



## Gruppo II - Firenze



Elena Vannuccini

# Sigle CSN2-Fi 2017

|                   | FISH        | GAPS       | HUMOR       | LISA-PF    | MAGIA-ADV   | SUPREMO    | WIZARD     | VIRGO       |
|-------------------|-------------|------------|-------------|------------|-------------|------------|------------|-------------|
| FTE TOT           | 5,6         | 4,2        | 10,1        | 15,05      | 14,45       | 4,4        | 11,05      | 72,65       |
| P TOT             | 10          | 16         | 15          | 24         | 19          | 11         | 25         | 102         |
| RN                | FI          | TS         | FI          | TIFPA      | FI          | NA         | TS         | GE          |
| FTE FI            | <b>2,7</b>  | <b>0,6</b> | <b>2,9</b>  | <b>2,8</b> | <b>10,7</b> | <b>2,7</b> | <b>1,4</b> | <b>9,6</b>  |
| FTE FI (%)        | <b>48</b>   | <b>14</b>  | <b>29</b>   | <b>19</b>  | <b>74</b>   | <b>61</b>  | <b>13</b>  | <b>13</b>   |
| P FI              | <b>4</b>    | <b>2</b>   | <b>4</b>    | <b>5</b>   | <b>14</b>   | <b>6</b>   | <b>3</b>   | <b>11</b>   |
| FTE/P FI          | <b>0,7</b>  | <b>0,3</b> | <b>0,7</b>  | <b>0,6</b> | <b>0,8</b>  | <b>0,5</b> | <b>0,5</b> | <b>0,9</b>  |
| kEuro 2017        | 102,5       | 53         | 102,5       | 189        | 126         | 77         | 74         | 814         |
| % budget          | 0,70        | 0,36       | 0,70        | 1,29       | 0,86        | 0,52       | 0,50       | 5,55        |
| kEuro FI          | <b>53,5</b> | <b>2</b>   | <b>17,5</b> | <b>10</b>  | <b>118</b>  | <b>31</b>  | <b>7</b>   | <b>60,5</b> |
| kEuro (tot >2005) | 735         | 53         | 493,5       | 2588,8     | 199,5       | 337,5      | 5901,9     | 9957,8      |

Linea scientifica 2: radiazione dall'universo

Linea scientifica 4: onde gravitazionali, fisica generale e quantistica



# Sigle CSN2-Fi 2018

| Sigla      | Start       | End         | FTE (Fi) 2017 | FTE (Fi) 2018 | Sedi                            | RN    |    |
|------------|-------------|-------------|---------------|---------------|---------------------------------|-------|----|
| FISH       | 2015        | 2019        | 2,7           | <b>3,4</b>    | FI+TIFPA                        | FI    | GP |
| GAPS       | 2017        | 2021 ?      | 0,6           | <b>1,3</b>    | FI+PV+RM2+TO+TS                 | TS    | CR |
| HUMOR      | 2013        | 2019        | 2,9           | <b>2,9</b>    | FI+PG+TIFPA                     | FI    | GP |
| LISA-PF    | 2005        | <b>2017</b> | 2,8           |               | FI+NA+RM2+TIFPA                 | TIFPA | GW |
| LISA       | <b>2018</b> |             | -             | <b>4,7</b>    | FI+TIFPA                        | TIFPA | GW |
| MAGIA_A DV | 2016        | 2018 ?      | 10,7          | <b>5</b>      | FI+PI                           | FI    | GP |
| SUPREMO    | 2014        | 2018 ?      | 2,7           | <b>2,6</b>    | FI+NA                           | NA    | GP |
| VIRGO      | <2005       |             | 9,6           | <b>6,6</b>    | FI+GE+NA+PA+PG+PI+RM1+RM2+TIFPA | GE    | GW |
| WIZARD     | <2005       | <b>2017</b> | 1,4           |               | BA+CNAF+FI+LNF+RM2+NA+TS        | TS    | CR |
|            |             |             | <b>33,4</b>   | <b>26,5</b>   |                                 |       |    |

Linea scientifica 2: radiazione dall'universo

Linea scientifica 4: onde gravitazionali, fisica generale e quantistica

Overview scientifica GW  
→ Filippo Martelli

# LISA

Interferometro in orbita eliocentrica di  $5 \cdot 10^6$  Km di braccio → rivelazione di GW

FI+TIFPA

1. Catia Grimani (PA UniUrb) 100%
2. Ruggero Stanga (Ric UniFi) 70%
3. Noemi Finetti (Ric UniAq) 60%
4. Assegnista INFN (da bandire) 100%
5. Simone Benella (dottorando) 100%
6. Daniele Telloni (INAF) 20%
7. Monica Laurenza (INAF) 20%

FTE 4.7



# VIRGO

**Interferometro a terra di braccio 3 km → rivelazione di GW**

(FI+GE+NA+PA+PG+PI+RM1+RM2+TIFPA )

|    |                                              |       |
|----|----------------------------------------------|-------|
| 1. | Giuseppe GRECO (assegnista, 04/2018)         | 100 % |
| 2. | Gianluca Maria GUIDI (PA UniUrb)             | 100 % |
| 3. | Filippo MARTELLI (PA UniUrb)                 | 100 % |
| 4. | Matteo MONTANI (assegnista – 12/20017)       | 100 % |
| 5. | Francesco PIERGIOVANNI (tecnologo UniUrb)    | 100 % |
| 6. | Maria Giuliana STRATTA (assegnista, 07/2018) | 100 % |
| 7. | Flavio VETRANO (PO UniUrb)                   | 0 %   |
| 8. | Andrea VICERÉ (PA UniUrb)                    | 60 %  |

FTE 6.6

(Marica Btanchesi, Jan Harms traferiti)



# Sigle CSN2-Fi 2018

| Sigla      | Start | End    | FTE (Fi) 2017 | FTE (Fi) 2018 | Sedi                            | RN    |    |
|------------|-------|--------|---------------|---------------|---------------------------------|-------|----|
| FISH       | 2015  | 2019   | 2,7           | 3,4           | FI+TIFPA                        | FI    | GP |
| GAPS       | 2017  | 2021 ? | 0,6           | 1,3           | FI+PV+RM2+TO+TS                 | TS    | CR |
| HUMOR      | 2013  | 2019   | 2,9           | 2,9           | FI+PG+TIFPA                     | FI    | GP |
| LISA-PF    | 2005  | 2017   | 2,8           |               | FI+NA+RM2+TIFPA                 | TIFPA | GW |
| LISA       | 2018  |        | -             | 4,7           | FI+TIFPA                        | TIFPA | GW |
| MAGIA_A DV | 2016  | 2018 ? | 10,7          | 5             | FI+PI                           | FI    | GP |
| SUPREMO    | 2014  | 2018 ? | 2,7           | 2,6           | FI+NA                           | NA    | GP |
| VIRGO      | <2005 |        | 9,6           | 6,6           | FI+GE+NA+PA+PG+PI+RM1+RM2+TIFPA | GE    | GW |
| WIZARD     | <2005 | 2017   | 1,4           |               | BA+CNAF+FI+LNF+RM2+NA+TS        | TS    | CR |
|            |       |        | <b>33,4</b>   | <b>26,5</b>   |                                 |       |    |

Overview scientifica  
→ Leonardo Fallani

Linea scientifica 2: radiazione dall'universo

Linea scientifica 4: onde gravitazionali, fisica generale e quantistica

# FISH

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**Fundamental Interactions Simulations with quantum gases**

**Simulazione quantistica con gas atomici di interazioni e processi della fisica delle alte energie**

|    |                         |                  |         |
|----|-------------------------|------------------|---------|
| 1. | <u>Leonardo Fallani</u> | PA UNIFI         | 0.6 FTE |
| 2. | Jacopo Catani           | Ricercatore CNR  | 0.4 FTE |
| 3. | Giacomo Cappellini      | Assegnista UNIFI | 0.8 FTE |
| 4. | Lorenzo Livi            | Dottorando UNIFI | 0.8 FTE |
| 5. | Lorenzo Franchi         | Dottorando       | 0.8 FTE |

FTE 3.4

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# HUMOR

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**Variazioni alla dinamica di un oscillatore meccanico dovute a deformazioni del commutatore x-p.**

|    |                                     |                |      |
|----|-------------------------------------|----------------|------|
| 1. | Chowdhury Avishek<br>(da associare) | Assegnista CNR | 100% |
| 1. | Cataliotti Francesco                | PA             | 50%  |
| 2. | <u>Marin Francesco</u>              | PA             | 70%  |
| 3. | Marino Francesco                    | CNR            | 70%  |

FTE 2.9



# MAGIA-ADV

Interferometro atomico con atomi ultrafreddi → Misure di gravità

|     |                                       |                   |      |
|-----|---------------------------------------|-------------------|------|
| 1.  | Cacciapuoti Luigi                     | Ric.straniero     | 20%  |
| 2.  | D'Amico Giulio                        | Dottorando        | 30%  |
| 3.  | De Angelis Marella                    | Ricercatore UniFi | 10%  |
| 4.  | Fattori Marco                         | PA                | 50%  |
| 5.  | Hu Liang                              | Dottorando        | 50%  |
| 6.  | Poli Nicola                           | Ricercatore UniFi | 40%  |
| 7.  | Salvi Leonardo                        | Dottorando        | 100% |
| 8.  | <u>Tino Guglielmo Maria Associato</u> | PO UniFi          | 60%  |
| 9.  | Vetrano Flavio Associato              | PO UniUrb         | 0%   |
| 10. | Vicerè Andrea Associato               | PA UniUrb         | 40%  |
| 11. | Zhan Su                               | PostDoc           | 100% |

FTE 5 (trasferimento di parte delle attività in CSN5)



# SUPREMO

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**Fascio di molecole stabili fredde interrogato spettroscopicamente in configurazione Ramsey da un laser a cascata quantica riferito allo standard primario di cesio attraverso un pettine di frequenze ottiche.**

**→ Verifica della costanza temporale del rapporto massa protone/elettrone.**

|    |                       |            |     |
|----|-----------------------|------------|-----|
| 1. | Simone Borri          | CNR-INO    | 0.6 |
| 2. | Gabriele Santambrogio | INRIM      | 0.6 |
| 3. | Giacomo Insero        | CNR-INO    | 0.4 |
| 4. | Davide D'Ambrosio     | INRIM      | 0.4 |
| 5. | Paolo De Natale       | CNR-INO    | 0.2 |
| 6. | Maurizio Verde        | Dottorando | 0.4 |

FTE 2.6

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| LISA       | 2018  |        | -             | 4,7           | FI+TIFPA                        | TIFPA | GW |
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| SUPREMO    | 2014  | 2018 ? | 2,7           | 2,6           | FI+NA                           | NA    | GP |
| VIRGO      | <2005 |        | 9,6           | 6,6           | FI+GE+NA+PA+PG+PI+RM1+RM2+TIFPA | GE    | GW |
| WIZARD     | <2005 | 2017   | 1,4           |               | BA+CNAF+FI+LNF+RM2+NA+TS        | TS    | CR |
|            |       |        | <b>33,4</b>   | <b>26,5</b>   |                                 |       |    |

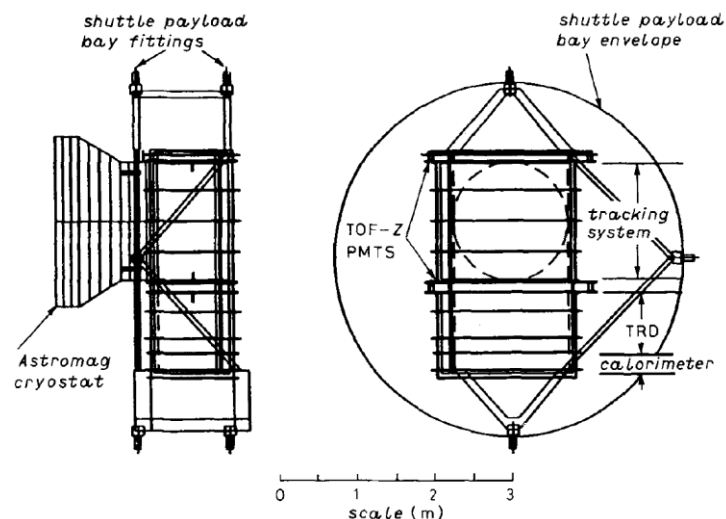
Linea scientifica 2: radiazione dall'universo

Linea scientifica 4: onde gravitazionali, fisica generale e quantistica

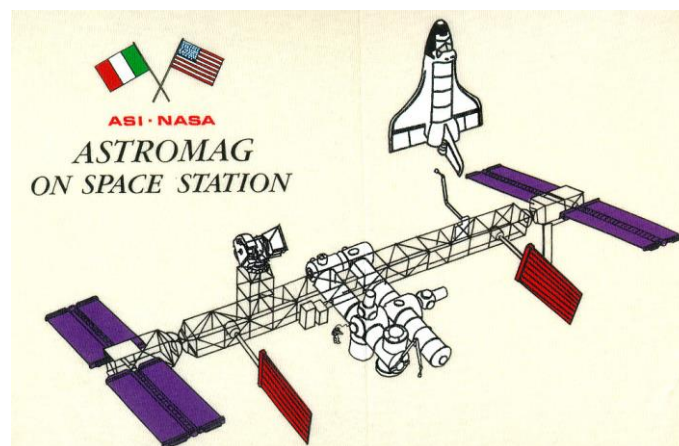
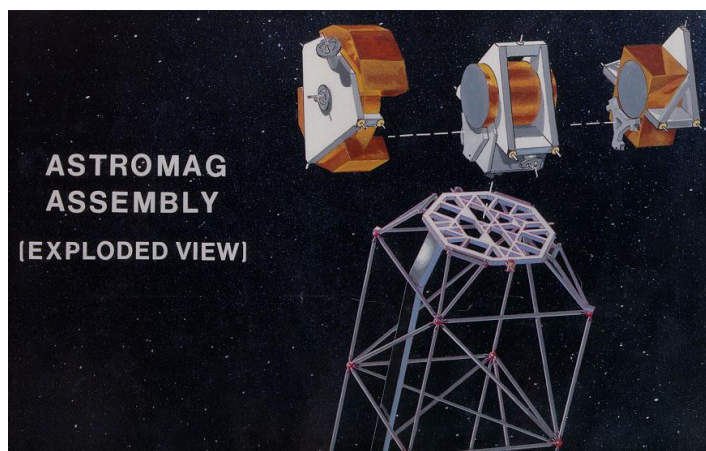


# WIZARD

- ▶ Esperimento US-Italia per ricerca di antimateria di origine primordial
  - ▶ Inizio dell'attività INFN nel campo della rivelazione diretta di raggi cosmici
- ▶ Concepito per la facility Astromag, sulla stazione spaziale Freedom
  - ▶ Progetto spaziale cancellato nel 1990

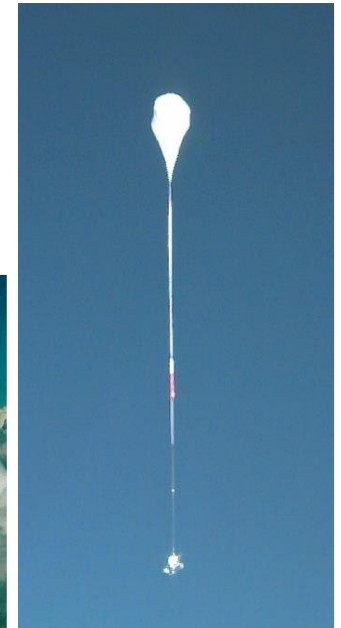
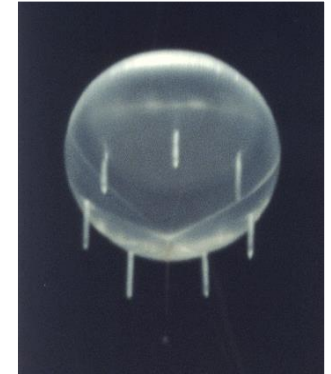
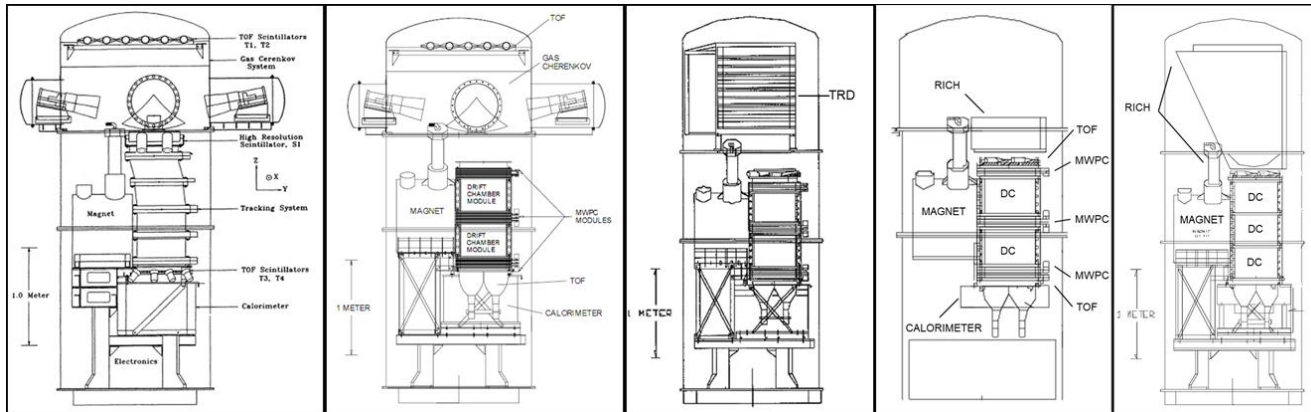


Golden et al N.Cim. 105 (1990) 191



# Voli su pallone

- MASS89/91, TS93, CAPRICE94/98



# The PAMELA experiment



PAMELA flight model



Preparation of pressurized container



RESURS DK1

## MAIN TOPICS:

- CR **antiproton** and **positron** spectra:
  - $\sim 10^4$  antiprotons  $\rightarrow$  80 MeV/c - 190 GeV/c
  - $\sim 10^5$  positrons  $\rightarrow$  50 MeV/c - 270 GeV/c
- search for light antinuclei

## SECONDARY TOPICS:

- Modulation of GCRs in the Heliosphere
- Solar Energetic Particles (SEP)
- Earth Magnetosphere

- PAMELA on board of Russian satellite **Resurs DK1**
- Orbital parameters:
  - inclination  $\sim 70^\circ$  ( $\Rightarrow$  low energy)
  - altitude  $\sim 360$ -600 km (elliptical)
  - active life  $> 3$  years ( $\Rightarrow$  high statistics)
- *Launched on 15<sup>th</sup> June 2006*

## $\rightarrow$ First switch-on on 21<sup>st</sup> June 2006

- Detectors in nominal conditions (no problems due to the launch)
- Tested different trigger and hardware configurations
- Commissioning phase successfully ended on September 15th 2006

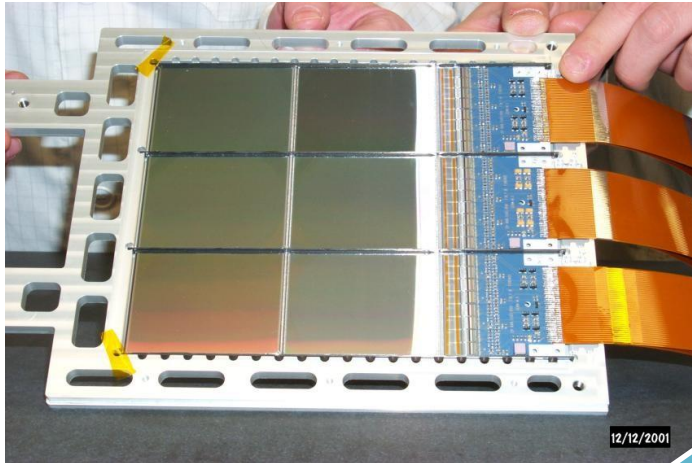


Launch from Baykonur

Missione ufficialmente conclusa nel 2017



# Lo spettrometro magnetico



## Spectrometer

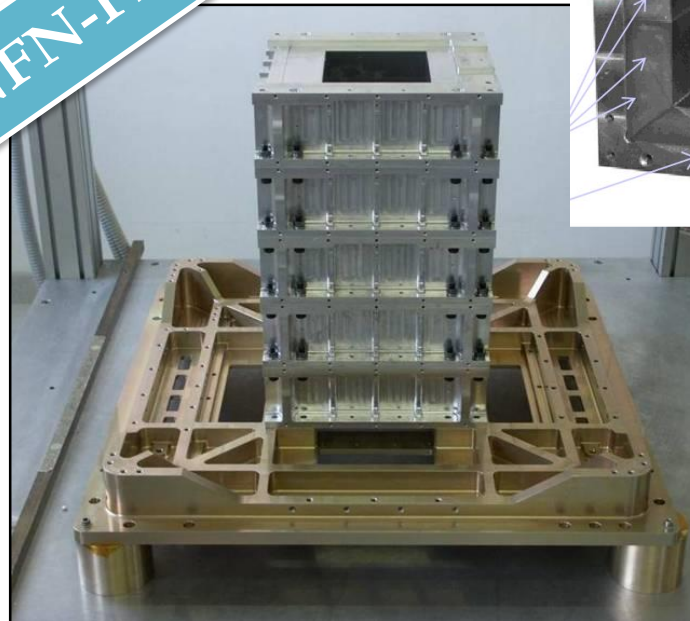
microstrip silicon tracking system + permanent magnet

It provides:

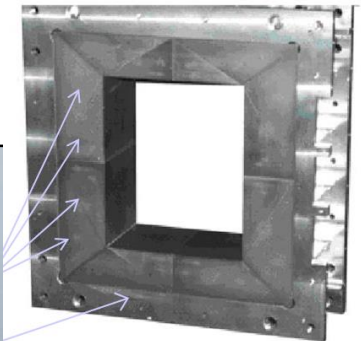
- *Magnetic rigidity* →  $R = pc/Ze$
- *Charge sign*
- *Charge value from  $dE/dx$*

MDR up to 1.2 TV

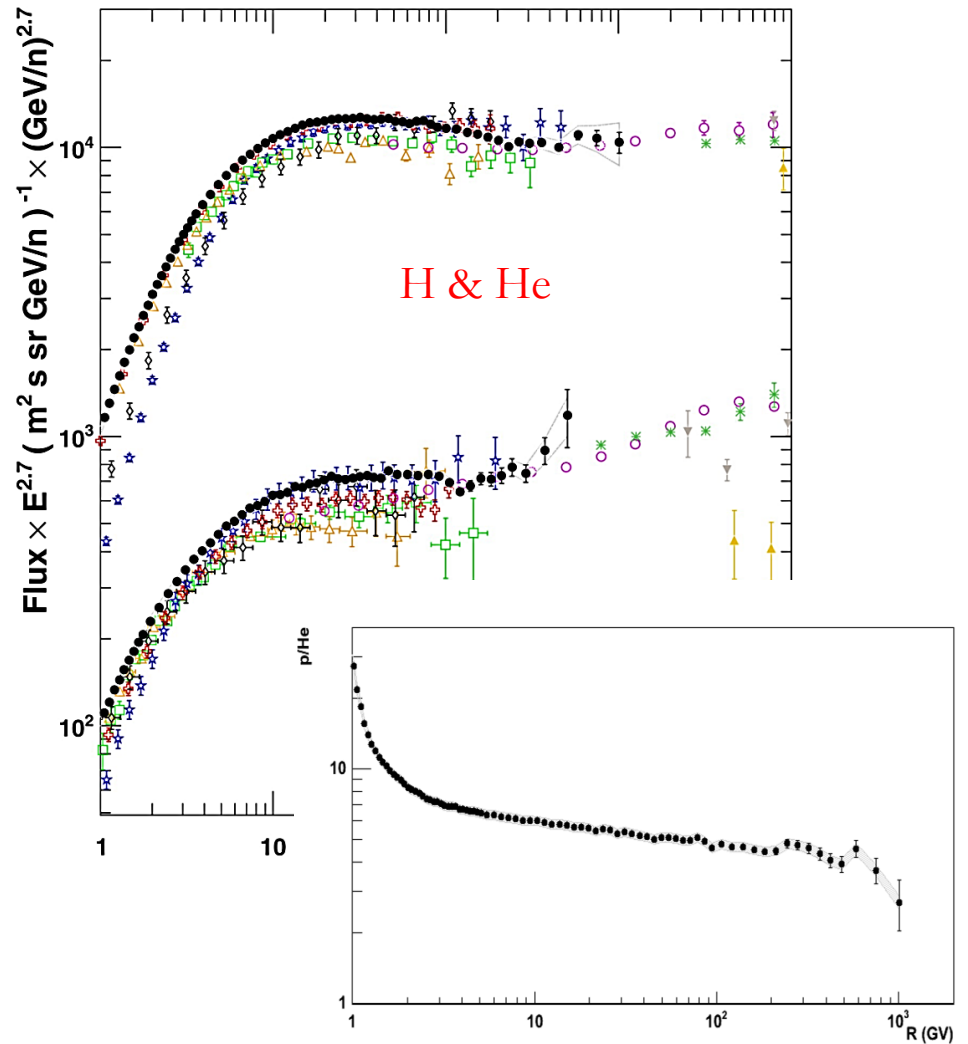
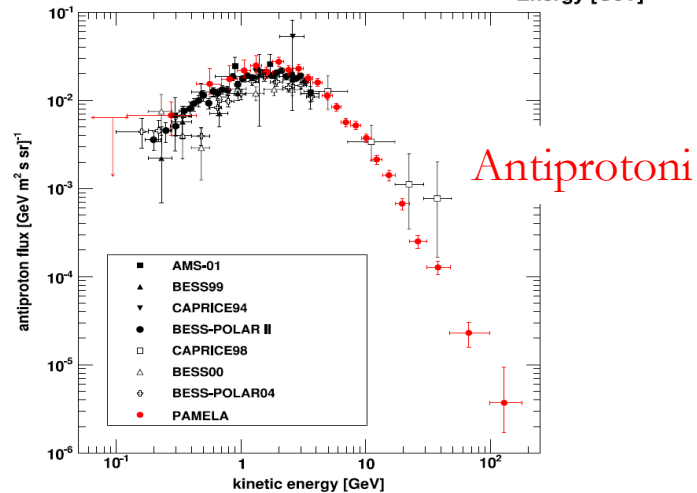
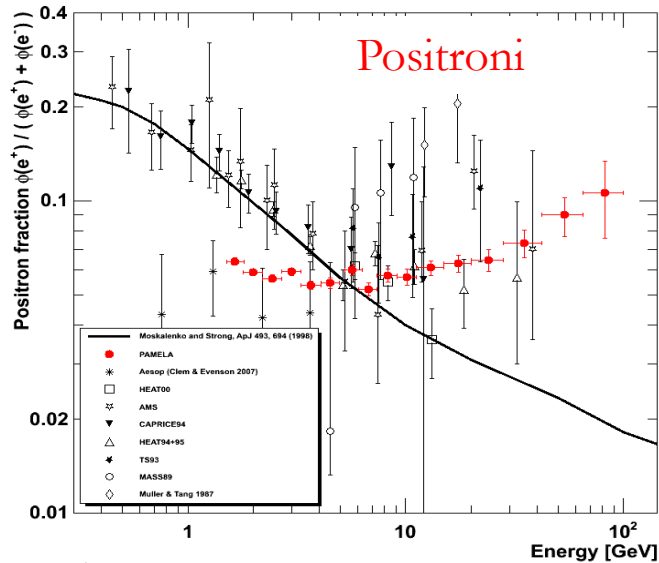
INFN-FI



Magnetic module



# Risultati scientifici (fisica galattica)



# GAPS

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## General Anti-Particle Spectrometer

Studio dei processi fisici di produzione di antiparticelle (antiprotone, antideuterio, antielio) nei raggi cosmici; misure indirette di possibili signature di materia oscura.

|    |                  |      |     |
|----|------------------|------|-----|
| 1. | Sergio Bottai    | INFN | 40% |
| 2. | Paolo Papini     | INFN | 40% |
| 3. | Elena Vannuccini | INFN | 70% |

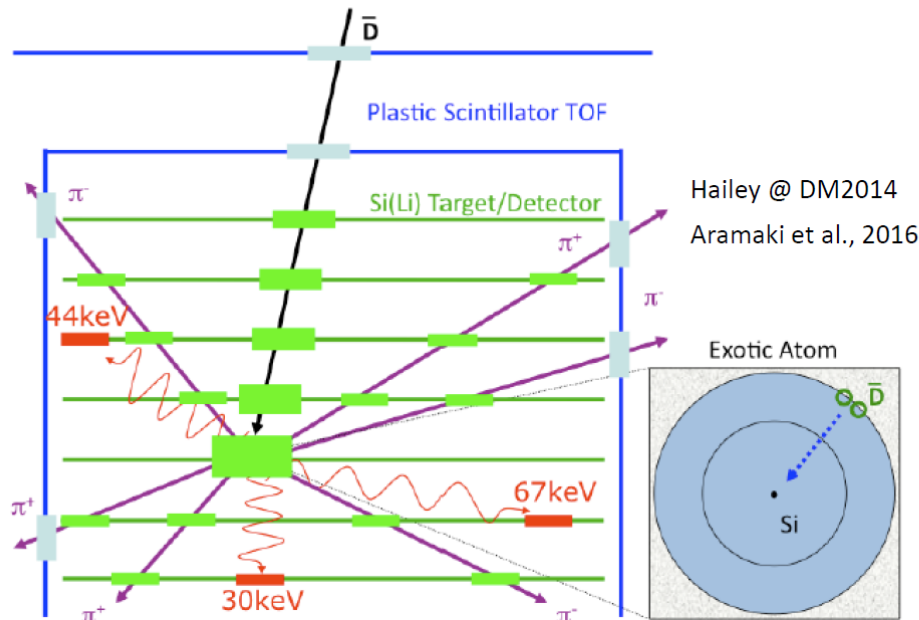
FTE 1,5

@Fi → coordinamento attività italiana di simulazione e analisi

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# GAPS (General Anti-Particle Spectrometer)



Hailey @ DM2014  
Aramaki et al., 2016

$\bar{p} / \bar{D}$  separation based on:

- Time-of-light measurement along antiparticle trajectory
- Multiple dE/dx measurements
- X-ray energies
- Pion/proton multiplicity

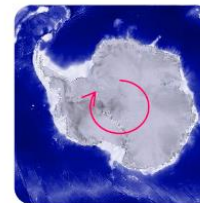
~novel antimatter detection technique

## Detection concept

1. Low-energy antiparticles ( $\bar{p}$ ,  $\bar{D}$ ) slow-down and stop in the medium, forming an **exotic atom** in its **excited state**
2. The atom de-excites via emission of **X-rays**
3. The antiparticle undergoes **annihilation** with atomic nucleus, emitting **pions** and **protons**

Hailey @ DM2014

Approved by  
NASA in October  
2017 for LDB  
flight in 2020/21



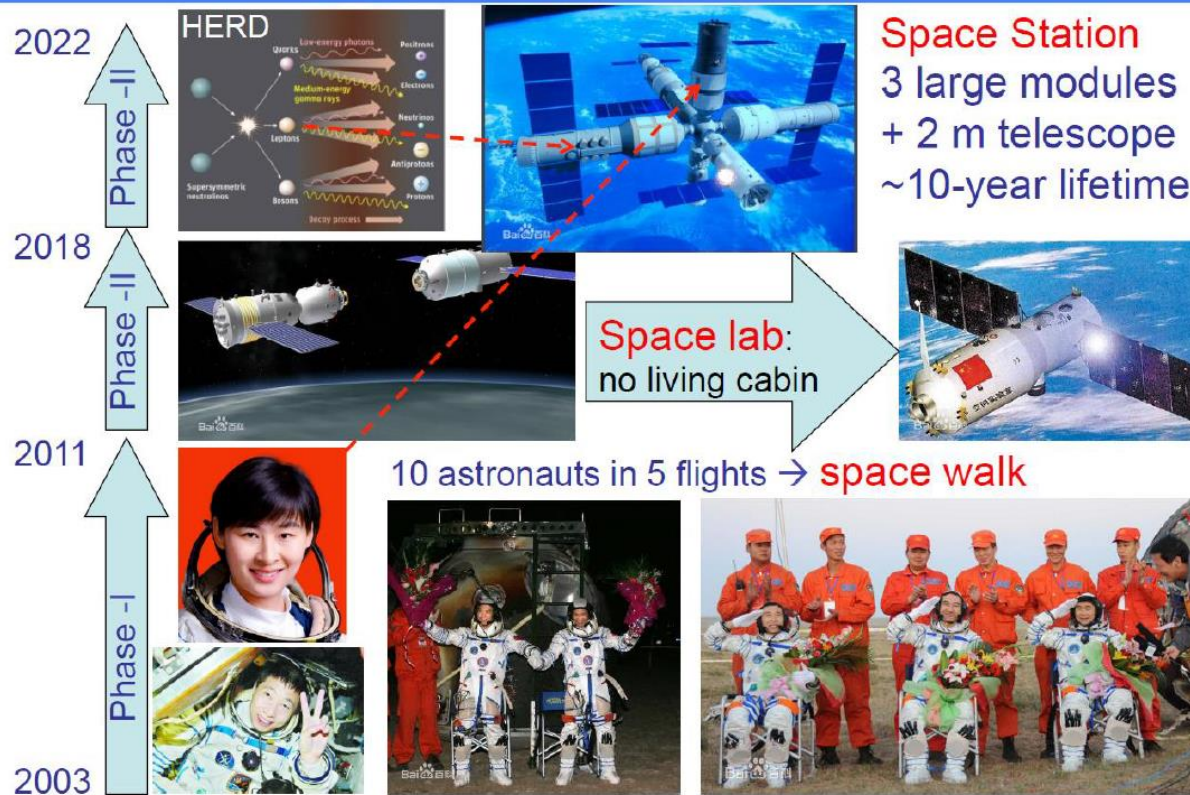
# R&D in CSN5

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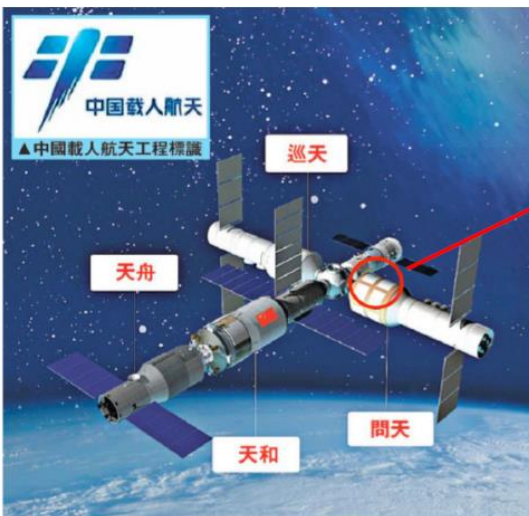
- ▶ R&D per future missioni spaziali:
  - ▶ CaloCube/TIC
    - ▶ Esperimento HERD sulla CSS
  - ▶ LAPUTA
    - ▶ Spettrometri magnetici di prossima generazione



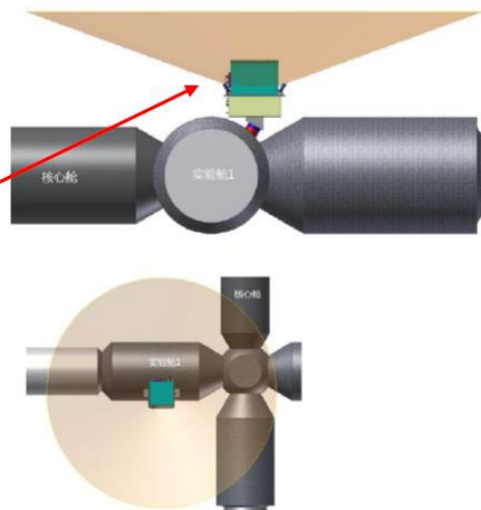
# China's Space Station Program



- High Energy cosmic-Ray Detector (HERD), on board China's space station (2018-2020)
- Part of a long-term DM detection plan, that includes DAMPE



## HERD

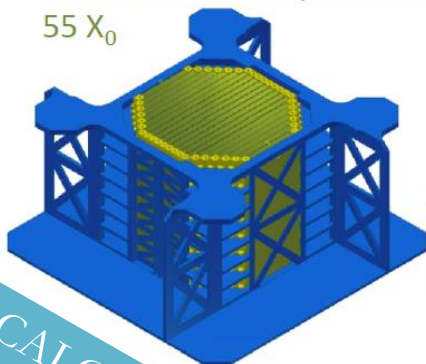


- Performance study for  $\gamma$ -rays under progress
- Preliminary design report within July 2017

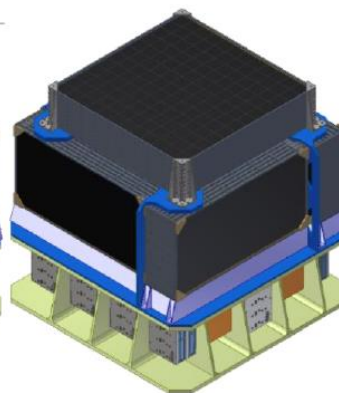
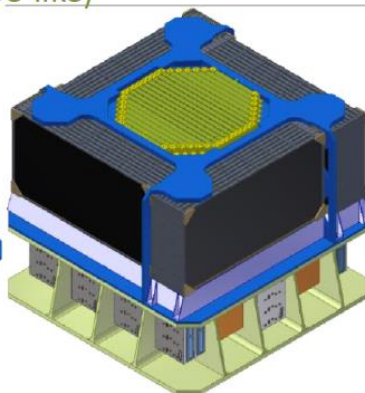
TIC

LYSO calorimeter (CaloCube-like)

$55 X_0$



CALOCUBE



Top+lateral Si/W tracker/converter

$6 \times 0.14 X_0$

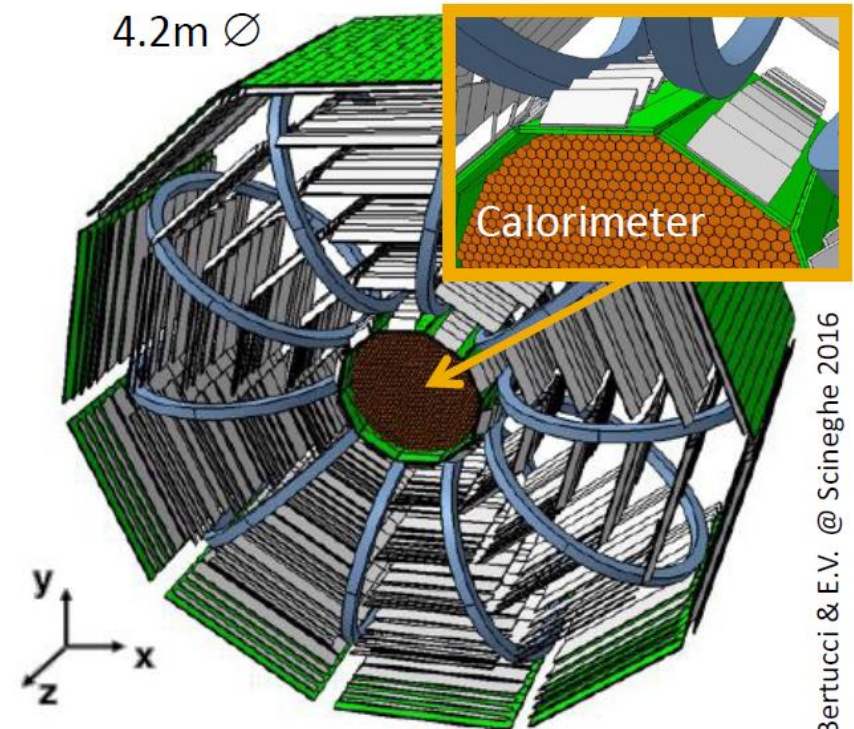
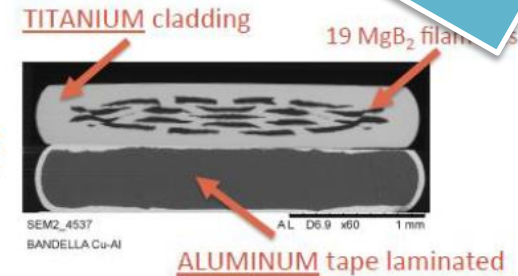
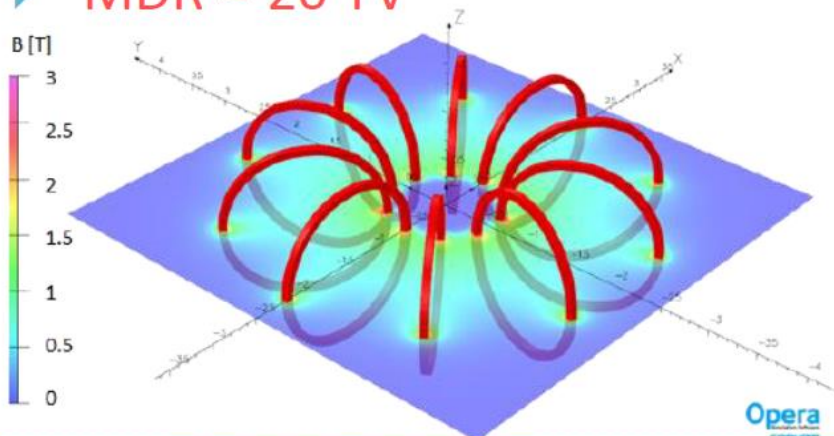
Heritage: Fermi  
DAMPE

$\sim 1.7 \text{ m}^2$  total  
effective area

Vannuccini - CSN2 - 10-12 Aprile 2017

# Next generation spectrometers

- ▶ Must rely on **superconducting magnets**
- ▶ ALADINO magnetic spectrometer
  - ▶ Toroidal superconducting magnet
    - ▶ 10 coils wound with high-temperature (10s°K) superconductor ( $\text{MgB}_2$ )
    - ▶  $\langle B \rangle \sim 0.8$  T average magnetic field
  - ▶ Microstrip silicon tracking system
    - ▶ 4 layer with  $O(\mu\text{m})$  spatial resolution
  - ▶ **MDR  $\sim 20$  TV**



# Richieste 2018 (preliminari)

|              | FISH | GAPS | HUMOR | LISA | MAGIA-<br>ADV | SUPREMO | VIRGO |
|--------------|------|------|-------|------|---------------|---------|-------|
| FTE          | 3.4  | 1.3  | 2.9   | 4.7  | 5             | 2.6     | 6.6   |
| Missioni     |      | 8    |       | 20   | ?             | 8       | 50    |
| Consumo      | 30   |      |       |      | 50            |         | 15    |
| Altri cons   |      |      |       |      |               | 12      |       |
| Trasporti    |      |      |       |      |               |         |       |
| Manutenzione |      |      |       |      | 3             |         |       |
| Inventario   |      |      |       |      |               | 25      | 5     |
| Licenze      |      |      |       |      |               |         |       |
| Apparati     | 20   |      |       |      | 130           |         | 18    |
| Servizi      |      |      |       |      |               |         |       |
| tot          | 50   | 8    | 40    | 20   | 183+          | 45      | 88    |



# Richieste servizi 2018

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| Sigla     | Elettronica<br>(m.u.) | Off.meccanica<br>(m.u.) | Stampante 3D<br>(m.u.) |
|-----------|-----------------------|-------------------------|------------------------|
| FISH      |                       |                         |                        |
| GAPS      |                       |                         |                        |
| HUMOR     |                       |                         |                        |
| LISA      |                       |                         |                        |
| MAGIA_ADV | 1                     | 2                       | 1                      |
| SUPREMO   |                       |                         |                        |
| VIRGO     |                       |                         |                        |

