



Updates pT Training: KNN

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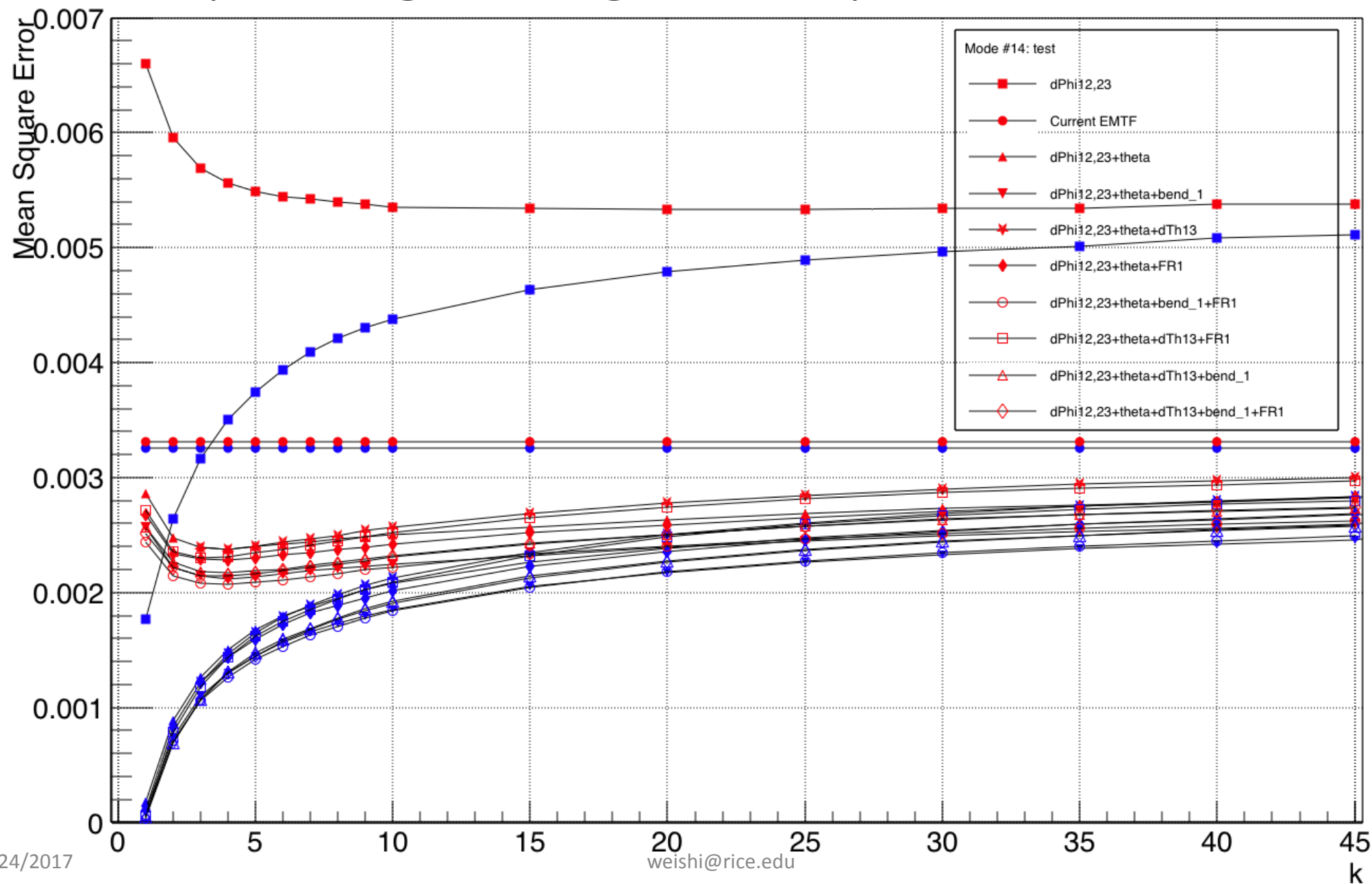
EMTF Working Meeting

Mode 14: Station 1-2-3

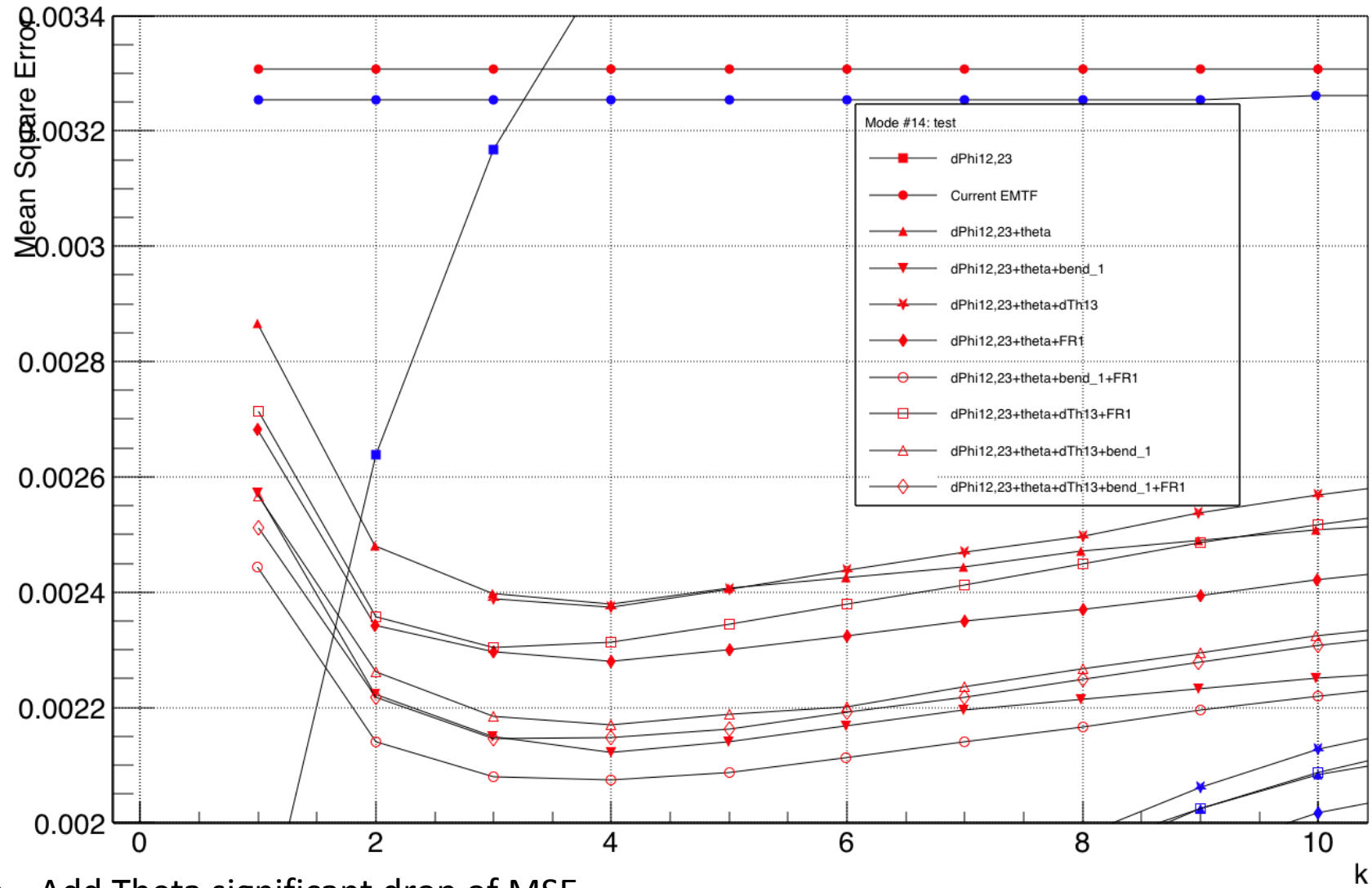
Compare to last time:

- Much higher statistics(10M events, mode 14 has 787858 train and 788544 test), 42 * last time: 18746 train)
- 2016 LUT(dPhi12, 23; theta; CLCT1; dTheta13; FR 1)(mainly tune value k)
- Low/high pT divide up
- Weight 1/pT(unweight not plotted yet)
- Tune KNN scale frac
- Add more input combinations of dPhis?
- Doing classification instead of regression?

Whole pT range, weighted 1/pT

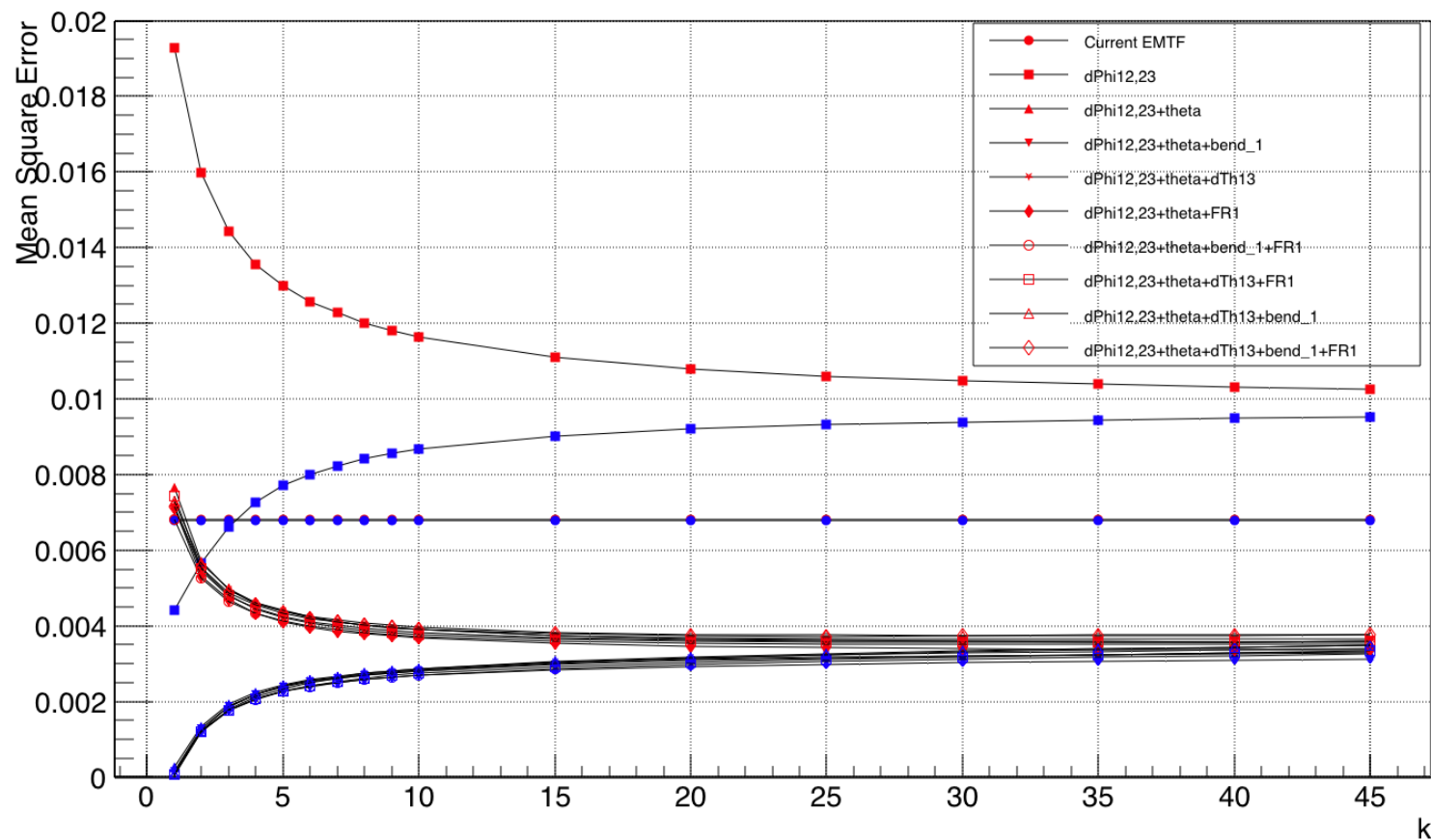


Zoom in



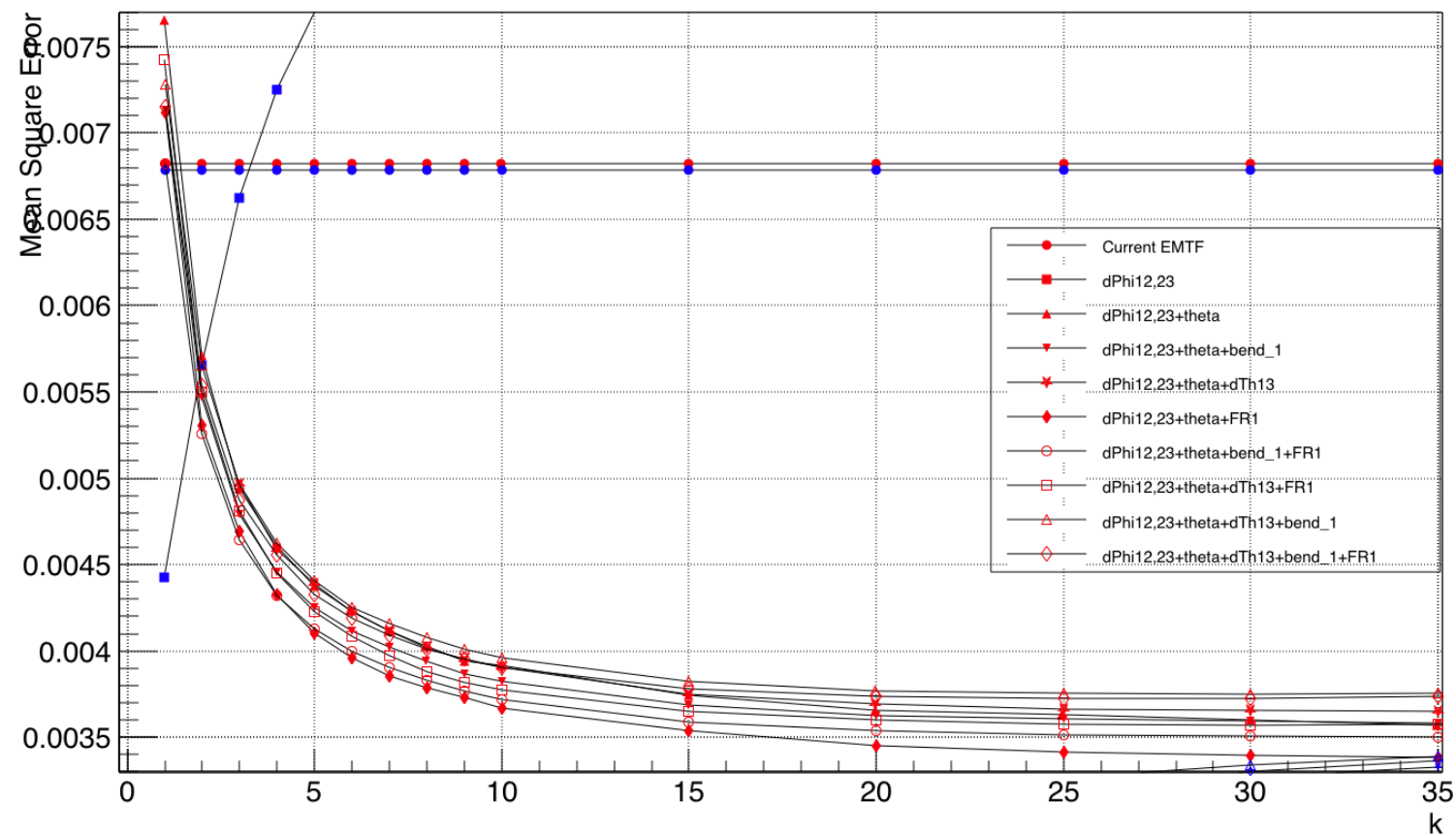
- Add Theta significant drop of MSE
- dPhi+theta+bend_1+FR1 give best performance

pT 1-8GeV

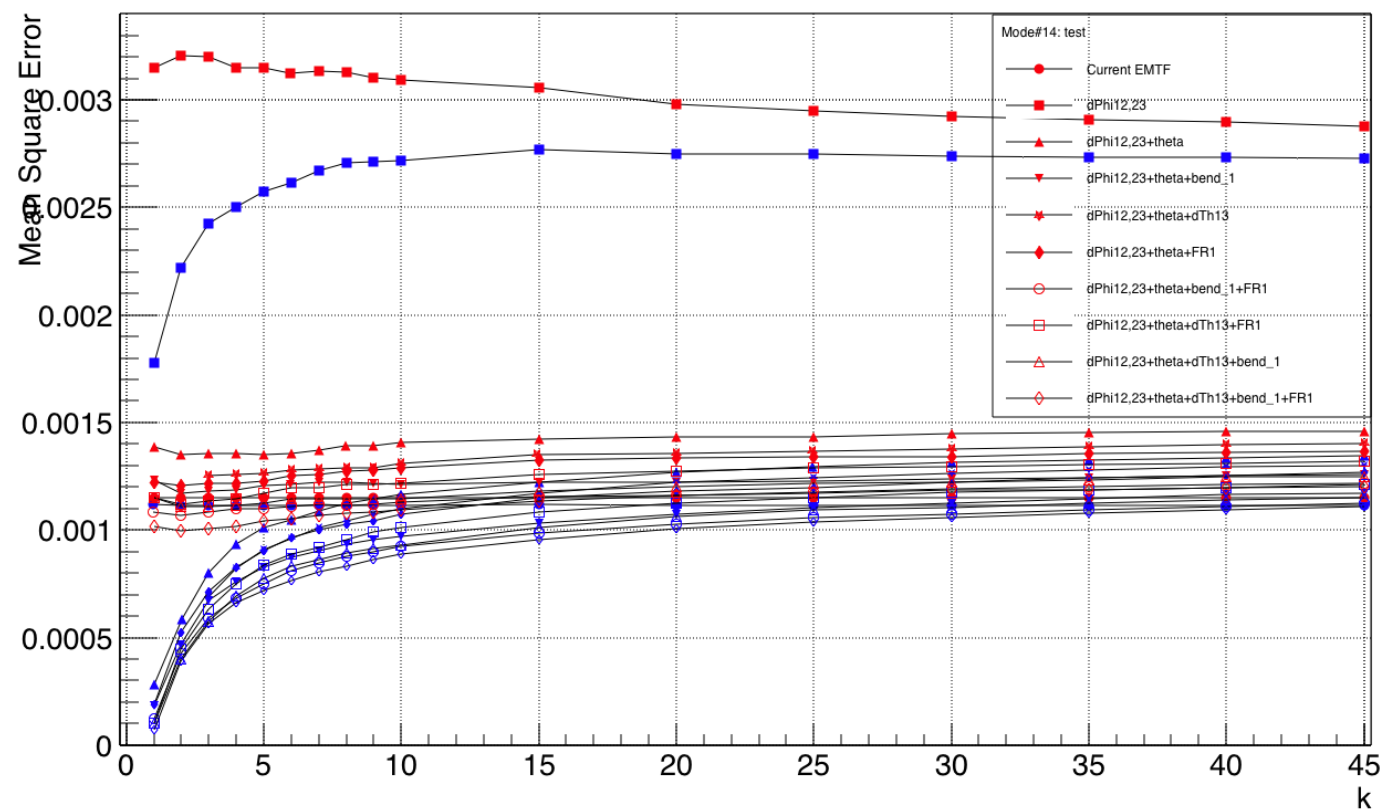


- Over fit starts when $k < 10$, main contribution to overtrain in whole pT range plot
- Large k performance unchanged, still not enough statistics?

1-8GeV zoom in

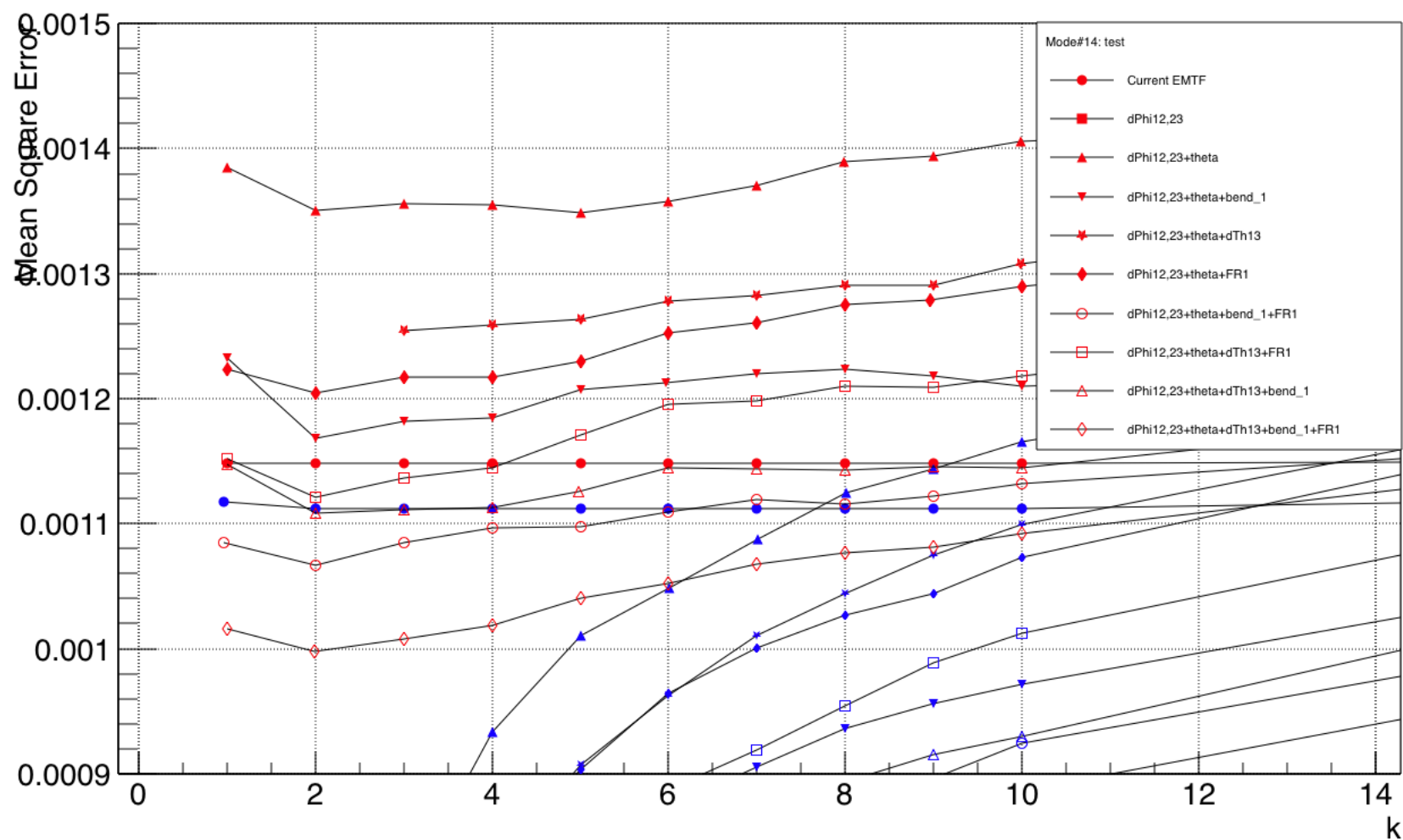


8-30GeV

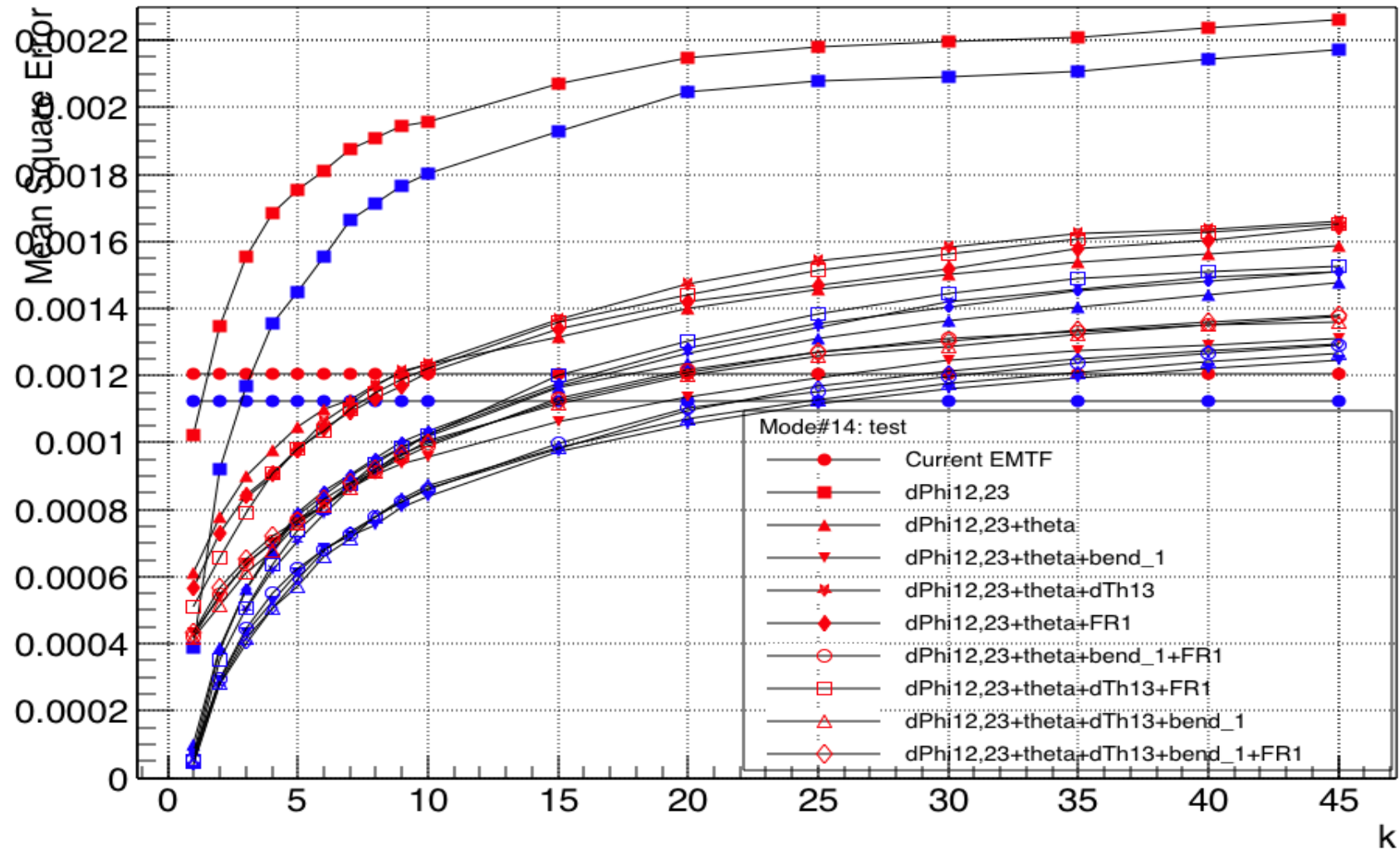


- Minima at $k \sim 2$

8-30GeV zoom in

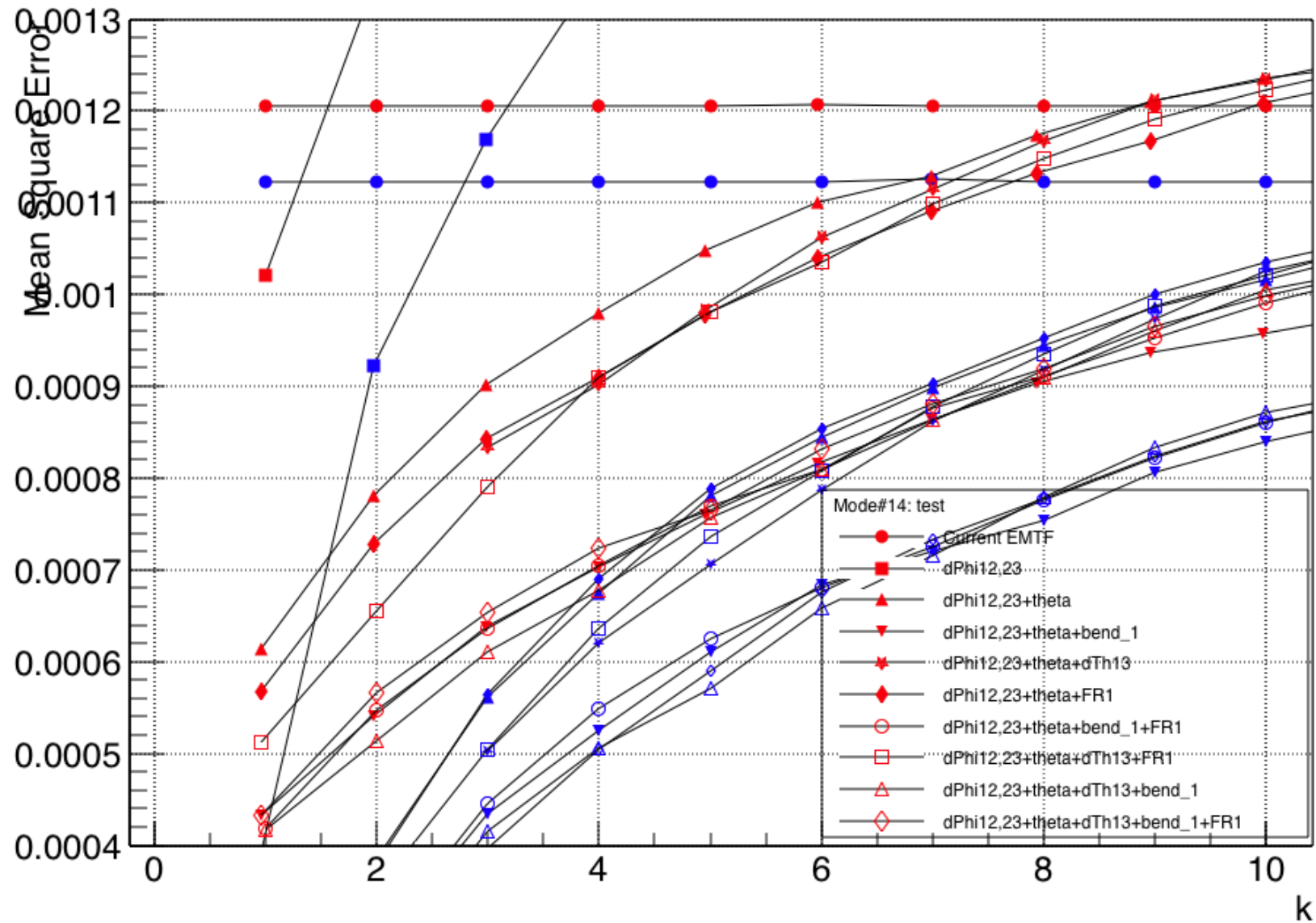


30-120GeV

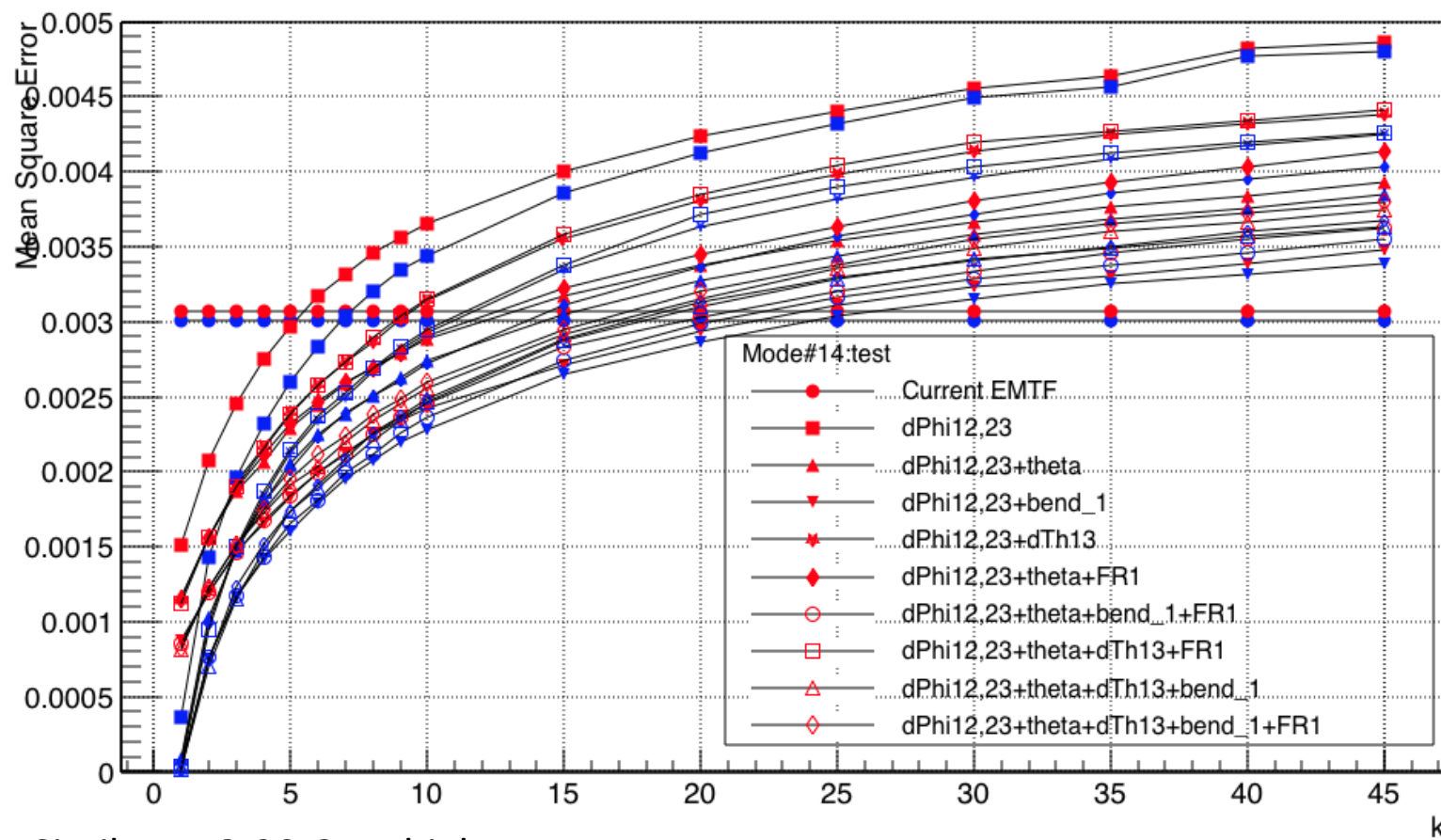


- MSE keeps decreasing even when $k=1$, too sparse input variable space?

30-120GeV zoom in



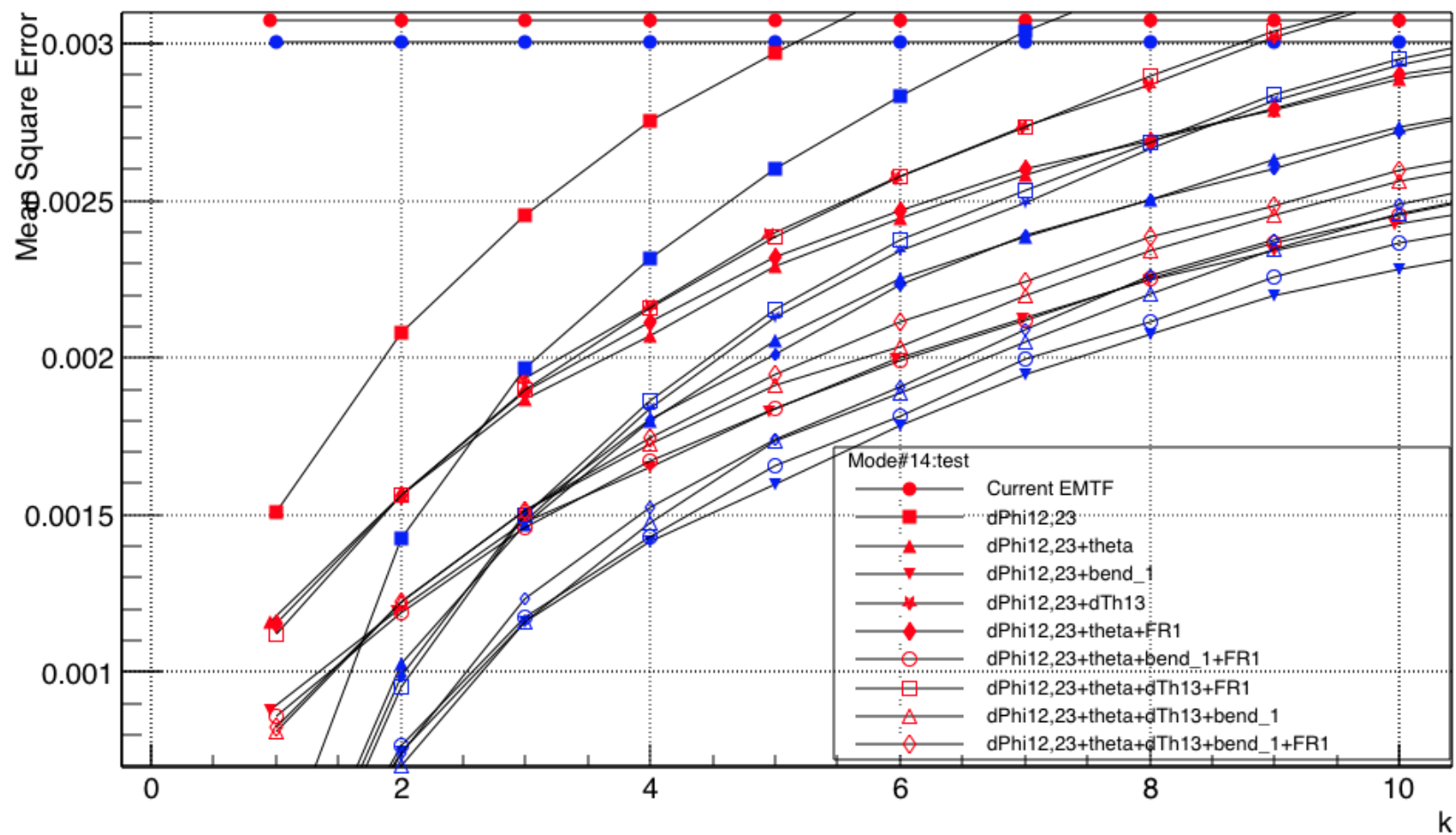
120-1000GeV



- Similar to 8-30 GeV, high pT

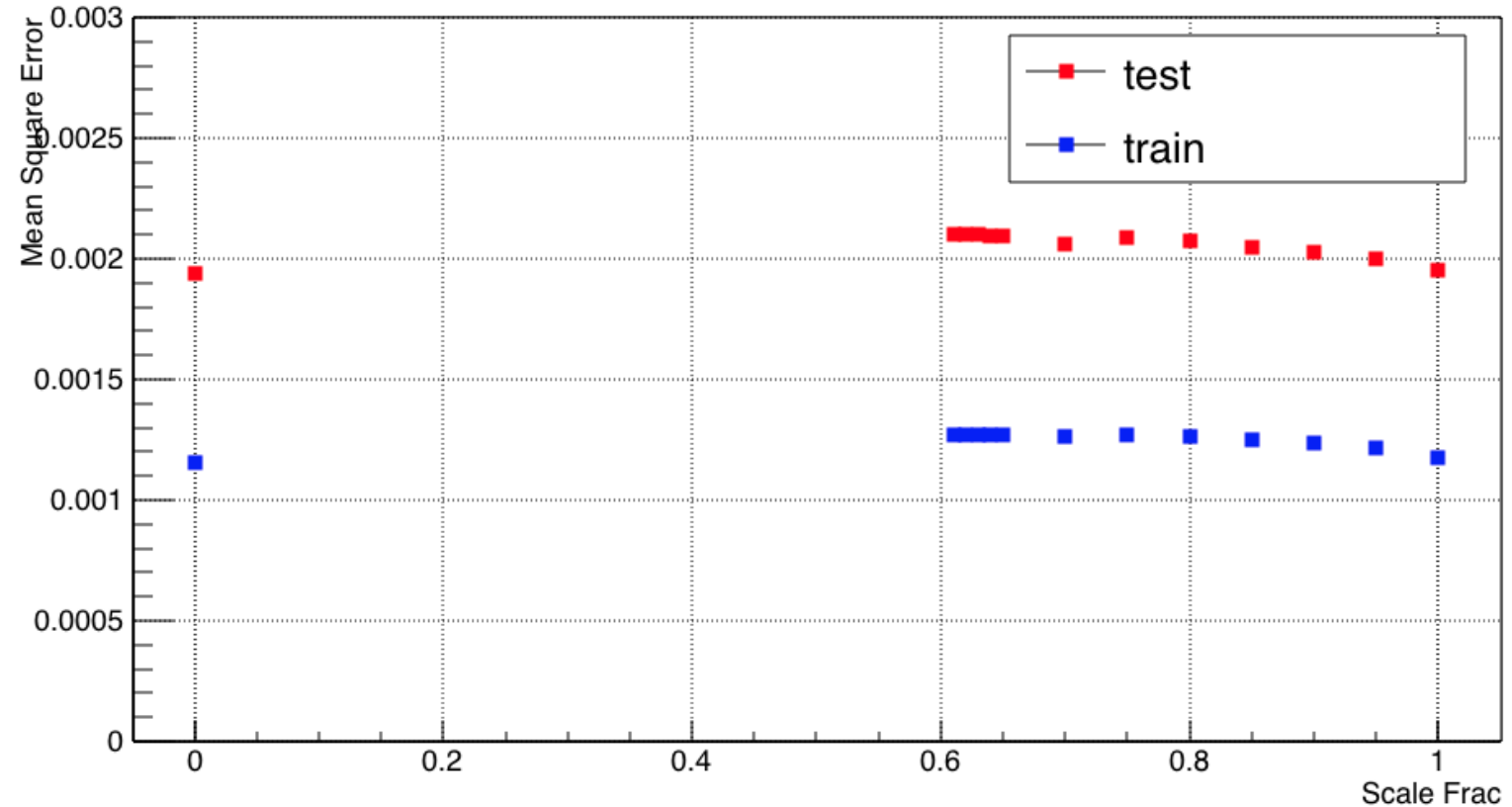


120-1000GeV



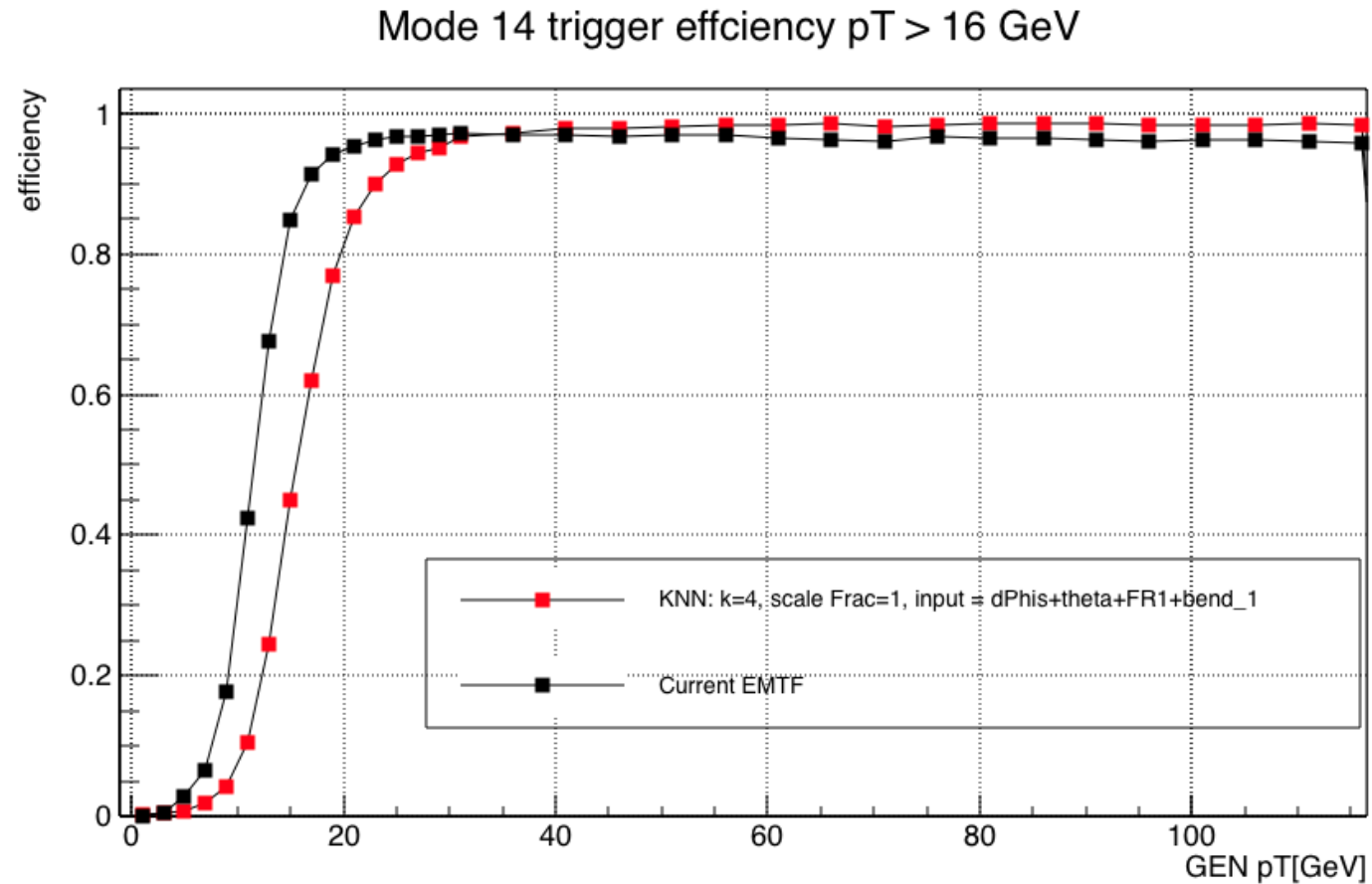
Scale the variables

- Input variables have different distribution
- e.g. theta has larger distribution than dphis
- Need to standardize variables when calculating distance

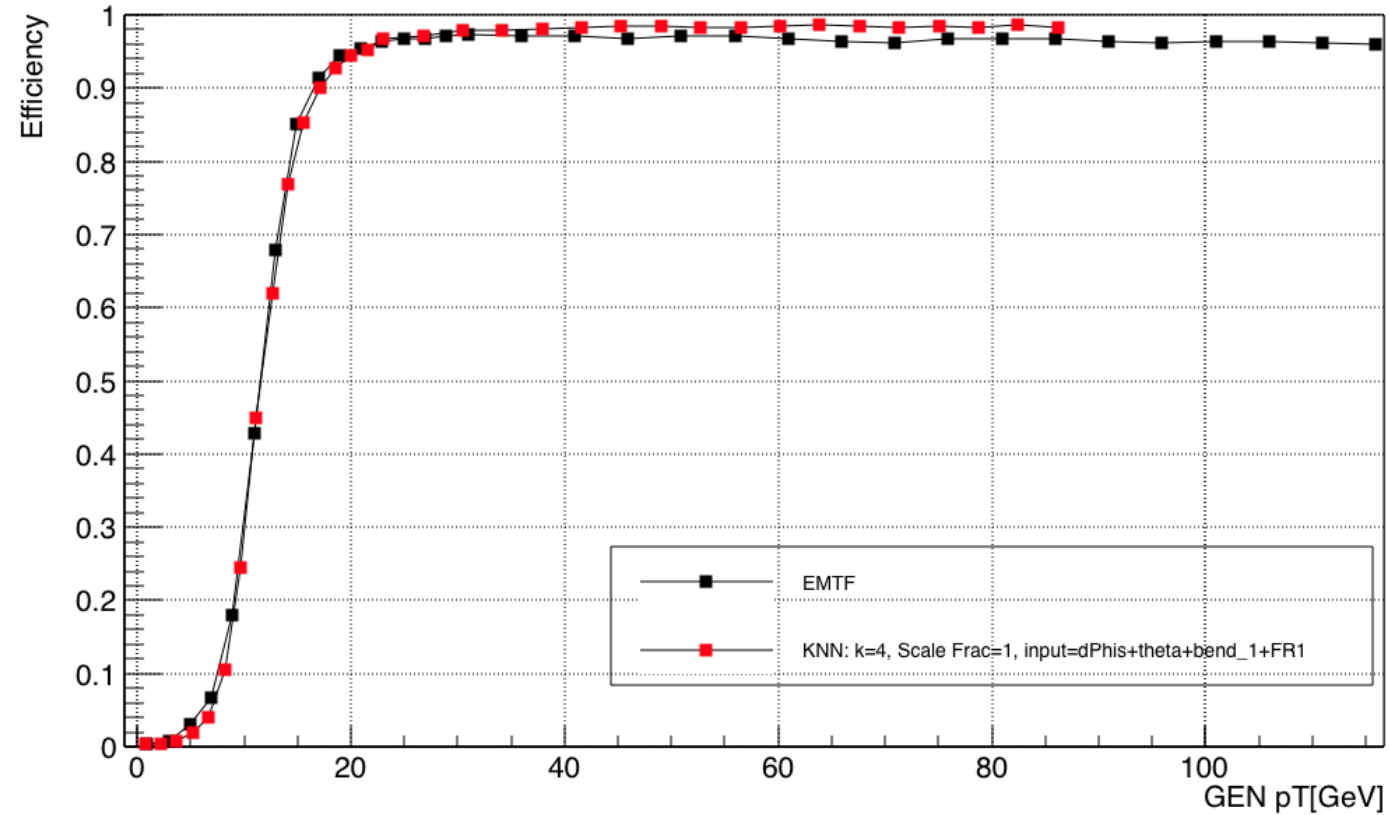


- Scale Frac = 0 means turning off scale
- Scale Frac = 1 gives best performance

Efficiency on test sample(Not on zerobias!)

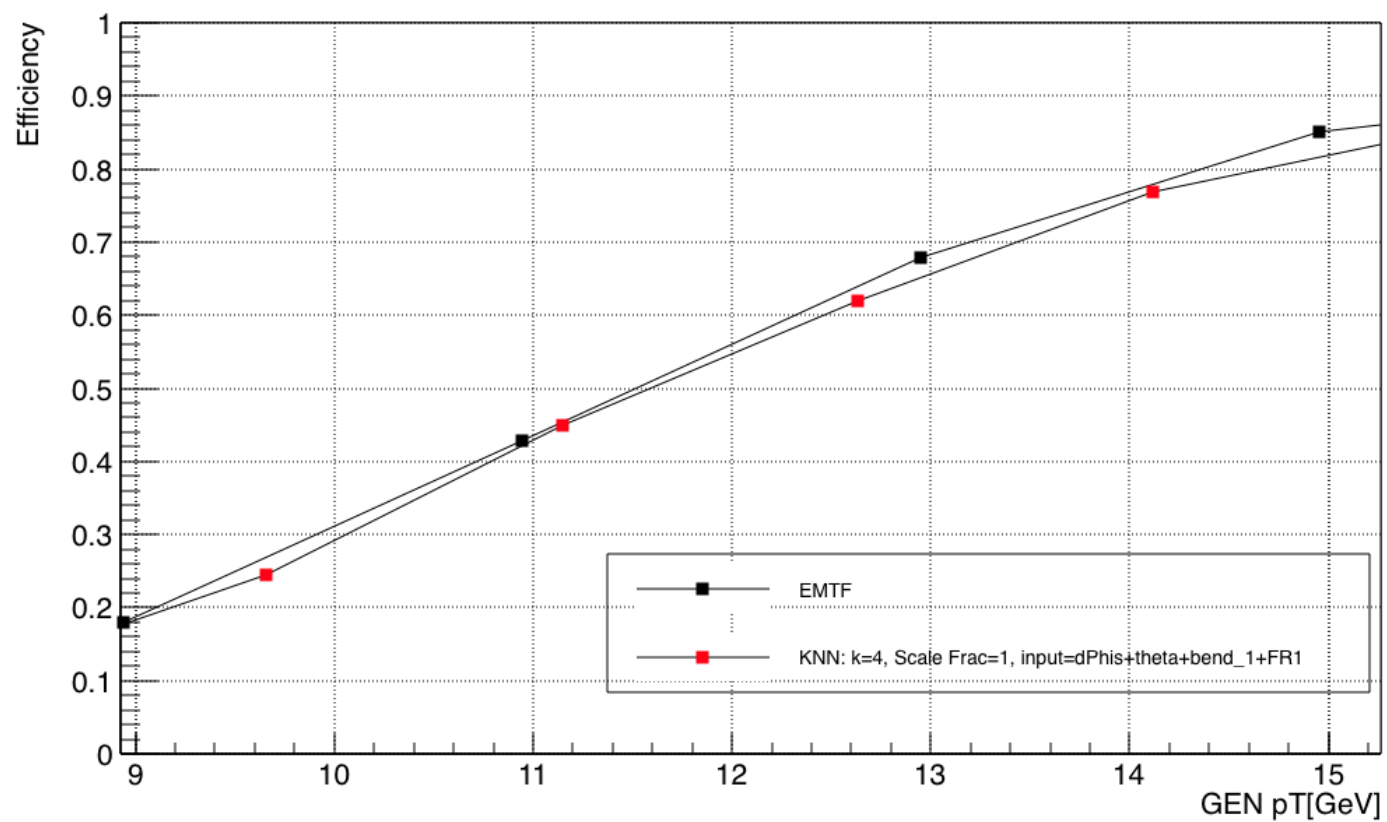


Cross at 50%



- Similar performance on test set
- Not accurate, hard to tell by eye; Need to evaluate using zerobias data, rate reduction plot?

Zoom in



Conclusions

- Significant drop when adding theta
- Almost for all sets of input variables, $k=4$, Scale Frac=1, gives best performance
- $d\Phi(12,23)$, theta, bend_1, FR1 are best input variables
- Overfit at small k contributed from low p_T 1-30GeV
- high momentum seems need more data(weight $1/p_T$)
- Flat curve at large k indicates statistics still not high enough(?)
- Non-parametric method/depend on local data structure/no mapping
- Large dataset/cross validation dataset

BACK UP

Steps

- Find optimized input/target/k/scalfrac for KNN for other modes
- Select the better method used for other modes: change inputs
- Include RPC hits and repeat 1-3 step
- Remove/truncate to fit in 29 bits
- Repeat for other modes
- Train charge assignment(classification)

Mode 14

- train events: 787858(blue)
- test events: 788544 (red)

Overall EMTF performance[marker 20]

- EMTF SD of train: 0.00325463
- EMTF SD of test: 0.00330735

1-8GeV:215837, 215442

- EMTF SD of train: 0.00678562
- EMTF SD of test: 0.0068219

8-30GeV:161893, 163132

- EMTF SD of train: 0.00111222
- EMTF SD of test: 0.00114859

30-120GeV:166127, 165505

- EMTF SD of train: 0.00112246
- EMTF SD of test: 0.00120542

120-1000GeV:244001, 244465

- EMTF SD of train: 0.00300435
- EMTF SD of test: 0.00307362

dPhis weighted marker 21

K(overall)	1	2	3	4	5	6	7	8	9
train	0.00176646	0.00263829	0.00316725	0.00350307	0.00374539	0.00393243	0.00409194	0.00421173	0.00430717
test	0.00660051	0.00595772	0.00569287	0.00556525	0.00548916	0.00544611	0.00542184	0.00540143	0.00537927
K	10	15	20	25	30	35	40	45	50
train	0.00437654	0.004639	0.00479074	0.00489073	0.00496563	0.00500657	0.00508776	0.00511004	--
test	0.00535497	0.00533783	0.00532939	0.00532983	0.00534399	0.0053438	0.00538274	0.00537939	--

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	0.0044069	0.00564745	0.00662196	0.00725022	0.00768767	0.00799273	0.00821802	0.00840296	0.00855085
test	0.0192802	0.0159831	0.0144378	0.0135641	0.0129895	0.0125784	0.0122711	0.0120097	0.0118032
K	10	15	20	25	30	35	40	45	50
train	0.00866189	0.0090073	0.00919383	0.00930826	0.0093862	0.00944135	0.00947819	0.00951042	--
test	0.0116233	0.0110895	0.0107902	0.0106024	0.0104928	0.0103955	0.010321	0.010256	--

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	0.00177577	0.0022171	0.00242412	0.00249948	0.002576	0.00261698	0.00266968	0.00270696	0.00271329
test	0.00314753	0.00320737	0.00320031	0.00315078	0.00314676	0.00312423	0.00313284	0.00312907	0.00310248
K	10	15	20	25	30	35	40	45	50
train	0.00271906	0.00276767	0.00274619	0.00274698	0.00273733	0.00273397	0.0027329	0.00272946	--
test	0.00309081	0.00305881	0.00298001	0.00294883	0.00292446	0.00290772	0.00289705	0.00287683	--
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	0.000384502	0.000920427	0.0011663	0.00135327	0.0014471	0.00155499	0.00166553	0.0017135	0.00176665
test	0.00102133	0.00134885	0.00155429	0.0016842	0.00175421	0.00181135	0.00187518	0.00190838	0.00194351
K	10	15	20	25	30	35	40	45	50
train	0.00180276	0.0019294	0.0020449	0.00207842	0.00208877	0.00210901	0.00214203	0.00217054	--
test	0.00195574	0.00206901	0.00214635	0.00217922	0.0021962	0.00221023	0.00223516	0.00226244	--
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	0.000365503	0.00142551	0.00196672	0.00231801	0.00259883	0.00283227	0.0030378	0.00320359	0.00334057
test	0.00150747	0.00207809	0.00245131	0.00275476	0.00297092	0.00317072	0.00331427	0.00345886	0.00356337
K	10	15	20	25	30	35	40	45	50
train	0.0034379	0.00386133	0.00412191	0.0043202	0.00449246	0.00456431	0.00477212	0.00479842	--
test	0.003643	0.00400286	0.00423953	0.00440501	0.00455207	0.00463889	0.00482045	0.00486192	--

dPhis+theta weighted marker 22

K(overall)	1	2	3	4	5	6	7	8	9
train	0.000175655	0.000890127	0.00126378	0.00150348	0.00167575	0.00179383	0.00188252	0.00195635	0.00202567
test	0.00286361	0.00248023	0.00239592	0.00237648	0.0023978	0.00241887	0.00244029	0.00246701	0.00248143
K	10	15	20	25	30	35	40	45	50
train	0.00208292	0.00226585	0.00238524	0.00247187	0.00254425	0.00259589	0.0026331	0.00267777	0.00271159
test	0.00250471	0.002569	0.00263425	0.00268587	0.00273052	0.00276483	0.0027884	0.00282059	0.00284736

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	0.000265564	0.00135399	0.00192063	0.00224078	0.00244116	0.00256898	0.00266991	0.00274679	0.00280904
test	0.00764548	0.00568607	0.00493178	0.00457527	0.00435141	0.00420696	0.00409707	0.00401509	0.00393585
K	10	15	20	25	30	35	40	45	50(not used)
train	0.00285759	0.00302045	0.00310326	0.00316005	0.00320347	0.00324047	0.00326432	0.00329008	0.0033141
test	0.00388252	0.00371944	0.0036491	0.00360799	0.00358896	0.0035599	0.00355234	0.00354343	0.00354362

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	0.000274707	0.000578462	0.00079865	0.000928425	0.00100565	0.00104388	0.00108337	0.00111979	0.00113931
test	0.00138541	0.00135015	0.00135582	0.00135485	0.00134893	0.00135819	0.00137005	0.00138784	0.0013938
K	10	15	20	25	30	35	40	45	50
train	0.00116074	0.00121879	0.00126228	0.0012905	0.0013092	0.00132194	0.00132774	0.00133875	0.00134939
test	0.00140122	0.00142112	0.00143084	0.00143514	0.00144861	0.00145503	0.00145747	0.0014567	0.00146603
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	9.88163e-05	0.000386895	0.000561537	0.000674731	0.000780775	0.000844393	0.000898348	0.000945289	0.000986059
test	0.000611453	0.000777158	0.000899182	0.000975824	0.00104728	0.00109806	0.00112913	0.0011714	0.00120756
K	10	15	20	25	30	35	40	45	50
train	0.0010162	0.00116374	0.00123706	0.00130896	0.00136497	0.00140467	0.00143884	0.0014755	0.00149806
test	0.00123401	0.00131643	0.00139887	0.00145648	0.00150097	0.00153995	0.0015616	0.00158847	0.00160449
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	8.27185e-05	0.00102922	0.00146949	0.0017971	0.00205262	0.00225216	0.0023863	0.00250057	0.00262862
test	0.00116058	0.00156208	0.0018685	0.00206872	0.00229036	0.00244506	0.00258204	0.0027	0.00278789
K	10	15	20	25	30	35	40	45	50
train	0.00273579	0.00304343	0.00327691	0.00343871	0.00358348	0.00368201	0.00375393	0.00384313	0.00390867
test	0.00288712	0.00316911	0.00337927	0.00354014	0.00366184	0.00376743	0.00383383	0.00392785	0.00399696

dPhis+theta+bend_1 weighted marker 23

K(overall)	1	2	3	4	5	6	7	8	9
train	0.000109535	0.000737917	0.00110068	0.00130193	0.00144304	0.00156527	0.00165723	0.00173176	0.0017999
test	0.00256406	0.00221768	0.0021426	0.00212016	0.00213592	0.0021635	0.00218869	0.0022121	0.00223142
K	10	15	20	25	30	35	40	45	50
train	0.00185008	0.0020543	0.00217239	0.00226463	0.00232872	0.00238251	0.0024219	0.00246108	0.00248745
test	0.00224783	0.00232007	0.00239111	0.00245001	0.00249705	0.0025281	0.00255824	0.00259124	0.0026105

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	0.000167512	0.00127461	0.00186697	0.00217873	0.0023716	0.00251314	0.00261206	0.00269206	0.00274934
test	0.00713487	0.00546611	0.00479444	0.00445914	0.00425308	0.00411693	0.0040229	0.00393649	0.00386971
K	10	15	20	25	30	35	40	45	50
train	0.00279886	0.00297606	0.00307552	0.00314302	0.00319729	0.00324315	0.0032849	0.00331633	0.00334734
test	0.0038248	0.00368979	0.00362787	0.00360863	0.0035923	0.00358279	0.00358222	0.00358741	0.00359023

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	0.000181709	0.000465415	0.000670725	0.000757814	0.000823976	0.000874241	0.000905492	0.00093569	0.000956104
test	0.00123261	0.00116839	0.00118223	0.00118437	0.00120691	0.00121293	0.0012195	0.00122356	0.00121785
K	10	15	20	25	30	35	40	45	50
train	0.000971656	0.0010342	0.00107081	0.00110394	0.00112393	0.00114347	0.00116314	0.00117265	0.00117831
test	0.00121005	0.00122068	0.00122325	0.00122588	0.00123664	0.00124391	0.00125185	0.00125678	0.00126782
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	6.9858e-05	0.000290774	0.000433925	0.000525355	0.000610605	0.000684531	0.000720869	0.000754558	0.000806407
test	0.000430359	0.00053906	0.00063721	0.000702636	0.0007597	0.000813533	0.000863437	0.000902884	0.000936993
K	10	15	20	25	30	35	40	45	50
train	0.000839236	0.000975099	0.00105271	0.00111733	0.00116059	0.00119417	0.00122086	0.00124625	0.00126633
test	0.000955883	0.00106006	0.00113597	0.0011917	0.00124331	0.00127427	0.00128916	0.00130791	0.00132057
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	3.7378e-05	0.00074841	0.00116207	0.00141609	0.00159915	0.00178494	0.00194892	0.00207582	0.00219633
test	0.000868915	0.00119154	0.00146561	0.00164299	0.00182176	0.00199025	0.00211618	0.00223842	0.00234032
K	10	15	20	25	30	35	40	45	50
train	0.00228187	0.00265053	0.00286673	0.00303886	0.00315509	0.00325239	0.00331142	0.00338653	0.00342682
test	0.00242526	0.00269964	0.00293023	0.00309771	0.0032217	0.00330442	0.00338677	0.00347265	0.00351634

dPhis+theta+dTh13 weighted marker 29

K(overall)	1	2	3	4	5	6	7	8	9
train	0.000807493 (need to retrain 1 and 2)	0.000807493	0.00121402	0.00146892	0.00165234	0.00178644	0.00188632	0.00198001	0.00206136
test	0.00245523	0.00245523	0.00238918	0.00237406	0.00240589	0.00243886	0.00246978	0.00249729	0.0025365
K	10	15	20	25	30	35	40	45	50
train	0.00212802	0.00235065	0.00250051	0.00260303	0.00268265	0.00274714	0.00279427	0.00283114	--
test	0.00256919	0.00268446	0.00277658	0.00284226	0.00289906	0.00294106	0.00296987	0.0029955	--

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	0.00123881	0.00123881	0.00185262	0.00219191	0.00239933	0.0025453	0.00264847	0.00272329	0.00278711
test	0.0056878	0.0056878	0.00496438	0.00459083	0.00438942	0.00422488	0.00411306	0.00401583	0.00395112
K	10	15	20	25	30	35	40	45	50
train	0.00284345	0.00302329	0.0031342	0.00322203	0.00327764	0.00332644	0.00336592	0.00340141	--
test	0.00390422	0.00374987	0.00369199	0.00366396	0.00365691	0.00365085	0.00365391	0.00365956	--

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	0.000476732	0.000476732	0.000689687	0.000820104	0.000906986	0.00096223	0.00101073	0.00104404	0.00107479
test	0.00126447	0.00126447	0.00125459	0.00125901	0.0012631	0.00127777	0.00128287	0.00129039	0.00129047
K	10	15	20	25	30	35	40	45	50
train	0.00109933	0.00116946	0.00122107	0.00124474	0.00126159	0.00127877	0.00129169	0.0012981	--
test	0.00130741	0.00134202	0.00135489	0.00136712	0.00137825	0.0013845	0.00139599	0.00139962	--
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	0.000344692	0.000344692	0.00050223	0.000620992	0.000706517	0.000787264	0.00086244	0.00091821	0.000973259
test	0.000694452	0.000694452	0.000833819	0.000900999	0.000980488	0.00106187	0.00111421	0.00116799	0.00121159
K	10	15	20	25	30	35	40	45	50
train	0.00102495	0.00116651	0.00126516	0.00134223	0.00141905	0.00145736	0.00149231	0.00150962	--
test	0.00123439	0.00136728	0.00147235	0.00154346	0.00158396	0.00161882	0.00163619	0.00165925	
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	0.000960514	0.000960514	0.00148164	0.00183716	0.00213007	0.00234232	0.00249019	0.00266647	0.0028148
test	0.00159308	0.00159308	0.00192982	0.00216182	0.00238544	0.0025719	0.00273135	0.00286434	0.00301828
K	10	15	20	25	30	35	40	45	50
train	0.00292873	0.00334559	0.00362993	0.0038151	0.00395951	0.00408712	0.00417198	0.0042436	--
test	0.0031383	0.00353309	0.00380153	0.00398177	0.00413638	0.0042494	0.0043202	0.00437987	--

dPhis+theta+FR1 weighted marker 33

K(overall)	1	2	3	4	5	6	7	8	9
train	0.000114752	0.000828712	0.00121606	0.00144119	0.00159645	0.00172623	0.00182058	0.0018916	0.00195435
test	0.00267553	0.00233646	0.00229647	0.00228071	0.0023005	0.00232443	0.00234923	0.0023708	0.00239495
K	10	15	20	25	30	35	40	45	50
train	0.00201706	0.00222383	0.00235668	0.00245513	0.00252822	0.00259694	0.00264285	0.00268663	--
test	0.00242188	0.00251816	0.00258621	0.00264568	0.00270345	0.00275318	0.00278864	0.0028299	--

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	0.000151065	0.00122223	0.0017671	0.00207465	0.00227112	0.00239897	0.00249671	0.00257114	0.00263746
test	0.00711913	0.0053067	0.00469169	0.00432974	0.00410323	0.00396303	0.00385498	0.00378999	0.00373029
K	10	15	20	25	30	35	40	45	50
train	0.00268788	0.00283262	0.00292305	0.00298555	0.00303449	0.00307278	0.00310265	0.00313072	--
test	0.00366817	0.00352962	0.00344903	0.00341704	0.00339825	0.0033819	0.00337289	0.00336965	--

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	0.000186721	0.000523551	0.000713915	0.000824	0.000903153	0.000964097	0.00100018	0.00102693	0.00104442
test	0.00122351	0.00120477	0.0012168	0.00121743	0.00122949	0.00125266	0.00126055	0.00127542	0.00127935
K	10	15	20	25	30	35	40	45	50
train	0.00107291	0.00114984	0.00117878	0.00119571	0.00122142	0.00124056	0.00125395	0.00126935	--
test	0.00128945	0.0013243	0.00133621	0.00133886	0.00133881	0.00135334	0.00135894	0.00136556	--
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	7.31432e-05	0.000381833	0.000564364	0.000689982	0.000788815	0.000854691	0.000903253	0.000951809	0.00100057
test	0.000566963	0.000726971	0.000841777	0.000909826	0.000977666	0.00103857	0.0010901	0.00113058	0.00116609
K	10	15	20	25	30	35	40	45	50
train	0.00103477	0.001176	0.00128142	0.00135348	0.00140537	0.00145085	0.00148118	0.00151017	--
test	0.00120808	0.0013375	0.0014194	0.00146643	0.0015165	0.00157604	0.00159643	0.00164282	--
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	6.32095e-05	0.000987343	0.00150549	0.00180181	0.00200952	0.00223022	0.00239138	0.00250407	0.00260321
test	0.00115594	0.00156368	0.0018909	0.00211256	0.00232204	0.0024661	0.00260116	0.0026907	0.00279454
K	10	15	20	25	30	35	40	45	50
train	0.00271888	0.00311131	0.00336931	0.00357162	0.00371192	0.00385628	0.00394858	0.00403513	--
test	0.00290099	0.00322275	0.00344988	0.00363631	0.00380535	0.00393014	0.00403495	0.00413504	--

dPhis+theta+bend_1+FR1 weighted marker 24

K(overall)	1	2	3	4	5	6	7	8	9
train	7.26377e-05	0.000714256	0.00105996	0.0012622	0.00141964	0.00152781	0.00162871	0.00170525	0.00178074
test	0.00244133	0.00214049	0.00208023	0.00207417	0.00208704	0.00210859	0.00213982	0.00216688	0.00219594
K	10	15	20	25	30	35	40	45	50
train	0.00184139	0.00204725	0.00218363	0.00227619	0.00234292	0.00239863	0.00244538	0.00249066	--
test	0.0022198	0.00233547	0.00240123	0.00246397	0.00251345	0.00255587	0.00259289	0.00262107	--

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	9.89024e-05	0.0011967	0.00175397	0.00205353	0.00226495	0.00239749	0.00249538	0.00257665	0.00264402
test	0.00682156	0.00525553	0.00464606	0.00432138	0.00412924	0.00399678	0.00390588	0.00383243	0.00377092
K	10	15	20	25	30	35	40	45	50
train	0.00269339	0.0028631	0.00297502	0.00305225	0.00311498	0.00316375	0.00320634	0.00324438	--
test	0.00372051	0.00358967	0.00353623	0.00351691	0.00350526	0.00350046	0.00350399	0.00351265	--

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	0.00012228	0.000423489	0.000589406	0.000684434	0.000750589	0.000808654	0.000844941	0.000879626	0.000896621
test	0.00108145	0.00106705	0.0010852	0.0010962	0.00109715	0.00110933	0.00111964	0.00111601	0.00112181
K	10	15	20	25	30	35	40	45	50
train	0.000924148	0.000986997	0.00102776	0.00105636	0.00107542	0.00109391	0.00110815	0.00112305	--
test	0.00113202	0.00115499	0.00116221	0.00117496	0.00118995	0.0012013	0.00121288	0.00121466	--
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	5.39312e-05	0.000295461	0.000444937	0.000549002	0.000624426	0.000680979	0.000724932	0.000776434	0.00082169
test	0.000418756	0.000546509	0.000636465	0.000704931	0.000769623	0.000810051	0.000877028	0.000911362	0.000953129
K	10	15	20	25	30	35	40	45	50
train	0.000860814	0.000998672	0.00110141	0.00115186	0.00119644	0.00123791	0.00126614	0.00129189	--
test	0.000991214	0.00112993	0.00121652	0.00127156	0.00130742	0.00133249	0.0013527	0.00137568	--
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	2.92036e-05	0.000765554	0.001177	0.00143113	0.00165724	0.00181225	0.00199742	0.00211462	0.00225667
test	0.000857874	0.00119072	0.00146044	0.00167336	0.00183974	0.00199049	0.00211914	0.0022503	0.0023661
K	10	15	20	25	30	35	40	45	50
train	0.00236395	0.00274297	0.00298731	0.00316456	0.00328154	0.00337777	0.00346239	0.0035475	--
test	0.0024549	0.00283406	0.00302983	0.00320348	0.00333906	0.00345558	0.00355047	0.003617	--

dPhis+theta+dTh13+FR1 weighted marker 25

K(overall)	1	2	3	4	5	6	7	8	9
train	5.772e-05	0.000785819	0.0011806	0.00143627	0.00161803	0.00175161	0.00184983	0.00194044	0.00202459
test	0.00271318	0.00235695	0.00230438	0.00231266	0.0023437	0.00237891	0.00241196	0.00244983	0.00248575
K	10	15	20	25	30	35	40	45	50
train	0.00208766	0.00232251	0.00248694	0.00259126	0.00266563	0.0027229	0.00276526	0.00280128	--
test	0.0025174	0.00265331	0.00274224	0.00281386	0.00287041	0.00290765	0.00293681	0.00296856	--

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	5.91528e-05	0.00118764	0.00175296	0.0020824	0.0022815	0.00242267	0.00252659	0.00261093	0.00268184
test	0.00739461	0.00550147	0.00481123	0.00445075	0.00422974	0.00408316	0.00397268	0.00388223	0.00381948
K	10	15	20	25	30	35	40	45	50
train	0.00274029	0.00292891	0.00303923	0.00312192	0.00318099	0.00323733	0.00328728	0.00332963	--
test	0.00377783	0.00365261	0.00359824	0.00357708	0.00357073	0.00357419	0.00358071	0.00359228	--

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	0.000101818	0.000445202	0.000631486	0.000749661	0.000834376	0.000887715	0.000919217	0.000954613	0.000988911
test	0.00115196	0.00112137	0.0011364	0.00114436	0.00117119	0.0011957	0.00119816	0.00120992	0.00120933
K	10	15	20	25	30	35	40	45	50
train	0.00101217	0.00108523	0.00112383	0.0011479	0.00117578	0.00118862	0.00119587	0.00121167	--
test	0.00121839	0.00125768	0.00127513	0.0012879	0.00129534	0.00130184	0.00130926	0.00131757	--
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	5.14934e-05	0.000353198	0.00050479	0.000636153	0.000736396	0.000808444	0.000877416	0.000935246	0.000987005
test	0.000511071	0.000655257	0.000791137	0.000909201	0.000980595	0.00103547	0.00109868	0.00114831	0.00119041
K	10	15	20	25	30	35	40	45	50
train	0.00102022	0.00119878	0.0013015	0.00138251	0.00144491	0.00149031	0.00151153	0.00152453	--
test	0.00122238	0.0013587	0.00143904	0.00151463	0.00156223	0.00160678	0.00162934	0.00165057	--
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	3.14333e-05	0.000950921	0.00149876	0.00186505	0.00215136	0.00237337	0.00253072	0.00268582	0.00283682
test	0.0011202	0.00156232	0.00189902	0.00215817	0.00238681	0.00257606	0.00273559	0.002896	0.00303907
K	10	15	20	25	30	35	40	45	50
train	0.00295069	0.00337213	0.0037099	0.00390248	0.0040294	0.00412504	0.00419835	0.00425788	--
test	0.00315018	0.00358043	0.00384916	0.00403912	0.00418994	0.00427249	0.00434059	0.00441288	--

dPhis+theta+dTh13+ bend_1 weighted marker 26

K(overall)	1	2	3	4	5	6	7	8	9
train	5.19696e-05	0.000697575	0.00107443	0.00130661	0.00147693	0.00159257	0.00168939	0.0017805	0.00185771
test	0.00256592	0.00226129	0.00218487	0.00217071	0.00218898	0.00220043	0.0022355	0.00226729	0.00229577
K	10	15	20	25	30	35	40	45	50
train	0.00192144	0.00214375	0.00227608	0.00237613	0.00244956	0.00249698	0.00254238	0.00258117	--
test	0.00232344	0.00242953	0.00250717	0.00258096	0.00262858	0.00267361	0.00270559	0.00273206	--

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	5.72662e-05	0.00123741	0.00186269	0.00219082	0.00240854	0.00254903	0.00265155	0.00273766	0.00280227
test	0.00728033	0.00565674	0.00496845	0.00462567	0.00441044	0.00425458	0.00415945	0.00407662	0.00401177
K	10	15	20	25	30	35	40	45	50
train	0.00286477	0.00306736	0.00318602	0.00327106	0.00334096	0.00339297	0.00343831	0.00348125	--
test	0.00395984	0.00382722	0.00376683	0.00375569	0.00374695	0.00375402	0.00375905	0.00376458	--

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	9.99708e-05	0.000399508	0.000575274	0.000694707	0.00077624	0.00083118	0.000862363	0.000893816	0.0009151
test	0.00114782	0.00110811	0.00111124	0.00111307	0.00112577	0.00114445	0.00114403	0.00114322	0.00114564
K	10	15	20	25	30	35	40	45	50
train	0.000929617	0.00100975	0.00106291	0.0010914	0.00110561	0.00112393	0.00113734	0.00114961	--
test	0.00114476	0.00118155	0.00120327	0.00121617	0.00122092	0.00123372	0.00124676	0.00124689	--
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	4.58846e-05	0.00028109	0.000414516	0.000505221	0.000571419	0.000659132	0.000714983	0.000779293	0.000832743
test	0.000417332	0.000513937	0.000610912	0.000677911	0.00075685	0.00080923	0.000862802	0.000910377	0.000960557
K	10	15	20	25	30	35	40	45	50
train	0.000871744	0.000983396	0.00107146	0.00112629	0.00117488	0.00120839	0.00124328	0.00126526	--
test	0.00100524	0.00111678	0.00120144	0.00125766	0.00128392	0.00132249	0.00135162	0.00135973	--
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	1.95788e-05	0.000701377	0.00115765	0.00147607	0.00173426	0.00188723	0.00205045	0.00220378	0.00234543
test	0.000812127	0.00122143	0.00151379	0.00172361	0.00191031	0.00203665	0.00219763	0.0023415	0.00245495
K	10	15	20	25	30	35	40	45	50
train	0.00245974	0.00286916	0.00309626	0.00328785	0.0034206	0.00349273	0.00356659	0.00363075	--
test	0.00256029	0.0029193	0.00315115	0.00335231	0.00349265	0.00359701	0.00366733	0.00374225	--

dPhis+theta+dTh13+ bend_1+FR1 weighted marker 27

K(overall)	1	2	3	4	5	6	7	8	9
train	3.81526e-05	0.000696435	0.0010741	0.00129765	0.00145079	0.00157178	0.00167794	0.00176969	0.00184027
test	0.00251116	0.00221709	0.00214681	0.00214803	0.00216229	0.00219214	0.00221862	0.0022496	0.00227759
K	10	15	20	25	30	35	40	45	50
train	0.0019061	0.00212222	0.00226712	0.00236319	0.0024347	0.00249266	0.00254652	0.00258959	--
test	0.00230754	0.00241853	0.00250704	0.002573	0.00263673	0.00267752	0.00271234	0.00274328	--

K(1-8GeV)	1	2	3	4	5	6	7	8	9
train	3.84383e-05	0.00119673	0.001797	0.00212804	0.00233734	0.00248439	0.00259641	0.0026805	0.00275047
test	0.00715137	0.00553694	0.00487503	0.00455544	0.00432813	0.00418865	0.00409131	0.00400829	0.00395554
K	10	15	20	25	30	35	40	45	50
train	0.00281793	0.00301318	0.00313758	0.00322992	0.00330479	0.00336742	0.00342577	0.00347637	--
test	0.00390641	0.00378258	0.00373478	0.00372353	0.00372534	0.00373499	0.00374625	0.00376424	--

K(8-30GeV)	1	2	3	4	5	6	7	8	9
train	6.88033e-05	0.000390502	0.000562844	0.000660135	0.00071714	0.000766815	0.00080392	0.000833491	0.000863269
test	0.00101548	0.000994954	0.00100771	0.00101895	0.00104062	0.00105253	0.00106723	0.00107642	0.0010814
K	10	15	20	25	30	35	40	45	50
train	0.00088645	0.000953108	0.0010079	0.00103658	0.00105834	0.00107847	0.00109195	0.00110822	--
test	0.00109245	0.00113297	0.00116019	0.00117233	0.00118406	0.00118717	0.00119598	0.00120286	--
K(30-120GeV)	1	2	3	4	5	6	7	8	9
train	3.84256e-05	0.00027827	0.000398325	0.000504638	0.000589681	0.000675456	0.000733381	0.000778382	0.000823461
test	0.000432713	0.000565993	0.000654185	0.000722939	0.000764574	0.000832327	0.000881455	0.000918741	0.000965988
K	10	15	20	25	30	35	40	45	50
train	0.000861811	0.000983118	0.00109529	0.00116877	0.00121447	0.00125078	0.00127495	0.00129595	--
test	0.00099887	0.00112386	0.00121009	0.00126798	0.00130381	0.00133549	0.00136034	0.00138156	--
K(120—1000GeV)	1	2	3	4	5	6	7	8	9
train	1.73777e-05	0.000741573	0.00123394	0.001526	0.00173963	0.00190886	0.0020885	0.00226009	0.00237565
test	0.000827028	0.00122471	0.00151312	0.00174467	0.00194834	0.00211372	0.00224184	0.00238356	0.00248504
K	10	15	20	25	30	35	40	45	50
train	0.00248705	0.00288537	0.00313046	0.00328992	0.00340902	0.0035027	0.00359958	0.0036688	--
test	0.00259531	0.00295078	0.00320186	0.00337725	0.00354912	0.00364869	0.00372837	0.00379334	--

dPhi+theta+dPhiSum3

k	1	2	3	4	5	6	7	8
train	0.000173378	0.000898661	0.00127605	0.00151907	0.00168583	0.00181372	0.00190758	0.0019785
test	0.00290756	0.00251034	0.00242445	0.00241031	0.00242718	0.002443	0.00246962	0.00248495
Train1-8	0.000260811	0.00136209	0.00193215	0.00224735	0.00245001	0.00259744	0.00269786	0.00277425
Test1-8	0.00773645	0.00572551	0.00497046	0.00462695	0.00439637	0.00424664	0.00413542	0.00405371
Train8-30	0.00027177	0.000585601	0.000811253	0.000958956	0.00101694	0.0010607	0.00110806	0.00113883
Test8-30	0.00142295	0.00136947	0.00136608	0.00137922	0.00137846	0.00138251	0.00140196	0.00140664
Train30-120	9.75E-05	0.000399533	0.000575278	0.000689472	0.000793208	0.000848759	0.000913145	0.000958067
Test30-120	0.000640602	0.000808223	0.000934591	0.00100362	0.00107197	0.00112541	0.00117181	0.0011944
Train120-1000	8.24E-05	0.00103627	0.00148119	0.00181131	0.00206141	0.00227707	0.00241606	0.00252649
Test120-1000	0.0011774	0.00159053	0.00189561	0.00209721	0.00230907	0.00245319	0.00259266	0.00269572

Tune Scale Frac when k=4, dPhis+theta+bend_1+FR1

Scale Frac	0	0.61	0.62	0.63	0.64	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1
train	0.00115444	0.00127317	0.00127317	0.00127317	0.00127205	0.00127205	0.00125961	0.00127142	0.0012622	0.0012503	0.00123737	0.00121511	0.00117735
test	0.00193683	0.00210214	0.00210214	0.00210214	0.0020944	0.0020944	0.00205614	0.00209088	0.00207417	0.00204699	0.0020257	0.00200334	0.00195252
Train1-8	0.00194561	0.00208354	0.00208354	0.00208354	0.00206749	0.00206749	0.00203562	0.00207168	0.00205353	0.00202487	0.00201127	0.00199914	0.00196419
Test1-8	0.00411105	0.00437369	0.00437369	0.00437369	0.00430556	0.00430556	0.00424837	0.00434412	0.00432138	0.00426636	0.00423452	0.00420019	0.0041213
Train8-30	0.000647514	0.0006876	0.0006876	0.0006876	0.00068423	0.00068423	0.000679781	0.000683418	0.000684434	0.000675688	0.000674294	0.00067146	0.000651809
Test8-30	0.00101022	0.00110844	0.00110844	0.00110844	0.00111266	0.00111266	0.00109876	0.00110472	0.0010962	0.00109778	0.00108567	0.00106981	0.00104576
Train30-120	5.07E-04	0.000554101	0.000554101	0.000554101	5.47E-04	5.47E-04	0.000544083	0.000553031	0.000549002	0.000546359	0.000532228	0.000522622	0.000523127
Test30-120	0.000669573	0.000713521	0.000713521	0.000713521	0.000737045	0.000737045	0.000712268	0.00071577	0.000704931	0.000713775	0.000689143	0.000685072	0.000667237
Train120-1000	2/24/2017 1.23E-03	0.00143444	0.00143444	0.00143444	1.45E-03	1.45E-03	0.00144505	0.00144277	0.00143113	0.00142566	0.0014065	0.00135377	0.00127544

Track mode	$\Delta\varphi$							$\Delta\theta$						Bits
	1-2	1-3	1-4	2-3	2-4	3-4	+/-	1-2	1-3	1-4	2-3	2-4	3-4	
15	7			5		6	2**							20
14	7			5			2		3					17
13	7				5		2			3				17
12	9						1	3						13
11		7				5	2			3				17
10		9					1		3					13
9			9				1			3				13
7				7		6	2					3		18
6				9			1				3			13
5					9		1					3		13
3						9	1						3	13

Track mode	Bend (CLCT)					FR				θ	Md	Σ	Σ	Bits
	1	2	3	4	+/-	1	2	3	4					
15						1				5	4	10	20	30
14	2				1	1				5	4	13	17	30
13	2				1	1				5	4	13	17	30
12	2	2			2	1	1			5	4	17	13	30
11	2				1	1				5	4	13	17	30
10	2		2		2	1	1			5	4	17	13	30
9	2			2	2	1			1	5	4	17	13	30
7		2			1					5	4	12	18	30
6		2	2		2		1	1		5	4	17	13	30
5		2		2	2		1		1	5	4	17	13	30
3			2	2	2			1	1	5	4	17	13	30

Modes

Mode #	Definition in code	Stations
15	1+2+4+8	1,2,3,4
14	2+4+8	1,2,3
13	1+4+8	1,2,4
12	4+8	1,2
11	1+2+8	1,3,4
10	2+8	1,3
9	1+8	1,4
8	8	1
7	1+2+4	2,3,4
6	2+4	2,3
5	1+4	2,4
4	4	2
3	1+2	3,4
2	2	3
1	1	4

Euclidean distance

x: input variables(dimension d)
of train event

y: input variables of test event

f: polynomial kernel weight
function

w_j : weight of j in train sample

$$R_{\text{rescaled}} = \left(\sum_{i=1}^d \frac{1}{w_i^2} |x_i - y_i|^2 \right)^{\frac{1}{2}}$$

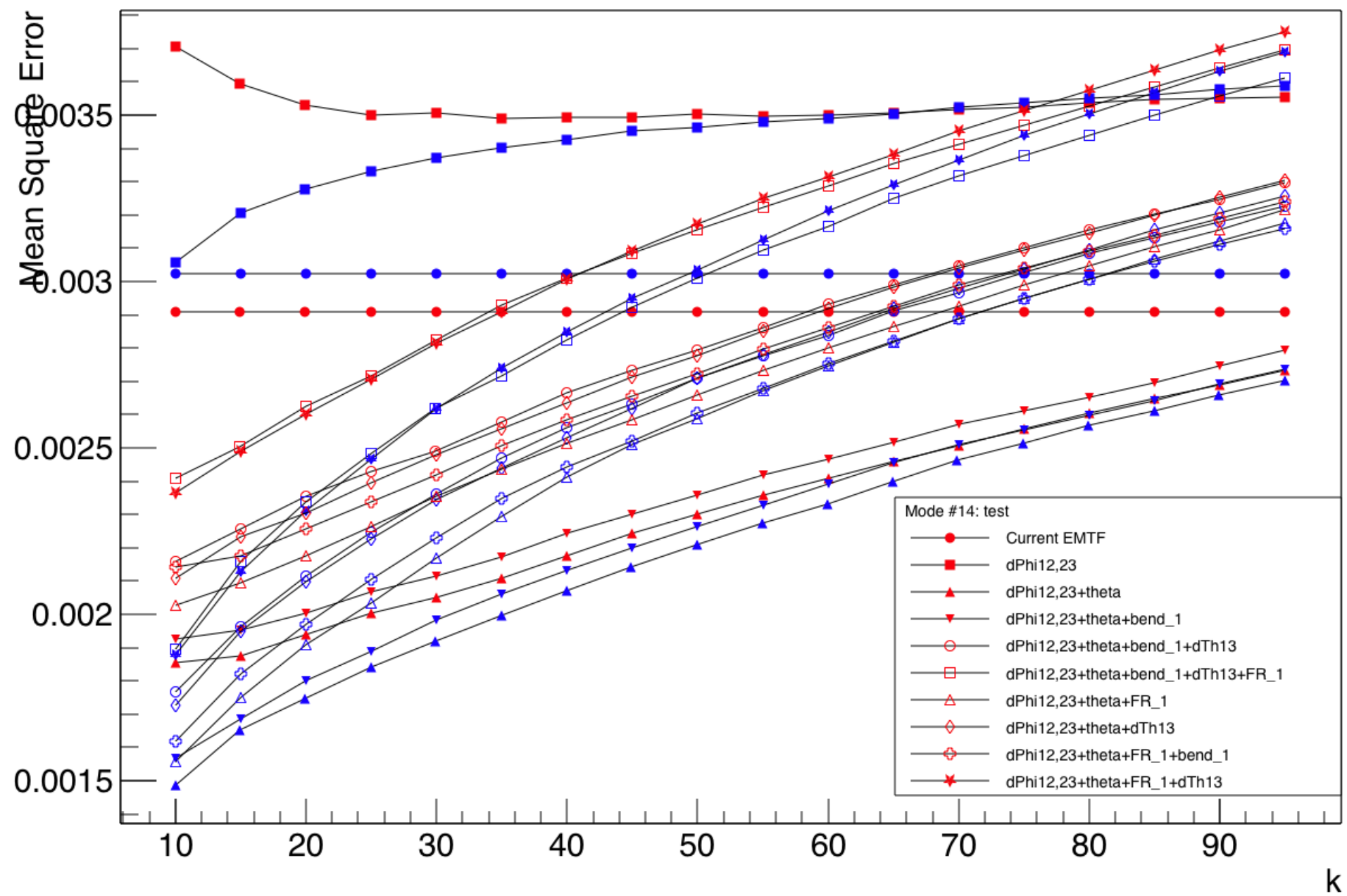
$$\langle t(i, V) \rangle = \frac{\sum_{j \in V} w_j t_j f(\text{dis}(i, j))}{\sum_{j \in V} w_j f(\text{dis}(i, j))}$$

kNN

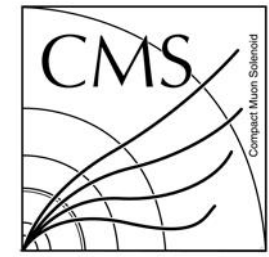
- Tune k and Scale frac
- Continuous/categorical variable: different metric(Euclidean/Hamming)
- When mixture of both kinds of variables, standardization or scale variables(called feature normalization)
- E.g. $x' = (x - \min) / (\max - \min)$; $x' = (x - x_mean) / x_variance$; assign weights to $d(i,j)$ (TMVA adopts this)
- A non-parametric method
Unlike other supervised learning algorithms, K-Nearest Neighbors doesn't learn an explicit mapping f from the training data
- Simply uses the training data at the test time to make predictions
- Need large dataset/cross validation dataset

KNN Regression

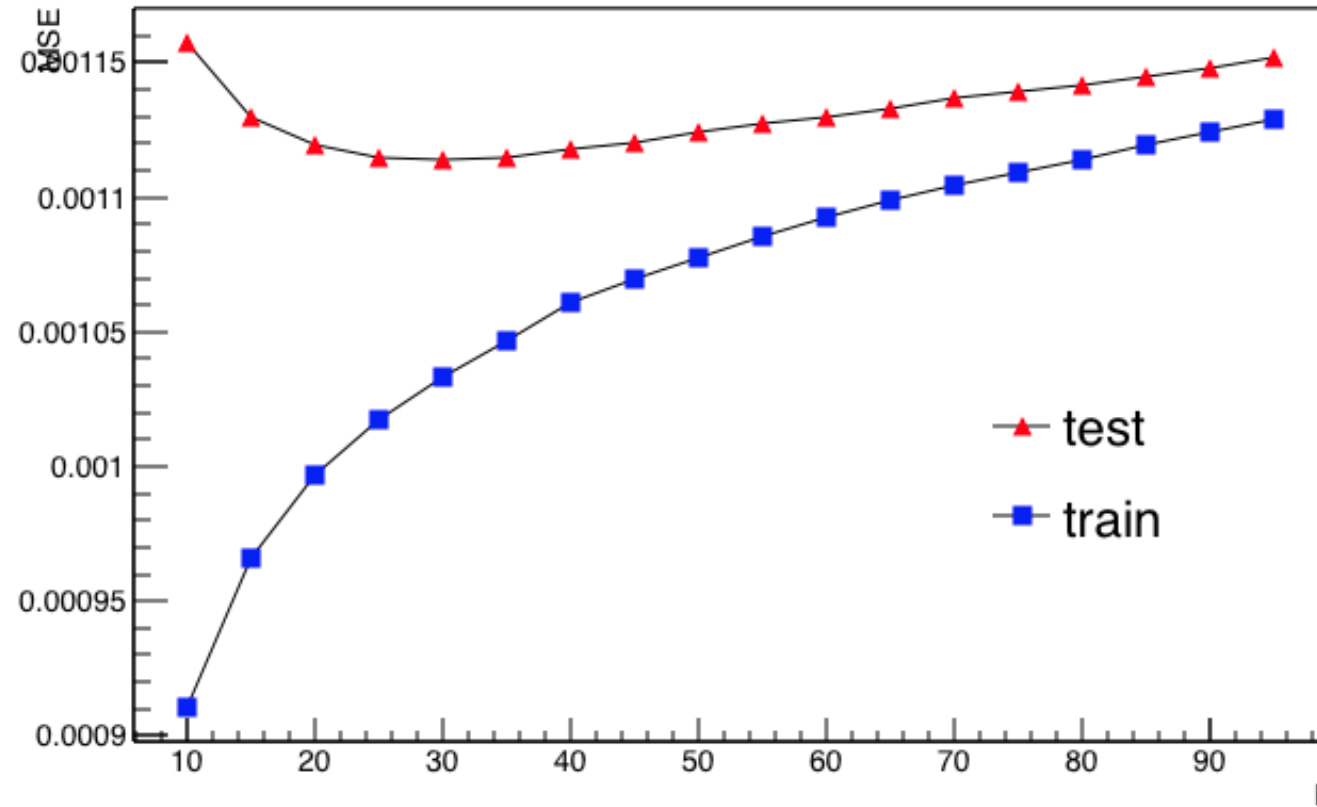
- For a test event, the algorithm finds the k-nearest neighbours using the input variables, where each training event contains a regression value. The predicted regression value for the test event is the weighted average of the regression values of the k-nearest neighbours
- The choice of the metric governs the performance of the nearest neighbour algorithm. When input variables have different units a variable that has a wider distribution contributes with a greater weight to the Euclidean metric. This feature is compensated by rescaling the variables using a scaling fraction determined by the option ScaleFrac.



"nkNN=30:ScaleFrac=0.8:SigmaFact=1.0:
Kernel=Gaus:UseKernel=F:UseWeight=T:!
Trim"



MSE =
 $\text{Deviation}^2/N$



Mode: 15
Input variables:
dphi12, dphi23,
dphi34
Target variable:
1/Gen pT

Comments

- Maybe we don't need to choose the best model, instead, we can use weighted models for final pT LUT
- Maybe we can use different model for different input variables, some model may perform better than others in certain parameter region(η)

BDT parameters(mode 15) from Andrew B.(check)

For mode 15

- 400 trees
- Depths: 5
- $1/pT$ weight(0-120 GeV), $\text{Log2}(pT)$ is better target than $1/pT$
- For very high pT , unweighted events better(>120 GeV)
- Input variables: FR bits bring significant improvement at low and high pT
- In addition to track theta, FR 1, and $d\Phi$ 1-2, 2-3, and 3-4(LUT v1), add combinations of $d\Phi$ s, and ring number of station 1
- https://indico.cern.ch/event/608207/contributions/2451751/subcontributions/218758/attachments/1402616/2142649/2017_01_26_Mode_15_BDT.pdf

BDT good/bad

- Good: little tuning required(simple)
- Bad:
 1. will ignore non-discriminating variables as for each node splitting only the best discriminating variable is used
 2. theoretically best performance on a given problem is generally inferior to other techniques like neural networks.
- See TMVA tutorial