



27カ国
>1000共同研究者



CTA 報告58 全体報告

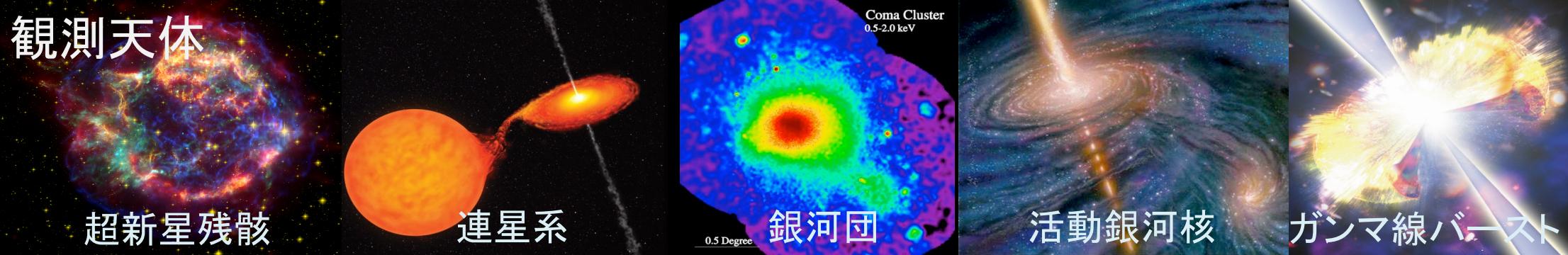
東京大学宇宙線研究所 手嶋政廣

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、
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荻野桃子、奥村暁、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、榎直人、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、
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野田浩司、畠中謙一郎、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

観測天体

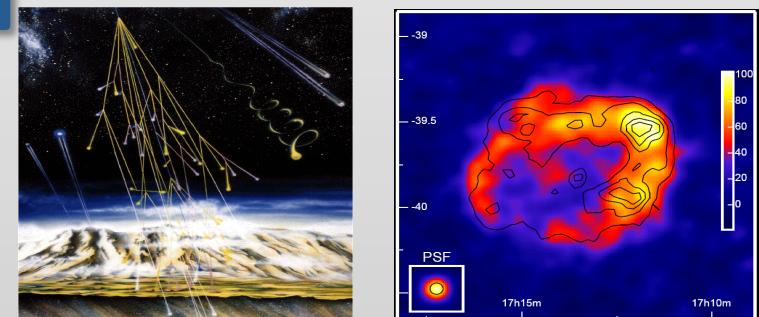


超高エネルギー宇宙ガンマ線の研究

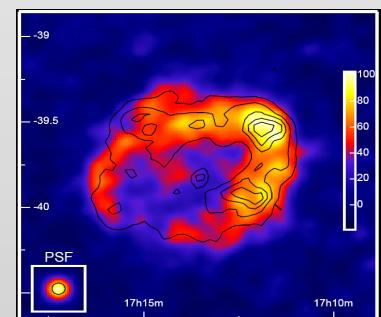
- 宇宙線の起源
- 銀河系内、系外の高エネルギー天体の研究
- 赤外・可視背景放射(宇宙の星形成史)の研究
- 暗黒物質対消滅からのガンマ線の探索
- 相対論(量子重力理論)の高精度検証

→ *Astroparticle Physics Special Issue, Vol 43 (2013)*

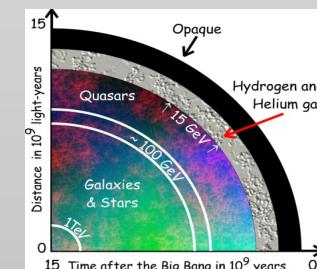
狙うサイエンス



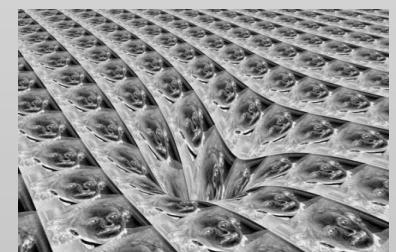
宇宙線の起源



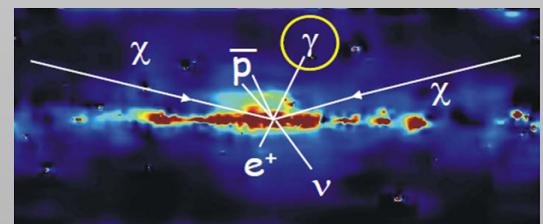
高エネルギー天体



宇宙論・星形成史



時空の構造

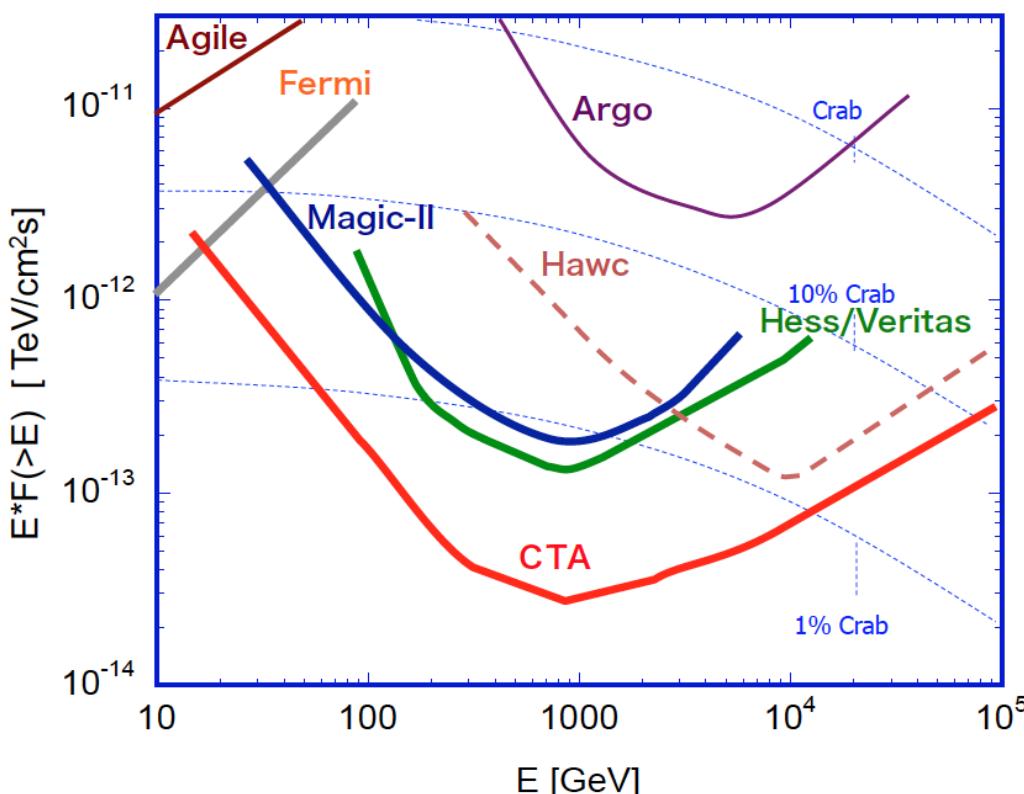


暗黒物質の探索

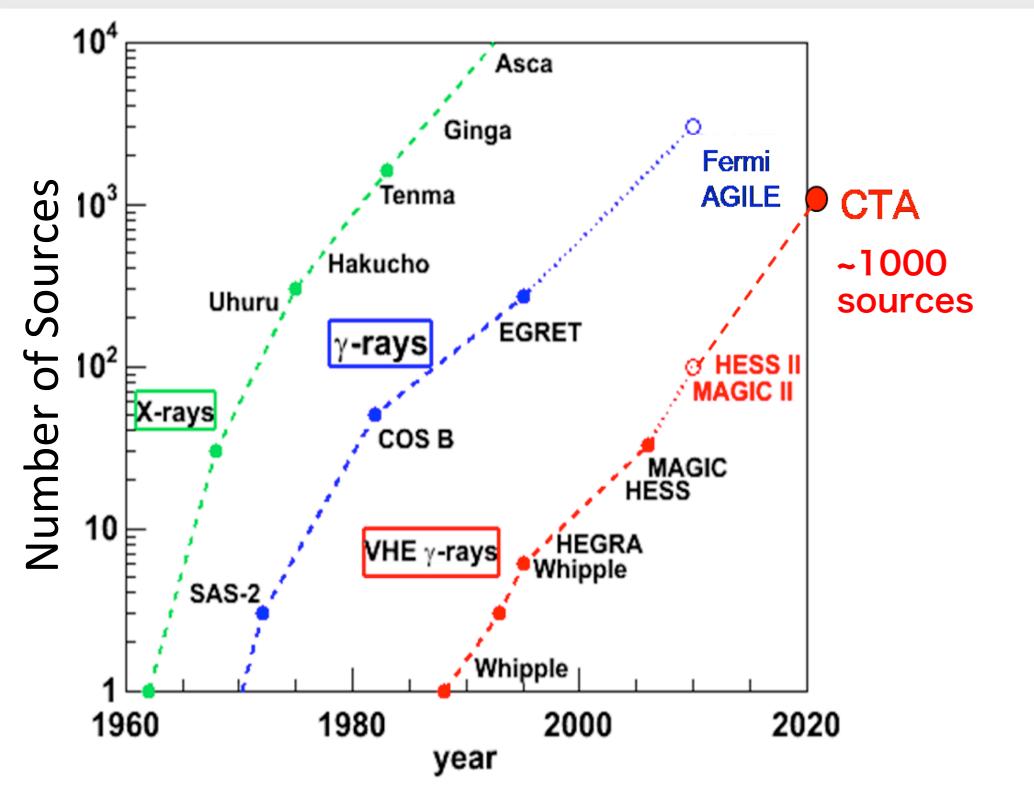
CTA (Cherenkov Telescope Array)

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

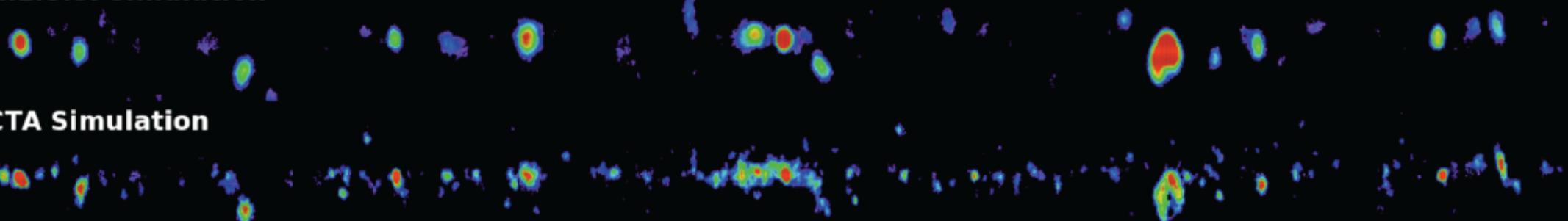
An order of magnitude better sensitivity
Wide energy coverage



More than 1000 sources will be discovered



H.E.S.S. Simulation

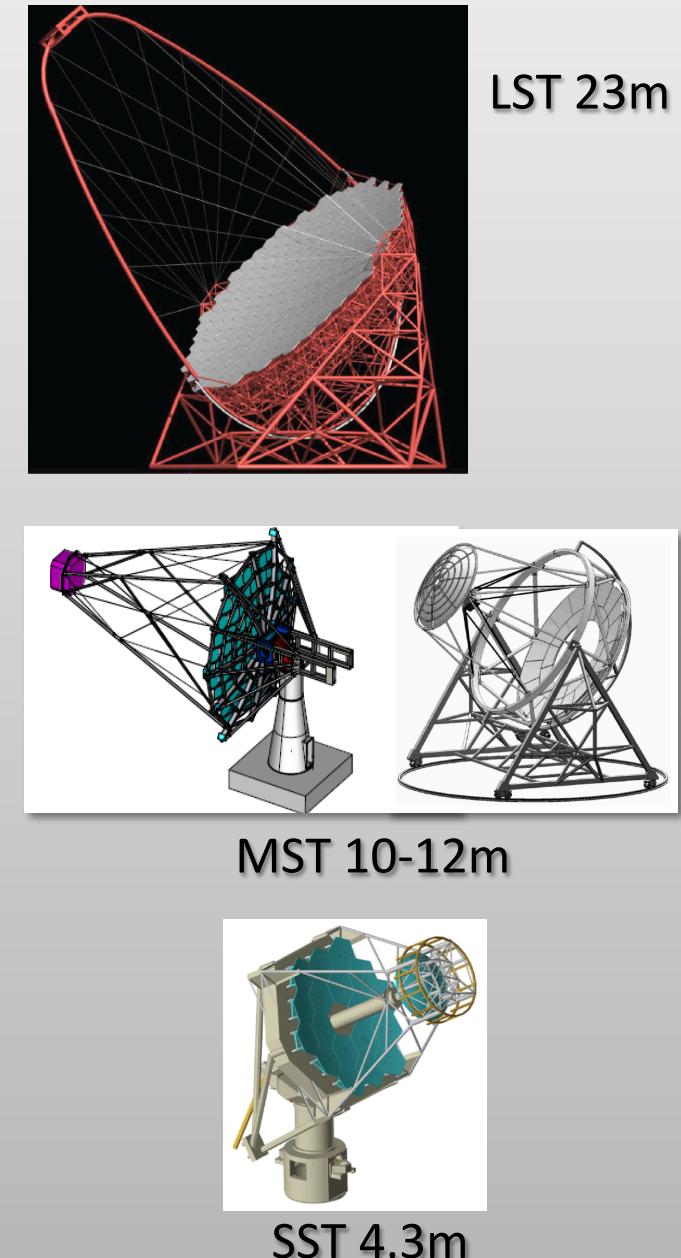
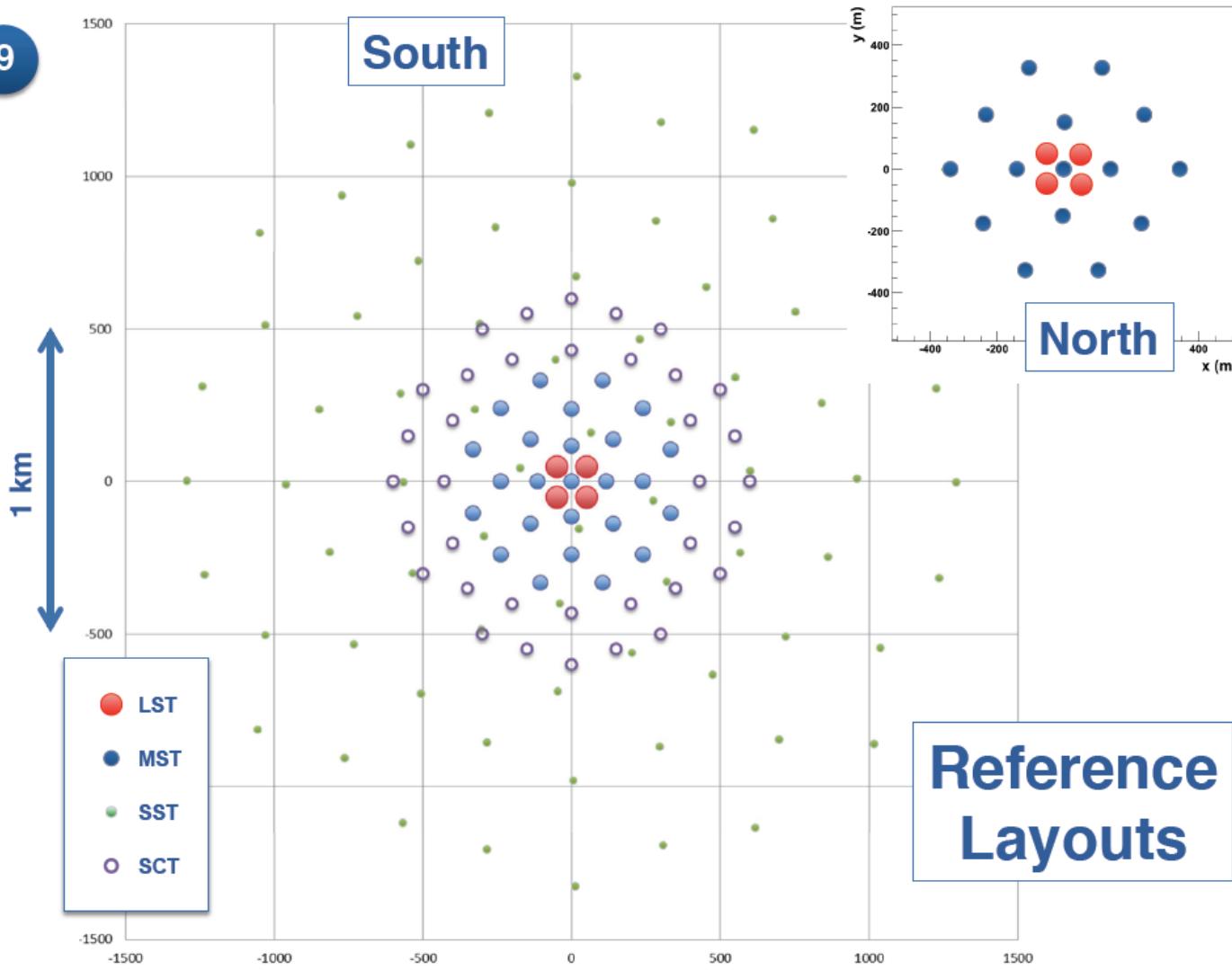


Simulation Galactic Plane scan (HESS and CTA)

Possible array configuration

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

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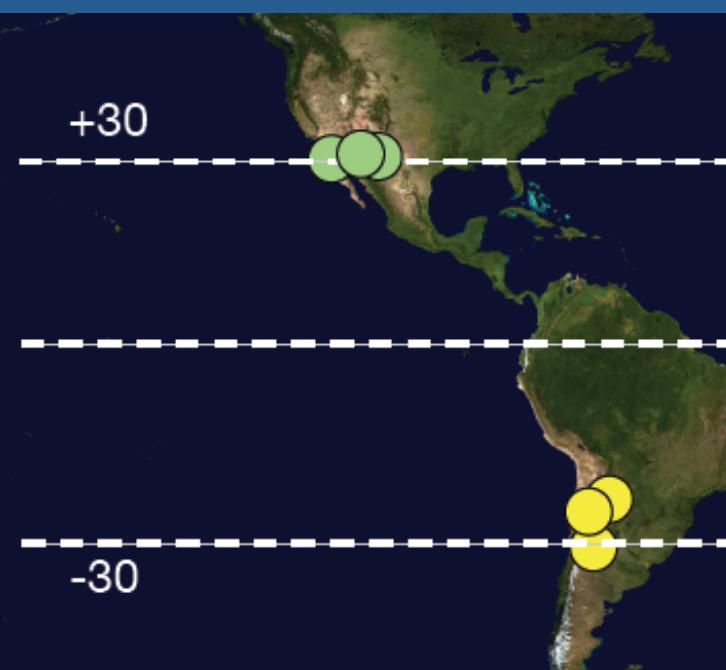
SITE CANDIDATES

Sites will be selected in the end of 2013



1st : Teide (Canaries, Spain)

2nd : San Pedro Martir (Mexico),
Meteor Crater (USA), Yavapai (USA)



1st : Aar (Namibia)

2nd : Armazones (Chile), HESS

3rd : Leoncito (Argentina)

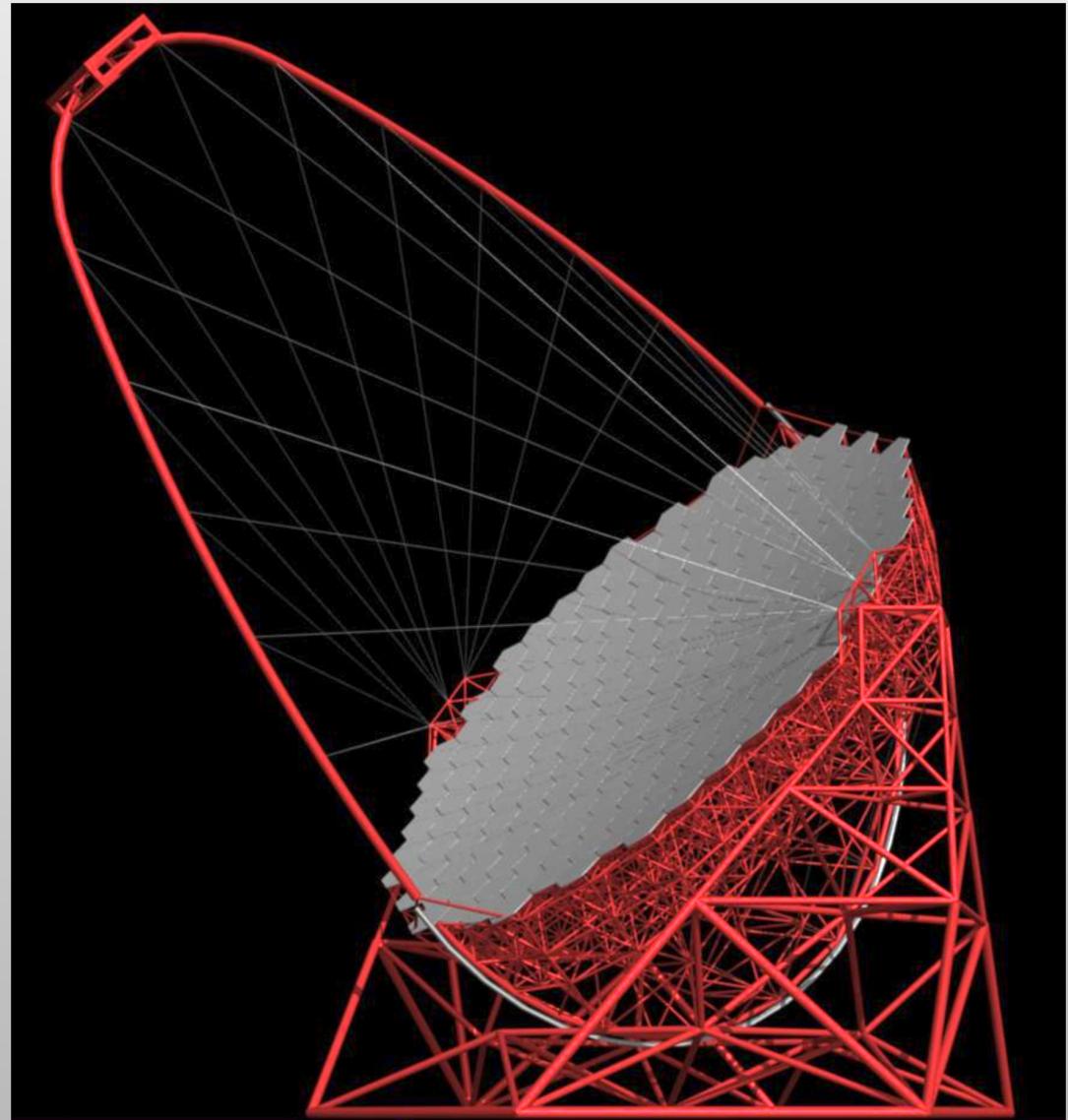
4th : San Antonio (Argentina)

two sites to cover full sky
at 20°-30° N, S

Warning: map not quite accurate

Major contribution by CTA-Japan

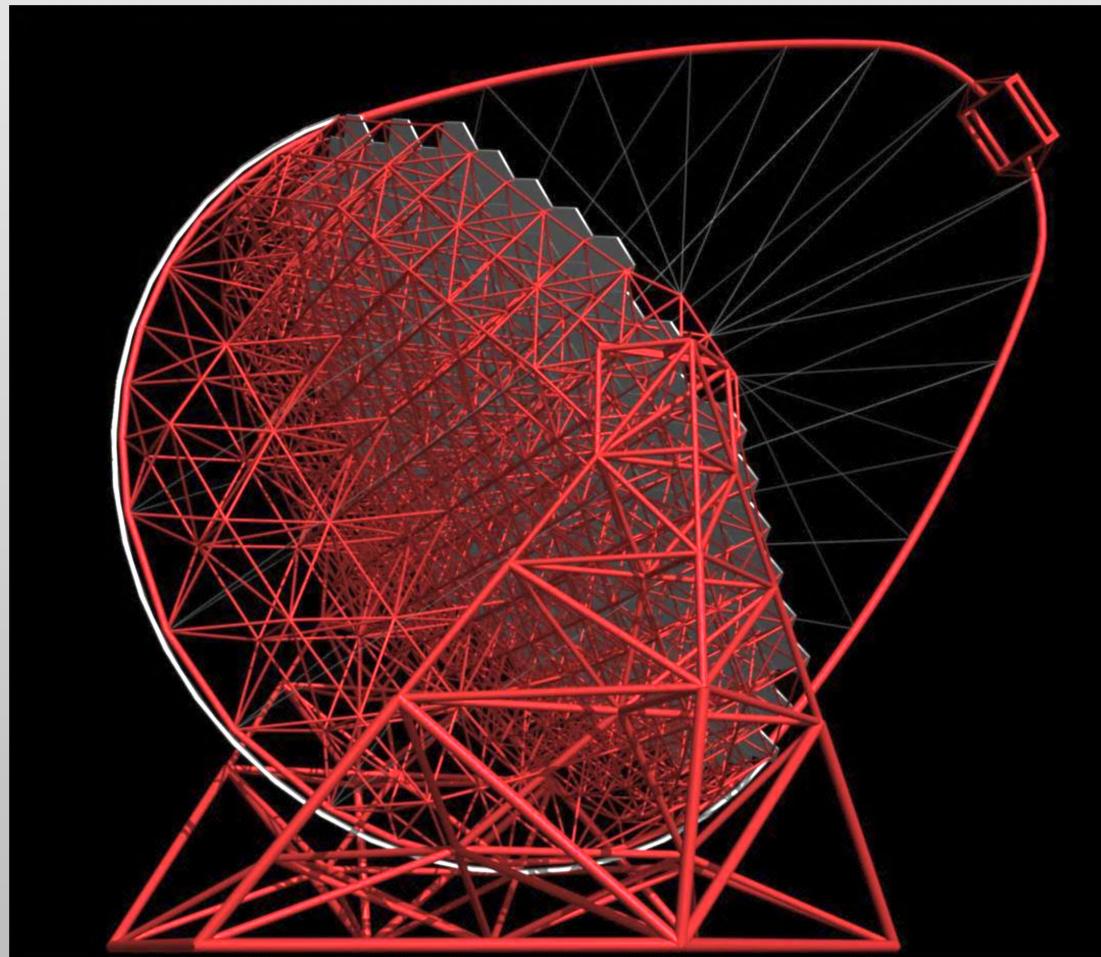
- The role of LST sub-system is
 - Achieve the lowest possible Energy Threshold
 - Key energy range: 20GeV-1000GeV
- Expand Gamma Ray horizon
 - GRBs ($z < 4$), high redshift AGNs($z < 2$)
 - Pulsars, Galactic transients
- Specific challenges
 - Fast rotation for the GRB follow-up observation
 - High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



Designed by MPI Munich and MERO

Specifications

- The Threshold Energy
 - 20GeV
- Telescope Structure
 - Diameter: 23m
 - Dish area: 400 m²
 - 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



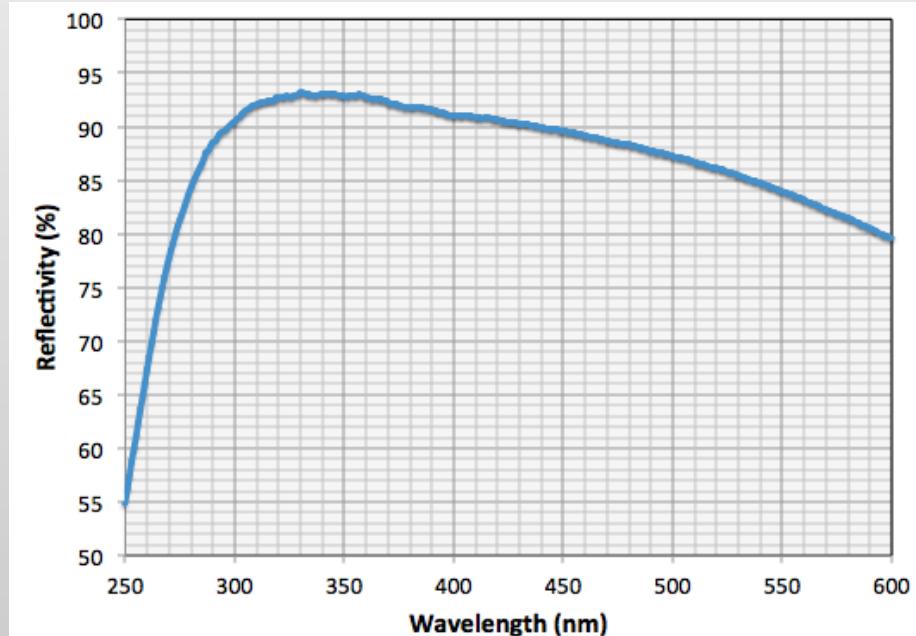
Designed by MPI Munich and MERO

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

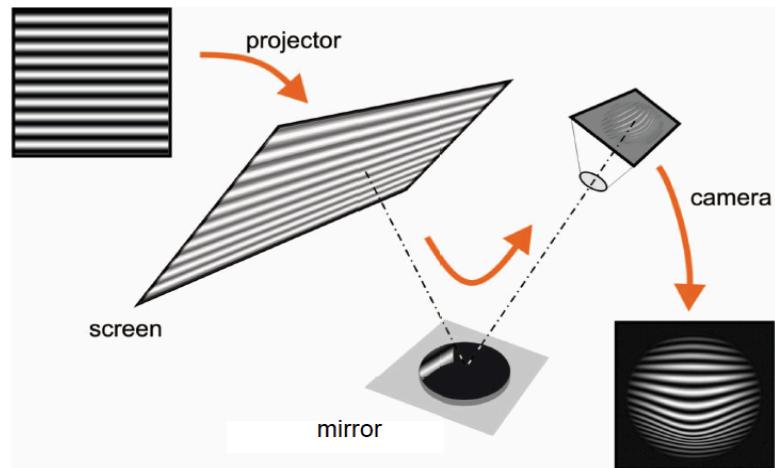


- Sputtering multi layer coat
 - ➔ Cr + Al + SiO₂ + HfO₂ + SiO₂
- Reasonably High reflectivity
- Strong protective surface
 - ➔ Long life time

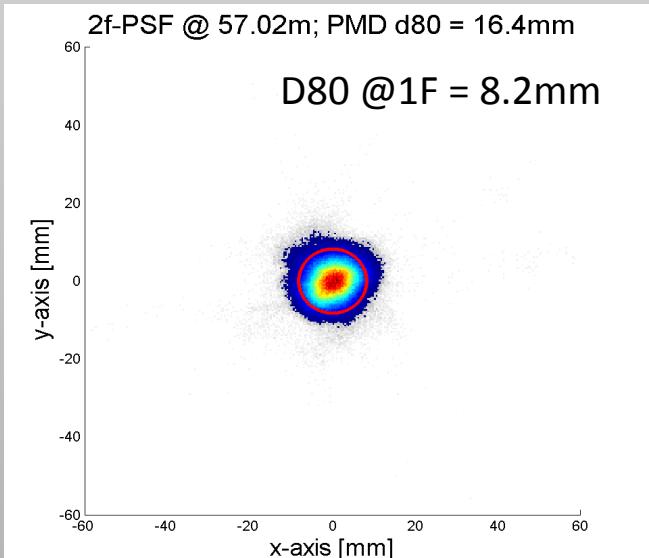
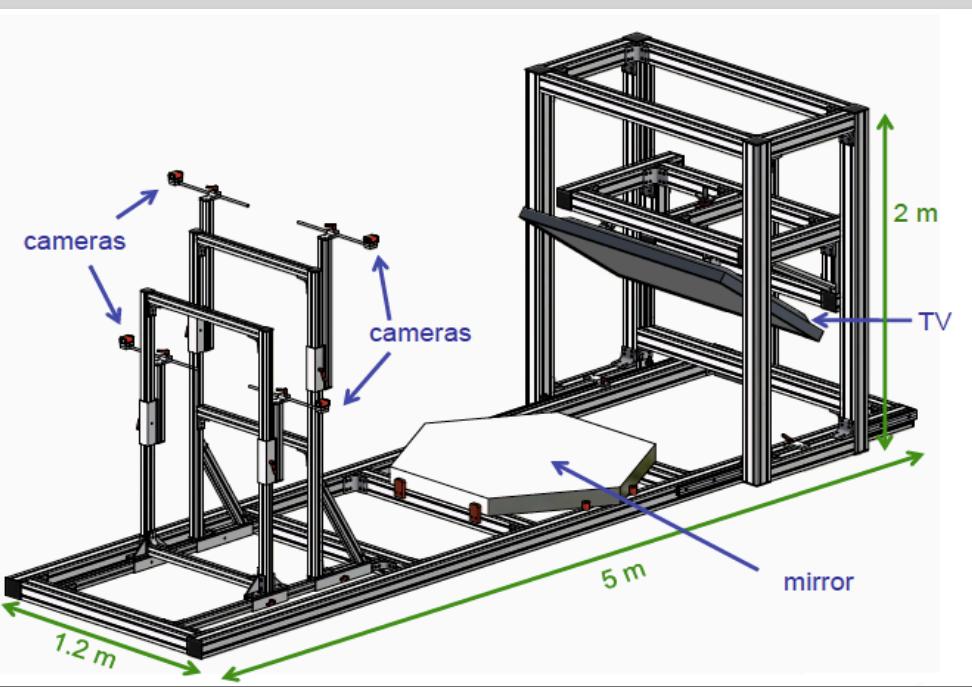
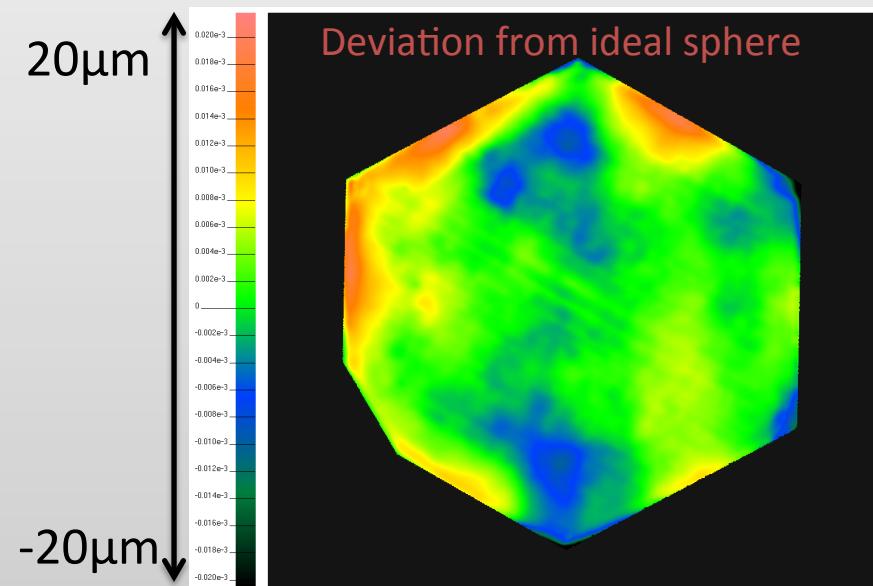
PMD system is installed at ICRR, U-Tokyo

→ CTA報告 63 馬場 (茨城大)

PMD - Measurement Principle

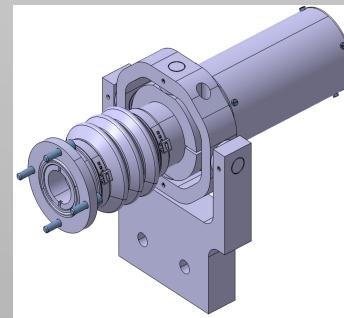
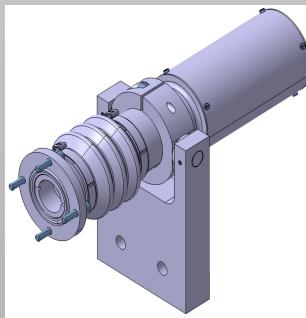
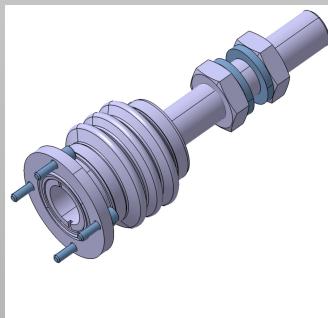
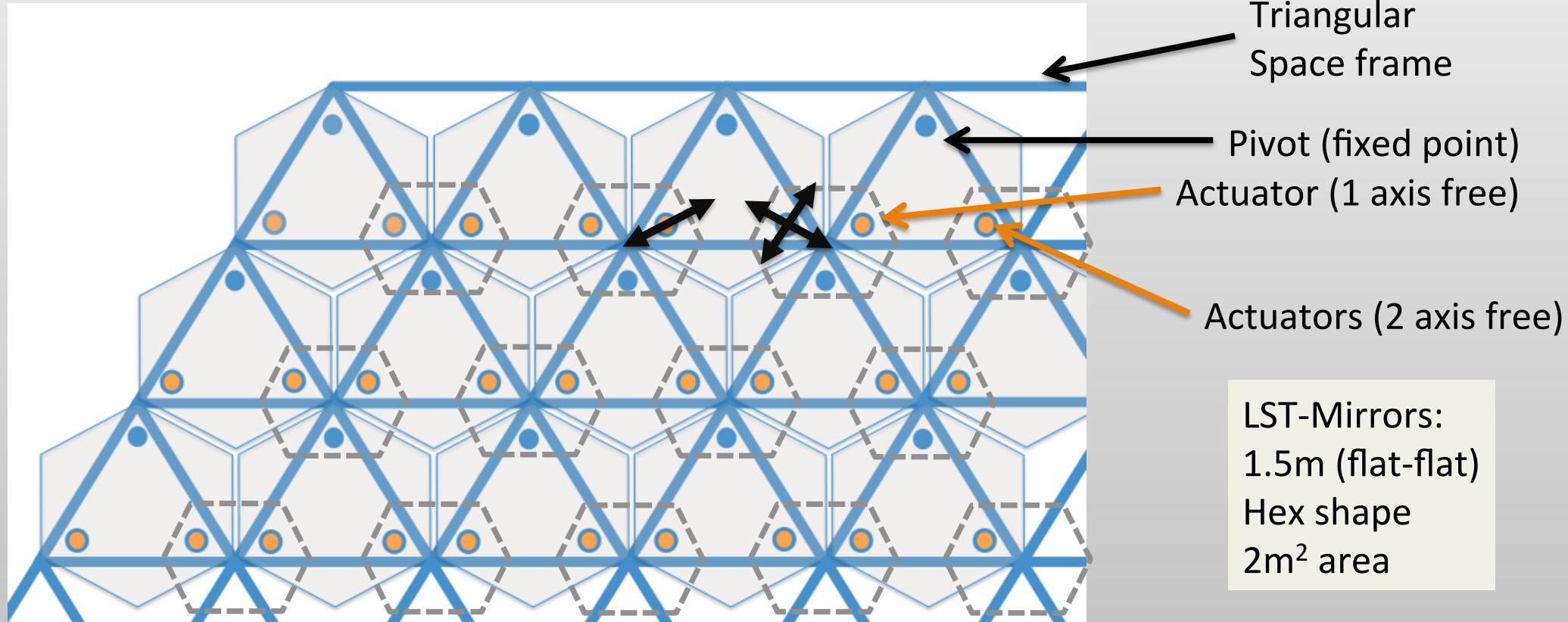


No.007, R = 57.02m

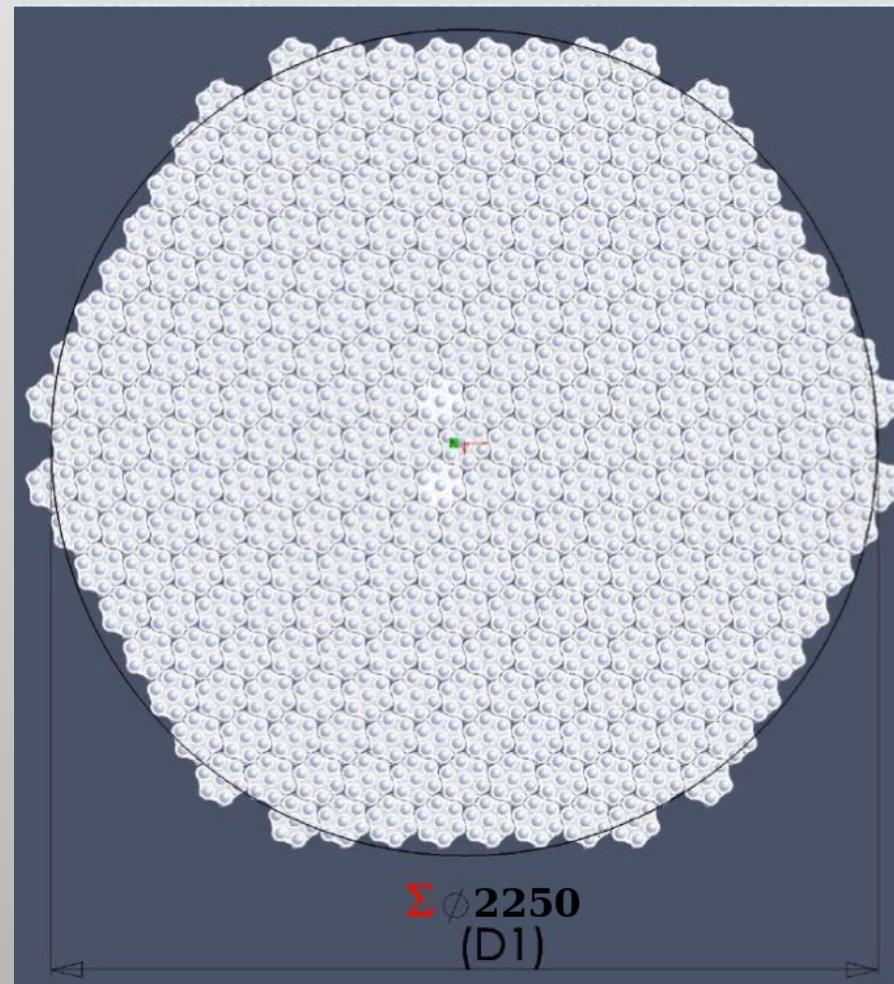
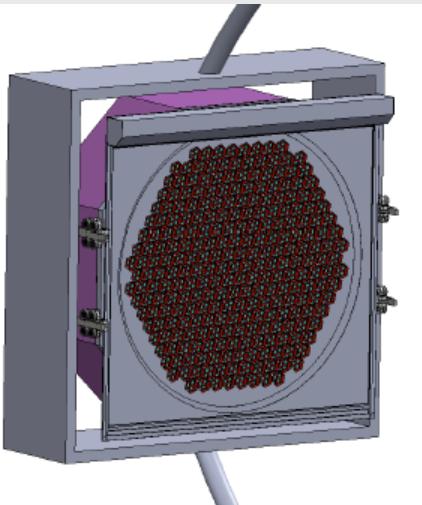


Mirrors and actuators on the space frame

→ CTA報告64 野里(近畿大)



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



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

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

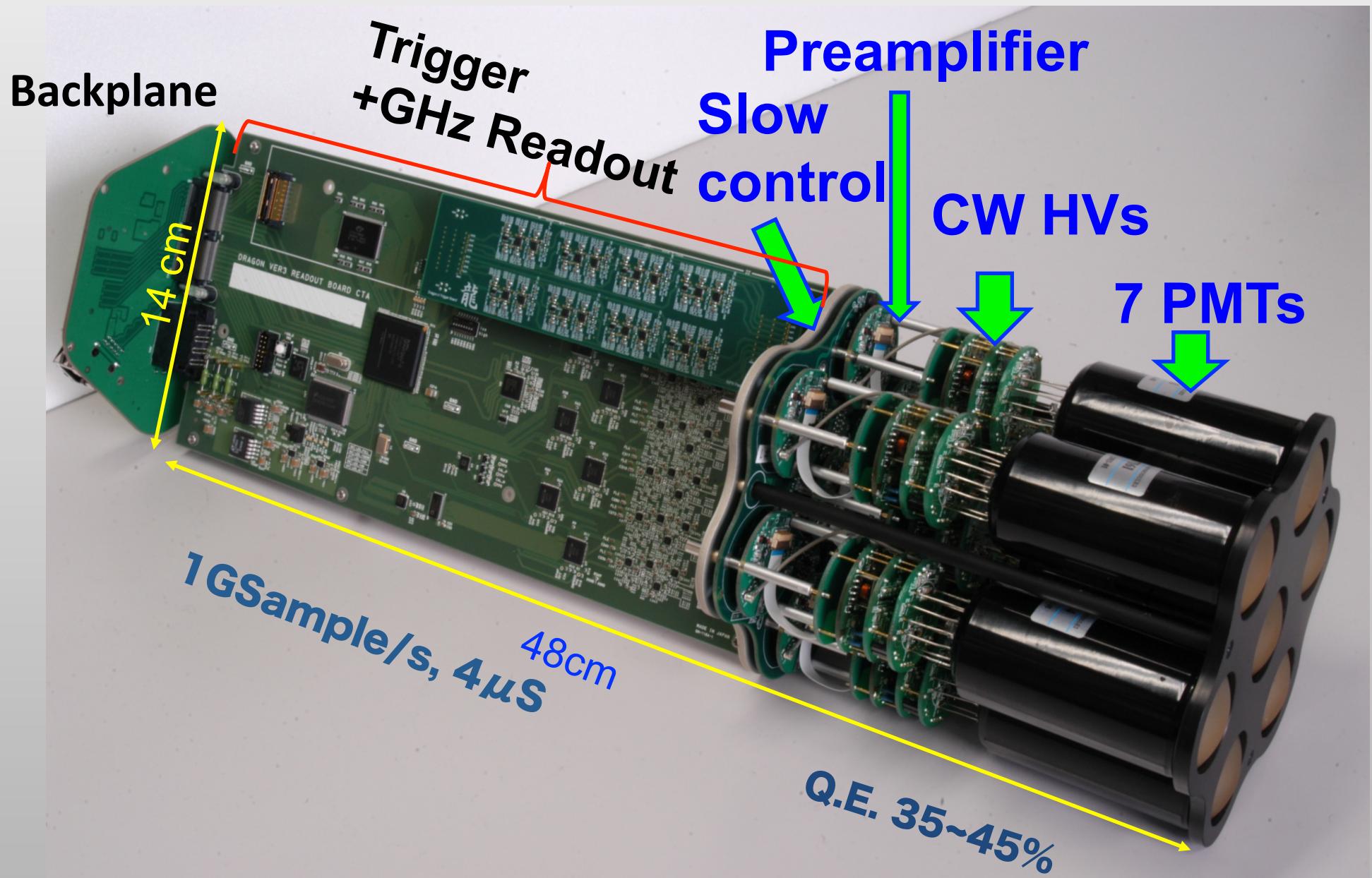
Supporting frame < 100kg
Skin of Camera < 200kg
Interface with Arch < 100kg
Garage door < 200kg

Total <1820 kg

< 2 tons

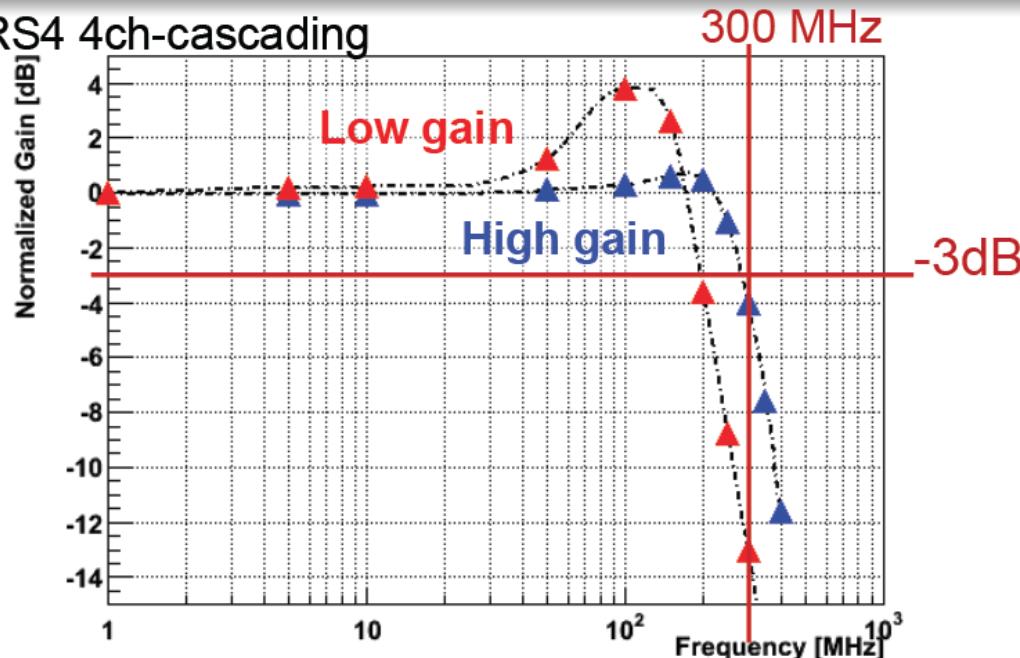
Camera Readout

→ CTA 報告61土屋 (京大)



Bandwidth of DRS4 Readout Board

with DRS4 4ch-cascading

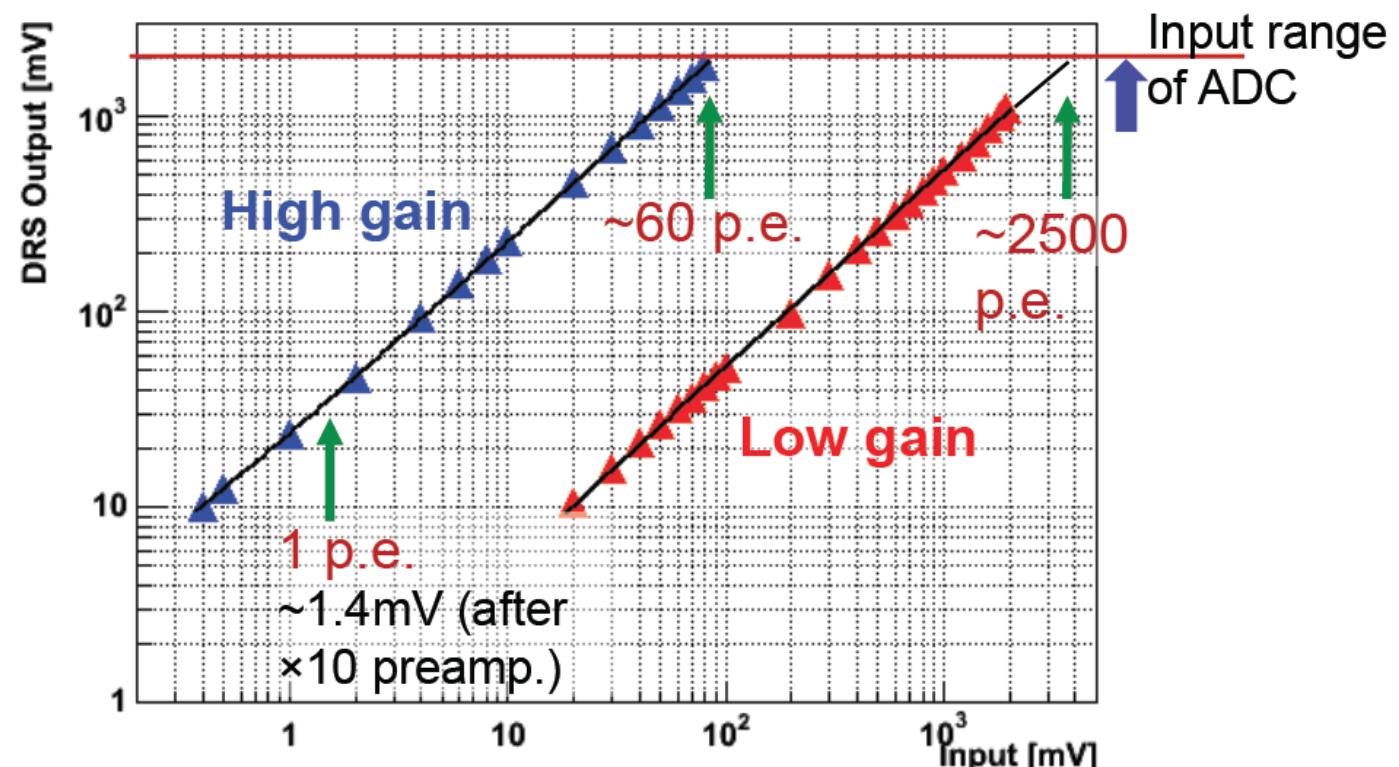


Bandwidth(-3dB) (requirement is not

High gain: 275 MHz OK or not

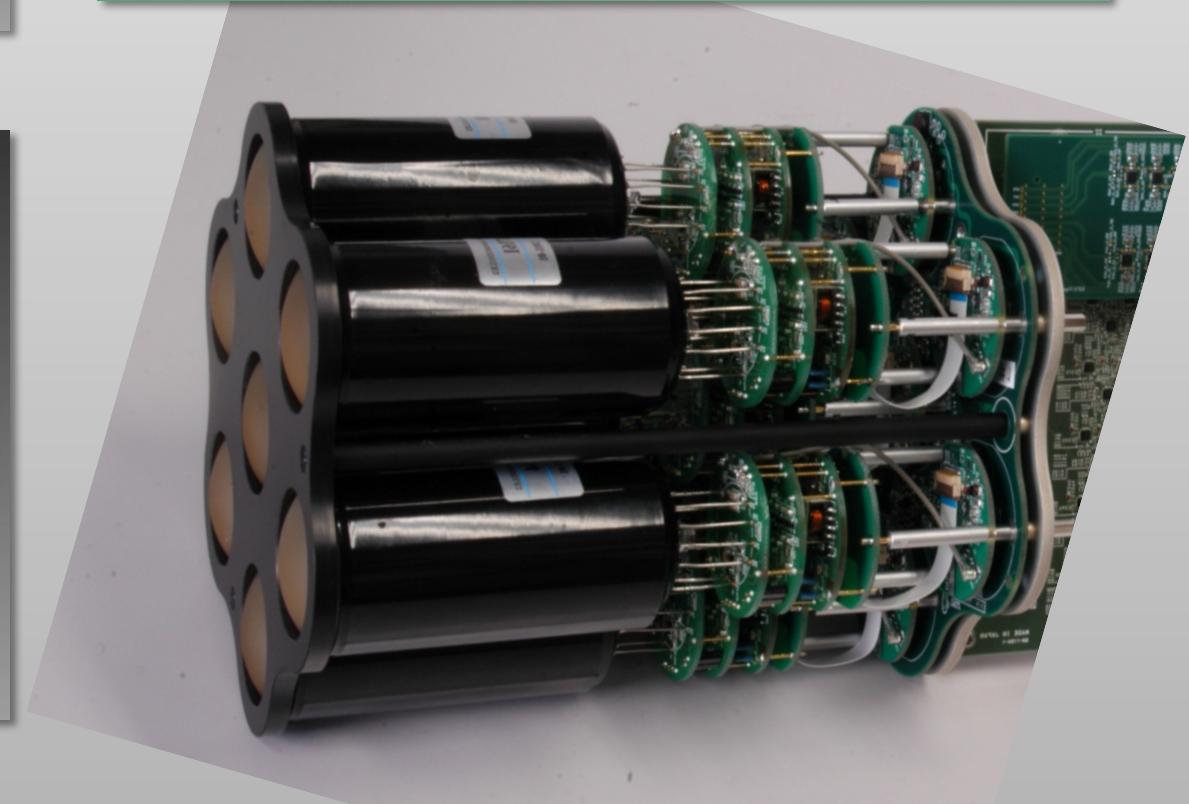
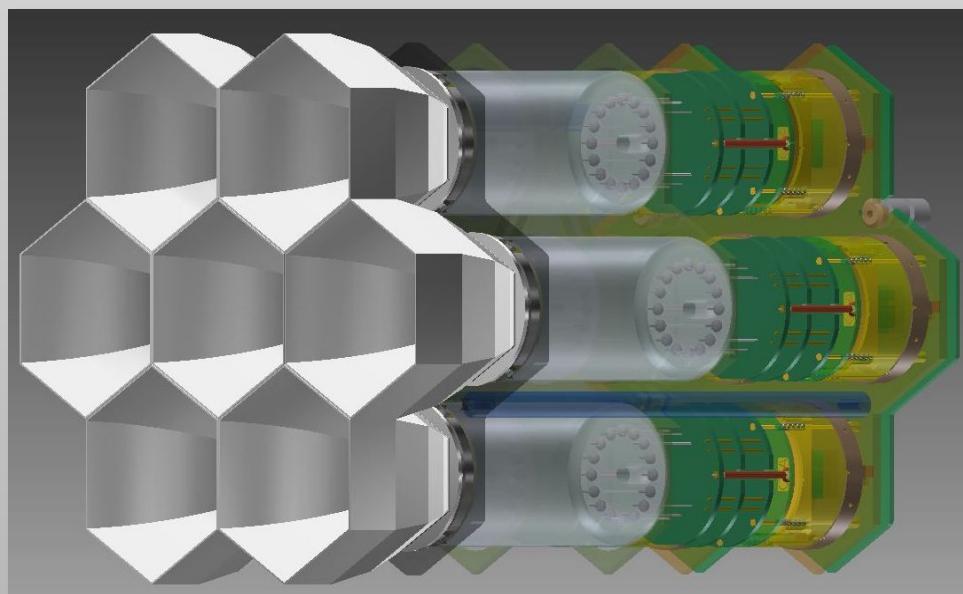
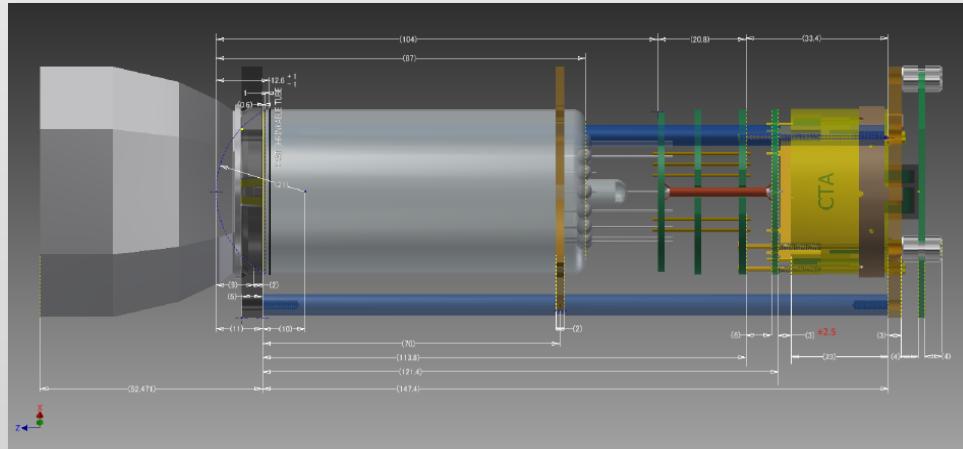
Low gain: 200 MHz OK BW is lower

Trigger: >350 MHz OK capacitance



光電子増倍管とクラスター

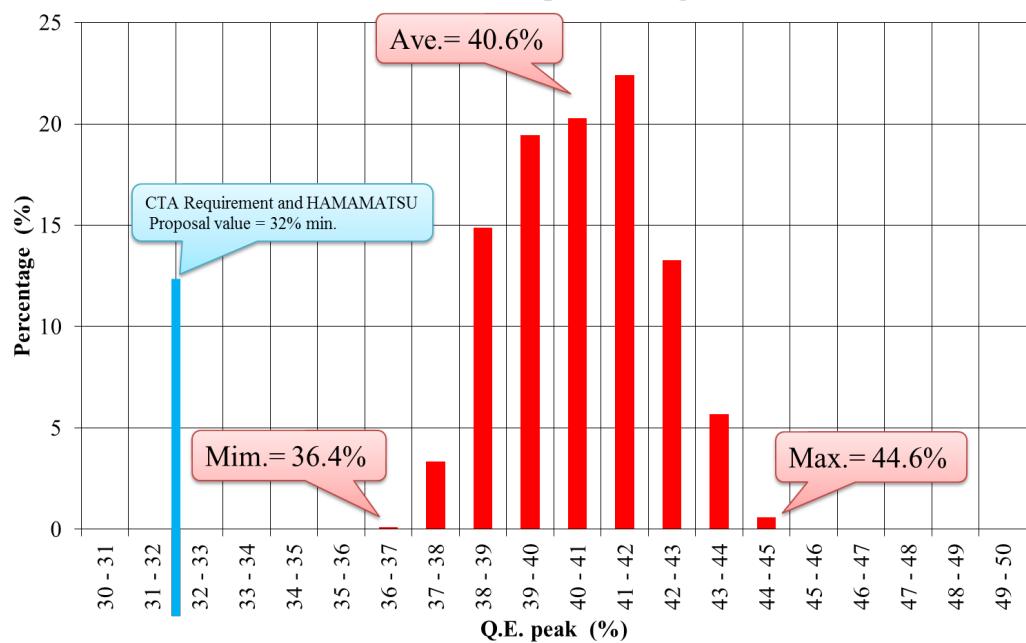
→ TA 報告60 光検出器 永吉(埼大)、TA報告62ライトガイド 田中 (茨城大)



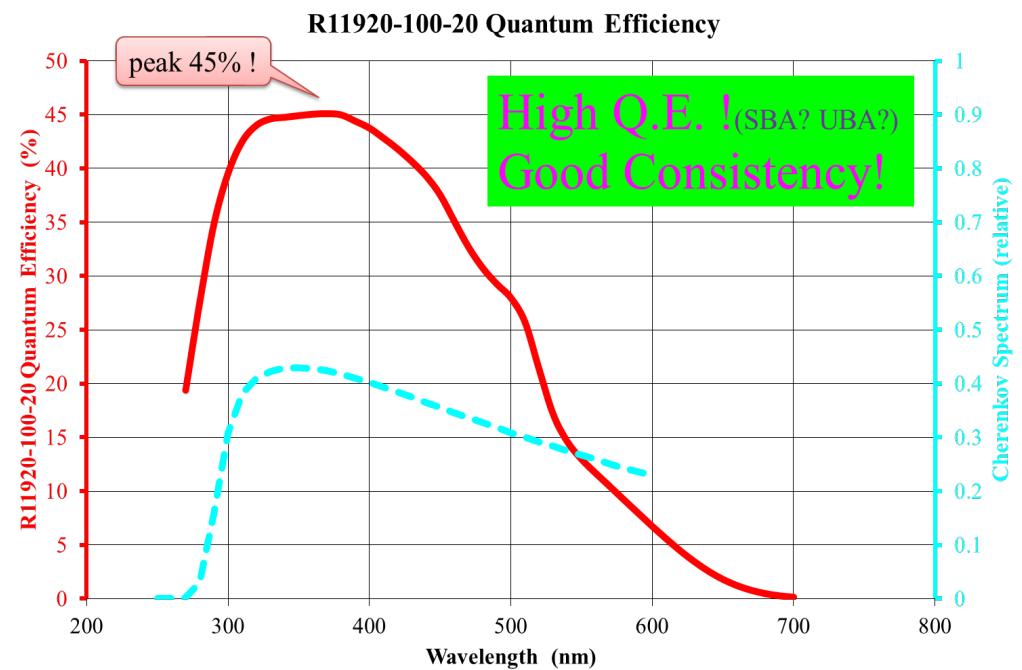
光電子増倍管特性 (R11920)

Very High QE

R11920-100-20 Q.E. peak Histogram



R11920-100-20 Quantum Efficiency



Time Schedule for LST construction

LST construction (Jan 2013)

The Gantt chart illustrates the project timeline across various phases:

- Design Phase (2011-2012):** Includes Baseline Design Doc, Detail Design, Technical Report Doc, Prototype of elements, Prelim. Tech. Doc, Second Review, Third Review, and Final Design Doc.
- Prototyping/construction 1st Telescope (2013-2015):** This phase is divided into three main segments: FP7 EU Preparatory Phase, Production of the First LST elements, and Quality Control. It also includes Element prototyping, PTDR, Reviews, and FDD.
- Evaluation (2015-2016):** This phase involves Site Decision, Site Ready, Site Infrastructure, Site Agreement, Contract, and MEXT Project (4 BJPY over 5yrs).
- Construction Phase (2016-2020):** This phase is divided into Element Production I, Element Production II, and Construction. It includes Integration Test, Shipping, Construction, and Commissioning.
- Finance (2016-2020):** This phase covers JSPS Grants-in-Aid: Specially Promoted Research (400 MJPY) and MEXT Project (4 BJPY over 5yrs).

Key milestones marked with stars include the First Light, Partial Oper., and Full Oper. phases.

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)

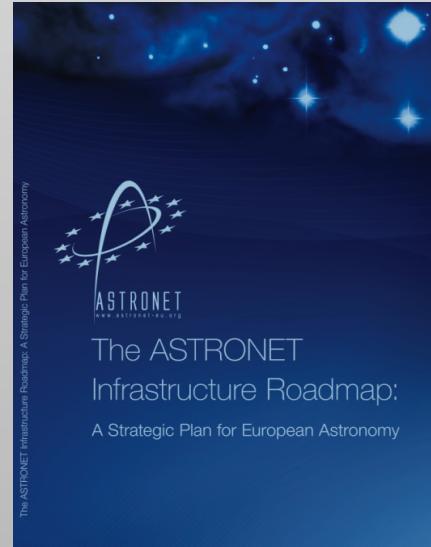
■ Discussion in the domestic communities

- Future strategy committee in CRC
→ 3S Recommendation (Highest Priority)
- Future planning committee in ICRC (Highest Priority)

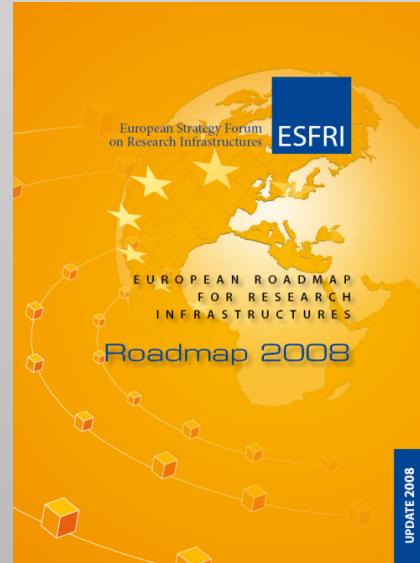
■ Rec. by EU, US, International organization



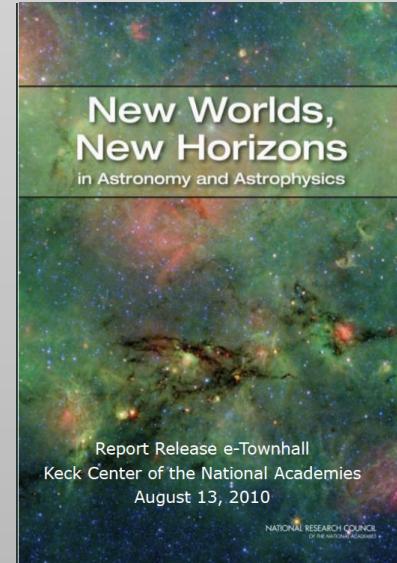
ASPERA
EU Astroparticle



ASTRONET
EU Astrophysics



ESFRI
European Commission



Deacadal Survey
US Astronomy and Astrophysics



OECD
WG on Astroparticle physics

Summary

- Science Case:
 - Astroparticle 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, Helmholtz 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)