UPDATE ON THE ANALYSIS OF GSI2 AND GSI1 ¹⁶O (200 MEV)

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Physics Meeting, ZOOM, 07/04/2021

Outline

- Status of the paper submitted on OPEN PHYSICS
- Status of the analysis
 - Scanning Progresses
 - GSI1: tracking, vertexing, charge measurement



Paper on OPEN PHYSICS

- Answers received from referees
- Mainly minor comments and additional explanation required
- Answers prepared, article's text+figures modified
- We'll submit the new version before the end of the week

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ogy [11] In this framework, the FOOT (FragmentatiOn O E. Fiandrini, G. Silvestre: University of Perugia, Department of Target) experiment [8, 16] has been proposed to mea-sure the target fragmentation induced by a proton beam in the human tissues in the energy range relevant for E. Fandrini, G. Silvestre University of Polygia, Department of Physics and Geology, Pengia, Italy C. Finck, A. Sécher, M. Vanstalle: Université de Strasbourg, CNRS, IPHC UMR 7871, F-07000 Strasbourg, France M. Fischetti, V. Patera, A. Sarti, A. Schiaba, A. Sciabba, M. Toppi: University of Rome La Sapienza, Department of therapeutic applications (150 - 250 MeV for protons and 200-400 MeV/n for carbon ions). As fragments generate or di Base e Applicate per l'Ingegneria (SBAI), Rome, Italy a proton beam have few micrometer R. Hetzel, A. Stahl: RWTH Aachen ematic approach has been adopted in which a pr beam (carbon or Oxygen) impinge on targets made carbon and hydrogen-enriched carbon materials (C₂H₄ y Desarrollo Nuclear, Havana, Cuba M. Marafini, A. Sarti: Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi, Rome, Italy Therefore, the cross-section on hydrogen is derived from M. C. Montesi: University of Napoli, Department of Chemistry. FOOT is based by two complementary setups:

eter, covering a polar angle acceptance u versity of Rome Tor Vergata, Department of to about 10° with respect to the beam axis, for fragment xome, Italy wome: INFN Section of Roma Tor Vergata, Rome, Italy Physics, norm, car, M. C. Morone: INFN Section of Roma Tor Ve A. Pastore: INFN Section of Bari, Bari, Italy $Z \ge 3$, and an emulsion spectrometer, to measure light fragments (Z \leq 3) up to 70° with respect to the bear axis. P. Placidi: University of Penuria. Department of Engineering In this paper, the charge identification perform

of the secondary fragments generated by the interactio hnological Innovation, Alessandria, Italy iity, Department of Physics, Nagoya, of ¹⁶O (200 MeV/n) primary beam on a C₂H₄ target by meter is reported A. Alexandrov, A. Di Crescenzo, V. Gentile, A. Iuliano, A. Lau-ria, M. C. Montesi, V. Tioukov, G. De Lellis: INFN Section of Nanoli Italy The method for the charge identification is based on n established technique already performed in previous

 Number of tracks
 Syst. Err.

 21199
 1649

 1438
 161

 22637
 161

Table 1. Number of fragments classified as Z = 1 or high energy

studies [10, 18, 19], consisting of a controlled fading of and keep memory their trajectory [19] a seq avaume (ny, on, on), on any constant of a Continuous along of a more service (ny, on), one of the service (ny, one of the service (ny, one)) and the service (ny, one) and the

grains which can be seen with an optical microscope [7 The darkness of these grains depends on the ion Nuclear emulsion films used in the 2019 FOOT 2 Experimental setup and track measurements were produced by the Nagoya University (Japan) and Slavich Company¹ (Russia) (75% and 25%) espectively). Their sensitivity corresponds to 30 grains

at and cannot be reconstructed as penetrating tracks

wrtheless, they can still contribute to the background

2.2 Emulsion spectrometer exposure

2.4 cm side (in a grid of 25 × 25 points), starting from the

random association of two or more aligned base

meter was installed in the case A of

In April 2019, an emplaion and wer a track length of 100 μm for a Minimum Ionizin a 200 MeV/n 16 O kon beam at the GSI facility in Darm-stadi (Germany). The spectrometer acts both as target and tracking device. The target made of C₂H₁ layers, chemical development, nuclear emulsion films are senwas embedded in the detector structure. The exposure sitive to charged particles. In particular, during their return and the second secon wanted background, before the detector assembly, were transported in a random order, so that cosmic ray accumulated during that period have a different align

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ionization power and charge.

reconstruction

the GSI facility. The incident beam flux was monitored

by the start counter, made of a thin plastic scintillator After the exposure, emulsions were first thermally and by the beam monitor, consisting of a drift chamber After the explosited of the start channel weight of a start channel with the start channel of the start channel o stics, the emulsion spectrometer exposure, structure ment for large statistics. The corresponding number of and the thermal treatment procedure are described. triggered events in the start counter was 19375. Th primary-beam had a Gaussian shape ($\sim 1 \text{ mm}$ sigma a fixed energy, and was used to scan a square area of

2.1 Nuclear Emulsion Film:

center and following a squared spiral shape with 1 mm Nuclear emulsion films consist of two 70 μ m thick sensitive emulsion layers, called top and bottom layers, de posited on both sides of a 210 μ m thick plastic base resulting in a total thickness of 350 μ m. A model emulsion comprises a large number of small AgBr cry tals, dispersed in the gelatinematrix forming uniform hispersed in gelatine. When a charged particle cross he emulsion laws, are sensitive to ionizing partic

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2.4 Track reconstruction 2.3 Emulsion spectrometer structu The emulsion spectrometer structure, shown in fig. 2, wa built according to the Emulsion Cloud Chamber (ECC) sequence of AgBr crystals is sensitized alon-

technique [17], which consists of nuclear emulsion films al- its-trajectory, producing a latent image, that th ternated with passive material lavers. The emulsion spece of dark silve rometer structure is organised in three main sections: iection I acts as target region and vertex determination, rains. Emulsion films were analysed by fast automate croscopes with high tracking efficiency ($\sim 90\%$) and Section II for the charge identification and Section III for speed (up to 190 cm²/hour) [4-6]. The automated sca ing matem consists of a microscope equipped with a 2D tification of fragments torized translation stage, a dedicated optical syste and a CCD camera.

alled track [3]

During the scanning, silver grains produced by th

particle are recognised as aligned clusters of dark pixels and associated to form the so-called *micro-track* in the emulsion layer, as shown in fig. 3. For each film, micro-

tracks on the top and bottom lavers are then connects

across the plastic base to form a base-track with an acc

racy of about 0.3 μ m in position and 1.2 mrad in angle. A sequence of base-tracks in different emulsion films allows

o reconstruct the particle trajectory inside the detector

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Fig. 2. Structure of the emulsion spectr

Each of these variables was fitted with three gaus-

={\ . Section I consists of 30 emulsion films interleaved with 30 polyethylene layers (2 mm thick) and is meant for the detection of primary beam interactions with the NA ---- IVI target (vertex detector). Its length is optimised so that 11 about 33% of 200 MeV/n 16O ions interacts therein, as cording to Monte Carlo simulations based on FLUKA code [9, 14]. At this energy, the Bragg peak is contained Fig. 3. Schematic drawing of a micro-tracks reconstruction in different tomographic images, grabbed at equally spaced dept levels through the sensitive layer (inft), micro-tracks association of between two emulsion layers to form a base-tracks (center) a base-tracks association to form a track. in this section and occurs after 26 layers. Section II is made of a sequence of 36 emulsion film divided into nine cells, each consisting of four films. The four nuclear emulsions of each cell underwent an appropriate thermal treatment to extend the dynamic range The sum of all pixels corresponding to the same traof the emulsion sensitivity to ionization with the aim o portional to the specific ionization of the incide easuring the charge of fragments. A detailed description of the thermal process is reported in paragraph 3. Section III is made of a sequence of 55 nuclear emu sion films interfaved with lexan (0:4H14O3, 1:2 g/cm³, 1 mm thick), tungsten (19.25 g/cm³, 0.5 mm and 0.9 mm 3 Charge identification thick) and lead (11.34 g/cm³, 1 mm and 2 mm thick layers. It is desirned to measure particle momenta taking In nuclear emulsions, the grain density along particle tr nto account the particle range and the Multiple Coulomb jectories is proportional to the particle energy loss over certain dynamic range. For highly ionizing particles, such as the ion beam considered here and induced fragment a saturation effect occurs due to the limited range of the rain density, thus preventing the charge

The dynamic range of the emulsion film response can Combining these variables, the particle charge ca be extended by keeping them for a certain amount of time, be distinguished with two complementary methods: an typically 24 hours, at temperatures above 28° C with a malysis based on event selections, bereafter referred to relative humidity around 95%: a controlled fading is induced, which can partially or totally erase base-tracks of $Z \leq 2$, and the Principal Components Analysis (PCA) [1] less ionising particles [19]. The use of films which under, for Z > 2 fragments. Excluding the combinatorial had associating particles (19). The tast on immediate the second state of $Z \ge 2$ regulators. Excitating the commatorian tasks went different thermal treatments allows to recover the ground, the sample can be divided into three disjoin original ionisation of the track, thus reconstructing the sets, according to the number of base-tracks (NR:

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survived to each thermal treatment. The combine In order to exploit this technique. Section II was divided into nine cells of four emulsion films each, denoted as Rx, with $x \in \{0,1,2,3\}.$ Each of these films underwent a specific thermal treatment (see fig. 4): R0 films did not here tracks have less than four hose-tracks) witho ndergo any treatment, R1, R2 and R3 ones were kept tion with Re-

> for the identification of these particles requires the reco struction of track segments in R0 films and allows th

presence of one track segment elsewhere: NR0 > 1 and $NRx_{x\in\{1,2,3\}} \leq 1$. The number of tracks fulfilling this request is 78905 and MIP cosmic rays and high energy

protons can be senarated through a cut-based analysis

deed, have le

ture of 28°C, 34°C and 36°C, respectively. Applying these Minimum Ionizing Particle tracks, such as muc thermal treatments, the number of residual grains along ments, therefore, they are present only in R0 films. Th therms twill have a state of the state will be propriositely protons, and in the state will be propriositely protons, and in the state will be a state of the state will be propriositely protons, and inclusion. For example, the ensed fraction of base-tracks shown in previous tests [18]. Nevertheless, given listric for cosmic rays has been measured to be larger than 99%, six statistical flattuations of the number of grains, dis in R1, while proton base-tracks are erased with an effitiency larger than 96% in R2. treatments efficiency, a single base-track may be forme in films other than R0. Therefore, the criterion adopte

particle charge.

The cut based-analysis is applied also to fragm rviving R1 thermal treatment (NR0 > 1 and NR1Fig. 4. Section II is divided into nine cells, each one nulsion films which underwent different tents. The more base-tracks survive to thermal treatments, th that do not have a statistically significant number of ba higher the particle's 7 racks in R2 and R3 (NR2 \leq 1 and NR3 \leq 1) are 385

Fragments not included in previous selection base-tracks survived also to R2 and/or R3 thern For this analysis, Section II has been considered as a For this analysis, Section II has been considered as a stand-alone detector. In this Section, 91876 transition were reconstructed. For each track, the following variables were at least three $V R_{x \in \{0,1,2,3\}}$ is required. This condition is arabitated by 7209 fragments. The predinging tracks, above 1.7% of the whole sample (1584) are due to cor m association (

$\tan \theta$: the tangent of the inclination of most upstream fitted track segment w.r.t. the Z axis; NRx: the number of base-tracks belonging to the track for each set of thermal treatments Rz, with $x \in$ (0, 1, 2, 3):	spare base-tracks 95% of these tracks, in than four base-tracks without any spe- with Rz.	
VRx: for each base-track, a variable named "volume" is defined as the sum of the pixel brightness and	3.1 Identification of Cosmic Ra	
expressed in arbitrary units related to particles'	First of all we want to separate MIP cosmi	

nic rays from high urray (> 80 MeV) protons, which are particles that a $\langle VRx \rangle = \sum_{NNN} VN$

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charge has been assigned also to fragments with $Z \ge 2$. applied to the Section II of the emulsion spectrometer in It is not possible to further distinguish $Z \ge 4$ particles order to distinguish the charge of fragments gener with the current thermal treatments used. Oxygen interactions and separate them from cosmic rays To crosscheck the results obtained with PCA, other two methods have been tried: the Singular Value Decom-position (SVD) and the Non-negative Matrix Factoriza-Section II of the detector. The charge of the tion (NMF) [13]. Both lead to compatible results within was measured using two complementary methods: a cutbased analysis and the Principal Component Analysis Our aim was to identify fragments as heavy as lithiun and this goal was achieved. Within the FOOT experi

ment, identification of $Z \ge 4$ fragments is a task of the ectronic detector actum. For future data takings, the av The charge has been measured or assigned for 98.3% of tematic uncertainty, which is the dominant one, will be retified and duced by optimising the thermal treatments to get a bet ter separation between fragments with different charge

			We thank GSI for the successful operation of their facil-
		RMS	ities during the data taking. This paper is dedicated to
~	$(\tan \theta)$	RWP	the memory of Ennio Morricone, a source of inspiration
1	0.32	0.23	
2	0.17	0.17	for many of us.
3	0.11	0.09	
>4	0.08	0.07	

References

Table 5. Mean and RMS of fragments inclination

 Number of tracks
 %

 6801
 90.3%

 546
 7.3%

 111
 1.5%
 sian functions, as shown in fig. 11. To each gaussian fit the particle population with increasing Z was associated: violet for Z = 2 fragments, pink for Z = 3 and green for Z ≥ 4 ones. The fit model has been inferred by the study 7.3% Z ≥ 4 costs. The fit model has been inserted by the study of a high-party sample pregnitic tracked-cosing at least 7 cells (JND 2 7). With the crit based inalysis, a firstic 7 and by CMD 2 7. By With the crit based inalysis, a firstic 7 and the composition question of the star UP_{2p}, is used, according to which aggressive thremal tractionet and the composition question in the star first 2 and R2, the (DM) how here relations to the star UP_{2p} is used, according to which aggressive thremal tractionet and the composition question in the star first 2 and R2, the (DM) how here relations the star first 2 and R2, the (DM) how here relations the star first 2 and R2, the (DM) how here relation to the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used, according to which aggressive thremal traction and the star UP_{2p} is used. According to which aggressive thremal traction and the star UP_{2p} is used. According to which aggressive thremal traction traction traction and the traction tract component of Z = 2 fragments with higher ionization (lower energy) is expected. For this reason, the Z = 2gaussian will be partially erased. The threshold value de-

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ber of fragments is expected to decrease as Z increases. Consequently, the mean value of the Z = 2 gaussian is

lower than the mean value of Z = 3 gaussian, which in turn is lower than the mean value of $Z \ge 4$ gaussian. The charge is assigned to each fragment by gen-erating of a random number which takes into account gible with respect to the one of VP_{123} , which is used for probabilities given by the height of each gaussian curve for its VP_{rev} value with respect to the height of the for its VP_{xyz} value with respect to the height of the overall fit distribution. As far as the evaluation of the been applied, that differ from each other for the plo binning and lower limits. For each one of them, the er ative contribution of each population is concerned, th ror due to uncertainties of fit parameters was evaluated nethod is equivalent to estimating the relative weight of through the generation of 10⁴ fits, where mean values o ch gaussian distribution. Neve eless, the pr the three caussian curves are normally distributed around their mean within 1 or Only fits with a probability large than 0.001 have been accepted. An example is shown in The variable VP_{123} is used if (VR1), (VR2) and (VR3) are available. Especially for tracks with a small figure 12.

(126) are available. Especially for tracks with a small figure 12. multiple of segments (i.e. a happent that spectra is a present is a present is a first set of the six different fits, the average on the specific R are not reconstructed or are not correctly as - multiple obtained over the 10⁴ random generations gives a solicitod to the track, or is no possible co-adulate their preside radius of the number of particles with a given VRz. In this case, nor 0 the other VP_{xyy}, combinations Δ with the set of the start of the size of the start of the size of the start of the sta pplies. In table 2 we report the number of fragments agged with the corresponding variable. Three error components have been identified: a sys. tagged with the corresponding variable.

cause of pot binning or lower mint, the error due to un-evaluation to account of the parameters and a statistical error due to due to uncertainties of the parameters are subglightly to the size of the available sample. All error components have been evaluated only for VP_m2, the contribution of table 3, together with relative uscertainties. Combining the error coming from the other VP_{xyz} , indeed, is negli-the $\langle VRx \rangle$ information through the PCA analysis, the

tematic uncertainty due to the fit, which can differ be systematic uncertainty, while the statistical error and the









ed particles. Different fragments corresponding fractions are reported in table 4. The $tan \theta$ distribution for all identified fragments is

The tan θ' distribution for an extension anyonese -shown in fig. 13. The mean and RMS of distributions are reported in table 5. As expected, the mean of the 5 Acknowledgements





cles with higher ionization are expected to also have higher VP_{xyz} .

Fig. 11. Distributions of the four variables obtained with the PC reg. 11. Distributions of the four variable obtained with the PCS method: black dots represent data. Each gaussian fit corresponds to a particle Z: violet for Z = 2 fragments, pink for Z = 3 and green for $Z \ge 4$.



01 02 03 04 05 06 07 08 09



is equivalent to a rotation of the original pattern space into a new set of coordinate vectors. Being VR the vector con

c. and with non-null, positive eigenvalues The base formed by the eigenvalues. The base formed by the eigenvalues of the C ma-trix and belonging to the largest eigenvalues corresponds

These variables are expressed in arbitrary units, as VRx

The first principal component is calculated in order to account for the highest variance in the data. Considering how VP.... have been evaluated, parti



 $(an \theta)$ cosmic rays and Z = 1 fragments, which have higher ionization. Green and red lines, instead, define th range of the boundary between the two populations an herefore have been used to evaluate the systematic un certainty, given by half of the difference between the high

Fig. 5. MIP particles ($NR0 \ge 0$ and NRx_{xi}) $c_{\{1,2,3\}} \le 1$: (a) dis-est and lowest values obtained. 0) versus the track's With this analysis condition, 60126 particles out Fig. 5. MF particles (MOS \ge 0 and MFR equations 5.51 (c) serves serves the serves of the serves o

From the (V R0) profile, shown in fig. 5 (a) for all user isotopic distrimination in task is addressed in Section III, ticles fulfilling the request ND ≥ 0 and NR₂ $< (1, 2) \le$ therefore we refer to these fragments as Z = 1 rather 1, it is possible to distinguish two populations. These are than protons. The same will apply for Z > 1 fragments. will separated looking at $\tan \theta$, as in fig. 5 (b). The particles at lower (VR0) have angles which span over a wide

Integer at lower (v 100) may also a state and a state of the state of Indeed, the beam direction is orthogonal to the emulsion

film surface and fragments produced by beam interactions. There are 3858 fragments which have not been include film surface and fragments produced by beam interaconservations were associated with the star of the star of the star direction in previous solection because of $NR \rightarrow 1$ and that do while cosmic rays implange at wider angles. The distribution shows a statictically significant number of base-tracks tion is truncated at tan $\theta = 1$ due to limits used during R 2 and $RM (NR \ge 1$ and $NR \ge 1$). These are shown

a reconstruction. in fig. 8, where the (VR1) is plotted versus (VR0). One To study the behaviour of cosmic rays, a control sam population is visible: tracks with (VR1) below the yellow To find by the intermeter of continue rays, a same as supposition is while tracks with (*HD*) below the spectrum tracks and the state of the state Bux measurements [15]. Therefore, MIP cosmic rays can be identified by com-systematic uncertainties bining the information of NRx, tan θ and (VR0). The yellect this nonulation and therefore were used to evaluat

low line in fig. 5 is used to separate in the plane (VR0).







Fig. 7. Distribution of (VR1) versus (VR0) for tracks with $NR2 \le 1$ and $NR3 \le 1$. The yellow line represents the

bution of (VR1) versus (VR0) for all tra-

Fig. 9. Distribution of the inclination of cosmic rays and of fragments identified by the cut based parahetic

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2 (high energy) Manurad

Z = 2 with the cut-based analysis

ragments with $\langle VR1 \rangle$ larger than the cut have b terpreted as belonging to the next atomic species, Z =

M. C. Morone: Univ

3.3 Identification of $Z \ge 2$ fragments with othesis of two populations and thei the Principal Component Analysis med looking at the same plot whe

to cuts have been applied on NR2 and NR3. The number To further distinguish $Z \ge 2$ fragments surviving also R2 of fragments below the cut is stable in the two cases, ints below the cut is stable in the two cases, and/or R3 thermal treatments a cut-based analysis α sting that these are Z = 1 particles which do (VR2) and (VR3) variables is not powerful enough du sents more aggressive than R1. to saturation effects, as shown in fig. 10, where only cuts the ones above the cut, having higher ionization, are (VR2) > 0 and (VR3) > 0 were applied jority of them will be analysed In order to disentangle different fragment tracks, the Principal Component Analysis, a multidimensional tech-

the next section with the PCA analysis. Principal Component Analysis, a multidimensional tech-nique, well established in the field of pattern recognifilms, the charge has been measured for 3858 particles: tion [1], was adopted. This technique is based on an 2420 fragments constitute the Z = 1 populations, while p|y|g| a linear transformation to the measured variables 1438 have been recognised as Z = 2 fragments. The sys-and is useful when these are not the most significant for

in table 1. The $\tan \theta$ distribution for cosmic rays is reported in fig. 9, compared with the distribution of oth ents whose charge was measured with the cut-base



data classification, while reducing the dimensionality of the problem results in an easier classification procedure This transformation, described by an orthogonal matrix

to the most significant features of the description of the The PCA method was applied to all fragments with at least three measured VRx, which are 7529. For these fragments, four new variables, called VP_{xyz} are defined



the covariance matrix is defined as $C = \langle yy^T \rangle$, where $y = VR - \langle VR \rangle$. C matrix is real, positive definite, sym-

Paper on OPEN PHYSICS

Reviewer #2

Reviewer #1: The text in figure 10 is very small and difficult to read. Please make this figure bigger so the text and data points are easier to see.

Major comments

1) Page 5- Lines 52-59 - left column The procedure used to extract the percentage of combinatorial background (1.7%) should be detailed.

2) Par. 3.2 and Fig. 7

While the presence of two populations (cosmics and Z=1) is evident in Fig. 5, the same is not true for Fig. 7. It is not clear to me how the presence of Z=2 fragments can be inferred by data for the class of events reported in Fig. 7. Moreover, the choose of the position of the boundaries between the "two populations" looks to me completely arbitrary. This also affects the associated systematic uncertainties.

The authors should better ague the results of this paragraph or maybe reconsider their interpretation.

3) Page 8 - Lines 44-47 and 53-57 - left column Authors should specify why the charge assignment is done taking into account the gaussian height and not the integral. What is the meaning of the sigma in the fits of Fig. 10?

Minor comments

1) Page 3 - Lines 57-60 - left column The effects of ionizing radiation on AgBr crystals could be described more clearly.

2) Page 3 - Line 39 - right column Change "primary beam" with "beam"

3) Page 5 - Lines 38-39 - left column

What are the units of the VRx variable? They should be included in all the plots where this variable appears.

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- Two populations and their boundaries are confirmed looking at the same plot where no cuts have been applied on NR2 and NR3
- The number of fragments below the cut (Z=1) is stable in the two cases
- New plot and related explanation added also in the paper







Distribution of $\langle VR1 \rangle$ versus $\langle VR0 \rangle$ for all tracks with NR1>1 No cuts have been applied on NR2 and NR3



Scanning Progress



- 2019 (GSI1, GSI2, GSI3, GSI4):
 - scanning: 100%
 - alignment: GSI1: 100% GSI2: 100% GSI3: 47% GSI4: 21%
 - tracking: GSI2: S1+S2 completed, S3 (=S3+S4+S5+S6+S7) started GSI1: S1+S2 quality checks ongoing
- 2020 (GSI5, GSI6): • scanning: 328/328 (100%)

GSI1: MC Analysis

• New MC simulation with Fluka2020

- 5623 vertices expected in S1
- Mean multiplicity: 4
- •96.2% of tracks contained



Tracks reconstruction

MC exported in data format, with smearing and inefficienciesCombinatorial background due to spare base tracks added to MC



Vertices Reconstruction (MC)

• 5188 vertices reconstructed with at least 3 tracks • Vertices quality improvements: ongoing



Charge reconstruction - preliminary

- Charge analysis ongoing on GSI1-S2 data
- The charge assignment strategy works also on this dataset, as expected
- Results still preliminary





Charge reconstruction - preliminary



- <u>Cosmic Rays:</u> $0 < \langle VR0 \rangle < a\theta + b \&$ nseg1<2 & nseg2<2 & nseg3<2
- 10³ <u>High energy Z=1:</u> $\langle VR0 \rangle \ge a\theta + b \&$ nseg1<2 & nseg2<2 & nseg3<2
- 10² Low energy Z=1: $\langle VR0 \rangle \ge 0\&$ 0 < $\langle VR1 \rangle < c \&$ nseg2<2 & nseg3<2
- 10 <u>High energy Z=2:</u> $\langle VR1 \rangle \ge c \& nseg2<2 \& nseg3<2$
 - Z≥2: at least 3 VRx → Principal Components Analysis

Principal Component Analysis - Preliminary



Conclusions

- The paper with charge assignment results will be submitted again in few days: all comments by referees have been answered
- GSI1 analysis started both on "reconstructed MC" and Data: quality checks ongoing before giving first results
- Still working to improve tracking and vertices reconstruction
- Charge analysis on GSI1 ongoing

