

# HEAVENS

**Mathias.Beck@unige.ch**  
**ISDC, Geneva Observatory**  
**for the HEAVENS collaboration**

# Thank you

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Lyon, Oct 2010



Aspera workshop



Mathias Beck

# Thank you

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- to the organisers

# Thank you

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- to the organisers
- to Christian NEISSNER

# The ISDC

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# The ISDC

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- **High-energy Astrophysics group at the Geneva Observatory**

# The ISDC

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- **High-energy Astrophysics group at the Geneva Observatory**
- **1995 ESA selects ISDC as the INTEGRAL Science Data Centre**



# The ISDC



Lyon, Oct 2010



Aspera workshop



Mathias Beck



# The ISDC



Lyon, Oct 2010



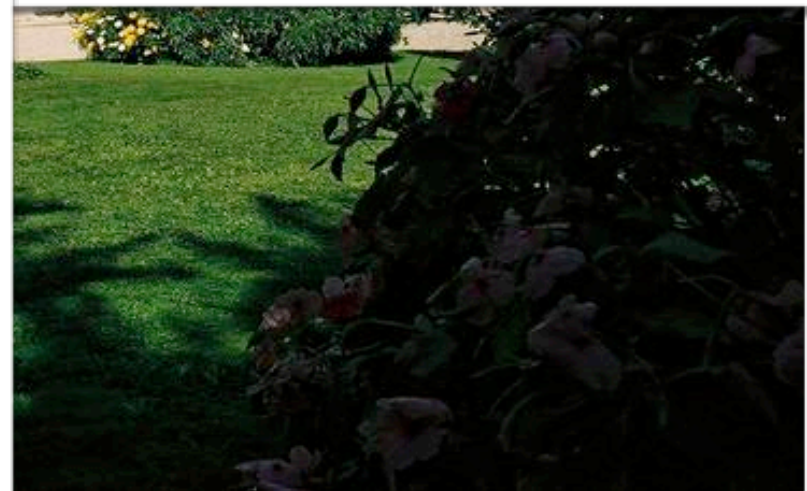
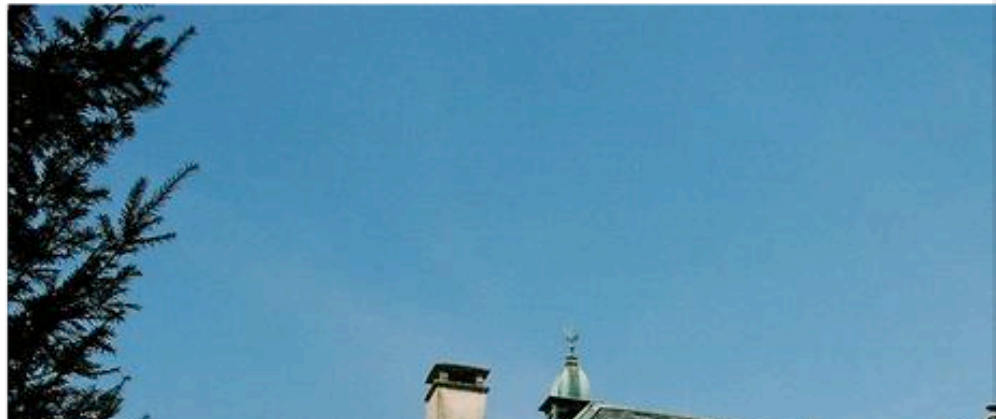
Aspera workshop



Mathias Beck



# The ISDC



Lyon, Oct 2010



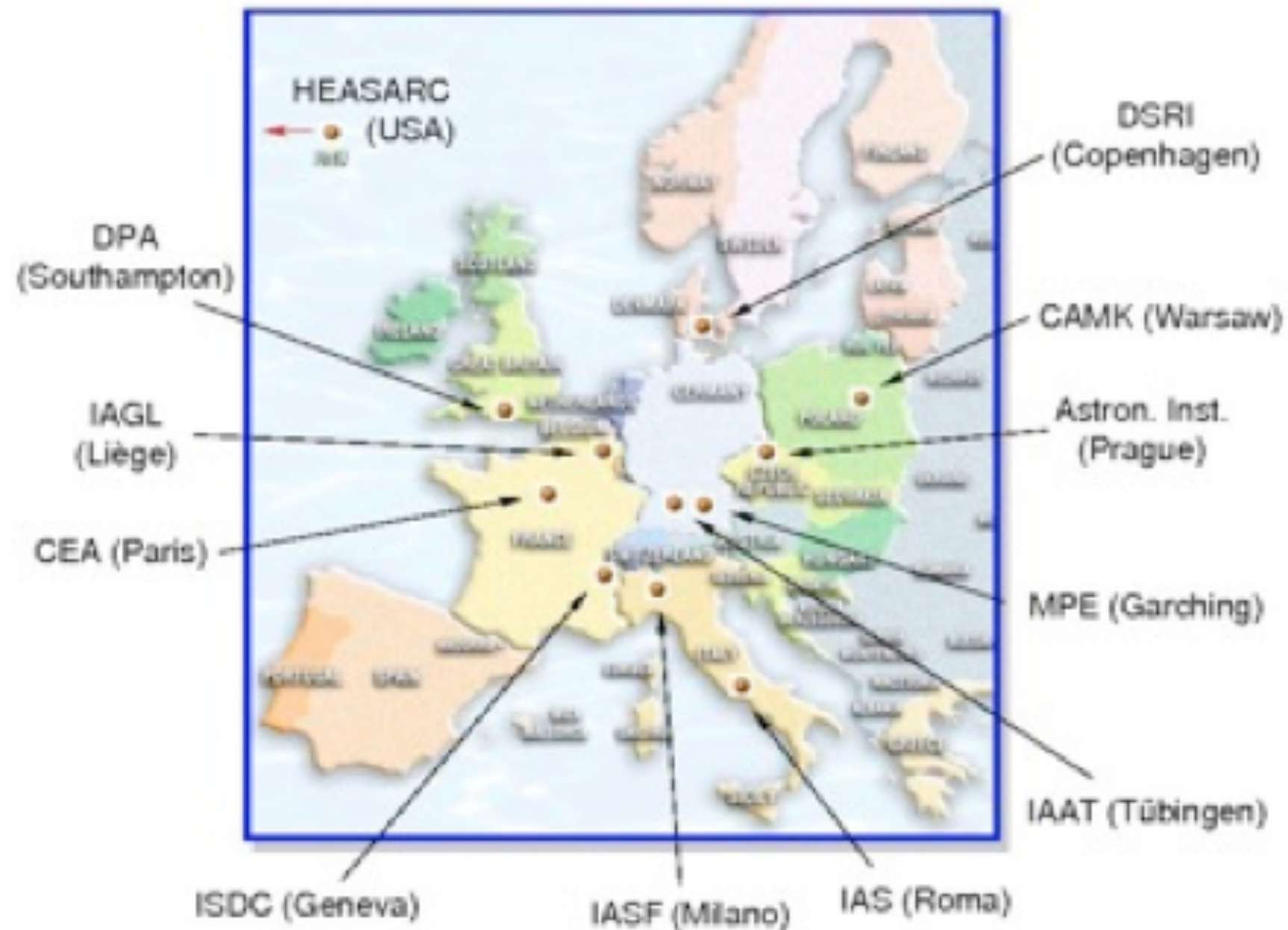
Aspera workshop



Mathias Beck



# The ISDC



# ISDC Reloaded

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## 1995: INTEGRAL Science Data Centre

# ISDC Reloaded

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## 2008: Data Centre for Astrophysics

# ISDC Reloaded

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## 2008: Data Centre for Astrophysics

2010\*: Centre for **Astro**Particles

ISDC and Particle Physics at UniGE

\* awaiting signature

# The ISDC today

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# The ISDC today

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- 50 people

# The ISDC today

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- 50 people
- mission: data centre for HEA

# The ISDC today

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- **50 people**
- **mission: data centre for HEA**
- **serve the scientific community**

# The ISDC today

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- **50 people**
- **mission: data centre for HEA**
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- **foster science and mission impact**

# The ISDC today

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- **50 people**
- **mission: data centre for HEA**
- **serve the scientific community**
- **foster science and mission impact**
- **co-locate engineers, operators and scientists**

# The ISDC today

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- **50 people**
- **mission: data centre for HEA**
- **serve the scientific community**
- **foster science and mission impact**
- **co-locate engineers, operators and scientists**
- **provide critical mass to operate for many years**

# (HEA) projects @ ISDC

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- **INTEGRAL:**  
**Science Data Centre**
- **Planck:**  
**provision of LFI L1 software**
- **Gaia:**  
**DPC for Variability**
- **FACT:**  
**Data Centre**



# (HEA) projects @ ISDC

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**provision of LFI L1 software**
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# (HEA) projects @ ISDC

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- **INTEGRAL:**  
**Science Data Centre**
- **Planck:**  
**provision of LFI L1 software**
- **Gaia:**  
**DPC for Variability**
- **FACT:**  
**Data Centre**



# (HEA) projects @ ISDC

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- **Astro-H:**  
**Filter wheels+Ground segm.**
- **Euclid:**  
**Swiss data centre**
- **IXO:**  
**the longterm goal**
- **CTA:**  
**involved in several WPs**



# ISDC & The Community

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# ISDC & The Community

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- **AHEAD: FP7 proposal to organise the European HEA community**

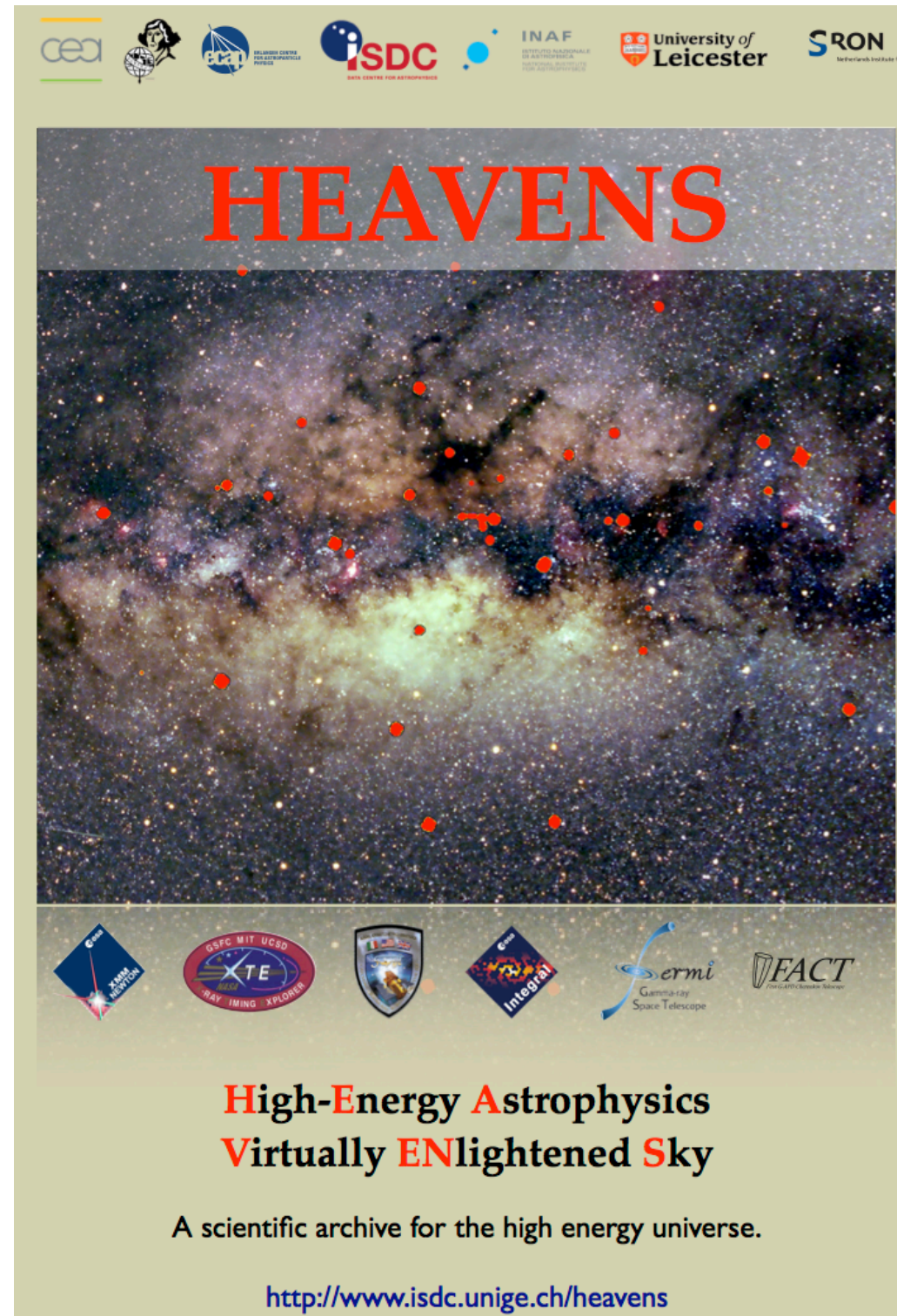
# ISDC & The Community

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- **AHEAD: FP7 proposal to organise the European HEA community**
- **HEAVENS: HEA specific science interface/archive and add-ons to the VO**



# The HEAVENS project



The poster for the HEAVENS project features a central image of a starry sky with numerous red dots scattered across it. The word "HEAVENS" is written in large, bold, red letters at the top. Below the image, there are logos for various institutions: CEA, ESA, ISDC, INAF, University of Leicester, and SRON. At the bottom, there are logos for XMM-Newton, XTE, INTEGRAL, Fermi, and FACT. The text "High-Energy Astrophysics Virtually ENlightened Sky" is written in red and black, followed by "A scientific archive for the high energy universe." and the URL "http://www.isdc.unige.ch/heavens".

**HEAVENS**

High-Energy Astrophysics  
Virtually ENlightened Sky

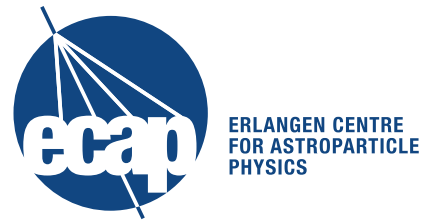
A scientific archive for the high energy universe.

<http://www.isdc.unige.ch/heavens>



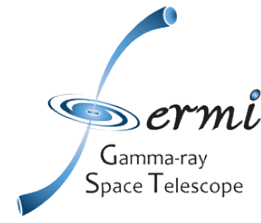
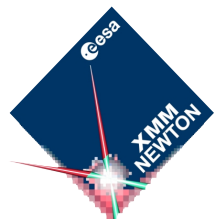
# A collaborative effort ...

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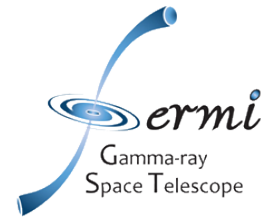
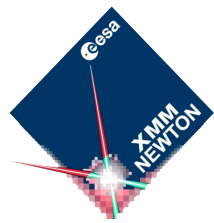
# ... for many HEA missions

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# ... for many HEA missions

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...

# Facts on FACT

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Photomontage



# Facts on FACT

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- **F**irst **G-APD** **C**herenkov **T**elescope



# Facts on FACT

- **F**irst **G-APD** **C**herenkov **T**elescope
- **S**tep stone towards **C**TA



# Facts on FACT

- **F**irst **G-APD** **C**herenkov **T**elescope
- **S**tep stone towards **C**TA
- **E**THZ, **T**U Dortmund, **I**SDC, **E**PFLL, **U**ni **W**ürzburg





# Facts on FACT

- **F**irst **G-APD C**herenkov **T**elescope
- **S**tep stone towards **CTA**
- **E**THZ, **TU** Dortmund, **I**SDC, **E**PFL, **U**ni **W**ürzburg
- **S**tart data taking spring 2011



# Facts on FACT

- **F**irst **G-APD** **C**herenkov **T**elescope
- **S**tep stone towards **C**TA
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- **S**tart data taking spring 2011
- **100 TB** of **RAW** data / year



# Facts on FACT

- **F**irst **G-APD** **C**herenkov **T**elescope
- **S**tep stone towards **C**TA
- **E**THZ, **T**U Dortmund, **I**SDC, **E**PFLL, **U**ni **W**ürzburg
- **S**tart data taking spring 2011
- **100** TB of **RAW** data / year
- **D**ata will become immediately public



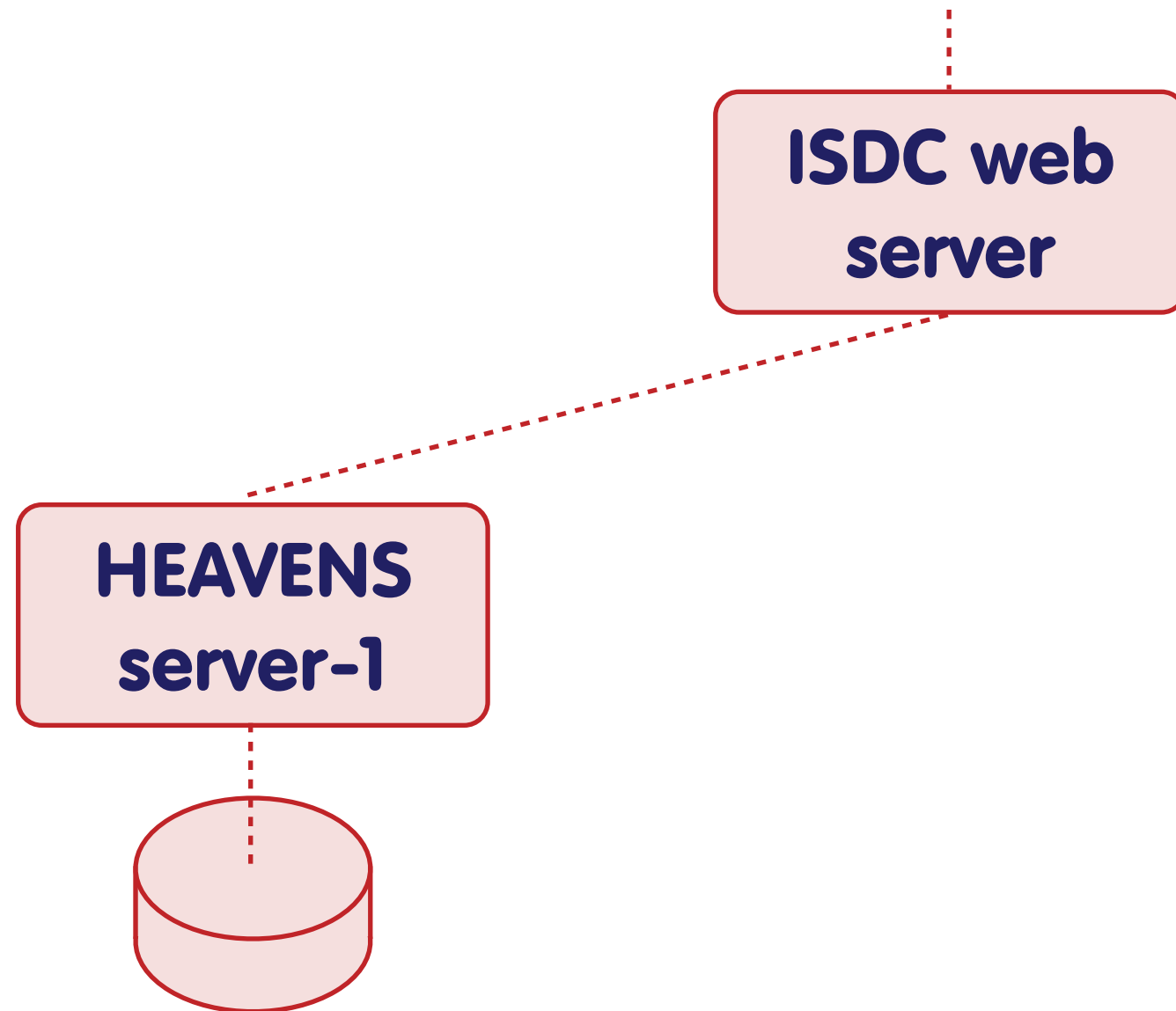
# HEAVENS - the high level view

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ISDC web  
server

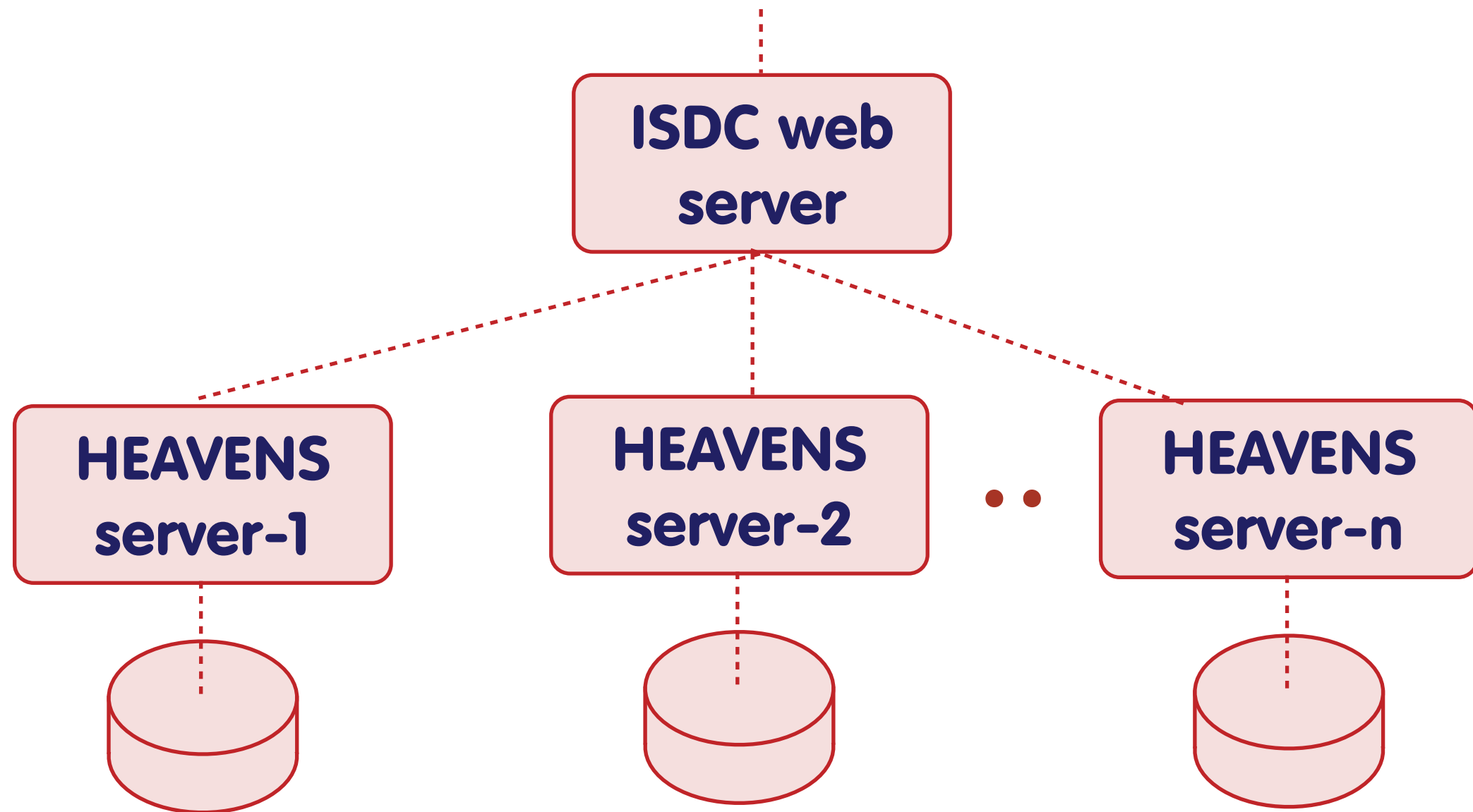
# HEAVENS - the high level view

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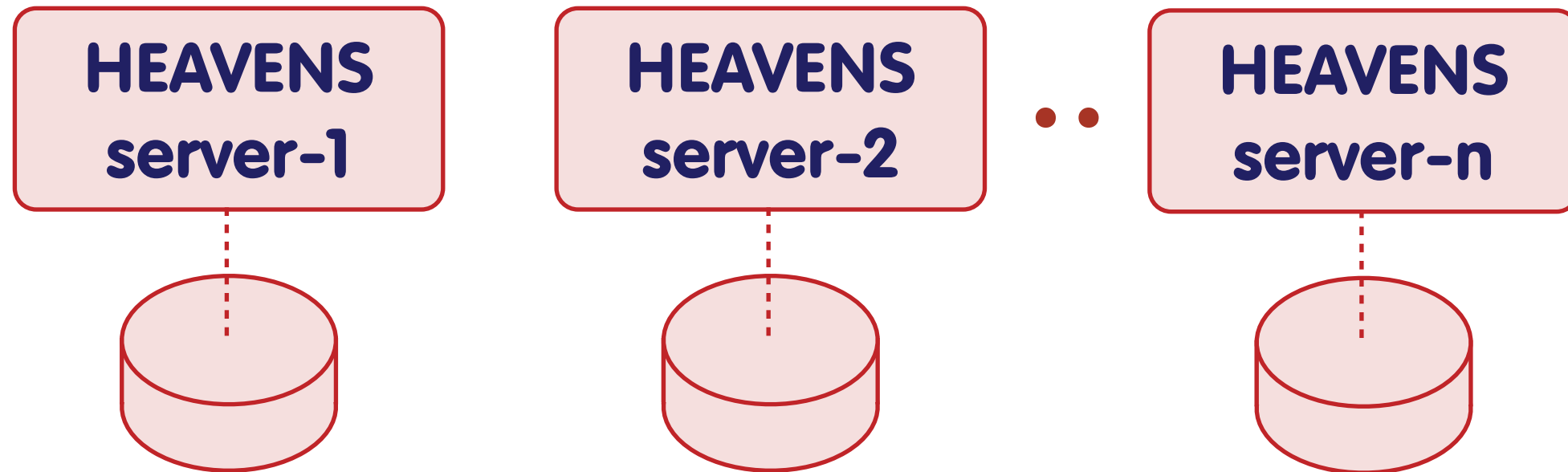
# HEAVENS - the high level view

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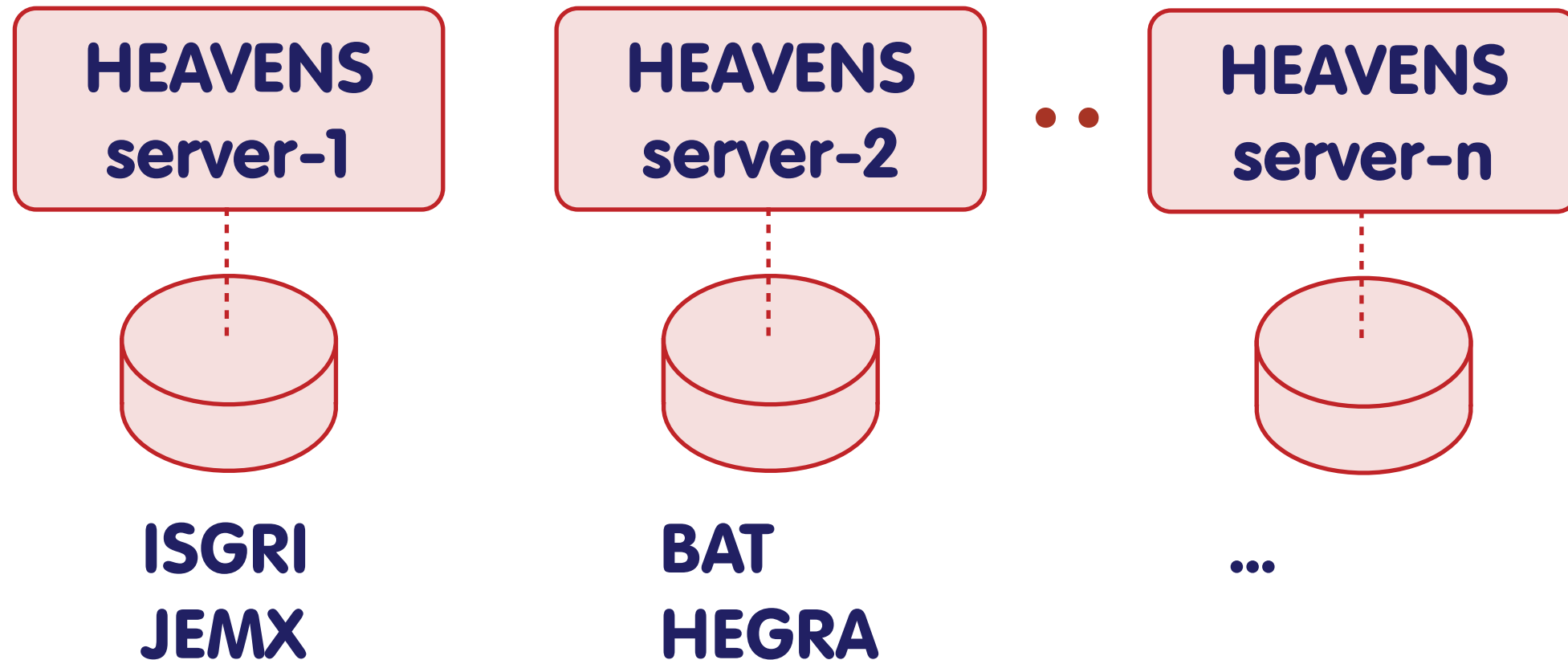
# HEAVENS - the high level view

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# HEAVENS - the high level view

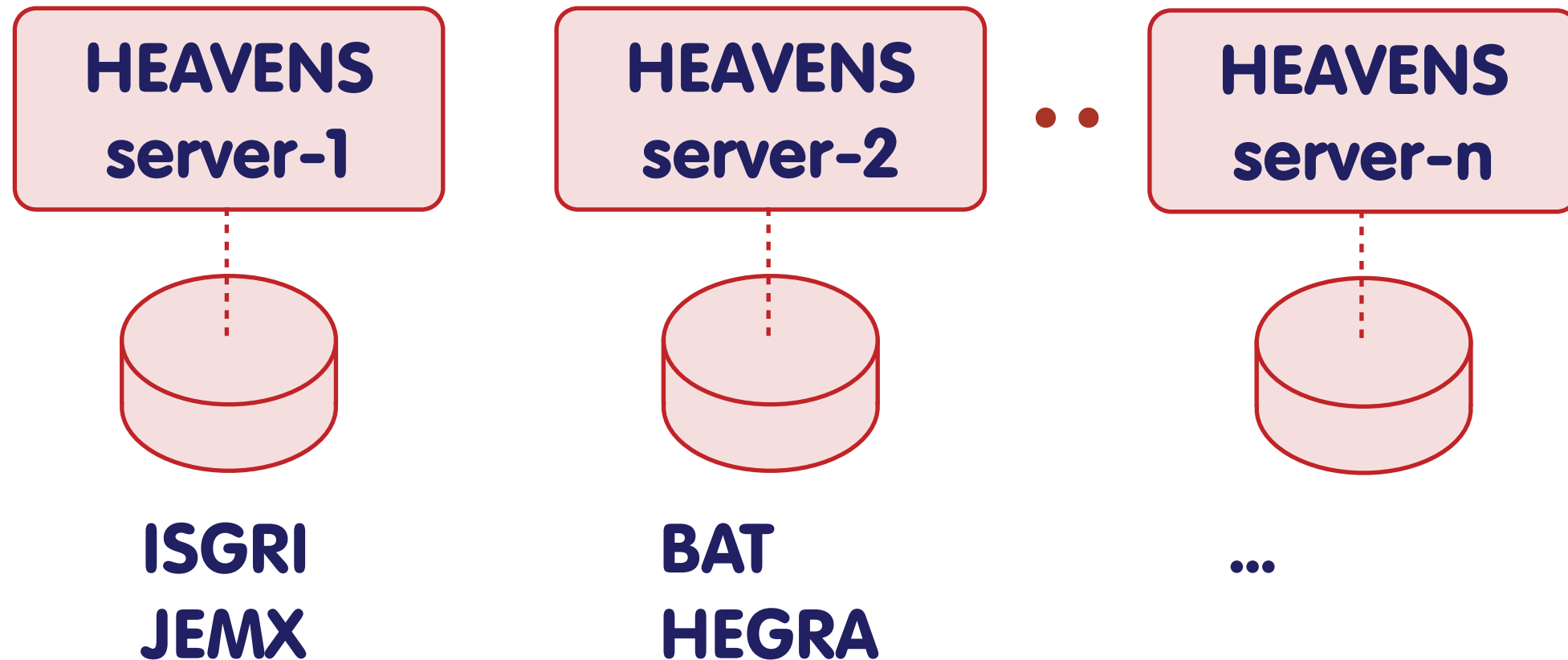
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# HEAVENS - the high level view

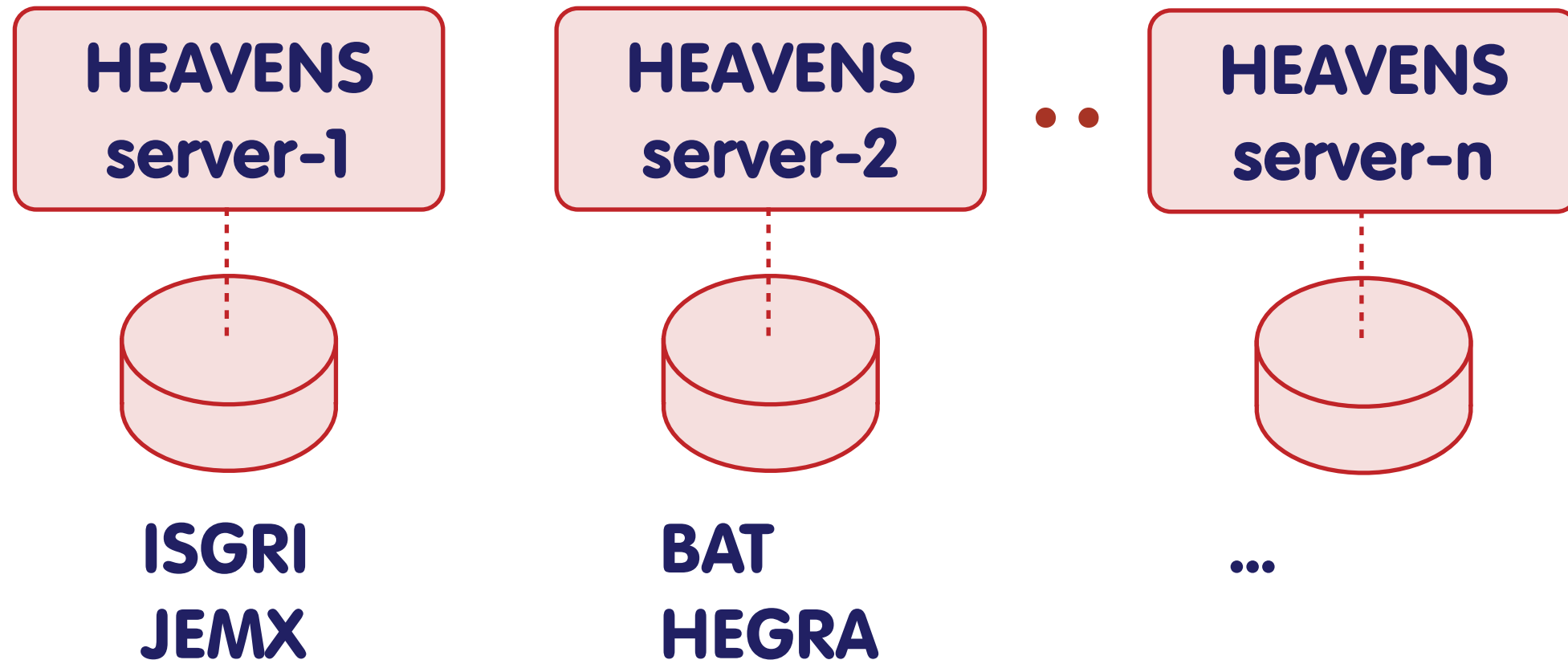
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**static serving:**

**image-files / object  
lc-files / object  
spectra-files / object**

# HEAVENS - the high level view



**static serving:**

**image-files / object  
lc-files / object  
spectra-files / object**

**dynamic serving:**

**pixel-files / position  
lc-files / object**



## HEAVENS

## HEAVENS

Welcome

Querying **NEW**

Architecture

VO Support

Enhancements

References

## INTEGRAL news

- Complete ISGRI, OMC, SPI-ACS, IREM data are now available in HEAVENS.
- Complete JEM-X data are expected in late September.

## Query parameters

[About](#) [Citing](#) [Help](#)
Source name: or RA DEC:   Equatorial FK5 Time interval:   MJD (TT) 
 INTEGRAL OMC
  INTEGRAL JEM-X
  **INTEGRAL ISGRI**
 INTEGRAL PICsIT  
 INTEGRAL SPI
  INTEGRAL SPI ACS
  HEGRA
  INTEGRAL IREM

Sky image

Energy band [keV]:  
 Lightcurve  
 with bin size  hours 
Min - Max:    
 Spectrum



# HEAVENS

## HEAVENS

Welcome

Querying **NEW**

Architecture

VO Support

Enhancements

References

### INTEGRAL news

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### Query parameters

[About Citing](#) [Help](#)

Source name:

or RA

Time

Equatorial FK5

MJD (TT)

- INTEGRAL SPI ACS
- JEM-X
- INTEGRAL ISGRI
- INTEGRAL PICsIT
- INTEGRAL SPI ACS
- HEGRA
- INTEGRAL IREM

Energy band [keV]: 17.3-80.0

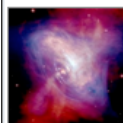
Min - Max: 13.0 520.9

hours

Submit Reset

**Processing on Demand**

Crab






The Crab Nebula (catalogue designations M 1, NGC 1952, Taurus A) is a supernova remnant and pulsar wind nebula in the constellation of Taurus. At the center of the nebula lies the Crab pulsar, a rotating neutron star, which emits pulses of radiation from gamma rays to radio waves with a spin rate of 30.2 times per second. The nebula was the first astronomical object identified with a historical supernova explosion.

RA 83.6332 » SIMBAD  
 DEC 22.0145 » ADS  
 RA 05:34:32.0  
 DEC +22:00:52  
 l 184.5575  
 b -5.7843

Instruments detecting light

 <b>INTEGRAL OMC</b> V band 	V band  TXT FITS	<ul style="list-style-type: none"> <li>» About OMC</li> <li>» OMC products</li> <li>» Analysis software</li> <li>» Archive data</li> </ul>
 <b>INTEGRAL JEM-X</b> 3 - 35 keV 	3.0-10.2 keV  PNG FITS 3.0-10.2 keV  TXT FITS Counts  PNG EPS FITS Photons  PNG EPS FITS	<ul style="list-style-type: none"> <li>» About JEM-X</li> <li>» JEM-X products</li> <li>» Analysis software</li> <li>» Archive data</li> </ul>
 <b>SWIFT BAT</b> 15 - 150 keV 	15.0-148.8 keV  PNG FITS 15.0-148.8 keV  TXT FITS Counts  PNG EPS FITS Photons  PNG EPS FITS	<ul style="list-style-type: none"> <li>» About BAT</li> <li>» BAT products</li> <li>» Analysis software</li> <li>» Archive data</li> </ul>
 <b>INTEGRAL ISGRI</b> 13 keV - 1 MeV 	17.3-80.0 keV  PNG FITS 17.3-80.0 keV  TXT FITS Counts  PNG EPS FITS Photons  PNG EPS FITS	<ul style="list-style-type: none"> <li>» About ISGRI</li> <li>» ISGRI products</li> <li>» Analysis software</li> <li>» Archive data</li> </ul>
 <b>INTEGRAL PICsIT</b> 200 keV - 6 MeV 	Counts  PNG EPS FITS Photons  PNG EPS FITS	<ul style="list-style-type: none"> <li>» About PICsIT</li> <li>» PICsIT products</li> <li>» Analysis software</li> <li>» Archive data</li> </ul>
 <b>INTEGRAL SPI</b> 20 keV - 8 MeV 	Counts  PNG EPS FITS Photons  PNG EPS FITS	<ul style="list-style-type: none"> <li>» About SPI</li> <li>» SPI products</li> <li>» Analysis software</li> <li>» Archive data</li> </ul>
 <b>INTEGRAL SPI ACS</b> 80 keV - 8 MeV 	80keV-8MeV  TXT FITS	<ul style="list-style-type: none"> <li>» About SPI</li> <li>» SPI ACS products</li> <li>» Analysis software</li> <li>» Archive data</li> </ul>
 <b>FERMI LAT</b> 0.1 - 100 GeV 	15.0-148.8 GeV  PNG FITS 15.0-148.8 GeV  TXT FITS Counts  PNG EPS FITS Photons  PNG EPS FITS	<ul style="list-style-type: none"> <li>» About LAT</li> </ul>
 <b>HEGRA</b> 0.5 - 100 TeV	0.5-5 TeV  PNG FITS 0.5-100 TeV  PNG FITS 5-100 TeV  PNG FITS 0.5-100 TeV  TXT FITS	<ul style="list-style-type: none"> <li>» About HEGRA</li> </ul>

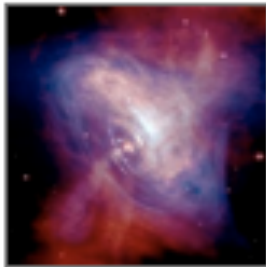
Instruments detecting particles

 <b>INTEGRAL IREM</b> >0.5 MeV 	TC3 - E(e) > 0.5 MeV  TXT FITS	<ul style="list-style-type: none"> <li>» About IREM</li> <li>» IREM products</li> <li>» Analysis software</li> <li>» Archive data</li> </ul>
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# HEGRA in HEAVENS

## Crab



The Crab Nebula (catalogue designations M 1, NGC 1952, Taurus A) is a supernova remnant and pulsar wind nebula in the constellation of Taurus. At the center of the nebula lies the Crab pulsar, a rotating neutron star, which emits pulses of radiation from gamma rays to radio waves with a spin rate of 30.2 times per second. The nebula was the first astronomical object identified with a historical supernova explosion.

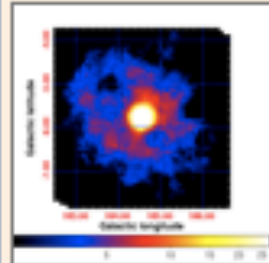
RA	83.6332	» SIMBAD
DEC	22.0145	» ADS
RA	05:34:32.0	
DEC	+22:00:52	
l	184.5575	
b	-5.7843	

## Instruments detecting light



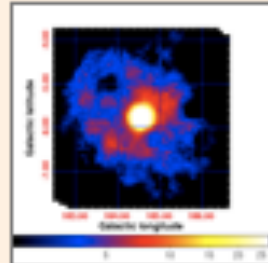
**HEGRA**  
0.5 - 100 TeV

0.5 - 5 TeV



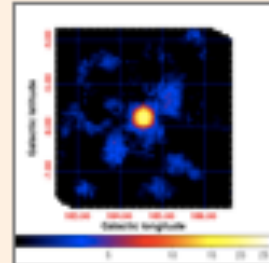
PNG FITS

0.5 - 100 TeV



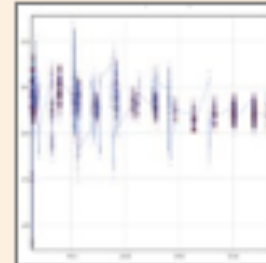
PNG FITS

5 - 100 TeV



PNG FITS

0.5 - 100 TeV



TXT FITS

» [About HEGRA](#)

# HEGRA in HEAVENS

## Crab



The Crab Nebula (catalogue designations M 1, NGC 1959, and SNR A) is a supernova remnant and pulsar wind nebula in the constellation of Taurus. At the center of the nebula is the Crab pulsar, a rotating neutron star, which emits radiation from gamma rays to radio waves with a spin period of 33 milliseconds per second. The nebula was the first astronomical object identified with a historical supernova explosion.

RA	05:34:32.0	» SIMBAD
DEC	+22:00:52	» ADS
l	184.5575	
b	-5.7843	

## Instruments detecting light



**HEGRA**  
0.5 - 100 TeV

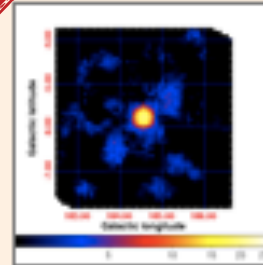
0.5 - 5 TeV



PNG

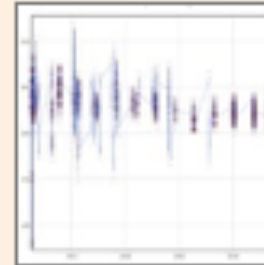
PNG FITS

5 - 100 TeV



PNG FITS

0.5 - 100 TeV

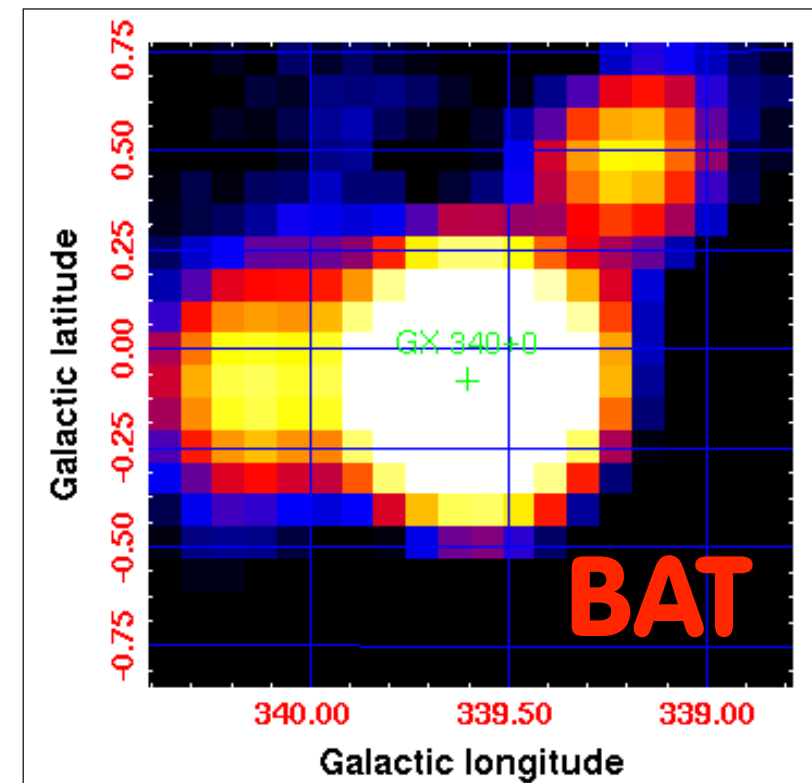
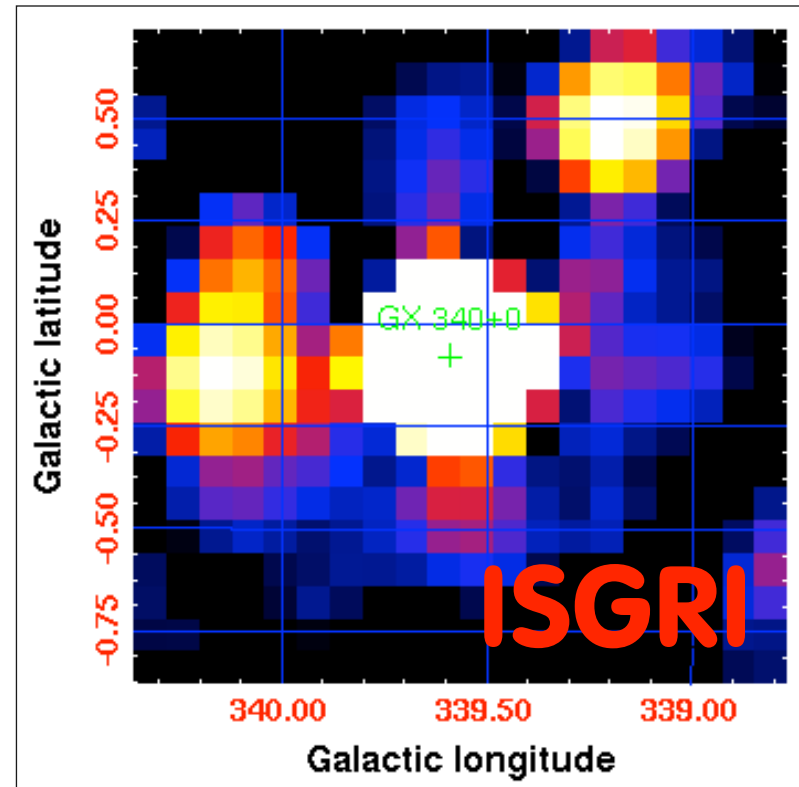
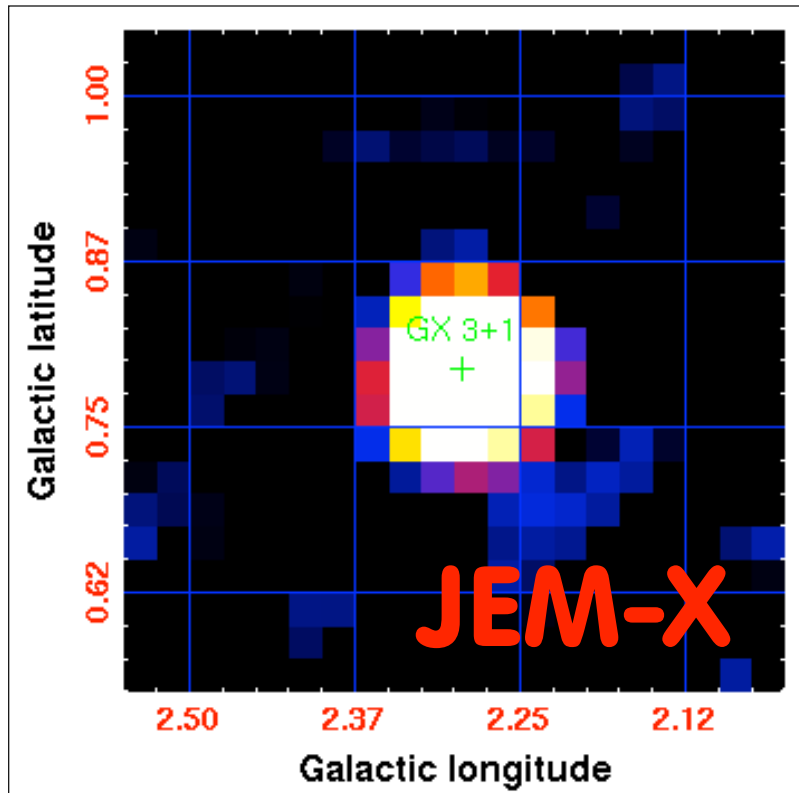


TXT FITS

» [About HEGRA](#)

First TeV data on the VO

# Images in HEAVENS

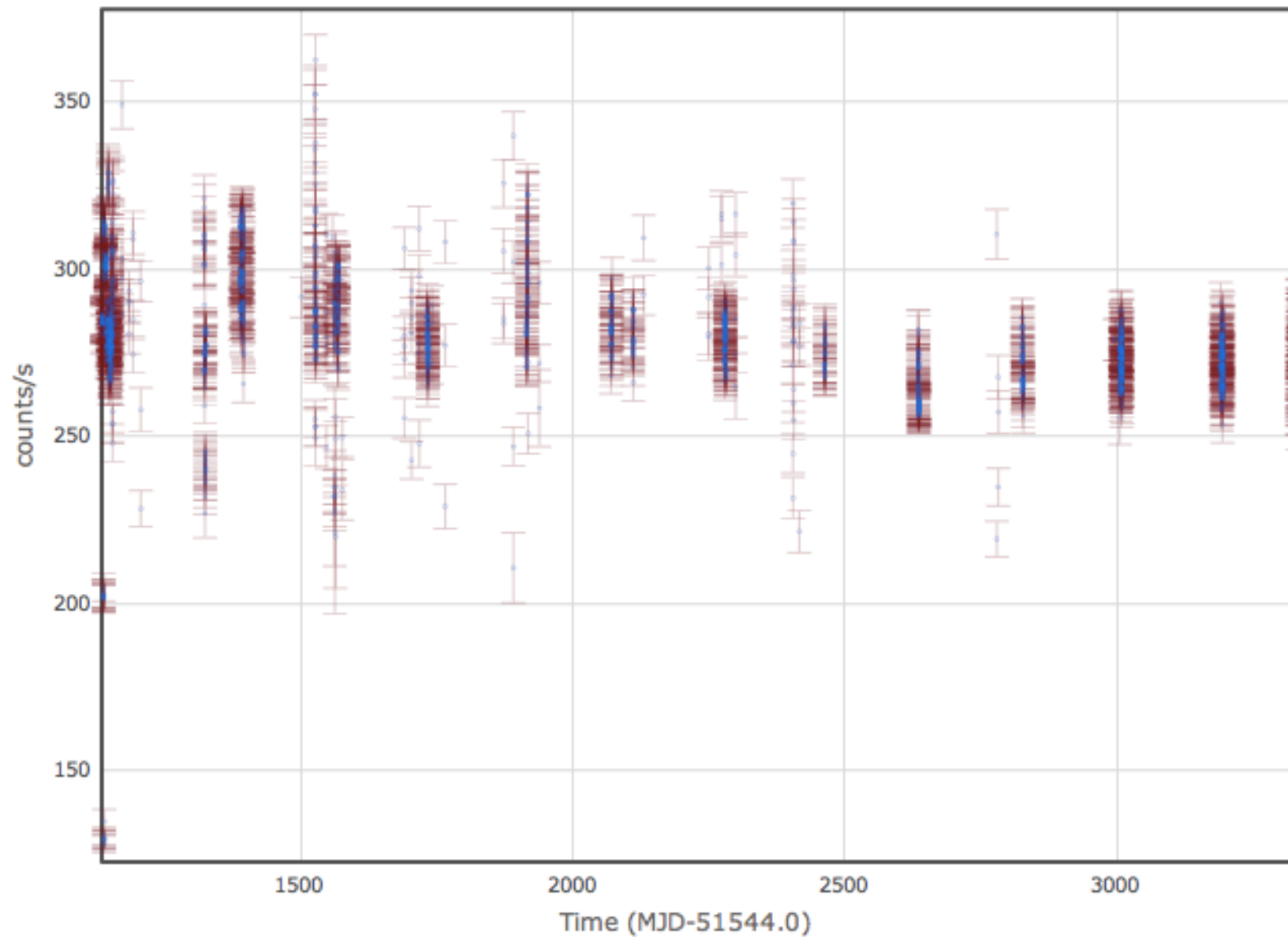




# Lightcurves in HEAVENS

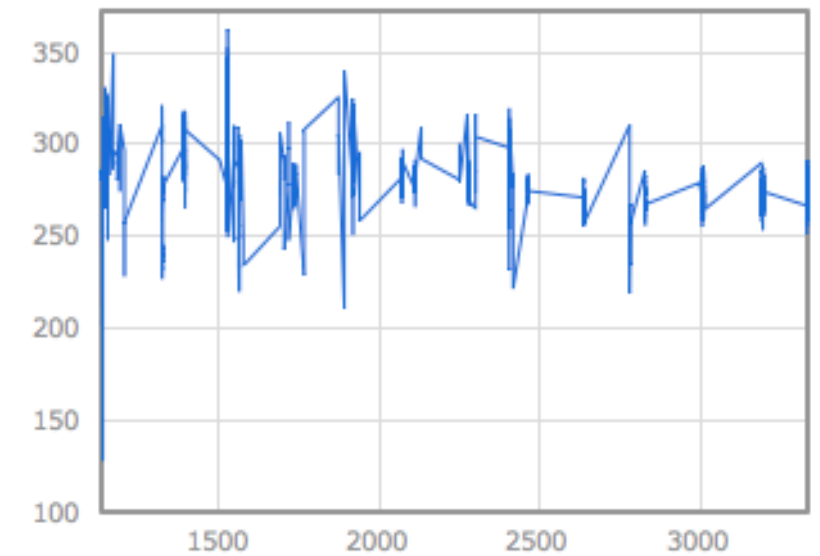
## Crab

INTEGRAL ISGRI (17.3-80.0 keV)



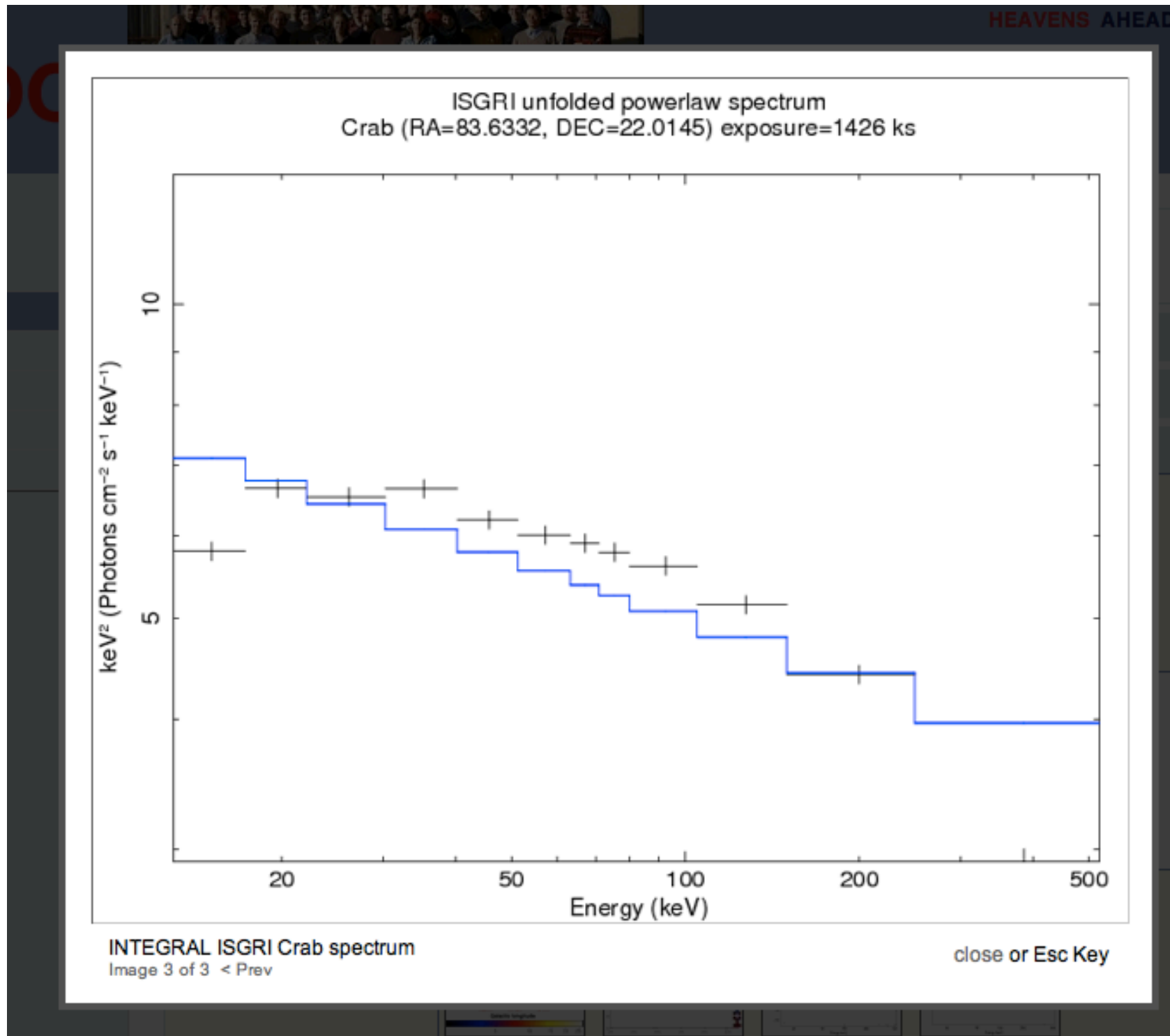
Click and drag to zoom  
Double click to unzoom

## Overview

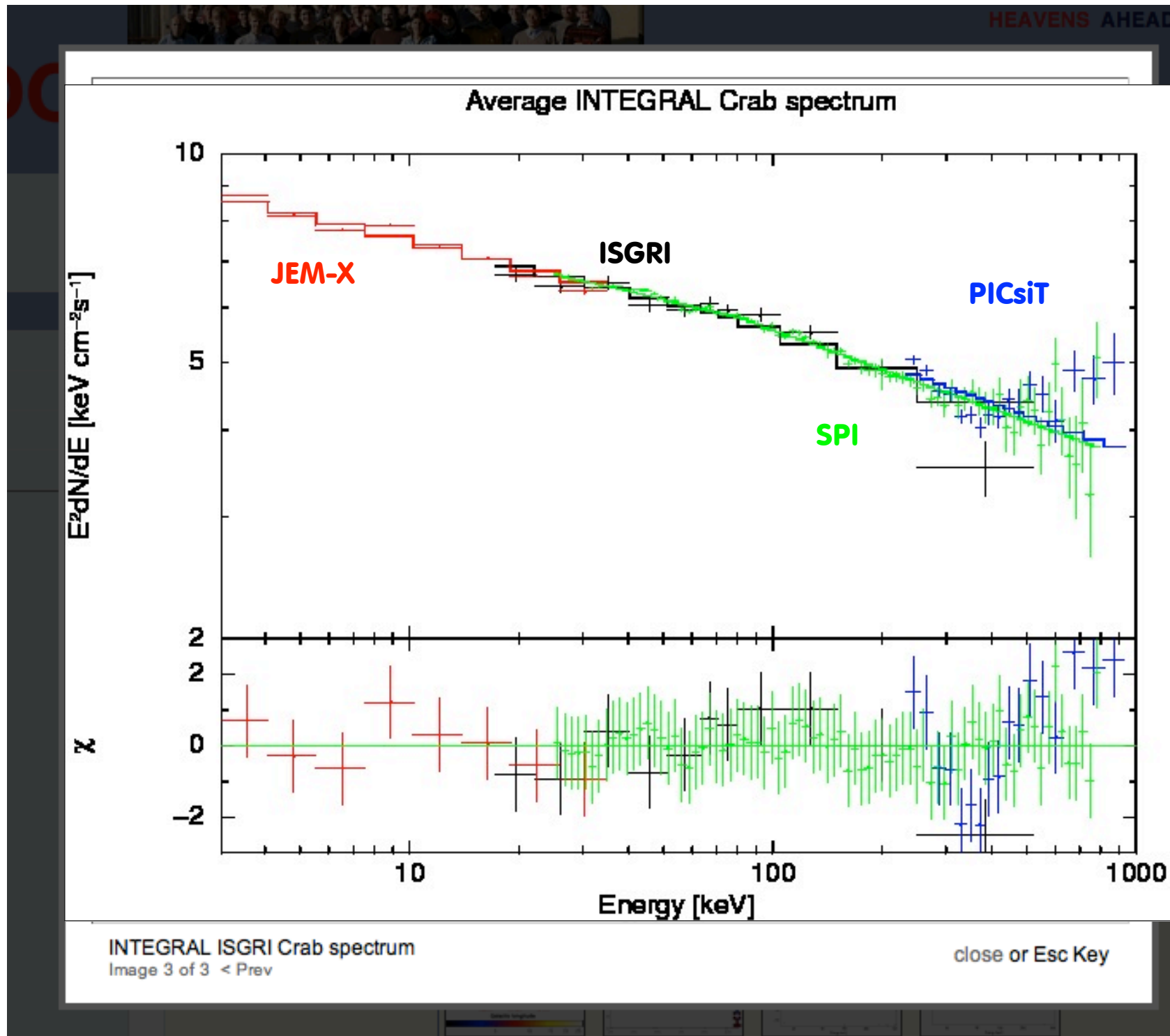


Show:  Lines  Y error bars

# Spectra in HEAVENS



# Spectra in HEAVENS



# HEAVENS & The VO

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# HEAVENS & The VO

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- **Already available:**
  - **Pointed image services**
  - **Image cutout services**
  - **Lightcurve services**

# HEAVENS & The VO

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- **Already available:**
  - **Pointed image services**
  - **Image cutout services**
  - **Lightcurve services**
- **A bit later:**
  - **Spectra services**
  - **Extended queries**

# HEAVENS & The VO

The screenshot displays the Heavens & The VO software interface. At the top, the location is set to `..24.69 -00:11:45.0` in ICRS coordinates, with a pixel size of 2776. The main window is split into two panels. The left panel, titled 'DSS2.F.POSSII', shows a wide-field star field with a red arrow pointing to a specific star. The right panel, titled 'INTEGRAL.17.8-80', shows a zoomed-in view of a star with a central crosshair. The interface includes a toolbar with tools such as 'select', 'pan', 'zoom', 'dist', 'draw', 'tag', 'text', 'filter', 'cross', 'rgb', 'assoc', 'cont', 'mglss', 'pixel', 'prop', and 'del'. A layer panel on the right shows the following layers: 'RGB img' (unchecked), 'INTEGRAL.17.8-80' (checked), 'NED' (unchecked), 'Simbad' (unchecked), and 'DSS2.F.POSSII' (checked). The zoom level is set to 32x. The bottom status bar shows '[View B1] - INTEGRAL.17.8-80' and a search field.

# Data & CPUs

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**(Rapidly) growing need for data storage and processing resources:**

	<b>Data</b>	<b>CPUs</b>	<b>Start</b>
<b>FACT</b>	<b>100 TB/y</b>	<b>50</b>	<b>2011</b>
<b>Gaia</b>	<b>1 PB</b>	<b>1000</b>	<b>2012/13</b>
<b>CTA</b>	<b>few PB/y</b>	<b>N/A</b>	<b>2014/15</b>
<b>Euclid</b>	<b>5 (to 500) PB</b>	<b>N/A</b>	<b>2018</b>



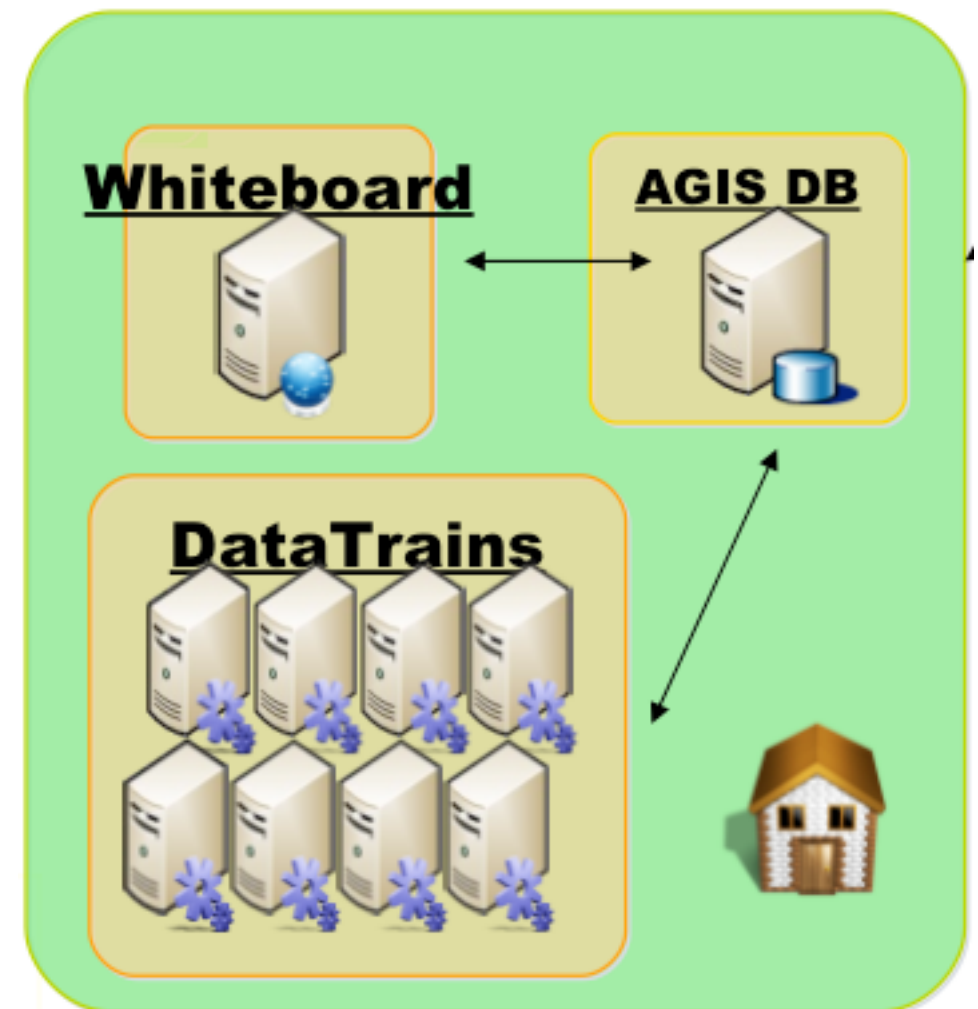
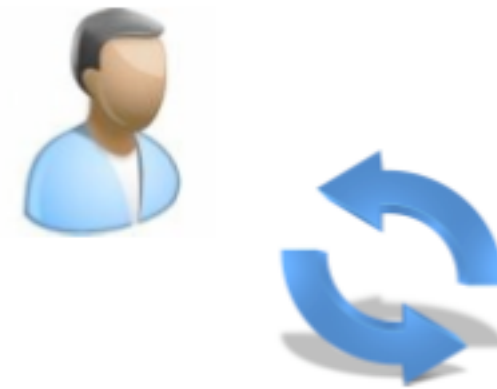
# The Cloud - a few words

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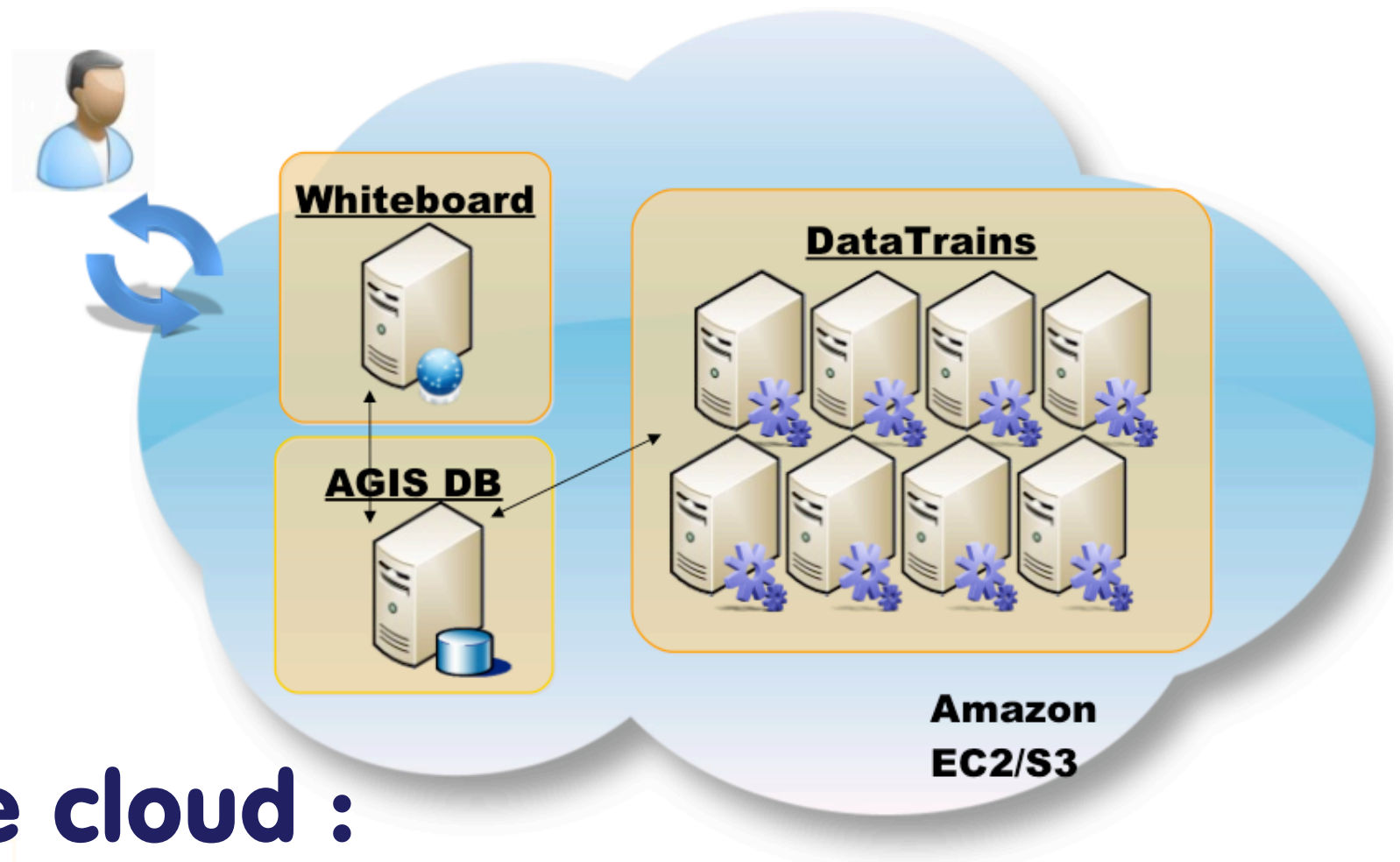


# The Cloud - a 'real' world example

- **AGIS for ESA's Gaia mission :**
  - **Inherently distributed**
  - **Data and CPU intensive**
  - **developed on a (small) local cluster**

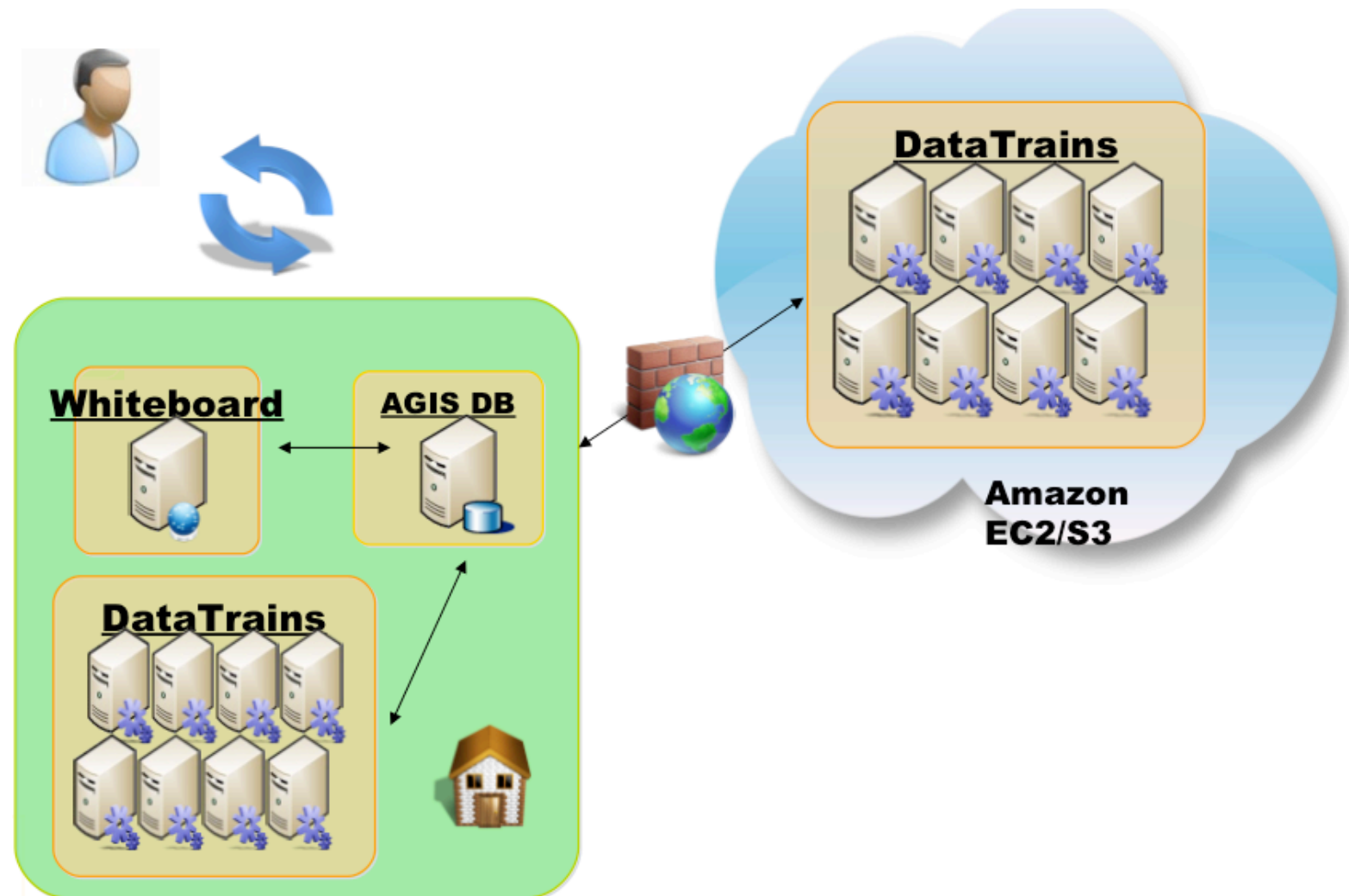


# The Cloud - a 'real' world example



- **AGIS in the cloud :**
  - **deployed on  $> 100$  nodes in the cloud**

# The Cloud - a 'real' world example



- The future
  - a hybrid system ?

# The Cloud - a 'real' world example

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**(rough) cost analysis for processing power :**

**→ cloud is cheaper than local cluster**

**(at least for short term data storage)**



# General Remarks

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- **BIG data ahead for many projects**

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- **A lot of processing power is needed**
- **Relatively few users of bulk data**

# General Remarks

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- **BIG data ahead for many projects**
- **A lot of processing power is needed**
- **Relatively few users of bulk data**
- **'end user' data sets often remain at much smaller sizes**

**Thank you**

**for your attention**