



# Design of a Scientific Data Management System Based on DOMAS at CSNS-II

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# Content

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**1** Background

**2** Framework & Application

**3** Plans

# Challenges of Data Management at CSNS-II

**20 Instruments** at CSNS-II



## Data Characteristics

**Data Volume 2 PB/year**

**Diversity of sources**

**Interdisciplinary**

**High Complexity**

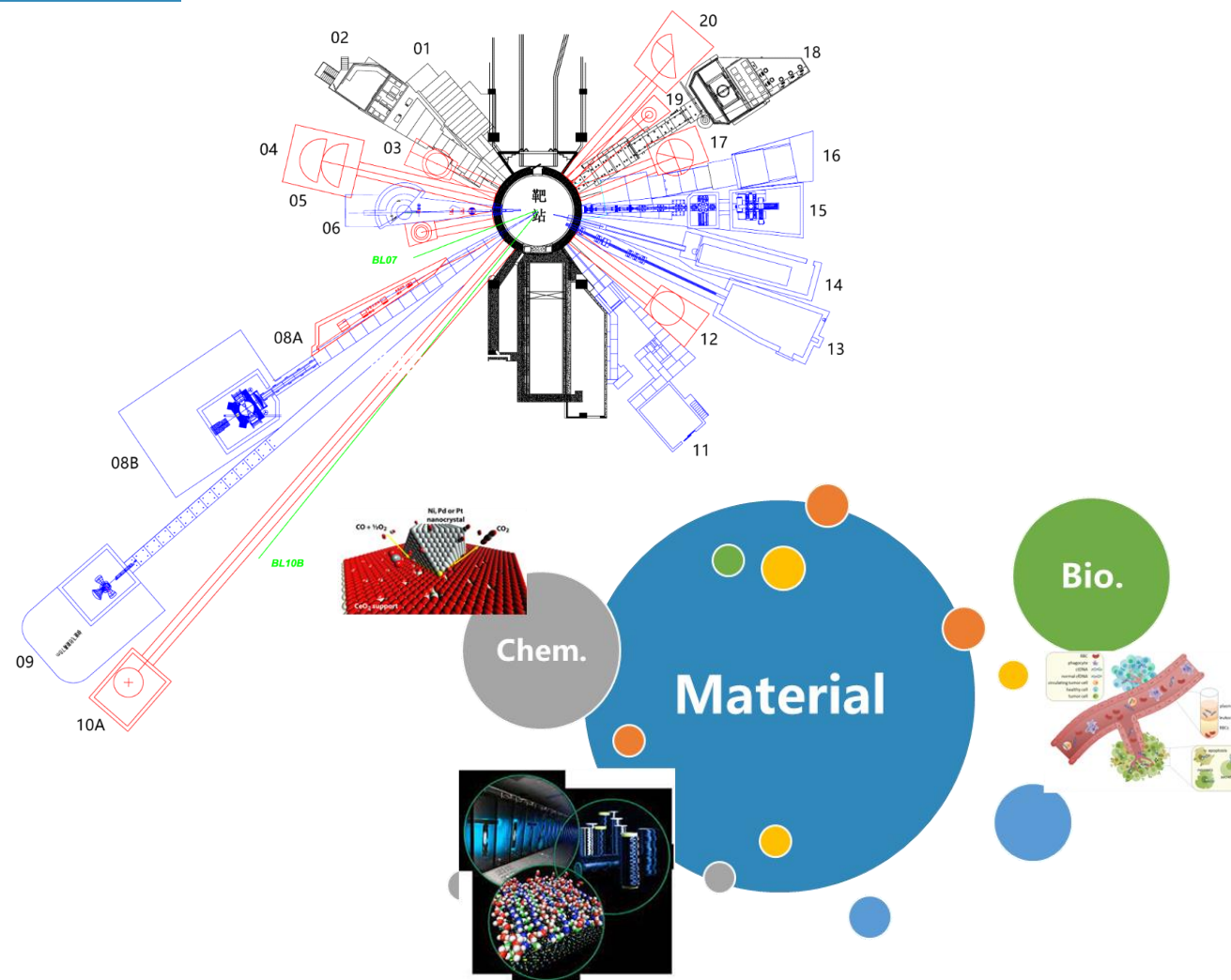
**Challenges**



**Collection  
&  
Analysis**

**Transfer  
&  
Storage**

**Mining  
&  
Management**



**Data Management Challenges**

# Challenges of Data Management at CSNS-II




ICAT@CSNS <https://github.com/icatproject/>

Deployed at 4 instruments for CSNS-I

Limitations for CSNS-II:

- ❑ The full lifecycle data management is **inadequate**
- ❑ Metadata database based on MySQL is **limited** scalability
- ❑ Rule-based ACL is **complex**
- ❑ **Inflexible** API



Framework	Release	Technology	User	Developer
 ICAT	2007	MySQL, Glassfish, Java	<b>CSNS</b> , DLS, ISIS, HZB, ESRF, ALBA	Collaborations of ISIS, STFC, ILL & DLS
 SciCat	2016	MongoDB, NodeJS, Rabbit MQ, Kafka, Nest.js(Loopback), Javascript	MAX IV, PSI, ESS, ALS, SSRF	Collaborations of MAX IV, ESS & PSI
 <b>DOMAS</b>	2021	MongoDB, Rabbit MQ, Kafka, Java, Redis, Elasticsearch	<b>HEPS, SHINE, HALF</b>	IHEP (CAS)

Investigation in SciCat <https://scicatproject.github.io/>



- ❑ Open source, but **many issues** in intermediate versions, lots of bugs
- ❑ Functional upgrades **require** a higher level of expertise from developers
- ❑ **Inflexible** API

**Limitations in ICAT, SciCat Framework**

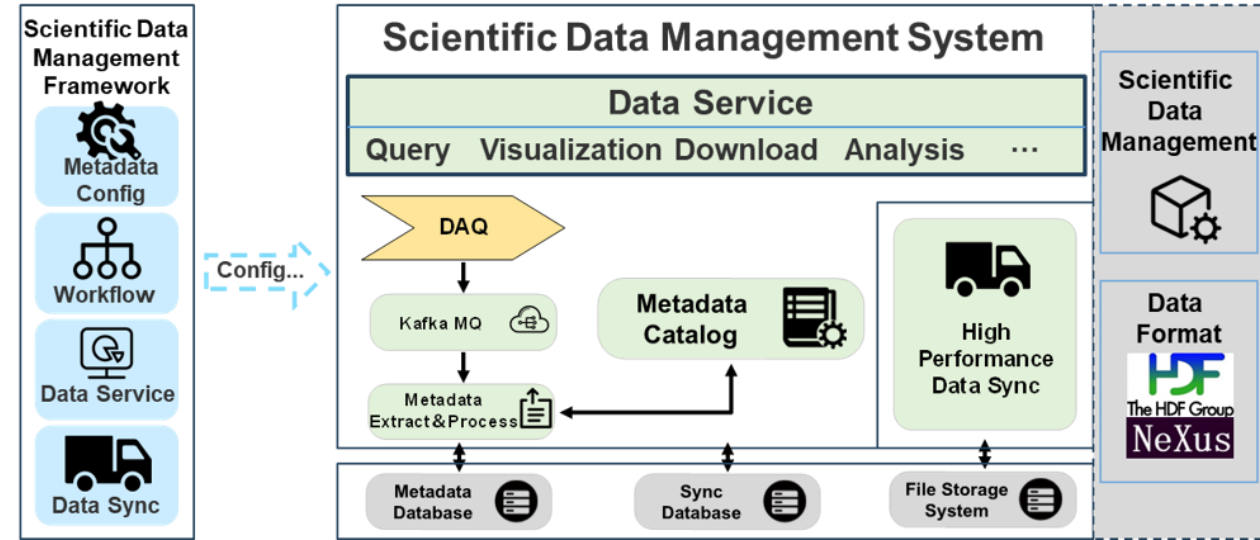
# DOMAS (Data Organization Management Access Software)

## Advantages of DOMAS

<https://code.ihep.ac.cn/hepscc/domas>



- ❑ Develop for next generation large-scale facilities
- ❑ Strong scalability and flexible data structure based on MongoDB database
- ❑ Comprehensive data lifecycle management
- ❑ Faster and more efficient metadata retrieval
- ❑ Simplify access and management of metadata for ACL
- ❑ Standard API for easier integration with other systems & platforms
- ❑ Microservices architecture for easy deployment: message queues, container and K8S



- **Guided by Management Norms**
- **Centered around Software Framework**
- **Targeting System Applications**

**Deployed at HEPS, BRSF**

**Develop Data Management System Based on  
DOMAS Framework for CSNS-II**

# Aim for Data Management at CSNS-II

## ❑ Full Lifecycle Management:



- ❑ **Data Retrieve, Analysis, Sharing, Utilization** → **Higher Efficiency**
- ❑ **Data Access, Authority Management, Data Security** → **Efficient & Convenient**
- ❑ **Data Download** → **High Concurrency, Multiple Methods**  
→ **“National Data Openness & Sharing Strategy”**
- ❑ **API for Analysis System & Platform** → **Flexible & Configurable**

**Develop a High-Performance DMS for CSNS-II**

# Content

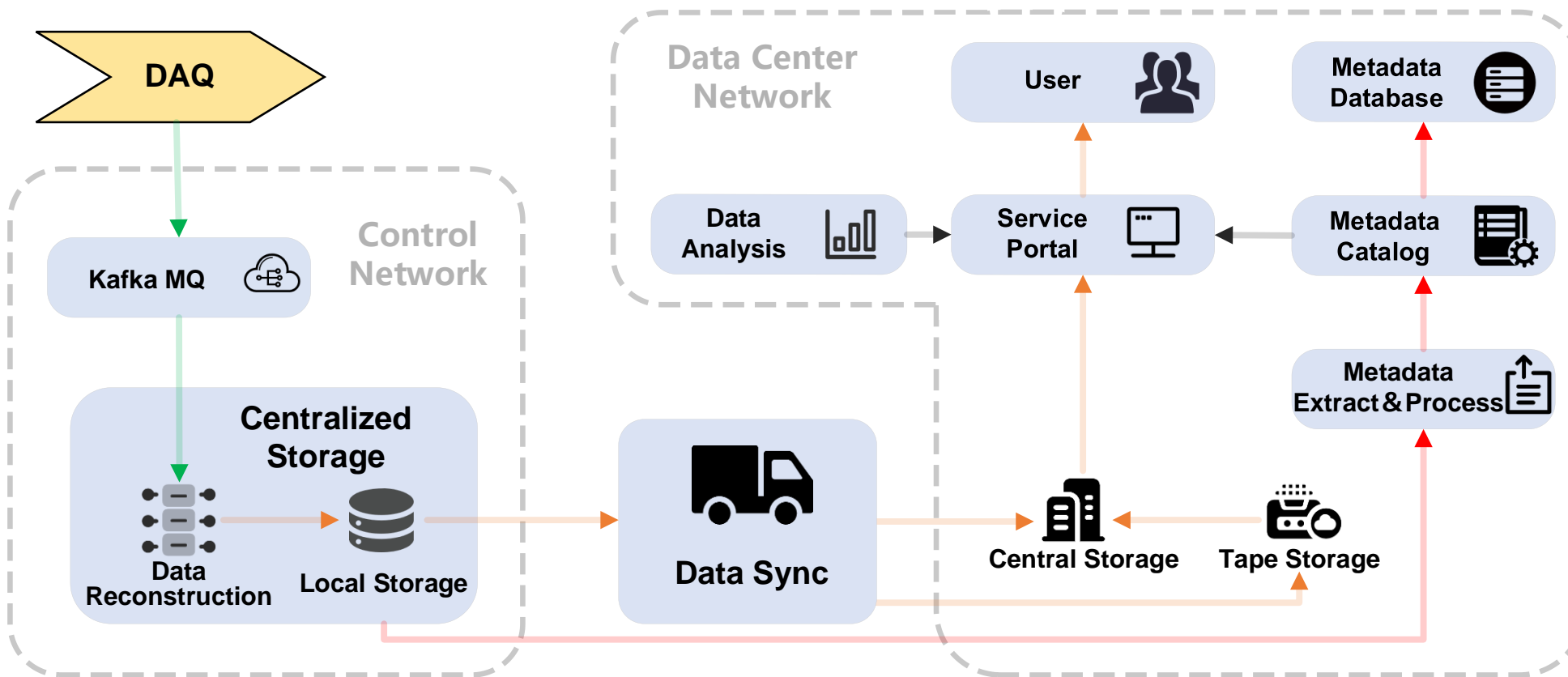
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# Framework & Components



## Metadata Acquisition System:

from DAQ, file, database...

## Metadata Catalog Service:

create, store, access, API...

## Data Transfer System:

multiple storage media, disk, tape...

## Data Service:

separation of front-end and backend...

→ Data Stream

→ Data File

→ Metadata

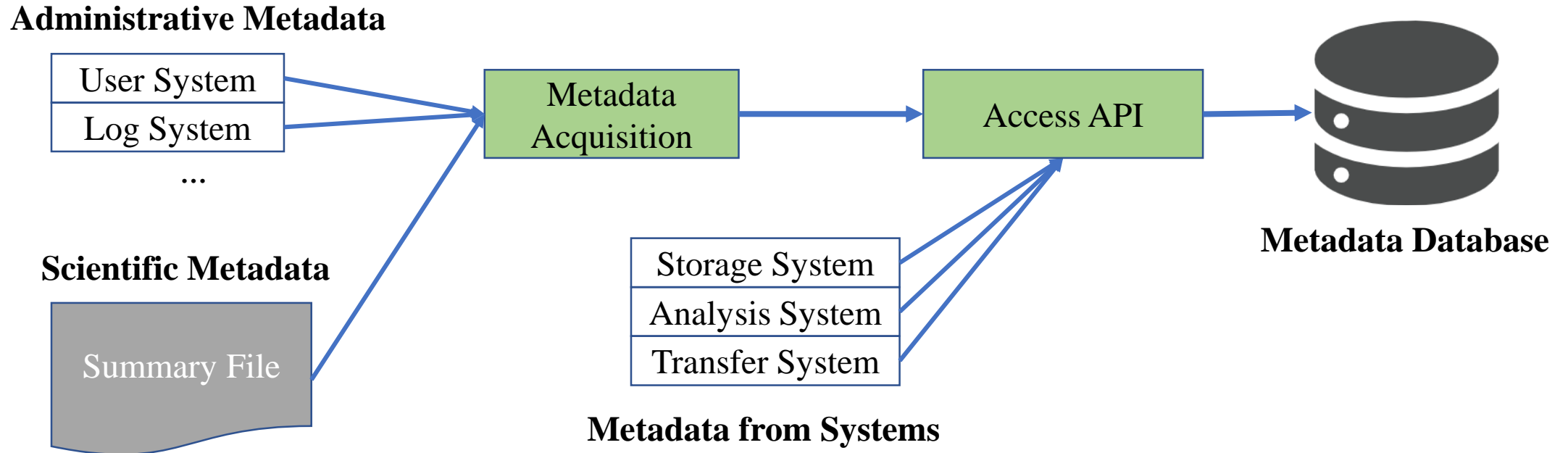
● Acquired from DAQ → Stream to a MQ → Reconstruction

● Store Data Files in Local Storage → Data Transfer System → Central Storage & Tape Storage → Online Access

● Local Storage → Extract & Process → Metadata Catalog Service → Metadata Database Storage



# Metadata Acquisition — Workflow



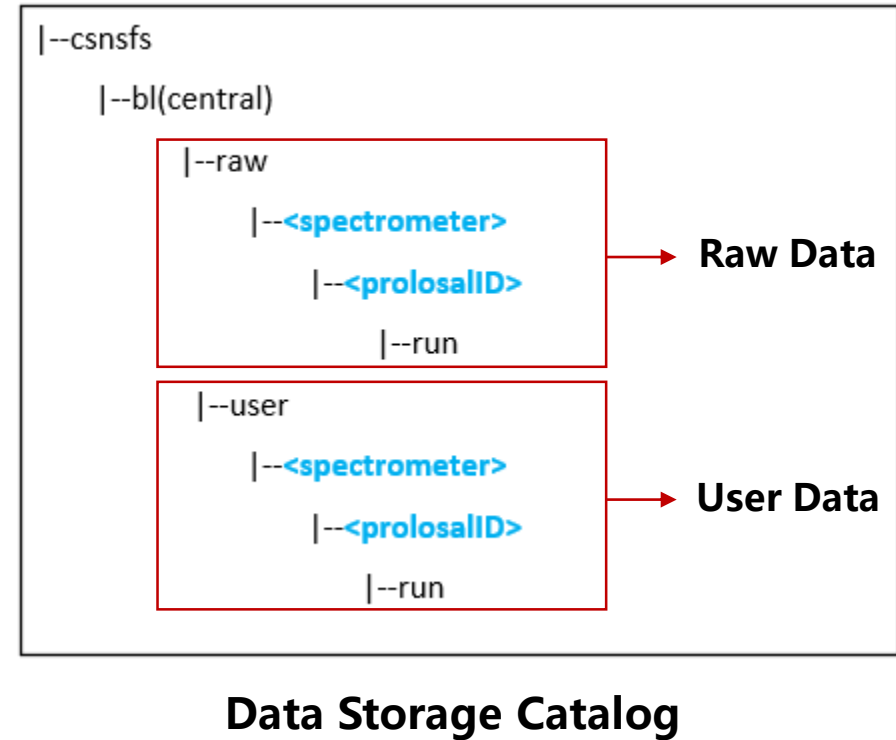
- **Support multiple metadata sources: multiple data types, systems & APIs**
- **Customize** metadata model for different instruments with flexible data scalability

# Metadata Items

Classification	Item	Source
<b>Administrative Metadata</b>	● Proposal, User, instruments...	
	● Data Type: Raw Data, Processed Data, Simulated Data, Standard-samples Data...	
	● Dataset: PID, Storage Path, File List, File Size, Checksum...	User Service System, Transfer System, Storage System...
	● Data State: Disk/Tape Storage, Transfer State, Transfer Checksum...	
	● Analysis Software, Update Time...	
<b>Scientific Metadata</b>	● Sample	Data Reconstruction Service from ' <i>Summary</i> ' File
	● Experimental Environment: High Voltage, Magnetic, Electric Field...	
	● instrument Experiment: Scanning, X-ray...	
	● Experimental Log	E-Log System

# Data Storage Directory & Authority Design

- Storage Path for **User Data**: *.../user/<instrument>/<proposalID>*
- Storage Path for **Raw Data**: *.../raw/<instrument>/<proposalID>*
- Storage Path for **Analyzed Data**: */home/username/*
- Set **ACL** for **User Access** at the *proposalID* Directory/**Data Storage Layer** → Improve Security of data access
- Mount User Data on Computing Platform for **Data Analysis**



Catalog	Data Type	Access	Tape Storage
raw	Raw Data	Read-Only	Yes
user	User Data	Read-Only	Yes

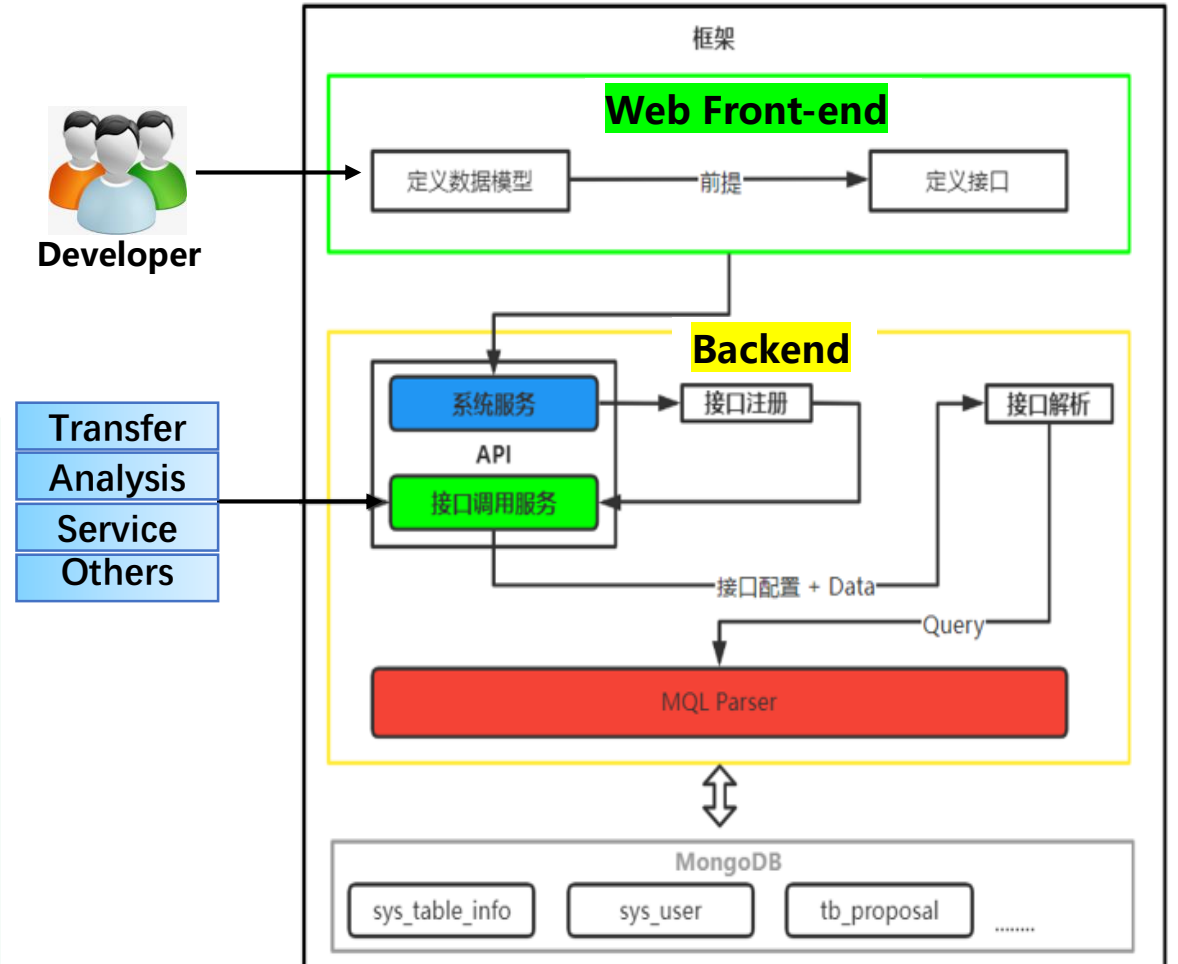
**Protecting User Data and Intellectual Property by Technological Method**

# Metadata Catalog Service

- **Core component** of DOMAS, providing standard APIs for metadata access
- **MongoDB** database for complex metadata storage
- **Customize metadata model** based on instruments
- **Generate “API” automatically** from the customized “Metadata Model”

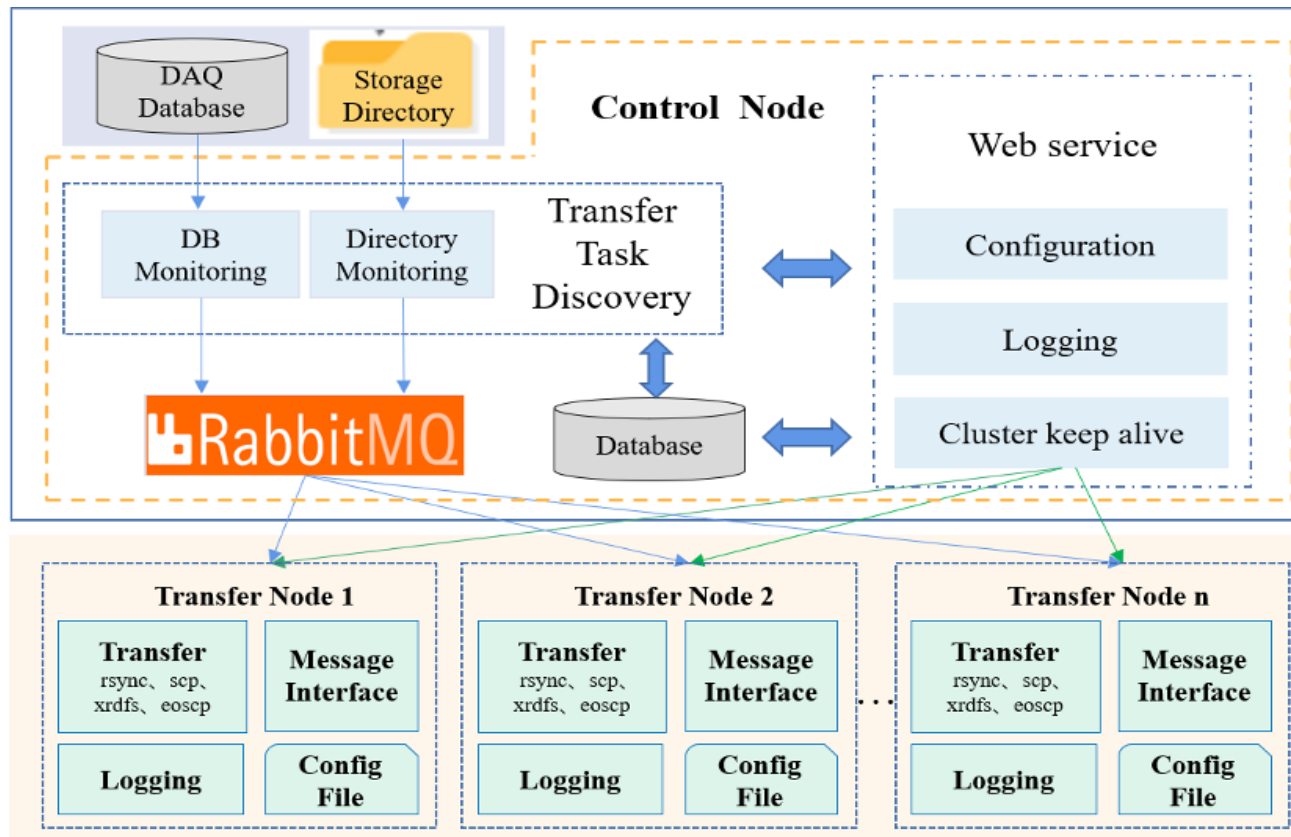
## Service Logic:

1. **Design Metadata Model**
2. **Model Analysis and Verification at backend**
3. **Config and generate interface at WEB front-end**
4. **For other systems/modules to call**



# Data Transfer

- **Automatic** Data Transfer in the Whole Process
- **Multiple Transfer Protocols**
- **Multiple-threading**
- **Checksum** for Transfer Efficient and Security



## Function Module:

### a) Multiple Sources

Connect to multiple databases and monitor multiple directories in real time;

### b) Message Queue

Asynchronous message management;  
Fully decouple: different message queues can be configured for instrument, experiment, etc.;

### c) Data Transfer

Multiple data transmission protocols based on configuration;  
Support cluster and multi-thread transmission, high data transmission performance;

**Data checksum** verification ensures high reliability;

### d) Flexible & Configurable Data Transfer Task

### e) Real-time Monitoring of Transfer Log

**Control Master Node + Transfer Slave Node**

# Data Service Application (1) User Service Portal

- Suitable for all CSNS instrument experiment users;
- Both internal and external networks can be accessed;
- Provide **data view**, **data retrieval**, **data visualization** & **data download**.

数据检索:  BeamtimeID:  PI:  PI Email:  ScanID:  获取时间:  请选择日期 to 请选择日期

如果数据下载出现问题, 请联系管理员获取数据

批量下载

<input type="checkbox"/>	数据集	BeamtimeID	样品	PI	PI Email	获取时间	ScanId	Size	操作
<input type="checkbox"/>	Fe3O4-50nm	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 09:23:31	19	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	Fe3O4-20nm	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 09:12:23	18	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	Fe3O4-20nm	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 09:05:01	17	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	Fe3O4-20nm	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 09:02:51	16	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	Cit-Fe	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 08:53:30	15	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	Cit-Fe	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 08:44:20	14	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	5D-FESO4	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 08:33:47	13	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	5D-FESO4	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 08:22:41	12	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	Fe-50nm	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 08:12:14	11	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	Fe-50nm	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 08:02:31	10	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	Fe-50nm	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 07:51:33	9	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>
<input type="checkbox"/>	2-Fe3O4-50nm	GB06-20220718-01		刘敦一	liudy1989@swu.edu.cn	2022-07-20 07:38:01	8	157.73MB	<input type="button" value="查看数据"/> <input type="button" value="下载"/>

# Data Service Application (2) Data View and Retrieval

Online **View**, Retrieval and Download

**All data:** Raw data, user data, analyzed data from each experiment and proposal

The screenshot displays a web-based data service application interface. On the left is a dark sidebar with navigation options: 工作台, 参与线站, 4W1A, 1W1A, 3W1, 数据集, 数据文件, 数据授权, and 我的数据. The main content area is divided into three sections. The top section contains a breadcrumb path: /hwhepsfs/3W1/202307/Data/G3W1-230715-01/raw/hm/Ti\_W\_2/Projection9. Below the path is a search bar with the text '输入文件名进行搜索' and buttons for '搜索' and '重置'. The middle section shows a file list with checkboxes and a '批量高速下载' option. The bottom section displays a grid of file thumbnails, each with an HDF icon and a filename. The files are: ID21\_Dhyana\_Projection\_!ID21\_Projection\_9.nxs, 0000.h5, 0007.h5, 0011.h5, 0005.h5, 0009.h5, 0002.h5, 0006.h5, 0010.h5, 0001.h5, 0003.h5, 0008.h5, and 0004.h5. A file icon with a NeXus logo is also visible.

# Data Service Application (2) Data View and Retrieval

- Supports global search based on the keyword
- Search **all summary files contain the keyword** (metadata information)



**great convenience  
for data retrieval**

	数据集名称	获取时间	联系人	联系人邮箱	Scan ID	Size	操作
<input type="checkbox"/>	21044375ji_flat_Count4/ID21_C...	2023-07-21 05:06:33	张三	zhangsan@ihep.ac.cn	4	0.14GB	<a href="#">普通下载</a>   <a href="#">高速下载</a>

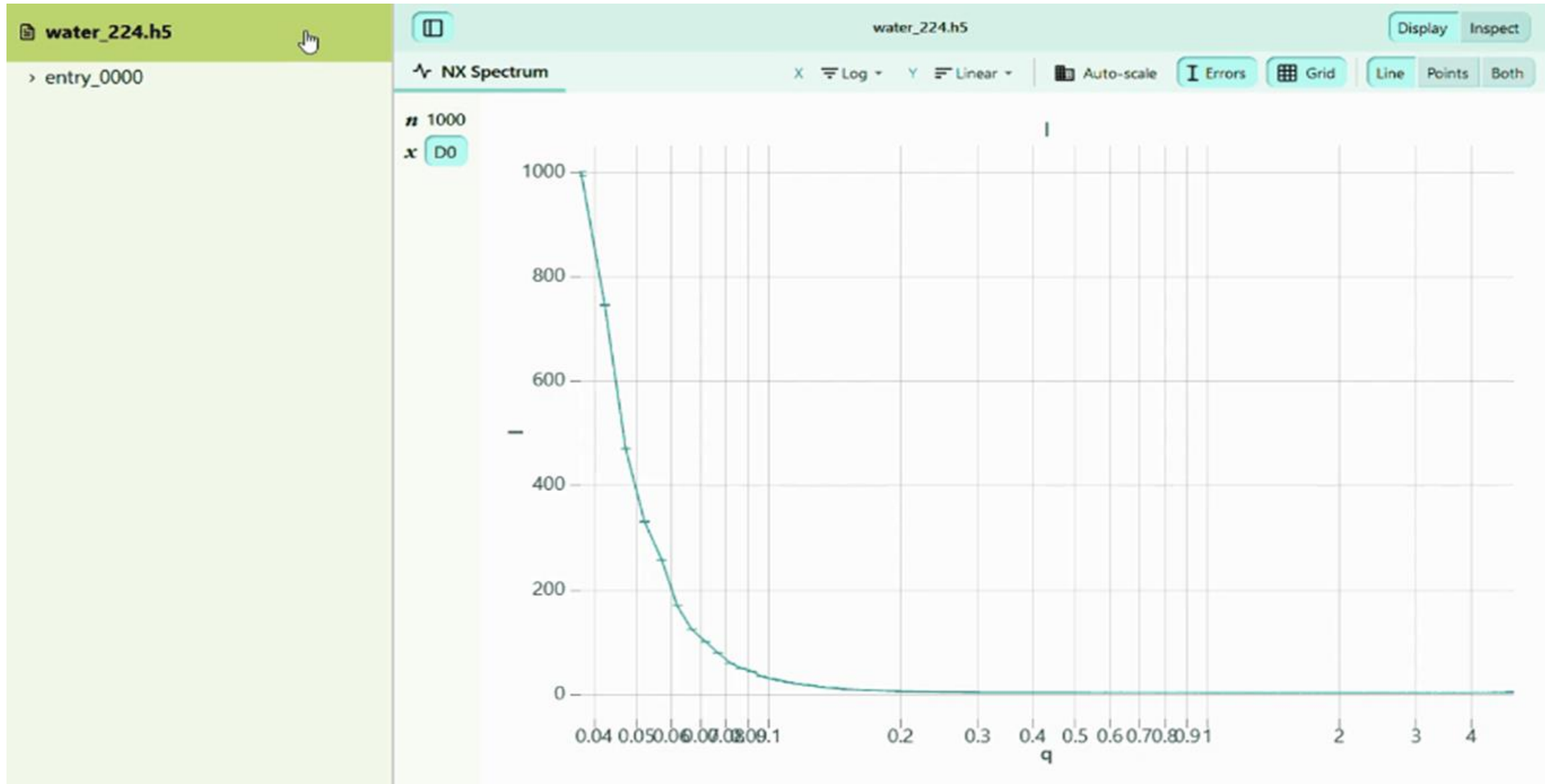
  

元数据信息		文件列表	
输入关键字搜索元数据			
Name	Value		
Name	Experiment for sample Si		
density	g cm-3		
chemical_formula	orientation		
type	nxbbox		
description	Run for Si Experiment		
rotation_speed	EXP_IB2_RM:NO:T1:rSpd:ai		
degree	13151.0908203		
Size	2x3x7		
electric_field	CSNS_SE_CCR01		
density	3		
magnetic_field	12		
interest_zone	EXP_IB2_RM:SL1:YN:POS, EXP_IB2_RM:SL1:ZN:POS, 0		



# Data Service Application (3) Data Visualization of HDF5 Files

Provides online data visualization for HDF5 files.

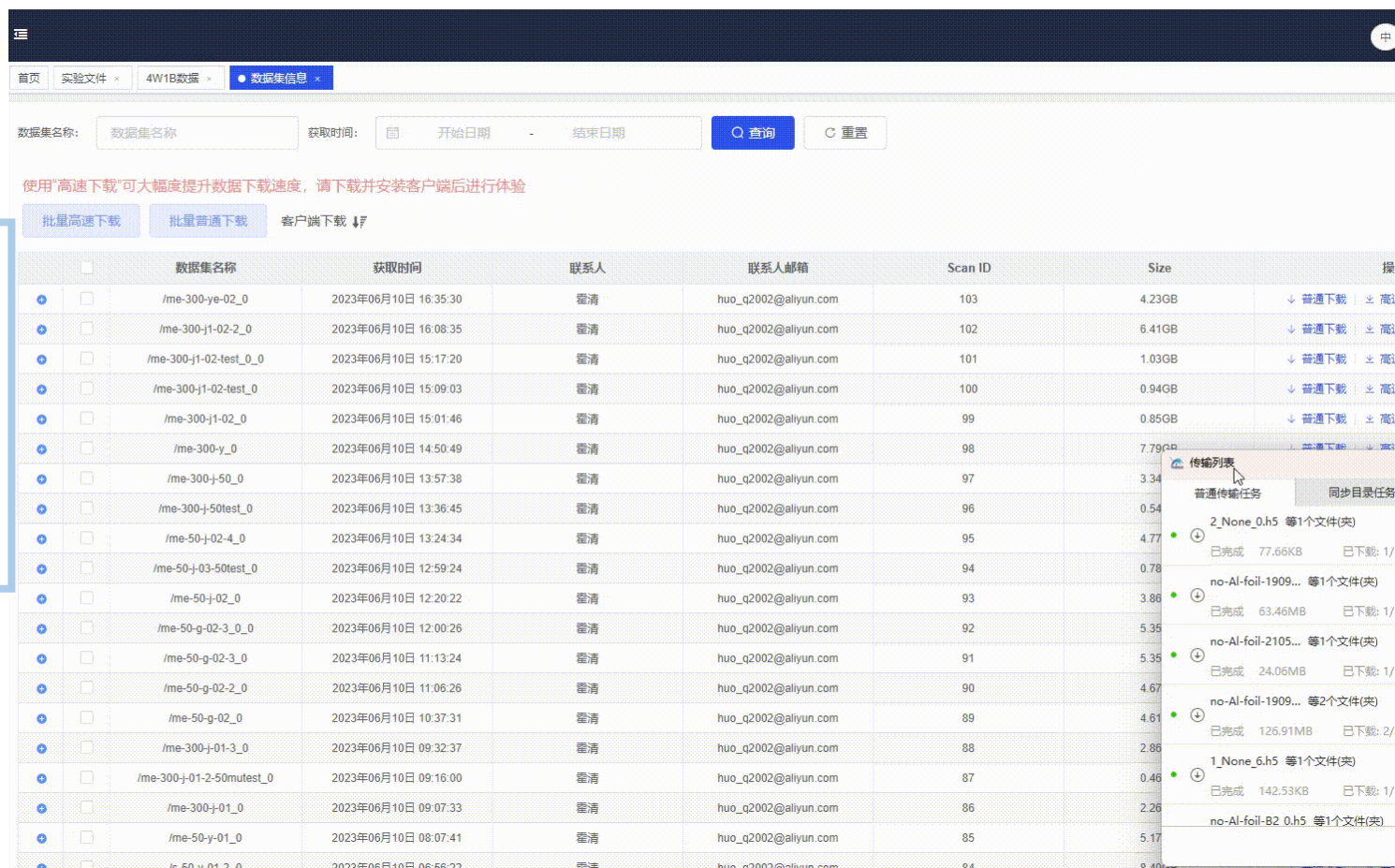
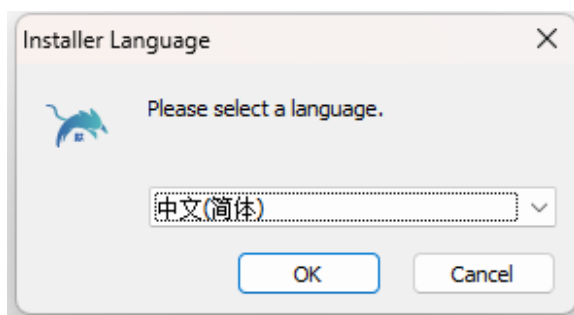


# Data Service Application (4) Web-based Download

- Integrated data bulk high-speed download client
- Integrated ZSTD compression algorithm, support data breakpoint download
- Make full use of network bandwidth, download speed greatly improved

## Download data for test:

Network	Bandwidth	Download Time	Download Speed
Internal	1000Mbps	2:52	839Mbps
External	100Mbps	28:00	85Mbps



	数据集名称	获取时间	联系人	联系人邮箱	Scan ID	Size	操
+	/me-300-ye-02_0	2023年06月10日 16:35:30	霍清	huo_q2002@aliyun.com	103	4.23GB	普通下载 高速下载
+	/me-300-j1-02-2_0	2023年06月10日 16:08:35	霍清	huo_q2002@aliyun.com	102	6.41GB	普通下载 高速下载
+	/me-300-j1-02-test_0_0	2023年06月10日 15:17:20	霍清	huo_q2002@aliyun.com	101	1.03GB	普通下载 高速下载
+	/me-300-j1-02-test_0	2023年06月10日 15:09:03	霍清	huo_q2002@aliyun.com	100	0.94GB	普通下载 高速下载
+	/me-300-j1-02_0	2023年06月10日 15:01:46	霍清	huo_q2002@aliyun.com	99	0.85GB	普通下载 高速下载
+	/me-300-y_0	2023年06月10日 14:50:49	霍清	huo_q2002@aliyun.com	98	7.79GB	普通下载 高速下载
+	/me-300-j50_0	2023年06月10日 13:57:38	霍清	huo_q2002@aliyun.com	97	3.34	普通下载 高速下载
+	/me-300-j50test_0	2023年06月10日 13:36:45	霍清	huo_q2002@aliyun.com	96	0.54	普通下载 高速下载
+	/me-50-j02-4_0	2023年06月10日 13:24:34	霍清	huo_q2002@aliyun.com	95	4.77	普通下载 高速下载
+	/me-50-j03-50test_0	2023年06月10日 12:59:24	霍清	huo_q2002@aliyun.com	94	0.78	普通下载 高速下载
+	/me-50-j02_0	2023年06月10日 12:20:22	霍清	huo_q2002@aliyun.com	93	3.86	普通下载 高速下载
+	/me-50-g-02-3_0_0	2023年06月10日 12:00:26	霍清	huo_q2002@aliyun.com	92	5.35	普通下载 高速下载
+	/me-50-g-02-3_0	2023年06月10日 11:13:24	霍清	huo_q2002@aliyun.com	91	5.35	普通下载 高速下载
+	/me-50-g-02-2_0	2023年06月10日 11:06:26	霍清	huo_q2002@aliyun.com	90	4.67	普通下载 高速下载
+	/me-50-g-02_0	2023年06月10日 10:37:31	霍清	huo_q2002@aliyun.com	89	4.61	普通下载 高速下载
+	/me-300-j01-3_0	2023年06月10日 09:32:37	霍清	huo_q2002@aliyun.com	88	2.86	普通下载 高速下载
+	/me-300-j01-2-50mutest_0	2023年06月10日 09:16:00	霍清	huo_q2002@aliyun.com	87	0.46	普通下载 高速下载
+	/me-300-j01_0	2023年06月10日 09:07:33	霍清	huo_q2002@aliyun.com	86	2.26	普通下载 高速下载
+	/me-50-y-01_0	2023年06月10日 08:07:41	霍清	huo_q2002@aliyun.com	85	5.17	普通下载 高速下载
+	/me-50-y-01-2_0	2023年06月10日 06:56:22	霍清	huo_q2002@aliyun.com	84	0.40	普通下载 高速下载

Installing the **client** to download data in batches, the download speed is **greatly improved**.

# Data Service Application (5) Client-based Download

After the **client** is installed on the PC, you can log in and the data is **automatically synchronized** (experiment data and analyzed data) to the local PC.

同步传输

默认空间

个人文件夹

群组文件库

普通传输

同步传输

点对点传输

链接管理

隔离区

同步上传 同步下载 双向同步

创建同步任务 全部开始 全部暂停 全部删除

<input type="checkbox"/>	任务名称	源路径	目标路径	大小	数量	任务进度
--------------------------	------	-----	------	----	----	------

暂无任务

# Data Service Application (6) Data Authorization

Data owners (PIs) can grant the data access to other users.

The interface displays a data authorization workflow. On the left, a table lists beamtimes with their IDs and proposal IDs. A modal window titled '实验数据权限列表 - GB06-20220111001 - CT谱学准确性研究' is open, showing a user management table with columns for '头像', '登录名', '邮箱', 'Web访问', '集群访问', and '操作'. A green arrow labeled '2' points from the '+ 添加用户' button to the '增加授权用户' modal. This modal contains fields for '统一认证邮箱' (hfwang@ihep.ac.cn), 'Web访问' (是), '集群访问' (否), and a '备注' field. A second green arrow labeled '1' points from the '数据授权' link in the table to the '增加授权用户' modal. The table on the right has columns for '结束时间', '数据集数量', and '操作'. The '操作' column contains links for '查看数据集', '数据授权', and '交互式计算平台'. A red box highlights the '数据授权' links in the table.

Beamtime ID	提案ID
GB06-20230426-01	2021-BE
GB06-20230417-01	2023-BE
GB06-20230414-01	2014-BE
GB06-20230330-01	2023-BE
GB06-20230327-01	2021-BE
GB06-20230322-01	2021-BE
GB06-20230317-01	2022-BE
GB06-20230315-01	2014-BE
GB06-20230308-02	2014-BE
GB06-20230308-01	2023-BE

头像	登录名	邮箱	Web访问	集群访问	操作	
<input type="checkbox"/>	无	线站管理员	3w1-heps@ih...	是	是	移除

结束时间	数据集数量	操作
2023-04-28 01:00:00	174	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-04-24 01:26:00	334	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-04-15 01:00:00	87	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-04-01 01:00:00	187	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-03-30 01:00:00	155	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-03-25 01:00:00	207	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-03-18 01:00:00	47	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-03-17 01:00:00	93	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-03-08 15:00:00	17	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>
2023-03-11 01:00:00	237	<a href="#">查看数据集</a> <a href="#">数据授权</a> <a href="#">交互式计算平台</a>

# Data Service Application (7) Data Lifecycle Visualization

Provide the visualization for data lifecycle management and the real-time data states.



# Content

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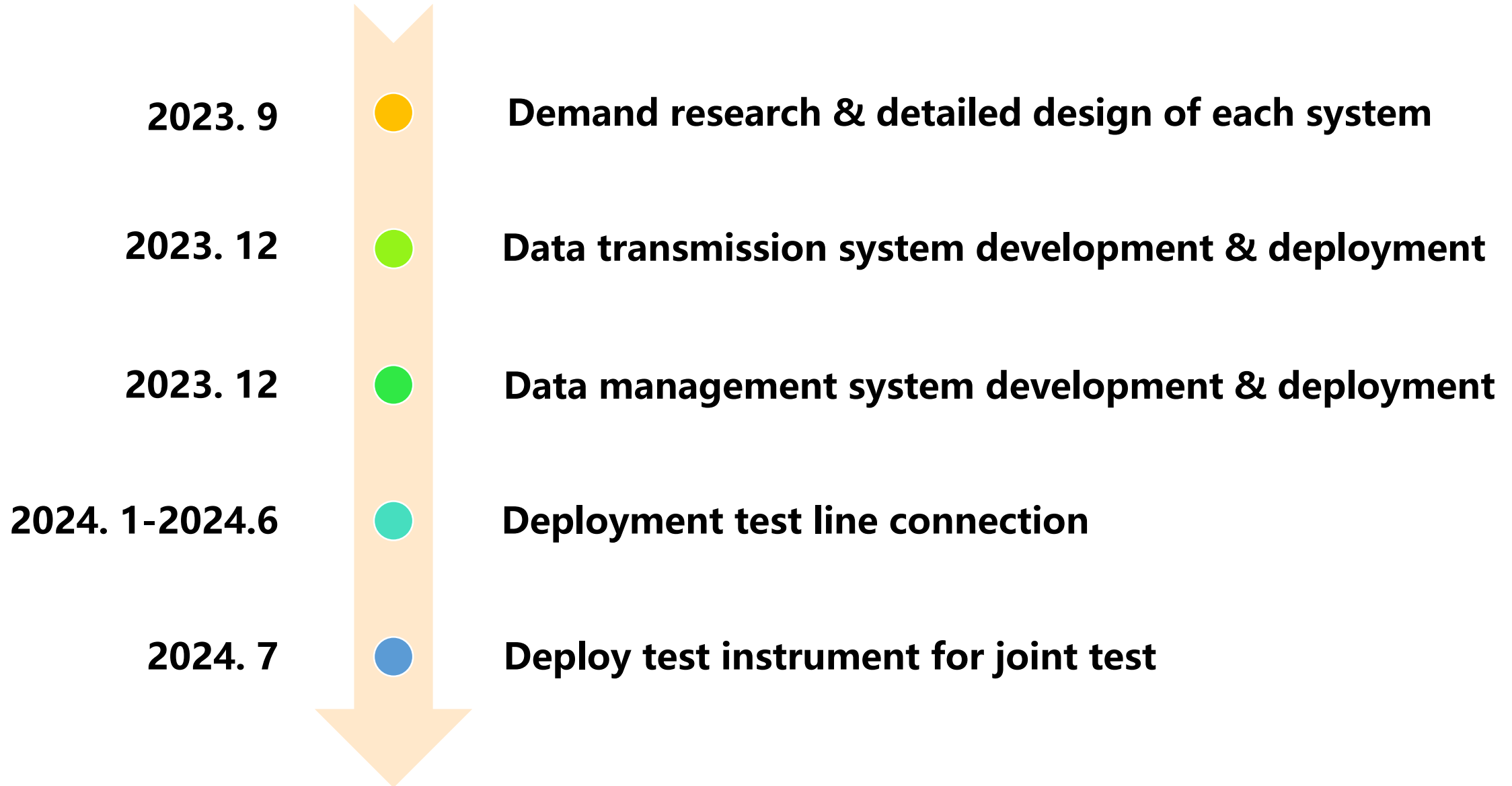
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**2** Framework & Application

**3** Plans

# Plan

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**Thanks for your listening!**