

# *International Meteor Conference 2014*

18 - 21 September, Giron - France

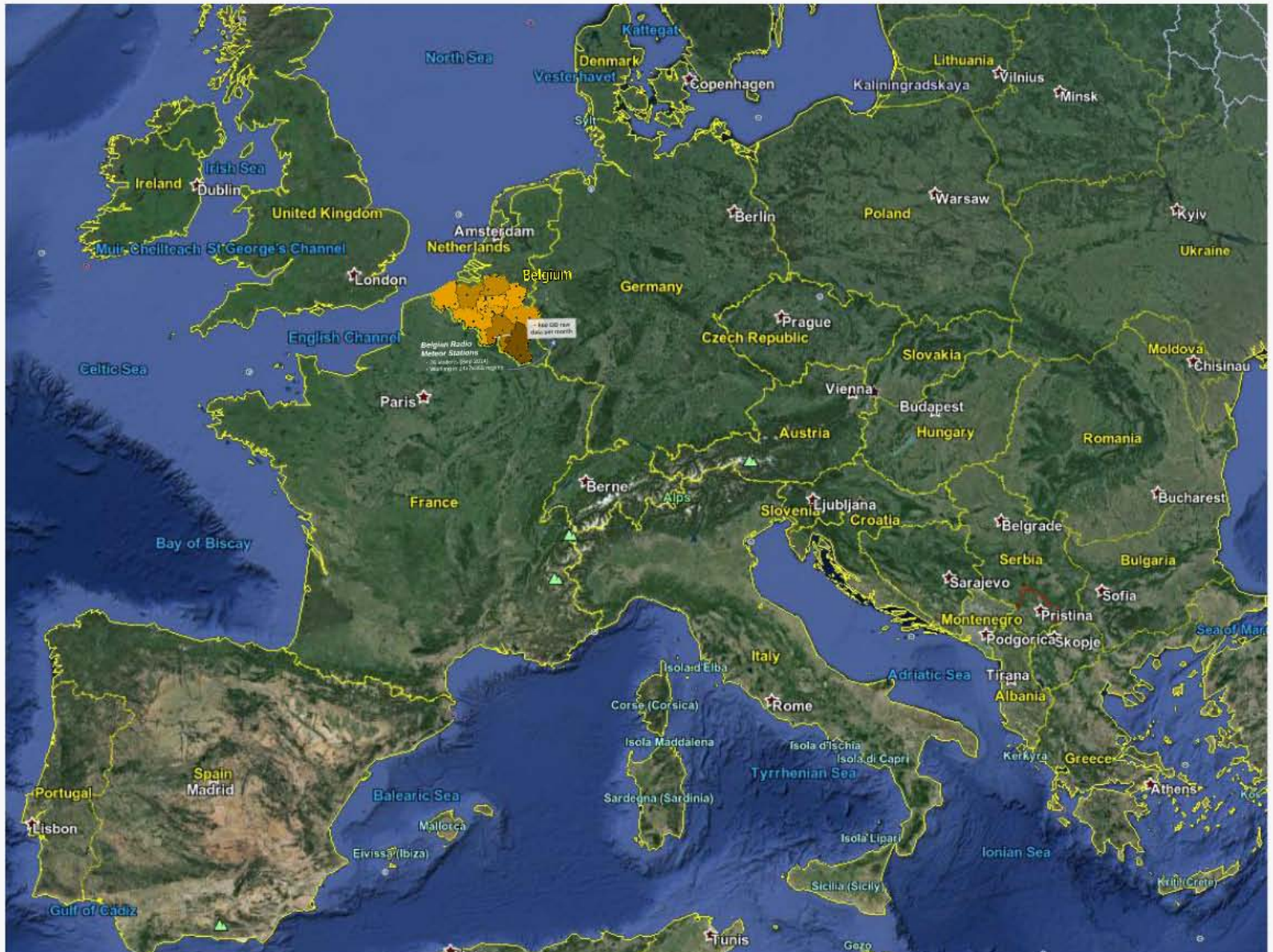


## **Modeling and Calibration of BRAMS antenna systems**



*Antonio Martínez Picar*

# BRAMS – Background





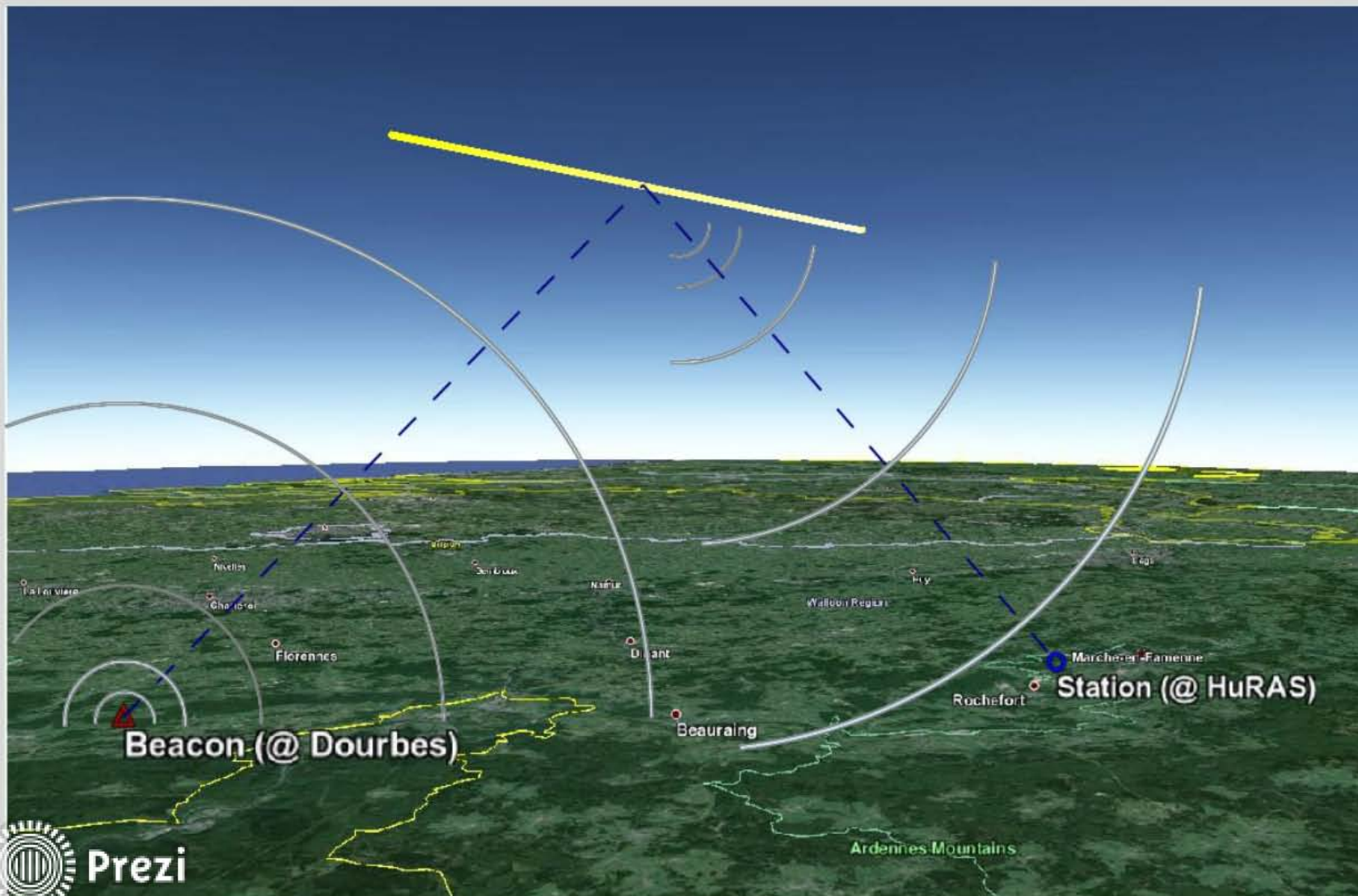
# Belgium

## *Belgian Radio Meteor Stations*

- 26 stations (Sep 2014)
- Working in 24x7x365 regime

~ 600 GB raw  
data per month

# Forward Scatter





We need more data!



Processing Machine

- *Meteoroid Flux Density*
- *Mass Index*

Some Extra Inputs....

- Distances
- Angles
- Gains of the

BRAMS Raw Data

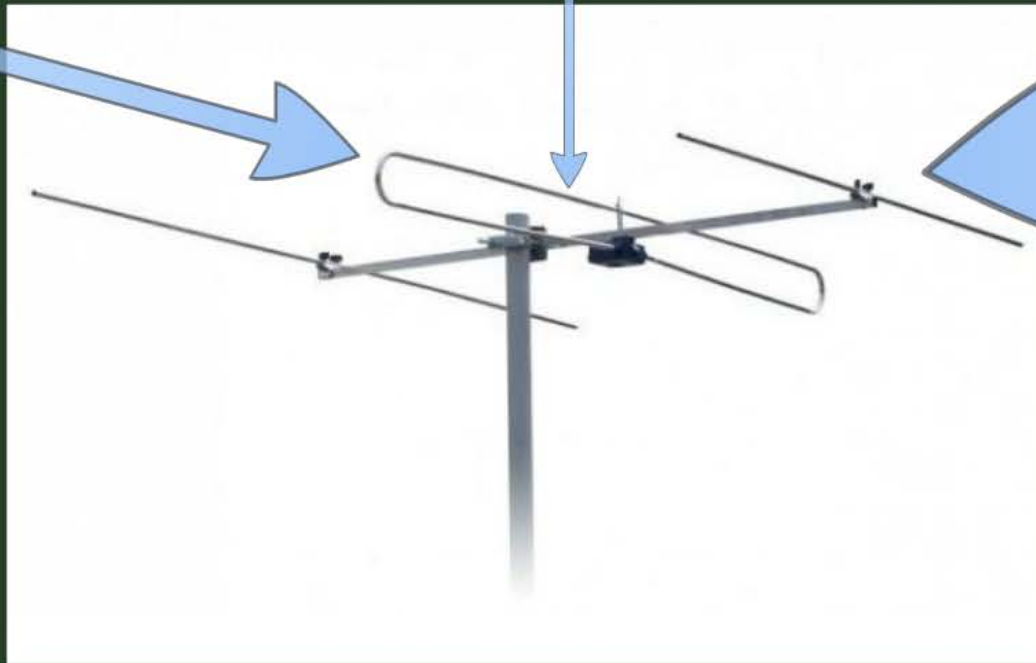
Antennas

# Antennas

- Bidirectional Interfaces
- Guided medium  $\leftrightarrow$  Unguided medium
- Non constant gain (*3D sensitivity*)

Even lower  
sensitivity

Low  
sensitivity



High  
sensitivity

# The Project – Antenna Patterns

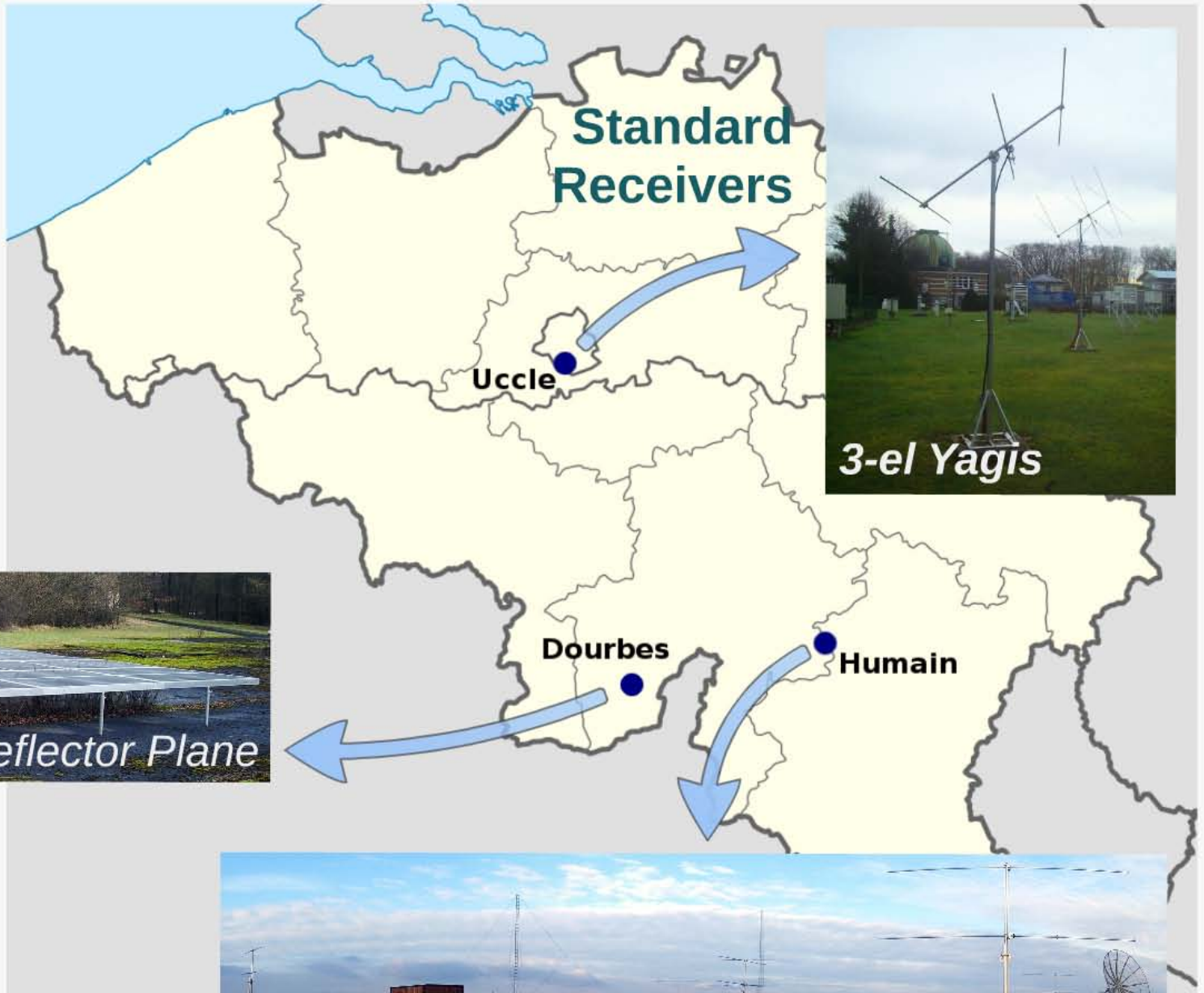
**Main Objective:** To obtain a reliable description of the BRAMS antenna patterns

**Scope:** Stations directly managed by BISA





# Stations directly managed by BISA



## Beacon



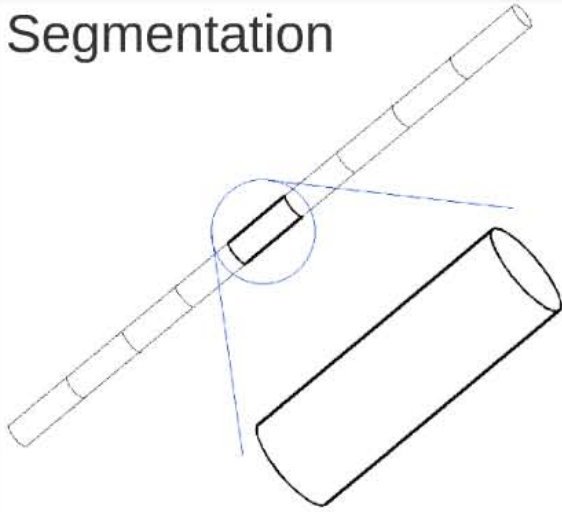
## Future Interferometer 3-el Yagis



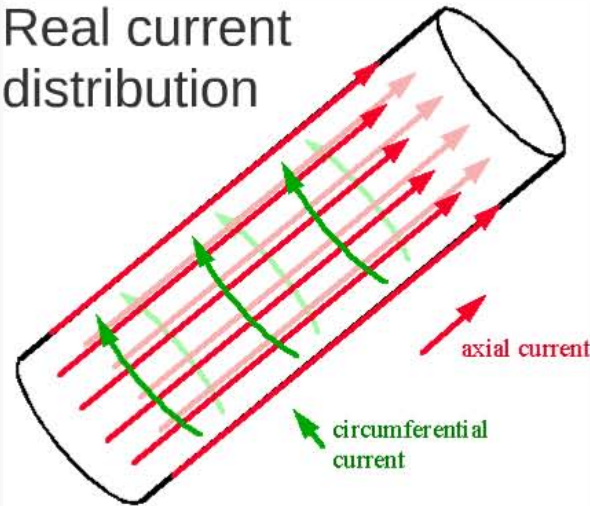


# NEC { Numerical Electromagnetics Code }

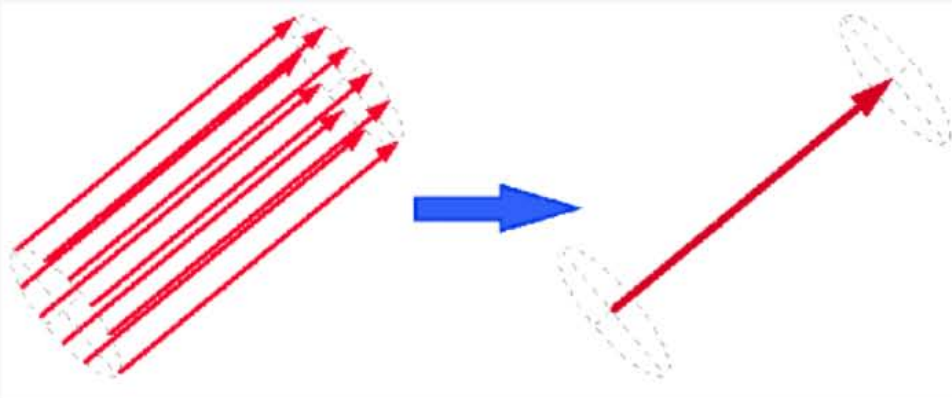
Segmentation



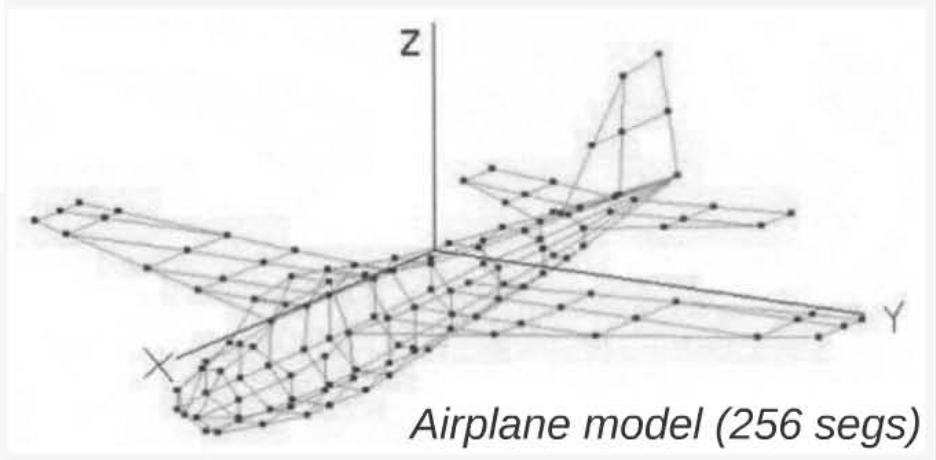
Real current distribution



- Based on Method of Moments (**MoM**)
- NEC2 (1981):  
Public Domain
- NEC2C:  
Fortran → **C**



"Thin wire" assumption

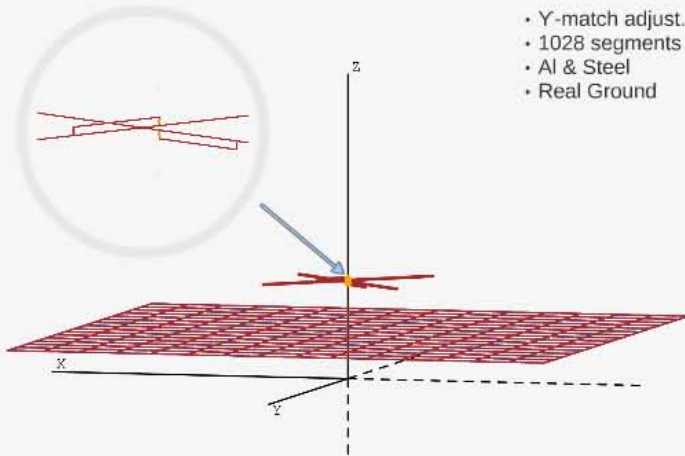


Airplane model (256 segs)

# Models

## BRAMS Transmitting Antenna @ Dourbes

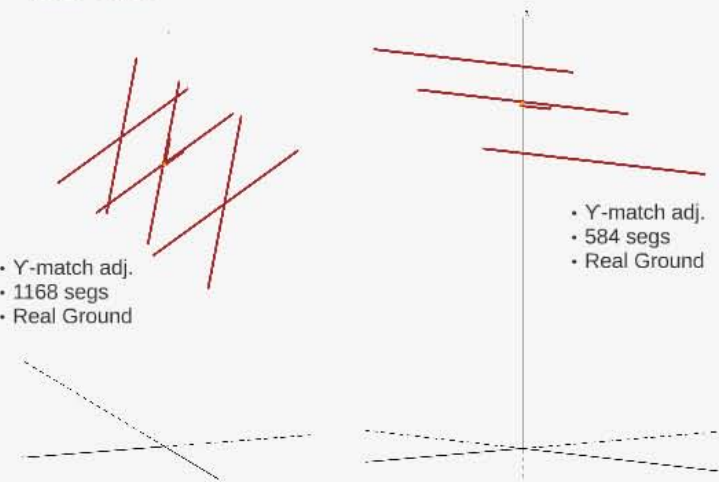
$f = 49.97 \text{ MHz}$



- Y-match adjust.
- 1028 segments
- Al & Steel
- Real Ground

## BRAMS Receiving Antennas @ Uccle

$f = 49.97 \text{ MHz}$

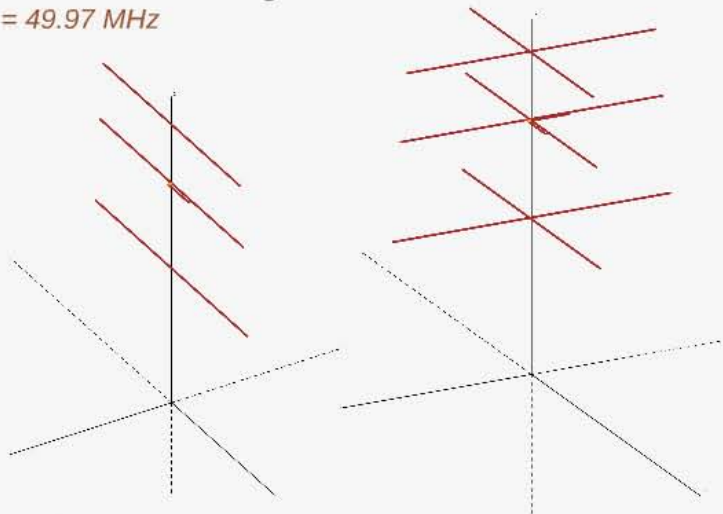


- Y-match adj.
- 1168 segs
- Real Ground

- Y-match adj.
- 584 segs
- Real Ground

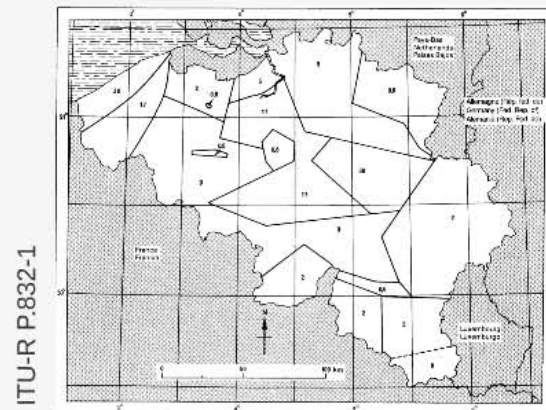
## BRAMS Receiving Antennas @ Humain

$f = 49.97 \text{ MHz}$



## Criteria and parameters

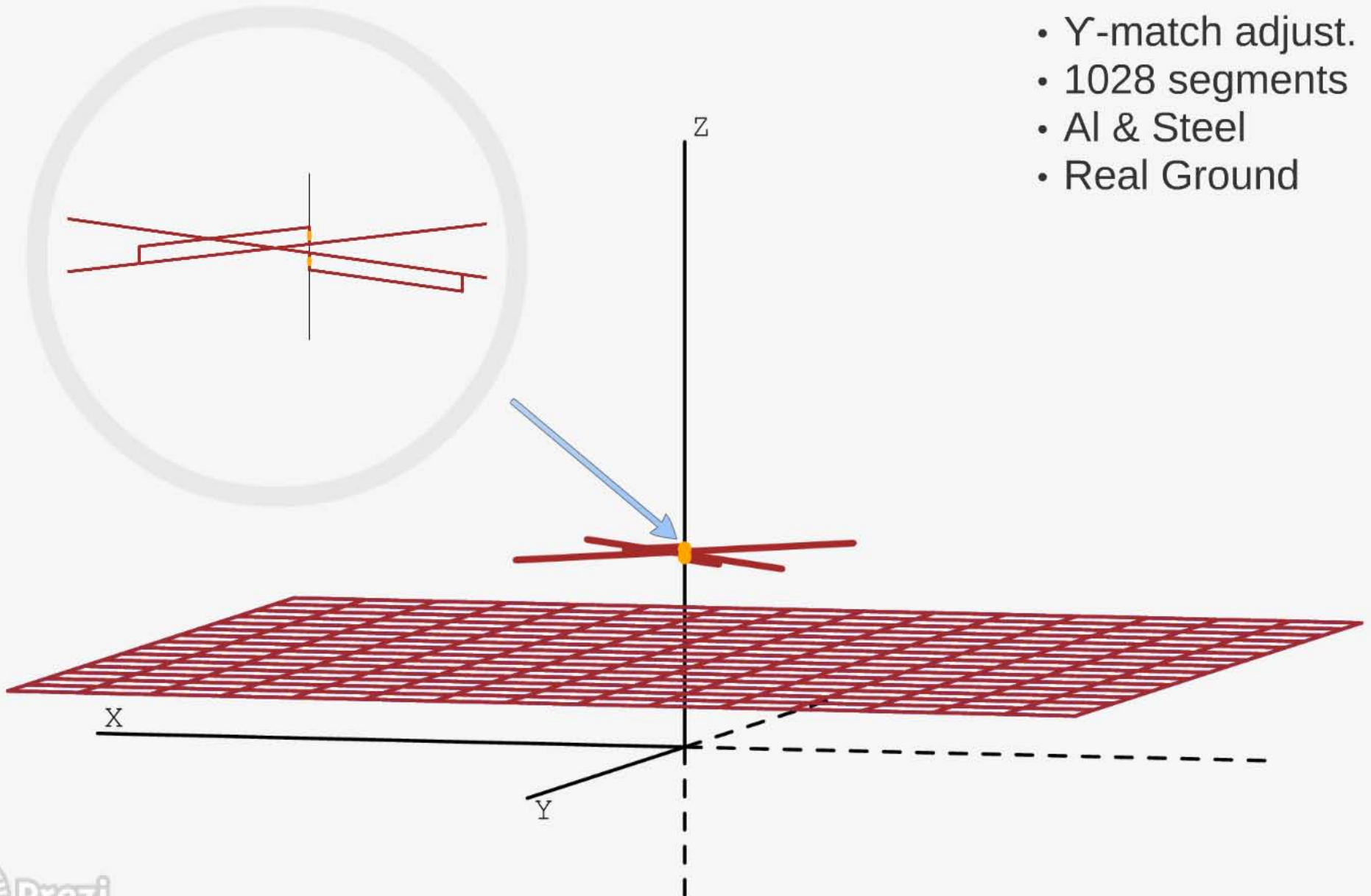
- Segment length  $\leq \lambda/20$
- Segment length  $\leq 8r$  (radius)
- Resistivity of materials
- Ground  $\sigma$  and  $\epsilon$





# BRAMS Transmitting Antenna @ Dourbes

$f = 49.97 \text{ MHz}$



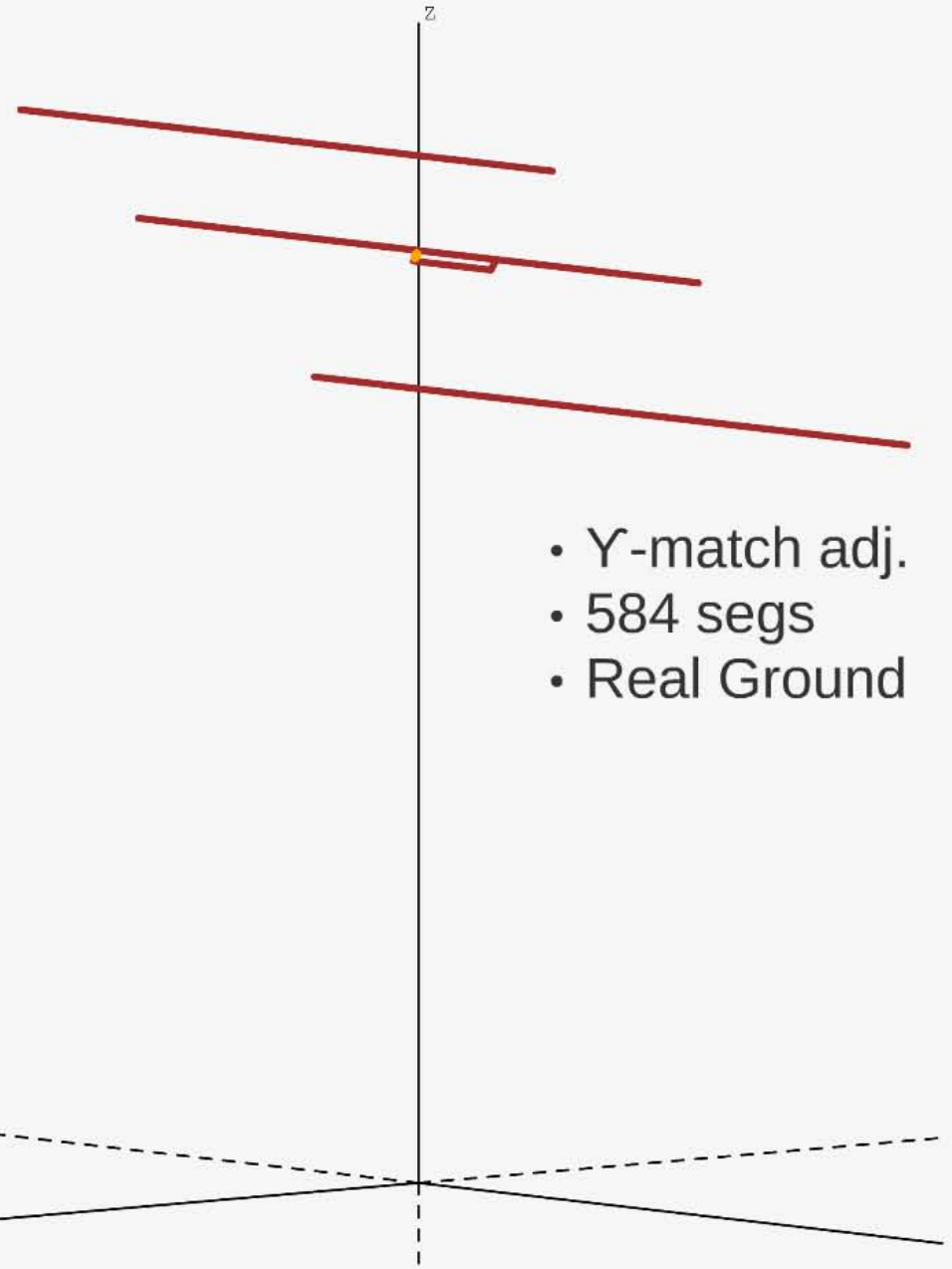
- Y-match adjust.
- 1028 segments
- Al & Steel
- Real Ground

# BRAMS Receiving Antennas @ Uccle

$f = 49.97 \text{ MHz}$



- Y-match adj.
- 1168 segs
- Real Ground

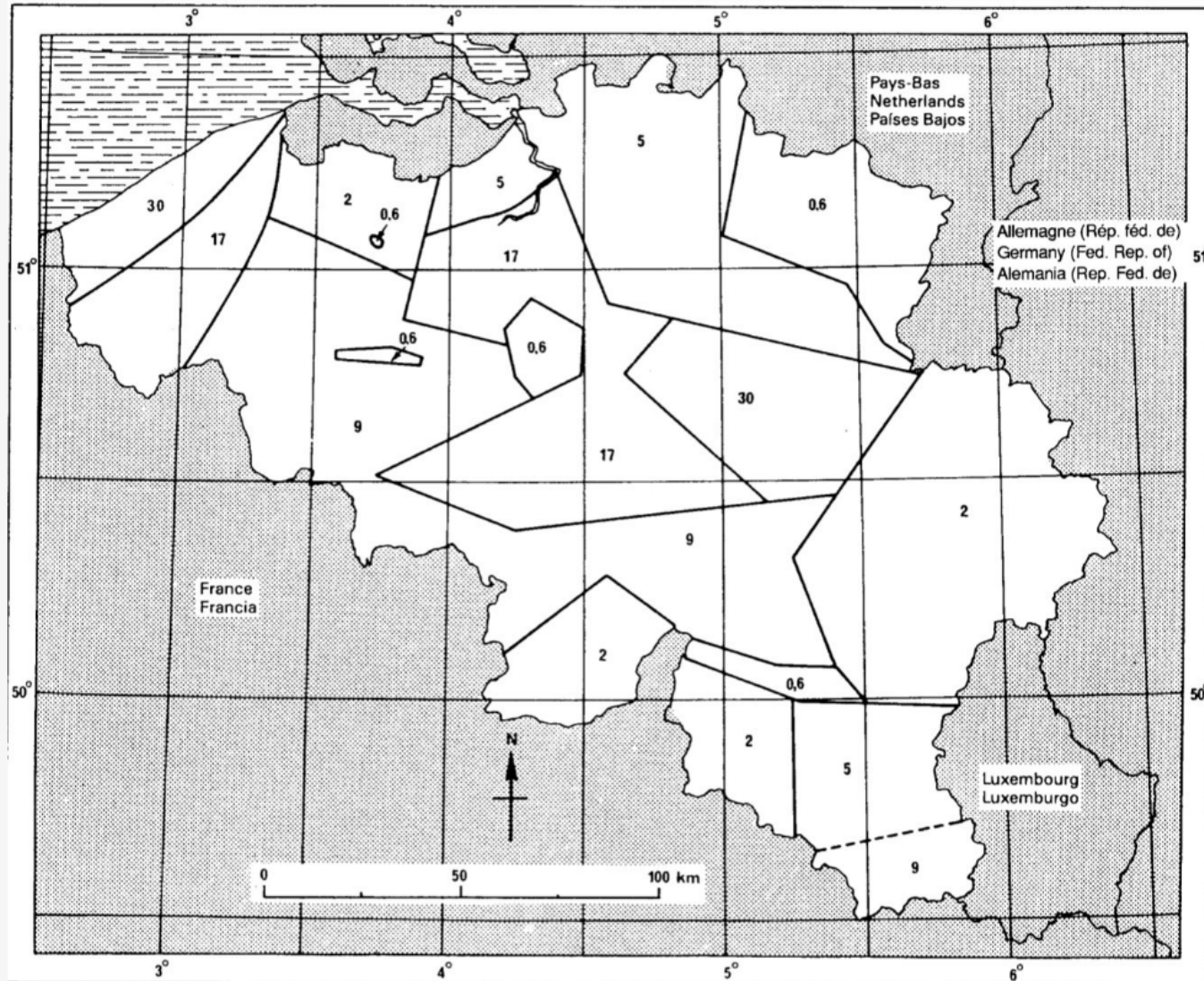


- Y-match adj.
- 584 segs
- Real Ground



# Criteria and parameters

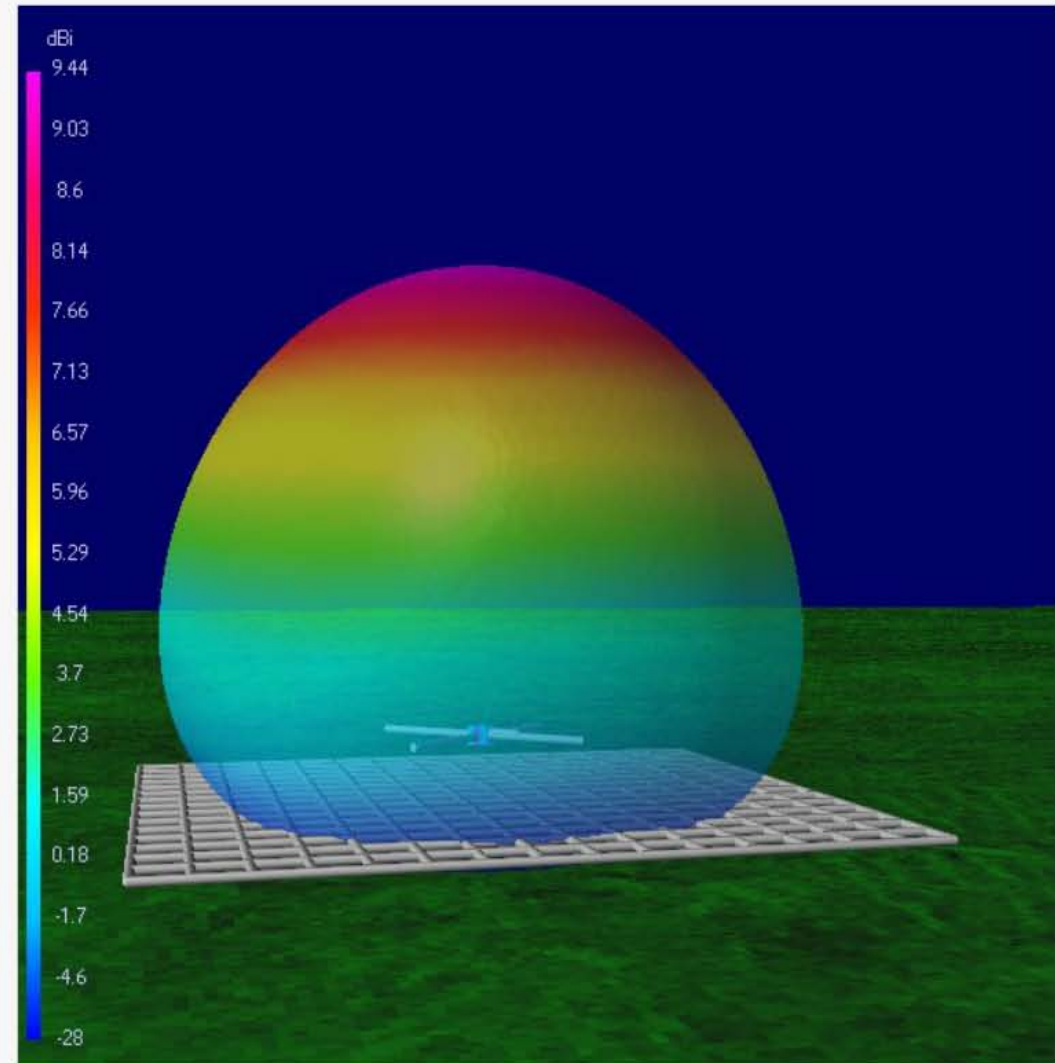
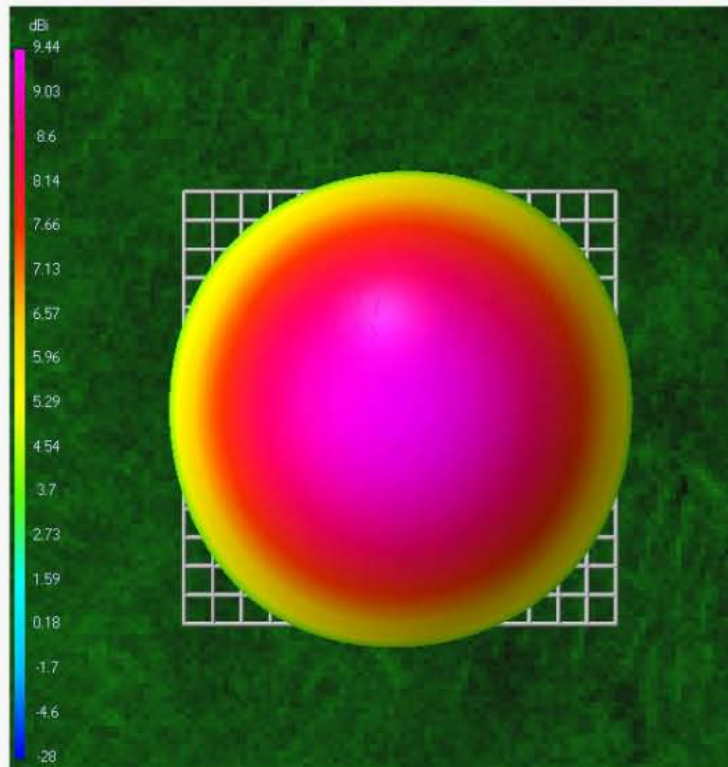
- Segment length  $\leq \lambda/20$
- Segment length  $\leq 8r$  (radius)
- Resistivity of materials
- Ground  $\sigma$  and  $\epsilon$



ITU-R P.832-1

# Runs

## BRAMS Transmitting Antenna @ Dourbes

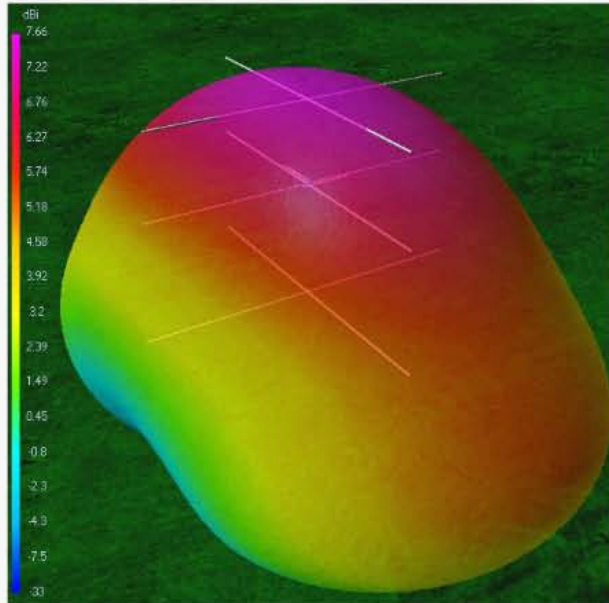


### Quality Check:

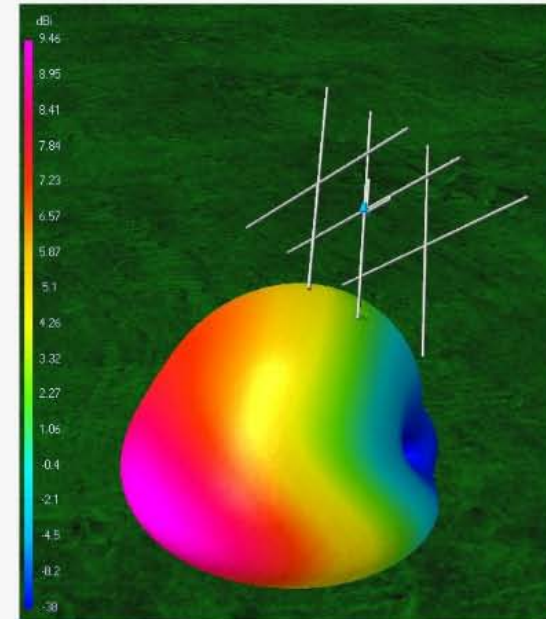
- Convergence
- Average Gain Test (Free Space)



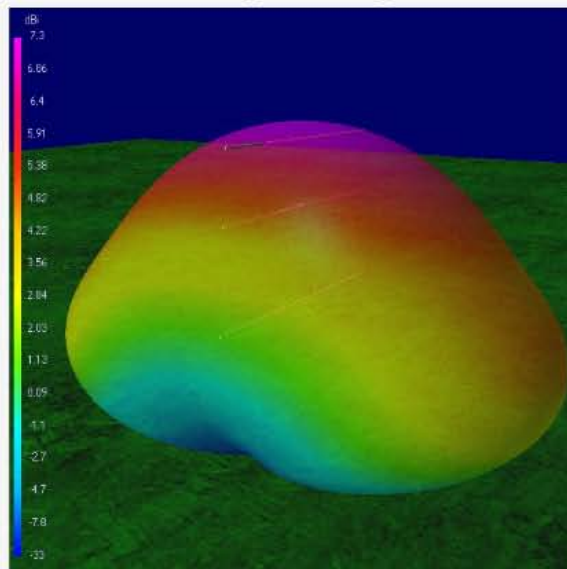
**Receiving Antenna - Yagi Double**  
@ Humain



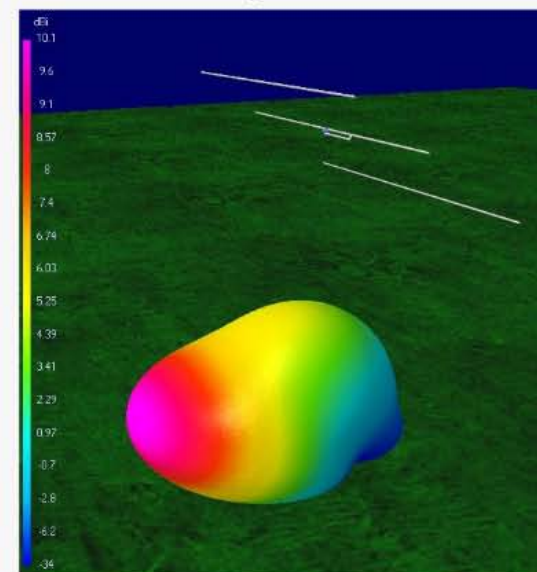
**Receiving Antenna - Yagi Double**  
@ Uccle



**Receiving Antenna - Yagi Single**  
@ Humain




**Receiving Antenna - Yagi Single**  
@ Uccle



# Options

{ 3 m  $\leq$  *Far Field Dist.*  $\leq$  43 m }

- Pulley system
- Telescopic mast
- Classical
- Balloon
- UAV



Unmanned  
Aerial  
Vehicle

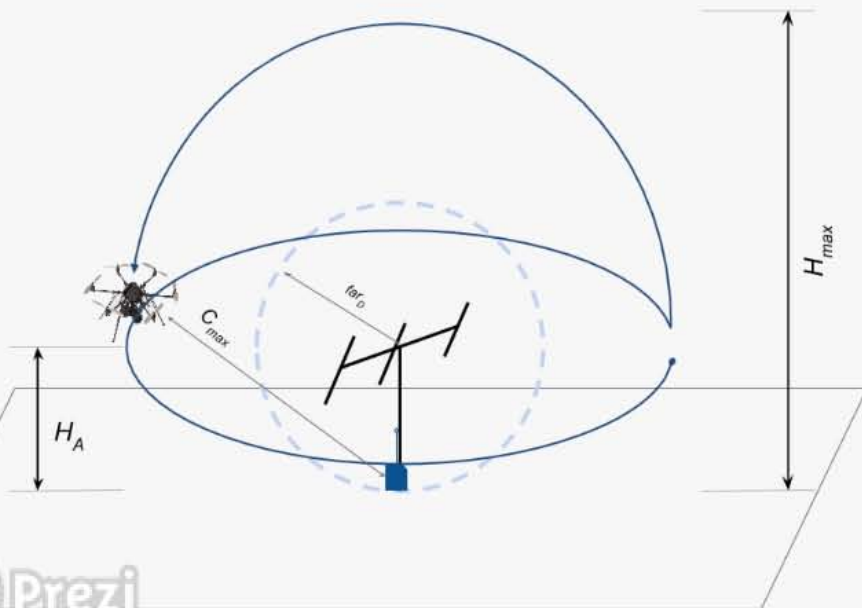
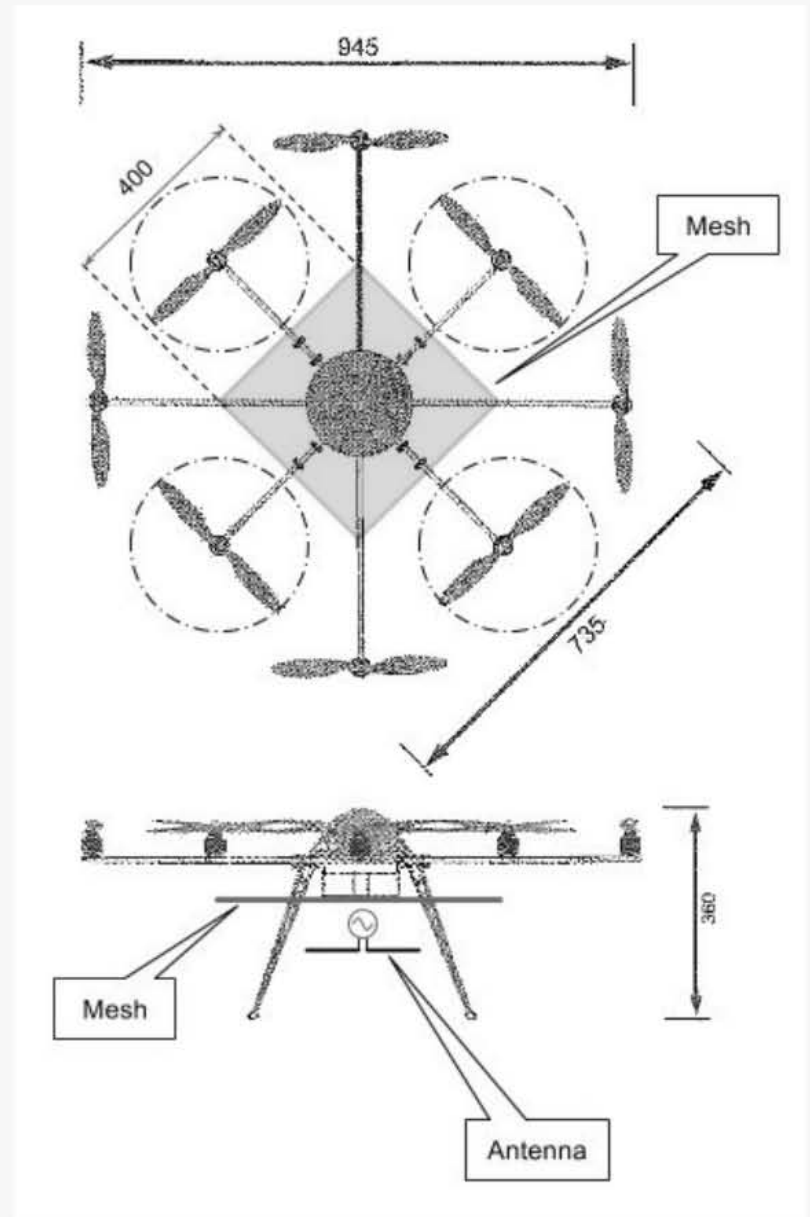


# UAV

## OktoXL (Mikrokopter)



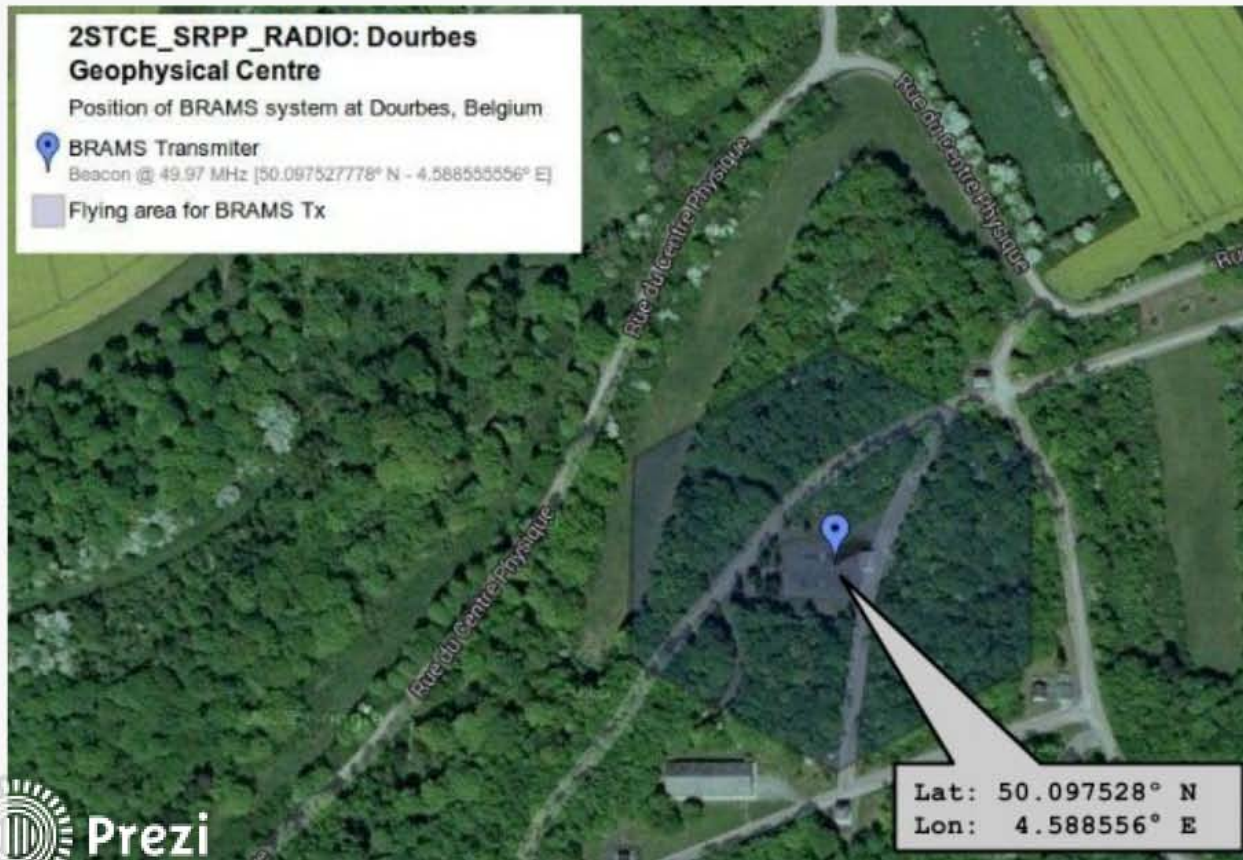
- Max Payload: 2.5 kg
- GPS
- Range: 500 m





# Regulations

## Special Flight Permission: R&D Belgocontrol



- Liability insurance
- Safety procedures
- Training

# *Final Assembly*

EM isolating  
mesh

Tx + Battery

Legs  
Extensions



Antenna



# First Flights



Waypoint List

| Nr. | Latitude   | Longitude | Time | Radius | WP-Event | Climb rate | Altitude | Heading | Delay time [s] | Altitude [m] |
|-----|------------|-----------|------|--------|----------|------------|----------|---------|----------------|--------------|
| POI | 53.2313673 | 7.4942875 |      |        |          |            | 1        |         |                | 15.0         |
| 1   | 53.2316756 | 7.4951424 | 5    | 10     | 100      | 10         | 15       | POI     |                | 10           |
| 2   | 53.2319967 | 7.4947064 | 5    | 10     | 0        | 11         | 25       | 180     |                | 10           |
| 3   | 53.2320546 | 7.4942875 | 5    | 10     | 0        | 12         | 20       | 90      |                | 10           |
| 4   | 53.2320481 | 7.4936876 | 5    | 10     | 0        | 0          |          | WP1     |                | 10           |
| 5   | 53.2320417 | 7.4932274 | 5    | 10     | 0        | 0          |          | WP2     |                | 10           |
| 6   | 53.2320546 | 7.4928513 | 5    | 10     | 0        | 10         | -30      |         |                | 10           |

Waypoint Generator

Area: Circle  
New Map: Draw Grid

Radius [m]: 32  
#WPs: 12  
Circle Rotation [°]: 74  
Direction: CW  
Add point to close circle:

Waypoint:  
Radius [m]: 10  
Altitude [m]: 64  
Speed [0.1m/s]: 40  
Climb rate [0.1m/s]: 30  
DelayTime [s]: 2  
WP event: 100

Use POI  
 Camera nick control

- Way-point flight
- Testing/tuning
- Wind influence



# *To Do*

- Calibrate the UAV's Tx antenna
- Start long-stay measurement campaigns (more efficient)
- Apply statistical approach and/or Differential GPS (increase on the accuracy in positioning)



Antonio Martinez Picar

# Modeling and Calibration of BRAMS antenna systems

## BRAMS – Background



## The Project – Antenna Patterns

**Main Objective:** To obtain a reliable description of the BRAMS antenna patterns

**Scope:** Stations directly managed by BISA



## Stage 1 – Simulations

**NEC** (Numerical Electromagnetics Code)

Reparameterization: Integral current distribution. Based on Method of Moments (MoM). NEC2 (1983) Public Domain. NEC3C Fortran-C.

**Models**

Model 1: Theoretical antenna of 100m. Model 2: Realistic antenna of 100m. Model 3: Realistic antenna of 100m. Model 4: Realistic antenna of 100m.

**Runs**

BRAMS Transmitting Antenna @ Dourbes. Quality Check: Convergence, Average Gain Test (Free Space).

Receiving Antenna - Yagi Double @ Humein. Receiving Antenna - Yagi Double @ Uccle. Receiving Antenna - Yagi Single @ Humein. Receiving Antenna - Yagi Single @ Uccle.

## Stage 2 – Measurements

- Options** (8 m s Far Field Dist. < 43 m)
- Pulley system
  - Telescopic mast
  - Classical
  - Balloon
  - UAV

### First Flights



- Way-point flight
- Testing/tuning
- Wind influence

**OknaL (Microkopter)**

**Regulations** Special Flight Permission: R&D (Kategorie 1)

**Final Assembly**

### To Do

- Calibrate the UAV's Tx antenna
- Start long-stay measurement campaigns (more efficient)
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