sTGC project summary

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BNL

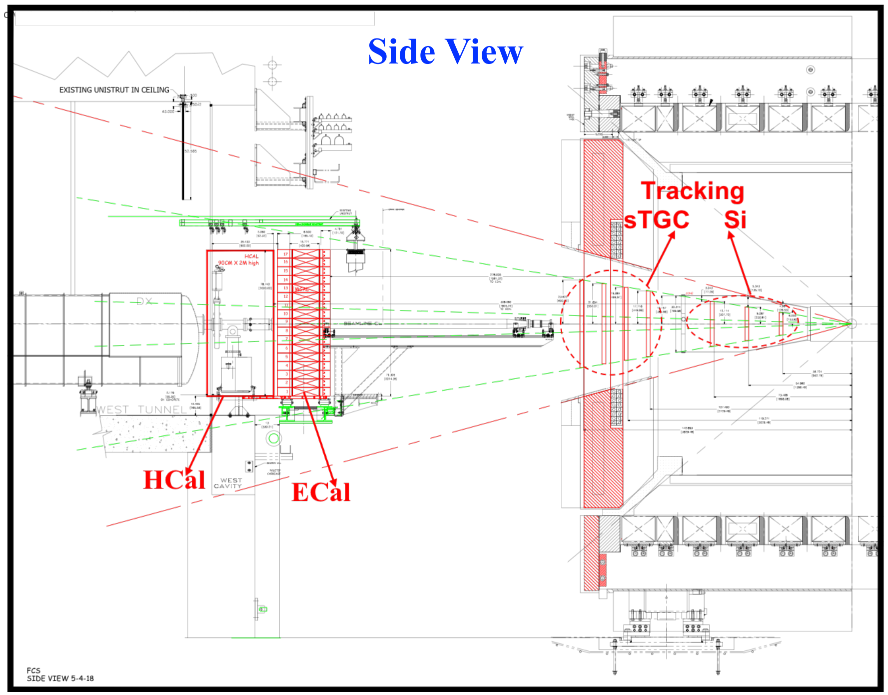
Introduction

The project

The prototype performance at STAR

Summary

STAR forward upgrade for 2.5 < η < 4



Calorimetry:
Electromagnetic and Hadronic

Tracking:
Silicon detectors and
small-strip Thin Gap Chambers (sTGC)

pp, pA and AA data taking in FY2021/22 and parallel with sPHENIX data taking period

AA physics at 200 GeV for 2023-2025:
Constrain 3D hydro evolution
Temperature dependent η/s
Rapidity dependent vorticity

Successful cost and schedule review on Nov 19, 2018, BNL

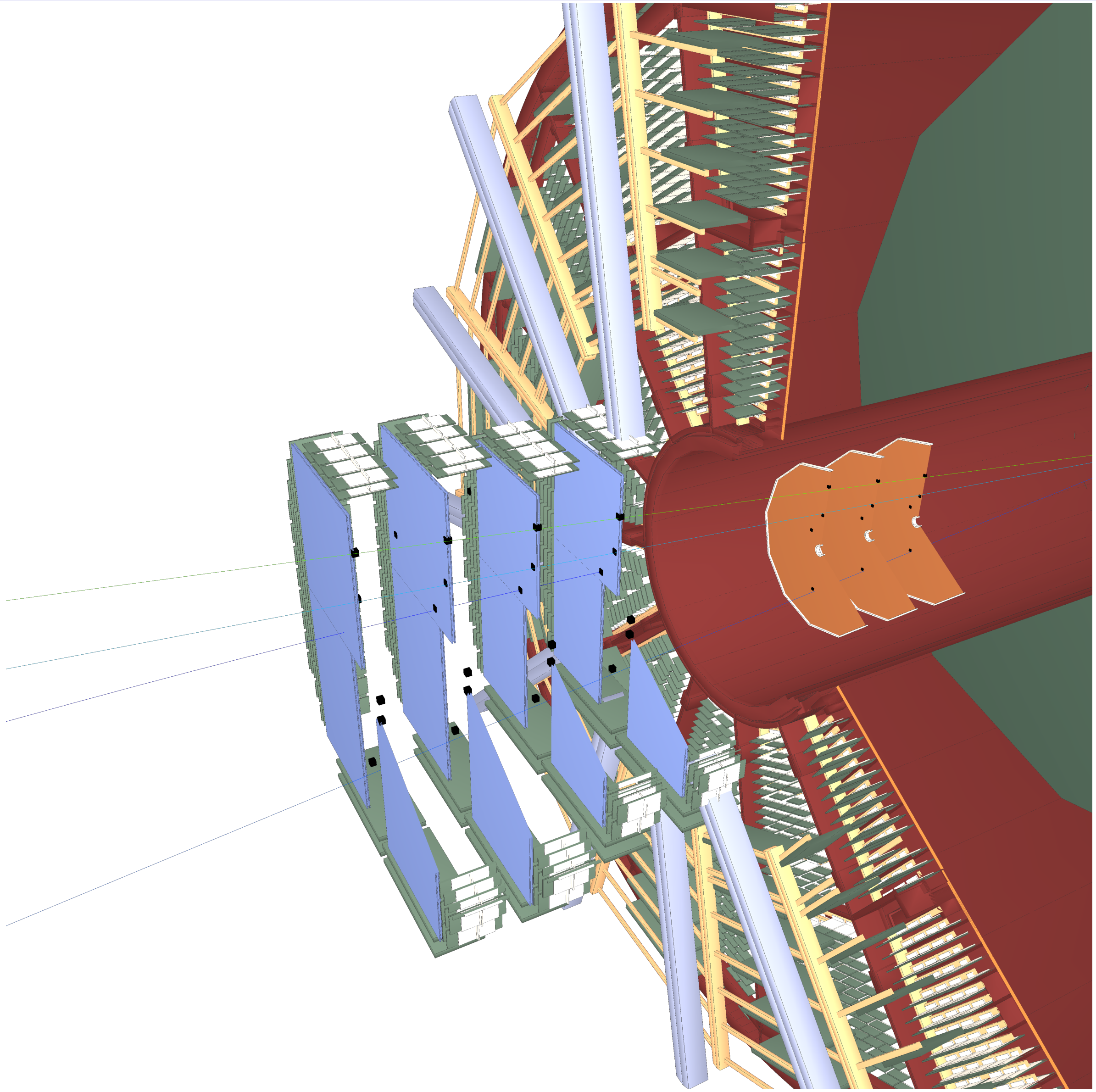
Key Performance Requirements

Charged sign separation for cold QCD physics

Momentum resolution 20-30% for peripheral heavy ion physics

Detector	pp and pA	AA
ECal	$\sim 10\%/\sqrt{E}$	$\sim 20\%/\sqrt{E}$
HCal	$\sim 50\%/\sqrt{E} + 10\%$	---
Tracking	charge separation photon suppression	$0.2 < p_T < 2$ GeV/c with 20-30% $1/p_T$

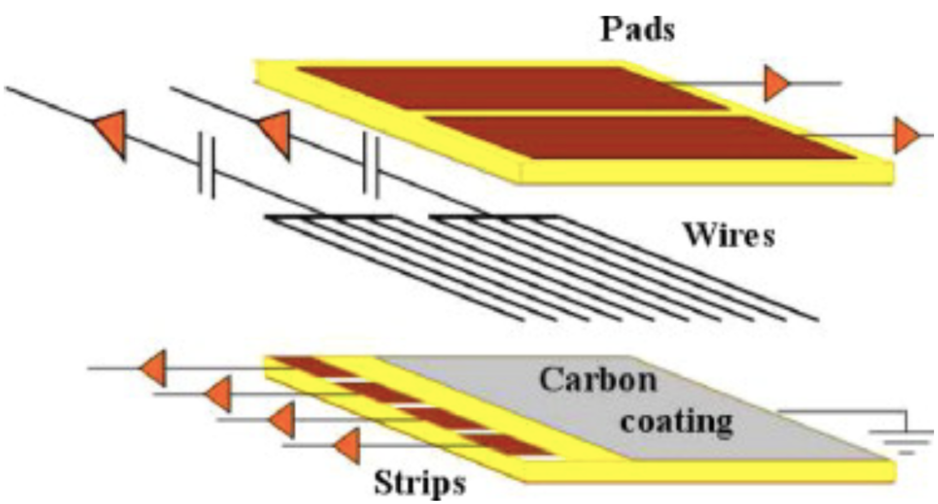
The tracking

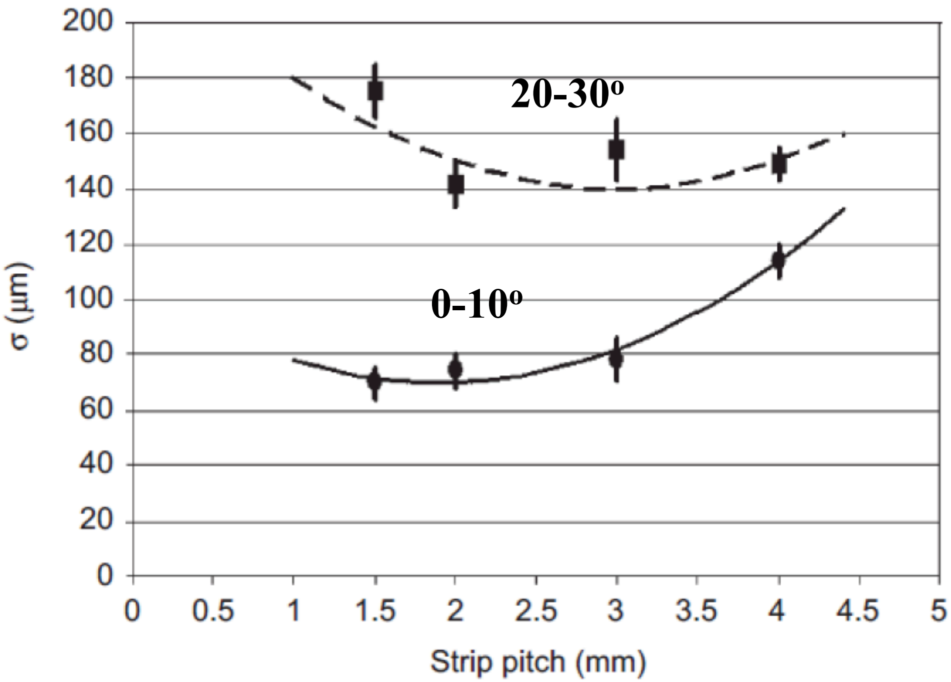


The sTGC

Four double-sided, pentagon-shape sTGC with x, y, and diagonal-direction readouts will form a disk. We will have ~22000 readout channels in total.

The sTGC module is much smaller than ATLAS sTGC.
All the PCB boards can be fabricated in China.



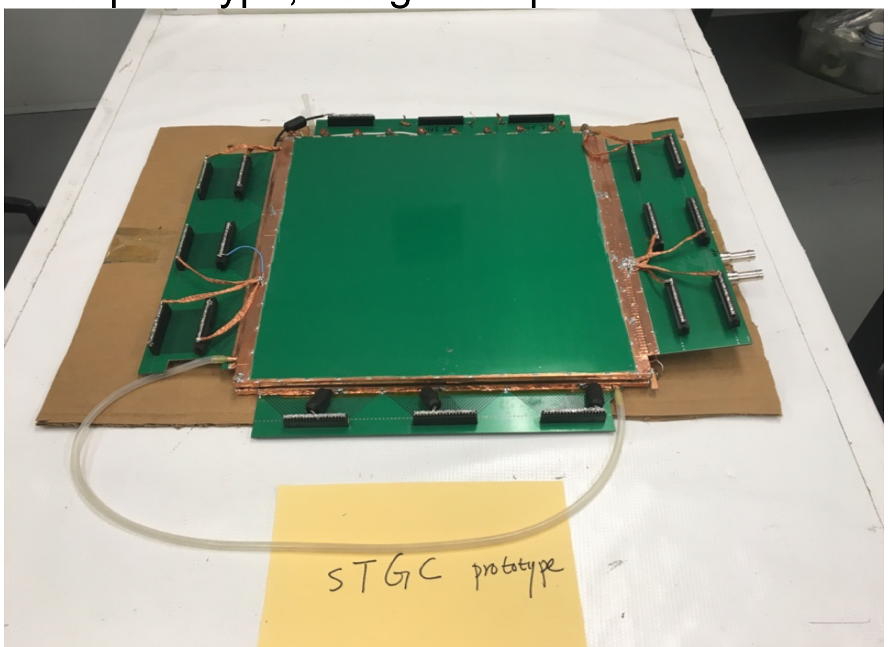


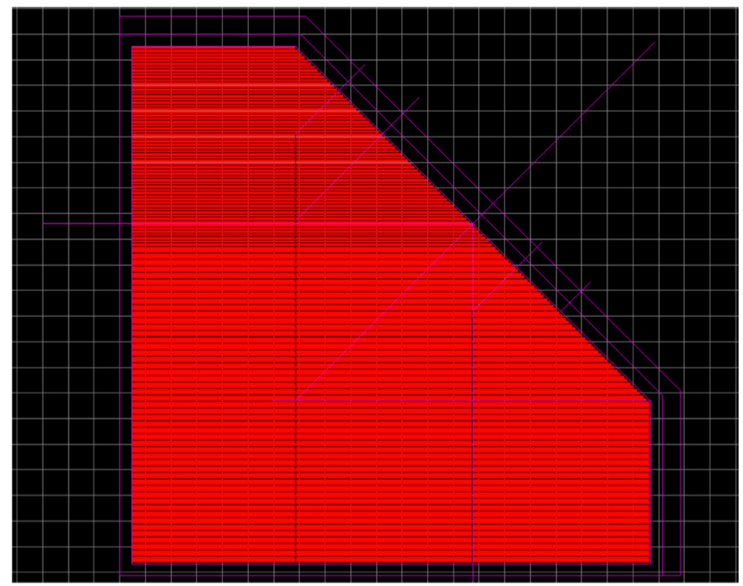
sTGC module production

Shandong University (SDU) will produce all the pentagon-shape modules.

For the 30*30 cm2 prototype, we successfully integrated it to STAR; the efficiency at clean room test showed >98% with optimal gas.
For 60*60 cm2 prototype, efficiency > 95%, detailed study of position resolution ongoing at SDU.

For final prototype, design completed.





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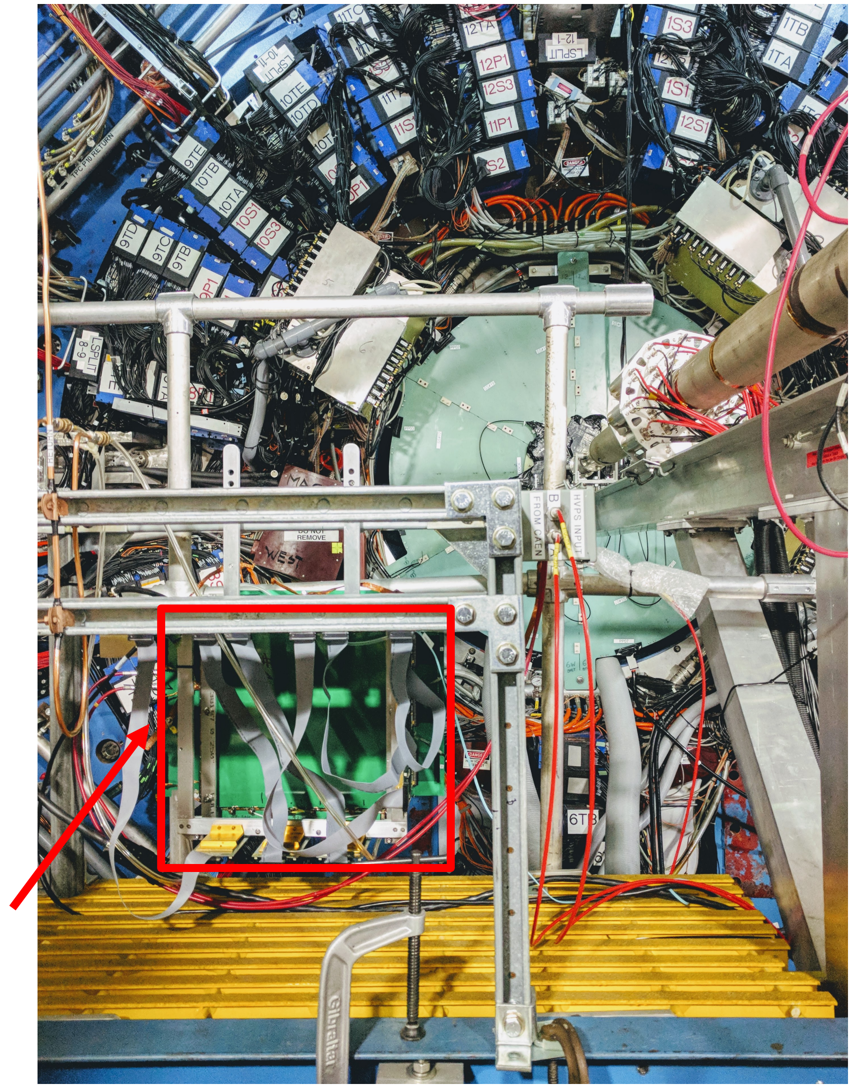
sTGC prototype at STAR in 2019

Prototype installed on June 5, 2019 at STAR

Gas: C10

Performed a voltage scan at 7.7 GeV and 9.2 GeV Au+Au run, and took data in 200 GeV Au+Au



Time bin vs ADC with different high voltages

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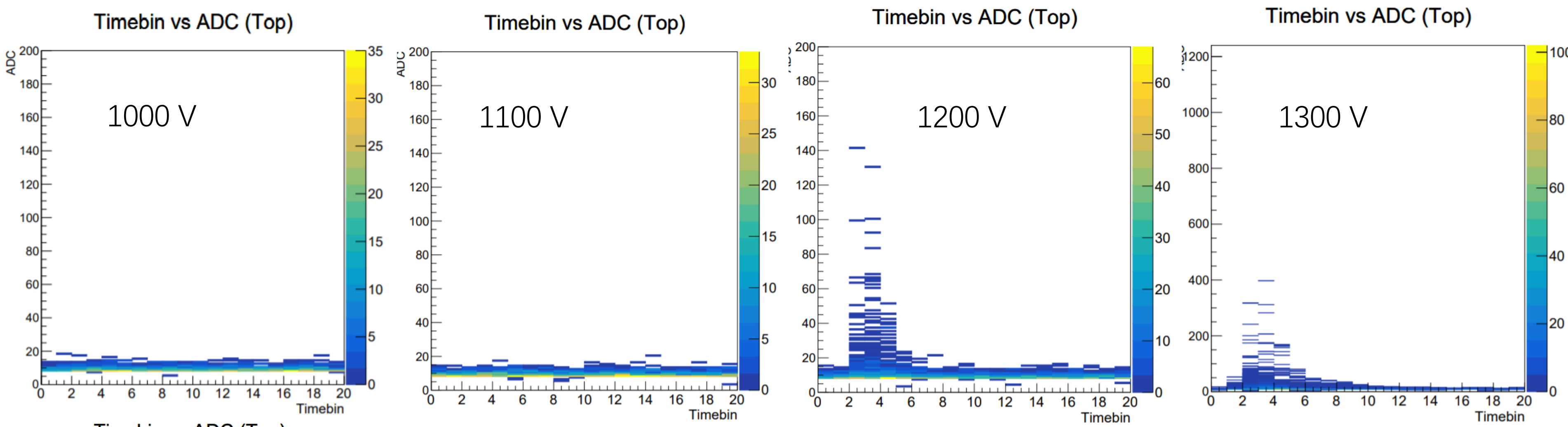
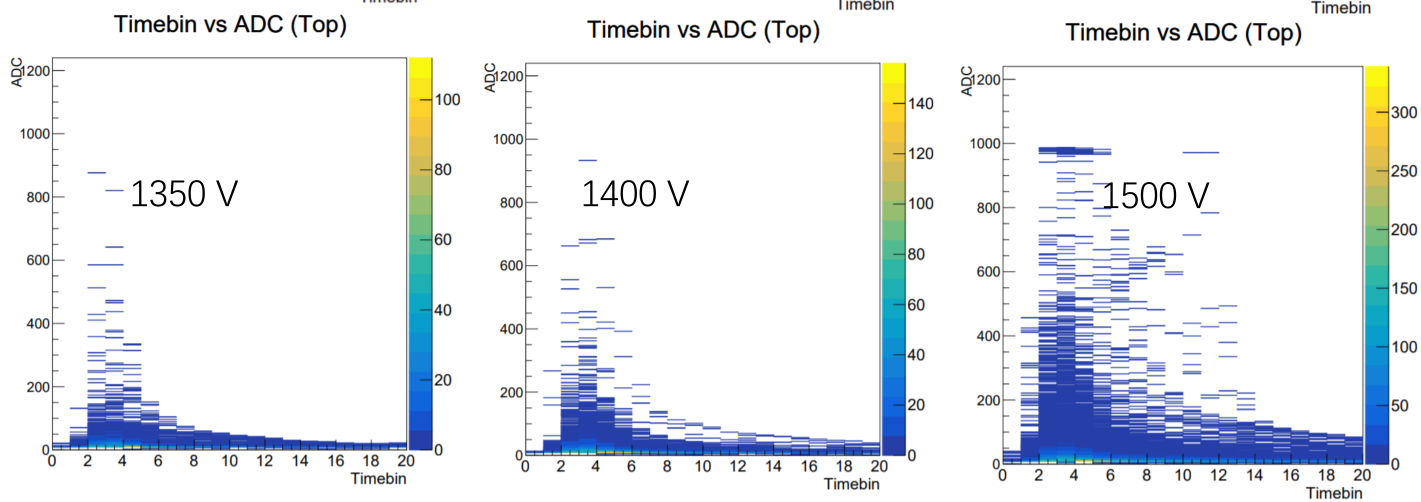




Maximums of y axis in 1300V , 1400V, 1350V, 1500V are 1200

Maximums of y axis in 1000V , 1100V, 1200V, are 200

Schedule presented on 11-19-2018

Milestones:
Aug 2019, sTGC R&D completed (build another two 60 cm✖60 cm modules)
Sep 2019, sTGC mass production readiness review
Oct 2019 to Oct 2020, mass production of 32+8 (spare) sTGCs
May 2021, Last batch of sTGCs installed at STAR
Schedule float: 6 months

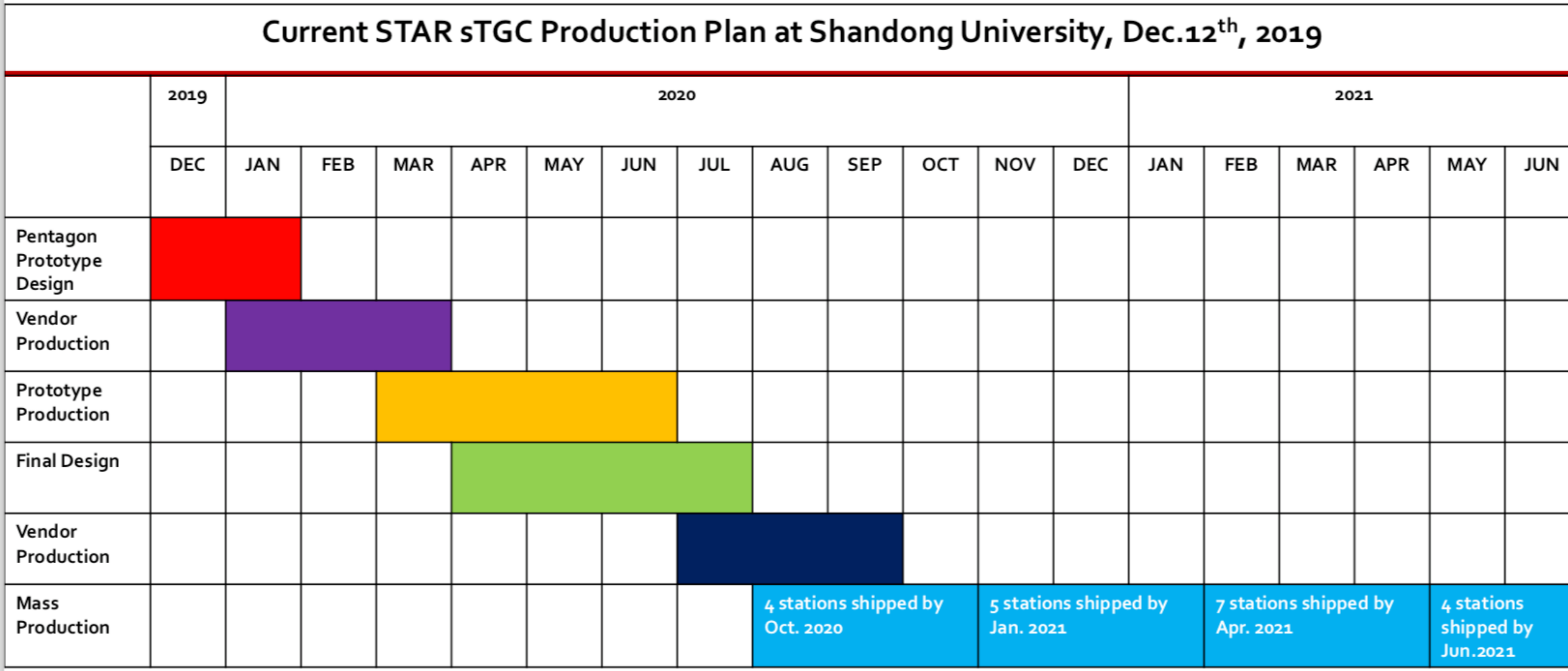
SDU made a detail assessment for the production time:

#	Step	Duration(hour)
1	Material inspection/cleaning	14
2	PPPCB masking tape pasting	2
3	Graphite mixing/spraying/polishing	8
4	Half-chamber production, HV burn-in	48
5	wire winding, soldering, washing	24
6	Two half combination	24
7	Air tap installation and sealing	48
8	Gas leak inspection and repairing	4
9	Flow in CO2 HV burn-in	12
10	Flow in CO2+N.P X-ray test	24
11	CO2 washing residual N.P.	12

About 9 days per chamber, including preparation and testing.

In addition, the ALTAS sTGC production project will end in Aug-Sep, 2019.
If using their technicians, SDU can finish the project in 4-6 months after mass production is started

Module production schedule

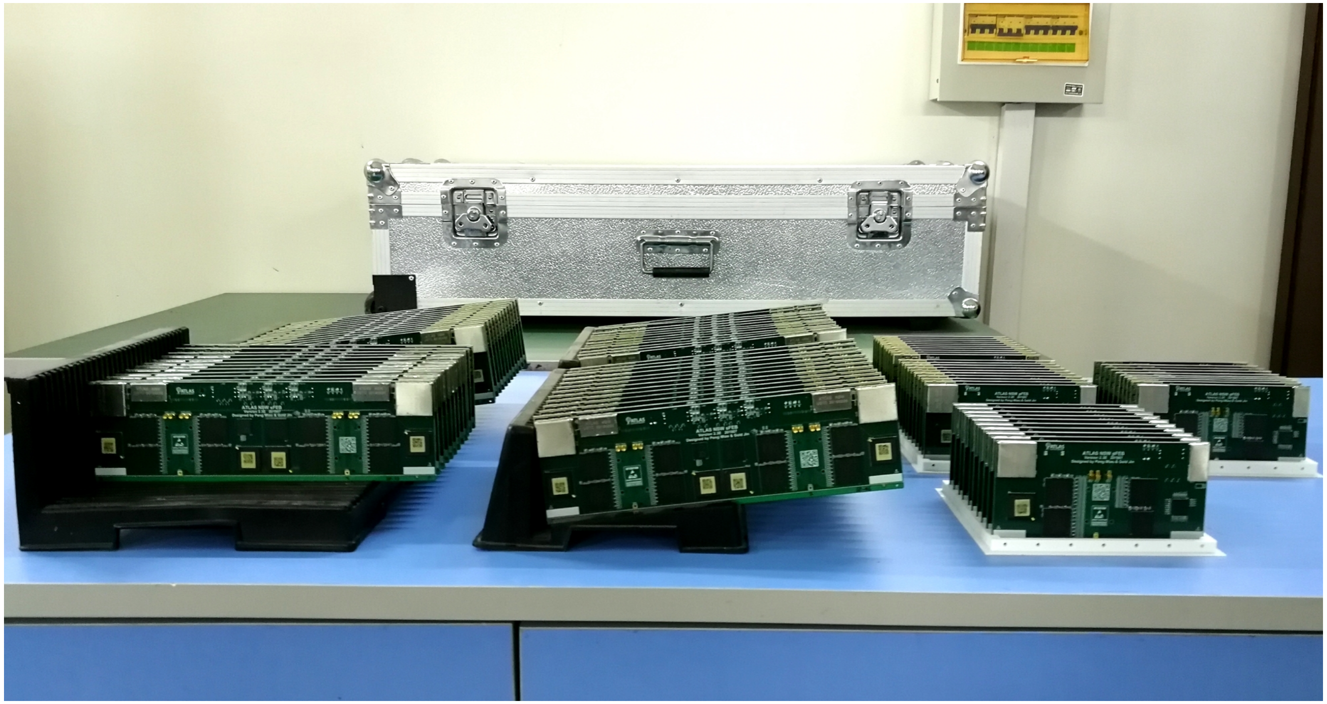


- Need 9 days per chamber, 15 days (3 weeks) per station.
- Parallel work has already been considered.

16 stations shipped

Electronics: based on VMM chips

- 4 chips per board, 96 FEE boards in total.
- 16 ROD boards
- USTC (Prof. Jin Ge and Dr. Feng Li) are designing the board.



The chips (464 needed) will be purchased through BNL. Waiting for CERN to provide the info on the exact funds we need transfer for chips (25 ladders) and packaging.

Paperwork on subcontract purchase order of electronics boards through BNL is ongoing

Electronics design schedule

- Schematics of FEB prototype be done in late Feb. Board layout completed in March.
- Schematics of ROD prototype be done in March. Board layout completed in early April.
- FEB and ROD manufacturing and assembly be done in April, then integration test at SDU for 2-3 months(start from May).
- ROD firmware development to work compatible with STAR DAQ from July. Two USTC people will go to US to work with BNL guys.
- Prof. Jin and Dr. Feng Li intend to visit BNL in June or July: FEB site test, ROD interface protocol with STAR DAQ, other site problems for experiments.
- Final design completed before October.
- After mass production, all boards can be shipped to BNL before December.

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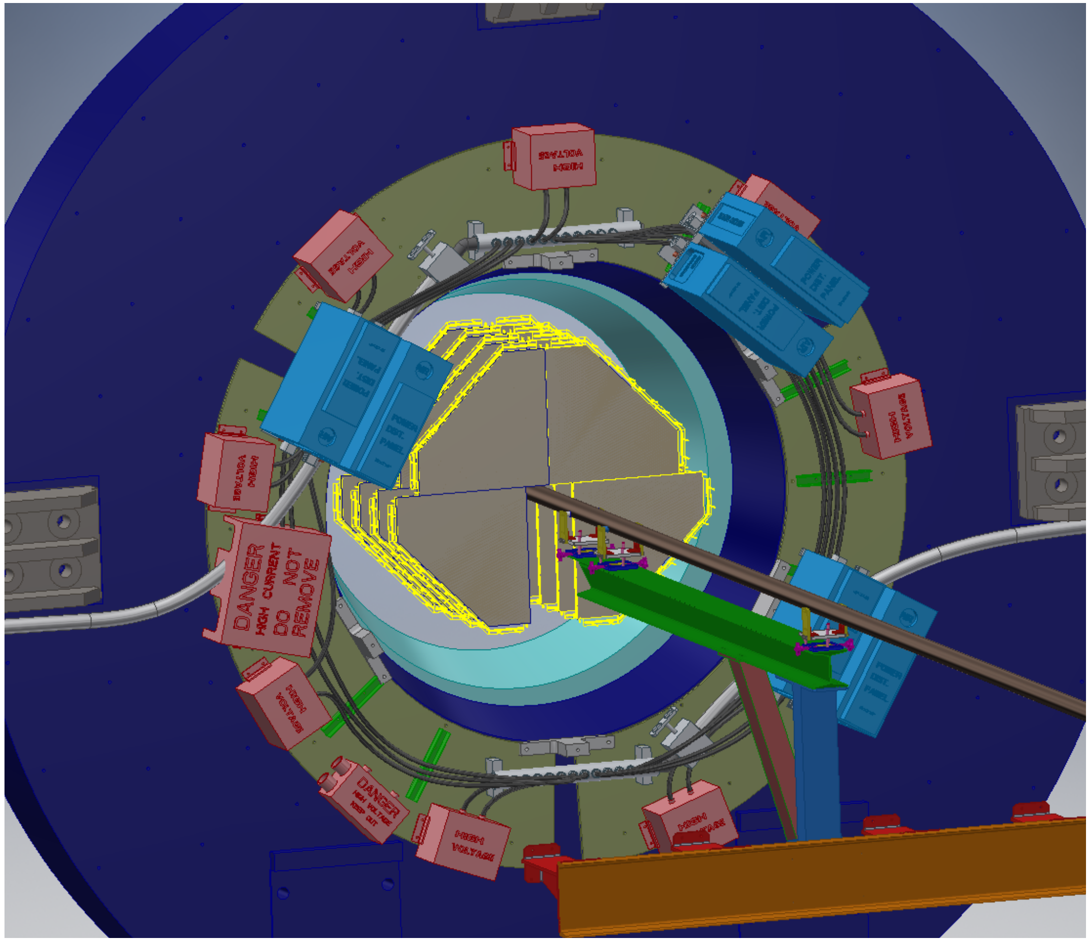
sTGC integration and gas



See Rahul's talk.

Final remarks

1. Electronics: continue to push for an answer from CERN and from BNL
2. Module production: need a readiness review before mass production in summer
3. Gas: need to install all the components at STAR and test them in run 2020
4. Integration: more frequent communication need happen between SDU+USTC (Chi/Feng) and BNL (Rahul)
5. Software simulation: need to develop clustering algorithm with high efficiency (prototype run in 2020)
6. Visa denial: we need provide a virtual STAR drawing/video and do more email exchanges related to STAR