

5 Visions of NTT-AT



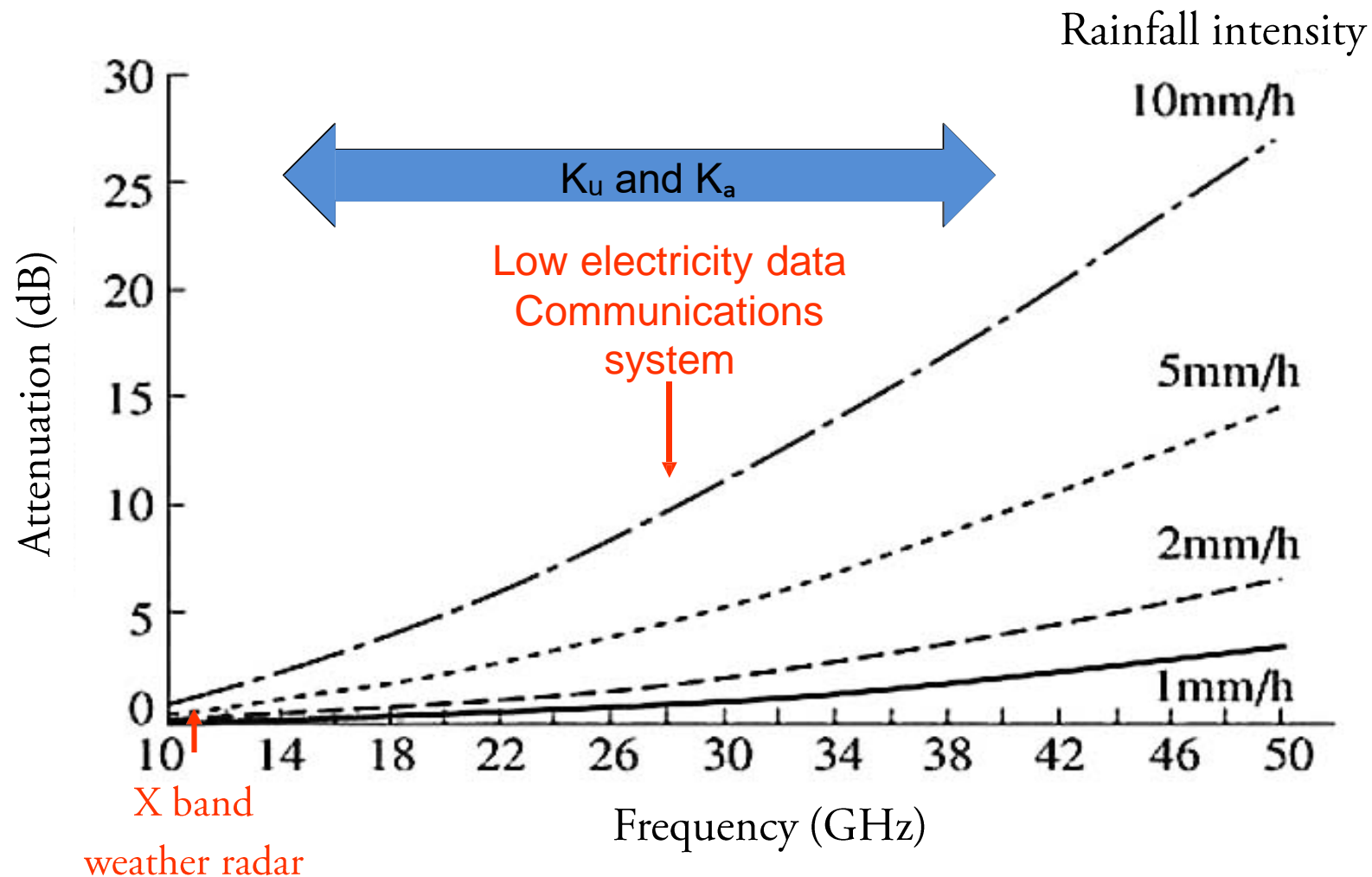
# High frequency application

**Reduces signal deterioration and maintenance during precipitation**

October, 2020

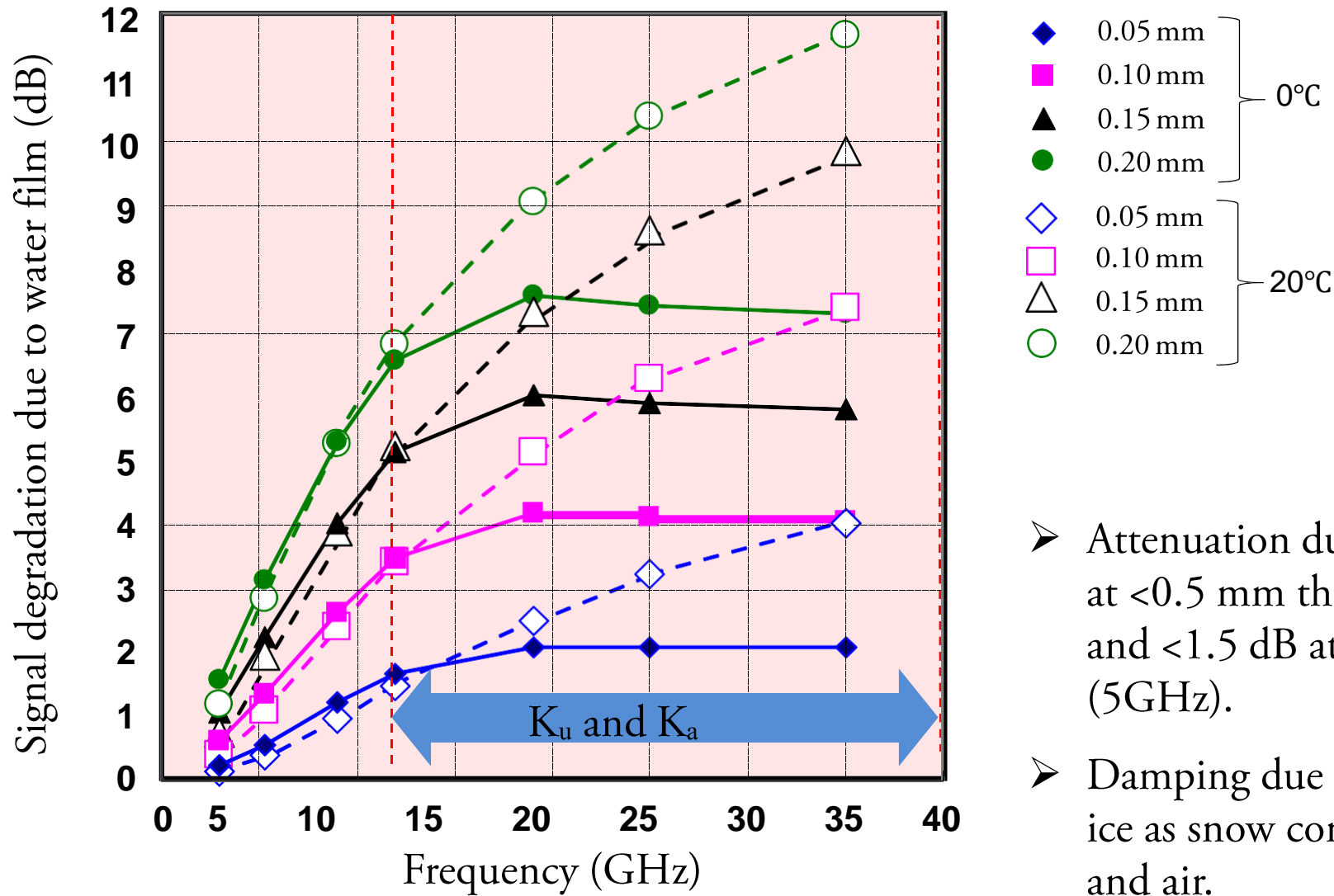
NTT Advanced Technology Corporation

NanoTech Solutions Norway AS



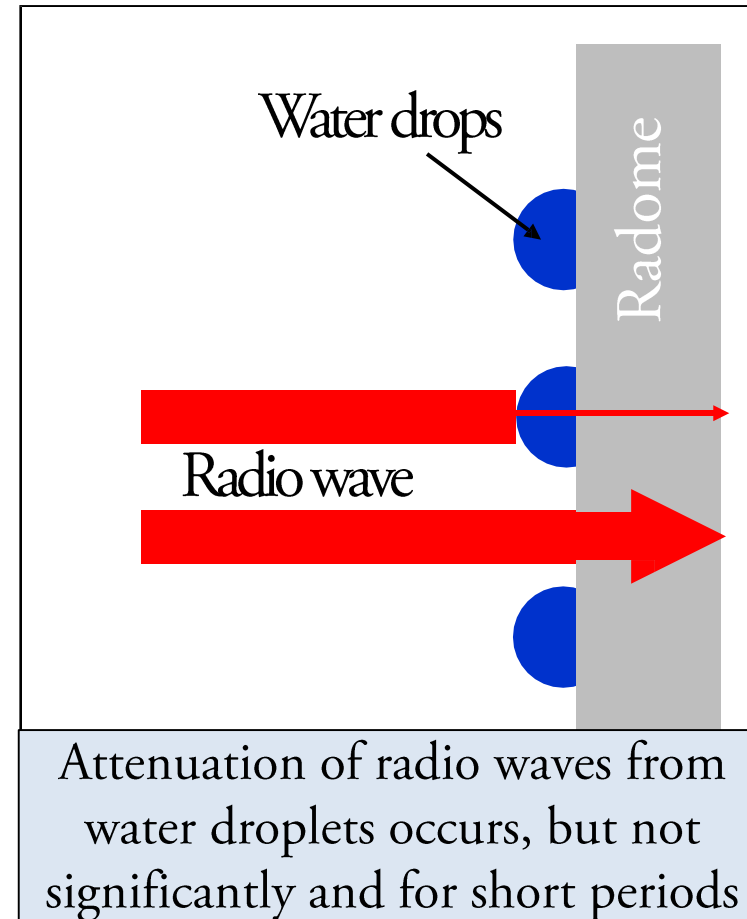
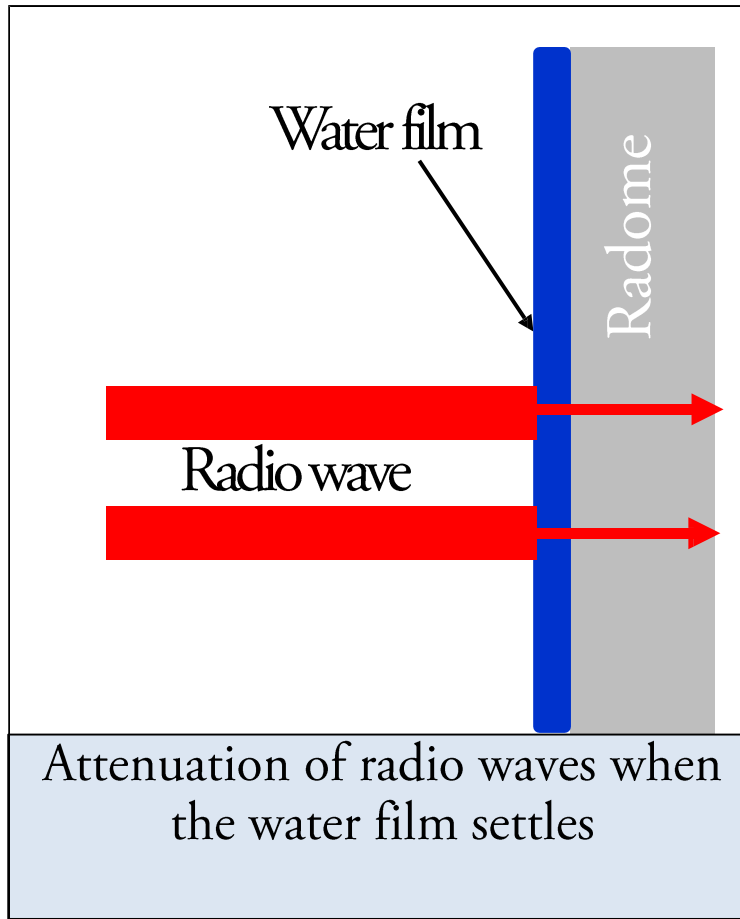
- During satellite broadcasting, 2dB rain attenuation is calculated for 10 mm/h rain
- At higher frequencies, the deterioration of the signal becomes stronger

# Signal degradation due to water film



Based on a report issued by The Meteorological Society of Japan

- Attenuation due to ice is <math><0.1\text{ dB}</math> at <math><0.5\text{ mm}</math> thickness (5GHz) and <math><1.5\text{ dB}</math> at 2-5 mm thickness (5GHz).
- Damping due to snow is less than ice as snow consists of both ice and air.



- Superhydrophobicity prevents signal degradation from water film



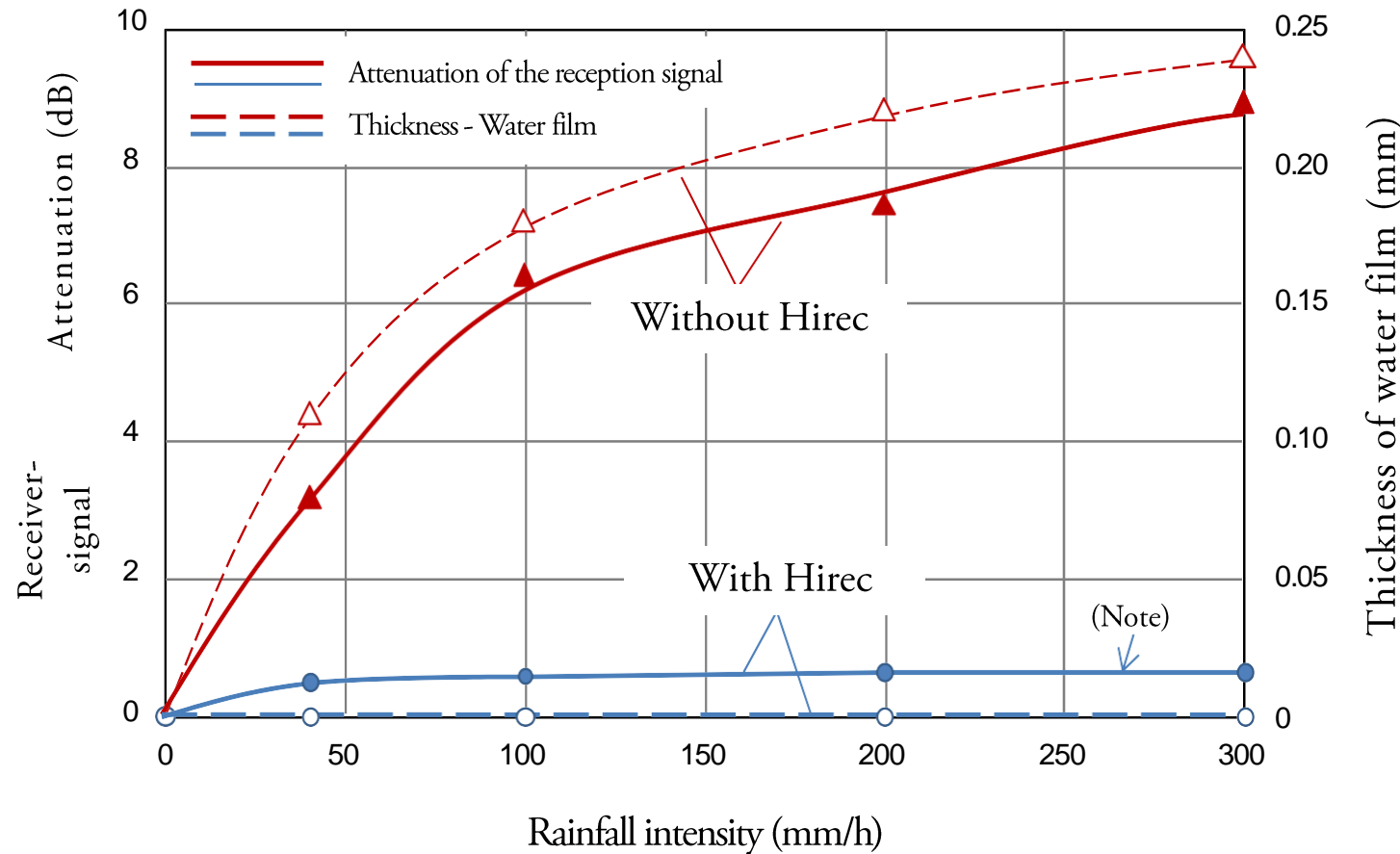
Without Hirec



With Hirec  
(Superhydrophobic surface)



- Rain simulator; rainfall intensity of 40-300 mm/h
- Bell-shaped radom with a diameter of 4 meters

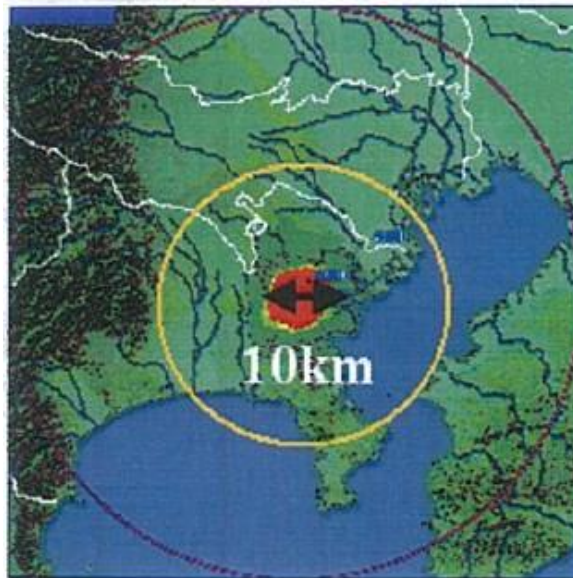


- One receiver was placed inside the radome, and one transmitter outside
- 5 meters distance with a frequency of 9.8 GHz
- With Hirec, the attenuation was effectively counteracted



## The photo that was taken

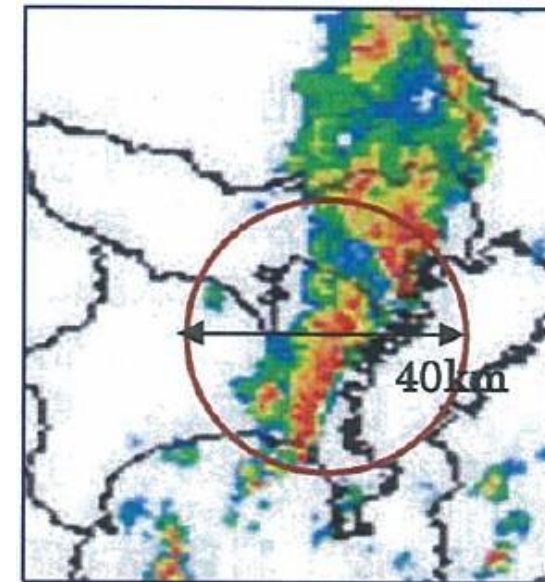
Not observed correctly due to radioattenuation



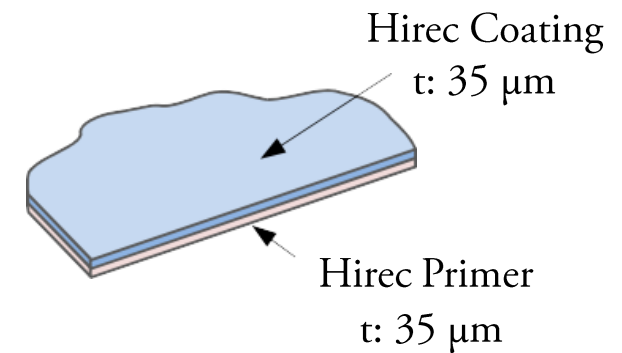
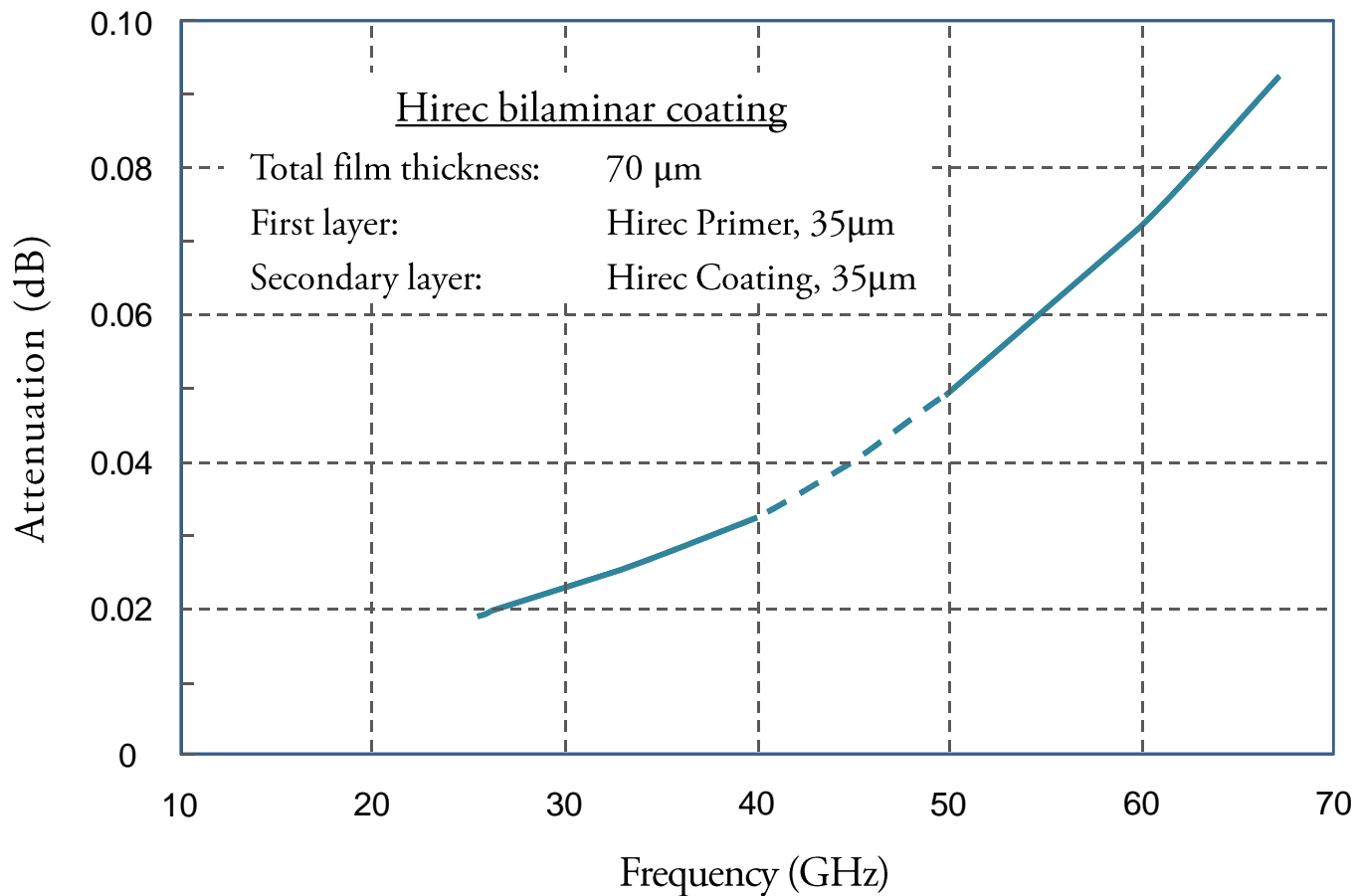
Heavy rain ~ 30mm/h

## Weather in reality

(Rain from north to south)

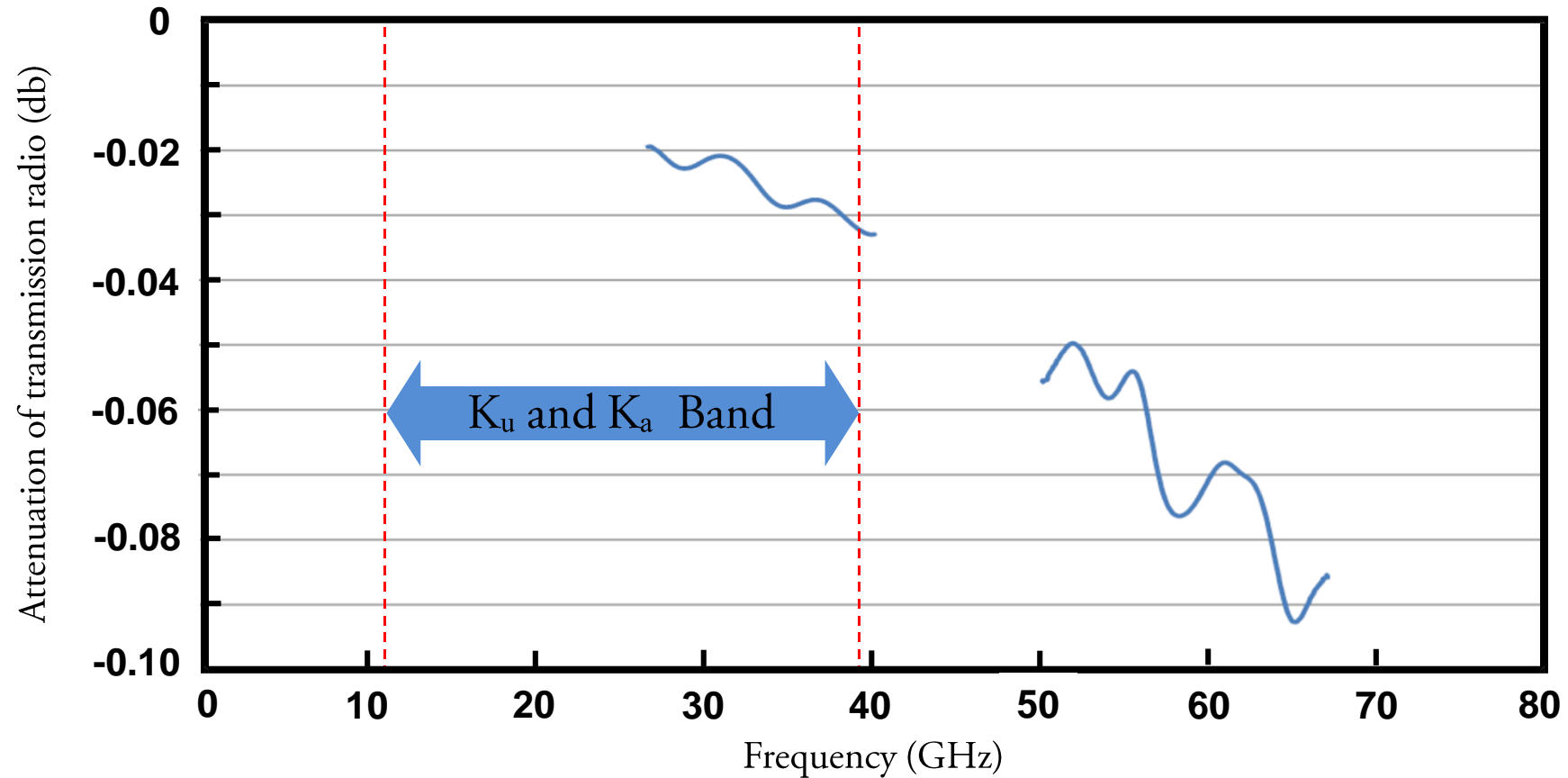


- Operating range for MP radar is dramatically limited due to attenuation from water film



- Hirec itself is harmless to RF signal
- 0.1 dB or less at 30 - 70 GHz
- Hirec can be used for radar and radio application

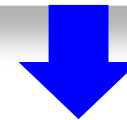
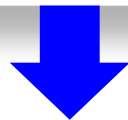




- Hirec causes almost no radio attenuation with coated superhydrophobic film, even for  $K_u$  and  $K_a$  band



- Hirec is used on the X-band (9GHz) radomes of MLIT \*
- The research committee of MIC \*\* selected Hirec from many water-repellent coatings, based on the results of an exposure test
- Hirec's water repellency was the best!
- The competition candidates could not reject snow on any of the radomes in the test

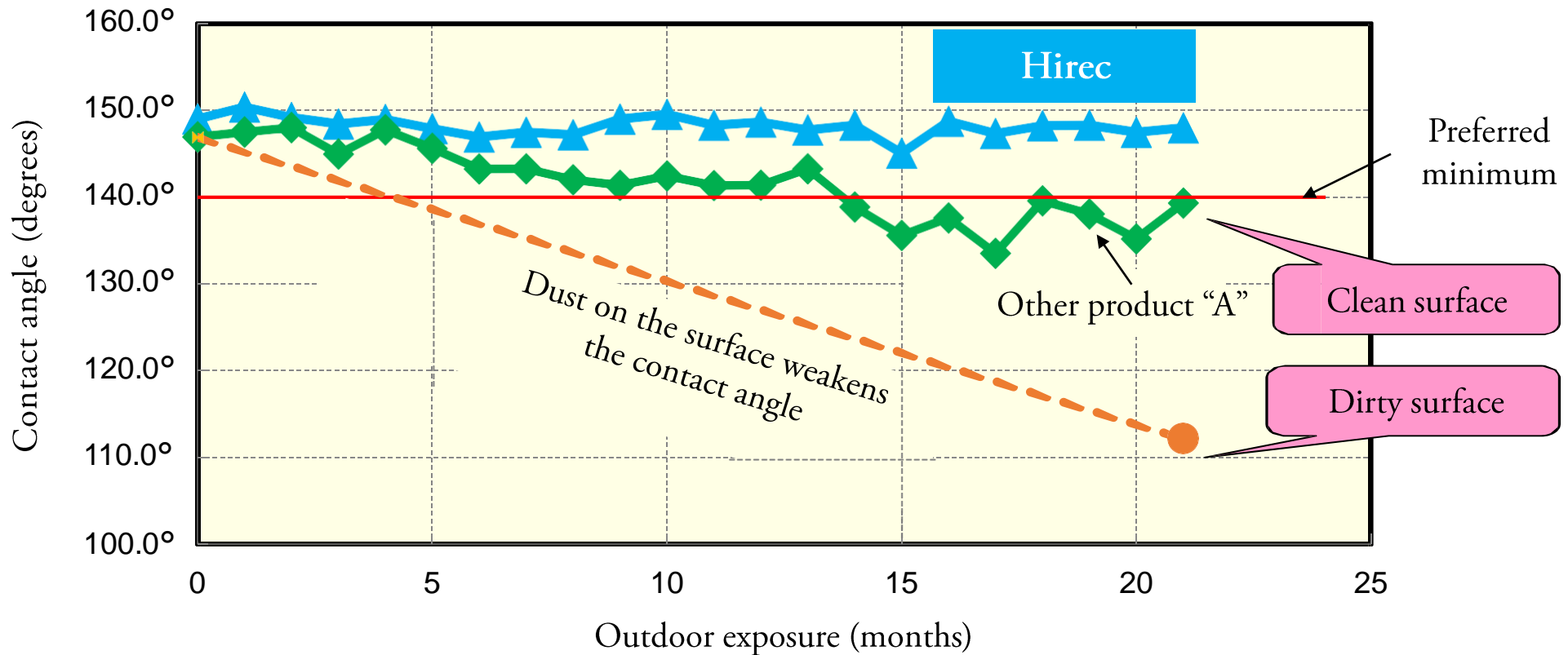


- ✓ As a result, MLIT entered into a partnership with NTT-AT
- ✓ Self-cleaning function is a key factor for Hirec`s sovereignty

\* MLIT = Ministry of Land, Infrastructure, Transport and Tourism (Japan)

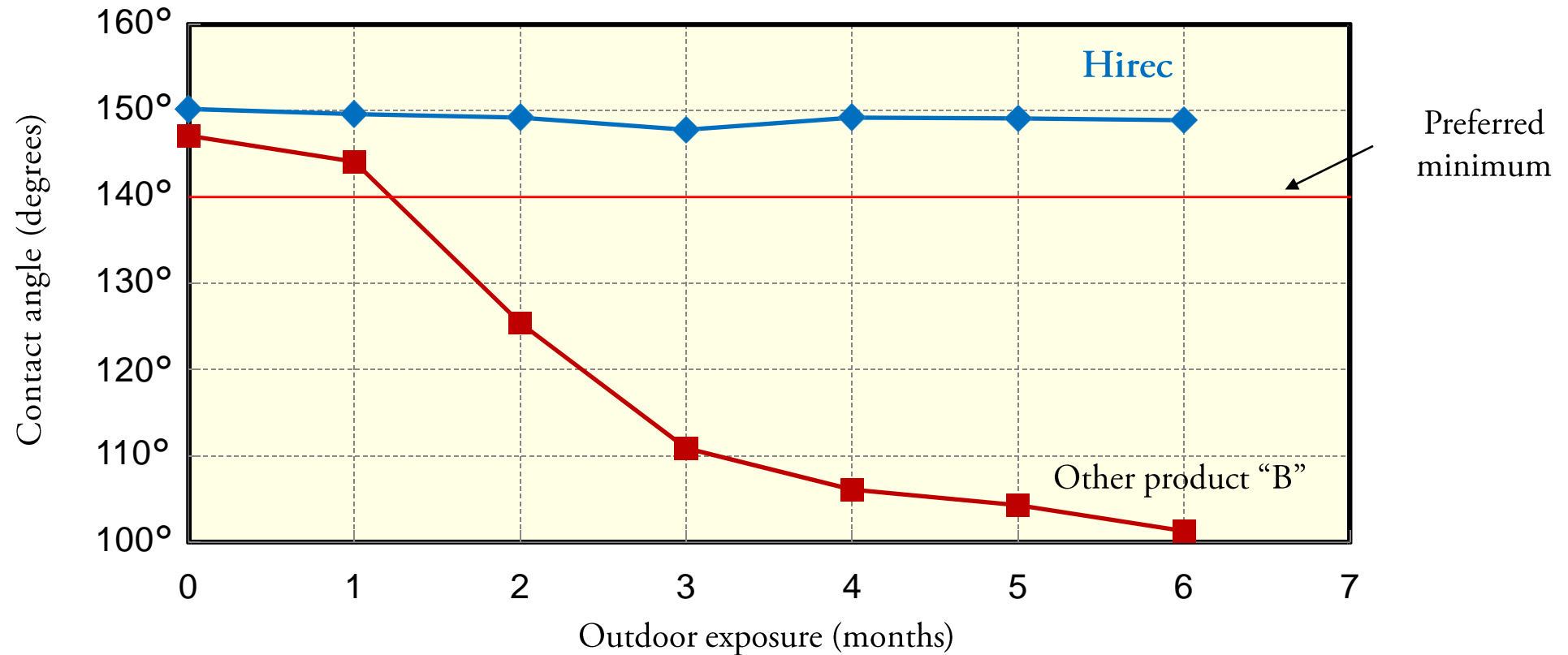
\*\* MIC = Ministry of Internal Affairs and Communications (Japan)

# Results of exposure test (1)

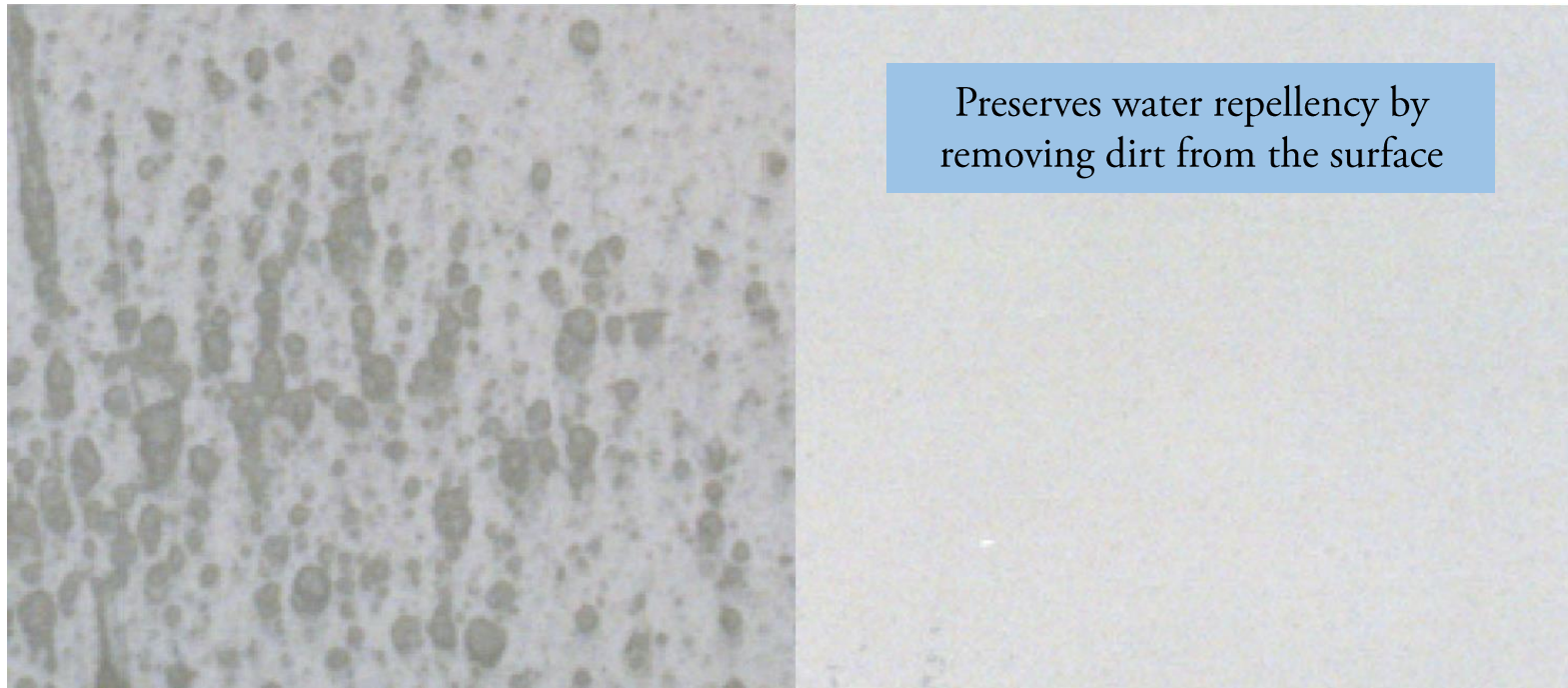


- Self-cleaning function with Hirec can maintain a high contact angle for a long period of time during outdoor exposure
- Even after 20 months, the contact angle was almost the same as in the initial phase

# Results of exposure test (2)



- Product B also guarantees self-cleaning function, but the contact angle dropped significantly after only one month



## **Without** self-cleaning function

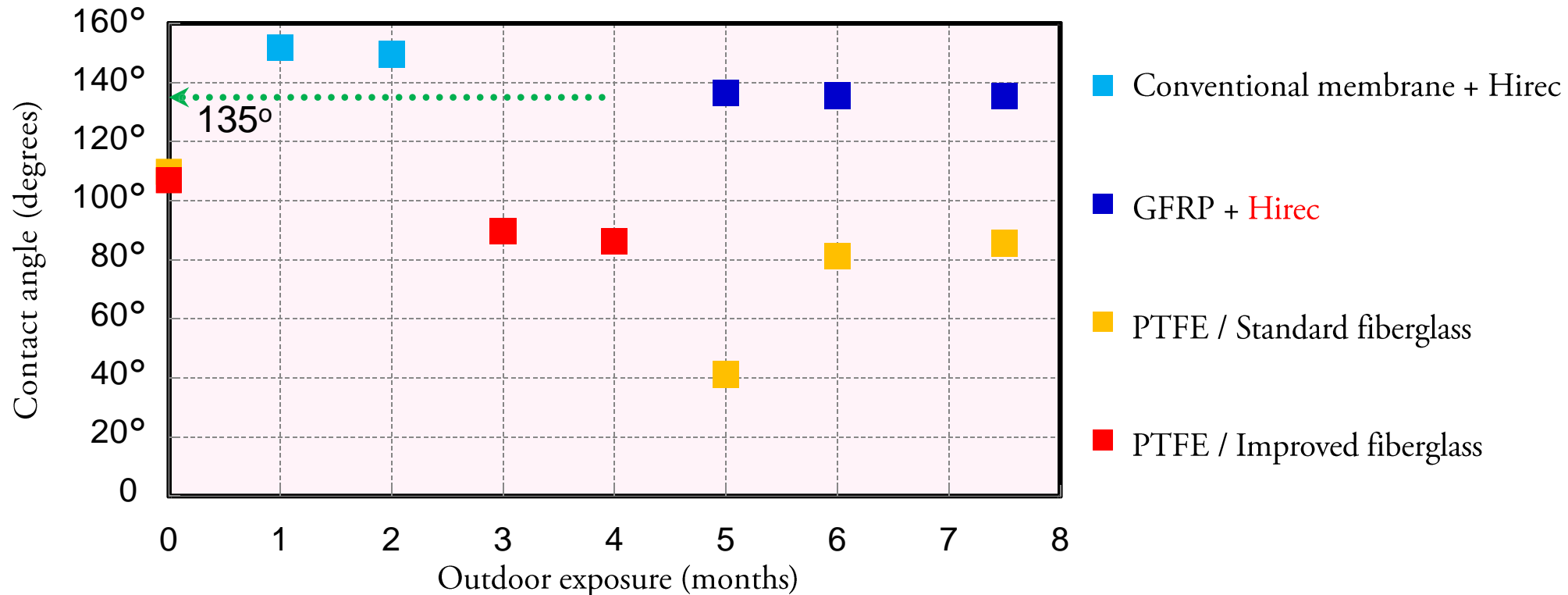
- Contact angle: 110 degrees.
- After 1 year of exposure

## **With** self-cleaning function

- Contact angle: 143 degrees.
- After 3 years of exposure

\* The durability of Hirec varies depending on the conditions of use.

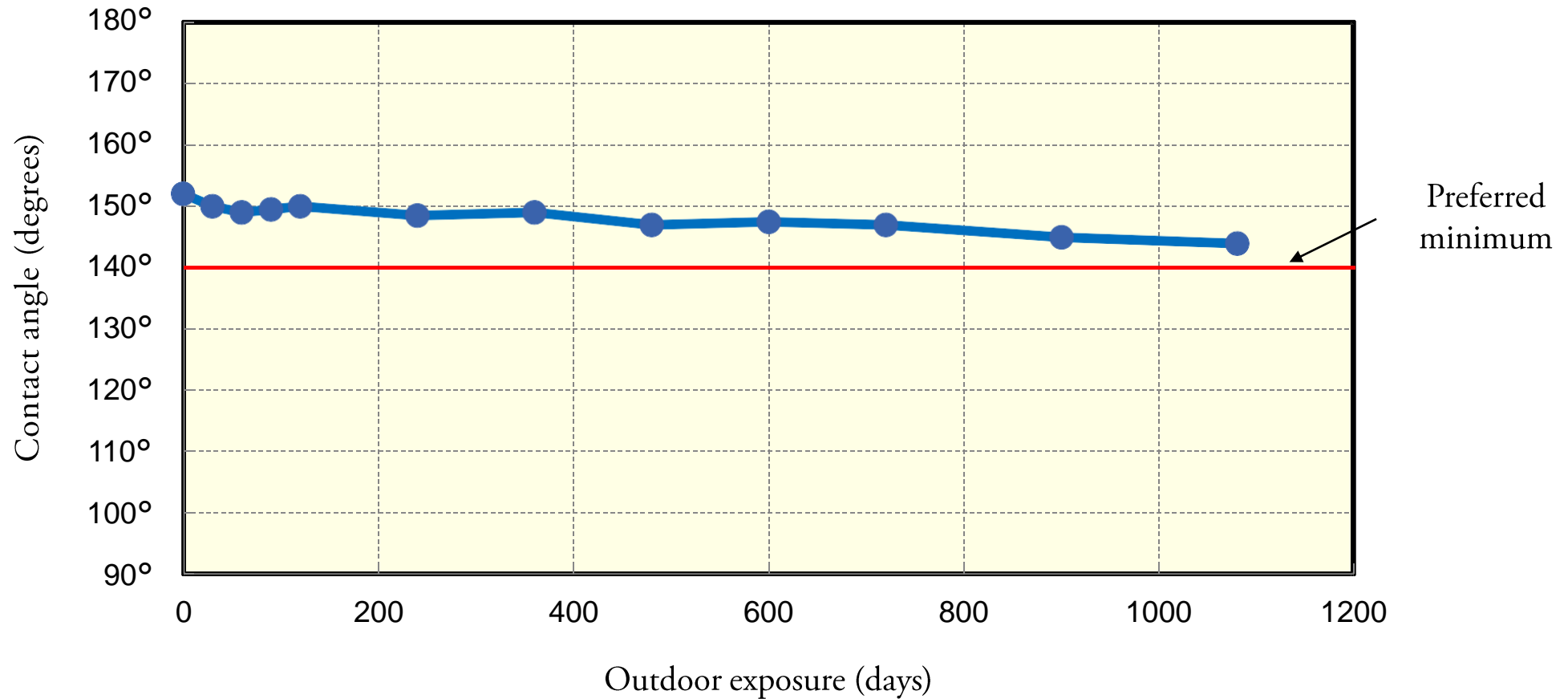
Measured contact angle on coated radomes during outdoor exposure  
(Based on a report issued by MIC \* in March 2008)



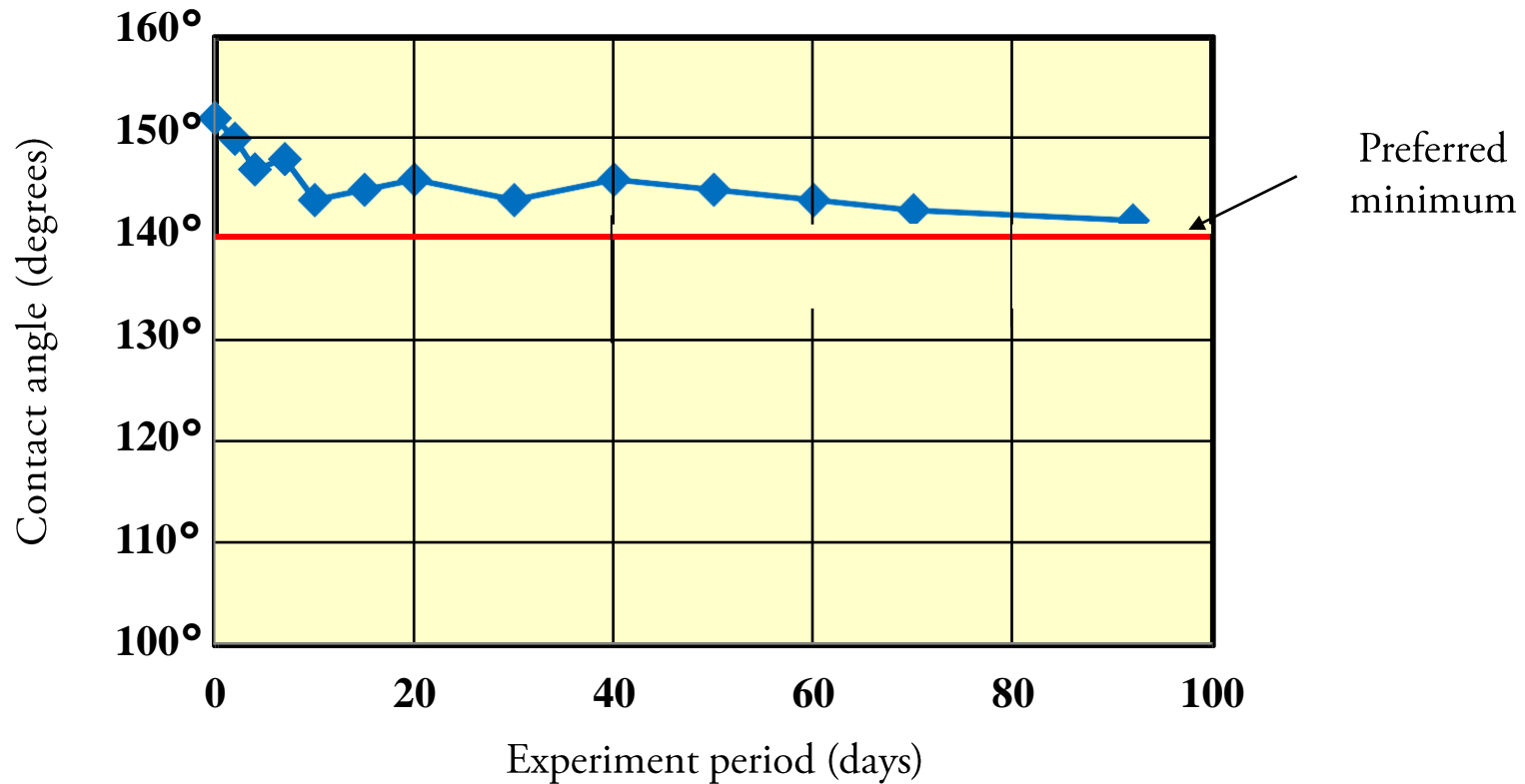
- The report concluded that the minimum contact angle to avoid damping due to heavy rain is 135 degrees
- Only Hirec could maintain that quality

\*Ministry of Internal Affairs and Communications

# Superhydrophobic with long-lasting durability



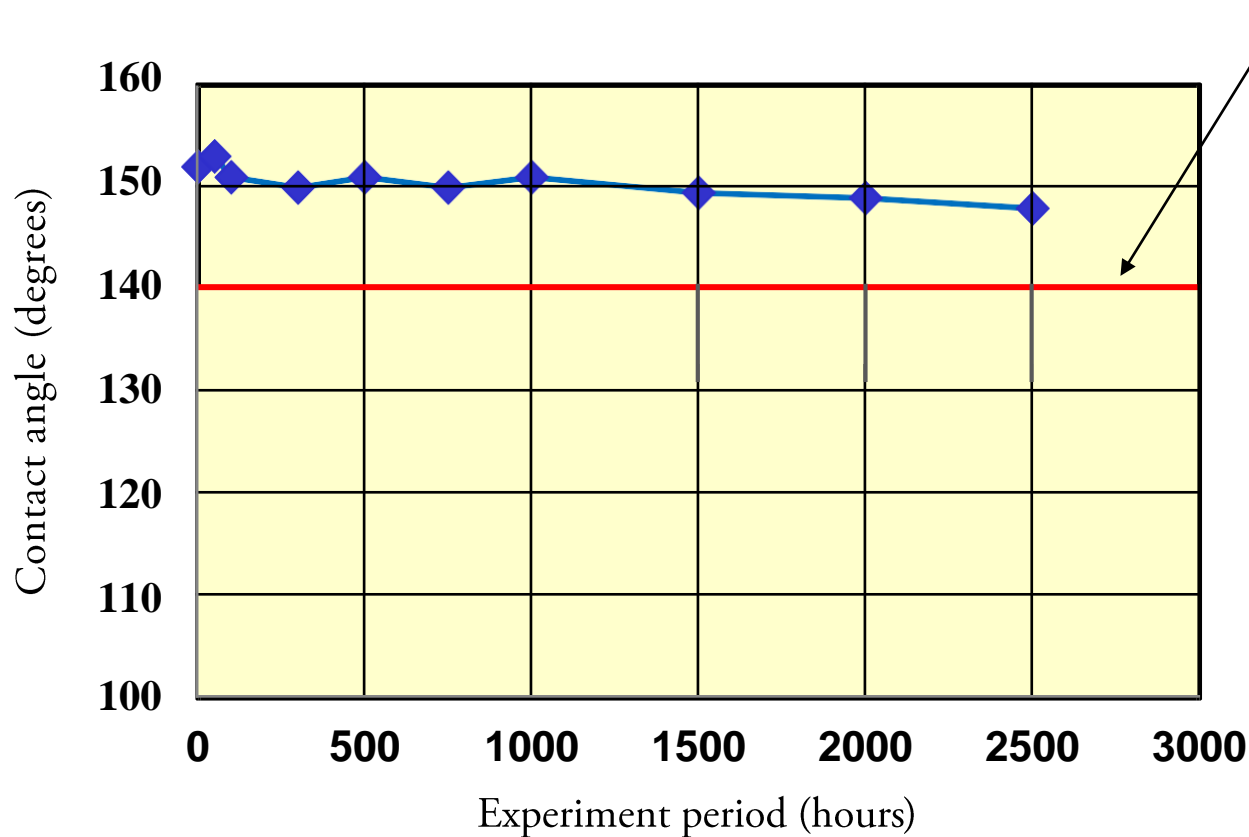
➤ Even after 3 years of exposure, Hirec maintains the contact angle above 140°



- A test piece was dipped in water every day for three months
- Hirec maintained a contact angle of 140 ° even after 3 months

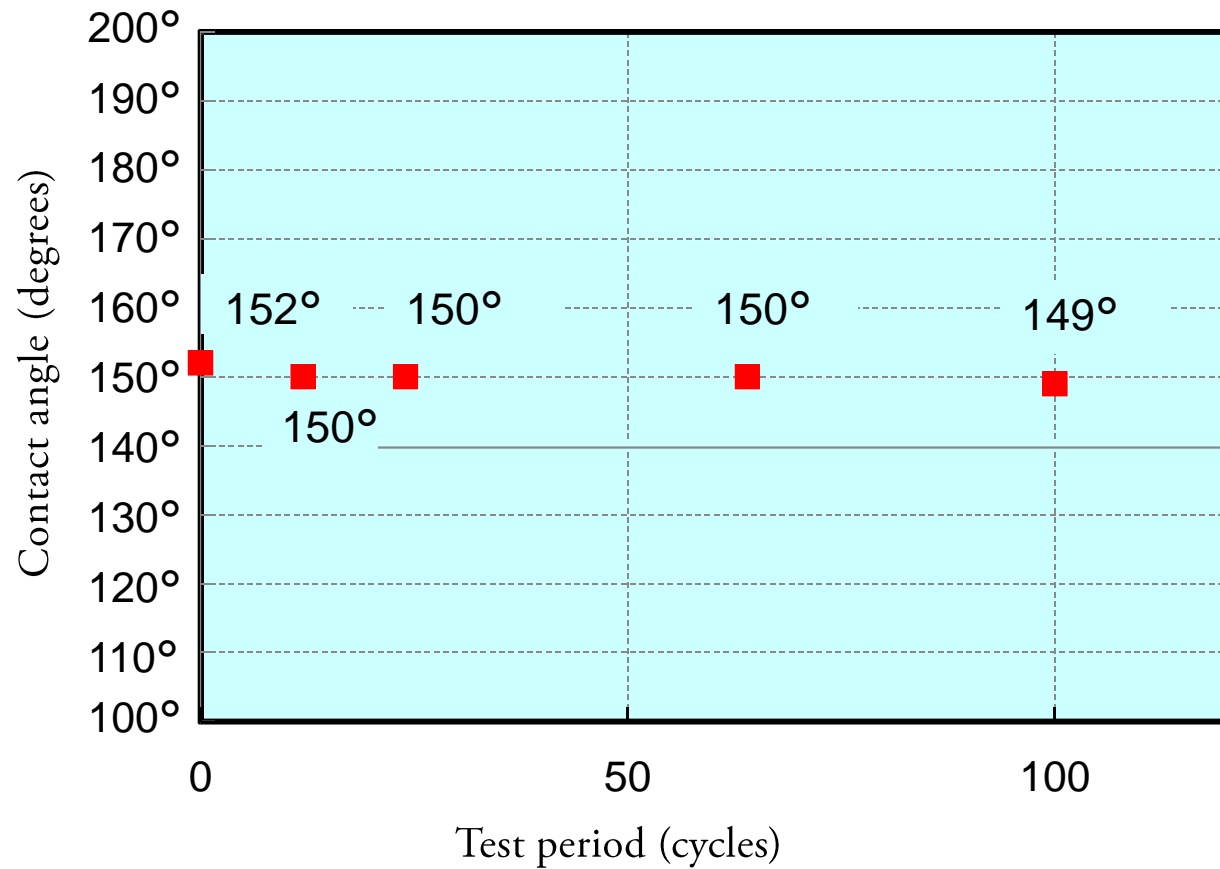
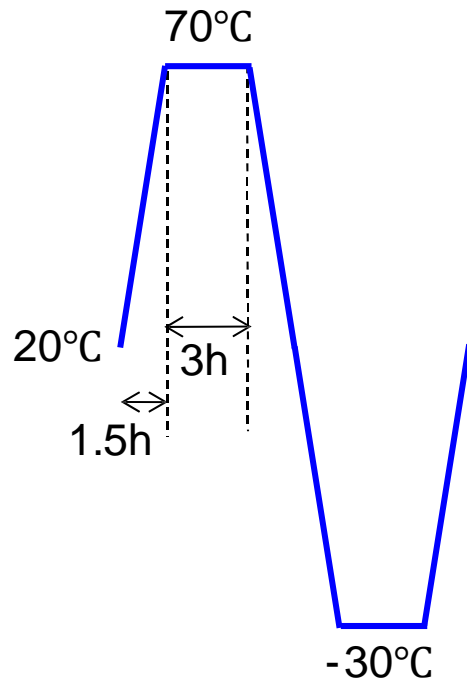


# UV resistance test (accelerated)



Conditions (JISK5400)	
Solar radiation	255w/m <sup>2</sup>
Discharge voltage	48~52V
Discharge current	58~62A
Use time of glass filter	2000h
Temperature on black panel	63±3°C
Condition of water jet	18min/2h
Relative temperature	50±5%

- Irradiated UV for approximately 2500 hours continuously
- Hirec maintained a contact angle of over 140° even after 2500 hours (equivalent to approximately 3 years of outdoor exposure)



## After 100 cycles

- Contact angle, more than 140 degrees
- No visible cracks on the surface

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