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# Plans for STAR eTOF

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# Acknowledgments

Thanks to the following for figures used in this presentation:

Norbert Hermann

Ingo Deppner

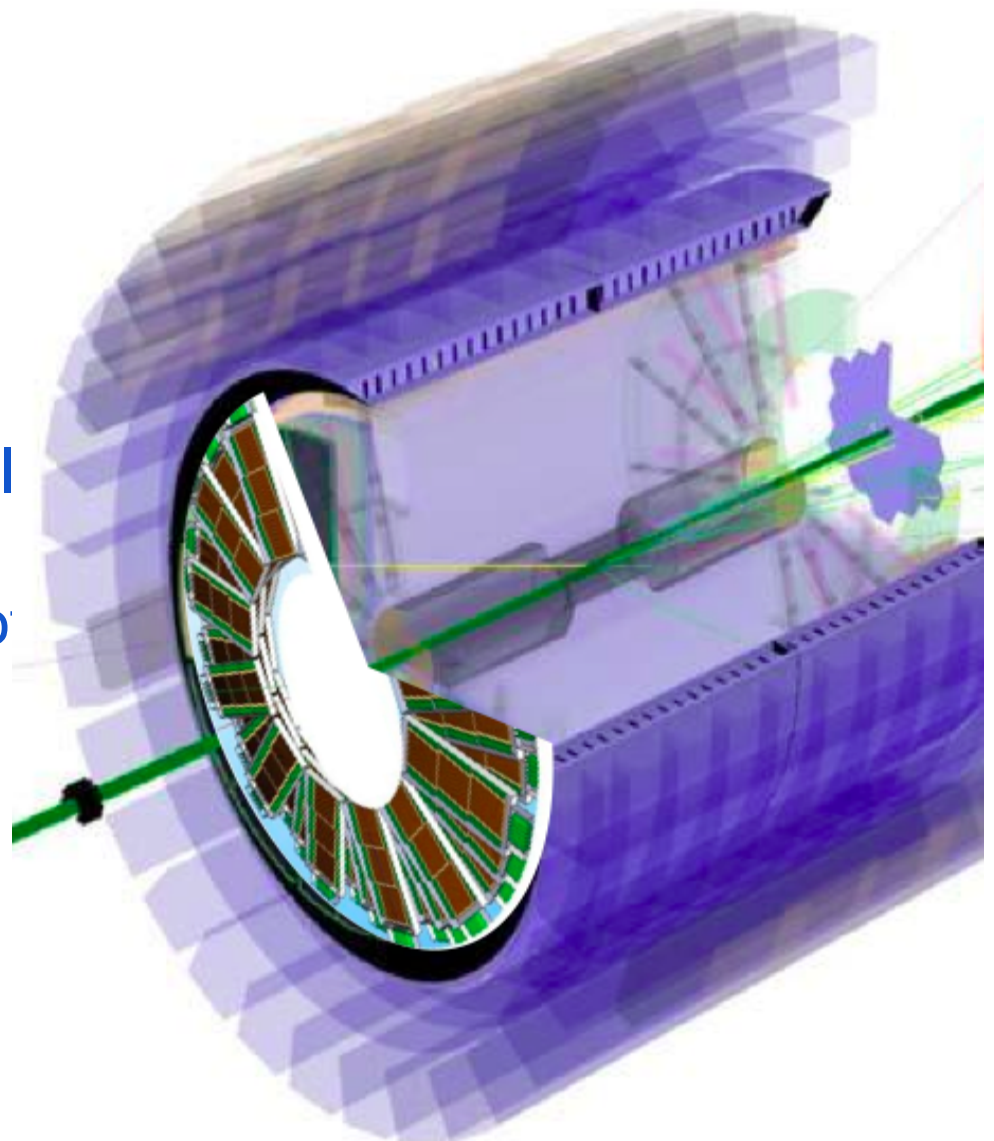
Jochen Fruehauf

Daniel Cebra

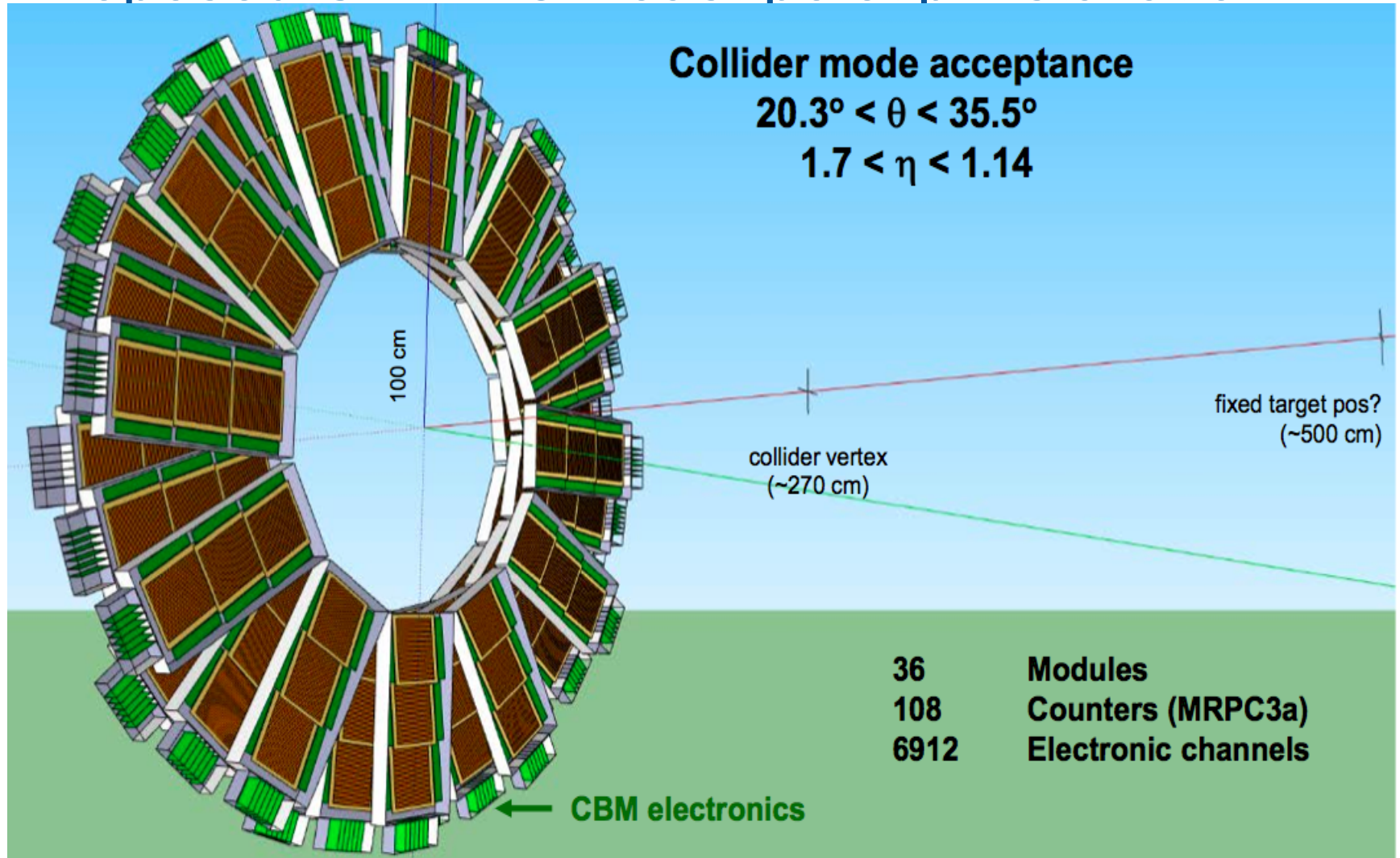
CBM and STAR have proposed entering into a cooperative agreement which would

- provide STAR an endcap TOF for BES II
- provide CBM a large-scale integration test of the CBM TOF system.

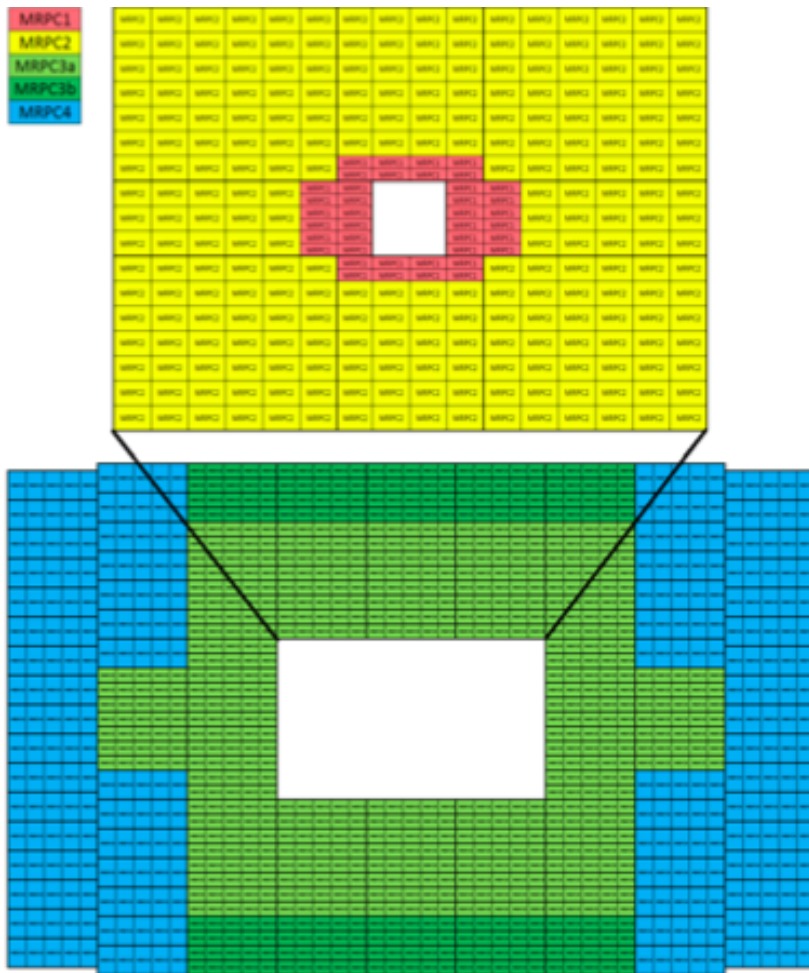
108 of the 1376 MRPCs slated for the CBM TOF wall would be used at STAR



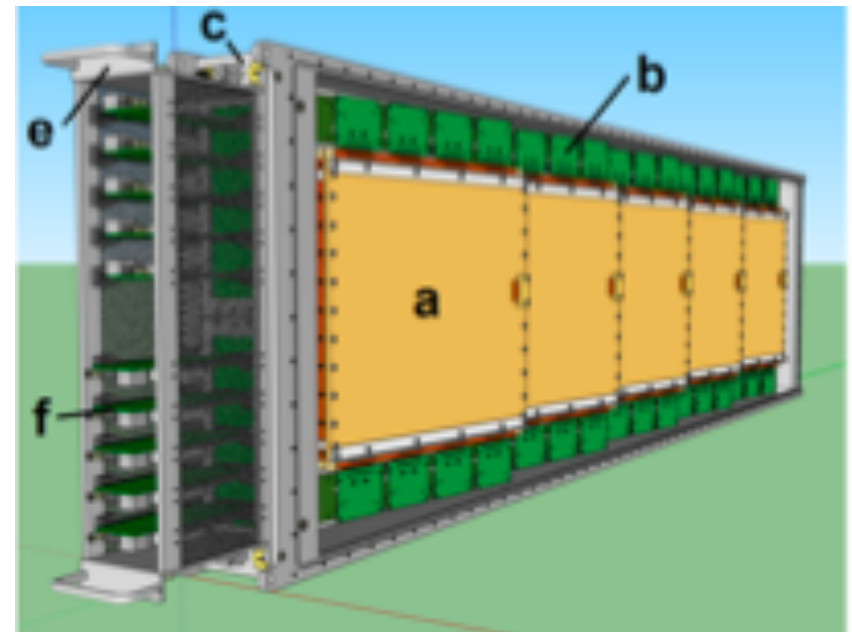
# Proposed CBM TOF east poletip installation



# CBM TOF wall schematic



12m x 9m - MRPCs designed for the light green area in the CBM wall are slated for STAR use.



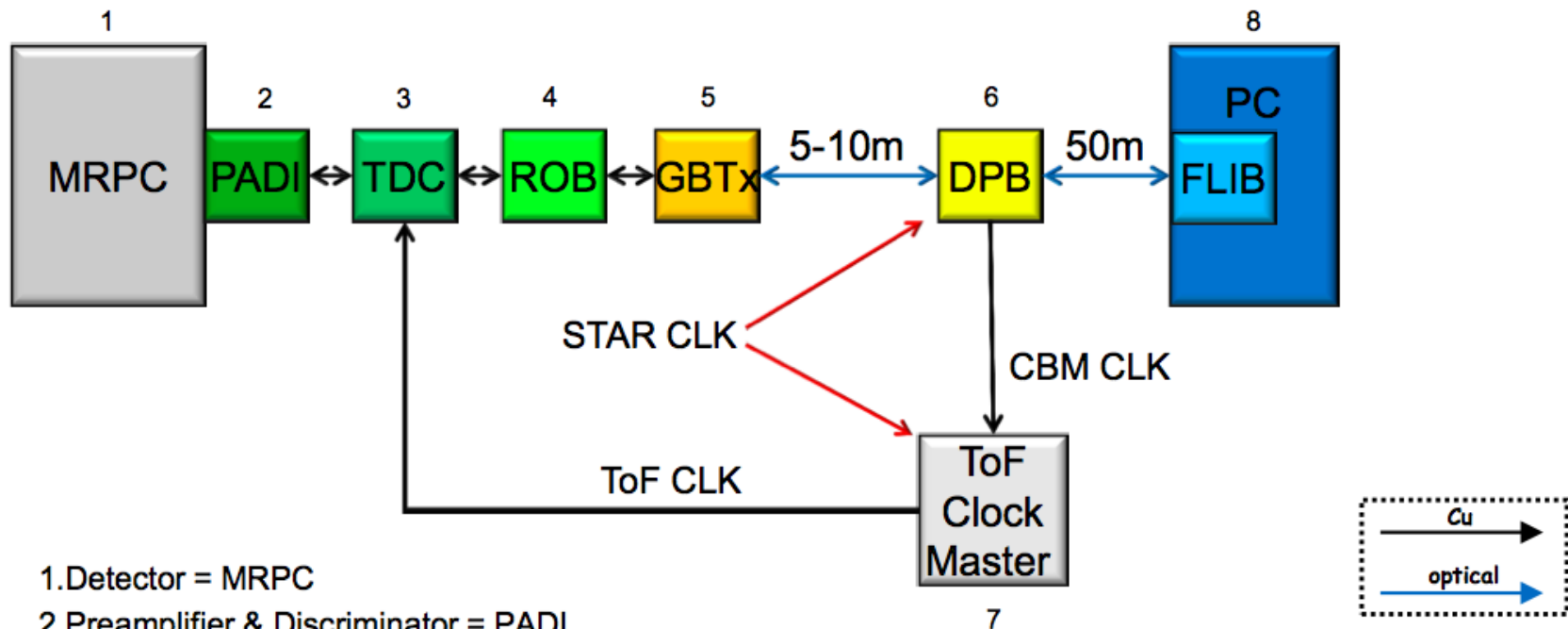
CBM module type M5 will be shortened for use in STAR. It will have 3, 32-strip MRPCs (type 3a) with double-ended read out. The MRPC strips are 27 cm x 1 cm. Low-resistive 1mm glass sheets. 8 gaps.

## CBM will provide for eTOF:

- Run 17 prototype system for STAR integration test
- Detectors and electronic readout
- Electronics monitoring and configuration controls
- LV & HV power supplies and controls
- Gas mixing system and controls
- Onsite support for commissioning and operation



# CBM TOF readout chain



1. Detector = MRPC
2. Preamplifier & Discriminator = PADI
3. Time to Digital Converter (TDC) = GET4 or FPGA TDC
4. Readout board for TDC = **1<sup>st</sup> concentrator stage**
5. GBTx = Data Concentrator ASIC from CERN = **2<sup>nd</sup> concentrator stage**
6. Data Processing Board = **3<sup>rd</sup> concentrator stage**
7. Clock Master (CLOSY) & Clock Distribution for ToF
8. PC = storage Device



# STAR will provide for eTOF:

- Design for mechanical installation, mounting fixtures, and installation
- Gas connections from the mixing room to the detectors, installation of the connections, and gas for operations
- Rack space, power, and cooling as required
- The interface to STAR trigger and DAQ, commissioning the interface
- LV & HV cables
- A reference clock signal to tie CBM TOF data to STAR TOF data



# Interface to STAR trigger and DAQ

- STAR Level 0 trigger commands are distributed to each subsystem over a TCD and TCD fanouts at each RHIC clock cycle, 9.38 MHz.
- STAR will deliver the L0 commands to the CBM PC at the end of the CBM TOF readout chain.
- The L0 *accept* command needs to be identified by the CBM PC with approximately 25 ns precision.
- The CBM PC will need to buffer the most recent 5 us of the streamed CBM TOF data.
- When an L0 accept is received, the CBM pc will send the most recent 5us of data over fiber to a STAR DAQ receiver.

# Interfacing CBM stop times to STAR start times

- The 9.38 MHz RHIC (experimental) clock can be digitized by both STAR and CBM providing a reference time in every event between the two independent timing systems.
- We need a few spare PADI channels to digitize the clock edge in CBM.
- We plan to digitize 8 channels of the RHIC clock in TOF HPTDC channels this year to test that there is no channel-to-channel jitter. Peak-to-peak jitter will not matter since it is removed by the *start-stop* subtraction.
- In 2017, we will move 4 channels of the RHIC clock to PADI channels on the CBM TOF prototype to test the interface.

# Current status

- The cooperative agreement between CBM and STAR is complete. It is in the form of a *Letter of Interest*. The agreement is actually between STAR and Heidelberg, Tsinghua, USTC, and CCNU. CBM will give its blessing to lending the equipment to STAR.
- The *Letter of Interest* is being expanded to a full proposal to be submitted to BNL for approval and GSI for endorsement in December.

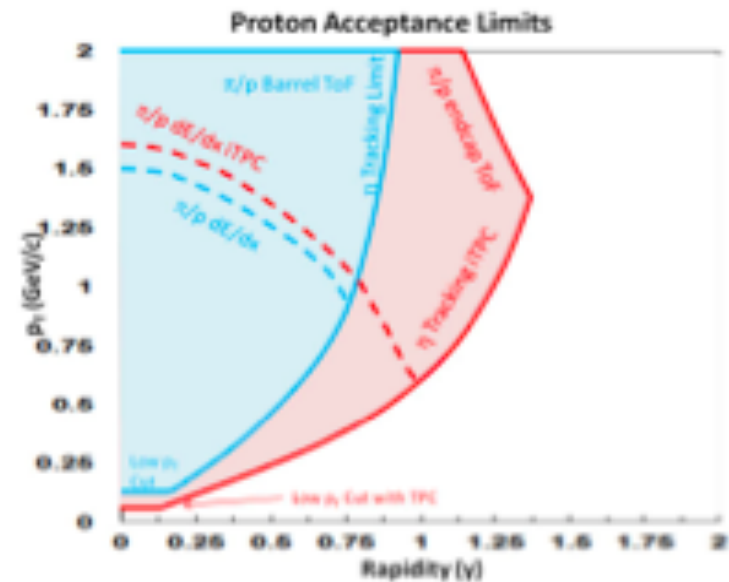
## current status ...

- Proposal sections underway
  - di-electrons - Lijuan Ruan
  - v1 - Declan Keane
  - v2 - Shusu Shi
  - hypernuclei - Jinhui Chen
  - kurtosis - Grazyna Odyniec
  - strange hadrons - Xianglei Zhu
  - fixed target - Daniel Cebra

# eTOF in BES II

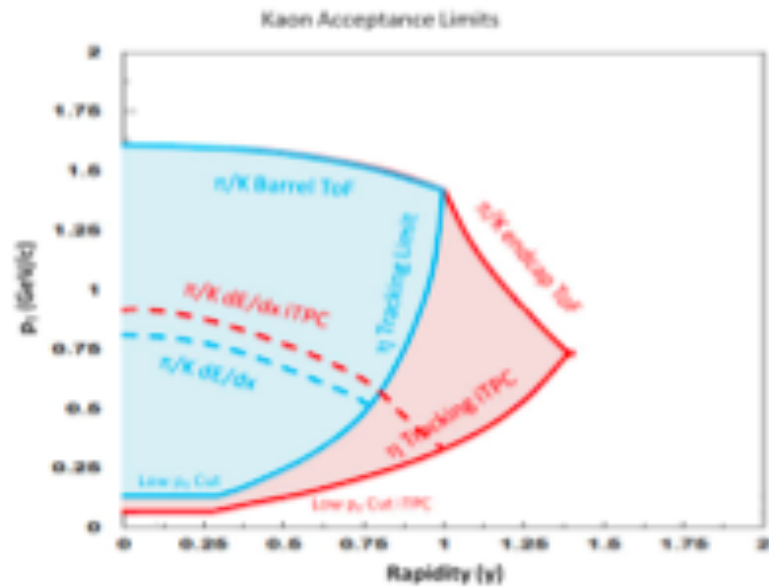
For the collider program at 7.7 - 19.6 GeV, eTOF with iTPC extends the rapidity coverage for identified protons, kaons, and pions from  $y=0.8$  to  $y=1.2$ . This allows studying the rapidity dependence of bulk property observables

protons

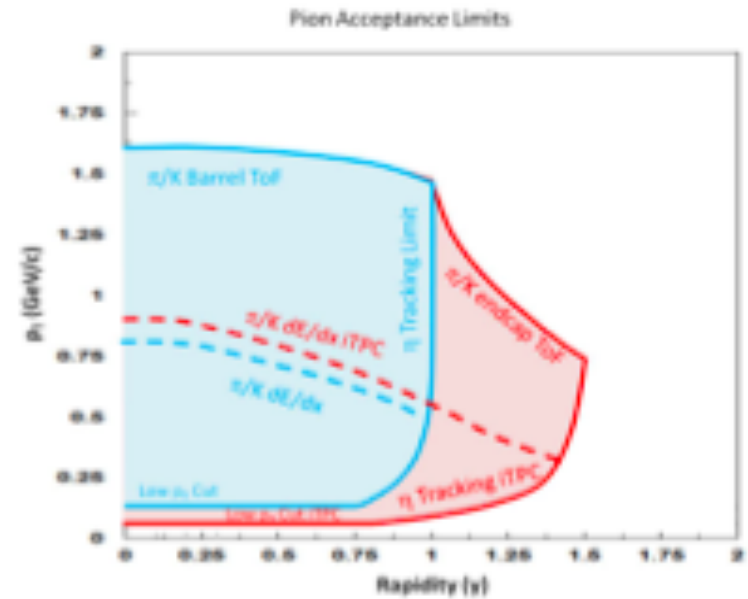


# eTOF in BES II ...

kaons



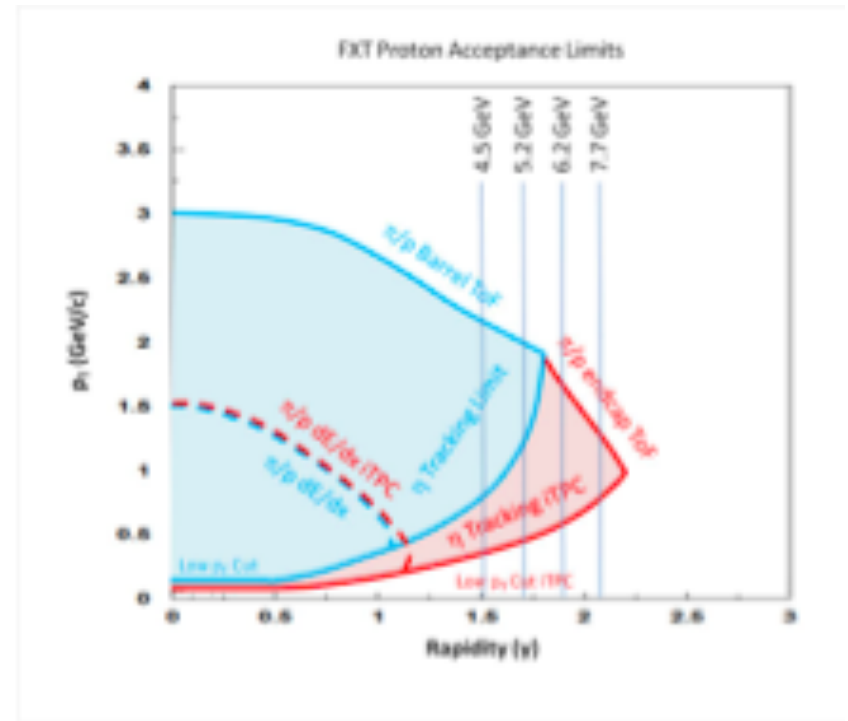
pions



# eTOF in BES II, fixed-target

For the fixed target program, eTOF with iTPC allows the energy range of 3.0-7.7 GeV to be studied, The range is limited to 3.0-4.5 without eTOF. The energy of 7.7 GeV can be studied in both collider and fixed-target mode providing important systematic checks.

protons

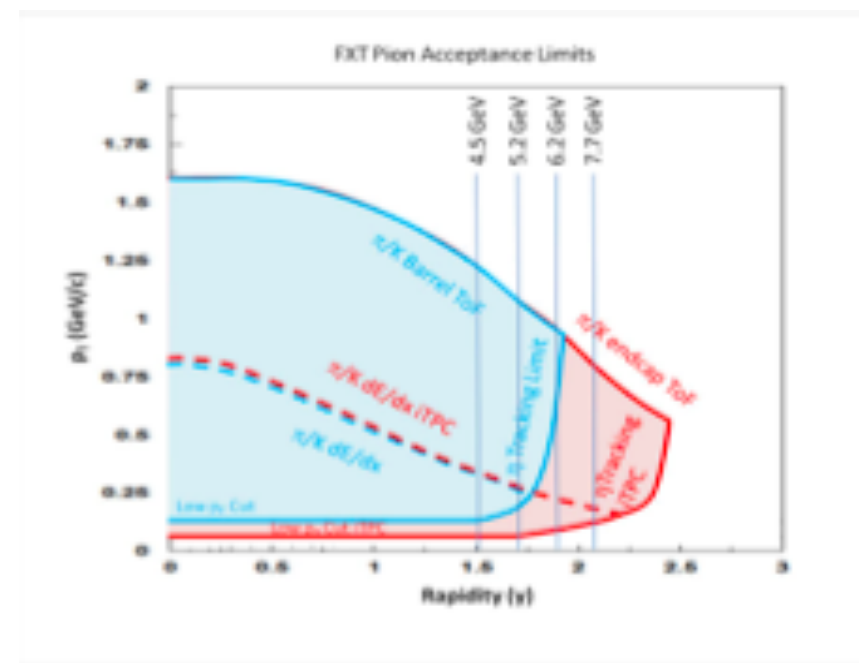
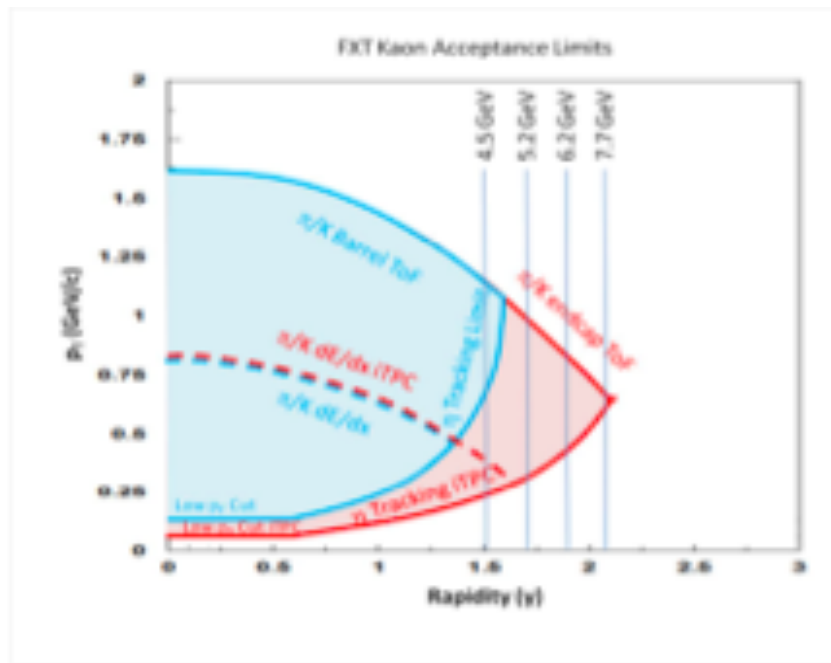




# eTOF in BES II, fixed-target ...

kaons

pions



# Project milestones

- December 2015 - submit proposal to BNL for approval and GSI for endorsement
- June 2016 - submit plan and schedule for prototype installation to STAR Ops
- June 2017 - submit plan and schedule for eTOF installation to STAR Ops
- October 2018 - complete installation; begin commissioning
- July 2020 - decommission eTOF; prepare CBM equipment for return to CBM

# Summary

- The rapidity coverage with precision PID for the collider BESII program, 7.7 - 19.6 GeV, is extended to the  $y = 0.8-1.2$  range. The increased range allows varying the rapidity window to change the baryon chemical potential, adding an additional handle for the search for critical behavior.
- eTOF will allow the internal fixed-target program to run at energies from 3.0 - 7.7 GeV (instead of only 3.0 to 4.5 GeV).

backup

# CBM test beam plans

- November 2015. 30 AGeV Pb beam at SPS.
  - test latest electronics
  - test full-size 5 MRPC module
  - test pad vs. strip for inner MRPCs (not STAR design)
  - test single vs. double HV stack (could affect STAR design)
- November 2016 158 AGeV Pb beam at SPS
  - test electronics
  - performance test of streaming readout

