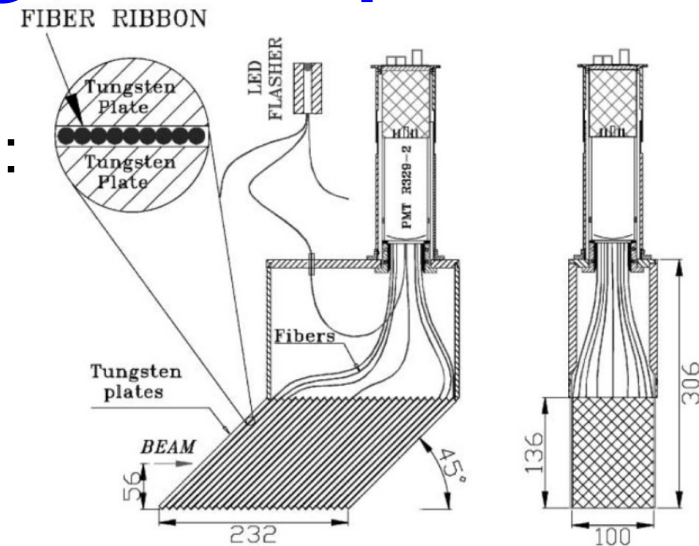# ³He breakup tagging: setup

- RHIC ZDC (zero degree calorimeter) modules:
- W-Cherenkov fibers
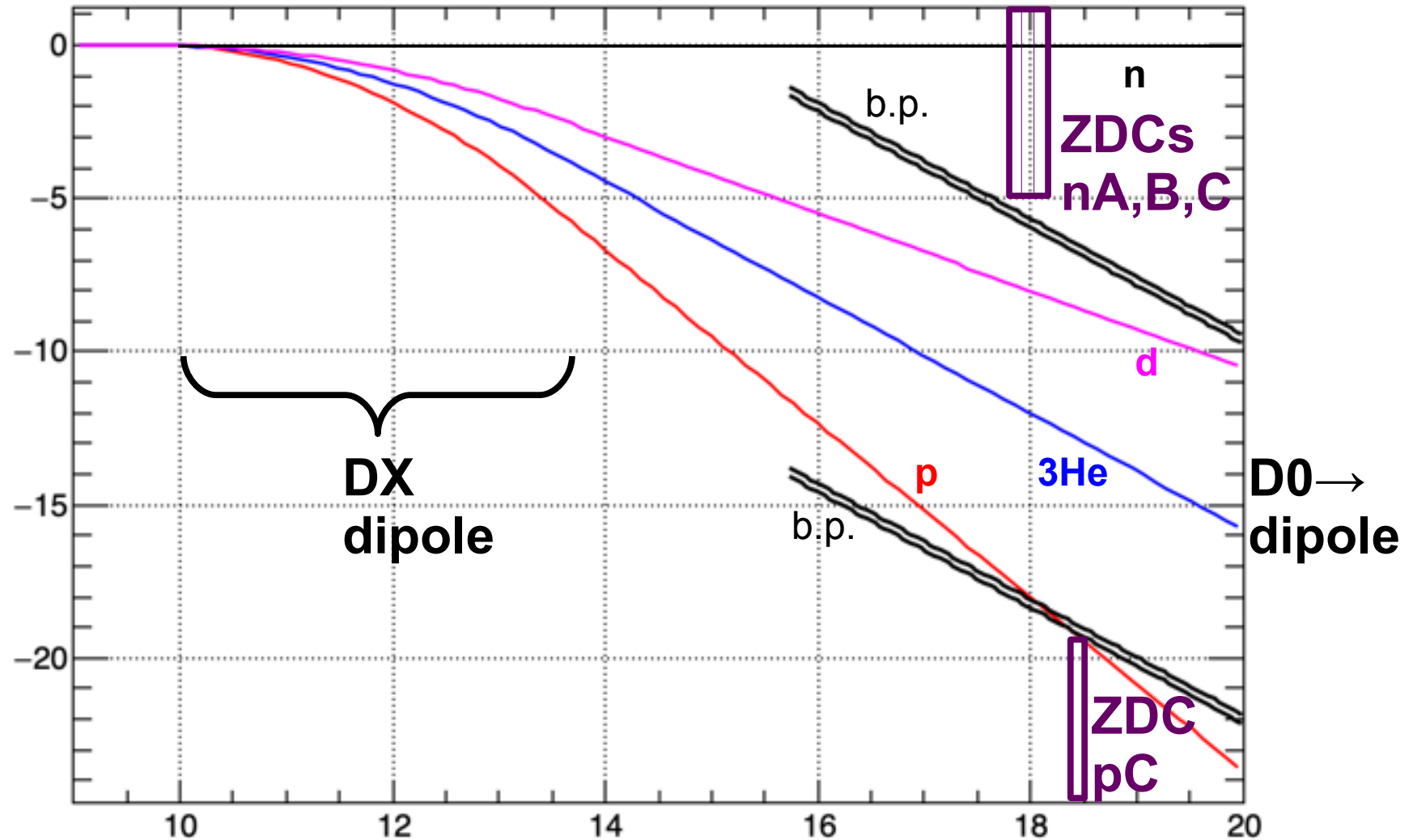- Each module 1.7 interaction lengths

@ IP12:
- 3 modules stacked, between beampipes (usual config. at RHIC collider experiments)
- One outside of outgoing beam pipe

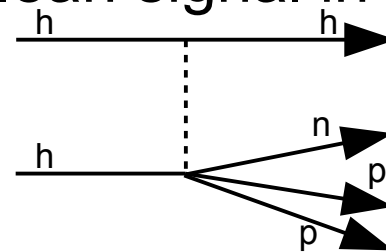- only 4 complete modules were available
- **nC**: PMT seems dead

soft mod: ID
nA: 108
nB: 109
nC: 110
pC: 111

Trajectories

- deuterons disappear down beam pipe (b.p.)
- protons scrape as exiting b.p., no clean signal in **pC**
- focus on breakup neutrons
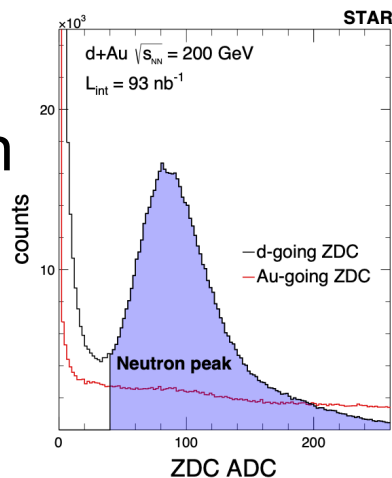 two working channels **nA**, **nB**

STAR ZDC spectra

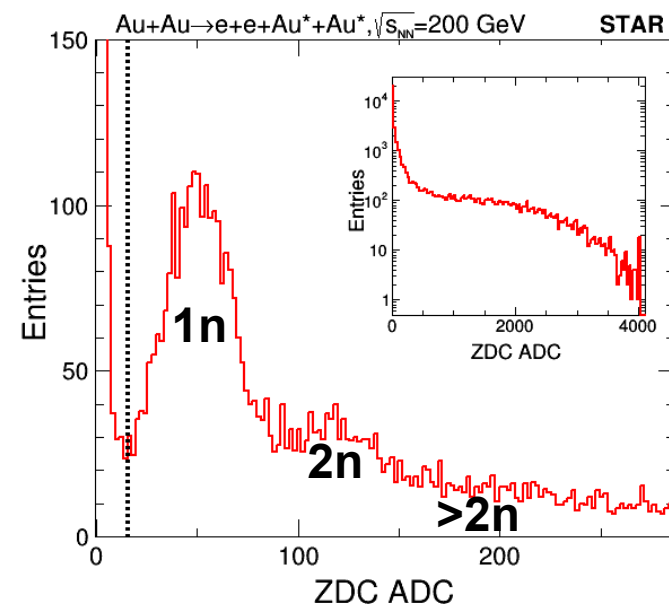- Identical modules @ STAR, example spectra: - calibrated sum 3 mods.
  - ADC scales vary

2016 dAu RHIC run

- Single neutron from deuteron breakup: 100 GeV neutron
- Should be ~same as single neutron from ^{3}He breakup

d+Au $\sqrt{s_{NN}}$ = 200 GeV
L_{int} = 93 nb^{-1}
STAR
counts
— d-going ZDC
— Au-going ZDC
Neutron peak
ZDC ADC

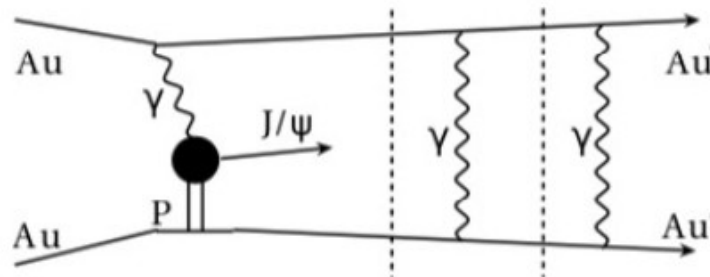**2016 AuAu RHIC run**

- Clear single neutron from Au breakup: 100 GeV neutron
- Should be ~same as single neutron from 3He breakup
- Inset: spectrum out to ~80 n

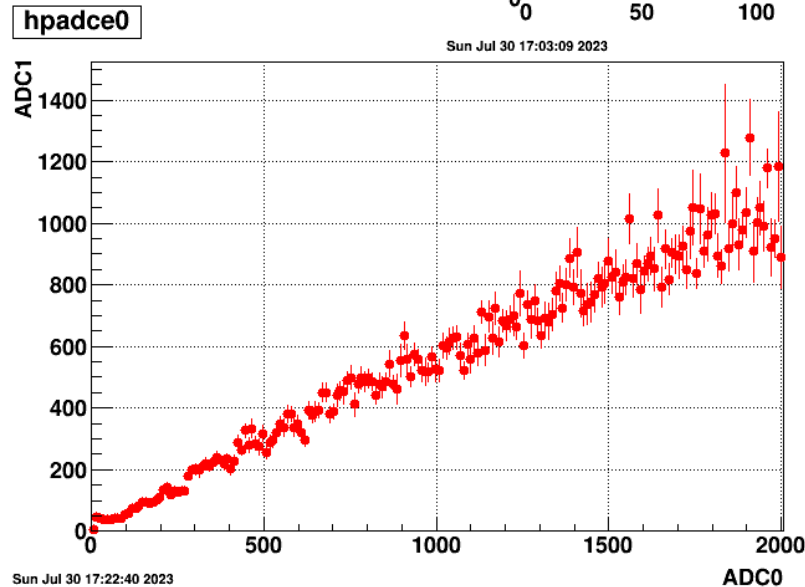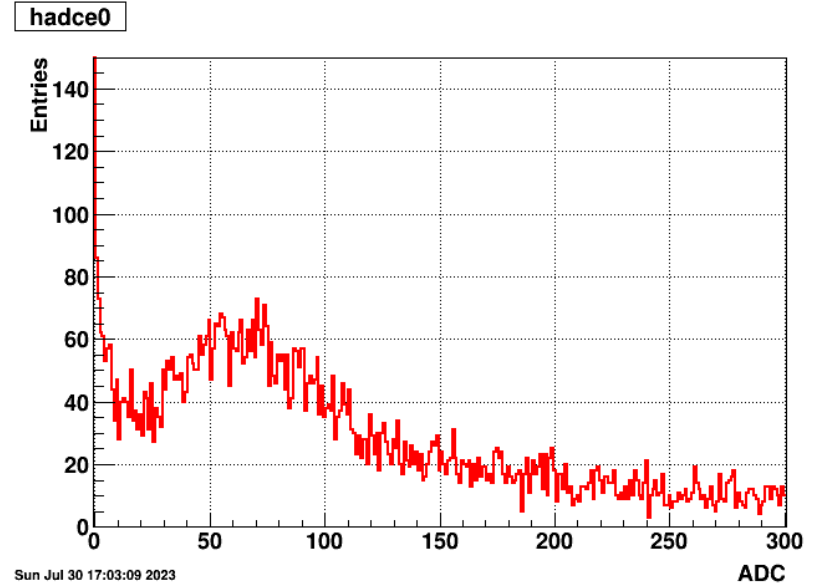Au+Au→e+e+Au*+Au*, $\sqrt{s_{NN}}$=200 GeV   STAR
Entries
1n
2n
>2n
ZDC ADC

Au breakup: Coulomb excitation

- Exchange soft photons
- Similar in pAu, p = HJet target
- High rate, calibrate ZDCs

Au γ J/ψ γ γ Au*
P   Au*

3

Calibration w/ Au beam

- From the same AuAu data previous slide

- Front module (**nA**) shows broader but still clear single neutron peak:

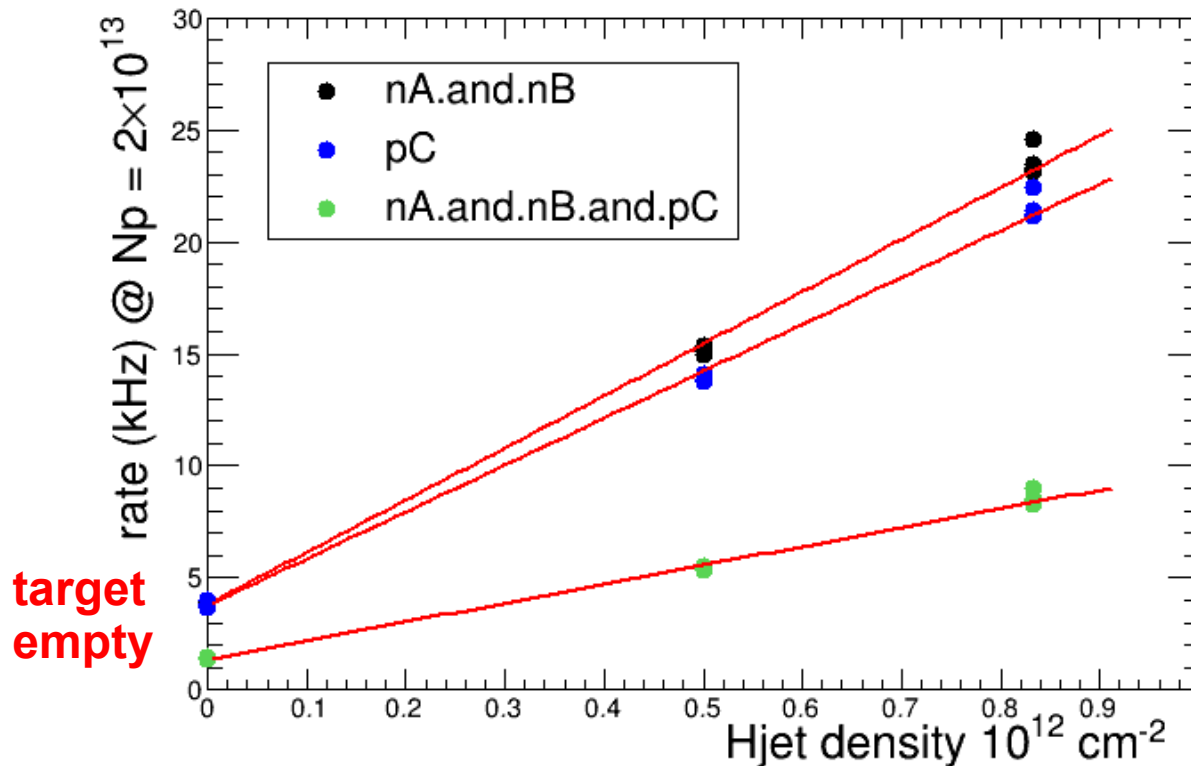- 2nd module (**nB**) ~linear relation vs. front (**nA**):

<u>Strategy</u>
- Once Hjet on OK, Au beam, **ZDCs self triggered**:
  HV scan, find single n peak in front module (**nA**)
- Have relative calibration **nB/nA**

4

HJet target on/off

- pp data (2022) showed clear 'target empty' rate:

- All rate measurements should include target off
  target on: HJet shutter open
  target off: HJet shutter closed

Measurements w/ ^{3}He beam

- The 3He-p breakup rate likely substantial,
  not all is CNI scattering w/ recoil in Hjet detector
- Need to measure total tagger rates:
  r_{tag} = (hits / bunch $\times$ing) $\Rightarrow$ accidental overlap rate

Measurements w/ ^{3}He beam
- Tagger rate
  DAQ: tagger self triggered
  1) Hjet on
  2) Hjet off
  Result: tagger r_{tag} = (tagger hits / bunch $\times$ing)
- Hjet recoil, tagger hits
  DAQ: Hjet recoil triggered, tagger readout
  3) Hjet on
  4) Hjet off
  Result: coincidence r_{coinc} = (recoil+tagger hits)/(recoil hits)
- If r_{coinc} > r_{tag} : signal for Hjet recoil w/ ^{3}He breakup

Needed ingredients

- DAQ & readout analysis:
   Seems in good shape as Andrei showed

- Hjet target:
   - has not run so far this year
   - Grigor was going to turn on this week
   - status?

- ^{3}He beam, email from Haixin last Friday:
   "We plan to do it this year. The major problem
    was that the EEBIS source took time to be
    commissioned for He3 beam. I will check
    when I come back from my vacation to see
    when we can do it."

Cabling / channels

ZDCs @ IP12

Cables & HV & VME readout 2023+

Section	module	HV cable	BiRa	signal cable	p.p.*	ADC ch.**	offline ID
ZDCnA	1-8	30732	CHAN0	30742	2	12	108
ZDCnB	1-7	30733	CHAN1	30743	3	13	109
ZDCnC	1-9	30734	CHAN2	30744	4	14	110
ZDCpC	1-10	30739	CHAN3	30749	9	15	111

* patch panel Rack 4, below BiRa HV unit
** VME ADC module 4th from left