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Form Approved
OMB No. 0704-0188

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1. REPORT DATE (DD-MM-YYYY) 20-10-2005		2. Report Type: Presentation		3. DATES COVERED (From - To) 06-07-2005 to 20-10-2005	
4. TITLE AND SUBTITLE Optimization of a Constrained-Feed Rotman Lens Beamformer				5a. CONTRACT NUMBER In-House	
				5b. GRANT NUMBER N/A	
				5c. PROGRAM ELEMENT NUMBER 61102F	
6. AUTHOR(S) Scott G. Santarelli, Michelle H. Champion, James P. Kenney, *Robert J. Mailloux				5d. PROJECT NUMBER 2304	
				5e. TASK NUMBER HA	
				5f. WORK UNIT NUMBER 01	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Antenna Technology Branch (AFRL/RHYA) 80 Scott Drive Hanscom AFB, MA 01731-2909 *University of Massachusetts, Amherst, MA				8. PERFORMING ORGANIZATION REPORT N/A	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Electromagnetics Technology Division Source Code 437890 Sensors Directorate Air Force Research Laboratory 80 Scott Drive Hanscom AFB MA 01731-2909				10. SPONSOR/MONITOR'S ACRONYM(S) AFRL-RY-HS	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-RY-HS-TP-2008-0014	
12. DISTRIBUTION / AVAILABILITY STATEMENT Statement A: Approved for Public Release; distribution unlimited.					
13. SUPPLEMENTARY NOTES The U. S. Government is joint author of this work and has the right to use, modify, reproduce, release, perform, display, and disclose the work. Presented at the 2005 IEEE Antennas and Propagation Society International Symposium and USNC/URSI National Radio Science Meeting, Washington, D. C. Cleared for Public Release by ESC/PA number ESC 05 – 0736.					
14. ABSTRACT A previous mathematical analysis has demonstrated the utility of a partially overlapped, constrained-feed network for time-delay control of large linear arrays (R.J. Mailloux, IEEE Trans. 49, February 2001, pp.280-291). In particular, this novel method allows for approximately –30 dB sidelobe suppression over a 20% bandwidth. An array with time-delayed contiguous subarrays with the same separation would have quantization lobes at the –10 dB level; thus, this technique appears to offer significant advantages. We recently developed an experiment to demonstrate this concept. We collected data for the broadside case (array phase shifters set to zero) from –45° to 45° in 0.25° increments and from 9.0 to 11.0 GHz in 0.05 GHz increments (center frequency of 10 GHz). We allowed weighting of both the Rotman lens outputs (constituent beams) and the Butler matrix outputs (subarray patterns). We used a genetic algorithm to optimize these complex weightings. We realized that our data set didn't represent the best measure of system performance, since there is no beam squinting at broadside; therefore, we performed a limited field of view (LFOV) test. Using this LFOV test, we were able to demonstrate at least –28 dB sidelobes over an angular field of view corresponding to a 20% bandwidth.					
15. SUBJECT TERMS Constrained-feed network, overlapped subarray architecture, phased arrays					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			SAR
19b. TELEPHONE NUMBER (include area code) N/A					

Optimization of a Constrained-feed Rotman Lens Beamformer

20 October 2005



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This research was sponsored by DARPA



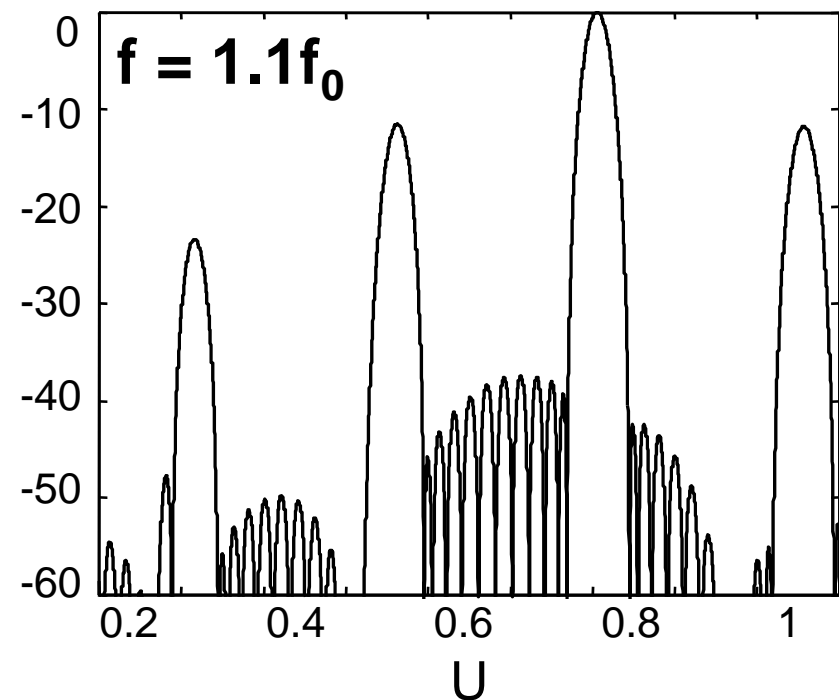
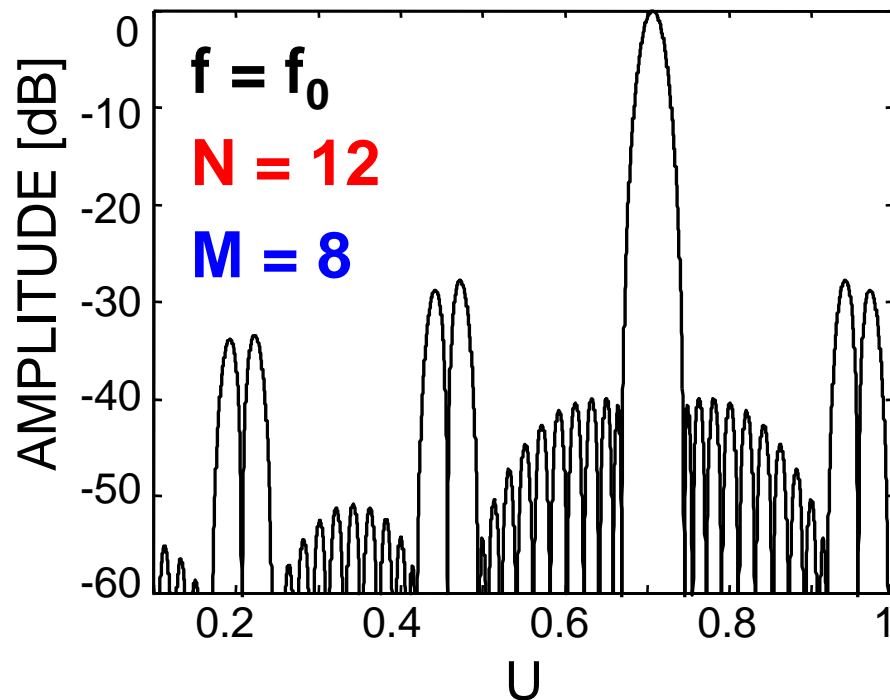
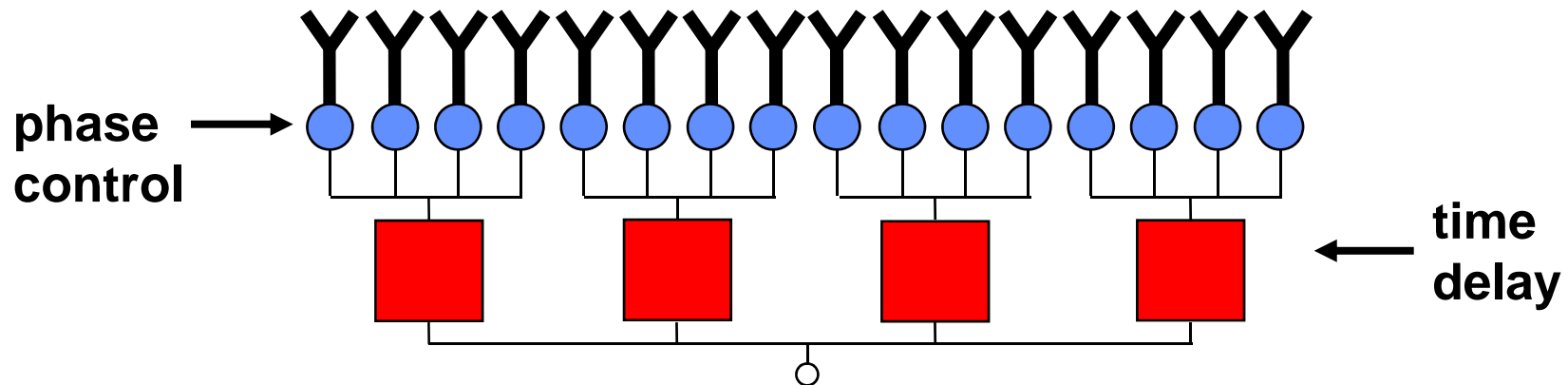
Outline



- **Motivation**
- **Experiment**
 - **Experimental Setup**
 - **Parameter Optimization**
 - **Results**
- **Summary/Conclusions/Future Work**



Contiguous Subarrays

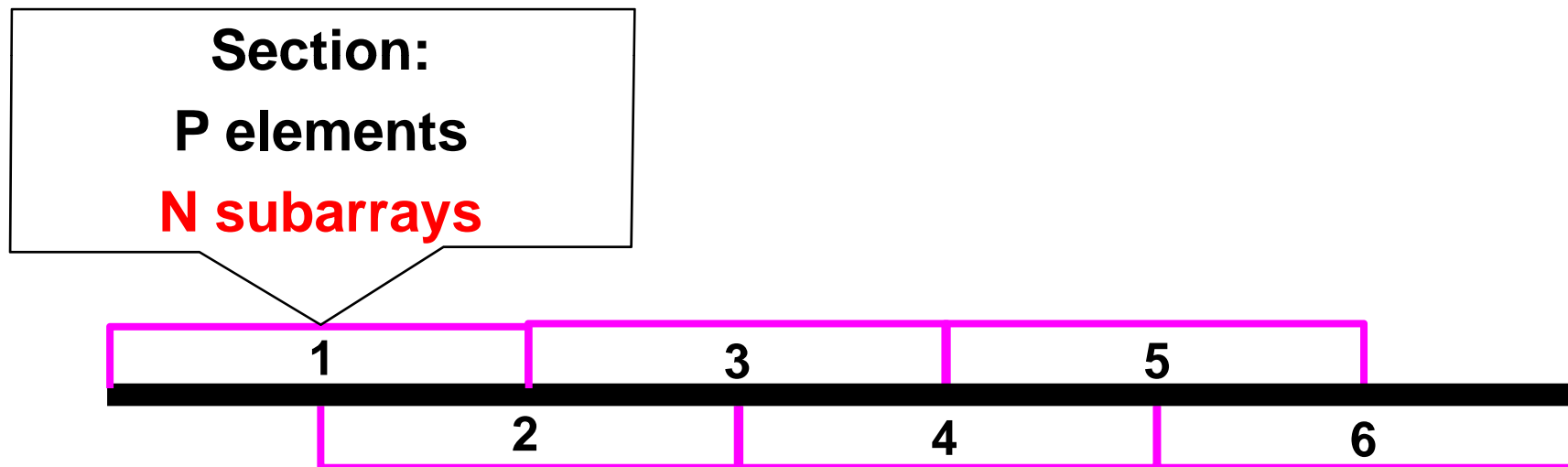




Partially Overlapped Constrained-Feed Network



Mailloux, R. J. (2001), "A Low-Sidelobe Partially Overlapped Constrained Feed Network for Time-Delayed Control," IEEE Transactions on Antennas and Propagation, Vol. 49, No. 2, February 2001.



- -30dB sidelobe levels over 20% bandwidth
- Design experiment to test theory

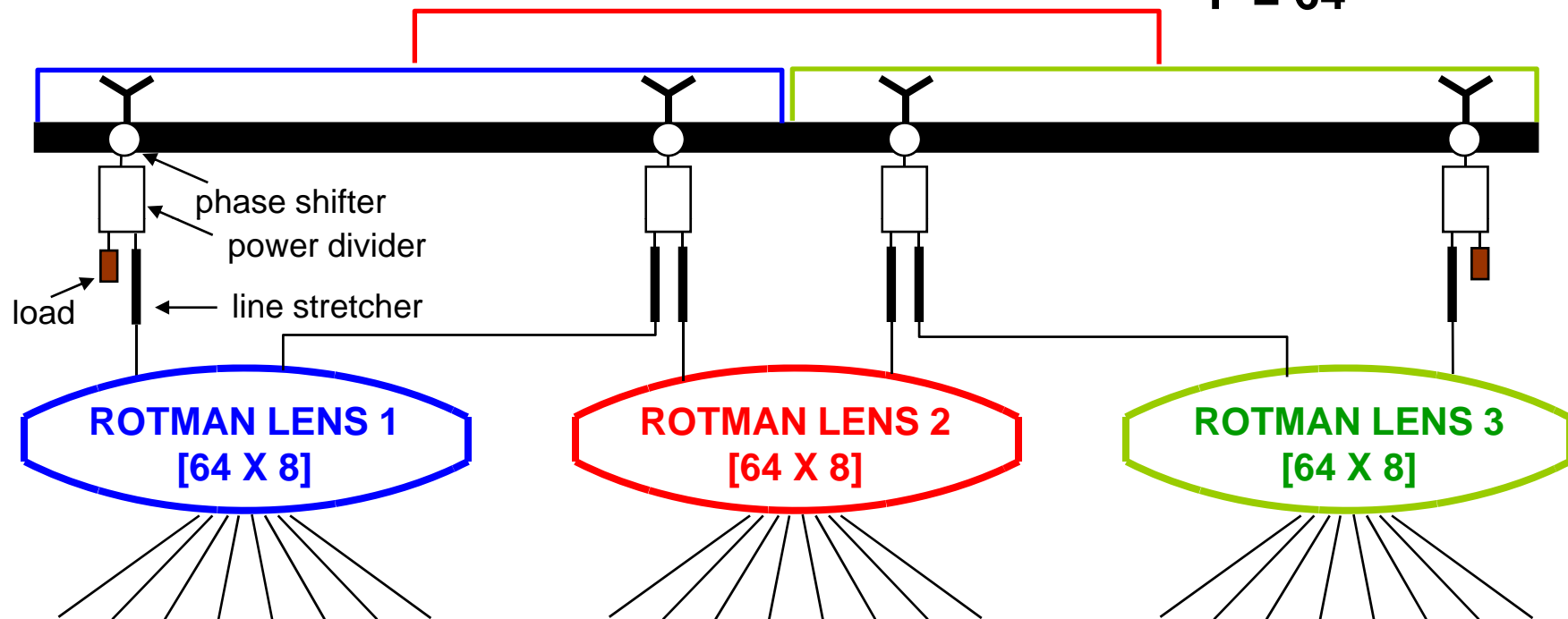


Experimental Block Diagram



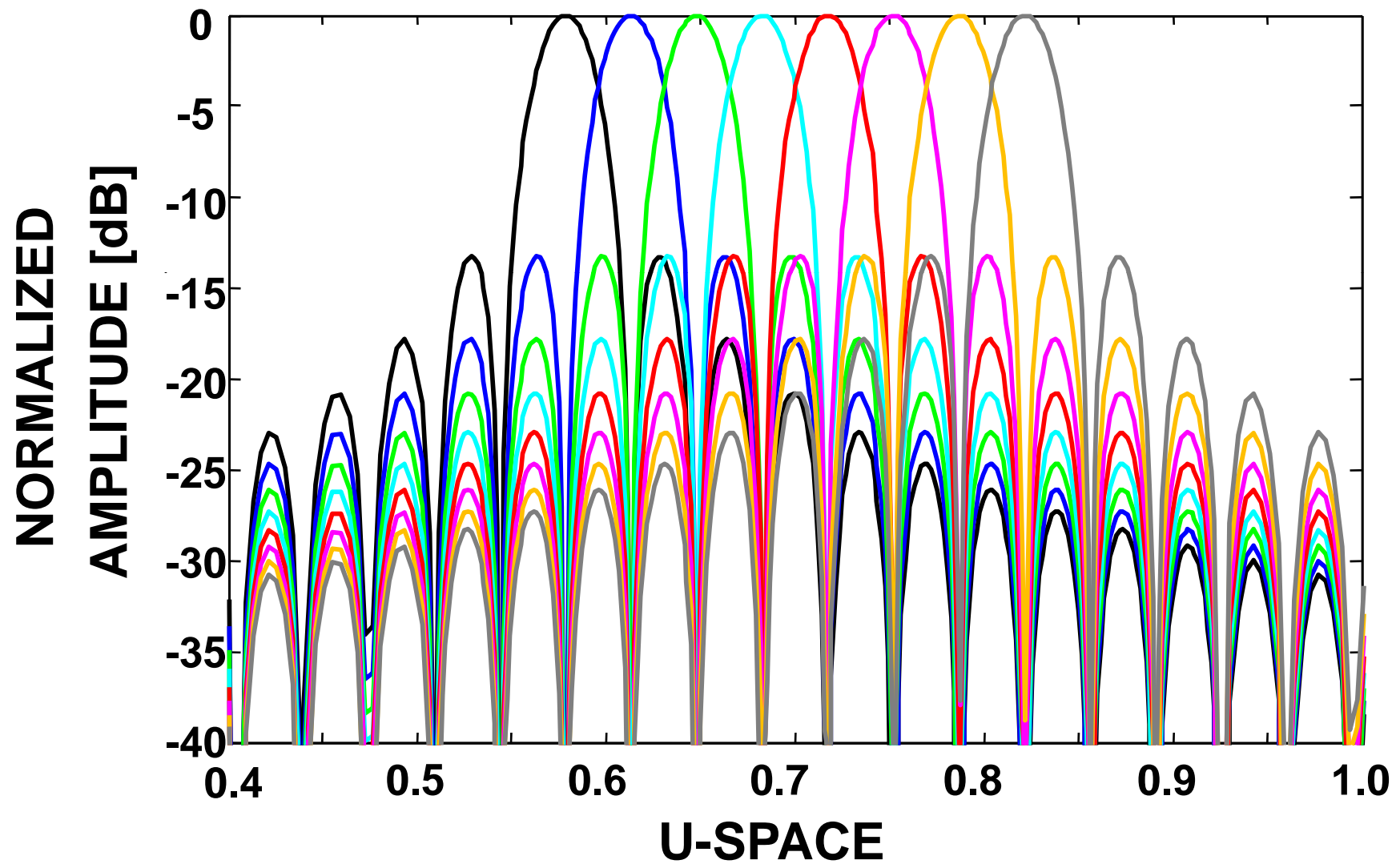
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$P = 64$





Constituent Beams



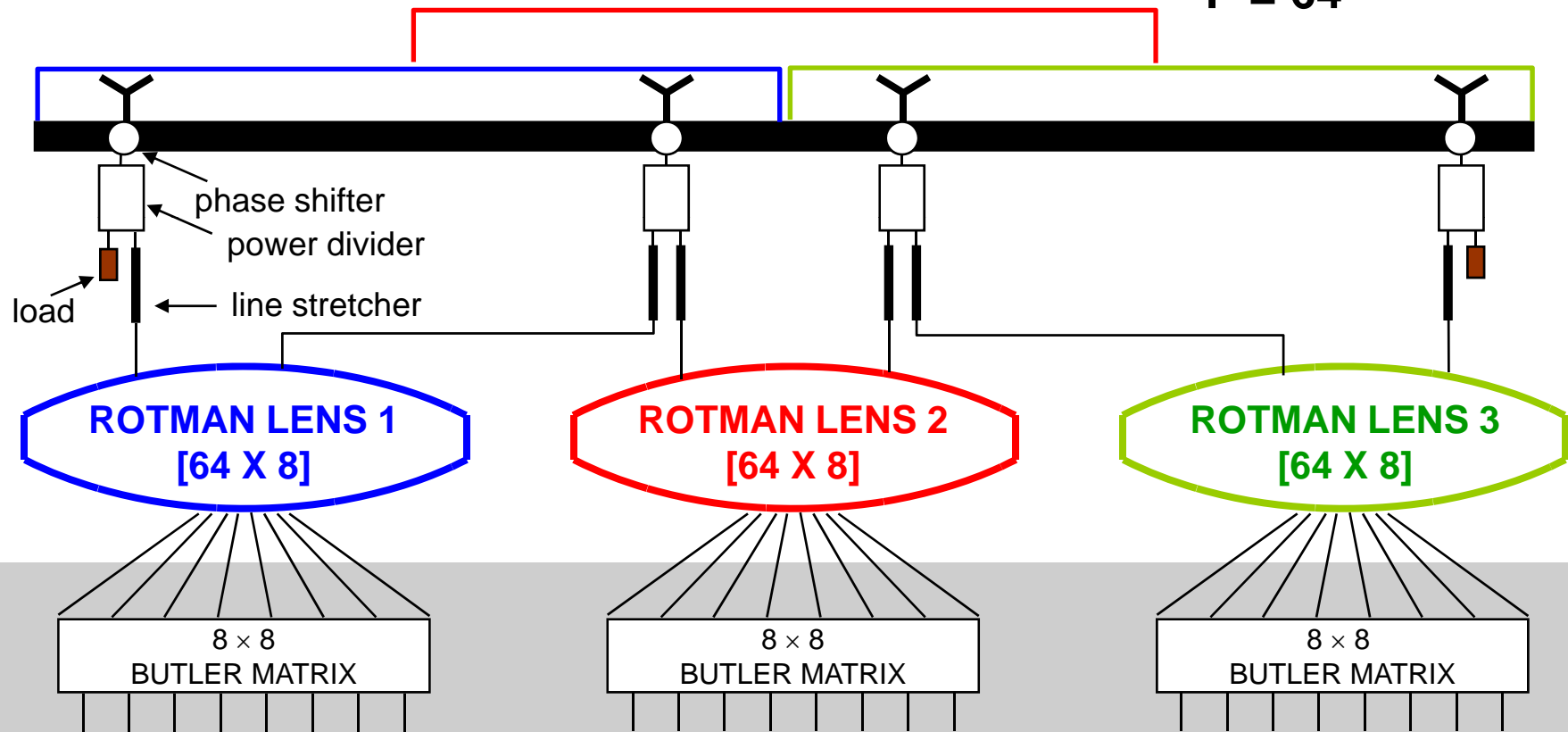


Experimental Block Diagram



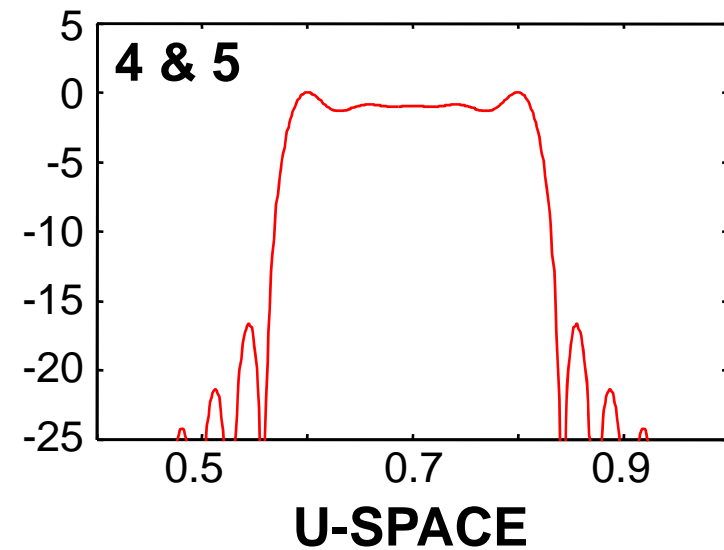
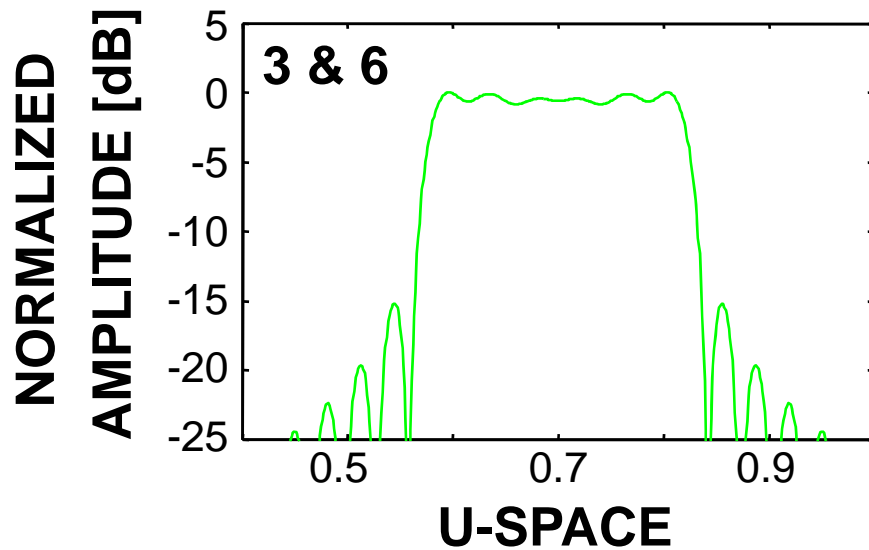
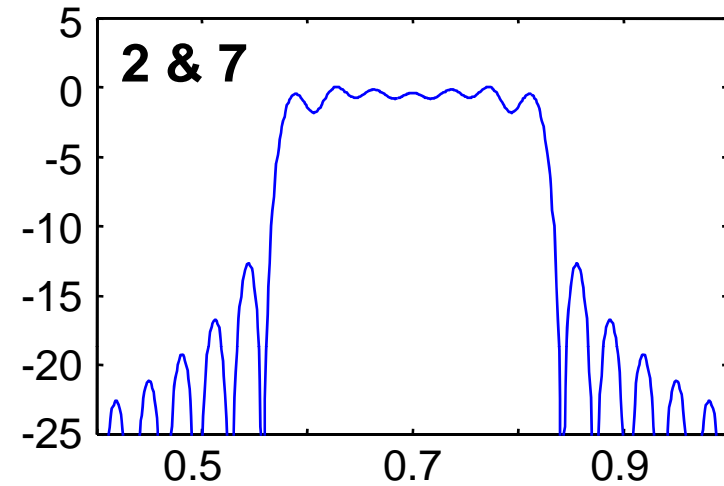
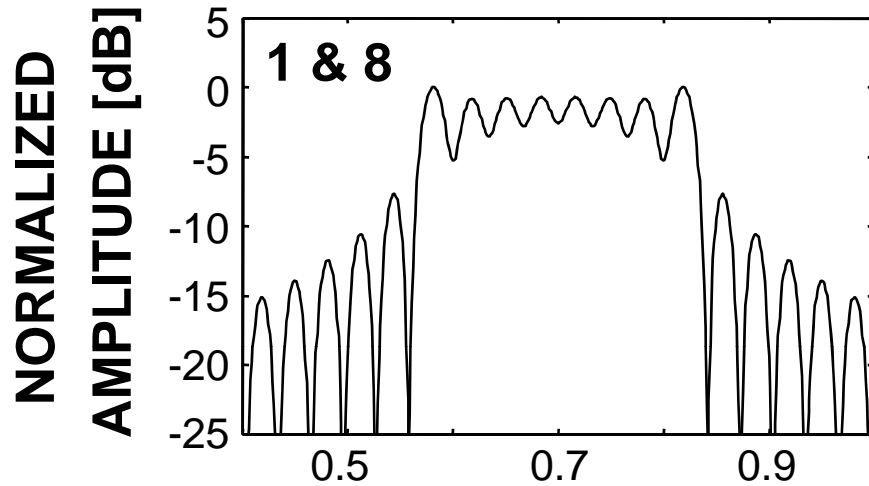
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Subarray Patterns





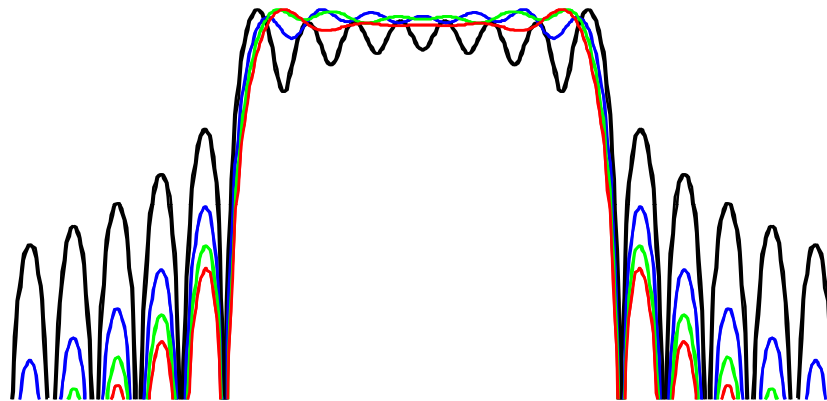
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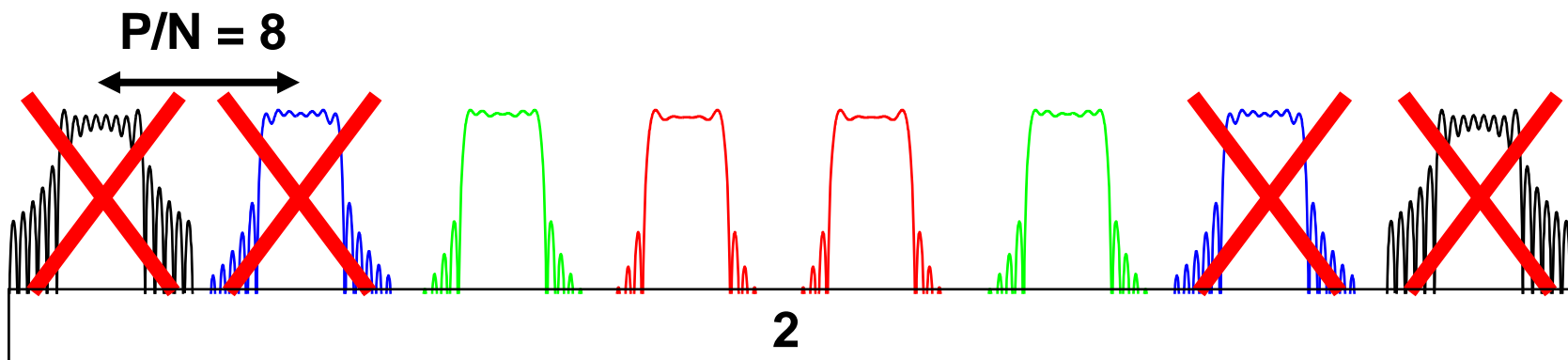
1	2	3
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P = 64

N = 8



U-SPACE



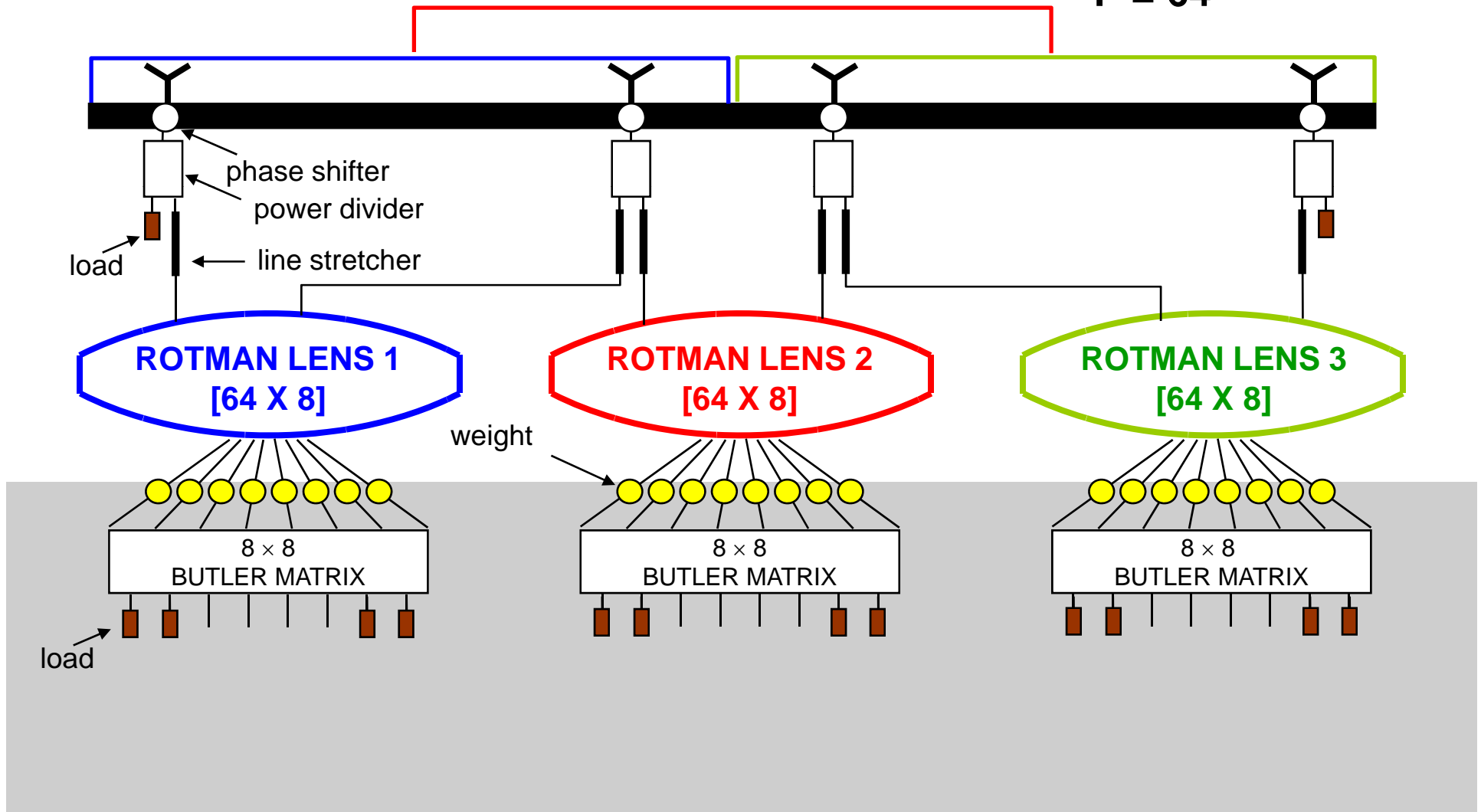


Experimental Block Diagram



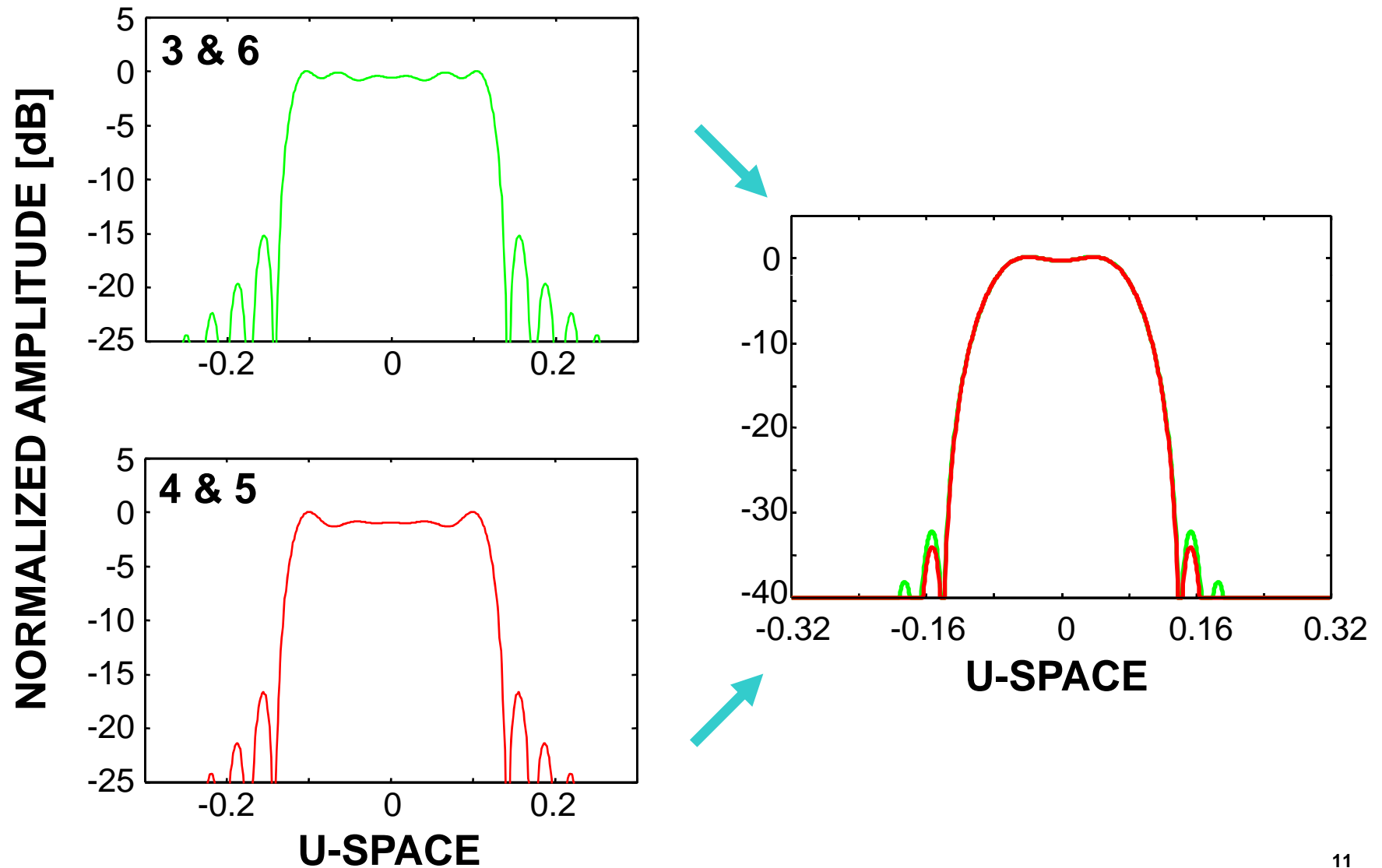
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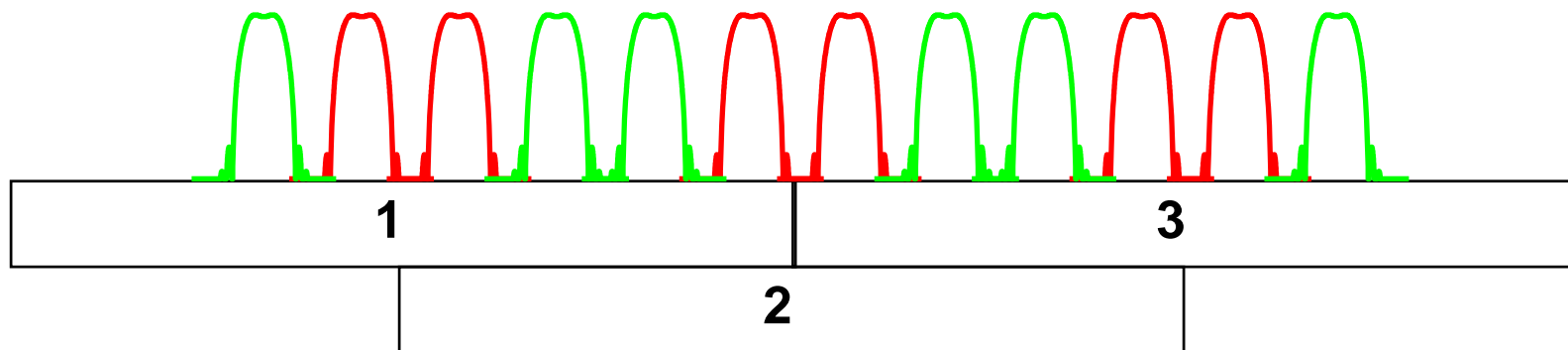
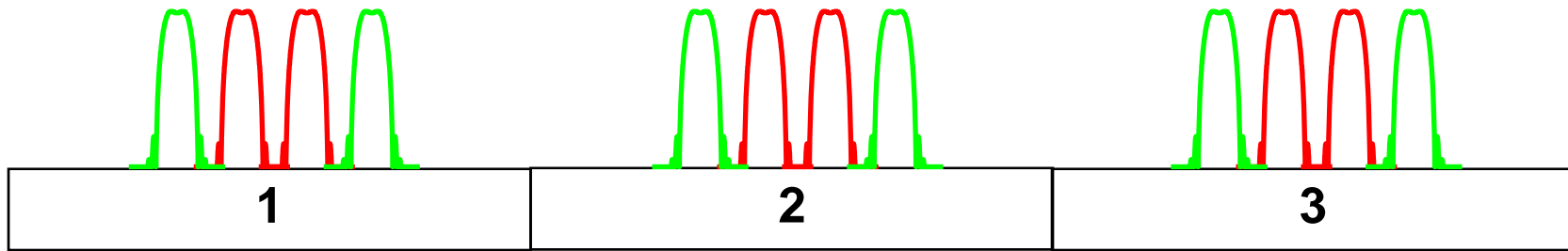


Constituent-Beam Weighting





Partially Overlapped Sections



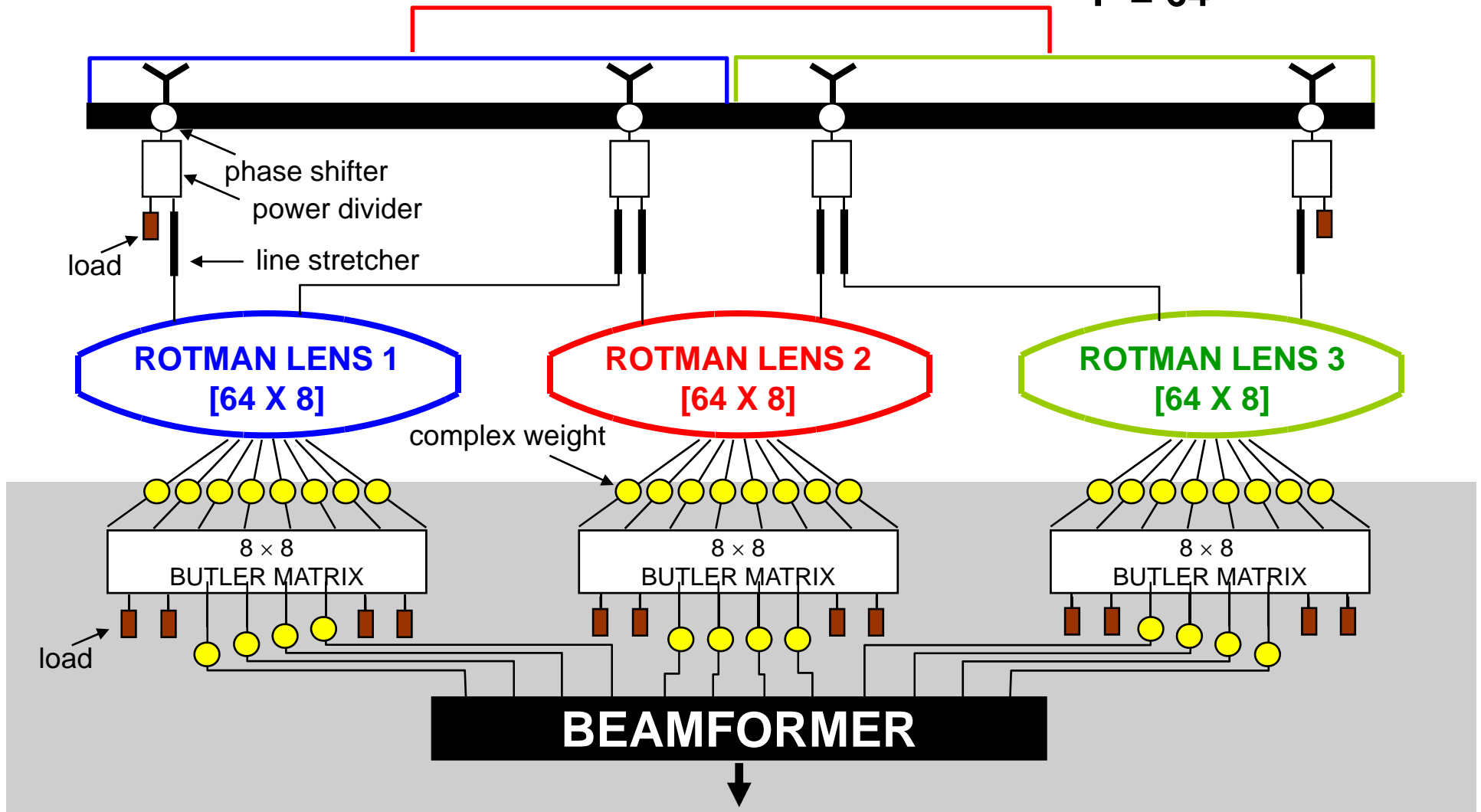


Experimental Block Diagram



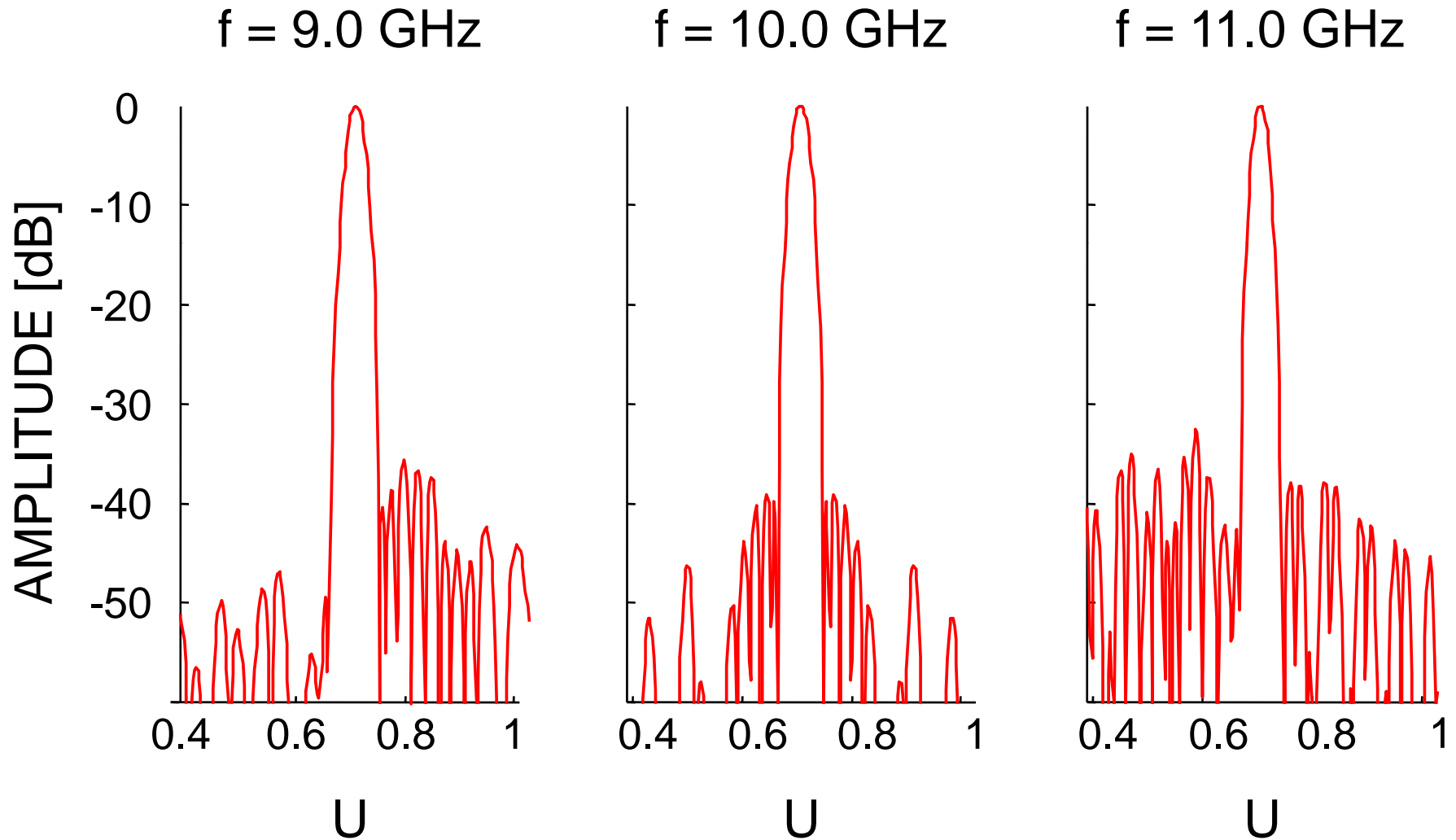
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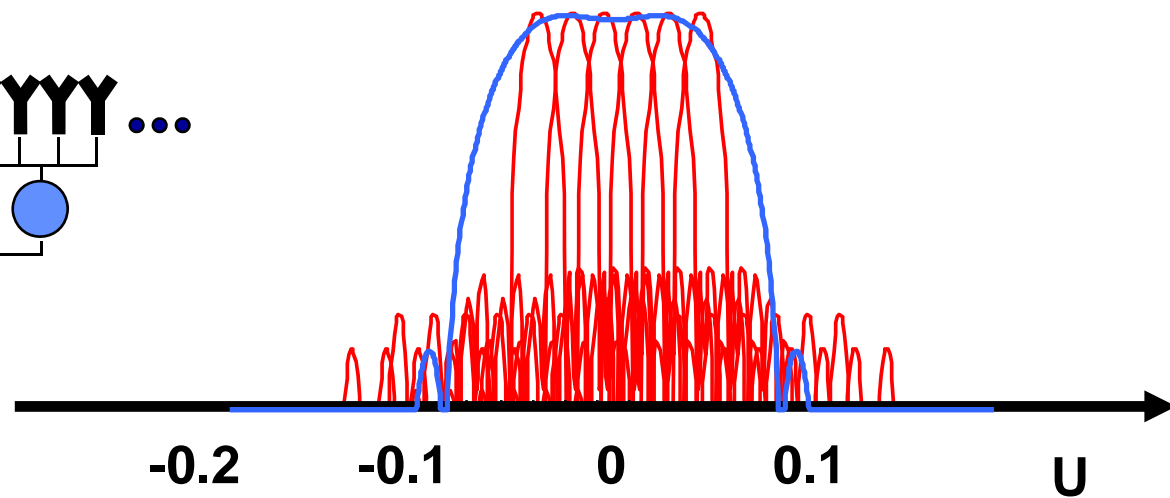
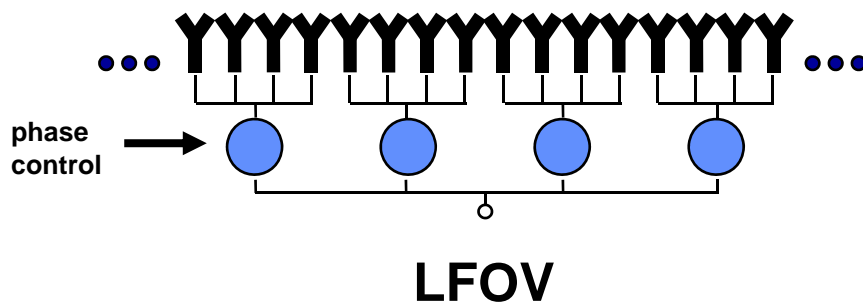
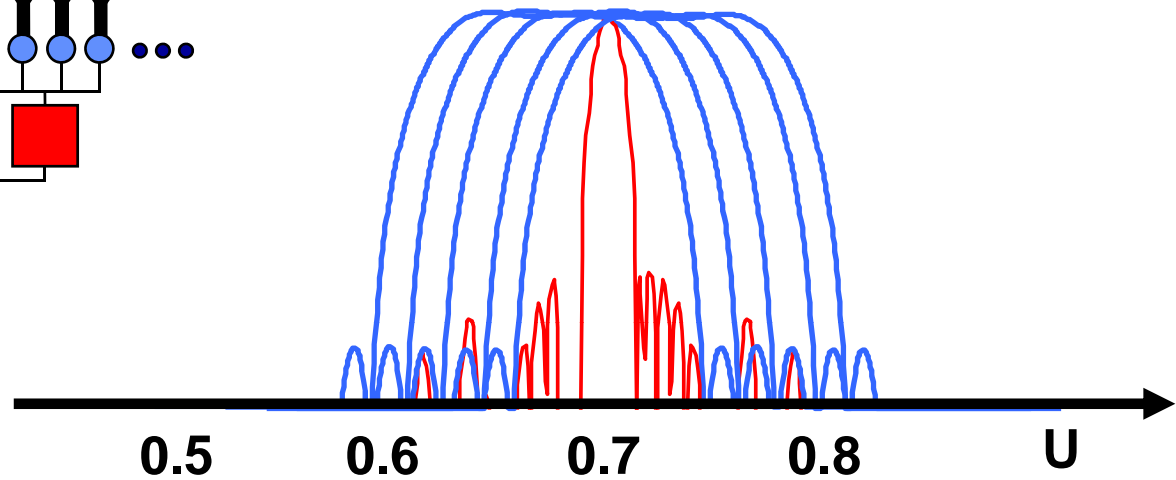
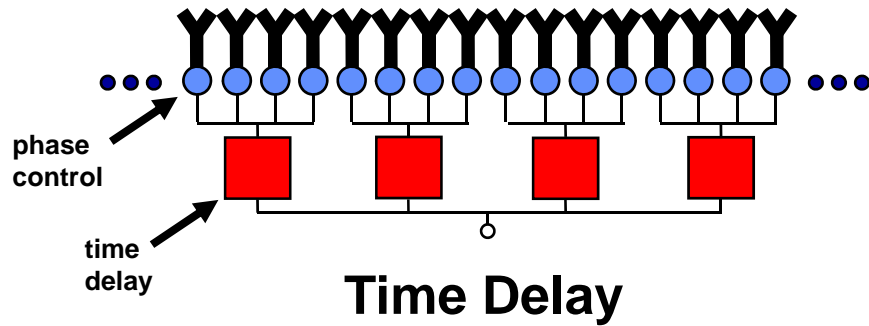


System Radiation Pattern (Ideal System)





Time Delay vs. LFOV

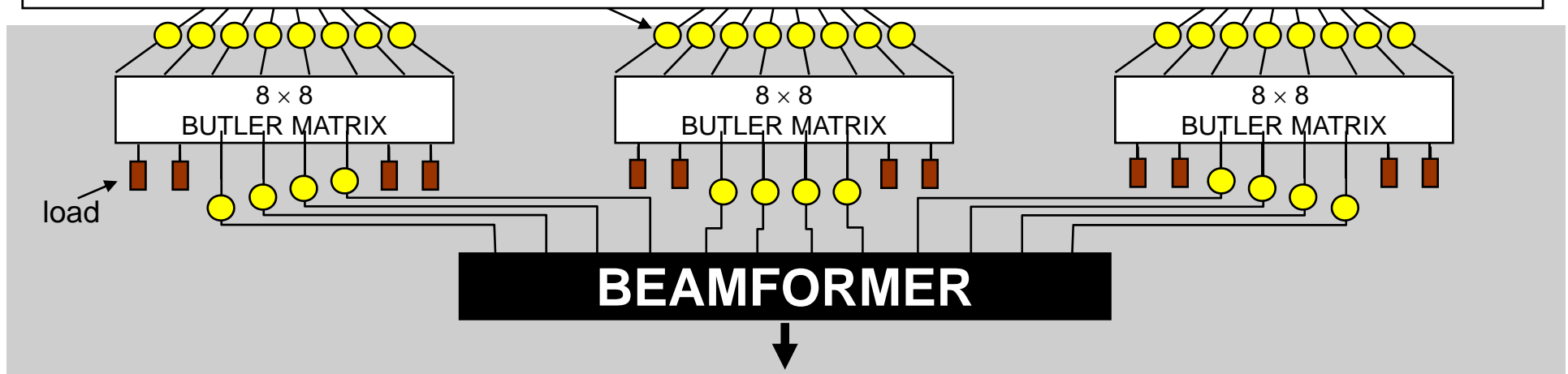




System Optimization

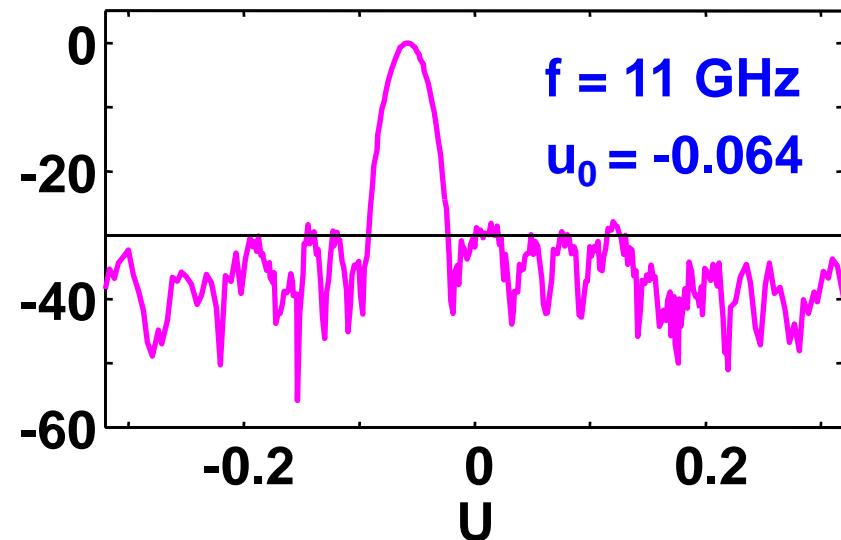
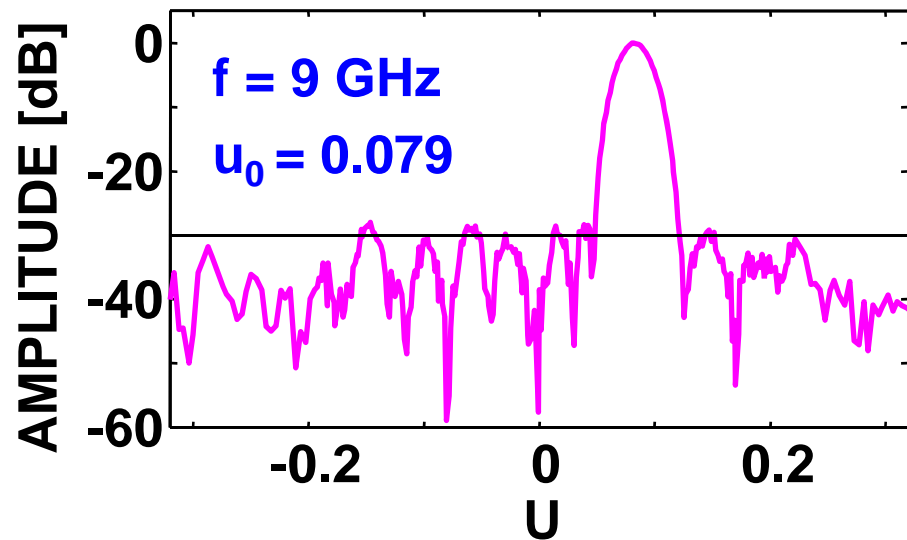
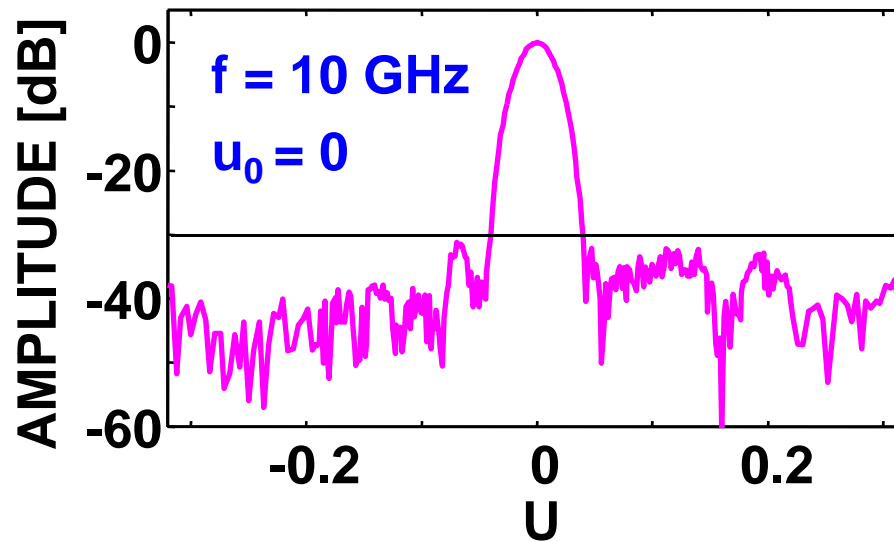


- Optimize weights for constituent beam and subarray ports
- Ideal System
 - Method of Alternating Projections (constituent beams)
 - 40-dB Taylor weighting (subarray ports)
- Experiment
 - Used genetic algorithm to optimize both sets of weights



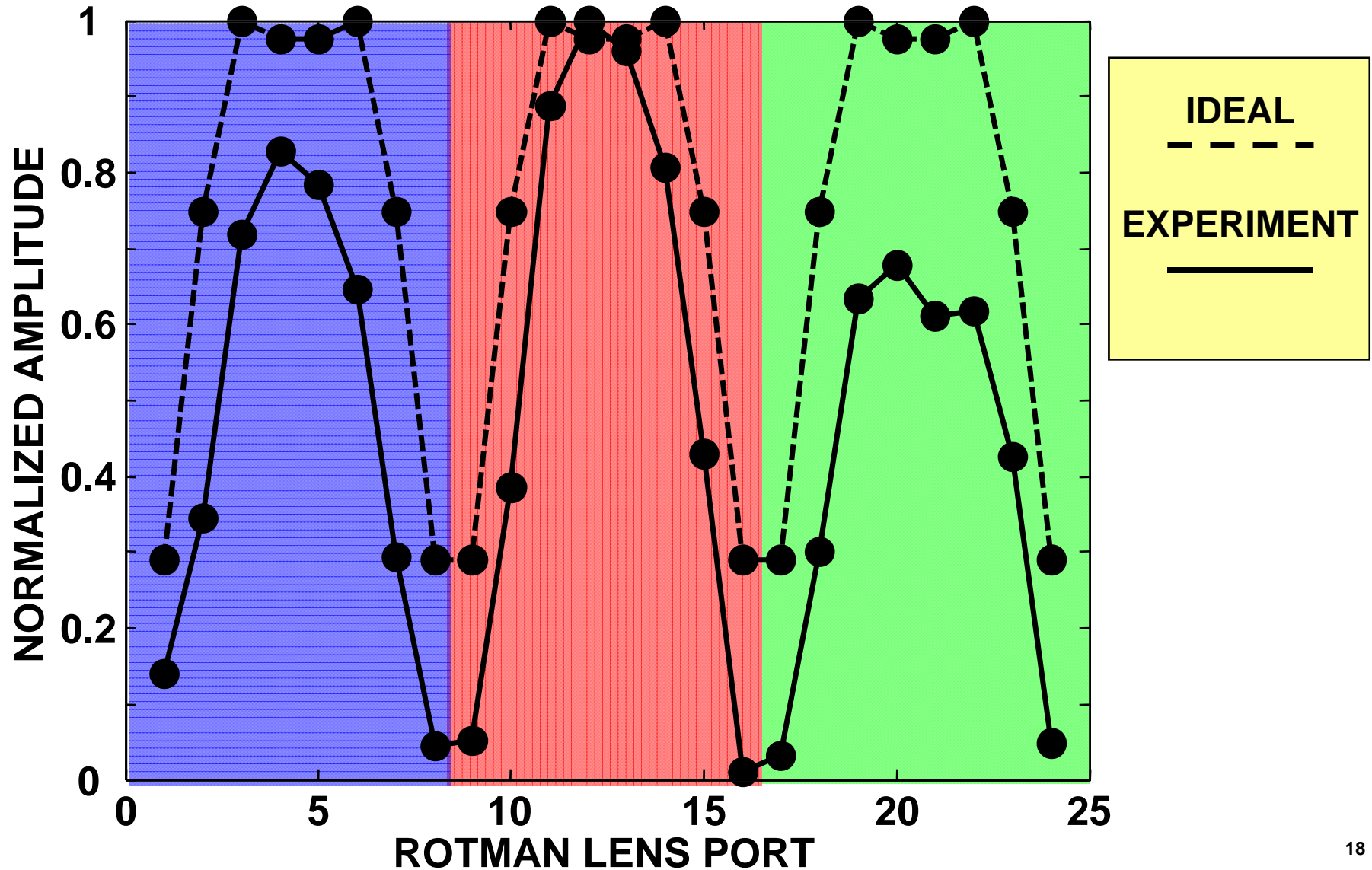


Results



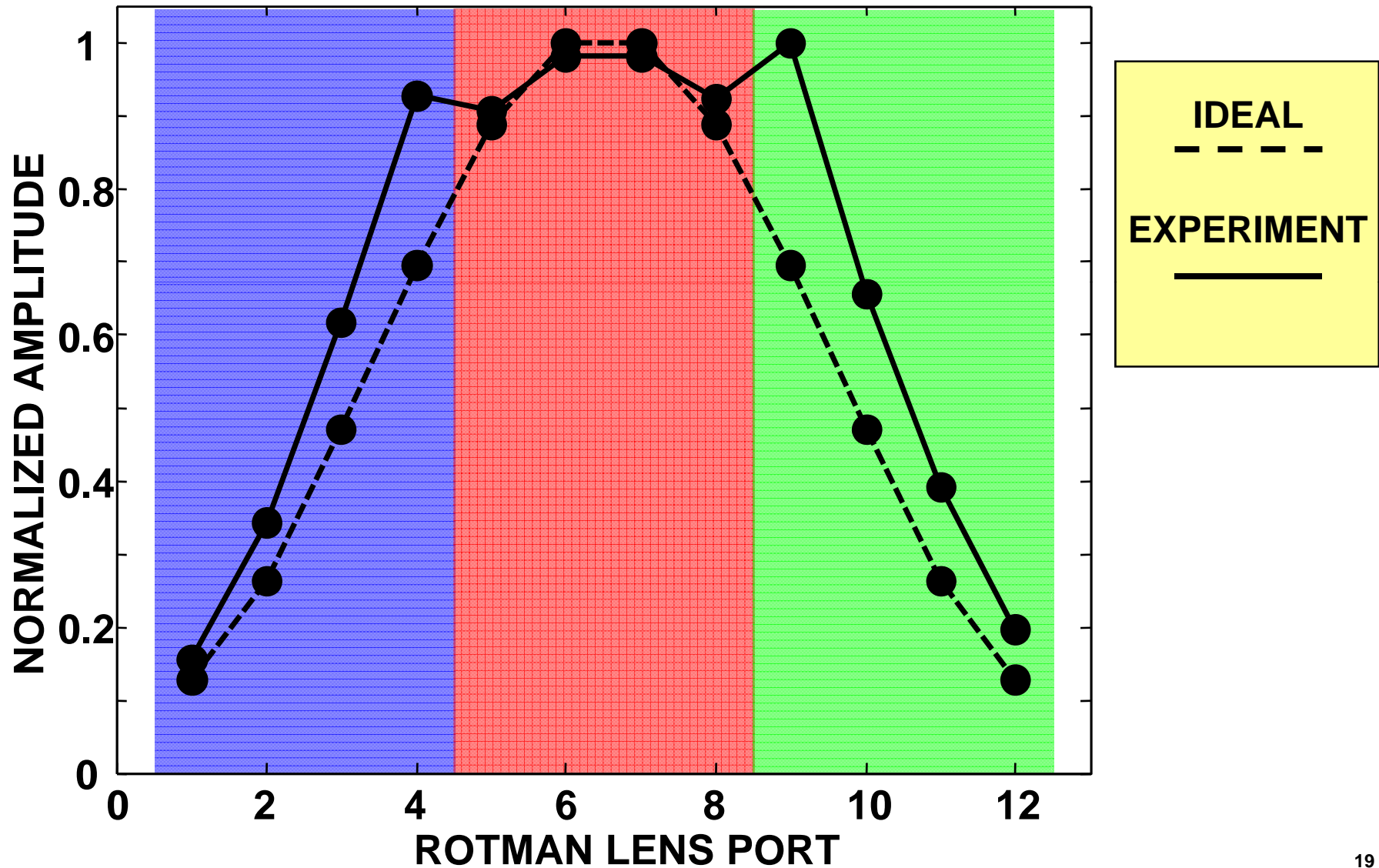


Constituent-Beam Weights



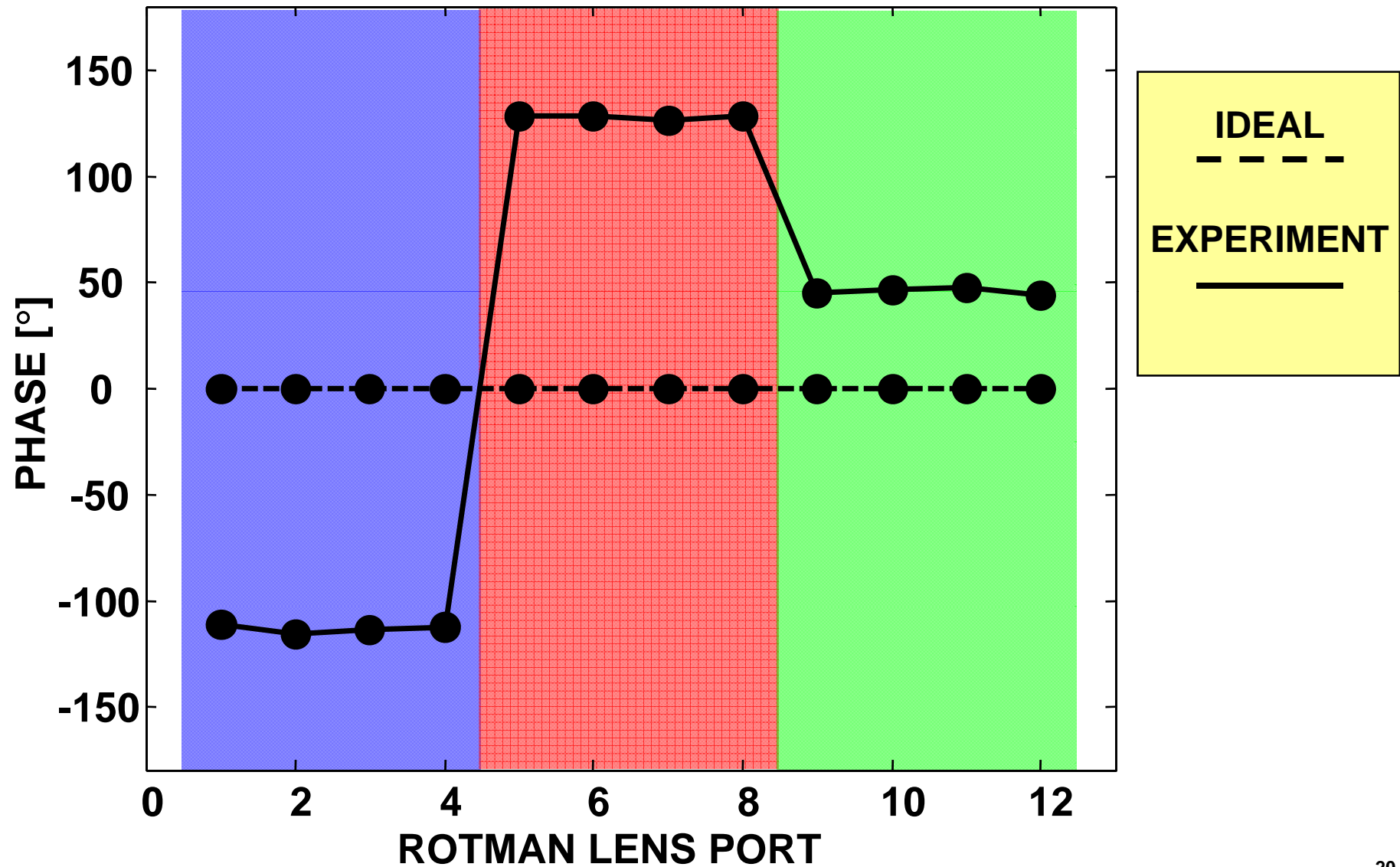


Subarray Weights



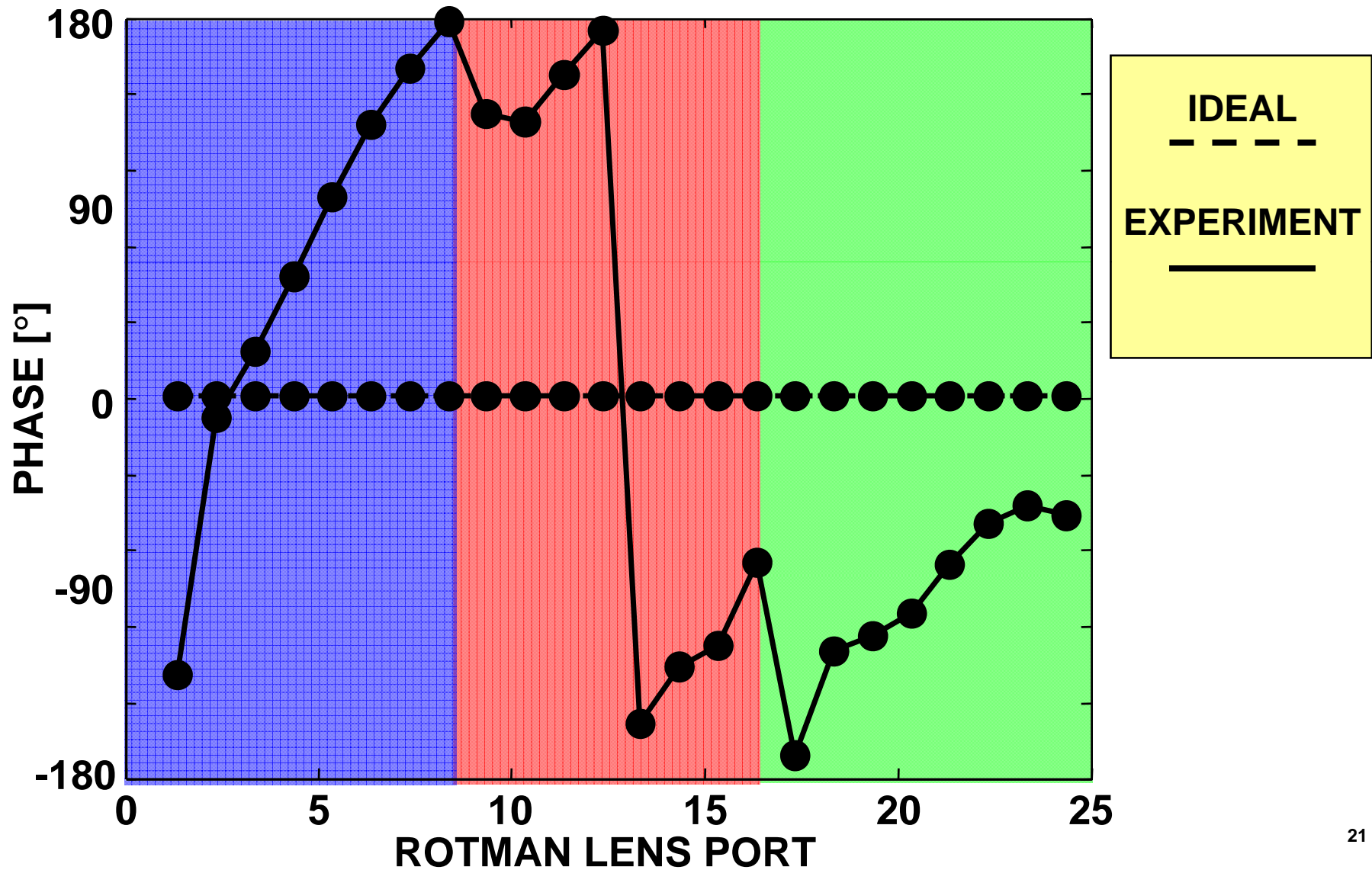


Subarray Weights (Phase)



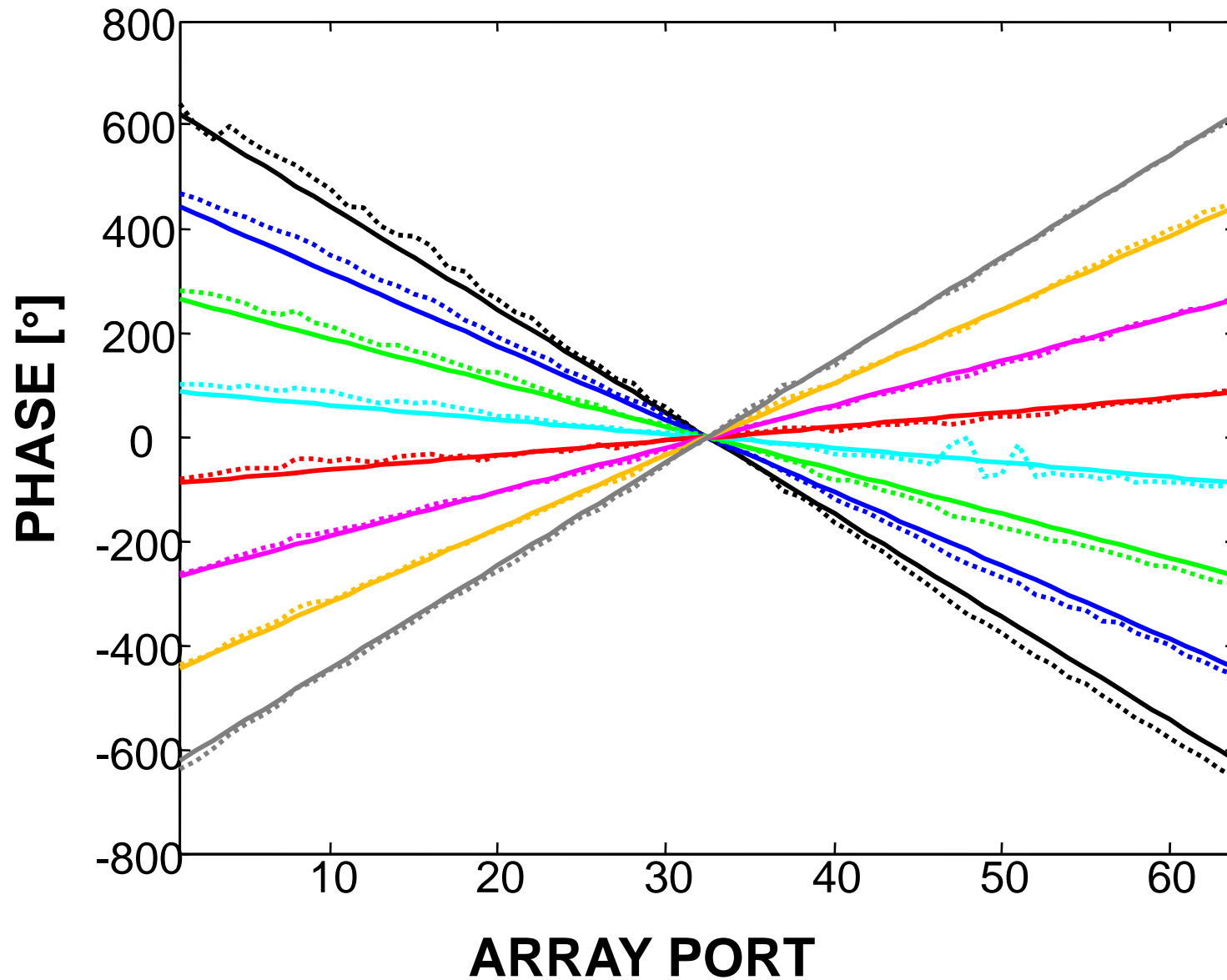


Constituent-Beam Weights (Phase)





Rotman Lens Transfer Function: Phase





Conclusions/Future Work



- **Partially overlapped constrained-feed network:**
 - **Solves the quantization lobe problem associated with contiguous subarrays**
 - **Experiment demonstrated -30 -dB sidelobes over a 20% bandwidth**
 - **Constrained nature allows for array expansion without increasing depth of system**
- **Future Work**
 - **Phase shifters at element level**
 - **Transfer function of entire system**