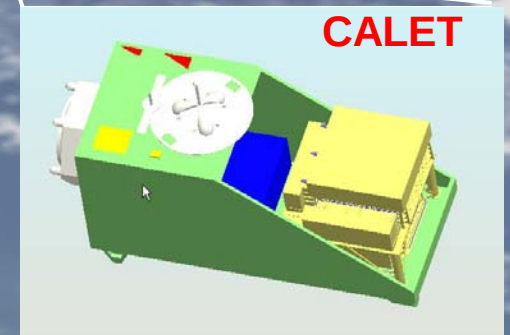
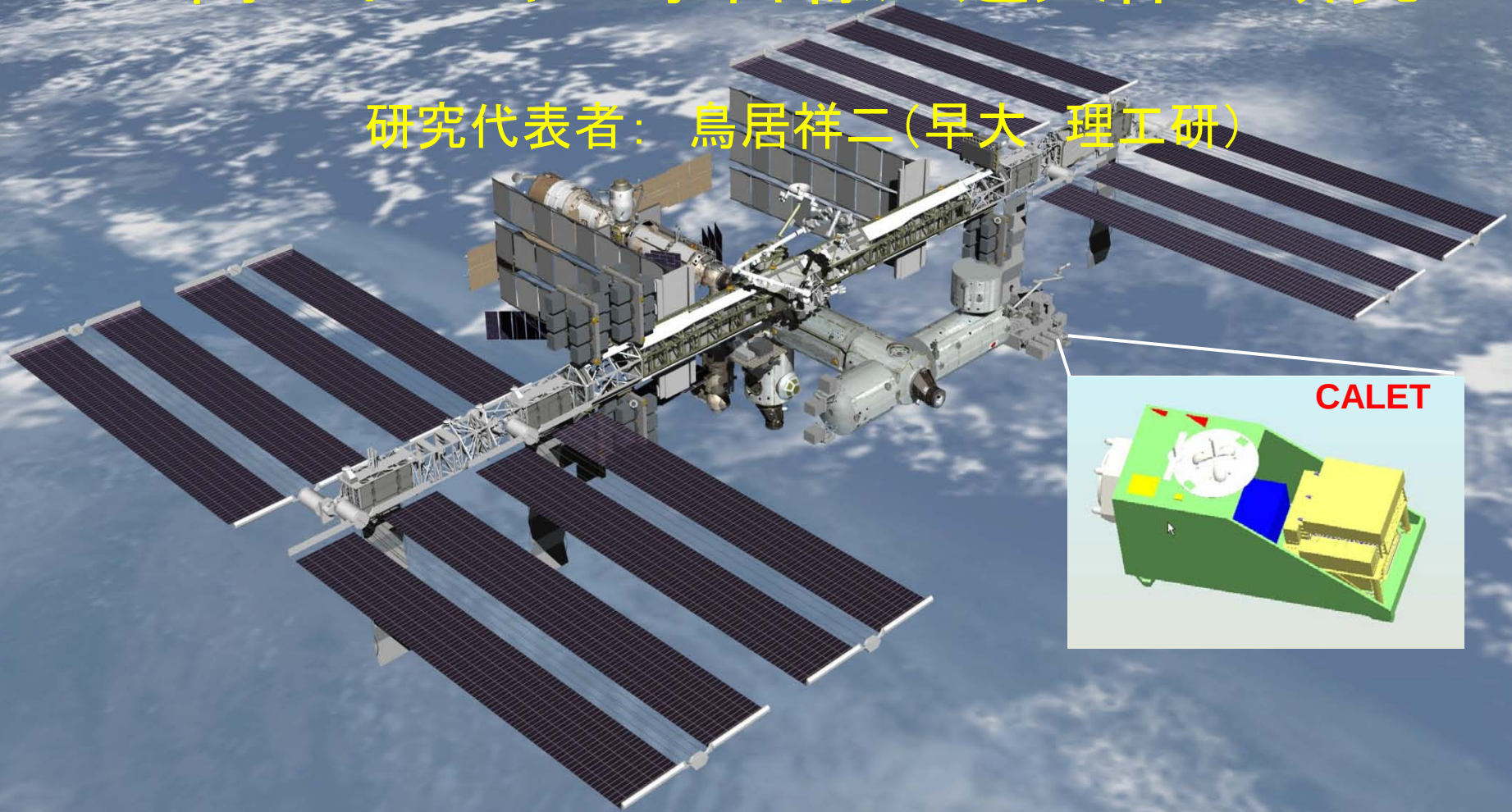




飛翔体観測による 高エネルギー宇宙線加速天体の研究

研究代表者： 鳥居祥二(早大 理工研)



共同利用研究概要

■ 研究内容

- Calorimetric Electron Telescope (CALET)の要素技術開発
- CALET性能最適化のためのシミュレーション計算

■ 発表概要

- CALETプロジェクト
- 電荷測定器 (CHD)モデル開発
- (CERN-SPSビーム実験)
- CALET 観測データ解析プラン

■ 予算 研究費 500千円

支出内容 (予定) : 電荷測定器(CHD)開発用 PMT、ライトガイド、プラスチックシンチレータ

■ 共同利用 計算機 (シミュレーション計算)

参加研究者及び研究補助

早稲田大学	笠原克昌、小澤俊介、赤池陽水、鈴木拓也、植山良貴、仁井田多絵、伊藤大二郎、 苅部樹彦、近藤慧乃輔、九反万里恵、中村政則、二宮翔太、舟橋良輔、吉田圭祐	神奈川大学	田村忠久、日比野欣也
宇宙線研究所	寺澤敏夫、瀧田正人	JAXA/SEUC	清水雄輝、
JAXA/ISAS	齊藤芳隆、福家英之	芝浦工業大学	吉田健二
横浜国立大学	柴田槇雄、片寄祐作	弘前大学	市村雅一
立命館大学	森正樹		



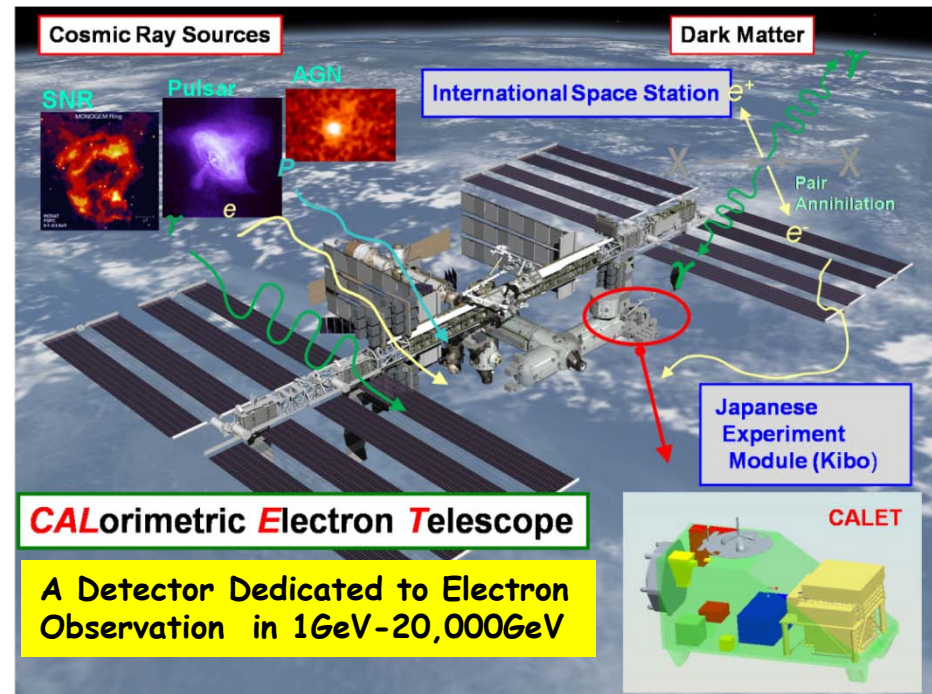
CALET Observation

Calorimeter (CALET/CAL)

- Electrons: 1 GeV - 20,000 GeV
- Gamma-rays: 10 GeV - 10,000 GeV
(Gamma-ray Bursts: > 1 GeV)
- Protons and Heavy Ions:
several tens of GeV - 1,000 TeV
- Ultra Heavy Ions:
over the rigidity cut-off

Gamma-ray Burst Monitor (CGBM)

- Soft Gamma-rays : 30 keV - 30 MeV
- Hard X-rays: 3keV - 3 MeV



Science Objectives	Observation Targets
Nearby Cosmic-ray Sources	Electron spectrum in trans-TeV region
Dark Matter	Signatures in electron/gamma energy spectra in 10 GeV – 10 TeV region
Origin and Acceleration of Cosmic Rays	p-Fe over several tens of GeV, Ultra Heavy Ions
Cosmic –ray Propagation in the Galaxy	B/C ratio up to several TeV /n
Solar Physics	Electron flux below 10 GeV
Gamma-ray Transients	Gamma-rays and X-rays in 3 keV – 30 MeV

Electron Observation for Nearby Sources

Energy (GeV)	Primary e^-	e^- from Vela
500-600	1168	154
600-800	1235	239
800-1000	501	168
1000-1500	546	270
1500-2000	146	134
2000-3000	99	134
3000-4000	23	51
4000-5000	7	23
5000-7000	5	22
7000-9000	1	7
>9000	0	3
> 1000	827	644

Conditions applied:

Electron efficiency = 70%
 Proton rejection factor = 10^5
 Geometrical factor = $0.12 \text{ m}^2 \text{sr}$
 Exposure time = 5 years

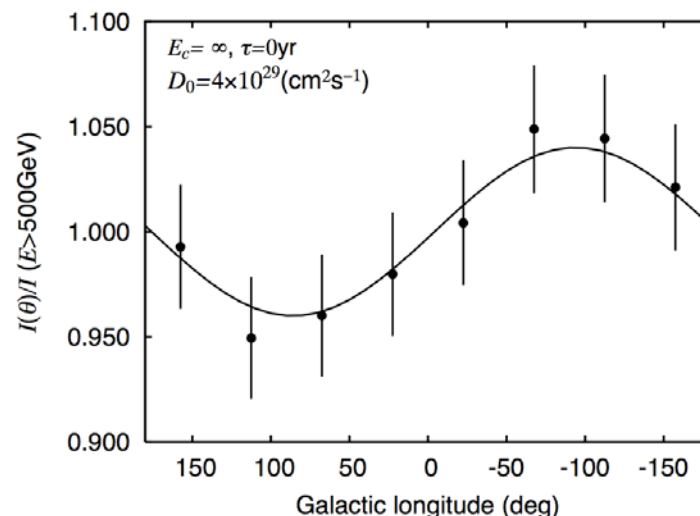
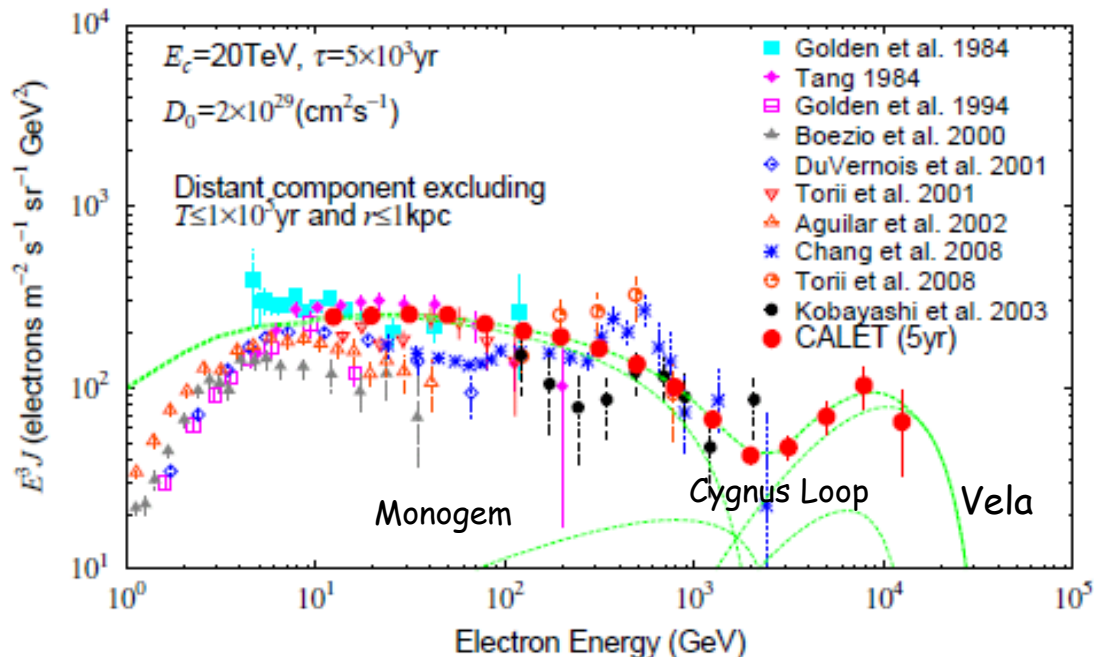
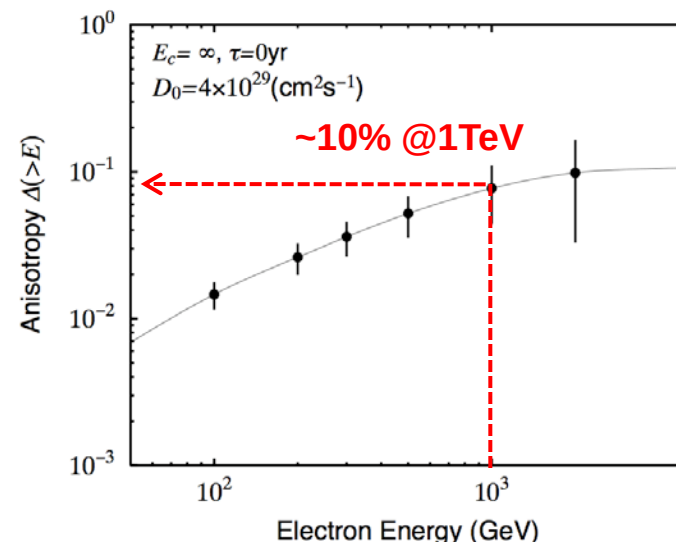
Primary electron spectrum from Fermi data with Hess cutoff:

$$J(E) = 185 * (E/1 \text{ GeV})^{-3.045} e^{-E/3.4 \text{ TeV}} \text{ GeV}^{-1} \text{ m}^{-2} \text{ s}^{-1} \text{ sr}^{-2}$$

Vela spectrum from Astro-ph/0308470v1, Kobayashi et al., Figure 4 Top

Expected Flux

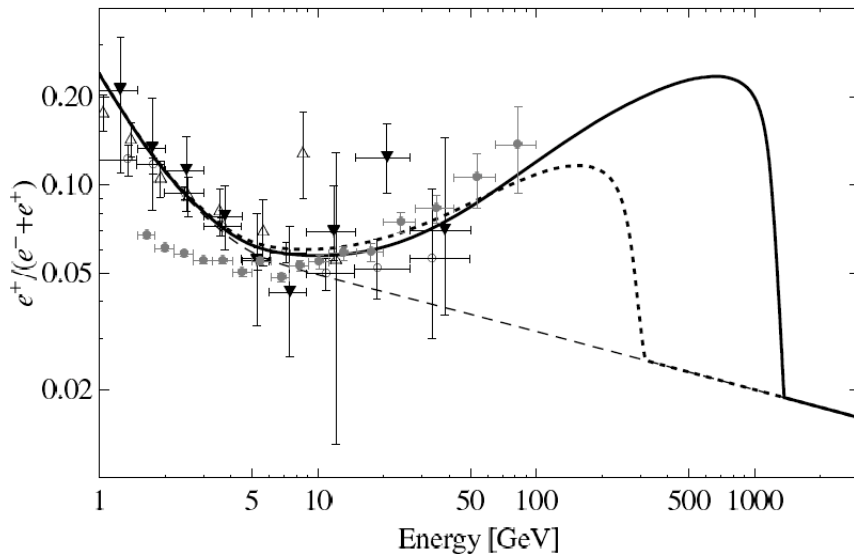
Expected Anisotropy from Vela SNR



Electron and Positron from Dark Matter Decay

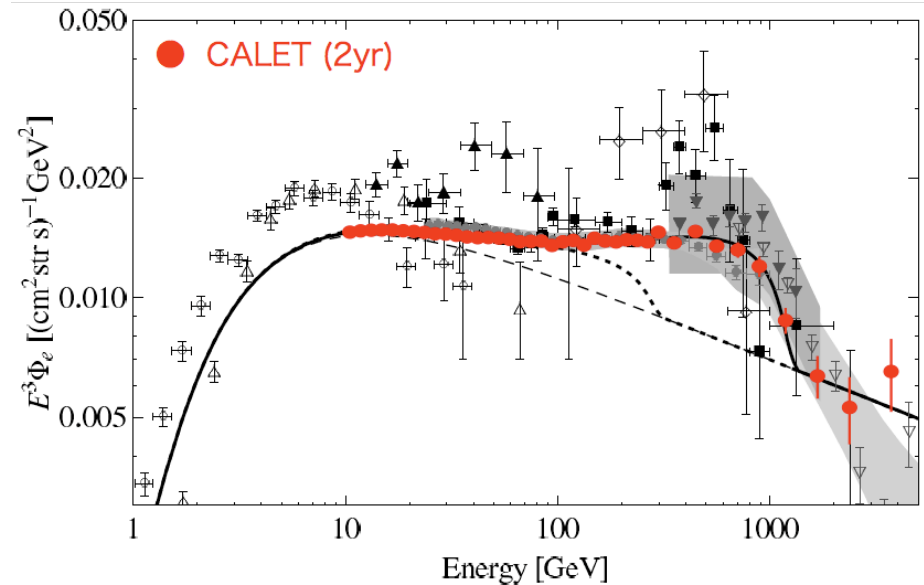
Decay Mode: D.M. $\rightarrow l^+l^- \nu$
Mass: $M_{\text{D.M.}} = 2.5 \text{ TeV}$
Decay Time: $\tau_{\text{D.M.}} = 2.1 \times 10^{26} \text{ s}$

Expected $e^+/(e^-+e^+)$ ratio by a theory and the observed data



Ibarra et al. (2010)

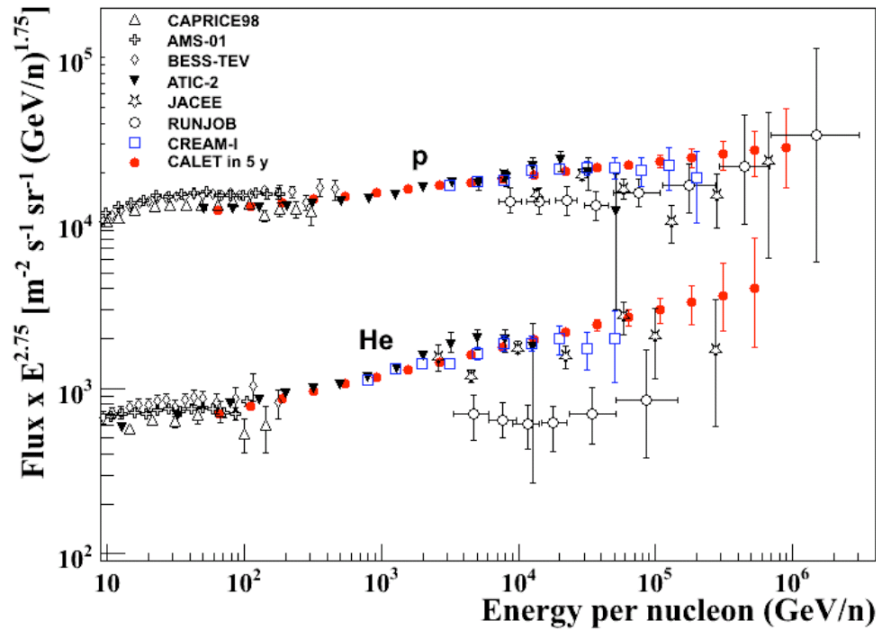
Expected e^-+e^+ energy spectrum by CALET observation



Observation in the trans-TeV region

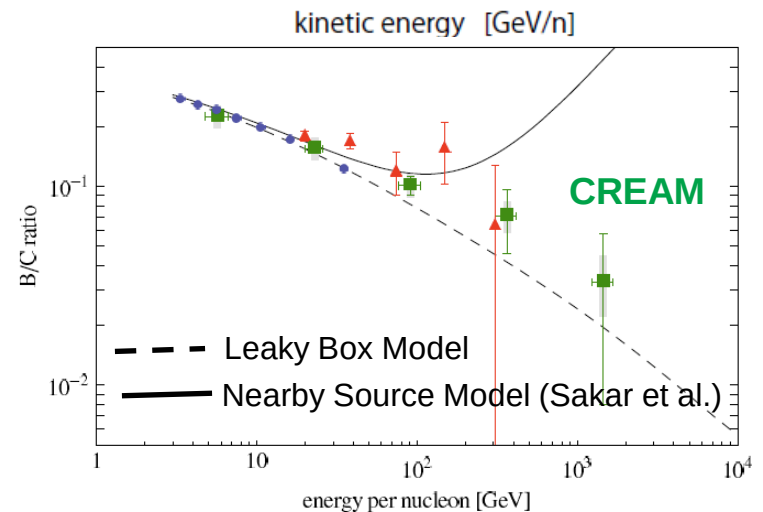
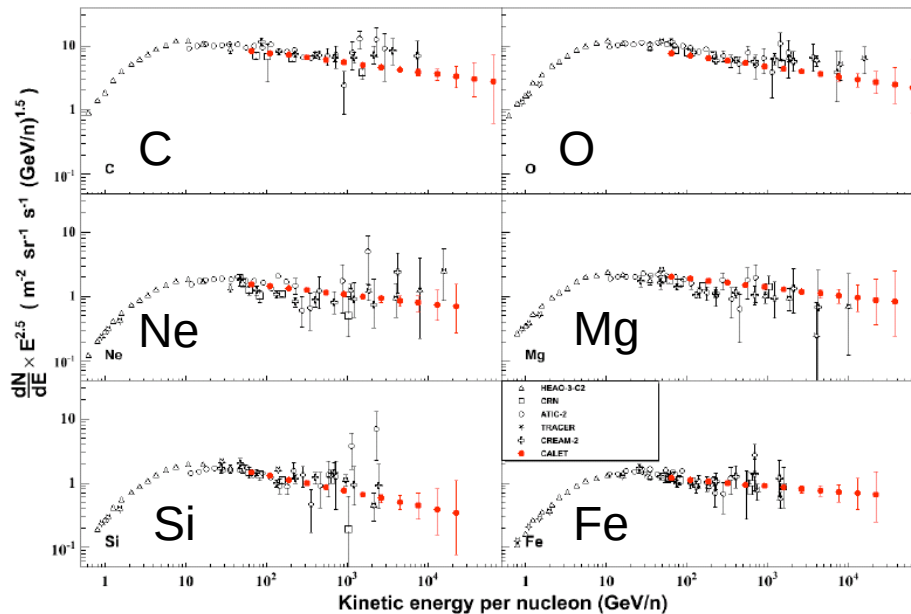
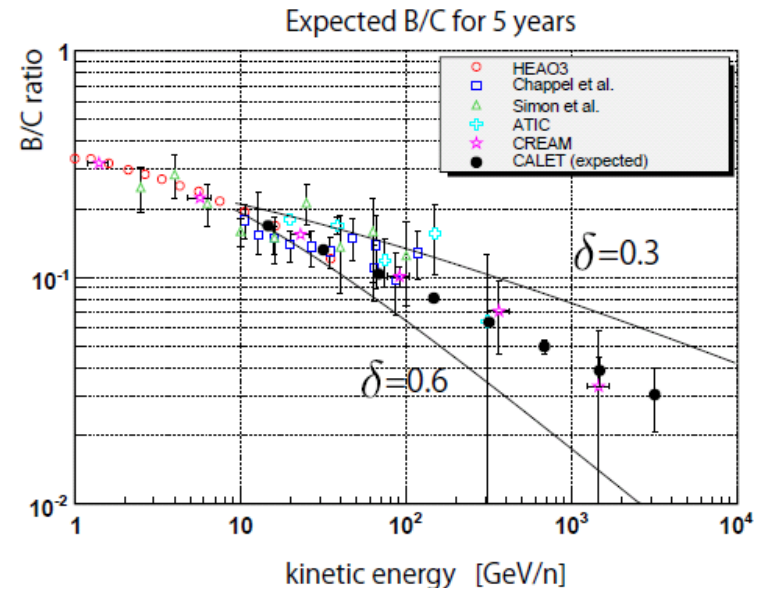
Dark Matter signal

Proton and Nucleus Observation (5years)



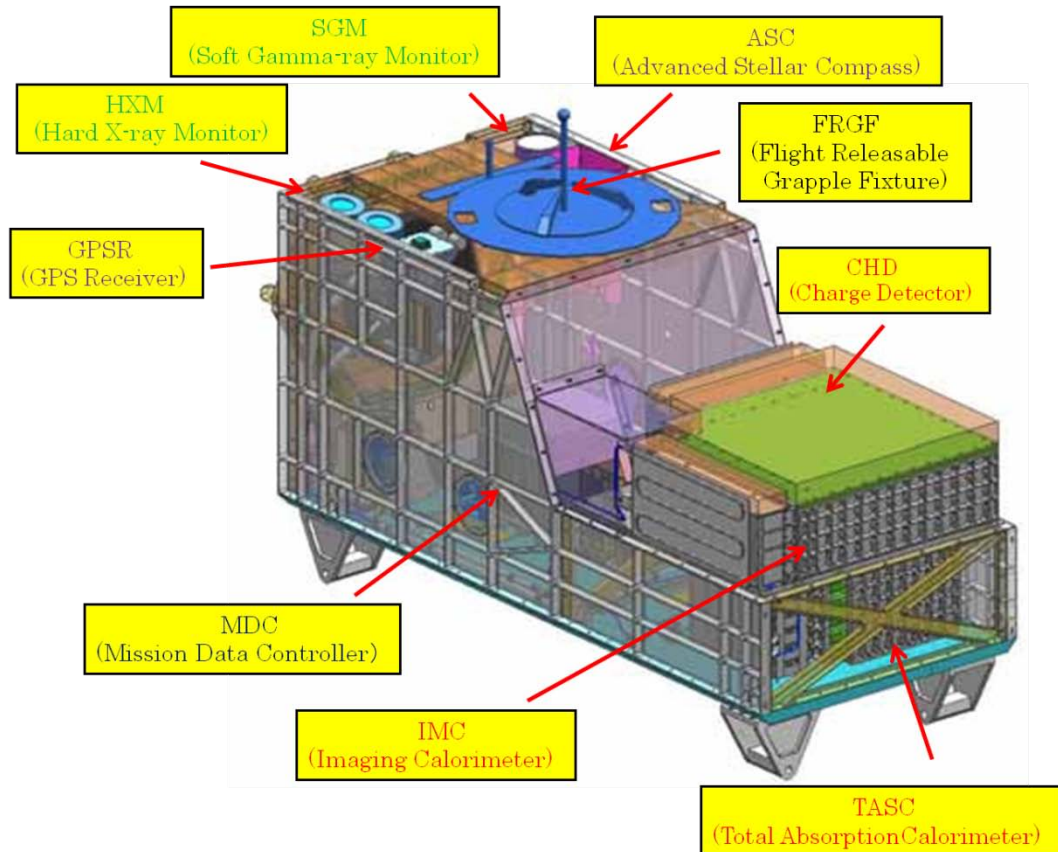
2ry/ 1ry ratio (B/C)

- Energy dependence of diffusion constant: $D \sim E^\delta$
- Observation free from the atmospheric effect up to several TeV/n





CALET Payload



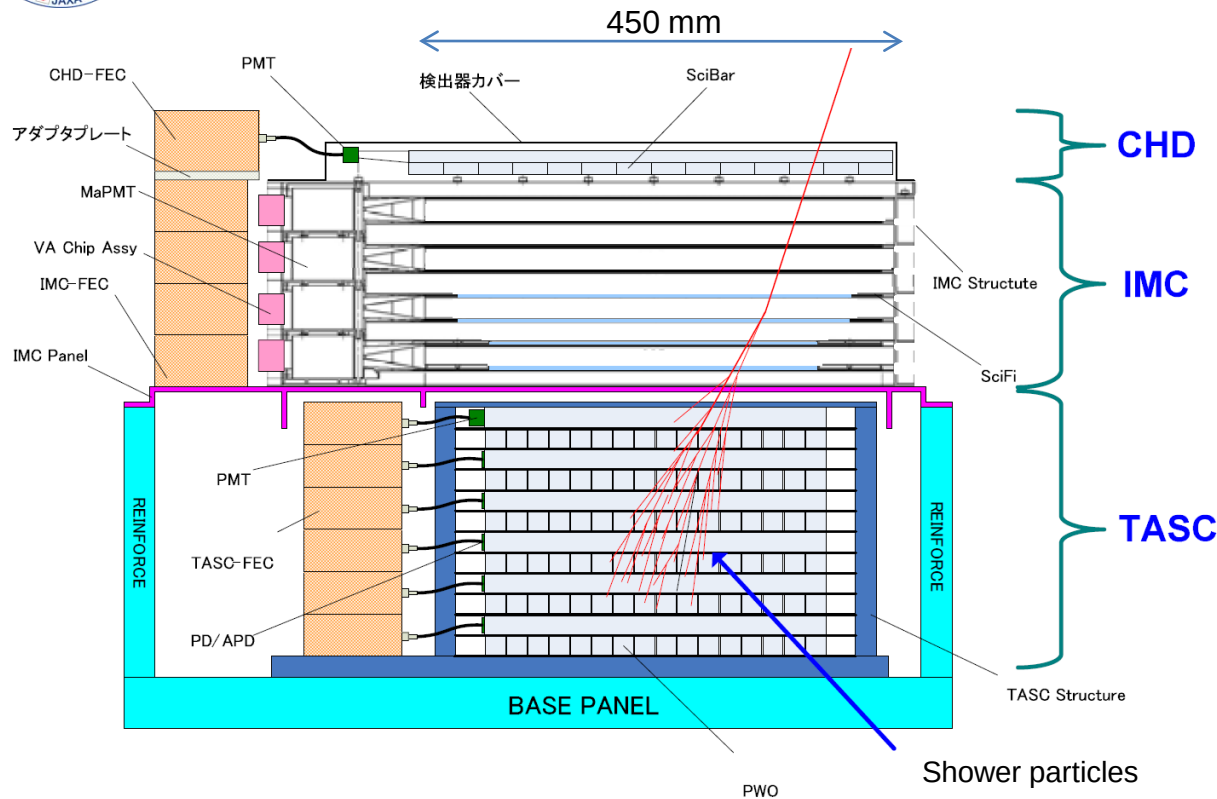
Items	Specification
Mission Equipment	CAL: Calorimeter CGBM: Gamma-ray Burst Monitor
Launch Carrier	HTV-5
Launch Target Date	CY 2014
Mission Period	More than 2 years (5 years target)
Mass	650kg (Max)
Envelope	Standard Payload Size
Power	Less than 500 W
Data Rate	Medium Data Rate : 300 kbps Low Data Rate : 20 kbps

3

CALET Detector System	Support Sensor	JEM/EF Equipment
Calorimeter: CHD, IMC, TASC+MDC GBM : HXM, SGM	GPSR ASC	FRGF



CALET/CAL Instrument

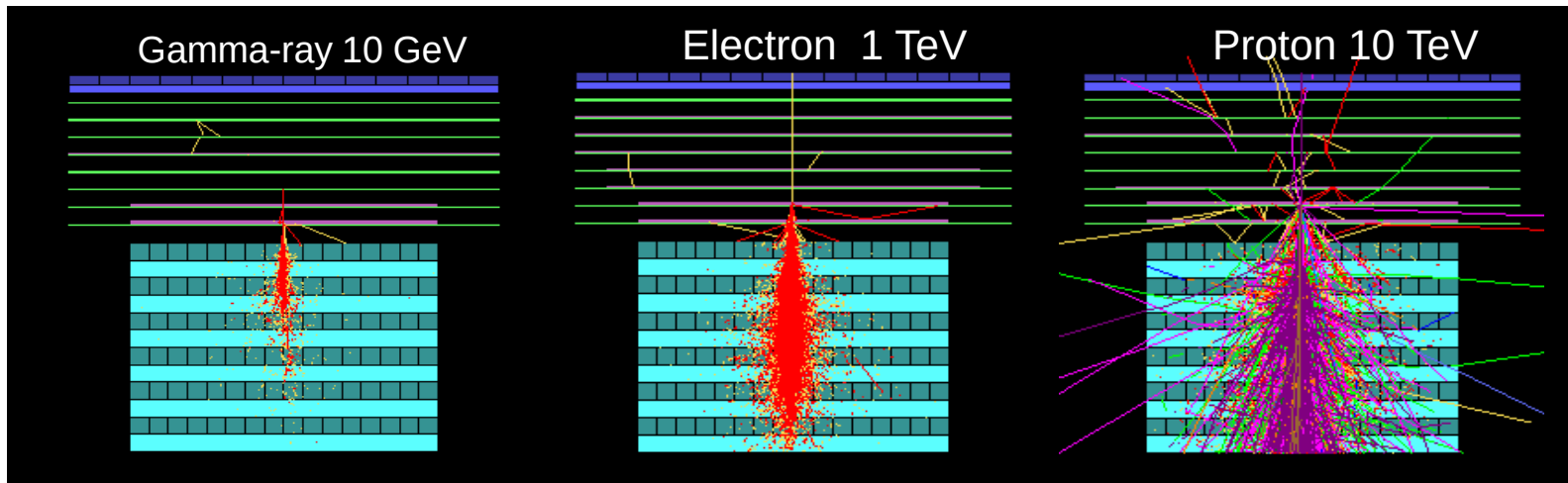


- Expected Performance**
(from Simulations and/or Beam Tests)
- $S\Omega$:
1200 cm²sr for electrons
1000 cm²sr for gamma-rays
 - $\Delta E/E$:
a few % (>10 GeV) for e, γ 's
~30 % for protons
 - e/p separation : 10⁻⁵
 - Charge resolution : 0.15-0.3 e
 - Angular resolution : **Preliminary**
0.24-0.76 deg. for gamma-rays

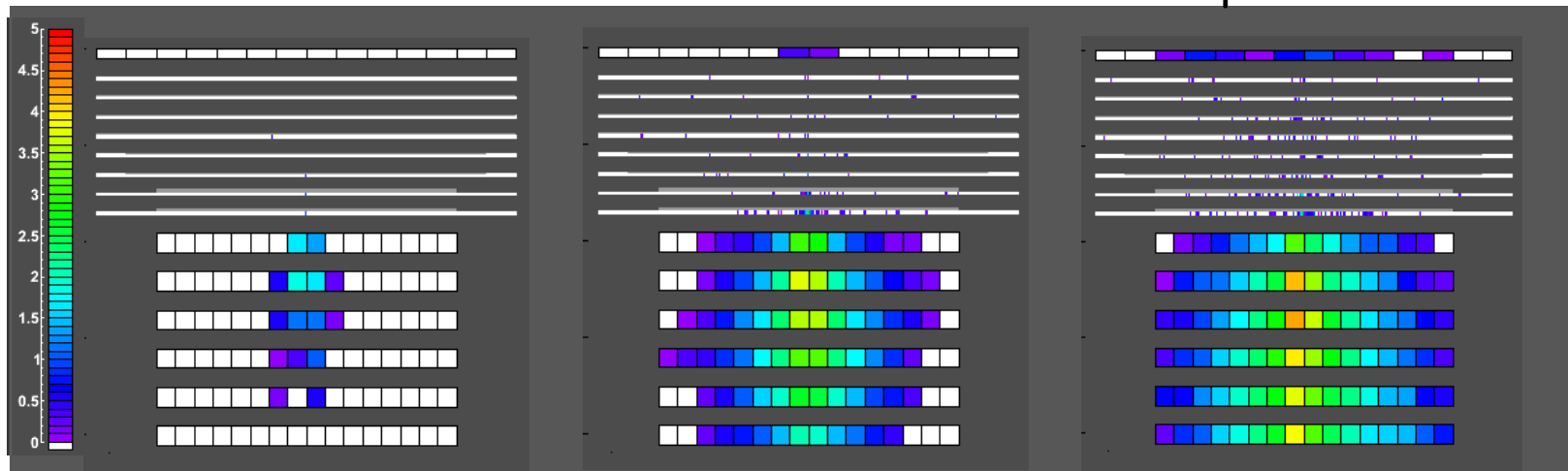
	CHD (Charge Detector)	IMC (Imaging Calorimeter)	TASC (Total Absorption Calorimeter)
Function	Charge Measurement (Z=1-40)	Arrival Direction, Particle ID	Energy Measurement, Particle ID
Sensor (+ Absorber)	Plastic Scintillator : 14 × 1 layer (x,y) Unit Size: 32mm x10mmx450mm	SciFi : 448 x 8 layers (x,y) = 7168 Unit size: 1mmsq x 448 mm Total thickness of Tungsten: 3 r.l.	PWO log: 16 x 6 layers (x,y)= 192 Unit size: 19mm x 20mm x 326mm Total Thickness of PWO: 27 r. l.
Readout	PMT+CSA	64 -anode PMT+ ASIC	APD/PD+CSA PMT+CSA (for Trigger)



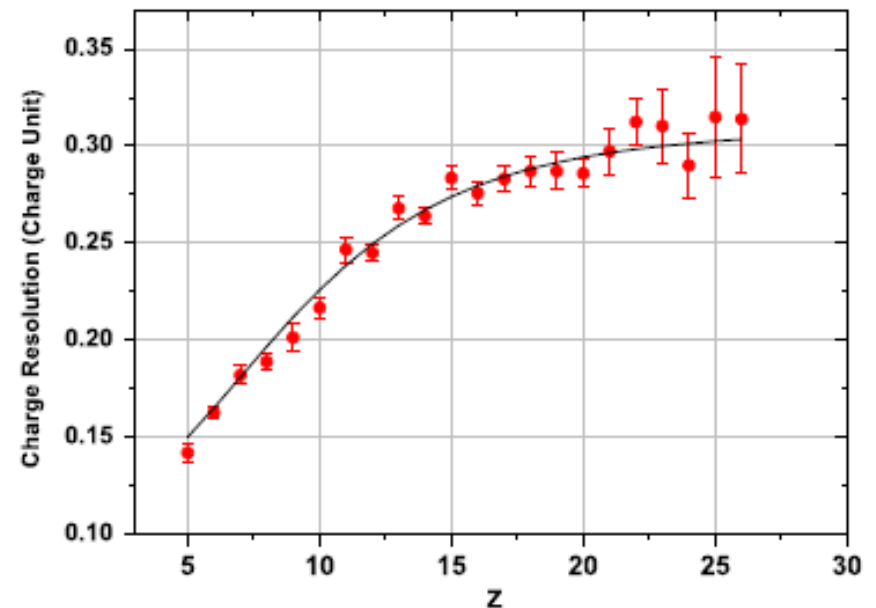
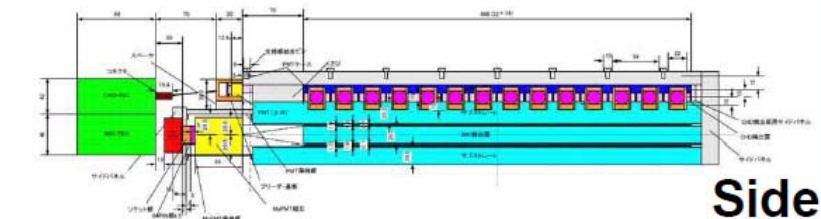
CALET Shower Imaging Capability (Simulation)



In Detector Space



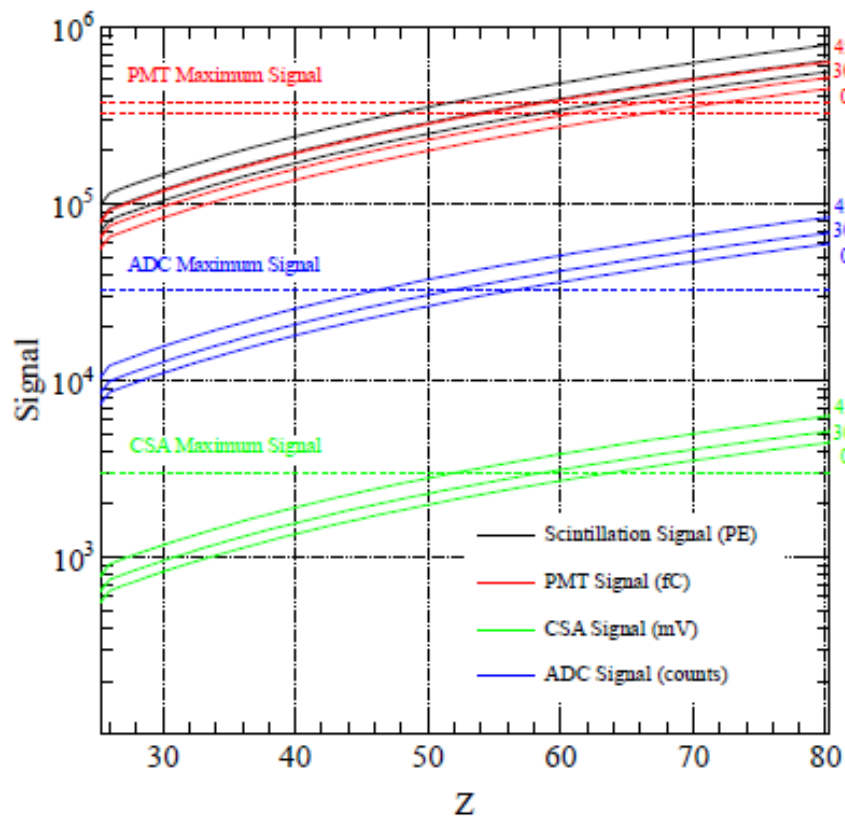
- ⊕ Proton rejection power of 10^5 can be achieved with the IMC and TASC shower imaging capability.
- ⊕ Charge of incident particle is determined to $\Delta Z=0.15-0.3$ with the CHD.



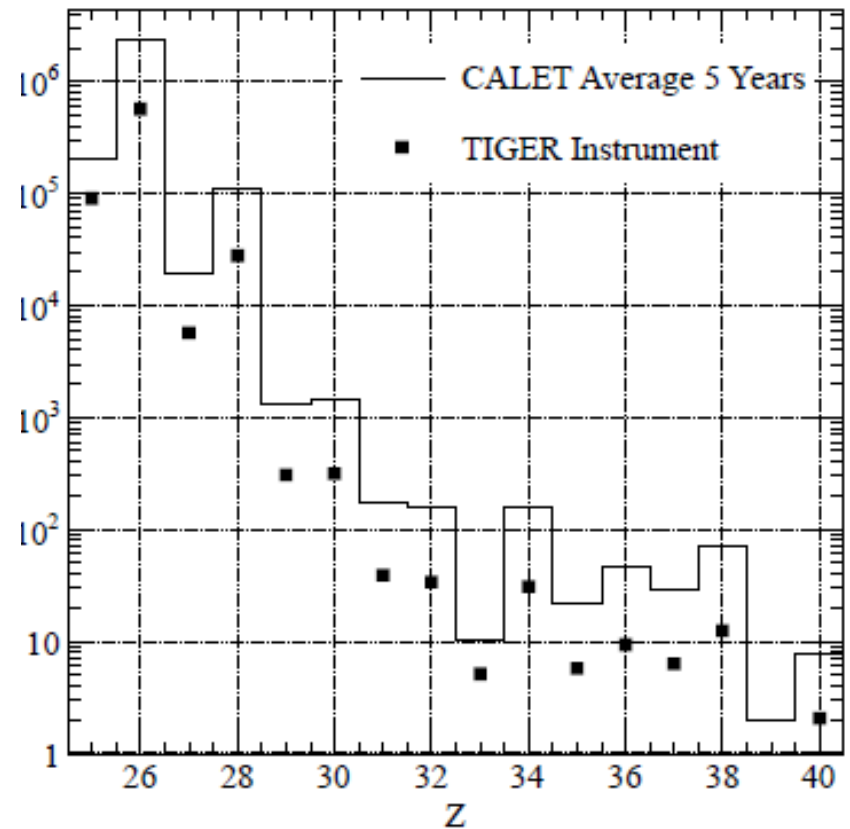


CALET 搭載モデルの性能と超重核観測予測

搭載モデルの測定レンジ(Z=1-50)



CALET5年間の観測予測



CALET Data Downlink for Analysis

