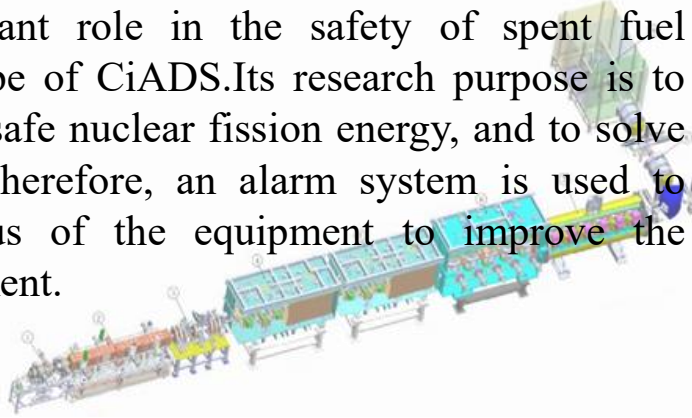


### Introduction

CiADS plays an important role in the safety of spent fuel handling. CAFe as a prototype of CiADS. Its research purpose is to develop clean, efficient and safe nuclear fission energy, and to solve the future energy supply. Therefore, an alarm system is used to monitor the operating status of the equipment to improve the maintainability of the equipment.



### Methods

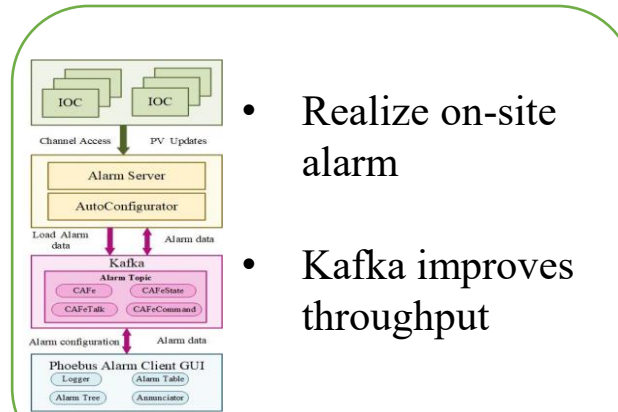
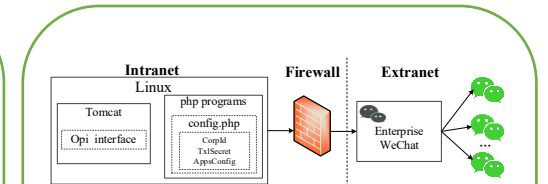


Fig 1. The framework of the alarm system.

- Realize on-site alarm
- Kafka improves throughput



- Ensure data security
- Realize remote real-time interface

Fig 2. Deployment of remote interface

### Results

The interfaces of fault equipment and alarm data are displayed in the central control room and mobile terminal respectively.

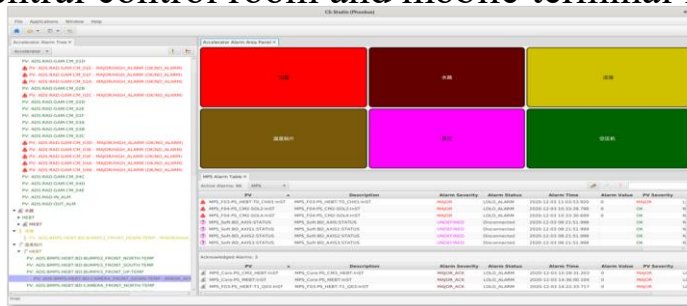


Fig 3. The alarm interface of the central control room

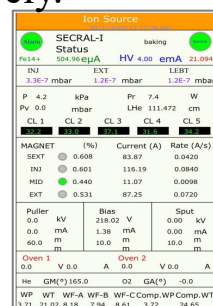


Fig 4. Mobile terminal interface

### Conclusions

- The alarm function of central control room and mobile terminal is realized
- The throughput of alarm information is improved
- Reduced troubleshooting time
- The maintainability of cafe is improved

# Introduction

China Initiative Accelerator Driven System (CiADS) plays an important role in the safety of spent fuel handling. This is a global challenge that has not yet been resolved by our country and the international nuclear energy community. Chinese ADS Front-end Demo Linac (CAFe) as a CiADS prototype. Figure 1 is the layout of the CAFe superconducting linear accelerator, which consists of nine parts. CAFe as a prototype of CiADS. Its research purpose is to develop clean, efficient and safe nuclear fission energy, and to solve the future energy supply. Therefore, the stable operation of the CAFe equipment is particularly important for the debugging and stable operation of the beam experiment. The alarm system can effectively improve the maintainability of CAFe.

- ①ECRIS: Electron Cyclotron Resonance LEBT: Low Energy Beam Line
- ②RFQ: Radio Frequency Quadrupole
- ③MEBT: Medium Energy Beam Line
- ④CM1
- ⑤CM2
- ⑥CM3
- ⑦CM4
- ⑧HEBT: High Energy Beam Line
- ⑨Beam Dump

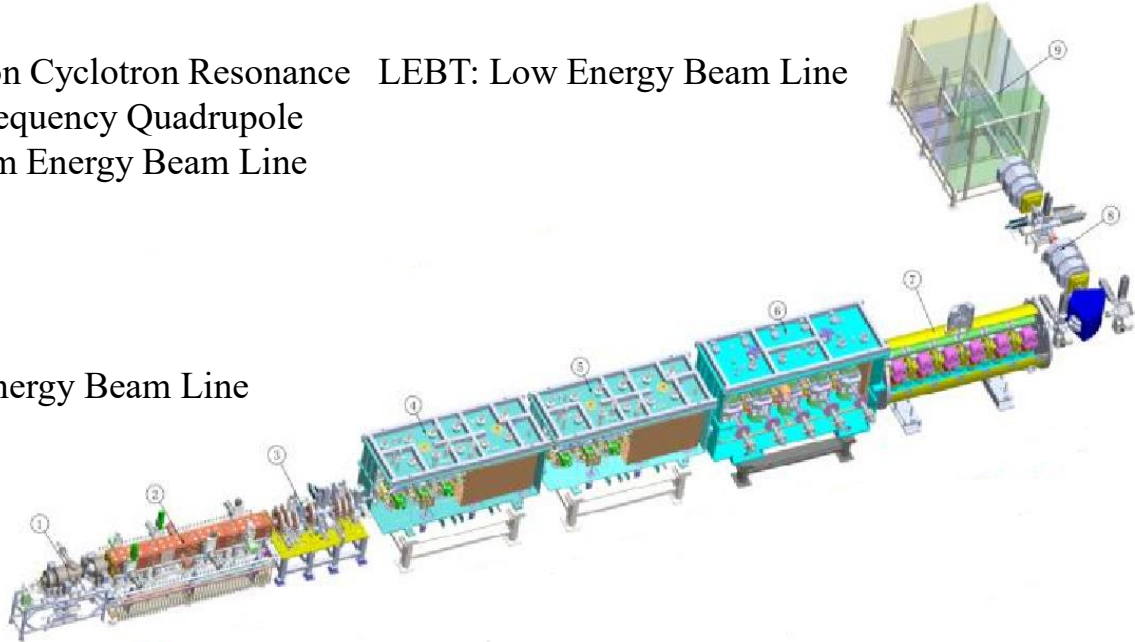


Fig 1. Layout of CAFe superconducting linear accelerator

# Methods

## IOC

It is used to obtain the data of the monitoring equipment and define the alarm threshold of the equipment.

## Alarm service

It is the core of the alarm system. It can record alarm status, update alarm status and send alarm information.

## Kafka

Realize two functions: ① Store the information of four alarm topics. ② Send alarm information.

## Phoebus

Display alarm interface: Alarm Tree , Alarm Area Panel, Alarm Log Table, Annunciator and Alarm Table.

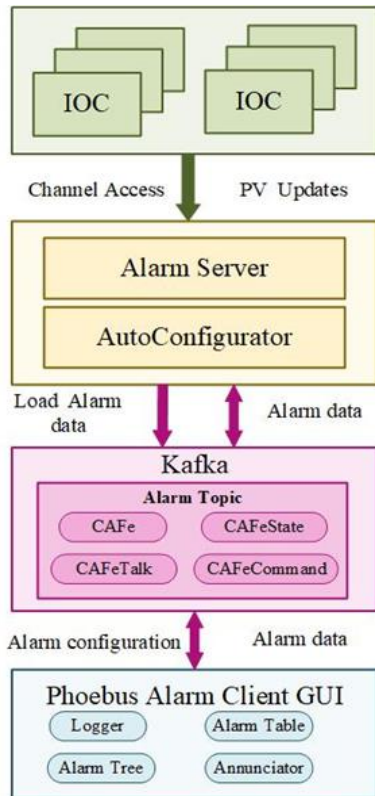


Fig 2. The framework of the alarm system.

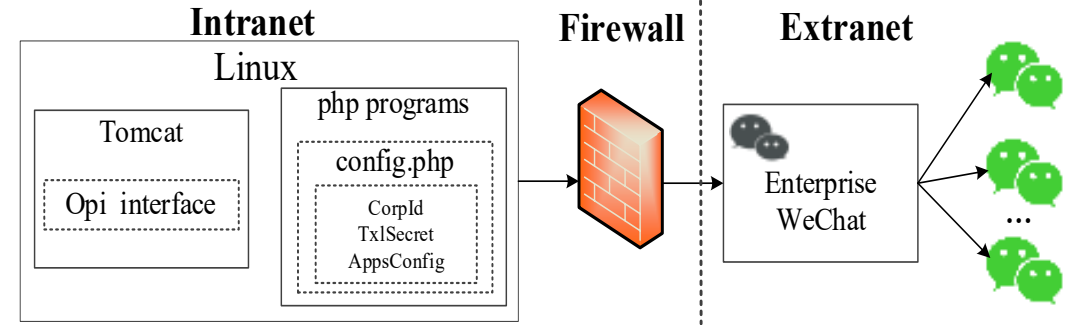


Fig 3. Deployment of remote interface

- In order to ensure data security, the server and enterprise WeChat account are deployed to the intranet and the extranet respectively.
- Intranet: The opi interface drawn by CS-Studio is deployed in the tomcat server on the intranet.
- Extranet: Deploy enterprise WeChat account, and log in to the enterprise WeChat account through the administrator's authorization for staff in the office.
- The staff can view the real-time remote interface anytime and anywhere to understand the experimental situation.

# Results

## Alarm Area Panel

Accelerator Alarm Area Panel X

## Alarm Table

MPS Alarm Table

PV	Description	Alarm Severity	Alarm Status	Alarm Time	Alarm Value	PV Severity	PV Status
MPS_F03_PS_HEBT-T0_CH01-INST	MPS_F03_PS_HEBT-T0_CH01-INST	MAJOR	LOLO_ALARM	2020-12-03 11:03:33.920	0	MAJOR	LOLO_ALARM
MPS_F04_PS_CM2-SOL4-INST	MPS_F04_PS_CM2-SOL4-INST	MAJOR	LOLO_ALARM	2020-12-03 10:33:28.798	0	OK	NO_ALARM
MPS_F04_PS_CM2-SOL4-INST	MPS_F04_PS_CM2-SOL4-INST	MAJOR	LOLO_ALARM	2020-12-03 10:33:30.699	0	OK	NO_ALARM
MPS_Soft_BD_AKX5-STATUS	MPS_Soft_BD_AKX5-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.999		OK	NO_ALARM
MPS_Soft_BD_AKX1-STATUS	MPS_Soft_BD_AKX1-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.999		OK	NO_ALARM
MPS_Soft_BD_AKX2-STATUS	MPS_Soft_BD_AKX2-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.999		OK	NO_ALARM
MPS_Soft_BD_AKX3-STATUS	MPS_Soft_BD_AKX3-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.999		OK	NO_ALARM
MPS_Soft_BD_AKX4-STATUS	MPS_Soft_BD_AKX4-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.999		OK	NO_ALARM
MPS_Soft_BD_AKX5-STATUS	MPS_Soft_BD_AKX5-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.999		OK	NO_ALARM
MPS_Soft_BD_AKX6-STATUS	MPS_Soft_BD_AKX6-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.997		OK	NO_ALARM
MPS_Soft_BD_AKX7-STATUS	MPS_Soft_BD_AKX7-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.997		OK	NO_ALARM
MPS_Soft_BD_AKX8-STATUS	MPS_Soft_BD_AKX8-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.996		OK	NO_ALARM
MPS_Soft_BD_AKX9-STATUS	MPS_Soft_BD_AKX9-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.997		OK	NO_ALARM
MPS_Soft_BD_AKX10-STATUS	MPS_Soft_BD_AKX10-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.997		OK	NO_ALARM
MPS_Soft_BD_AKX11-STATUS	MPS_Soft_BD_AKX11-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.997		OK	NO_ALARM
MPS_Soft_BD_AKX12-STATUS	MPS_Soft_BD_AKX12-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.998		OK	NO_ALARM
MPS_Soft_BD_AKX13-STATUS	MPS_Soft_BD_AKX13-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.999		OK	NO_ALARM
MPS_Soft_BD_AKX14-STATUS	MPS_Soft_BD_AKX14-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.996		OK	NO_ALARM
MPS_Soft_BD_AKX15-STATUS	MPS_Soft_BD_AKX15-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.998		OK	NO_ALARM
MPS_Soft_BD_AKX16-STATUS	MPS_Soft_BD_AKX16-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.998		OK	NO_ALARM
MPS_Soft_BD_AKX17-STATUS	MPS_Soft_BD_AKX17-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.996		OK	NO_ALARM
MPS_Soft_BD_AKX18-STATUS	MPS_Soft_BD_AKX18-STATUS	UNDEFINED	Disconnected	2020-12-03 08:21:51.998		OK	NO_ALARM

Acknowledged Alarms: 3

PV	Description	Alarm Severity	Alarm Status	Alarm Time	Alarm Value	PV Severity	PV Status
MPS_Core_PS_CM3_HEBT-INST	MPS_Core_PS_CM3_HEBT-INST	MAJOR_ACK	LOLO_ALARM	2020-12-03 13:28:31.203	0	MAJOR	LOLO_ALARM
MPS_Core_PS_HEBT-INST	MPS_Core_PS_HEBT-INST	MAJOR_ACK	LOLO_ALARM	2020-12-03 14:26:06.104	0	MAJOR	LOLO_ALARM
MPS_F03_PS_HEBT-T1_D03-INST	MPS_F03_PS_HEBT-T1_D03-INST	MAJOR_ACK	LOLO_ALARM	2020-12-03 14:22:33.717	0	MAJOR	LOLO_ALARM

## Alarm Log Table

CS-Studio (Phoebus)

Event	Time	Message	Current Severity	Current Message	Comment	User	Host
MPS_F03_PS_HEBT-T0_CH01-INST	2020-12-03 11:03:33.920	MAJOR	LOLO_ALARM				
MPS_F04_PS_CM2-SOL4-INST	2020-12-03 10:33:28.798	MAJOR	LOLO_ALARM				
MPS_F04_PS_CM2-SOL4-INST	2020-12-03 10:33:30.699	MAJOR	LOLO_ALARM				
MPS_Soft_BD_AKX5-STATUS	2020-12-03 08:21:51.999	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX1-STATUS	2020-12-03 08:21:51.999	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX2-STATUS	2020-12-03 08:21:51.999	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX3-STATUS	2020-12-03 08:21:51.999	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX4-STATUS	2020-12-03 08:21:51.999	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX5-STATUS	2020-12-03 08:21:51.999	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX6-STATUS	2020-12-03 08:21:51.997	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX7-STATUS	2020-12-03 08:21:51.997	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX8-STATUS	2020-12-03 08:21:51.996	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX9-STATUS	2020-12-03 08:21:51.997	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX10-STATUS	2020-12-03 08:21:51.997	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX11-STATUS	2020-12-03 08:21:51.997	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX12-STATUS	2020-12-03 08:21:51.998	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX13-STATUS	2020-12-03 08:21:51.999	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX14-STATUS	2020-12-03 08:21:51.996	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX15-STATUS	2020-12-03 08:21:51.998	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX16-STATUS	2020-12-03 08:21:51.998	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX17-STATUS	2020-12-03 08:21:51.996	UNDEFINED	Disconnected				
MPS_Soft_BD_AKX18-STATUS	2020-12-03 08:21:51.998	UNDEFINED	Disconnected				

## Annunciator

CS-Studio (Phoebus)

MPS Annunciator X

MPS Test Clear Messages

Time Received	Severity	Description
2021-01-06 15:21:19.750	OK	Annunciator started
2021-01-06 15:21:33.333	MAJOR	MAJOR Alarm: MPS_Core:RF_LLR2F1:InST
2021-01-06 15:23:47.341	MAJOR	MAJOR Alarm: MPS_Soft:CM2_BPM01_TEMP:STATUS
2021-01-06 15:23:48.140	MAJOR	MAJOR Alarm: MPS_Soft:BPM_TEMP:STATUS
2021-01-06 15:23:48.240	MAJOR	MAJOR Alarm: MPS_Soft:TOTAL:STAUTUS
2021-01-06 15:29:46.919	MAJOR	MAJOR Alarm: MPS_F05:PS_CM4-DCH4:InST
2021-01-06 15:29:46.919	MAJOR	MAJOR Alarm: MPS_F05:PS_CM4-DCV4:InST
2021-01-06 15:29:46.919	MAJOR	MAJOR Alarm: MPS_F05:PS_CM4-SOL4:InST
2021-01-06 15:29:46.938	MAJOR	MAJOR Alarm: MPS_Core:PS_CM4_DUMP:InST

## Alarm Tree

Accelerator Alarm Tree X

Accelerator

- 剂量
  - PV: ADS-RAD-GAM-CM\_01A
  - PV: ADS-RAD-GAM-CM\_01B
  - PV: ADS-RAD-GAM-CM\_01C - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_01D
  - PV: ADS-RAD-GAM-CM\_01E - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_01F - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_02A - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_02B
  - PV: ADS-RAD-GAM-CM\_02C - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_02D
  - PV: ADS-RAD-GAM-CM\_02E
  - PV: ADS-RAD-GAM-CM\_02F
  - PV: ADS-RAD-GAM-CM\_03A
  - PV: ADS-RAD-GAM-CM\_03B
  - PV: ADS-RAD-GAM-CM\_03C
  - PV: ADS-RAD-GAM-CM\_03D - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_03E - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_03F - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_04A - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_04B - MAJOR/HIGH\_ALARM (OK/NO\_ALARM)
  - PV: ADS-RAD-GAM-CM\_04C
  - PV: ADS-RAD-GAM-CM\_04D
  - PV: ADS-RAD-GAM-CM\_04E
  - PV: ADS-RAD-INFL\_ARM
  - PV: ADS-RAD-OUT\_ARM
- HEBT
- HEBT
- 流量
  - PV: ADS-BMPS\_HEBT\_BD\_BUMPS3\_FRONT\_DOWN\_TEMP - MINOR/HIGH\_ALARM
- 温度贴片
- 真空
- 空压机

## Interface Tree

Ion Source

SECRAL-I Status baking

Fe14+ 504.96eμA HV 4.00 emA 21.094

INJ	EXT	LEBT
3.3E-7 mbar	1.2E-7 mbar	1.2E-7 mbar

Pv	kPa	Pr	W
4.2		7.4	
0.0	mbar	LHe	111.472 cm

CL 1	CL 2	CL 3	CL 4	CL 5
32.2	33.0	37.1	31.6	34.2

MAGNET	(%)	Current (A)	Rate (A/s)
SEXT	0.608	83.87	0.0420
INJ	0.601	116.19	0.0840
MID	0.440	11.07	0.0098
EXT	0.531	87.25	0.0720

Puller	Bias	Sput
0.0 kV	218.02 V	0.00 kV
0.0 mA	1.38 mA	0.00 mA
60.0 m	10.0 m	10.0 m

Oven 1	V 0.0	A 0.0	Oven 2	V 0.0	A
0.0			0.0		

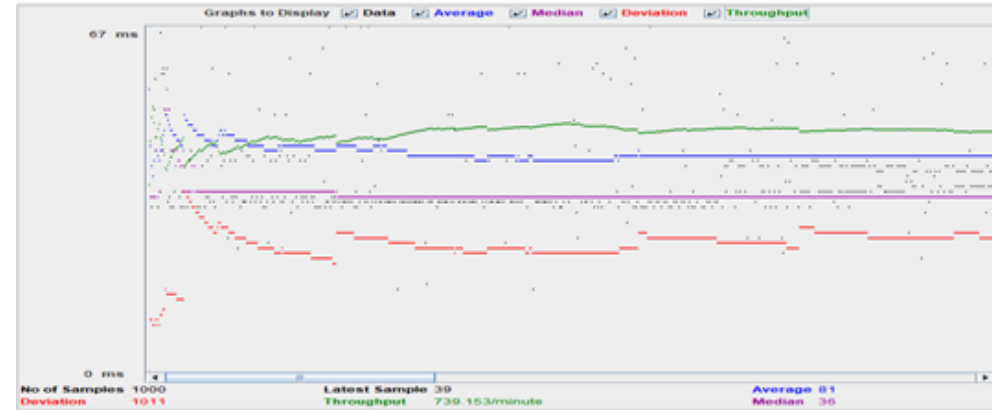
He	GM(°)	165.0	O2	GA(°)	-0.0
3.71	21.02	8.18	7.94	8.61	3.72

WP	WT	WF-A	WF-B	WF-C	Comp.WP	Comp.WT
3.71	21.02	8.18	7.94	8.61	3.72	24.65

# Conclusions



The throughput of Kafka



The throughput of ActiveMQ

The above figure shows that using Kafka can effectively improve data throughput and ensure real-time alarms.

CAFe alarm system was built based on Kafka streaming media platform. Phoebus provides some alarm interfaces for monitoring PV.

- ✓ Remote real-time interface to achieve cross-regional alarm function.
- ✓ Phoebus's interface is simple to operate and easy to maintain.
- ✓ The alarm system saves troubleshooting time and improves the maintainability of CAFe.
- ✓ The entire control system has been deployed and put into operation in the central control room and is working well.