

# All-Sky-Cameras for CTA

Dusan Mandat, Miroslav Pech, Ladislav Chytka

CCF meeting Barcelona 2-5.10.2017



Joint Laboratory of optics of Palacky University and Institute of Physics of CAS



## Annex No. 5: Research Infrastructures in Czech Republic

Scientific field	Name	Acronym	Main hosting institution / Coordinator	Location	Priority *	Life-cycle phase (2015)	Previous major funding source
Physical sciences	Pierre Auger Observatory – participation of the Czech Republic	AUGER-CZ	Institute of Physics, Academy of Sciences of the Czech Republic	Argentina	A1	Operational	state budget
	Brookhaven National Laboratory – participation of the Czech Republic	BNL-CZ	Czech Technical University in Prague	United States of America	A2	Operational	state budget
	Center of Accelerators and Nuclear Analytical Methods	CANAM	Nuclear Physics Institute, Academy of Sciences of the Czech Republic	Czech Republic	A2	Operational	state budget
	CEITEC Nano	CEITEC Nano	Brno University of Technology	Czech Republic	A1	Operational	ERDF + state budget
	Center of Materials and Nanotechnologies	CEMNAT	University of Pardubice	Czech Republic	A3	Operational	ERDF + state budget
	Cherenkov Telescope Array – participation of the Czech Republic	CTA-CZ	Institute of Physics, Academy of Sciences of the Czech Republic	Chile, Spain	A1	Implementation	state budget
	Extreme Light Infrastructure – ELI beamlines	ELI beamlines	Institute of Physics, Academy of Sciences of the Czech Republic	Czech Republic	A2	Implementation	ERDF + state budget
	European Spallation Source – participation of the Czech Republic	ESS Scandinavia-CZ	Nuclear Physics Institute, Academy of Sciences of the Czech Republic	Sweden	A1	Implementation	state budget
	Atacama Large Millimeter / Submillimeter Array – participation of the Czech Republic	EU-ARC-CZ	Astronomical Institute, Academy of Sciences of the Czech Republic	Germany	A2	Operational	ERDF + state budget
	Facility for Antiproton and Ion Research – participation of the Czech Republic	FAIR-CZ	Nuclear Physics Institute, Academy of Sciences of the Czech Republic	Germany	A1	Implementation	state budget
	Research Infrastructure for Fermilab Experiments	Fermilab-CZ	Institute of Physics, Academy of Sciences of the Czech Republic	United States of America	A2	Operational	state budget
	HiLASE: New Lasers for Industry and Research	HiLASE	Institute of Physics, Academy of Sciences of the Czech Republic	Czech Republic	A4	Operational	ERDF + state budget
	Institut Laue-Langevin – participation of the Czech Republic	ILL-CZ	Charles University in Prague	France	A1	Operational	state budget
	Infrastructure for Study and Application of Advanced Materials	IPMINFRA	Institute of Physics of Materials, Academy of Sciences of the Czech Republic	Czech Republic	A2	Operational	ERDF + state budget
	Laboratory of Nanostructures and Nanomaterials	LNSM	Institute of Physics, Academy of Sciences of the Czech Republic	Czech Republic	A4	Operational	state budget
	Laboratoire Souterrain de Modane – participation of the Czech Republic	LSM-CZ	Czech Technical University in Prague	France	A2	Operational	state budget
	Prague Asterix Laser System	PALS	Institute of Plasma Physics, Academy of Sciences of the Czech Republic	Czech Republic	A3	Operational	state budget
	Centre for Analyses of Functional Materials	SAFMAT	Institute of Physics, Academy of Sciences of the Czech Republic	Czech Republic	A4	Operational	ERDF + state budget
	Système de Production d'Ions Radioactifs Accélérés en Ligne – participation of the Czech Republic	SPIRAL2-CZ	Nuclear Physics Institute, Academy of Sciences of the Czech Republic	France	A2	Operational	state budget
	Surface Physics Laboratory – Materials Science Beamline	SPL-MSB	Charles University in Prague	Italy	A2	Operational	state budget
	Van de Graaff Accelerator – A Source of Tunable Monoenergetic Neutrons and Light Ions	VdG	Czech Technical University in Prague	Czech Republic	A2	Operational	state budget
Energy	Efficient Use of Energy Resources Using Catalytic Processes	CATPRO	Research Institute of Inorganic Chemistry	Czech Republic	A1	Operational	ERDF + state budget
	COMPASS – Tokamak for Thermonuclear Fusion Research	COMPASS	Institute of Plasma Physics, Academy of Sciences of the Czech Republic	Czech Republic	A1	Operational	state budget
	CVOZE Power Laboratories	CVOZEPowerLab	VŠB – Technical University of Ostrava	Czech Republic	A4	Operational	ERDF + state budget
	Jules Horowitz Reactor – participation of the Czech Republic	JHR-CZ	Research Centre Řež	France	A2	Implementation	state budget
	Nuclear Research Reactors LVR-15 and LR-0	Reactors LVR-15 and LR-0	Research Centre Řež	Czech Republic	A2	Operational	state budget
	Research Infrastructure for Geothermal Energy	RINGEN	Charles University in Prague	Czech Republic	A3	Implementation	state budget
	Sustainable Energy	SUSEN	Research Centre Řež	Czech Republic	A4	Operational	ERDF + state budget
	VR-1 – Training Reactor for Research Activities	WCZV	Czech Technical University in Prague	Czech Republic	A1	Operational	state budget

\* Indicates the priority for public funding within the “large infrastructures for research, experimental development and innovation”  
Scale 1 to 4, in proportion to the quality-differentiated output of the evaluation.  
**A1** (highest priority), **A2** (high priority), **A3** (middle priority), **A4** (low priority).

## Cherenkov Telescope Array – participation of the Czech Republic

**Acronym:**  
CTA-CZ

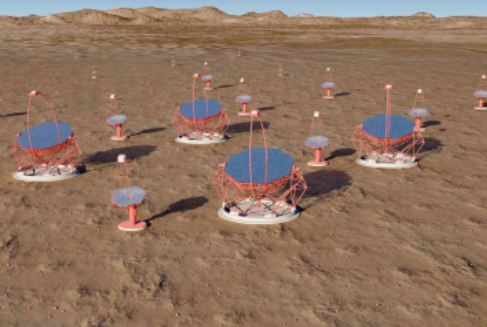
**Hosting institution:**  
Institute of Physics,  
Academy of Sciences of the Czech Republic

**Partner institutions:**

- Charles University in Prague
- Palacký University in Olomouc

**Responsible person:**  
TRÁVNÍČEK Petr  
[petr.travnicek@fzu.cz](mailto:petr.travnicek@fzu.cz)

**Website:**  
[cta.fzu.cz](http://cta.fzu.cz)



### Background description

CTA is a European and international research infrastructure in astroparticle physics. It will enable the discovery of a large number of new astrophysical sources of gamma rays and determination of their characteristics. The research community of the Czech Republic is significantly involved in CTA preparation; namely the Czech researchers develop telescope mirrors as well as evaluate candidate sites for CTA location. Their participation in CTA includes involvement in organizational structures, expert panels and CTA scientific groups. The Czech research community developed the all-sky cameras and innovative methods for the analysis of satellite images in order to identify the optimal location for CTA. The research community of the Czech Republic will also continue in monitoring the atmosphere during the CTA operation, when another camera system with robotic telescopes (also provided by the Czech Republic) shall define detailed cloudiness conditions in real time during CTA observation. The CTA mirror prototypes and optical samples are extensively tested in the optical laboratory of the Palacký University in Olomouc and the Institute of Physics, Academy of Sciences of the Czech Republic. Czech opticians develop technology for future production of mirrors for the so-called *Small Size Telescopes* (SST), drawing on the expertise from the Pierre Auger Observatory. With respect to providing computing resources for CTA, the collaboration with CESNET e-infrastructure plays an important role.

### Future development

The CTA is currently at the beginning of its construction phase, which is envisaged for 2016–2020. The final design and management decisions concerning the location, exact layout and technical realization should be finalized soon, so that the production of all CTA components can start simultaneously with development of the chosen sites (La Palma – Canary Islands, Paranal in Chile). This encompasses ground work, setting up infrastructure and engineering networks as well as production of experimental components such as telescopes, cameras, mirrors and various auxiliary devices. The Czech research community will continue in its activities, namely it will prepare several systems for the central calibration of CTA, and will participate in the production and deployment of SST mirrors.

### Socio-economic impact

The Czech Republic has been involved in CTA especially by the production of components for the camera systems used for selection of the CTA final location. The participation of the Czech Republic in CTA is important from the point of view of the long history of development of optical elements in the Czech Republic. Furthermore, the Czech involvement is crucial for ensuring the excellent level of astroparticle physics in the Czech research organizations.

## INFRA č. LM2015046 – P. Travnicek

	2016		2017		2018		2019		Celkem	
	Uznané náklady	Dotace MŠMT	Uznané náklady	Dotace MŠMT	Uznané náklady	Dotace MŠMT	Uznané náklady	Dotace MŠMT	Uznané náklady	Dotace MŠMT
Osobní náklady	3 105	3 105	3 359	3 359	3 425	3 425	3 492	3 492	13 381	13 381
Investice	1 750	1 750	250	250	0	0	0	0	2 000	2 000
Členské poplatky	5 593	5 593	6 633	6 633	6 633	6 633	6 633	6 633	25 492	25 492
Provozní náklady	2 924	2 924	3 833	3 833	3 640	3 640	3 649	3 649	14 046	14 046
<b>Celkem</b>	<b>13 372</b>	<b>13 372</b>	<b>14 075</b>	<b>14 075</b>	<b>13 698</b>	<b>13 698</b>	<b>13 774</b>	<b>13 774</b>	<b>54 919</b>	<b>54 919</b>

54919000 CZK = 2120k€

CTAO-CZ - European support of the Czech participation in construction of CTA observatory – D. Mandat

*Time period:* 1/7/2017 - 31/12/2020

*Total costs:* 19,759,181.20 CZK = 760 k€

## List of Research Activities

#	Title	Activity Leader
1	<p>The CTA SST1M telescope optimization</p> <p><u>Focus on:</u> Optimization and functional testing of optical telescopes for the detection of high energy cosmic gamma photons within the CTA Observatory. Design, implementation and testing of optical and related components of these telescopes. Coordination of the work within the consortium CTA in the construction and optimization of the prototype.</p>	Mgr. Miroslav Pech, Ph.D.
2	<p>The design, implementation and testing of components of optical telescopes</p> <p><u>Focus on:</u> Optimization of optical components of Cherenkov telescopes to maximize the imaging and transmission properties of these telescopes. These are mainly mirror segments and light concentrators and elements of telescopes related to the optical parts.</p>	RNDr. Petr Schovánek
3	<p>Rapid monitoring of nightsky atmosphere</p> <p><u>Focus on:</u> The construction and operation of instruments for monitoring of selected properties of the atmosphere in order to optimize the operation of the CTA telescopes and precise reconstruction parameters of observed gamma-ray sources.</p>	Mgr. Dušan Mandát, Ph.D.

4	<p>Data correction using atmospheric parameters</p> <p><u>Focus on:</u> The development and subsequent implementation of algorithms for data correction using the obtained atmospheric parameters and the associated large-scale simulations of the atmosphere using the IoP computer farms and the grid.</p>	<p>RNDr. Michael Prouza, Ph.D.</p> <p>Petr Janecek</p>
5	<p>Monte Carlo atmospheric simulations and data analysis</p> <p><u>Focus on:</u> Creation and implementation of Monte Carlo simulations, allowing detailed studies and modeling of the atmosphere. The aim of the extensive MC simulations using data from the sites of future observatories is to create input parameters for correction of the measured data.</p>	<p>RNDr. Michael Prouza, Ph.D.</p> <p>Petr Janecek</p>
6	<p>Detection of High energy photons using CTA observatory</p> <p><u>Focus on:</u> Preparation of the Czech groups for the future physics CTA program. Analysis of physical data of detected high-energy photons, studying data of an entire telescope array, determining the profile of energy spectra of detected sources and analysis of selected key scientific topics.</p>	RNDr. Petr Trávníček, Ph.D.

## 7.2 Direct Costs

### 7.2.1 Investments

**Land** – this chapter is not relevant

**Buildings and Constructions** – this chapter is not relevant

**Machinery and Equipment** – Within the technology costs will be purchased the project technologies. Detailed description of the cost of technology and equipment for the center is provided in Chap. 4.5 and in Chap. 5.2.2. The investments will be realized in 2018.

CZK incl. VAT	2017	2018	2019	2020	Total
<b>MACHINERY AND EQUIPMENT</b>		7,552,804			7,552,804
CTA-SI-components:					
1) Robotic Equatorial Telescope Mount		318,835			318,835
2) Astronomy cooled camera		178,959			178,959
3) High speed Len with 130 mm focal length		50,820			50,820
4) Astro Telescope Dome incl. montage and accessories		750,200			750,200
RF ion beam source		2,764,490			2,764,490
Confocal Microscope with accessories		3,549,500			3,549,500

Includes the shippment and installation on La Palma

Fram for CTA-S – see Jan Ebr pres.

ASC-S -> resources for intergation, maintenance etc.

CCF\_wbs\_cost\_table

4.10.3.4.3.1	All-Sky-Cameras							58 195 €							
4.10.3.4.3.1.1	Purchase Components														
4.10.3.4.3.1.2.1.1	Purchase Fish-eye	purchase of off-the-shelf item	2 pc	750,00EUR		40,00 €	40,00 €	1 500 €	1 420 €	1420 €			Purchase	contracted at home	
4.10.3.4.3.1.2.1.2	Purchase CCDs	purchase of off-the-shelf item	2 pc	3 000,00EUR		150,00 €	150,00 €	6 000 €	5 700 €	5700 €			Purchase	contracted at home	
4.10.3.4.3.1.2.1.3	Purchase Filters	purchase of off-the-shelf item	2 pc	650,00EUR		35,00 €	35,00 €	1 300 €	1 230 €	1230 €			Purchase	contracted at home	
4.10.3.4.3.1.2.1.4	Purchase Housing	purchase for in-house production	2 pc	360,00EUR		20,00 €	20,00 €	720 €	680 €	680 €			Purchase	contracted at home	
4.10.3.4.3.1.2.1.5	Purchase Electronics	purchase of off-the-shelf item	2 pc	350,00EUR		20,00 €	20,00 €	700 €	660 €	660 €			Purchase	contracted at home	
4.10.3.4.3.1.2.1.6	Purchase House for Electronics	purchase of off-the-shelf item	2 pc	100,00EUR		5,00 €	5,00 €	200 €	190 €	190 €			Purchase	contracted at home	
4.10.3.4.3.1.2.1.7	Purchase Lens Cover	purchase for in-house production	2 pc	200,00EUR		10,00 €	10,00 €	400 €	380 €	380 €			Purchase	contracted at home	
4.10.3.4.3.1.2.2	Purchase Spares	purchase of off-the-shelf item	2 pc	5 000,00EUR		250,00 €	250,00 €	10 000 €	9 500 €	9500 €			Purchase	contracted at home	

CCF\_wbs\_cost\_table

4.10.3.4.3.1	All-Sky-Cameras							58 195 €							
4.10.3.4.3.1.2	Purchase Components														
4.10.3.4.3.1.2	Purchase Fish-eye	purchase of off-the-shelf item	2pc	750,00EUR	40,00 €	40,00 €	1 500 €	1 420 €	420 €	1			Purchase	contracted at home	
4.10.3.4.3.1.2	Purchase CCDs	purchase of off-the-shelf item	2pc	3 000,00EUR	150,00 €	150,00 €	6 000 €	5 700 €	700 €	5			Purchase	contracted at home	
4.10.3.4.3.1.2	Purchase Filters	purchase of off-the-shelf item	2pc	650,00EUR	35,00 €	35,00 €	1 300 €	1 230 €	230 €	1			Purchase	contracted at home	
4.10.3.4.3.1.2	Purchase Housing	purchase for in-house production	2pc	360,00EUR	20,00 €	20,00 €	720 €	680 €	680 €				Purchase	contracted at home	
4.10.3.4.3.1.2	Purchase Electronics	purchase of off-the-shelf item	2pc	350,00EUR	20,00 €	20,00 €	700 €	660 €	660 €				Purchase	contracted at home	
4.10.3.4.3.1.2	Purchase House for Electronics	purchase of off-the-shelf item	2pc	100,00EUR	5,00 €	5,00 €	200 €	190 €	190 €				Purchase	contracted at home	
4.10.3.4.3.1.2	Purchase Lens Cover	purchase for in-house production	2pc	200,00EUR	10,00 €	10,00 €	400 €	380 €	380 €				Purchase	contracted at home	
4.10.3.4.3.1.2	Purchase Spares	purchase of off-the-shelf item	2pc	5 000,00EUR	250,00 €	250,00 €	10 000 €	9 500 €	500 €	9			Purchase	contracted at home	

On-site (LP &amp; Chile)



CCF\_wbs\_cost\_table

4.10.3.4.3.1	All-Sky-Cameras							58 195 €							
4.10.3.4.3.1.1	Purchase Components														
4.10.3.4.3.1.2.1	Purchase Fish-eye	purchase of off-the-shelf item	2 pc	750,00EUR		40,00 €	40,00 €	1 500 €	1 420 €	420 €	1			Purchase	contracted at home
4.10.3.4.3.1.2.1.1															
4.10.3.4.3.1.2.1.2	Purchase CCDs	purchase of off-the-shelf item	2 pc	3 000,00EUR		150,00 €	150,00 €	6 000 €	5 700 €	700 €	5			Purchase	contracted at home
4.10.3.4.3.1.2.1.3	Purchase Filters	purchase of off-the-shelf item	2 pc	650,00EUR		35,00 €	35,00 €	1 300 €	1 230 €	230 €	1			Purchase	contracted at home
4.10.3.4.3.1.2.1.4	Purchase Housing	purchase for in-house production	2 pc	360,00EUR		20,00 €	20,00 €	720 €	680 €	680 €				Purchase	contracted at home
4.10.3.4.3.1.2.1.5	Purchase Electronics	purchase of off-the-shelf item	2 pc	350,00EUR		20,00 €	20,00 €	700 €	660 €	660 €				Purchase	contracted at home
4.10.3.4.3.1.2.1.6	Purchase House for Electronics	purchase of off-the-shelf item	2 pc	100,00EUR		5,00 €	5,00 €	200 €	190 €	190 €				Purchase	contracted at home
4.10.3.4.3.1.2.1.7	Purchase Lens Cover	purchase for in-house production	2 pc	200,00EUR		10,00 €	10,00 €	400 €	380 €	380 €				Purchase	contracted at home
4.10.3.4.3.1.2.2	Purchase Spares	purchase of off-the-shelf item	2 pc	5 000,00EUR		250,00 €	250,00 €	10 000 €	9 500 €	500 €	9			Purchase	contracted at home

In Olomouc, except filters, lens.



## ASC-N location

The final location of the All-Sky-Camera (on top of the technical building) would then be achieved only in phase-2, however it is very important to have the All-Sky-Camera already operative, and integrated in CTA-N, during the Phase-1.

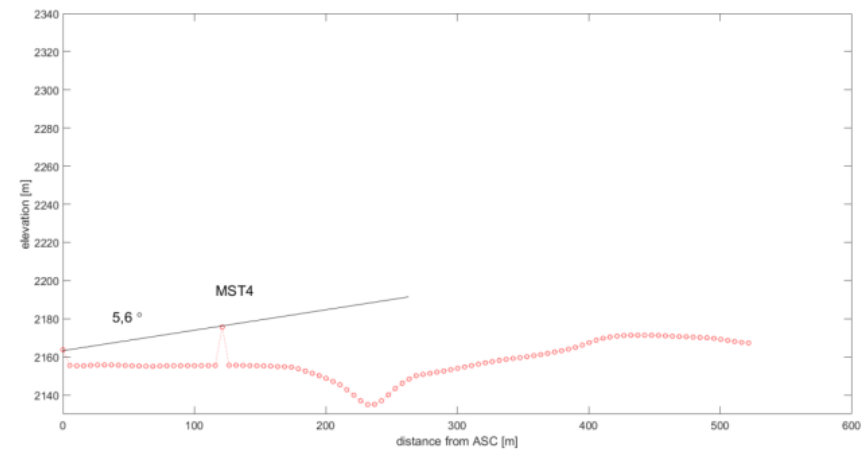
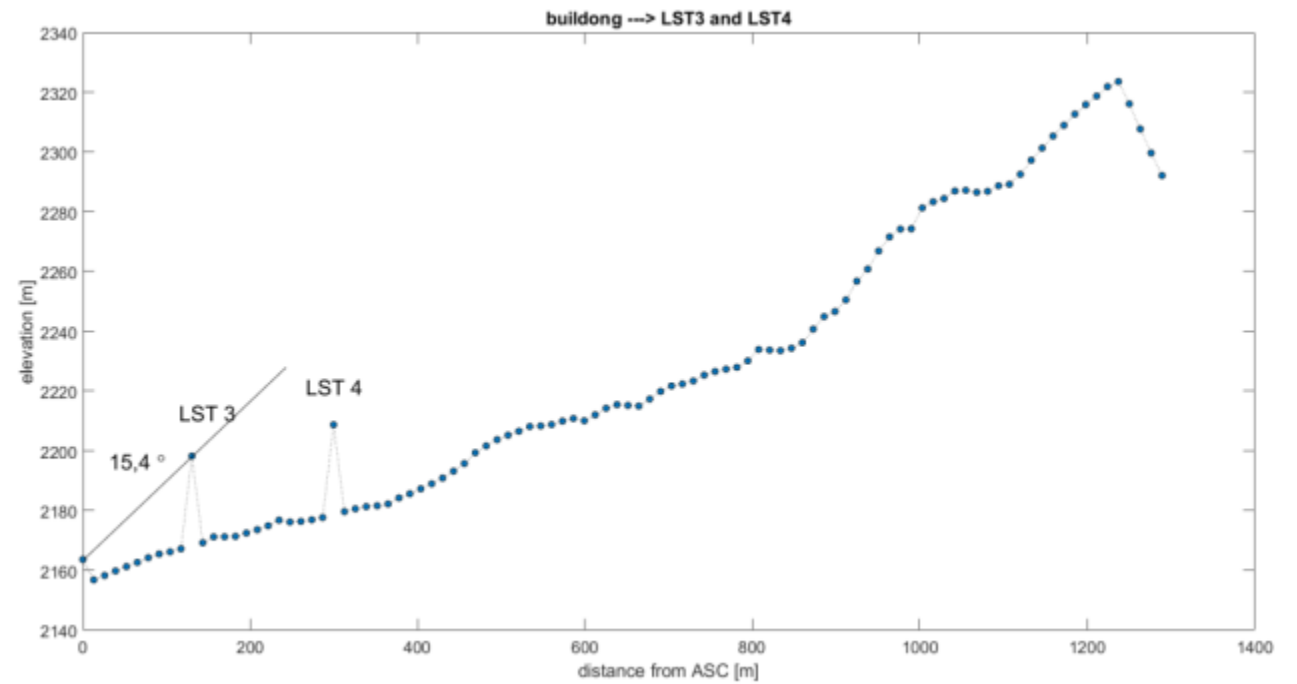
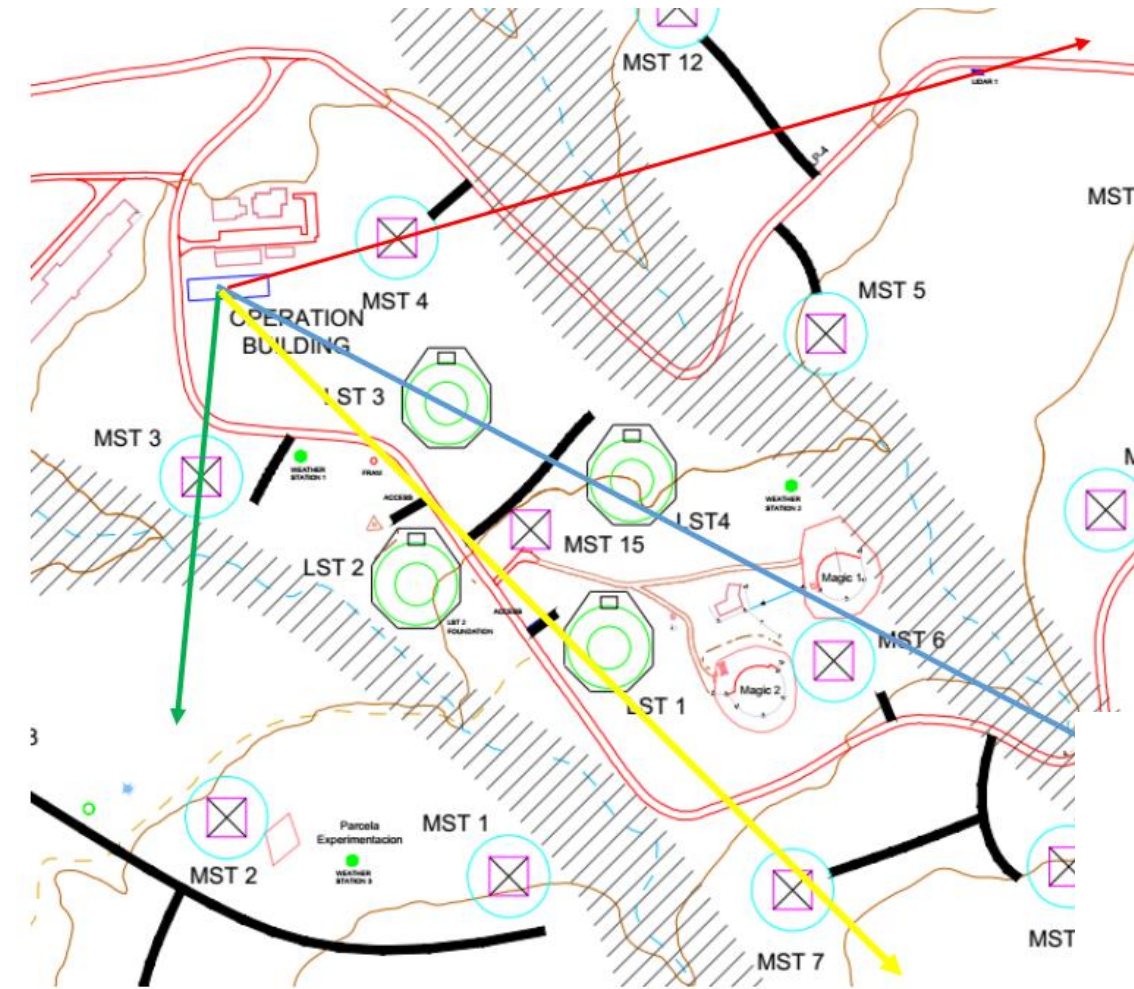
So, our suggestion would be the following:

Plan A: Leave the ASC on top of the MAGIC control house, and negotiate with MAGIC an interface to the CTA-N central control, until it can be moved to the technical building.

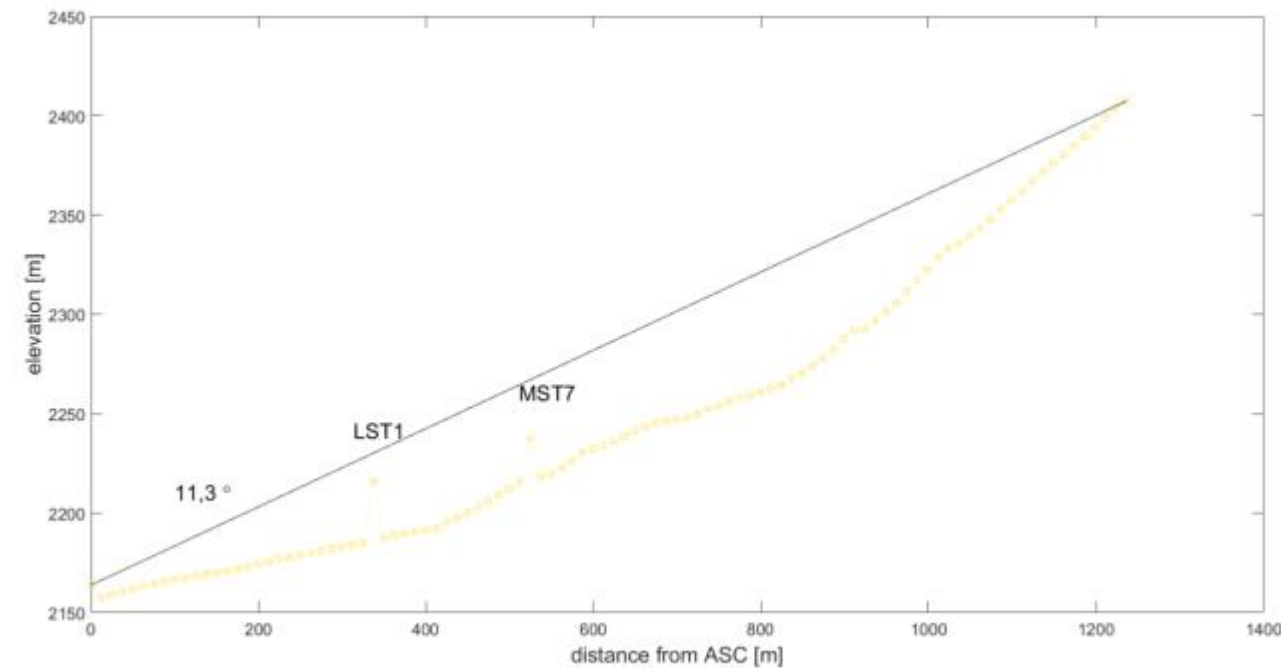
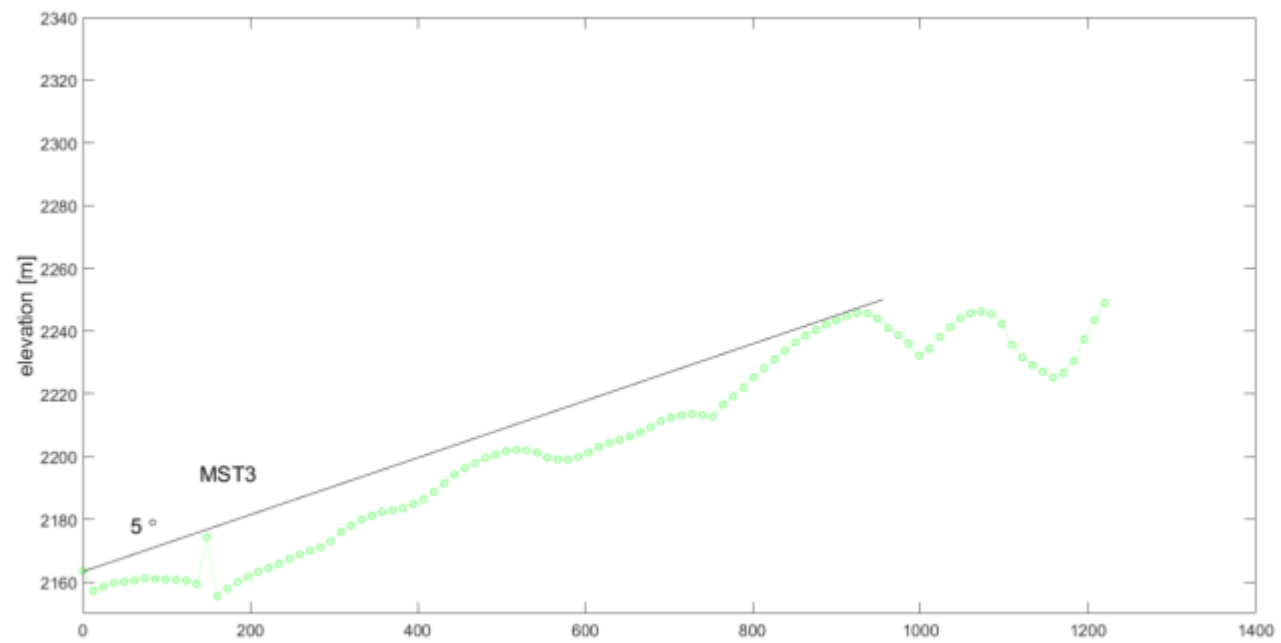
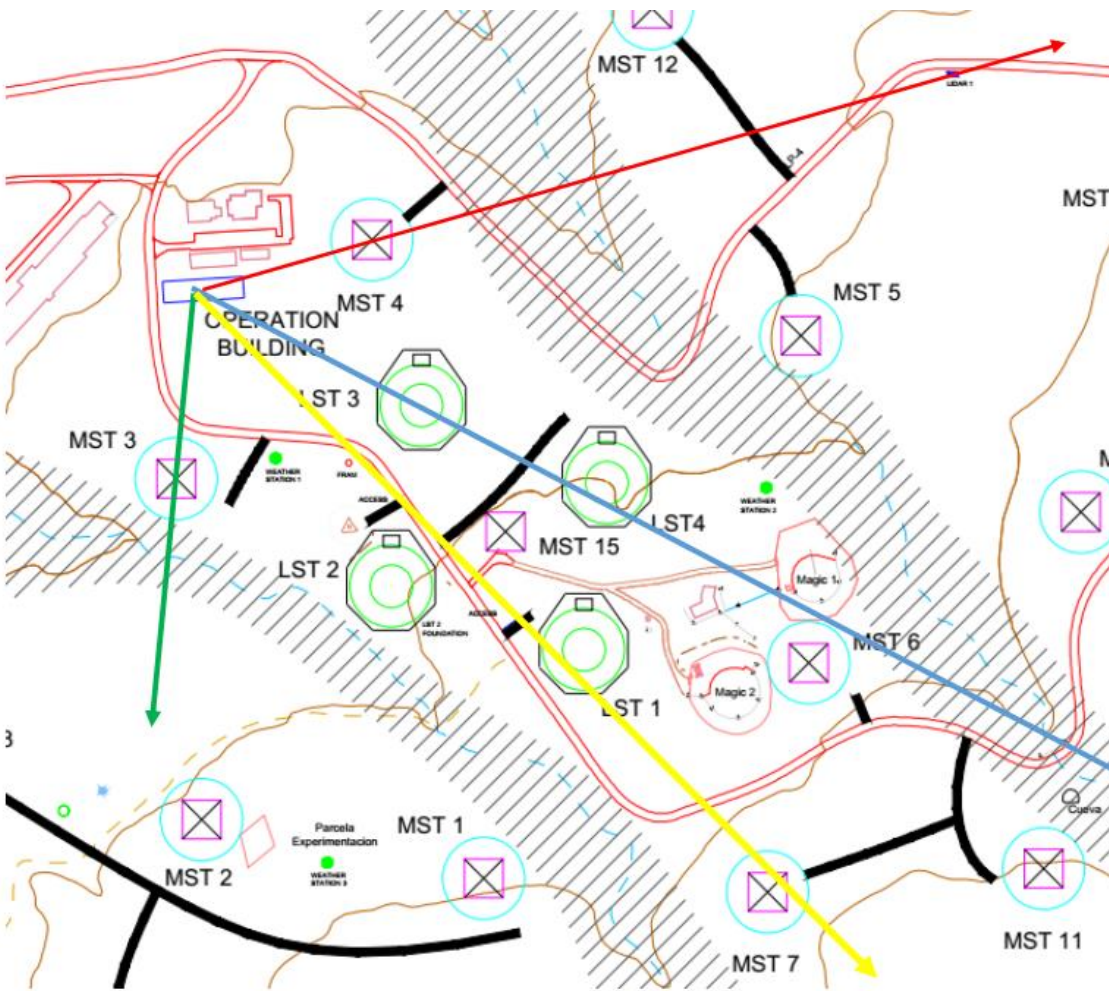
Plan B: Move the ASC to the place where the ceilometer is hosted, and move it then to its final location on the technical building.

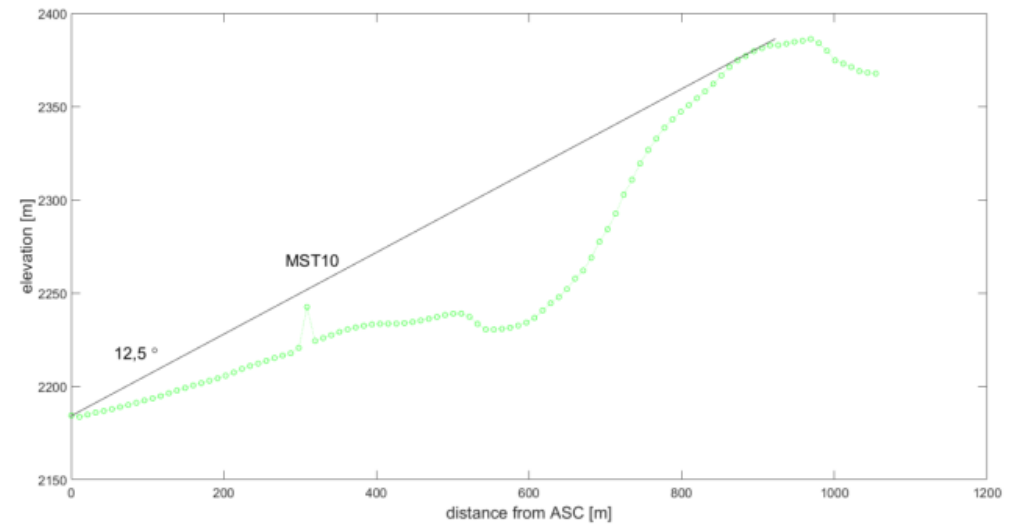
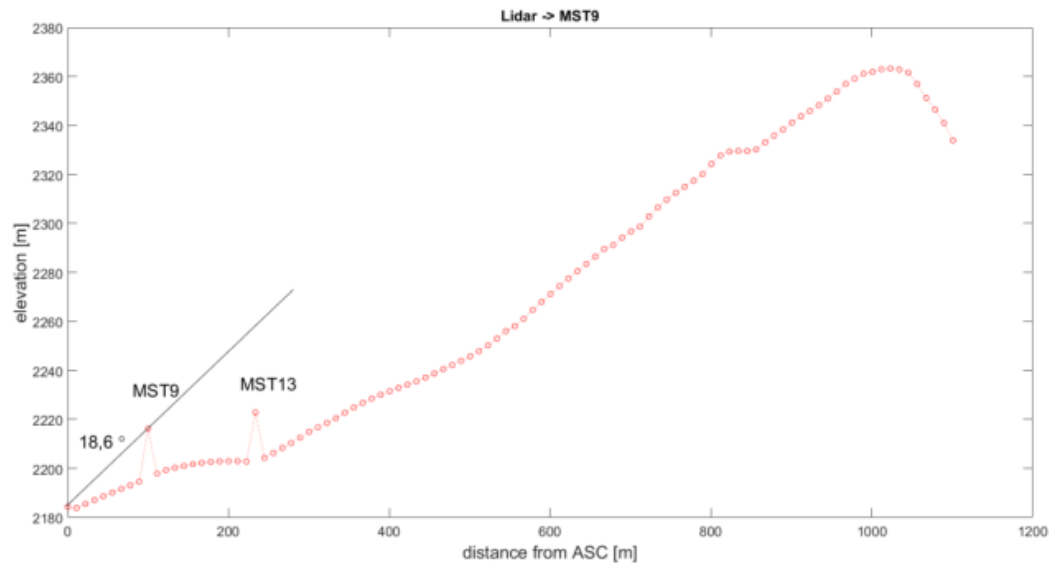
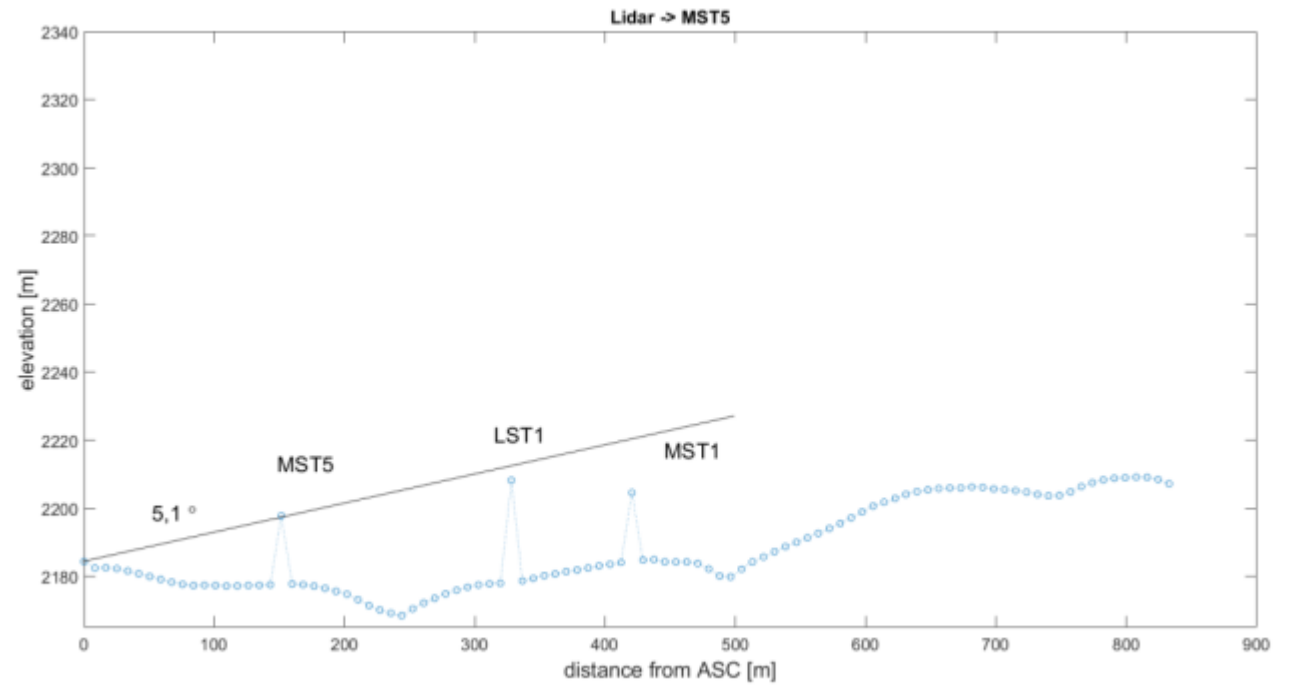
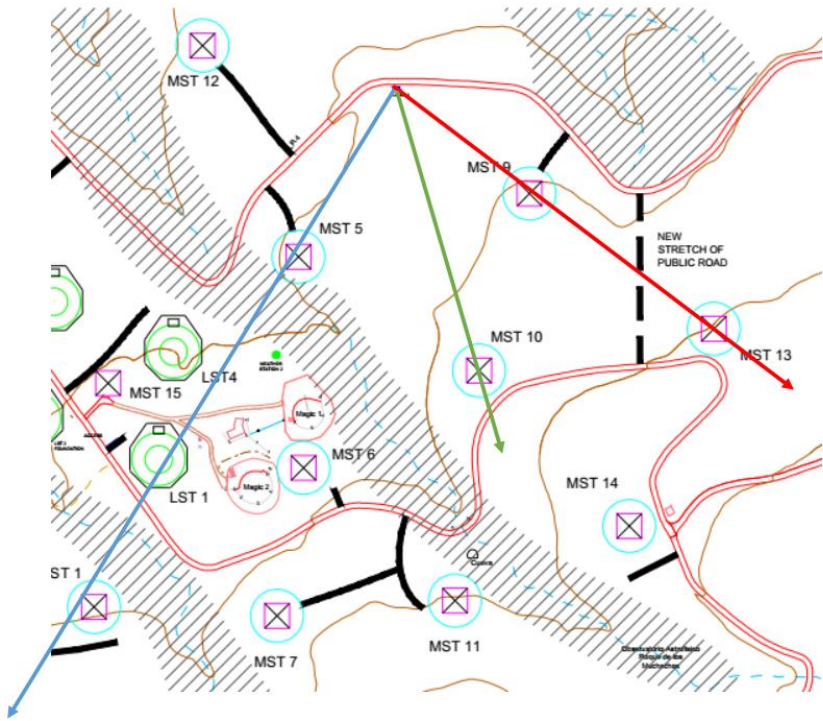
Study of different location of ASC and the FOV

# Study of different location of ASC and the FOV



## Study of different location of ASC and the FOV





## Conclusions

ASC budget covered by local grants at least till 2020 (very optimistic after 2020), evaluation committee assigned the best score (thanks to advisory group – Markus, Tomek)

Further financing covered by 2 grants

Still paperwork to be done !!!!!

Future location of ASC

Current status (Magic site) – power, internet exist, FOV shadowed by the Magic telescopes and Surrounding.

New negotiations with Magic group

Move to Ceilometer site – need power (about 80W) and internet!!!

