Exploring the Fast Evolution of QGP

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Laboratório de Instrumentação e Física de Partículas

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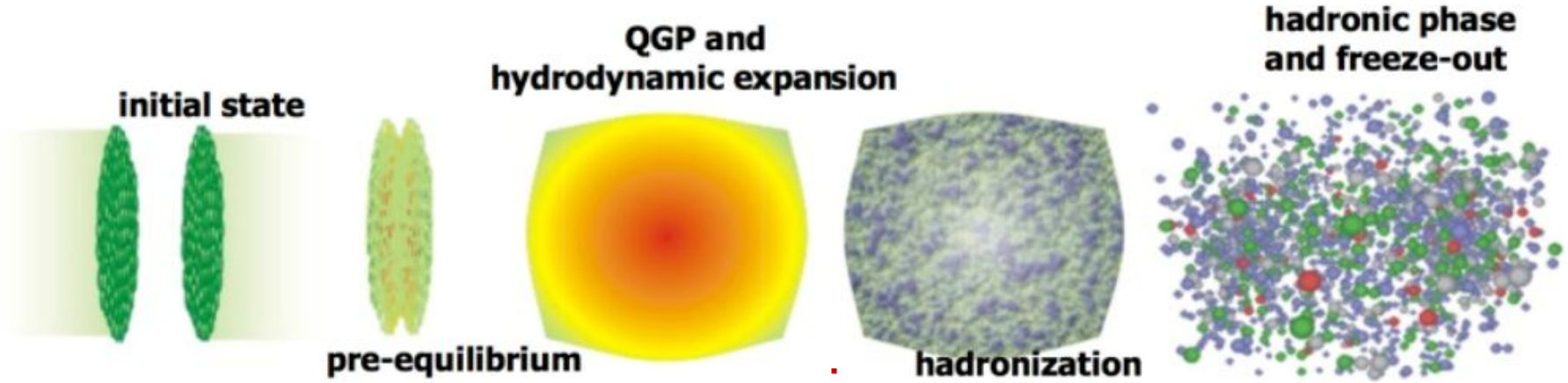
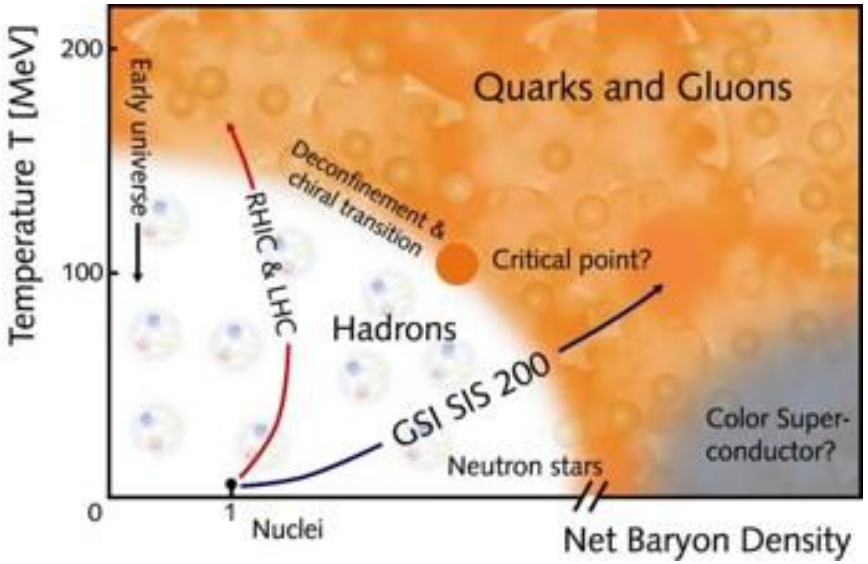
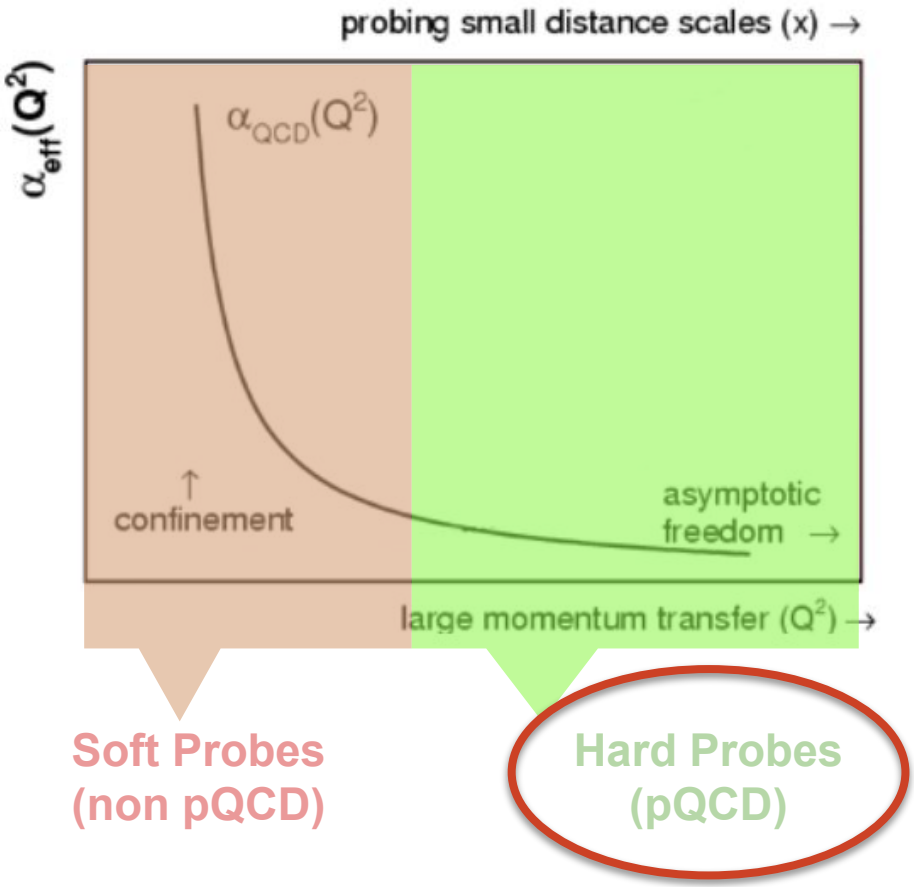
Introduction - Quark Gluon Plasma (QGP)





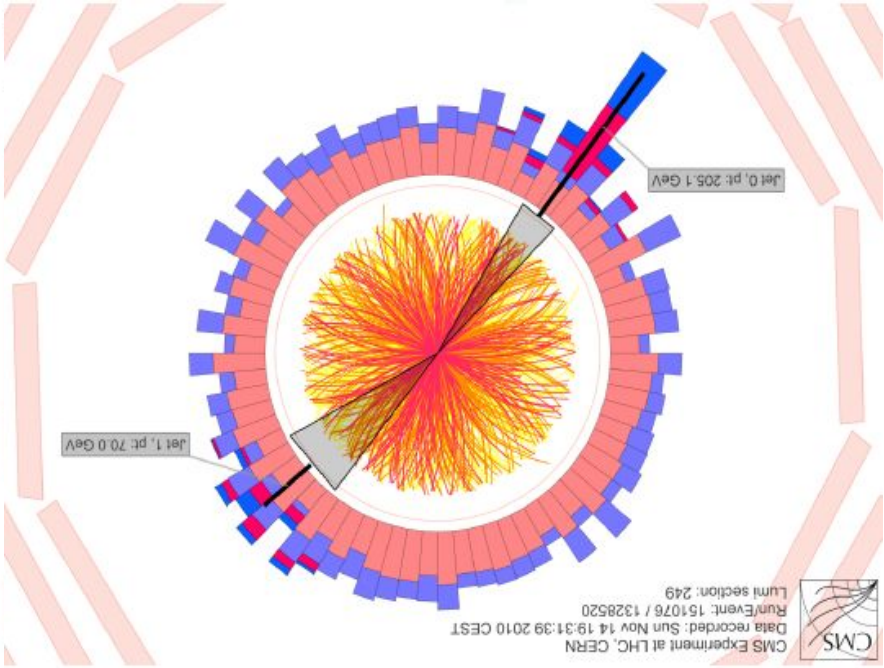
Fast evolving medium

Introduction - Hard Probes and Jets

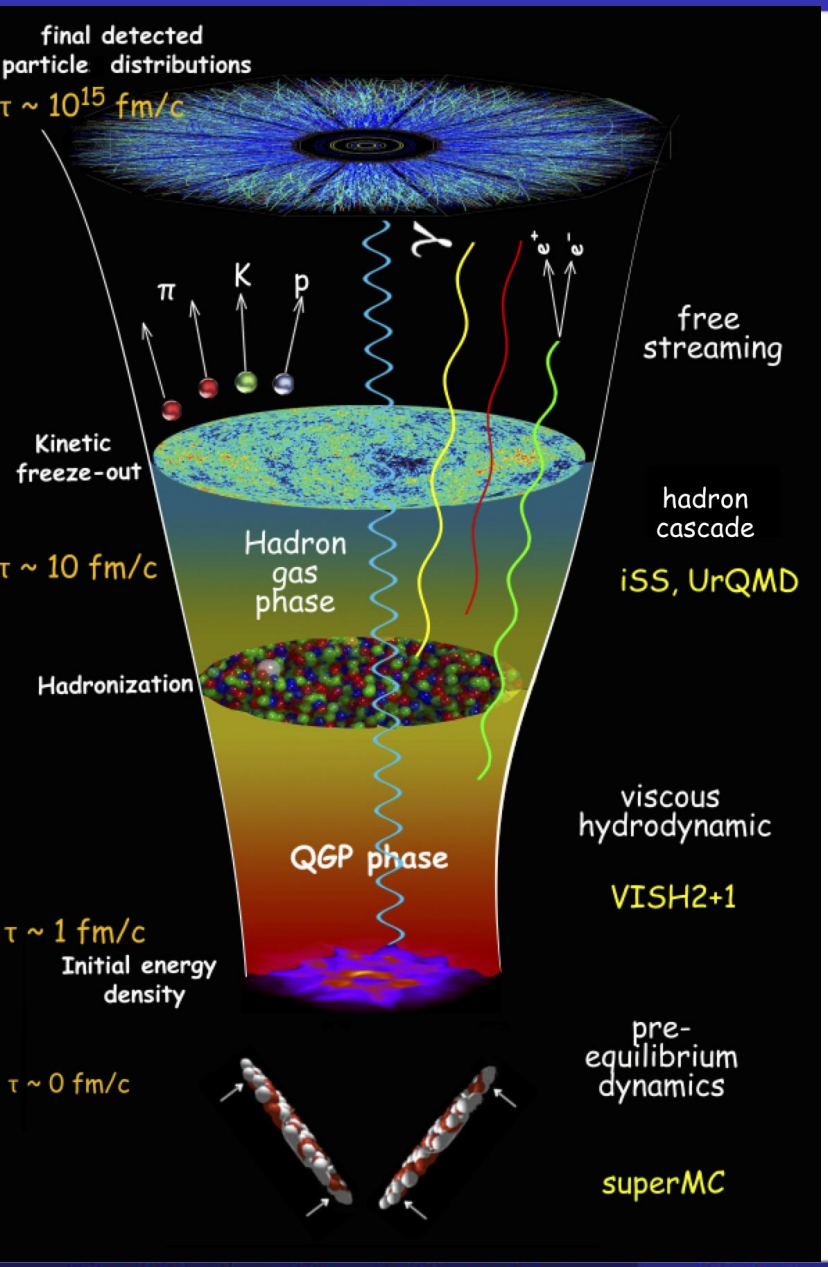


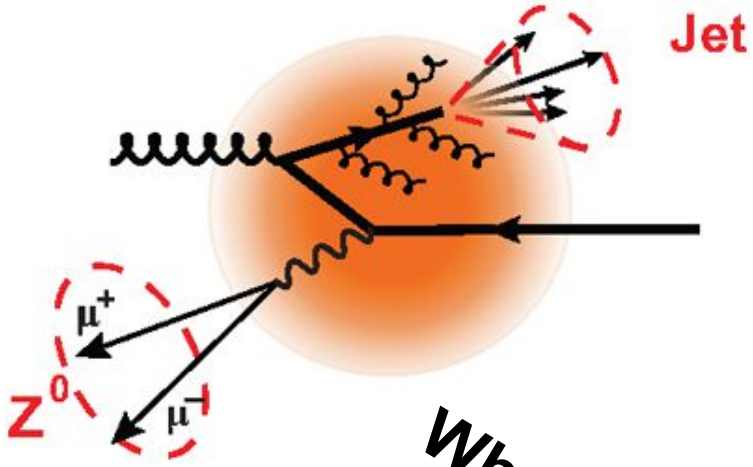
- Some jets can be thermalized by the medium! This is a clear indication of the **presence of QGP**

PbPb collision *pp collision*



Our Goal





How does it evolve?

What happens at the very beginning?

What is the "right" observable?

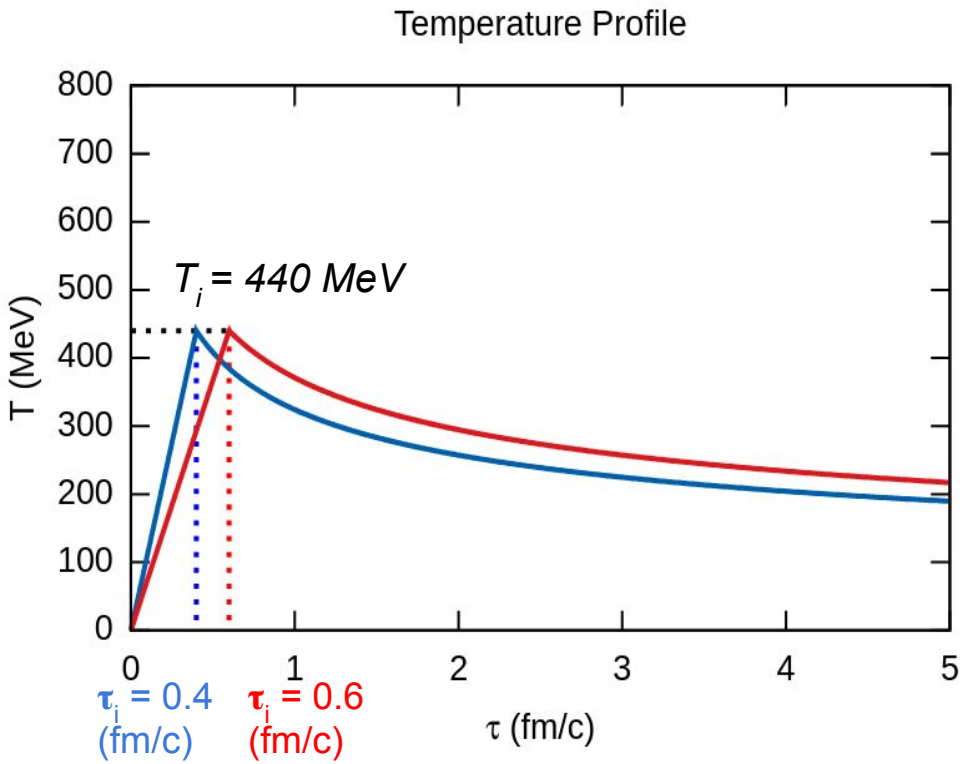
Tools

Monte Carlo event generator: JEWEL 2.2.0 (pp + jet quenching)

- pp collision + effects of QGP propagation
  - QGP model: Bjorken expansion

$$T = \begin{cases} T_i \dfrac{\tau}{\tau_i} & \tau < \tau_i \\ T_i \left(\dfrac{\tau_i}{\tau}\right)^{1/3} & \tau \geq \tau_i \end{cases}$$

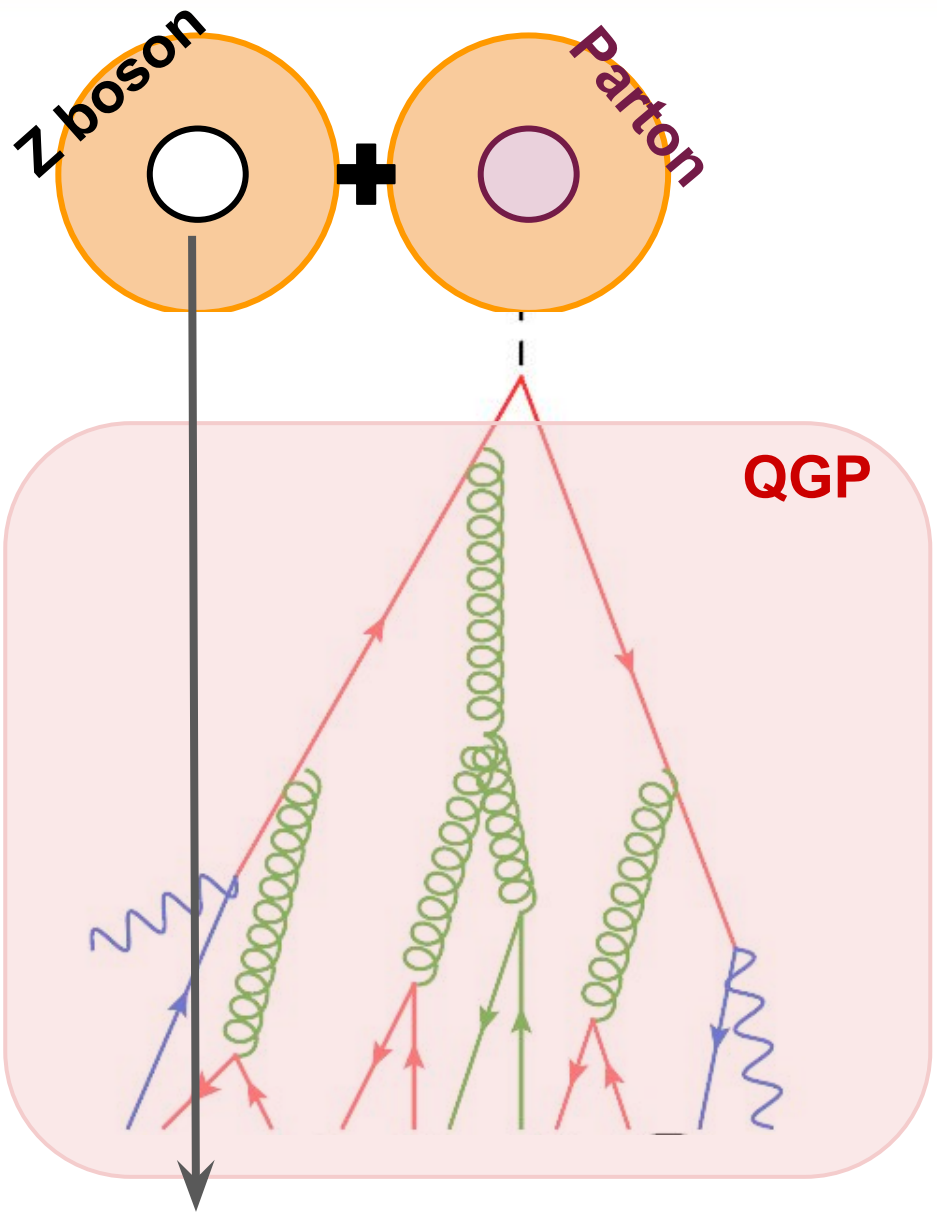
Input parameters:
- Initial temperature (T_i)
- Initial time ($\boldsymbol{\tau}_i$)



Analysis - Jet Setup

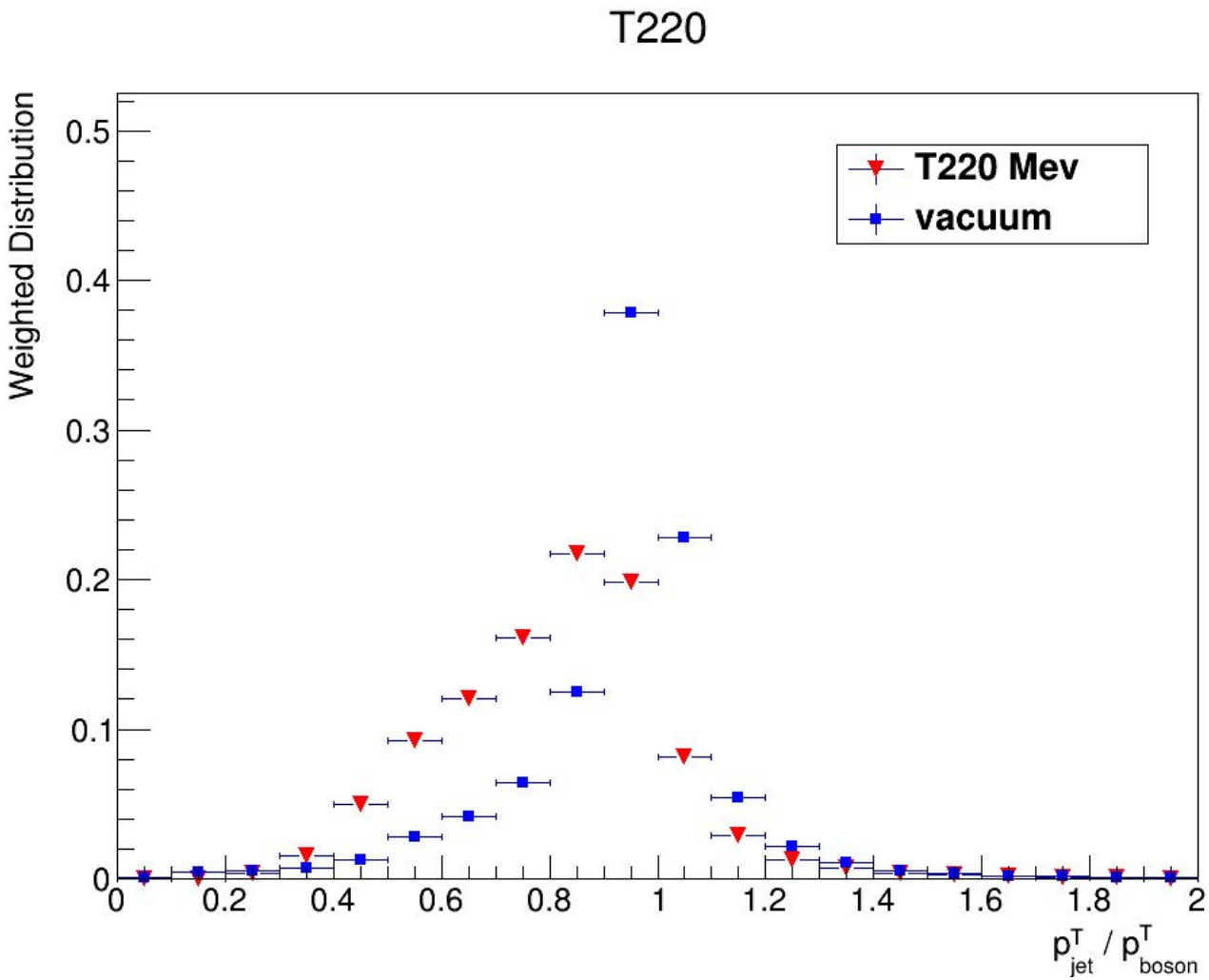
- Z boson is a **colourless** particle, therefore won't interact with the QGP, carrying the information of the **initial jet pt**!

$$X_J = p^T_{Jet} / \ p^T_{Boson}$$



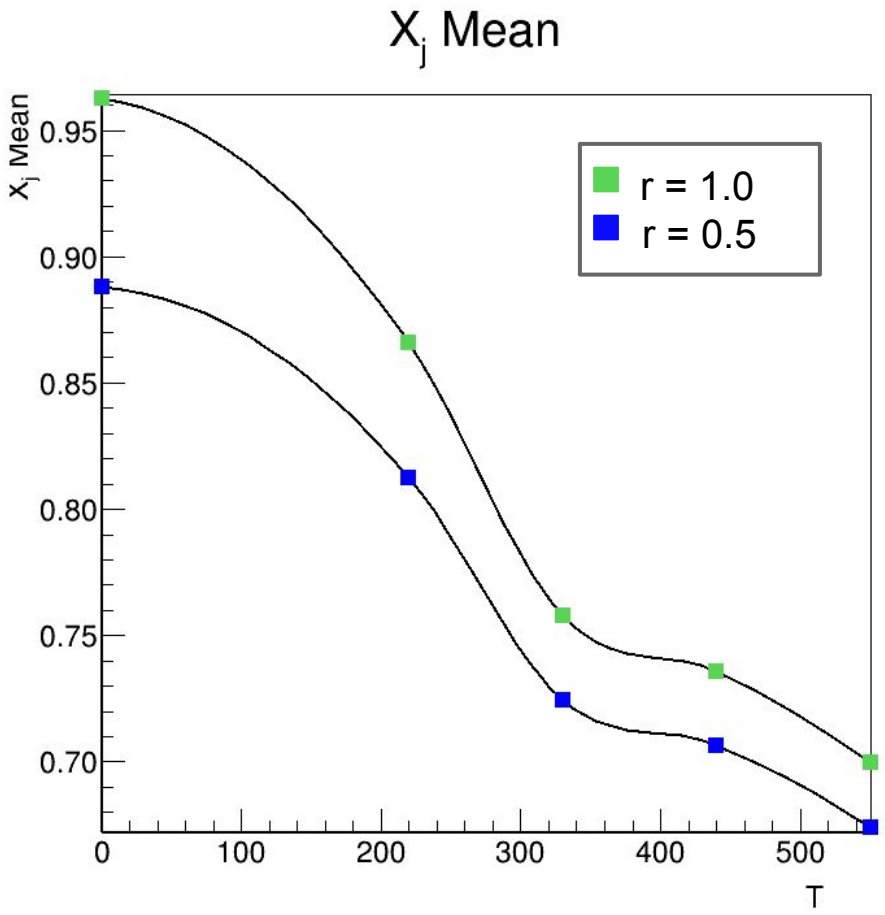
Results - Xj - Temperature

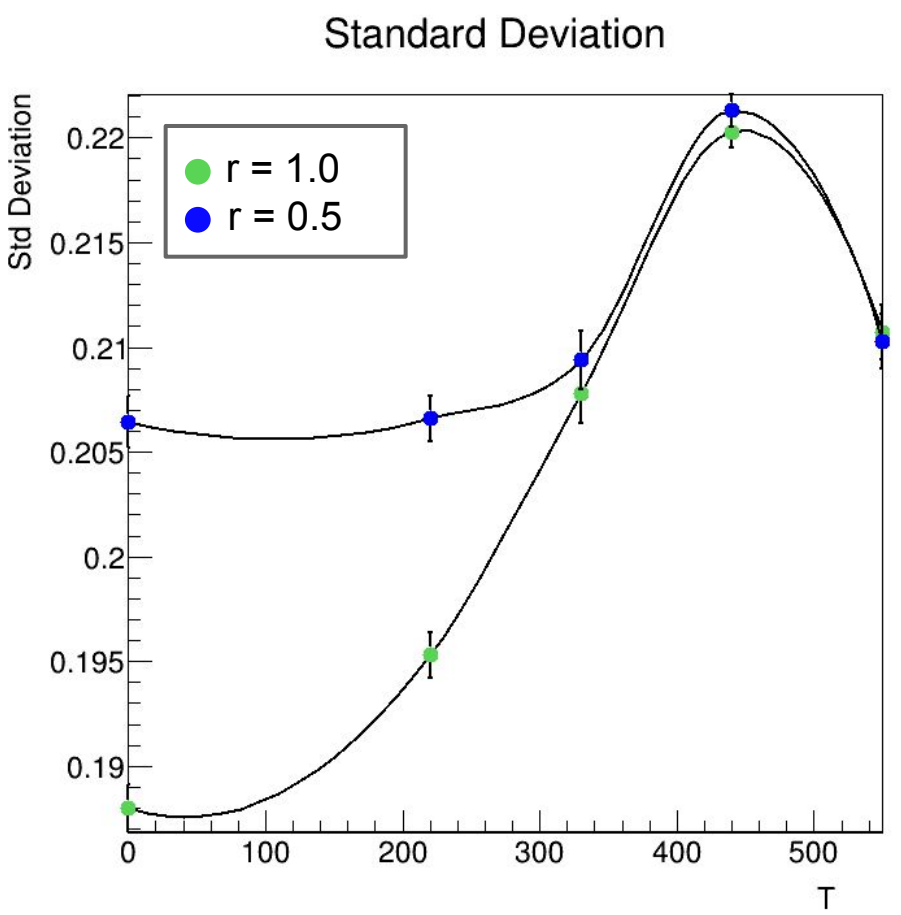
- **Decreasing average value of $X_J = p^T_{Jet} / p^T_{Boson}$ with the increase of the initial temperature**



Results - Xj - Temperature & Jet Radius

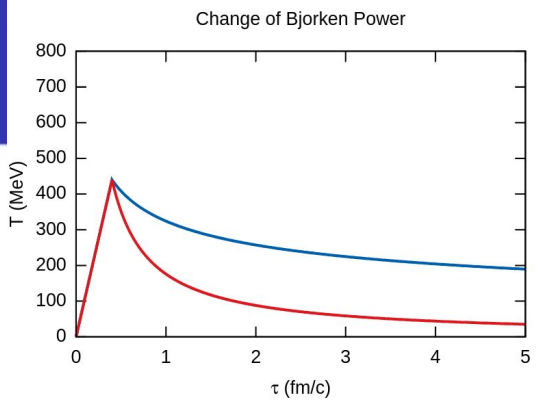
- **Consistent results for different jet radius!**

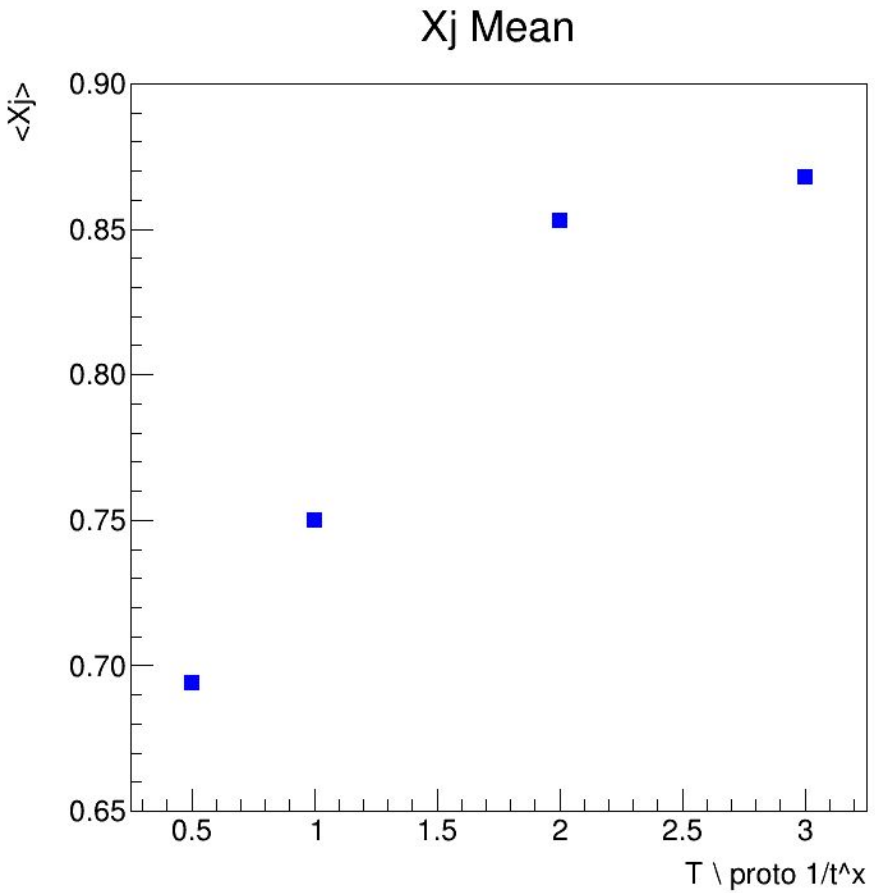


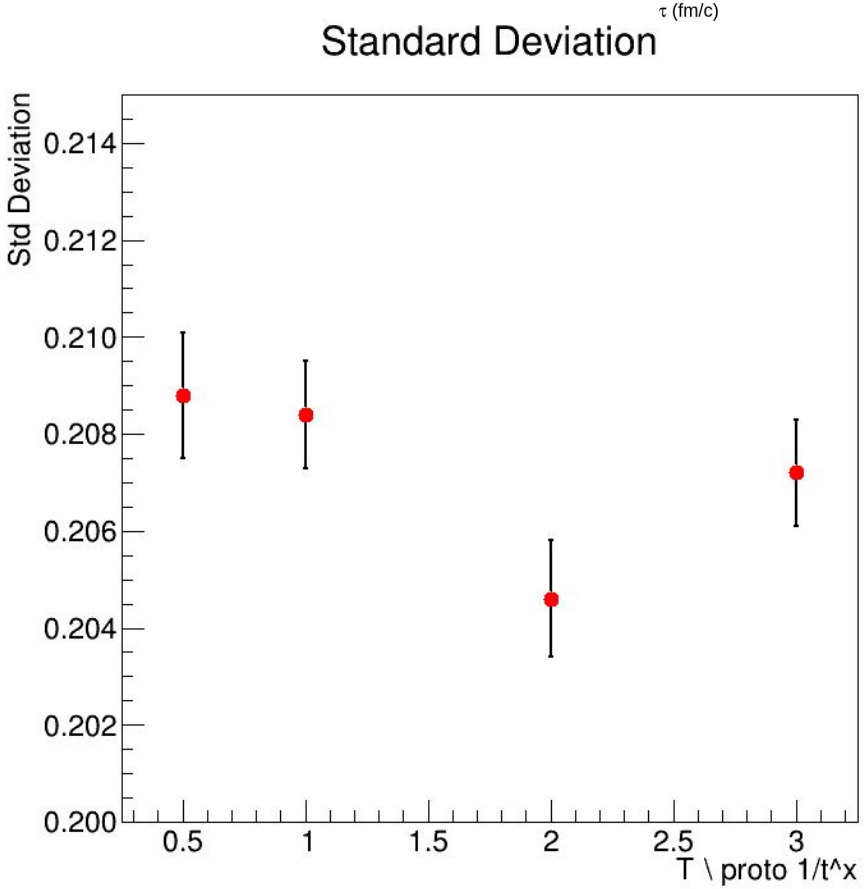


Results - Xj - Bjorken Power

- **Less energy loss for a faster decreasing temperature**

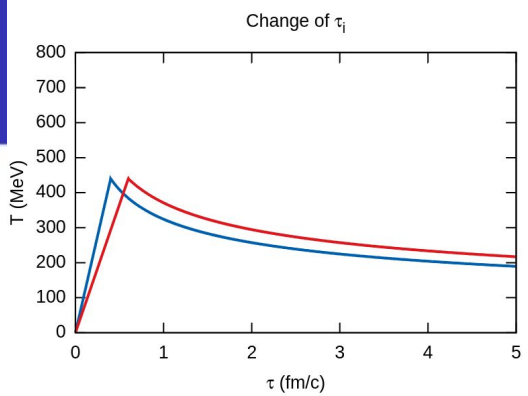


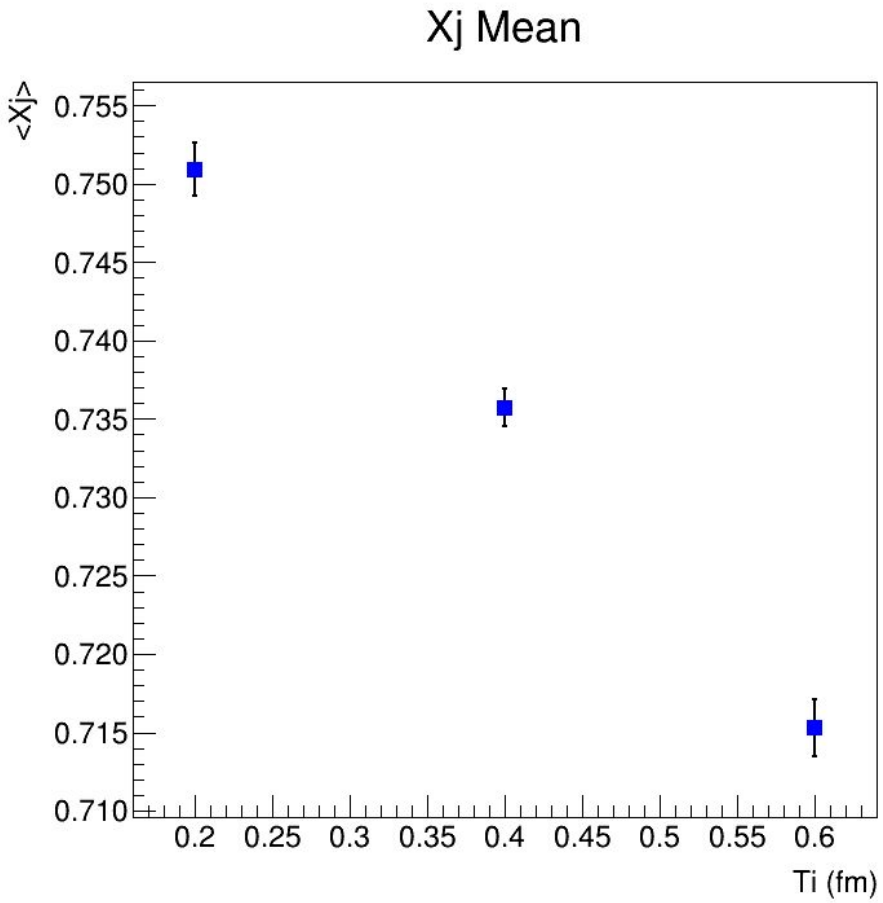


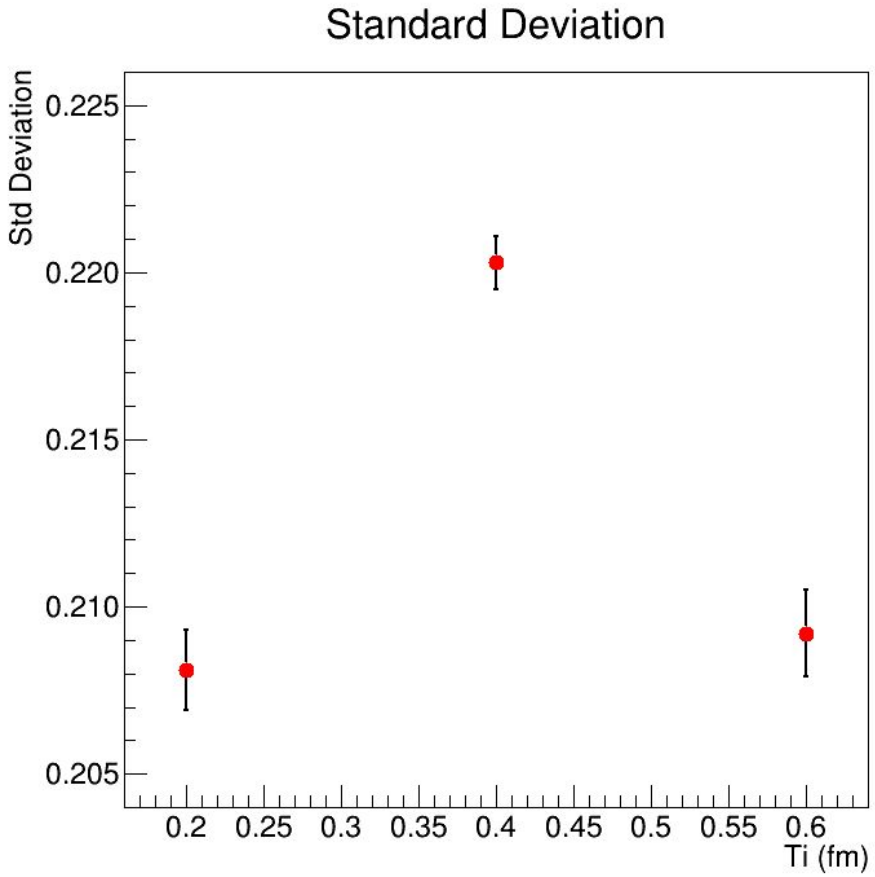


Results - Xj - Inicial Time

- **More energy loss for higher initial time values!**

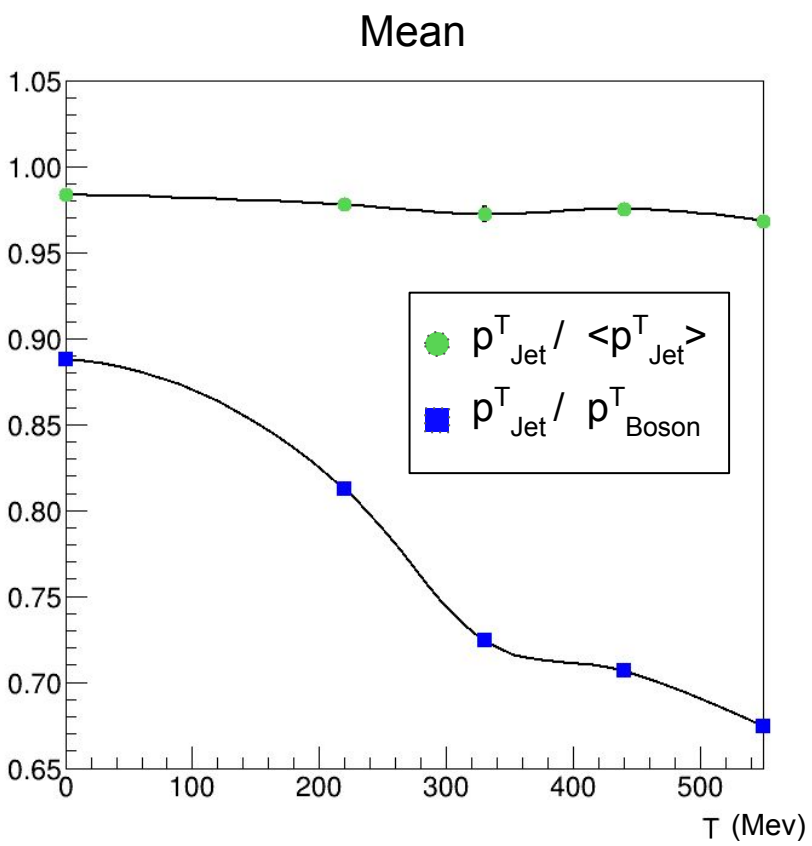


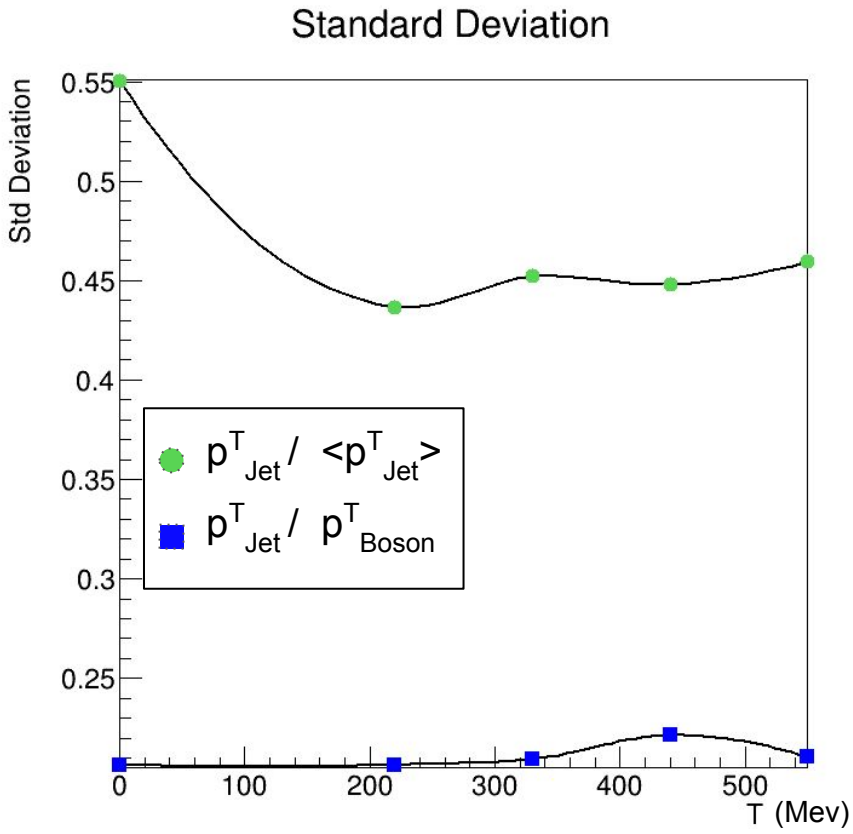




Results - pT_Jet / pT_Boson & pT_Jet / <pT_Jet>

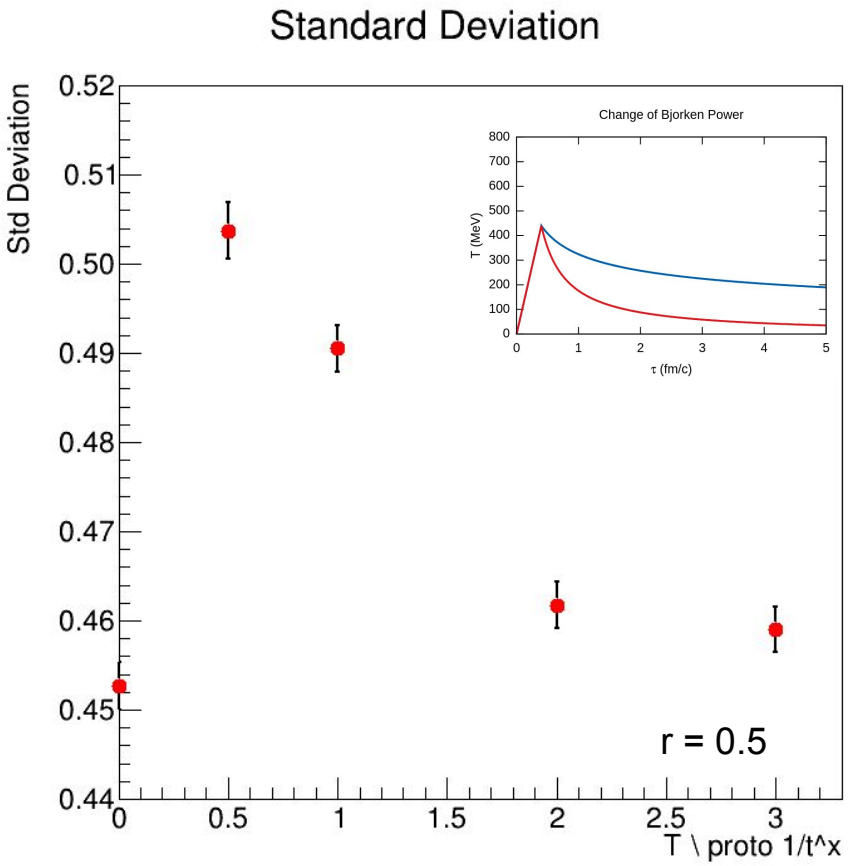
- $X_J = p^T_{Jet} / p^T_{Boson}$ and $p^T_{Jet} / \langle p^T_{Jet} \rangle$
- **More differences between pp and PbPb!**

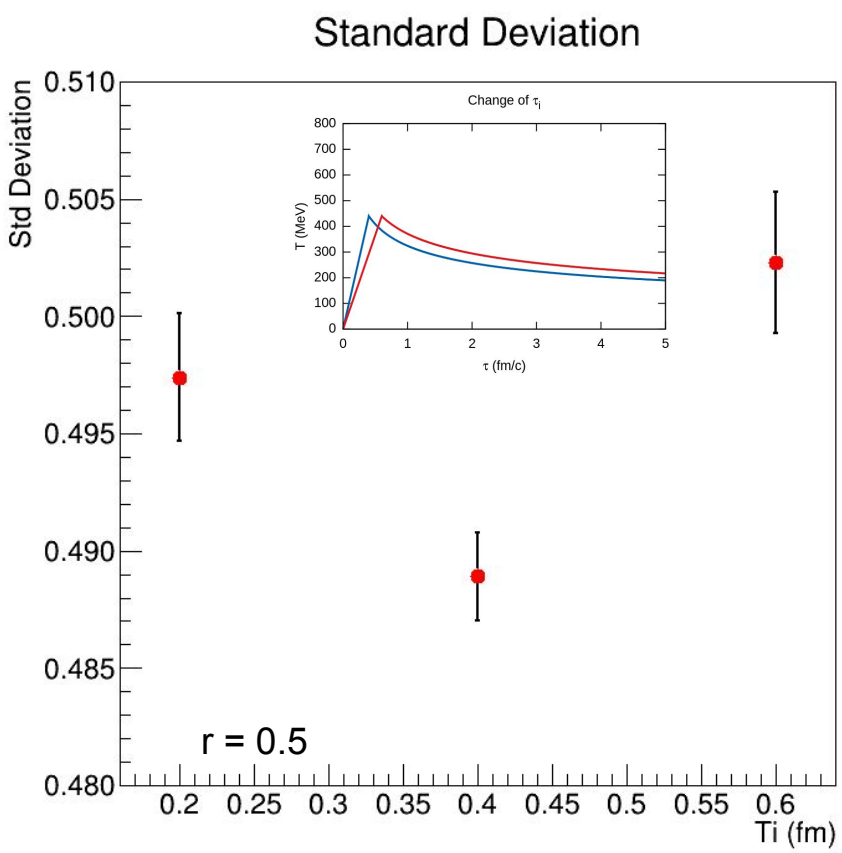




Results - pT_jet/<pT_jet> - Bjorken Power & Initial Time

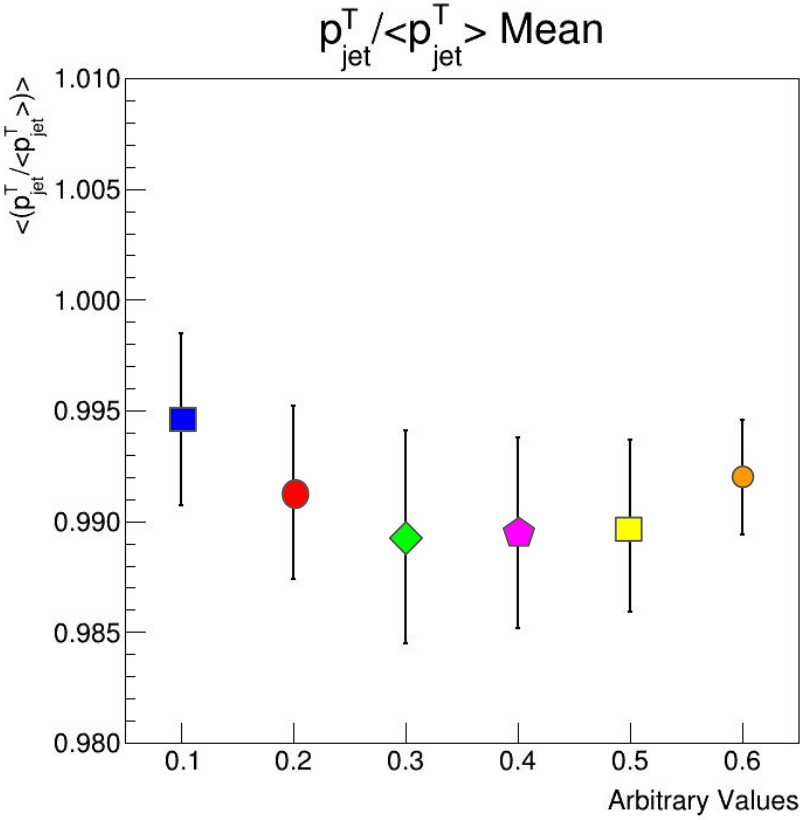
- **There is a difference of roughly 5% (QGP final shape)**
- **Fluctuations remains mostly unchanged, meaning it's not sensitive to initial time**

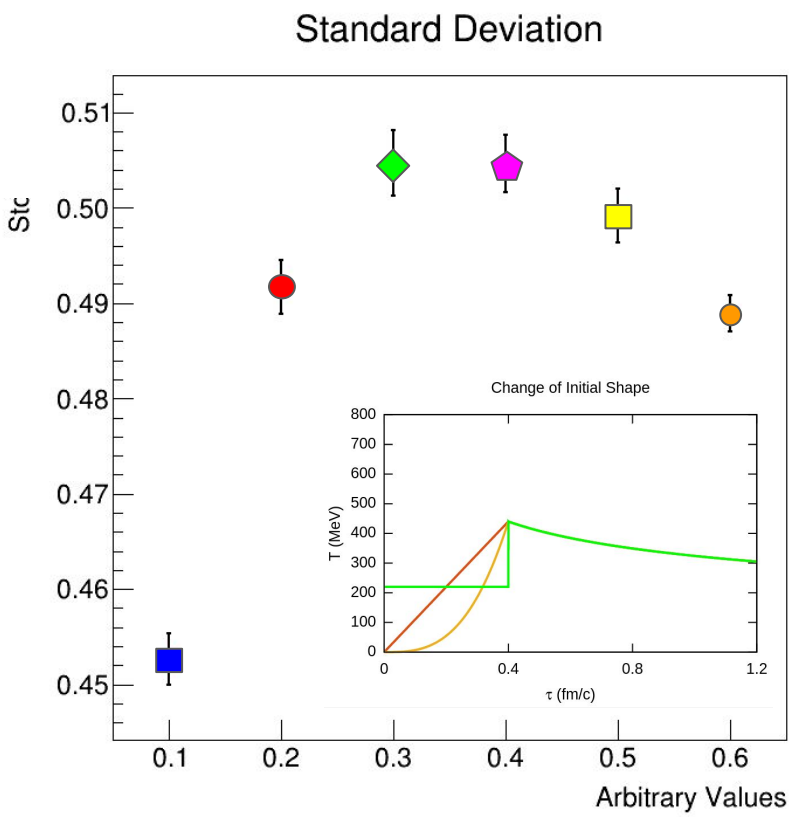




Results - pT_jet/<pT_jet> - Initial T profiles

- **There is a differentiation of ~13% between pp and PbPb and of ~5% between the shapes of PbPb**

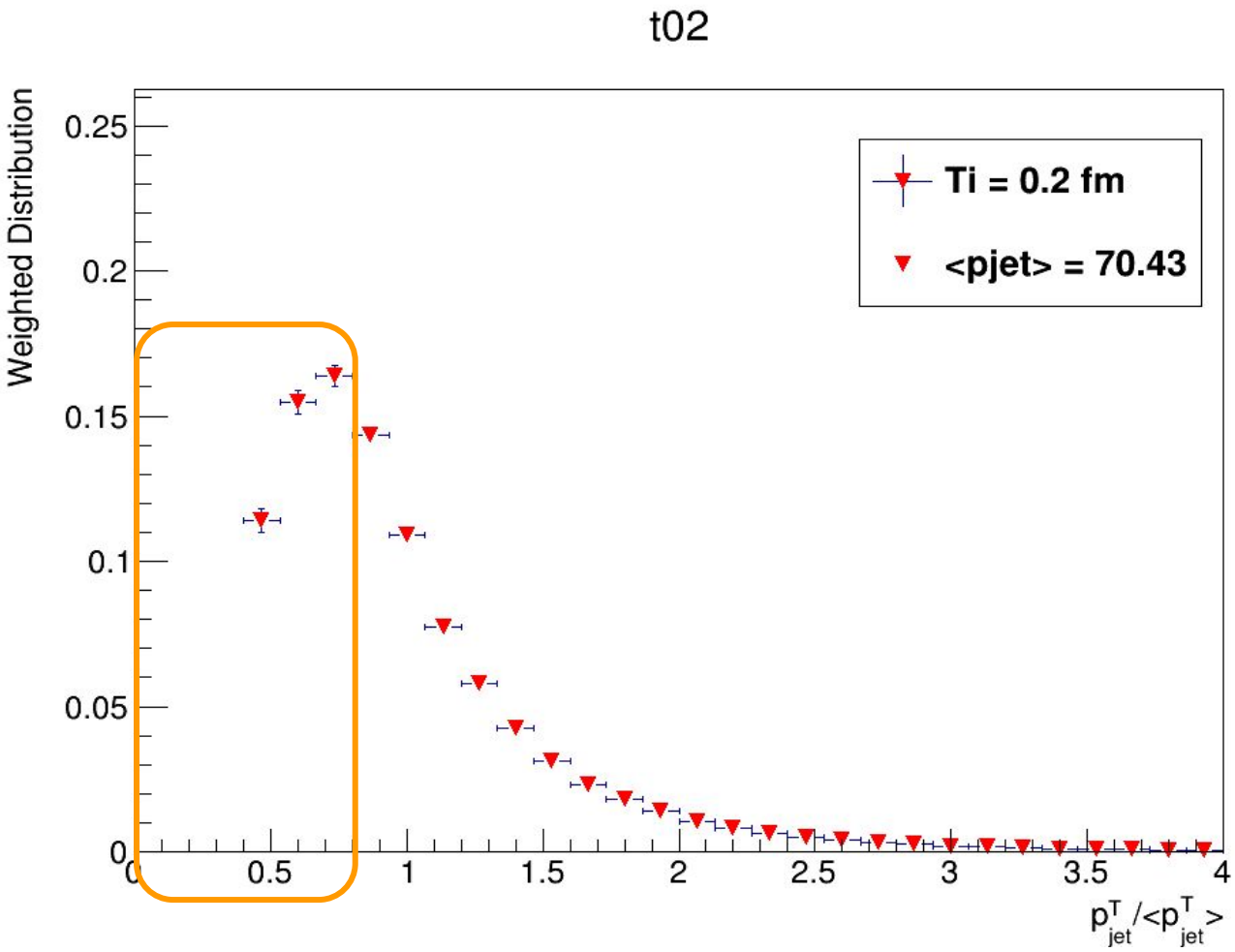




pp
T=Ti/3
T=Ti/2
T=Ti
T^3
linear

Results - pT_jet/<pT_jet> - T profiles & Initial Time

- **The right side of the distribution doesn't change, we should focus instead on the left. A new direction to explore!**



Conclusions

- There is a good differentiation between pp and PbPb collisions when the distribution is normalized by the mean value, that can be explored further using light-ions physics.

- There seems to be descrimination between shapes regarding the initial time and final stages.

More study is necessary!

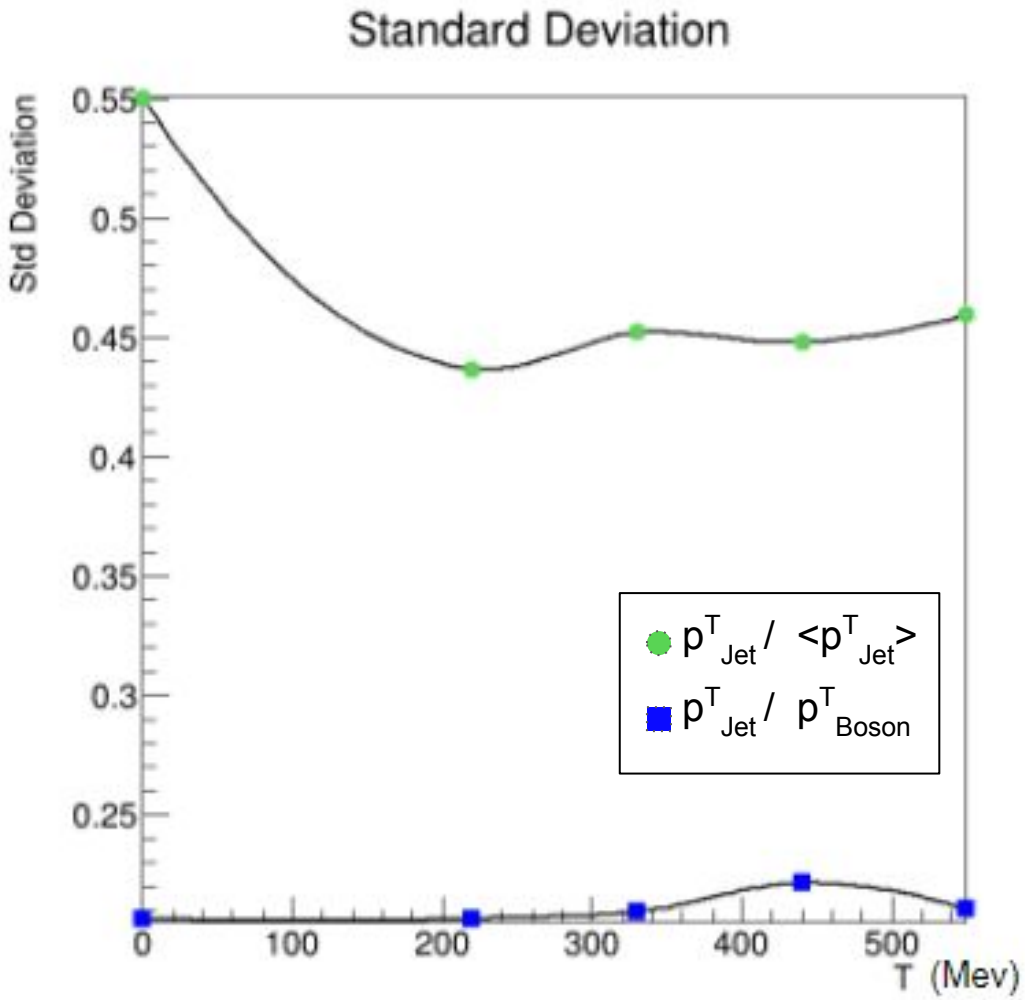
Questions?

Bibliography

- L. Apolinário, “Energy loss of fast partons in a colored medium” (2013)
- The CMS Collaboration, “Study of jet quenching with Z+jet correlations in PbPb and pp collisions at sNN = 5.02 TeV” (2017)
- L. Cazon, R. Conceição, M. A. Martins, F. Riehn, “Measuring the energy spectrum of neutral pions in ultra high energy proton air interactions” (2020)

Extra Slides

Results - Std pT_Jet / <pT_Jet>

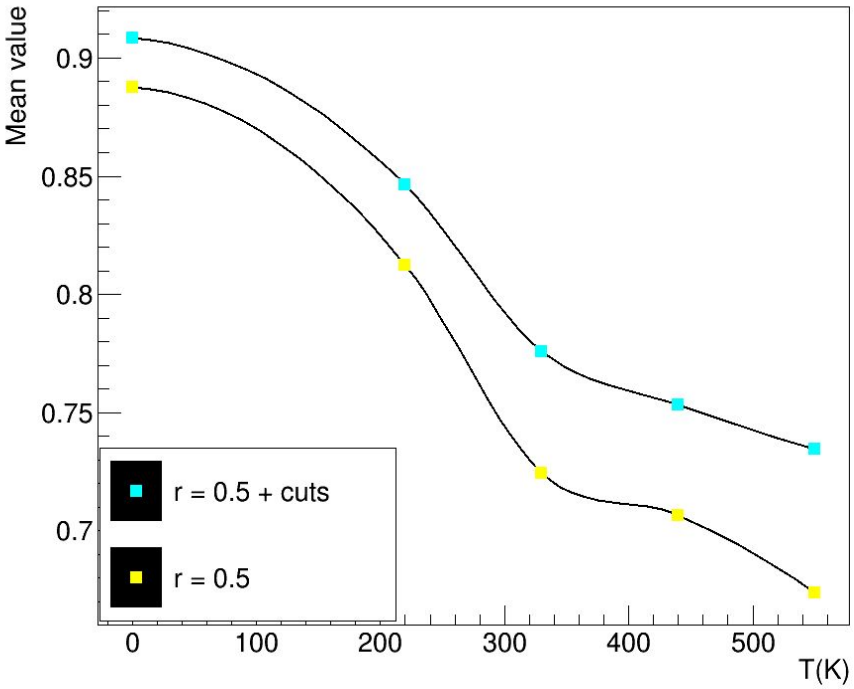


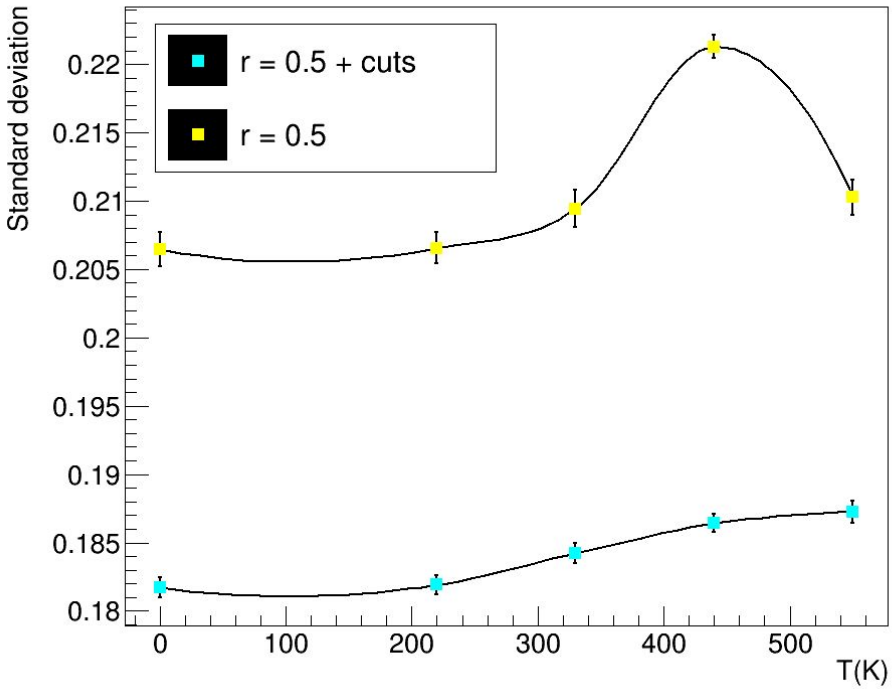
Results - Xj - with Cuts in pt

- Comparison of Xj original distribution (pt_boson > 60, pt_jet > 30) with the same when applied the following cuts:

pt_boson>80 and pt_jet>50

- There is only a small correction.



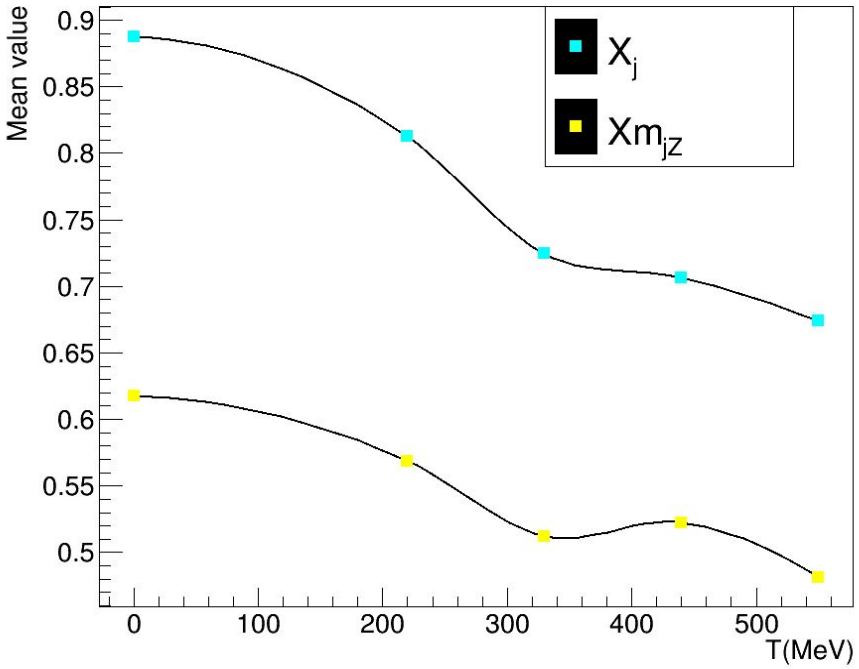


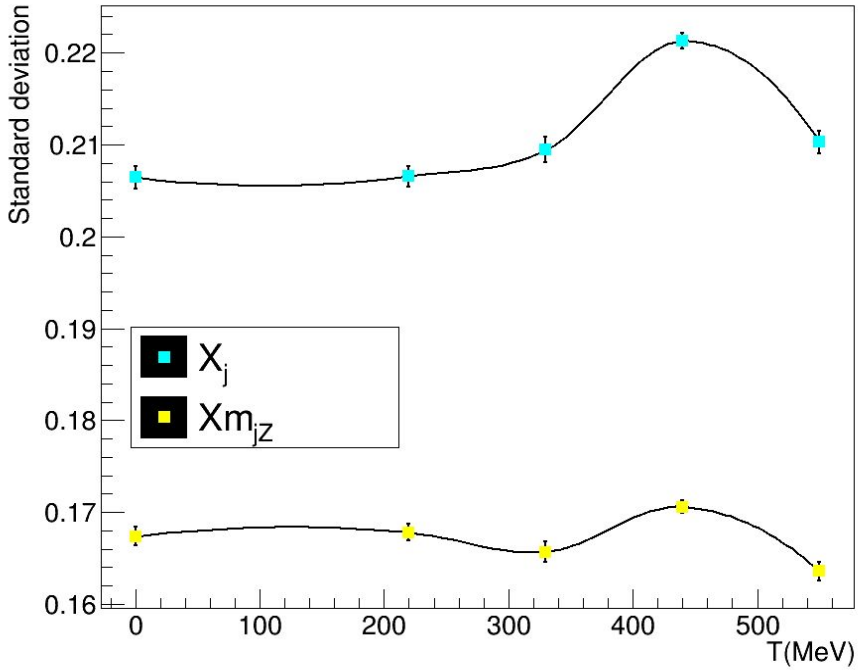
Results - Xm_{JZ}

- $\mathbf{Xm_{JZ} = m^{T}_{Jet} / m^{T}_{Boson}}$

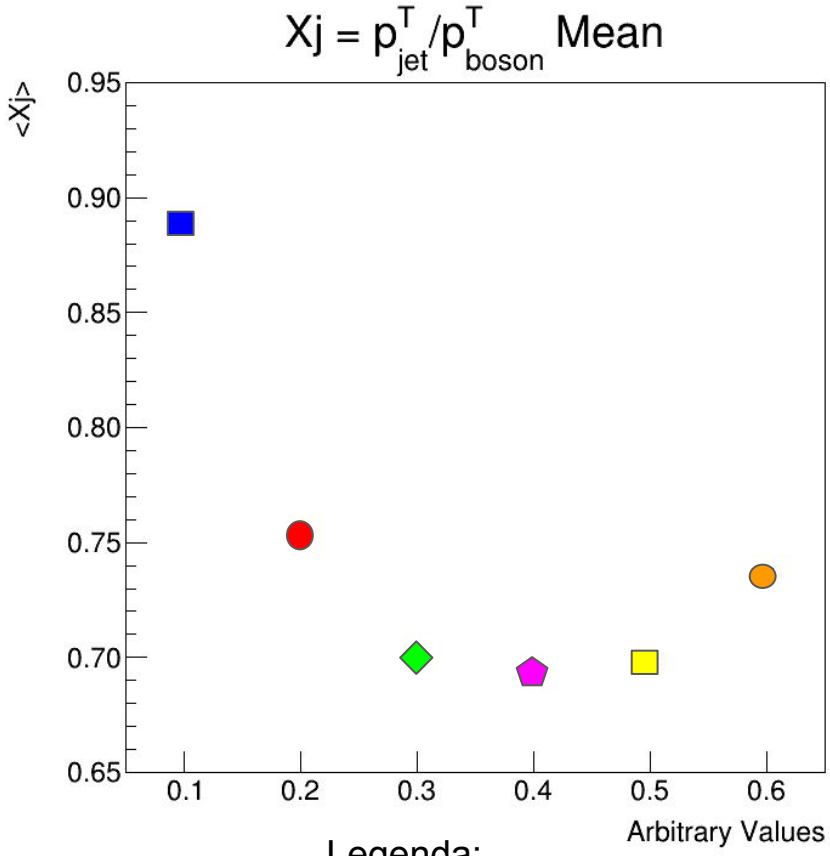
$$m^{T} = \sqrt{p^{T2} + m^{2}}$$

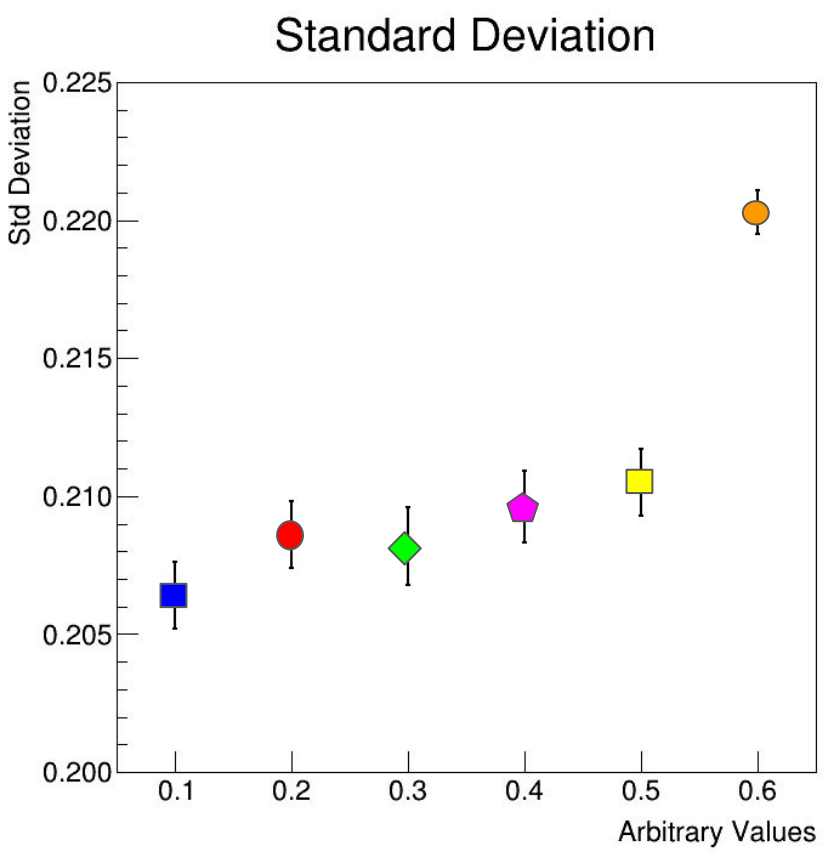
- There is only a small correction.





Results - Xj - T profiles & Initial Time





Legenda:

- pp
- T=Ti/3
- T=Ti/2
- Ti=T
- T^3
- linear