***** Tentative *****

EEP592 (575?) Radar and Imaging Techniques Spring 2022

Instructor: Yasuo Kuga, Rm430 ykuga@uw.edu, Office hours: TBD
Class Schedule: TBD
TA: TBD

Objectives:
This course will introduce the different radar target detection and imaging techniques. Students will become familiar with radar cross-section (RCS) measurements techniques.

Prerequisite:
Basic knowledge of electromagnetics (EM), transmission lines (TL) and signal processing. ECE361 level

Course Materials (class web site):

Lecture notes and journal papers
Ref: Microwave Radar and Radiometric Remote Sensing, Ulaby and Long

HW (tentative):

RCS
Radar reflection models using TL technique and signal processing
RCS calculation and measurement using network analyzer
Polarimetric RCS measurement
AOA (angle of arrival) estimation
SAR(synthetic aperture radar) /ISAR (inverse SAR) processing
Others

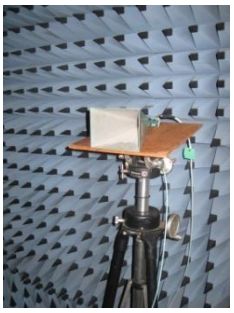
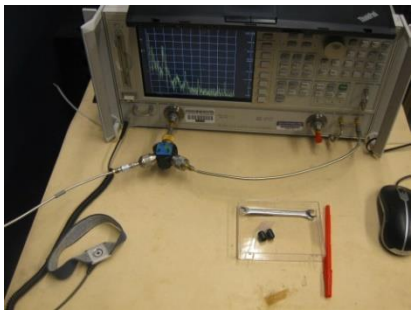
Lab: Not included in 2022

Tentative Course Topics:
1. Radar equations and radar cross section (RCS) of different targets
2. Polarimetric calibrations and polarimetric imaging of targets
3. FMCW radar for automobile and other applications
4. Detection of angle or arrival (AOA)
5. Inverse Synthetic Aperture Radar (ISAR) and SAR imaging techniques.
6. Weather radar and detection of rain fall
7. Radiometer and applications
8. Passive radars

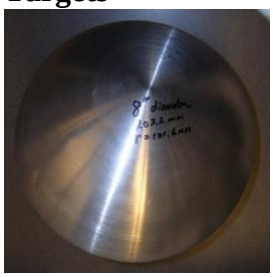
Grading policy:
Six to seven projects will be assigned. The final grade will be based on the projects/reports. No exam.

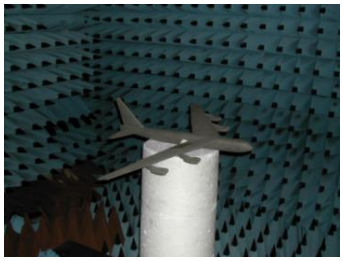
Lab X: Radar Cross-Section (RCS) Measurements

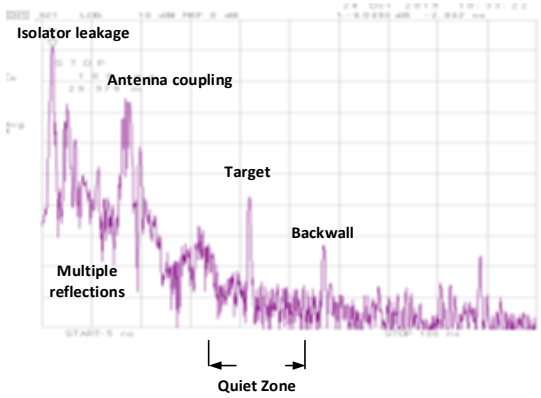
Setup

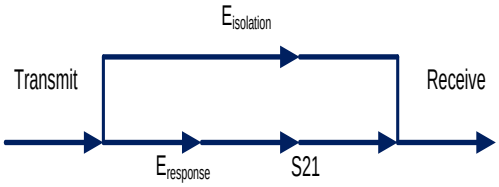

Targets



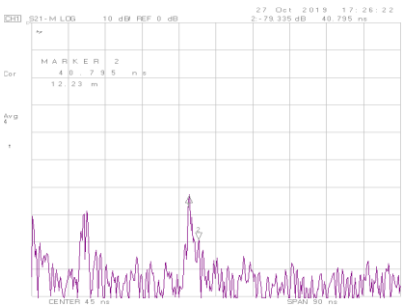





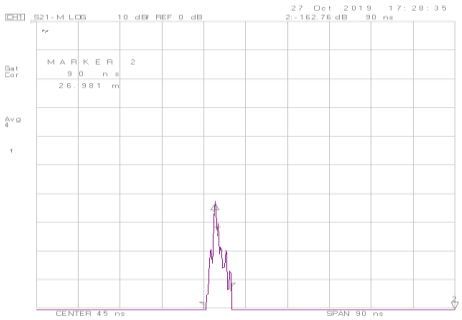
Time-domain data



Error diagram



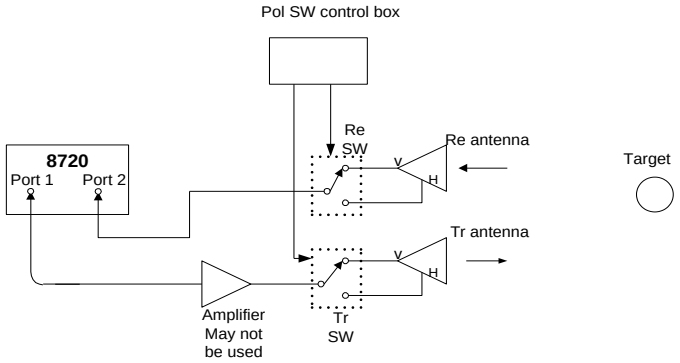
After background subtraction

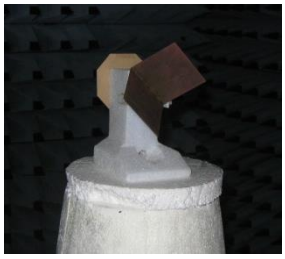
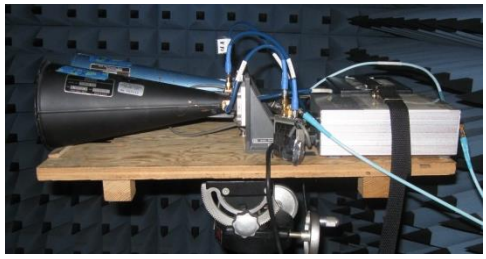


After time gating

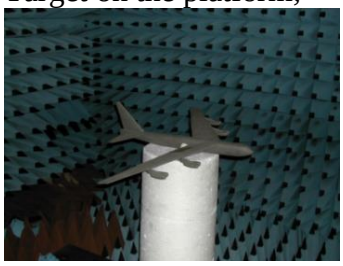
Transform the time-domain data to frequency-domain.
Then show results in dBm^2 (dBsm) which is the unit of RCS.

Lab X: Polarimetric Radar Measurements




Target on the platform, wideband polarimetric radar



Definition of the scalar RCS. Target σ_T is given by the following equation

$$\sigma_T = P_r R^4 \left(\frac{\sigma_o}{P_{r0} R_0^4} \right) = \left(\frac{P_r}{P_{r0}} \right) \left(\frac{R}{R_0} \right)^4 \sigma_o$$

P_r, P_t: received and transmitted power.

R, R_o: distance to target, distance to a calibration target

σ_o: RCS of a calibration target

Definition of the polarimetric RCS

$\sigma_b = 4\pi |S_{xx}|^2$ where $|S_{xx}|$ are

$$\begin{pmatrix} S_{vv} & S_{vh} \\ S_{hv} & S_{hh} \end{pmatrix} = |S_{vv}| e^{i\theta_{vv}} \begin{pmatrix} 1 & \left| \frac{S_{vh}}{S_{vv}} \right| e^{i(\theta_{vh} - \theta_{vv})} \\ \left| \frac{S_{hv}}{S_{vv}} \right| e^{i(\theta_{hv} - \theta_{vv})} & \left| \frac{S_{hh}}{S_{vv}} \right| e^{i(\theta_{hh} - \theta_{vv})} \end{pmatrix}$$

Raw data is useless.
The polarimetric calibration must be performed to obtain useful results.