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

24.10.18

A Discrepancy

- Rotational curves

A Discrepancy

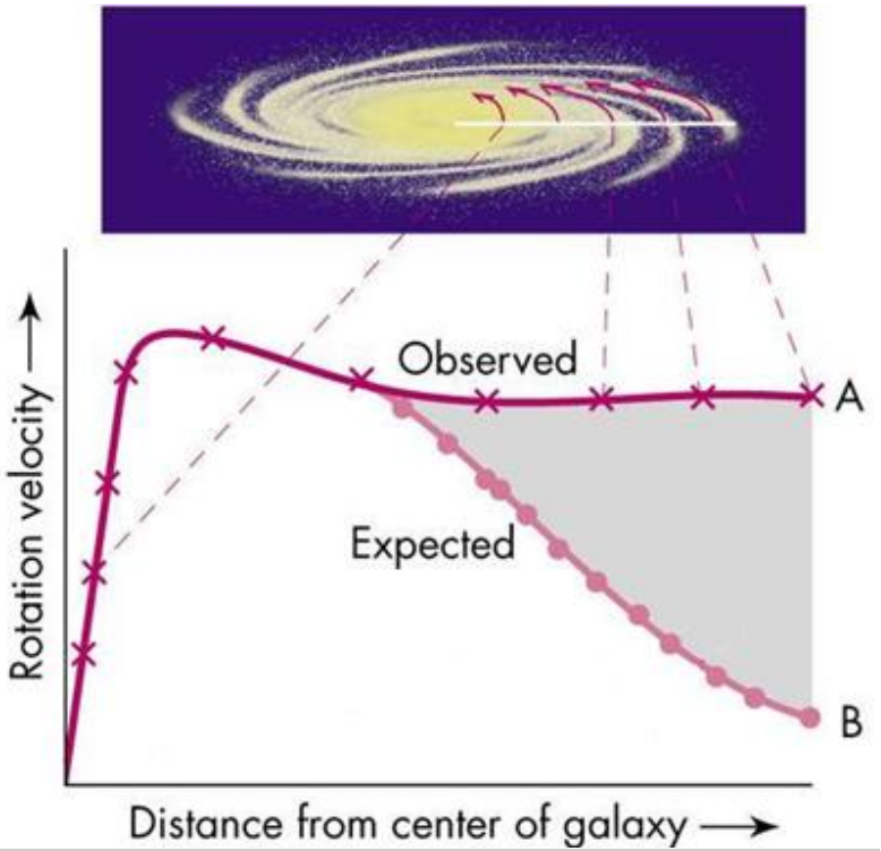
- Rotational curves
- Keplerian

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

A Discrepancy

- Rotational curves
- Keplerian

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



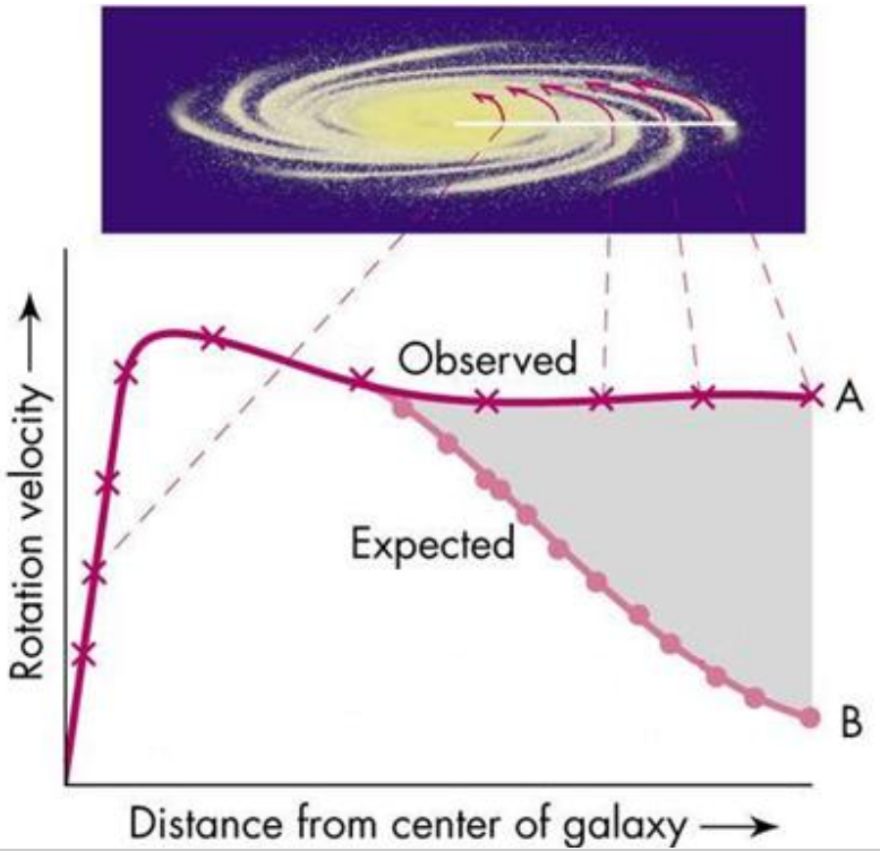
A Discrepancy

- Rotational curves
- Keplerian

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

- Observation

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



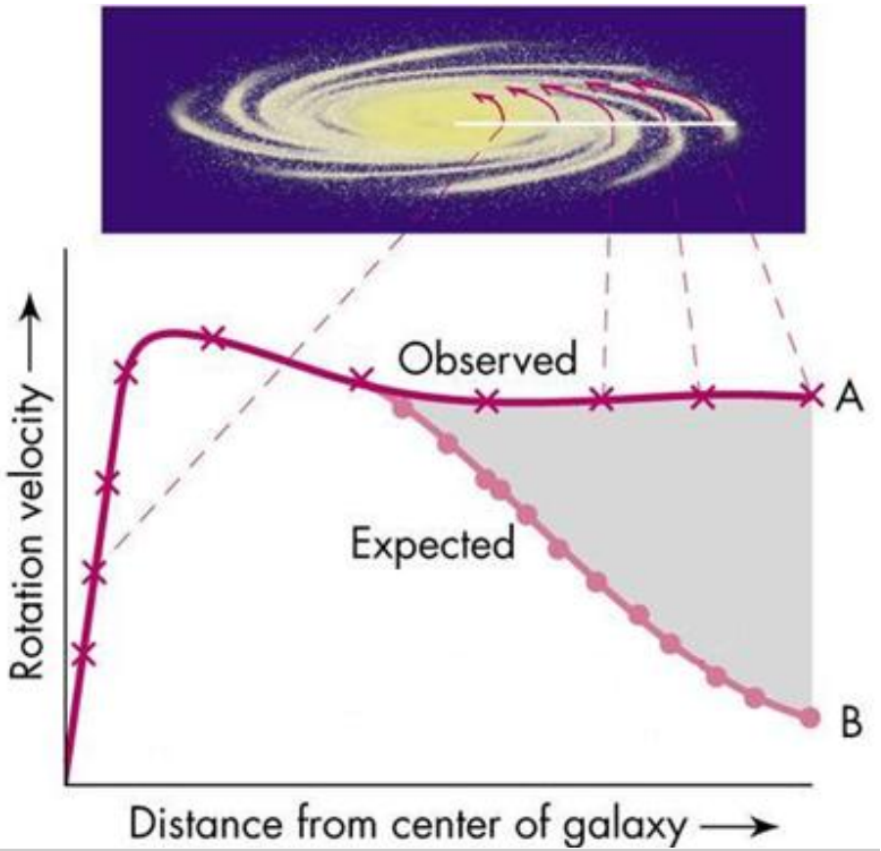
A Discrepancy

- Rotational curves
- Keplerian

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

- Observation

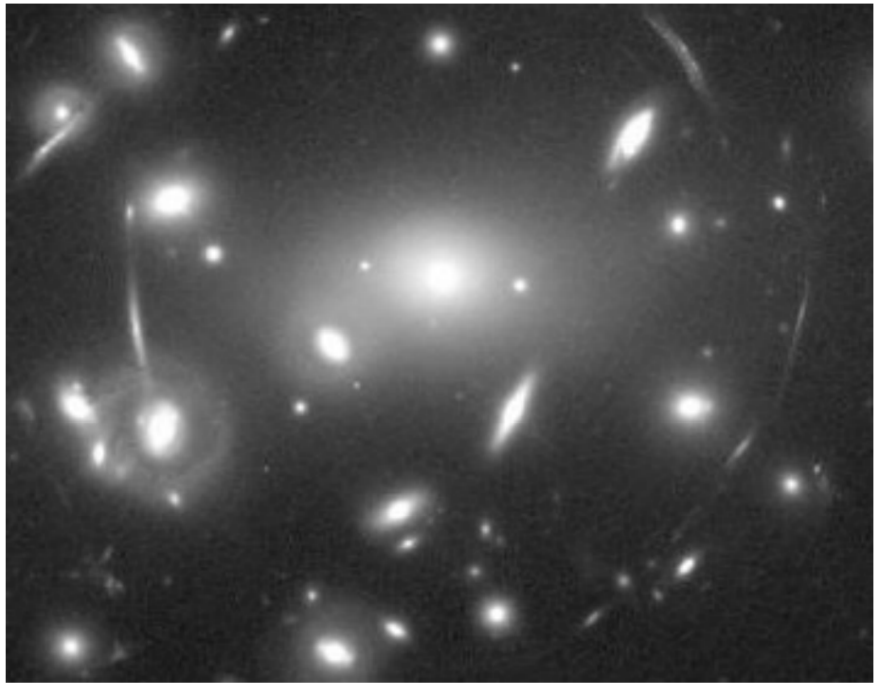
$$v(r) \sim \text{constant}, \quad r > R$$



- Galaxy cluster (M/L)

DM evidence

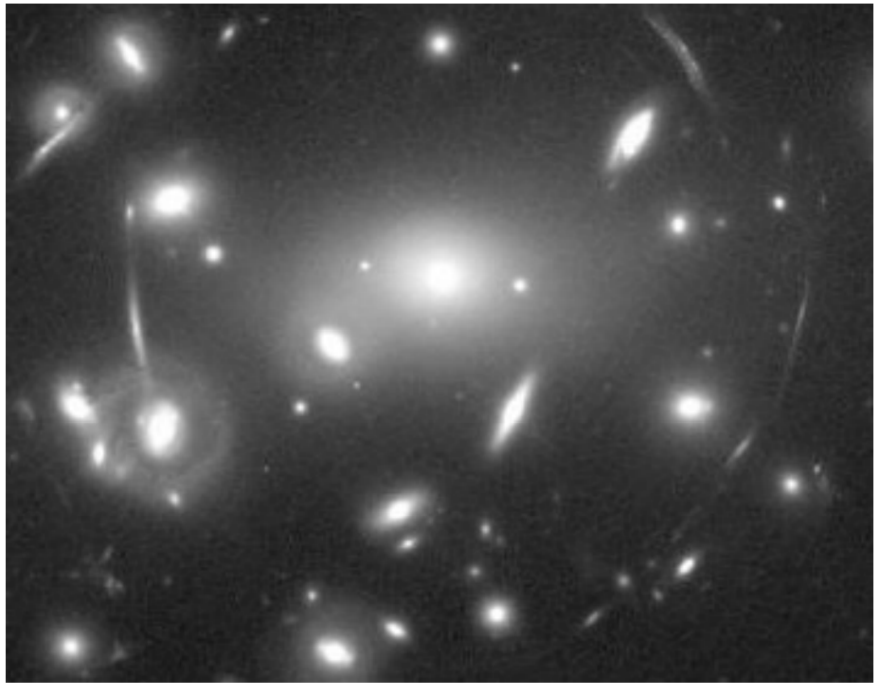
Gravitational Lensing with no luminous mass:



DM evidence

Gravitational Lensing with no luminous mass:

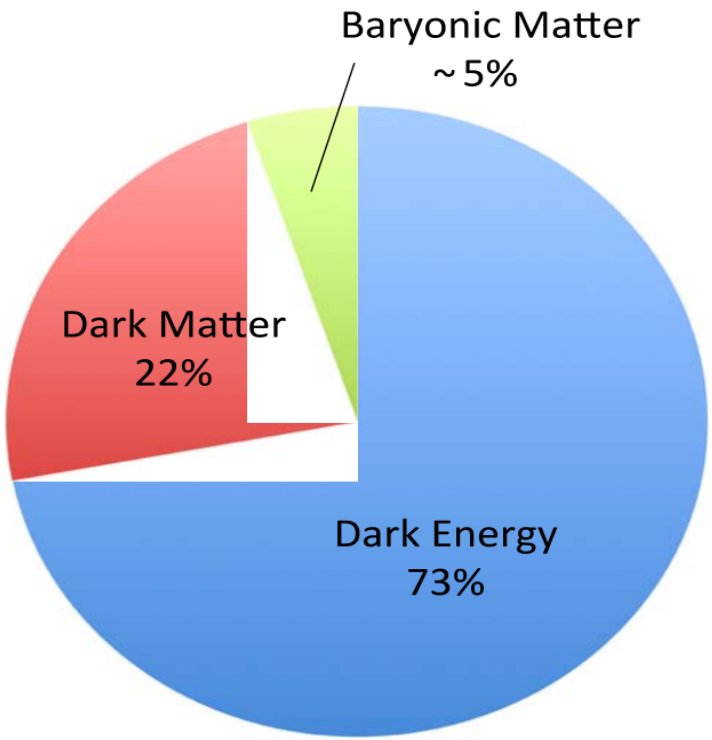
- Bullet Cluster (1E0657-56)
- MACSJ0025

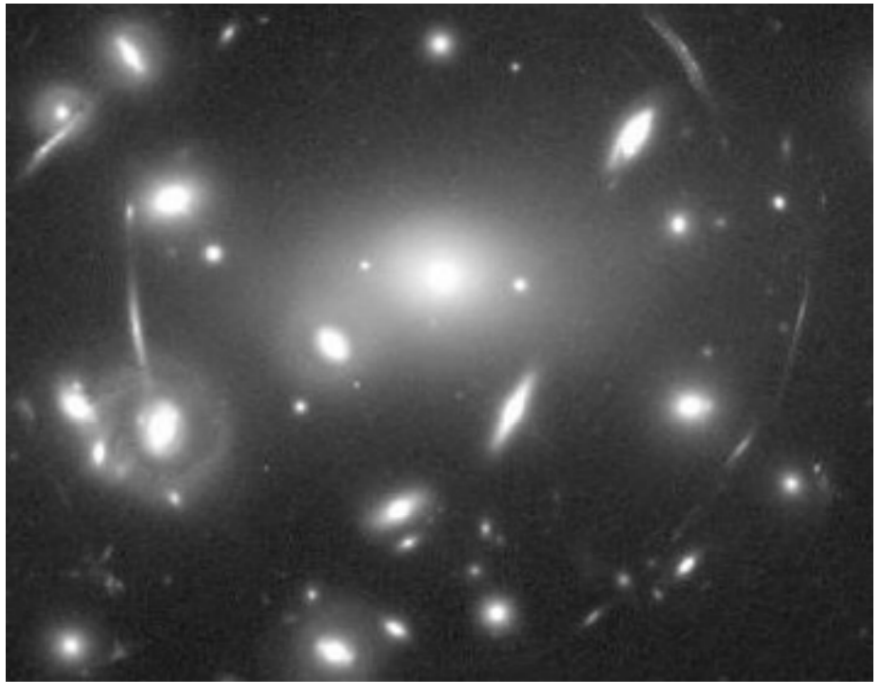


DM evidence

Gravitational Lensing with no luminous mass:

- Bullet Cluster (1E0657-56)
- MACSJ0025





Candidates

Classifications:

Candidates

Classifications:

- Possible production (thermal, non-thermal)

Candidates

Classifications:

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

Candidates

Classifications:

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

Candidates

- WIMPs (Weakly Interacting Massive Particles)

Classifications:

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

Candidates

- WIMPs (Weakly Interacting Massive Particles)
- MACHOs
- SUSY candidates
- Kaluza-Klein candidates
- Sterile neutrinos
- Axions

Classifications:

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

WIMPs

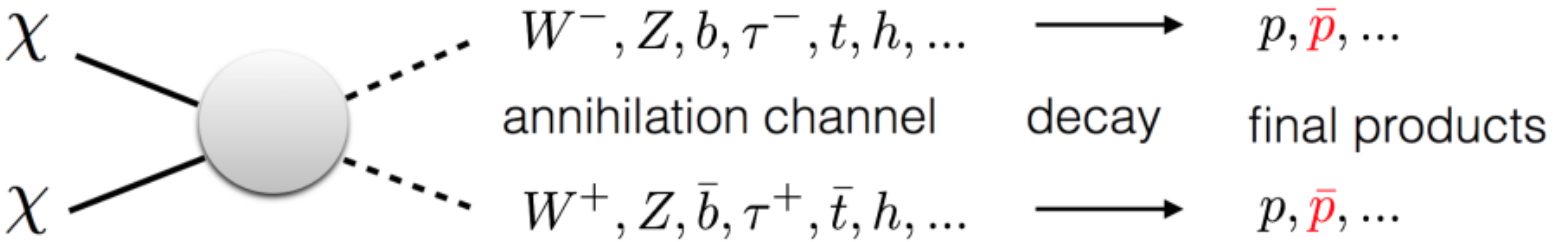
- Expected mass range $\sim$ 10 GeV$-$10 TeV

WIMPs

- Expected mass range $\sim$ 10 GeV$-$10 TeV
- Can elastically scatter on ordinary-matter nuclei
- Expected recoil energy $\sim$ 1 to 100 keV

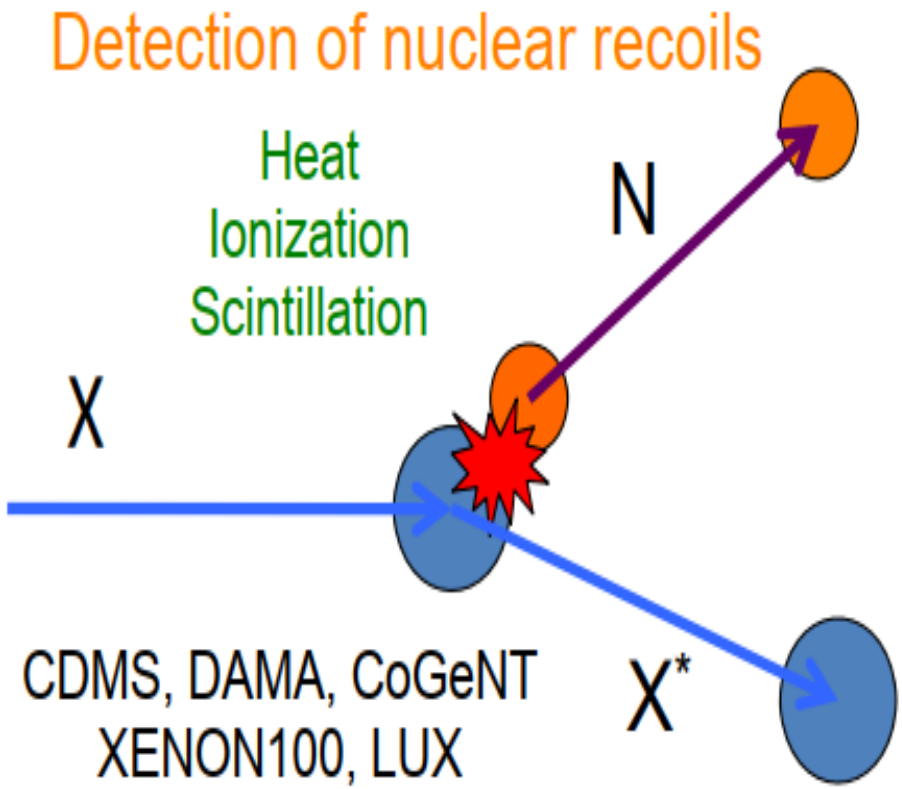
WIMPs

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



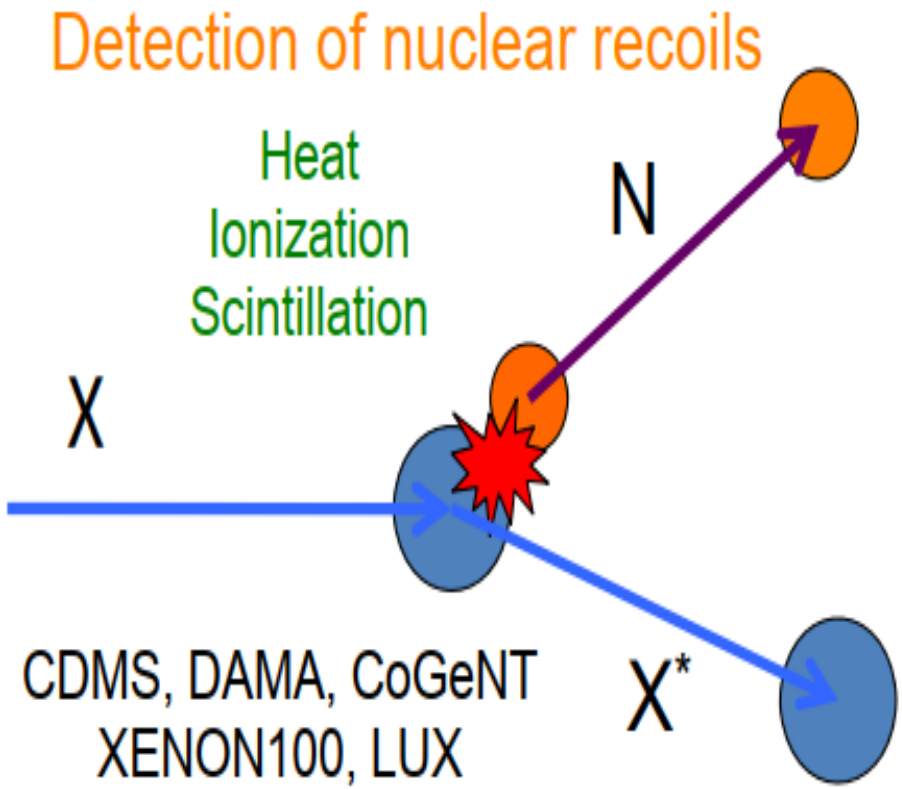
Direct Detection

- Interaction of DM with terrestrial detectors



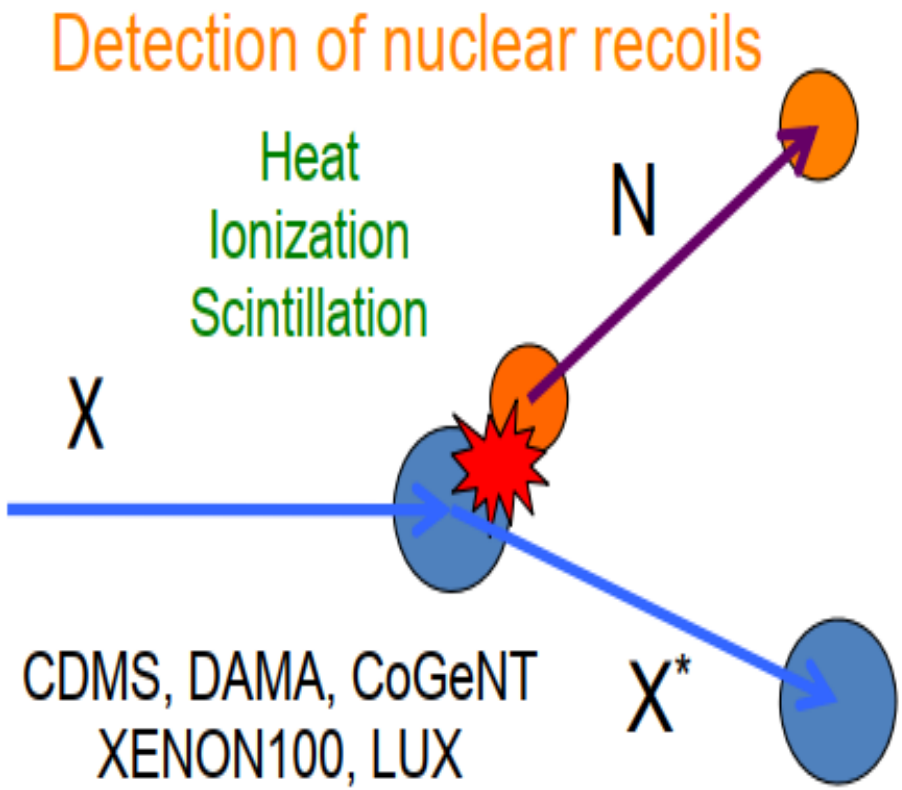
Direct Detection

- Interaction of DM with terrestrial detectors
- $\sim$ keV recoil energy



Direct Detection

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

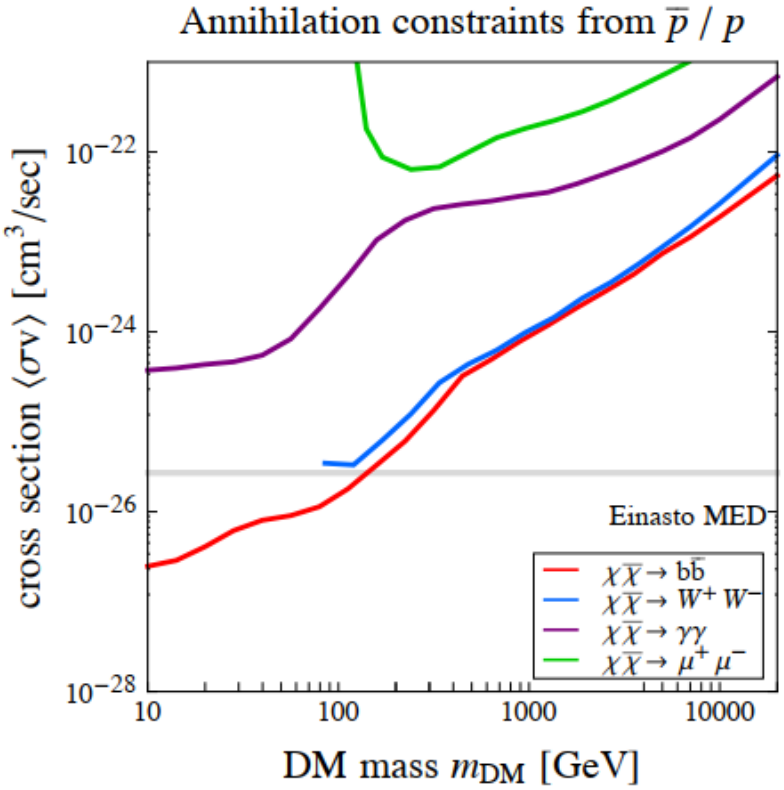


Indirect DM Search

- Spectral distortion in CR spectrum

Indirect DM Search

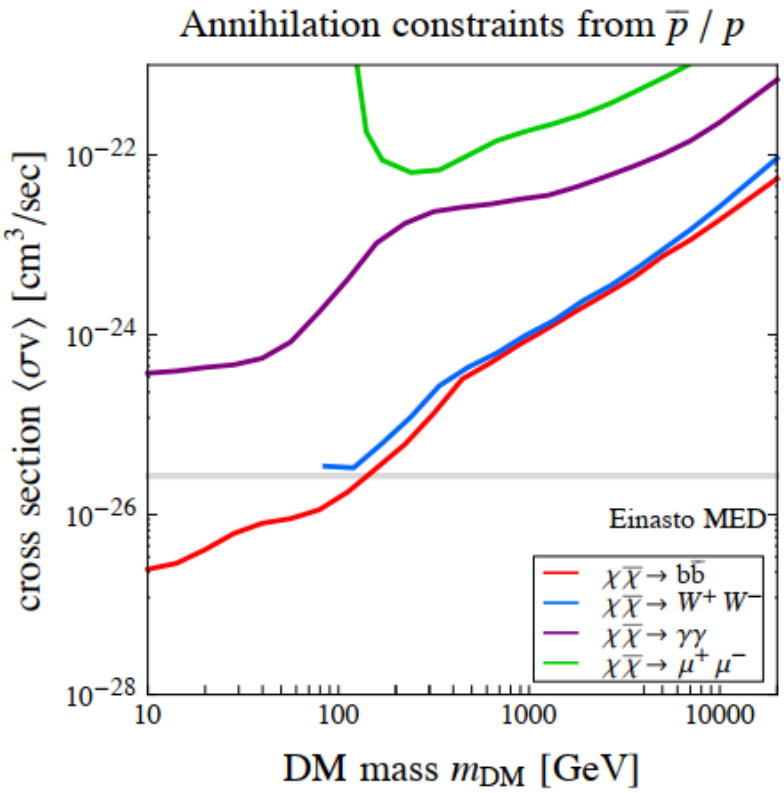
- Spectral distortion in CR spectrum
- WIMP decay and pair-annihilation
- Possible products: ν, γ, $\bar{p}$, etc



JCAP09(2015)023.©IOP and SISSA, 2015

Indirect DM Search

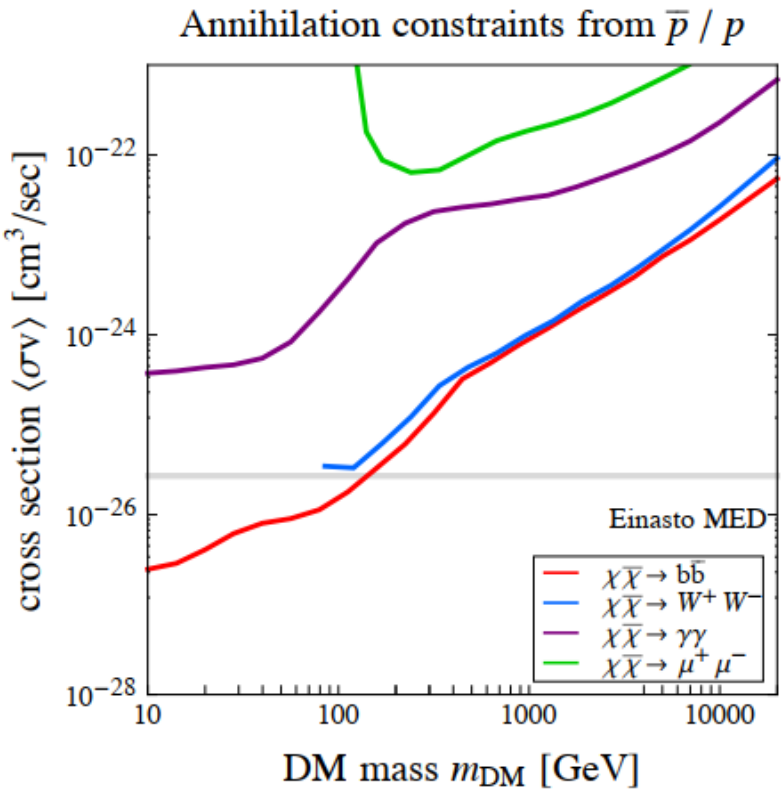
- Spectral distortion in CR spectrum
- WIMP decay and pair-annihilation
- Possible products: ν, γ, $\bar{p}$, etc
- Experiments:
  - Ground-based (γ-ray detectors): H.E.S.S., MAGIC, VERITUS



JCAP09(2015)023.©IOP and SISSA, 2015

Indirect DM Search

- 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



JCAP09(2015)023.©IOP and SISSA, 2015

PAMELA

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

PAMELA

- 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.

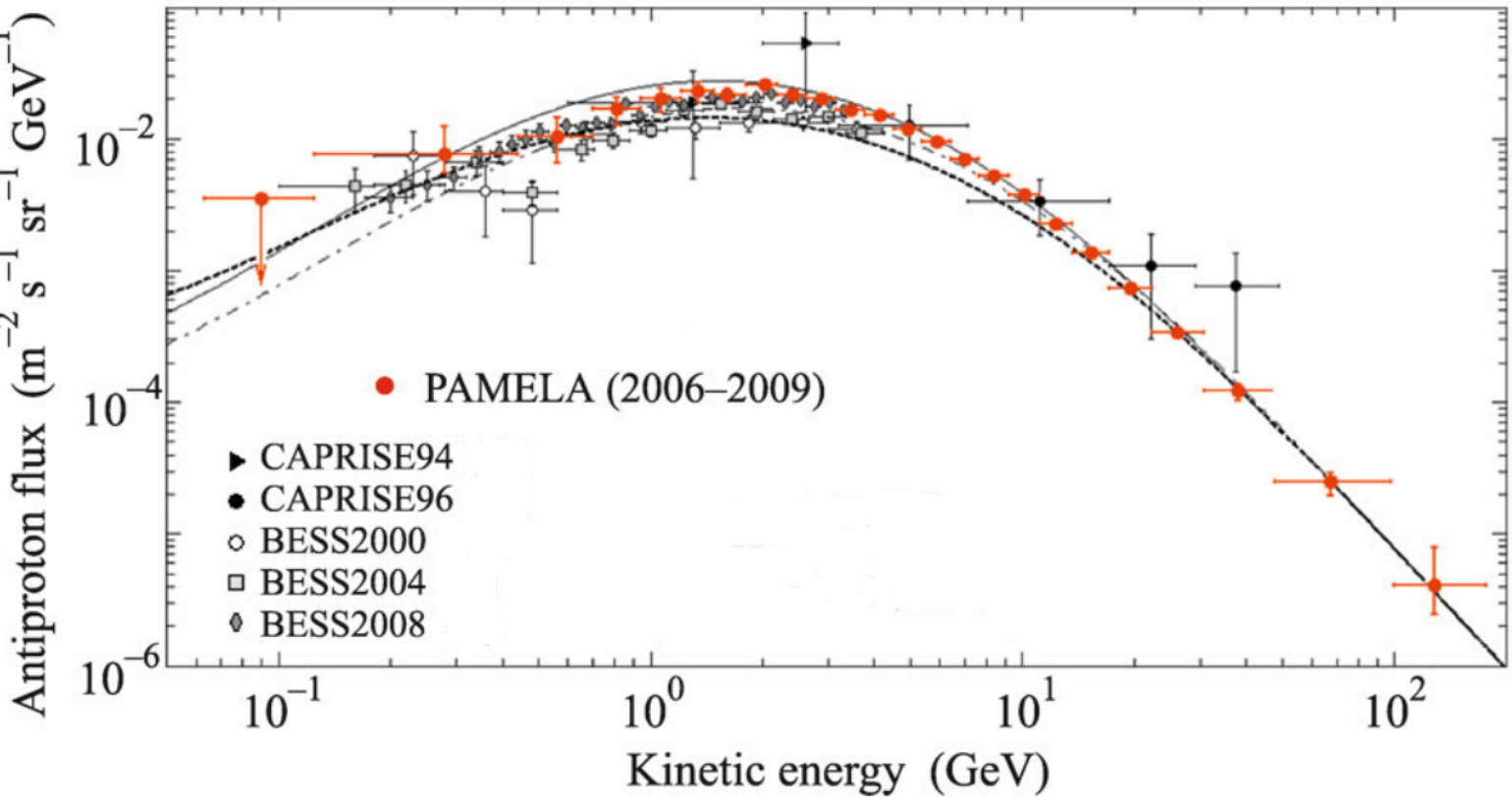
PAMELA

- 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.

PAMELA

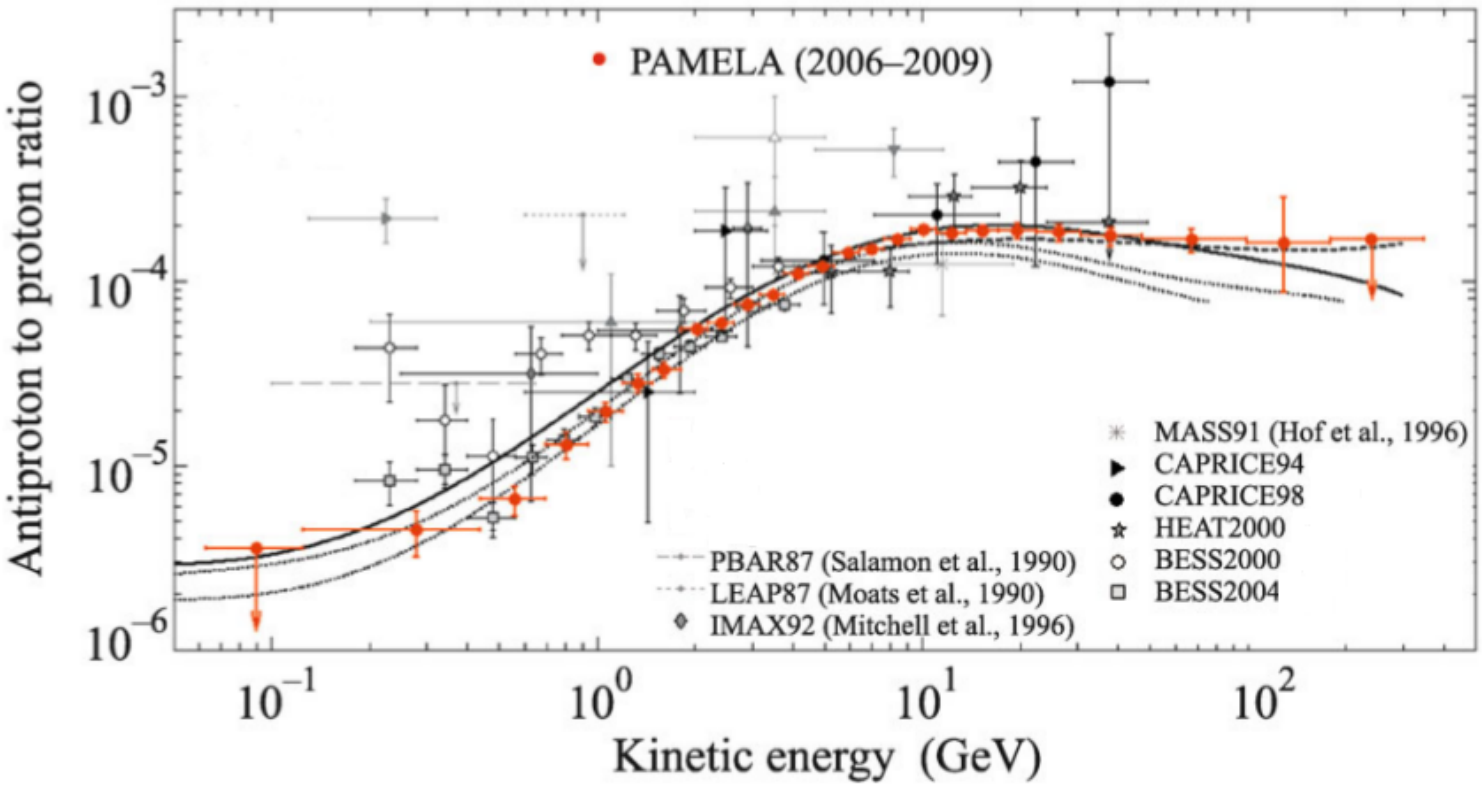
- PAMELA (Payload for Antimatter Matter Exploration and Light Nuclei Astrophysics) magnetic spectrometer performed precision measurements of antiparticle fluxes in primary cosmic rays.
- The Resurs-DK1 satellite with the on-board scientific equipment was launched in June 2006 and the mission ended in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

PAMELA



JETP Letters, 2012, Vol. 96, No. 10, pp. 621627. ©Pleiades Publishing, Inc., 2012.

PAMELA



JETP Letters, 2012, Vol. 96, No. 10, pp. 621627. ©Pleiades Publishing, Inc., 2012.

AMS-02

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

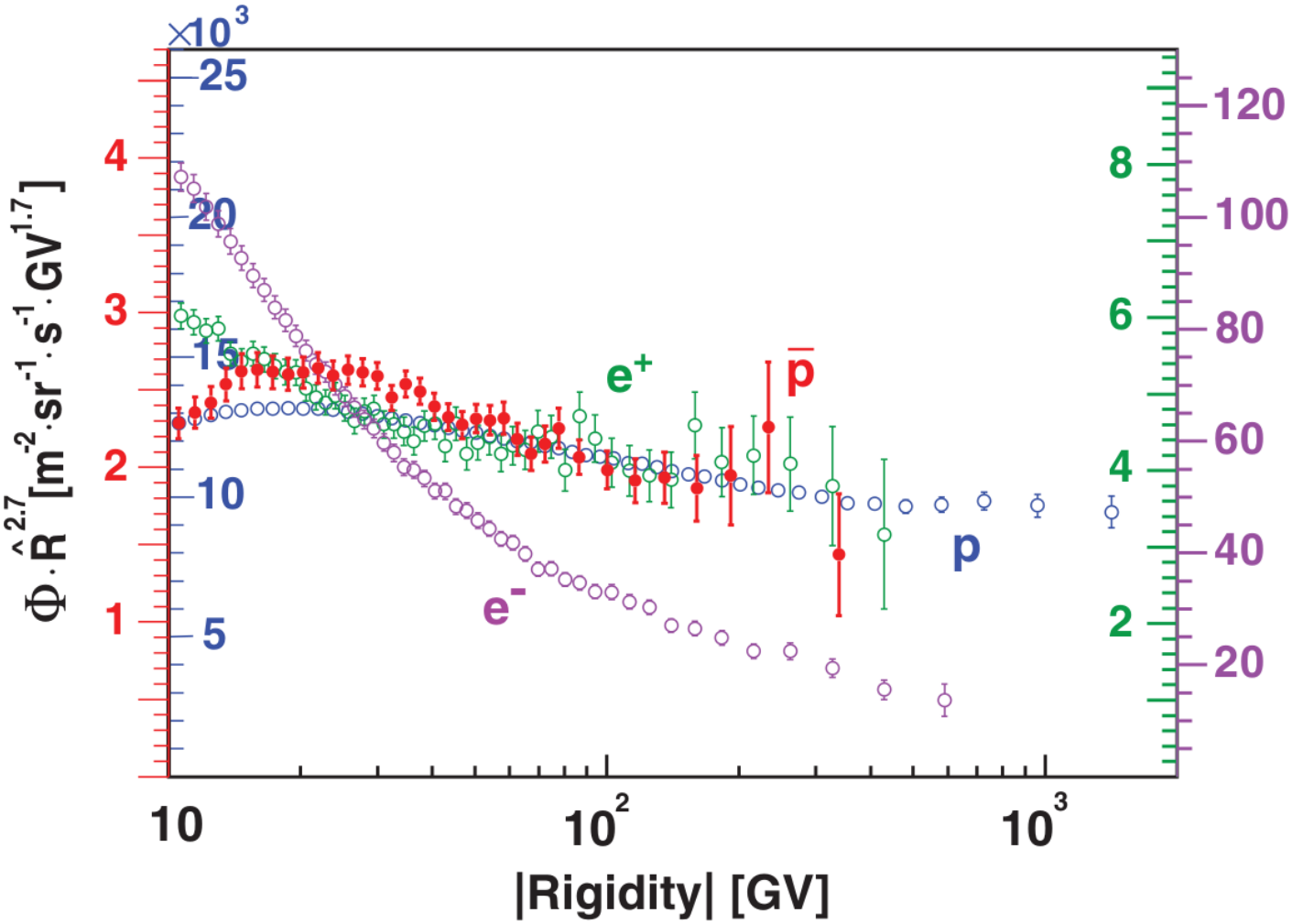
AMS-02

- 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.

AMS-02

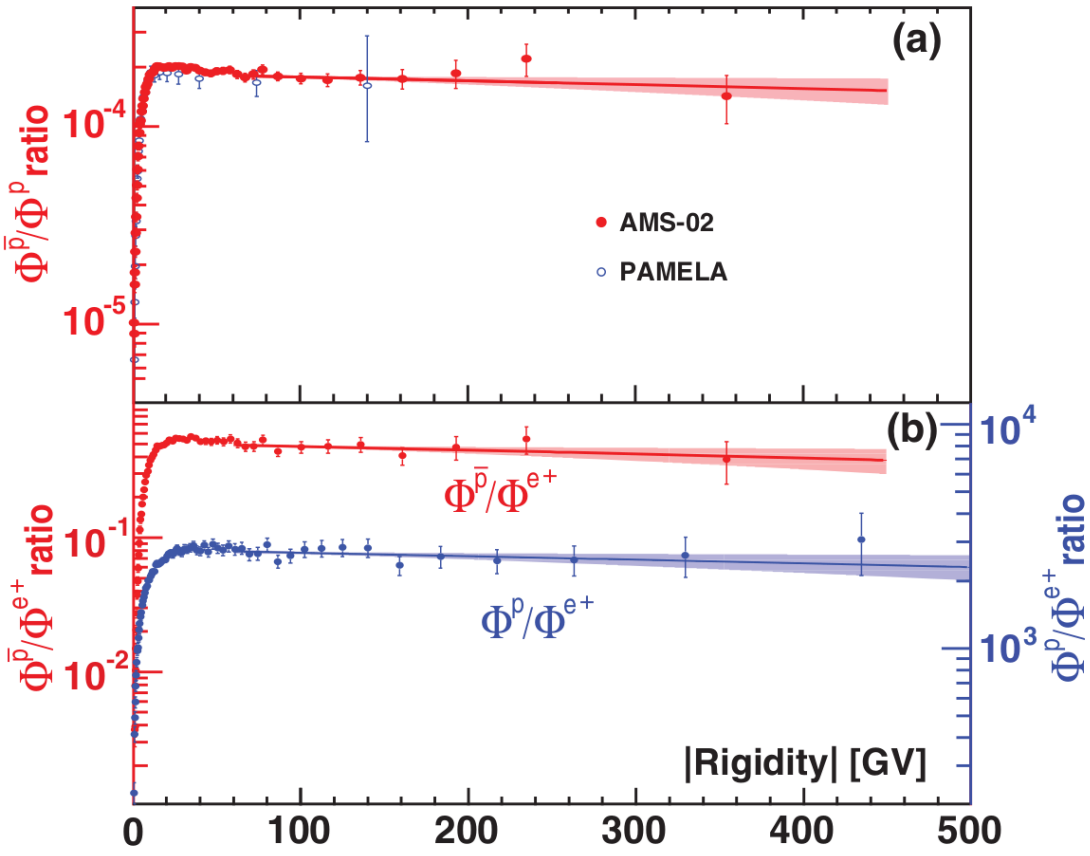
- AMS-02 (The Alpha Magnetic Spectrometer) on-board the International Space Station (ISS), is the most advanced detector for charged CR flux measurements.
- The spectrometer includes: a silicon tracker, a permanent magnet, time of flight counters TOF, anti-coincidence counters ACC, a transition radiation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

AMS-02



(AMS Collaboration) PRL 117, 091103 (2016)©American Physical Society, 2016.

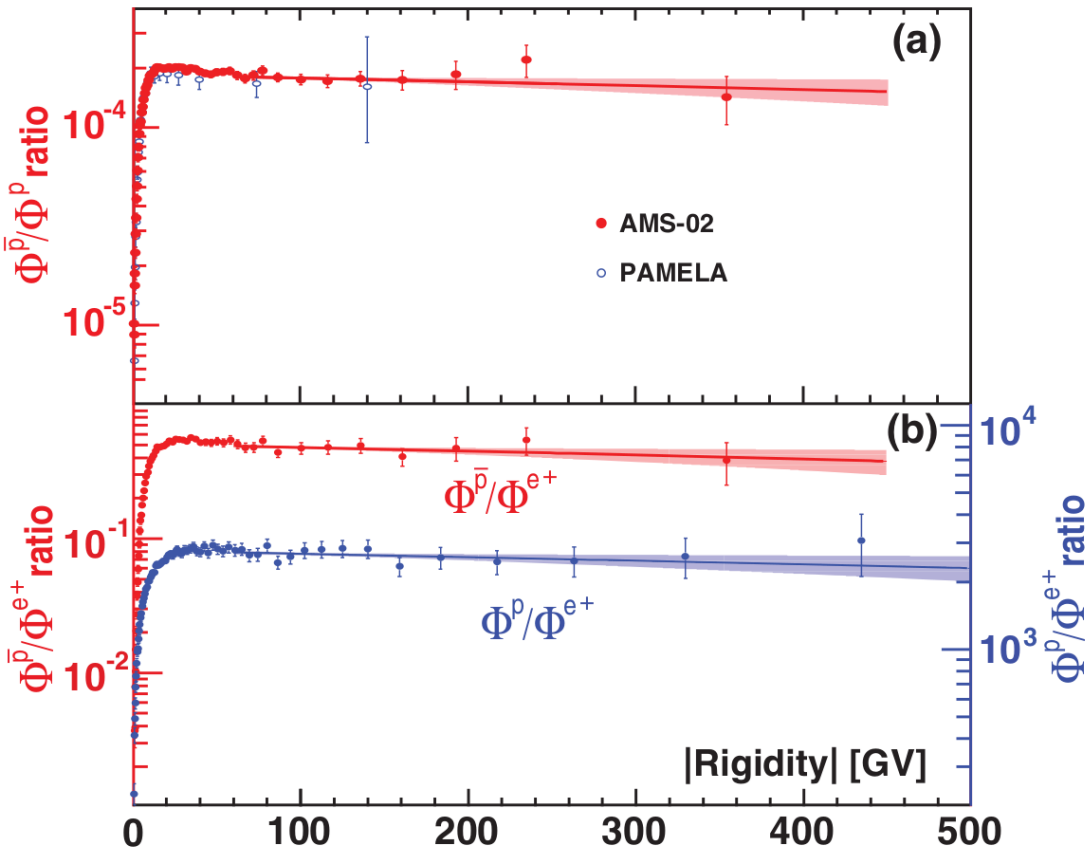
AMS-02



(AMS Collaboration) PRL 117, 091103 (2016)©American Physical Society, 2016.

AMS-02

error $< 5\%$



(AMS Collaboration) PRL 117, 091103 (2016)

Secondary CR production

Collisions of primary CRs and ISM

Secondary CR production

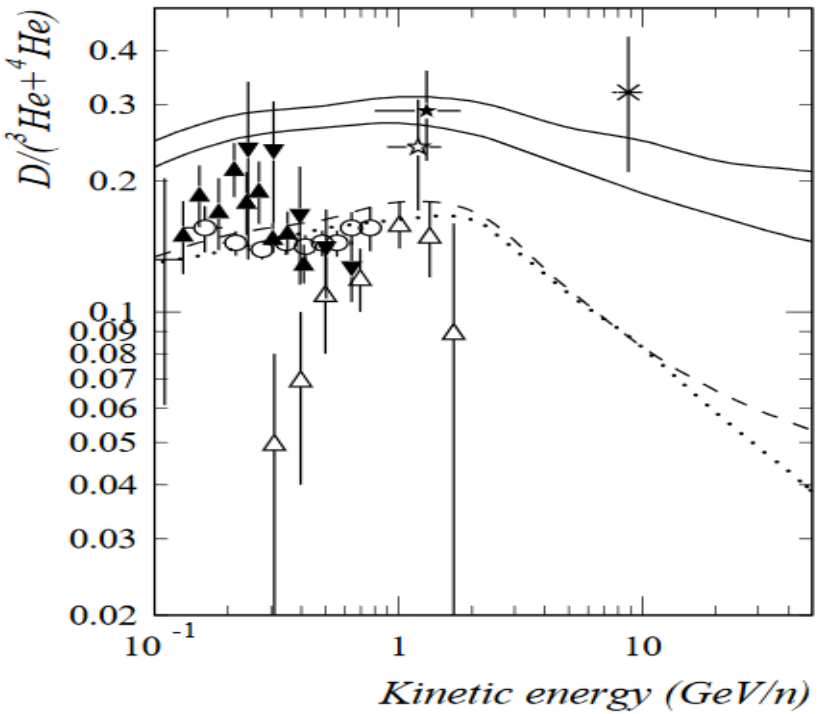
Collisions of primary CRs and ISM

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

Secondary CR production

Collisions of primary CRs and ISM

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



Production channels for $\bar{p}$

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

Mathieu Boudaud - LAPTh - Annecy, France

Production channels for $\bar{p}$

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

Mathieu Boudaud - LAPTh - Annecy, France

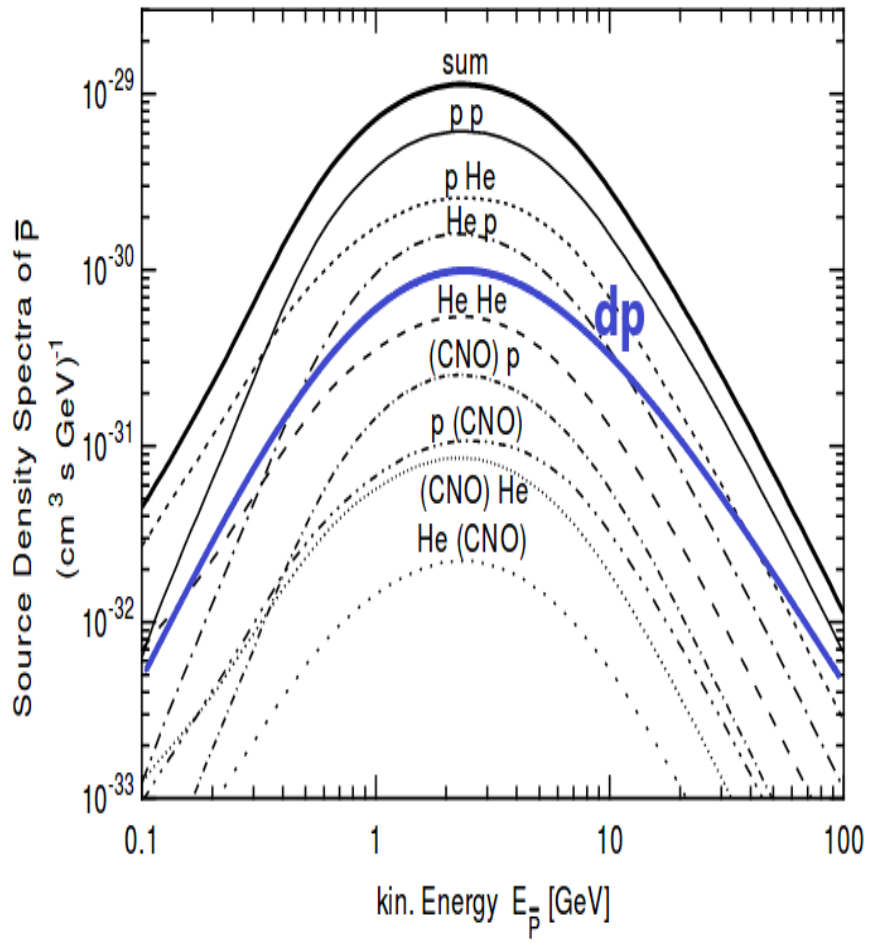
$$d + H \to \bar{p} + X \sim 1\text{–}4\%$$

Production channels for $\bar{p}$

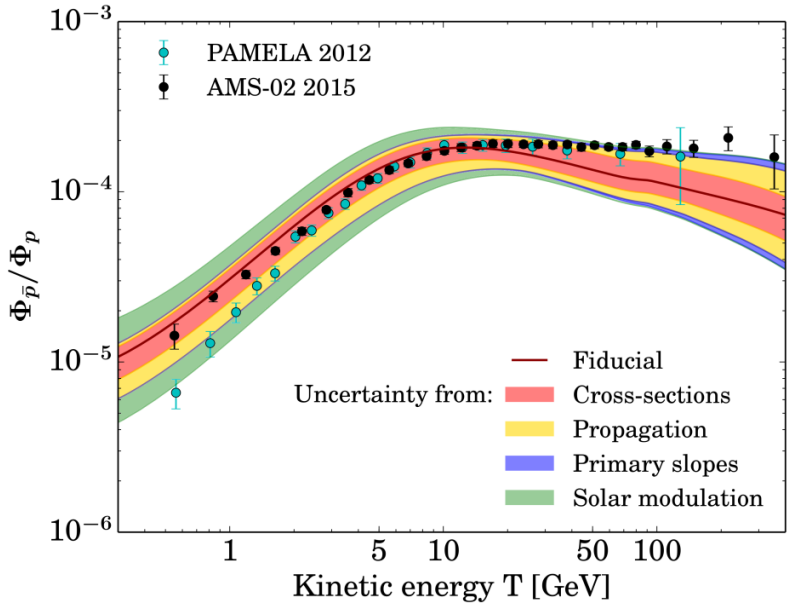
$$\begin{cases} p + H \to \bar{p} + X & \sim 70\% \\ \alpha + H \to \bar{p} + X & \sim 25\% \\ p + He \to \bar{p} + X & \sim 4\% \\ \alpha + He \to \bar{p} + X & \sim 1\% \end{cases}$$

Mathieu Boudaud - LAPTh - Annecy, France

$$d + H \to \bar{p} + X \sim 1\text{–}4\%$$



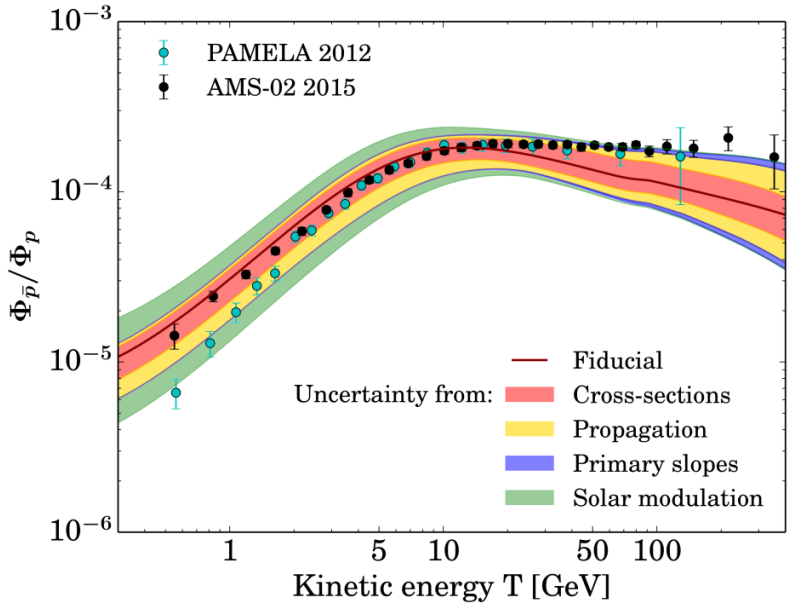
Uncertainties



JCAP09(2015)023.©IOP and SISSA, 2015

Uncertainties

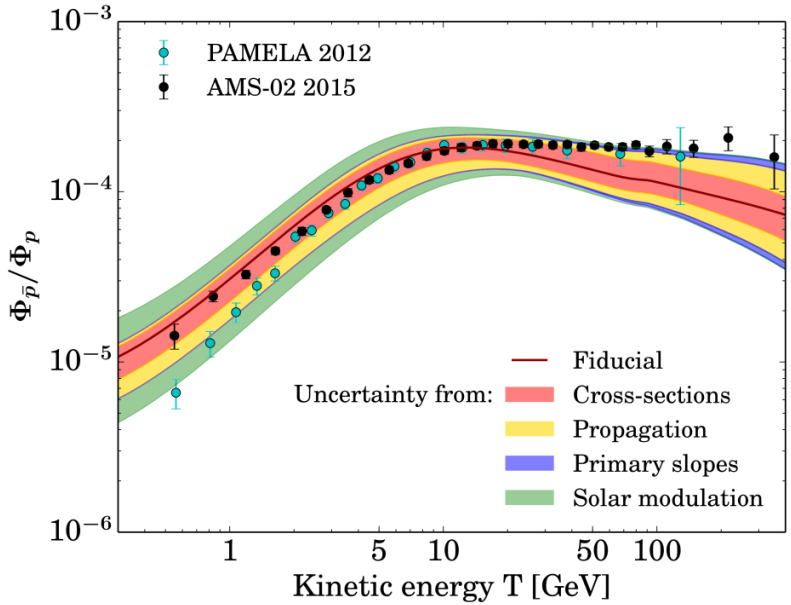
- Primary spectra slopes



JCAP09(2015)023.©IOP and SISSA, 2015

Uncertainties

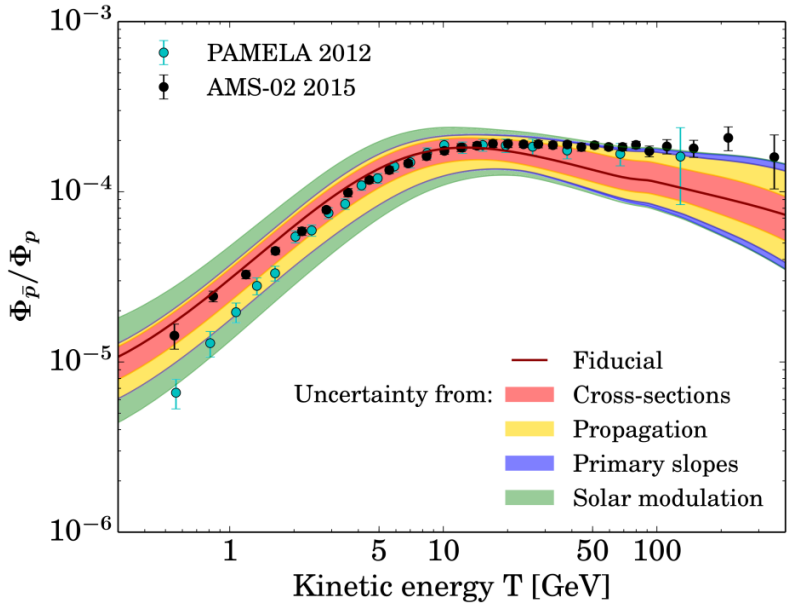
- Primary spectra slopes
- Propagation parameters (diffusion and convection) in the local galactic environment



JCAP09(2015)023.©IOP and SISSA, 2015

Uncertainties

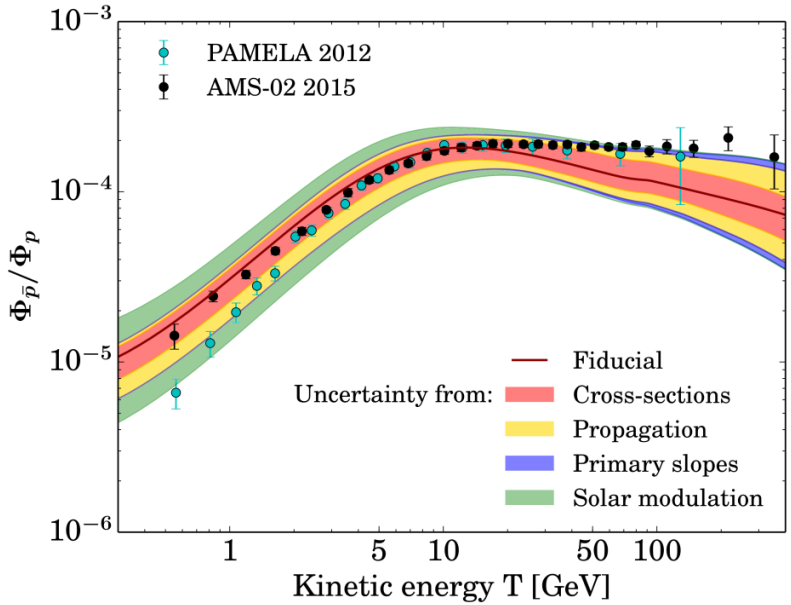
- Primary spectra slopes
- Propagation parameters (diffusion and convection) in the local galactic environment
- Solar modulation



JCAP09(2015)023.©IOP and SISSA, 2015

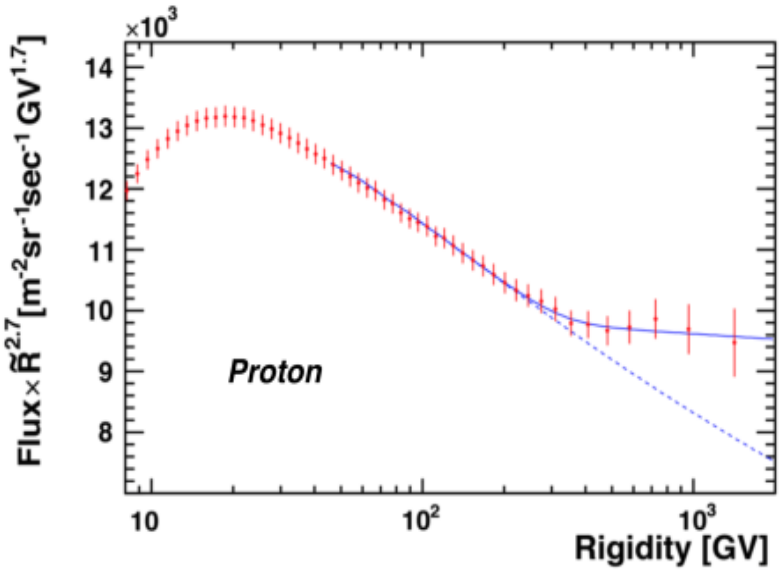
Uncertainties

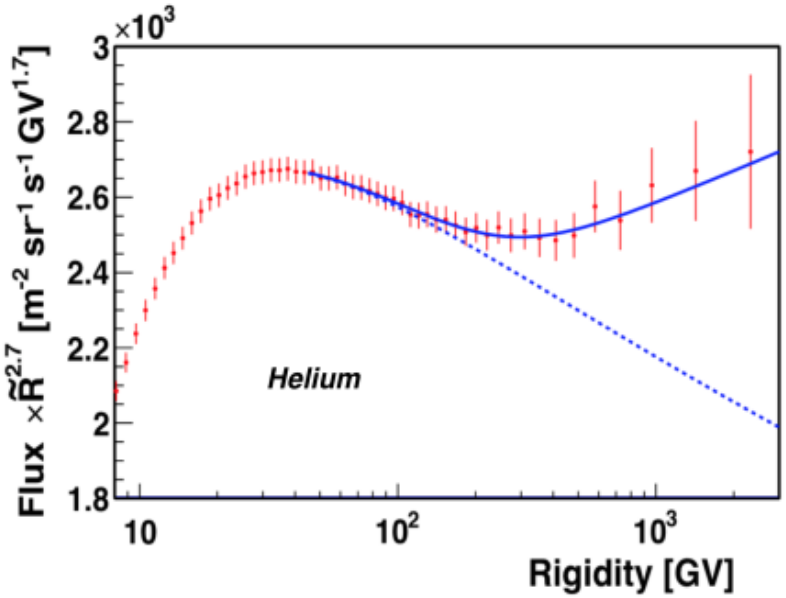
- Primary spectra slopes
- Propagation parameters (diffusion and convection) in the local galactic environment
- Solar modulation
- $\bar{p}$-production cross section (20 – 50%)



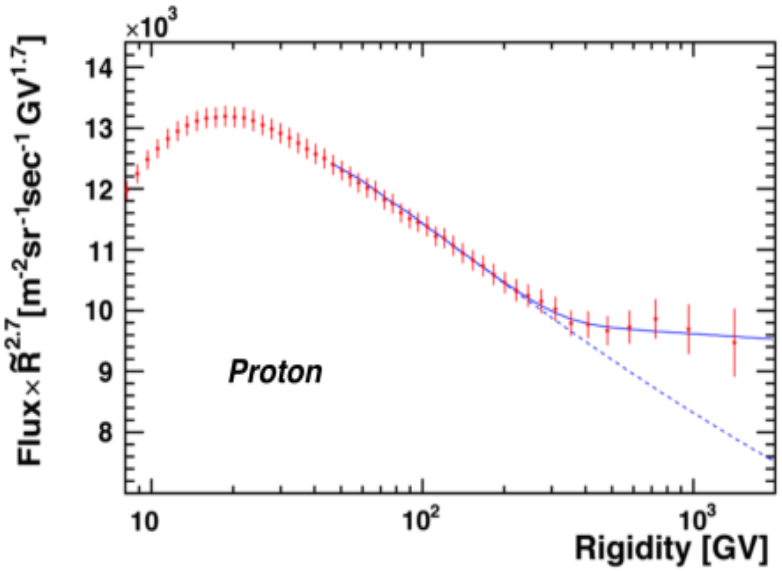
JCAP09(2015)023.©IOP and SISSA, 2015

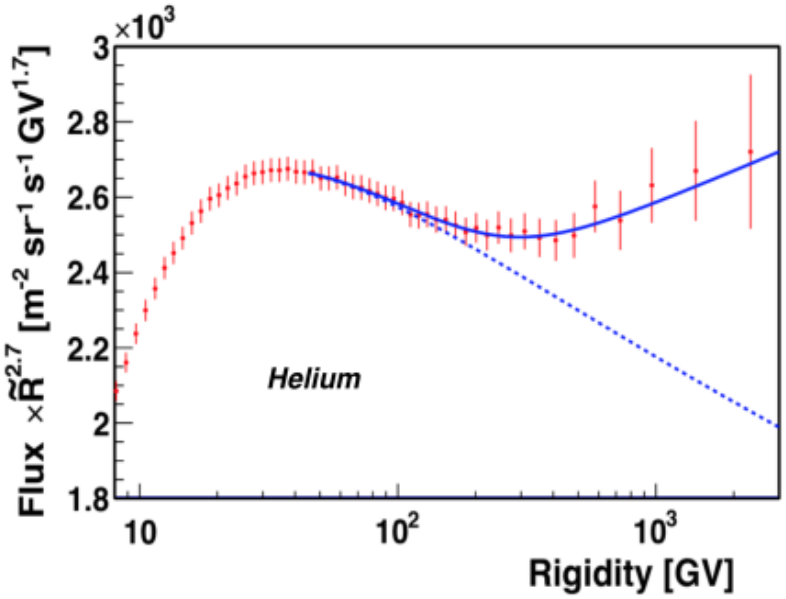
Primary spectra slopes

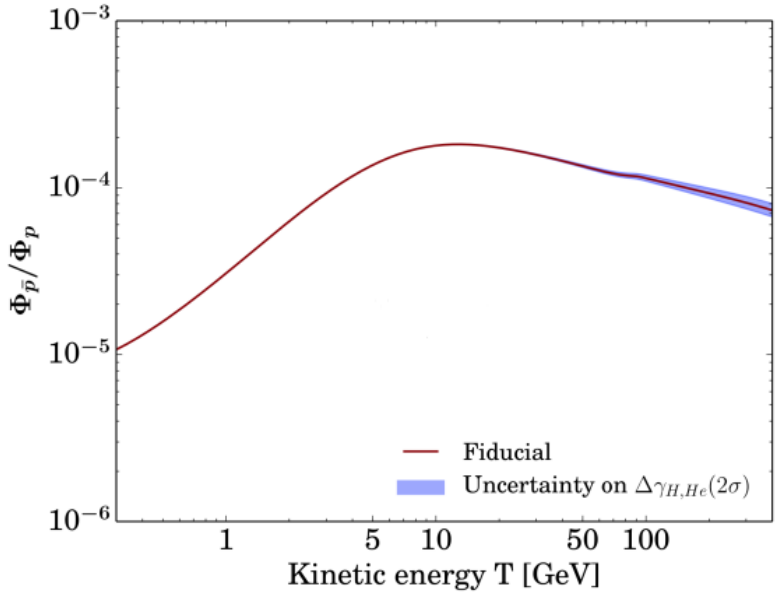




Primary spectra slopes



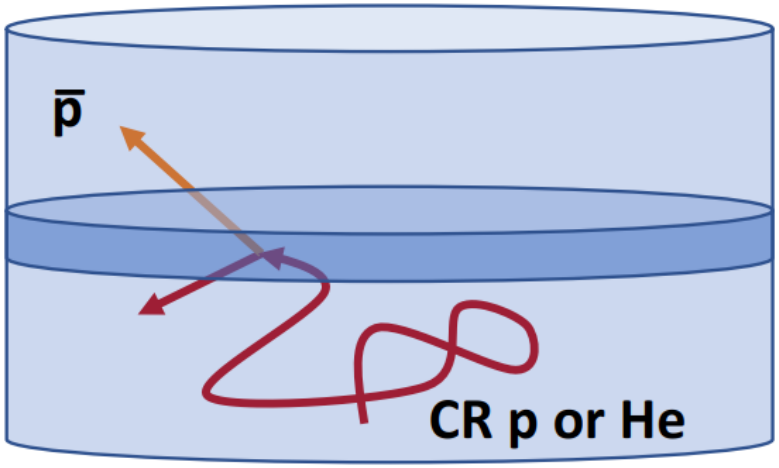




JCAP09(2015)023.©IOP and SISSA, 2015

Propagation parameters

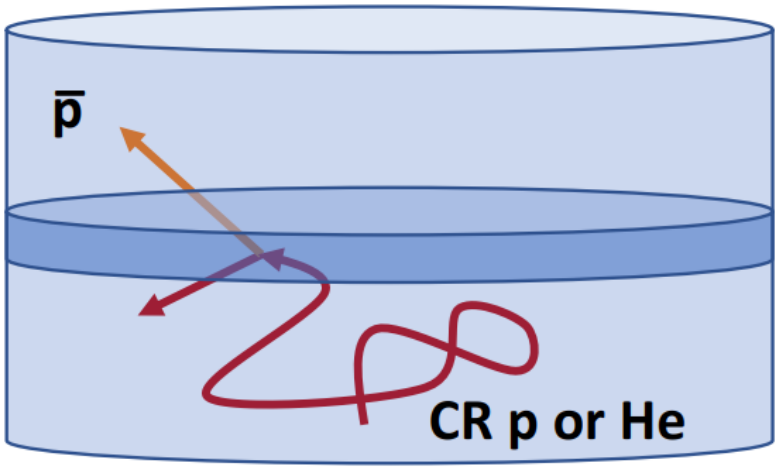
Diffusion and convection parameters



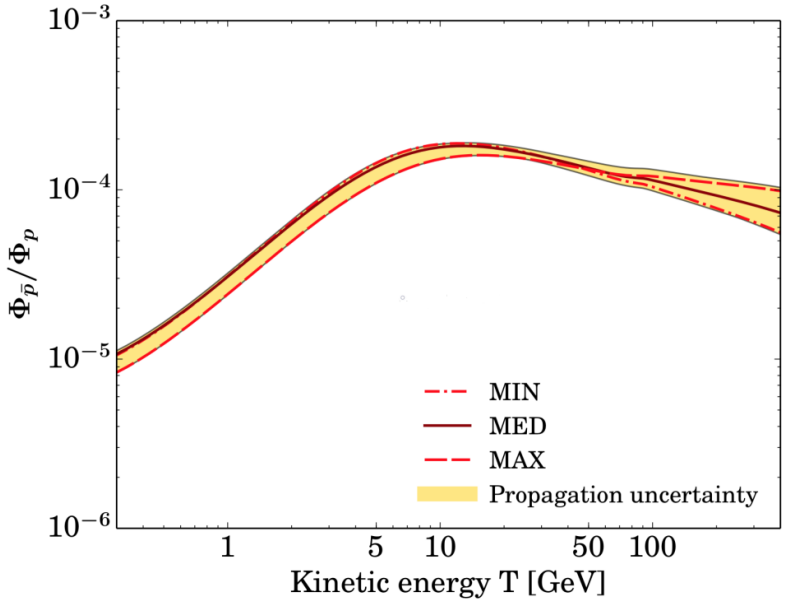
$$\mathrm{CR}_i + \mathrm{ISM}_j \rightarrow \bar{p} + X$$

Propagation parameters

Diffusion and convection parameters



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



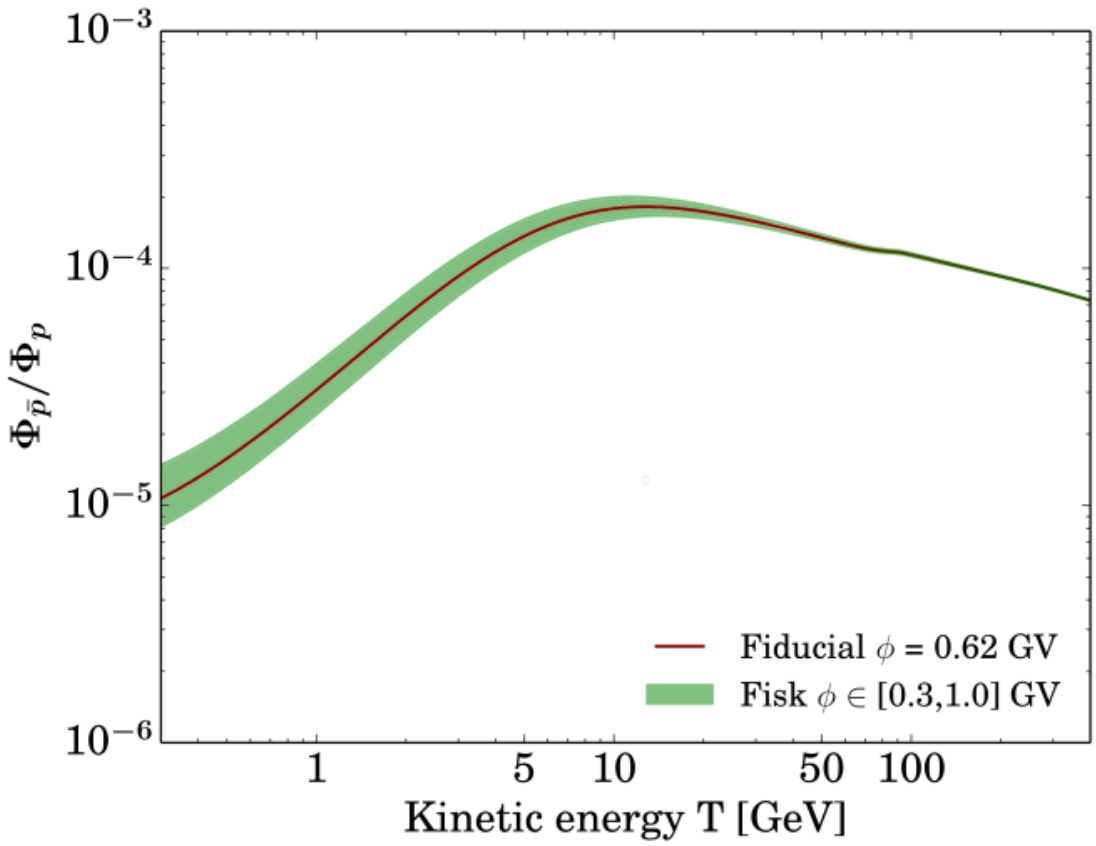
JCAP09(2015)023.©IOP and SISSA, 2015

Solar modulation

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

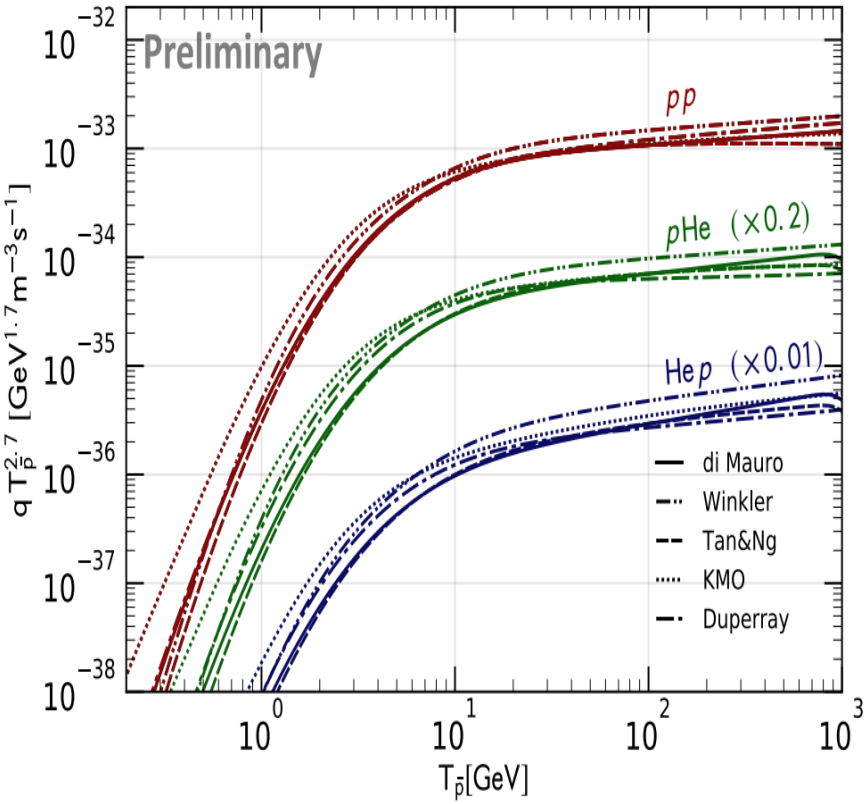
Solar modulation

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



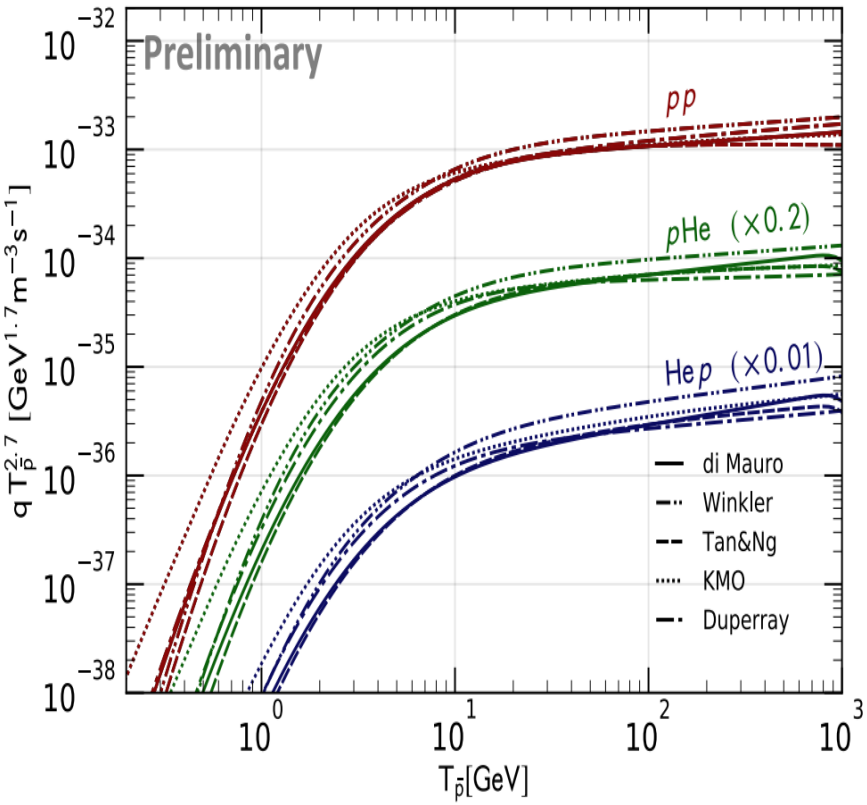
JCAP09(2015)023. ©IOP and SISSA, 2015

Production cross sections

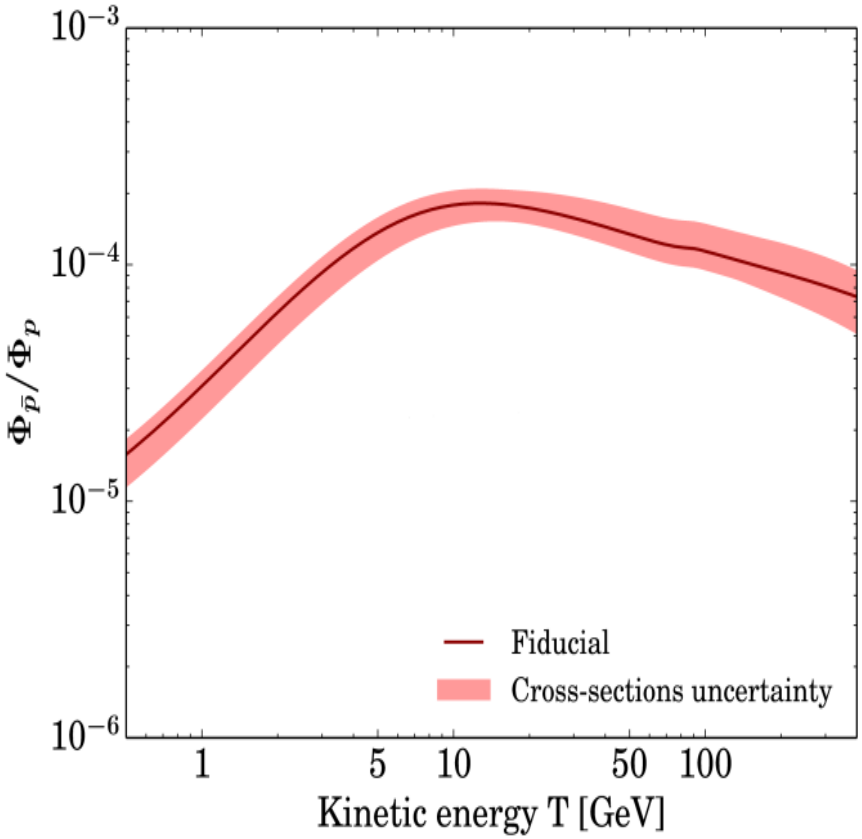


Production cross sections

$\sim 20 - 50\%$



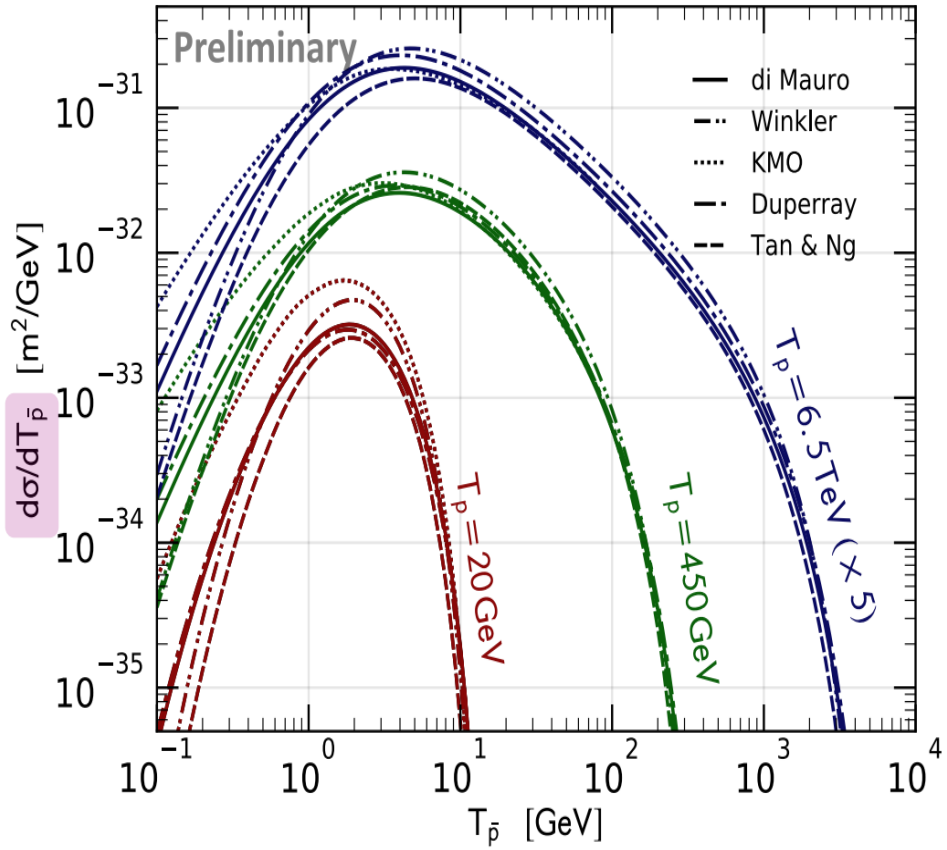
PhysRevD.96.043007.©2017 American Physical Society



JCAP09(2015)023.©IOP and SISSA, 2015

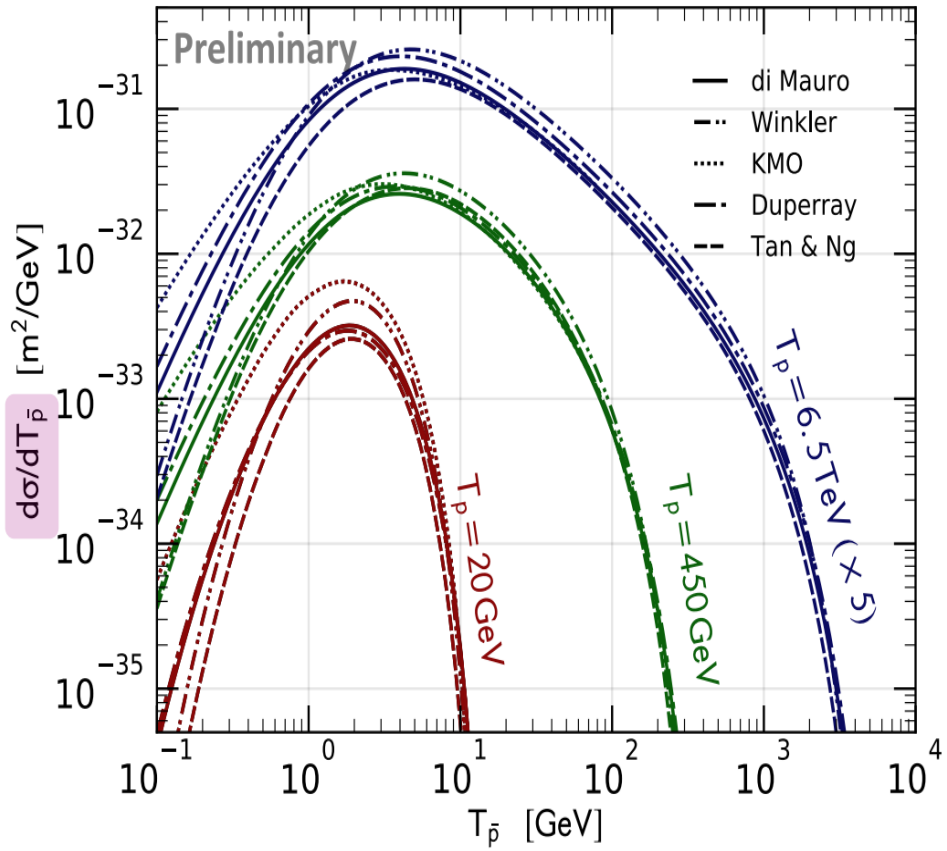
Different parameterizations

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



Different parameterizations

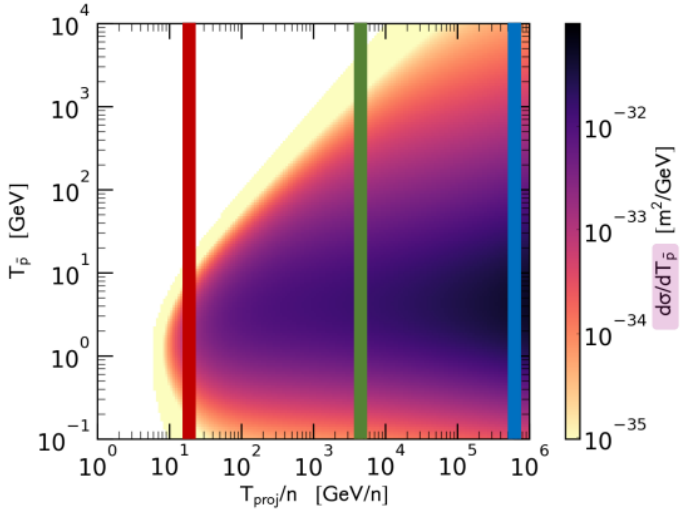
- Reasonable agreement for $T_{\bar{p}} > 10$ GeV and T_p above a few 100 GeV
- Significant deviation for $T_{\bar{p}}$ below a few GeV

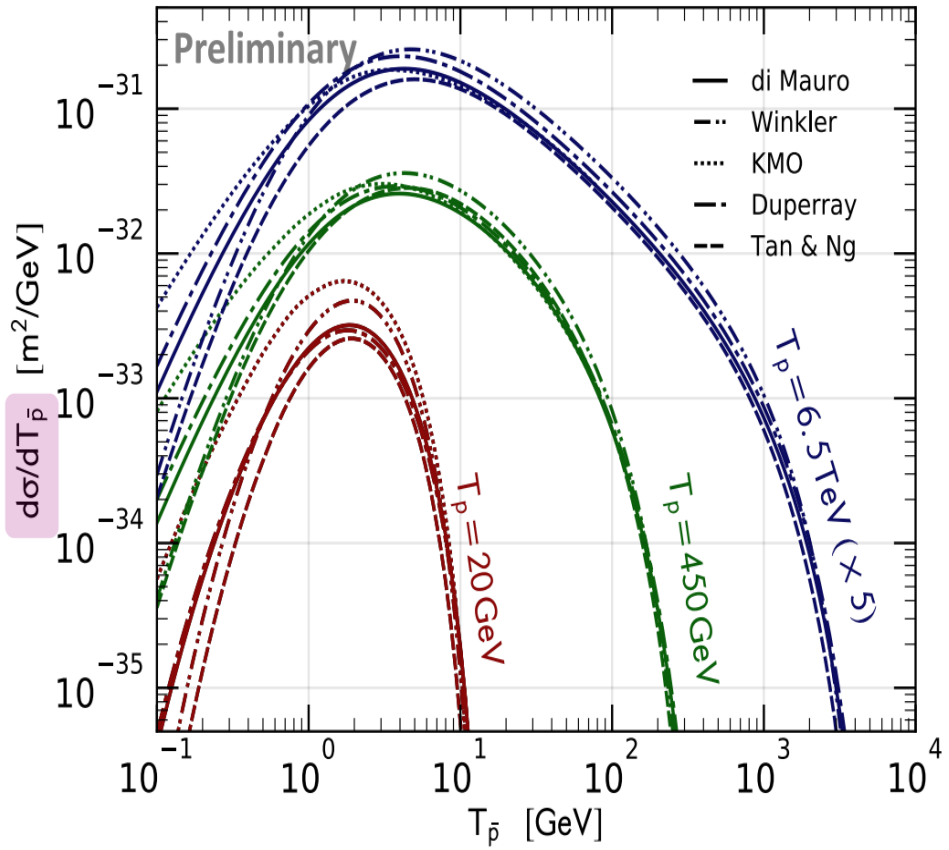


PhysRevD.96.043007.©2017 American Physical Society

Different parameterizations

- 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





$p - p$ collisions

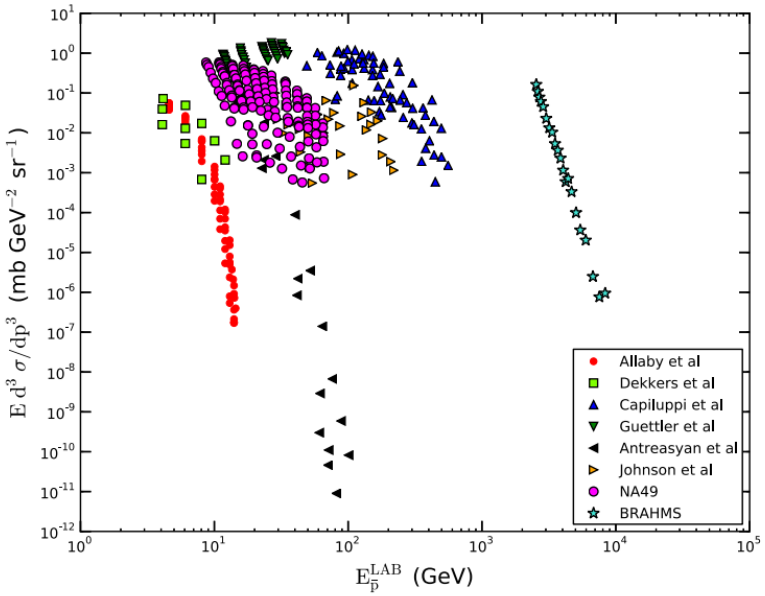
Radial-scaling variable: $x_R = \dfrac{E_{\bar{p}}}{E_{\bar{p}.max}}$, $\quad E_{\bar{p}.max} = \dfrac{s - 8m_p^2}{2\sqrt{s}}$

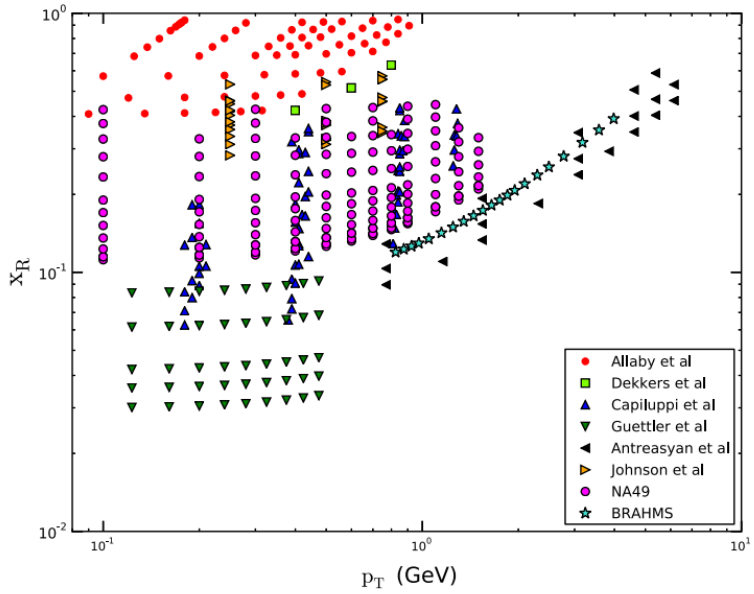
Experiment	$\sqrt{s}$ (GeV)	P_T (GeV)	x_R
Dekkers *et al.*, CERN 1965	6.1, 6.7	(0.00, 0.79)	(0.34, 0.65)
Allaby *et al.*, CERN 1970	6.15	(0.05, 0.90)	(0.40, 0.94)
Capiluppi *et al.*, CERN 1974	23.3, 30.6, 44.6, 53.0, 62.7	(0.18, 1.29)	(0.06, 0.43)
Guettler *et al.*, CERN 1976	23.0, 31.0, 45.0, 53.0, 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

LAB frame

CM frame





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

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

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

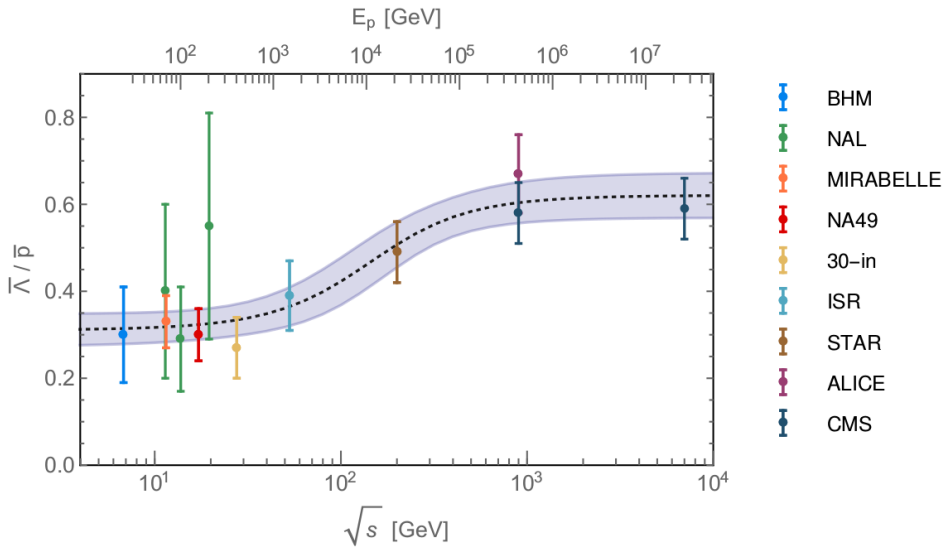
- First ever measurement of prompt $\bar{p}$-production in $p - He$ collisions was published by the LHCb collaboration only last August.
- No measurements for other $\bar{p}$-production channels.

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

- 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.

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

- 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.



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

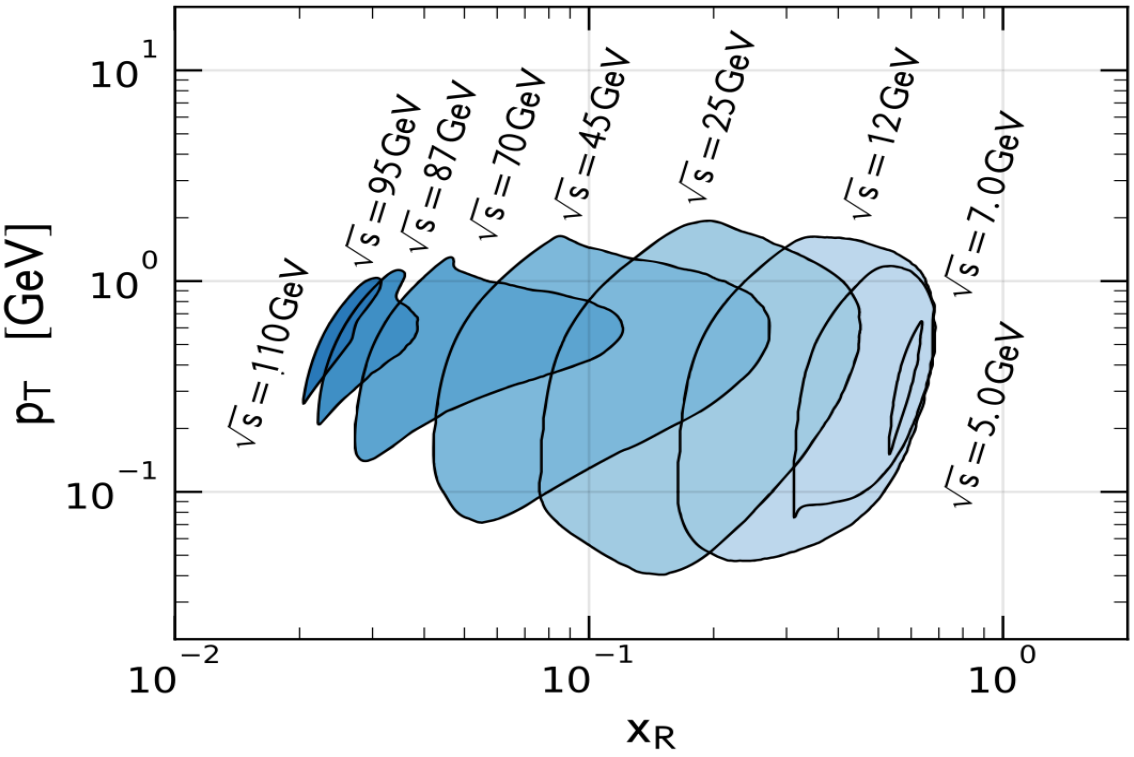
Parameter Space & AMS-02 measurements

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

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

- 3% inside contours
- 30% outside



Planned Measurements

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

Planned Measurements

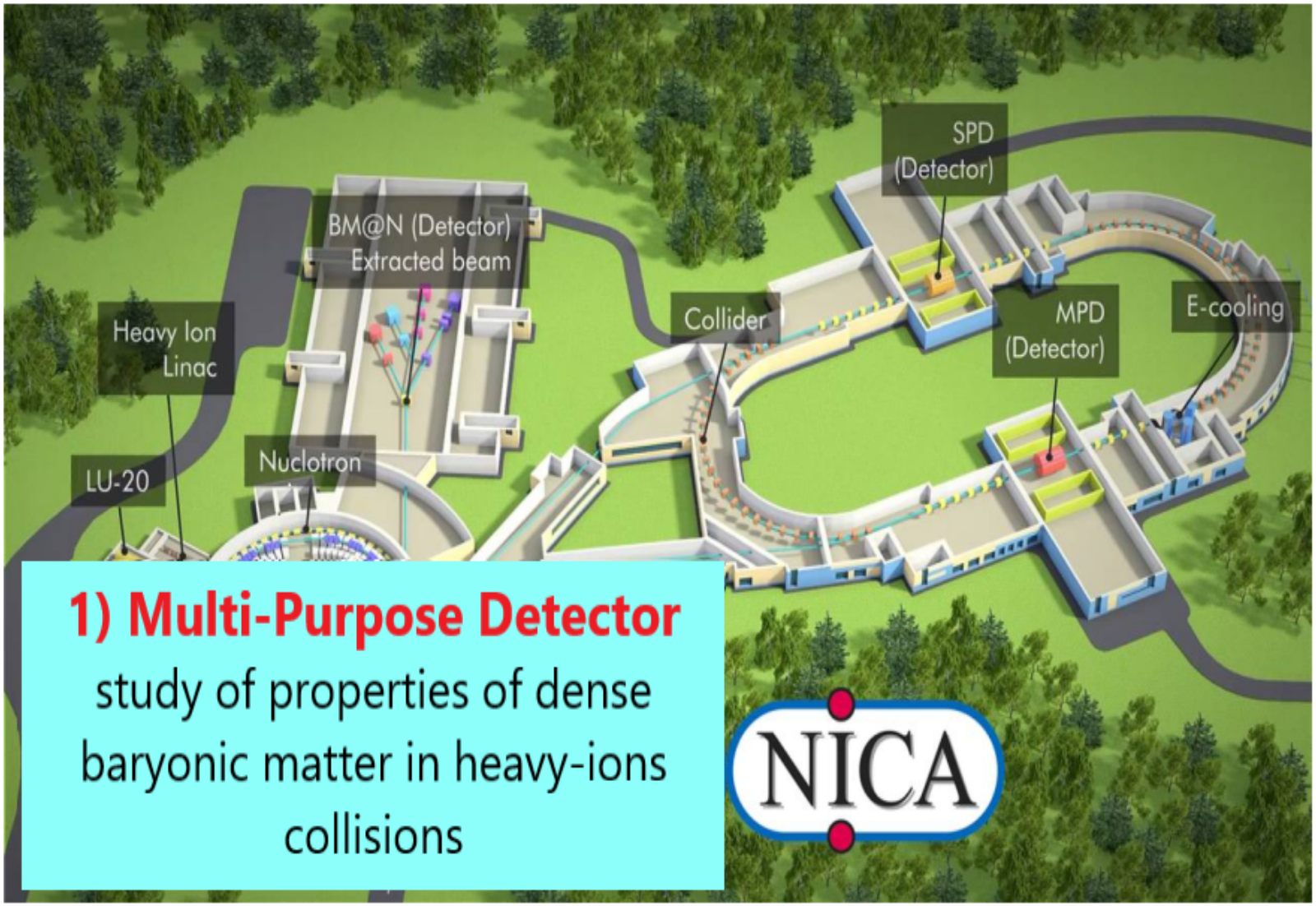
- Continuing *pHe* measurements at LHCb after the fixed-target $\sqrt{s} = 114$ GeV measurement.
- All LHCb measurements are expected to be in the high-energy range.

Planned Measurements

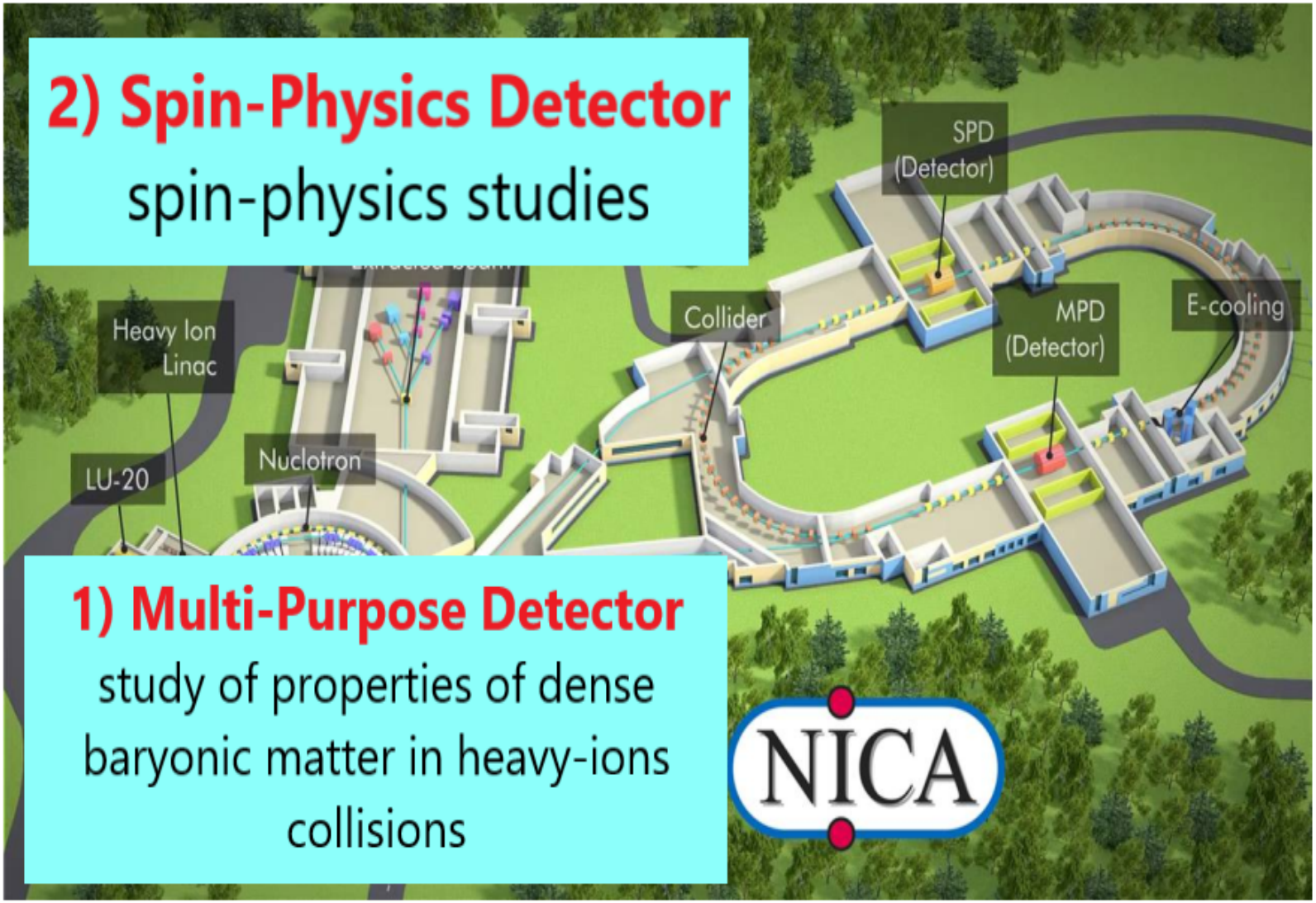
- Continuing *pHe* measurements at LHCb after the fixed-target $\sqrt{s} = 114$ GeV measurement.
- All LHCb measurements are expected to be in the high-energy range.
- COMPASS plans fixed-target *pp* and *pHe* measurements at CERN SPS from $\sqrt{s} \sim 9 - 20$ GeV.

The Nuclotron-based Ion Collider fAility (NICA)

The Nuclotron-based Ion Collider fAility (NICA)



The Nuclotron-based Ion Collider fAility (NICA)



NICA and SPD

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

NICA and 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 p^3He.

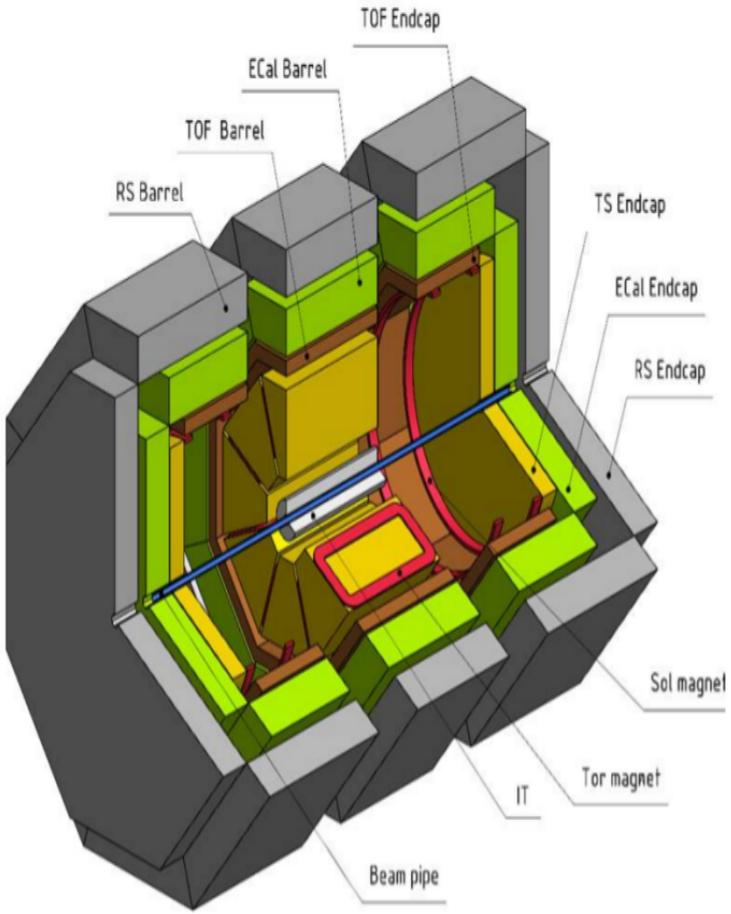
NICA and SPD

- 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 p^3He.
- Planned kinetic energies for $p \sim 5 - 12.6$ GeV; and for $D \sim 4 - 11.8$ GeV.

NICA and SPD

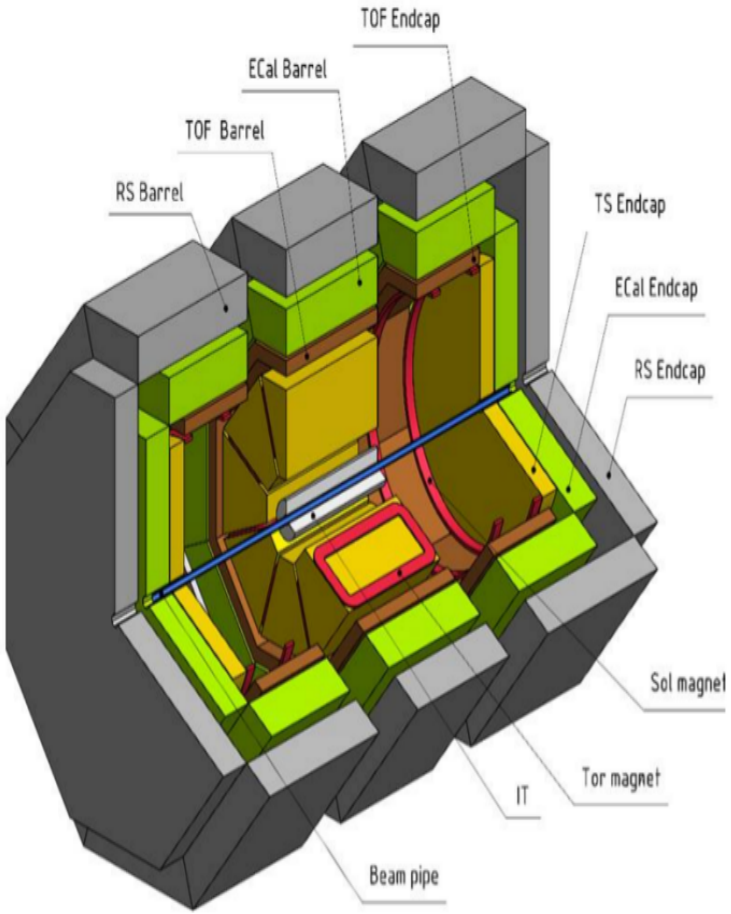
- It is planned to use polarized protons, deuterons, and possibly, helium-3 ions in the second stage.
- Possibility to collide any available polarized particles: pp, pD, and p^3He.
- Planned kinetic energies for $p \sim 5 - 12.6$ GeV; and for $D \sim 4 - 11.8$ GeV.
- At $\sqrt{s} = 27$ GeV in pp collisions,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

SPD setup


TOF Endcap
ECal Barrel
TOF Barrel
RS Barrel
TS Endcap
ECal Endcap
RS Endcap
Sol magnet
Tor magnet
IT
Beam pipe

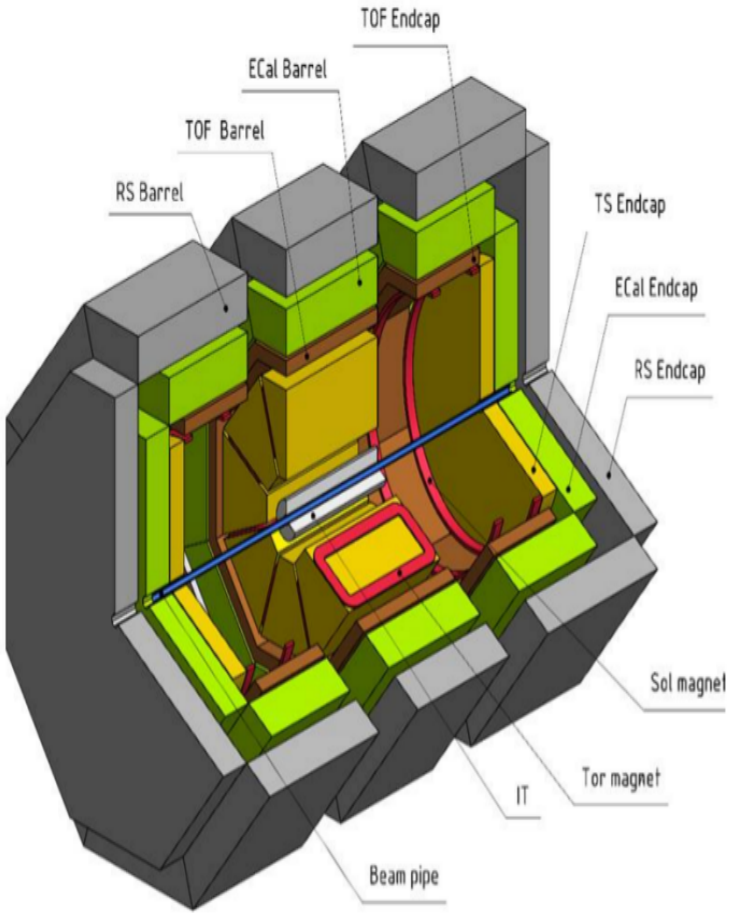
SPD setup

- Magnetic System



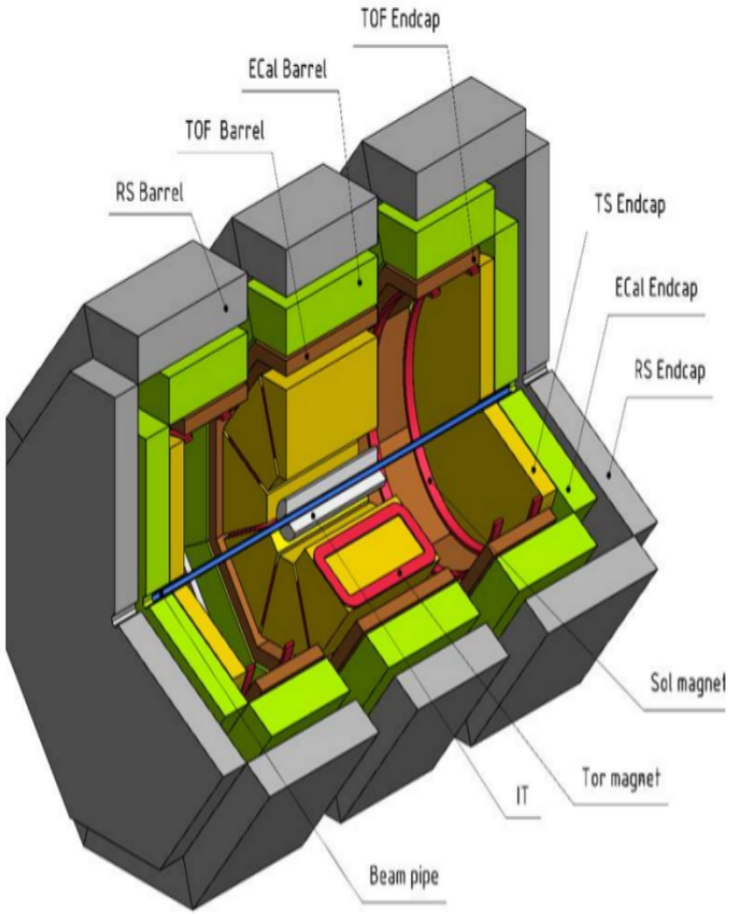
SPD setup

- Magnetic System
- Vertex Detector (IT)



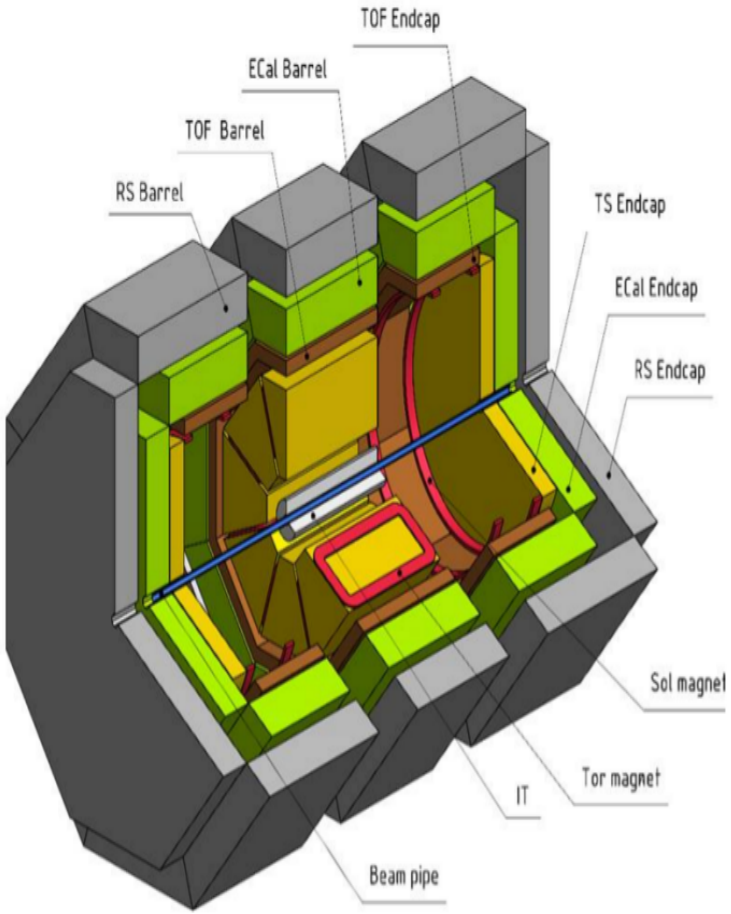
SPD setup

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



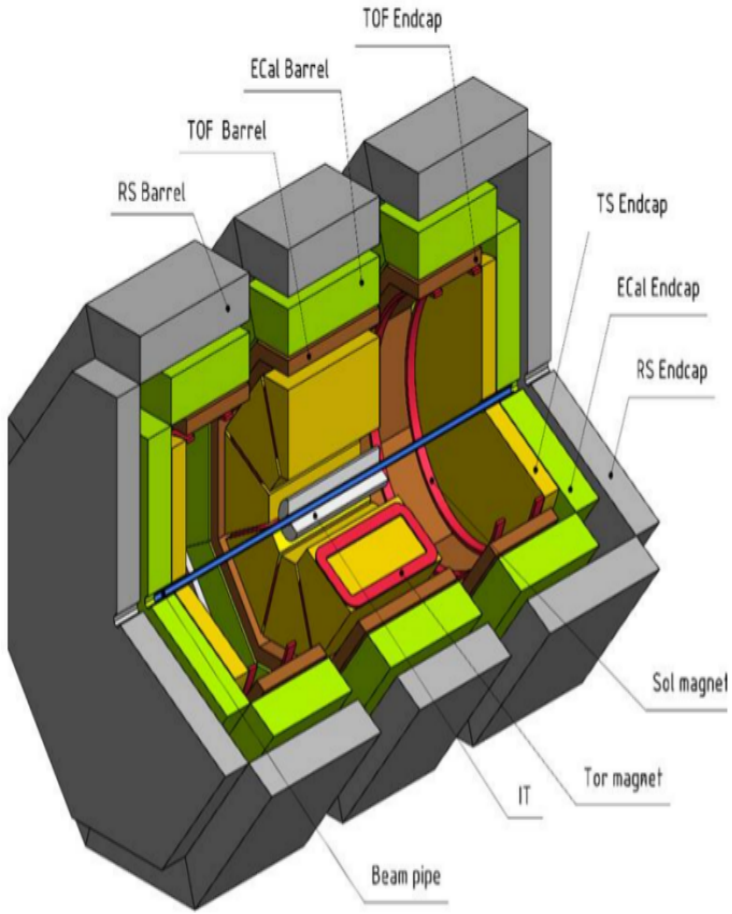
SPD setup

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



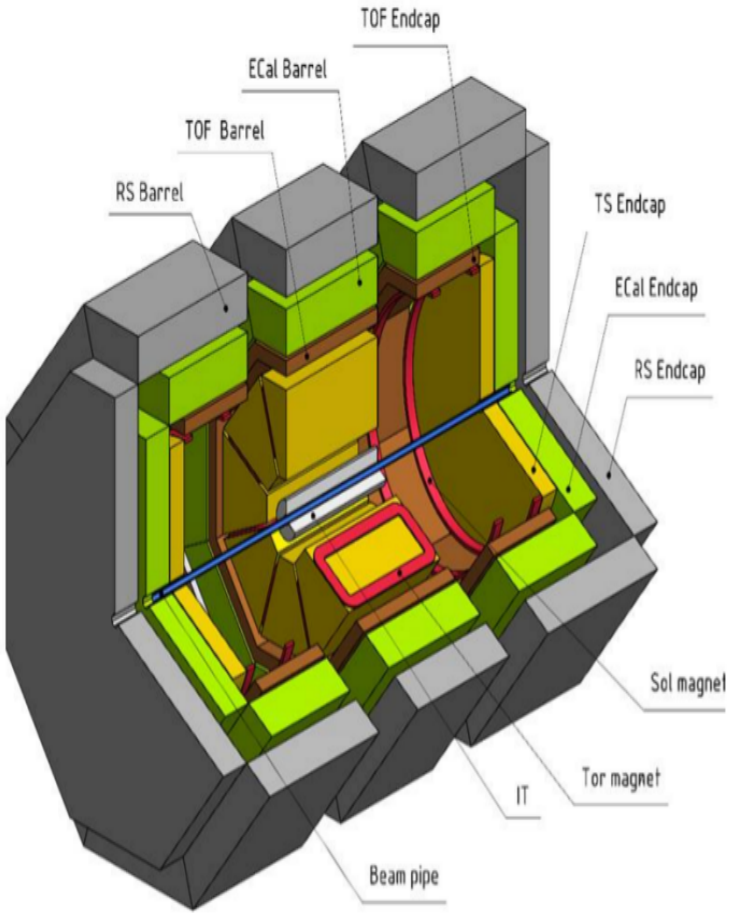
SPD setup

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



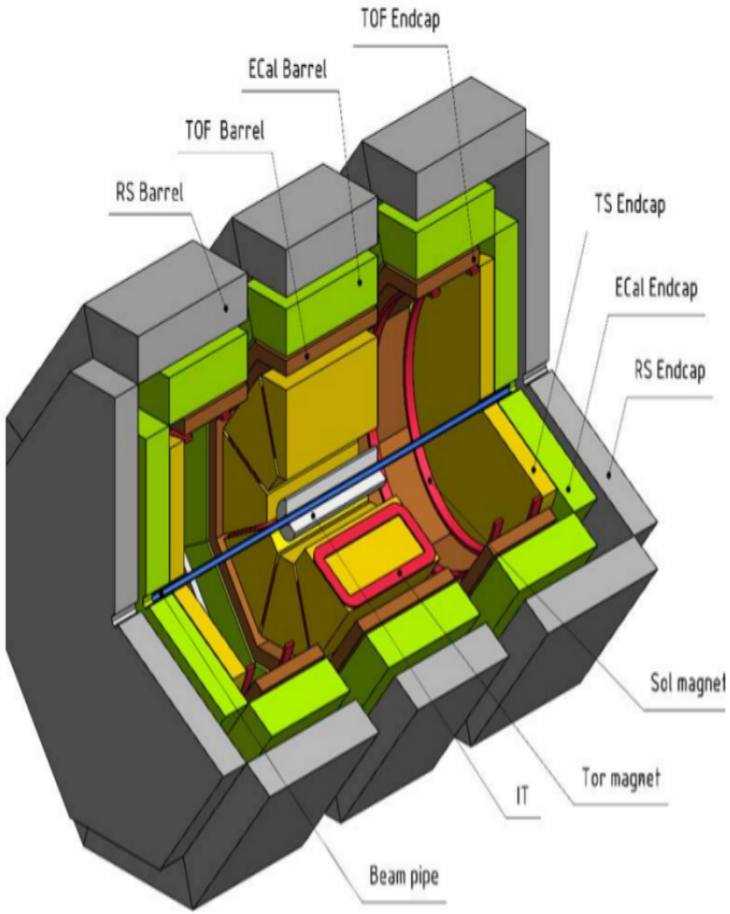
SPD setup

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



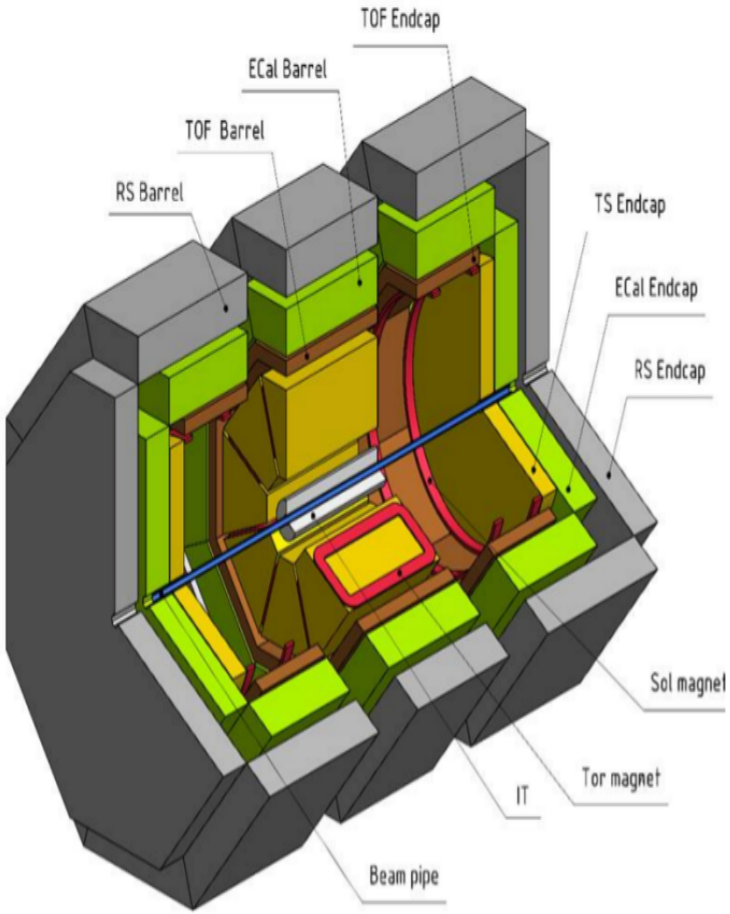
SPD setup

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



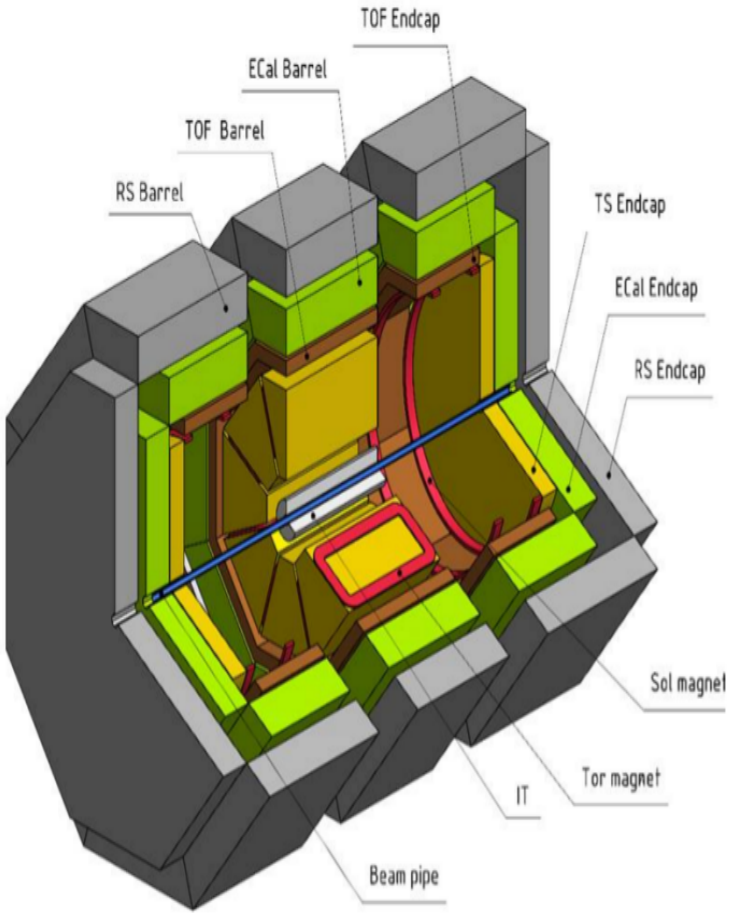
SPD setup

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



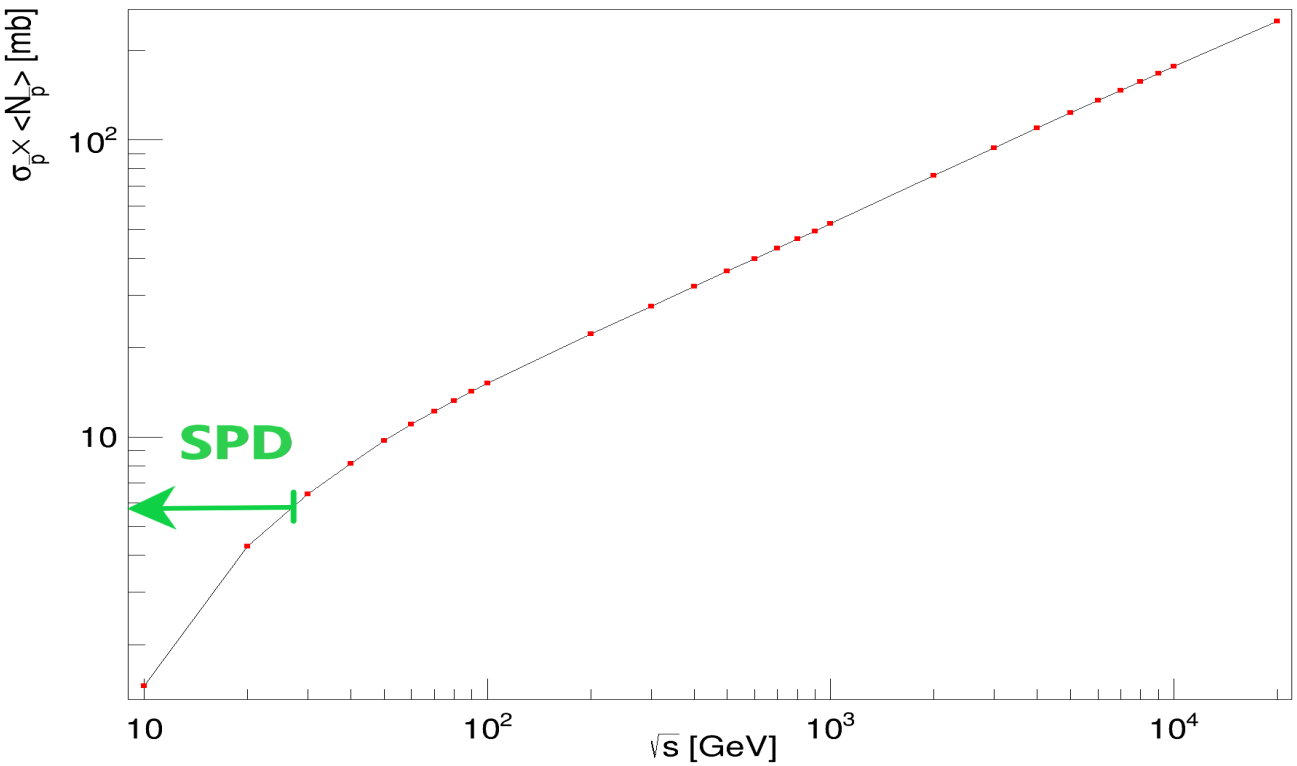
SPD setup

- 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

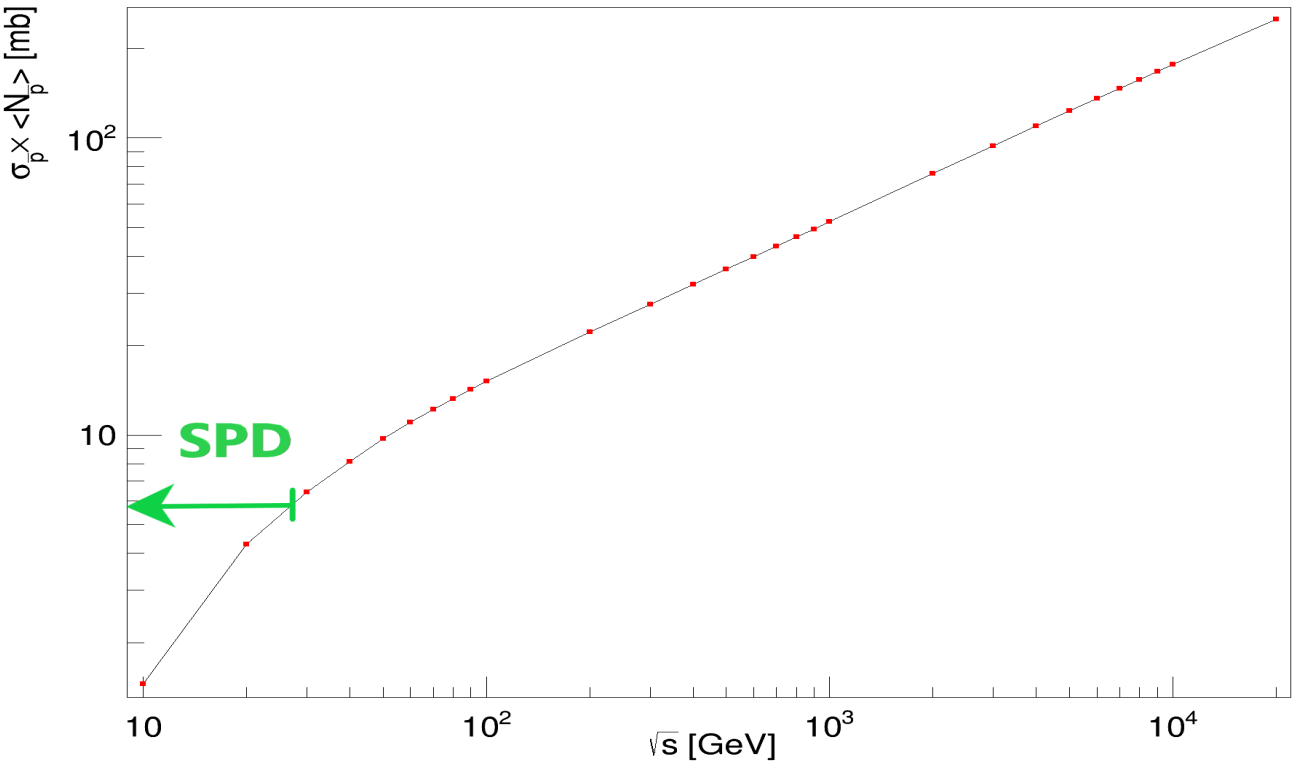
PYTHIA8 wide-range results



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

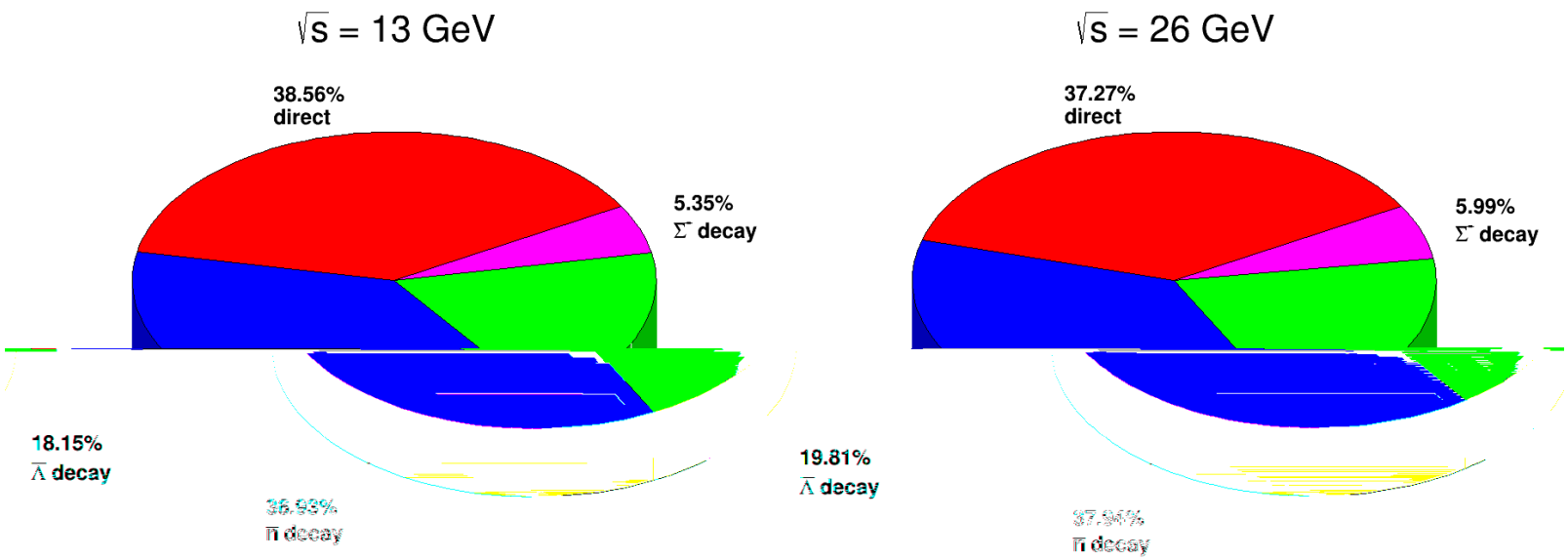
PYTHIA8 wide-range results

Near threshold energies would likely be accessible as well.

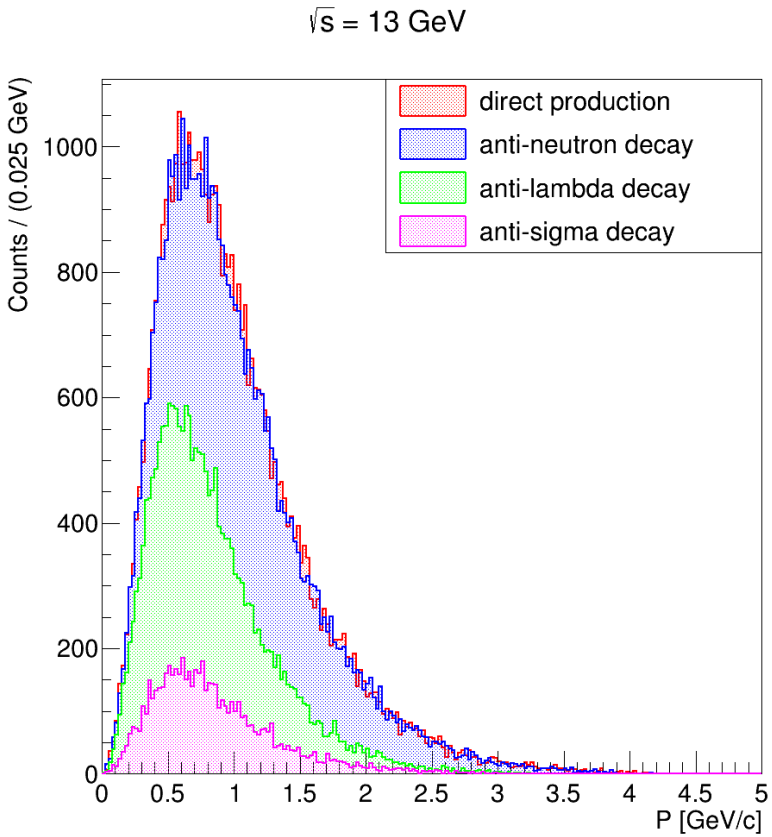


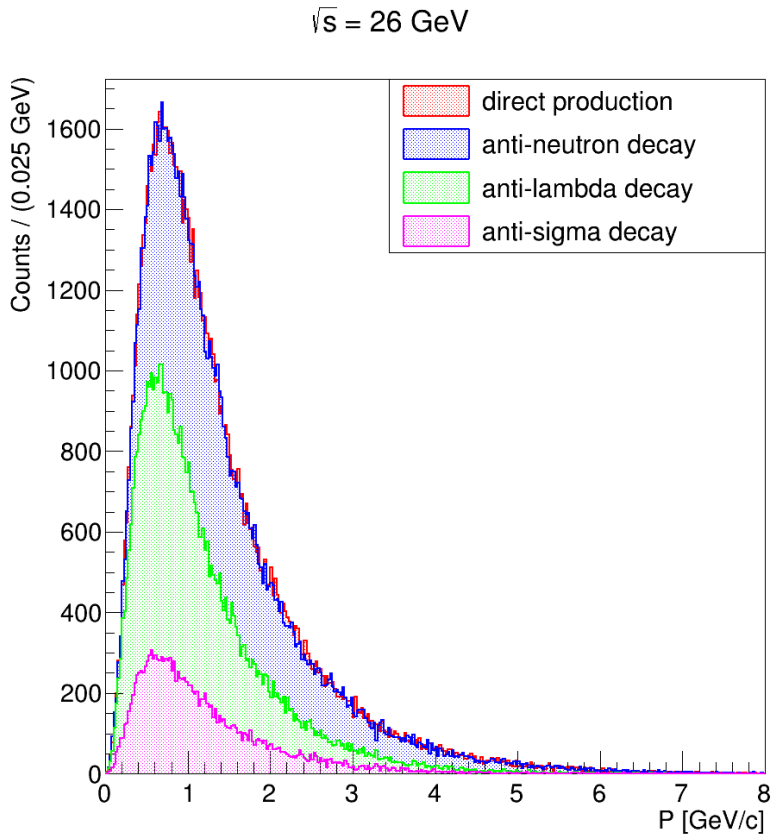
Hyperons and $\bar{n}$ decay

Reconstruction of secondary vertices



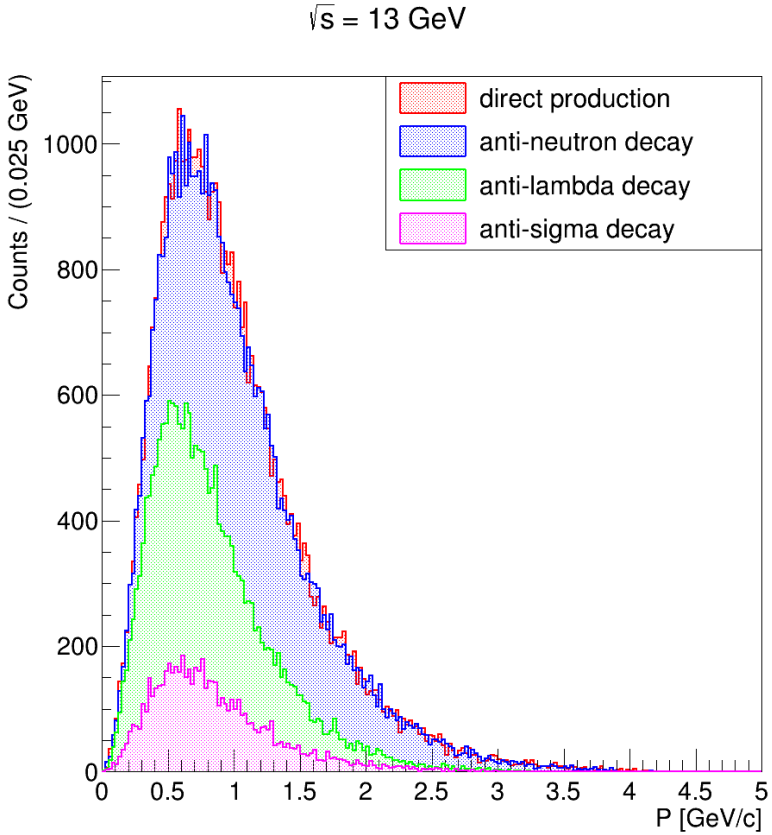
Produced momenta

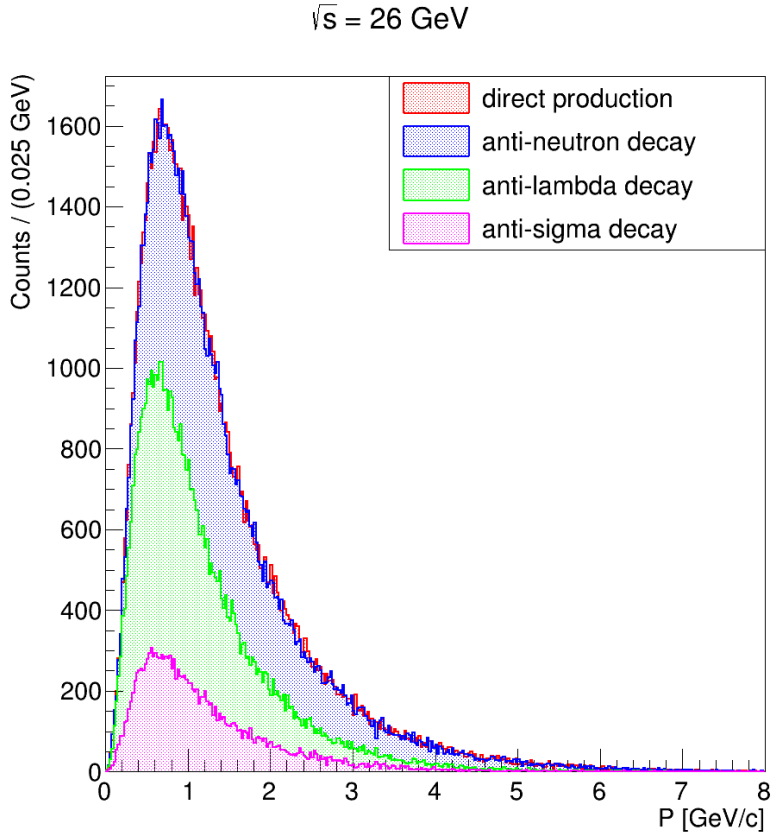




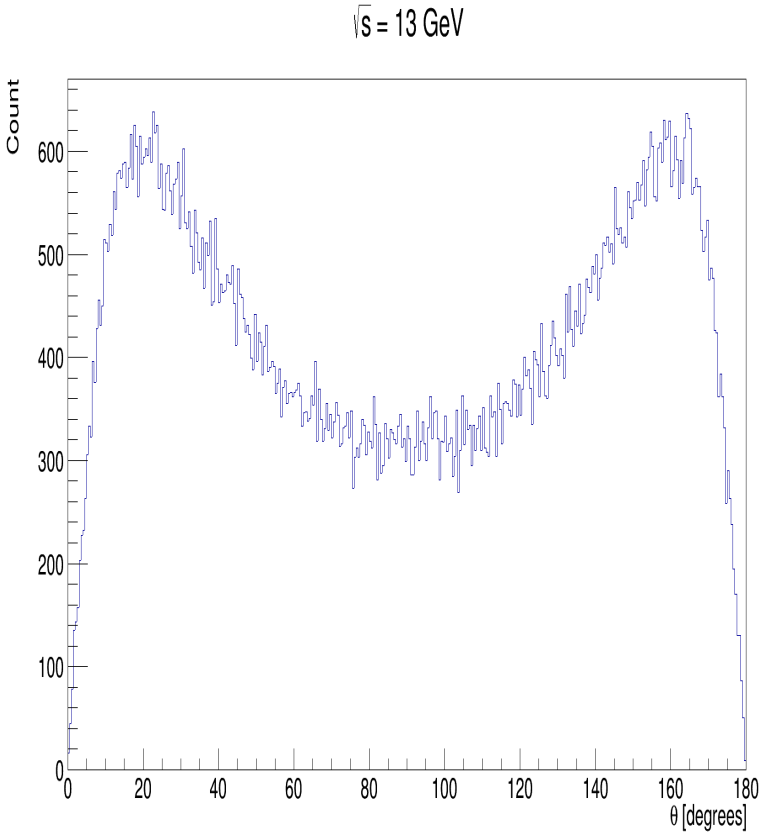
Produced momenta

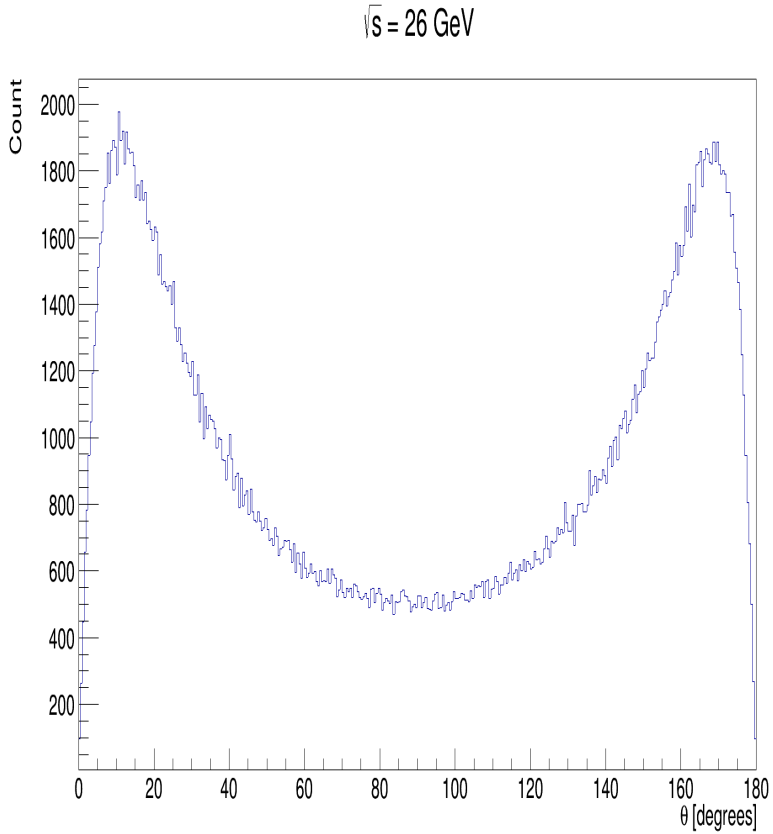
Most produced $\bar{p}$'s would have momenta less than ~ 5 GeV/c, which should be accessible by the SPD.





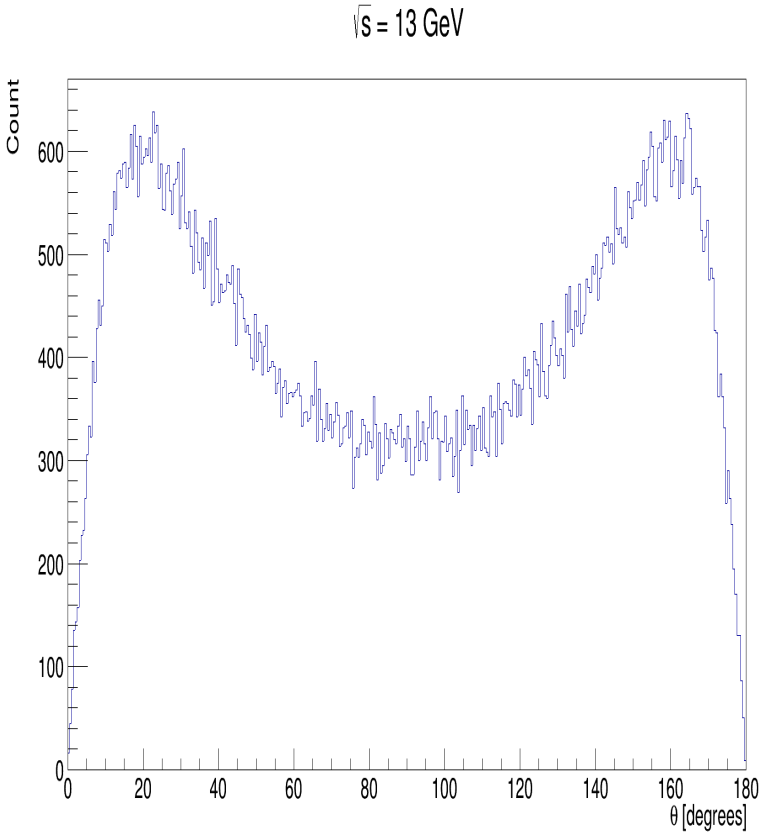
Angular distribution

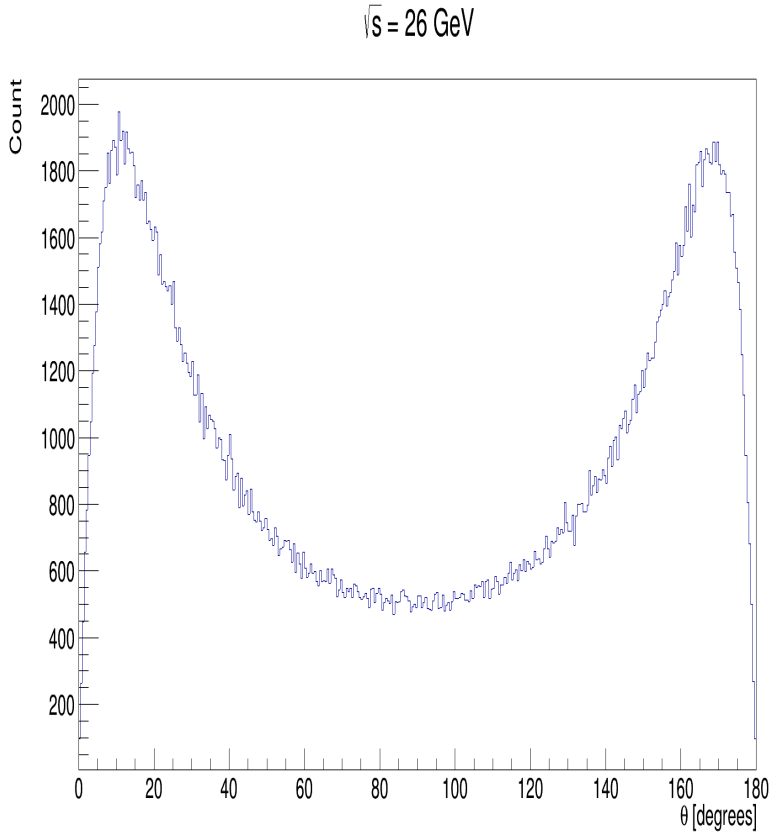




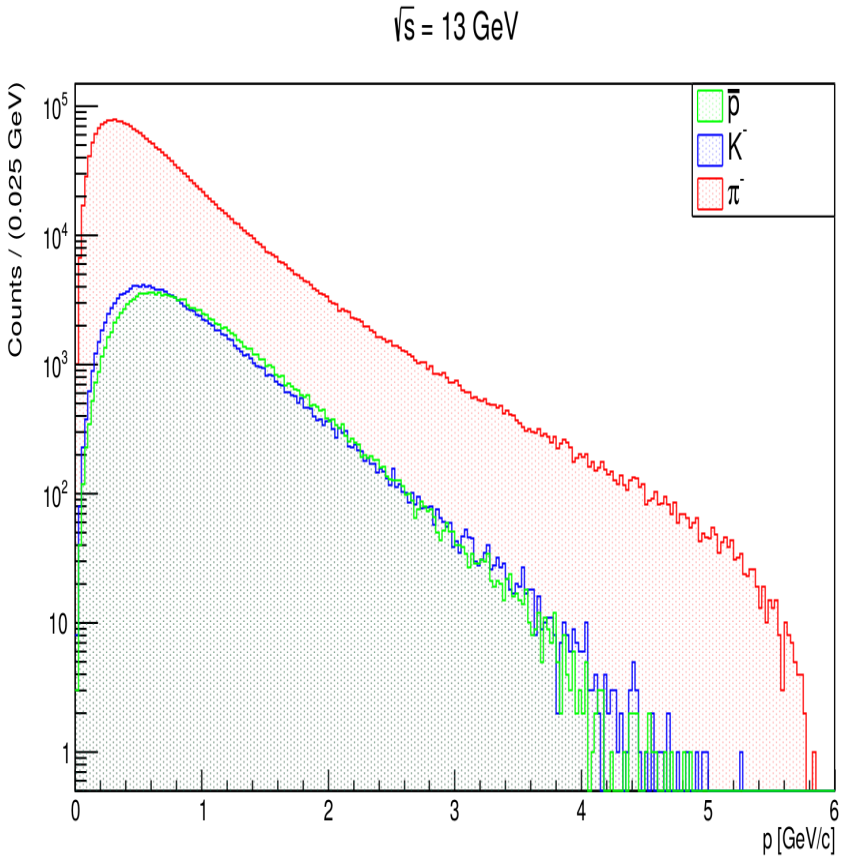
Angular distribution

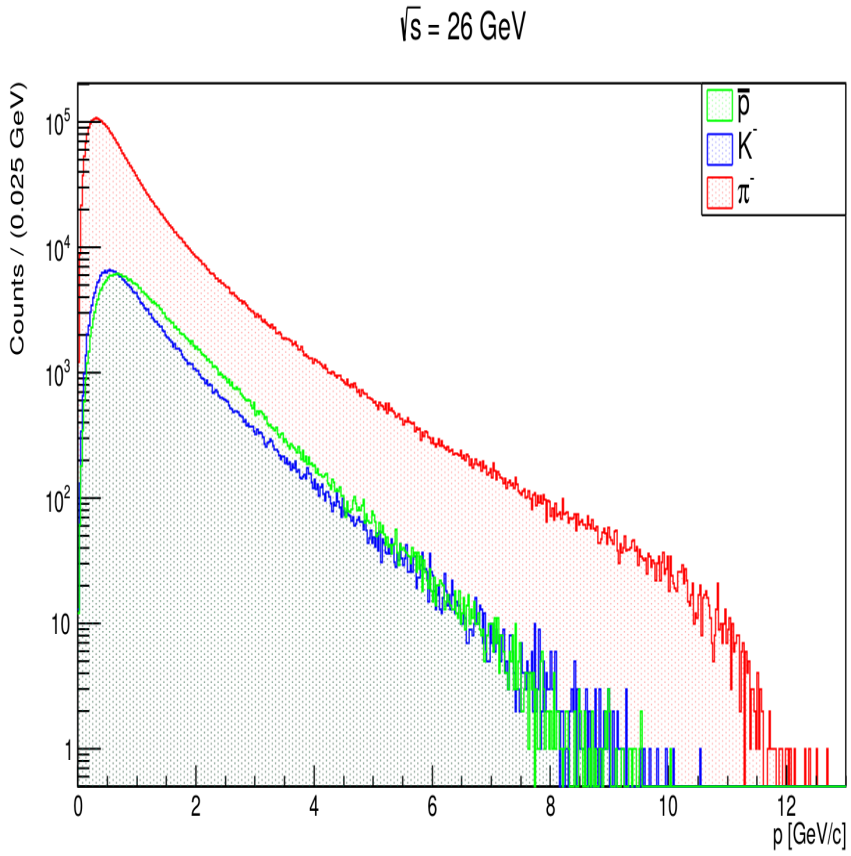
$\sim 4\pi$ angular acceptance and low material budget (planned to be ~ 0.012 RL)





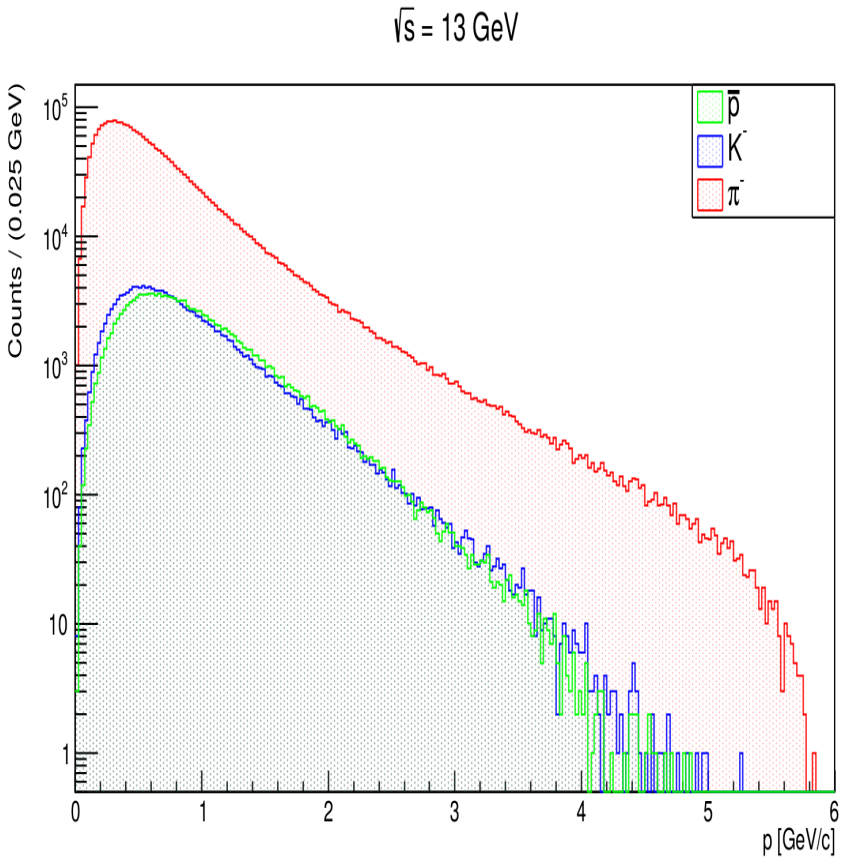
Other particles

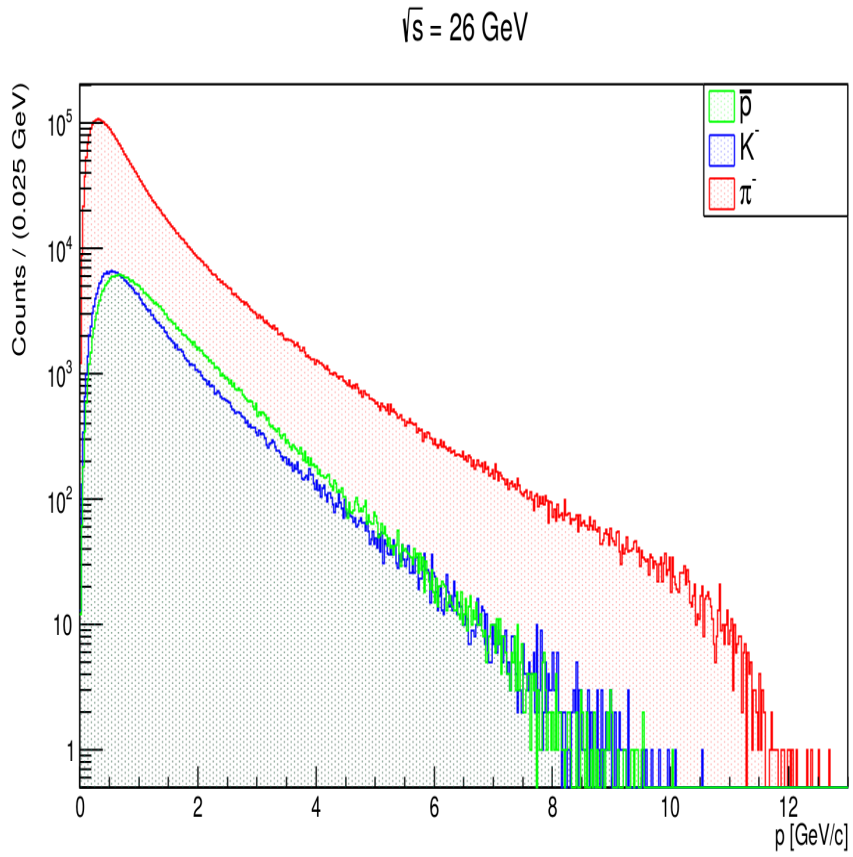




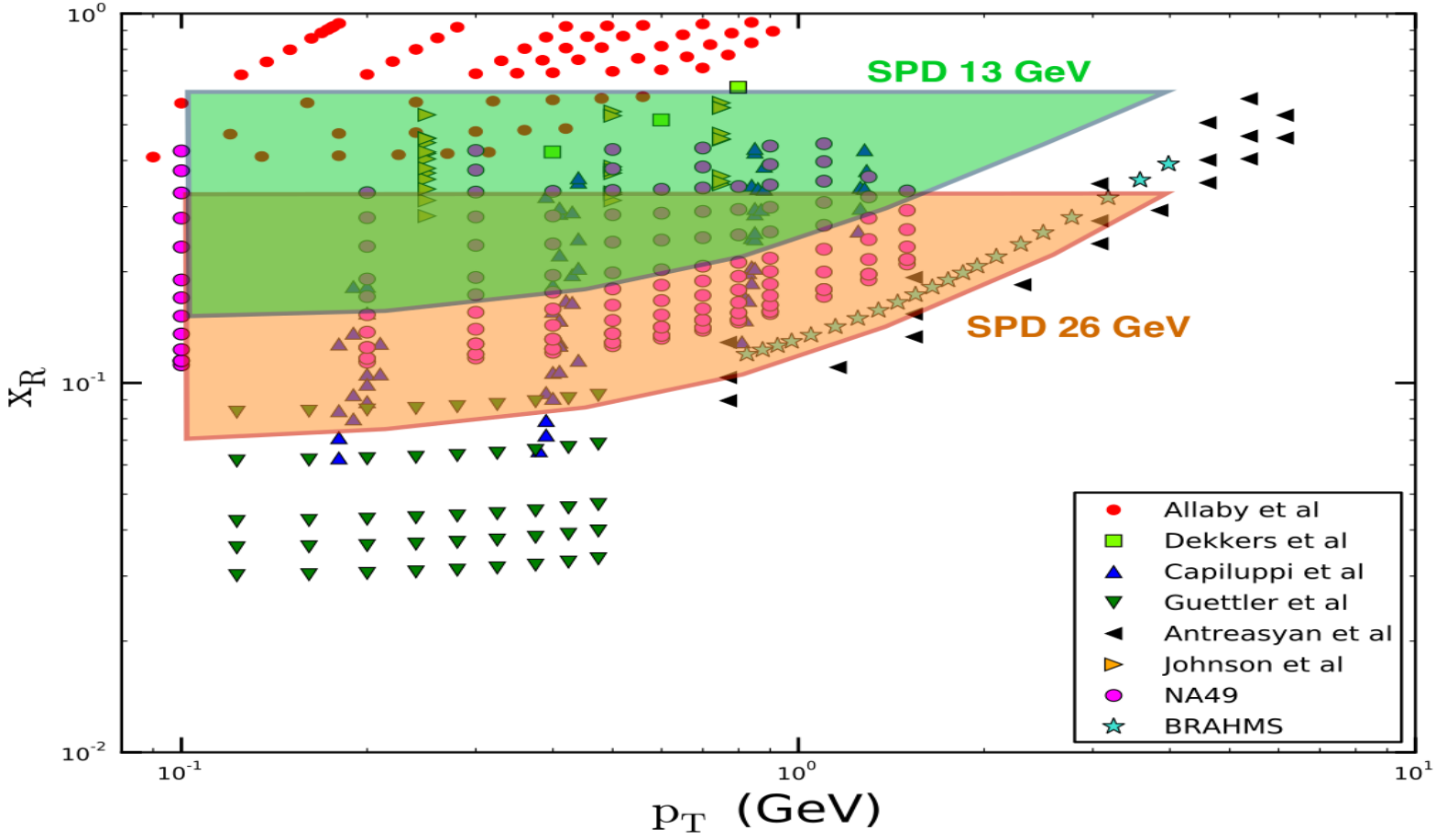
Other particles

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



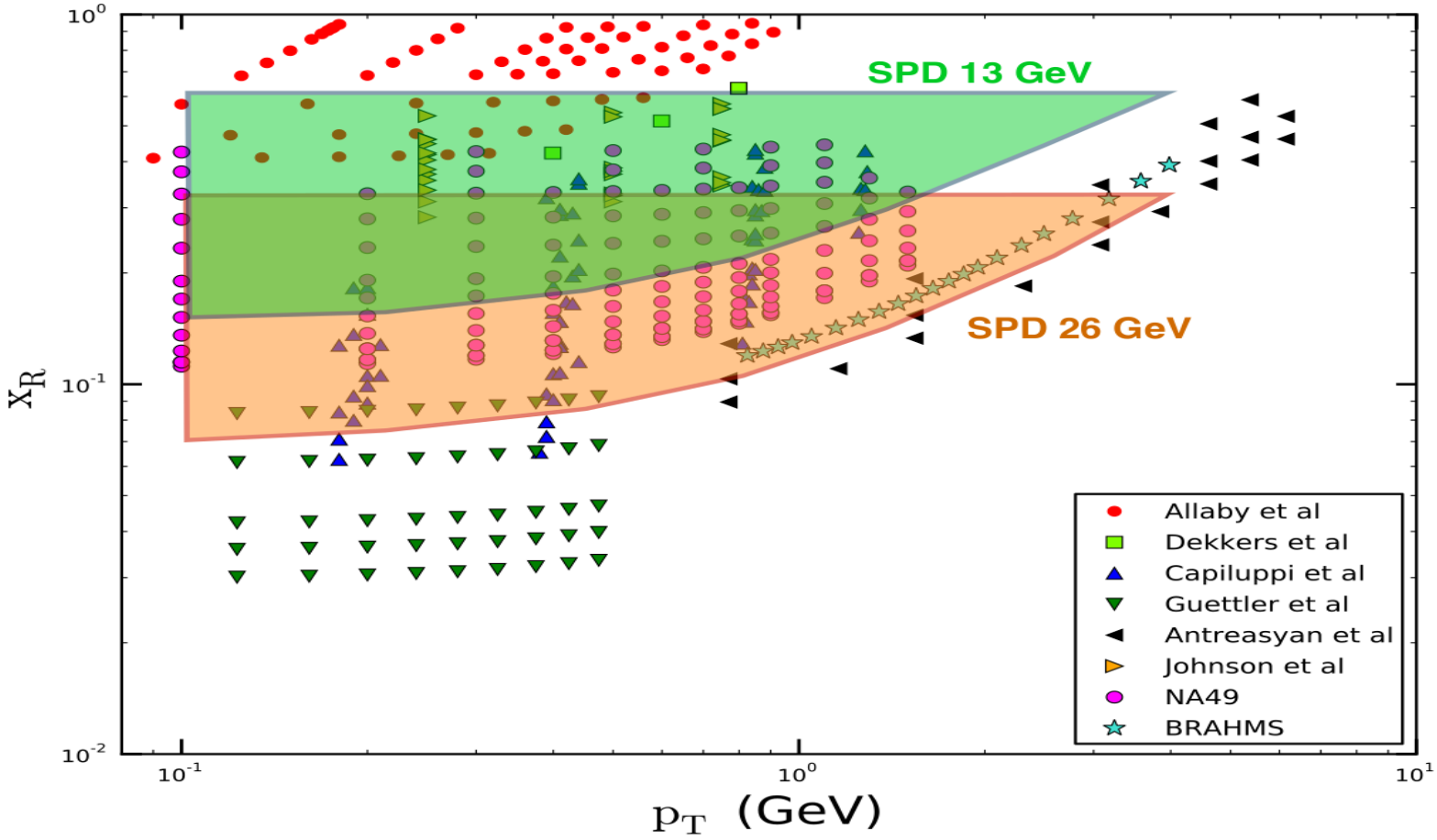


SPD Cuts & Coverage



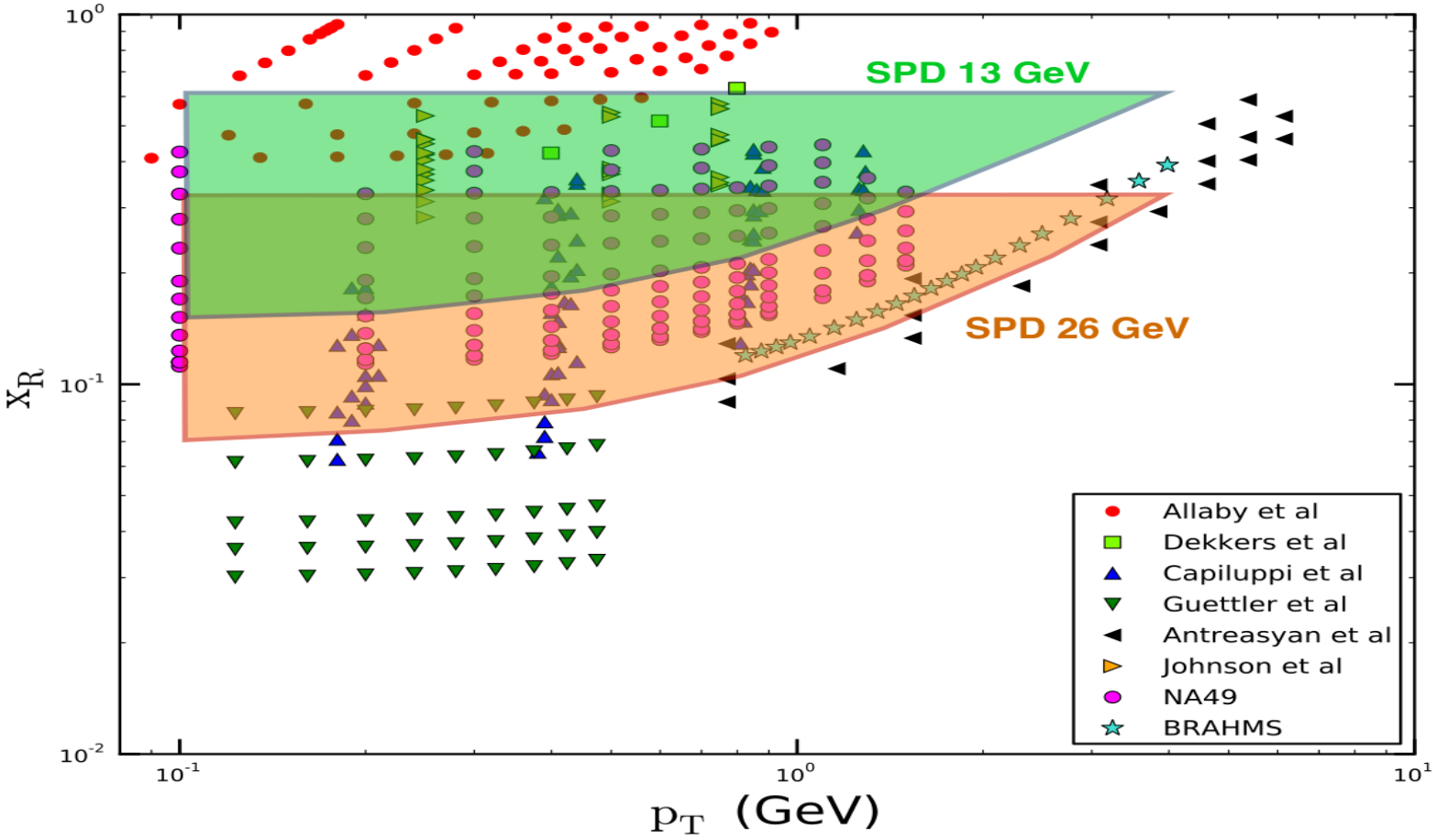
SPD Cuts & Coverage

$p < 4$ GeV/c



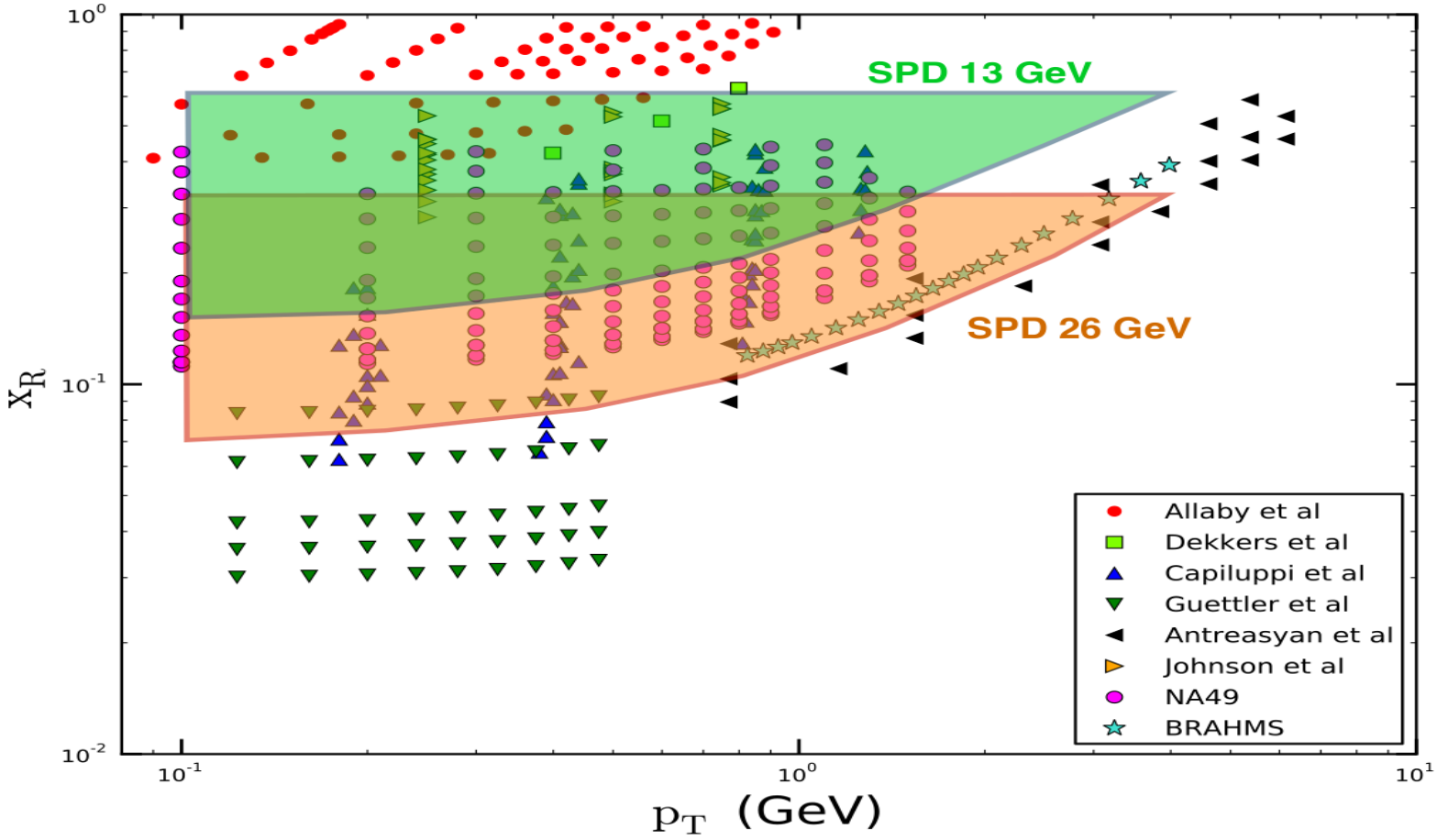
SPD Cuts & Coverage

$p < 4$ GeV/c, $P_T > 100$ MeV/c

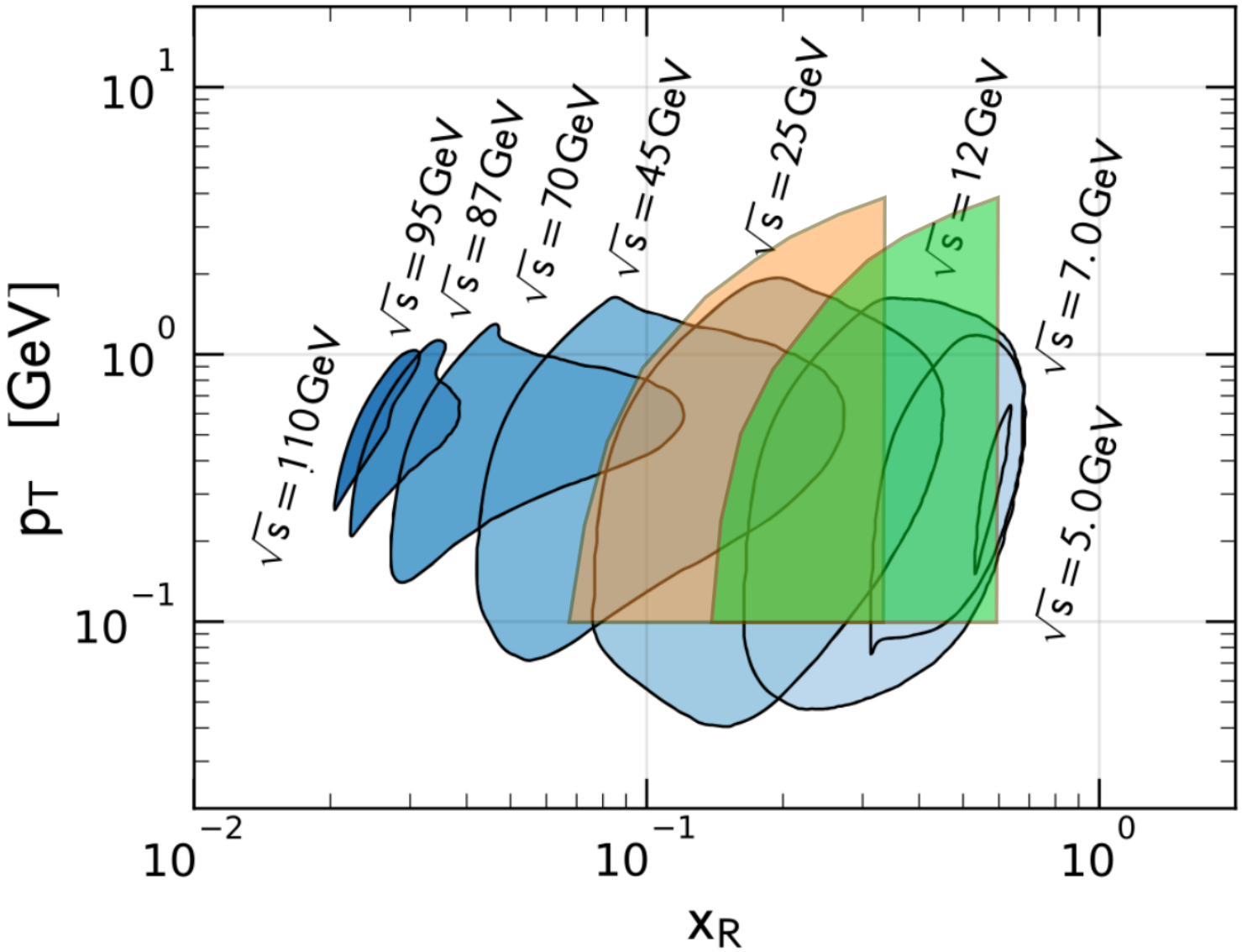


SPD Cuts & Coverage

$p < 4$ GeV/c, $P_T > 100$ MeV/c, $0.02 < \theta < (\pi - 0.02)$ rad



SPD Coverage



Requirements for SPD

Requirements for SPD

- $\sim 4\pi$ acceptance and a good tracking system

Requirements for SPD

- $\sim 4\pi$ acceptance and a good tracking system
- Low material budget

Requirements for SPD

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

Requirements for SPD

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

Conclusions

- 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.

Conclusions

- 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.

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.

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.
- The programme could be further extended by the possibility for NICA to operate with light-nuclei beams; e.g. ^{3}He, ^{4}He.

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.
- The programme could be further extended by the possibility for NICA to operate with light-nuclei beams; e.g. ^{3}He, ^{4}He.
- The main requirements for performing the measurements would be an advanced PID (ToF system) and precision reconstruction of secondary vertices.

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.
- The programme could be further extended by the possibility for NICA to operate with light-nuclei beams; e.g. ^{3}He, ^{4}He.
- 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.

Thank You!