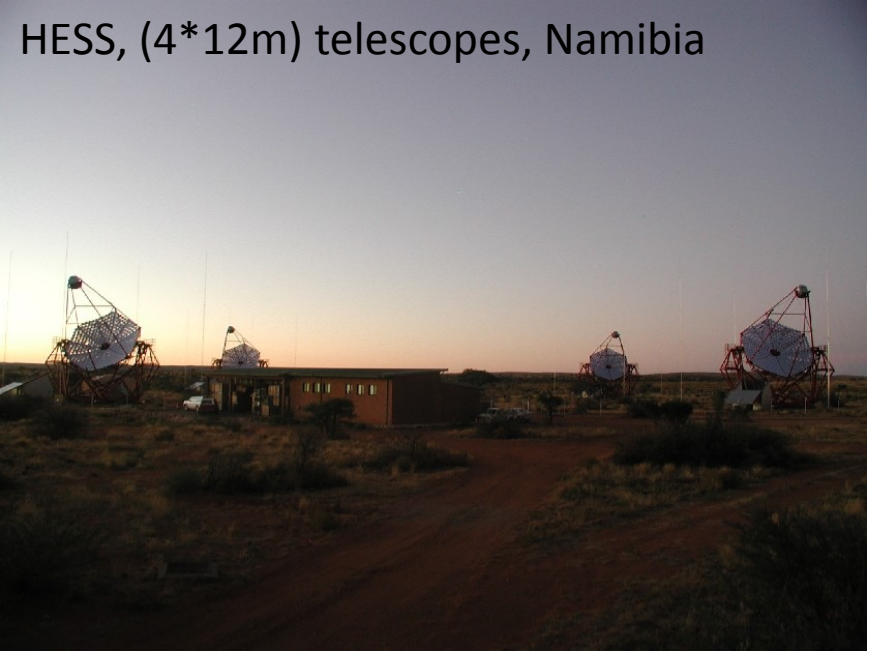
INAF IN CTA: Il progetto ASTRI

Bruno Sacco
IASF-Palermo/INAF

HESS, (4*12m) telescopes, Namibia



VERITAS, Arizona

MAGIC (2*17m) telescopes , La Palma Canary Islands

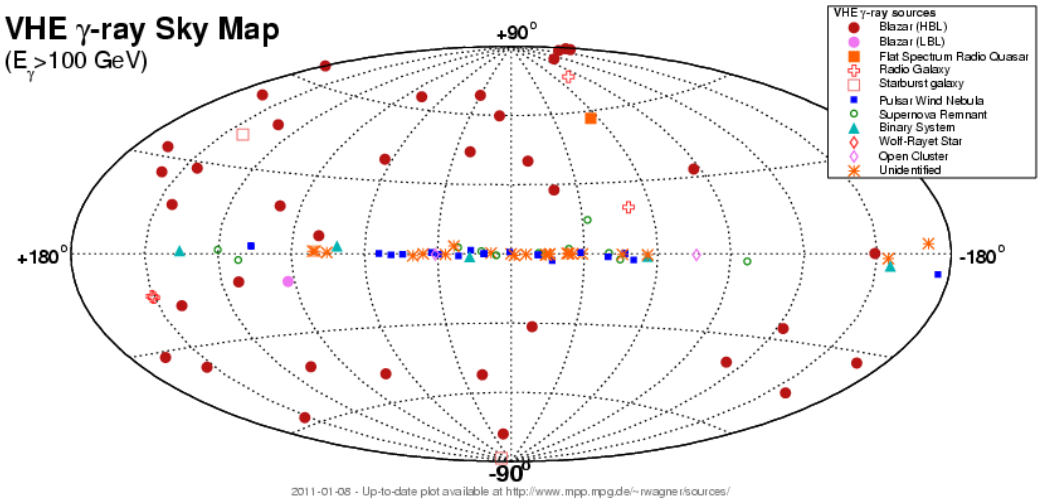
	WIPPLE	HESS	MAGIC	VERITAS
Site	Arizona	Namibia	Canary Island	Arizona
Lat (°)	32	-25	29	32
Alt (km)	1.3	1.8	2.2	1.3
Tel. Ø (m)	10	12	17	12
N. Tel.	1	4	2	4
FoV Ø (°)	2.3	5	3	3.5
Thresh. (GeV)	300	100	50	100
Sensitivity (mCrab)	150	7	20	10

2011

http://www.mppmu.mpg.de/~rwagner/sources/

R.Wagner, VHE γ-ray Sky Map and Source Catalog

> 100 Sources



Gain one order of magnitude in sensitivity at 1 TeV (1mCrab), more and more sources

Reach 10-20 GeV in lower energy threshold: Space mission upper threshold

FUTURE !

Reach 100-200 TeV in upper energy threshold:acceleration processes and Cosmic Ray paradigma

Improve angular resolution (< 1 arc-minute) : extensive sources, unidentified sources.

Increase the FoV (2-4 ° ==> 8-10°): trigger efficiency for high energy events, surveys

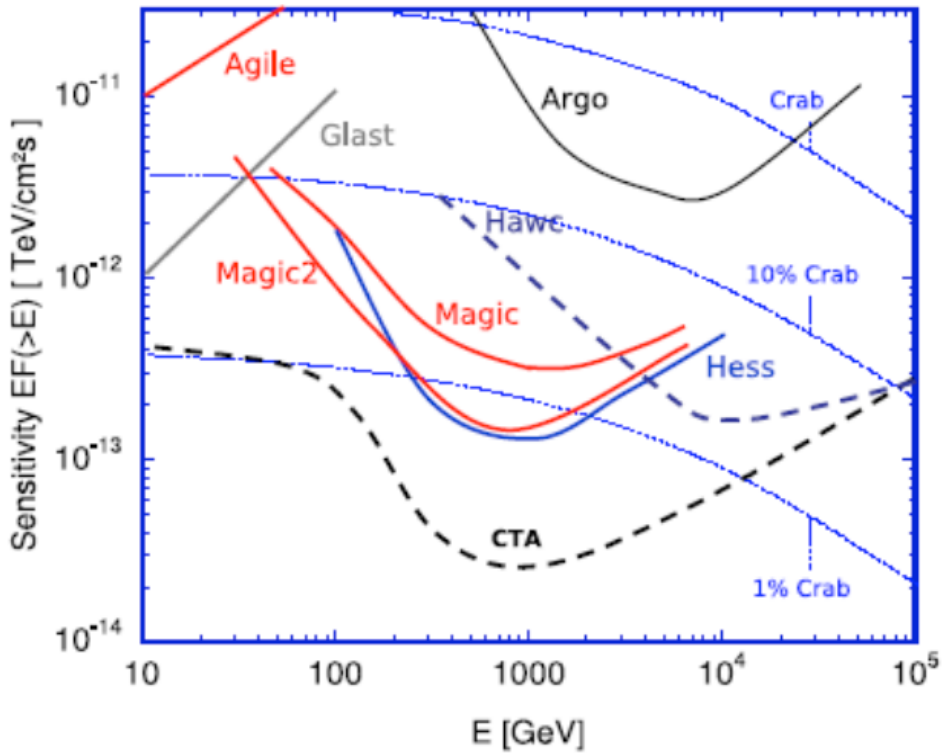
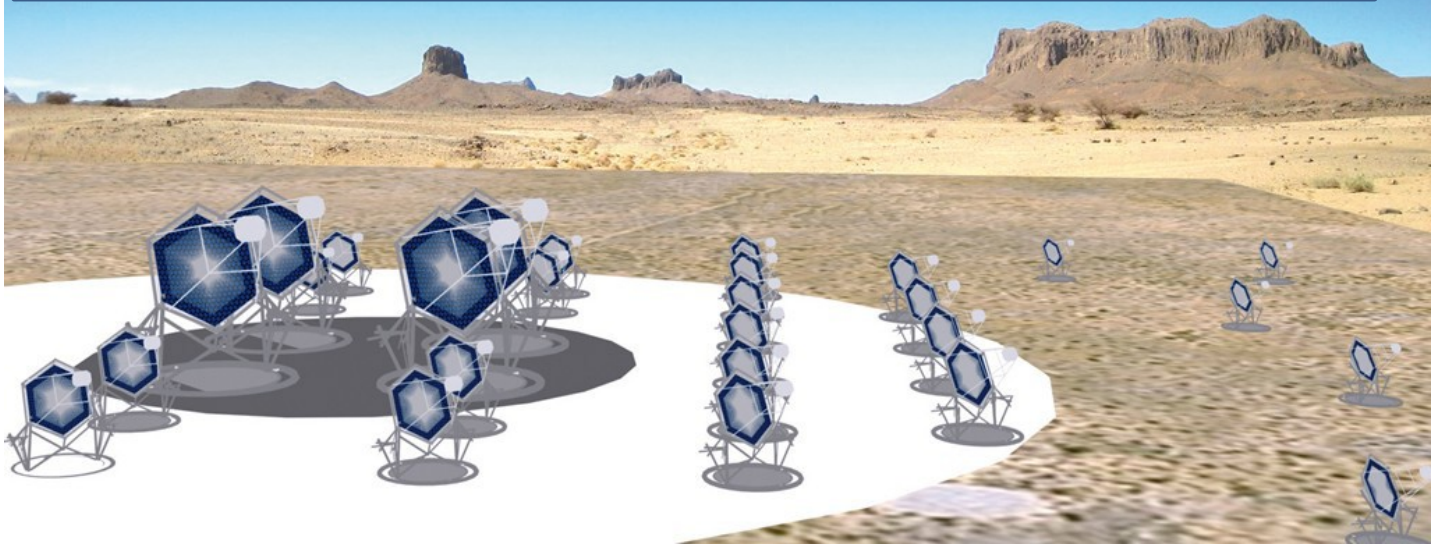


Fig. 1.4.1: Sensitivities of some present and future HE gamma detector, measured as the minimum intensity source detectable at 5 sigma. The performance for EAS and satellite detector is based on one year of data taking; for Cherenkov telescopes it is based on 50 hours of data (from [3]).

Cherenkov Telescope Array

n1 LST: 24 m telescopes for the low energy (E > 0.01 TeV)
n2 MST: 12 m telescopes for the medium energy (E > 0.1 TeV)
n3 SST: 4/7 m telescopes for the high energy (E > 10 TeV)

> 60 The telescopes will be spread in > 2*2 km square



Artists view of a possible CTA configuration, with three different telescopes types covering the overlapping energy ranges, and area coverage which increases with increasing gamma-ray energy. (from the CTA –PP, Preparatory Phase)


Interesting Places
North Hemisphere
Canary Islands
Mexico (Baja California)
BUT SOME MORE WORK NEED HERE
South Hemisphere
Argentina (Puna,Naranjo,more)
Namibia (Hess,Khomas)
Chile (Site D, others)
S.Africa (?)

CTA construction costs for 2 sites = > 200 Meuro, rough order of magnitude

CTA Consortium is composed by more than 100 scientific Institutes belonging to 23 countries : 14 from European Union (Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Holland, Poland, Spain,Sweden and UK), 3 European (Armenia, Croatia and Switzerland) and 6 extra-european (Argentine, Brasil, Japan, Namibia, South Africa e USA). Participations in fieri: India, Slovenia

2008 : CTA is in the roadmap of the European Strategy Forum on Research and Infrastructure (ESFRI).

2009: CTA has been evaluated by ASPERA as one of the seven most important European projects for the Astro-particle physics.

2010: The Preparatory Phase for the Cherenkov Telescope Array (October 1, 2010 – September 30, 2013) is funded by CE in the framework of the FP7-INFRASTRUCTURES-2010-1 call for 5.2 Meuro

2013/2014: Start of the **CTA** construction

A3.2:
What it costs

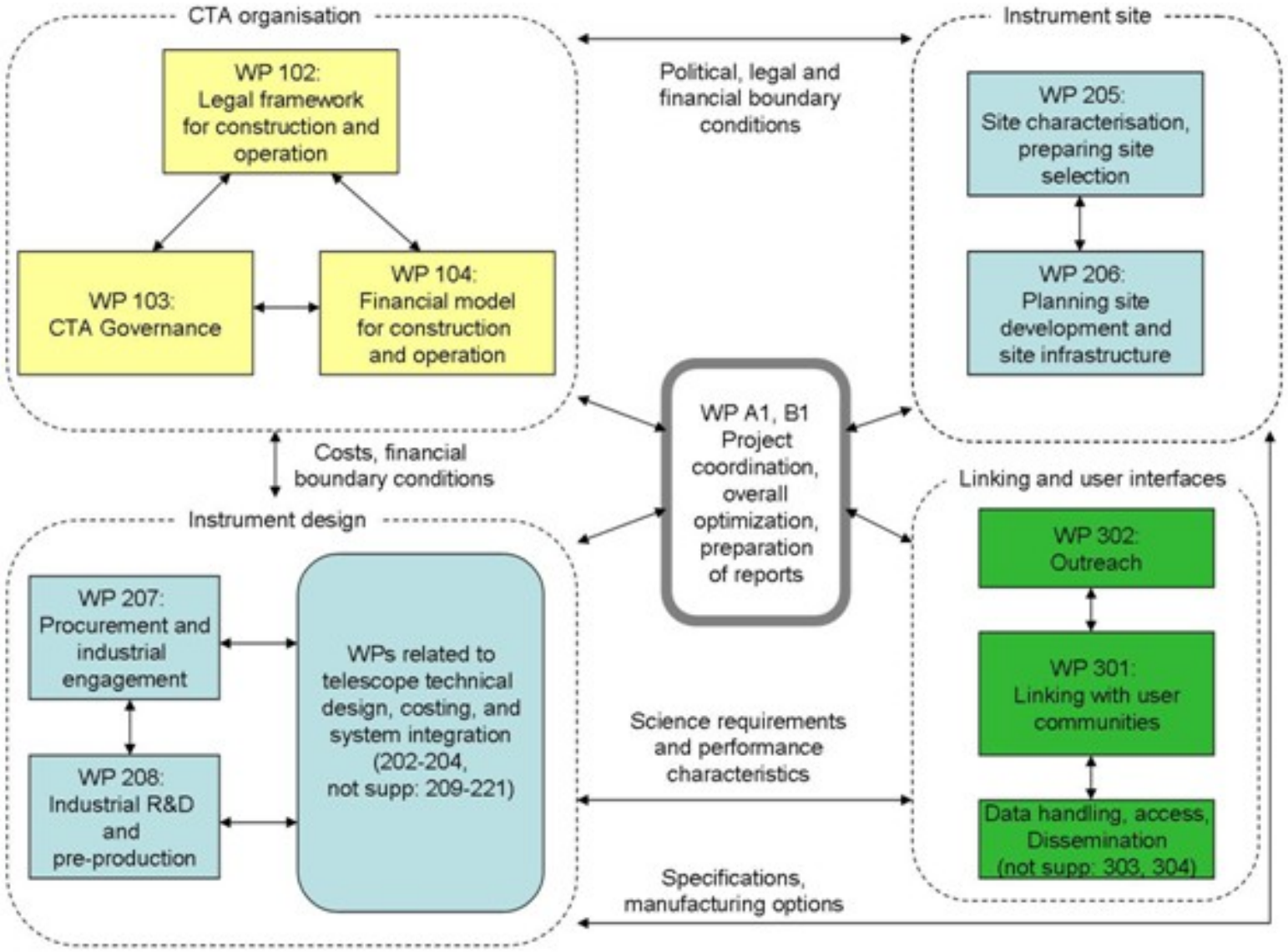
Project Number [1]	262053	Project Acronym [2]	CTA-PP

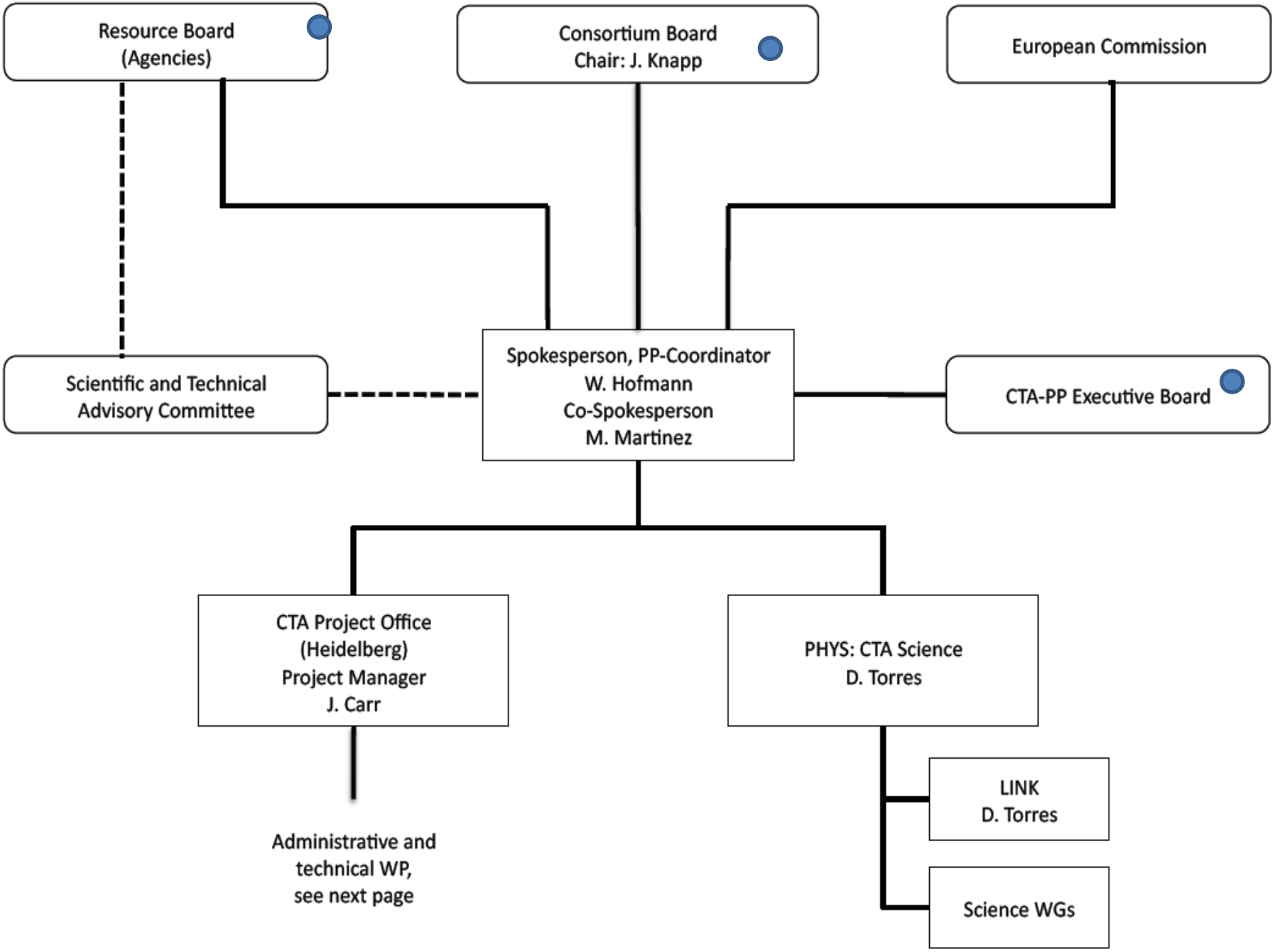
One Form per Project

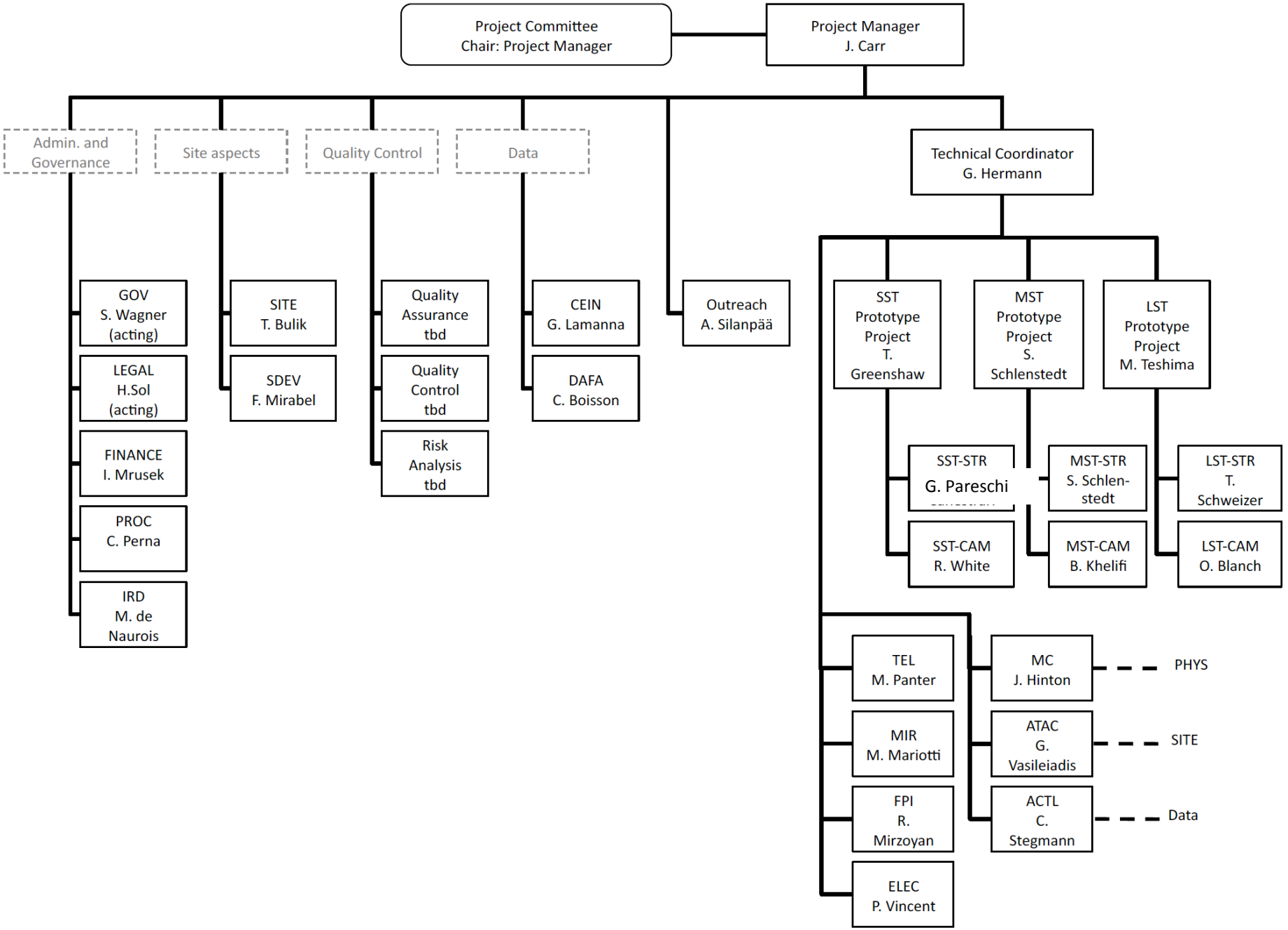
Participant number in this project [3]	Participant short name	Estimated eligible costs (whole duration of the project)						Total receipts	Requested EU contribution
		RTD (A)	Coordination (B)	Support (C)	Management (D)	Other (E)	Total A+B+C+D+E		
1	MPG	300,000.00	0.00	621,000.00	460,800.00	0.00	1,381,800.00	0.00	944,023.00
2	UHEI	0.00	0.00	472,500.00	652,500.00	0.00	1,125,000.00	0.00	877,200.00
3	DESY	0.00	0.00	720,000.00	0.00	0.00	720,000.00	0.00	481,500.00
4	CNRS	685,200.00	0.00	336,000.00	0.00	0.00	1,021,200.00	0.00	693,689.00
5	CEA	280,000.00	0.00	305,000.00	0.00	0.00	585,000.00	0.00	474,328.00
6	IFAE	25,000.00	276,000.00	416,000.00	0.00	0.00	717,000.00	0.00	477,894.00
7	JU	148,000.00	0.00	288,000.00	0.00	0.00	436,000.00	0.00	303,600.00
8	UnivLeeds	25,000.00	0.00	648,000.00	0.00	0.00	673,000.00	0.00	448,469.00
9	INAF	300,000.00	0.00	472,000.00	0.00	0.00	772,000.00	0.00	497,073.00
10	UNIPD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	UZH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	UIBK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	U. Turku	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	UStockholm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	CNEA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	ICRR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	NWU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	UNAM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Participant number in this project [3]	Participant short name	Estimated eligible costs (whole duration of the project)						Total receipts	Requested EU contribution
		RTD (A)	Coordination (B)	Support (C)	Management (D)	Other (E)	Total A+B+C+D+E		
TOTAL		1,763,200.00	276,000.00	4,278,500.00	1,113,300.00	0.00	7,431,000.00	0.00	5,197,776.00

PREPARATORY PHASE




Resource Board
(Agencies)
Consortium Board
Chair: J. Knapp
European Commission
Scientific and Technical
Advisory Committee
Spokesperson, PP-Coordinator
W. Hofmann
Co-Spokesperson
M. Martinez
CTA-PP Executive Board
CTA Project Office
(Heidelberg)
Project Manager
J. Carr
PHYS: CTA Science
D. Torres
LINK
D. Torres
Science WGs
Administrative and
technical WP,
see next page


Project Committee
Chair: Project Manager
Project Manager
J. Carr
Admin. and Governance
Site aspects
Quality Control
Data
Technical Coordinator
G. Hermann
GOV
S. Wagner
(acting)
LEGAL
H.Sol
(acting)
FINANCE
I. Mrusek
PROC
C. Perna
IRD
M. de
Naurois
SITE
T. Bulik
SDEV
F. Mirabel
Quality
Assurance
tbd
Quality
Control
tbd
Risk
Analysis
tbd
CEIN
G. Lamanna
DAFA
C. Boisson
Outreach
A. Silanpää
SST
Prototype
Project
T.
Greenshaw
MST
Prototype
Project
S.
Schlenstedt
LST
Prototype
Project
M. Teshima
SST-STR
G. Pareschi
MST-STR
S. Schlen-
stedt
LST-STR
T.
Schweizer
SST-CAM
R. White
MST-CAM
B. Khelifi
LST-CAM
O. Blanch
TEL
M. Panter
MIR
M. Mariotti
FPI
R.
Mirzoyan
ELEC
P. Vincent
MC
J. Hinton
ATAC
G.
Vasileiadis
ACTL
C.
Stegmann
PHYS
SITE
Data

Italian participation to CTA:
INAF + University of Padova (Siena, Udine)

INAF ====➔ 56 (Scientists, Engineers, Technicians) (24 FTE)
Dip.Progetti, IFSI-To, OAB, IASF-Mi, OAPd, OATs, OABo, OARm, IASF-Rm, IASF-Pa, OACt + OANa, TNG

Within the CTA_PP
INAF has representative members in:
Resource Board , General Board, Executive Board, Technical Committee
INAF is responsible for the CTA_PP Procurement (C. Perna)
INAF is responsible for the SST Mirror&Structure (G. Pareschi)
INAF participates to several CTA_PP activities:
Science, Mirrors, Telescope Structures, MC, Data Handling, SST camera sensors and electronics, SST dual/single mirror choice

ASTRI
(Astrofisica con Specchi a Tecnologia Replicante Italiana)
R&D program financied by MIUR

In the spring 2010 INAF submitted to the Italian Ministry of Reaserch the ASTRI project, where has been requested a financial support (8Meuro) for a three years program (2011-2013) to develop technologies for the CTA : Mirrors (with replica tecnique) , sensors and electronics for the telescope cameras

ASTRI has been approved as one of the, so called, “Progetti Bandiera “and INAF received 3Meuro in 2011.

QUADRO FINANZIARIO PROGETTI BANDIERA - PNR 2011-2013							
	PROGETTI	2010	2011	2012	2013	Annualità successive	TOTALE MIUR/ENTI
							A
1	Epigenomica	3,00	8,00	9,00	10,00		30,00
2	Ritmare - ricerca italiana per il mare	20,00	70,00	90,00	90,00	180,00	450,00
3	L'ambito nucleare	3,00	10,00	13,00	13,00		39,00
4	ASTRI – astrofisica con specchi a tecnologia replicante italiana	3,00	2,00	2,00	1,00		8,00
5	La fabbrica del futuro	2,00	2,00	4,00	4,00		12,00
6	NanoMax	0,00	6,00	8,00	9,00		23,00
7	InterOmics	0,00	8,00	9,00	8,00		25,00
8	Elettra-Fermi – EUROFEL	5,00	11,00	13,00	16,00		45,00
9	Super B factory	34,00	22,00	34,00	45,00	115,00	250,00
10	SIGMA	80,00					80,00
11	Satellite ottico per telerilevamento	100,00					100,00
12	Ricerca e Innovazione tecnologica nei processi di conoscenza, tutela, valorizzazione e sicurezza dei Beni Culturali	2,00	8,00	10,00	10,00	0,00	30,00
13	Cosmo - Skymed II generation		100,00	100,00	100,00	300,00	600,00
14	IGNITOR		25,00	25,00	30,00		80,00
		252,00	925,00				
	totale 2010/2013	1177,00				595,00	1772,00

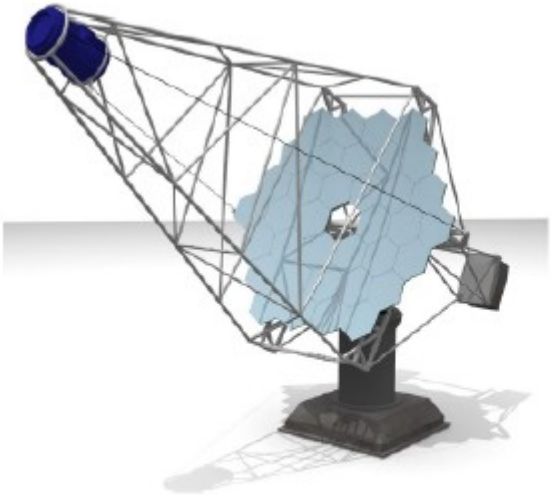


Fig. 5 The Davies-Cotton design.

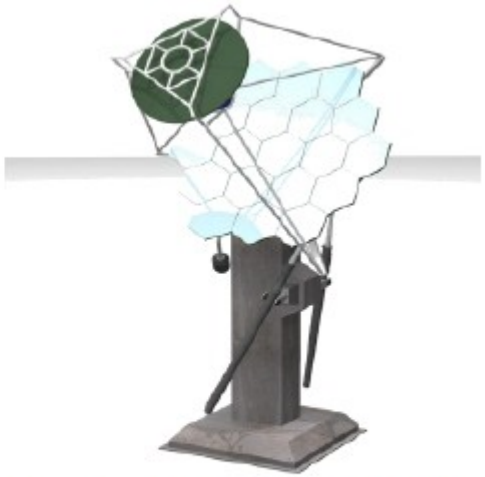


Fig. 6 The Schwarzschild-Couder design.

Single mirror DC is the optical model of the present Cherenkov telescopes
Single mirror DC is the baseline for LST and MST of CTA.

Dual mirror SC, originally proposed by the american AGIS group , in the CTA is now in competition with DC for SST and it is also studied as alternaitve solution for MST.

Output of ASTRI

- **SST-Dual-Mirror end-to-end prototype:** Study, design, manufacturing, assembly and tests of a dual-mirror SST end-to-end prototype.

- **SST-DC Mechanical Structure:** Design of the mechanical structure for the classical layout (Davies-Cotton) and prototyping of the critical components.

- **SST-DC Mirrors:** Design, development and manufacturing of part of the mirror facets in the Davies-Cotton layout for the Small Size Telescope prototype.

- **MST Mirrors:** Design, development and manufacturing of part of the the mirror facets in the Davies-Cotton layout for the Medium Size Telescope prototype.

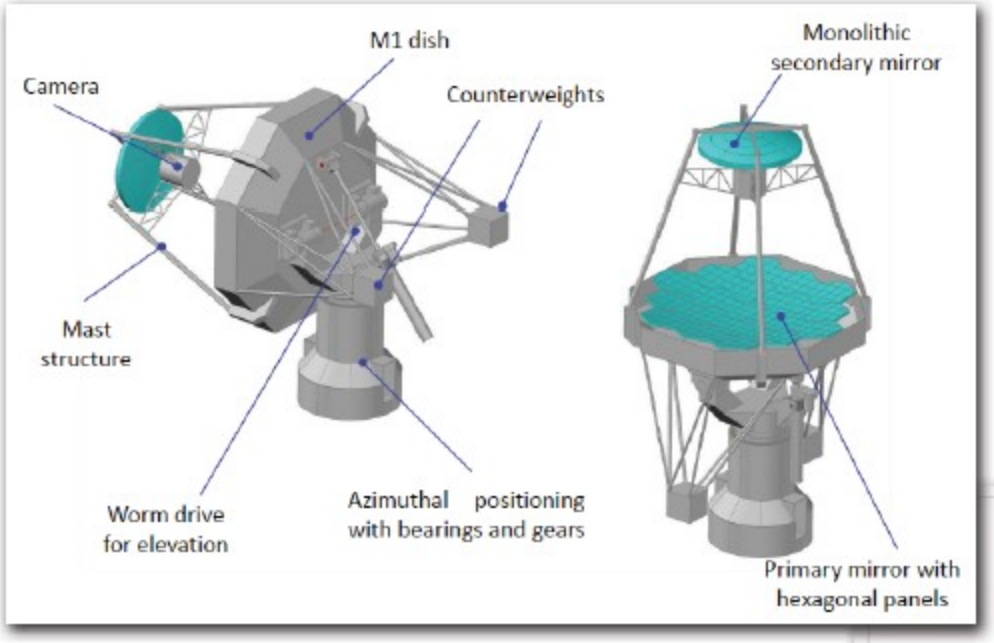
- **Ancillary activity**: The ASTRI program will support all the INAF CTA activities necessary for the finalization of the technological aspects as Scientific Requirements, MC simulation, and Data Handling.

ASTRI: Astrofisica con Specchi a Tecnologia Replicante Italiana	Consum. /contracts	Travel	Personnel	Lab. Instr	Over head	total
Project Management	10	5				15
Dual mirror-SST End to End Prototype	1030	87	590	250		1957
Single mirror-SST Structure	200	9	""	50		259
SST+MST Mirrors	260	9	""			269
Ancillary activities						
Science	10	9	100			119
M.C. simulation	9	5	50			64
Observatory & data hand.	9	7	50			66
Industrial Procurement	12	9	50			71
INAF Overhead					180	180
total	1540	140	840	300	180	3000

ASTRI activities	Not Staff Personnel	FTE	Staff Personnel	FTE	Total FTE
Dual Mirror SST: End to End Prototype	7	6	27	5.4	14.4
Single mirror SST Structure	1	1			
SST+MST Mirrors and RTD activity	2	2			
Science	3	3	5	0.6	3.6
M.C.Simulation	1	1	2	0.4	1.4
Data handling	1	1	2	0.5	1.5
Procurement	1	1	1	1	2
CTA general management	--	--	3	1	1
total	16	15	40	8,9	23,9

ASTRI current status

Strucure design

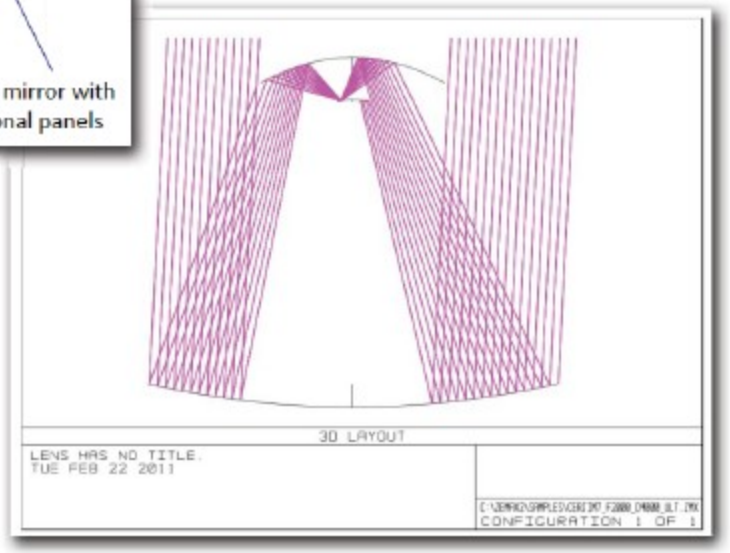


Canestrari, Conconi
CTA Cons. Meeting Toulouse

Alt-Az mounting:

Classical solution
Excellent performance

No eigenfrequencies problems ≥6 Hz



ASTRI current status

Optical design

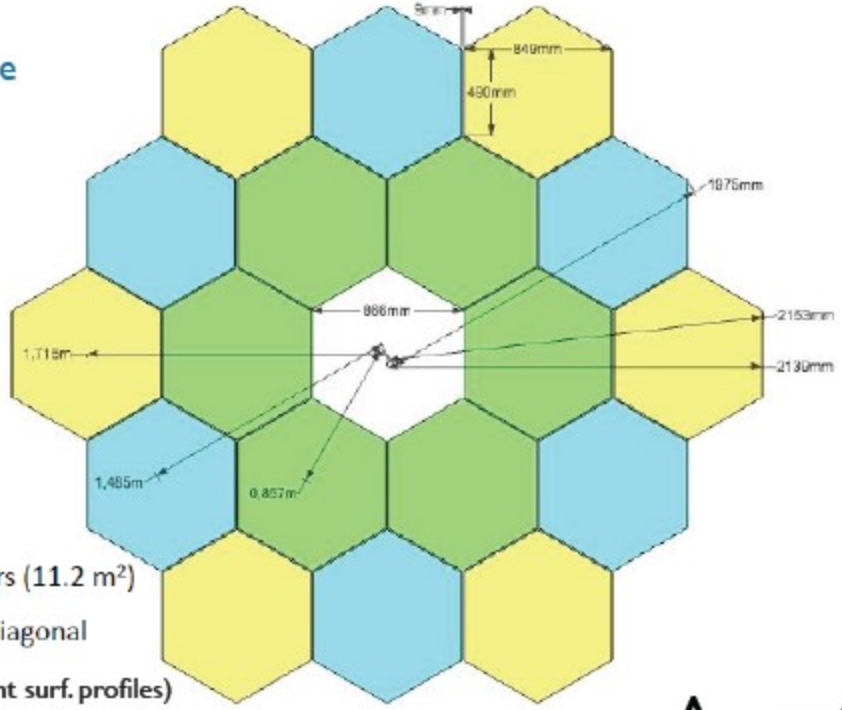
Mirrors' main characteristics:

- **Primary Mirror diameter:** 4.3 m (tessellated)
- **Secondary Mirror diameter:** 1.8 m (monolithic)
- **$F_{\#}$:** 0.5
- **Equivalent focal length:** 2150 mm
- **FoV diameter**: 9.6 degrees

ASTRI current status

Optical design

Canestrari, Conconi
CTA Cons. Meeting Toulouse



Primary mirror (M1)

18 hexagonal shaped mirrors (11.2 m²)

850 mm face-to-face, 1 m diagonal

3 types of segments **(different surf. profiles)**

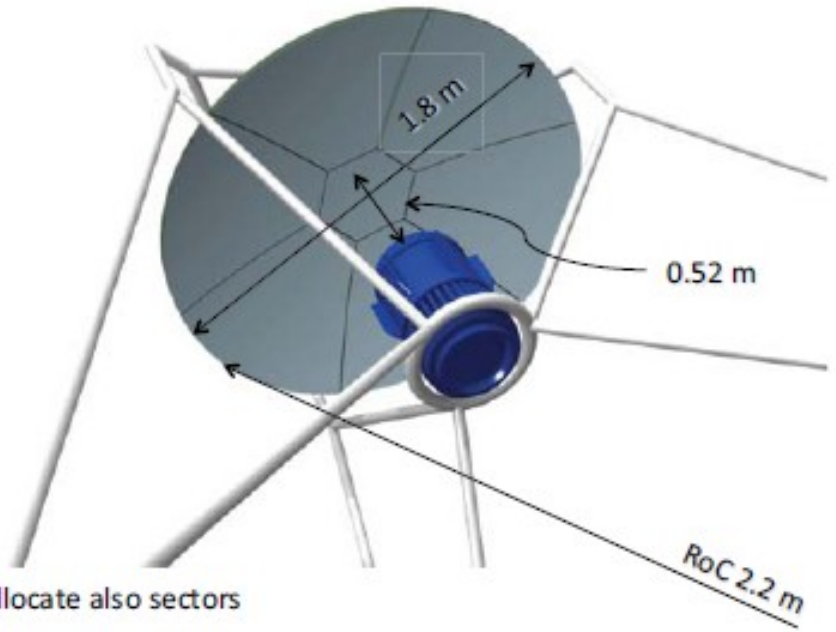
2 actuators + 1 fixed point: tip-tilt corrections for alignment purposes

$A_{eff} \sim 6.5\ m^2$

ASTRI current status

Optical design

Canestrari, Conconi
CTA Cons. Meeting Toulouse



Secondary mirror (M2)

Monolithic

But supporting structure may allocate also sectors

3 actuators: tip-tilt and piston corrections for alignment and focusing purposes

ASTRI current status

Camera

Camera' main characteristics:

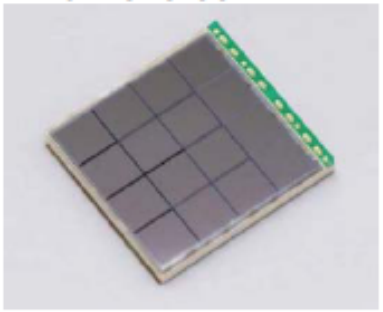
- **Detector type:** monolithic MPPC array
- **Pixel size:** 6.2 mm x 6.2 mm [0.17 deg]
- **Plate scale:** 37.5 mm/deg
- **Camera size :** 360 mm x 360 mm
- **Number of Pixels :** 7936
- **Number of channels :** 1984 (grouping 2 x 2 pixels)

ASTRI current status

Camera

Start working with off-the-shelf HAMAMATSU sensors:

S11828-3344M



SIPM

Pixel size= 3 mm

↓

Base- Line

H10966A

MAPMT

Pixel size= 6 mm

↓

Back-Up

Catalano, Bonanno
CTA Cons. Meeting Toulouse

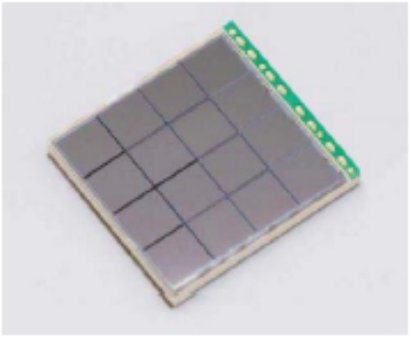
ASTRI current status

Catalano, Bonanno
CTA Cons. Meeting Toulouse

Camera

Monolithic MPPC array in SMD package

S11828-3344M



■ **Features**

- Monolithic array: 16 ch (4 x 4 array)
- Nonmagnetic package
- Effective active area: 3 x 3 mm/ch
- Pixel pitch: 50 μm
- Allows multiple devices to be arranged in a buttable format

■ **Specifications**

Parameter	Condition	Value	Unit
Number of elements		16 (4 x 4)	elements
Effective active area / channel		3 x 3	mm
Pixel pitch		50	μm
Number of pixels / channel		3600	-
Number of pixels / device		57600	-
Fill factor		61.5	%
Photon detection efficiency *	λ=440 nm	50	%
Dark current / channel	per channel	3	μA
Terminal capacitance / channel		320	pF
Gain		7.5×10^5	-

* Includes cross-talk and after-pulse

ASTRI current status

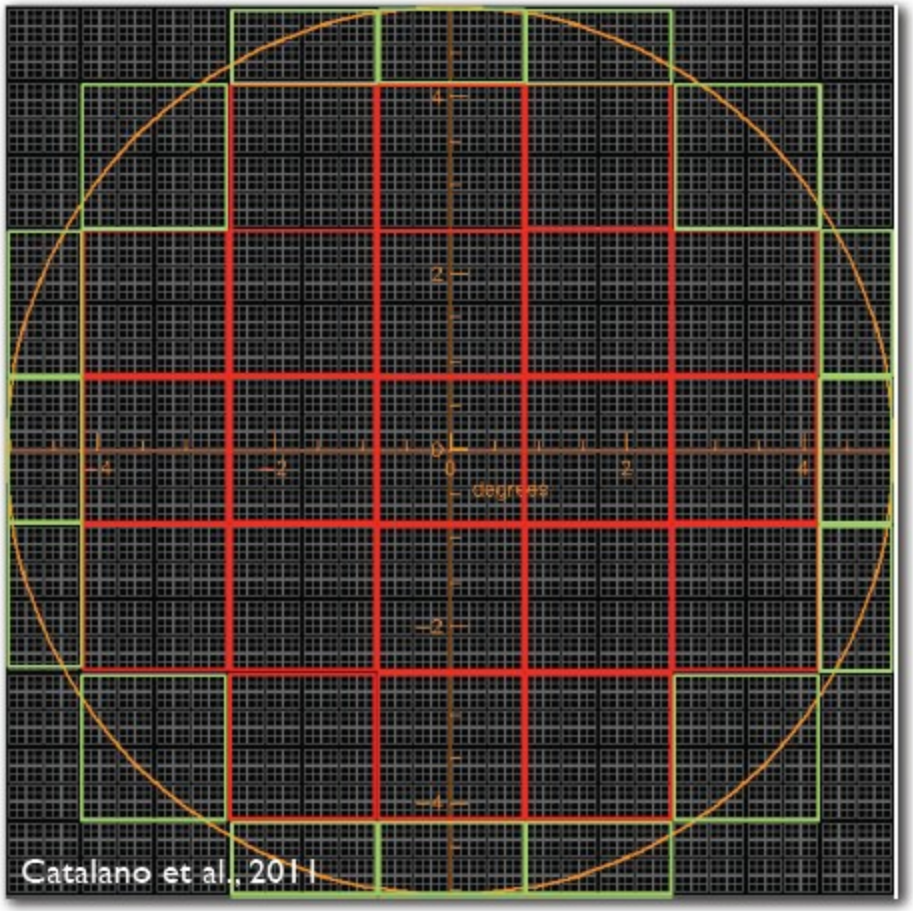
Camera

21 PDMs = 8 deg

31 PDMs = 9.6 deg

Mechanically half PDM can be accommodated on the supporting structure that will be designed for the maximum size (9.6° FOV).

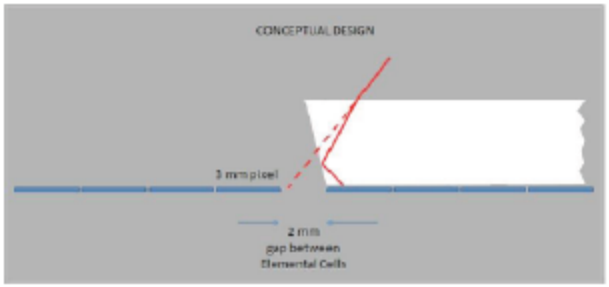
The central PDM will be devoted also for the alignment of the primary hexagonal mirrors.



S.Vercellone - The SST prototype of the ASTRI Project - Project Committee Meeting, Heidelberg 2011-07-05 18

ASTRI current status

Camera

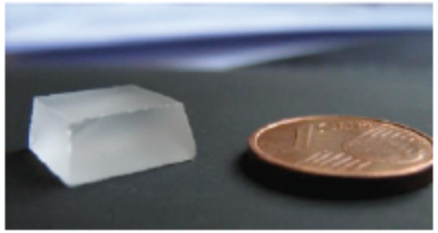


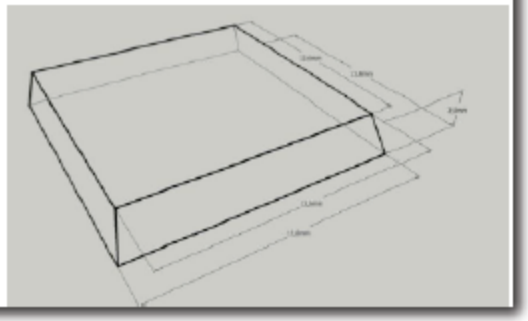
Re-imaging system

A truncated pyramid as large as the detection UNIT can easily be used to recover most of the losses caused by photons that go into UNIT-UNIT dead area.

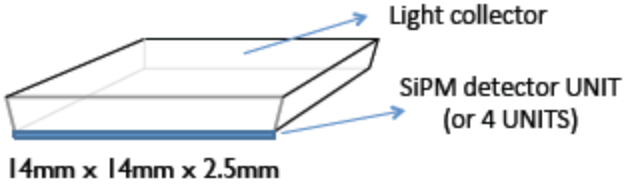
The choice of the type of glass is crucial to limit the absorption.

Optical manufacturer already successfully contacted.



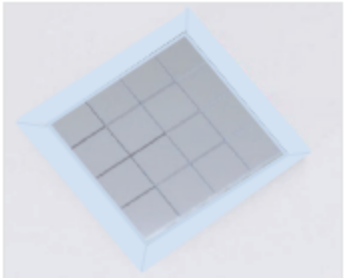


Catalano, Canestrari, CTA Cons. Meeting Toulouse



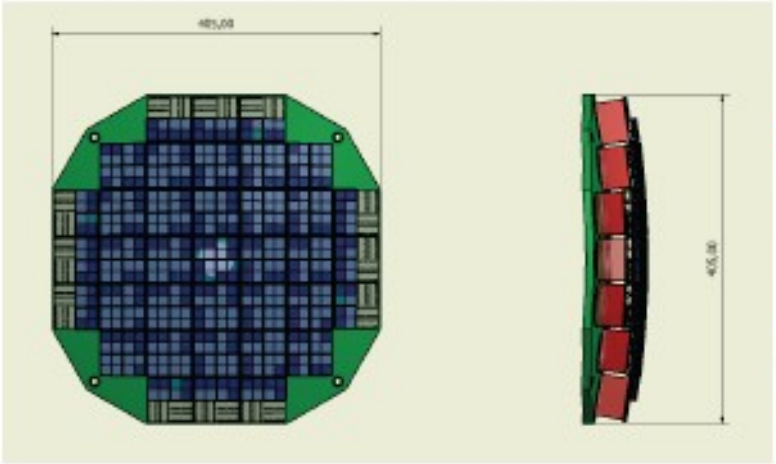
The upper part of the light collector can be coated (antireflection). The light collector protects the SiPM from external environment.

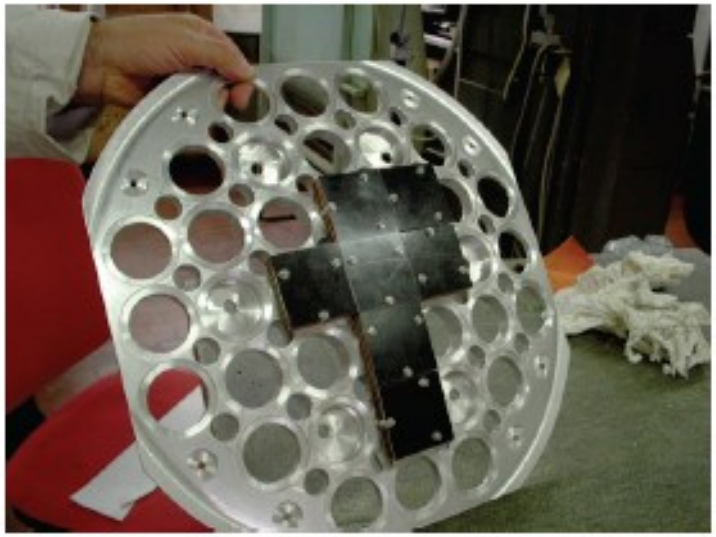
Simulation of the entire chain (HIR glass light collector+ coating + UV glue) shows a transmission efficiency vs. incident angle of ~90% (up to 70° incident photons).



INAF SST-2M CAM

We start to develop a 1:1 Structural Model (SM) at IASF-MI, OACn and IASF-PA Labs.





The SM with a few PDM's mock-ups. The SM PDM casing are circular instead of square for the sake of manufacturing simplicity.

INAF SST-2M E2E

Location: it will be chosen among a specific subset of the INAF observational stations in Italy.

Work in progress (study of: weather data, sky visibility, night sky background, geo-phys data, accessibility, infrastructures, ...)

Final choice:

end of October 2011

Once the site location will be chosen, it will be monitored with specific instrumentation before and during the SST-2M calibration.

ASTRI current status

Site Selection

INAF - Catania Astrophysical Observatory

The "M. G. Fracastoro" Mountain Station

Serra La Nave (Mt. Etna)

Altitude: 1735 m a.s.l.

Longitude: +14° 58'.4; Latitude +37° 41'.5

ASTRI SST-2M Timeline

A detailed schedule of the ASTRI activities will be provided at the CTA Consortium Meeting in Madrid.

On May 15-16 2011 we had the first INAF ASTRI Progress Review (PR).

The next INAF ASTRI PR will take place in Milano on mid-October.

At the beginning of 2012 we will have the First Year ASTRI Review with a Panel of the Ministry of Research in Rome.

By Summer 2012: detailed design at the production level of the SST-2M

By Winter 2013: SST-2M end-to-end prototype in situ

ASTRI SST-1M activities

Canestrari, Conconi
CTA Cons. Meeting Toulouse

Ø7m class telescope

Collecting area: 38m²

Single mirror f=10.5m

Mirror curvature radius: 21m

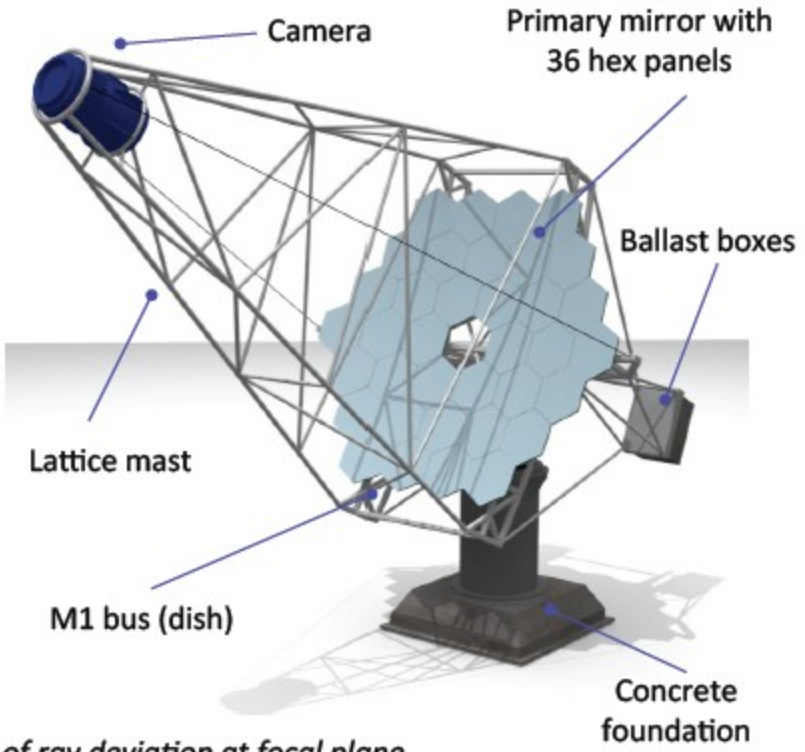
Camera mass: 1.6tons

Field of view: 8°

Operating Wind: 50Km/h

Dish contribution to PSF* < 1mrad

Camera displacement 0.5PMT pixel



**PSF being computed as the RMS of ray deviation at focal plane*

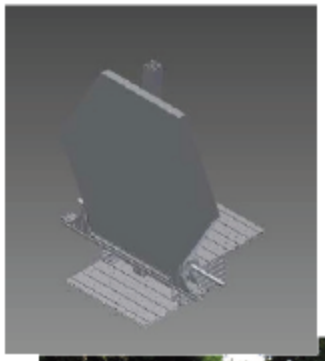
ASTRI MST activities

A development contract with MLT signed on May, 31st.

Canestrari, Pareschi
ASTRI Review Palermo

Main topics are:

- Repetition of all the qualifications done for MAGIC II in order to have updated documents;
- Production of about 20 (full specs) mirror panels for the DESY MST prototype;
- Investigation on new glues;
- Investigation on radius of curvature reduction toward the SST-DC layout

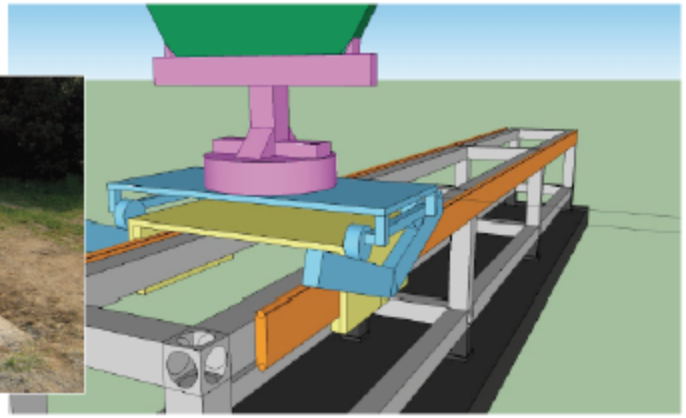


Outdoor Testing Facility

In-house design and realization

The designs of the mirror support, alignment and focusing system is well advanced.

Main structure is already mounted.



ASTRI gives support to other activities

Science: contribution to CTA science
& scientific performance of the SST prototype

MC Simulation: contribution to CTA MC
& specific activities for the SST prototype

Data Handling: contribution to CTA specific wps

Site: contribution to CTA sites specific wp

Conclusions:

CTA is a project of a large array of Cherenkov telescopes for TeV astronomy.
CTA is in the Preparatory Phase funded by the European Commission
(October 2010- Sep. 2013).
CTA will be located in two sites (southern and nothern emispheres).
CTA is well supported at International level and it has good chances to be realized.
CTA construction will start in 2013/2014
CTA will be operated as an observatory on the base of the scientific merit

INAF is funded by EC for the preparatory phase
INAF has a major role in the CTA and it is present in the relevant boards
INAF is responsible for the CTA_PP Procurement and for the SST structure&mirrors
INAF participates to several CTA_PP activities (Science, Mirrors, Telescope Structures,
MC, Data Hand., Obs. definition)
In the framework of the program ASTRI funded by the Italian Ministry of Research :
INAF plans to build an end_to_end prototype of the Dual Mirror SST
INAF will contribute to the mirrors and structure of the Single Mirror SST prototype
INAF will contribute to the mirrors for MST prototype
INAF will support the CTA activity ancillary to the ASTRI program