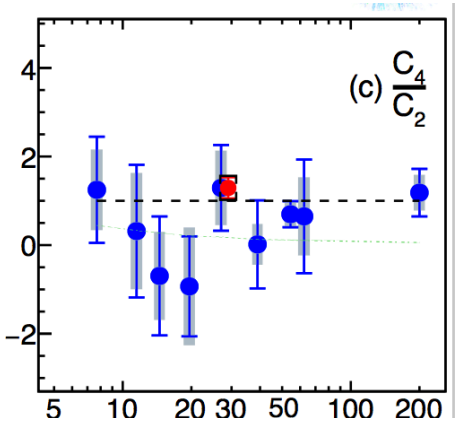
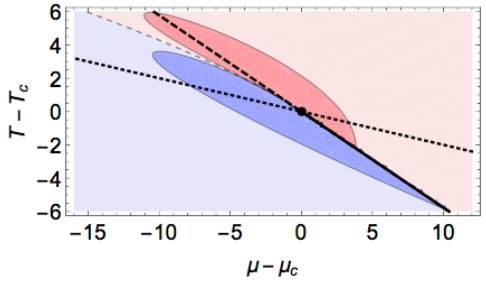
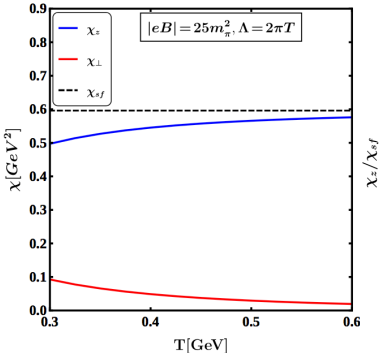
Session: Relativistic heavy-ion physics & QCD – VI

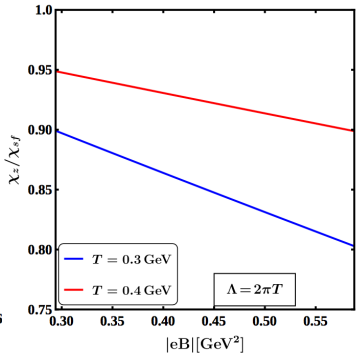
Prof. Lokesh Kumar, Chair of the session on Relativistic Heavy-ion collisions and QCD said : *All talks were excellent and contained interesting results. The session was dominated by the talks related to QCD critical point. Some of the highlights of the session are:*

- *Ashish Pandav presented new measurements of cumulants of net-kaon distributions and their ratios in BES-II, and found them consistent with the established energy dependence trend.*
- *Maneesha S. Pardeep presented universality of the critical point mapping between Ising model and QCD at small quark mass. Results suggest that skewness which can be measured in heavy-ion collisions could provide clue to the values of nonuniversal parameters mapping of the QCD phase diagram to that of the Ising model.*
- *Bithika Karmakar presented anisotropic pressure and quark number susceptibility (QNS) of strongly magnetized QCD medium. Results suggest that the presence of magnetization causes the system to be anisotropic, and two different pressures in directions parallel and perpendicular to the magnetic field are obtained. The (longitudinal) transverse second-order QNS is found to (increase) decrease with temperature and (decrease) increase with the increase of magnetic field.*









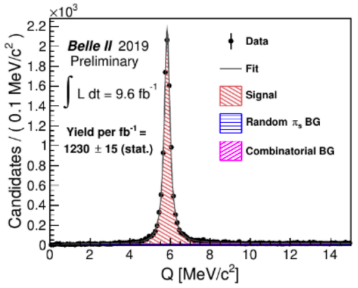
Slides: https://www.niser.ac.in/daehep2020/talkposter/Ashish_Pandav_TLK_381_258.pdf
https://www.niser.ac.in/daehep2020/talkposter/Maneesha%20Sushama_Pradeep_TLK_123_422.pdf
https://www.niser.ac.in/daehep2020/talkposter/Bithika_Karmakar_TLK_421_535.pdf

$D^0 \to K_s\pi^+\pi^-$ Belle II prospectus

Uncertainty due to Dalitz model

$$x = (0.56 \pm 0.19^{+0.03+0.06}_{-0.09-0.09})\%$$
$$y = (0.30 \pm 0.15^{+0.04+0.03}_{-0.05-0.06})\%$$

$$|q/p| = 0.90^{+0.16+0.05+0.06}_{-0.15-0.04-0.05}$$
$$arg(q/p) = (-6 \pm 11^{+3+3}_{-3-4})^\circ$$



BELLE2-NOTE-PL-2020-010

Data	stat.	syst. red.	syst. irred.	Total	stat.	syst. red.	syst. irred.	Total
		σ_x (10^{-2})				σ_y (10^{-2})		
976 fb^{-1}	0.19	0.06	0.11	0.20	0.15	0.06	0.04	0.16
5 ab^{-1}	0.08	0.03	0.11	0.14	0.06	0.03	0.04	0.08
50 ab^{-1}	0.03	0.01	0.11	0.11	0.02	0.01	0.04	0.05
		$\|q/p\|$ (10^{-2})				ϕ (°)		
976 fb^{-1}	15.5	5.2-5.6	7.0-6.7	17.8	10.7	4.4-4.5	3.8-3.7	12.2
5 ab^{-1}	6.9	2.3-2.5	7.0-6.7	9.9-10.1	4.7	1.9-2.0	3.8-3.7	6.3-6.4
50 ab^{-1}	2.2	0.7-0.8	7.0-6.7	7.0-7.4	1.5	0.6	3.8-3.7	4.0-4.2

Systematic uncertainty start dominating at ~5 ab^{-1}.

Can this be avoided ?

The Belle II Physics Book, PTEP2019, 12, 123C01 (2019)

Measuring strong phase variation across Dalitz plane using coherent $D^0\overline{D}^0$ pairs (BESIII).

Forward-Backward Asymmetry $A^l_{FB}(q^2)$

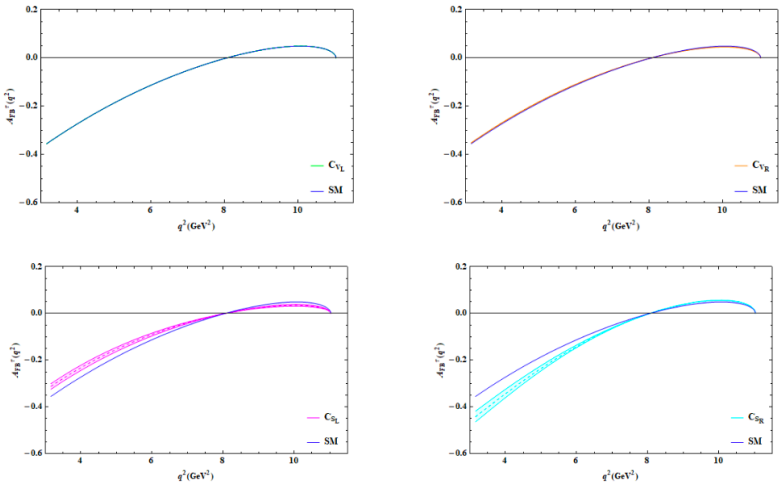
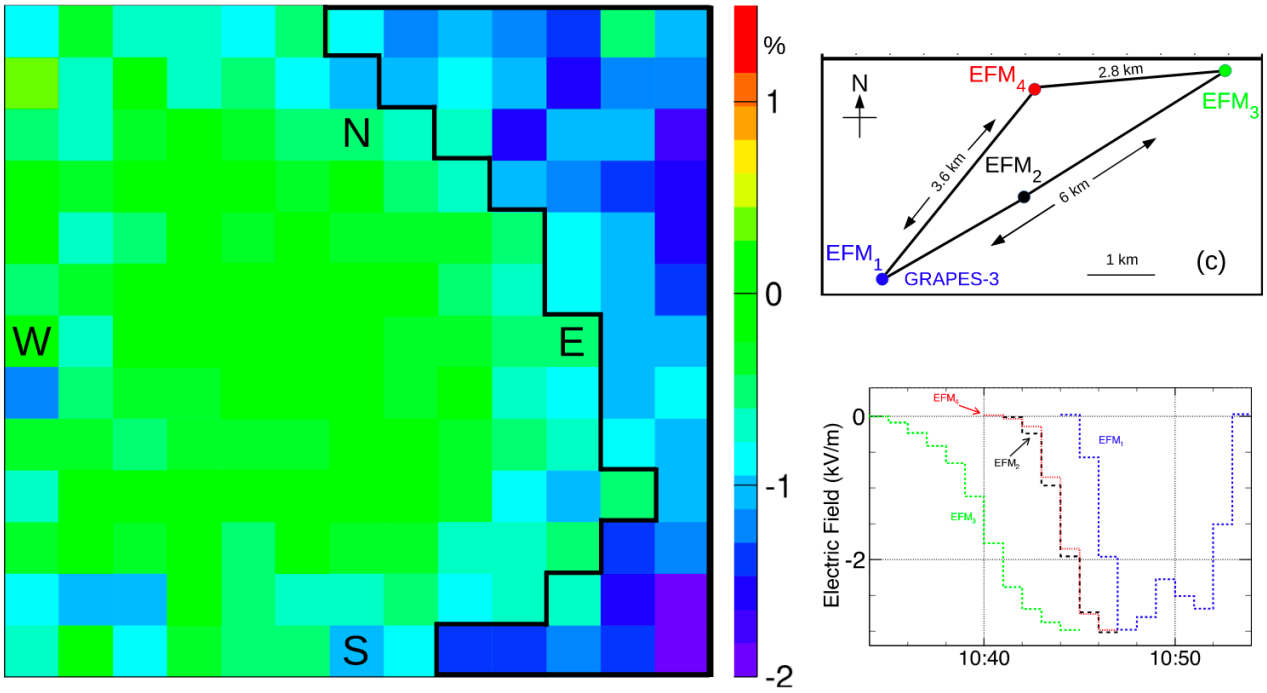


Figure 9: The Forward-Backward Asymmetry of the charged lepton $A^\tau_{FB}(q^2)$ for the $\Xi_b \to \Xi_c \tau^- \overline{\nu}_\tau$ in different NP scenarios.

Prof. Seema Bahinipati, Chair of the session on Standard Model physics and beyond said: "Mixing parameters in the charm decays of D0 to Ks pi+ pi- will be systematics-dominated at Belle II with the huge data set of 5 ab-1. The results from BESIII on the strong phase variation across the Dalitz plane will play a pivotal role in constraining the systematic errors. This nice symbiosis amongst the various charm factories is highly appreciable. We foresee a future of excellent precision measurements in the charm sector. [V. Bharadwaj's talk]. The theoretical predictions for various q2-dependent observables, such as differential branching fractions, forward-backward asymmetry of charged lepton, convexity parameters in b-baryon decays with different New Physics scenario will motivate experimentalists to analyse these modes. These b-baryon modes will act as complementary decay modes to the widely analysed B-meson decay channels to probe hints of physics beyond Standard Model. [Haritha C. P.'s talk]."

Slide: https://www.niser.ac.in/daehep2020/talkposter/Vishal_Bhardwaj_699_795.pdf and https://www.niser.ac.in/daehep2020/talkposter/HARITHA_C%20P_TLK_382_699.pdf

Muon image of event 1st Dec 2014



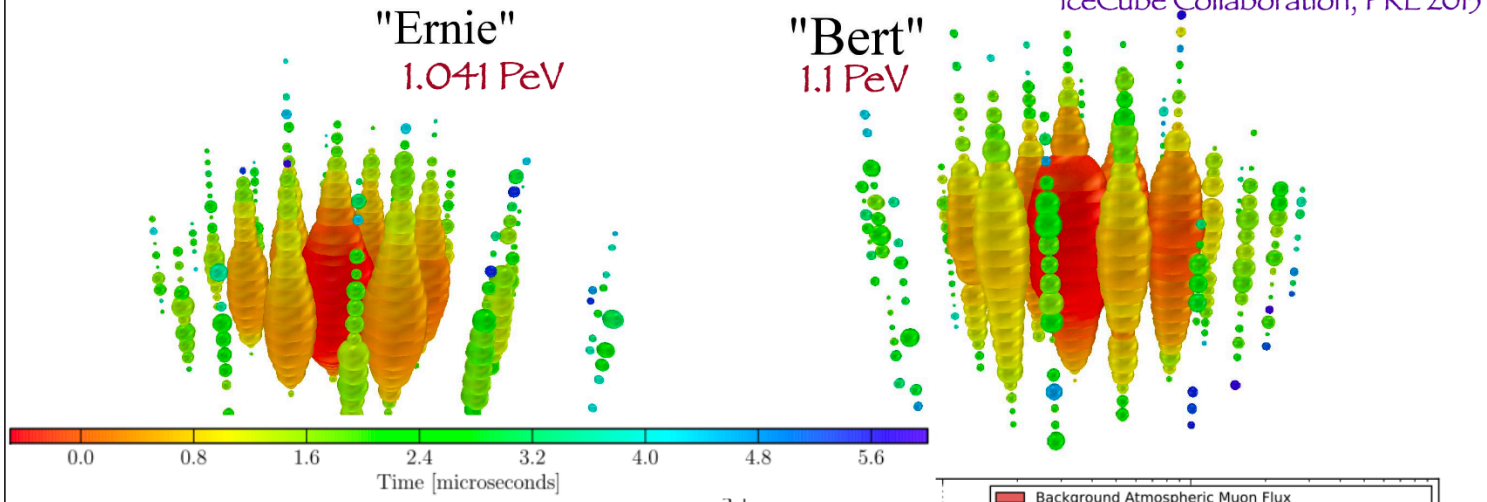
18 minutes 45 directions

Prof. Pravat Kumar Mohanty, Chair of the session on Particle Astrophysics and Cosmology said: "Thunderstorms are one of leading causes of fatalities by natural disasters. However, the formation and large potential obtained by thunderstorms is poorly understood. The talk by B. Hariharan discussed that the GRAPES-3 experiment has made the first ever measurement of thunderstorm potential exceeding a Gigavolt using the most sensitive muon telescope, which has confirmed the prediction by the Nobel Laureate C.T.R. Wilson in 1929. This could also possibly explain the production of highest energy gamma rays in the terrestrial gamma ray flashes. Detailed studies of a large number of thunderstorm events observed by the GRAPES-3 experiment could provide better insight into this least explained phenomena."

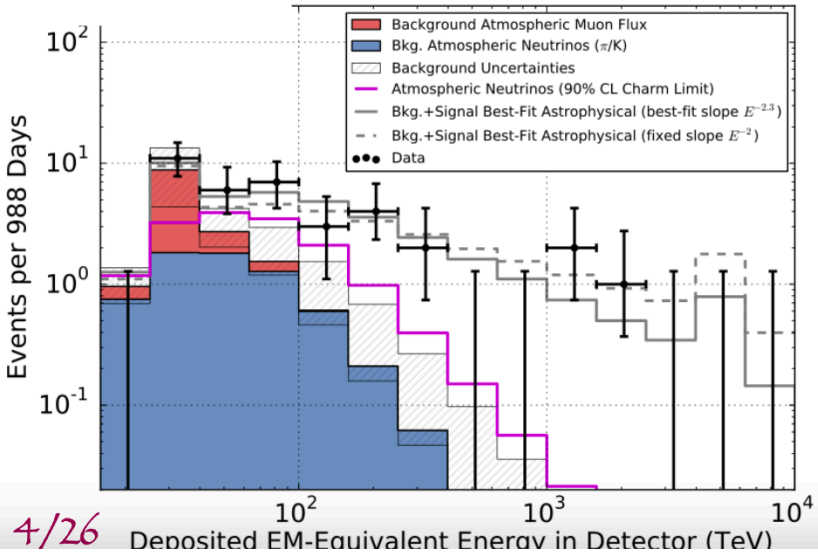
Slide:
https://www.niser.ac.in/daehep2020/talkposter/Hari%20Haran_Balakrishnan_TLK_11_322.pdf

IceCube high energy starting neutrino events (HESE)

IceCube Collaboration, PRL 2013



- Rejecting only background origin with 5.7σ level.
- Total 37 events, 28 cascades, 9 tracks of which 2 coincident muon event.
- Over background expectation $15.0^{+7.2}_{-4.5}$ of which atmospheric muons 8.4 ± 4.2 and atmospheric neutrinos $6.6^{5.9}_{-1.6}$.



IceCube Collaboration, PRL 2014 4/26

Prof. Tanumoy Mandal, Chair of the session on Neutrino Physics said: "This session was dedicated to neutrino physics. In the mini-review talk, Dr. Reetanjali Maharana nicely discussed the possible correlations of cosmic neutrinos detected by the IceCube and ultra-high-energy cosmic ray events detected by PAO and TA. In their statistical analysis, they found high correlations between them. This suggests that possibly they are originating from the same astrophysical sources. There were also interesting discussions by other speakers of this session on non-standard neutrino interactions, merits of second oscillation peak, and sensitivity of neutrino unknowns at DUNE."
Slides:

Vector LQ $U_1^\mu(3,1,2/3)$: 1609.04367, 2004.09464,1511.06024, $\cdots$

- Vector LQ $U_1^\mu(3,1,2/3)$ with $Y = 2/3$ and $F = 0$ can mediate $b \to s\ell\ell$ and $b \to c\ell\nu$
- The int. Lagrangian of U_1^μ LQs with the SM fermion bilinear in int basis

$$\mathcal{L} \quad = \quad \left(h_{1L}^{ij}\bar{Q}_{iL}\gamma^\mu L_{jL} + h_{1R}^{ij}\bar{d}_{iR}\gamma^\mu l_{jR}\right) U_{1\mu},$$

- Down type quark fields are rotated into the mass basis by the V_{CKM}
- Fierz transformation gives new WC to the $b \to c\tau\bar{\nu}$,

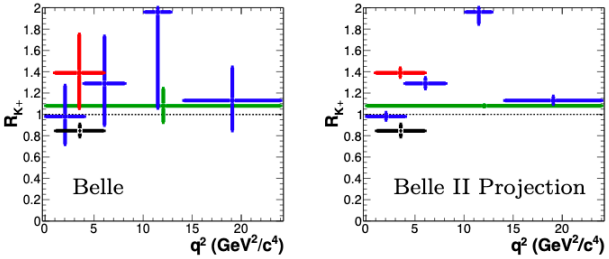
$$C_{V_1} = \frac{1}{2\sqrt{2}G_F V_{cb}} \sum_{k=1}^{3} V_{k3}\left[\frac{h_{1L}^{2l} h_{1L}^{k3*}}{M^2_{U_1^{2/3}}}\right],$$

- The new WC for $b \to s\ell\ell$

$$C_9^{NP} = -C_{10}^{NP} = \frac{\pi}{\sqrt{2}G_F V_{tb}V_{ts}^*\alpha}\left[\frac{h_{1L}^{2l} h_{1L}^{k3*}}{M^2_{U_1^{2/3}}}\right]$$

R_{K^+} Projection for Belle II

- Belle II is successor of Belle experiment and is expected to collect 50 times (50 ab^{-1}) more data compared to its predecessor by early 2030, so far we have collected $\sim$ 75fb^{-1} of data.
- The Belle result of R_{K^+} is projected to Belle II, assuming same central value as Belle.
- R_{K^+} is measured for [0.1 , 4.0], [4.0 , 8.12], [1.0 , 6.0], [10.2, 12.8], $>$ 14.18, and $>$ 0.1 GeV$^2/c^4$ bins. The LHCb R_{K^+} result for [1.1 , 6.0] GeV$^2/c^4$ is shown as black marker.



- The statistical uncertainty of Belle II will be $< 2\%$ for whole q^2 region.
- For $q^2 \in [1.0, 6.0]$ GeV$^2/c^4$ bin, considering same central value of Belle, the R_{K^+} of Belle II will deviate from LHCb [PRL 122, 191801 (2019)] by $> 10\sigma$.

Prof. Jim Libby, Chair of the session on Standard model and Beyond said: "Rukmana Mohanta and the details in the talk by Suchismita Sahoo's in the same session and https://arxiv.org/abs/2004.09464 showed b->c tau nu and b->s l l anomalies explained with a vector leptoquark model, further adding a scalar diquark with the SM gauge symmetry will generate neutrino mass too. Seema Choudhury discussed latest results on R_K anomaly from Belle presented and the long term prospects with Belle II when 2% precision will be reached are shown. Such measurements are essential to resolving the B anomalies."
Slide: https://www.niser.ac.in/daehep2020/talkposter/Rukmani_Mohanta__828_789.pdf
and https://www.niser.ac.in/daehep2020/talkposter/Seema_Choudhury_TLK_115_526.pdf