

# The Rx-CADRE Integrated Prescribed Fire Measurements Campaign

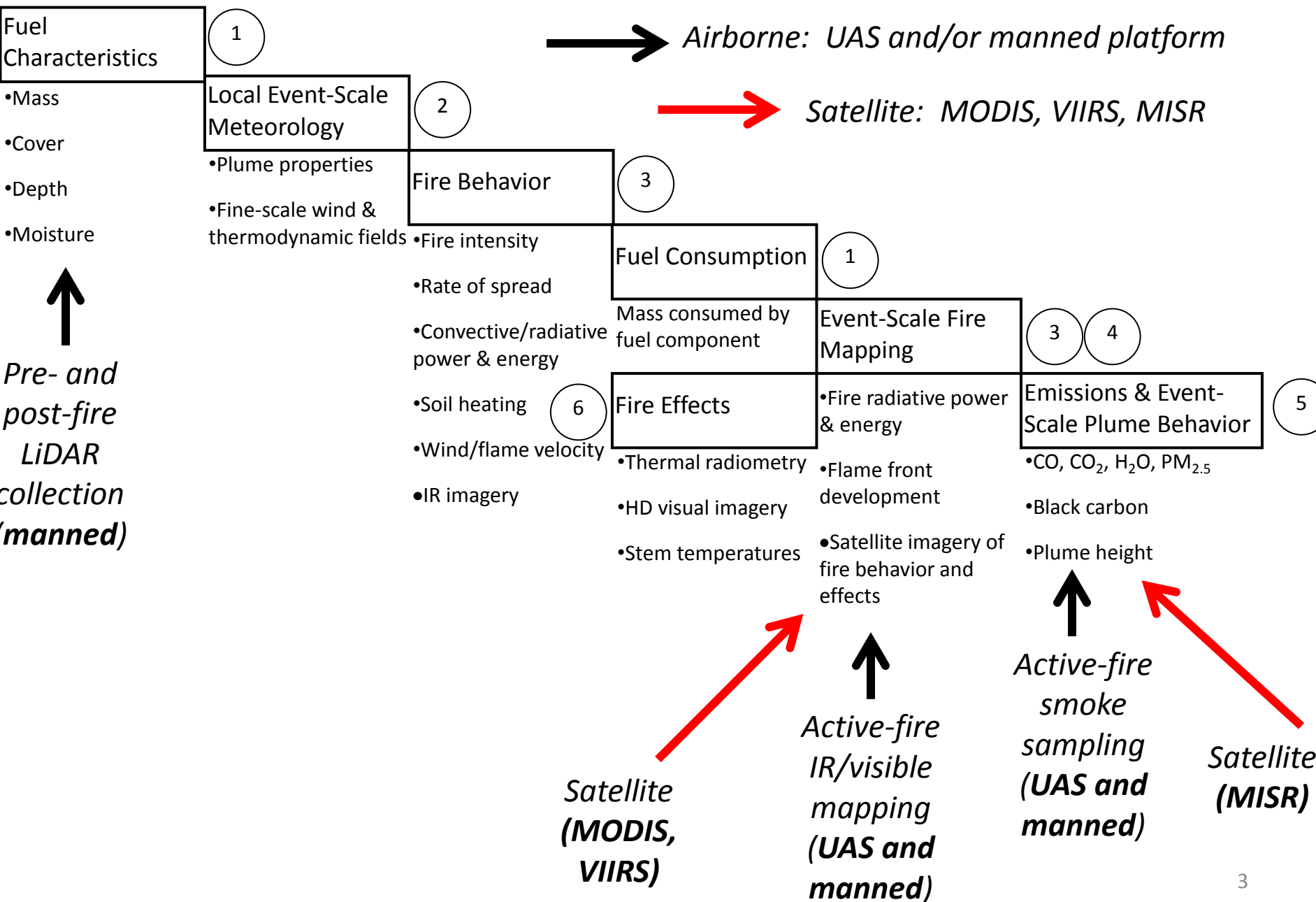
## *Remote Sensing Measurements from Satellite and Piloted and Un-Piloted Aircraft*

Travel:	<=29 October 2012
General briefing:	30 October
UXO briefing (0900), test burn, & MISR overpass	31 October
Pilot briefing:	1 November
Main event:	2 – 19 November

# *Rx-CADRE Airborne Measurements - overview*

- Rx-CADRE (Prescribed Fire Combustion and Atmospheric Dynamic Research) has conducted successful research campaigns at Eglin Air Force Base in 2008 and 2011
- The Rx-CADRE team is inter-agency (e.g., DoD, USFS, NASA, DoE, Academia) and multidisciplinary (e.g., ecology, remote sensing, meteorology, fire physics)
- 2011 Campaign
  - Small Unmanned Aircraft Systems (UAS) integrated into the research program
  - Satellite observations successful (Ichoku)
- Rx-CADRE (November) 2012 funded by the interagency Joint Fire Science Program to conduct a third campaign in non-forested fuels
- Primary objectives of Rx-CADRE 2012 - produce evaluation datasets for:
  - Smoke chemistry and transport models
  - Fire behavior models
- Secondary objectives include
  - Ecological measurements
  - Coordination with satellite observation

# Rx-CADRE Airborne Measurements - overview



# *Rx-CADRE Airborne Measurements - overview*

- Rx-CADRE campaign prescribed fires are run within the Incident Management System, each with their own Incident Action Plan
- UAS flights are included in Branch III of the Operations Section
- For the 2011 fires, Bill Holley (46 TSSQ) was the UAS Branch Director

## **The MEOC (not for Rx-CADRE 2012)**





# *Rx-CADRE Airborne Measurements – objectives and layout*

- Burns involving aircraft will be conducted on Range B-70
- There will be two kinds of units
  - **Large units** (500-1000 acres, N=3)
    - ✓ Two grass and turkey oak fuels
    - ✓ One forested
    - ✓ Objective: evaluate smoke chemistry and transport models
  - **Small units** (~5-10 acres, N=6)
    - ✓ Grass fuels (N=3) and grass and turkey oak fuels (N=3)
    - ✓ Objective: evaluate fire behavior models





NAPP

11034-33

Range B70



B70 Center  
Road

Safety Zone



B70E  
100 X 200 m  
S7, S8, S9

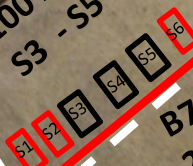


Grass & Shrub

B70EL4G  
400 ha  
(Priority 3)

Red small blocks  
possible test units

B70E  
100 X 200 m  
S3 - S5



Creek



Safety Zone



B70EL2G  
200 ha  
(Priority 2)

Grass

B70EL2F  
200 ha  
(Priority 1)

B70CL1G  
400 ha  
(Priority 1)

Road 253



Range—B70

C—Central

E—east

L—Large

S—small

G—Grass/Shrub

F—Forest

— Unit Boundary

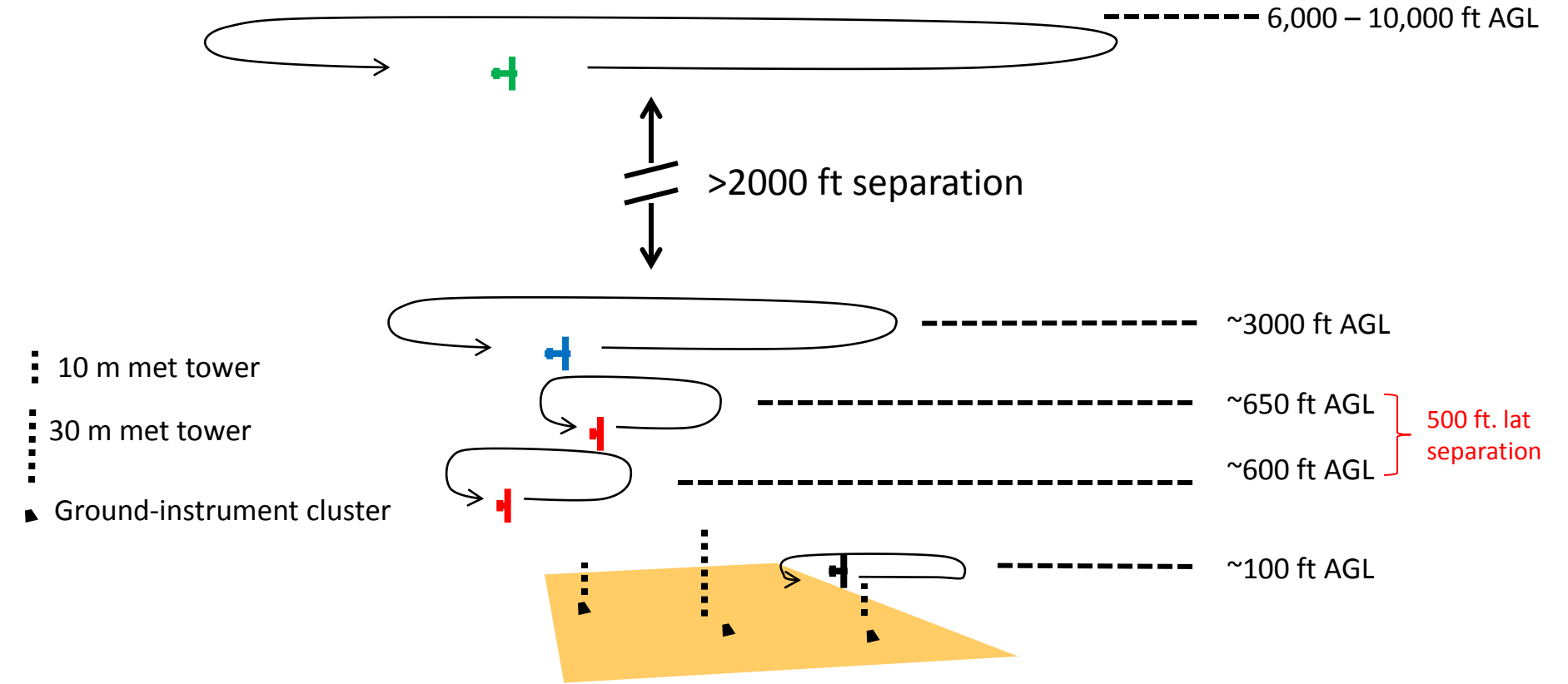
— Roads

Prevailing wind  
direction SE



# Rx-CADRE Active Fire Measurements – Large Units (500-1000 acres)

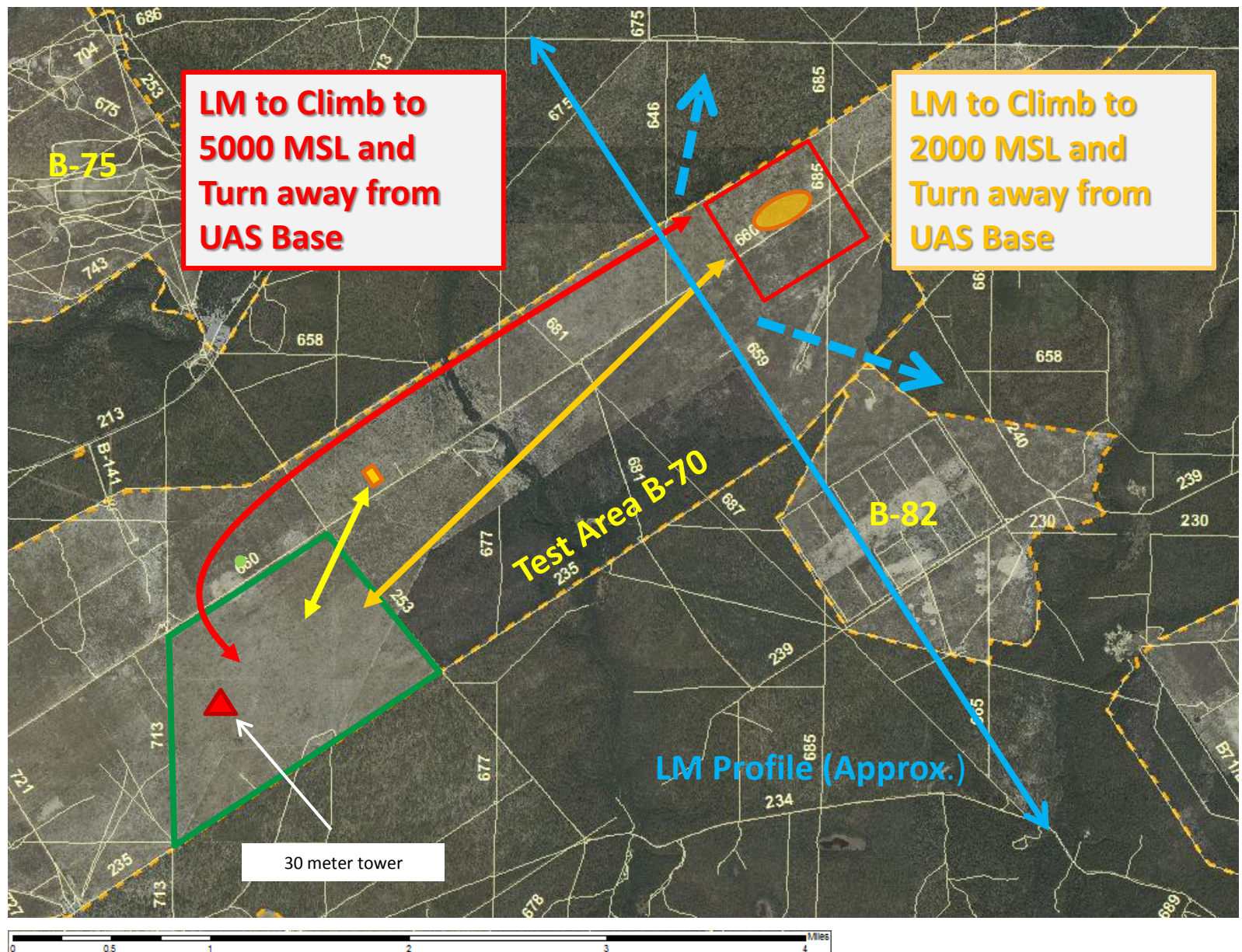
## Active fire measurements



- Manned**    Piper Navajo – WASP sensor (LWIR/MWIR/SWIR and visible fire mapping at zenith)
- UAS**    {    UAF Scout – LWIR, Flight 1 HIP-3, Flight 2 as directed
- {    EAFB Test Wing G2R1, G2R2 – LWIR smoke sensor, wind, T, and RH sampler, F1 HIP-1, HIP-2; F2 MAPPS
- {    U. Alaska ScanEagle – LWIR synoptic view

**NOTE: Piper smoke sampling aircraft is downwind following plume ~1000 - 8000 ft AGL**





**Burn Block L1G UAS Lost Link**

↔ UAS Routes

○ UAS Bases

▲ MAPPS 8

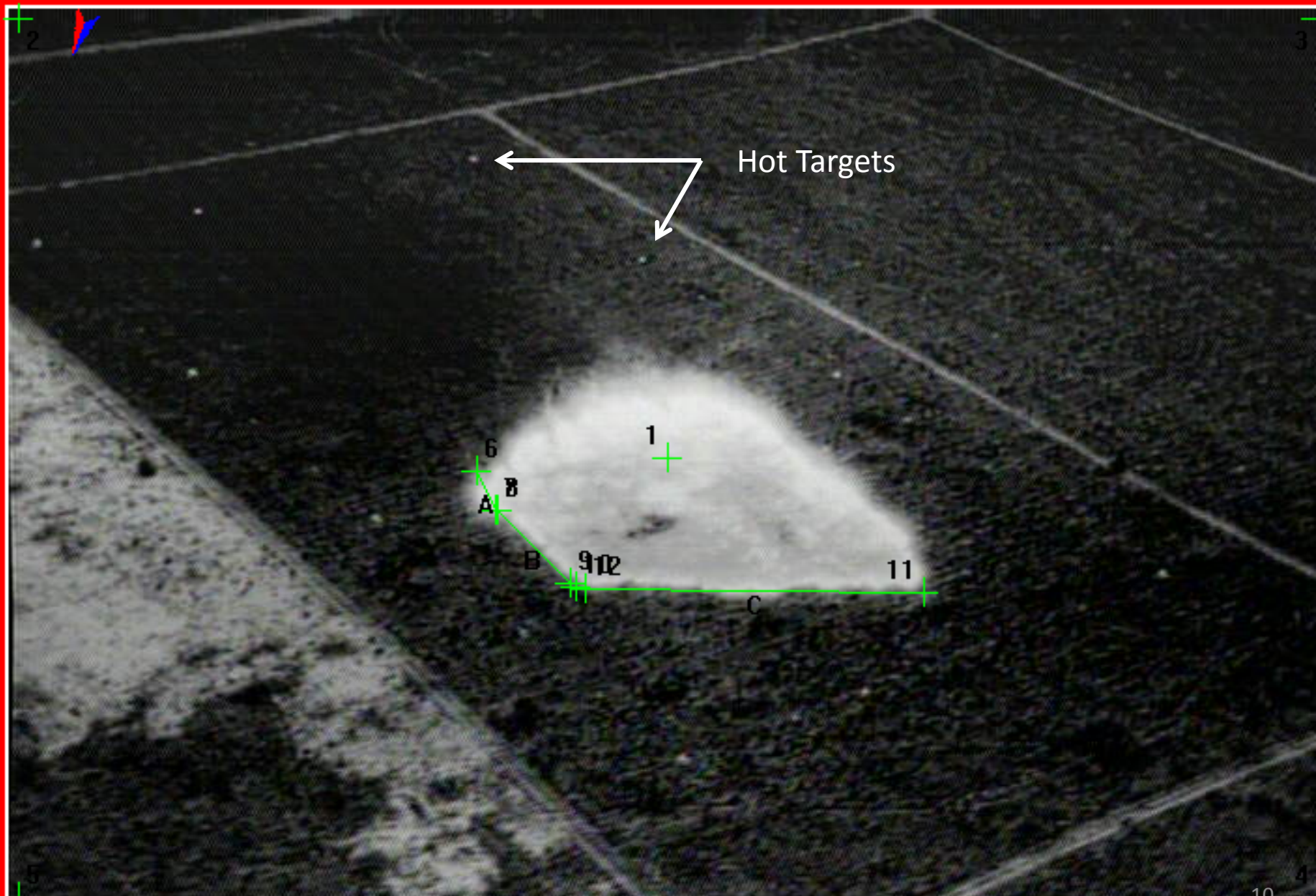


# B70L1G Manned/Unmanned Schedule November 4, 2012 V2

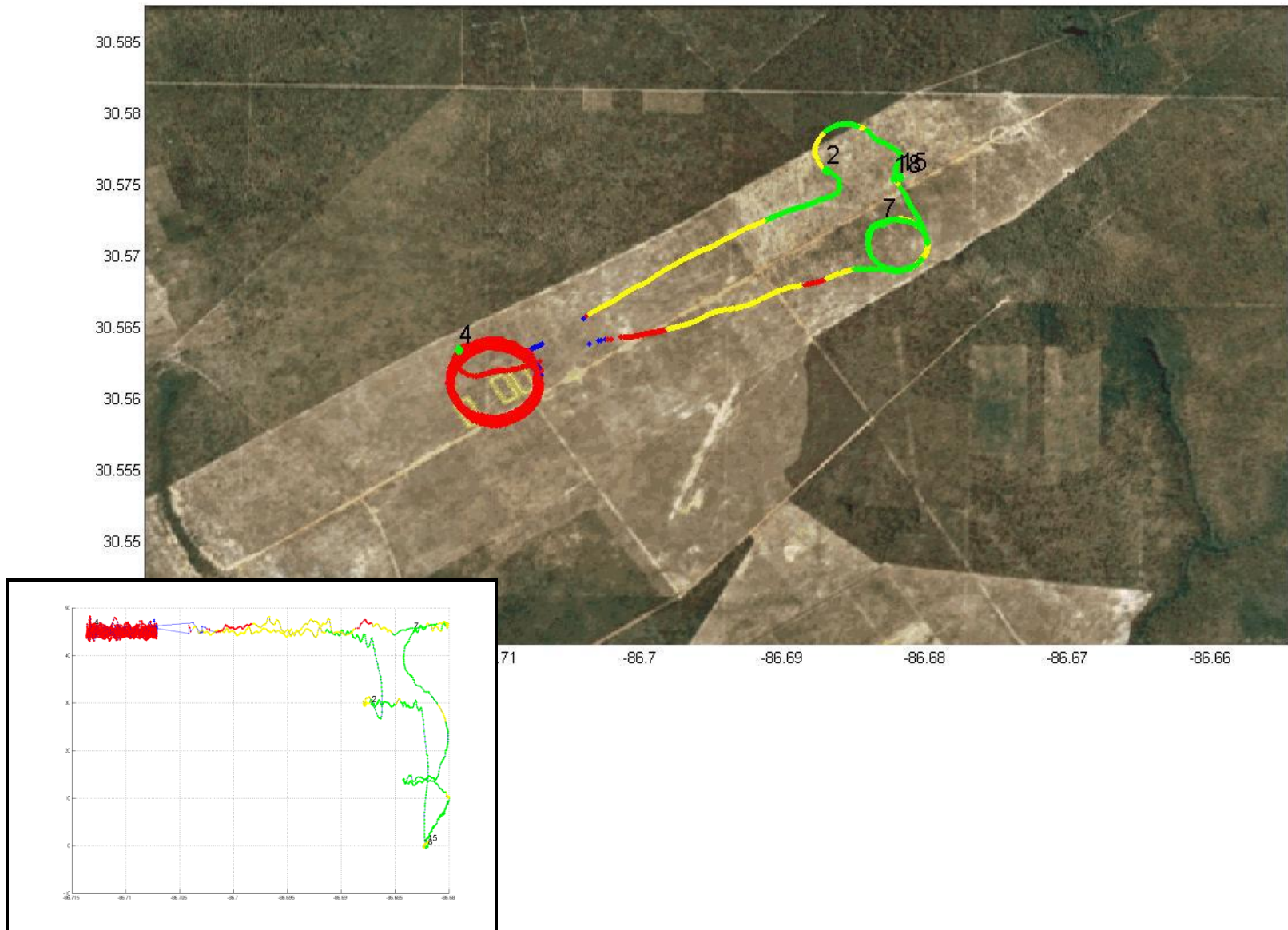
**All time approximate based upon ignition time**

- 1100 Launch Weather Balloon 1
- 1115 Launch Low Manned (LM) (Urbanski, Smoke Sampling)
- 1115 Launch Scan Eagle (SE)
- 1130 Low Manned begins sampling over B70L1G once SE Upwind LG1
- 1130 Launch High Manned (HM) (Kremens, WASP)
- 1145 Launch G2R1
- 1155 Launch G2R2
- **1200 IGNITION**
  - **Launch Scout**
  - **LM Cleared to Orbit as desired**
  - **HM Orbit 6000 – 10000 ft. AGL over L1G**
  - **SE Orbit 3000 ft. AGL over L1G**
  - **G2R1 – G2R2 Orbit 600/650 ft. AGL , 500 ft. lateral separation over HIP 1 – 2**
  - **Scout Orbit 50 – 100 ft. AGL HIP - 3**
- 1215 Retrieve G2R1 once LM confirms it is clear of B70 (Tree Line) or above 5000 ft. AGL
- 1215 Retrieve Scout
- 1220 LM cleared to Profile as desired
- 1230 Re-launch Scout (As needed / Directed)
- 1230 Re-launch G2R1 once LM confirms it is clear of B70 (Tree Line) or above 5000 ft. AGL
- 1230 Retrieve G2R2
- 1240 LM cleared to Profile as desired
- 1245 G2R1 On station Orbit 600 ft. AGL over MAPPS
- **1330 Burnout Complete**
  - **Retrieve SE once LM confirms it is clear of B70 (Tree Line) or above 5000 ft. AGL**
  - **Retrieve G2R1**
  - **Release HM**
- 1430 Launch Weather Balloon 2
  - Confirm LM is well clear downwind
  - Confirm HM has departed B70
  - Confirm SE has landed

Sarnoff TerraSite Output S-5



# Hier's Triangle





# *Rx-CADRE Active Fire Measurements - Calibration and geo-location targets*

Options on the table:

- ❖ ~10 dual-band radiometers/burn
- ❖ Four (4), 0.25 m<sup>2</sup> propane targets (higher T) (RIT)
- ❖ EAFB Test Wing targets
- ❖ Hot pots with charcoal for image rectification (esp. FLIR)
- ❖  $\geq 3 \times 3$  m charcoal target located where it won't interfere with ground-based smoke measurements

Note: this arrangement too subpixel for ground calibration, need larger area with more heat release



# *Rx-CADRE Active Fire Measurements - Flame front depth from UAS data*

Knowing we can't get quantitative fire radiative flux density measurements...

Key objective of UAS fire monitoring is to describe flame front depth  
(describing rate of spread will be possible if we meet this objective)

Visible imagery OK.

Methods for small-UAS-capable  
infrared sensors that don't have the  
dynamic range of heavier sensors  
(e.g., WASP, Joe's FLIRs)

Issues:

- ❖ Pixel distortion from oblique angles (minimize)
- ❖ Sub-pixel flames (altitude as low as possible)
- ❖ Gain/signal control
- ❖ Geolocation targets - how many targets and where
- ❖ Calibration targets – ditto
- ❖ Two boom-mounted FLIR as backup

Ruddy Mell's efforts (USFS, NIST, USD...)

