

IEEE Milestone Supporting Materials

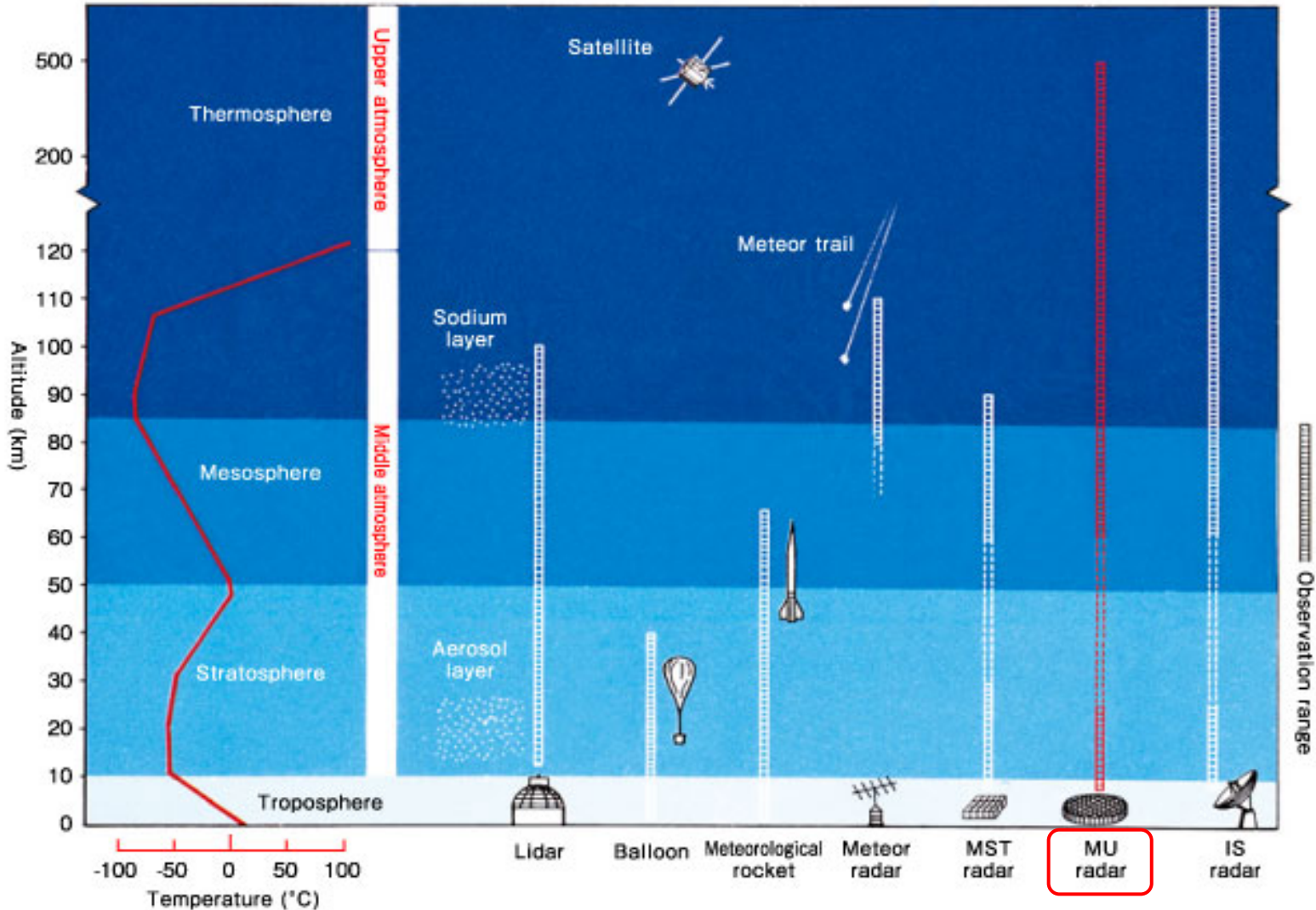
The MU (Middle and Upper atmosphere) radar, 1984

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and
Mitsubishi Electric Corporation,
Information Technology R&D Center



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The MU Radar, Shigaraki, Shiga

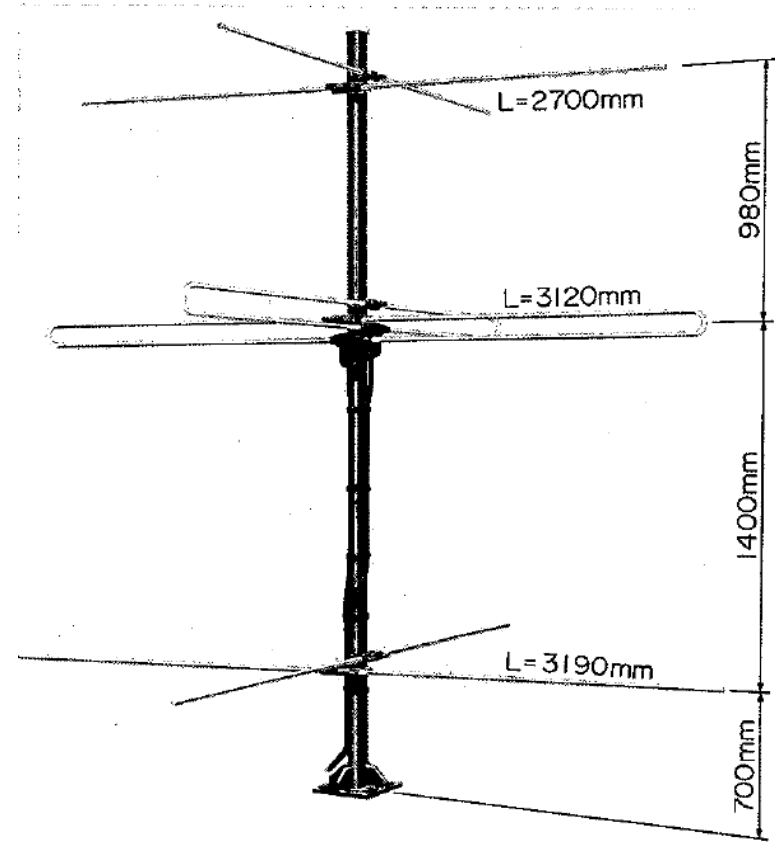
Observation ranges of the MU radar and other instruments



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475 Crossed Yagi Antennas [3]

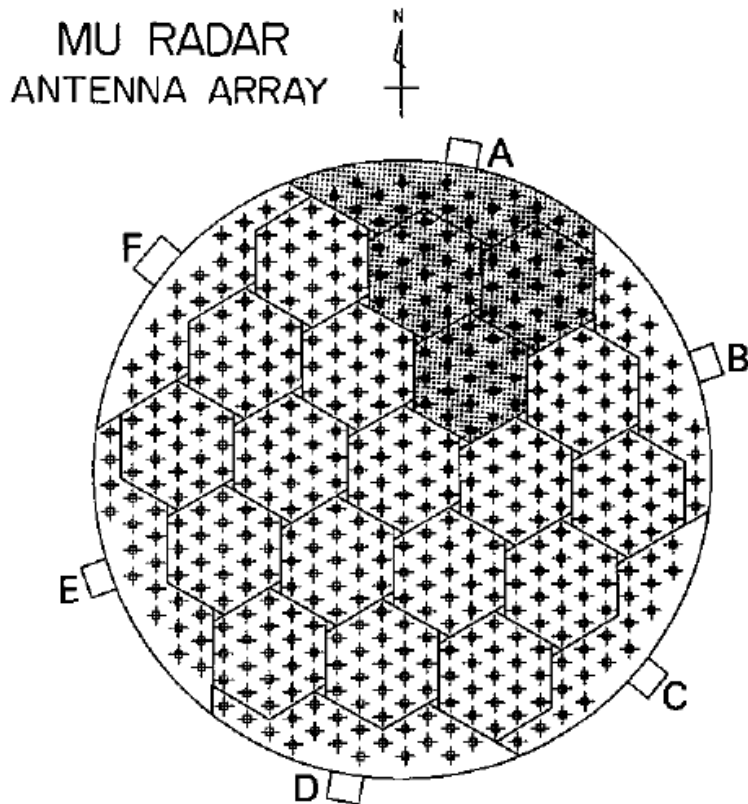


Individual crossed three-subelement Yagi [1] [2]

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[1] Kato, S., T. Ogawa, T. Tsuda, T. Sato, I. Kimura, and S. Fukao, The Middle and Upper Atmosphere Radar: First Results Using a Partial System, Radio Sci., 19, 1475-1484, 1984., [2] Fukao, S., T. Sato, T. Tsuda, S. Kato, K. Wakasugi, and T. Makihira, The MU Radar with an Active Phased Array System: 1. Antenna and Power Amplifiers, Radio Sci., 20, 1155-1168, 1985. [3] <http://www.rish.kyoto-u.ac.jp/mu/en/>

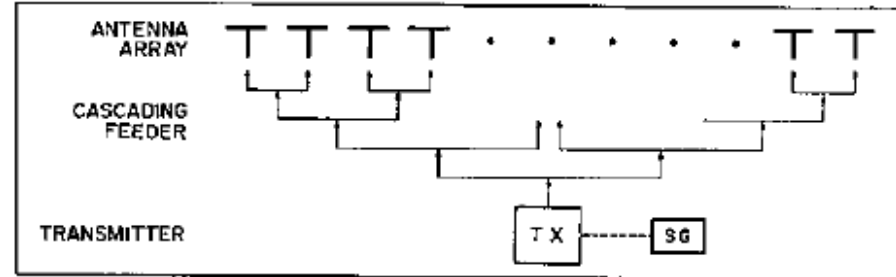
Active antenna array system



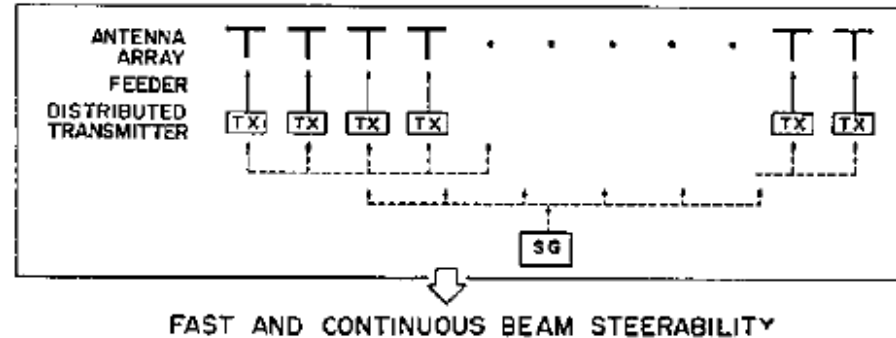
MU radar antenna array [1] [2]

The 475 antennas are divided into 25 groups, each consisting of 19 elements. Each group can be driven separately. The six boxes A-F represent the booths which accommodate the TR modules. The shaded area shows groups accommodated by booth A.

I. PASSIVE ARRAY SYSTEM (Conventional)



II. ACTIVE ARRAY SYSTEM (MU radar)

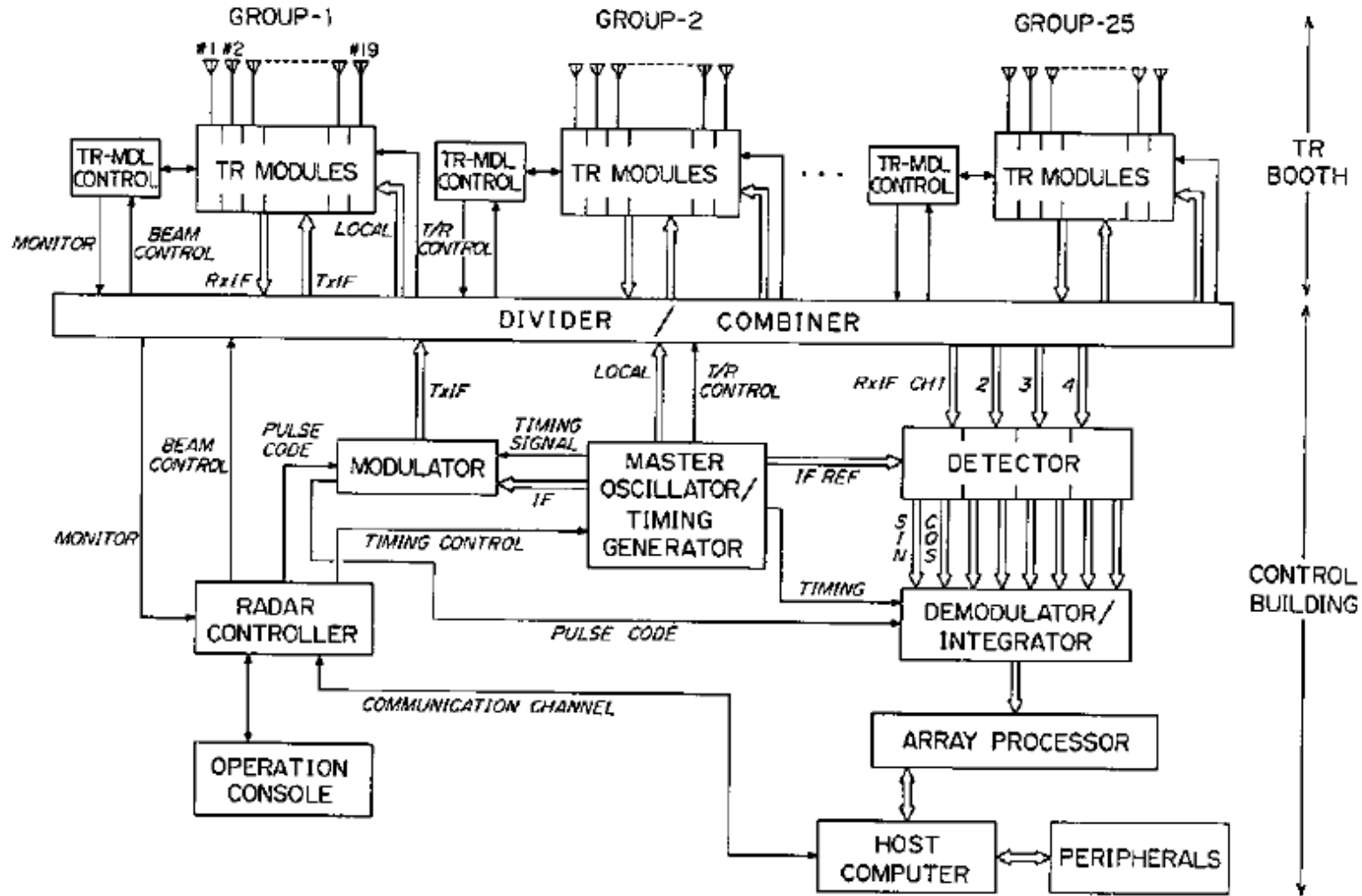


Comparison of passive and active phased array systems [1] [2]

In conventional radar systems, a high-power transmitter feeds all array elements. Instead in the MU radar system, each element of the phased array is provided with a low power amplifier. All the amplifiers are driven coherently.

Block diagram

MU RADAR BLOCK DIAGRAM



MU radar block diagram [1] [2]

[1] Kato, S., T. Ogawa, T. Tsuda, T. Sato, I. Kimura, and S. Fukao, The Middle and Upper Atmosphere Radar: First Results Using a Partial System, Radio Sci., 19, 1475-1484, 1984., [2] Fukao, S., T. Sato, T. Tsuda, S. Kato, K. Wakasugi, and T. Makihira, The MU Radar with an Active Phased Array System: 1. Antenna and Power Amplifiers, Radio Sci., 20, 1155-1168, 1985.

Parameter	Value
Location	Shigaraki, Shiga, Japan (34.85°N, 136.10°E)
Radar system	monostatic pulse radar; active phased array system
Operational frequency	46.5 MHz
Antenna	circular array of 475 crossed yagis
aperture	8330 m ² (103 m in diameter)
beam width	3.6° (one way; half power for full array)
steerability	steering is completed in each IPP
beam directions	1657; 0°–30° off zenith angle
polarizations	linear and circular
Transmitter	475 solid state amplifiers (TR modules; each with output power of 2.4 kW peak and 120 W average)
peak power	1 MW (maximum)
average power	50 kW (duty ratio 5%)(maximum)
bandwidth	1.65 MHz (maximum) (pulse width: 1–512 μs variable)
IPP	400 μs to 65 ms (variable)
Receiver	
bandwidth	1.65 MHz (maximum)
dynamic range	70 dB
IF	5 MHz
A/D converter	12 bits × 8 channels
Pulse compression	binary phase coding up to 32 elements; Barker and complementary codes presently in use

[1] [2]