KCDC short User Manual for

MAKET-ANI data

KCDC - the **K**ASCADE **C**osmic Ray **D**ata **C**entre

Open Access Solution for the

KArlsruhe **S**hower **C**ore and **A**rray **De**tector (**KASCADE)**

and other ground based Cosmic Ray Experiments

KIT - University of the State of Baden-Wuerttemberg
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1 Introduction

We owe Ashot Chilingarian and Gagik Hovsepyan from the MAKET-ANI Collaboration a big THANK YOU for the permission to publish the data in the KCDC DataShop and for their help in realizing this project.

Publications of analyses based on MAKET-ANI data sets downloaded from the KCDC DataShop should be cited in a proper way.

For MAKET-ANI, two references should be named:

1. A.Chilingarian , G. Gharagyozyan , G. Hovsepyan , S. Ghazaryan , L. Melkumyan , and A. Vardanyan; *Light and Heavy Cosmic Ray Mass Group Energy Spectra as Measured by the MAKET-ANI Detector* Astrophysical Journal, 603:L29-L32, 2004
2. A.Chilingarian , G. Gharagyozyan , G. Hovsepyan , S. Ghazaryan , L. Melkumyan , A. Vardanyan, E.Mamidjanyan, V.Romakhin, and S. Sokhoyan; *Study of extensive air showers and primary energy spectra by MAKET-ANI detector on Mount Aragats*; Astroparticle Physics, Volume 28, Issue 1, September 2007, Pages 58–71

for KCDC:

1. A.Haungs et al; *The KASCADE Cosmic-ray Data Centre KCDC: Granting Open Access to Astroparticle Physics Research Data*; The European Physical Journal C (2018) 78:741

The user Manual for MAKET-ANI detector data provides a rough explanation of data taken by the MAKET-ANI Collaboration and made publicly accessible with the KCDC Project Internet Application.

Unlike in KASCADE, we have neither the background information of the detector builders or the detector operators have, nor the detailed knowledge like the MAKET-ANI data analysis team. This means that in this manual we will limit ourselves to the brief detector descriptions given in the papers published by the MAKET-ANI Collaboration (see chapter 7 'Reference List'). The data sets published will be described in a more detailed way if possible.

For technical details on information, regulations, KCDC news etc. we refer to the '*KCDC User Manual'* which can be accessed via the 'Materials' button at the KCDC Homepage https://kcdc.iap.kit.edu/ .

1.1 About KCDC - The KASCADE Cosmic Ray Data Centre

KCDC is the **'KASCADE Cosmic Ray Data Centre**', where via a web-based interface data of the astroparticle physics experiment KASCADE and other ground based cosmic ray experiments are made available via various so called 'DataShops' for the interested public.

Moreover, with KCDC we provide to the public the edited data, i.e. the reconstructed parameters of the primary cosmic rays measured via the detection of EAS via a customized web page. The aim of this particular project is the installation and establishment of a public data centre for high-energy astroparticle physics. In the research field of astroparticle physics, such a data release is a novelty, whereas the data publication in astronomy has been established for a long time. However, due to basic differences in the measurements of cosmic-ray induced air showers compared with astronomical data, KCDC provides the first conceptional design, how the data can be treated and processed so that they are reasonably usable outside the community of experts in the research field.

In November 2013 we published in a first step 15 parameters of reconstructed and calibrated data taken by the KASCADE detector array, which we thought are necessary to do simple astroparticle physics analysis, e.g. the time, arrival direction and energy of events, etc.

With every new release, we added more data sets or more quantities to enable the users to perform more complex and more sophisticated analysis with the KASCADE data. With the release PENTARUS we added a second experiment based as well on the KASCADE-Grande data, but analysed in a completely different way, which cannot be compared to formerly published KASCADE data sets. This was the first time we added a new DataShop to KCDC. Now, with the latest release SKARAGAN we published the data sets from an experiment outside KASCADE, the **MAKET-ANI Detector** (details see chapters 2 & 3).

More detailed information on the KCDC motivation and other topics related to cosmic ray experiments like spectra published by other experiments can be derived from the '*KCDC User Manual*' directly.

1.2 The KCDC Team

Fig. 1.2.1 *The KCDC-Team (status 2017)*

2 The MAKET-ANI Detectors

2.1 The MAKET-ANI Experiment

MAKET-ANI is an extensive air shower experiment array to study the cosmic ray primary flux in the ‘knee’ region of the primary cosmic ray spectrum. The MAKET-ANI detector is placed on Mt. Aragats (Aragats Cosmic Ray Observatory, Armenia), 3200m above the sea level at 40°25’N, 44°15’E operating at an atmospheric depth of ~700g/cm^2. At this altitude the shape of the showers is not distorted by the attenuation in the terrestrial atmosphere and it is possible to reliably reconstruct EAS size and shape.

The MAKET-ANI surface array (fig. 2.1.1 & 2.1.2) consists of 92 particle density detectors formed from plastic scintillators with a thickness of 5 cm. Twenty-four of them have an area of 0.09m^2 and 68 an area of 1m^2. The central part consists of 73 scintillation detectors and is arranged in a rectangle of 85 x 65 m^2. Two peripheral points at a distance of 95 m and 65 m from the centre of the installation consist of 15 and 4 scintillators, respectively.

In order to estimate the zenith and azimuthal angles, 19 detectors out of the 92 (each with an area of 1m^2) are equipped with timing readouts to measure the timing of the appearance of the shower front with an accuracy of ~5 ns.

The photomultiplier tubes (PM-49) in of the detectors are placed in the light-tight iron boxes (fig. 2.1.3). Logarithmic analog-to-digital converters (ADC) and constant fraction discriminators (CFD) are assembled just above the Photomultiplier tube (see Fig. 2.1.3). The dynamic range of the registered particle number is ~5x10^3.

Three types of detector triggers are used:

1. the hardware trigger: at least 7 of 11 central density detectors must be hit by more than three particles;
2. the timing trigger: at least 4 from 9 preselected timing detectors, symmetrically arranged relative to the centre of array, should be hit;
3. the software trigger adding several additional restrictions was used off-line.

If the first two conditions are fulfilled in a time window of 20 µS, the information from all 92 channels is stored.

The average frequencies of the selected EAS are very stable and equal to 0.234 ± 0.013 min^{-1} for $N_e >= 1.6 \cdot 10^5$; 0.056 ± 0.006 min^{-1} for $N_e >= 4 \cdot 10^5$ and 0.013 ± 0.003 min^{-1} for $N_e >= 10^6$.

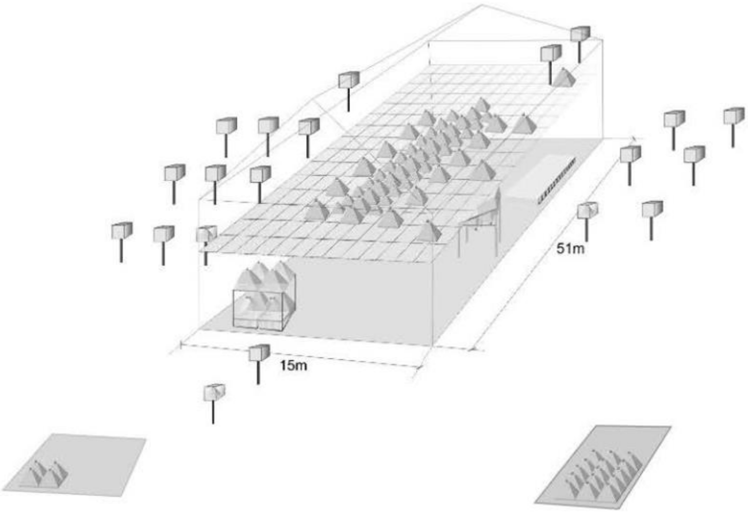


Fig. 2.1.1 *The MAKET-ANI detector setup*

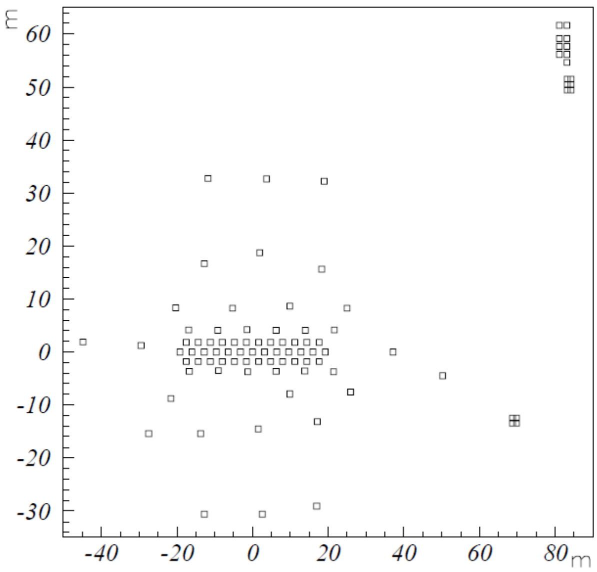


Fig. 2.1.2 *Schematic view of the MAKET-ANI detector array*

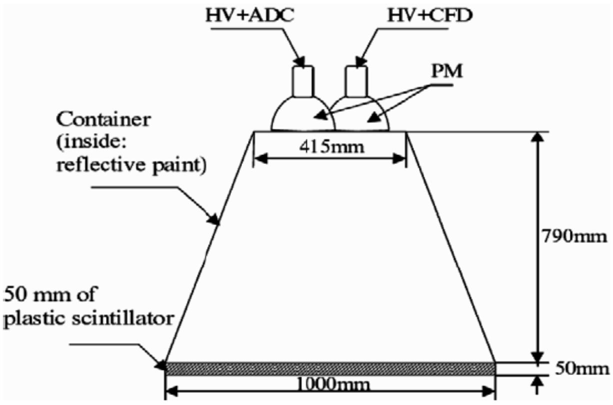


Fig. 2.1.3 *The MAKET-ANI scintillator–PMT configuration for the 19 detectors with timing*

During multiyear measurements, the detecting channels were continuously monitored. Data on background cosmic-ray spectra was collected for each detector. The slope of the spectra was used for detector calibration. The slope of background spectra is a very stable parameter and does not change even during very severe Forbush decreases, when the mean count rates can decrease as much as 20%.

Fig. 2.1.4 *View of the Maket-Ani location at Mount Aragats*

3 MAKET-ANI Data in KCDC

The MAKET-ANI data in general are made publicly available via the ‘UNESCO Open Science recommendation’. The current data sets for KCDC, however, are taken from an ASCII file provided by the MAKET-ANI collaboration directly.

Based on data generation and data handling we distinguish between:

Measuring Data

Corresponding to data which are directly measured or reconstructed by the MAKET-ANI analysis software like core positions and angles of the incoming air showers.

Astronomical Data

Corresponding to astronomical data like *Right Ascension* or *Local Sidereal Time*.

Event Information

Used to characterise an event uniquely like *Event Time*.

Quantity	Description	Unit	ID
Measuring Data			
Core Position X	location of the reconstructed shower core, x-position	m	Xc
Core Position Y	location of the reconstructed shower core, y-position	m	Yc
Zenith Angle	reconstructed zenith angle with respect to the vertical	° *(degree)*	Ze
Azimuth Angle	reconstructed azimuth angle with respect to the north	° *(degree)*	Az
Electron Number	reconstructed number of electrons (fit)	*(number of)*	*Ne*
Age	Shower shape parameter		*Age*

Quantity	Description	Unit	ID
Astronomical Data			
Right Ascension	Right Ascension (celestial longitude)		*Ra*
Declination	Declination (celestial latitude)		*De*
Local Sidereal Time	LST at MAKET-ANI location		*St*
Event Information			
Event Number	internal Event counting number (arbitrary increasing with time)	*(number of)*	*Ev*
Event Date	event date in UTC		*date*
Event Time	event time in UTC		*time*
Global Time	event date time in seconds since 1.1.1970 in UTC	*s*	*Gt*
UUID	Universally Unique IDentifier		*UUID*

The plots schown in this chapter are only examples. So, applying user cuts either in the KCDC DataShop or in your own analysis can change these spectra drastically and the physical relevance depends solely on the user and his cuts applied.

3.1 Shower Core Position (Xc, Yc)

The Core Position is the reconstructed location of the shower centre at MAKET-ANI level derived from the particle densities measured by the array of scintillators, by reconstructing the center of gravity of the 2-dimensional particle density distribution. The EAS core location is measured applying of a NKG-type function.

The resolution of the X- and Y-positions is about 1m. The unit of the core position is [m].

The distribution of the shower cores within the valid detector area is plotted in the fig. 3.1.1, the X- and Y-Core core distributions are schown in fig 3.1.2 and 3.1.3 respectively.

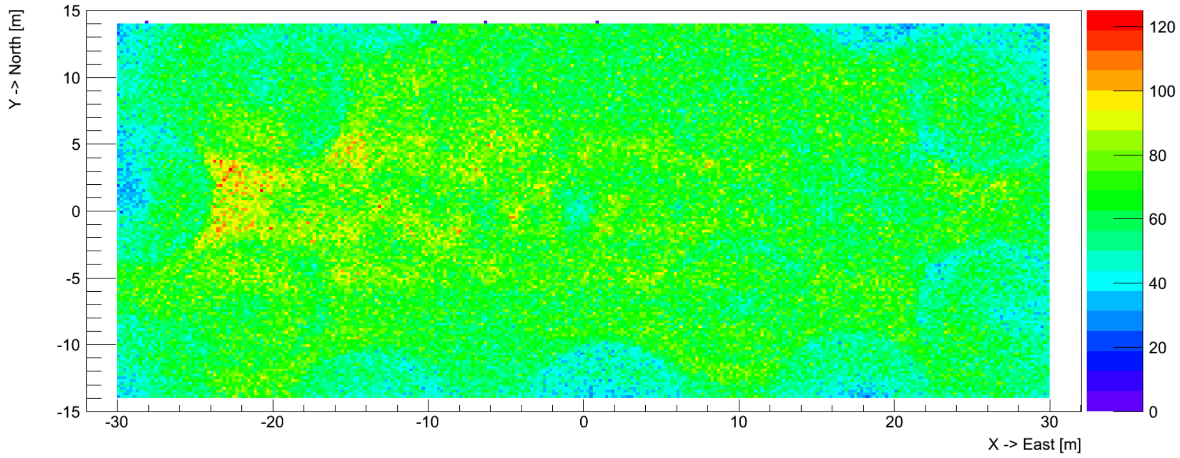


Fig. 3.1.1 *Shower core distribution*

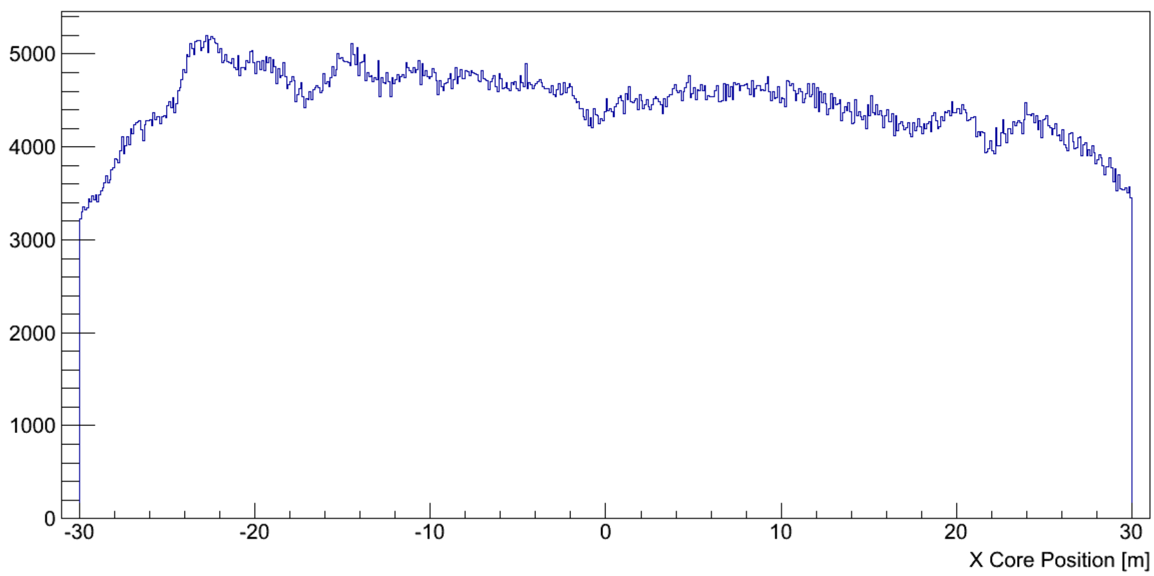


Fig. 3.1.2 *X-Shower core distribution*

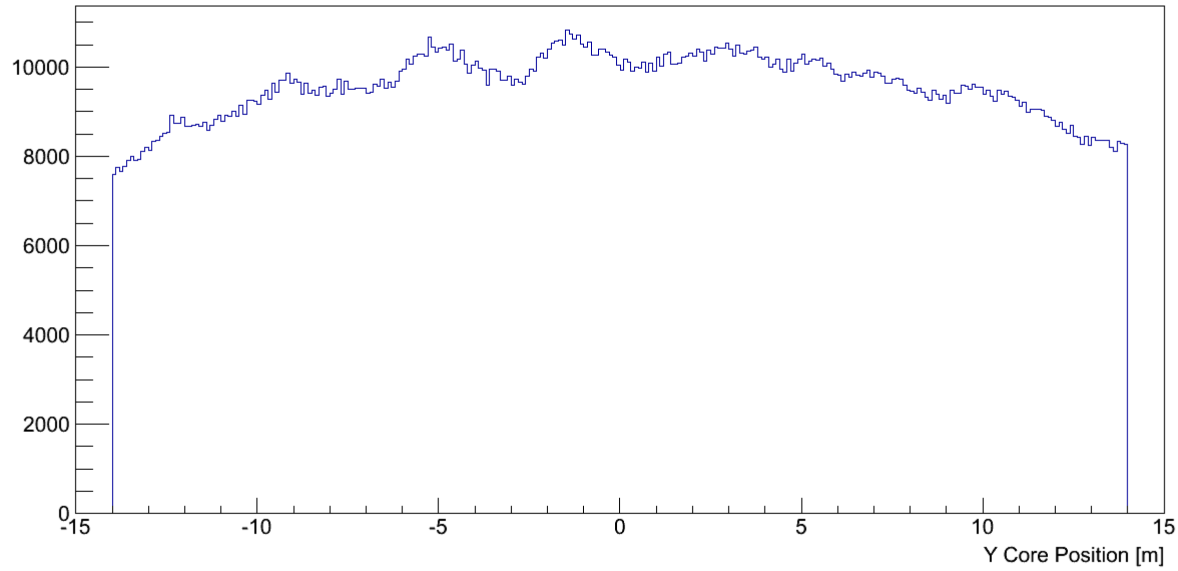


Fig. 3.1.3 *Y-Shower core distribution*

3.2 Shower Direction (Ze, Az)

In MAKET-ANI coordinates, the zenith angle is measured against the vertical direction, which means that θ=0° is pointing upwards and 90° denotes a horizontal shower. The azimuth angle φ is defined as an angle measured clockwise starting in northern direction (90° is east). The unit of the azimuth and zenith angles is [°]. The angular coordinates θ and φ were derived from timing information. In MAKET-ANI array 19 detectors are equipped with two PMs (see fig. 2.1.1 to 2.1.3). One of them is used for particle density estimation, and the second for the precise timing. The output signal from the timing channel triggers the 200 MHz frequency generator. The signal of the timing trigger is used as a STOP signal. The quantification level for the timing information is 5 ns.

The uncertainties for θ and φ are less than 1.5° and 5°, respectively for showers within the zenith angle range $15° < \theta < 45°$. The accuracy of the azimuth angle strongly depends on the zenith angle and becomes very poor at small zenith angles. The angular accuracies do not depend on N_e in interval 10^5 to 10^7. The angular accuracy for "young" showers (s < 0.5) is ~ 15%, worse than for the older showers.

In fig. 3.2.1 the distributions of the azimuth angle is shown while, fig. 3.2.2 shows the distribution of the zenith angle. Fig. 3.2.3 holds a 2-dimensional spectrum of θ and φ.

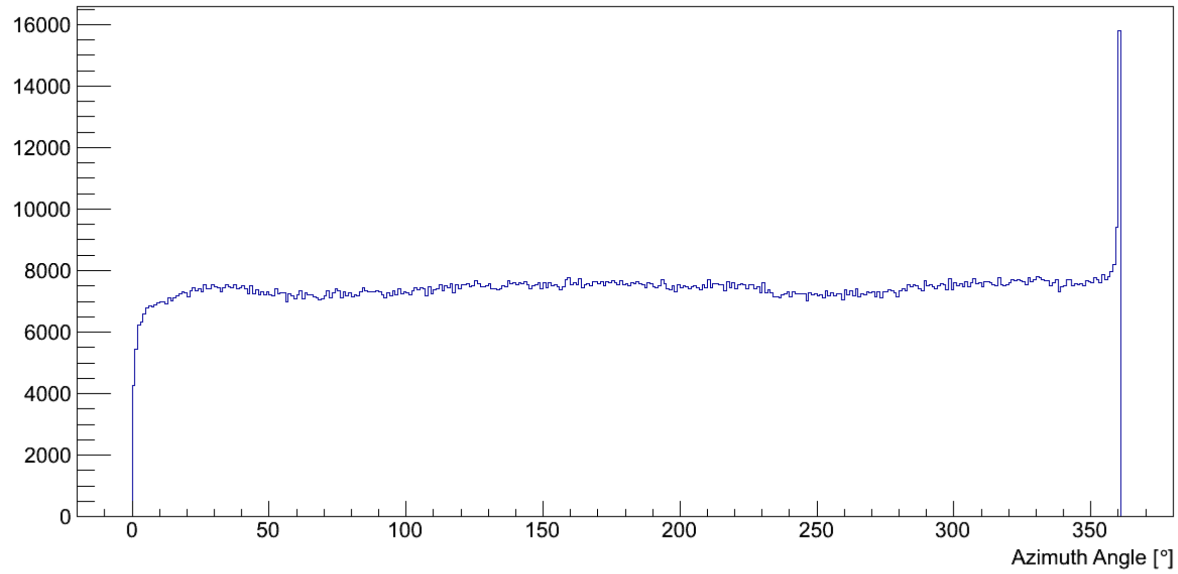


Fig. 3.2.1 *The distribution of the reconstructed azimuth angle φ*

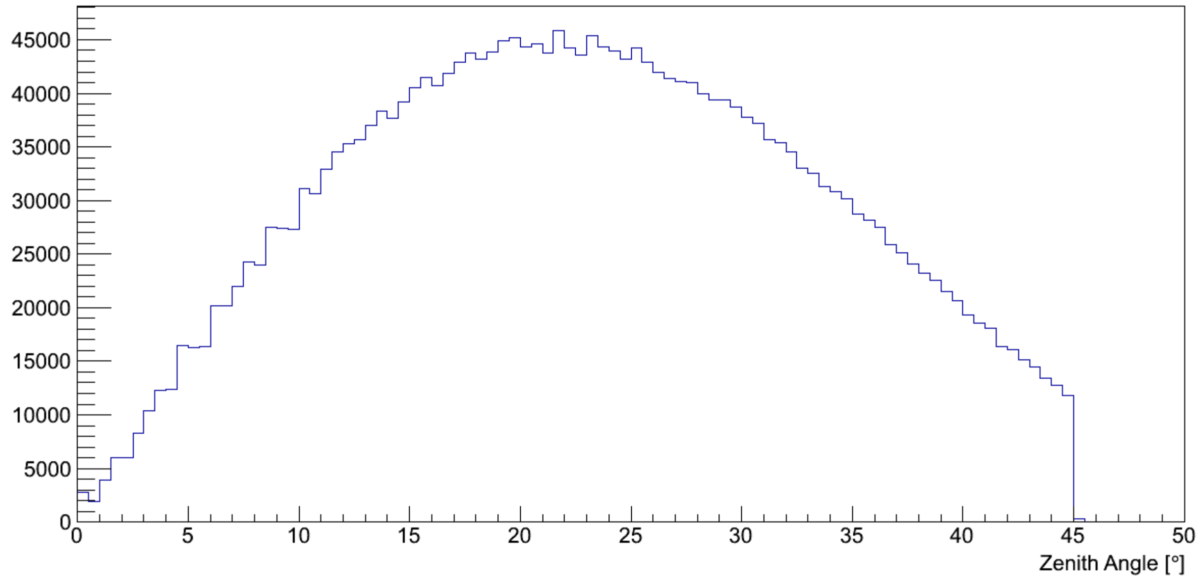


Fig. 3.2.2 *The distribution of the reconstructed zenith angle θ*

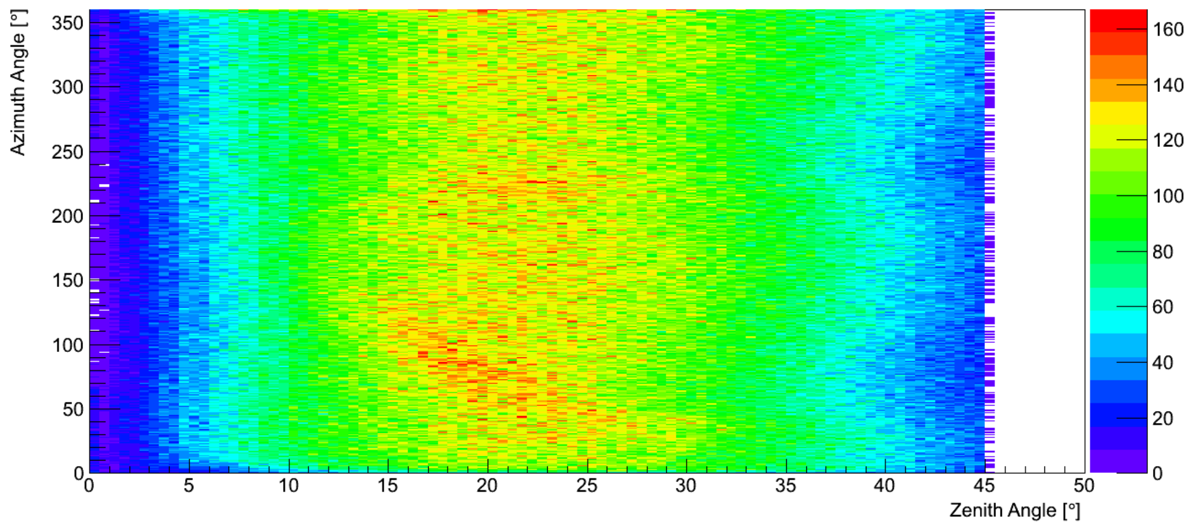


Fig. 3.2.3 *The distribution of the reconstructed zenith angle* θ ***over*** φ

3.3 Number of electrons (Ne)

The total number of particles (the EAS size N_e) is derived from the particle densities measured by the grid of array scintillators by applying a NKG-type function. The logarithmic ADCs provide linearity up to 10,000 particles/m^2.

The systematic uncertainties in the determination of the N_e parameter are $\Delta(N_e)$ ~ 10%

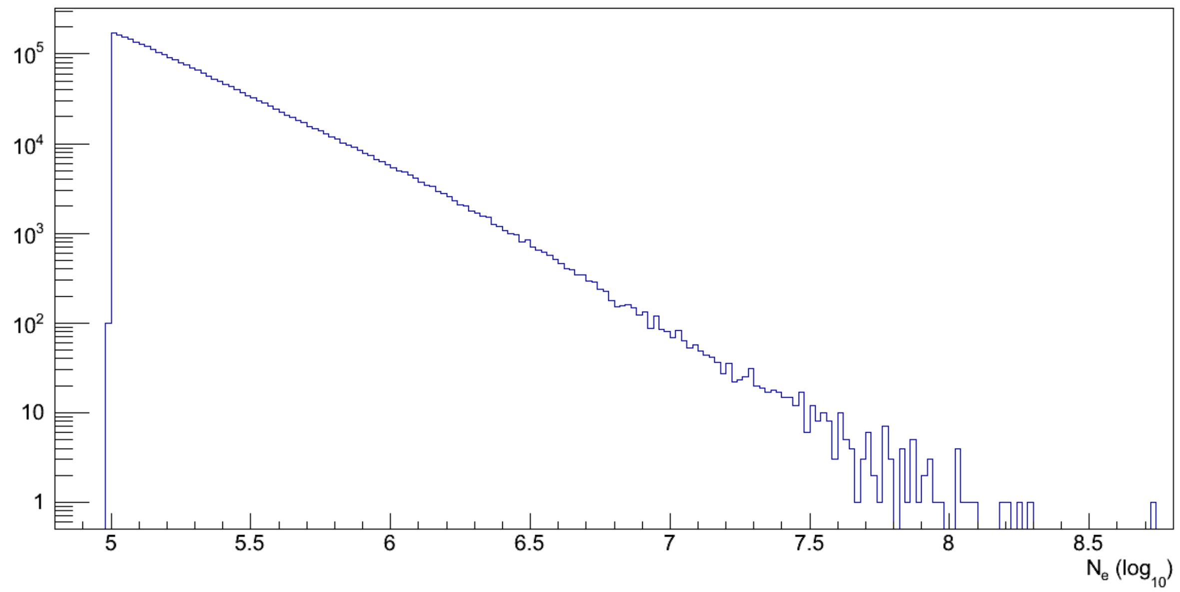


Fig. 3.3.1 *The spectrum of the number of electrons*

3.4 Age (Age)

From the particle densities measured by the grid of array scintillators, it is possible to derive the so-called, s shower shape (age) parameter, correlated with the height of the first interaction of primary ion with the nuclei of terrestrial atmosphere.

Contrary to variables like number of electrons N_e, the value of the age parameter has no absolute meaning, as it depends on the choice of the lateral distribution function, which is fitted, to the shower data. It may also be called lateral shape parameter because it describes the steepness of the lateral electron density distribution. MAKET-ANI uses a modified NKG-function to fit the lateral shower shape. Within this function, the age parameter values are limited theoretically to a range from 0.2 to 1.7.

The shape (steepness) of the lateral density distribution of a given shower depends on the energy of the primary particle, as well as on its nature. The higher the shower energy, the steeper the lateral distribution. A heavy primary particle with the same energy as a light one gives rise to a flatter lateral distribution, as the shower starts earlier in the atmosphere. When reaching ground, the shower is "older", which gives the age parameter its name. The age parameter therefore may help (in combination with number of electrons) to distinguish between primary particles of different mass.

The systematic uncertainties in the determination of the Age parameter are $\Delta(S) \sim 0{,}03$ at $N_e=10^5$.

Fig. 3.4.1 shows the distribution of the Age parameter within its valid range.

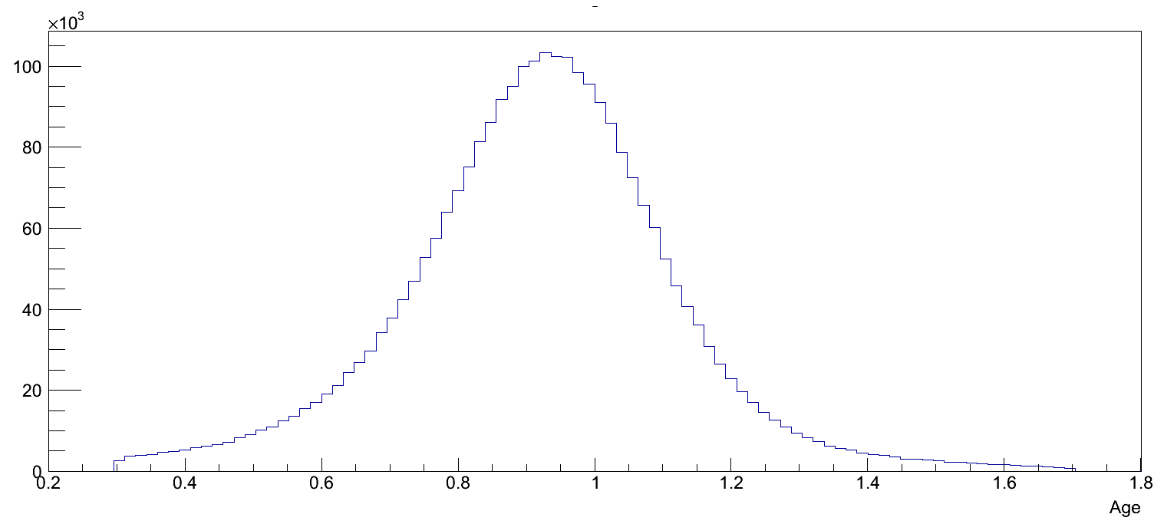


Fig. 3.4.1 *The AGE distribution from the modified NKG function for reconstructed showers.*

3.5 Right Ascension and Declination (Ra, De)

Every point on a celestial sphere is characterized by two parameters called *right ascension* and *declination*, more generally referred to as the object's *celestial coordinates*. Declination corresponds to latitude and right ascension to longitude in terrestrial coordinates.

Right ascension is the angular distance of a particular point measured eastward along the celestial equator from the Sun at the March equinox to celestial object above the earth. Paired with declination, these astronomical coordinates specify the location of a point on the celestial sphere in the equatorial coordinate system. The declination is measured from the celestial equator positive to the north and negative to the south.

Fig 3.5.1 shows the distribution of the right ascension, fig. 3.5.2 the distribution of the declination for the MAKET-ANI data published. The structure at about 40° in the declination spectrum is caused by the azimuth angle reconstruction at 0°/360° as indicated in the Az-spectrum fig. 3.2.1.

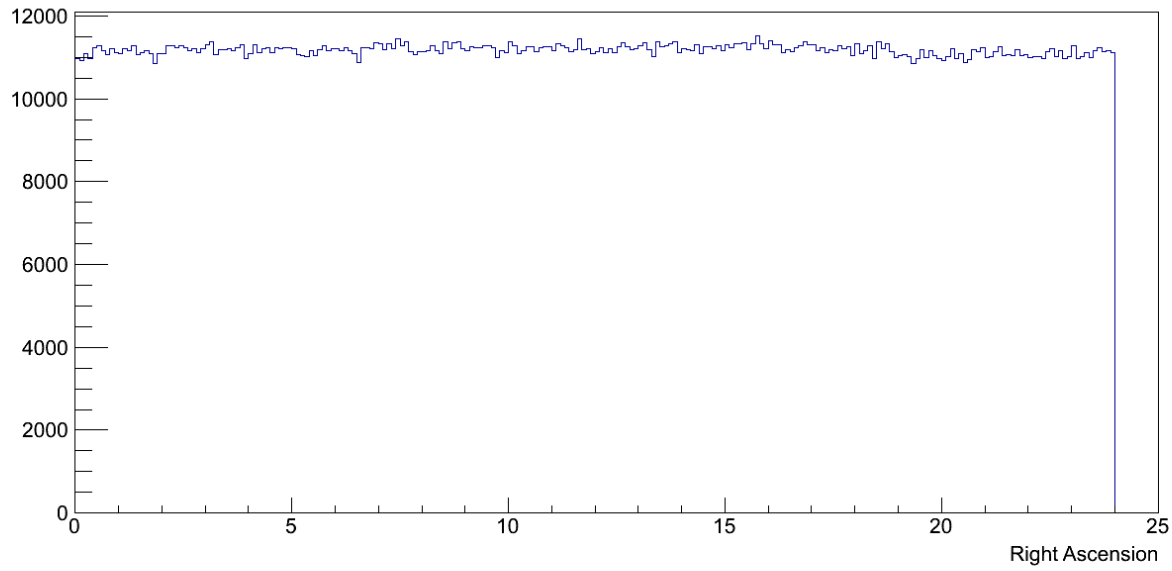


Fig. 3.5.1 *The Right Ascension distribution*

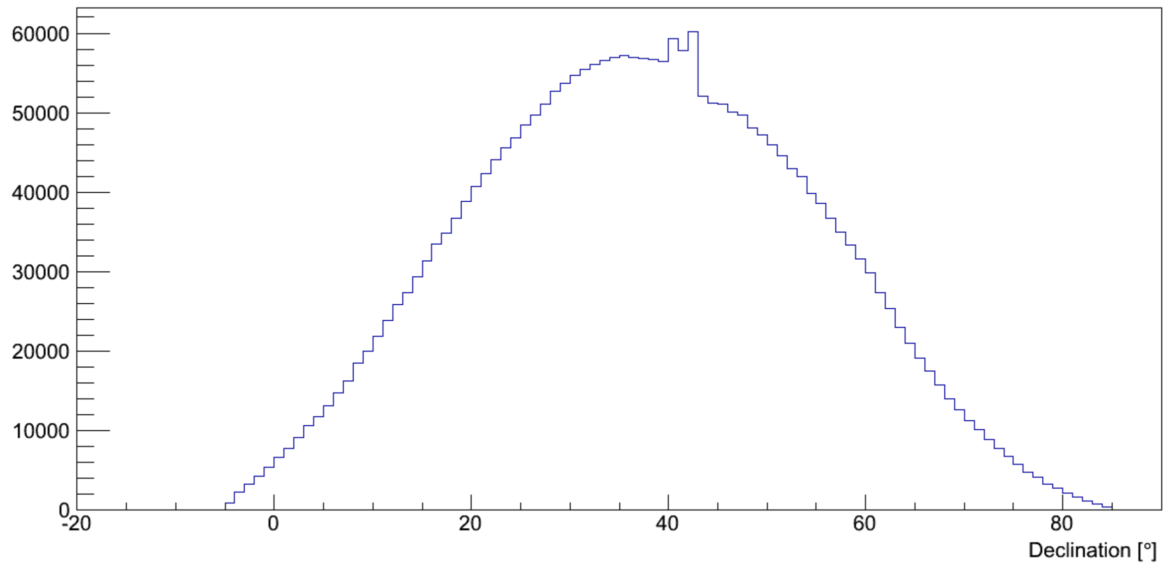


Fig. 3.5.2 *The Declination distribution*

3.6 Local Sidereal Time (St)

Sidereal Time literally means "star time". The Sidereal Time is useful for determining where the stars are at any given time. Sidereal Time divides one full spin of the Earth into 24 Sidereal Hours; similarly, the map of the sky is divided into 24 Hours of *Right Ascension*.

Local Sidereal Time (LST) indicates the *Right Ascension* on the sky that is currently crossing the Local Meridian.

In astronomy, one is concerned with how long it takes the Earth to spin with respect to the "fixed" stars. So, one uses a timescale that removes the complication of Earth's orbit around the Sun, and just focuses on how long it takes the Earth to spin 360 degrees with respect to the stars. This rotational period is called a *Sidereal Day*. On average, it is 4 minutes shorter than a Solar Day, because of the extra 1 degree the Earth spins in a Solar Day. Rather than defining a Sidereal Day to be 23 hours, 56 minutes, we define Sidereal Hours, Minutes and Seconds that are the same fraction of a Day as their Solar counterparts. Viewed from the same location, a star seen at one position in the sky will be seen at the same position on another night at the same sidereal time.

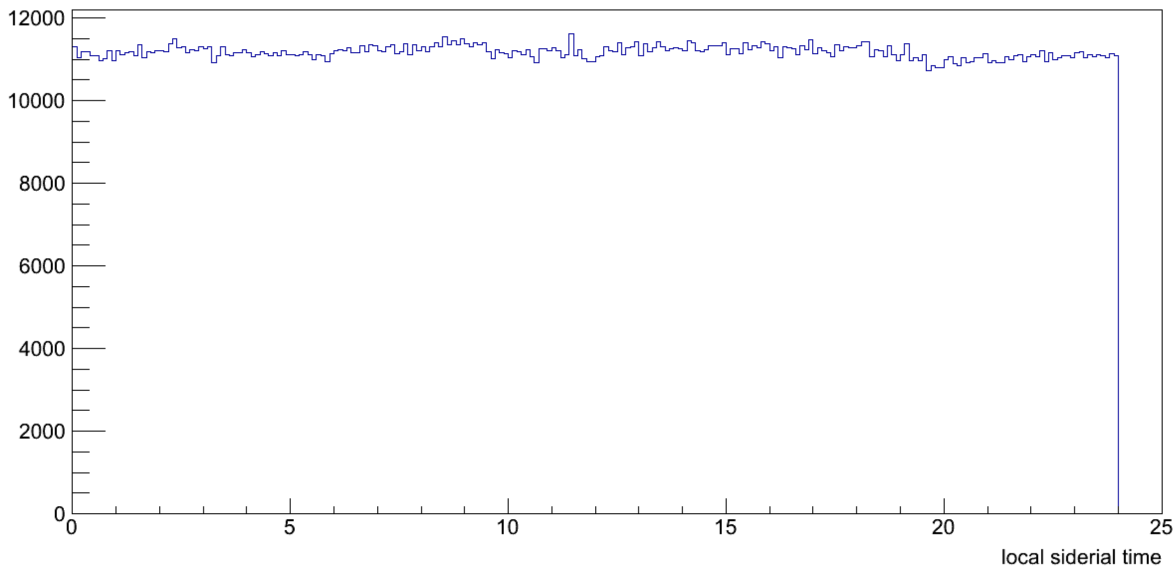


Fig. 3.6.1 *The Local Sidereal Time (LST) distribution*

3.7 Eventtime (Event Date, Event Time, GT)

The 'Event Date' and 'Event Time' are given in UTC which is affected with an offset of -5h for summer time (AMST) and -4h for winter time (AMT). As a redundant time information the *Unix Time (Gt)* is given, a system timestamp counting the number of seconds elapsed since 1. January 1970 (midnight UT), which is internally referenced as *Global Time*.

The Global Time ranges from 865190820 (1.6.1997 18:47:00 UTC) to 1174561392 (22.3.2007 11:03:12 UTC) seconds.

Fig 3.7.1 shows the Gt distribution for the MAKET-ANI events published in KCDC.

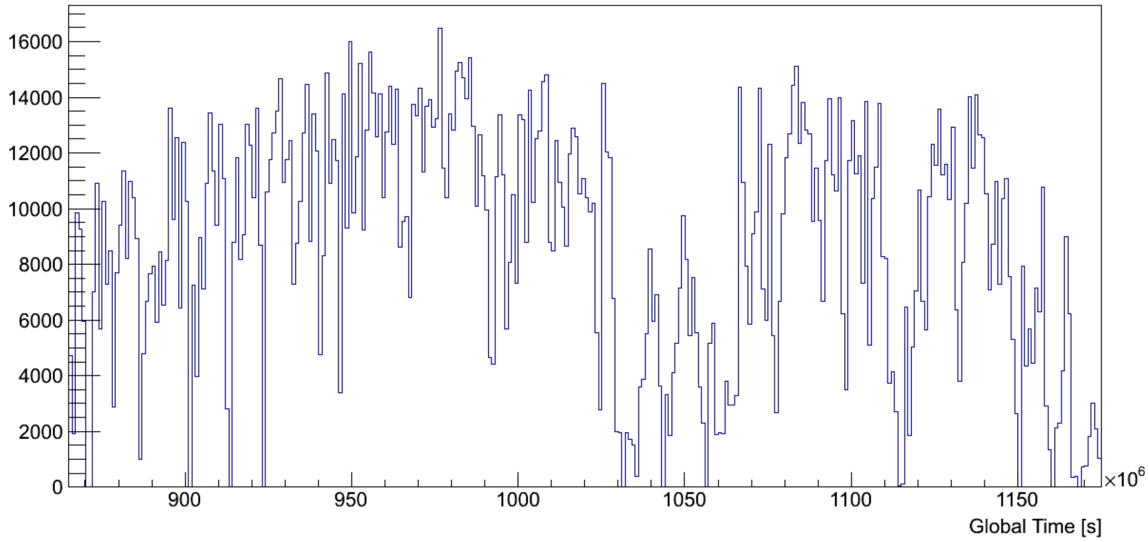


Fig. 3.7.1 *The Global Time distribution for events published in KCDC*

The precision of the Event Time is 1 second. Before event number 809416 [28.3.2000 23:28:00 UTC] the precision was 1 minute

3.8 Event Number

The **Event Number** is a parameter that characterise an event uniquely. The Event Number has been added only for the data publication via the KCDC web portal and is increased for every event sorted by time.

3.9 UUID

The **UUID (Universally Unique Identifier)** has been introduced to identify a single event by one unique string. This identifier is required to match the MAKET-ANI data published via the KCDC web portal with the data of other experiments for example the TAIGA/TUNKA experiment data published within the GRADLC Initiative (**G**erman-**R**ussian **A**stroparticle **D**ata **L**ife **C**ycle **I**nitiative).

A unique UUID represents an object independent from versions and the reference is immutable. Records that were once published in KCDC are frozen by versions, which means that even if the data are extended or changed the reproducibility is maintained.

The UUID is of the form: "f8085b19-6838-4ae4-ac31-64af3b2f4bd7"

3.10 Applied Cuts to the Data Sets

The present data sets have been generated by the MAKET-ANI collaboration with the following quality cuts applied to the full sample of triggered and recorded events:

- $N_e > 10^5$
- 0.3 < age < 1.7
- |Yc| < 14m; |Xc| < 30m
- $\Theta < 45°$ (zenith angle)

4 MAKET-ANI Data Shop

Through the MAKET-ANI DataShop in KCDC, we offer the possibility to select data sets from 14 quantities and apply cuts that match your analysis requirements.

4.1 MAKET-ANI Data Shop Overview

To have access to the MAKET-ANI DataShop via the KCDC web portal you need to be a registered user as described in chapter 17 of the '*KCDC User Manual*'. You enter the Data Shop via the **'Data Shops'** Menu Item on the KCDC Homepage (https://kcdc.iap.kit.edu/ ; fig. 4.1.1) where you can either submit a new request within **'Maket-Ani'** or **'Review'** your earlier requests.

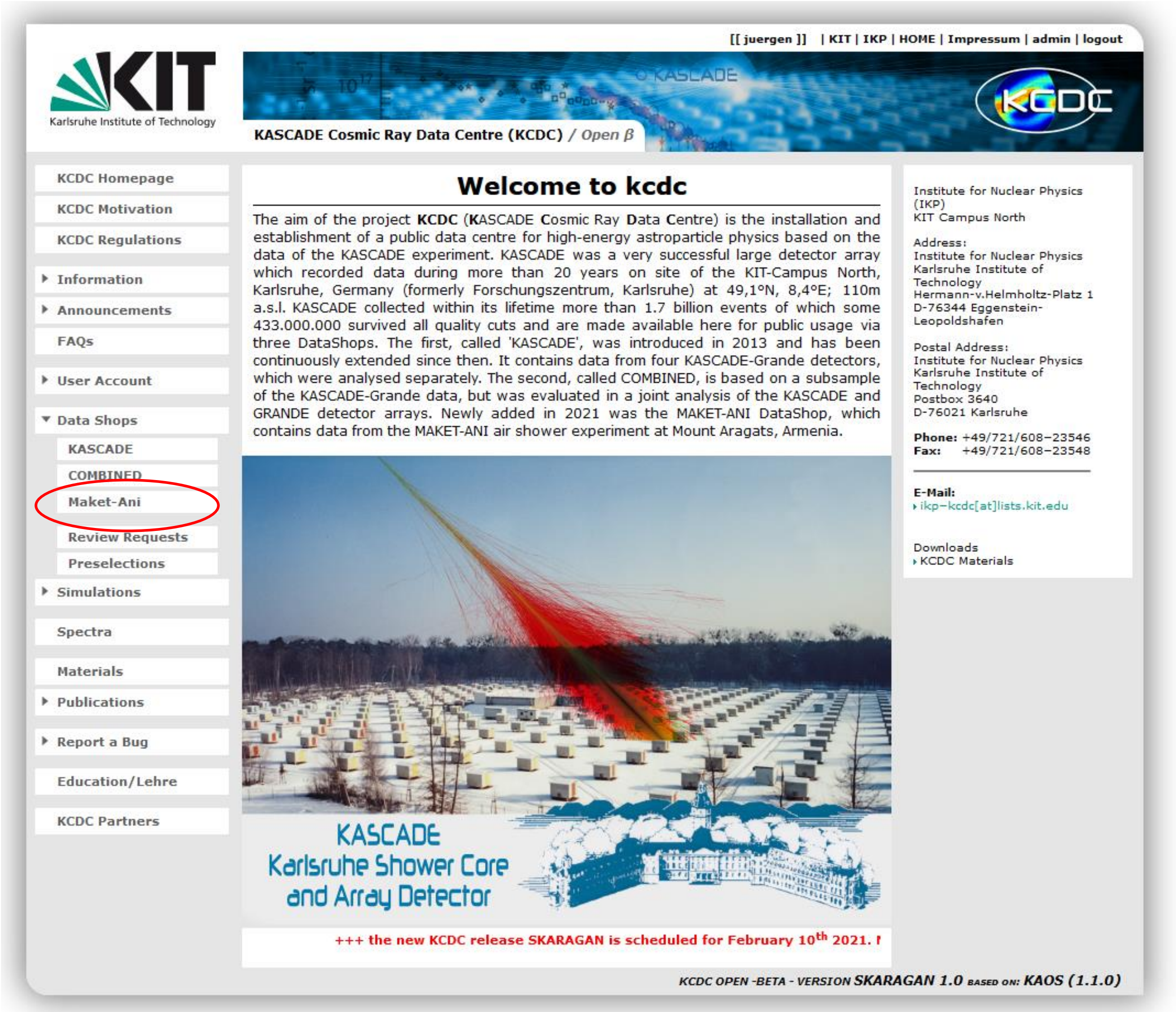


Fig. 4.1.1 *KCDC Homepage with DataShop selection*

On the right hand side of the shops page invoked by *'Maket-Ani'* an information box (orange) is located with some simple helps to find your way through the KCDC DataShop. This box changes when you *hover* for example over the detector components or later over quantities and cuts.

The link included at the bottom of the 'Welcome to the DataShops' info box will open this manual which holds descriptions on the MAKET-ANI detector components, quantities available and a short way how these quantities are gained from the parameters recorded with the MAKET-ANI experiment.

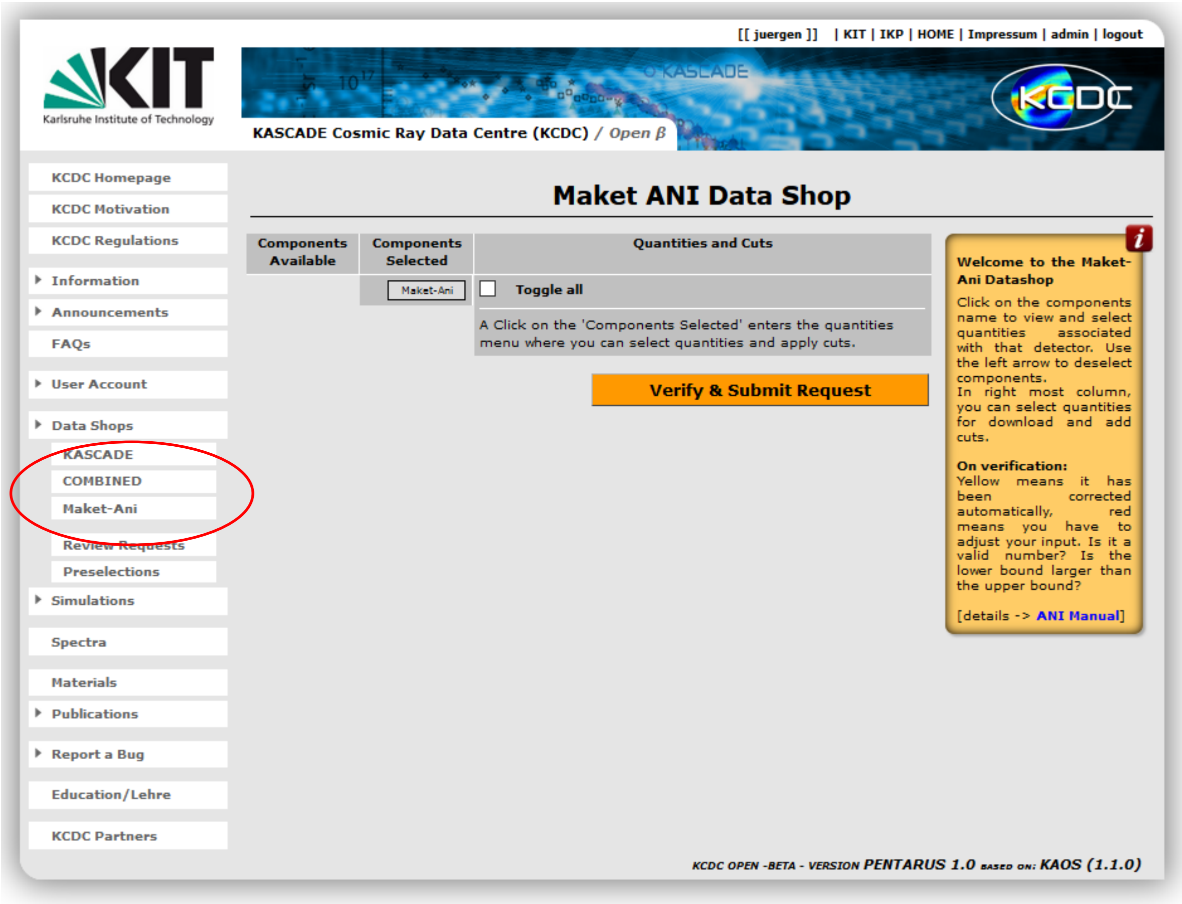


Fig. 4.1.2 *'Maket-Ani DataShop intro page*

4.2 User Defined Selections

The column 'Components Selected' holds a list of the detector components of the MAKET-ANI experiment from which quantities can be selected by the user to apply cuts and to download.

Pressing the *'Maket-Ani'* button opens a list of all available quantities with information on their ranges. Here you can select quantities for download and apply cuts by pressing the *'Add Cut'* button for the respective quantity.

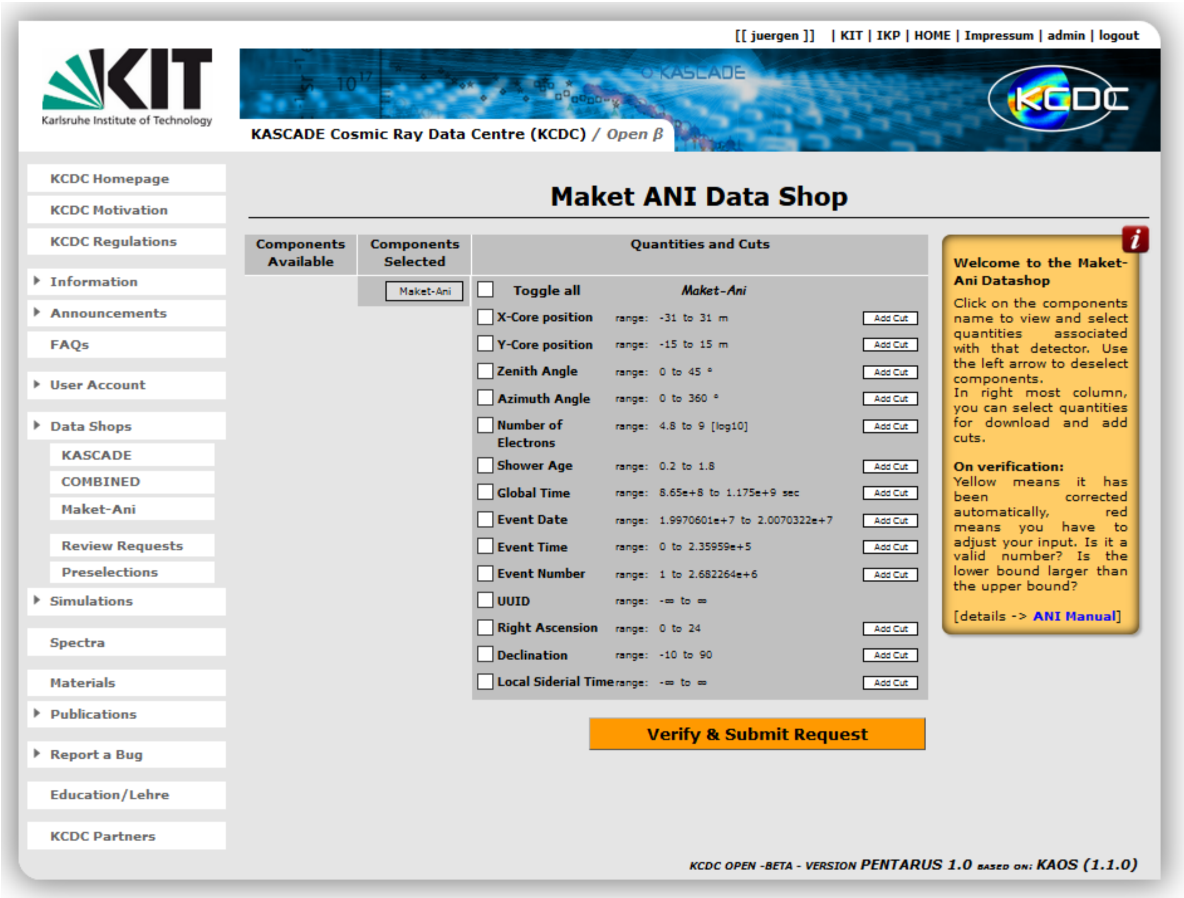


Fig. 4.2.1 *Available quantities of the 'Maket-Ani' DataShop*

4.3 User Defined Cuts

To select only a subsample of the MAKET-ANI data available you can apply your own cuts on most of the quantities. No cuts can be applied on quantities where the '*Add Cut*' Button is missing like '*UUID*'.

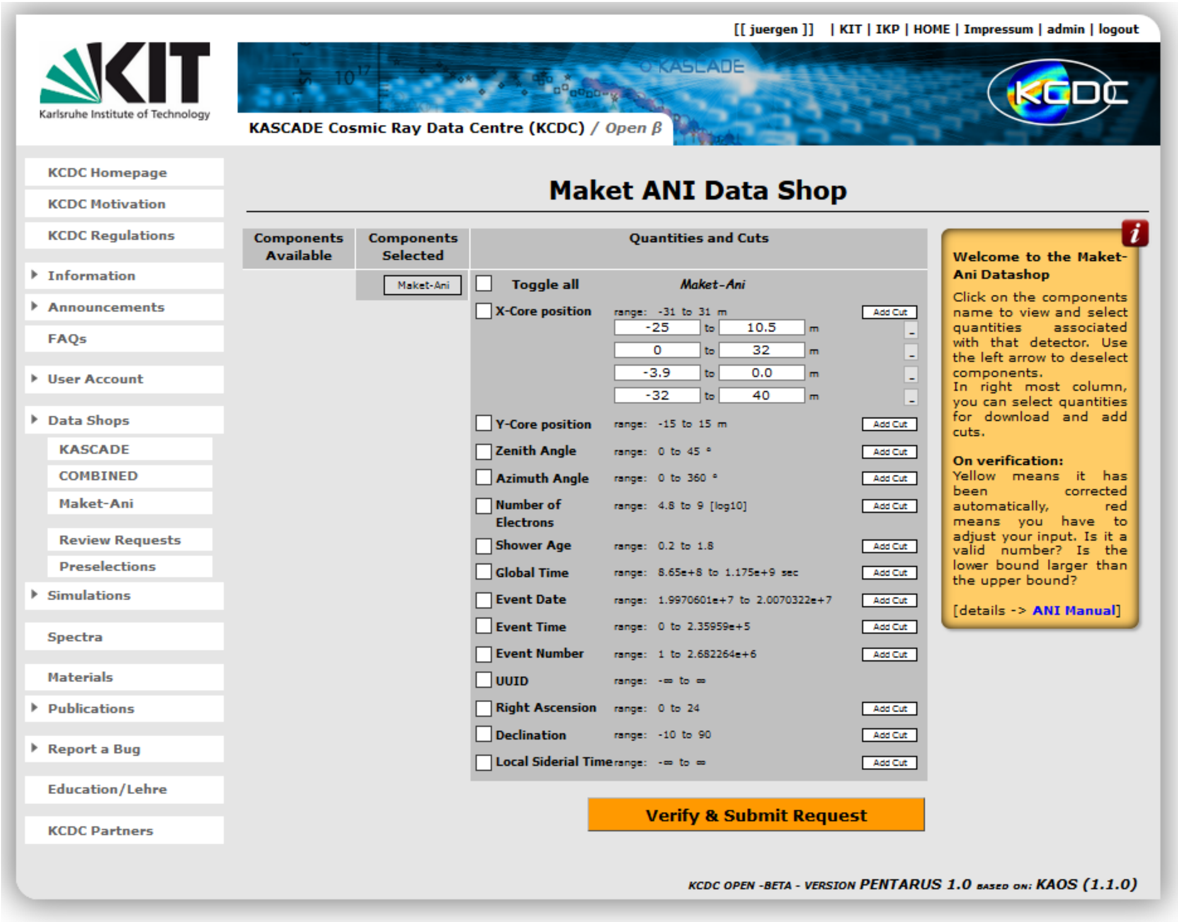


Fig. 4.3.1 *Applied cuts on 'X Core Position' with some example cuts*

To check and submit your requests press the *'Verify & Submit Request'* –Button.

The summary page gives an overview on your quantities selected and on the cuts applied. Additional information on the cuts is provided as well in the last column like:

full range	the full data range for this quantity is selected
user cut	the user has applied cuts which are effective
corrected cut	the user has applied a cut outside the valid range, this cut has been corrected to be within the limits
obsolete now	the user has applied cuts which is beyond the limits, thus the range has been corrected and the selection covers now the full range of data

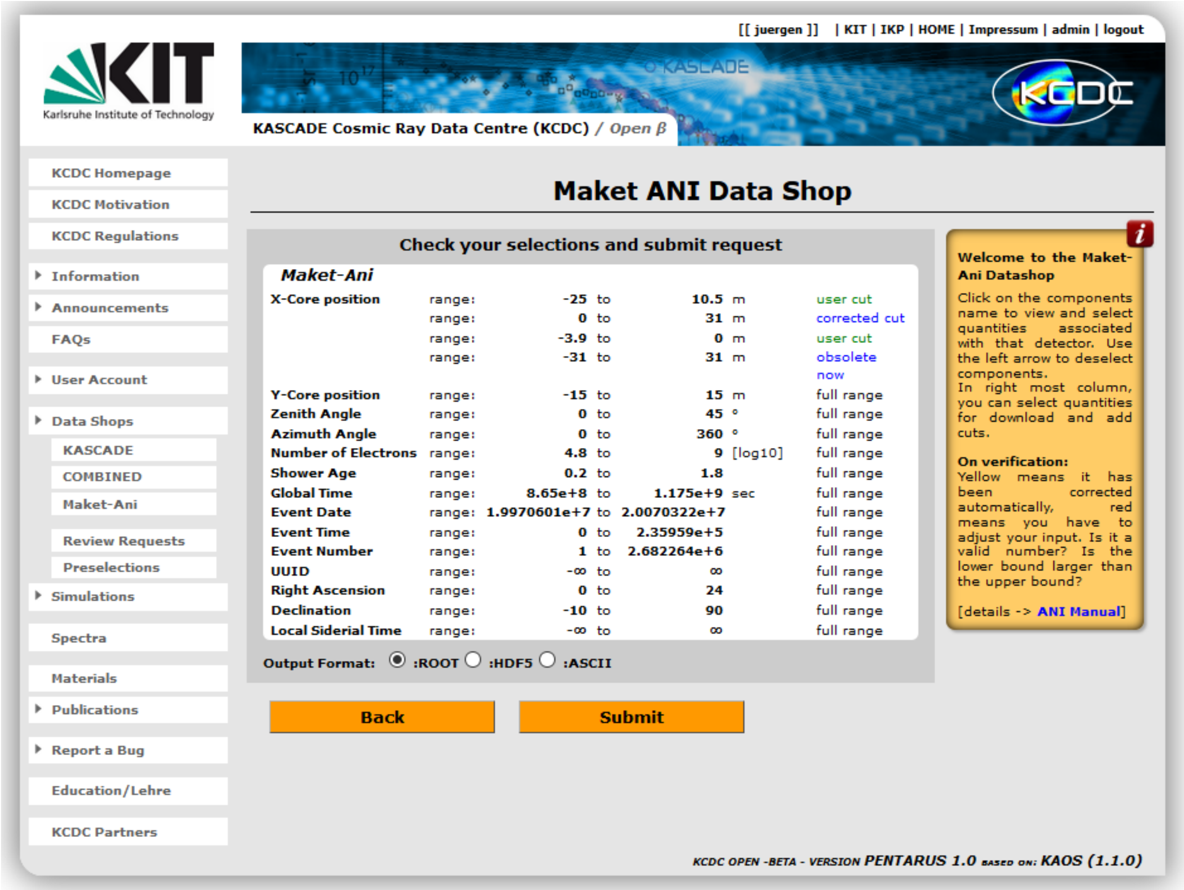


Fig. 4.3.2 *Check and submit your requests*

4.4 Job Submission and Review

After pressing the '*Submit*' –button you are redirected to your '*Review Requests'* page. Details see chapter 4.5. '*Job Status Information'.*

4.5 Job Status Information

The '*Review Requests'* page holds a complete list of all your requests submitted in all DataShops available via the KCDC web portal and enables you to check the present status of your jobs submitted.

Displayed on this page are the date of your request, the data format selected for download and a job status information as described in the table below.

PENDING	job is in the queue to be started
STARTED	job has started
REVOKED	job has been cancelled by the user
SUCCESS	job has been successfully finished data are ready for download
FAILURE	job has failed for some reason
DL EXPIRED	the link to download your data sets is no longer valid

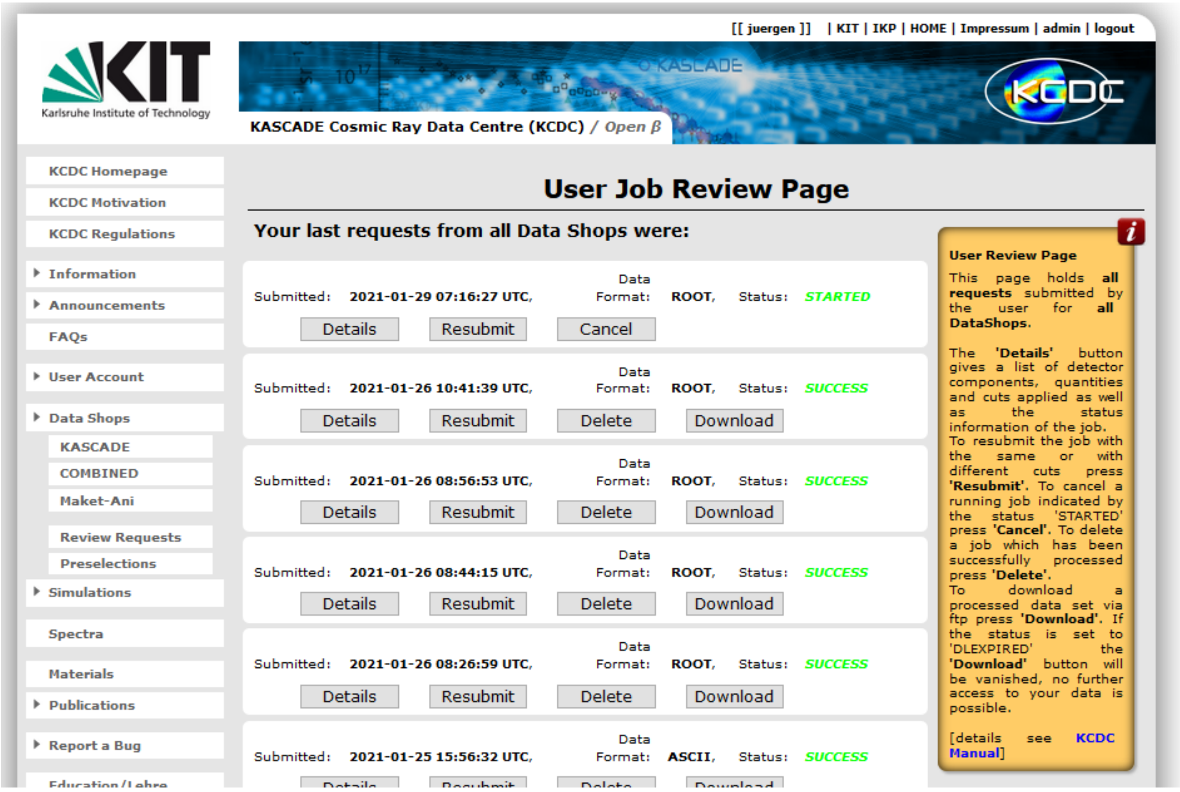


Fig. 4.5.1 *Job 'Review' -page*

On the '*Review Requests*' -page you have several buttons to navigate through your requests. Some of these buttons may change according to the status of the job.

Button	Description	Visibility
Details	shows a list of your request as interpreted by the *'worker'*	switches to 'Hide' when pressed
Resubmit	offers the possibility to resubmit your job and change quantities, selections and cuts	always
Cancel	cancel the job	only while the job is running it will change to 'Delete' after the job has finished
Delete	delete the complete request	only when the job is finished
Download	get the link to download your data file	only when successfully finished and the download link has not expired

To get a more detailed list of your requests press the '*Details*' –button

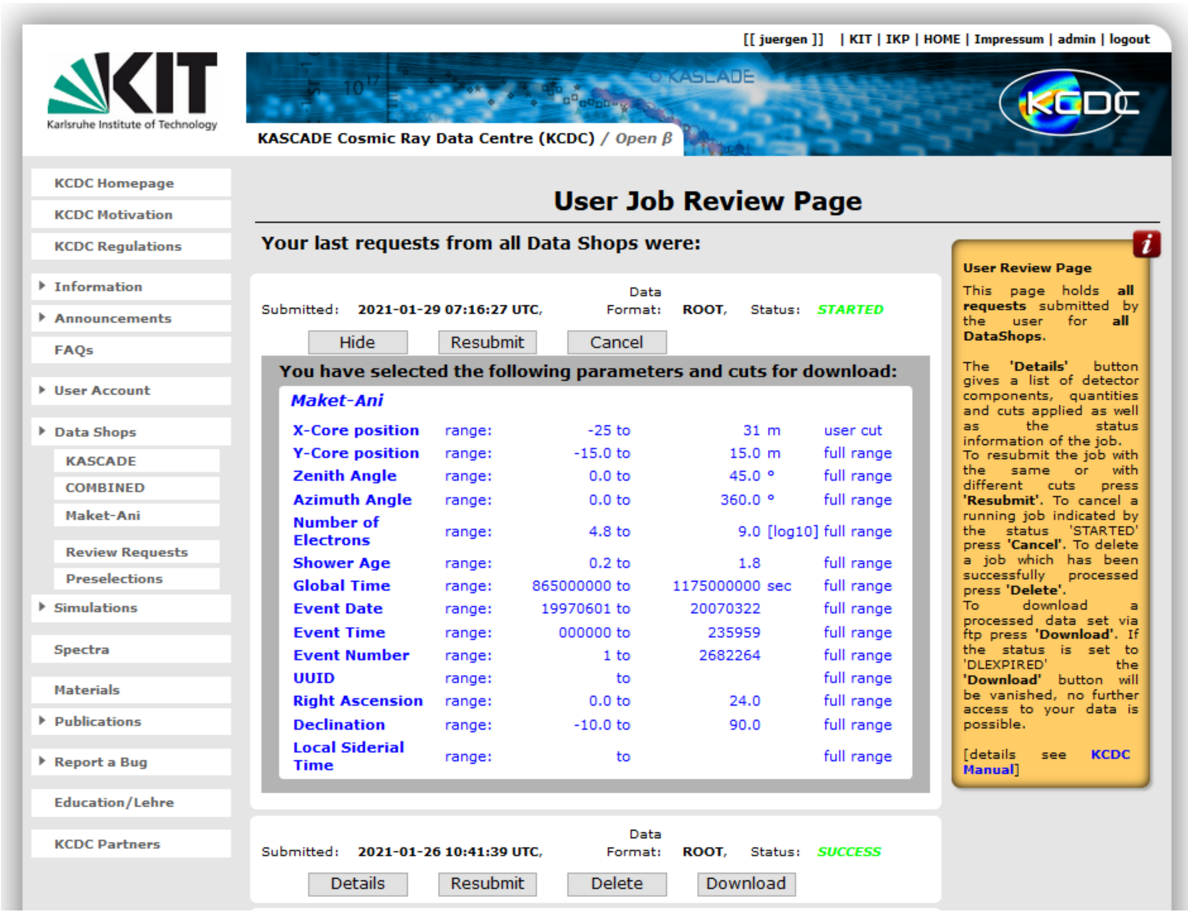


Fig. 4.5.2. *Details of user selections and cuts*

The information provided here may be different compared to the one displayed on the '*Check & Submit Page'*. This is due do the fact that here only the effective ranges are displayed. Overlapping user defined cuts like in the above example are merged to one effective cut.

4.6 Advices to use the Data Shop

Using the KCDC DataShop efficiently requires a little background knowledge how the MongoDB is accessed and how 'Cuts' can speed up your request.

The present MongoDB, which holds the data for the release SKARAGAN, has a total size of about 3200 GB, of which only 1 GB are occupied by the MAKET-ANI data sets and the indices, necessary to speed up the data access via the DataShop.

The query to the database uses indices for most of the quantities which can be applied cuts on.

4.7 Troubleshooting

4.7.1 …a general Error Information occurs

Some error information occurring while manoeuvring inside the DataShops is displayed in a red banner on top. Please act according the hints given there.

4.7.2 …the Submitted Request does not start?

If you have submitted a request correctly but the status information on the 'Review Page' is not switching from 'pending' to 'started' please try again later. 'Pending' indicates that either there a several requests in the queue waiting to be executed, or that there is problem on the server side of KCDC. Wait for a couple of minutes and if the error persists, resubmit the request using the 'Resubmit' button. If the problem remains please report bugs to the KCDC-Team using the 'Report a Bug' feature (details see 'KCDC User Manual').

4.7.3 …the Submitted Request returns with 'Failure'

If you have submitted a request and the job status information returns 'FAILURE' please try to resubmit the request using the 'Resubmit' button. If the problem remains please report bugs to the KCDC-Team using the 'Report a Bug' feature (details see 'KCDC User Manual').

4.7.4 …Downloading a Preselection returns with Error 421

If you have created a new user account and you want to download a preselection from the DataShop’s Preselection page, an error might occur indicating your home directory is not available (Error 421). This means that your download directory in the download area has not yet been created. A workaround to this problem is to start a ‘New Request’. Once the request is submitted your download directory is available and the preselections can be transmitted.

5 Data Retrieval Process

5.1 Get Your Data

Once a request has been successfully processed the status will change to '*SUCCESS*' and a '*Download*' button will appear.

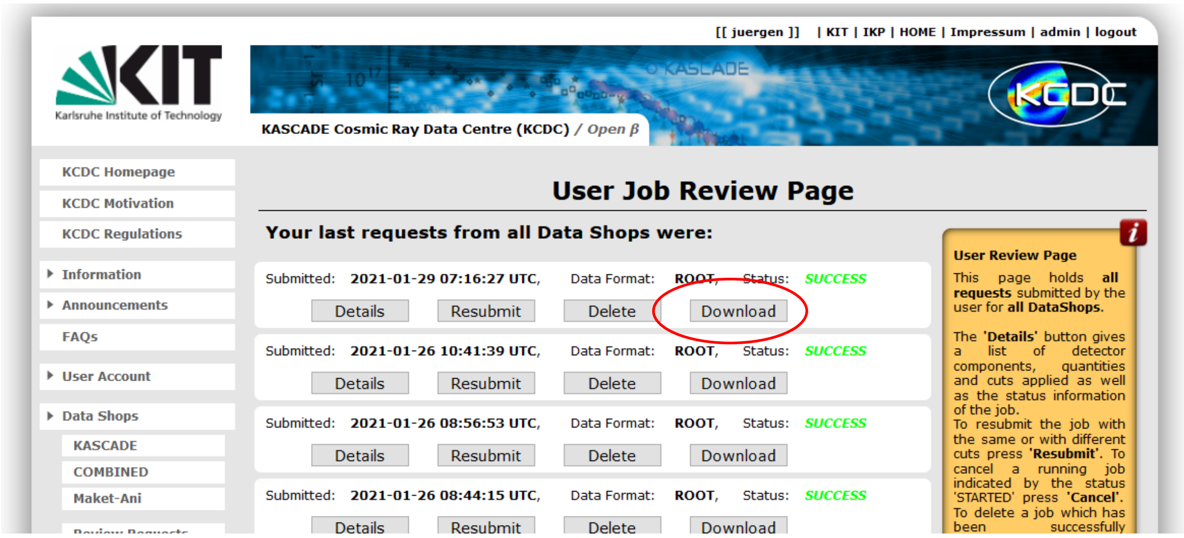


Fig. 5.1.1 *Request successfully finished → ready for 'Download'*

To start download you have to authenticate in the authentication window popping up. The download link will expire two weeks after your job has been successfully finished. After that, the status will switch to '*DL EXPIRED*' and the '*Download*' button will vanish.

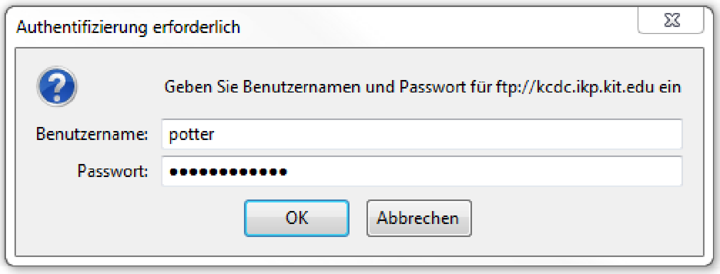


Fig. 5.1.2 *Download authentication window*

6 Data Formats

6.1 ASCII

ASCII is a plain text data format. For **ASCII** format four files are transmitted, depending on the detector components selected.

infos.txt	holds information on your requests, like the quantities selected and the cuts applied
ani.txt	data sets of the KASCADE array quantities
row_mapping.txt	event table, 'active/inactive' information on detector components → not important for MAKET-ANI data sets
EULA.pdf	End User Licence Agreement

The file **'row_mapping.txt'** is usually necessary to match different detector components if more than one component are available. It is of no meaning for the MAKET-ANI data sets.

6.2 ROOT

ROOT is an object-oriented framework developed by CERN aimed at solving the data analysis challenges of high-energy physics.

For **ROOT** format only three files are transmitted

infos.txt	holds information on your requests, like the quantities selected and the cuts applied
events.root	root data sets for all selected quantities including 'row_map'
EULA.pdf	End User Licence Agreement

The root file contains one date tree 'ani' and a 'row-map' tree (see fig. 6.2.1.).

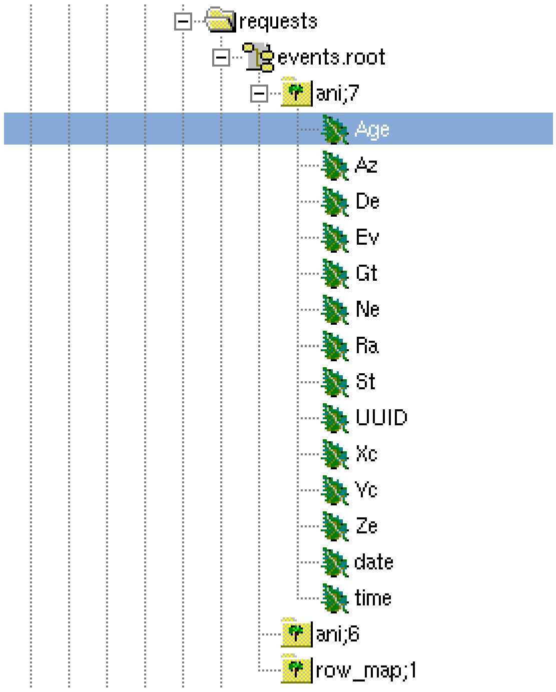


Fig. 6.2.1. *ROOT –trees example*

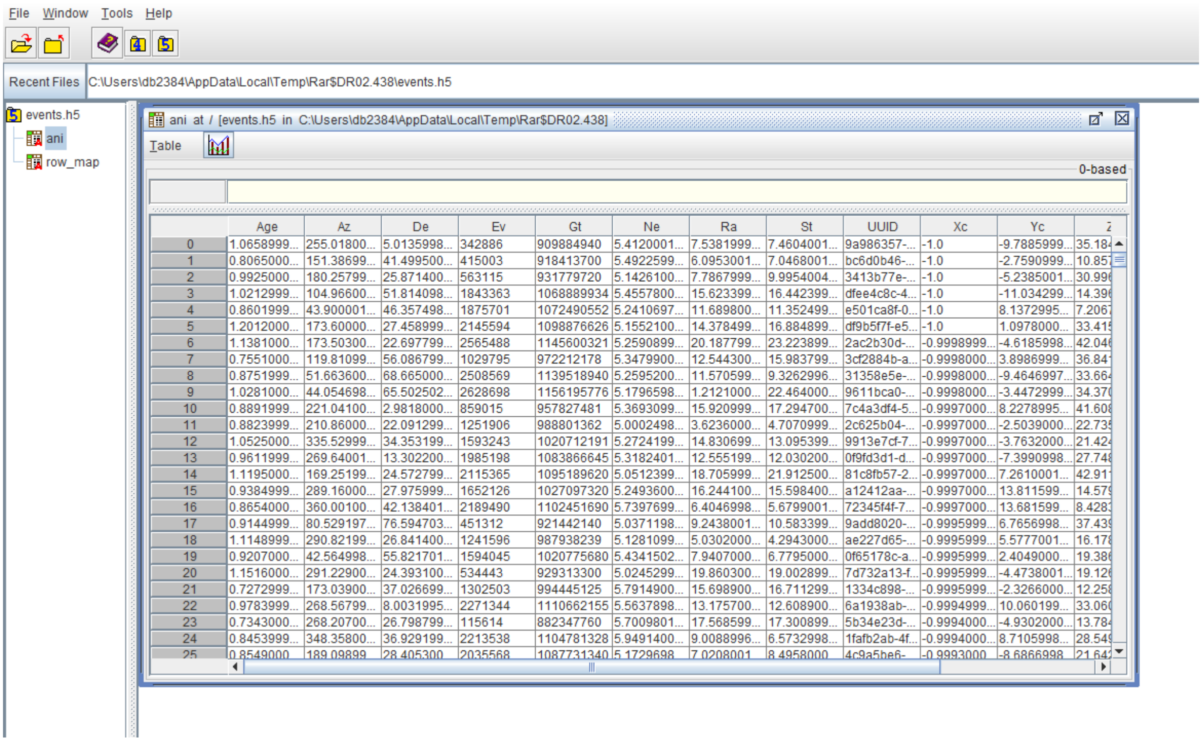
6.3 HDF5

Hierarchical Data Format (**HDF**) is a file format designed to store and organize large amounts of numerical data objects and a wide variety of metadata. HDF is a unique technology suite that makes possible the management of extremely large and complex data collections with no limit on the number or size of data objects. HDF is freely available distribution supported by many commercial and non-commercial software platforms, including Java, C, C++, Fortran 90 and Python. HDF provides a rich set of integrated performance features that allow for access time and storage space optimizations.

For **HDF5** format only three files are transmitted

infos.txt	holds information on your requests, like the quantities selected and the cuts applied
events.h5	hdf5 data sets for all selected quantities including ‘row_map’
EULA.pdf	End User Licence Agreement

The h5 file will contain one table for the MAKET-ANI detector component ‘ani’ and a ‘row-map’ table (see fig. 6.3.1.).



	Age	Az	De	Ev	Gt	Ne	Ra	St	UUID	Xc	Yc	Z
0	1.0658999...	255.01800...	5.0135998...	342886	909884940	5.4120001...	7.5381999...	7.4604001...	9a986357-...	-1.0	-9.7885999...	35.18
1	0.8065000...	151.38699...	41.499500...	415003	918413700	5.4922599...	6.0953001...	7.0468001...	bc6d0b46-...	-1.0	-2.7590999...	10.85
2	0.9925000...	180.25799...	25.871400...	563115	931779720	5.1426100...	7.7867999...	9.9954004...	3413b77e-...	-1.0	-5.2385001...	30.99
3	1.0212999...	104.96600...	51.814098...	1843363	1068889934	5.4557800...	15.623399...	16.442399...	dfee4c8c-4...	-1.0	-11.034299...	14.39
4	0.8601999...	43.900001...	46.357498...	1875701	1072490552	5.2410697...	11.689800...	11.352499...	e501ca8f-0...	-1.0	8.1372995...	7.206
5	1.2012000...	173.60000...	27.458999...	2145594	1098876626	5.1552100...	14.378499...	16.884899...	df9b5f7f-e5...	-1.0	1.0978000...	33.41
6	1.1381000...	173.50300...	22.697799...	2565488	1145600321	5.2590899...	20.187799...	23.223899...	2ac2b30d-...	-0.9998999...	-4.6185998...	42.04
7	0.7551000...	119.81099...	56.086799...	1029795	972212178	5.3479900...	12.544300...	15.983799...	3cf2884b-a...	-0.9998000...	3.8986999...	36.84
8	0.8751999...	51.663600...	68.665000...	2508569	1139518940	5.2595200...	11.570599...	9.3262996...	31358e5e-...	-0.9998000...	-9.4646997...	33.66
9	1.0281000...	44.054698...	65.502502...	2628698	1156195776	5.1796598...	1.2121000...	22.464000...	9611bca0-...	-0.9998000...	-3.4472999...	34.37
10	0.8891999...	221.04100...	2.9818000...	859015	957827481	5.3693099...	15.920999...	17.294700...	7c4a3df4-5...	-0.9997000...	8.2278995...	41.60
11	0.8823999...	210.86000...	22.091299...	1251906	988801362	5.0002498...	3.6236000...	4.7070999...	2c625b04-...	-0.9997000...	-2.5039000...	22.73
12	1.0525000...	335.52999...	34.353199...	1593243	1020712191	5.2724199...	14.830699...	13.095399...	9913e7cf-7...	-0.9997000...	-3.7632000...	21.42
13	0.9611999...	269.64001...	13.302200...	1985198	1083866645	5.3182401...	12.555199...	12.030200...	0f9fd3d1-d...	-0.9997000...	-7.3990998...	27.74
14	1.1195000...	169.25199...	24.572799...	2115365	1095189620	5.0512399...	18.705999...	21.912500...	81c8fb57-2...	-0.9997000...	7.2610001...	42.91
15	0.9384999...	289.16000...	27.975999...	1652126	1027097320	5.2493600...	16.244100...	15.598400...	a12412aa-...	-0.9997000...	13.811599...	14.57
16	0.8654000...	360.00100...	42.138401...	2189490	1102451690	5.7397699...	6.4046998...	5.6799001...	72345f4f-7...	-0.9997000...	13.681599...	8.428
17	0.9144999...	80.529197...	76.594703...	451312	921442140	5.0371198...	9.2438001...	10.583399...	9add8020-...	-0.9995999...	6.7656998...	37.43
18	1.1148999...	290.82199...	26.841400...	1241596	987938239	5.1281099...	5.0302000...	4.2943000...	ae227d65-...	-0.9995999...	5.5777001...	16.17
19	0.9207000...	42.564998...	55.821701...	1594045	1020775680	5.4341502...	7.9407000...	6.7795000...	0f65178c-a...	-0.9995999...	2.4049000...	19.38
20	1.1516000...	291.22900...	24.393100...	534443	929313300	5.0245299...	19.860300...	19.002899...	7d732a13-f...	-0.9995999...	-4.4738001...	19.12
21	0.7272999...	173.03900...	37.026699...	1302503	994445125	5.7914900...	15.698900...	16.711299...	1334c898-...	-0.9995999...	-2.3266000...	12.25
22	0.9783999...	268.56799...	8.0031995...	2271344	1110662155	5.5637898...	13.175700...	12.608900...	6a1938ab-...	-0.9994999...	10.060199...	33.06
23	0.7343000...	268.20700...	26.798799...	115614	882347760	5.7009801...	17.568599...	17.300899...	5b34e23d-...	-0.9994000...	-4.9302000...	13.78
24	0.8453999...	348.35800...	36.929199...	2213538	1104781328	5.9491400...	9.0088996...	6.5732998...	1fafb2ab-4f...	-0.9994000...	8.7105998...	28.54
25	0.8549000	189.09899	28.405300	2035568	1087731340	5.1729698	7.0208001	8.4958000	4c9a5be6-	-0.9993000	-8.6866998	21.64

Fig. 6.3.1. *HDF5 –tree & data tables example*

6.4 Problems while handling the Data Files

6.4.1 Warning when opening root files

The root files are created using the 'ROOT 6' version. If you open the *events.root* file with a different version you might get some warnings as outlined below which can be ignored.

```
root [1] Warning in <TStreamerInfo::BuildCheck>:
  The StreamerInfo of class TTree read from file events.root
  has the same version (=19) as the active class but a different checksum.
  You should update the version to ClassDef(TTree,20).
  Do not try to write objects with the current class definition,
  the files will not be readable.

Warning in <TStreamerInfo::CompareContent>: The following data member of
the on-file layout version 19 of class 'TTree' differs from
the in-memory layout version 19:
  double fWeight; //
  :
  :
```

6.4.2 32-bit LINUX Systems

As the files transmitted can be rather large, we strongly recommend using a 64-bit system. There is p.e. a 2GB file-size limit in LINUX. This limit is deeply embedded in the versions of Linux for 32-bit CPUs so there is no workaround for this situation.

7 Reference List

7.1 MAKET-ANI

1992 - The ANI experiment: on the investigation of interactions from hadrons and nuclei in the energy range 10^3-10^5 TeV

Nuclear Instruments and Methods in Physics Research A323 (1992) 104 - l07

1995 - STATUS REPORT ON "MAKET-ANI" EXPERIMENT

International Cosmic Ray Conference, Vol. 1, held August 28-September 8, 1995 in Rome, Italy.

1998 - Extension of the GAMMA muon underground detectors for studies of the longitudinal air shower development

FZK Report 6215 p90-97

1998 - EAS size spectrum for 1 · 105 < Ne < 5 · 107 measured by the MAKET installation

FZK Report 6215 p51-54

1998 - Investigation of the integral EAS size spectra in the knee region

FZK Report 6215 p55-60

1999 - The EAS Size Spectrum measured at ANI Cosmic Ray Observatory in the region of Knee

26th International Cosmic Ray Conference 1999

1999 - Status of the Experiment ANI. The first stage-Installation “GAMMA”

Proceedings of ICRC 1999

2000 - The Dependence of the Age Parameter from EAS Size and Zenith Angle of Incidence

arXiv:astro-ph/0002077v1 3 Feb 2000

2000 - Determination of the EAS Attenuation Length from Data of the ANI Experiment

Astro-ph/0002076v1 3 Feb 2000

2001 - Determination of angular accuracy of the MAKET ANI surface array

Proceedings of ICRC 2001: 818

2001 - Investigation of extensive air shower development using large slant depth of atmosphere

Proceedings of ICRC 2001; 2001ICRC....1.165S

2001 - Determination of primary energy spectra from MAKET ANI data

Proceedings of ICRC 2001: 93

2001 - Concept and layout of the EAS delayed particles arrival time distribution measurements at Aragats cosmic ray observatory

Proceedings of ICRC 2001: 818

2002 - The cosmic ray energy spectrum around the knee measured with the GAMMA array at Mt. Aragats

J. Phys. G: Nucl. Part. Phys.28(2002) 2317–2328

2004 - Light and Heavy Cosmic-Ray Mass Group Energy Spectra as Measured by the MAKET-ANI Detector

The Astrophysical Journal, 603:L29–L32, 2004 March 1

This publication has to be cited when publishing MAKET-ANI data downloaded from the KCDC web portal.

2005 - The Size Spectra of Extensive Air Showers in the "Knee" region Measured by MAKET-ANI detector

29th International Cosmic Ray Conference Pune (2005) 6, 93-96

2007 - Study of extensive air showers and primary energy spectra by MAKET-ANI detector on mountain Aragats

Astroparticle Physics 28 (2007) 58–71

This publication has to be cited when publishing MAKET-ANI data downloaded from the KCDC web portal.

2009 - Cosmic Ray research in Armenia

Advances in Space Research 44 (2009) 1183–1193

2011 - Particle bursts from thunderclouds: Natural particle accelerators above our heads

Physical Review D83,062001 (2011)

lOth anniversary of the MAKET -ANI results on the energy spectra at "knee" energies

A. Chilingarian

EAS data classification into light and heavy mass groups by MAKET installation

http://crd.yerphi.am/ANI_Collaboration_Scientific_Papers_Reports

MAKET-ANI Homepage: http://crd.yerphi.am

7.2 KCDC

The KASCADE Cosmic-ray Data Centre KCDC: Granting Open Access to Astroparticle Physics Research Data

The European Physical Journal C (2018)

This publication has to be cited when publishing data downloaded from the KCDC web portal. Details concerning the KCDC publication policy can be found in: https://kcdc.iap.kit.edu/lawnorder/

The KASCADE Cosmic-ray Data Centre KCDC: Releases and Future Perspectives

4th International Workshop on Data Life Cycle in Physics (DLC 2020), Online, 08.06.2020 – 10.06.2020

Data Structure Adaption from Large-Scale Experiment for Public Re-Use

3rd International Workshop on Data Life Cycle in Physics (DLC 2019), Irkutsk, Russia, 02.04.2019 – 07.04.2019

7 Reference List

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