



EUROPEAN  
SPALLATION  
SOURCE

LoKI

# A SANS Instrument for Soft Matter, Materials and Bioscience at the ESS

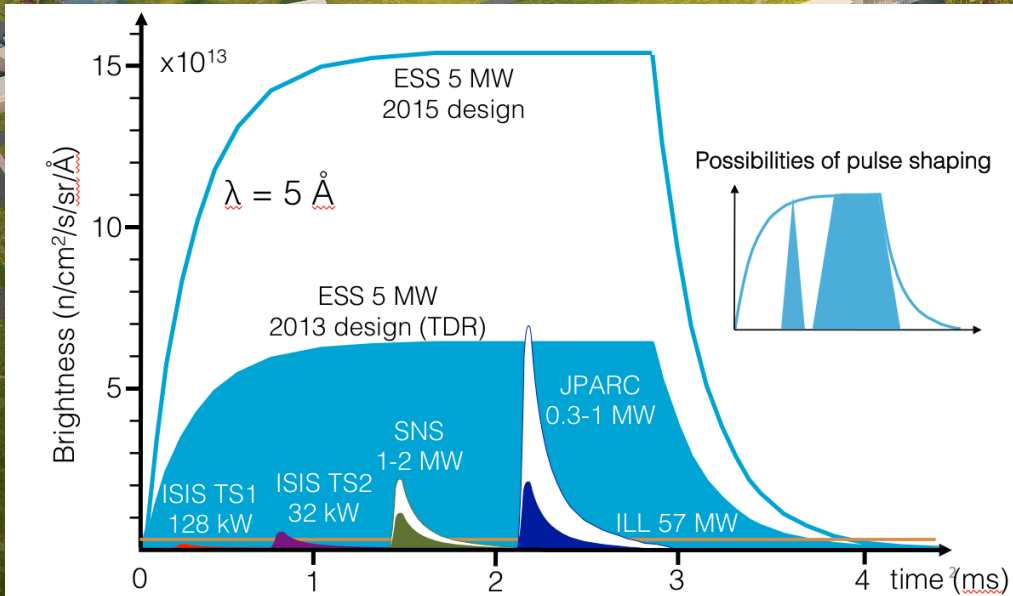
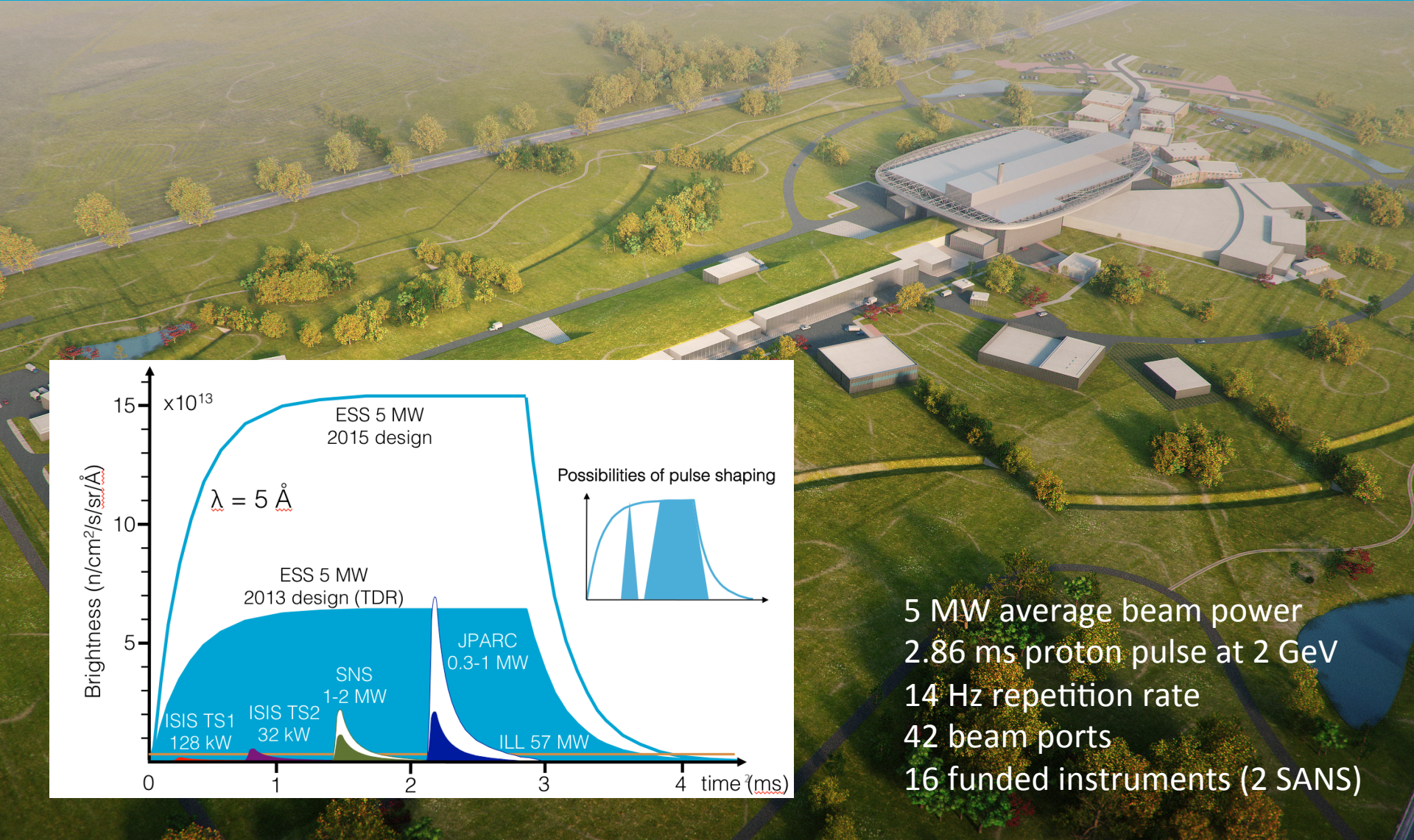
Andrew Jackson

Advances in Sample Environment and Experimental Control

Lund

September 10<sup>th</sup> – 11th, 2015

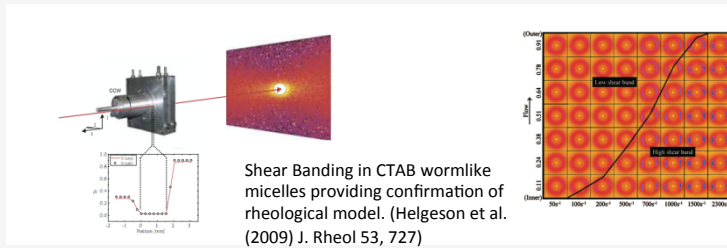
# European Spallation Source



5 MW average beam power  
2.86 ms proton pulse at 2 GeV  
14 Hz repetition rate  
42 beam ports  
16 funded instruments (2 SANS)

# Science Case

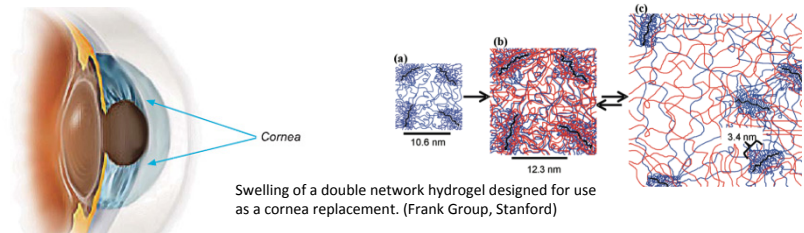
## FLOW



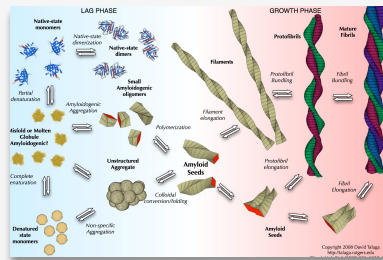
The flow of **complex fluids** through **complex geometries** is relevant to many industrial processes. There is a need to understand **structural effects of flow** both for practical purposes and to compare with fluid flow models.

## KINETICS

Gel structure forms over **multiple length scales**. **Kinetics** of gelation can be rapid needing **sub-second** time resolution. Neutrons provide the structure of each component in the presence of the other.



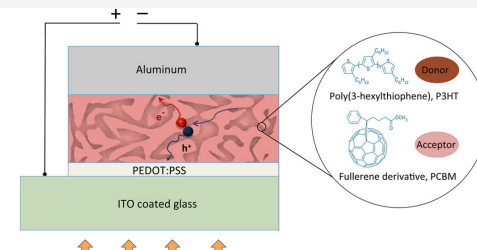
## MULTI SCALE



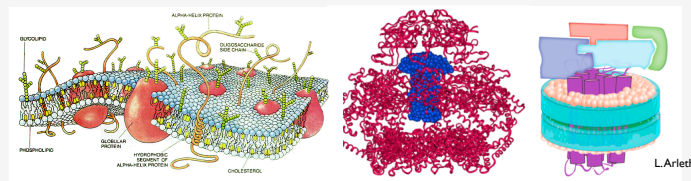
**Amyloid fibril** formation and growth is a **multi-length scale problem** and to understand methods of formation and inhibition the structural evolution must be observed.

## DEVICES

**Organic Solar Cells** promise to provide cheap and accessible solar energy. The **lifespan** and **efficiency** of the devices depends on the **nano-structure** polymer mixture. Understanding the **structural evolution** under operation guides development of new devices.



## BIOLOGY



**Membrane proteins** are key drug targets and cannot easily be crystallised for study by macromolecular crystallography. Examining such proteins in their native environment is vital to understanding their function.

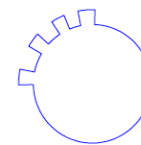
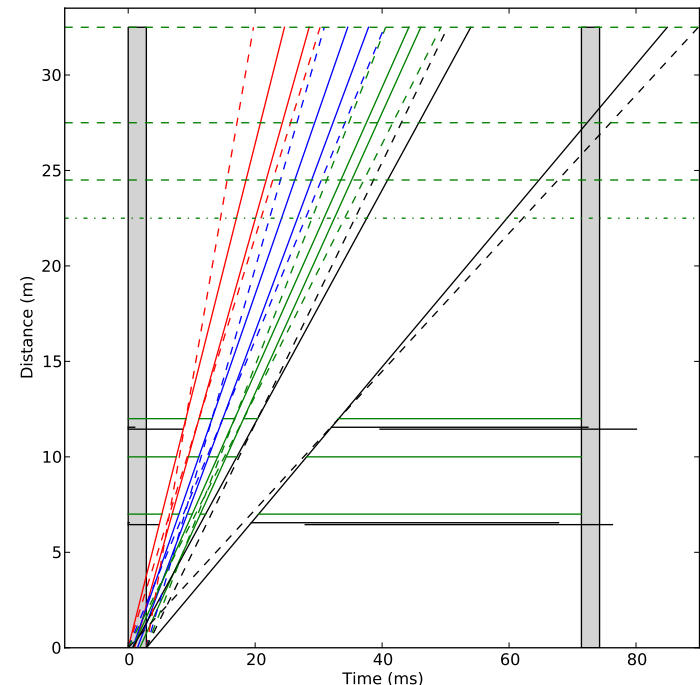
## A broad Q range, high flux SANS instrument for materials science and soft matter

### *High-level Scientific Requirements for the Instrument*

- The instrument shall allow data to be collected to a  $Q_{\min}$  of  $< 0.001 \text{ \AA}^{-1}$ .
- The instrument shall allow data to be collected to a  $Q_{\max}$  of  $> 2 \text{ \AA}^{-1}$ .
- The instrument shall allow data to be collected simultaneously over a continuous Q range with  $Q_{\max}/Q_{\min} > 1000$ .
- The instrument shall match the size of the neutron beam to the size of the sample.
- The instrument should allow the Q resolution ( $dQ/Q$ ) to be optimised for the experiment.
- The instrument should be capable of providing a Q resolution  $< 10\% dQ/Q$  over the whole Q range.
- The instrument should allow data collection from samples  $< 8 \text{ mm}^3$  volume

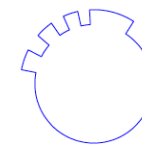
# Wavelength Selection and Resolution Enhancement

- Variable opening double disc choppers at 6.5 m and 11.5 m
- Operate at 14 Hz or 7 Hz
  - 2 Å – 11 Å @ 14 Hz
  - 2 Å – 19.5 Å @ 7 Hz
- Option for single disk choppers at 7m, 10m and 12m.
- 3x, 2x and 1x source frequency
- Provide short pulses for short wavelengths to improve resolution
- Can be thought of as enhanced flux at a given resolution compared with not using short wavelength bins in data processing



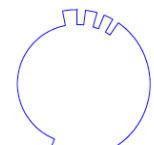
Chopper 7 m

42 Hz



Chopper 10 m

28 Hz

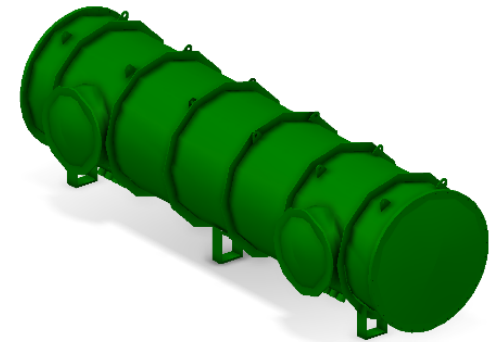
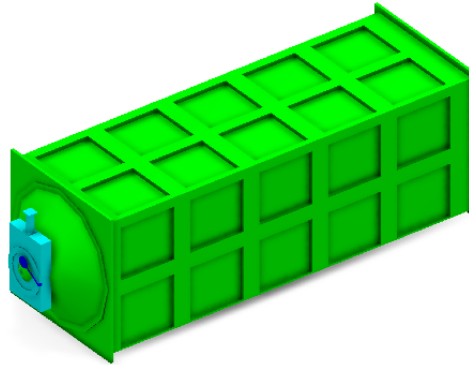
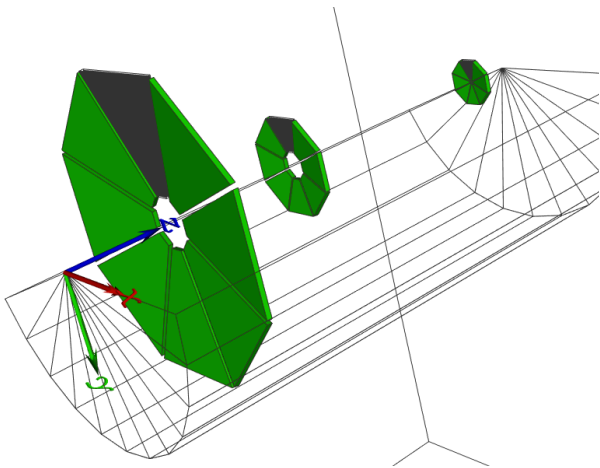


Chopper 12 m

14 Hz

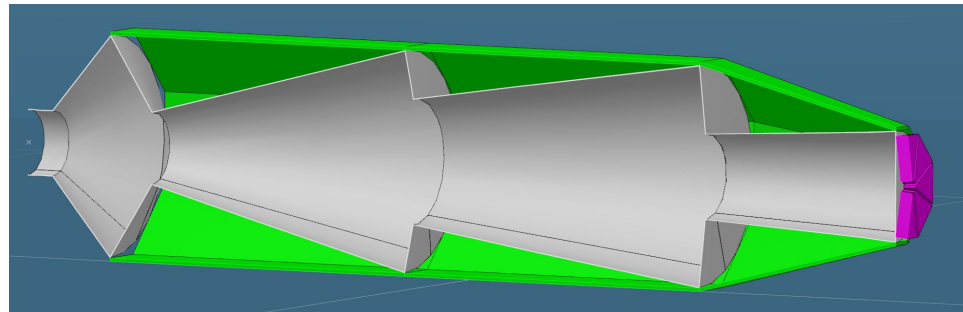
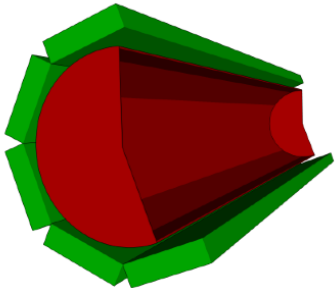
# Detector Geometry Choices

Baseline:  
Half-size window-frame using  $^{10}\text{B}$  is LoKI baseline as recommended by the STAP (below shows full frame).



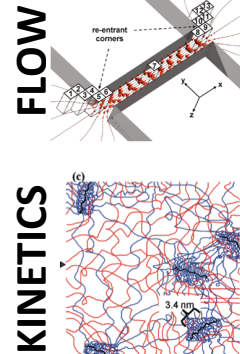
Alternative option: The barrel geometry

In this case the detector banks are arranged around a cylinder, the diameter can be reduced without loss of performance, the vacuum tank becomes smaller. This has evolved into a “christmas tree” tank design.

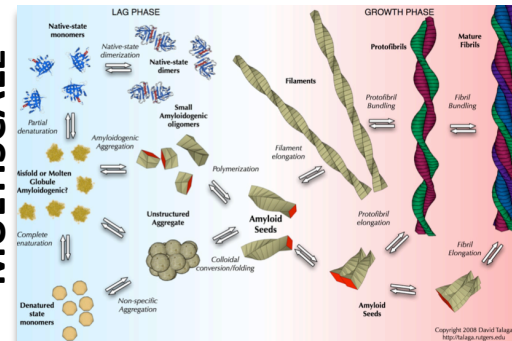


### Key Features

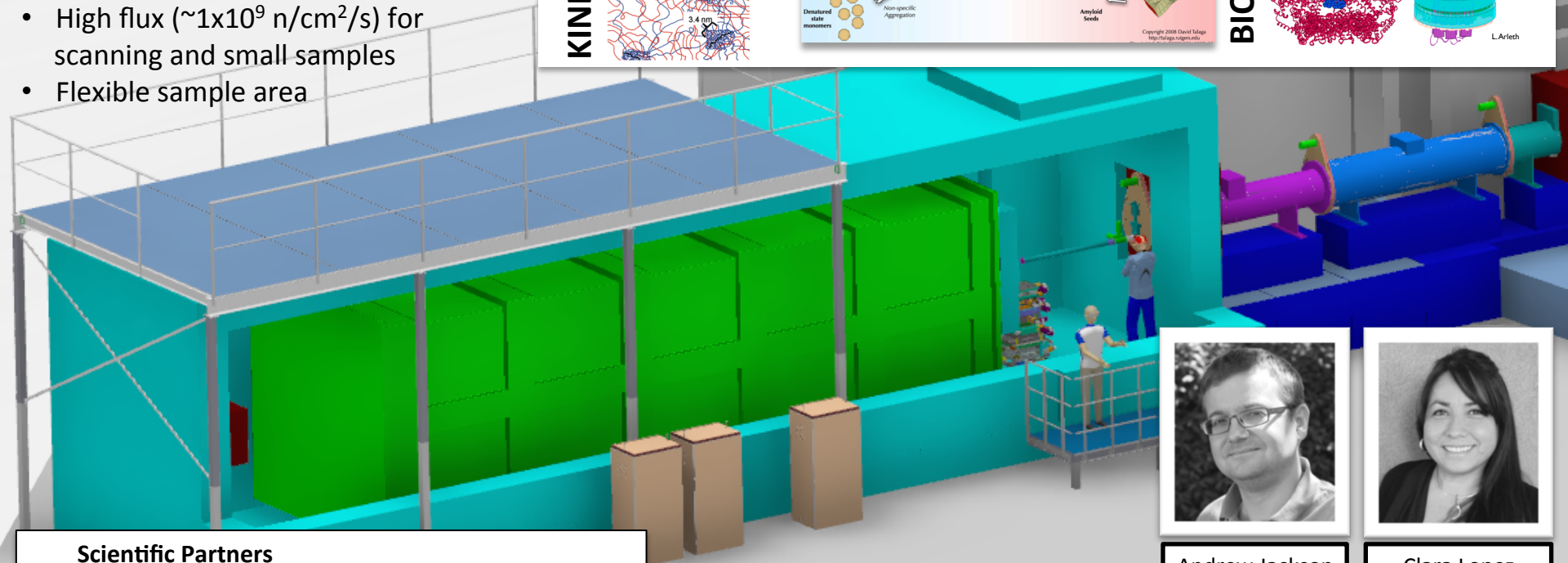
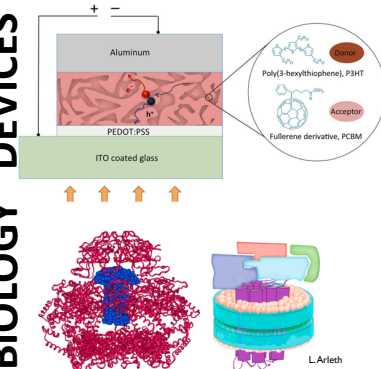
- 10 m collimation + 10 m detector distance
- Large detector coverage
- $Q_{\min} < 1 \times 10^{-3} \text{ \AA}^{-1}$
- $Q_{\max} > 2 \text{ \AA}^{-1}$
- $Q_{\max}/Q_{\min}$  up to 2500
- High flux ( $\sim 1 \times 10^9 \text{ n/cm}^2/\text{s}$ ) for scanning and small samples
- Flexible sample area





### MULTISCALE



### BIOLOGY DEVICES



### Scientific Partners

-  Prof. Adrian Rennie, Uppsala University
-  Dr. Joachim Kohlbrecher and Dr. Gergely Nagy, PSI



Andrew Jackson  
Lead Instrument  
Scientist



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