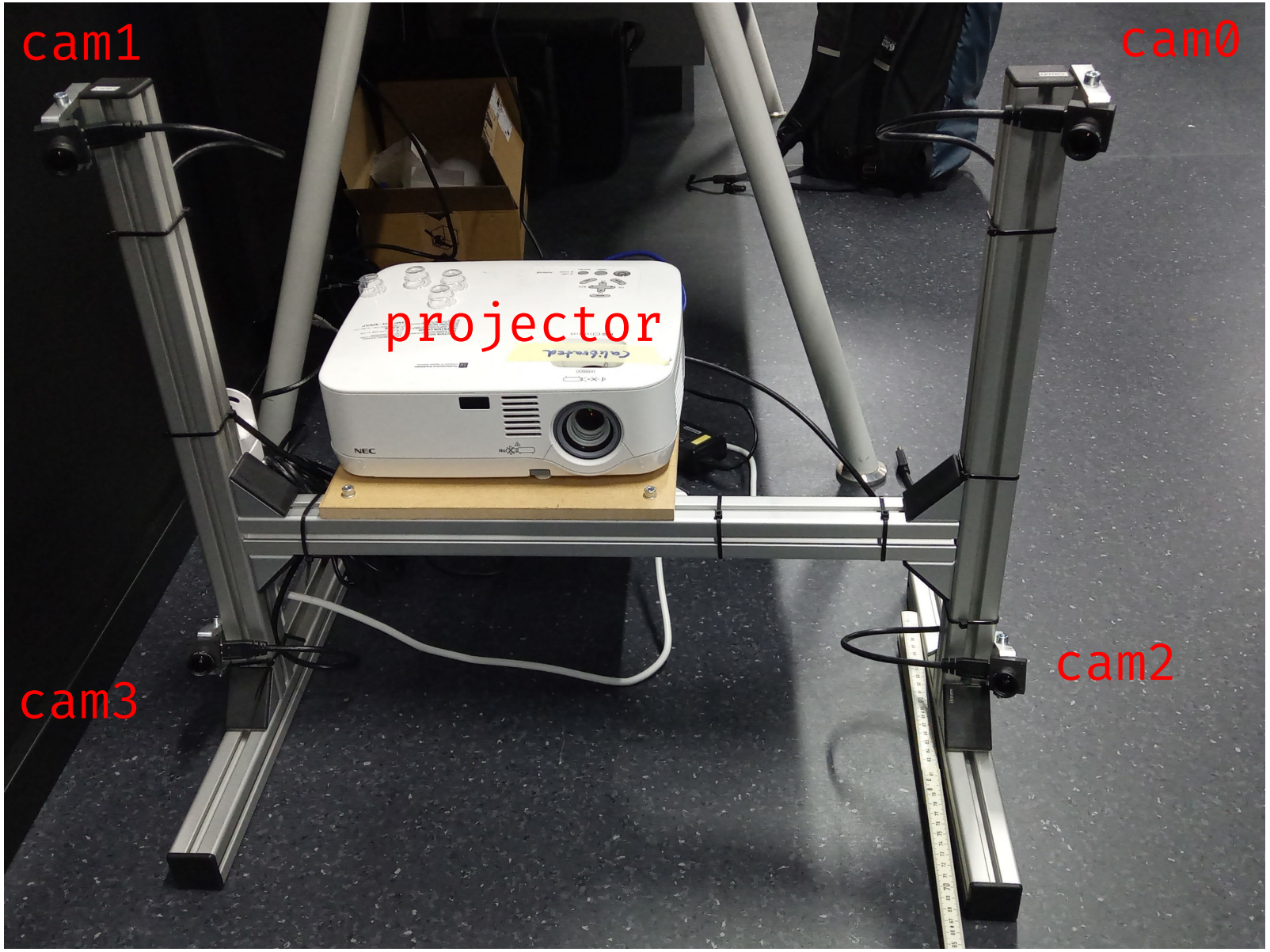

Wenglor MLBS


IDS Ensenso

Photoneo PhoXi 3D

FH GR

# Let’s build our own: How hard can it be?




Off-the-shelf components:

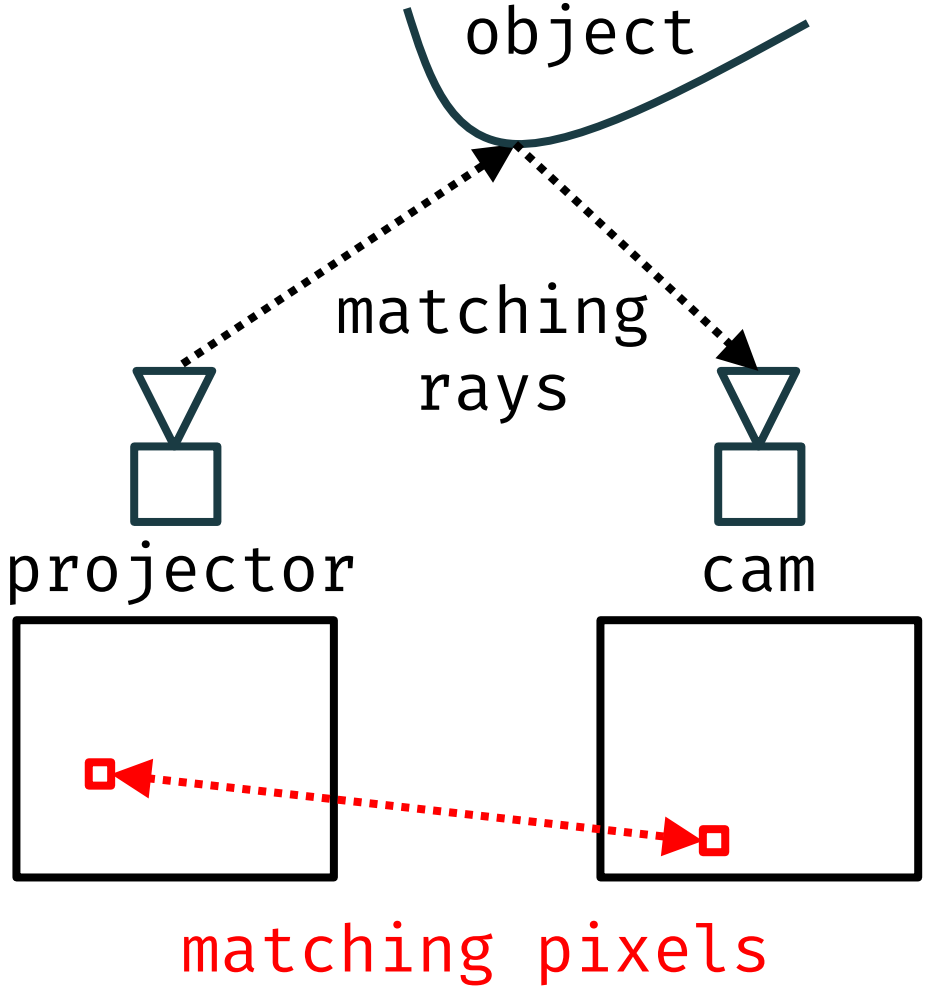
- Projector NEC NP610 with 1024x768 resolution
- Cameras 4x Basler daA3840-45µm 8 MPix, monochrome, USB, lens 8mm/F1.8, resolution scaled down to 1920x1080
- Distance to object: 90cm

FH GR

# Test target


FH GR

# Approach




- Turn on single pixel on projector
- Camera sees bright pixel (region)
- In 3D, corresponding projector and camera rays meet at point at object surface -> 3D Point!
- Switching on every single projector pixel and taking an image is not practical, we need to encode the projector pixels over a series of images

TODO:

- Match pixels projector -> camera(s)
- Intersect rays (bundle adjust)

FH GR

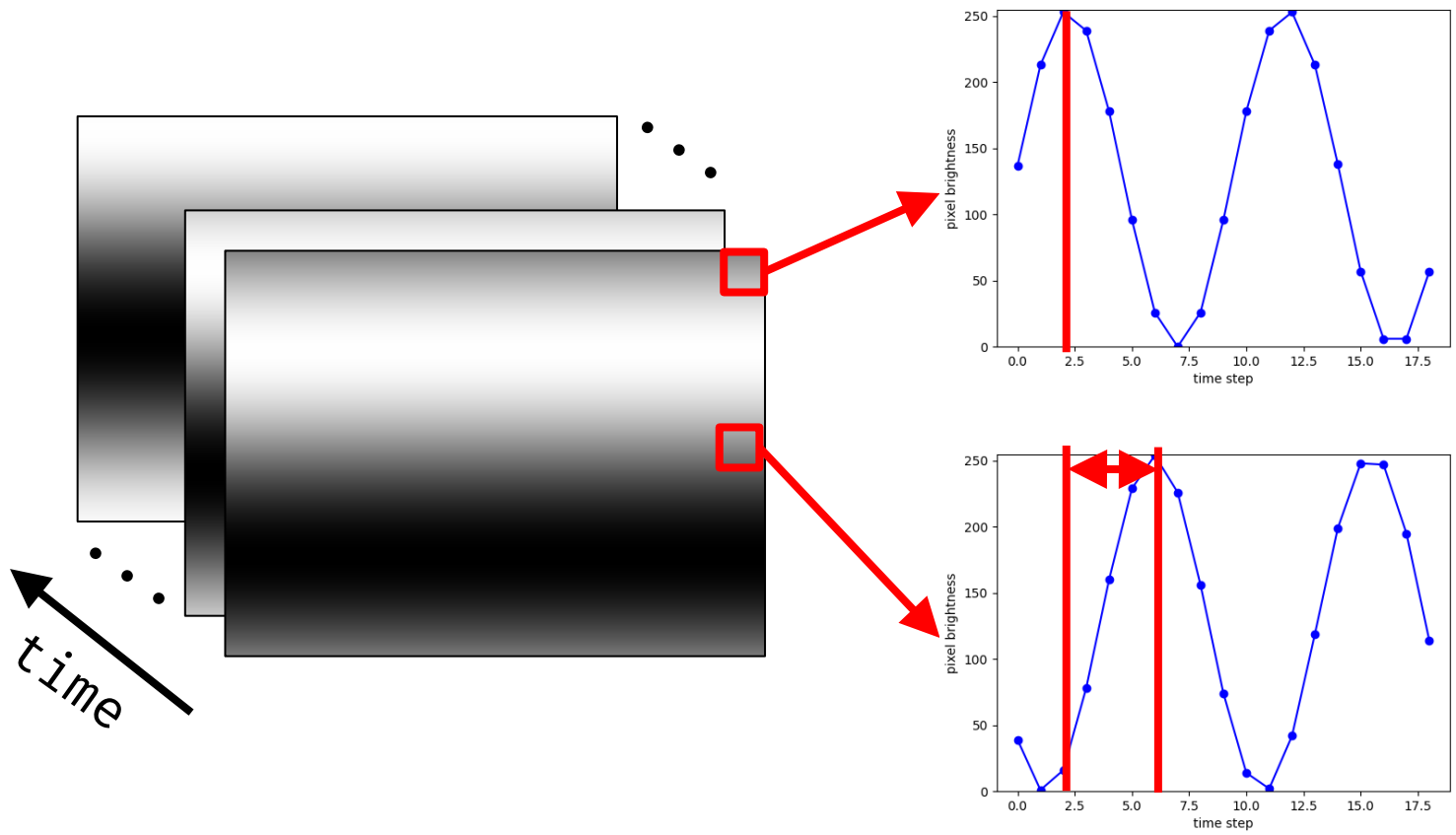
# Phase shift correspondence matching

projector

cam1

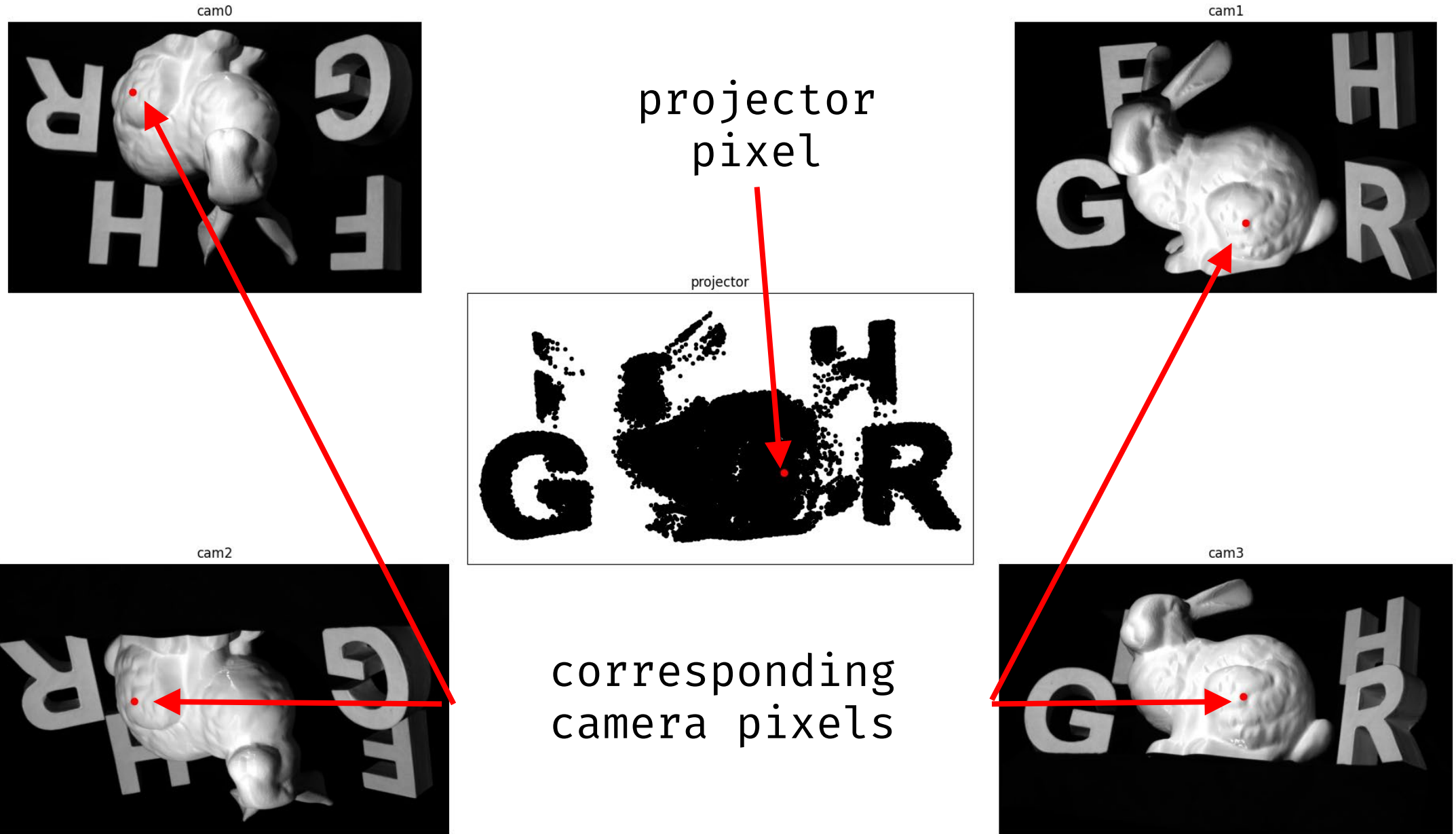
FH GR

# Phase shift correspondence matching



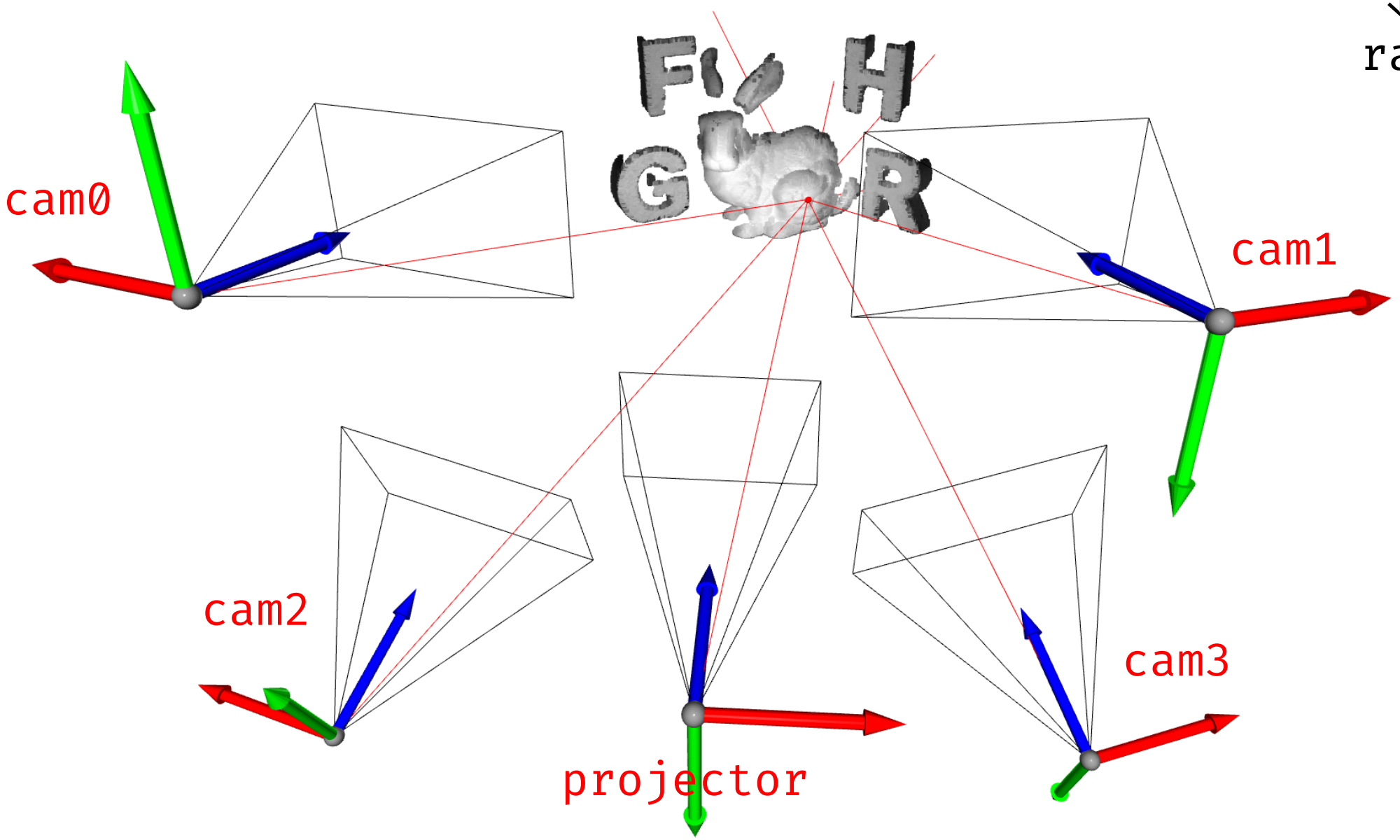

phase encodes image row!

# Bundle adjustment: Corresponding pixels



# Bundle adjustment: Corresponding rays

camera model:
pixel on chip
↓
ray

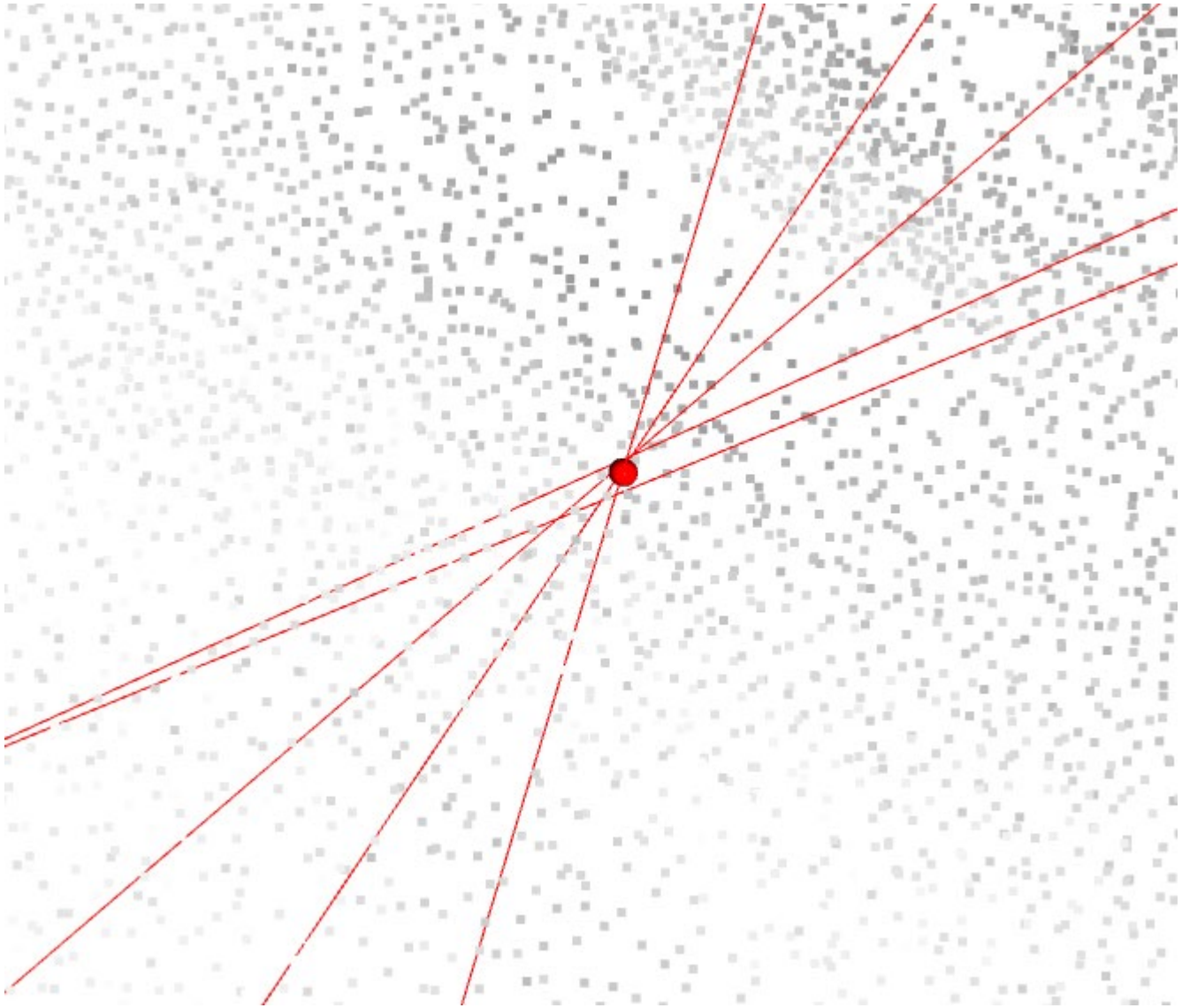



FH GR

# Raw reconstruction

190k points

# Bunde adjustment error estimation



Bundle adjustments find the 3D object point where all rays are closest to each other.

We can calculate the average distance of all rays to the object point as a measure of error!

FH GR

# Bundle adjustment residuals


190k points

## Filtered by residual error <2mm

150k points

# Conclusion


Randall Munroe / Riverhead Books

# References


- Institut für Photonics und Robotics (IPR) an der Fachhochschule Graubünden
- Open-Source Project: Computer vision problems, simulations and solutions: Lighthouse
- IEEE Standard 1057: IEEE Standard for Digitizing Waveform Recorders
- D. Moreno and G. Taubin, "Simple, Accurate, and Robust Projector-Camera Calibration," *2012 Second International Conference on 3D Imaging, Modeling, Processing, Visualization & Transmission*, Zurich, Switzerland, 2012, pp. 464-471, doi: 10.1109/3DIMPVT.2012.77.


FH GR