



# A Smart and Versatile Scattering Beamline Platform for Industrial and Scientific Applications at SILF

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Monday, July 10, 2023

# Outline

**01 SAXS Beamline of SILF Project**

**02 Data Processing**

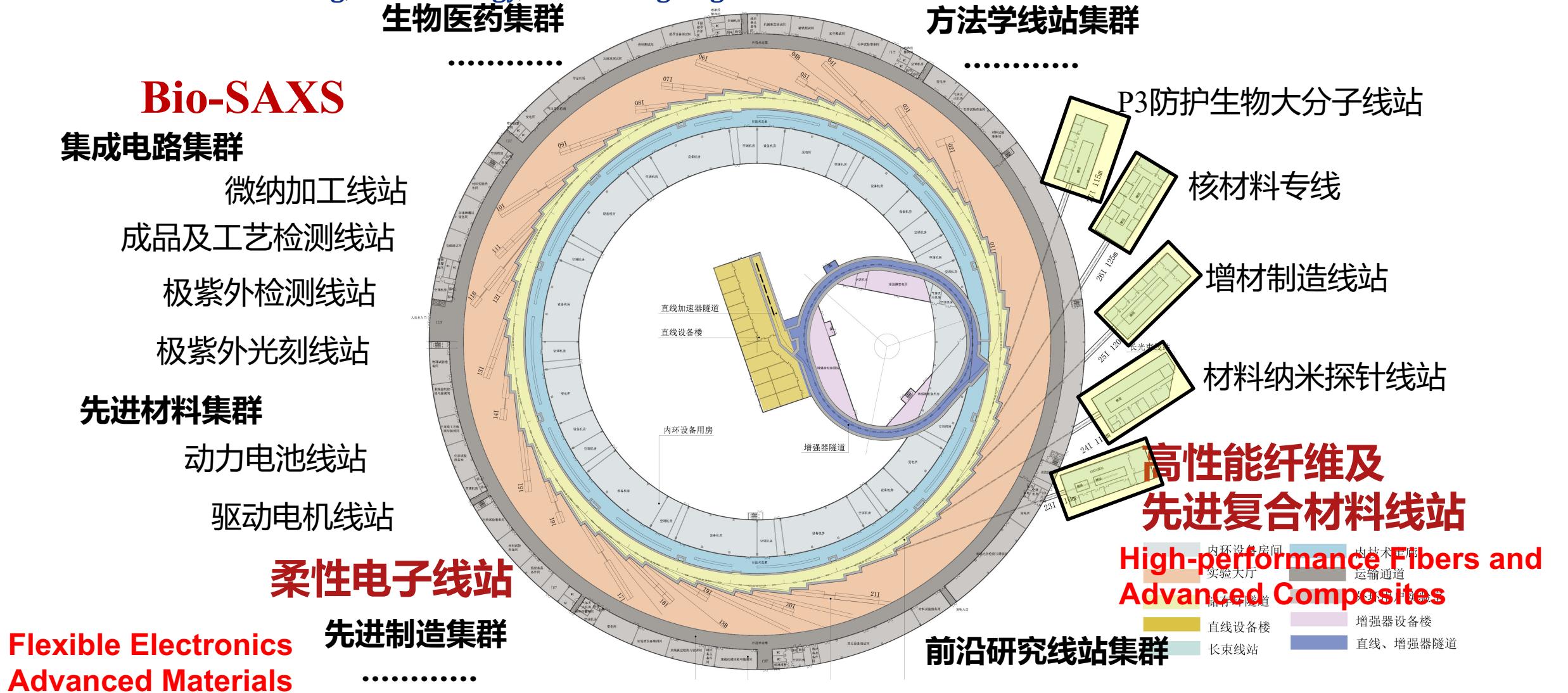
**03 Measurement Informatics**

**04 Future Outlook**



# 1. SAXS Beamlne of SILF Project

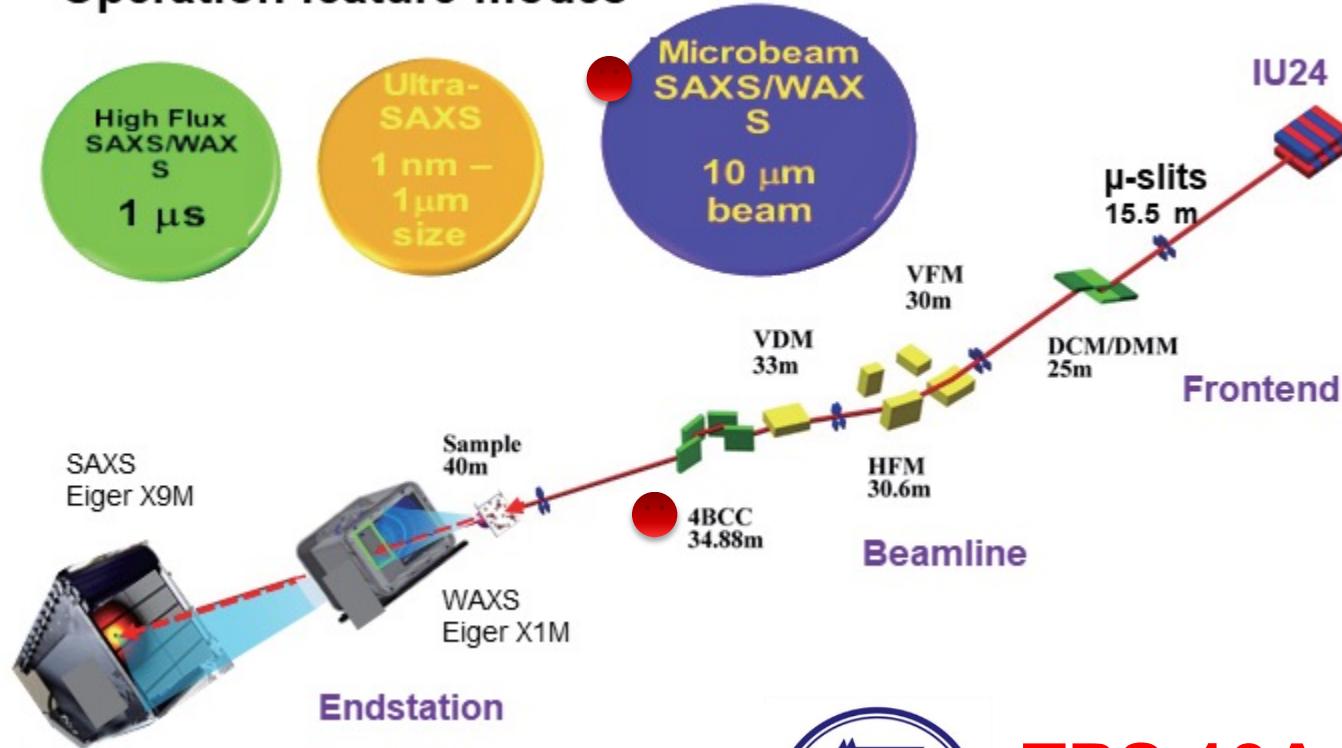
- For the sake of industrial agglomeration, functional differentiation, and complementary advantages, the first batch of 27 line stations will be planned to form a distinctive cluster of integrated circuits, biopharmaceuticals, advanced materials, advanced manufacturing, methodology, and cutting-edge research line stations



# TPS 13A : Advanced Cases of Beam Line Station Design

## □ 3D drawing of the primary optical components and beam path

### Operation feature modes

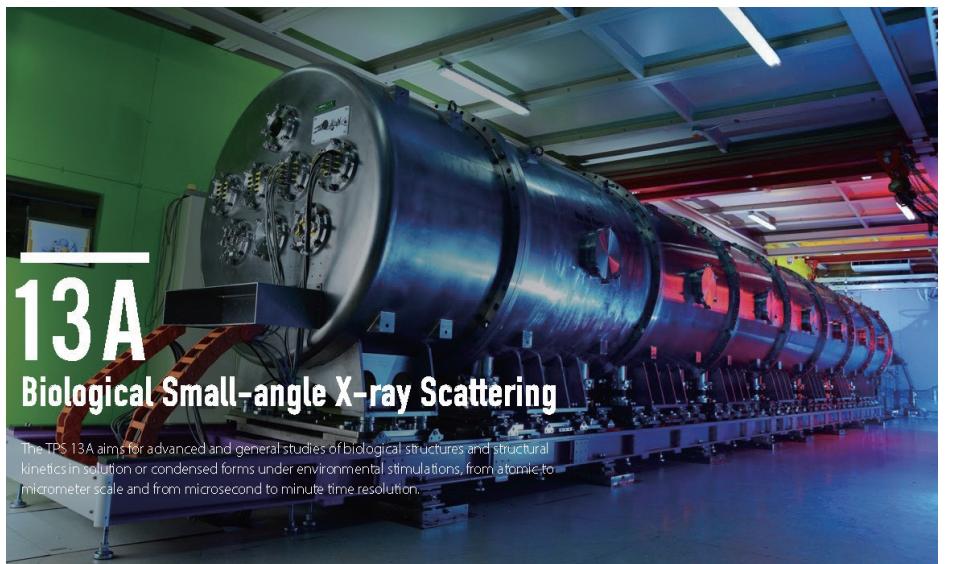


**TPS 13A**

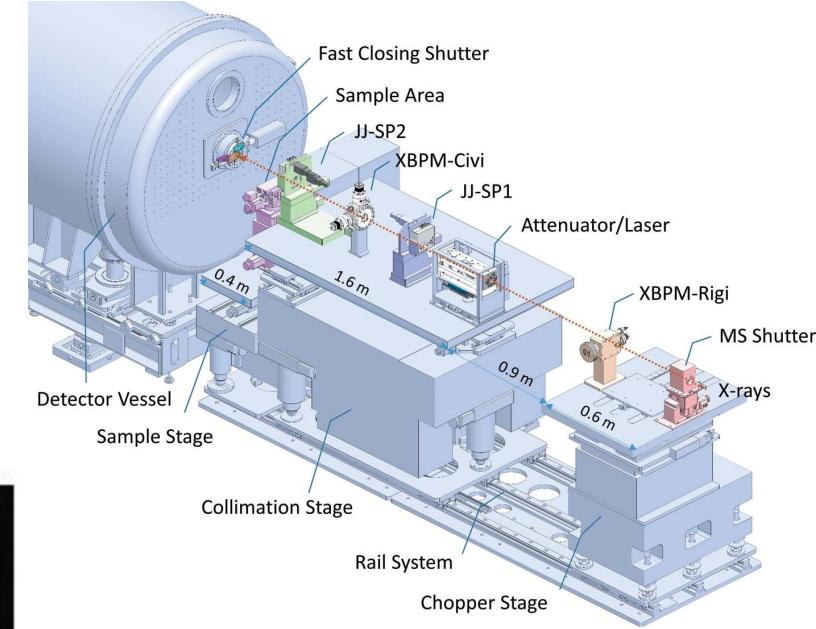
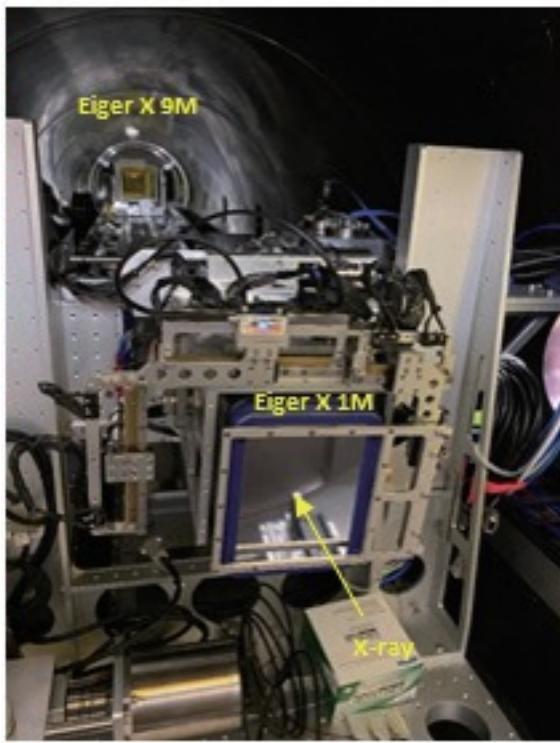
Nov. 18, 2020

Source:	ID24
Monochromator:	crystal monochromator Si(111) (DCM)/ multilayer (DMM)
Mirror:	KB mirrors (4BCM + KB-2 for m-Beam)
Energy Range:	4-23 keV
Focusing Position:	Detector (USAXS) / Sample (Microbeam)
Performance:	SAXS/WAXS/ASAXS/ <b>USAXS</b> /MB-USAXS-WAXS
Sample Environment:	HPLC/Robotic sample loading/ stopped-flow mixer/ humidity cell
Total flux (ph/s):	2'1013 (Si 111) / 2'1014 (DMM)
Detector:	In-vacuum Eiger X 9M(SAXS) / Eiger X 1M(WAXS)
q-range (Å-1):	0.0003 – 4
Energy resolution:	1.5'10-4 (Si 111) / 1'10-2 (DMM)

## □ Hardware system of TPS 13A



Eiger X 1M and X 9M pixel detectors

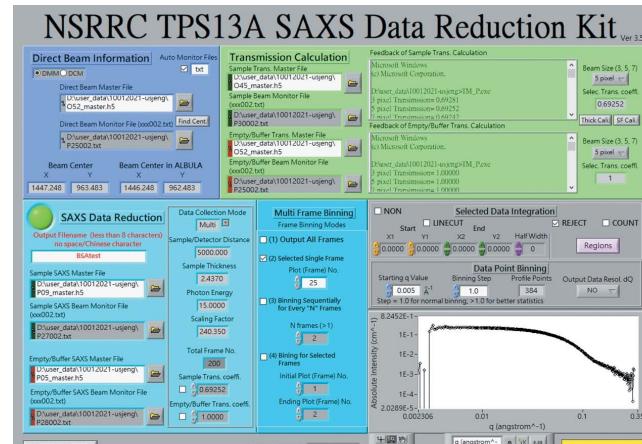


Key components along the X-ray path before the sample position

Eiger X 1M

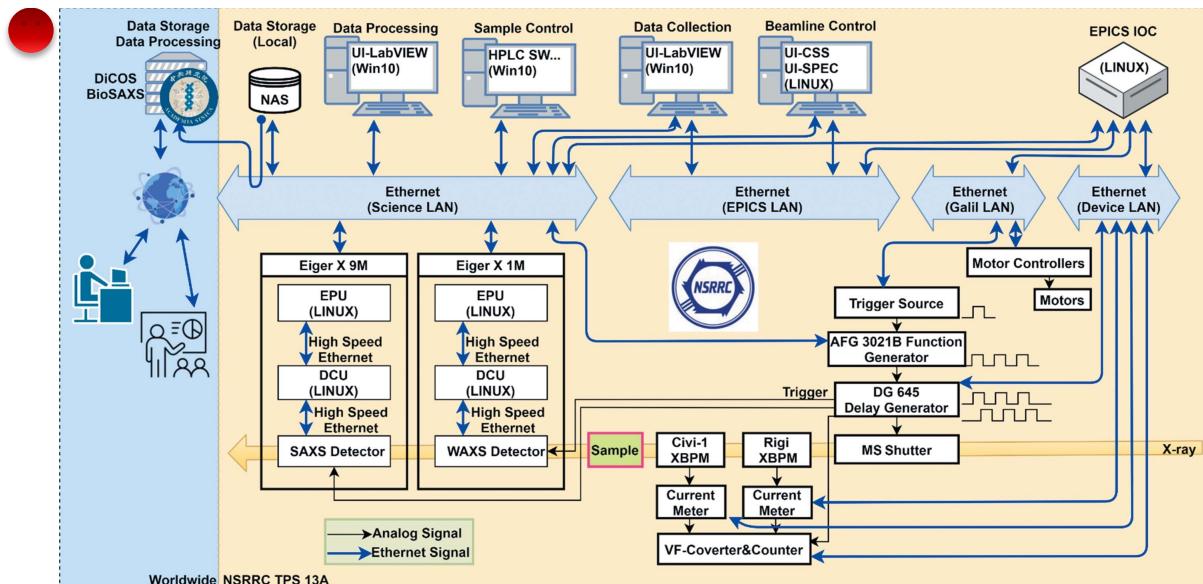
## □ Software system of TPS 13A

# The SAXS DR-GUI

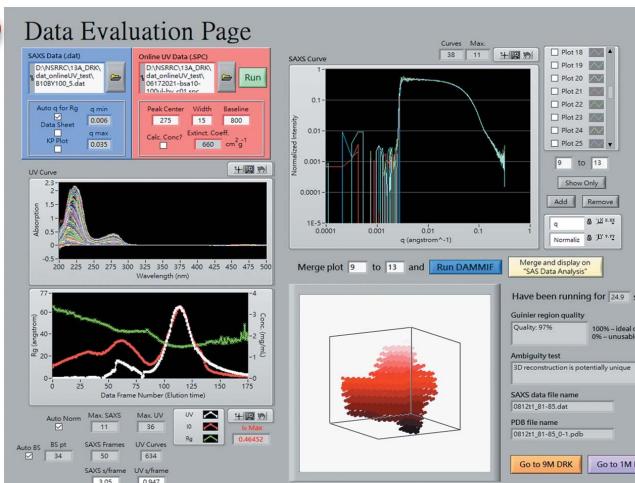


(a)

(b)



Ethernet network of the TPS 13A endstation.

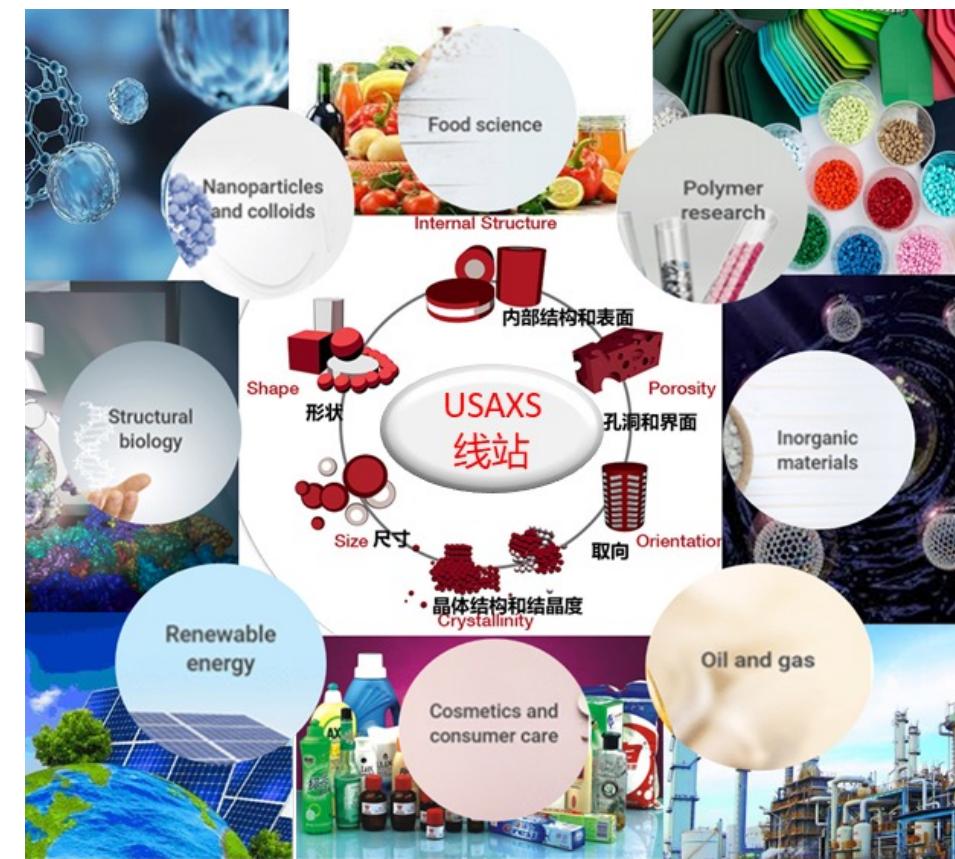
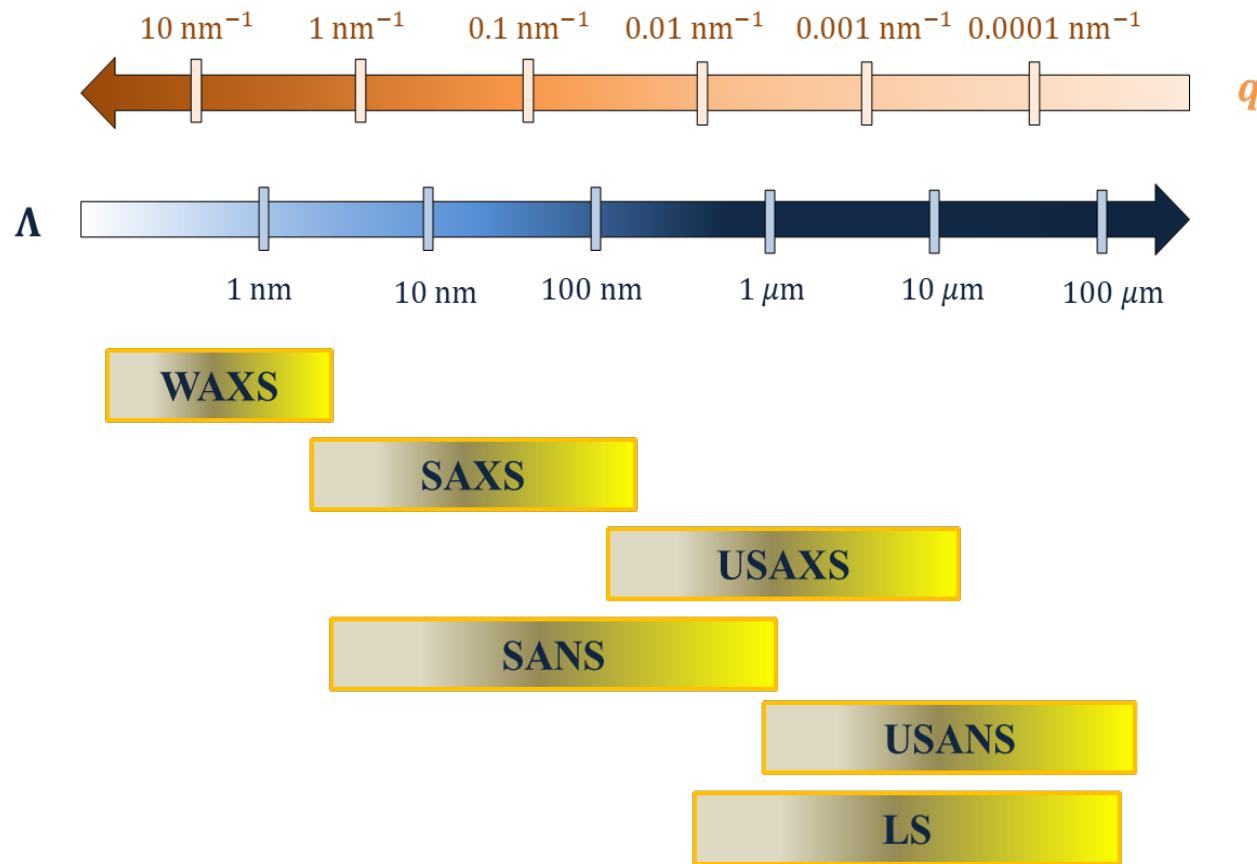


(c)

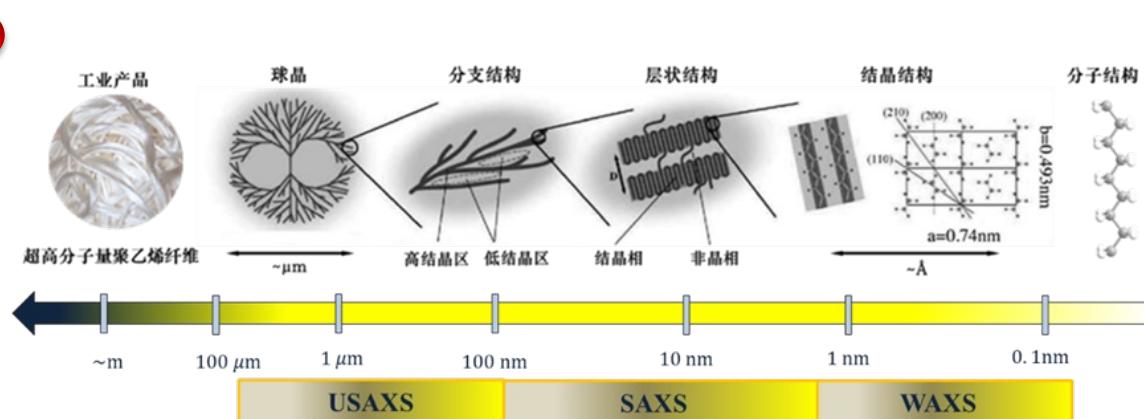
## The data evaluation page (DEP)

# (1) Beamline for High-performance Fibers and Advanced Composites

□ High-performance Fiber and Advanced Composites Beamline: Utilizing the USAXS-SAXS-WAXS coupling technology to conduct multi-scale time-resolved characterization of materials, integrating various experimental methods such as 2D-USAXS, **USAXS-SAXS-WAXS coupling**, SAXS-WAXS coupling, GISAXS-GIWAXS coupling, etc., to study the internal multi-level structure evolution process and mechanism of samples under different external field environments.



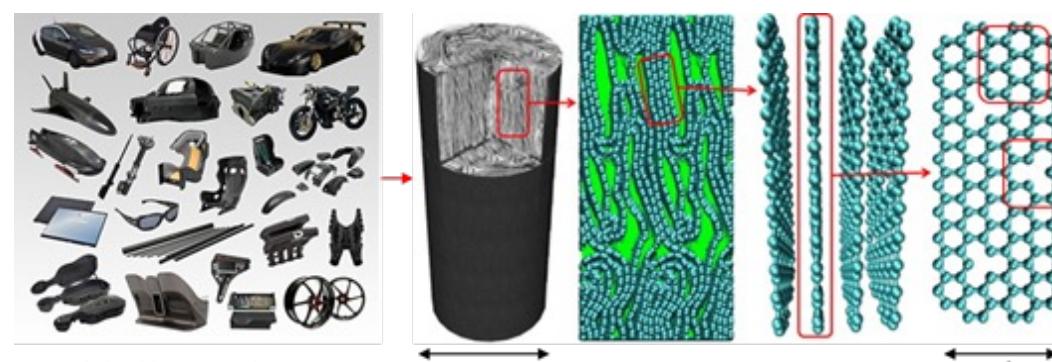
□ In-situ multi-scale research on the entire production process of fiber materials such as spinning, oxidation and carbonization, as well as the service performance of fiber composites, can optimize key processing processes and obtain higher performance fiber composite products.



超高分子量聚乙烯纤维  
( Ultra-High Molecular Weight Polyethylene Fiber , UHMW-PE )



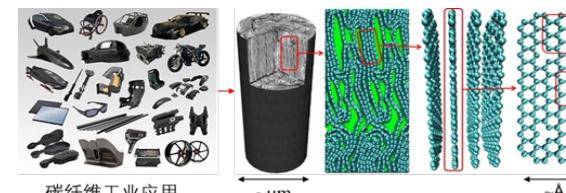
C919机身复材占比为12%，仍有很高的轻量化空间，轻量化对提高载荷、燃油经济性至关重要。C919发动机核心碳纤维复合材料风扇叶片国内尚未得到产业应用。



碳纤维工业应用

*Carbon*, 2012, 50(1): 235-243  
碳纤维 ( Carbon Fiber )

# ① For example, carbon fiber composite material technology:



## Polymer polymerization process

## Fiber forming process

Including resin polymerization, spinning of precursor fibers, water washing, drafting, pre oxidation, carbonization, graphitization, and more than 20 steps of procedures and processes, with nearly 3000 process control nodes

## Thermal treatment and resin composite process

Mechanism of local microstructure evolution and polymer spherulite growth during material stretching or fracture process (Number of fiber diameters)  $\mu\text{m}$  to dozens  $\mu\text{m}$ )

## time-resolved

In-situ scattering technology with time resolution up to 10ms

## spatial structure

In-situ multi-scale simultaneous characterization by USAXS/SAXS/WAXS

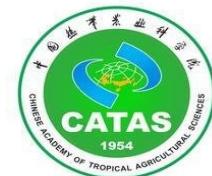
## spatial-resolved

Up to sub micron by  $\mu$ - SAXS

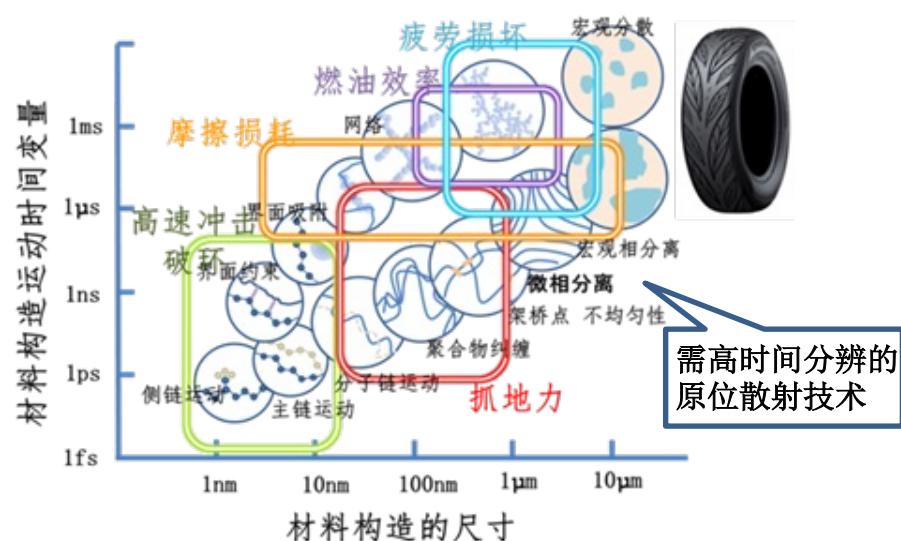
## In situ experiment

bench scale      pilot scale      . . . .

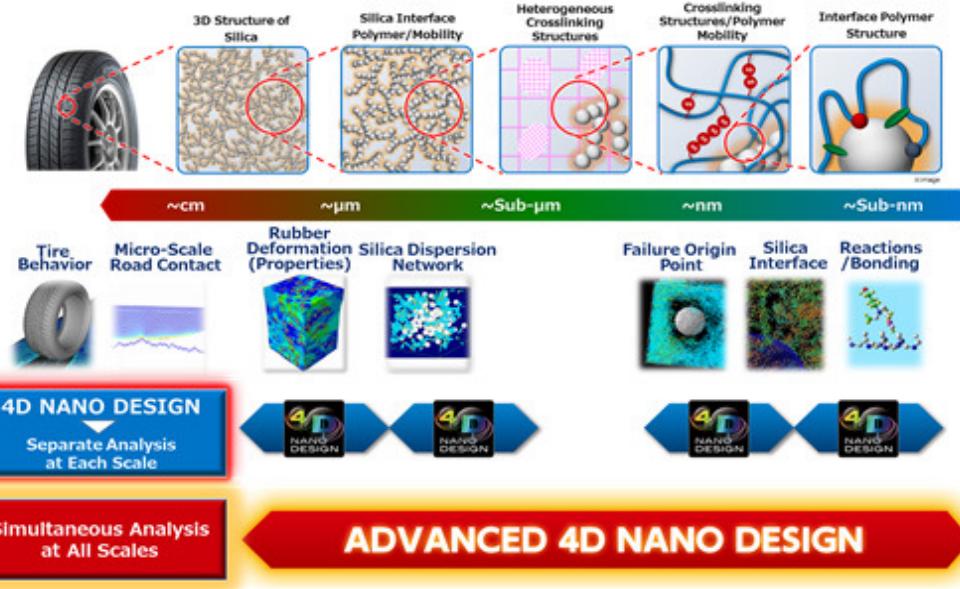
## ② For example, high performance rubber and its composite materials



轮胎的宏观性能与橡胶材料时空间的各层构造关系



"ADVANCED 4D NANO DESIGN" 的关键技术  
SPring-8 BL20XU线站的时间分辨2D-USAXS技术



通过精确调控橡胶中 $\text{SiO}_2$ 纳米粒子的三维排列获得高性能橡胶，与传统轮胎相比能效提升约6%，湿抓地性能提升约9%。

从nm~μm多级结构

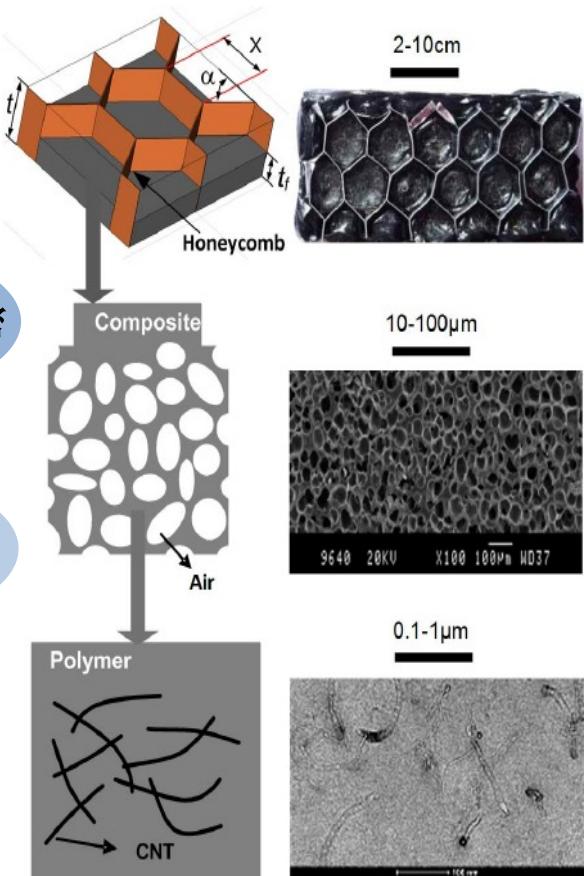
需USAXS/SAXS/WAXS联用

- Based on the advantages of the fourth generation Synchrotron light source, such as high flux density and high collimation, the use of time resolved USAXS-SAXS-WAXS joint in-situ measurement technology, through the analysis of the hierarchical structure of rubber materials and the evolution law between them, to develop high-performance rubber tires that are "low-carbon, environmentally friendly, green and energy-saving".

### ③ For example, high performance polymer foam materials

#### 多层次结构

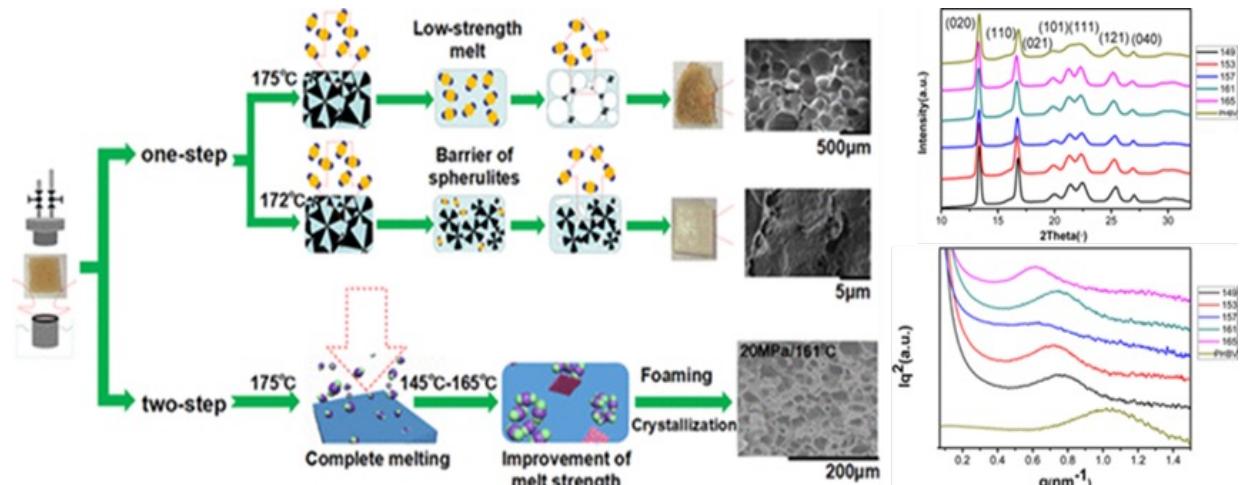
常见发泡材料(泡孔尺寸 $>300\text{ }\mu\text{m}$ , 泡孔密度 $<10^6\text{ 个}/\text{cm}^3$ )



细孔发泡材料(泡孔尺寸 $10\text{~}300\text{ }\mu\text{m}$ , 泡孔密度 $10^6\text{~}10^9\text{ 个}/\text{cm}^3$ )

微孔发泡材料(泡孔尺寸 $0.1\text{~}10\text{ }\mu\text{m}$ , 泡孔密度 $10^9\text{~}10^{15}\text{ 个}/\text{cm}^3$ )

纳米发泡材料(泡孔尺寸 $<0.1\text{ }\mu\text{m}$ , 泡孔密度 $>10^{15}\text{ 个}/\text{cm}^3$ )

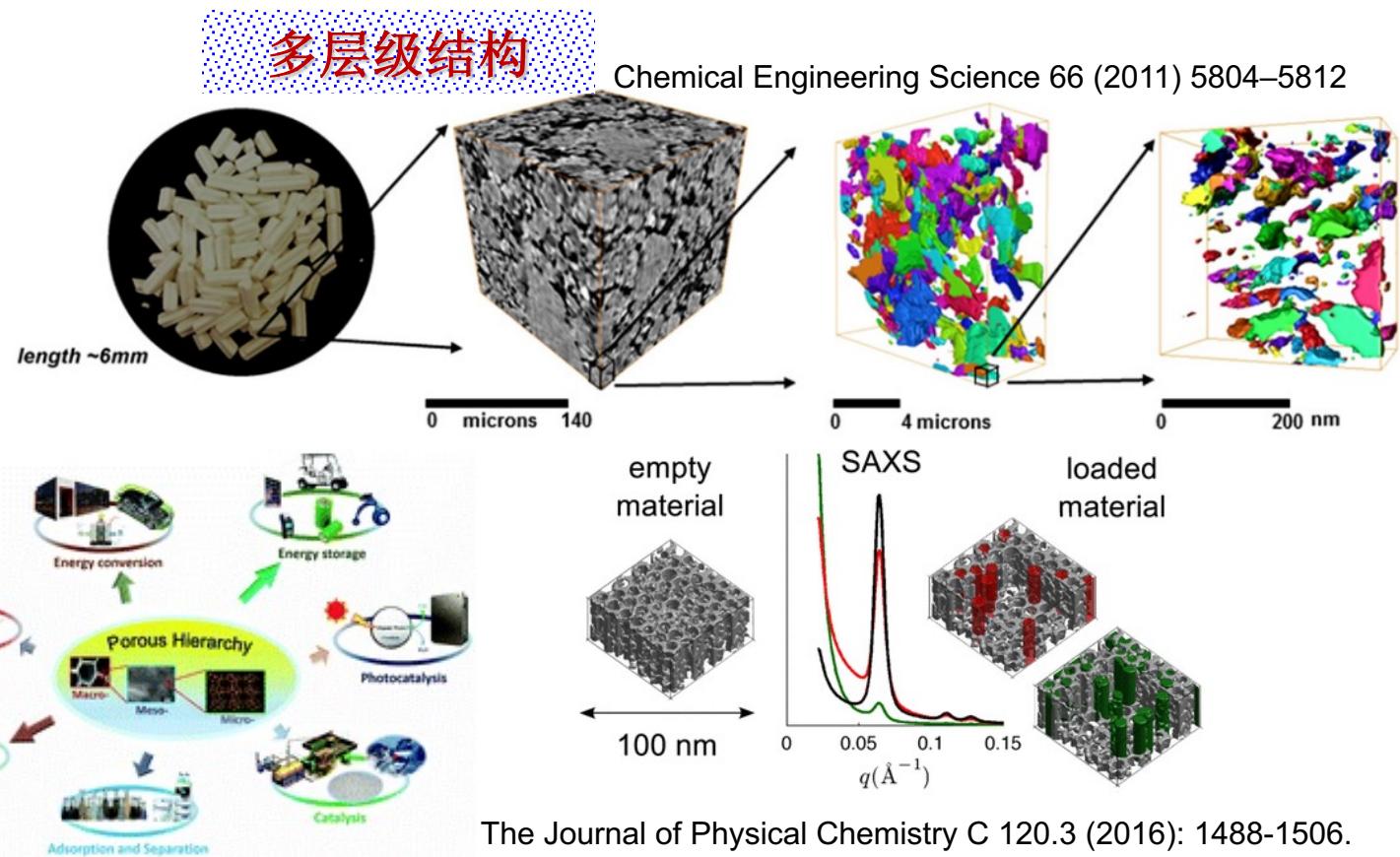
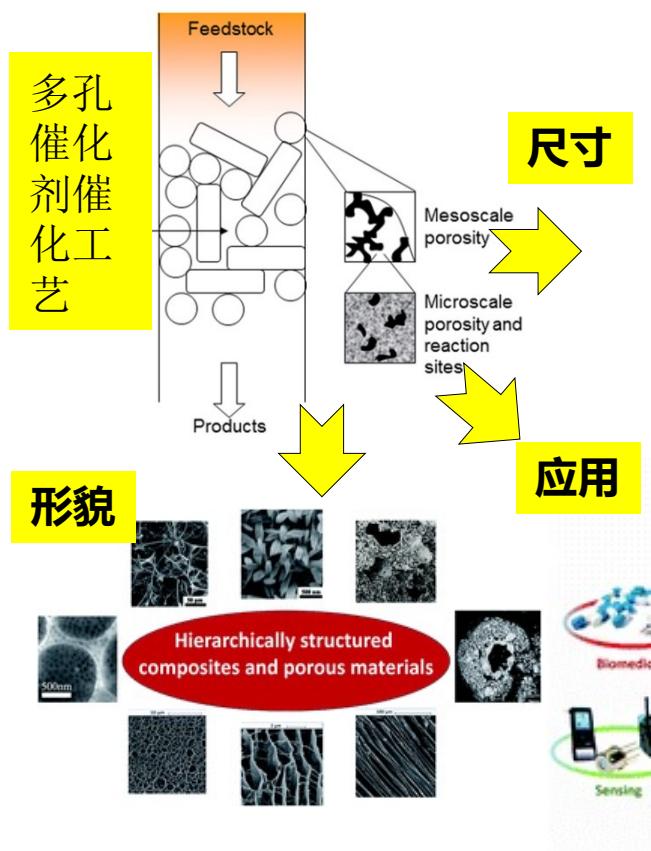


ACS omega 5.17 (2020): 9839-9845.



- Using the time resolved USAXS-SAXS-WAXS combined measurement technology, the production process is optimized by analyzing the evolution law of foam structure at all levels, so as to effectively regulate the foam structure (size and density, etc.) of polymer foam, and finally develop a "green" high-performance foam material

## ④ For example, high performance porous catalyst materials

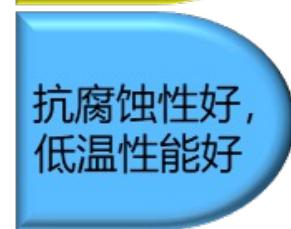


- Synchrotron USAXS-SAXS-WAXS in-situ measurement technology can be used to analyze the pore structure (pore size, pore size distribution) of porous materials in the full scale space (0.1 nm to 10 um), and can also conduct in-depth research on the pore forming dynamics of macroporous materials.

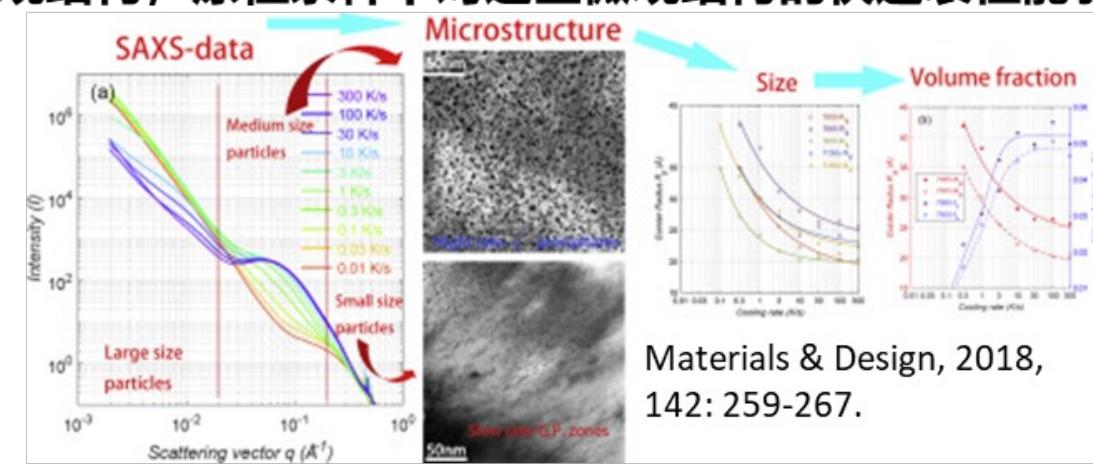
## ⑤ For example, high performance alloy materials

高性能合金材料通常表现出复杂的跨越多个长度尺度的微观结构，原位条件下对这些微观结构的快速表征能够极大的加速新型合金材料的开发。

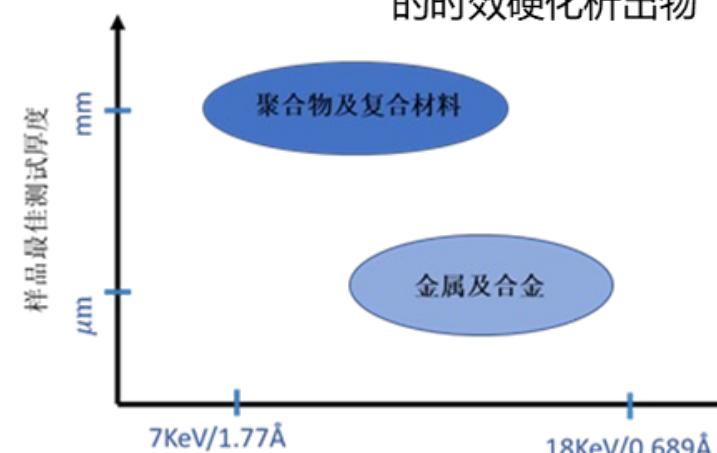
合金材料的优势



合金材料的应用



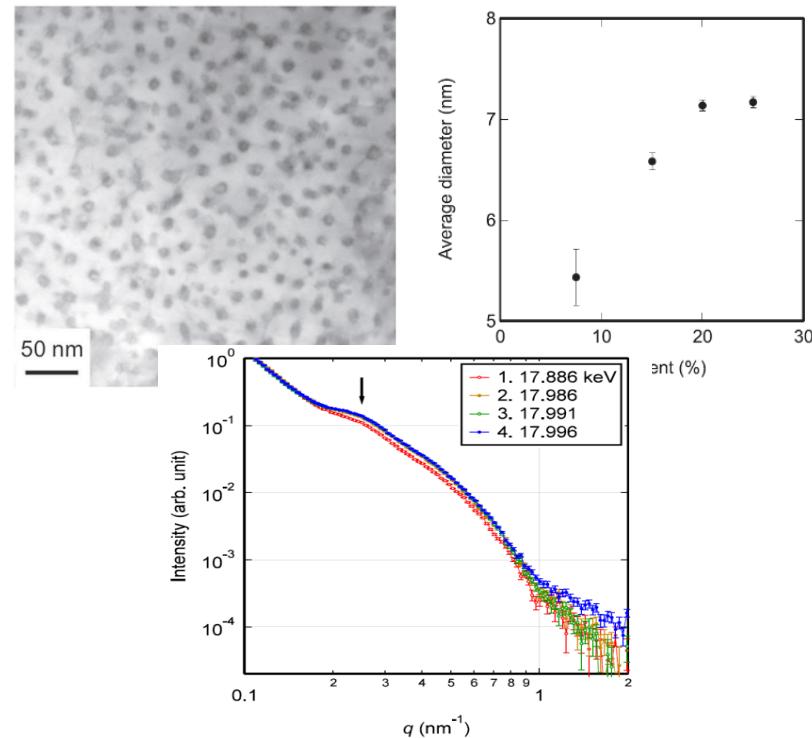
SAXS分析在很宽的淬火速率范围内 Al-Zn-Mg-Cu 合金的时效硬化析出物



X线能量      10keV / 7~18keV

## ⑥ Other technologies and applications

### Abnormal X-ray Small Angle Scattering (ASAXS)



- Study of the structure of flux pinning additive ( $\text{BaZrO}_3$ ) in high temperature superconductor (Gd, Y)  $\text{BaCuO}$  thin films was studied



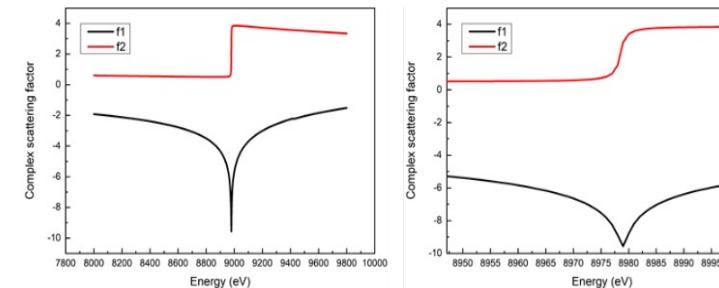
单色器

散射函数  $I_{reso}(q)$

$$I_{reso}(q) = NS(q)V^2(q) = \frac{1}{K} \left[ \frac{\Delta I(q, E_1, E_2)}{f'(q, E_1) - f'(q, E_2)} - \frac{\Delta I(q, E_1, E_3)}{f'(q, E_1) - f'(q, E_3)} \right]$$

$$K = f'(q, E_2) - f'(q, E_3) + \frac{f''^2(q, E_1) - f''^2(q, E_2)}{f'(q, E_1) - f'(q, E_2)} - \frac{f''^2(q, E_1) - f''^2(q, E_3)}{f'(q, E_1) - f'(q, E_3)}$$

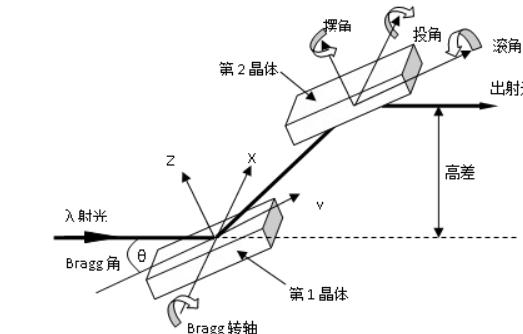
$$f(E) = f_0 + f'(E) + if''(E)$$



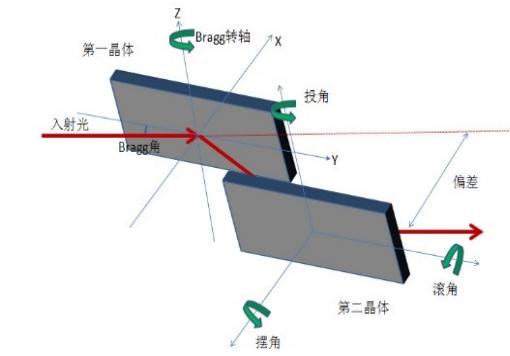
X线能量分辨

$2 \times 10^{-4}$

高分辨 DCM (Si111)



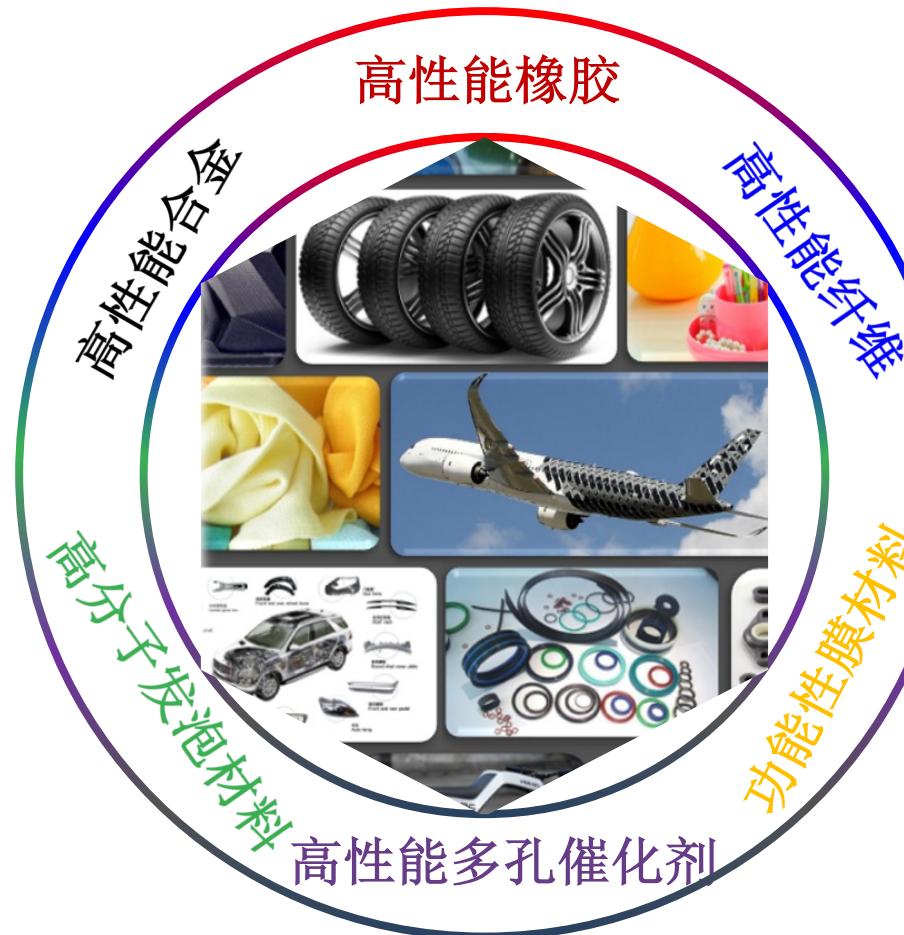
高通量 DMM  
多层膜单色器



# Beamline Design



**High energy resolution**



**跨尺度表征**

为复杂结构提供 **1 nm~10 μm** 的跨尺度表征技术

**高空间分辨率**

为材料原位研究提供最低 **2.5μm** 分辨能力

**高时间分辨率**

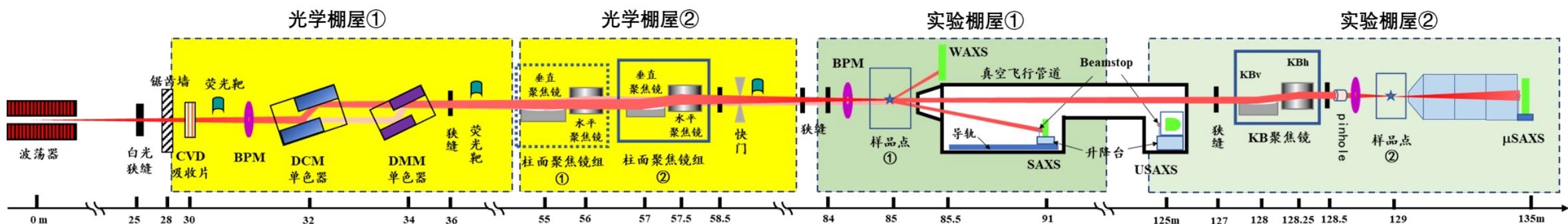
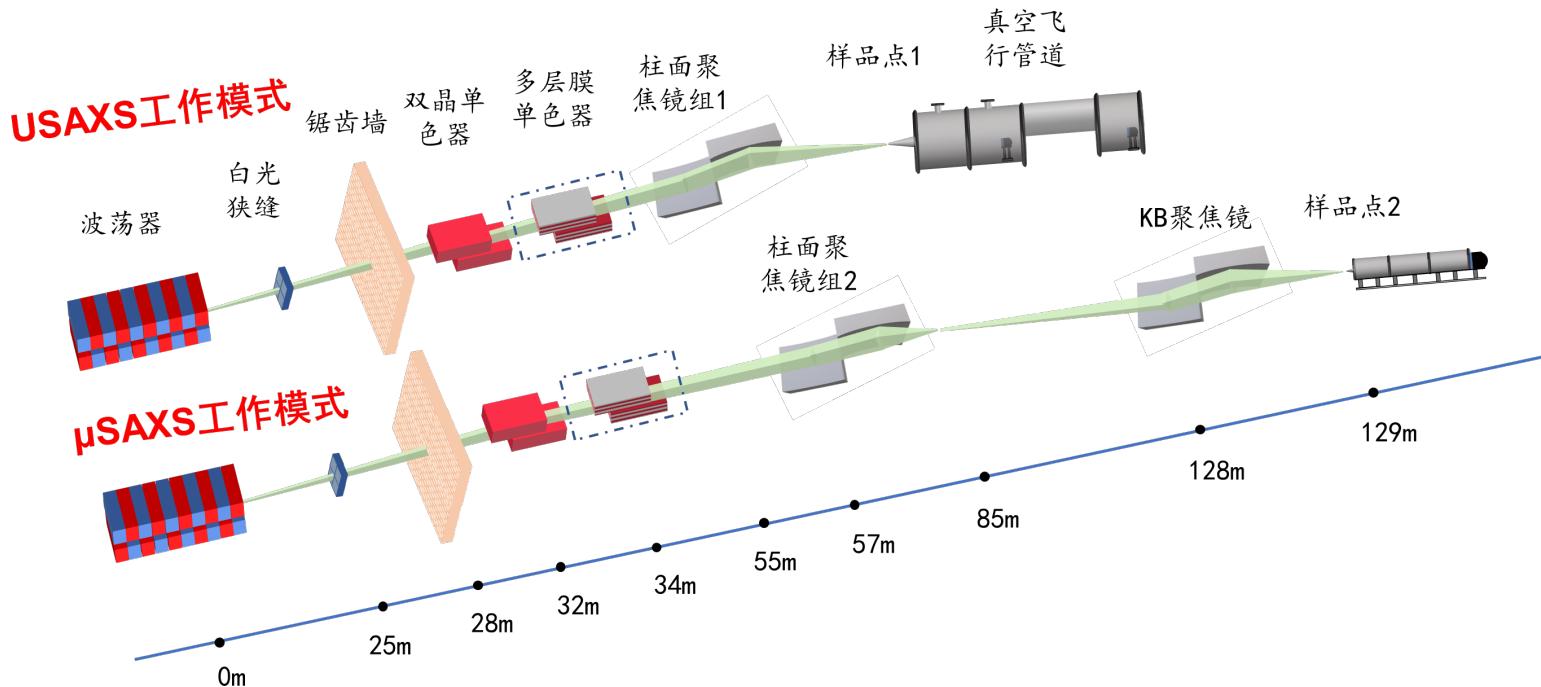
为材料原位研究提供最低 **2ms** 的时间分辨能力

**联用和分析智能化**

高通量条件下，通过智能控制系统实现 **USAXS-SAXS-WAXS** 三种实验方法的**高速联用和结果分析**

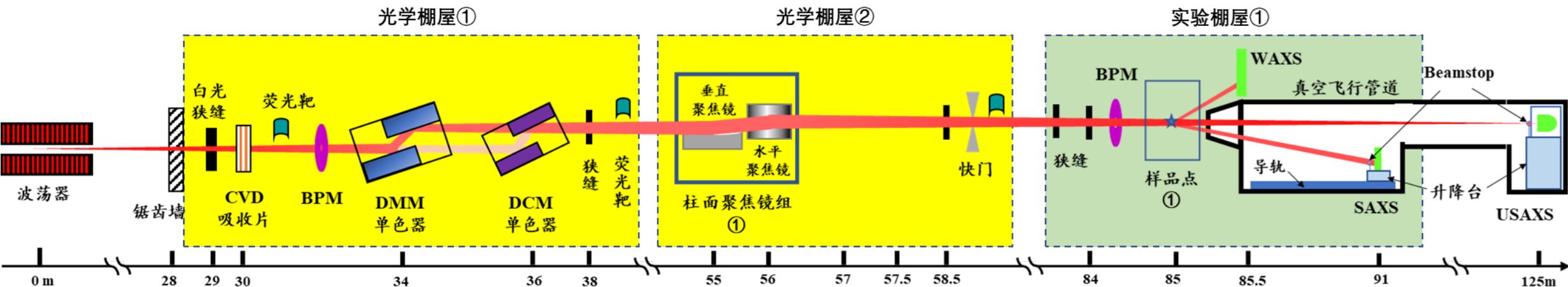
# Beamline Layout and Performance

设计指标	
光束线	能量范围 6~18 keV
	能量分辨率 ( $\Delta E/E$ ) DCM: $\leq 2 \times 10^{-4}$ @ 10 keV
	光子通量 @300mA USAXS: $1 \times 10^{13}$ @ 10 keV μSAXS: $1 \times 10^{12}$ @ 10 keV
	光斑尺寸 @10keV USAXS: 400μm × 400μm μSAXS: 2μm × 2μm
	可探测 $q_{\min}$ USAXS: $5.7 \times 10^{-4}$ μSAXS: $1.27 \times 10^{-2}$
实验站	时间分辨率 10ms

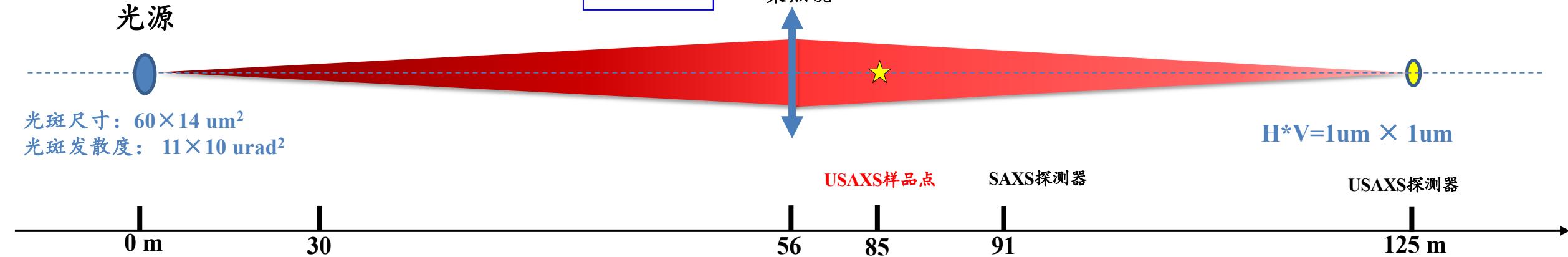


# USAXS Workstation

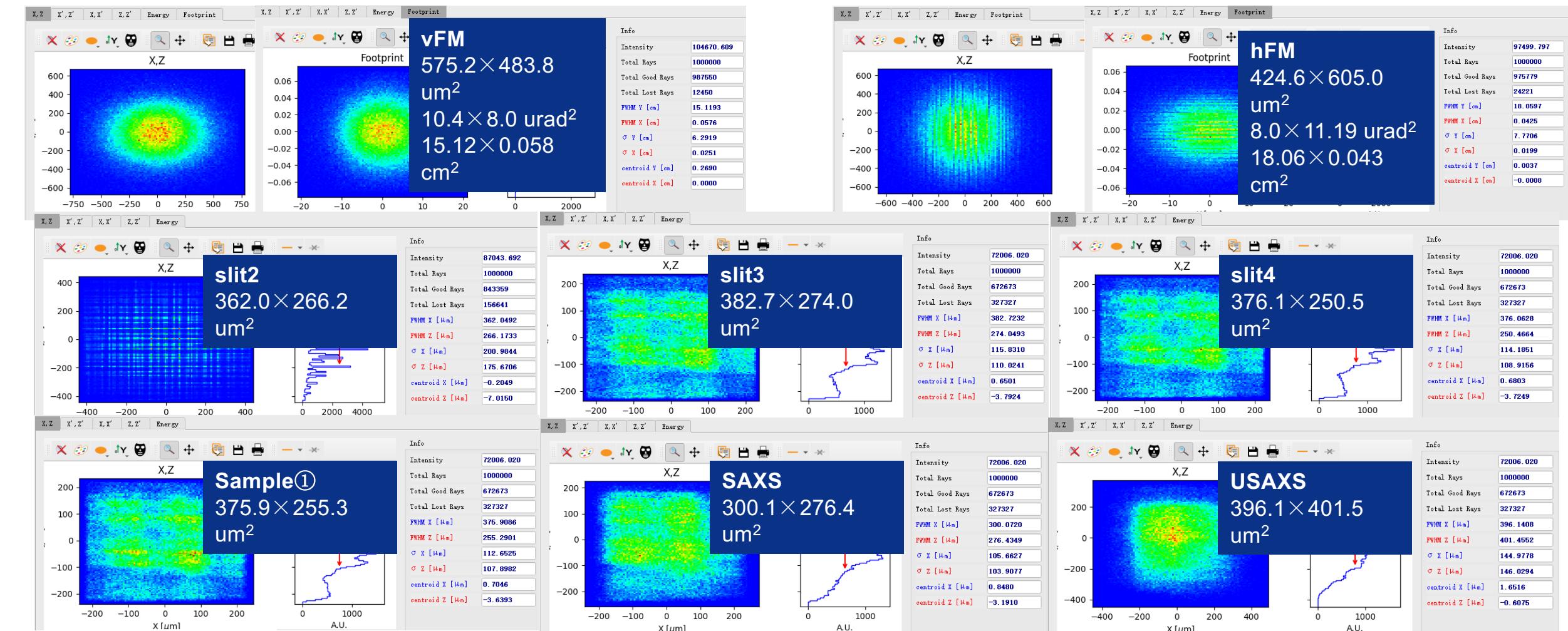
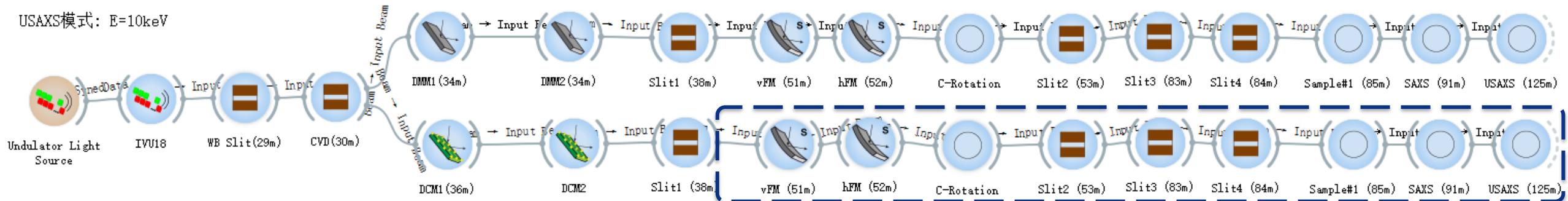
## General beamline layout



## Workstation: one line, two stations

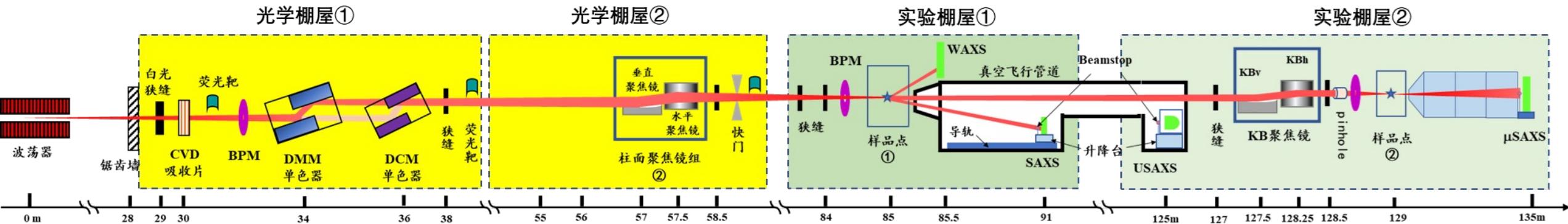


USAXS 模式: E=10keV

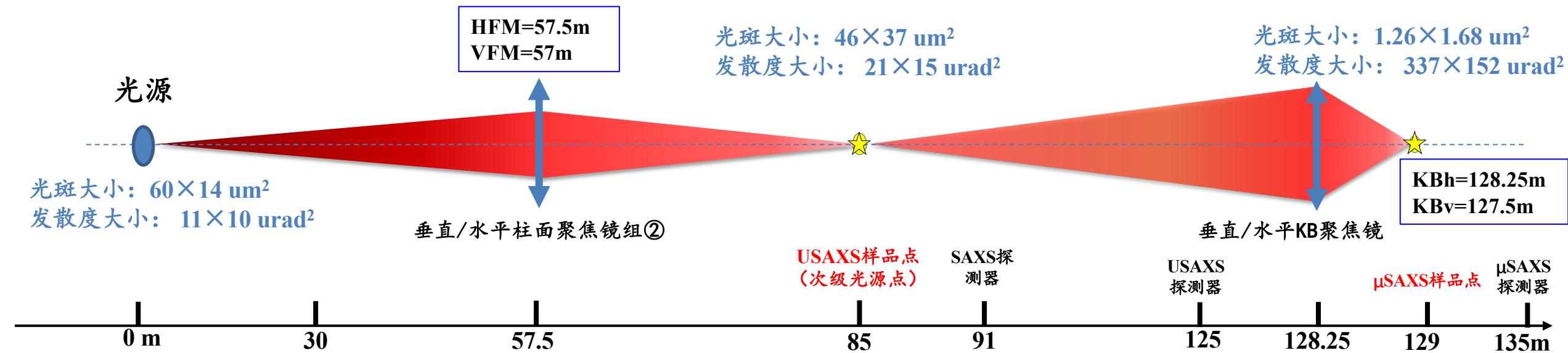


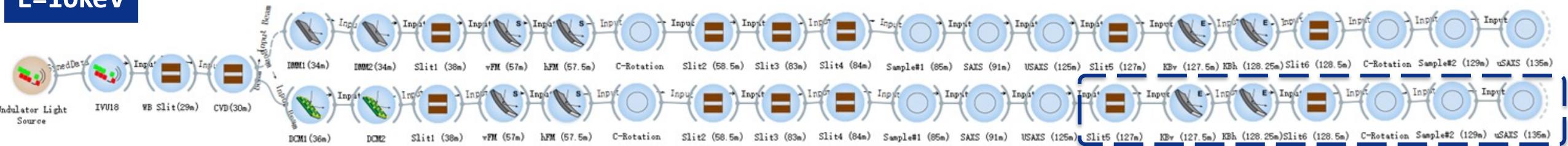
# μSAXS Workstation

## General beamline layout

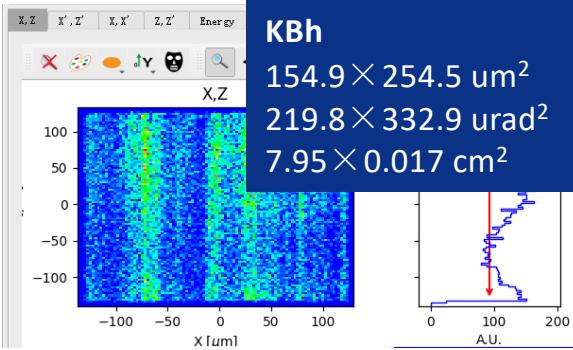
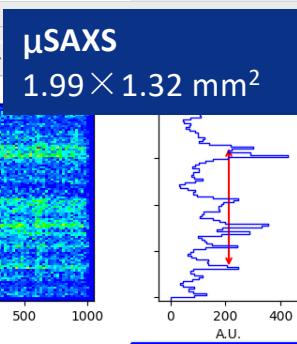
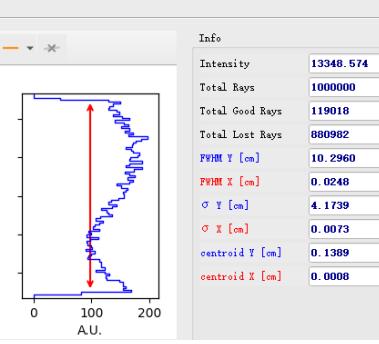
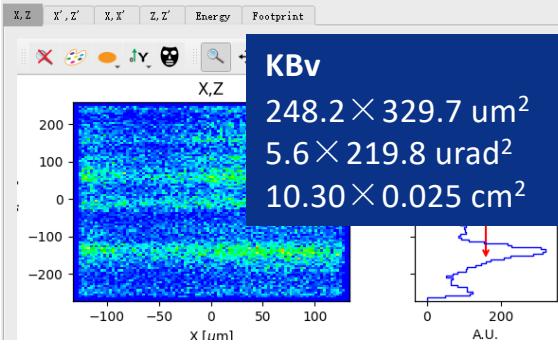
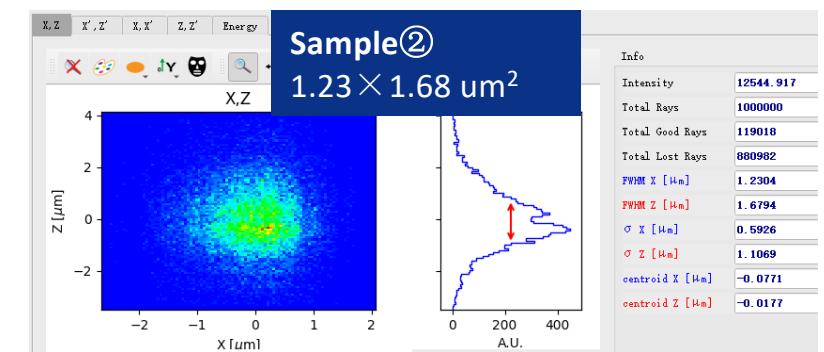
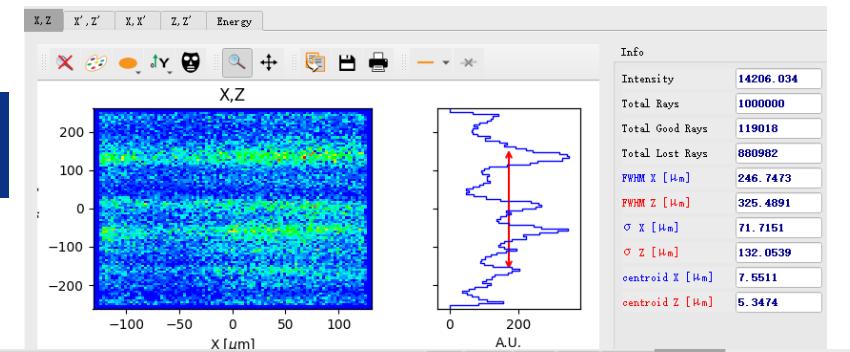


## Workstation: one line, two stations



**E=10keV**

**slit5**  
246.7×325.5  $\mu\text{m}^2$



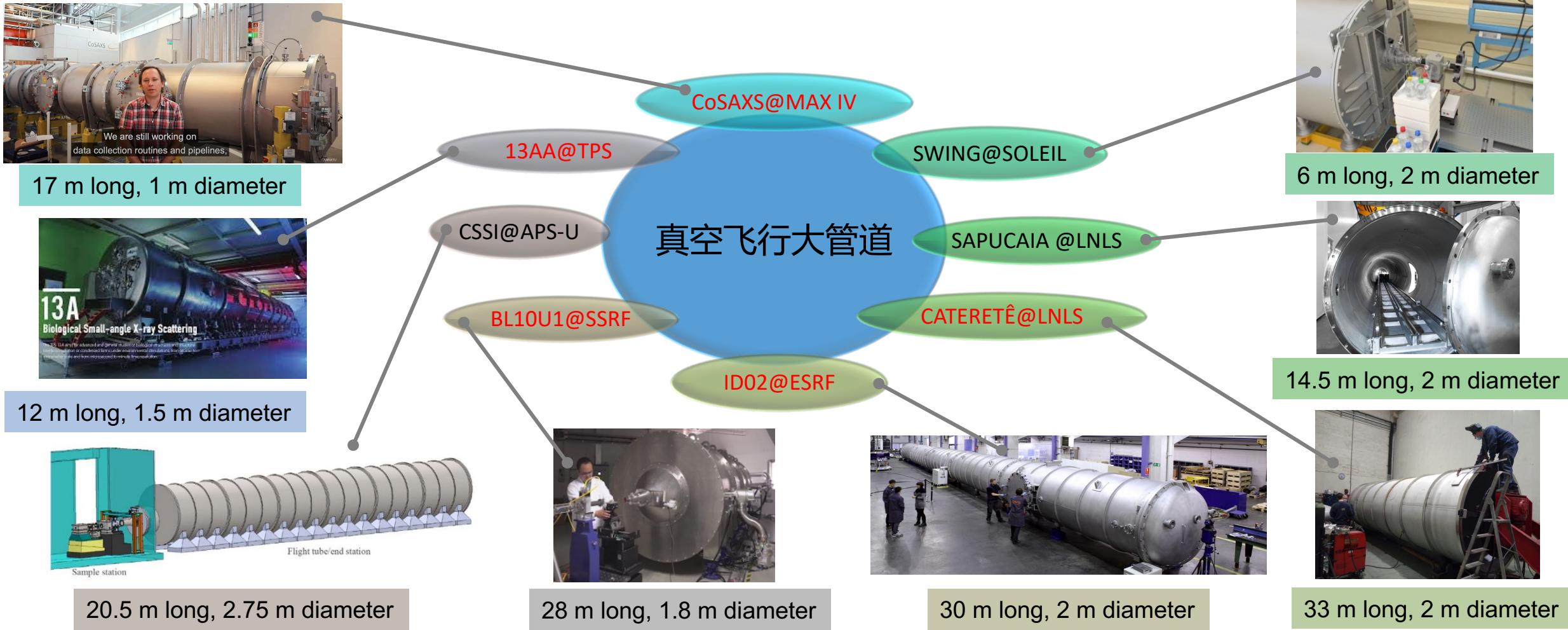
slope error(弧矢/子午)=1.0 urad /0.3 urad  
 slit5 : 250×500  $\mu\text{m}^2$   
 USAXS : 44.9×36.2  $\mu\text{m}^2$ , 5.523e+13 ph/s  
 μSAXS : 1.23×1.68  $\mu\text{m}^2$ , 8.002e+12 ph/s  
 Efficiency=1.254%,  $\Delta E/E=0.013\%$

# Experimental Station Design

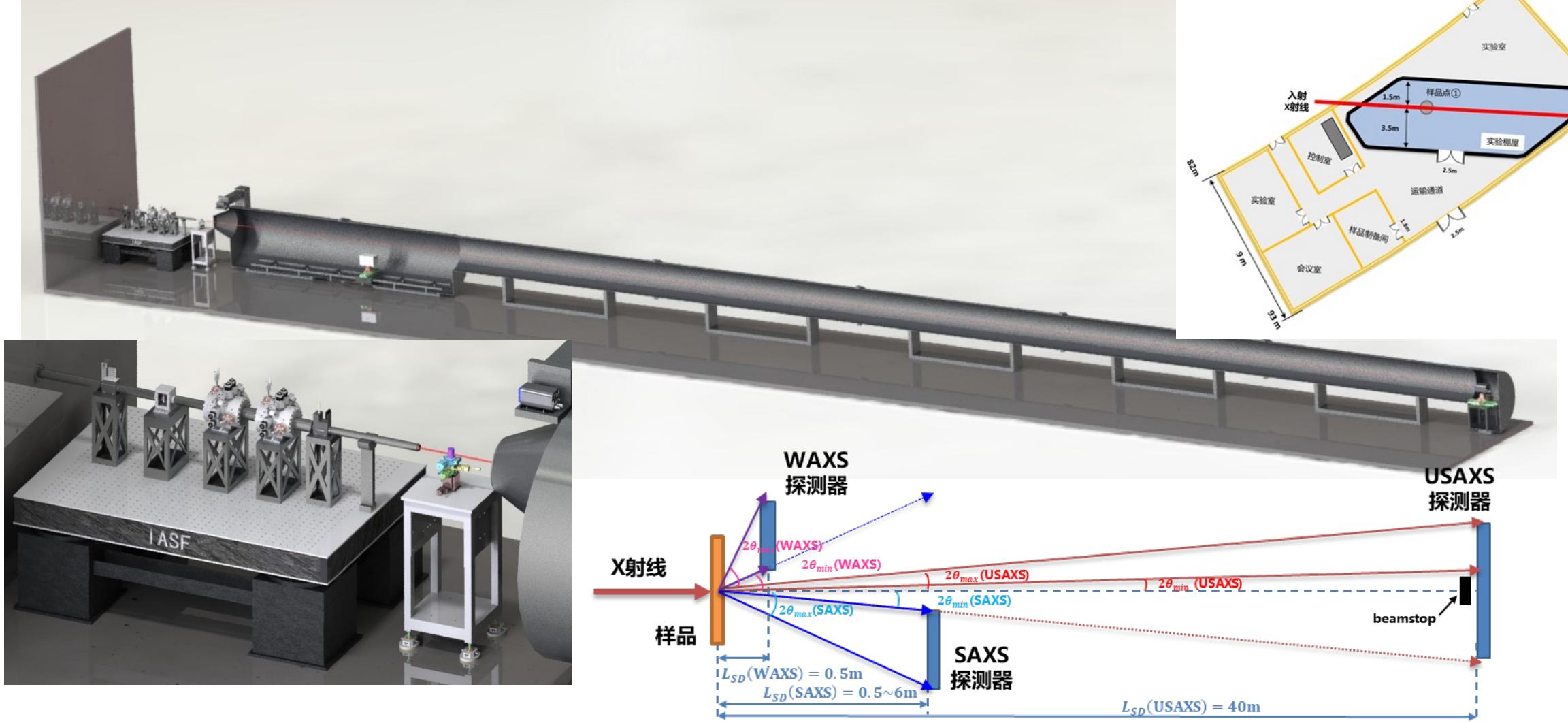
实验方法	实验能力
USAXS-SAXS-WAXS联用	时间分辨： $\geq 10\text{ ms}$ ，跨尺度范围， $q_{\min}=0.000\ 95\text{ nm}^{-1}$ @10keV
SAXS-WAXS联用	时间分辨： $\geq 5\text{ ms}$ ， $q_{\min}=0.00633\text{ nm}^{-1}$ @10keV
$\mu$ SAXS	空间分辨： $\geq 2\text{ um}$ ，时间分辨： $\geq 5\text{ ms}$ ， $q_{\min}=0.0211\text{ nm}^{-1}$ @10keV
2D-USAXS	$q_{\min}=0.000\ 95\text{ nm}^{-1}$ @10keV
反常SAXS	能量分辨率 $\leq 0.02\%$ @6-18keV

# Vacuum flight camera system

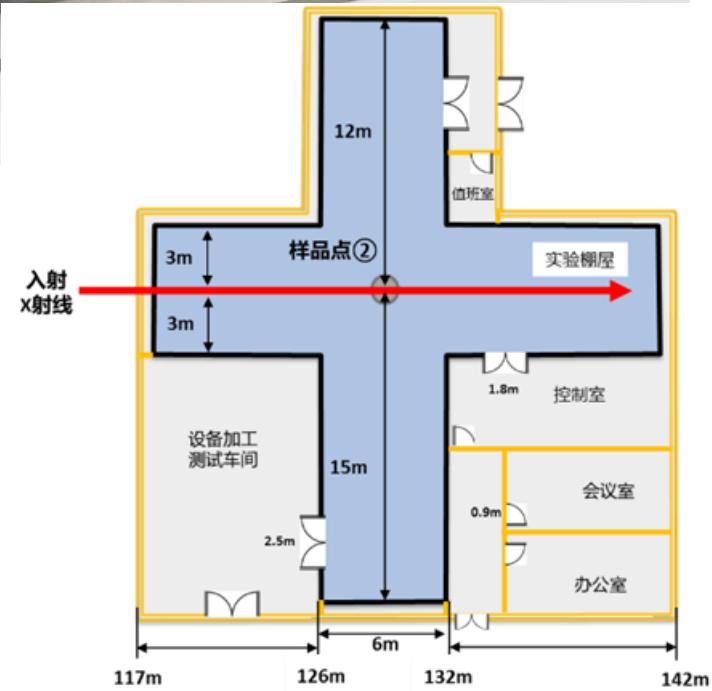
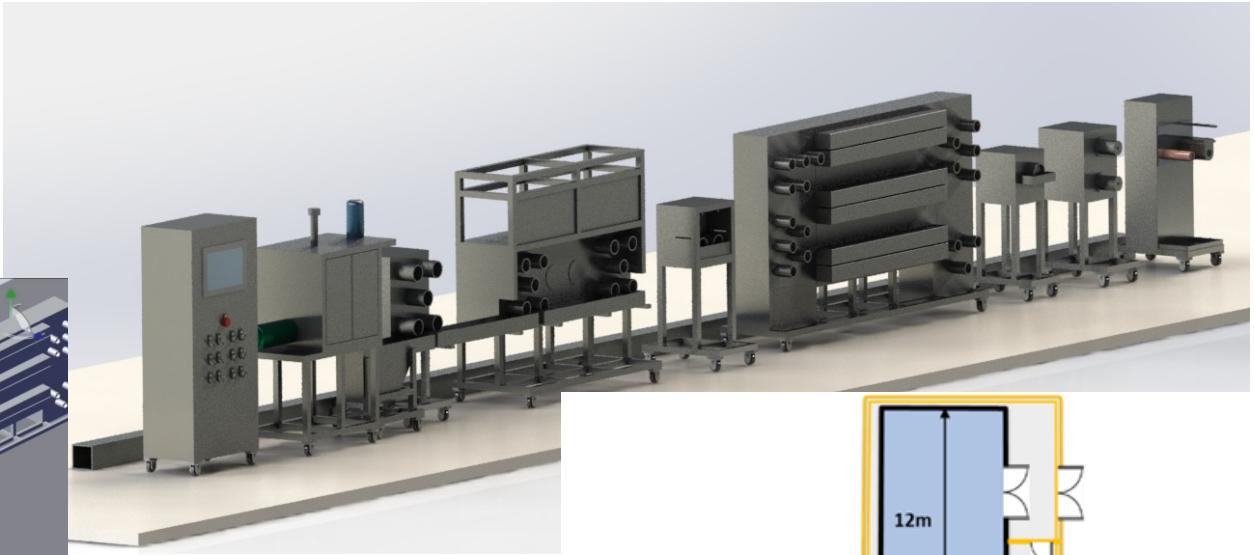
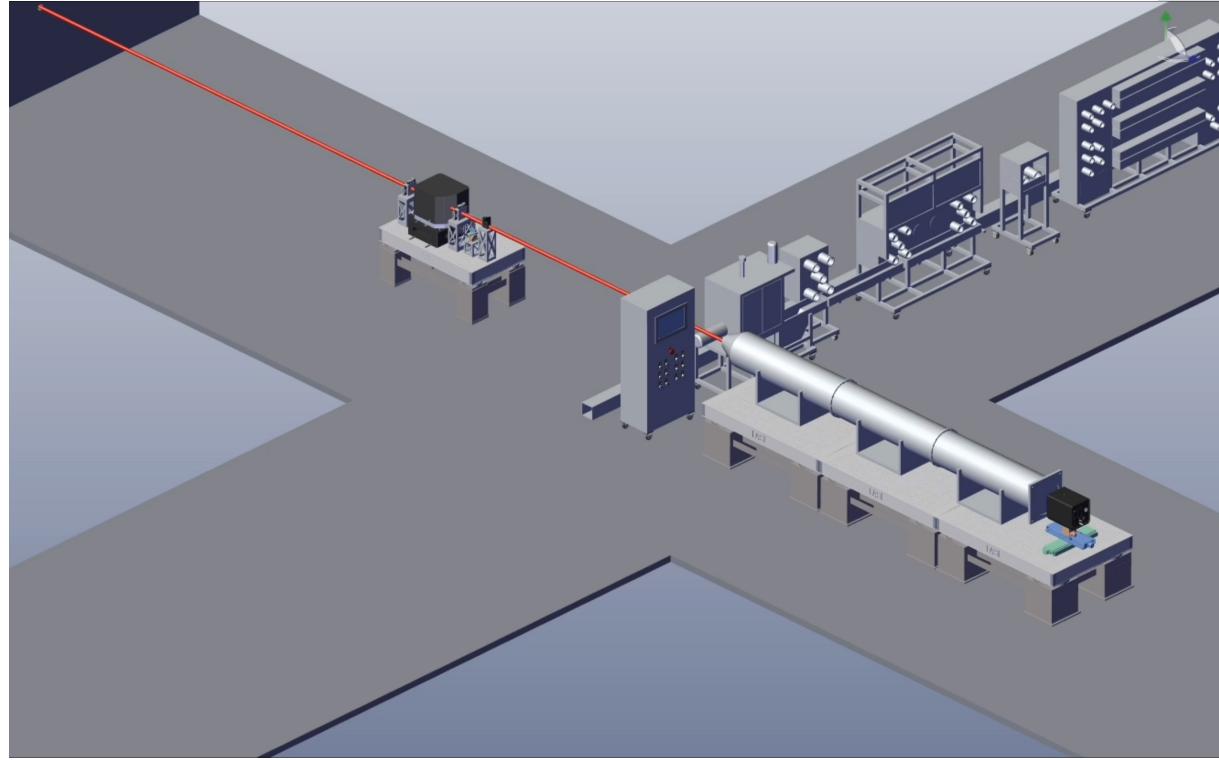
- The vacuum flight large pipeline and track adjustment system is a mature commercial customized product, widely used in line stations such as ESRF ID02, LNLS CATERETÊ, MAX IV CoSAXS, etc; Domestic SSRF BL10U1 line station, TPS 13 line station, and SANS line station of hash Neutron source also have successful cases.



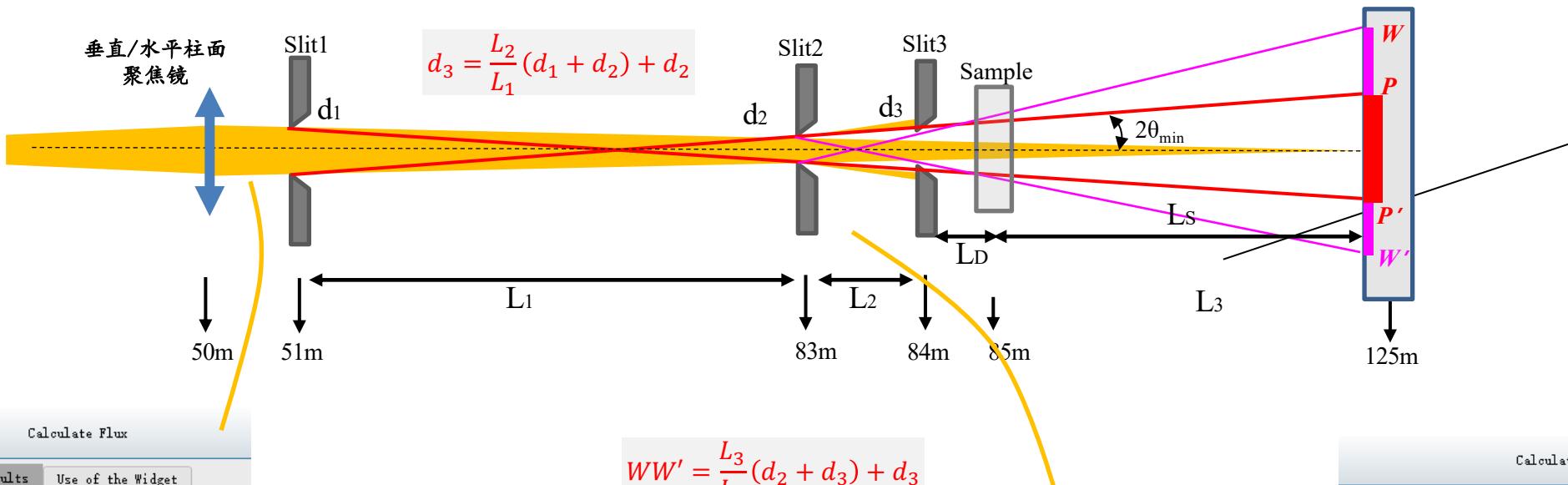
# General layout of USAXS experimental station



# Overall layout of $\mu$ SAXS experimental station



# Three slit collimation system (parasitic scattering)



Flux Calculation Results Use of the Widget

```
# SOURCE
Source Central Energy: 10000 eV
Source Energy Range : 9995.02 - 10005 eV
Source ΔE: 10 eV

# BEAMLINE
Shadow Intensity (Initial): 1e+06
Shadow Intensity (Final) : 65648.1
Efficiency: 6.565%
Bandwidth (at the Image Plane): 1.2 eV

# FLUX INTERPOLATION
Initial Flux from Source: 3.77112e+14 ph/s/0.1%bw
--> Integrated Flux : 2.47566e+13 ph/s
--> <Flux Density> : 1.37578e+14 ph/s/mm^2
--> Resolving power : 8333.35
```

开口设置	Slit1 (mm <sup>2</sup> )	Slit2 (mm <sup>2</sup> )	Slit3 (mm <sup>2</sup> )	PP'(beams top)	WW'(寄生散射)(mm <sup>2</sup> )	传输效率
H=5 σ , V=7 σ	1.030×1.064	0.064×0.045	0.098×0.079	Φ1.5mm	0.68×0.52	86.95%
H=5 σ , V=6 σ	1.030×0.912	0.064×0.131	0.098×0.164	Φ1.5mm	0.68×1.22	88.59%
H=5 σ , V=5.75 σ	1.030×0.874	0.064×0.153	0.098×0.185	Φ1.5mm	0.68×1.40	88.43%
H=4.25 σ , V=5.75 σ	<b>0.876×0.874</b>	<b>0.152×0.153</b>	<b>0.184×0.185</b>	<b>Φ1.5mm</b>	<b>1.39×1.40</b>	<b>96.16%</b>
H=4.25 σ , V=6 σ	0.876×0.912	0.152×0.131	0.184×0.164	Φ1.5mm	1.39×1.22	96.32%

经追迹，三狭缝准直的通量最低损失约为：  
 $(2.38457-2.47566)/9.17322*100\% = 3.8\%$

Flux Calculation Results Use of the Widget

```
# SOURCE
Source Central Energy: 10000 eV
Source Energy Range : 9995.02 - 10005 eV
Source ΔE: 10 eV

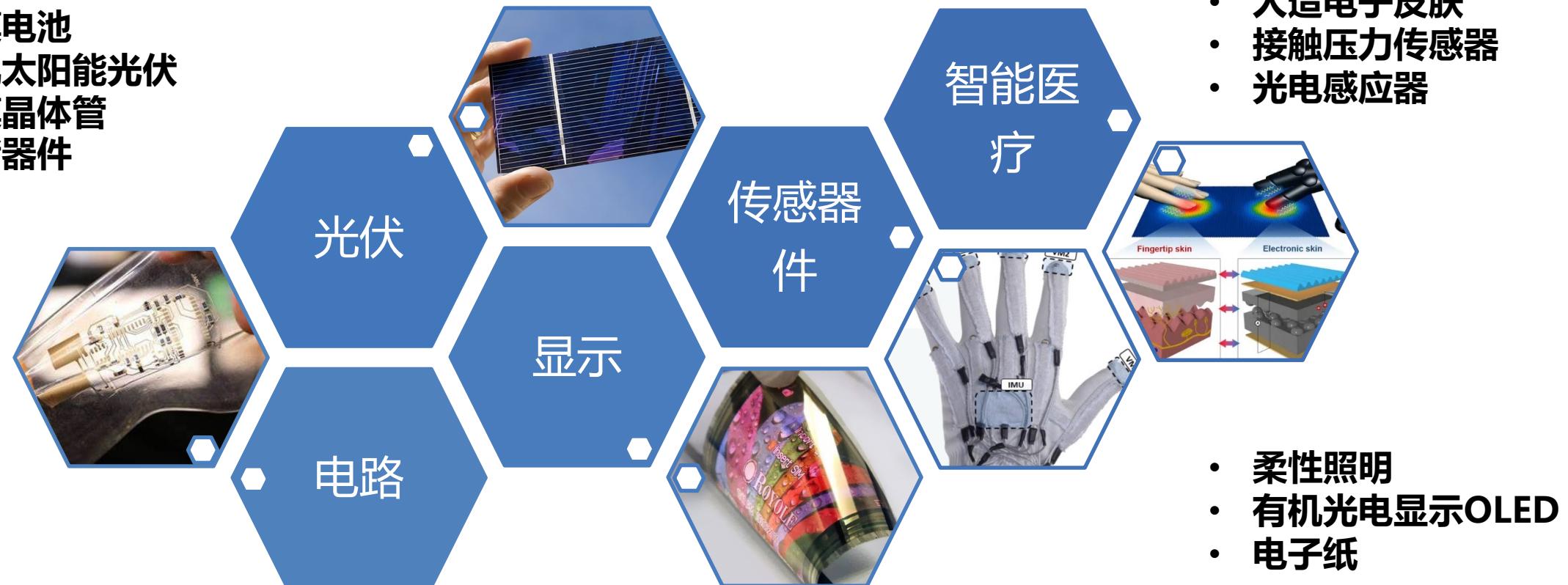
# BEAMLINE
Shadow Intensity (Initial): 1e+06
Shadow Intensity (Final) : 63232.8
Efficiency: 6.323%
Bandwidth (at the Image Plane): 1.2 eV

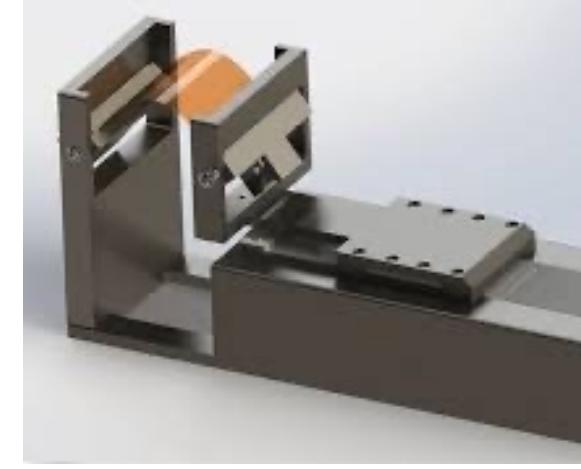
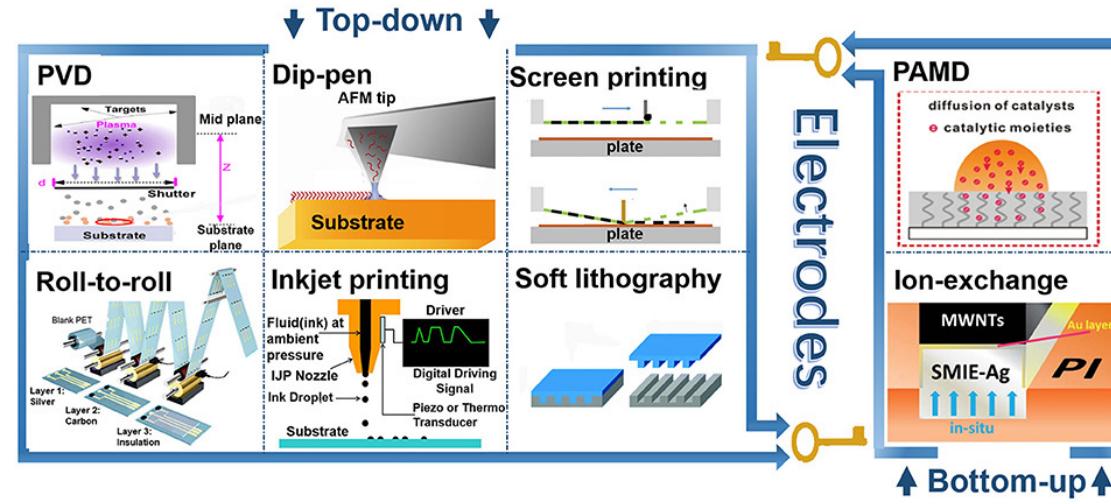
# FLUX INTERPOLATION
Initial Flux from Source: 3.77112e+14 ph/s/0.1%bw
--> Integrated Flux : 2.38457e+13 ph/s
--> <Flux Density> : 4.43159e+16 ph/s/mm^2
--> Resolving Power : 8333.35
```

## (2) Beamline for Flexible Electronics Advanced Materials

- Flexible electronics is a disruptive science and technology based on highly interdisciplinary integration, providing innovative leadership for consumer electronics, intelligent healthcare, and energy revolution. At present, the flexible electronics industry is still in a high-speed development stage and is a new track for achieving industrial upgrading

- 薄膜电池
- 有机太阳能光伏
- 薄膜晶体管
- 存储器件





### 柔性电子材料研发

- 基材：PI、PEEK等
- 电子材料：OLED、  
有机光伏、导电油墨
- .....

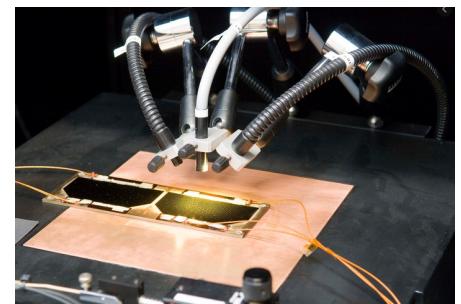
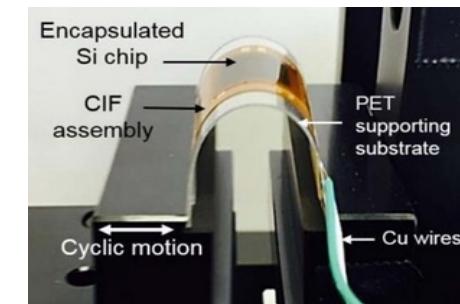
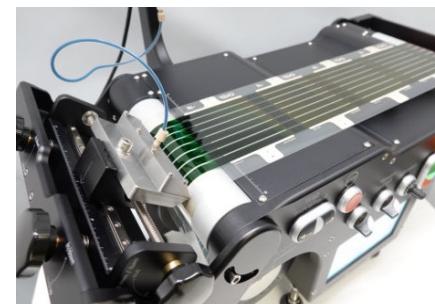
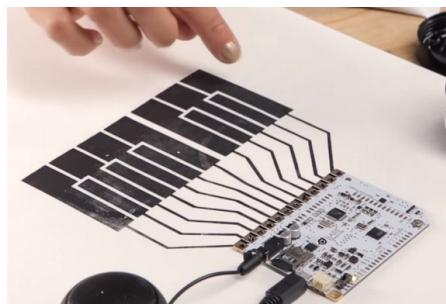
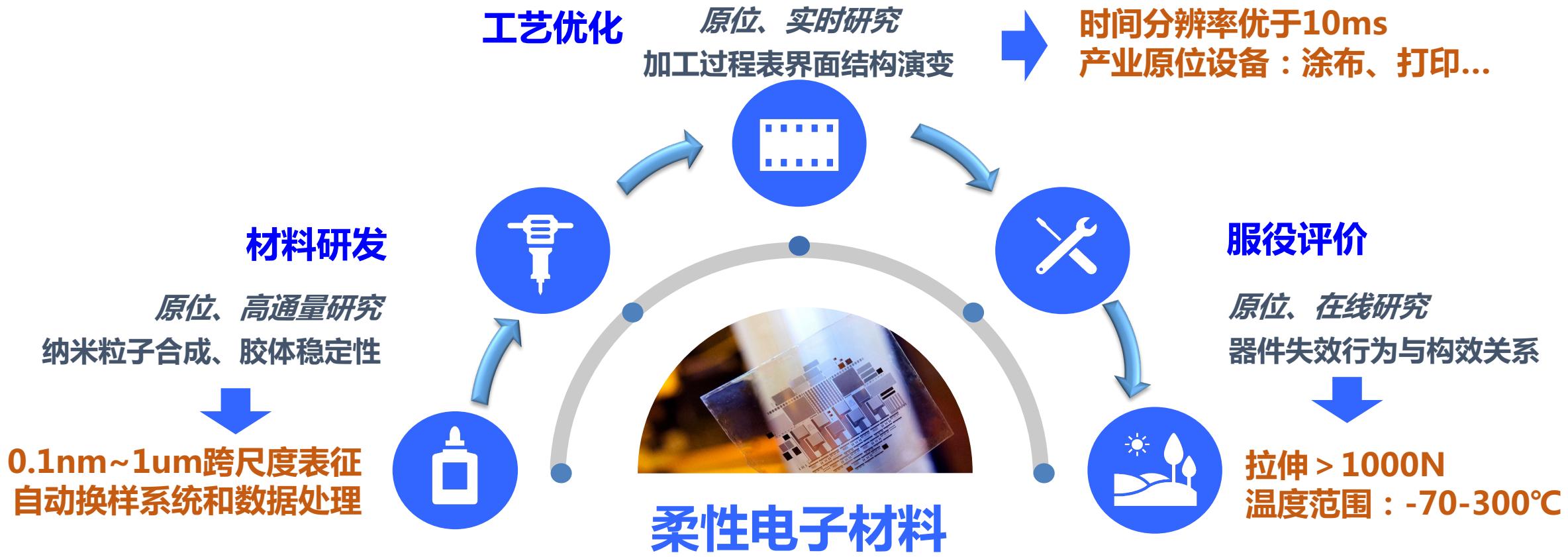
### 柔性电子制造工艺

- 喷墨打印
- 槽模涂布
- 卷对卷涂布
- .....

### 柔性电子器件评价

- 性能
- 寿命
- 服役
- .....

# Beamline Industry Objectives



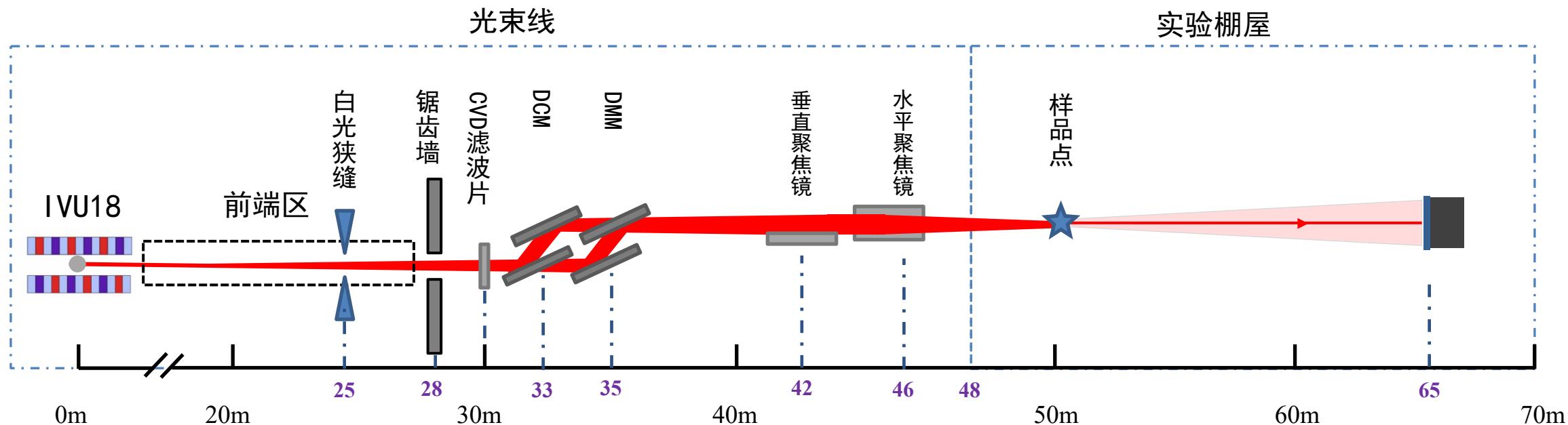
# Beamline Construction Objectives



# Beamline Layout and Performance

	设计指标
光束线	能量范围
	7~18 keV
	能量分辨率( $\Delta E/E$ )
	DCM: $2 \times 10^{-4}$ @10 keV
实验站	通量
	$1 \times 10^{13}$ phs/s@10 keV
	光斑尺寸
	10 $\mu\text{m}$ @10 keV
实验站	时间分辨
	10 ms
	可探测 $q_{\min}$
	0.01 nm $^{-1}$

- 保持高通量:
  - 利用波荡器作为光源，并尽可能地占满直线节部分
  - 配备多层膜单色器，用于获取更高通量
- 优化光路:
  - 使用可变压弯半径聚焦镜，焦点位置、光斑发散度连续可调

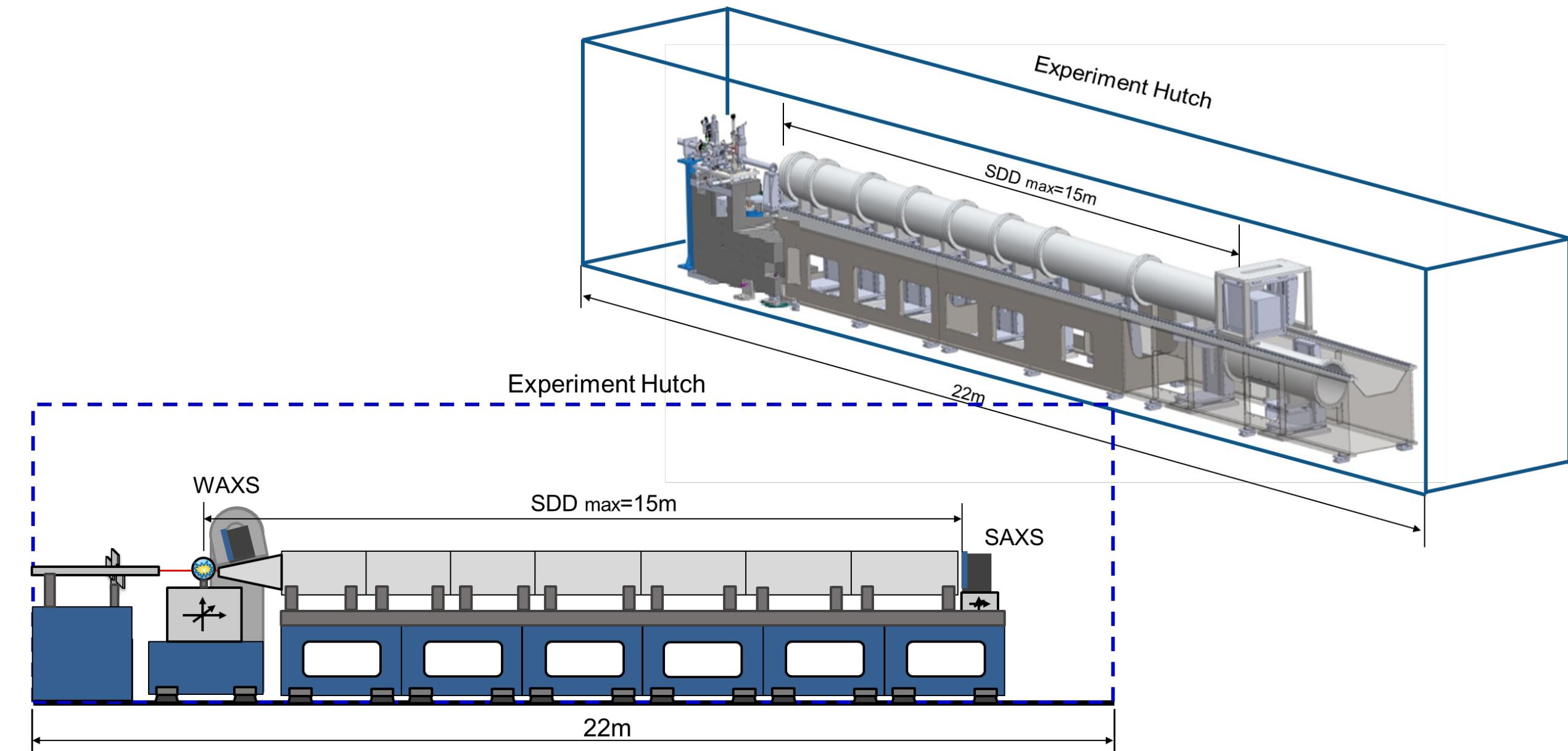


# Flux at sample and transmission efficiency (DCM)

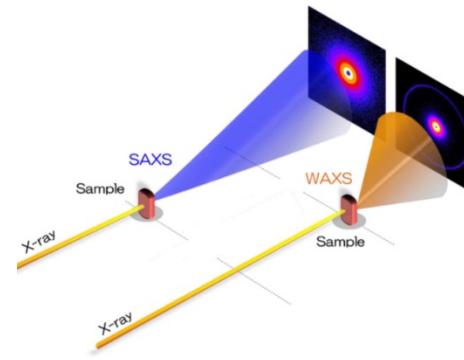


能量	7keV	10keV	12.4keV	18keV
偏转参数K	1.2895	<b>1.5078</b>	1.2026	1.5078
光源光通量ph/s/0.1%bw	8.20e+14	<b>4.72e+14</b>	1.88e+14	7.92e+13
白光狭缝&CVD	78.22%	<b>91.73%</b>	95.36%	97.97%
DCM效率	11.96%	<b>13.58%</b>	14.31%	16.73%
DCM能量分辨率	1.2e-4 (0.84eV)	<b>1.2e-4(1.2eV)</b>	1.3e-4(1.6eV)	1.4e-4(2.5eV)
VFM效率	91.93%	<b>93.16%</b>	93.38%	87.62%
HFM效率	89.91%	<b>91.70%</b>	92.37%	86.71%
样品点光斑尺寸um^2	7.12*6.08	<b>6.62*6.25</b>	6.96*6.60	7.12*5.91
样品点通量 ph/s	6.39e+13	<b>5.02e+13</b>	2.18e+13	1.00e+13
样品点通量ph/s (with 4 degree phase error)	<b>6.11e+13</b>	<b>4.44e+13</b>	<b>1.93e+13</b>	<b>6.74e+12</b>
总效率	7.80%	<b>10.67%</b>	11.58%	12.66%
谐波占比	8.5e-4 (21keV)	<b>6.9e-6 (30keV)</b>	/	/

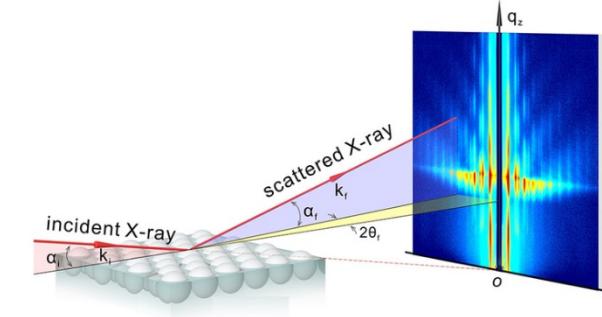
# General layout of the experimental station



# Main experimental methods



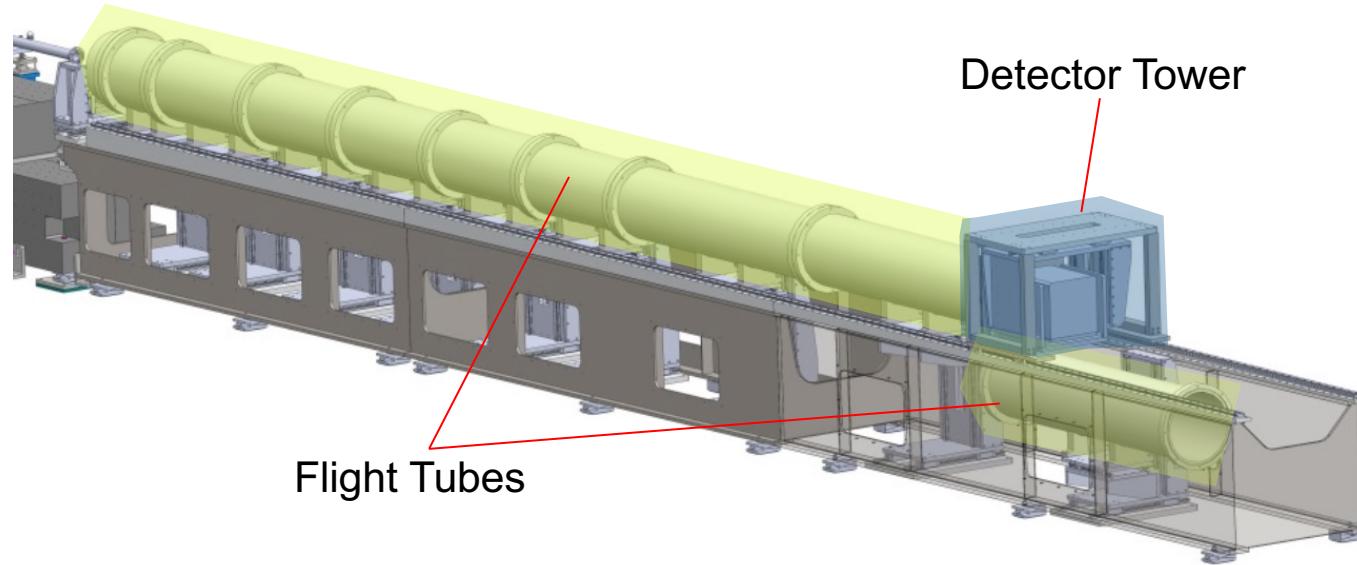
SAXS/WAXS



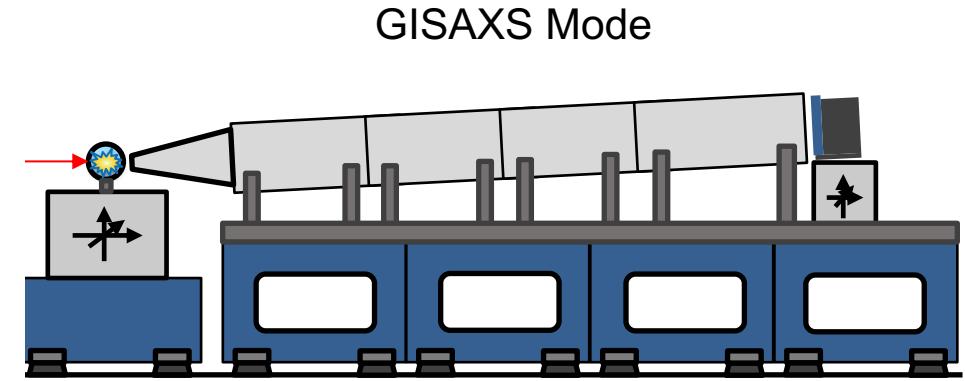
GI-SAXS/GI-WAXS

实验方法	实验能力
<ul style="list-style-type: none"><li>◆时间分辨SAXS/WAXS</li><li>◆时间分辨GISAXS/GIWAXS</li><li>◆空间分辨SAXS/WAXS</li><li>◆空间分辨GISAXS/GIWAXS</li></ul>	<ul style="list-style-type: none"><li>◆通量<math>1 \times 10^{13}</math> ( DCM@10keV )</li><li>◆空间分辨 10 um</li><li>◆时间分辨 10 ms</li><li>◆大空间尺度探测范围~0.63 um@10keV</li><li>◆<math>q=0.01 \sim 24 \text{ nm}^{-1}</math>@10keV</li></ul>

# Key equipment: SAXS camera system



特点：调整便利！技术成熟！安全可靠！



## □ 管道分级自动拼接：

- 15m管道由多级0.5m、1m、1.5m管道拼接而成，由电动滑台支撑；更换SDD时，飞行管道自动调整升降和拼接

## □ 管道倾角自动调整：

- 对于GISAXS ( SDD≤6m ) 实验，为获取更宽角度范围，管道需要具备自动调整倾角功能，各滑台升降高度根据倾角自动调整

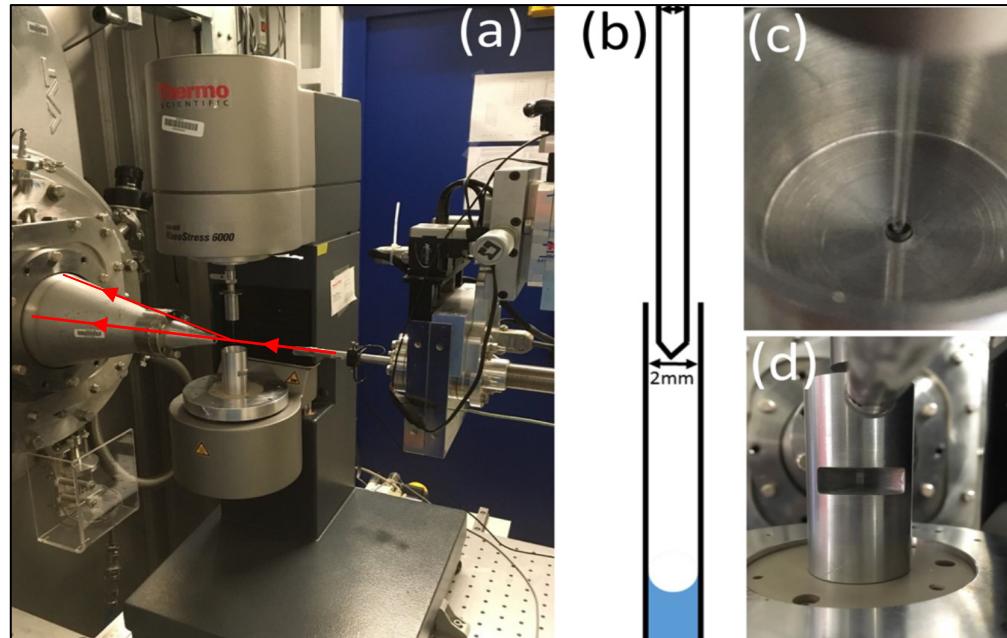
## □ SDD自动调整：

- 为快速切换SDD，探测器固定在可沿导轨移动的塔架上；根据实验模式不同，探测器可进行二维平动和俯仰角调节

SAXS实验对flight tube和探测器位置精度不敏感，上述自动化设备运行精度达到 $\pm 50\mu\text{m}$ 即可。

# Combined equipment: in-situ solution testing

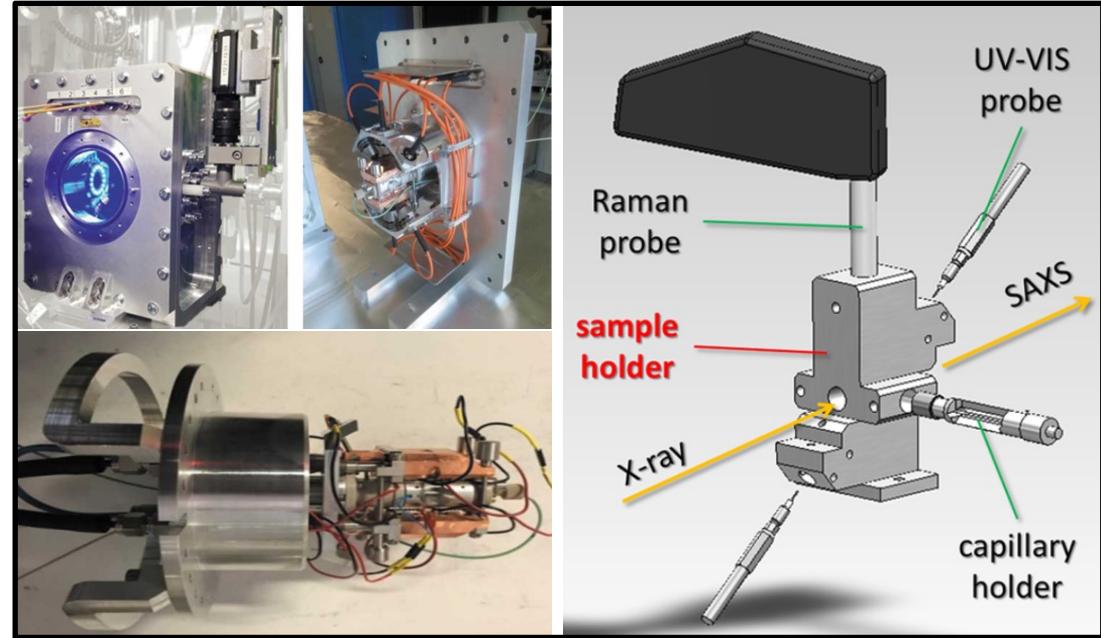
旋转流变仪



- 降低背景散射，使弱各项异性结构特征得到检测
- 适用于复杂结构的胶体、生物大分子、自组装结构

参数指标	数值
剪切力	10 nNm ~ 200 mNm
温度范围	-10~120°C
转子与样品腔间距	不超过1mm

多功能真空腔

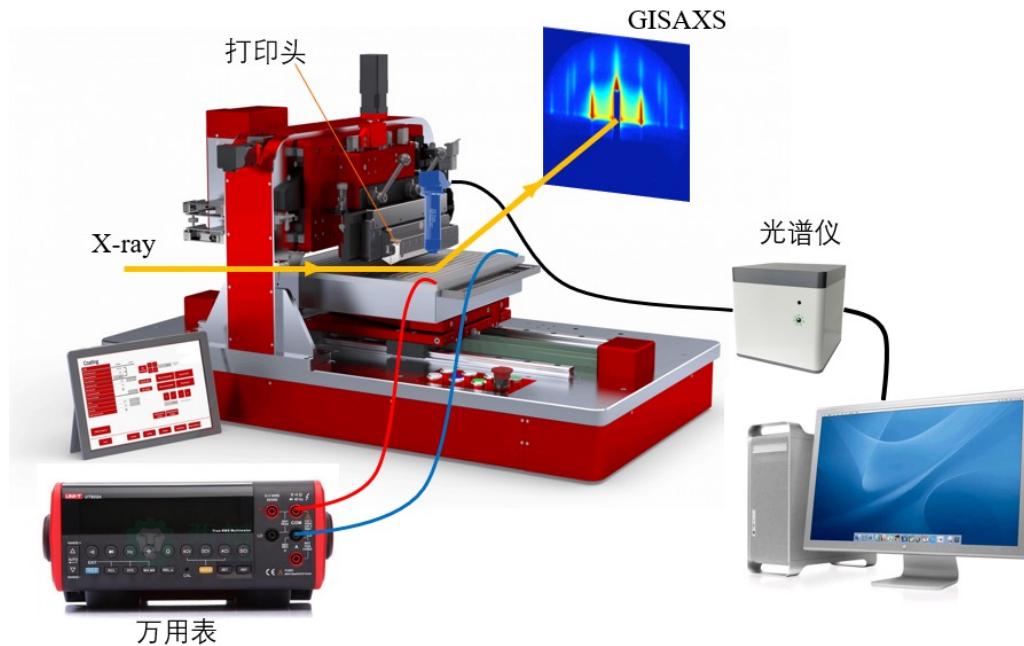


- 取消空气路径，减少背底散射，提高信噪比
- 使用石英管样品架，实现Raman\UV-Vis的多技术联用

参数指标	数值
光路窗口	> 5mm
温度范围	5~70°C

# In situ coating equipment

Slot die coating & GISAXS 集成示意



- 涂布系统用于印刷功能材料，如太阳能电池、燃料电池、LED、传感器等
- 集成平台配套有冷热板、紫外-可见光谱仪、数字源表等设备
- 可针对柔性电子材料的加工过程的结构演变进行原位评测

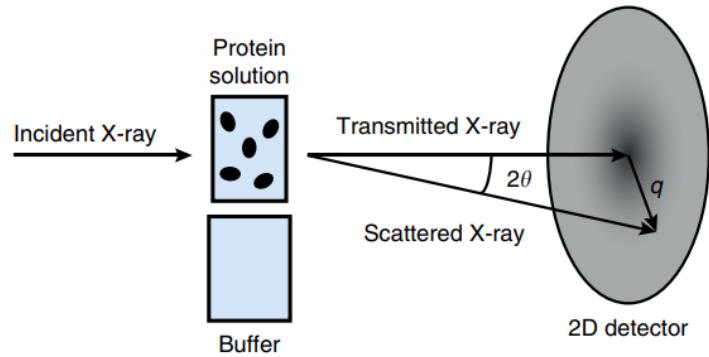


参数指标	数值
涂膜速度	1~50mm/s
调速精度	0.1mm/s
最大基片	> 20cm×15cm
基板温度	RT~150°C

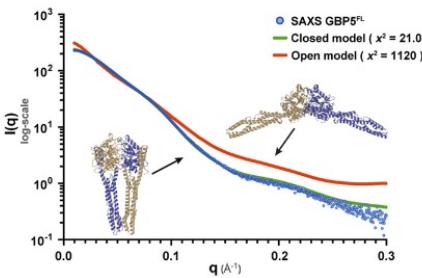


# (3) Beamline for Bio-SAXS

## Small Angle Scattering(SAS)

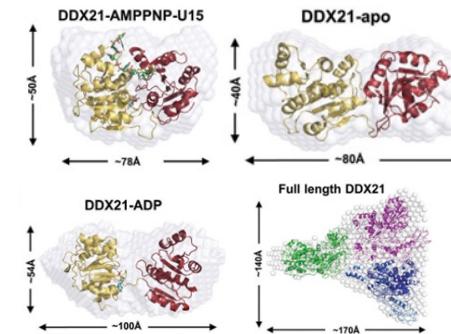


## Conformation

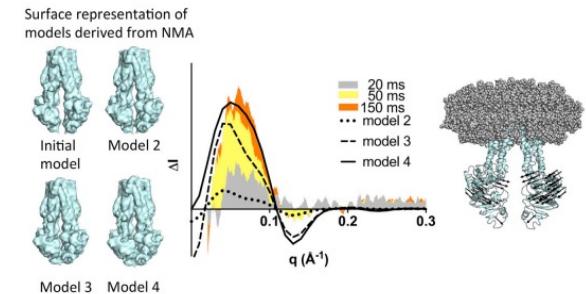


## Structural biology

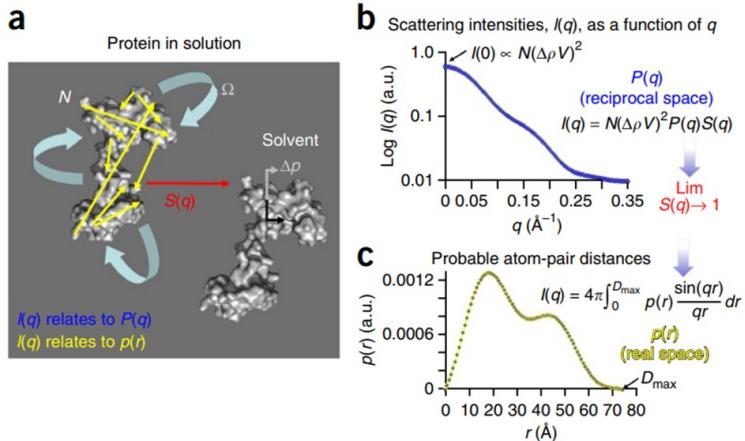
### Modeling



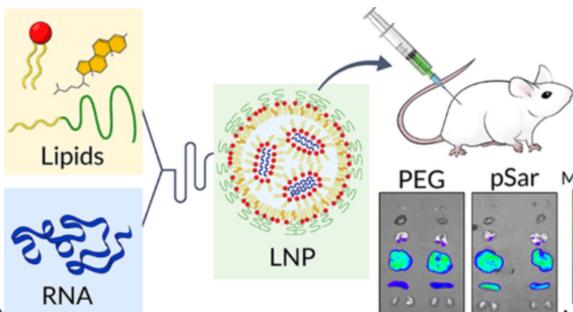
### Structural kinetics



## Simple equation, Big implications

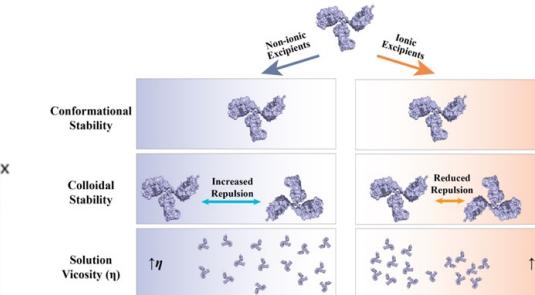


## Structure of carrier protein

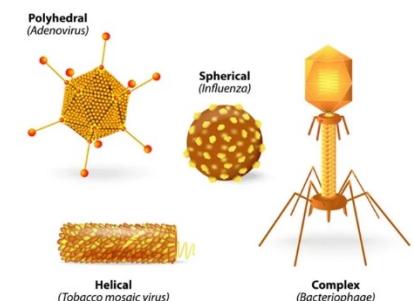


## Biomedical industry

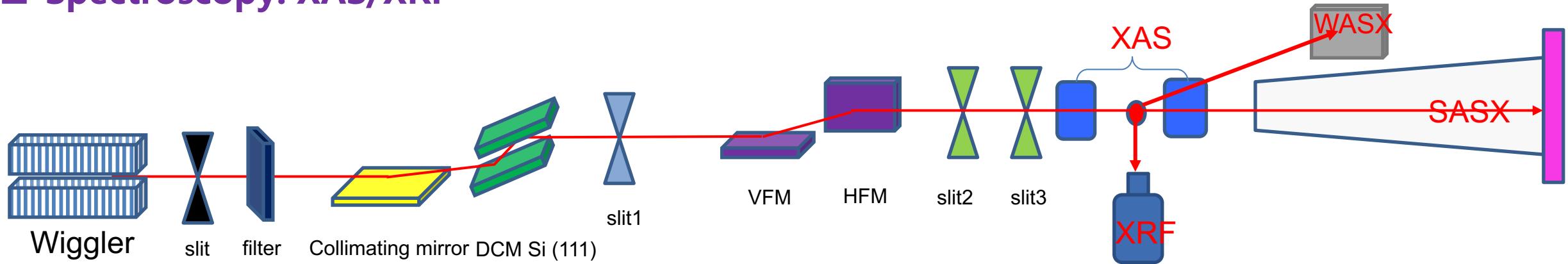
### Stability of biomedicine



### Viral shapes

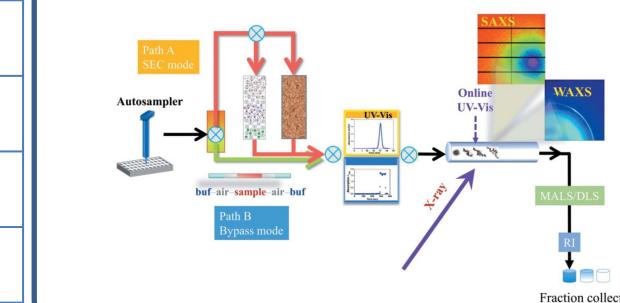


- Scattering: SAXS/GISAXS/time-resolved SAXS/WAXS/MAD;
- Spectroscopy: XAS/XRF

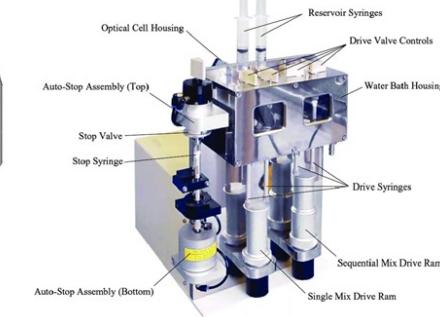
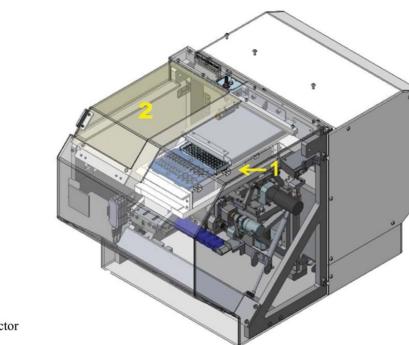


Beamlne	BioSAXS
Source	In-Vacuum Wiggler
Energy (keV)	4~25
Resolution ( $\Delta E/E$ )	$\sim 1 \times 10^{-4}$ @ 12.4 keV
Flux (phs/s)	$> 2 \times 10^{12}$ @ 12.4 keV
Beam size (mm <sup>2</sup> )	$< 0.1 \times 0.1$ ( Sample@47m )

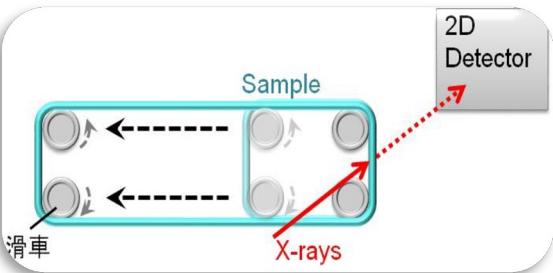
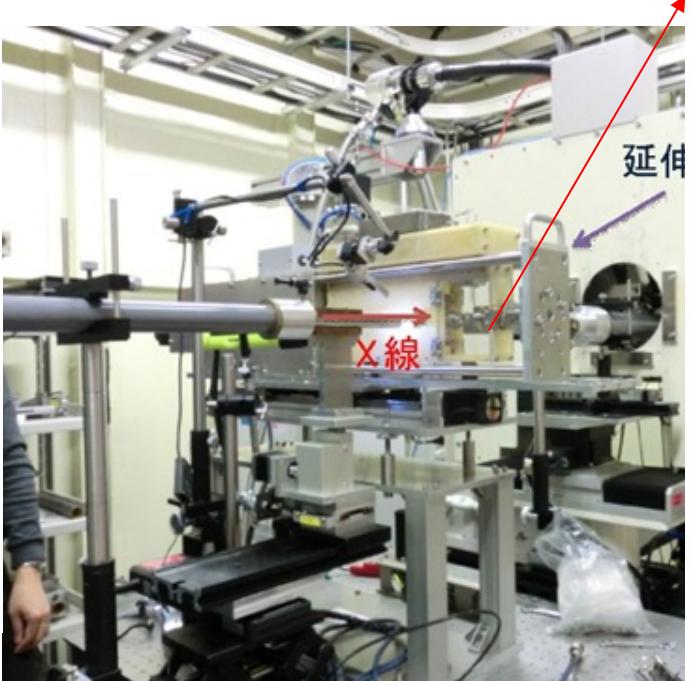
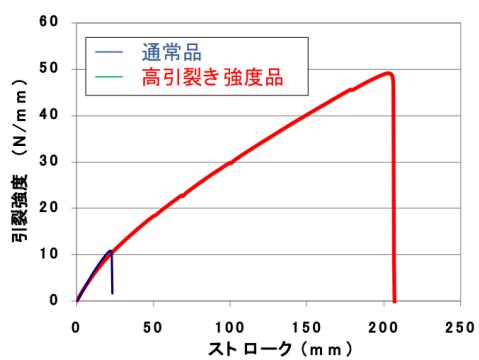
### *In situ* instruments ( selected )



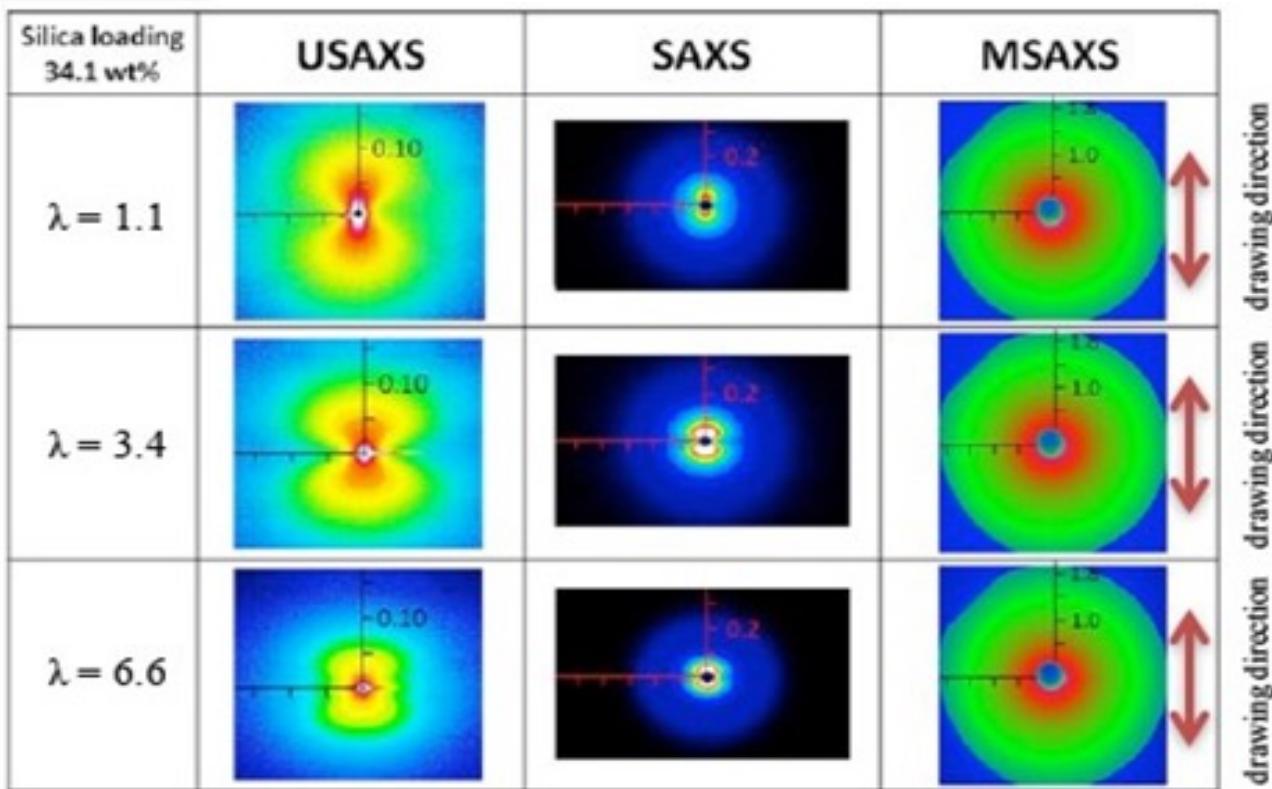
SEC-MALS-DLS-UV-RI-SAXS



## 2. Data Processing



结构? 异向二维图的处理与结构?



住友電不株式会社

# Scattering Data Processing Software

散射软件的要求：

**准确性**：精细的结构分析需要准确的数据

**灵活性**：支持多种标样、算法与积分方式

**高速与自动化**：先进同步辐射X射线散射产生的高时间分辨与大数据量

## 独立软件



- 科研用户免费使用
- 使用最为广泛
- 老旧

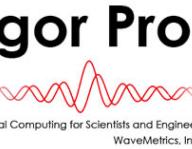
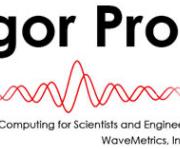


- 开源，免费
- 专注于溶液散射，其他功能不够丰富，性能较差



- 开源，免费，Python库
- 专注于高性能数据处理，比较基础，图形化与使用便利程度一般

## 基于平台开发



Technical Computing for Scientists and Engineers  
WaveMetrics, Inc.

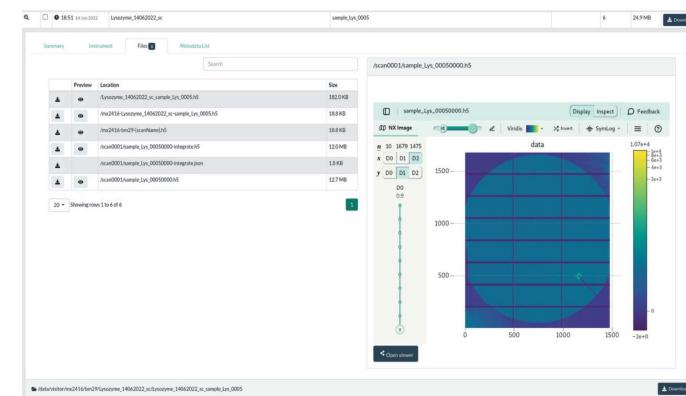
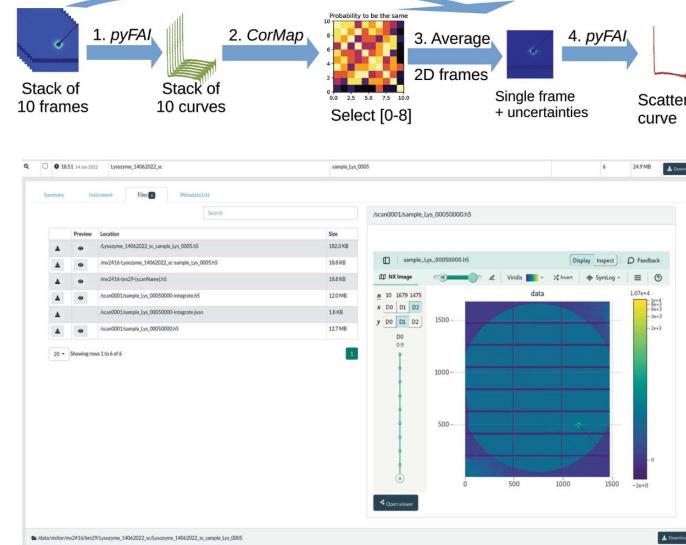
Igor Pro

• Igor的宏，本身开源免费，但基于商业软件平台Igor Pro

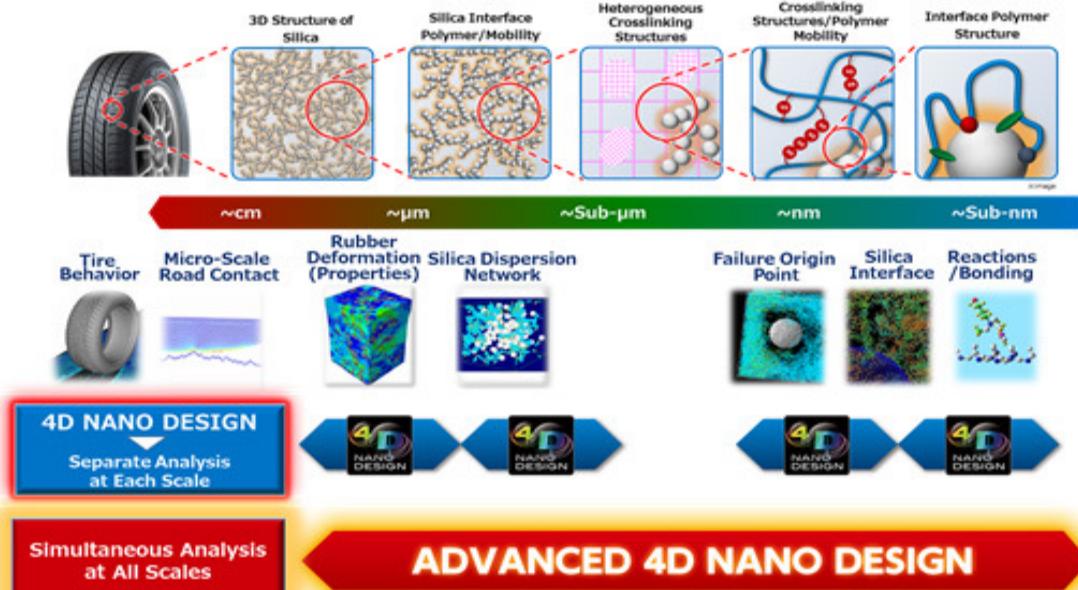
## 发展趋势

更需要实验中的实时在线处理，因此线站本身的数据处理软件开发更加重要

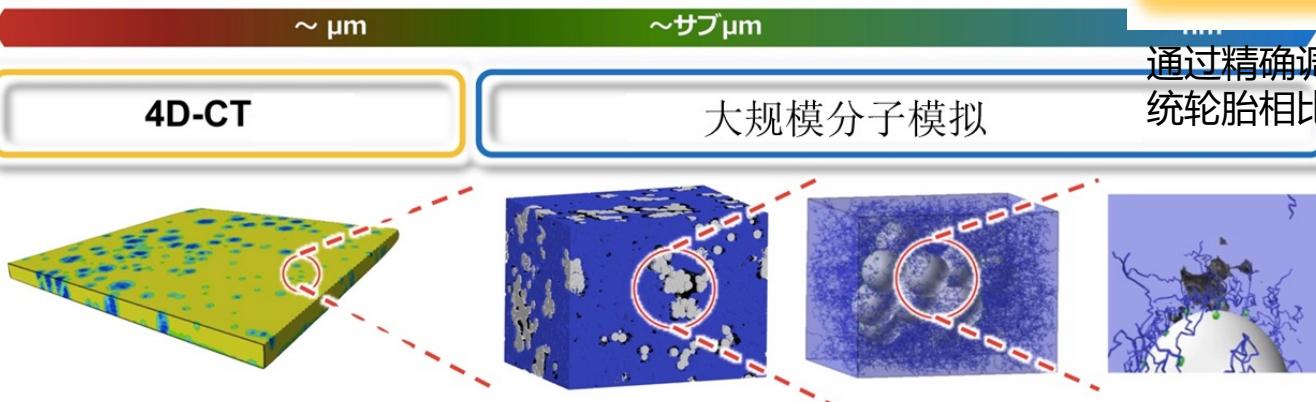
- 开源并以开源软件为基础
- 更丰富的元数据以及可交换的通用数据格式，未来hdf5将成为主流
- 由各线站开发与本站设备和装置紧密结合的专用运行软件与前端界面
- 数据处理底层使用通用的高性能散射数据处理库，以PyFAI库为主流
- 前后端分离，前端使用基于浏览器的Web技术，方便图形界面开发、远程使用与可移植性



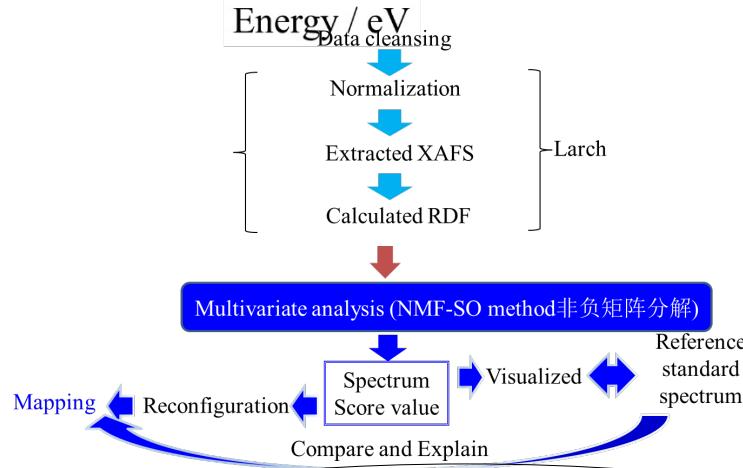
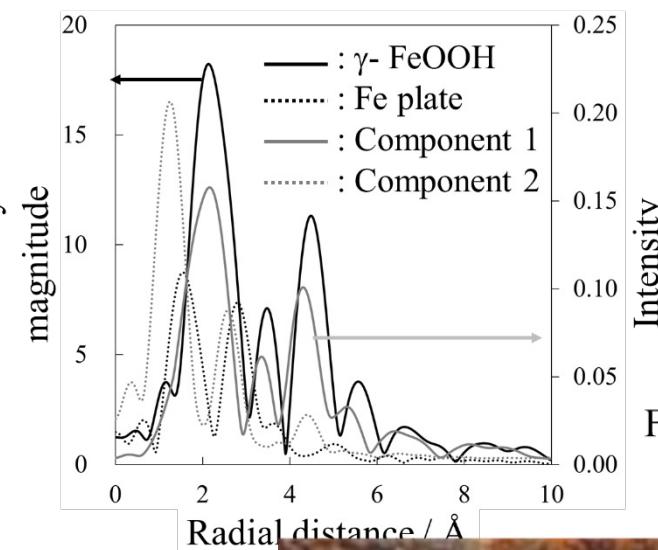
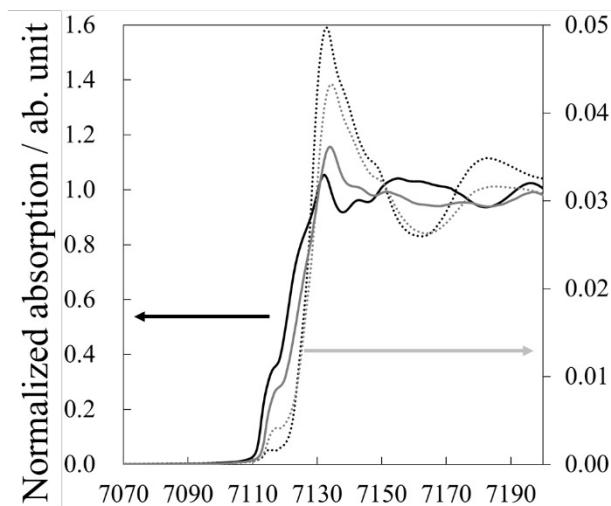
# Materials Informatics



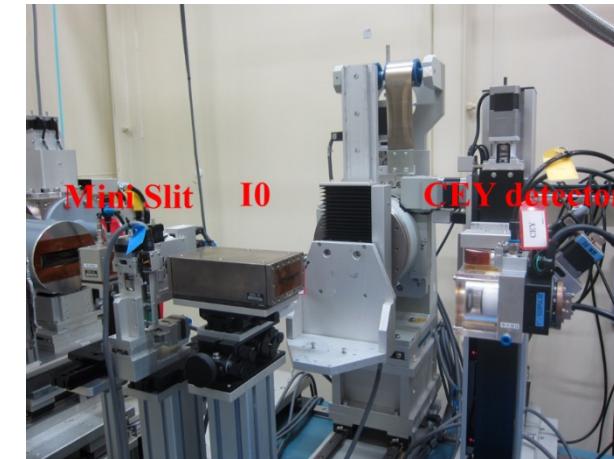
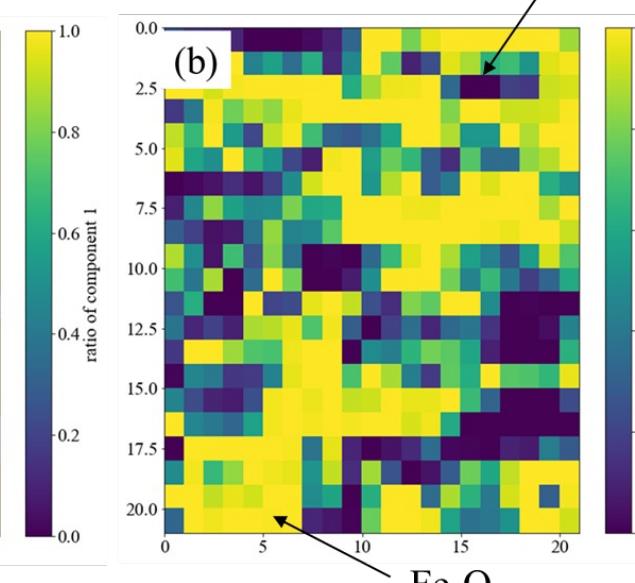
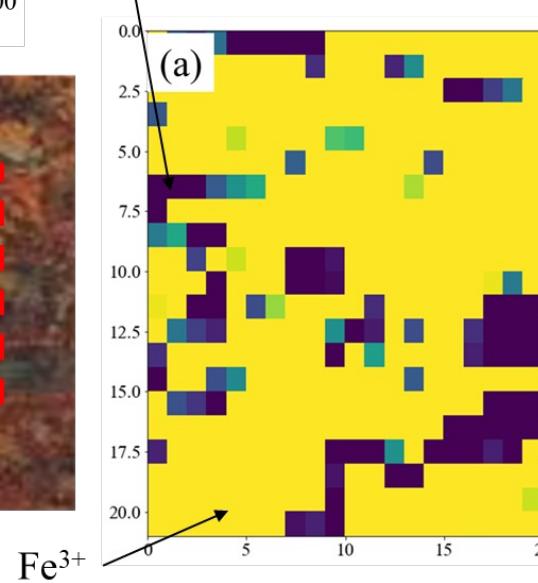
通过精确调控橡胶中SiO<sub>2</sub>纳米粒子的三维排列获得高性能橡胶，与传统轮胎相比能效提升约6%，湿抓地性能提升约9%。



# Deep Learning and Synchrotron radiation Data Processing

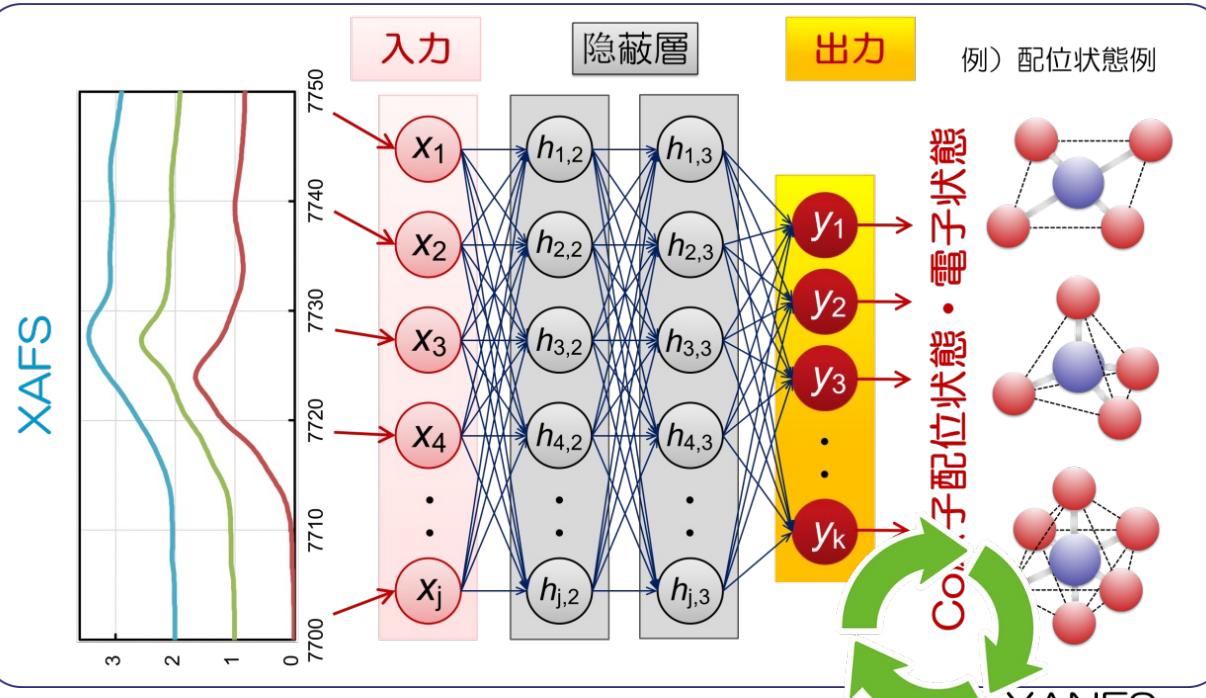


**Materials Informatics**

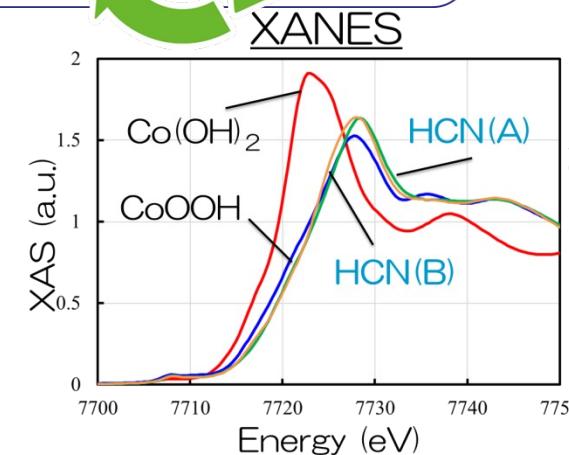


**KOBELCO**

(a) XANES and (b) RDF score map of steel surface after 3 hour corrosion test ((323 K,  $10^4$  ppm NaCl, 0.5 mm / pixel).

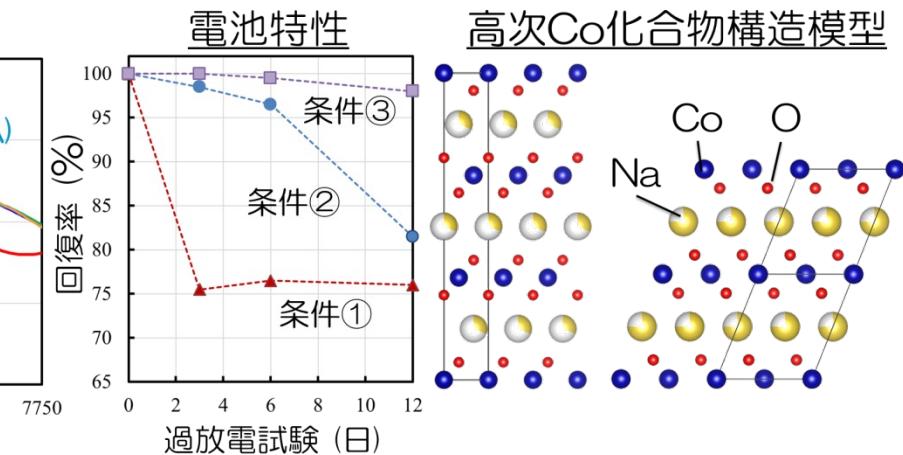


**Materials Informatics**



**Guiding the development  
of new materials through  
data science**

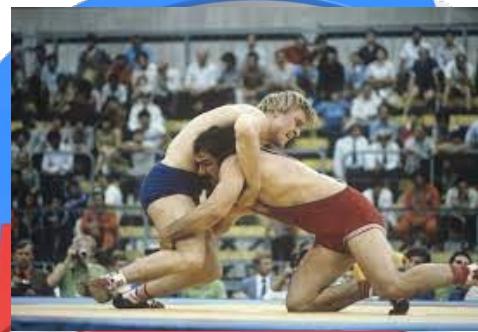
**FUJITSU**  
shaping tomorrow with you



### 3. Measurement Informatics

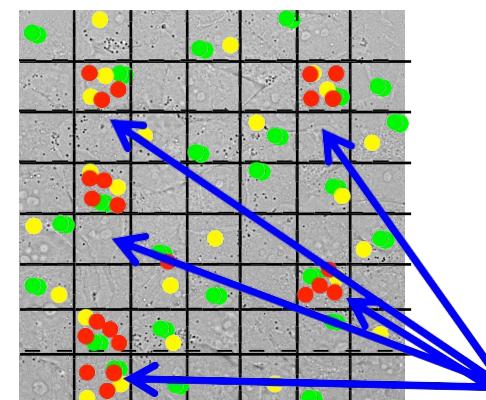
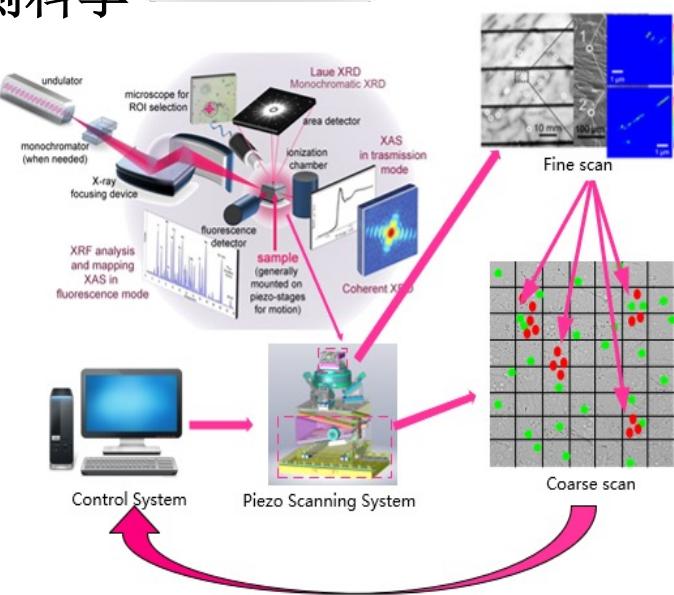
Mathematical Information

Measurement Science (MIMS)

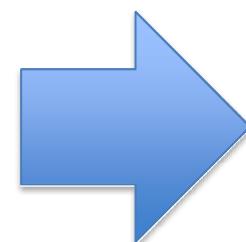


数理・情報  
科学

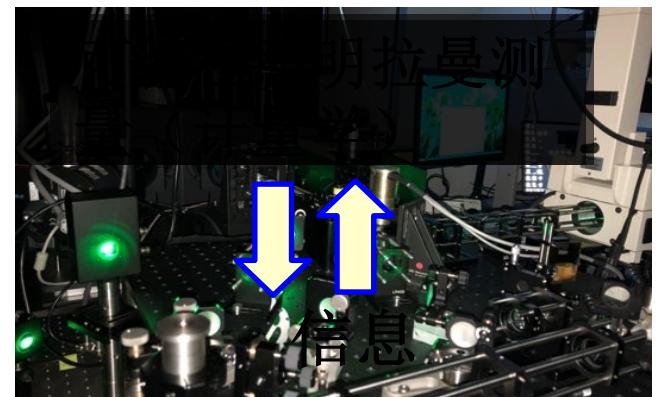
计测科学



对所有像素进行扫描的效率  
很低

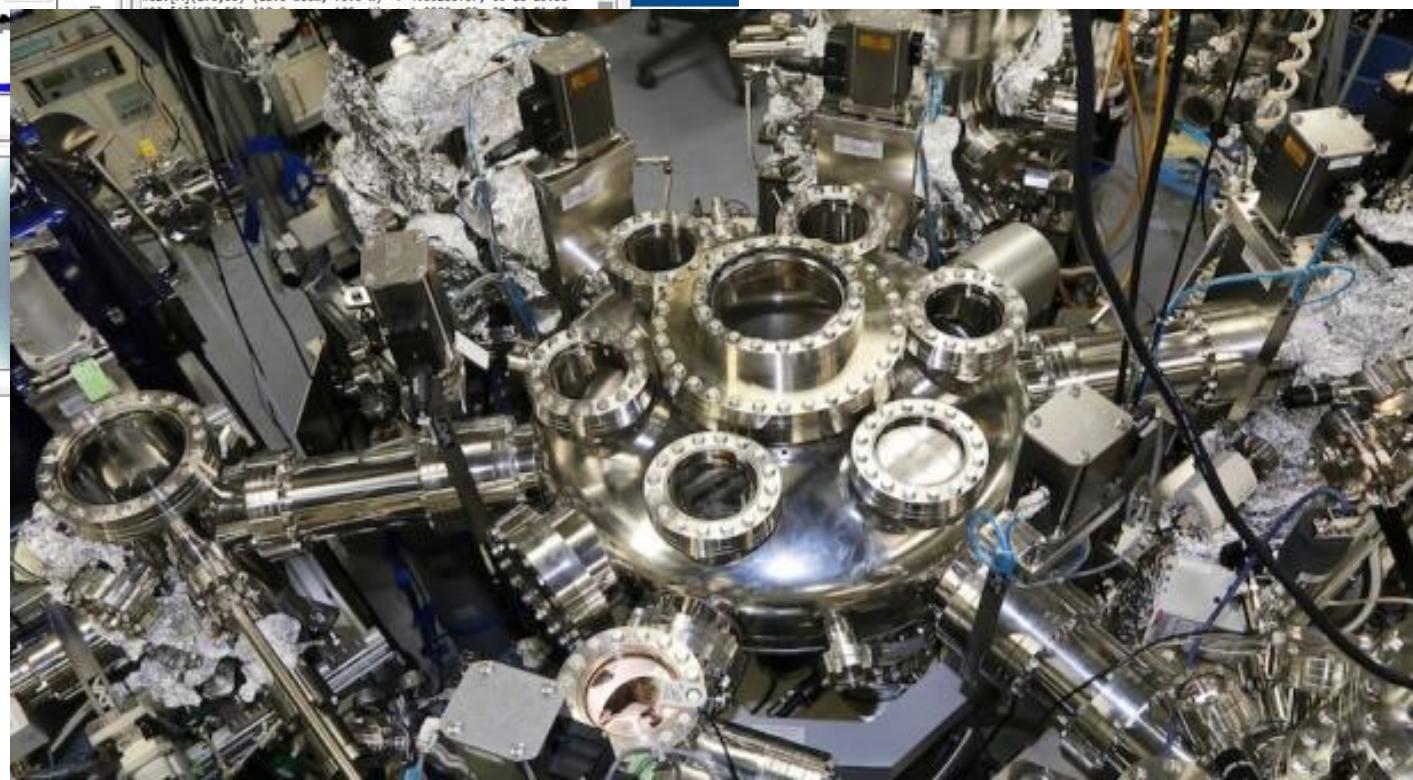
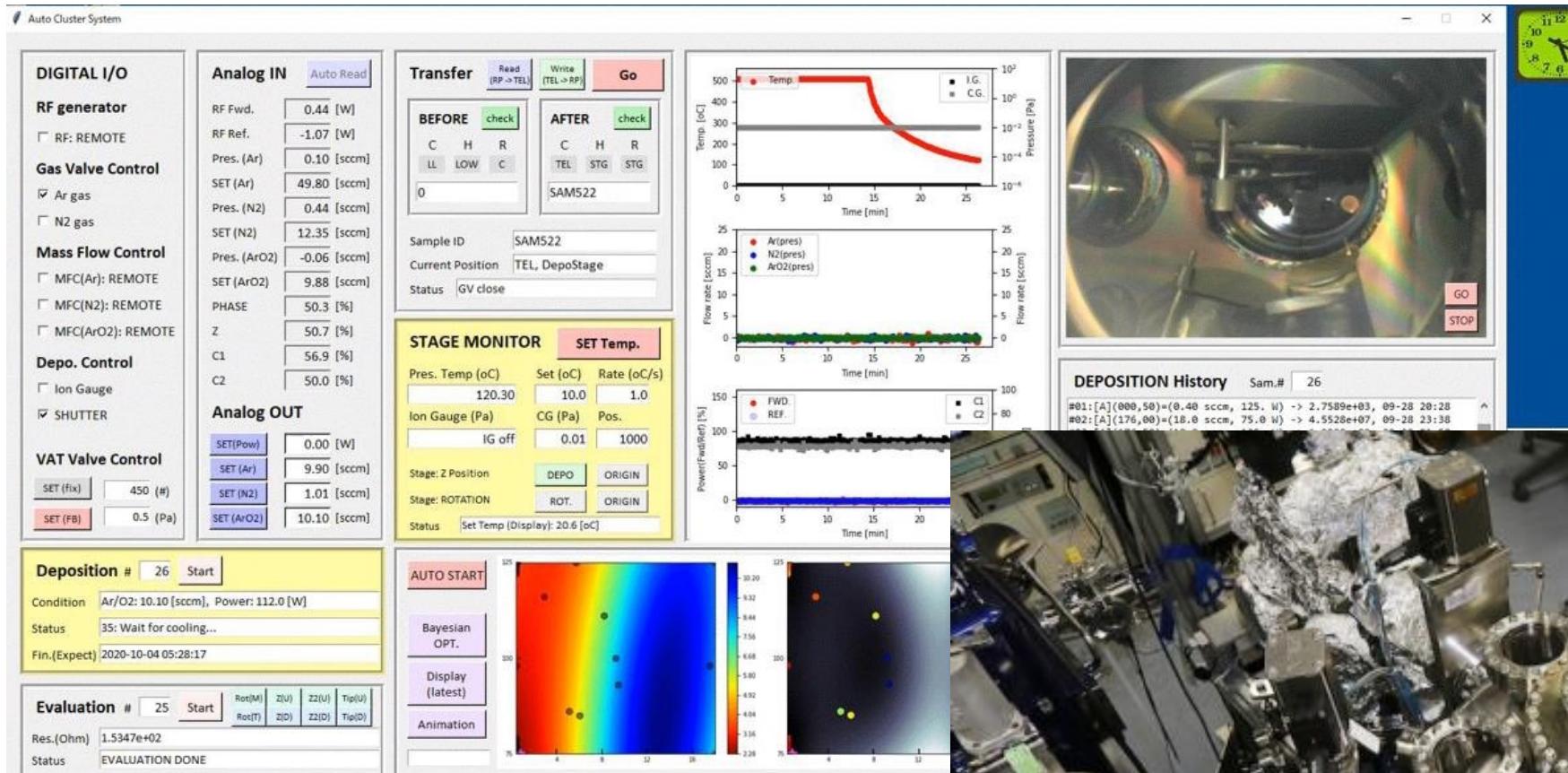


癌症严重程  
度高的地区



Machine Learn. 109,327(2020).  
FEBS Lett. 593, 2535(2019)

分析每次测量获得的拉  
曼信息，以计算出最佳  
的测量方式，并将其反  
馈给设备以加快进程。



R. Shimizu et al. APL Materials 8, 111110 (2020)

# Example: Japan Online Seminar

The screenshot shows a Windows desktop environment with a browser window displaying the Japan Online Seminar series website. The browser title bar says '国立研究開発法人 科学技術振興' and the URL is 'https://measurement-informatics-seminars.jp'. The website content includes a banner for the 'Information Measurement Online Seminar Series', a summary section, and a list of 35 seminars with details like date, time, speaker, and title. The Windows taskbar at the bottom shows various pinned icons and the system tray indicates the date as 2023/2/27 and the time as 11:09.

回数	日付	時間	講師	題目
第11回	2021/11/20	10:30-11:50	吉川 元起	「情報計測による嗅覚センサの高度化」
第12回	2021/11/27	10:30-11:50	工藤 博幸	「筑波大学システム情報系」「新方式CTと先端トモグラフィー画像再構成」
第13回	2021/12/11	10:30-11:50	矢野 恵佑	「統計数理研究所」「予測の情報量規準」
第14回	2021/12/25	10:30-11:50	溝口 照康	「東京大学生産技術研究所」「スペクトルを記述子とした物性計測」
第15回	2022/01/08	10:00-11:20	永井 健治	「大阪大学産業科学研究所」「100万細胞をミクロの空間分解能で瞬時に撮像・解析するトランスクーラスコープAMATERAS」
第16回	2022/01/15	10:30-11:50	廣島 通夫	「理化学研究所 生命機能科学研究センター」「細胞内1分子イメージングと機械学習」
第17回	2022/02/05	10:30-11:50	太田 穎生	「東京大学先端科学技術研究センター」「細胞解析技術の融合と結合」
第18回	2022/02/19	10:30-11:50	青西 亨	「東京工業大学 情報理工学院」「多次元X線吸収スペクトルからの物理特徴量検出」
第19回	2022/07/23	10:30-11:50	久保 久彦	「防災科学技術研究所 地震津波火山ネットワークセンター」「日本の地震観測とその観測データへの機械学習の適用事例」
第20回	2022/10/29	10:30-11:50	森川 耕輔	「大阪大学大学院基礎工学研究科」「不完全データに対する統計解析と統計地図学への応用」
第21回	2022/08/20	10:30-11:50	桑谷 立	「国立研究開発法人海洋研究開発機構 海域地震火山部門 火山・地球内部研究センター 固体地球データ科学研究グループ」「情報計測の実践：地球科学分野を例に」
第22回	2022/09/03	10:30-11:50	米原 厚憲	「京都産業大学理学部」「重力レンズ現象を利用した宇宙の探索」
第23回	2022/09/17	10:30-11:50	佐藤 いまり	「国立情報学研究所」「光3Dイメージング技術による非破壊・非侵襲計測」
第24回	2022/10/01	10:30-11:50	小野 寛太	「大阪大学大学院工学研究科」「材料の計測の自動化」
第25回	2022/10/15	10:30-11:50	竹内 繁樹	「京都大学大学院工学研究科」「光量子センシングの現状と展望」
第26回	2022/10/22	10:30-11:50	村松 正吾	「新潟大学自然科学系」「計測信号解析のための局所構造化辞書学習」
第27回	2022/11/05	10:30-11:50	西本 伸志	「大阪大学大学院生命機能研究科」「脳計測と脳内情報表現」
第28回	2022/11/19	10:30-11:50	庄野 逸	「電気通信大学大学院情報理工学研究科」「画像処理に基づいた物性材料解析へのアプローチ」
第29回	2022/12/03	10:30-11:50	安藤 康伸	「産業技術総合研究所 機能材料コンピュテーションナルデザイン研究センター」「データ生成・蓄積・活用サイクルの実現に向けたデータ駆動型材料研究・開発について」
第30回	2022/12/24	10:30-11:50	松永 康祐	「埼玉大学工学部情報工学科」「微分可能なアプローチによる高速原子間力顕微鏡データの解析」
第31回	2023/01/14	10:30-11:50	石川 亮	「東京大学総合研究機構」「深さ断層法による原子分解能3次元計測」
第32回	2023/01/28	10:30-11:50	珠玖 隆行	「岡山大学学術研究院環境生命科学学域」「土木工学における不確実性とデータに基づく意思決定」
第33回	2023/02/11	10:30-11:50	永田 賢二	「国立研究開発法人物質・材料研究機構 統合型材料開発・情報基盤部門」「ベイズ推定による情報計測の推進とマテリアルズインフォマティクスに向けて」
第34回	2023/02/25	10:30-11:50	舟橋 啓	「慶應義塾大学理工学部生命情報学科」「深層学習による定量的な体外受精胚評価手法の開発」
第35回	2023/03/11	10:30-11:50	水牧 仁一朗	「公益財団法人高輝度光科学研究所」「ベイズ統合～物性物理学への展開～」



人才不足，同步辐射利用方法众多，数据解析专业化要求，  
实验的门槛，技术普及不足。。

## 专用线站的建立

常规方法 XRD, SAXS, XAFS, XPS, CT等  
光学系的标准化  
计测设备以及计测控制软件的共同化，  
测量的自动化及遥控化  
常规解析的自动化  
同步辐射测量数据化库  
线站技术管理的制度化  
常用测量环境的整备等

## 工业化应用机构的建立

大学，企业的交流部门和机制  
其他关联大科学装置建立对接和横  
跨平稳过渡机制从而扩大用户群和  
开发新的需求方向  
引导大企参与管理或建站。  
普及同步辐射利用，开展各种实验  
方法，数据分析的研究会，实习等  
方案，积极推近成果转化。

# 4. Future Outlook



企业

AsahiKASEI

住友化学  
SUMITOMO CHEMICAL

TOYOB

MITSUBISHI  
CHEMICAL

'TORAY'

YOKOHAMA

関西学院大学  
KWANSEI GAKUIN UNIVERSITY

住友ゴム工業株式会社  
SUMITOMO RUBBER INDUSTRIES, LTD.

住友ベークライト株式会社

kuraray

DENSO  
Crafting the Core

BRIDGESTONE

三井化学

TEIJIN  
Human Chemistry, Human Solutions

Color & Comfort

DIC 株式会社

组对

大学，研发机构

東京大学  
THE UNIVERSITY OF TOKYO

東京工業大学  
Tokyo Institute of Technology

山形大学  
Yamagata University

名古屋工業大学  
NAGOYA INSTITUTE OF TECHNOLOGY

産総研

QST

京都大学  
KYOTO UNIVERSITY

神戸大学  
KOBE UNIVERSITY

信州大学  
SHINSHU UNIVERSITY

三重大学  
MIE UNIVERSITY

理化学研究所  
RIKEN

CROSS

九州大学  
KYUSHU UNIVERSITY

広島大学  
Hiroshima University

山口大学  
YAMAGUCHI UNIVERSITY

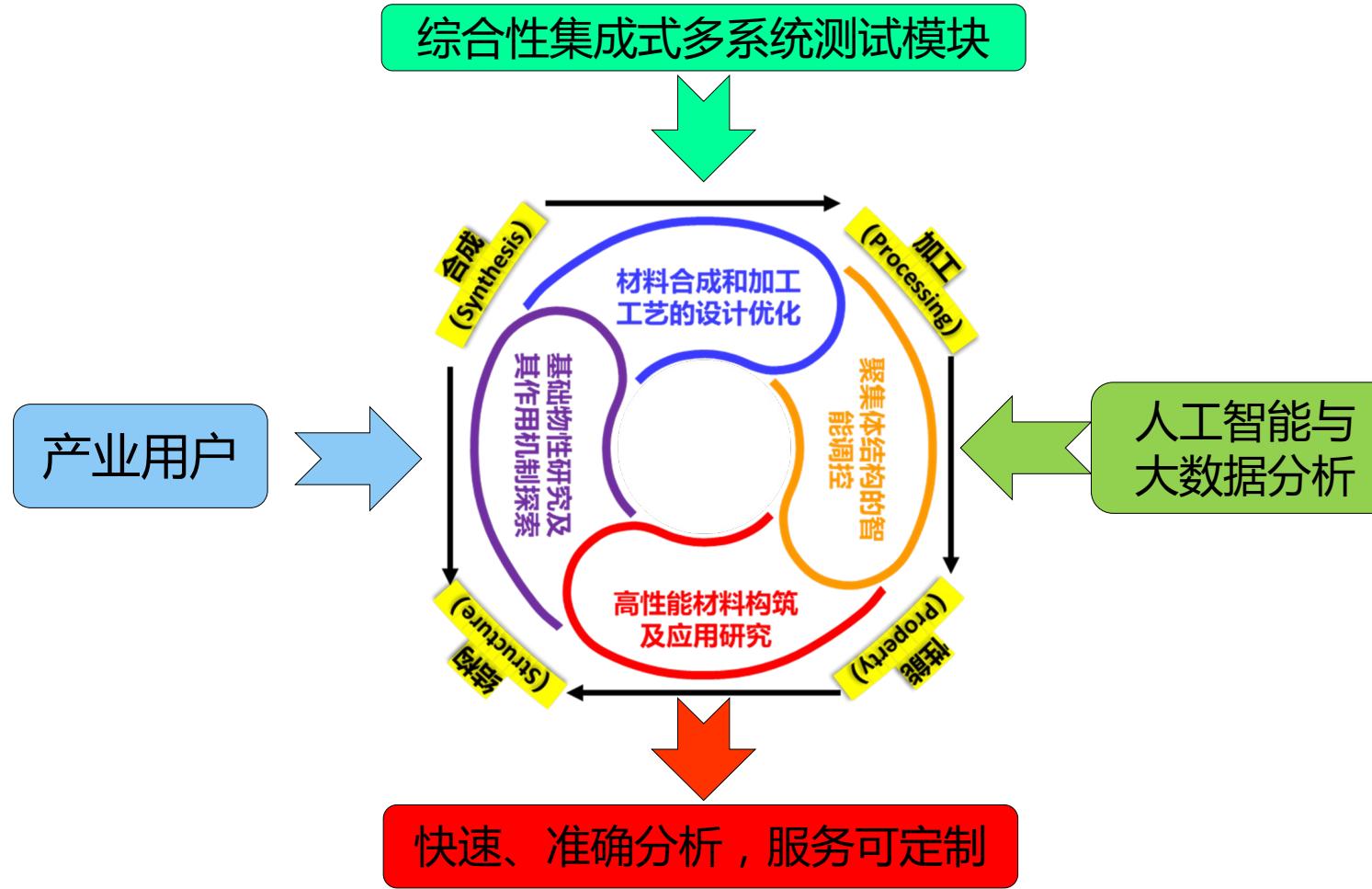
北九州市立大学  
THE UNIVERSITY OF KITAKYUSHU

JASRI

AichiSR

最终目标：实现原位测试分析模块化、集成化与智能化

多维度设计高性能材料



# THANK YOU!

谢谢聆听！

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Guangming District,  
Shenzhen, Guangdong, P.R.China

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