SPD NICA

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Dark Matter

Search

Astrophysics

Search

CRs

Uncertainties

Available Dat

Planned

NICA and

 \bar{p} production at 13-26 GeV

at 13-26 GeV

Requirement for SPD

Conclusions

On the possibility to study antiproton production at the SPD detector at NICA collider for dark matter search in astrophysical experiments

Alexey Guskov JINR-DLNP

Reham I. El-Kholy

Astronomy Department Cairo University

SPD NICA

Dark Matter

Search Methods

Astrophysics Search

Secondary CRs

Uncertainties

6 Available Data for $\sigma_{\bar{p}}$

Planned Measurements

NICA and SPD

 \bigcirc \bar{p} production at 13-26 GeV

SPD Coverage

Requirements for SPD

SPD NICA

R. El-Kholy

Dark Matter

Search

Astrophysi

Secondary

CRs

Uncertainties

Available Da for $\sigma =$

Planned Measuremen

NICA and SPD

at 13-26 Ge

SPD Coverag

Requirement

Conclusions

Rotational curves

SPD NICA

R. El-Kholy

Dark Matter

Methods

Astrophysic

Secondary CRs

Uncertainties

Available Da

Planned

NICA and

 \bar{p} production at 13-26 GeV

SPD Covera

Requiremen

Conclusions

Rotational curves

Keplerian

$$v(r) \propto \begin{cases} r, & r < R \\ \frac{1}{\sqrt{r}}, & r > R \end{cases}$$

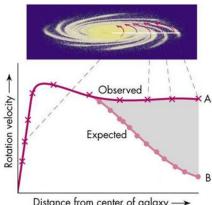
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Rotational curves

Keplerian

$$v(r) \propto \begin{cases} r, & r < R \\ \frac{1}{\sqrt{r}}, & r > R \end{cases}$$



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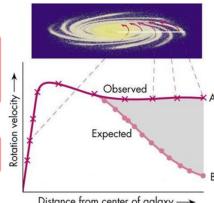
Rotational curves

Keplerian

$$v(r) \propto \begin{cases} r, & r < R \\ \frac{1}{\sqrt{r}}, & r > R \end{cases}$$

Observation

$$v(r) \sim \text{constant}, \quad r > R$$



Distance from center of galaxy ->

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Astrophysic

Secondary CRs

Uncertainties

Planned

NICA and

 \bar{p} production

at 13-26 Ge

Requirement

onclusions

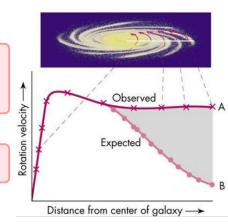
- Rotational curves
- Keplerian

$$v(r) \propto \begin{cases} r, & r < R \\ \frac{1}{\sqrt{r}}, & r > R \end{cases}$$

Observation

$$v(r) \sim \text{constant}, \quad r > R$$

• Galaxy cluster (M/L)



DM evidence

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Astrophysi

Search

CRs

Uncertainties

Available Da

Planned Measurement

NICA and SPD

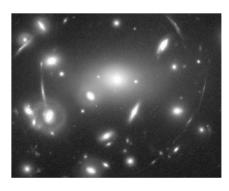
 \bar{p} production at 13-26 GeV

SPD Cover

Requirement for SPD

Conclusions

Gravitational Lensing with no luminous mass:



DM evidence

SPD NICA

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Dark Matter

Search

Astrophysic Search

Secondary CRs

Uncertainties

Available Da

Planned Measurement

NICA and SPD

 \bar{p} production at 13-26 GeV

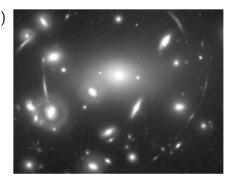
Requiremen

Requirement for SPD

Conclusions

Gravitational Lensing with no luminous mass:

- Bullet Cluster (1E0657-56)
- MACSJ0025



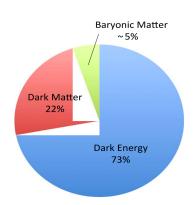
DM evidence

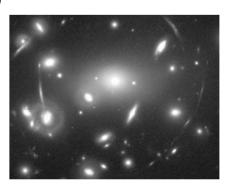
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Dark Matter

Gravitational Lensing with no luminous mass:

- Bullet Cluster (1E0657-56)
- MACSJ0025





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Dark Matter

Search Metho

Astrophysic

Secondary

CRs

Uncertainties

Available Da

Planned Measuremen

NICA and SPD

p production at 13-26 GeV

SPD Coverage

Requiremen

Conclusion

SPD NICA

R. El-Kholy

Dark Matter

Search

Astrophysic

Search

Secondary CRs

Uncertainties

Available Dat

Planned

NICA and

p̄ production at 13-26 GeV

SPD Covera

Requiremen

Conclusions

Classifications:

 Possible production (thermal, non-thermal)

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Dark Matter

Search

Astrophysic

Secondary

Uncertainties

Available Data

Planned

NICA and

 \bar{p} production at 13-26 GeV

SPD Covera

Requirement

Conclusions

- Possible production (thermal, non-thermal)
- Particle nature (baryonic, non-baryonic)

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Search Methods

Astrophysics

Secondary CRs

Uncertainties

Available Data

Planned Measurement

NICA and

 \bar{p} production at 13-26 GeV

SPD Covera

Requiremen

Conclusions

- Possible production (thermal, non-thermal)
- Particle nature (baryonic, non-baryonic)
- Particle mass (low mass (HDM), heavy (CDM))

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Dark Matter

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Search

Secondary CRs

Uncertainties

Available Dat

Planned

NICA and SPD

 \bar{p} production at 13-26 GeV

SPD Covera

Requiremen

Conclusions

 WIMPs (Weakly Interacting Massive Particles)

- Possible production (thermal, non-thermal)
- Particle nature (baryonic, non-baryonic)
- Particle mass (low mass (HDM), heavy (CDM))

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Dark Matter

WIMPs (Weakly Interacting Massive Particles)

- MACHOs
- SUSY candidates
- Kaluza-Klein candidates.
- Sterile neutrinos
- Axions

- Possible production (thermal, non-thermal)
- Particle nature (baryonic, non-baryonic)
- Particle mass (low mass (HDM), heavy (CDM))

WIMPs

SPD NICA

R. El-Kholy

Dark Matter

Search

Astrophysi

Secondary

CRs

Uncertainties

Available Da

Planned Measuremen

NICA and SPD

at 13-26 Ge

SPD Covera

Requirement for SPD

Conclusions

 \bullet Expected mass range $\sim 10~\text{GeV}{-}10~\text{TeV}$

WIMPs

SPD NICA

R. El-Kholy

Dark Matter

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Astrophysics

Search

CRs

Uncertainties

Available Dat

Planned Measurement

NICA and SPD

 \bar{p} production at 13-26 GeV

SPD Covera

Requirement

Conclusions

\bullet Expected mass range $\sim 10~\text{GeV}{-}10~\text{TeV}$

- Can elastically scatter on ordinary-matter nuclei
- ullet Expected recoil energy ~ 1 to 100 keV

WIMPs

SPD NICA

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Dark Matter

Methods

Astrophysics Search

Secondary CRs

Uncertainties

Available Dat

Planned Measurement

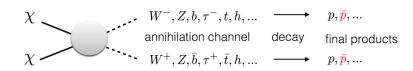
NICA and SPD

 \bar{p} production at 13-26 GeV

SPD Covera

Requirement for SPD

- Expected mass range $\sim 10~\text{GeV}{-10}~\text{TeV}$
- Can elastically scatter on ordinary-matter nuclei
- ullet Expected recoil energy ~ 1 to 100~keV
- Can pair-annihilate and produce, through primary and secondary processes: $\nu, \gamma, e^+, \bar{p}$, and other anti-nuclei



Direct Detection

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Dark Matter

Search Methods

Astrophysics Search

Secondary CRs

Uncertainties

Available Da

Planned

NICA and SPD

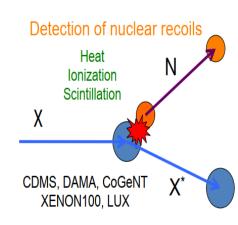
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SPD Covera

Requirement

Conclusions

 Interaction of DM with terrestrial detectors

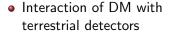


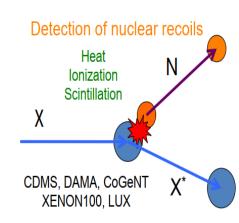
Direct Detection

SPD NICA

Search

Methods



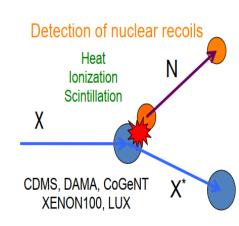


Direct Detection

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Search Methods

- Interaction of DM with terrestrial detectors
- ∼ keV recoil energy
- Minimization and identification of background noise are crucial



SPD NICA

Search Methods

 Spectral distortion in CR spectrum

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Dark Matter Search

Methods Astrophysics

Secondary CRs

Uncertainties

Available Dat for $\sigma \bar{s}$

Planned Measurement

NICA and SPD

 $ar{p}$ production at 13-26 GeV

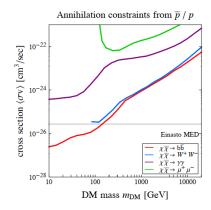
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Requirement

Conclusions

Spectral distortion in CR spectrum

- WIMP decay and pair-annihilation
- Possible products: ν , γ , \bar{p} , etc



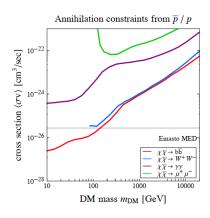
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Search

Methods

- Spectral distortion in CR spectrum
- WIMP decay and pair-annihilation
- Possible products: ν , γ , \bar{p} , etc
- Experiments:
 - Ground-based (γ -ray detectors): H.E.S.S., MAGIC, VERITUS

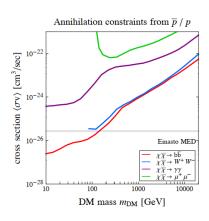


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Search Methods

- Spectral distortion in CR spectrum
- WIMP decay and pair-annihilation
- Possible products: ν , γ , \bar{p} , etc
- Experiments:
 - Ground-based (γ -ray detectors): H.E.S.S., MAGIC, VERITUS
 - Satellite-borne: FERMI-LAT (γ -ray detector), PAMELA, AMS-02



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Search

Astrophysics Search

Secondary CRs

Uncertainties

Available Dat

Planned Measurement

NICA and SPD

p̄ production at 13-26 Ge\

SPD Covera

Requirement for SPD

Conclusion:

 PAMELA (Payload for Antimatter Matter Exploration and Light Nuclei Astrophysics) magnetic spectrometer performed precision measurements of antiparticle fluxes in primary cosmic rays.

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Dark Matter Search

Astrophysics Search

Secondary CRs

Uncertainties

Available Data

Planned Measurement

NICA and SPD

p̄ production at 13-26 Ge\

SPD Covera

Requirement

- PAMELA (Payload for Antimatter Matter Exploration and Light Nuclei Astrophysics) magnetic spectrometer performed precision measurements of antiparticle fluxes in primary cosmic rays.
- The Resurs-DK1 satellite with the on-board scientific equipment was launched in June 2006 and the mission ended in Feb. 2016.

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Dark Matter Search

Astrophysics Search

Uncertainties

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Flanned
Measurements

NICA and SPD

p̄ production at 13-26 GeV

Requirement for SPD

- PAMELA (Payload for Antimatter Matter Exploration and Light Nuclei Astrophysics) magnetic spectrometer performed precision measurements of antiparticle fluxes in primary cosmic rays.
- The Resurs-DK1 satellite with the on-board scientific equipment was launched in June 2006 and the mission ended in Feb. 2016.
- The spectrometer includes: the time-of-flight system (ToF), coordinate tracking system (tracker) in the magnetic field, position-sensitive calorimeter, anti-coincidence system, lower scintillation shower detector, and neutron detector.

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Dark Matter Search

Astrophysics Search Secondary CRs

Uncertainties

for $\sigma_{\bar{p}}$ Planned Measurements

NICA and SPD

p̄ production at 13-26 GeV SPD Coverag

Requirements for SPD

- PAMELA (Payload for Antimatter Matter Exploration and Light Nuclei Astrophysics) magnetic spectrometer performed precision measurements of antiparticle fluxes in primary cosmic rays.
- The Resurs-DK1 satellite with the on-board scientific equipment was launched in June 2006 and the mission ended in Feb. 2016.
- The spectrometer includes: the time-of-flight system (ToF), coordinate tracking system (tracker) in the magnetic field, position-sensitive calorimeter, anti-coincidence system, lower scintillation shower detector, and neutron detector.
- Performed analysis antiprotons of energies \sim 80 MeV–190 GeV, on data taken from 2006 to 2009.

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Secondary CRs

Uncertainties

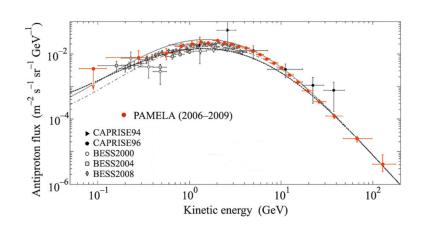
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 \bar{p} production at 13-26 GeV

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Requirement for SPD



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Secondary CRs

Uncertainties

Available Dat

Planned Measurement

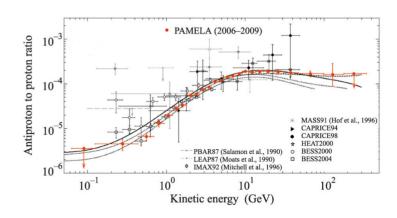
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 \bar{p} production at 13-26 GeV

SPD Covera

Requirement for SPD

Conclusions



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Dark Matter

Astrophysics Search

Secondary CRs

Uncertainties

Available Dat

Planned Measurement

NICA and SPD

p̄ production at 13-26 Ge\

SPD Covera

Requirement for SPD

Conclusions

 AMS-02 (The Alpha Magnetic Spectrometer) on-board the International Space Station (ISS), is the most advanced detector for charged CR flux measurements.

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Dark Matter Search

Astrophysics Search

Secondary CRs

Uncertainties

Planned

Measuremen

 \bar{p} production at 13-26 Ge³

SPD Covera

Requiremen for SPD

- AMS-02 (The Alpha Magnetic Spectrometer) on-board the International Space Station (ISS), is the most advanced detector for charged CR flux measurements.
- The spectrometer includes: a silicon tracker, a permanent magnet, time of flight counters TOF, anti-coincidence counters ACC, a transition radiation detector TRD, a ring imaging Čerenkov detector RICH, and an electromagnetic calorimeter ECAL.

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Astrophysics Search

Secondary CRs

Uncertainties

Planned

Measurement

 \bar{p} production at 13-26 GeV

SPD Coverage

Requirement for SPD

- AMS-02 (The Alpha Magnetic Spectrometer) on-board the International Space Station (ISS), is the most advanced detector for charged CR flux measurements.
- The spectrometer includes: a silicon tracker, a permanent magnet, time of flight counters TOF, anti-coincidence counters ACC, a transition radiation detector TRD, a ring imaging Čerenkov detector RICH, and an electromagnetic calorimeter ECAL.
- Performed analysis of antiprotons of energies \sim 1–450 GeV, on data taken from May, 2011 to May, 2015.

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Dark Matter

Astrophysics Search

Secondary

Uncertainties

Available Dat

Planned Measurement

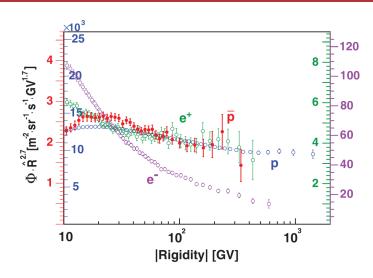
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 \bar{p} production at 13-26 GeV

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Requirement for SPD

Conclusions



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Astrophysics

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Uncertainties

for $\sigma_{\bar{p}}$

Planned Measurements

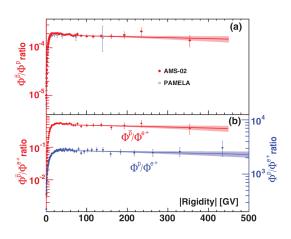
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Requirements for SPD

Conclusions



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Dark Matter

Astrophysics

Search

Secondary CRs

Uncertainties

Available Dat

Planned Measurement

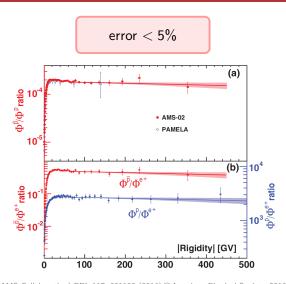
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Requirements for SPD

Conclusions



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Secondary CR production

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Secondary

CRs

Uncertainties

Available Dat

Planned Measuremen

NICA and

p production at 13-26 GeV

SPD Coverage

Requirement

Conclusions

Collisions of primary CRs and ISM

Secondary CR production

SPD NICA

R. El-Kholy

Dark Matter

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Astrophysic Search

Secondary CRs

Uncertainties

Available Dat

Planned

Measurement

NICA and SPD

p̄ production at 13-26 Ge\

SPD Covera

Requirement for SPD

Conclusions

Collisions of primary CRs and ISM

Nuclei	Cosmic Rays	Interstellar Medium
\overline{p}	0.844	0.911
D	0.029	1.6×10^{-5}
$^3{ m He}$	0.027	2×10^{-5}
⁴ He	0.10	0.089

Secondary CR production

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Dark Matter

Search

Astrophysics Search

Secondary CRs

Uncertainties

Available Dat

Planned

NICA and

p̄ production

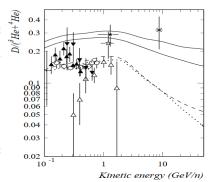
at 13-26 Ge

Requirement

Conclusions

Collisions of primary CRs and ISM

Nuclei	Cosmic Rays	Interstellar Medium
\overline{p}	0.844	0.911
D	0.029	1.6×10^{-5}
$^3\mathrm{He}$	0.027	2×10^{-5}
⁴ He	0.10	0.089



Production channels for \bar{p}

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Search Secondary

CRs

Uncertainties

Planned

Measurement

NICA and SPD

p̄ production at 13-26 GeV

SPD Covera

Requiremen for SPD

Conclusions

$$\begin{cases} p+H \rightarrow \bar{p}+X & \sim 70\% \\ \alpha+H \rightarrow \bar{p}+X & \sim 25\% \\ p+He \rightarrow \bar{p}+X & \sim 4\% \\ \alpha+He \rightarrow \bar{p}+X & \sim 1\% \end{cases}$$

Mathieu Boudaud - LAPTh - Annecy, France

Production channels for \bar{p}

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Secondary CRs

$$\begin{cases} p+H \rightarrow \bar{p}+X & \sim 70\% \\ \alpha+H \rightarrow \bar{p}+X & \sim 25\% \\ p+He \rightarrow \bar{p}+X & \sim 4\% \\ \alpha+He \rightarrow \bar{p}+X & \sim 1\% \end{cases}$$

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$$d+H \rightarrow \bar{p}+X \sim 1-4\%$$

Production channels for \bar{p}

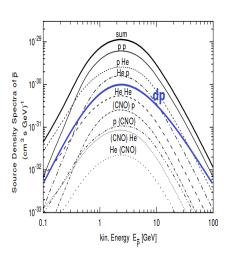
SPD NICA

Secondary CRs

 $\left\{ \begin{array}{ll} p+H \rightarrow \bar{p} + X & \sim 70\% \\ \alpha + H \rightarrow \bar{p} + X & \sim 25\% \\ p+He \rightarrow \bar{p} + X & \sim 4\% \\ \alpha + He \rightarrow \bar{p} + X & \sim 1\% \end{array} \right.$

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$$d+H \rightarrow \bar{p}+X \sim 1-4\%$$



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Astrophysics

Secondary CRs

Uncertainties

Available Dat

Planned

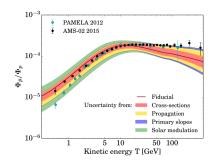
NICA and SPD

 \bar{p} production at 13-26 GeV

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Astrophysics

Secondary CRs

Uncertainties

Available Dat

Planned Measuremen

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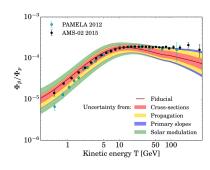
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Requirement for SPD

Conclusion

Primary spectra slopes



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Astrophysics

Secondary CRs

Uncertainties

for $\sigma_{\bar{p}}$

Measurement

NICA and SPD

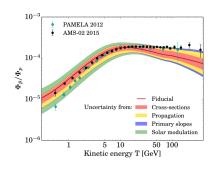
 \bar{p} production at 13-26 GeV

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Conclusions

- Primary spectra slopes
- Propagation parameters (diffusion and convection) in the local galactic environment



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Methods

Search

Secondary CRs

Uncertainties

Planned

Planned Measurement

SPD

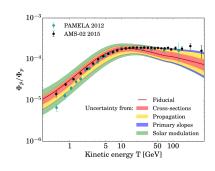
p̄ production at 13-26 Ge\

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Requirement for SPD

Conclusions

- Primary spectra slopes
- Propagation parameters (diffusion and convection) in the local galactic environment
- Solar modulation



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Astrophysics

Secondary CRs

Uncertainties

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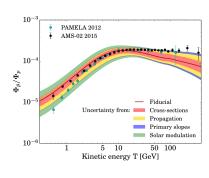
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NICA and SPD

 \bar{p} production at 13-26 GeV

Requirement

- Primary spectra slopes
- Propagation parameters (diffusion and convection) in the local galactic environment
- Solar modulation
- \bar{p} -production cross section (20 50%)



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Primary spectra slopes

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Astrophysics

Secondary

Uncertainties

Uncertainties

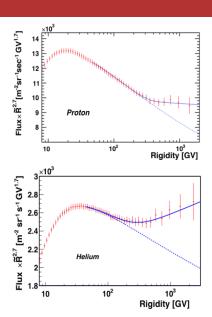
Planned Measurements

NICA and

 \bar{p} production at 13-26 GeV

at 13-26 GeV

Requirements



Primary spectra slopes

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Dark Matter

Search

Astrophysics Search

Secondary CRs

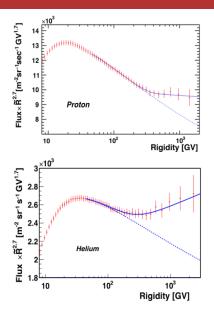
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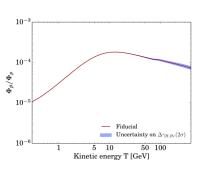
for $\sigma_{\bar{p}}$ Planned
Measurement

NICA and

p̄ production at 13-26 Ge\

Requirements





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Propagation parameters

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Search

Astrophysic Search

Secondary CRs

Uncertainties

Available Data for $\sigma_{ar{ heta}}$

Planned Measurement

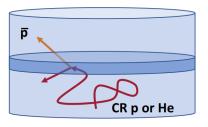
NICA and SPD

p̄ production at 13-26 Ge\

Requirement

Conclusions

Diffusion and convection parameters



$$\frac{\mathrm{CR}_i}{\mathrm{ISM}_j} \to \bar{p} + X$$

Propagation parameters

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Astrophysics Search

Secondary CRs

Uncertainties

Planned

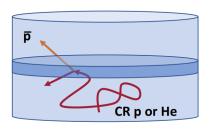
NICA and

 \bar{p} production at 13-26 GeV

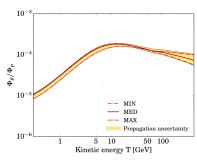
Requirement

Conclusions

Diffusion and convection parameters



$$\frac{\mathrm{CR}_i}{+} + \mathrm{ISM}_j \to \bar{p} + X$$



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Solar modulation

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Astrophysic

Secondary CRs

Uncertainties

.

for $\sigma_{\bar{p}}$

Planned Measuremen

NICA and SPD

p̄ production at 13-26 Ge\

SPD Coverag

Requirement for SPD

Conclusions

Solar modulation depends on the solar activity at the time of observation.

Solar modulation

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Search Methods

Astrophysics Search

Secondary CRs

Uncertainties

Available Data

Planned Measurement

NICA and SPD

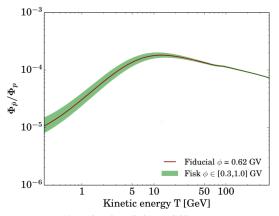
p̄ production at 13-26 Ge\

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Requirements for SPD

Conclusions

Solar modulation depends on the solar activity at the time of observation.



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Production cross sections

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Secondary CRs

Uncertainties

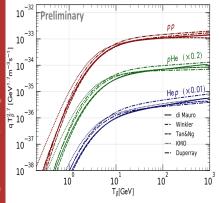
for $\sigma_{\bar{p}}$

Planned Measurements

SPD

p̄ production at 13-26 GeV

Requirements

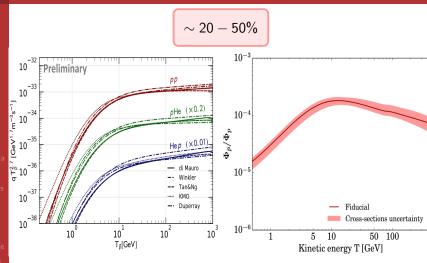


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Production cross sections

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Different parameterizations

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Secondary

Uncertainties

Available Dat

Planned Measurement

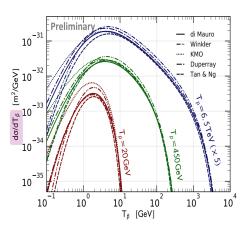
NICA and

 \bar{p} production at 13-26 GeV

Requiremen

Conclusions

ullet Reasonable agreement for $T_{ar p}>10$ GeV and T_p above a few 100 GeV



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Different parameterizations

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Astrophysics Search

Secondary CRs

Uncertainties

for $\sigma_{\bar{p}}$

Planned Measurement

NICA and SPD

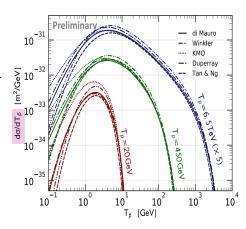
 \bar{p} production at 13-26 GeV

Requirement

onclusions

ullet Reasonable agreement for $T_{ar p} > 10$ GeV and T_p above a few 100 GeV

• Significant deviation for $T_{\bar{p}}$ below a few GeV



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Different parameterizations

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Methods Actrophysics

Search

Uncertainties

Oncertainties

Planned Measurements

NICA and SPD

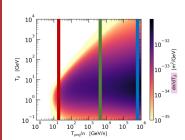
 \bar{p} production at 13-26 GeV

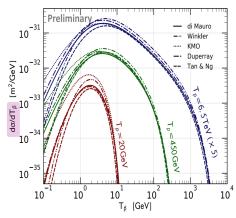
Requirements

Conclusions

• Reasonable agreement for $T_{\bar{p}} > 10$ GeV and T_p above a few 100 GeV

• Significant deviation for $T_{\bar{p}}$ below a few GeV





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p-p collisions

SPD NICA

Available Data for $\sigma_{\bar{p}}$

Radial-scaling variable:
$$x_R = \frac{E_{\bar{p}}}{E_{\bar{p}.max}}, \qquad E_{\bar{p}.max} = \frac{s - 8m_p^2}{2\sqrt{s}}$$

Experiment	$\sqrt{s} \; (\mathrm{GeV})$	P_T (GeV)	x_R
Dekkers et al., CERN 1965	6.1, 6.7	(0.00, 0.79)	(0.34, 0.65)
Allaby et al., CERN 1970	6.15	(0.05, 0.90)	(0.40, 0.94)
Capiluppi et al., CERN 1974	23.3, 30.6, 44.6, 53.0, 62.7	(0.18, 1.29)	(0.06, 0.43)
Guettler et al., CERN 1976	23.0, 31.0, 45.0, 53.0, 63.0	(0.12, 0.47)	(0.036, 0.092)
Johnson et al., FNAL 1978	19.4, 23.8, 27.4	(0.77, 6.15)	(0.08, 0.58)
Antreasyan et al., FNAL 1979	23.0, 31.0, 45.0, 53.0, 63.0	(0.12, 0.47)	(0.036, 0.092)
BRAHMS, BNL 2008	200	(0.82, 3.97)	(0.11, 0.39)
NA49, CERN 2010	17.3	(0.10, 1.50)	(0.11, 0.44)
NA61, CERN 2017	6.3, 7.7, 8.8, 12.3, 17.3		

p - p collisions

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Secondary

Uncertainties

Available Data

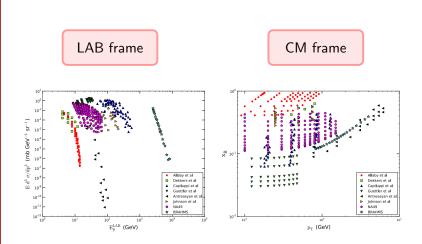
for $\sigma_{\bar{p}}$ Planned

NICA and

 \bar{p} production at 13-26 Ge

2LD Covers

Requirement for SPD



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Methods

Astrophysics Search

Secondary CRs

Uncertainties

Officertamilies

Available Data

Planned

Measuremer

NICA and SPD

for $\sigma_{\bar{n}}$

p̄ production at 13-26 Ge\

SPD Cover

Requirement for SPD

Conclusions

 First ever measurement of prompt p̄-production in p - He collisions was published by the LHCb collaboration only last August.

SPD NICA

for $\sigma_{\bar{n}}$

Available Data

 First ever measurement of prompt \bar{p} -production in p-He collisions was published by the LHCb collaboration only last August.

 No measurements for other \bar{p} -production channels.

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Dark Matter

Astrophysic

Secondary

Available Data

for $\sigma_{\bar{p}}$ Planned

Measurements

NICA and SPD

p̄ production at 13-26 Ge\

Requirement

for SPD

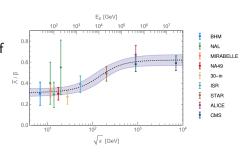
- First ever measurement of prompt p̄-production in p - He collisions was published by the LHCb collaboration only last August.
- No measurements for other p̄-production channels.
- Asymmetry from \bar{n} decay.

SPD NICA

Available Data

for $\sigma_{\bar{n}}$

- First ever measurement of prompt \bar{p} -production in p - He collisions was published by the LHCb collaboration only last August.
- No measurements for other \bar{p} -production channels.
- Asymmetry from \(\bar{n}\) decay.



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• Older p - p datasets did not include a feed-down for \bar{p} -production via hyperons.

Parameter Space & AMS-02 measurements

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Secondary

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for $\sigma_{ar{p}}$

Planned Measurements

NICA and SPD

p̄ production at 13-26 Ge\

SPD Covera

Requirement for SPD

Conclusions

Coming to a conclusion about a DM \bar{p} -signal from the AMS-02 measurements (F. Donato, M. Korsmeier, and M. Di Mauro):

Parameter Space & AMS-02 measurements

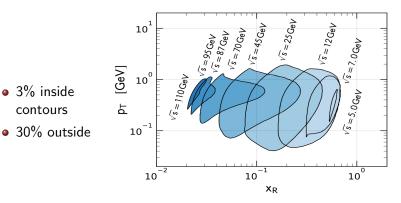
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• 3% inside

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Planned Measurements

Coming to a conclusion about a DM \bar{p} -signal from the AMS-02 measurements (F. Donato, M. Korsmeier, and M. Di Mauro):



Planned Measurements

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Secondary

CRs

Uncertainties

Available Dat

Planned Measurements

NICA and

 \bar{p} production

SPD Covera

Requirement

Conclusions

• Continuing *pHe* measurements at LHCb after the fixed-target $\sqrt{s}=114$ GeV measurement.

Planned Measurements

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Search

Astrophysics Search

Secondary CRs

Uncertainties

Available Dat

Planned Measurements

NICA and

 \bar{p} production

SPD Covera

Requiremen

- Continuing *pHe* measurements at LHCb after the fixed-target $\sqrt{s} = 114$ GeV measurement.
- All LHCb measurements are expected to be in the high-energy range.

Planned Measurements

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Search

Astrophysics Search

Secondary CRs

Uncertainties

Available Dat

Planned Measurements

NICA and SPD

p̄ production at 13-26 GeV

SPD Cover

Requiremen

- Continuing *pHe* measurements at LHCb after the fixed-target $\sqrt{s} = 114$ GeV measurement.
- All LHCb measurements are expected to be in the high-energy range.
- COMPASS plans fixed-target pp and pHe measurements at CERN SPS from $\sqrt{s} \sim 9-20$ GeV.

The Nuclotron-based Ion Collider fAility (NICA)

SPD NICA

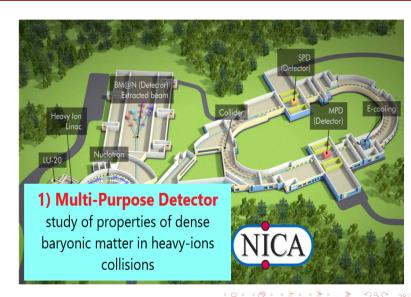
NICA and



The Nuclotron-based Ion Collider fAility (NICA)

SPD NICA

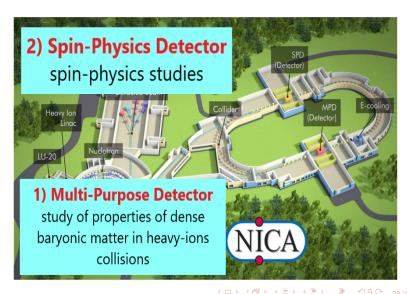
NICA and SPD



The Nuclotron-based Ion Collider fAility (NICA)

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NICA and



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Astrophysics

Search

Secondary CRs

Uncertainties

Available Dat

Planned

NICA and SPD

p̄ production

SPD Coverage

Requirement

Conclusions

 It is planned to use polarized protons, deuterons, and possibly, helium-3 ions in the second stage.

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Astrophysic

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Planned Measurement

NICA and SPD

 \bar{p} production at 13-26 GeV

SPD Covera

Requiremen

- It is planned to use polarized protons, deuterons, and possibly, helium-3 ions in the second stage.
- Possibility to collide any available polarized particles: pp, pD, and p^3 He.

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Astrophysic

Secondary CRs

Uncertainties

Planned

NICA and

 \bar{p} production at 13-26 GeV

SPD Covera

Requiremen

- It is planned to use polarized protons, deuterons, and possibly, helium-3 ions in the second stage.
- Possibility to collide any available polarized particles: pp, pD, and p^3 He.
- Planned kinetic energies for $p \sim 5-12.6$ GeV; and for $D \sim 4-11.8$ GeV.

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Search Methods

Astrophysic Search

Secondary CRs

Uncertainties

Available Dat

Planned Measurements

NICA and SPD

 \bar{p} production at 13-26 GeV

SPD Coverag

Requirement for SPD

- It is planned to use polarized protons, deuterons, and possibly, helium-3 ions in the second stage.
- Possibility to collide any available polarized particles: pp, pD, and p³He.
- Planned kinetic energies for $p \sim 5-12.6$ GeV; and for $D \sim 4-11.8$ GeV.
- At $\sqrt{s} = 27$ GeV in *pp* collisions, $L = 10^{32}$ cm⁻² s⁻¹ should be achievable.

SPD NICA

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Search

Astrophysics Search

Secondary CRs

Uncertainties

for $\sigma_{\bar{p}}$

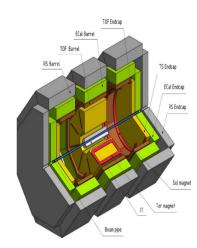
Planned Measuremen

NICA and

p̄ production at 13-26 Ge\

SPD Covera

Requiremen



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Astrophysics

Secondary CRs

Uncertainties

Available Dat

Planned

NICA and SPD

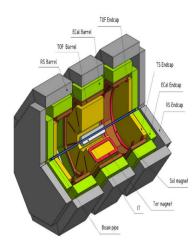
 \bar{p} production at 13-26 GeV

SPD Covera

Requirement

Conclusions

Magnetic System



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Methods

Astrophysics Search

Secondary CRs

Uncertainties

Available Dar

Planned Measuremen

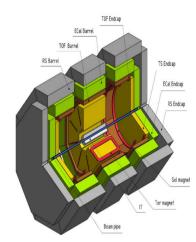
NICA and

 \bar{p} production at 13-26 GeV

SPD Cover

Requirement

- Magnetic System
- Vertex Detector (IT)



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Astrophysics

Search

CRs

Uncertainties

Available Da

Planned Measurement

NICA and SPD

 \bar{p} production at 13-26 GeV

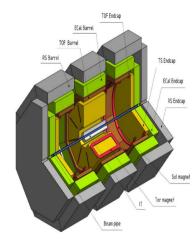
SPD Cover

Requirement for SPD

Conclusions

Magnetic System

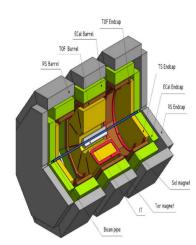
- Vertex Detector (IT)
- Tracking System (TS)



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NICA and SPD

- Magnetic System
- Vertex Detector (IT)
- Tracking System (TS)
- Electromagnetic Calorimeter (ECAL)



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Astrophysics

Secondary

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Measuremen

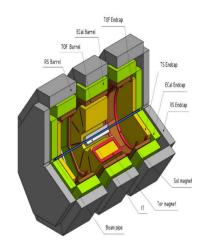
NICA and SPD

p̄ production at 13-26 Ge\

SPD Cover

Requirement for SPD

- Magnetic System
- Vertex Detector (IT)
- Tracking System (TS)
- Electromagnetic Calorimeter (ECAL)
- Range (muon) System (RS)



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Methods Astrophysics

Secondary

Uncertainties

Planned

Measurements

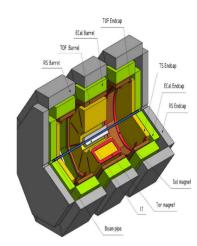
NICA and SPD

p̄ production at 13-26 Ge\

SPD Cover

Requirement for SPD

- Magnetic System
- Vertex Detector (IT)
- Tracking System (TS)
- Electromagnetic Calorimeter (ECAL)
- Range (muon) System (RS) (Coarse HCAL)



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Astrophysic

Secondary CRs

Uncertainties

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Planned

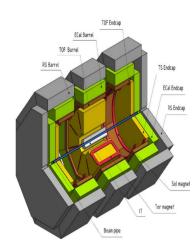
NICA and SPD

 \bar{p} production at 13-26 GeV

SPD Covera

Requirement for SPD

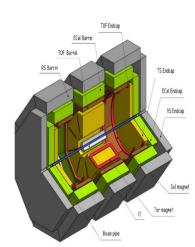
- Magnetic System
- Vertex Detector (IT)
- Tracking System (TS)
- Electromagnetic Calorimeter (ECAL)
- Range (muon) System (RS) (Coarse HCAL)
- Time-of-Flight System (ToF)



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NICA and

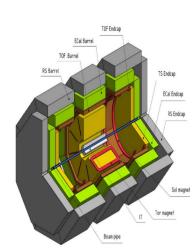
- Magnetic System
- Vertex Detector (IT)
- Tracking System (TS)
- Electromagnetic Calorimeter (ECAL)
- Range (muon) System (RS) (Coarse HCAL)
- Time-of-Flight System (ToF)
- Luminosity Monitors



SPD NICA

NICA and SPD

- Magnetic System
- Vertex Detector (IT)
- Tracking System (TS)
- Electromagnetic Calorimeter (ECAL)
- Range (muon) System (RS) (Coarse HCAL)
- Time-of-Flight System (ToF)
- Luminosity Monitors
- Local Polarimetry

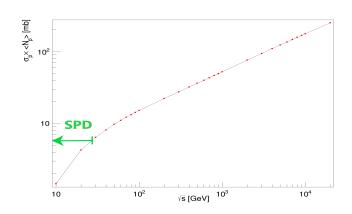


\bar{p} -production cross section in pp collisions

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NICA and

PYTHIA8 wide-range results



\bar{p} -production cross section in $p\bar{p}$ collisions

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Dark Matter

Astrophysics

Secondary

CRs

Uncertainties

Available Dat for $\sigma_{\bar{p}}$

Planned Measurement

NICA and SPD

p production at 13-26 GeV

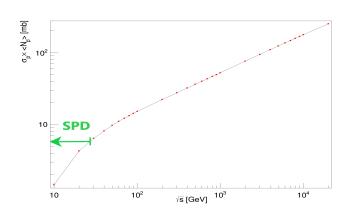
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Requirement for SPD

Conclusions

PYTHIA8 wide-range results

Near threshold energies would likely be accessible as well.



Hyperons and \bar{n} decay

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Astrophysic

Secondary

Uncertainties

Available Dat

Planned Measuremen

NICA and

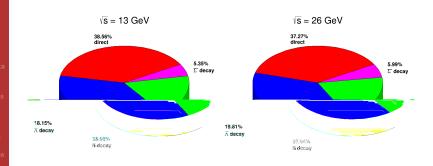
 \bar{p} production at 13-26 GeV

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Requirement

Conclusions

Reconstruction of secondary vertices



Produced momenta

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Astrophysics

Secondary CRs

Uncertainties

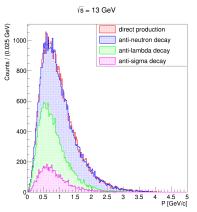
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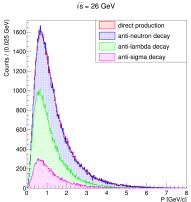
NICA and

 \bar{p} production at 13-26 GeV

SPD Coverag

Requirements for SPD





Produced momenta

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Astrophysics

Secondary CRs

Uncertainties

Planned Measuremen

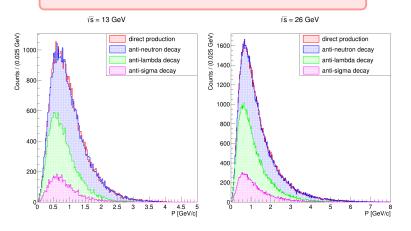
NICA and SPD

 \bar{p} production at 13-26 GeV

Requirements

Conclusions

Most produced \bar{p} 's would have momenta less than ~ 5 GeV/c, which should be accessible by the SPD.



Angular distribution

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Methods

Astrophysics Search

Secondary CRs

Uncertainties

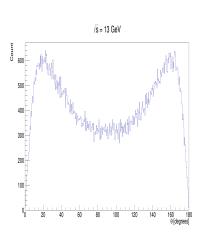
Planned Measurement

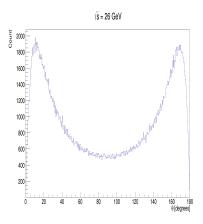
NICA and

 \bar{p} production at 13-26 GeV

SPD Coverage

Requirements for SPD





Angular distribution

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Search

Astrophysics

Secondary

Uncertainties

Planned Measurement

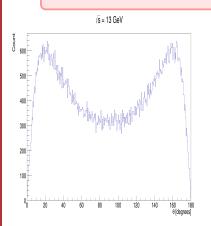
NICA and

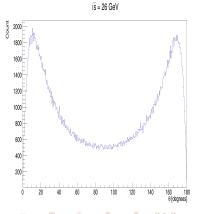
 $ar{p}$ production at 13-26 GeV

Requirements

Conclusions

 \sim 4 π angular acceptance and low material budget (planned to be \sim 0.012 RL)

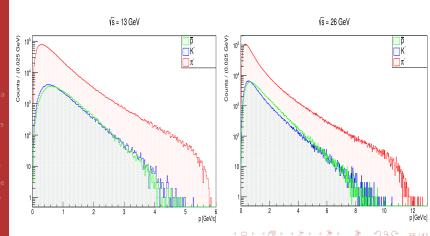




Other particles

SPD NICA

 \bar{p} production at 13-26 GeV



Other particles

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Astrophysics

Secondary

 ${\sf Uncertainties}$

Available Data

Planned Measurement

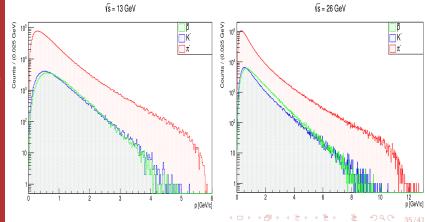
NICA and SPD

 \bar{p} production at 13-26 GeV

Requirements for SPD

Conclusions

ToF system: planned time-resolution <60ps, which corresponds to a proton/kaon separation up to 5 GeV/c



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Astrophysics

Secondary

Uncertainties

Planned

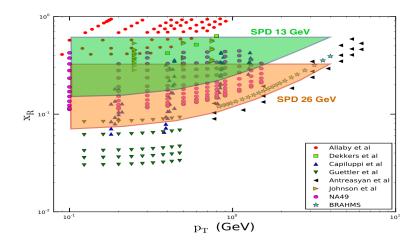
Measuremen

 \bar{p} production

at 13-26 GeV

SPD Coverage

Requirement for SPD



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Dark Matter

Astrophysics

Secondary CRs

Uncertainties

Planned

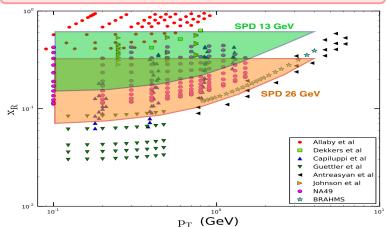
NICA and

p̄ production

at 13-26 GeV SPD Coverage

Requirement





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Astrophysics

Secondary CRs

Uncertainties

Planned

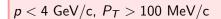
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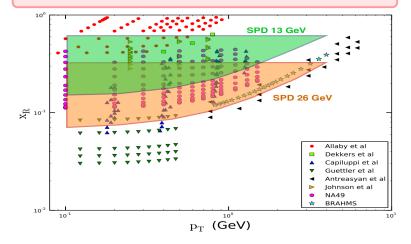
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p production at 13-26 GeV

SPD Coverage Requirements

for SPD





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Astrophysics

Secondary

Uncertainties

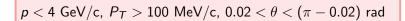
Planned

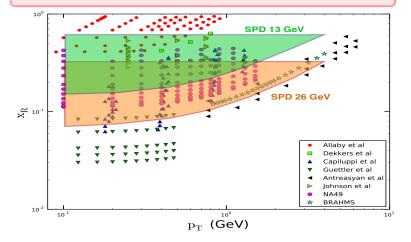
NICA and SPD

 \bar{p} production at 13-26 GeV

at 13-26 GeV SPD Coverage

Requirement





SPD Coverage

SPD NICA

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Dark Matter

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Astrophysics Search

Secondary CRs

Uncertainties

Available Data for σπ

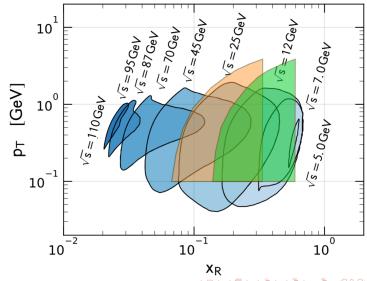
Planned Measurement

NICA and SPD

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Requirements for SPD

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Secondary CRs

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Requirements for SPD

Conclusions

ullet \sim 4π acceptance and a good tracking system

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Astrophysics

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Requirements for SPD

- ullet \sim 4π acceptance and a good tracking system
- Low material budget

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NICA and SPD

p production at 13-26 Ge

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Requirements for SPD

- ullet \sim 4π acceptance and a good tracking system
- Low material budget
- ullet ToF system (time-resolution < 100 ps) for good PID

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Methods

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Secondary CRs

Uncertainties

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Planned Measurement

NICA and SPD

 \bar{p} production at 13-26 GeV

SPD Cover

Requirements for SPD

- ullet \sim 4π acceptance and a good tracking system
- Low material budget
- ullet ToF system (time-resolution < 100 ps) for good PID
- Secondary vertices reconstruction (for investigating $\bar{\Lambda}$ & $\bar{\Sigma}$ decays)

SPD NICA

- The SPD planned at NICA could make a sizable contribution to the search for physics beyond the SM.
- SPD could perform precision measurements of differential cross section of \bar{p} -production in pp and pD collisions required by the astrophysical search for DM.

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Astrophysics

Secondary CRs

Uncertainties

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Planned Measurements

NICA and SPD

 \bar{p} production at 13-26 GeV

SPD Covera

Requirement

- The SPD planned at NICA could make a sizable contribution to the search for physics beyond the SM.
- SPD could perform precision measurements of differential cross section of \bar{p} -production in pp and pD collisions required by the astrophysical search for DM.
- SPD can measure energy and angular distributions of \bar{p} 's produced either promptly or via hyperon decay in the kinematic range starting from threshold.

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Search

Astrophysics Search

Secondary CRs

Uncertainties

Available Da

Planned Measurement

NICA and SPD

p̄ production at 13-26 Ge\

SPD Covera

Requirement

Conclusions

• The collider mode and 4π geometry of SPD provide a unique possibility to study \bar{p} -production at high P_T ($\sim \sqrt{s}/2$) which is not possible in fixed-target experiments.

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Secondary CRs

Uncertainties

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p̄ production at 13-26 GeV

SPD Covera

Requiremen

- The collider mode and 4π geometry of SPD provide a unique possibility to study \bar{p} -production at high P_T ($\sim \sqrt{s}/2$) which is not possible in fixed-target experiments.
- The programme could be further extended by the possibility for NICA to operate with light-nuclei beams; e.g. ³He, ⁴He.

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- The main requirements for performing the measurements would be an advanced PID (ToF system) and precision reconstruction of secondary vertices.

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Measurements

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p production at 13-26 GeV SPD Coverag

Requirements for SPD

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- The programme could be further extended by the possibility for NICA to operate with light-nuclei beams; e.g. ³He, ⁴He.
- The main requirements for performing the measurements would be an advanced PID (ToF system) and precision reconstruction of secondary vertices.
- More detailed MC studies are needed to discuss the accuracy of the proposed measurements; which would be carried out with SpdRoot.

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Conclusions

Thank You!