Development of power self-sufficiency system

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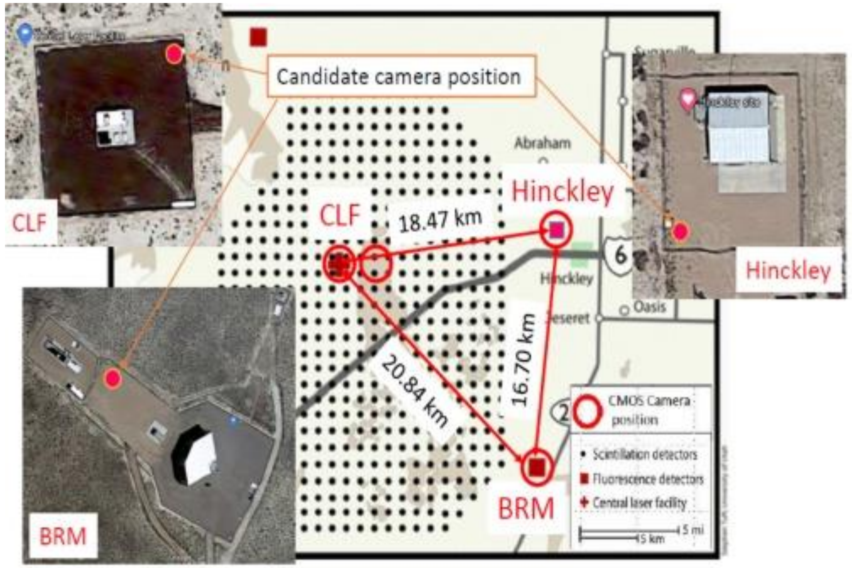
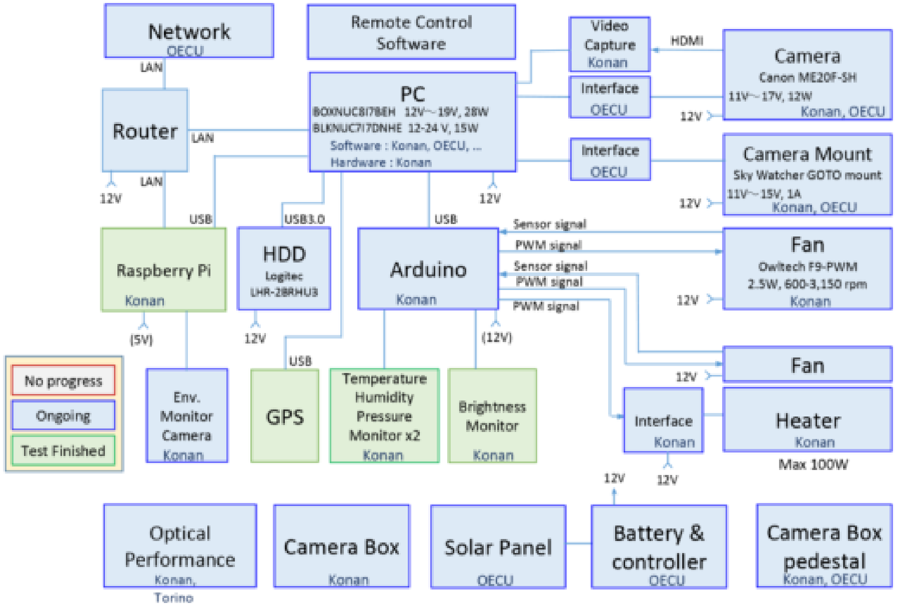
Research background DIMS experiment observation equipment

- Observation equipment will be installed in each of CLF, BRM, and Hinckley.
- CLF has no power source.
- Power self-sufficiency system needs to be installed in CLF.



Installation location in Utah, USA



Wiring diagram of observation equipment

Purpose of research

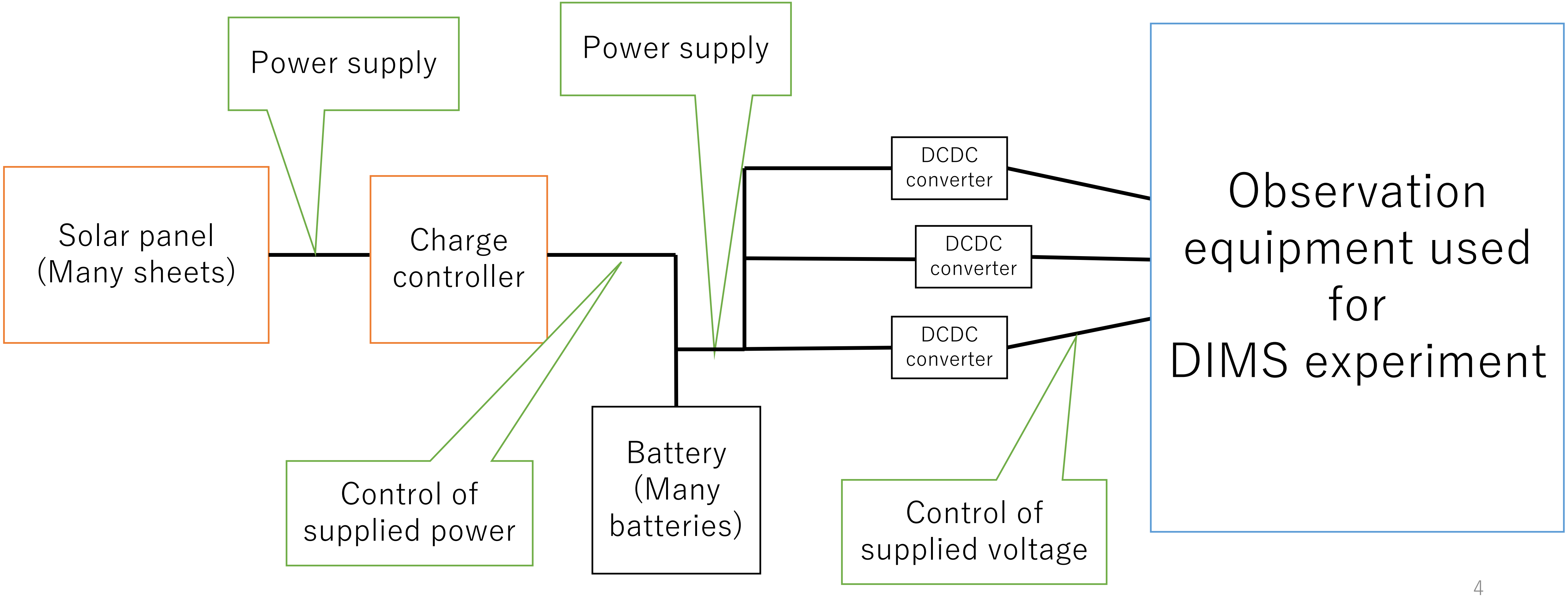
<Research>

- I’m developing power self-sufficiency system that can be permanently installed in Utah, USA.

<Purpose>

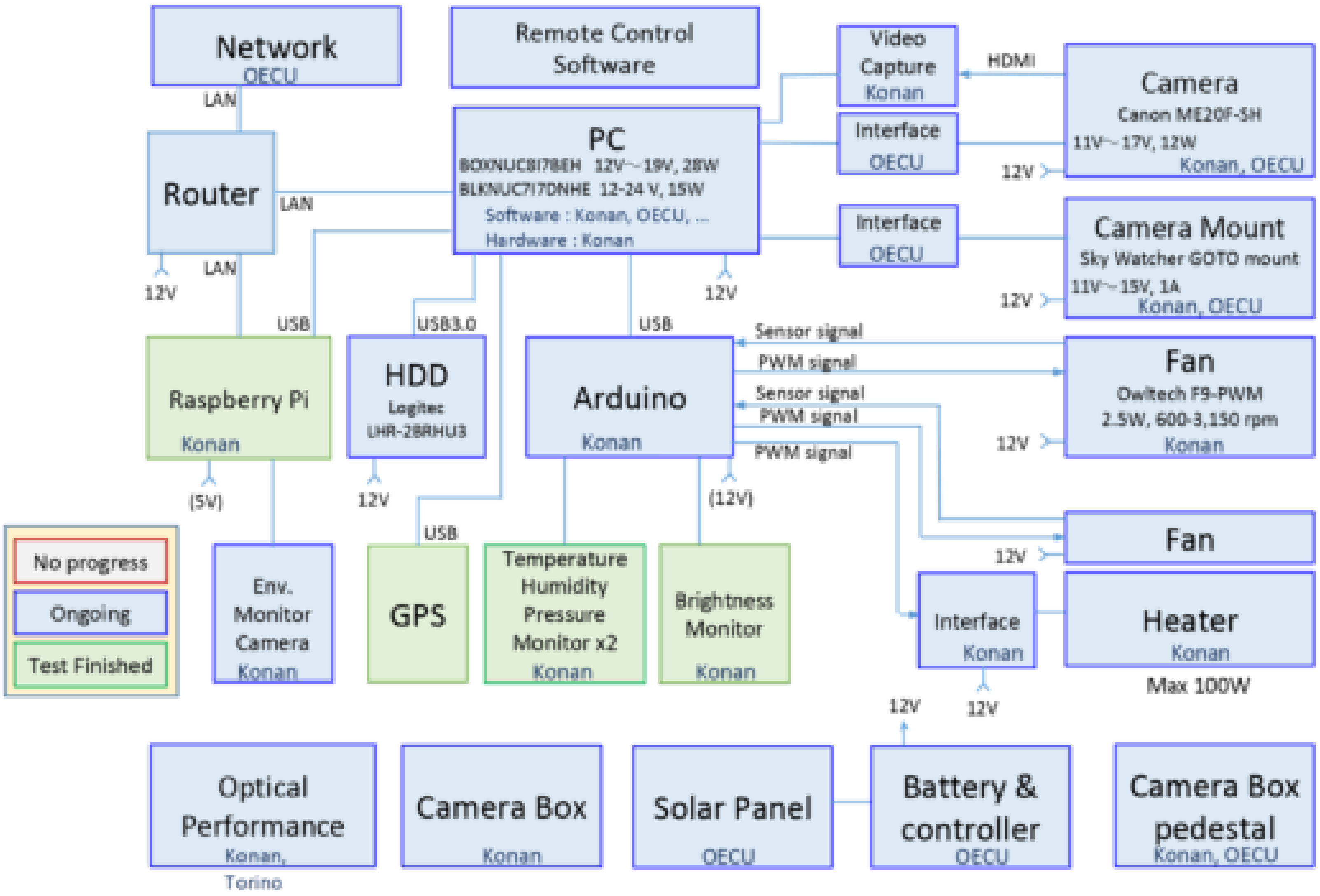
- Search for Nuclearite.

Overview of power self-sufficiency system



Observation equipment for DIMS experiment

- This wiring diagram is the equipment to be used in DIMS experiment.



Wiring diagram of observation equipment

Power required for DIMS experiment

Table 1: Power list for DIMS experiment

Equipment	Voltage tolerance (V)	Power consumption (W)
Raspberry Pi 3 Model B		2.0W
Router		about 6～18W
Buffalo LSW6-GT-5EPL(Switching hub)		3.3W
BLKNUC7I7DNHE(PC)	12～24V	15W
Logitec LHR-2BRHU3(HDD)	DC+12V	36W
Seagate ST12000VN0008(HDD)		7.8W
Seagate ST12000VN0009(HDD)		7.8W
BU-353S4(GPS)	3.0～5.0V	0.3W
Arduino(Uno R3)	6～20V(recommended value7～12V)	0.6W
Canon ME20F-SH(Camera)	11～17V	12W
Sky Watcher GOTO mount(Camera Mount)		
OwltechF9-PWM(Fan)	4.5～13.8V	2.5W
OwltechF6-PWM(Fan)		1.92W
PTC heater		100W
total		195.22～207.22W

- It was operated equipment in the table by batteries and solar panels.
- It is necessary to decide whether the power supply voltage is 12V system or 24V system.

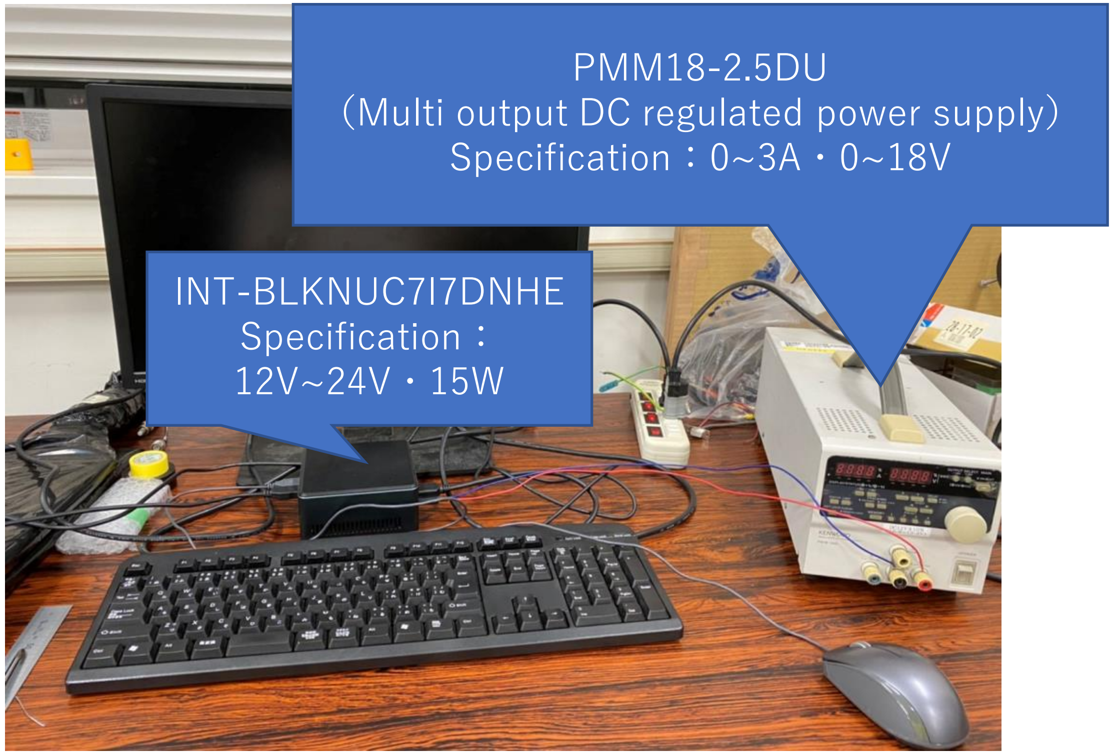
Measurement of voltage at which the PC operates stably

<Purpose>

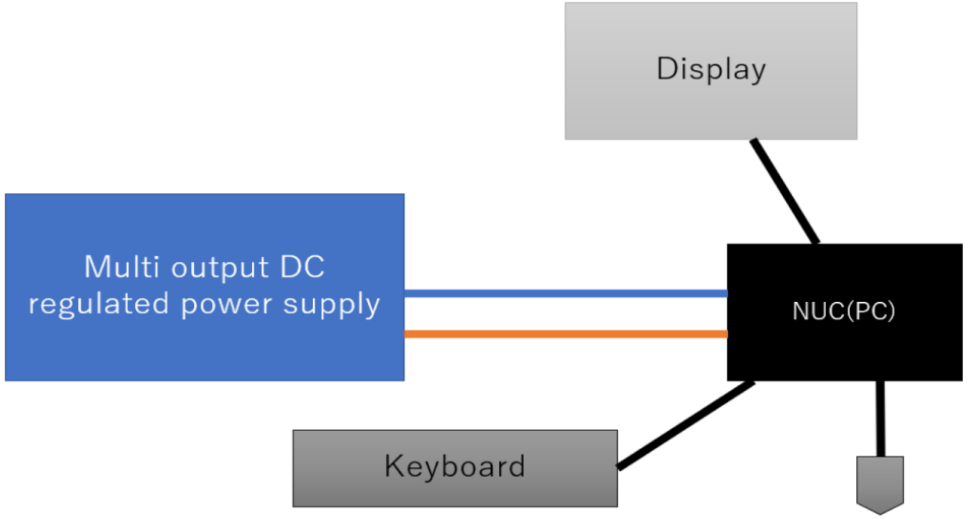
- Determination of the using battery voltage.
- It measure the lowest voltage that the PC(BLKNUC7I7DNHE) can always use.

<Measuring method>

- The output voltage of the multi output DC regulated power supply is reduced at regular intervals.
- I recorded the voltage and current output each time, and grasped the voltage and current when the power of the PC was turned off.



PC voltage measurement



Wiring diagram for PC voltage measurement

Measurement of voltage at which the PC operates stably

Table 2: When starting with an operating voltage of 18.45V

Voltage[V]	Change in current[A]	Time[minutes]	Was it working
18.44	0.1～0.5	5	○
17.44	0.2～0.5	1	○
16.44	0.2～0.5	1	○
15.44	0.2～(MAX)1.5	1	×

Table 3: When starting with an operating voltage of 17.45V

Voltage[V]	Change in current[A]	Time[minutes]	Was it working
17.44	0.1～0.5	5	○
16.44	0.1～0.4	1	○
15.44	0.2～0.5	1	○
14.44	0.2～(MAX)1.5	1	×

Table 4: When starting with an operating voltage 16.45V

Voltage[V]	Change in current[A]	Time[minutes]	Was it working
16.44	2.7	0	×

Table 5: When focusing on time

Voltage[V]	Time[minutes]	Was it working
18.44	10	○
17.44	1	○
16.44	1	×

<Result>

- The result was different from the PC specifications.
- In Table 5, I focused on the operating time of the PC, but it was not particularly relevant.

<Consideration>

- There may be a problem with the DC plug or wire that connects the PC to the power supply.
- It is possible that the current of the PC was stronger than expected and the power supply could not withstand.

Measurement of voltage at which the PC operates stably

- The power supply, lead wire, and DC plug were changed to those that can handle high output currents, and the same experiment as last time was conducted.

Multi output DC regulated power supply

GPR-1820HD
（Multi output DC regulated power supply）
Specification：0~18V・0~20A

Measurement of voltage at which the PC operates stably

Table 6: When starting with an operating voltage of 18V

Voltage[V]	Change in current[A]	Time[minutes]	Was it working
(Operating)18.00	0.2〜2.2	10	○
17.00	0.2〜1.6	1	○
16.00	0.2〜0.6	1	○
15.00	0.3〜0.6	1	○
14.00	0.3〜0.9	1	○
13.00	0.3〜0.5	1	○
12.00	0.3〜0.5	1	○
11.00	0.3〜0.7	1	○
10.00	0.4〜0.7	1	○
9.00	0.4〜1.0	1	○
8.00	0.4〜1.0	1	○
7.00	0.5〜1.0	1	○
6.00			×

Table 7: When the voltage that starts the PC is changed every time

Operating voltage[V]	Change in current[A]	Time[minutes]	Was it working
17.00	0.3〜2.6	5	○
16.00	0.2〜2.8	5	○
15.00	0.2〜3.0	5	○
14.00	0.2〜3.2	5	○
13.00	0.3〜3.5	5	○
12.00	0.3〜3.7	5	○
11.00	0.3〜4.1	5	○
10.00	0.3〜4.6	5	○
9.00			×

Table 8: Start with the rated voltage of the PC of 12V and lower the voltage every hour

Voltage[V]	Time[minutes]	Was it working
12.00	3	○
10.00	3	○
9.00		×

<Result>

- This time the result was as expected.
- It turned out that if the operating voltage of the PC is at least 10V, it can operate without problems.

<Consideration>

- When the PC is started at 12V or less, the output current value becomes large, so the 24V system has less anxiety.

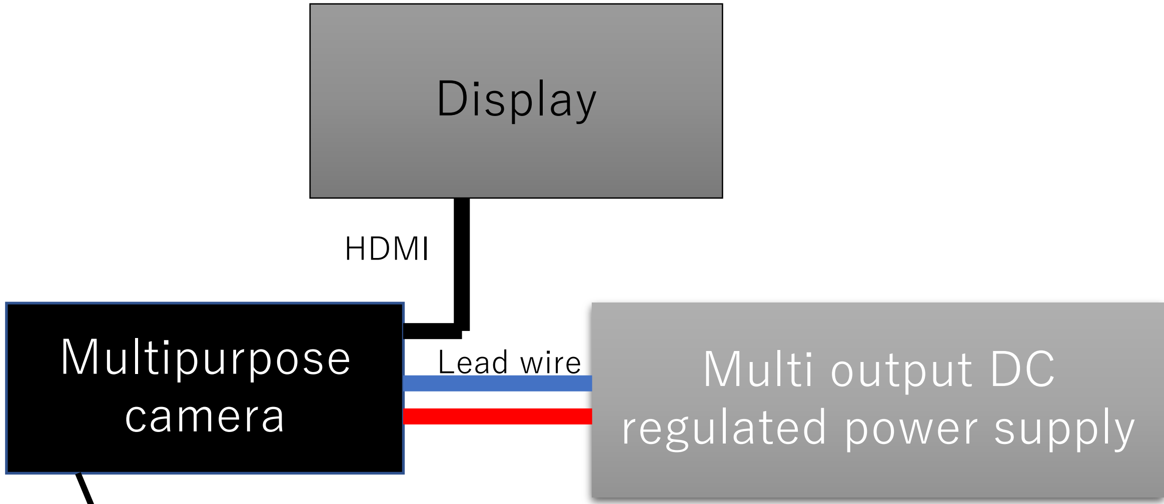
Multipurpose camera power measurement

<Purpose>

- The voltage to be stepped down and distributed by the DCDC converter is determined by grasping the power of the multipurpose camera.

<Measuring method>

- The output voltage of the multi output regulated power supply is reduced at regular intervals within the permissible range of the multipurpose camera.
- I recorded the voltage and current output each time to see if the multipurpose camera works as specified.



Wiring diagram for power measurement of multipurpose camera

Model number :
ME20F-SH
Specification :
11V~17V・12W

Multipurpose camera power measurement

<Result>

- The result was as specified by the multipurpose camera.
- In Table 9, the current value increased a little at startup, but it was stable after that.

<Consideration>

- This time, I just started the multipurpose camera and did not shoot.
- It is thought that the current value rises a little when shooting with a multipurpose camera.
- Since the dedicated connection jack is rated at 1A, the voltage of the multipurpose camera is considered to be 14V, which allows shooting of meteors without anxiety.
- 24V system is required for power self-sufficiency system!

Table 9: When starting with an operating voltage of 16V and gradually lowering the voltage

Voltage[V]	Current[A]	Time[minutes]
16.00	0.7	2
15.00	0.7	1
14.00	0.8	1
13.00	0.8	1
12.00	0.9	1
11.00	1.0	1

Table 10: When starting with an operating voltage of 15V and lowering the starting voltage each time

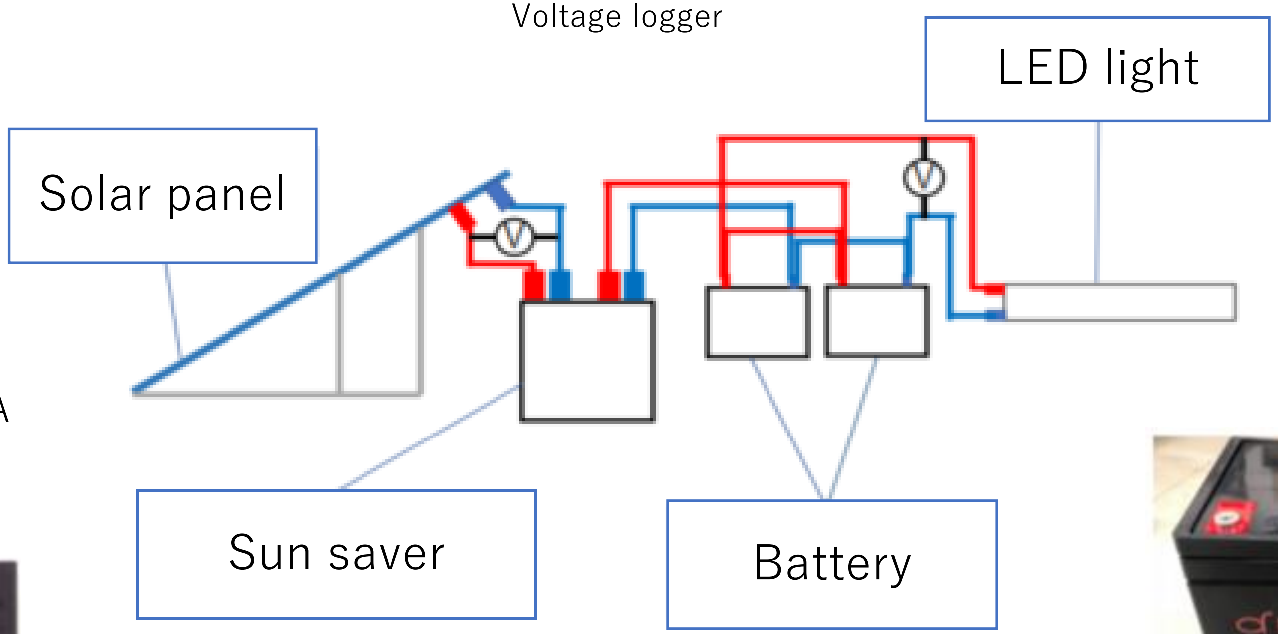
Starting voltage[V]	Current[A]	Instantaneous maximum current[A]	Time[minutes]
15.00	0.7		1
14.00	0.8	0.9	1
13.00	0.9	1.0	1
12.00	0.9	1.0	1
11.00	1.0	1.2	1

Operation test of power self-sufficiency system (Overview)

Model number：KC125TJ
Specification：125W・17.4V・7.2A

Voltage logger

Specification：12V・36W



Model number：SS-20L

Model number：JR100-12
Specification：12V・100Ah（10 hour rate）

Operation test of power self-sufficiency system

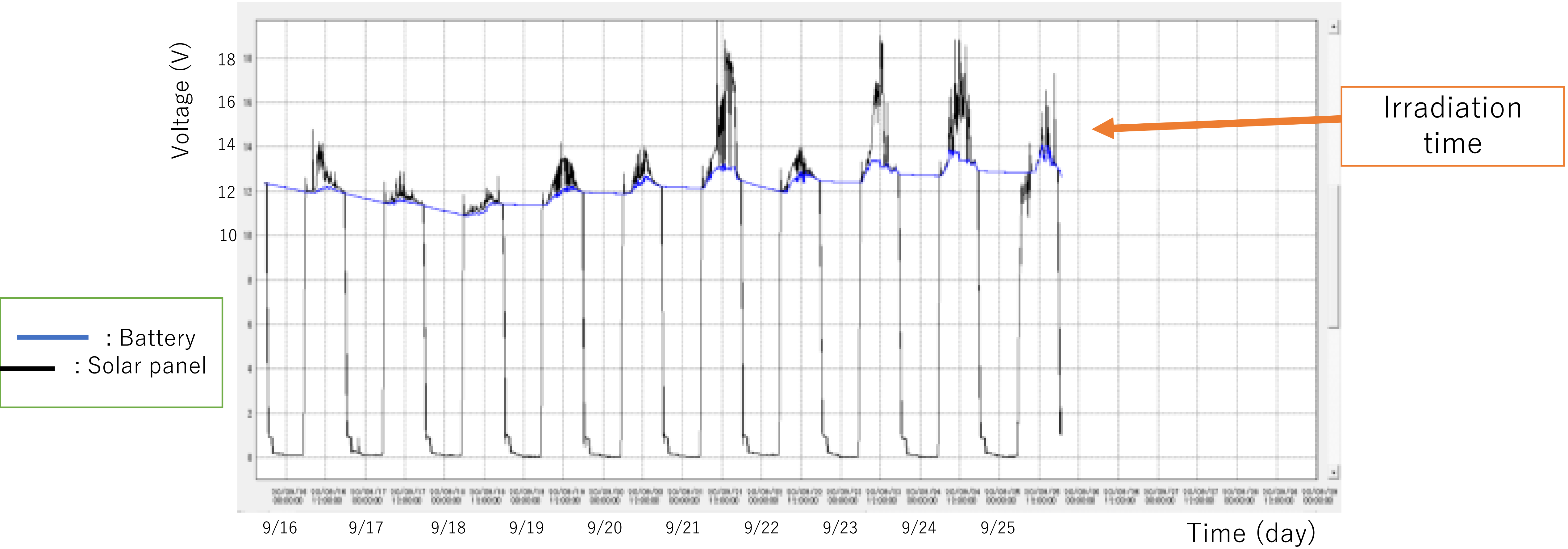
<Purpose>

- Use LED lights as a substitute for the equipment used in the DIMS experiment and check if the power self-sufficiency system can operate normally.

<Test method>

- It install the power self-sufficiency system in a place with good sunlight.
- A voltage logger is used to measure changes in the voltage of the solar panel and battery every minute.
- It measure for 7 days and check if the power self-sufficiency system is operating normally from changes in voltage.

Operation test of power self-sufficiency system



Battery and solar panel voltage changes

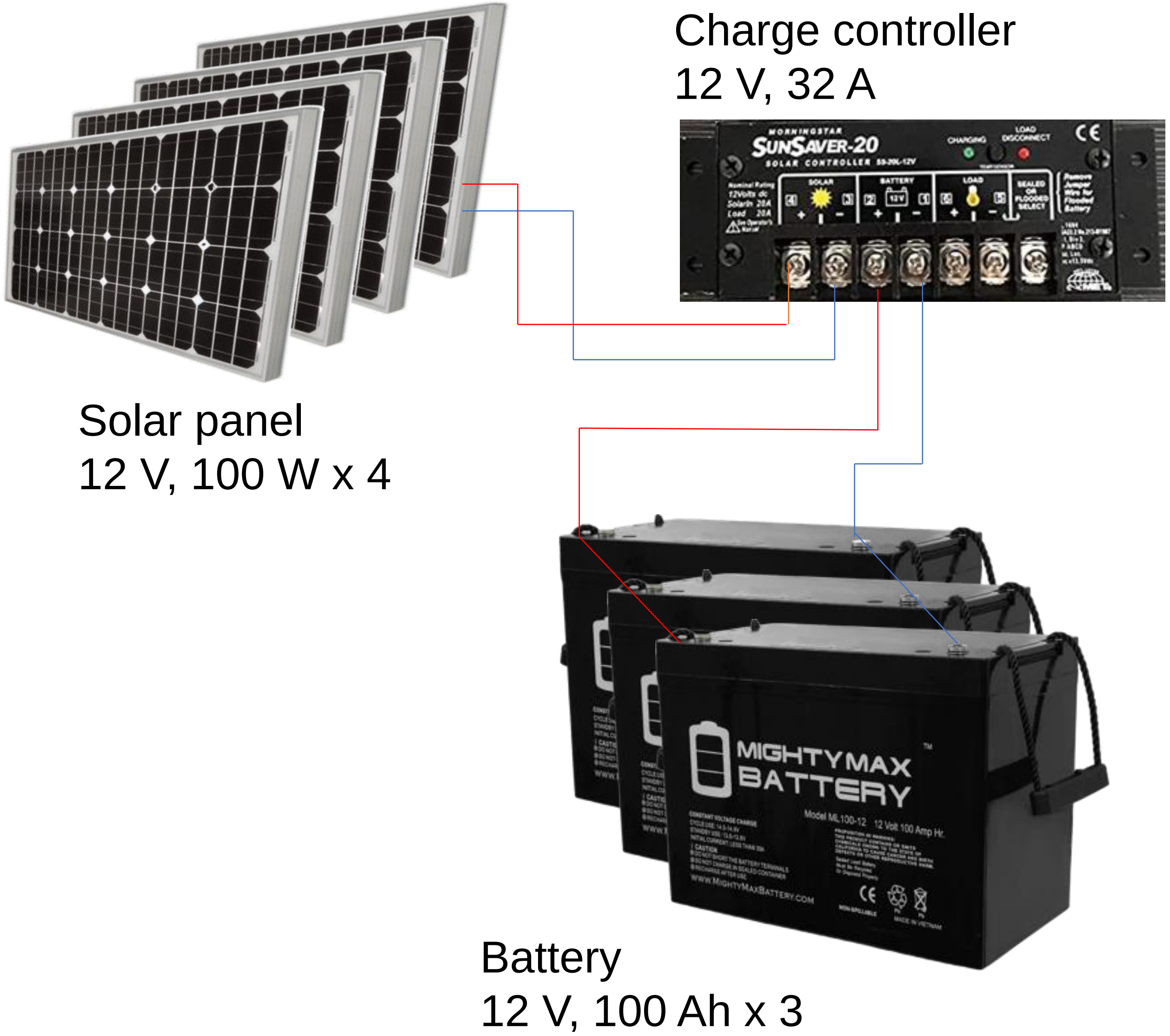
<Result>

- It turned out that the power self-sufficiency system was operating normally.
- Since the battery voltage rises when the solar panel voltage is increasing, it can be seen that it is operating without problems.

Summary

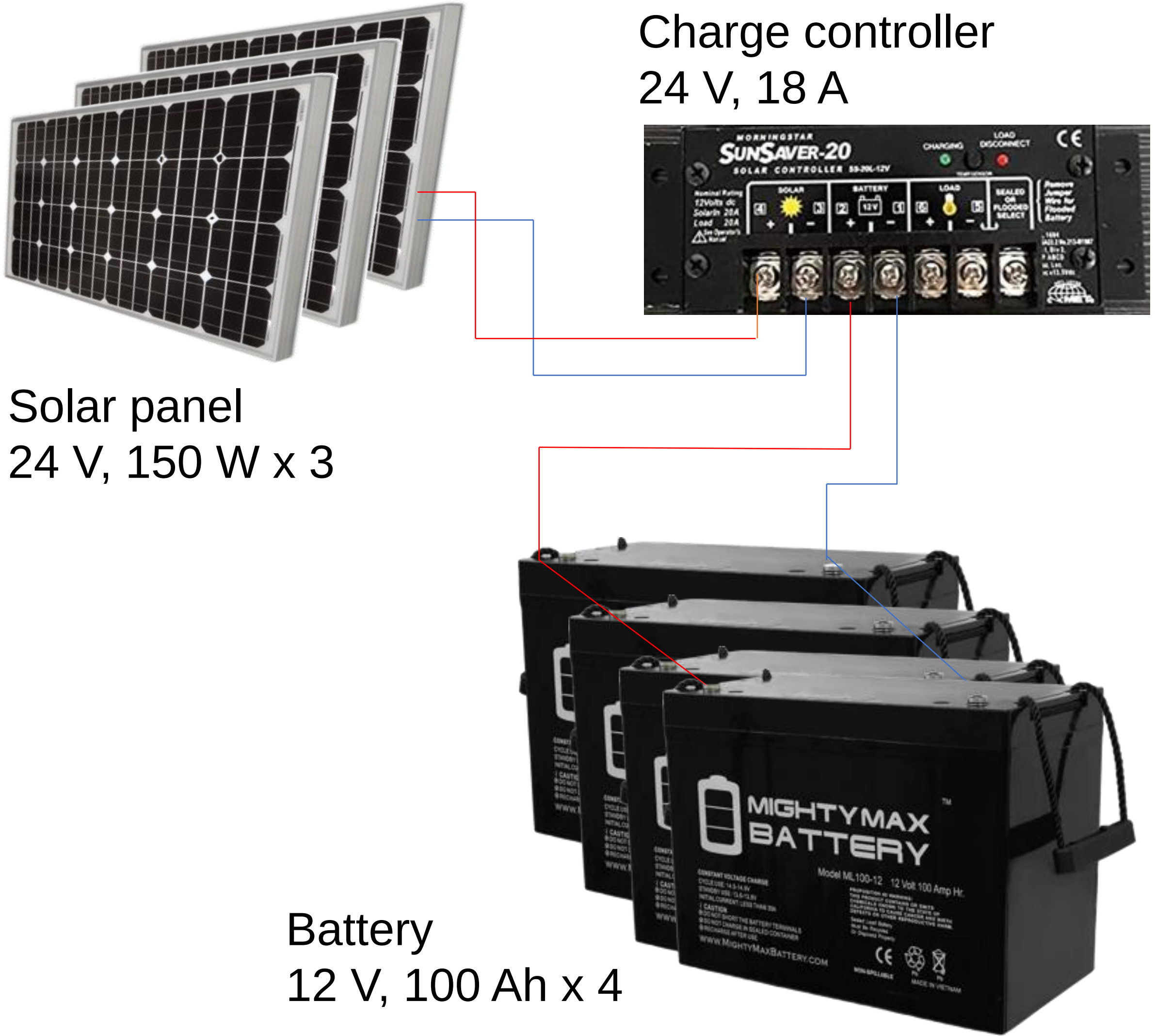
- We are developing a power self-sufficiency system that can be permanently installed at in CLF.
- We grasped the power of the equipment of the power self-sufficiency system.
- We checked the operation of the power self-sufficiency system.

Power self-sufficiency system (1) for the heater



- Power consumption of the heater is 100W
- Requirement
  - Batteries should be charged in a day (8h)
  - Capability of 3 days operation of 10h without charge
  - Power consumption is 3,000 Wh = 100W x 10h x 3
- Batteries (12 V, 100 Ah, deep cycle)
  - Total capacity is 250Ah = 3,000Wh / 12V
  - Three batteries will be enough.
- Solar panels (12V, 100W)
  - Charge current is 8A = 100W / 12V
  - 4 panels with parallel-connection
  - 4 ~ 250Ah / (8A x 8h)
- Charge controller
  - 12 V, 32 A

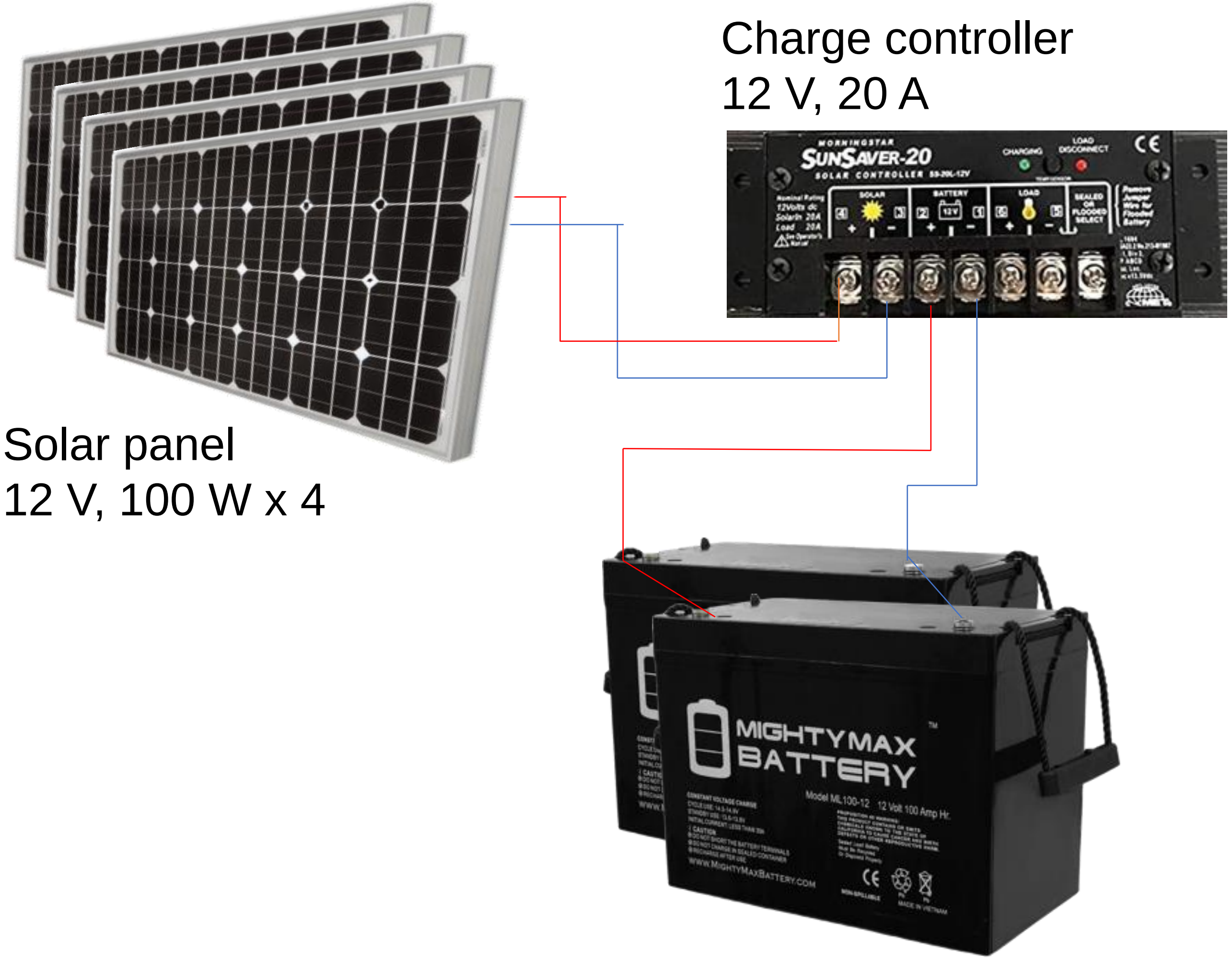
Power self-sufficiency system (2) for the PC and camera, HDD



- Power consumption of the PC and camera, HDD are 63W
- Requirement
  - Batteries should be charged in a day (8h)
  - Capability of 3 days operation of 10h without charge
  - Power consumption is 1,890 Wh = 63W x 10h x 3
- Batteries (12 V, 100 Ah, deep cycle)
  - This connects 12V batteries in series.
  - Total capacity is 135Ah = 1,890Wh / 14V
  - Four batteries will be enough.
- Solar panels (24V, 150W)
  - Charge current is 6A = 150W / 24V
  - 3 panels with parallel-connection
  - 3 ~ 135Ah / (6A x 8h)
- Charge controller
  - 24 V, 18 A

Power self-sufficiency system (3) for remaining equipment

Charge controller
12 V, 20 A



Solar panel
12 V, 100 W x 4

Battery
12 V, 100 Ah x 2

- Power consumption of remaining equipment is 47W
- Requirement
  - Batteries should be charged in a day (8h)
  - Capability of 3 days operation of 10h without charge
  - Power consumption is 1,410 Wh = 47W x 10h x 3
- Batteries (12 V, 100 Ah, deep cycle)
  - Total capacity is 118Ah = 1,410Wh / 12V
  - Two batteries will be enough.
- Solar panels (12V, 100W)
  - Charge current is 4A = 47W / 12V
  - Four panels with parallel-connection
  - 4 ~ 118Ah / (4A x 8h)
- Charge controller
  - 12 V, 16 A

What to do and research plan

<What to do>

- Development of power self-sufficiency system using a DCDC converter.
- I perform a shooting test with a multipurpose camera.
- We make a total of three power self-sufficiency system.
- Actually I perform a meteor observation test in Japan using a power self sufficiency system.
- A power self-sufficiency system will be installed in CLF to analyze meteors and Nuclearite based on observation data.

<Research plan>

2020 **~December**	**2021** **January**	**2021** **February**
Operation check and completion of power self-sufficiency system	Test of meteor observation using a power self-sufficiency system in Japan	・Modification of power self-sufficiency system ・Analysis of data acquired by meteor observation