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# Minoh Campus Smart Campus Initiative

## Contents of the demonstration experiment

August 25, 2021

Daikin Industries, Ltd.

Osaka University

Initiative for Life Design Innovation (iLDi)

Institute for Open and Transdisciplinary Research Initiatives (Di-CHILD)

# Concept of the new Minoh Campus

A research hub for studying languages, cultures, and societies from around the world.



A Global Campus to Connect Citizens to the World



Introducing Japanese culture through accepting and interacting with people from around the world

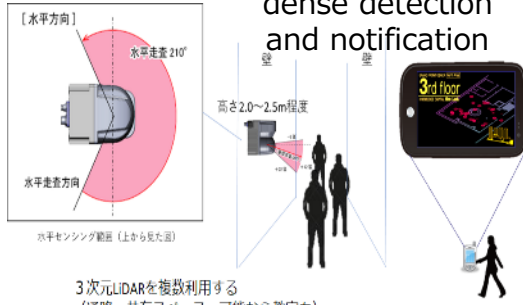


Serving as a foothold for students, researchers, and corporations in advancing global marketing



## safety

dense detection and notification



Verification of new campus aimed at improving QOL  
Promotion of mental and physical health  
Learning with fun

## "Mental and Physical Health"



## relief

Face authentication attendance management



## individual care

concentration visualization



Quantifying the level of communication



Health management in "Arukudake"



body composition  
"Aruki Shinan"  
walking game

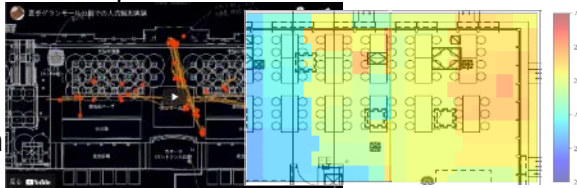
## joy

## "The Future of People and Space"

Harmonized with the quality of life of diverse individuals  
Realization of safe, secure and sustainable school space

## connection

Human flow analysis and heat map visualization



switchless air conditioning

replacement ventilation air conditioning



Outdoor Air Conditioning (3F Pilotis)

5G NETWORK



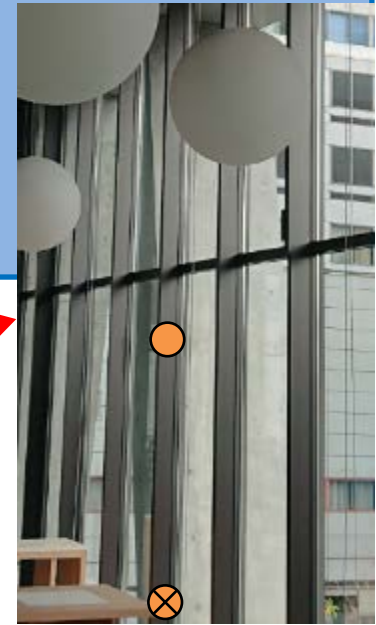
By the 5G air conditioner  
Dissemination of information

Experiment 1

## ENVIRONMENTAL AND EQUIPMENT DATA

- Power consumption and peak power for each floor and classroom
- Temperature, humidity, wind speed, CO2 concentration, noise, and window opening and closing conditions
- Air conditioner operation data and lighting equipment operation data

**\*All floors are equipped with air conditioners manufactured by Daikin industries.**  
**We have already introduced a ventilation and air conditioning system that can be monitored and controlled.**

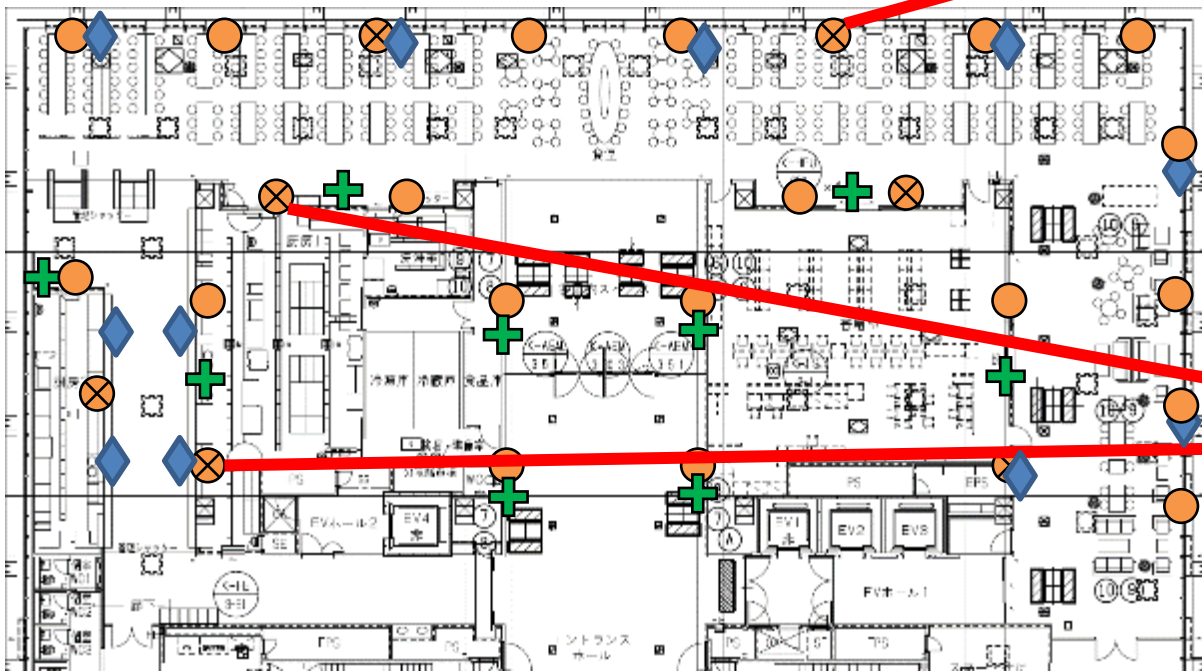
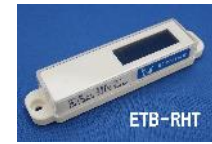


Temperature and Humidity Sensors (33)

- Vertical 1 Point x 19
- ⊗ Vertical 2 points x 7

CO2 sensors (9)  
+ Vertical 1 Point x 9

◆ Illuminance sensors (11)  
Vertical 1 point x 11 (0.6 m)



# Classification of data acquired in the experiment 2

	Do not handle personal information	handle personal information	
Unspecified majority	Research theme using the information that is not personally identifiable  <u>Experiment 2</u>	Research theme including analysis of someone's behavior from sensor images and data  (Opt-out * supported)  <u>Experiment 4</u>	Today's topic
Subjects with consent	Research theme including questionnaires without personal information in relation to environmental data  <u>Experiment 3</u>	Research theme using personal information such as behavioral analysis and questionnaires (Face and behavior data, etc.)  (Opt-in Support for Obtaining Identity Consent)  <u>Experiment 5</u>	

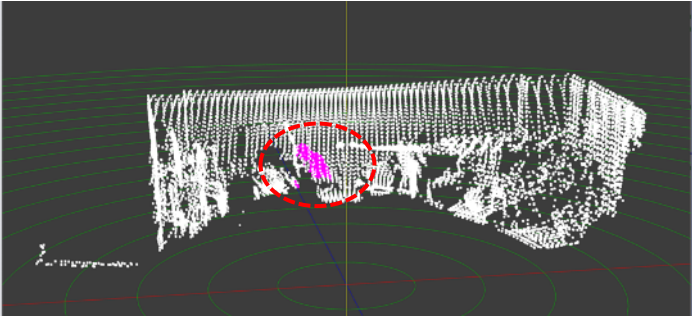
\*Opt-out support:

We will notice about the acquisition of personal data in advance. Unless the principal disagrees with the provision, such consent shall be deemed to have been given. If you disagree, the personal data will be deleted.

Human flow measurement and temperature distribution measurement are not image information that can identify individuals.

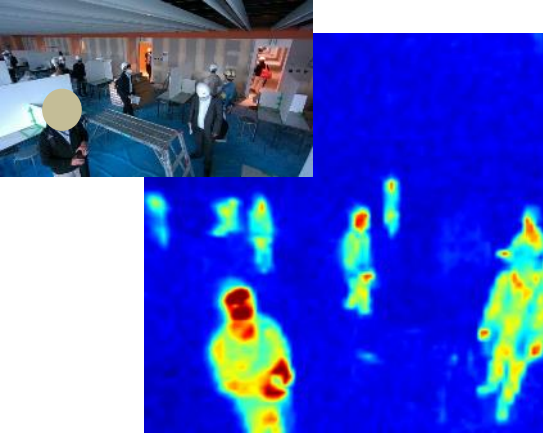
### 3D LiDAR

Hokuyo Electric  
YVT -35 LX-F0      Livox Avia



Measure Human Flow  
Measure 3D Structure  
(Point Cloud Data)

[Reference] Camera image with the same field of view



### thermoimager

Optris Xi 80



Measurement of two-dimensional temperature distribution

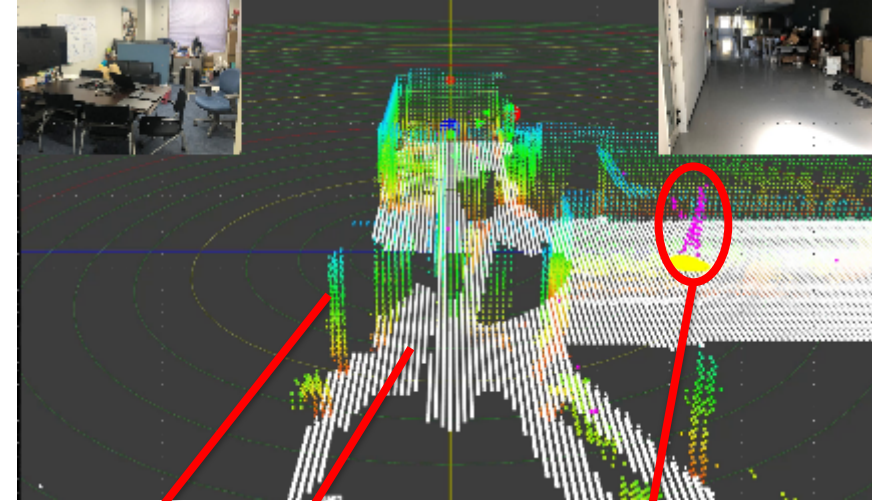
### Depth Camera

Intel RealSense D 455



Measure Distance Image

- Install 3D LiDAR sensors in cafeterias, hallways, etc.
- Develop "hitonabi" system for estimating congestion by obtaining human location in real time
- Provide users with information such as congestion levels of cafeterias and lecture rooms
- Evaluate the prediction of human behavior and congestion by machine learning at a wide area level
- Construct a system applicable to various cases such as COVID-19 infection prevention and optimization of air conditioning.



Wall

floor face

Loose silhouette of a pedestrian (point cloud)

3D point cloud from the sensor

Congestion visualization

Only anonymous crowd location information is displayed



real-time data processing

In consideration of personal information

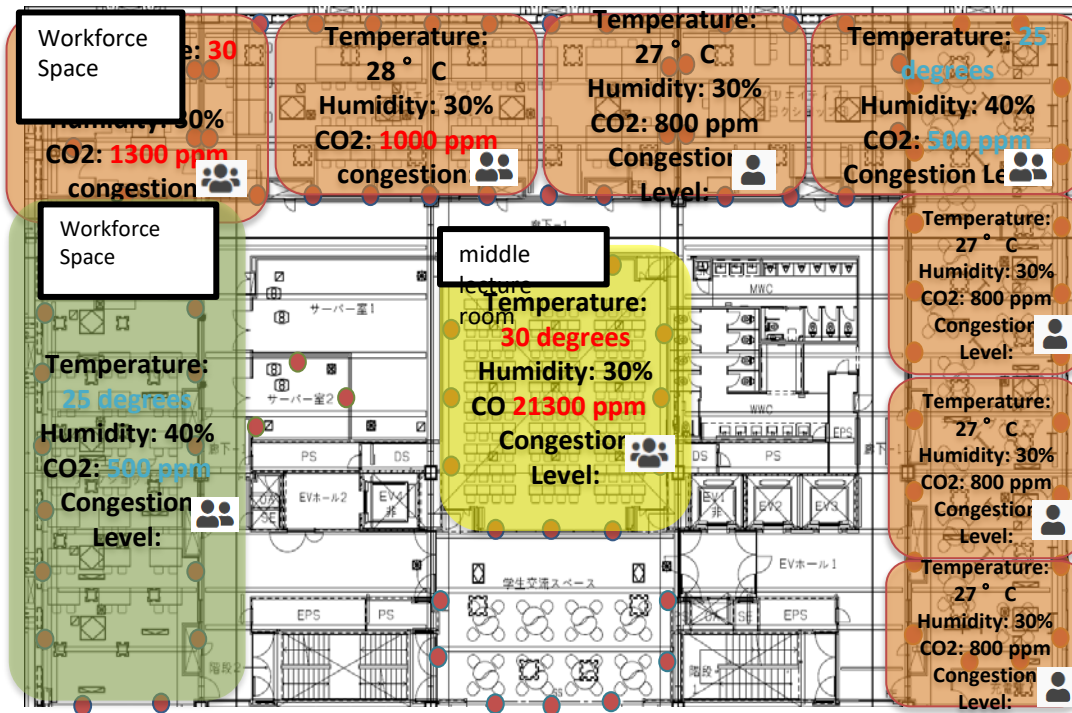
Discard 3D point cloud data

# Experiment 2-2: Utilization of data of unspecified majority without personal information

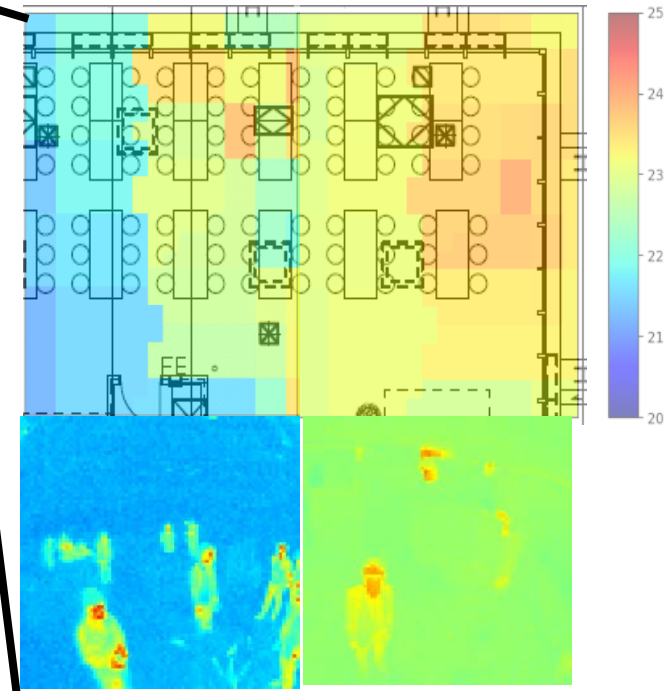
Research on environmental information estimation and visualization technology by multimodal sensing

Estimate and visualize environmental information (dense temperature distribution in a space) from sensor data (images, thermography, depth of space, temperature, humidity, illuminance, sound) obtained from a small number of various sensor devices (multimodal sensors) installed in lecture rooms and common space.

• image of the visualization screen



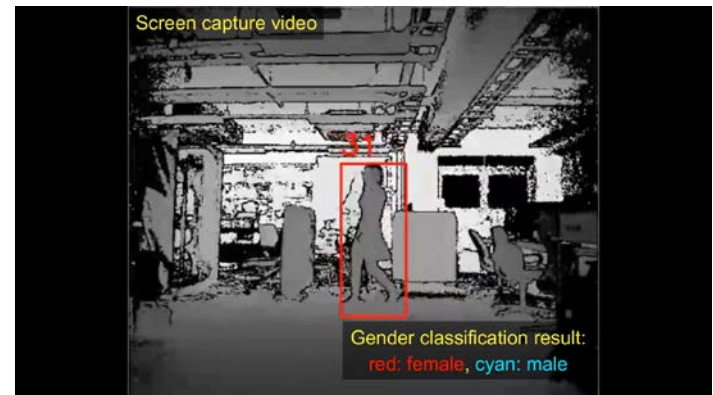
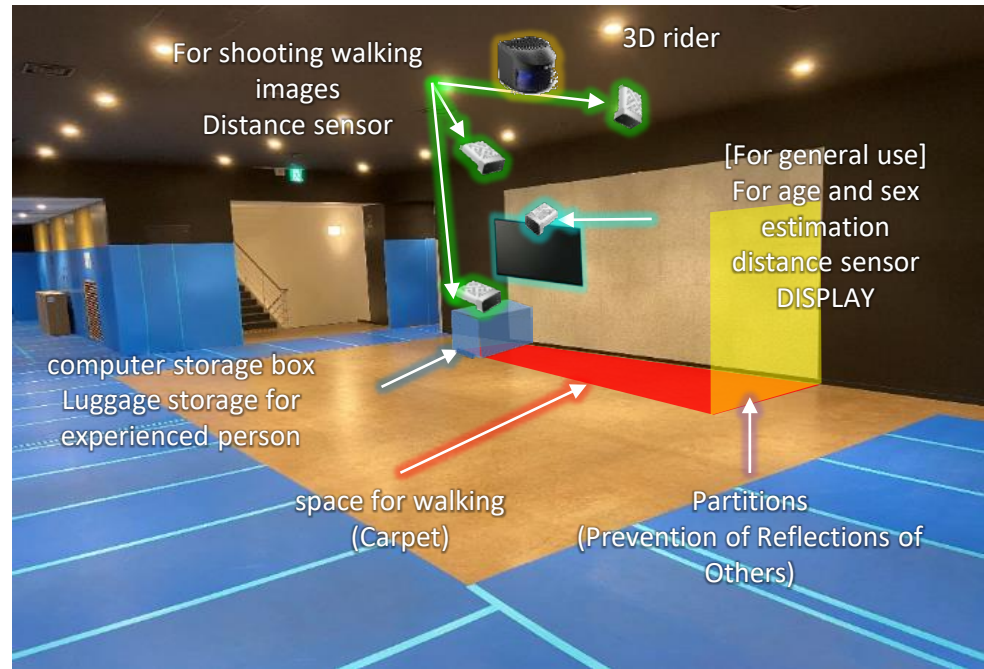
Tap an area of the screen to go to the detail screen





## Age Estimation by Gait Image Analysis

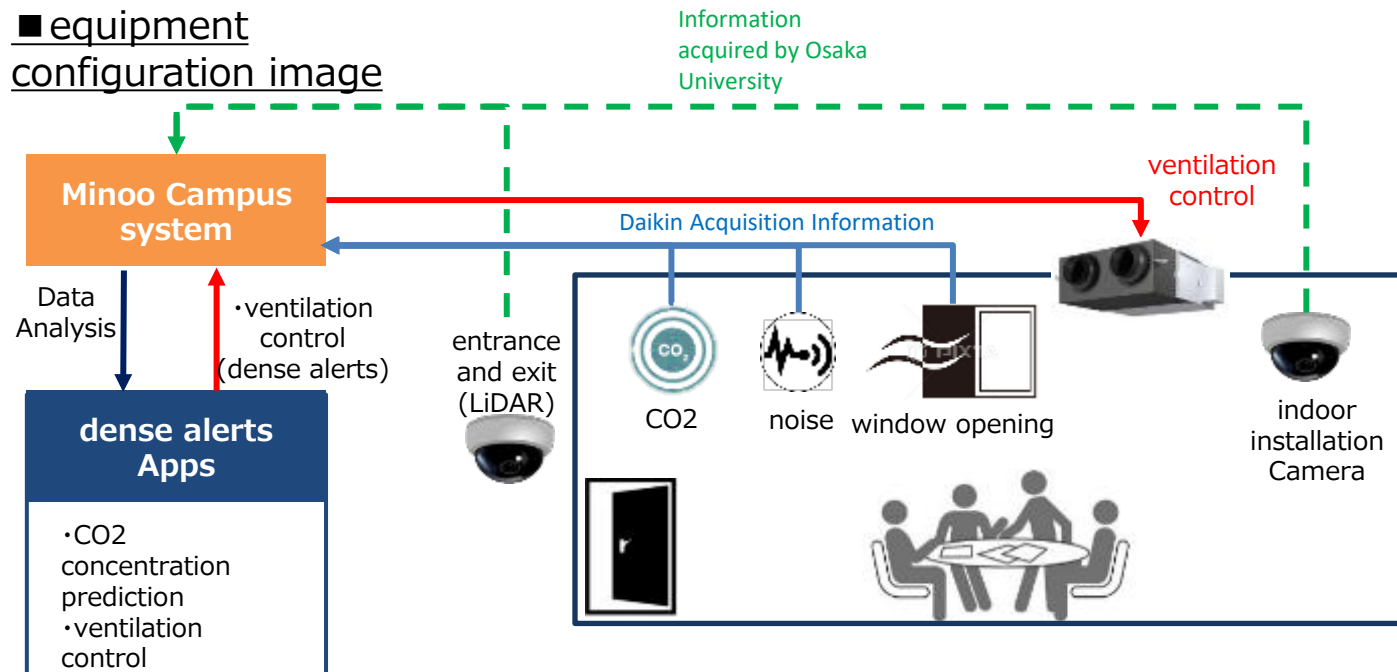
- Demonstration of age estimation technology by gait image analysis
- The estimated walking age (a certain physical fitness age) can be used by students, faculty, and staff for daily health care.



[General Users] Walking Age Estimation  
Results of estimation of certain physical strength age can be confirmed on display in real time.

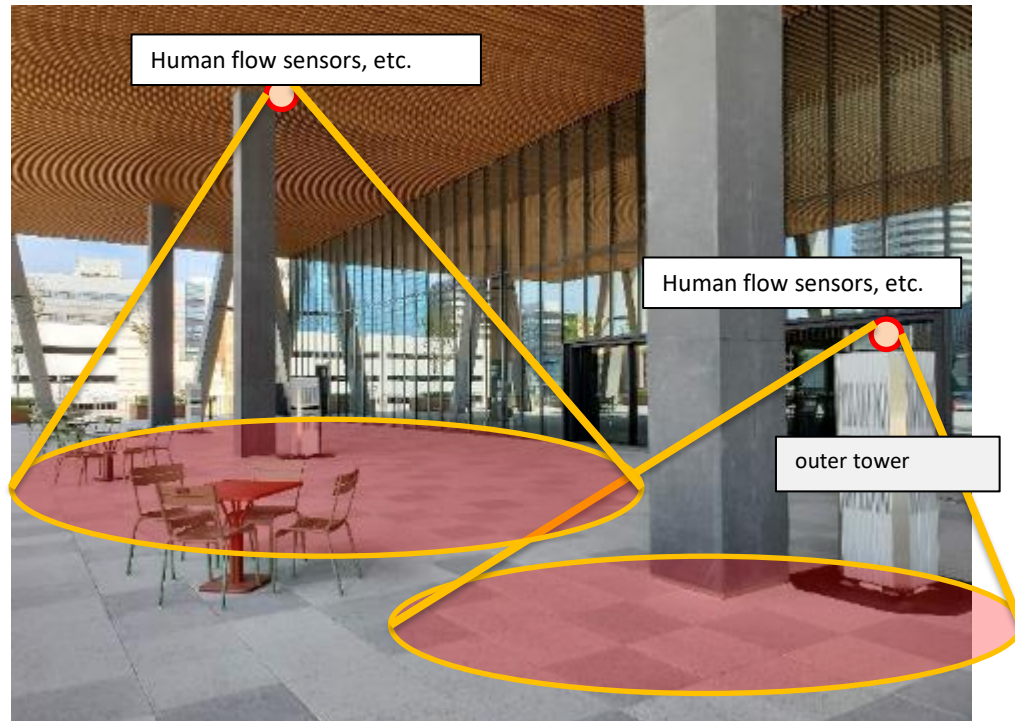
Crowd alert system demonstration experiment

- Develop **crowd alert system that automatically controls ventilation systems by detecting predicted Three Cs** based on data such as CO2 concentration, number of people, position of people, noise, and window opening and closing
- Evaluate the developed system



## Establish a new evaluation method and index for outdoor and semi-outdoor air conditioning equipment different from conventional indoor air conditioning.

Explore appropriate IoT/AI technologies to safely and efficiently operate outdoor air conditioners.

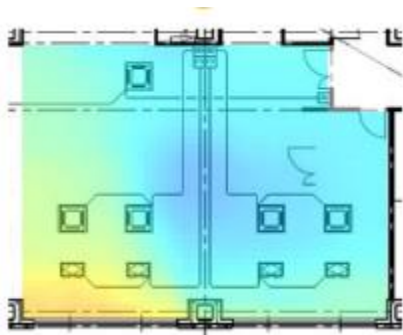


1. Human flow sensors are installed in the outer tower and space to sense the situation of people around the equipment.
2. The operation of the outdoor air conditioner is controlled using the obtained data.
3. Data such as air conditioning effects are collected and analyzed.

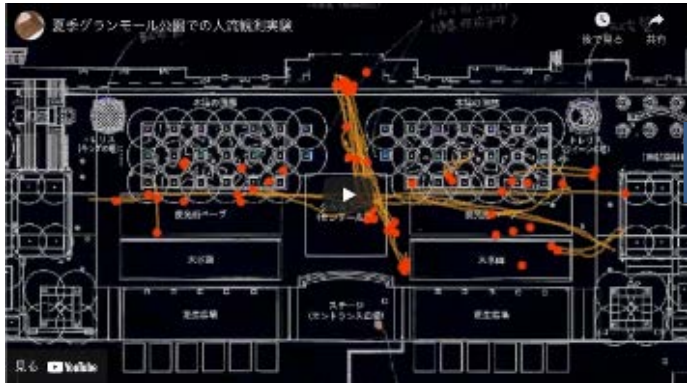
Develop a platform that allows students to use the data without personal information

- Provide an environment that users (students) can create a service to share in real time the availability of remote classes and events

heat map

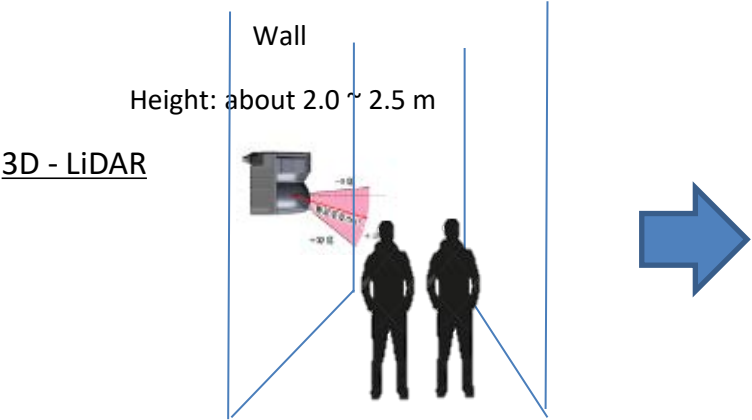


human data

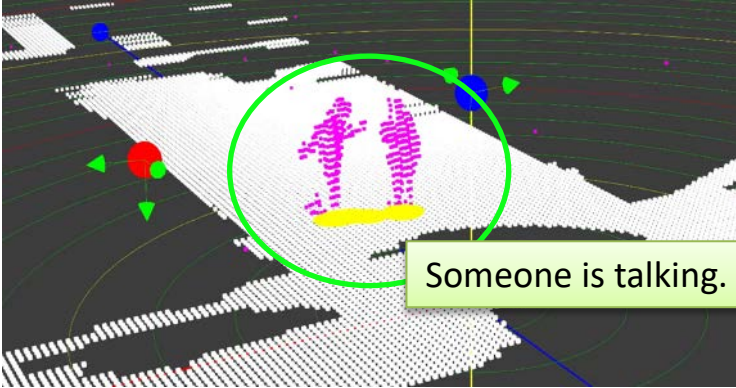


Anonymous understanding of activity of communication among students and occupancy of cafeteria and free space

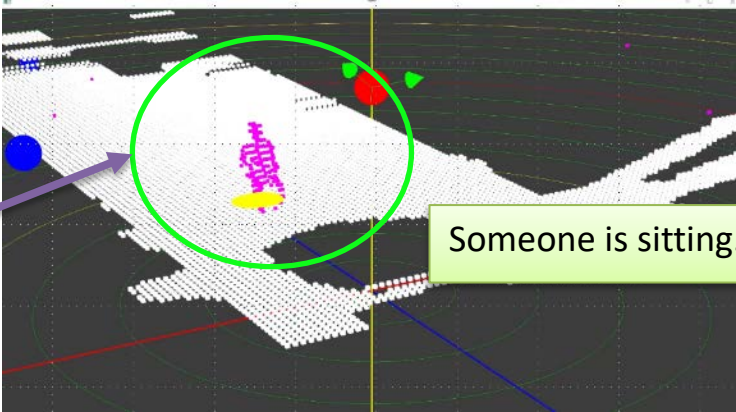
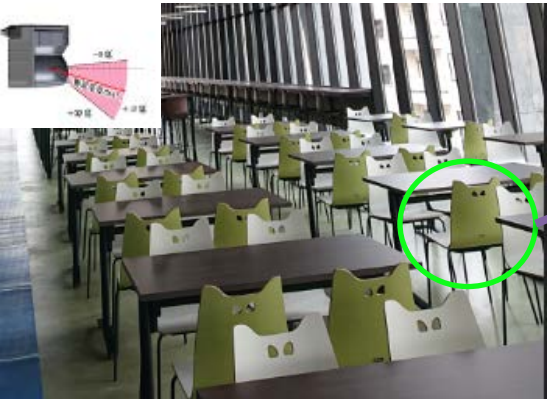
\*Opt-out: We will notice about the acquisition of personal data in advance and delete the personal data of the person who wishes to delete.



point cloud data



By developing technology that utilizes not only human flow data but also sensor information (point cloud data), it is possible to provide seating conditions for each seat in a cafeteria and anonymous communication activity.



point cloud data

Location		Theme Name	
entire building		Energy management of entire building	energy management Contact: Di-ChiLD/CSO
6F to 1F		Measurement of human flow in the entire building and its application	
5F/2F		Demonstration of behavioral analysis in "human flow measurement and its utilization in the entire building"	Concentration of learning, attendance management, etc. Research themes conducted only in individual classrooms Contact: iLDi
5F	515 classrooms	Visualization system of concentration degree of student in lecture	
	515 classrooms Other	Attendance management system by face authentication	
4F	HALC/ALS	Spatial Control of Indoor Thermal Environment Using Sensor Information	
		Crowd alert system demonstration experiment	
	Development and demonstration of highly efficient and comfortable control and operation methods for "split type membrane ceiling air conditioning"		
	Aroma Environment Design of Learning Space Considering Adaptation Characteristics of Olfactory Sensory		
	middle lecture room	Development of design guidelines for replacement ventilation and air conditioning	
	Other	Designing spaces to increase learning efficiency in "classrooms of the future"	
		Proof of Concept of Comfortable Environment in Response to Changes in Lifestyle in Coronavirus	
3F 4F	dining room shared space (Partial study room)	Research on environmental information estimation and visualization technology by multimodal sensing	
		Study of switchless fully automated air conditioning system	
		User Innovation API Platform/Air Conditioner 5G	
3F	Piloti	Activation of activities in outdoor and entrance and required air conditioning environment	
2F	Foyer	Health Index Estimation by Gait Image Analysis	health and enjoyment Contact: iLDi
		Age Estimation by Gait Image Analysis	
		Demonstration of utilization of personal data in "human flow measurement and its application throughout buildings"	

Today's topic

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## **THE OTHER RESEARCH THEMES**

**EXPERIMENT 1: RESEARCH WITHOUT USING PERSONAL INFORMATION**

**EXPERIMENT 3,5: RESEARCH USING INFORMATION OF SUBJECTS WITH CONSENT**

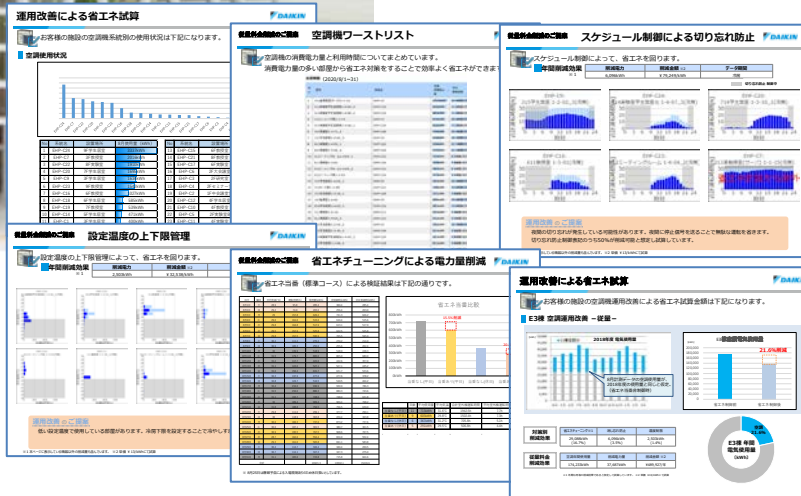
Energy management of the entire building  
Target: 20% reduction in primary energy emissions



- After the second year
- ① Remote automatic energy saving setting
  - ② Forgot to turn off setting
  - ③ set temperature limit



Acquisition of detailed data in vacant classrooms



Air conditioning data collection

Analysis, formulation of countermeasures, and demonstration



5G in common space (3F)

5G antenna



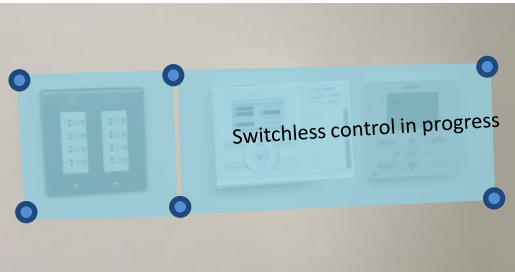
Lend broadcasting equipment to students and disseminate information globally through 5G





## Experiment with questionnaire survey for air conditioning control and service

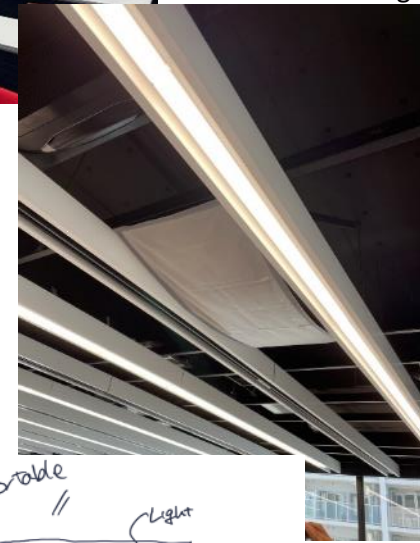
Switchless control (human detection, pre-cooling, pre-humidity, etc.)



replacement ventilation



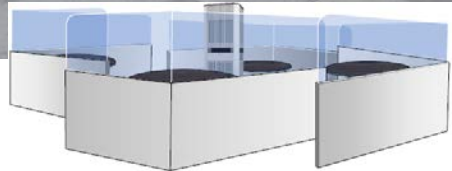
membrane ceiling



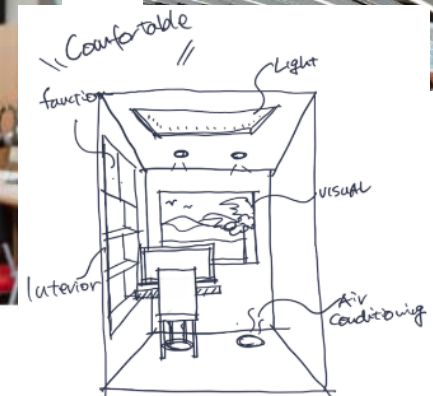
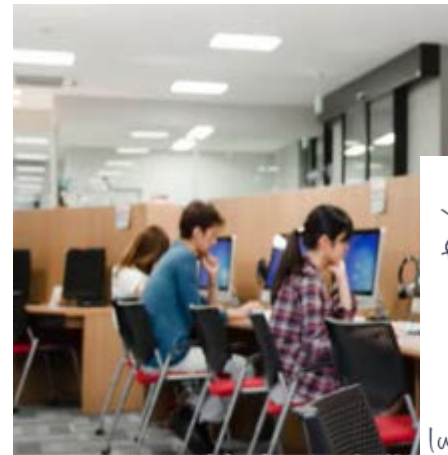
outdoor space



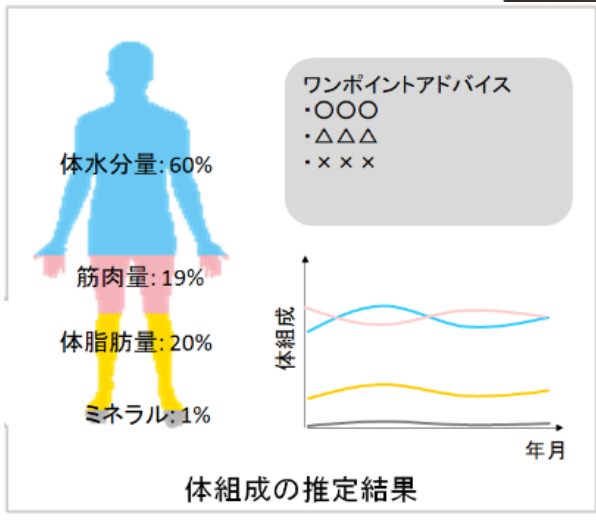
Observation equipment (mobile)



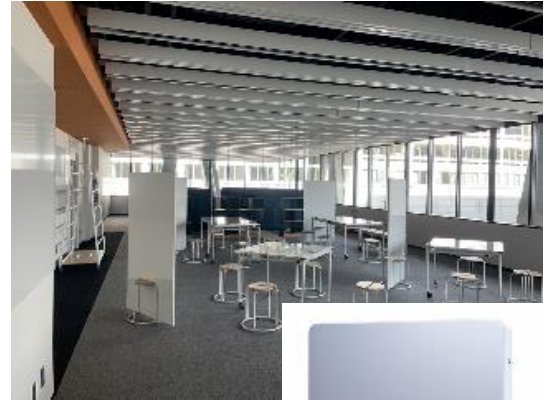
Private room and private shared space



Health Index Estimation by Gait Image Analysis



Improvement of the performance in the learning space by using aroma diffuser



aroma diffuser (Flooring)

Provision of information on the degree of congestion and closeness by identifying the location of individuals

communication quantification



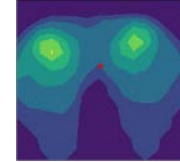
スマホ



## visualization of student concentration

By monitoring students' behavior during lectures, we aim to improve their concentration and understanding.

seat pressure



facial image



gaze



## increase learning efficiency "Class of the Future"

Changing lighting, room temperature, humidity and so on, we monitor the the subjects by using camera and wearable sensors.

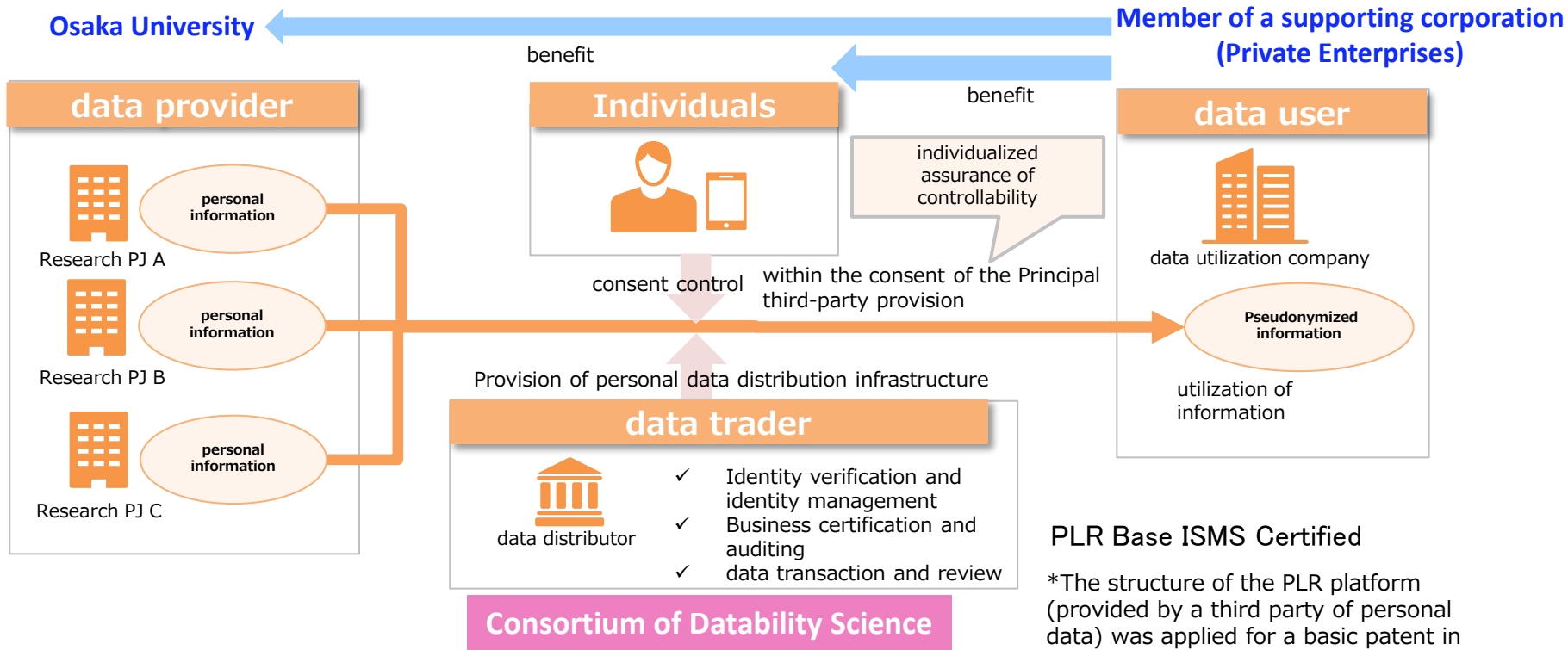


## Attendance management system

We evaluate the Possibility of Attendance Management by Face Authentication



The data of subjects with consent (opt-out is possible) is provided to the member of a supporting cooperation after pseudonymization so that the individuals cannot be identified by using the PLR (Personal Life Records) platform developed by the iLDi (Initiative for Life Design Innovation) through the mediation of the consortium of datability science.



\*The structure of the PLR platform (provided by a third party of personal data) was applied for a basic patent in 2019.

\*For those who have agreed to the registration, Data distribution will be conducted by informing in advance of the purpose of each utilization and obtaining agreement each time, and points will be granted to individuals according to the price of data distribution. The points are also linked with the co-op headquarters, and are being promoted so that it can be used at the university cafeteria shop, etc.

Data obtained on experimental themes, including personal information, will be safely managed as pseudonymized Personal Data (MYPLR) and utilized for new research and product development.

## Experimental themes to be provided by the third party

No	Theme Name	Departments and staff in charge	Location	investment period	Unspecified majority?	consenting collaborator	data third-party provision	ethics review presence or absence
	Demonstration of behavioral analysis in "human flow measurement and its utilization in the entire building"	Graduate School of Information Science and Techonology Hirozumi Yamaguchi	5F	2021 October ~	○	×	None	○
	Demonstration of utilization of personal data in "human flow measurement and its application throughout buildings"	Graduate School of Information Science and Techonology Hirozumi Yamaguchi	5F		×	○	Yes	○
	Demonstration of utilization of personal data in "human flow measurement and its application throughout buildings"	Graduate School of Information Science and Techonology Hirozumi Yamaguchi	2F		×	○	Yes	○
	Health Index Estimation by Gait Image Analysis	Institute for Advanced Co-creation Studies Yasushi Makihara	2F		×	○	Yes	○
	Visualization system of concentration degree of student in lecture	Hajime Nagahara, DatabilityFrontier Organization	5F		×	○	Yes	○
	Attendance management system by face authentication	SANKEN Yasushi Yagi	5F		×	○	Yes	○

\*Response by opt-in agreement each time

(Face images (questionnaires), face images, line of sight, LiDAR data, walking moving images, etc.)

At iLDi, we propose Personal Life Records (PLR) information, which combines PHR (Personal Health Records) information with various data on daily activities such as daily life, workplace/school activities, meals, and sports activities.

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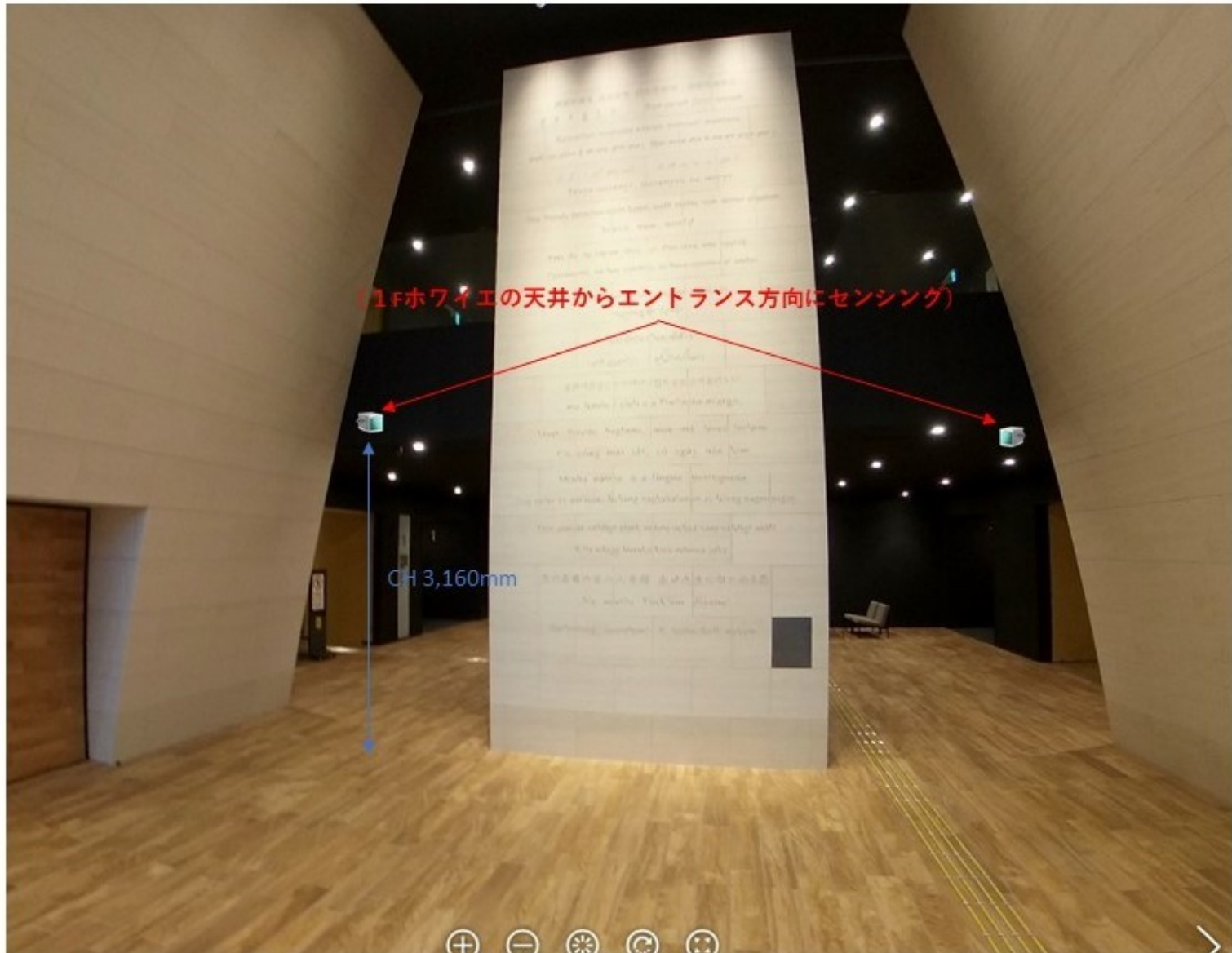
## APPENDIX



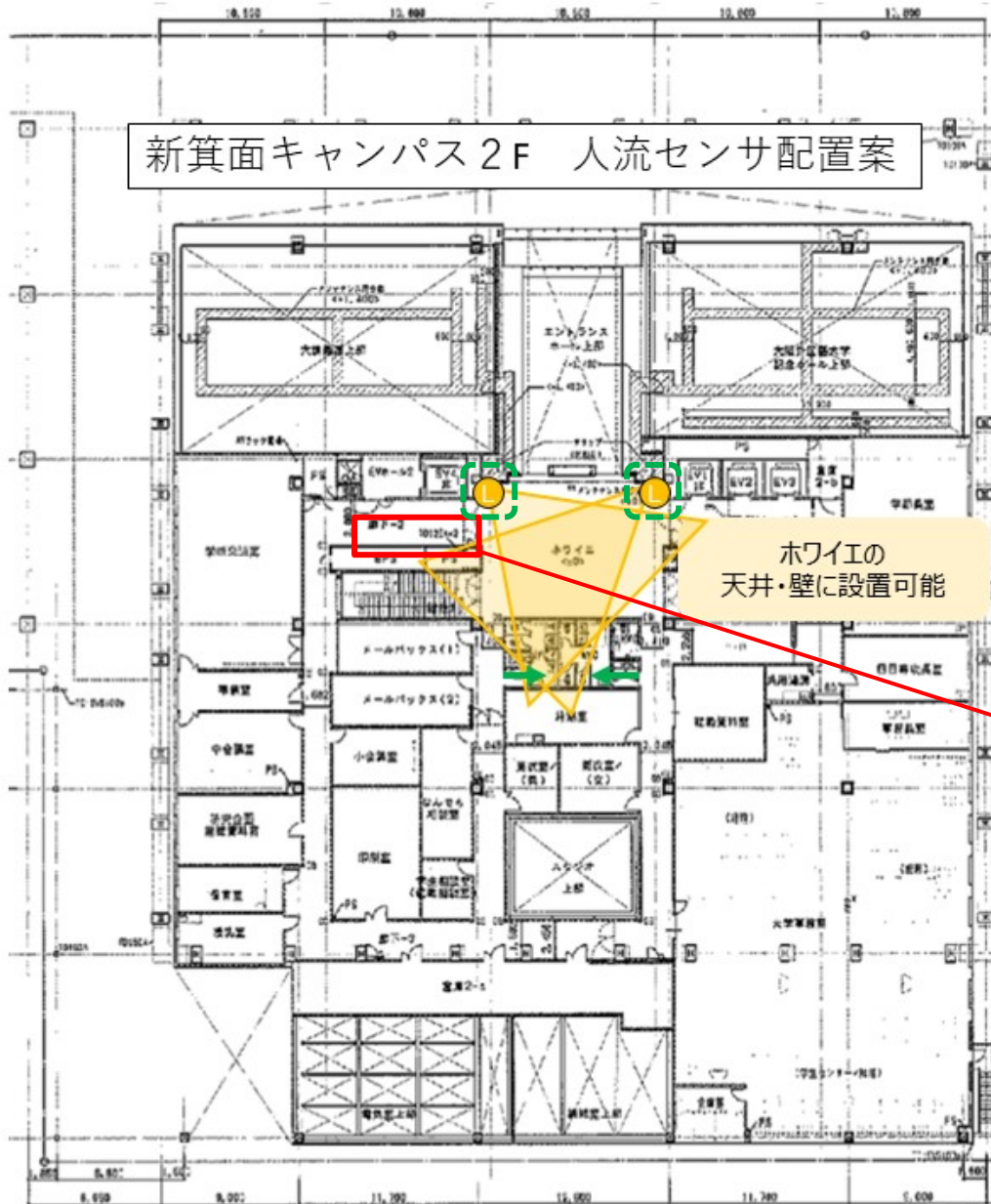
← トイレ入口 (Society 5.0設置)

toilet consideration by installation by

- **Livox Avia**  
ホワイエからエントランス向き2台  
ホワイエ 1台  
(計3台)





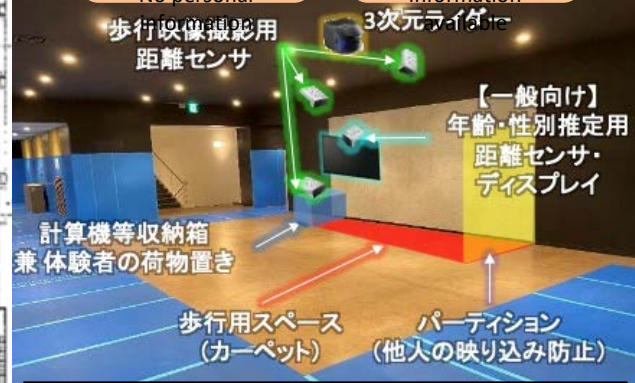


新箕面キャンパス 2F 人流センサ配置案

- ← トイレ入口 (Society 5.0設置)   toilet consideration by installation by
- Livox Avia  
ホワイエ掲示板前 2台

ホワイエの天井・壁に設置可能

- Demonstration experiment 2 unspecified majority No personal
- Demonstration experiment 5 consenting party Personal information




Age and gender estimation theme by walking image analysis  
Health index estimation theme by walking image analysis



# 3F: Installation drawing of cafeteria human flow sensor and thermoimager, installation

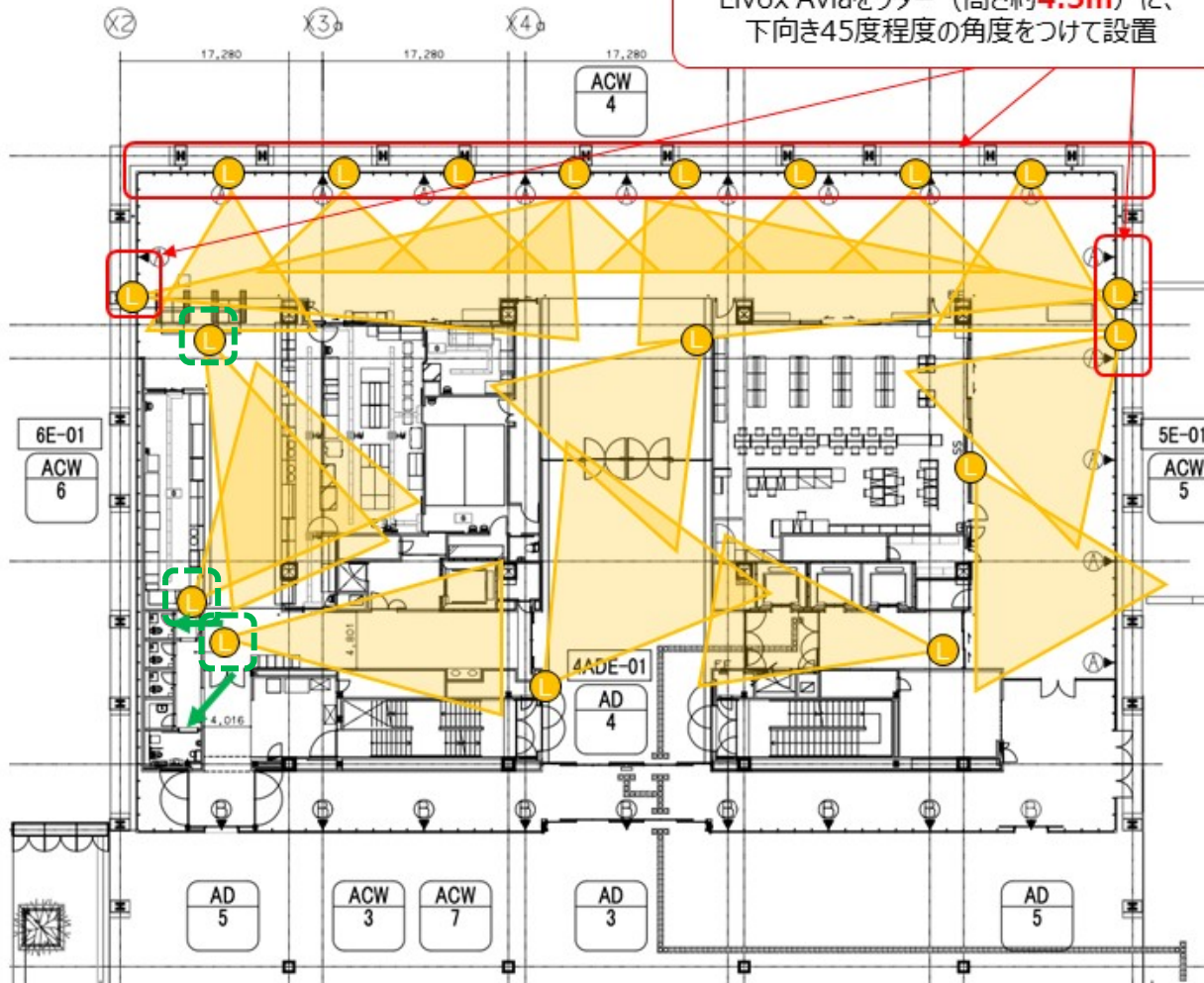
## 3F 食堂 (人流センサー 天井ラダーへの設置案)

toilet consideration  
installation by  トイレ入口

(Di-CHILD設置)

Livox Aviaをラダー (高さ約4.5m) に、  
下向き45度程度の角度をつけて設置

- Livox Avia  
食堂ロング 8台+2台  
食堂ショート 2台  
配膳ゾーン 2台  
食堂エントランス 2台  
通路 2台  
(計18台)



# 3F: Installation drawing of cafeteria human flow sensor and thermoimager, installation

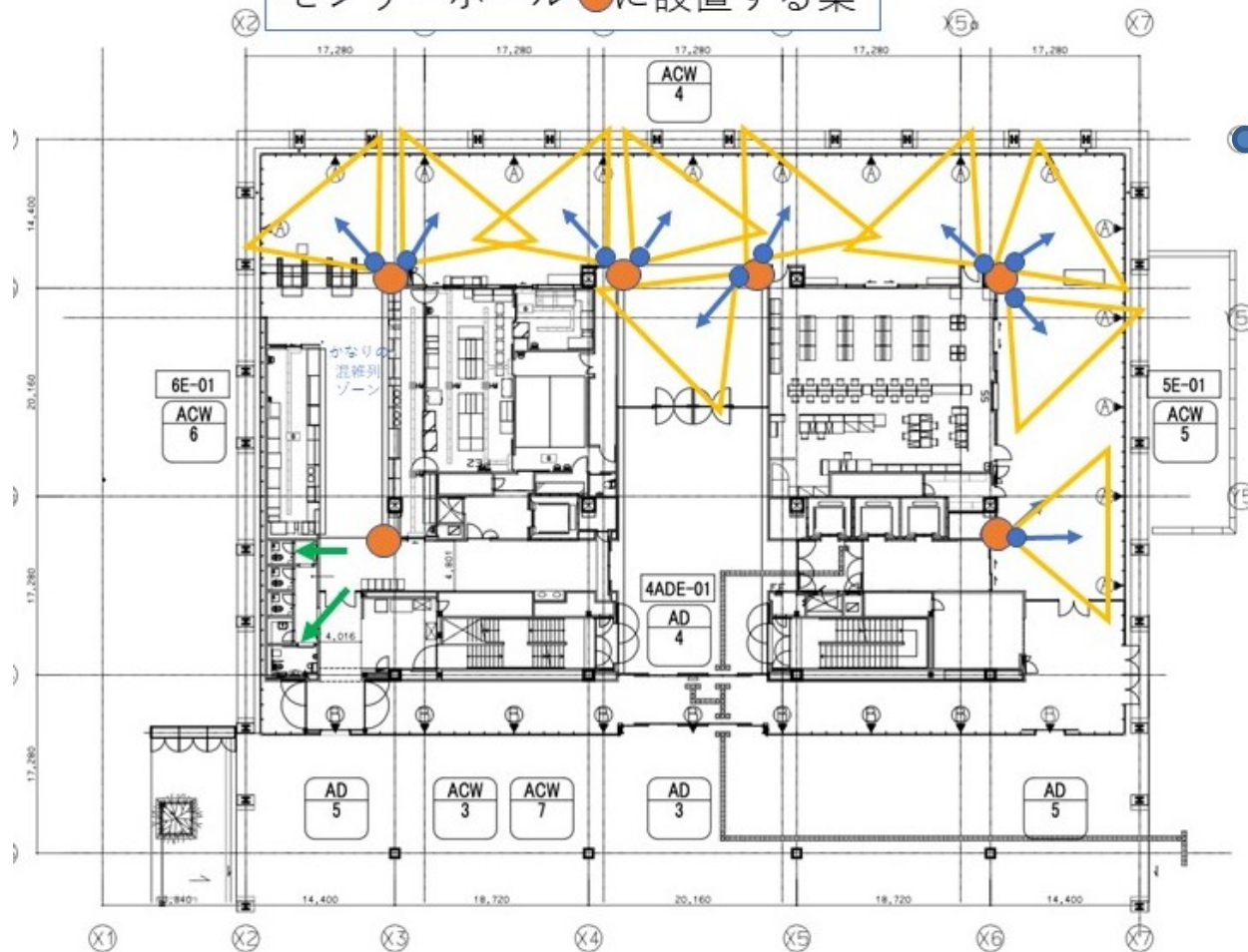
新箕面キャンパス 3F 食堂でのサーモイメージャー配置案

センサーポール ● に設置する案

← Toilet entrance

(Di-CHILD installed)

● thermoimager

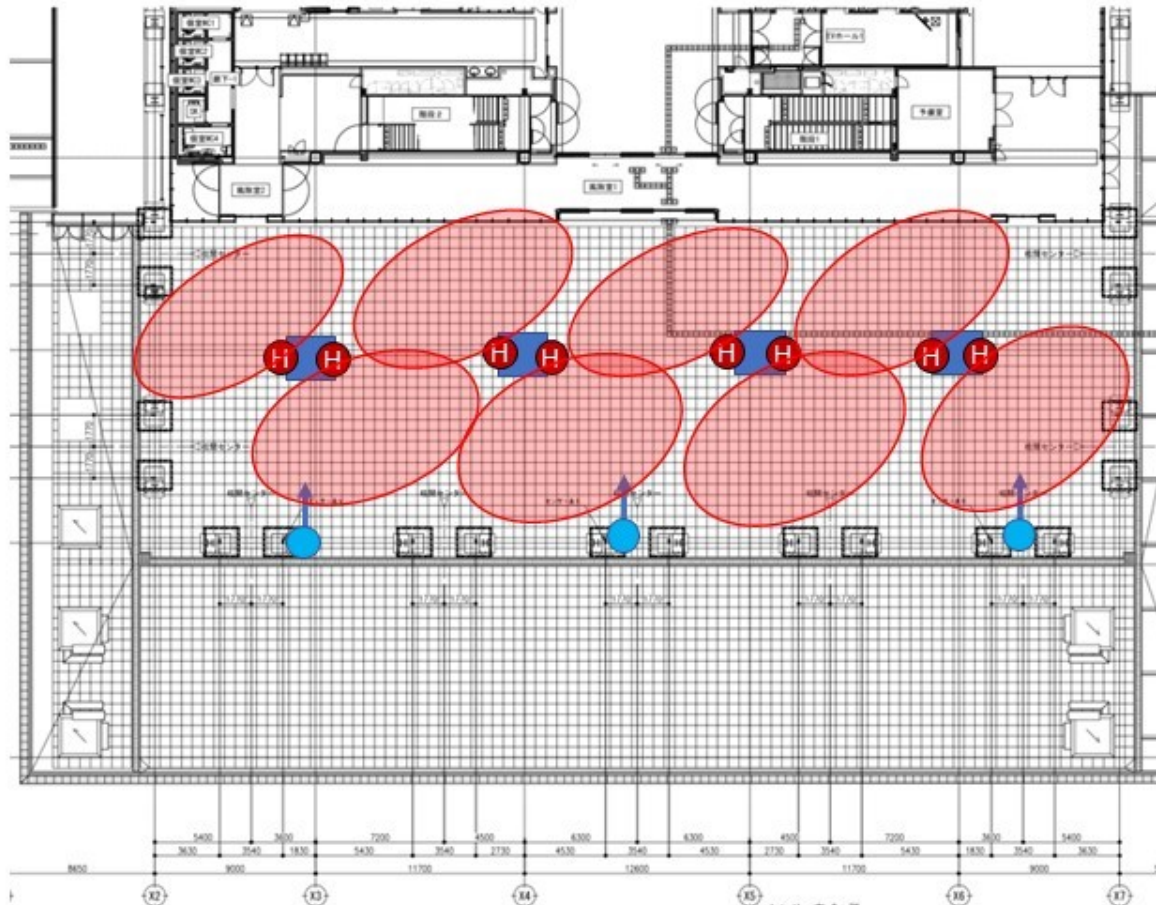


新箕面キャンパス3F食堂 人流センサ・サーモイメージャ設置イメージ



## 3Fピロティ 人流センサ設置案

(Di-CHILD設置)



■ Outer Tower

● 2D LiDAR  
3台

● H Hokuyo YVT-35LX  
8台

OuterTowerへのLiDAR設置が  
振動・配線などの理由により不可の場合は、  
天井からつるす可能性あり

## 新箕面キャンパス3Fピロティ 人流センサ設置イメージ

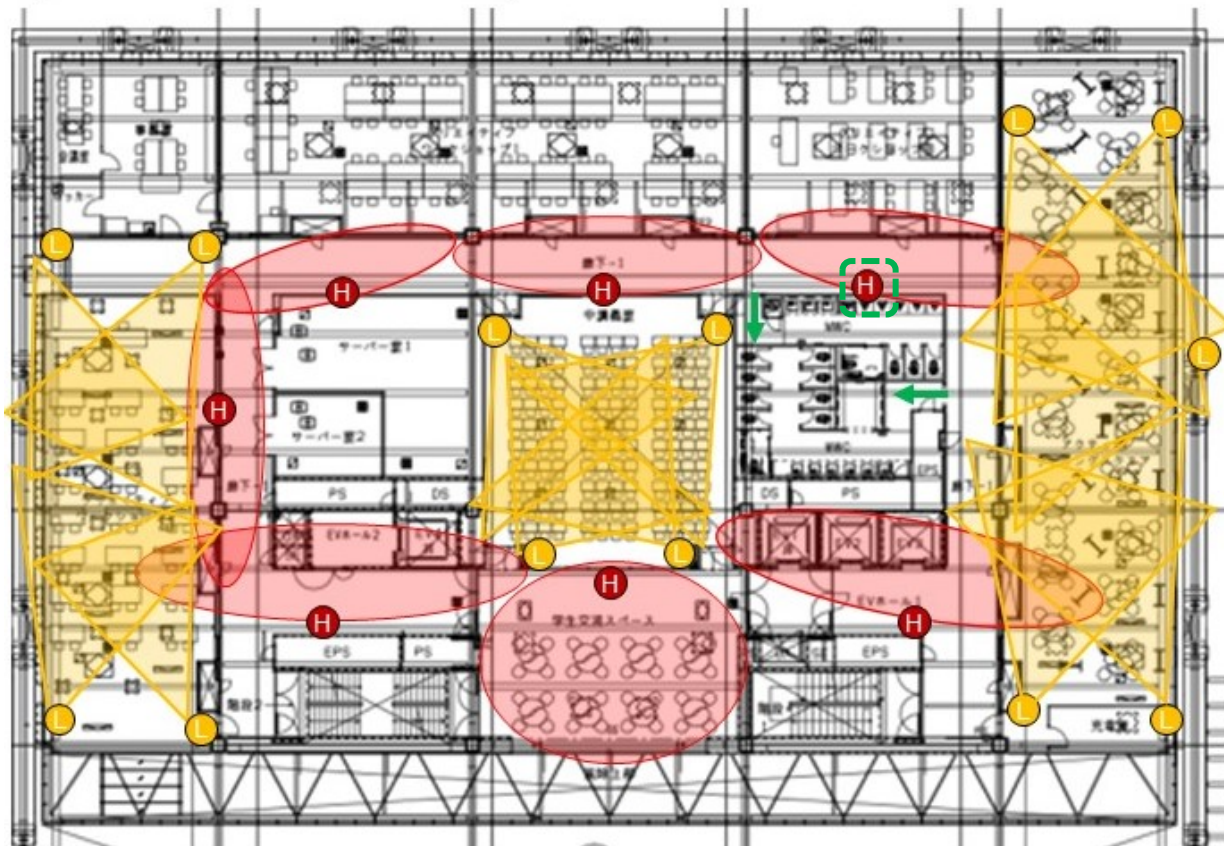


# 4F Person Flow Sensor/Thermoimager Installation Drawing, Installation Location

## 4F 人流センサー設置案

toilet consideration  
installation by トイレ入口

(Di-CHILD installed)



**L** Livox Avia  
中講義室4台  
HALC 5台  
SALC 4台  
(計13台)

**H** Hokuyo YVT-35LX  
廊下6台  
交流スペース 1台  
(計7台)  
6月末 納期分10台のうち  
7台使用



# 4F Person Flow Sensor/Thermoimager Installation Drawing, Installation Location

## 4F サーモイメージャ・DEPTHカメラ配置案

(Di-CHILD installed)

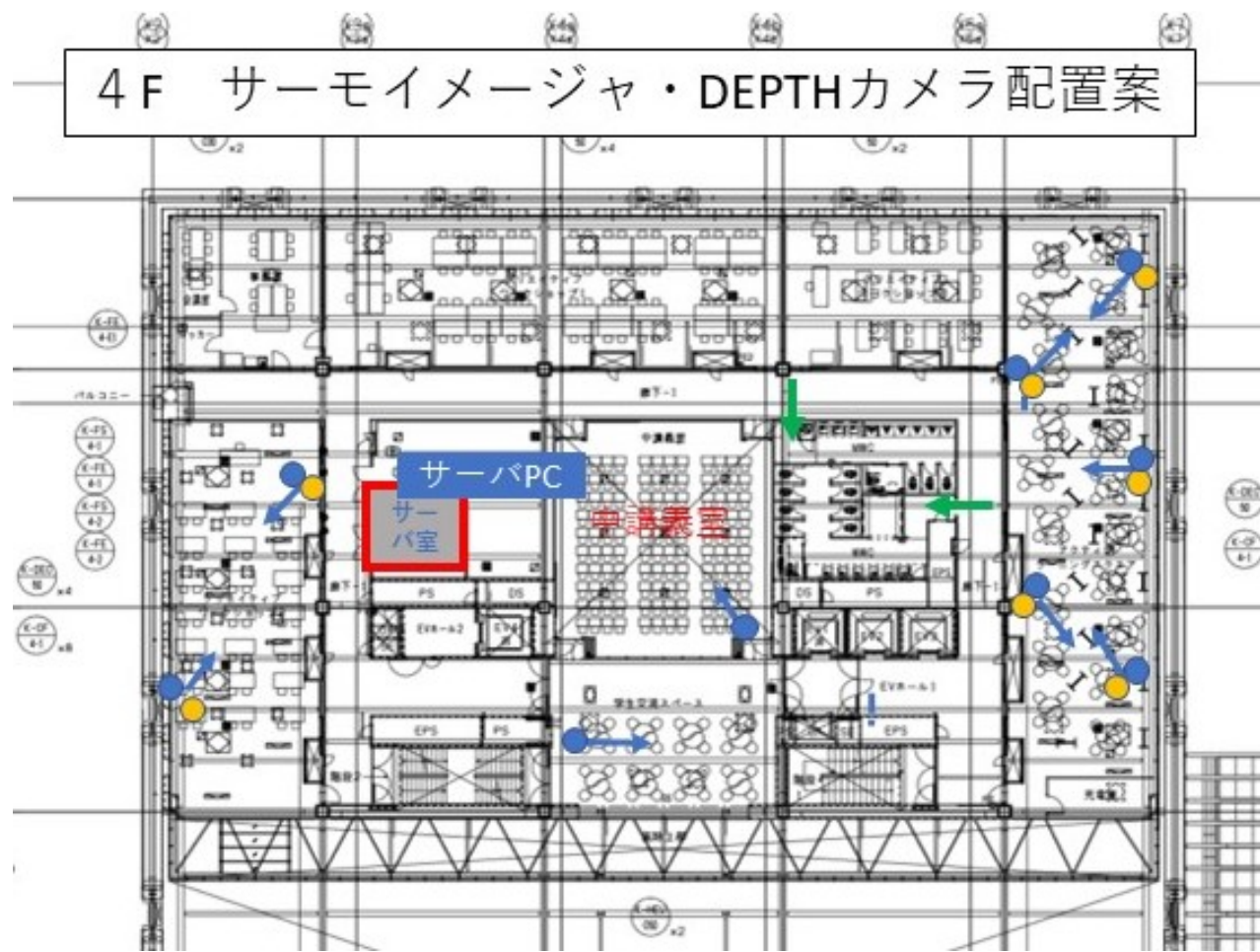
← Toilet entrance

●  
thermoimager

9 units

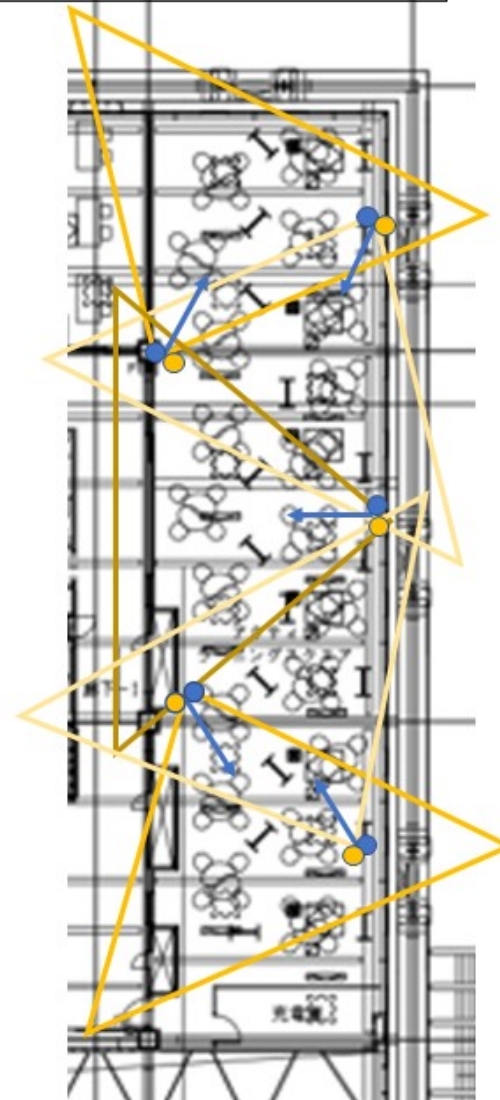
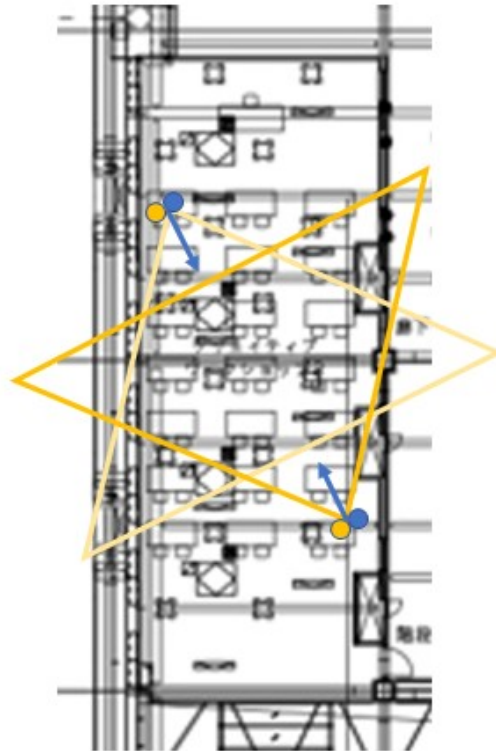
●  
DEPTH camera

7 units



# 4F Person Flow Sensor/Thermoimager Installation Drawing, Installation Location

4 F SALC/HALCでのサーモイメージャー、DEPTHカメラ配置詳細図 (Di-CHiLD設置)



4F 中講義室でのLidar・サーモイメージャー設置イメージ

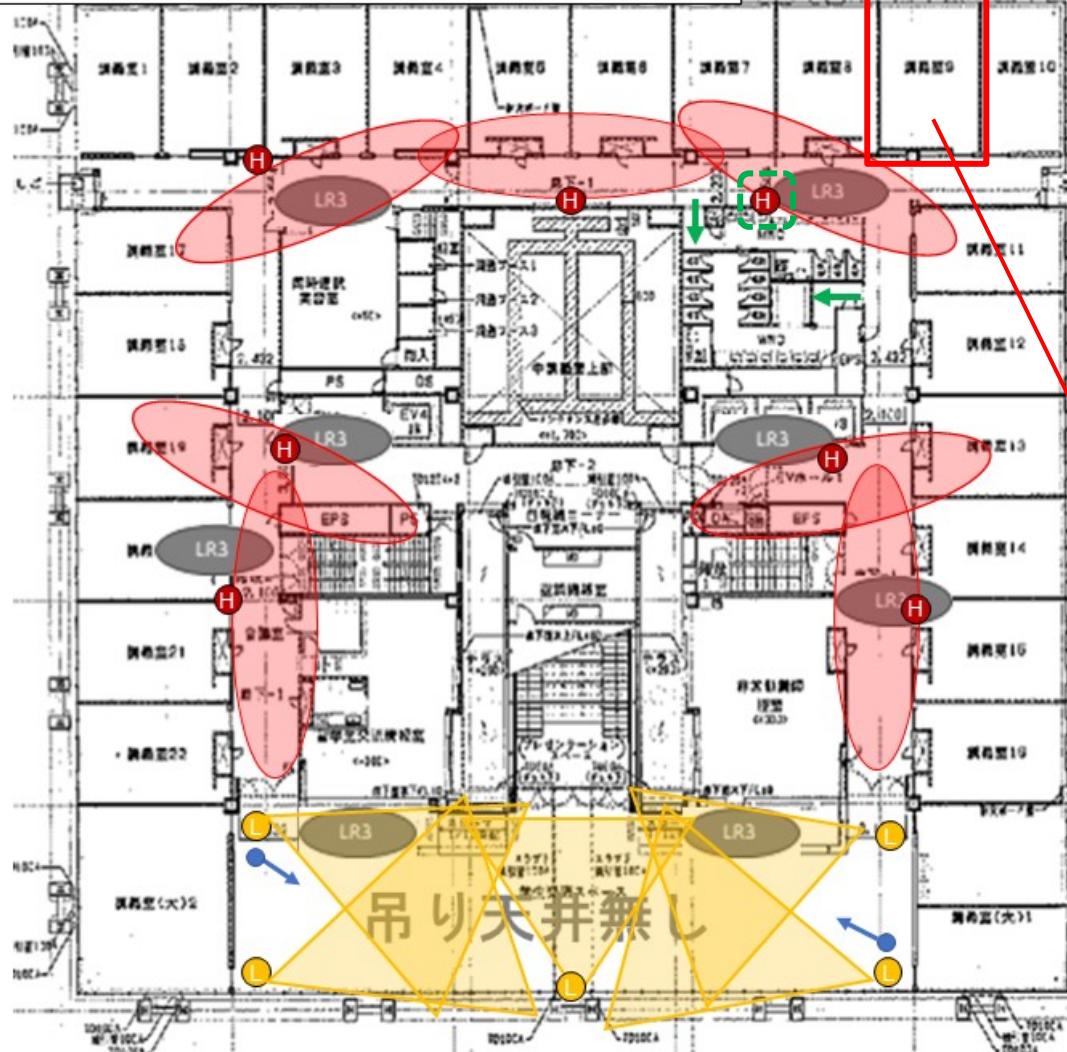


4F SALCでのLidar・サーモイメージャー・DEPTHカメラ設置イメージ



# 5F Human Flow Sensor/Thermoimager Installation Drawing, Installation Location

5F 人流センサ・サーモイメジャー設置位置



← トイレ入口

toilet consideration  
installation by

(Society 5.0設置)

● Livox Avia  
交流スペース 5台

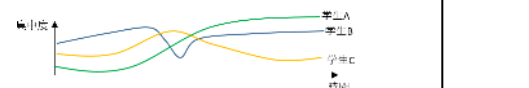
● Hokuyo YVT-35LX  
廊下7台

(Di-CHILD設置)

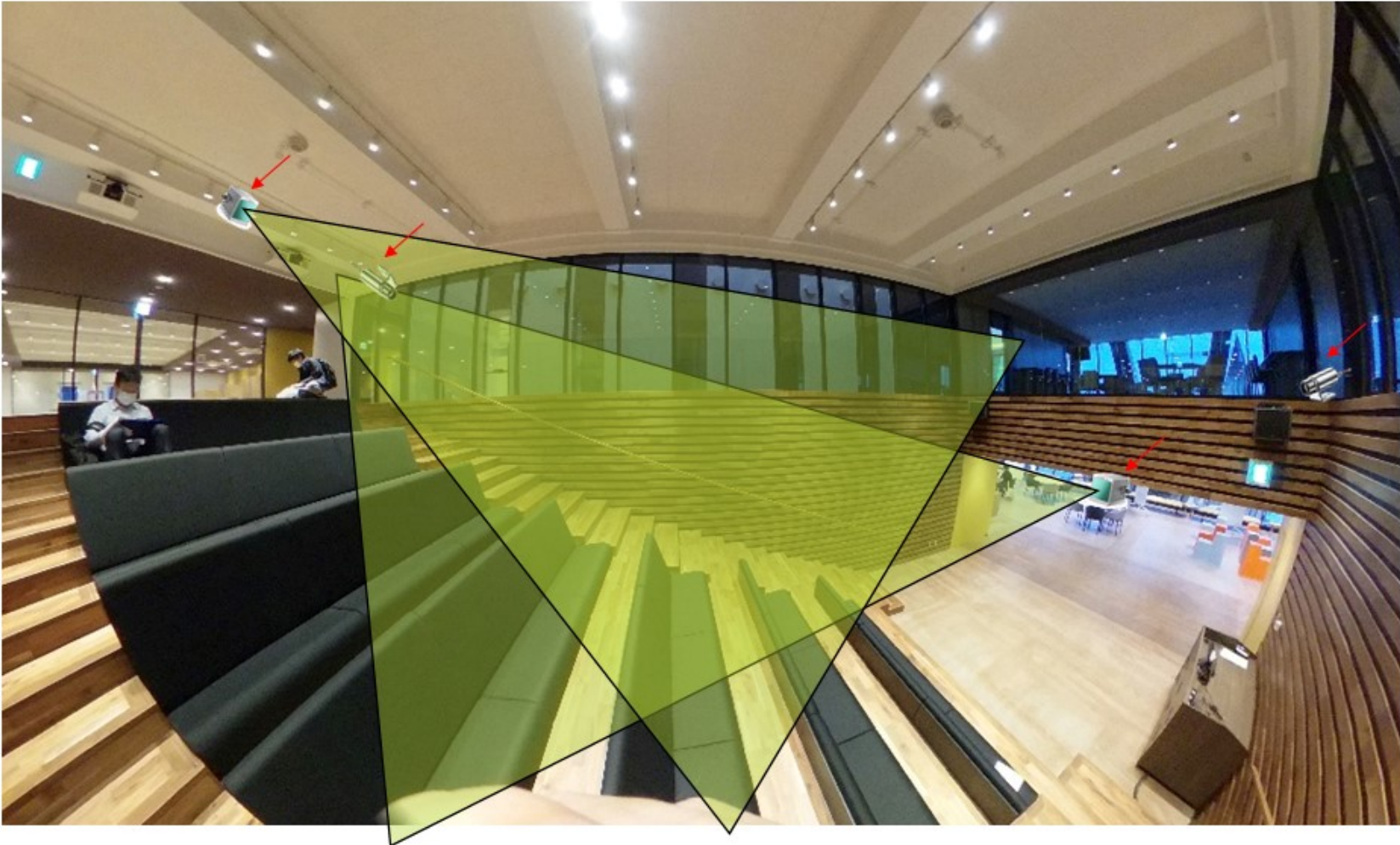
● サーモイメジャー  
交流スペース 2台

Demonstration experiment 5  
Consent/Personal  
Information Available

511 rooms  
of students during lectures  
On the centralization  
visualization theme  
Planned to be implemented.



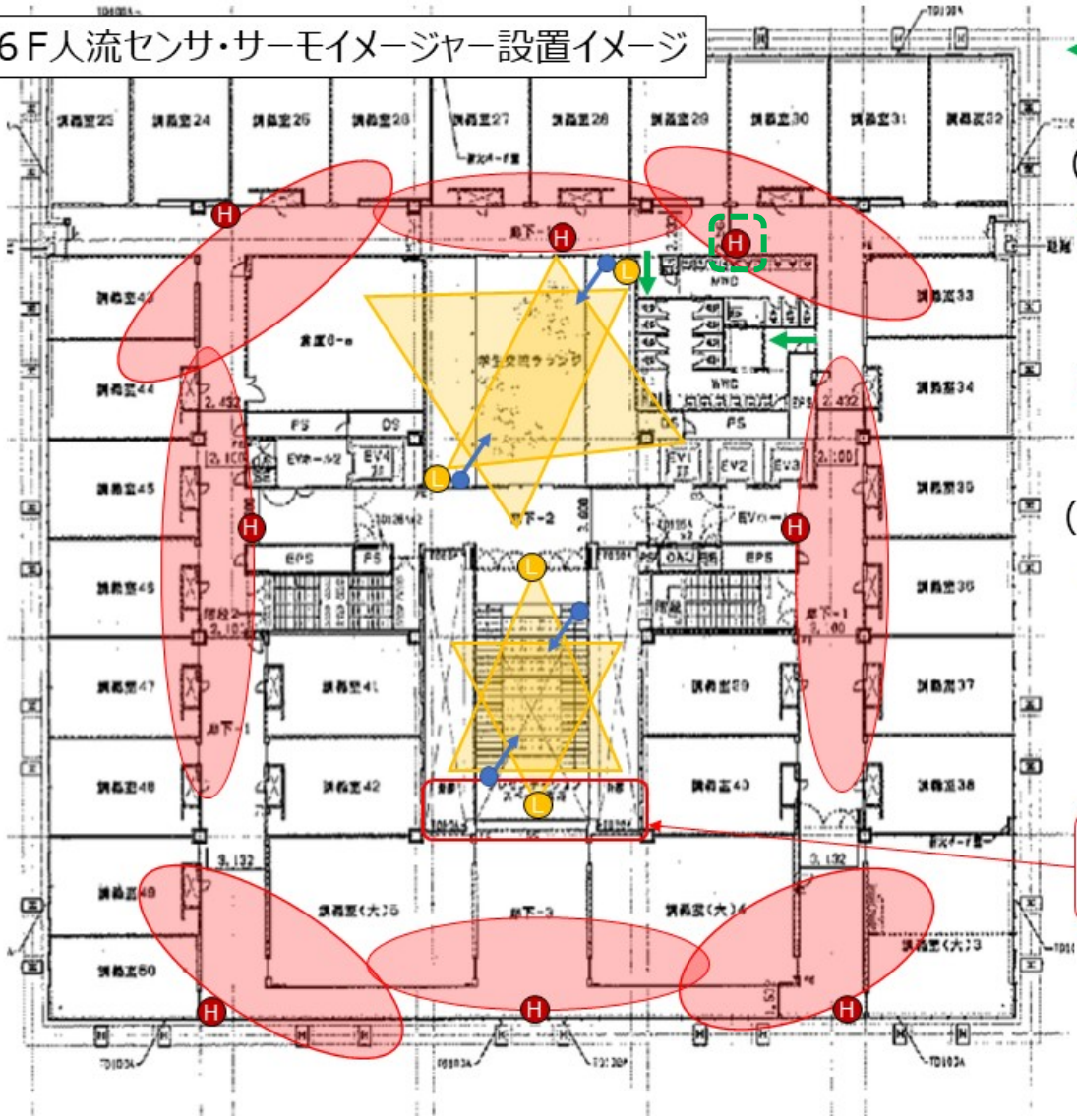
5- 6F プレゼンスペースでのLidar・サーモイメージャー設置イメージ





# 6F Person Flow Sensor/Thermoimager Installation Drawing, Installation Location

6F人流センサ・サーモイメジャー設置イメージ



← トイレ入口    toilet consideration installation by

(Di-CHILD設置)

**L Livox Avia**  
 学生交流ラウンジ 2台  
 プレゼンスペース 2台  
 (計4台)

**H Hokuyo YVT-35LX**  
 廊下8台

(Di-CHILD設置)

**● サーモイメジャー**  
 学生交流ラウンジ  
 プレゼンルーム  
 4台

6F側からプレゼンテーション  
 ペースに向けて設置



## 6F 学生交流ラウンジでの人流センサ・サーモイメージャ設置イメージ

