

# Nuclear Track Etch Detector Evaluation Studies in the Frame of the DOSIS 3D Experiment – 19th WRMIS

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Knowledge for Tomorrow

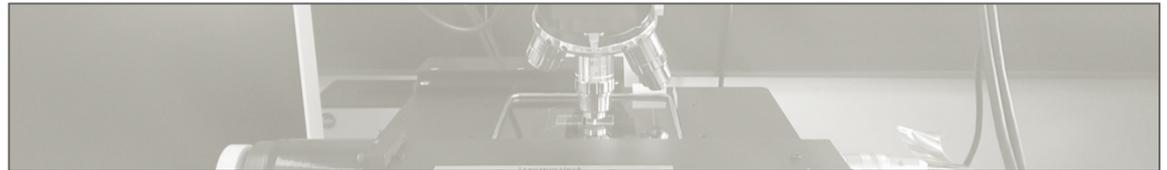


# Overview

- DOSIS 3D



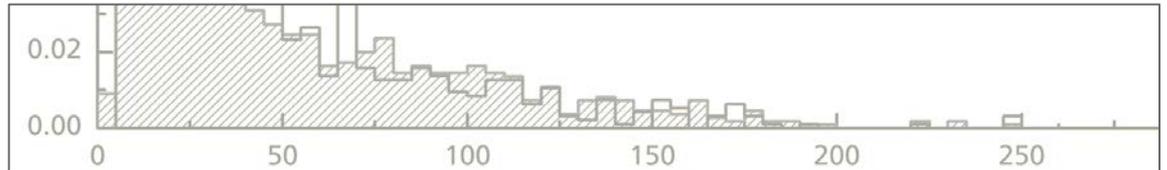
- DLR System



- NIRS System



- System Comparison



- Summary



# DOSIS 3D: Science Team

Berger Thomas<sup>1</sup>, Burmeister Sönke<sup>2</sup>, Bilski Pawel<sup>3</sup>, Horwacik Tomasz<sup>3</sup>, Twardak Anna<sup>3</sup>, Przybyla Bartos<sup>1</sup>, Hajek Michael<sup>4,5</sup>, Hofstätter Christina<sup>5</sup>, Palfalvi Jozsef<sup>6</sup>, Szabo Julianna<sup>6</sup>, Ambrozova Iva<sup>7</sup>, Vanhavere Filip<sup>8</sup>, Gaza Ramona<sup>9,15</sup>, Semones Edward<sup>9</sup>, Yukihiro Eduardo<sup>10</sup>, Benton Eric<sup>10</sup>, Labrenz Johannes<sup>2</sup>, Uchihori Yukio<sup>11</sup>, Kodaira Satoshi<sup>11</sup>, Kitamura Hisashi<sup>11</sup>, Shurshakov Vyacheslav<sup>12</sup>, Tolocek Raisa<sup>12</sup>, Nagamatsu Aiko<sup>13</sup>, Boehme Matthias<sup>14</sup>, Reitz Günther<sup>1</sup>

<sup>1</sup> DLR	German Aerospace Center	Cologne, Germany
<sup>2</sup> CAU	Christian Albrechts Universität zu Kiel	Kiel, Germany
<sup>3</sup> IFJ	Institute of Nuclear Physics	Krakow, Poland
<sup>4</sup> IAEA	International Atomic Energy Agency	Vienna, Austria
<sup>5</sup> ATI	Technical University Vienna	Vienna, Austria
<sup>6</sup> CER-HAS	Centre for Energy Research	Budapest, Hungary
<sup>7</sup> NPI	Nuclear Physics Institute	Prague, Czech Republic
<sup>8</sup> SCK-CEN	Belgian Nuclear Research Center	Mol, Belgium
<sup>9</sup> NASA	Space Radiation Analysis Group	Houston, United States
<sup>10</sup> OSU	Oklahoma State University	Stillwater, United States
<sup>11</sup> NIRS	National Institute of Radiological Sciences	Chiba, Japan
<sup>12</sup> IMBP	Russian Academy of Sciences	Moscow, Russia
<sup>13</sup> JAXA	Japan Aerospace Exploration Agency	Tsukuba, Japan
<sup>14</sup> OHB System AG		Bremen, Germany
<sup>15</sup> Lockheed Martin Exploration & Mission Support		Houston, United States



# DOSIS 3D: Columbus



S122E008223

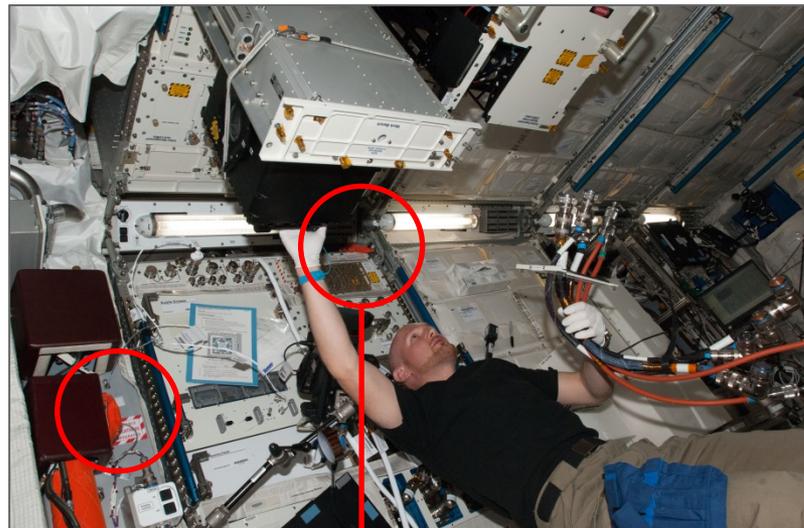


# DOSIS 3D: Scientific Goals

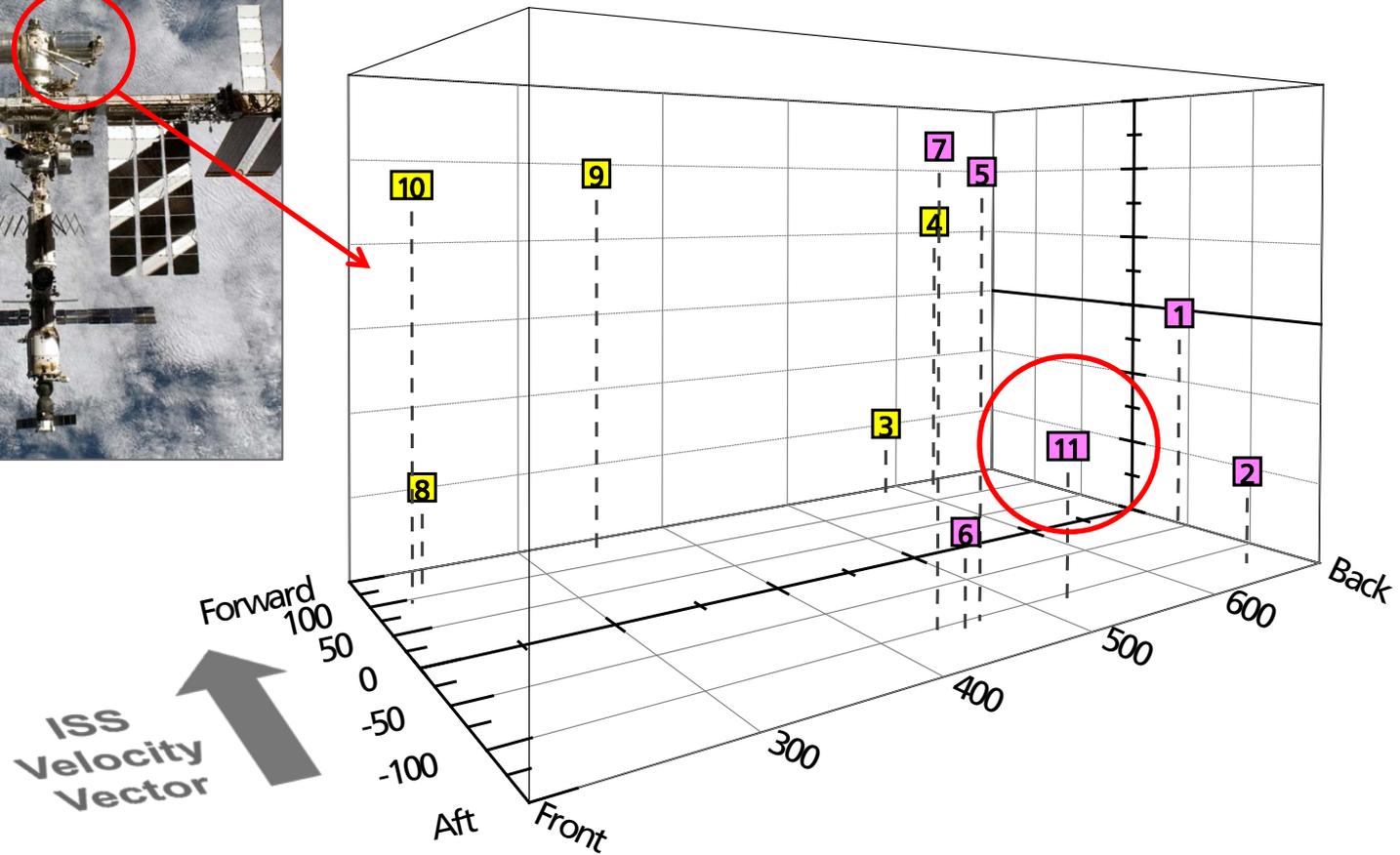
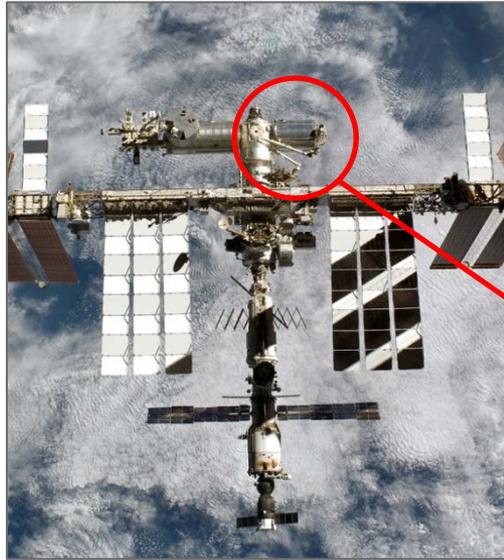
- Monitoring radiation environment inside Columbus
- Determination of temporal and spacial dose distributions
- Combining data from NASA, JAXA, IMBP and ESA



**3D radiation map for the ISS**

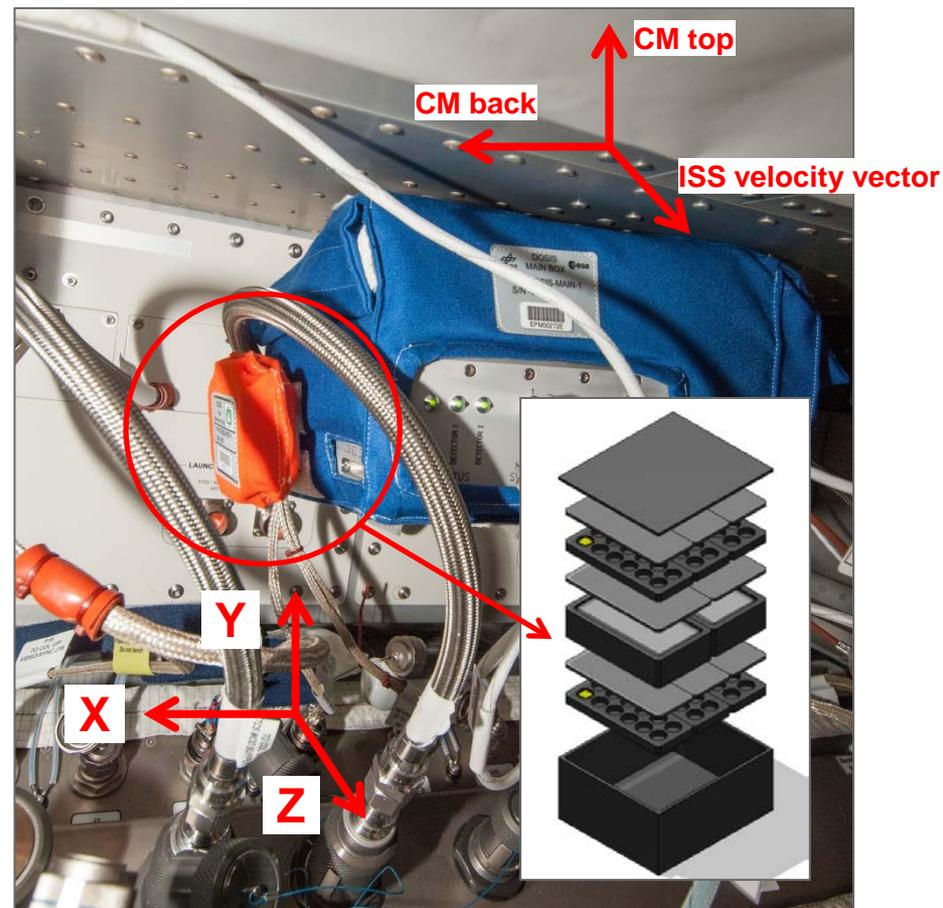


# DOSIS 3D: Columbus PDP locations

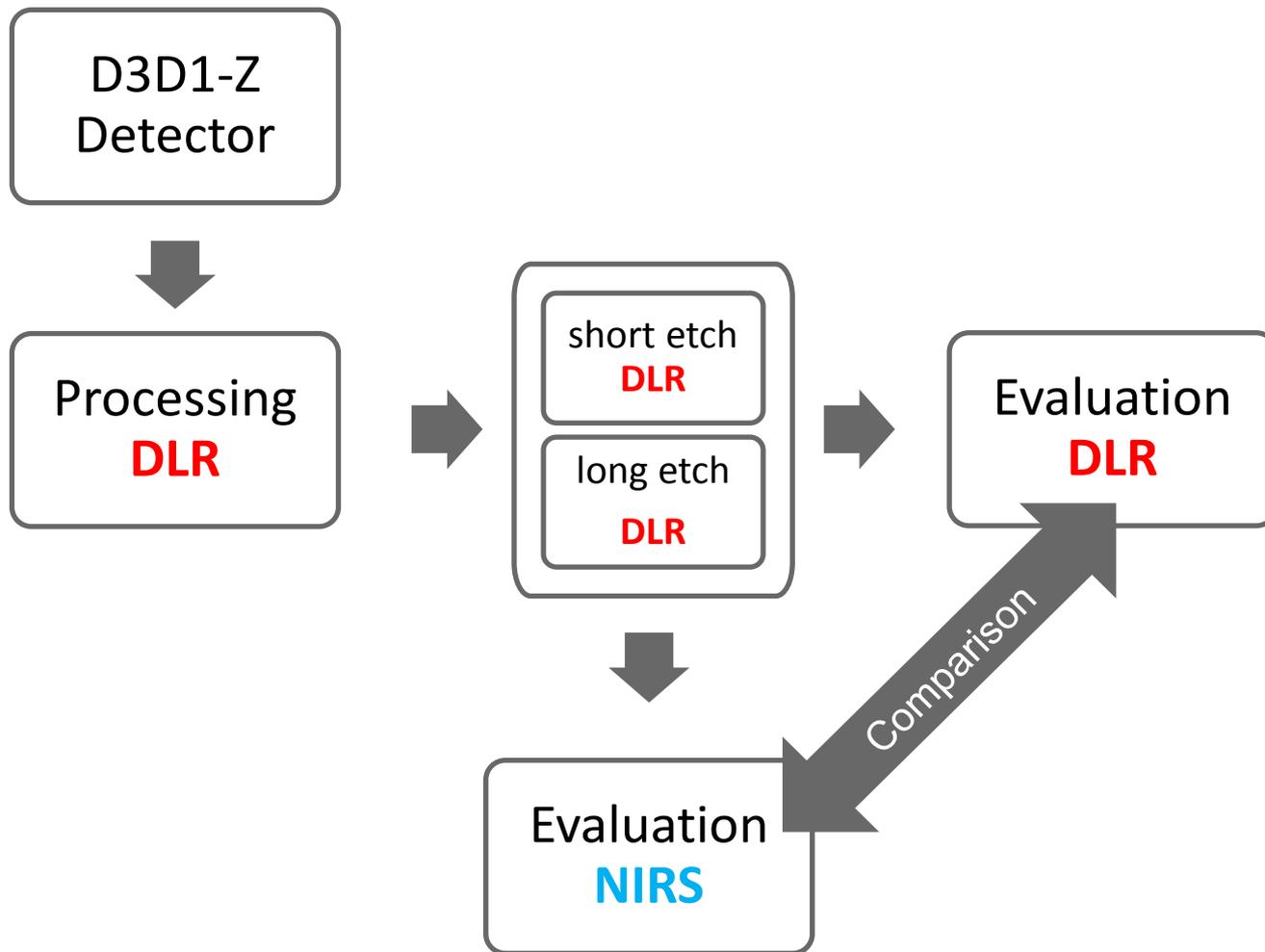


# DOSIS 3D: Triple Pack PDP 11

- Passive Detector Packages
    - Thermoluminescence (TLD)
    - Nuclear track etch (CR-39)
  - Position 11: X-Y-Z array
- ↓
- DOSIS 3D 1 Experiment
    - May 2012 to September 2012
    - Z-Detector



# DOSIS 3D: Nuclear Track Etch Detector (CR39) Evaluation



# Overview

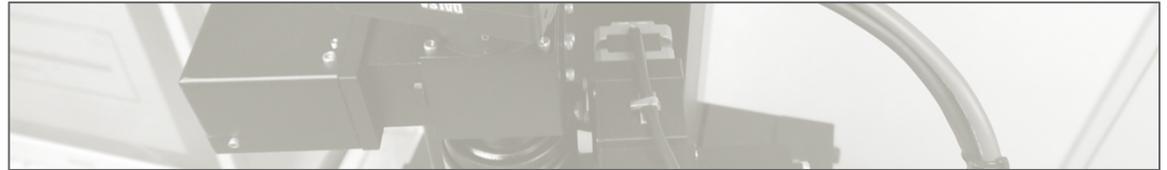
- DOSIS 3D



- DLR System



- NIRS System



- System Comparison

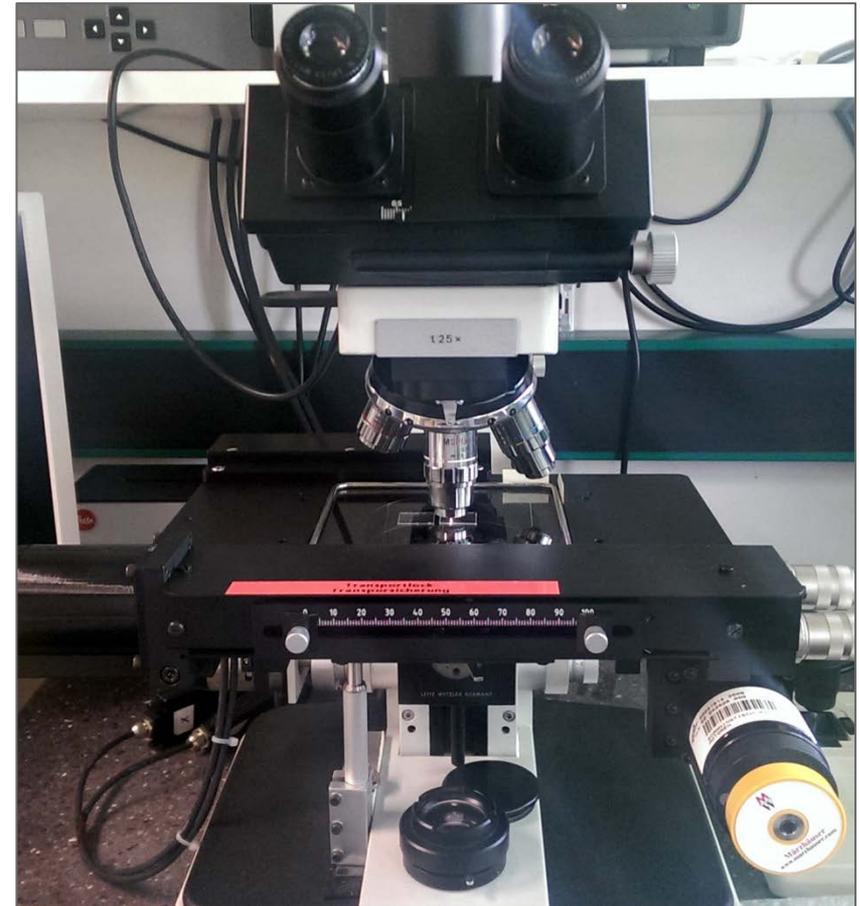


- Summary



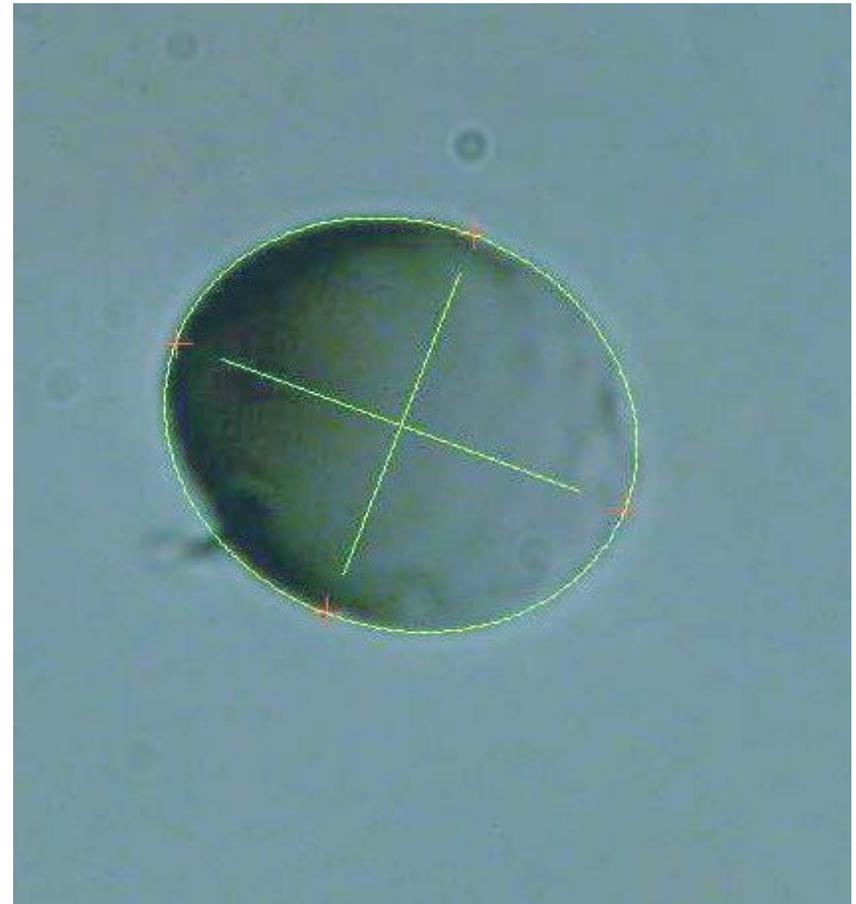
# DLR System: Hardware Short Summary

- Transmitted light microscope (bright field)
- Automated X-Y-Z stage control
- Color CMOS camera
- Objectives (used) 100x/50x
- Micrometer to pixel ratio
  - 0.05 $\mu\text{m}/\text{px}$  (100x)
  - 0.10 $\mu\text{m}/\text{px}$  (50x)
- Semi-automated system



# DLR System: Software Short Summary

- Manual track detection and selection
- Manual track measurement
- Semi-automated track evaluation



# Overview

- DOSIS 3D



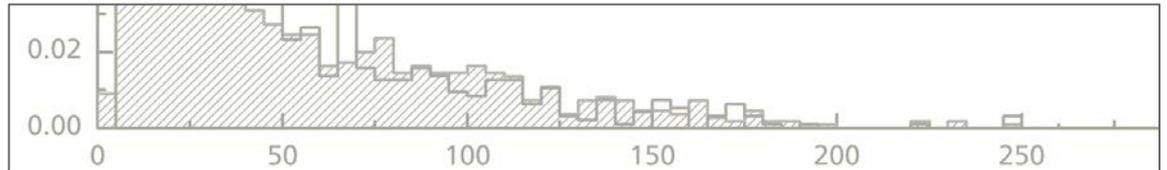
- DLR System



- NIRS System



- System Comparison

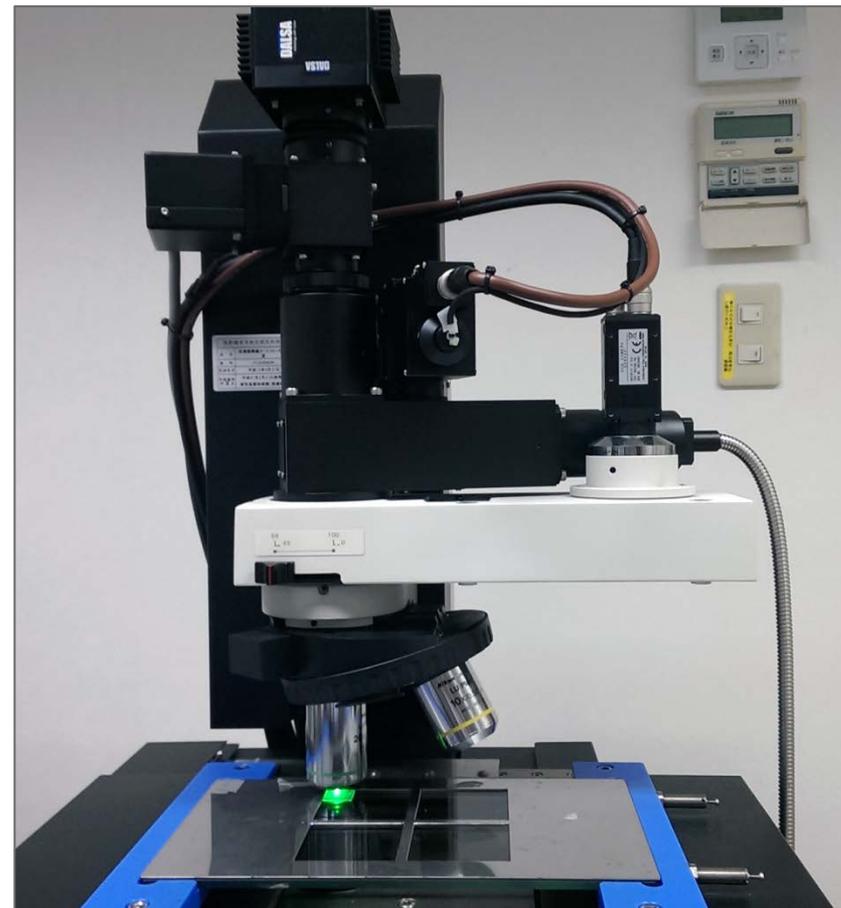


- Summary



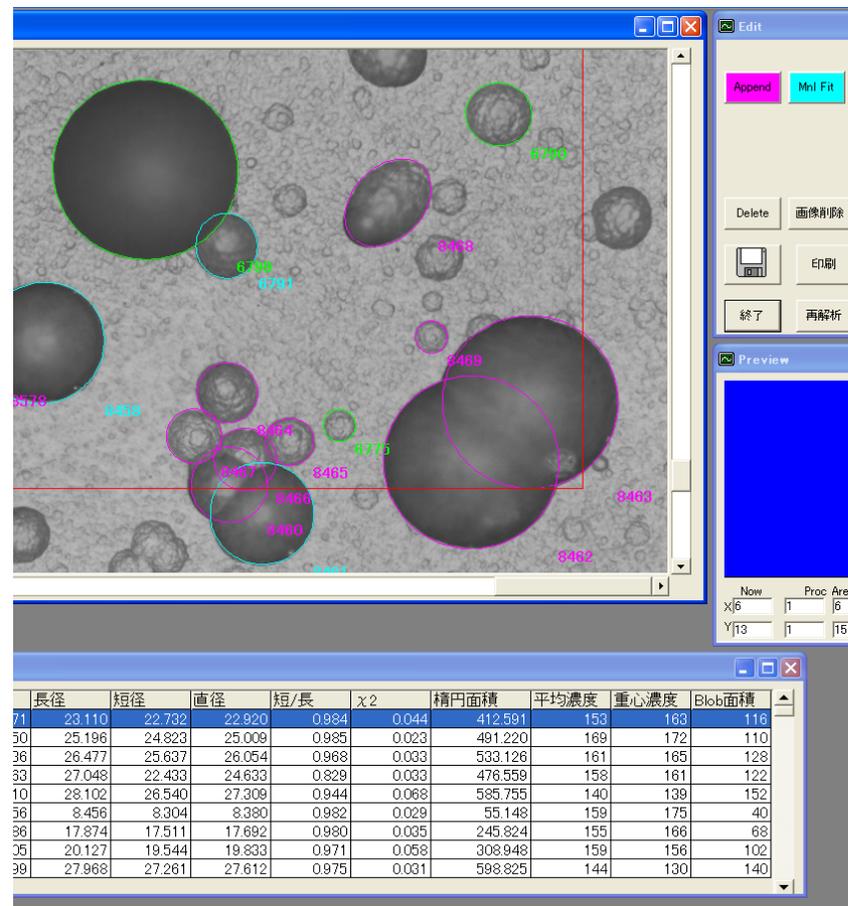
# NIRS System: Hardware Short Summary

- Reflected light microscope (bright field)
- Automated X-Y-Z stage control
- Line scan CMOS camera
- Objectives (used) 20x
- Micrometer to pixel ratio
  - 0.35 $\mu$ m/px
- Fully automated system



# NIRS System: Software Short Summary

- Automated track detection and selection
- Automated track measurement
- Semi-automated track evaluation



# Overview

- DOSIS 3D



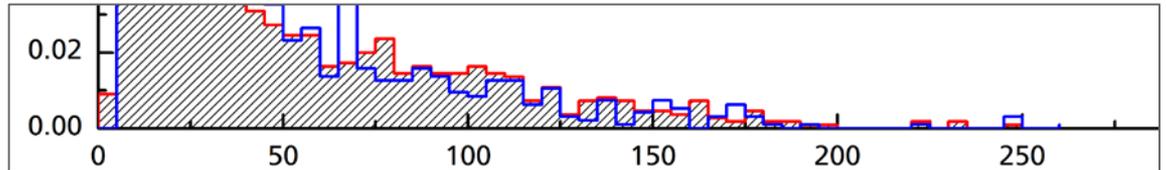
- DLR System



- NIRS System



- System Comparison



- Summary



# System Comparison: DLR – NIRS

## DLR

- Desired bulk removal
  - Short ~10um
  - Long ~50um
- Semi-automated system  
High user interaction
- Manual track detection and selection



DLR protocol already included in workflow

## NIRS

- Desired bulk removal
  - Short ~16um
  - Long ~40um
- Fully-automated system  
Low user interaction
- Automated track detection and selection



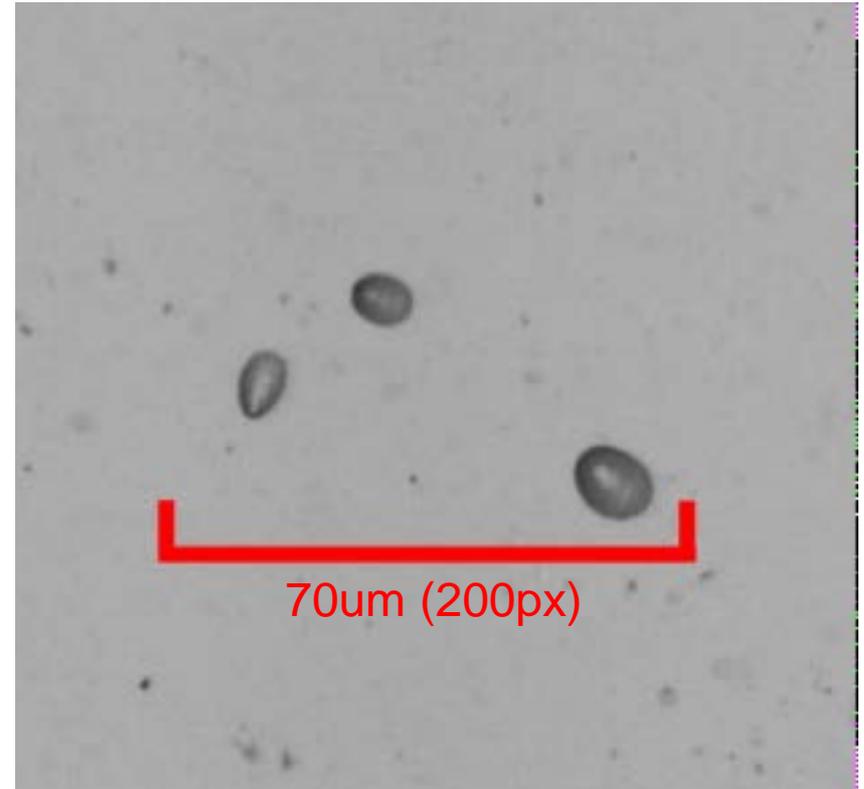
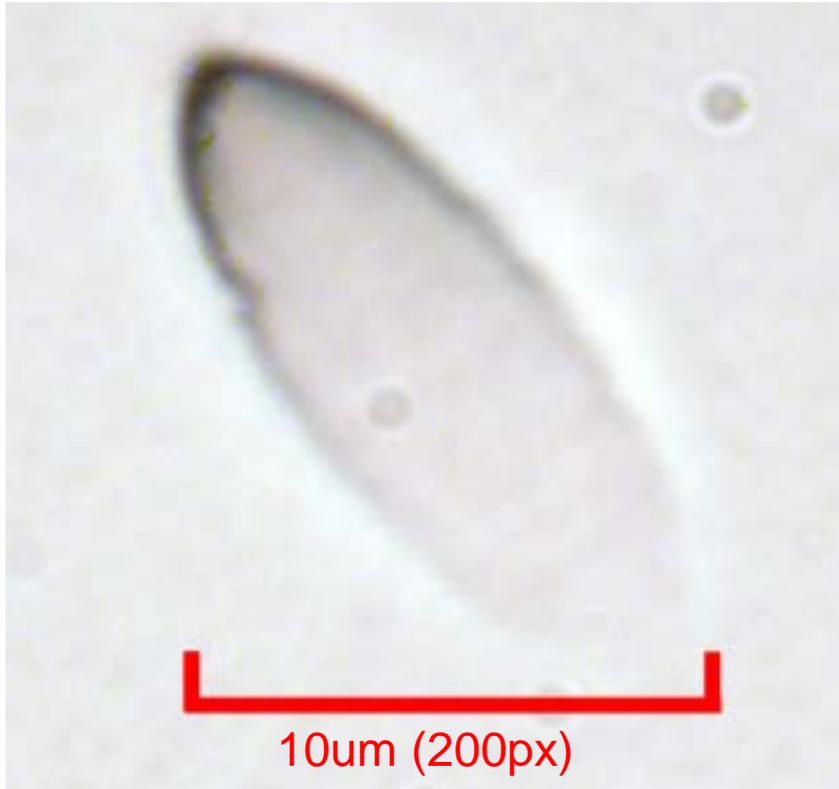
NIRS protocol (manual exclusion of all overetched tracks)



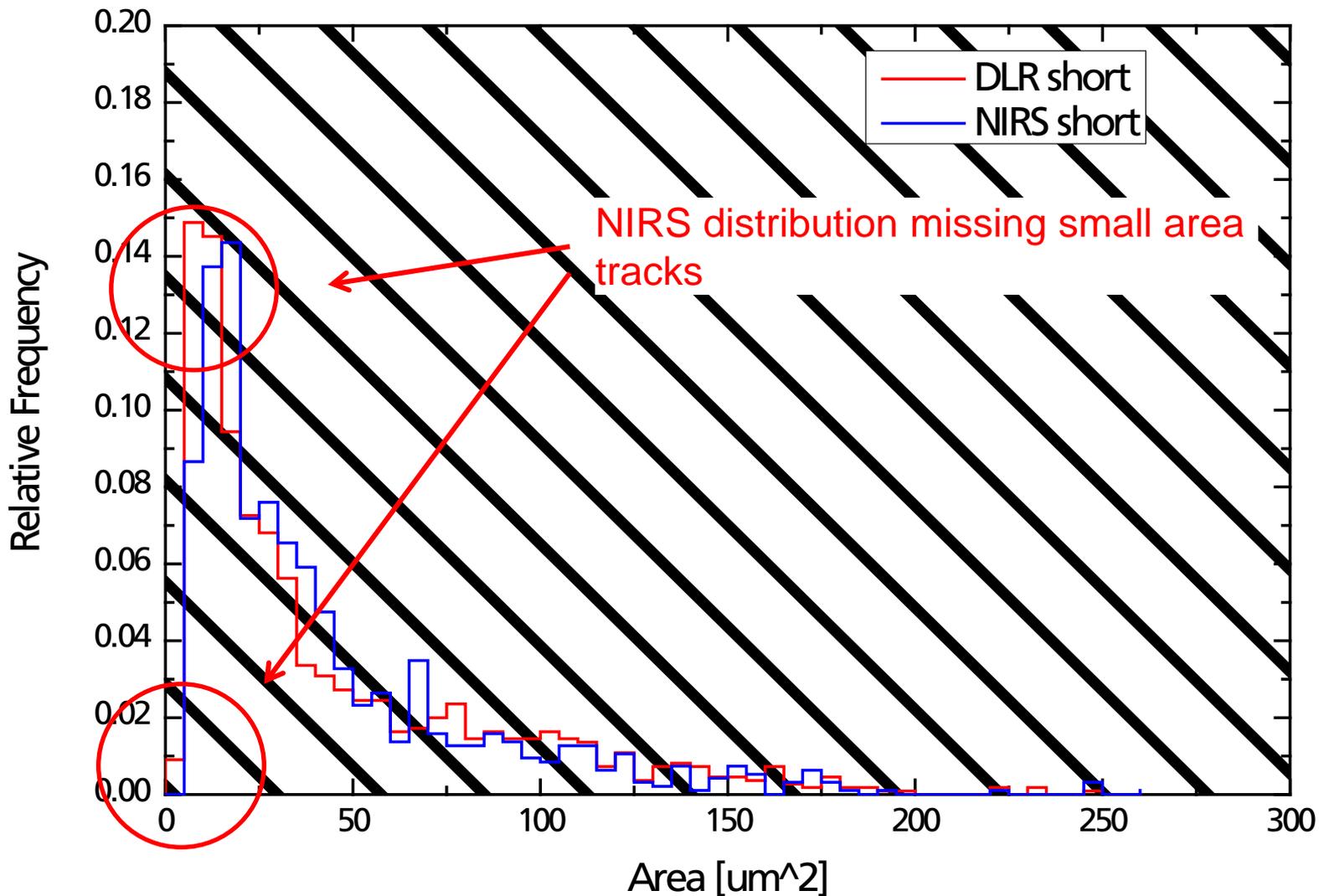
# System Comparison: DLR – NIRS short

**DLR**

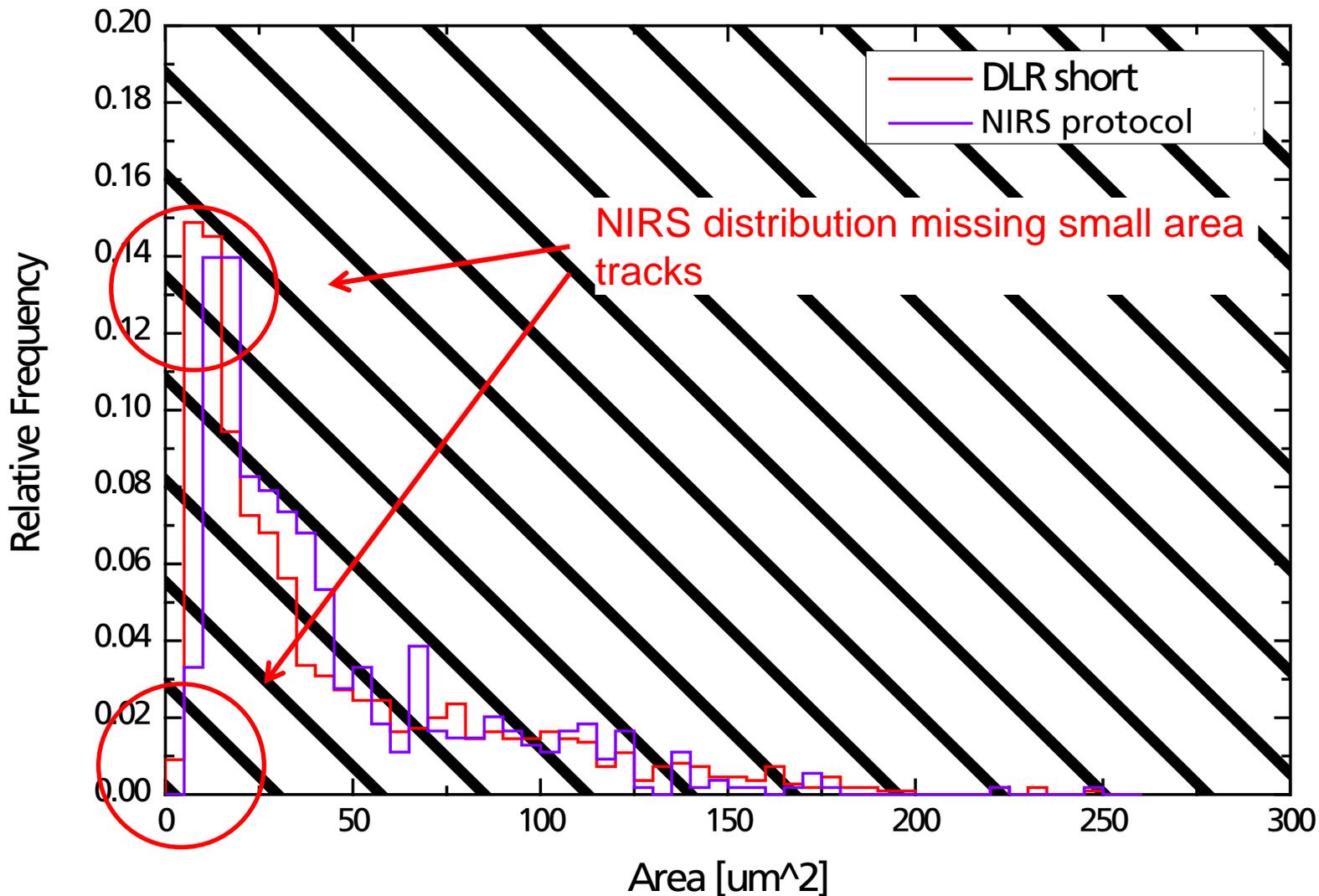
**NIRS**



# System Comparison: Ellipse Area Distribution – short (all tracks)

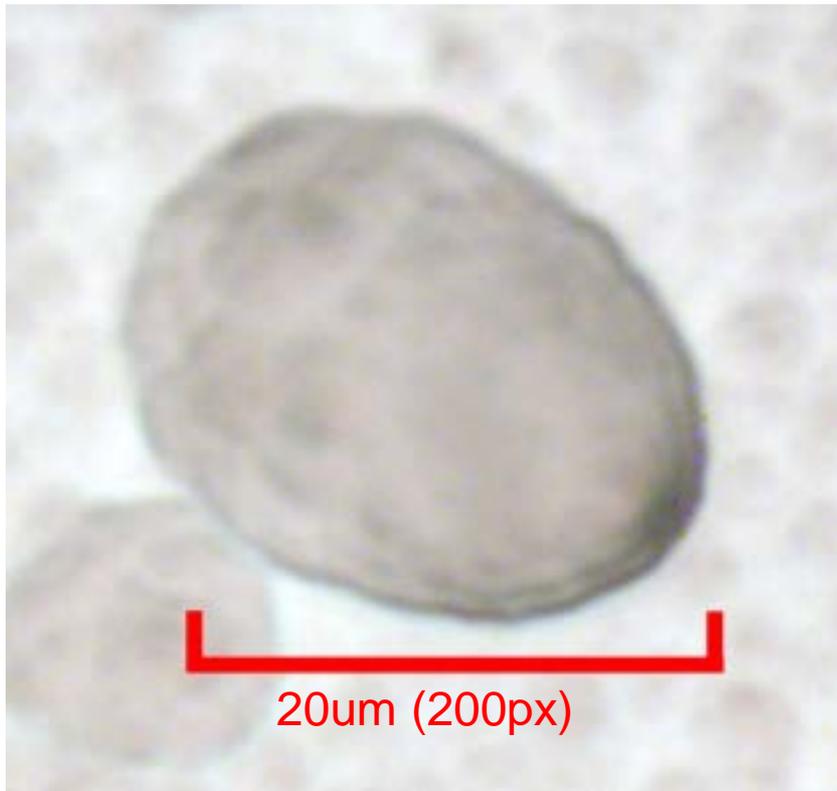


# System Comparison: Ellipse Area Distribution – short (NIRS protocol)

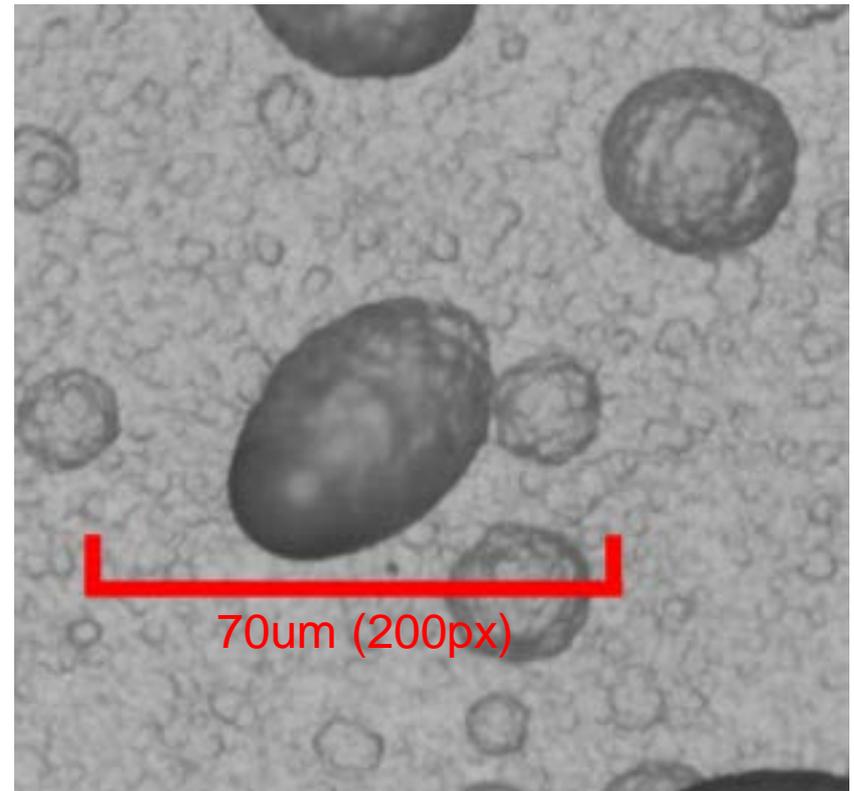


# System Comparison: DLR – NIRS long

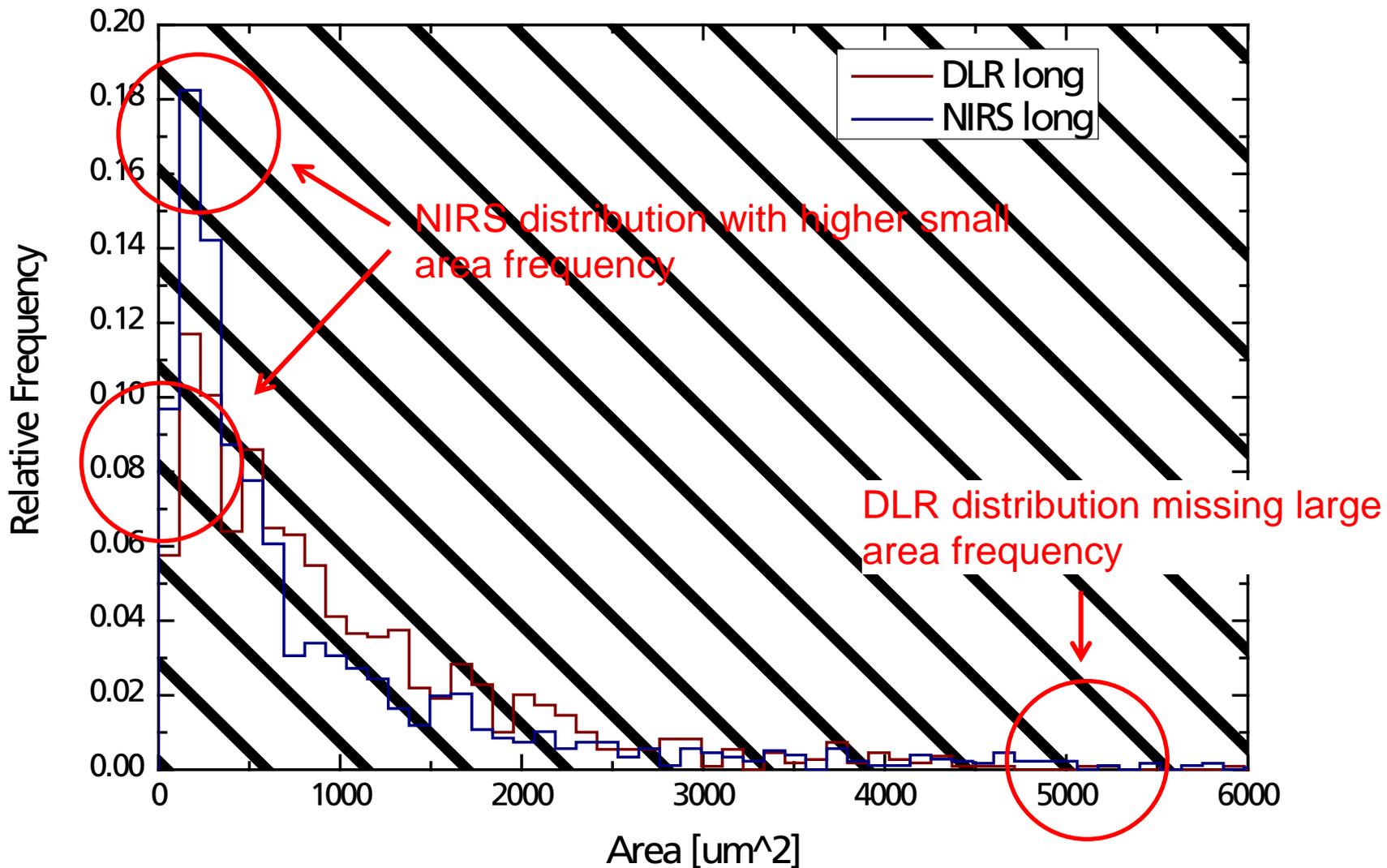
**DLR**



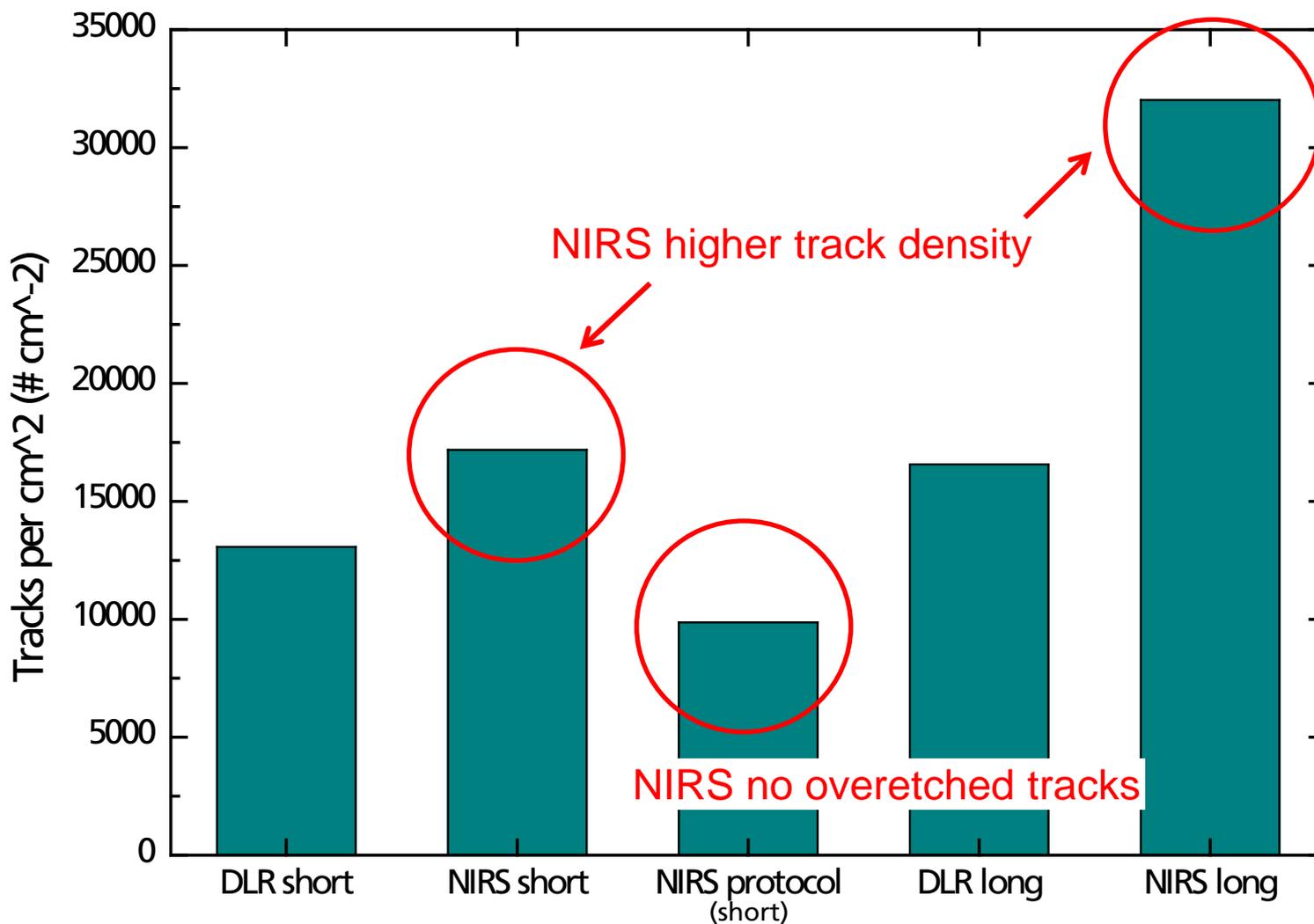
**NIRS**



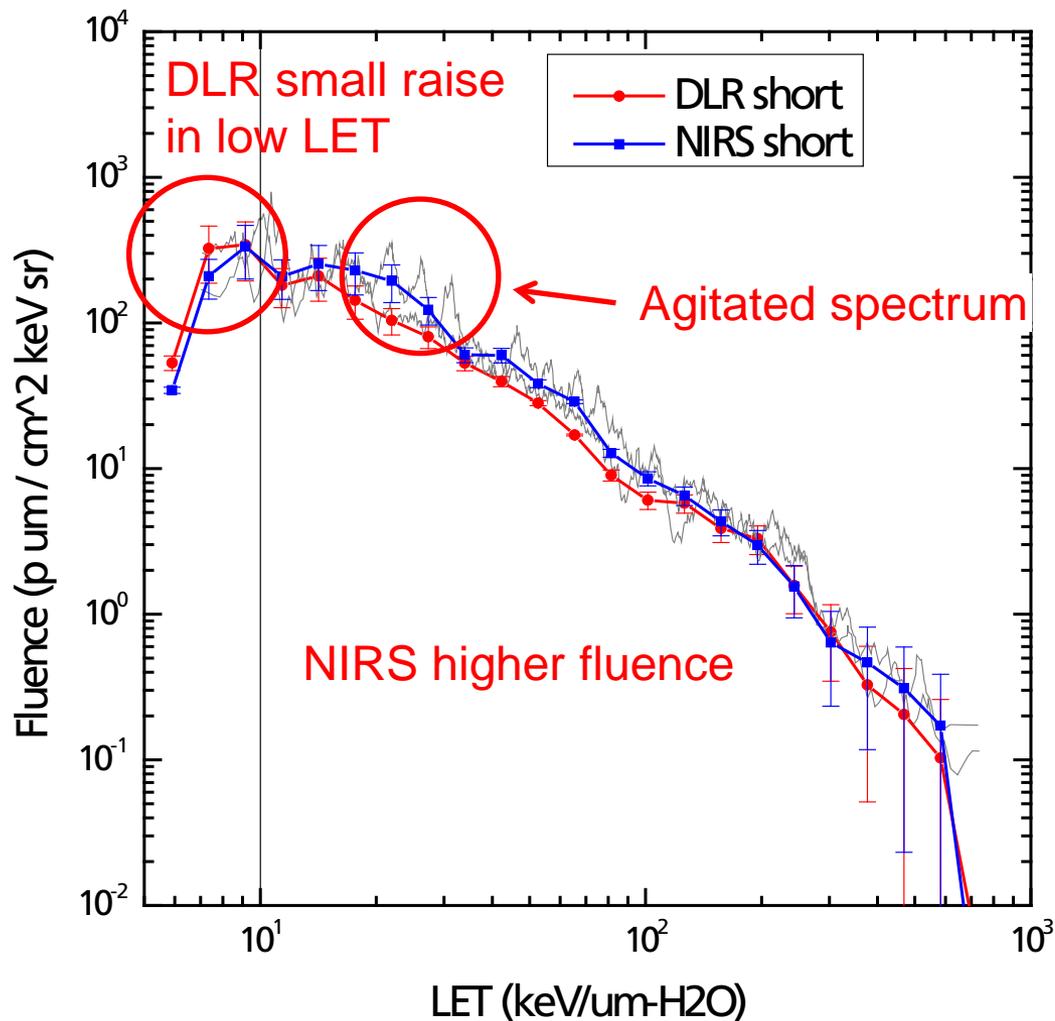
# System Comparison: Ellipse Area Distribution – long (all tracks)



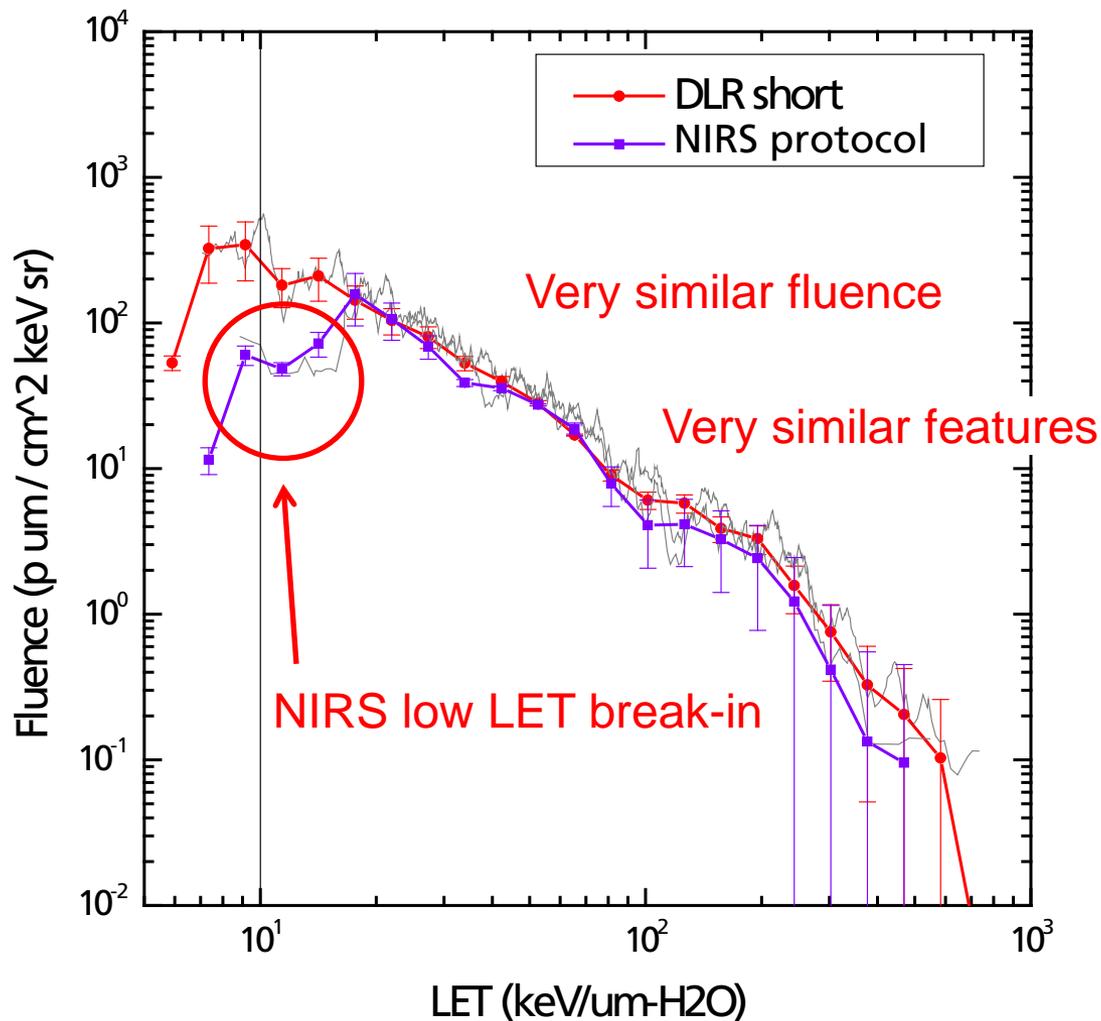
# System Comparison: Track Density



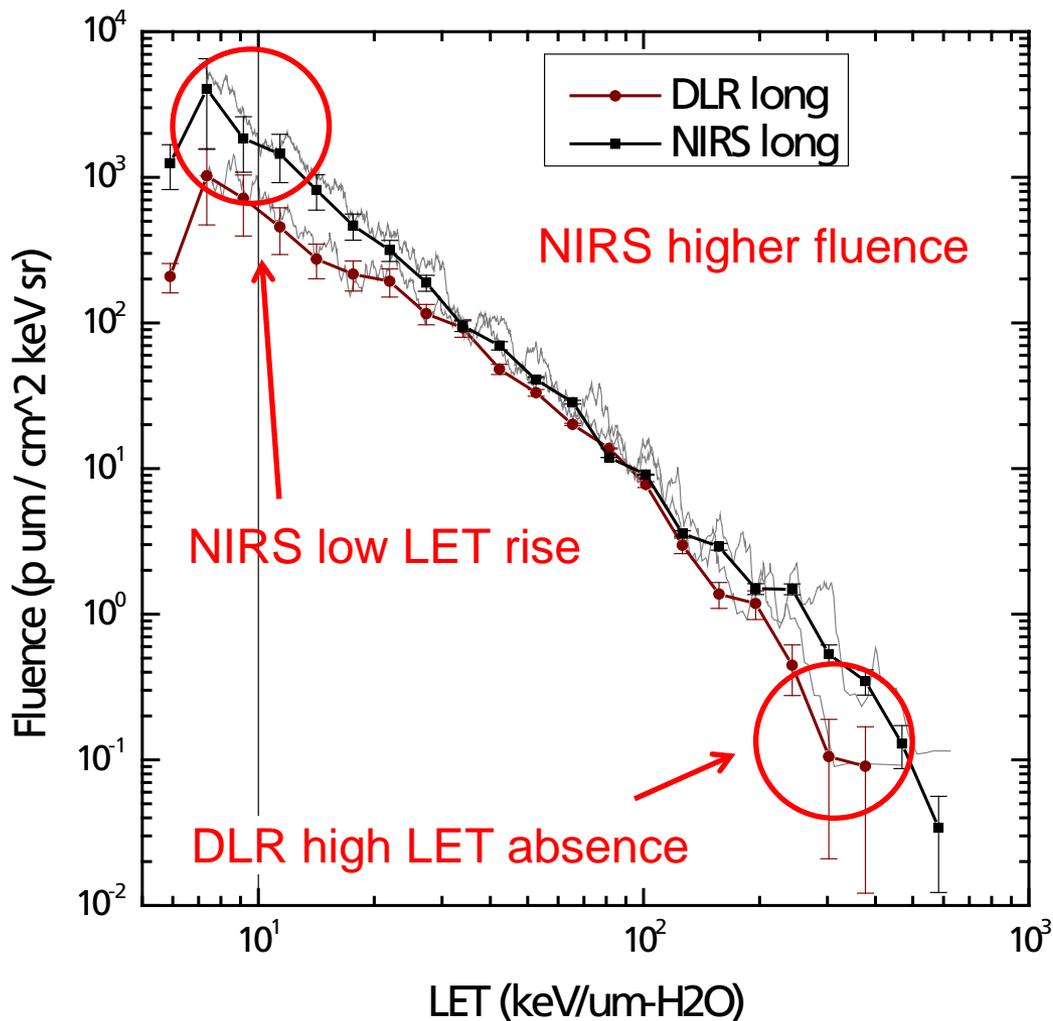
# System Comparison: Fluence Spectra - short (all tracks)



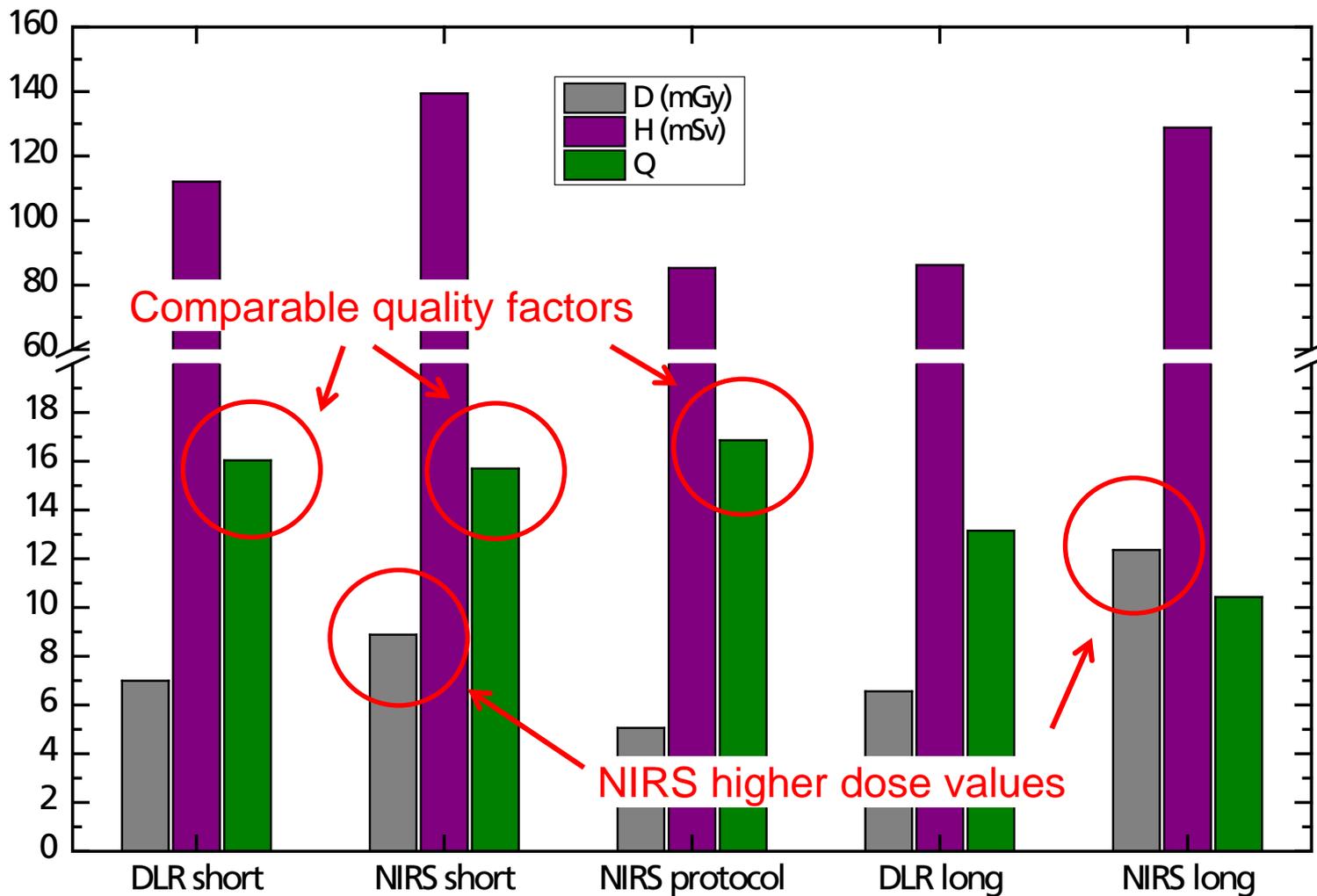
# System Comparison: Fluence Spectra – short (NIRS protocol)



# System Comparison: Fluence Spectra - long



# System Comparison: D/H/Q (total LET)

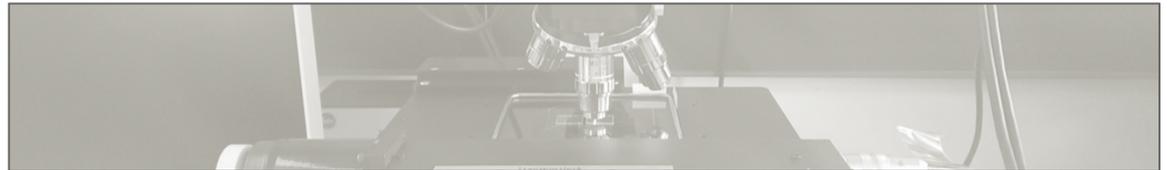


# Overview

- DOSIS 3D



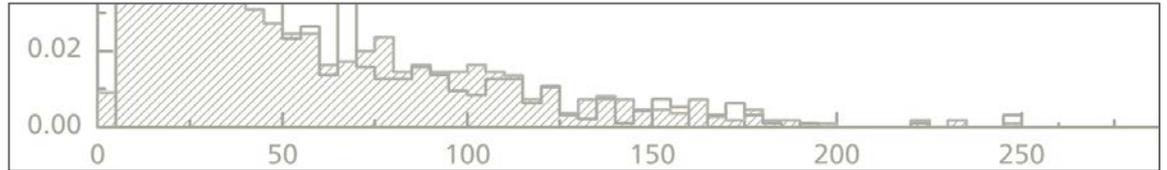
- DLR System



- NIRS System



- System Comparison

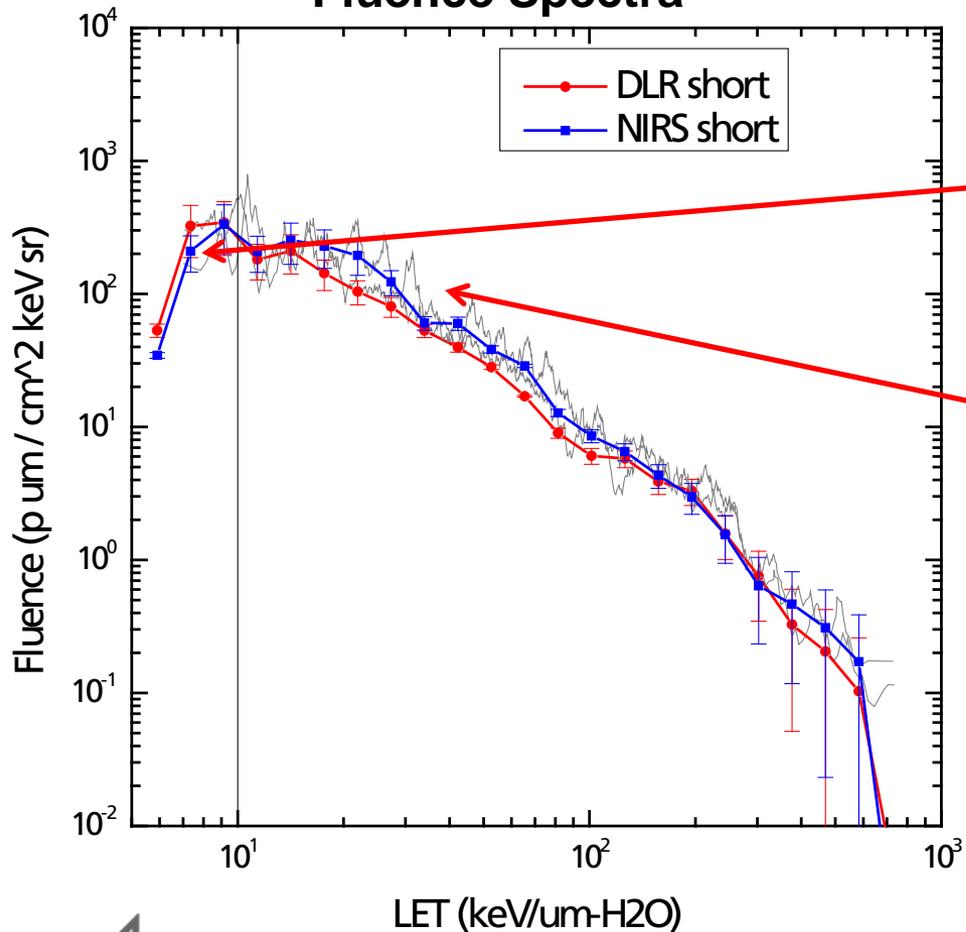


- Summary

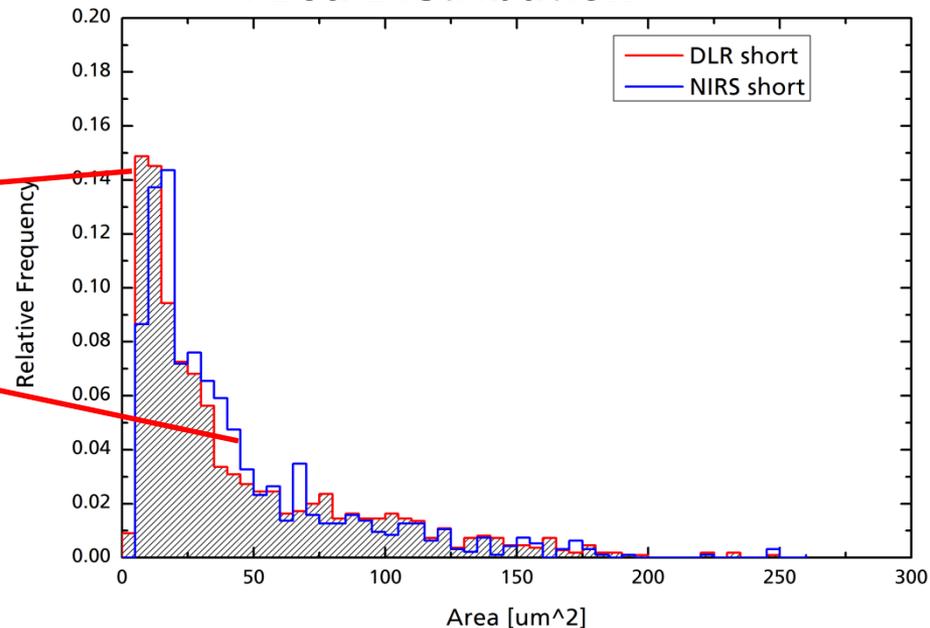


# Summary: DLR – NIRS short (all tracks)

## Fluence Spectra

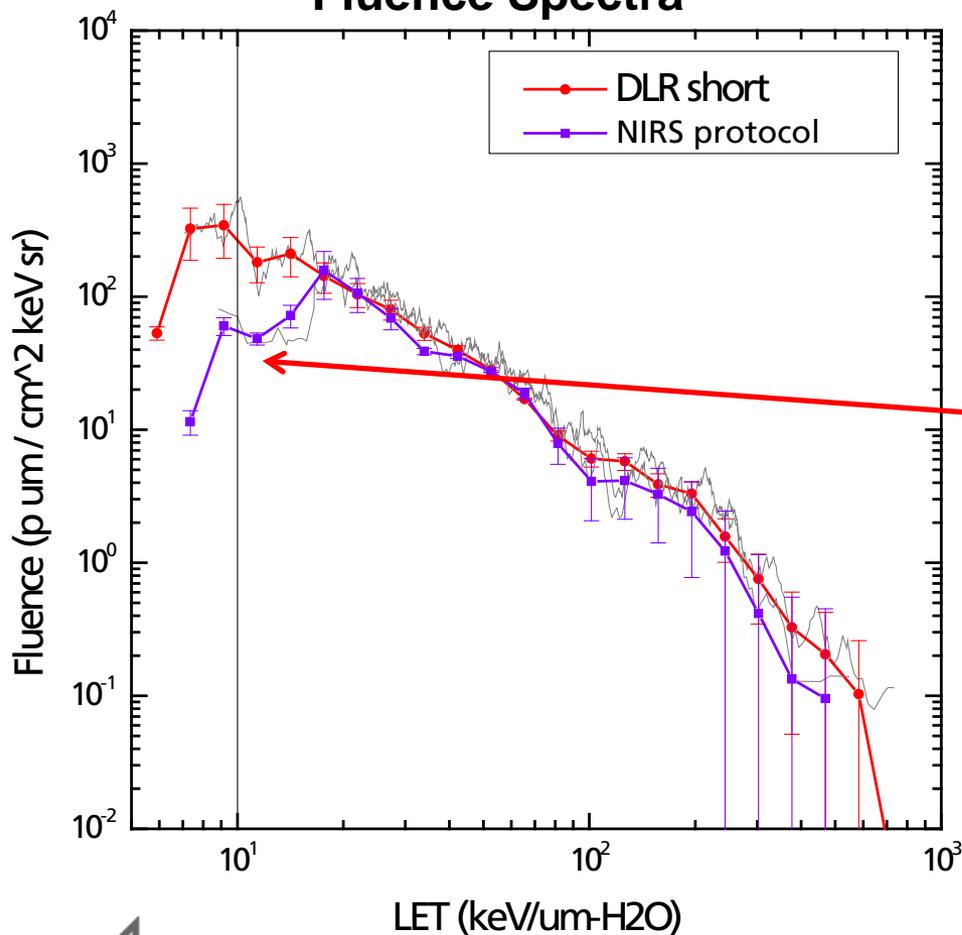


## Area Distribution

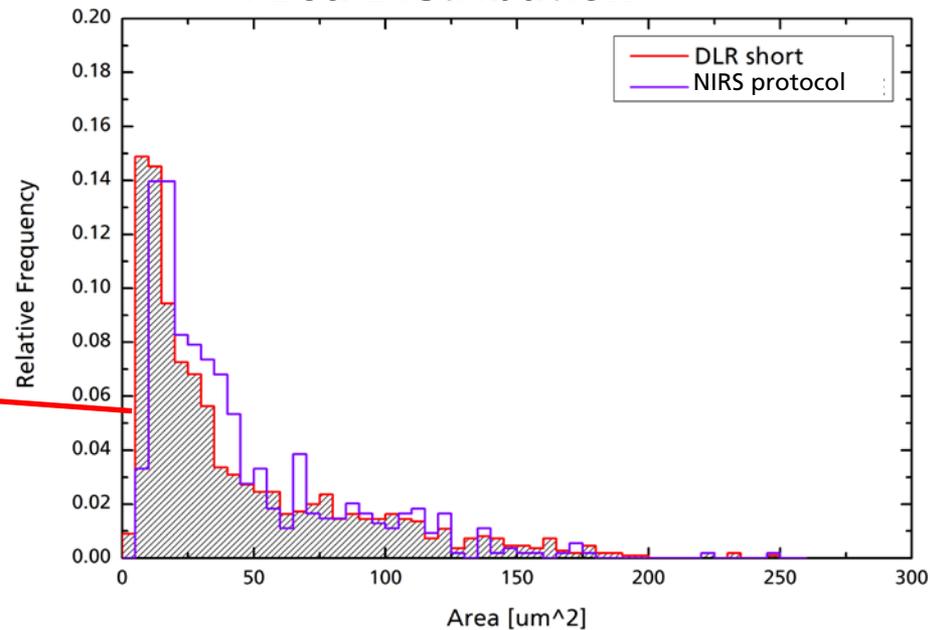


# Summary: DLR – NIRS short (NIRS protocol)

## Fluence Spectra

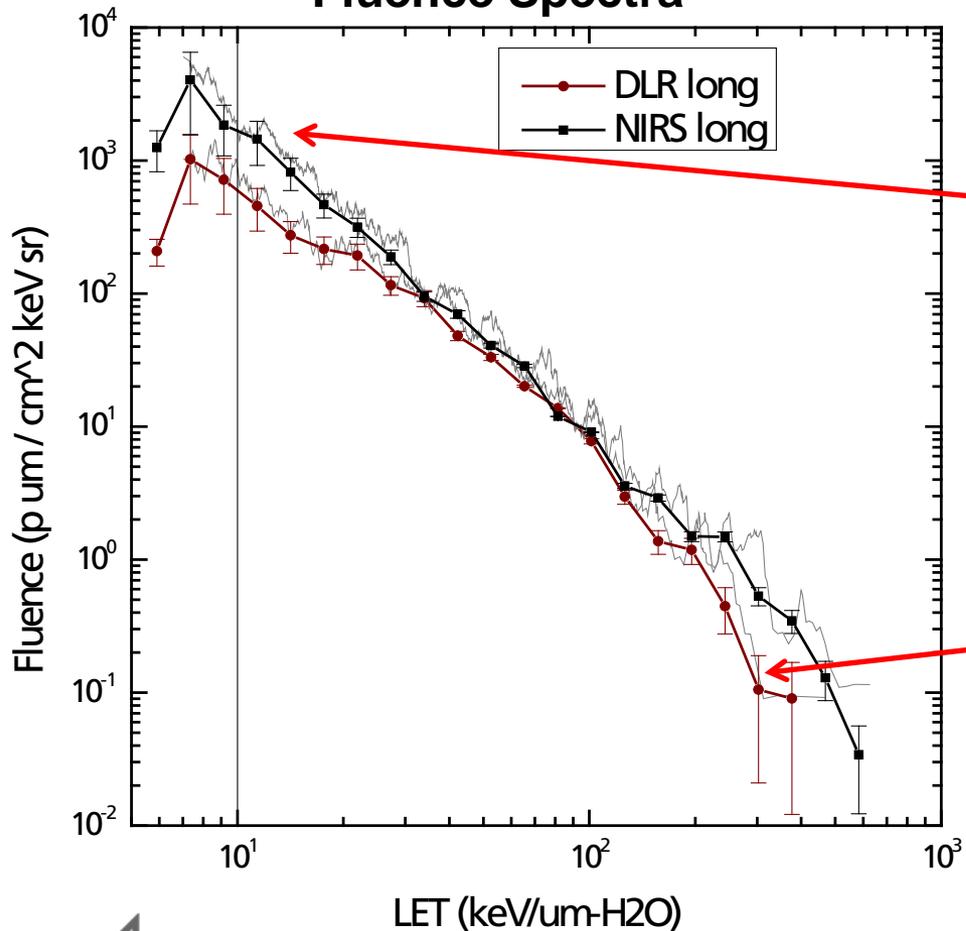


## Area Distribution

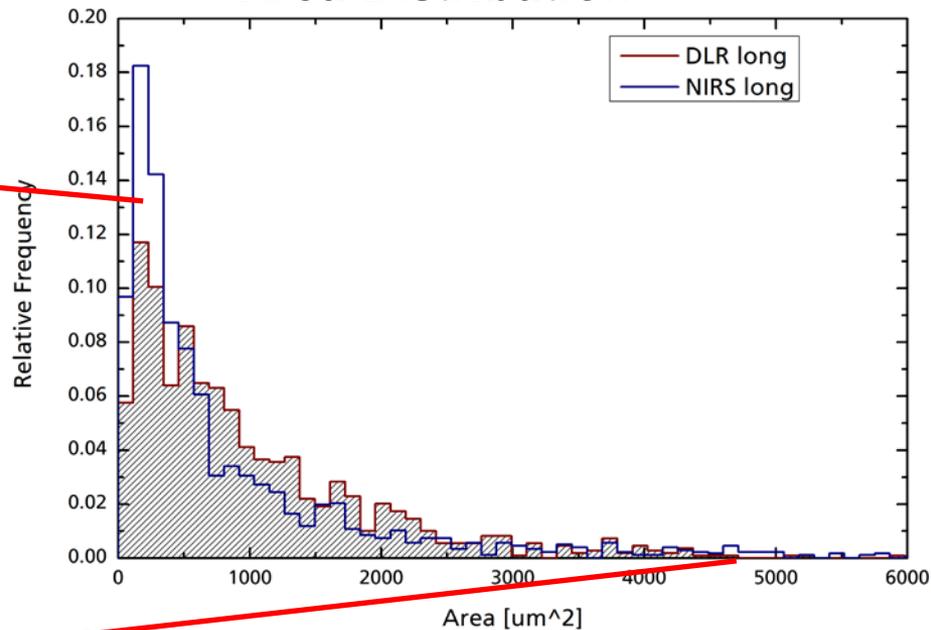


# Summary: DLR – NIRS long

## Fluence Spectra

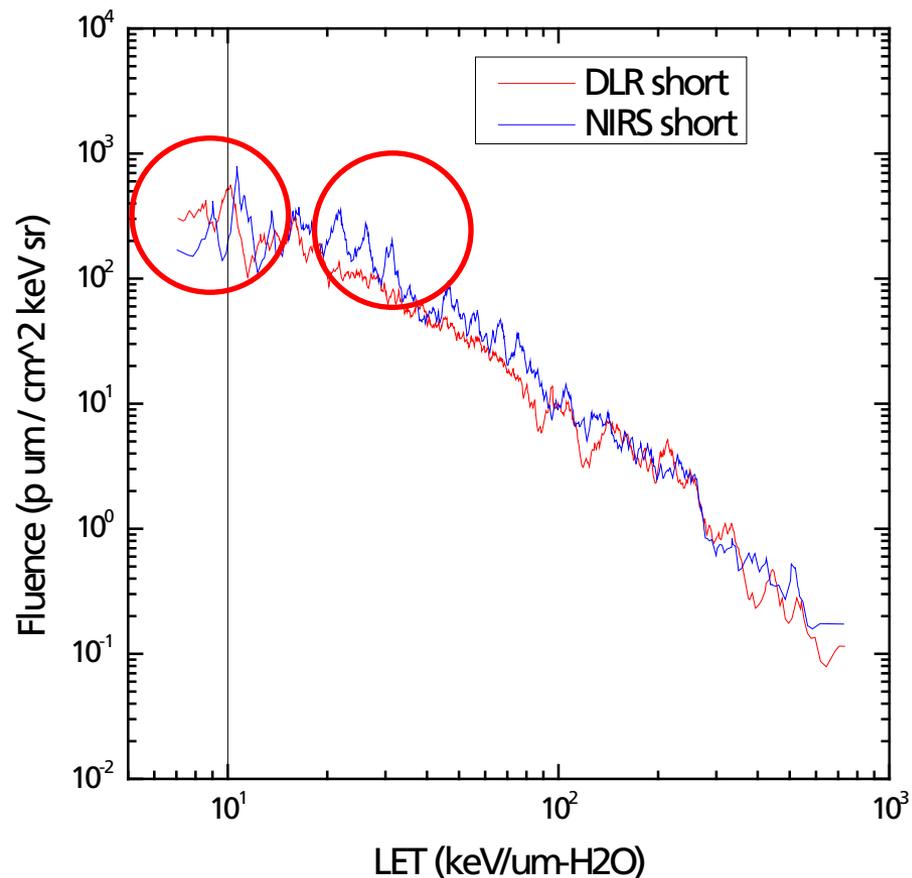


## Area Distribution



# Summary: DLR – NIRS

- Different  $\mu\text{m}$  to pixel ratio
  - Shifts threshold for small and large track detection
- Fully automated track detection
  - Raises track density, dose values and fluence
  - „Agitates“ spectrum

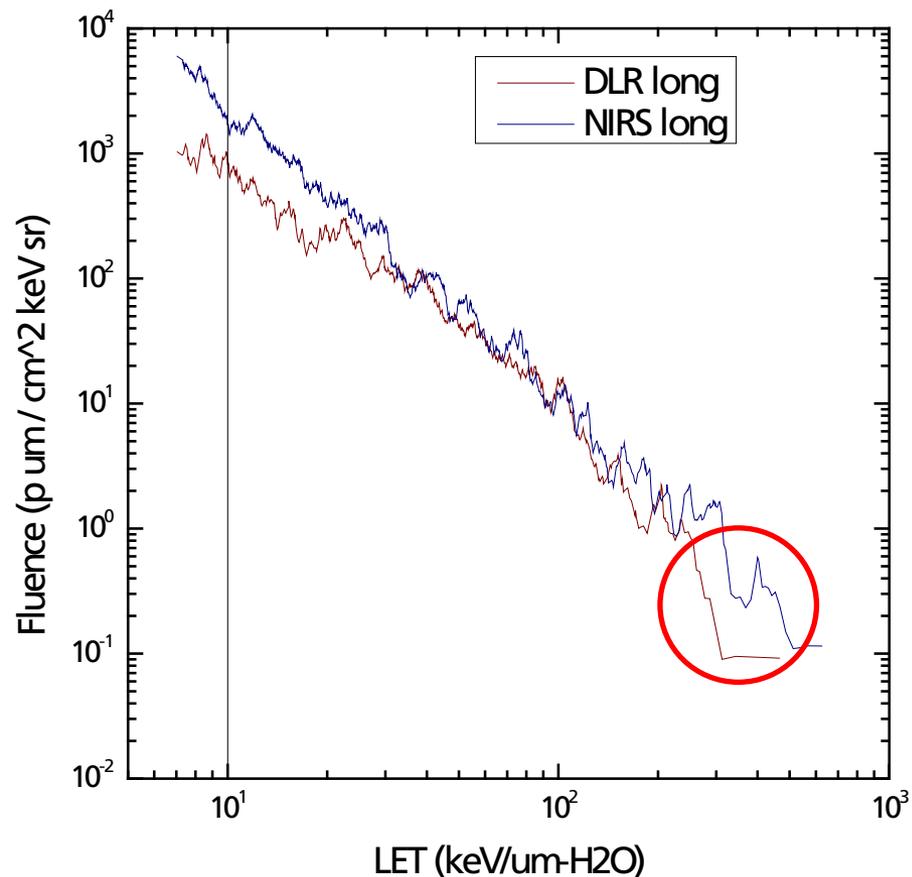


# Summary: DLR – NIRS

- Different track sensitivity of each system
  - Highly dependend on bulk etch
  - Each system has ist own operational „sweet spot“
- Manual removal of overetched tracks and surface artefacts still necessary



**Common guidlines for track classification**



# Acknowledgement

- *Institute of Aerospace Medicine,  
German Aerospace Centre, Cologne,  
Germany*

- T. Berger
- G. Reitz



- *National Institute of Radiological  
Sciences, Chiba, Japan*

- S. Kodaira
- H. Kitamura
- Y. Uchihori



# Thank you for your attention

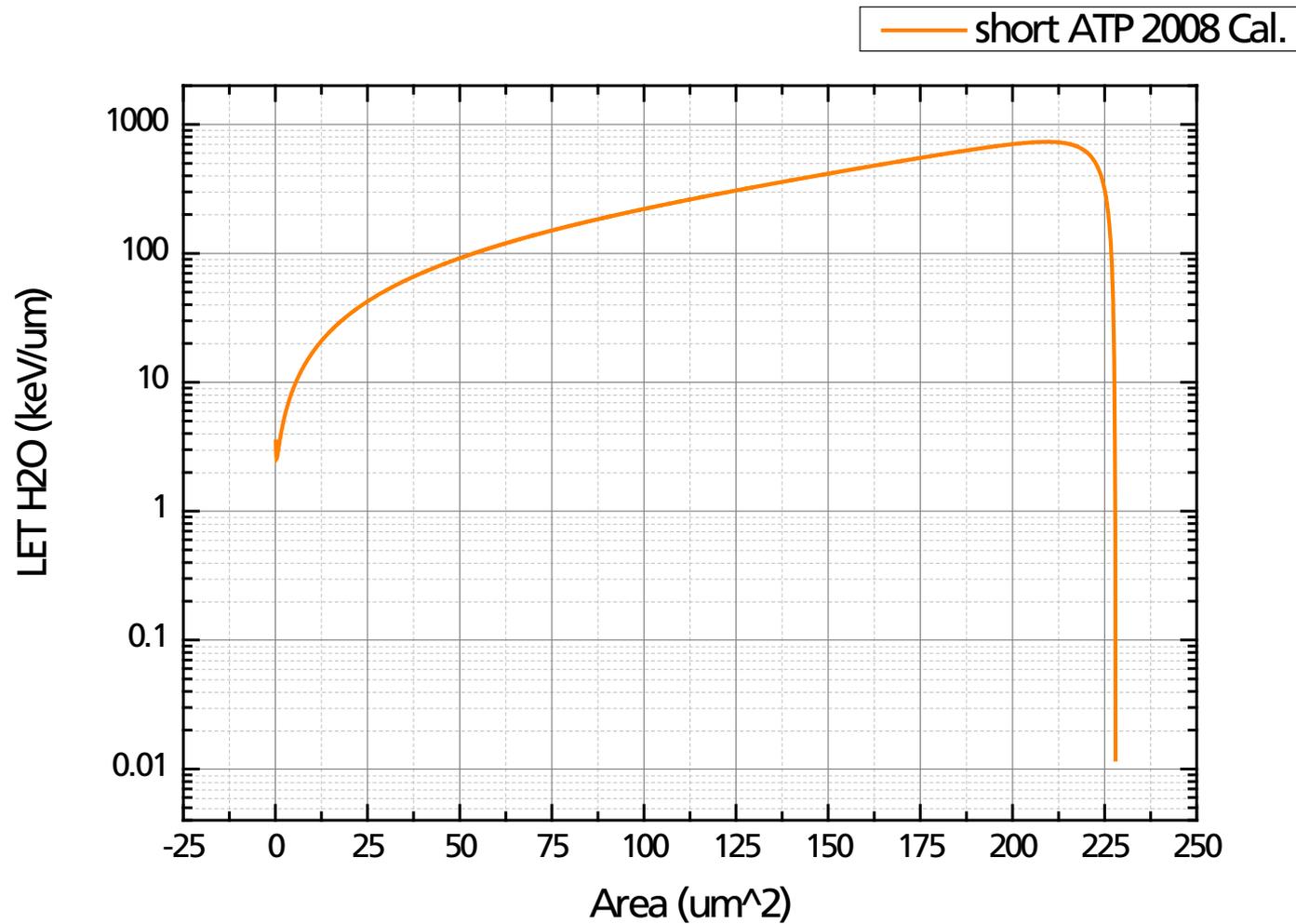


# Additional Charts

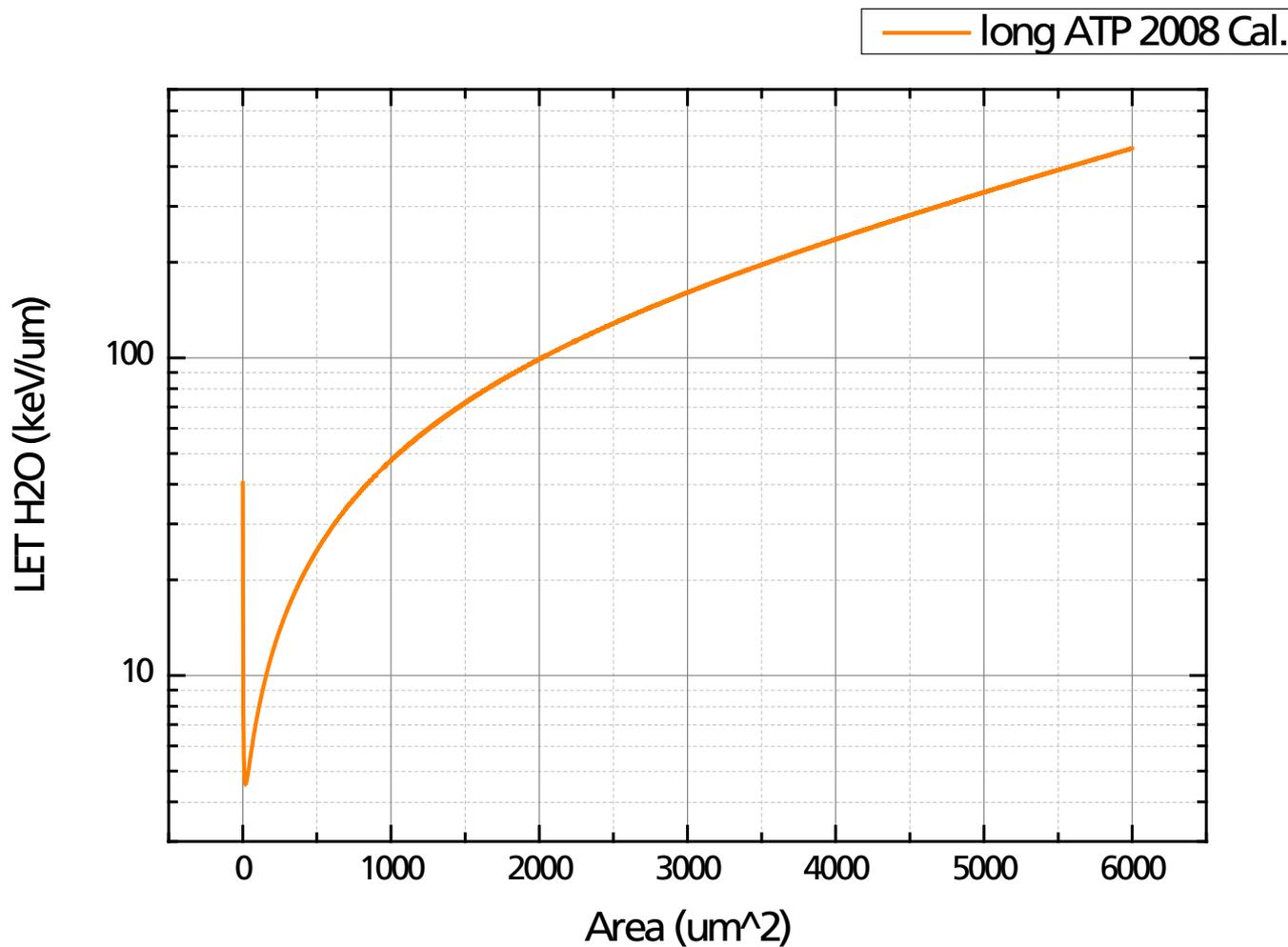
Knowledge for Tomorrow



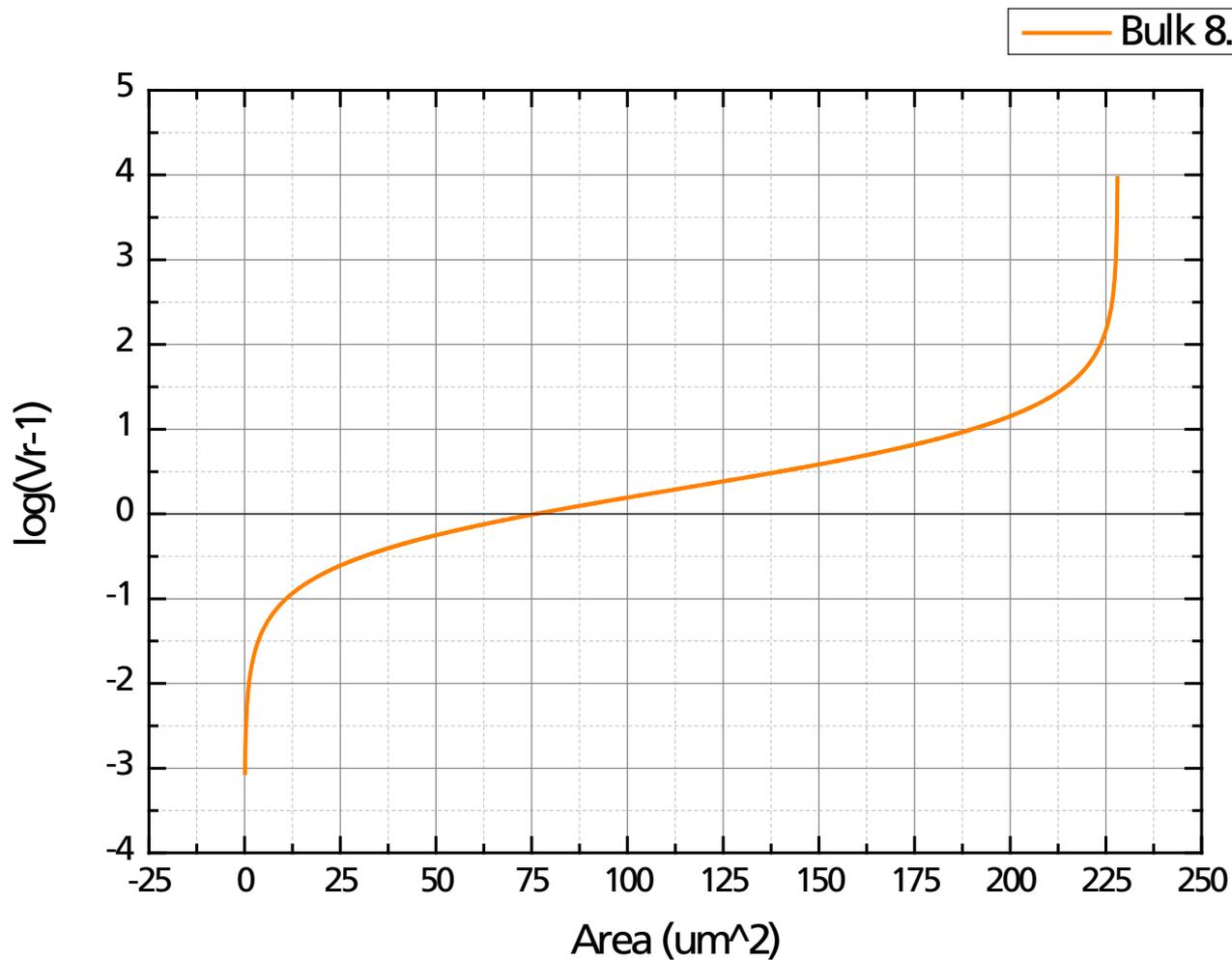
# Simulated Area-LET dependency short



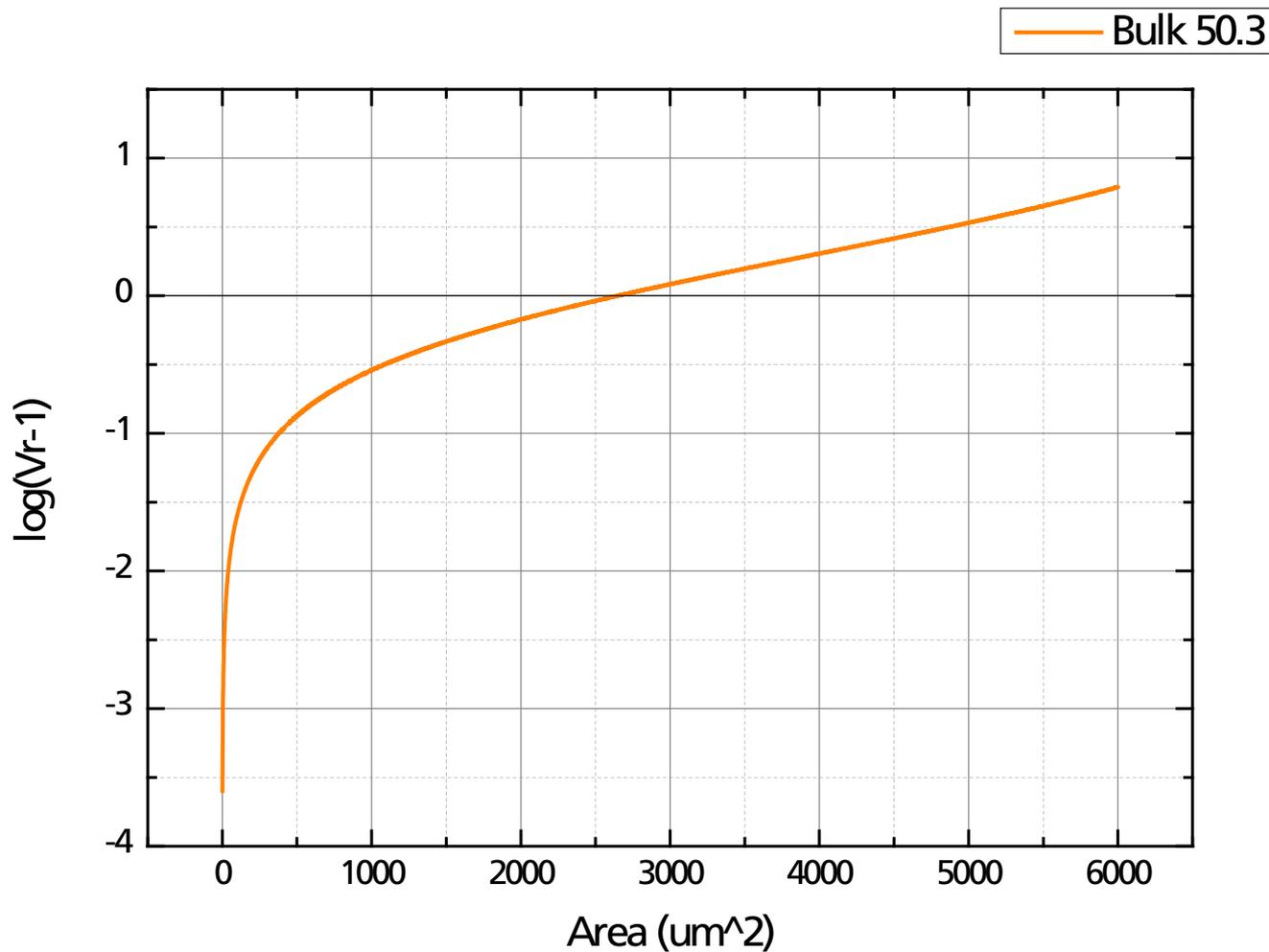
# Simulated Area-LET dependency long



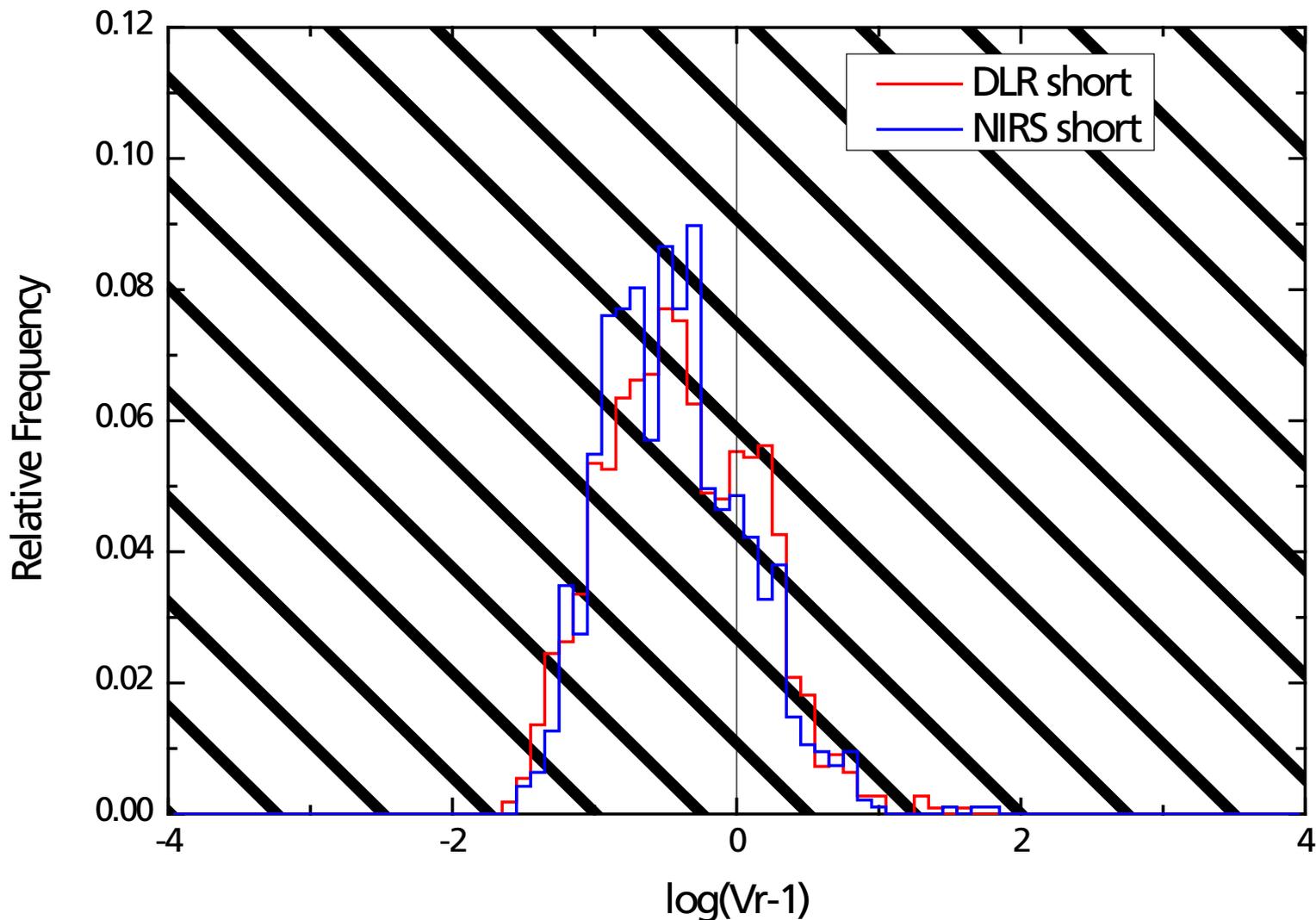
# Simulated Area-log(Vr-1) dependency short



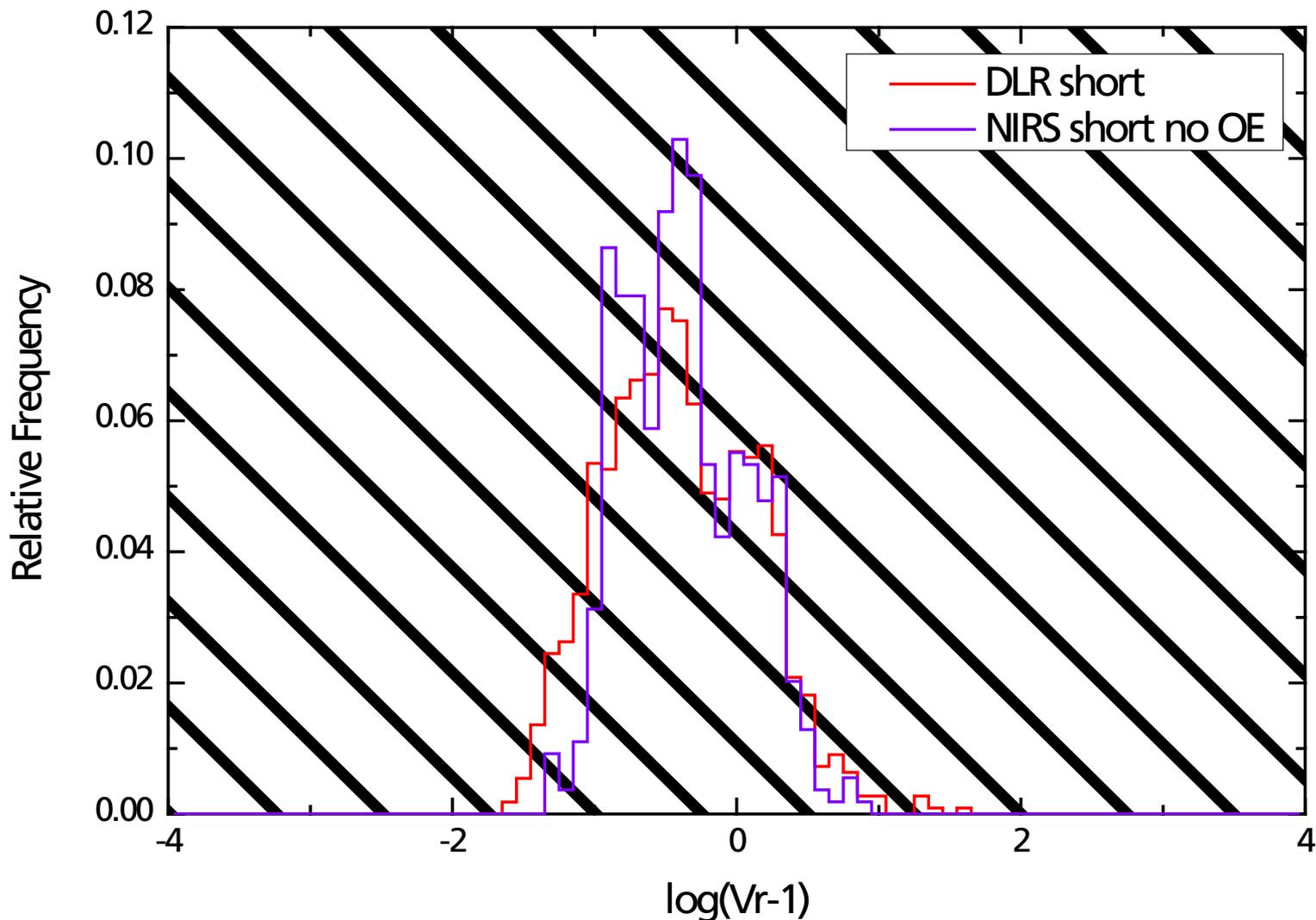
# Simulated Area-log(Vr-1) dependency long



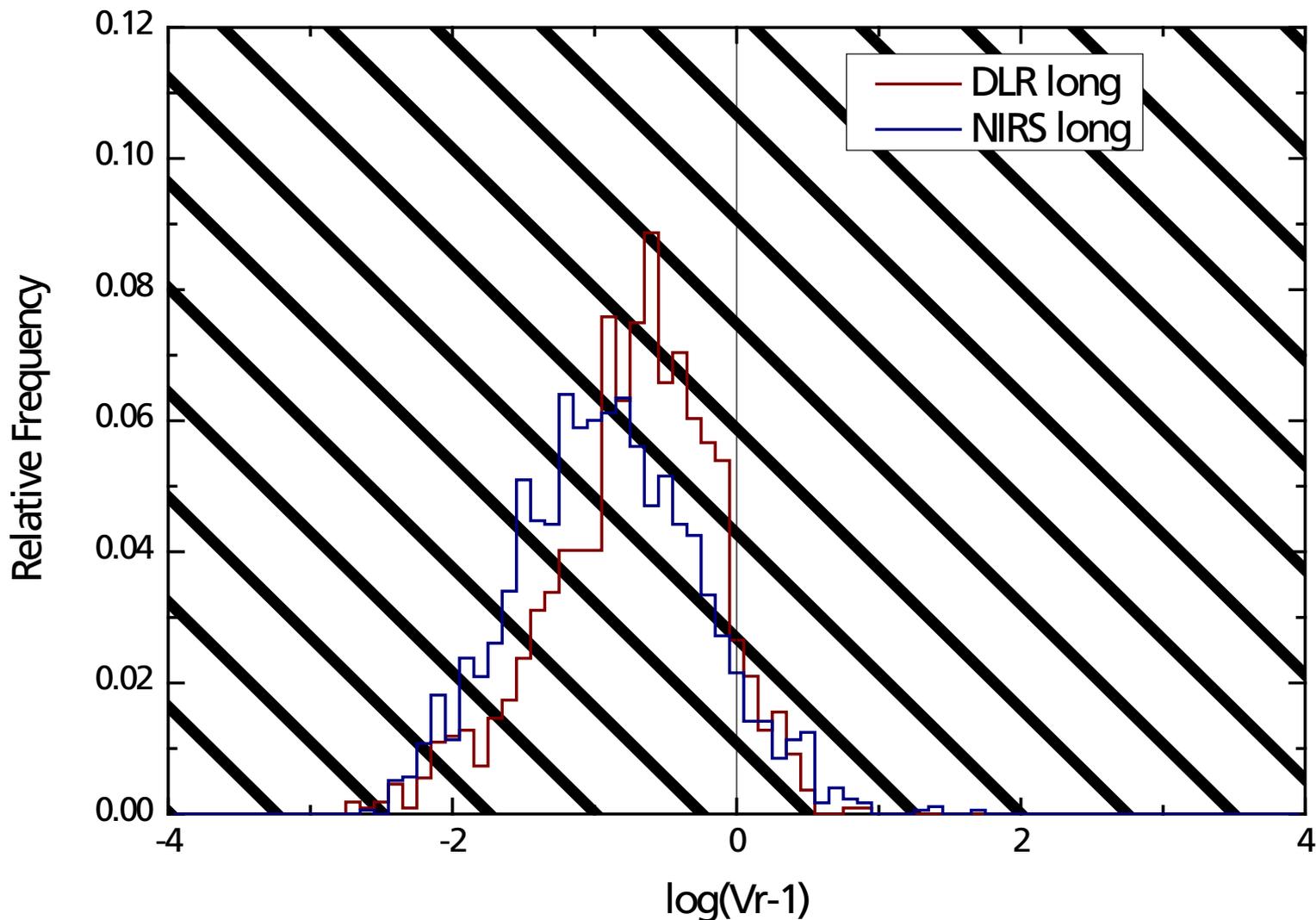
# Reduced etch ratio comparison short



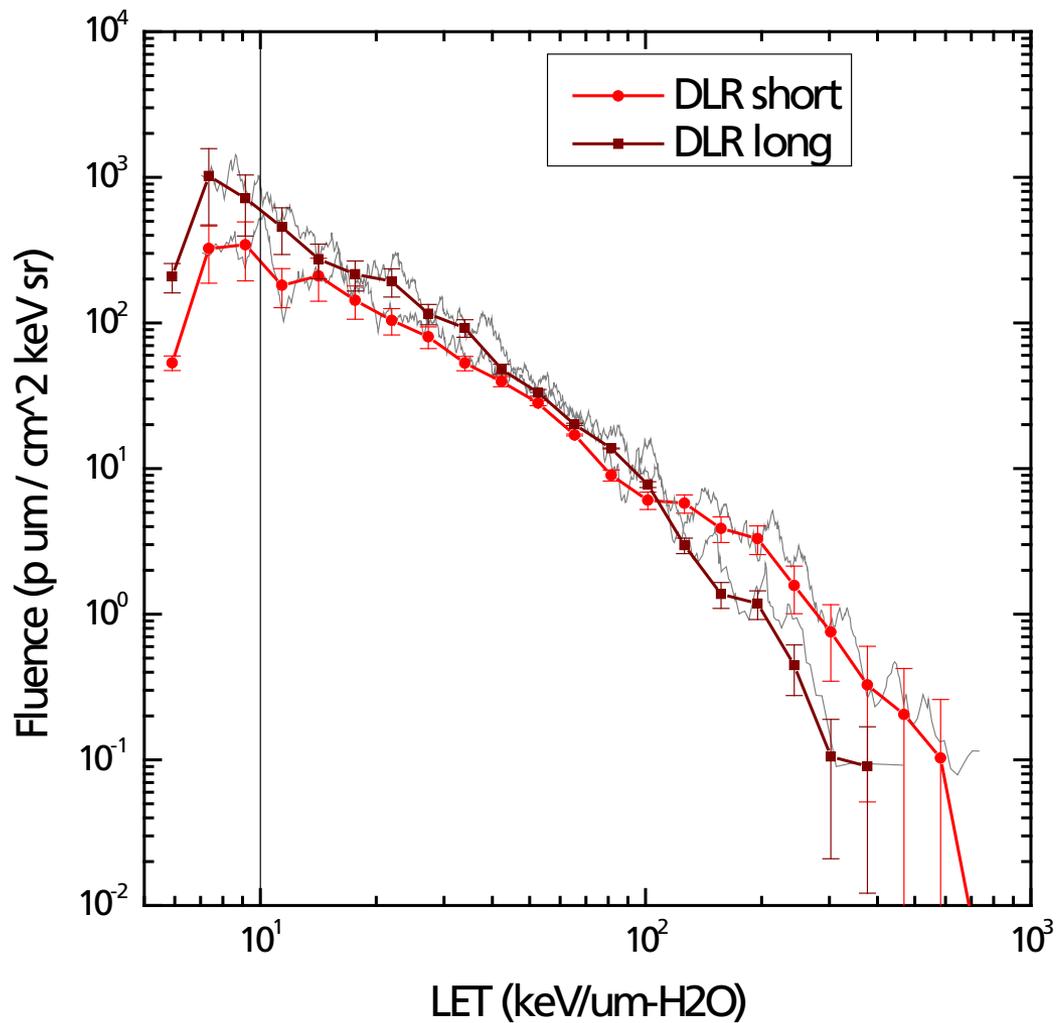
# Reduced etch ratio comparison short no overetched



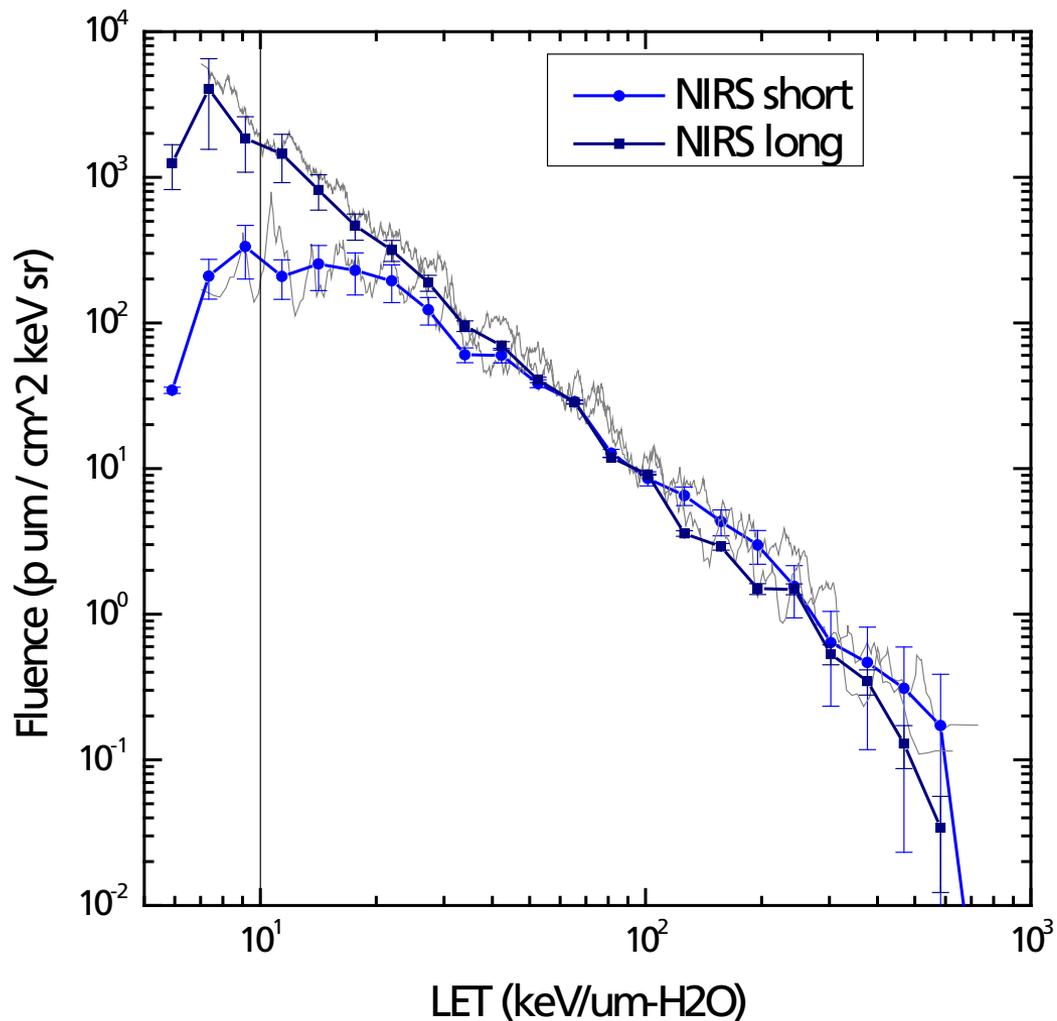
# Reduced etch ratio comparison long



# DLR short + long



# NIRS short + long



# NIRS short no overetched + long

