27カ国
>1000共同研究者

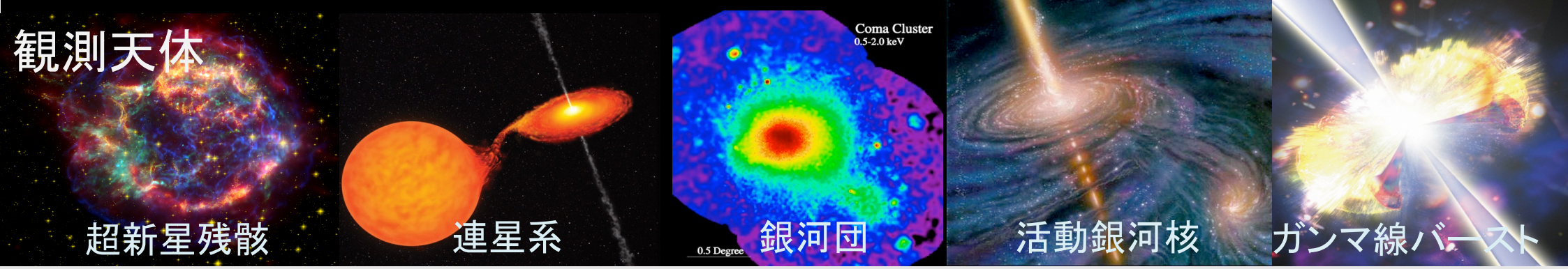
CTA 報告58 全体報告

東京大学宇宙線研究所　手嶋政廣

CTA-Japan メンバー（９４名）

手嶋政廣、窪秀利、戸谷友則、浅野勝晃、井岡邦仁、井川大地、石尾一馬、井上進、
井上芳幸、猪目祐介、上野遥、内山泰伸、大石理子、大岡秀行、大竹峻平、大平豊、
荻野桃子、奥村曉、折戸玲子、加賀谷美佳、格和純、片岡淳、片桐秀明、株木重人、
河島孝則、川中宣太、岸本哲朗、櫛田淳子、郡司修一、郡和範、小島拓実、小谷一仁、
小山志勇、今野裕介、齋藤浩二、榊直人、佐々木浩人、澤田真理、柴田徹、菅原隆希、
高橋慶太郎、高橋弘充、高橋光成、高見一、田島宏康、立原研悟、田中駿也、田中真伸、
千川道幸、辻本晋平、土屋優悟、坪根義雄、寺田幸功、當真賢二、門叶冬樹、鳥居和史、
内藤統也、中嶋大輔、長瀧重博、中森健之、中山和則、永吉勤、西嶋恭司、野里明香、
野田浩司、畑中謙一郎、花畑義隆、馬場浩則、早川貴敬、林田将明、原敏、馬場彩、
日高直哉、広谷幸一、深沢泰司、福井康雄、藤田裕、増田周、松本浩典、水野恒史、
村石浩、村瀬孔大、森浩二、柳田昭平、山崎了、山本常夏、山本宏昭、吉越貴紀、
吉田篤正、吉田龍生、李兆衡

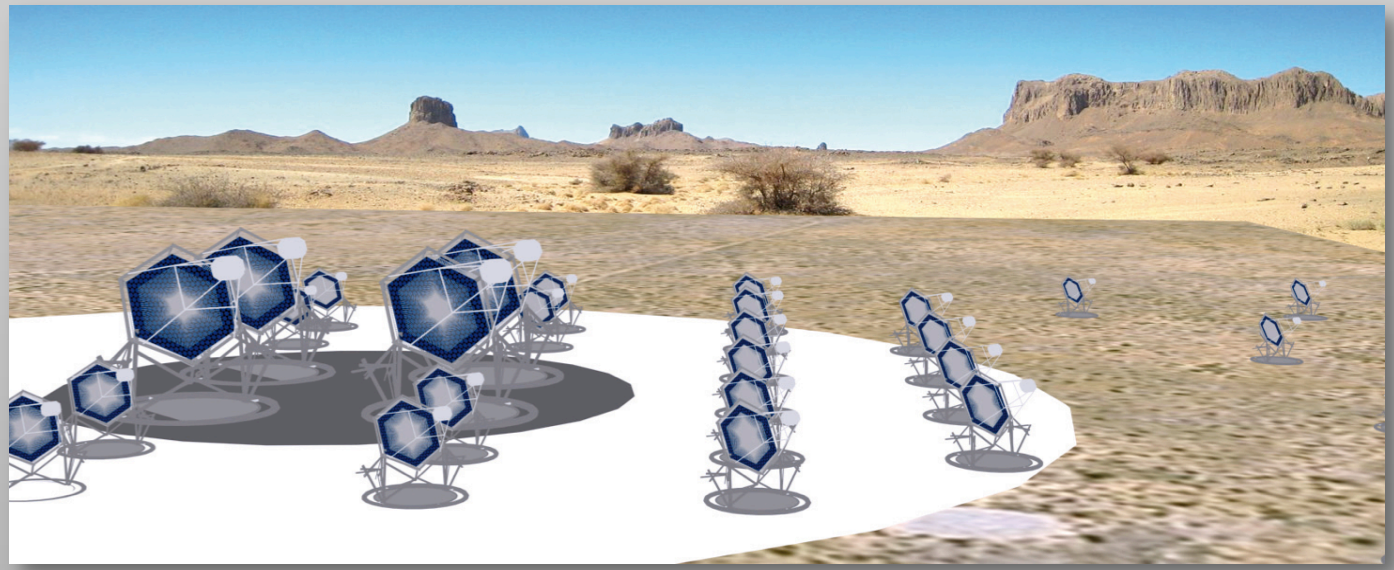
東大宇宙線研、MPI for Physics、京大理、東大理、KEK 素核研、東海大理、甲南大理工、
埼玉大理、立教大山形大理、青学大理工、名大STE 研、レスター大、徳島大総科、
茨城大理、広大理、早大理工、東海大医、熊本大理、名大理、近畿大理、阪大理、
山梨学大、理研、名大KMI、北里大医療衛生、宮崎大工



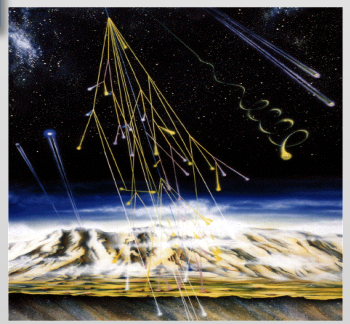
超高エネルギー宇宙ガンマ線の研究

- 宇宙線の起源
- 銀河系内、系外の高エネルギー天体の研究
- 赤外・可視背景放射（宇宙の星形成史）の研究
- 暗黒物質対消滅からのガンマ線の探索
- 相対論（量子重力理論）の高精度検証

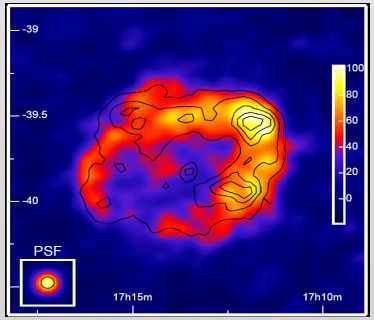
➔ Astropaticle Physics Special Issue, Vol 43 (2013)



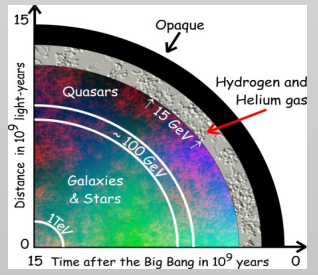
狙うサイエンス



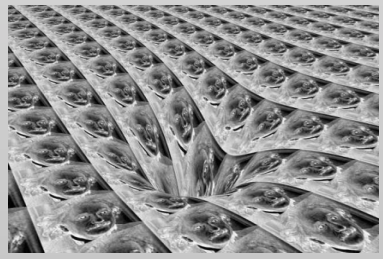
宇宙線の起源



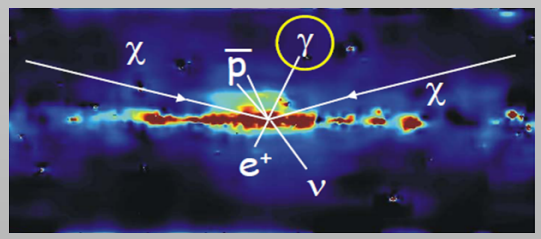
高エネルギー天体



宇宙論・星形成史



時空の構造

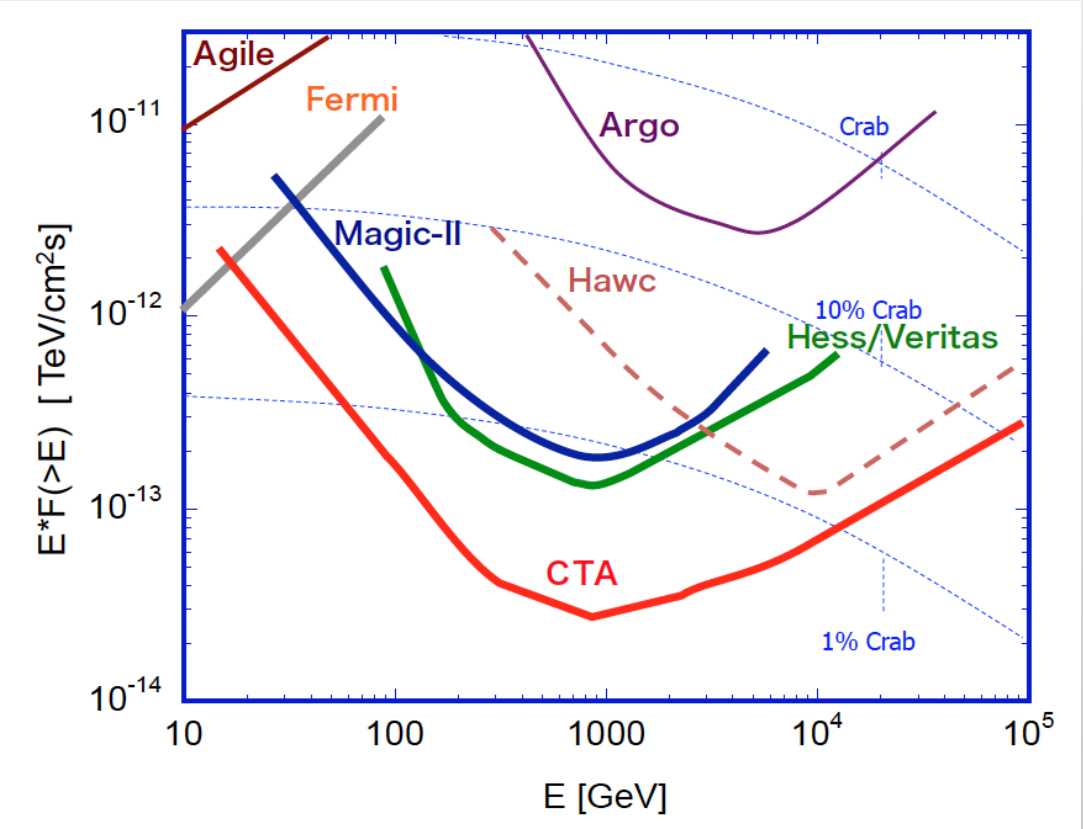


暗黒物質の探索

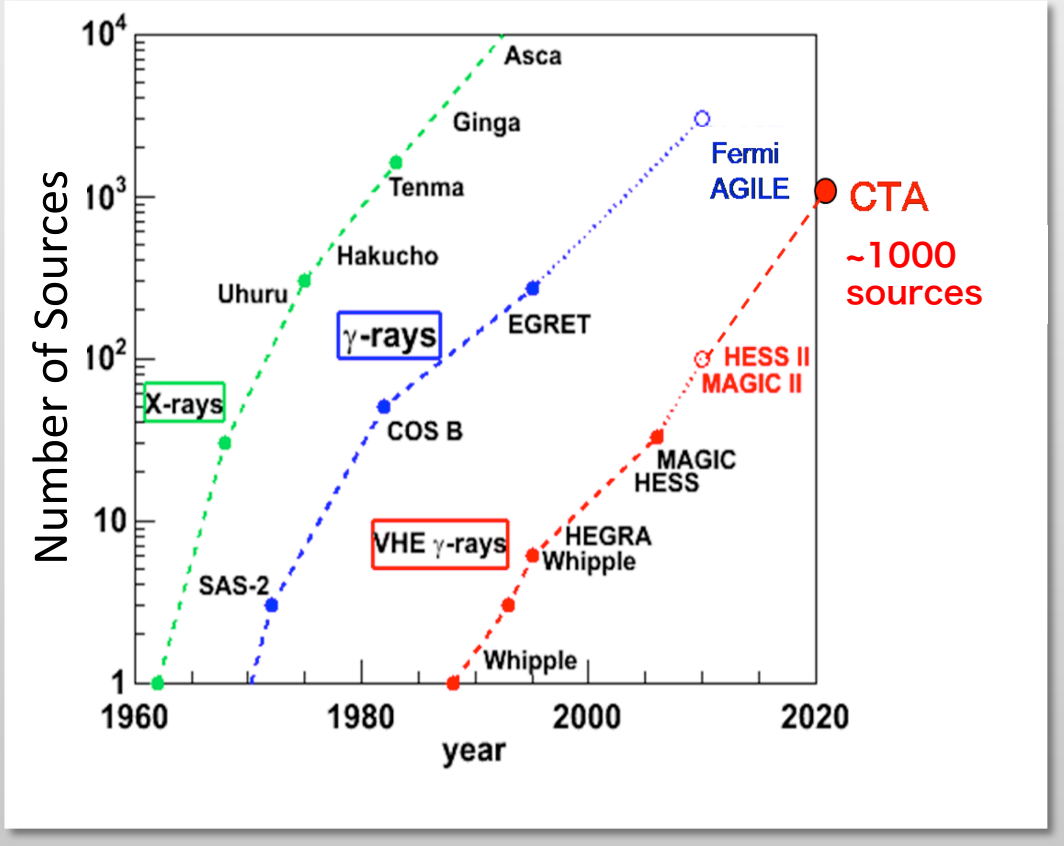
CTA（Cherenkov Telescope Array）

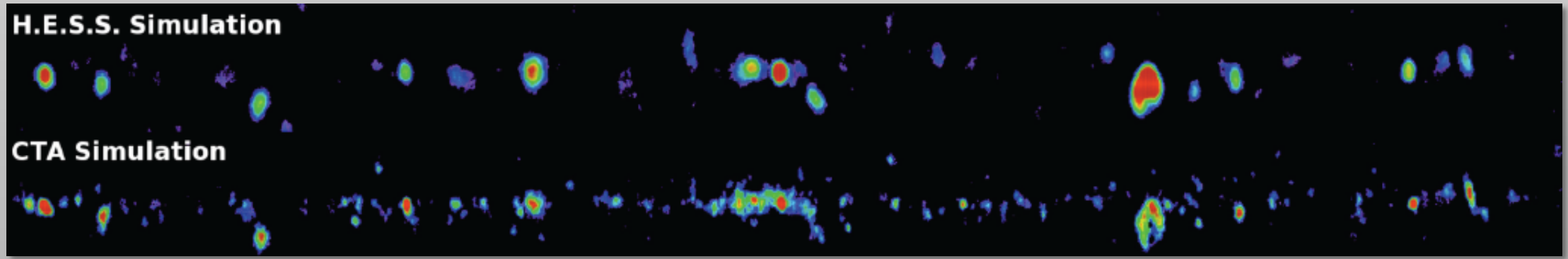
CTA Monte Carlo Study ➔ 講演59:大石（東大宇宙線研）

An order of magnitude better sensitivity
Wide energy coverage



More than 1000 sources will be discovered

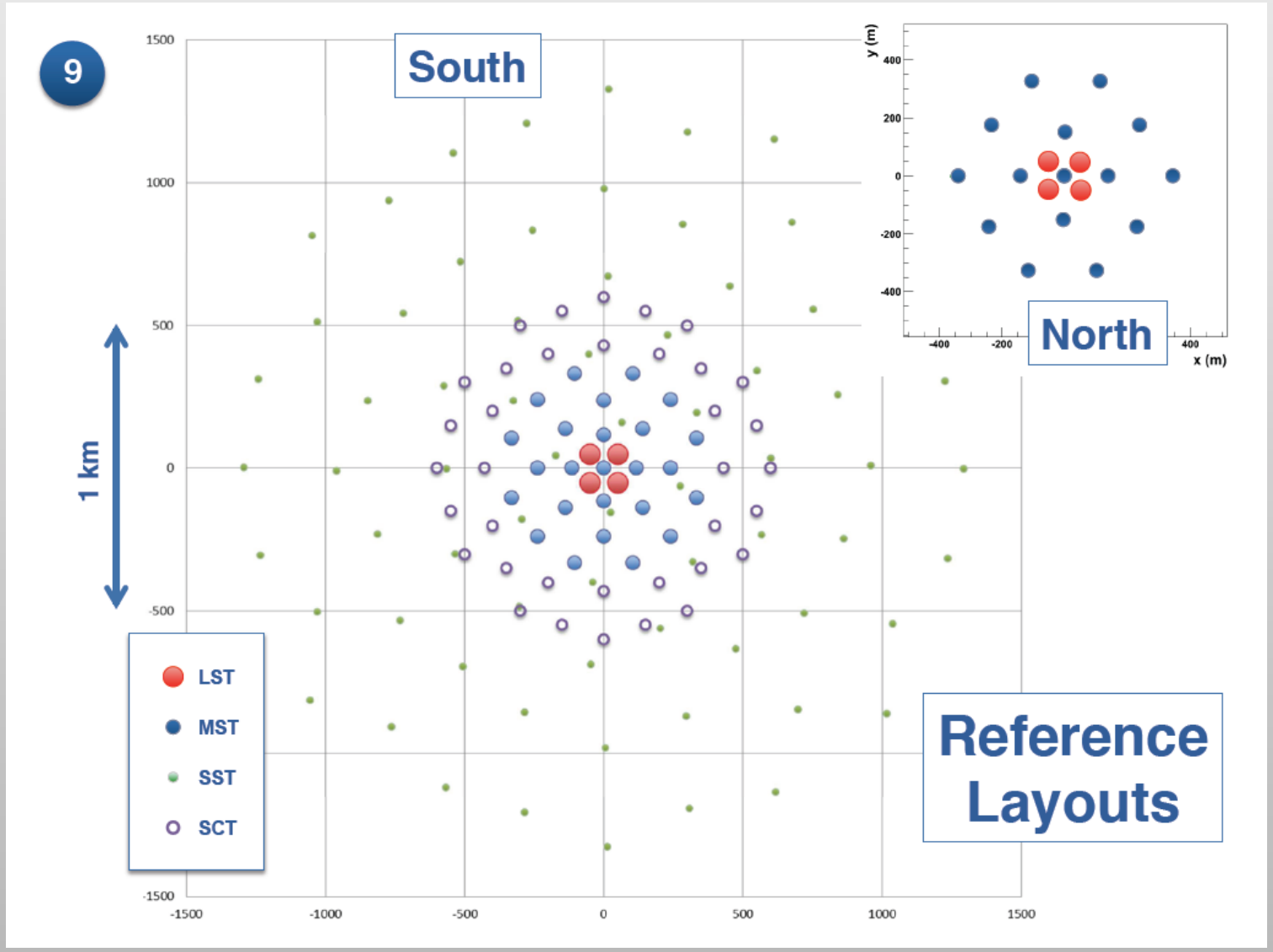


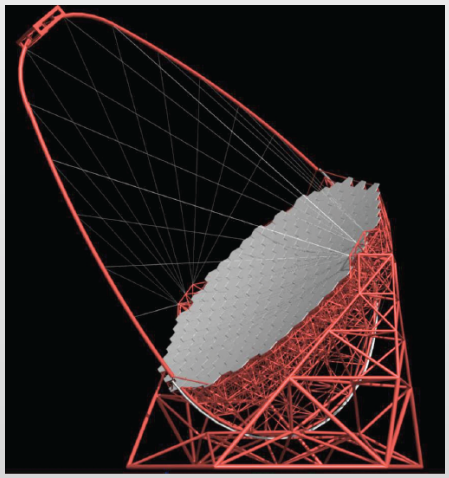


Simulation Galactic Plane scan（HESS and CTA）

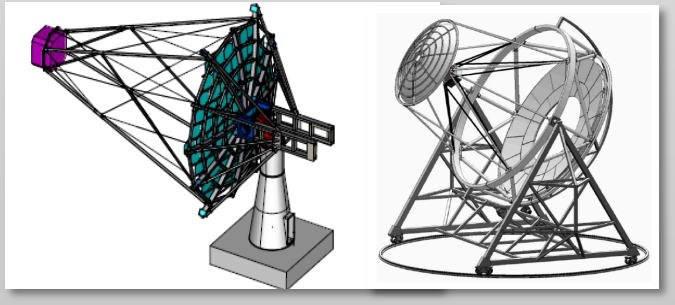
Possible array configuration

CTA Monte Carlo Study ➔ 講演59:大石(東大宇宙線研)

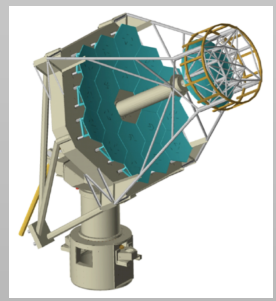




LST 23m



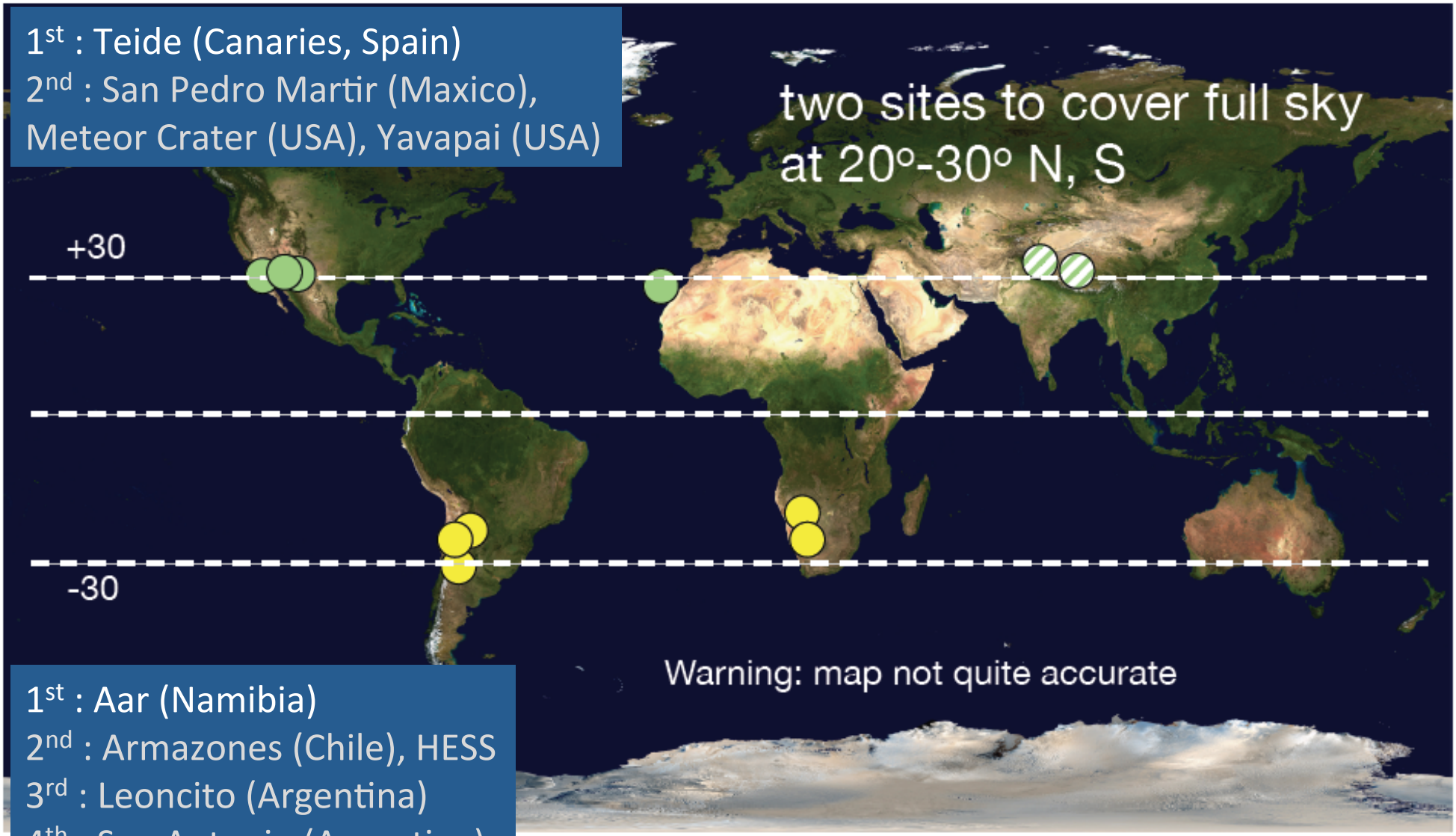
MST 10-12m



SST 4.3m

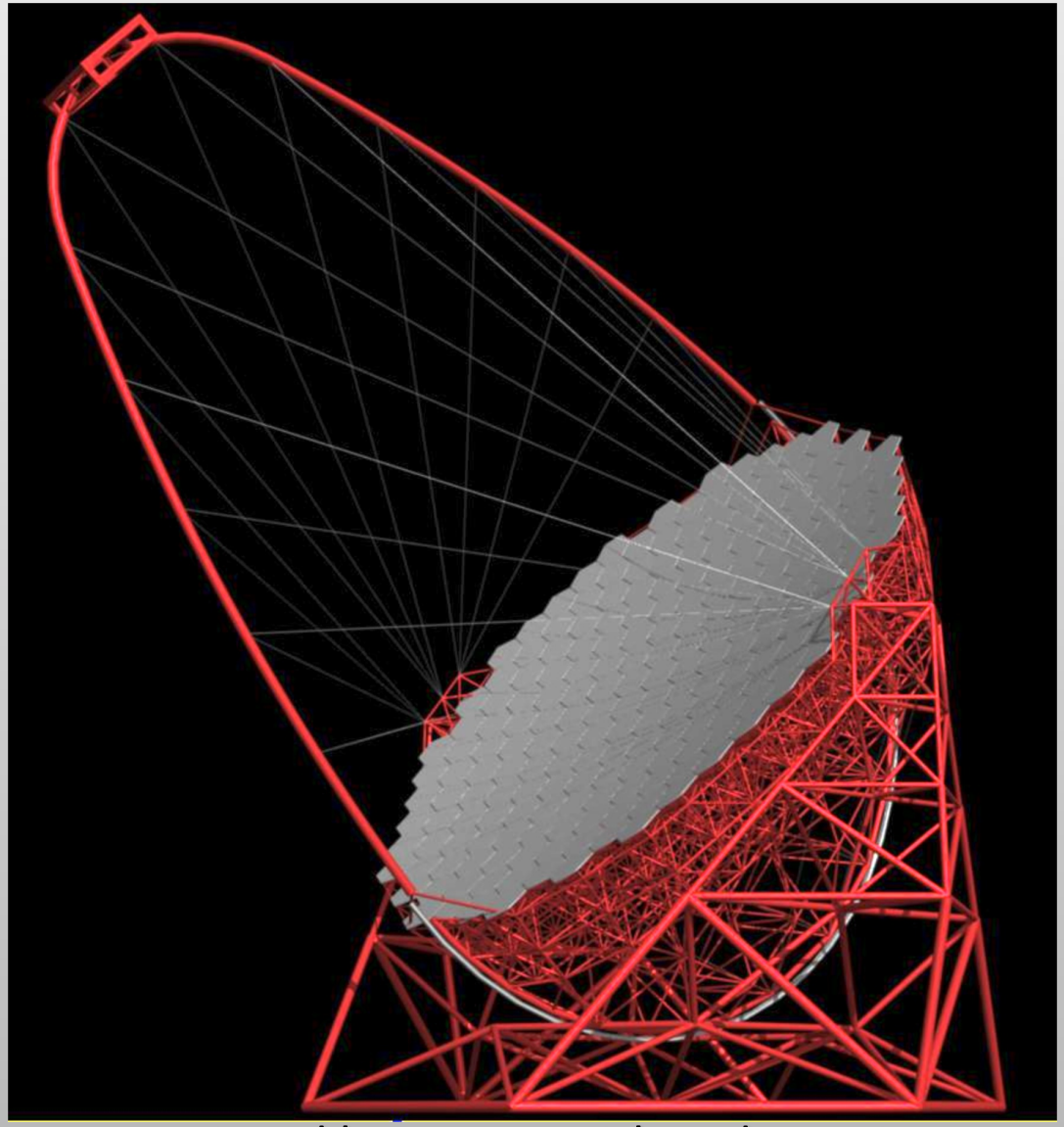
SITE CANDIDATES

Sites will be selected in the end of 2013



Major contribution by CTA-Japan

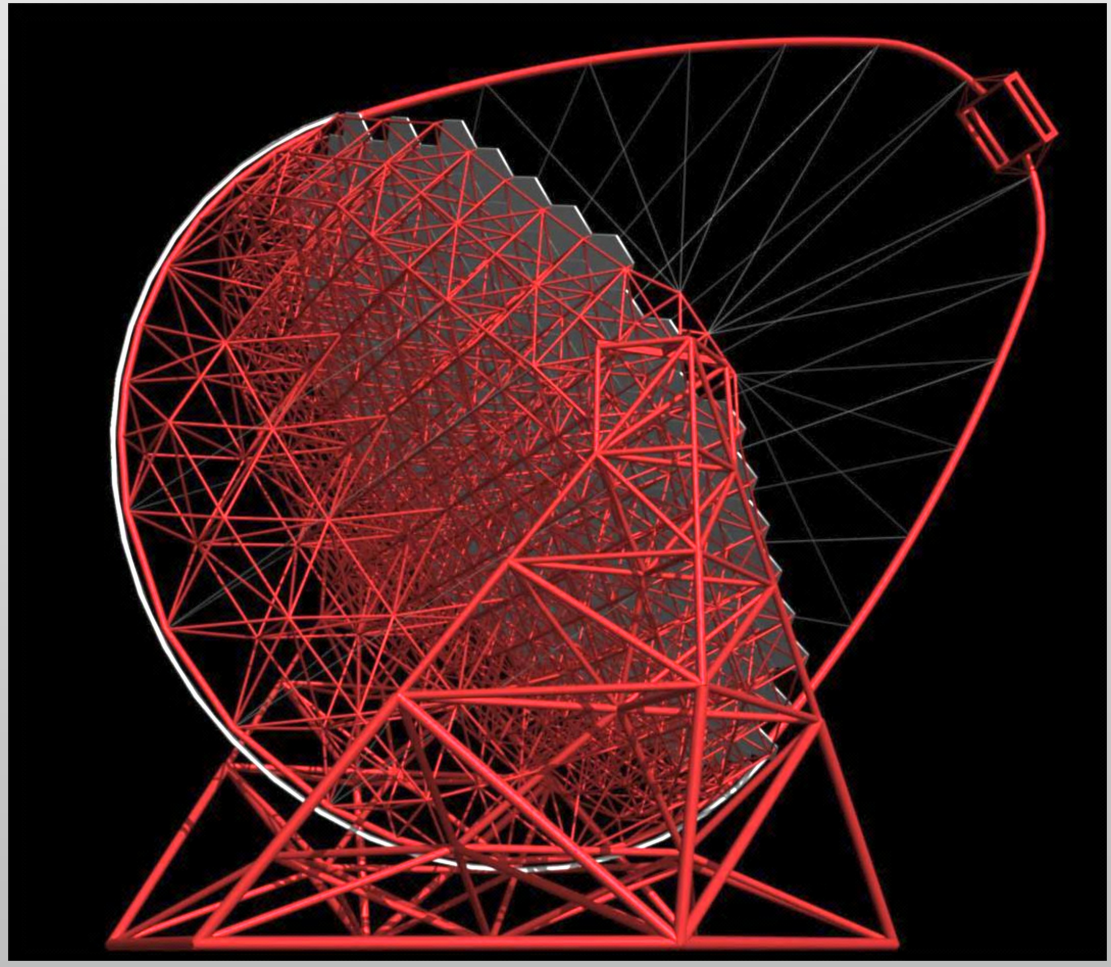
- The role of LST sub-system is
  - Achieve the lowest possible Energy Threshold
  - Key energy range: 20GeV-1000GeV
- Expand Gamma Ray horizon
  - GRBs (z<4), high redshift AGNs(z<2)
  - Pulsars, Galactic transients
- Specific challenges
  - Fast rotation for the GRB follow-up observation
  - High throughput optics



Designed by MPI Munich and MERO

Specifications

- The Threshold Energy
  - 20GeV
- Telescope Structure
  - Diameter: 23m
  - Dish area: 400 m^2
  - F/D = 1.2, F=28m
  - Dish profile: Parabolic
    - ➔ Isochronicity < 0.6 nsec in RMS
  - Single mast supporting the camera
    - ➔ Reduce the shadow
  - Total weight: ~70 tons
  - Fast rotation: 180 deg/ 20sec
  - Deformation of mirror dish: <~10mm
    - Active mirror Control
  - Pointing accuracy: 14 arcsec

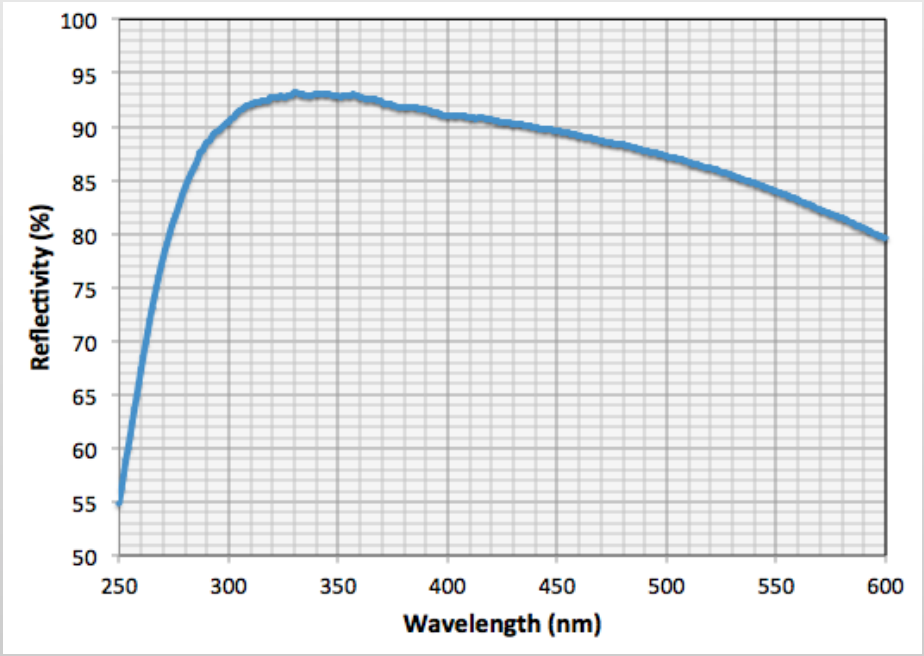


Designed by MPI Munich and MERO

1510mm LST MIRROR prototype at Sanko
2.7mm Glass+60mm Al.Honeycomb+2.7mm Glass

➔ CTA 報告65 野田(MPI)

Sputtering Cr + Al + SiO2 + HfO2 + SiO2

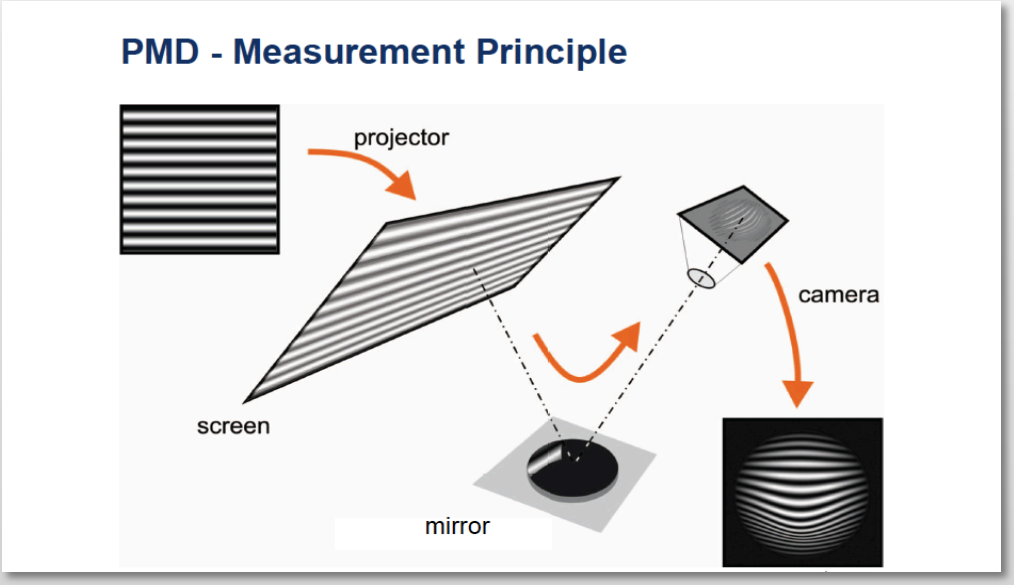


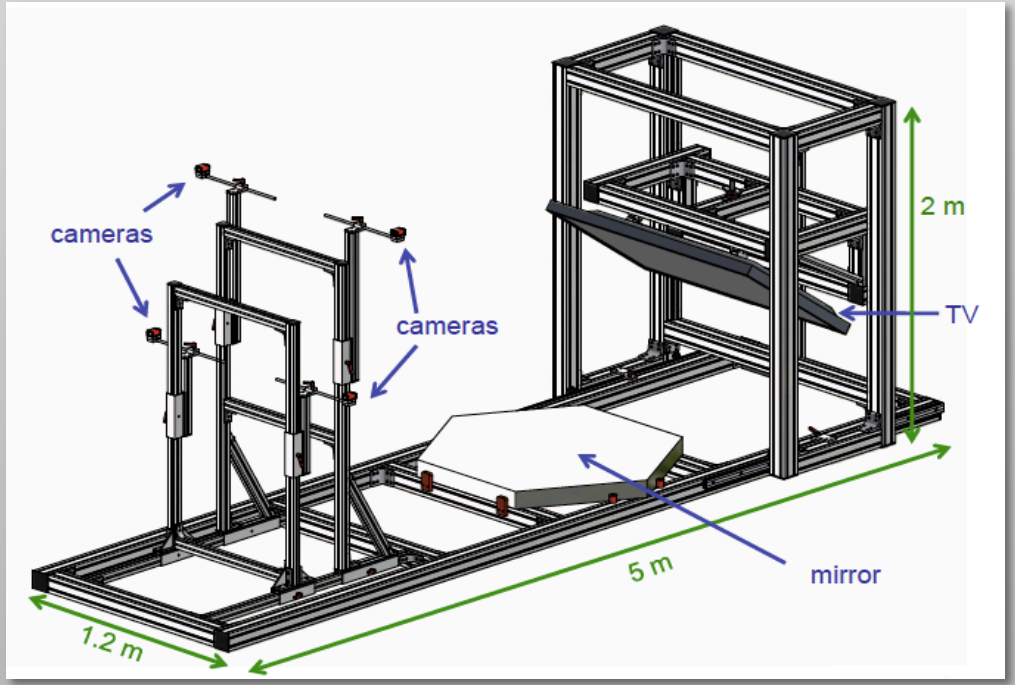
Specifications

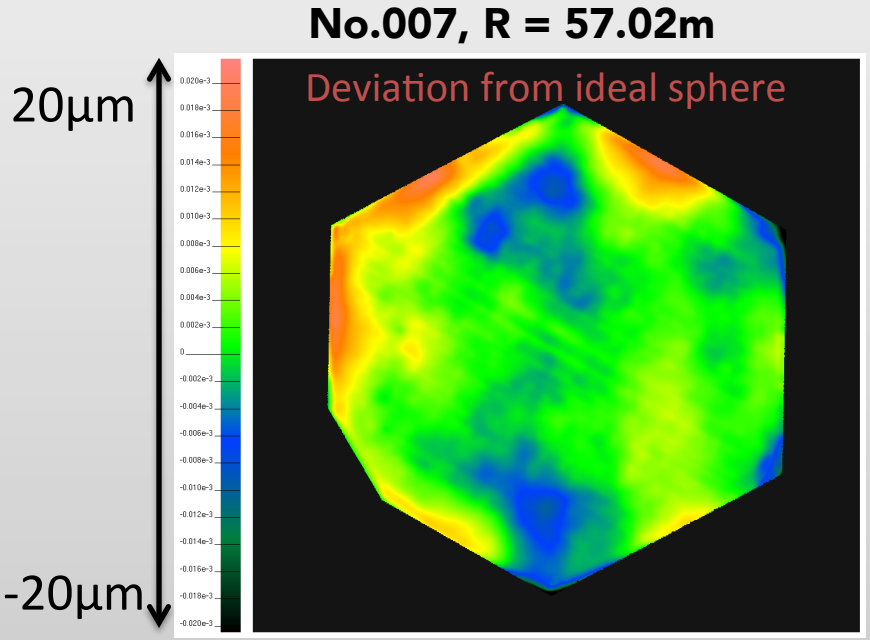
- F2F : 1510mm
- Area : 2m²
- R: 56.0 – 58.4 m
- D80 : 15mm(1/3 pixel)
- Weight : 45kg
- Honeycomb with Slits
- Water drains

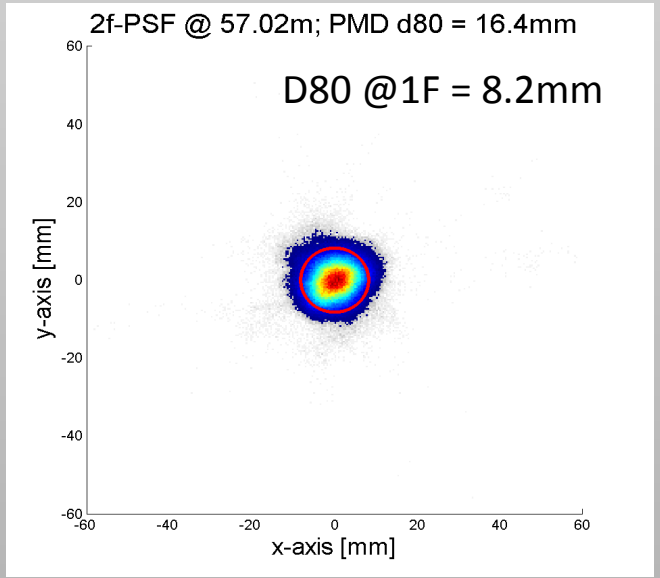
- Sputtering multi layer coat
  - ➔ Cr + Al + SiO2 +HfO2 + SiO2
- Reasonably High reflectivity
- Strong protective surface
  - ➔ Long life time

PMD system is installed at ICRR, U-Tokyo
→ CTA報告 63 馬場 (茨城大)



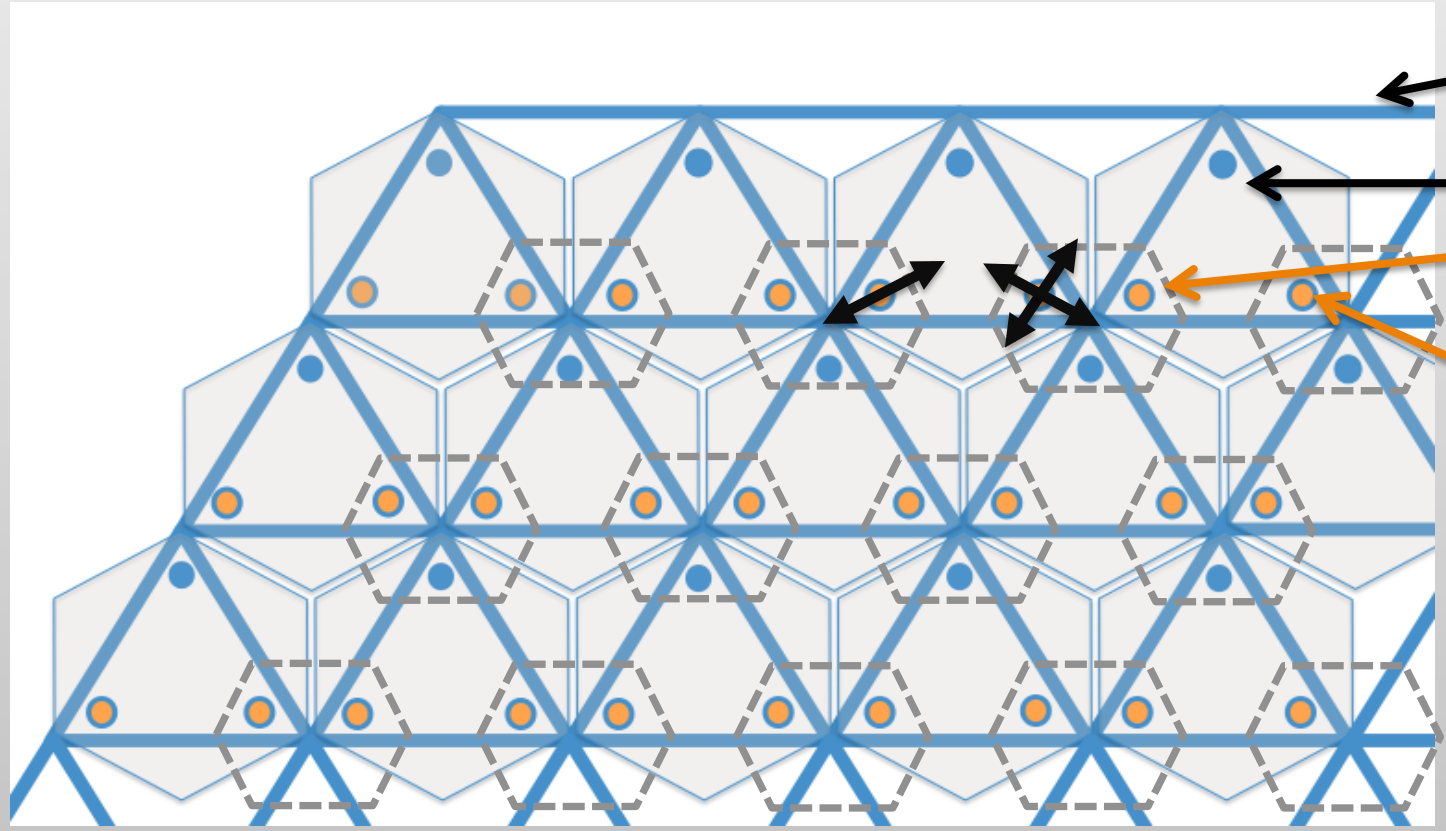




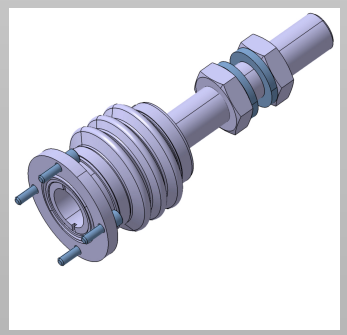


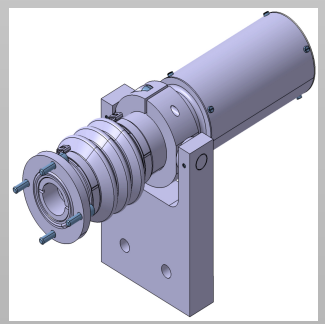
Mirrors and actuators on the space frame

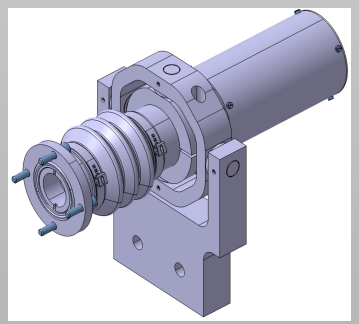
➔ CTA報告64 野里(近畿大)



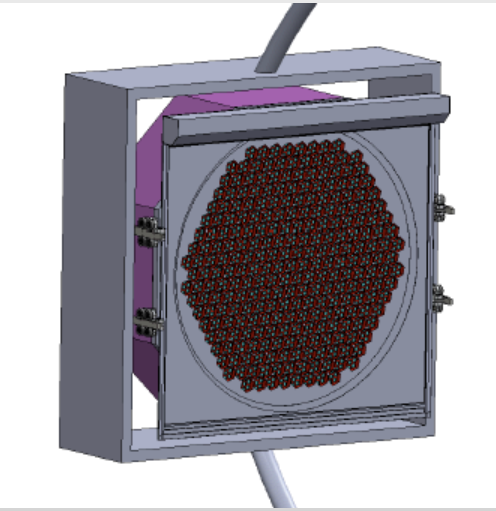
LST-Mirrors:
1.5m (flat-flat)
Hex shape
2m^2 area



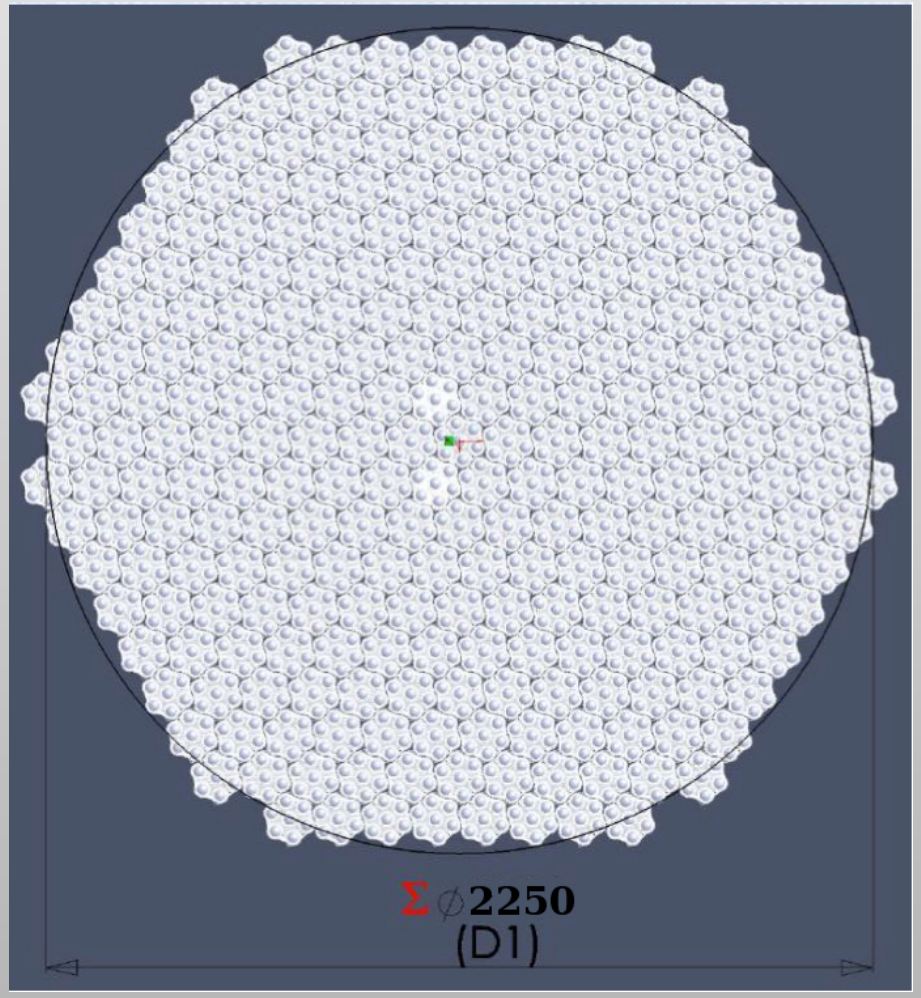




LST-Camera 265 clusters/1855 pixels
(0.1°pixel, FOV 4.5°, Weight< 2 ton)



W = 68kg



Clusters 1.33kg x 265 <400kg
Two cooling plates <500kg

Plex glass < 70kg
Cables, Switching hub < 100kg
Power module <150kg

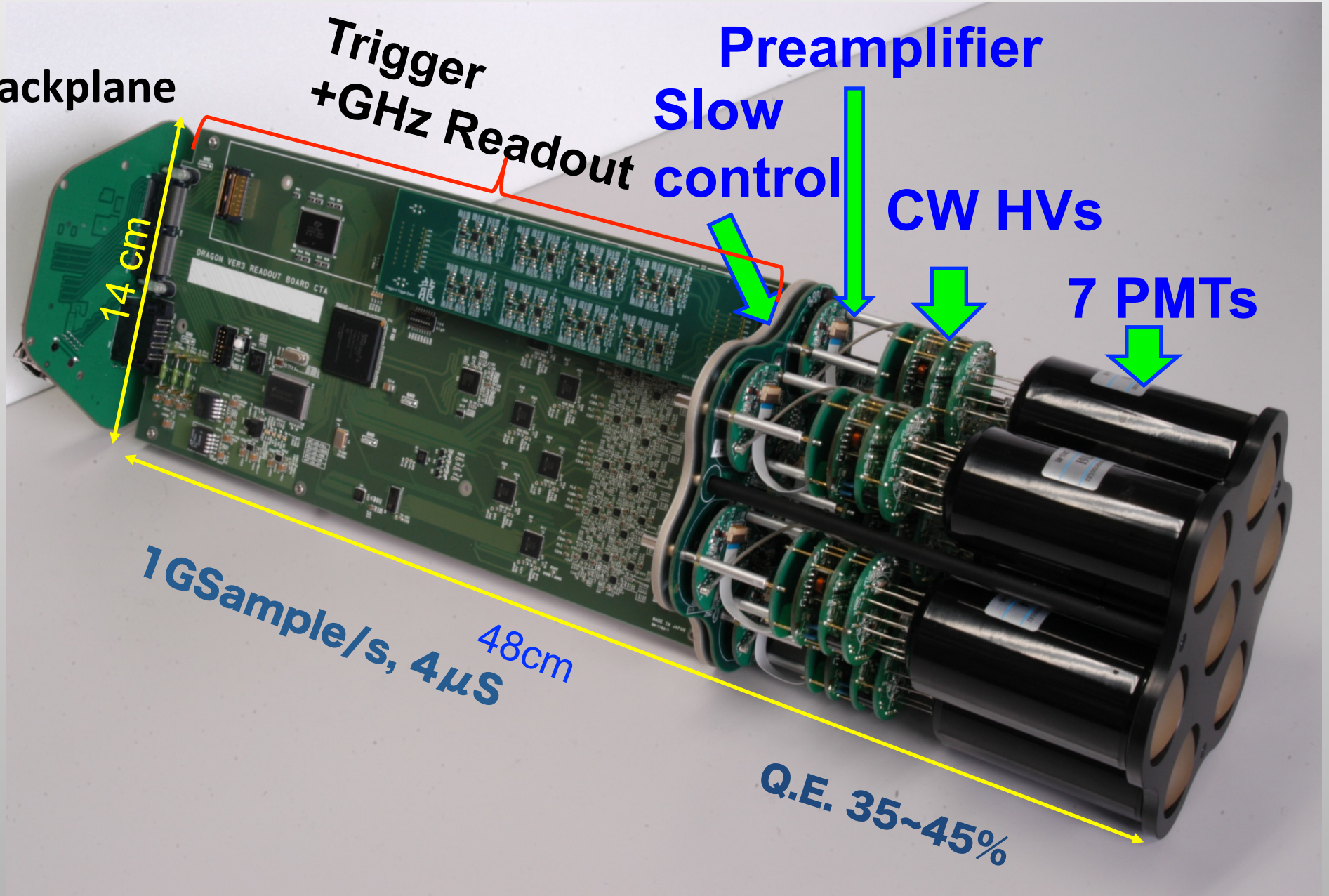
Supporting frame < 100kg
Skin of Camera < 200kg
Interface with Arch < 100kg
Garage door < 200kg

Total <1820 kg

< 2 tons

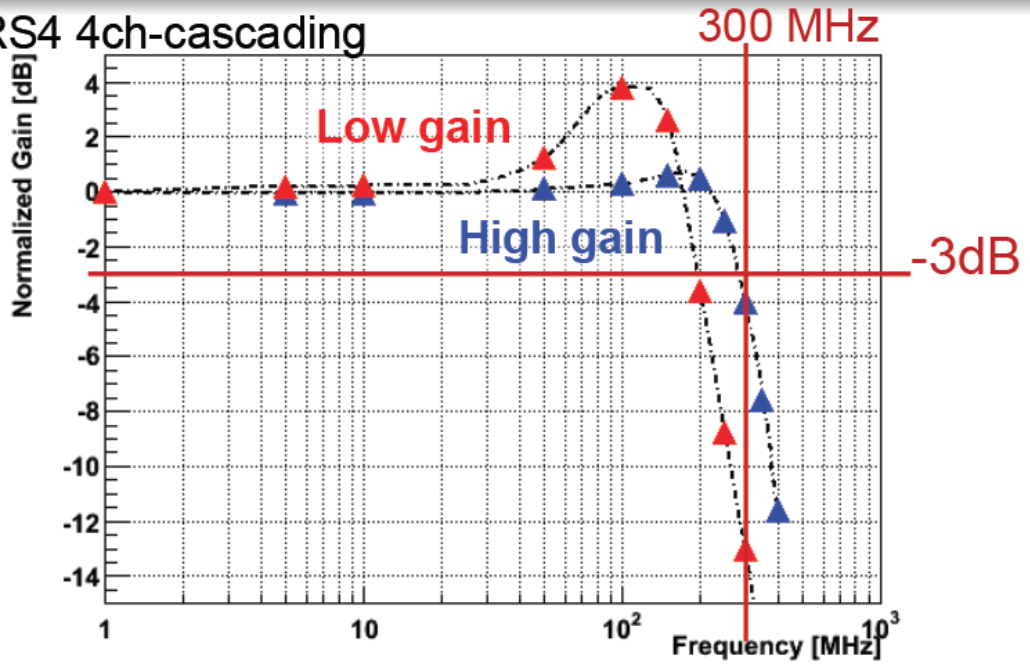
Camera Readout

→ CTA 報告61土屋（京大）



Bandwidth of DRS4 Readout Board

with DRS4 4ch-cascading



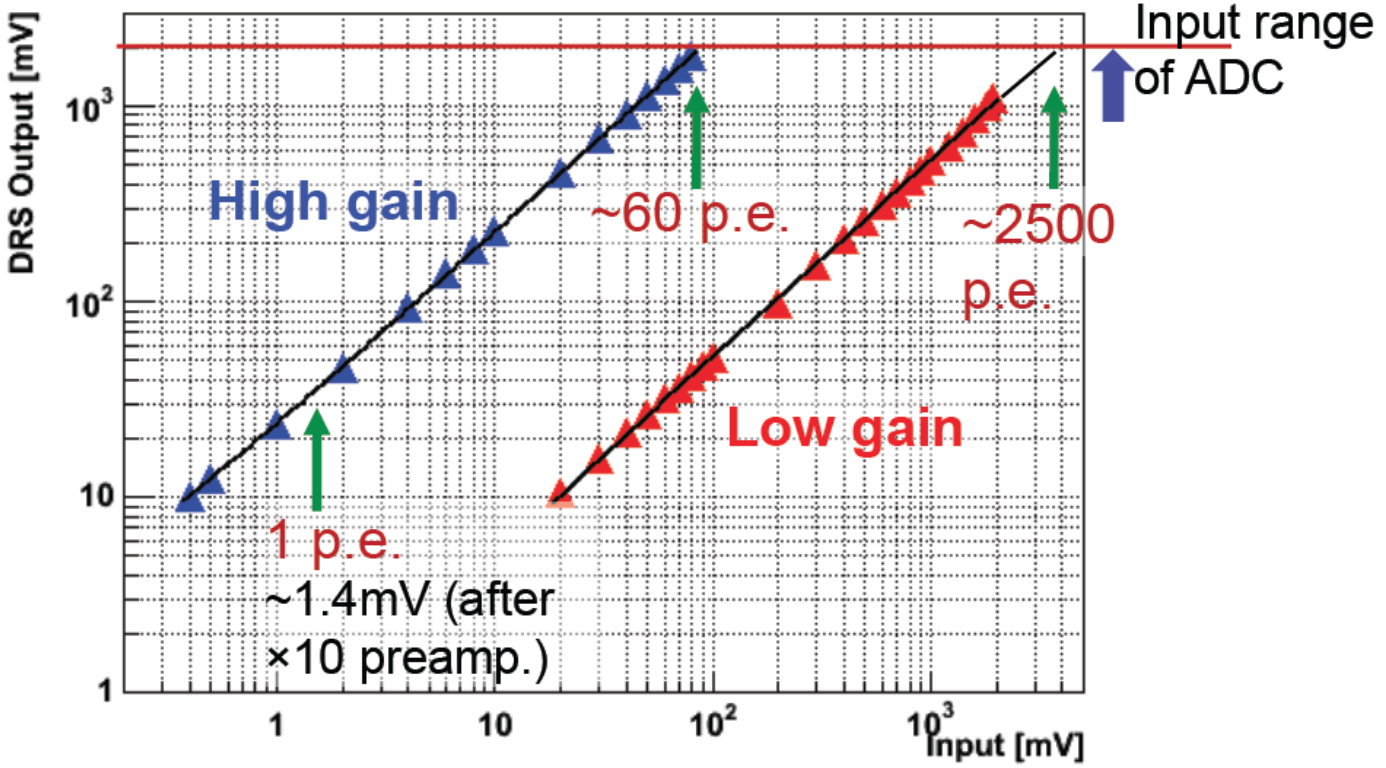
Bandwidth(-3dB) (requirement is not

High gain: 275 MHz OK or not

Low gain: 200 MHz OK

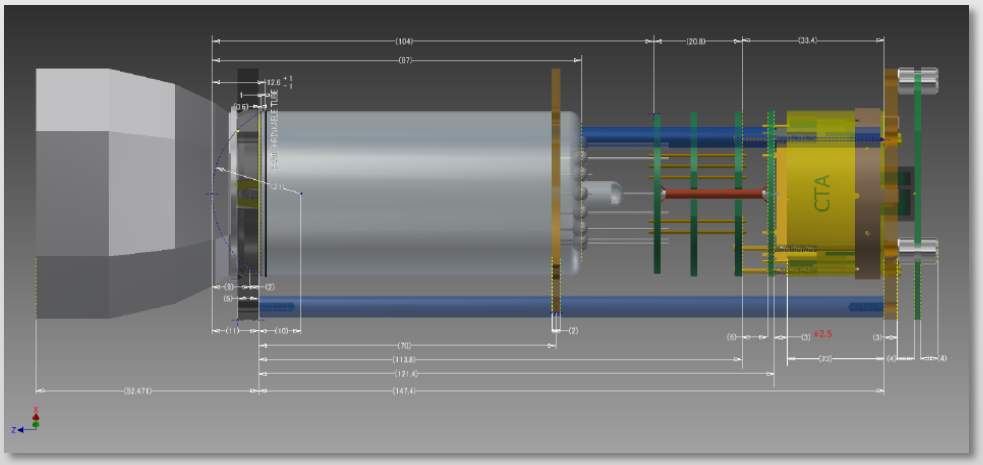
Trigger: >350 MHz OK

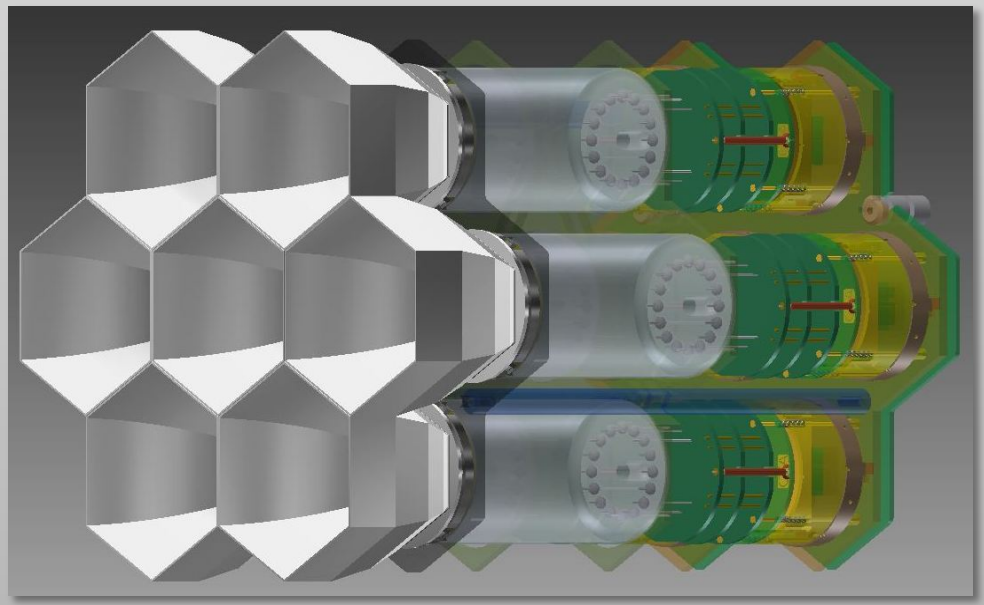
BW is lowe
capacitanc

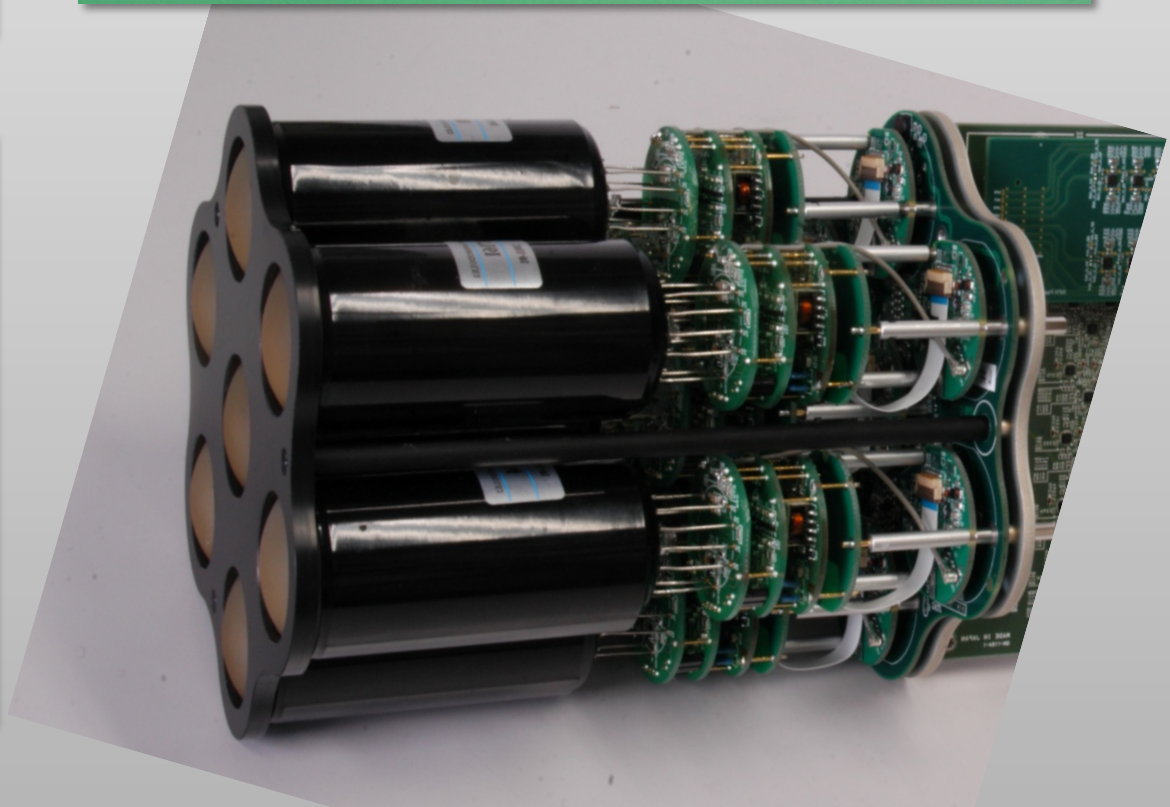


光電子増倍管とクラスター

→ TA 報告60 光検出器 永吉(埼大) 、TA報告62ライトガイド　田中（茨城大）

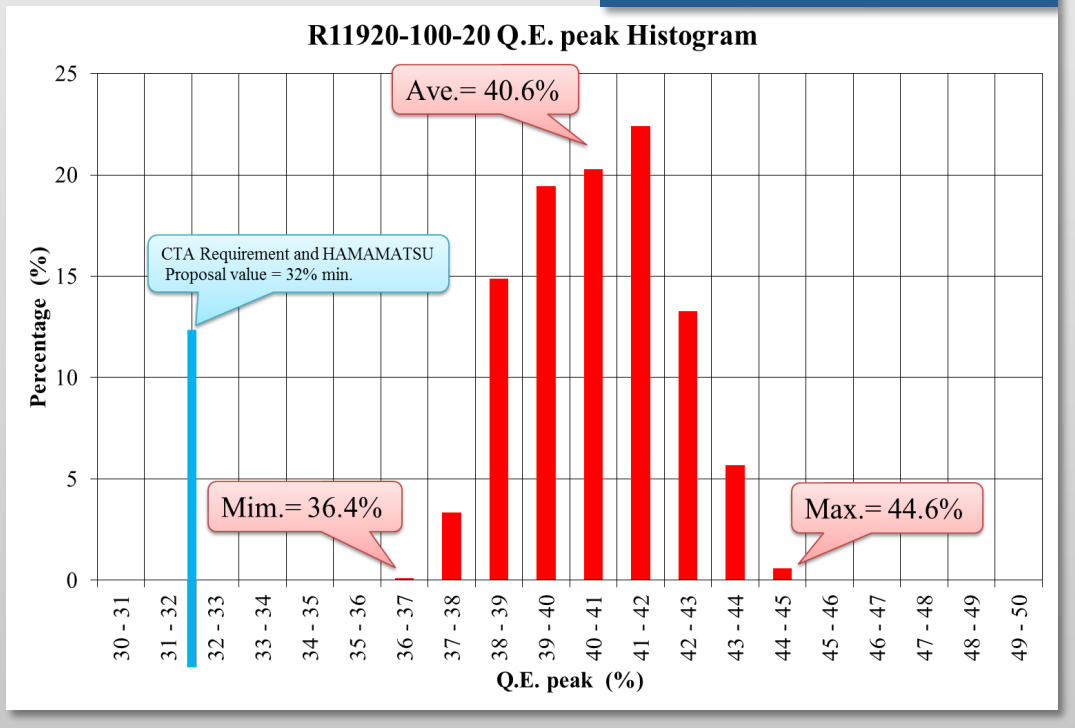


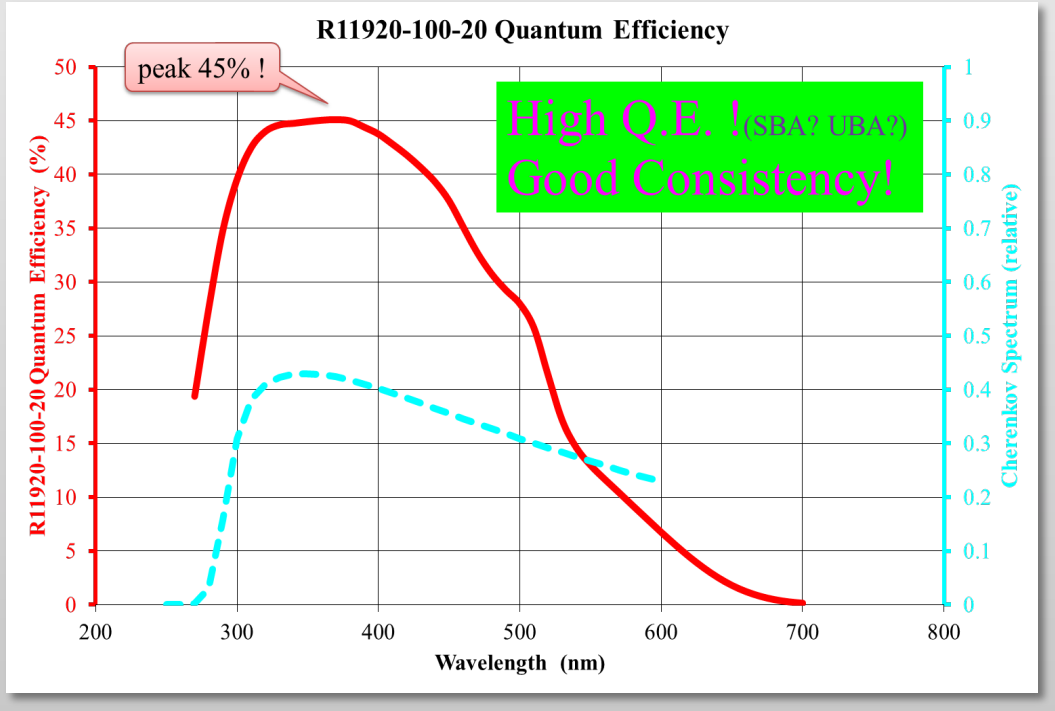




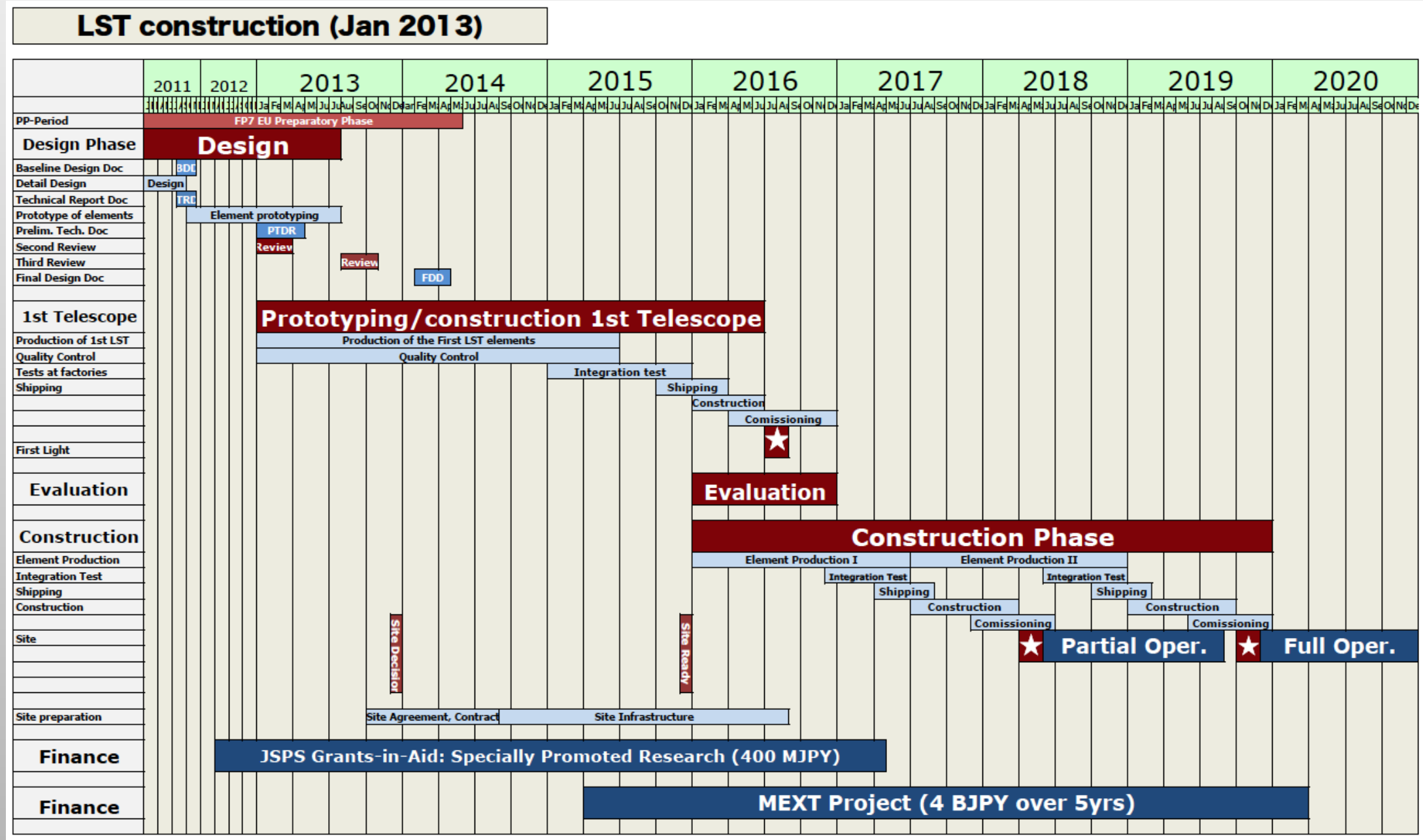
光電子増倍管特性　(R11920)

Very High QE





Time Schedule for LST construction



Timeline, Budget and Recommendations

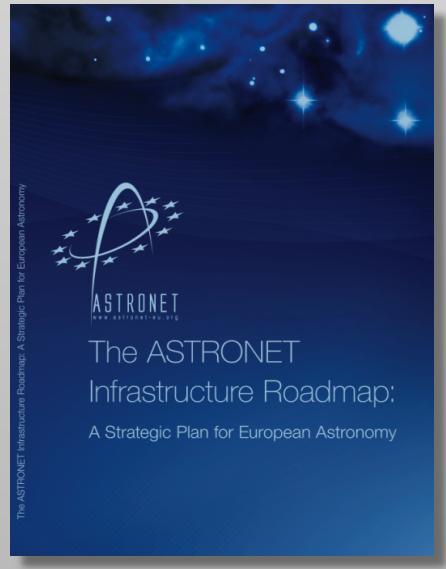
- **Timeline (CTA Consortium)**
  - Design Study 2007 – 2010 (completed)
  - Prep. Phase 2010 – 2014 (on going)
  - Construction 2015 – 2020
  - Partial operation 2017 –
  - Full operation 2020 – 2040

- **Budget**
  - CTA (as of 2010): 190MEuro ～ 20 BJPY
  - CTA Japan ~20% of the whole construction (4BJPY)

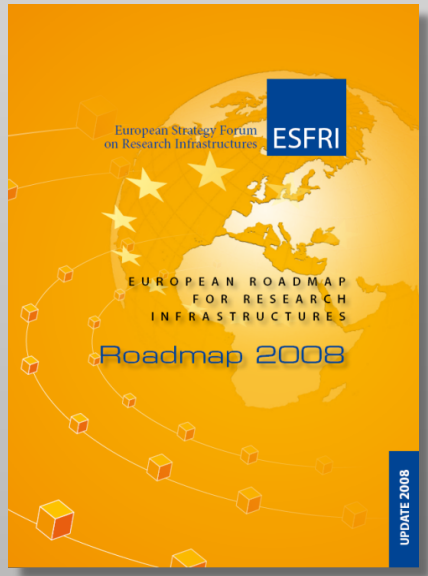
- **Discussion in the domestic communities**
  - Future strategy committee in CRC
    - ➔ 3S Recommendation (Highest Priority)
  - Future planning committee in ICRC (Highest Priority)

- **Rec. by EU, US, International organization**

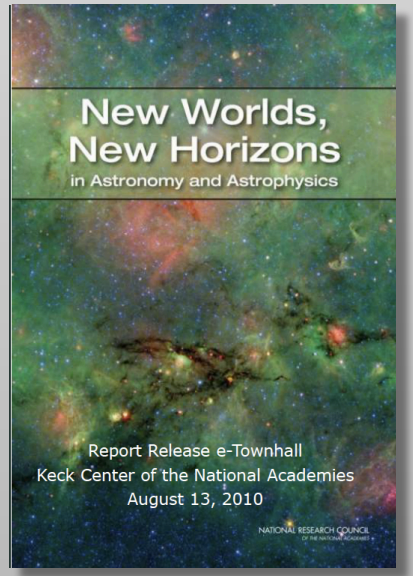
ASPERA
EU Astropartilce



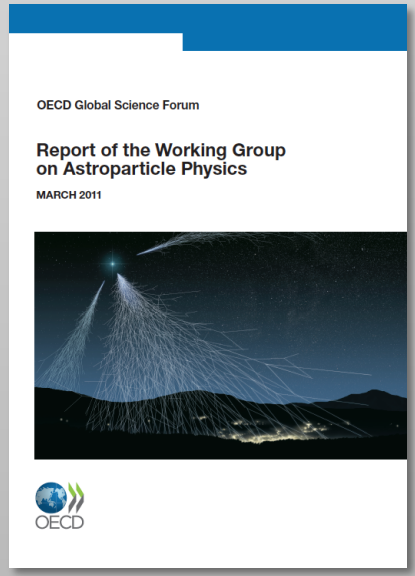
ASTRONET
EU Astrophysics



ESFRI
European Commission



Deacadal Survey
US Astronomy and Astrophysics



OECD
WG on Astroparticle physics

Summary

- Science Case:
  - Astropaticle Physics Special Issue, Vol 43(2013)
- 望遠鏡、アレイ最終仕様策定へ
  - Reviews, BDD, PTDR, Final TDR
- 天文台としての運用へ向けて
  - Interim Legal Entity (2014-2015/2016) at MPG HQ?
  - ERIC (European Research Infrastructure Consortium)
- サイト選定へ向けて (Priority List after the long evaluation)
  - 北半球 Teide (Canaries, Spain)
  - 南半球 Aar (Namibia)
- 予算
  - ドイツにて建設費の予算化が始まる(MPG, Helmholz Assoc., BMBF)
- CTA Japan
  - Leading the construction of the first Large Size Telescope (特別推進、科研費)
  - Optics for LST: Mirrors, Actuators, Winston cones
  - Cameras for LST: PMTs, HVs, Amplifiers, GHz Readout, Cooling, DAQ
  - Cameras for SST: MPPCs, GHz Readout (Target　System) ➔ CTA報告66 田島 (名大)