

Development of Remote Experiment System

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SPring-8(JASRI)

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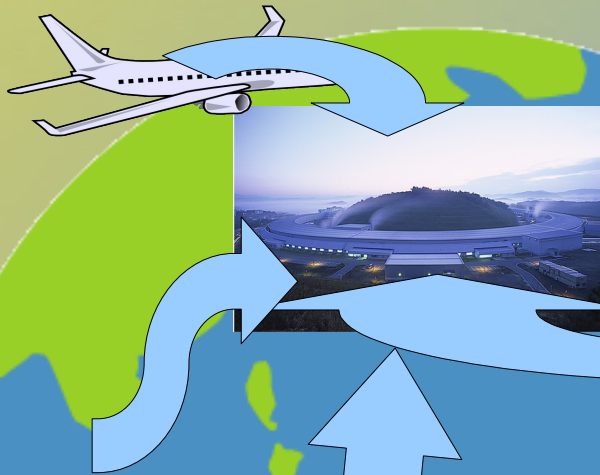
SPring-8(RIKEN)

Outline

- Introduction
- Design Concept
- Overview of the Remote Experiment System
- Sequence of Authentication
- Details of Components
- Application for Protein Crystallography
- Summary

Introduction

- SPring-8 has been operated over 10 years, and 50 beamlines under operational
- Over 10,000 synchrotron radiation users visit SPring-8 from over the world per one year.



Reducing travel cost and time brings many benefits for users.

Remote Experiment System will cut Travel costs and time.

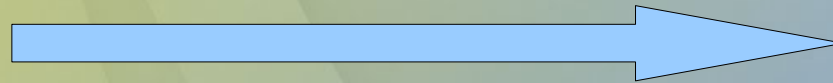
Design Concept

Message Exchanging

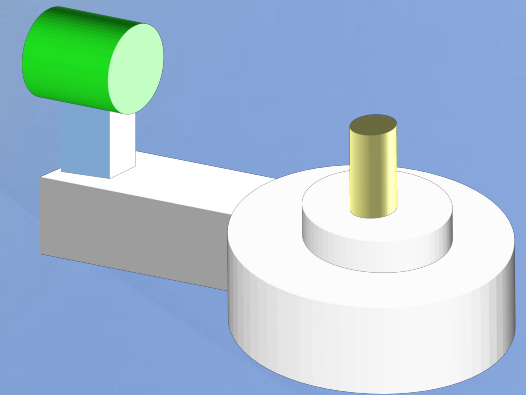
“put/detector_arm/60degree”



Remote User



Station
Control PC



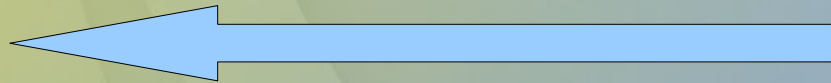
Experimental Station

Message Exchanging

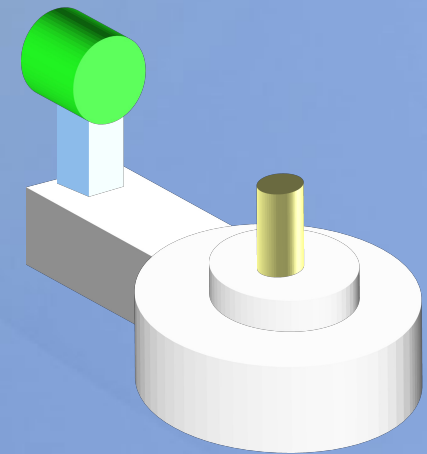
“put/detector_arm/ok”



Remote User



Station
Control PC



Experimental Station

Compared with remote control system using VPN or Windows' Remote Assistance, the message exchanging has these merits,

- Message can be filtered to restricts the message related only specified station.
- Remote users can build-up experimental control programs using simple scripting languages. (SPring-8 makes basic experiment softwares and distributes them.)
- Seamlessly access to the “MADOCA” which is the SPring-8 standard control system.

To realize a Remote Experiment System

To realize a remote experiment system, we have to take into following issues.

1. Ensure radiation safety
2. Ensure human physical safety
3. Avoid interference - Other users of the beamline connected via the Internet should not affect the remote experiment.

Radiation Safety

- A radiation safety interlock system of the beamline protects radiation safety.
- Remote Experiments are also protected by the radiation safety interlock system.

No additional radiation safety system for the remote experiment is required.

Physical Safety(1)

- What is physical safety?
 - If the remote user, who has no information about the status of the experimental station, moves equipment while the SPring-8 staffs accessing equipment, the staff may get hurt.

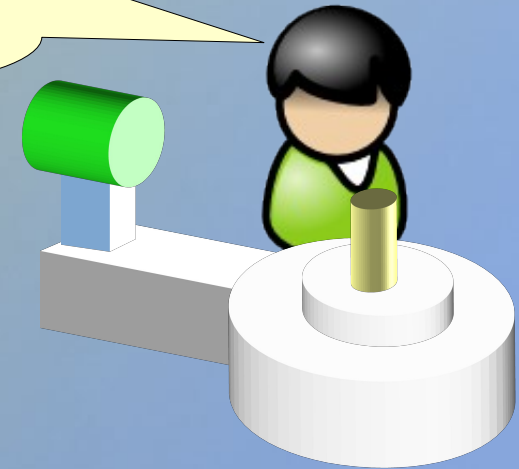


Remote User

Physical Safety(1)

- What is physical safety?
 - If the remote user, who has no information about the

Changing setup for the next user



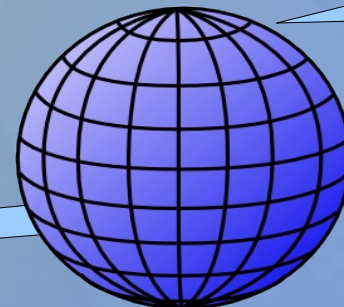
Spring-8 Exp. Station

Checking programs for coming beamtime... equipment

Spring-8 staff accessing equipment, the staff may get hurt.



Remote User



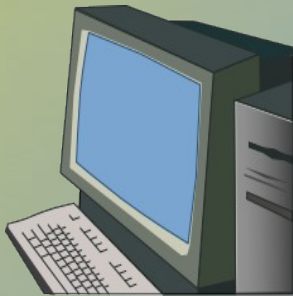
Physical Safety(1)

- What is physical safety?
 - Why the equipment moved?
 - If the remote user has no information about the location of the experimental equipment, the SPring-8 staff accessing equipment, the staff may get hurt.

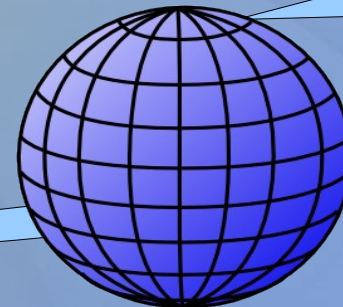
Checking programs for coming beamtime..



SPring-8

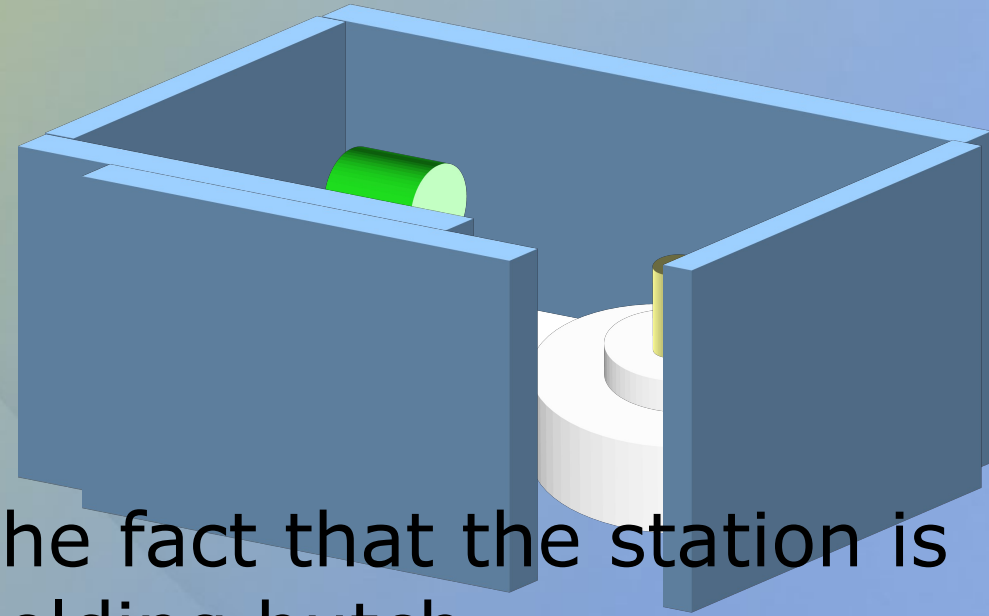


Remote User



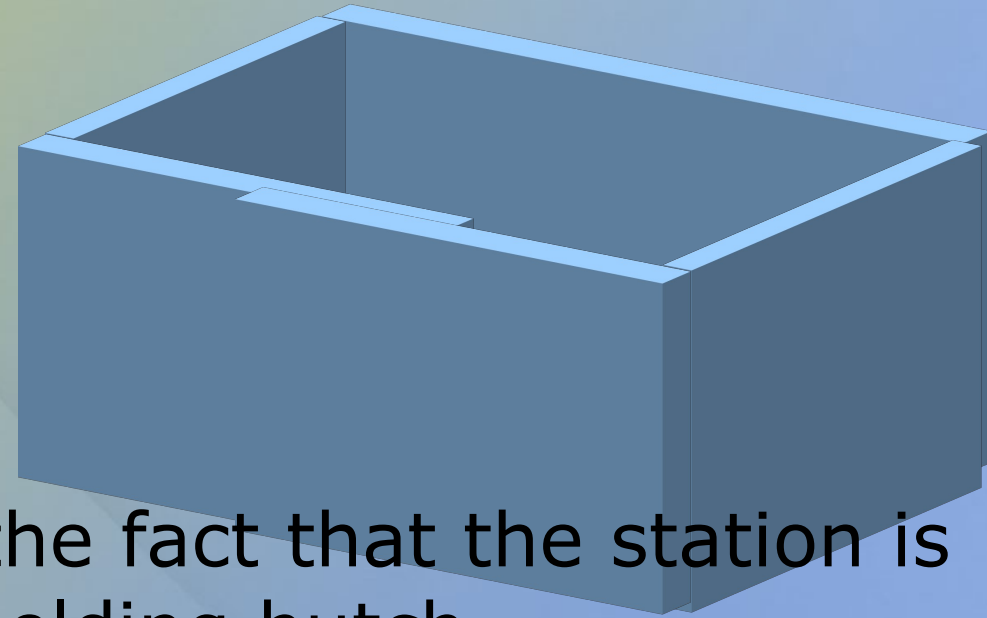
Physical Safety(2)

- To avoid this situation, the remote user can control only when no person at the experimental station.
- To achieve this, we use the fact that the station is enclosed by radiation shielding hutch.



Physical Safety(2)

- To avoid this situation, the remote user can control only when no person at the experimental station.
- To achieve this, we use the fact that the station is enclosed by radiation shielding hutch.
- The radiation safety interlock system ensures no person in the hutch when X-ray beam is introduced into the hutch(hutch closed “normally”).

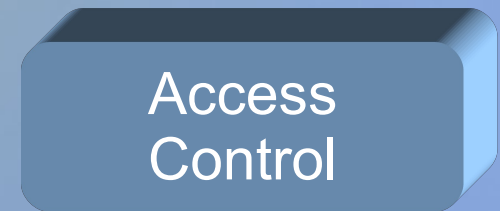
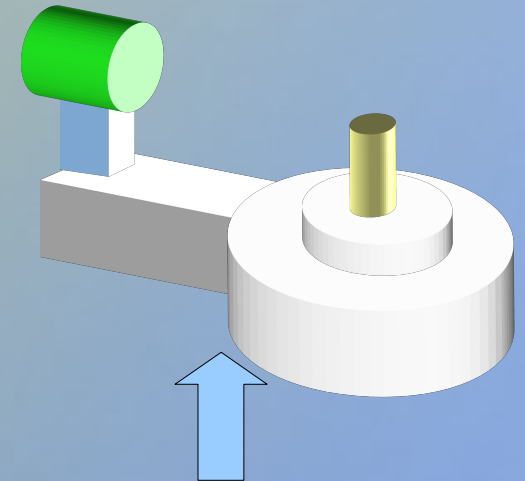


Interference

- When the remote experiment is under performing, other user might access to the experimental station accidentally. It may disturb experiment.
- To avoid this, access control have to be introduced.



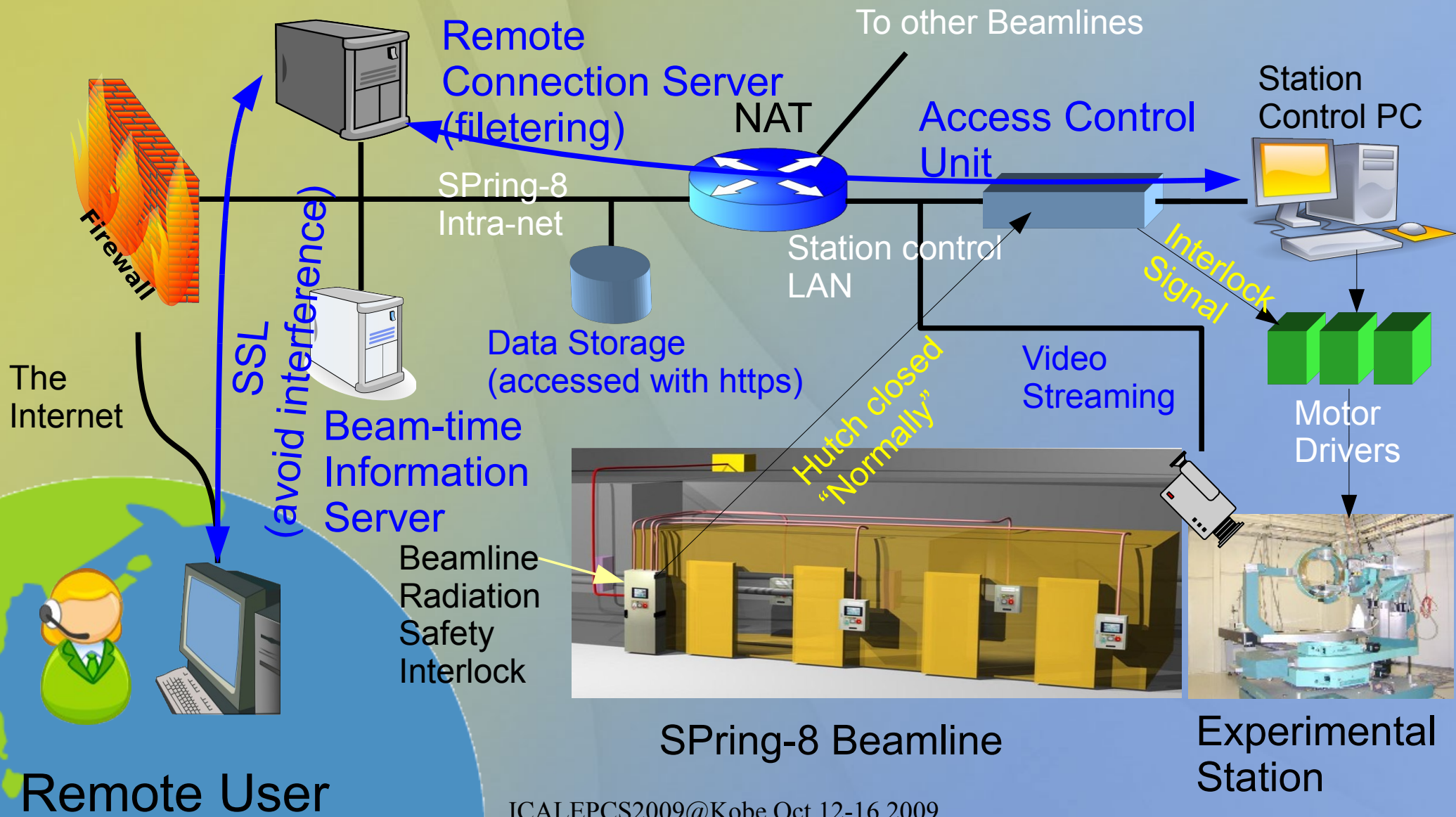
The Authorized Remote User



SPring-8



Overview of the system



Sequence of Authentication

SSL Connection

Authentication Certificate
is generate at SPring-8
(Electric File)

Certificate is sent by e-mail

Proposal ID
(Beamtime ID)

Signed by SPring-8
electrically.

Locked by Password

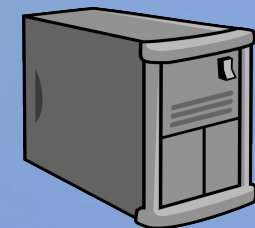
Password sent by
postal mail

Remote
Connection Server

SSL with
Interactive Authentication



Remote User



SSL Connection

Authentication Certificate

Proposal ID
(Beamtime ID)

- The server checks signature and beam time, using the beam-time information server.
- The server relays messages from the remote user to experimental station only during given beam time.

ed by SPring-8
rically.

ked by Password

on Server

Interactive Authentication

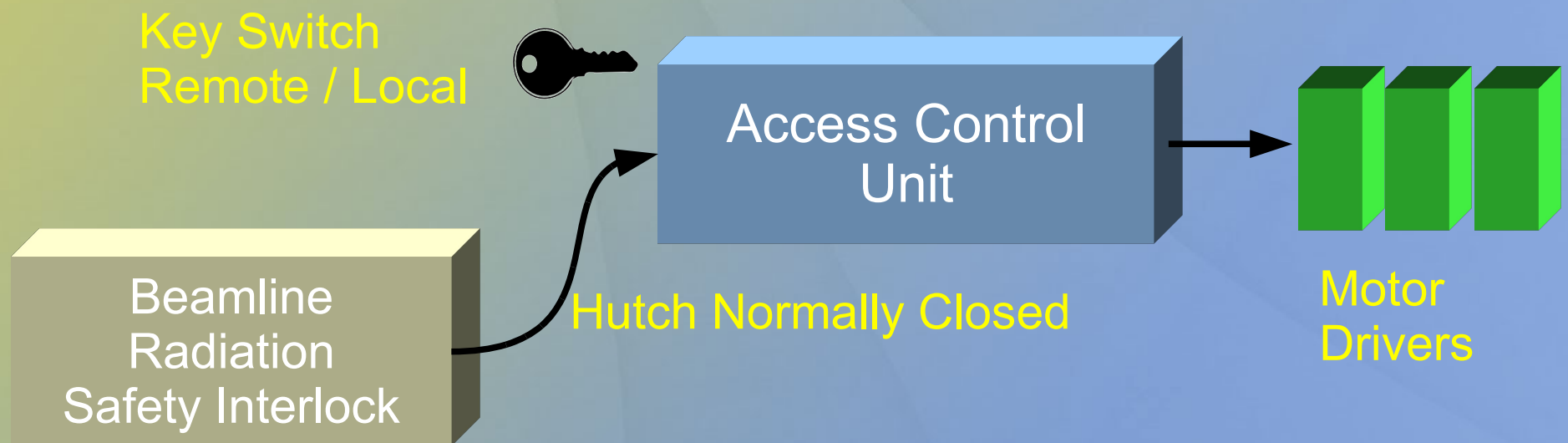
Remote

User's program sent
the certificate for
SSL connection.

Details of Components

Access Control Unit

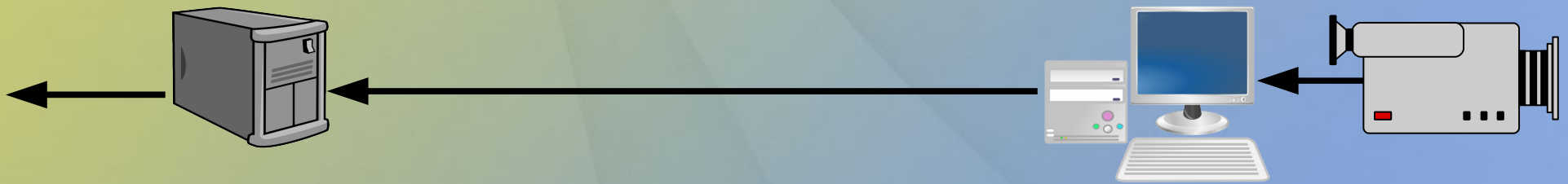
- The access control unit ensure the human physical safety.
- When the key switch "remote" and the experimental hutch is "closed normally", the unit enables motor rotation.



Video Streaming

- For monitoring the experimental station, samples, etc., a video streaming system is introduced.

To Remote User



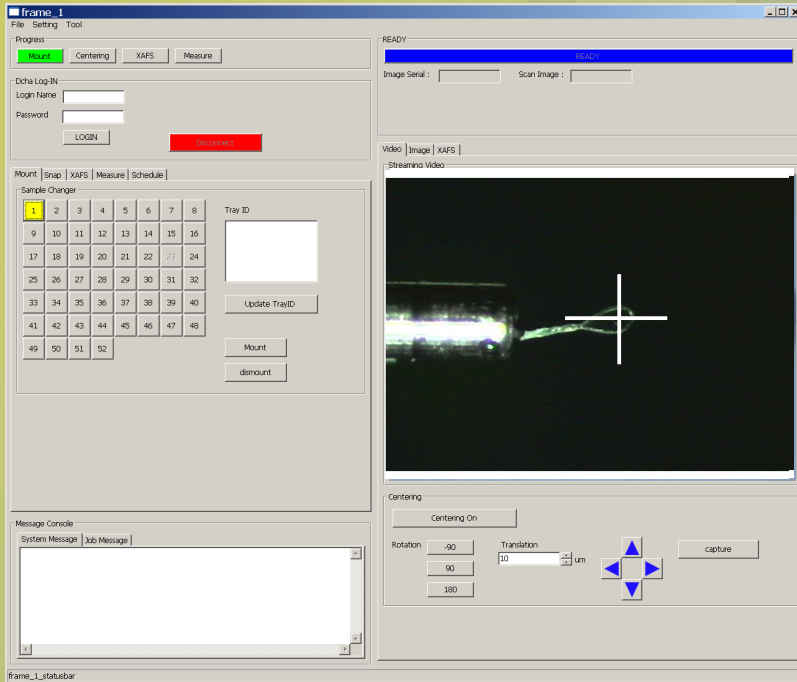
“FFserver” runs on the Remote Connection Server, For distributing Video Data

“FFmpeg” runs on the PC beside the exp. Hutch For Video Compression.

Application to the Protein Crystallography

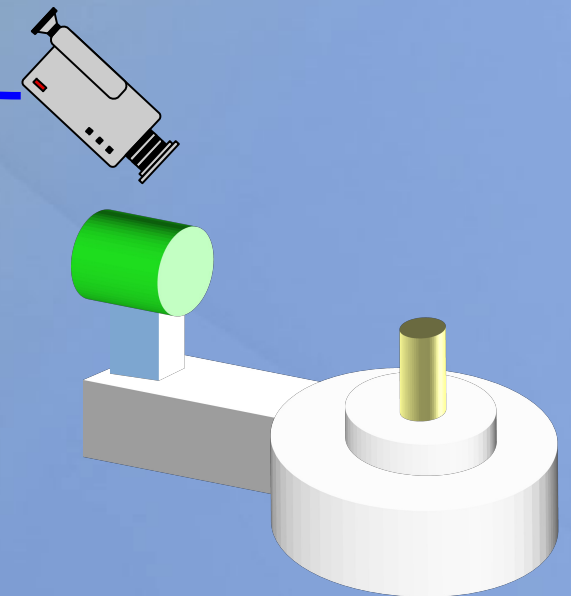
Remote centering system

On the protein crystallography experiment, data quality depends on the x-ray irradiated position, users prefer control sample position directly. (“centering”)



Total latency from clicking to recognition of the sample motion on the remote user's video screen is less than 1 sec. Most of latency is caused by the video compression, the latency of the exchanging message is around 100msec. The actual delay is depend on the network condition between remote user and SPring-8.

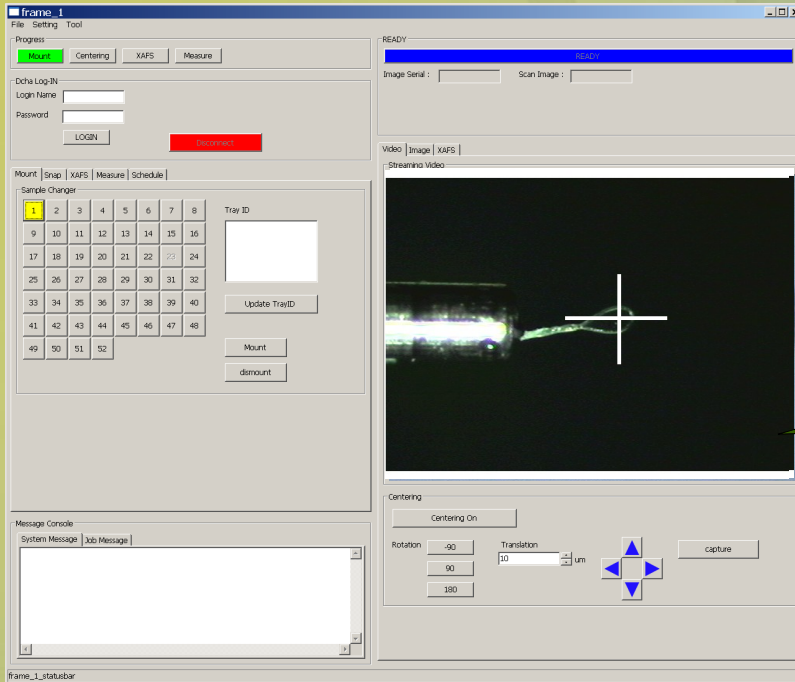
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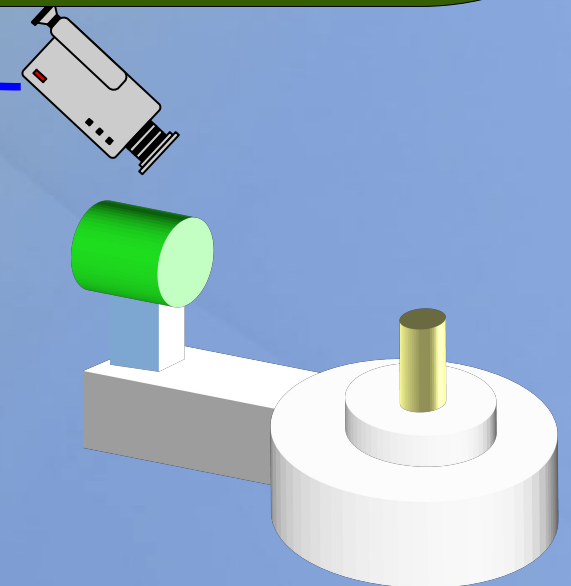
Clicking on the remote user's video image, the sample is moved to x-ray beam position



Total latency from clicking to recognition of the sample motion on the remote user's video screen is less than 1 sec.

Most of latency is caused by the video compression, the latency of the exchanging message is around 100msec. The actual delay is depend on the network condition between remote user and SPring-8.

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Summary

- We developed the remote experiment system.
- Remote users can perform their experiments safely and flexibly.
- System latency is around 100msec for message exchanging and less than 1sec for interactive operation with streaming video, it is enough for synchrotron radiation experiments.
- Protein crystallography experiment system is now under trial and will be opened for users in next April.
- We are planning to apply the system to other synchrotron radiation experiment like power diffraction, diffuse scattering etc.

Message Exchanging

- To control the experimental station, the remote client exchange messages with the control system.
- Message format:
 - Remote control programs using simple scripting languages.
 - Seamlessly access to the "MADOCA" which is the SPring-8 standard control system.

Example of Message
put/monochromator/10keV
get/counter/counts

Connection Server

- Accept remote user connection using Secure Socket Layer (SSL) with interactive authentication.
 - User side certification file (CF) is signed by the SPring-8 and contains a "Proposal ID".
 - The CF is sent by e-mail.
 - The CF is locked with randomly generated password and the password is sent by physical mail.
 - Users who has both password and the CF can access the remote experiment.
 - Connection server can find the beam time from the Proposal DB using the ID.