Inovação em instrumentação para o CTA MST

Marcelo Leigui

on behalf of the

MST-CTA Brazilian Team

[redacted]

KEY SCIENCE PROJECTS

1. CTA Galactic Plane Survey
2. CTA Extragalactic Survey
3. Exploring extreme particle acceleration in the Galaxy
4. Probing DM with precision measurements of the Galactic Center
5. CTA studies on active galaxies
6. On the connection between cosmic rays and the star-formation process
7. Observations of clusters of galaxies
8. Observations of the LMC
9. Observations of the Cygnus region
10. Observation of Galactic DM dominated targets
11. Observations of transient phenomena

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CTA Brazil

12 Instituions

19 Researches

21 Students

5 Technicians

CTA - SP - MST

- IFSC- USP Prof. Vitor de Souza
  - Profa. Manuela Vecchi
  - Profa. Cibelle Celestino
  - Dr. Humberto Huerta
  - Dr. Aion Viana
  - Raul Prado
  - Rodrigo Lang
  - Luan Arbeletche
  - Andres Delgado
  - Rodrigo Guedes Lang
  - Danielle Kaori
- IF-USP Prof. Edivaldo Moura
  - Douglas Pimentel
- UFABC Prof. Marcelo Leigui
  - Raquel de Almeida
- UFSCar Dr. Gustavo Rojas
- UFPR Prof. Rita de Cássia
- EEL / USP Prof. Fernando Catalani
  - Prof. Carlos Todero
- SAIFR / IFT - UNESP
  - Dr. Fabio Iocco
  - Maria Benito

CTA - Rio

- CBPF
  - Prof. UIisses de Almeida
  - Prof. Ronald Shellard
  - Bruno Fontes
  - Bernardo Fraga
- UFRJ
  - Prof. João Torres

CTA - SP - SST

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  - Profa. Elisabete dal Pino
  - Prof. Rodrigo Nemmen
  - Dr. Claudio Melioli
  - Dr. Chandra Singh
  - Dr. Grzegorz Kowal
  - Dr. Reinaldo Lima
  - Dr. Paramita Barai
  - Dr. Luis Kadowki
  - Tania Torrejon
  - Renato Gimenes
  - Pankaj Kushwaha
  - Saib Hussain
  - Carlos Fermino
  - Raniere Menezes
  - William Bohórquez
  - Lucas Santos
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  - Mohammad Ali

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This Talk

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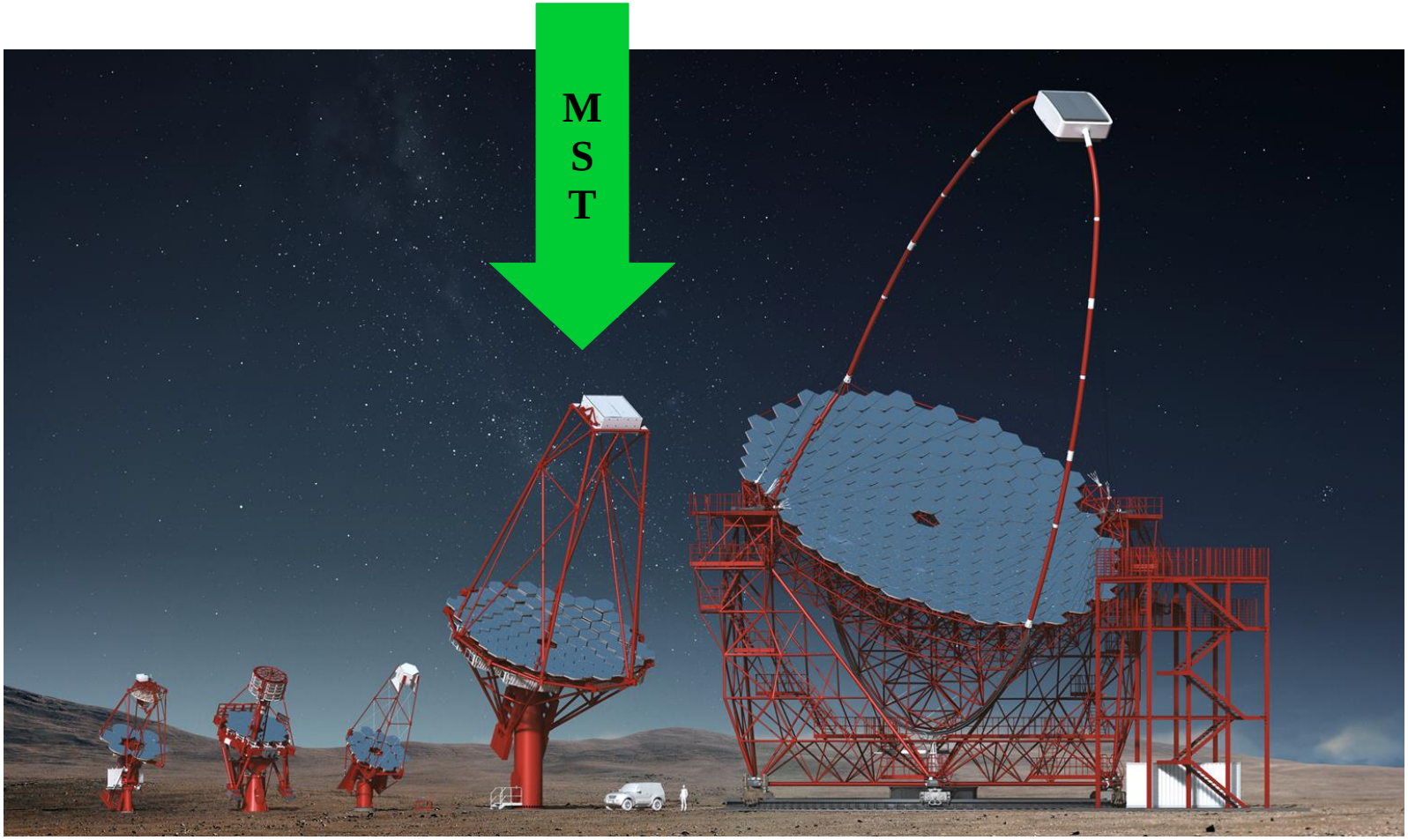
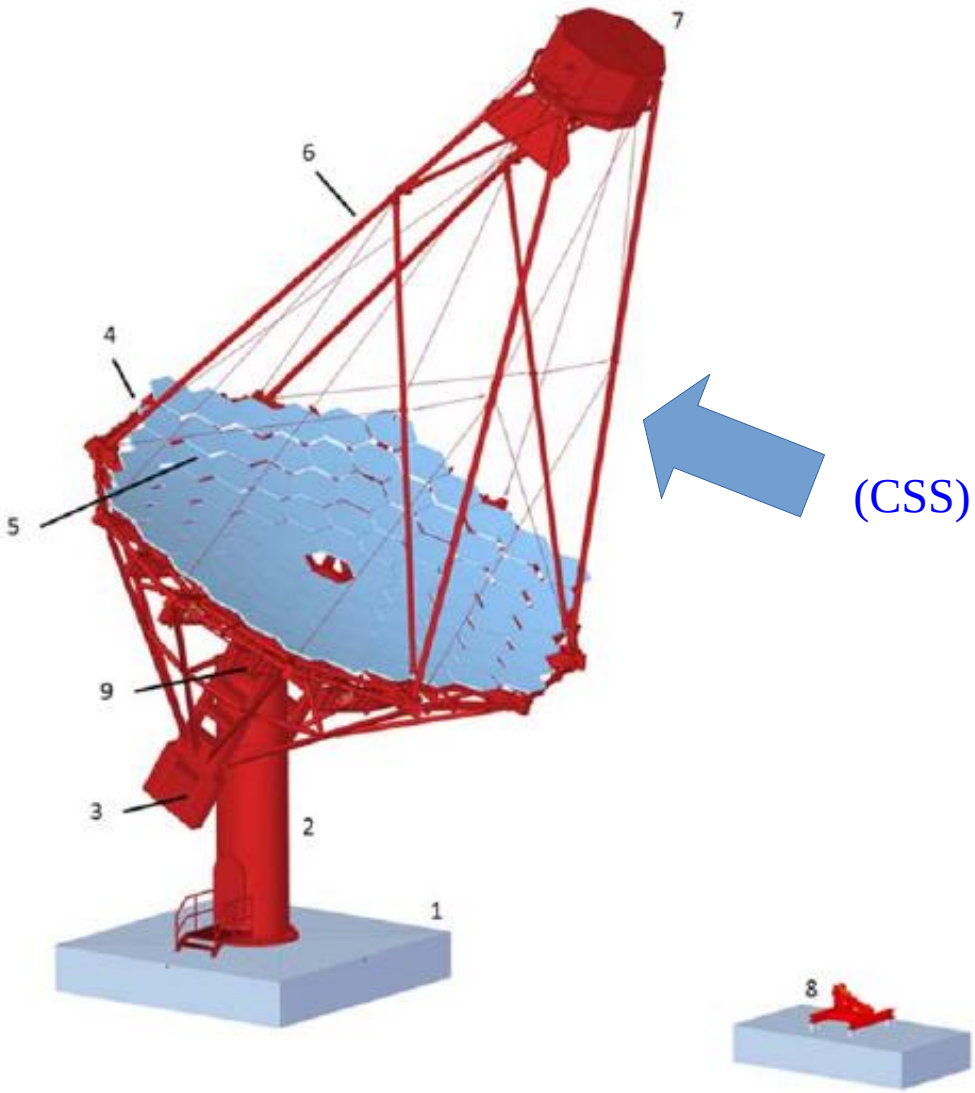
Nossa contribuição instrumental ao Medium Size Telescope



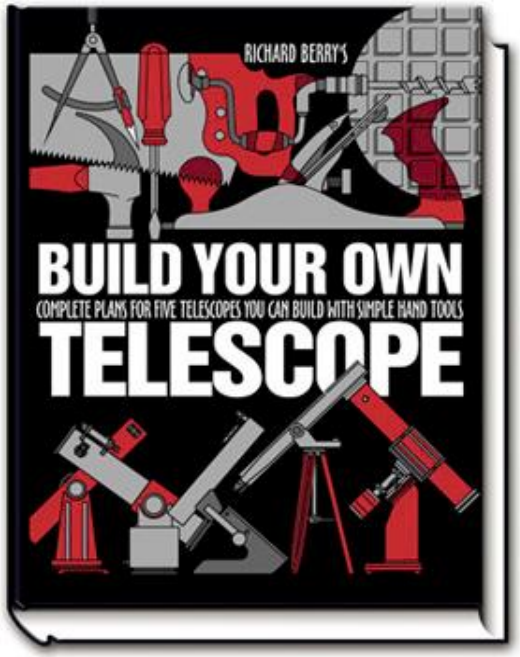
Construindo Telescópios: MST



(CSS)

1 – Foundation
2 – Tower
3 – Counterweight
4 – Optical Support Structure
5 – Mirrors
6 – Camera Support Structure
7 – Camera
8 – Camera Lock
9 - Head

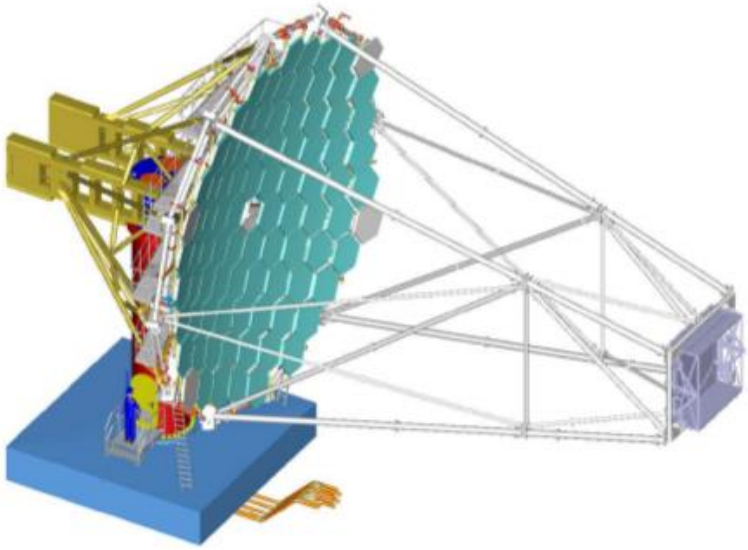
Figure 1: Description of the telescope structure



CSS Brasileiro

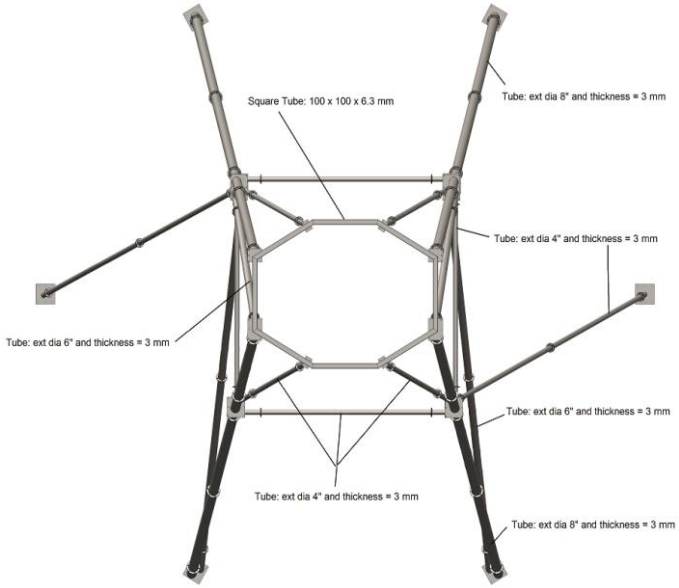
- 2010: Auxílio Regular FAPESP: Início.
- 2011: Estudando os requisitos e procurando por parceiros.
- 2012: Auxílio Regular FAPESP: projeto e protótipo.
- 2013: Desenvolvimento e aprovação do projeto.
- 2014: Construção, instalação e teste do protótipo.
- 2015: Protótipo aprovado e melhorias sugeridas.
- 2016: Auxílio Temático FAPESP: projeto melhorado e pré-produção.
- 2017: Projeto de versão de melhorada terminado. Início da construção de 2 CSS nos próximos meses.
- 2018: Instalação no sítio do Observatório.
- 2019: Tomada de dados científicos.

Projeto, Contrução e Teste do Protótipo



Parameter	Definition
Life expectancy (for bearings and structure)	30 years
Eigenfrequency (whole structure)	$\geq$ 2.5 Hz
Amplitude of camera due to vibrations	$\leq$ 3 mm
Tracking accuracy	$\leq$ 1.2 arcmin
Displacement of camera due to loading	$\leq$ ½ pixel ~ 19 mm
Angular misalignment of camera	not significant
Weight of mirrors including mirror control units	$\leq$ 35 kg/m^2
Weight camera	$\leq$ 2.5 t

Parameter	Definition	Remarks
Telescope Design	Modified Davies-Cotton	Mirror centre layout on a sphere
Diameter of dish (D)	~12 m	
Radius of the dish	1.2 * focal length	
Focal length (f)	16 m	Distance centre of the hypothetical middle mirror to the camera
Camera field of view	8°	
Gross mirror area	> 100 m^2	
Point spread function (mirror misalignment due to loading)	$\leq$ 1 mrad	


Square Tube: 100 x 100 x 6.3 mm
Tube: ext dia 8" and thickness = 3 mm
Tube: ext dia 4" and thickness = 3 mm
Tube: ext dia 6" and thickness = 3 mm
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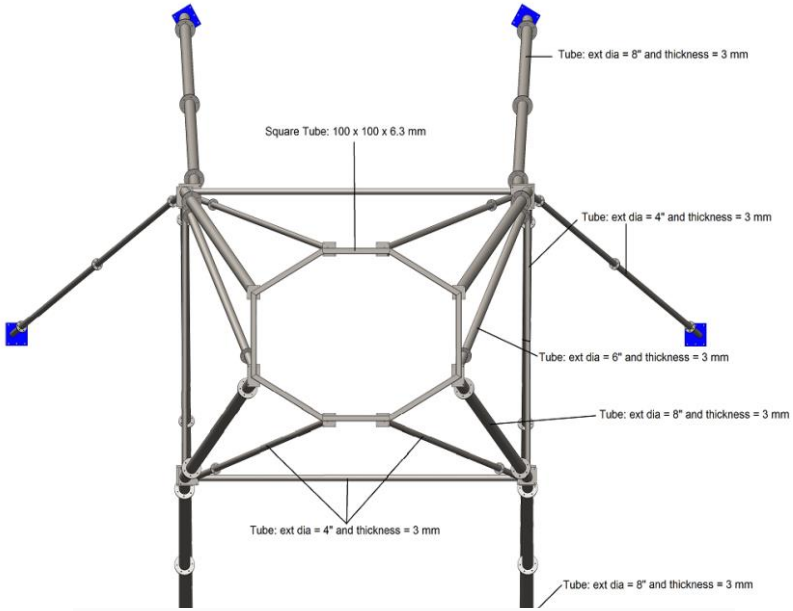
Tube: ext dia 4" and thickness = 3 mm
Tube: ext dia 8" and thickness = 3 mm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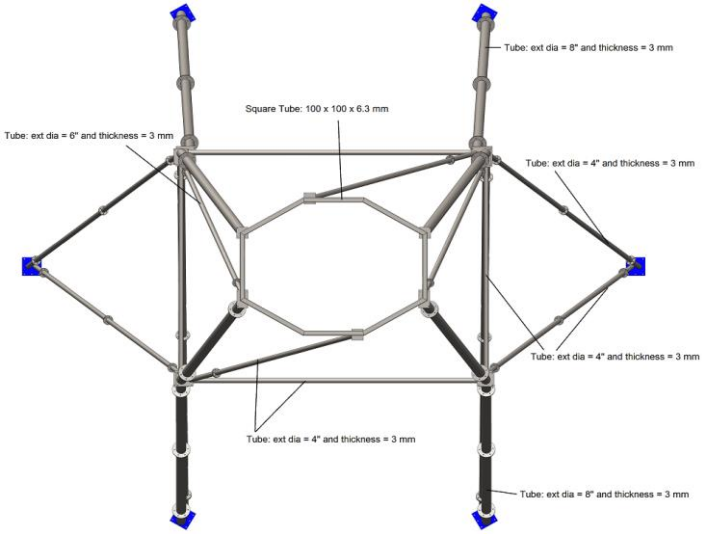
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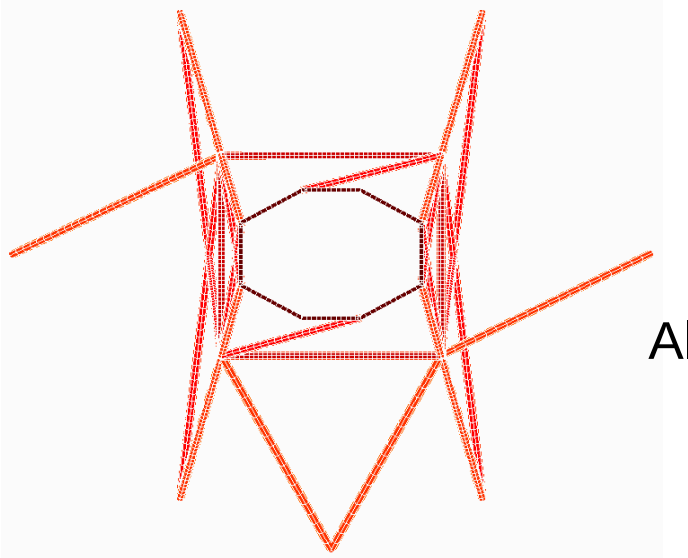


Aluminium

Description	Requirements	Conception 1	Conception 2	Conception 3	Conception 4	Conception 5
Fundamental Frequency	> 3.00 Hz	3.60	3.10	3.00	3.50	3.63
Amplitude due to Vibration of the Camera Structure	< 3.00 mm	2.80	2.80	2.94	2.80	2.90
Shadow on the mirror projected by the Structure (see note #1)	< 8.48 %	9.6%	9.3%	10.0%	10.2%	13.5%
Mass (ton)	-	3.1	2.9	3.0	3.1	2.4

CSS Análises detalhadas

LOAD CASE 03:

- Horizontal
- 50 km/h
- Ice load
- Wind load X

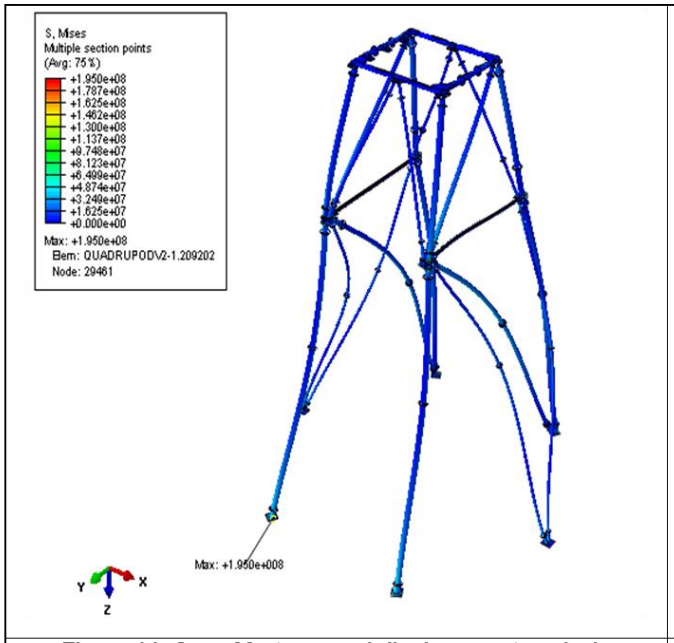


Figure 14: Case 03 stress and displacement analysis

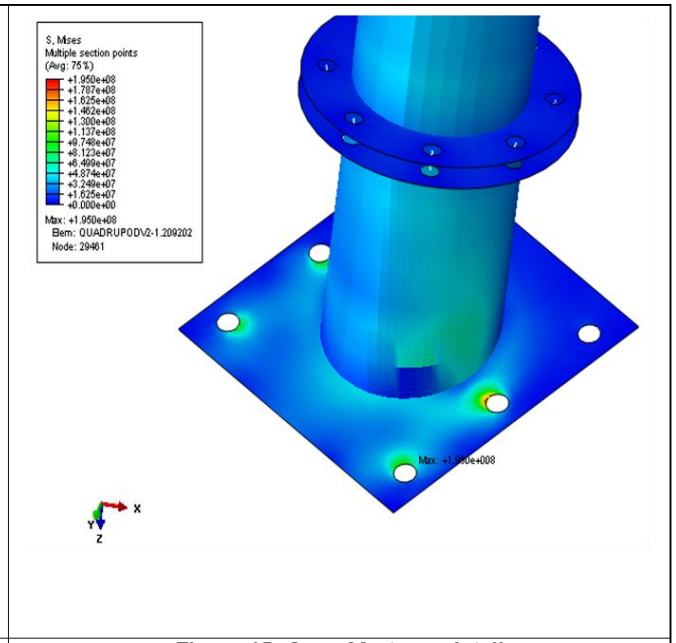
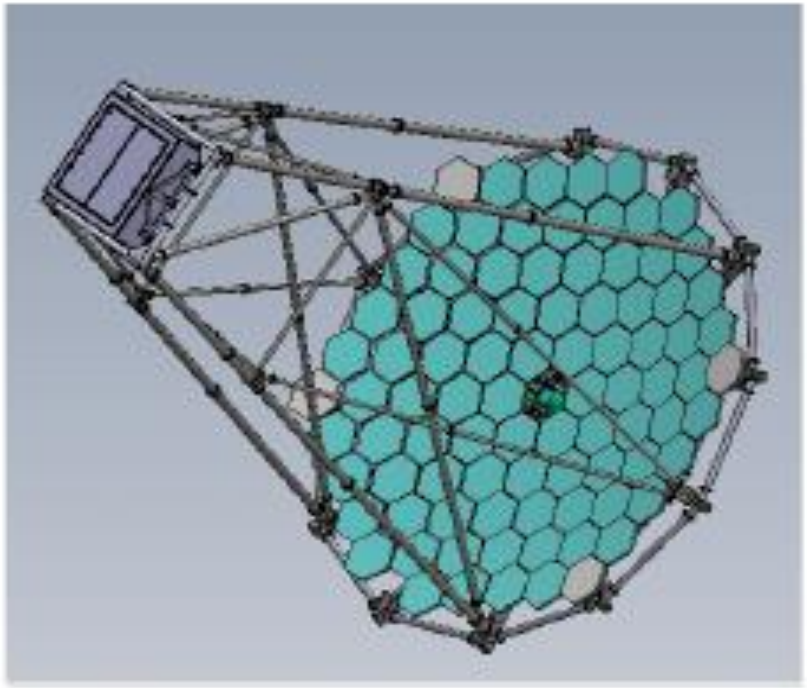


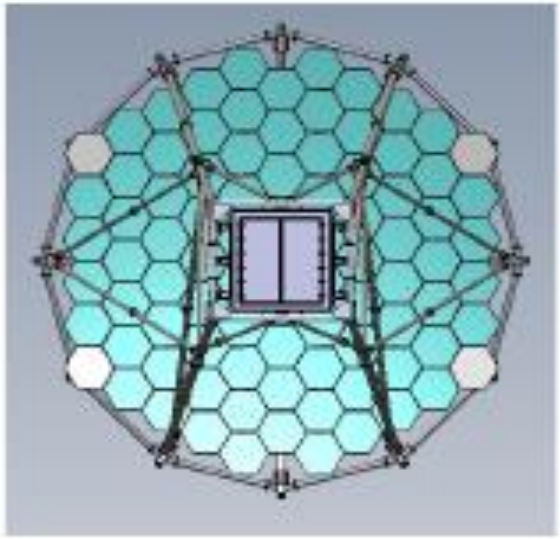
Figure 15: Case 03 stress detail

	Wind Load	Ice Load	Gravity	Global Displacement (mm)	Camera Displacement (mm)	Stress (MPa)	Buckling factor	Safety Coefficient
	X+ 50 km/h	Superior	Y-	23,31	5,31	195	7,11	**1,59**

APROVADO EM TODOS OS TESTES

CSS Construção





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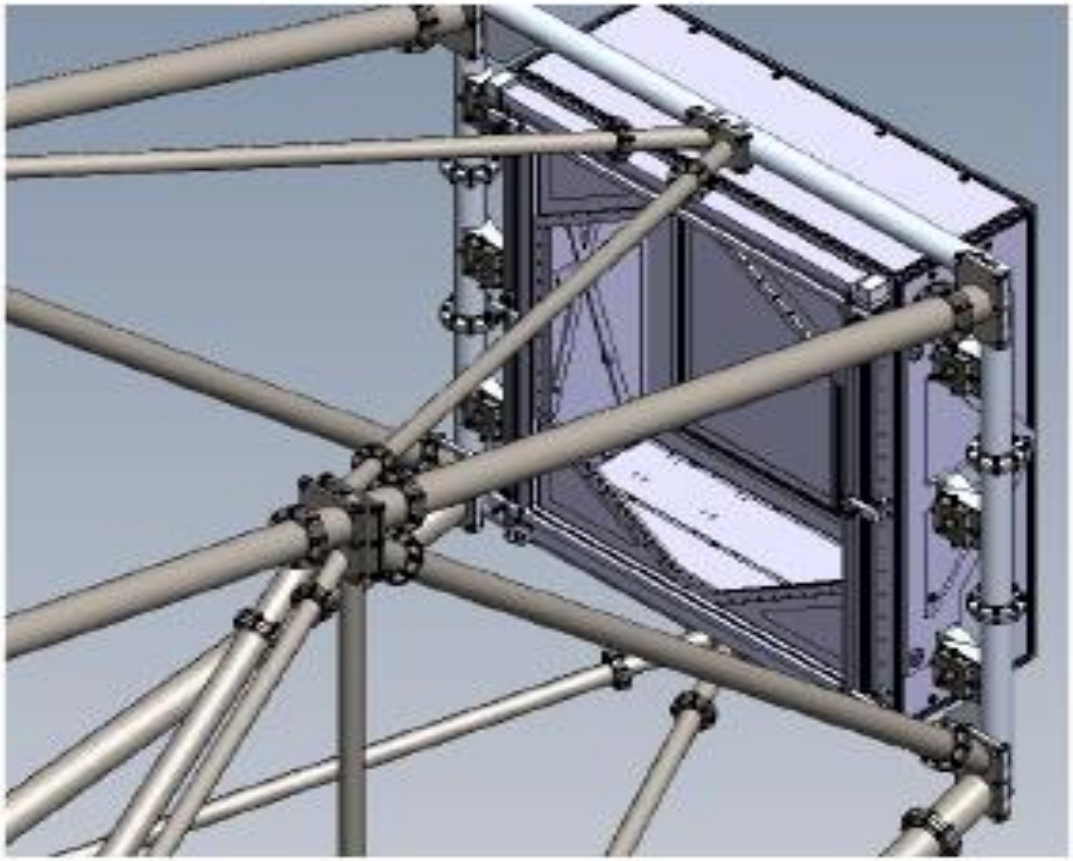
Universidade Federal do ABC

ORBITAL ENGENHARIA

Dispositivo de Ajuste



Mover toneladas com precisão milimétrica

Inovação

Patente em solicitação

IFSC USP Instituto de Física de São Carlos

Universidade Federal do ABC

ORBITAL ENGENHARIA

USP inovação

CSS Brasileiro: Montagem @ Berlim

CSS Brasileiro: Montagem @ Berlim

CSS Brasileiro: Montagem @ Berlim

CSS Brasileiro: Montagem @ Berlim

CSS Brasileiro: Montagem @ Berlim

CSS Brasileiro: Montagem @ Berlim

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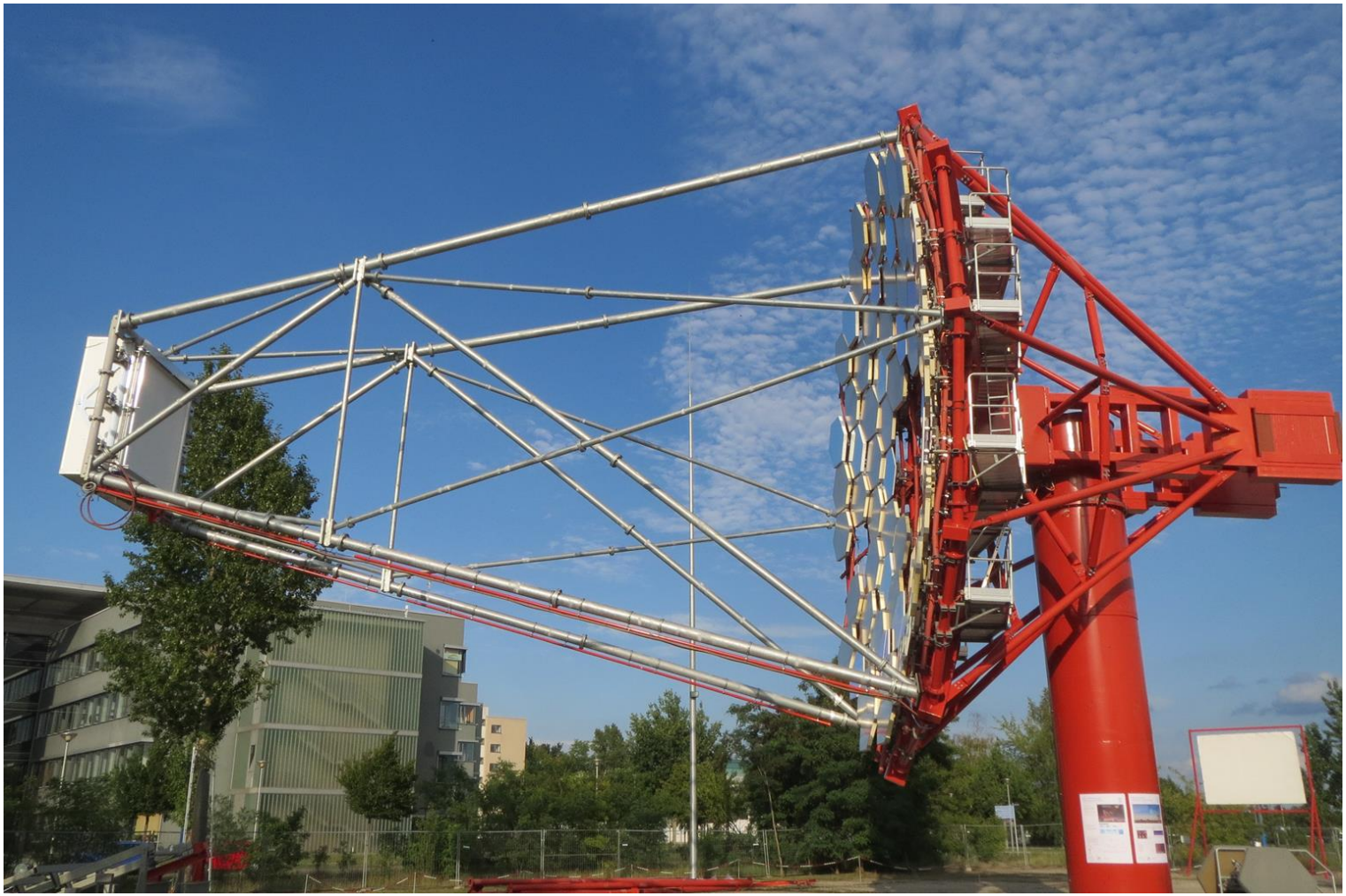
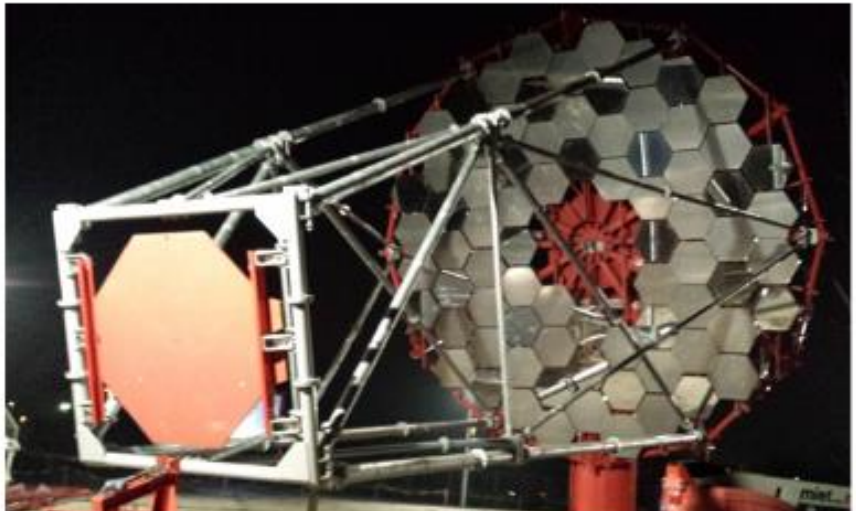


CSS Test Report

DESY and Humboltd University Berlin

Authors: Anja Schubert, Dirk Naumann,
Stefan Schlenstedt,
Louise Oakes and Ulrich Schwanke

CEA/IRFU - France



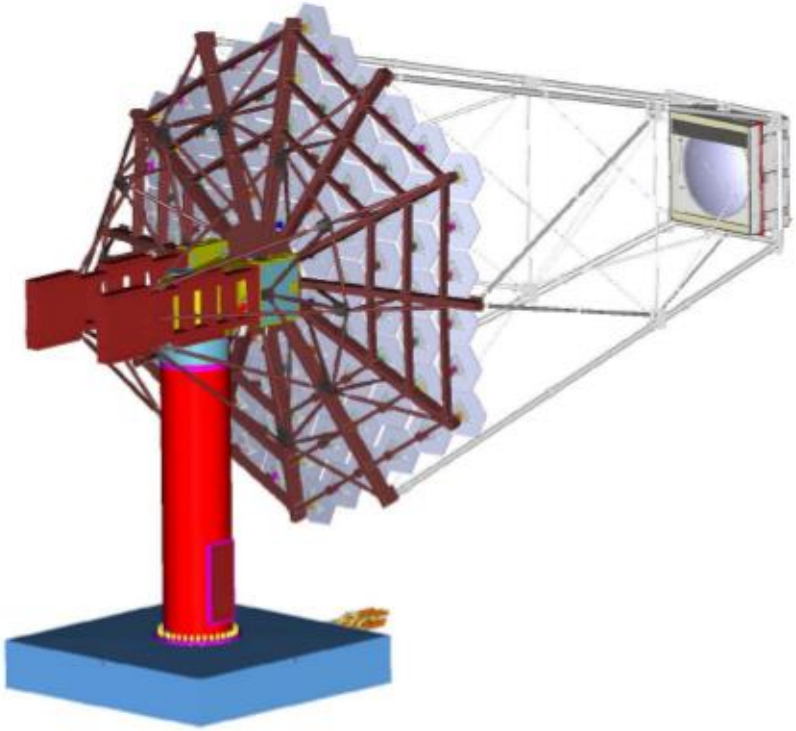
IFSC/USP - UFABC - Orbital Brazil

CSS Test Report: Conclusions

- Vibration studies: both proposals meets the requirements
- Displacement under control for both structures
- Lack of pre-tension ropes is a **advantage** of the Brazilian proposal
- **Better** temperature balance of the Brazilian proposal
- Galvanized steal in the Brazilian structure **garantees** 30 years operation
    - Adjustment device in the Brazilian proposal is **advantange**
- The increased shadowing of the Brazilian structure can be compensated with the use of two extra mirror facets

Authors: Anja Schubert, Dirk Naumann, Stefan Schlenstedt,
Louise Oakes and Ulrich Schwanke
Desy and Humboltd University Berlin

CSS Versão Melhorada



Objetivos Re-design:

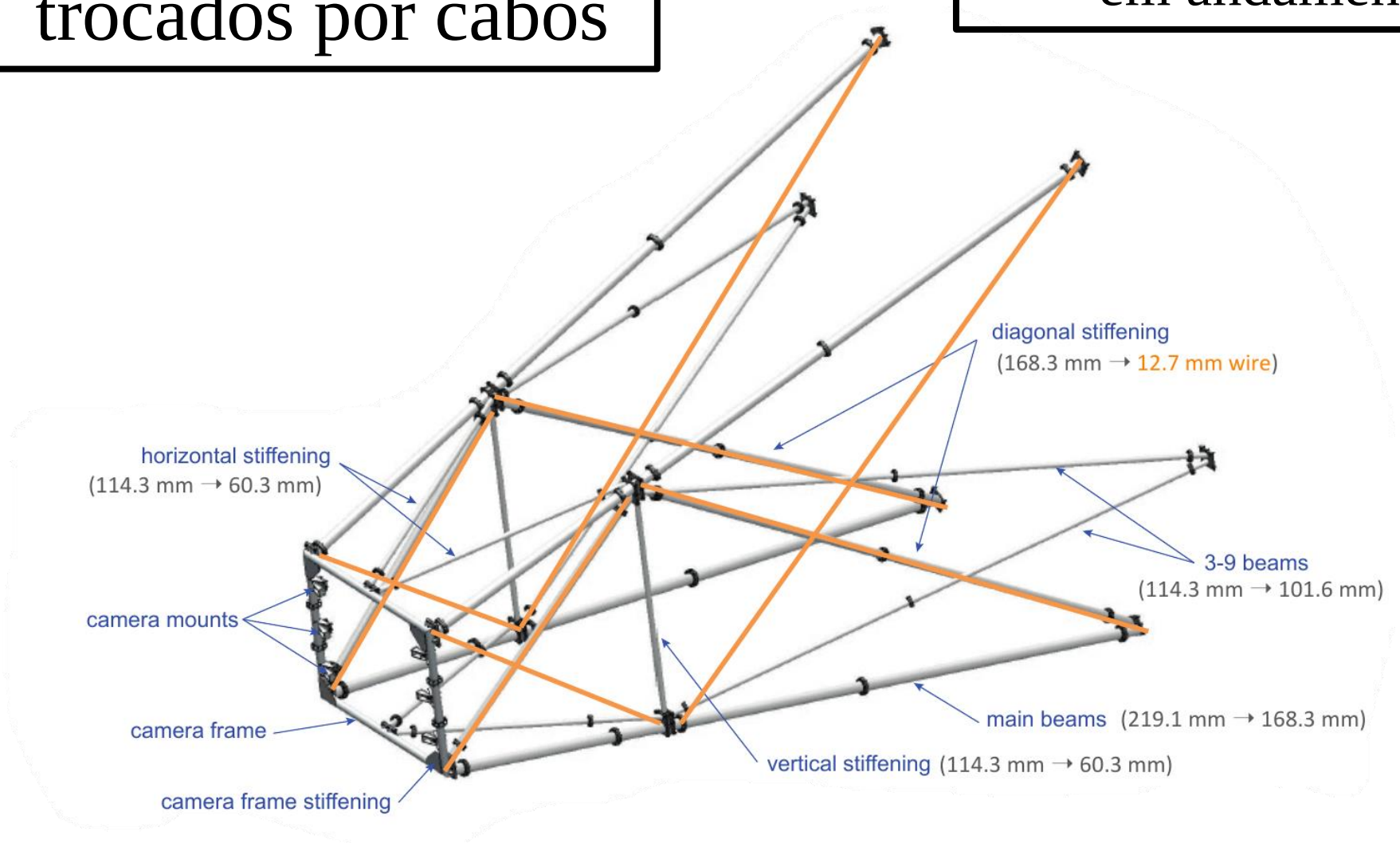
Reduzir peso e sombreamento

	old design	new design
weight [kg]	4.479	3.843
shadow [% / m^2]	19.0 / 86.8	17.2 / 88.7

Principal Modificação

Alguns tubos foram trocados por cabos

Cotação para fabricação em andamento



Conclusão

- Projeto e construção no Brasil
- Protótipo aprovado
- Melhorias implementadas
- Construção de pré-produção nos próximos meses
- Solicitar nos próximos anos recursos para construir 25 CSS no Brasil (~ 8MR$).