

Retrodirective Cross-Eye Jammer Implementation using Software-Defined Radio (SDR)

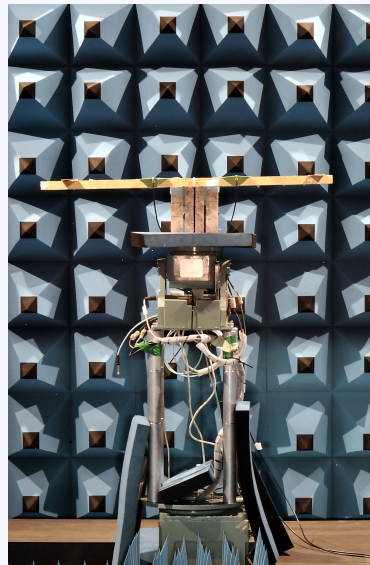
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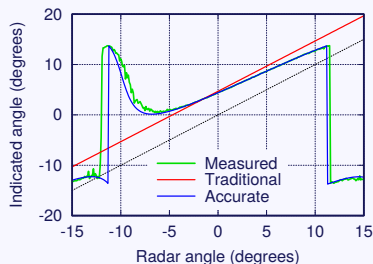
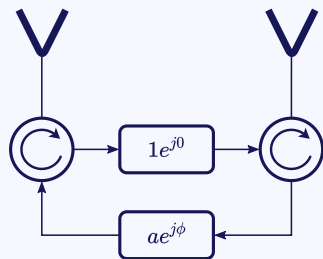
Background

- Electronic attack (EA)
Electronic countermeasures (ECM)
- Induces angular error
 - Based on glint
 - Affects all radars
- Old idea
 - Patents filed in 1958
- Implementation
 - Extremely challenging
 - Isolation
 - Tolerances
 - Since turn of the century

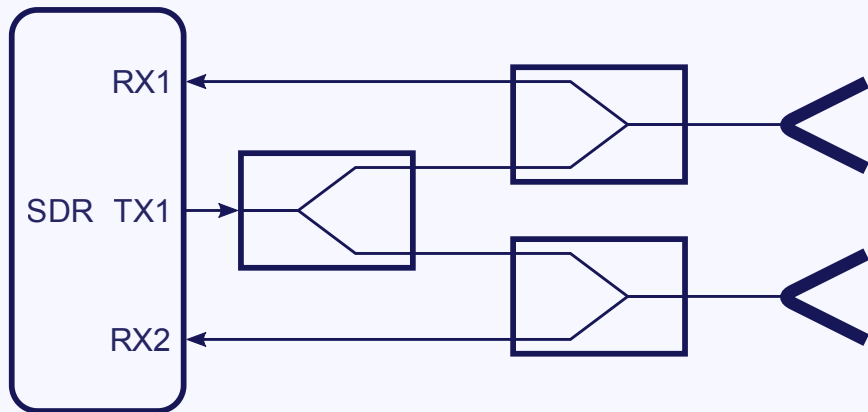


Retrodirective Cross-Eye Jamming

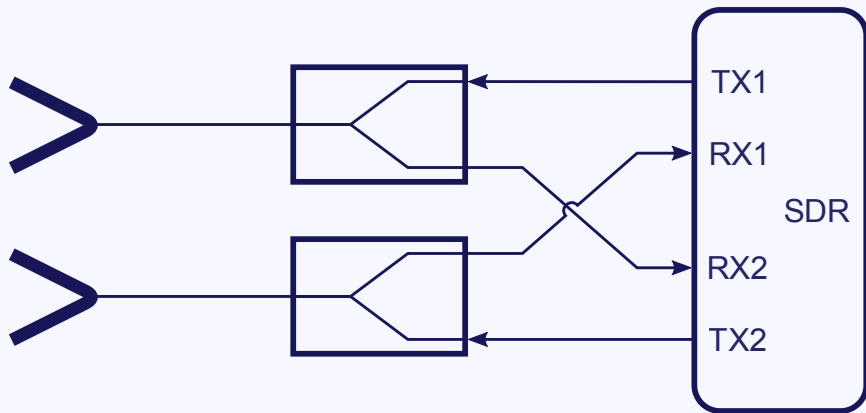
- Non-retrodirective effective over small angular region
 - Minor pointing errors (≈ 1.5 mrad) are dramatic
- Retrodirective implementation
 - Transmits jamming signal in direction of incoming signal
 - Removes effects of shared components
 - Ignored by most experiments
 - Simulated by some experiments
- Need retrodirective experiments to validate theory
 - Historically, errors



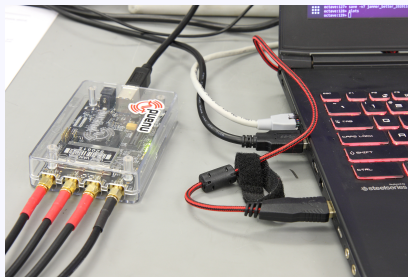
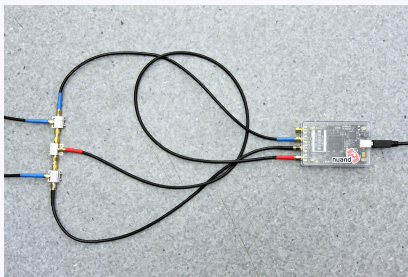
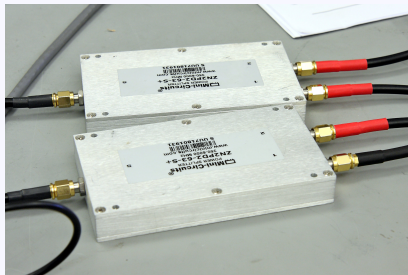
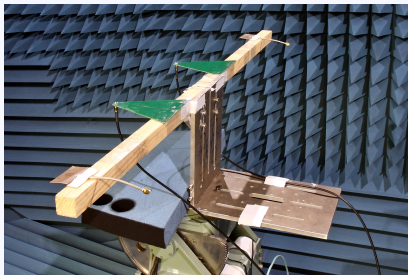
Monopulse Radar Implementation



Retrodirective Cross-Eye Jammer Implementation

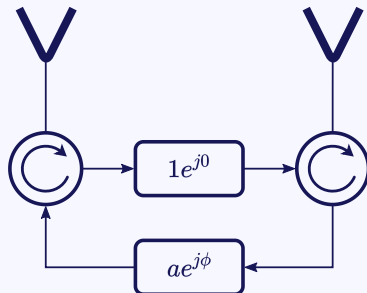


Hardware

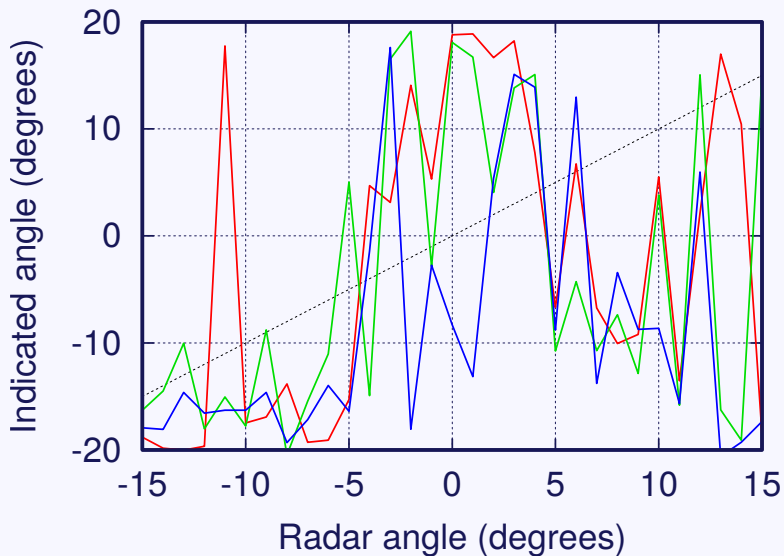


Calibration – Jammer

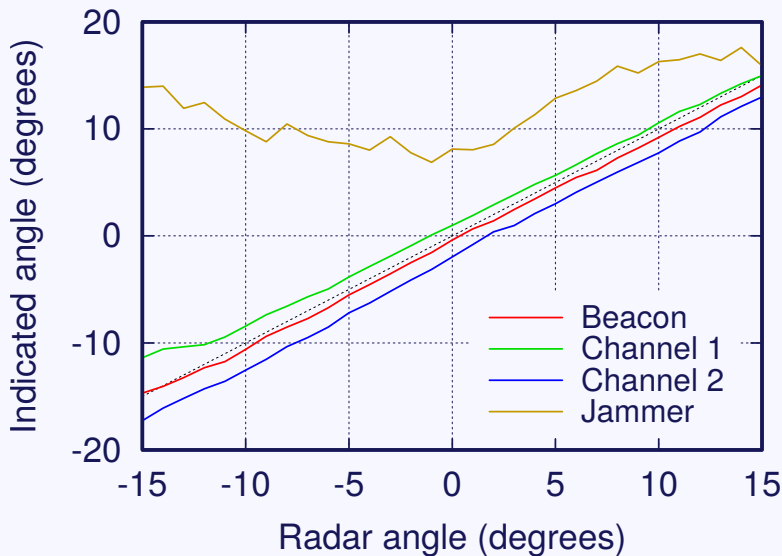
- Ideal cross-eye jamming
 - $a \rightarrow 1$
 - $\phi \rightarrow 180^\circ$
 - Correspond to minimum radar sum-channel return
- Process
 - Adjust ϕ to minimise sum-channel return
 - Adjust a to minimise sum-channel return



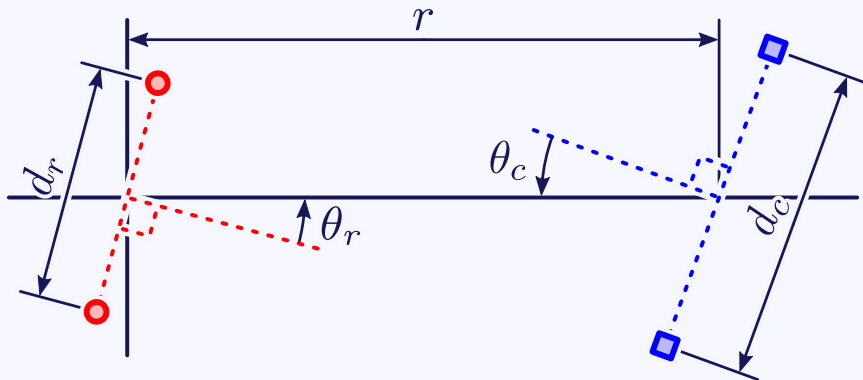
Initial Measurements



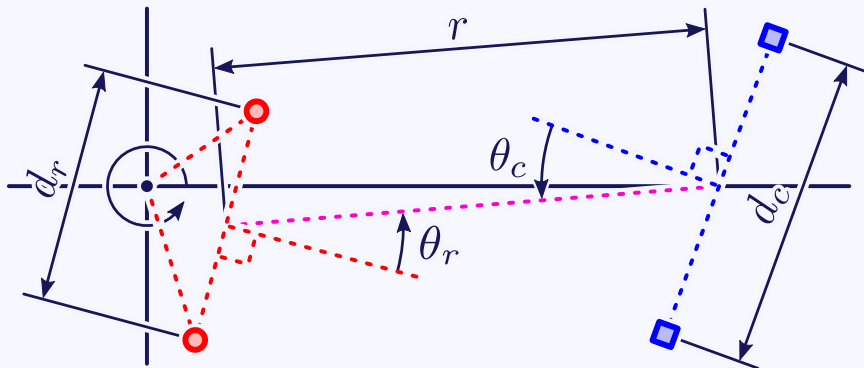
Initial Measurements (Averaged)



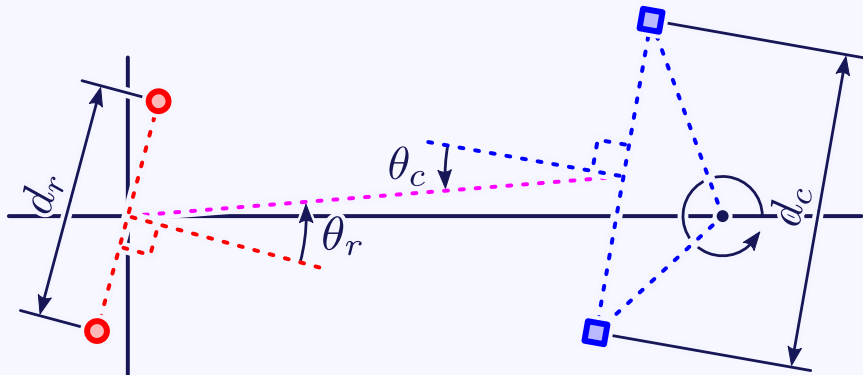
Calibration – Ideal Case



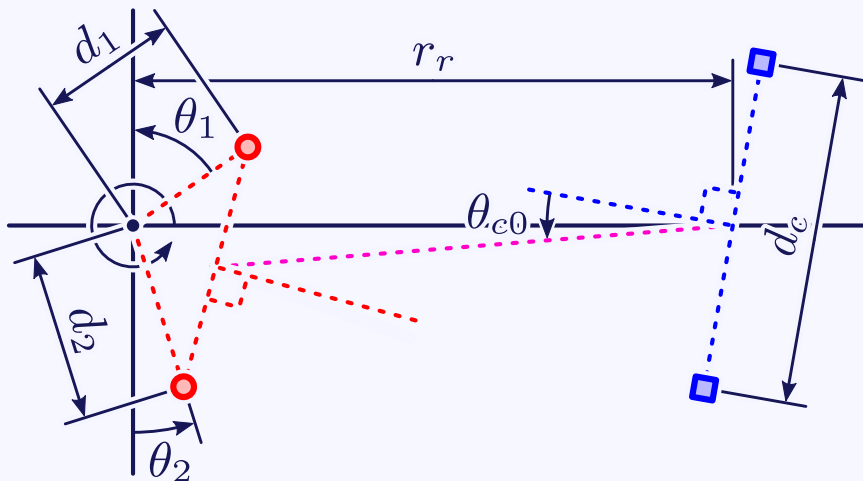
Calibration – Radar Rotation



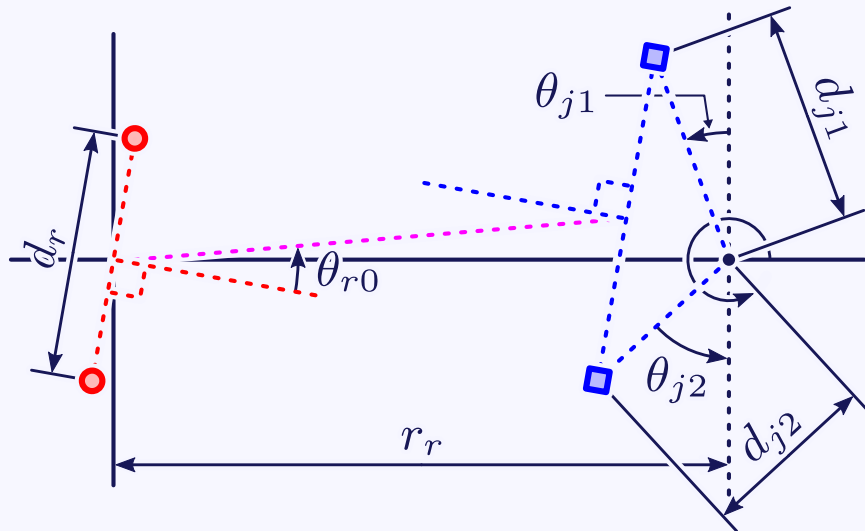
Calibration – Jammer Rotation



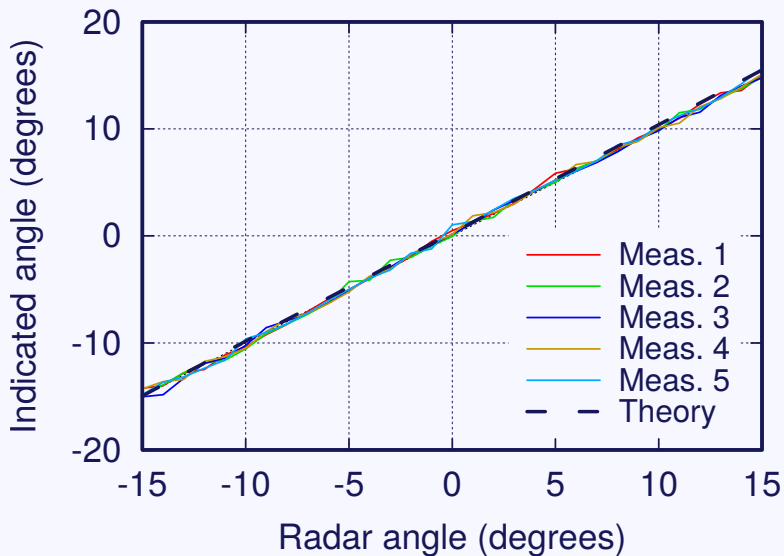
Calibration – Radar Rotation



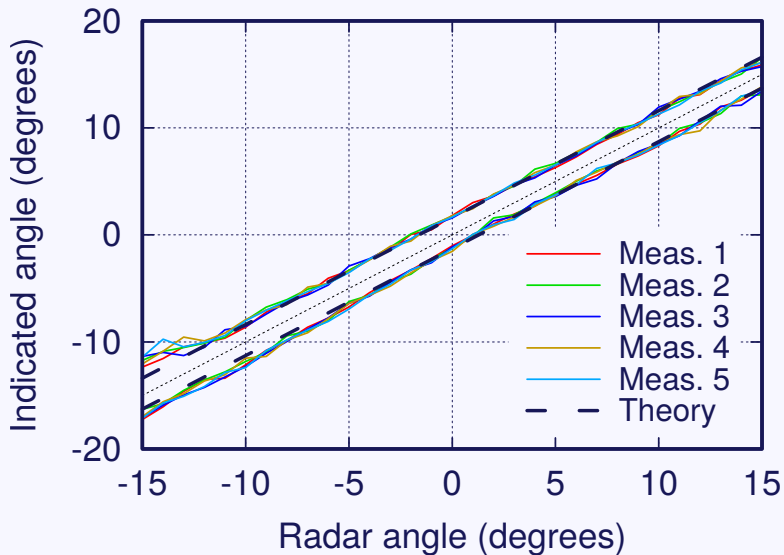
Calibration – Jammer Rotation



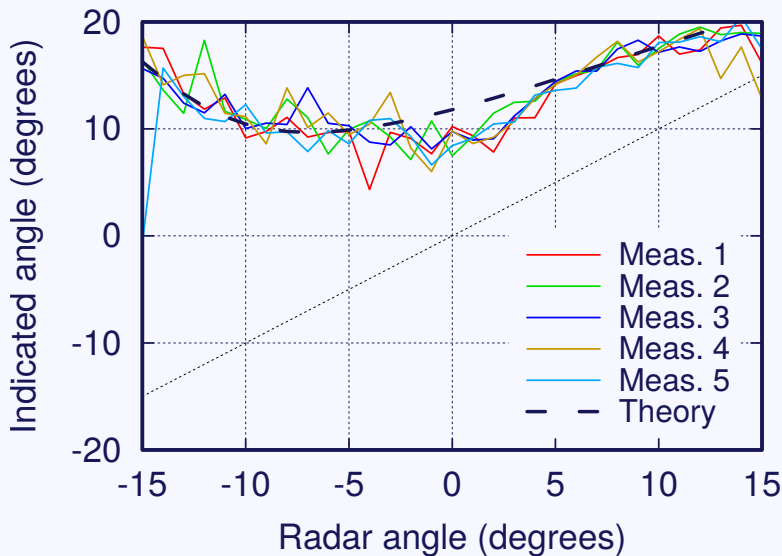
Result – Radar Rotated (Beacon)



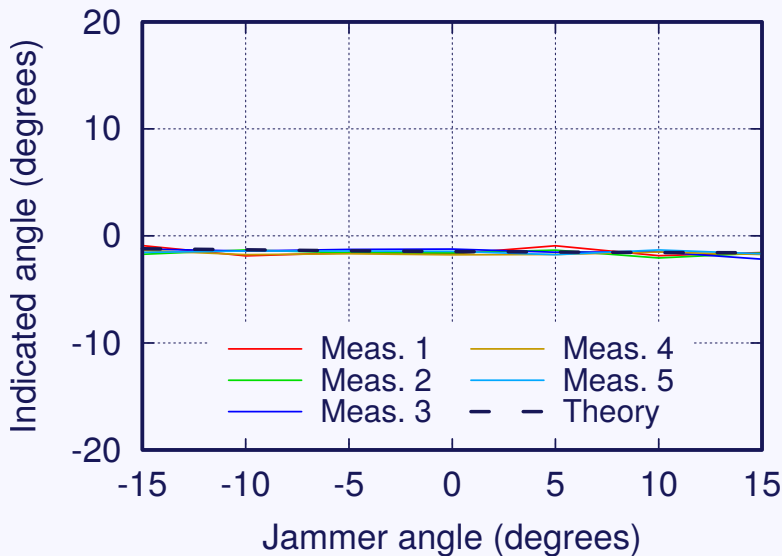
Result – Radar Rotated (Channels)



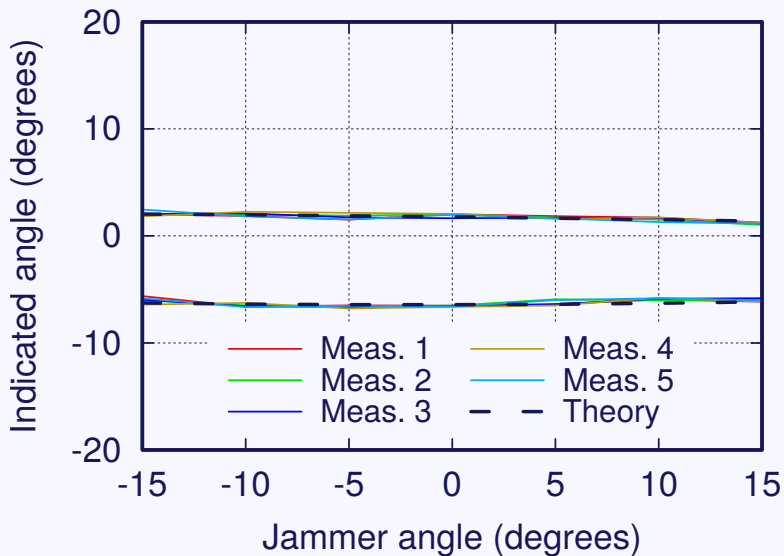
Result – Radar Rotated (Jammer)



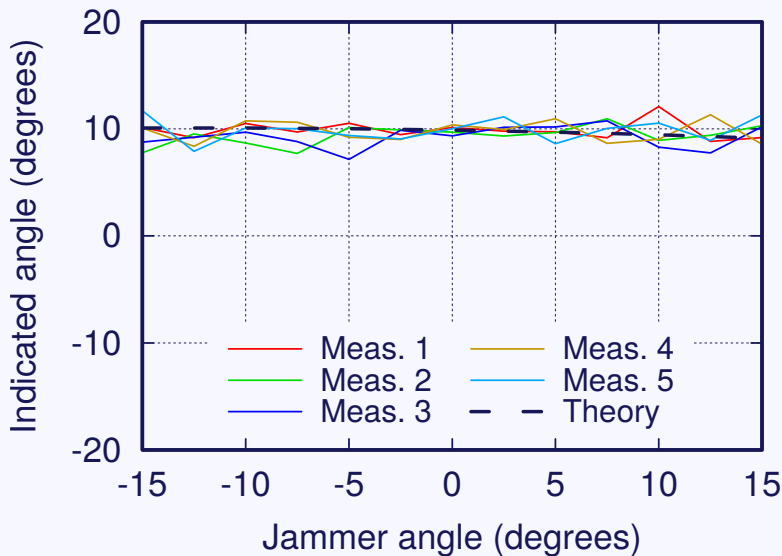
Result – Jammer Rotated (Beacon)



Result – Jammer Rotated (Channels)

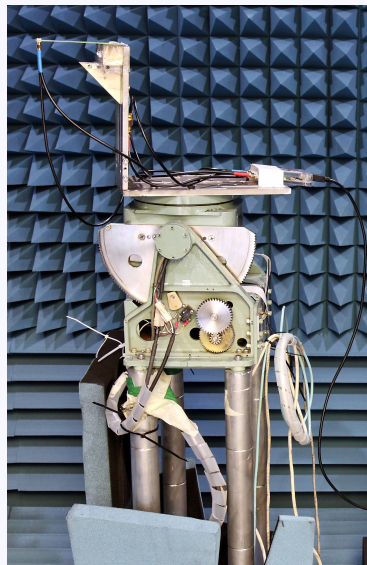


Result – Jammer Rotated (Jammer)



Conclusion

- Cross-eye jamming
 - Remains of interest
 - Challenging implementation
 - Isolation
 - Calibration
- Achievements
 - Used low-cost components
 - Achieved true retrodirective operation
 - Achieved large angular errors
 - Comparisons to theory could be better
- Thanks to CSIR REW for use of facilities



A circular frame showing the interior of an anechoic chamber. The walls, floor, and ceiling are covered with numerous grey, pyramidal-shaped electromagnetic absorbers designed to eliminate reflections. In the center, a piece of electronic equipment is mounted on a stand. Two bright light sources are visible in the upper part of the frame, creating a starburst effect. The text "Thank you!" is overlaid in a large, white, sans-serif font with a black outline.

Thank you!