



SSS Endstation: construction progress and experiment planning

TAC report

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2026-10

SSS-introduction



SSS - Soft X-ray Scattering and Spectroscopy Endstation

Technique:

soft X-ray resonant elastic scattering, absorption, and resonant inelastic X-ray scattering spectroscopy based time resolved studies.

Scientific scope – solid state samples:

sub pico-second non-equilibrium evolution of the charge, spin and orbital dynamics in condensed matter physics, chemistry and energy materials.

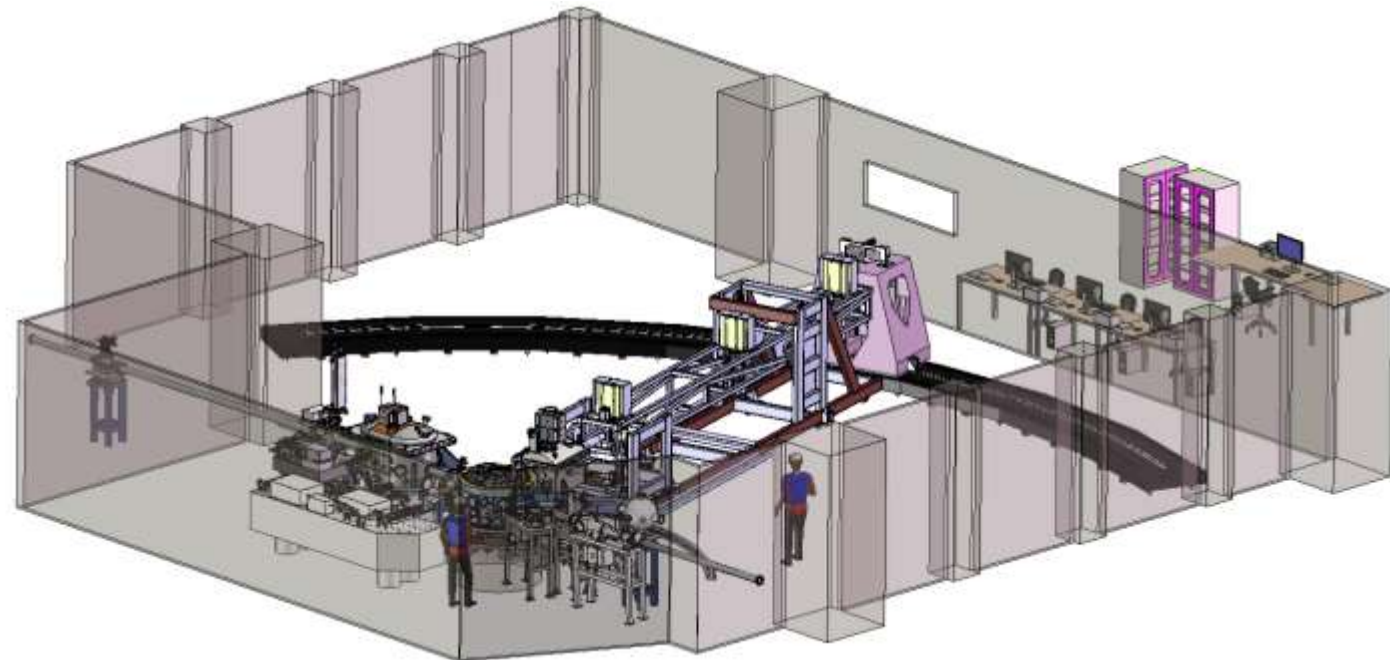
Main parameters:

energy range: 400~1700eV

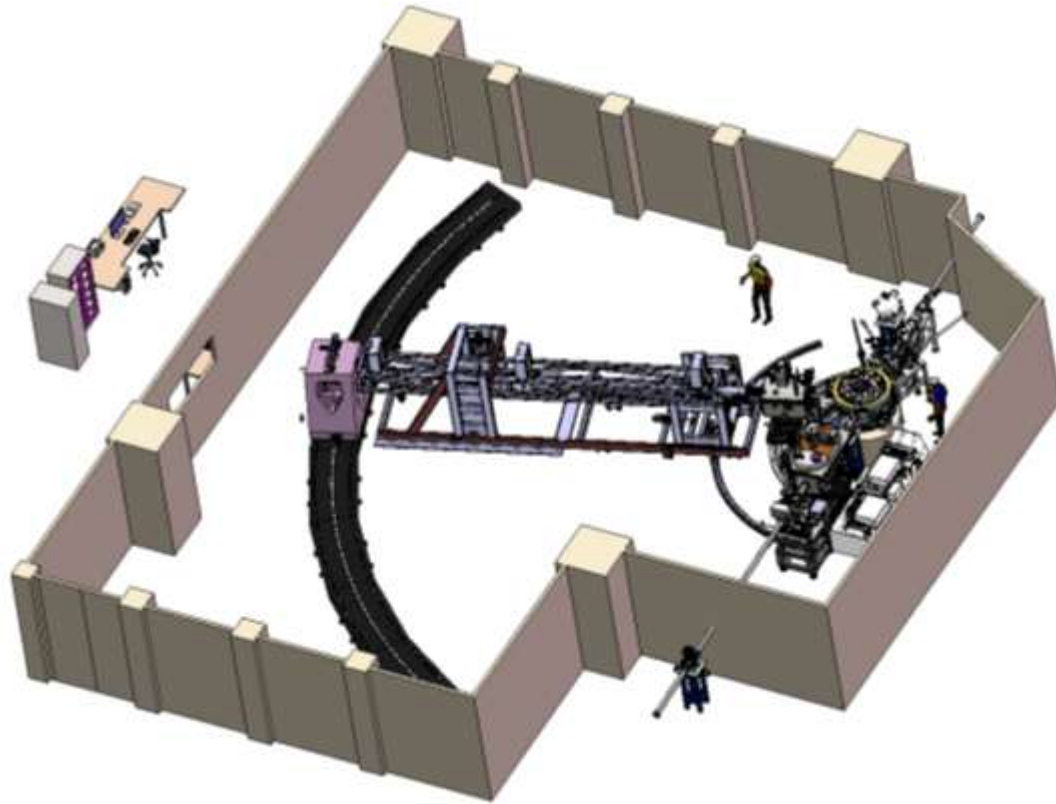
energy resolution:

On day-one	Design objective
100meV@930eV	50meV@930eV

SHINE



Major components and the floor plan



Hatch wall

Standard
element
target

Time
diagnosis
tool

Focusing
chamber

Front
peripheral
device

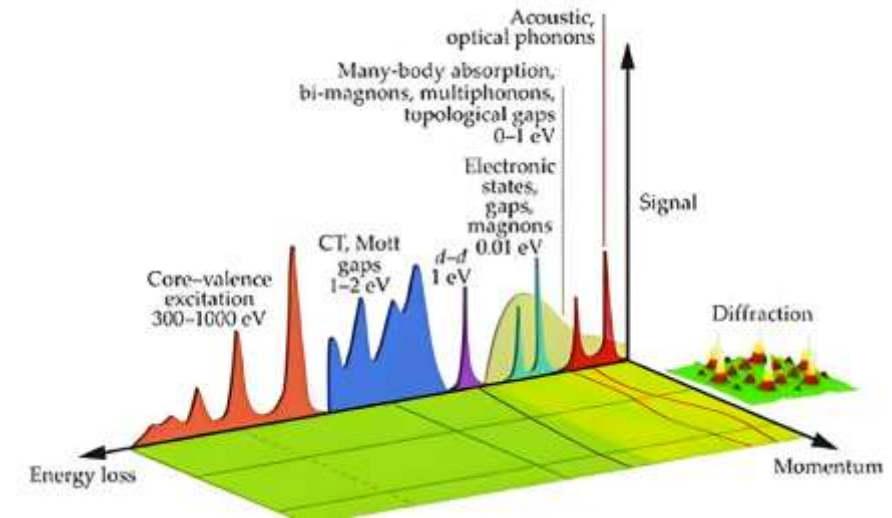
Sample
chamber

End
peripheral
device

Detector &
supporting

Signal
arm

Optics
chamber



- Time resolved (sub-ps): RIXS, RES, XAS
- Energy resolved (<50 meV): charge, spin and orbital dynamics

Hutch overview



Summary of the updates



Device	Status in April	Status in Oct
Detector and supporting	Center conf.: $\sim 40\mu\text{m}$ & $\sim 60\mu\text{m}$ Height variation: $\sim 60\mu\text{m}$ Loading deformation: $\sim 15\mu\text{m}$	Vibration: amplification 1 + 3%; Motion accuracy tested; Project closed
Signal arm	In production	Installed; vacuum tested; Tuning rotation
Optical chamber	Mechanics was ready; optics problem	Optics problem solved; Installation in Dec
Sample chamber	Fixed ports: In production	FAT done; installation in Dec
	Sliding seal: pre-FDR	In production; delivery next year
End peripheral device	In production	Delivery in Nov.
X-ray & laser coupling chamber	N/A	Delivery in Oct.
Standard element chamber	In production	Installed; Project closed
Laser alignment chamber	N/A	Delivery in Oct.

Construction - Detector and supporting

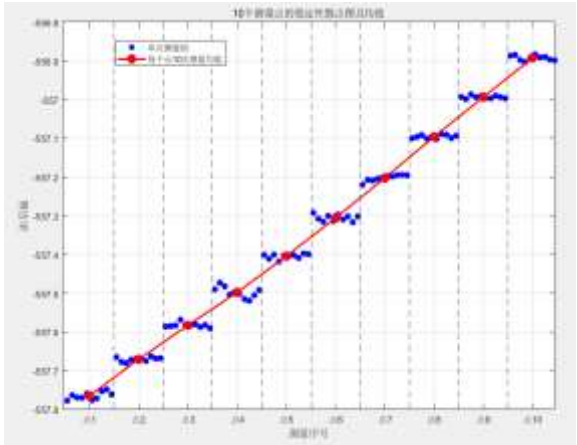
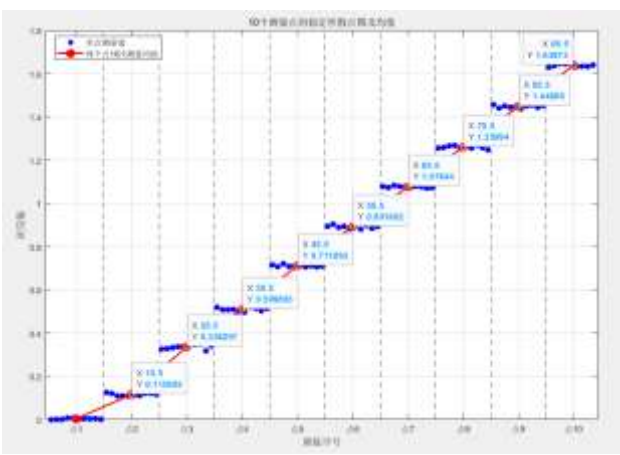
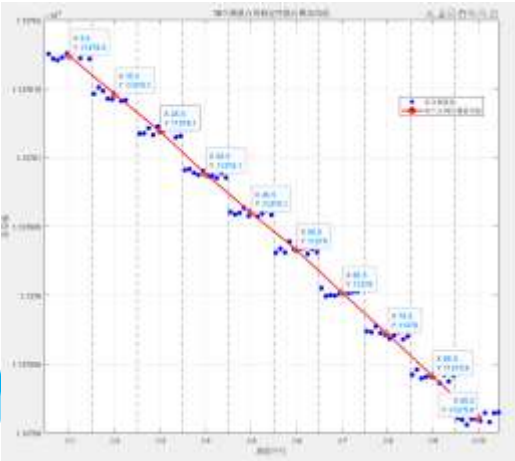


	01(极高点)	02(极高点)	放大率 (极高点)		01(极低点)	02(极低点)	放大率 (极低点)
D_u-Z	128.60	113.87	1.002	D_d-Z	142.62	106.20	0.999
G_Z	123.81	117.85		G_Z	137.49	110.40	
D_u-E	114.01	103.01	1.014	D_d-E	130.99	92.78	1.001
G_E	111.53	102.33		G_E	129.23	93.85	
D_u-N	103.01	107.43	1.034	D_d-N	105.3	92.69	1.013
G_N	102.39	101.15		G_N	106.77	89.16	

radius 0.03mm

angular 0.001degree

Vertical 0.1mm



Construction – signal arm

3.5 T weight v.s. floor condition



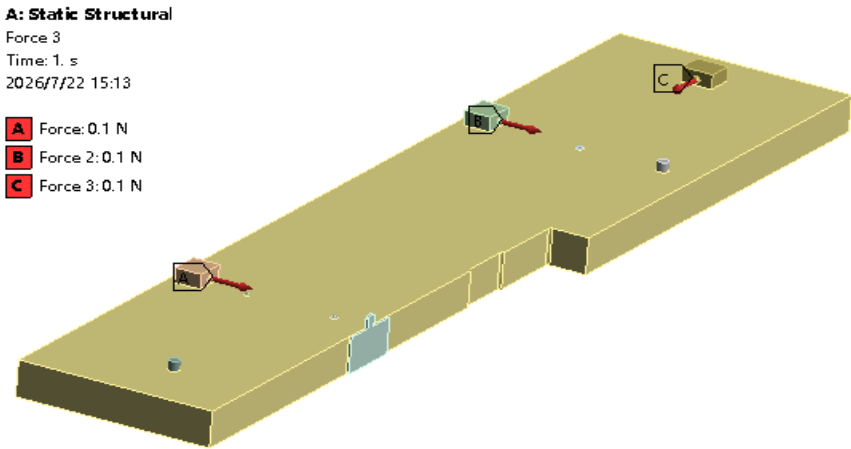
Vacuum test:



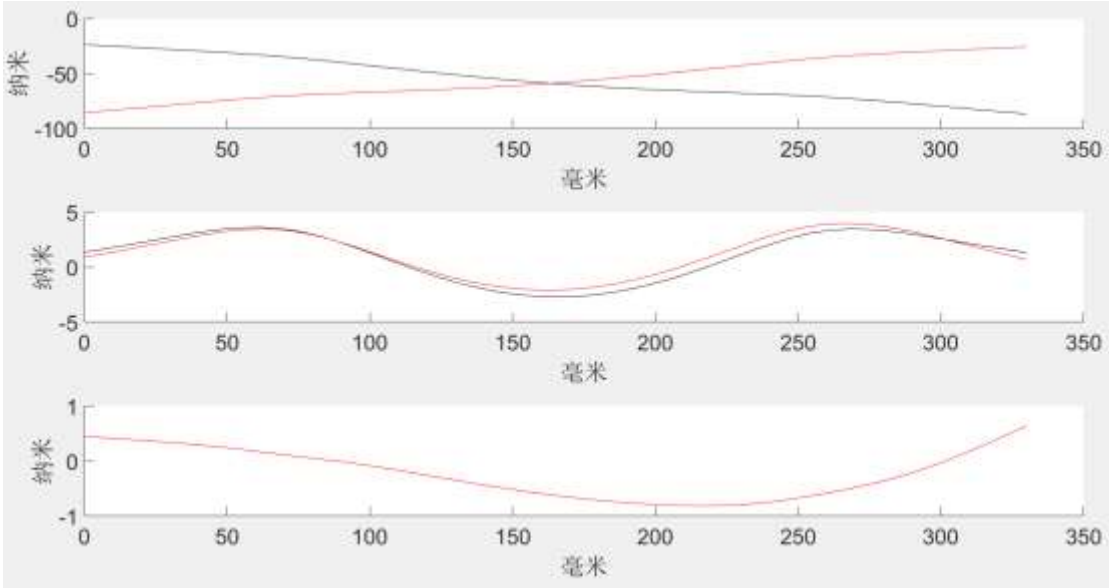
Construction – optical chamber



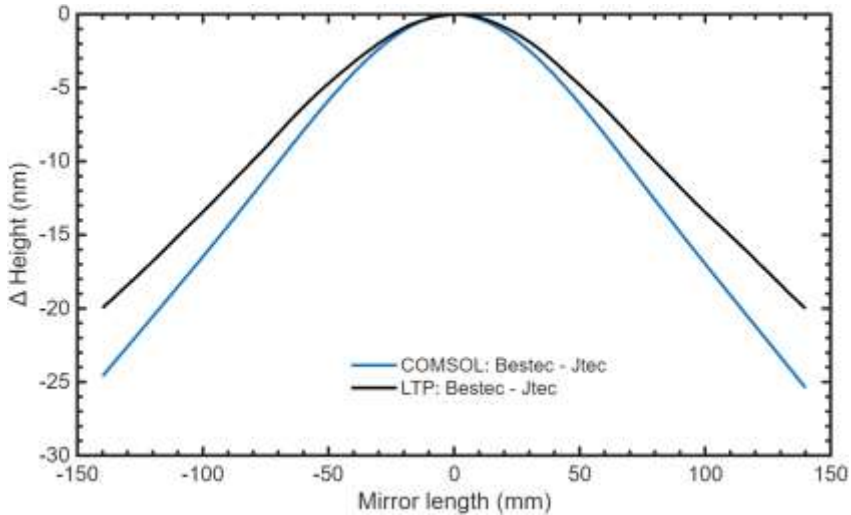
Bessel support + side security protection



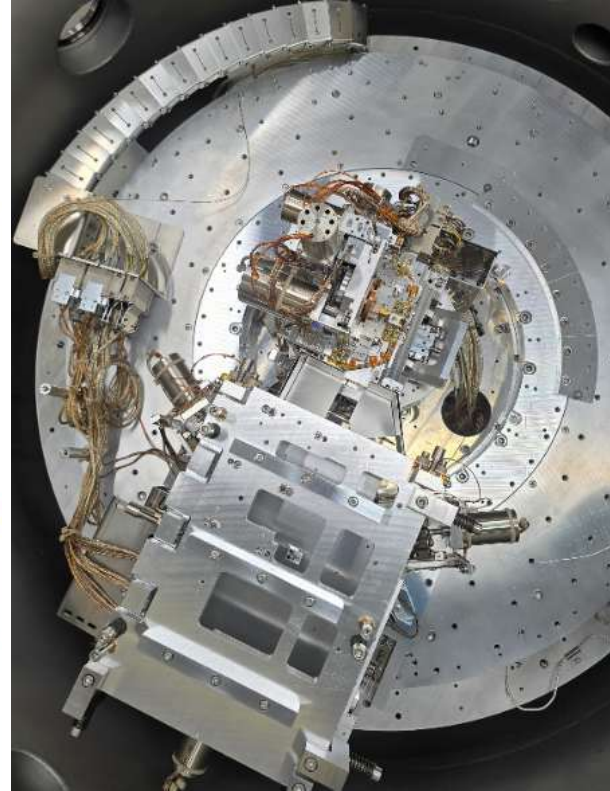
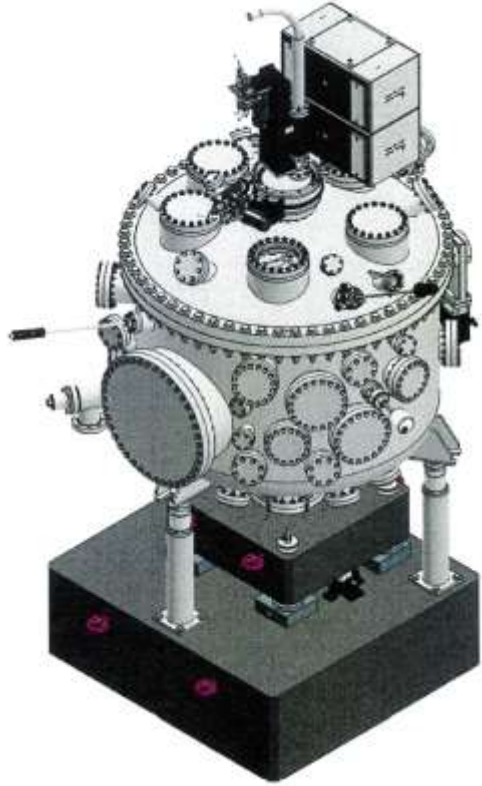
Securing force + gravity considered deformation



Measurement v.s. Comsol protocol



Construction – sample chamber fixed ports



ing details of tasks are agreed to be performed for SAT:

ignment of system with using a precision water level, laser tracker, theodolite with collimation function and prepared optics for the sample manipulator, together with C test and COR alignment (details in Chapter 8).

ustment of the collision switches (DRY/CMSRY).

ontrol PC: Modify of IP address, name and EPICS PV names according to SHINE rules

asurement of the mechanical stability to meet the requirements.

chedule for delivery and installation of the Sample Chamber during the time of the ng:

1. Delivery is scheduled for October 2026.

2. Installation is scheduled for November 2026 on condition that the Energy Dispersing Spectrometer (Bestec Project P517) and the KB Mirror System (Bestec Project P519) have been completed beforehand.

Construction – sample chamber sliding seal

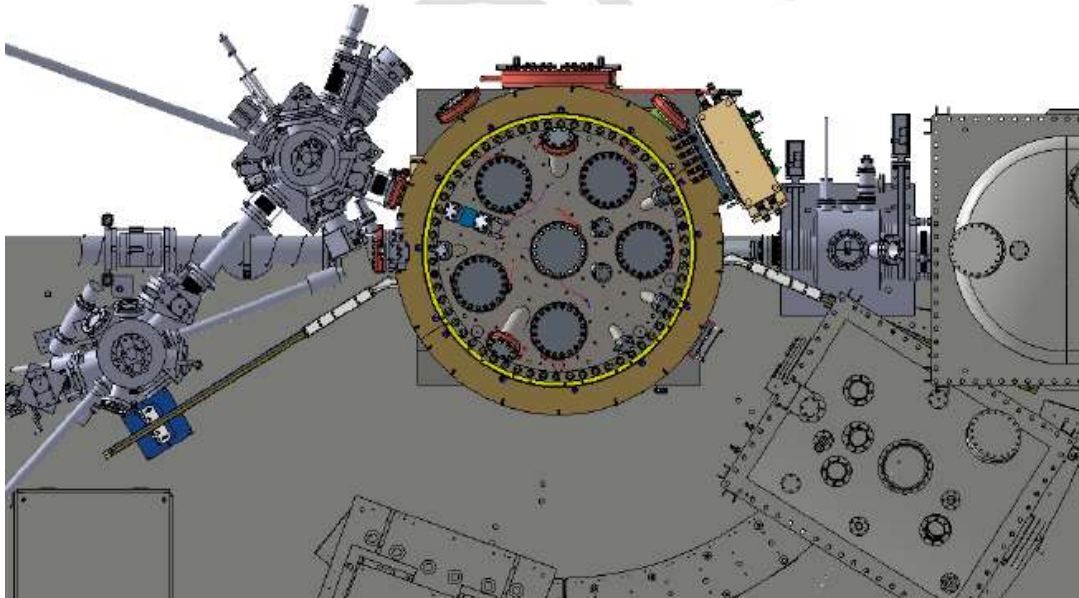
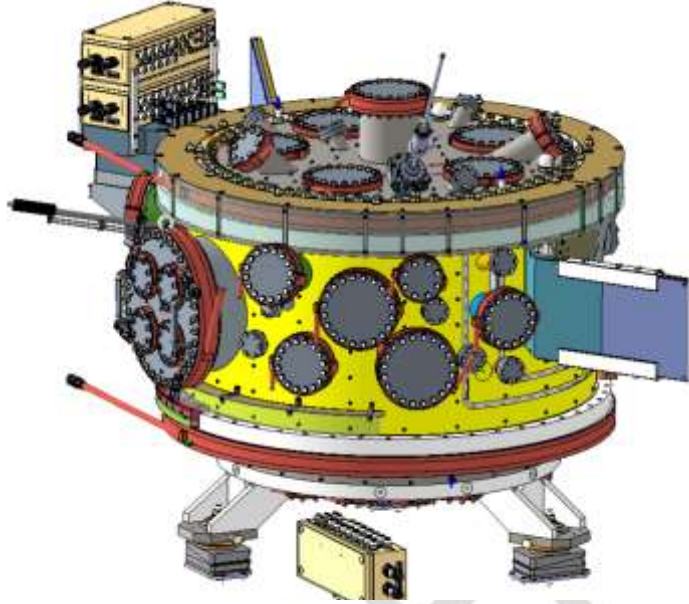
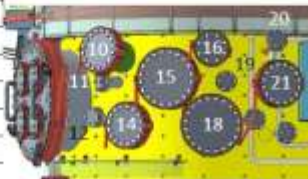
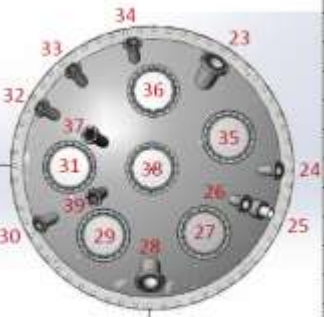
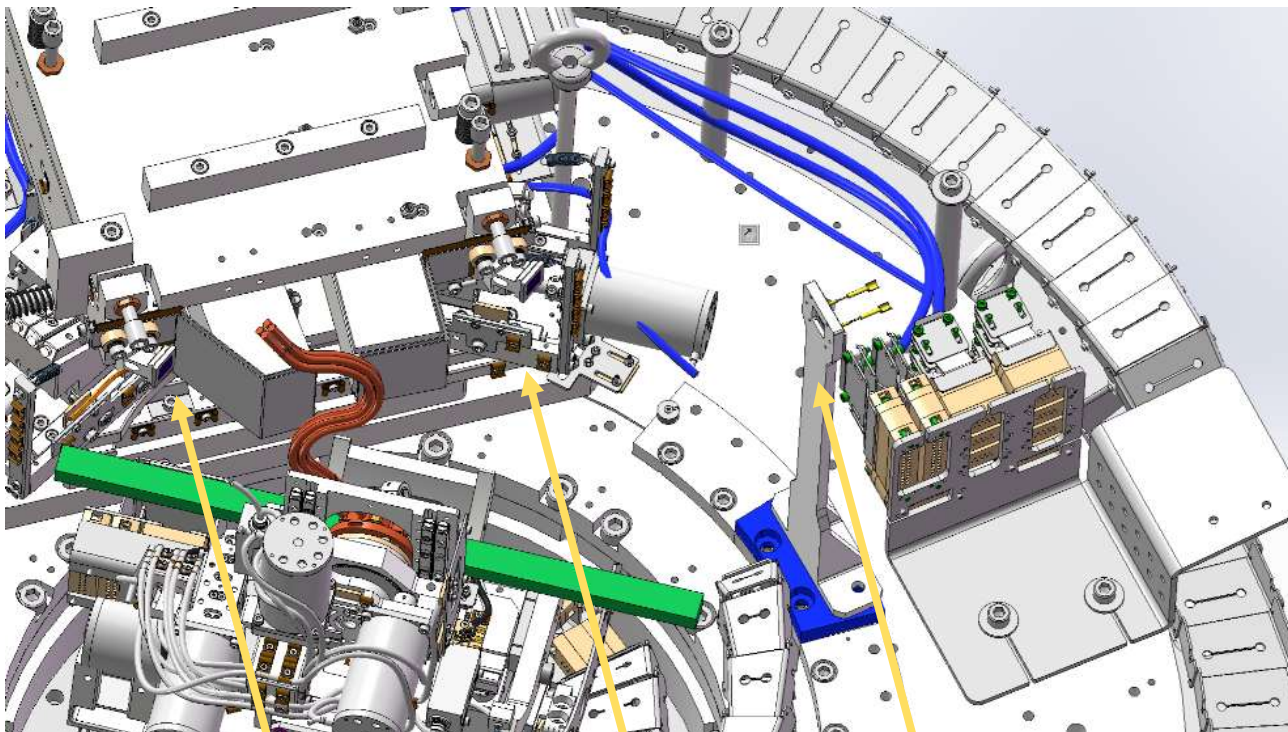


Table 3: Parts comparison

Bestec vessel	Ports	Cinel vessel
	1 Changed angle and distance	
	2 Changed distance (now @ 780 from the sample rotation center) and pipe shape (cross section locally reduced)	
	3 Changed position and distance	
	4 Changed angle, position and distance	
	5 Same position	
	6 Same position	
	7 Changed position and distance	
	8 Replaced by 9A	
	9 Changed dimension, position and distance	
	9D Added	
	10 Changed angle and distance	
	11 Same position	
	12 Changed angle and distance	
	13 Replaced by 9B	
	14 Changed angle and distance	
	15 Changed distance	
	16 Changed distance	
	17 Replaced by 9C	
	18 Changed distance	
	19 Changed distance	
	20 Changed distance	
	21 Changed distance	
	22 Removed	
	23 Changed angle and distance	
	24 Changed angle and distance	
	25 Changed angle and distance	
	26 Changed angle and distance	
	27 Changed distance	
	28 Changed distance	
	29 Changed distance	
	30 Changed angle and distance	
	31 Changed distance	
	32 Changed angle and distance	
	33 Changed angle, position and distance	
	34 Removed	
	35 Changed distance	
	36 Changed distance	
	37 Changed angle and distance	
	38 Same position	
	39 Changed angle and distance	

Construction – in-chamber PDs

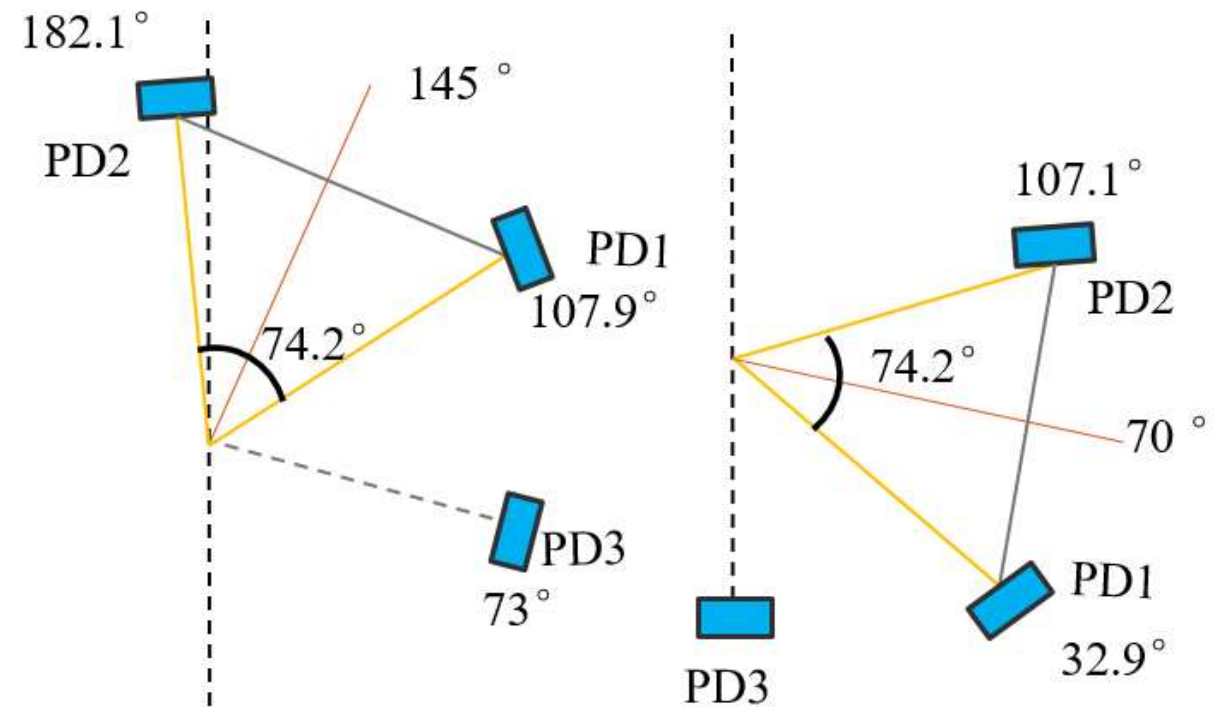


PD2

PD1

PD3

SHINE



Construction – Standard element chamber



SHINE

- 16 slots for different element combination.

刻度/mm	
202	16# Cr2O3 (重复)
194	15# SrTiO3 (重复)
180	14# Hf
172	13# W
158	12# BaTiO3
150	11# NiO
136	10#
128	9#
114	8# MnO2
106	7# Er2O3
92	6#
84	5# SrTiO3
70	4# VO2
62	3# CeO2
48	2# Tb2O3
40	1# Yb2O3
22	YAG中心
10	移入光路
0	零位

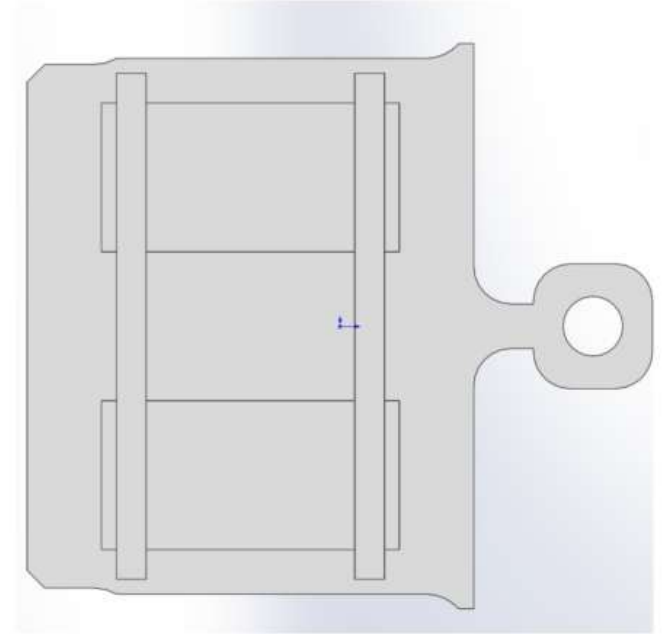
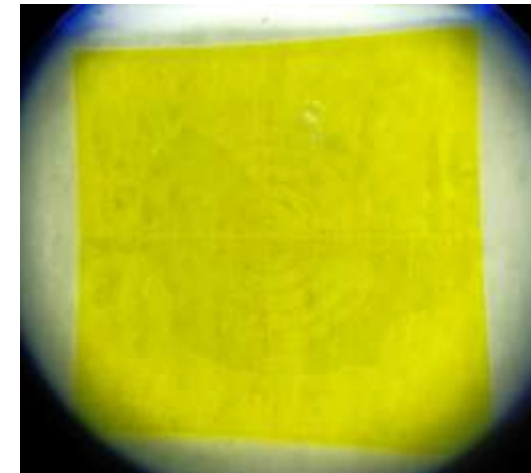
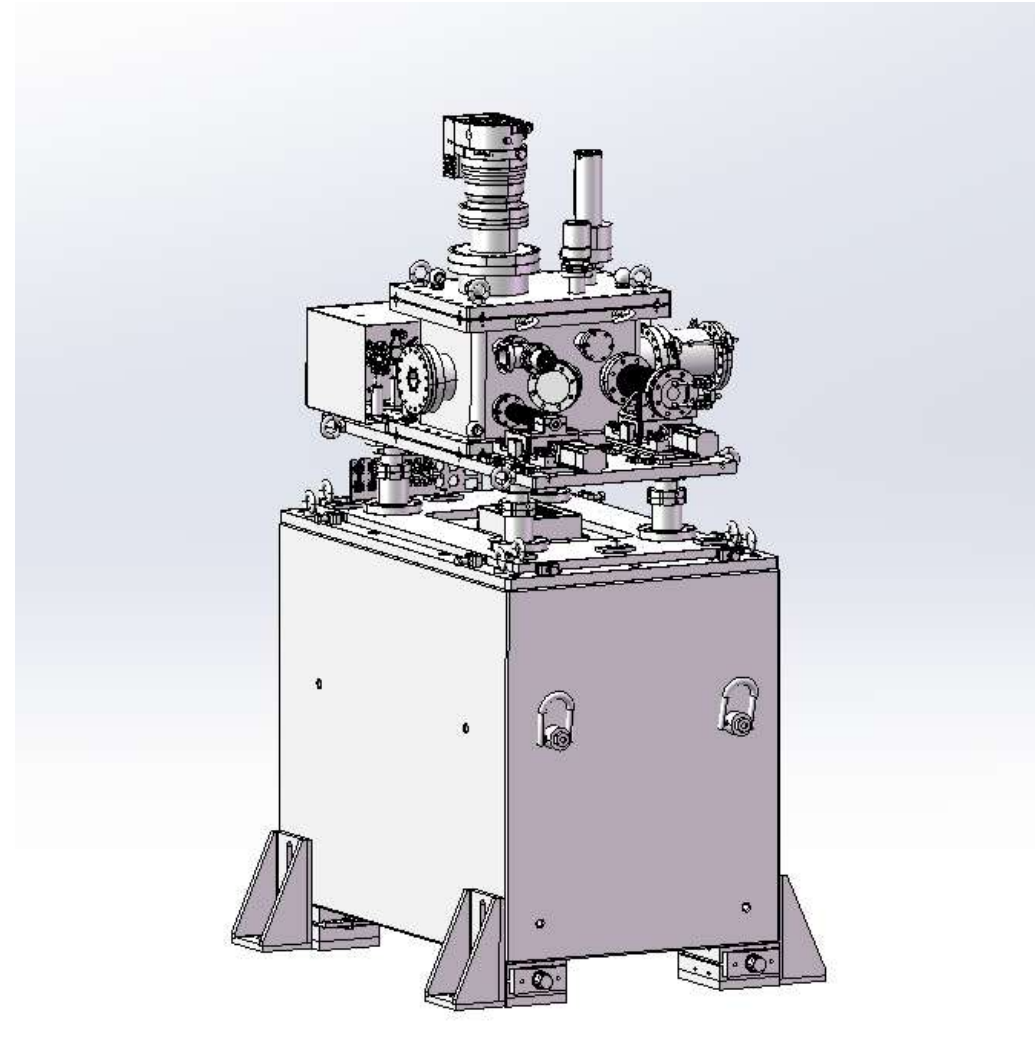
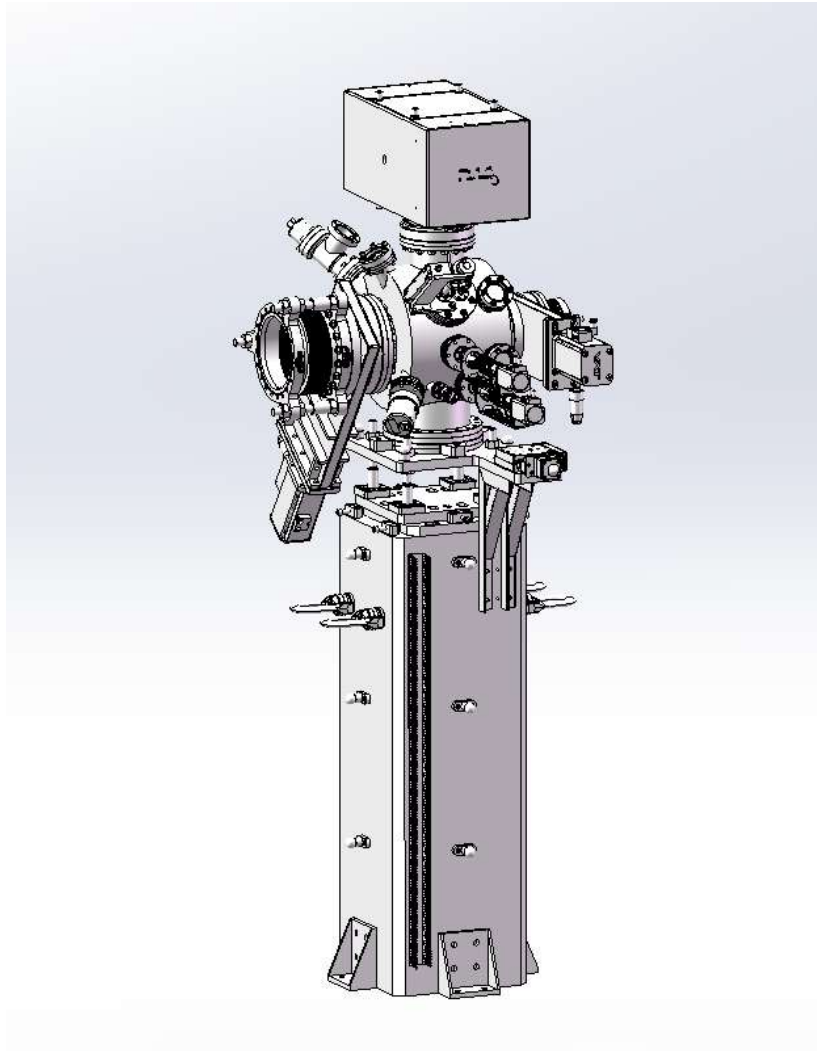


图2 靶信息、位置与电机行程关系示意图（左）及样品托设计（右）

- Marked YAG for alignment

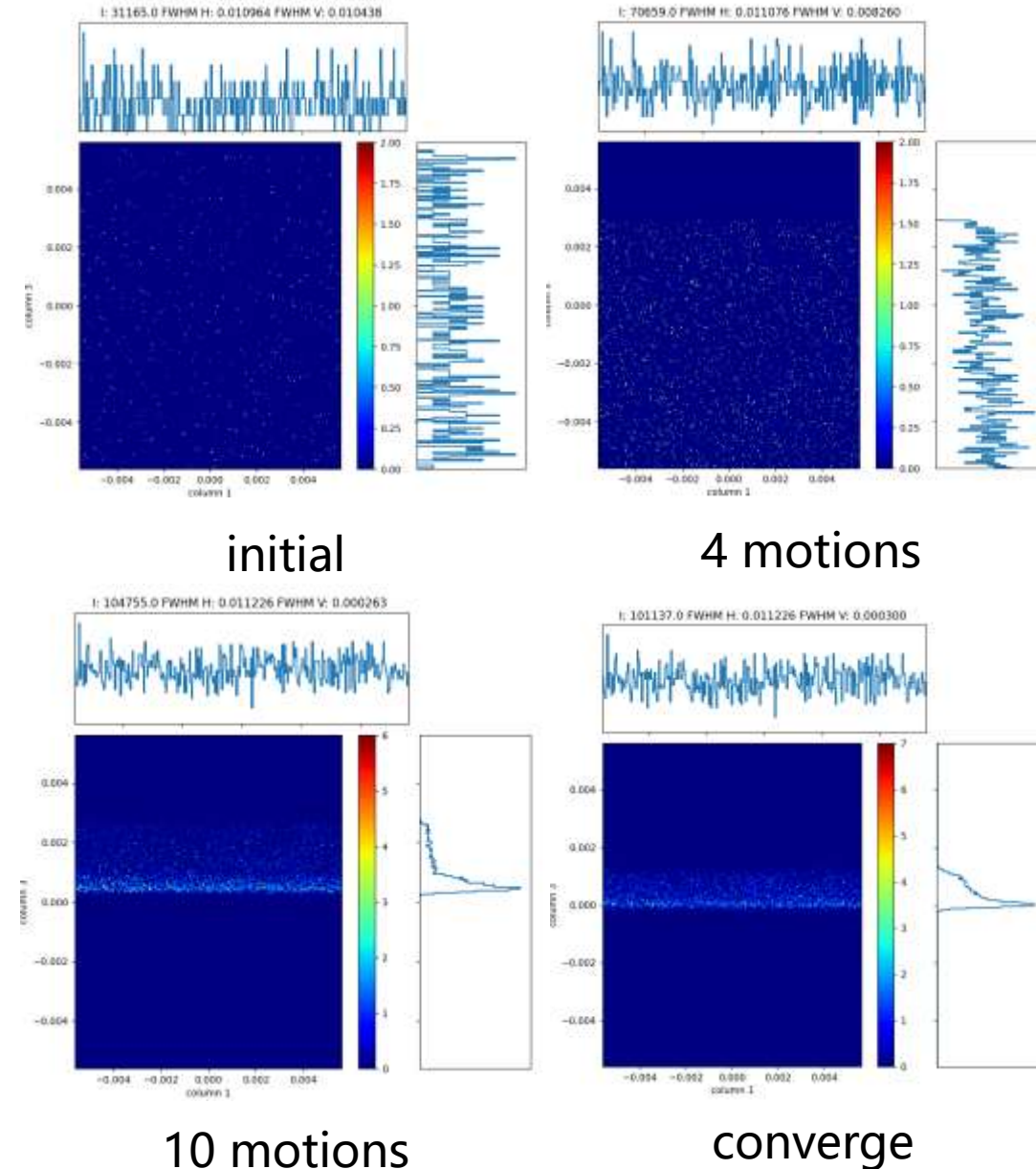
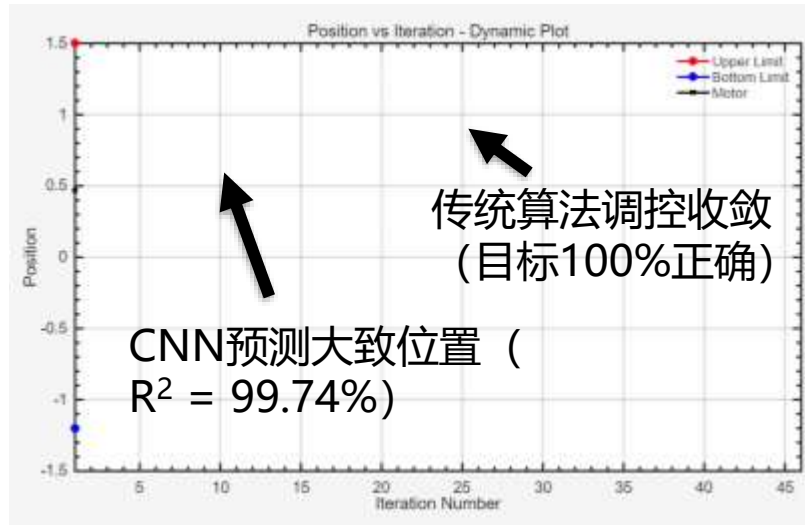


Construction – coupling chamber & alignment chamber

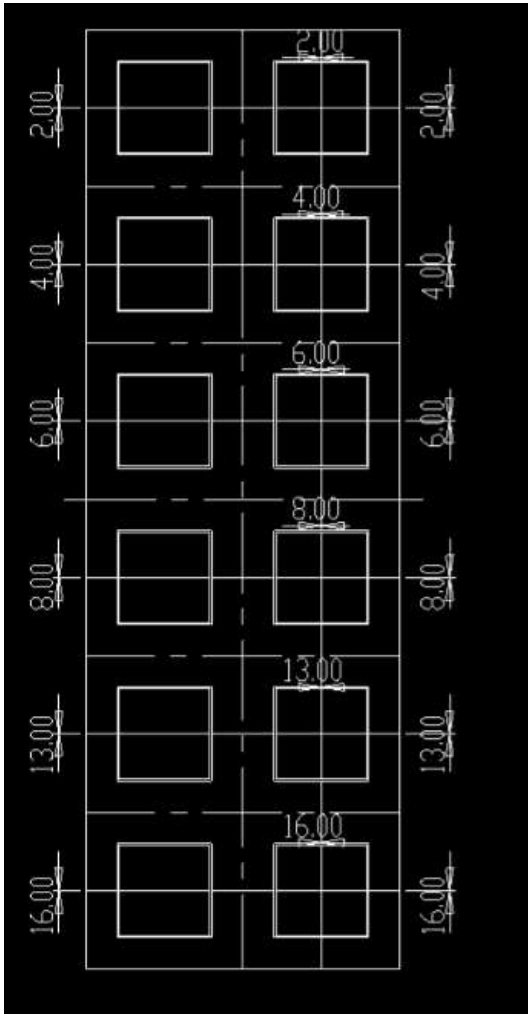
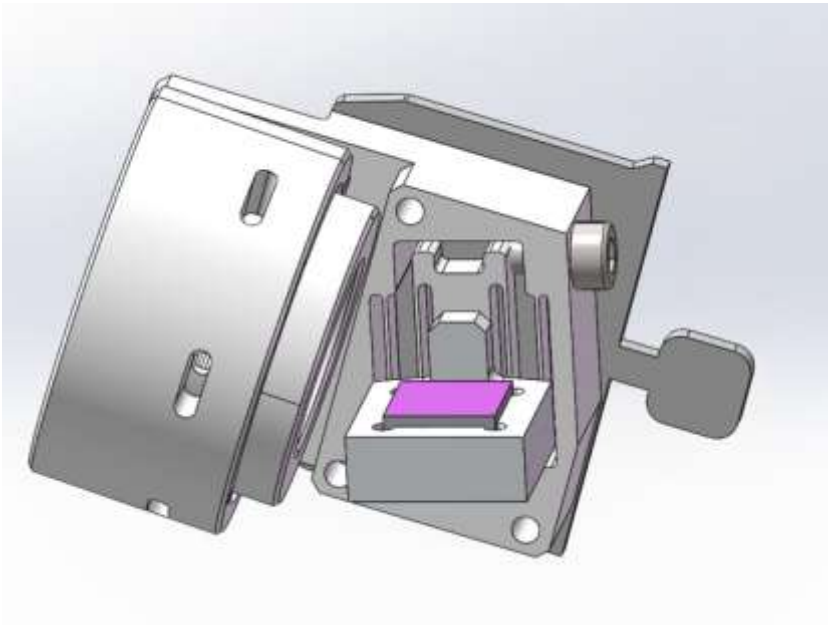
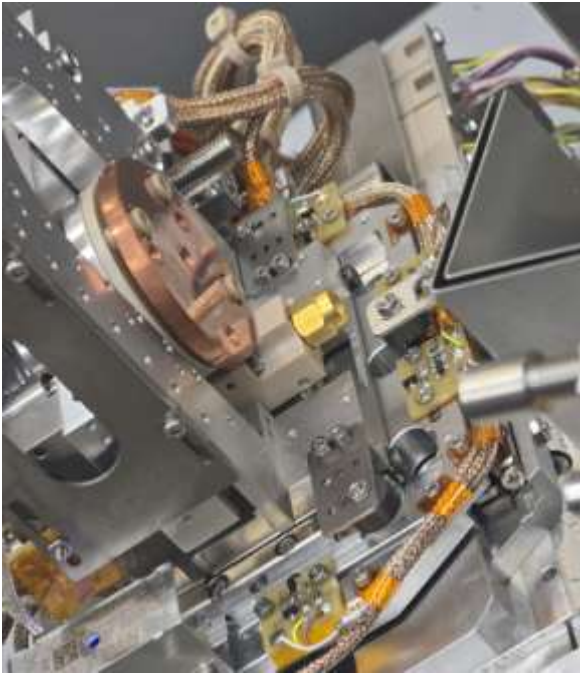


Commissioning – AI assisted alignment

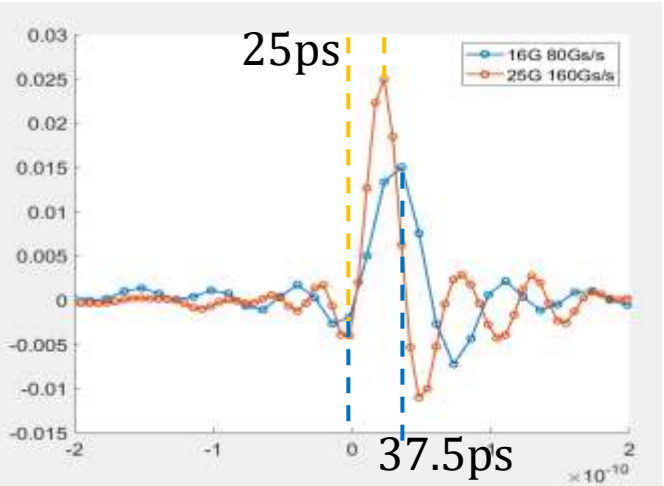
- Convolutional Neural Network + golden-section search
- Tested with focusing mirror motion
- Will expand to full freedom after framework test



Commissioning – spatial and temporal overlap

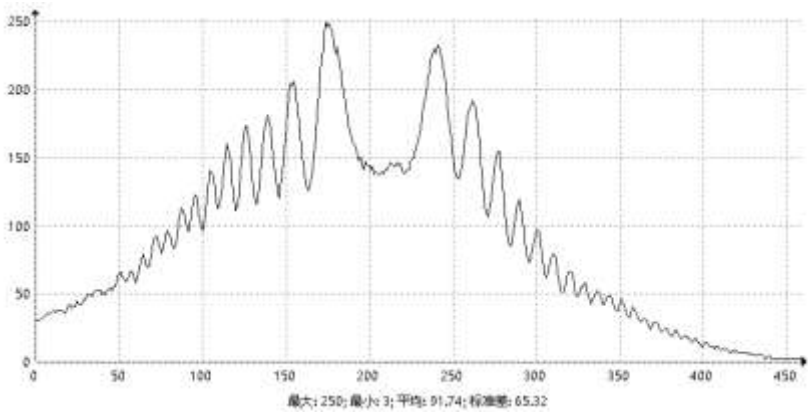


HF-SMA

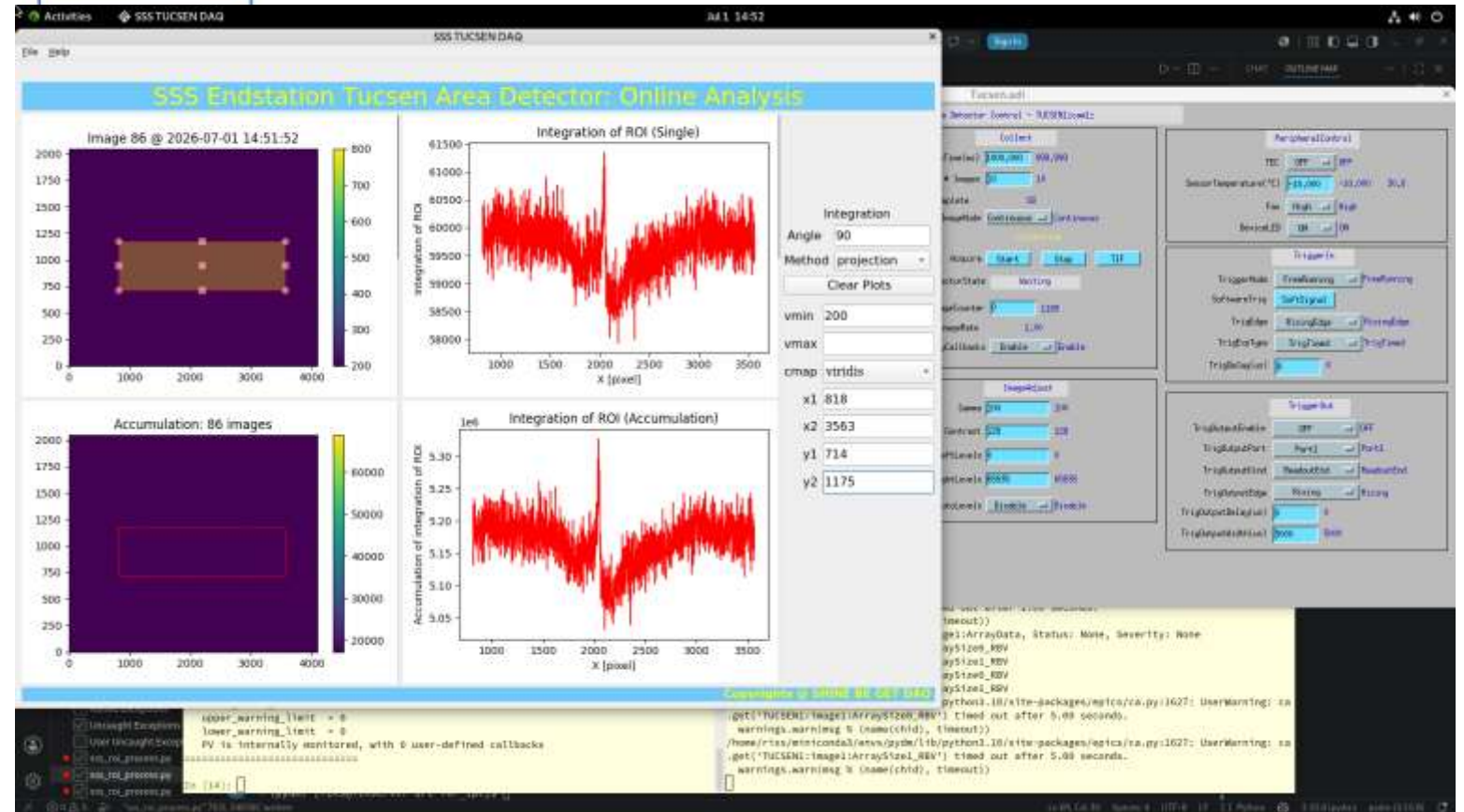
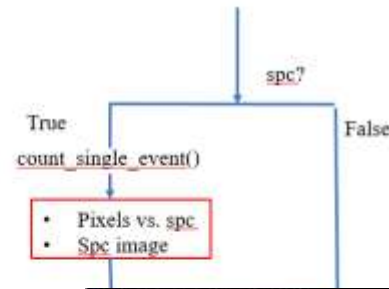
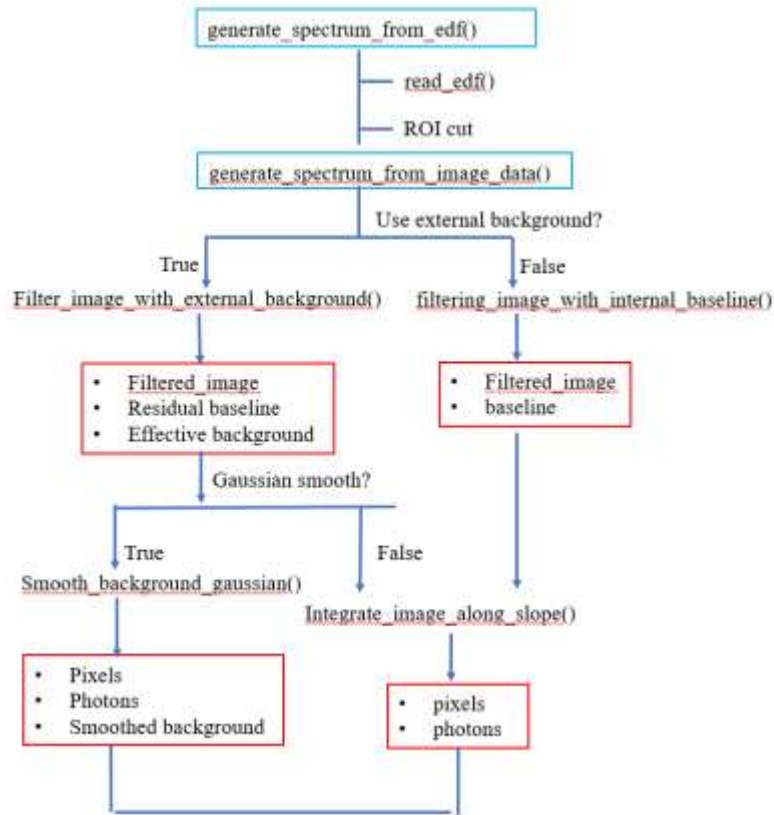


< 8ps expected

Laser interferometer



Commissioning – data collection



Scientific planning



energy range: 400~1700eV

energy resolution:

On day-one	Design objective
100meV@930eV	50meV@930eV

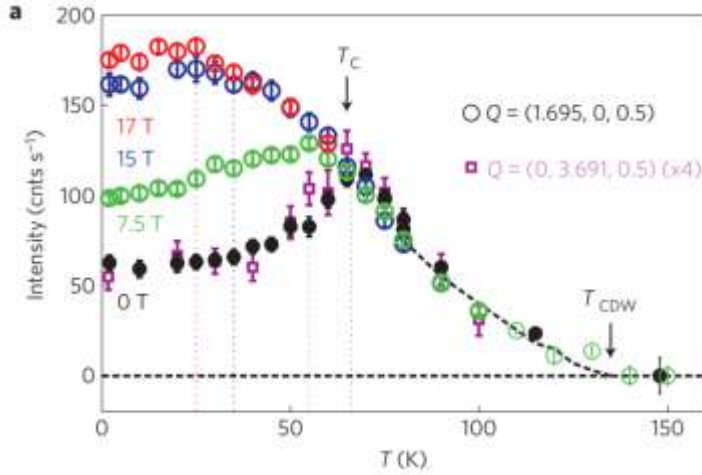
Initial measurements @ resolution ~100meV, rep-rate ~ 10K:

1. Optical triggered chemical process (photosynthesis) ;
2. Quasi-elastic response & inelastic response of the orderings in electron-correlated materials;

Cuprates :

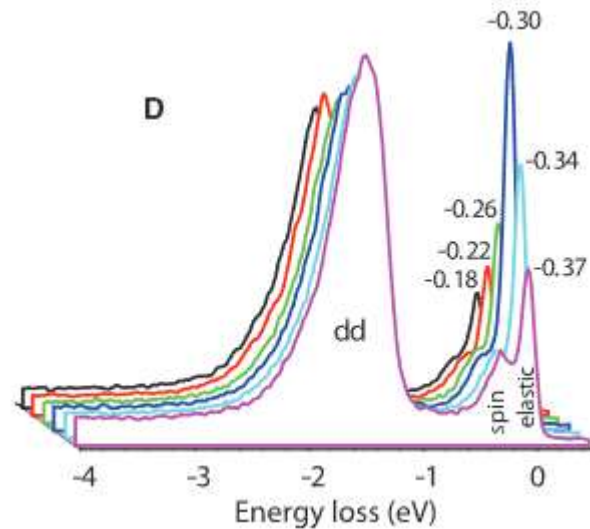
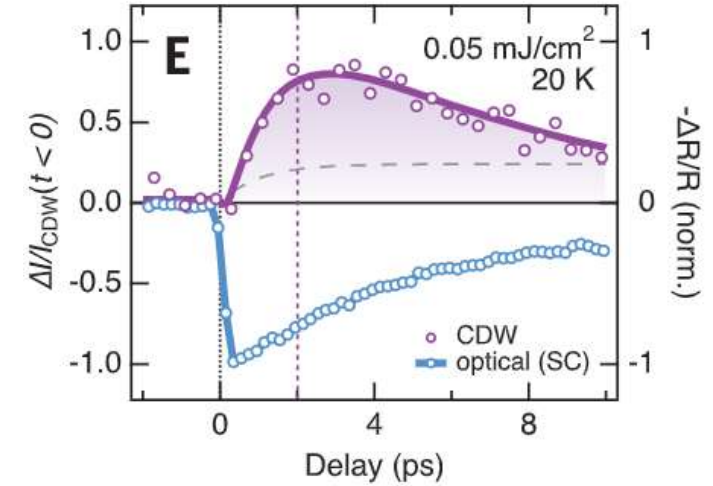
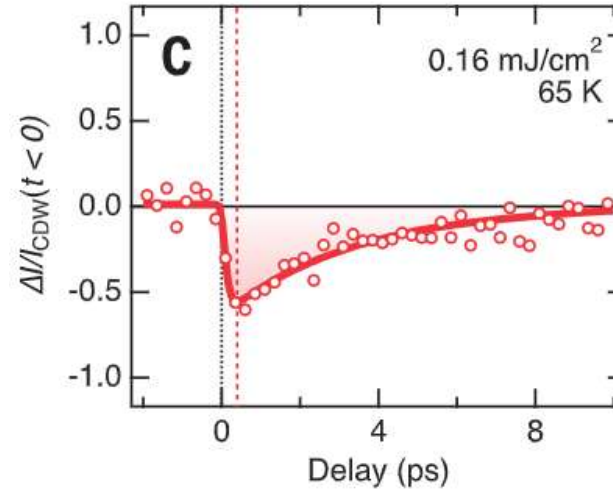
CDW, SDW, phonon coupling, charge plasmon, charge continuum etc.

Scientific planning – example: CDW v.s. SC transition

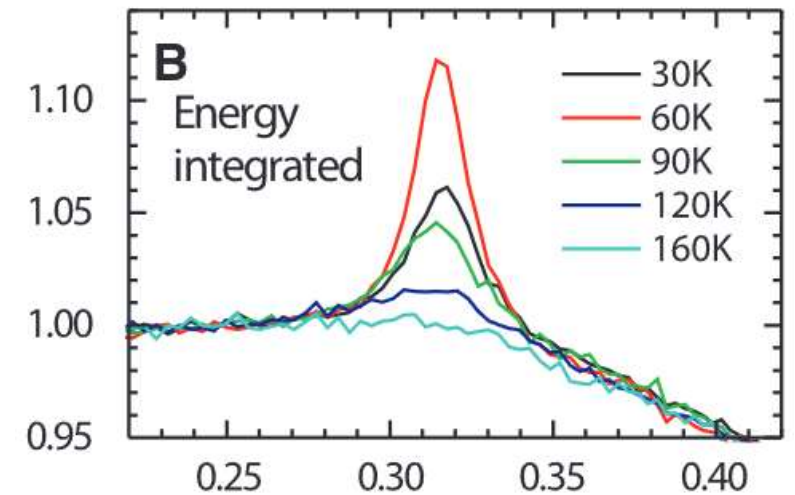
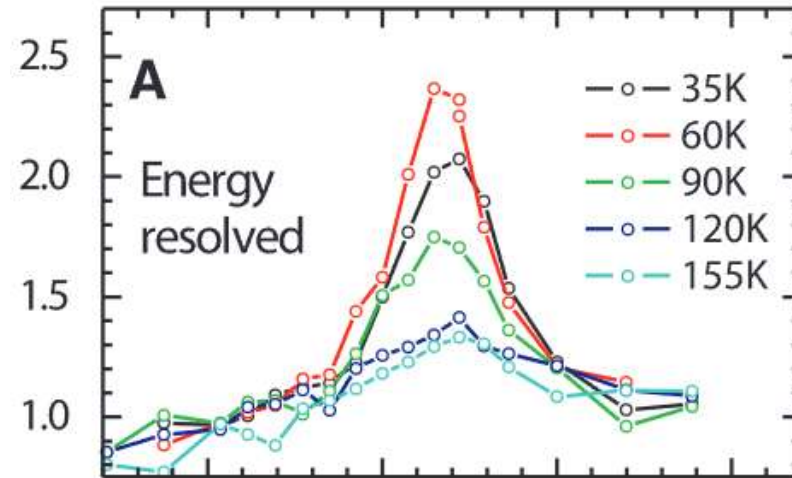


J. Chang et al. NATURE PHYSICS 2012

Wandel et al. Science (2022) tr-RXS

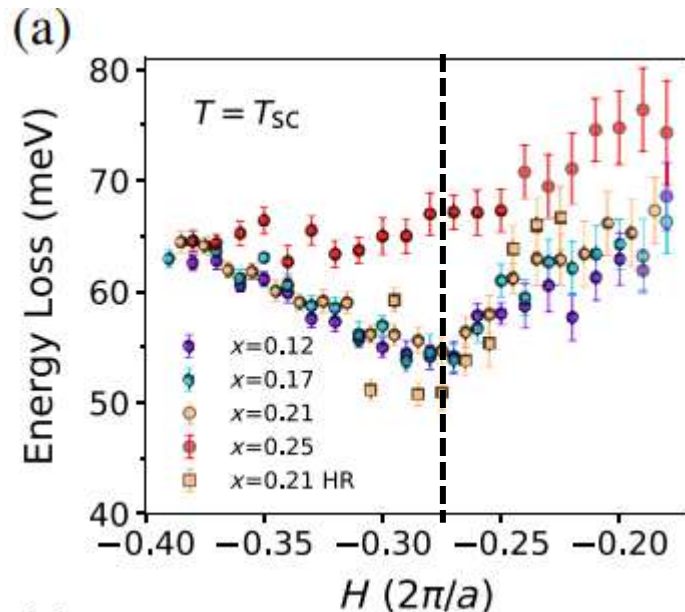
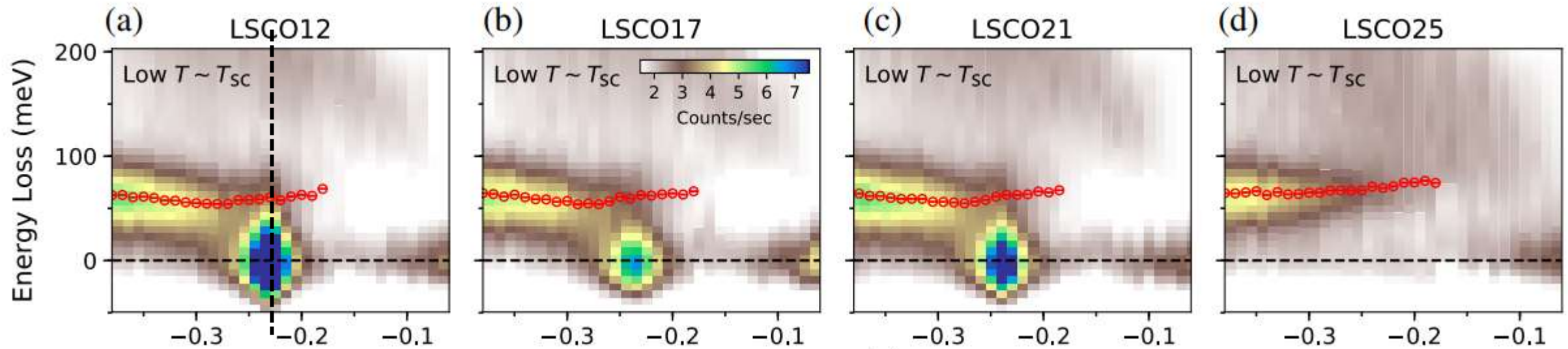


G. Ghiringhelli et al. Science 2012



Scientific planning – example: CDW v.s. electron-phonon

J. Q. Lin et al. PRL 2020



- A clear coupling of the CDW v.s. phonon softening
- A clear mismatch in momentum

What is the role of electron-phonon coupling for SC in the cuprates?



Thank you!

SSS team:

Liu, Jun

Wang, Renshu

Feng, Jiatai

Li, Xiaoting





Multi-magnons

<https://www.nature.com/articles/s41467-023-38341-8>

Magnetic excitations beyond the single- and double-magnons

Fig. 1: Crystal structure and X-ray L_3 -edge measurements in a (0001) α - Fe_2O_3 single crystal.

