

Raytheon 1090 ES ADS-B
Receiver/Decoder Testing Results
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RTCA SC-186 Working Group 3
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Raytheon Demonstrator Evaluation

- Raytheon has extensive experience developing 1090 MHz Ground Receivers for SSR Systems
- Developed Extended Squitter (ES) decoder using DO-260A MOPS Enhanced Decoder as a basis
- Made available Demonstrator Systems for evaluation by the FAA at the WJ Hughes Technical Center

Test Objectives

- Evaluate to determine if decoder is a MOPS Compliant Receiver Implementation
 - Measure and baseline performance against MOPS requirements
 - Measure and characterize performance in various 1090 MHz environments
- Collect data with 6 sector antenna with 4 receiver channels sectors installed and sited to support Angle of Arrival (AoA) development

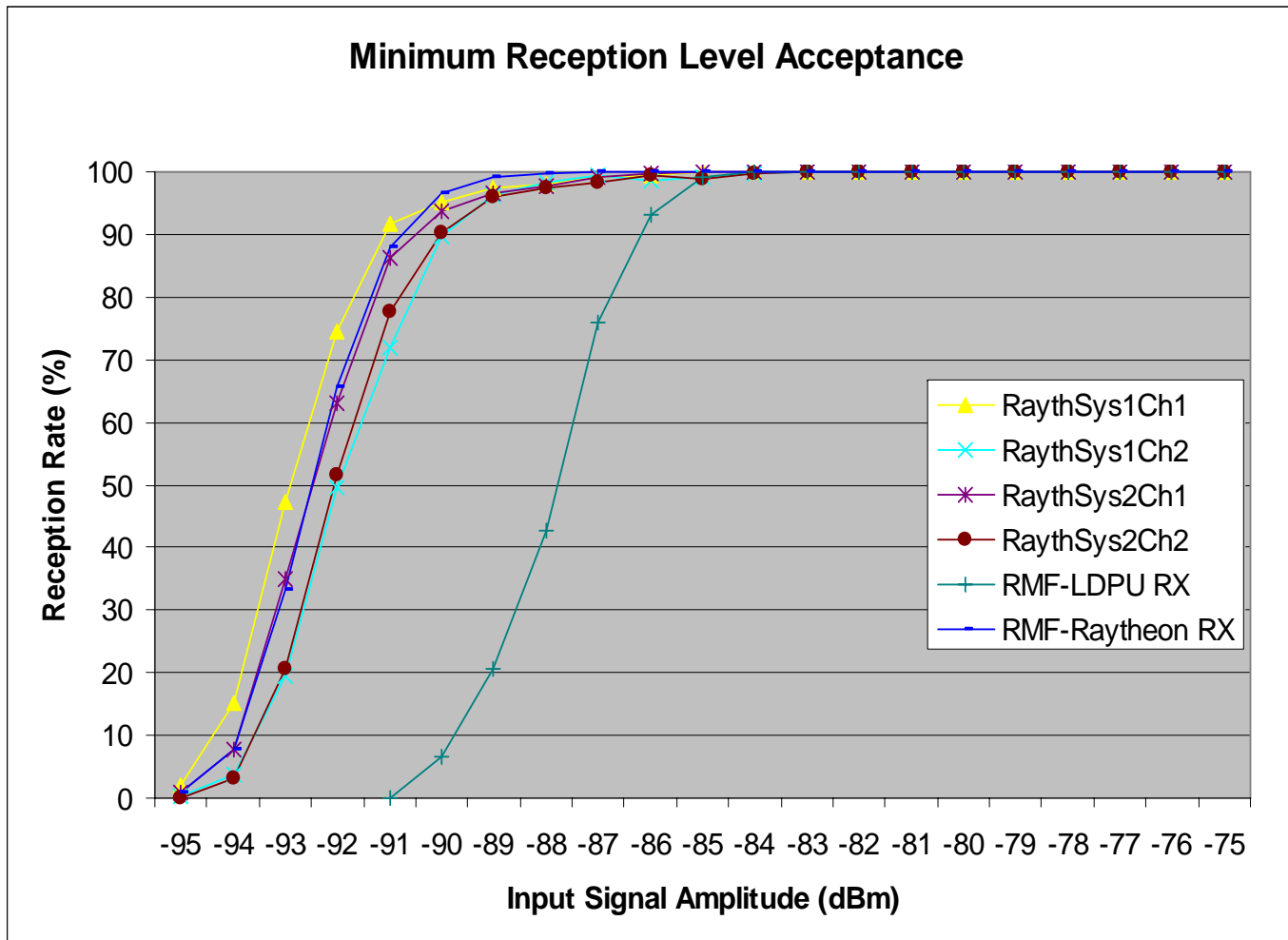
Approach

- Ran tests to Measure Performance of Raytheon ADS-B Demonstration System
 - Sensitivity Measurement
 - Expanded MOPS ATCRBS Overlap Tests
 - Expanded MOPS Mode S Overlap Tests
 - ATCRBS Future High Density Interference Scenarios
 - Mode S Future High Density Interference Scenarios

Approach

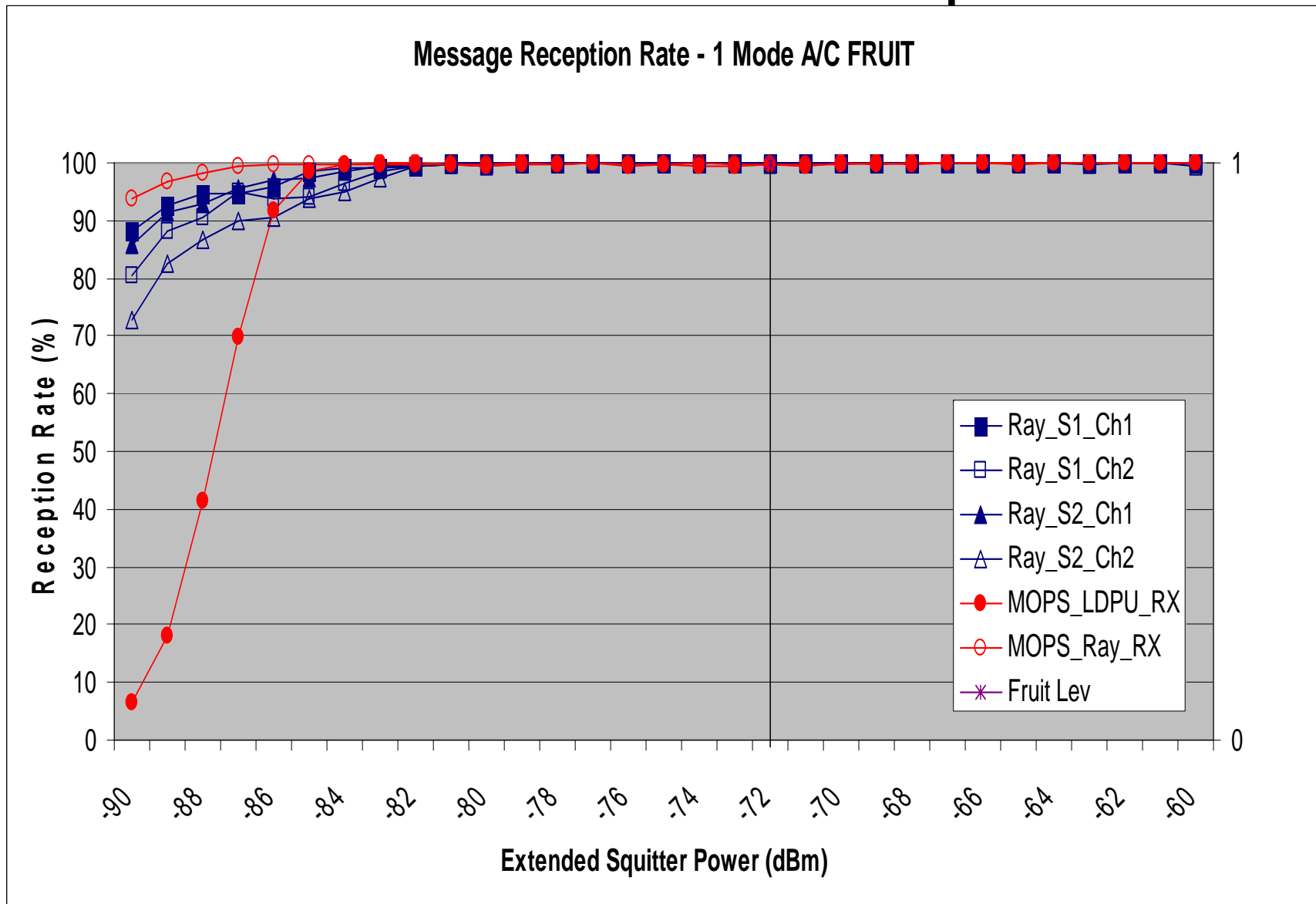
- Using Raytheon receiver (video output) for RMF decoder processing (MOPS compliant decoder)
 - Compared Raytheon to MOPS decoder with same receiver characteristics
- Testing performed on 4 Receiver/Decoder Channels. 2 Demonstrator Systems each with 2 Channels were tested.

Sensitivity Measurements Raytheon Receivers and LDPU



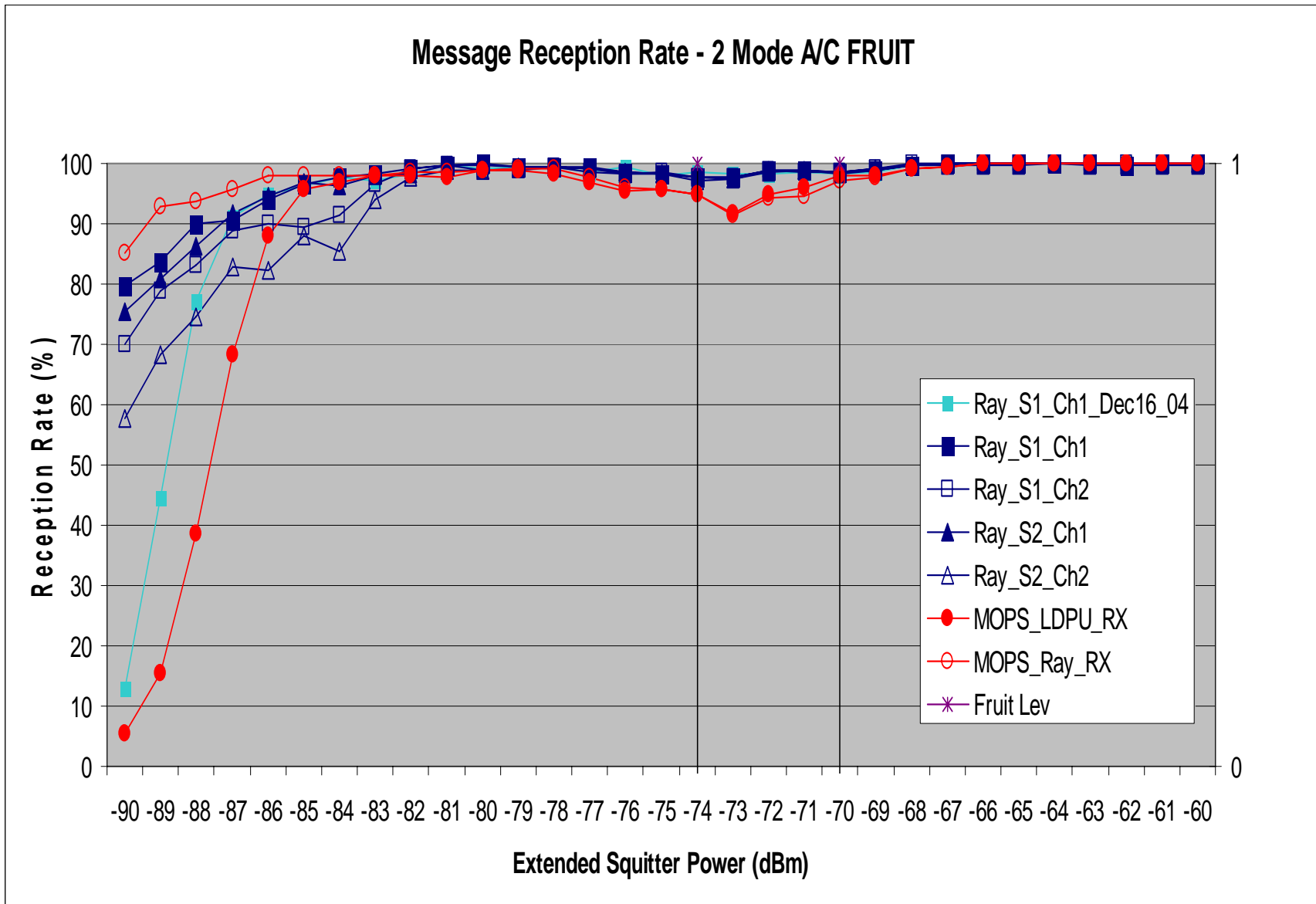
ATCRBS Overlap Testing

1 ATCRBS Overlap



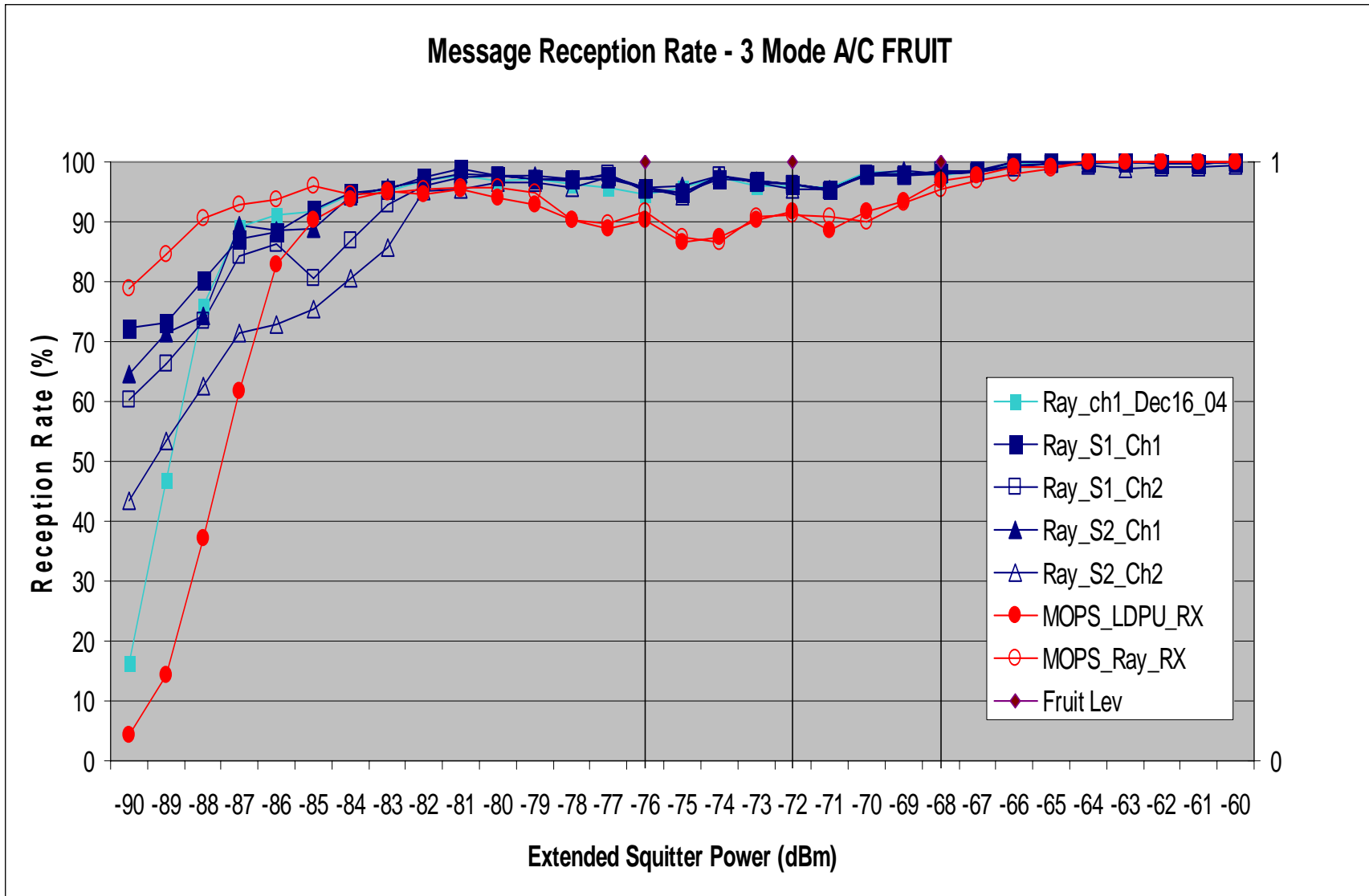
ATCRBS Overlap Testing

2 ATCRBS Overlaps



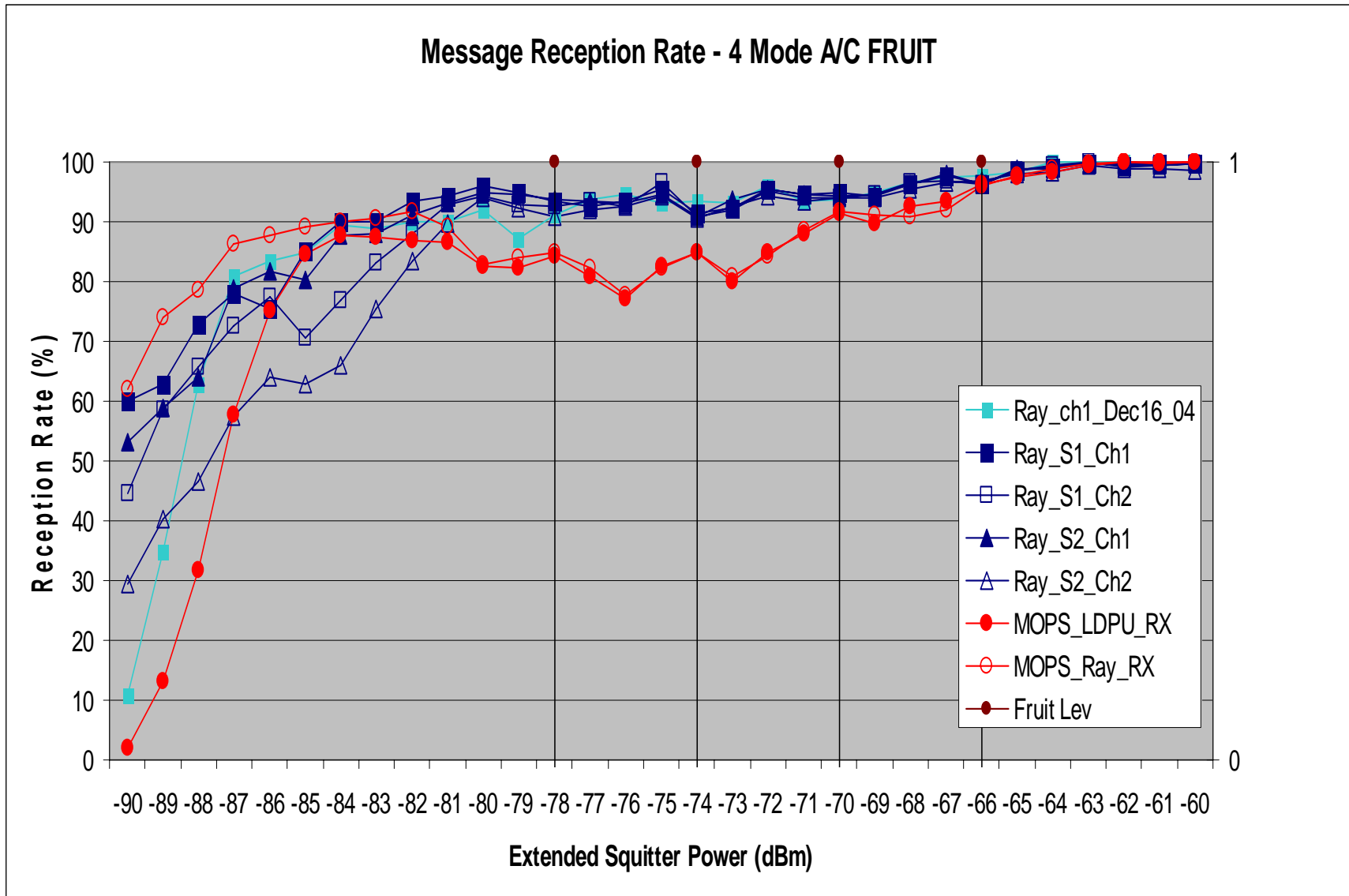
ATCRBS Overlap Testing

3 ATCRBS Overlaps



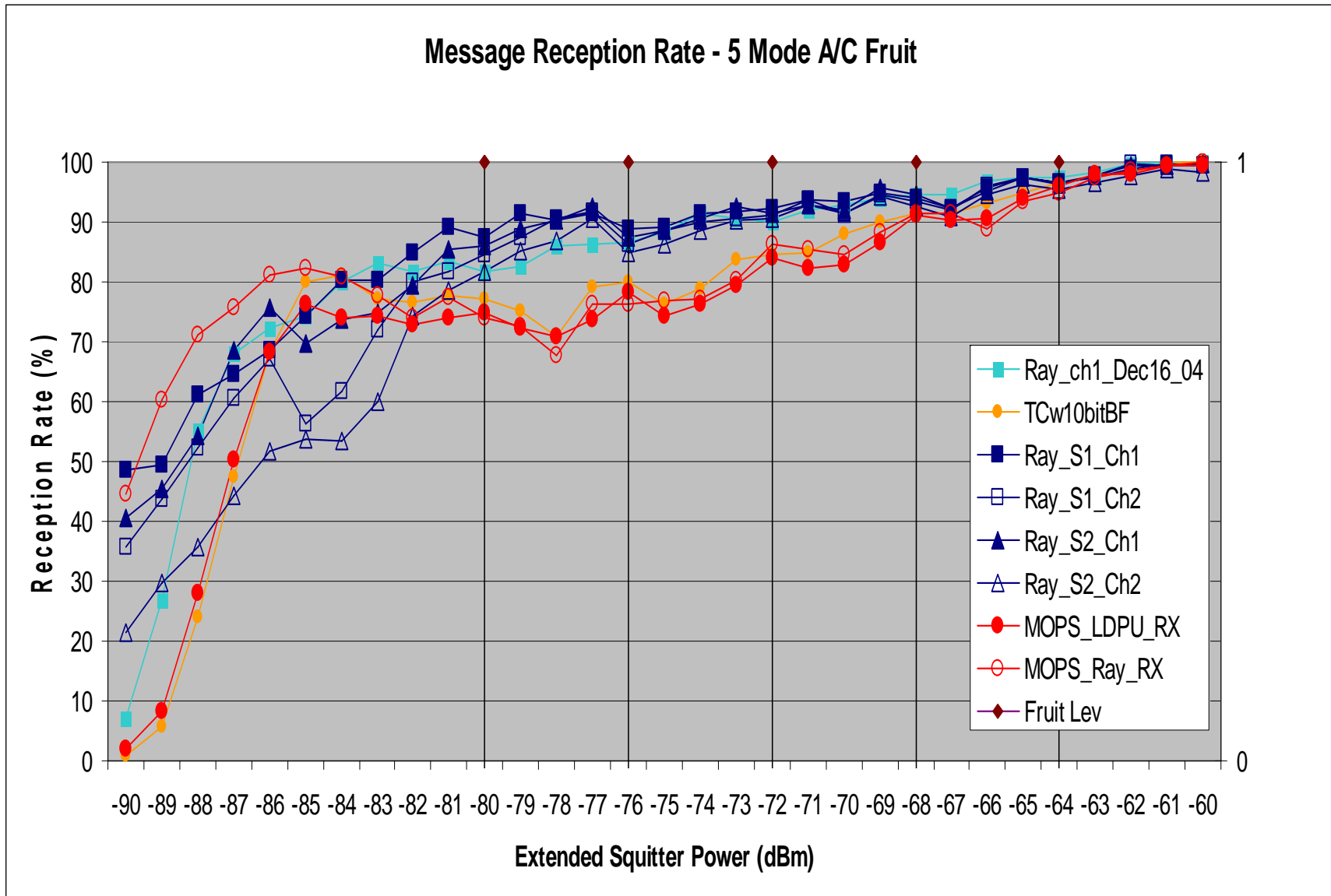
ATCRBS Overlap Testing

4 ATCRBS Overlaps



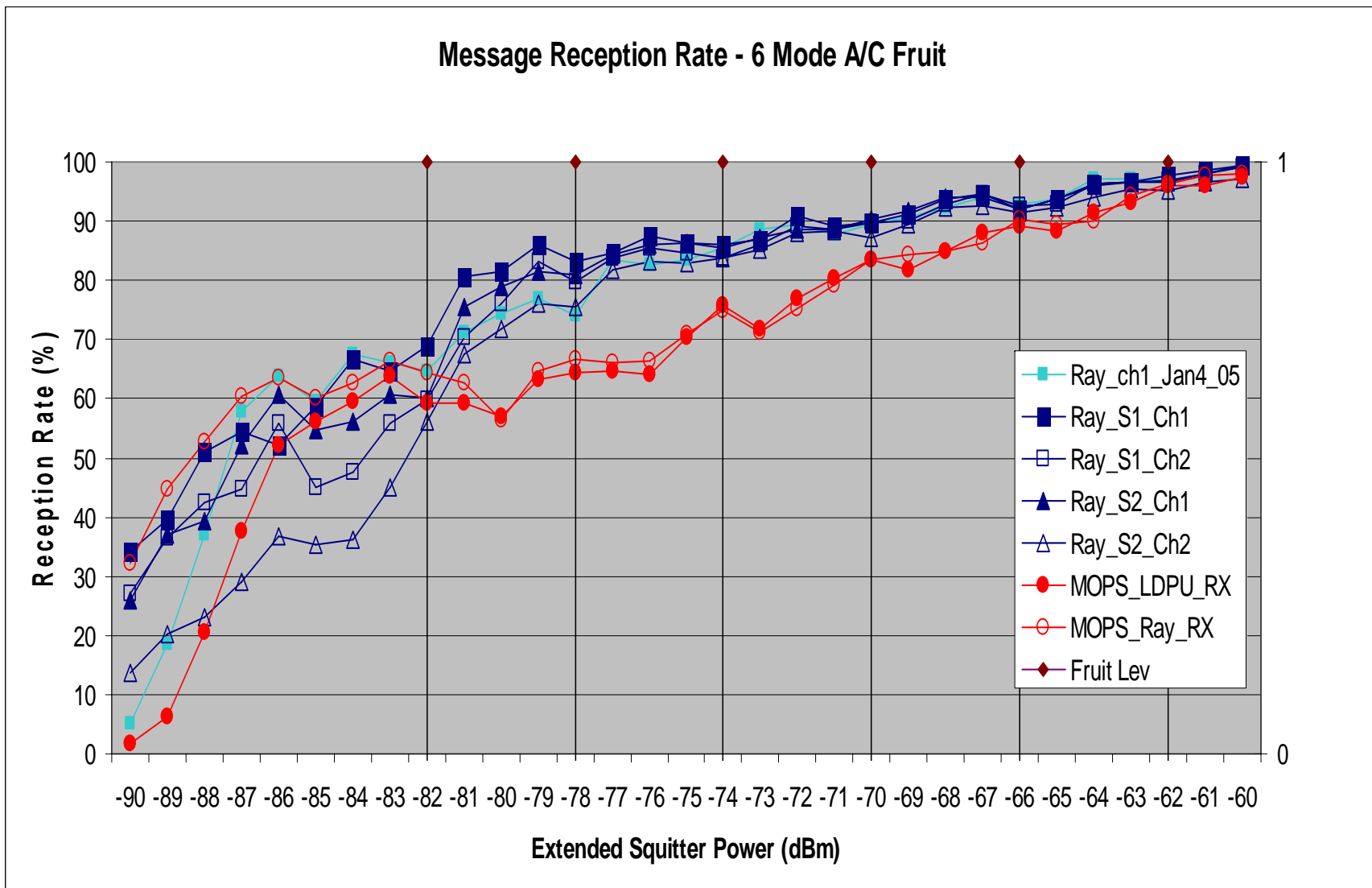
ATCRBS Overlap Testing

5 ATCRBS Overlaps



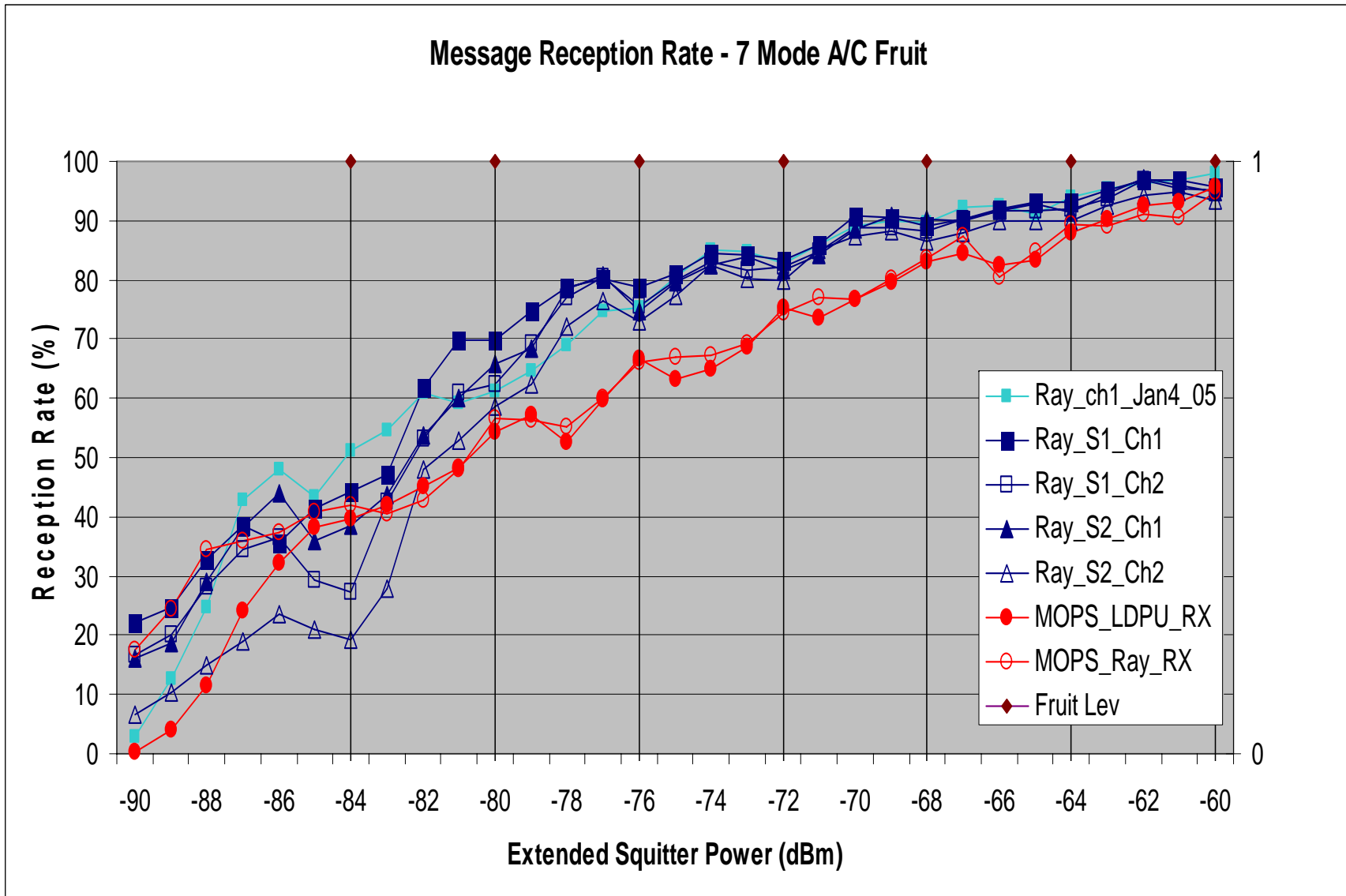
ATCRBS Overlap Testing

6 ATCRBS Overlaps



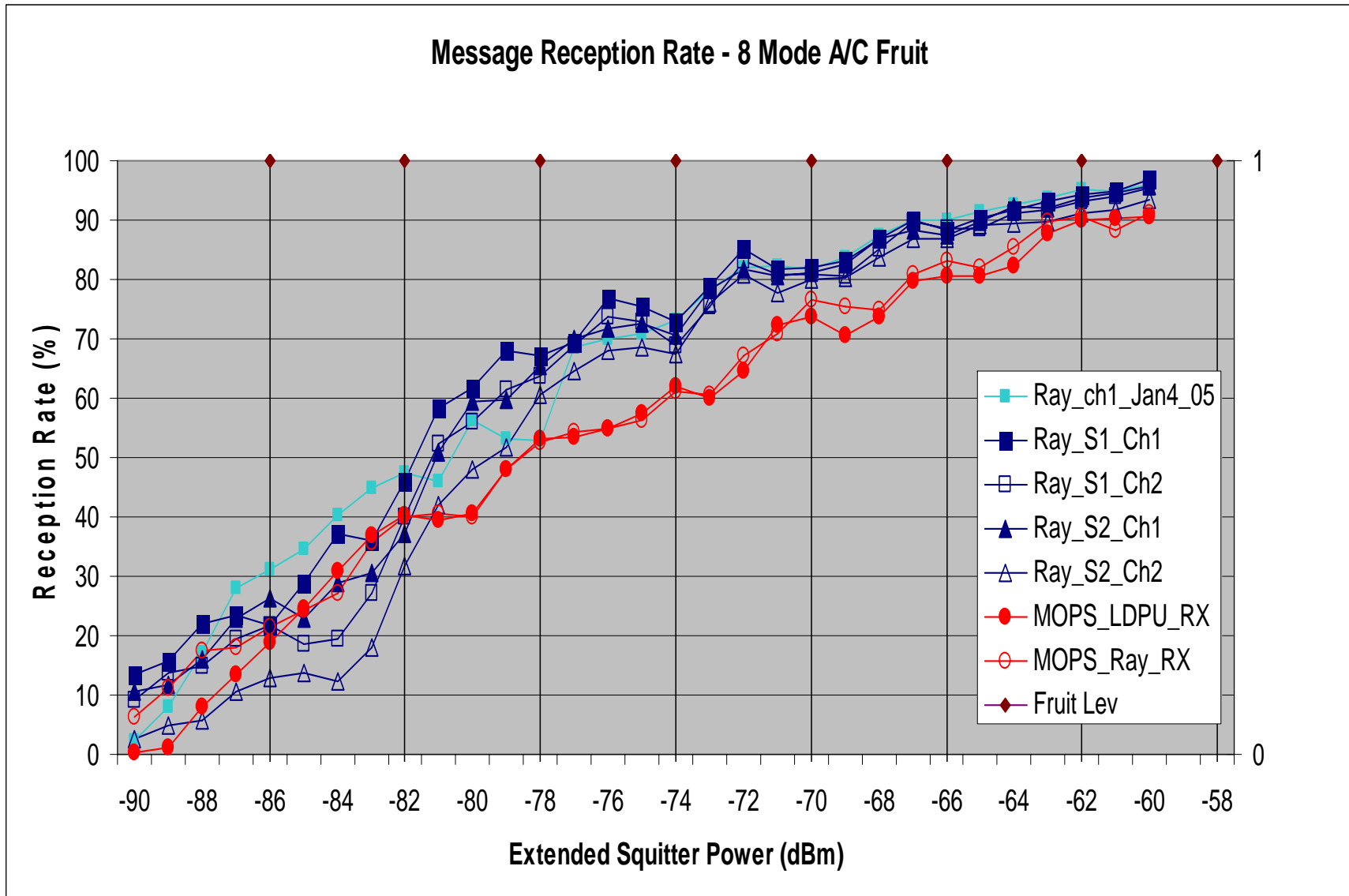
ATCRBS Overlap Testing

7 ATCRBS Overlaps

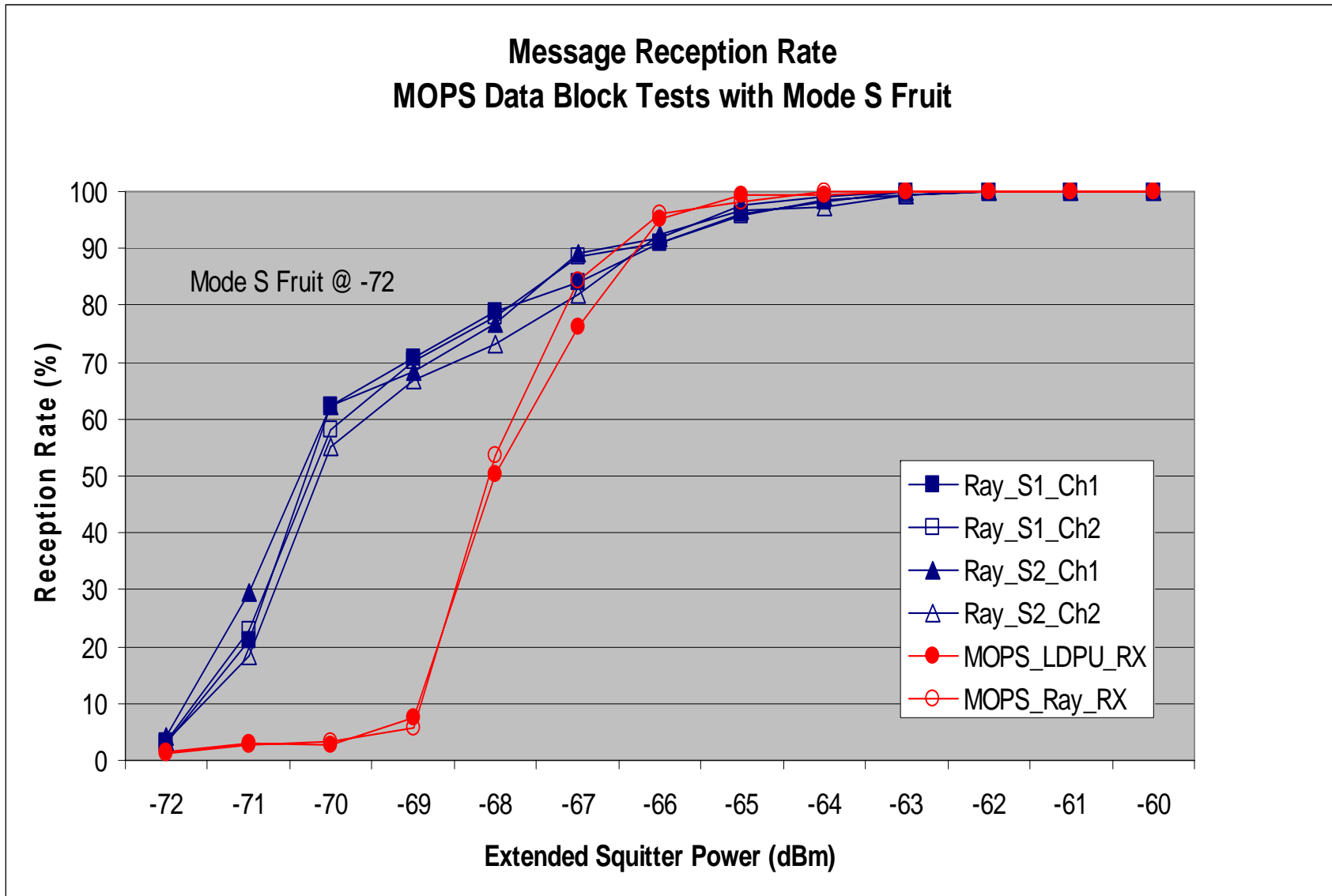


ATCRBS Overlap Testing

8 ATCRBS Overlaps

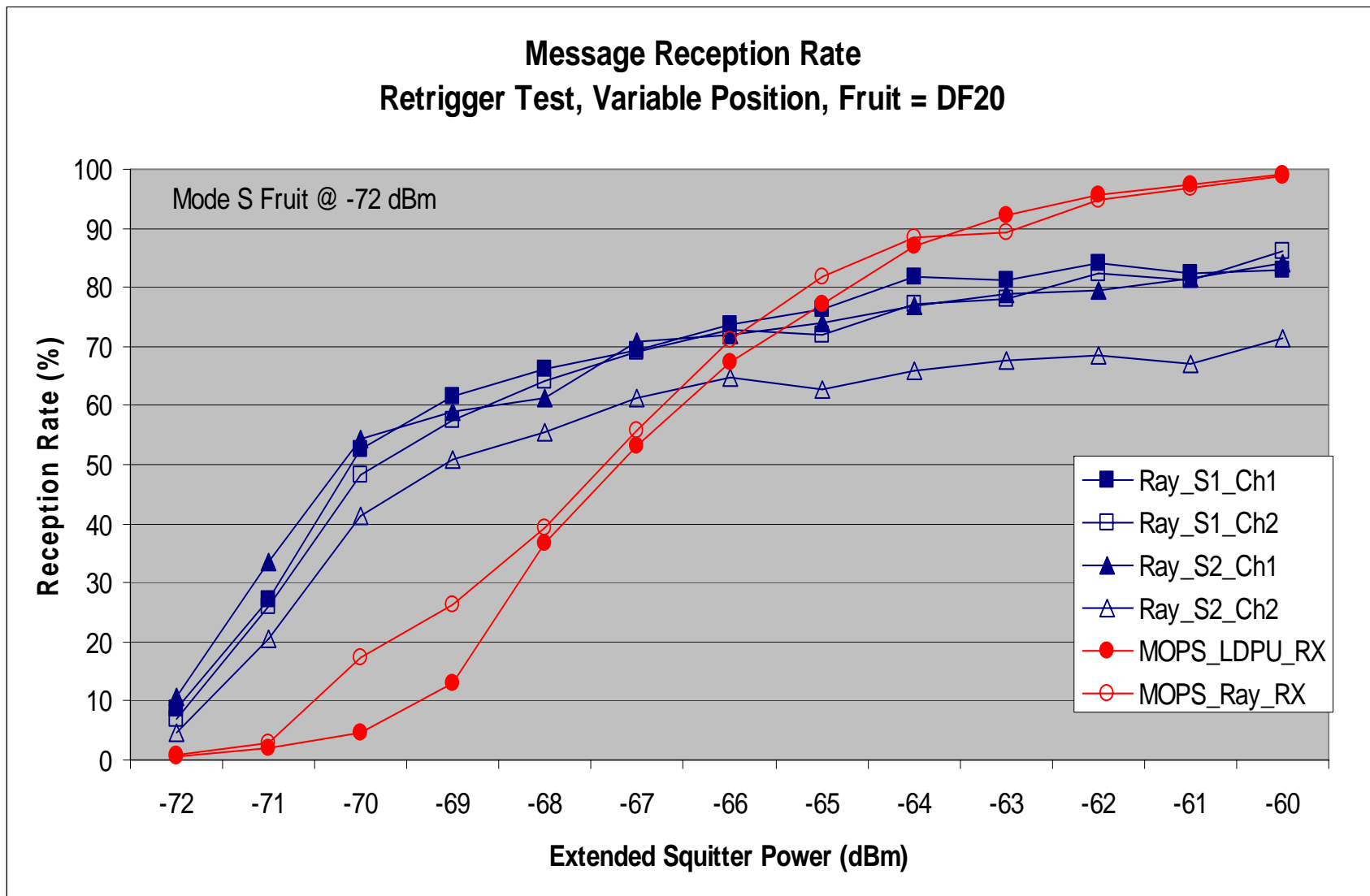


Mode S MOPS Testing Data Block Overlap



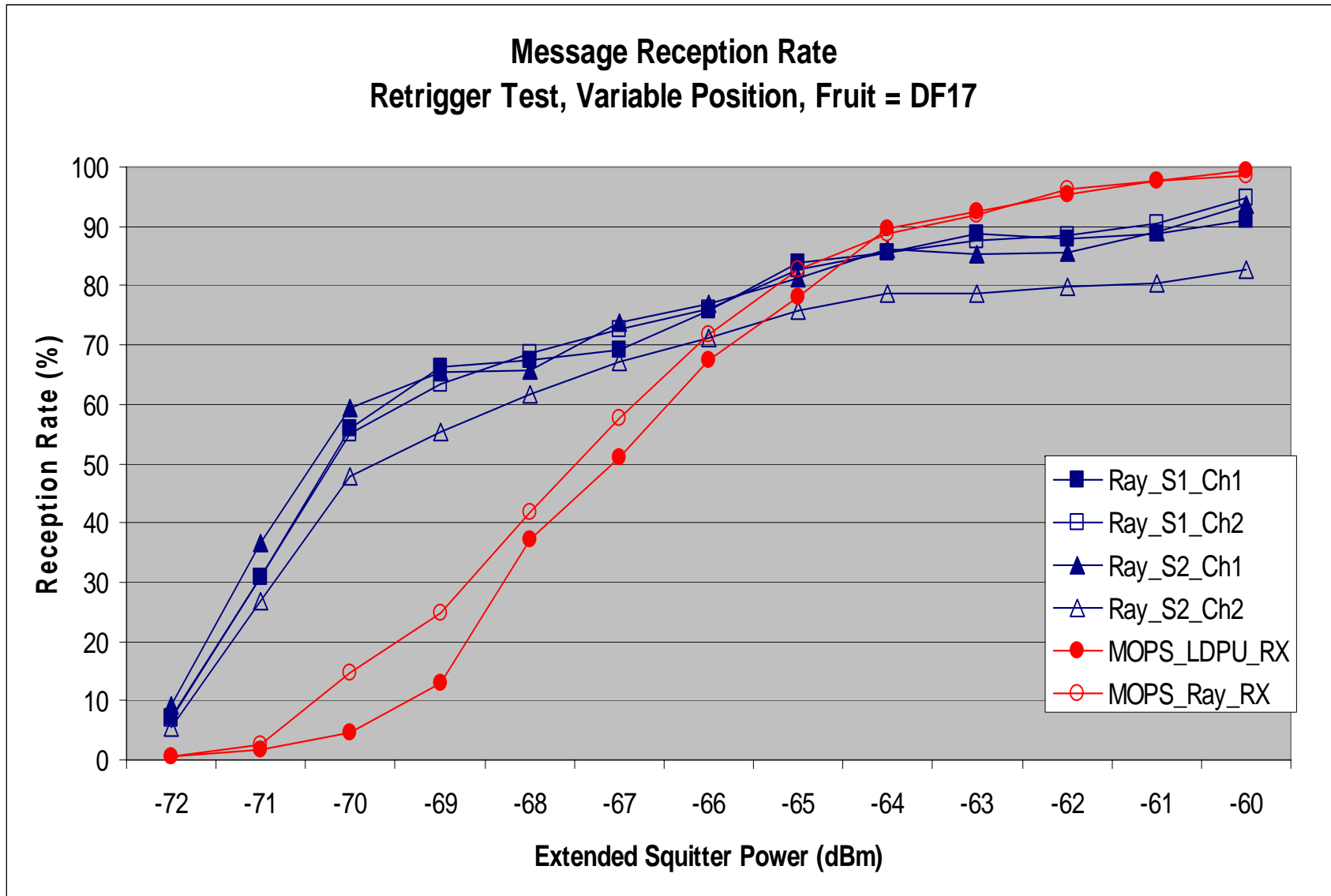
Mode S MOPS Testing

Retrigger Test, DF=20



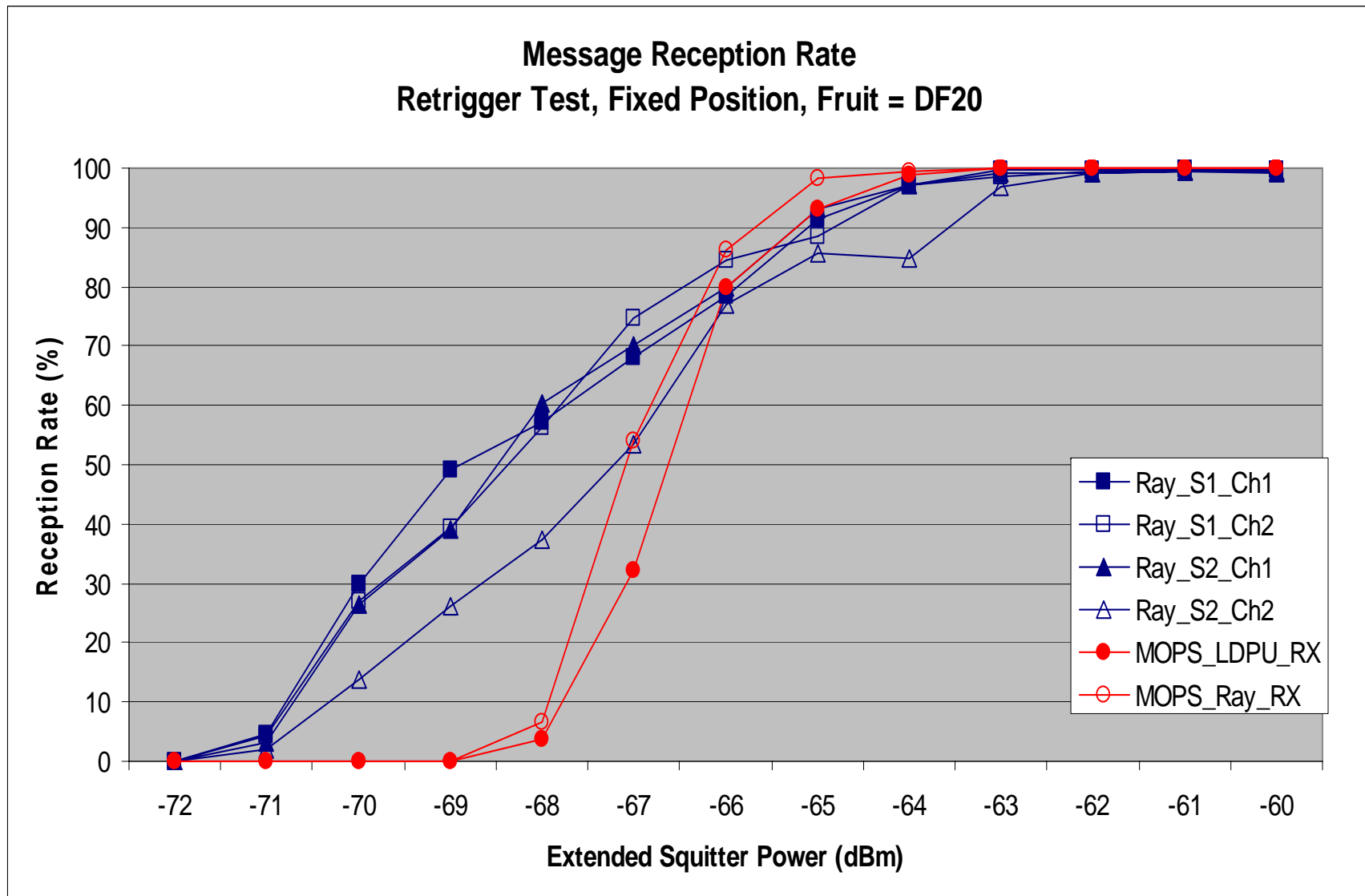
Mode S MOPS Testing

Retrigger Test, DF=17



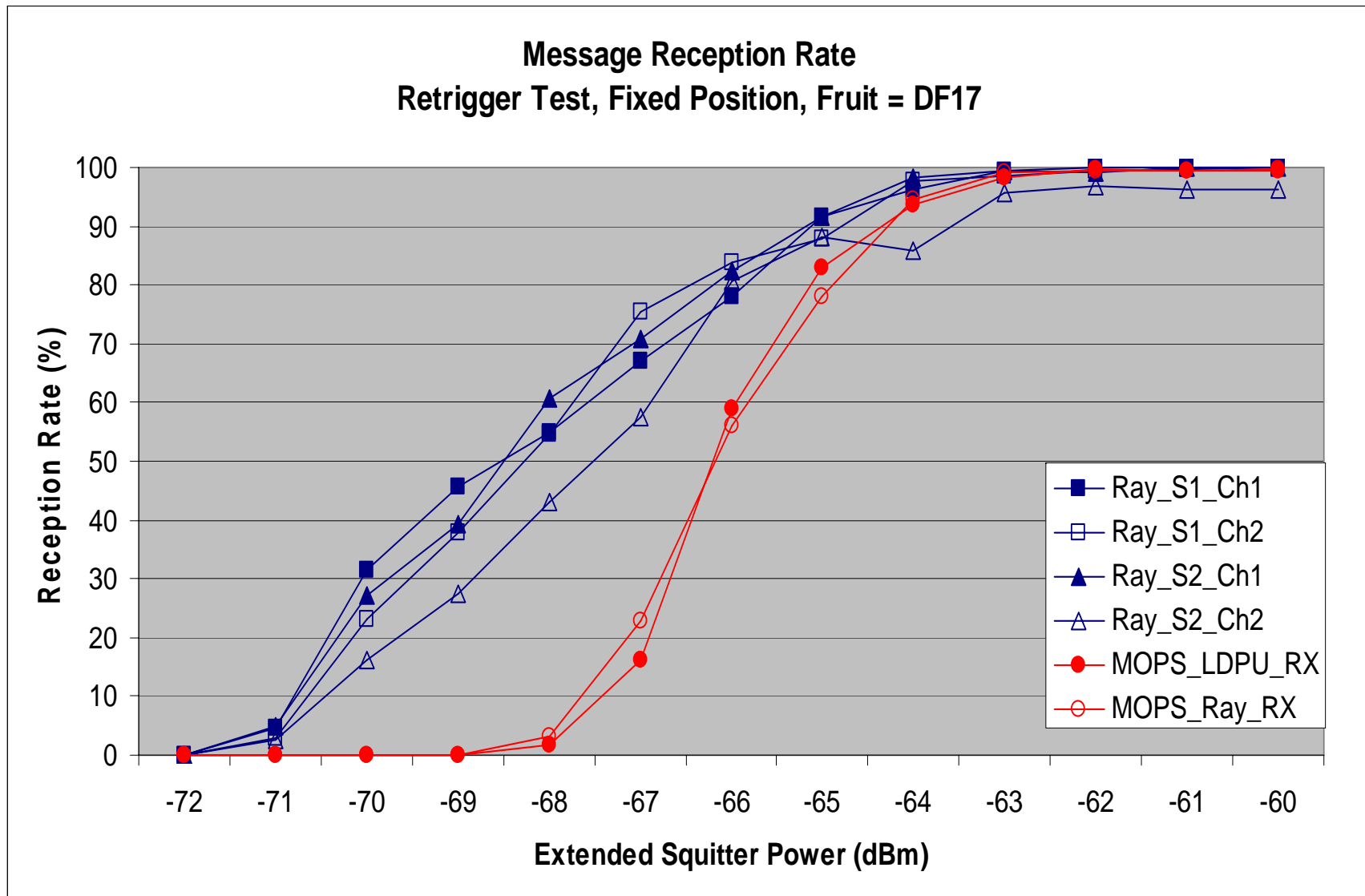
Mode S MOPS Testing

Retrigger Test, DF=20, Fixed Position

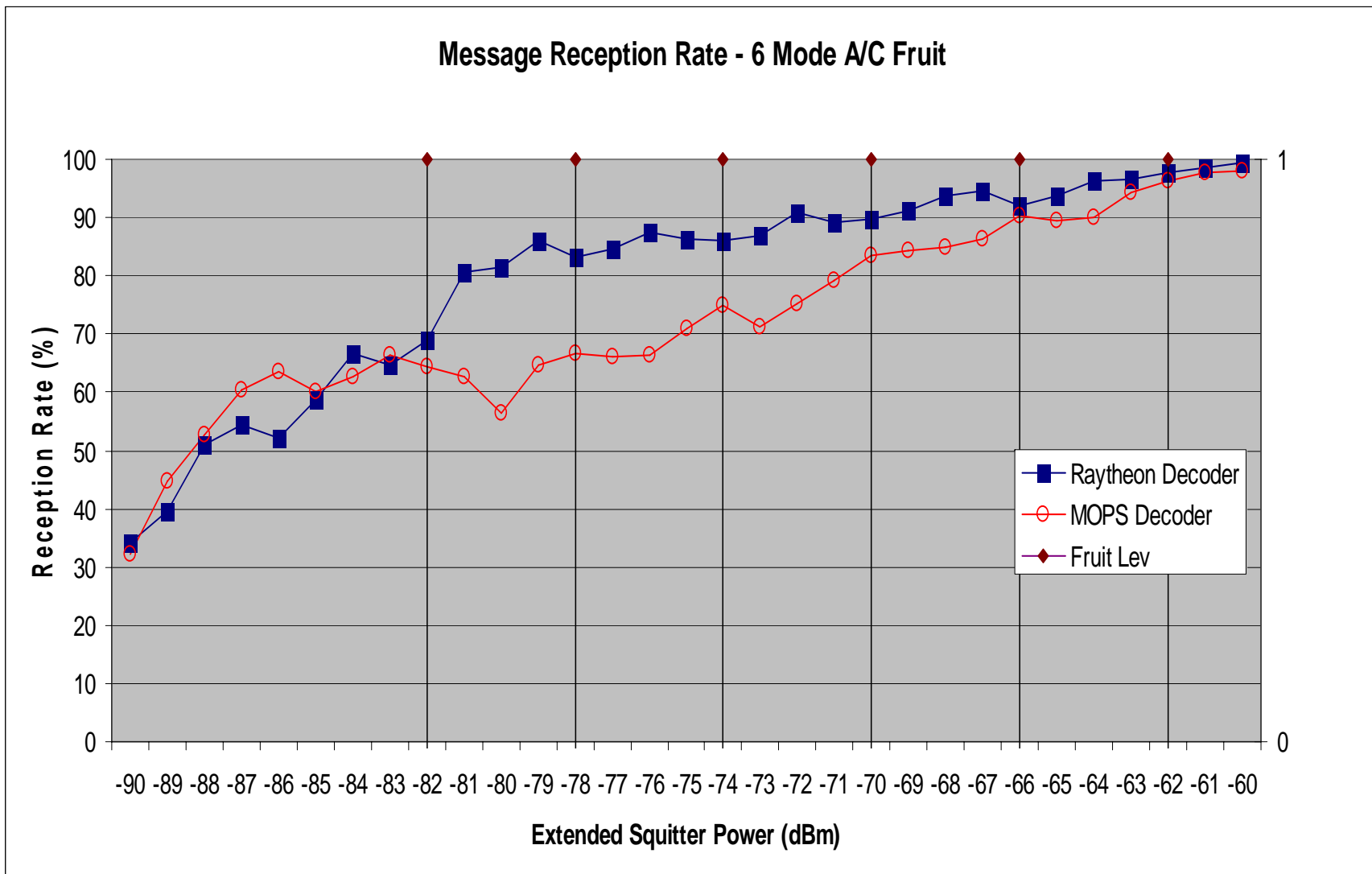


Mode S MOPS Testing

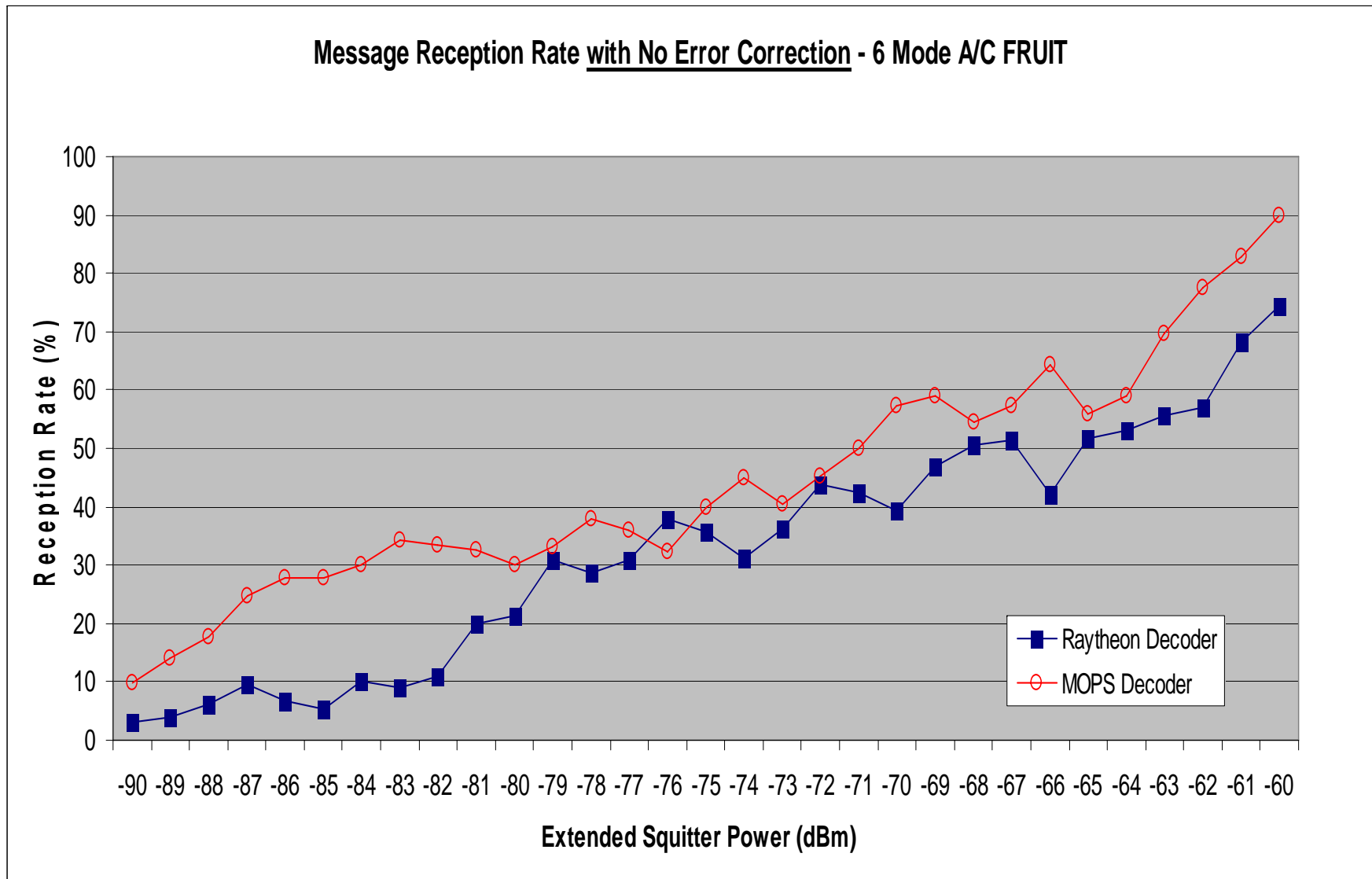
Retrigger Test, DF=17, Fixed Position



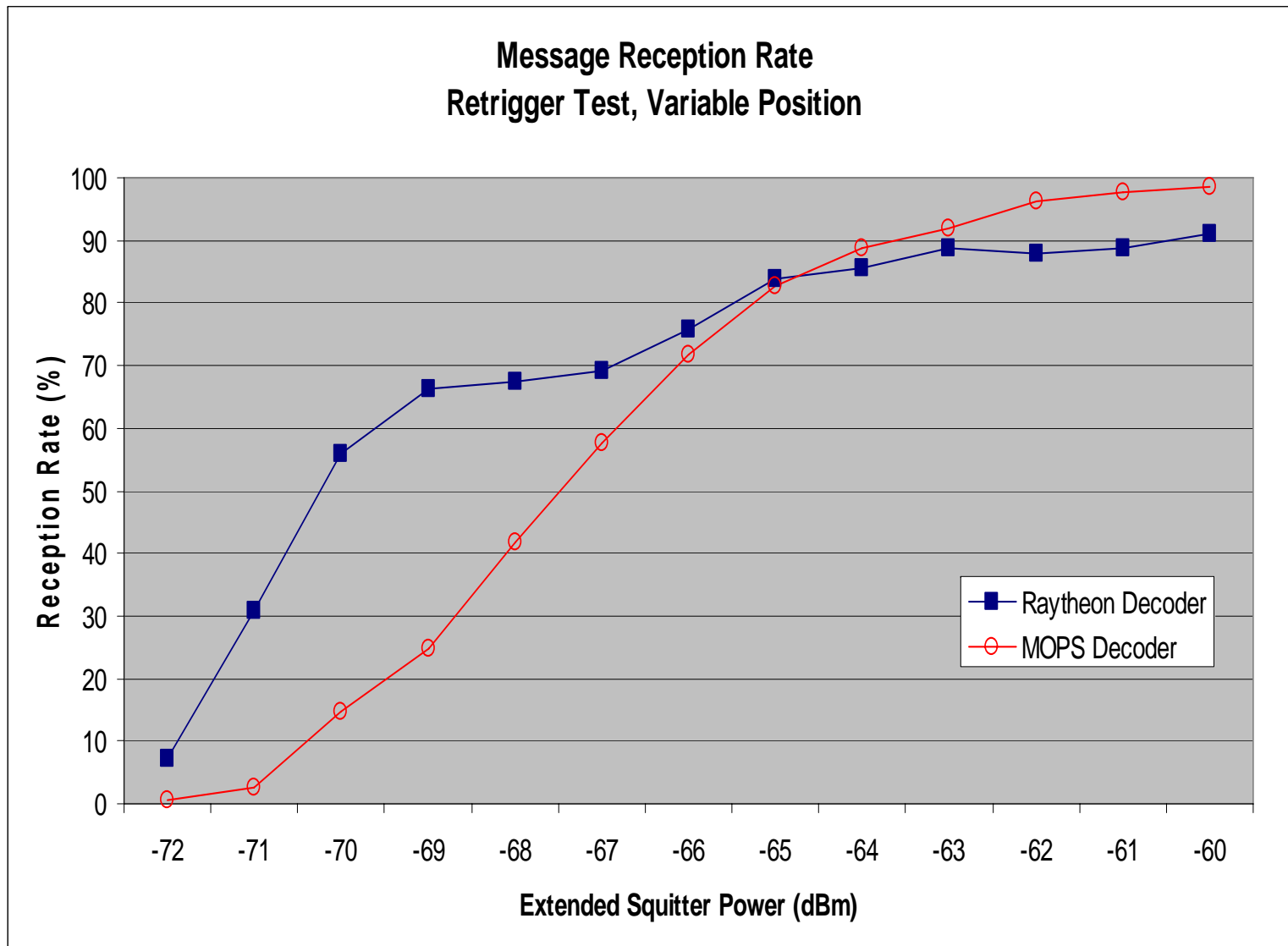
ATCRBS Bench Test Results to Compare Bit Detection



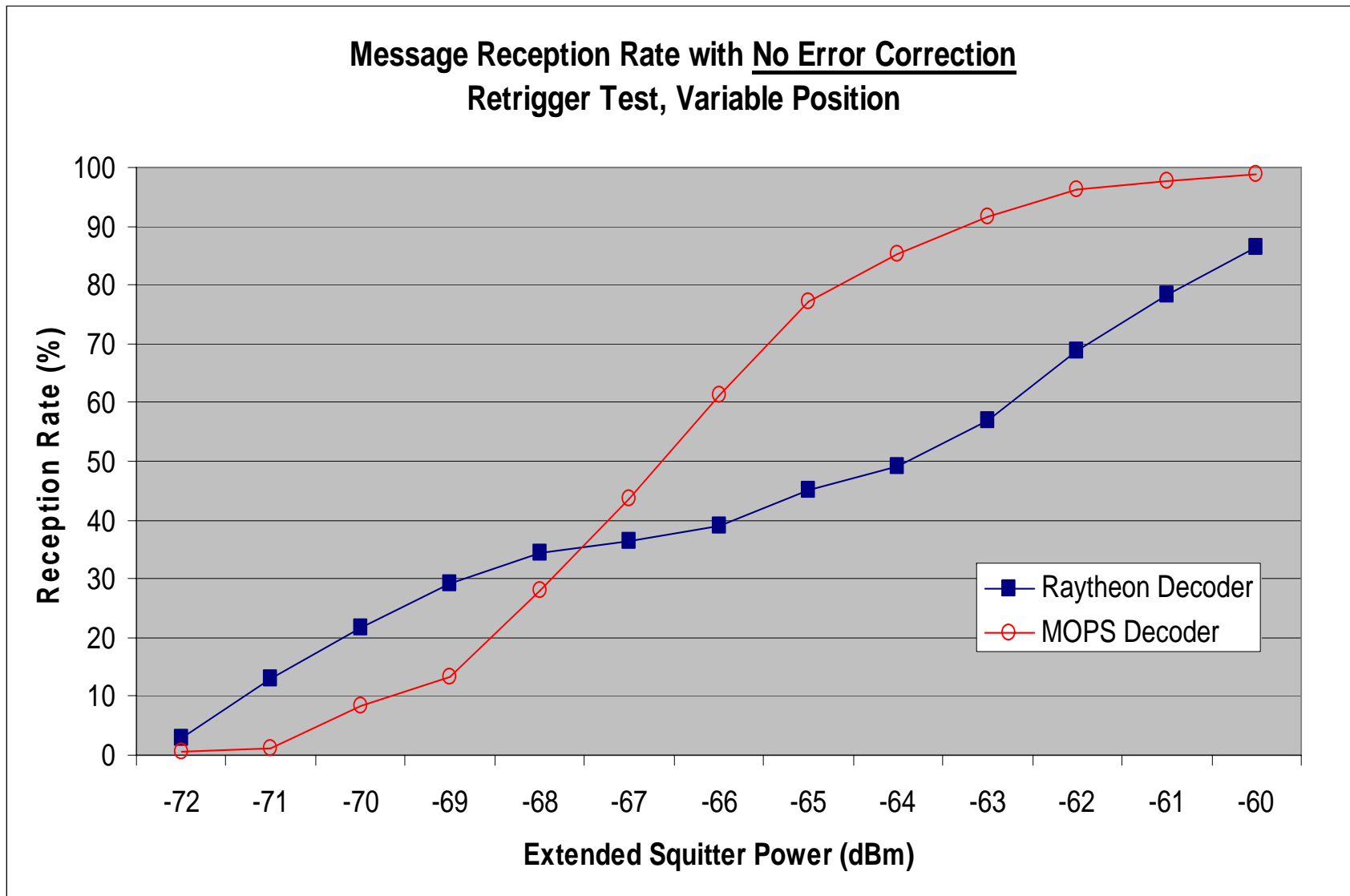
ATCRBS Bench Test Uncorrected Message Reception Comparison



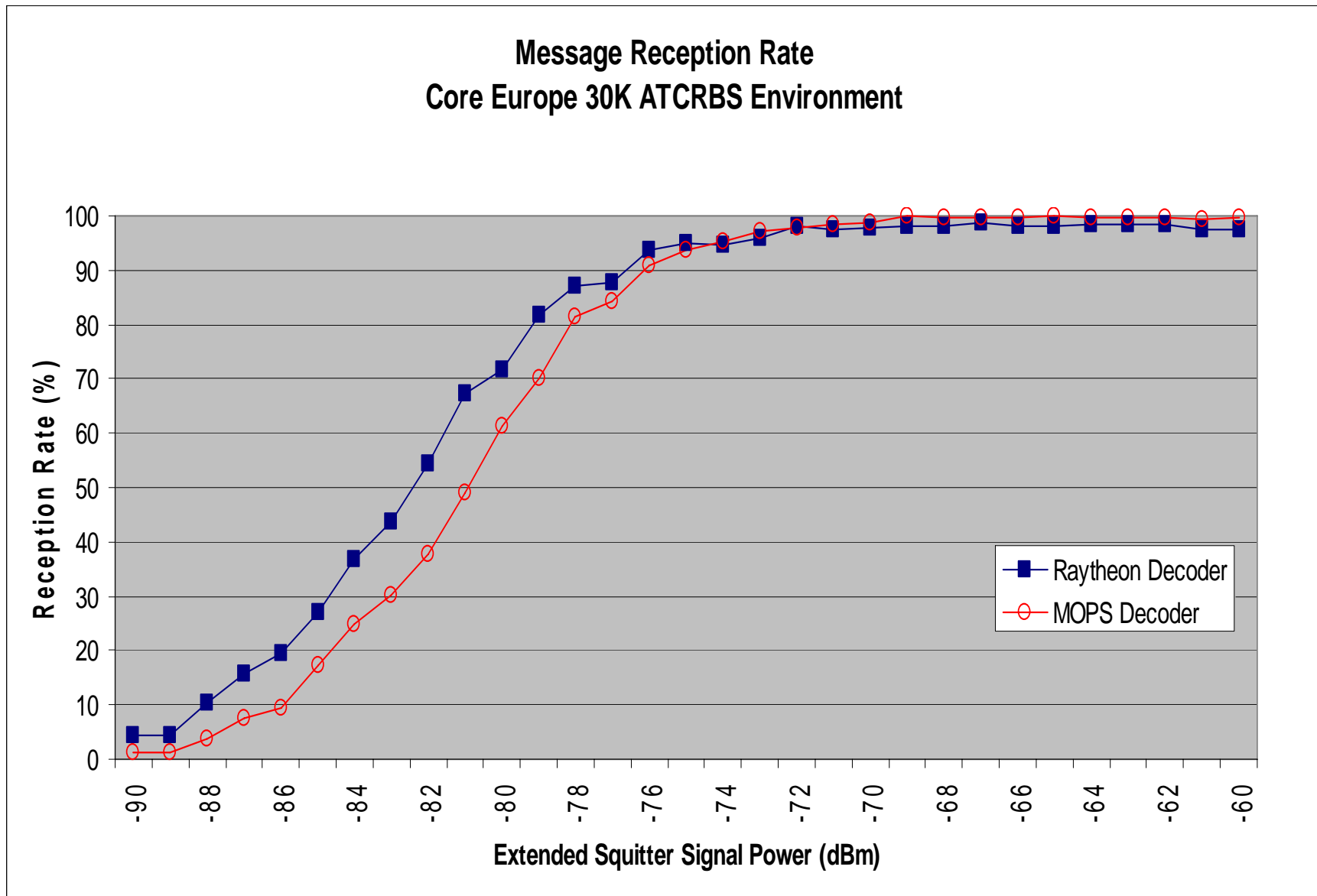
Mode S Bench Test Results to Compare Bit Detection



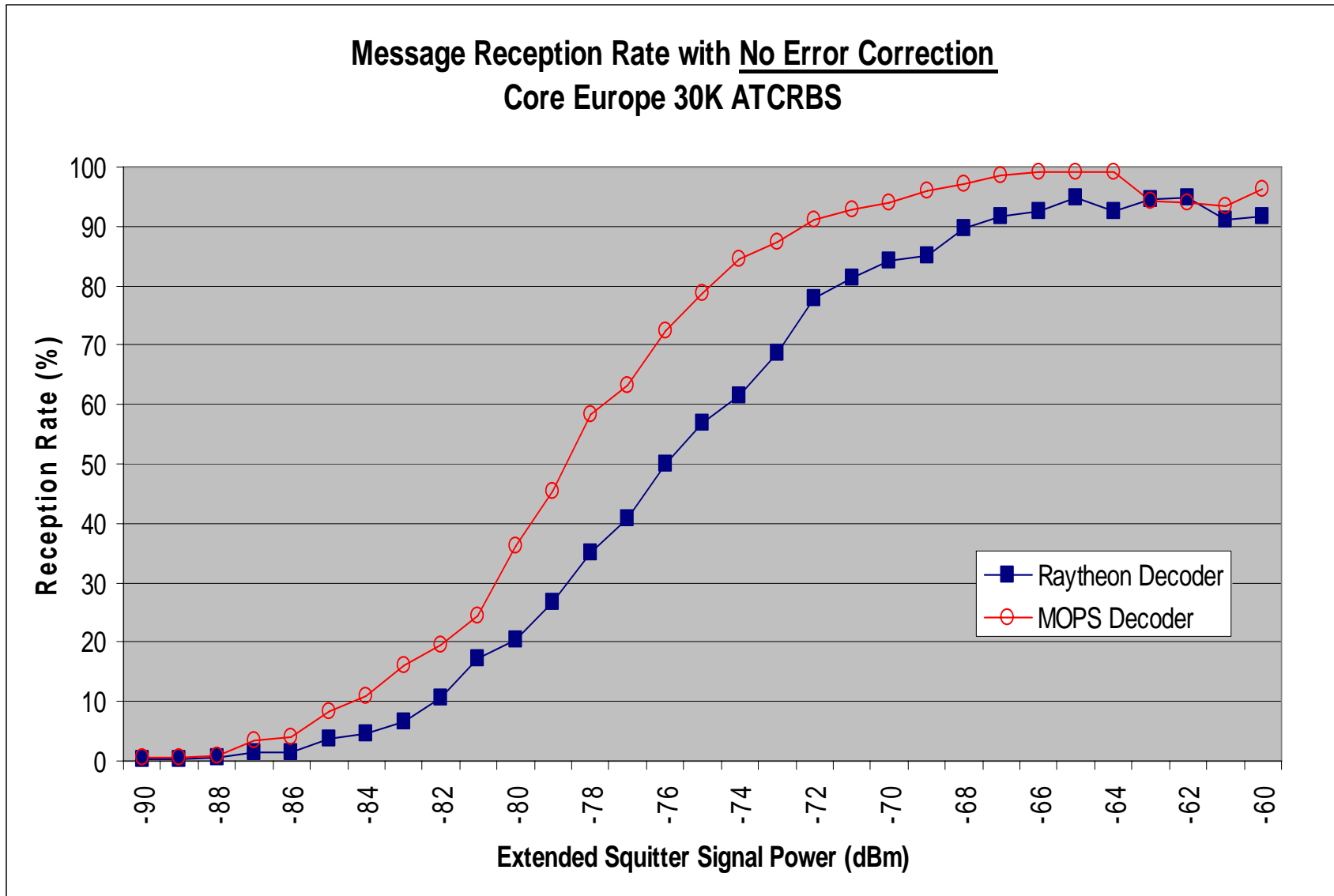
Mode S Bench Test Uncorrected Message Reception Comparison



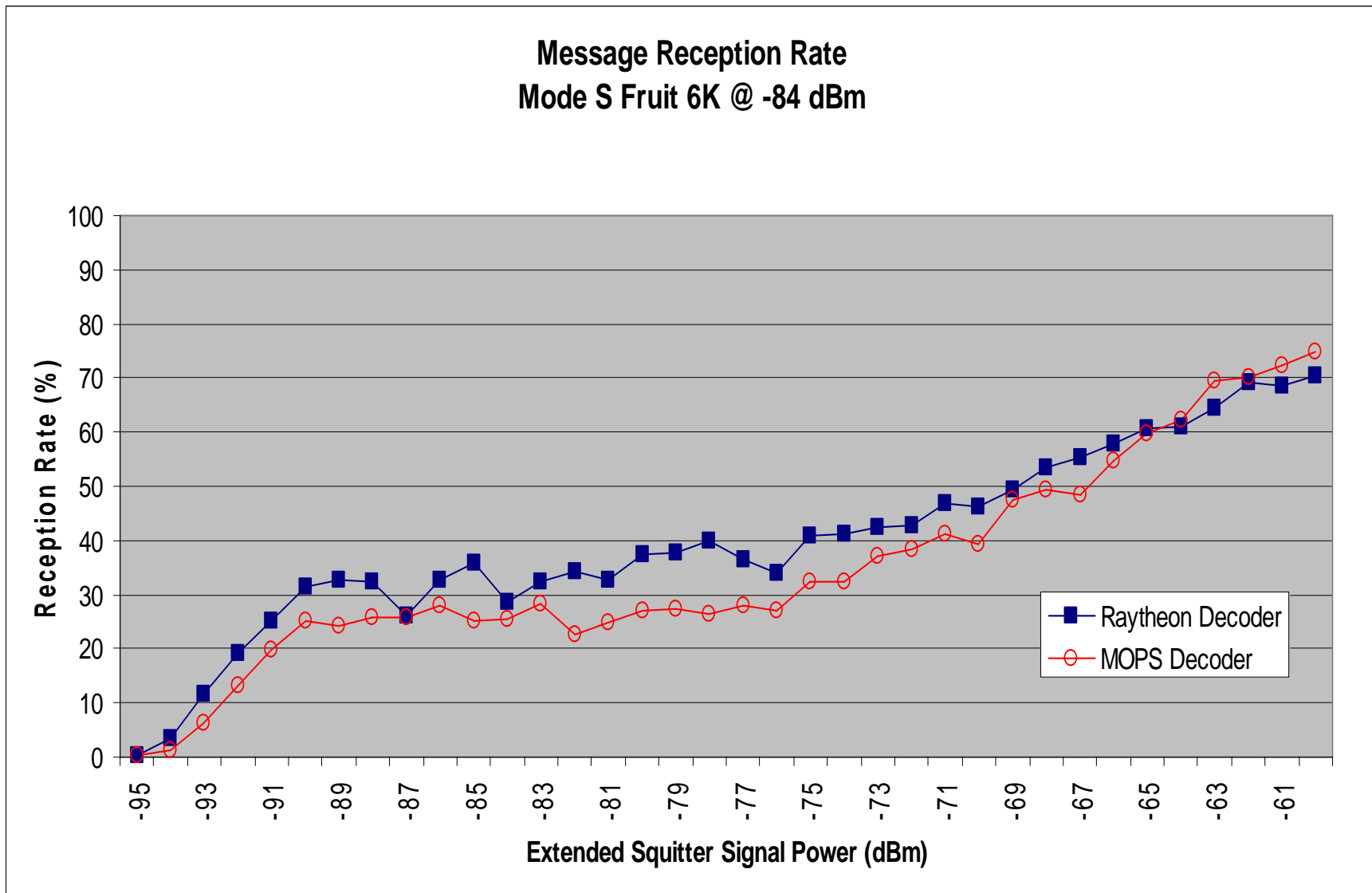
ATCRBS Interference Scenario Performance



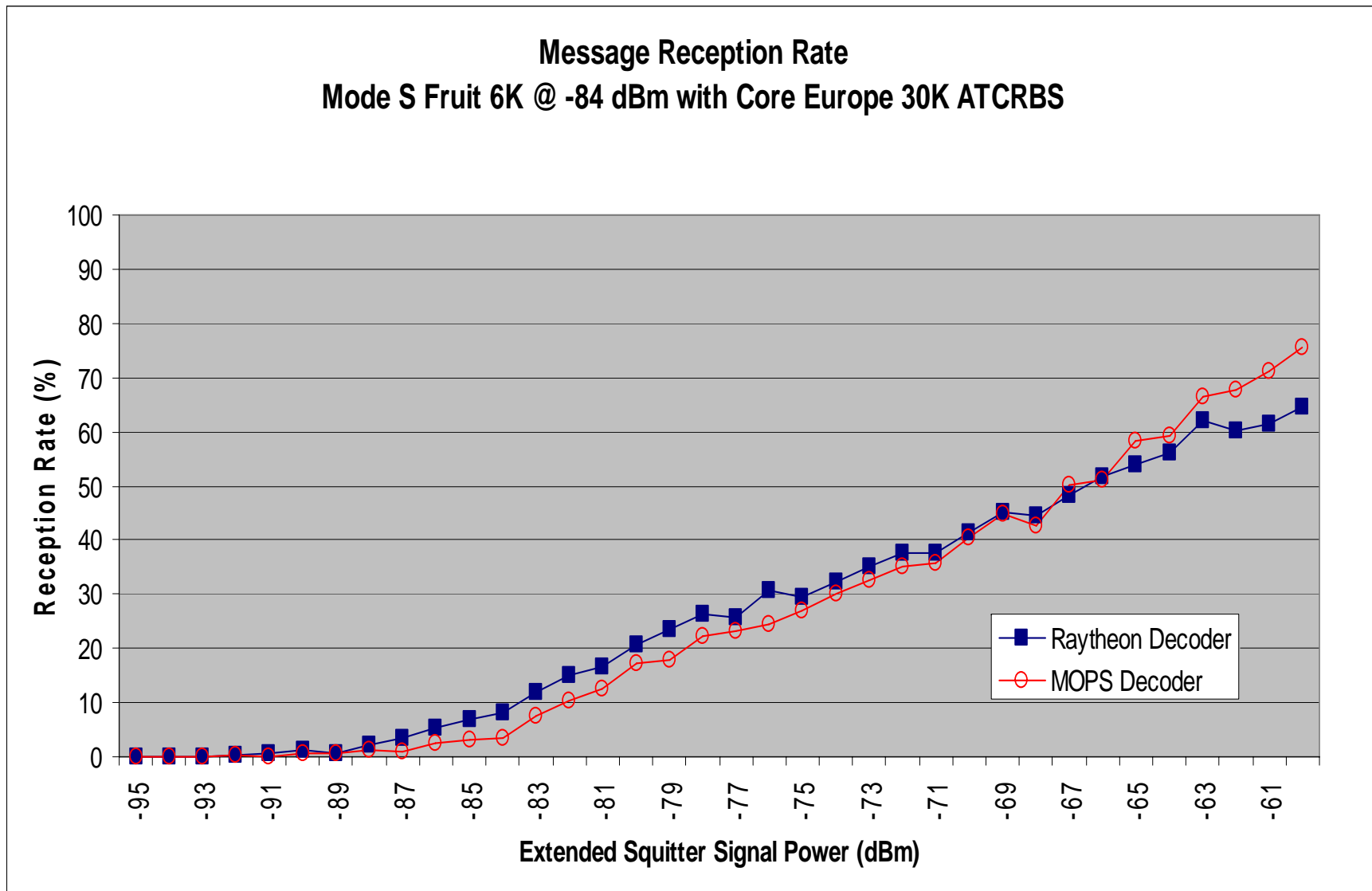
ATCRBS Interference Scenario Uncorrected Message Reception Comparison



Decoder Comparison - Mode S Interference Only



Decoder Comparison with Combined Mode S and ATCRBS Interference



Undetected Error Rate

- Undetected Error Rate was computed for receptions recorded during the MOPS tests and the high interference scenarios
- Undetected error rate was about 10^{-5} for the Raytheon System
- Undetected error rate of the MOPS decoder was 10^{-6}

Conclusion

- The Raytheon ADS-B Demonstrator System meets the MOPS performance requirements for detection in the presence of ATCRBS and Mode S Overlaps tested in accordance with the MOPS
- Raytheon ADS-B Demonstrator System performance in simulated high density interference environments is similar to the performance of a MOPS compliant decoder implementation