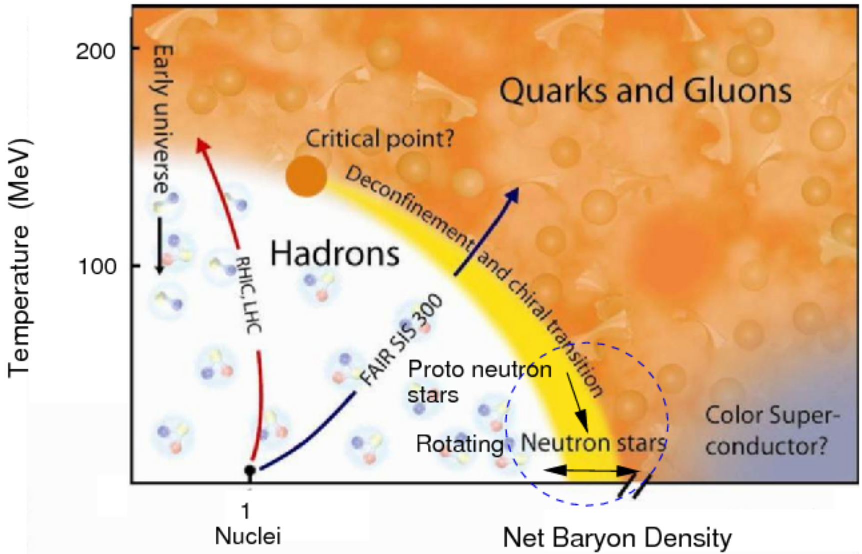
Multi-Strange baryon production at FAIR energies

Hushnud Jahan

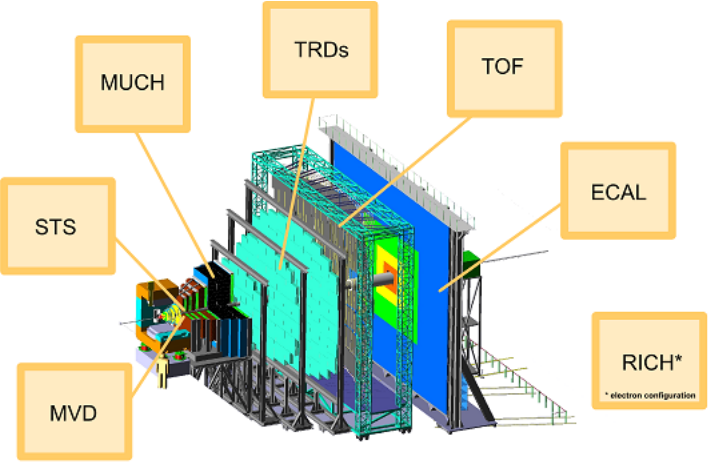
Department of Physics
Aligarh Muslim University
Aligarh-202002
India

3 Feb 2015

Outline


Temperature (MeV)
200
100
Early universe
RHIC, LHC
FAIR SIS 300
Critical point?
Quarks and Gluons
Hadrons
Deconfinement and chiral transition
Proto neutron stars
Rotating Neutron stars
Color Super-conductor?
1
Nuclei
Net Baryon Density

Introduction(CBM Experiment set-up)



Introduction(cont...)

Heavy Ion Collisions

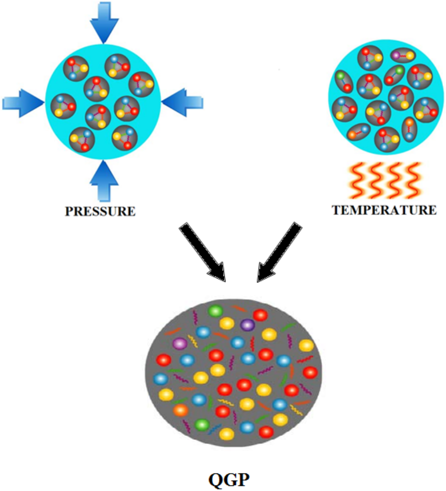
Lorentz-contracted nuclei approach

Nuclei collide. Binary collisions between quarks and gluons can produce jets or heavy quarks

Quarks and gluons freed, plasma formed

Plasma expands and cools, quarks and gluons form bound states (particles)

Introduction(cont...)

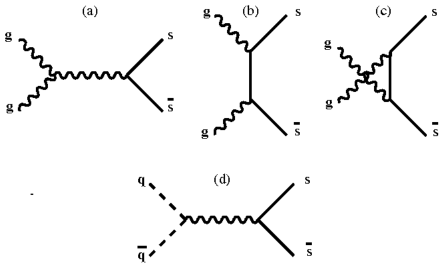


- Dilepton production
- J/ψ supression
- Direct photon
- **Strangeness enhancement**
- Hanbury-Brown-Twiss effect

Measured by the relative enhaancement of yields ratio in A+A collisions compared to p+p collisions/ central to peripheral collisions.

Production mechanism : 1) **N+N** → *N*+Λ+**K**

2)



Strange Particle production mechanism (cont.)

- more production of $s\bar{s}$ in dense baryonic matter → enhanced production of strange particle (having more than one strange quarks)
- strangeness enhancement observed experimentally at AGS, SPS and RHIC energies
- more enhancement at lower energy
- at lower energy region only strange particle with strangeness upto 2 are measured experimentally
- CBM experiment, capability of handling high interaction rate → detect particles with very low cross-section
- performed model base systematic study of the production of strange particle with varying strangeness.

Strange Particle production mechanism (cont.)

- more production of $s\bar{s}$ in dense baryonic matter → enhanced production of strange particle (having more than one strange quarks)
- strangeness enhancement observed experimentally at AGS, SPS and RHIC energies
- more enhancement at lower energy
- at lower energy region only strange particle with strangeness upto 2 are measured experimentally
- CBM experiment, capability of handling high interaction rate → detect particles with very low cross-section
- performed model base systematic study of the production of strange particle with varying strangeness.

Strange Particle production mechanism (cont.)

- more production of $s\bar{s}$ in dense baryonic matter → enhanced production of strange particle (having more than one strange quarks)
- strangeness enhancement observed experimentally at AGS, SPS and RHIC energies
- more enhancement at lower energy
- at lower energy region only strange particle with strangeness upto 2 are measured experimentally
- CBM experiment, capability of handling high interaction rate → detect particles with very low cross-section
- performed model base systematic study of the production of strange particle with varying strangeness.

Strange Particle production mechanism (cont.)

- more production of $s\bar{s}$ in dense baryonic matter → enhanced production of strange particle (having more than one strange quarks)
- strangeness enhancement observed experimentally at AGS, SPS and RHIC energies
- more enhancement at lower energy
- at lower energy region only strange particle with strangeness upto 2 are measured experimentally
- CBM experiment, capability of handling high interaction rate → detect particles with very low cross-section
- performed model base systematic study of the production of strange particle with varying strangeness.

Strange Particle production mechanism (cont.)

- more production of $s\bar{s}$ in dense baryonic matter → enhanced production of strange particle (having more than one strange quarks)
- strangeness enhancement observed experimentally at AGS, SPS and RHIC energies
- more enhancement at lower energy
- at lower energy region only strange particle with strangeness upto 2 are measured experimentally
- CBM experiment, capability of handling high interaction rate → detect particles with very low cross-section
- performed model base systematic study of the production of strange particle with varying strangeness.

Strange Particle production mechanism (cont.)

- more production of $s\bar{s}$ in dense baryonic matter → enhanced production of strange particle (having more than one strange quarks)
- strangeness enhancement observed experimentally at AGS, SPS and RHIC energies
- more enhancement at lower energy
- at lower energy region only strange particle with strangeness upto 2 are measured experimentally
- CBM experiment, capability of handling high interaction rate → detect particles with very low cross-section
- performed model base systematic study of the production of strange particle with varying strangeness.

Energy range = 5-90 A GeV

Central Au+Au collision

No of Events = 1 Million

Rapidity cut = $-0.5 < y < 0.5$

Model Used

Transport Model AMPT (both default and string melting mode)

Statistical model

- THERMUS model
- THERMINATOR

Input parameters(cont...)

Input parameters for AMPT model

- Lund string parameters; a = 2.2 and b = 0.5 $/\mathrm{GeV}^2$
- parton screening mass = 1.8 (1/fm) corresponds to cross section 10mb
- strong coupling constant $\alpha_s = 0.47$

Input parameters for THERMUS model

Ratio of particle and antiparticle yield

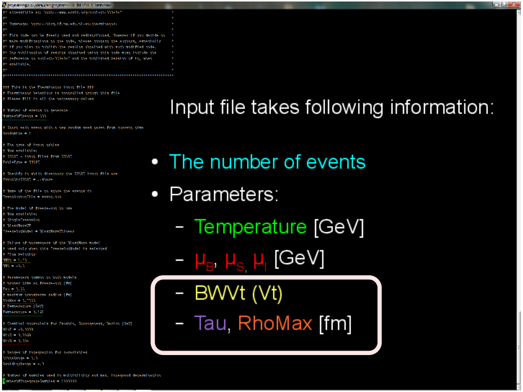
Input parameters for THERMINATOR model

- PPT by **Krzysztof Brzeziński** for STAR Regional Meeting

  $\rho_{max} = 2.003 \log(0.4041\sqrt{s_{NN}})$ fm

  $V_t = \frac{1}{132.2\sqrt{(2\pi)}} \exp^{-\frac{\sqrt{(s_{NN}+45.99)^2}}{34593.98}}$

  $\tau = const = 9.91 fm$
- THERMUS model



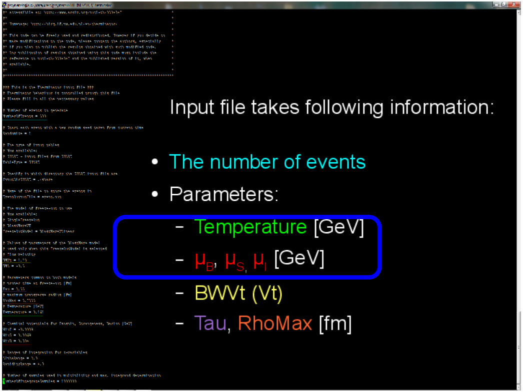
Input parameters for THERMINATOR model

- PPT by **Krzysztof Brzeziński** for STAR Regional Meeting

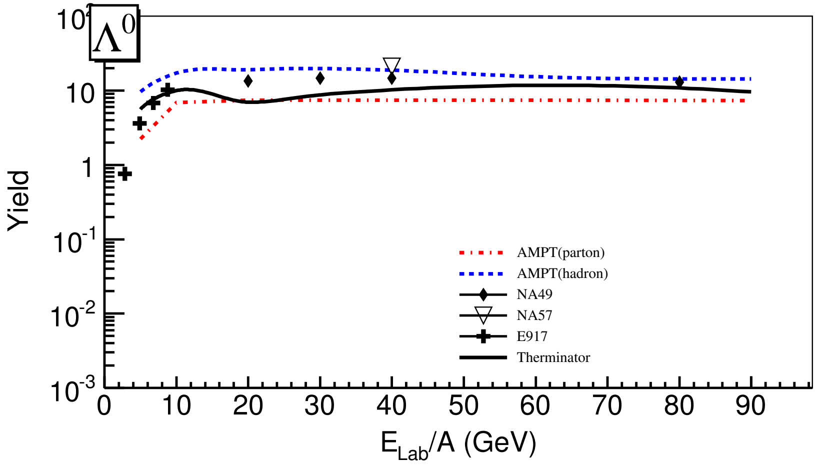
  $\rho_{max} = 2.003 \log(0.4041\sqrt{s_{NN}})$ fm

  $V_t = \frac{1}{132.2\sqrt{(2\pi)}} \exp^{-\frac{\sqrt{(s_{NN}+45.99)}^2}{34593.98}}$

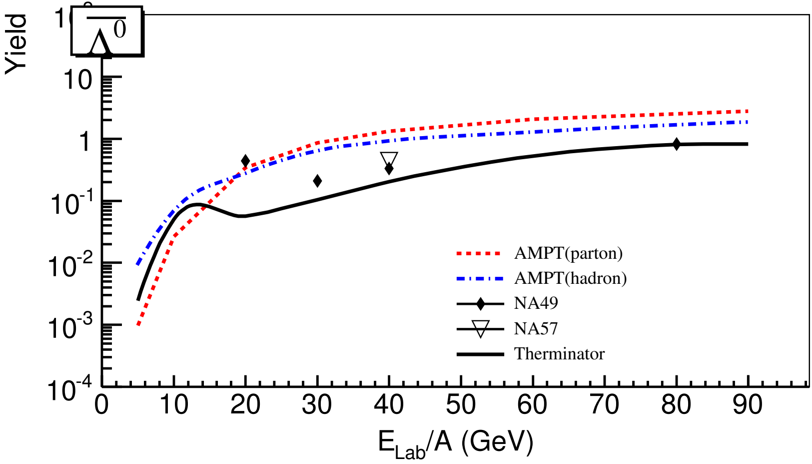
  $\tau = const = 9.91 fm$
- THERMUS model



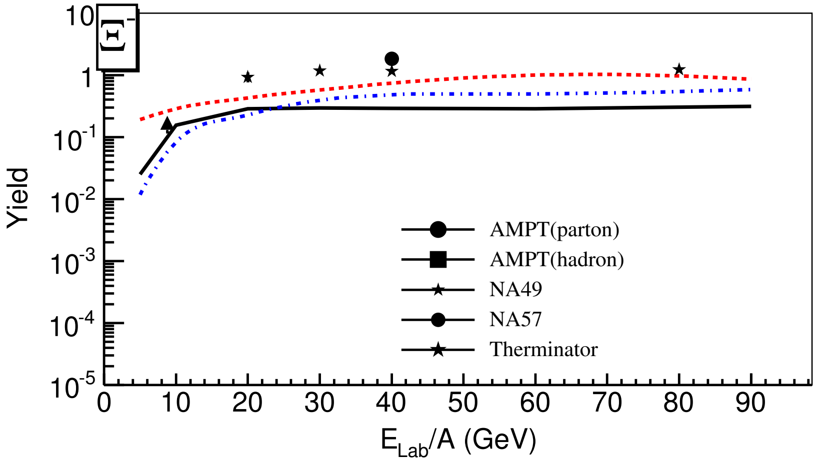
Energy dependence of yields



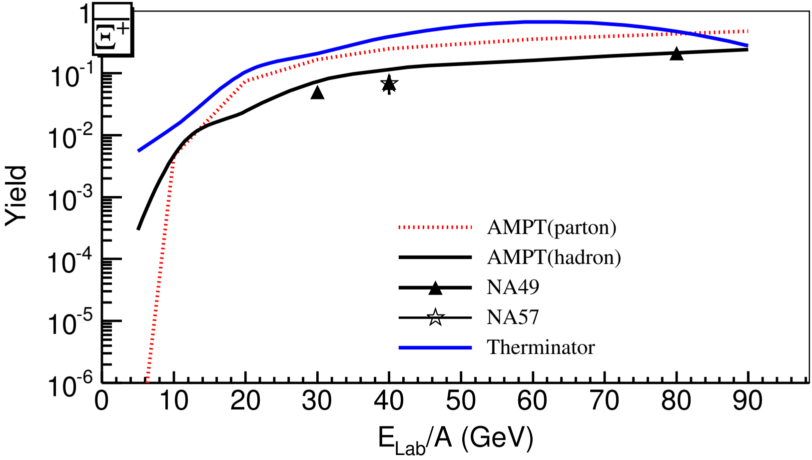
Energy dependence of yields



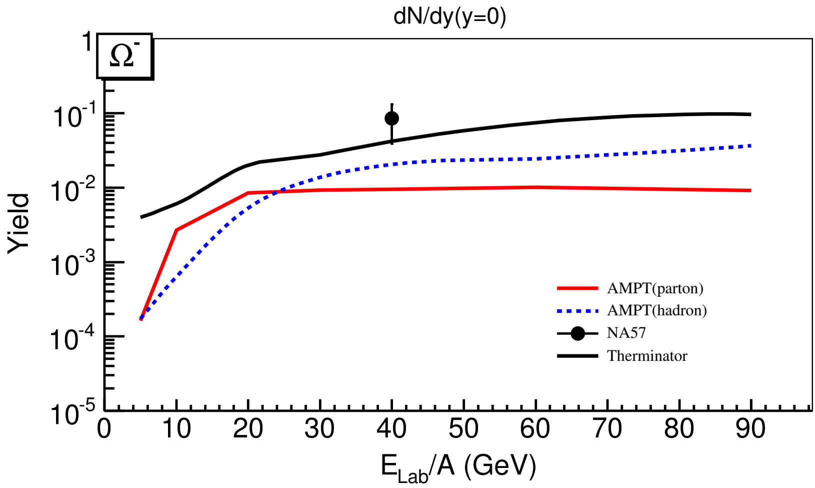
Energy dependence yields(cont.)



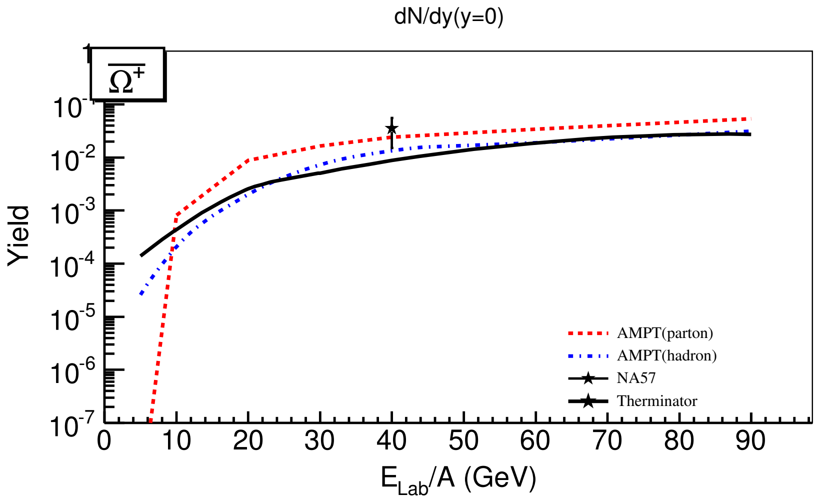
Energy dependence yields(cont.)



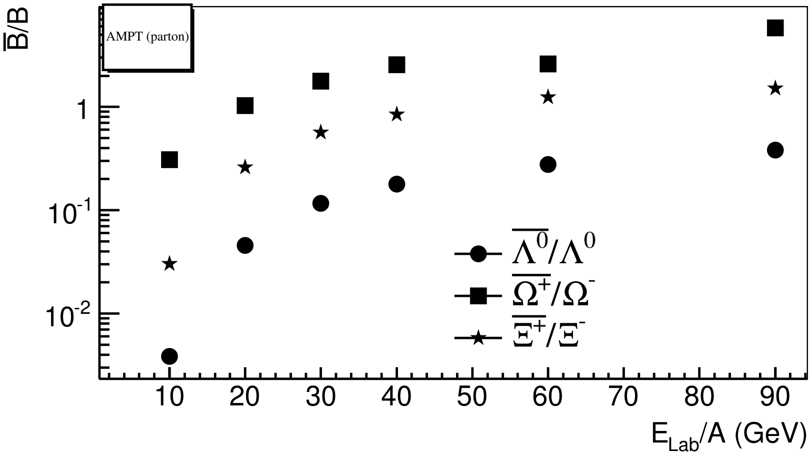
Energy dependence yields(cont.)



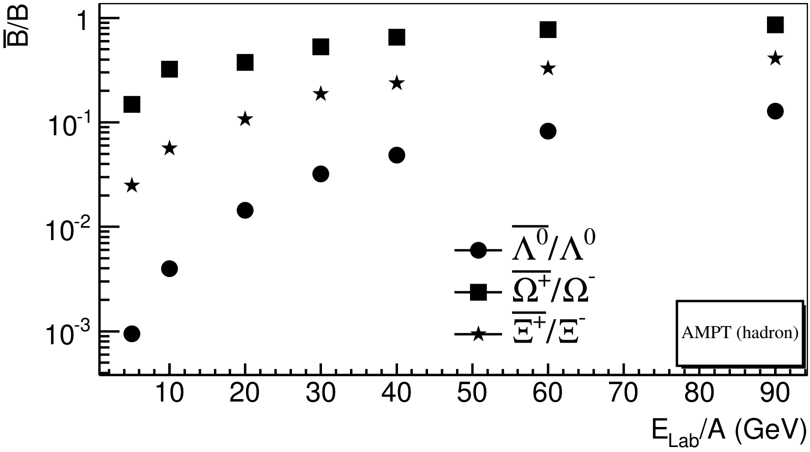
Energy dependence yields(cont.)



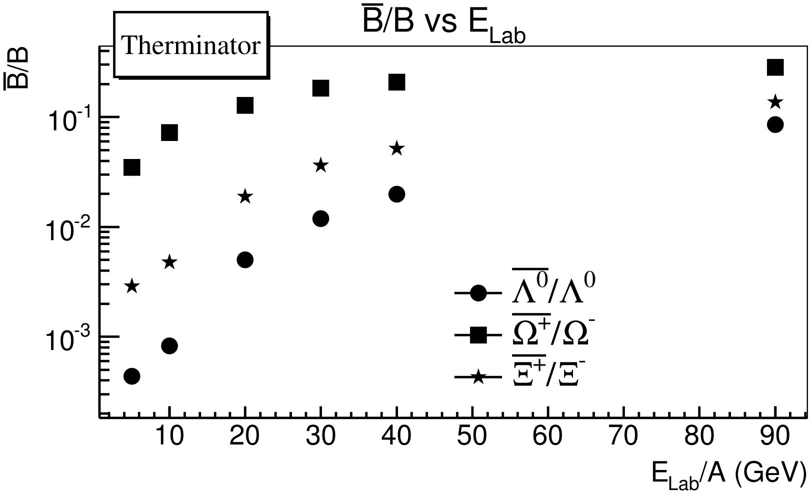
Energy Dependence of particle ratios (cont.)



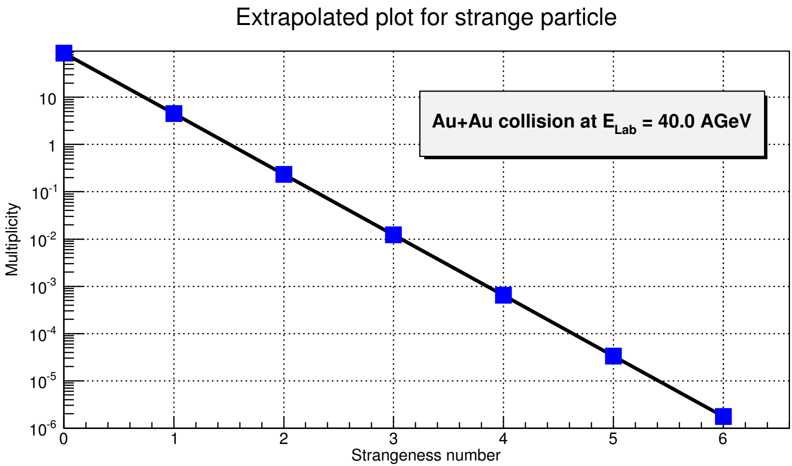
Energy Dependence of particle ratios (cont.)



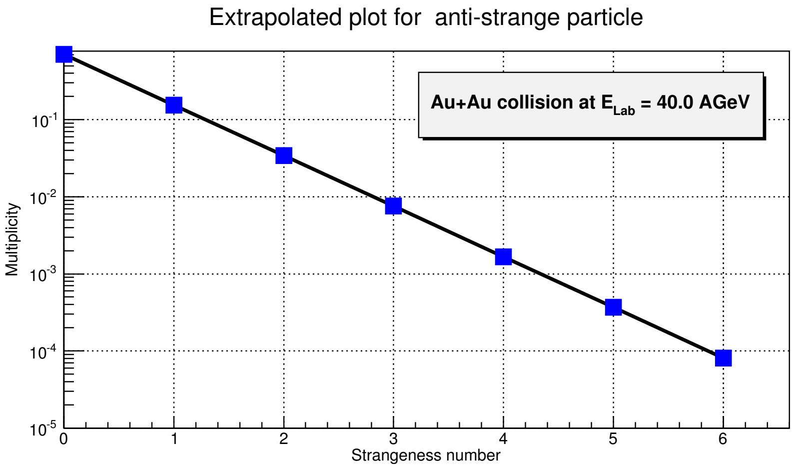
Energy Dependence of particle ratios (cont.)



Results (cont.)



Results (cont.)



Summary

- All models shows strangeness enhancement upto $E_{LAB} = 20$ AGeV before saturation
- THERMINATOR and AMPT partonic mode show enhanced strange particle production respectively
- AMPT partonic mateches well with increasing strangeness number and anti-starnge data matches well with THERMINATOR model
- AMPT partonic model show more production of anti-particle with increasing energy
- Yields of strange (antistrange) objects with 6 quarks is almost (10^{-6}) 10^{-4},thus FAIR is ideal place for investigating them.

- S. Chattopadhyay
- VECC collaborators
- Shabir Ahmad
- Kalyan Dey


Thank You!