

Эксперимент «Памела» и поиски частиц «темной» материи

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сотрудничества ПАМЕЛА

III Черенковские чтения: “Новые методы в
экспериментальной ядерной физике и физике частиц”,
ФИАН, 6 апреля 2010 г.

СОДЕРЖАНИЕ

- Задачи эксперимента
- Спектрометр ПАМЕЛА
- Отношение потоков (P_{bar}/P)
- Отношение потоков $e^+/(e^+ + e^-)$
- Спектр галактических электронов с энергией более 100 ГэВ
- Выводы

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- **Выводы**

v (km/s)

100

50

observed

expected
from
luminous disk

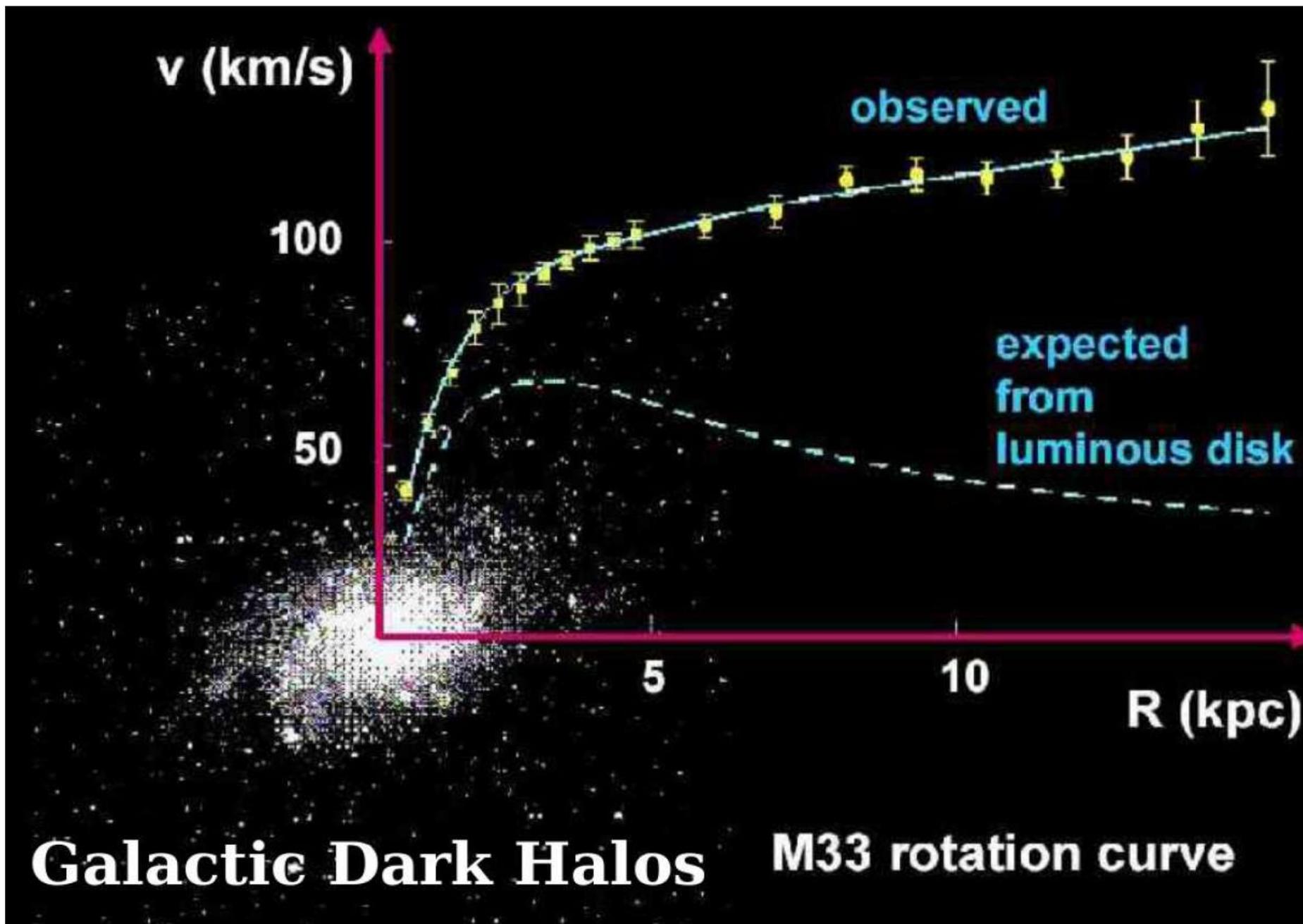
5

10

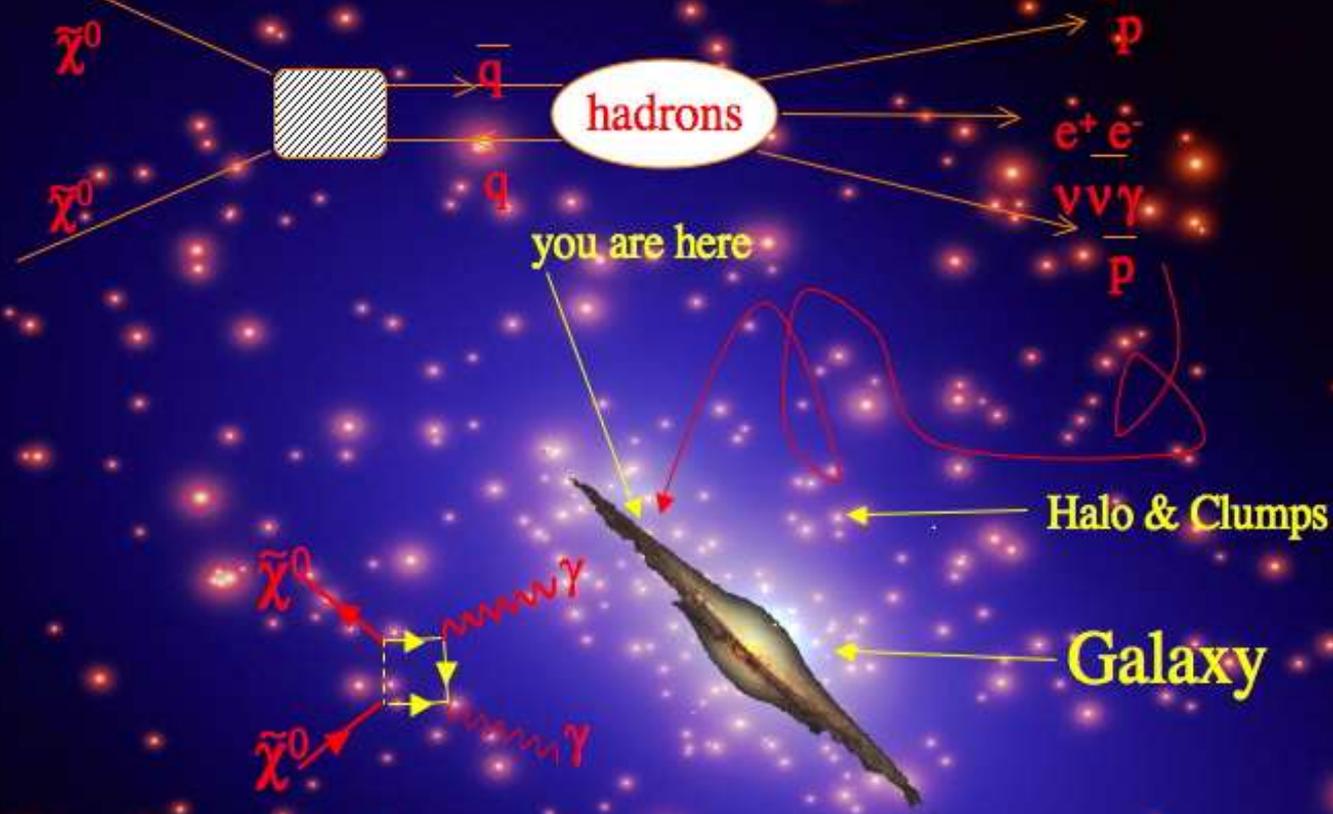
R (kpc)

Galactic Dark Halos

M33 rotation curve



Signal (supersymmetry)...



Will distort the antiproton positron and gamma spectra from purely secondary production

... and background

$$p_{CR} + p_{ISM} \rightarrow \bar{p} + p + p + p$$

$$p_{CR} + p_{ISM} \rightarrow \pi^+ \rightarrow \mu^+ \rightarrow e^+$$

$$\rightarrow \pi^0 \rightarrow \gamma\gamma \rightarrow e^+e^-$$

Neutralino Annihilations

$$\chi + \bar{\chi} \rightarrow X + \gamma$$

$$+ \nu$$

$$+ \bar{p}$$

$$+ e^+$$

$$+ \bar{D}$$

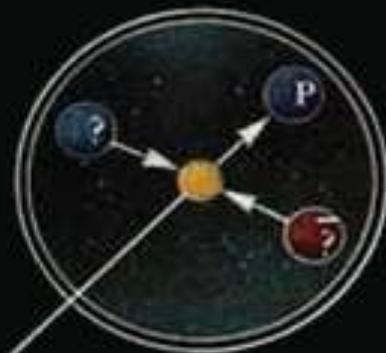
(GLAST-FERMI AMS-02)
 (AMANDA / IceCube)
PAMELA
 (and Bess, HEAT, AMS etc.)

ANTIMATTER

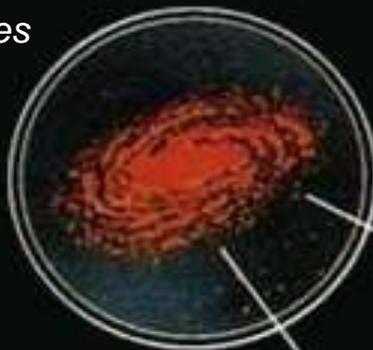
Collision of High Energy Cosmic Rays with the Interstellar Gas



Annihilation of Exotic Particles



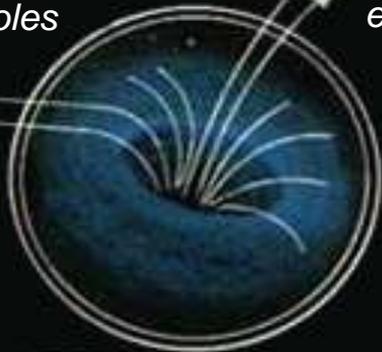
Cosmic Rays Leaking Out of Antimatter Galaxies



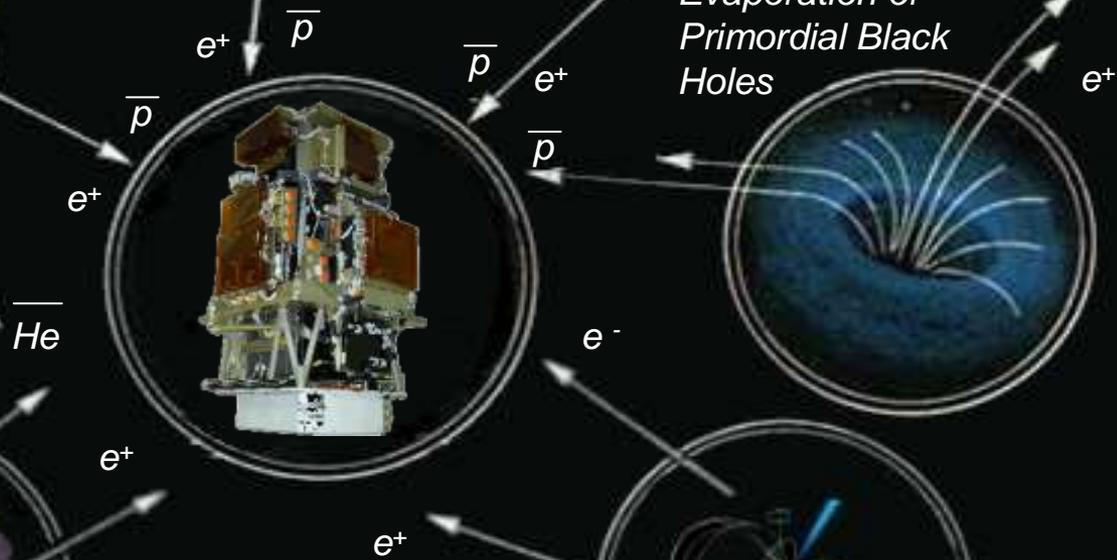
Antimatter Lumps In the Milky Way



Evaporation of Primordial Black Holes



Pulsar's magnetospheres



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- **Выводы**

PAMELA Collaboration

Italy:



Bari



Florence



Frascati



Naples



Tor Vergata

Rome



Trieste



CNR, Florence



Russia:



Moscow

St. Petersburg

Germany:



Siegen

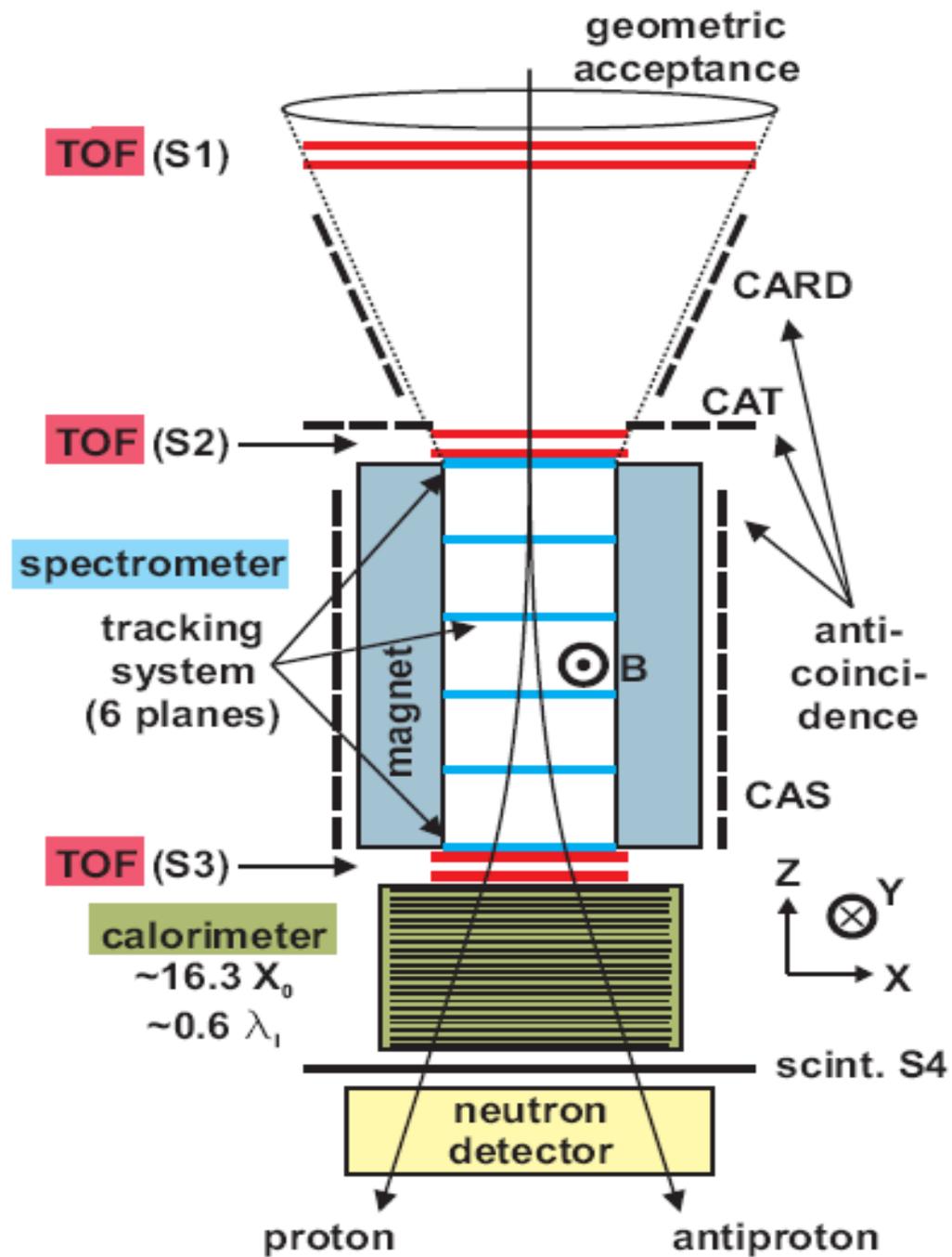
Sweden:



KTH, Stockholm

PAMELA

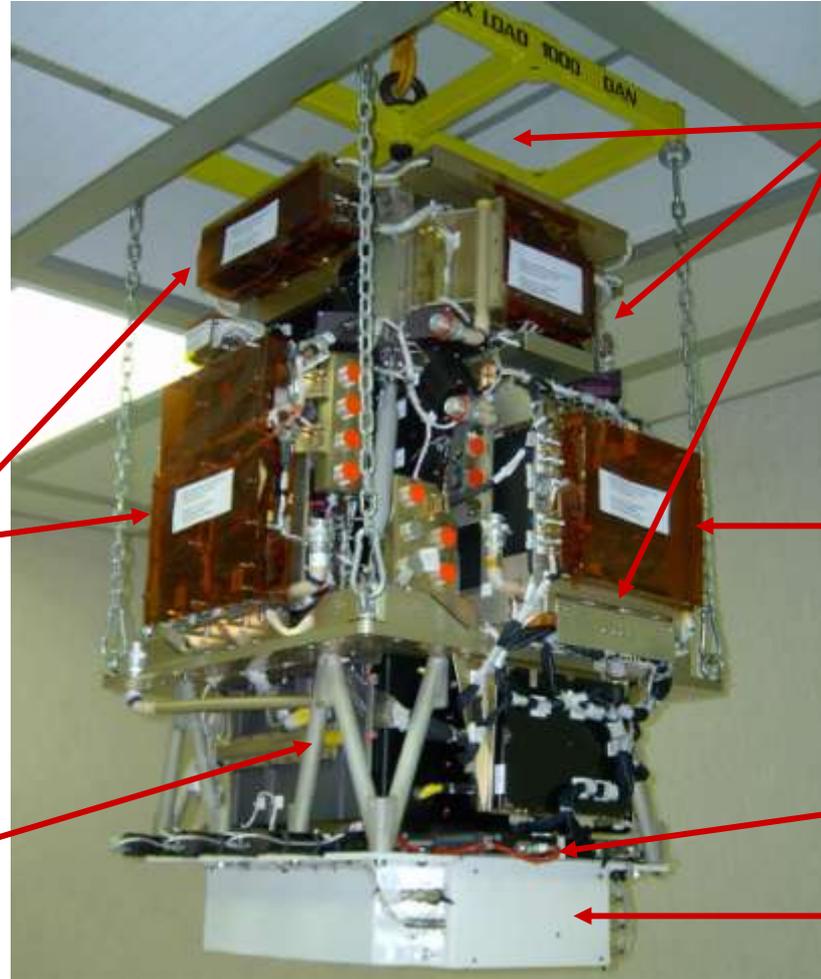
Payload for **A**ntimatter -
Matter **E**xploration and
Light Nuclei **A**strophysics



СПЕКТРОМЕТР ПАМЕЛА

Геометрич. фактор:
21.5 см² ср
Вес: 470 кг
Размеры:
130x70x70 см³
Мощность (потреб.) :
360 Вт

Антисовпадат.
защита



Время-пролетная
система (TOF)

Определение напр.
движения частицы
с P до 1 ГэВ/с

Магнитн. спектрометр

$B = 0.48$ Т

6 плоскостей Si
(2 слоя на каждой)
Толщина каждого
стрипа 300 μm
Разрешение $\sim 3\mu\text{m}$
MDR ~ 1400 GV/c

Сцинтиллятор C4

Нейтронный
детектор (ND)

36 ³He счетчиков
полиэтил. замедлит.

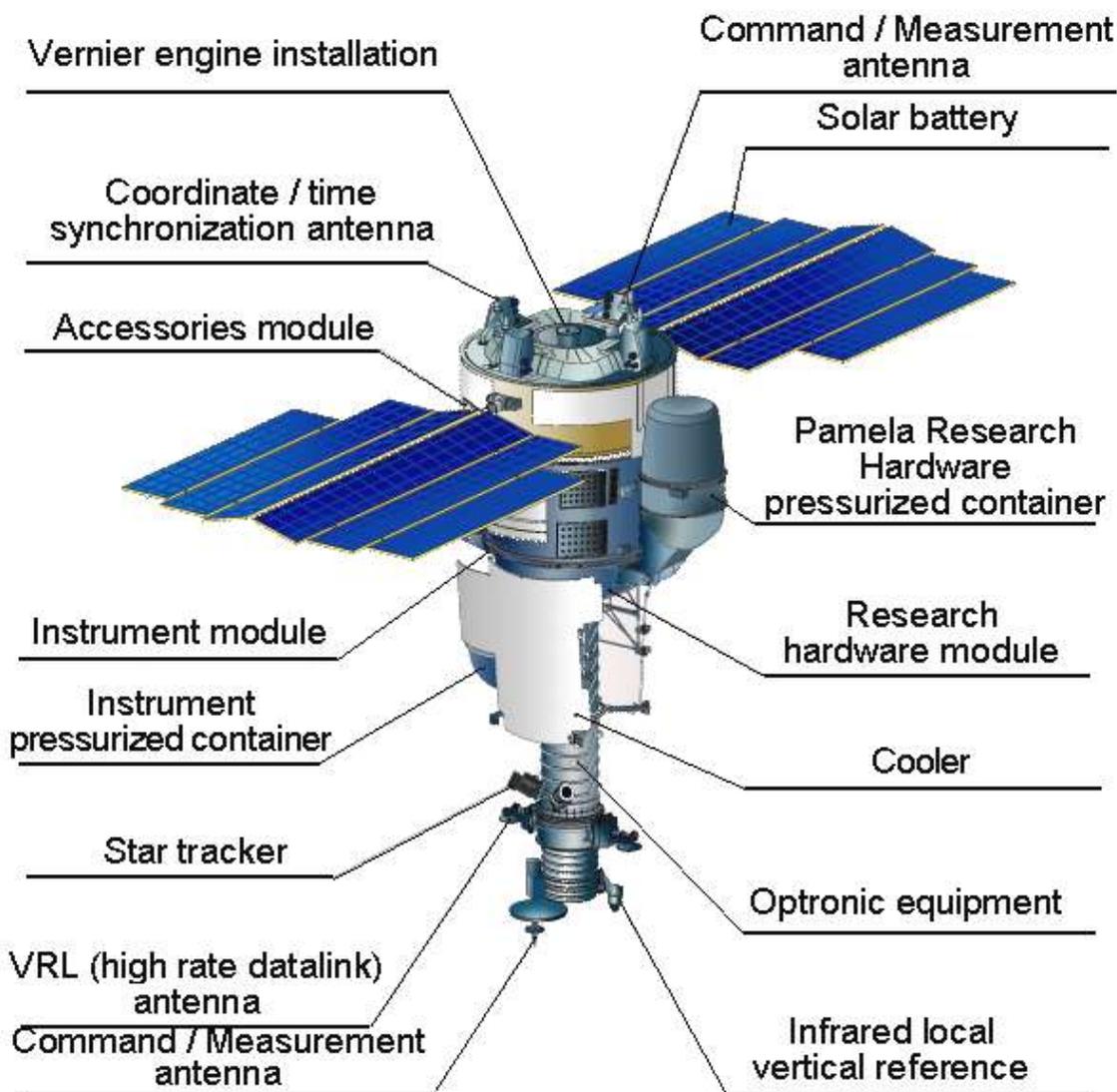
Калориметр
изображения:

44 плоскости Si с 22
слоями W между ними
 $16.3 X_0 / 0.6 L_0$

e^+/p и \bar{p}/e^-

на уровне $10^{-4} \sim 10^{-5}$

Ресурс - ДК1



- **Задача:** зондирование Земли в широком спектральном диапазоне
- **Изготовлен** ЦСКБ Прогресс в Самаре
- **Время работы** >3 лет
- **Передача данных** по высокоскоростной радиолнии
- **ПАМЕЛА** находится внутри герметичного контейнера

Масса: 6.7 т
Высота: 7.4 м
Солнечные батареи: 36 м²

ФУНДАМЕНТАЛЬНЫЕ ПРОБЛЕМЫ

- Космология (антивещество, темная материя, новые частицы)
- Физика космических лучей (источники космических лучей, генерация, распространение)
- Физика Солнца и гелиосферы (солнечные космические лучи, аномальная компонента, модуляционные процессы)
- Частицы в магнитосфере Земли



ГАГАРИНСКИЙ

СТАРТ

МЕЖДУНАРОДНЫЙ ЭКСПЕРИМЕНТ ПАМЕЛА : научные задачи и первые результаты



Ю. Стожков (ФИАН) от имени коллаборации ПАМЕЛА
(семинар ФИАН РАН, 27.04.2007)

15 июня 2006 г.

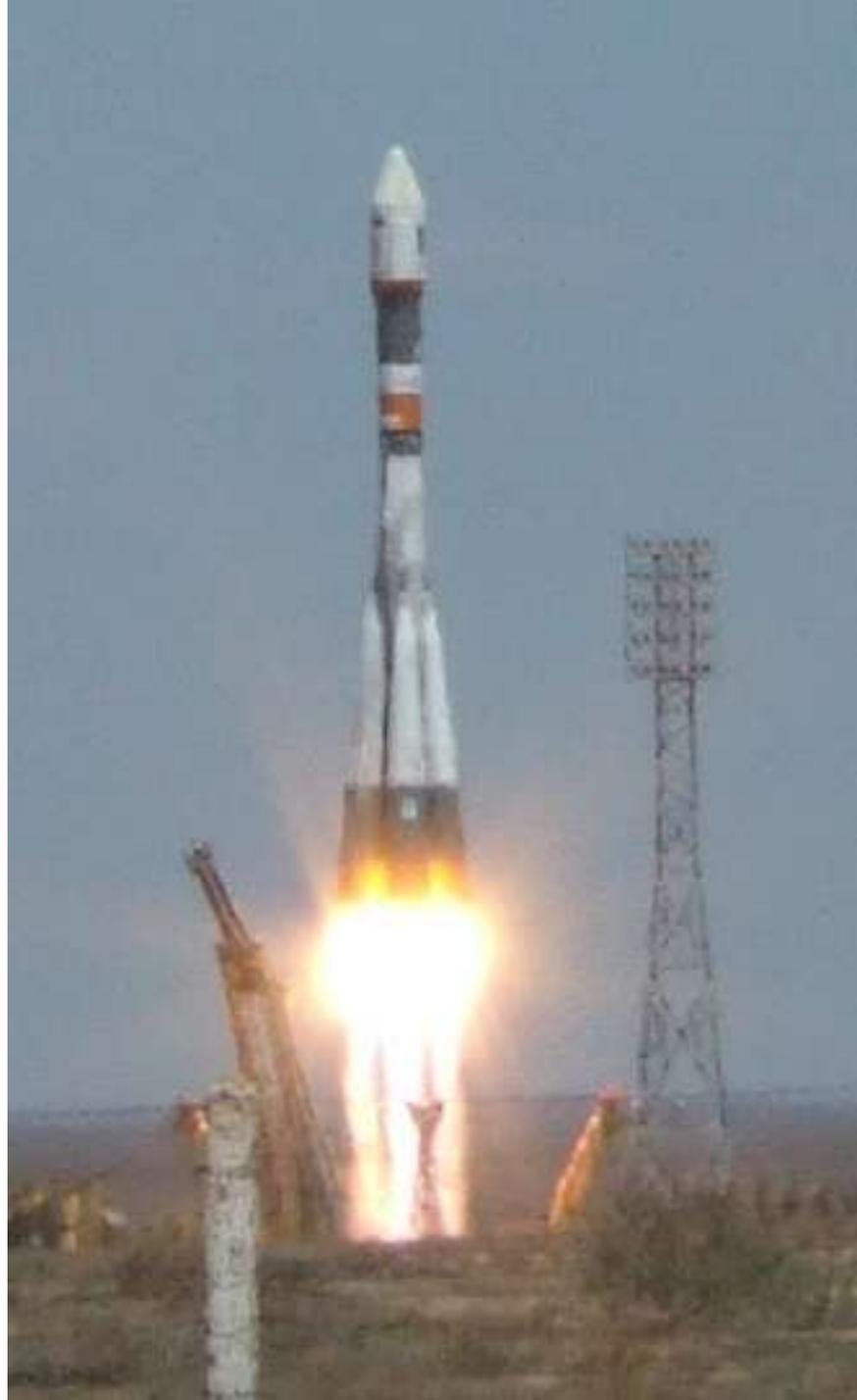
**с полигона Байконур ракетой
СОЮЗ был успешно проведен
запуск космического аппарата
РЕСУРС - ДК1 со спектрометром
ПАМЕЛА на борту**

**С 11 июля по настоящее время научная
аппаратура передает информацию на
Землю**

ПАМЕЛА

**ЗАПУСК
15/06/06**

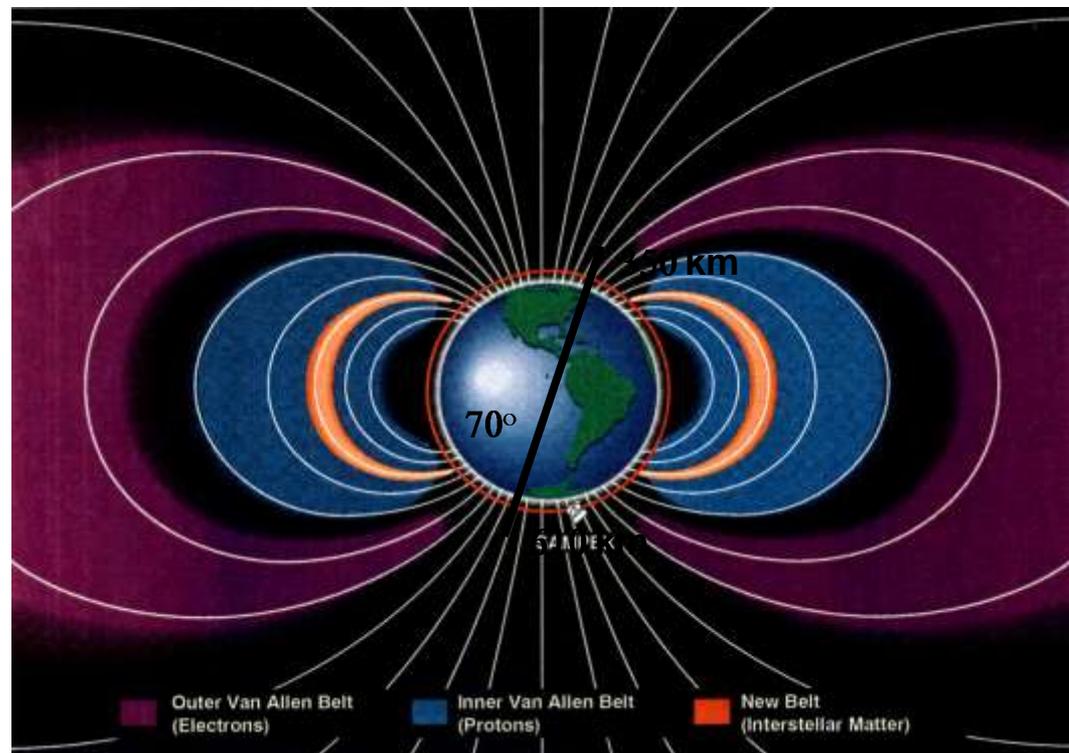
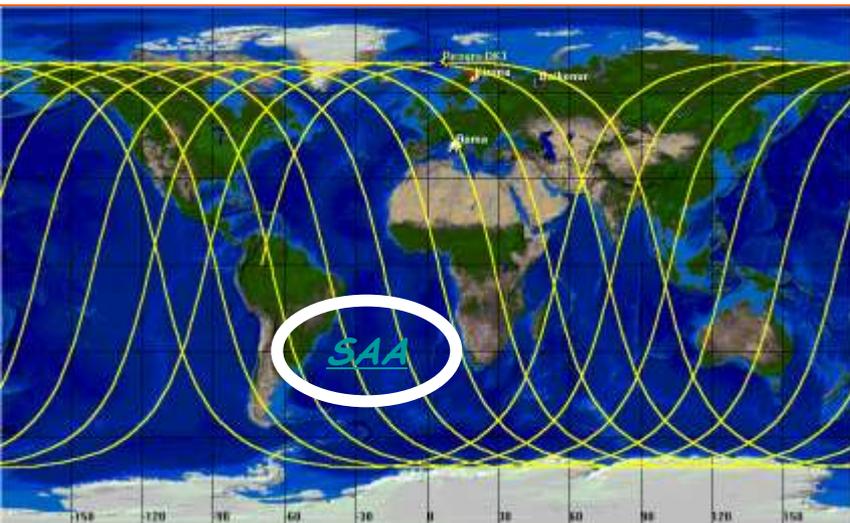
*~ 15 Гигабайт данных
передается на Землю
ежедневно в НЦОМЗ, Москва*







Характеристики орбиты



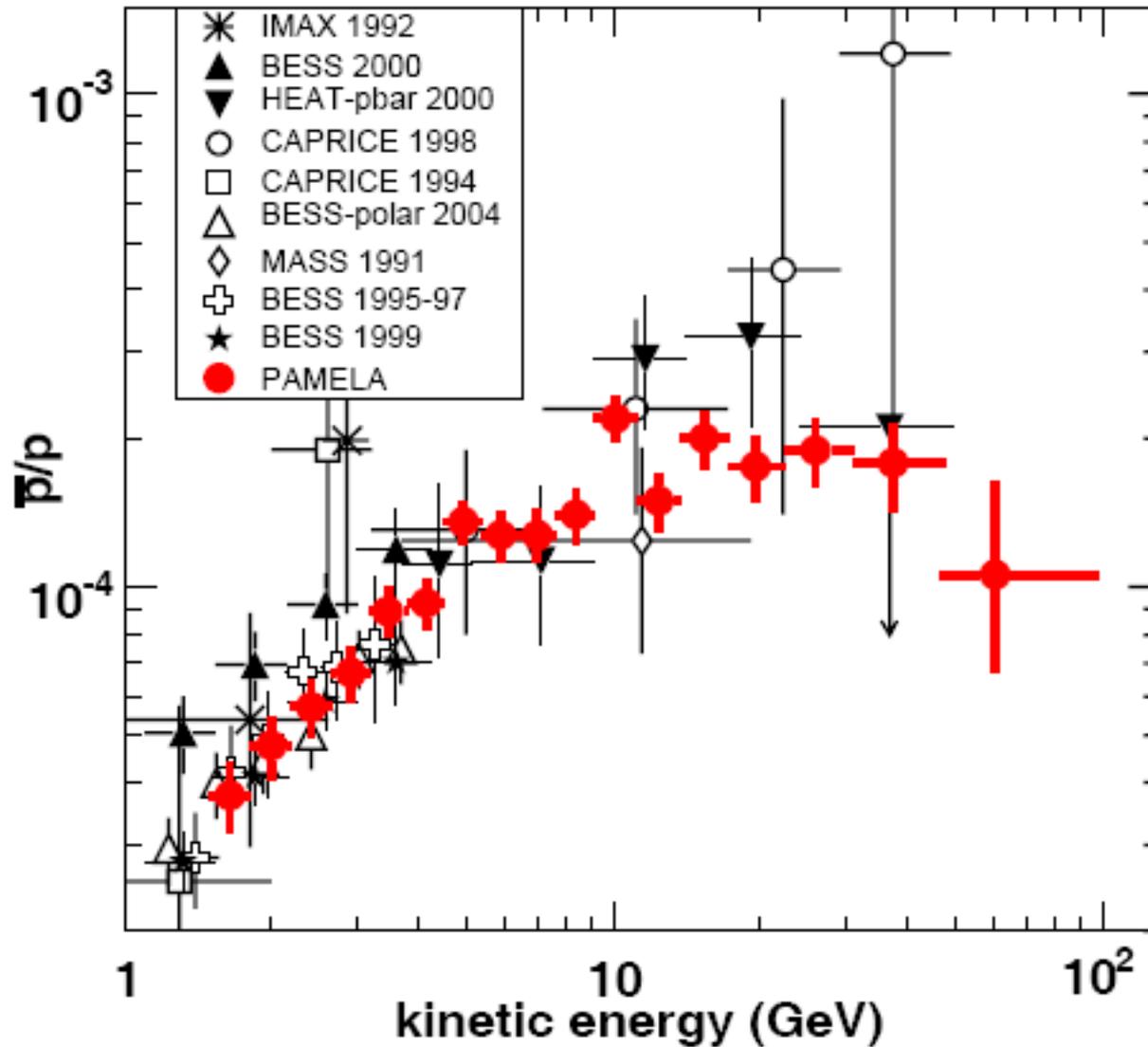
- 300 – 600 км
- Квазиполярная орбита (70° наклонение)
- Время работы >3 лет
- Эллиптическая орбита

СОДЕРЖАНИЕ

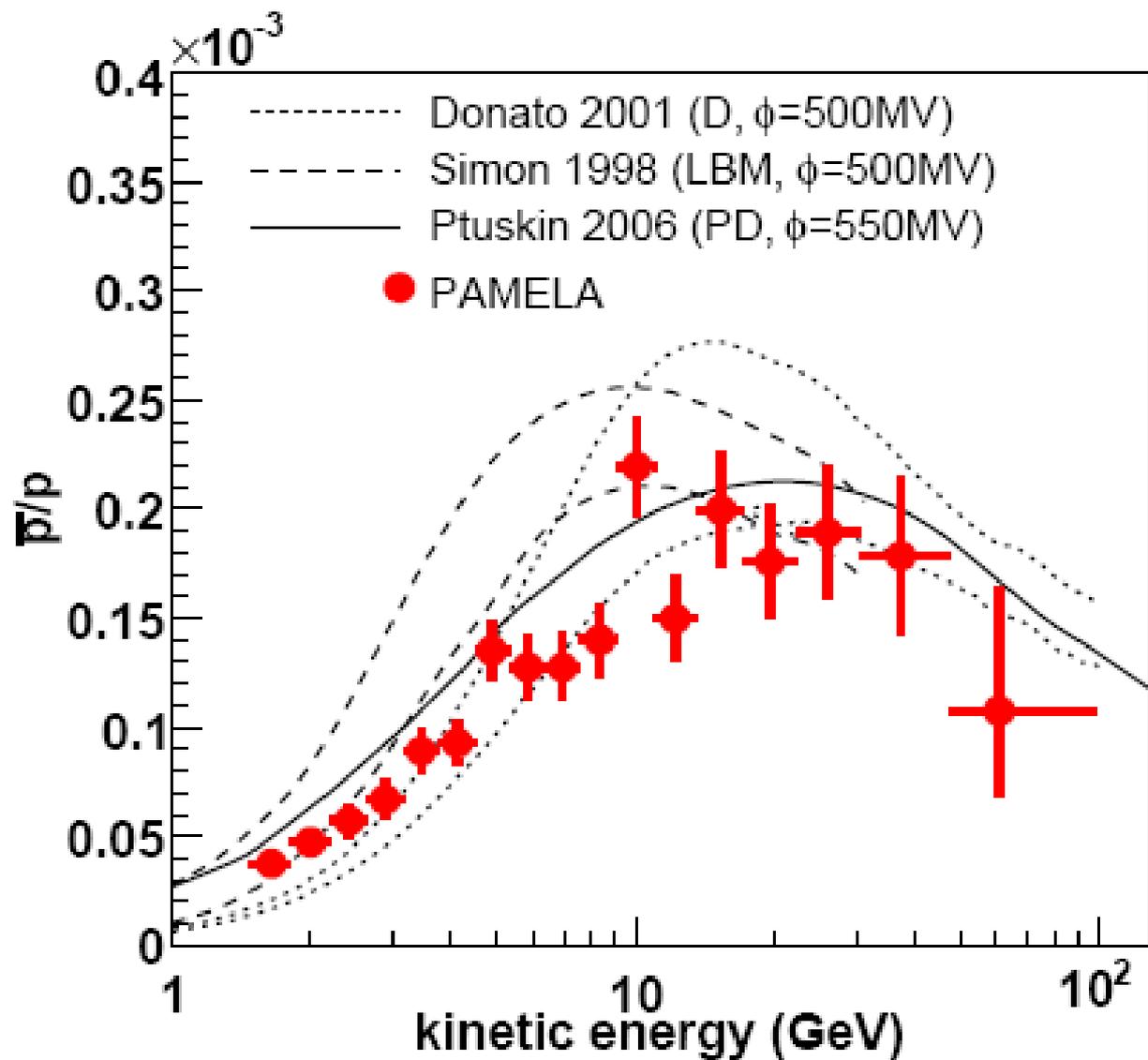
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Antiproton to proton ratio

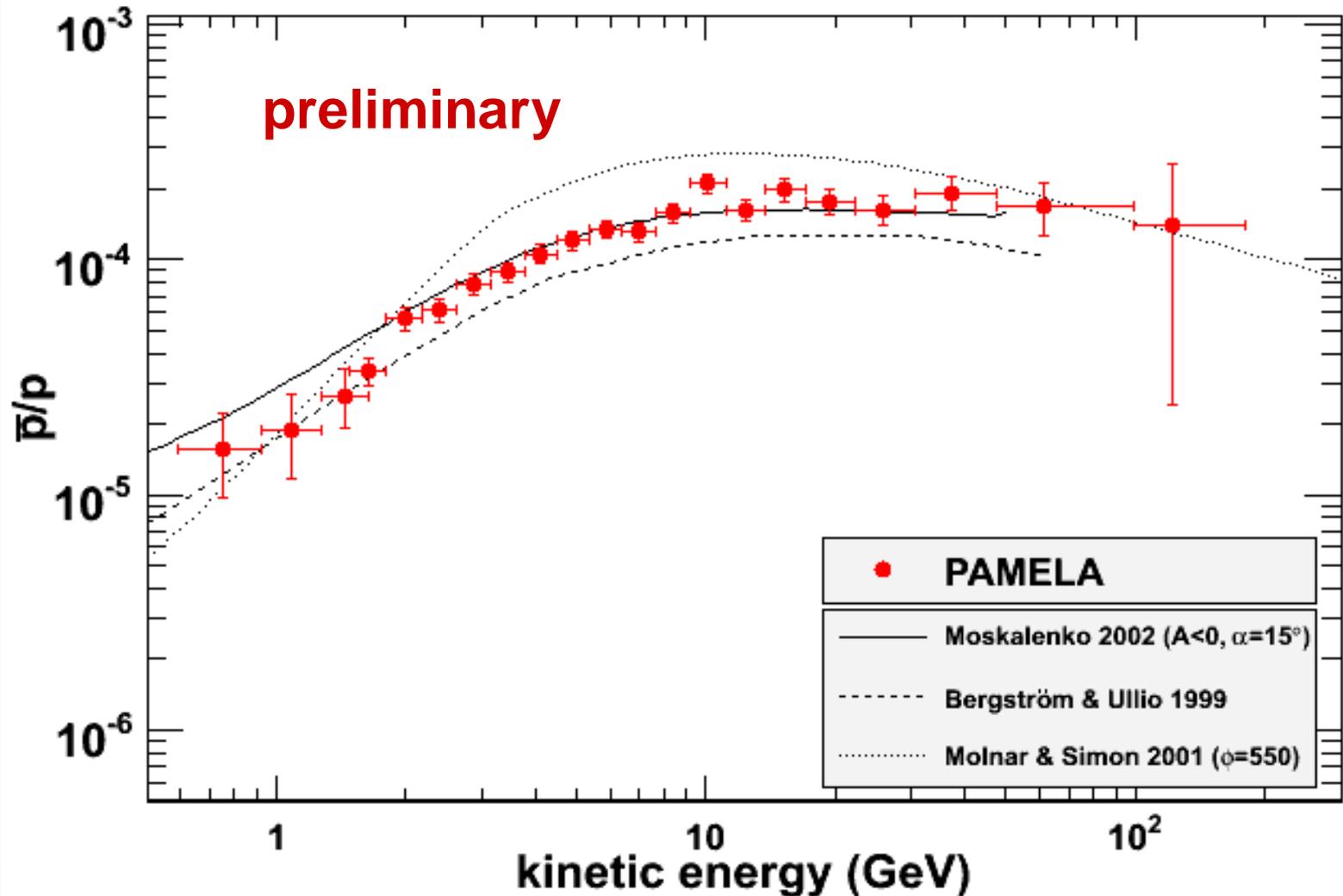
PRL 102, 051101 (2009)

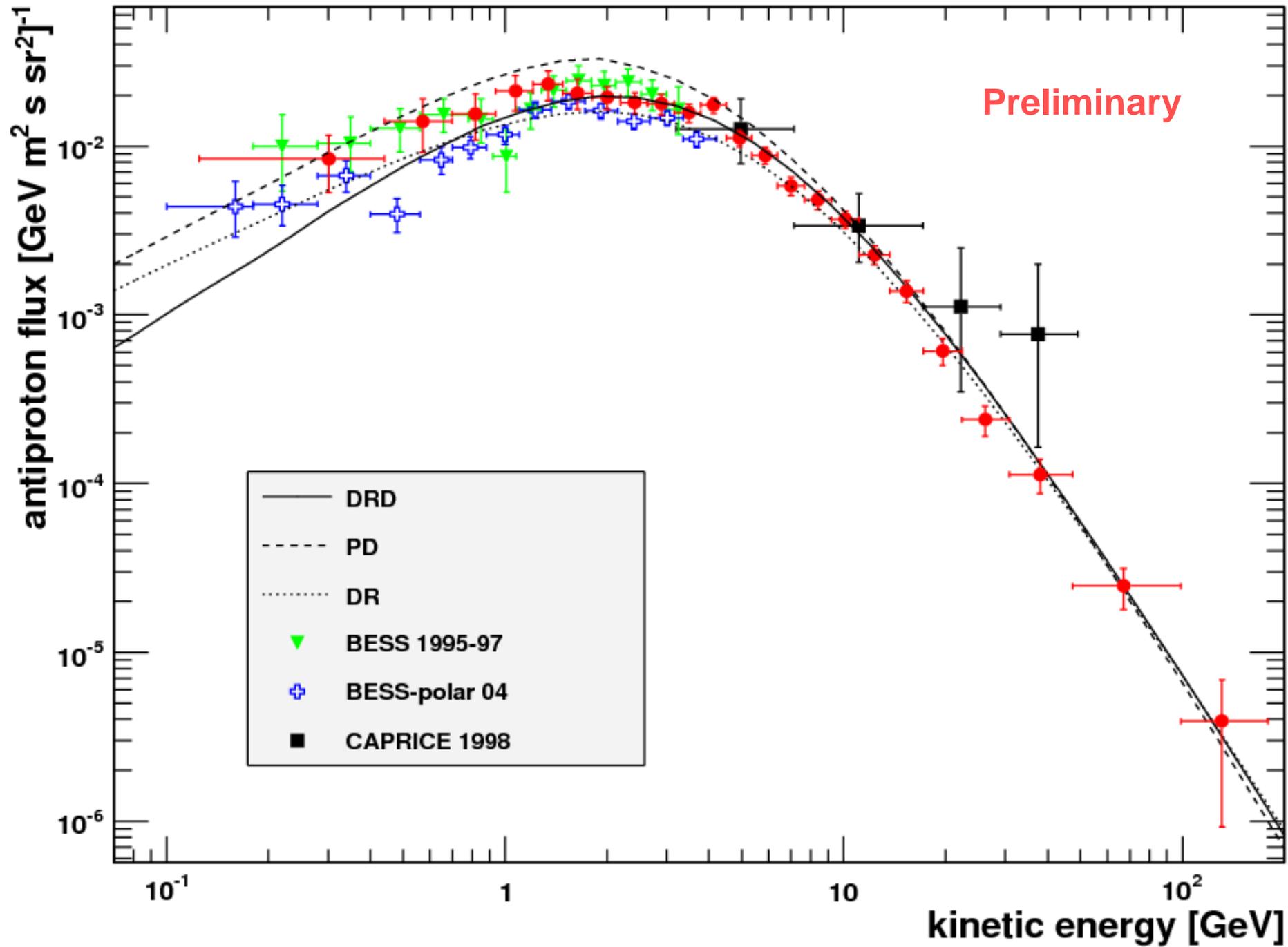


Антипротон - протон отношение



Antiproton to proton ratio





Вывод

В Галактике антипротоны образуются в результате взаимодействия протонов космических лучей с ядрами межзвездной среды



Для описания величины потока и энергетического спектра \bar{p} не требуется других источников.

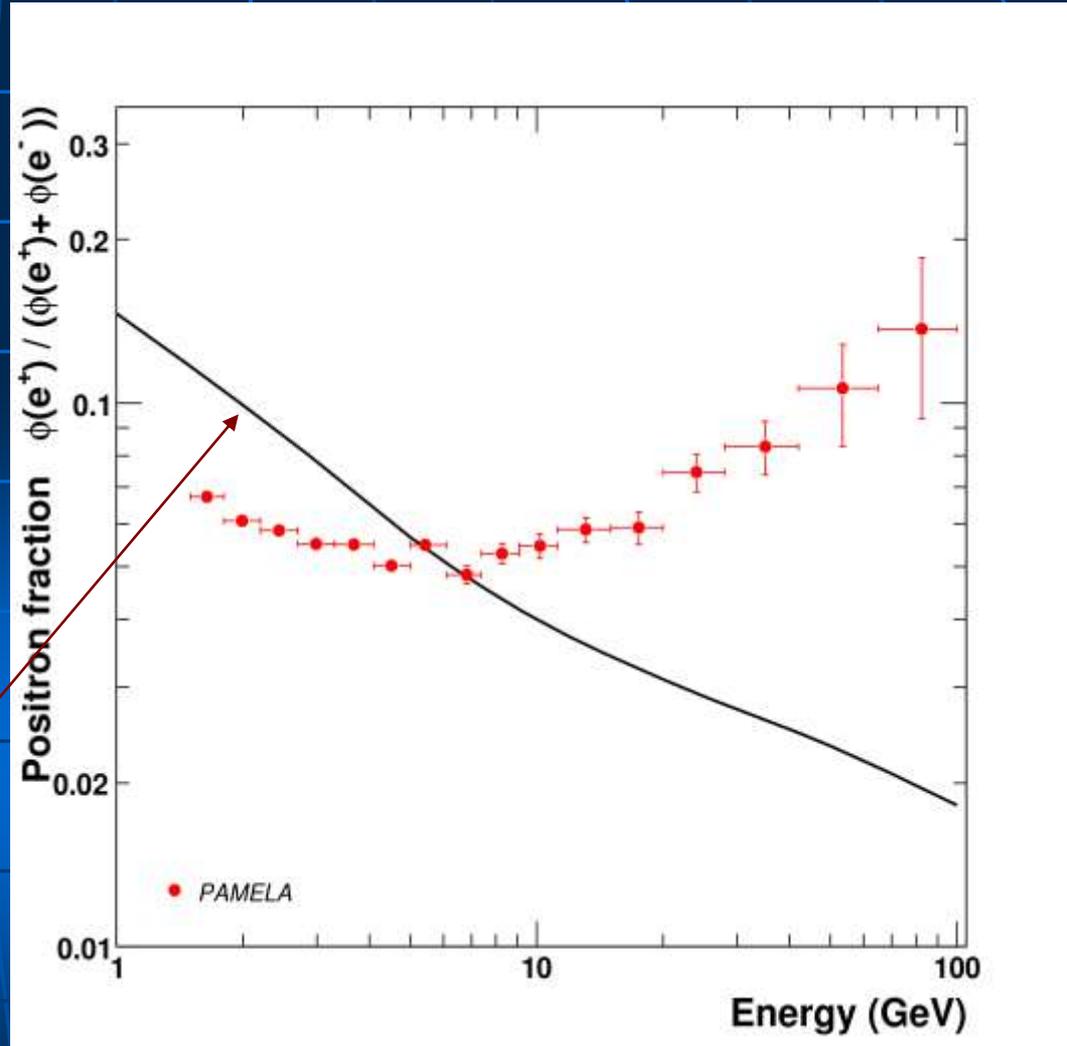
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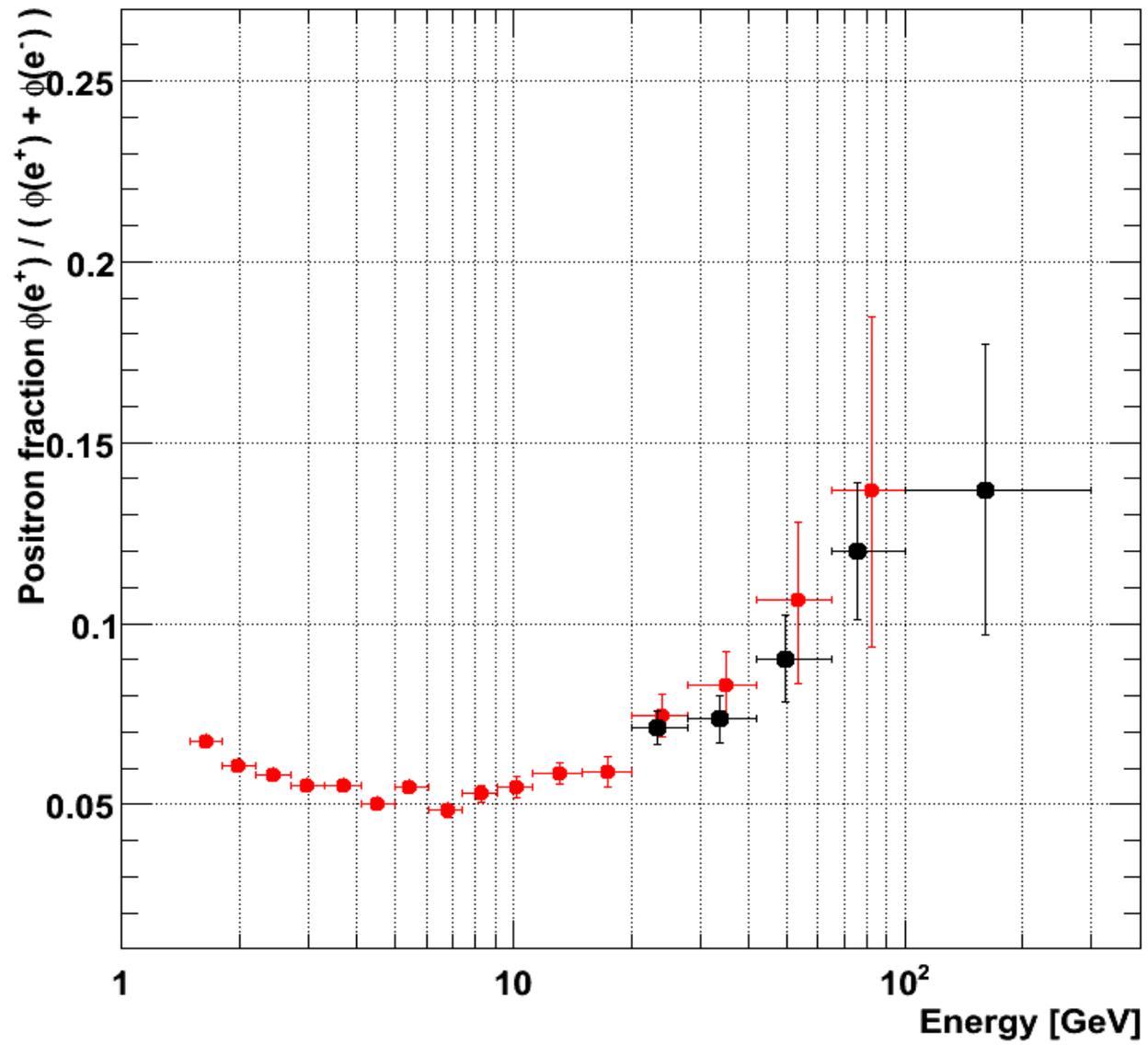
Positron to all electron ratio

Nature 458, 697, 2009

$$R(E) = \frac{\Phi_{e^+}}{\Phi_{e^+} + \Phi_{e^-}}$$



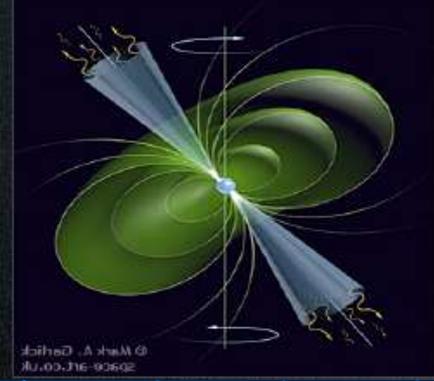
Secondary production
Moskalenko & Strong 98



Astrophysical Explanation

Pulsars

S. Profumo Astro-ph 0812-4457

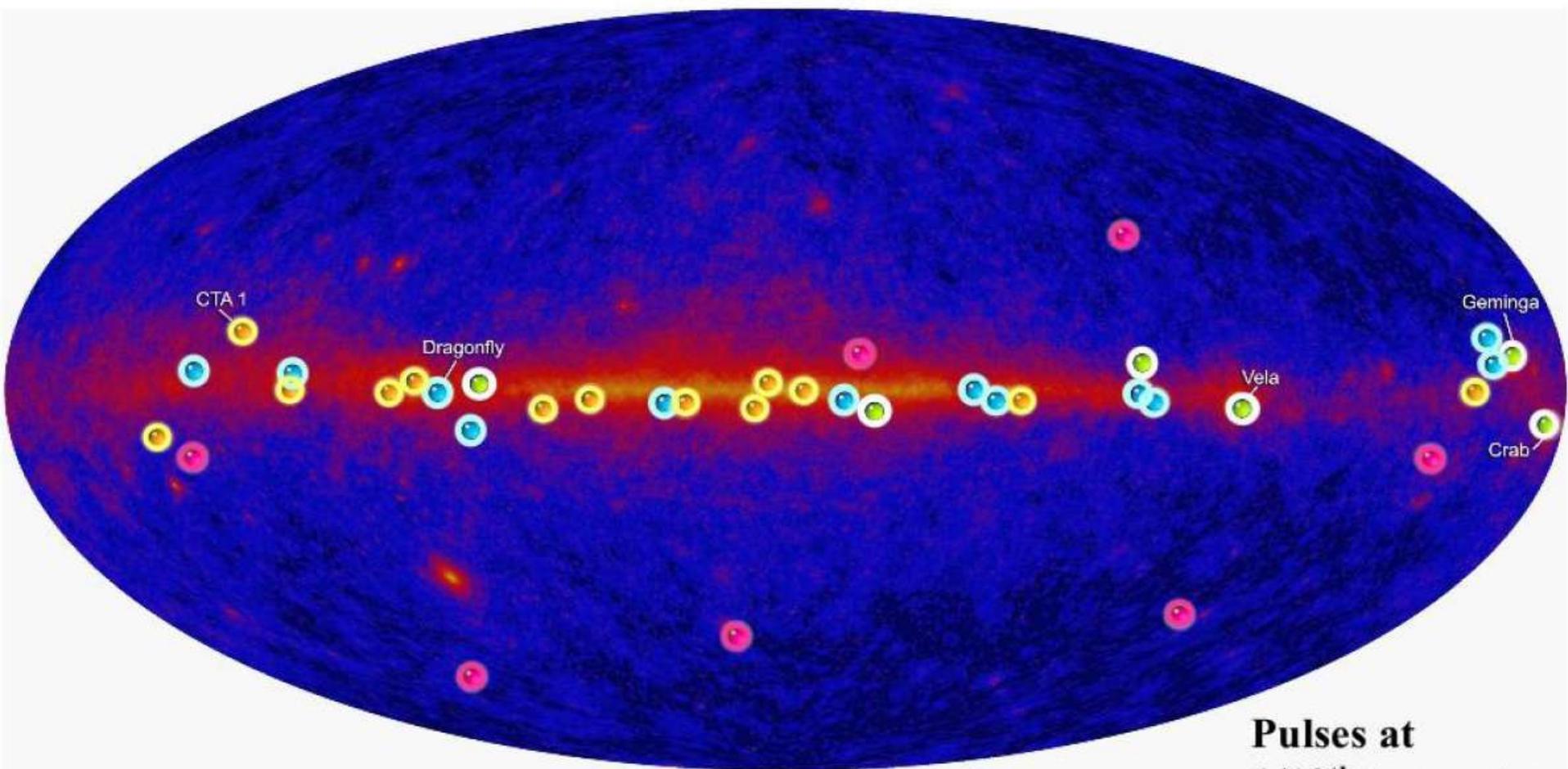


-
- Mechanism: the spinning **B** of the pulsar strips e^- that accelerated at the polar cap or at the outer gap emit γ that make production of e^\pm that are trapped in the cloud, further accelerated and later released at $\tau \sim 10^5$ years.

$$E_{tot} \simeq 10^{46} \text{ erg}$$

- Young ($T \sim 10^5$ years) and nearby ($< 1\text{kpc}$)
- If not: too much diffusion, low energy, too low flux.
- Geminga: 157 parsecs from Earth and 370,000 years old
- B0656+14: 290 parsecs from Earth and 110,000 years old
- Many others after Fermi/GLAST
- Diffuse mature pulsars

Fermi Pulsar detection



Fermi Pulsar Detections

- New pulsars discovered in a blind search
- Millisecond radio pulsars
- Young radio pulsars
- Confirmed pulsars seen by Compton Observatory EGRET instrument

**Pulses at
1/10th true rate**

Interaction of high energy gamma-rays with star-light

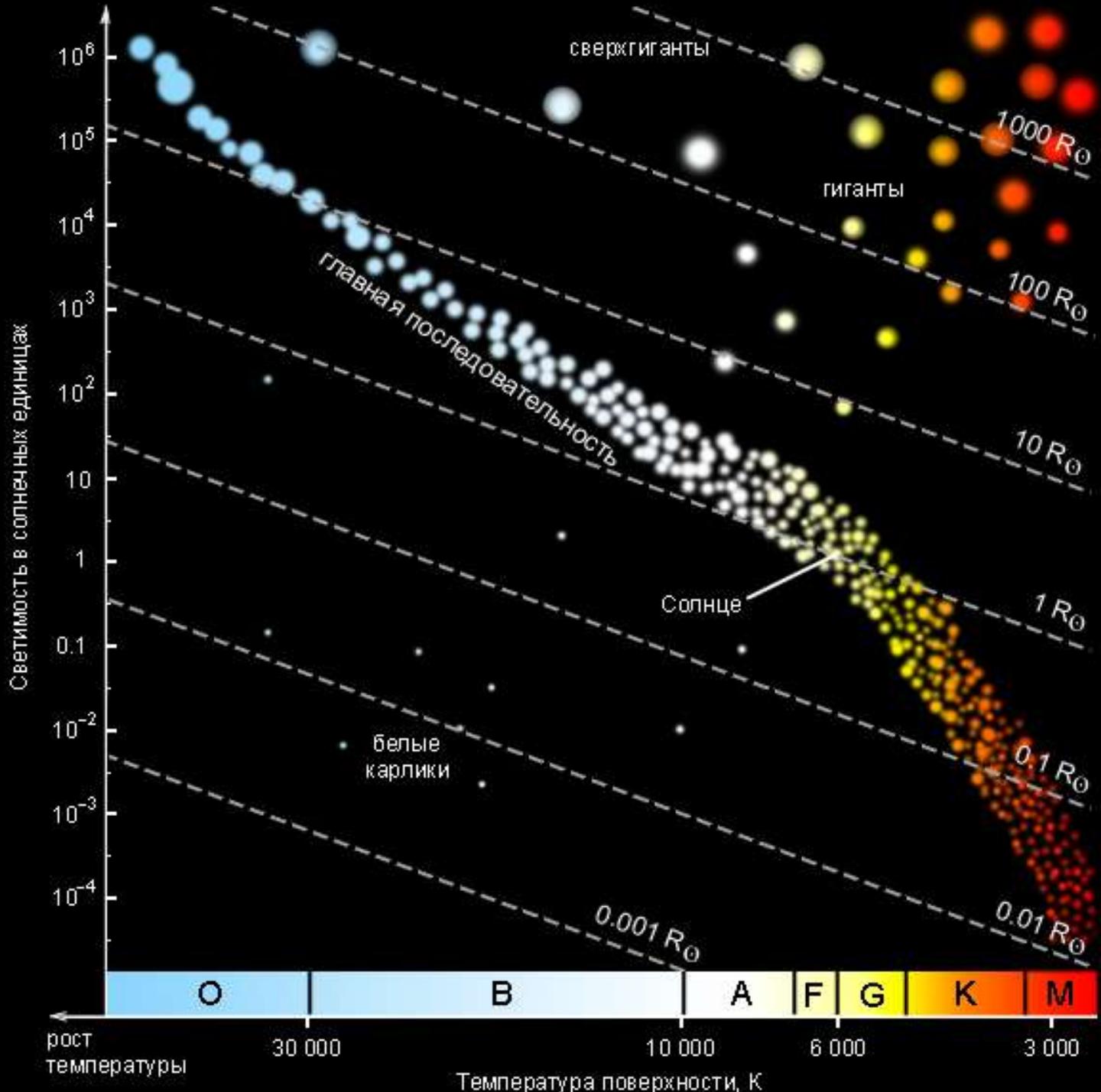
F. A. Aharonian and A M Atoyan

J. Phys. G: Nucl. Pan. Phys. **17 (1991) 1769-1778.**

A. Eungwanichayapant and F. A. Aharonian

0907.2971v1 [astro-ph.HE]

After discovery of TeV binaries like LS5039 and LSI 61 by HESS/Magic/VERITAS in which the powerful production of high and very high energy gamma-rays is accompanied by their absorption (which leads to the modulation of the gamma-ray signal), it is clear that these objects are also sources of electron-positron pairs.



Концентрация звезд в Галактике, на которых наблюдаются вспышки, равна ~ 0.056 звезд/пс³.

Концентрация всех звезд только в ~ 2 раза выше этой величины (~ 0.133 звезд/пс³).

(Р.Е. Гершберг «Активность солнечного типа звезд главной последовательности», изд-во Астропринт, Одесса, 2002 г., 688 стр.)

Карликовые звезды – звезды главной последовательности спектральных классов G – M.

(красный карлик AU Mic находится на расстоянии $r = 10$ пс от Солнца, $T = 4 \times 10^7$ К) ----

Температура – (7000 – 2500) К

Масса – (1 – 0.06) M

Радиус – (1 – 0.1) R

Светимость – (2 – 0.0008) L

($L = 3.86 \times 10^{33}$ эрг/с)

Во время вспышек на красных карликах оптическая светимость звезды увеличивается в несколько раз. Полная энергия оптического диапазона увеличивается до $\sim 10^{35}$ эрг. Длительность звездных вспышек – от долей секунд до десятков часов.

Например, вспышка 15 июля 1992 г. на AU Mic длилась ~ 2 часа и энергия, которая выделилась за 2 часа в ультрафиолете (65-190 Å) была равна 3×10^{34} эрг. Через сутки наблюдалась следующая вспышка с полной энергией EUV 2×10^{33} эрг.

AU Mic имеет следующие характеристики: $r = 9.9$ пк, имеются пятна, $(R_{AU} / R) \approx 0.39$, $(M_{AU} / M) \approx 0.52$, $\log L_{AU} \approx 32.38$.

Зарегистрировано более 1200 вспыхивающих звезд с числом вспышек более 4000. На UV Get ~ каждый час происходит вспышка.

UV Get имеет следующие характеристики: $r = 2.7$ пс, имеются пятна, $(R_{UV}/R) \approx 0.16$, $(M_{UV}/M) \approx 0.1$, $\log L_{UV} \approx 30.91$.

Вспышечная активность Солнца на ~ 4 порядка величины ниже, чем у самых активных карликов. Полная энергия солнечной вспышки 4 августа 1972 г. оценивается равной 2×10^{32} эрг.

Полная энергия мощных звездных вспышек может достигать значений до 3×10^{36} эрг.

В Галактике плотность энергий

$$w_H \approx w_\Gamma \approx w_{\text{КЛ}} \approx 0.5 \text{ эВ/см}^3.$$

Полная энергия КЛ равна $W_{\text{КЛ}} = w_{\text{КЛ}} \times V_{\text{Гал}} \approx 10^{54}$ эрг,
где $V_{\text{Гал}} = 5 \times 10^{66} \text{ см}^3$ – объем диска Галактики.

$$W_{\text{КЛ}} = P_{\text{ист}} \times \tau \times n_{\text{КЛ}} \approx 10^{54} \text{ эрг.}$$

Средняя мощность 1 вспышки в КЛ на красном карлике $\approx 10^{35}$ эрг. Пусть вспышки происходят 1 раз в 3.5 дня. Тогда $P_{\text{ист}} \approx 10^{37}$ эрг/год.

Число источников КЛ: $n_{\text{КЛ}} = k \times N = 2 \times 10^{10}$, где

$N = 2 \times 10^{11}$ – число звезд в нашей Галактике,

$k = 0.1$ - коэффициент. Время жизни КЛ в Галактике

$\tau \approx 10^7$ лет.

Тогда от вспышек на красных карликах имеем

$$W_{\text{КЛ}} = P_{\text{ист}} \times \tau \times n_{\text{КЛ}} \approx (10^{37} \text{ эрг/год}) \times (10^7 \text{ лет}) \times (2 \times 10^{10})$$

$$W_{\text{КЛ}} \approx 10^{54} \text{ эрг.}$$

Спектр КЛ в сверхновых $N(E) = A/E^\gamma$,

где $\gamma_{\text{кл}} \approx 2.2$, $\gamma_{\text{эл}} \approx 2.2$.

В Галактике за время $\sim 10^7$ лет $\gamma_{\text{кл}} = 2.7$ и

$\Delta \gamma_{\text{кл}} \approx 0.5$. Для электронов $\gamma_{\text{эл}} \approx 3.2$, т.е.

$\Delta \gamma_{\text{эл}} \approx 1$.

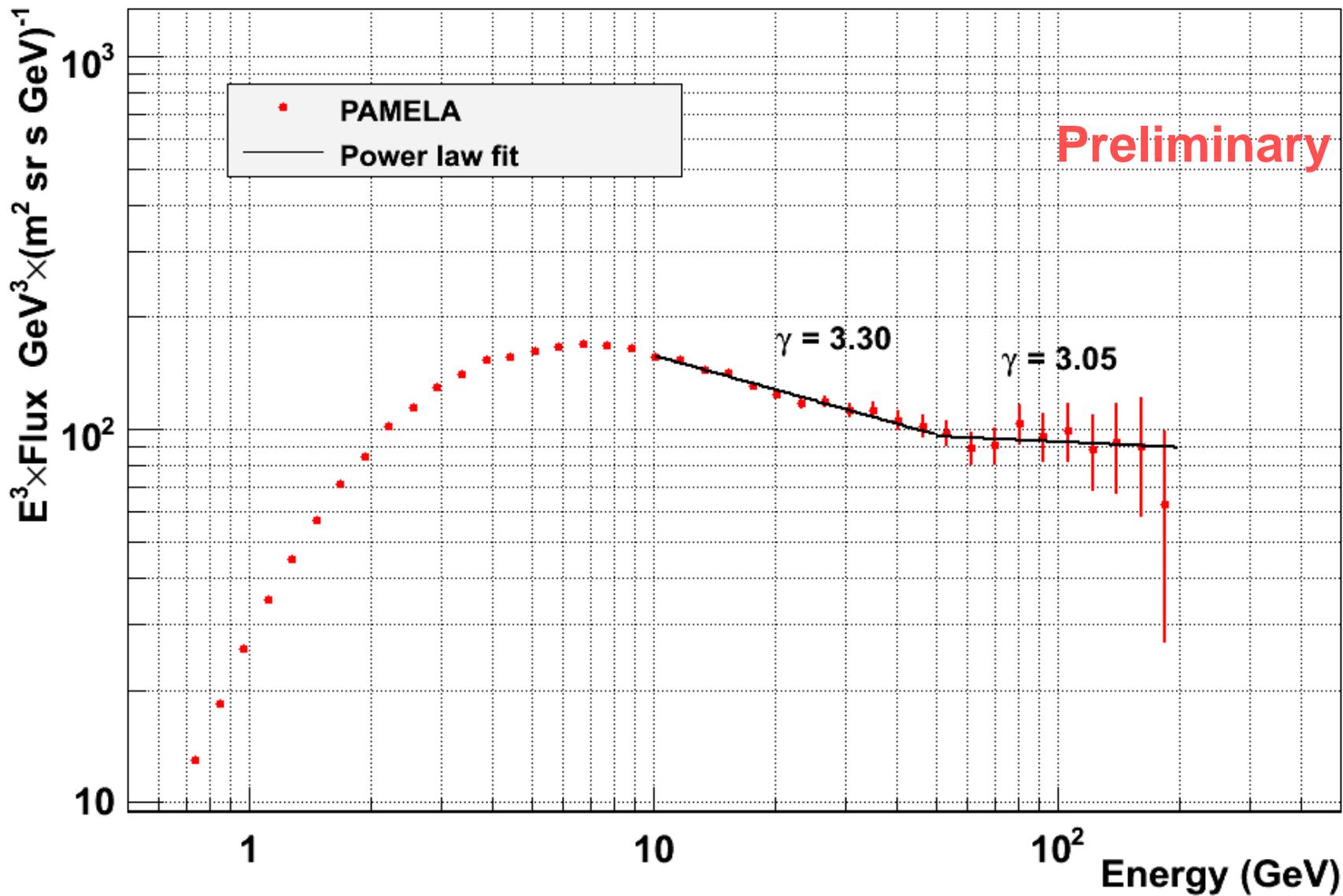
Спектр позитронов и электронов, рождаемых Галактике в результате взаимодействий КЛ с межзвездным газом, имеет $\gamma_e \approx 2.7$. Принимая, что для позитронов $\Delta \gamma_{\text{поз}} \approx 1$, спектр позитронов будет иметь $\gamma_{\text{поз}} \approx 3.7$. Отношение потока позитронов к потоку электронов будет падать с ростом энергии частиц.

Если спектр частиц, ускоренных во вспышках на красных карликах, имеет вид $N(E) = A/E^\gamma$, где $\gamma_{\text{кар}} \approx 2.2$, тогда спектр вторичных позитронов будет иметь $\gamma_{\text{поз}} \approx 2.2$. При распространении в Галактике $\Delta \gamma_{\text{поз}} \approx 1$ и $\gamma_{\text{поз}} \approx 3.2$. Т.е. в Галактике для позитронов от красных карликов отношение потока позитронов к потоку электронов не будет зависеть от энергии частиц.

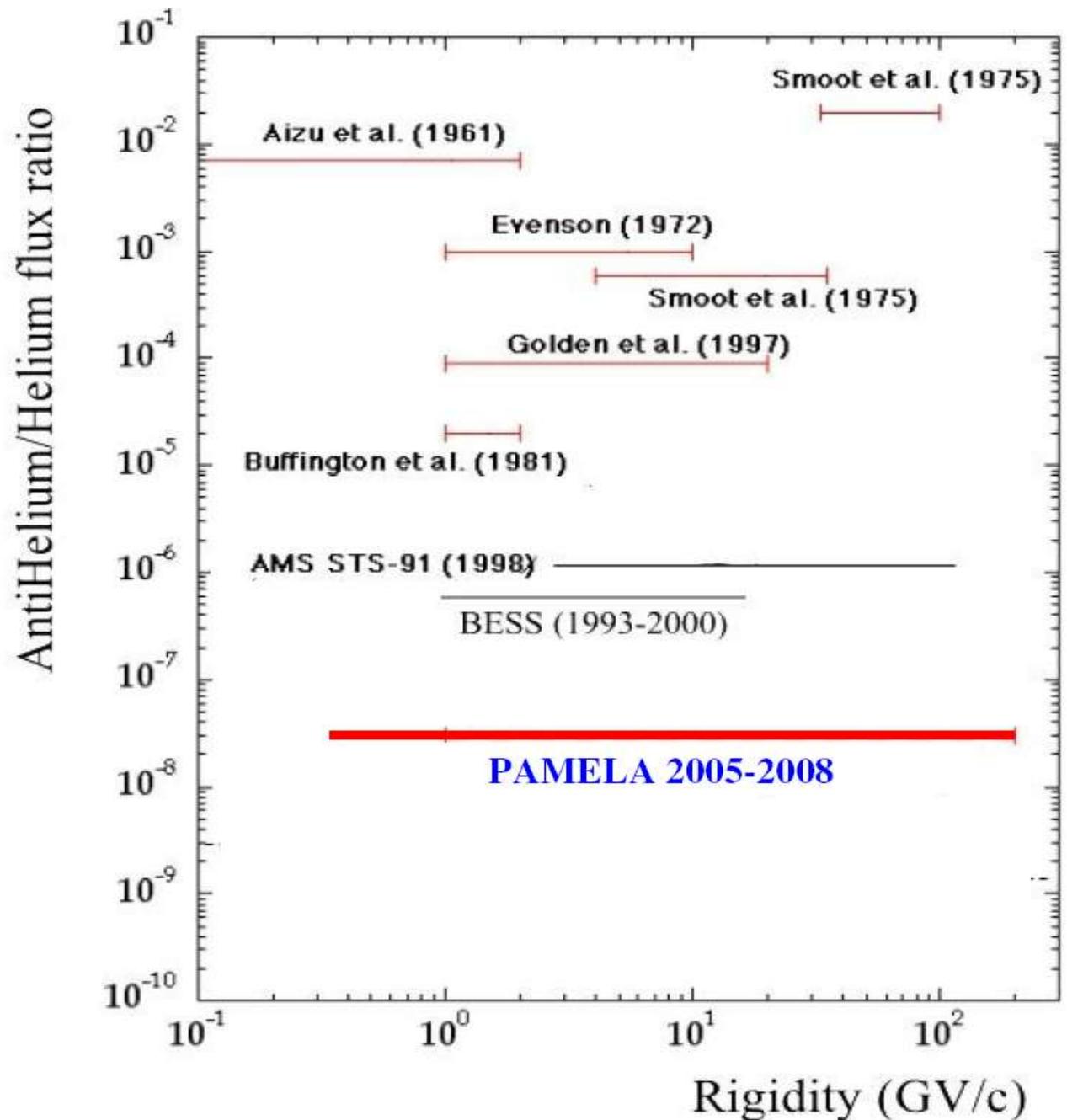
Рост отношения $e^+/(e^- + e^+)$ при энергиях $E > \sim 5 \text{ GeV}$ можно объяснить образованием дополнительного потока позитронов в звездных вспышках на красных карликах через процесс взаимодействия с веществом звезды ускоренных во вспышке протонов с образованием π^+ и последующего их распада: $\pi^+ \rightarrow \mu^+ e^+$.

В этом случае отношение $e^+/(e^- + e^+)$ будет расти с увеличением энергии E и иметь максимум при $E \sim (100-300) \text{ ГэВ}$. После этой энергии отношение $e^+/(e^- + e^+)$ будет падать, т.к. максимальная энергия частиц ускоренных во вспышках на красных карликах вряд ли превосходит 10^{13} эВ .

PAMELA Electron Flux



Антиматерия



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ВЫСОКОЭНЕРГИЧНЫЕ ЭЛЕКТРОНЫ

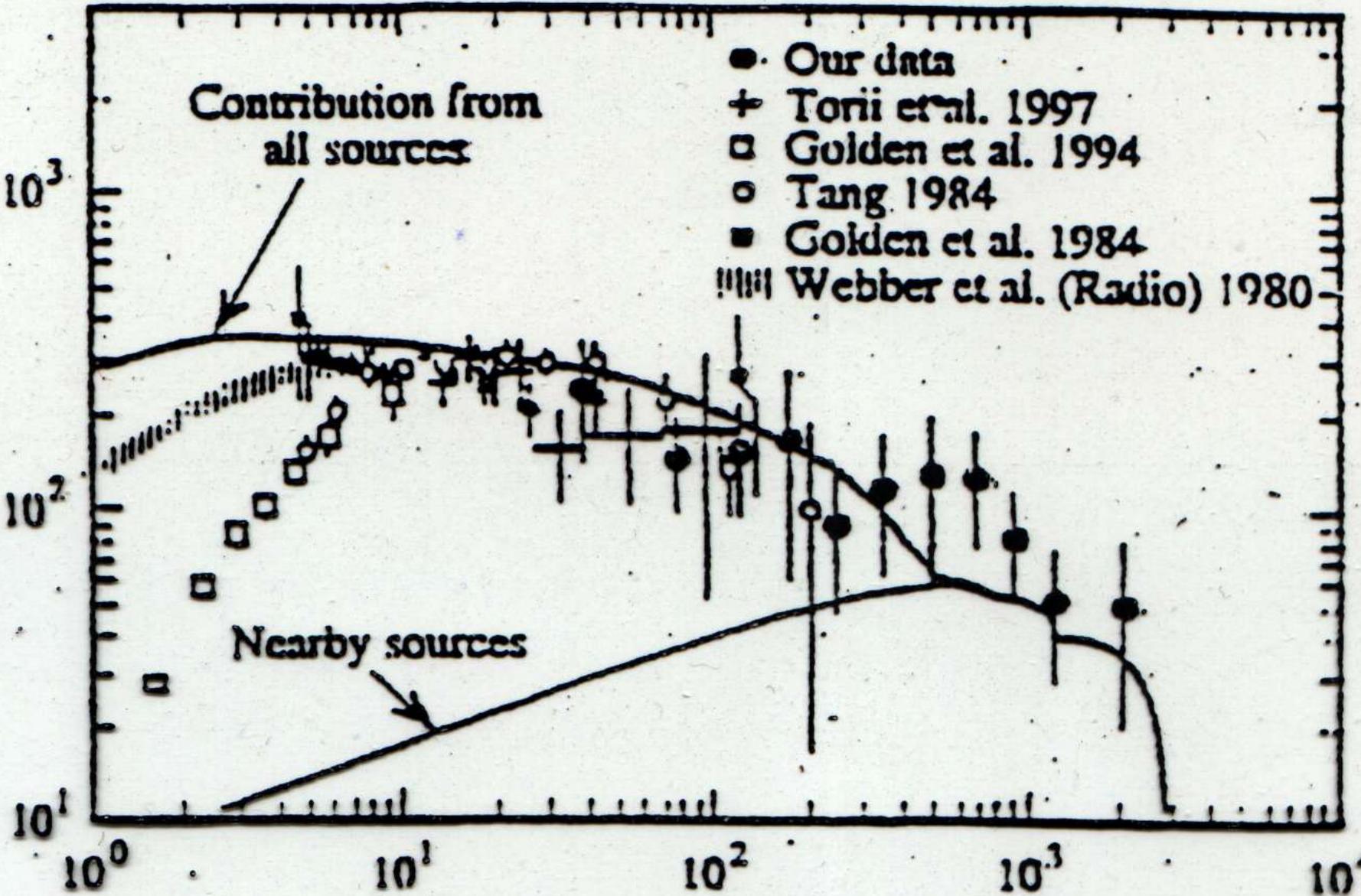
- Высокоэнергичные электроны дают информацию о близких источниках космических лучей, находящихся на расстояниях менее нескольких сотен парсек.
- Электроны с энергией больше 10^{12} эВ быстро теряют ее из-за синхротронных потерь и обратного комптоновского рассеяния.
- Обнаружение первичных электронов с энергией больше 10^{12} эВ будет свидетельствовать о существовании источника (источников) космических лучей в ближней межзвездной среде ($r \leq 400$ пс)

$E^3 \times J$ (electrons/m² · sec · s: GeV⁻²)

- Our data
- + Torii et al. 1997
- Golden et al. 1994
- Tang 1984
- Golden et al. 1984
- |||| Webber et al. (Radio) 1980

Contribution from
all sources

Nearby sources



ENERGY (GeV)

Электроны с энергией $E \geq 10^{12}$ эВ

- - $(dE_e/dx) \sim (w_{ph} + w_H) \cdot E_e^2$
 $w_{ph} = 0.75$ эВ $H = 6.7 \cdot 10^{-6}$ Гс
- $t(E_e/2) = (2.3 \cdot 10^5)/E_e$,
где $[t] =$ годы, $[E_e] =$ ТэВ
- $r = [2D(E_e) \cdot t]^{0.5}$
 $D(E_e) = 10^{28} \cdot E_e^\delta$ см²/с
 $\delta = (0.3 - 0.7)$ $[E_e] =$ ГэВ

Электроны с энергией $E \geq 1$ ТэВ

E_e , ТэВ	1	10	100
T, годы	$2.3 \cdot 10^5$	$2.3 \cdot 10^4$	$2.3 \cdot 10^3$
D, см ² /с	$8 \cdot 10^{28}$	$1.5 \cdot 10^{29}$	$3.1 \cdot 10^{29}$
r, пс	400	200	100

В эксперименте ПАМЕЛА

- Для отбора электронов используются данные трекера (ТРК, траектория и заряд частицы), калориметра (КАЛО, каскадная кривая, энергия частицы) и нейтронного детектора (НД, разделение электромагнитных и ядерных каскадов).
- Имеется 2 ряда данных :
 1. ТРК + КАЛО + НД (электроны с $E \geq 100$ ГэВ)
 2. КАЛО + НД (электроны с $E \geq 300$ ГэВ)

При взаимодействии протона с $E_p = 300$ ГэВ с ядром вольфрама образуются сильно ионизирующие частицы $\langle n_h \rangle = 12.9 \pm 1.2$, ливневые частицы $\langle n_s \rangle = 18.6 \pm 1.5$ и средний угол образовавшихся ливневых частиц $\langle \tan(\theta/2) \rangle = 2.83 \pm 0.06$, где θ - угол в лабораторной системе координат

(эксперимент в лаборатории Ферми. J.R. Floricen et al. Interaction of 300 GeV protons with tungsten and chromium. Phys. Rev. D13, 1976, 558-565, Issues February 1976).

- **W:** $Z = 74$ $A = 183.84$ $\rho = 19.3 \text{ г/см}^3$
 $\Lambda_1 = 189.7 \text{ г/см}^2$
 $X_o = 6.76 \text{ г/см}^2 = 0.35 \text{ см}$

- **Pb:** $Z = 78$ $A = 207.2$ $\rho = 11.35 \text{ г/см}^3$
 $\Lambda_1 = 194 \text{ г/см}^2$
 $X_o = 6.37 \text{ г/см}^2 = 0.56 \text{ см}$

- **Калориметр:** Вес 110 кг $24*24*5.72 \text{ см}^3$
22 W пластины (0.26 см or 5.018 г/см^2 ;
 $0.74 X_o$ or $0.027 \Lambda_1$)
Всего: $16.3 X_o$ или $0.6 \Lambda_1$
 $1 \Lambda_1 = 37.8$ пластины

Спектр галактических протонов:

$$J_p(E) = kE^\gamma \quad 1/(\text{м}^2 \text{ с ср ГэВ})$$

$$[E] - \text{ГэВ}; \quad K = 14900 \pm 600; \quad \gamma = 2.74 \pm 0.01$$

$$\text{Для } E \geq 20 \text{ ГэВ} \quad J_p(E) = 1.49 \cdot 10^4 / E^{2.74}$$

(Т.К. Gaisser, M. Honda, R. Lipari, and T. Stanev. Primary spectrum to 1 TeV and beyond. Proc. 27-th of ICRC, 2001).

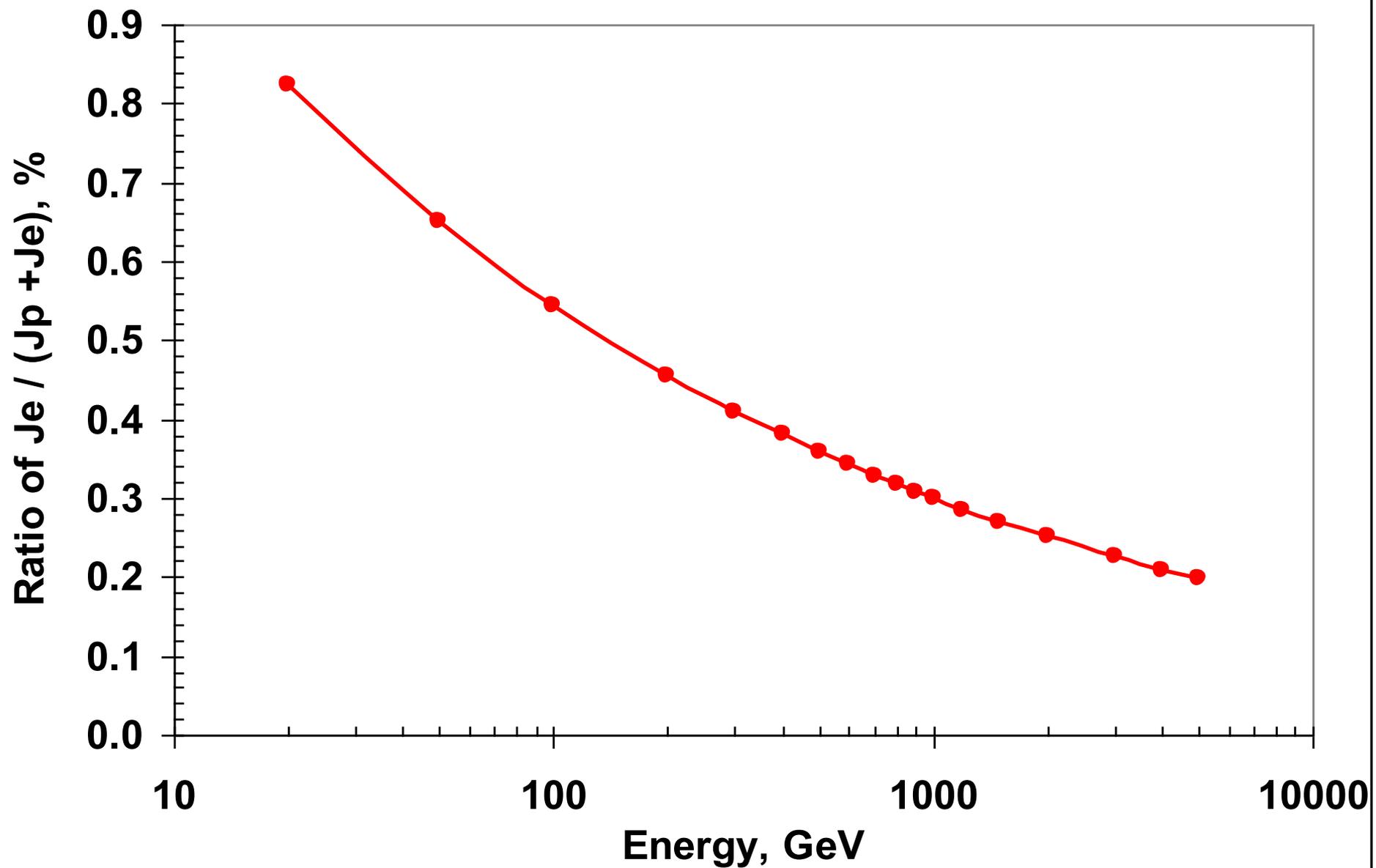
Спектр галактических электронов:

$$J_e(E) = kE^\gamma \quad 1/(\text{м}^2 \text{ с ср ГэВ})$$

$$[E] - \text{ГэВ}; \quad K = 270; \quad \gamma = 3$$

$$\text{Для } E \geq 20 \text{ ГэВ} \quad J_e(E) = 2.7 \cdot 10^2 / E^3$$

(Лучи космические галактические (энергетические спектры), ГОСТ 25645.122-85 - ГОСТ 25645.125-85, Госкомитет по стандартам, СССР, Москва.1986).



Основная трудность – разделение электронов и протонов.

Для выделения электронов из полного потока частиц мы использовали следующие критерии отбора электронов:

1. Взаимодействие в (1-3) слоях W ;
2. Число нейтронов n в каскаде КАЛО должно удовлетворять соотношению $n \leq 3 \cdot 10^{-5} Q_t + 2$, где Q_t – энергия, выделенная в КАЛО;
3. Для электронов отношение $A = (S_1/S_2) \geq 0.5$, где S_1 и S_2 есть площади под каскадной кривой от ее начала до максимума (S_1) и от максимума до ее конца в калориметре (S_2);
4. Каскадная кривая должна быть гладкой и иметь один максимум.

Фит каскадной кривой в КАЛО

$$N(x) = N_m \exp[-2(x - x_m)^2 / (d(x + kx_m))],$$

где N_m и x_m – максимум числа частиц каскадной кривой (N_m) и положение этого максимума (x_m), d и k являются вычисляемыми параметрами.

(C. Song for HIREs collaboration. Study of the longitudinal development of air shower with CORSICA. Proc. of ICRC, 2001, Hamburg, Germany, HE, 490-494).

$$(dE/dt) = E_0 b [(bt)^{a-1}]^* \exp(-bt) / \Gamma(a),$$

где t – число радиационных единиц, E_0 – полная энергия каскада, b и a – параметры, определяемые из выражений $[(a-1)/b] = \ln (E_0/E_k) + C$, E_k – критическая энергия, равная, $C = -0.5$ для электронных каскадов и $C = 0.5$ для каскадов, образуемых гамма-квантами, $\Gamma(a)$ – гамма-функция.

(The European Physical Journal C15, 1-878 (2000); Review of Particle Physics).

E, relative units

0.10
0.08
0.06
0.04
0.02
0.00

0

5

10

15

20

t, radiation length

$E_e = 180 \text{ GeV}$

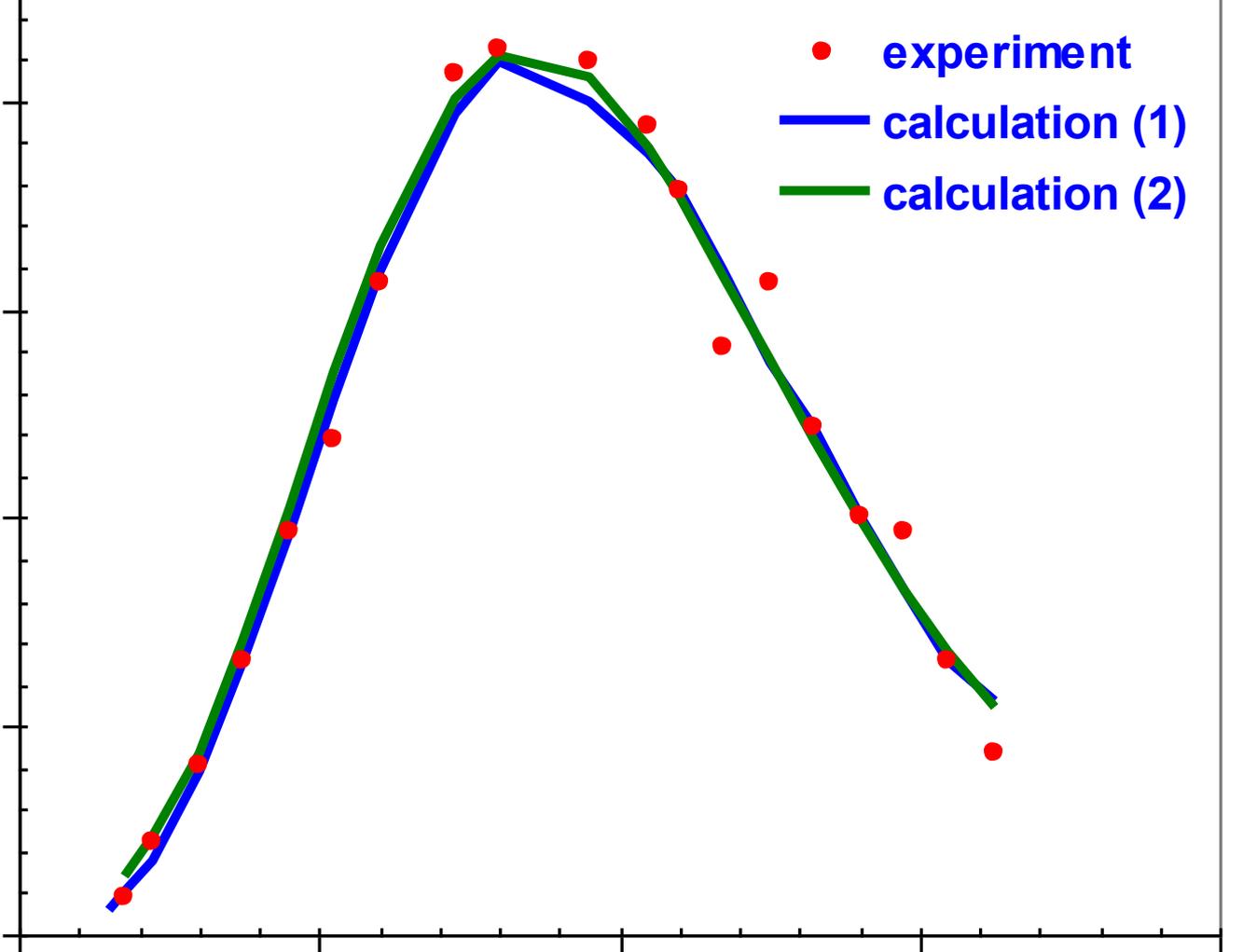
• **experiment**

— **calculation (1)**

— **calculation (2)**

$k = 0.83$

$d = 2 \text{ g/cm}^2$



Определение энергии частицы

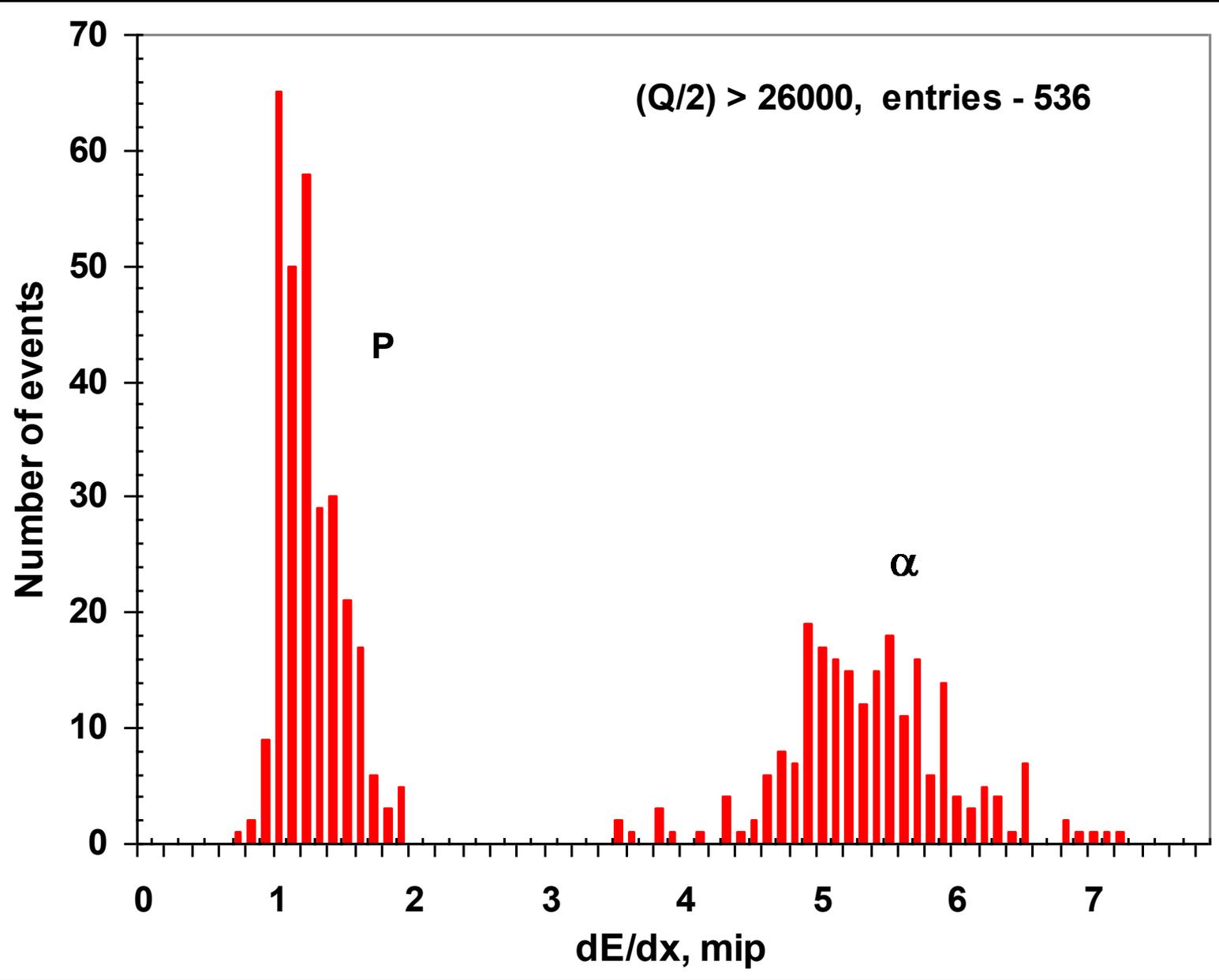
Электроны

Из полной площади каскадной кривой $(Q_{\text{tot}}/2)_{\text{fit}}$:
1 ГэВ = 138.1 ± 13.8 mip

Из числа частиц в максимуме каскадной кривой
(N_{max}): 1 ГэВ = 11.14 mip

Протоны

Из полной площади каскадной кривой $(Q_{\text{tot}}/2)_{\text{fit}}$
1 ГэВ ≈ 48 mip



Events selection

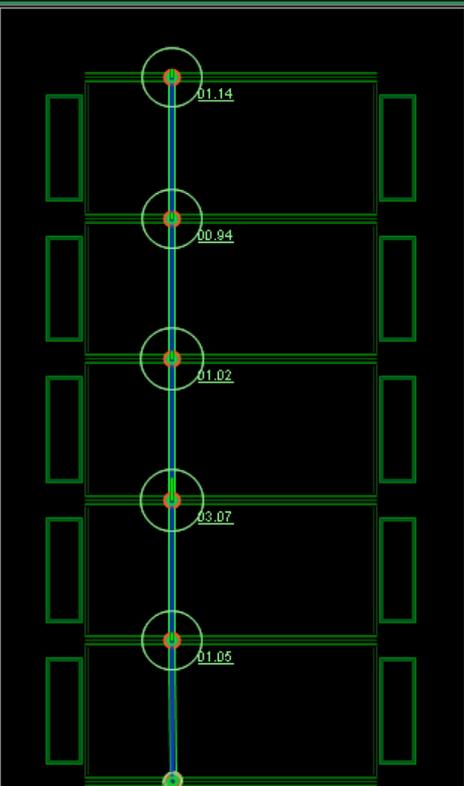
(example: L2PAM060727c, 2074940 events)

1. Calorimeter ($Q_t/2 > 13\ 000$ mip) – 5171
2. Tracker (> 0) – 947
3. Tan x (-0.5;+0.5) – 492
4. Tan y (-0.4;+0.4) – 223
5. Neutron number (< 20) – 110
6. Charge $Z = 1$ ($dE/dx < 3$) - 74

**The visual inspection and analysis is made for
selected 74 events**

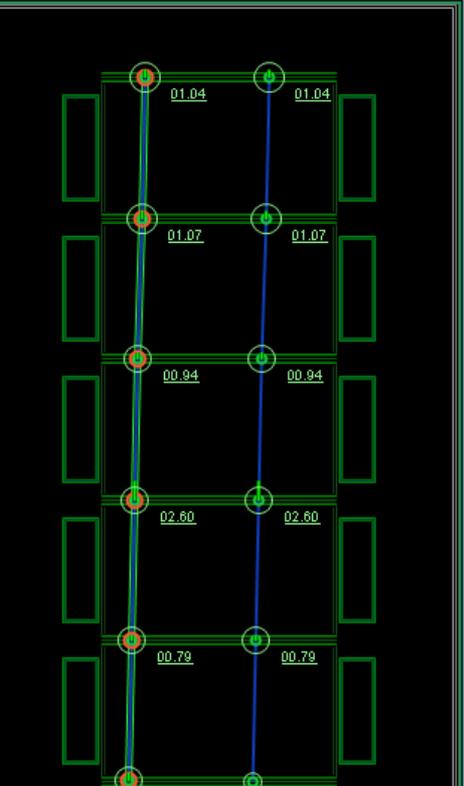
Flight date: 25.07.2006 Entry number: 903442

Event viewer _ □ ×



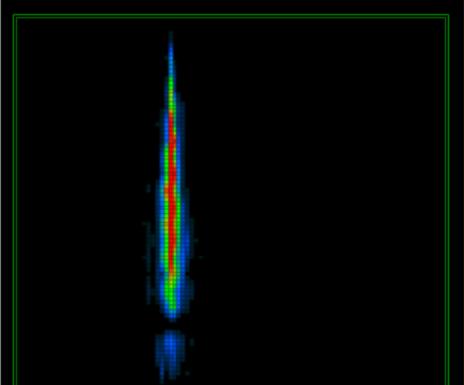
```

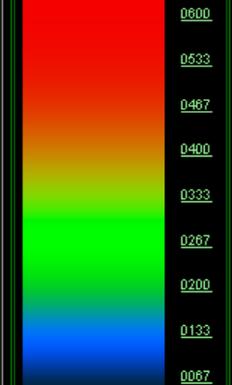
tracker
summary information
n-tracks 2 n-singlets 0
summary mips left 0.00
x-view n 0 mips 0.00
y-view n 0 mips 0.00
track details
selected track 0
base sum 5 x 5 y 6
fit chi-square 12.9148
<dEdx>, mips 1.35
rigidity 126.1 deflection -0.01
charge sign negative
ToF system
beta 1.028 direction down
<dEdx>, mips 0.00
s4 detector
energy release, mips 172.03
neutron detector
event 1 upper 11 bottom 10
calorimeter
summary information
half q-total, mips 26696
n-hits s 1377 x 667 y 690
released mips sum/2 26696
x-view 26005 y-view 27387
saturated sum 0 x 0 y 0
qx22 465.6 nx22 30
xplm 11 yplm 14 slf.trig true
Gev(e) 275.20 error 32.97
selected strip
view X plane 00 strip 00
mips left 00000 saturated
plots helpers
          
```

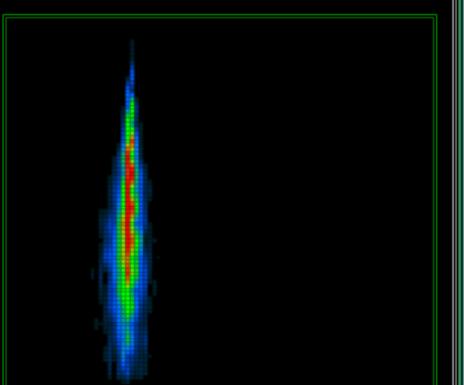


```

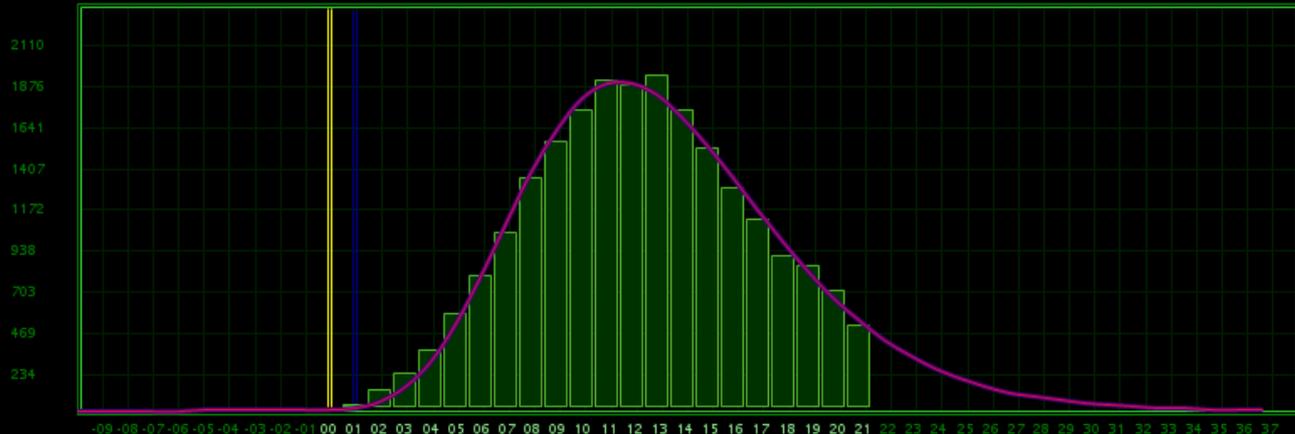
current file summary
file name L2PAM060725c.root date 25.07.2006
total events 1775280 inflight time 80292
lifetime n/a deadtime n/a Calculate
file position (entries explore)
current entry 903442
event layering
event layers # 04 name tan Y
comment no comment
size 221 time 1000000 ms
part 00.00 % flux 00.0000 e/(s g)
current subentry 124.221
manual layer filtering
Add current event Delete current event Reset current layer
layer management utilities
Open layers manager Update layers content Browse files
event quick search
quick search criteria cl-qtot 100000
current event summary information
orbital information
packet number 4756103 latitude, deg 19.992
absolute time, s 1153838375 longitude, deg 162.287
board time, ms 175584618 altitude, km 392.831
GM time 14:39:35 L-shell, radii 1.078
GMC rigidity 12.833 B-abs, gauss 0.294
trigger information
runevent 2061 livetime 52 deadtime 9
rates top 18 middle 2 bottom 6
trigger rates 55 26 88 32 123 112
s4+calorimeter rates 17 0 trigger config CALO
horus database quick info
current user owner task abstract order 1
record no recs N? -- created --
owner -- task --
code ID -- filtering order -- access level --
calorimeter data analysis utilities
Cascade curve analysis Cascade plane profiles Update data
ASC-II formatted data output
Save event Save layer
Show file content Preferences
additional actions
Change user data Show ROOT console Spectrum database
Time variations plotting Histogram plots Table designer
Open database explorer Configuration Leave event viewer
          
```



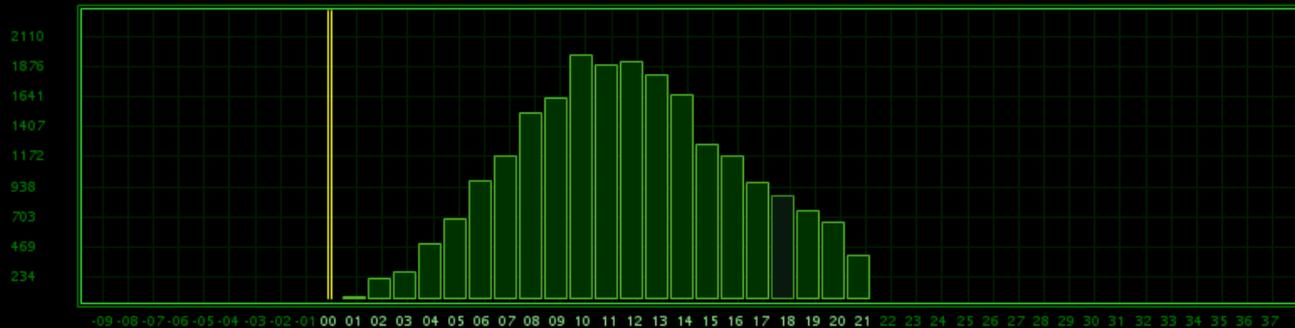




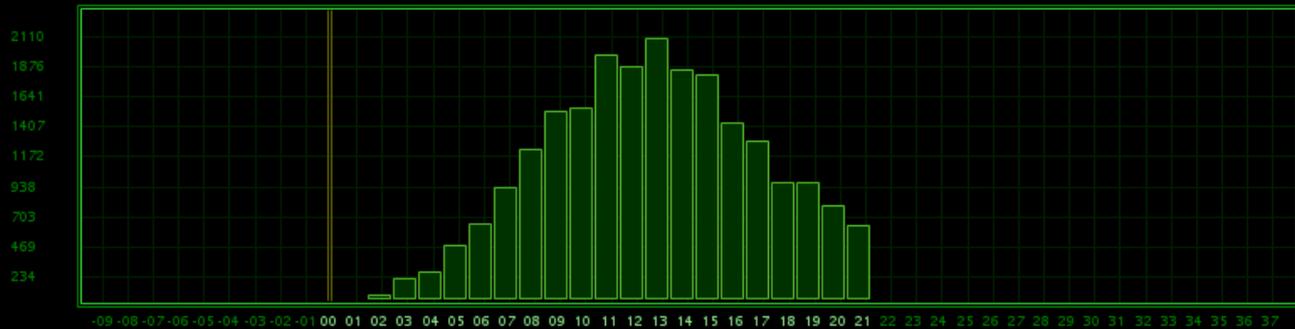
summary cascade curve



x-view cascade curve



y-view cascade curve



planes treatment tools

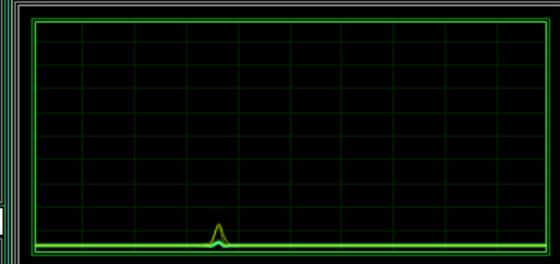
summary curve cursor

plane **00** source mips 17.59 fit mips 00000.00
 x-mips 34.28 y-mips 0.89 [x/y] ratio 3833.4
 [Left Arrow] [Right Arrow] [Green Plus] Include plane [Red Minus] Exclude plane [Blue Refresh] Reset

x-view curve cursor

plane **00** mips 34.28 hits 0 confidence --
 parametric quality (chi2) -- passes done --
 q.core -- w.core -- q.pvm -- w.pvm --

slice profile



[Left Arrow] [Right Arrow] Middle average [Another View Icon] Another view [Blue Refresh] Reset

cascade curve approximation

primary cascade parameters

x-max 11.53 [Up Arrow] 0.250 [Down Arrow] [Lock Icon] 1st impact 1 [Lock Icon]
 q-max 2344.45 [Up Arrow] 95.850 [Down Arrow] [Lock Icon] passes to do 10 [Up Arrow]
 K 0.9602 [Up Arrow] 0.00010 [Down Arrow] [Lock Icon] passes done 3840 [Down Arrow]
 D 4.5782 [Up Arrow] 0.01000 [Down Arrow] [Lock Icon] ... chi^2 58.51524 [Down Arrow]

secondary cascade parameters actions

[Sun Icon] [Green Plus] Include plane [Red Minus] Exclude plane [Initial Values Icon] Initial values
 x.s 00.00 [Up Arrow] q.s 00.00 [Up Arrow] w.s 00.000 [Up Arrow] [Approximate Icon] Approximate

resulting data (level.3)

l2 summary mips 26696 half-quot mips 26696
 profiled mips 27212 x 27037 y 27387 ratio 98.7
 integral mips 29153 restoration increment 109.20
 attack 11811.777 decay n/a sustain n/a
 release 17341.599 cascade asymmetry 0.681

approximation logger

chi^2 course [Recall pass Icon] Recall pass
 selected pass 00
 chi^2 value 00.000000

additional actions
 [Blue Refresh] Reset all fits [Smooth Curve Icon] Smooth curve [Pass LNF analysis Icon] Pass LNF analysis
 [Save ASC-II Icon] Save ASC-II [Add to DB Icon] Add to DB [DB manager Icon] DB manager [Exit Icon] Exit

Electron: neutrons - 1 $C = 2.74$ $A = 0.63$ $E \approx 210 \text{ GeV}$

Calorimeter strip analysis

cascade course profile x-view planes y-view planes

selected plane summary plane : 1

s-mips : 2359.21	s-hits : 0	s-sat : 0
x-mips : 2307.19	x-hits : 0	x-sat : 0
y-mips : 2411.22	y-hits : 0	y-sat : 0

selected strip summary [x-view] [plane:11] [strip:95]

mips:0000.00	good	w:0.0000	a:n/a
--------------	------	----------	-------

region selection [00]-[95]

Plane Strip section Region toggle Strip toggle

crosstalk effect parameters

parameters	delta 0.0270	offset 38	Details
------------	--------------	-----------	---------

plane profile approximation

profile fit curves plotting Affected curve Normal curve

sk:34.25	q:0771.73	qp:077.58	wc:00.640	wp:00.924
----------	-----------	-----------	-----------	-----------

chi:10.3198 2.743 passes to do 5 repeats to do 5

Initial parameters Approximate all Approximate plane

Middle average Smooth parameters Pass LNF analysis

Discard all Discard qualification Qualify current profile

additional analysis

Profile course Cscd. curve Sec. cscds. Particle ID

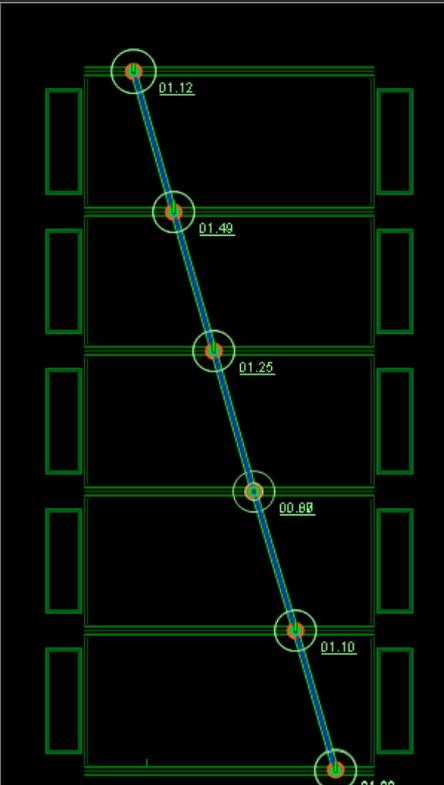
work results management

Prof Fits Add to the database DB manager

Save all results in ASC-II format Leave cascade analysis

Flight date: 25.07.2006 Entry number: 192647

Event viewer



01.12
01.48
01.24
00.88
01.10
01.08

tracker

summary information

n-tracks 2 n-singlets 2
summary mips left 1.68
x-view n 1 mips 0.87
y-view n 1 mips 0.82

track details

selected track 0
base sum 5 x 6 y 5
fit chi-square 0.5262
<dEdx>, mips 1.14
rigidity 143.8 deflection 0.01
charge sign positive

ToF system

beta 0.934 direction down
<dEdx>, mips 0.00

s4 detector

energy release, mips 447.37

neutron detector

event 3 upper 2 bottom 2

calorimeter

summary information

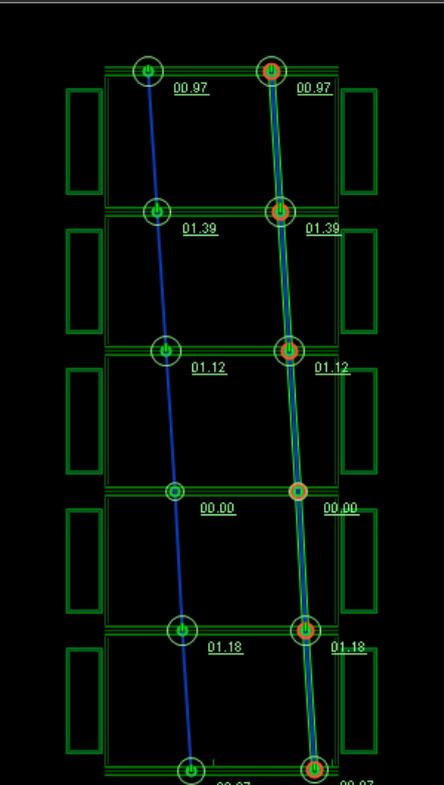
half q-total, mips 43750
n-hits s 1266 x 561 y 208
released mips sum/2 42931
x-view 4184 y-view 43820
saturated sum 12 x 7 y 5
qx22 468.5 nx22 34
xplm 12 yplm 14 sfl.trig true
Gev(e) 572.61 error 68.79

selected strip

view X plane 00 strip 00
mips left 00000 saturated

plots helpers





00.97
01.38
01.12
00.00
01.18
00.97

current file summary

file name L2PAM060725c.root date 25.07.2006
total events 1775280 inflight time 80292
livetime n/a deadtime n/a

file position (entries explore)

current entry 192847

event layering

event layers	#	04	name	tan Y
1	2	3	4	5
6	7	8	9	10

comment .no comment
size 221 time 1000000 ms
part 00.00 % flux 00.0000 e/(s g)

current subentry 32.221

manual layer filtering

layer management utilities

event quick search

quick search criteria cl-qtot

current event summary information

orbital information

packet number	3828780	latitude, deg	-7.423
absolute time, s	1153801444	longitude, deg	132.846
board time, ms	138652372	altitude, km	527.529
GM time	4:24:04	L-shell, radii	1.096
GMC rigidity	12.408	B-abs, gauss	0.335

trigger information

runevent	15082	livetime	61	deadtime	9	
rates top	23	middle	3	bottom	6	
trigger rates	69	19	114	27	144	145
s4+calorimeter rates	22	0	trigger config CALO			

horus database quick info

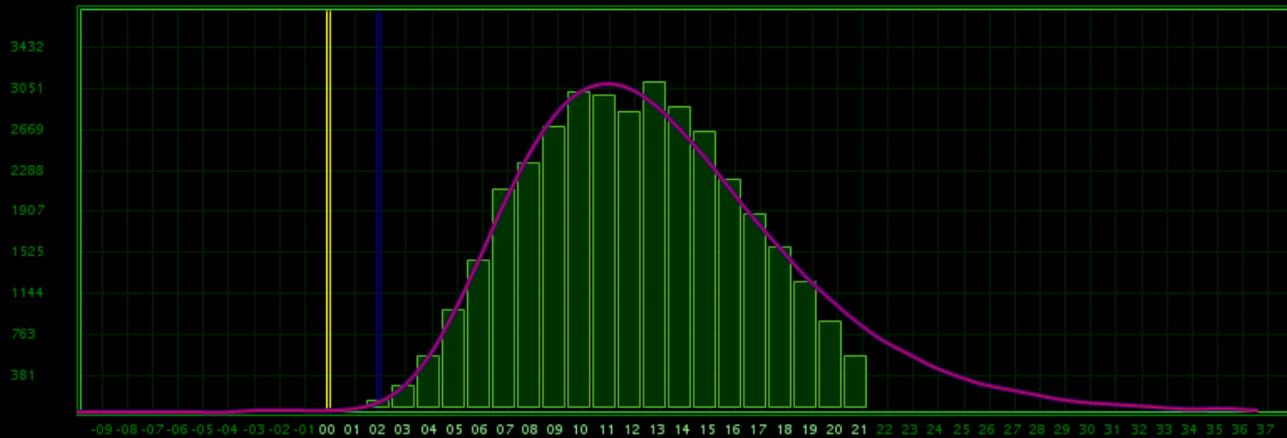
current user	owner	task	abstract	order	1
record	no recs	N?	created	--	
owner	--	task	--	--	
code ID	--	filtering order	--	access level	--

calorimeter data analysis utilities

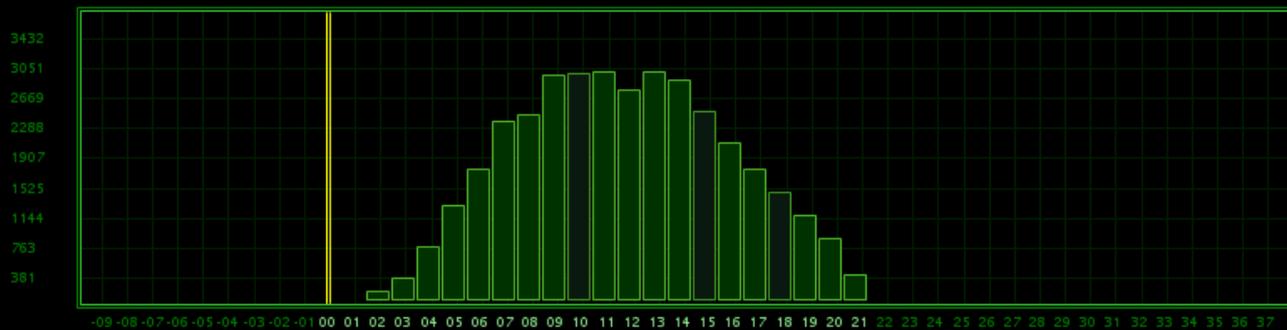
ASC-II formatted data output

additional actions

summary cascade curve



x-view cascade curve



y-view cascade curve



planes treatment tools

summary curve cursor

plane **00** source mips 5.56 fit mips 00000.00
 x-mips 6.84 y-mips 4.28 [x/y] ratio 159.61

← → + Include plane - Exclude plane b Reset

x-view curve cursor

plane **00** mips 6.84 hits 0 confidence --
 parametric quality (chi2) -- passes done --
 q.core -- w.core -- q.pvm -- w.pvm --

slice profile



← → Middle average ↔ Another view b Reset

cascade curve approximation

primary cascade parameters

x-max	11.08	Δ 0.250	1st impact	2
q-max	3813.21	Δ 153.143	passes to do	10
K	0.8898	Δ 0.00010	passes done	3200
D	5.6362	Δ 0.01000	... chi^2	123.4955 E1

secondary cascade parameters

+ Include plane	- Exclude plane	Initial values
x.s 00.00	q.s 00.00	w.s 00.000
Approximate		

resulting data (level.3)

l2 summary mips	42831	half-quot mips	43750
profiled mips	44466	x 45112	y 43820
integral mips	48418	ratio	102.9
attack	20428.733	restoration increment	110.67
release	27989.559	decay	n/a
		sustain	n/a
		cascade asymmetry	0.730

approximation logger

chi^2 course

selected pass **00**
 chi^2 value 00.000000

additional actions

Reset all fits Smooth curve Pass LNF analysis
 Save ASC-II Add to DB DB manager Exit

Calorimeter strip analysis

cascade course profile

x-view planes

y-view planes

selected plane summary plane : 1

s-mips : 3690.19	s-hits : 0	s-sat : 2
x-mips : 3687.78	x-hits : 0	x-sat : 1
y-mips : 3692.59	y-hits : 0	y-sat : 1

selected strip summary [x-view] [plane:11] [strip:00]

mips:0000.00 good w:0.0000 a:n/a

region selection - [00]-[95] - Strip cutter

Plane Strip section Region toggle Strip toggle

crosstalk effect parameters

parameters delta: 0.0270 offset: 38 Defaults

plane profile approximation

profile fit curves plotting Affected curve Normal curve

pk:86.18 qc:0875.69 qp:183.83 wc:00.925 wp:01.007

chi:11.5265 2.558 passes to do 5 repeats to do 5

Initial parameters Approximate all Approximate plane

Middle average Smooth parameters Pass LNF analysis

Discard all Discard qualification Qualify current profile

additional analysis

Profile course Cscd. curve Sec. cscds. Particle ID

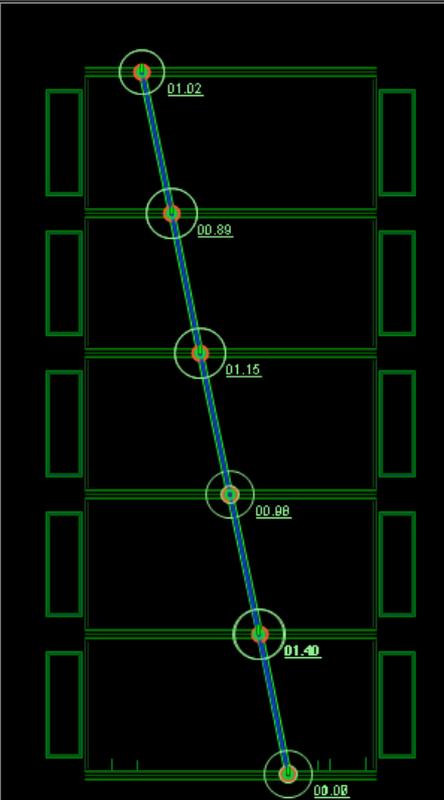
work results management

Prof.Fits Add to the database DB manager

Save all results in ASC-II format Leave cascade analysis

Flight date: 09.07.2006 Entry number: 163665

Event viewer



tracker

summary information

n-tracks 2 n-singlets 14
summary mips left 38.71
x-view n 6 mips 13.01
y-view n 8 mips 25.70

track details

selected track 0

base sum 4 x 5 y 5
fit chi-square 0.6636
<dEdx>, mips 1.09
rigidity 2494. deflection 0.00
charge sign n/a

ToF system

beta 100.00 direction n/a
<dEdx>, mips 0.00

s4 detector

energy release, mips 603.30

neutron detector

event 13 upper 10 bottom 15

calorimeter

summary information

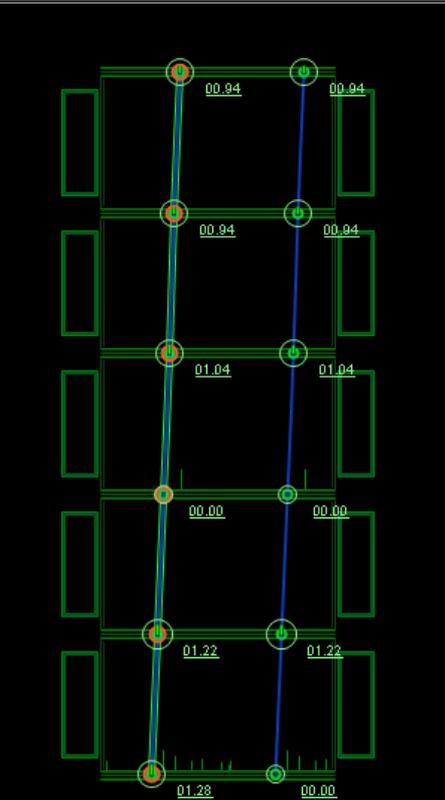
half q-total, mips 20561
n-hits s 1405 x 662 y 793
released mips sum/2 20561
x-view 19437 y-view 21686
saturated sum 0 x 0 y 0
qx22 1043.4 nx22 43
xplm 15 yplm 15 slf.trig true
Gev(e) 180.77 error 21.66

selected strip

view plane 00 strip 00
mips left 00000 saturated

plots helpers





current file summary

file name L2PAM060709c.root date 09.07.2006
total events 456600 inflight time 46955
lifetime n/a deadtime n/a

file position (entries explore)

current entry 163665

event layering

event layers	#	01	name	tan Y
1	2	3	4	5
comment	no comment			
size	55	time	1000000 ms	
part	00.00 %	flux	00.0000 e/(s g)	

current subentry 1355

manual layer filtering

layer management utilities

event quick search

quick search criteria cl-qtot 100000

current event summary information

orbital information

packet number	163963	latitude, deg	-69.101
absolute time, s	1152414811	longitude, deg	-81.605
board time, ms	6542527	altitude, km	607.516
GM time	3:13:31	L-shell, radii	3.371
GMC rigidity	1.311	B-abs, gauss	0.347

trigger information

runevent	21249	lifetime	29	deadtime	10	
rates top	123	middle	29	bottom	40	
trigger rates	195	95	364	128	775	433
s4+calorimeter rates	0	0	trigger config CALO			

horus database quick info

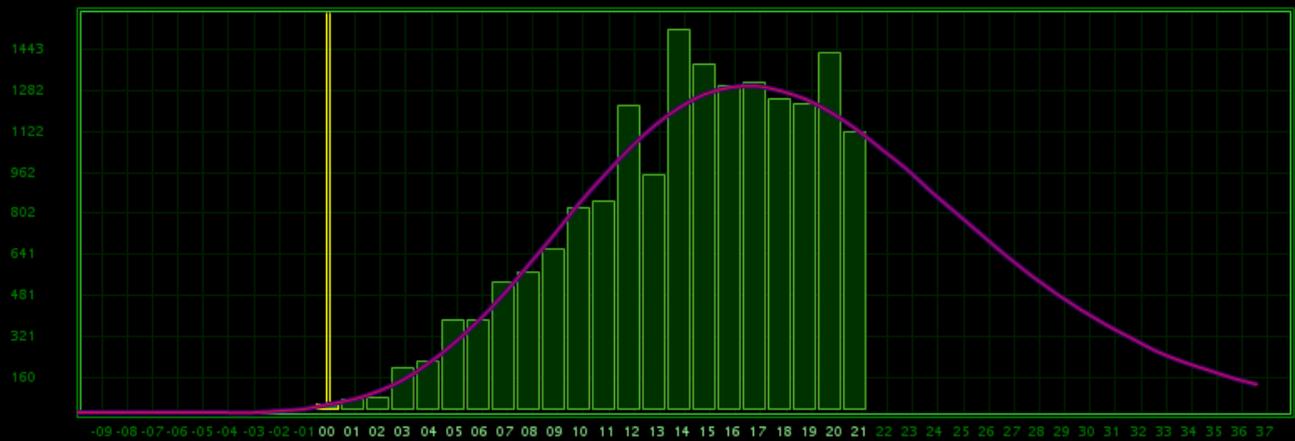
current user	owner	task	abstract	order	1
record	no recs	Nº	created	--	
owner	--	task	--	--	
code ID	--	filtering order	--	access level	--

calorimeter data analysis utilities

ASC-II formatted data output

additional actions

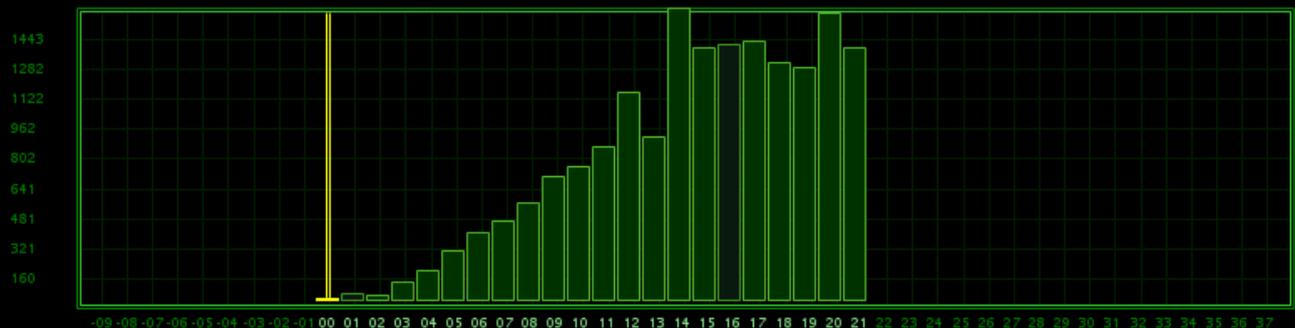
summary cascade curve



x-view cascade curve



y-view cascade curve



planes treatment tools

summary curve cursor

plane 00 source mips 40.80 fit mips 00000.00
 x-mips 40.80 y-mips 40.80 [x/y] ratio 100.00
 [Left Arrow] [Right Arrow] [Include plane] [Exclude plane] [Reset]

y-view curve cursor

plane 00 mips 40.80 hits 0 confidence --
 parametric quality (chi2) -- passes done --
 q.core -- w.core -- q.pvm -- w.pvm --

slice profile



[Left Arrow] [Right Arrow] [Middle average] [Another view] [Reset]

cascade curve approximation

primary cascade parameters

x-max 16.73 Δ 0.250 1st impact 0
 q-max 1603.02 Δ 75.117 passes to do 10
 K 1.7853 Δ 0.00211 passes done 1920
 D 5.0931 Δ 0.01000 ... chi^2 58.8193U

secondary cascade parameters

actions

[Include plane] [Exclude plane] [Initial values]
 x.s 00.00 q.s 00.00 w.s 00.000 [Approximate]

resulting data (level.3)

l2 summary mips 20561 half-quot mips 20561
 profiled mips 21452 x 20908 y 21997 ratio 95.0
 integral mips 31219 restoration increment 151.83
 attack 13183.525 decay n/a sustain n/a
 release 18035.813 cascade asymmetry 0.731

approximation logger

chi^2 course

[Recall pass]
 selected pass 00
 chi^2 value 00.000000

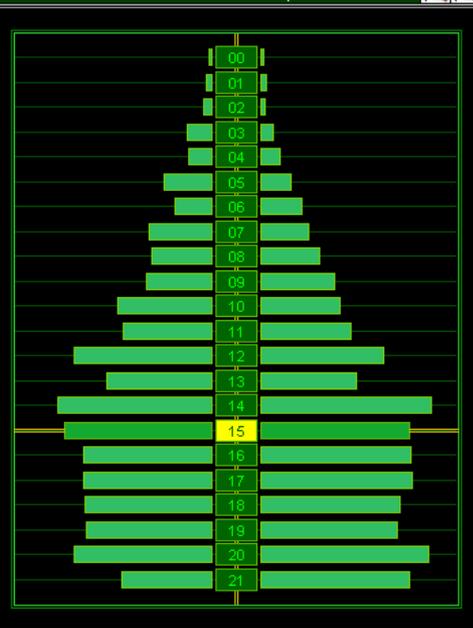
additional actions

[Reset all fits] [Smooth curve] [Pass LNF analysis]
 [Save ASC-II] [Add to DB] [DB manager] [Exit]

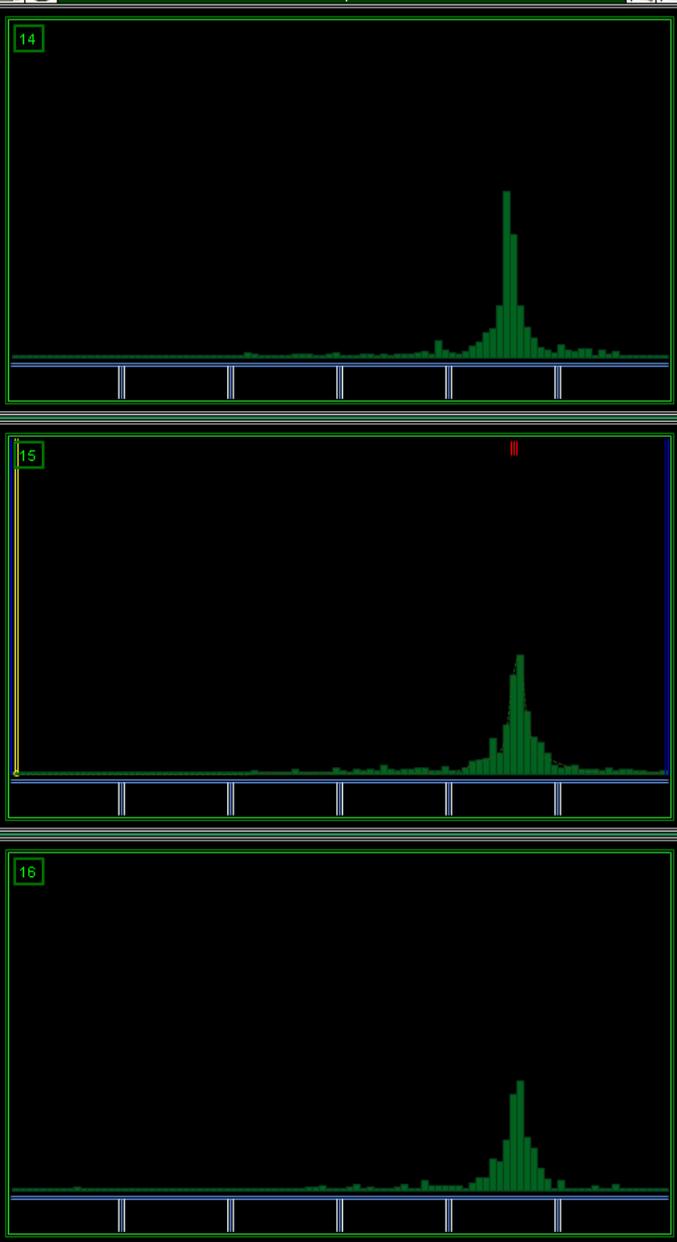
Proton: neutrons - 13 C=5.55 A = 0.73 E ≈ 650 GeV

Calorimeter strip analysis

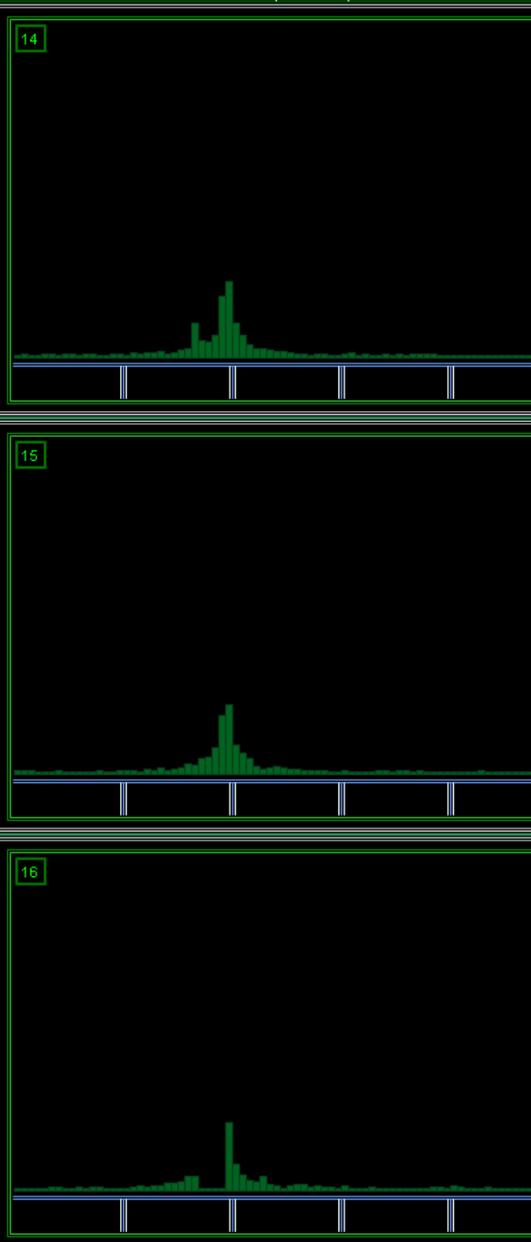
cascade course profile



x-view planes



y-view planes



selected plane summary

plane : 1

s-mips : 1708.74	s-hits : 0	s-sat : 0
x-mips : 1700.72	x-hits : 0	x-sat : 0
y-mips : 1716.75	y-hits : 0	y-sat : 0

selected strip summary

[x-view] [plane:15] [strip:00]

mips:0000.00	good	w:0.0000	a:n/a
--------------	------	----------	-------

region selection

[00]-[95] Strip cutter

crosstalk effect parameters

parameters	delta	0.0270	offset	38	Defaults
------------	-------	--------	--------	----	----------

plane profile approximation

profile fit curves plotting

pk:73.71	qc:0295.54	qp:075.08	wc:00.795	wp:00.940
chi:07.3290	5.555	passes to do 5	repeats to do 5	

Initial parameters Approximate all Approximate plane
Middle average Smooth parameters Pass LNF analysis
Discard all Discard qualification Qualify current profile

additional analysis

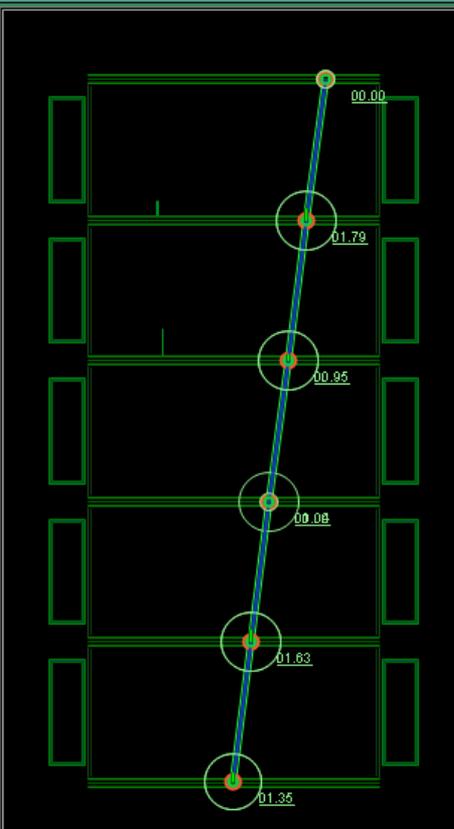
Profile course Cscd. curve Sec. cscds Particle ID

work results management

Prof. Fits Add to the database DB manager
Save all results in ASC-II format Leave cascade analysis

Flight date: 16.07.2006 Entry number: 1374659

Event viewer _ □ ×



tracker

summary information

n-tracks 2 n-singlets 6

summary mips left 46.97

x-view n 4 mips 32.59

y-view n 2 mips 14.38

track details

selected track 0

base sum 4 x 5 y 4

fit chi-square 0.2944

<dEdx>, mips 1.28

rigidity 314.8 deflection 0.00

charge sign positive

ToF system

beta 0.793 direction down

<dEdx>, mips n/a

s4 detector

energy release, mips 508.08

neutron detector

event 4 upper 6 bottom 4

calorimeter

summary information

half q-total, mips 6806

n-hits s 482 x 240 y 242

released mips sum/2 6806

x-view 6745 y-view 6867

saturated sum 0 x 0 y 0

qx22 1109.6 nx22 33

xplm 21 yplm 22 slf.trig false

Gev(e) 3539076. error 42094

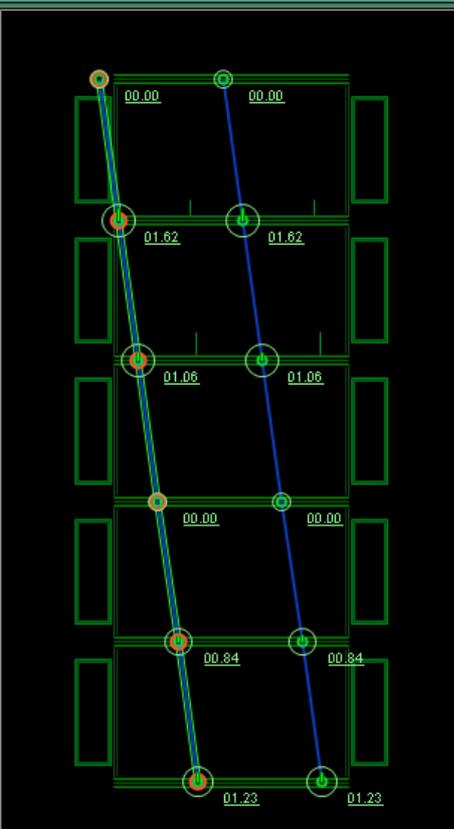
selected strip

view plane strip

mips left 00000 saturated

plots helpers





current file summary

file name L2PAM060716c.root date 16.07.2006

total events 1530170 inflight time 87163

livetime n/a deadtime n/a

file position (entries explore)

current entry 1374659

event layering

event layers	#	00	name	unnamed
1	2	3	4	5
comment	not commented			
size	10000000	ev	time	1000000 ms
part	00.00 %	flux	00.0000 e/(s g)	

current subentry 0

manual layer filtering

layer management utilities

event quick search

quick search criteria cl-qtot

current event summary information

orbital information

packet number	6151569	latitude, deg	-52.730
absolute time, s	1153085758	longitude, deg	-69.094
board time, ms	324261135	altitude, km	593.524
GM time	21:35:58	L-shell, radii	1.871
GMC rigidity	4.255	B-abs, gauss	0.254

trigger information

runevent	29529	livetime	13	deadtime	13
rates top	47	middle	9	bottom	15
trigger rates	129	45	246	63	367
s4+calorimeter rates	36	0	trigger config CALO		

horus database quick info

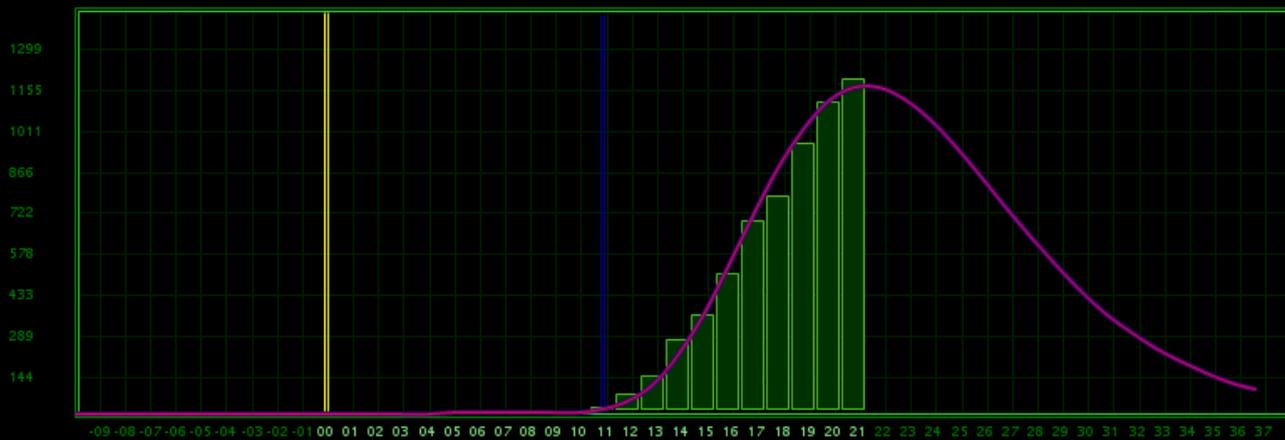
current user	owner	task	abstract	order	1
record	no recs	Nº	--	created	--
owner	--	task	--		
code ID	--	filtering order	--	access level	--

calorimeter data analysis utilities

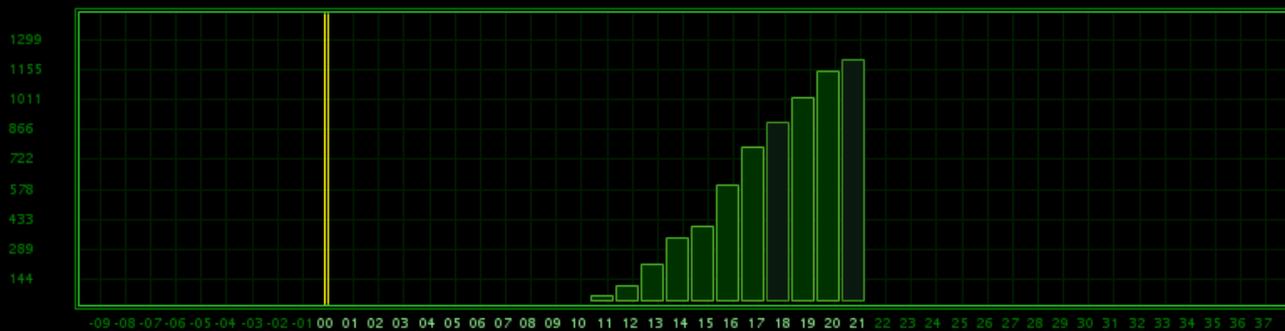
ASC-II formatted data output

additional actions

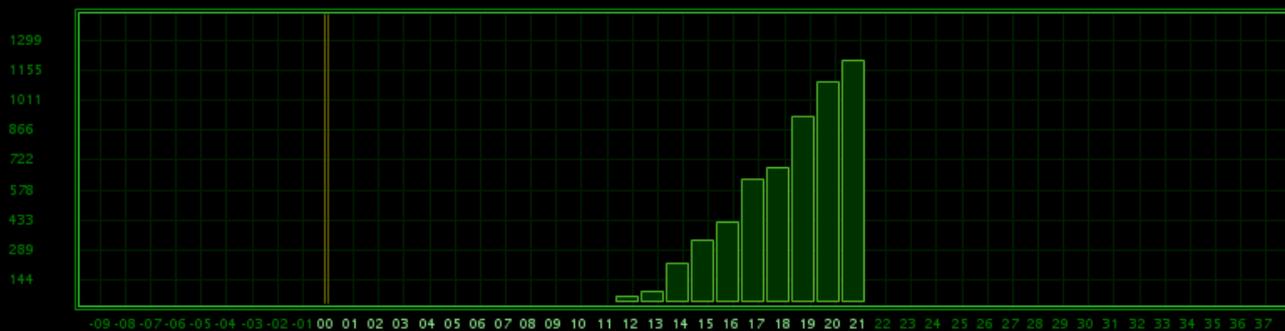
summary cascade curve



x-view cascade curve



y-view cascade curve



planes treatment tools

summary curve cursor

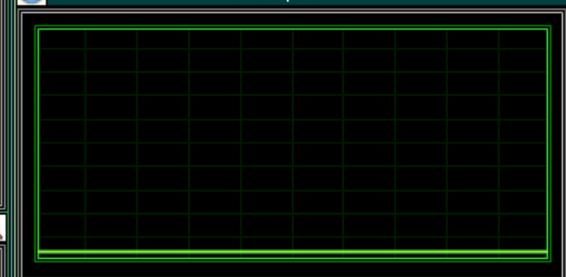
plane 00 source mips 1.32 fit mips 00000.00
 x-mips 1.73 y-mips 0.91 [x/y] ratio 191.00

← → + Include plane - Exclude plane b Reset

x-view curve cursor

plane 00 mips 1.73 hits 0 confidence -
 parametric quality (chi2) - passes done -
 q.core -- w.core -- q.pvm -- w.pvm --

slice profile



← → Middle average ↔ Another view b Reset

cascade curve approximation

primary cascade parameters

x-max	21.50	Δ 0.000	1st impact	11
q-max	1443.78	Δ 0.000	passes to do	10
K	0.9165	Δ 0.00500	passes done	20480
D	5.1635	Δ 0.01000	... chi^2	21.76971

secondary cascade parameters

actions	Initial values
<input checked="" type="checkbox"/> Include plane <input type="checkbox"/> Exclude plane	Approximate

resulting data (level.3)

l2 summary mips	6806	half-qtot mips	6806
profiled mips	7534	x	8202
integral mips	18880	y	6867
attack	7577.329	ratio	119.4
release	11302.205	restoration increment	277.39
decay	n/a	sustain	n/a
cascade asymmetry	0.670		

approximation logger

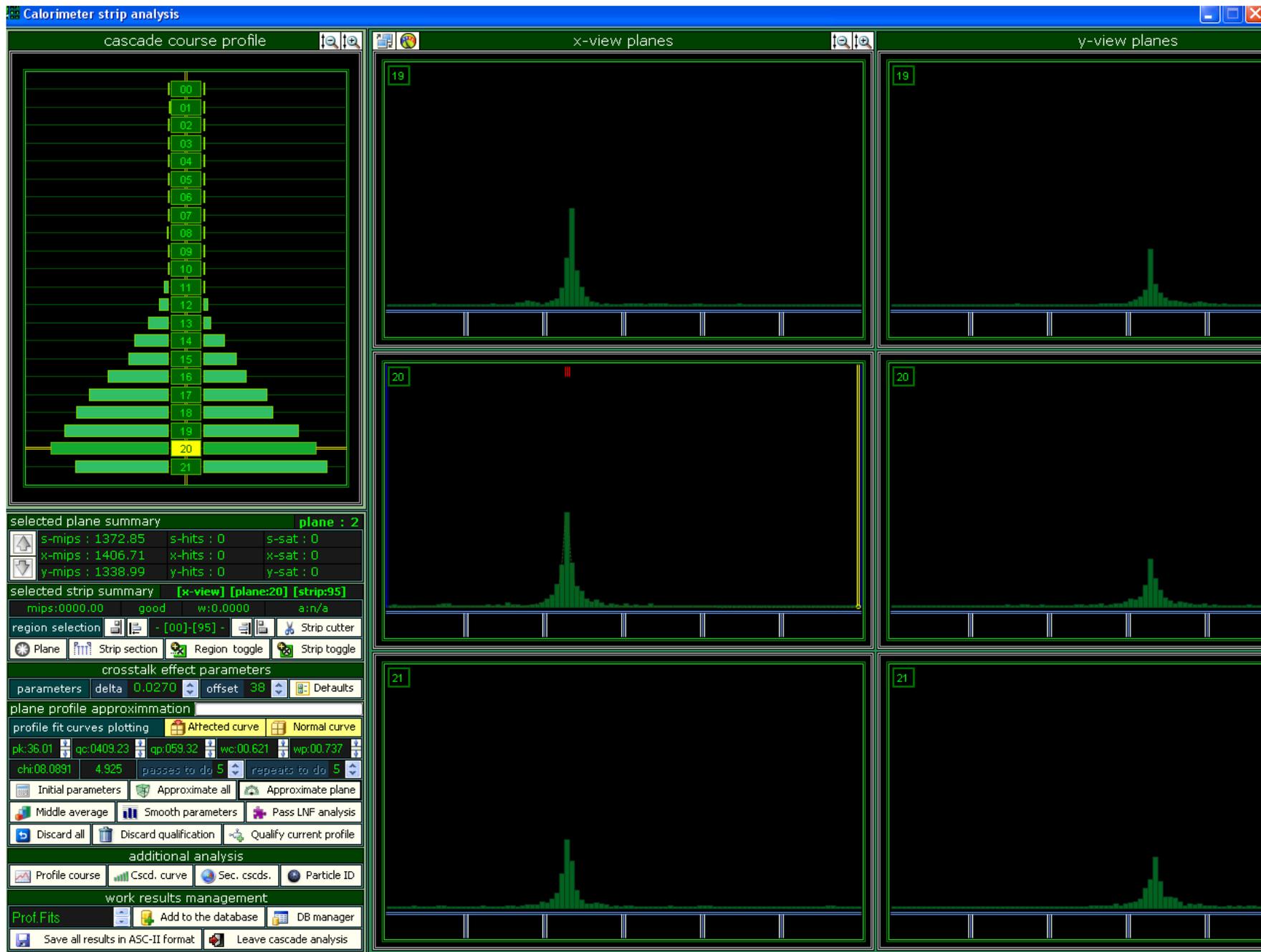
chi^2 course

selected pass 00
 chi^2 value 00.000000

additional actions

Reset all fits Smooth curve Pass LNF analysis
 Save ASC-II Add to DB DB manager Exit

Proton: neutrons - 13 C= 4.92 A = 0.67 E ≈ 380 GeV



Flight date: 11.07.2006 Entry number: 584205

Event viewer

tracker

summary information

n-tracks 1 n-singlets 0
summary mips left 0.00
x-view n 0 mips 0.00
y-view n 0 mips 0.00

track details

selected track 0

base sum 3 x 5 y 3
fit chi-square 1.1197
<dEdx>, mips 0.99
rigidity 663.8 deflection 0.00
charge sign n/a

ToF system

beta 100.00 direction n/a
<dEdx>, mips 0.00

s4 detector

energy release, mips 442.66

neutron detector

event 11 upper 2 bottom 1

calorimeter

summary information

half q-total, mips 13218
n-hits s 1260 x 608 y 652
released mips sum/2 13218
x-view 12989 y-view 13447
saturated sum 0 x 0 y 0
qx22 1125.0 nx22 45
xplm 20 yplm 21 slf.trig False
Gev(e) 6873301. error 81628.

selected strip

view plane 00 strip 00
mips left 00000 saturated

plots helpers

current file summary

file name	L2PAM070711c.root	date	11.07.2007
total events	1857362	inflight time	86023
lifetime	n/a	deadtime	n/a

file position (entries explore)

current entry 584205

event layering

event layers	#	01	name	Z=1	
<input checked="" type="checkbox"/>	1	2	3	4	5
comment no comment					
size		71	time	1000000 ms	
part		00.00 %	flux	00.0000 e/(s g)	

current subentry 31.71

manual layer filtering

layer management utilities

event quick search

quick search criteria

current event summary information

orbital information

packet number	2968301	latitude, deg	21.849
absolute time, s	1184139317	longitude, deg	67.624
board time, ms	133250950	altitude, km	572.732
GM time	7:35:17	L-shell, radii	1.100
GMC rigidity	12.308	B-abs, gauss	0.324

trigger information

runevent	2559	livetime	269	deadtime	10	
rates top	21	middle	0	bottom	8	
trigger rates	74	26	125	38	171	130
s4+calorimeter rates	15	0	trigger config	CALO		

horus database quick info

current user task order

record no recs N# --

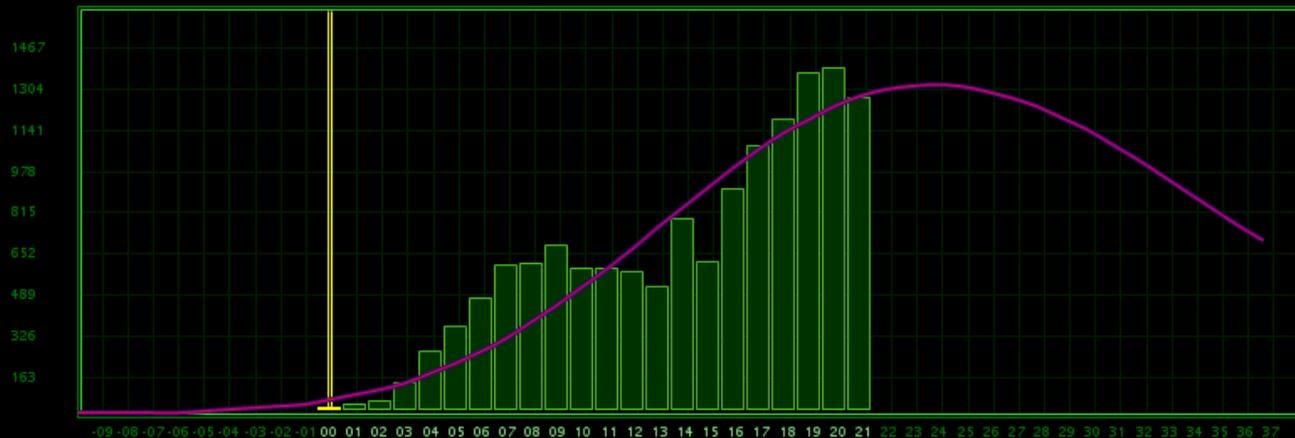
owner -- task --

code ID -- filtering order -- access level --

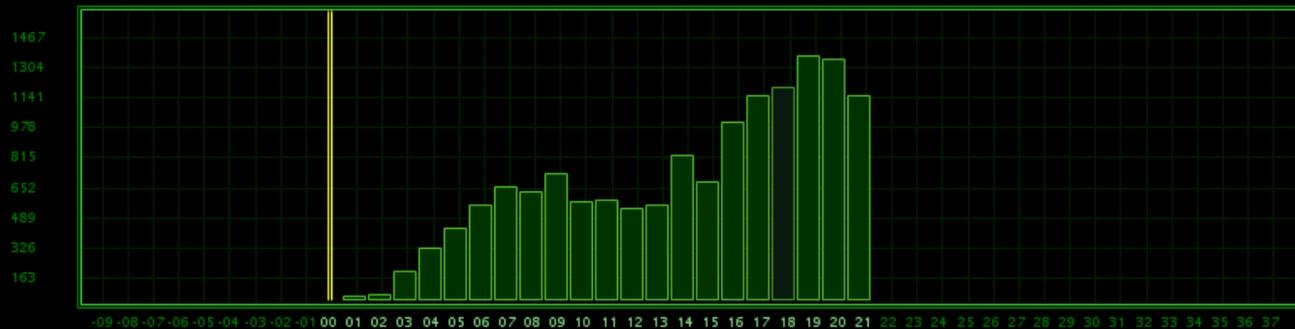
calorimeter data analysis utilities

ASC-II formatted data output

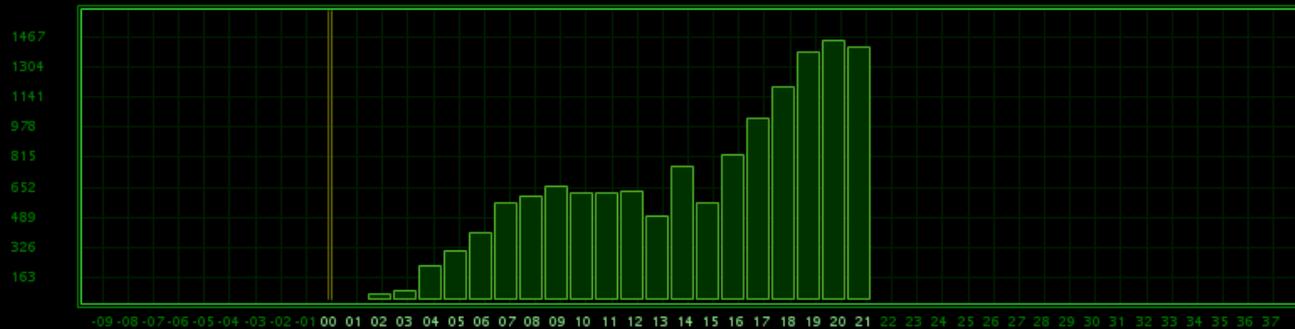
summary cascade curve



x-view cascade curve



y-view cascade curve



planes treatment tools

summary curve cursor

plane 00 source mips 21.60 fit mips 00000.00
 x-mips 26.12 y-mips 17.08 [x/y] ratio 152.85
 [Left] [Right] [Include plane] [Exclude plane] [Reset]

x-view curve cursor

plane 00 mips 26.12 hits 0 confidence --
 parametric quality (chi2) -- passes done --
 q.core -- w.core -- q.pvm -- w.pvm --

slice profile



[Left] [Right] [Middle average] [Another view] [Reset]

cascade curve approximation

primary cascade parameters

x-max 23.94 Δ 0.250 imp.pl 0 Find
 q-max 1303.73 Δ 54.676 passes to do 10
 K 3.2998 Δ 0.00500 passes done 1280
 D 4.5574 Δ 0.01000 chi^2 137.499440

secondary cascade parameters

actions

[Include plane] [Exclude plane] [Initial values]
 x.s 00.00 q.s 00.00 w.s 00.000 [Approximate]

resulting data (level.3)

l2 summary mips 13218 half-qtot mips 13218
 profiled mips 13218 x 12989 y 13447 ratio 96.6
 integral mips 35414 restoration increment 267.92
 attack 15582.296 decay n/a sustain n/a
 release 19831.431 cascade asymmetry 0.786

approximation logger

chi^2 course

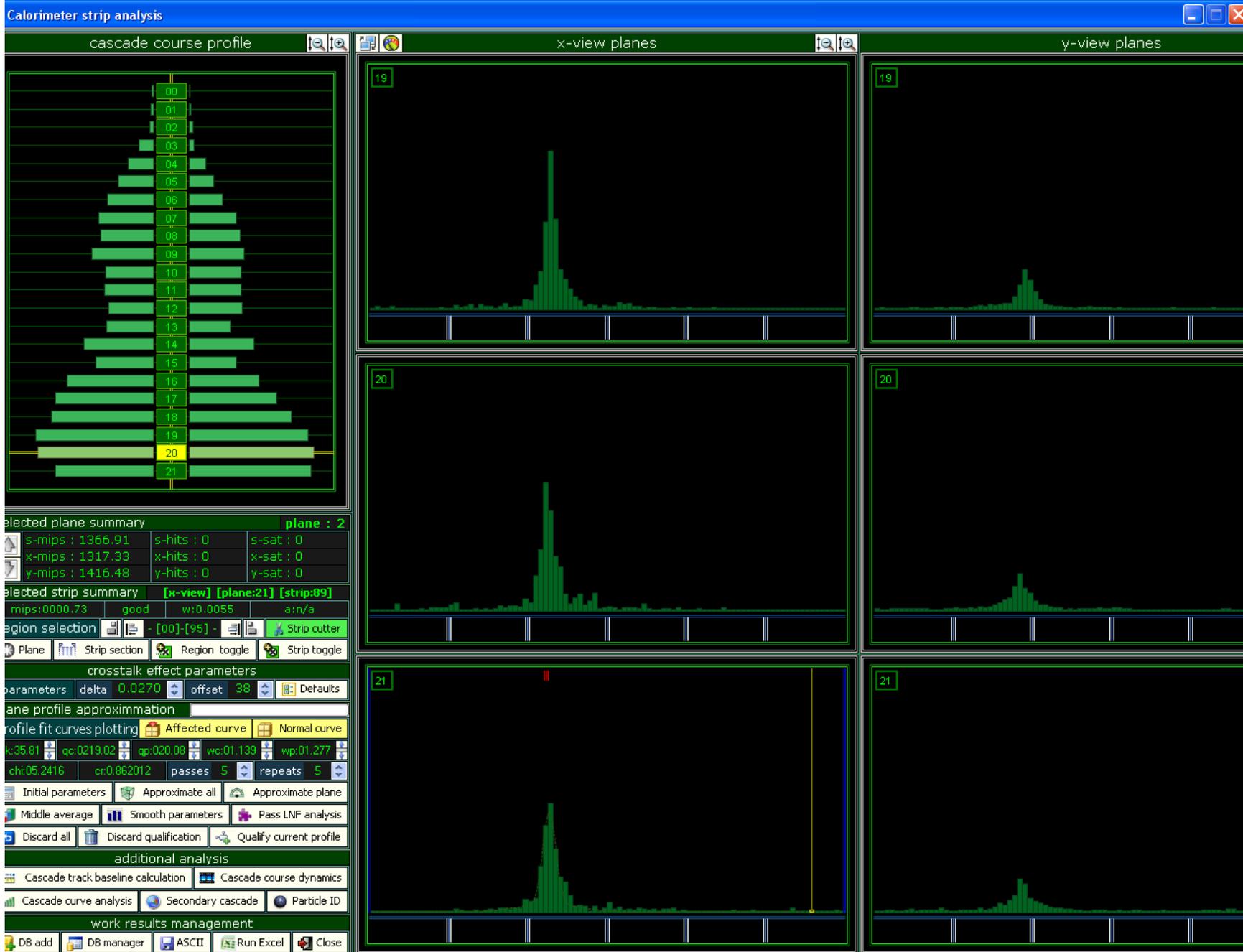
[Recall pass]
 selected pass 00
 chi^2 value 00.000000

additional actions

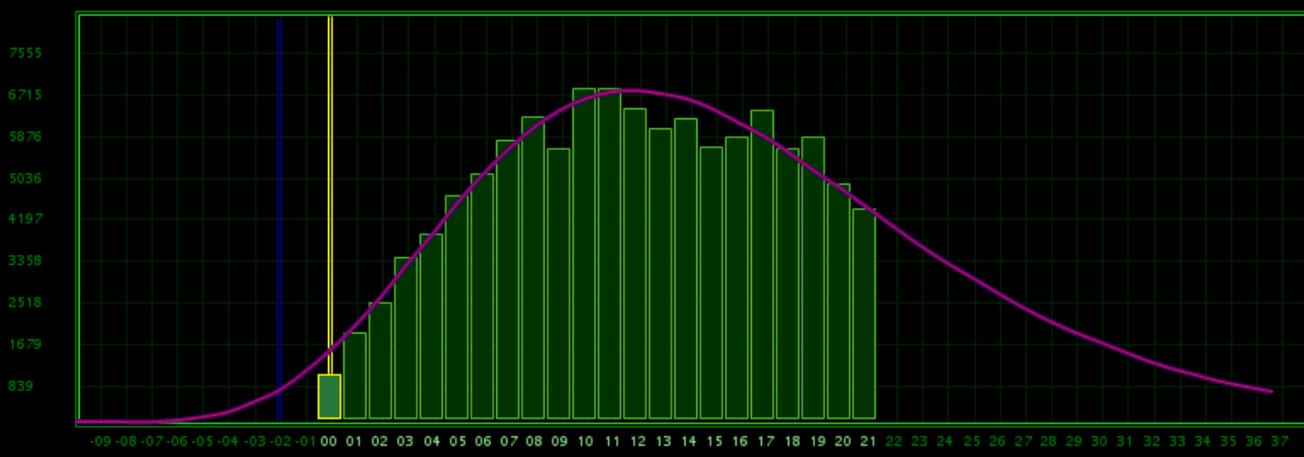
[Reset all fits] [Smooth curve] [Pass LNF analysis]

[ASCII] [Excel] [DB add] [DB manager] [Exit]

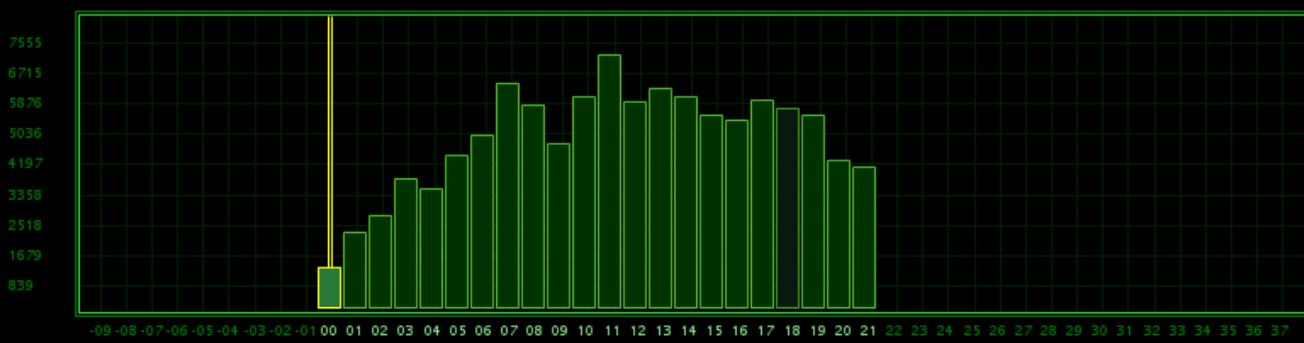
Proton: neutrons - 6 C= 0.86 A = 0.79 E ≈ 400 GeV



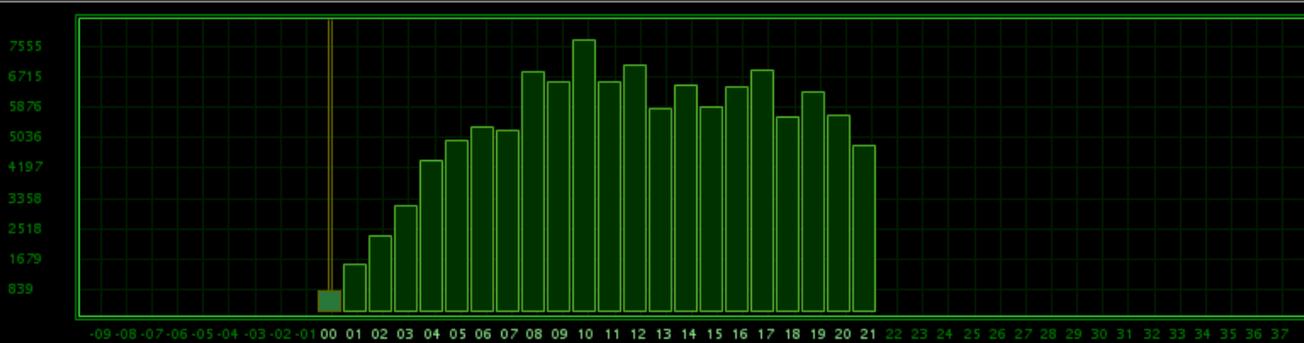
summary cascade curve



x-view cascade curve



y-view cascade curve



planes treatment tools

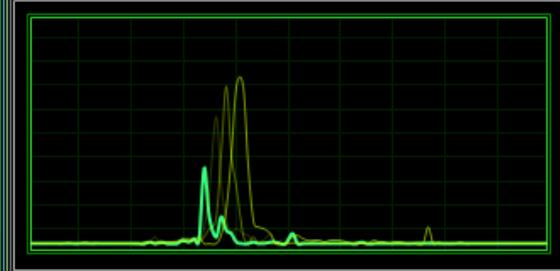
summary curve cursor

plane	00	source mips	1185.85	fit mips	00000.00
x-mips	1550.50	y-mips	821.20	[x/y] ratio	188.81

x-view curve cursor

plane	00	mips	1550.50	hits	0	confidence	--
parametric quality (chi2)	--	passes done	--				
q.core	--	w.core	--	q.pvm	--	w.pvm	--

slice profile



cascade curve approximation

primary cascade parameters

x-max	11.95	Δ	0.250	1st impact	-2
q-max	8393.91	Δ	337.888	passes to do	10
K	1.3052	Δ	0.00500	passes done	3200
D	9.2770	Δ	0.01000	... chi^2	3/4.50000 07

secondary cascade parameters

<input type="button" value="+ Include plane"/> <input type="button" value="- Exclude plane"/> <input type="button" value="Initial values"/>						
x.s	00.00	q.s	00.00	w.s	00.000	<input type="button" value="Approximate"/>

resulting data (level.3)

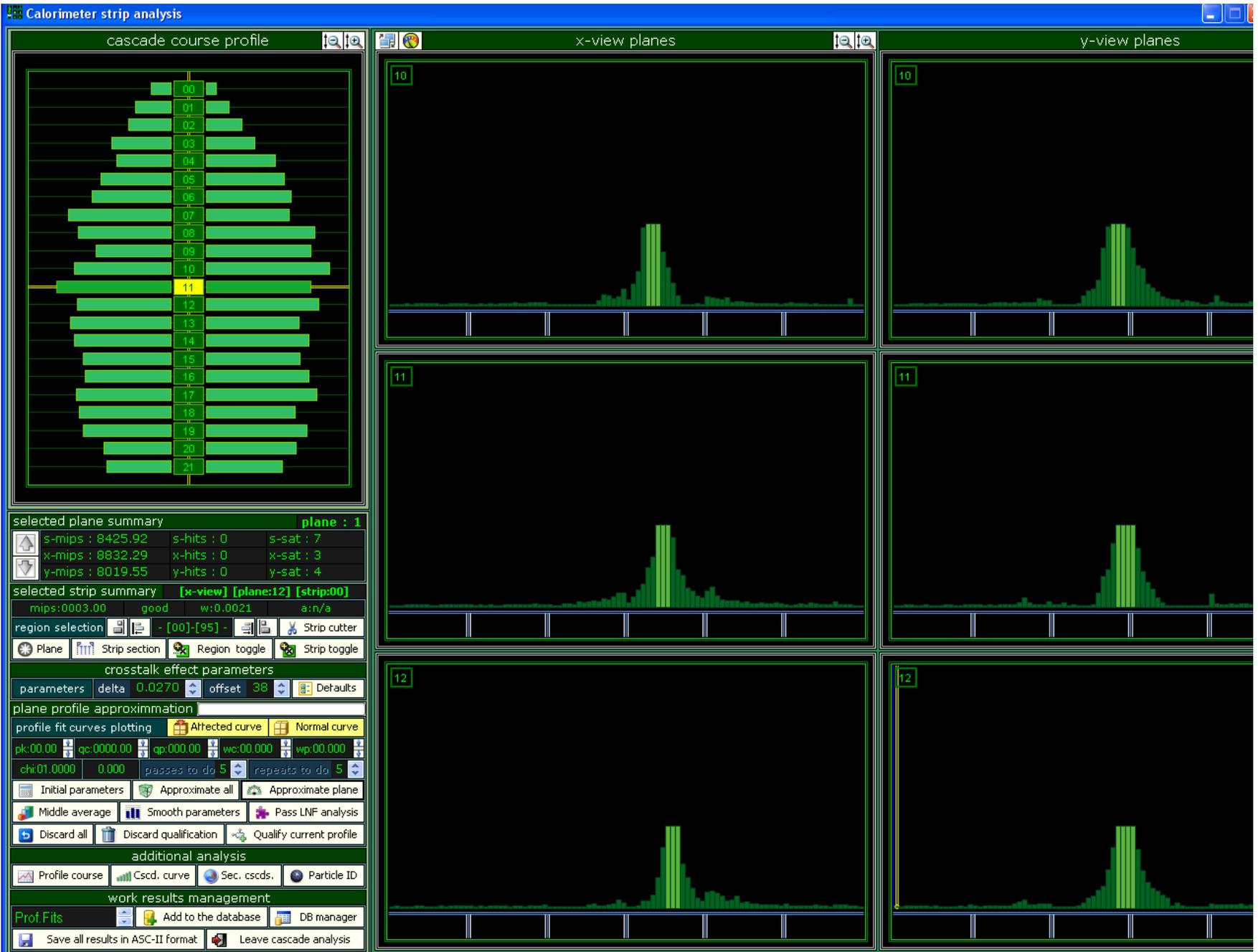
l2 summary mips	133296	half-quot mips	140189				
profiled mips	136808	x	131900	y	141717	ratio	93.1
integral mips	183385	restoration increment	130.81				
attack	66848.609	decay	n/a	sustain	n/a		
release	116536.37	cascade asymmetry	0.574				

approximation logger

chi^2 course	<input type="button" value="Recall pass"/>
selected pass	00
chi^2 value	00.000000

additional actions

Proton: neutrons - 50 $A = 0.57$ $E \approx 3600$ GeV



Flight date: 19.07.2006 Entry number: 1178943

Event viewer

tracker

summary information

n-tracks 0 n-singlets 38

summary mips left 99.02

x-view n 22 mips 68.00

y-view n 16 mips 31.02

track details

selected track --

base	sum	no	x	no	y	no
------	-----	----	---	----	---	----

fit chi-square n/a

<dEdx>, mips n/a

rigidity n/a deflection n/a

charge sign n/a

ToF system

beta 100.00 direction n/a

<dEdx>, mips n/a

s4 detector

energy release, mips 288.33

neutron detector

event 10 upper 9 bottom 7

calorimeter

summary information

half q-total, mips 46922

n-hits s 4010 x 1002 y 1010

released mips sum/2 46083

x-view 45039 y-view 47126

saturated sum 11 x 9 y 2

qx22 374.4 nx22 57

xplm 10 yplm 11 slf.trig False

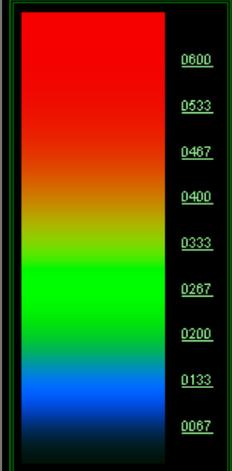
Gev(e) 485.85 error 58.23

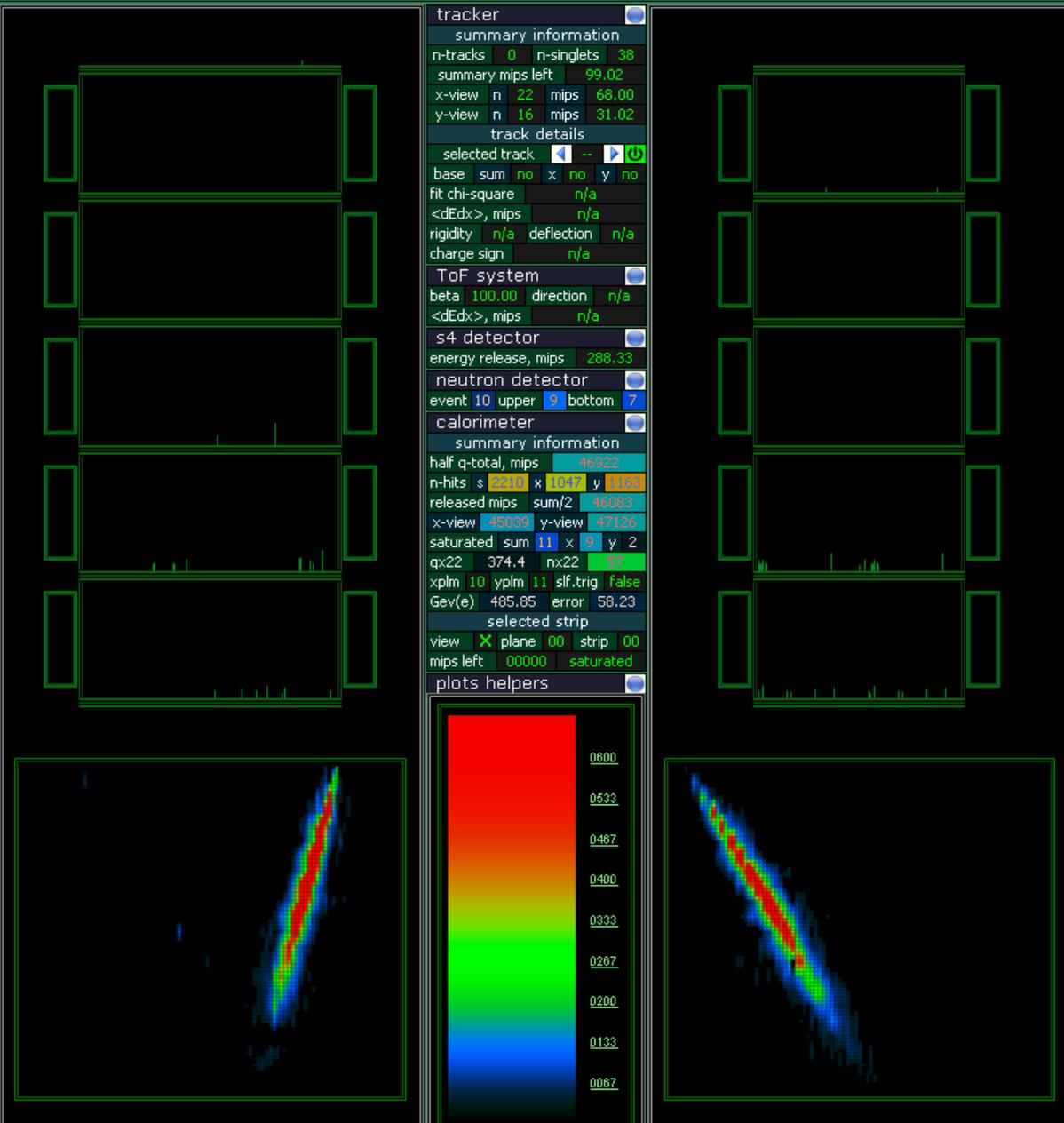
selected strip

view plane 00 strip 00

mips left 00000 saturated

plots helpers





current file summary

file name	L2PAM060719c.root	date	19.07.2006
total events	1870596	inflight time	87044
livetime	n/a	deadtime	n/a

Calculate

file position (entries explore)

current entry 1178943

event layering

event layers	#	00	name	unnamed
1	2	3	4	5
6	7	8	9	10

comment .not commented

size 10000000 ev time 1000000 ms

part 00.00 % flux 00.0000 e/(s g)

current subentry 0

manual layer filtering

Add current event Delete current event Reset current layer

layer management utilities

Open layers manager Update layers content Browse files

event quick search

quick search criteria cl-qtot 100000

current event summary information

orbital information

packet number	11022710	latitude, deg	-6.912
absolute time, s	1153321900	longitude, deg	-8.980
board time, ms	560406361	altitude, km	509.721
GM time	15:11:40	L-shell, radii	1.190
GMC rigidity	10.520	B-abs, gauss	0.227

trigger information

runevent	17201	livetime	20	deadtime	9	
rates top	21	middle	9	bottom	2	
trigger rates	86	27	143	39	179	176
s4+calorimeter rates	20	0	trigger config	CALO		

horus database quick info

current user owner task abstract order 1

record no recs N# created --

owner -- task --

code ID -- filtering order -- access level --

calorimeter data analysis utilities

Cascade curve analysis Cascade plane profiles Update data

ASC-II formatted data output

Save event Save layer Show file content Preferences

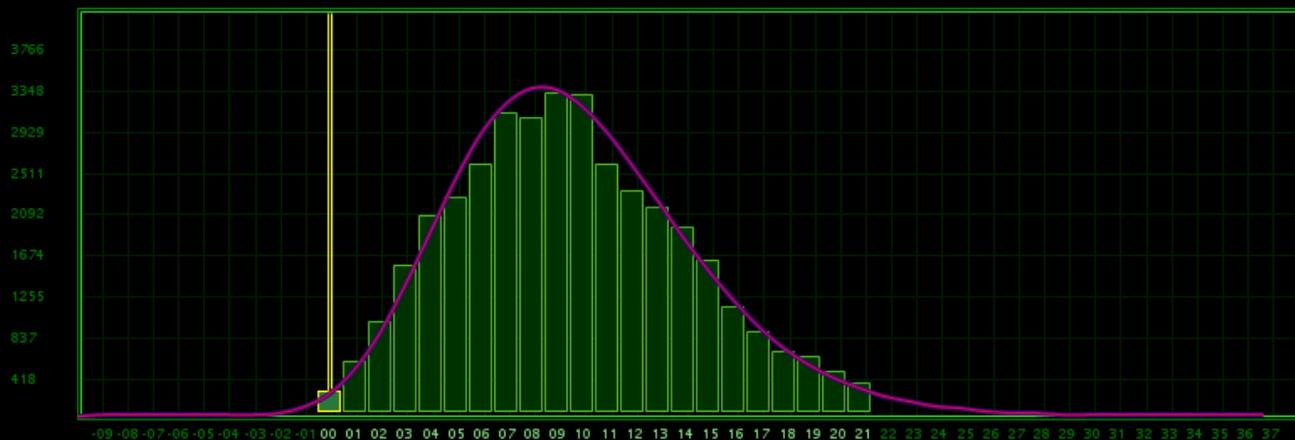
additional actions

Change user data Show ROOT console Spectrum database

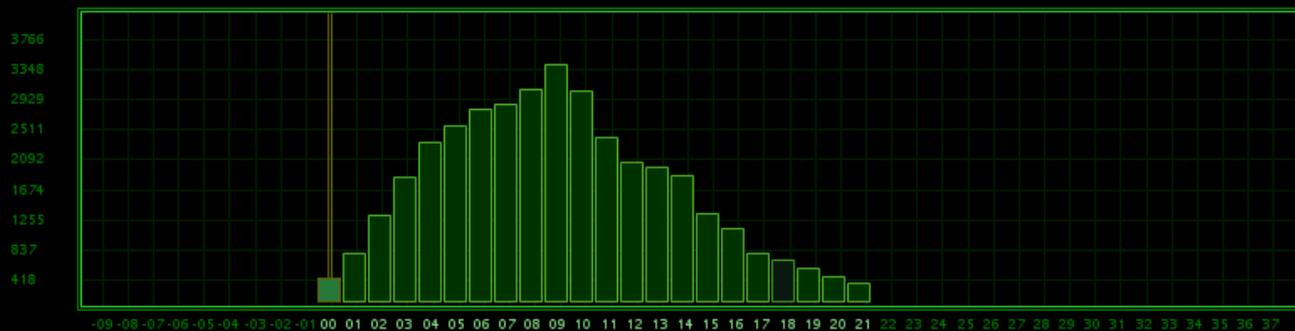
Time variations plotting Histogram plots Table designer

Open database explorer Configuration Leave event viewer

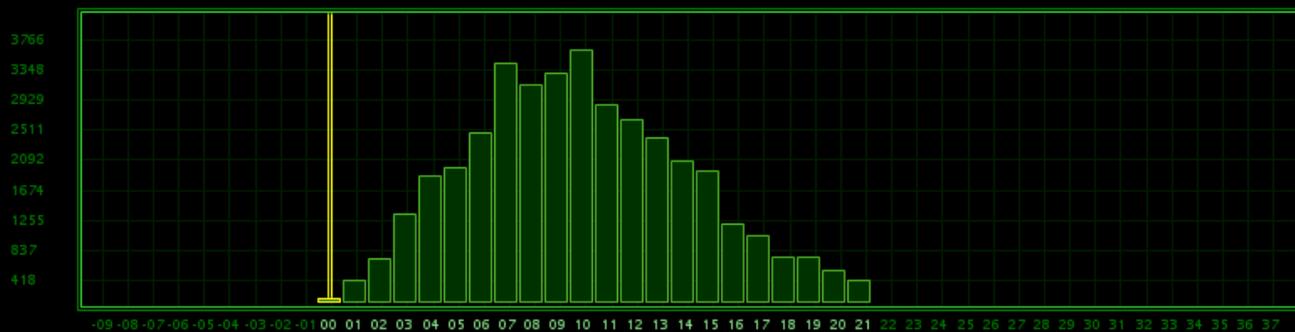
summary cascade curve



x-view cascade curve



y-view cascade curve



planes treatment tools

summary curve cursor

plane **00** source mips **302.18** fit mips **00000.00**
 x-mips **463.92** y-mips **140.44** [x/y] ratio **330.34**

← → ⊕ Include plane ⊖ Exclude plane ⏪ Reset

y-view curve cursor

plane **00** mips **140.44** hits **0** confidence **--**
 parametric quality (chi2) **--** passes done **--**
 q.core **--** w.core **--** q.pvm **--** w.pvm **--**

slice profile



← → Middle average ↔ Another view ⏪ Reset

cascade curve approximation

primary cascade parameters

x-max **8.38** Δ **0.250** 1st impact **0**
 q-max **4184.83** Δ **164.399** passes to do **10**
 K **1.7315** Δ **0.00500** passes done **3200**
 D **3.6106** Δ **0.01000** ... chi^2 **157.2833**
06

secondary cascade parameters actions

☀ ⊕ Include plane ⊖ Exclude plane ⏪ Initial values
 x.s **00.00** q.s **00.00** w.s **00.000** Approximate

resulting data (level.3)

l2 summary mips **46083** half-qtot mips **46922**
 profiled mips **46474** x **45821** y **47126** ratio **97.2**
 integral mips **48216** restoration increment **102.75**
 attack **20305.390** decay **n/a** sustain **n/a**
 release **27182.997** cascade asymmetry **0.747**

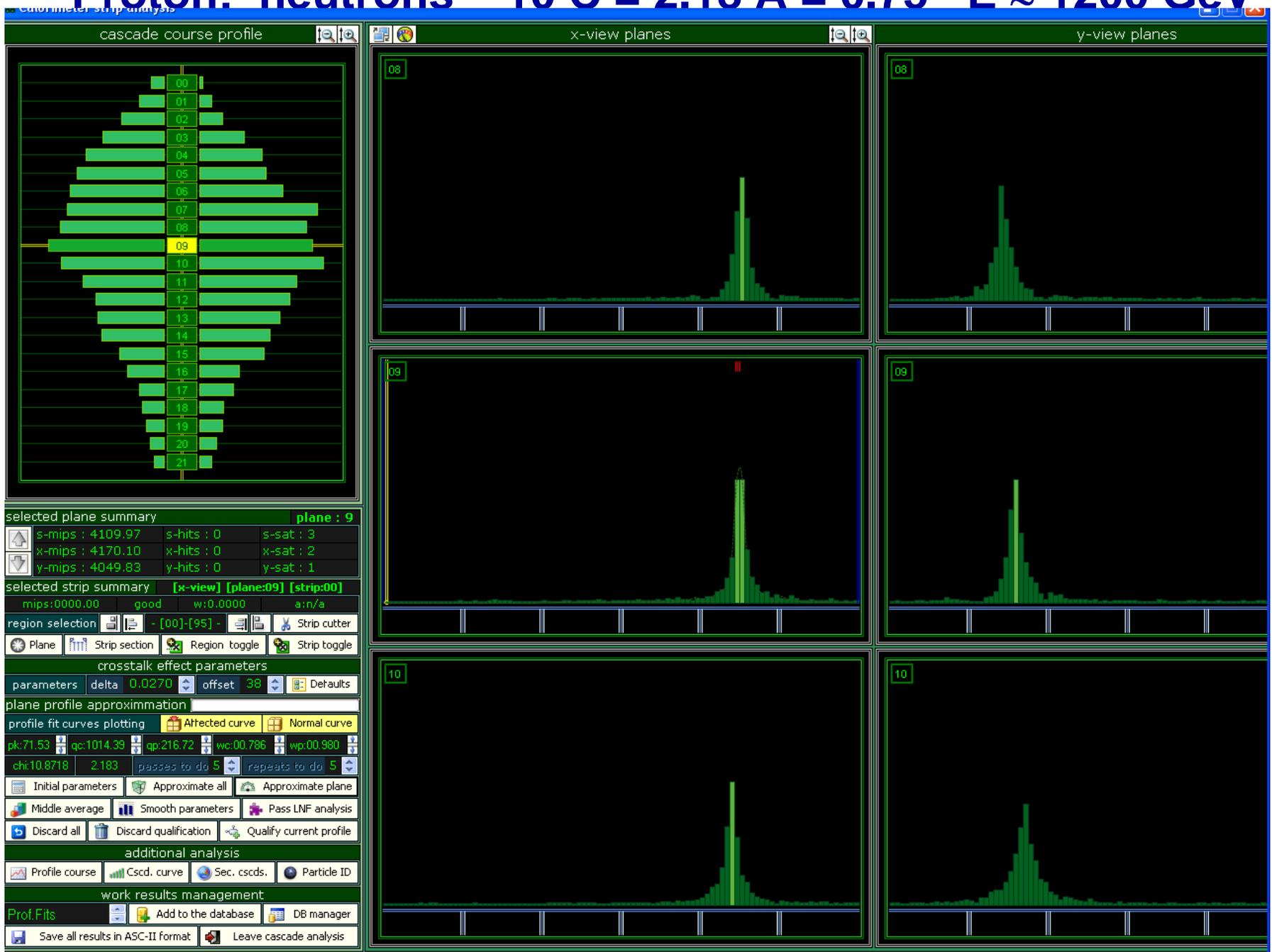
approximation logger

chi^2 course ⏪ ⏩ ⏪ Recall pass
 selected pass **00**
 chi^2 value **00.000000**

additional actions

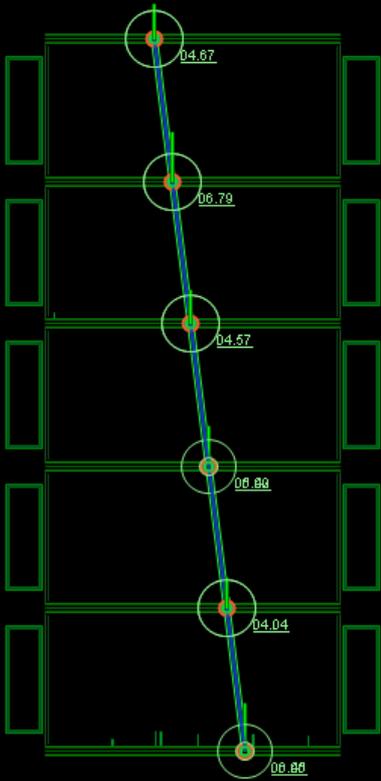
⏪ Reset all fits ⏪ Smooth curve ⏪ Pass LNF analysis
 ⏪ Save ASC-II ⏪ Add to DB ⏪ DB manager ⏪ Exit

Proton: neutrons – 10 C = 2.18 A = 0.75 E ≈ 1200 GeV



Flight date: 19.07.2006 Entry number: 994458

Event viewer



tracker

summary information

n-tracks 2 n-singlets 20
summary mips left 35.39
x-view n 9 mips 17.49
y-view n 11 mips 17.90

track details

selected track 0

base sum 4 x 6 y 4
fit chi-square 1.3672
<dEdx>, mips 5.13
rigidity 128.3 deflection 0.01
charge sign n/a

ToF system

beta 100.00 direction n/a
<dEdx>, mips 0.00

s4 detector

energy release, mips 368.31

neutron detector

event 15 upper 6 bottom 15

calorimeter

summary information

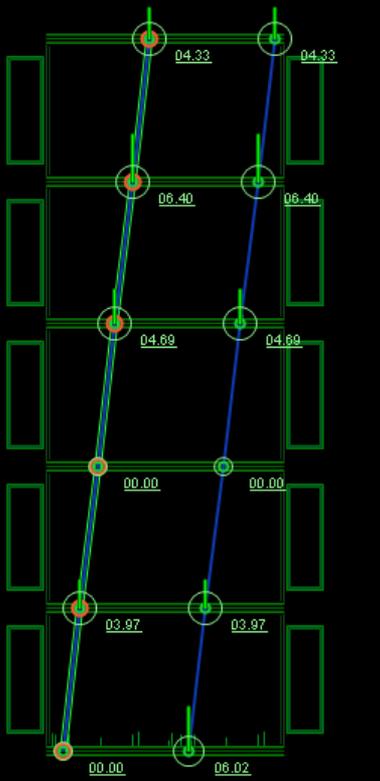
half q-total, mips 19651
n-hits s 1065 x 854 y 611
released mips sum/2 19651
x-view 19805 y-view 19497
saturated sum 0 x 0 y 0
qx22 631.6 nx22 41
xplm 13 yplm 12 sif.trig true
Gev(e) 185.17 error 22.18

selected strip

view plane strip 00
mips left 00000 saturated

plots helpers





current file summary

file name	L2PAM060719c.root	date	19.07.2006
total events	1870596	inflight time	87044
livetime	n/a	deadtime	n/a

file position (entries explore)

current entry 994458

event layering

event layers	#	01	name	tan Y
<input type="checkbox"/>				
comment no comment				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	size 289	time 1000000 ms
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	part 00.00 %	flux 00.0000 e/(s g)

current subentry 148.289

manual layer filtering

layer management utilities

event quick search

quick search criteria

current event summary information

orbital information

packet number	10838085	latitude, deg	68.518
absolute time, s	1153314634	longitude, deg	-93.587
board time, ms	553140705	altitude, km	367.323
GM time	13:10:34	L-shell, radii	22.189
GMC rigidity	0.030	B-abs, gauss	0.499

trigger information

runevent	27298	livetime	40	deadtime	10	
rates top	130	middle	27	bottom	28	
trigger rates	226	89	399	134	739	439
s4+calorimeter rates	59	0	trigger config CALO			

horus database quick info

current user owner task abstract order 1

record no recs N# created --

owner -- task --

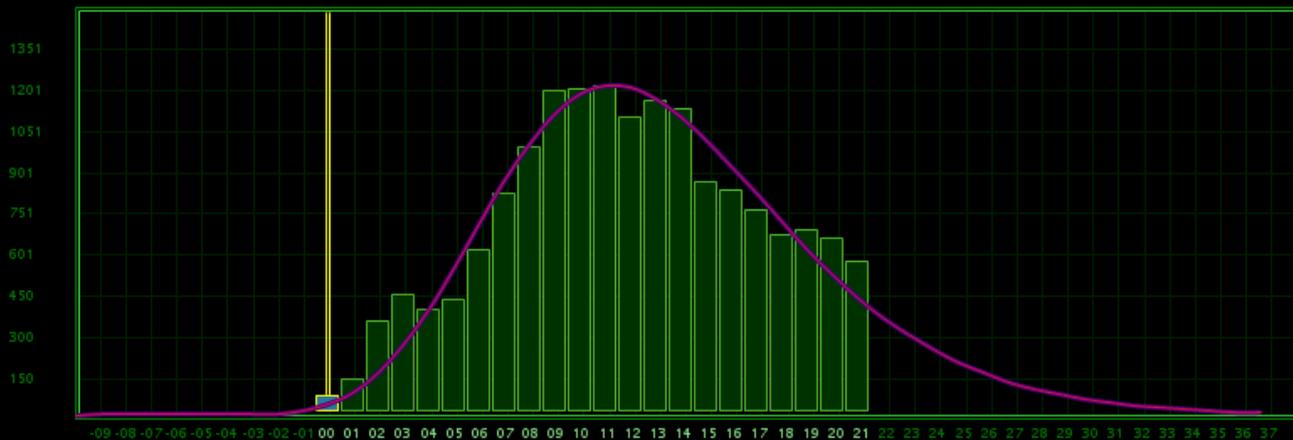
code ID -- filtering order -- access level --

calorimeter data analysis utilities

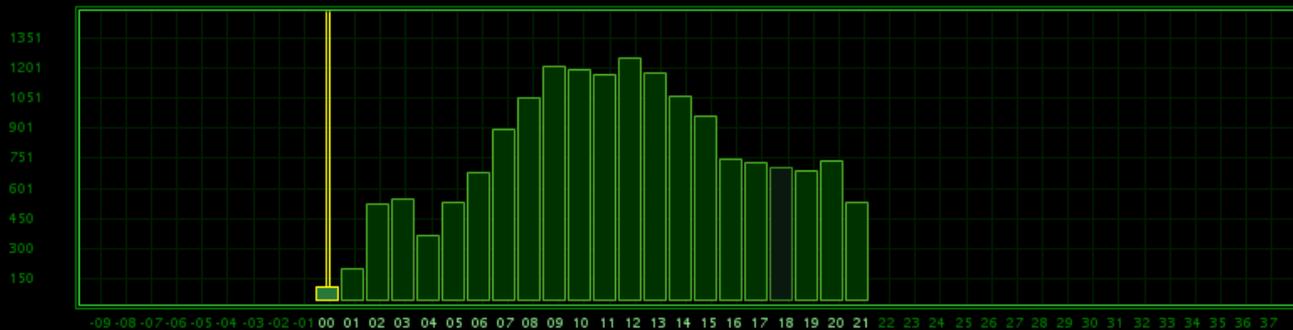
ASC-II formatted data output

additional actions

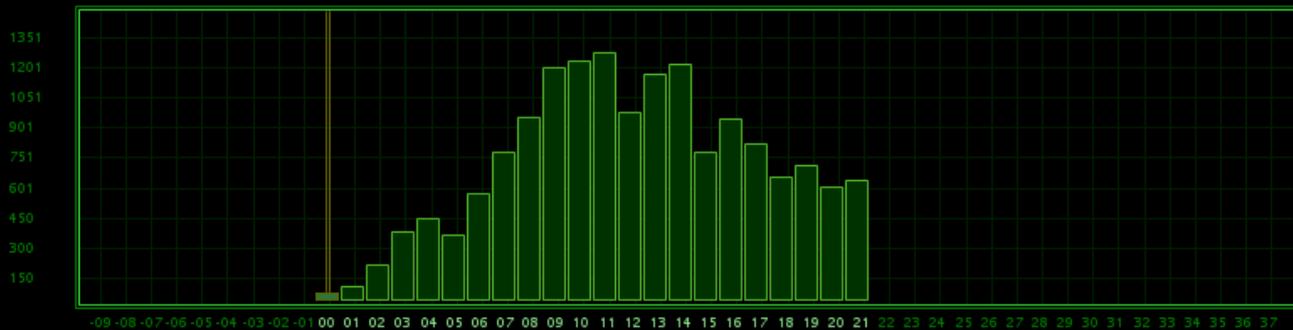
summary cascade curve



x-view cascade curve



y-view cascade curve



planes treatment tools

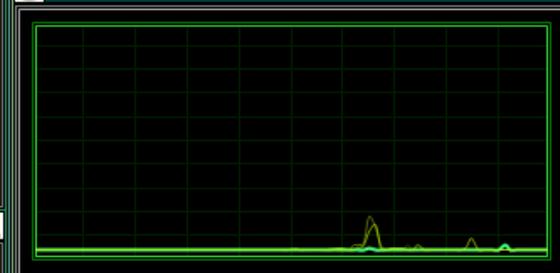
summary curve cursor

plane 00 source mips 83.70 fit mips 00000.00
 x-mips 103.91 y-mips 63.49 [x/y] ratio 163.67
 [Left Arrow] [Right Arrow] [Include plane] [Exclude plane] [Reset]

x-view curve cursor

plane 00 mips 103.91 hits 0 confidence --
 parametric quality (chi2) -- passes done --
 q.core -- w.core -- q.pvm -- w.pvm --

slice profile



[Left Arrow] [Right Arrow] [Middle average] [Another view] [Reset]

cascade curve approximation

primary cascade parameters

x-max 11.32 Δ 0.250 1st impact 0
 q-max 1501.61 Δ 59.996 passes to do 10
 K 1.2517 Δ 0.00100 passes done 1920
 D 5.1901 Δ 0.01000 ... chi^2 96.51333
 n

secondary cascade parameters

[Include plane] [Exclude plane] [Initial values]
 x.s 00.00 q.s 00.00 w.s 00.000 [Approximate]

resulting data (level.3)

l2 summary mips 19651 half-qtot mips 19651
 profiled mips 20078 x 20658 y 19497 ratio 106.0
 integral mips 22024 restoration increment 112.07
 attack 9329.230 decay n/a sustain n/a
 release 12694.965 cascade asymmetry 0.735

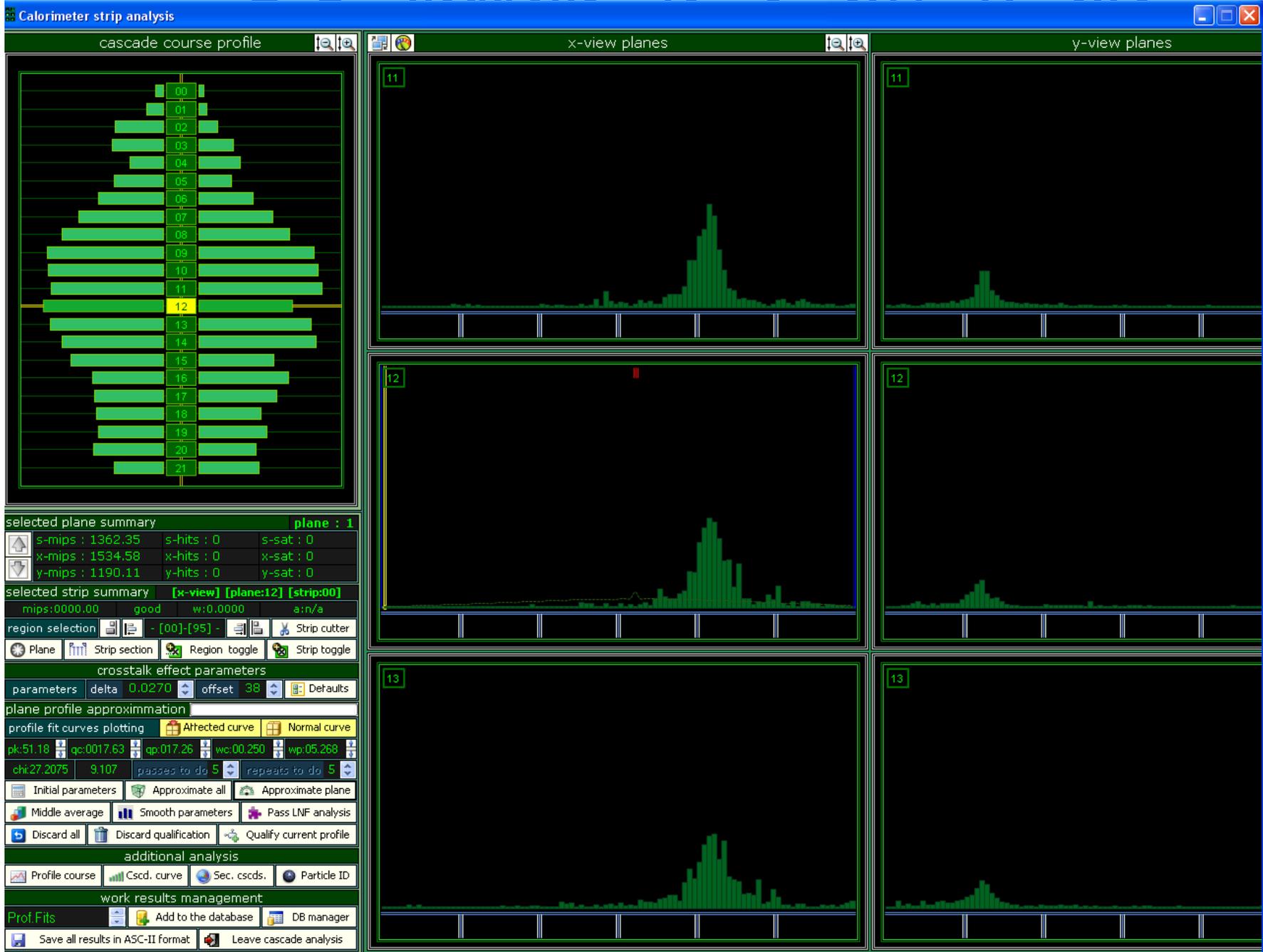
approximation logger

chi^2 course [Recall pass]
 selected pass 00
 chi^2 value 00.000000

additional actions

[Reset all fits] [Smooth curve] [Pass LNF analysis]
 [Save ASC-II] [Add to DB] [DB manager] [Exit]

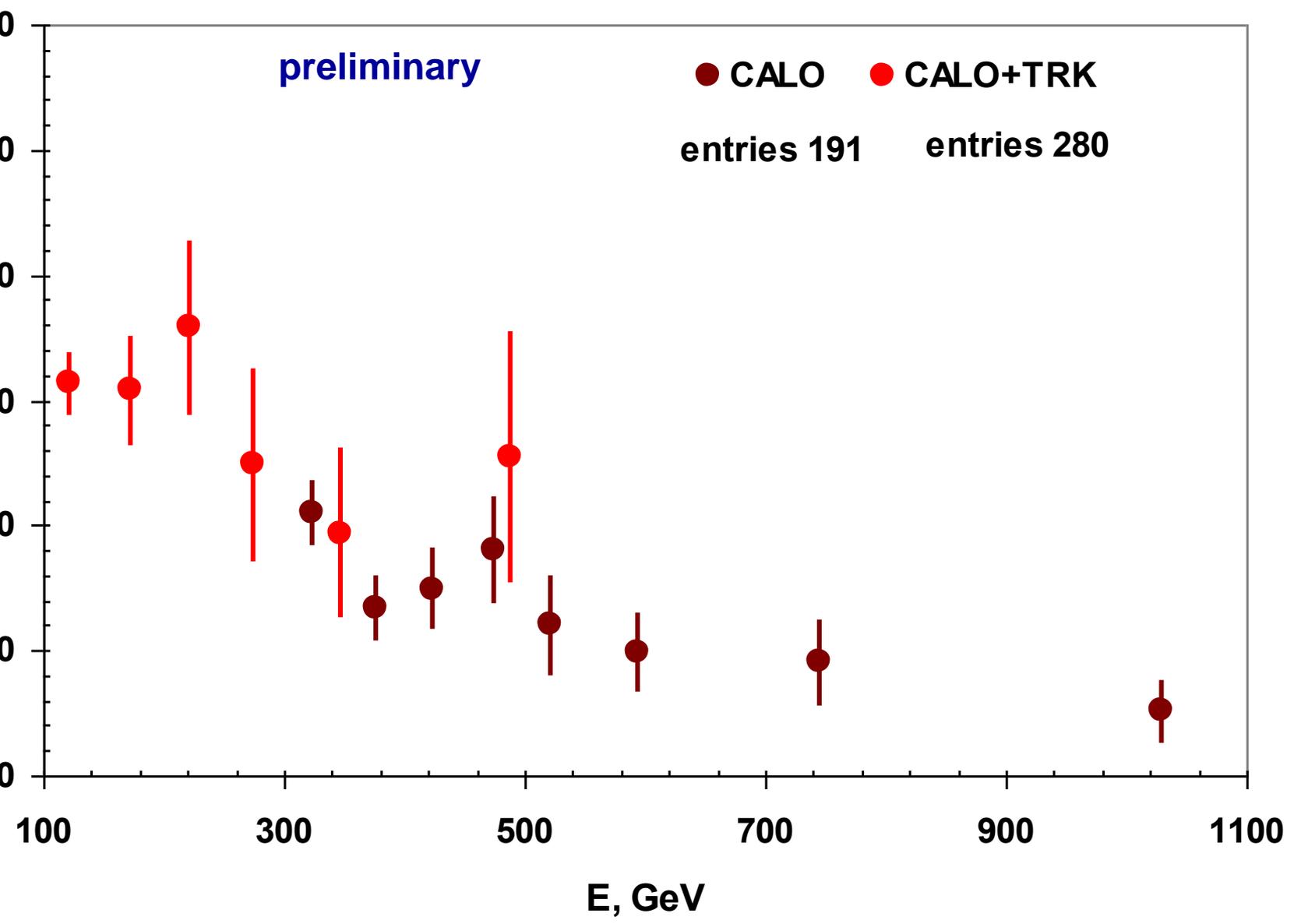
Z = 2 neutrons – 15 C = 9.11 A = 0.73



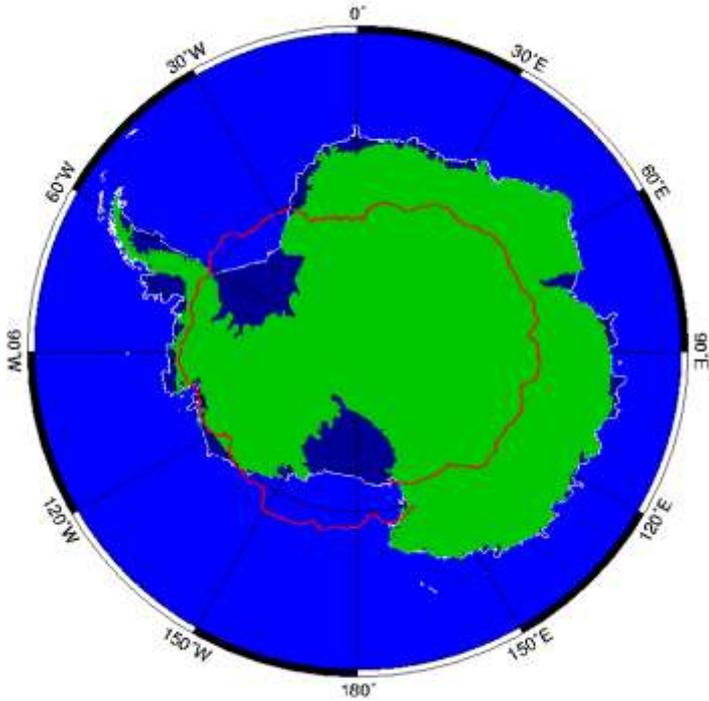
preliminary

● CALO ● CALO+TRK
entries 191 entries 280

$J(E) \cdot E^3$, relative units



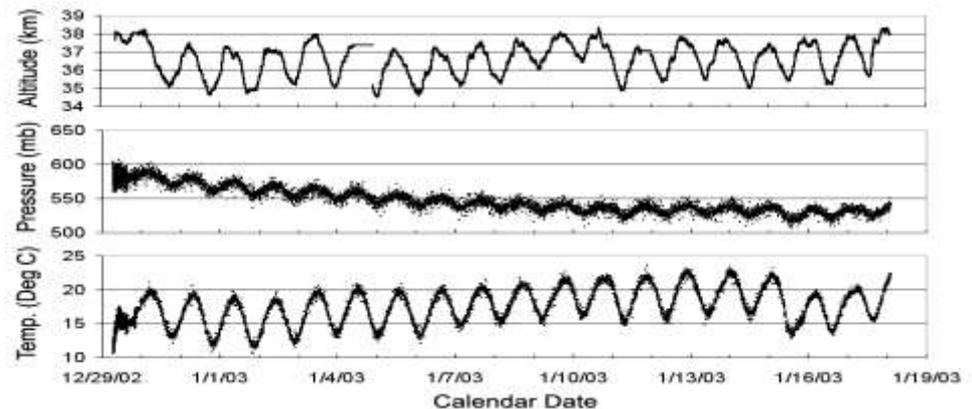
ATIC-2 Science Flight from McMurdo - 2002



GMT [2003 Jan 16 07:40:31] L08_Antarctica_ATIC

- Launch: 12/29/02 04:59 UTC
- Begin Science: 12/30/02 05:40 UTC
- End Science: 01/18/03 01:32 UTC
- Termination: 01/18/03 02:01 UTC
- Recovery: 01/28/03; 01/30/03

- 65 Gbytes Recorded Data
- 16,900,000 Cosmic Ray events
- High Energy Trigger > 75 GeV for protons
- $>96\%$ Live-time
- Internal pressure (~ 8 psi) decreased slightly (~ 0.7 psi) for 1st 10 days then held constant
- Internal Temperature: 12 – 22 C
- Altitude: 36.5 ± 1.5 km



Recovery expeditions to the plateau



The good ATIC-1 landing (left) and the not so good landings of ATIC-2 (middle) and ATIC-4 (right)



ATIC is designed to be disassembled in the field and recovered with Twin Otters. Two recovery flights are necessary to return all the ATIC components. Pictures show recovery flight of ATIC-4

Joachim Isbert PAMELA 2009

LETTERS

An excess of cosmic ray electrons at energies of 300–800 GeV

J. Chang^{1,2}, J. H. Adams Jr³, H. S. Ahn⁴, G. L. Bashindzhagyan⁵, M. Christl³, O. Ganel⁴, T. G. Guzik⁶, J. Isbert⁶, K. C. Kim⁴, E. N. Kuznetsov⁵, M. I. Panasyuk⁵, A. D. Panov⁵, W. K. H. Schmidt², E. S. Seo⁴, N. V. Sokolskaya⁵, J. W. Watts³, J. P. Wefel⁶, J. Wu⁴ & V. I. Zatsepin⁵

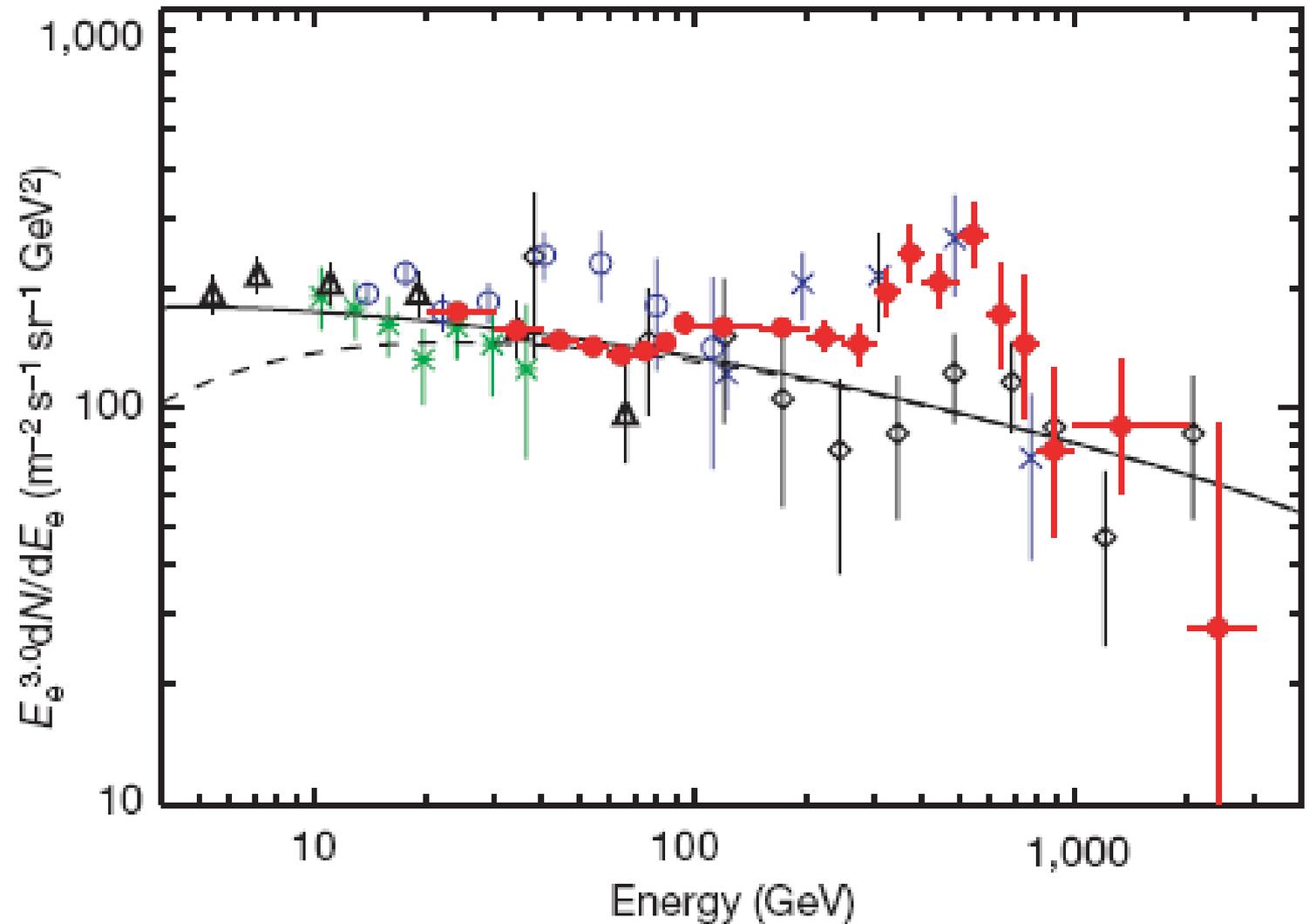


Figure 3 | ATIC results showing agreement with previous data at lower energy and with the imaging calorimeter PPB-BETS at higher energy. The



11th june 2008





FIRST RESULTS ON THE HIGH ENERGY COSMIC RAY ELECTRON SPECTRUM FROM FERMI LAT

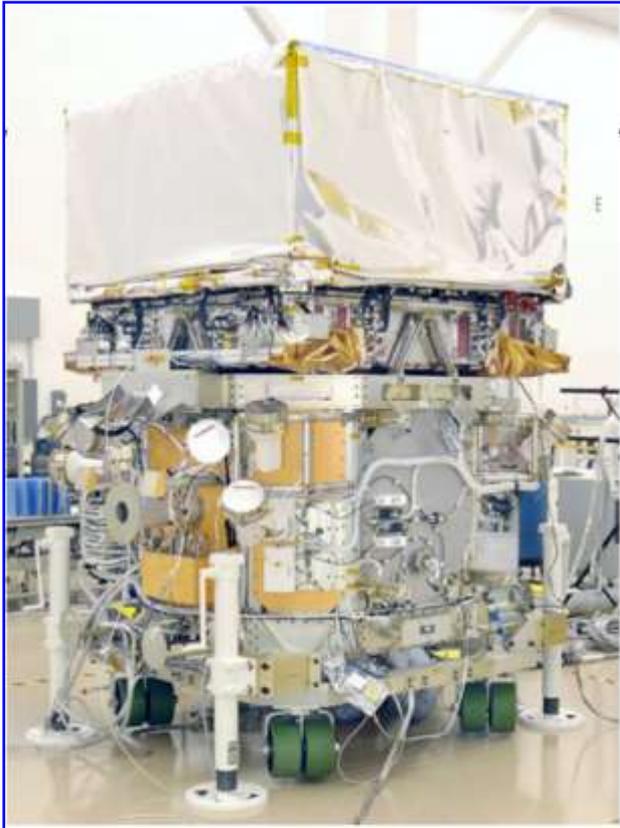
Alexander Moiseev

***CRESST/NASA GSFC and University of
Maryland***

for the Fermi LAT Collaboration

Fermi Gamma-ray Observatory

Two instruments onboard Fermi:



- ✓ Large Area Telescope LAT
 - main instrument, gamma-ray telescope, **20 MeV - >300 GeV energy range**
 - scanning (main) mode - 20% of the sky all the time; all parts of sky for ~30 min. every 3 hours
 - ~ 2.4 sr field of view, **8000 cm² effective area above 1 GeV**
 - high energy (5-10%) and spatial (~3° at 100 MeV and <0.1° at 1 GeV) resolution
 - **1 μs timing, <30 μs dead time**
- ✓ GLAST Burst Monitor GBM

5-year mission (10-year goal), 565 km circular orbit, 25.6° inclination

The LAT Instrument Overview

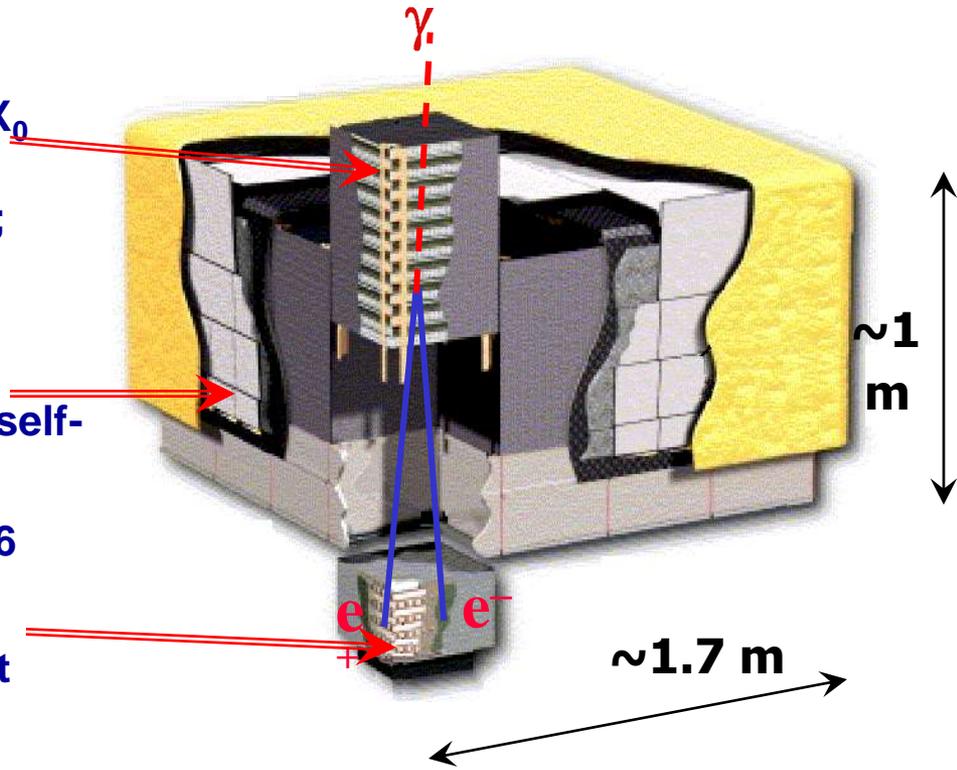
Pair-conversion gamma-ray telescope: 16 identical “towers” providing **conversion of γ into e^+e^- pair** and determination of its arrival direction (Tracker) and energy (Calorimeter). Covered by segmented **AntiCoincidence Detector** which rejects the charged particles background

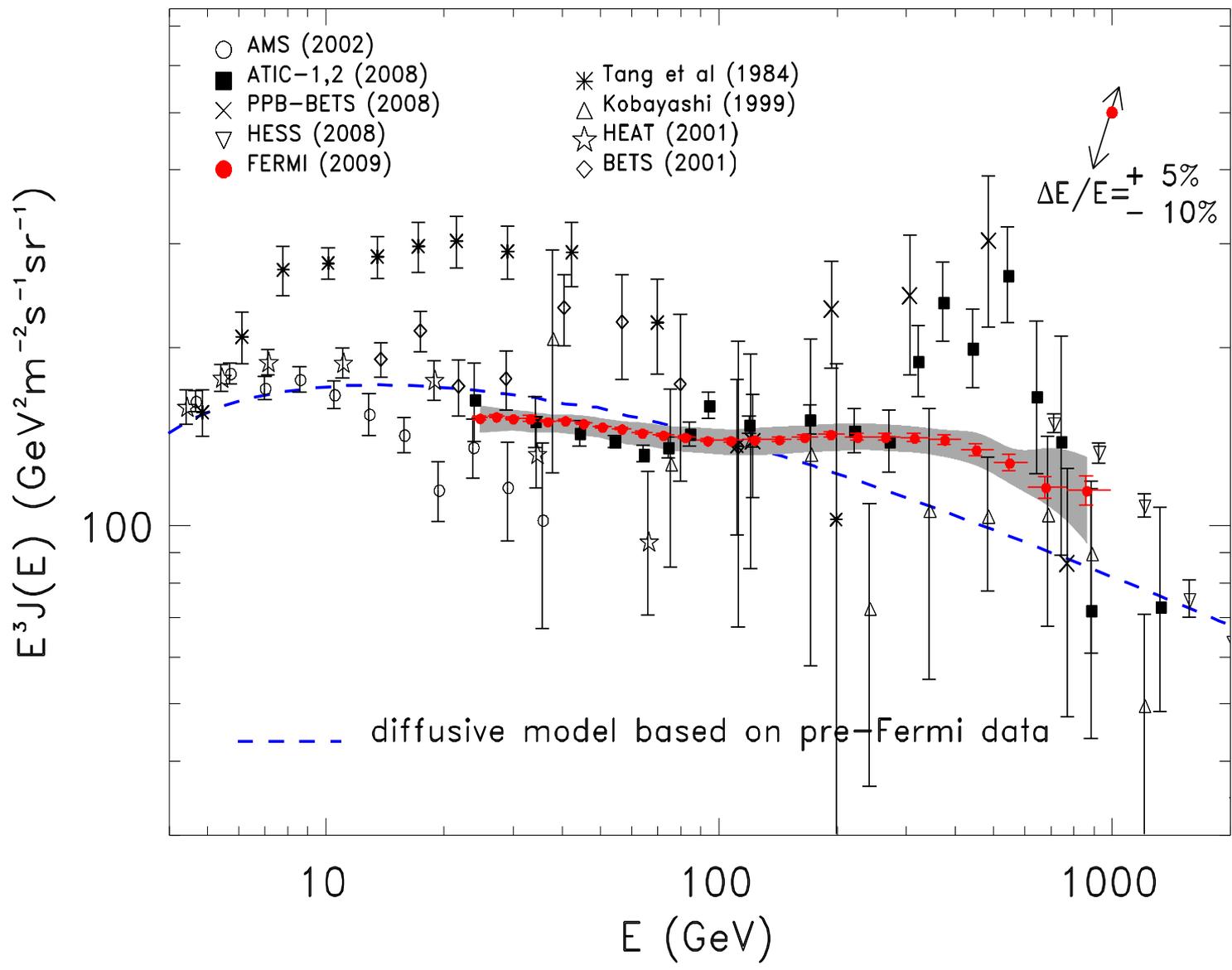
Silicon-stripped tracker: 18 double-plane single-side (x and y) interleaved with 3.5% X_0 thick (first 12) and 18% X_0 thick (next 4) tungsten converters. Strips pitch is 228 μm ; total $8.8 \cdot 10^5$ readout channels

Segmented Anticoincidence Detector: 89 plastic scintillator tiles and 8 flexible scintillator ribbons. Segmentation reduces self-veto effect at high energy.

Hodoscopic CsI Calorimeter Array of 1536 CsI(Tl) crystals in 8 layers.

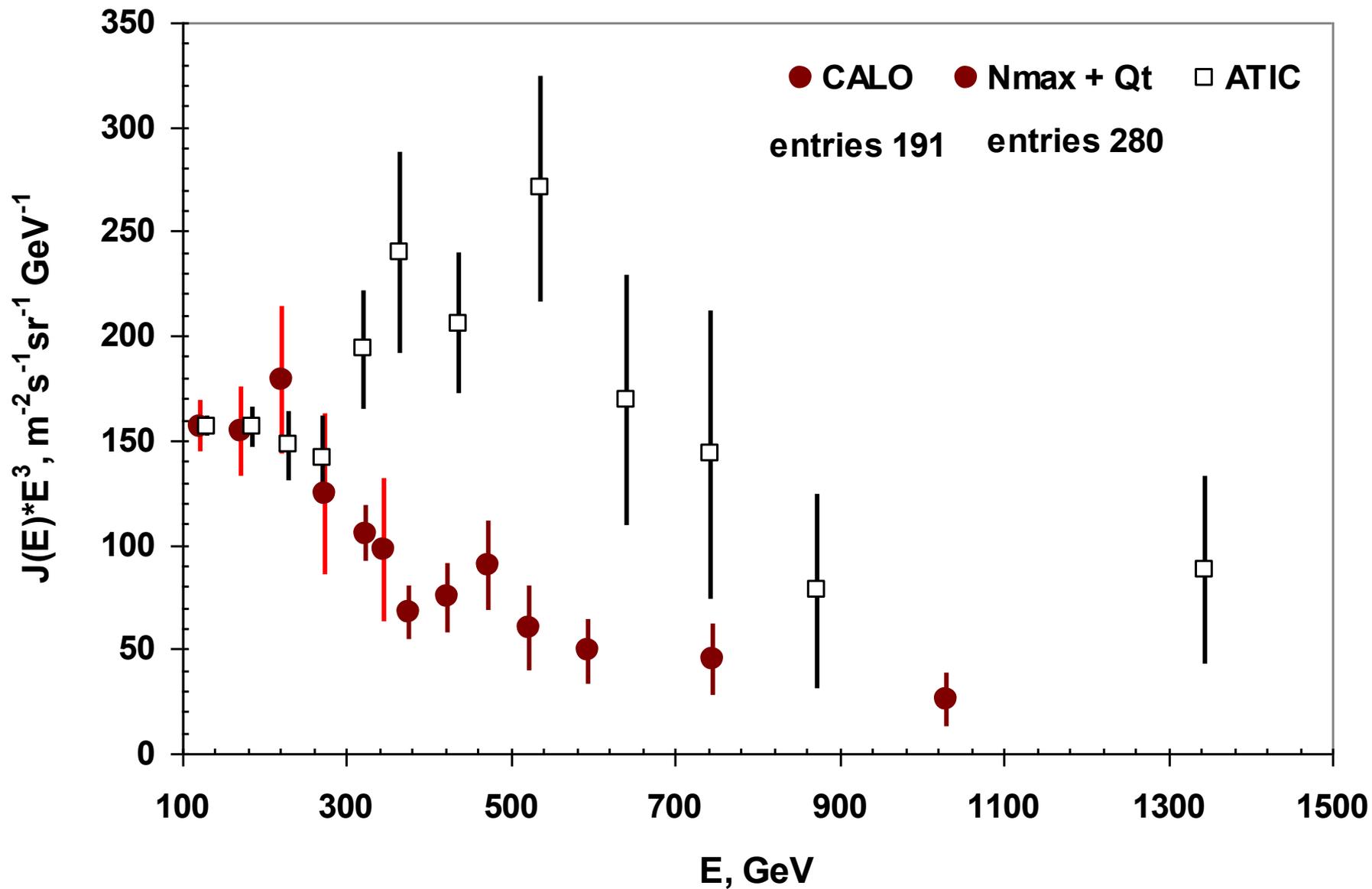
Electronics System Includes flexible, robust hardware trigger and software filters.





Characteristics of ATIK, FERMI and PAMELA instruments

Experiment	ATIC	FERMI	PAMELA
Number of planes in SiM	2	32	12
CALO, radiation units	18.4	8	16.3
Number of planes in CALO	8	8	20
Resolution of plane in CALO, mm	~ 25	~ 1	2.4
Magnet	no	no	yes
ND	no	no	yes
G, cm²sr	~ 2400	Very large	20 or 400



Electron spectrum

$E^3 J(E), \text{GeV}^2 \text{m}^{-2} \text{s}^{-1} \text{sr}^{-1}$

100

300

500

700

900

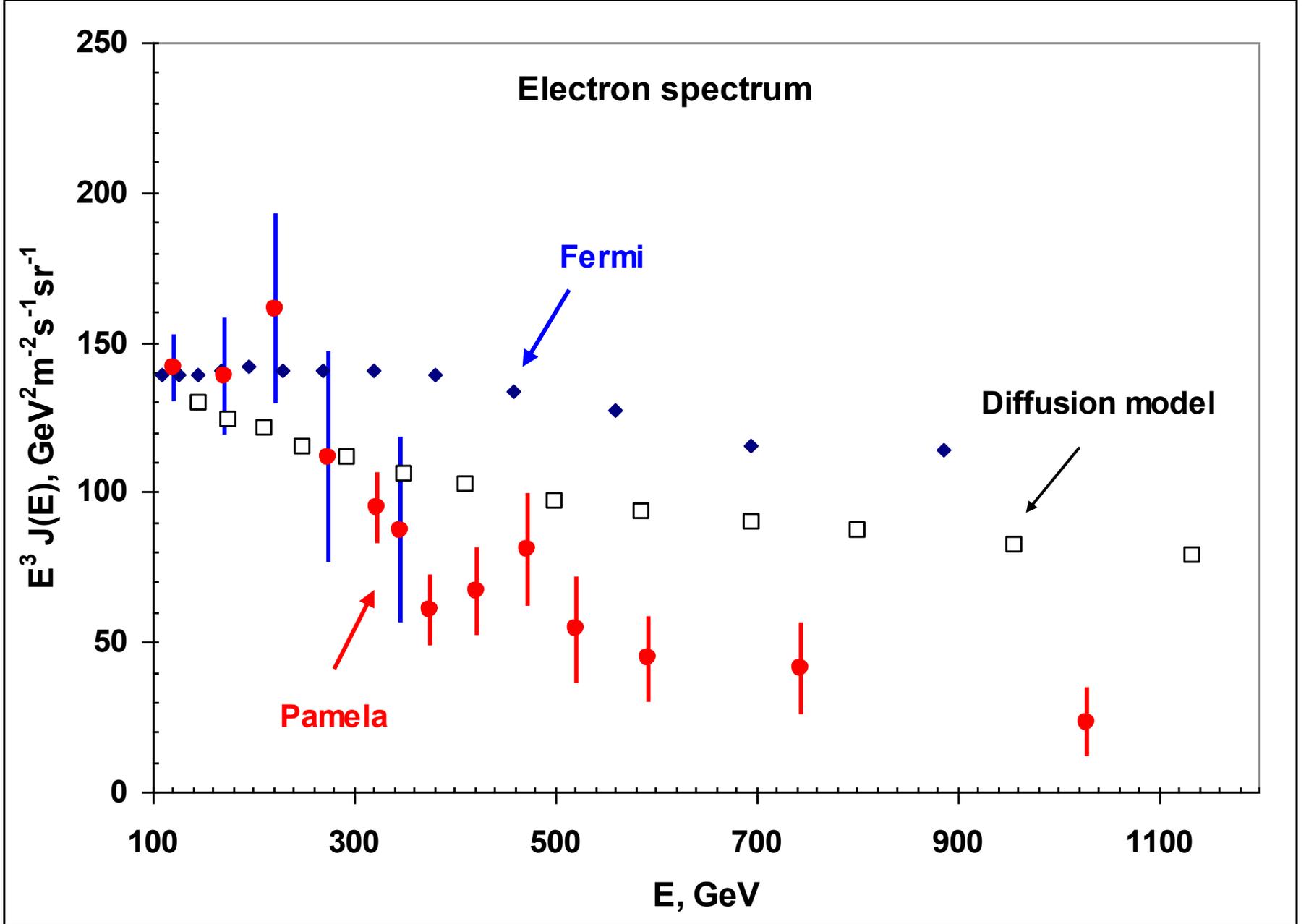
1100

E, GeV

Pamela

Fermi

Diffusion model



Выводы

Спектр высокоэнергичных электронов, полученный в эксперименте ПАМЕЛА, имеет $\gamma \approx 3.1$ в области энергий $E \geq 100$ ГэВ (предварительный результат).

Эти данные не согласуются с данными экспериментов ATIC и FERMI.

Спасибо за внимание

