A Large Ion Collider Experiment

European Organisation for Nuclear Research

First results from pp900GeV in ALICE with EM-Calorimeters

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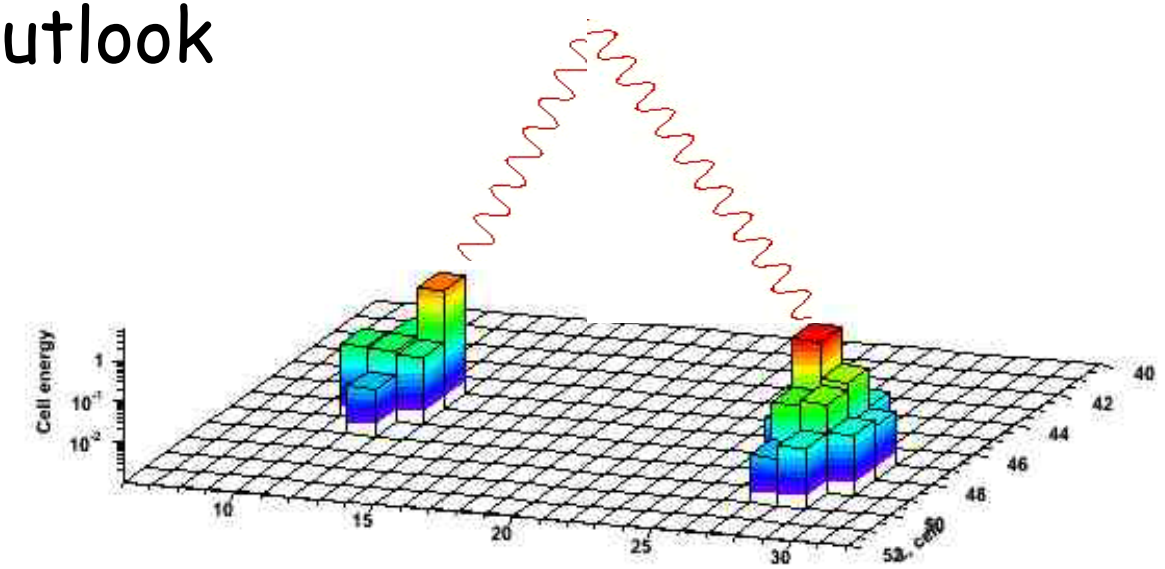
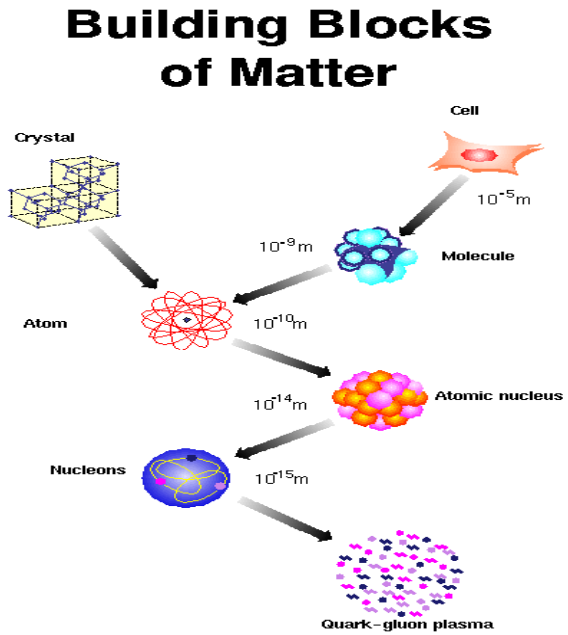
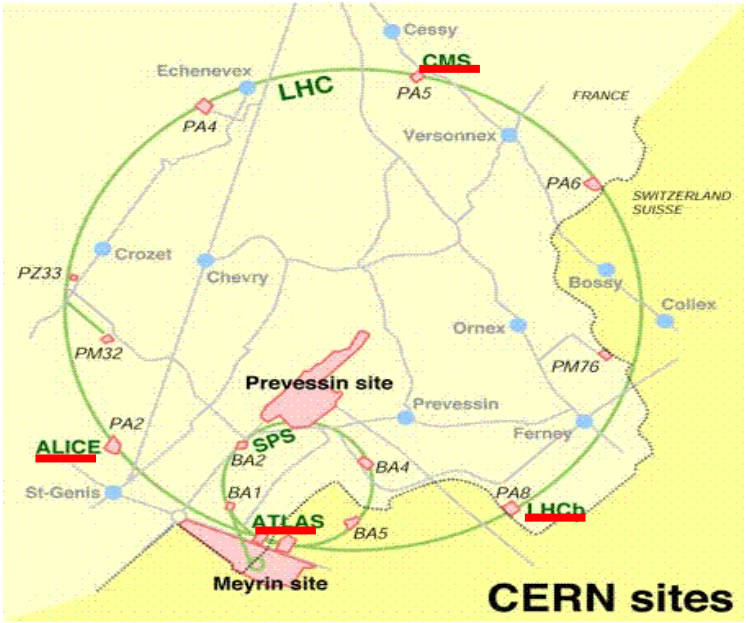
Outline

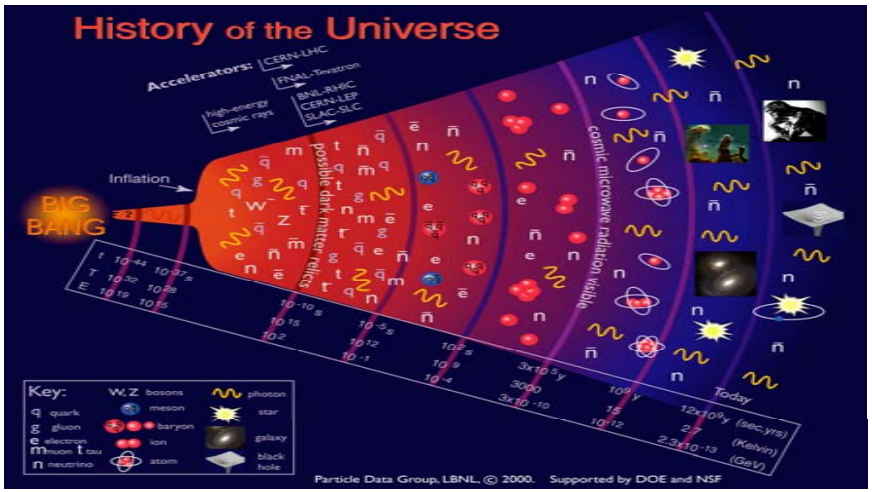
- Physics motivation
- ALICE EM-Calorimeters
- Data process from raw data to physics results
- First results from 900GeV proton-proton collisions with run-2009
- Conclusions and outlook

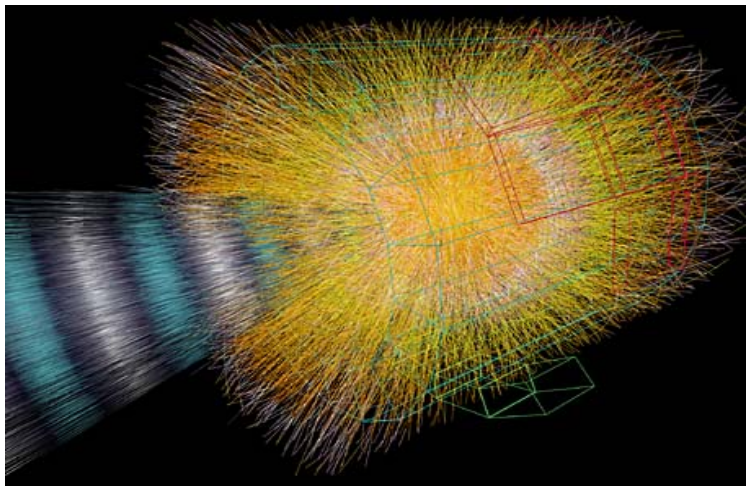


Motivation





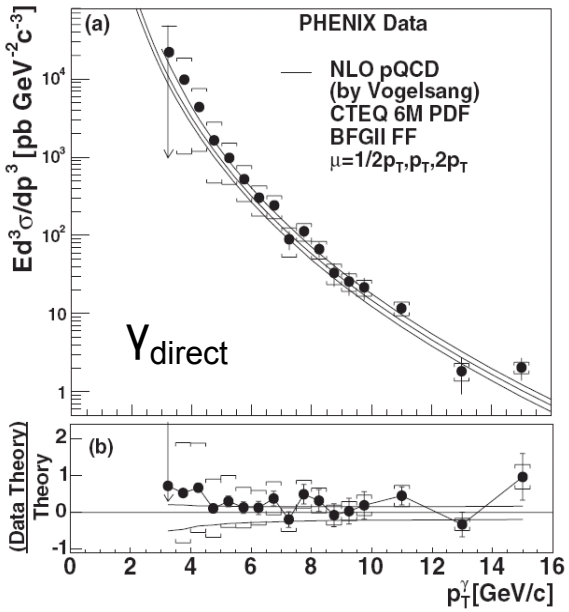




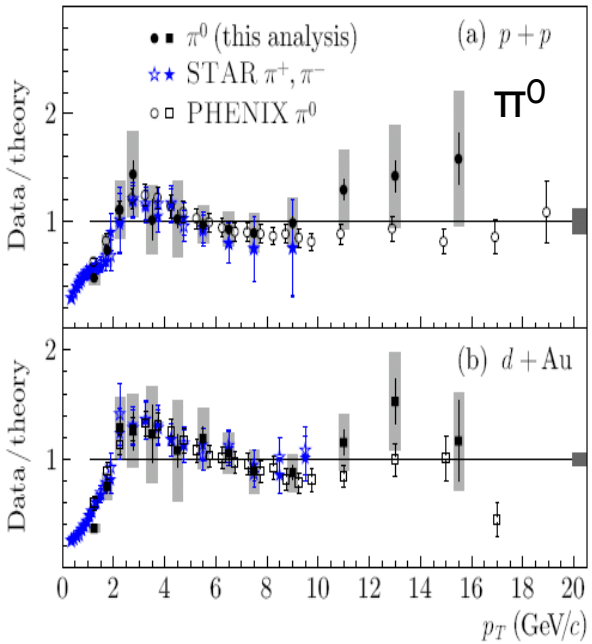
Fundamental matter, early universe, QGP …

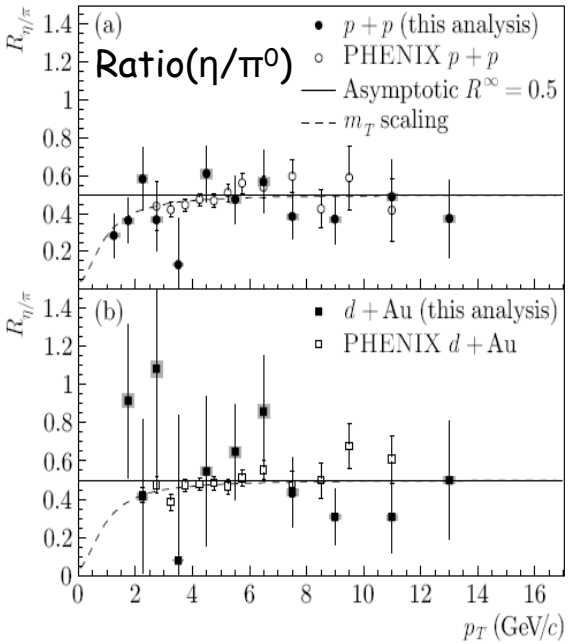
Observations

- Study the QGP and learn about the QCD matter
- Golden probe by photon and jet
- Diagnose the QGP signal by direct photon (thermal +prompt) measurement
- Light neutral mesons extraction
- Test the pQCD, m_T scaling …



PRL 98,012002

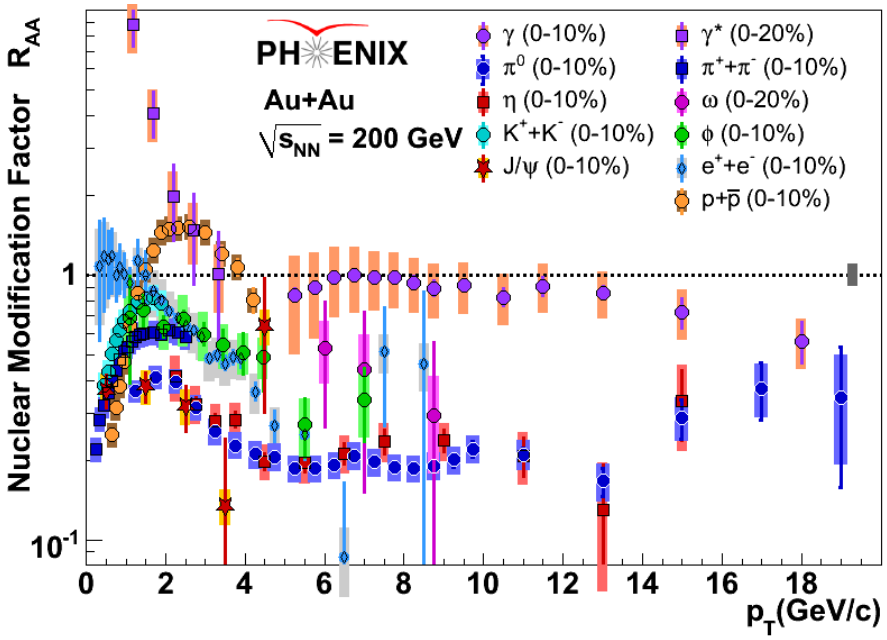




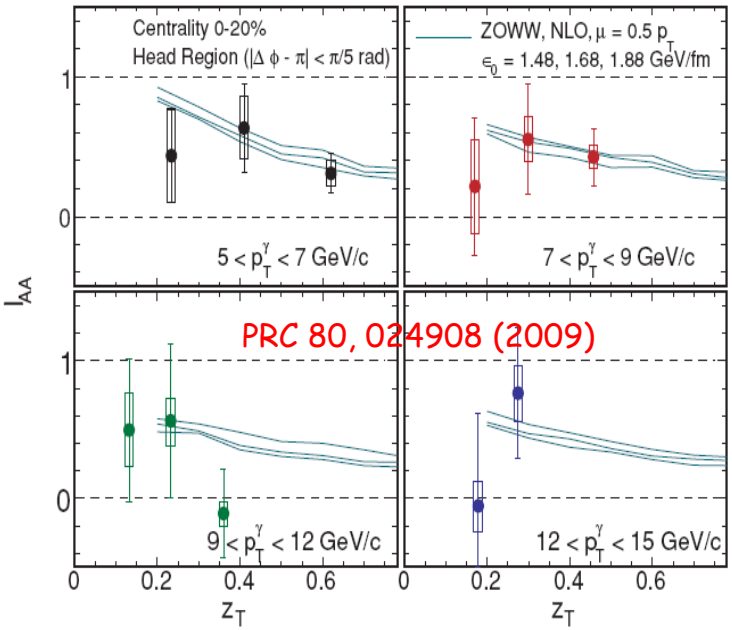
arXiv: 0912.3838

Observations

- Insight the properties of hot medium and understand the mechanism of parton energy loss
- Nuclear modification factor
- Azimuthal correlation measurement triggered by direct-photon, high pt π^0
- Feasibility to access the fragmentation function



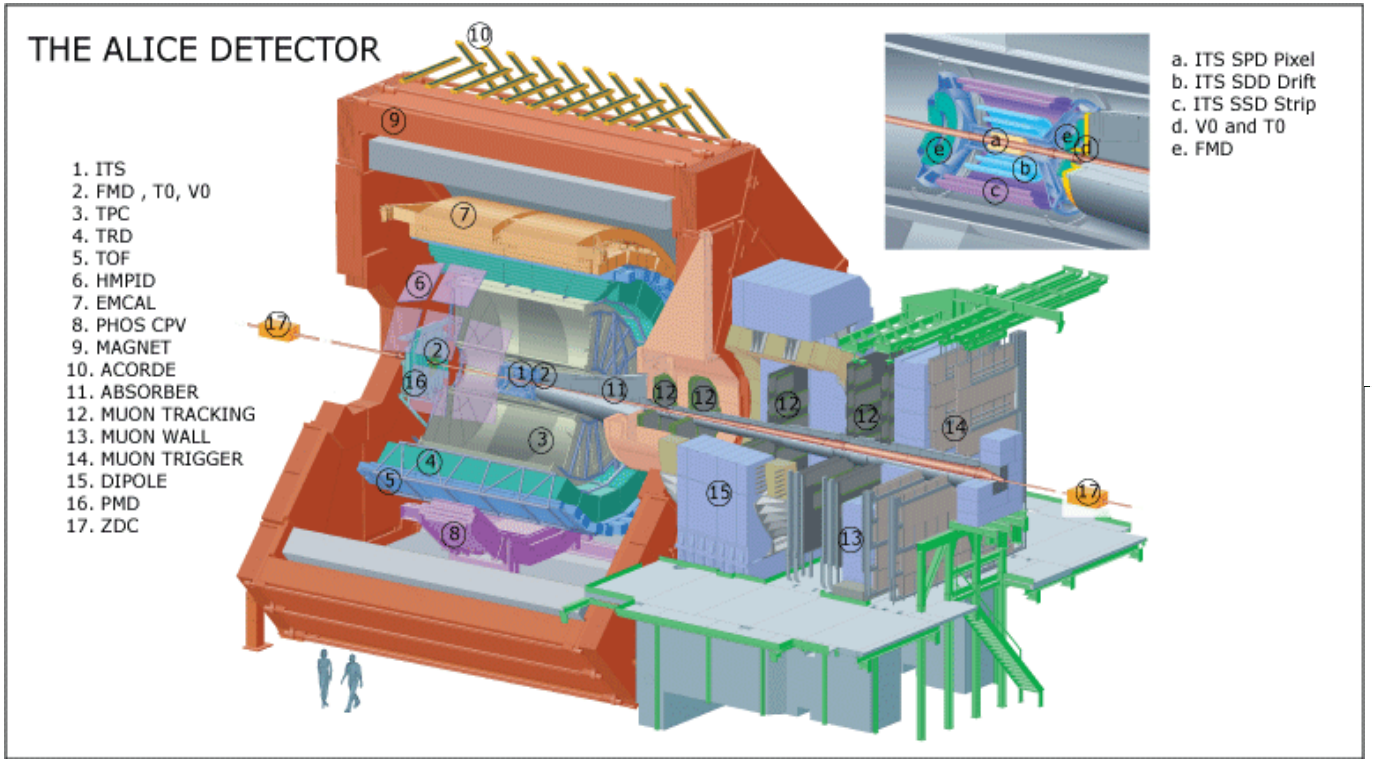
$$R_{AA} = \frac{1/N_{evt} d^2 N_{AA}/dydp_T}{<T_{AB}> d^2\sigma_{pp}/dydp_T}$$

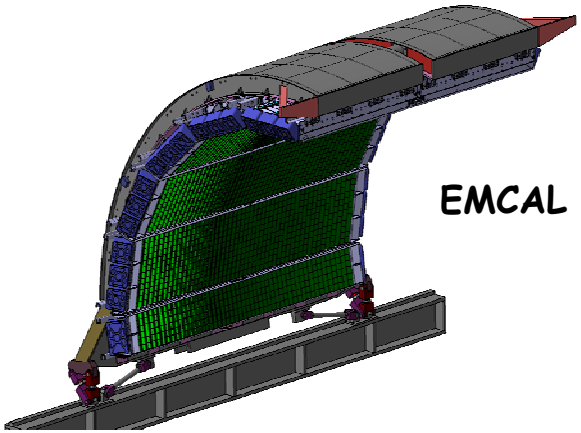


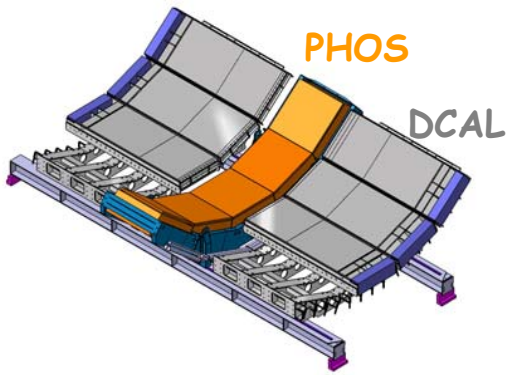
$$I_{AA}^{\gamma h(hh)}(z_T) = \frac{D_{AA}^{\gamma h(hh)}(z_T)}{D_{pp}^{\gamma h(hh)}(z_T)}$$

$$z_T = p_T^h / p_T^\gamma$$

ALICE detectors







- ALICE EM-Calorimeters = EMCAL + PHOS + DCAL (upgrade)
- Dedicated on heavy-ion collisions at $\sqrt{S_{NN}}$=5.5TeV
- Cope with high multiplicity dN_{ch}/dy~8000

Comparison of EM-Calorimeters

		Material	$\lvert\eta\rvert$	$\Delta\varphi$	Granularity	Resolution	
						Energy(GeV)	Position(mm)
RHIC	PHENIX	PbSc	<0.35	135	0.011×0.011	8.1%/√E⊕2.1%	1.4⊕5.9/ √E
		PbGl	<0.35	45	0.008×0.008	5.9%/√E⊕0.8%	6.0/ √E
	STAR(BEMC)	Pb	<1	360	0.05*0.05	14%/√E⊕1.5 %	3.2⊕5.8/ √E
ATLAS	Barrel LAr	Liquid Ar	<1.375	360	0.003*0.1	10%/√E⊕0.2 %	
	Endcap LAr		>1.4 <3.2		0.025*0.025 0.05*0.025		
CMS	EM-Barrel	PbWO4	<1.479	360	0.0174*0.0174	2.8%/√E⊕0.3 %	
	EM-Endcap		>1.479 <3.0		0.0174*0.0174 ~ 0.05*0.05		
ALICE	PHOS	PbWO4	<0.12	100	0.004*0.004	3.3%/√E⊕1.1 %	0.7⊕2.3/ √E
	EMCAL	Pb	<0.7	110	0.0143*0.0143	11%/√E⊕1.7%	1.5⊕5.3/ √E
	DCAL	Pb	>0.2 <0.7	60	0.0143*0.0143		

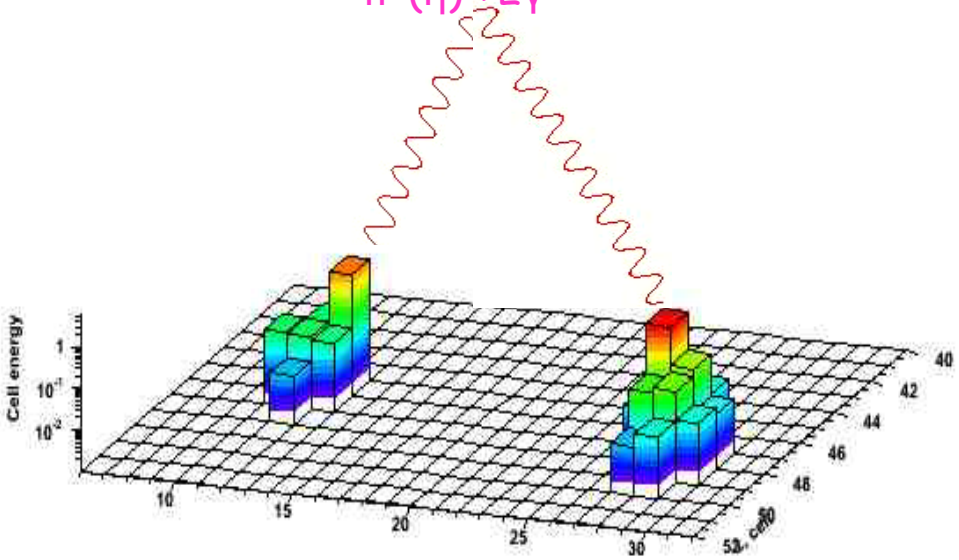
- High granularity and high resolution with PHOS
- Larger acceptance of the ALICE EM-Calorimeters
- EMCAL and PHOS+DCAL are back to back dedicated on jet measurement

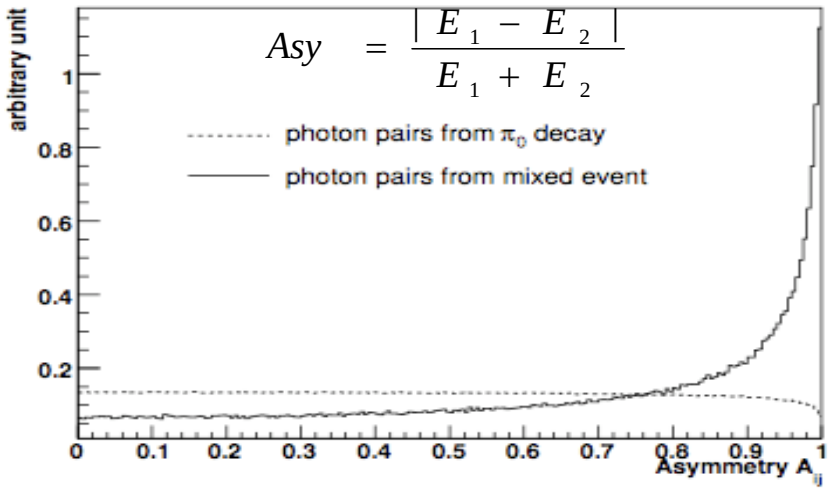
Light neutral mesons measurement

Decay channel	Branch ratio(%)
π^0 ->2 γ	99.98
η-> 2 γ	39.38
ω(782)-> π^0 γ->3 γ	8.9
η-> π^0 π^+ π^-	28.0
ω(782)->π^0 π^+ π^-	89.1
K_s^0-> π^0 π^0	30.69

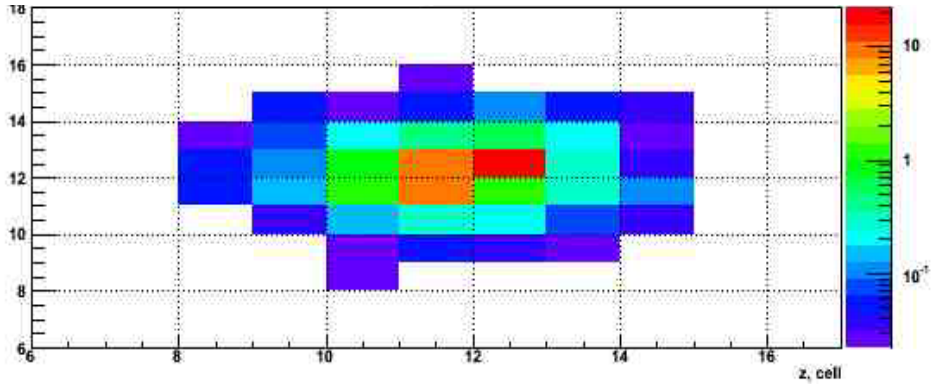
$$m_{\gamma\gamma} = \sqrt{(\vec{p_1} + \vec{p_2})^2} = \sqrt{2E_1E_2 \cdot (1 - \cos\theta_{12})}$$

$\pi^0(\eta)$->2γ





The two photons merged together when pt^{π^0}>20~30GeV/c (PHOS)

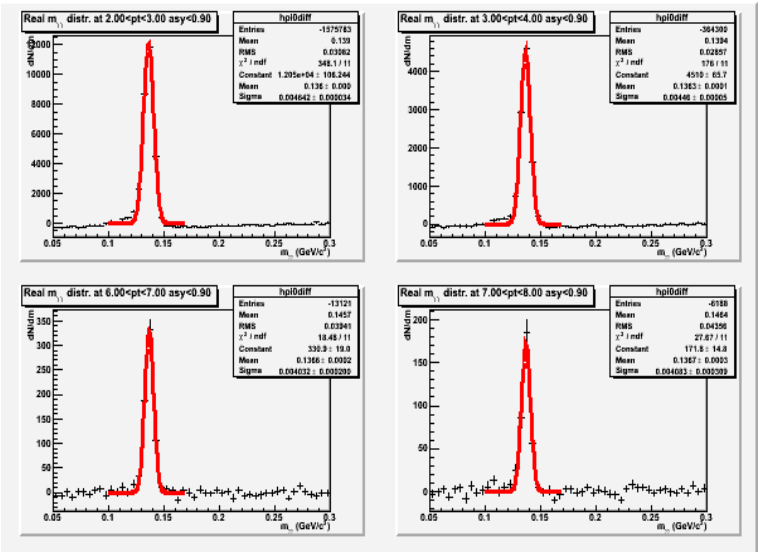


Role of pi0

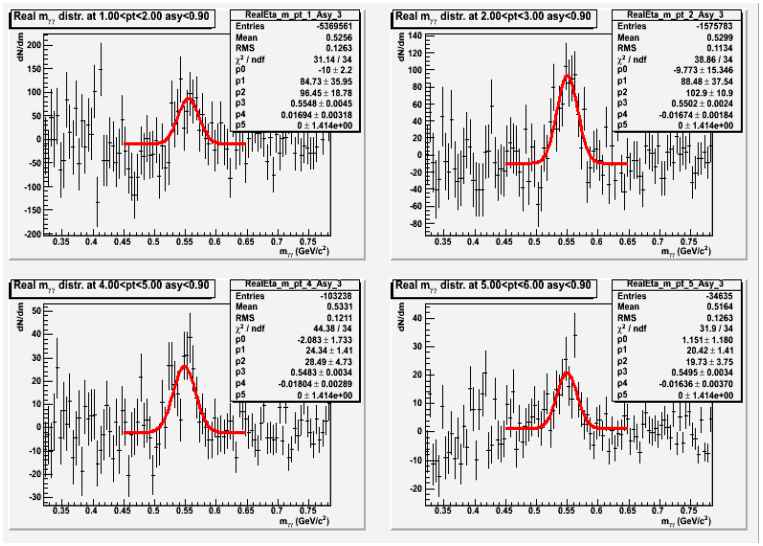
- Tuning and calibrate the detector in the early stage
- Main background for direct photon access
- Measurement of "Jet quenching"
  - R_{AA} measurement
  - Jet tomography
- pp runs as a reference for pA and AA
- Test the pQCD, m_T scaling

We can …

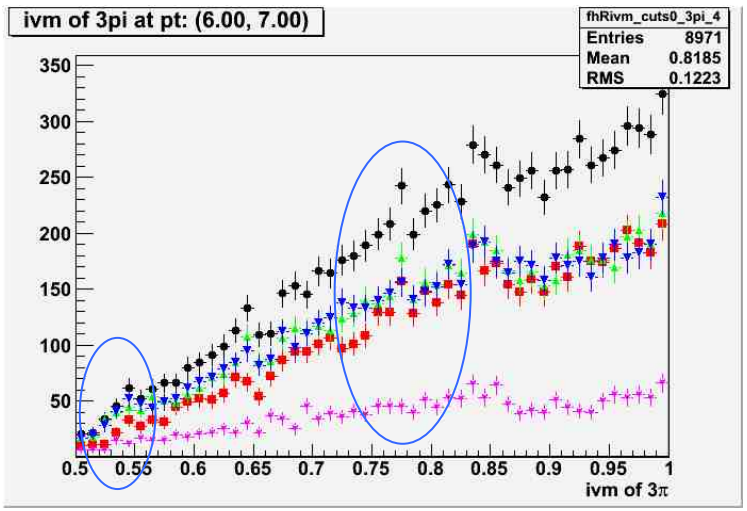
$\pi^0 \rightarrow 2\gamma$



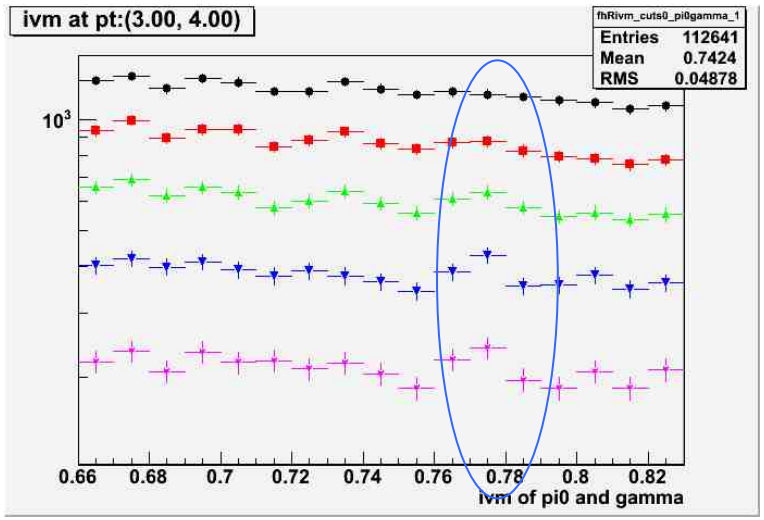
$\eta \rightarrow 2\gamma$



$\omega(782)$ (η) $\rightarrow 3\pi$ 6< pT<7 GeV/c with EMCAL

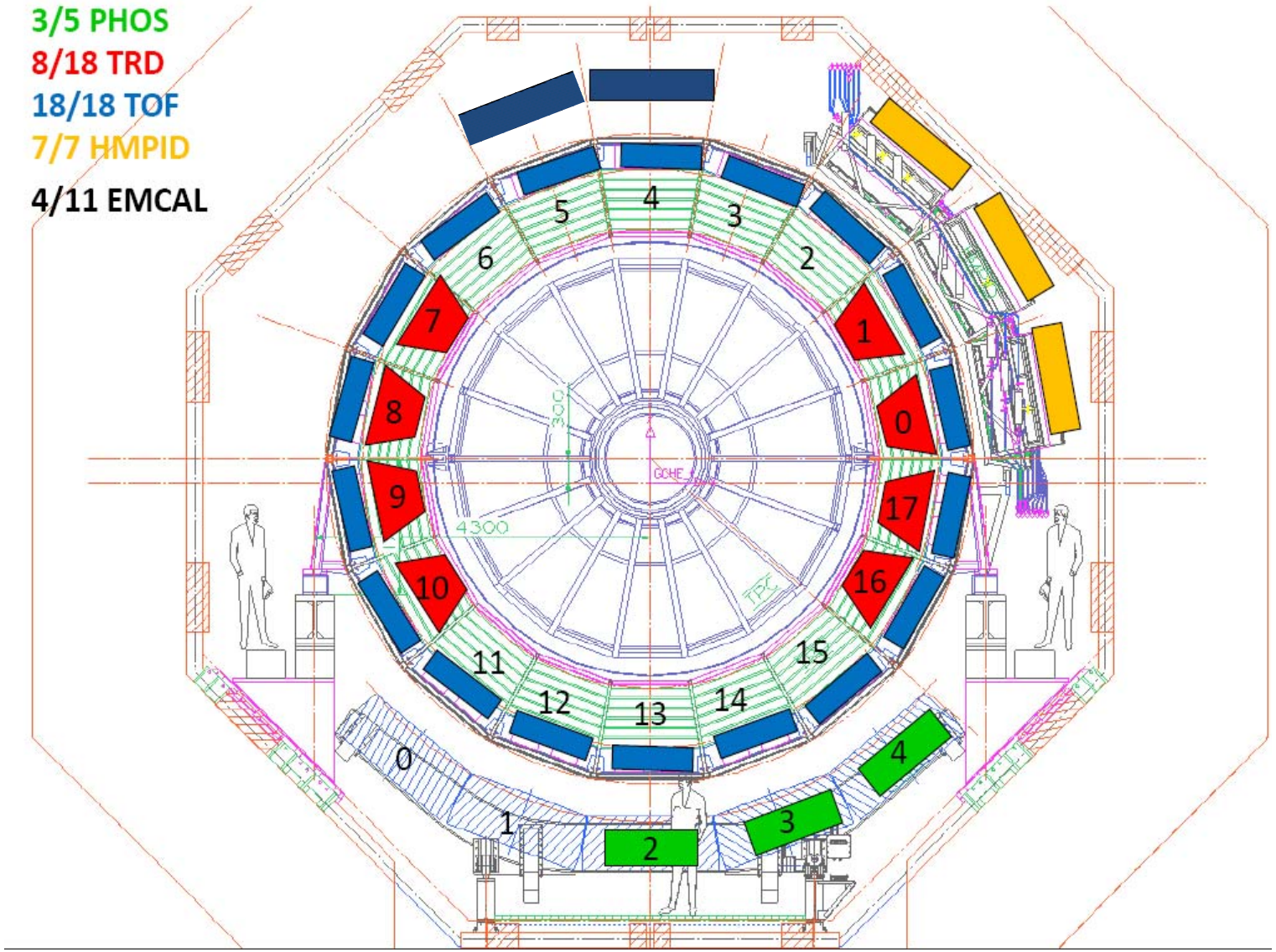


$\omega(782) \rightarrow \pi^0\gamma$, 3.< pT<4. GeV/c, with EMCAL



Pythia MB 10TeV, LHC09a4, http://alimonitor.cern.ch/job_details.jsp

ALICE detectors in run 2009~2010



Summary of run 2009

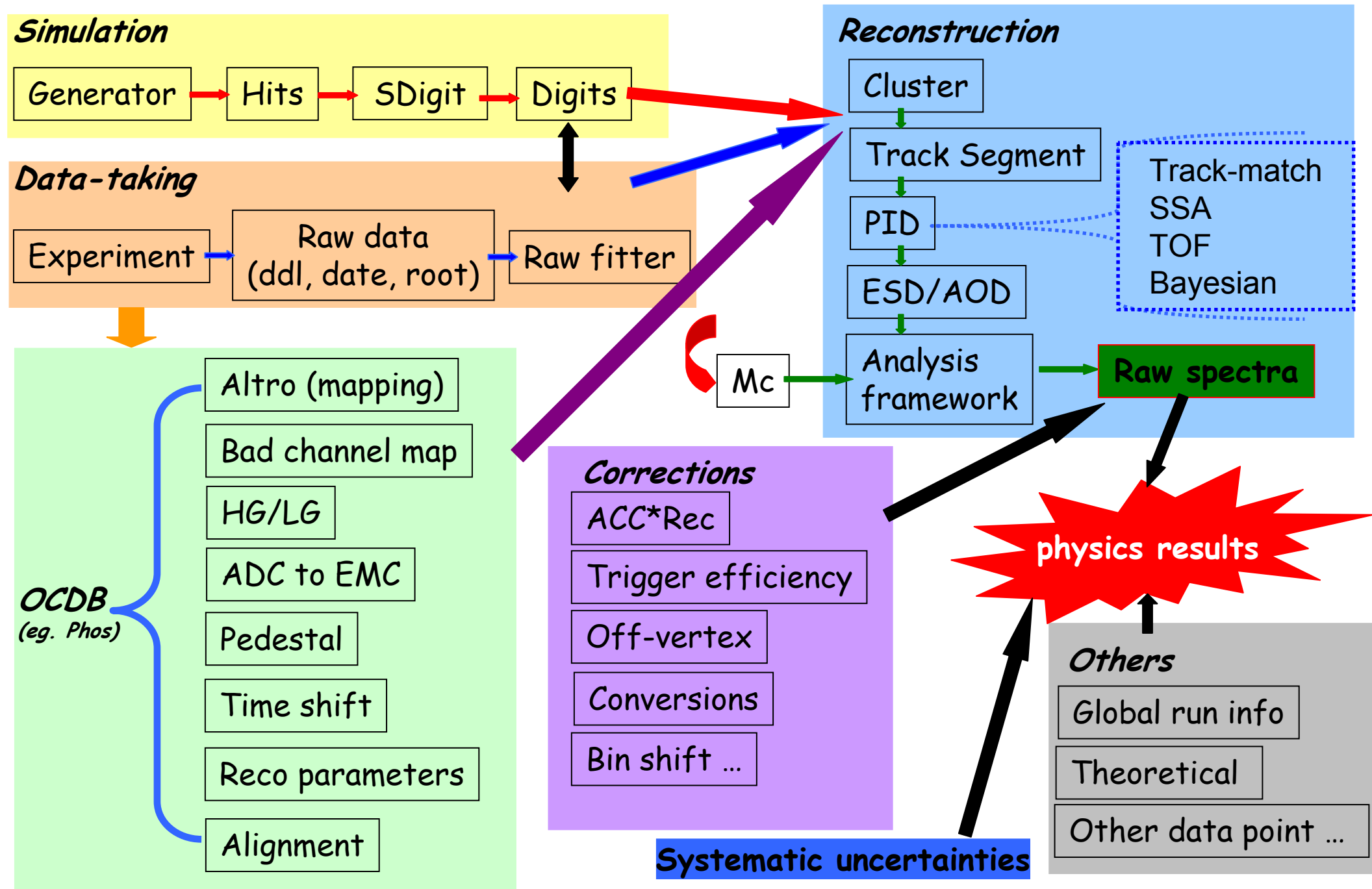
Physics Runs Summary

February 16, 2010

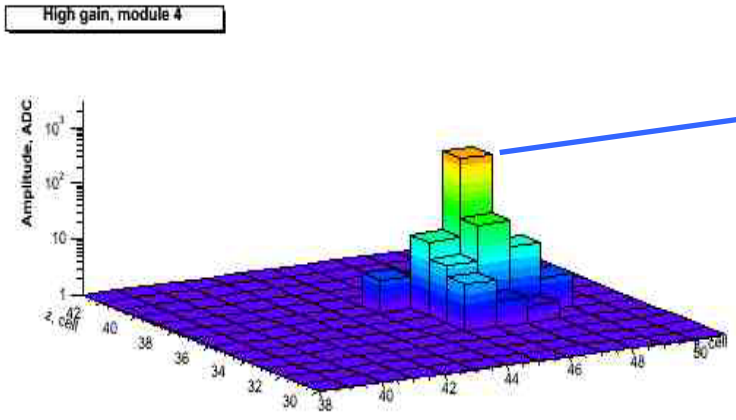
Date	Run#	Fill	Lumi (average inst)	Rec ∫Lumi	Trigger Classes						NGOOD = CINT1B - CINT1A - CINT1C + 2*CINT1E	Detectors	Comments	Bunches	Magnets L3 dipole
			10^24 /cm^2/s b^-1s^-1	10^30/cm^2 µb^-1	CBEAMB-ABCE NOPF-ALL	CINT1B-ABCE-NOPF-ALL	rate (Hz)	CINT1-E-NOPF-ALL	CINT1A-ABCE-NOPF-ALL	CINT1C-ABCE-NOPF-ALL					
SUM				10.2 µb^-1		538 kEvents					425 kEvents				
23-Nov	101498	900	2.2	0.007	92	284	0.11				284	only ITS	CSMBB trigger	1x1	0 0
6-Dec	104044	901	19.1	0.109		4303	0.94		4937	4832	4303	only ITS, PHOS, EMC	CSMBB trigger	4x4	+ +
	104065	901	19.4	0.113	7462	171	0.95	26	60	44	171		CSMBB trigger	4x4	+ +
	104068	901	16.2	0.131		759	0.8		884	865	759		CSMBB trigger	4x4	+ +
	104070	901	15.1	0.173		1749	0.74		2000	1969	1749		CSMBB trigger	4x4	+ +
	104073	901	12.7	0.179		240	0.62		274	276	240		CSMBB trigger	4x4	+ +
	104080	901	5.4	0.179		13	0.27		14	15	13		CSMBB trigger	4x4	+ +
	104083	901	7.5	0.181		93	0.36		109	109	93		CSMBB trigger		
6-Dec	104155	902	33.9	0.208	3122 (4.63)	1428	2.12	124	289	266	1121	no TPC		4x4	+ +
	104157	902	33.3	0.273	6176 (3.73)	3508	2.12	297	694	691	2717			4x4	+ +
	104159	902	26.2	0.280	617 (2.74)	411	1.83	27	97	78	290			4x4	+ +
	104160	902	25.8	0.343	7828 (3.73)	3592	1.71	339	828	782	2660			4x4	+ +
8-Dec	104315	903	56.6	0.387	3221 (4.85)	2163	3.26	96	262	248	1845	no TPC	HMP noisy	4x4	- 0
	104316	903	59.1	0.445	3061 (3.46)	2760	3.27	162	316	318	2450		HMP noisy	4x4	- 0
	104320	903	46.6	0.465	492 (1.37)	952	2.66	65	130	132	820			4x4	- 0
	104321	903	33.0	0.914	46897 (4.04)	25390	2.19	2821	6416	5960	18856		MU trigger shifted	4x4	- 0
9-Dec	104439	903	8.4	0.935	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1215	896	no HMP, EMC		4x4	- 0
10-Dec	104618	903	27.4	0.944	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	153	365	no TPC, HMP, EMC		3x4	0 0
11-Dec	104792	907	84.5	1.763	33428 (4.04)	45736	5.52	2277	7825	8055	34410			4x4	- 0
	104793	907	30.5	1.899	15283	10611	2.77	1051	3604	3379	5730			4x4	- 0
	104799	908	154.2	[illegible]	3063 (3.61)	[illegible]	[illegible]	207	[illegible]	1315	[illegible]	no TRD		4x4	- 0
	104800	908	32.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			4x4	- 0
	104801	908	94.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			4x4	- 0
	104802	908	56.0	2.818	1107 (2.67)	1601	3.87	86	296	336	1141			4x4	- 0
	104803	908	52.3	2.963	8929 (3.79)	9135	3.92	559	1942	2349	6062			4x4	- 0
	104821	909	14.7	[illegible]	682	1092	[illegible]	[illegible]	[illegible]	1644	[illegible]	[illegible]		4x4	- -
	104824	909	31.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3957	[illegible]			4x4	- -
	104825	909	22.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2078	[illegible]			4x4	- -
12-Dec	104841	909	72.7	3.267	[illegible]	3021	4.61	149	511	466	2342	no TPC		4x4	- -
	104845	909	43.6	3.610	25773	22117	3.29	1577	5729	5146	14396			4x4	- -
	104849	910	148.0	3.776	4382	8014	8.7	176	718	665	6983	no TPC		4x4	- -
	104852	910	81.8	4.721	39440	50719	5.14	2221	8029	7423	39709			4x4	- -
	104864	910	167.3	5.046		13645	8.3		14056	13978	13645	no V0, HMPID	CSMB trigger	4x4	- -
	104865	911	65.3	5.124	1595	3743	3.7	86	348	323	3244			4x4	- -
	104867	911	108.1	5.455	10398	16613	6.35	657	2147	1875	13905	no HMPID		4x4	- -
	104876	911	87.7	5.472	617	867	5.22	38	112	115	716		HLT Mode A	4x4	- -
	104878	911	87.4	5.528		2349	4.3				2349	no V0	CSMBB trigger	4x4	- -
	104879	911	57.7	5.567	1596	1824	3.1	19	105	91	1666	no V0	CINT6 triggers	4x4	- -
	104890	912	255.8	5.736	1926	7591	13.48	111	387	340	7086	no TPC		4x4	- -
	104892	912	243.7	7.373	22603	75638	13.11	1331	4922	4617	68761			4x4	- -
14-Dec	105054	916	99.0	**7.773**		29309	4.87				29309	only ITS	2.36 TeV CSMBB trig.	4x4	- -
	105057	916	66.7	**8.173**		12509	3.28				12509	only ITS, PHOS, EMC	2.36 TeV CSMBB trig.	4x4	- -
15-Dec	105143	919	520.9	**9.173**	4972	30093	34.31	482	4327	4153	22477	HLT-A,no TPC, MCH		16x16	0 -
	105160	919	387.8	**10.173**	10626	71680	27.02	1287	12023	11607	50624	HLT-A		16x16	0 -
16-Dec	105256	923	21.3	10.178	920	317	1.6	74	136	123	206	no TPC, TRD, TOF, HMP, SSD	2.36 TeV CINT1B trig.	4x4	- -
	105257	923	9.3	10.185	48809	567	1.26	87	238	208	295	see above	2.36 TeV CINT1B trig.	4x4	- -
	105268	923	19.1	10.193	*1800*	*663*	*1.86*	*129*	*283*	*303*	335	*see above*	*2.36 TeV CINT1B trig.*	*4x4*	- -

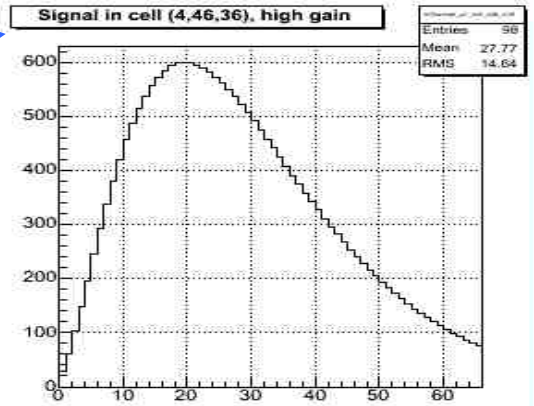
- 20 hours data-taking
- 316k pp@900GeV data collected
- Integrated luminosity: 10.2 μb^{-1}

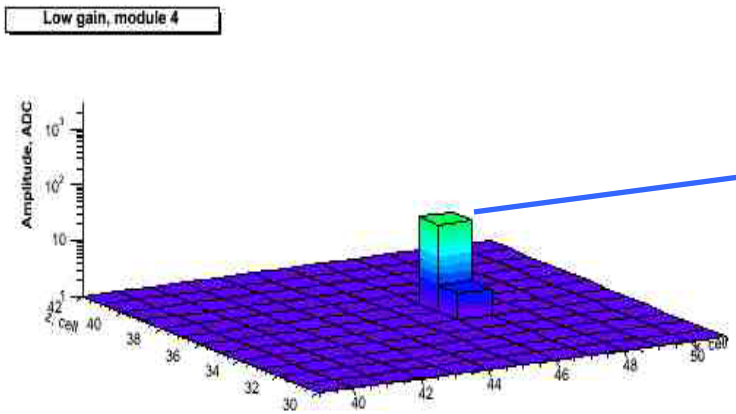
The course of analysis

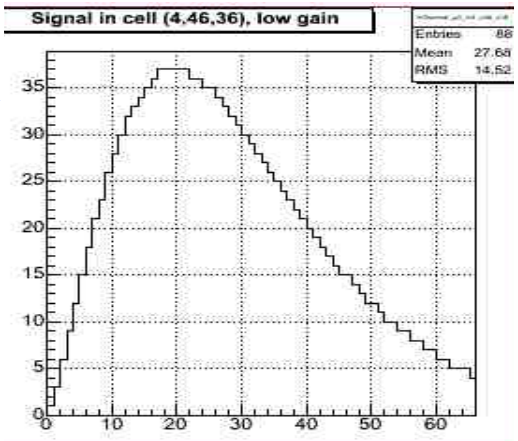


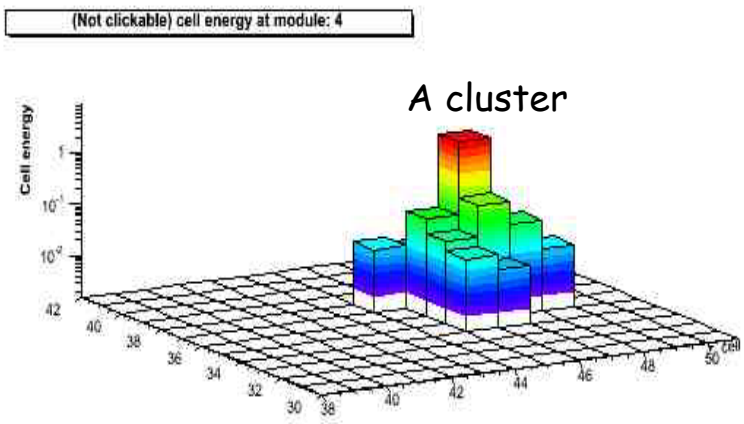
From raw data to cell energy







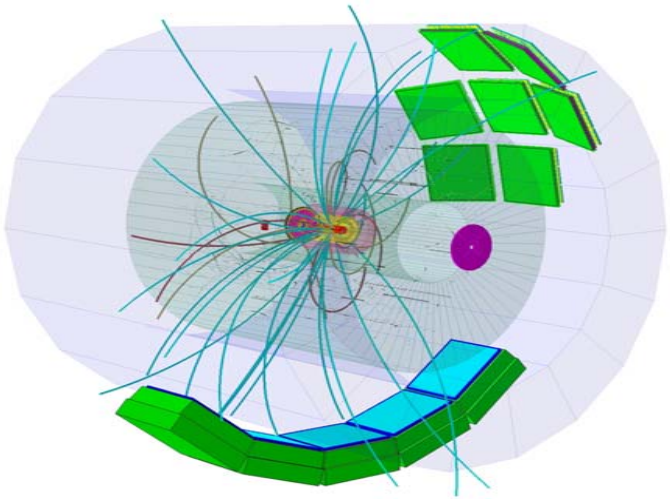


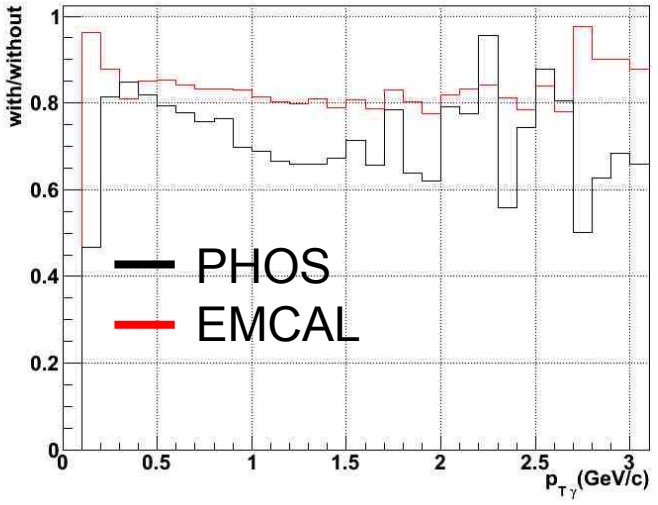


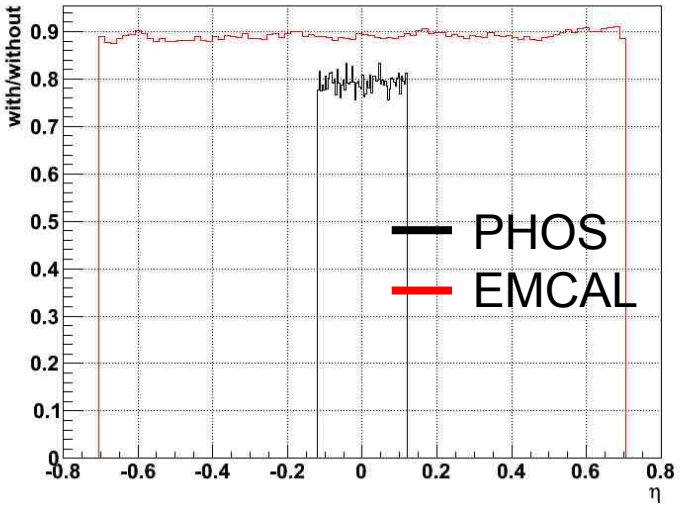
A cluster

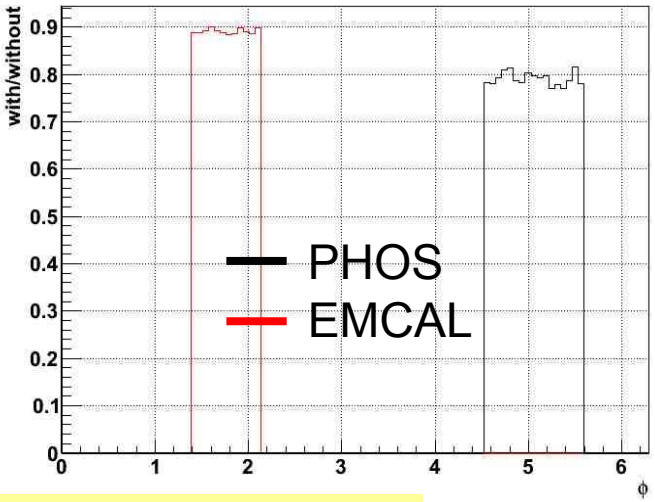
- The raw shape is fitted by Gamma2 to extract the amplitude and timing
- Ratio(HG/LG)~16
- Calibrated by LED cell by cell
- A cluster is a group of adjacent digits

Veto the charged by track-matching





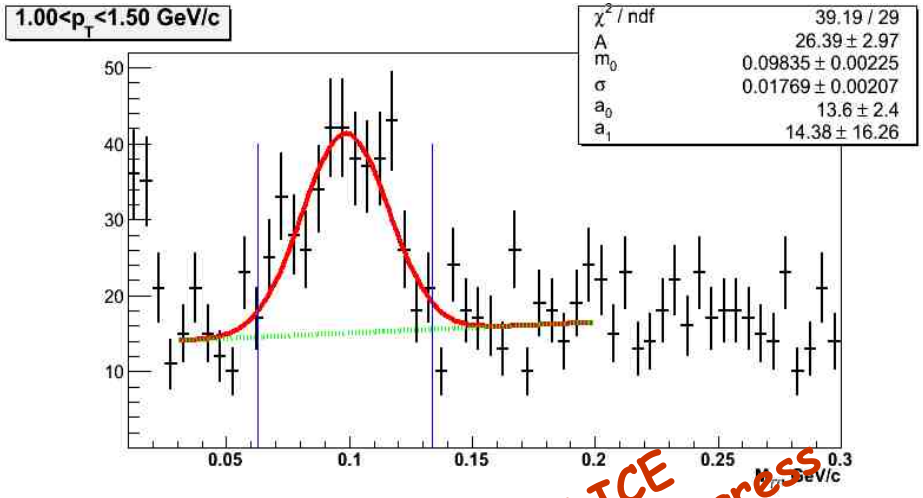




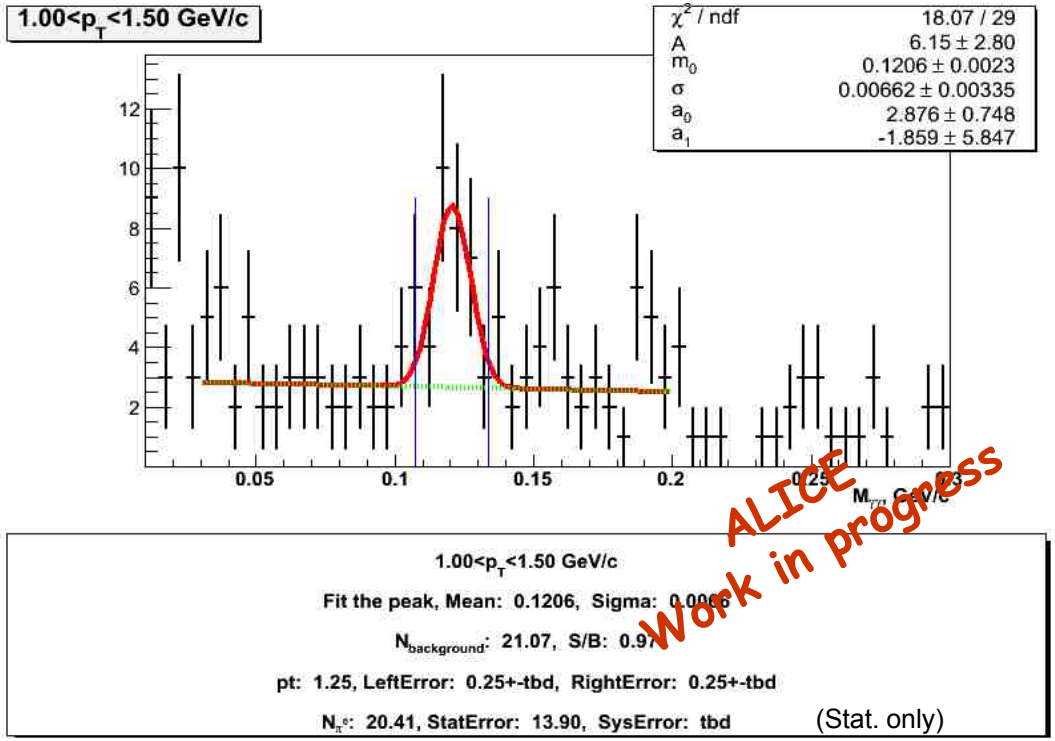
Simulation with pythia 900GeV pp MB
Charge particle contamination
- EMCAL: ~20%
- PHOS: ~30%

π^0 invariant mass spectra

EMCAL



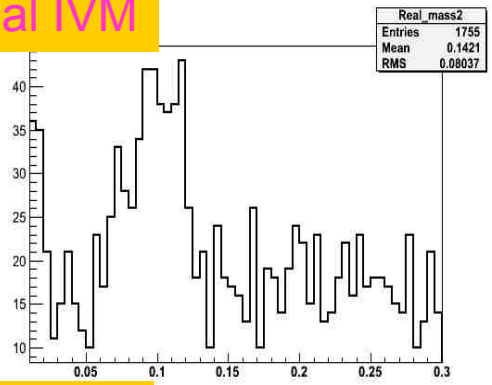
PHOS



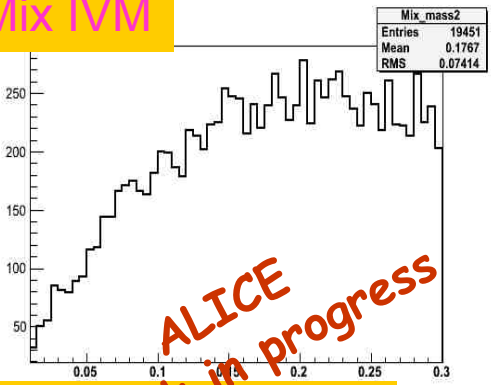
Background subtraction by mixing-events

- EMCAL

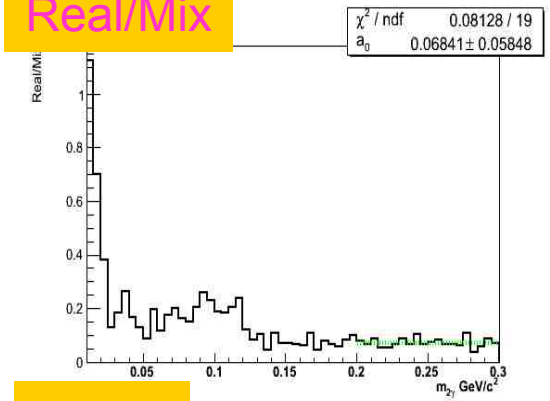
Real IVM



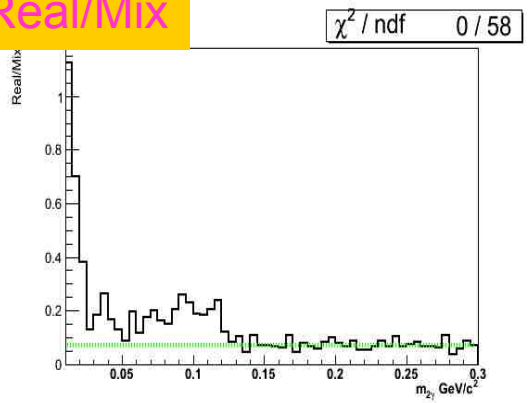
Mix IVM



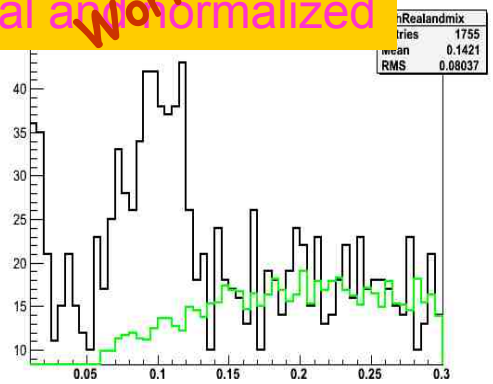
Real/Mix



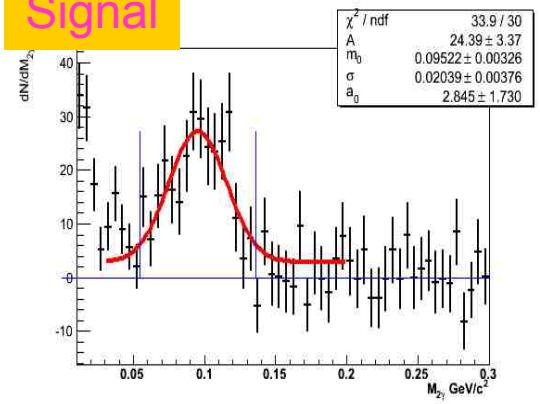
Real/Mix



Real and normalized



Signal



ALICE Work in progress

1.00<pT<1.5GeV/c

Fit the peak, Mean: 0.0952+-0.0033, Sigma: 0.0204+-0.0038

pt: 1.25, LeftError: 0.25+-tbd, RightError: 0.25+-tbd

N_{π^0} from H: 294.49, StatError: 26.97, SysError: tbd

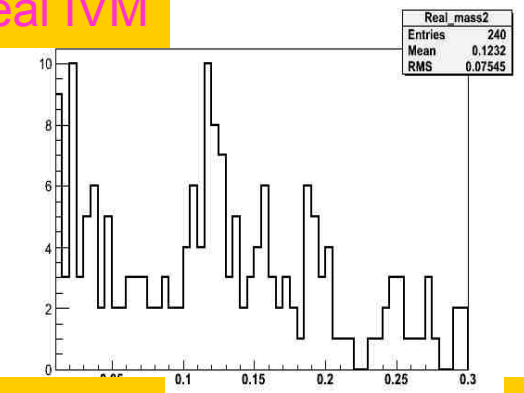
N_{π^0} from F: 293.83, StatError: 17.14, SysError: tbd

(Stat. only)

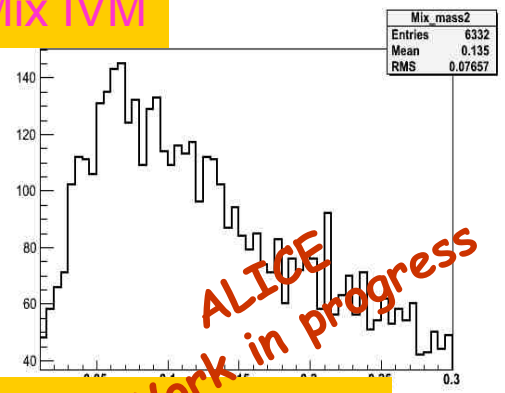
Background subtraction by mixing-events

- PHOS

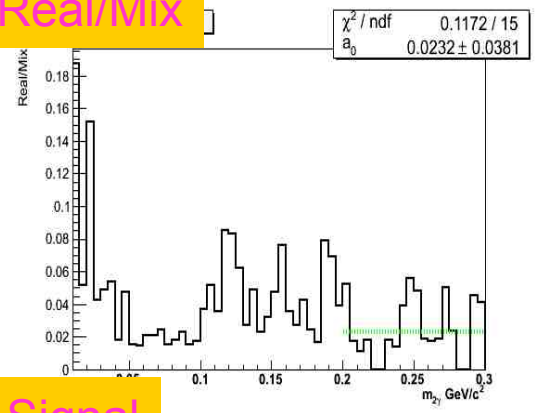
Real IVM



Mix IVM

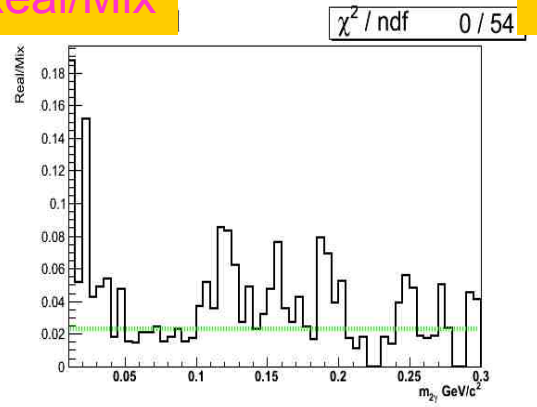


Real/Mix

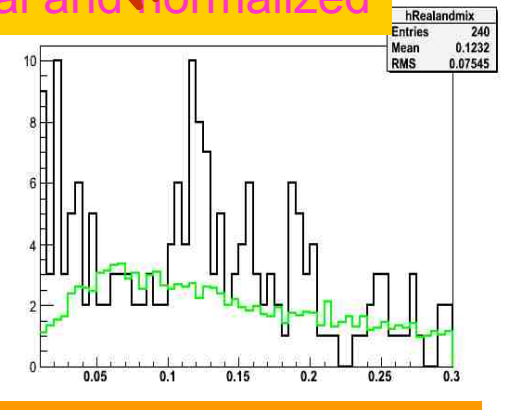


ALICE Work in progress

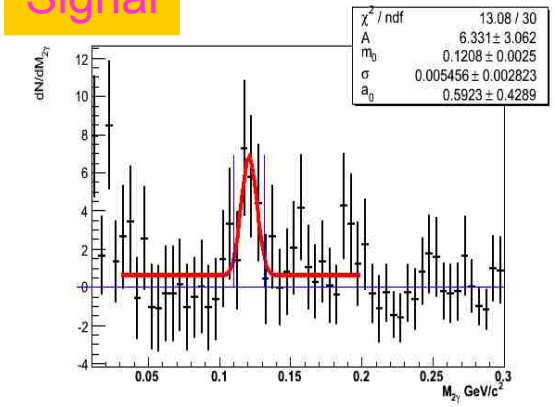
Real/Mix



Real and Normalized



Signal



1.00<pT<1.5GeV/c

1.00<p_T<1.50 GeV/c

Fit the peak, Mean: 0.1208+-0.0025, Sigma: 0.0055+-0.0028

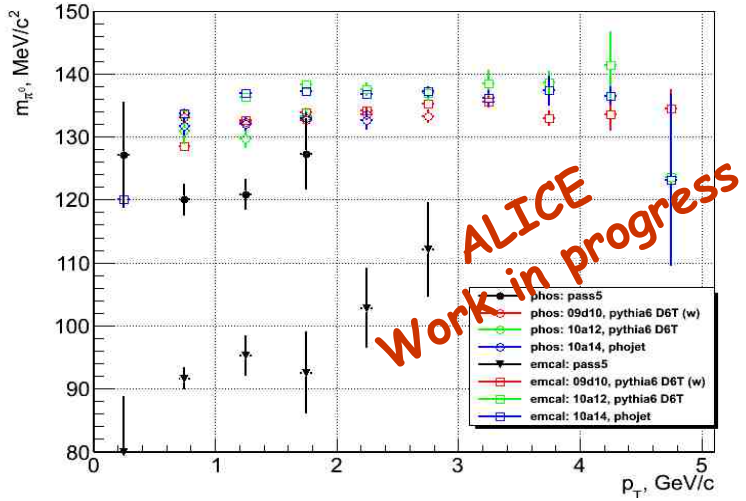
pt: 1.25, LeftError: 0.25+-tbd, RightError: 0.25+-tbd

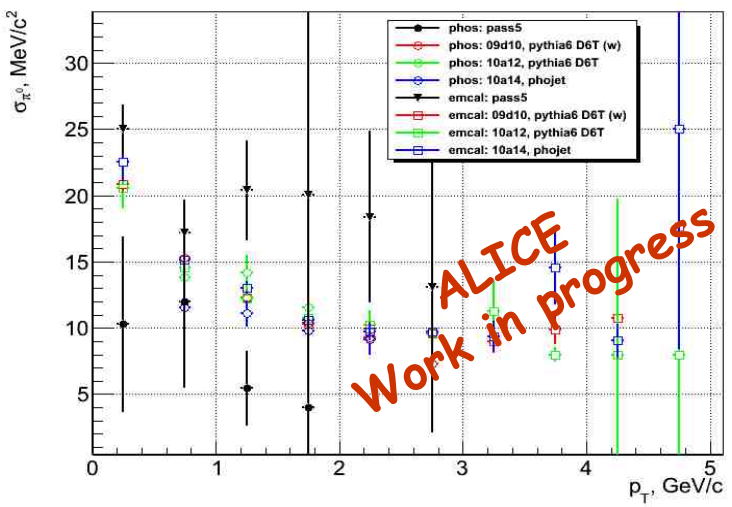
N_{π^0} from H: 22.57, StatError: 7.31, SysError: tbd

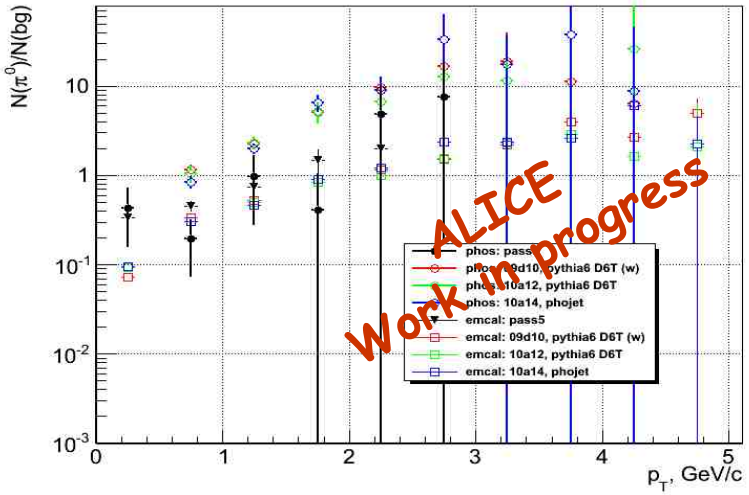
N_{π^0} from F: 20.79, StatError: 4.56, SysError: tbd

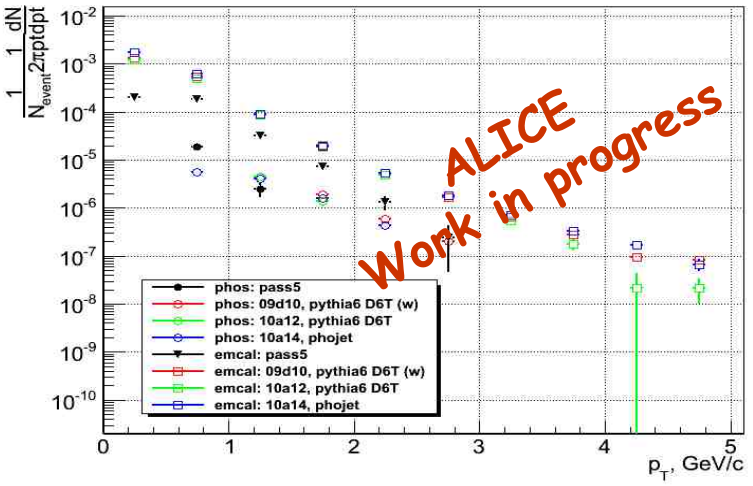
(Stat. only)

Real data vs. MC









- Peak position shift
- Better understanding with the detectors and real data

Outlook and conclusion

- Measure the π^0 pt up to 3 GeV/c by PHOS and EMCAL with the pp@2009
- Statistics is still limited to do a fine calibration
- 7TeV pp collisions have started from Mar. 30
- Better understand the detectors
- Expecting the physics at the new TeV era

Thanks for your attention!