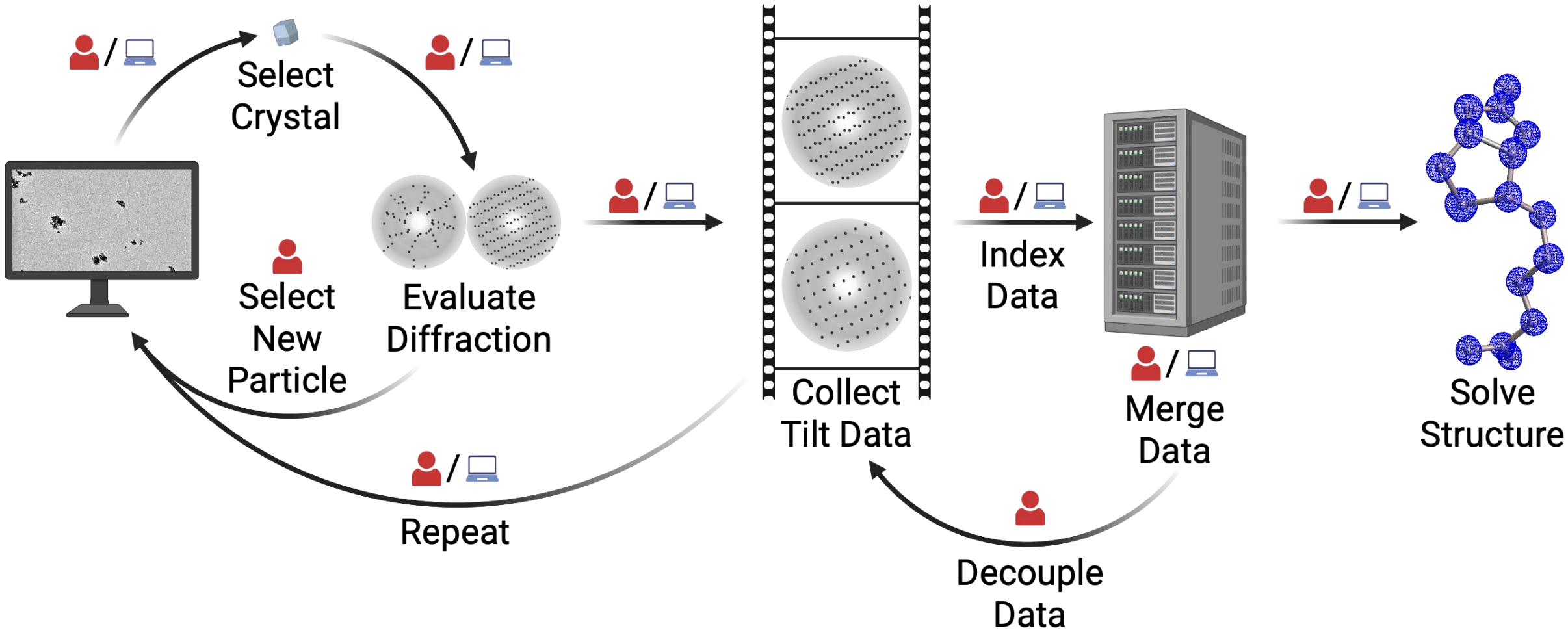
Caltech

Teaching Machines Electron Diffraction

Dmitry Eremin, David Delgadillo

Nelson Lab, Caltech

MicroED Acquisition Practices



Eremin, D.B. et al. **2025**, *JACS*, DOI: 10.1021/jacs.5c10751; Patent app. CIT-9295-P2 on 5/8/2025

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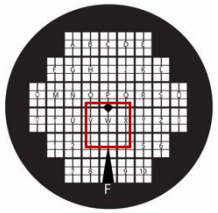
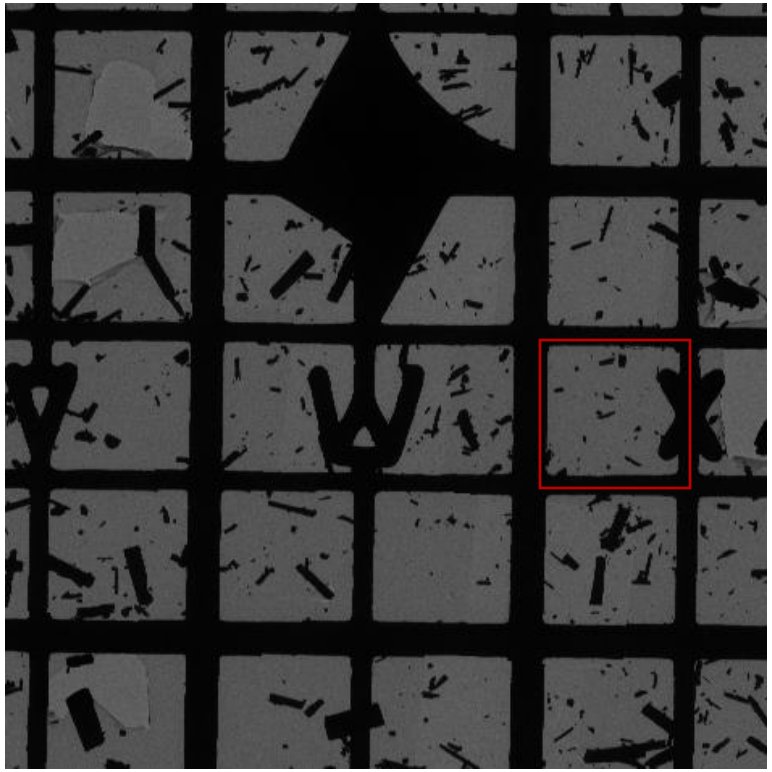
Dilemma of Target Selection



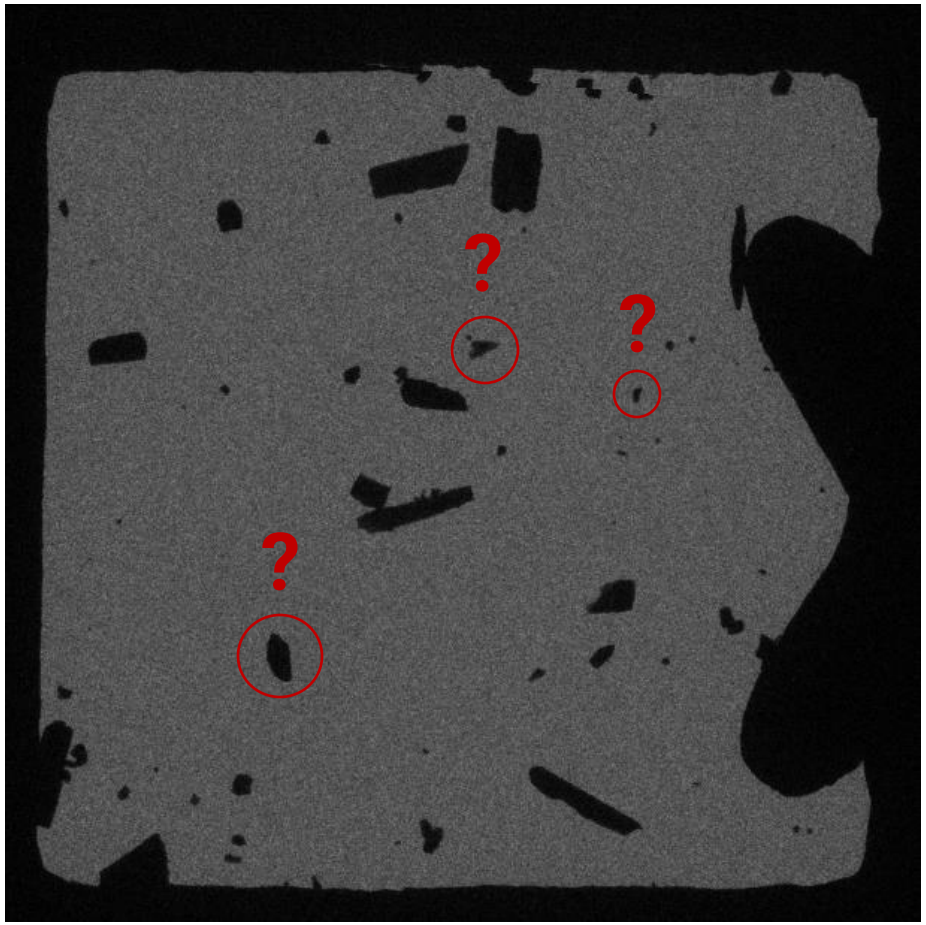
3 mm

Image



450 µm

Choose



90 µm

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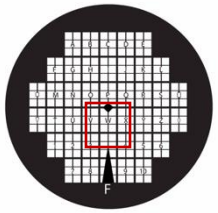
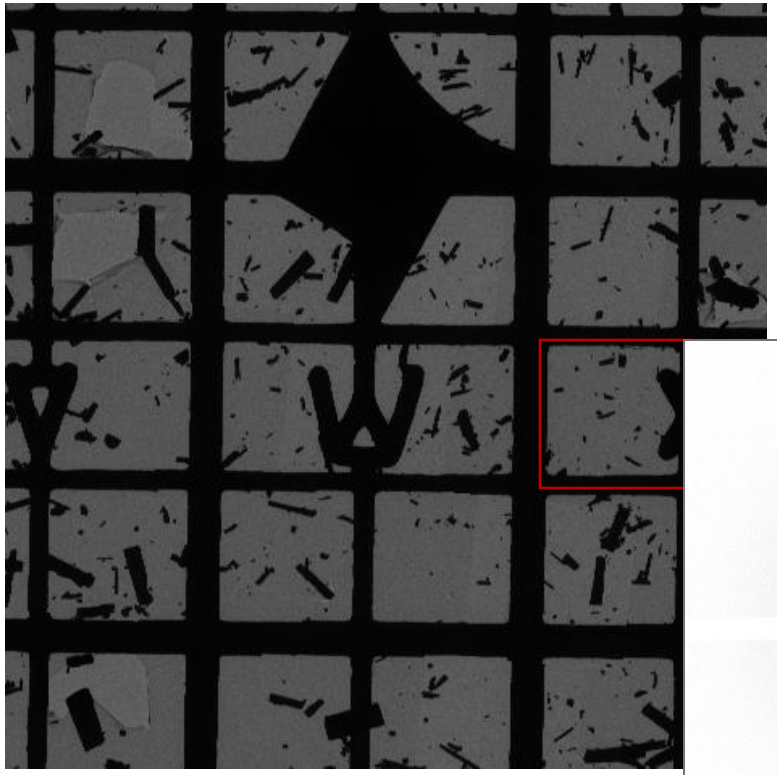
Dilemma of Target Selection

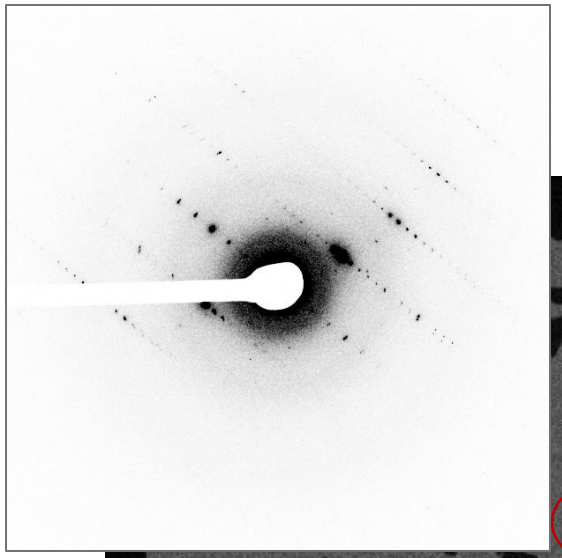


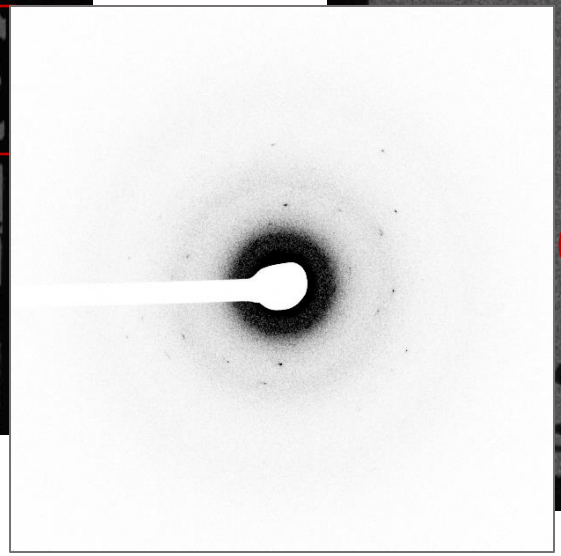
3 mm

Image



450 µm





90 µm

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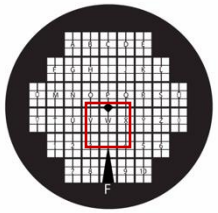
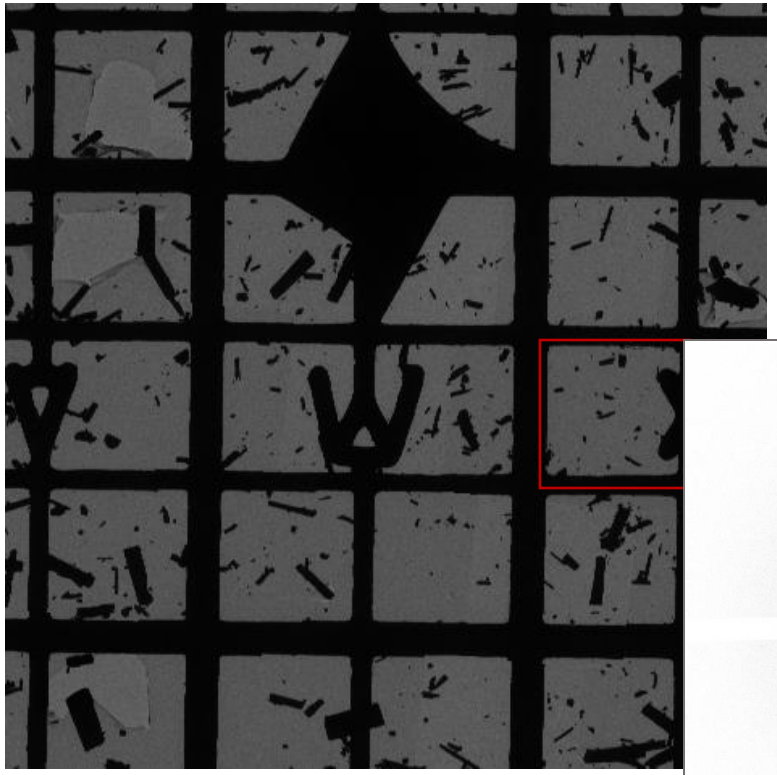
Dilemma of Target Selection

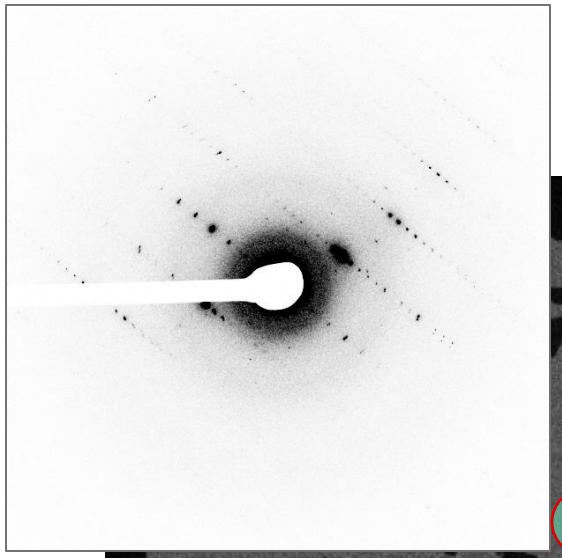


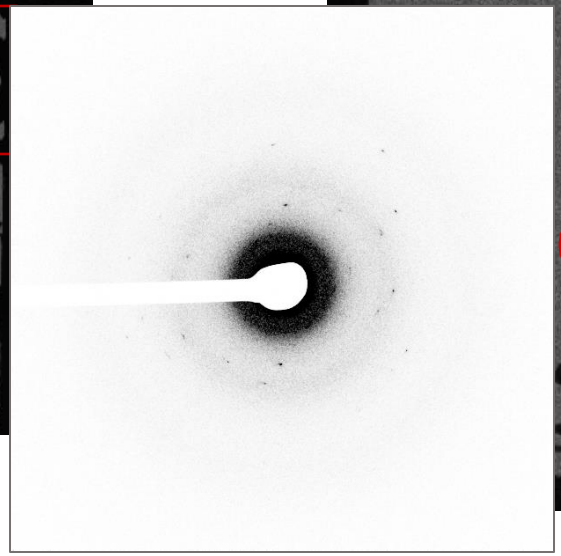
3 mm

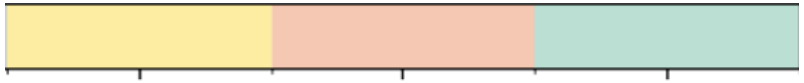
Image



450 µm







Poor Bad Good

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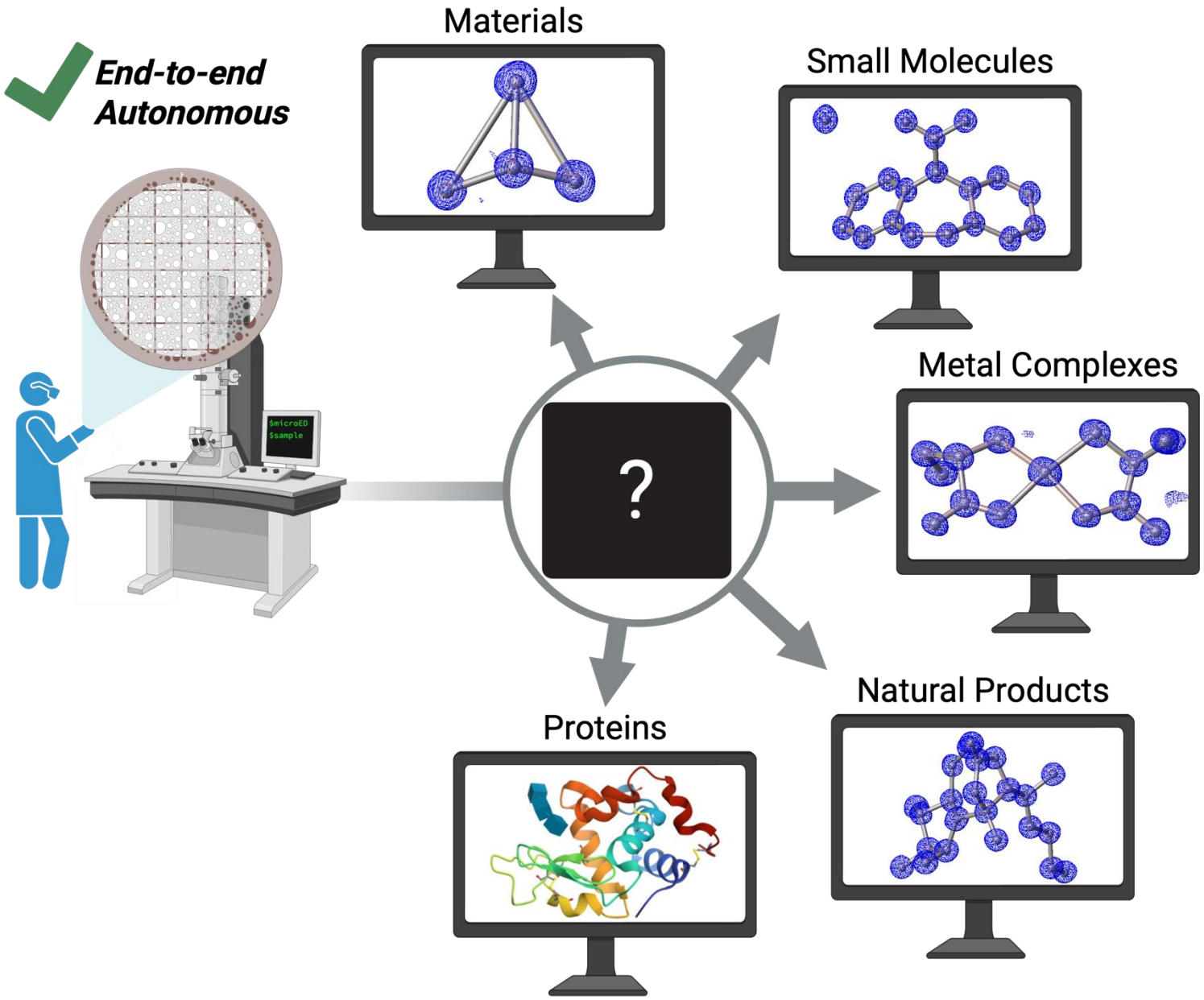
Intelligent Automated Data Collection: Future of MicroED



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Intelligent Automated Data Collection

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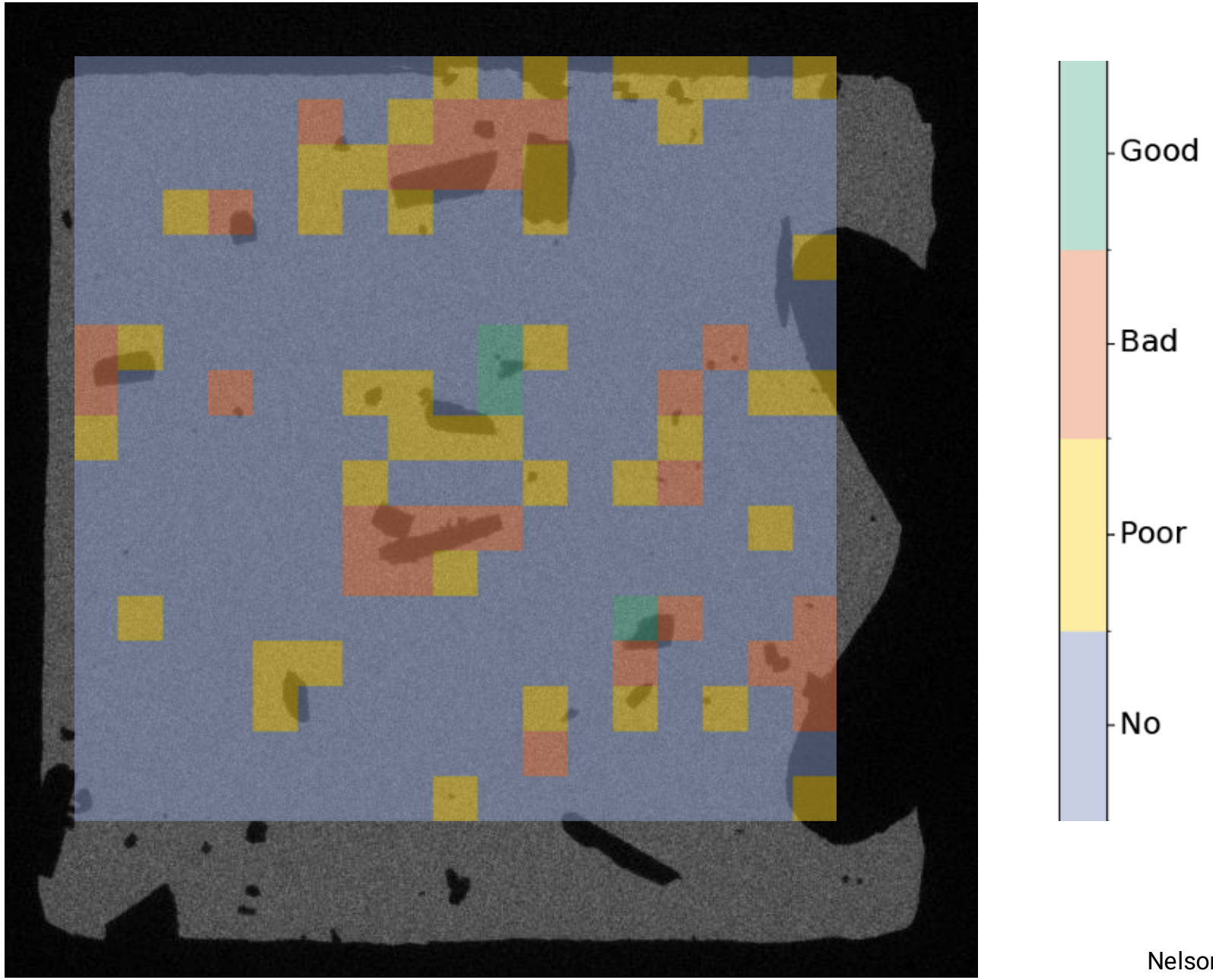
Diffraction over Imaging

What we want:



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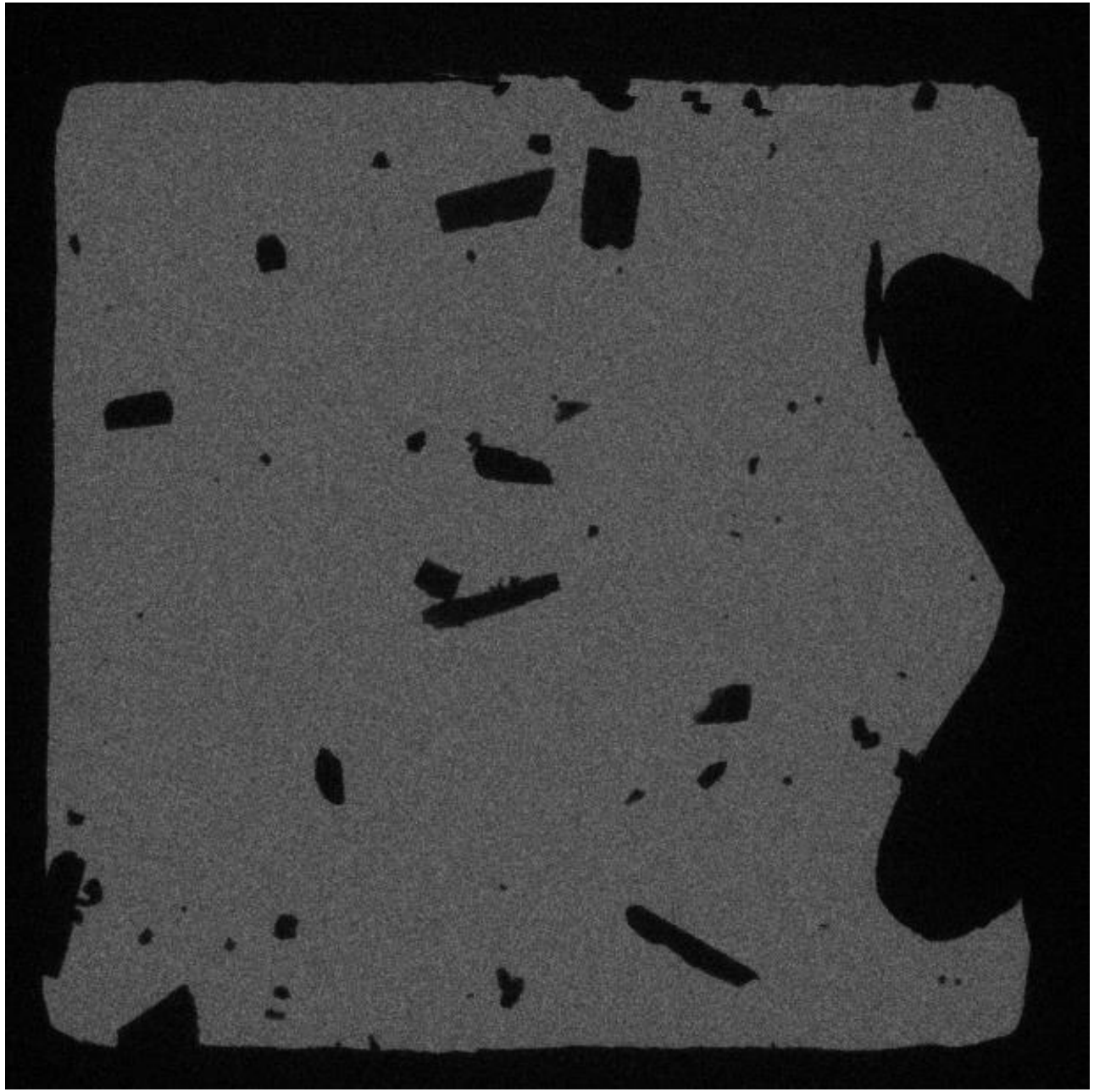
Diffraction over Imaging

Where to start?



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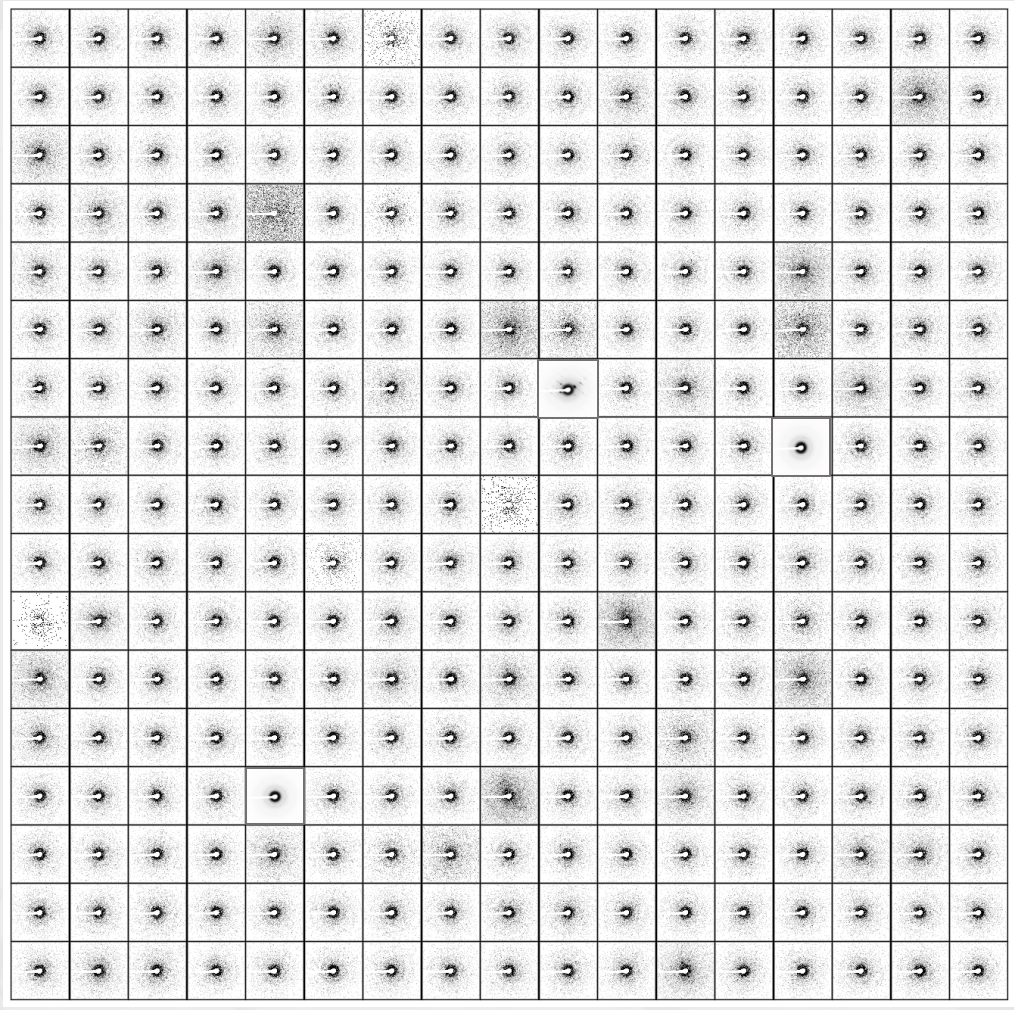
Diffraction over Imaging

Map in reciprocal space!



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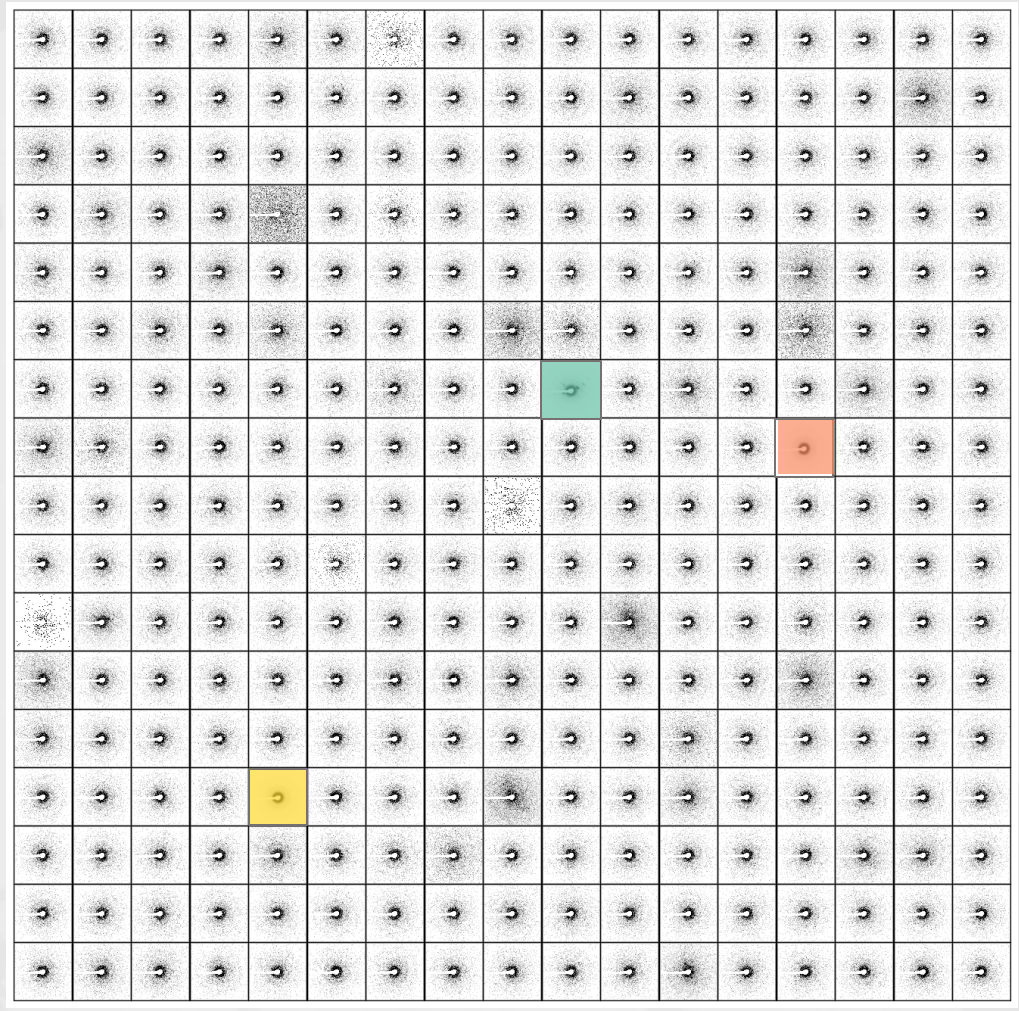
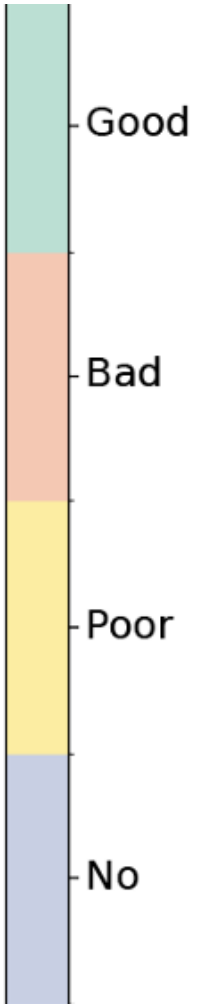
Diffraction over Imaging

Map in reciprocal space!





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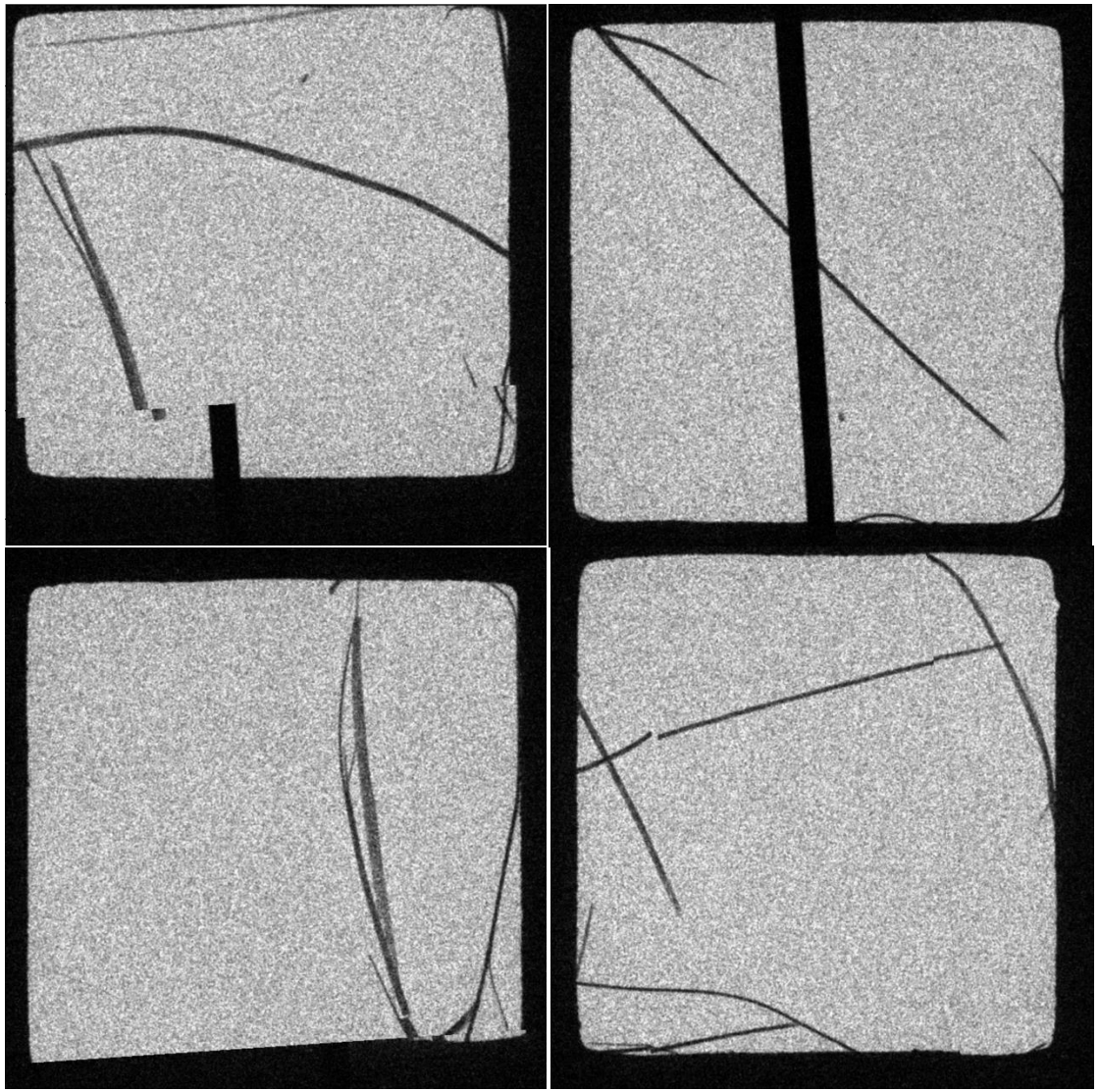
Reciprocal Eyes = REyes

Can we see crystals?



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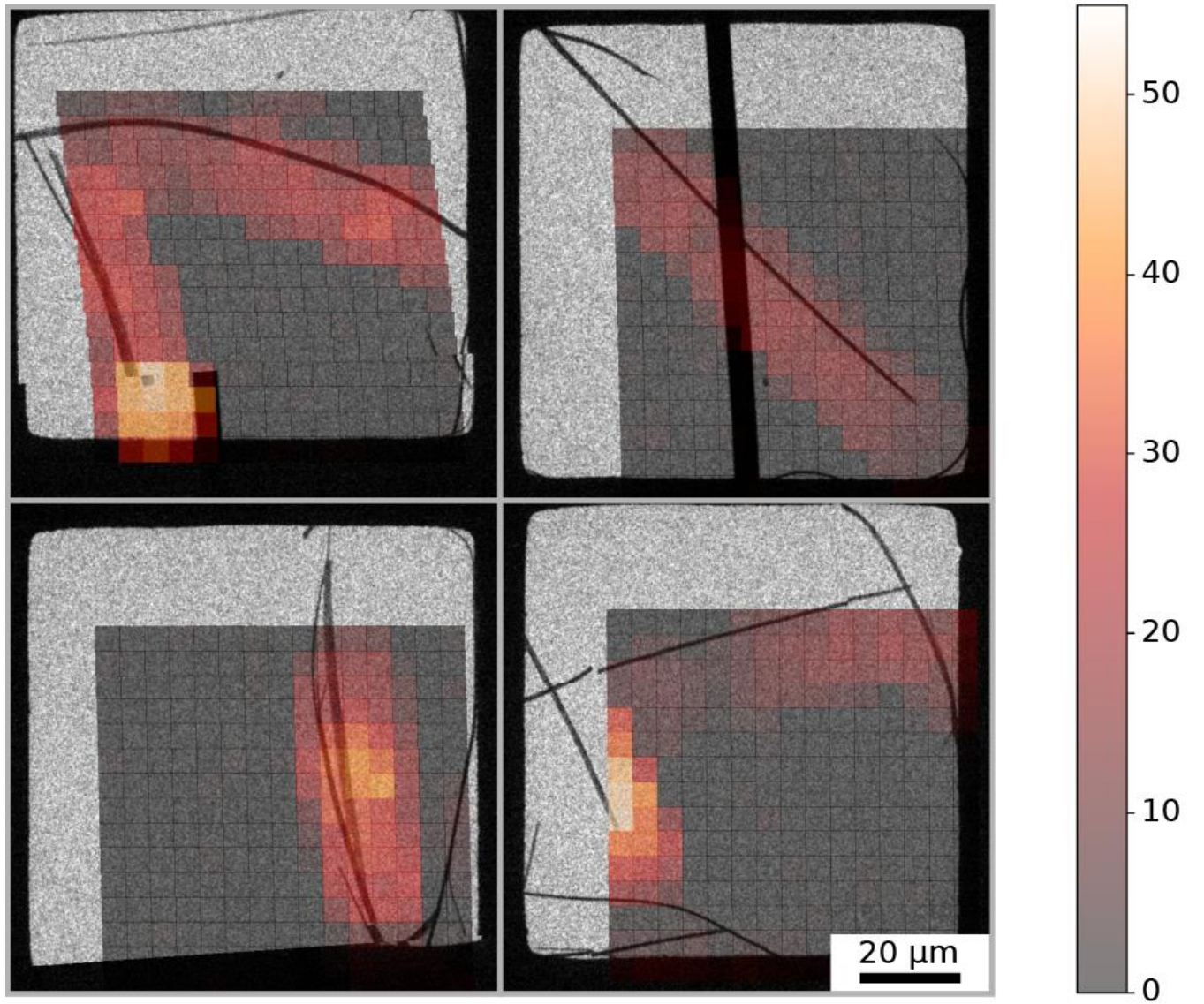
Reciprocal Eyes = REyes

Yes, we can!



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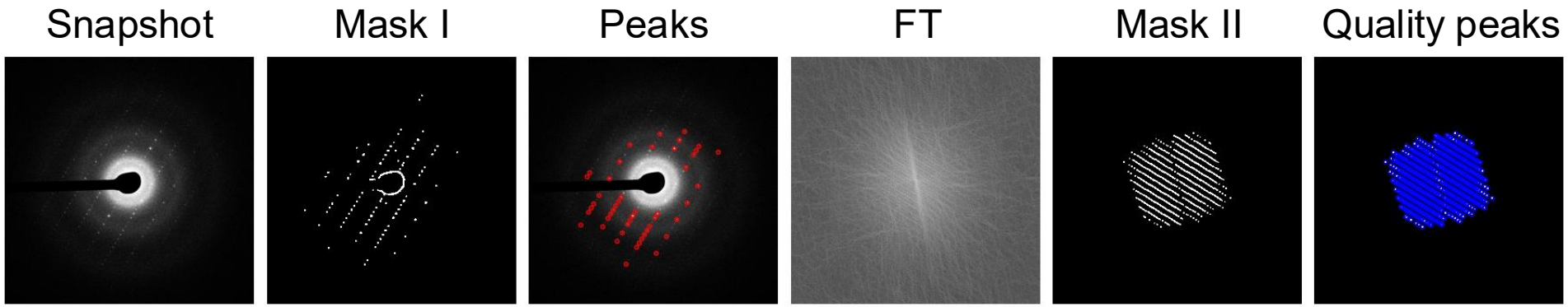
Diffraction Quality Index



DQI = LQP/DP

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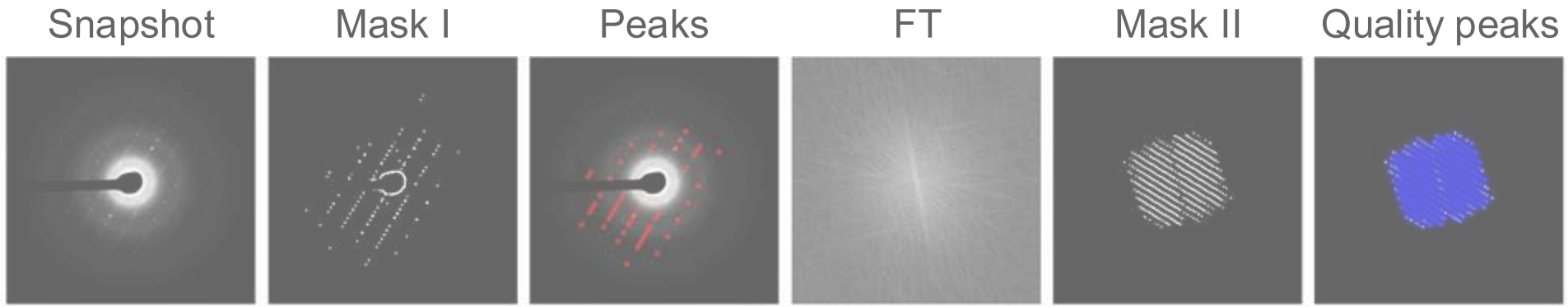
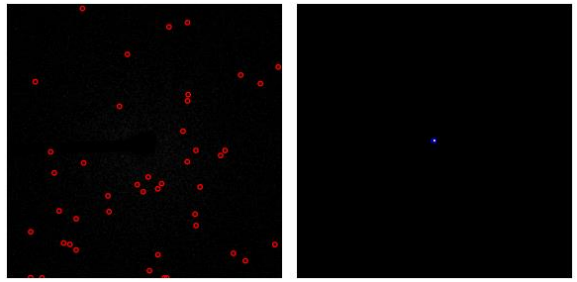
From a Snapshot to Diffraction Quality

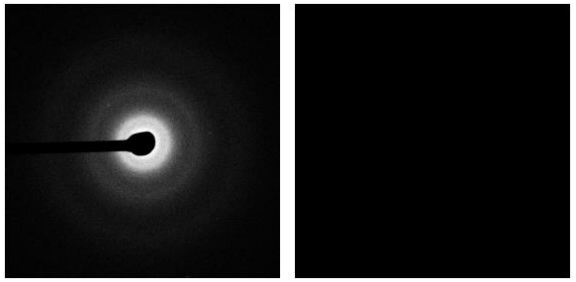


DQI = LQP/DP

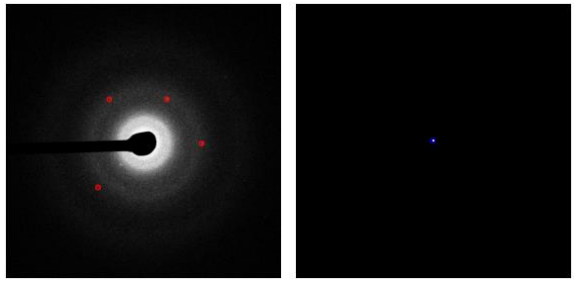
No scattering



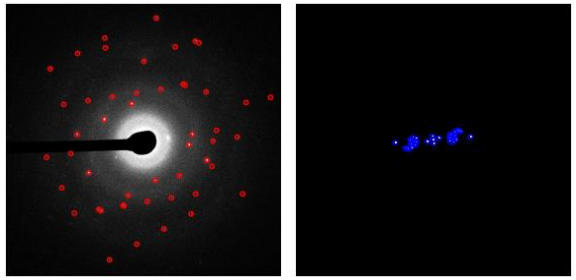
No diffraction (DP < 3)



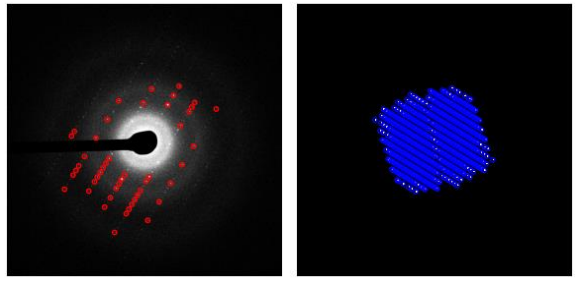
Poor diffraction (DP < 10)



Bad diffraction (DQI < 3)



Good diffraction (DQI > 3)



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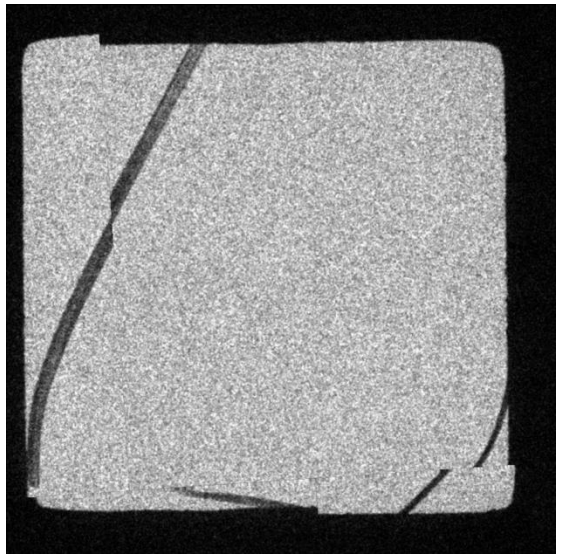
Intelligent Automated Data Collection



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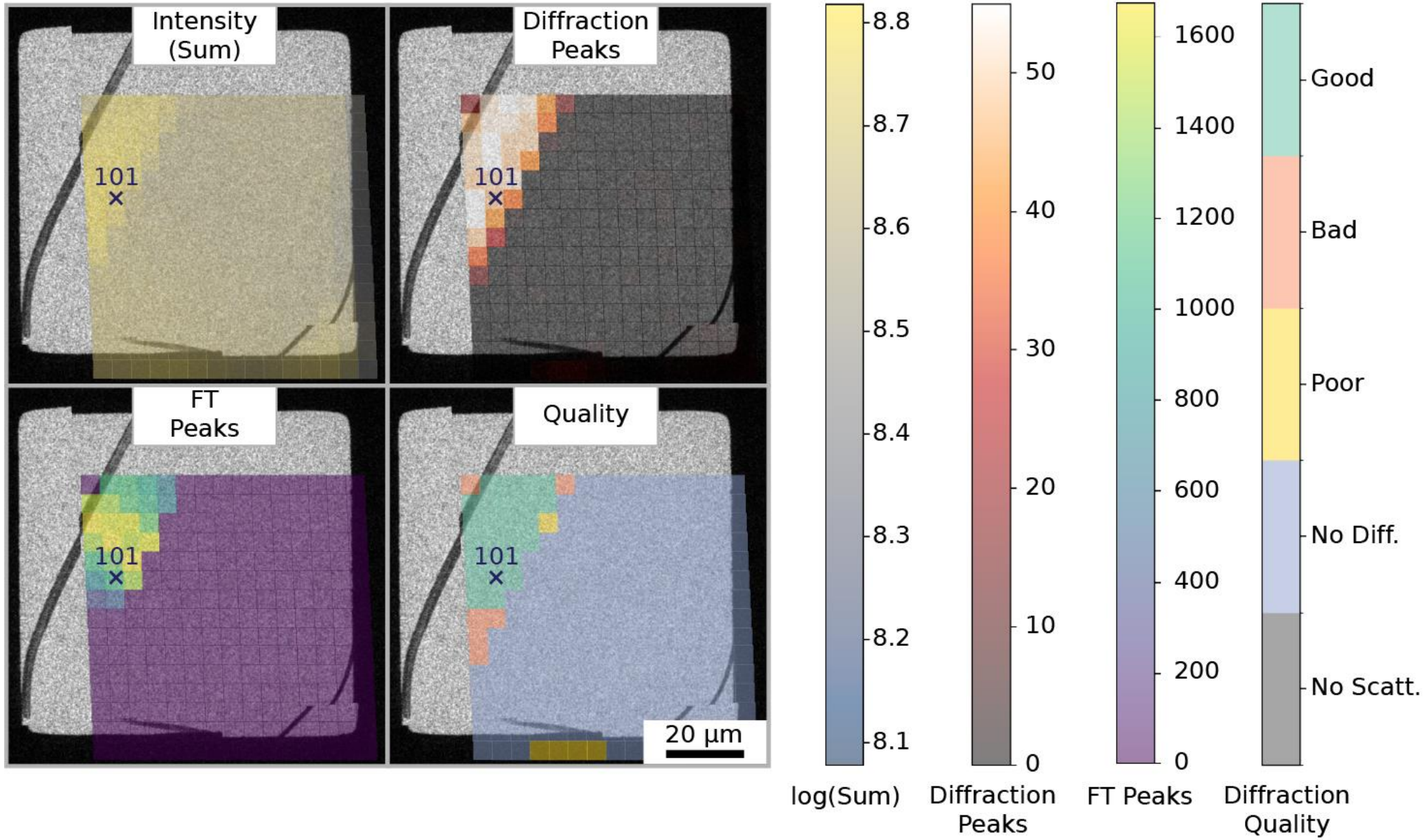
Intelligent Automated Data Collection



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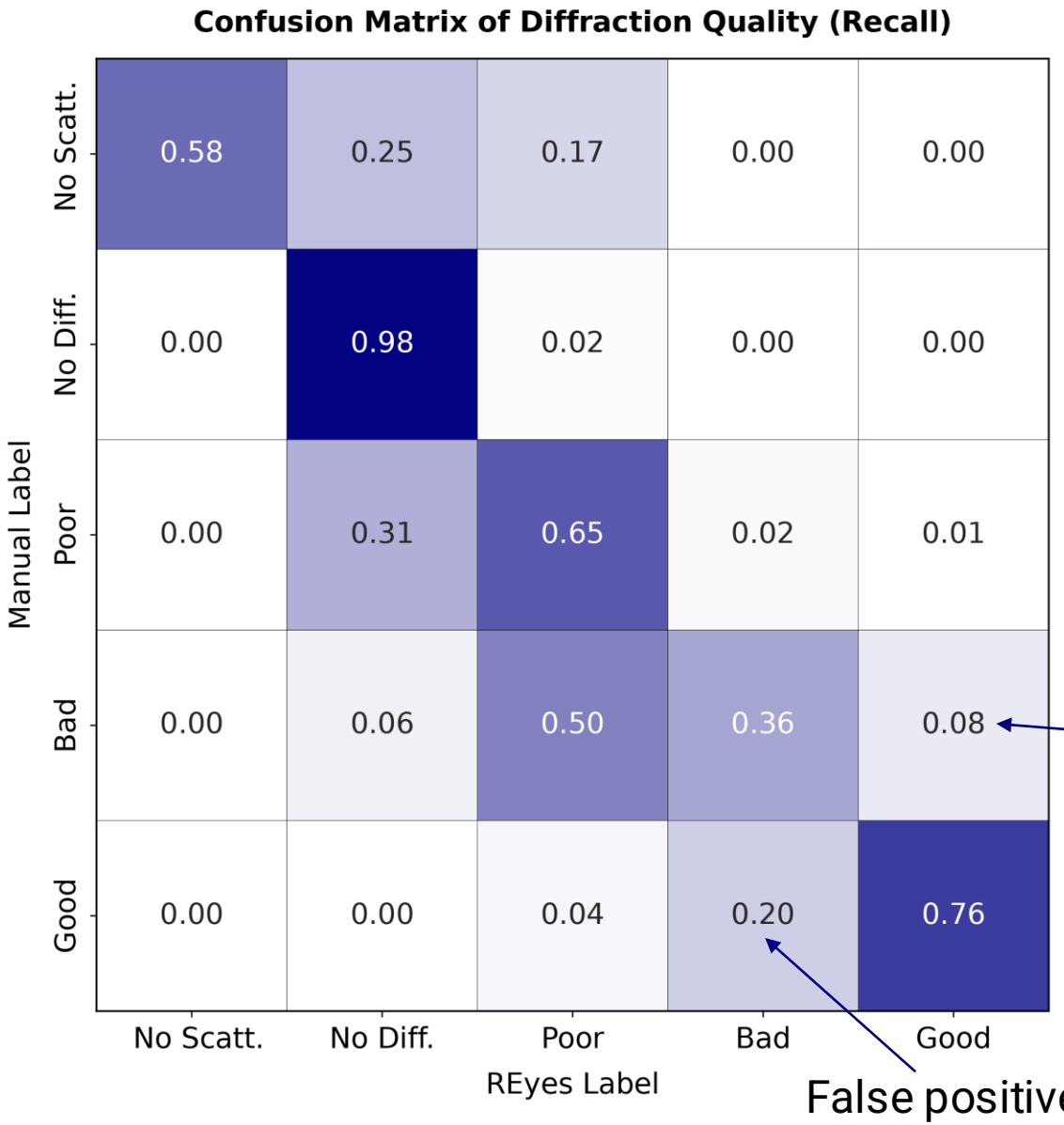
Natural Intelligence

Dataset: 2541 images



False negative

False positive

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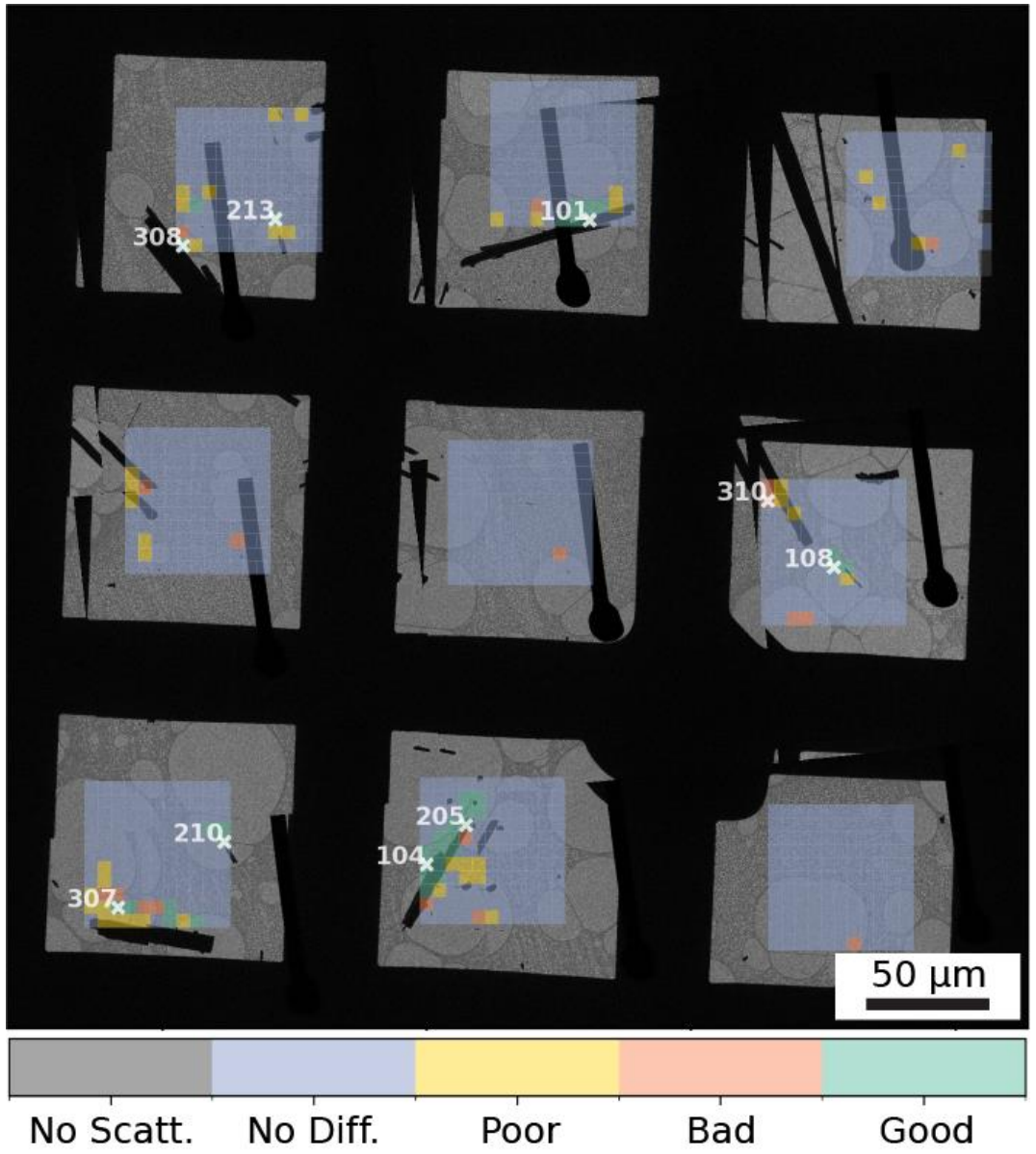
Sample-To-Solution



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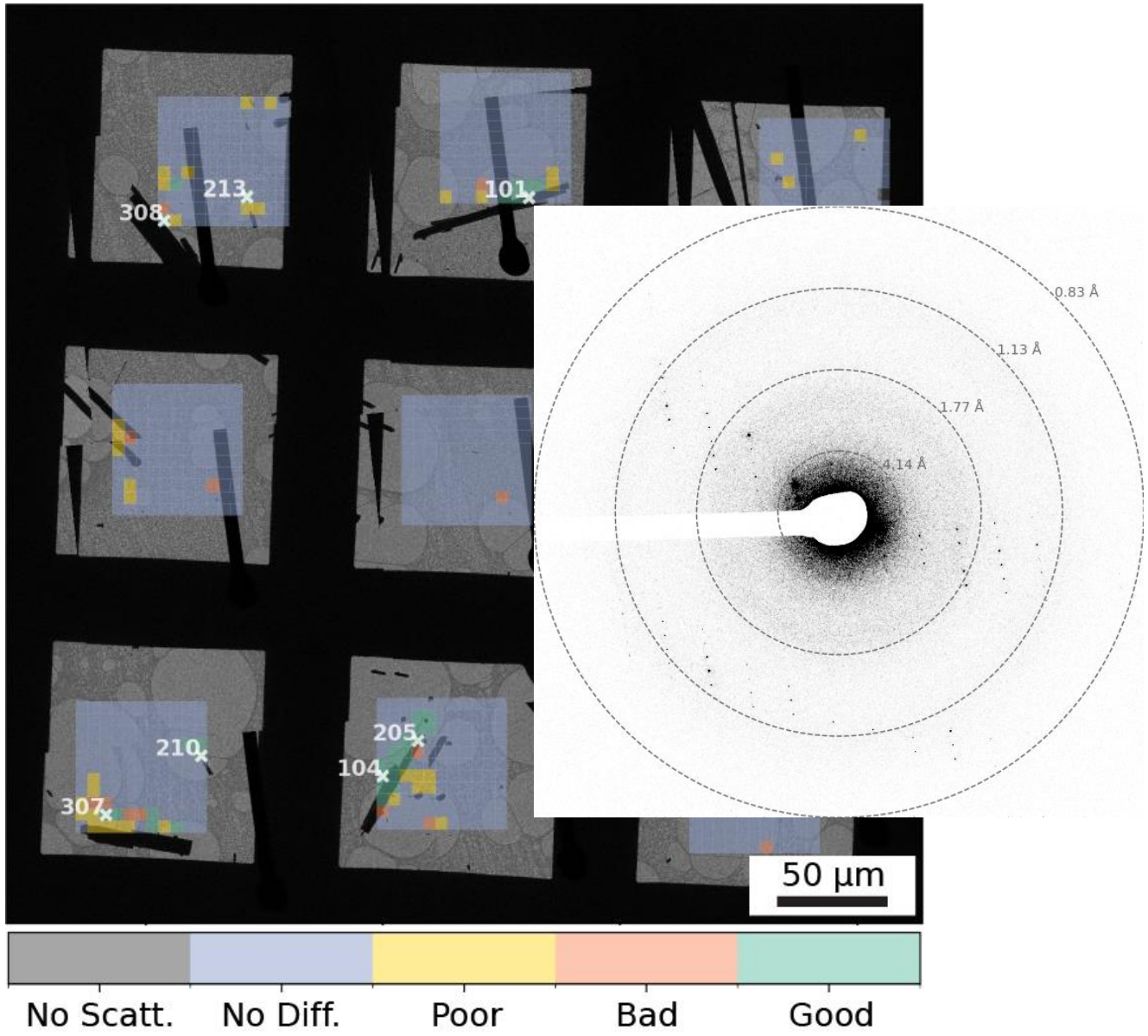
Sample-To-Solution



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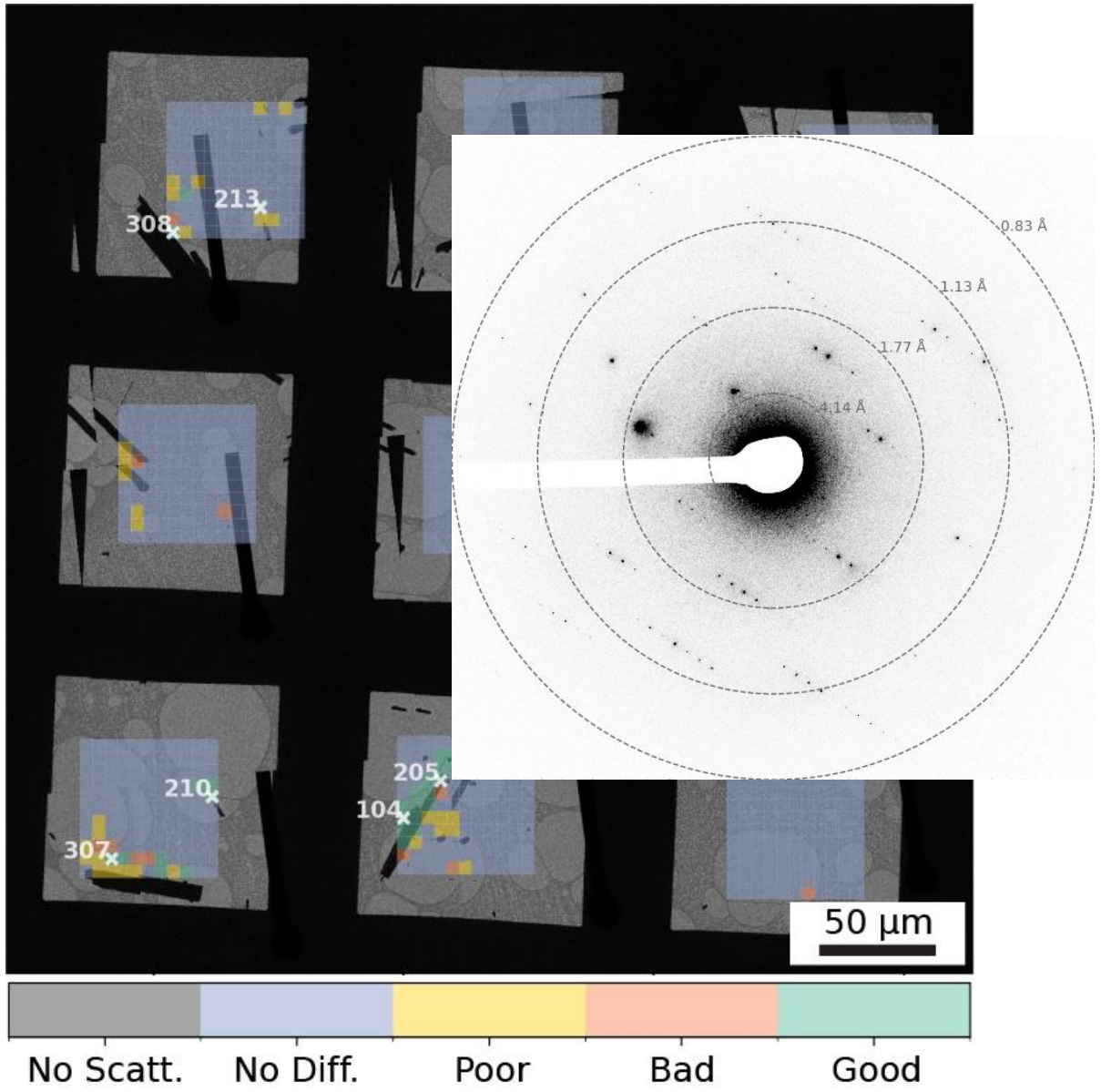
Sample-To-Solution



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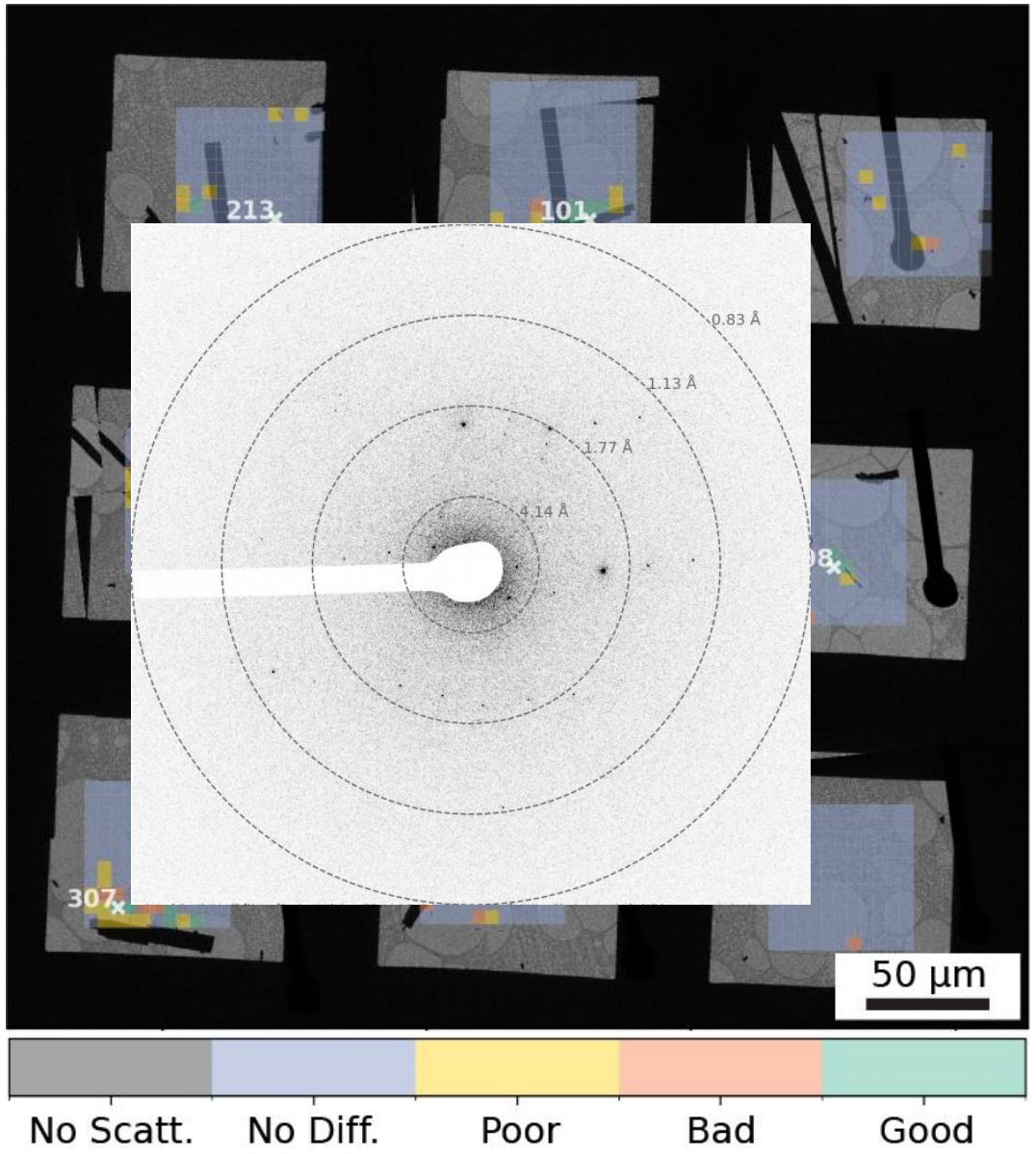
Sample-To-Solution



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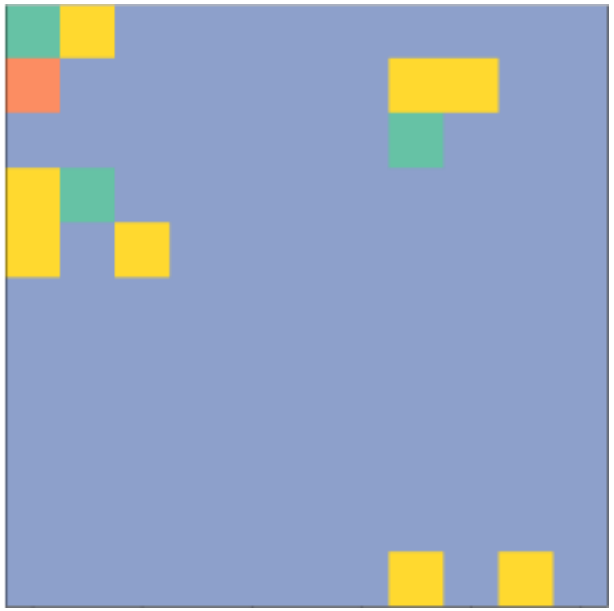
Sample-To-Solution

Quality Map



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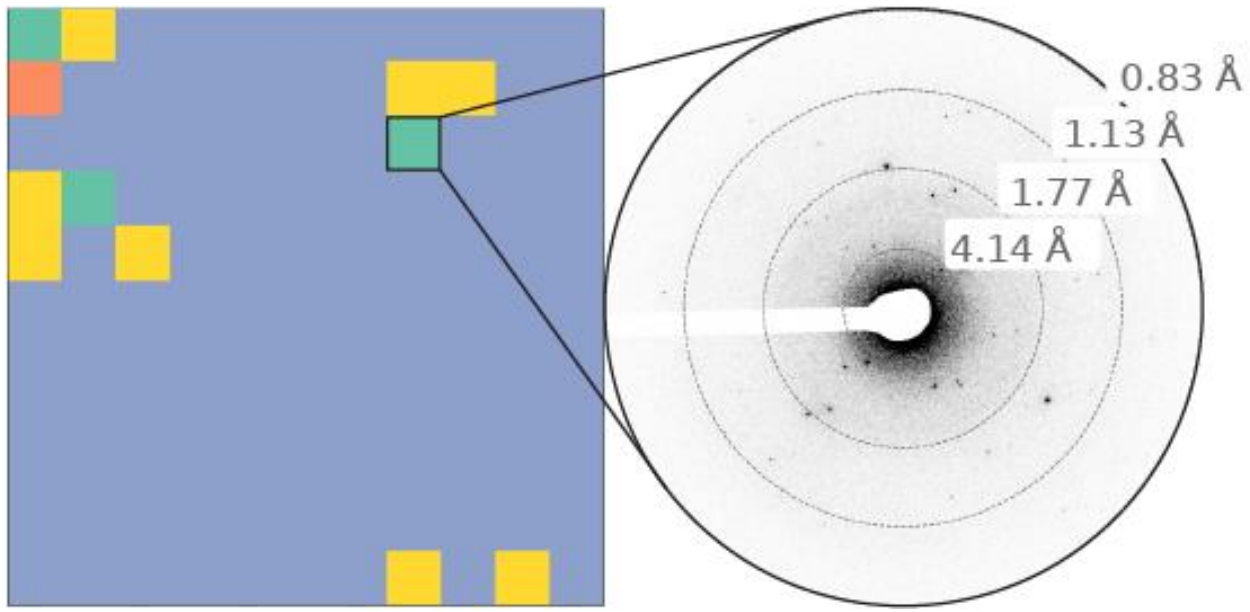
Sample-To-Solution

Quality Map

Diffraction Snapshot



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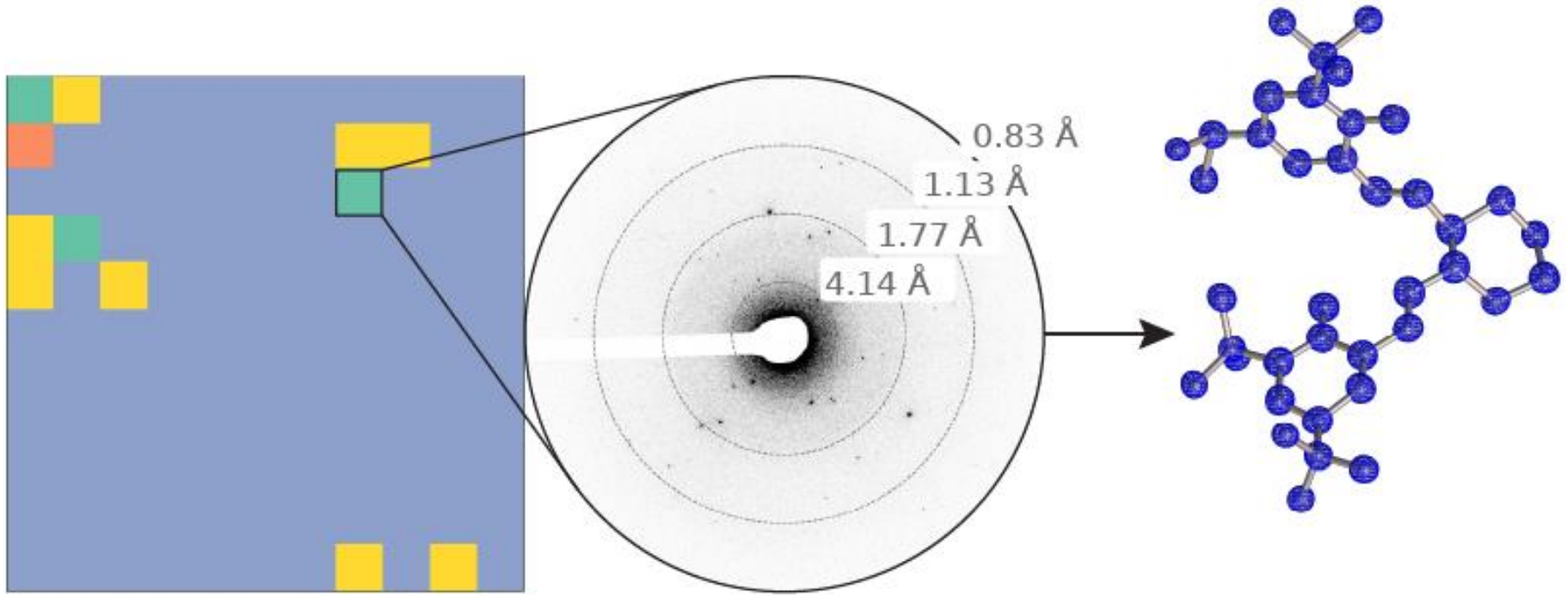
Sample-To-Solution

Quality Map

Diffraction Snapshot

Phasing Solution



I/σ 5.4
Rint 16.67%

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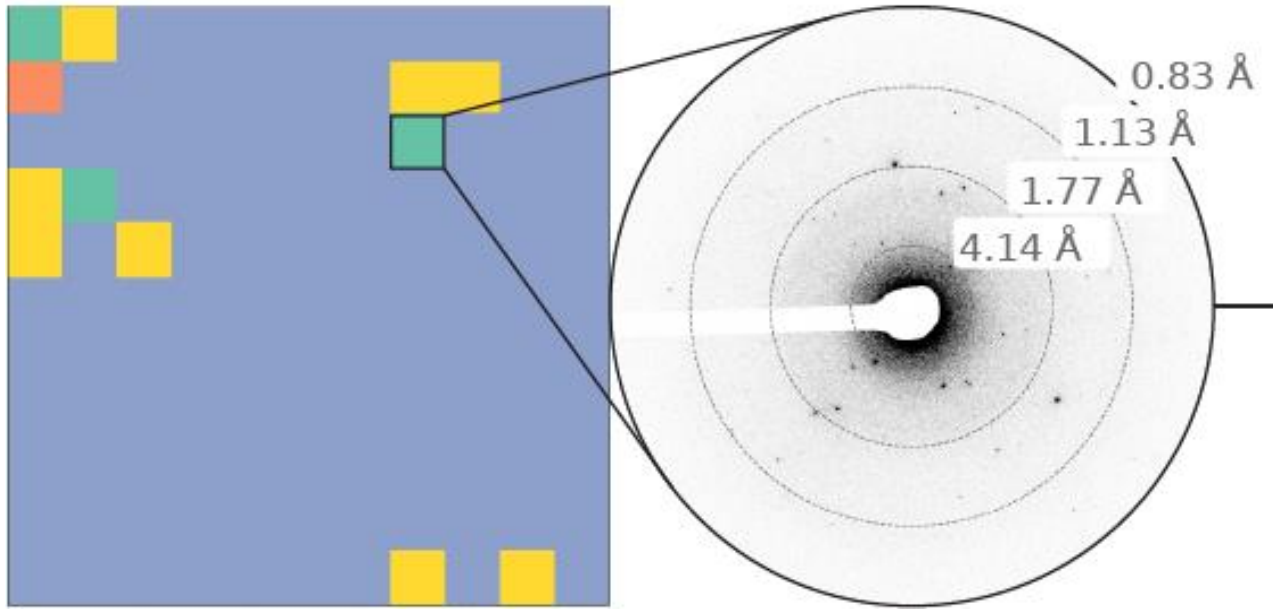
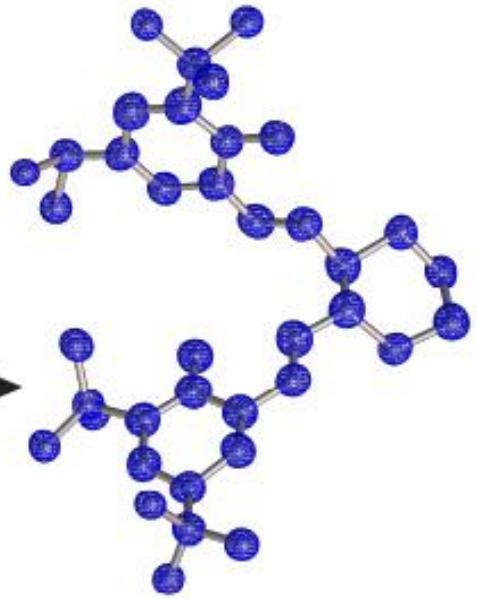
Sample-To-Solution

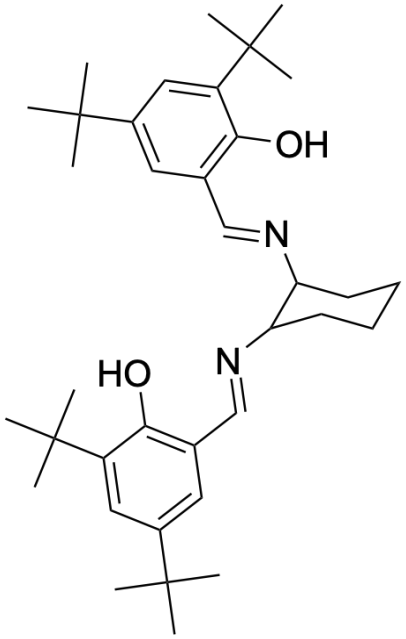
Quality Map

Diffraction Snapshot

Phasing Solution







I/σ 5.4
Rint 16.67%

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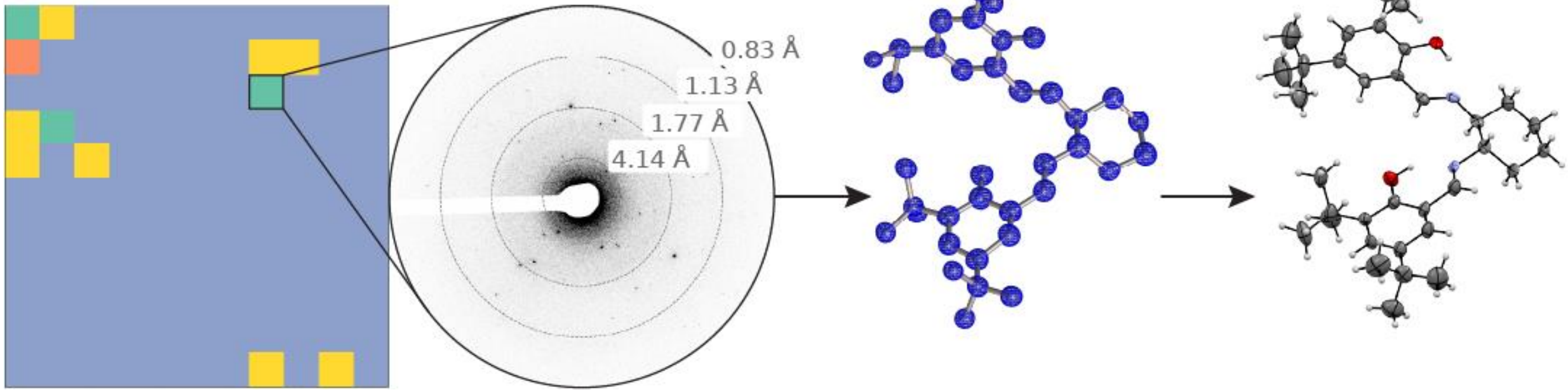
Sample-To-Solution

Quality Map

Diffraction Snapshot

Phasing Solution

Refined Structure



I/σ 5.4
Rint 16.67%

R1 13.36%
wR2 38.71%

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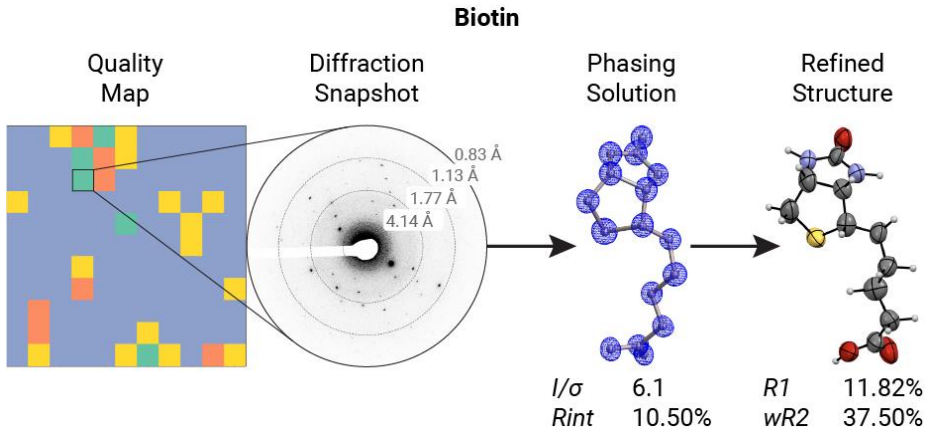
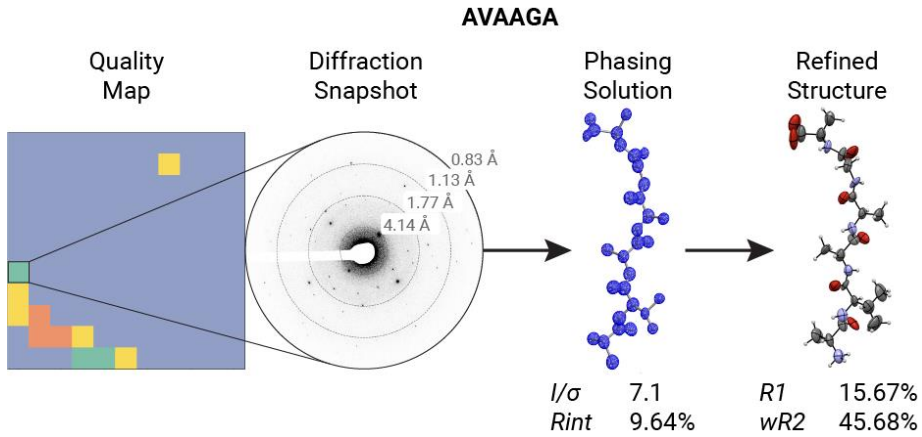
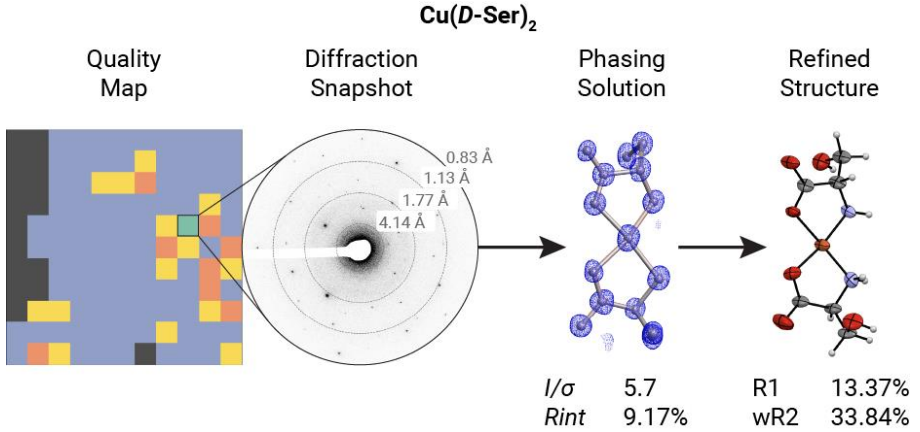
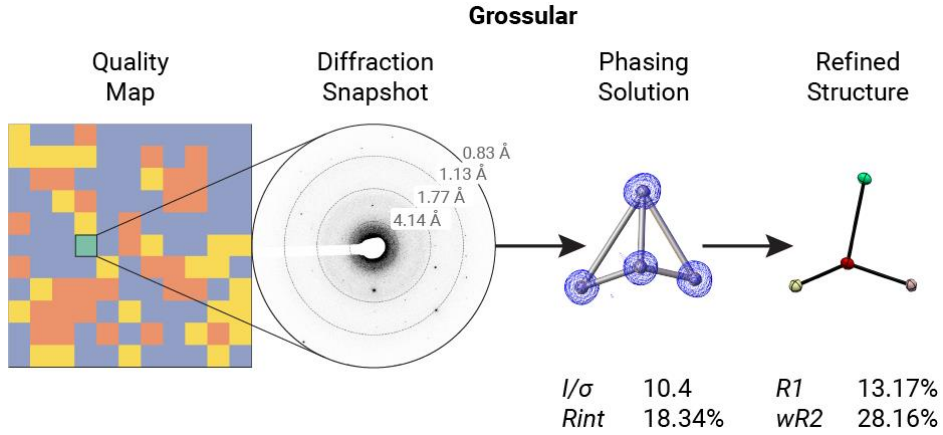
Translation is Key









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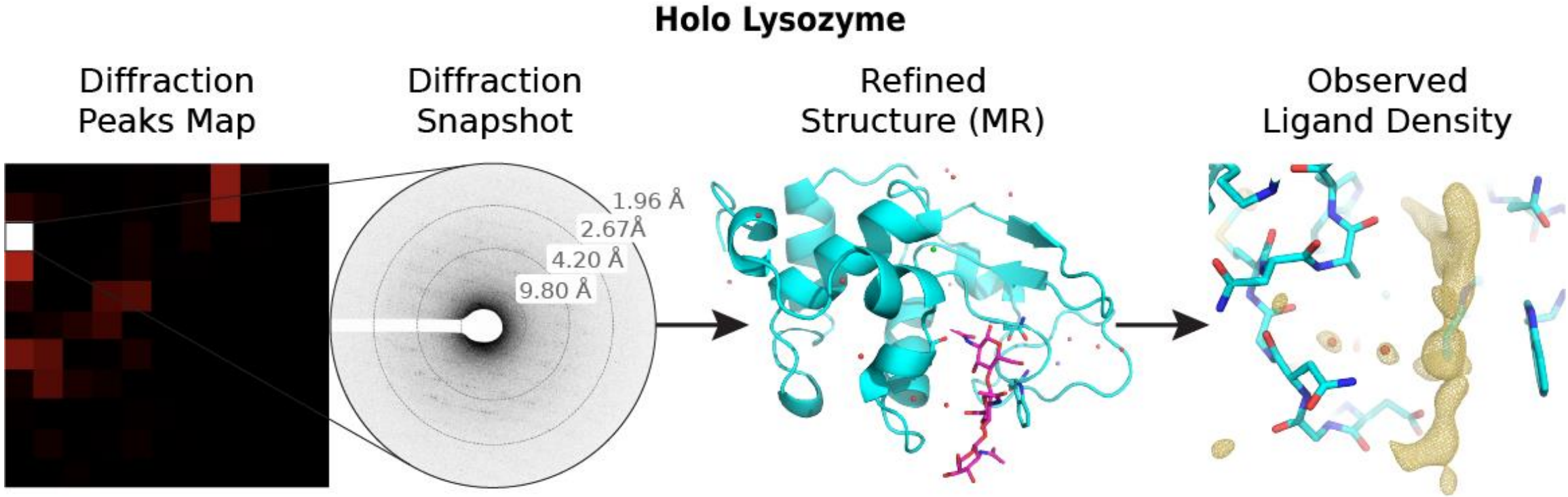
Translation is Key



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Something More Real

E. Terschekii in Riverside country

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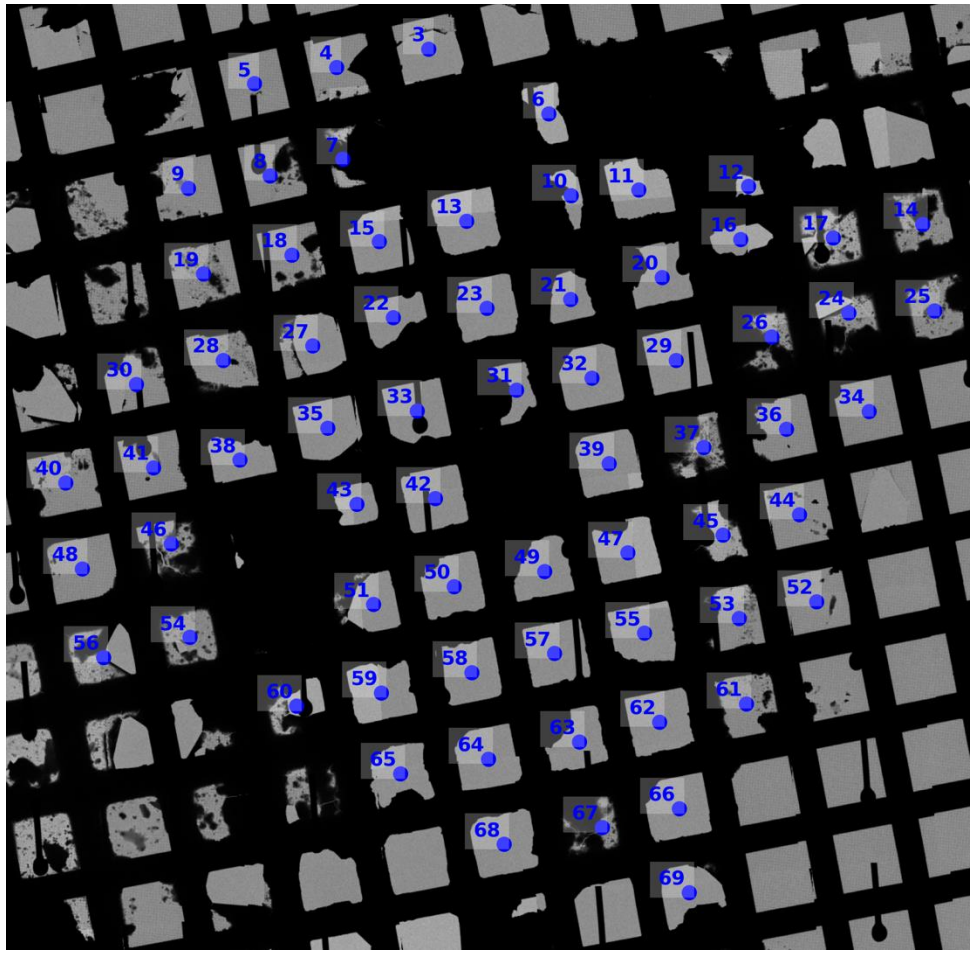
Something More Real

E. Terschekii in Riverside country



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Something More Real

E. Terschekii in Riverside country

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NelsonLab$ REyes --microscope
Arctica-Apollo
```

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Arctica-Apollo
2025-04-29 14:07:34 -
Initializing REyes
...
2025-04-30 11:02:40 -
Successfully completed
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Session statistics:

Elapsed time: 20 h 55 min 6 s
Used disk space: 340.03 GB
Grid squares screened: 68
Movies acquired: 60
Processed successfully: 55
Preliminary solutions: 22
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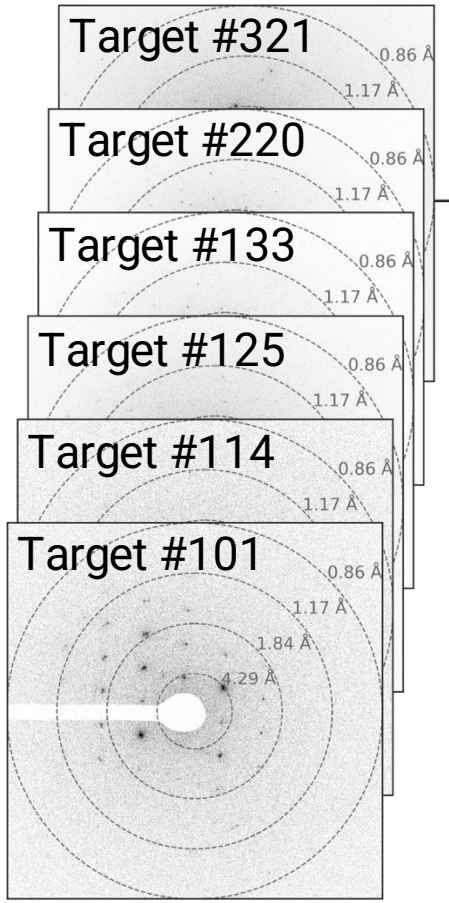

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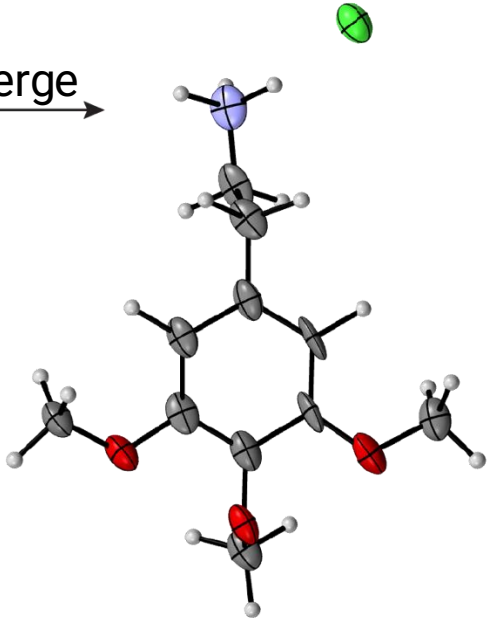

Mescaline hydrochloride

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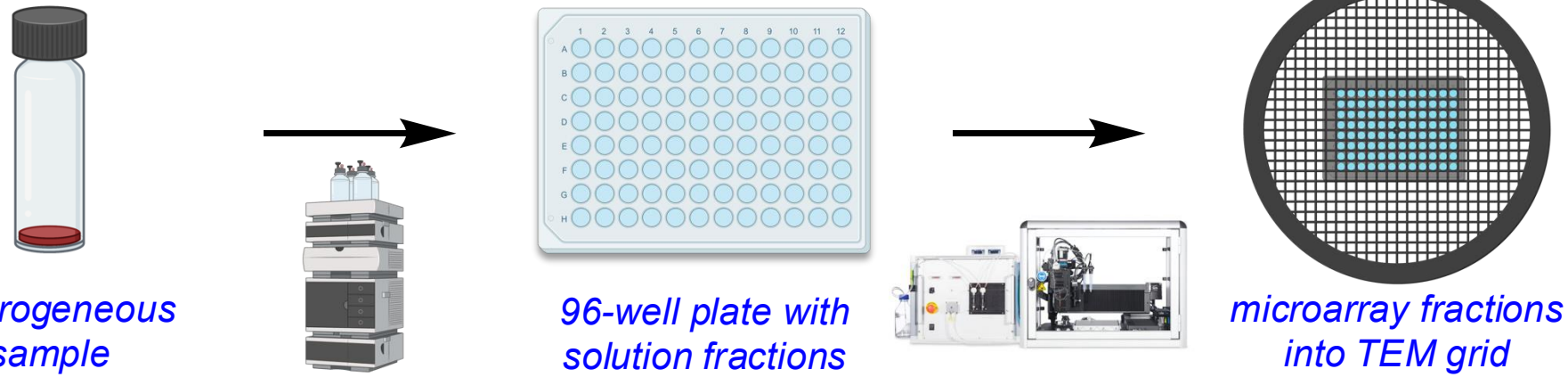
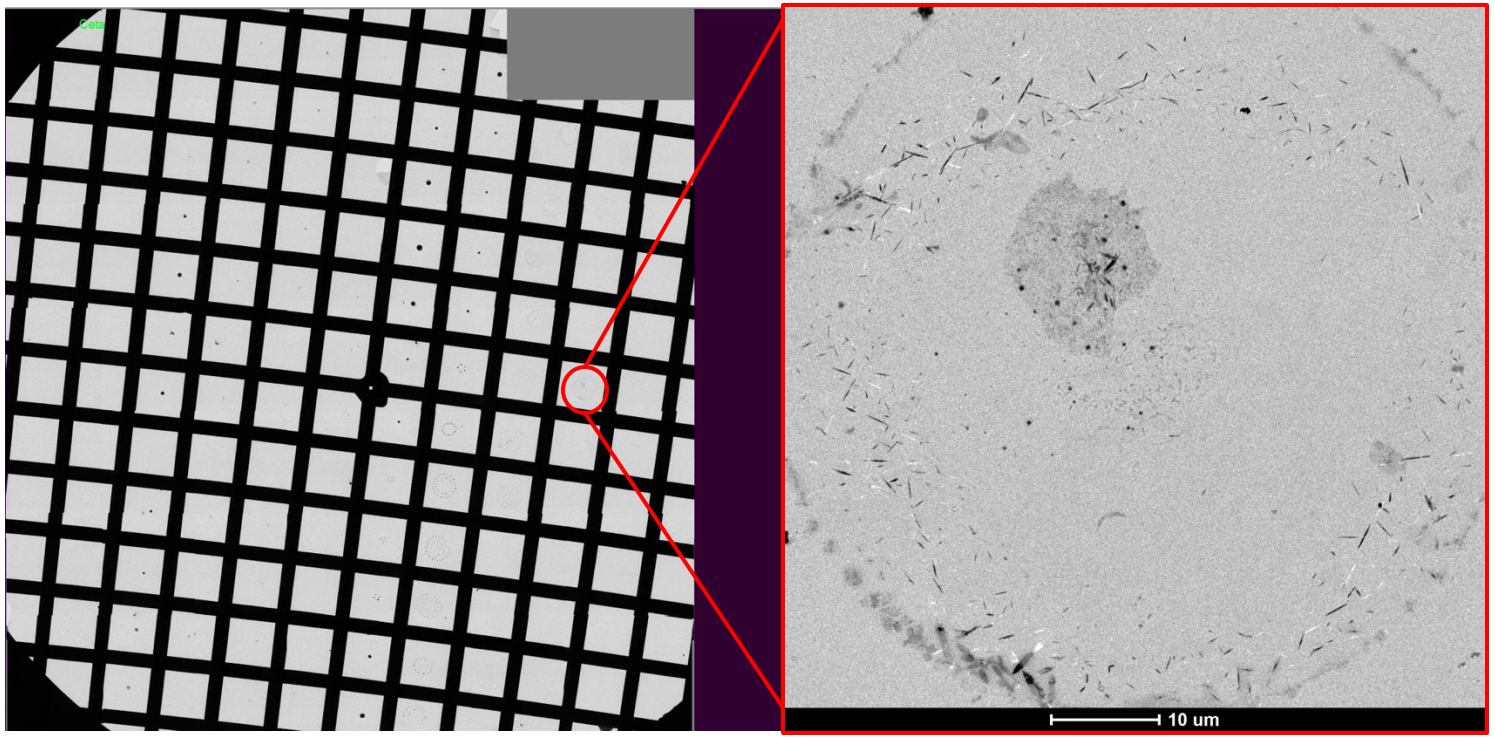
Merging ArrayED with REyes





Delgadillo, D.A. et al. **2023**, *ACS Cent. Sci.*, DOI: 10.1021/acscentsci.3c01365
Eremin, D.B. et al. **2025**, *JACS*, DOI: 10.1021/jacs.5c10751; Patent app. CIT-9295-P2 on 5/8/2025

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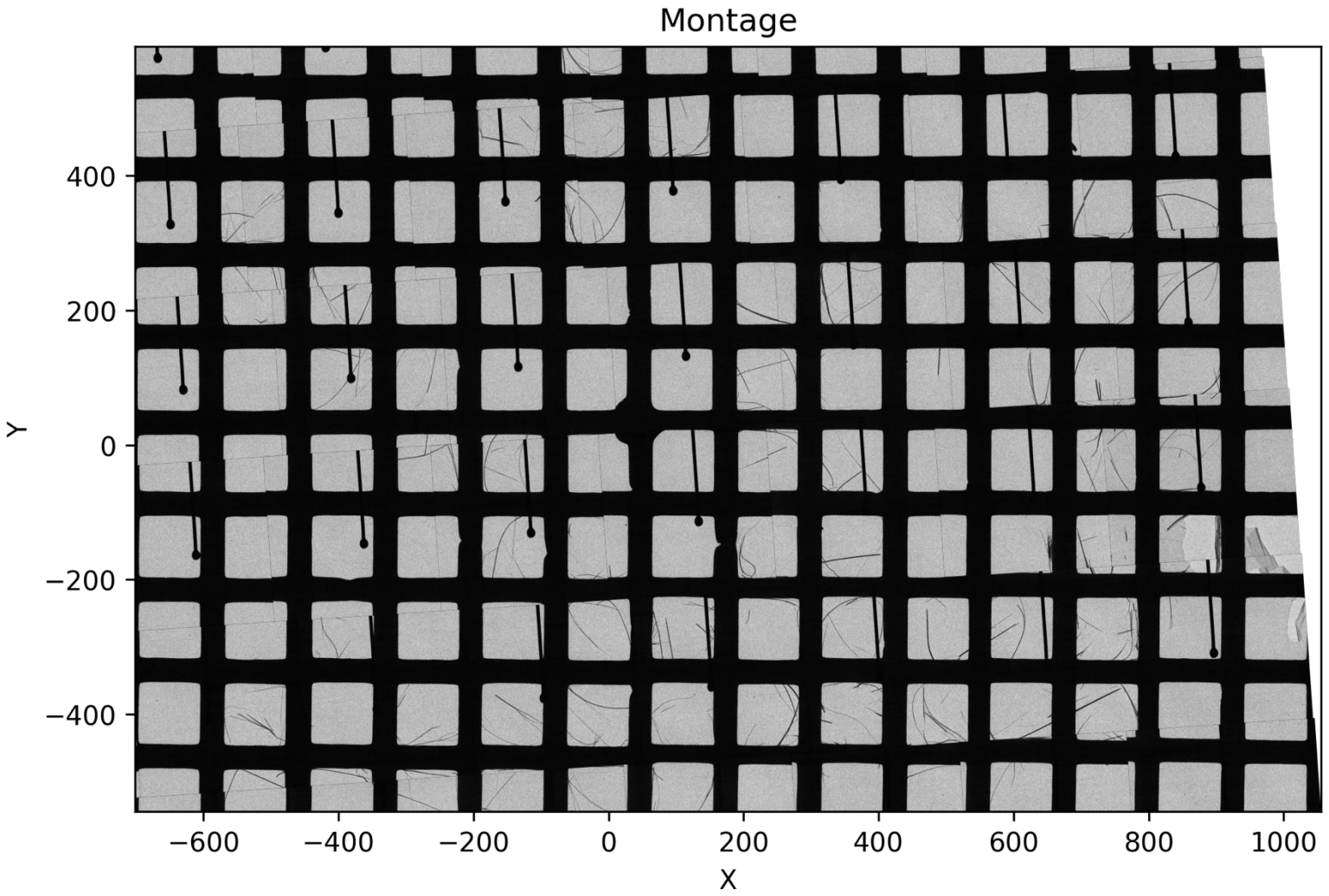

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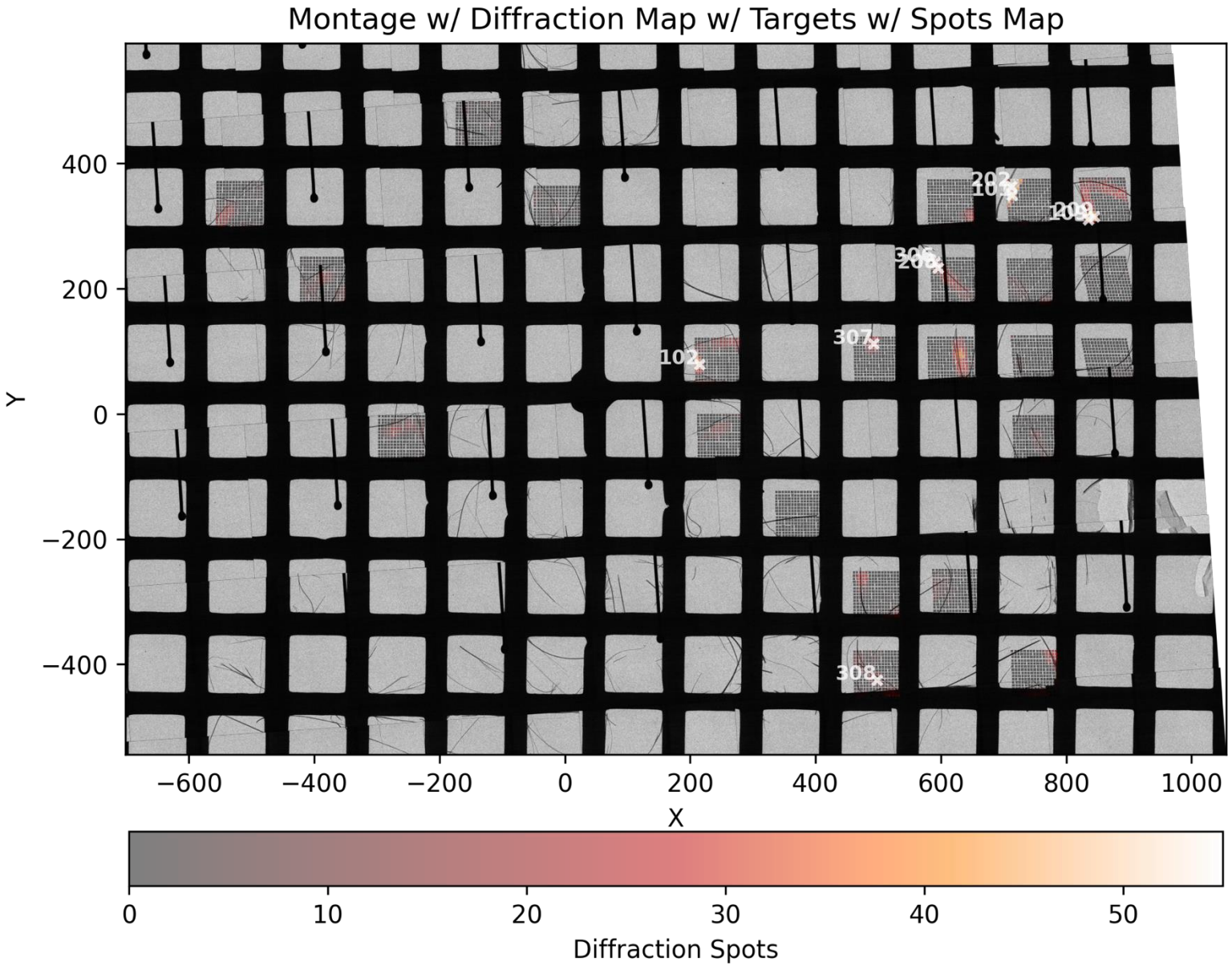

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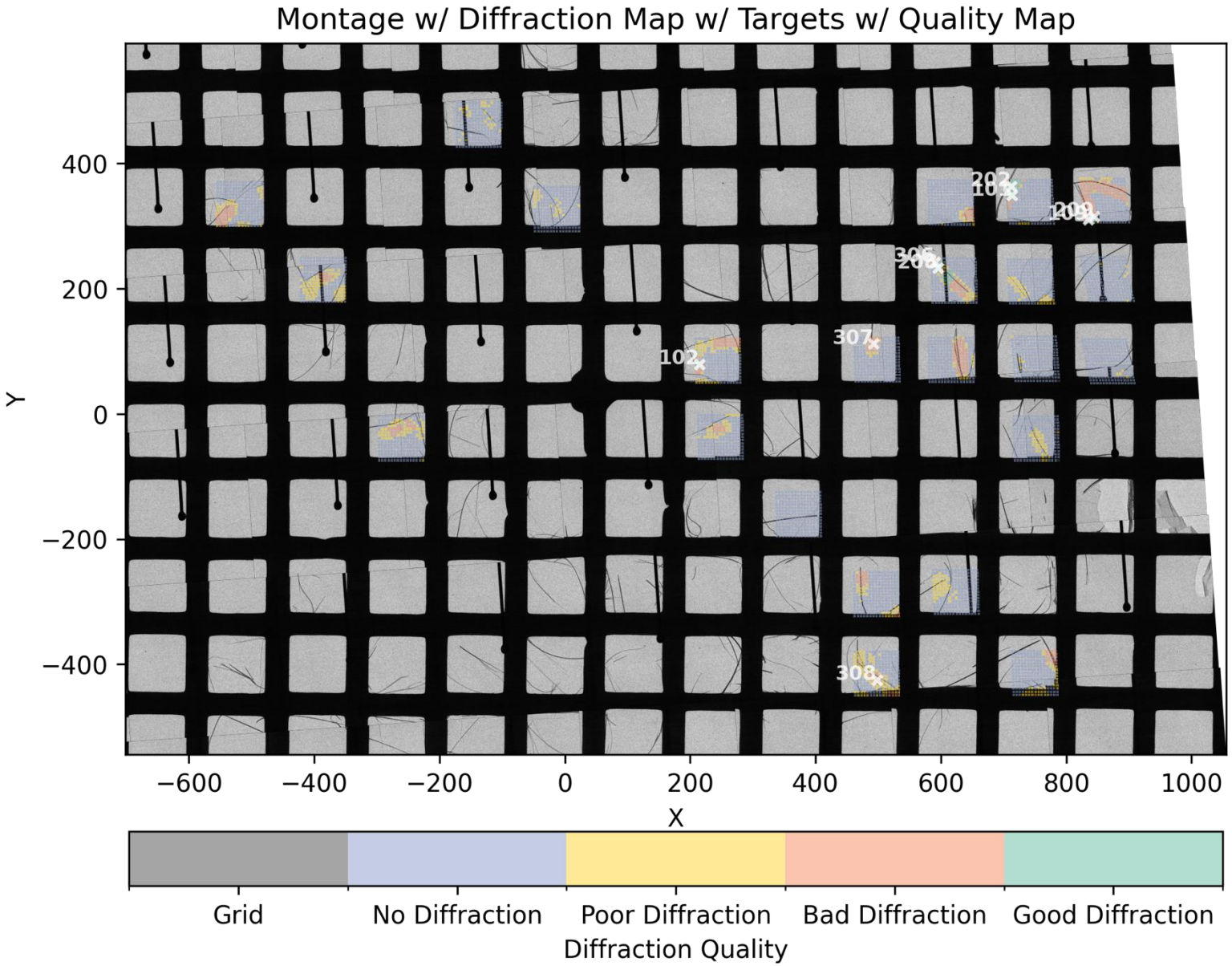

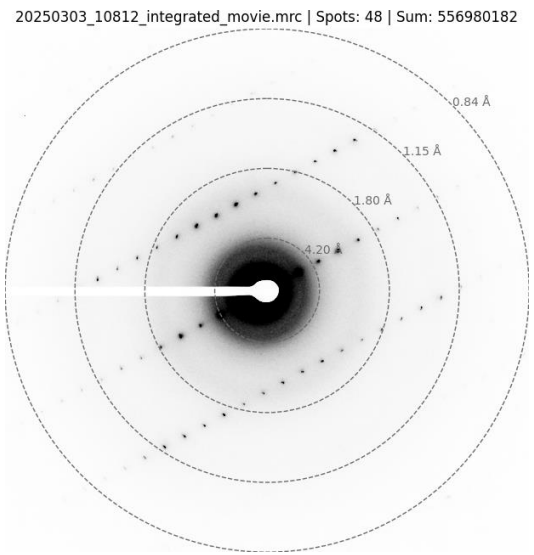

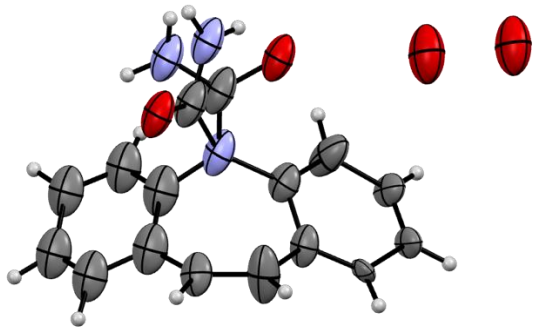

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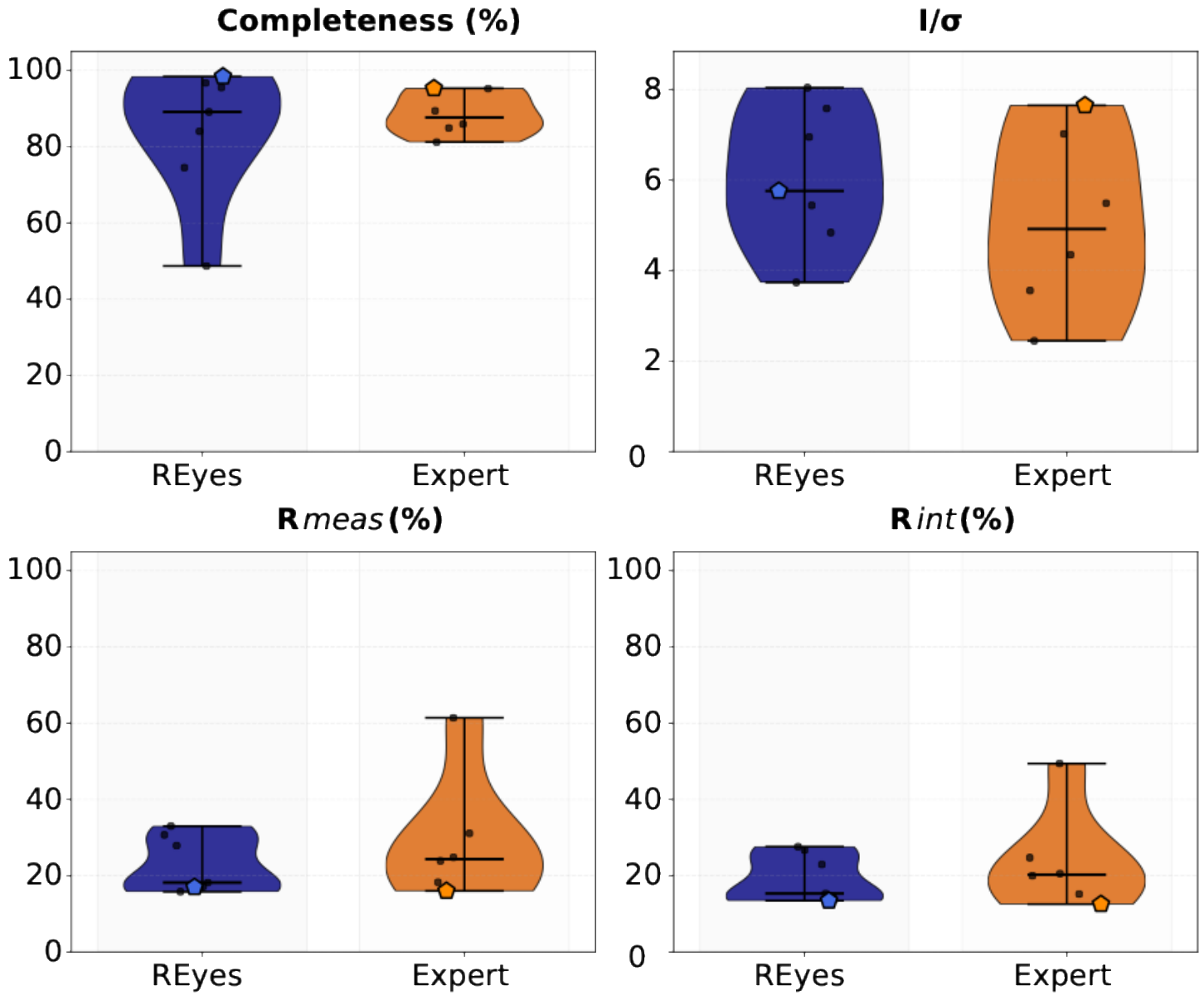
How intelligent is it now?



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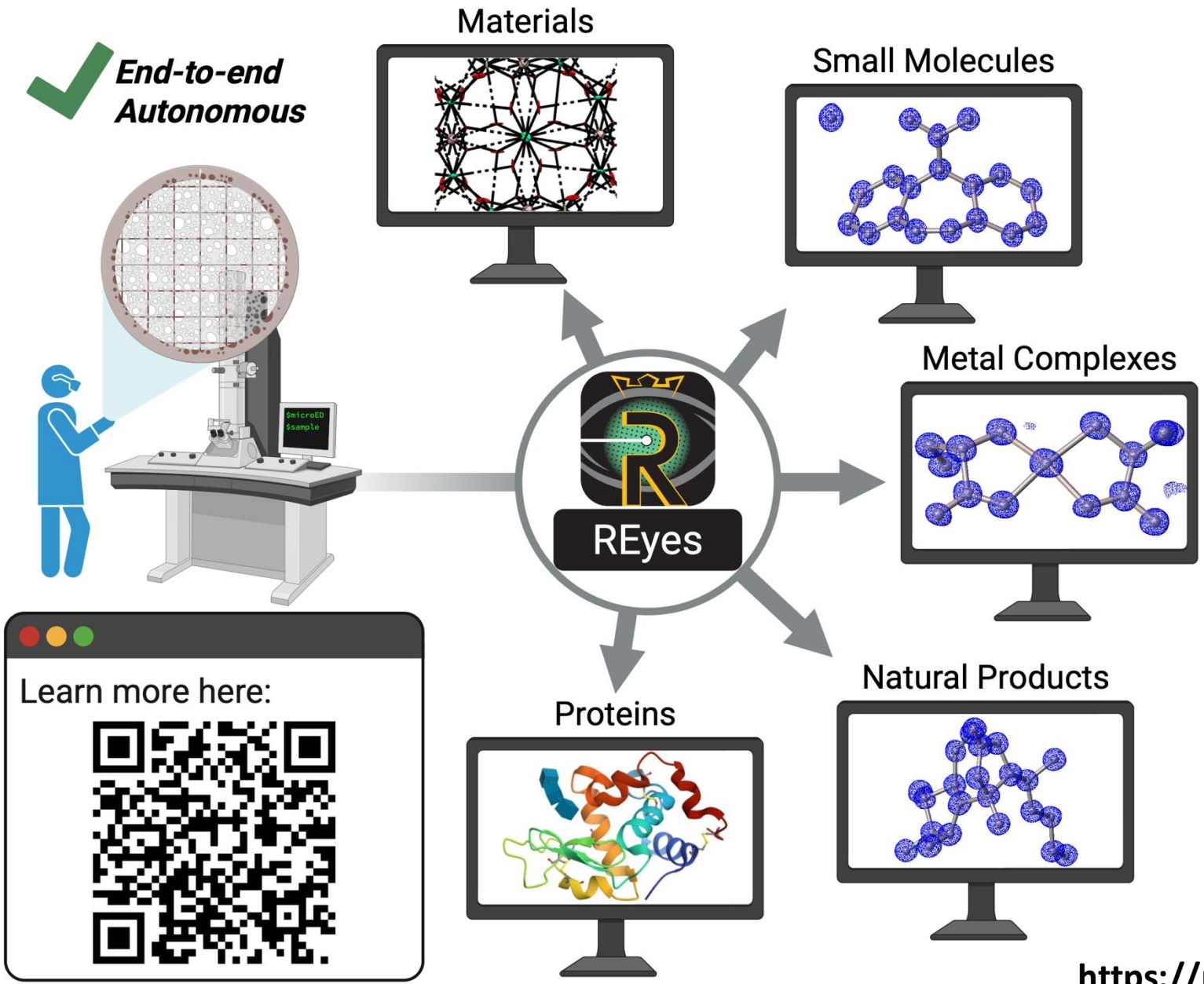
Take-Home Message



https://pypi.org/project/pyREyes

Acknowledgements

It Takes a Village:

Prof. Hosea Nelson

Nelson Lab

Prof. Jose Rodríguez (UCLA)

Duilio Cascio (UCLA)

Prof. Vincent Lavallo (UCR)

Unus pro omnibus, omnes pro uno

DBE, HZ, JAR, and HMN have filed a provisional patent, application number CIT-9295-P2 on 5/8/2025. JAR and HMN are equity stake holders in MedStruc Inc.