The HF-Radiometer in active mode

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Jon Buchli

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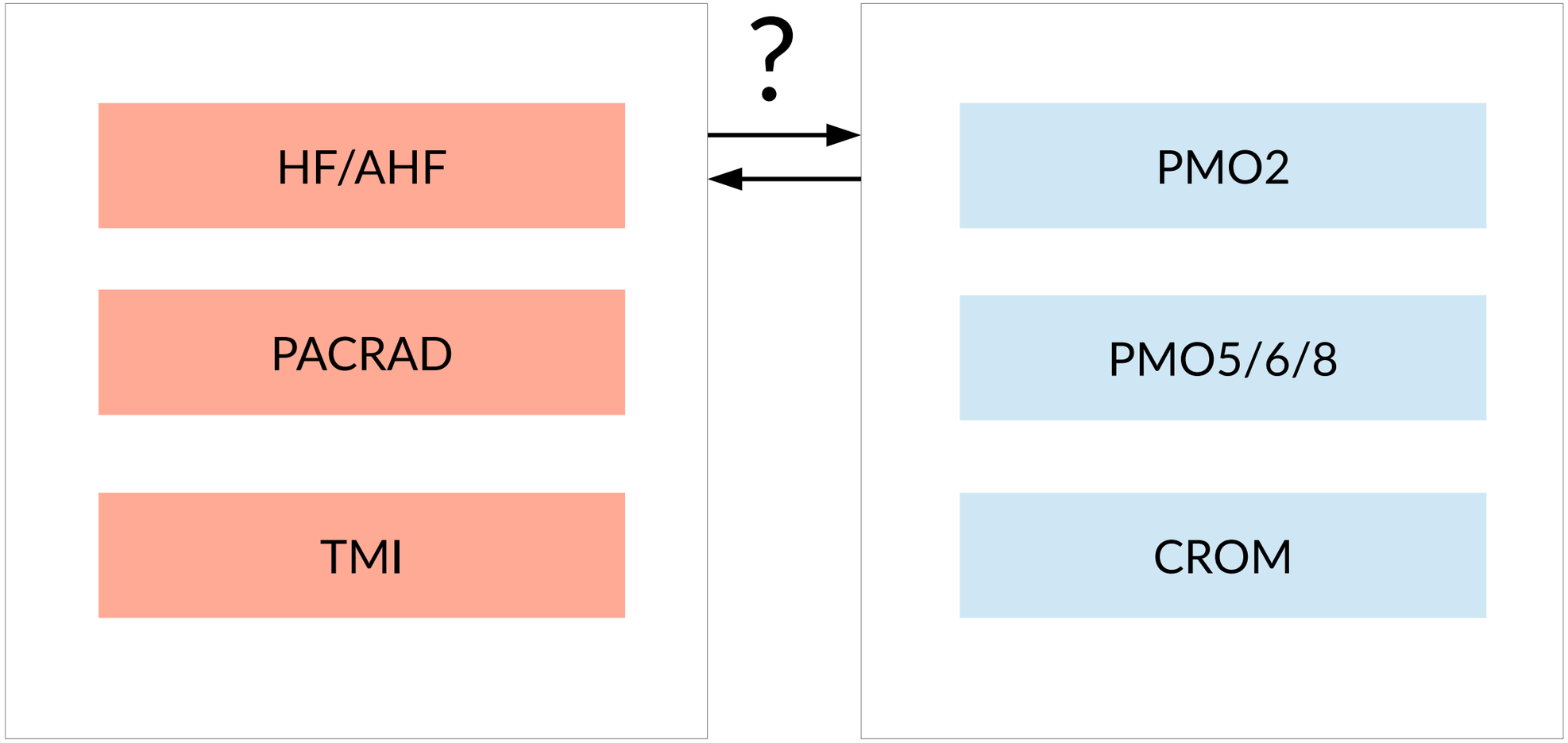
Passive and Active Radiometers



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Operation Modes of the HF

Extract from the HF-Manual:

Mode 1: PACRAD Mode

Front heater is set to a fixed level close or equal to the solar irradiance level. The thermopile output for the solar input and power input are sensed sequentially. This is the customary operational mode.

Mode 2: Passive Angstrom Mode

The rear heater is set to a level close to the power equivalent of the solar irradiance on the front cavity. With the front cavity irradiated, the thermopile signal is either continuously brought to null by varying rear heater power or the deviations from null for a set power level are recorded.

Mode 3. Thermopile Mode

With the pyrheliometer tracking the sun the thermopile output is monitored as a function of time. The front cavity sensitivity is applied to the readings to calculate irradiance.

Mode 4:* Active Front Cavity Mode

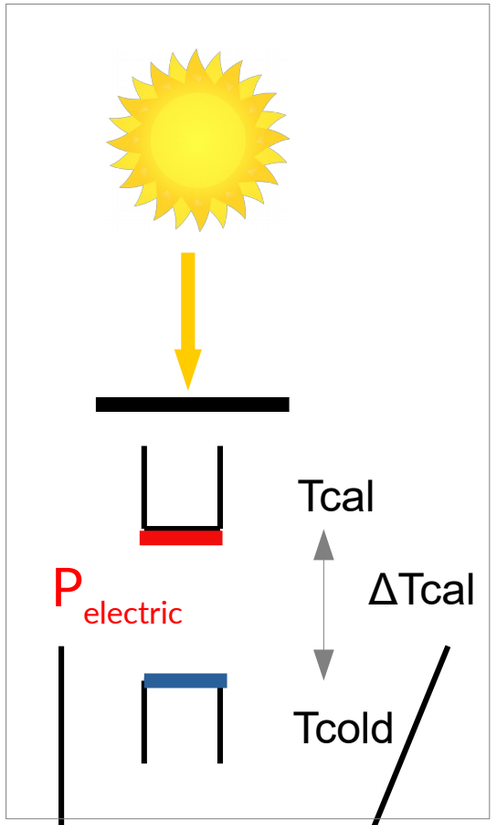
The front heater level is pre-set to a power higher than the expected irradiance equivalent. The thermopile output is employed to automatically adjust the power level using servo or other control techniques to the pre-set level. The power is continuously monitored. The difference in power required to reach the pre-set level during irradiation and shuttering is the power equivalent of the incident solar irradiance.

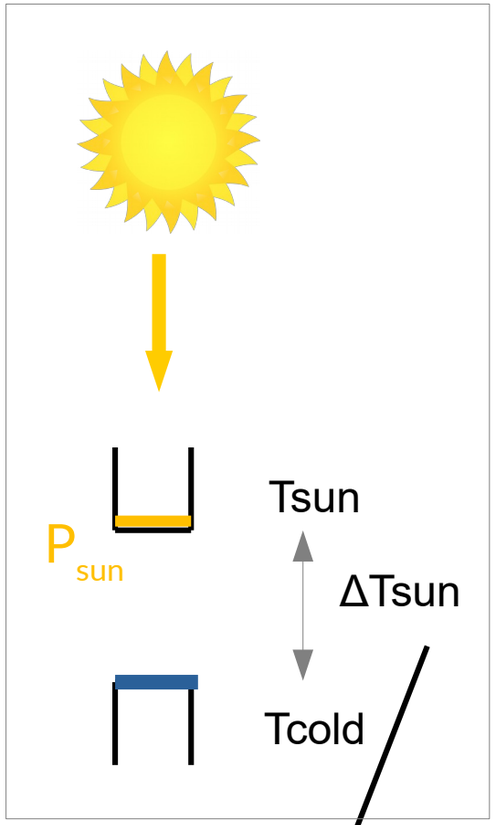
Mode 5:* Active Angstrom Mode

The rear heater is servo controlled to attain a null thermopile signal. The power to achieve null is monitored and is equivalent to the solar irradiance on the front cavity adjusted for imbalance. No shuttering is required in this mode.

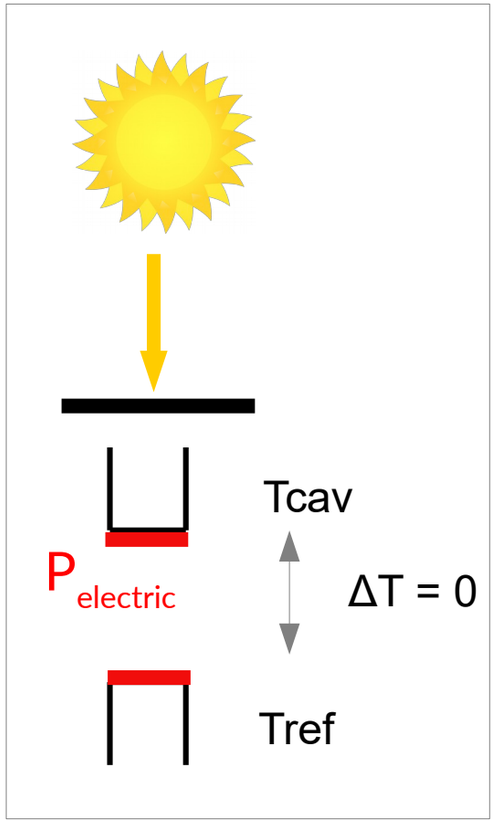
*Active modes are not possible with Model 405 radiometer control unit.

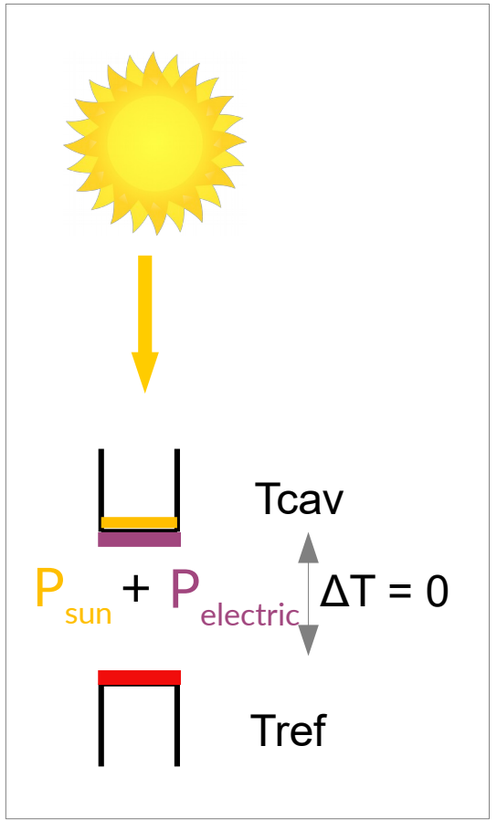
Passive and Active Mode





$$P = k * V(\Delta T) \longrightarrow P_{sun} = k * V(\Delta T_{sun})$$





$$P_{electric} = (P_{sun} + P_{electric})$$

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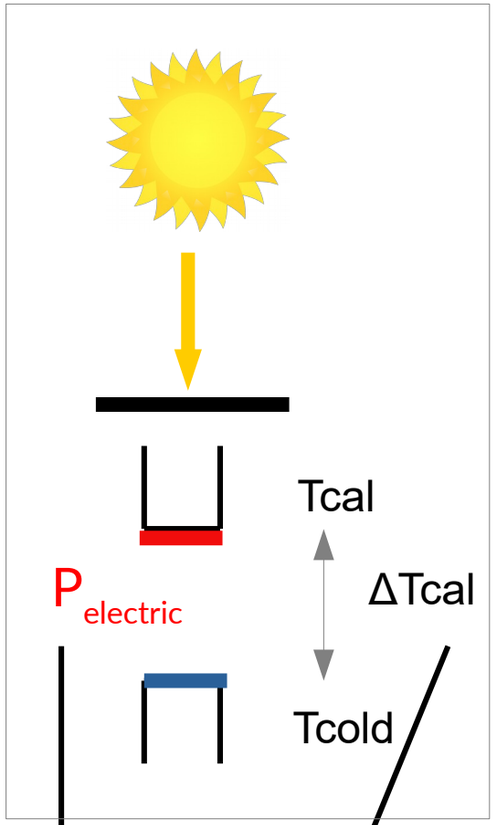
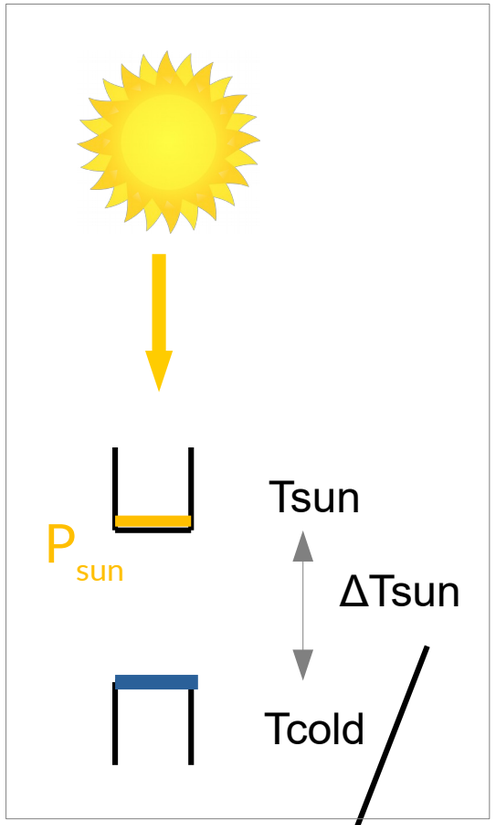
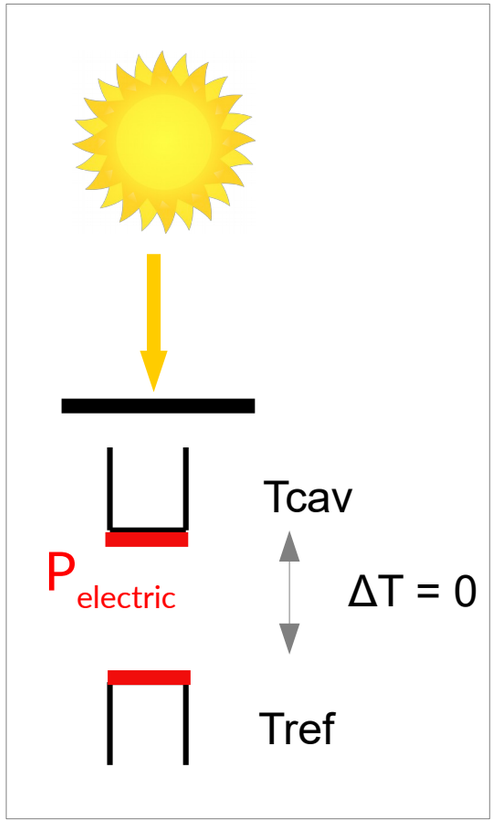
Passive and Active Mode

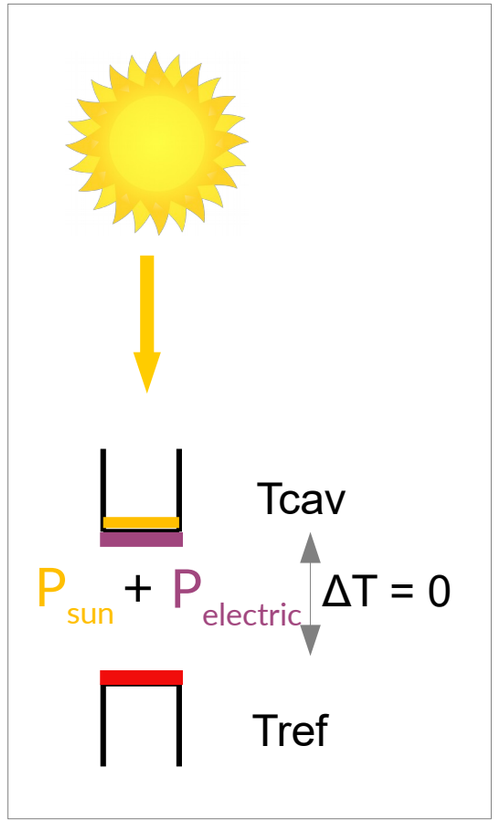




$P = k * V(\Delta T) \longrightarrow P_{sun} = k * V(\Delta T_{sun})$

$V(\Delta T)$





$P_{electric} = (P_{sun} + P_{electric})$

$V(\Delta T) = 0$

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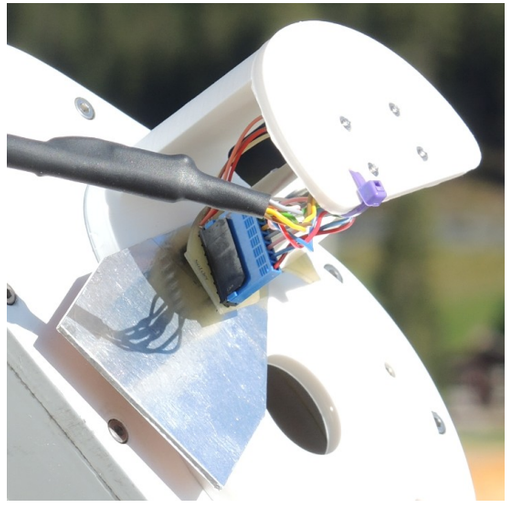
Equipment

AHF 29221

PMO8 Cable

External Shutter



PMO8 foot

PMO8 Control Unit *Linard*

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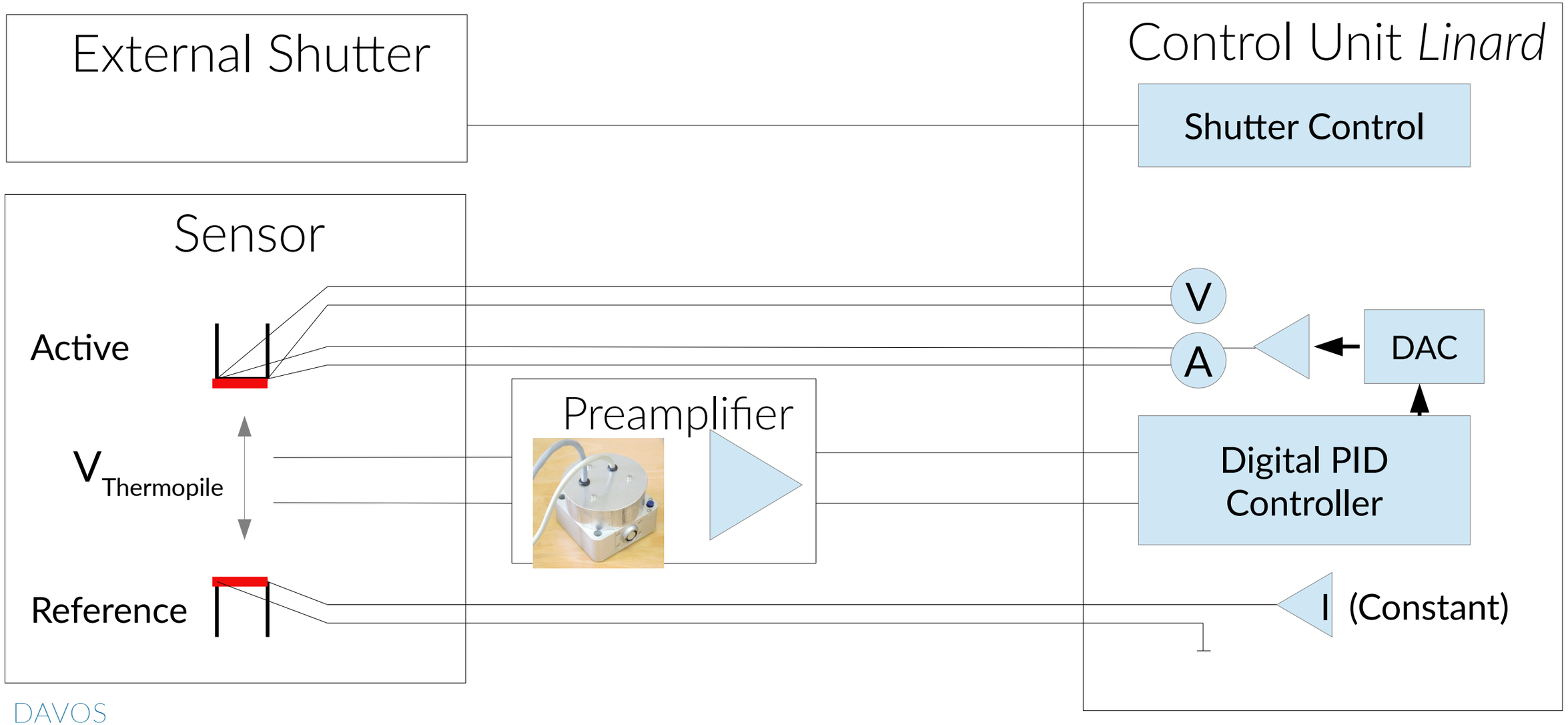
Controller Schematics



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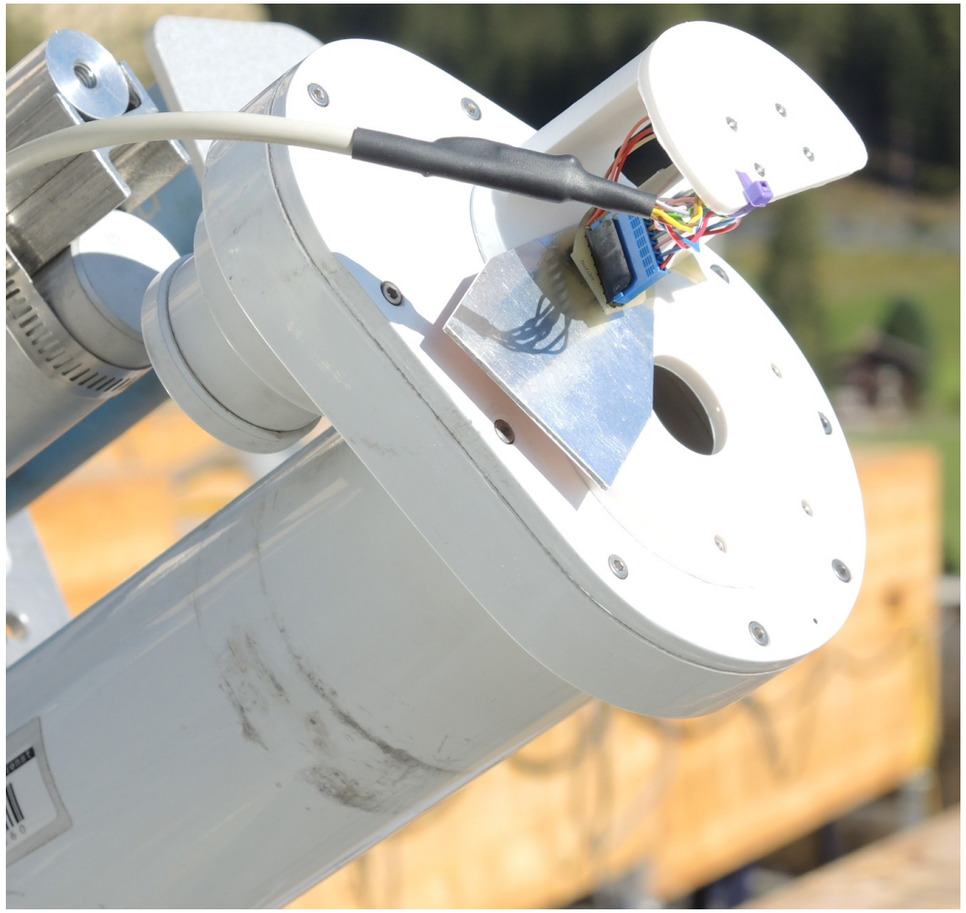
Cadence/Shutter Cycles

Operation:
- 15 s closed
- 15 s open
30 s cadence

9 AM to 4 PM:
14 Measurements series
-> 14 Cycles for passive mode
-> **840 Cycles for acitve mode**



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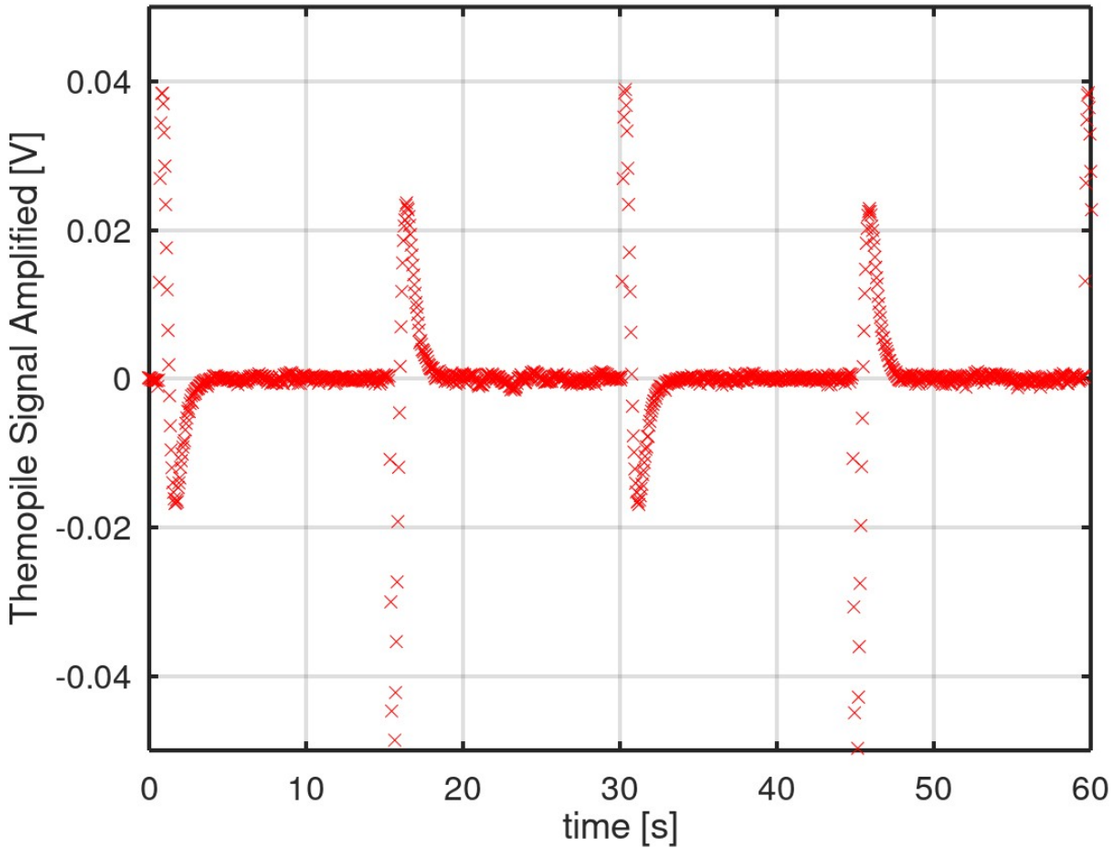
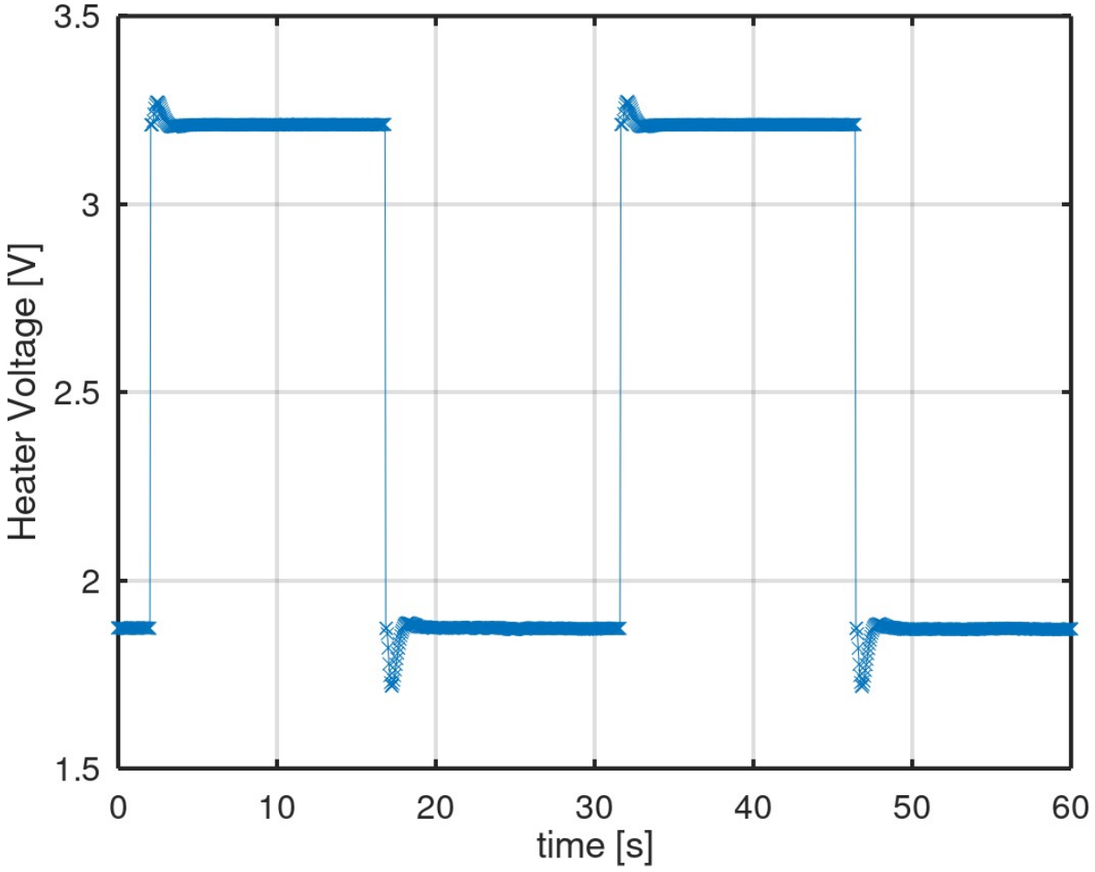
Raw Signals

Thermopile



Active Cavity Heater



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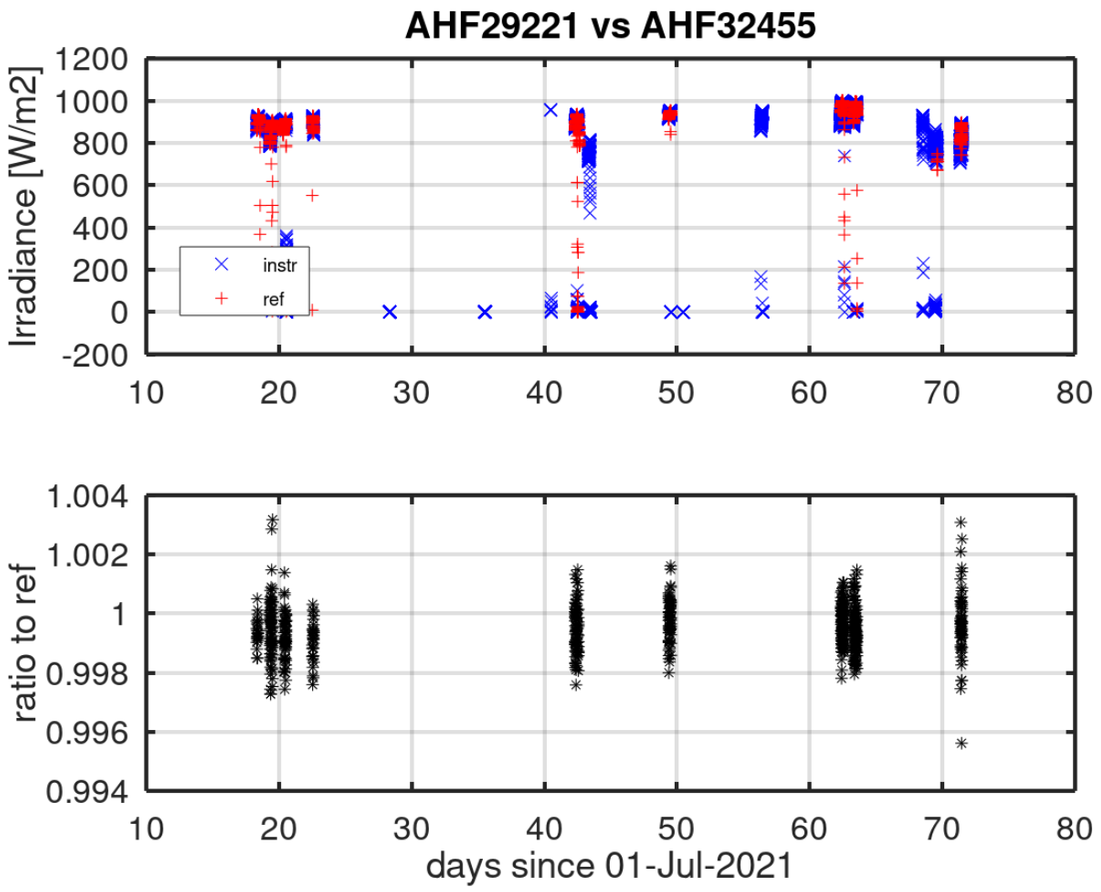
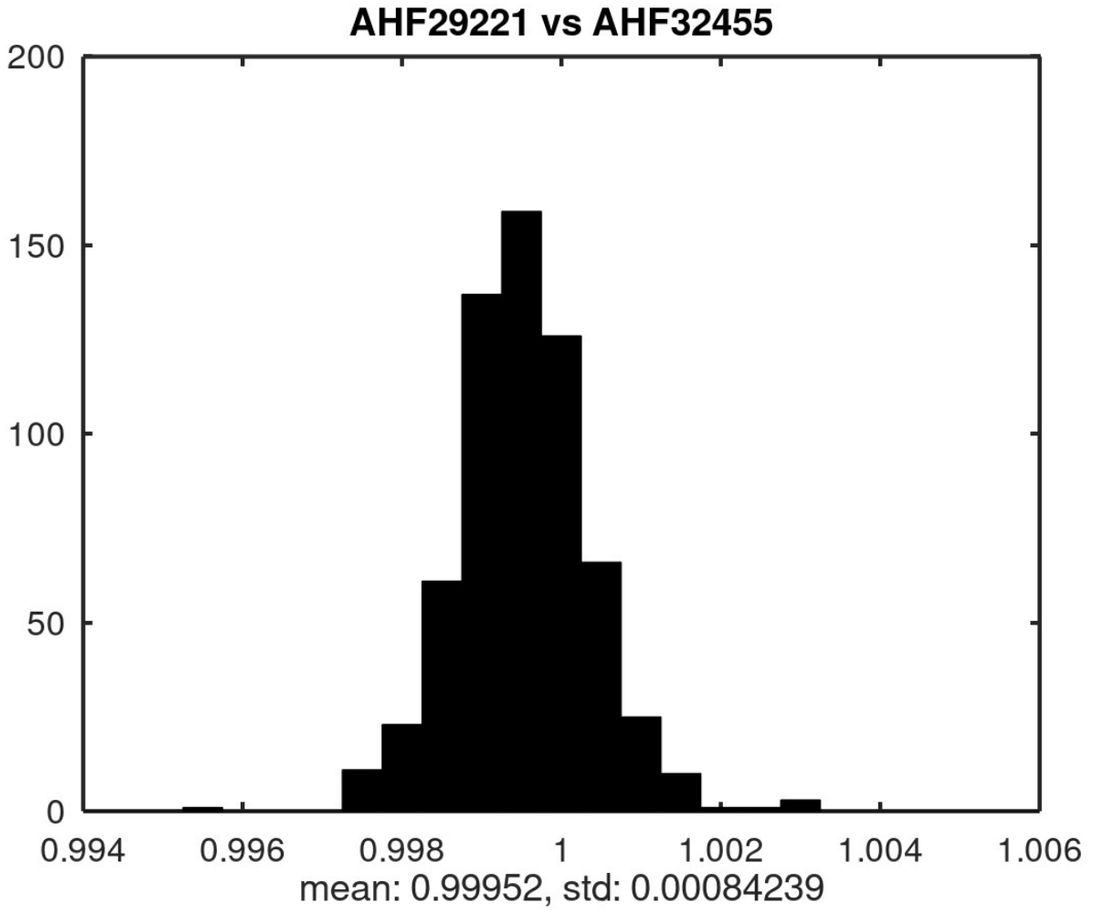
Results, Summer 2021

18. July - IPC





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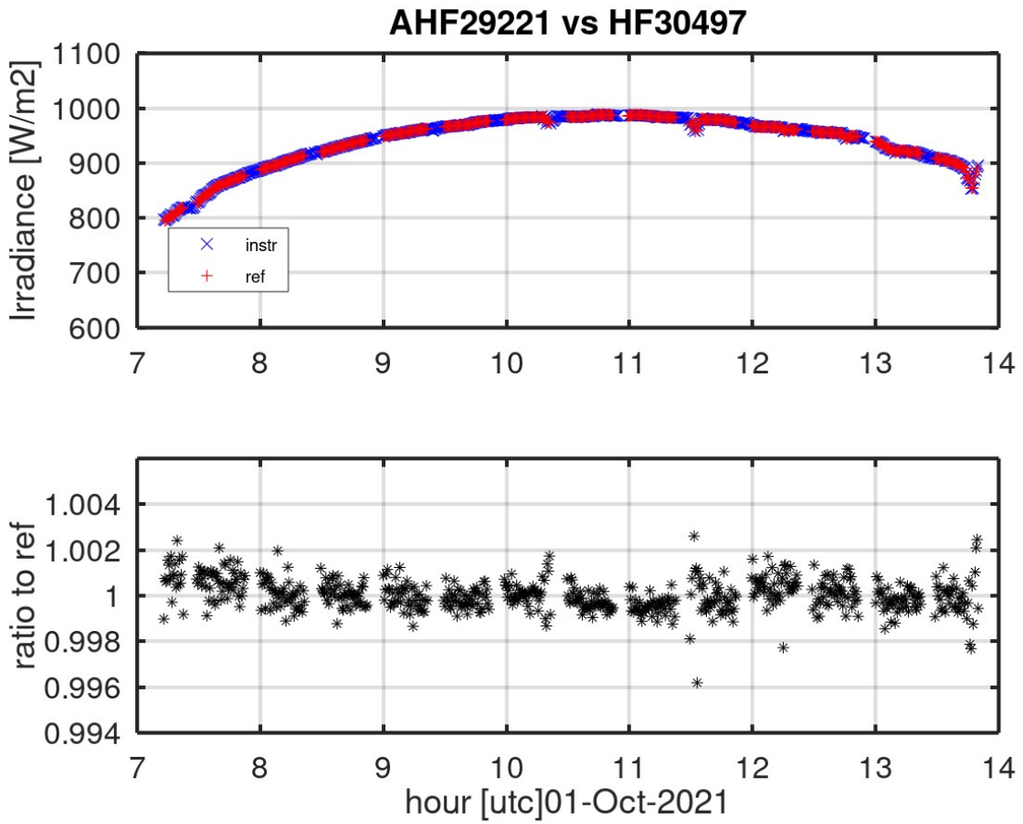
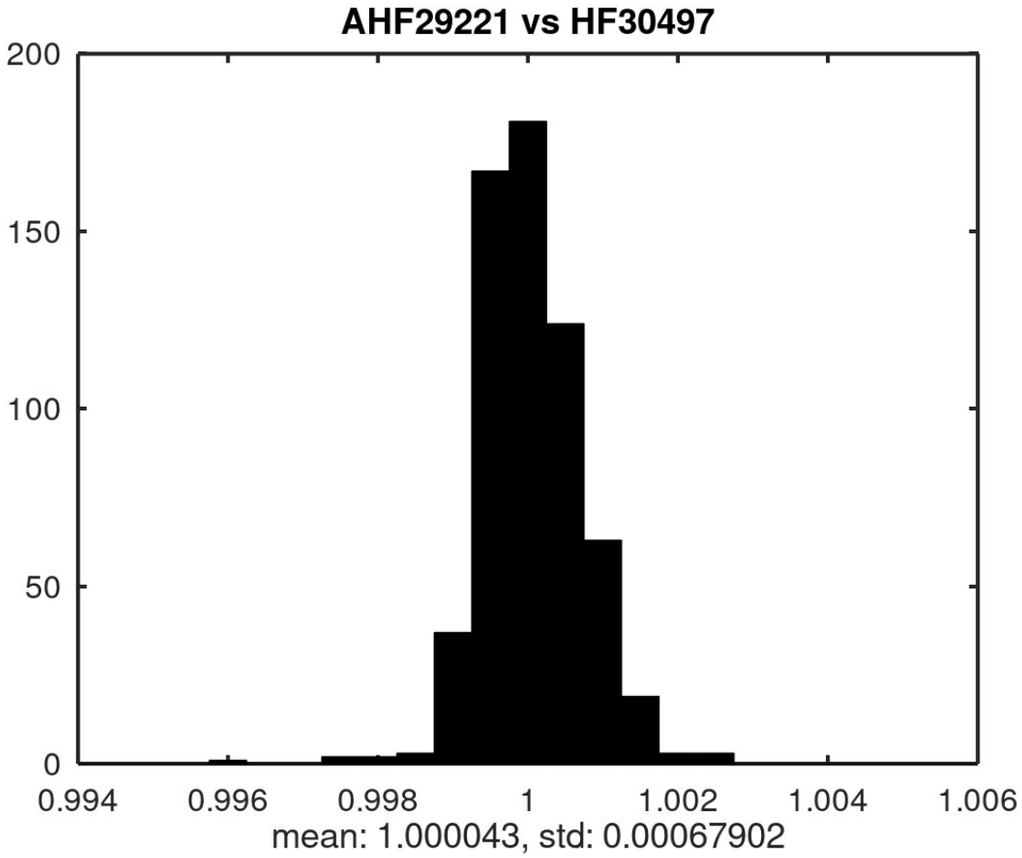
Results, IPC Oct 1





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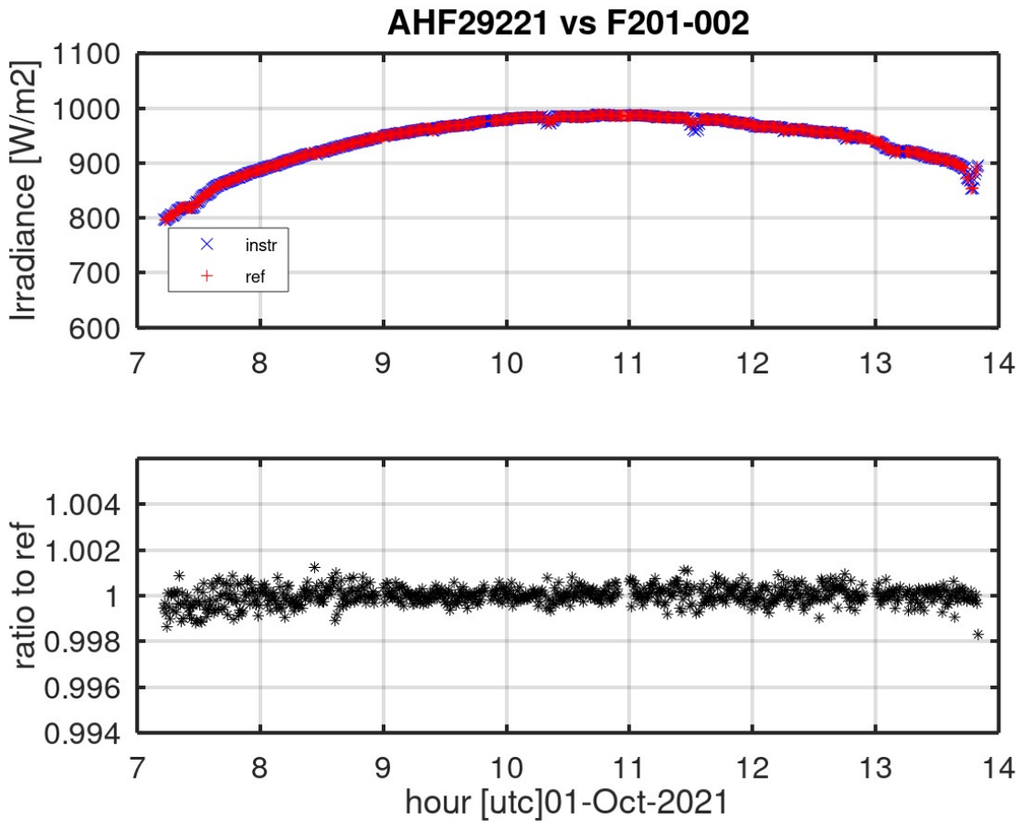
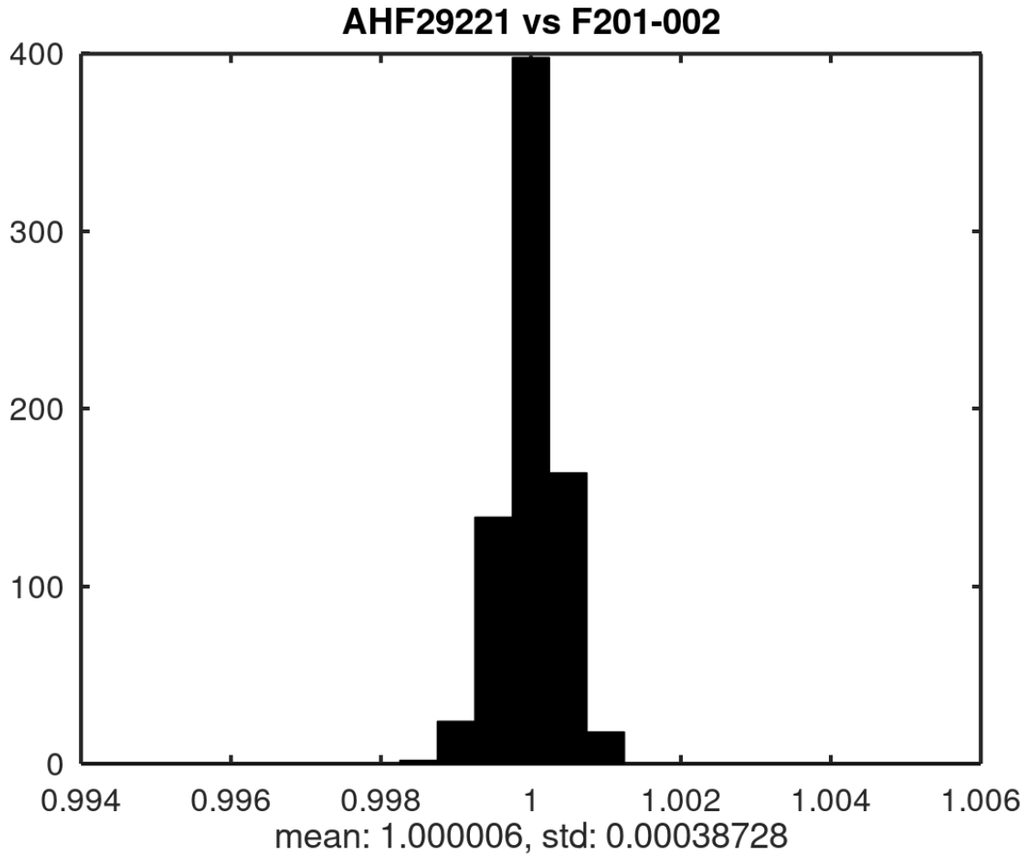
Results, IPC Oct 1





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Results, IPC Oct 1

Reference Instrument	Mean	Standard Deviation
PMO2	1.000013	0.00085
HF30497	1.000043	0.00070
TMI68018	0.999886	0.00080
F201-001	0.999894	0.00044
F201-002	1.000006	0.00039

Summary

- Active mode works well
- Relatively small effort necessary
- Original shutter yet to try
- Promising results from IPC
  - Can it be an advantage not to rely on a accurate Thermopile measurement?
  - Is it worth to continue?

Questions & Answers

Many thanks to

- Stefan from DWD
- Tom from EPPLEY
- Nic from PMOD
- Operators of the references & the audience

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