

# CAIPAN-2

WORKSHOP

## SIGMA2 Tour: focus on UAP physics and plasma



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(3AF SIGMA2 Commission)

<https://www.3af.fr/commission-technique/sigma>

TOULOUSE,  
13 > 14 octobre  
2022

## A brief overview on SIGMA2 activities



## UAPs: What do they look like? The observables

How can we discriminate UAPs from known aerial phenomena? Use some observables for discrimination. Observables like color and kinematics can substantially vary between UAPs, or even rapidly change during an observation.

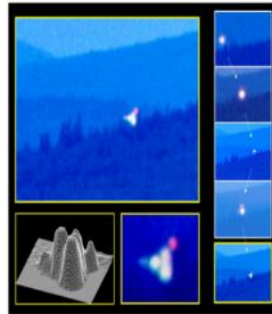
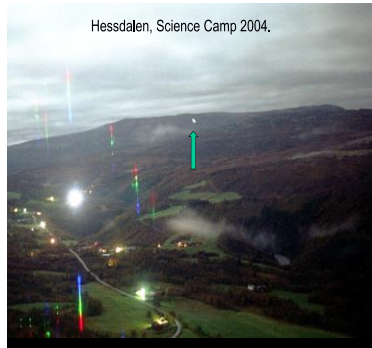
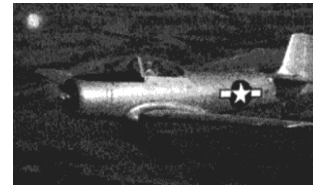


Figure 4. One example of a multi-light ball phenomenon in Hessdalen. Top: 2002 images and associated location in Hessdalen valley. Bottom: 3D model of the Hessdalen valley.



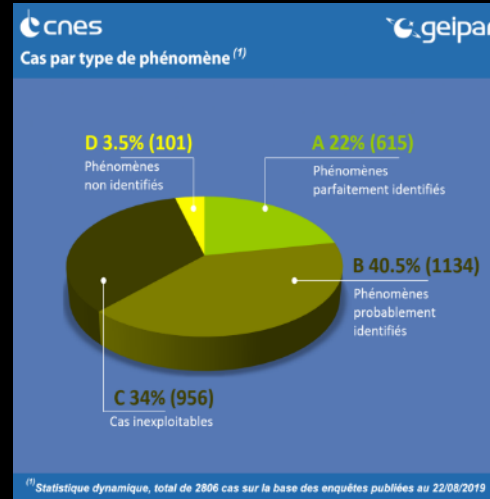
- "Luminous spheres", "plasmoids", alone or in groups, high speed maneuvers
- Hessdalen Lights
- Foo Fighter
- ball lightning phenomenon

Your NAME - reference



TOULOUSE, 13-14 octobre  
2022

# SIGMA2 IS COMPLEMENTARY TO GEIPAN



GEIPAN

Gendarmerie  
Armée de l'Air

Foreign Cases



D CASES SELECTION

PHYSICS ELEMENTS

OBSERVABILITY APPROACH &  
IMPROVEMENT

CASES INVESTIGATION RECOMMENDATION



# Natural Phenomena (ball lightning family)

## TYPOLOGIE VISUELLE DE LA Foudre EN BOULE

Basée sur 406 observations entre 1994 et 2020



Ball lightning (from NARCAP TR-7, 2002)  
www.narcap.org

Cette typologie des différentes catégories de la foudre en boule présente des reproductions fidèles des apparences visuelles du phénomène observées par les témoins. Elle n'est pas exhaustive, étant susceptible d'évoluer en fonctions des observations rapportées.

### I - LA Foudre EN BOULE



La foudre en boule est caractérisée par l'apparition d'un phénomène lumineux durant un orage, simultanément à un coup de foudre ou quelques secondes plus tard. Plusieurs autres critères sont nécessaires comme la forme qui doit être sphérique, la taille qui ne doit pas excéder cinquante centimètres, une durée de vie assez courte avec un maximum de 30 secondes et l'altitude d'évolution qui doit être comprise entre le sol et cinq mètres de hauteur. Le météore lumineux peut être statique ou mobile, son déplacement est la plupart du temps relativement rapide.

### II - LA Foudre GLOBULAIRE



La foudre globulaire est caractérisée par l'apparition d'un phénomène lumineux lors d'un orage ou durant une ambiance orageuse (temps lourd, éclairs ou tonnerre sporadiques...) ou en présence d'intenses champs électriques ou magnétiques naturels. Le point déterminant de caractérisation est l'aspect visuel qui n'est pas forcément sphérique, mais peut changer de forme ou comporter des aigrettes, cela induit des changements de dimensions et d'apparences durant son évolution. La durée de vie peut varier de quelques secondes à plusieurs minutes (exceptionnellement plusieurs dizaines de minutes), le météore lumineux peut être statique ou se déplacer sur des distances allant de quelques dizaines de mètres à des distances bien plus importantes, de l'ordre de plusieurs centaines de mètres. La taille peut varier de quelques dizaines de centimètres à plusieurs mètres, et son altitude d'évolution peut aller du niveau du sol à plusieurs centaines de mètres de hauteur. Des changements d'altitude ou des rebonds sur le sol sont régulièrement observés.

### III - LE P.L.O.T

Phénomène Lumineux Orageux Transitoire



Le P.L.O.T ou Phénomène Lumineux Orageux Transitoire est caractérisé par un phénomène lumineux atmosphérique de dimensions et d'apparences très variables qui se produit soit par temps orageux, soit en dehors de l'enveloppe d'un orage actif, soit par beau temps ou bien lors de champs électriques, magnétiques, électromagnétiques ou électrostatiques très élevés. Des phénomènes de ce type sont observés avant, durant, ou après les séismes, plus rarement dans le panache d'une éruption volcanique lorsque des décharges électriques viennent à se produire. Le P.L.O.T peut avoir des phases statiques sur une partie de sa durée de vie comprise entre quelques secondes et plusieurs minutes ou de sa trajectoire. Observable à toutes les altitudes, du sol jusqu'à la tropopause.

© Laboratoire de Recherche sur la Foudre  
www.laborfoudre.com contact@laborfoudre.com  
Version V3 - 2022

## Specific analysis of ball lightning and similar phenomena- Preliminary conclusion (SIGMA2 Progress report 2021)

PLOT (Phénomène Lumineux Transitoire Orageux) / Ball lightning can show different luminous features, spherical, flying in altitude, might reach sound speed, in group or single

No sudden change of direction, no stationary flight- not supersonic

Different analysis including from UK MoD analysis favoring plasmoid as a possible conclusion/explanation for UAP.



# UAPs observables and special air vehicles:

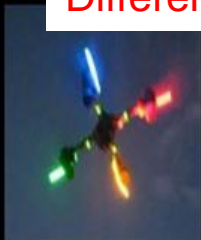
## Triangle shape versus many UAP



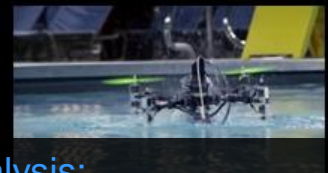
Dessine-moi un...ovni !?  
vs objets aérospatiaux



Different shapes/ change of shape during flight



Les performances techniques observées sont elles compatibles...

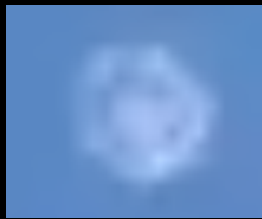


Specific analysis:  
UAS and micro UAS limit of performance  
Hypervelocity missiles inventory – flight domain- Signatures and plasmas at high speed



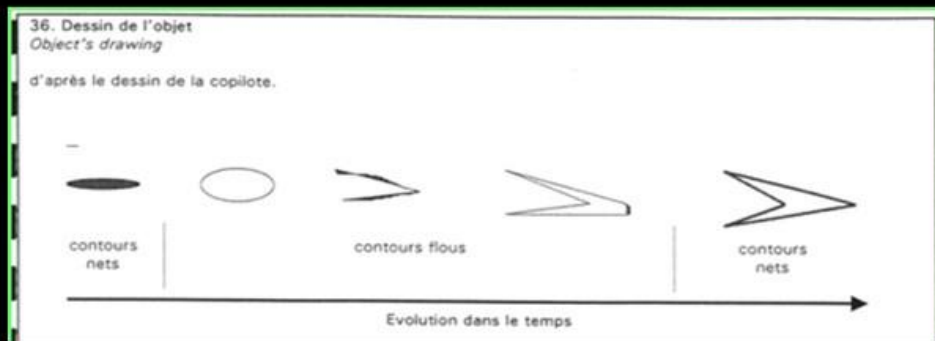
# UAPs shapes

Triangular bokeh?

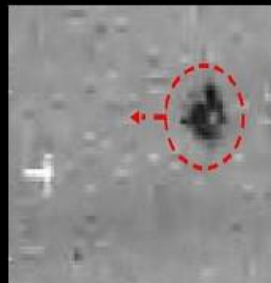


Discrete localized phenomena (orange point), then lenticular or ovoid, silver disk (many forms)

Variable phenomena



Change of geometric shape (disc-arrows), blur effect, static or slow, rectilinear or oscillating movement, sudden accelerations with angles at 90 degrees, reversal, silence or emission of crackling, ultrasound, change of appearance (bright, metallic), change in color and intensity...



IR observations:

Difficult interpretation, requiring other observations, in particular radar to remove the ambiguities on the distance (case of a drone? case of an airplane)

A satellite-style map of a coastal region, likely in the Netherlands, showing a large green area (heathland) and a blue area (water). A semi-transparent white text box is overlaid on the map. The text inside the box reads: "CAS", "LAKENHEATH-BENTWATERS", and "Nuit du 13-14 août 1956".

**CAS**  
**LAKENHEATH-BENTWATERS**

**Nuit du 13-14 août 1956**



Miles



LAKENHEATH



WATERBEACH  
RAF Station



BENWATERS



11

21 : 30

Miles



LAKENHEATH

WATERBEACH  
RAF Station

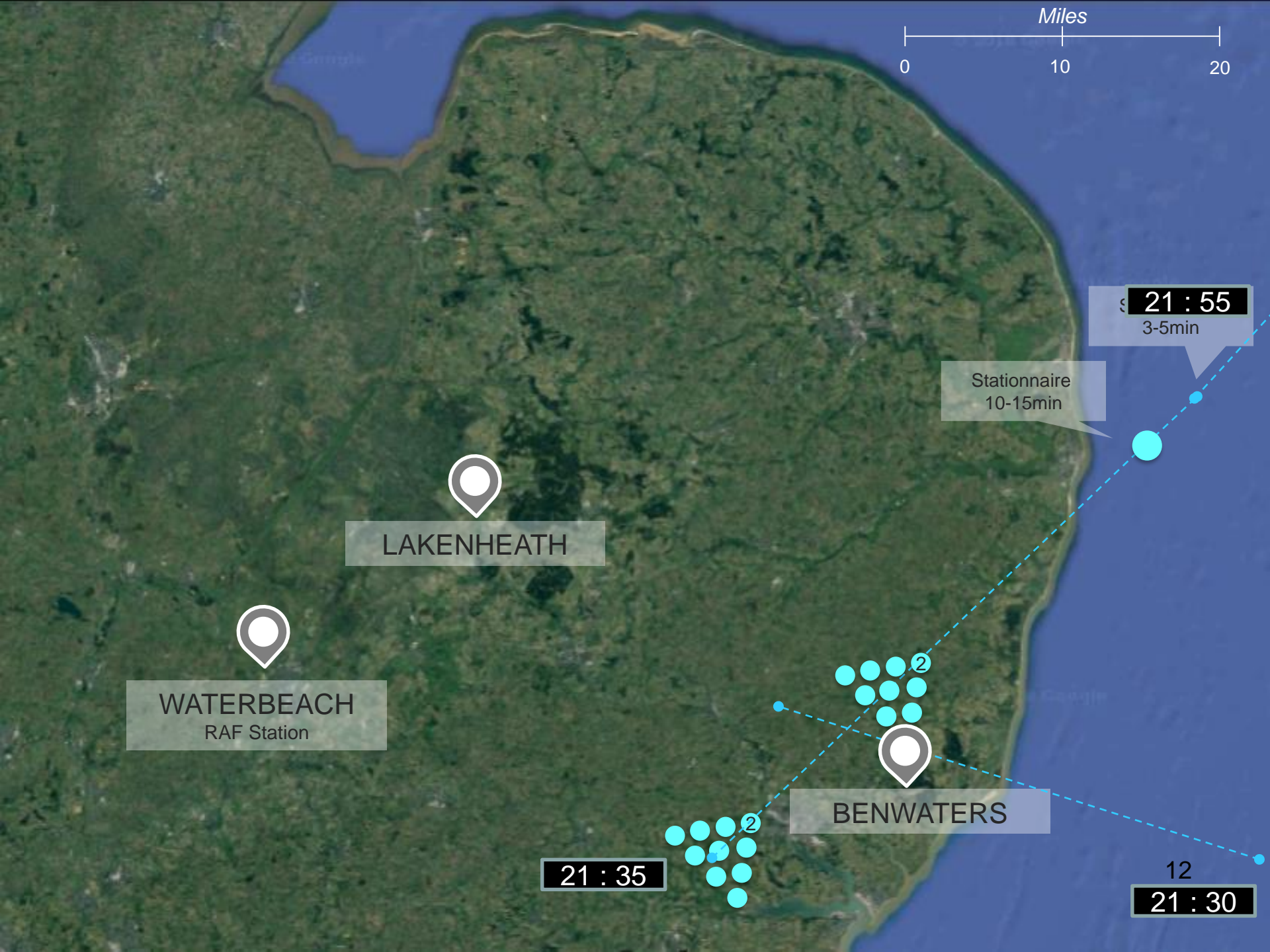
BENWATERS

21 : 55  
3-5min

Stationnaire  
10-15min

21 : 35

12  
21 : 30



Miles



21 : 55

MTI activé



LAKENHEATH



WATERBEACH  
RAF Station

Observation  
Visuel C-47



Observation  
Visuel pour  
de contrôle

MTI activé

Vitesse : 4000mph

22 : 00

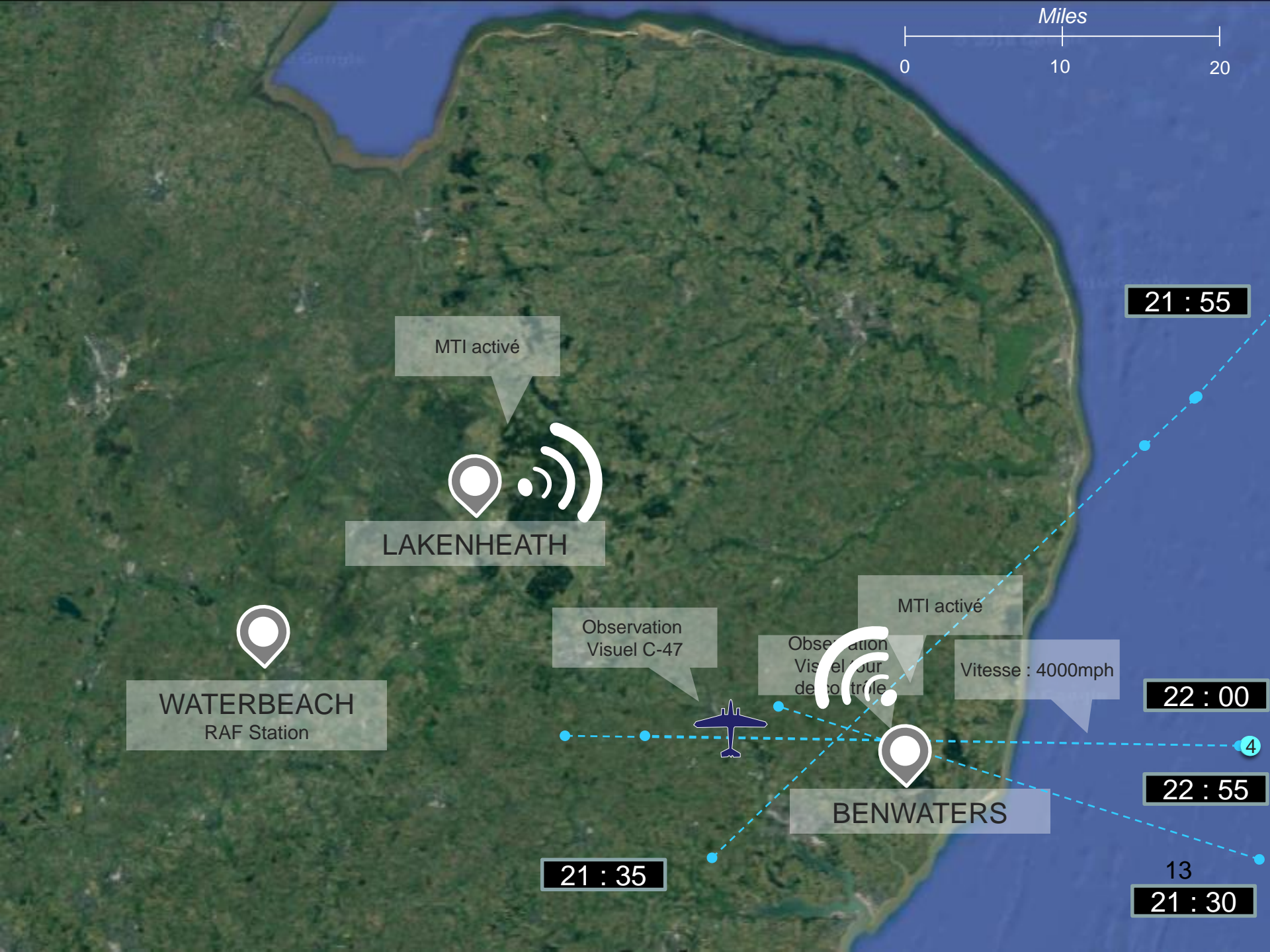
4

22 : 55

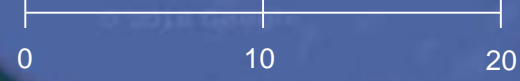
21 : 35

BENWATERS

13  
21 : 30



Miles



LAKENHEATH

« Stop & Go »  
~10min



WATERBEACH  
RAF Station

00 : 10

5

Stationnaire  
10-15min



BENWATERS

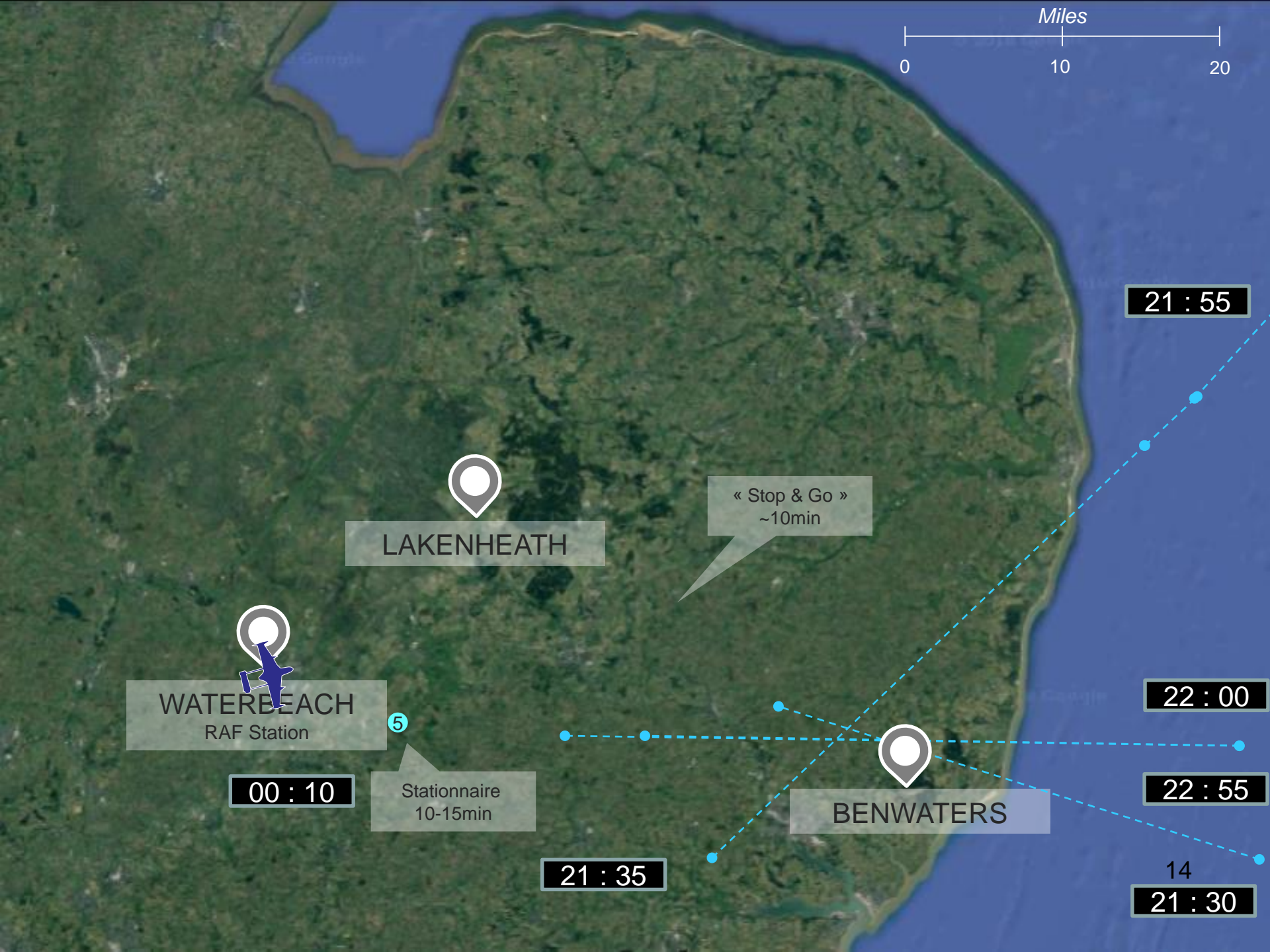
21 : 35

21 : 55

22 : 00

22 : 55

14  
21 : 30



Miles



03 : 30

21 : 55

Venom prit  
en chasse par la cible



LAKENHEATH



WATERBEACH  
RAF Station



00 : 10

21 : 35

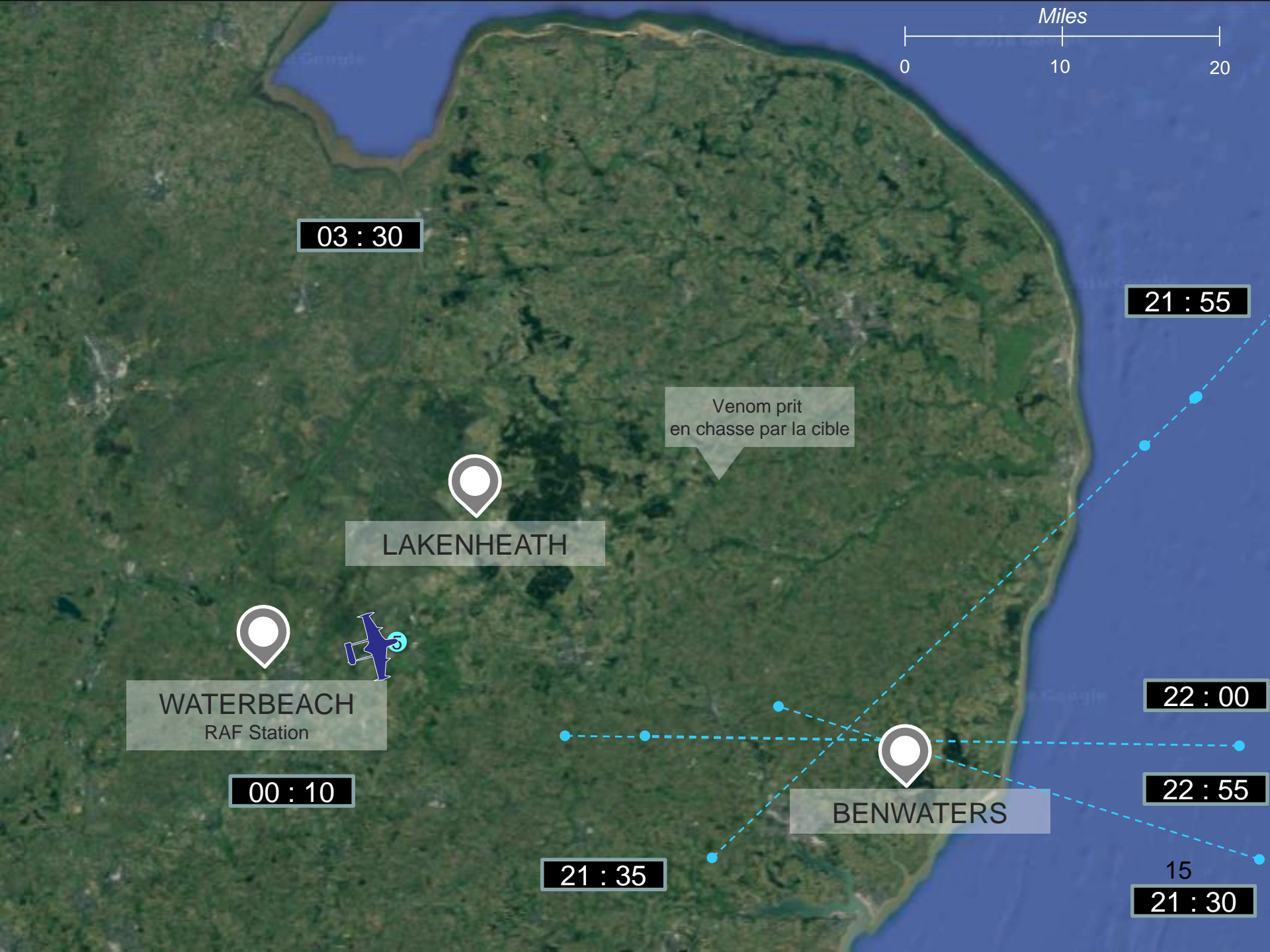


BENWATERS

22 : 00

22 : 55

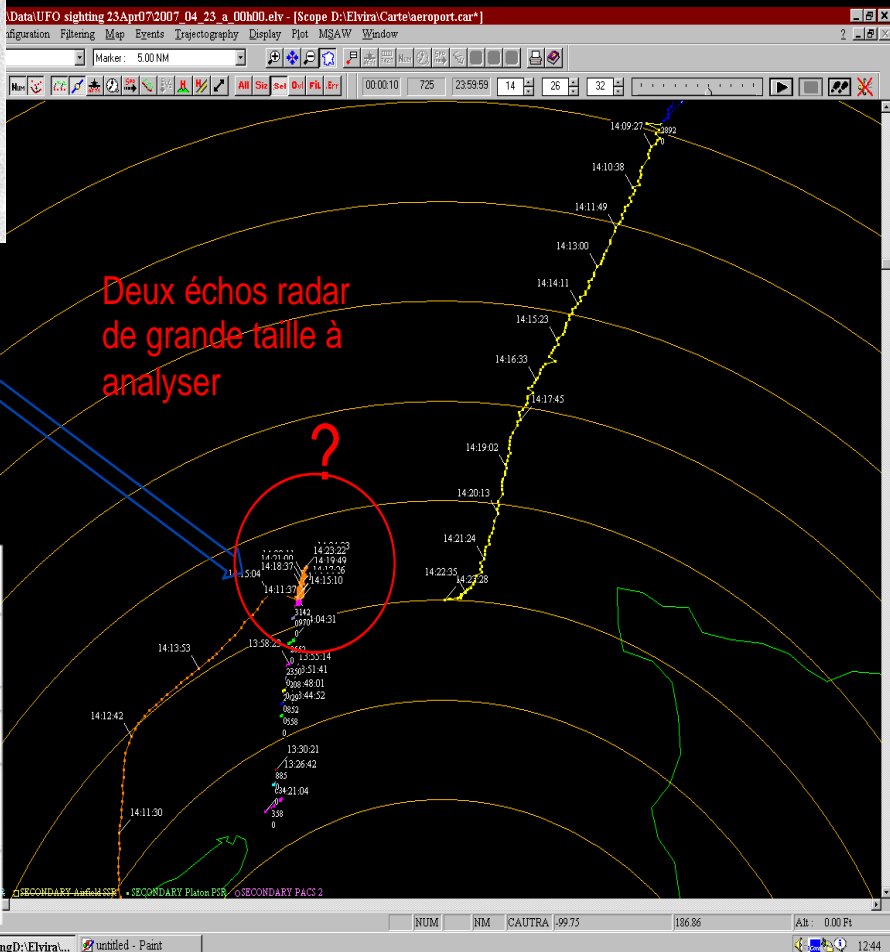
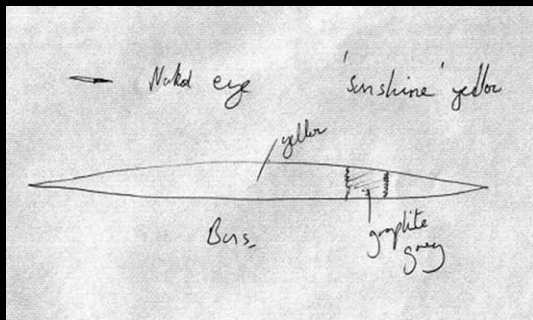
15  
21 : 30



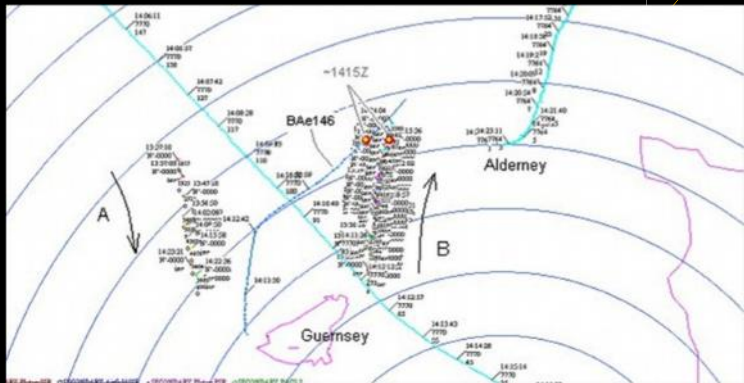


# Sighting case analysis

## CHANNEL ISLAND CASE (GUERNESEY-JERSEY) 23/04/2007 SIGMA2 attempt to analyze Elvira radar files (on going)



Deux échos radar de grande taille à analyser



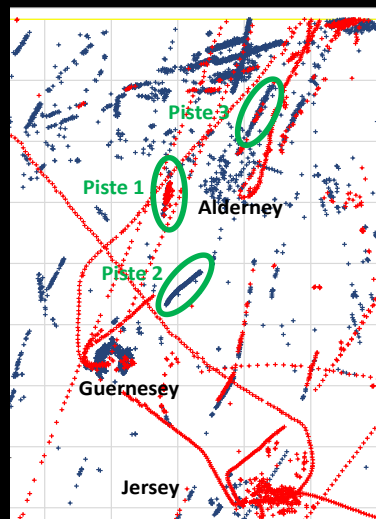
Elvira radar files are courtesy from M. Rob Jeffs who provided nicely these files to 3AF /SIGMA2 (Jersey+ Guernsey primary and secondary radar files+ audio records)

# CHANNEL ISLAND CASE (GUERNESEY-JERSEY) 23/04/2007

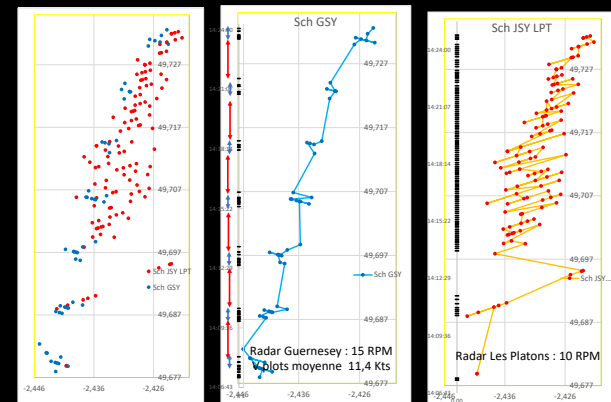
## SIGMA2 Elvira radars files analysis (on going)



Observation 3D Virtual restitution



Radar plots mapping  
3 tracks under analysis



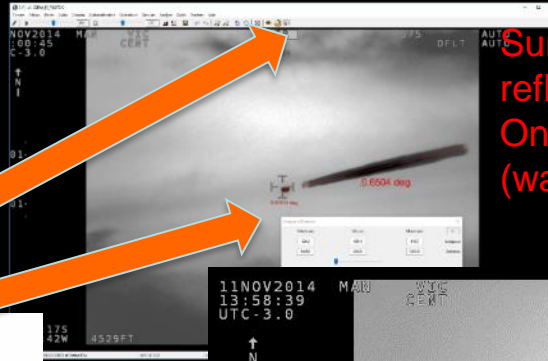
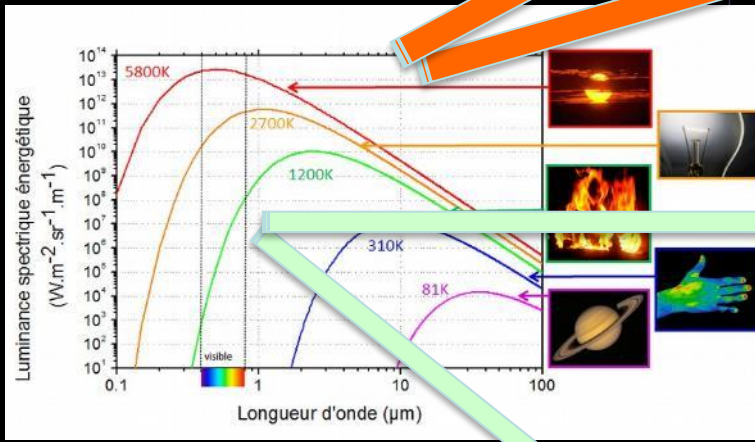
Track 1 plots fluctuation analysis  
Blue (Guernsey radar) group of leapfrog plots  
Red (Jersey radar)- strong fluctuations  
Suggesting strong RCS in one direction- glint effect

3 radar tracks under analysis 1-2 & 3 showing trains of radar returns in the area of visual sighting from two aircraft (in 12 H for AL544 flight -Ray Bowyer and 8H for Blue Island flight ).

- SIGMA2 conducted radar plots extraction and analyze the 3 tracks (trains of plots)
- Primary radar returns mean true radar returns and not secondary radar (air traffic position)
  - Primary radar returns are 2D (no altitude measured); try to estimate altitude+ velocity? Check with possible ships radar tracks
  - Q1: history of radar plots trains - cross check each track with initial position near harbour
  - Q2: try to estimate (minimum) altitude of radar plots- by comparing 2 primary radar position and altitude versus position of track and earth curvature (radar

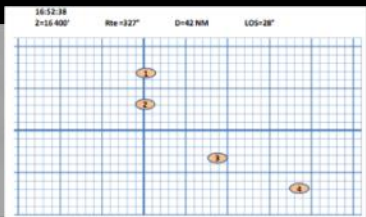
# Chilian Cougar (IR video Cougar)

Sun IR radiation (5800 °K) flux reflection (albedo)  
On aircraft exhaust trail (water droplets or ice chunks)



IR thermal self radiation from airliner hot nozzles (1200 °K)  
No plasma- white spot blurring  
Can be due to hot radiation inducing image saturation

R > 80 km Secteur avant



Cougar





# UAP observables : What link with the plasma? Source or consequence?

**Optical effect light glow (single, multiple in group)  
(blue, white, color change)**

RB47, Teheran, Lakeneath, 05/11/90 case...

Change of shape

**MW EM waves pulsed transmission**

**1-3 GHz, 9 GHz records**

Strong RCS ("707" RCS or low RCS observable/  
Instantaneous disappearance of radar plot

Pulsed active EM transmission from UAP sometimes  
Russian case, Teheran case

RB47 (US) 3 GHz, 1  $\mu$ s, 600 Hz, B52 (Malmstrom)

B52 SAC crews required to record EM signals at 3 GHz



**Hovering to hypervelocity  
Strong acceleration**

**Low inertia appearance**

**MW Pulse Effects on electronics  
Similar to EM weapons**

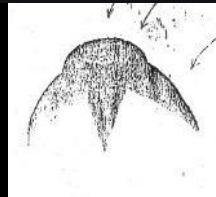


**MW EME Effects human**

**"heating" burning effect: skin, eye: UV  
Acoustical effect (infrasound, low  
frequency)- cerebral and memory  
Similar to EM Weapons**

**Low to no interaction with environment  
Air, water... MHD like?**

To compare to MHD EM energy effect on airflow



MW Effects on environment: vegetation

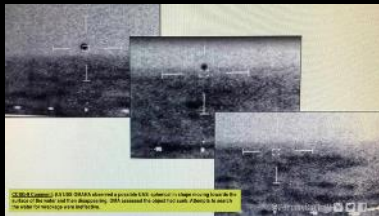
**MW High Energy deposit effects on atmosphere  
(striation)**

Petrozavosk (Russia)

"similar to nuclear radiation induced effect (X, gamma rays)  
or artificial stimulation on atmosphere or sprites

Green balls close to US atmospheric tests, Madagascar case...

US experimentation with electrons guns in the 80s to stimulate  
Atmosphere radiation under energy beam



# What is a plasma

Google definition: “a plasma is a fluid made of ionized particles, it is a 4th state of matter (gaz, liquid, solid, plasma)”

When energy is deposited in a gas (by mechanical work, heat, or radiation for instance), some electrons of the medium, initially bound to the atoms (in a so-called ground state), transition to excited states.

When the excitation energy is high enough, the final state of the transition is “in the continuum” and the excited electron is considered “free” from the influence of its parent atom, which is then called an ion.

A plasma is formed when a substantial fraction of the atoms of the gas has been ionized.

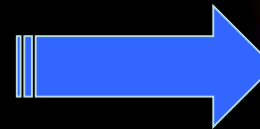
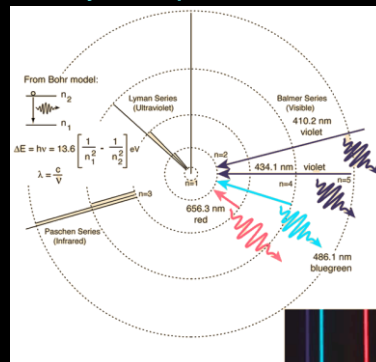
The decay of the electrons from their excited states results in the production of photons.

- The plasma electron density modifies the EM properties and reflectivity of the medium, including refraction to incident EM radiation (radar beam). Depending on the plasma density, EM wavelength and angle of incidence, this can increase or decrease the observables.
- The decay of excited but bound electrons results in the production of photons with discrete energies, and spectral lines can be observed. The distribution, energies (colour in the optical range) and amplitudes of those lines is the signature of the plasma and allow for remote identification of its thermodynamic state and constituents.

## Excitation and Ionization:

- Generation of excited electrons
- Decay with photons release

Energy deposition  
(different sources  
& mechanisms)



- Generation of photons, light generation
- Specific glow with spectral signature
- Visible and UV glow means relatively high energy

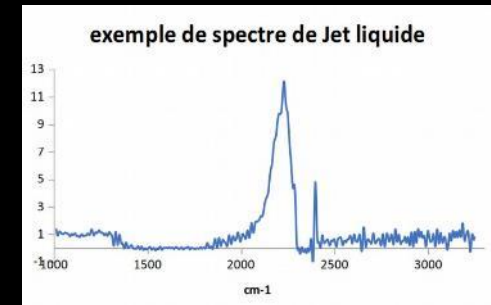
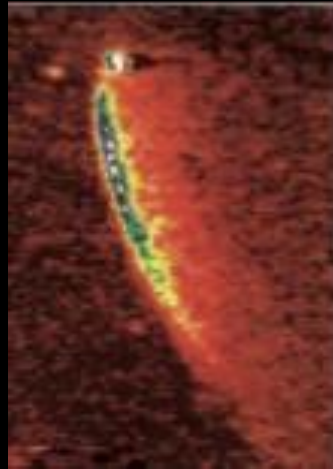


Nota: Some EM radiation effects can be induced by a plasma on electrical device (deposition of EM energy coupling with electronics, or high energy pulse with vaporization of matter). These effects can be similar to Directed Energy Weapons ones.



# Examples of mechanisms to generate a plasma

Source of energy: chemical combustion of ergols (rocket propellant)



Combustion of rockets ergols (liquid or solid) generates hot gas plumes partially ionized and sources of photons.

Plasma bound transitions will result in observable spectral lines.

At lower temperatures, molecular transitions can also produce discrete spectral lines in the IR domain and **do not imply the presence of a plasma.**

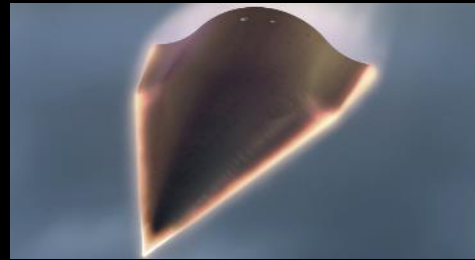


# Examples of mechanisms to generate a plasma

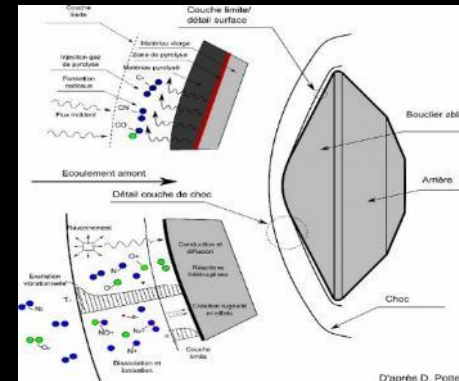
Source of energy: kinetic effect, compressional heating of the air in the boundary layer around the nose of the spacecraft, rocket or meteoroid



Shockwave with plasma shock generator



Hypervelocity glider vehicle with plasma boundary layer



The compressional heating of the air slowing down in the boundary layer creates a plasma. The recombination and deexcitation of the air plasma electrons release light in the IR, visible, UV and X-ray domain. This layer with free electrons can absorb EM radiation (radio blackout on reentry).



Atmospheric re entry shockwave plasma: bolid (natural- compression shockwave)

Generates plasma- can be used by EM RF trackers (like Fripon system)

# Plasma generation: natural or artificial



Ball lightning phenomena family (PLOT )

Similar to buoyant cold plasma mentioned by UK MOD report on UAP or Russian science academy (linking UAP to meteoroid reentry + solar activity)

The mechanism are quite complex, combining ionization, excitation and chemical reaction inside the ball light...

**PLOT can generate light balls travelling up to Mach1, no reverse trajectory or 90° turn (straight and steady trajectory)**

Similar to Nuclear radiation effect of X-ray , Gamma rays on atmosphere

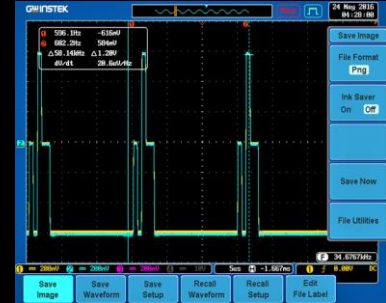
(Petrozadvosk) UAP Russia case to be compared with some PLOT effects with gamma rays-electrons cascade generating short duration glow in visible/UV in the ionosphere





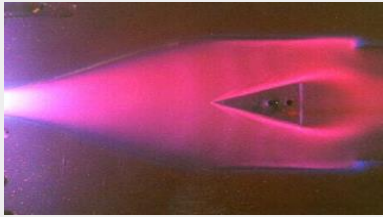
# Plasma generation in visible and UV spectrum

## « visible and blue glows »: artificial generation or natural?

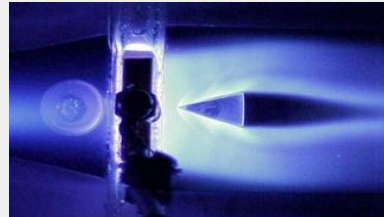


Electrical discharge can create plasma  
The modulation of the discharge can be detected

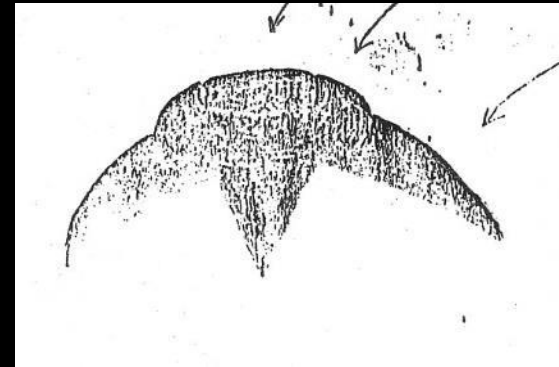
EME effect: close encounter with UAP (SCU Toronto case-object surrounded by a blue glow with pulsation- smart phone and camera jammed submitted to EME with periodic signal (recorded in the camera)



Photograph of the supersonic nitrogen plasma flow over a wedge in a DC discharge afterglow.  $P_0=2/3$  atm,  $M=3$



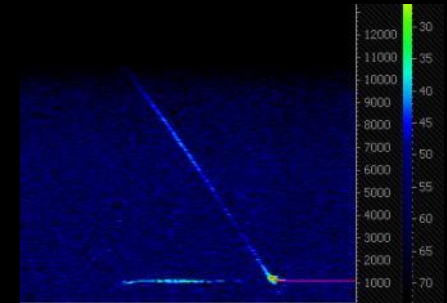
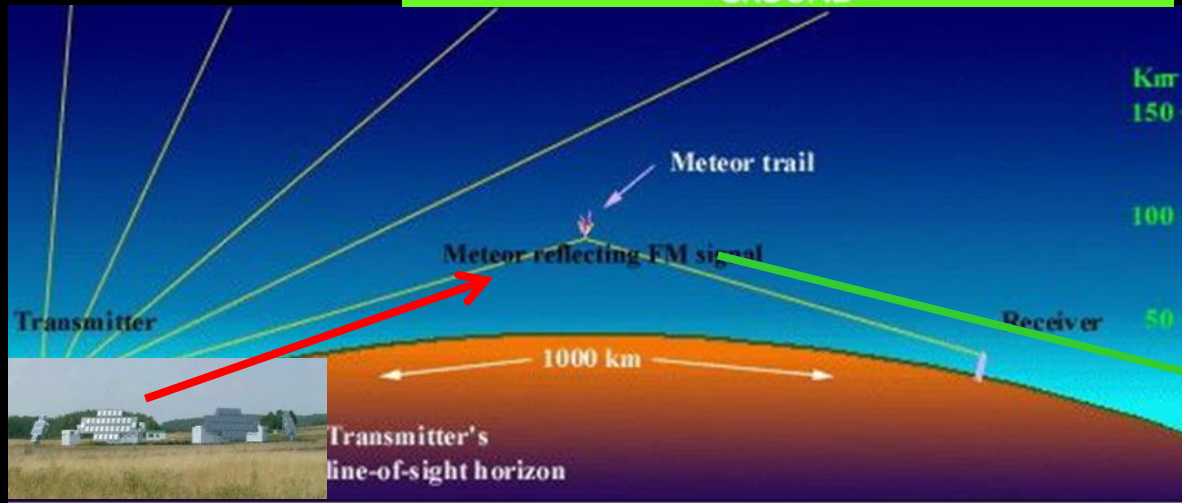
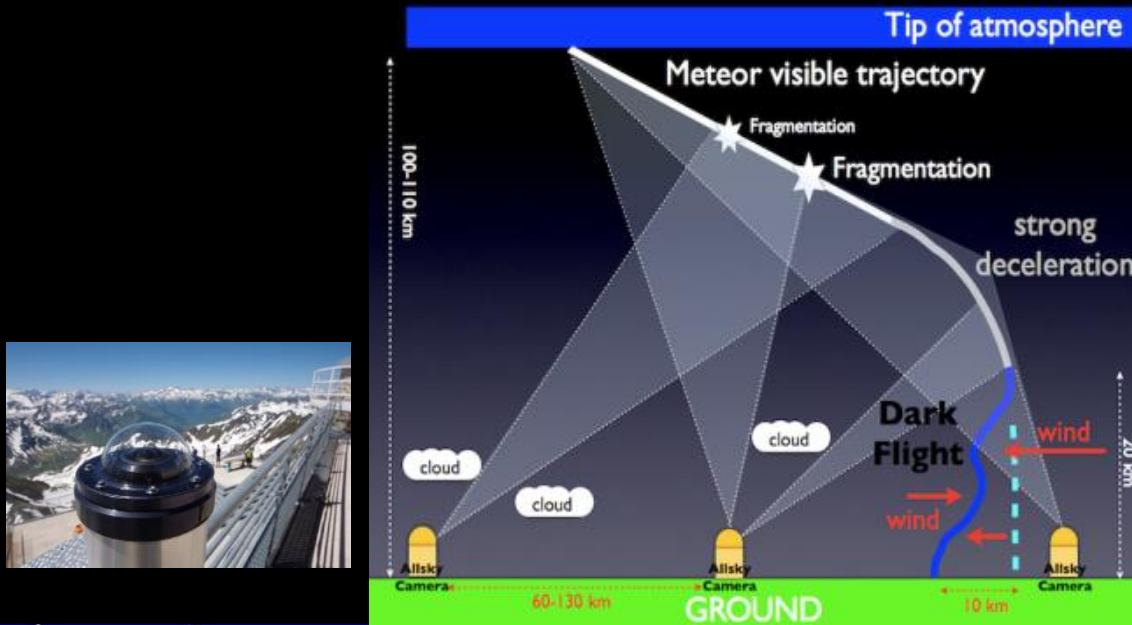
Photograph of the supersonic nitrogen plasma flow over a wedge in an RF discharge afterglow.  $P_0=1/3$  atm,  $M=2$



Nitrogen plasma blue afterglow can be generated by electrical discharge –MHD can be used to modify the airflow around a vehicle (aero coefficient) and the EM signature (virtual vehicle). The modulation of the EM field can induce modulation of the light glow.

Bright radiation (Teheran case) from UAP  
With EM jamming-neutralization of fighters' radio/missile firing equipment-jamming of civil traffic navigation devices in a sector

# Fripon: Observation of bolids by a network of cameras and RF receivers



FRIPON network for detection/trajctography of bolids.

Optical cameras to track luminous effect of bolids (plasma light radiation)

RF passive receiver use scattering of opportunity radar beam on the ionized trail of bolids to estimate velocity



# Conclusion on UAP observables and plasmas

- Some analysis on UAP (UK MoD report, Russian academy of science) concluded on:
  - Anomalous observables
    - Kinematics & accelerations suggesting low inertia objects
    - EM behaviour (interference, low observables,...)
    - Low interaction with the medium (air, water,...), "transmedium" evolution.
    - Ground tracks with MW effects on vegetation
  - The existence of the so called atmospheric "buoyant plasma" (UK MoD report on UAP/ Project Condign)
- Our analysis at the time being is:
  - Atmospheric transient light effect in case of thunderstorm may happen (plot)
  - They are unusual phenomena and could appear like fast light balls (up to Mach 1), travel at high altitude (8000 m) and last few minutes
  - However they don't match the high acceleration and change of velocity depicted in some UAP cases, they are also not transmedium and do not induce jamming, or land.
- We recommend the collection of optical, EM and trajectography data on these