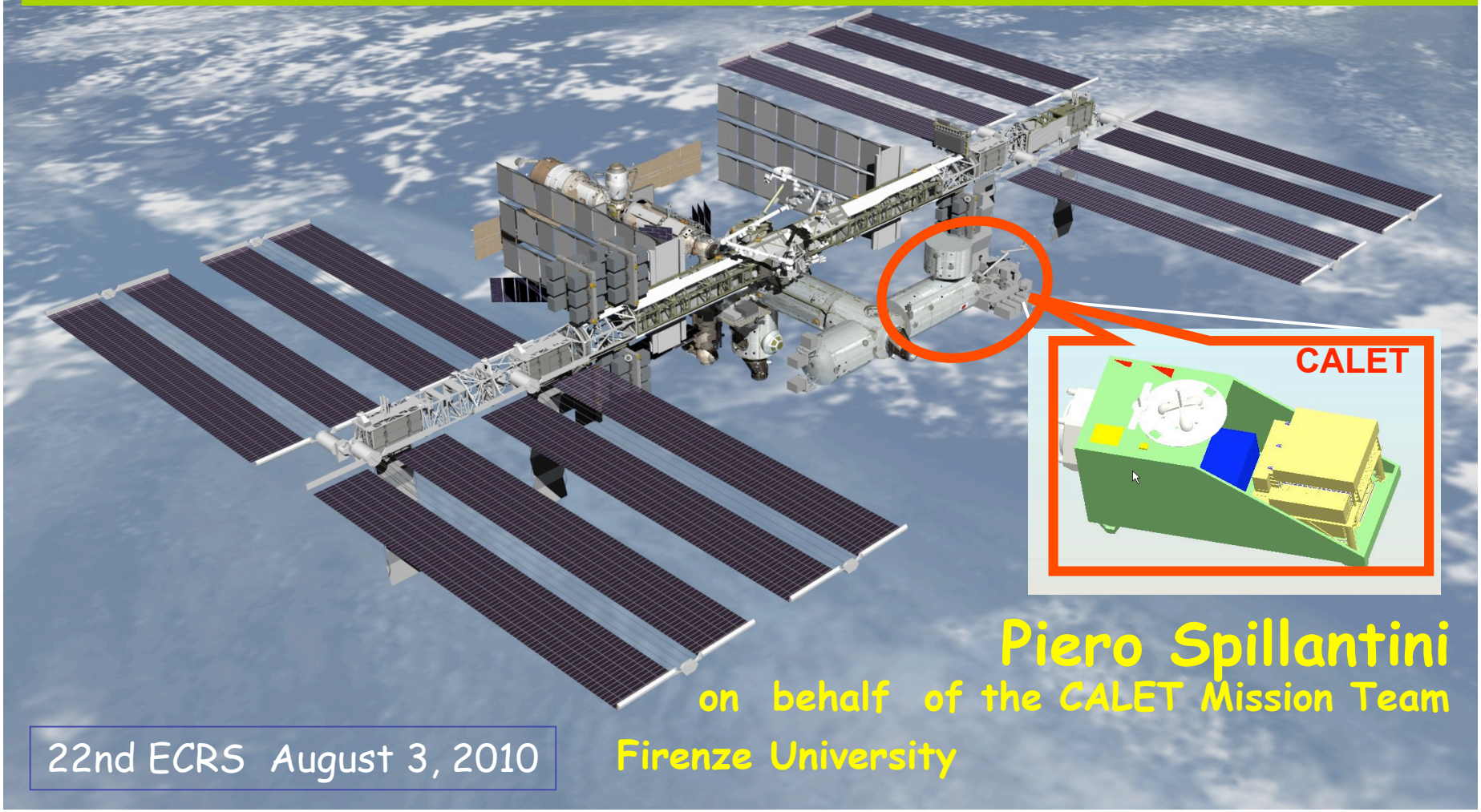
Status and Perspetives of the CALET (Calorimetric Electron Telescope) Mission for Japanese Experiment Module on ISS



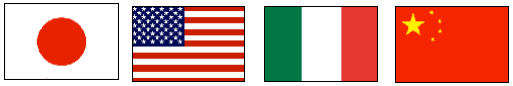
Piero Spillantini

on behalf of the CALET Mission Team

Firenze University

22nd ECRS August 3, 2010

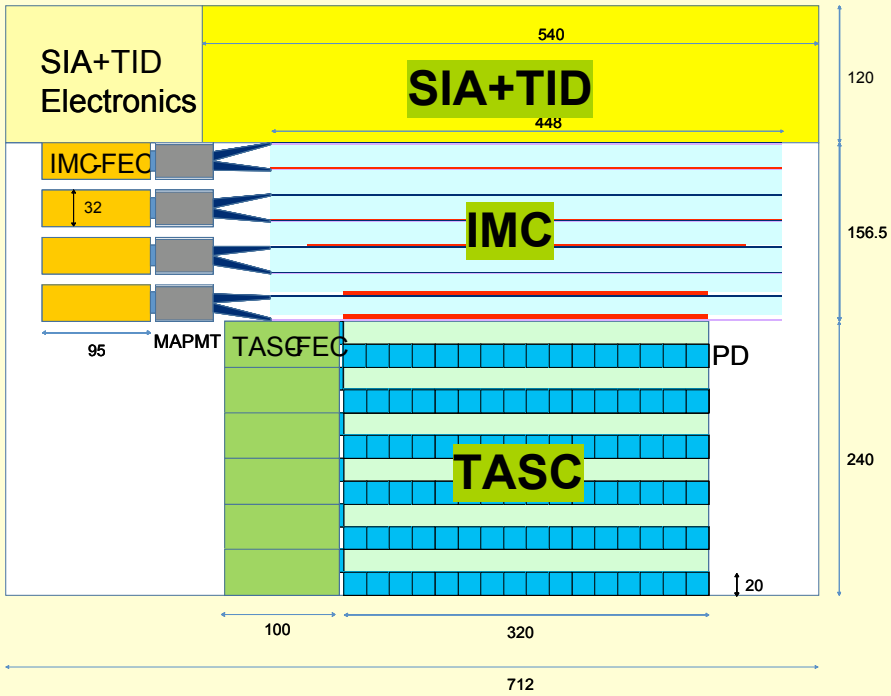
International Collaboration Team



O. Adriani[20] , F. Angelini[21] , C. Avanzini[21], M.G. Bagliesi[23], A. Basti[21], K. Batkov[23], G. Bigongiari[23], W.R. Binns[25], L. Bonechi[20], S. Bonechi[23], S. Bottai[20], M. Calamai[20], G. Castellini[20], R. Cesshi[23], J. Chang[13], G. Chen[4], M.L. Cherry[9], G. Collazuol[21], K. Ebisawa[5], A. J. Ericson[10], H. Fuke[5], W. Gan[13], T.G. Guzik[9], T. Hams[10], N. Hasebe[24], M. Hareyama[5], K. Hibino[7], M. Ichimura[2], K. Ioka[8], M. H. Israel[25], E. Kamioka[16], K. Kasahara[24], Y. Katayose[26],J. Kataoka[24], R.Kataoka [18],N. Kawanaka[8], M.Y. Kim[23], H. Kitamura[11], Y. Komori[6], T. Kotani[1], H.S. Krawzczynski[25], J.F. Krizmanic[10], A. Kubota[16], S. Kuramata[2], Y. Ma[4], P. Maestro[23], V. Malvezzi[22], L. Marcelli[22], P. S. Marrocchesi[23], V. Millucci[23], J.W. Mitchell[10], K. Mizutani[15], A.A. Moissev[10], M. Mori[14], F. Morsani[21], K. Munekata[17], H. Murakami[24], J. Nishimura[5], S. Okuno[7], J.F. Ormes[19], S. Ozawa[24], F. Palma[22], P. Papini[20], Y. Saito[5], C. De Santis[22], M. Sasaki[10], M. Shibata[26], Y. Shimizu[24], A. Shiomi[12], R. Spalvoli[22], P. Spillantini[20], M. Takayanagi[5], M. Takita[3], T. Tamura[7], N. Tateyama[7], T. Terasawa[3], H. Tomida[5], S. Torii[24], Y. Tunesada[18], Y. Uchihori[11], S. Ueno[5], E. Vannuccini[20], H. Wang[4], J.P. Wefel[9], K.Yamaoka[1], J. Yang[13], A. Yoshida[1], K. Yoshida[16], T. Yuda[7], R. Zei[23]

1) Aoyama Gakuin University, Japan
2) Hirosaki University, Japan
3) ICRR, University of Tokyo, Japan
4) Institute of High Energy Physics, China
5) JAXA/ISAS, Japan
6) Kanagawa University of Human Services, Japan
7) Kanagawa University, Japan
8) KEK, Japan
9) Louisiana State University, USA
10) NASA/GSFC, USA
11) National Inst. of Radiological Sciences, Japan
12) Nihon University, Japan
13) Purple Mountain Observatory, China
14) Ritsumeikan University, Japan
15) Saitama University, Japan
16) Shibaura Institute of Technology, Japan
17) Shinshu University, Japan
18) Tokyo Technology Inst., Japan
19) University of Denver, USA
20) University of Florence and INFN, Italy
21) University of Pisa and INFN, Italy
22) University of Rome Tor Vergata and INFN, Italy
23) University of Siena, Italy
24) Waseda University, Japan
25) Washington University in St Louis, USA
26) Yokohama National University, Japan

CALET Overview



Instrument

High Energy Electron and Gamma- Ray Telescope Consisting of (from bottom to top):

- **Total Absorption Calorimeter (TASC)**
  (Energy Measurement, Particle ID)
  PWO 20mmx20mmx320mm
  Total Depth of PWO: $27X_0/1.23\lambda$

- **Imaging Calorimeter (IMC)**
  (Particle ID, Direction)
  Total Thickness of Tungsten (W): $3X_0$ / 0.11λ
  Layer Number of Scifi Belts:
  8 Layers ×2(X,Y)

- **Silicon Pixel Array + Trans Iron Detector (SIA+TID)**
  (Charge Measurement in Z=1-35 + flux Measurements up to Z=60)
  Silicon Pixel 11.25mmx11.25mmx0.5mm
  2 Layers with a coverage of 54 x54 cm^2
  + 2 cherenkov (x,y strip) counters

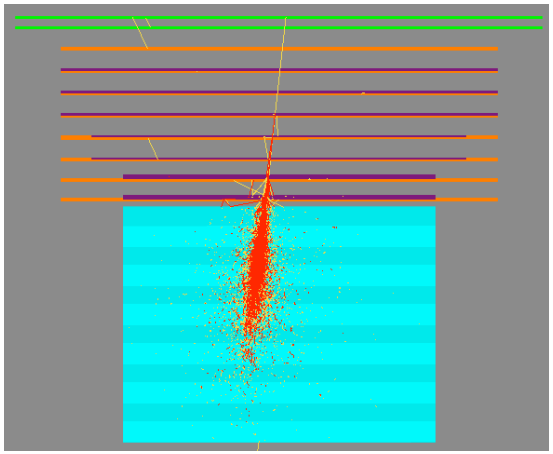
CALET Performance for Electron Observation

Electron 100 GeV

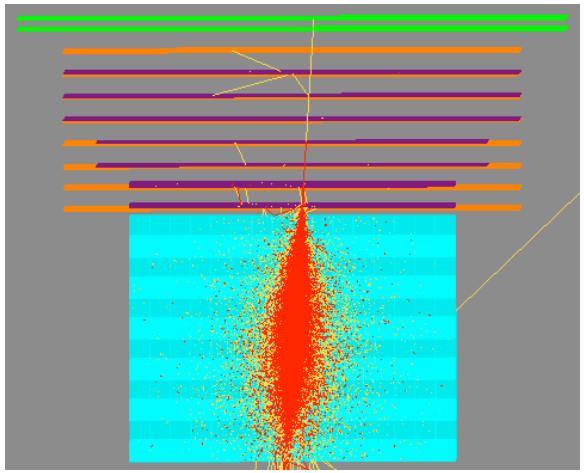
SIA

IMC

TASC

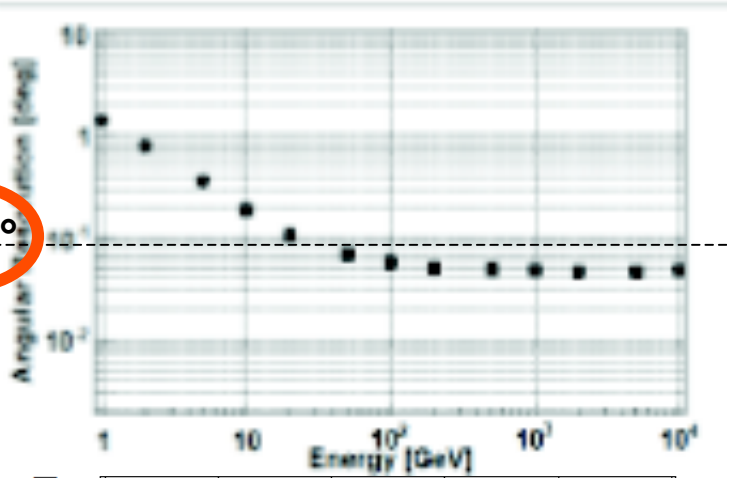


Electron 1 TeV

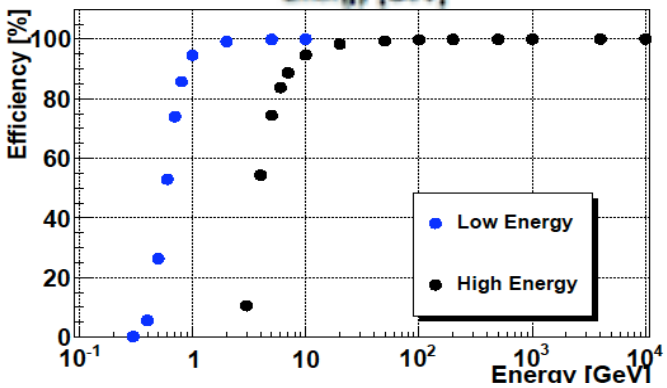


angular resolution

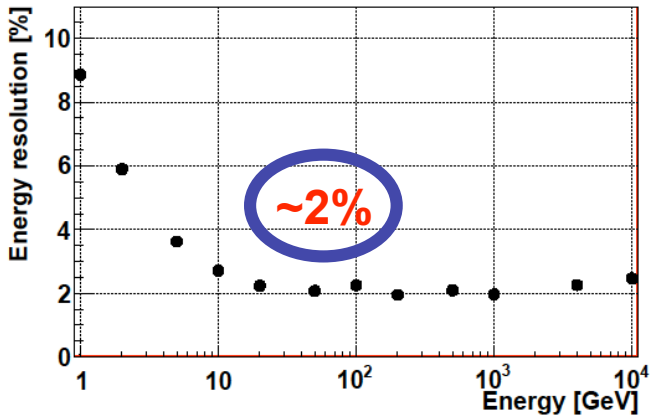
0.1°



Detection Efficiency



Energy Resolution



CALET: main objectives

I – High resolution measurements of energy spectrum of electrons for:

- I – A: research of DM signal
- I – B: research of KK DM
- I – C: research of astrophysical sources signals
- I – D: measurement of dipolar anisotropy
- I – E: study of solar modulation (@ low energy)

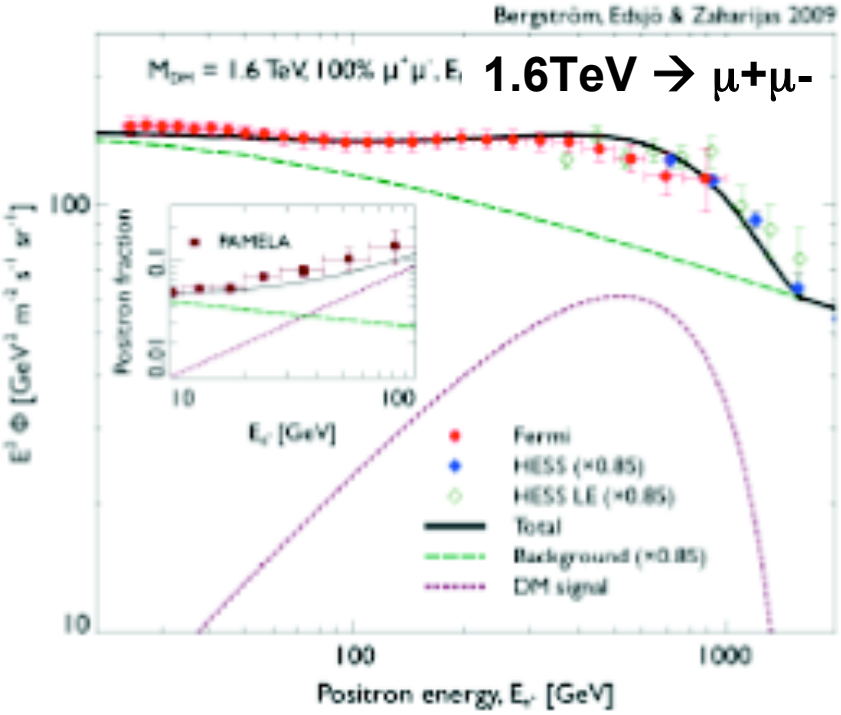
II – Measurements of VHE charged Cosmic Rays:

- II – A: research of a cut-off in the H and He spectra in multiTeV region
- II – B: measurement of energy spectra and fluxes of nuclei up to Fe
- II – C: determination of the diffusion parameter from the secondary-to-primary ratios (e.g. B/C, N/O, sub-Fe/Fe)
- II – D: fluxes measurement of trans-iron nuclei (up to Z=36) and ultra heavy nuclei (up to Z=60)

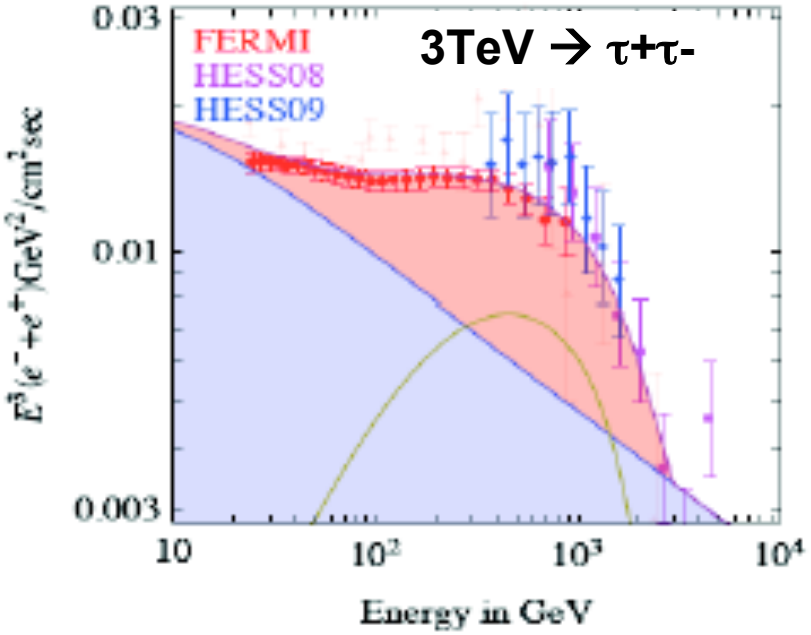
III – Measurements of gamma-ray energy spectrum:

- III – A: high resolution study of line-shape of a possible DM signal
- III – B: study of transient phenomena by Gamma Ray Burst monitor

I – A: research of DM signal

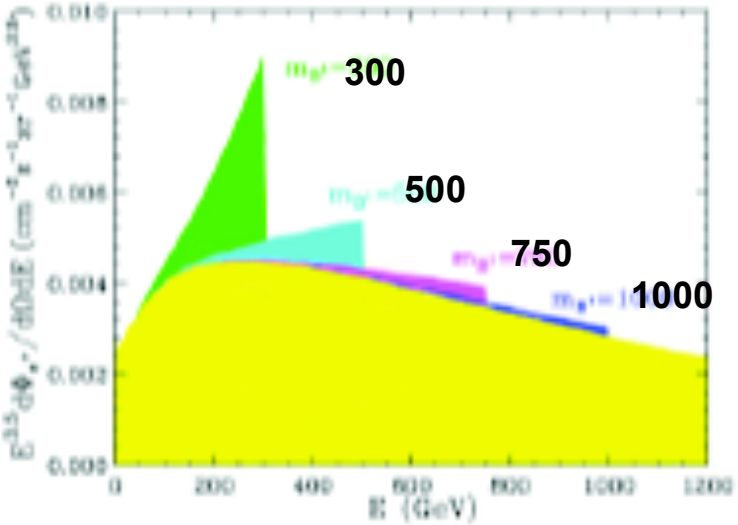


[Bergstrom 2009]

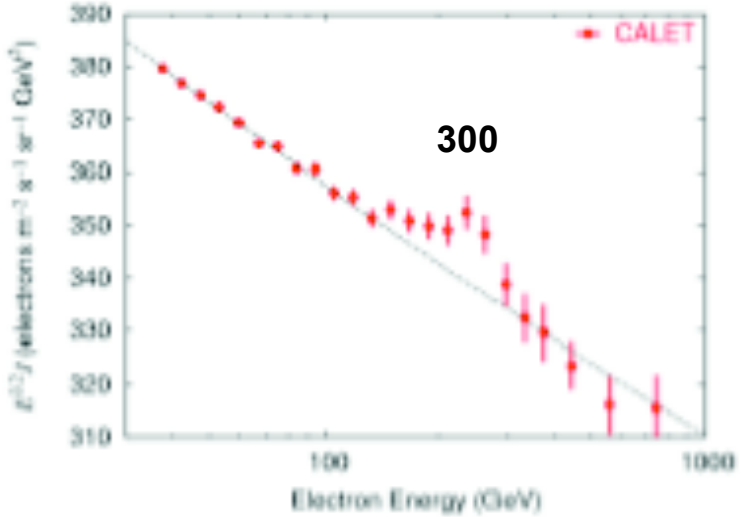


[Meade 2009]

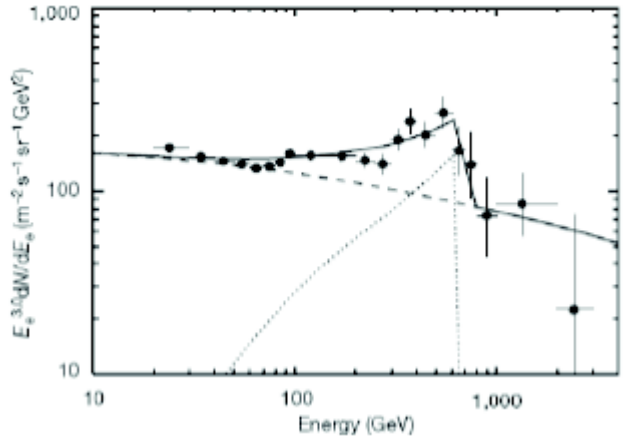
I – B: Kaluza-Klein Dark Matter search

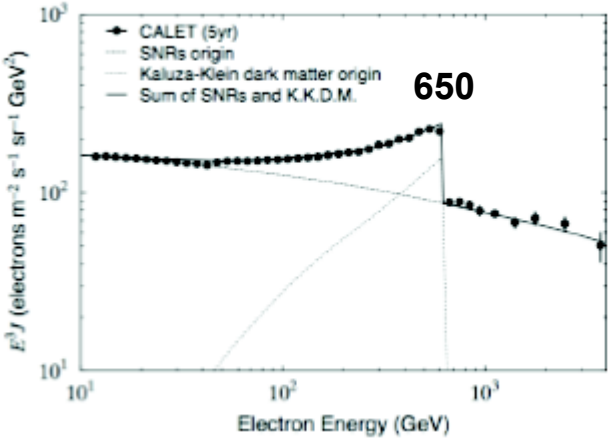


(a)

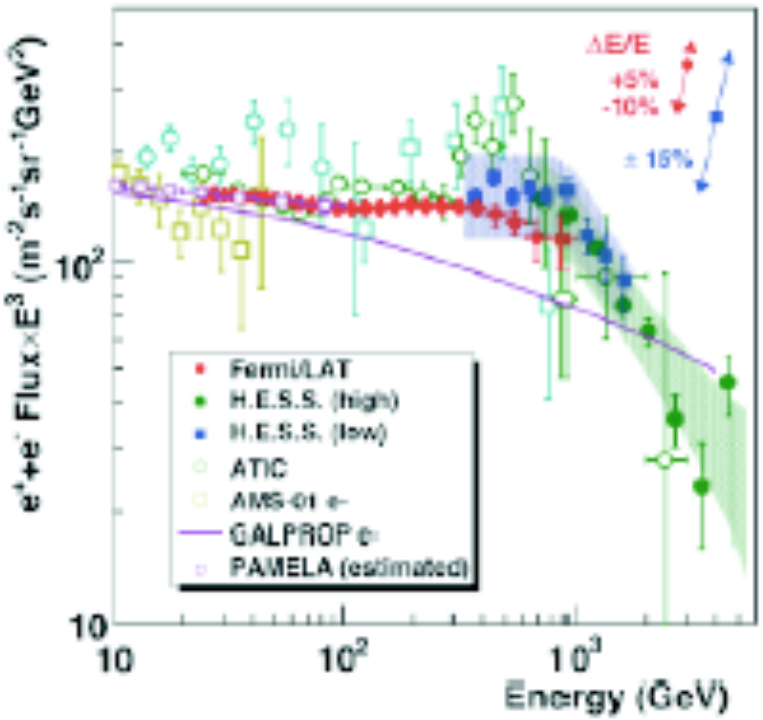


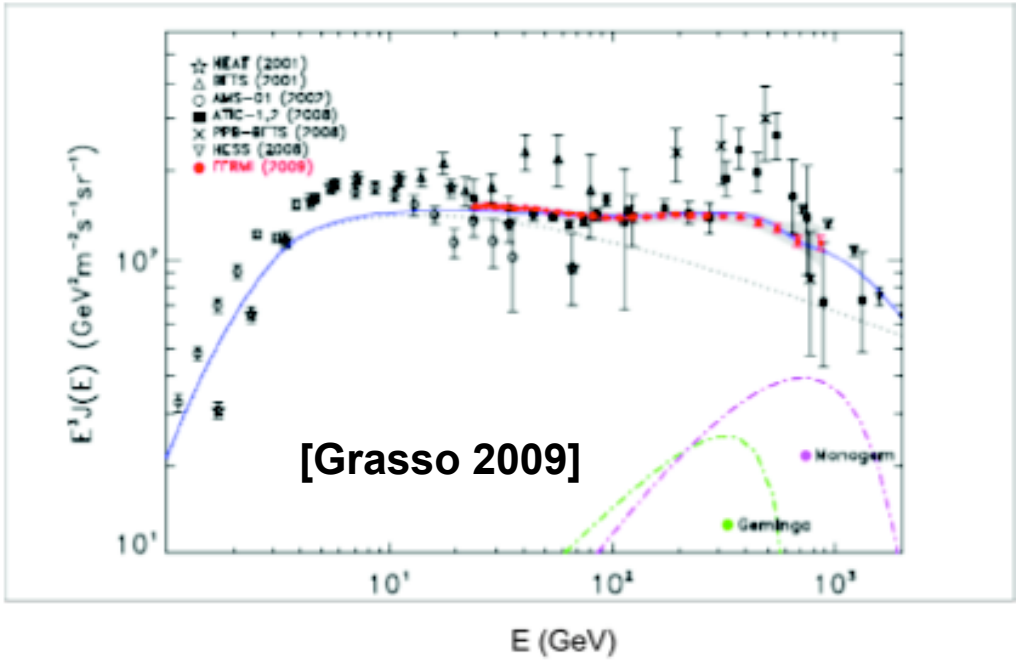
(b)





I – C: research of astrophysical sources signals



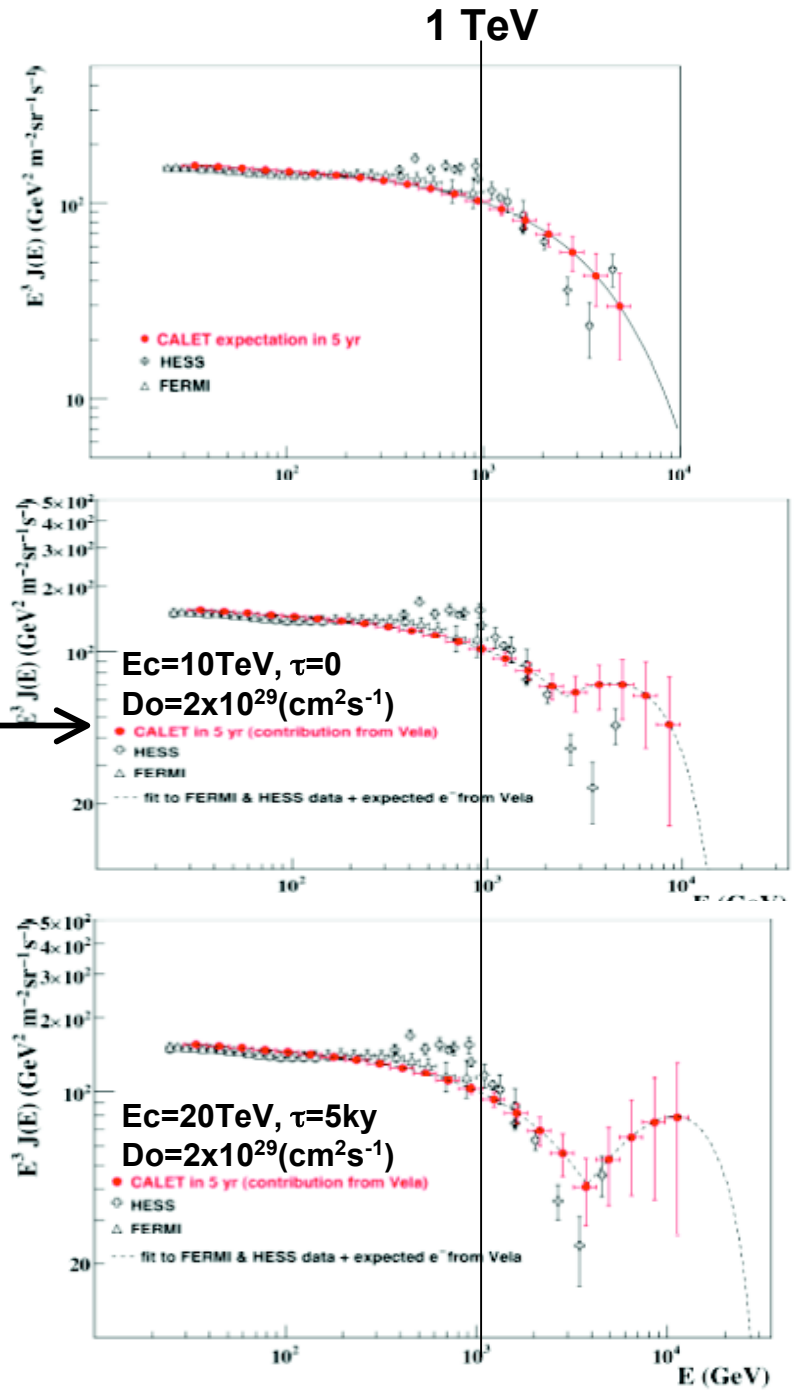


[Grasso 2009]

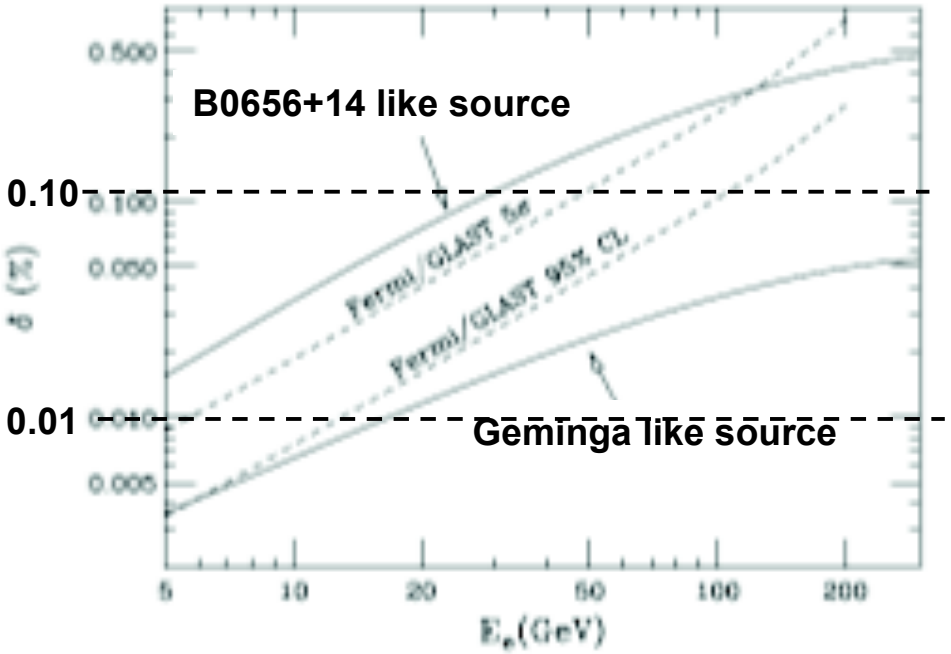
Electron Observation for Nearby Sources

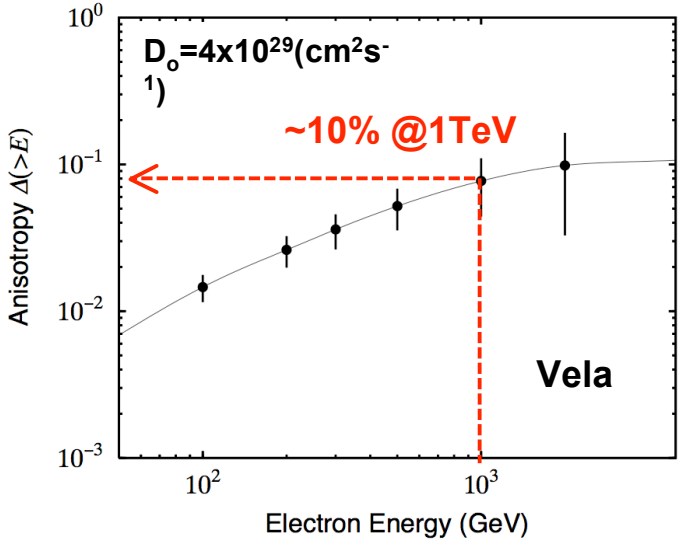
el. efficiency 0.7, p reject. 10^5, 0.12m^2sr, 5y

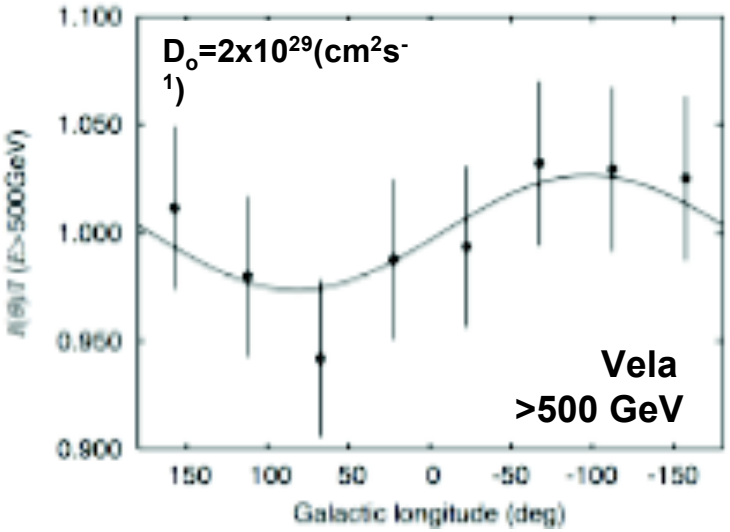
Energy range (GeV)	e- calculated from fit to FERMI +HESS data (counts)	e- expected from Vela **+Vela** (counts)
30-39	488222	488222
39-52	276586	276586
52-69	156532	156532
69-91	88469	88469
91-119	49913	49913
119-157	28095	28095
157-207	15766	15766
207-274	8811	8811
274-361	4898	4898
361-475	2704	2704
475-627	1479	1479
627-826	799	799
826-1089	425	425
1089-1436	221	221
1436-1893	112	112
1893-2495	55	55
2495-3289	25	29
3289-4336	11	18
4336-5716	4.5	11
5716-7536	1.6	5
7536-9934	0	2.3

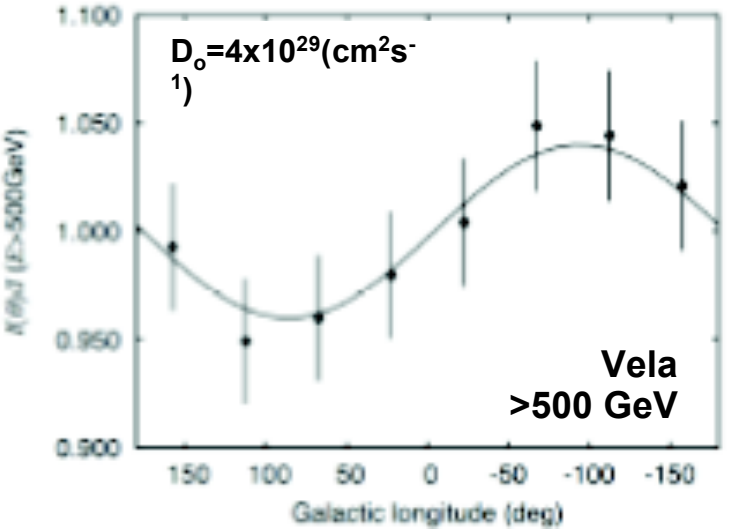


I – D: Contribution to asymmetry from nearby sources

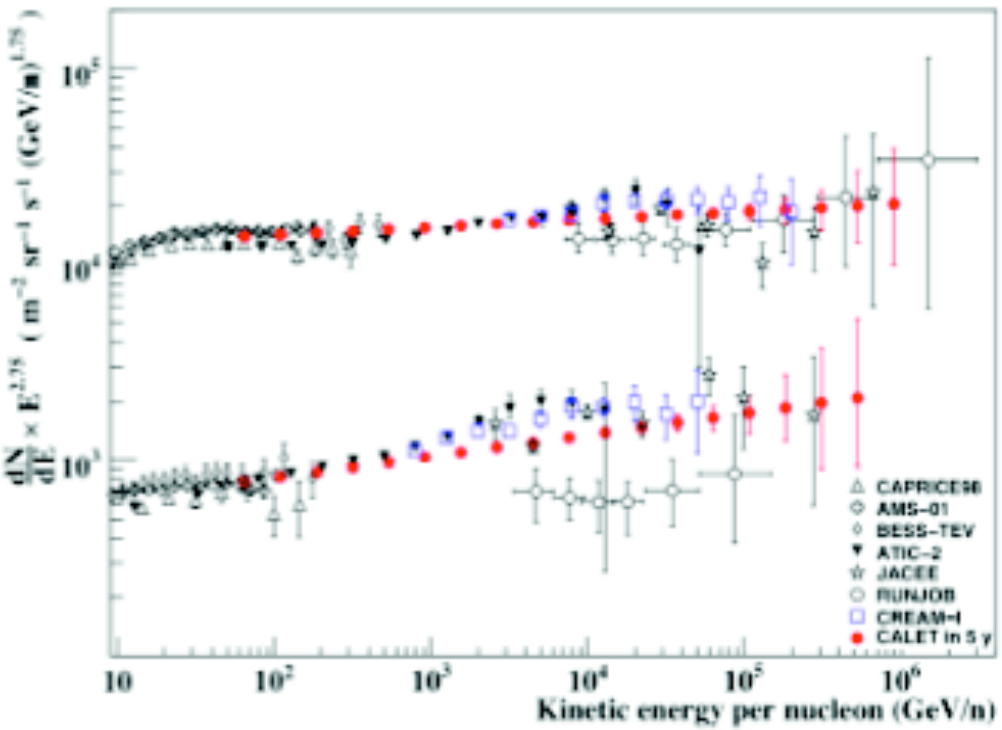






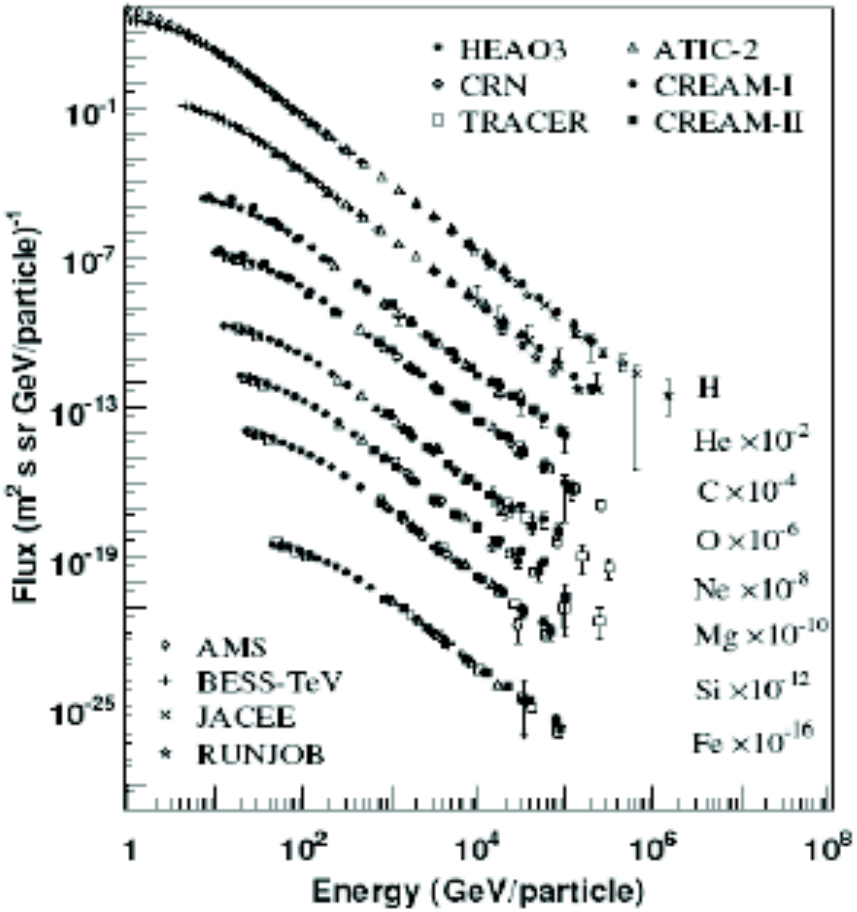


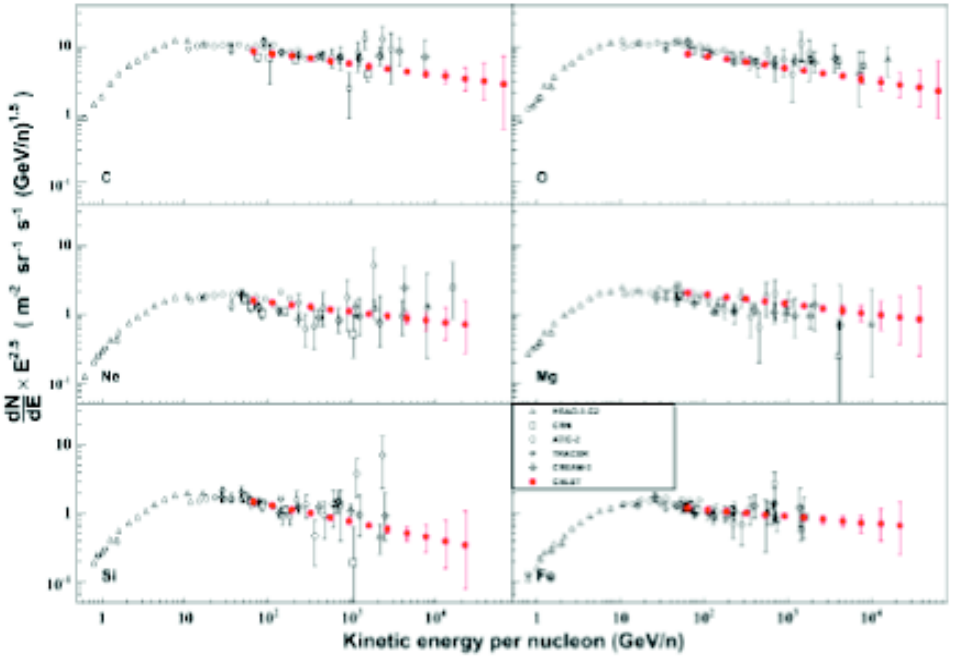
II – A: research of a cut-off in the H and He spectra in multiTeV region



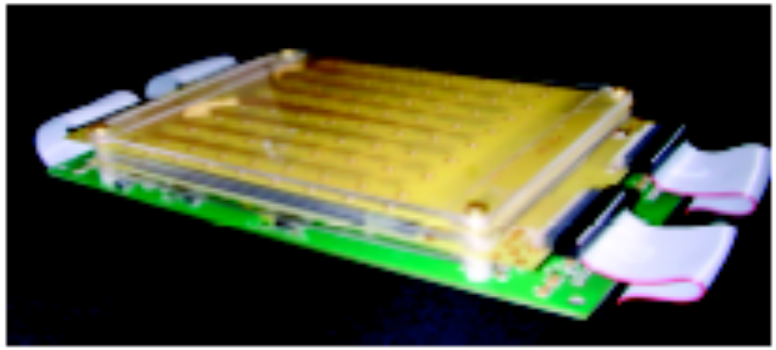
E range (TeV/n)	Proton	He
0.4-0.7	967734	128408
0.7-1.2	402176	56356
1.2-2.0	167138	24733
2.0-3.5	69460	10855
3.5-5.9	28866	4764
5.9-10.0	11996	2091
10.0-16.9	4986	918
16.9-28.8	2072	403
28.8-48.9	861	177
48.9-83.0	358	78
83.0-140.9	149	34
140.9-239.3	62	15
239.9-406.4	26	6.6
406.4-690-2	10.7	2.9
690.2-1172.1	4.4	1.3
>1172.1	1.8	0

II – B: measurement of energy spectra and fluxes of nuclei up to Fe

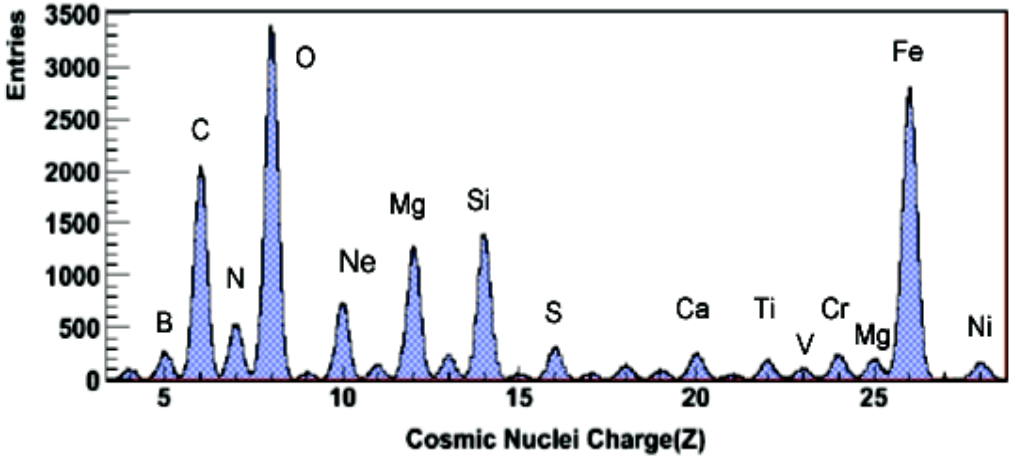


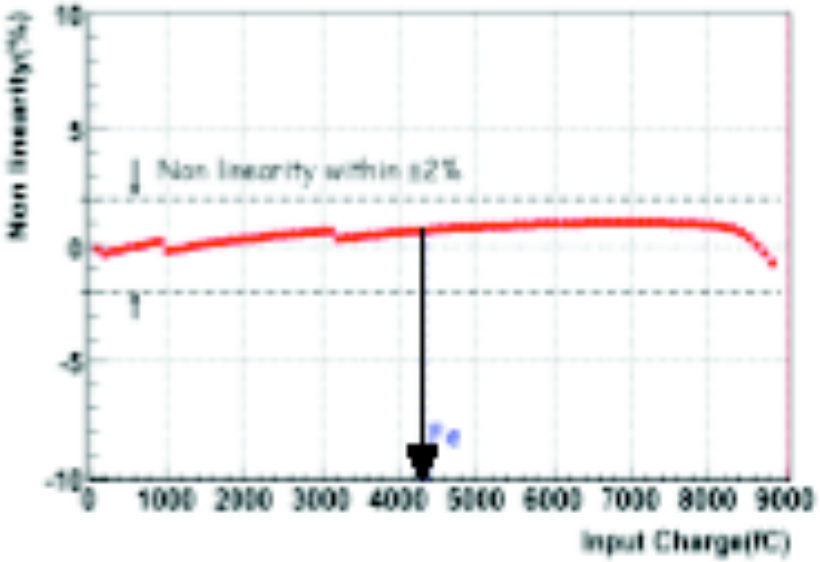


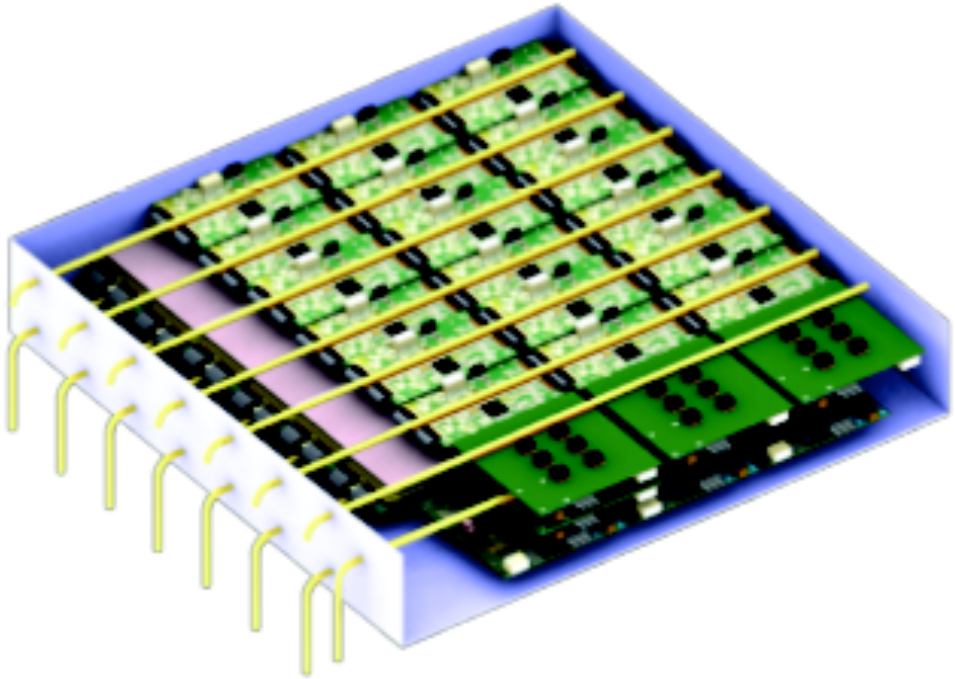
E range (TeV/n)	C	O	Ne	Mg	Si	Fe
0.4-0.7	4544	4135	931	1213	701	781
0.7-1.2	1887	1699	390	509	278	335
1.2-2.0	783	698	164	214	110	144
2.0-3.5	325	287	69	90	44	62
3.5-5.9	135	118	29	38	17	26
5.9-10.0	56	48	12	16	6.8	11
10.0-16.9	23	20	5.1	6.6	2.7	4.8
16.9-28.8	10	8	2.1	2.8	1.1	2.1
28.8-48.9	4.0	3.4	0	1.2	0	0
48.9-83.0	1.7	1.4	0	0	0	0



SIA prototype developed by INFN in the frame of the MATRIX project

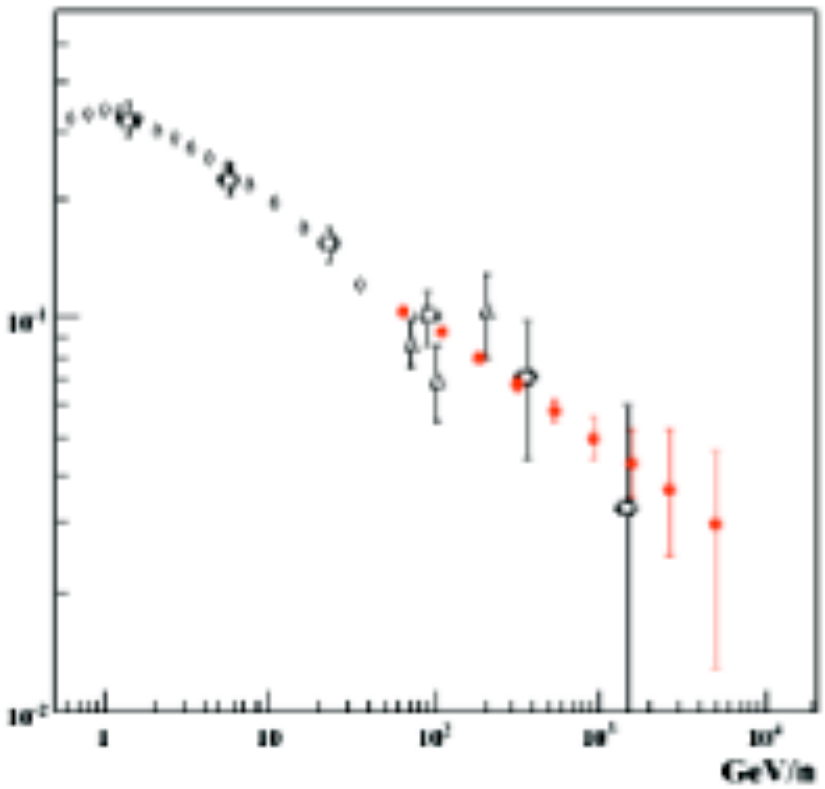




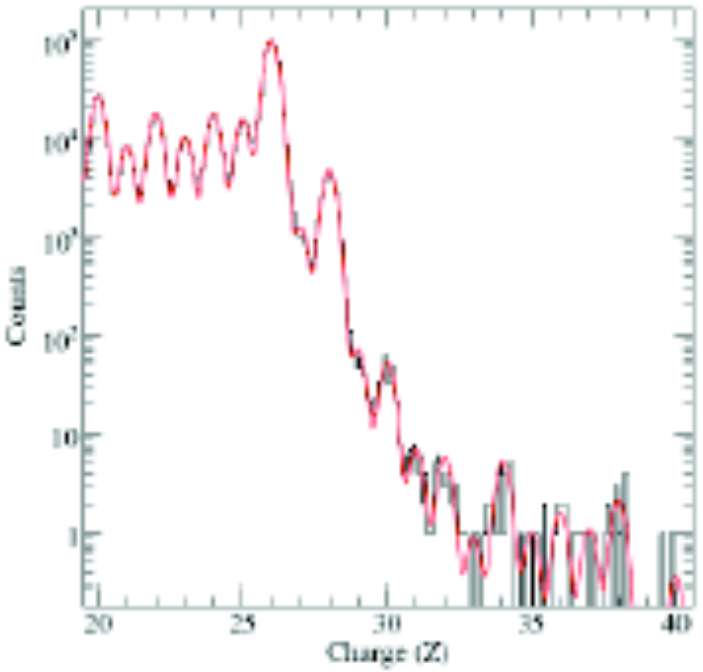


II – C: determination of the diffusion parameter from the secondary-to-primary ratios (e.g. B/C, N/O, sub-Fe/Fe)

E range (TeV/n)	B	C
0.4-0.7	264	4544
0.7-1.2	94	1887
1.2-2.0	34	783
2.0-3.5	12	325
3.5-5.9	4	135
5.9-10.0	1.5	56



II – D: fluxes measurement of trans-iron nuclei (up to Z=36) .....

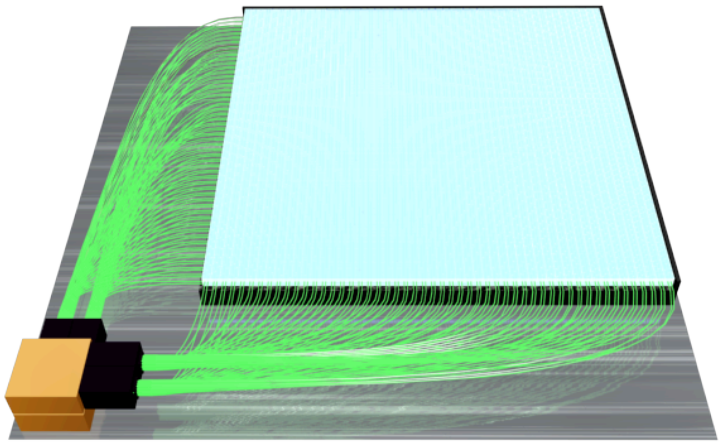


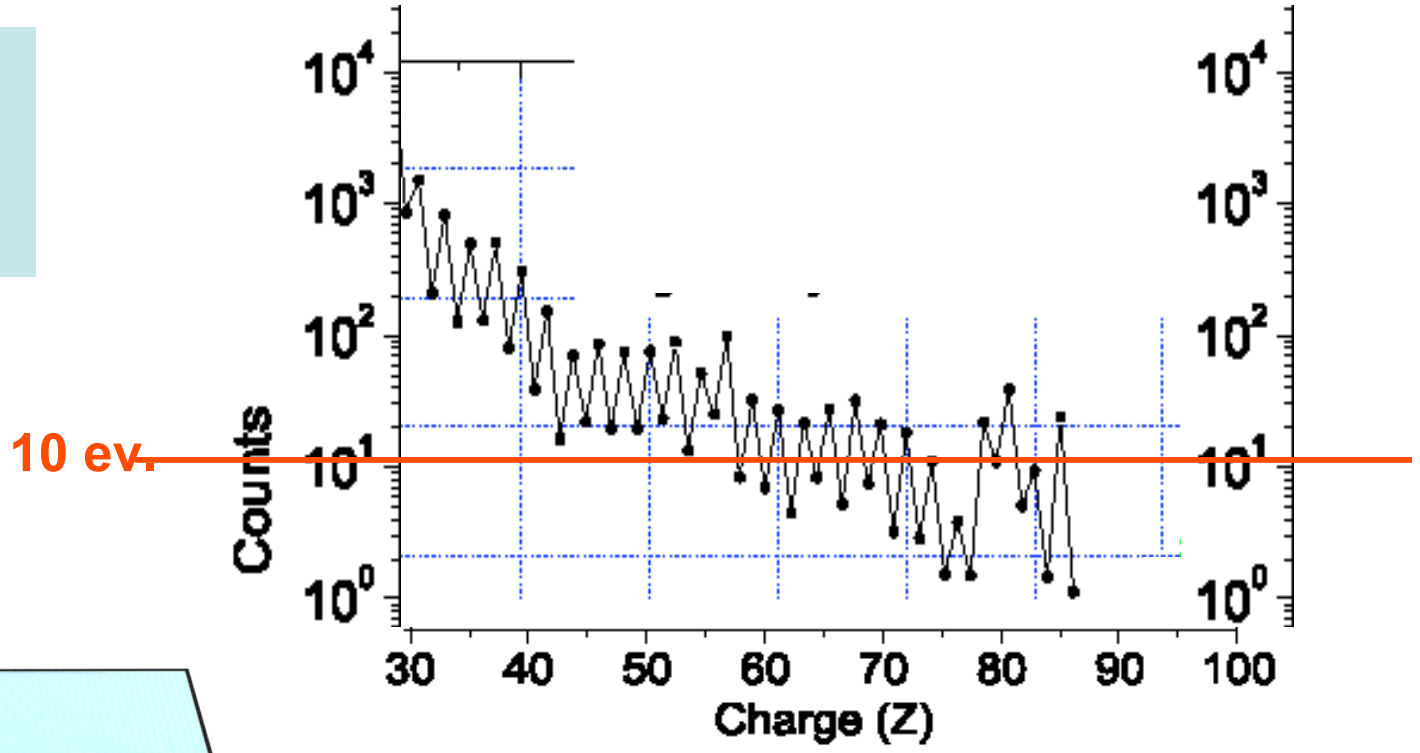
[TIGER, 2 flights]

Element	Z	E> 2.5 GeV/n	E>10 GeV/n	E>20 GeV/n	E> 30 GeV/n	E> 50 GeV/n
Fe	26	13443043	1462856	482563	252236	111391
Co	27	61074	5627	1708	850	353
Ni	28	617269	76096	26718	14485	6698
Cu	29	13151	1492	502	266	119
Zn	30	9423	1084	368	195	88
Ga	31	1376	160	55	29	13
Ge	32	1865	221	76	41	18
As	33	444	53	18	10	4
Se	34	858	103	36	19	9
Br	35	530	64	22	12	6
Kr	36	473	58	20	11	5

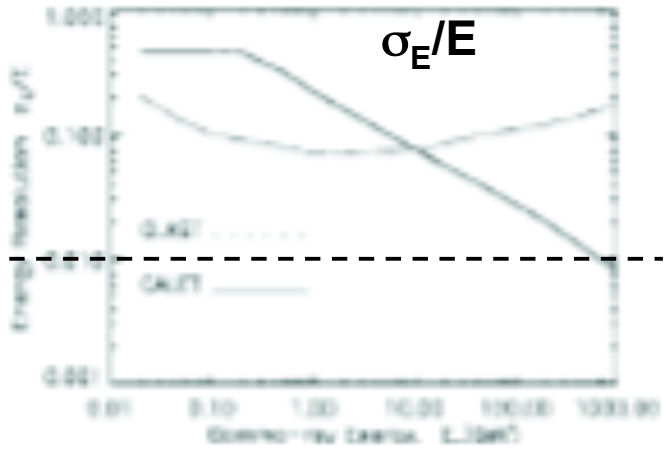
II – D: ..... and ultra heavy nuclei (up to Z=60)

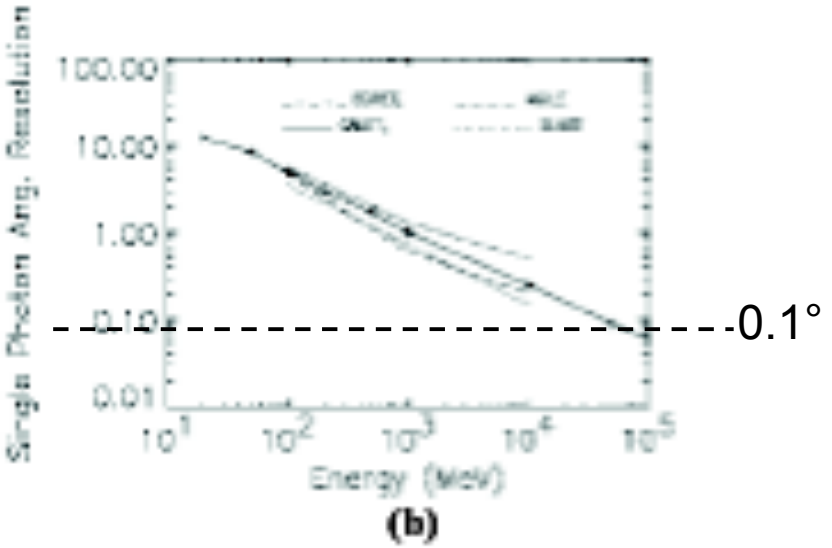
Calet, GF=0.33, 5 year

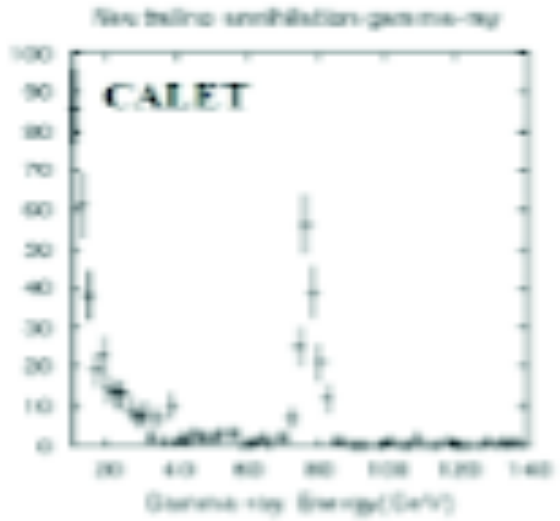




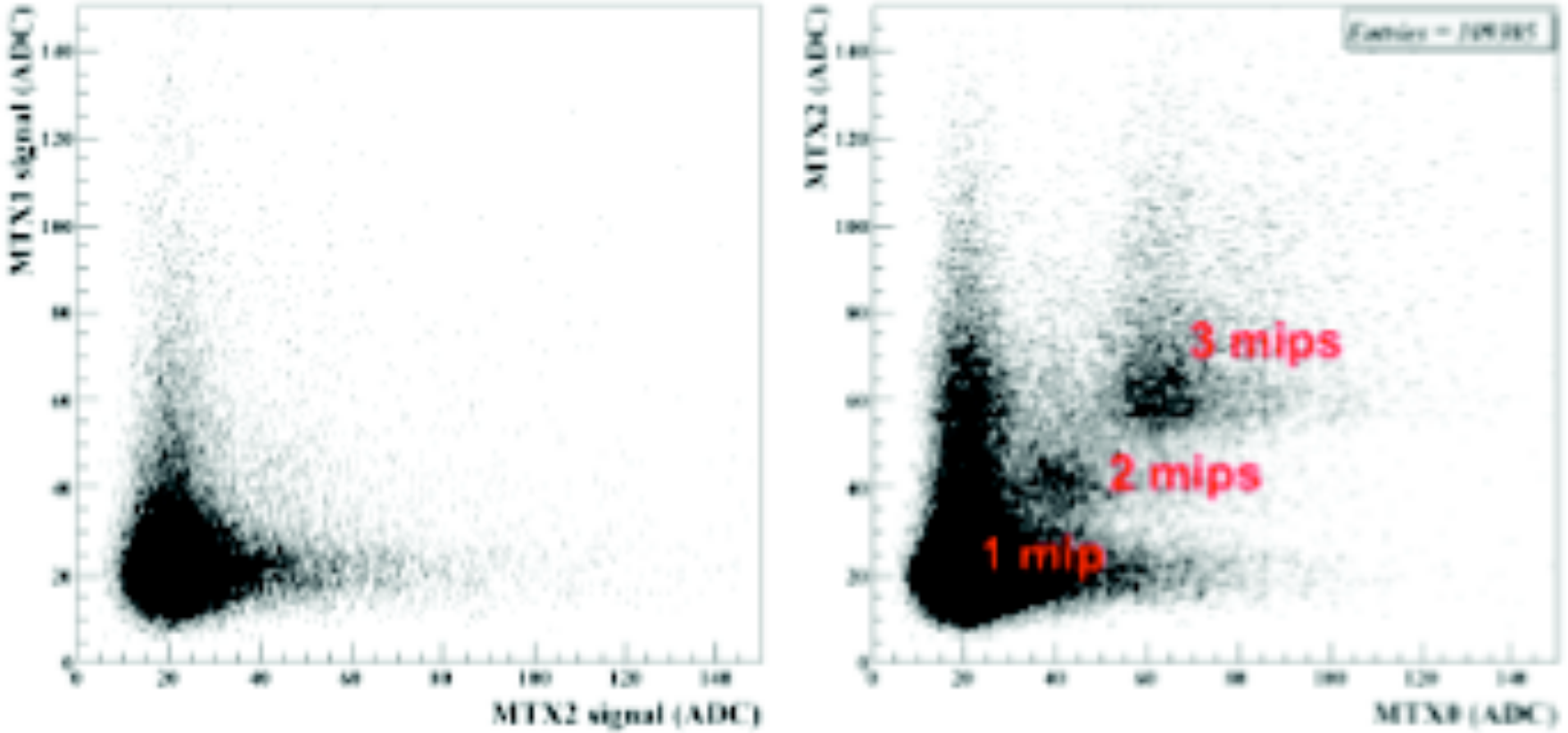
III – A: high resolution study of line-shape of a possible DM signal



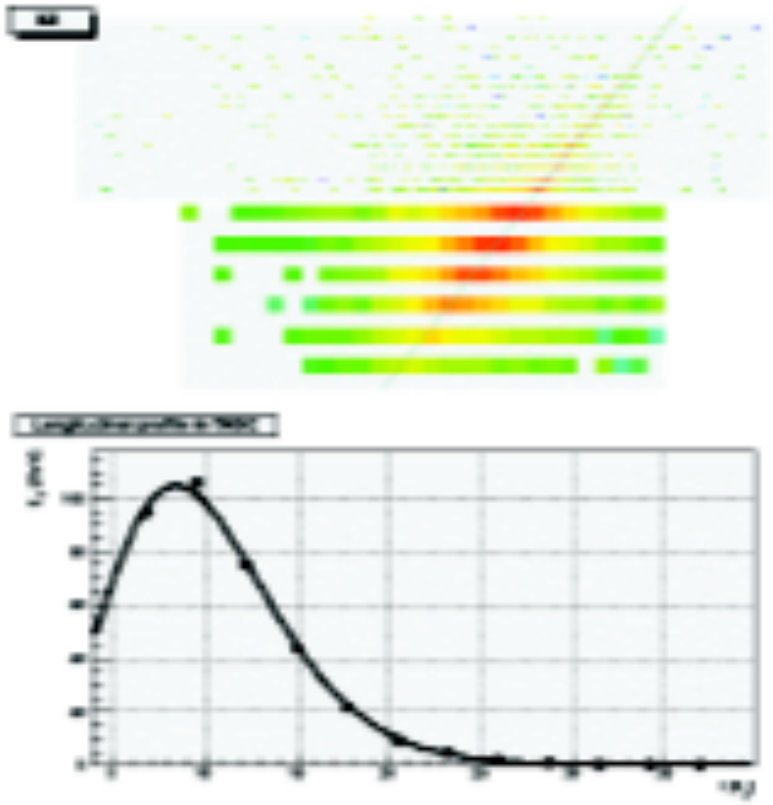


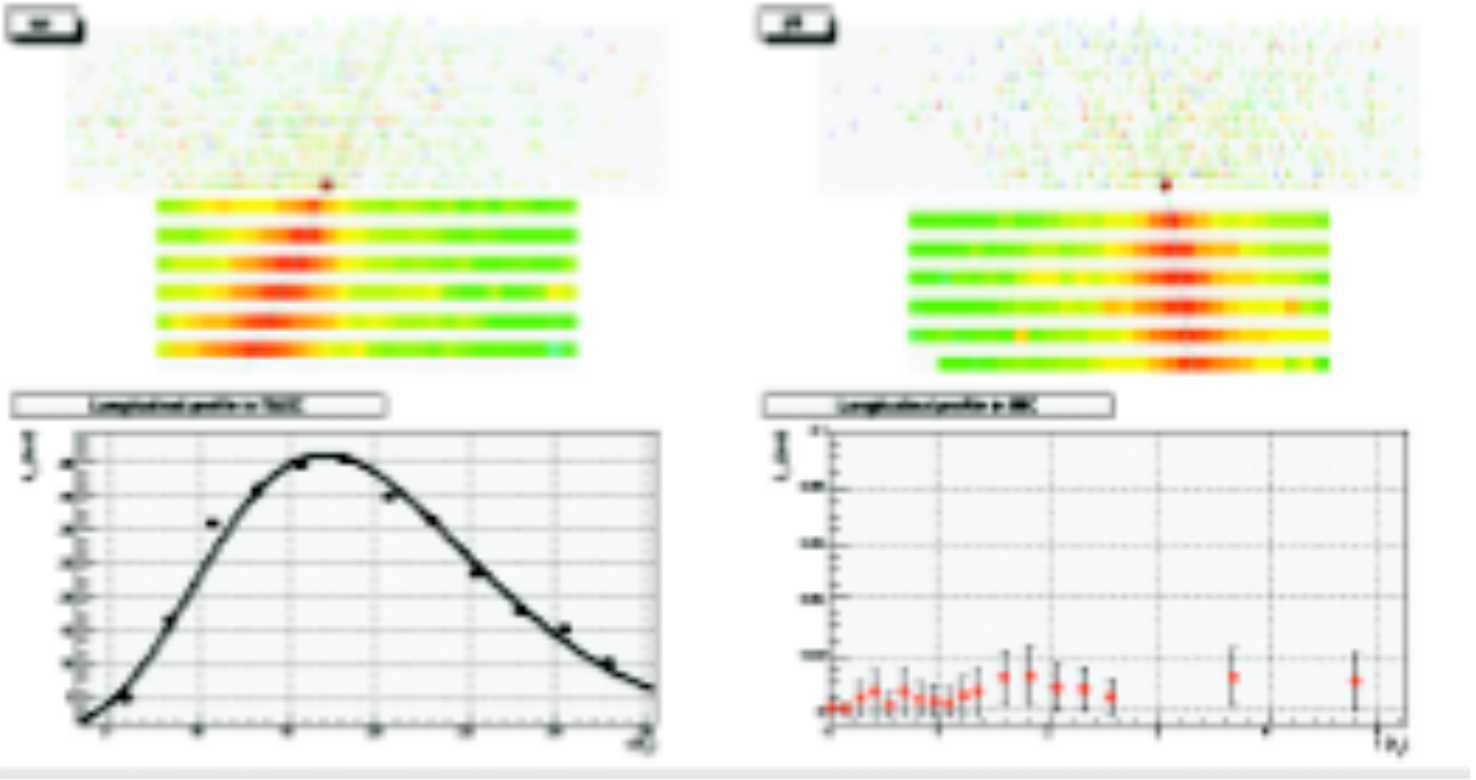


[Neutralino decay, Bergstrom 2001]


MTX1 signal (ADC)
MTX2 signal (ADC)
MTX2 (ADC)
MTX0 (ADC)
3 mips
2 mips
1 mip

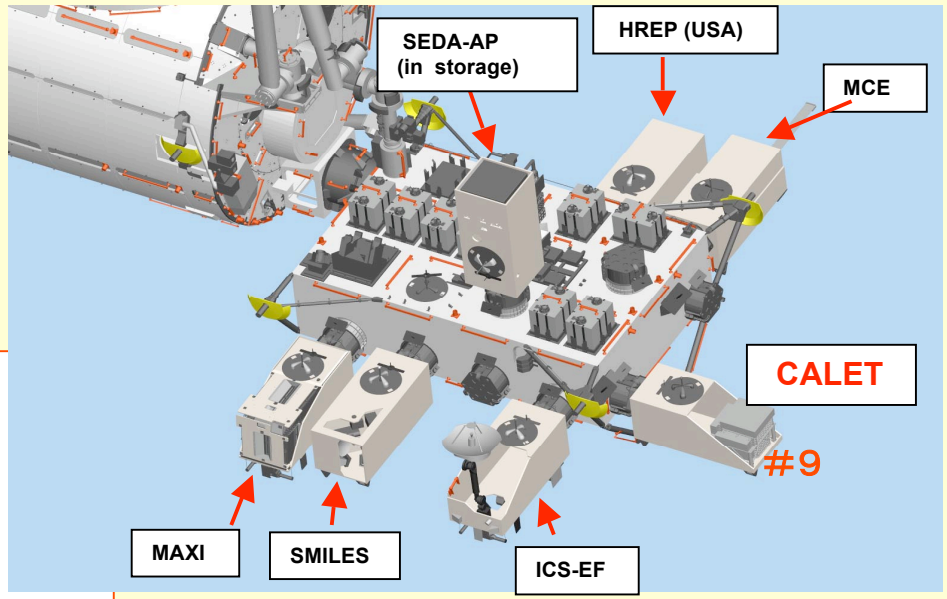
(a) (b)

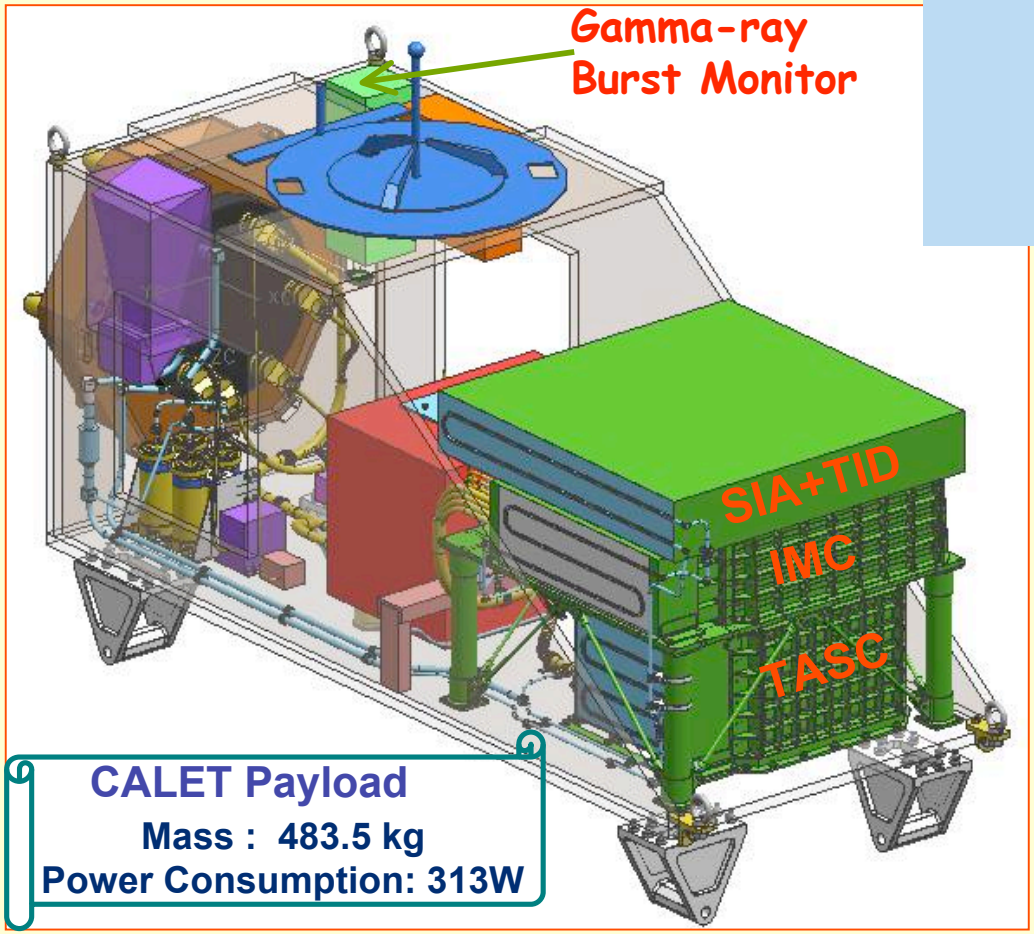




The CALET mission has been approved to proceed to the Phase B in target of launching in summer, 2013.

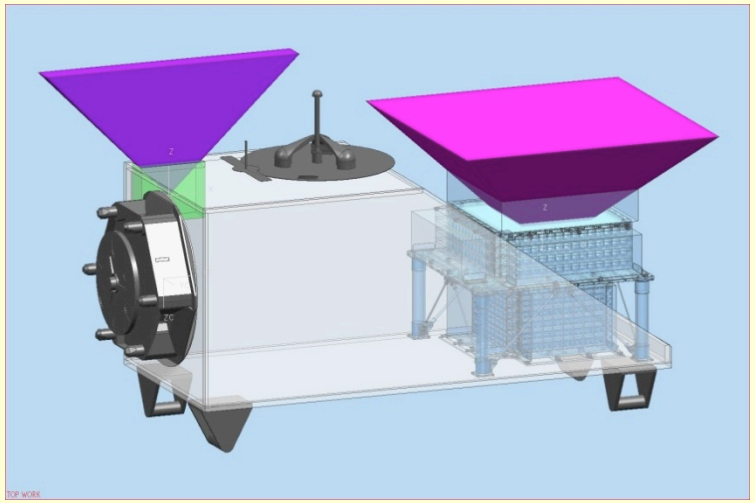
Future Plan of JEM/EF (as ~2013)



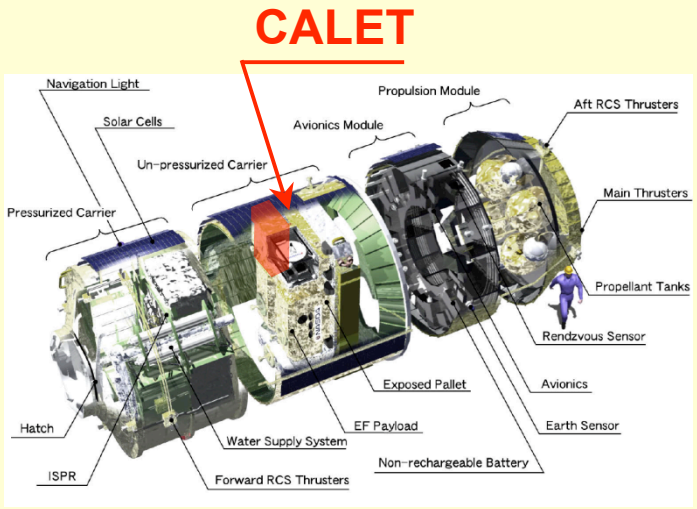


CALET Payload
Mass : 483.5 kg
Power Consumption: 313W

Field of View (45 degrees from the zenith)

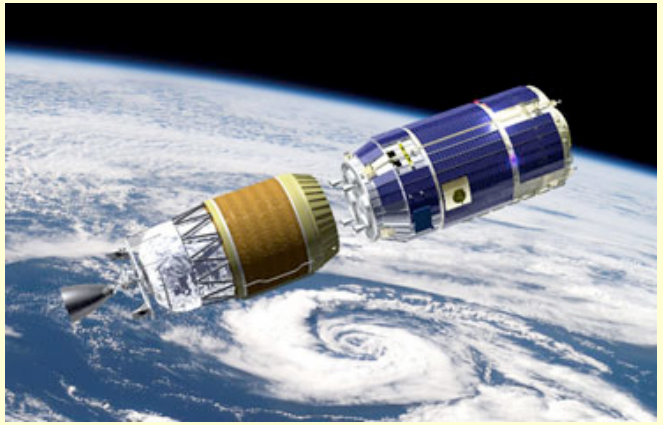


Launching Procedure of CALET

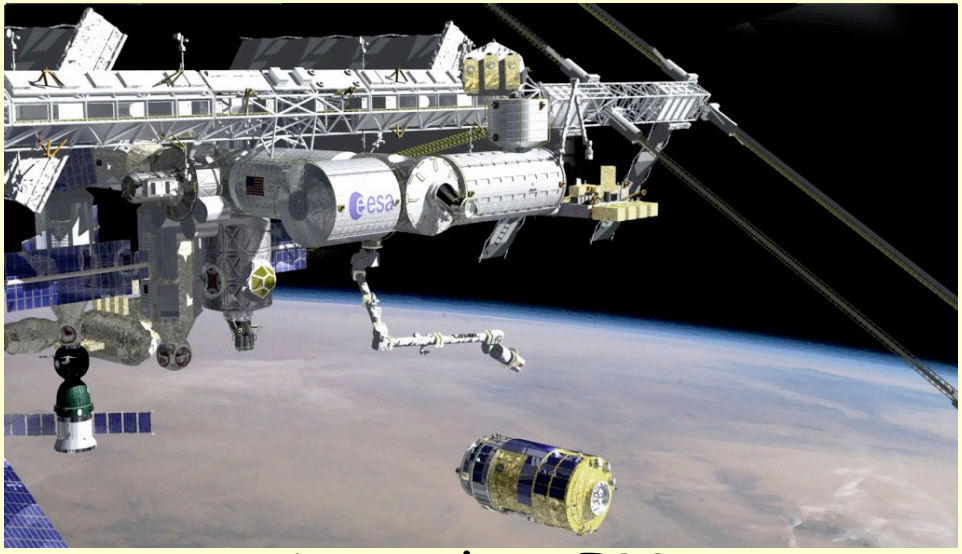


H2-B Transfer Vehicle (HTV)

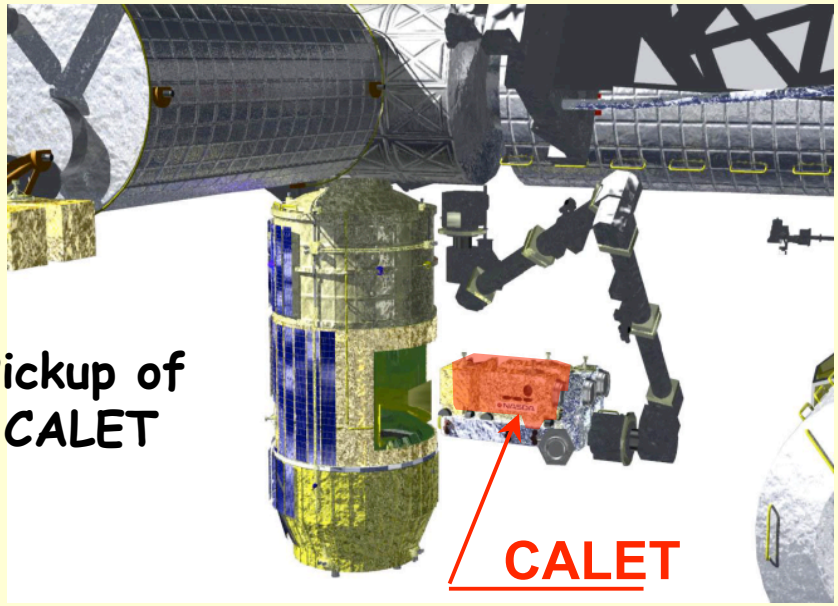
Launching by H-IIB Rocket



Separation from H2-B

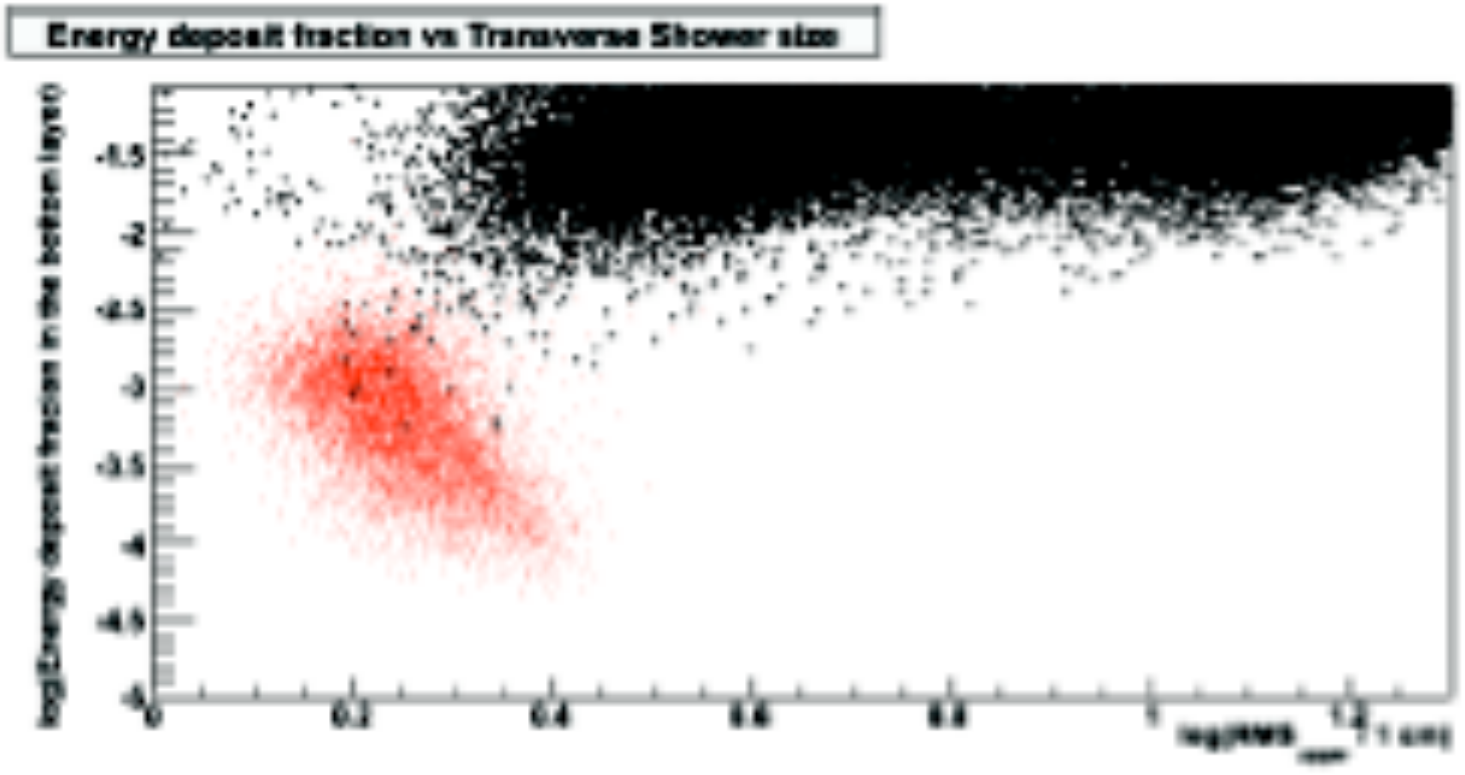


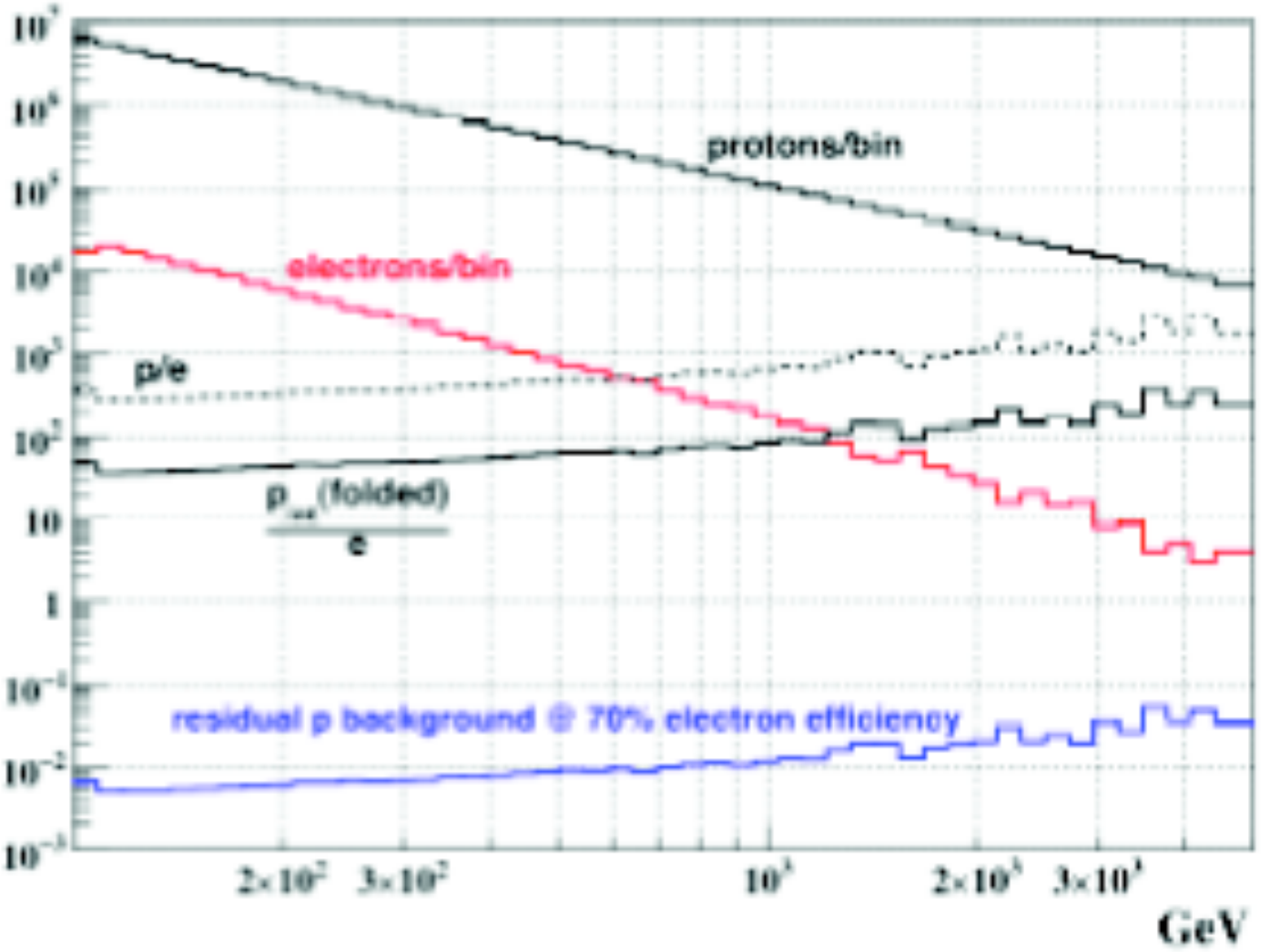
Approach to ISS

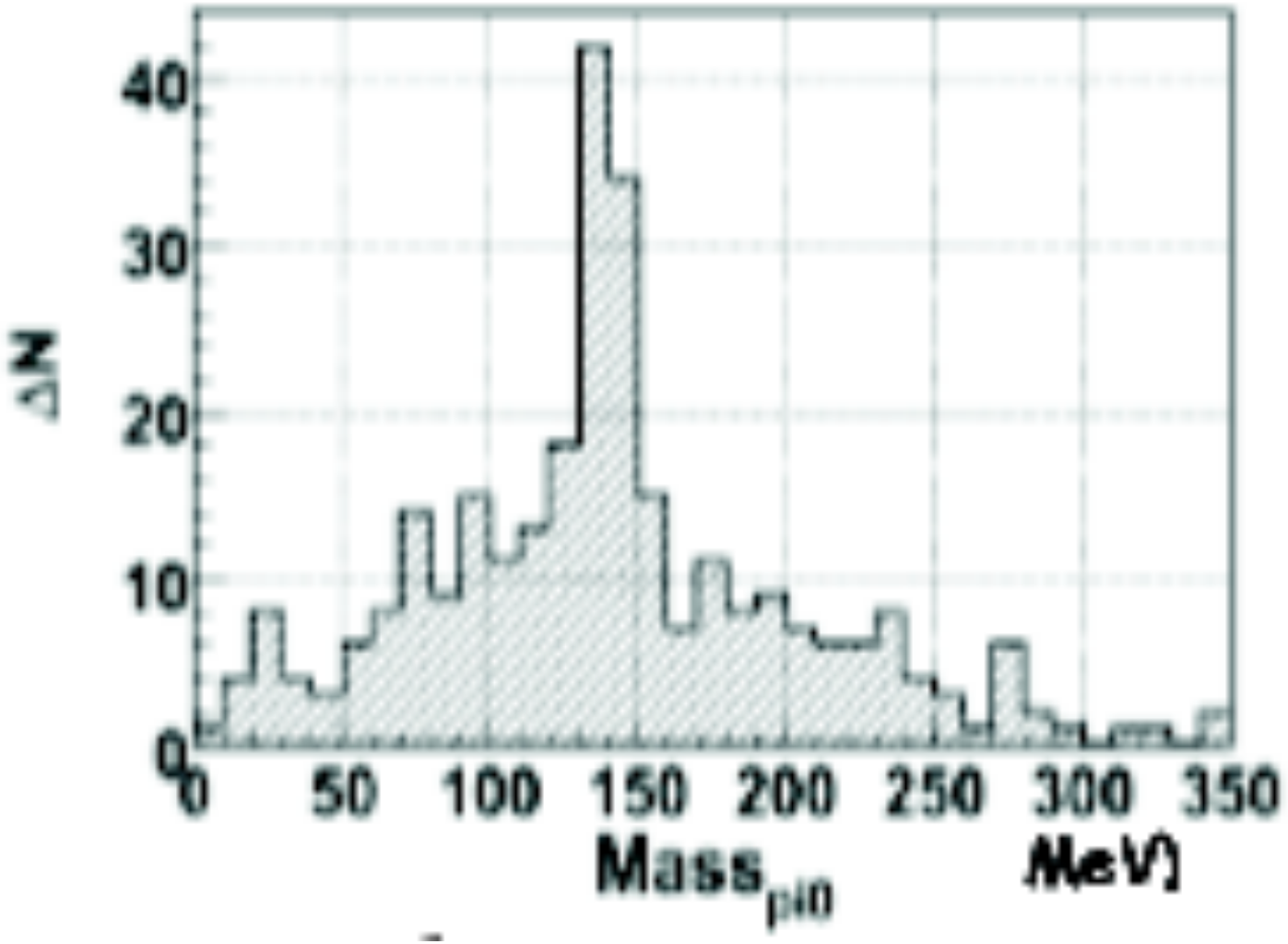


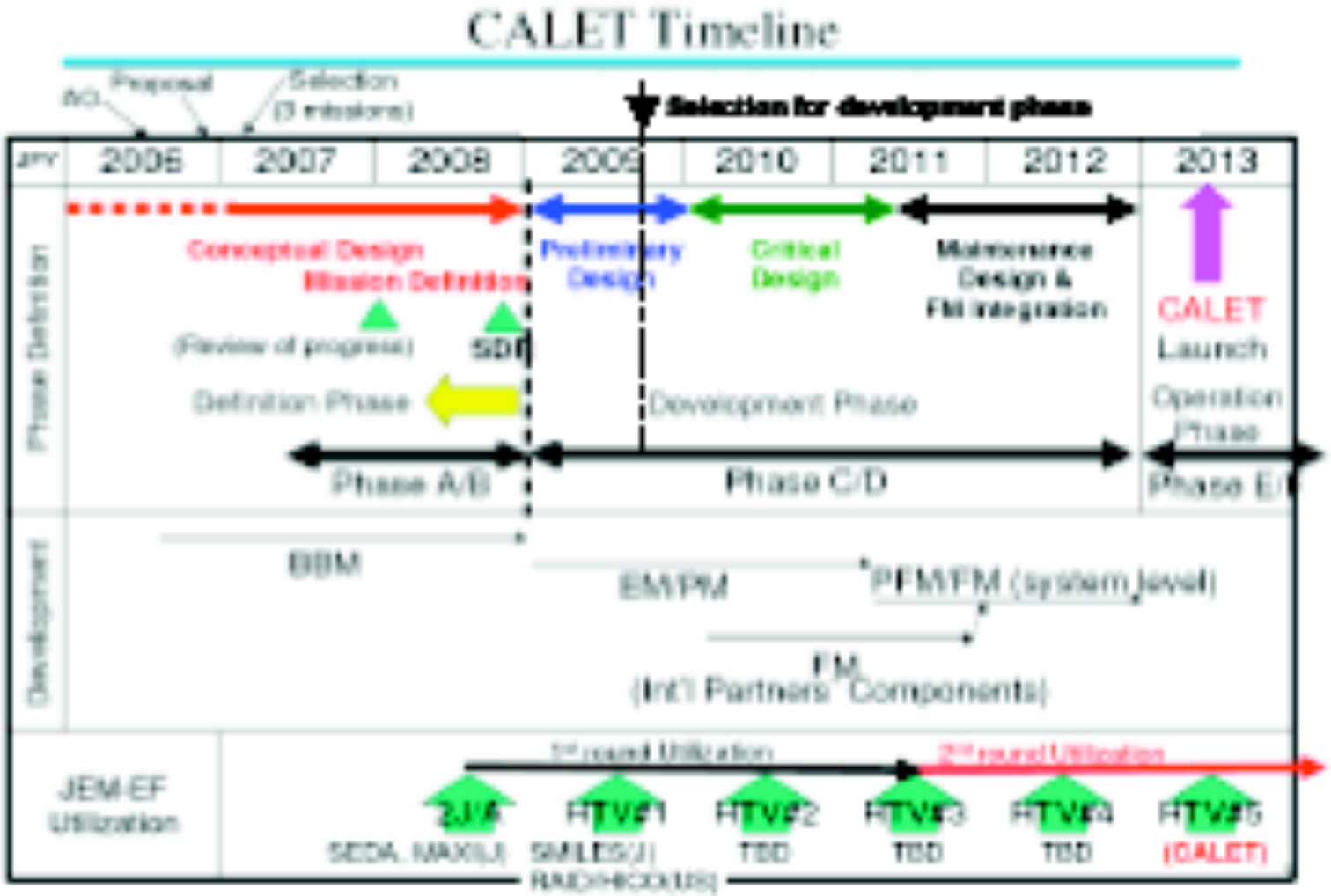
Pickup of CALET

Thank you for your attention


Energy deposit fraction vs Transverse Shower size
log(Energy deposit fraction in the bottom layer)
-0.5
-2
-2.5
-3
-3.5
-4
-4.5
-5
0
0.2
0.4
0.6
0.8
1
1.2
log(RMS_cm) (1 cm)


protons/bin
electrons/bin
p/e
p_sec(folded)
e
residual p background @ 70% electron efficiency
GeV


40
30
20
10
0
ΔN
0
50
100
150
200
250
300
350
Mass$_{p\pi^0}$
MeV)


CALET Timeline
Proposal
Selection
(3 missions)
Selection for development phase
JFY
2006
2007
2008
2009
2010
2011
2012
2013
Phase Definition
Conceptual Design
Mission Definition
Preliminary Design
Critical Design
Maintenance Design & FM integration
CALET Launch
(Review of progress)
SDR
Definition Phase
Development Phase
Operation Phase
Phase A/B
Phase C/D
Development
BBM
EM/PM
PFM/FM (system level)
FM
(Int'l Partners' Components)
JEM-EF Utilization
1st round Utilization
2nd round Utilization
2J/A
HTV#1
HTV#2
HTV#3
HTV#4
HTV#5
SEDA, MAXI-J
SMILES-J
TBD
TBD
TBD
(CALET)