NEEMC performance in arches and brycecanyon

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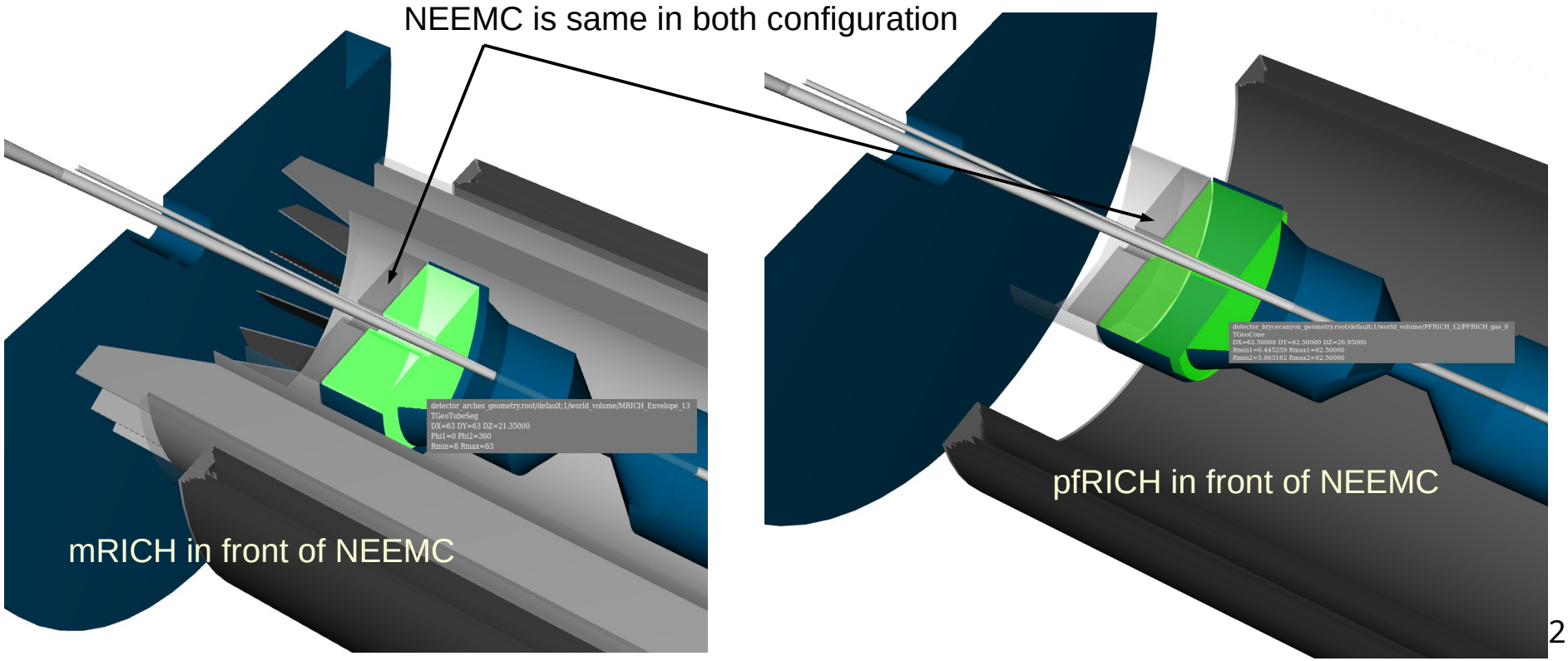
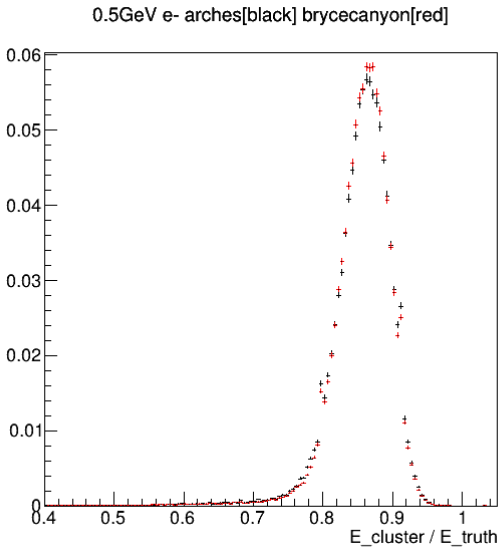
IJClab 08/12/2022

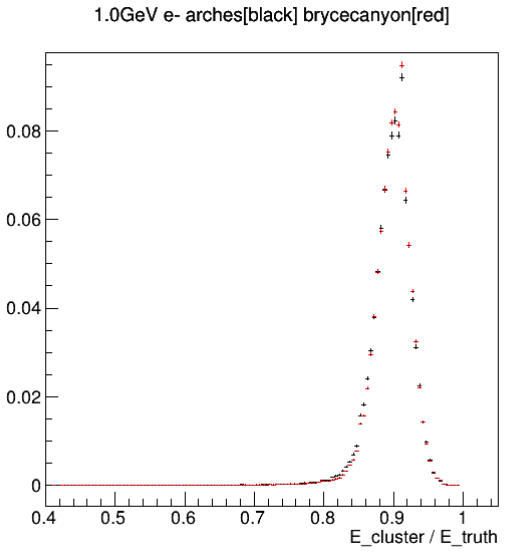
- Purpose: compare the performance of NEEMC in both arches and brycecanyon configuration
- Data from 22.11.2 arches and brycecanyon configuration eicrecon files
- Geometry cut on NEEMC: 15cm < r < 55cm (η: -3.14 ~ -1.87)

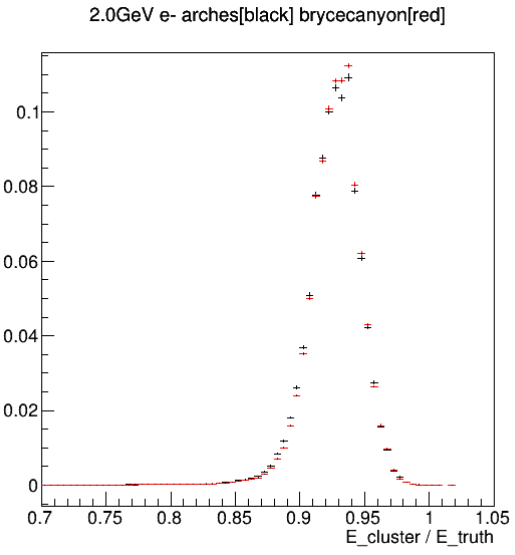


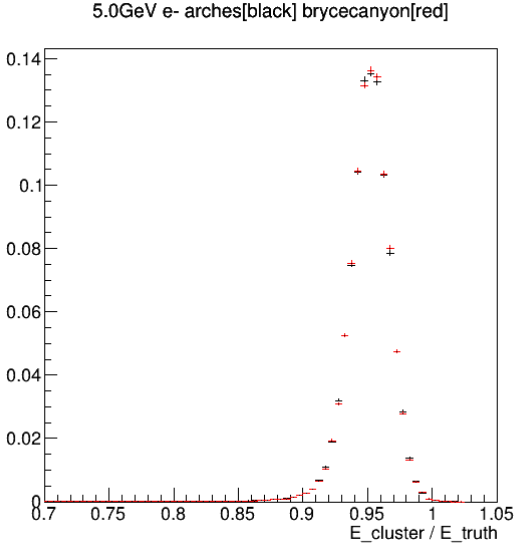
Arches configuration

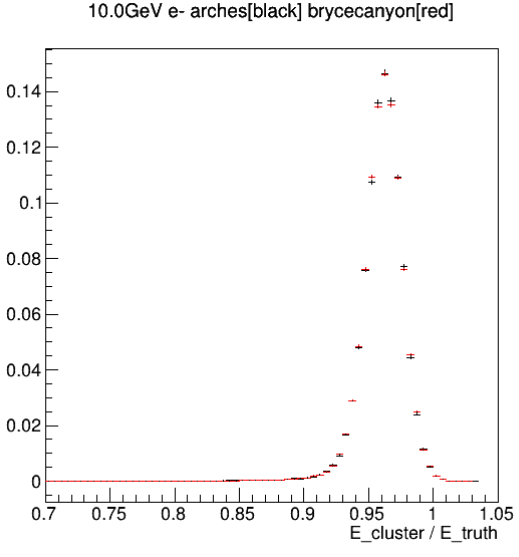
Brycecanyon configuration

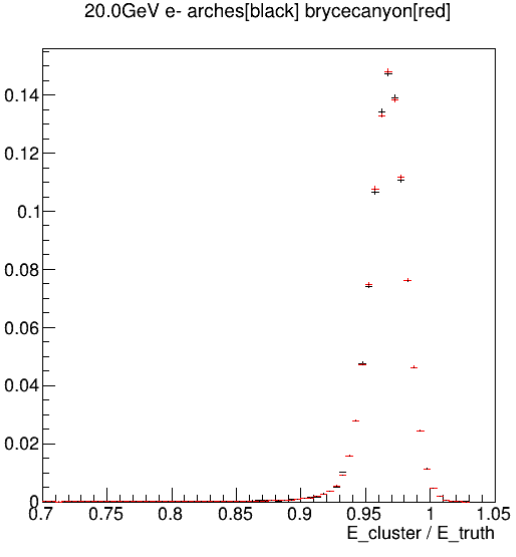






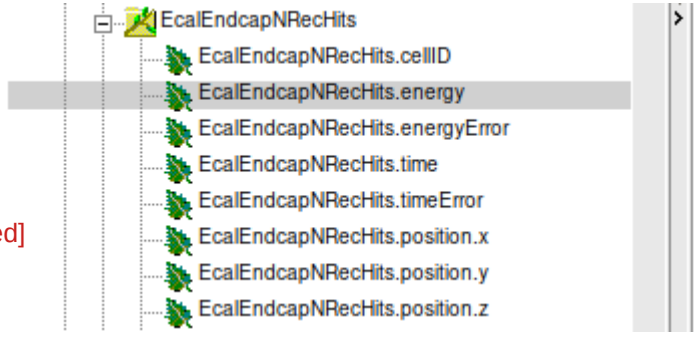






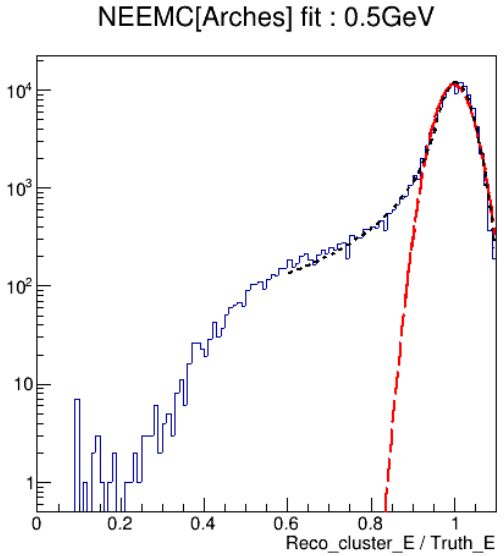
I found some problem in brycecanyon clustering, so I clustering the hits myself instead of official one.

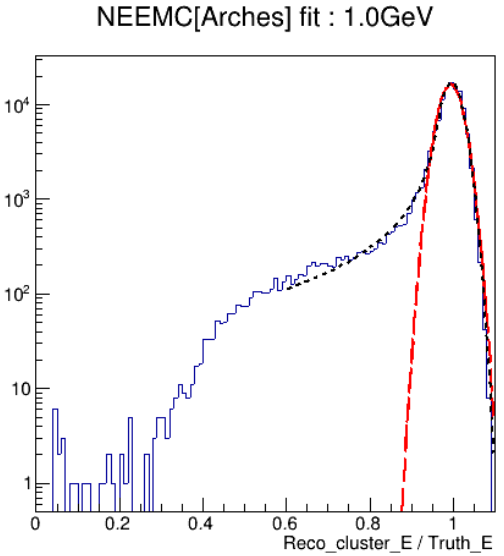
Simple island clustering:
- find the max energy hit and set it as seed
- clustering all hits around seed(radius <= 3 crystals)
hit energy threshold is 10MeV

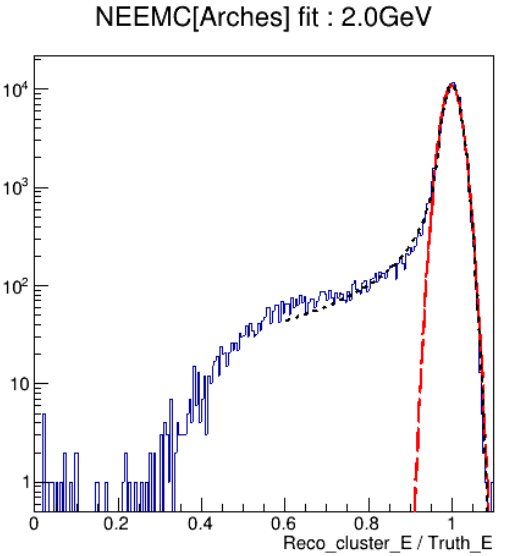


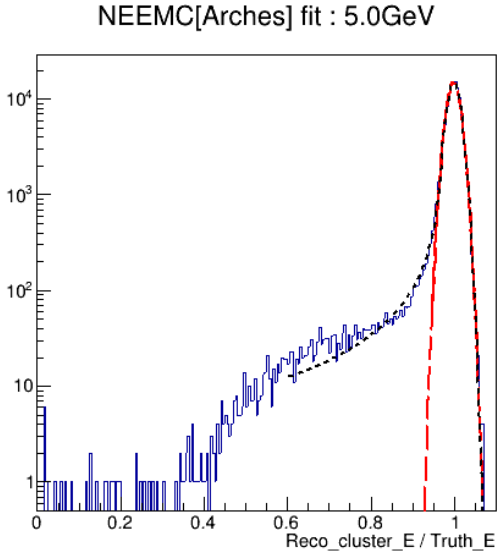
Arches[black]
Brycecanyon[red]
clustering E
are almost
identical

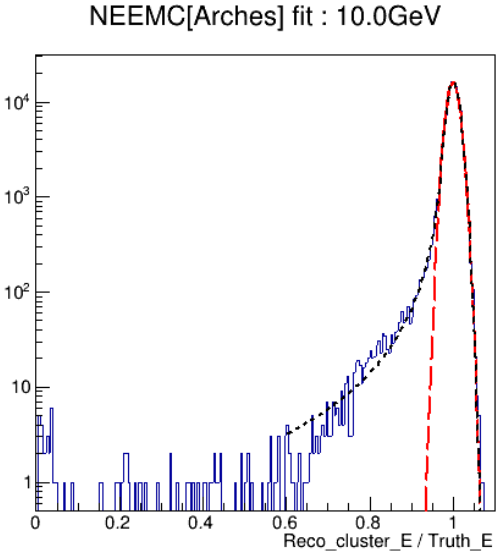
Gaussian[red dash] and **Crystalball[black dot]** fit of Arches configuration

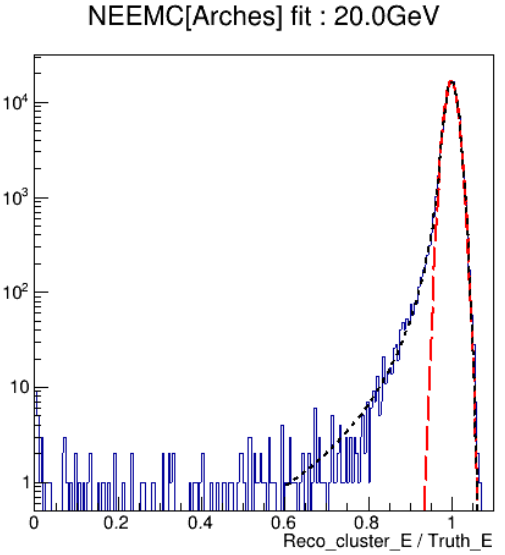












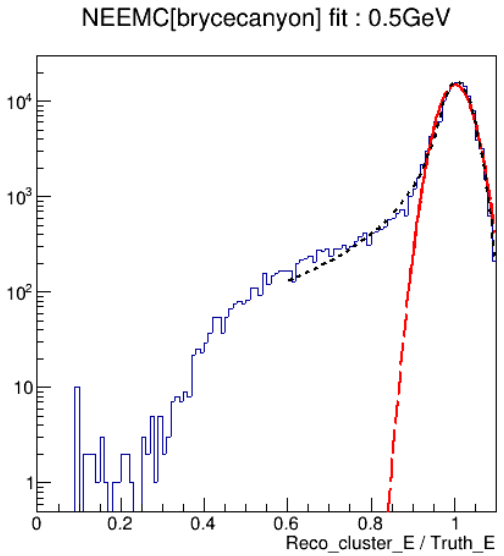
Crystalball function[wiki]:

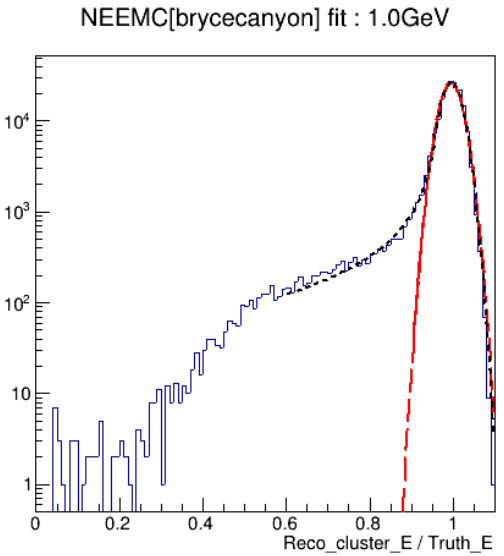
$$f(x;\alpha,n,\bar{x},\sigma) = N \cdot \begin{cases} \exp(-\frac{(x-\bar{x})^2}{2\sigma^2}), & \text{for } \frac{x-\bar{x}}{\sigma} > -\alpha \\ A \cdot (B - \frac{x-\bar{x}}{\sigma})^{-n}, & \text{for } \frac{x-\bar{x}}{\sigma} \leqslant -\alpha \end{cases}$$

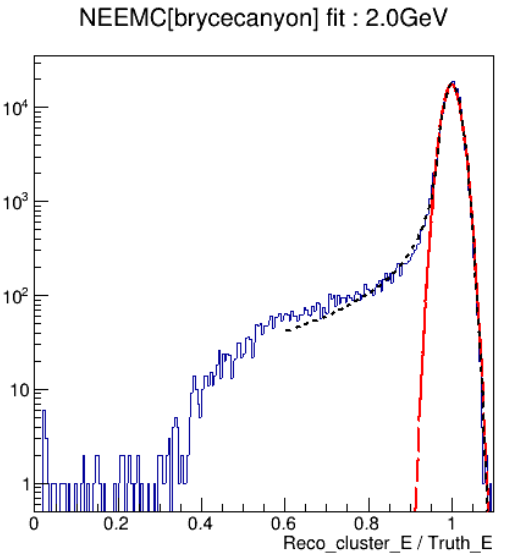
$$A = \left(\frac{n}{|\alpha|}\right)^n \cdot \exp\left(-\frac{|\alpha|^2}{2}\right),$$

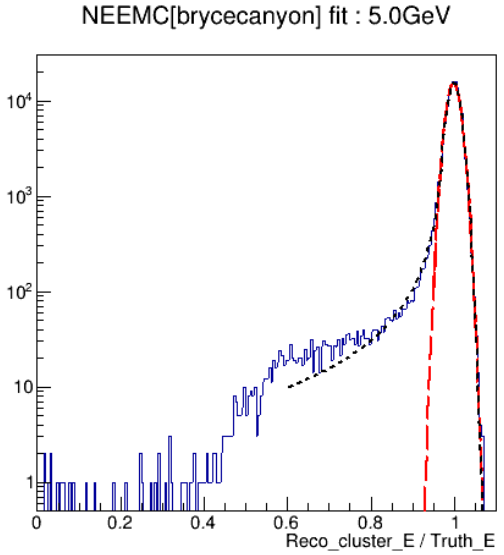
$$B = \frac{n}{|\alpha|} - |\alpha|,$$

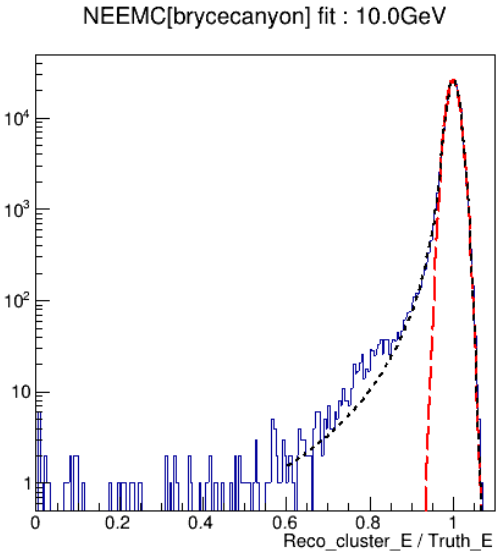
Gaussian[red dash] and **Crystalball[black dot]** fit of Arches configuration

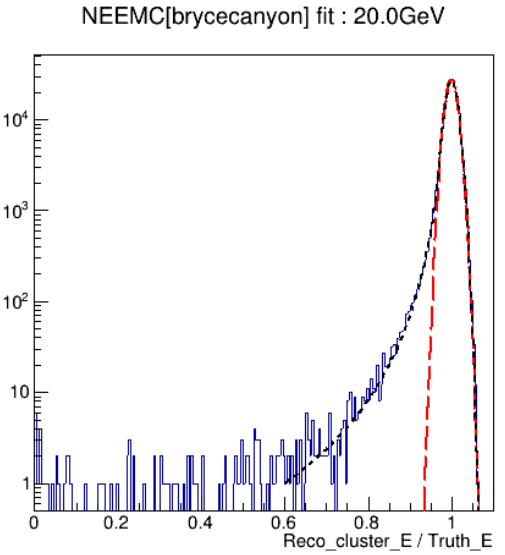


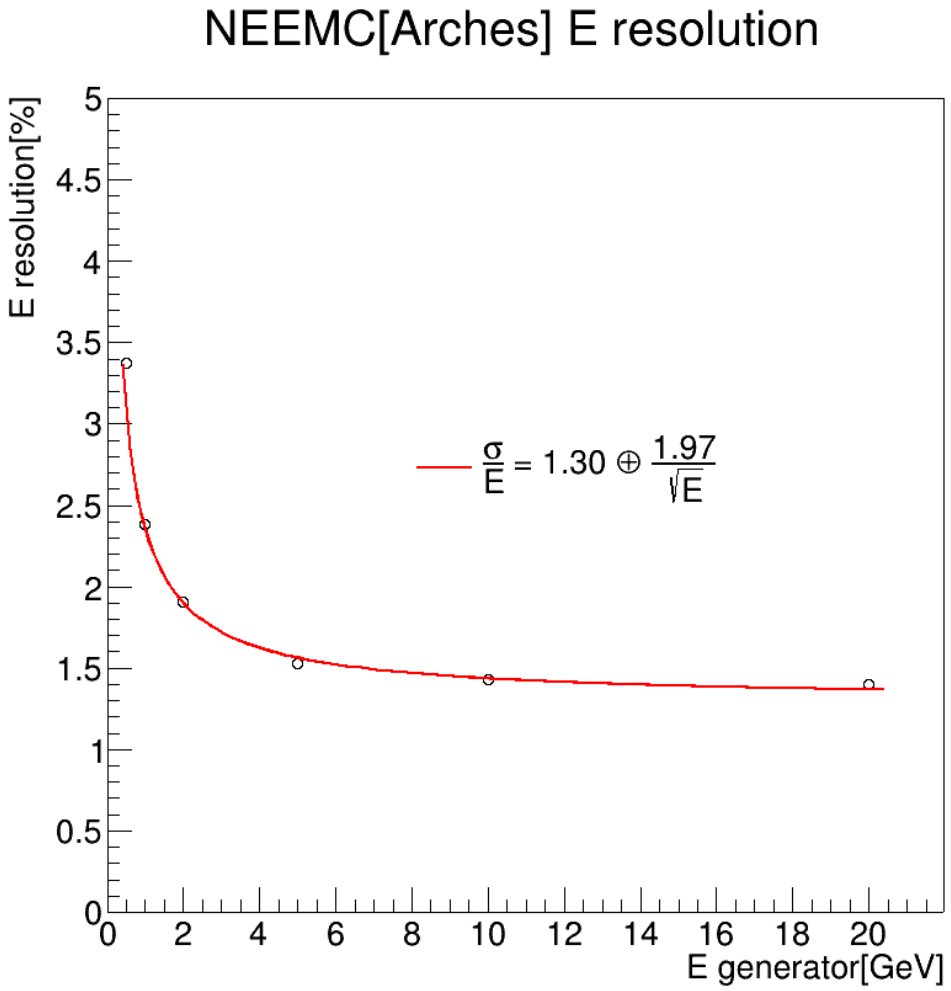


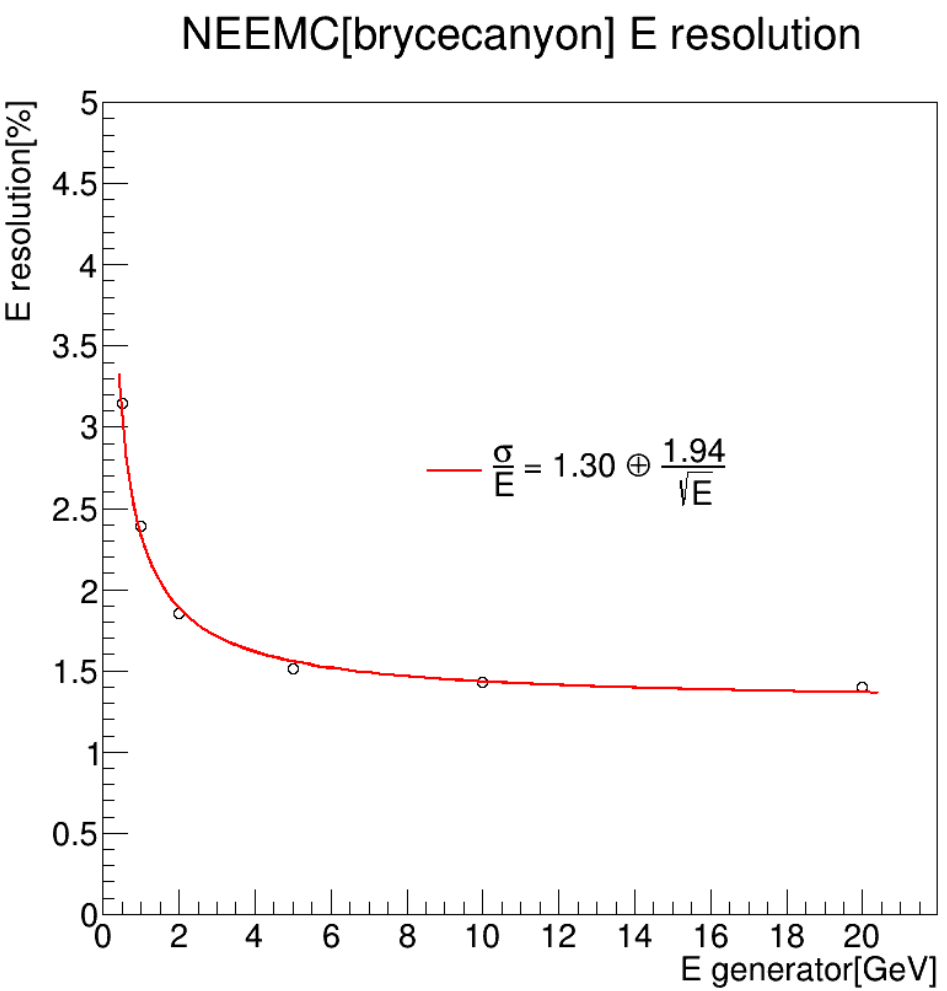












Both E resolution calculated from the sigma parameter of crystalball fit

No significant difference on energy resolution, which agrees with material scan results

31	AcrylicOptical	6	12.399	1.1800	34.3636	64.0375	0.033	139.00	0.072290	0.027226	(0.00, 33.71,-134.85)
32	AirOptical	7	14.784	0.0012	30528.8407	71998.1725	2.541	141.54	0.072374	0.027261	(0.00, 34.33,-137.32)
33	PyrexGlassOptical	10	20.495	2.2300	12.6748	43.5474	0.500	142.04	0.111832	0.038746	(0.00, 34.45,-137.80)
34	PyrexGlass	10	20.495	2.2300	12.6748	43.5474	0.030	142.07	0.114200	0.039435	(0.00, 34.46,-137.83)
35	PyrexGlass	10	20.495	2.2300	12.6748	43.5474	0.030	142.10	0.116567	0.040124	(0.00, 34.47,-137.86)
36	AluminumOxide	11	21.812	3.8900	7.1825	25.6258	0.380	142.48	0.169487	0.054957	(0.00, 34.56,-138.23)
37	Fr4	8	16.698	1.8600	17.7433	45.4285	0.200	142.68	0.180762	0.059360	(0.00, 34.61,-138.42)
38	Copper	29	63.546	8.9600	1.4356	15.6778	0.010	142.69	0.187730	0.059998	(0.00, 34.61,-138.43)
39	Kapton	6	12.701	1.4300	28.3749	55.9194	0.020	142.71	0.188435	0.060356	(0.00, 34.61,-138.45)
40	AirOptical	7	14.784	0.0012	30528.8407	71998.1725	11.419	154.13	0.188809	0.060515	(0.00, 37.38,-149.53)
41	CarbonFiber	6	11.968	1.5000	28.0746	51.2277	0.100	154.23	0.192372	0.062467	(0.00, 37.41,-149.63)
42	AirOptical	7	14.784	0.0012	30528.8407	71998.1725	12.133	166.37	0.192769	0.062636	(0.00, 40.35,-161.40)
43	CarbonFiber	6	11.968	1.5000	28.0746	51.2277	0.103	166.47	0.196441	0.064648	(0.00, 40.37,-161.50)
44	Air	7	14.784	0.0012	30528.8407	71998.1725	1.335	167.80	0.196484	0.064666	(0.00, 40.70,-162.79)
45	StainlessSteel	26	55.380	8.3000	1.6774	16.2392	0.003	167.81	0.198021	0.064825	(0.00, 40.70,-162.80)
46	VM2000	8	15.811	1.4300	25.6110	59.7748	0.005	167.81	0.198222	0.064911	(0.00, 40.70,-162.80)
47	leadtungsten_optical	68	170.881	8.3000	0.8903	20.9592	2.265	170.08	2.742445	0.172985	(0.00, 41.25,-165.00)
48	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	170.10	2.743250	0.173330	(0.00, 41.25,-165.02)
49	Air	7	14.784	0.0012	30528.8407	71998.1725	0.082	170.18	2.743253	0.173331	(0.00, 41.27,-165.10)
50	Air	7	14.784	0.0012	30528.8407	71998.1725	0.082	170.26	2.743256	0.173332	(0.00, 41.29,-165.18)
51	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	170.28	2.744061	0.173677	(0.00, 41.30,-165.20)
52	leadtungsten_optical	68	170.881	8.3000	0.8903	20.9592	8.246	178.53	12.006308	0.567118	(0.00, 43.30,-173.20)
53	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	178.55	12.007113	0.567463	(0.00, 43.30,-173.22)
54	Air	7	14.784	0.0012	30528.8407	71998.1725	0.082	178.63	12.007115	0.567464	(0.00, 43.32,-173.30)
55	Air	7	14.784	0.0012	30528.8407	71998.1725	0.082	178.72	12.007118	0.567465	(0.00, 43.34,-173.38)
56	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	178.74	12.007923	0.567810	(0.00, 43.35,-173.40)
57	leadtungsten_optical	68	170.881	8.3000	0.8903	20.9592	8.246	186.98	21.270170	0.961251	(0.00, 45.35,-181.40)
58	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	187.00	21.270975	0.961596	(0.00, 45.35,-181.42)
59	CarbonFiber	6	11.968	1.5000	28.0746	51.2277	0.082	187.09	21.273912	0.963206	(0.00, 45.37,-181.50)
60	CarbonFiber	6	11.968	1.5000	28.0746	51.2277	0.082	187.17	21.276849	0.964816	(0.00, 45.39,-181.58)
61	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	187.19	21.277654	0.965160	(0.00, 45.40,-181.60)
62	leadtungsten_optical	68	170.881	8.3000	0.8903	20.9592	1.240	188.43	22.669886	1.024300	(0.00, 45.70,-182.80)
63	StainlessSteel	26	55.380	8.3000	1.6774	16.2392	0.003	188.43	22.671422	1.024458	(0.00, 45.70,-182.80)
64	Air	7	14.784	0.0012	30528.8407	71998.1725	6.180	194.61	22.671624	1.024544	(0.00, 47.20,-188.80)
0	Average Material	52	128.295	0.8853	8.5838	189.9477	194.610	194.61	22.671624	1.024544	(0.00, 47.20,-188.80)

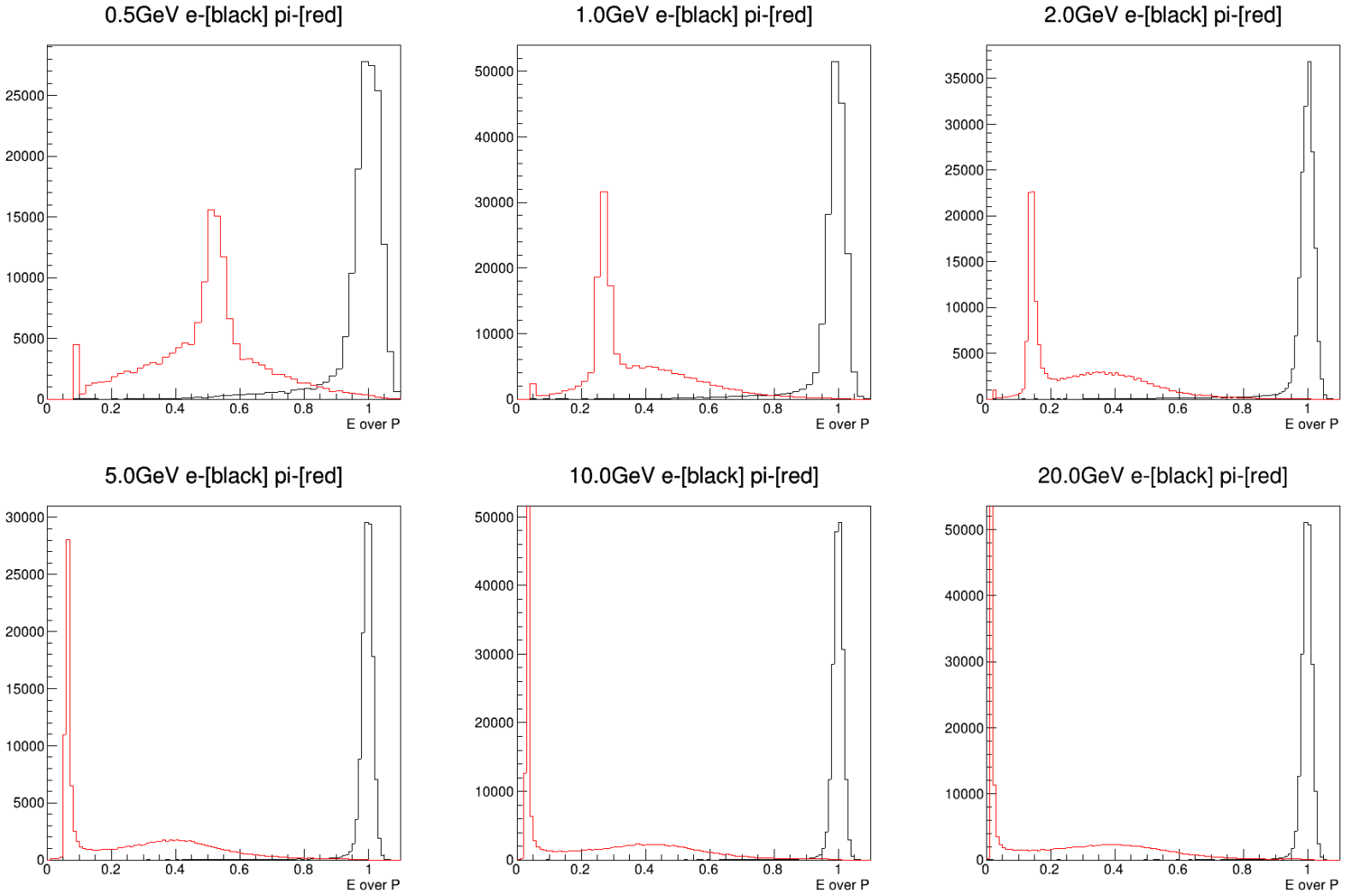
Arches config.
material scan
(0,0,0) – (0,50,-200)

Integrated rad. length
22.67 cm

31	AirOptical	7	14.784	0.0012	30528.8407	71998.1725	0.052	150.03	0.063985	0.024059	(0.00, 36.39,-145.55)
32	Aluminum	13	26.982	2.6990	8.8963	39.8672	0.515	150.54	0.121917	0.036987	(0.00, 36.51,-146.05)
33	Air	7	14.784	0.0012	30528.8407	71998.1725	6.958	157.50	0.122145	0.037084	(0.00, 38.20,-152.80)
34	Aluminum	13	26.982	2.6990	8.8963	39.8672	0.515	158.02	0.180078	0.050011	(0.00, 38.32,-153.30)
35	Air	7	14.784	0.0012	30528.8407	71998.1725	6.958	164.97	0.180306	0.050108	(0.00, 40.01,-160.05)
36	Aluminum	13	26.982	2.6990	8.8963	39.8672	0.515	165.49	0.238239	0.063035	(0.00, 40.14,-160.55)
37	C4F10_PFRICH	8	17.588	0.0099	3475.0176	9353.6609	0.876	166.37	0.238491	0.063129	(0.00, 40.35,-161.40)
38	Aluminum	13	26.982	2.6990	8.8963	39.8672	0.103	166.47	0.250077	0.065715	(0.00, 40.37,-161.50)
39	Air	7	14.784	0.0012	30528.8407	71998.1725	1.335	167.80	0.250121	0.065733	(0.00, 40.70,-162.79)
40	StainlessSteel	26	55.380	8.3000	1.6774	16.2392	0.003	167.81	0.251658	0.065892	(0.00, 40.70,-162.80)
41	VM2000	8	15.811	1.4300	25.6110	59.7748	0.005	167.81	0.251859	0.065978	(0.00, 40.70,-162.80)
42	leadtungsten_optical	68	170.881	8.3000	0.8903	20.9592	2.265	170.08	2.796082	0.174051	(0.00, 41.25,-165.00)
43	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	170.10	2.796887	0.174396	(0.00, 41.25,-165.02)
44	Air	7	14.784	0.0012	30528.8407	71998.1725	0.082	170.18	2.796890	0.174398	(0.00, 41.27,-165.10)
45	Air	7	14.784	0.0012	30528.8407	71998.1725	0.082	170.26	2.796893	0.174399	(0.00, 41.29,-165.18)
46	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	170.28	2.797697	0.174744	(0.00, 41.30,-165.20)
47	leadtungsten_optical	68	170.881	8.3000	0.8903	20.9592	8.246	178.53	12.059944	0.568185	(0.00, 43.30,-173.20)
48	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	178.55	12.060749	0.568530	(0.00, 43.30,-173.22)
49	Air	7	14.784	0.0012	30528.8407	71998.1725	0.082	178.63	12.060752	0.568531	(0.00, 43.32,-173.30)
50	Air	7	14.784	0.0012	30528.8407	71998.1725	0.082	178.72	12.060755	0.568532	(0.00, 43.34,-173.38)
51	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	178.74	12.061560	0.568877	(0.00, 43.35,-173.40)
52	leadtungsten_optical	68	170.881	8.3000	0.8903	20.9592	8.246	186.98	21.323806	0.962318	(0.00, 45.35,-181.40)
53	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	187.00	21.324611	0.962663	(0.00, 45.35,-181.42)
54	CarbonFiber	6	11.968	1.5000	28.0746	51.2277	0.082	187.09	21.327549	0.964273	(0.00, 45.37,-181.50)
55	CarbonFiber	6	11.968	1.5000	28.0746	51.2277	0.082	187.17	21.330486	0.965882	(0.00, 45.39,-181.58)
56	VM2000	8	15.811	1.4300	25.6110	59.7748	0.021	187.19	21.331291	0.966227	(0.00, 45.40,-181.60)
57	leadtungsten_optical	68	170.881	8.3000	0.8903	20.9592	1.240	188.43	22.723522	1.025366	(0.00, 45.70,-182.80)
58	StainlessSteel	26	55.380	8.3000	1.6774	16.2392	0.003	188.43	22.725059	1.025525	(0.00, 45.70,-182.80)
59	Air	7	14.784	0.0012	30528.8407	71998.1725	6.180	194.61	22.725261	1.025611	(0.00, 47.20,-188.80)
0	Average Material	53	131.227	0.8892	8.5636	189.7501	194.610	194.61	22.725261	1.025611	(0.00, 47.20,-188.80)

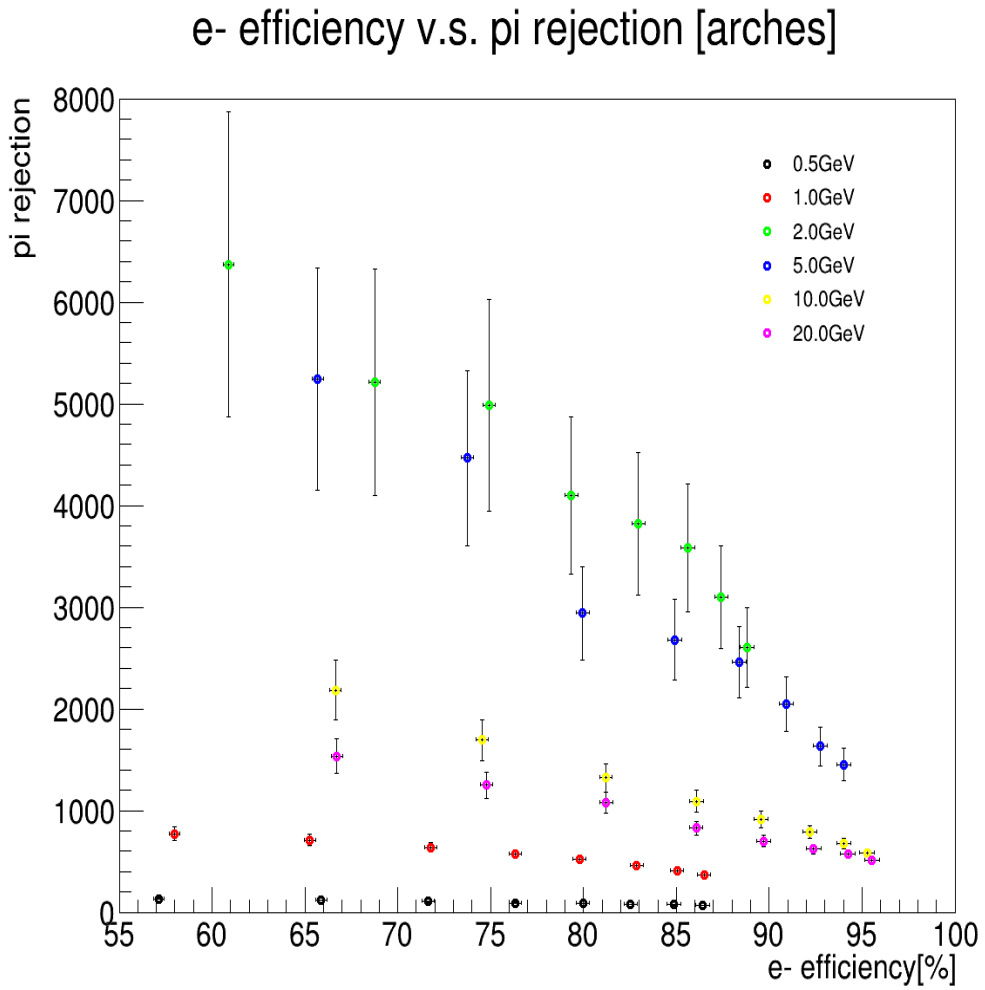
Brycecanyon config.
material scan
(0,0,0) – (0,50,-200)

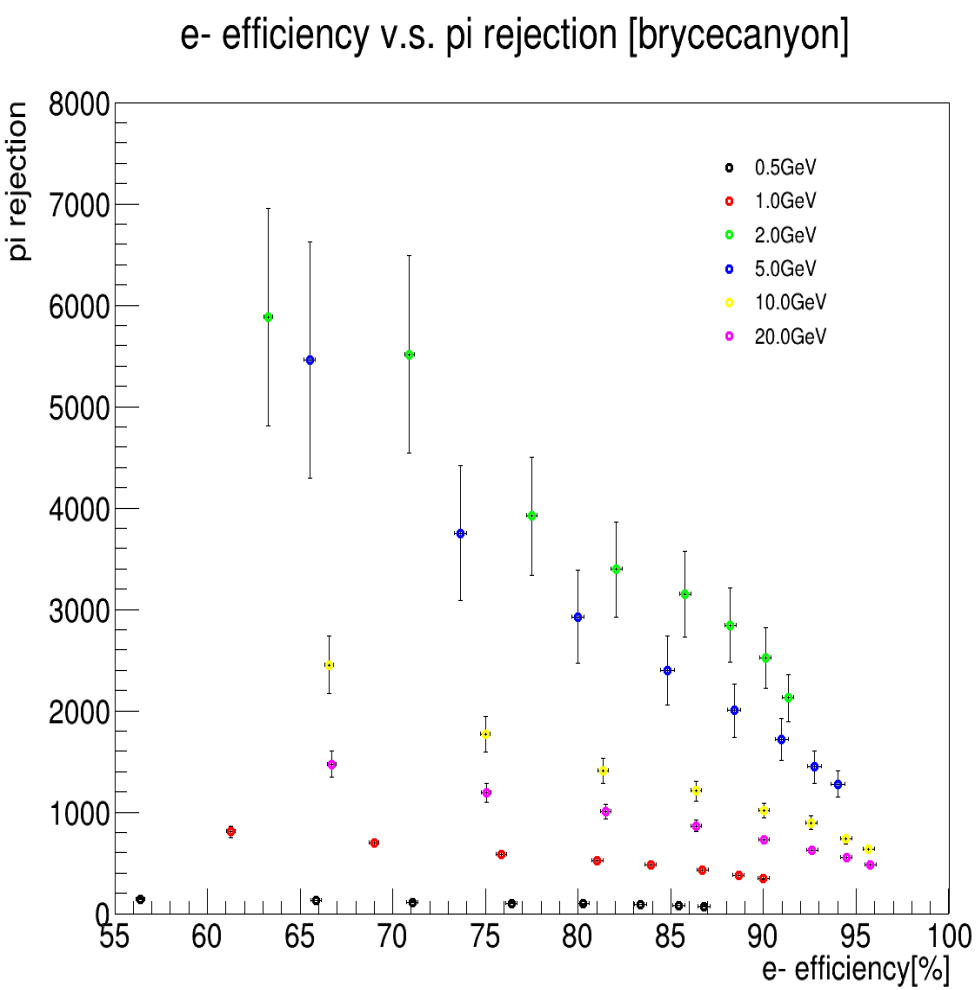
Integrated rad. Length
22.72 cm



Energy deposition of e- and pi- in NEEMC
after energy correction

Using the energy resolution from crystal ball fit
to apply the different E/P cut for calculating e- efficiency and pi rejection



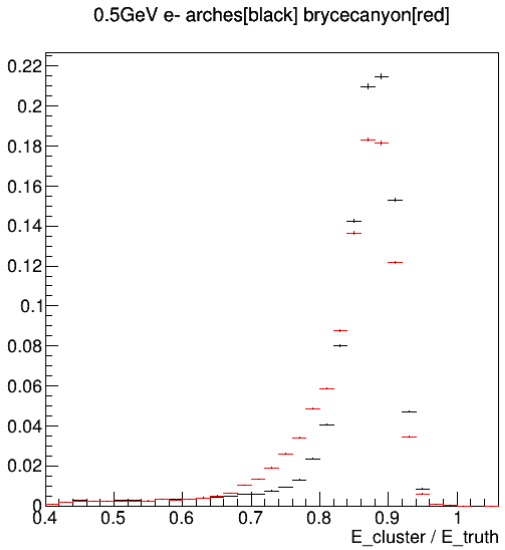


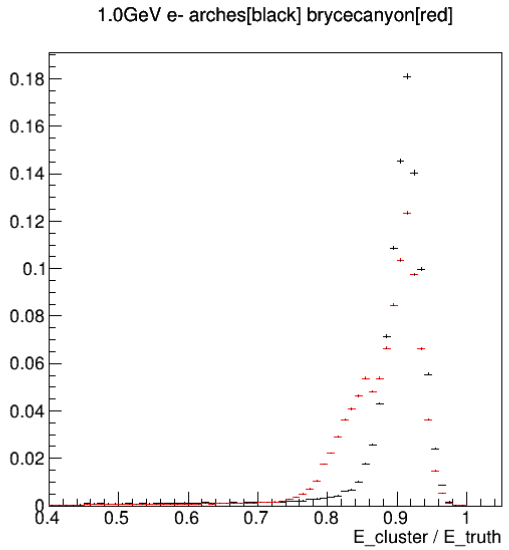
E/P cut: 1.0 ~ 2.4 * σ_E/E

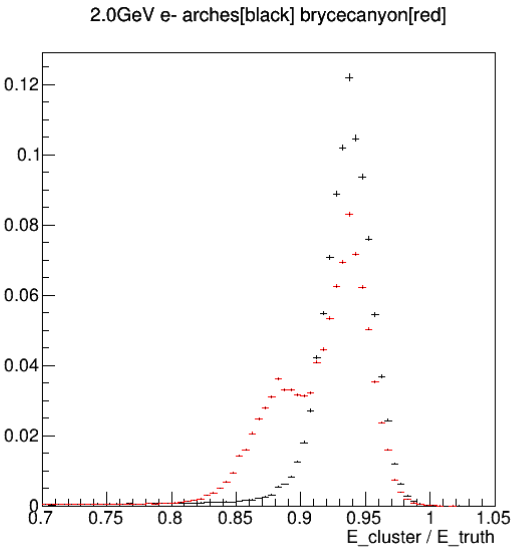
0.2 * σ_E/E increment for each point

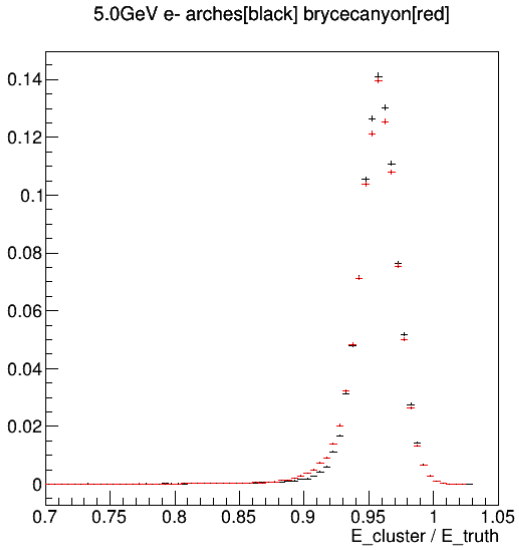
Summary:

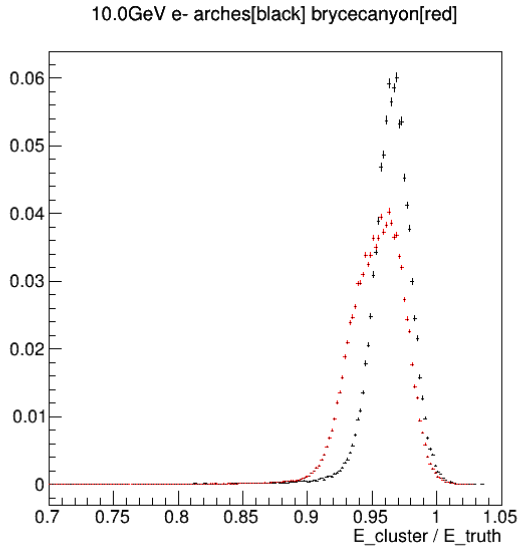
- No significant difference of performance of NEEMC as different RICH configuration in front of NEEMC

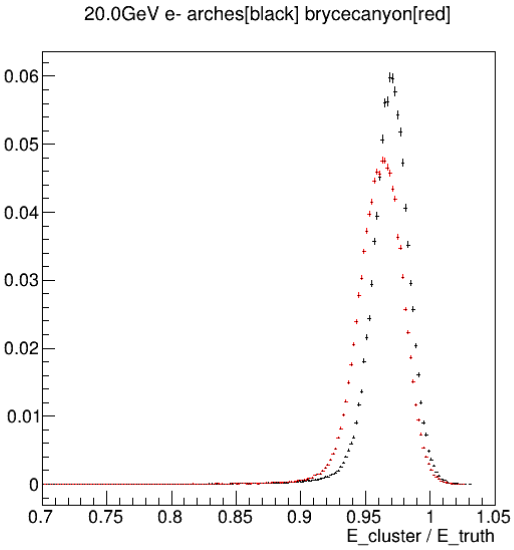




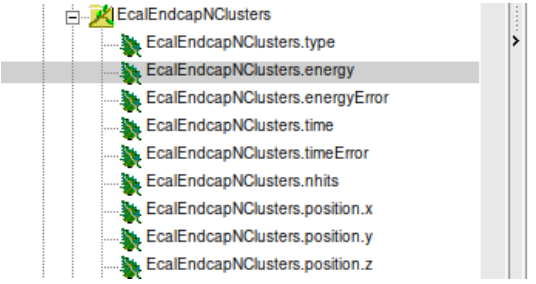


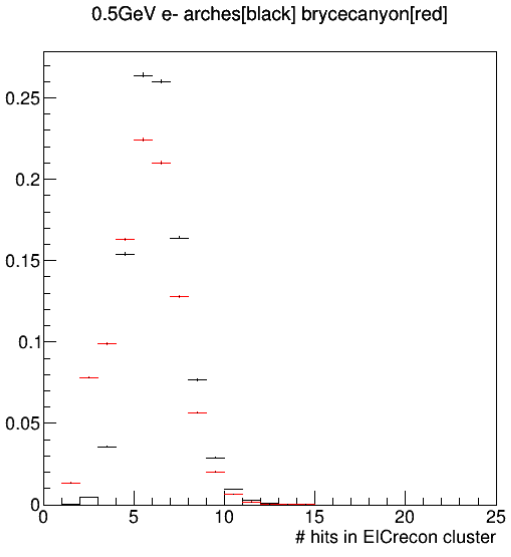


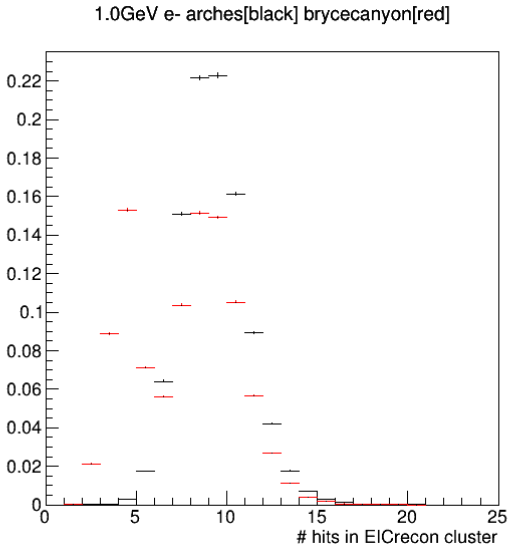


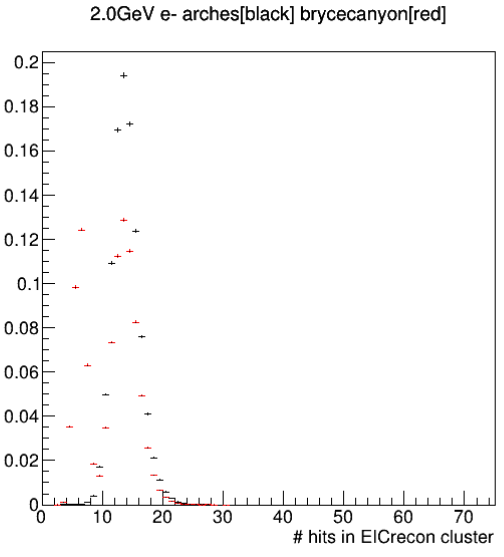


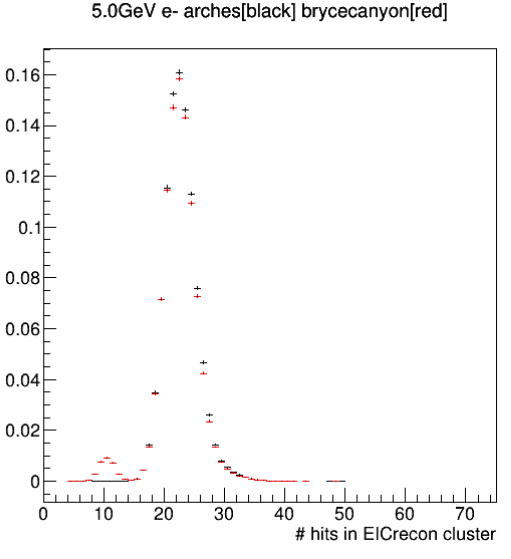
Max. cluster energy of each event
in **22.11.2** arches[black] and brycecanyon[red]

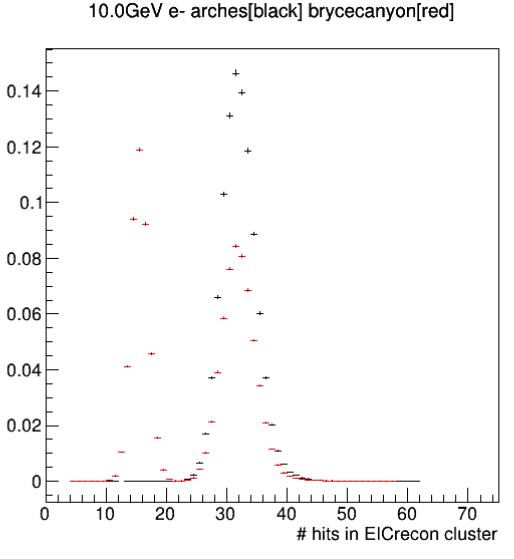


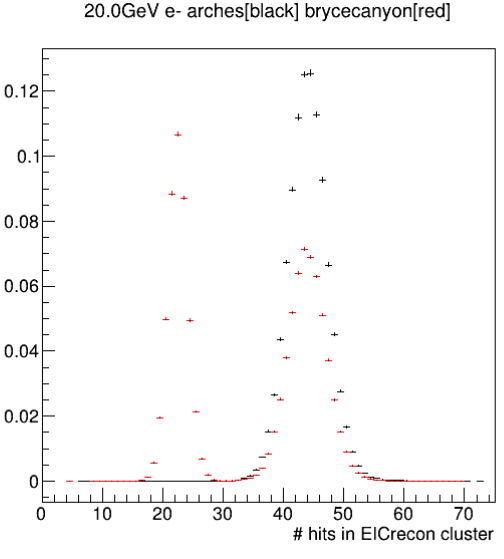




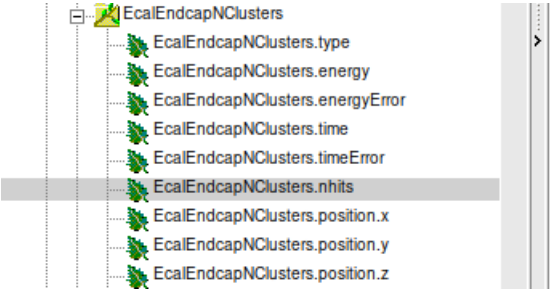


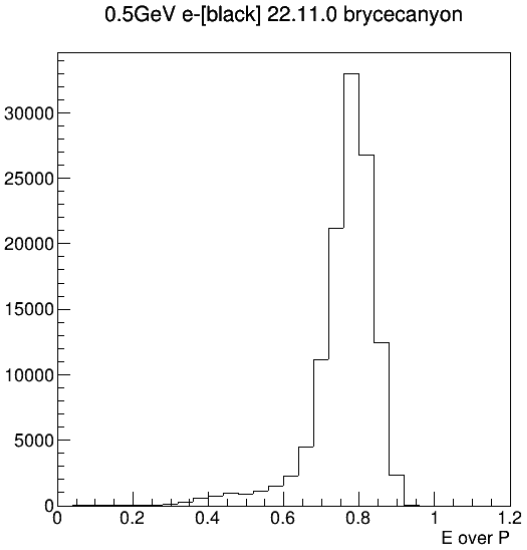


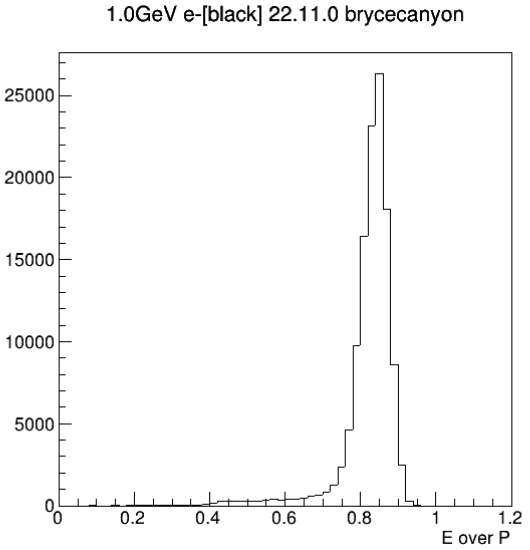


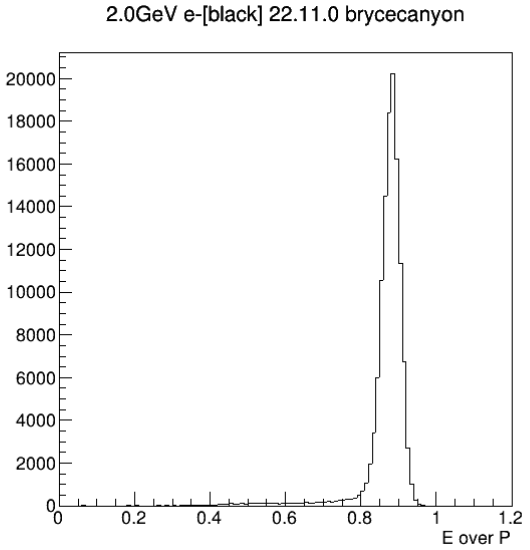


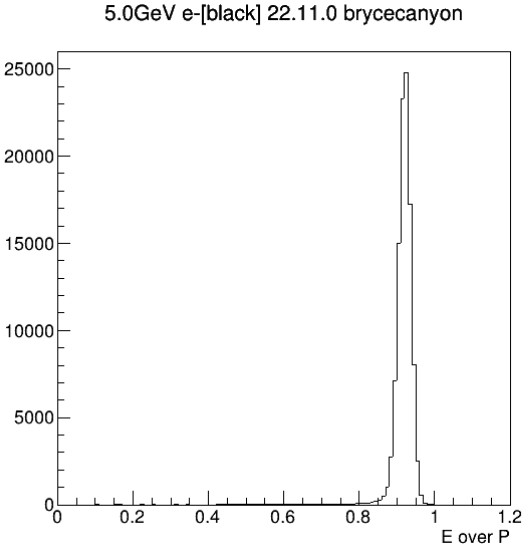
# of hits/cluster of Max. energy cluster
in **22.11.2** arches[black] and brycecanyon[red]

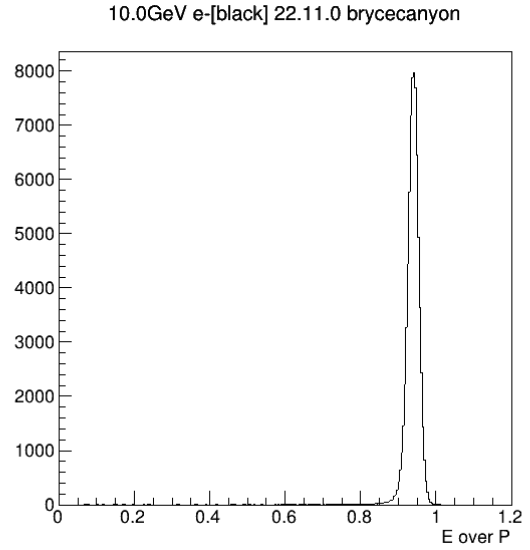


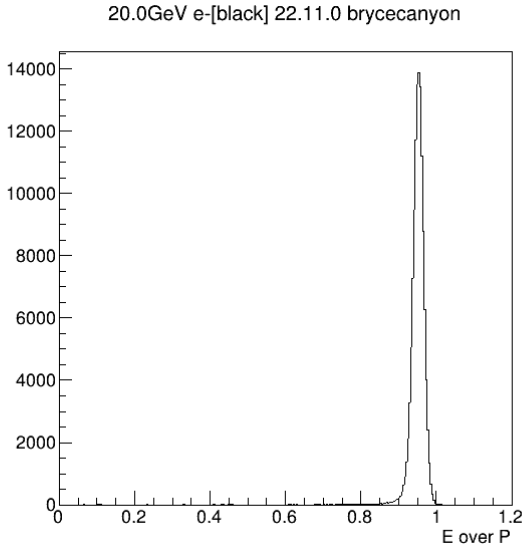




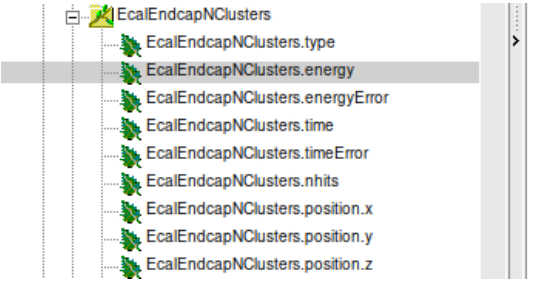




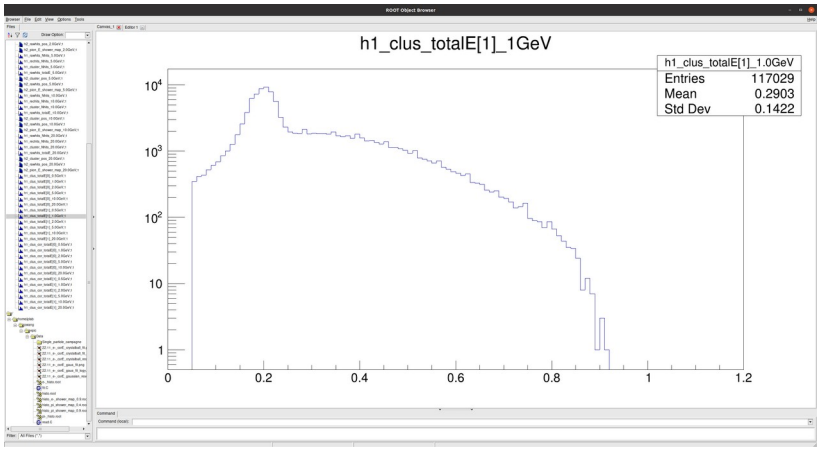


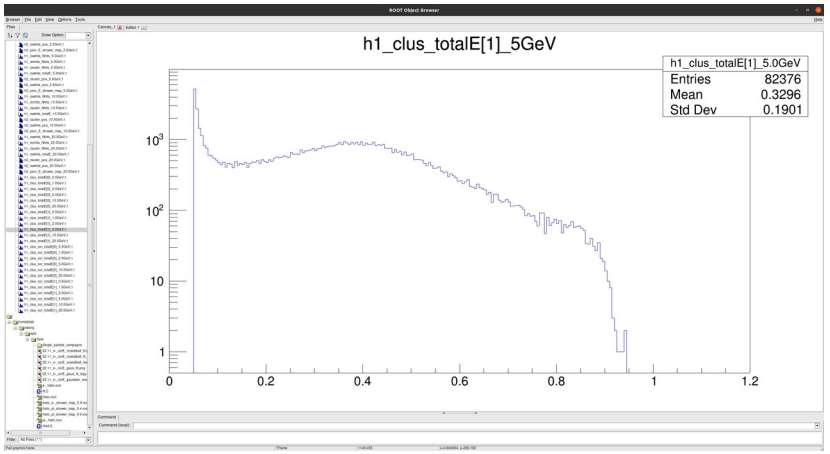


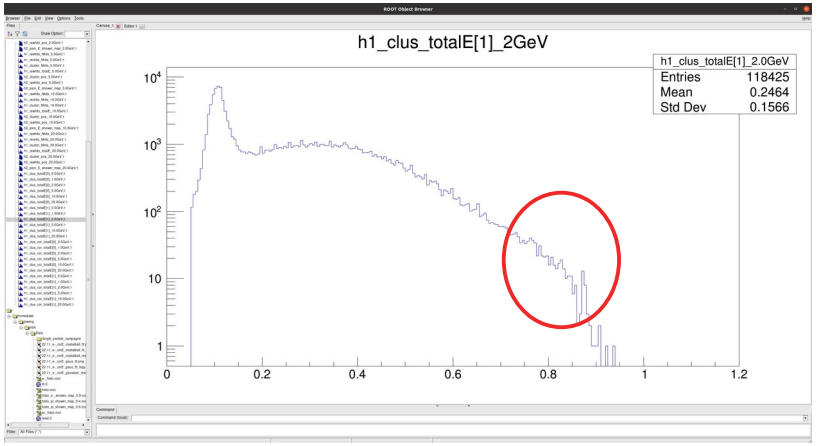
Max. energy cluster of each event
22.11.0 Brycecanyon

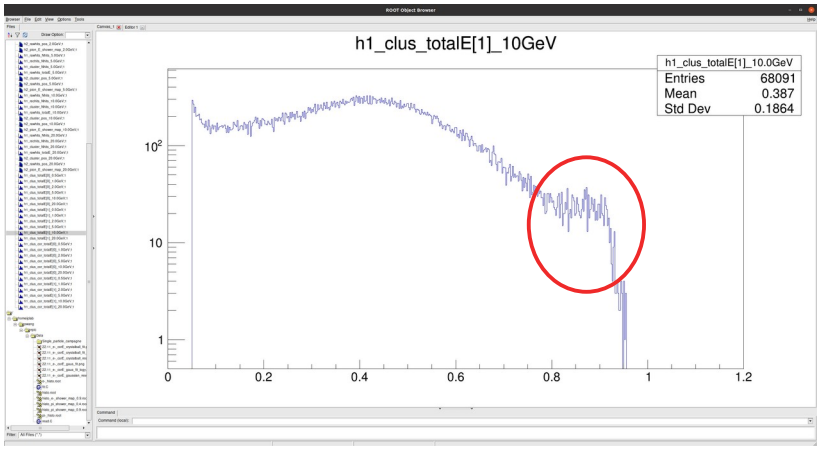


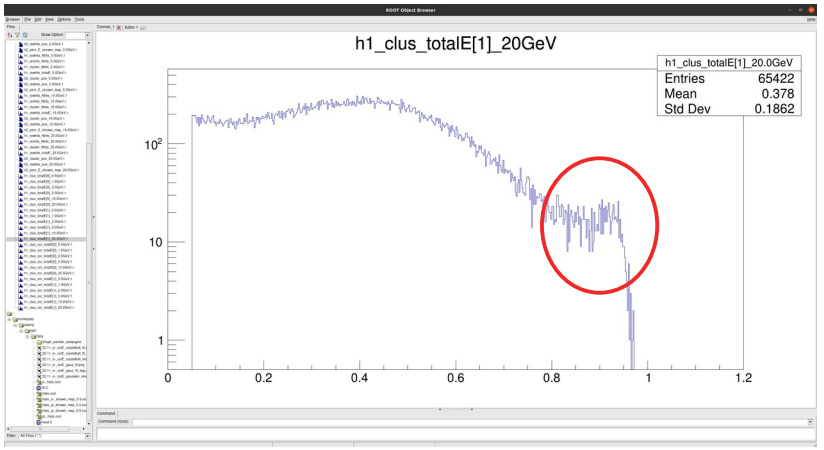
Backup











Pion energy deposition
before energy correction

Data processing in EICrecon

DD4Hep → Raw hits → Rec hits → Cluster

There is a sampling fraction for **rec hits**, which is 0.998

Everything in raw hits branch are in ADC or TDC

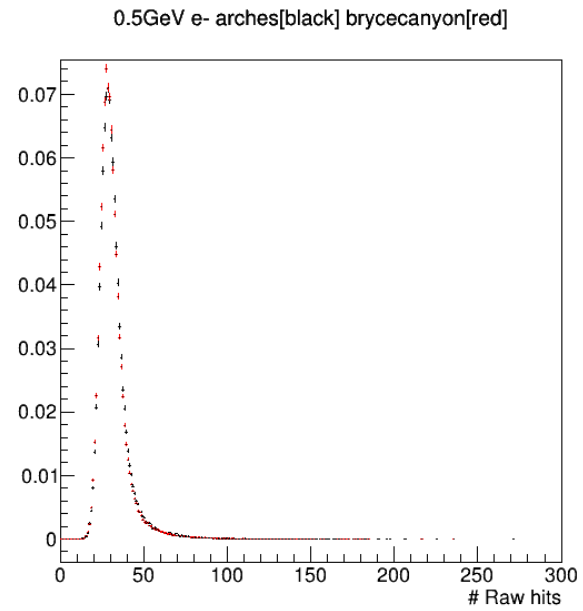
In simulation, we currently use **14-bit** ADC, and Dynamic range is **20GeV**, which means ~1.2MeV / bit

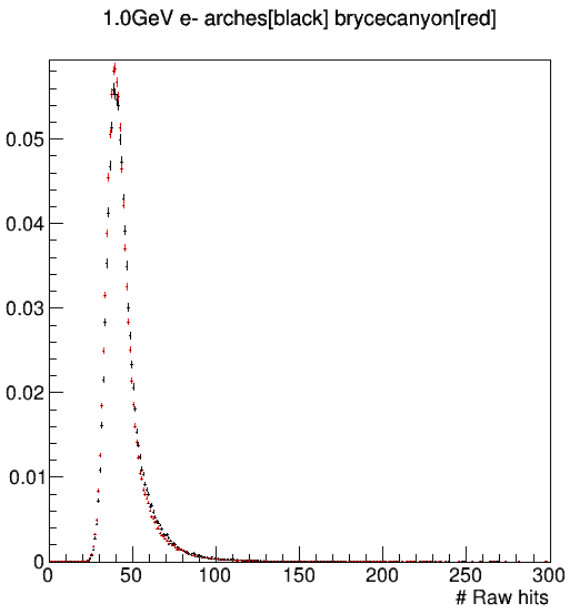
Pedestal mean is at 100 bits => 120 MeV

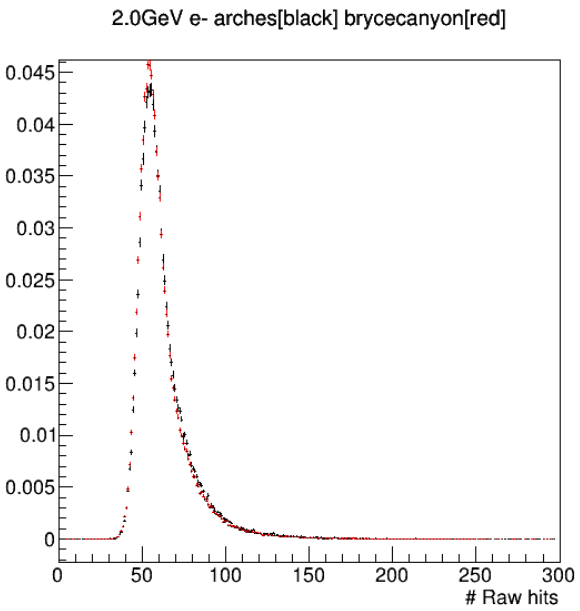
There is a sampling fraction for **cluster**, Which is around 0.95 from our fir results and it should be different from the one used in rec hits.
Minimum seed energy is **30MeV**
Minimum aggregation energy is **1MeV**
Meaning of few clustering parameters need to be checked:

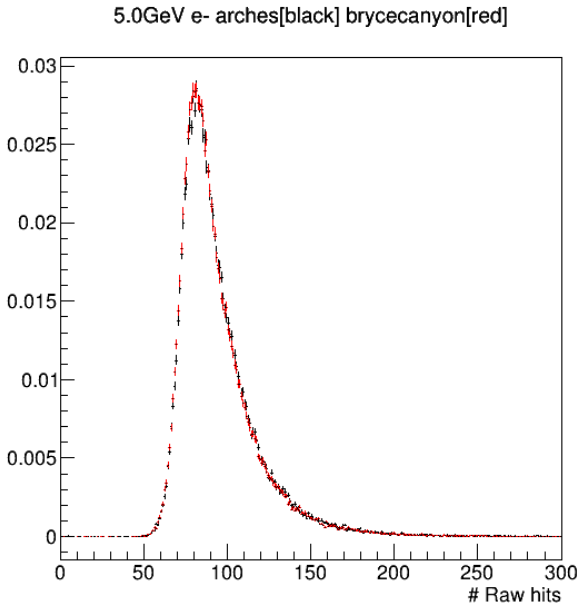
EEMC:EcalEndcapNIslandProtoClusters:sectorDist', '5.0*cm',
EEMC:EcalEndcapNIslandProtoClusters:dimScaledLocalDistXY', '1.8,1.8'
(These 2 values are marked “*”, which means they are well tuned)

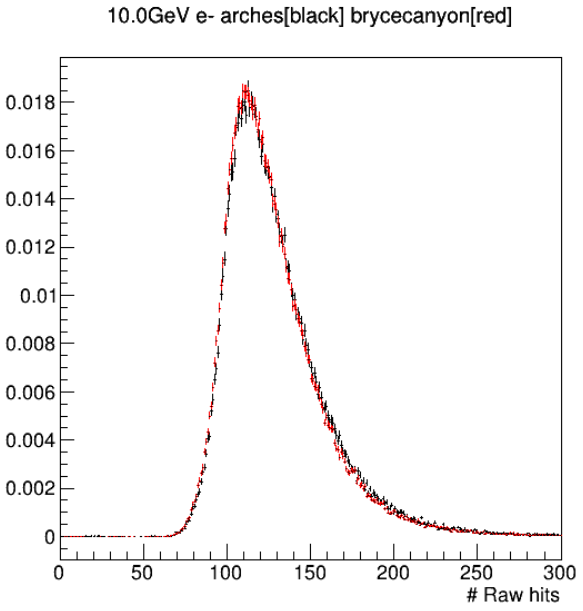
The following results will focus on 22.11.2 arches and brycecanyon

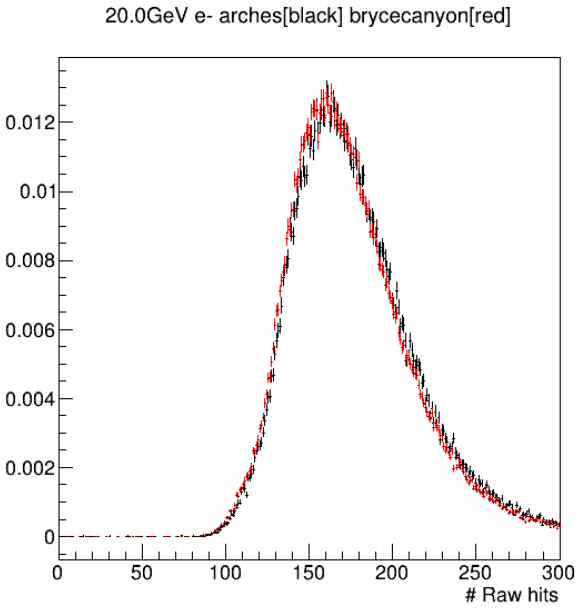






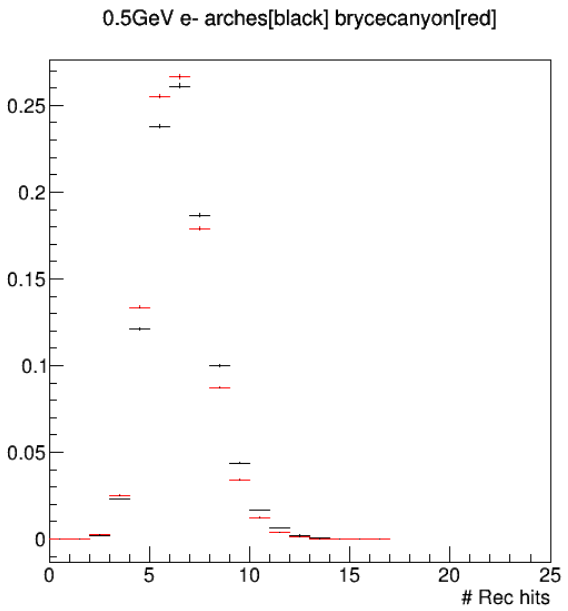


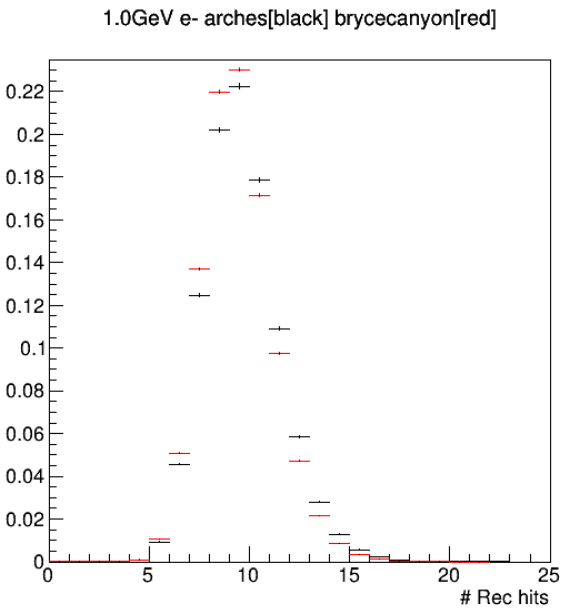


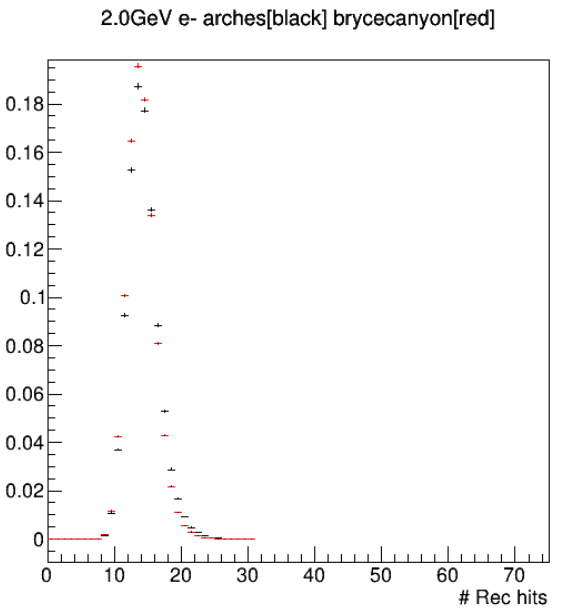


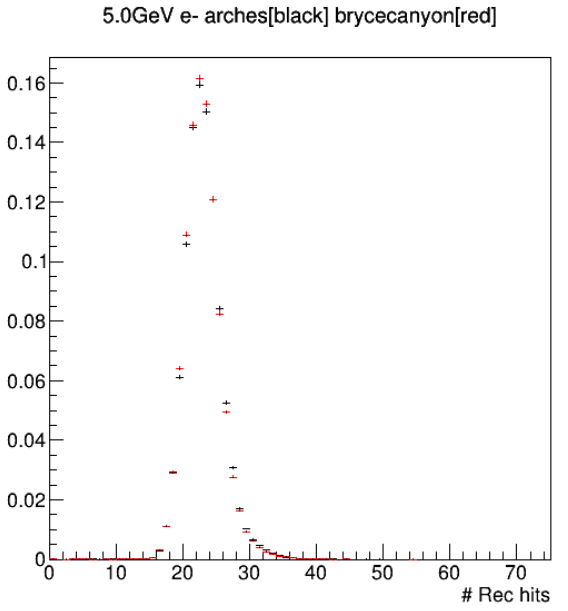
Number of **raw hits** in arches[black] and brycecanyon[red]

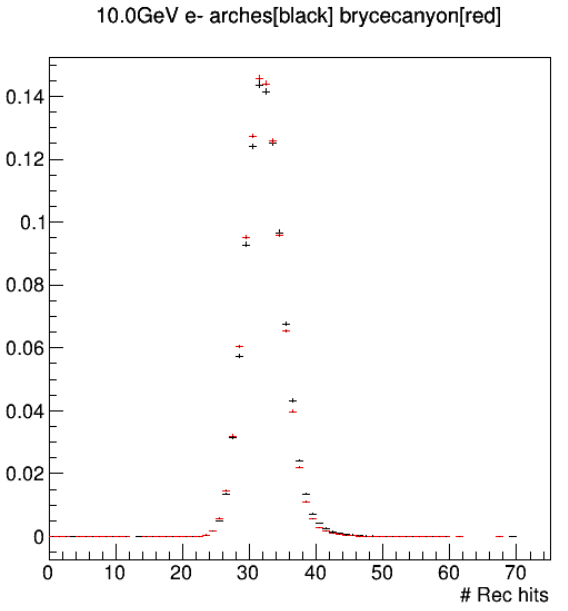
Notice the range of xaxis

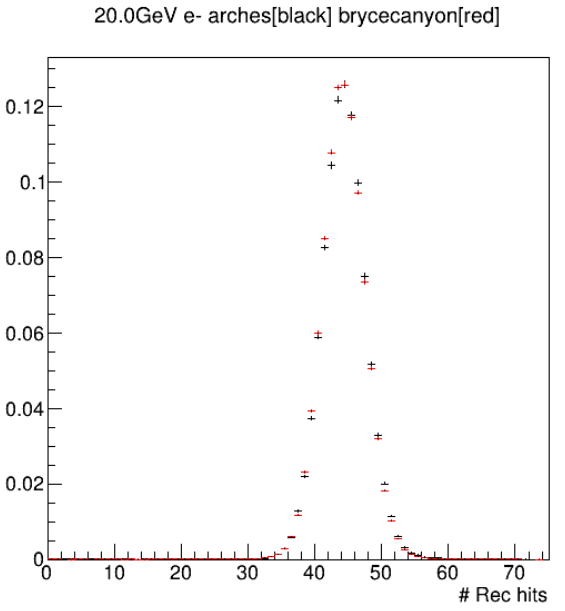












Number of **rec hits** in arches[black] and brycecanyon[red]

Notice the range of xaxis