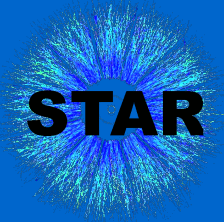
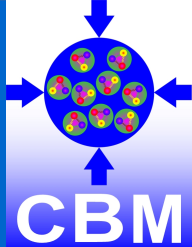


# Status of MRPC calibrations for the endcap-time-of-flight upgrade of STAR

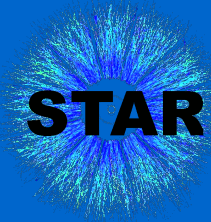


# Table of Contents

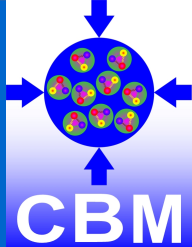


- Fair Phase 0 plans for CBM
- eToF @ STAR
- MRPCs
- DAQ
- Calibration
  - Position
  - T0
  - Walk
- Status & Outlook

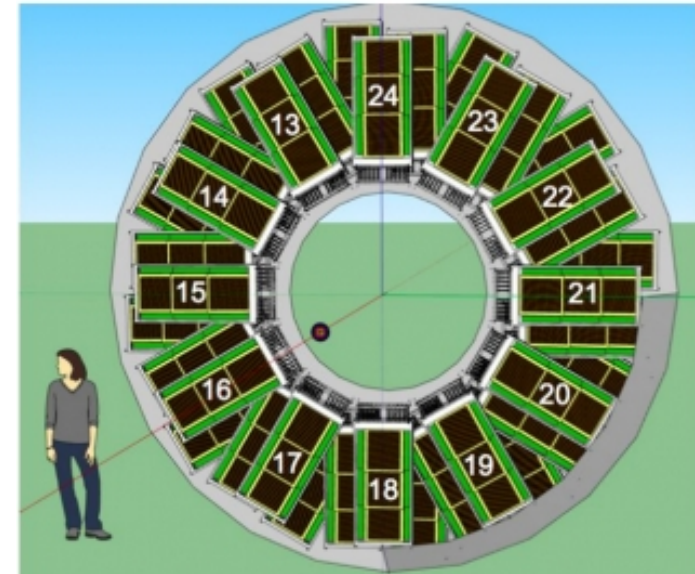
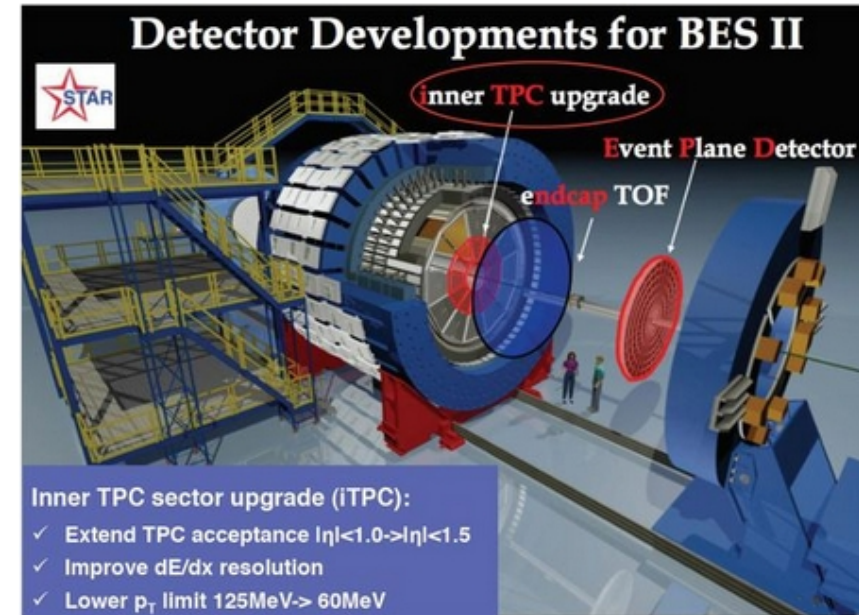
- Bridge program until the start of FAIR in 2025
- For CBM-ToF: mCBM @ SIS18  
eToF @ STAR
- Goals for eToF:
  - Detector tests in long-term beam conditions
  - DAQ QA and further development
  - Reconstruction algorithm tests
  - Participation in physics analysis



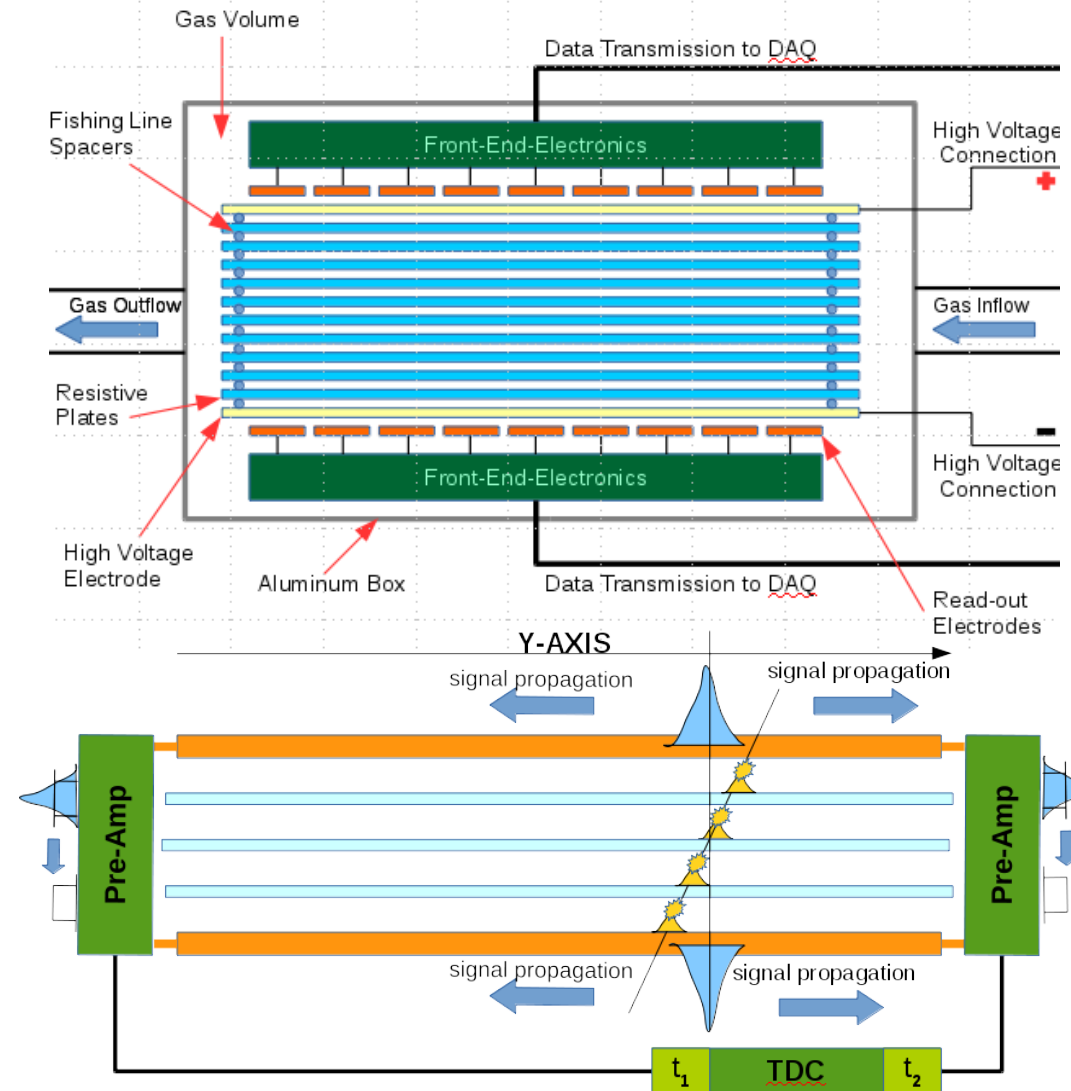
# eToF @ STAR

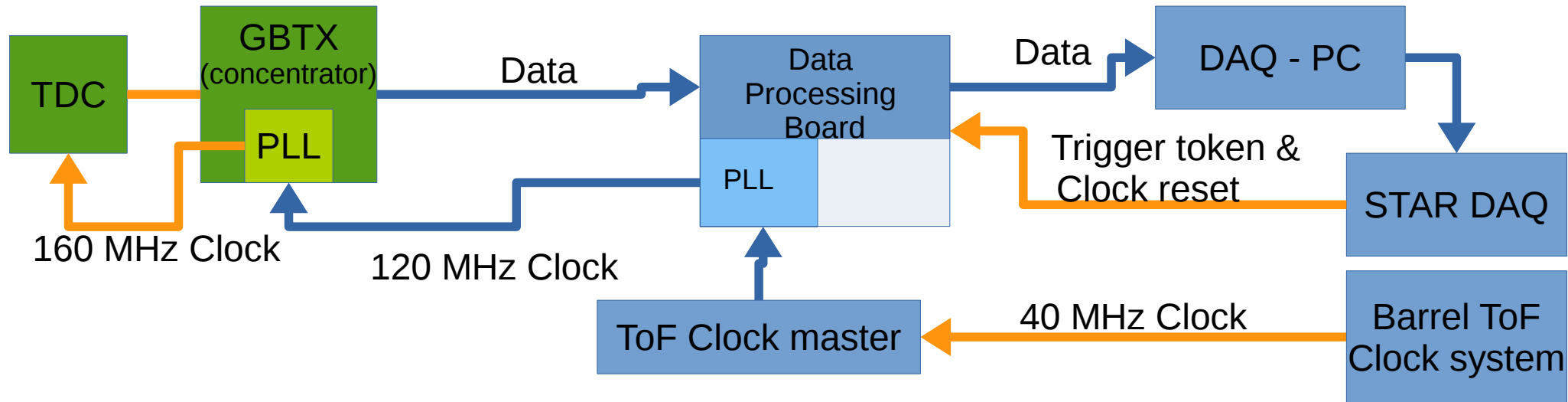
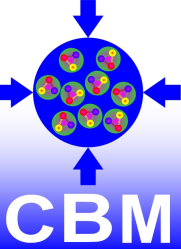


- 2019-2020: STAR Beam Energy scan II
- Energy range:  
19.6 GeV - 7.7 GeV (Collider)  
7.7 GeV – 2.5 GeV (Fixed Target)
- Studies: Turn-off of QGP, Critical point, Phase transitions
- Improved PiD in the forward region, needed for FXT program
- CBM-ToF MRPCs used for endcap time of flight upgrade of STAR
- 2018: commissioning run with 9 detectors in 1 sector
- 36 modules with in total 108 detectors in 12 sectors installed
- CBM interest: Long-term operation test, DAQ test, Software development input
- Many algorithms have been adapted from CBM software. First testing opportunity with physics data.



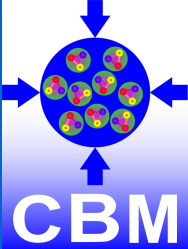
- Gas detector, electron avalanche in the gas gap induces signal in the read-out electrode
- Avalanche growth is stopped by the resistive plate. Avoids streamers / sparks
- Induced signal propagates to the pre-amp. Propagation delay depends on Y-position
- Signal is discriminated in pre-amp. Logical signal is delayed depending on analog signal height (Walk).
- Logical signal is registered on the TDC. Delay depending on Cable lengths.
- Hit Y-Position can be reconstructed as  $Y = (t_2 - t_1 / 2) * v_{prop}$
- Hit arrival time can be reconstructed as  $t = (t_2 + t_1 / 2)$
- Both observables require calibration due to delays.





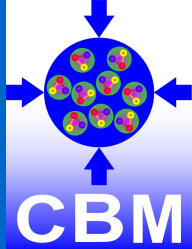
- Data from FEE is transmitted to STAR DAQ through two concentrator stages, GBTX and DPB
- 160 MHz FEE clock is generated and distributed over three PLLs from 40 MHz STAR Barrel ToF clock. Offsets have to be taken into account! Correlation has to be better than 100 ps (see last slide).
- Clock reset from STAR is transmitted to DPB. Has to be subtracted from TDC times
- Different time ranges between STAR clock and CBM clock have to be adjusted
- CBM FEE is free streaming. STAR trigger token is inserted into the data stream for event selection.



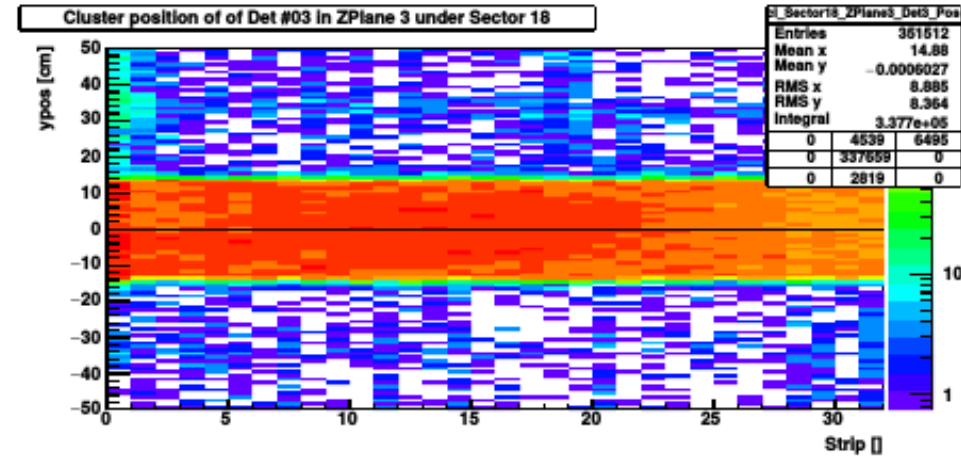
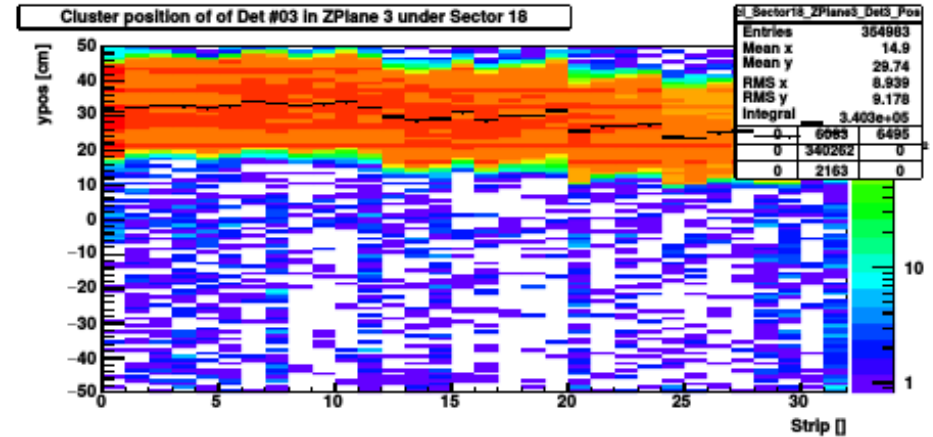


- 1. Clock reset delays between eToF and bToF
- 2. Clock range differences between eToF and bToF
- 3. Cable delays between eToF electronic channel
  - 3a: local y-position offsets
  - 3b: T0 offsets
- 4. Gain differences between eToF preamplifier channel
- 5. Signal height dependence of signal times: Walk / Slewing
- 6. Global position offsets
- 7. Signal velocity differences between MRPCs

**Calibration algorithms for most effects are in place  
and tested on 2018 data!**

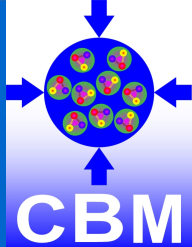


- Strategy: calibrate position influences and mean time influences separately.
- Match Digis on both sides preliminary to get a position distribution.
- Shift mean position of each strip to zero
- Width of hit distribution has to match physical detector width, otherwise assumed signal propagation velocity has to be adjusted

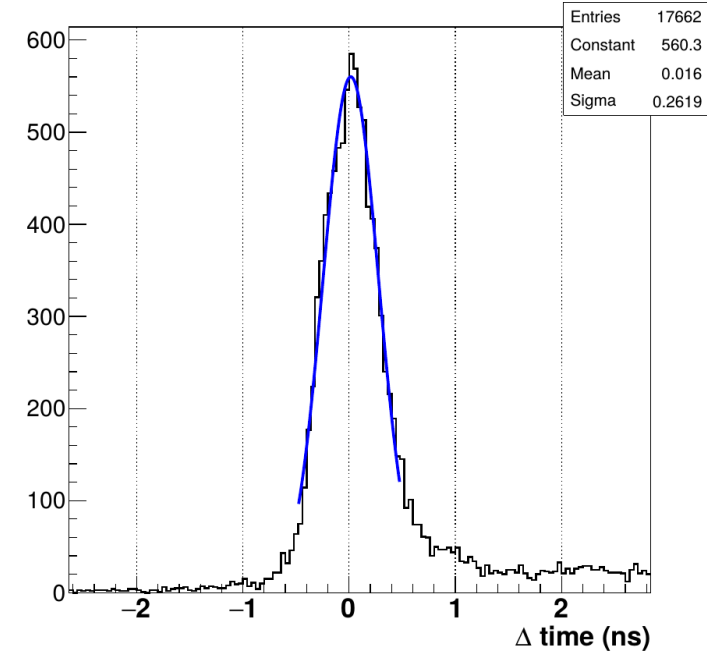


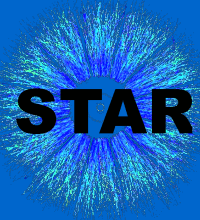


# T0 determination

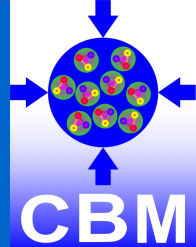


- STAR and CBM clock have different time ranges and resets.
- STAR reset signal is to CBM DAQ and substracted from data
- Physical observable needed to determine remaining offset
- Use calculated ToF of pion tracks as benchmark
- $T_{\text{offset}} = \text{ToF}_{\text{measured}} - \text{ToF}_{\text{expected}}$

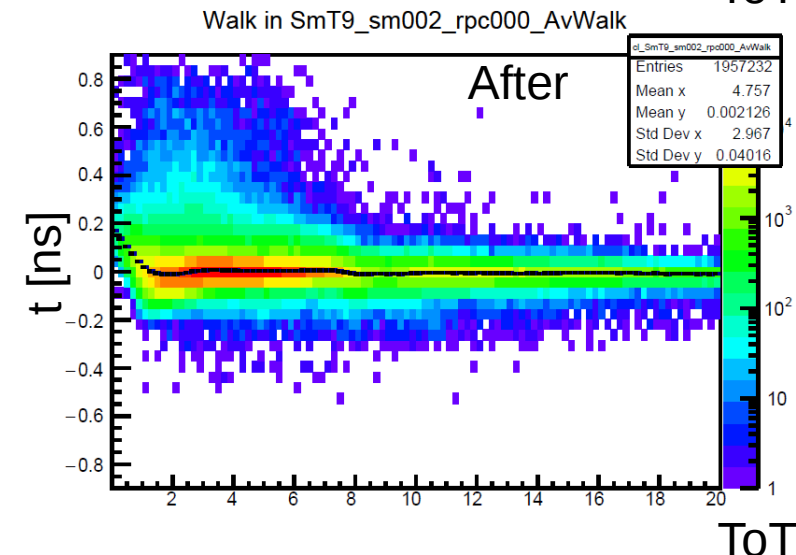
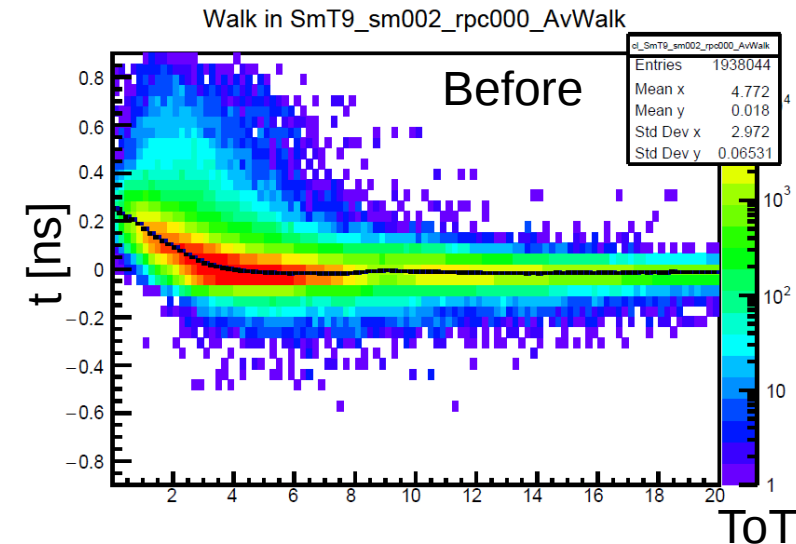




# Walk correction

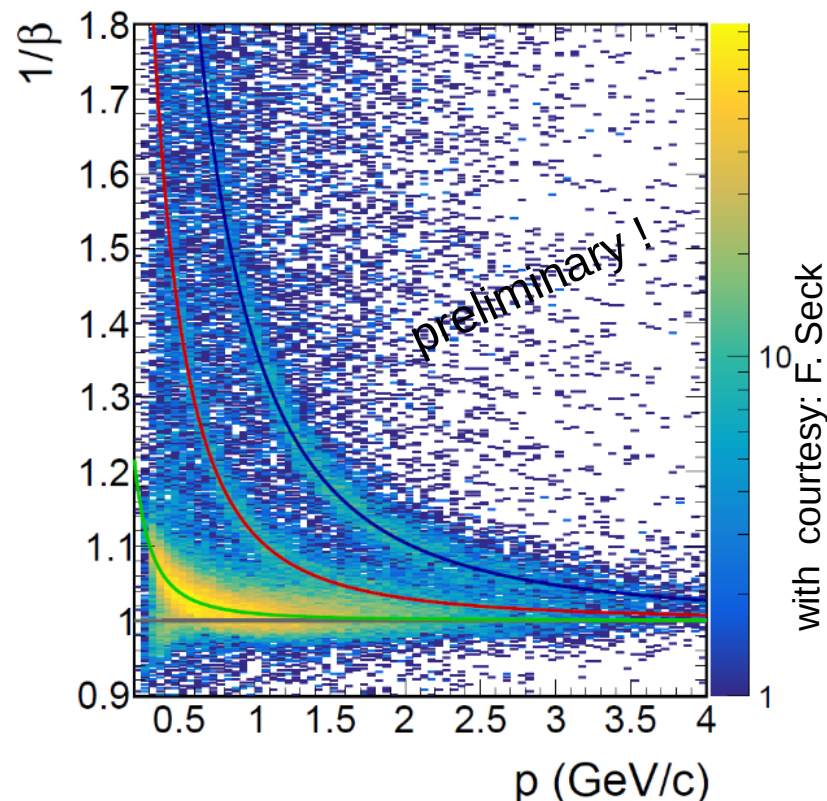
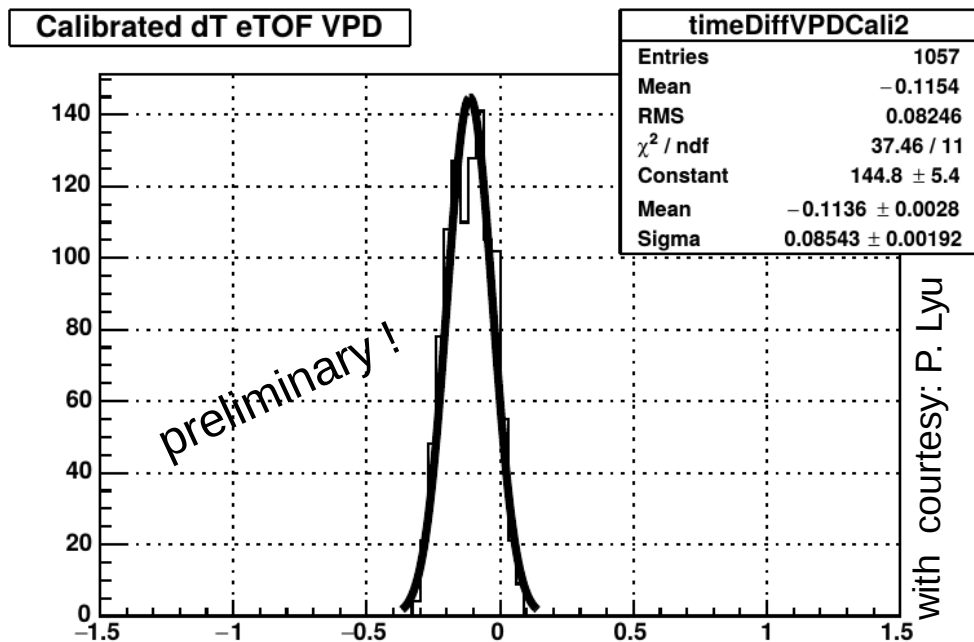
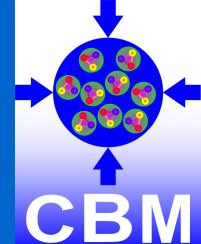


- Strategy: Calculate walk correction for each channel bin-by-bin in ToT. Linear Interpolation between bin centers
- High statistics required:  $\sim 10^6$  Events
- Require at least 15 Hits / ToT bin in each channel. Correct bins below limit with ToT averaged offset => effective fine-grained T0 correction
- Time resolution improvement: 120 ps => 80 ps
- Iterate calibration range alternately with position calibration



# Preliminary results

STAR



- preliminary combined time resolution including start time: 85 ps  
=> eToF single counter resolution < 65 ps
- Low statistics due to low track quality in 2018 run
- P/k separation up to ~2 GeV in 2018 data
- preliminary eToF calibration and low track quality in forward direction
- Will improve in 2019 with better calibration and inner TPC upgrade

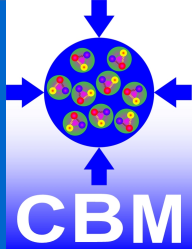
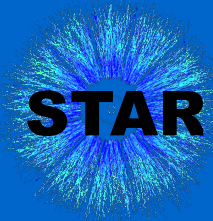


UNIVERSITÄT  
HEIDELBERG  
ZUKUNFT  
SEIT 1386



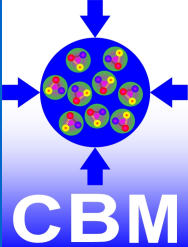
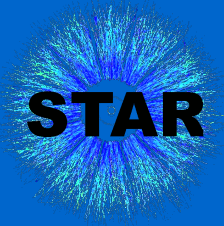
Philipp Weidenkaff  
Universität Heidelberg

# Status & Outlook



- eToF calibration algorithms have been developed for the ongoing STAR BES II
- Detector observables in 2018 data look OK with preliminary calibration. Improvements expected with higher statistics.
- MC validation of reconstruction and calibration algorithms pending
- eToF will improve PID capabilities in the forward region for STAR
- Calibration of 2019 data is starting now





THANK YOU FOR YOUR ATTENTION!



Philipp Weidenkaff  
Universität Heidelberg



