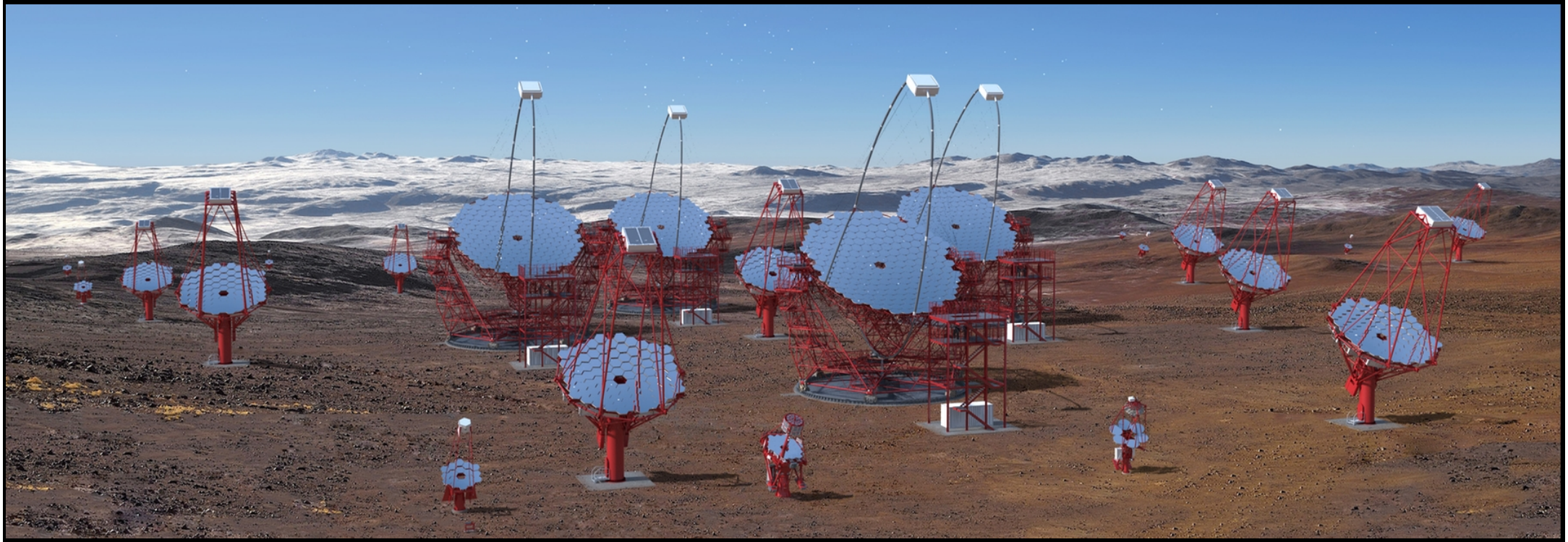
CTA国際宇宙ガンマ線天文台
All-Sky Observatory CTA

Masahiro Teshima

ICRR, The University of Tokyo
Max Planck Institute for Physics



CTA Consortium (32カ国, >1400名)

CTA-Japan 123名

青山大　木坂将大, 柴田徹, 山崎了, 吉田篤正

茨城大　片桐秀明, 鈴木萌, 三浦智佳, 柳田昭平, 吉田龍生

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近畿大　千川道幸, 藤原千賀己, 李健

熊本大　高橋慶太郎

KEK素核研　郡和範, 田中真伸, 廣島渚

甲南大　髙原大, 田中周太, 山本常夏

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名大ISEE　朝野彰, 奥村曉, 佐々井義矩, 関崎晴仁, 田島宏康, 中村裕樹, 日高直哉, Anatolii Zenin

広大理　高橋弘充, 深沢泰司

広大宇宙科学センター　田中康之, 水野恒史

宮崎大　森浩二

山形大　郡司修一, 高橋知也, 門叶冬樹, 中森健之

山梨学院大　内藤統也, 原敏

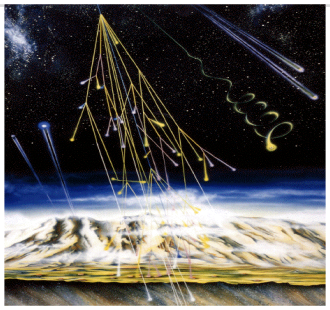
理研　井上進, 井上芳幸, 長瀧重博, Maxim Barkov, Gilles Ferrand, Haoning He, Donald Warren

立教大　内山泰伸

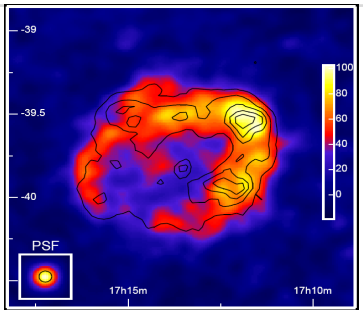
早稲田大　片岡淳

cherenkov telescope array

Science with CTA
Energy frontier of Astrophysics

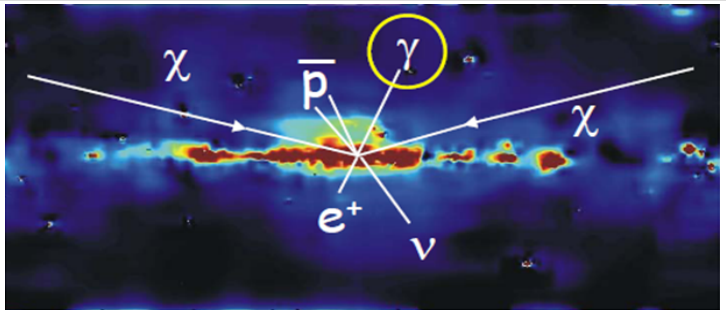


Origin of CR
UHECR



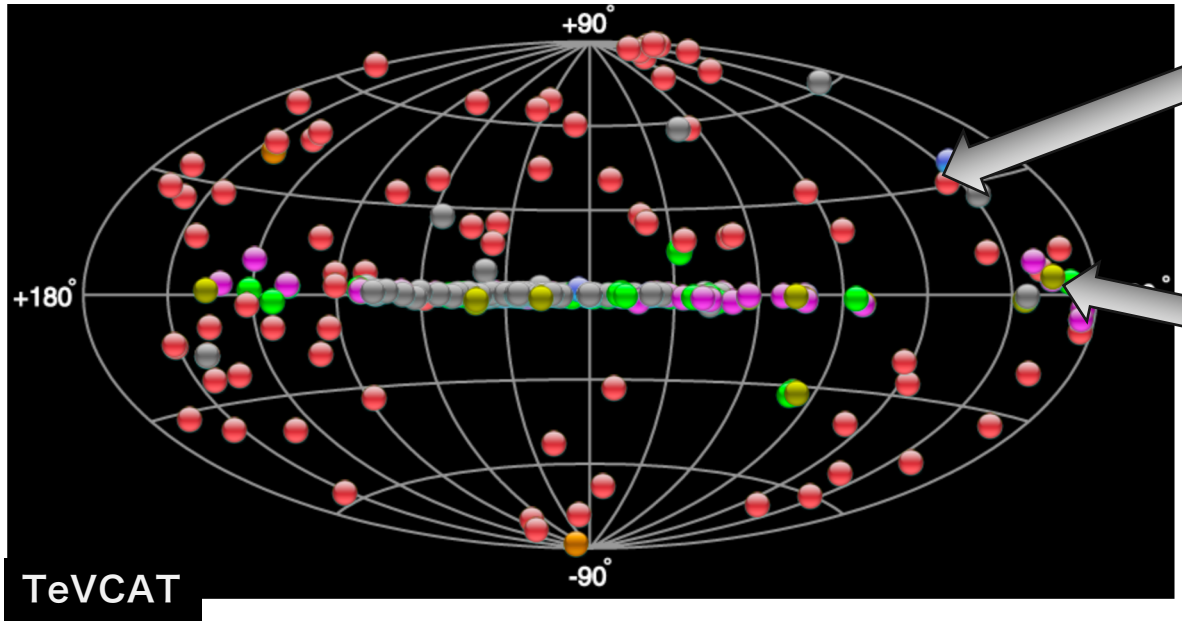
Cosmic Accelerators

Super Massive
Blackhole

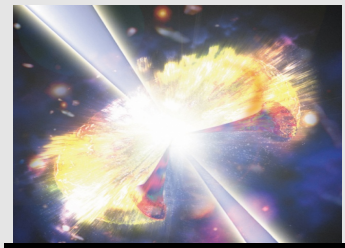


Dark Matter

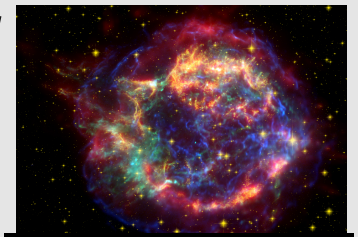
- Origin of Cosmic Rays (Cosmic Accelerators)
- High Energy Phenomena around Blackholes
- Gamma Rays from Dark Matter Annihilation

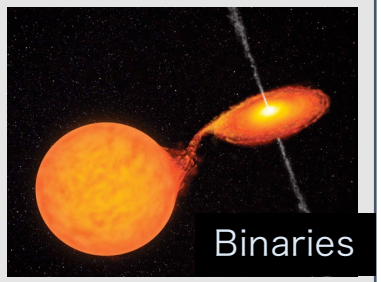


Extragalactic



Galactic Sources





Read this document!!

211 pages, >500 authors

It will invite you to support this project, and then to work on that!!

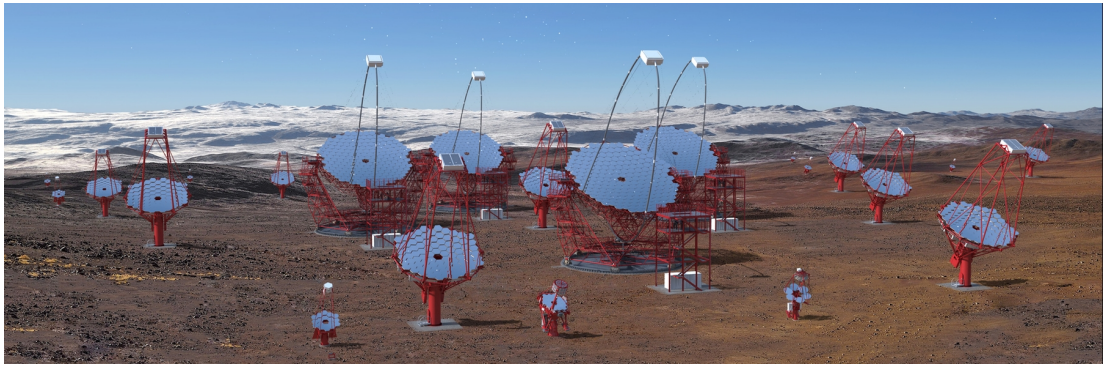
arXiv:1709.07997

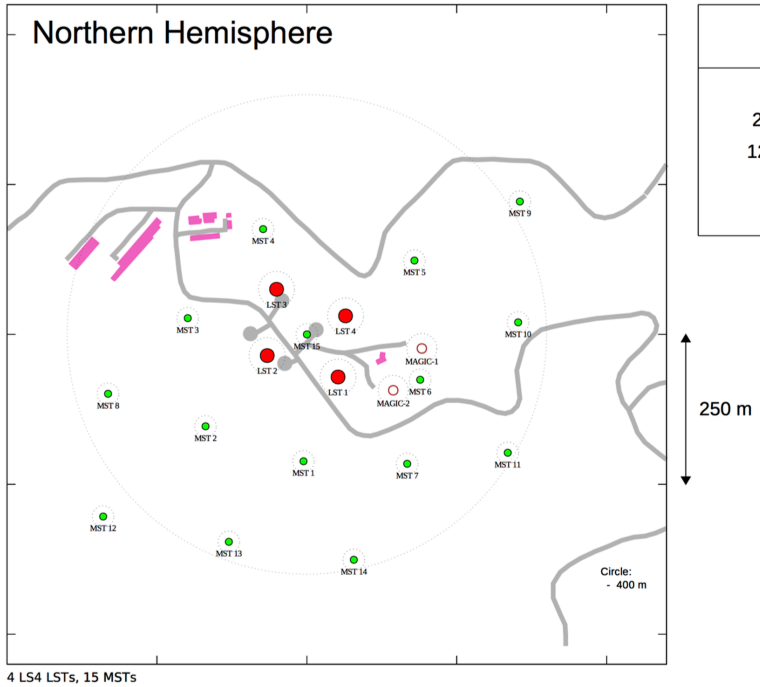
cherenkov telescope array

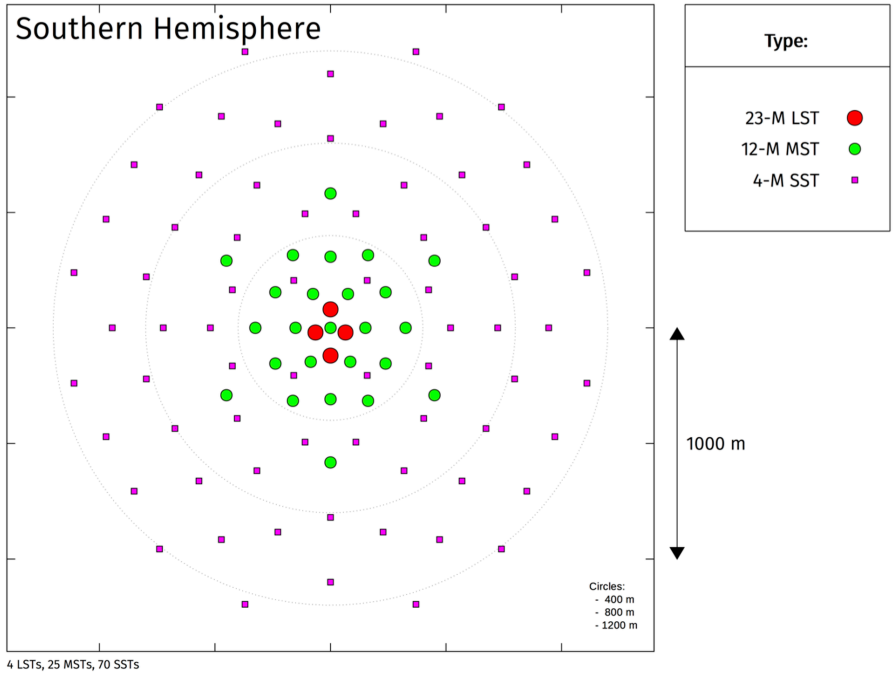
Two sites for all sky observatory

Roque de los Muchachos Observatory
La Palma, Spain

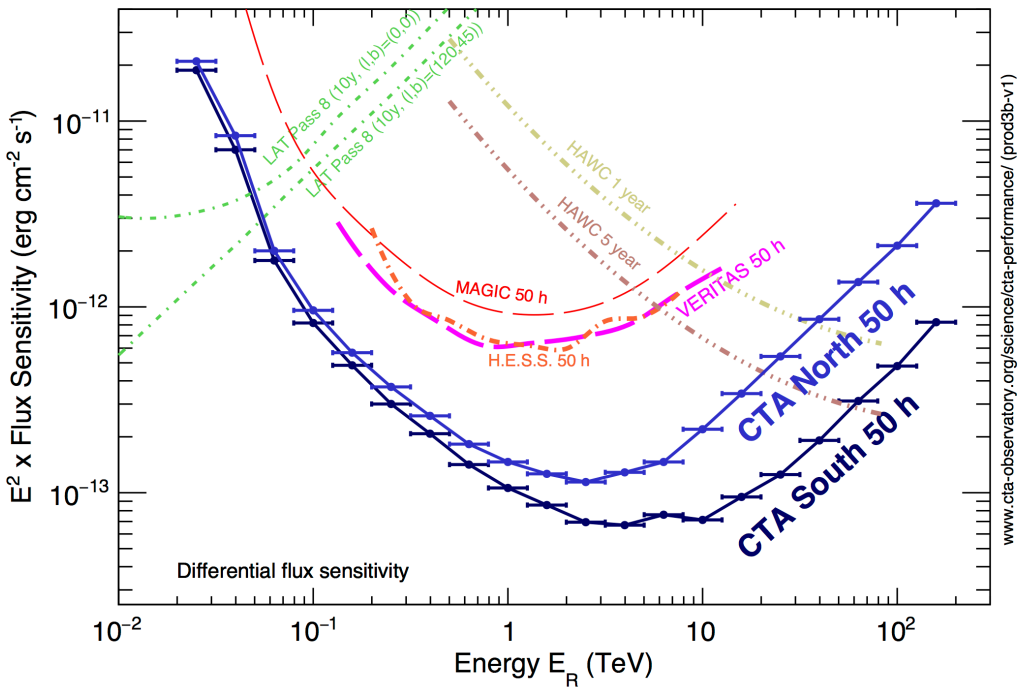
Paranal, Chile

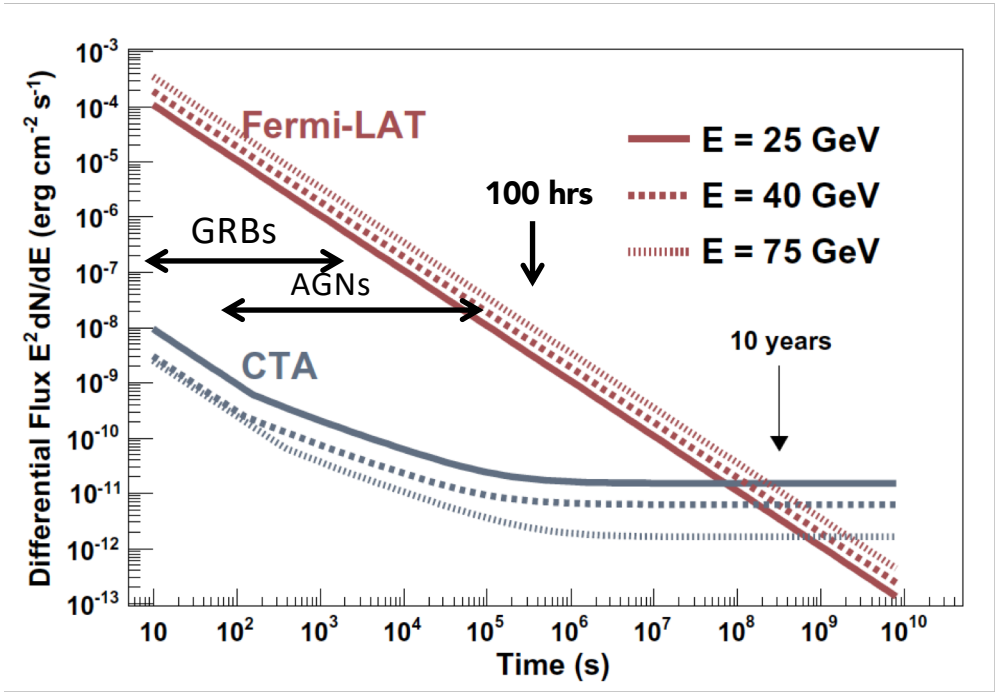




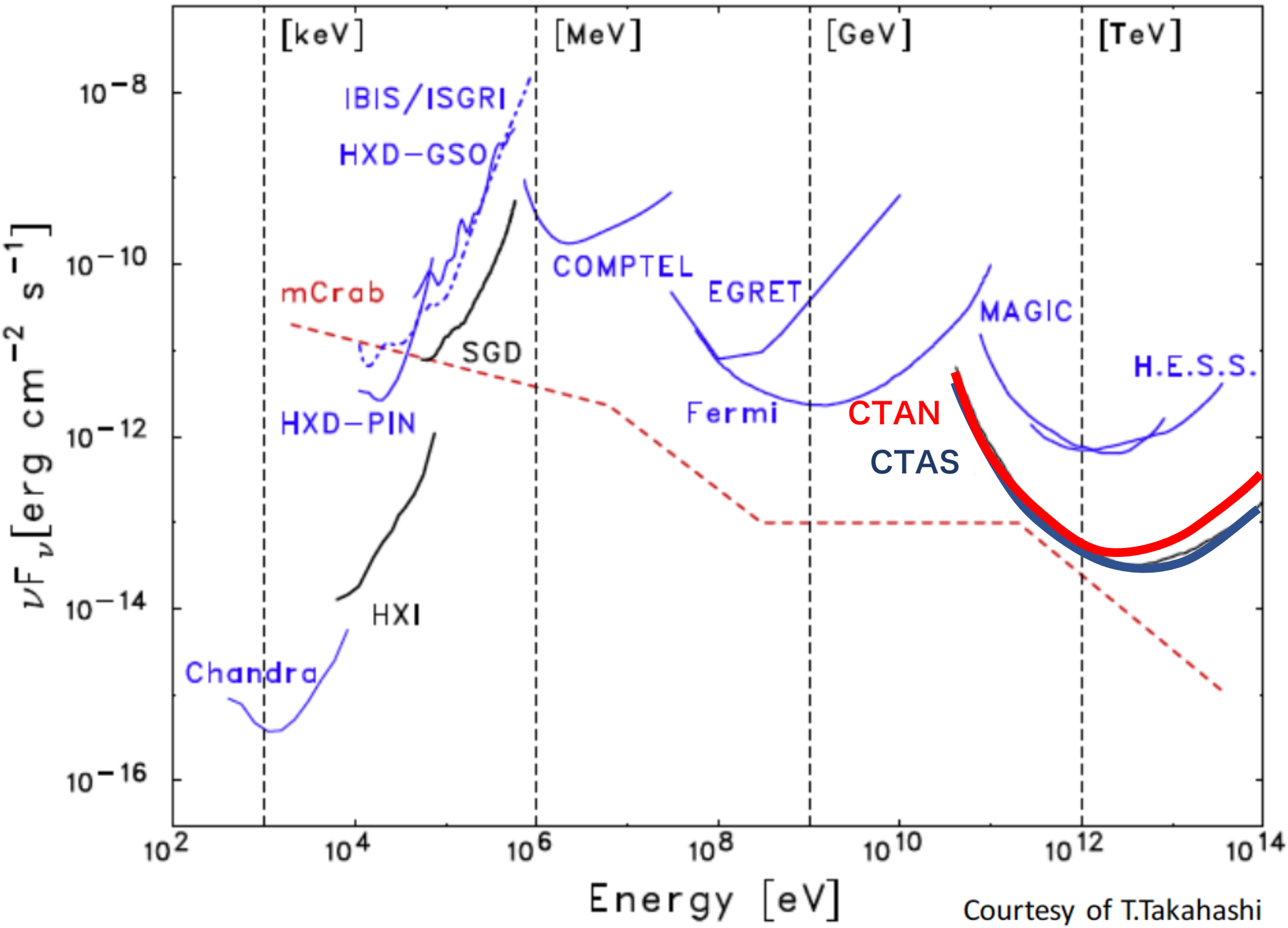


CTAN-LST Array
Sensitivity x3, Angular Resolution x2
Energy Range 20GeV~200TeV





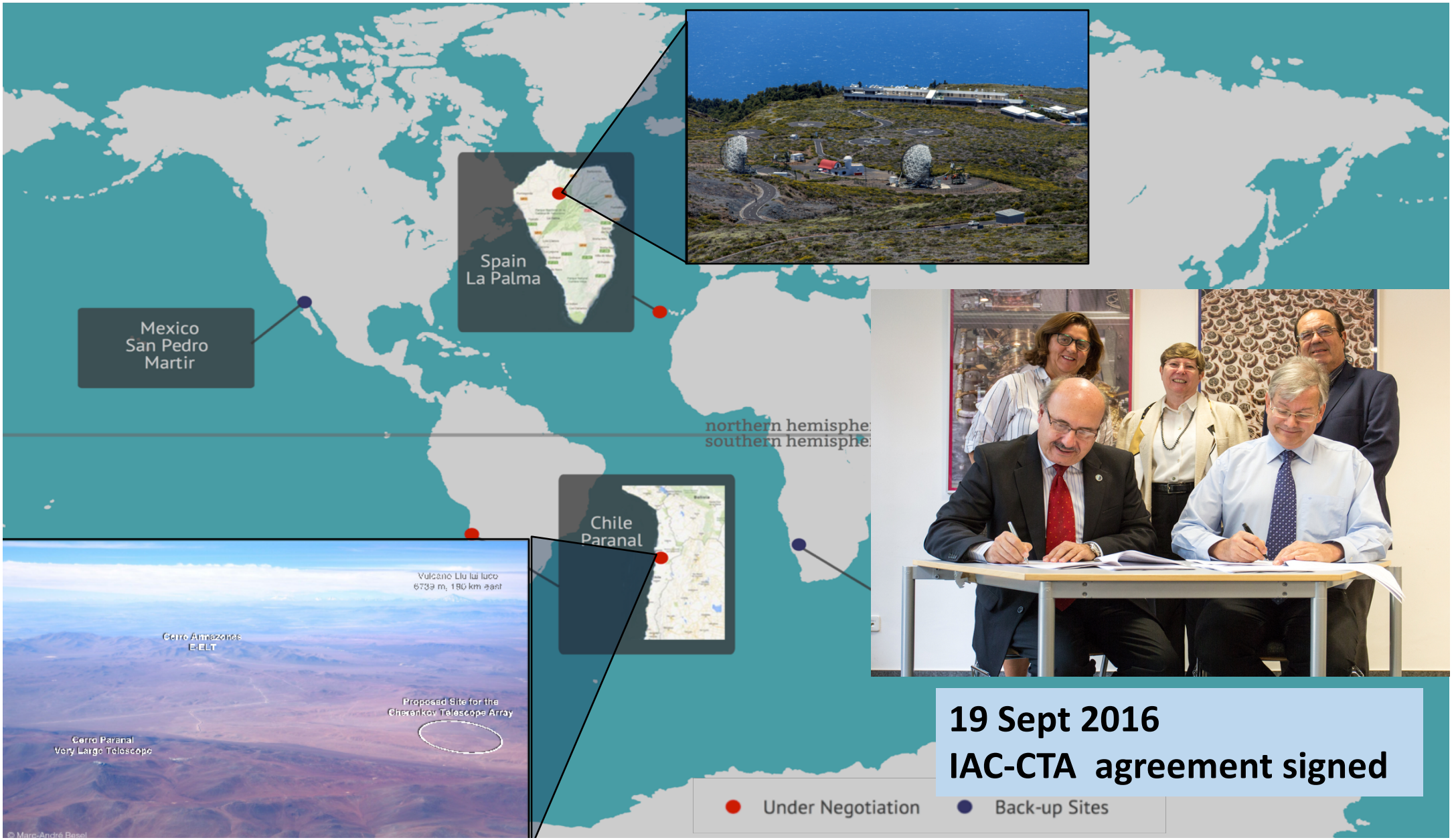
- CTA-LST array contributes to the sensitivity in low energies
- >20GeV Threshold Energy
- Distant AGNs are observable up to z=2, and GRBs up to z=4
- X10000 sensitivity for GRBs and AGN flares than Fermi
- First observation of GRBs from ground



Courtesy of T.Takahashi

cherenkov telescope array

Two sites were chosen in July 2015 (reported in Science)

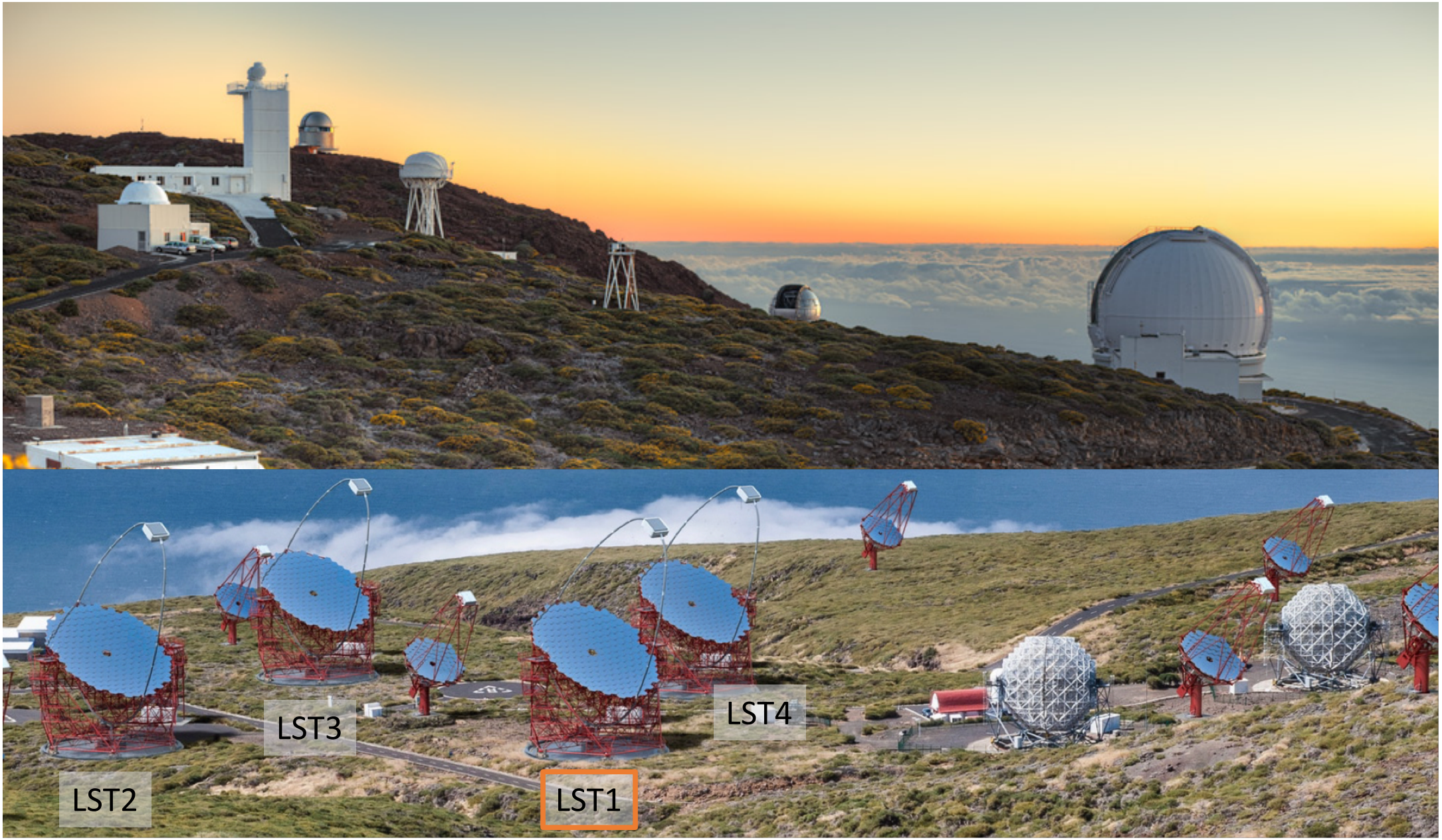


19 Sept 2016
IAC-CTA agreement signed

cherenkov telescope array

CTA North

Observatorio del Roque de los Muchachos



First stone ceremony
Signing ceremony for 4xLST

11. Oct. 2015 LST-1 First Stone Ceremony at ORM

14. Apr. 2016 4 LST Signing Cermony, Prof. Rebolo, Secretary of Stat C. Bella, Vice Minister Tomioka, Prof. Kajita

cherenkov telescope array

CTA South

ESO site Chile Paranal

CTA-South hosting agreement signatures

December 2018

Three agreements signed in December 2018 in Santiago de Chile

Chilean Ministry of Foreign Relations – ESO

ESO – CTAO

CTAO – CONICYT

CTA-LST Project: big International Effort

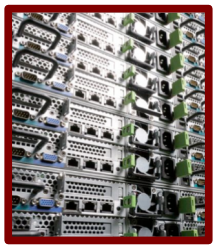
BR(Brazil), DE(Germany), ES(Spain), FR(France), IN(India), IT(Italy), HR(Croatia), JP(Japan), PL(Poland), SE(Sweden)

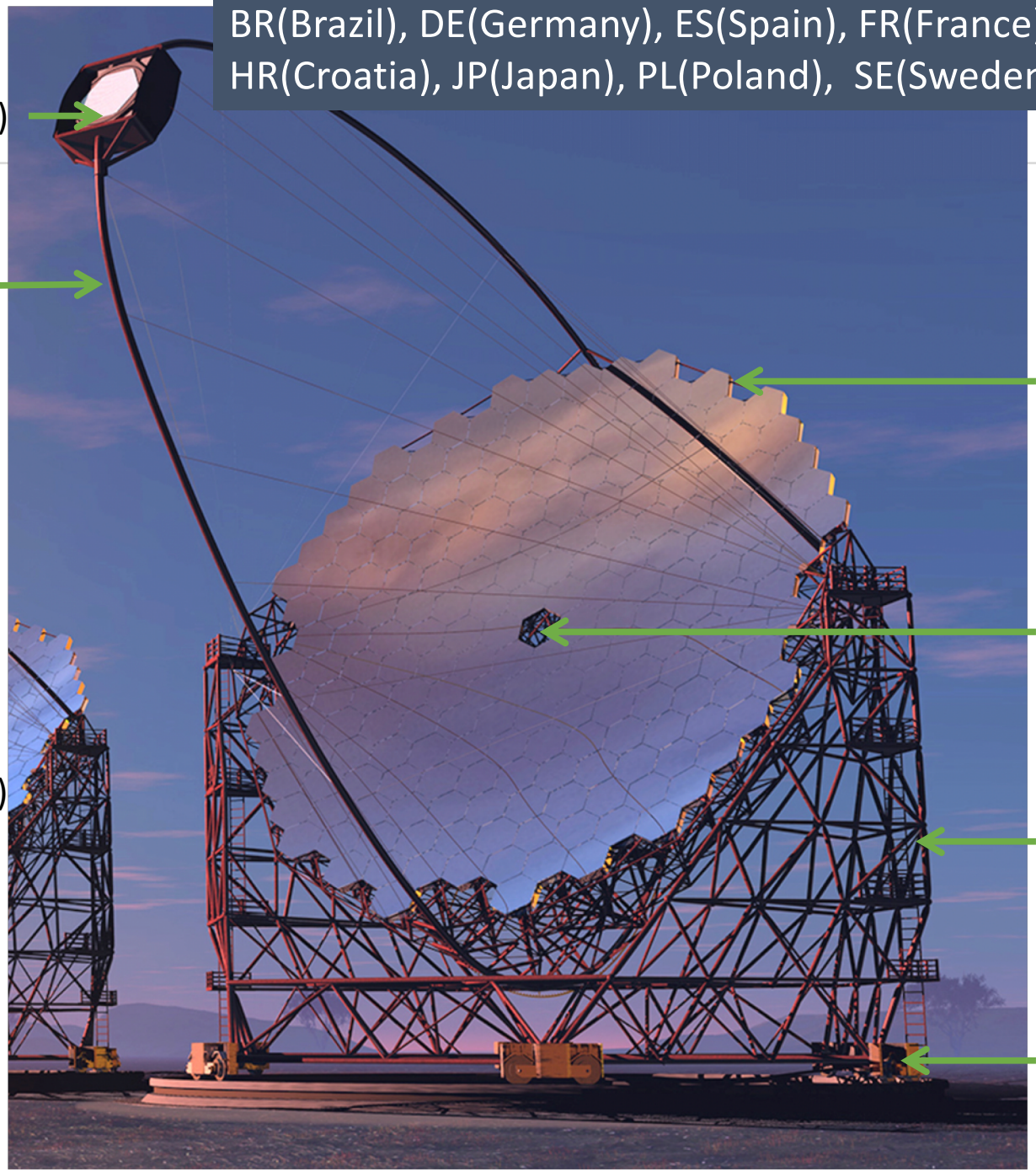
Focal Plane Instr.
Electronics (JP/IT/ES/FR)
Camera body (ES)

Camera Supporting Structure (FR/IT)

Camera Access Tower (ES/DE)

Flywheel, UPS (JP)
Computers, network (JP)
INFRA (ES)



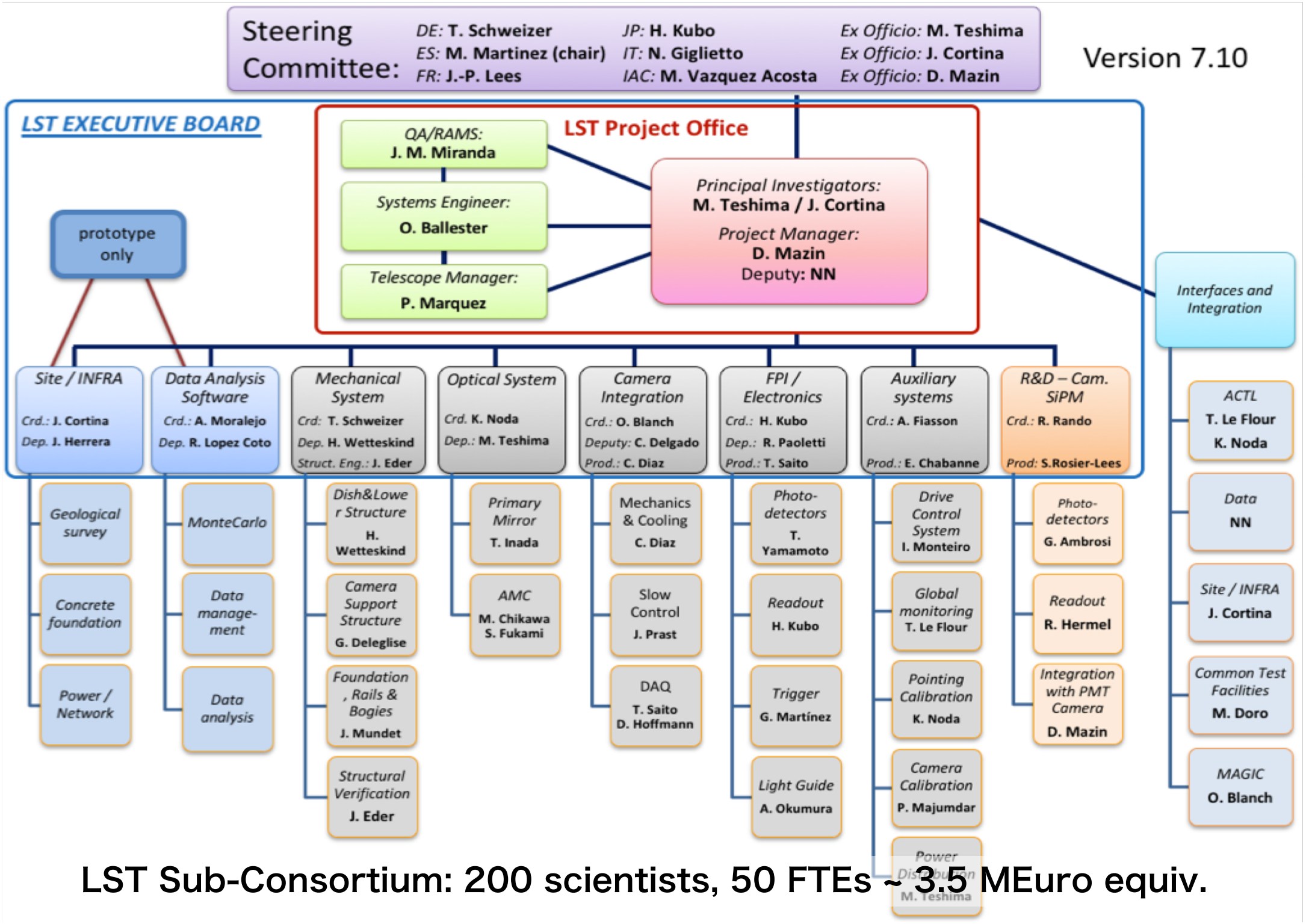


Mirror (JP)
Interface Plate(JP/BR)
Actuator (JP)
CMOS-Cam (JP)

Star Guider (JP/SE)
Calibration Box (IN/IT)
Cabling (DE/FR)

Structure (DE/ES)
Access Tower (DE/ES)

Drive (ES/FR/DE)
Bogie (ES/DE/IT)
Rail (ES/DE)
Foundation (ES)



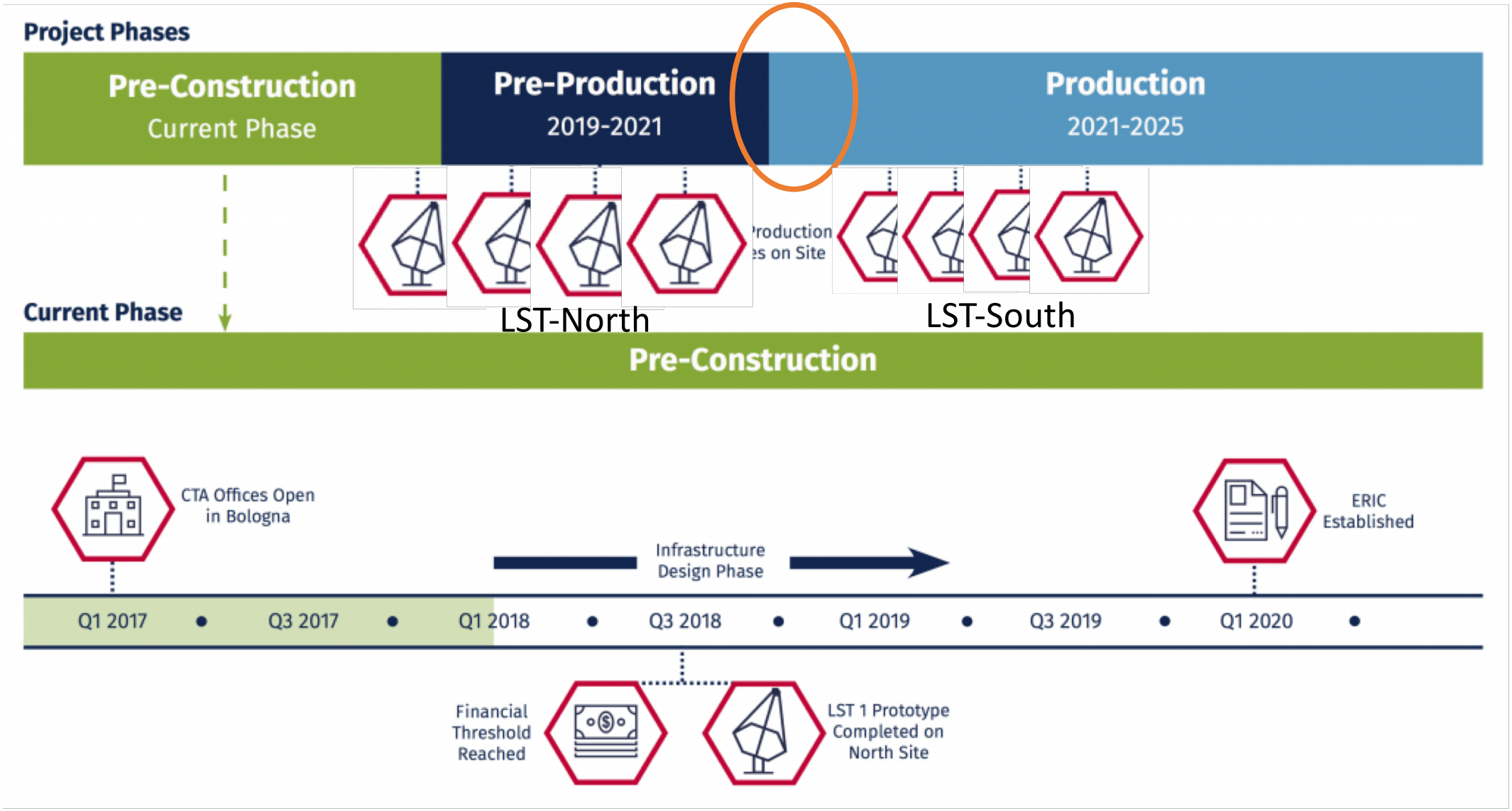
LST Sub-Consortium: 200 scientists, 50 FTEs ~ 3.5 MEuro equiv.

cherenkov telescope array

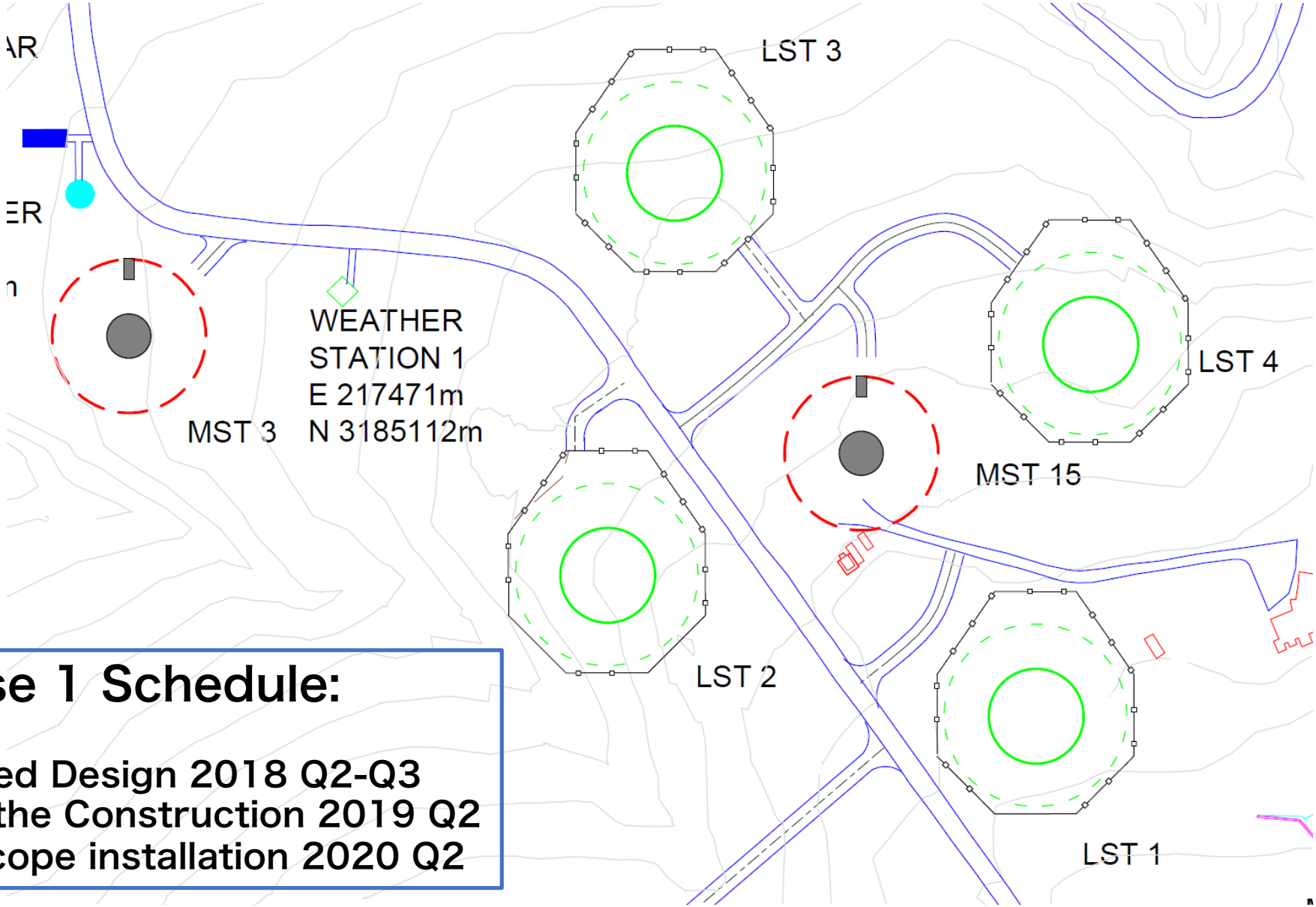
LST1 Inaugurated on 10 October 2018

Time line for CTA and CTA-LSTs

2022 4基のLSTアレイ完成



CTA-N INFRA in Phase 1



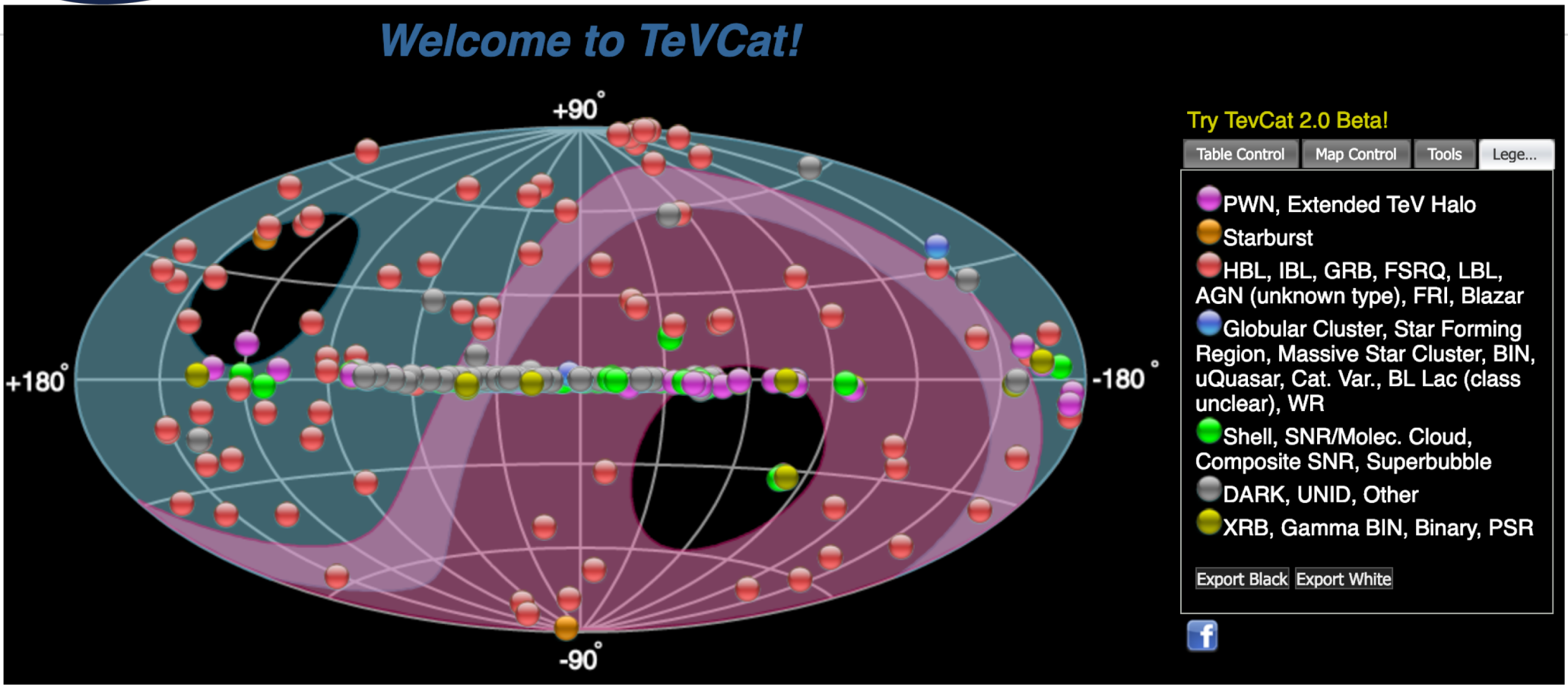
Phase 1 Schedule:

Detailed Design 2018 Q2-Q3
Start the Construction 2019 Q2
Telescope installation 2020 Q2

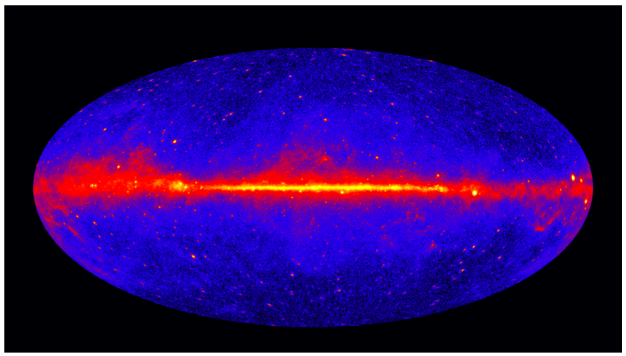
cherenkov telescope array

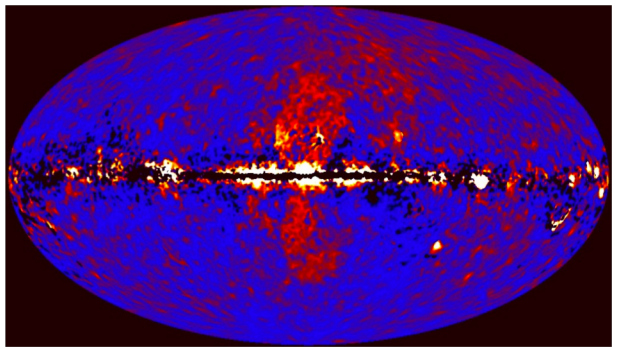
TeV Sky map

we can improve very much



Fermi-LAT Observation





Why do we need CTA South / LST South?

- Increase Number of sources
- Detailed study of galactic objects
  - Pulsars, PWNe, SNRs, Detailed study of Specific SNRs
  - Dwarf Spheroidal Galaxies for D.M. indirect search
- Doubling Sky and deep Universe (AGNs z<2, GRBs z<4)
  - AGNs, AGN Flares, GRBs

- Enhance Quality and Find New phenomena
  - G.C. and G.C. Halo
  - Our G.C. is the closest S.M.B.H.
    - Should be studied in detail, Spectrum, Time variation, Flares etc.
  - Dark Matter Halo
    - LST+MST array in South, and L.Z.A. observation from North (better Energy res.)
  - PeVatron, Fermi-bubble
    - Ultra High Energy galactic Cosmic Rays
  - Galactic diffuse
    - Cosmic Ray propagation

Why do we need CTA South/LST South?

- Multi Messenger Astronomy with PeV neutrinos
  - Ice Cube Source, high z (TXS 0506; z=0.336)
  - ➔ Low threshold is essential. Better coincidence with IceCube Neutrino Event
  - ➔ larger latitude coverage, wider time coverage, doubling discovery chance

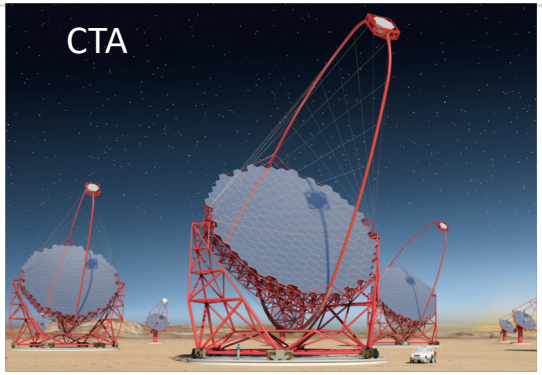
- Multi Messenger Astronomy with Gravitational Wave detectors
  - H.E. Gamma Ray emission from remnants?
  - ➔ low threshold is essential, ➔ larger sky coverage

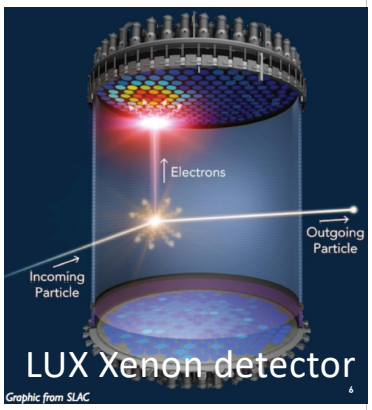
- Specific nearby sources in South
  - Cen A, (M87) --- Hadronic source? UHECRs, Jets (Fermi-Bubble structure?)
  - LMC, SMC (extragalactic PWNe, SNRs, cosmic ray density)
  - Detailed studies of close SNRs, 1ES1713, Vela Jr.
  - Fermi Bubble

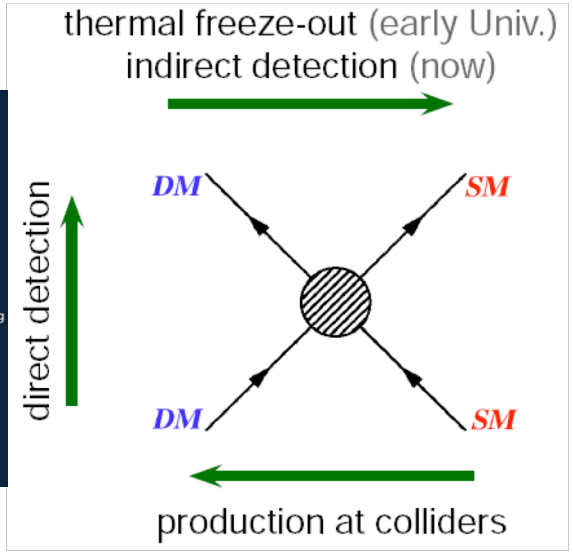
- LST South will have a lot of potential for new discoveries!! We also have good scientists and engineers to make it possible.

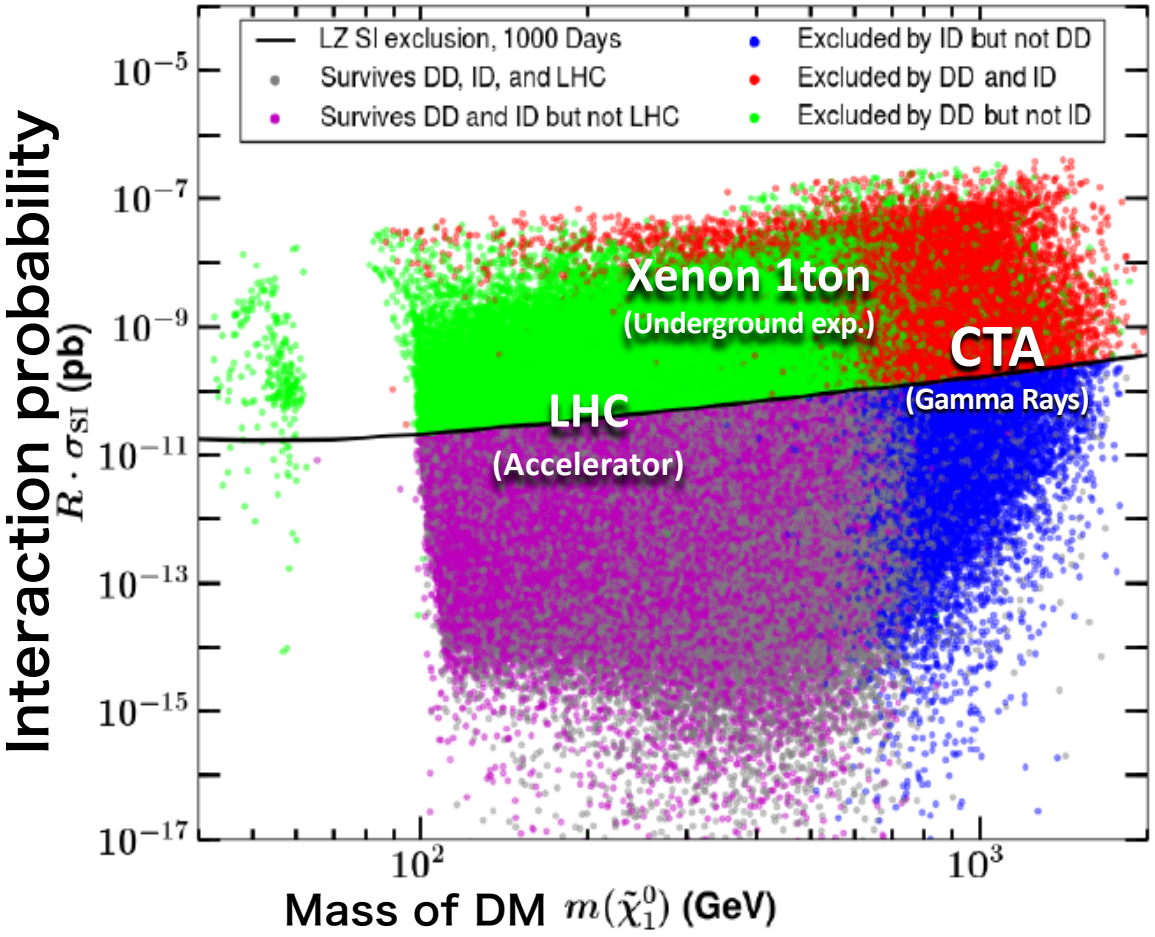
Toward the discovery of Dark Matter
Complementarity of different approaches

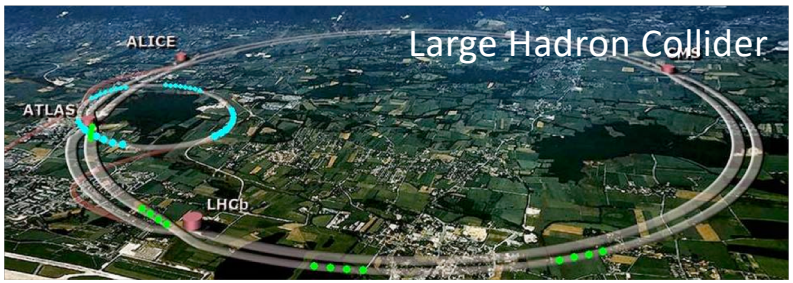
cherenkov telescope array







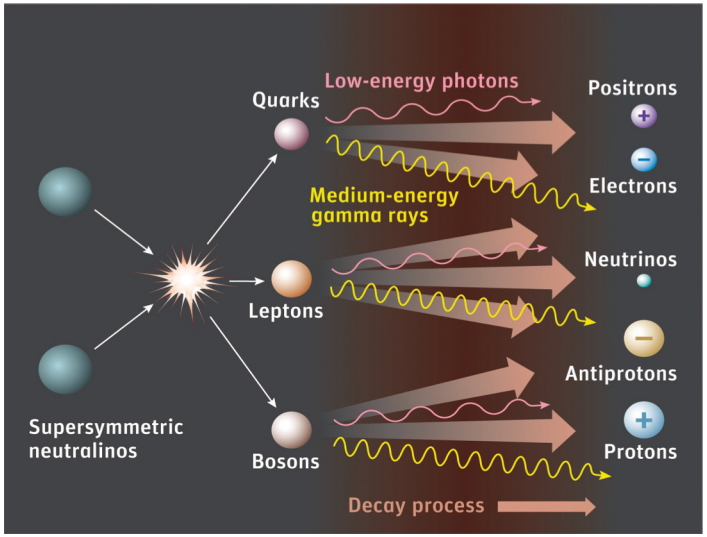




- Explore Dark Matter in the Galactic Center and Dwarf Sph. Galaxies
- CTA has the best sensitivity above 700GeV

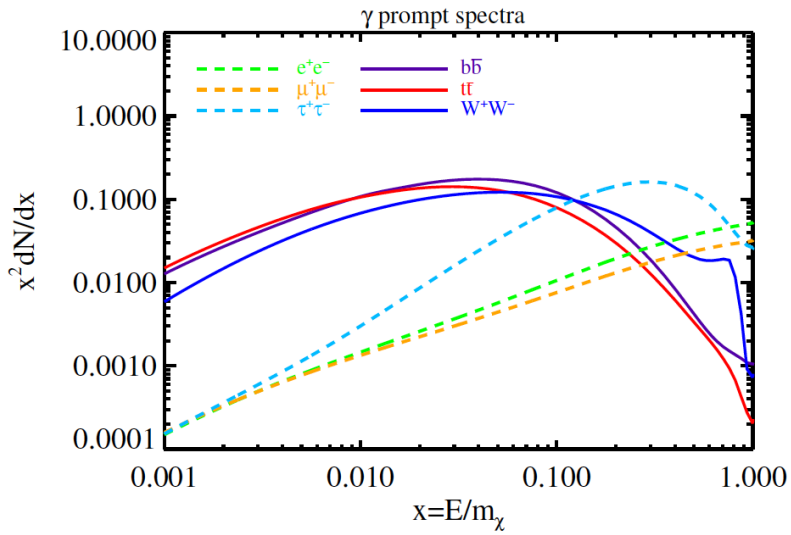
Dark Matter Search

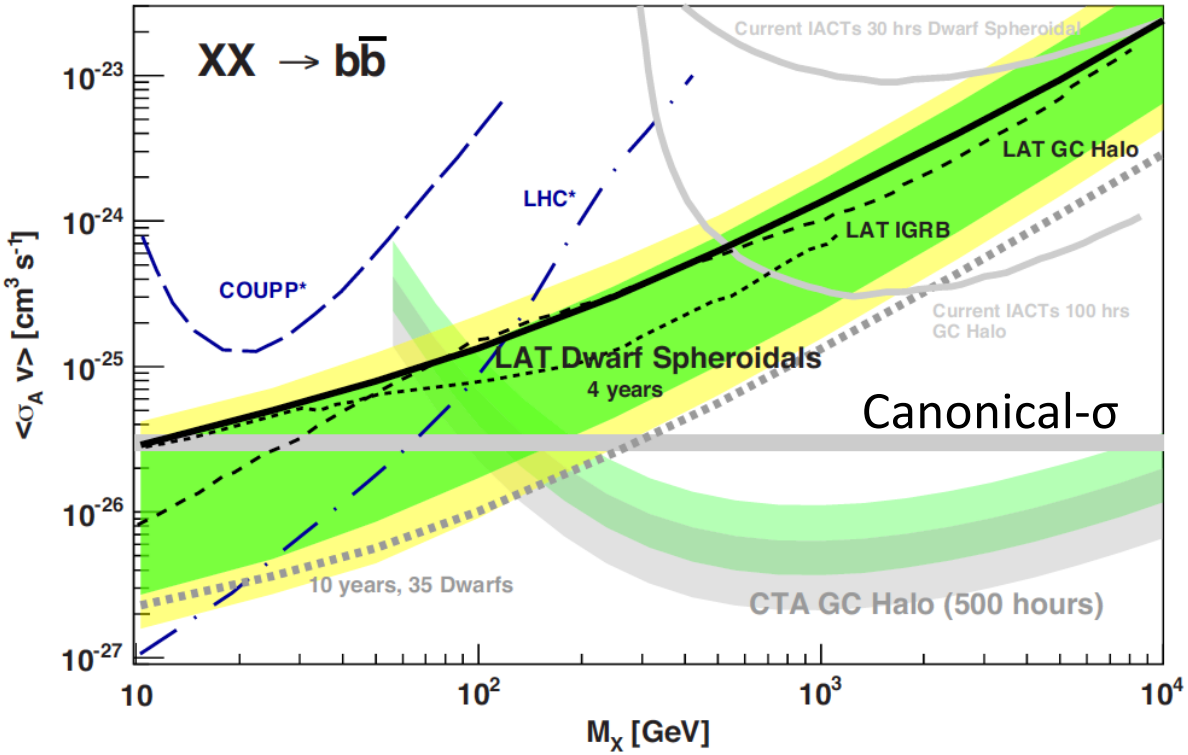
Sensitive M_χ: 200GeV - 10TeV



$$\frac{d\Phi_\gamma}{dE_\gamma} = \frac{1}{4\pi} \underbrace{\frac{<\sigma_{ann} v>}{2m^2_{WIMP}} \sum_f \frac{dN^f_\gamma}{dE_\gamma} B_f}_{\text{'Particle Physics'}} \times \underbrace{\int_{\Delta\Omega} d\Omega' \int_{los} \rho^2 dl(r,\theta')}_{\text{'Astrophysics' or } J(E)}$$

Particle Physics Astrophysics





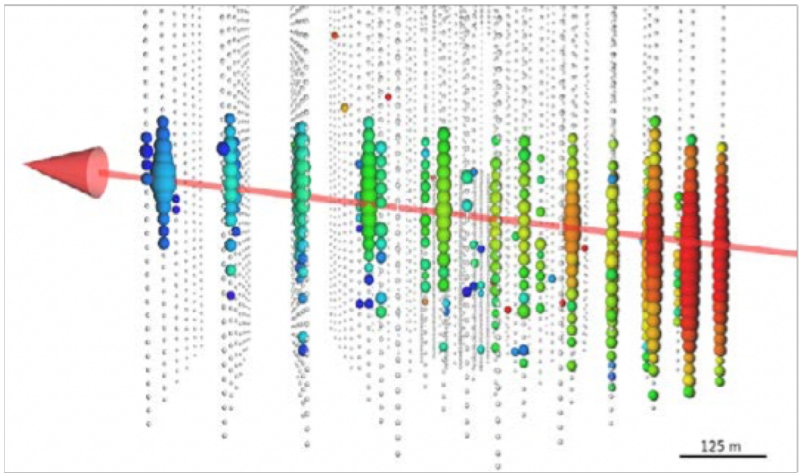
Gamma rays from Annihilation produce the bump around 1/10 -1/20 Mχ ➔ 20GeV-1TeV domain

CTA gives the stringent upper limit.
Stefan Funk 2015

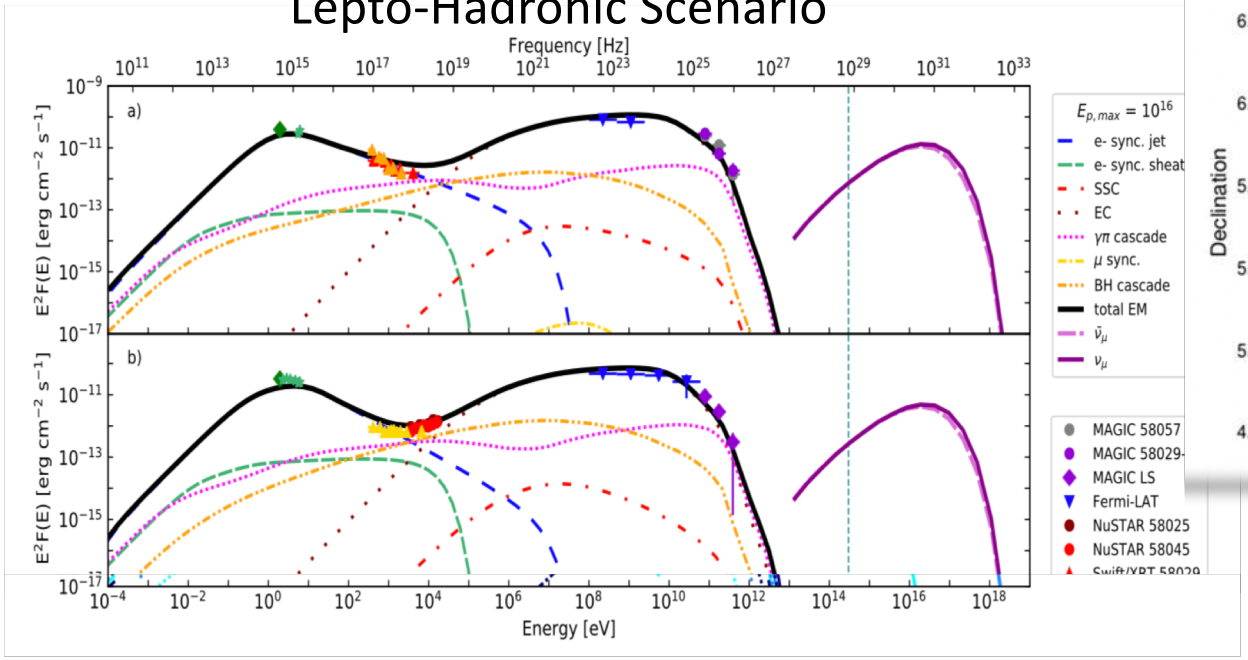
IC170922A / TXS 0506+056

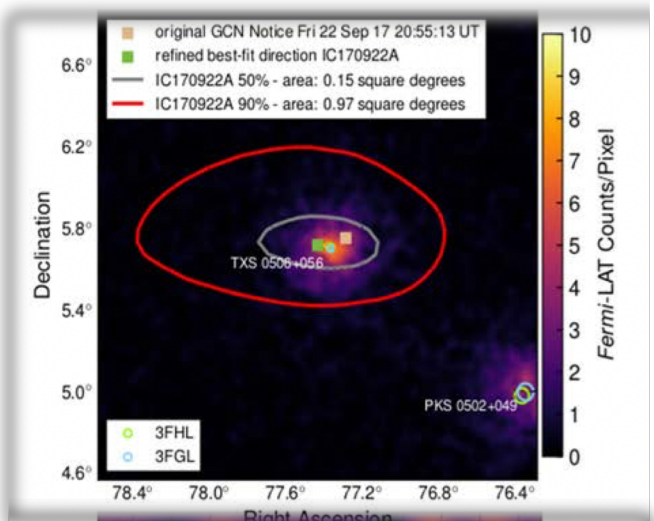
UHECR Sources / Neutrinos may come from distant sources

Ice Cube Observation (~300TeV)

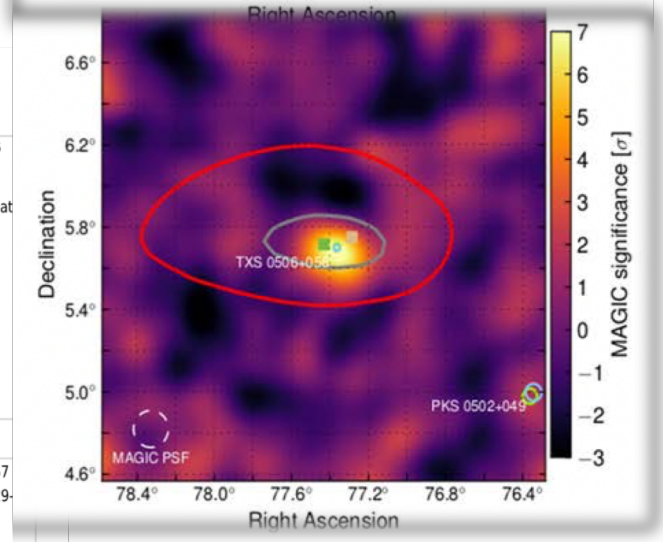


Lepto-Hadronic Scenario





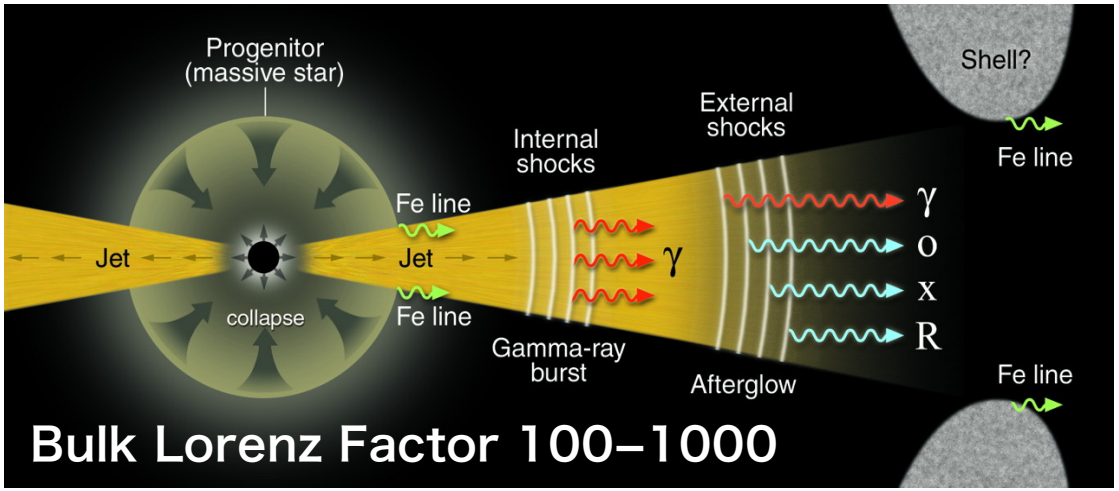
Fermi LAT
(>100 MeV)

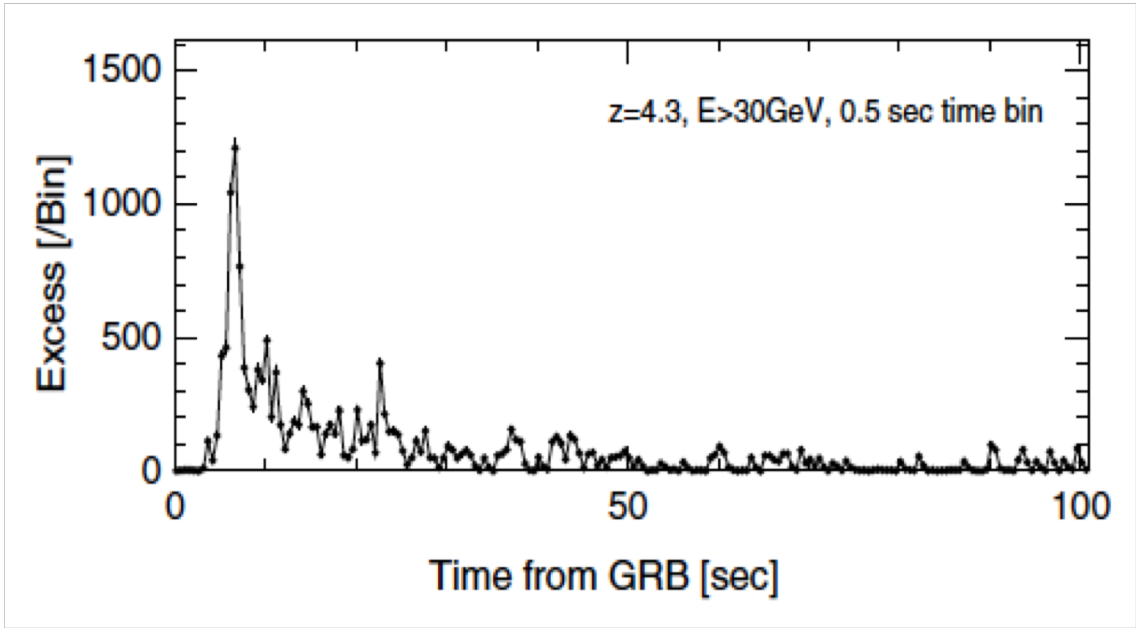


MAGIC
(>100GeV)

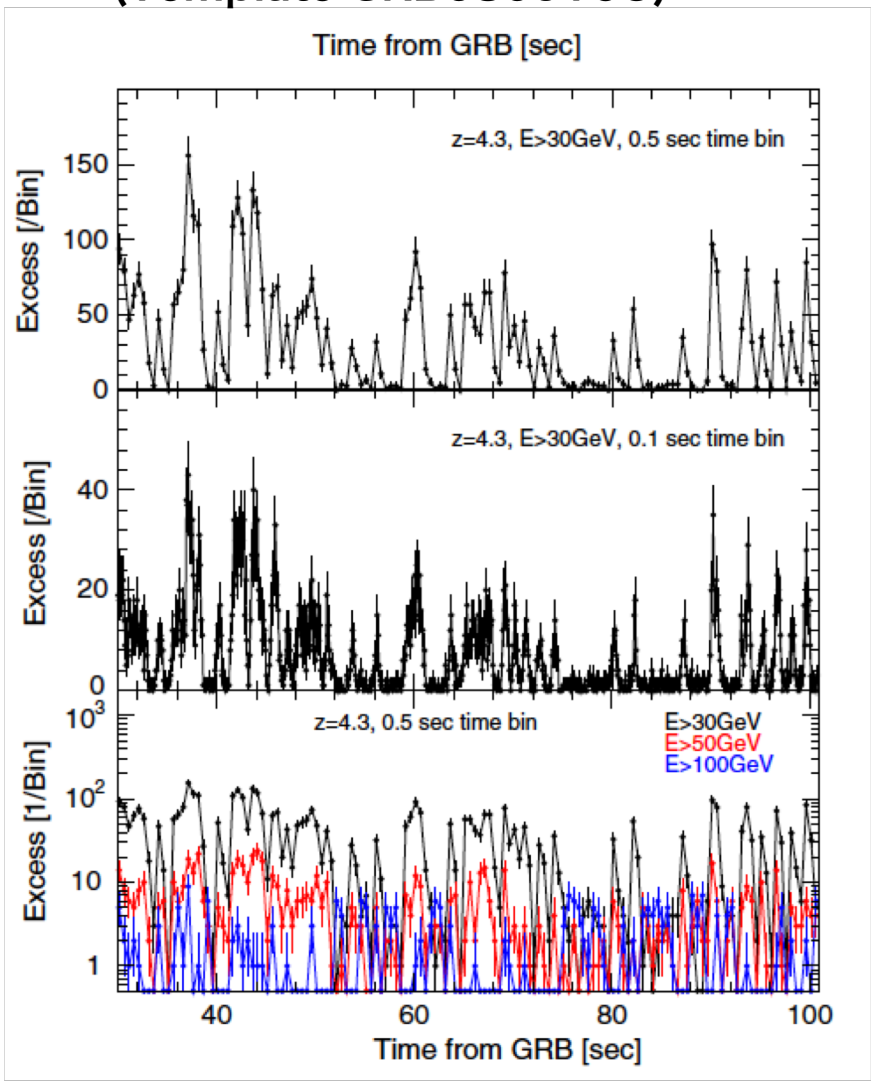
GTC Observation z = 0.3365
S. Paiano et. al 2018

GRBs: good targets for CTA-LSTs
Study the newborn baby black holes





CTA Simulation
(Template GRB080916C)



MAGIC Observed GRB190114C with >20 sigma above 300GeV
Source distance z=0.42

[Previous | Next]

First time detection of a GRB at sub-TeV energies; MAGIC detects the GRB 190114C

ATel #12390; *Razmik Mirzoyan on behalf of the MAGIC Collaboration*
on 15 Jan 2019; 01:03 UT
Credential Certification: Razmik Mirzoyan (Razmik.Mirzoyan@mpp.mpg.de)

Related
12395 GRB 190114C: Search for high-energy neutrinos with IceCube
12390 First time detection of a GRB at sub-TeV energies; MAGIC detects the GRB 190114C

Subjects: Gamma Ray, >GeV, TeV, VHE, Request for Observations, Gamma-Ray Burst

Referred to by ATel #: 12395

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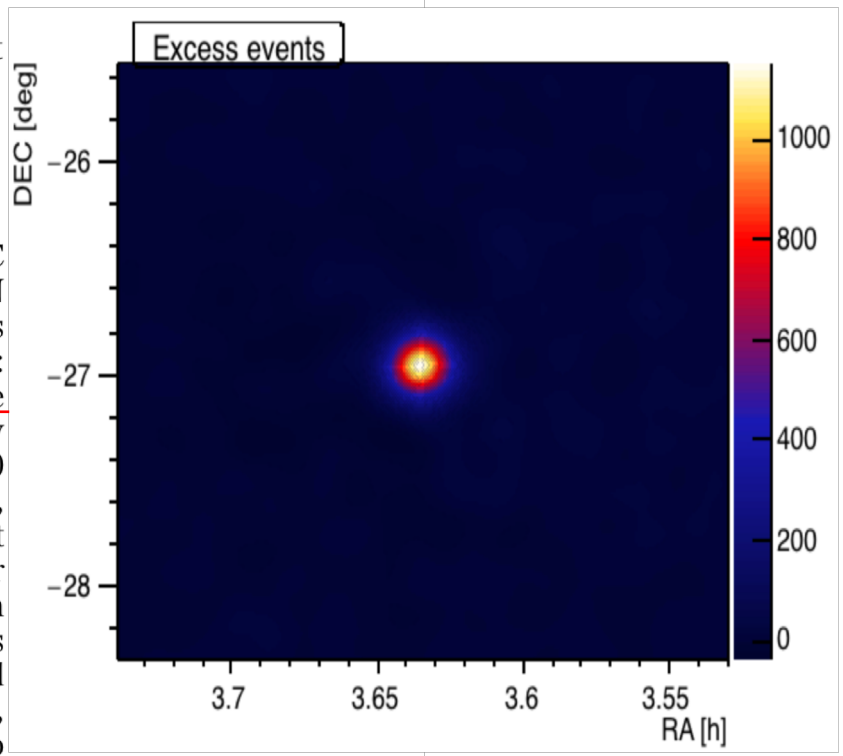
The MAGIC telescopes performed a rapid follow-up observation of GRB 190114C (Gropp et al., GCN 23688; Tyurina et al., GCN 23690, de Ugarte Postigo et al., GCN 23692, Lipunov et al. GCN 23693, Selsing et al. GCN 23695). This observation was triggered by the Swift-BAT alert; we started observing at about 50s after Swift T0: 20:57:03.19. The MAGIC real-time analysis shows a significance >20 sigma in the first 20 min of observations (starting at T0+50s) for energies >300GeV. The relatively high detection threshold is due to the large zenith angle of observations (>60 degrees) and the presence of partial Moon. Given the brightness of the event, MAGIC will continue the observation of GRB 190114C until it is observable tonight and also in the next days. We strongly encourage follow-up observations by other instruments. The MAGIC contact persons for these observations are R. Mirzoyan (Razmik.Mirzoyan@mpp.mpg.de) and K. Noda (nodak@icrr.u-tokyo.ac.jp). MAGIC is a system of two 17m-diameter Imaging Atmospheric Cherenkov Telescopes located at the Observatory Roque de los Muchachos on the Canary island La Palma, Spain, and designed to perform gamma-ray astronomy in the energy range from 50 GeV to greater than 50 TeV.



Budget for All Sky CTA-LSTs
Japanese contribution

4　マスタープラン 2017 への採否状況

採択（区分 II）

5　計画状況　（実施中・提案中）

実施中、2016 年より北サイトの大口径望遠鏡 4 基を建設開始

6　計画実施時期

準備開発期間：　2008-2015

北半球建設期間：　2016-2021　南半球建設期間：　2021-2025

観測運用（北半球）：　2018-2042　観測運用（南半球）：2023-2042

7　総経費および予算プロファイル

CTA 全体のプロジェクトでは LST8基、MST40基、SST70基であり、インフラ、人件費込みで 400MEuro と試算している。以下は日本の貢献分。

日本分担分総経費　152 億円

準備期間（開発研究）：　4 億円

北建設（LST 4 基）：　24 億円　南建設（LST 4 基+PD）：　34 億円

観測運用（北 25 年、南 20 年）：　90 億円（年間 2 億円/サイト）

Summary

- The prototype LST1 was successfully constructed. LST1 was awarded with the prize “Technology of 21 Century” in Spain in February 2019.
- We continue the construction LST2-4 with excellent young scientists, engineers and students.
- Operation of telescopes
  - 2019: Commissioning of LST1
  - 2020-2021: Engineering run of LST1
  - 2022: Commissioning of LST1-4 stereo system
- Launch the extention project LST South (LST5-8) in 2022-2026
  - We need new partners,,,,,,