ECE 495 – Electromagnetic Warfare and Survivability

Block 2: RF Electronic Warfare
Lesson 19: Project 2 Work Day

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Project 2: The Ask

Your group is the B-21 mission-planning cell.

Product: weapon-quality locations for the IADS emitters defending a target area — found passively, from RWR bearings, while the aircraft stays outside every threat's lethal range.

- Everything you need is in L13–L14: AoA, lines of position, crossing into a fix
- Handout, scenario CSV, collection simulator, and starter are posted
- Results presentations at L20 — 10 minutes, 5 of Q&A, everyone speaks

A bearing is a line. The fix — and its precision — is the product.

The Scenario: Three Emitters, Three Keep-Outs

A notional IADS sector near the grid origin (km, North/East):

ID	Class	Band	Prior (N, E)	Keep-out
E1	EW	UHF (0.5 GHz)	$(0, 0)$	20 km
E2	ACQ	S (3 GHz)	$(10, -8)$	45 km
E3	TTR	X (10 GHz)	$(-6, 6)$	40 km

- Positions are coarse ELINT priors (± 5 km) — good enough to plan, not to shoot
- Your entire flight path must stay **outside** all three keep-out circles

Bearings to a Fix to an Ellipse

Each RWR cut is a bearing with noise $\sigma_\theta = 0.5^\circ$. Cross cuts from different points and the lines meet at a fix — with an **error ellipse**.

- The ellipse comes from geometry and noise: $\mathbf{C} = \left[\frac{1}{\sigma_\theta^2}\sum_k \mathbf{H}_k^\top \mathbf{H}_k\right]^{-1}$
- **Wide cut** and **long baseline** shrink it; shallow cut or long range stretch it
- Summarize each fix by its $\mathrm{CEP} \approx 0.59(a+b)$ from the 1σ semi-axes

This is L14 made operational: geometry, not receiver quality, sets your accuracy.

The Spec — and the Tension

The standoff weapon's seeker acquires within a 1 km basket. To cue it confidently:

$$\mathrm{CEP} \leq \tfrac{1}{2}(1\ \mathrm{km}) = 0.5\ \mathrm{km}$$

- Meet it for the lethal emitters (ACQ and TTR at least)
- **Accuracy** wants you close and on a long baseline
- **Survivability** wants you far — outside every keep-out

The whole project lives in that tension. Defend your geometry.

Your Tasks

1. **Geolocation pipeline** — bearings to a fix to a 1σ ellipse; verify on the starter
2. **Collection design** — standoff, baseline, heading, cuts; stay outside every keep-out
3. **Execute and geolocate** — run the sim along your path; report fixes + CEP
4. **Meet the spec** — who passes, who doesn't, and the accuracy–standoff trade
5. **Visualization** — emitters, keep-outs, path, fixes, ellipses, to scale
6. **Recommendation** — one slide to the strike cell

Starting Point

The starter gives you a working pipeline for the simplest case:

- Reads `IADS_Scenario.csv` and flies a two-waypoint sample leg
- Calls `rwr_collection_sim.m` to collect noisy bearings
- Cross-fixes one emitter and draws its 1σ ellipse with CEP

Example File: `L19_Project2Starter.m`

The true emitter positions are hidden in the simulator — estimate them. Verify the two-point case, then add cuts, emitters, and geometry.

Today's Battle Rhythm

- **First 10 min** — groups assigned, claim a whiteboard, read the handout together
- **Next 30 min** — divide the work: pipeline, geometry design, visualization, story
- **Last 10 min** — regroup: what's done, what's blocked, who owns what before L20

I am floating between groups — pitch me your collection geometry early.

Sketch the geometry before you write code — it tells you what to fly.

Wrap-Up

Before you leave:

- Pipeline verified against the starter's two-point fix
- A first collection geometry sketched — and checked against the keep-outs
- Task owners assigned through L20

Next lesson:

- **L20: Project 2 results presentations** — slides + code due before class
- **HW2 due** at the start of L20
- **Quiz 2** (open book) in class, tied to your project work