Design an IACT for VHE gamma-rays

ACME Online Course

Guidelines to Design an IACT

Oscar Blanch Bigas

OUTLINE of the Course

- Support Material
- Guidelines to design an Imaging Air Cherenkov Telescope
  - Read the Support material
  - Step by step instructions
    i. Science case selection
    ii. Telescope dimensions and site selection
    iii. Telescope structure
    iv. Reflective surface
    v. Camera dimension and housing
    vi. Camera photosensors
    vii. Camera electronics
    viii. Auxiliary systems
    ix. Readout and storage
  - Ask for advice:Use ACME ticketing System
- Online discussion on proposed designs

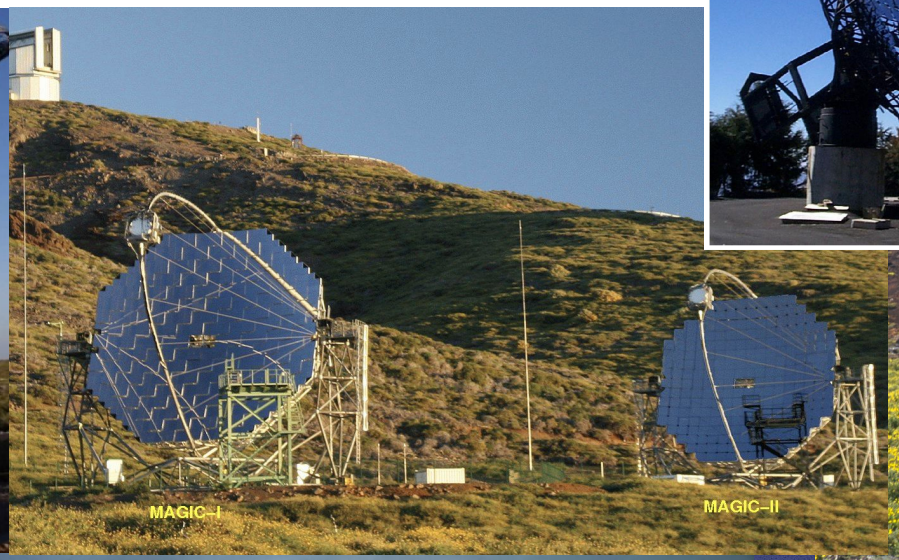
Read Support Material

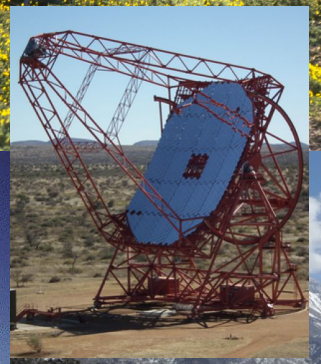
- The support material is not for memorising it but it is recommended to go through it before following the step by step instructions.
- It should be used to get a basic background on the different elements of a telescope as instrument.
- Examples appearing in the support material are just examples, not models to follow.
- Whatever is not clear in the support material can be ignored, looked for or asked (ACME ticketing system). All options are valid.
- The support material is support material where to look for ideas while following the step by step instructions

Step by step instructions

Image Air Cherenkov Telescope

Quite some of them have already been built





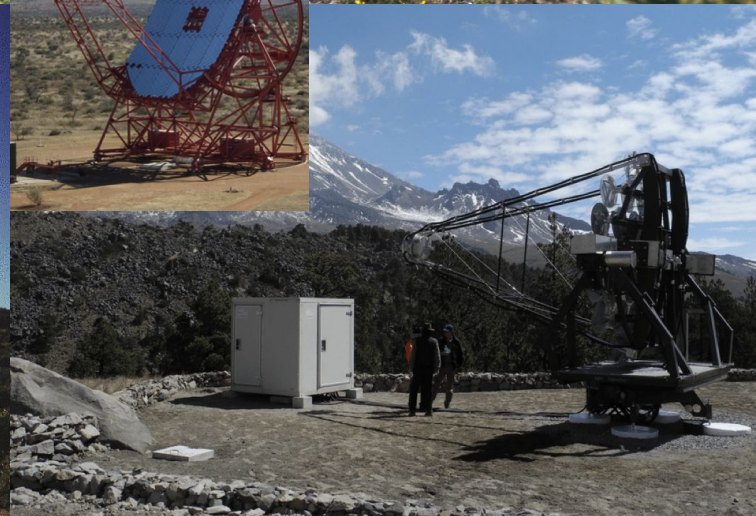


Image Air Cherenkov Telescope

- In terms of hardware instrumentation, the IACTs can be divided in three parts:
  - Structure
  - Reflective Surface
  - Camera
- This does not fully contain all that is needed to have them operative, some other elements are:
  - Auxiliary Systems
  - Readout and storage

Science case selection

- The science cases for VHE gamma-rays are quite diverse: CTAO Science cases.
- What you actually want to study with YOUR telescope may have an impact on the characteristics of the IACT that you need.
- Give a thought on which Science cases you would like to study, which does not need to be a unique it could even be as many as possible.
- Try to list what will require for your telescope in terms of:
  - Angular resolution
  - Energy ranger and resolution
  - Sensitivity
  - Size of the FoV
  - Reation time
- This requirement will be key to decide what you want to build, together with budget

Telescope Dimension and Site Selection

- The dimension of the telescope is a big driver of the overall design as well as for the cost.
- Choose the size of YOUR telescope, unfortunately you do not have the budget to built different sizes as it happened with CTAO telescopes
- You also need to think were to install the telescope, or more precisely the conditions that the side needs to fulfill (light contamination, height, connectivity, weather, …)

Telescope Structure

- The structure needs to handle the rest of the elements but it is also responsible to point the telescope where ever we need to point it
- Is the F/D of the structure relevant? Why? Which one will you choose?
- Which type of mount do you want to use?
- Material, colour, …

Reflective Surface

- The reflective surface may have different shapes, which one do you want? Which one are you going to built?
- Is it a single mirror or many mirrors? Which shape?
- Do you need to have something to adapt it shape or modify its orientation?
- Any consideration about its reflectivity in terms of wavelength?
- Some environmental protection?

Camera Dimension and Housing

- Which are the dimensions of your camera, both angular and actual dimensions?
- How is it protected from the external environment? Does it have any internal environment control?
- Which is the shape?
- Does it has any protection agains sun durin the day?
- Can you access the internal elements easily?

Camera Photosensors

- What type of photosensors are you planning to use?
- How many photosensor are you using?
- Which shape do the photosensors have? And which dimension?
- Do photosensors cover full camera area? Is there something that makes the sensitive area larger than the photosensor area?
- Do you collect also light coming from reflexions not in the reflective area of the telescope?
- Do they have some protections against high illumination?

Camera Electronics

- Are you recording the signal from the photosensors continuously? At which sampling rate?
- Do you need a system to decide when the signal from the photosensors is worth scientifically?
- Any trick to increase the dynamic range?
- Do you need to condition the signal from the photosensors? Where?
- Are you planning any testing system?

Auxiliary Systems

- Does your telescope need other elements beyond the structure, the reflective surface and the camera?
- Any thing related to calibration?
- Are you planning testing and verification mechanism?
- What about safety? For both the instrument and people.
- Any need to monitor the atmosphere and weather conditions?

Readout and Storage

- What are you planning to do with the signal recorded from the photosensors?
- Where do you store it?
- How do you bring it to the storing place?
- From where does it need to accessed for scientific exploitation?

Ask for advice

- For any question, doubt, thought while following the step by step instructions, do not hesitate to ask.
- But …
  - do not look for the best design, look for your design with your own choices.
  - do not expect answers when you ask, you will most likely get more questions.

Please use the ACME ticketing system