

# The Other Side of RF Measurements: Out of the Lab and into the Real World

## Some Selected Experiences

Prepared by

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for the

## Michaelson Research Conference

August 11, 2001

Kalispell, Montana



Richard Tell Associates, Inc.  
Las Vegas, NV

Hatfield & Dawson, LLC  
Seattle, WA

# Some Aspects of Real World RF Field Assessments

- Non-clean, non-lab conditions
- Reflections everywhere
- Often awkward exposure situations
- Adverse environmental conditions
- Commonly a circus environment
- Requirement to comply with regs or standards that are not necessarily clear
- **Legal ramifications of findings!**

# Factors Affecting RF Measurement Accuracy and Meaning

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- Probe calibration accuracy
- Probe frequency response
- Multiplicity of fields (rms response)
- Polarization of fields
- Spatial distribution of fields
- Interference with field to be measured by observer (field perturbation)

# Studying the Effect of Field Perturbation on Measured RF Fields

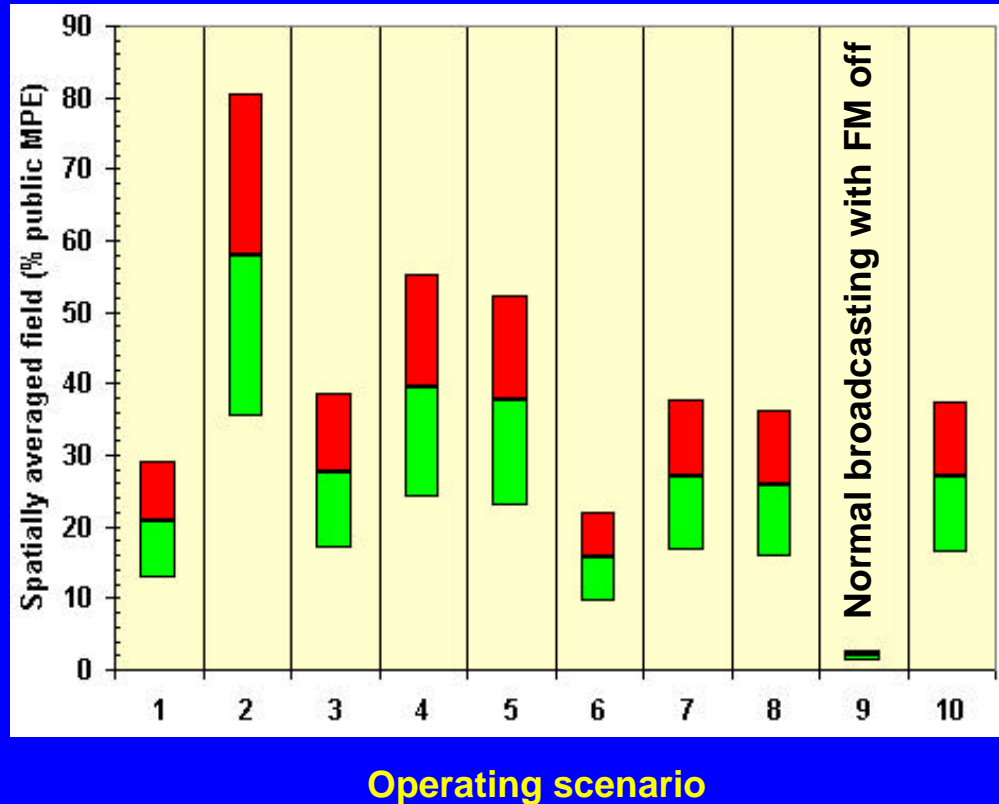
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- Establish a “pure” test environment
- Determine the “unperturbed” field
- Measure influence of field perturbation caused by observer

# Measured Spatially Averaged RF Fields at Point 5 on WTC South Tower Walkway

Based on study by Richard Tell Associates, Inc.

Mean values plus/minus one standard deviation

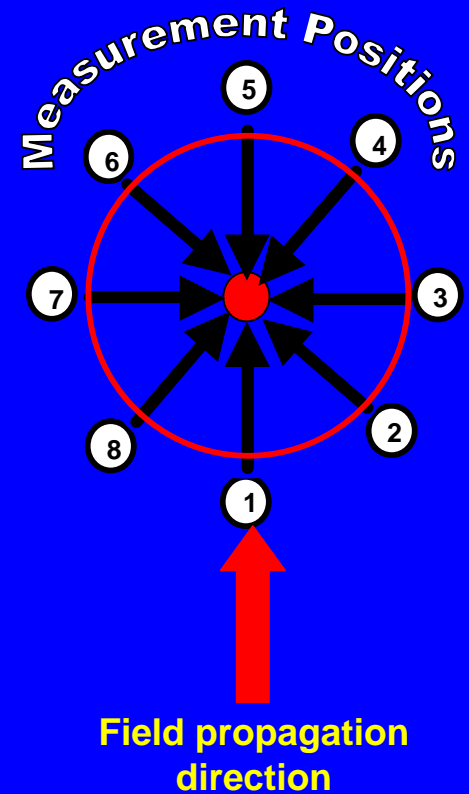
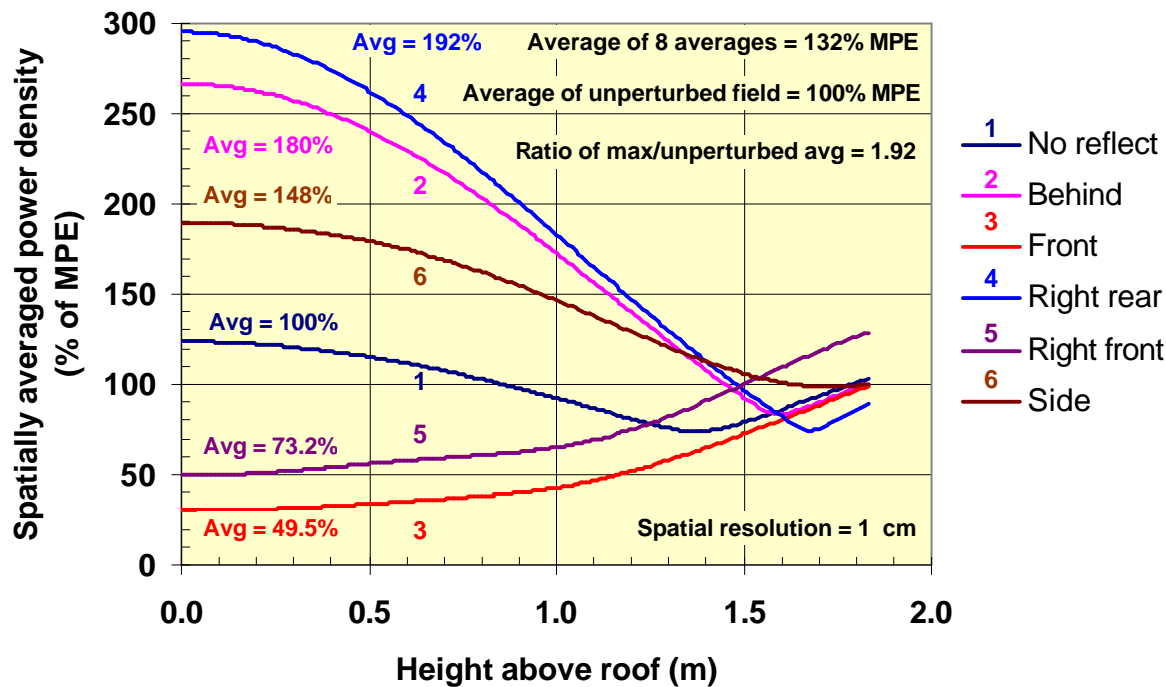


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# A Theoretical Assessment of Operator Interaction with Fields

Spatially Averaged Power Density Along Vertical 1.8 m Line with Effects of 20 cm Radius Reflecting Cylinder at 1 Meter in Different Orientations



# Montana RF A Cast of Characters

Happy Ricky



Smiling  
Andy



Philosophic  
Jimmy



Studious  
Davey

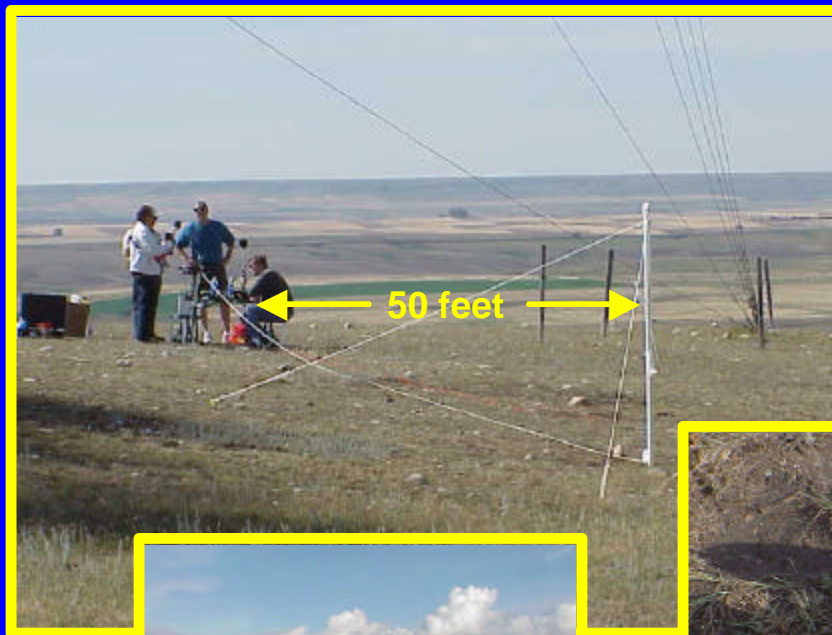
**Late Breaking Data**

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# The Test Site – Shelby, Montana



Main antenna

Auxiliary antenna

Holaday HI-6005 probe

Bottom pulley

Probe support isolation

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# Data Collection Instrumentation



Probe was raised from a distance of 50 feet from measurement point.



12 volt dc gear motor winder

Laptop & fiber optic modem



Car battery

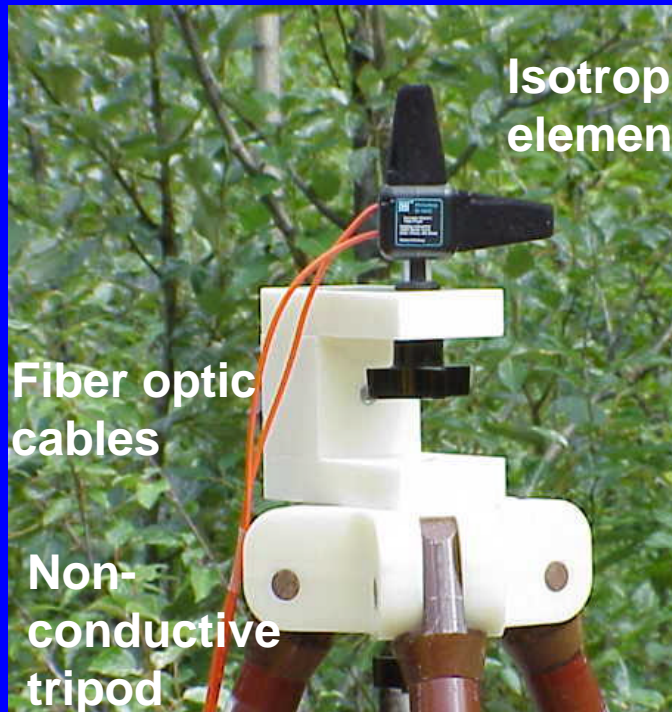


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# Isotropic Broadband Electric Field Strength Measurements

Pave Paws, Clear AFS



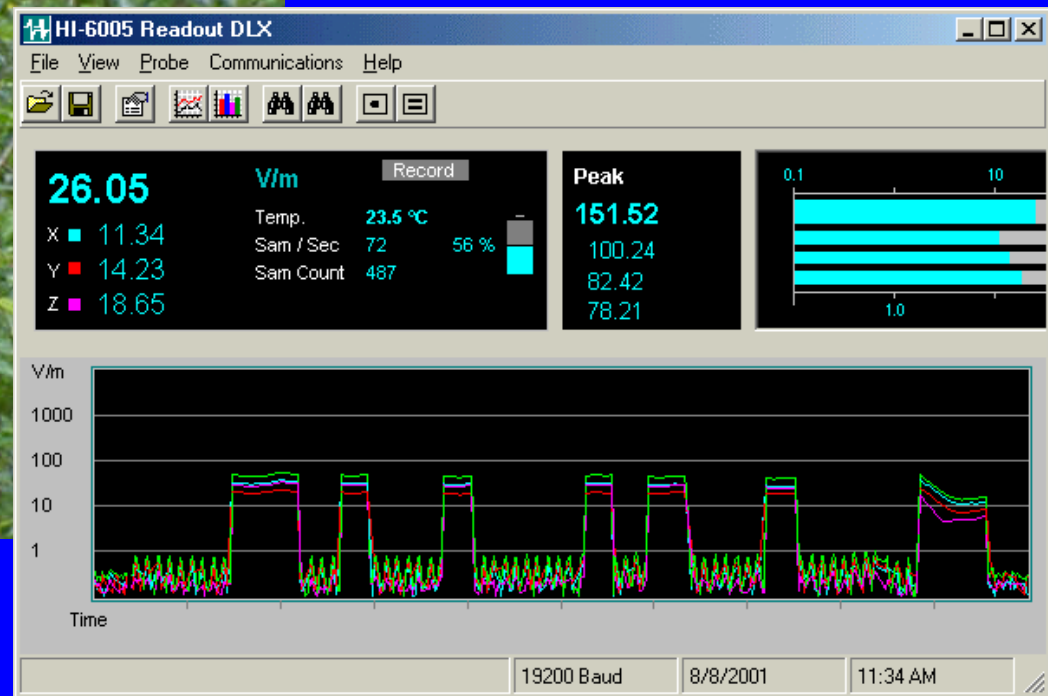
Isotropic elements

Fiber optic cables

Non-conductive tripod

Sampling software to measure approximately 70 readings per second.

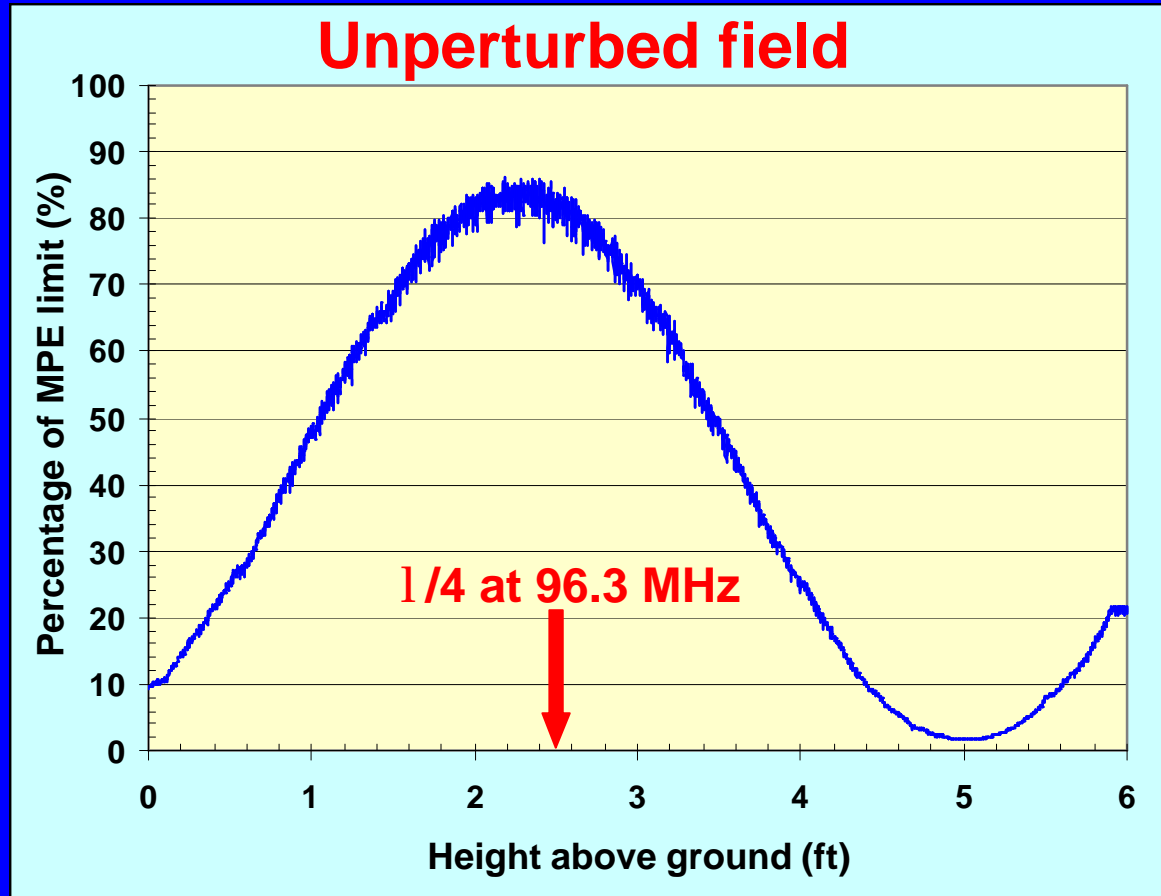
Holaday Industries HI-6005 fiber optic isolated, isotropic electric field probe.



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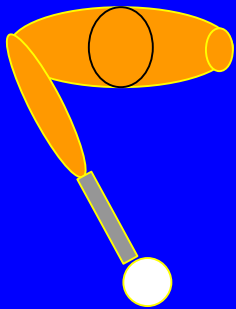
# Typical Spatial Variation of Power Density at 30 Feet from KZIN Tower, Shelby, Montana



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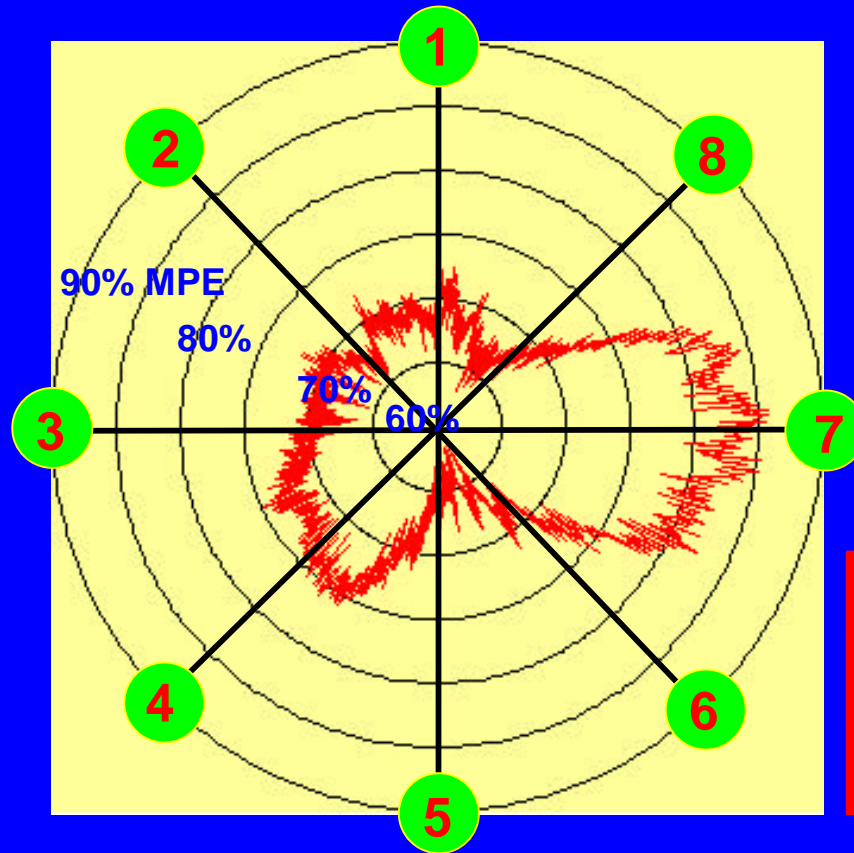
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# Polar Plot of Field Perturbation Caused by Observer



Technician faces measurement point from all directions.

KZIN FM 96.3  
MHz Shelby, MT  
8-1-2001



Plotted for height of maximum unperturbed field of 86.5% MPE.

$S_{\max} = 85.8\%$  MPE

$S_{\min} = 61.7\%$  MPE

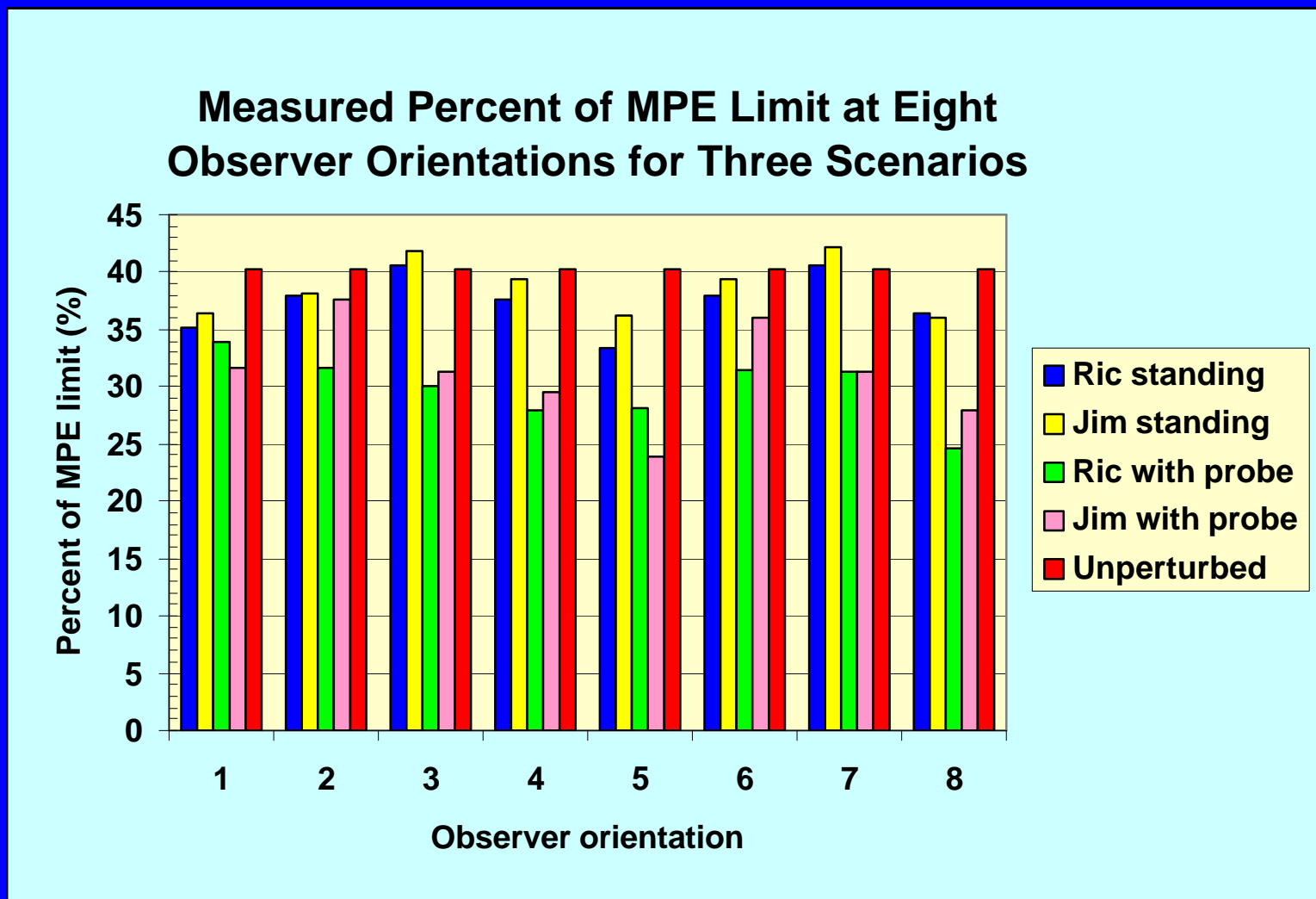
$S_{\text{avg}} = 71.2\%$  MPE



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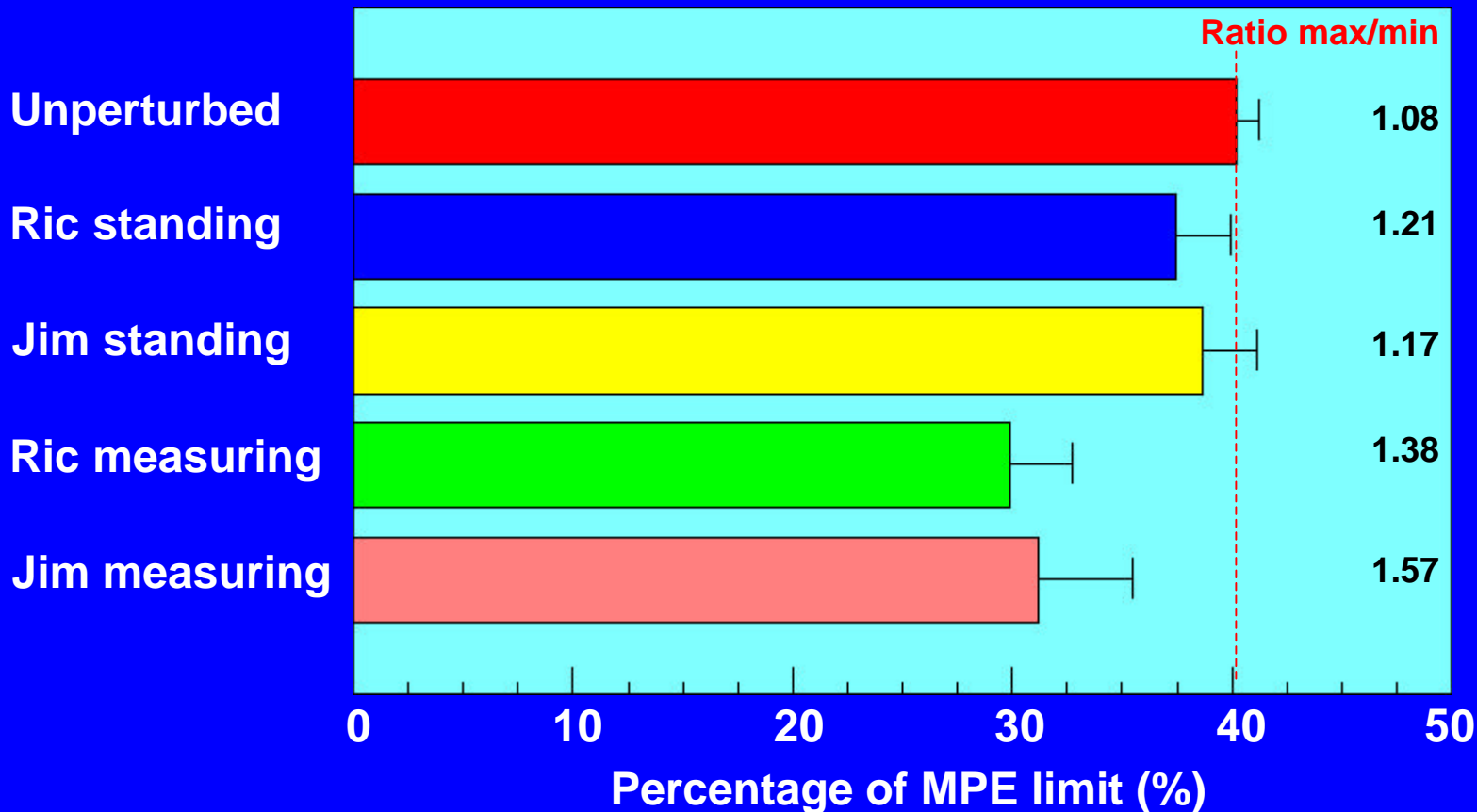
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# Preliminary Spatial Average Measurement Results



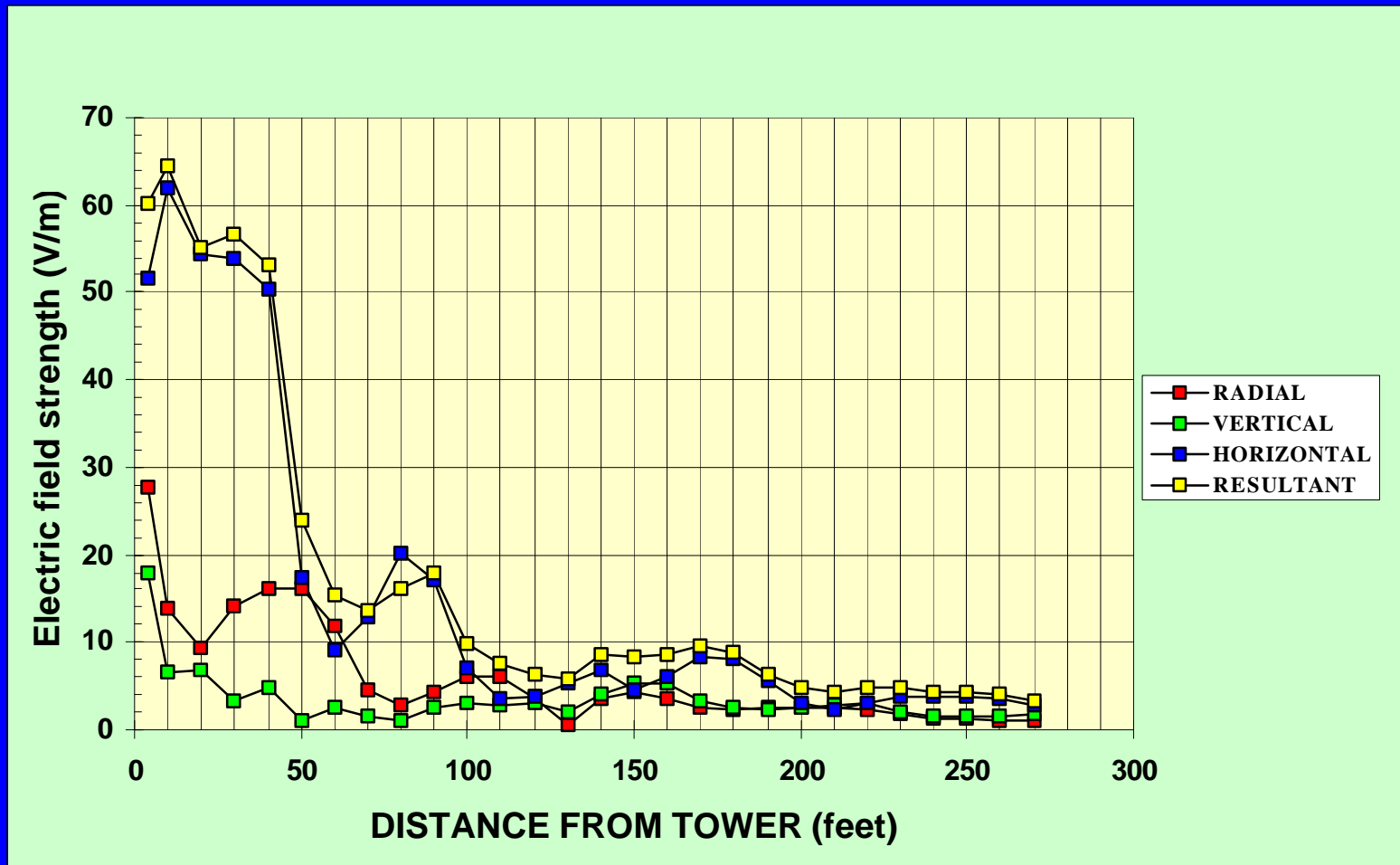
# Overall Average of Spatial Average Measurements

Based on 8 spatial averages for each scenario



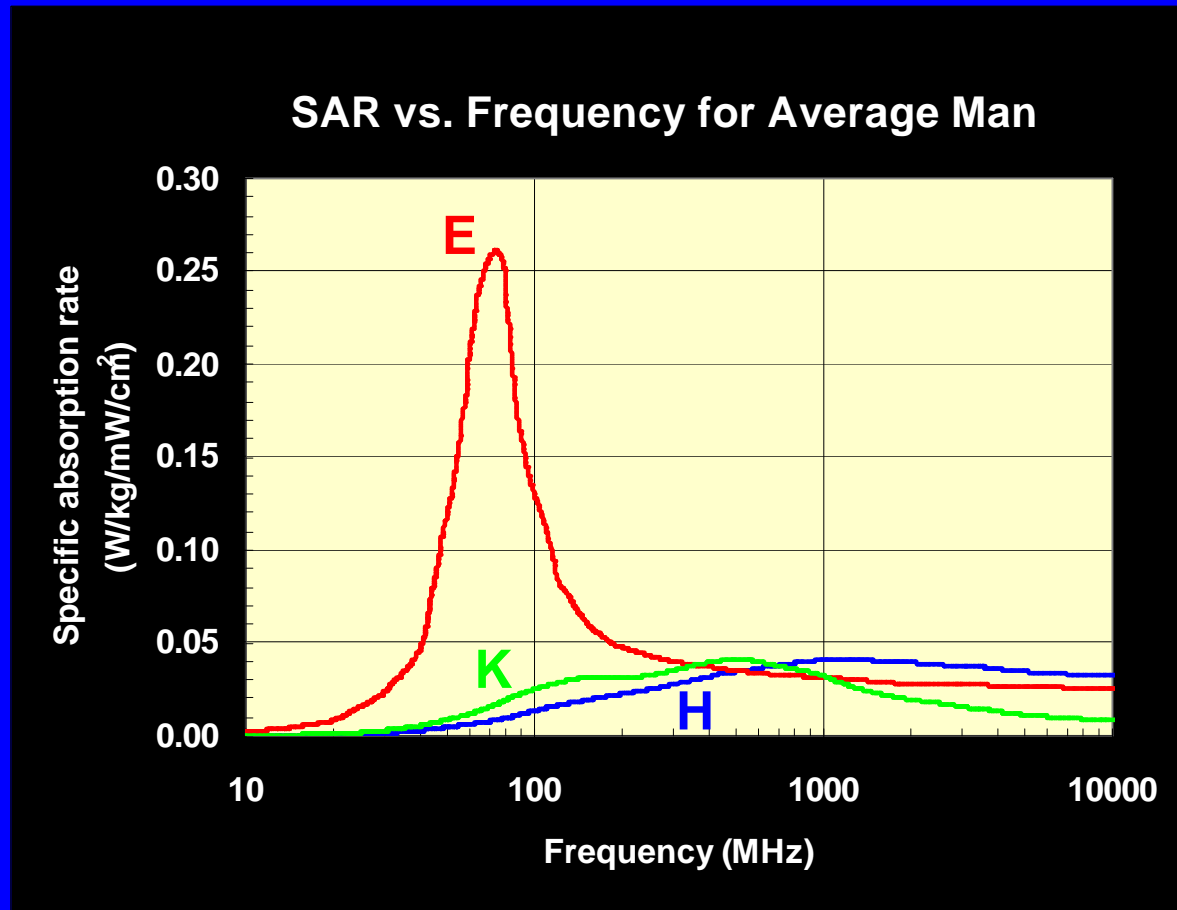


# Electric Field Strength Polarization Components vs. Distance from KZIN Tower



# Polarization and SAR

Isotropic field probes will generally overestimate resulting SAR



Relative SAR Contribution

F = 96.3 MHz

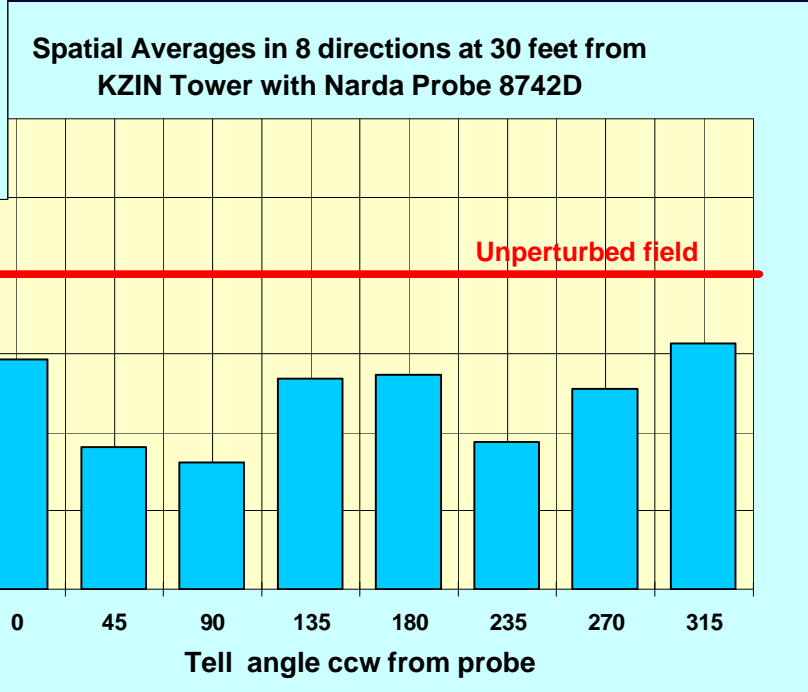
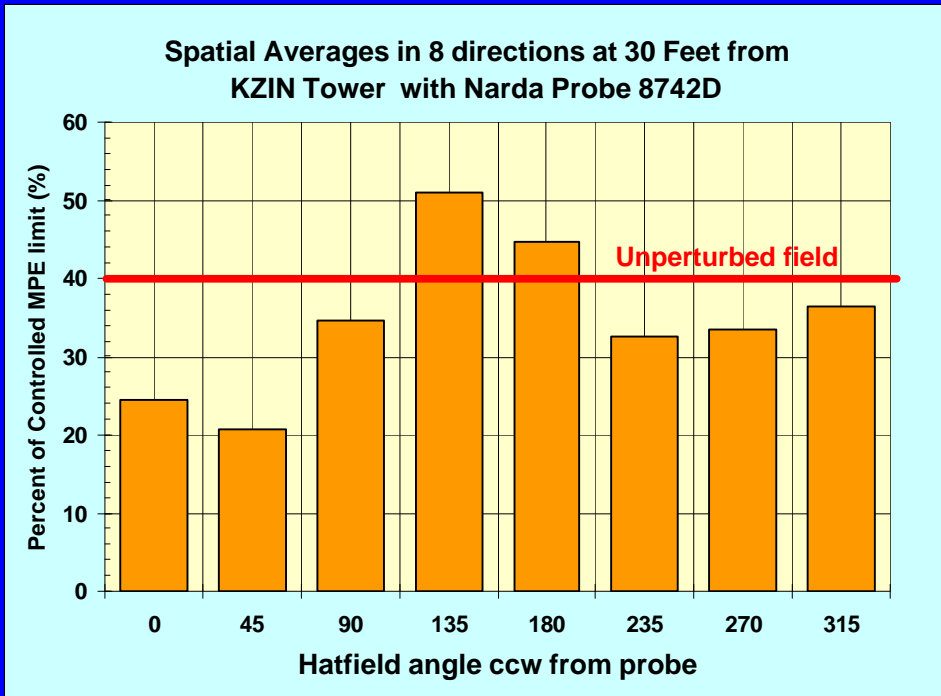
E: 100%

H: 9.3%

K: 17.6%

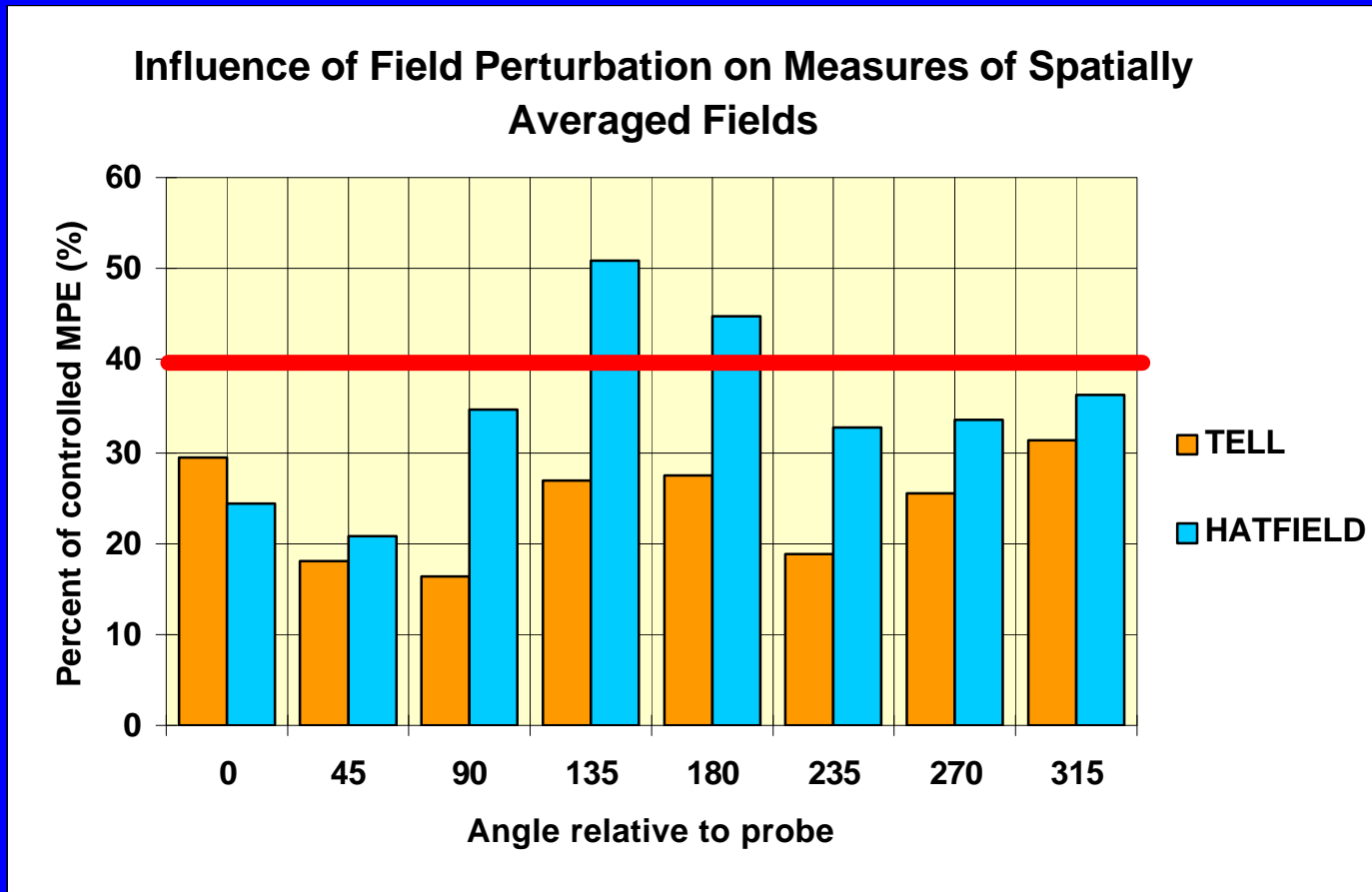
Total SAR from all field components at test point = 10% of the SAR that would be implied from a measurement of the resultant field.

# Comparison of measurements of spatially averaged RF fields



Assessing compliance with exposure limits can be difficult.

# Comparison of Two Persons Using the Same Probe at Same Point



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# How Strong is that Field?

- The FCC maximum permissible exposure (MPE) limits are in terms of spatially averaged values of plane wave equivalent power density over the body.
- The limits are derived from the presumption of uniform exposure to a field having the specified MPE limit.
- The most accurate assessment of exposure, relative to determining compliance with the FCC limits, is in the absence of any field perturbing effects introduced by either the person being exposed or the person attempting to measure the exposure.

# Tentative Conclusions

- **Measures of spatially averaged RF fields are inherently fraught with uncertainty caused by field perturbations.**
- **Operator interaction with the field can lead to significant differences in compliance measurements at antenna sites.**