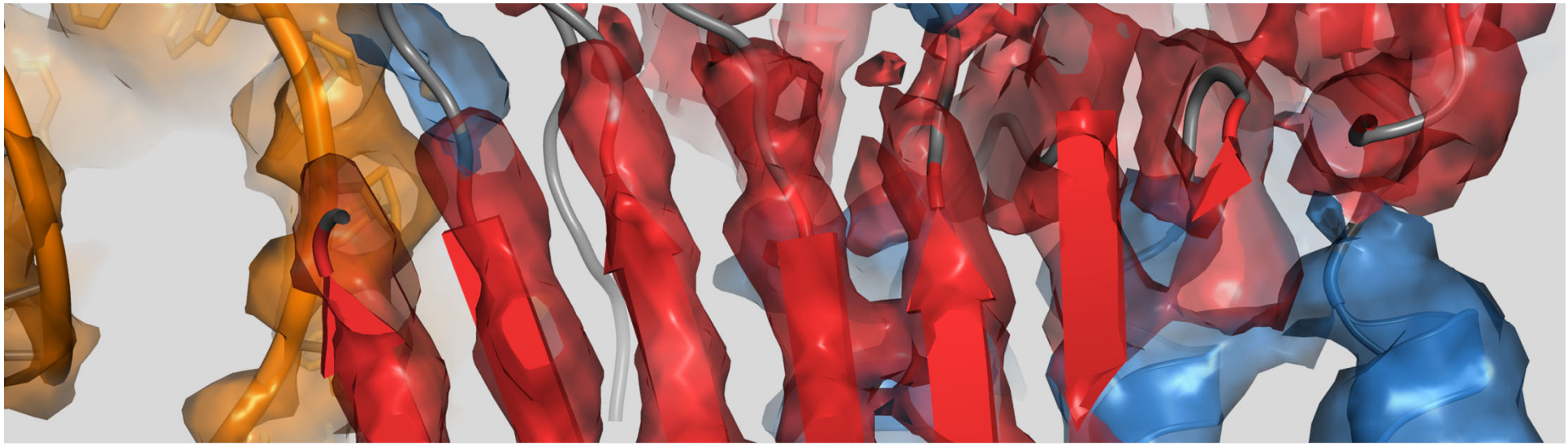
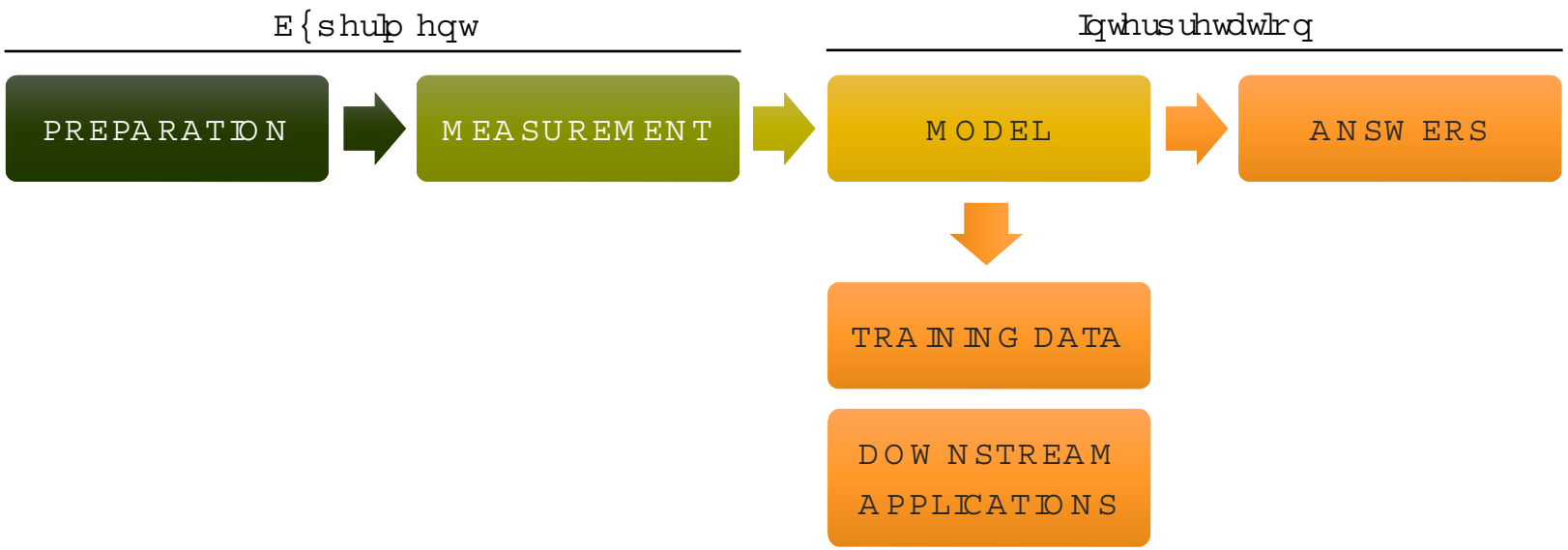


Visual Diagnostics for Macromolecular X-Ray Diffraction: AUSPEX

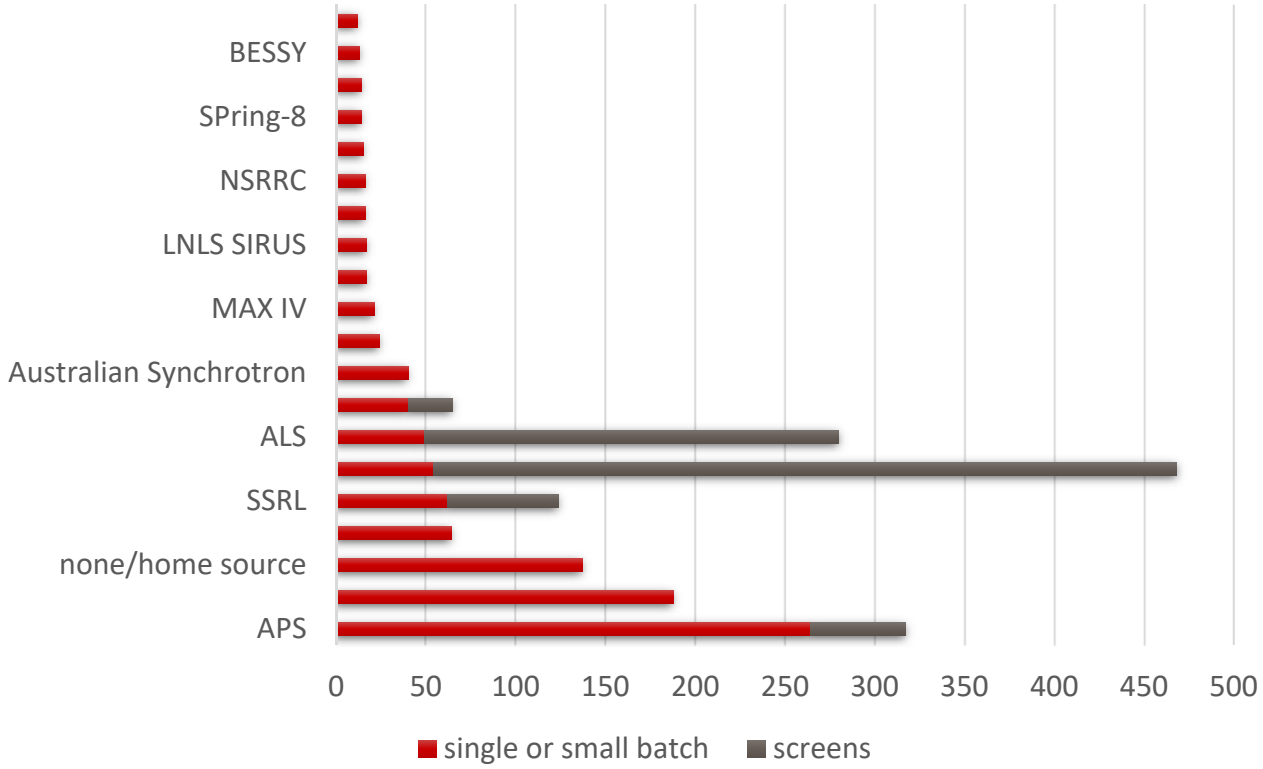
Andrea Thorn

THORN LAB

“Central Dogma” of Structural Biology



Quick aside: Large Facilities vs. COVID-19



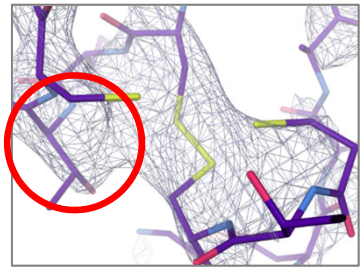
Quick aside: Coronavirus Structural Task Force

HARVESTING
- PDB entries
- Data base population
- Rmsd & Statistics

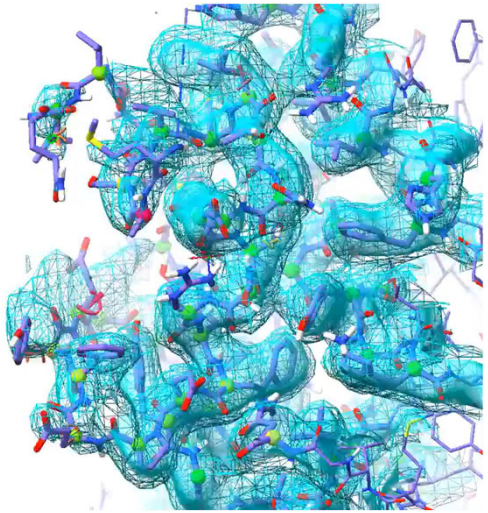
AUTOMATIC
- •Validation programs
- •Custom versions
- •Internal & external

MANUAL
- •Re-processing
- •Re-interpretation
- •Hypothesis comparison

DISSEMINATION
- •Open data
- •Blog posts
- •Social media



Pdsdlq0dnh surwhdvh
+PDE 9z<f,



RNA
srop hudvh
erxqg wr
uhp ghvlylu
+PDE :ey5,

Croll, T., Thorn A.*, et al. (2021) Making the Invisible Enemy Visible, Nature Structural & Molecular Biology 28, 404-408.

AUSPEX: Data Pathology Diagnostics

- Diffraction data problems more common than generally thought
- Implications for processing & structure solution
- **We need better indicators for diffraction data problems!**

Verbundforschungsprojekt:
AUSPEX - New AI-based, Visual and Automatic Diagnostics for Macromolecular Structure Determination at Large Facilities

Collaborators:

HZB Helmholtz Zentrum Berlin

ESRF

European XFEL

ESS EUROPEAN SPALLATION SOURCE

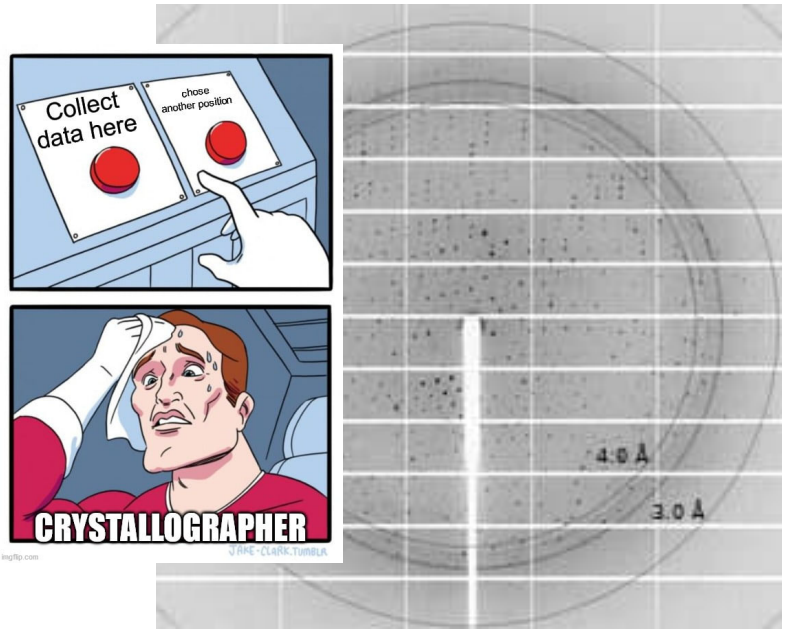
CCP4

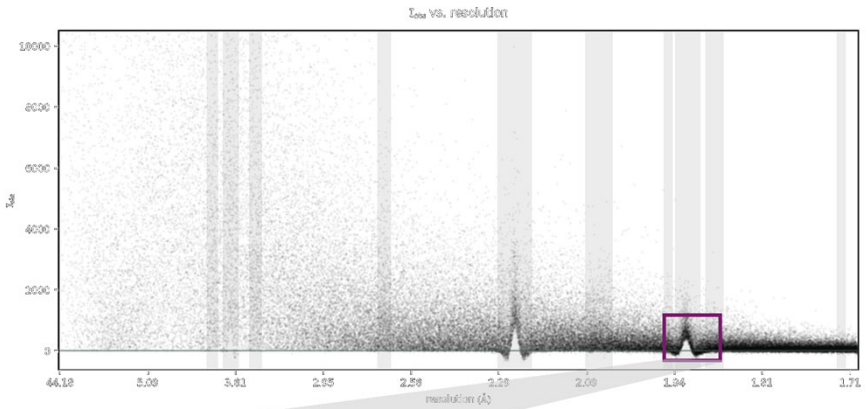
Funded by

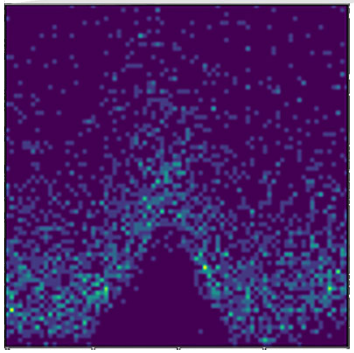
Bundesministerium für Bildung und Forschung

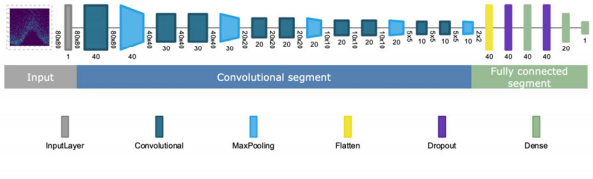
Thorn, A.* et al. (2017) AUSPEX: a graphical tool for X-ray diffraction data analysis, *Acta Cryst D*73, 729-737

Example: Ice rings







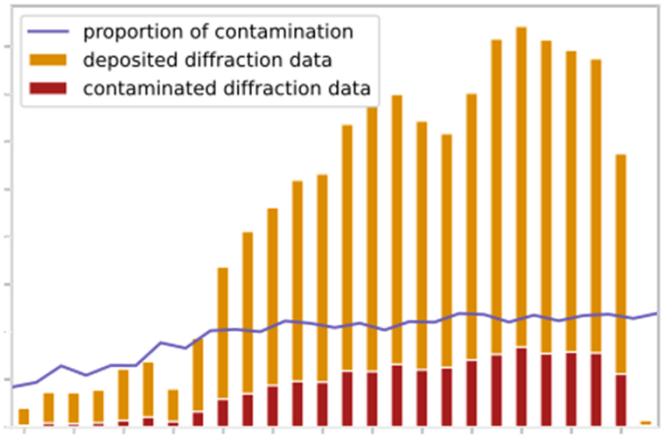


Nolte, K., Gao, Y., Stäb, S., Kollmannsberger, P., Thorn, A. (2022) Detecting ice artefacts in processed macromolecular diffraction data with machine learning, *Acta Cryst D*78, 187-195.

Diffraction image: Gianluca Santoni, ESRF

Neural network recognition

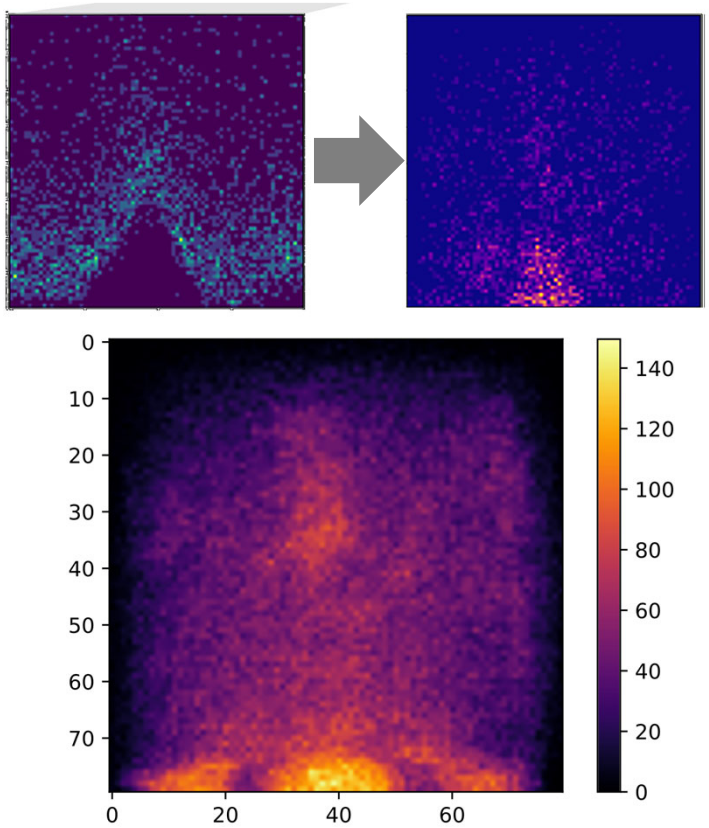
	True positives	True negatives	Accuracy	Sensitivity	Specificity
phenix.xtriage	13/44	142/156	78 %	30 %	91 %
CTRUNCATE	23/44	86/156	55 %	52 %	55 %
AUSPEX Icefinder	24/44	133/156	83 %	55 %	85 %
p_{ice}	29/44	147/156	88 %	66 %	94 %
AUSPEX Helcaraxe	38/44	153/156	96 %	86 %	98 %

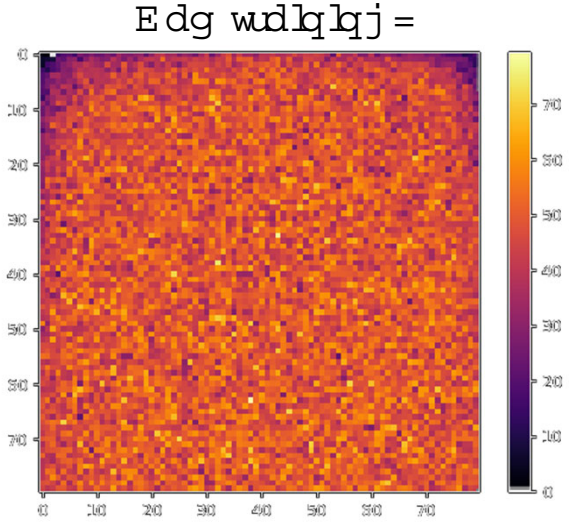


18.5% !

Nolte, K., Gao, Y., Stäb, S., Kollmannsberger, P., Thorn, A. (2022) Detecting ice artefacts in processed macromolecular diffraction data with machine learning, *Acta Cryst D*78, 187-195.

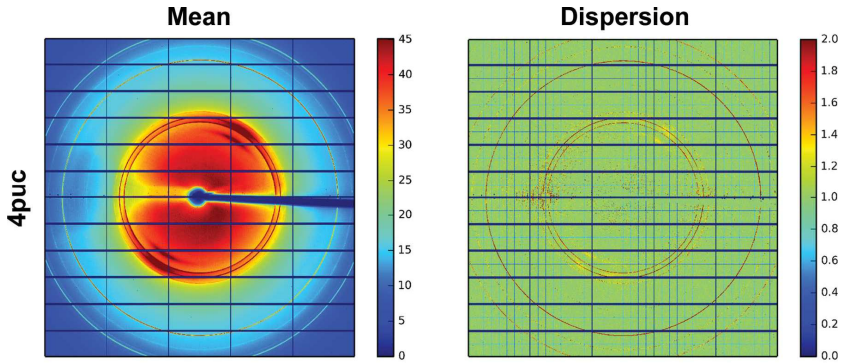
Explaining the black box: Sensitivity

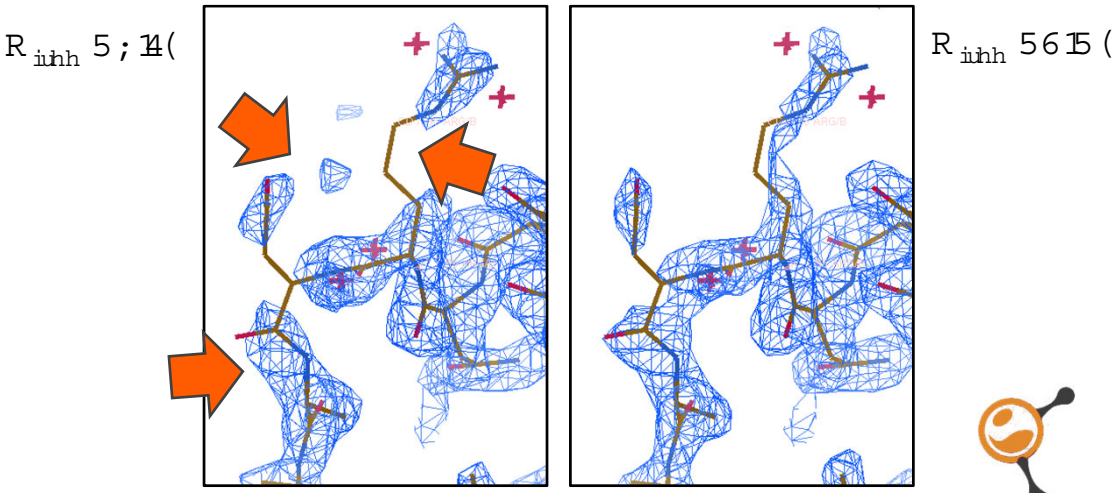




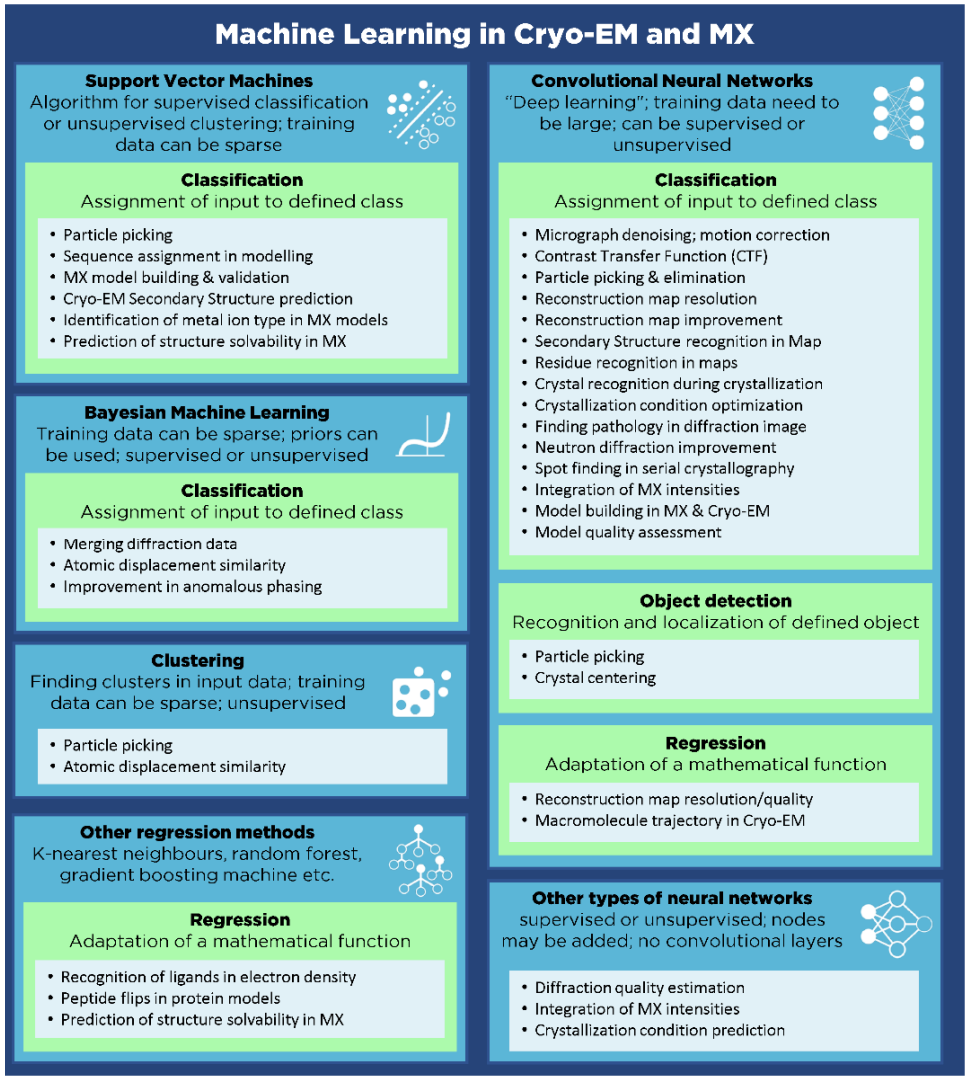
Smilkov, D., Thorat, N., Kim, B., Viégas, F. & Wattenberg, M. (2017). SmoothGrad: removing noise by adding noise *ArXiv*.

New background estimation in DIALS





Parkhurst, Thorn, Vollmar, Winter, Waterman, Fuentes-Montero, Gildea, Murshudov, Evans (2017) *IUCrJ* 4, 626-638.

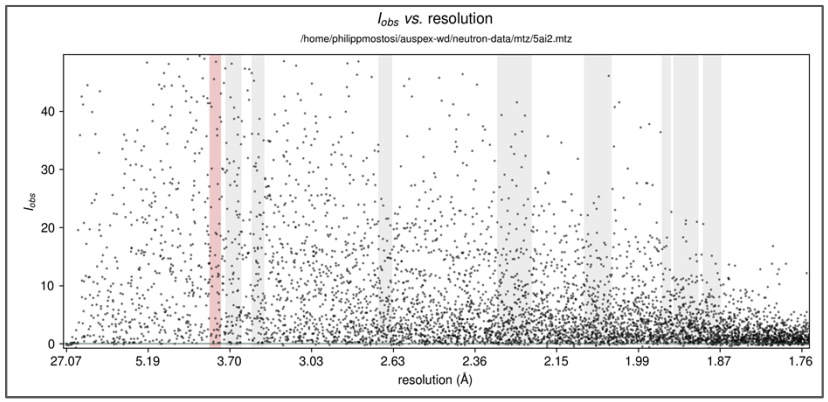


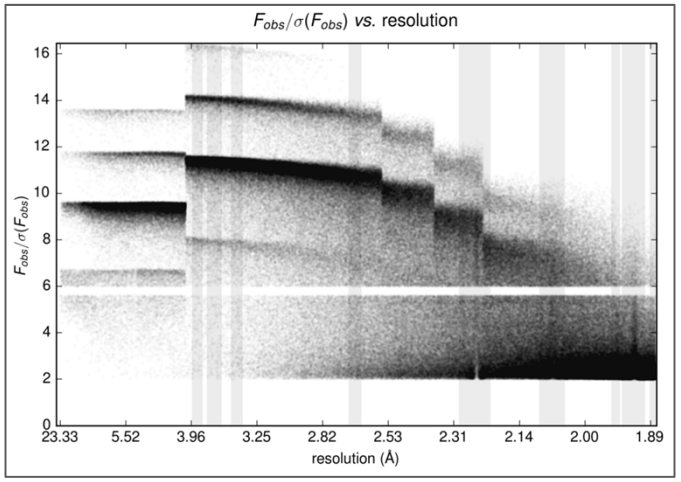
AI methods in experimental structural biology

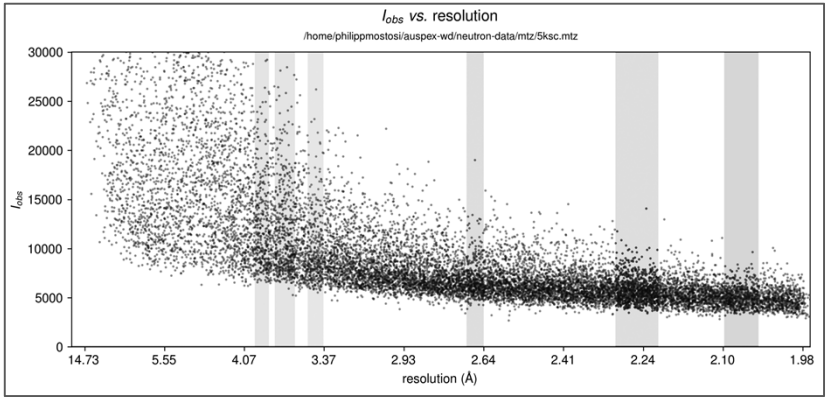
Download poster & add to list at thorn-lab.com

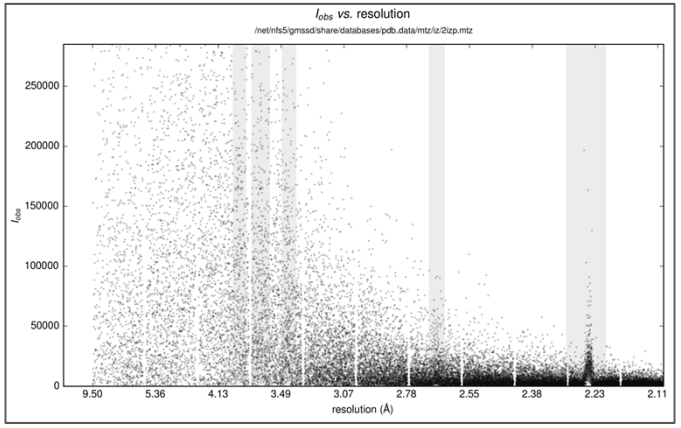
Thorn, A.* Artificial intelligence in the experimental determination and prediction of macromolecular structures (2022) Curr. Opin. Struct. Biol. 74, 102368

More problems





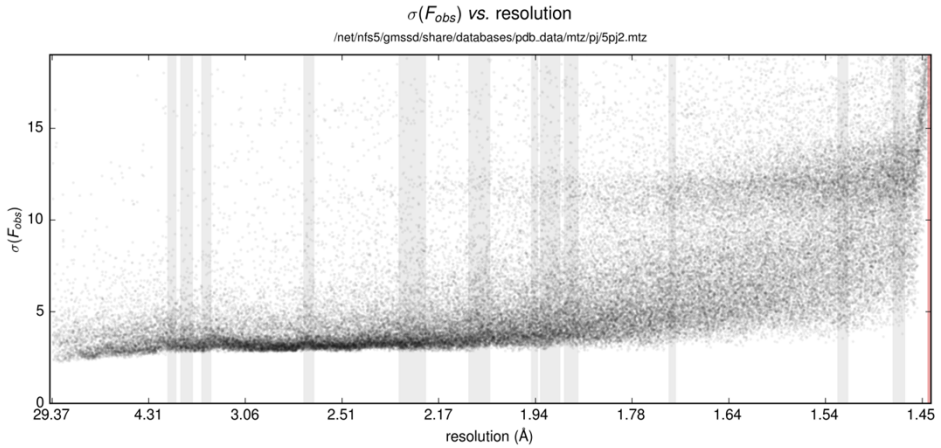




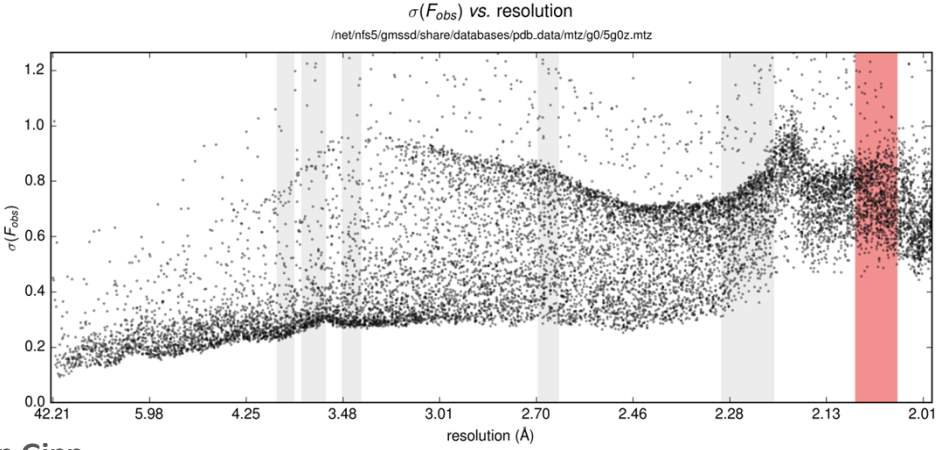
Thorn, A., Parkhurst, J.M., Emsley, P., Nicholls, r., Evans, G., Vollmar, M. & Murshudov, G.N. (2017) AUSPEX: a graphical tool for X-ray diffraction data analysis, *Acta Cryst D*73, 729-737.

Polyhedrin: σ of XFEL data

PDB 8PM5
Conventional
DIALS/AIMLESS



PDB 8G3J
LCLS
CuAMO V13 1815



Data kindly provided by Tom White and Helen Ginn

AUSPEX

www.auspex.de

A service provided by

Universität Hamburg

Home | **Analyze PDB/MTZ** | **View Jobs** | **Examples** | **Disclaimer**

AUSPEX is a diagnostic tool for graphical X-Ray data analysis, which enable users to visually and automatically detect ice-ring artefacts and other problems in integrated X-ray diffraction data.

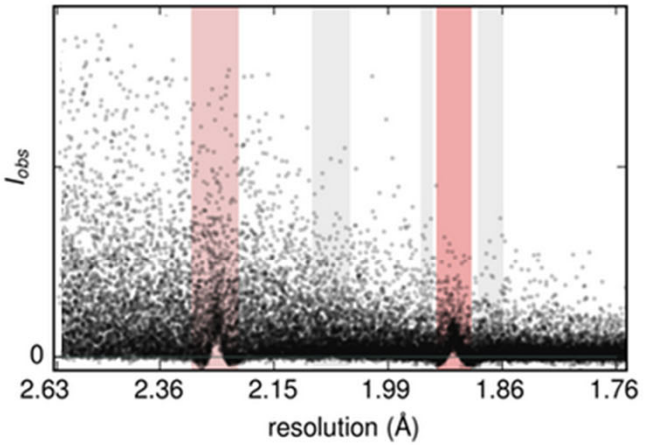
If you would like to plot your own data

Run Auspex

Some examples of common pathologies are available

Examples

For a more detailed description of AUSPEX and our systematic study of the PDB, please look at the bottom of this page.



Please Cite

Thorn, A., Parkhurst, J.M., Emsley, P., Nicholls, R., Evans, G., Vollmar, M. & Murshudov, G.N. (2017)
AUSPEX: a graphical tool for X-ray diffraction data analysis, *Acta Cryst D***73**, 729-737.
This helps us to develop AUSPEX as a free service.

Summary

- **Understanding experimental data (and errors) is crucial to avoid problems and pitfalls in macromolecular structure determination!**
- **We need better diagnostics to ensure best results from automation**
- **AUSPEX: tool for visual & easy diffraction data analysis**
  Webserver: **www.auspex.de**
- **Well curated and open data are badly needed!**
- **Particularly for machine learning (limited by training data)**

There is much to be done!

Acknowledgements

Gianluca Santoni & Max Nanao, ESRF Grenoble, France

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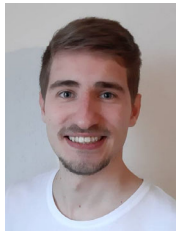
Student Assistant



Max Edich
PhD student

Oliver Kippes
Student assistant

Funded by

DFG Bundesministerium für Bildung und Forschu

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@thornlab

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