

Status report of the large 23m diameter LST telescope

MPI Review Meeting
December 2012



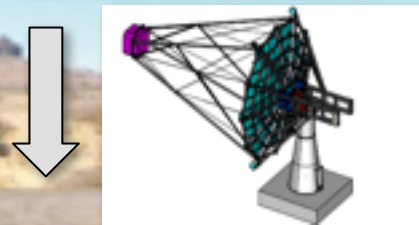
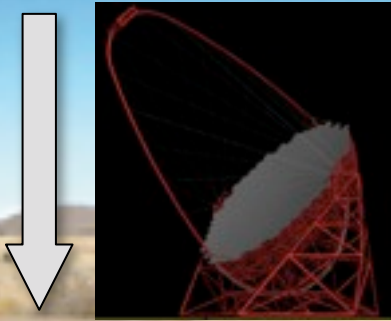
All sky observatory

LST 23m

Thomas Schweizer

MST 10-12m

SST 4-6m



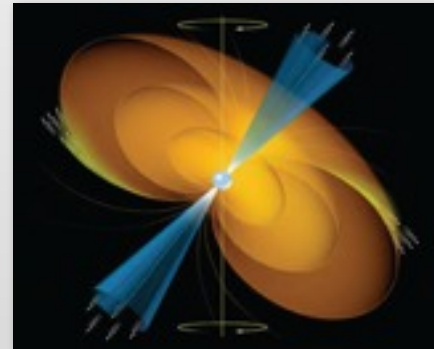
Rich Science cases with LSTs



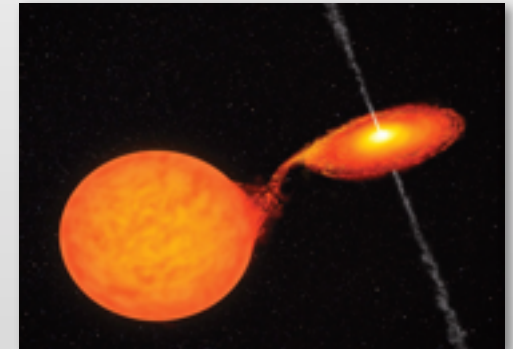
High redshift AGNs ($z < 2$)



GRBs ($z < 4$)



Pulsars



Binaries and transients

- LST should be optimized in the energy range between 20 - 200 GeV
- Low energy threshold
 - Trigger threshold: 15-20 GeV
 - Analysis threshold: 20-30 GeV
- key physics cases:
 - High-redshift AGNs and GRBs, **Expand the Gamma Ray Horizon**
 - Binaries, Pulsars and other type of transients at low energy

CTA Large Size Telescope: Structure by MPI Munich

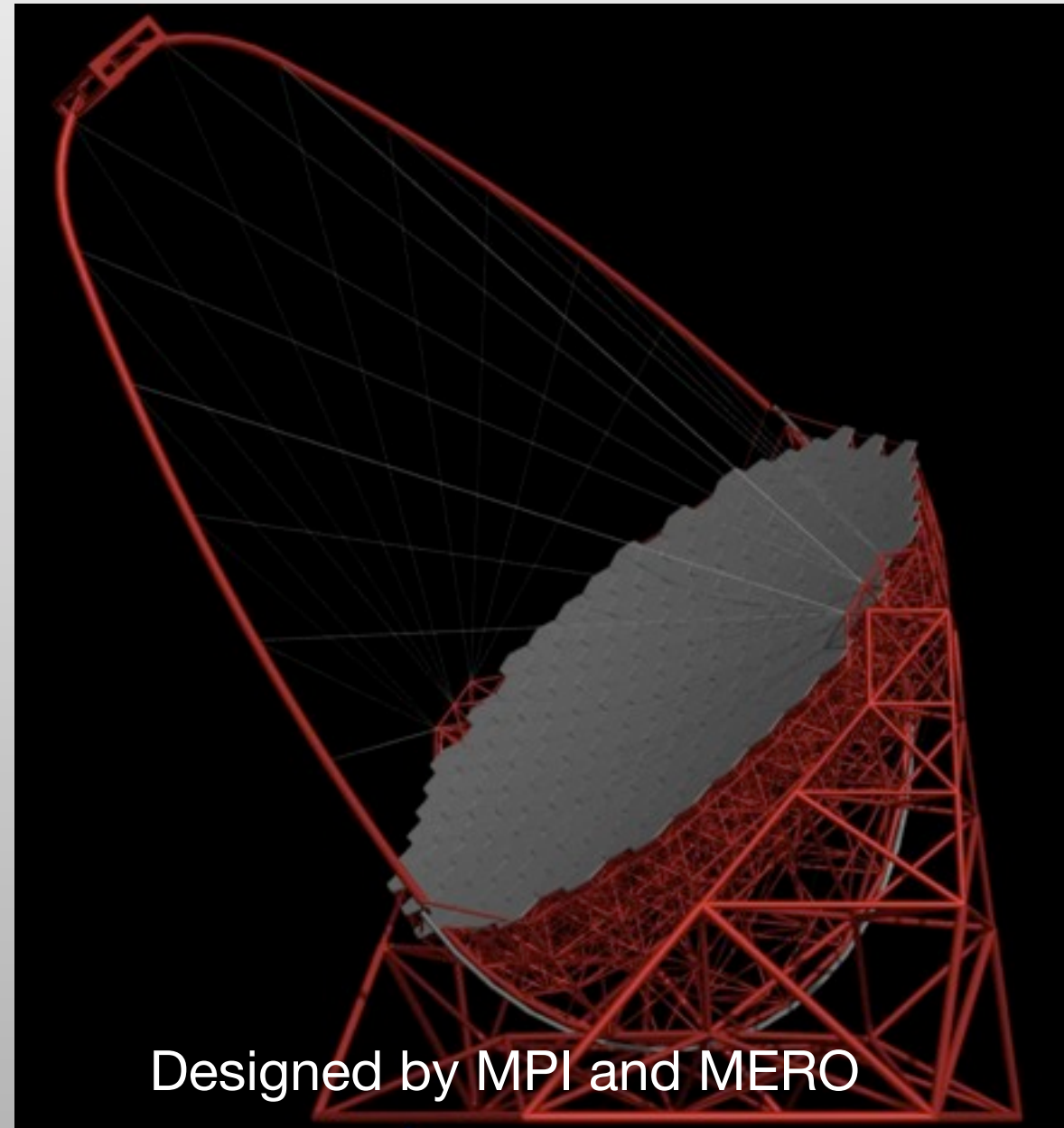


- Diameter: 23m
- Dish area: about 400 m²
- F/D = 1.2, F=28m
- Dish profile: Parabolic
- Permanent Active Mirror Control

- FOV = 4.5 degrees, Pixel size = 0.1 degrees (1855ch camera)

- Light weight carbon fibre structure ~ 65 tons
- Fast rotation: <180 deg/20 sec

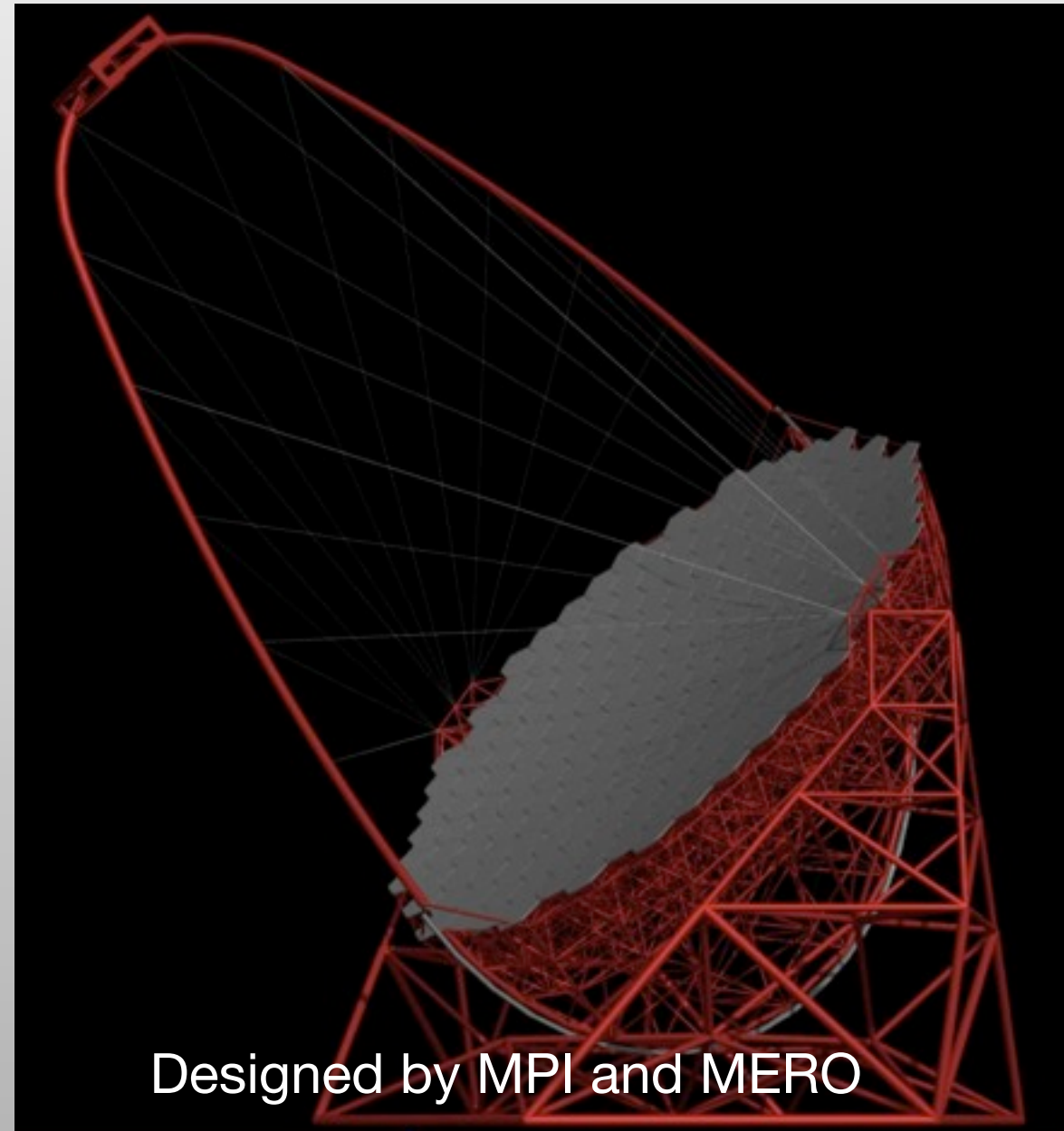
- Dish profile: parabolic
→ isochronicity: <0.6ns peak to peak
- Camera sagging: < 1 pixels
- Camera oscillation in wind gust: <8mm
50 km/h wind



Designed by MPI and MERO

CTA Large Size Telescope: Responsibilities by Institutes

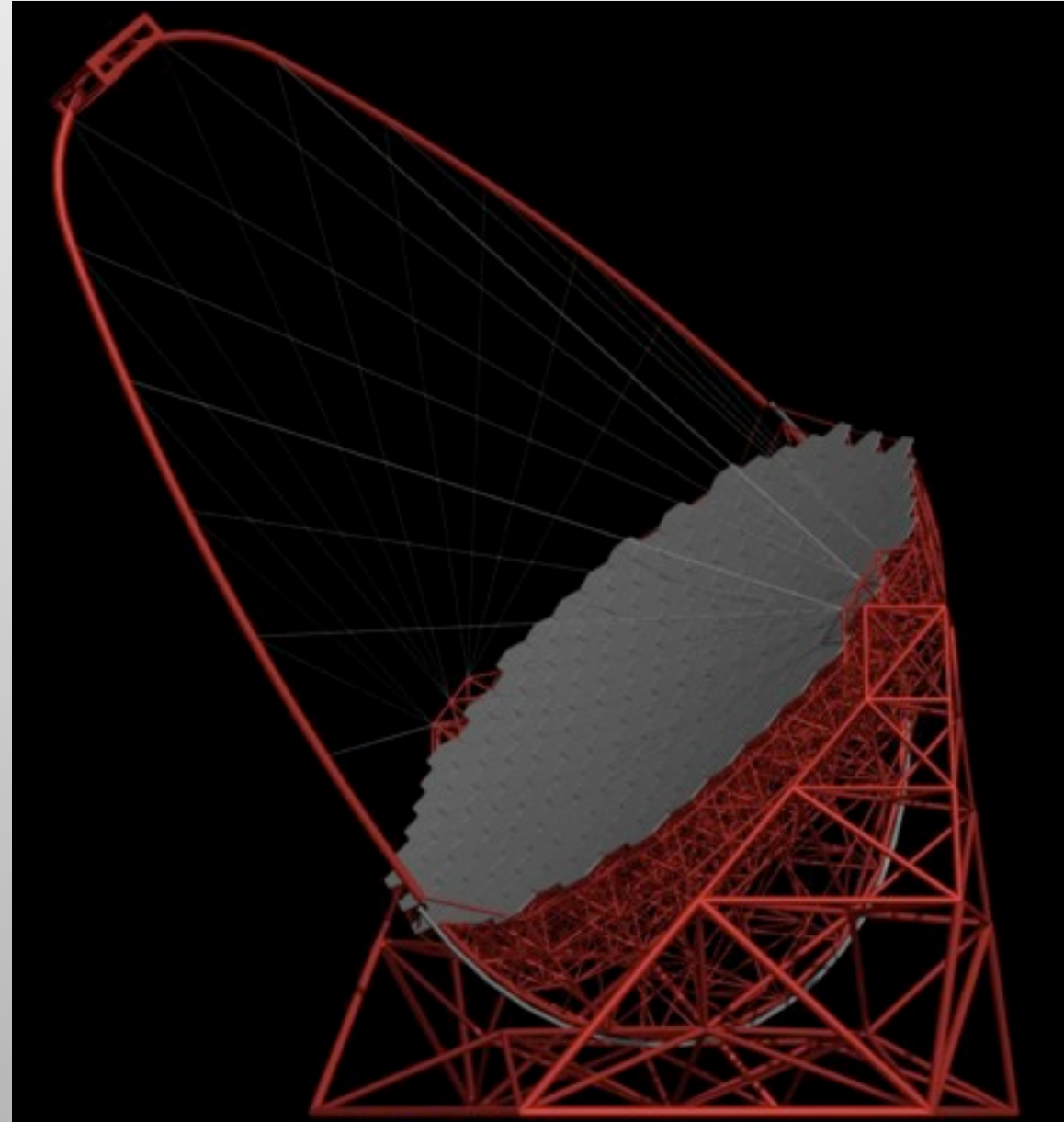
- MPI Munich:
 - Telescope design + LST project coordination
 - Dish structure
 - Understructure
- IFAE, Barcelona, Spain:
 - Rail system + Foundation
 - Boggies + Drive system
- LAPP, Annecy, France
 - Arch design
 - Camera Frame
 - Drive electronics
- Ciemat, Madrid, Spain:
 - Camera Body
- Spain, several institutes
 - Trigger electronics + Data transfer
- Japan:
 - Mirrors
 - Readout electronics



Main LST team at MPI



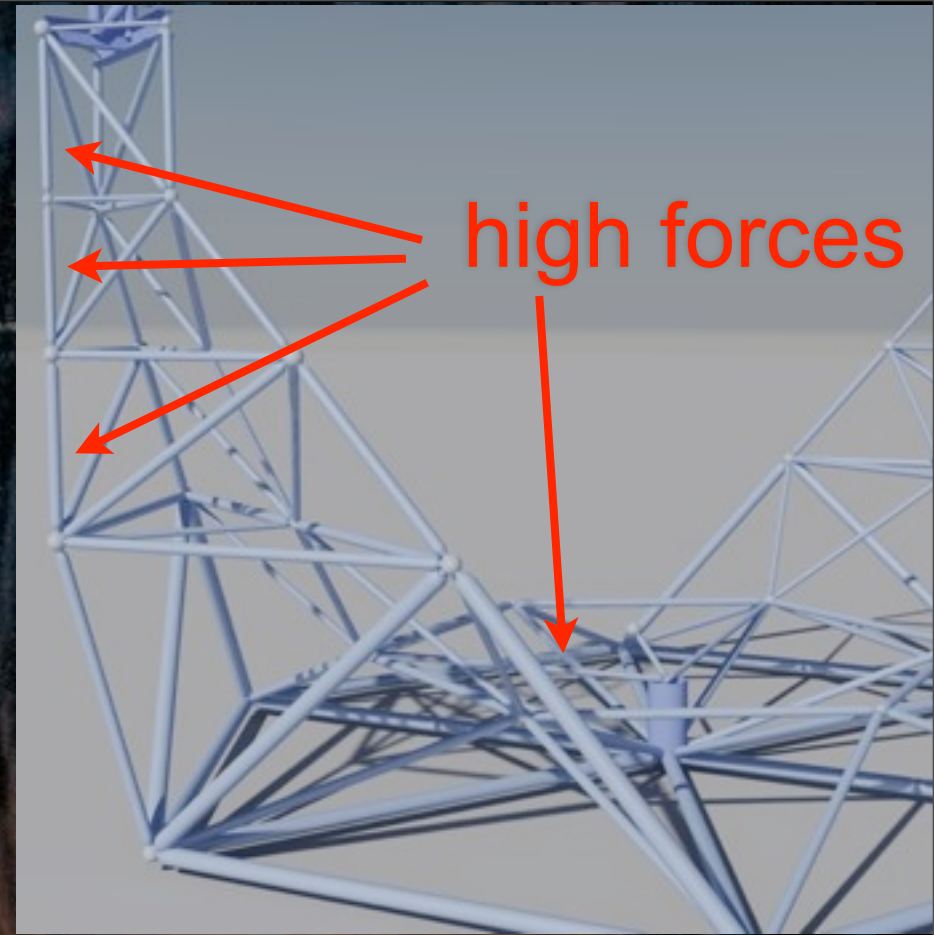
- Mechanical workshop head:
Thomas Haubold
- LST Structure Project engineer:
Holger Wetteskind
- Glueing und carbon fibre expert:
Christopher Jablonski
- Elevation drive:
Will get new engineer
- CTA LST telescope project coordinator:
Masahiro Teshima
- LST structure coordinator:
Thomas Schweizer
- LST Structure Designer with MERO:
Eckart Lorenz
- LST postdoc (new):
Koji Noda





Understructure with carbon fibre tubes: 2 technologies

- Tubes that have to hold up to 32 tons have glued end pieces with safety factor 4 on tubes (>130t), 5 (>150t) on glueing, 170mm diameter, 6-7 mm thickness
- Tubes that have to hold 32-65 tons Safety factor 4 on tubes (>260t), factor 1.8 on T-Igel endpiece (>130t), 280mm diameter, 10-12mm thickness
- Tubes on bottom, Steel

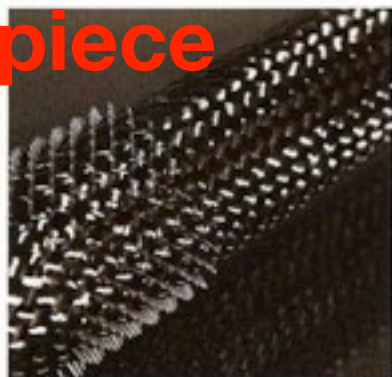


**glued
Endpieces**

T-Igel endpiece



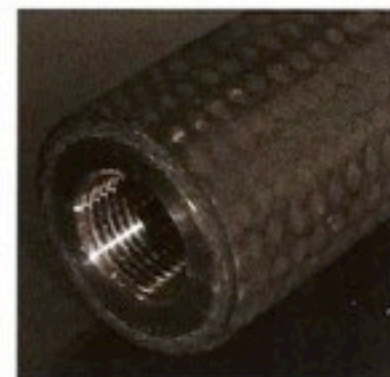
T-IGEL® Verbindung



T-IGEL® teilweise eingeflochten



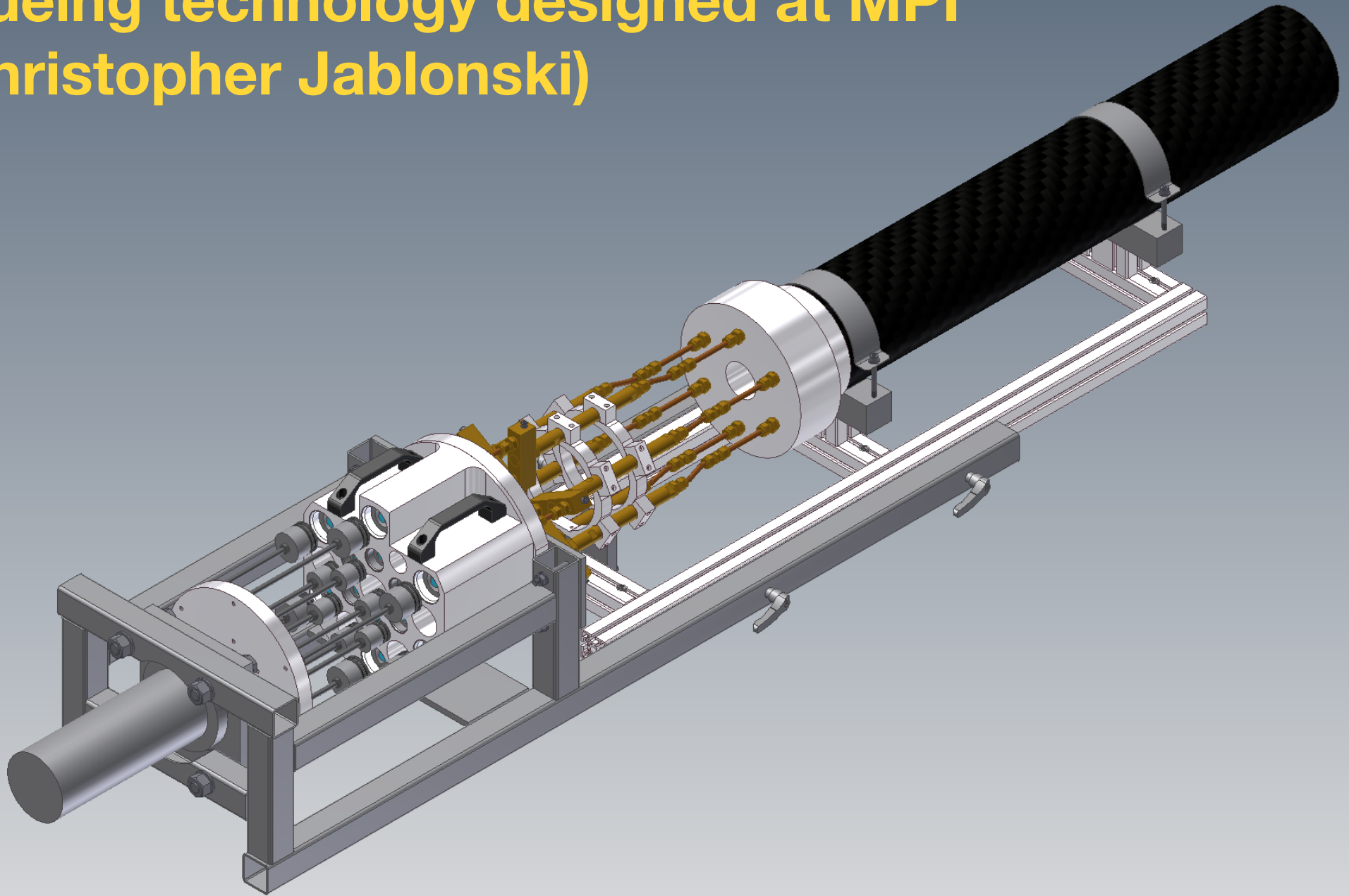
T-IGEL® vollständig eingeflochten



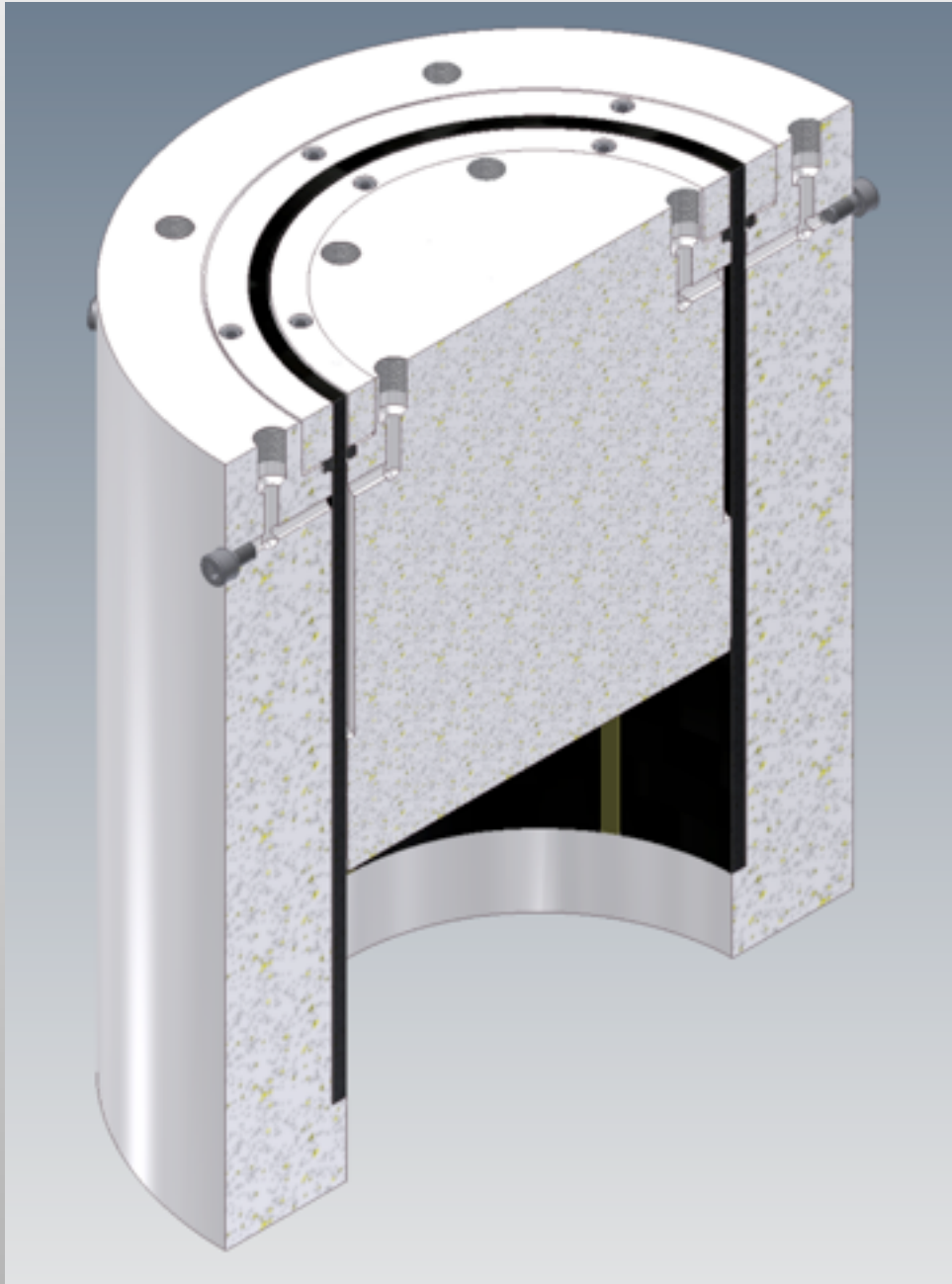
Ausgehärtete CFK-Welle



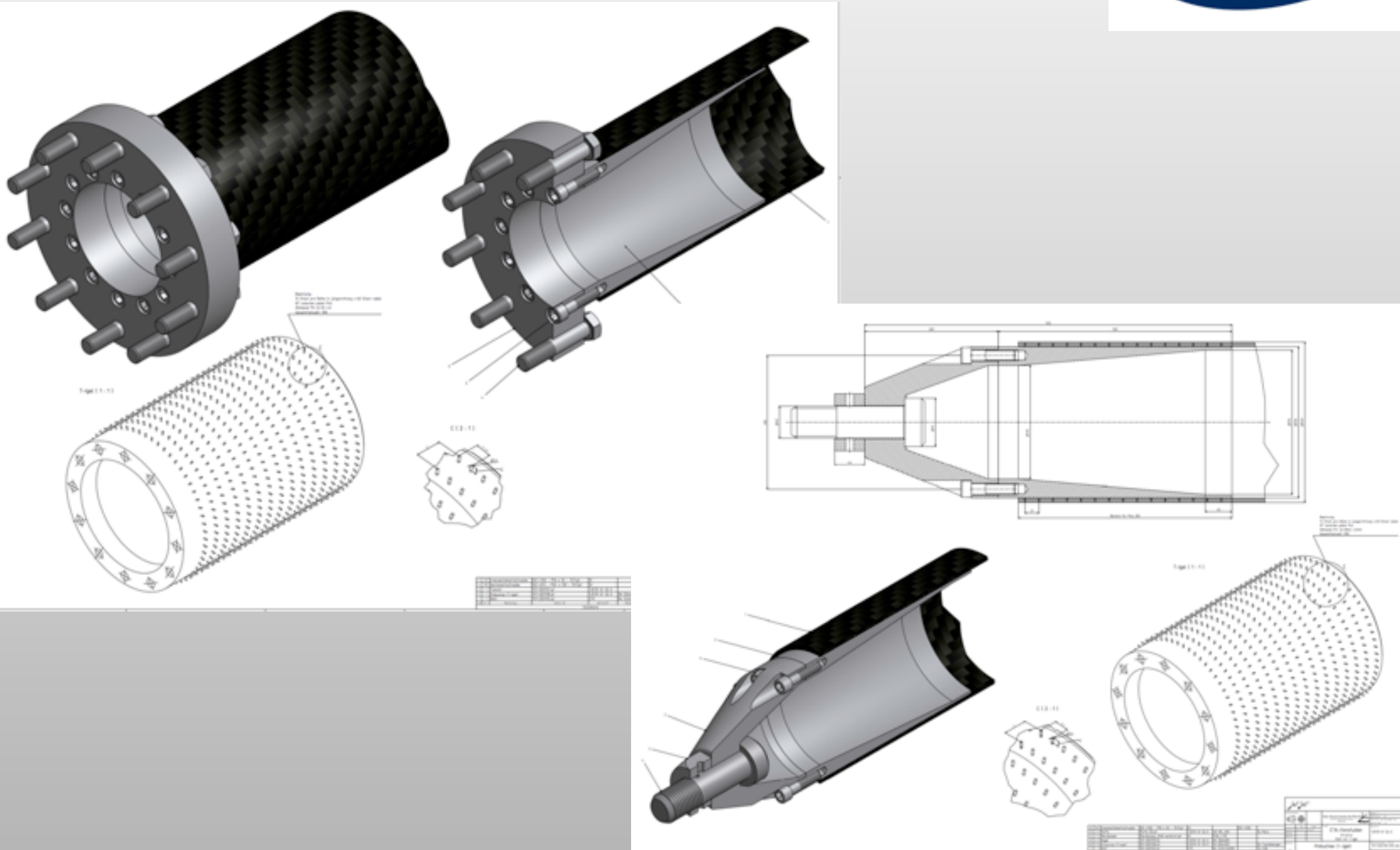
Glueing technology designed at MPI (Christopher Jablonski)



Glueing test design (Christopher Jablonski)



T-Igel endpiece design, flanch and cone (Christopher Jablonski)

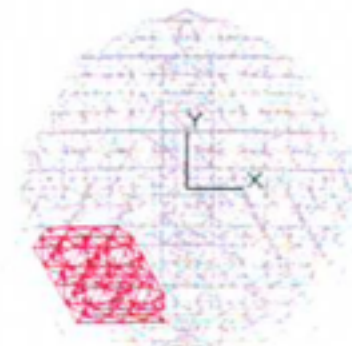
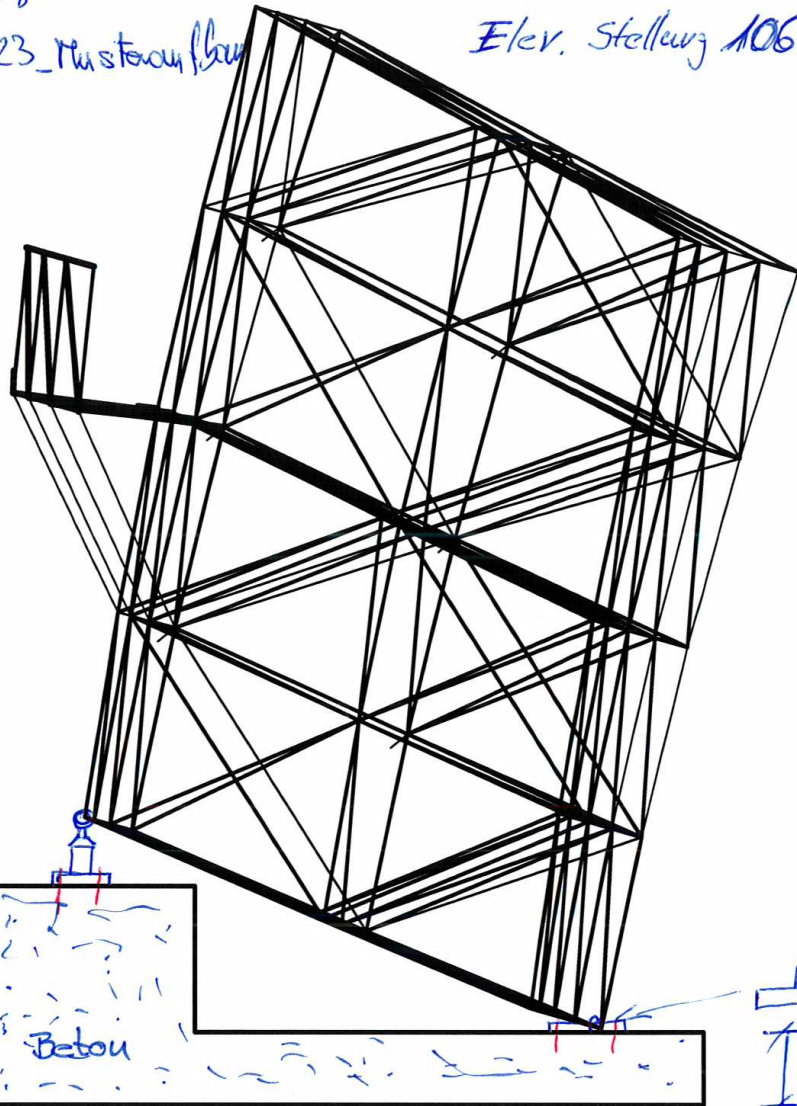


Segment of dish structure in MPI garden

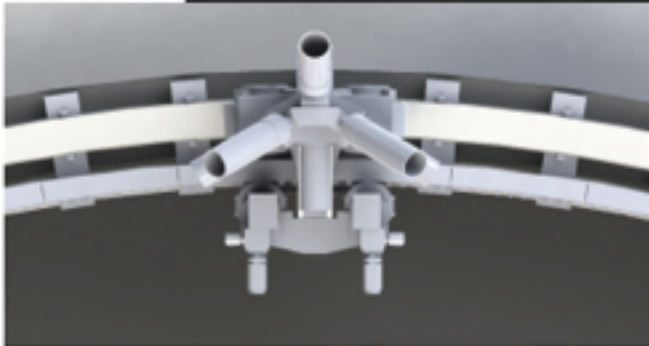
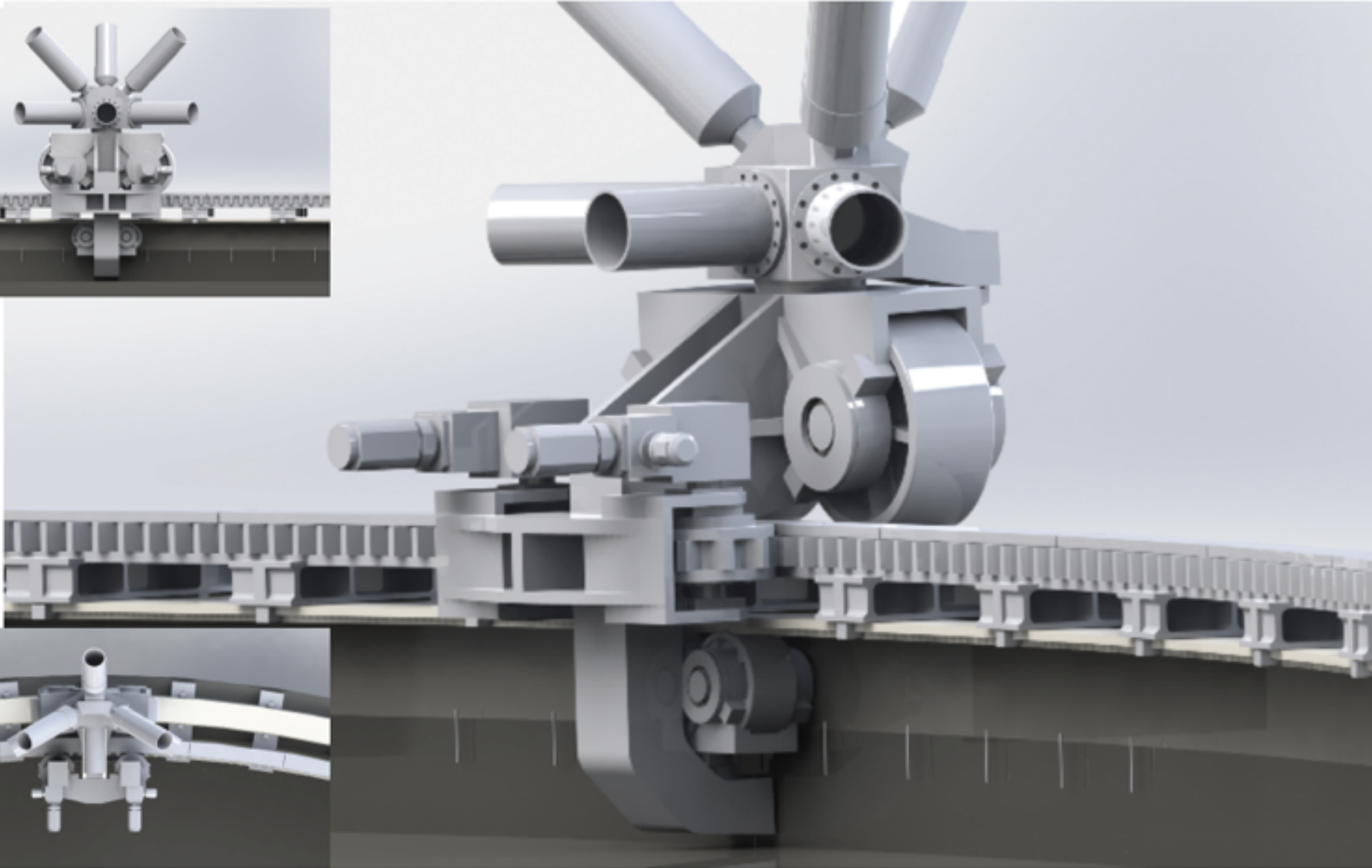
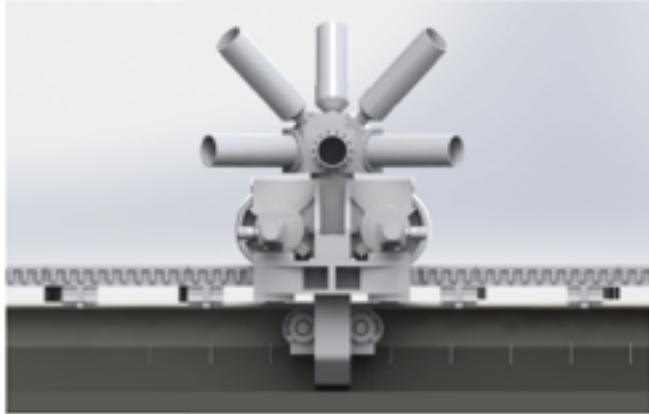
P100.188

MPI_CTA23_Mustardaybau

Elev. Stellung 106°

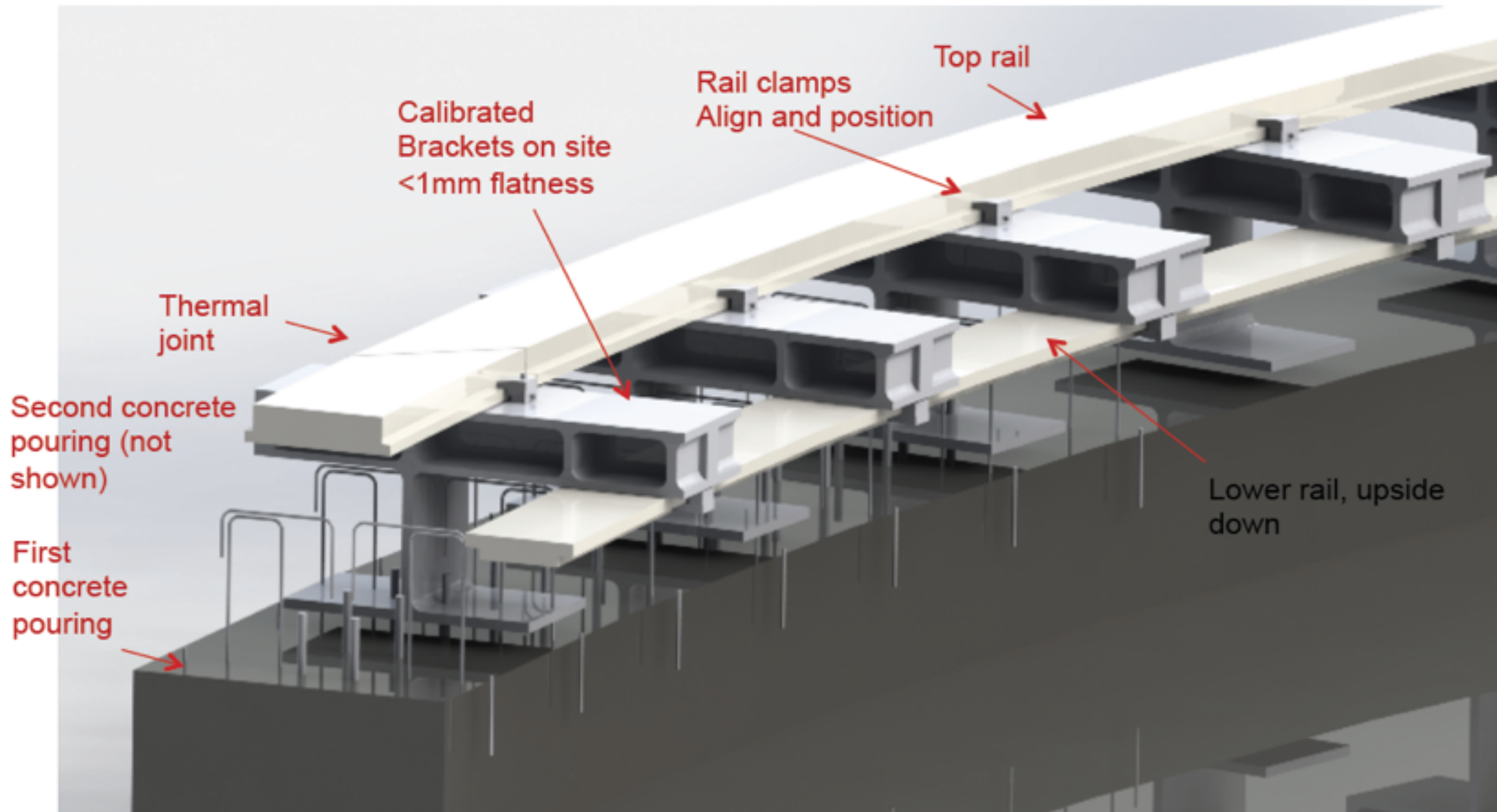


Rack and Pinion drive system by F. Granena (IFAE)



RAIL & Foundation Design

CTA LST RAILS DESIGN Overview:



Design of Drive electronics: LAPP



**Positioning speed in GRB follow up:
180 degrees / 20 sec**

LAPP IN2P3

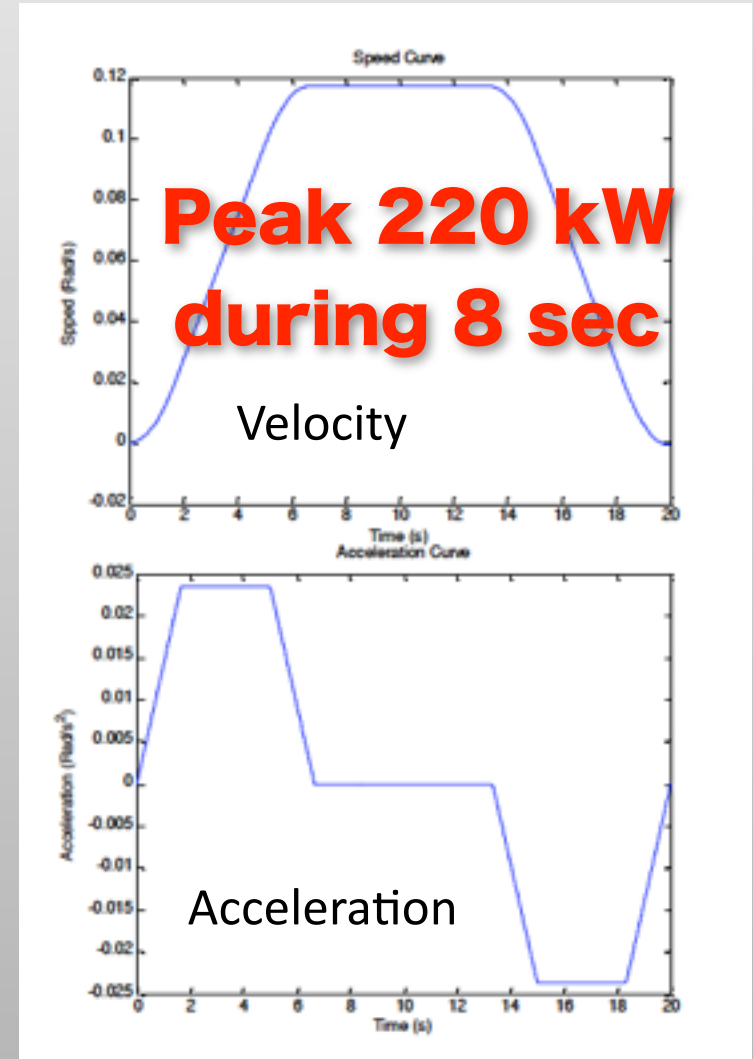
Drive PLC system
OPC UA test is on-going



Drive Motion Controller
Siemens S120 series



Synchronous motors
Siemens FT7 series



Design of the upper part of the LST:

1) Camera masts ("Arch") and camera frame

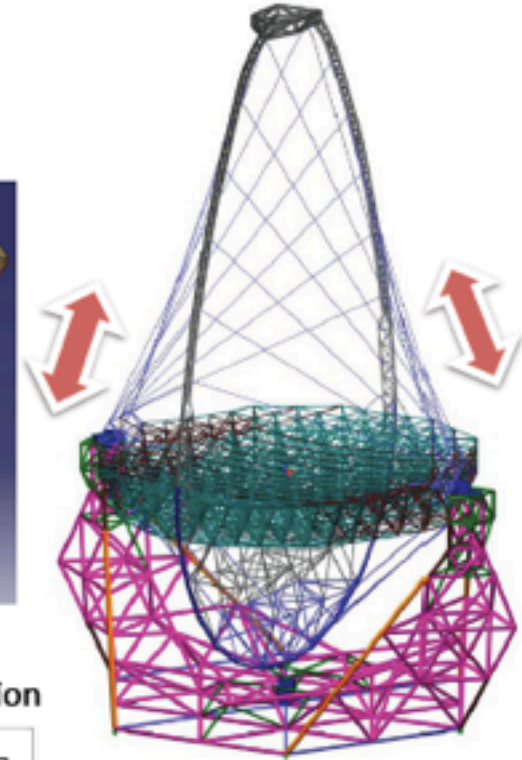
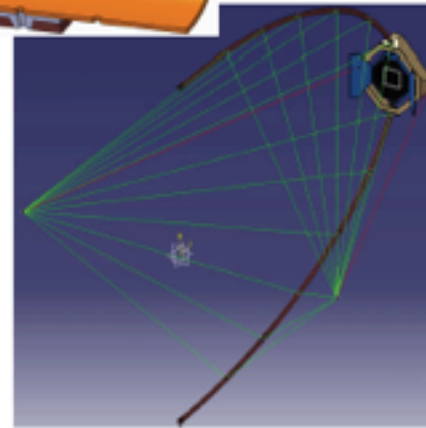
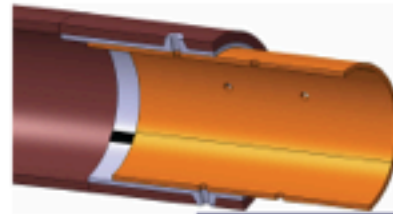
-> R&D: Hybrid discrete components (tubes) in Carbon Fibers tightened on interface components (industrial partnership).
Light and strong design (29 m focal length for 2 tons camera charge) + prototypes and tests.

1st IRD PP-FP7 contract (offers received by the 2 July 2012)

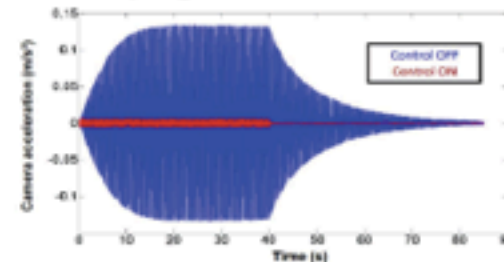
2) Active camera damping and control system

-> R&D: Mock-up prototype (Done !) + real size design study.
A damping device stabilizing the camera at <10 mm for an LST moving at 10m/s for GRB alert follow-up + fast repositioning control

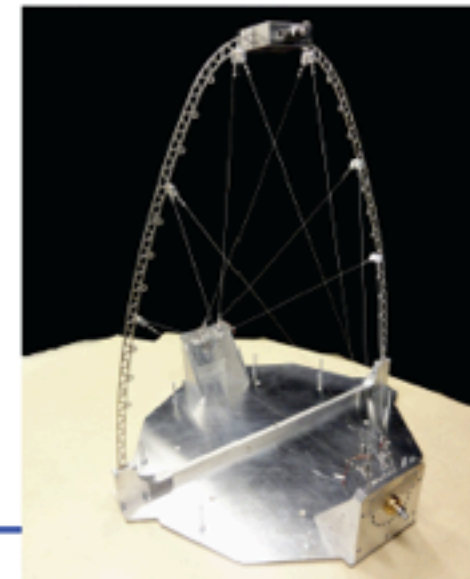
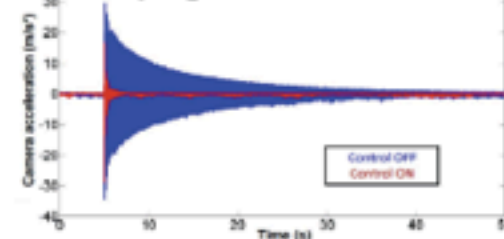
2nd IRD PP-FP7 contract (Call to be open in September 2012)



Damping sinusoidal oscillation

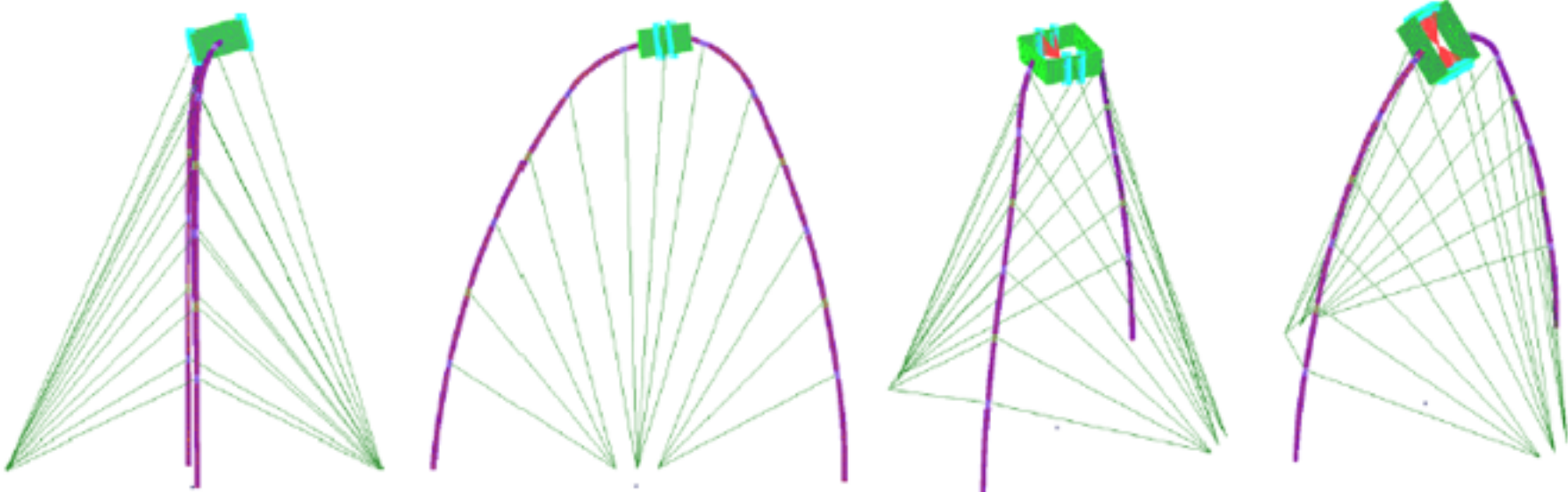


Damping hammer-shock oscill.



Dynamical calculation for Arch

Mode n°	Frequency (Hz)	Interface influence
<u>1</u>	1,77	Lightly coupled (cables)
<u>2</u>	2,38	Strongly coupled (arch)
<u>3</u>	2,88	Decoupled
<u>4</u>	3,9	Lightly coupled (cables)



Optical axis and permanent AMC (Active Mirror Control)

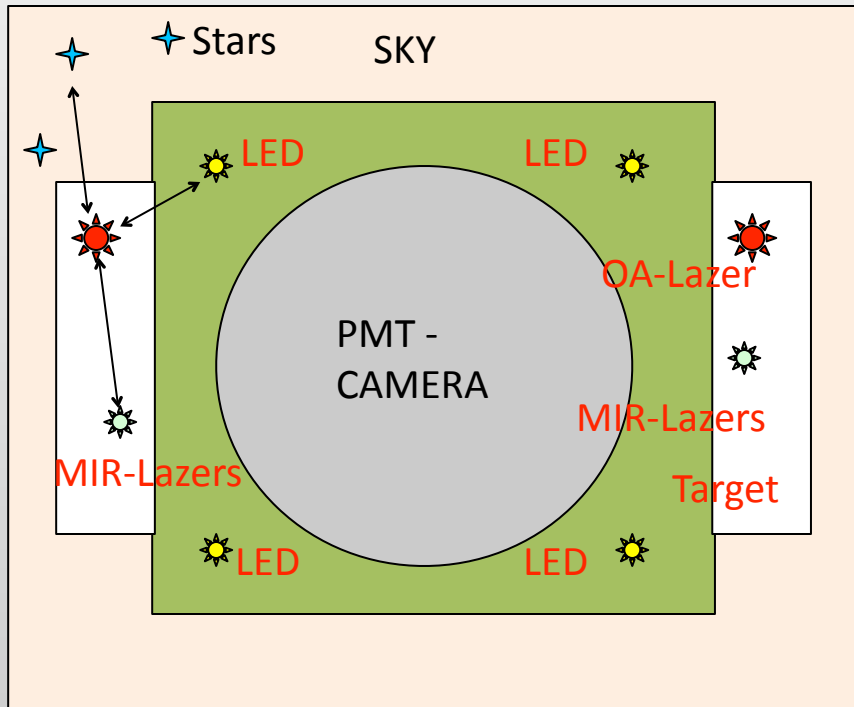
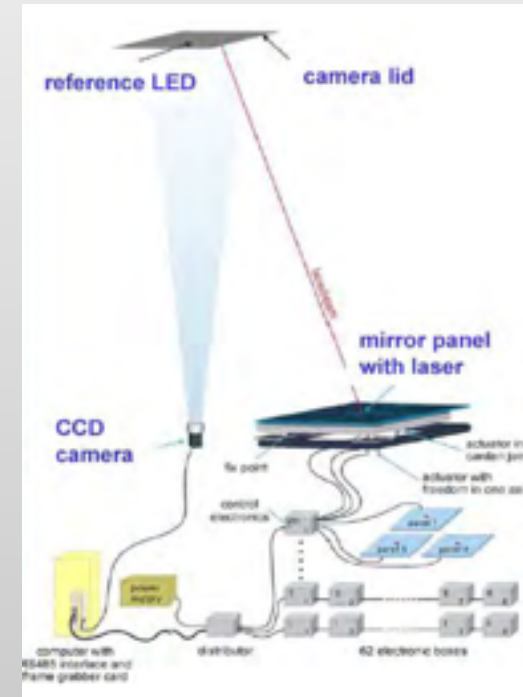
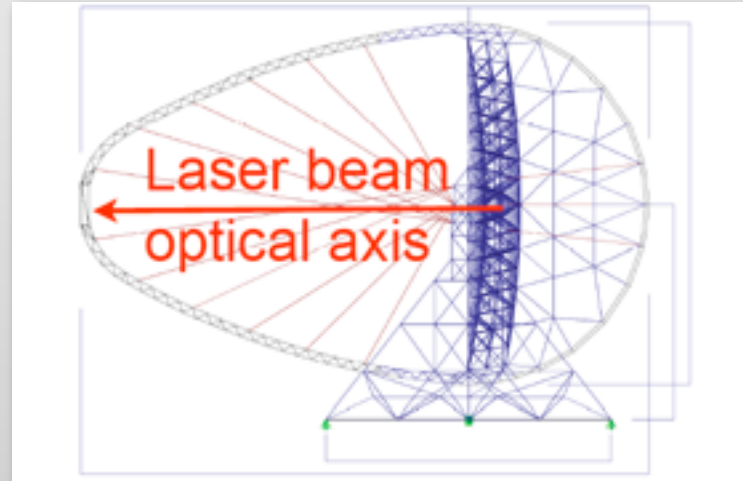


IMAGE with HR CCD Camera

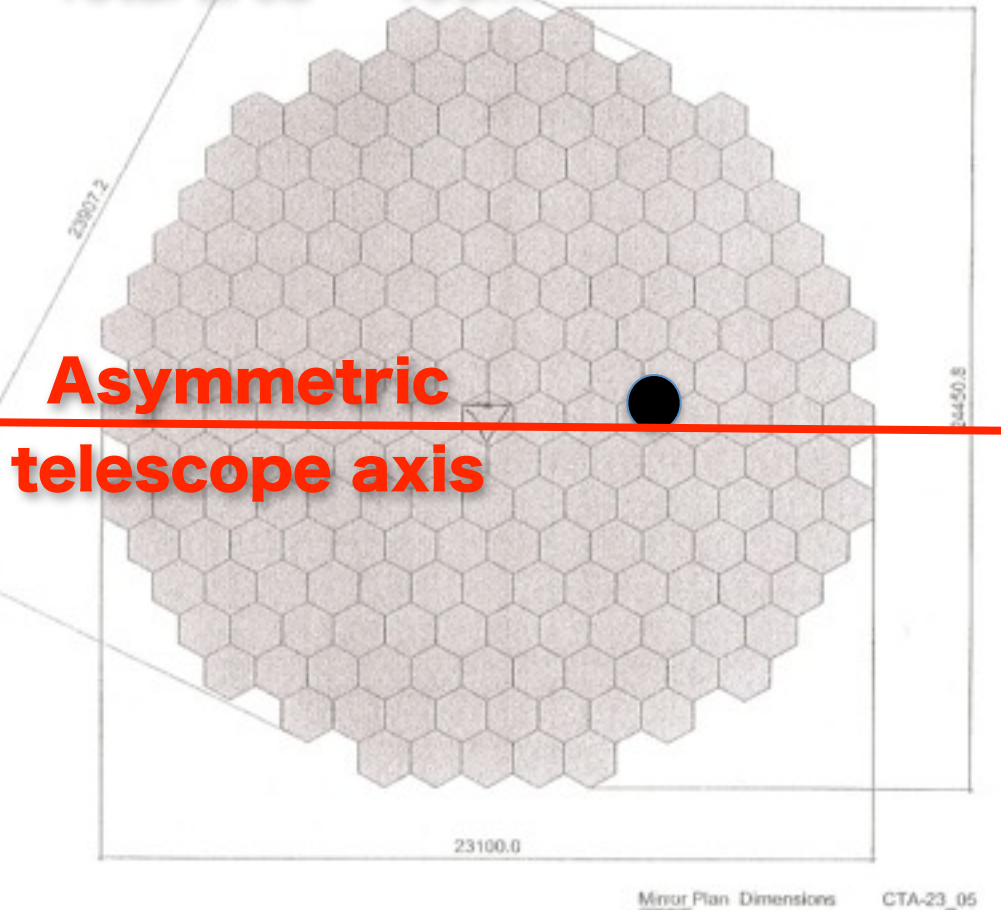


- Define optical axis with the IR Laser beams
- HR CCD camera at the center of dish to monitor the optical axis and star field
→ pointing direction in sky
- (Camera LED position) – (Optical axis Laser position) → camera sag
- (Mirror Laser positions) – (Optical axis Laser position) → mirror direction

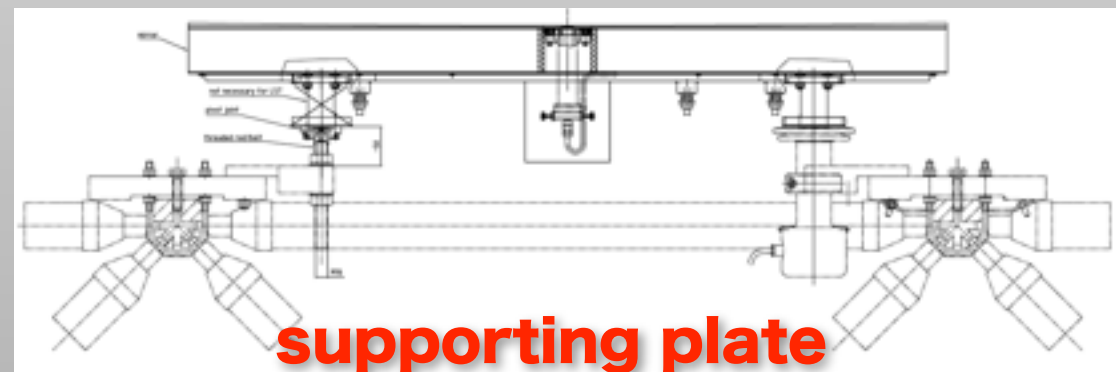
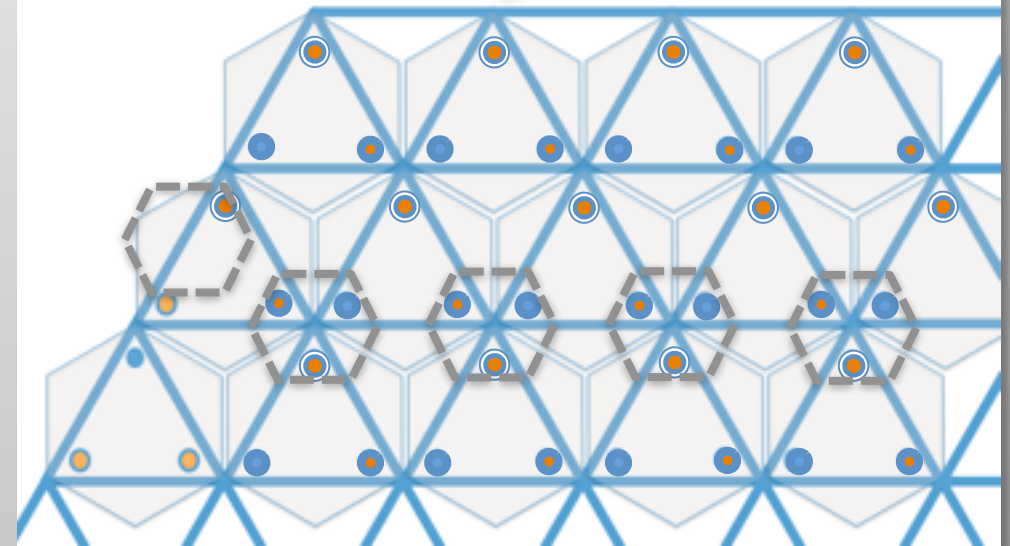
Mirror layout and mounting scheme



- 205 Hex-shape mirrors of 2m² area)
- Total area ~405m²



Mounting scheme

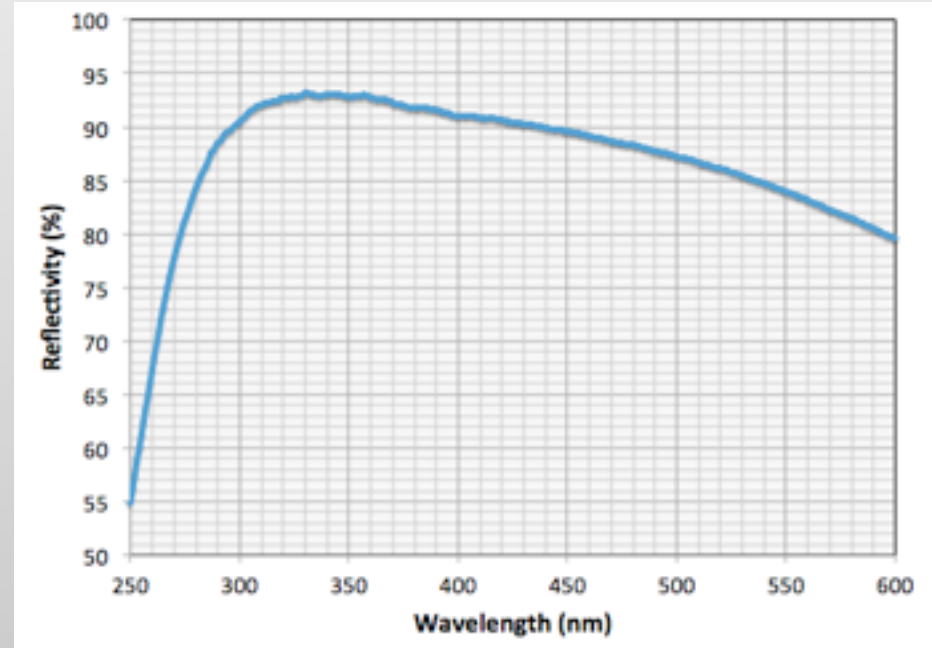


1510mm LST MIRROR prototype at Sanko

2.7mm Glass+60mm Al.Honeycomb+2.7mm Glass



Sputtering Cr + Al + SiO₂ + HfO₂ + SiO₂



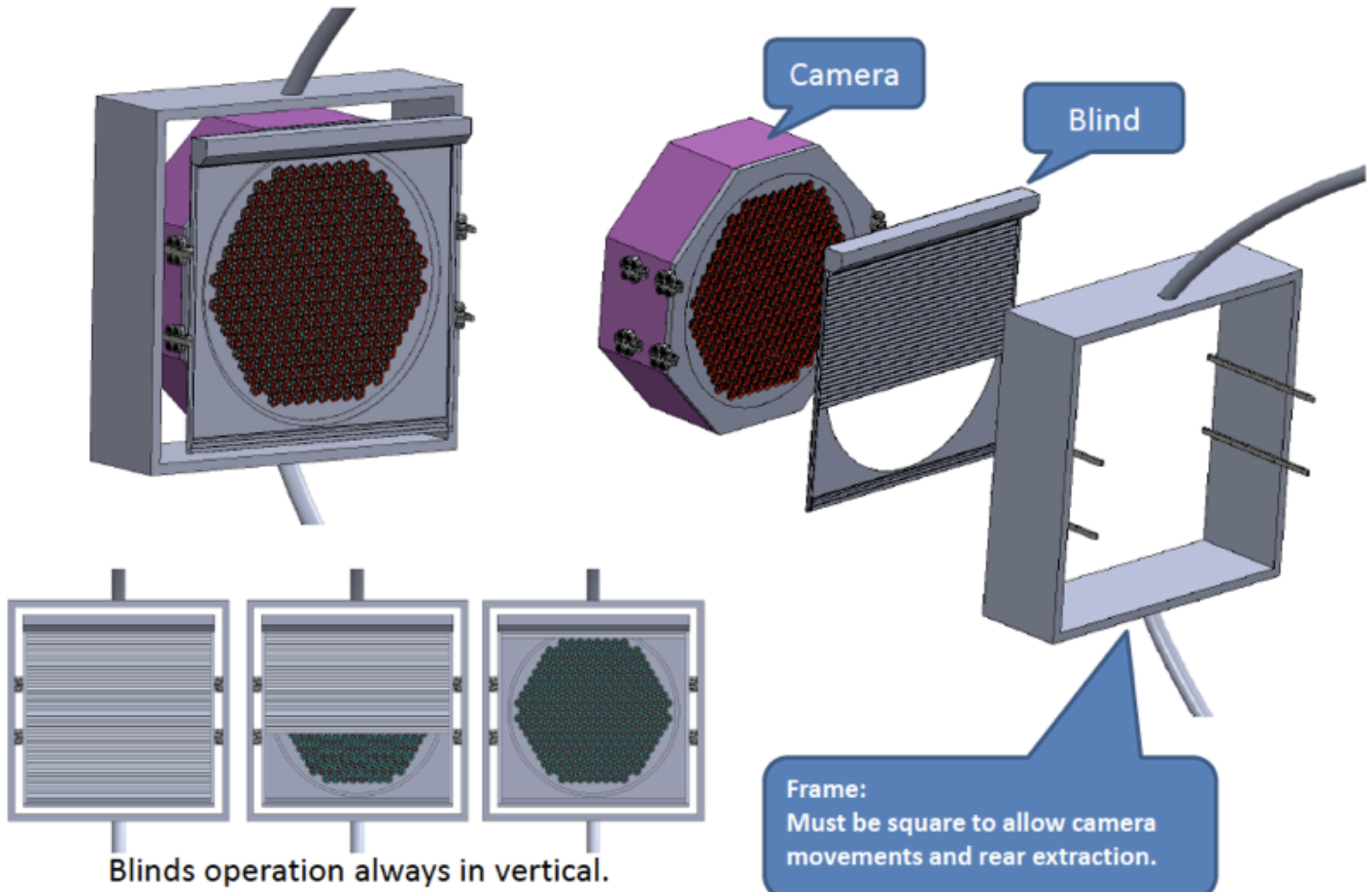
Specifications

- F2F : 1510mm
- Area : 2m²
- R: 56.0 – 58.4 m
- D80 : 10mm(1/5 pixel)
- Weight : 45kg



- Sputtering multi layer coat
→ Cr + Al + SiO₂ + HfO₂ + SiO₂
- Reasonably High reflectivity
- Strong protective surface
→ Long life time

Camera design

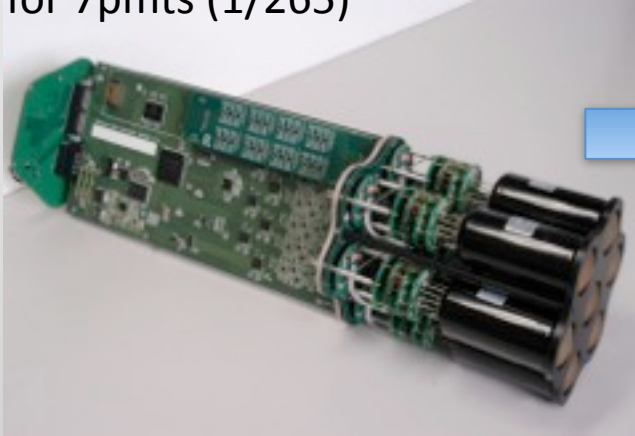


Readout Electronics and Water Cooling

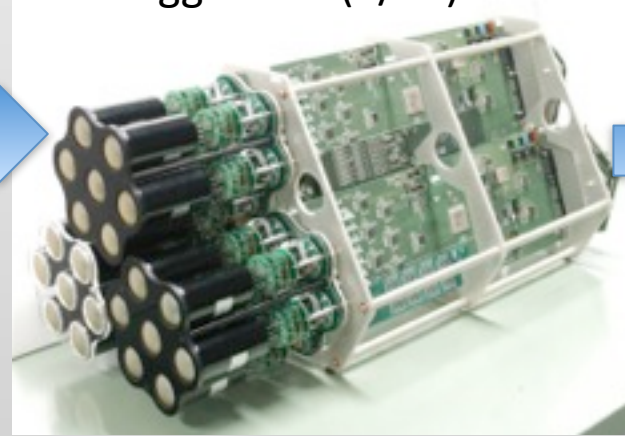
1GHz samples/s, 4096 memories/ch



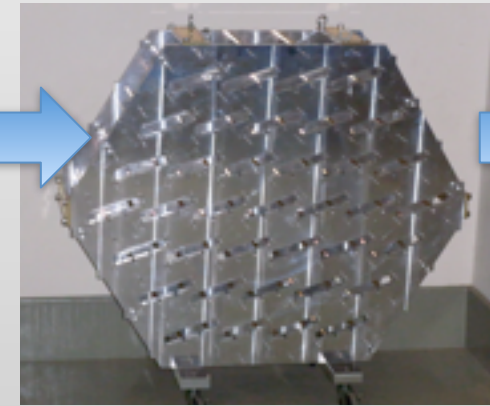
Dragon Cluster module for 7pmts (1/265)



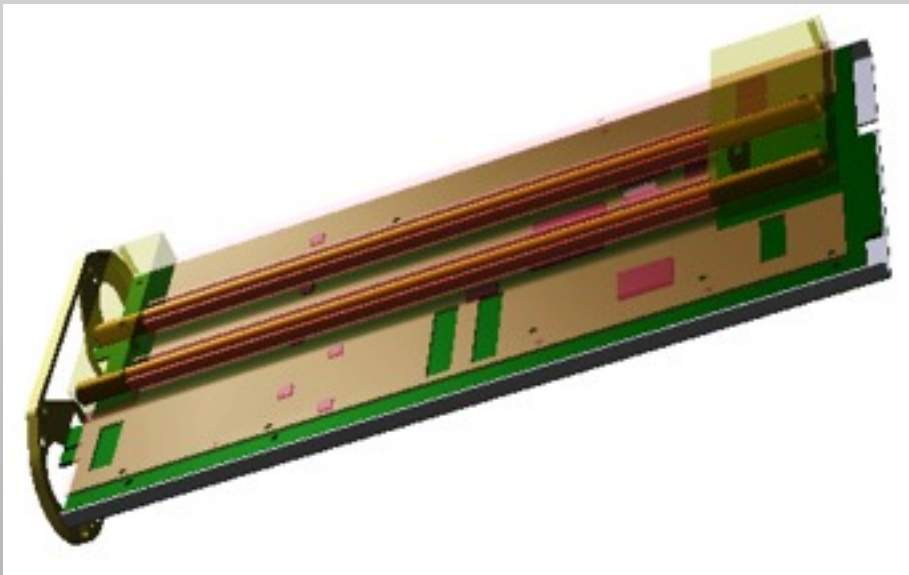
3 cluster module for trigger test (1/80)



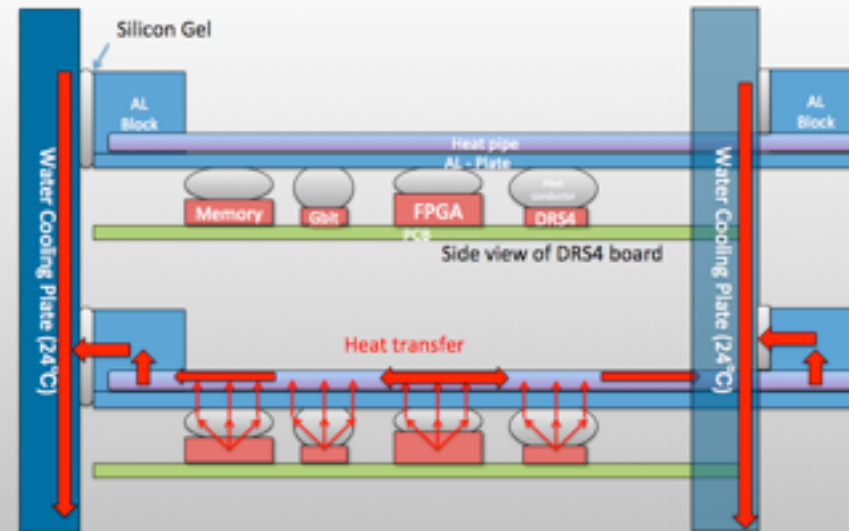
Water Cooling plates for 37 cluster modules (1/8)



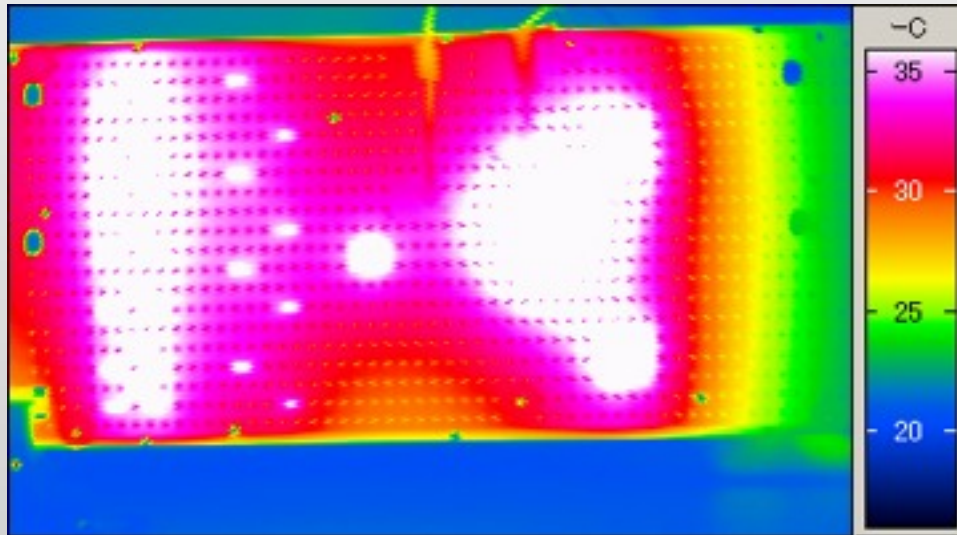
Full size



Possible structure (side view)



Testing water cooling of simulation PCB

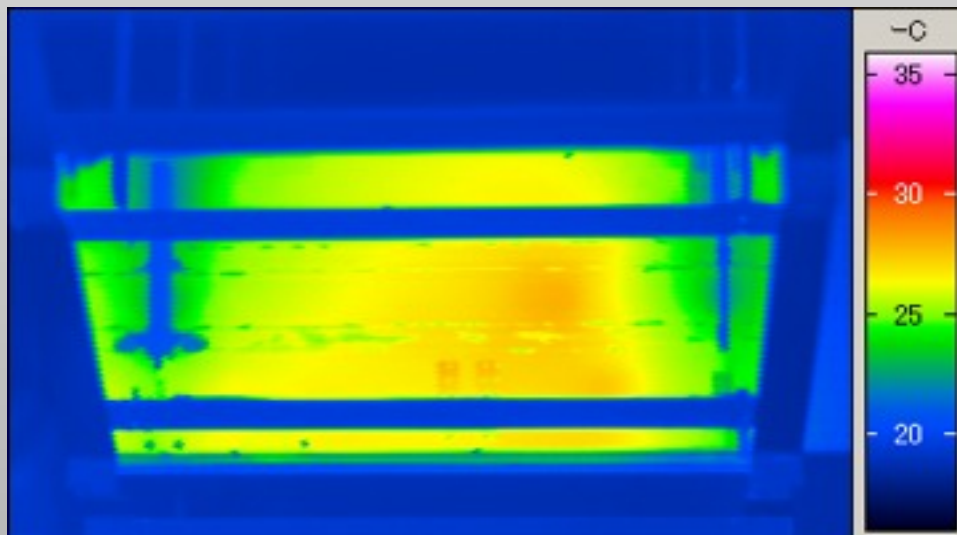


The location of FPGA shows 70 degrees.

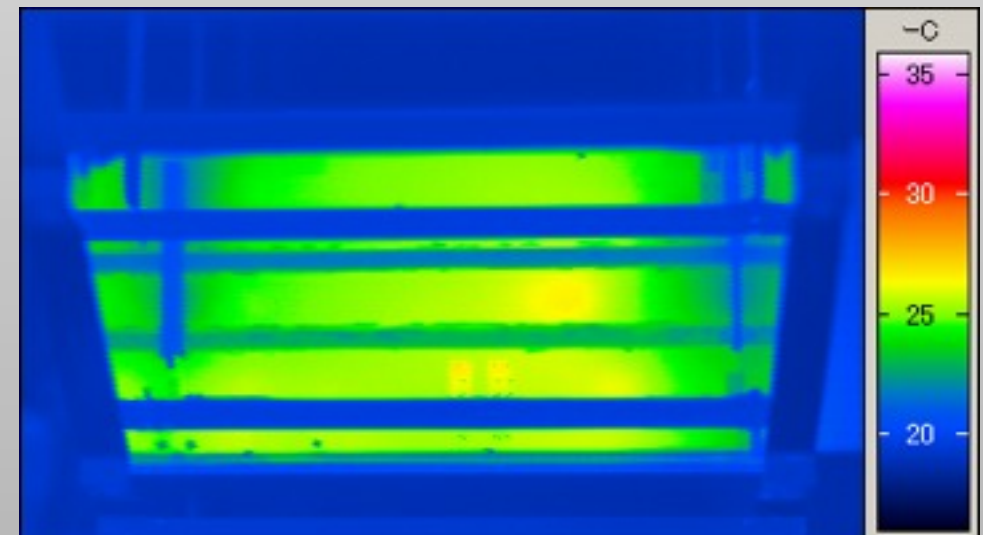
Just with Al. Plate is not so bad.

With Al. plate + cooling pies looks better

w/o Aluminum plate, heat pipes, floating



w Al. plate, contact to Water C.P.



w Al. plate, heat pipes, contact to Water C.P.

Alternative cooling with air

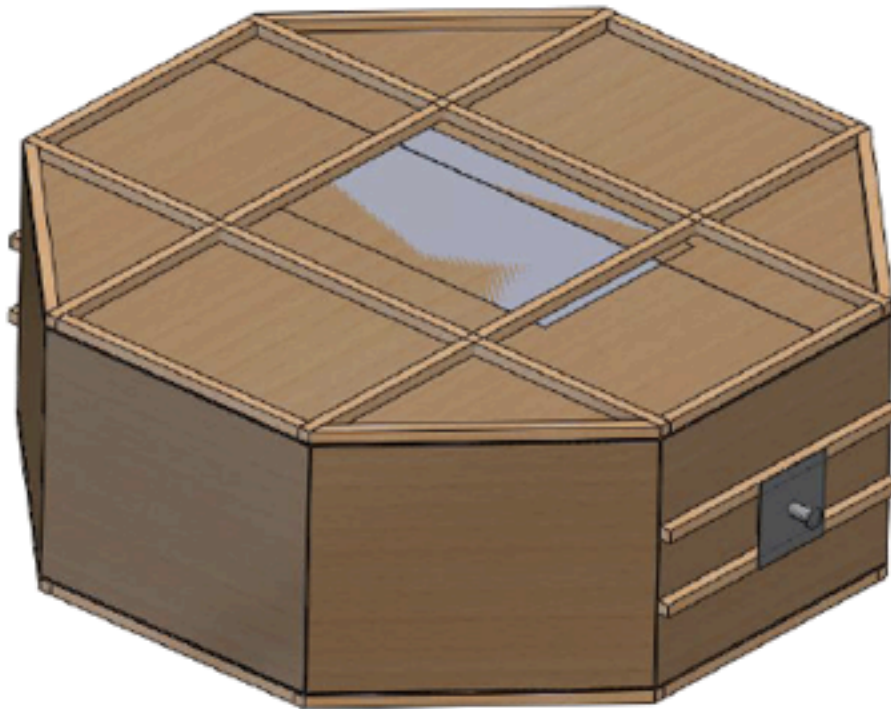
- Air conditioner prototype:
Test of the proposed AA machine in
different positions and working scenarios.



Air conditioner machine proposed
by Toshiba HVAC:

Suzuka Inverter 140

- Height between machines 30 m
- Pipe length between machines 70 m
- Air recirculation up to 1 per minute
- Pump for condensates
- Humidity control under study with
this prototype.
- Weight:
 - Internal machine 54 kg
 - External machine 71 kg



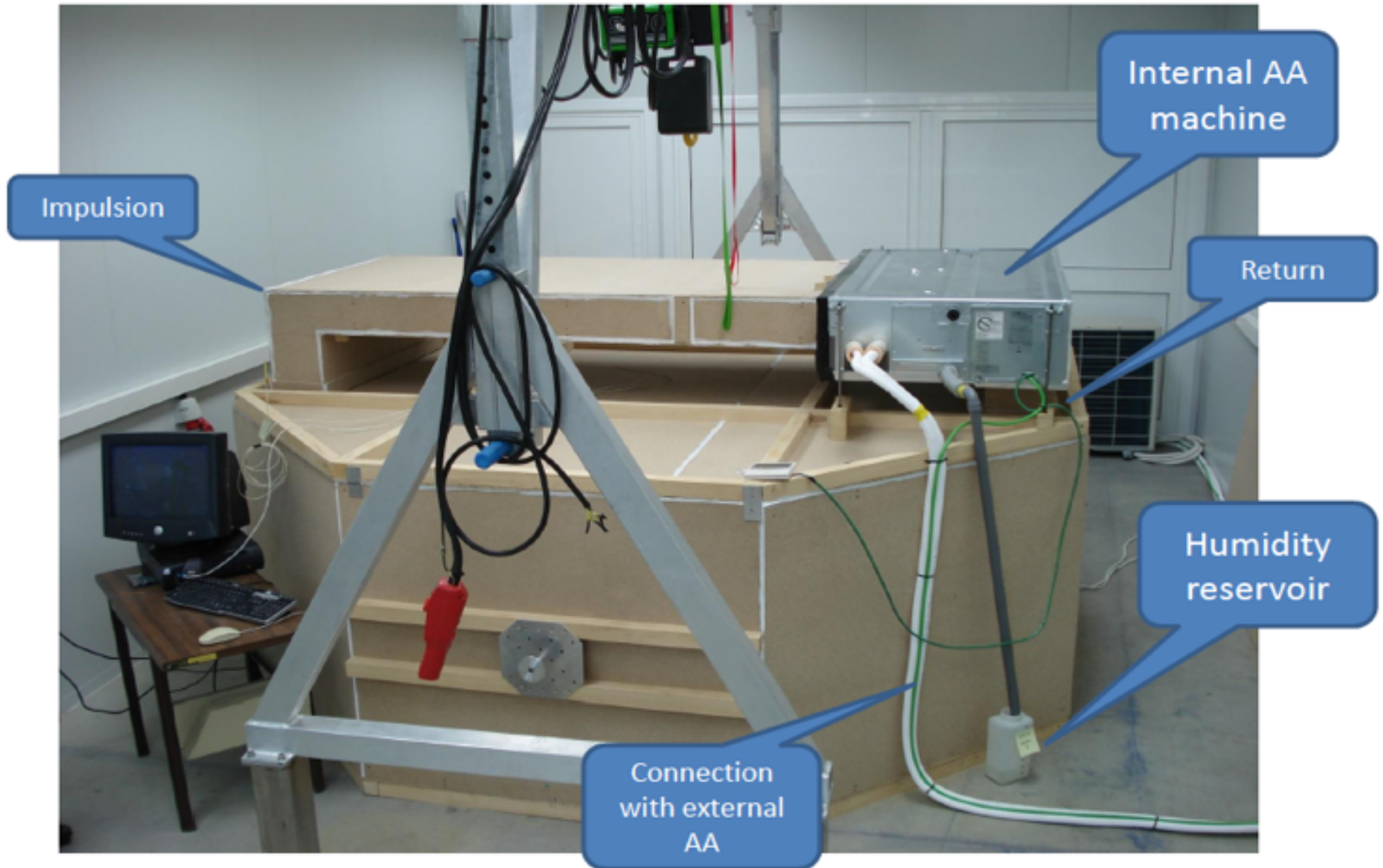
Camera like wood box

- Dimensions Octagon Diameter 3000 mm height 1000 mm
- Internal Heat power 6000 w
- Possibility of rotation

- Box materials on hand
- AA machine already purchased.

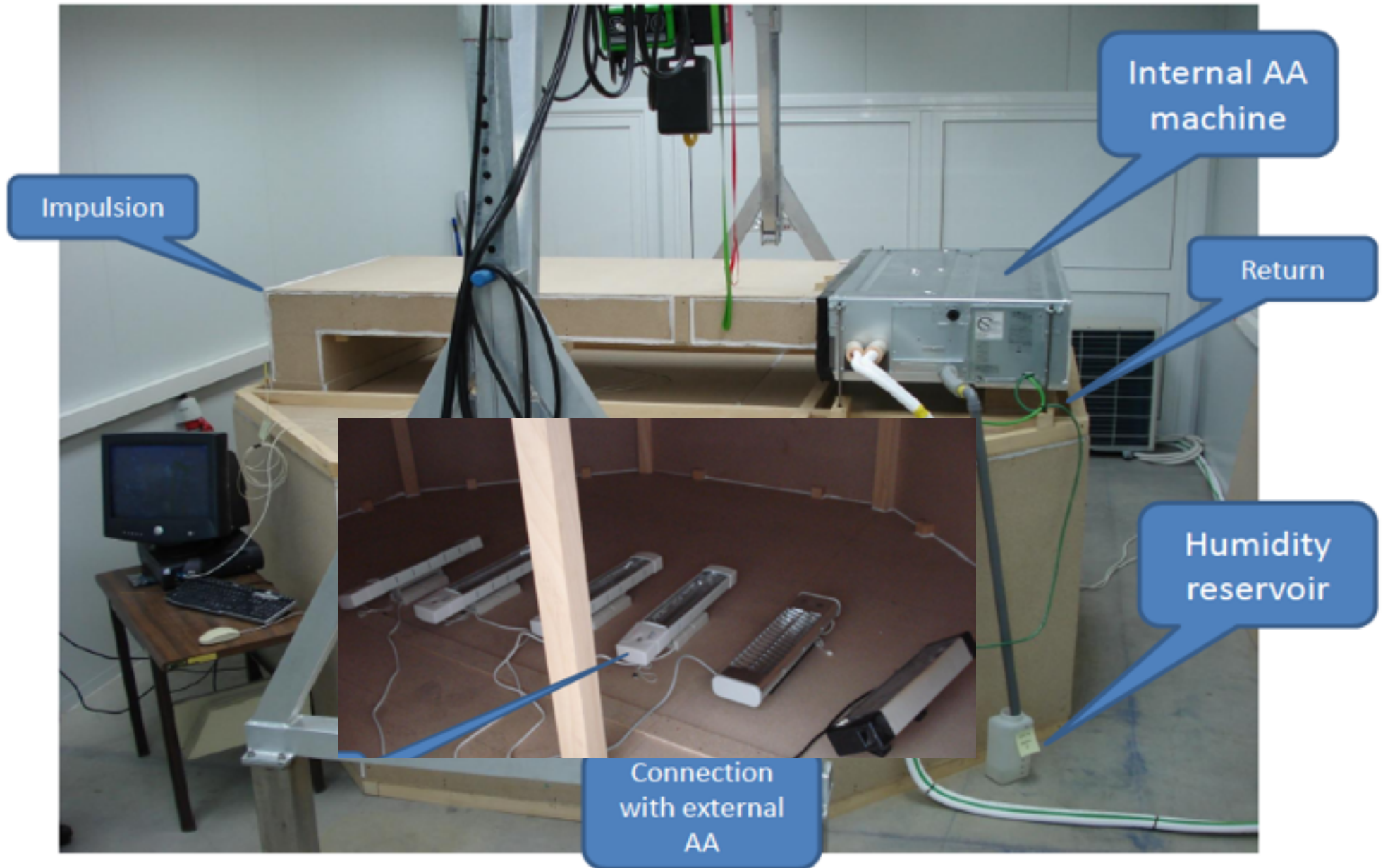
Testing air cooling

Test description: 3000x3000x1000 mm wood camera

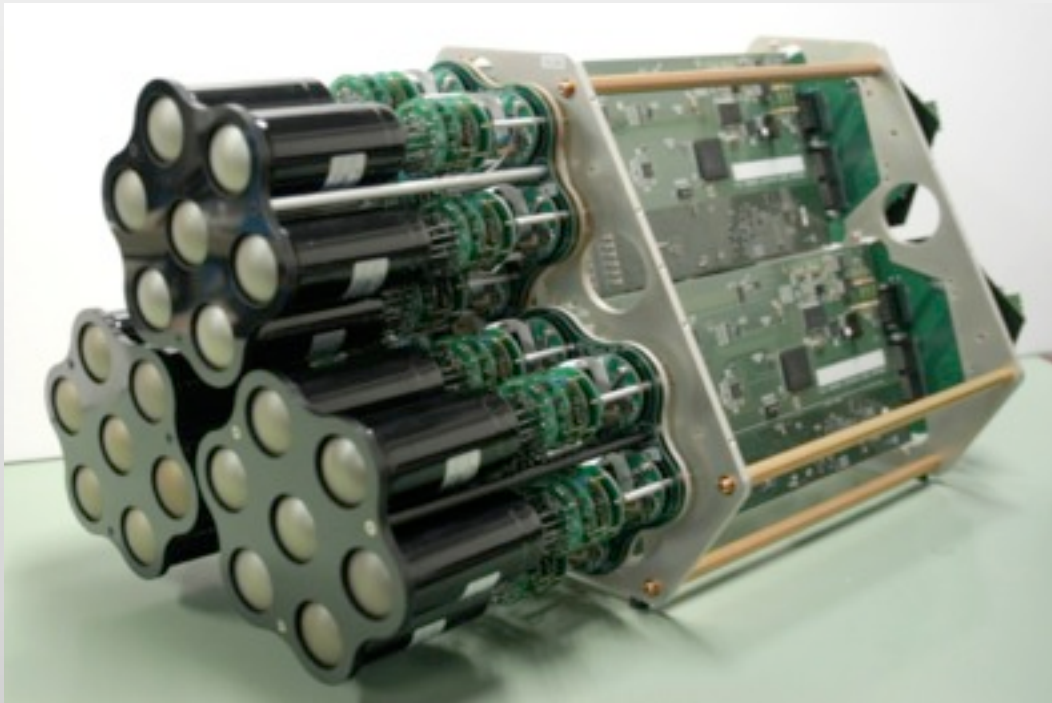


Testing air cooling

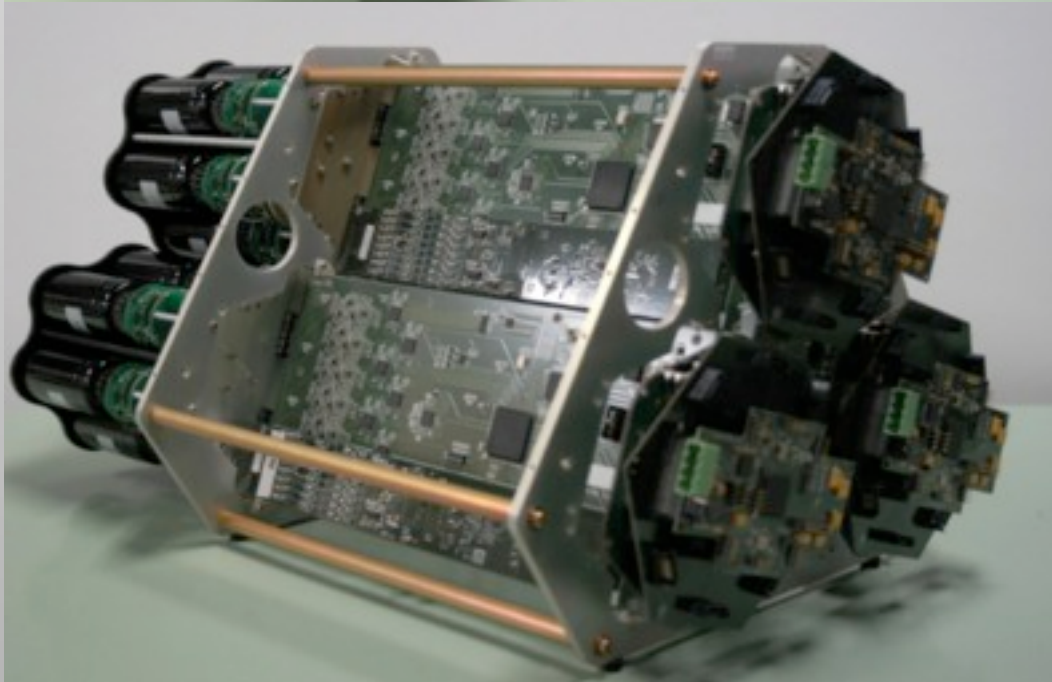
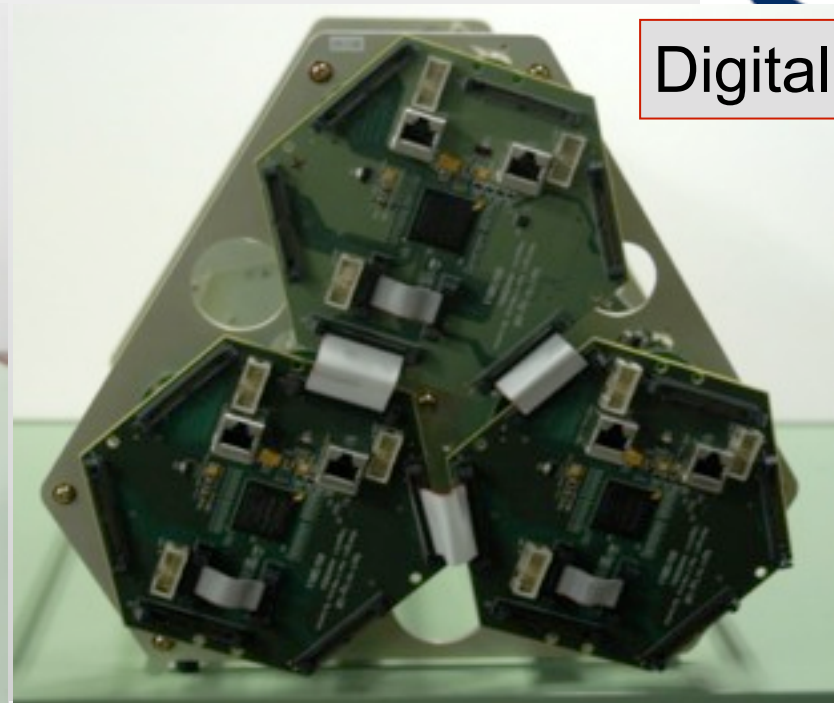
Test description: 3000x3000x1000 mm wood camera



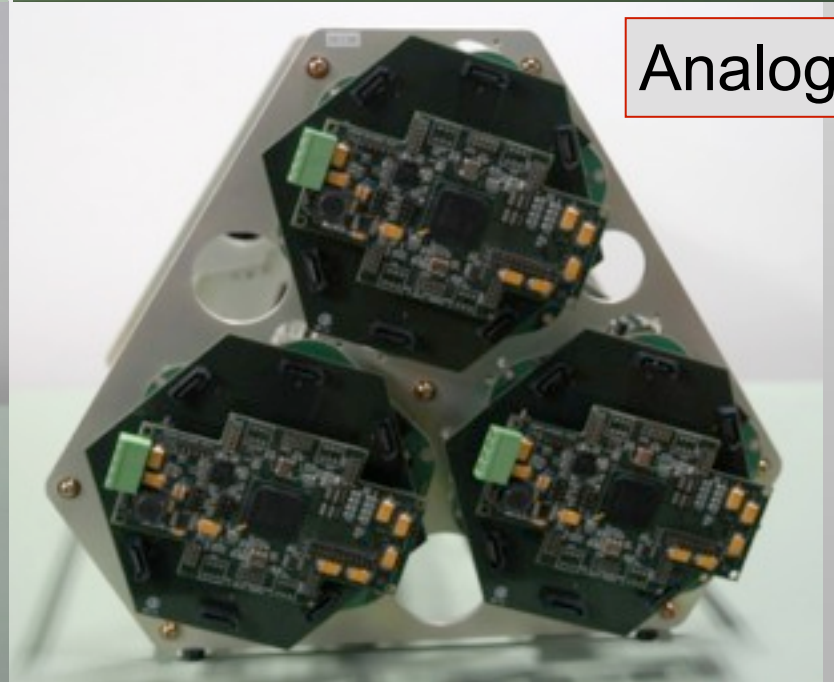
3-cluster camera



Digital Trigger



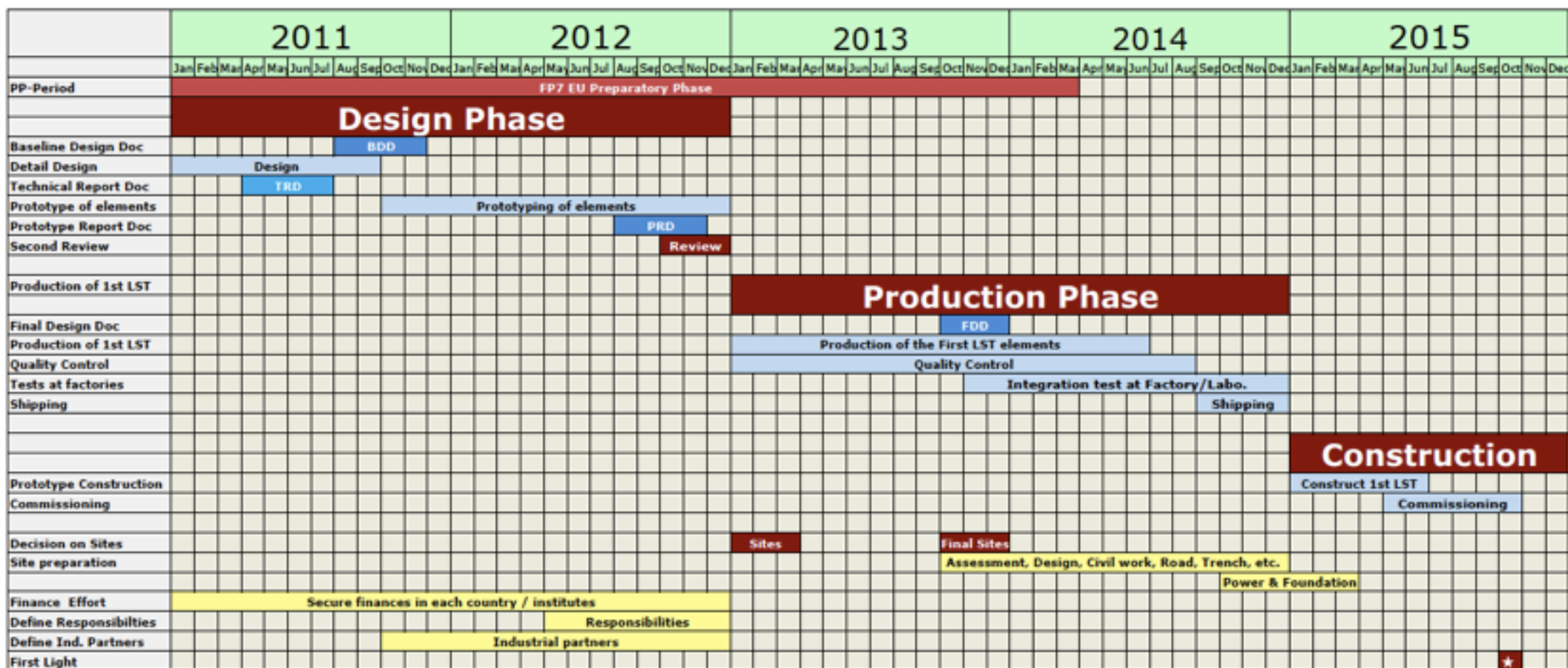
Analog Trigger



Tentative global time schedule



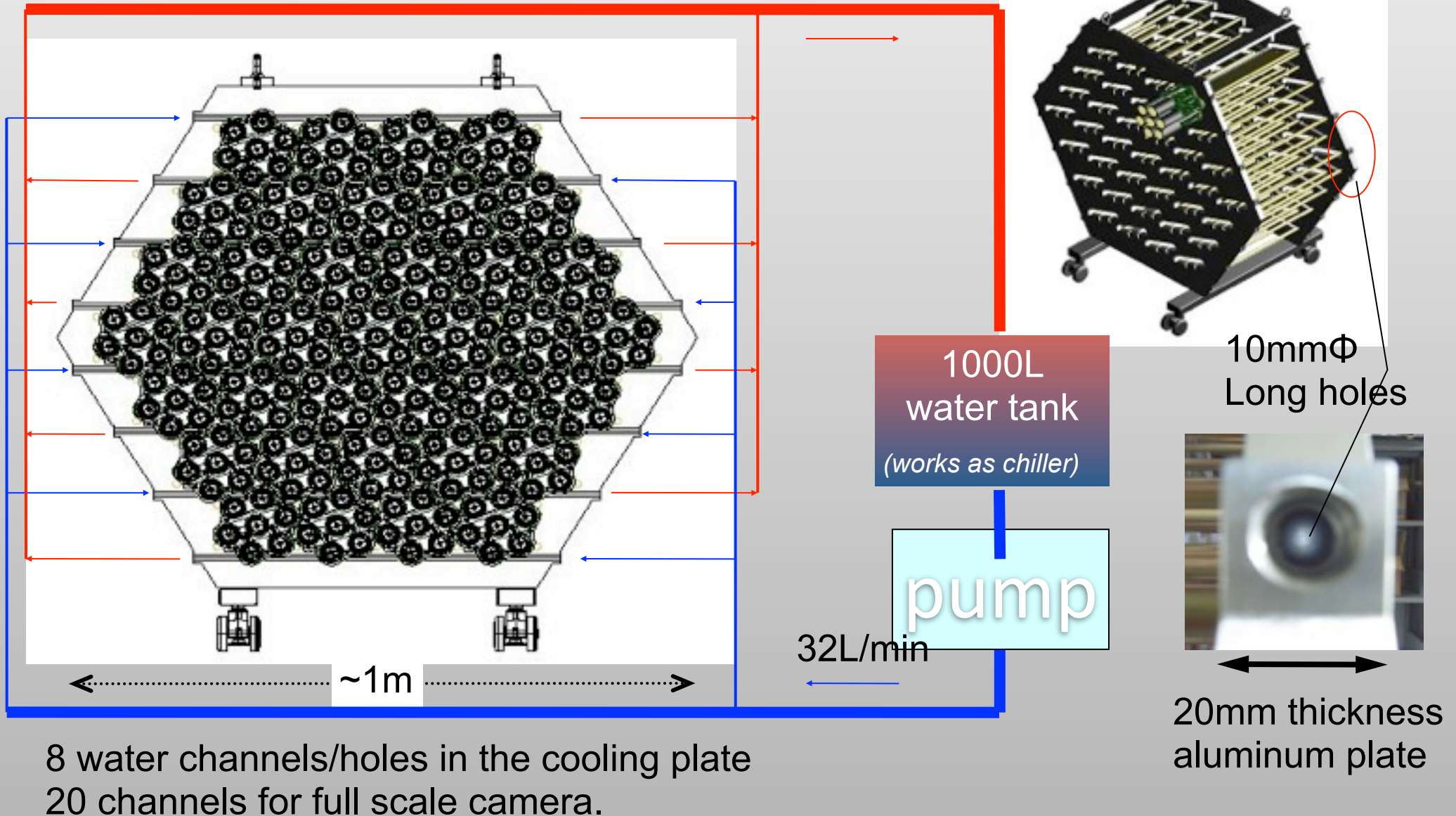
Time Schedule for 1st LST construction (May 2012)



The end

Test of Cooling plate

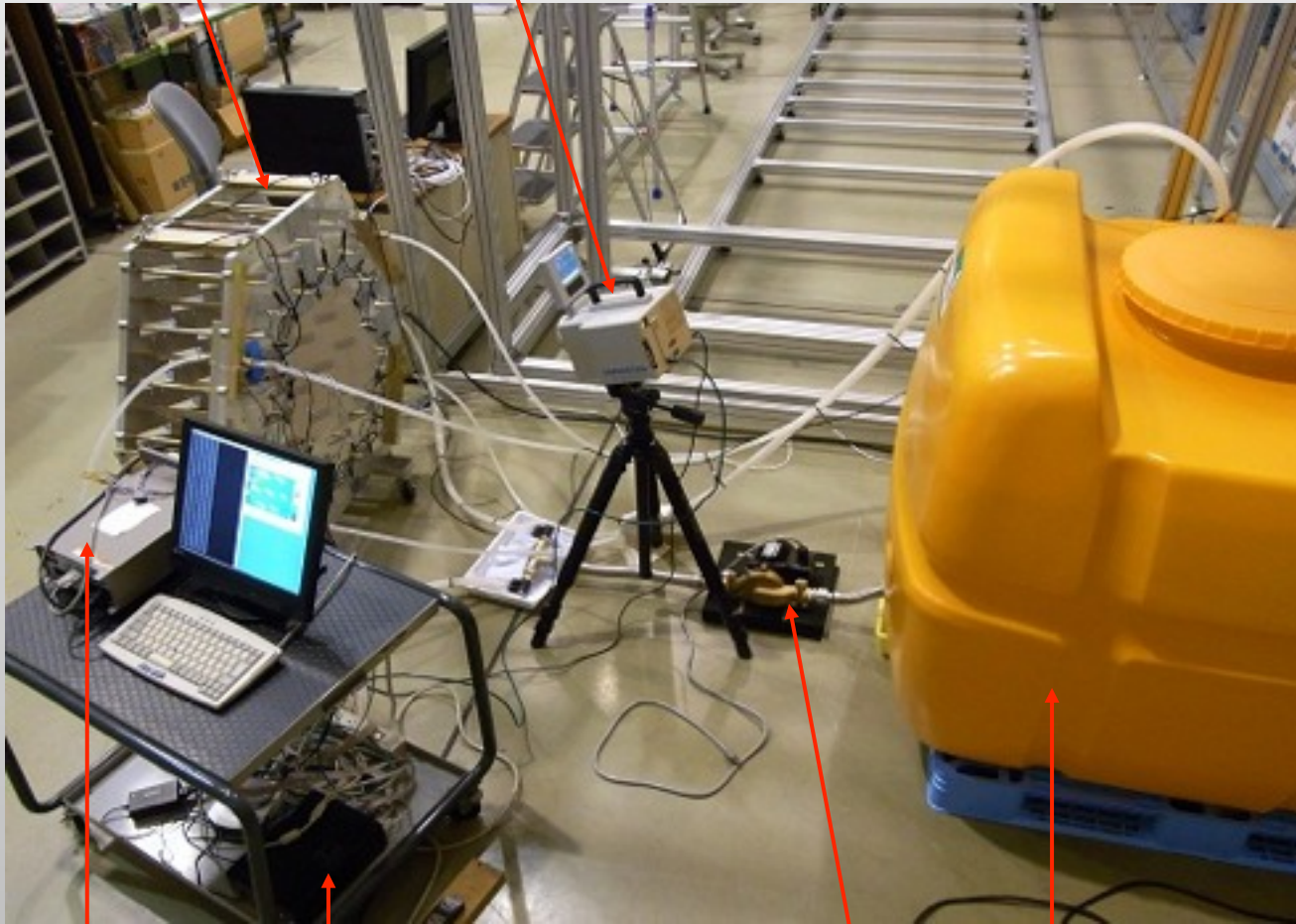
Mini-Camera(37clusters, 1/8 LST camera)



Test of water cooling plate

cooling plate

IR camera

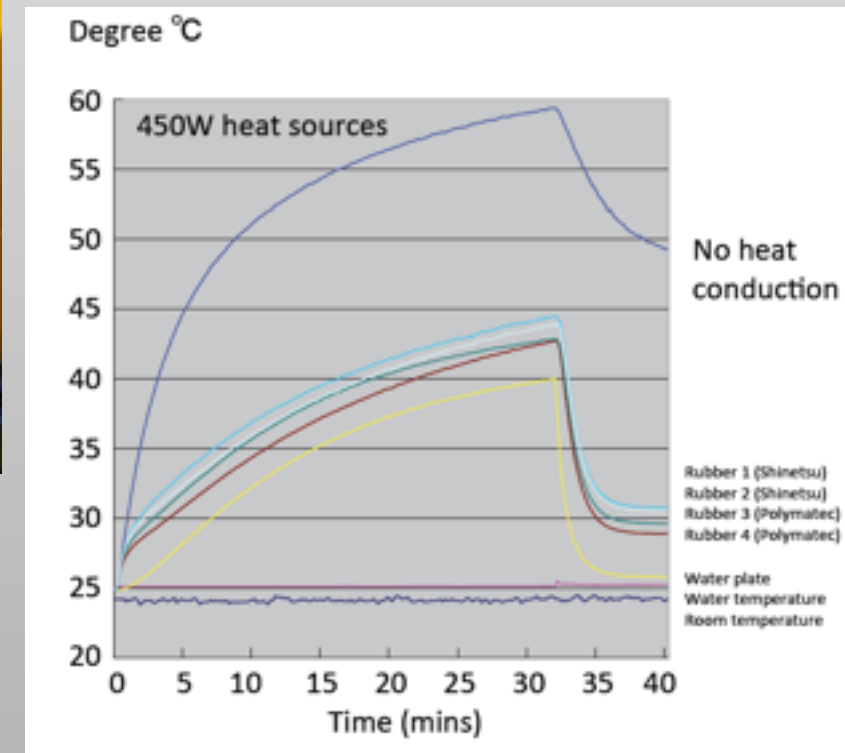


PC

pump

Water tank
as a chiller

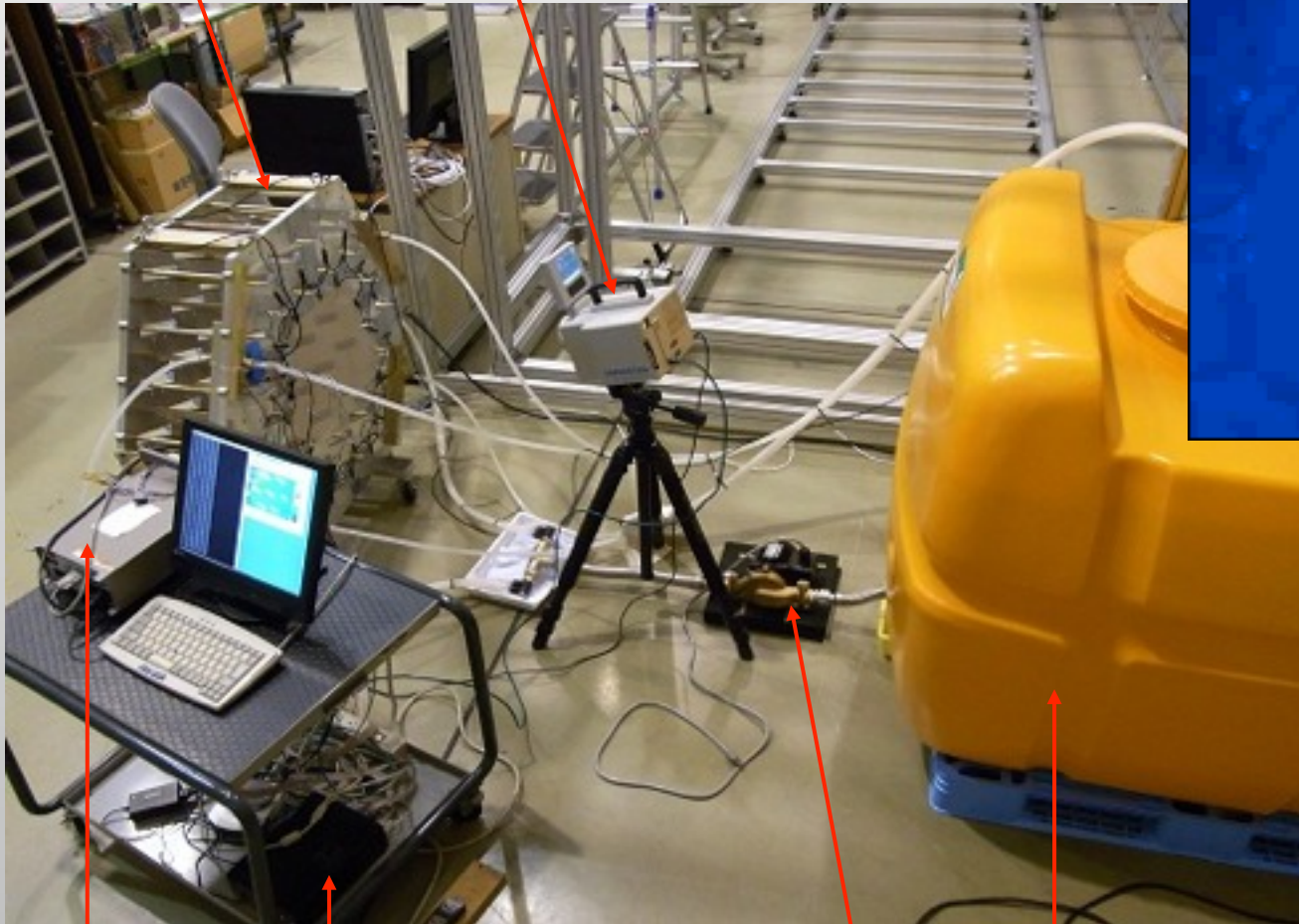
Thermometer



Test of water cooling plate

cooling plate

IR camera



PC

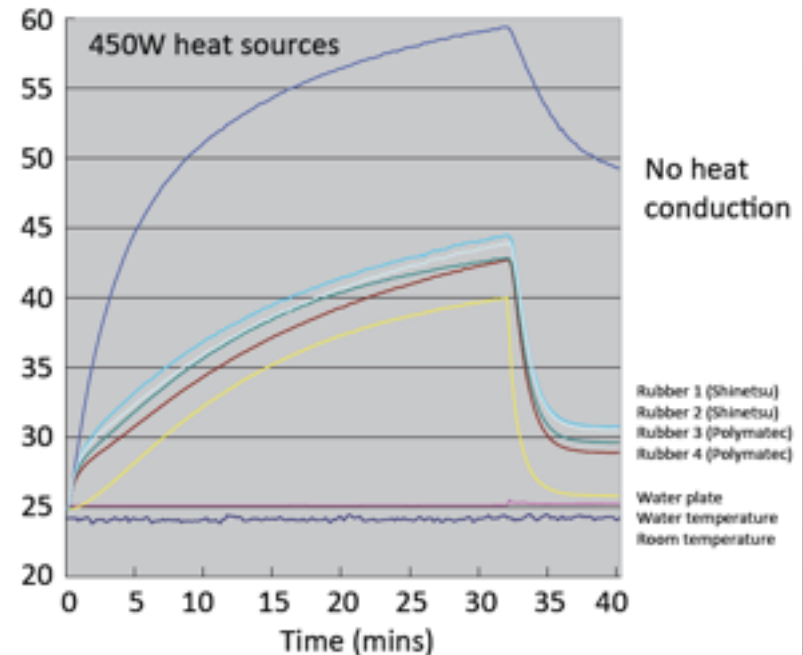
pump

Water tank as a chiller

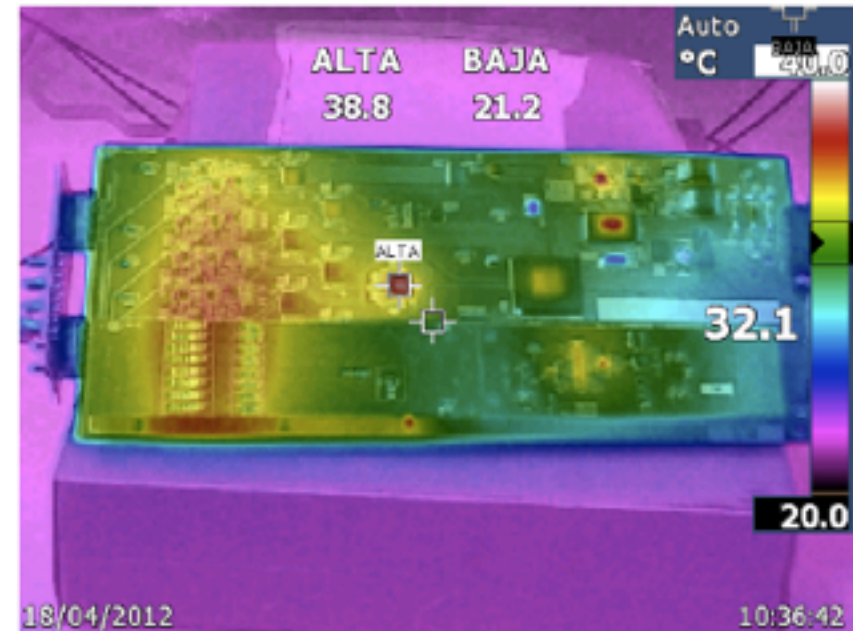
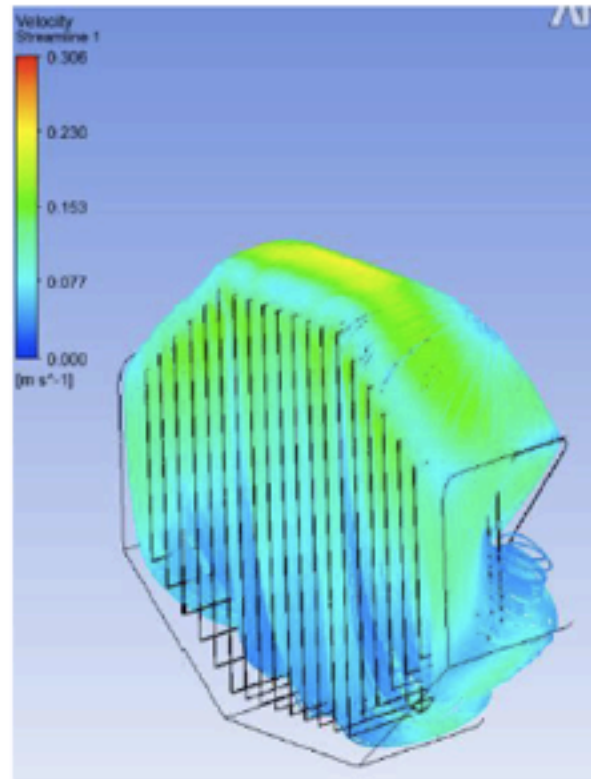
Thermometer



Degree °C

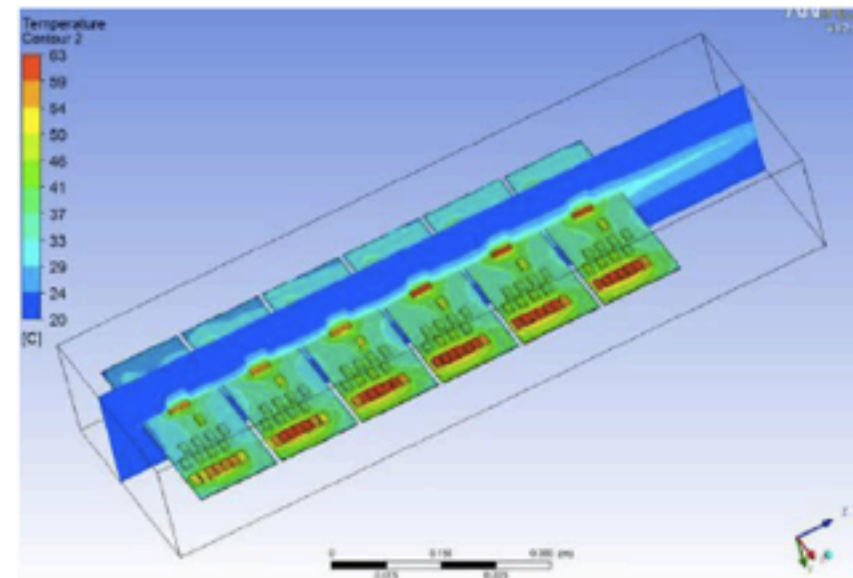


• Camera cooling strategy



Camera design is based in a force air cooling strategy to maintain the air inside an insulated body at a referenced temperature.

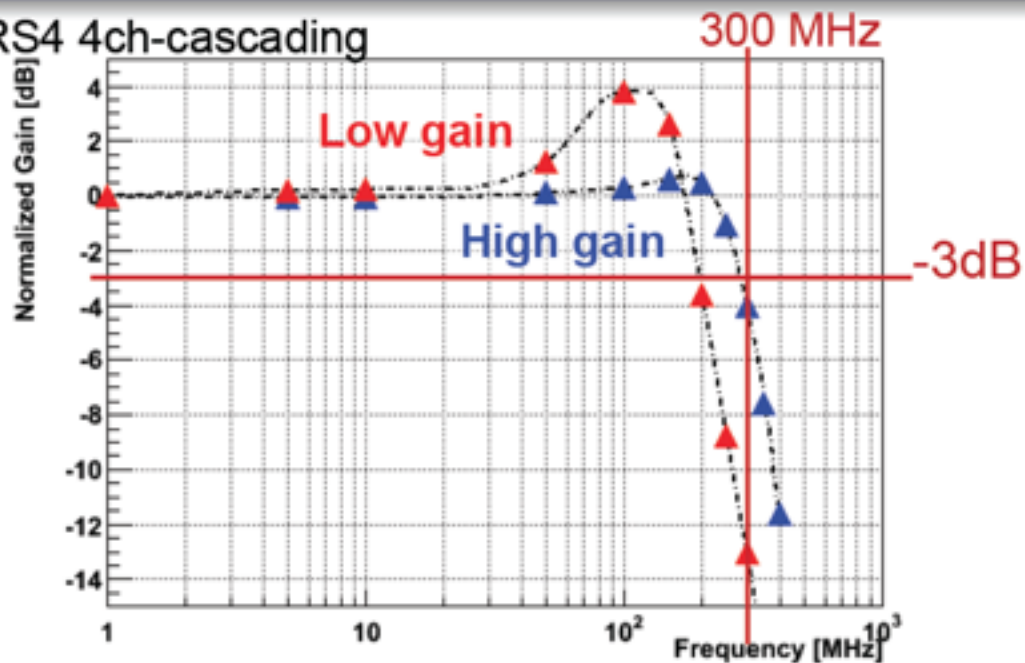
Electronic cards are mounted aligned in order to create channels in which recirculate the cooling air.



Bandwidth of DRS4 Readout Board

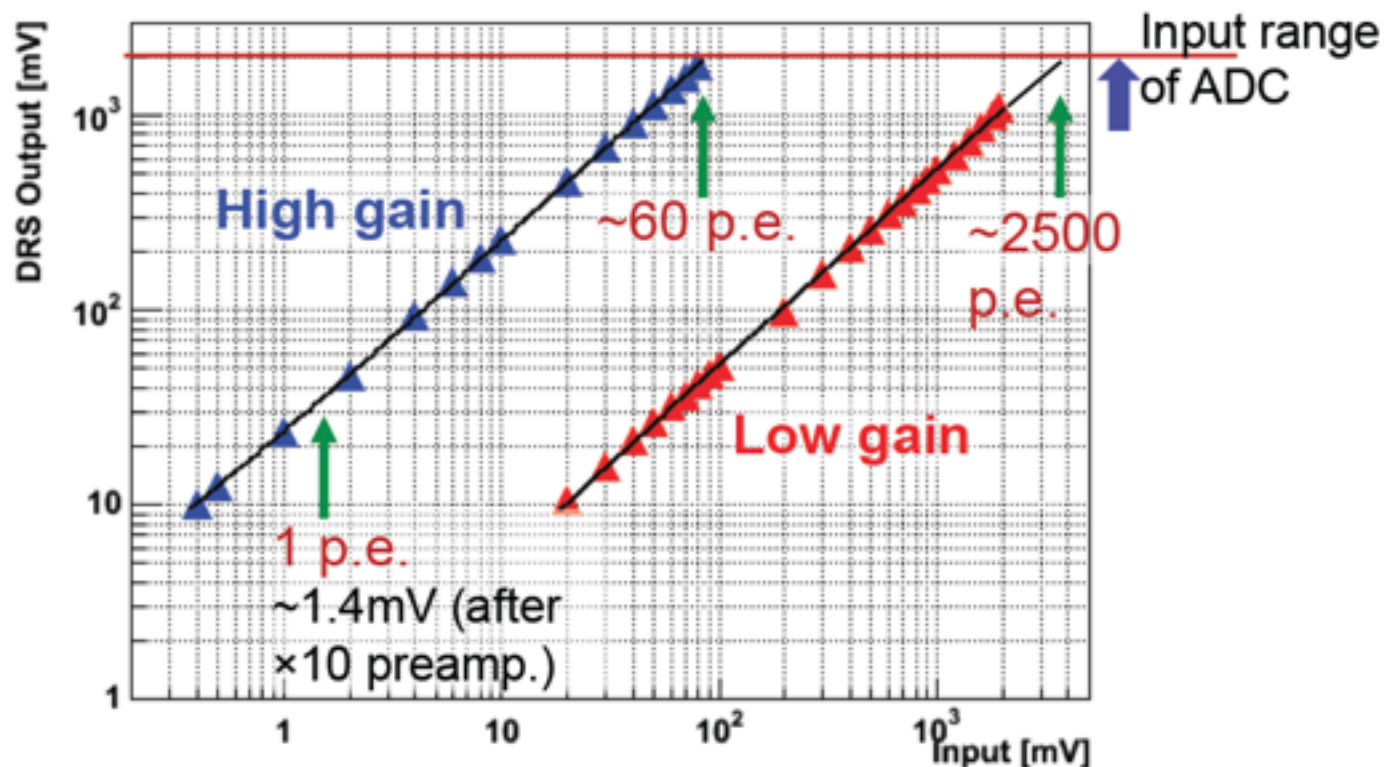


with DRS4 4ch-cascading



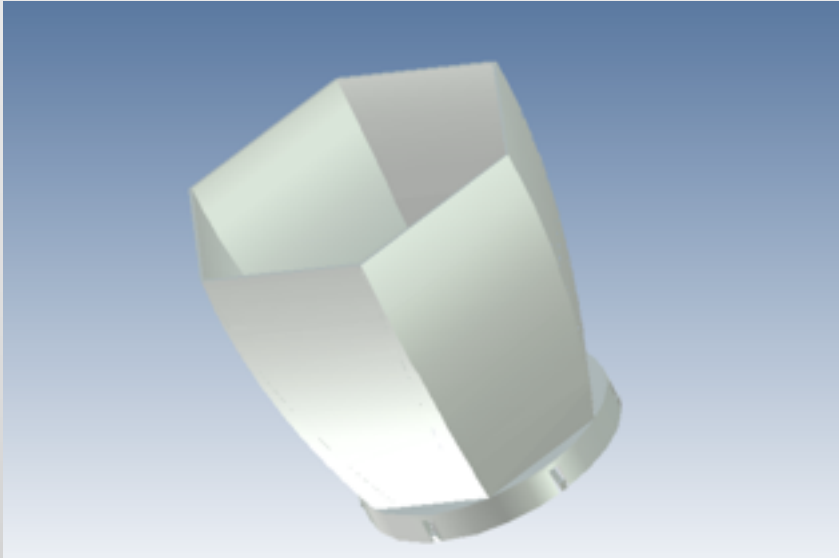
Bandwidth(-3dB) (requirement is not specified in Level 1 D. doc.)

- High gain: 275 MHz OK or not
- Low gain: 200 MHz OK BW is lower
- Trigger: >350 MHz OK capacitance

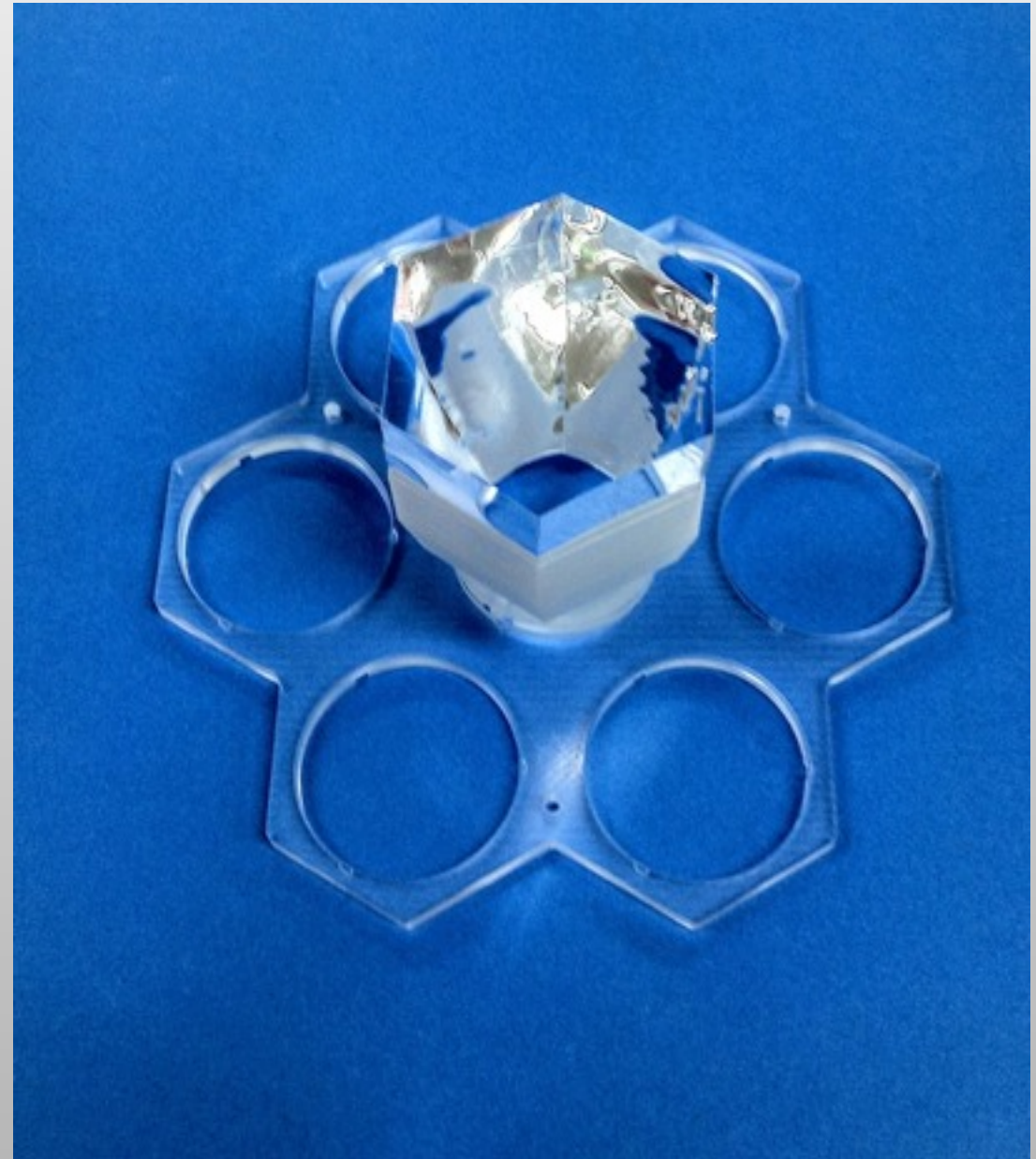


Winston Cone Prototyping in Japan

4Euro/pcs in mass production



Designed in ICRR, Ibaraki-U and Nagoya-U



protomold Injection Molding Service

proto labs Real Parts. Really Fast.

ISO 9001:2008 Certified

HOME RESOURCES COMPANY CONTACT US LOCATION

Print quote Print PDF

PROTOQUOTE[®]

Prepared for:
ABC Design Co
Quote Number: **173644** Quote Date: **7/1/2012**
Part Name/Number: **Sample Part**
Totals: **3.687** in x **1.896** in x **0.733** in

[View in 3D](#)

Thank you for the opportunity to quote your parts. We look forward to working with you on this project. Should you have any questions, please do not hesitate to contact us at 877.479.3680.

1 Confirm or Modify Specifications and Review Pricing

Cavities:	1 cavity
A-side (green) finish:	SP1-F1 (Low-cosmetic - most toolmarks removed)
B-side (blue) finish:	SP1-A2 (High polish)
Tooling Price: \$3,435.00	
Sample Quantity:	100 Sample Parts 100 @ \$3.27: \$327.00
Delivery:	Sample parts ship in 15 business days (standard delivery)
Material:	ABS, Black (usbrn 431-904000)
Change Material Color	
The selected material is not compatible with added colorants	

Total USD: **\$3,662.00**

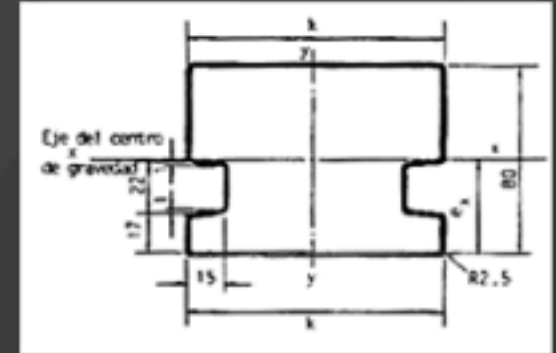
Rail Design

INSPIRED IN

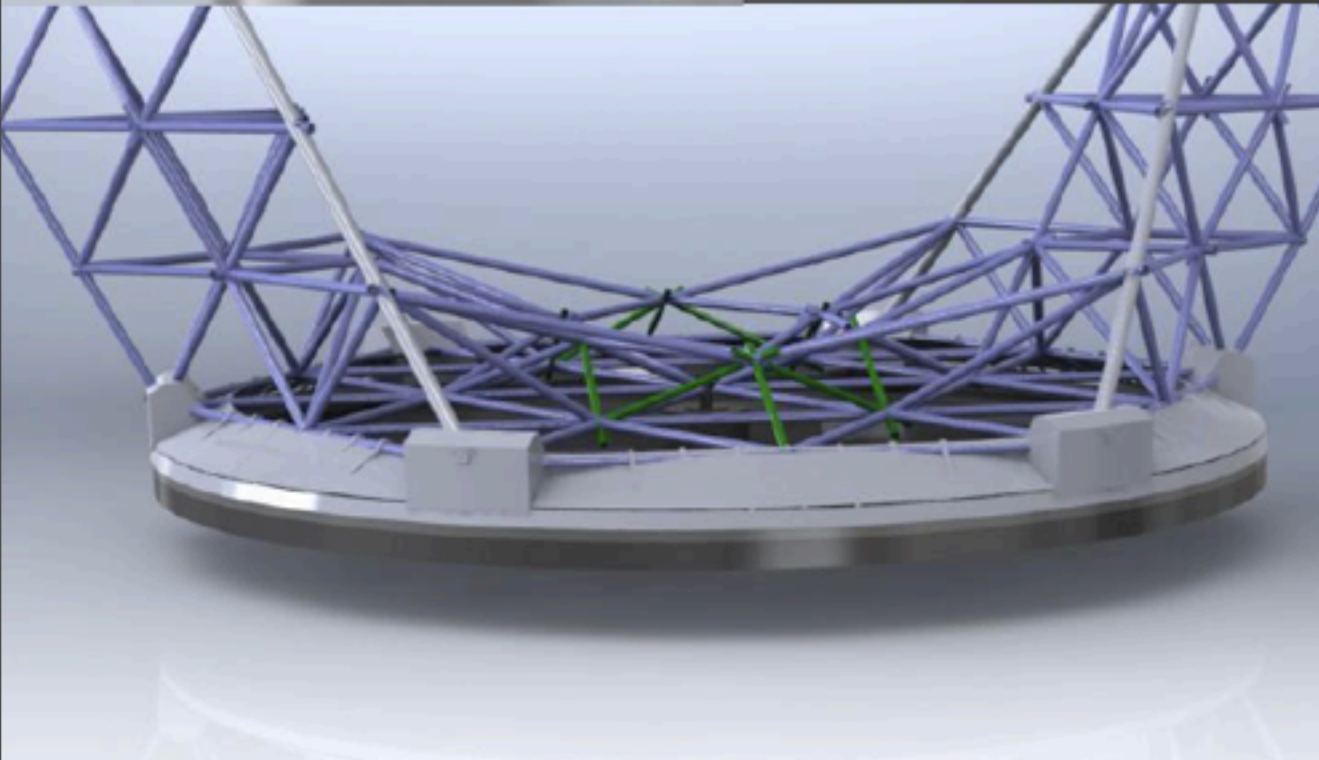
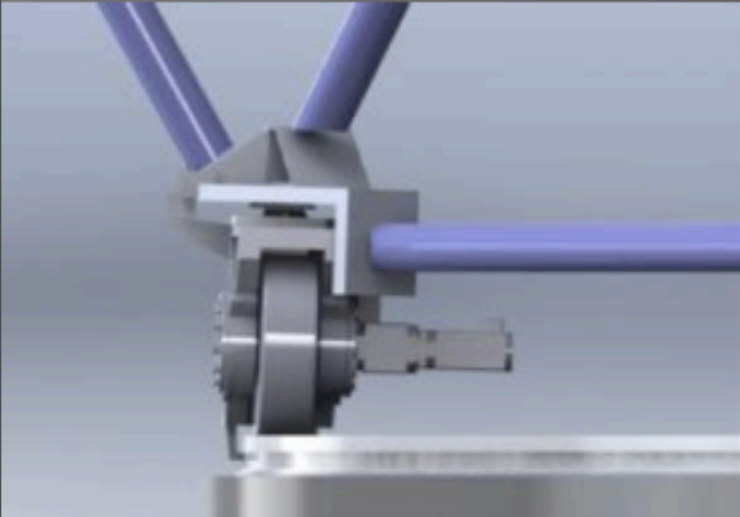
· LMT RAIL

FEATURES:

- Standard flat shape
- Line of contact
- Mat: F1250
- Cover to avoid dust, ice, sand, tools... piling up
- Floating anchorage



Alte- ria- tura	Anchura de la cabeza	Sección	Peso	Momento de inercia	Distancia al centro de gravedad	Momento de resis- tencia	Momento de inercia	Momento resis- tencia
	h	cm^2	kg/m	cm^4	cm	cm^3	cm^4	cm^3
1.100	100	70.2	43.5	458	4.09	90	541	118
1.120	110	85.2	51.3	499	4.27	120	567	130



Rail and bogey system

1 or 2 motor per tractor bogie. To be decided soon

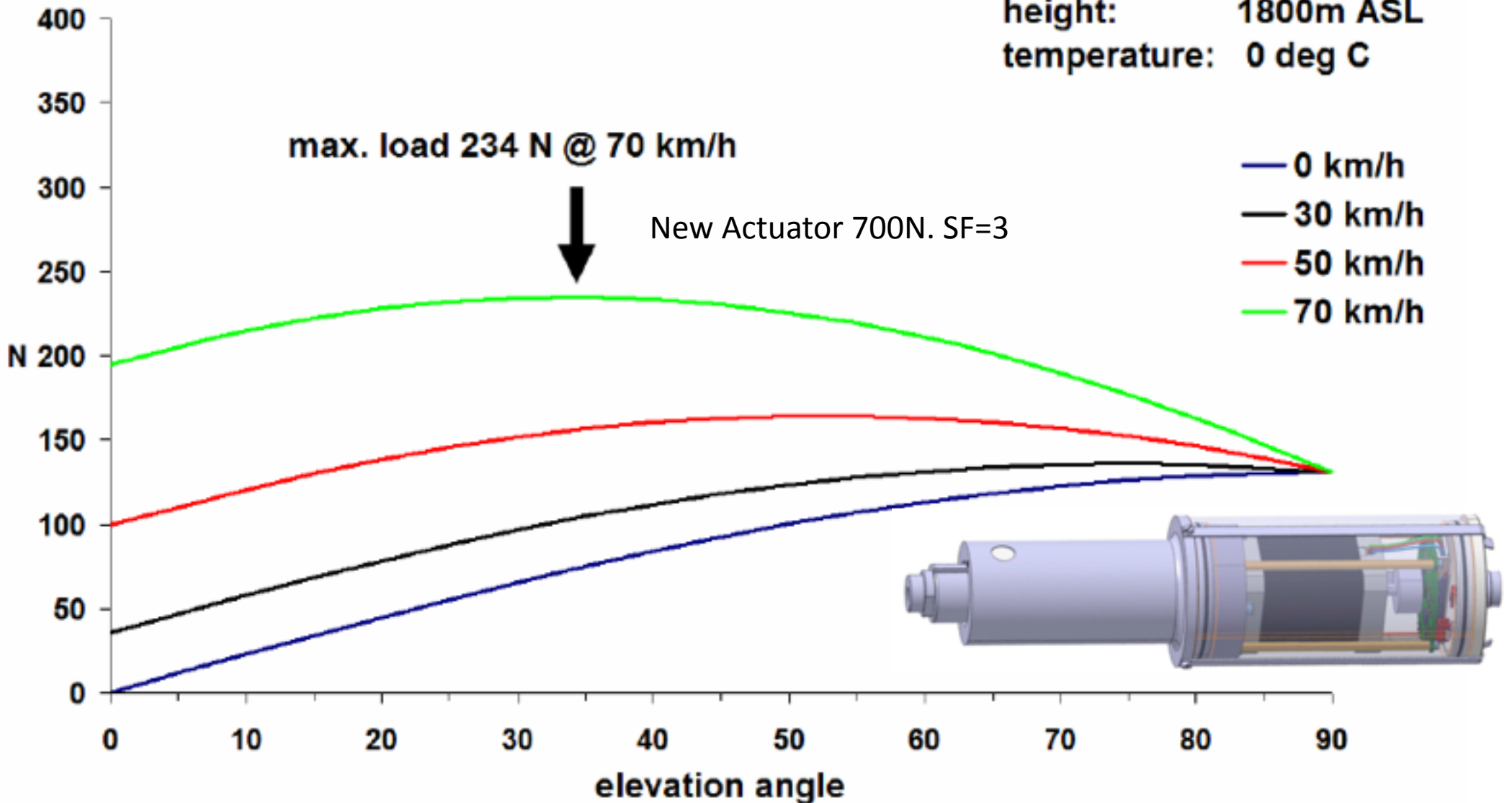




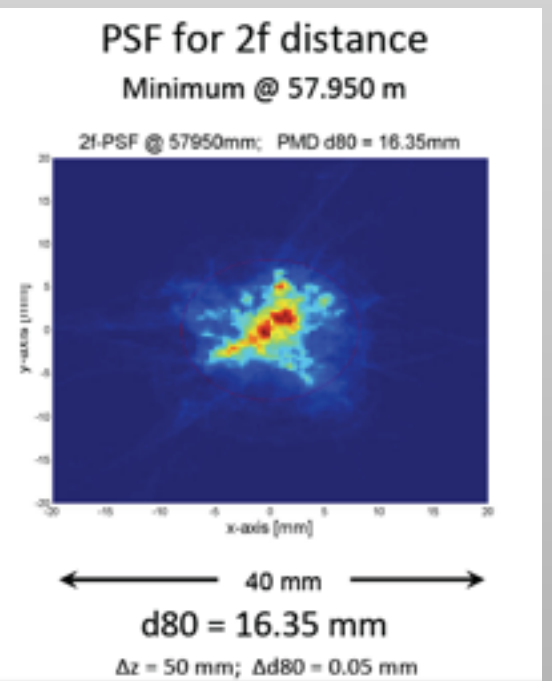
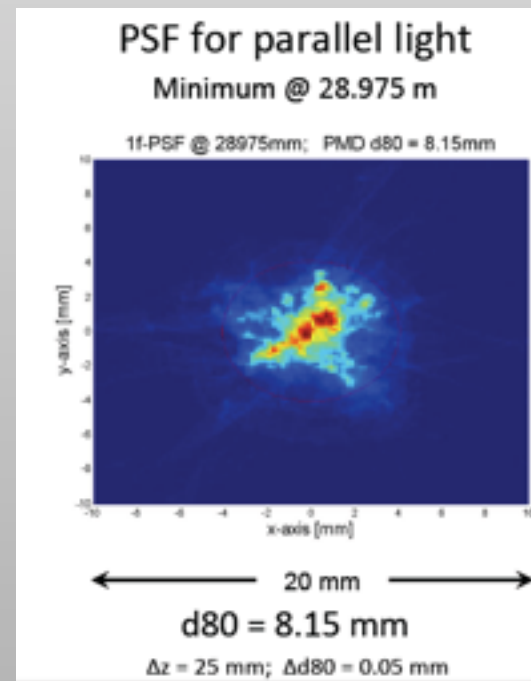
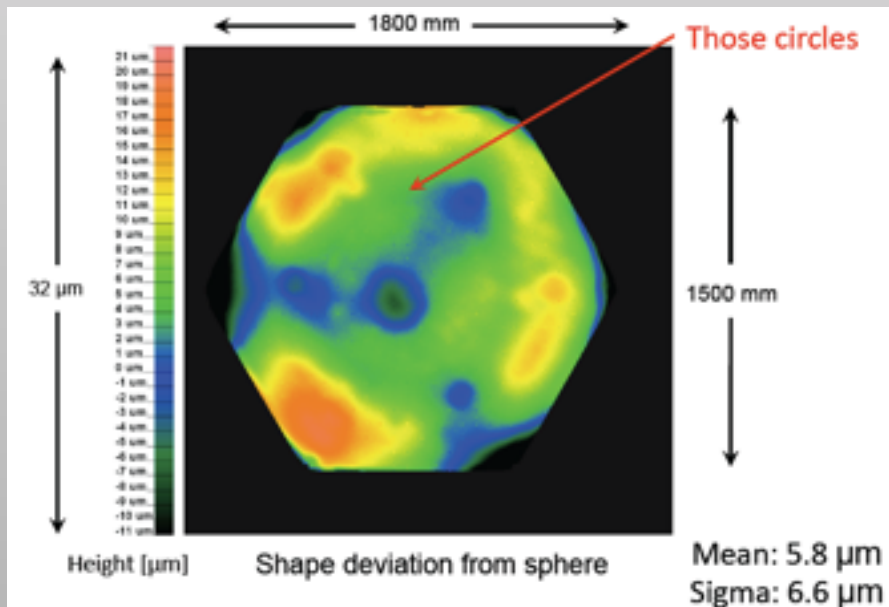
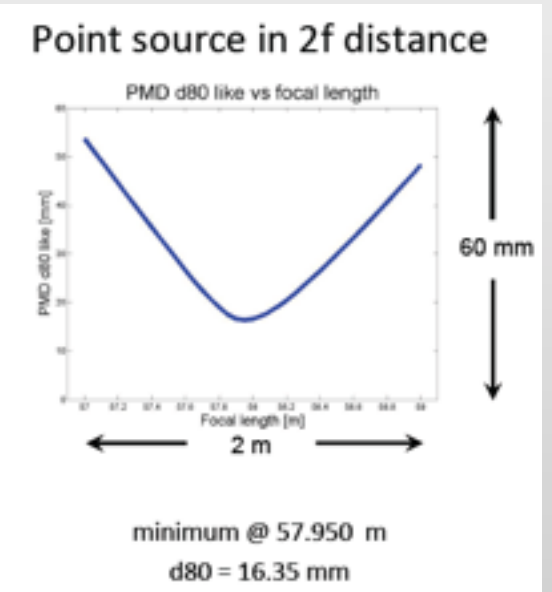
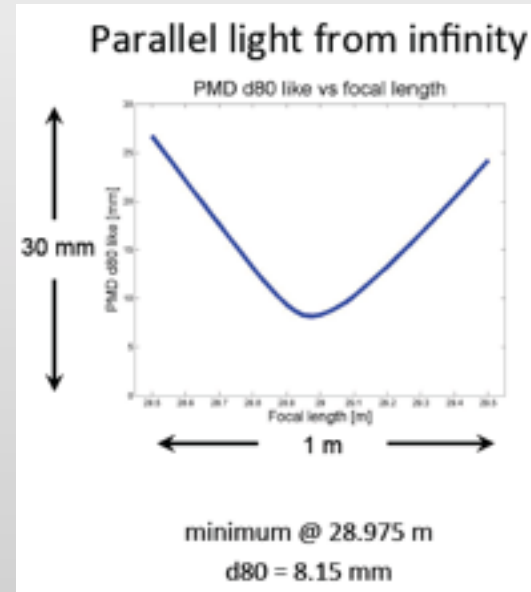
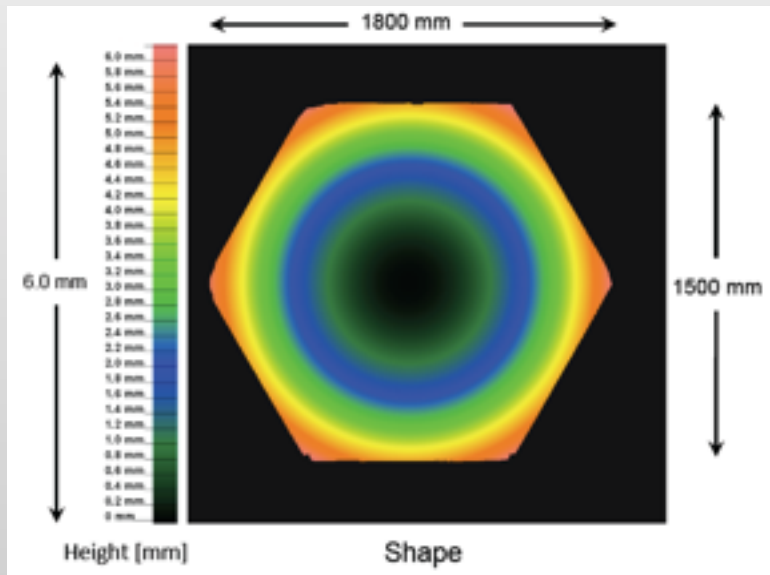
Loads @ 70 km/h

actuator load

mass: 40 kg
area: 2.0 m²
height: 1800m ASL
temperature: 0 deg C

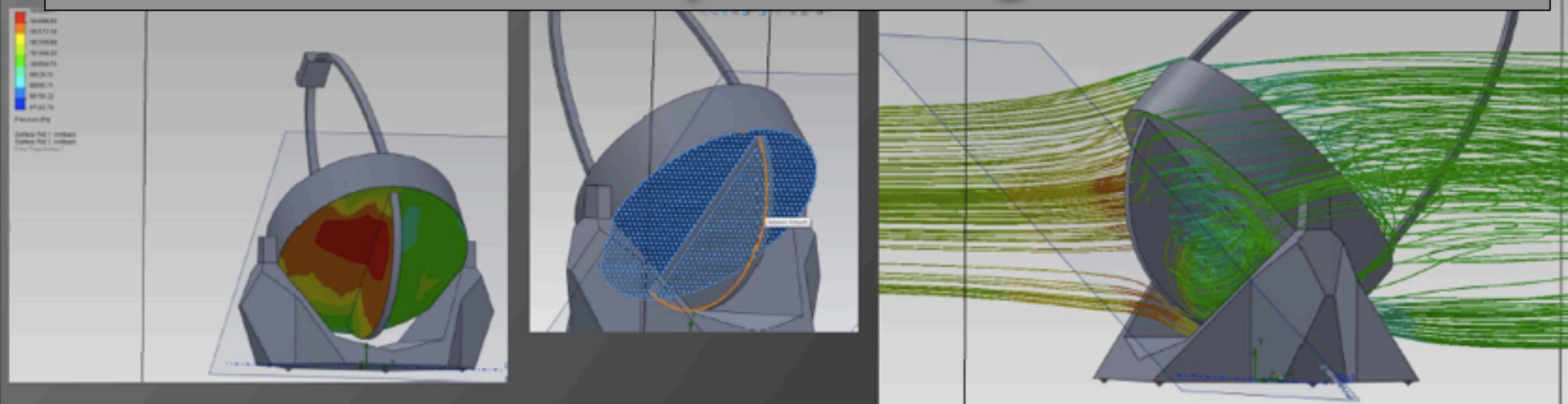


Sanko Mirror #01



Calculations for Wind by Ferran Granena (IFAE):

We have uplift during storm



kph / TON	FEA	MERO	error
200	75 / -30	70 / -28	7%
<u>200@45°</u>	.68 / -38	?	?
100	40 / -6	?	?
<u>100@45°</u>	<u>.37 / -8</u>	?	?
50	23 / 10.	28 / 8.	20%
<u>50@45°</u>	22 / 9	?	?

This is a straight estimation, of what could be the worse case situation under moving conditions.

All bogies could be under uplifting >> design needs to support this new constrain

Point Parameters 50kph

0,415 m2/point
10698,13741 Total Force
0,7563583 Uplifting force [TON]

Global Coordinate System

Medium - Fluid/Solid; Iteration = 54

x [m]	y [m]	z [m]	Pressure [Pa]
-3,032518625	13,28556347	0,545598149	99966,48062
-3,032518625	13,28556347	1,175110102	99966,39775
-3,032518625	13,28556347	1,804622054	99966,17621
-3,032518625	13,28556347	2,434134007	99965,59298
-3,032518625	13,28556347	3,063645960	99965,05087
-3,032518625	13,28556347	3,693157913	99966,34887
-3,032518625	13,28556347	4,322669866	99967,03756
-3,032518625	13,28556347	4,952181819	99966,26038
-3,032518625	13,28556347	5,581693772	99971,7306
-3,032518625	13,28556347	6,211205725	99975,0496

Point Parameters 200kph

0,415 m2/point
172876,1468 Total Force
12,1657129 Uplifting force [TON]

Global Coordinate System

Medium - Fluid/Solid; Iteration = 54

x [m]	y [m]	z [m]	Pressure [Pa]
-3,032518625	13,28556347	0,545598149	99470,06752
-3,032518625	13,28556347	1,175110102	99469,62784
-3,032518625	13,28556347	1,804622054	99469,12758
-3,032518625	13,28556347	2,434134007	99468,57722
-3,032518625	13,28556347	3,063645960	99468,07686
-3,032518625	13,28556347	3,693157913	99467,52650
-3,032518625	13,28556347	4,322669866	99466,97614
-3,032518625	13,28556347	4,952181819	99466,42578
-3,032518625	13,28556347	5,581693772	99465,87542
-3,032518625	13,28556347	6,211205725	99465,32506

Point Parameters 100kph

0,415 m2/point
40005,25065 Total Force
3,0440066 Uplifting force [TON]

Global Coordinate System

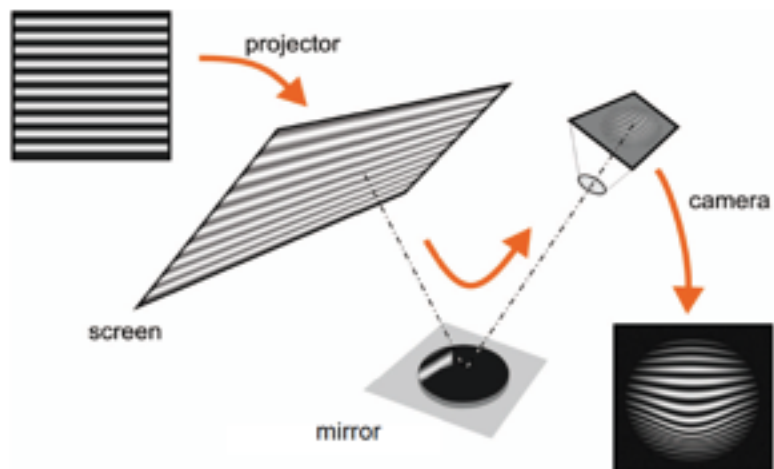
Medium - Fluid/Solid; Iteration = 54

x [m]	y [m]	z [m]	Pressure [Pa]
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-3,032518625	13,28556347	1,175110102	99865,84489
-3,032518625	13,28556347	1,804622054	99865,48247
-3,032518625	13,28556347	2,434134007	99865,12005
-3,032518625	13,28556347	3,063645960	99864,75763
-3,032518625	13,28556347	3,693157913	99864,39521
-3,032518625	13,28556347	4,322669866	99864,03279
-3,032518625	13,28556347	4,952181819	99863,67037
-3,032518625	13,28556347	5,581693772	99863,30795
-3,032518625	13,28556347	6,211205725	99862,94553

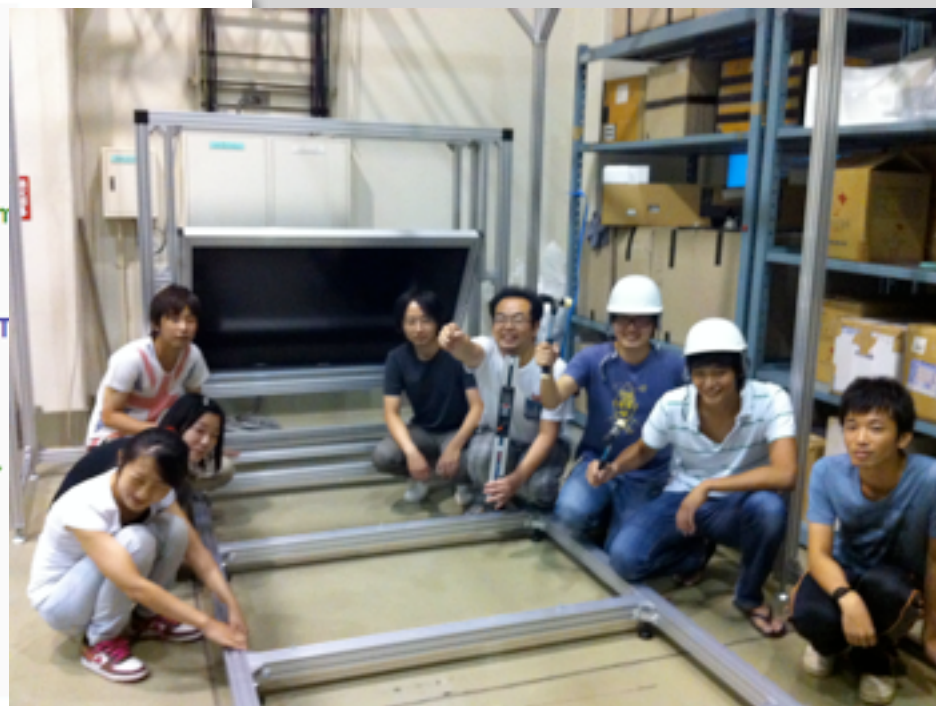
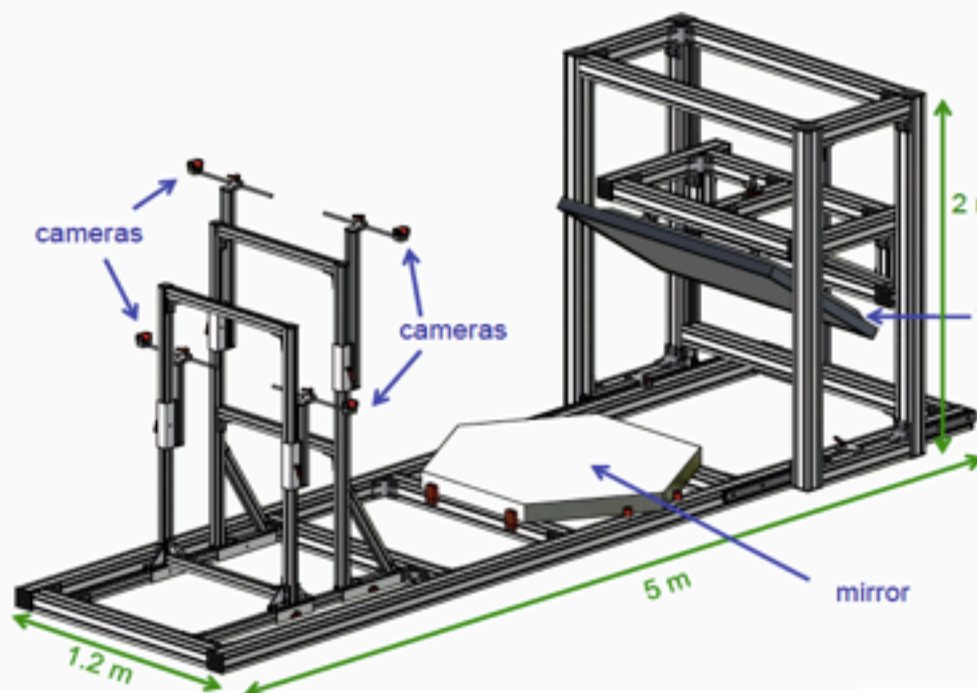
PMD system is installed at ICRR, U-Tokyo (developed by experts of Erlangen optic group)



PMD - Measurement Principle



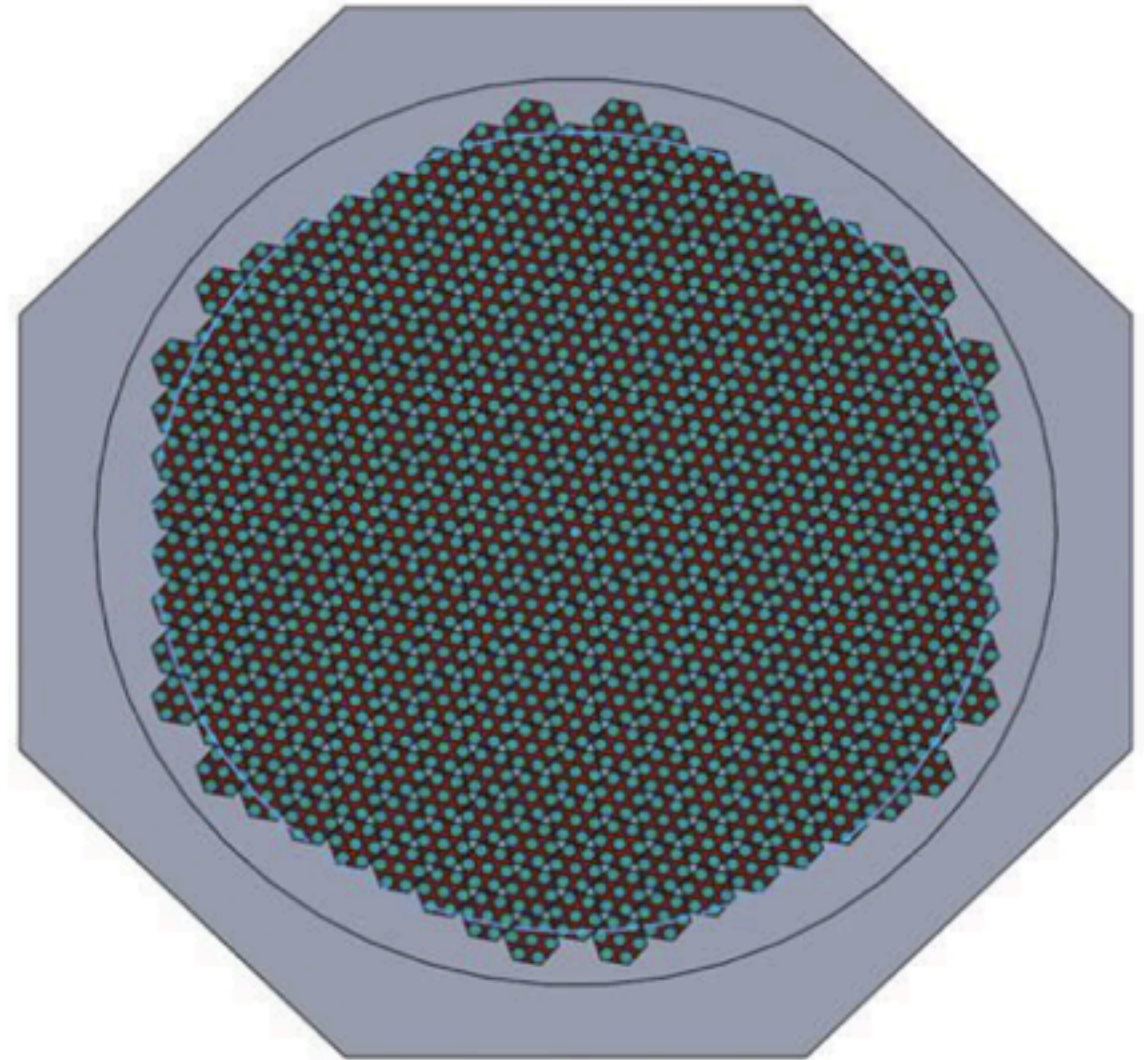
Installed at ICRR
U.Tokyo



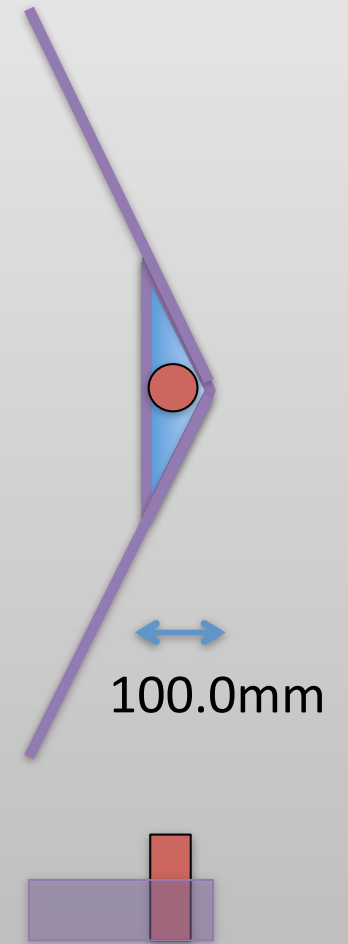
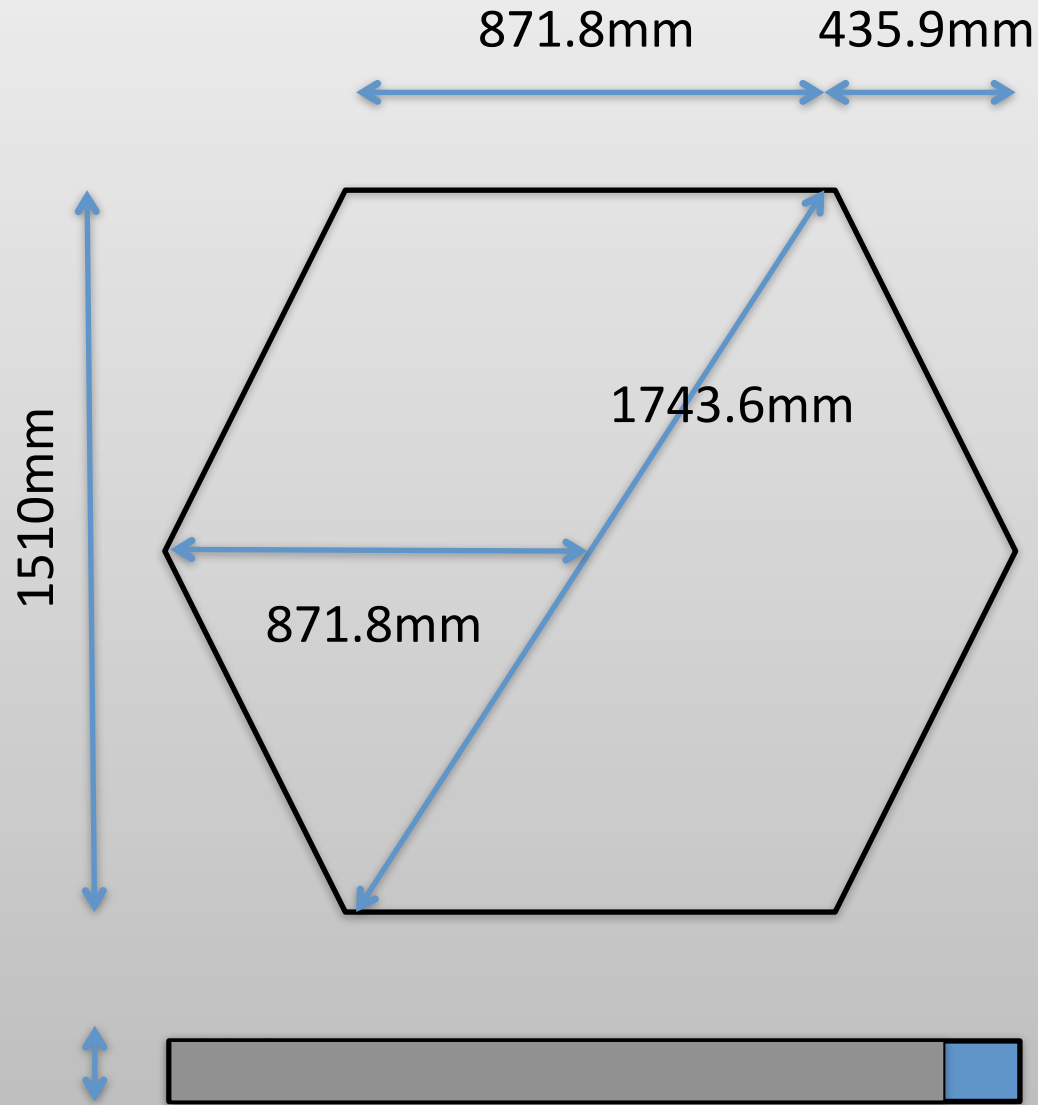
• Optical plane: Proposal

• Proposal:

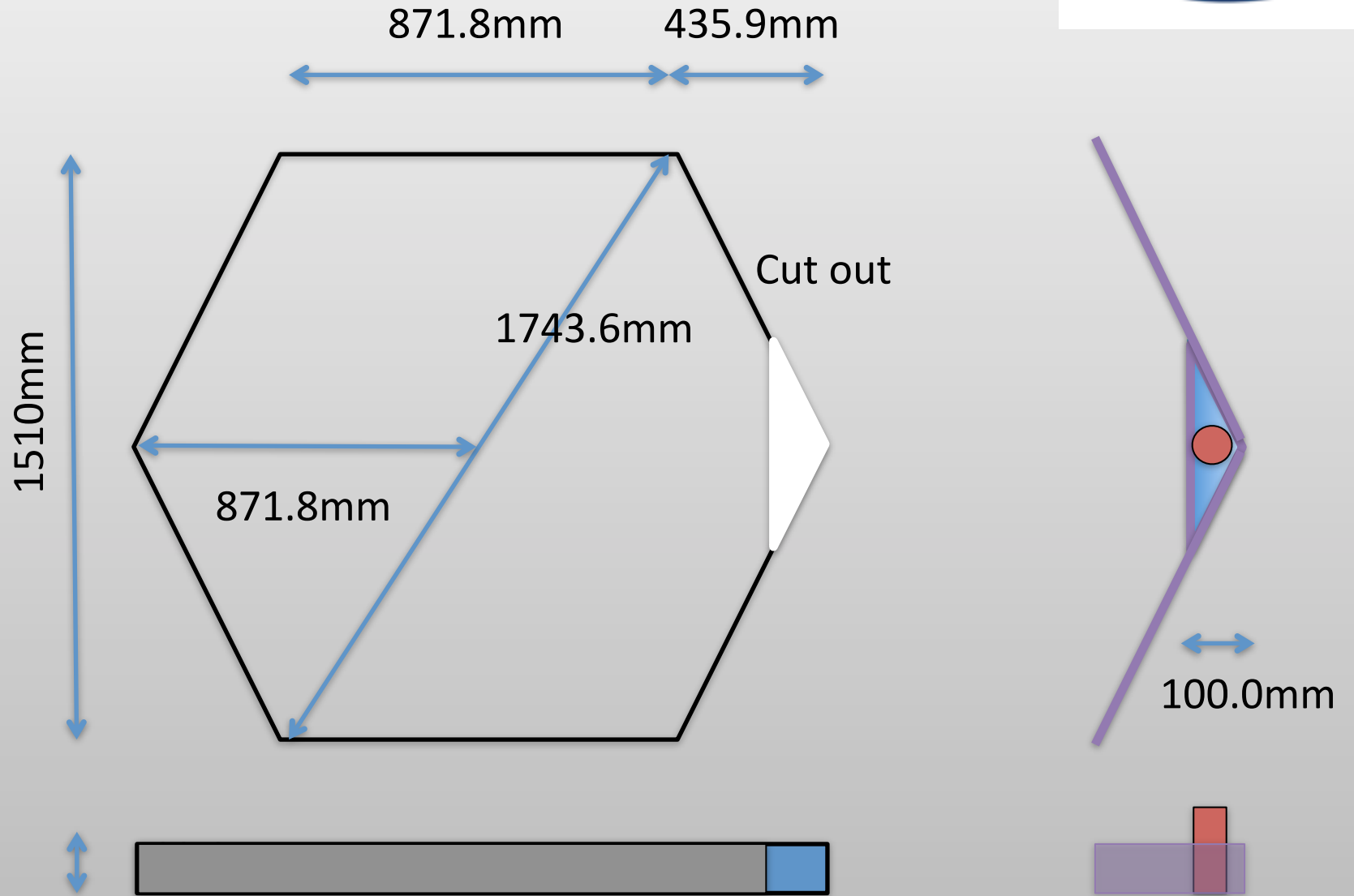
- Camera diameter: 2200 mm
 - Number of clusters: 265
 - Central cluster: Case 1
 - Rotation: Case 1
-
- Easy to compatibility with MST camera



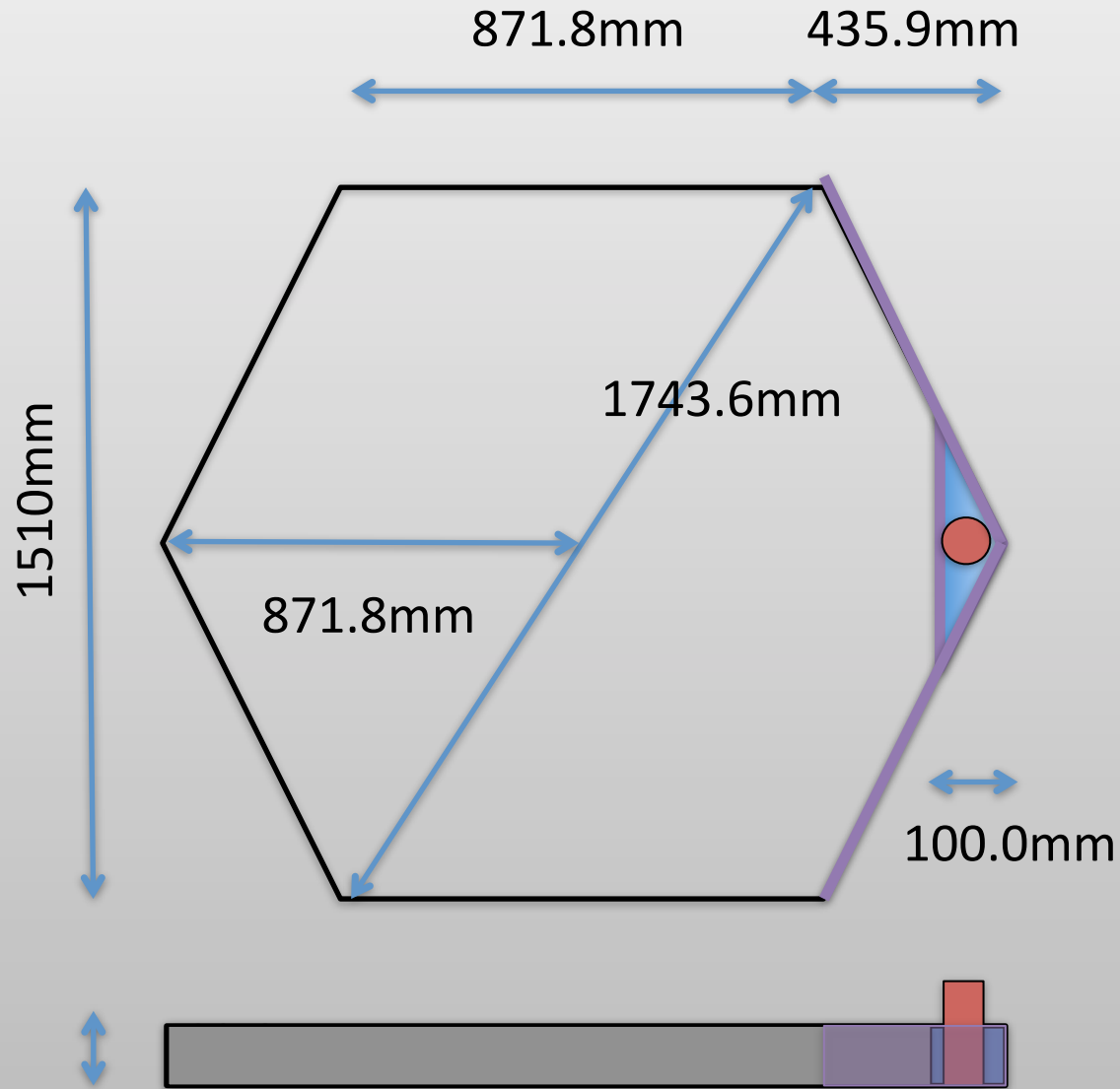
Attach AMC Laser Holder



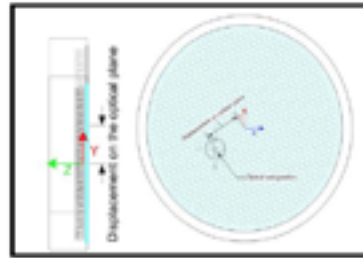
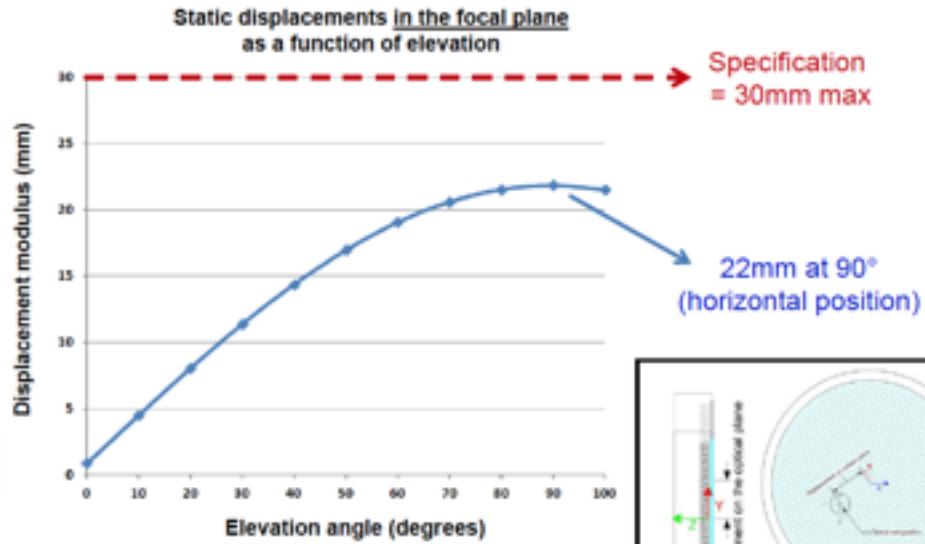
Attach AMC Laser Holder



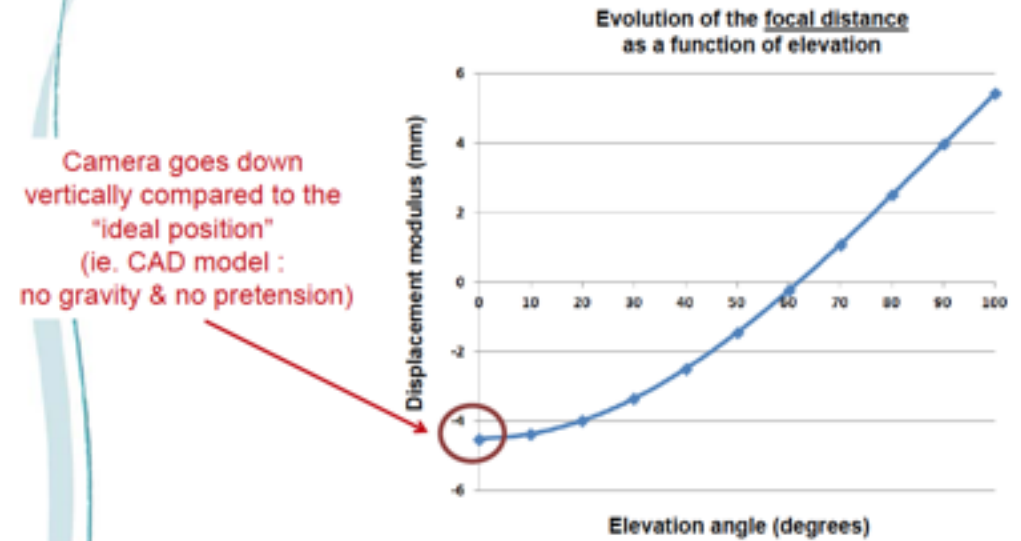
Attach AMC Laser Holder



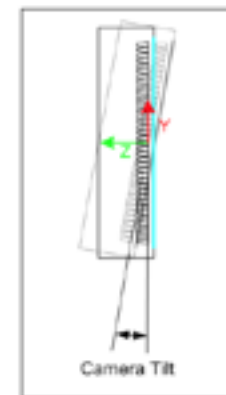
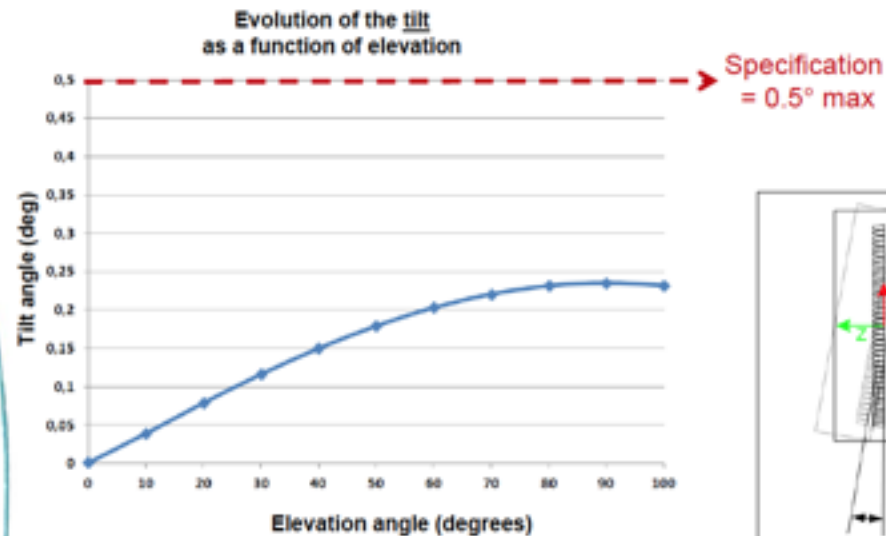
Static loadcases XY direction



Static loadcases Z direction



Static loadcases Tilt in YZ plane



NB : tilt = 3D angle and not in-plane angle