Drell-Yan and J/psi with RF-separated beams

Beam specifications

RF-separated beams for AMBER - Kick Off Meeting

Márcia Quaresma on behalf of the Drell-Yan subgroup - 30th September 2021

Outlook

- ✓ Drell-Yan and J/psi physics goals
- ✓ Drell-Yan energy dependence
- ✓ Beam intensity limitations
- ✓ Drell-Yan geometrical acceptance
- ✓ Beam assumptions
- ✓ Energy effect
- ✓ Beam particle identification
- ✓ Beam divergence
- ✓ Summary

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Disclaimer:

This is not an extensive talk - I will briefly draw your attention to the main beam specifications

Physics goal

- **Study the kaon structure**
  - The valence and sea structure through the Drell-Yan measurement
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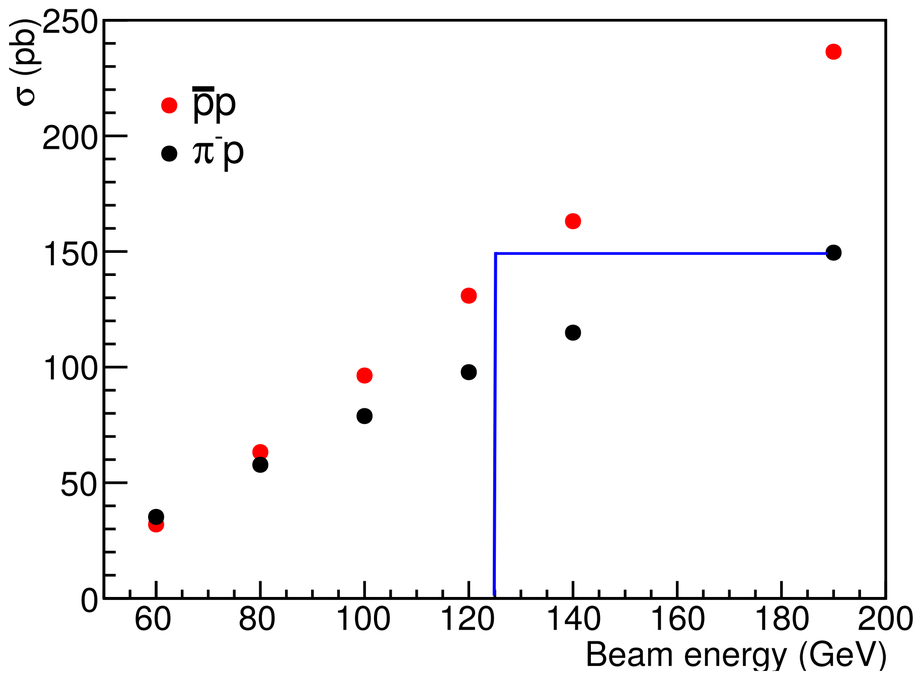
Measuring the cross sections

- **beam characteristics key factors:**
  - the beam energy - limited by the RF-separation techniques
  - the beam intensity - limited by the radiation protection requirements
  - the beam purity - limited by the RF-separation techniques together with the beam identification (with CEDARS)

Drell-Yan energy dependence



The cross-section increases with the beam energy

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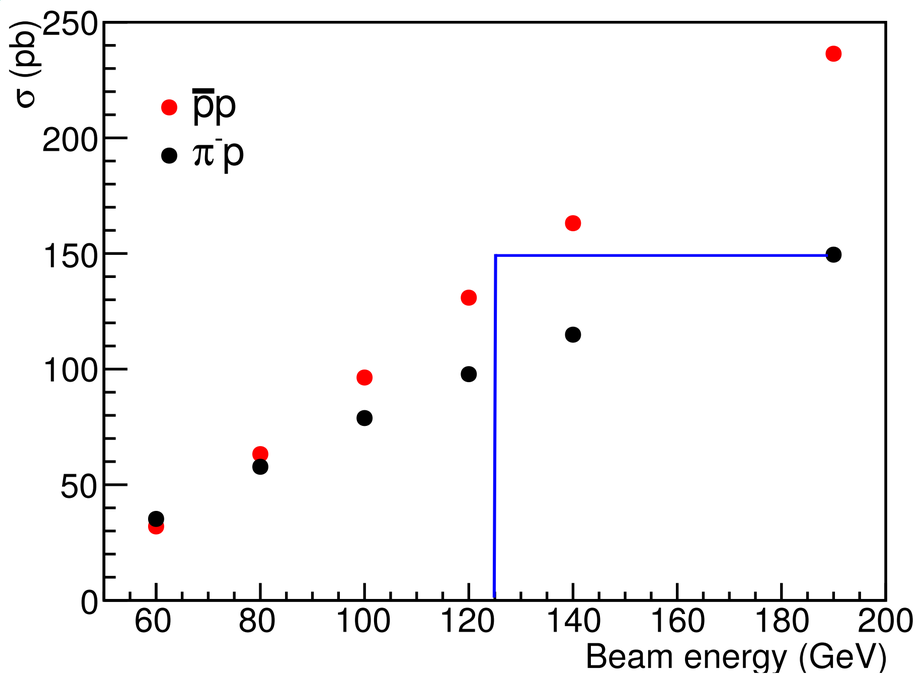

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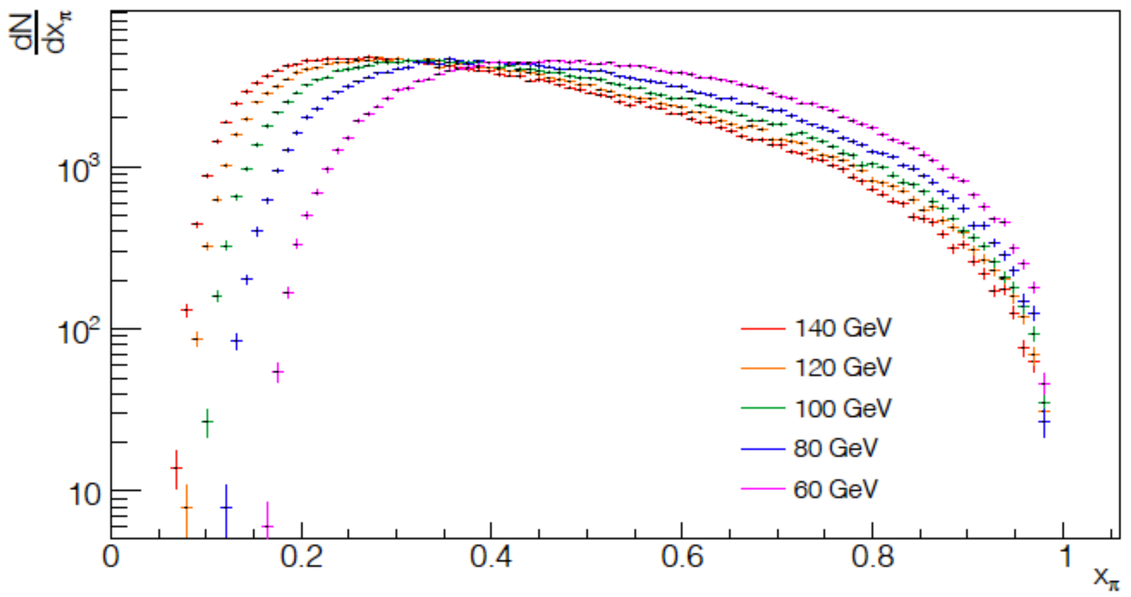

Access to the low-x region requires beam energy as high as possible

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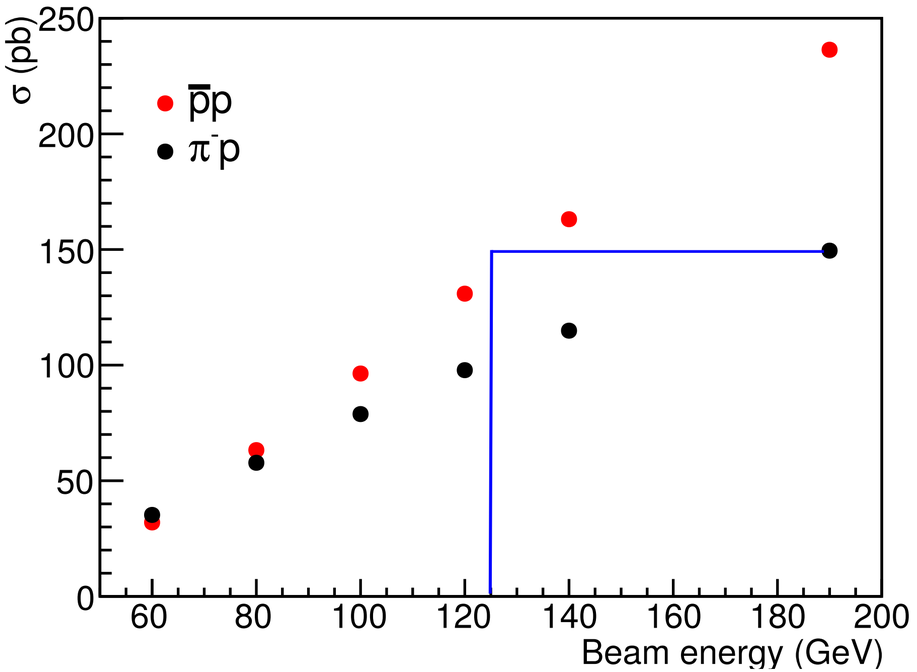

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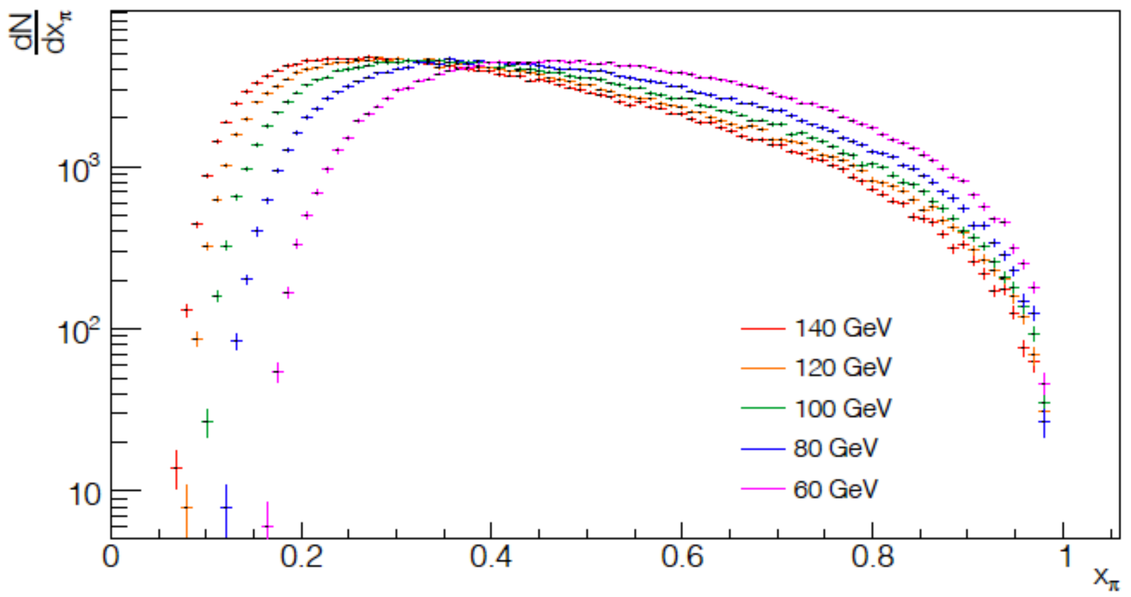

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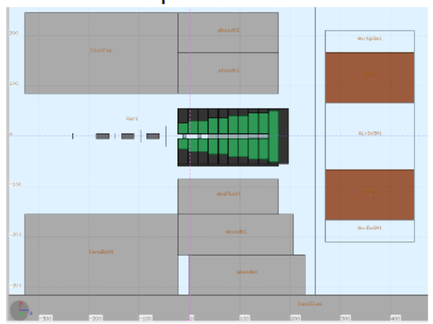
Main players to constrain the statistical uncertainty: beam energy and beam intensity

Beam intensity limitations

- studies on the target region shielding suggest the possibility to <u>increase the intensity</u>

Dose equivalent inside AMBER hall - with closed bunker

Open bunker



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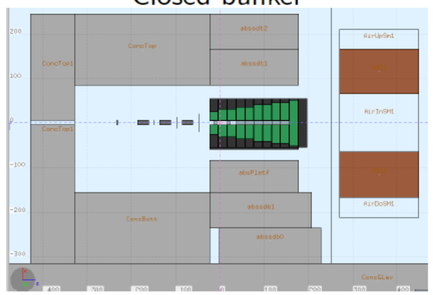

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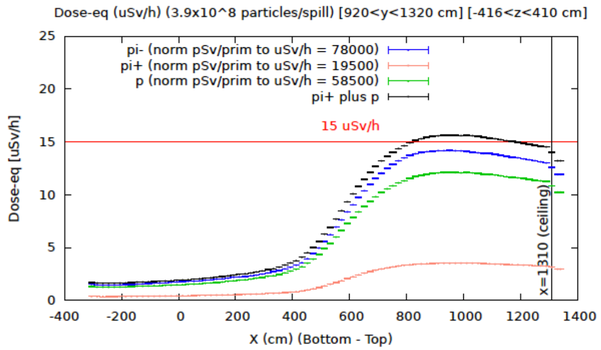

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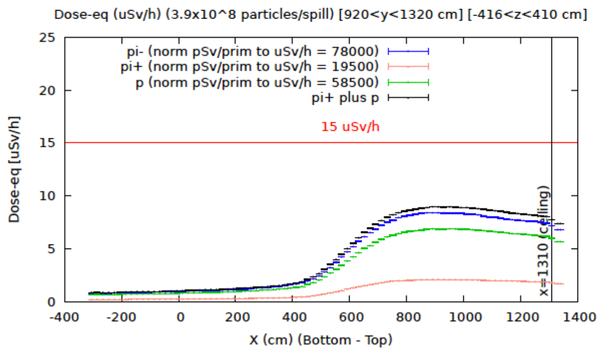

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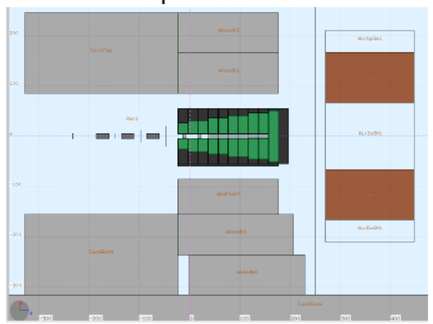

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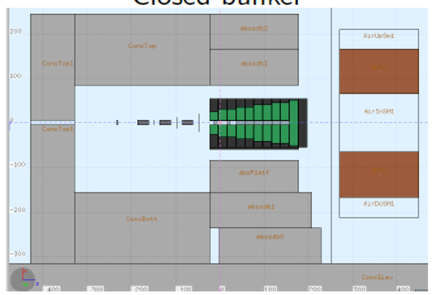

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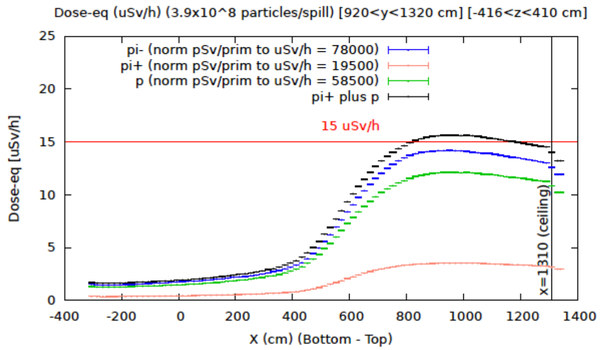

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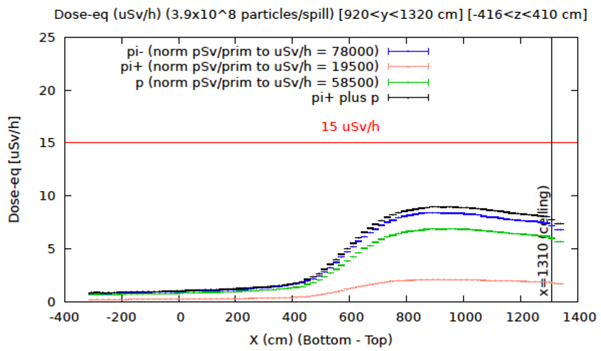

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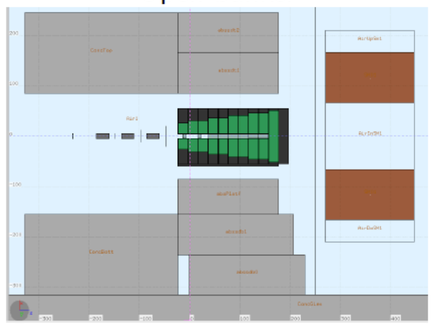

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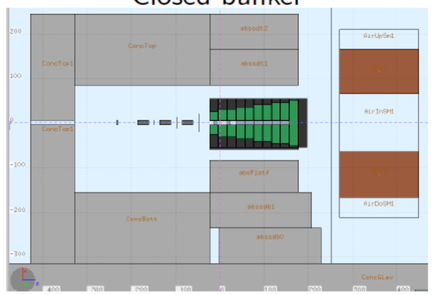

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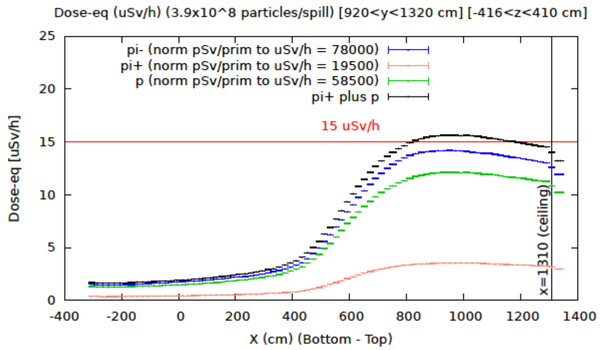

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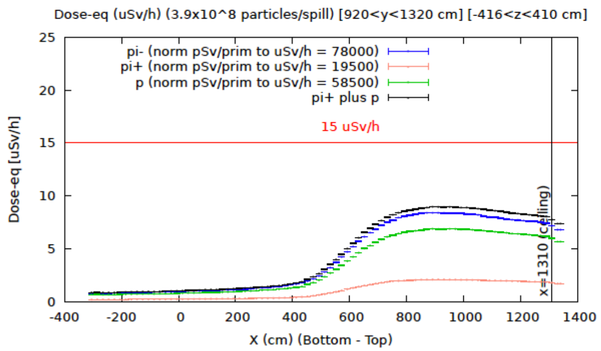

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Beam purity

- directly related with the intensity
- Is a % of the beam that is made of kaons
- Beam particle identification is crucial (with CEDARs)
- the possibility to measure pion and proton induced Drell-Yan and J/psi in parallel with kaons is very useful for comparisons

Drell-Yan geometrical acceptance

- the **beam energy** affects the lepton pairs **geometrical acceptance**
  - to keep a similar geometric acceptance of about 40% as for AMBER Phase-I the **spectrometer has to be compressed**

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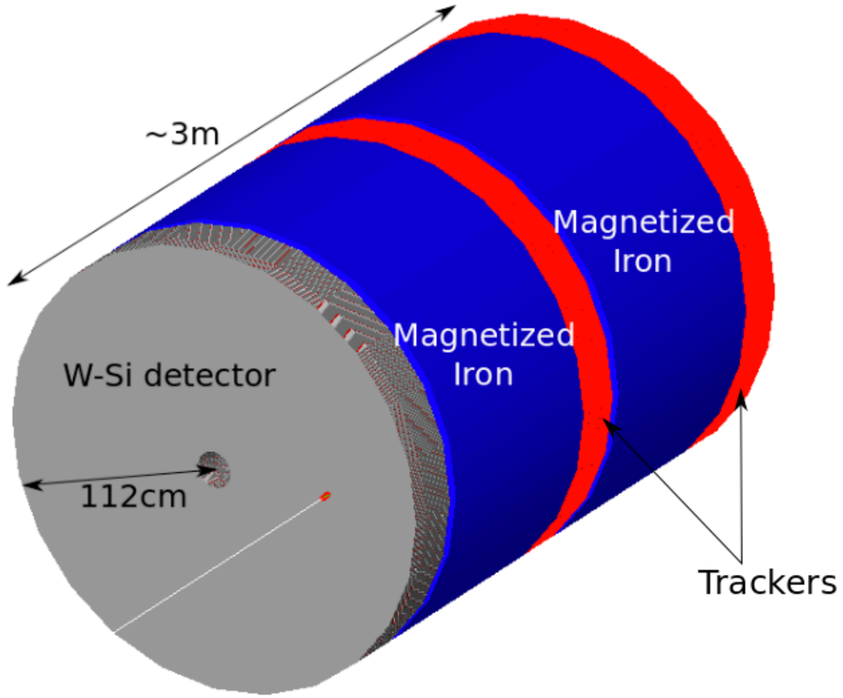

- a possibility is to consider an active absorber (magnetised iron detector)
- possibility to use electron pairs in addition to the muons
- dedicated R&D is needed

Beam assumptions

- primary intensity $7 \times 10^7\ particles/s$
- kaon purity 30% for both charges
- 2 years data taking (140 days per year) and equal time sharing between the two beam charges
- 3 different energies are compared

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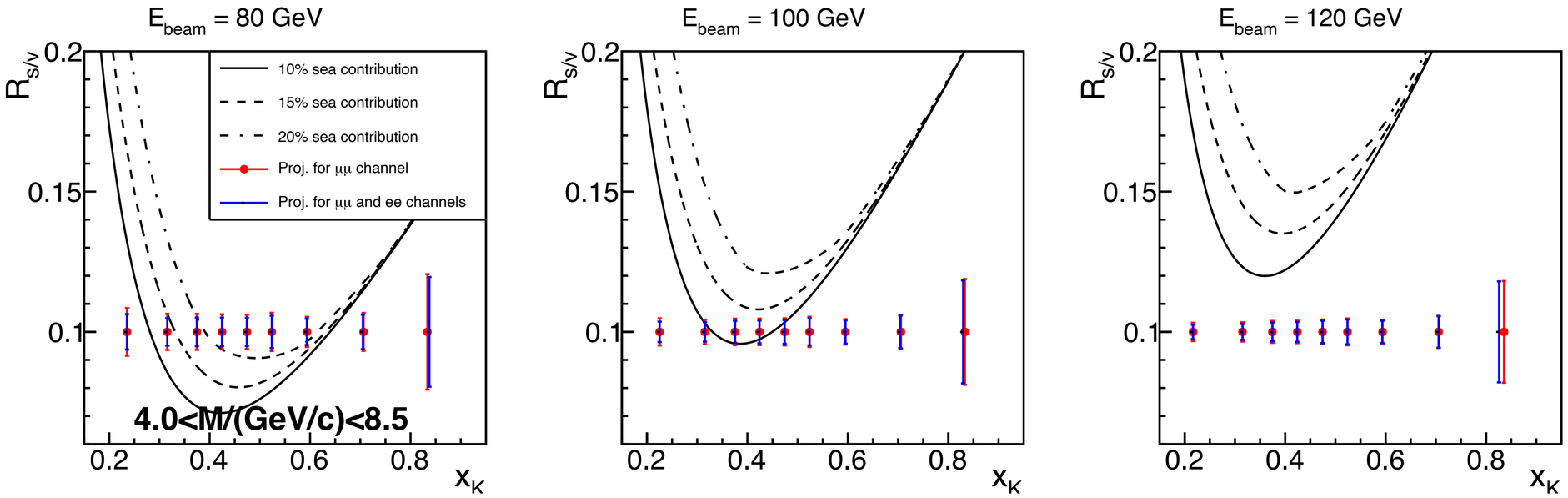
Overall Statistics

Experiment	Target type	Beam type	Beam intensity (part/sec)	Beam energy (GeV)	DY mass (GeV/c^2)	DY events $\mu^+\mu^-$	DY events e^+e^-
NA3	6 cm Pt	K^-		200	4.2 – 8.5	700	0
This exp.	100 cm C	K^-	2.1×10^7	80	4.0 – 8.5	25,000	13,700
				100	4.0 – 8.5	40,000	17,700
				120	4.0 – 8.5	54,000	20,700
		K^+	2.1×10^7	80	4.0 – 8.5	2,800	1,300
				100	4.0 – 8.5	5,200	2,000
				120	4.0 – 8.5	8,000	2,400
This exp.	100 cm C	π^-	4.8×10^7	80	4.0 – 8.5	65,500	29,700
				100	4.0 – 8.5	95,500	36,000
				120	4.0 – 8.5	123,600	39,800

Energy effect

$$R_{s/v} = \frac{\sigma^{K^+}}{\sigma^{K^-} - \sigma^{K^+}}$$



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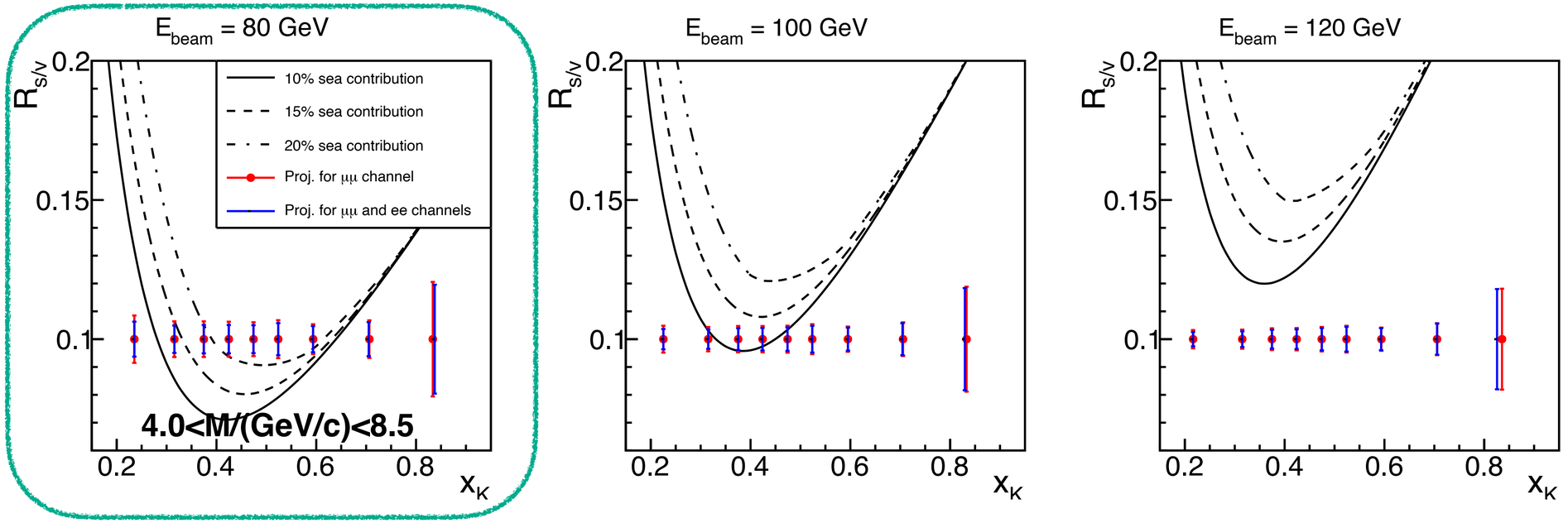
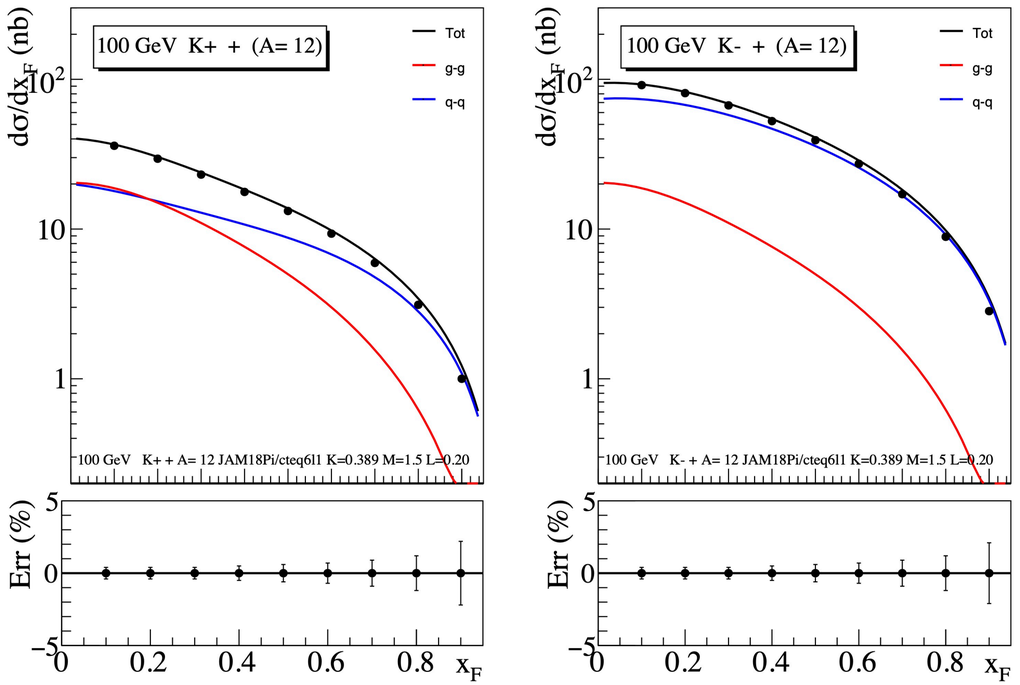
lowest energy limit to not compromise the relevance of the results

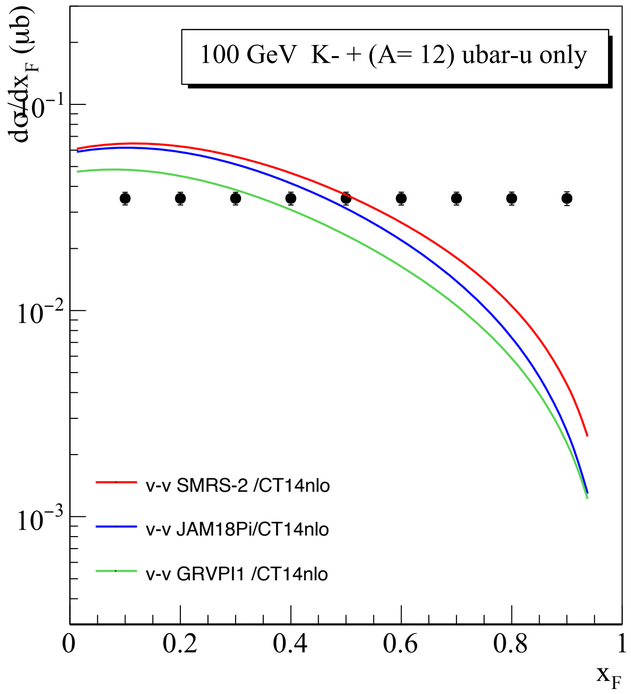


~10% uncertainty

J/psi measurement

- more than 300k events for each kaon charge are expected - **safe for statistics**





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  - relevant beam characteristics
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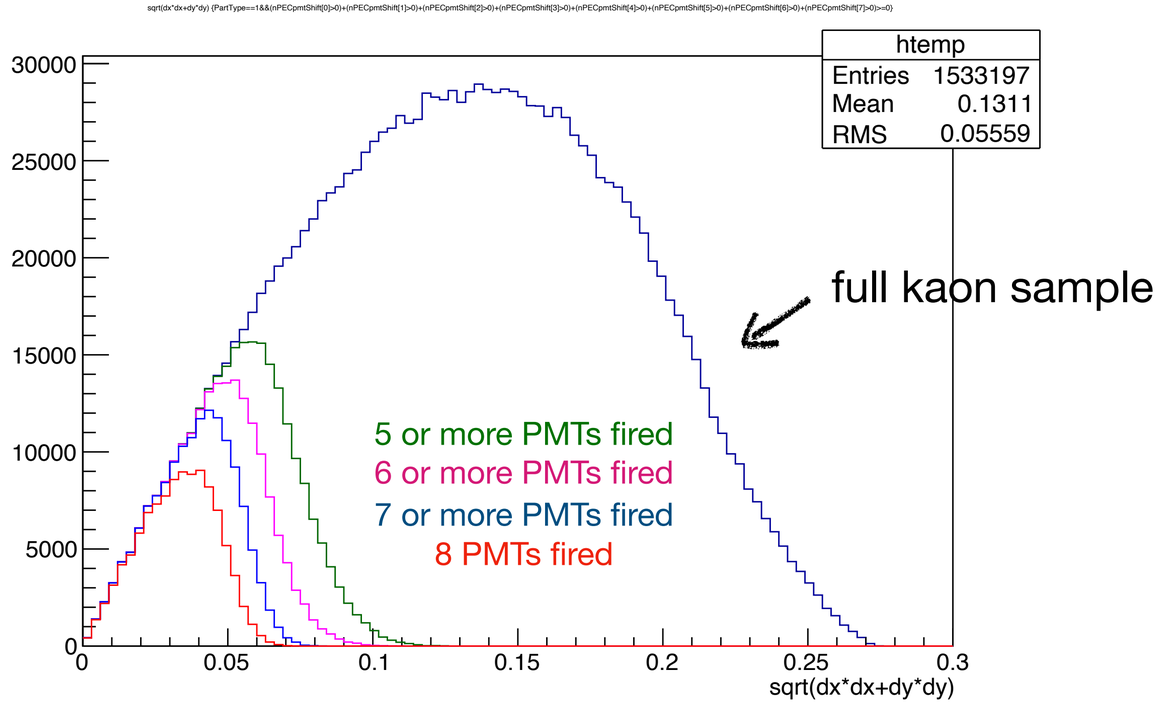
Studies are being preformed to determine the minimal requirements

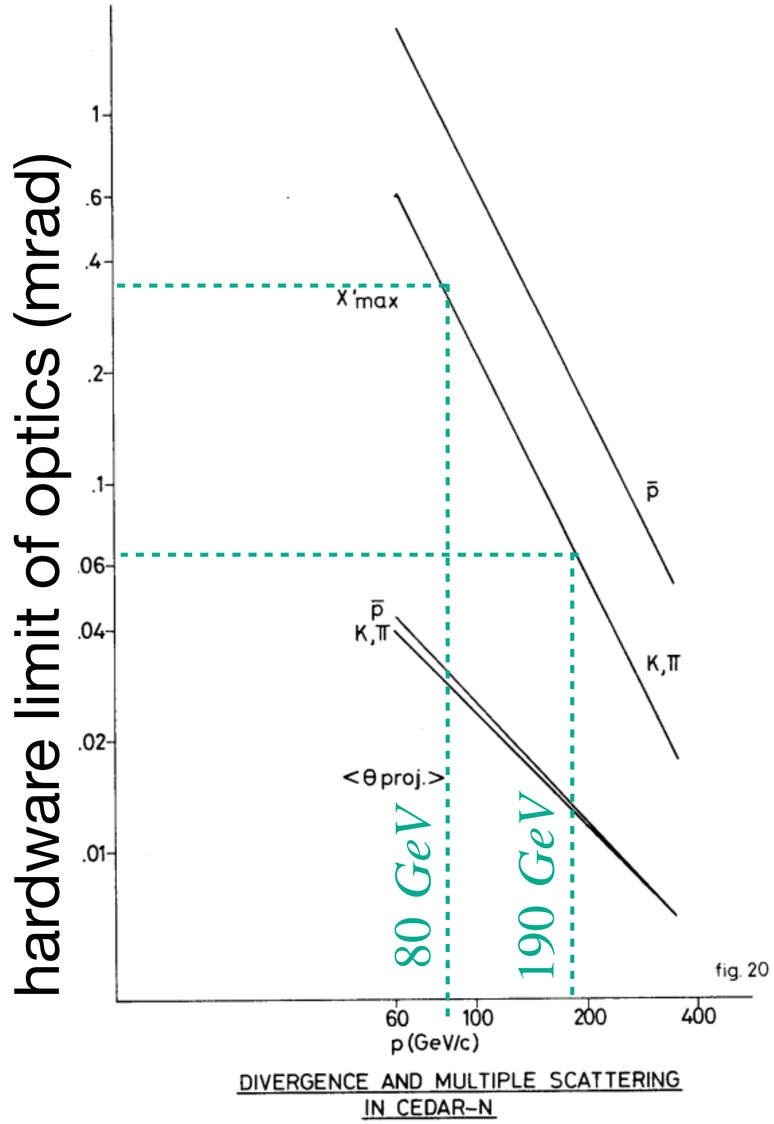
Beam divergence

Monte-Carlo simulation of the beam angle at the CEDAR position (considering similar conditions to 2018 COMPASS Drell-Yan run, 190 GeV pion beam and a divergergence of RMS of dx/dz * RMS of dy/dz = 0.11*0.09 mrad)



The majority of the kaons is out of the CEDARs acceptance

More studies are ongoing



Smaller impact for lower energies, but still a parallel beam is very important

Summary

- The feasibility of the Drell-Yan measurement with kaon beams is constrained by:
  - The **beam energy** - minimal requisite 80 GeV
  - The **beam intensity** - minimal requisite $7 \times 10^7\ particles/s$
  - The **beam purity** - minimal requisite 30%
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Thank you for your attention