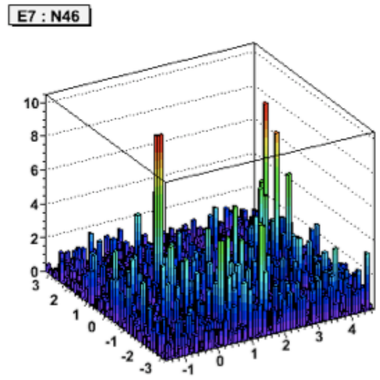
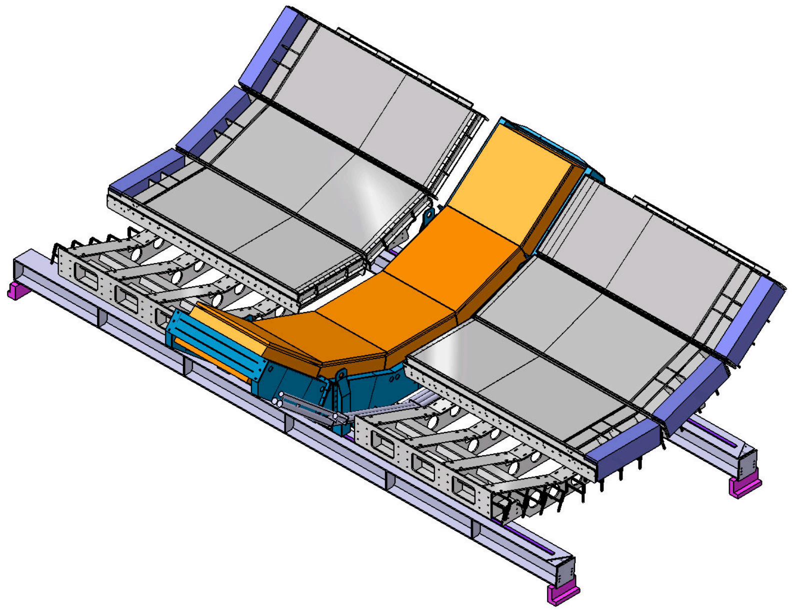
Jet as a homework from RHIC to LHC

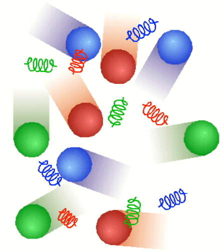


Success of soft physics and a homework from RHIC to LHC



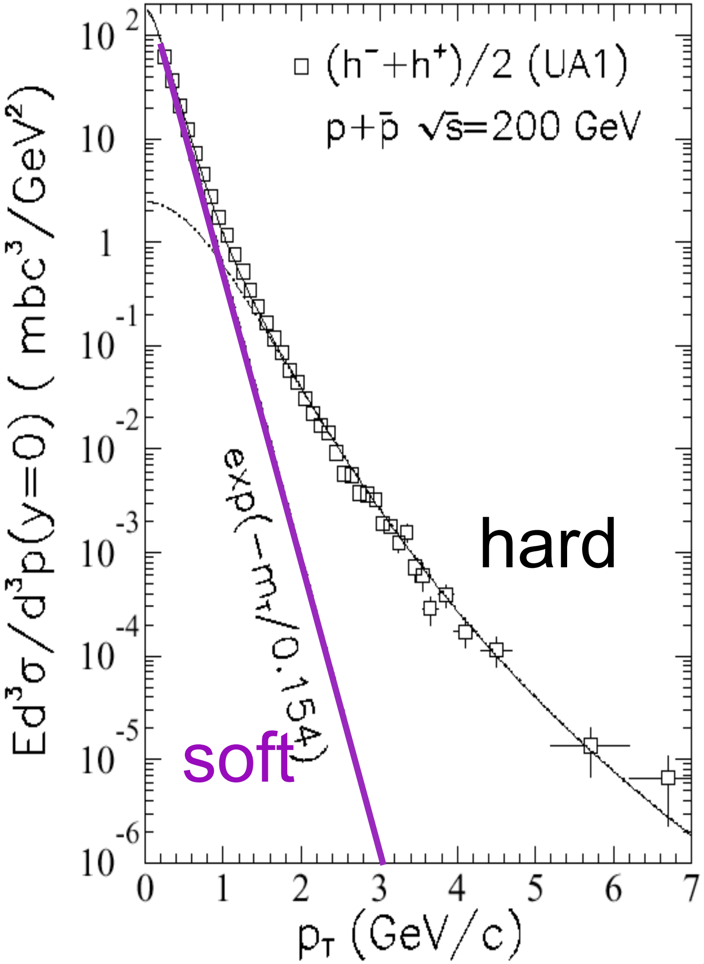
Yasuo MIAKE
Univ. of Tsukuba

Outline



- ✓ Soft and hard
- ✓ RHIC
  - Soft physics
    - ➡ well understood
  - Hard physics
    - ➡ poor understanding
- ✓ RHIC vs. LHC
  - Plenty of jets
- ✓ What we need for enhance jet physics
  - Extention of EM-Cal
- ✓ Status as a summary

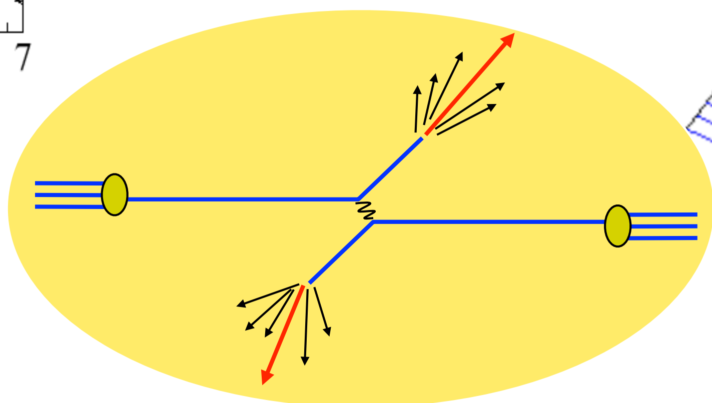
Soft & Hard comp. in pp

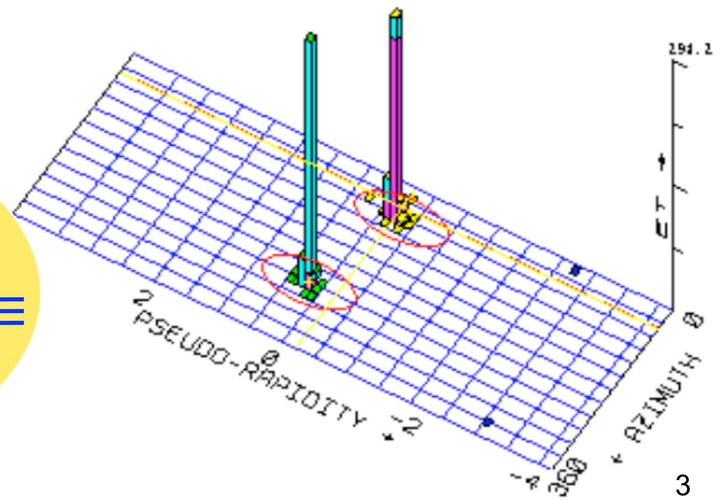


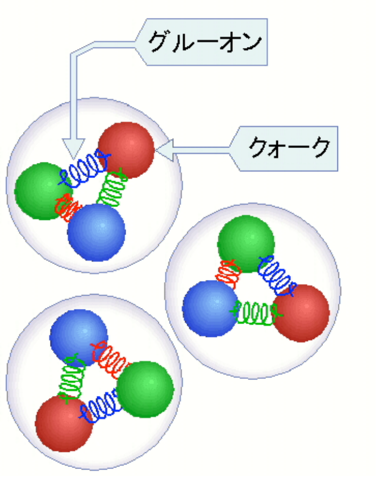
$$E\frac{d^3\sigma}{dp^3} = C_0 \exp(-\frac{m_t}{T_0}) + \frac{C_1}{(p_t + p_0)^n}$$

- ✓ At ISR in 1972, deviation from the m_t scaling at high p_t region is observed as a first time.
- ✓ Binary parton scattering followed by fragmentation produces back-to-back jet.
- ✓ Main source of high pt particles.

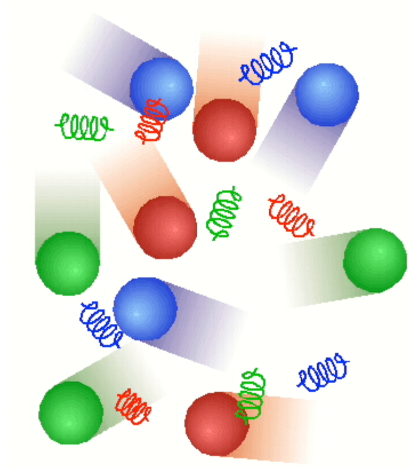
back-to-back jet







Soft comp.



Statistical and Collective Nature characteristic to the QGP formation

Key 1 ; Statistical Nature

$$\epsilon_{\mathrm{QGP}} \sim 2\ [\mathrm{GeV/fm^3}]$$ ← **Ex. Lattice QCD**

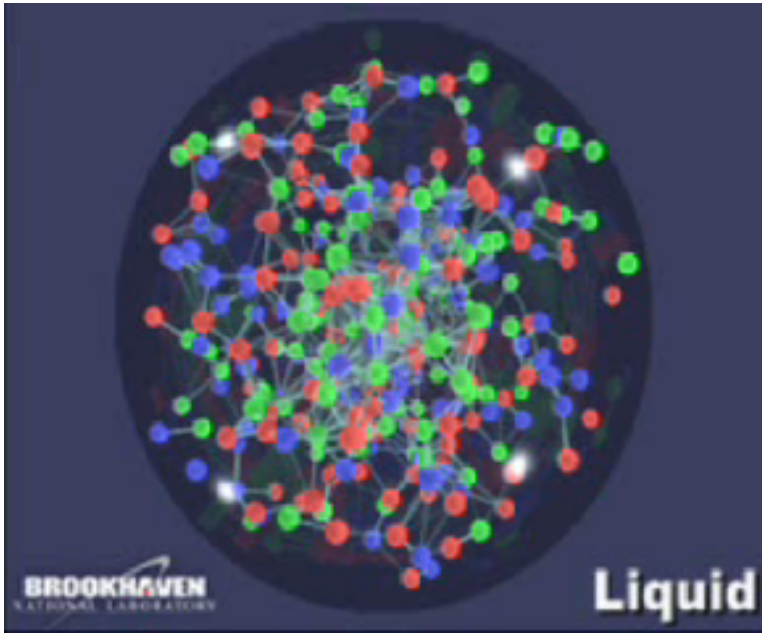
$$< n_{q,\bar{q}} > \sim \frac{\epsilon_{\mathrm{QGP}}}{< m_T >} \sim \frac{2\mathrm{GeV}}{0.4\mathrm{GeV}} \sim 5$$

$$\lambda_q = \frac{1}{n\sigma_{qq}}$$

$$\sim \frac{1}{5 \times 0.4} = 0.5\ [\mathrm{fm}]$$

$$\lambda_q \ll R_{\mathrm{system}}$$

$$\because \sigma_{qq} \sim \frac{\sigma_{NN}}{3 \times 3} \sim \frac{4[\mathrm{fm}^2]}{9} \sim 0.4$$

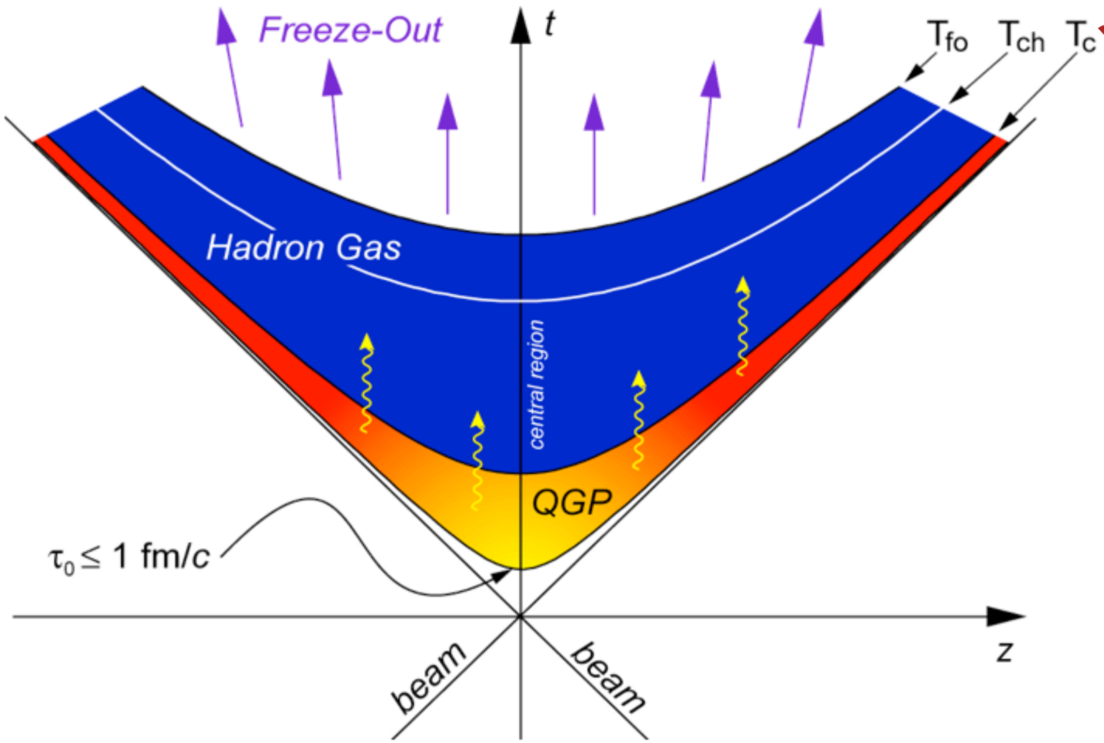


Animation by Jeffery Mitchell (Brookhaven National Laboratory). Simulation by the UrQMD Collaboration

✓ **What we expect,**

- **Statistical physics at quark level**
- **Hydrodynamical behavior at quark level**

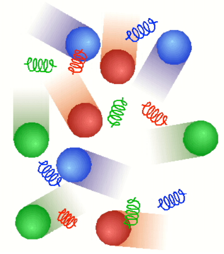
Key2; Time Evolution



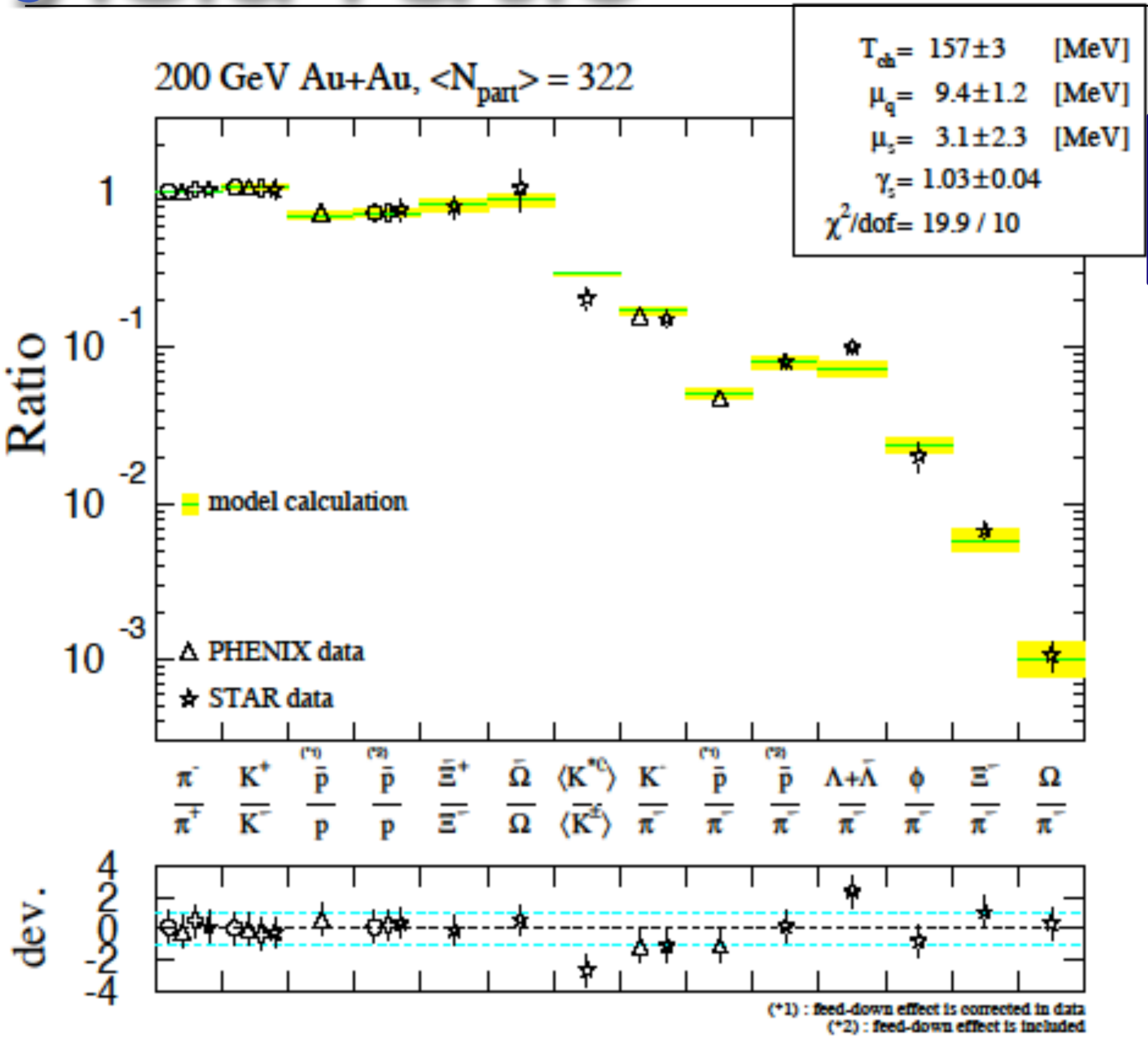
- ✓ It is like Big Bang.
- ✓ Time evolution in statistical nature
  - Parton cascade followed by partonic thermalization (QGP)
  - Hadron production
  - Freezeout of v_2 ?
  - Chemical freeze-out
  - Kinematical freeze-out

Need consistent understanding of these epocs, in particular, aspects of statistical nature.

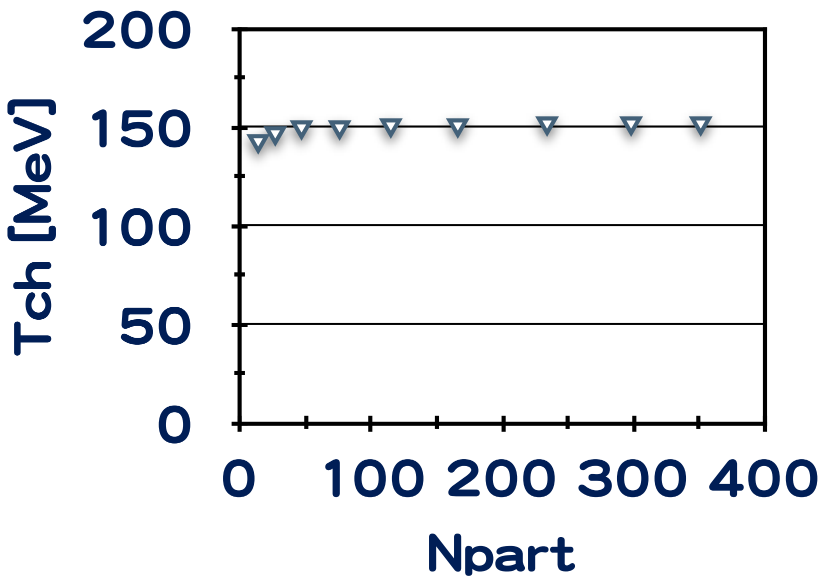
Chemical Eq. from particle yield ratio



M.Kaneta, N.Xu, nucl-th/0405068

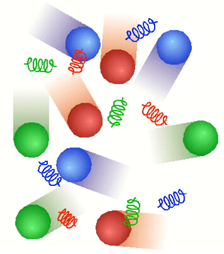


$$n_i = \frac{g_i}{2\pi^2}\int_0^\infty \frac{p^2 dp}{e^{(E_i-\mu_i)/T} \pm 1}$$

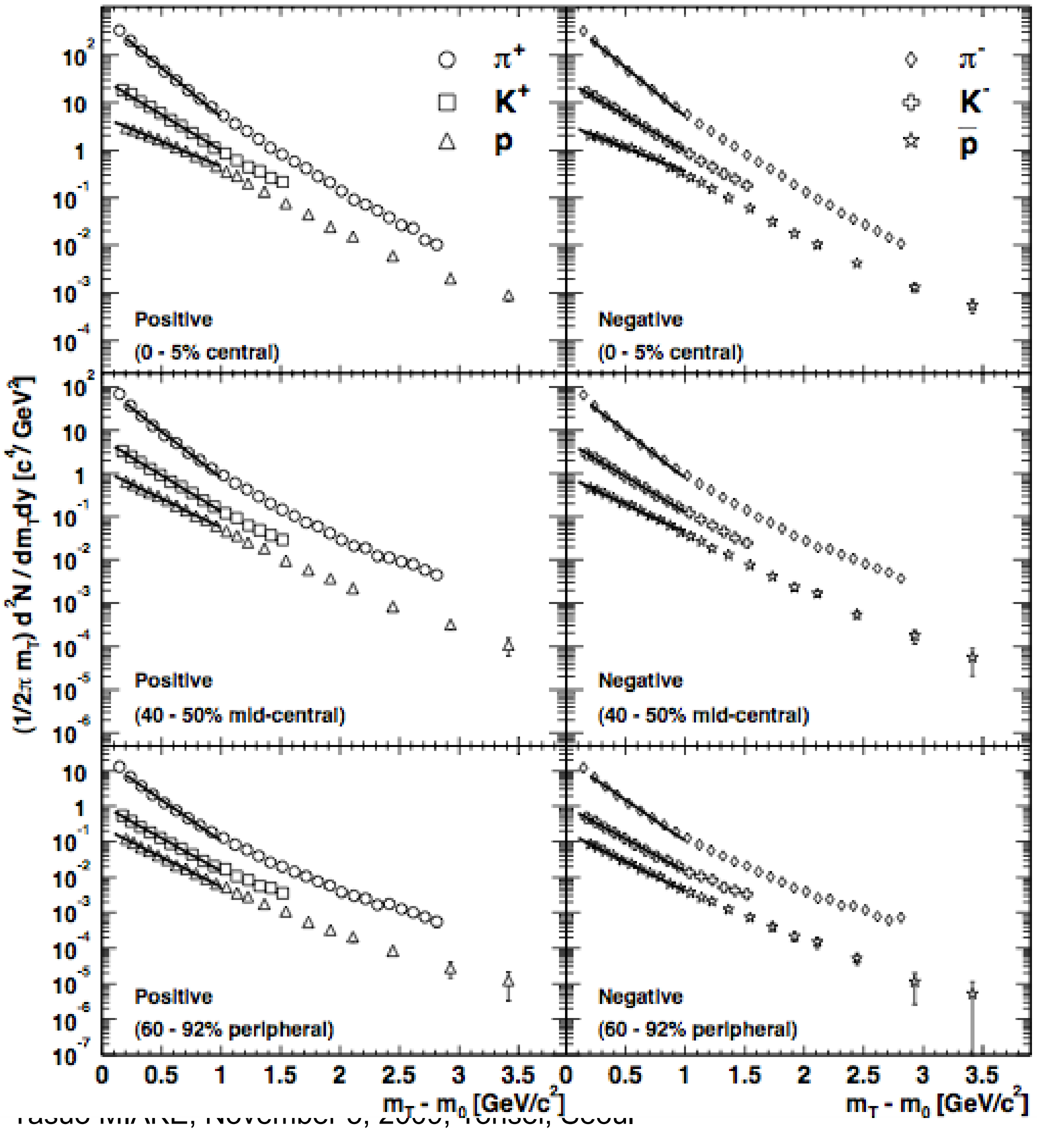


- ✓Only few parameters fit every ratio very well !
- ✓T_{ch} stays constant from peripheral to central collisions

Kinematical Distr.: Transverse mass distr.



$$m_t = \sqrt{p_t^2 + m^2} \qquad \frac{d^2N}{2\pi m_T dm_T dy} = \frac{1}{2\pi T(T+m_0)} A \exp\left(-\frac{m_T - m_0}{T}\right)$$



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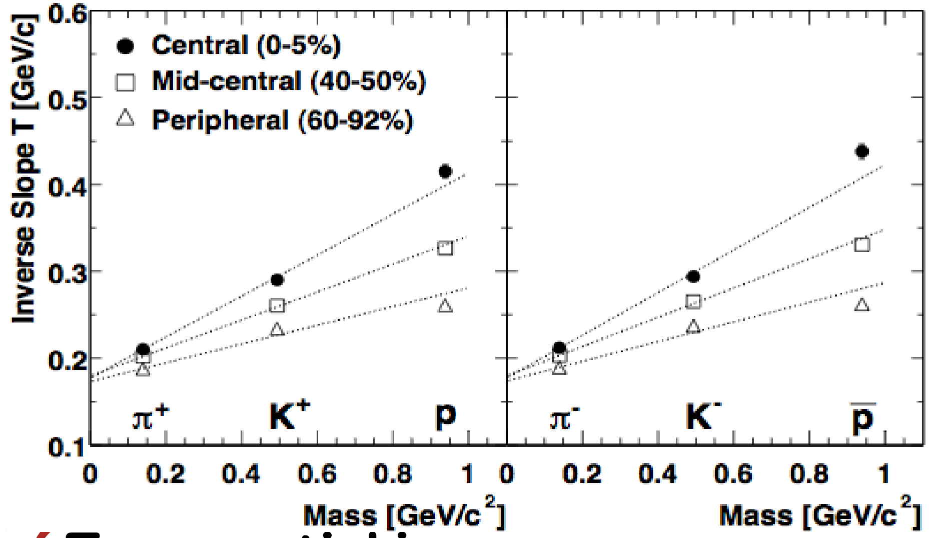
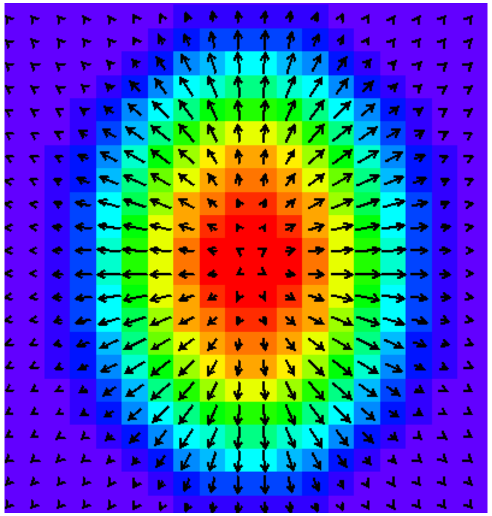


- ✓ Exponential in m_t
  - Known as m_t scaling
  - Thermal distr.
- ✓ Flatter m_t distr for heavier particle mass
  - Mass Ordering of Slope param.
  - Effect of Collective Flow

$$T \approx T_0 + \frac{1}{2} m \langle v_r \rangle^2$$

Collective Flow

Blast Wave Model



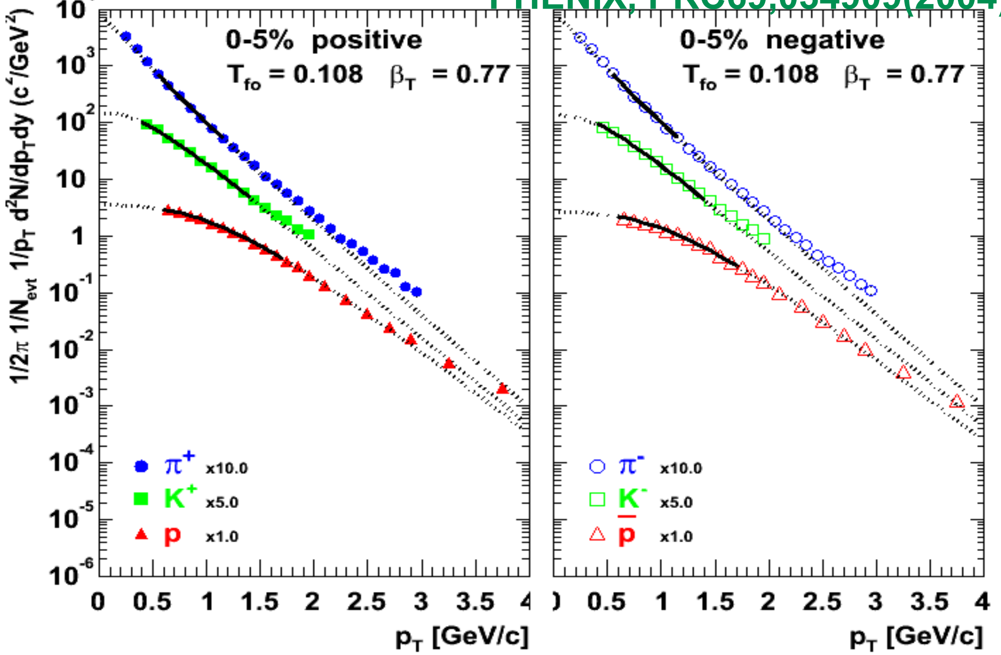
$$\frac{1}{m_T}\frac{dN}{dm_T} = A\int_0^R f(r)rdrm_T I_0\left(\frac{p_T \sinh\rho}{T_{fo}}\right)K_1\left(\frac{m_T \cosh\rho}{T_{fo}}\right)$$

PRC48(1993)2462.

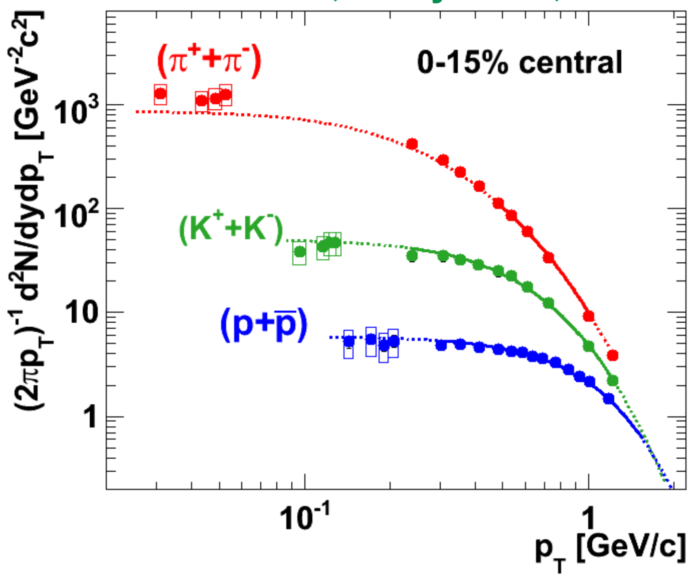
$$\rho(r) = \tanh^{-1}(\beta_T)\cdot r/R$$

I_0 , K_1: modified Bessel function

PHENIX, PRC69,034909(2004)



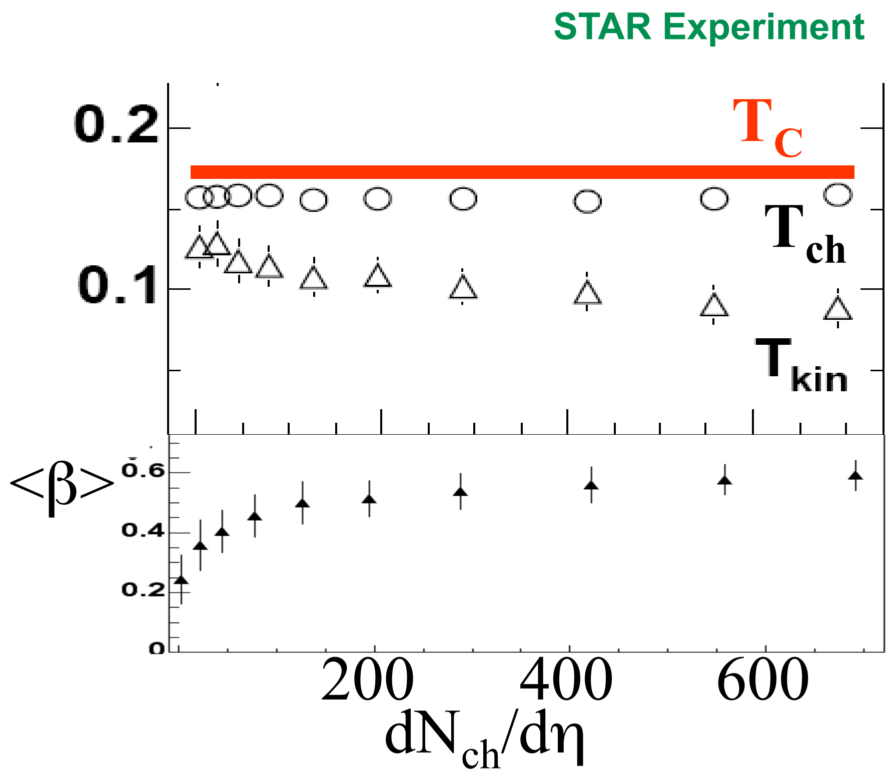
Phobos, J.Phys.G34,S1103-7(2007)



✓Good tool to separate thermal and collective

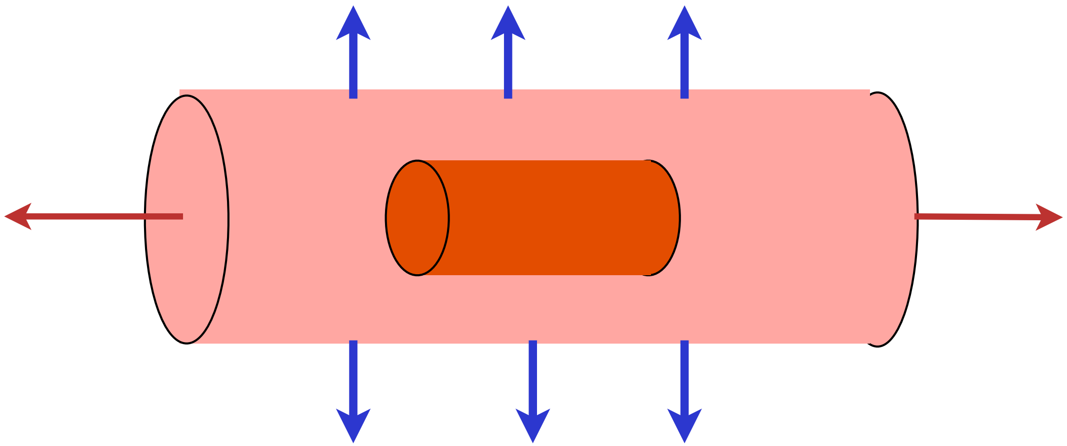
✓Well describe < 2 GeV/c

Time evolution & Freeze-out conditions



- ✓Difference of T_{ch} and T_{kin} corresponds to time evolution of the system.
- ✓Kinematical & Chemical freeze-out show difference in centrality dependence!
  - ➡Chem. freeze-out by T
  - ➡Kin. freeze-out by what?

Adiabatic Expansion Model



$$V(t) = ct\pi R(t)^2 = ct\pi(R_0 + \beta_{\rm T} t)^2$$

$$\frac{V(t_{\rm fo})}{k n_{\rm part}\sigma} \sim R(t_{\rm fo})$$

$$t_{\rm fo} = \frac{\sqrt{R_0^2 + 4\frac{k\sigma}{c\pi}\beta_{\rm T} n_{\rm part}} - R_0}{2\beta_{\rm T}}$$

$$T(t_{\rm fo}) = T_0\left(\frac{V_0}{t_{\rm fo}(R_0 + \beta_{\rm T} t_{\rm fo})^2}\right)^{1/3}$$

✓ Intuitive Model

✓ Assuming,

- Cylindrical expansion
- Freeze-out condition

$$\lambda = \frac{1}{n\sigma} \sim R$$

- Adiabatic expansion

$$T^3(t)V(t) = \mathrm{Const.}$$

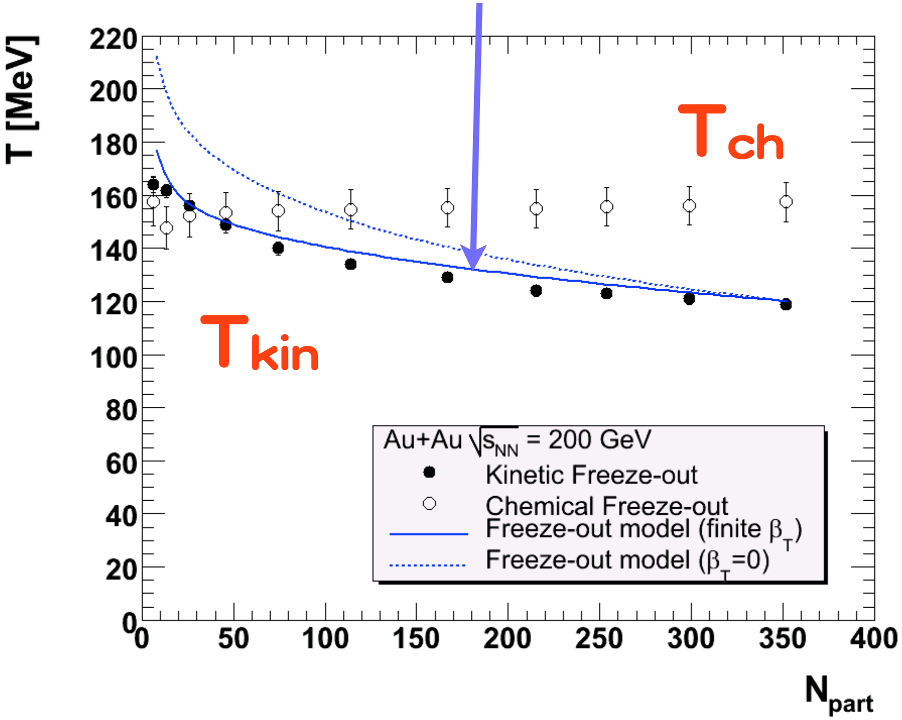
$$(\because s \propto T^3)$$

✓ Larger fireball freezees out later in time

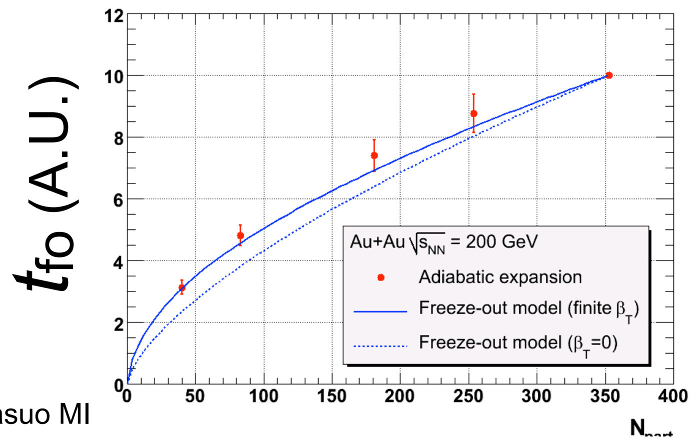
Kinematical Freeze-out w. Adiabatic Expansion

M. Konno, Tsukuba

Adiabatic Expansion Model (M.Konno,Y.M. 2008)



Central collisions freeze-out late.



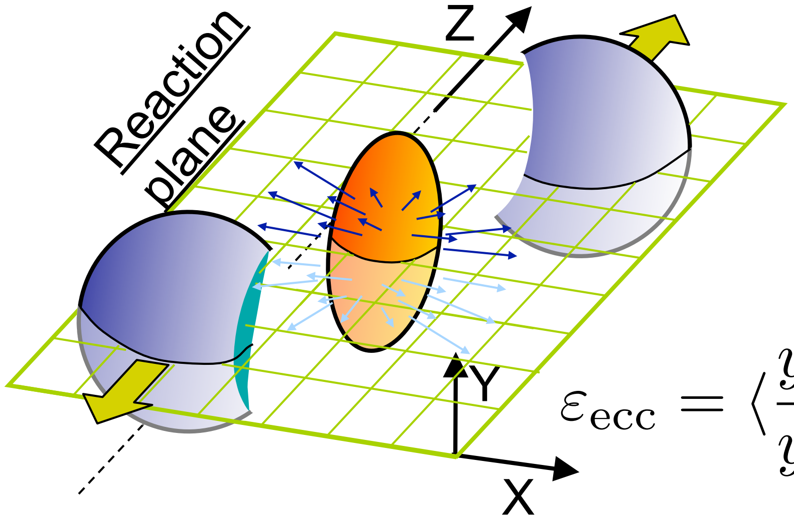
√ Adiabatic Expansion Model explains centrality dependence very well.

- Freeze-out conditions ; $\lambda \sim R$

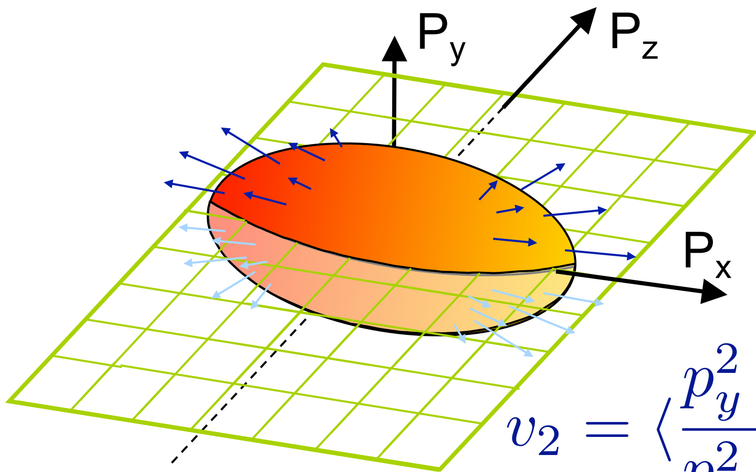
√ In central collsions, the F.B. is so large that F.O. occurs later than peripheral.

➡Kinematical freeze-out is collisional, while chemical is not.

Azimuthal modulation of collective flow, V2



$$\varepsilon_{ecc} = \langle \frac{y^2 - x^2}{y^2 + x^2} \rangle$$

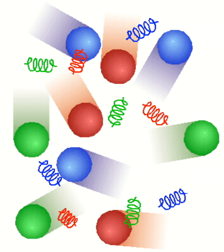


$$v_2 = \langle \frac{p_y^2 - p_x^2}{p_y^2 + p_x^2} \rangle$$

- √ In non-central collisions, participant region has almond shape.
  - ➡azimuthal anisotropy in coordinate space
- √ If λ<< R, azimuthal anisotropy of the coordinate space is converted to that of the momentum space.
  - ➡v_2 ; second Fourier harmonics of azimuthal distribution
- √ Goodies :
  - Clear origin of the signal
  - Collision geometry can be determined experimentally

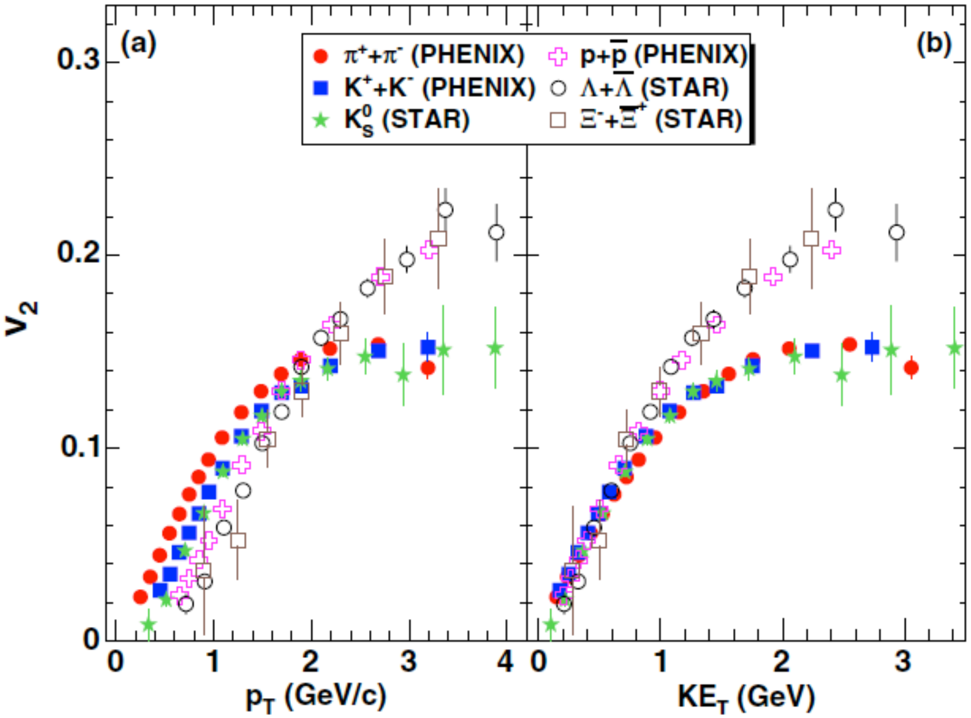
$$N(\phi) = N_0\{1 + 2v_1\cos(\phi - \Psi_0) + 2v_2\cos(2(\phi - \Psi_0))\}$$

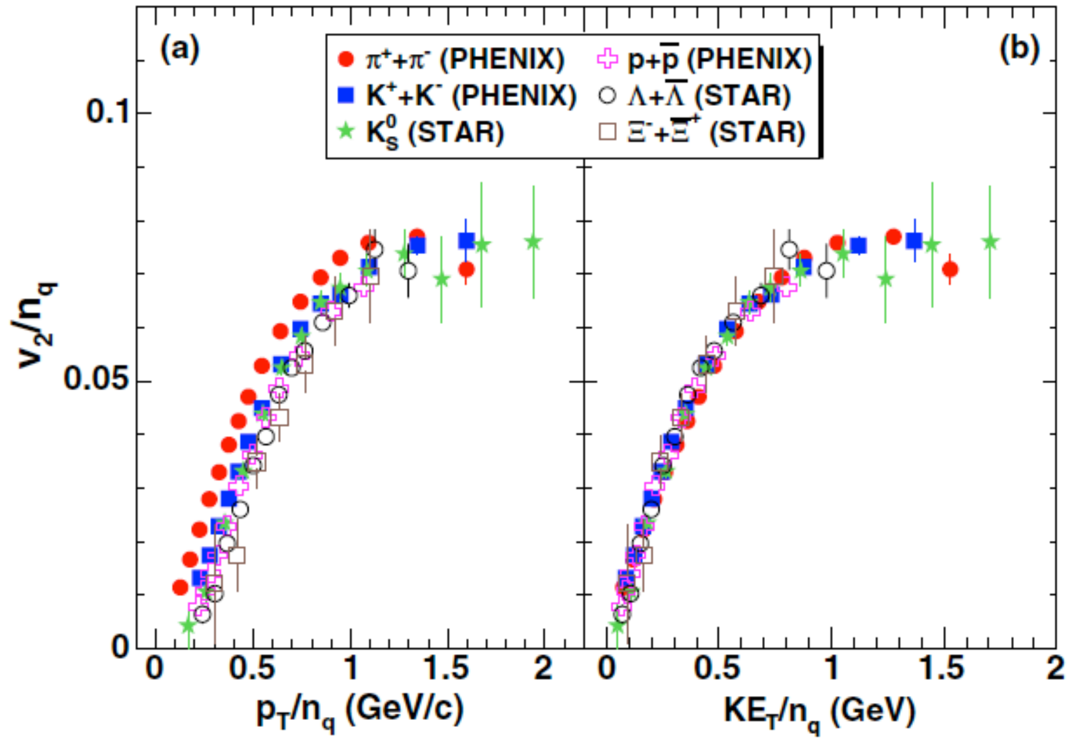
Beautiful scalings of v_2



PHENIX PRL 98(2007)162301

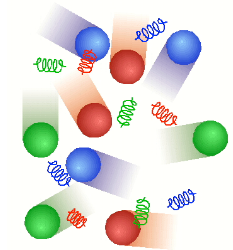
Au+Au 200 GeV



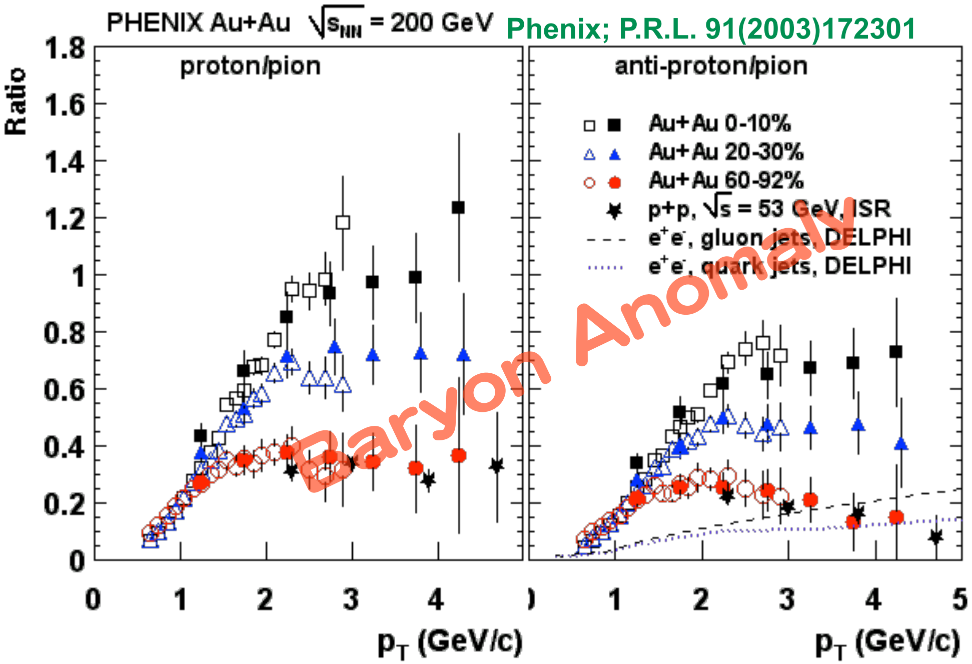


√ m_t scaling & quark number scaling hold!!

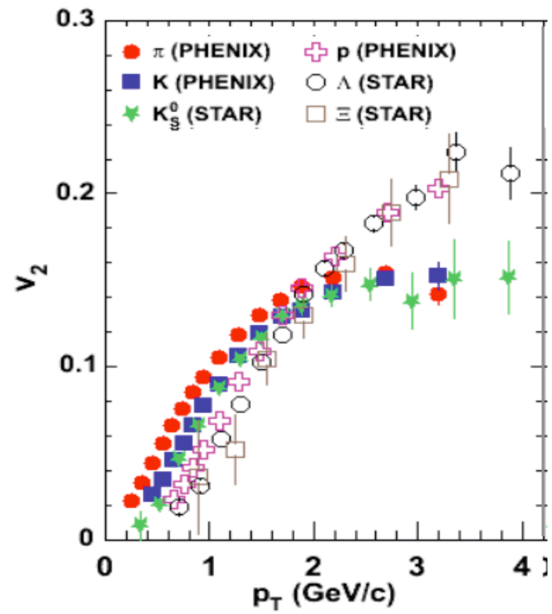
Puzzles in the mid-p_t region



p/π enhances above 1.5 GeV/c



v_2 deviates from the mass ordering above 2 GeV/c

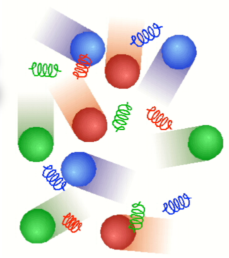


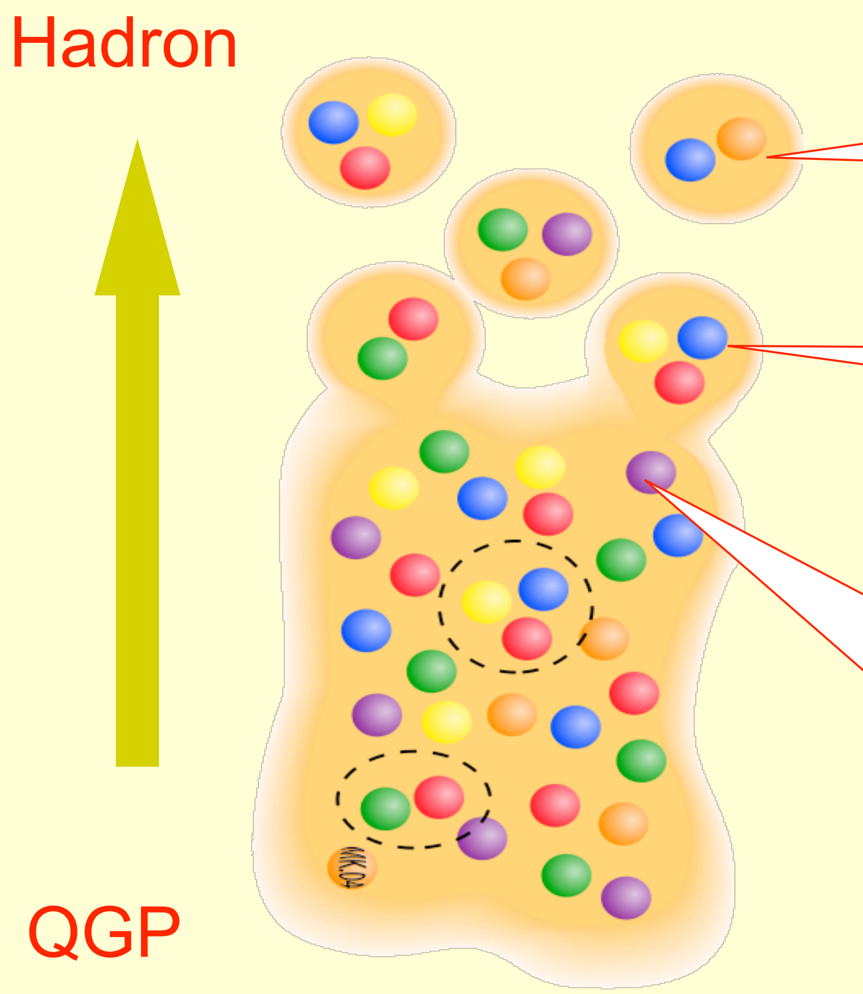
- ✓ In central col., p/π ratio is very large, while in peripheral, p/π ratio similar to those in ee/pp suggesting fragmentaton process.
  - Fragmentation process should show $n_p < n_\pi$ as seen in ee/pp.
- ✓ While mass ordering of v_2 seen at low pt region, clear departure observed.
- ✓ Suggesting other production mechanism.

↓

Quark Recombination Model (Quark Coalescence Model)

Quark Coalescence explains Baryon Anomaly, and ,,,





Because of the steep distr. of *w(pt), RECO* wins at high pt even w. small *Cx*.

✓ **Quarks, anti-quarks combine to form mesons and baryons from universal quark distribution, w(pt).**

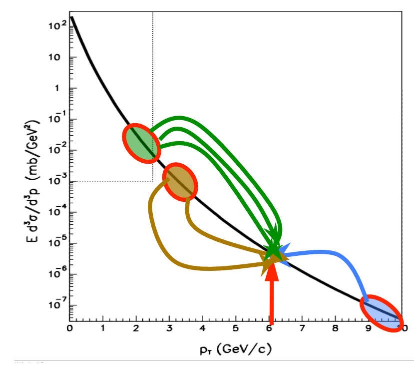
Mom. distr. of meson (2q);

$$W_M(p_t) \approx C_M \cdot w^2(p_t/2)$$

Mom. distr. of baryon (3q);

$$W_B(p_t) \approx C_B \cdot w^3(p_t/3)$$

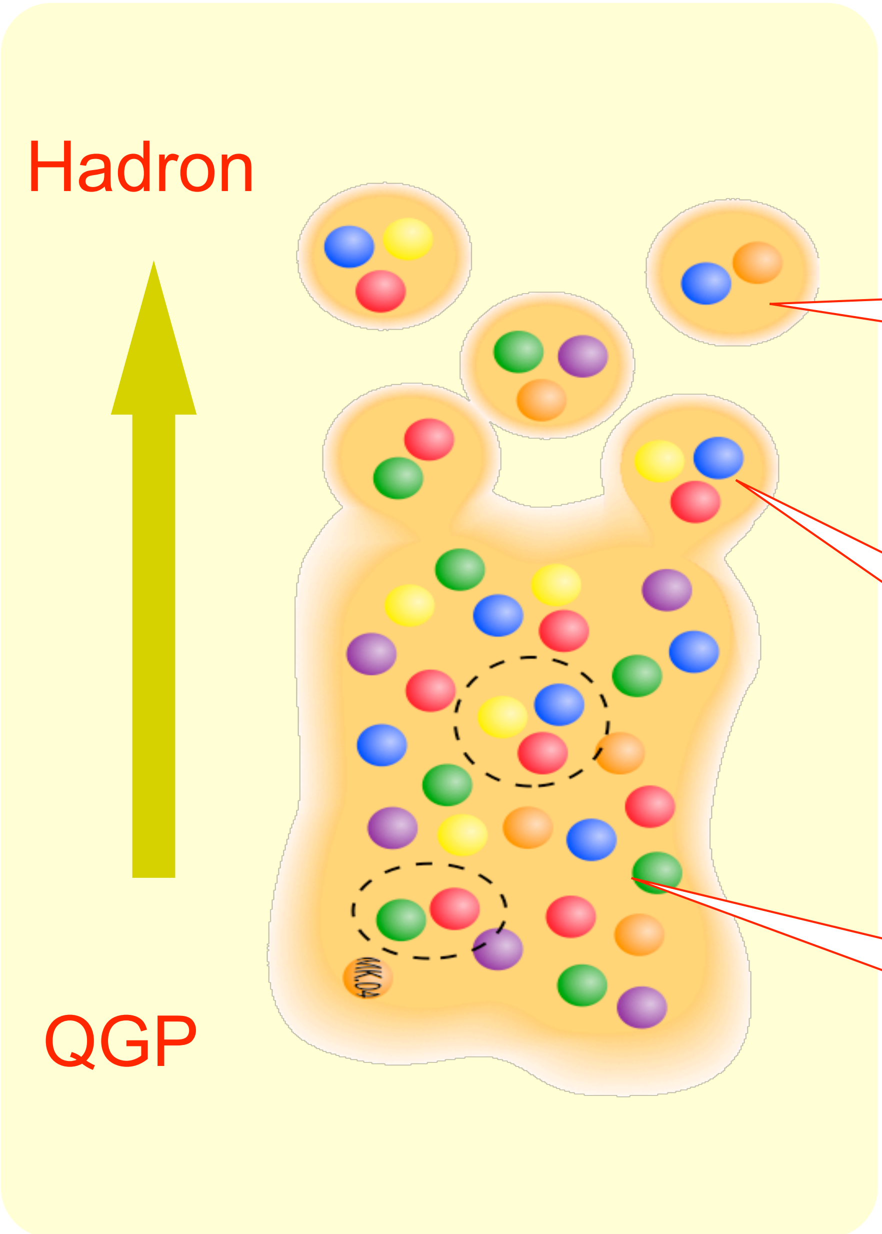
w(pt);
Universal mom. distr. of quarks
{*steep in pt*}



Characteristic scaling features expected.

➔Quark Number Scaling (QNS)

also explains n_q scaling !



✓ **Characteristic scaling behavior**

→**Quark Number Scaling**

Azimutal distr. of meson (2q);

$$\frac{dN_M}{d\phi} \propto w^2 = (1 + 2v_{2,q}\cos 2\phi)^2$$

$$\approx (1 + 4v_{2,q}\cos 2\phi)$$

Azimuthal distr. of baryon (3q);

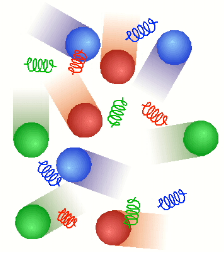
$$\frac{dN_B}{d\phi} \propto w^3 = (1 + 2v_{2,q}\cos 2\phi)^3$$

$$\approx (1 + 6v_{2,q}\cos 2\phi)$$

Azimuthal distr of quark; w

$$w \propto (1 + 2v_{2,q}\cos 2\phi)$$

Refer to the textbook !



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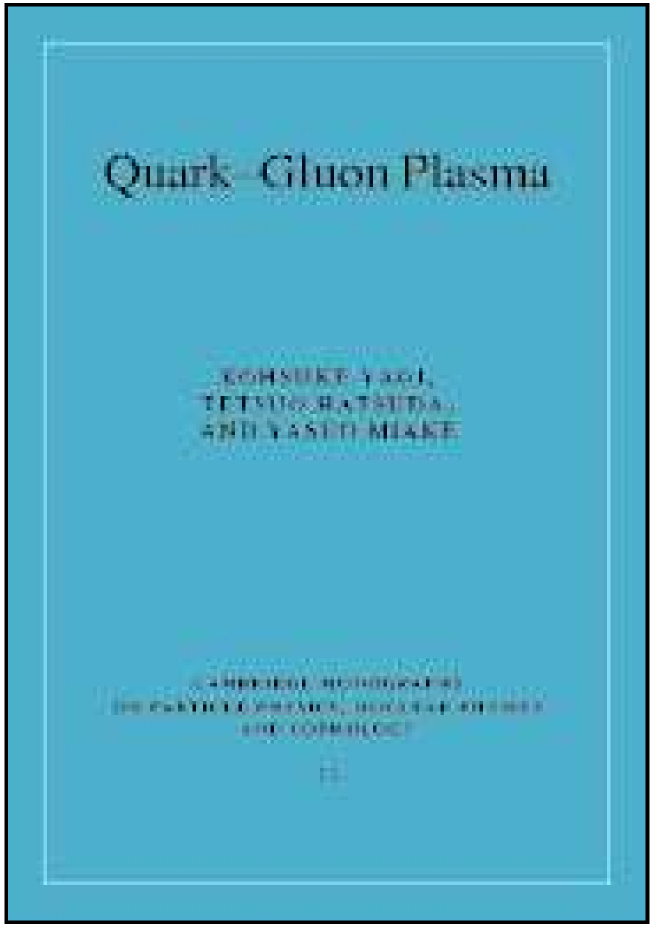

Quark-Gluon Plasma

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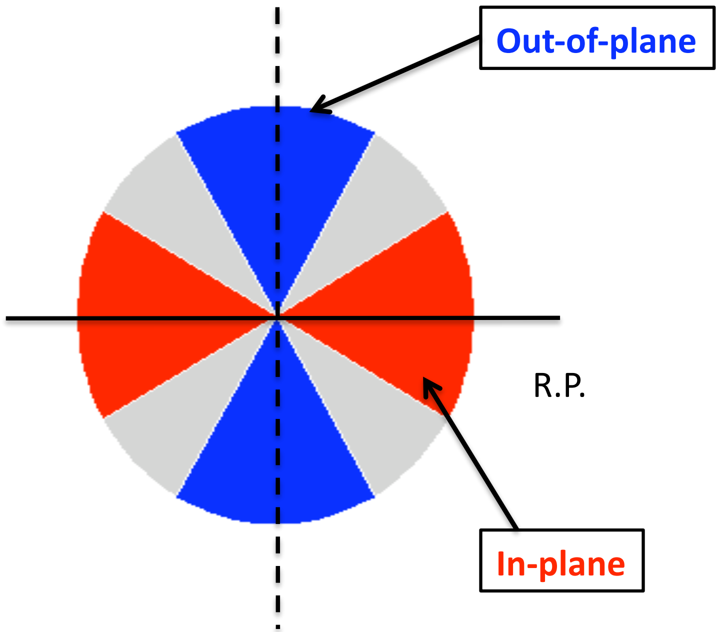
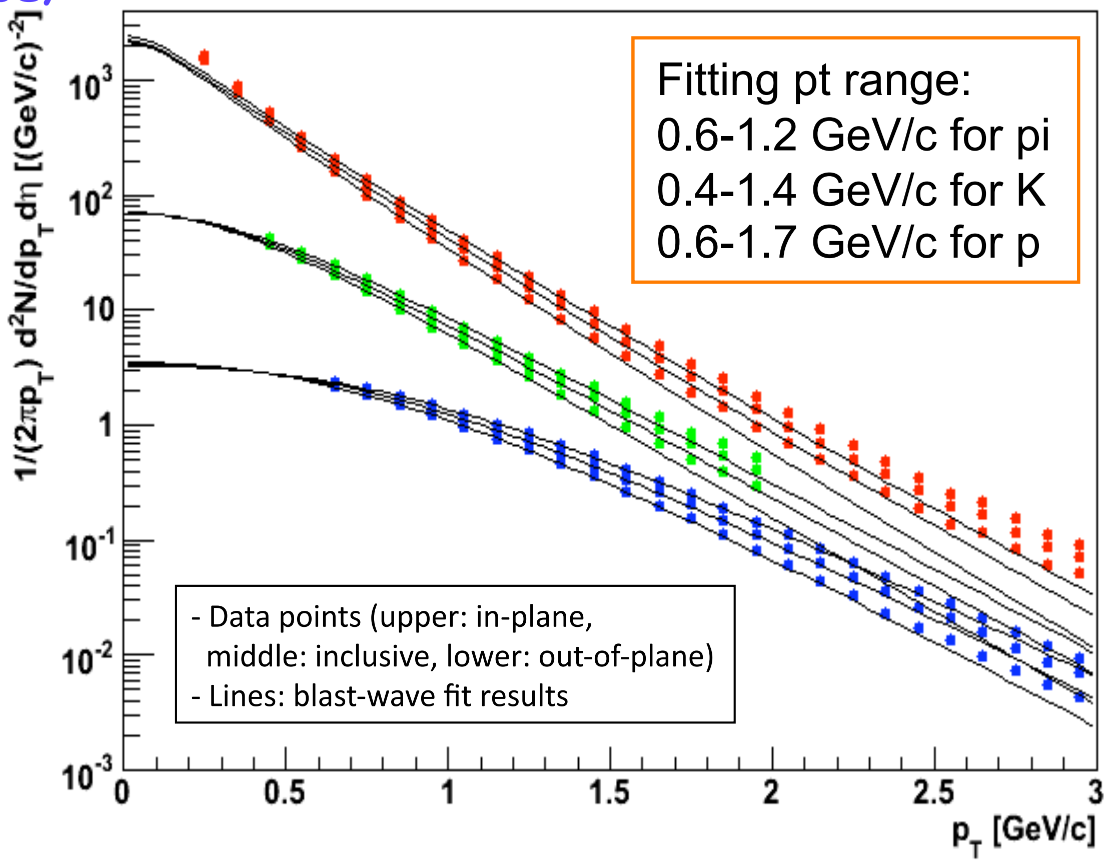
Blast Wave Fitting of v2 and spectra

M. Konno, Tsukuba

Adiabatic Expansion Model (M.Konno,Y.M. 2008)





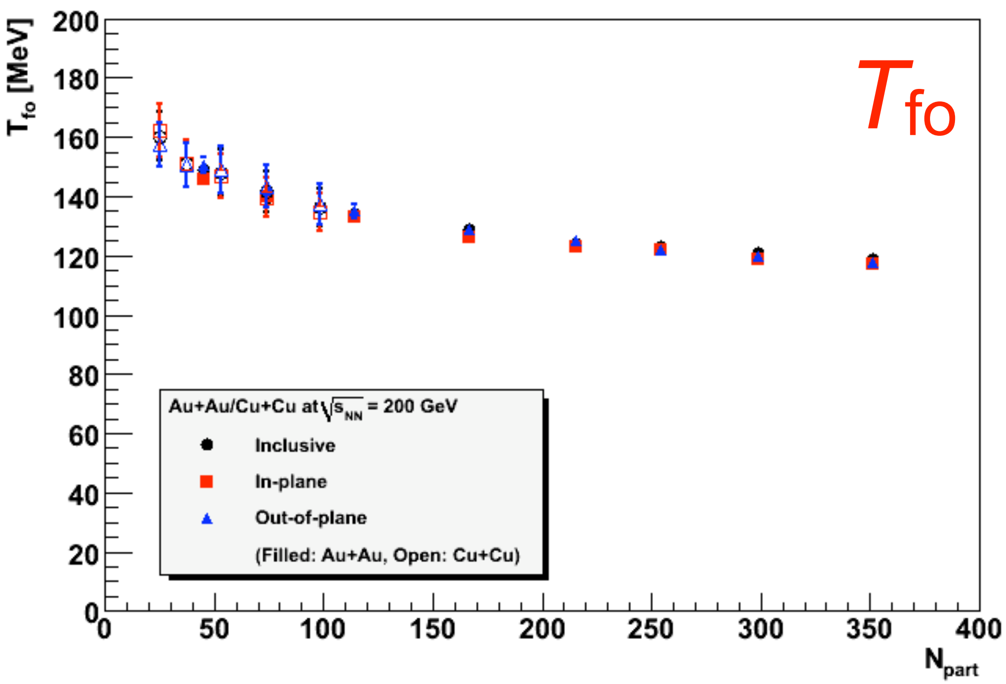
By Masahiro Konno

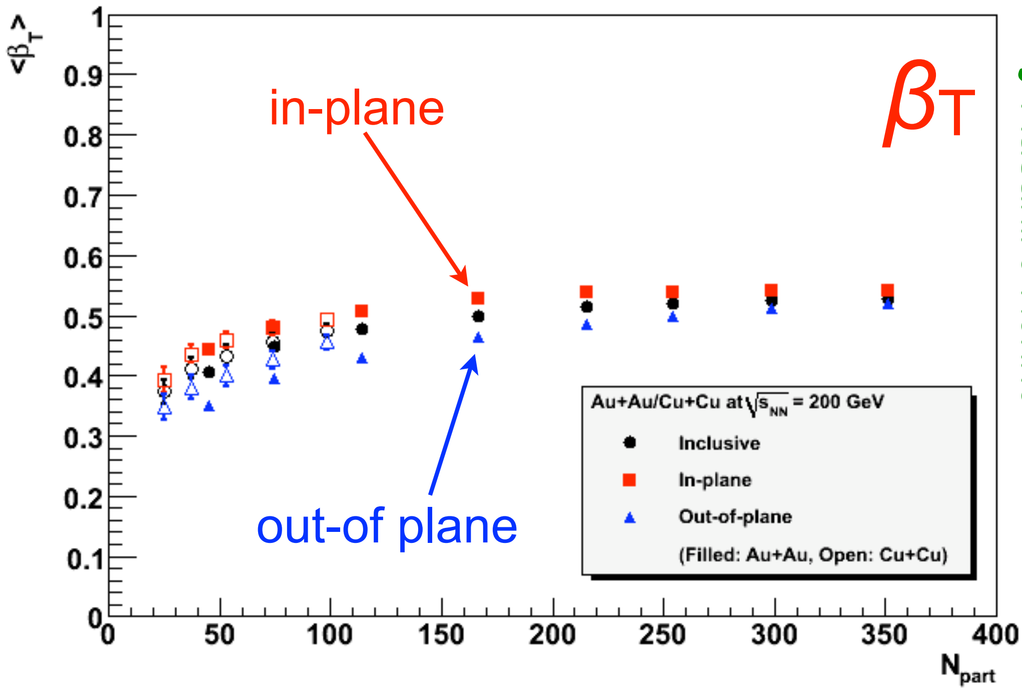
✓pt distributions measured in plane and out-of plane are B.W. fitted independently

B.W. Fitting Results

M. Konno, Tsukuba

Adiabatic Expansion Model (M.Konno,Y.M. 2008)





By Masahiro Konno

✓ T are the same in plane and out-of plane, while

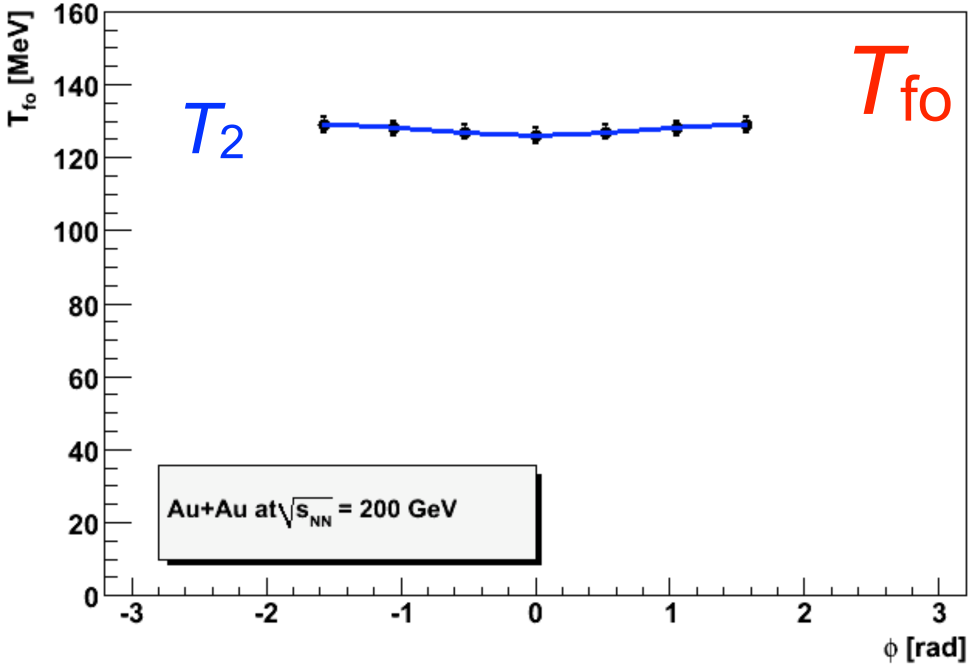
β_T(in-plane) > β_T(out-of plane) !

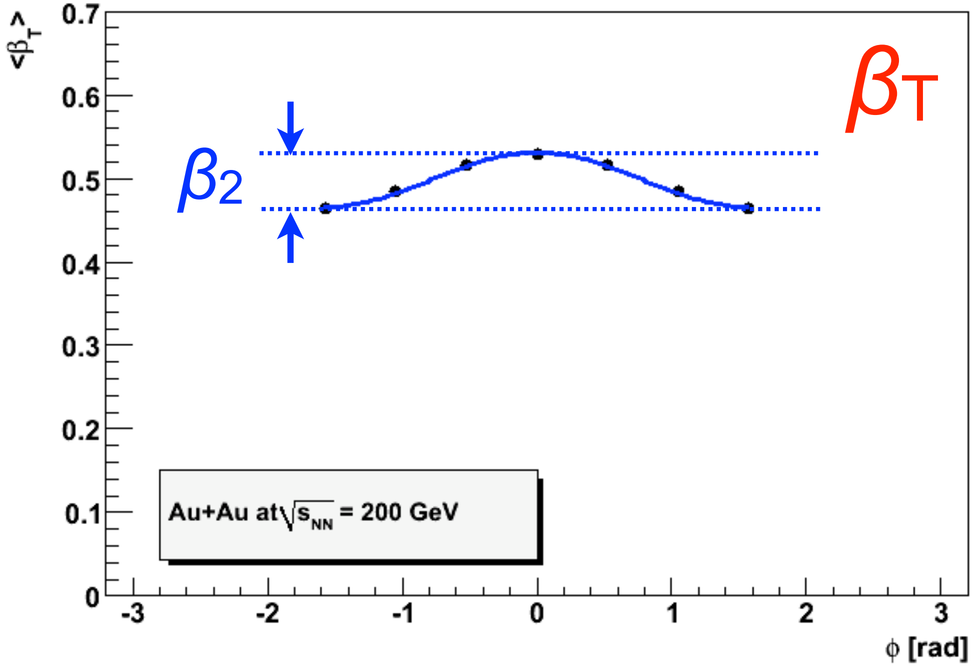
Modulations wrt. the ϕ_{RP}

M. Konno, Tsukuba

Adiabatic Expansion Model (M.Konno,Y.M. 2008)

Au+Au 200 GeV 20-30 %





By Masahiro Konno

$$T_{\rm fo}(\phi) = 1 + 2T_2\cos(\phi - \phi_{\rm RP})$$

$$\beta_{\rm T}(\phi) = 1 + 2\beta_2\cos(\phi - \phi_{\rm RP})$$

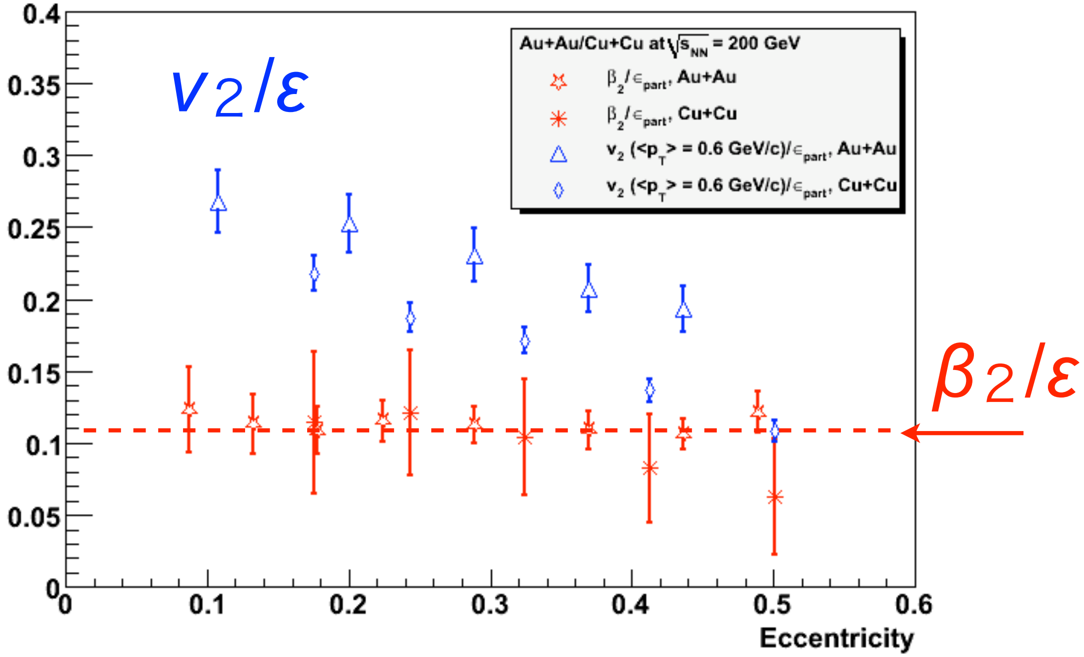
$T_2 = (-5.4 \pm 4.0) \times 10^{-3}$

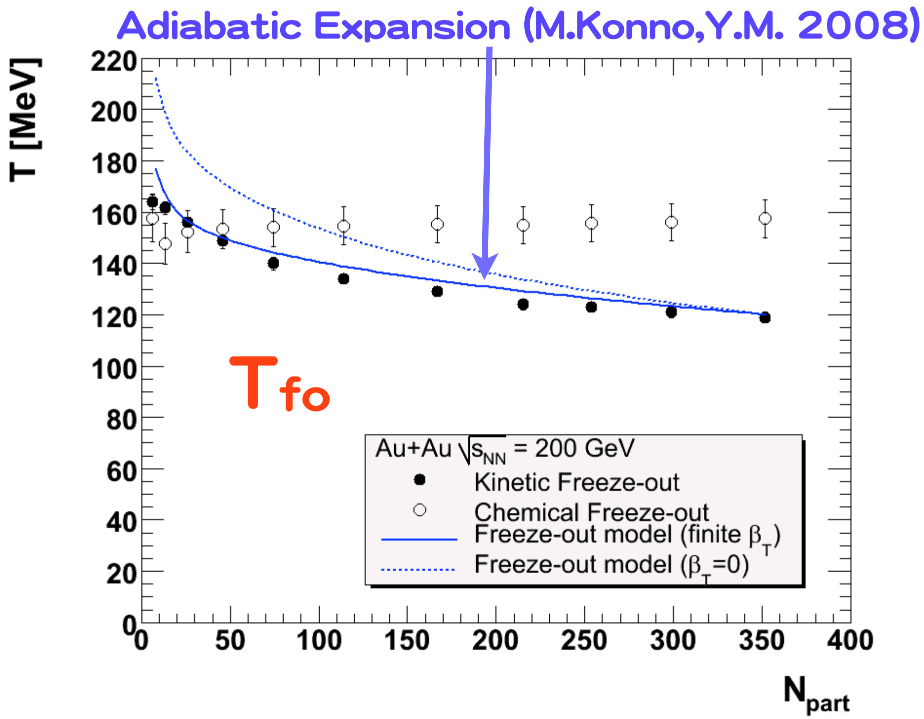
$\beta_2 = (3.3 \pm 0.2) \times 10^{-2}$

✓ $T_2 \simeq 0$, while clear modulation in β.

✓ Reaction Plane is determined independently.

β_2/ε is the constant !



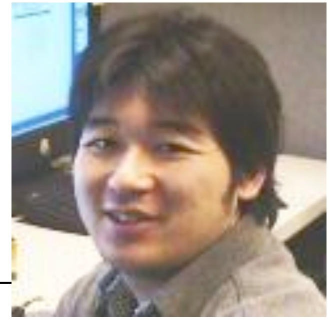


✓ β_2/ε is the constant in Au+Au and Cu+Cu, while v_2/ε shows ~ $N_{part}^{1/3}$.

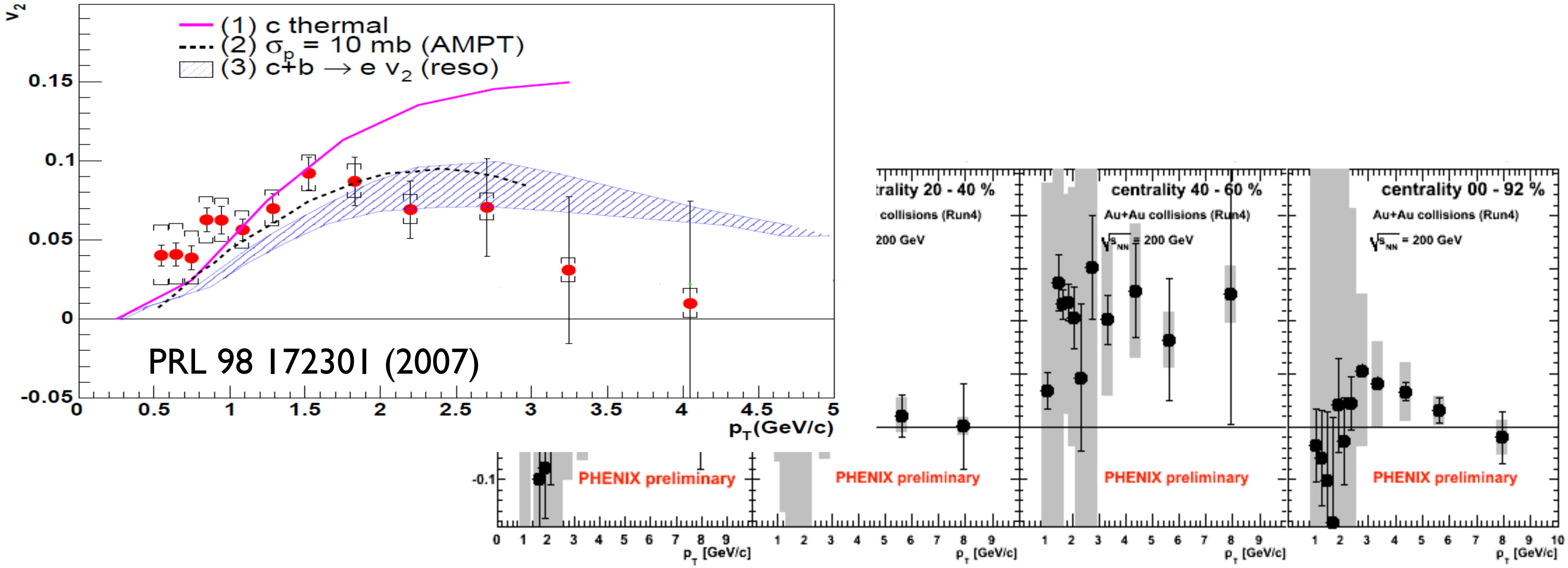
➡Difference comes from the fact that v2 is sensitive to T_{fo} as well. Strength of v2 is diluted if the T_{fo} is high.

➡Central collision shows lower T_{fo} because of the late freeze-out.

'Bright' future of v2; heavy flavor and thermal photon

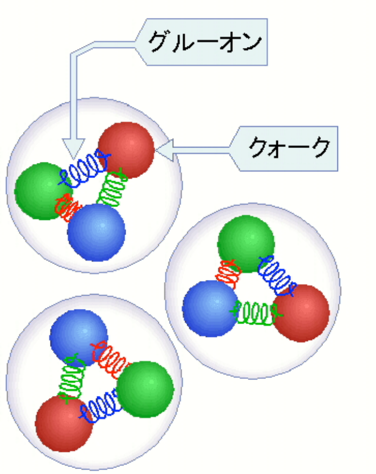


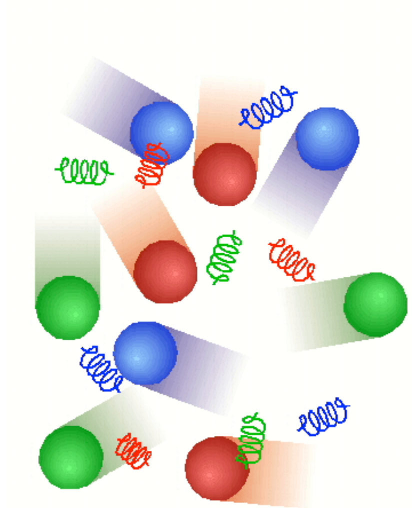
S. Sakai, Tsukuba



- ✓S. Sakai founds even charm flows
- ✓K. Miki is in his PhD defense of his positive results of thermal photon.

➡v2 is interesting business!!





Soft

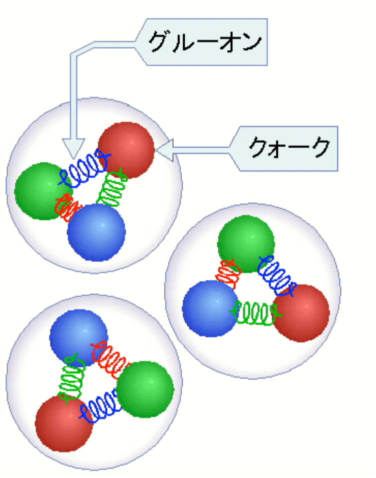
Statistica d

Collecti ature

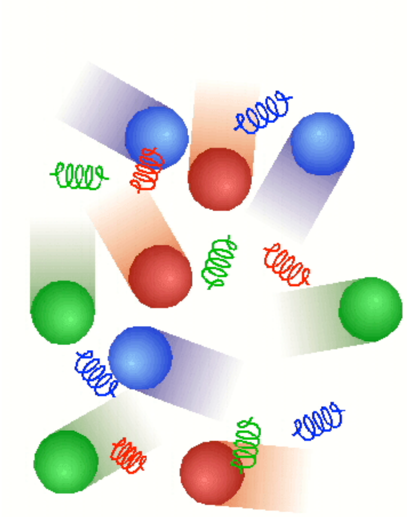
chara istic to the

P formation

well understood

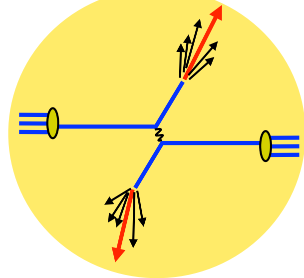


Hard comp.

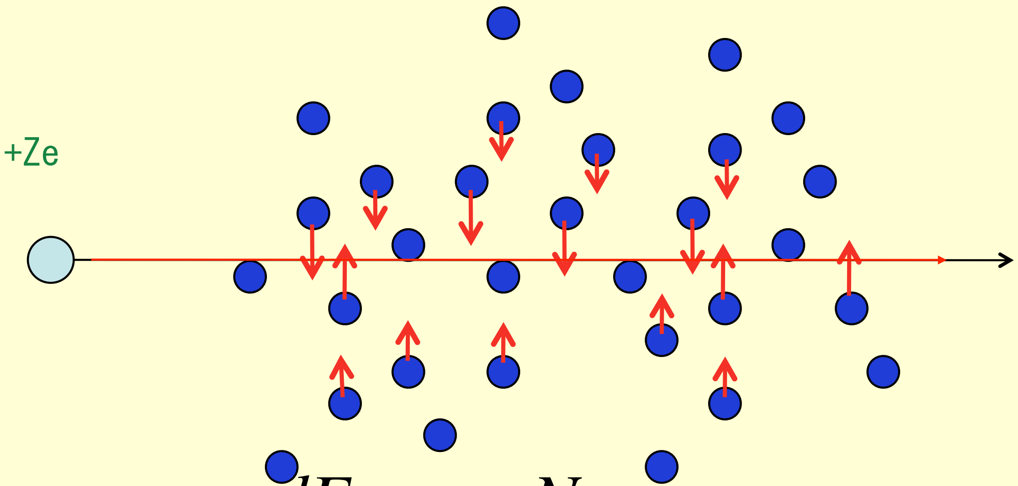


Partonic energy loss
Medium response
Tomography

Key 1; Energy Loss



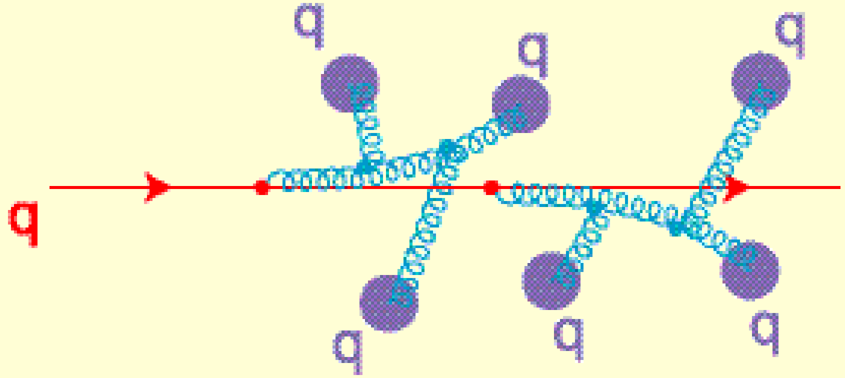
QED



$$-\frac{dE_{\mathrm{Bohr}}}{dx} \propto \frac{N_e}{\beta^2}\ln(\beta^2 \cdots)$$

Bethe-Heitler formula
Energy loss ∝ N_e

QCD

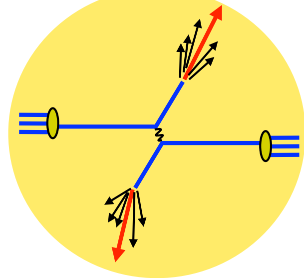


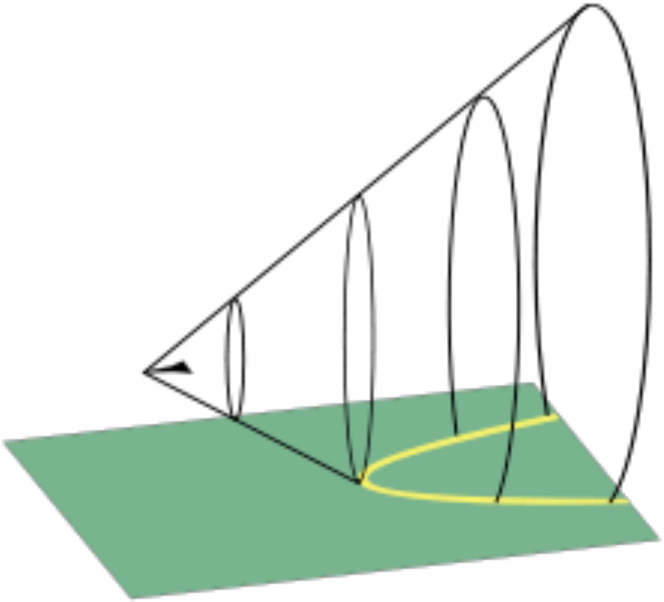
$$-\frac{dE_{\mathrm{GLV}}}{dx} \propto \frac{N_g}{f(E)}\ln(\frac{E}{\mu})$$

GLV formula
Energy loss ∝ N_g

✓ **Characteristic energy loss in dense matter**

Key2; Shock Wave in copious gluon field

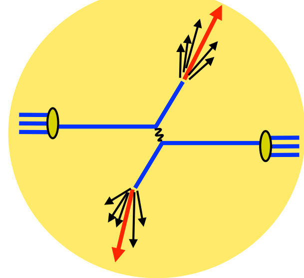




✓If confirmed, it is breakthrough from the era of QGP discovery to the study of property, such as sound velocity in the plasma

➡Sound velocity c_s ~ eq. of state

Shock Wave from Bevalac



From slides shown by S. Nagamiya at Tamura Symposium, Nov. 2008

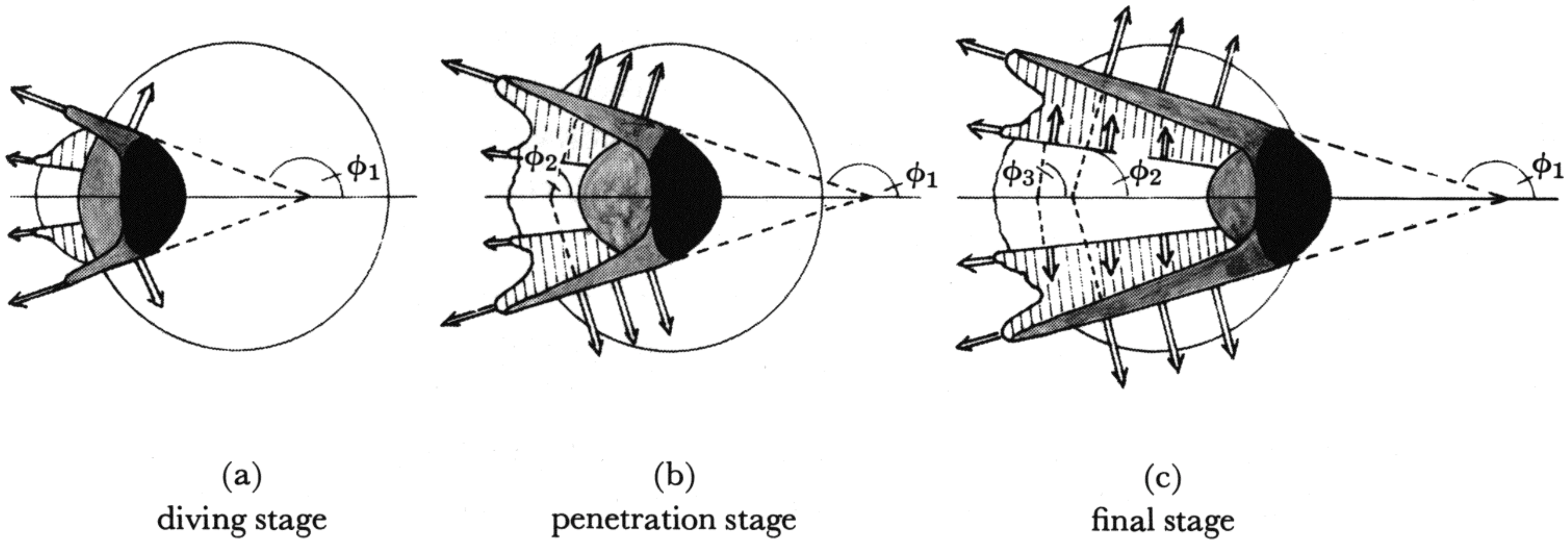
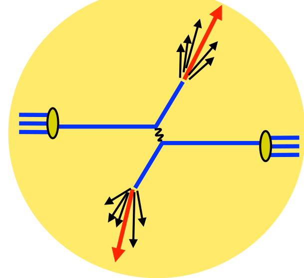


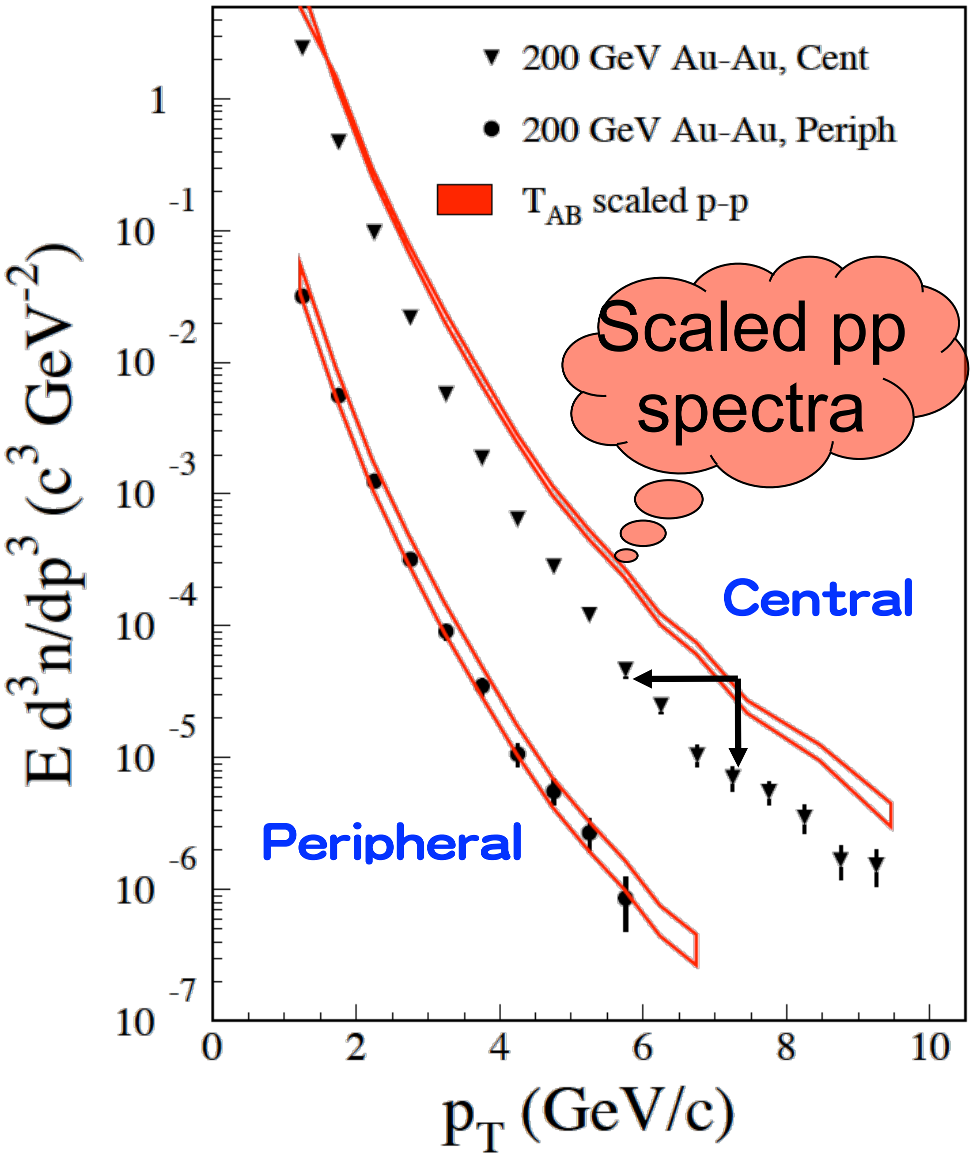
Figure 4. Schematic figure of the various stages in a central collision between an incident smaller (relativistically contracted) and a heavier target nucleus. The head-front shock is drawn very dark. The Mach-shock wave, which is traveling to the sides, also contains high density but not as high as the projectile head. A minor backward fragment ejection along the Mach-front is also indicated. This is expected especially in the diving stage, where it is easier to eject fast particles along the Mach-shock into free space. A secondary Mach-shock wave of intermediate density is also indicated.

W. Greiner's proposal.

✓It has been a dream of heavy ion physicists !

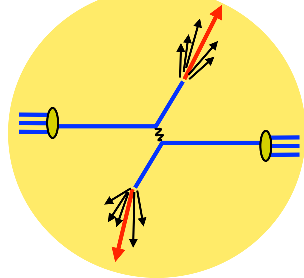
Effects in Hard comp. observed immediately





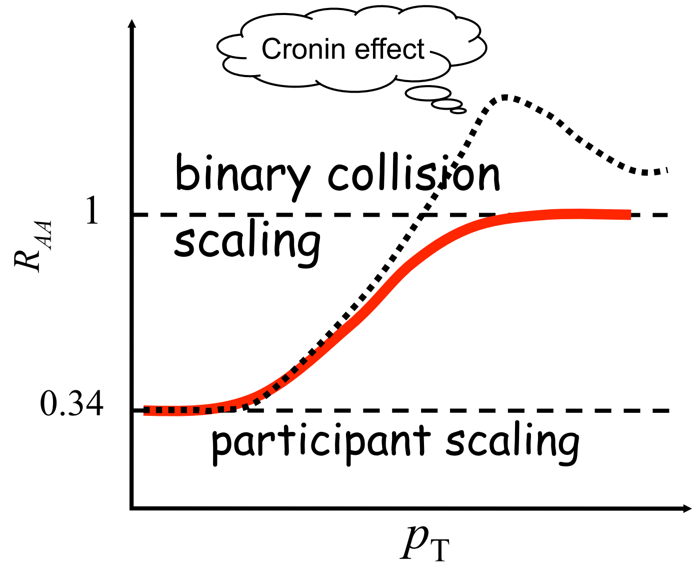
- ✓For comparison, Au+Au & pp spectra scaled by N_{binary}.
- ✓In peripheral collisions, Au+Au ~ pp
- ✓In central collisions, Au+Au < pp
  - Suppression of yield ?
  - Loss of p_T ?

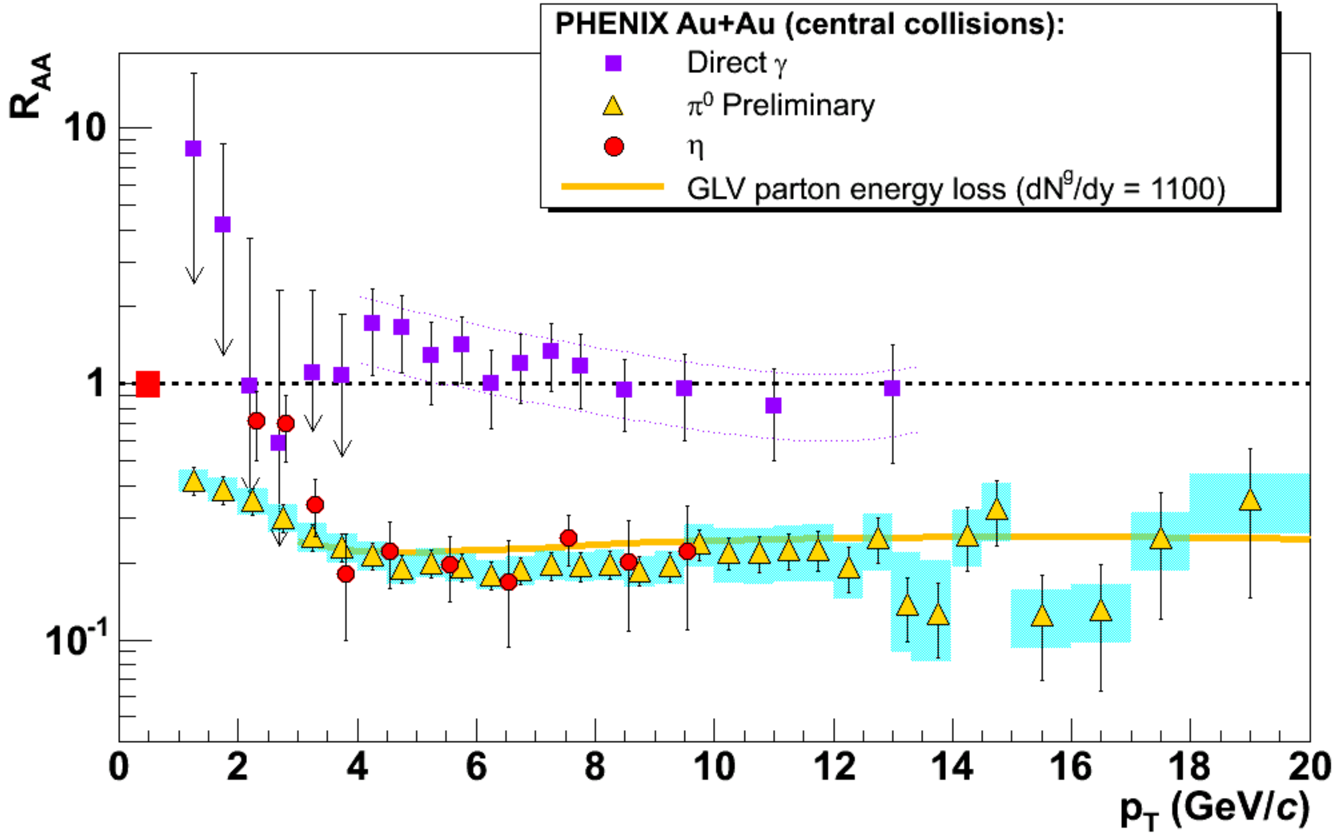
Suppression of high p_t particles



Nuclear Modification Factor

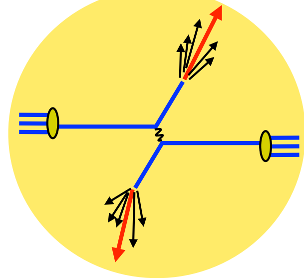
$$R_{Au+Au} = \frac{dn_{Au+Au}/dp_T dy}{\langle N_{binary} \rangle \cdot dn_{pp}/dp_T dy}$$



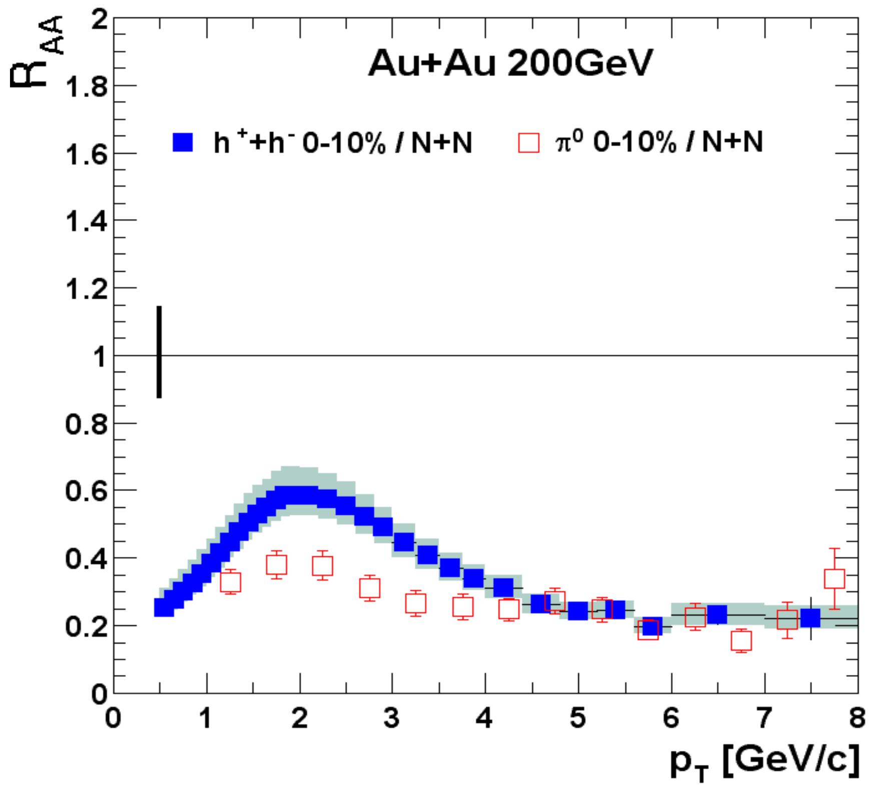


✓ **Pions are suppressed, direct photons are not**

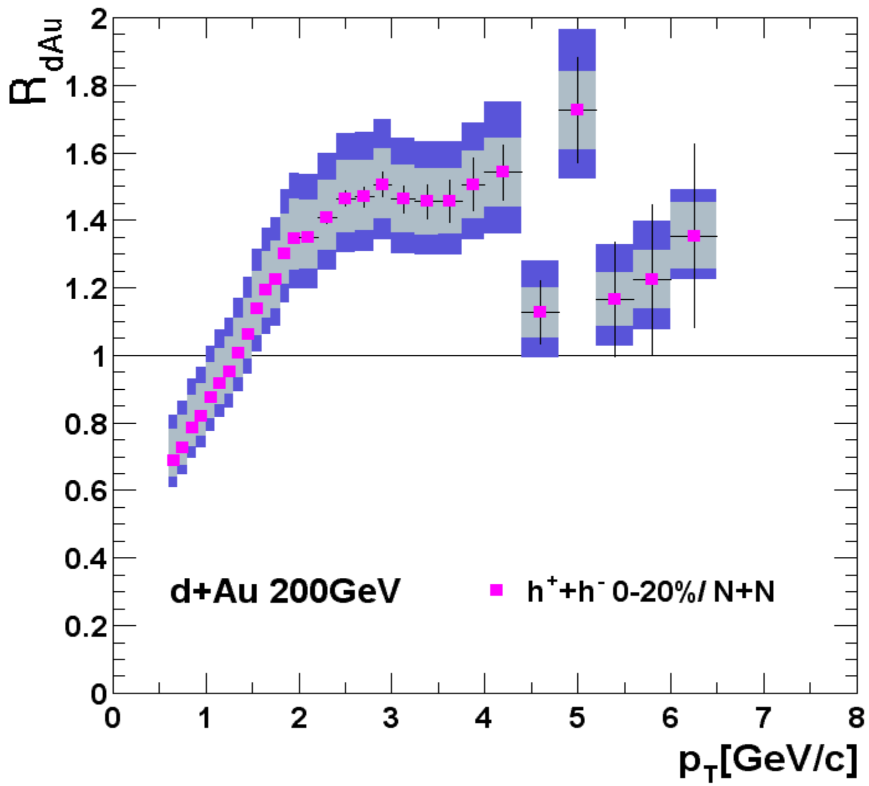
Au+Au vs d+Au



Phenix; P.R.L. 91, 072303 (2003)



Au+Au at $\sqrt{s_{NN}}$ = 200 GeV

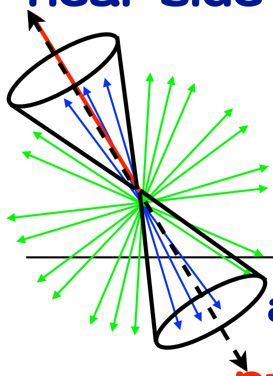


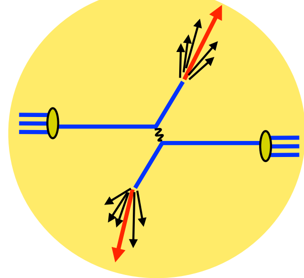
d+Au→$h^{\pm}$+X at $\sqrt{s_{NN}}$ = 200 GeV

✓High pt suppression in Au+Au, while not observed in d+Au.

➡Effect is not due to initial state, but final state.

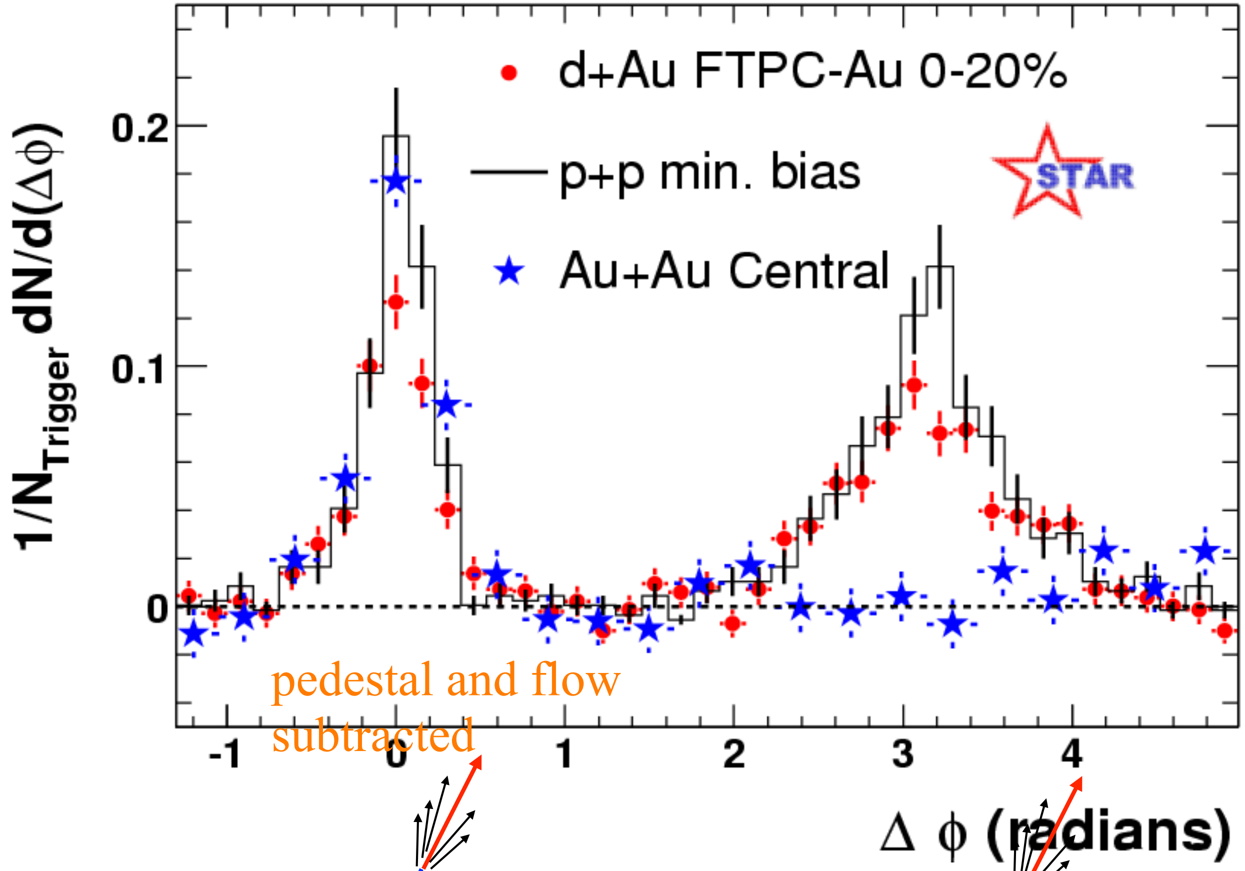
Disappearance of back-to-back corr.

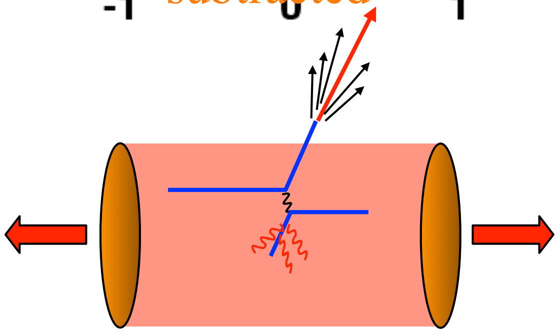


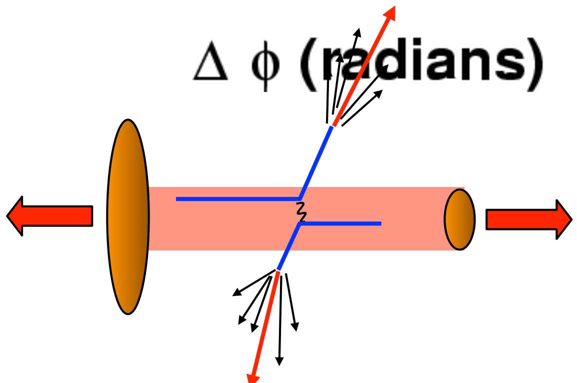


Star; P.R.L. 91, 72304 (2003)

p_T^{trig} = 4~6 GeV/c × p_T^{assoc} > 2 GeV/c

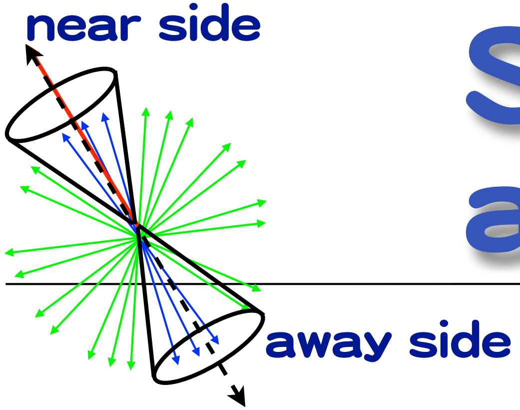


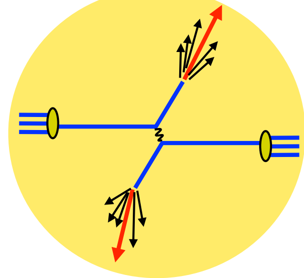




- Direct evidence of loss of 'jet'
- Azimuthal correlation w.r.t. high pt leading particle (trigger).
  - pp ; clean di-jet
  - dAu; similar to pp
  - Au+Au; Similar on the same side (suggesting jet-like mechanism), but b-to-b disappeared
    - Effect is not in initial but in final stage
    - Energy loss of partons in dense matter created in Au+Au

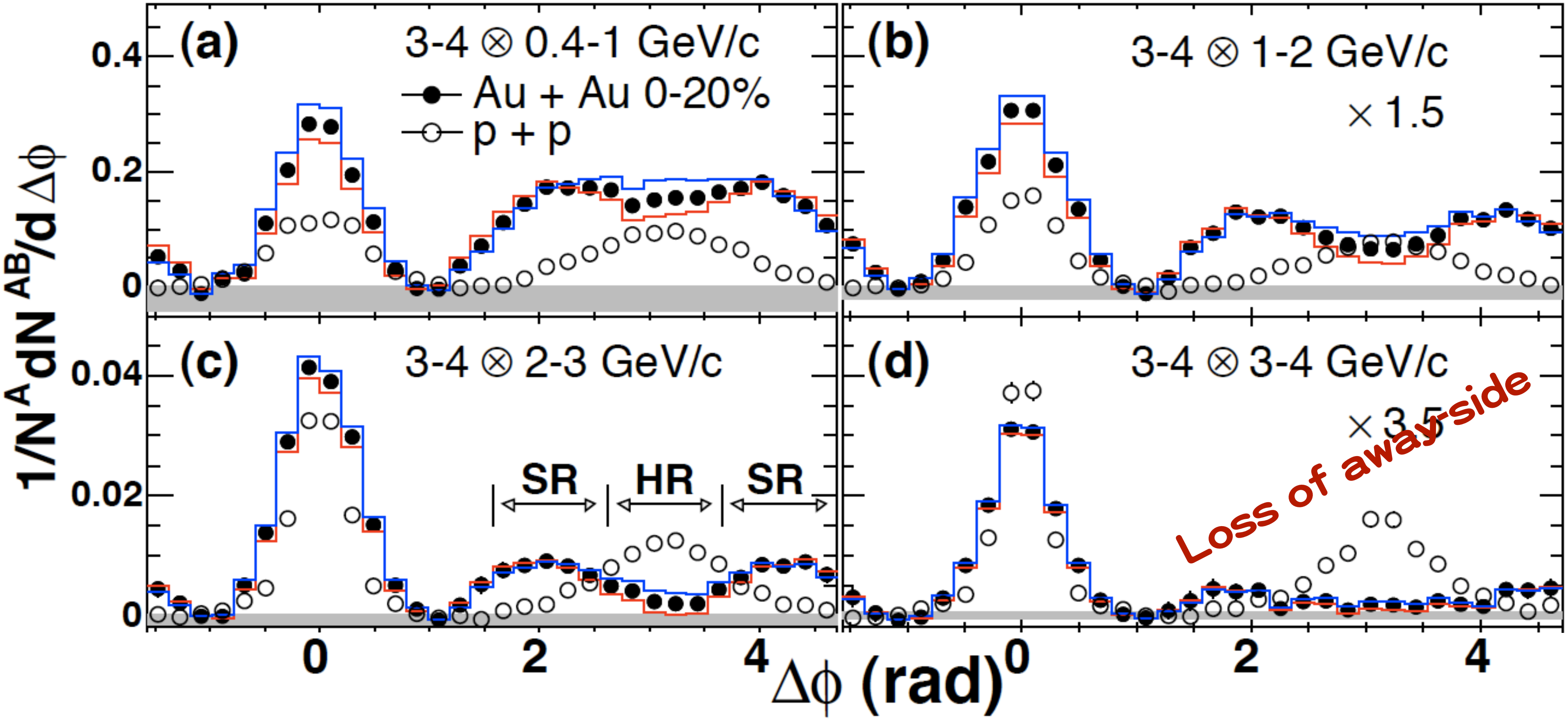
Shape change of away-side





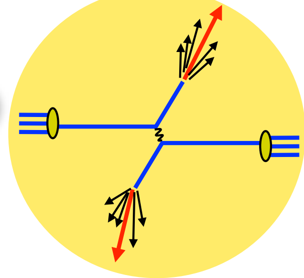
p_T^{trig} = 3~4 GeV/c × p_T^{assoc}

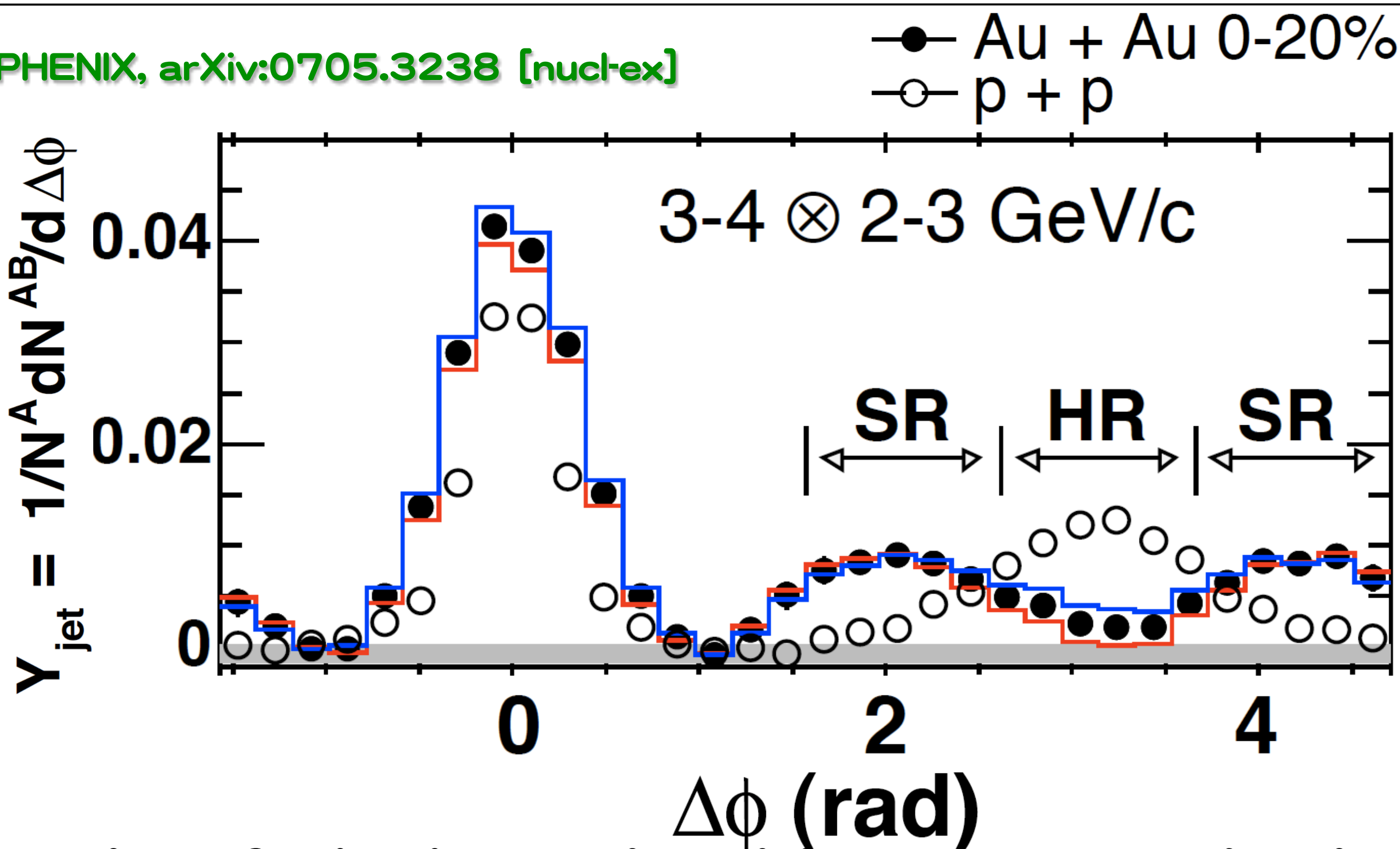
PHENIX, arXiv:0705.3238 [nucl-ex]



✓From broad/none to distinct two shoulders at ΔΦ＝π±1 with decreasing momentum.

Shoulders at $\Delta\Phi = \pi \pm 1$!?



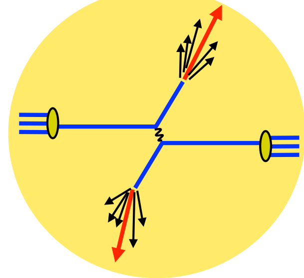


✓Location & <pt> of shoulder seem to be independent of centrality and pt.

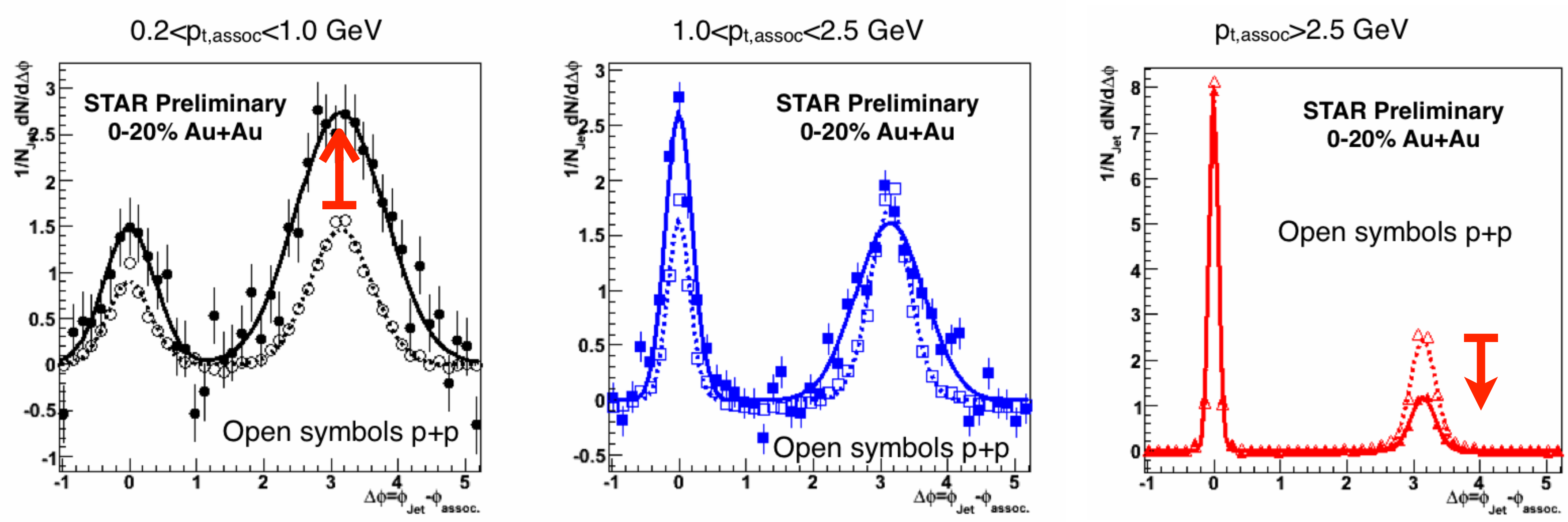
➡If confirmed, Shock Wave / Mach Cone !

✓Effect is very fragile, sensitive to mom. range and ZYAM correction

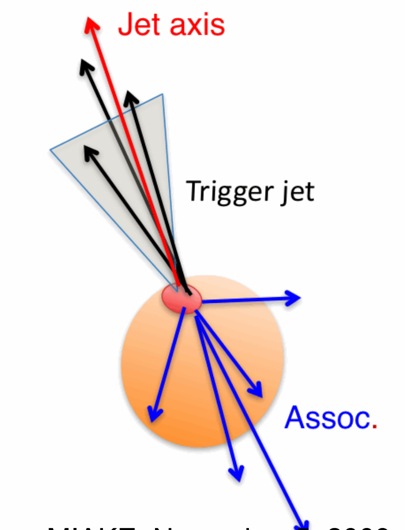
Jet - hadron correlation



High Tower Trigger (HT) : $(\eta \times \phi)$=(0.05x0.05) ET>5.4GeV



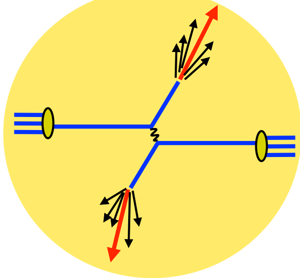
RHIC-AGS' 09, J. Putschke

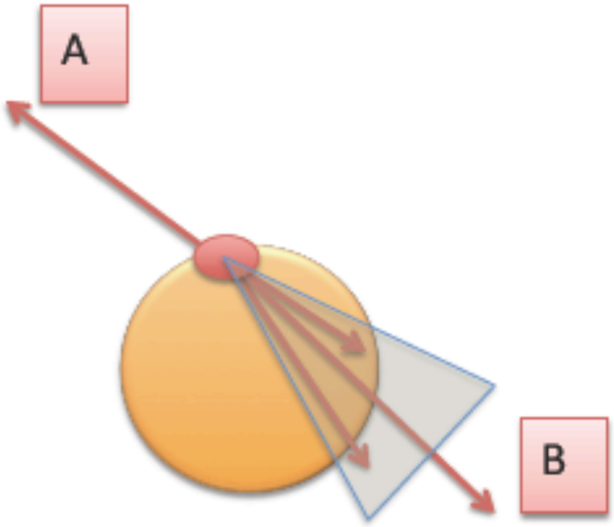


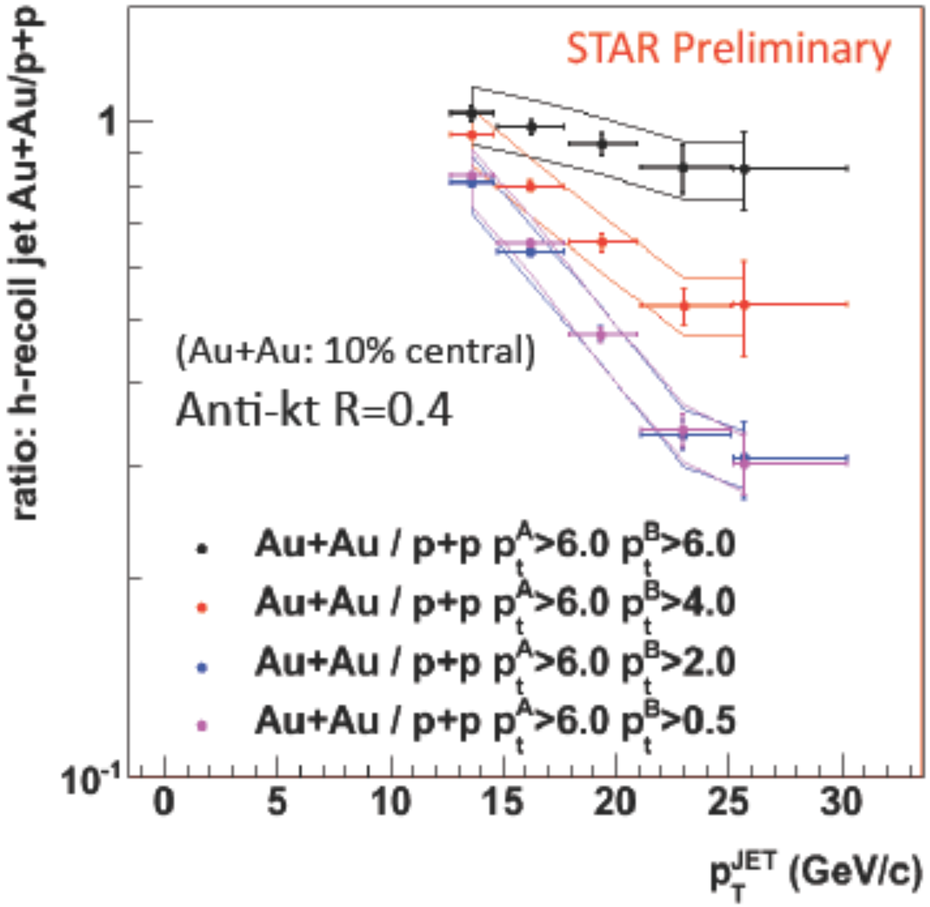
✓ On away side, less high p_t particles, while more low p_t particles

✓ No mach cone structure !?

Jet - hadron corr.





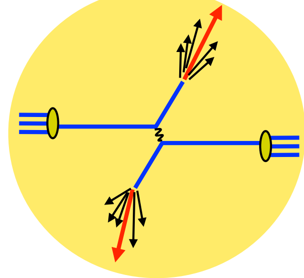


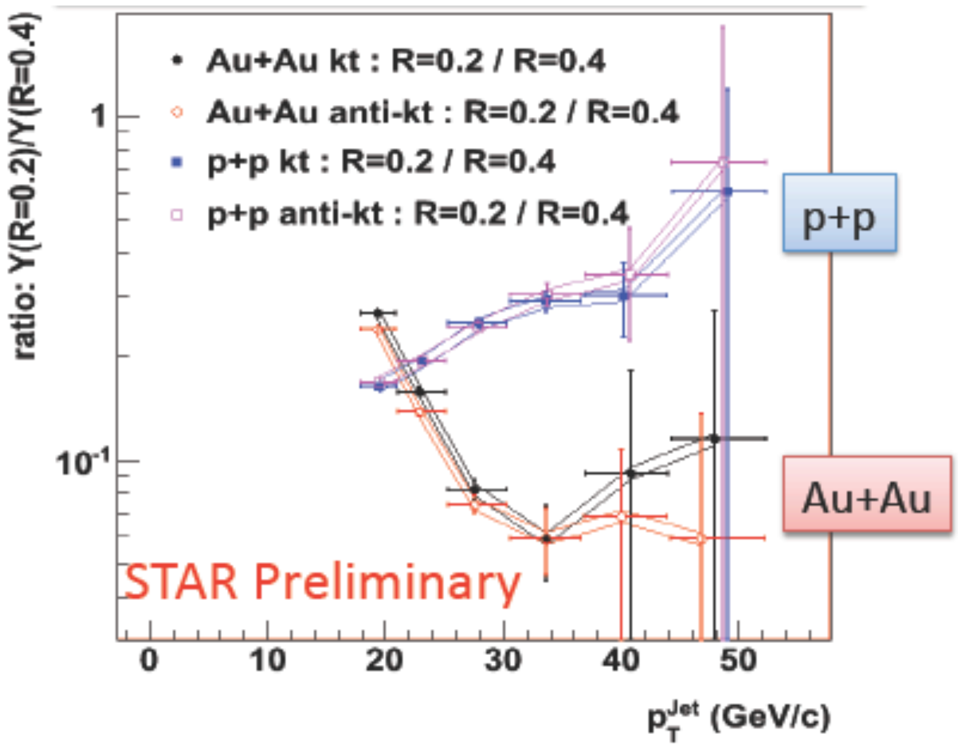
Significant suppression of the bias free recoil jet spectrum

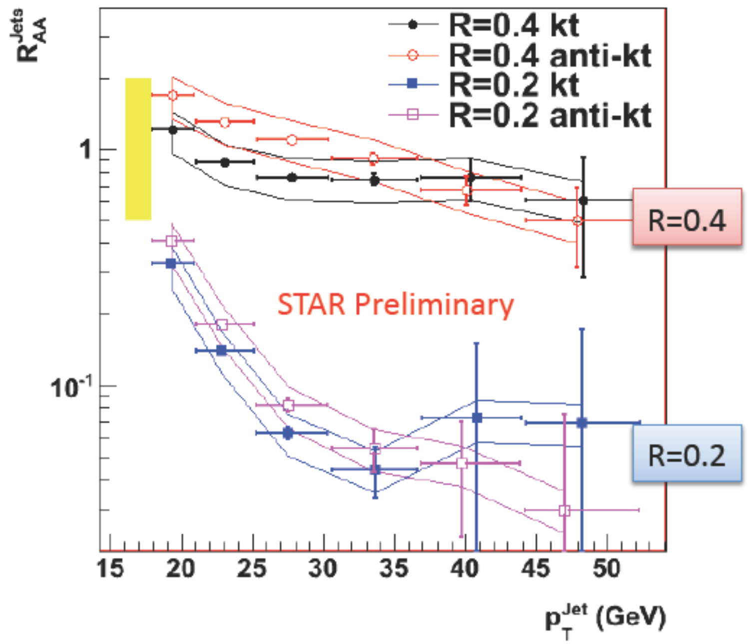
Mateusz Ploskon (LBNL), STAR, QM'09

✓ Study of "jet quenching" in terms of the energy flow

Jet analysis ~ cone radius







p+p: "Narrowing" of the jet structure with increasing jet energy

Au+Au: Strong broadening of the jet energy profile

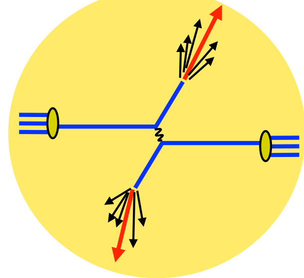
Mateusz Ploskon (LBNL), STAR, QM'09 22

√Effects are energy loss and broadening !!

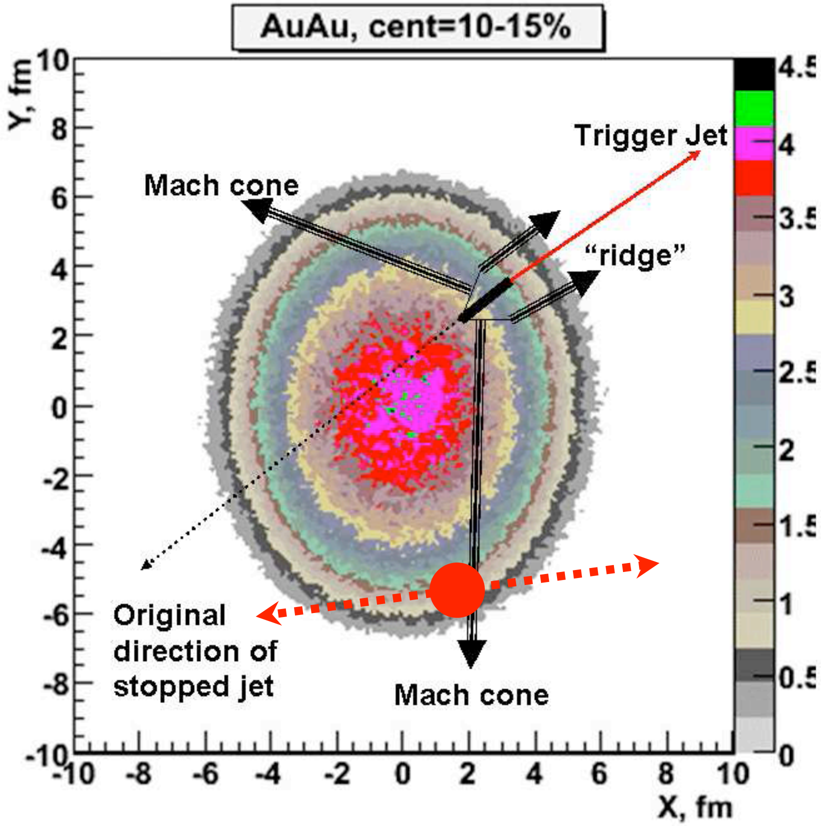
√Narrow cone may be another control variable

➡We like to extend and bring up to a precision meas.

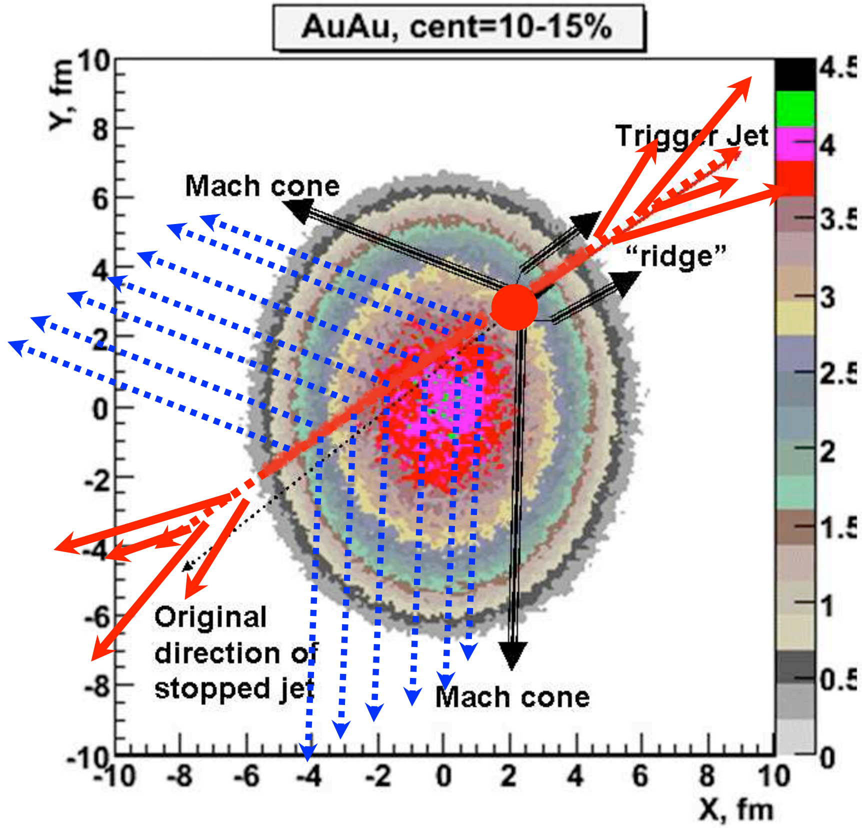
Frustration at RHIC, and hope at LHC



RHIC

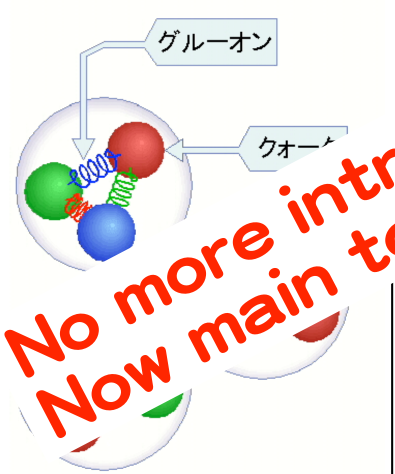


LHC

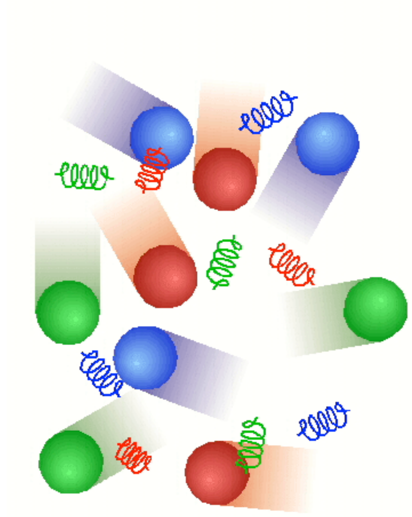


Pantuev, arXiv:hep-ph/0701.1882v1

✓ **What we want is high energy parton as a probe**
- All the frustrations at RHIC are due to low energy jet



No more introduction !!
Now main topic of my talk



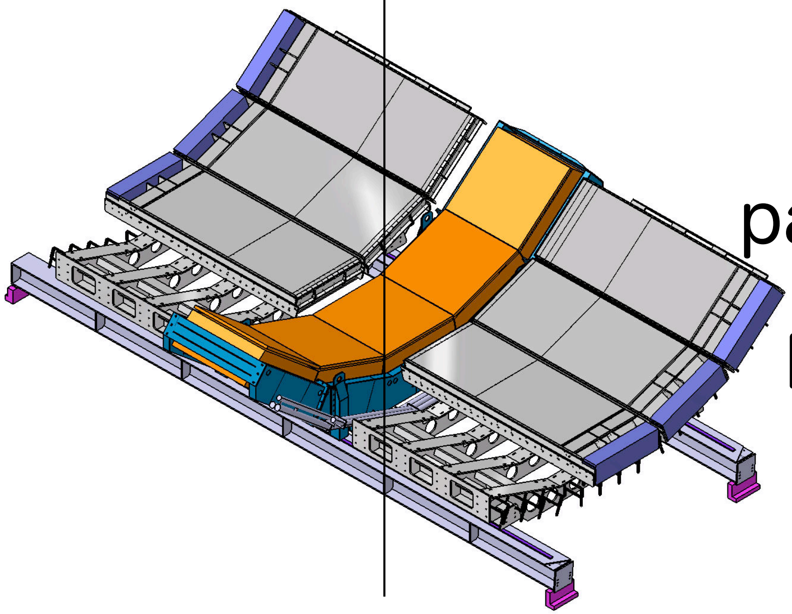
Now, LHC

One of the best outcomes from the RHIC:

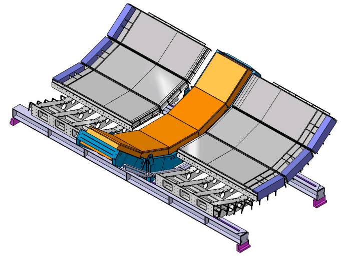
Jet Quench/
partonic energy loss

Medium response

Tomography



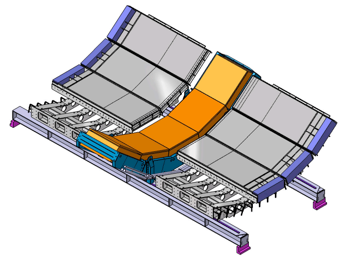
View from RHICians

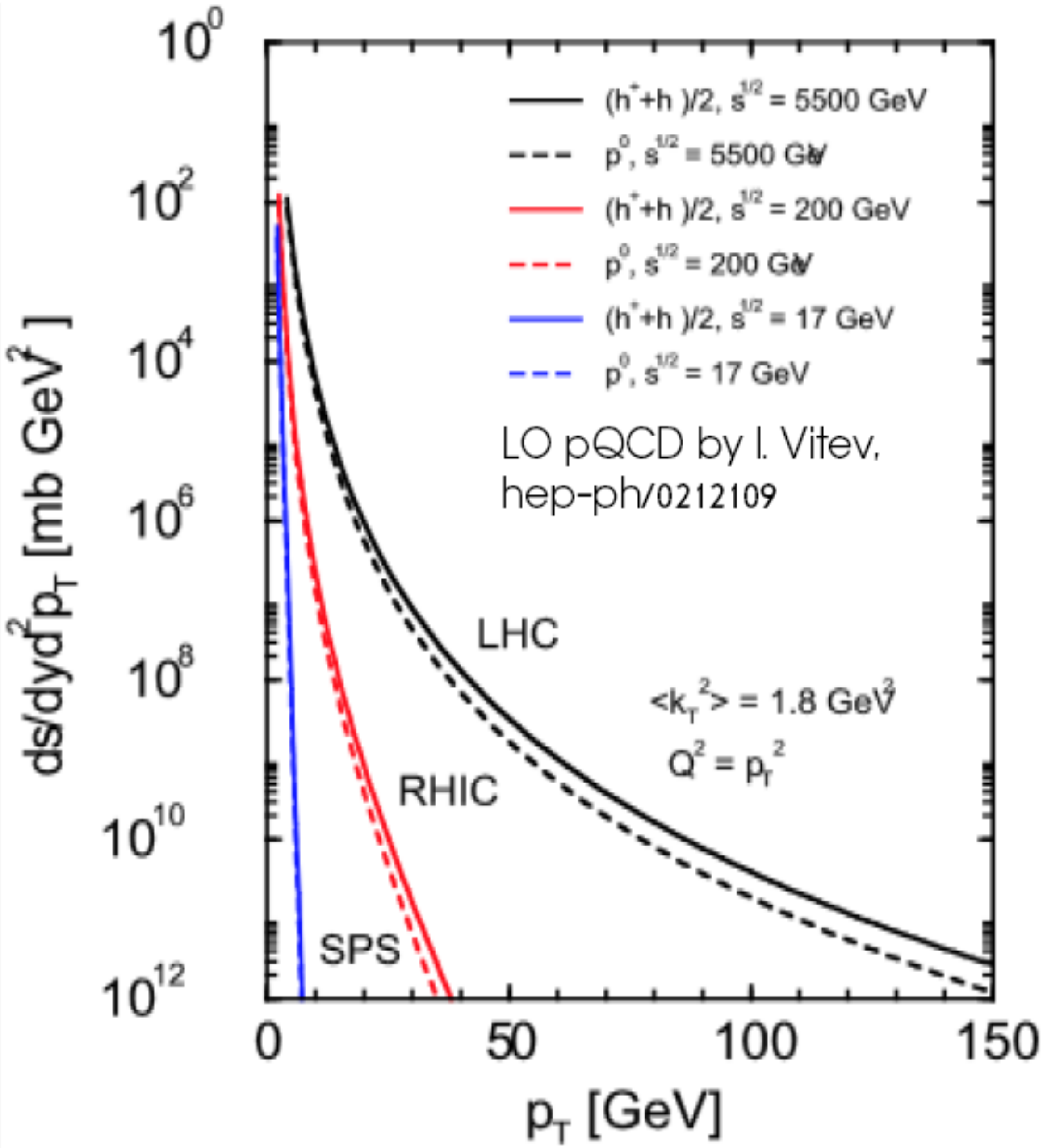


	RHIC	LHC
$\sqrt{s_{NN}}$ (GeV)	200	5500
T/T_c	1.9	3.0-4.2
ε (GeV/fm^3)	5	15-60
τ_{QGP} (fm/c)	2-4	>10

- ✓ Nothing much changes from RHIC to LHC.
  - Nevertheless,
    - ➡Larger/longer QGP
    - ➡Nice to confirm RHIC results
- ✓ Moreover, higher energy jets become available!

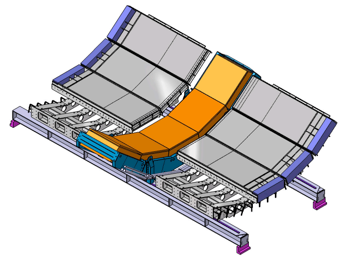
Chances are at LHC

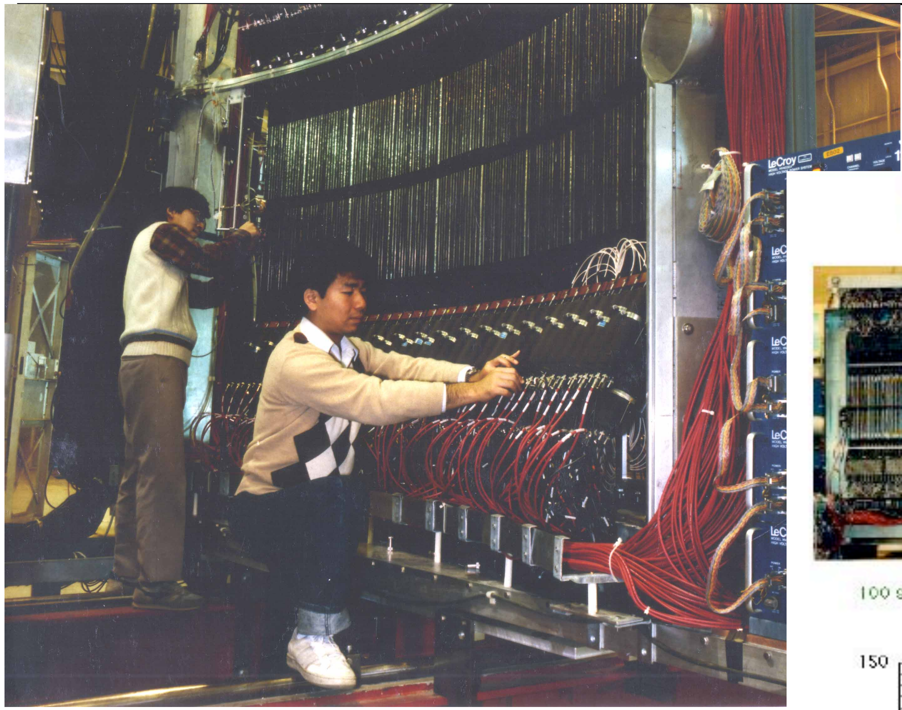




- ✓ **Many orders of magnitude!**
- ✓ **Jet Quench as a function of,**
  - **jet energy**
  - **path length, reaction plane angle**
  - **quark/gluon diff.**
- ✓ **From particle ID to parton ID !!**

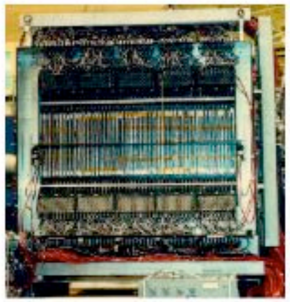
Indeed, my life with PID

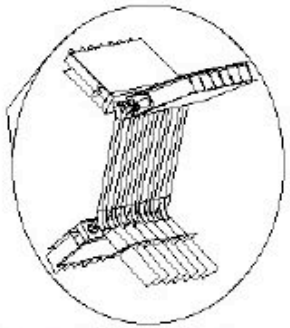




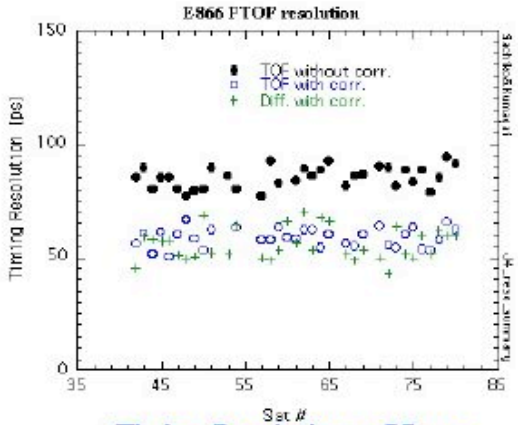
1986 BNL-AGS E802 TOF

E866 TOF with OTD



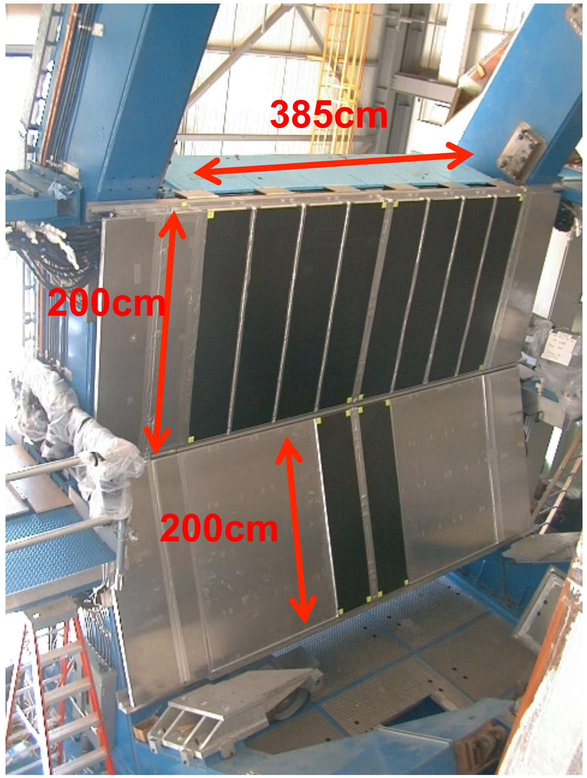


100 slats of BC404 1.25x1.25x48 cm with R3478S readout



Timing Resolution < 55 ps

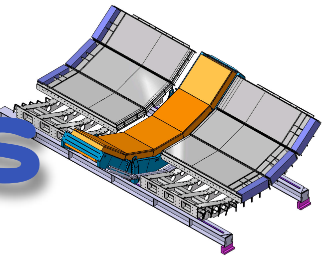
1995? BNL-AGS E866 TOF

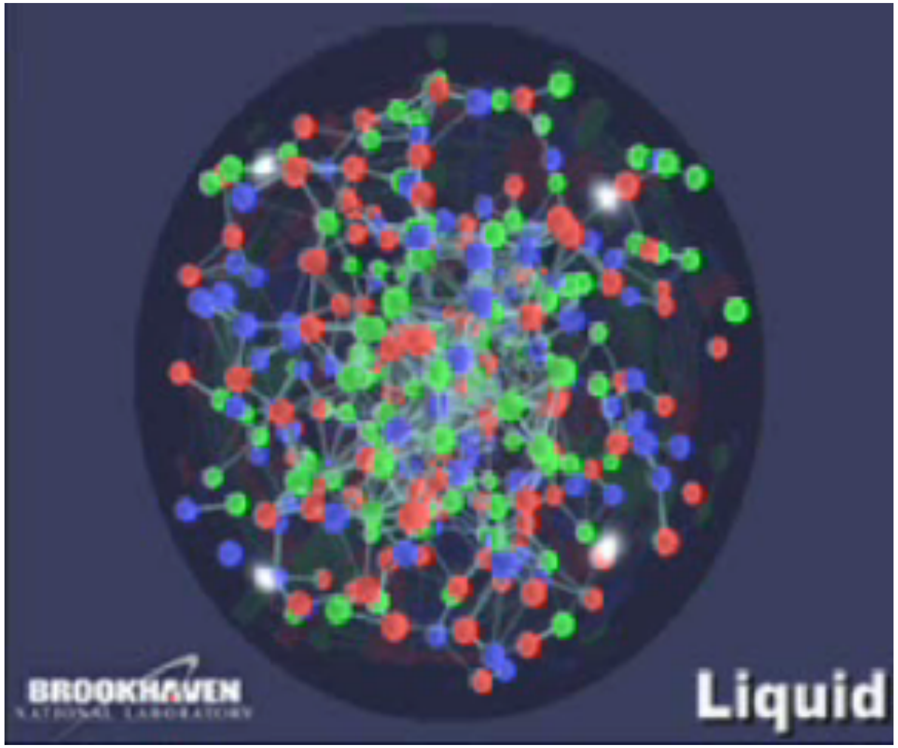


2000 BNL-RHIC PHENIX TOF

✓ Now from particle ID to parton ID

QGP made of soft particles



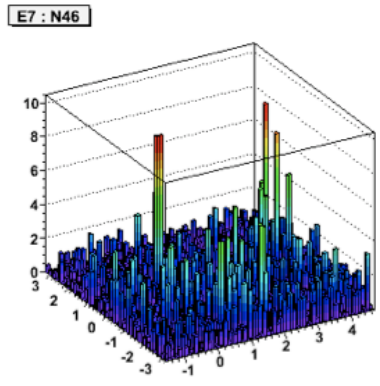


Animation by Jeffery Mitchell (Brookhaven National Laboratory). Simulation by the UrQMD Collaboration

- √ QGP with T~a few 100 MeV is made of soft particles.
  - Meas. of soft/low pt particles is a must for the property of QGP.
- √ As a probe of QGP, high p_t parton is important
- √ In other words, modification of soft particles with high energy jet is what we want to study.

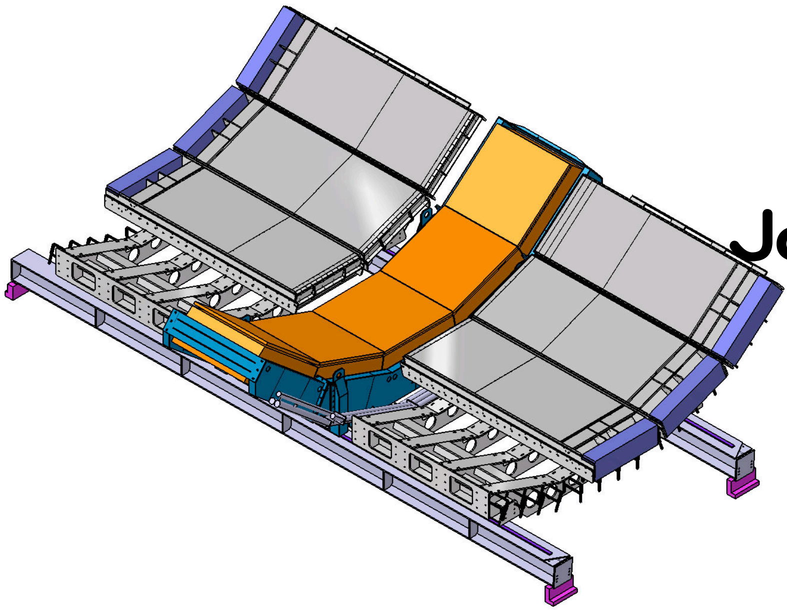
Please note that the name of the project is very sensitive issue !!

Extension of ALICE EM-Cal



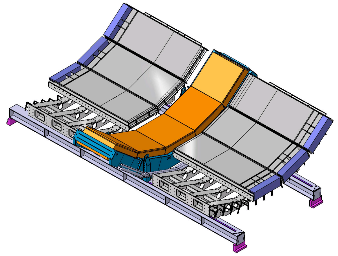
Enhance back-to back capability

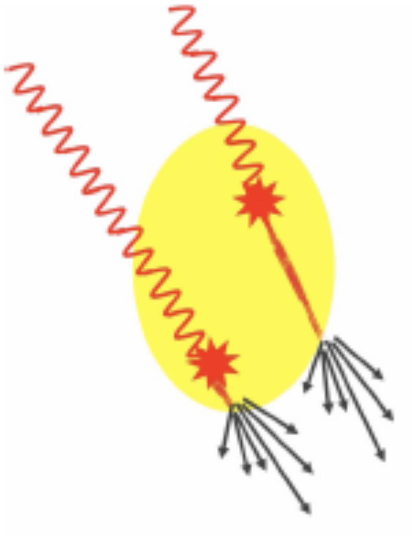
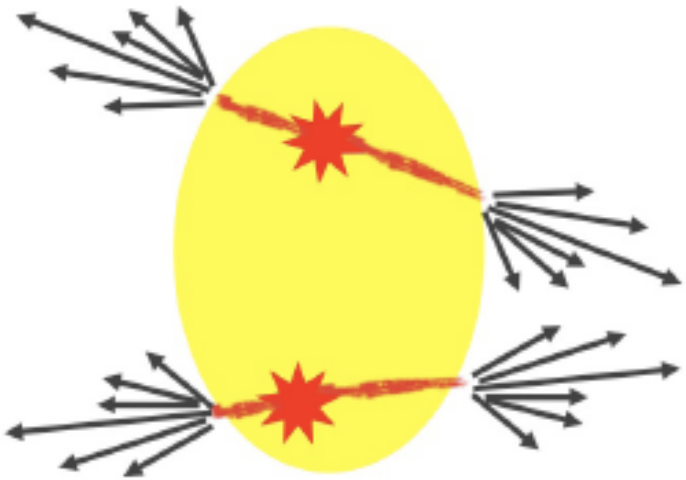
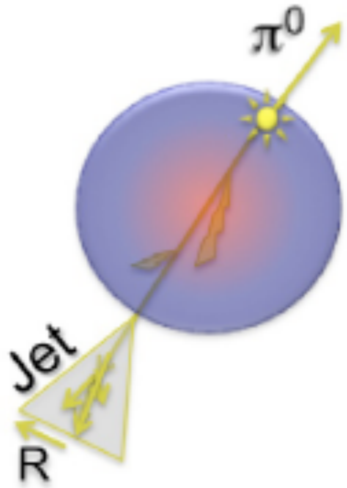
Proposed in Feb.,2009
Discussed in March
Proposal in May
Jcal(B1) approved in July
B6 approved in Oct.



Proposal available at
http://utkhii.px.tsukuba.ac.jp

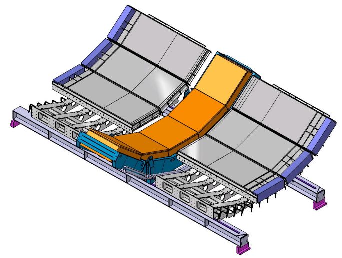
Probes for the study

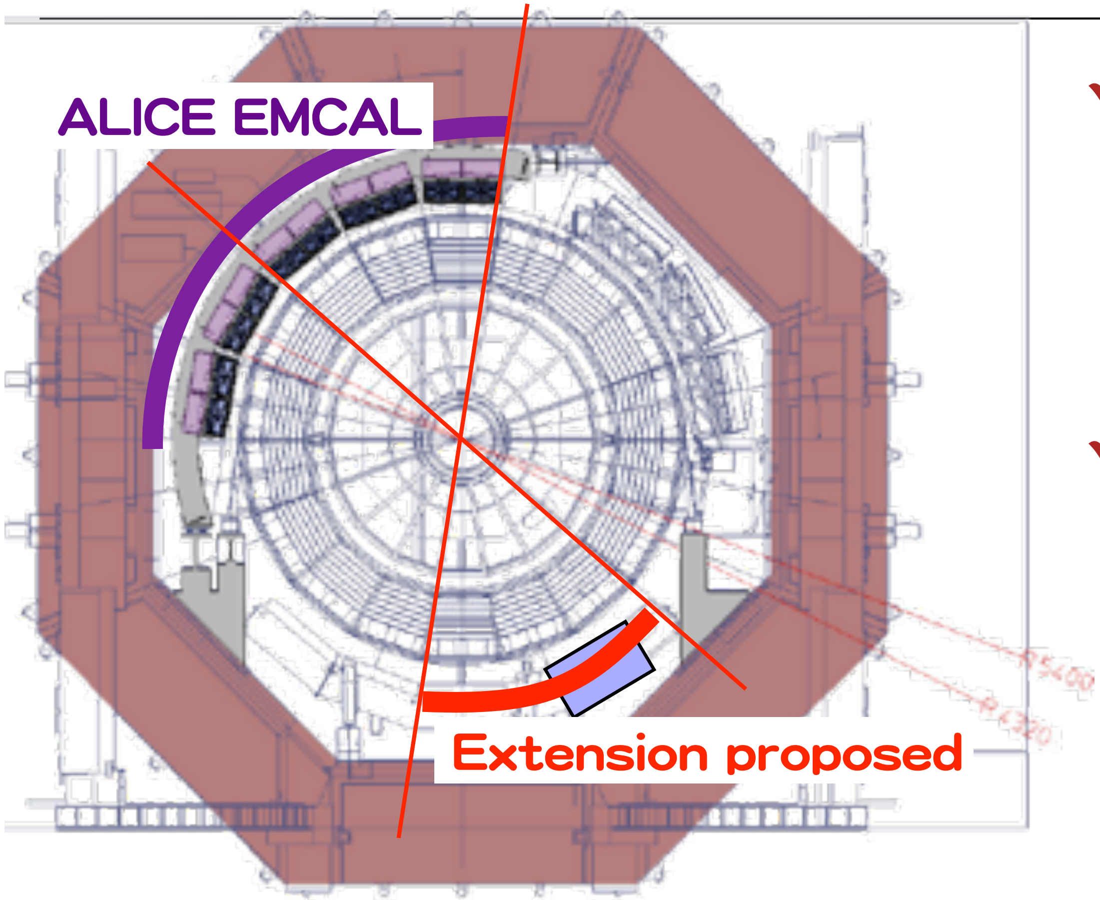


γ-Jet	Di-jet	π^0-Jet
		
✓Quark Jet ✓Small Xsection ✓Experimentally difficult	✓Mostly Gluon Jet ✓Larger Xsection ✓Interpretation may be difficult	✓Clean π^0 trig ✓Large Xsection ✓Important for J-Cal

Systematic meas. of these processes for model comparison provides at high precision level.

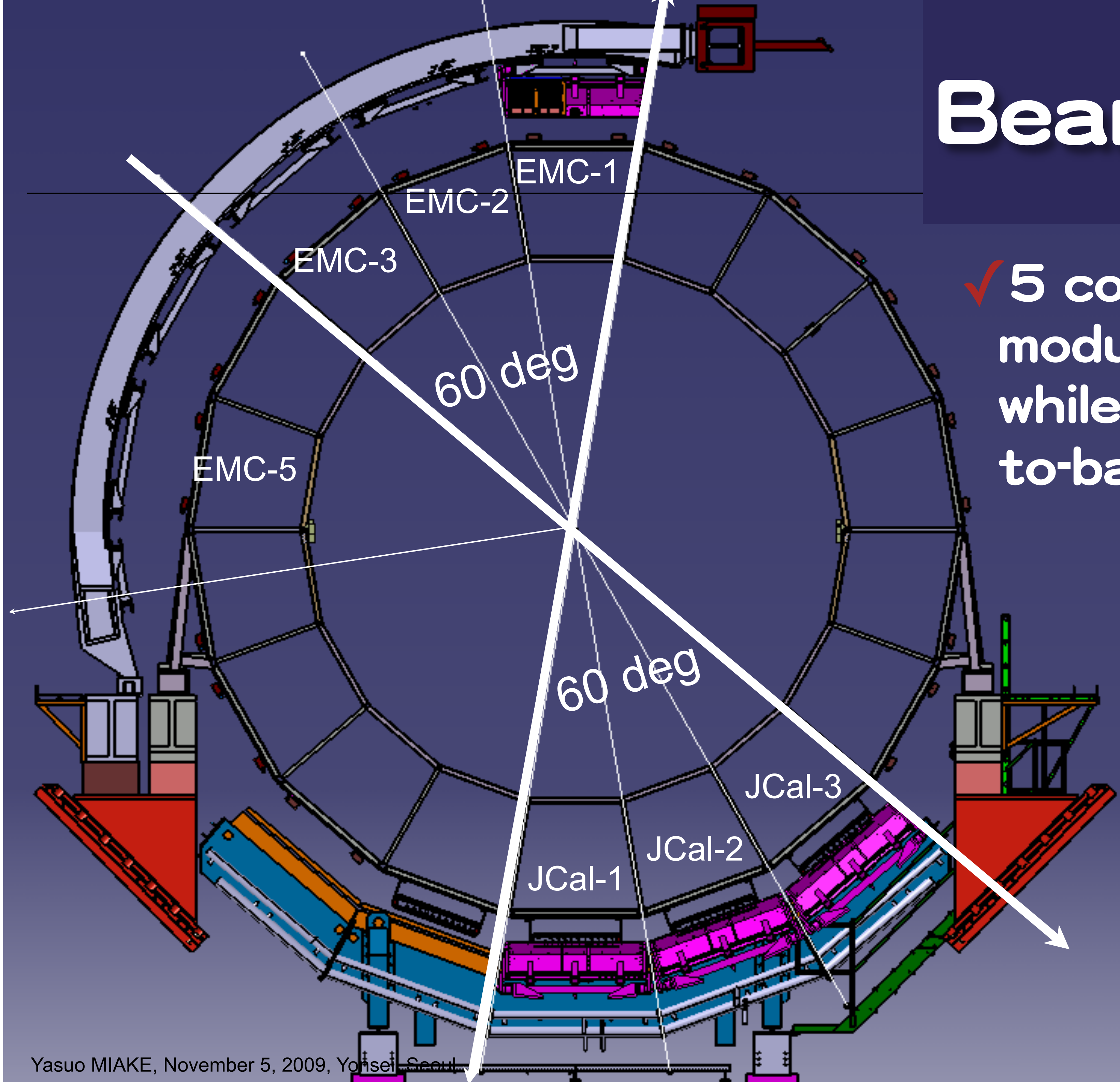
Extension of EM-Cal





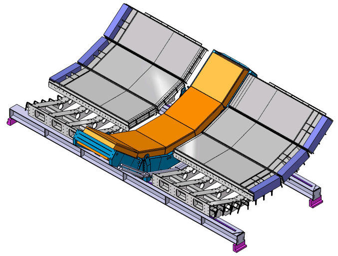
- ✓ J-Cal (EM) for back-to back jets in ALICE
  - ➡ Define back-to back jets
  - ➡ Trigger back-to back jets
- ✓ Why back-to back jets?
  - Origins clean
  - Kinematically clean
    - ➡ Energy balance
    - ➡ back-to back in phi
- ✓ Physics Goal
  - Modification of soft particles with high E jet
    - ➡ Mach Cone, Ridge, etc
  - Tomography of QGP

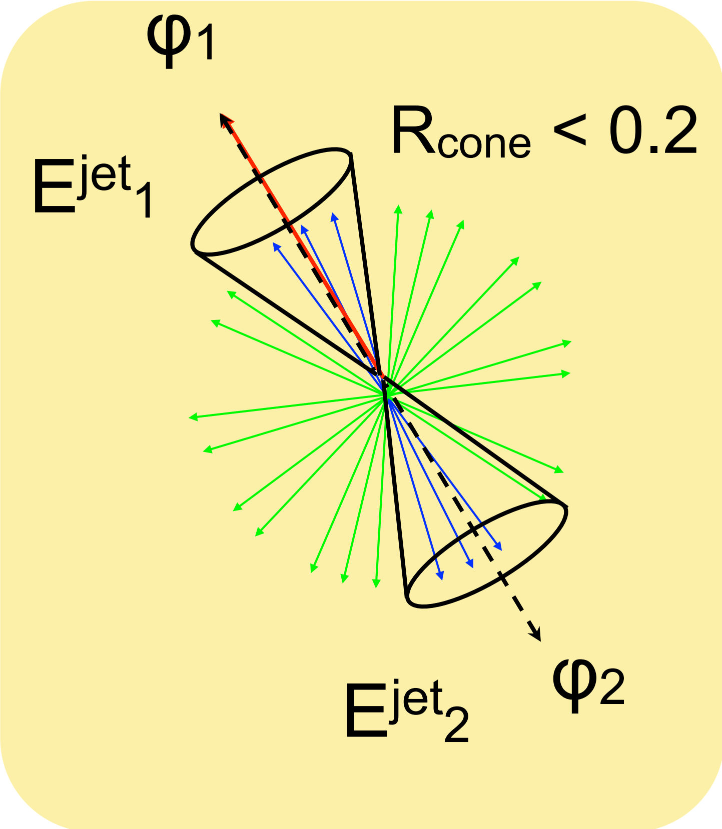
Beam View

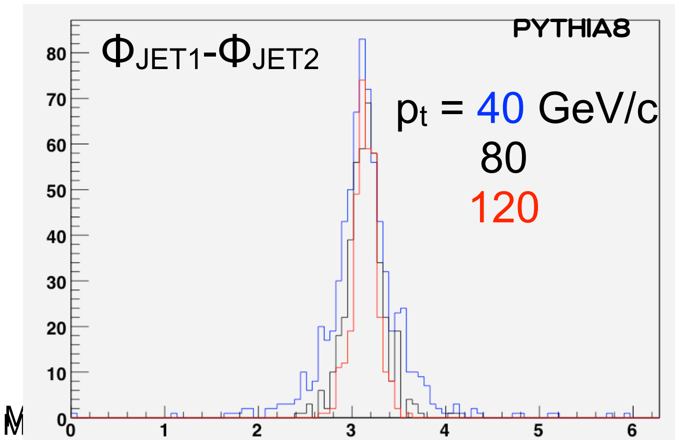


- 5 contiguous modules possible, while exact back-to-back is 3

Key issues; resolutions







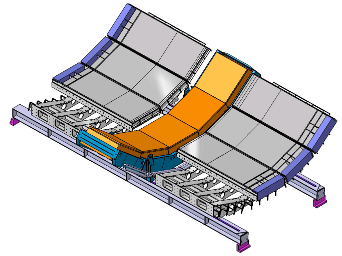
✓Good characteristics of Back-to back jets

- Origins clean
- Kinematically clean
  - ➡Energy balance
  - ➡back-to back in phi

✓Need to have better resolutions

- ➡RMS of (ϕ_1-ϕ_2)
- ➡RMS of (E^{jet}_1-E^{jet}_2)

Energy balance; ($E^{JET}{}_1$-$E^{JET}{}_2$)



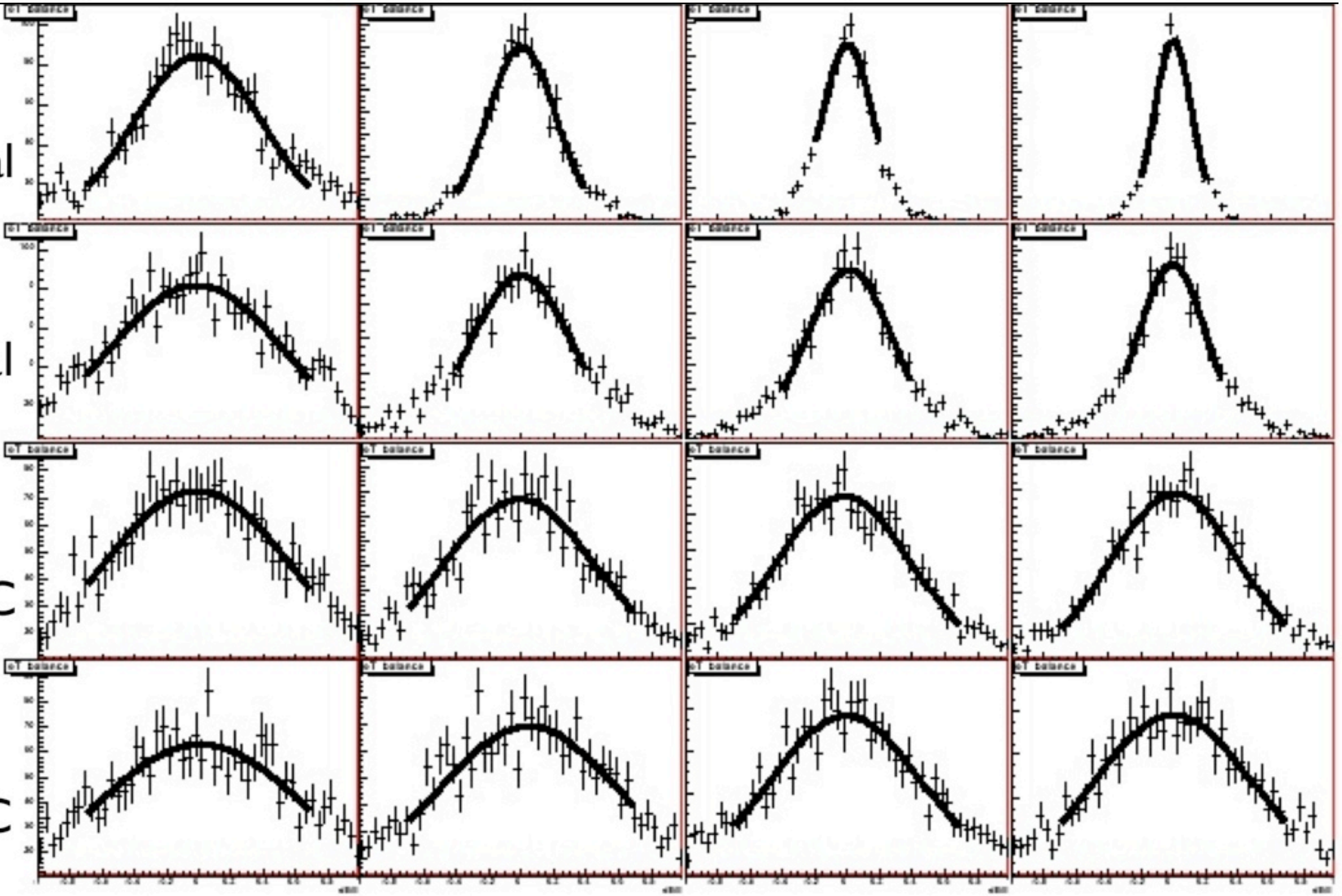
65 GeV | 105 GeV | 150 GeV

γ-Jet EMC - JCal

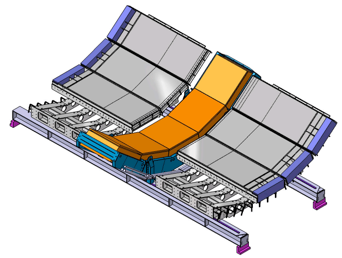
Di-Jet EMC - JCal

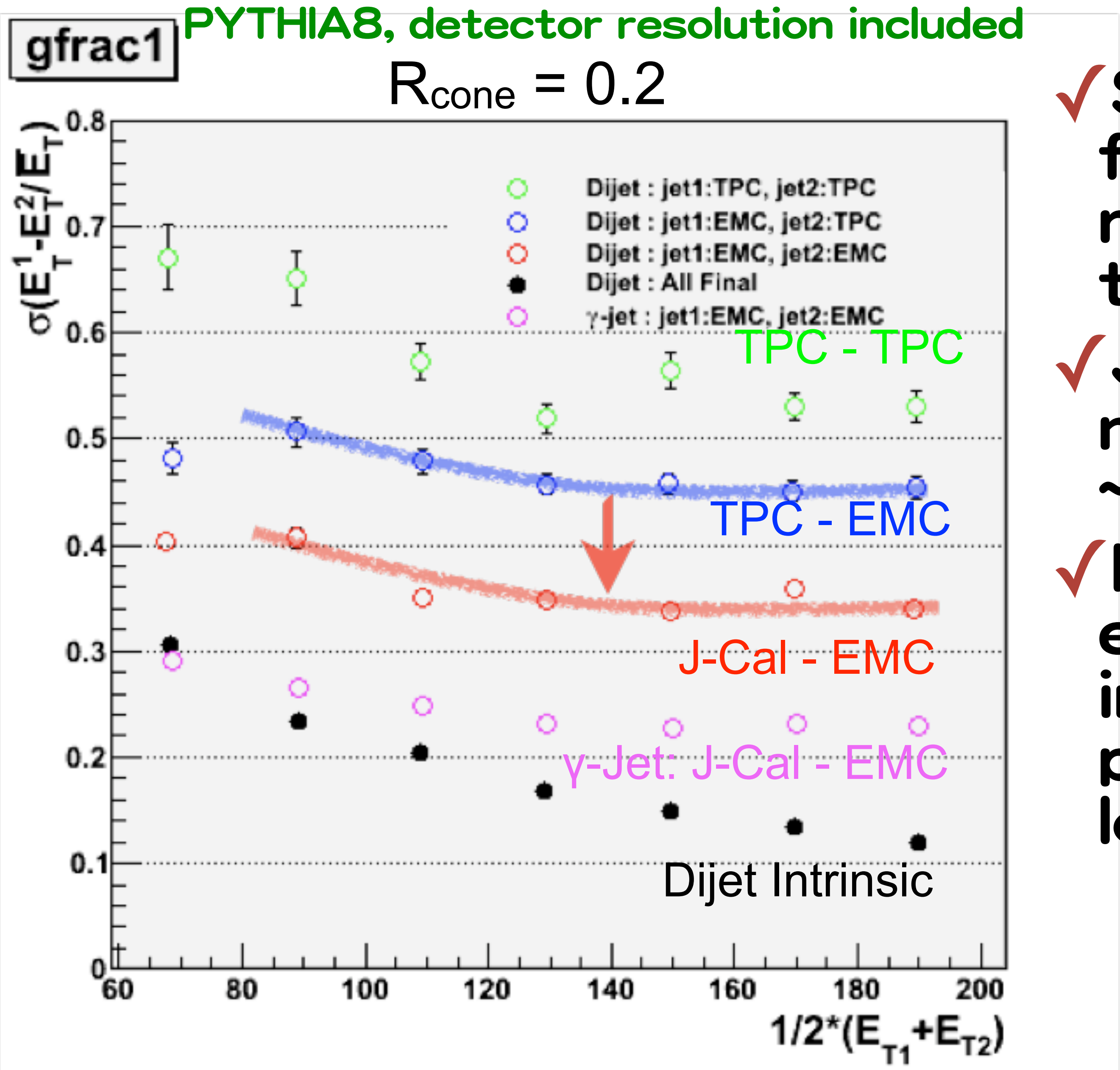
Di-Jet EMC - TPC

Di-Jet TPC - TPC



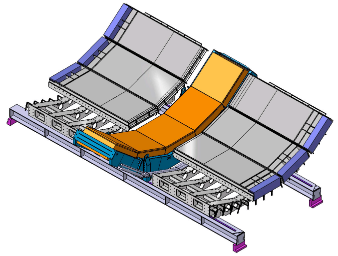
Energy Resolution



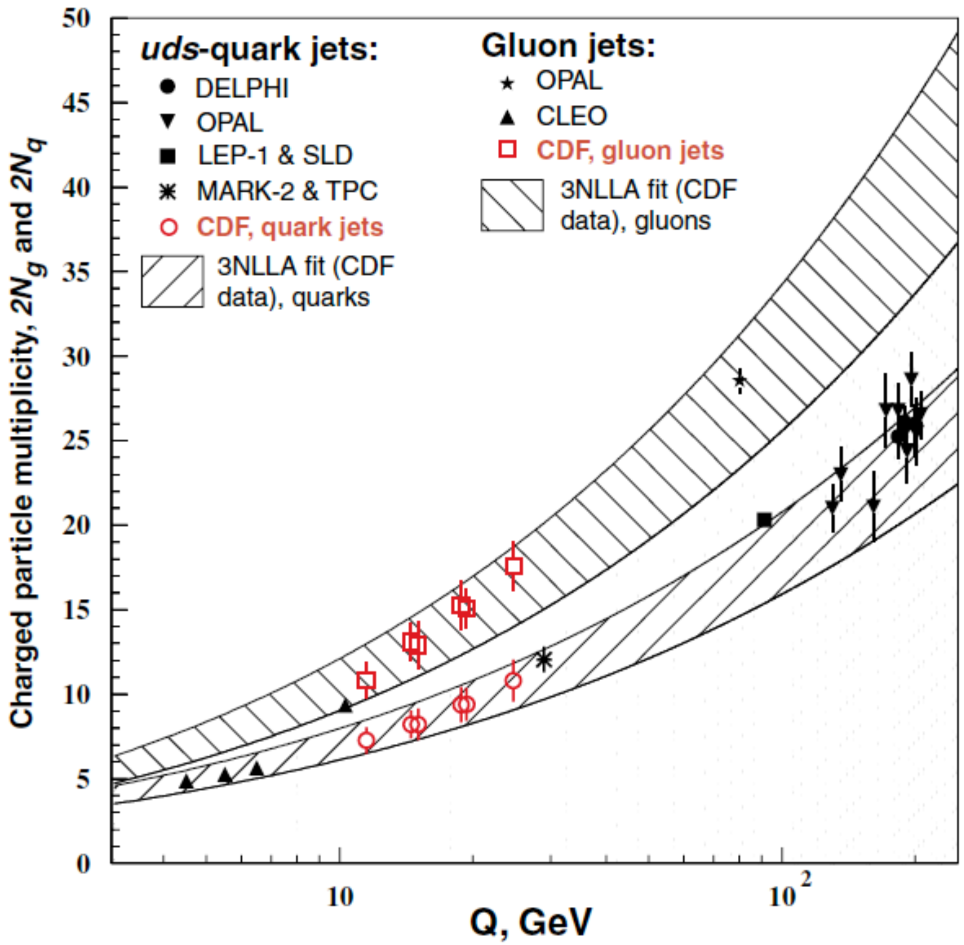


- ✓Statistical fluctuation in neutrals dominates the resolution.
- ✓J-Cal improves the resolution from ~45% to ~35%
- ✓Imbalance in energies provides information on the partonic energy loss.

Fluctuations under total energy conservation

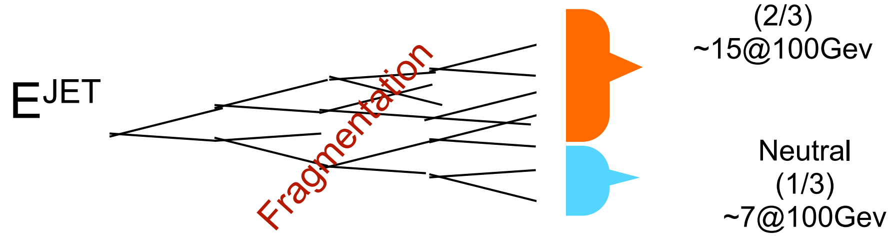


CDF, PRL94(2005)171802



$E^{JET} = E^{CHARGED} + E^{NEUTRAL}$

$dE^{CHARGED} = -dE^{NEUTRAL}$

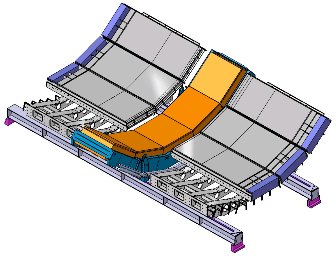


✓ **Statistical fluctuation with total energy limitation**

- **Total jet energy is fixed.**

  ➡ **fluctuation of neutral play significant role**

Jet trigger in Pb+Pb



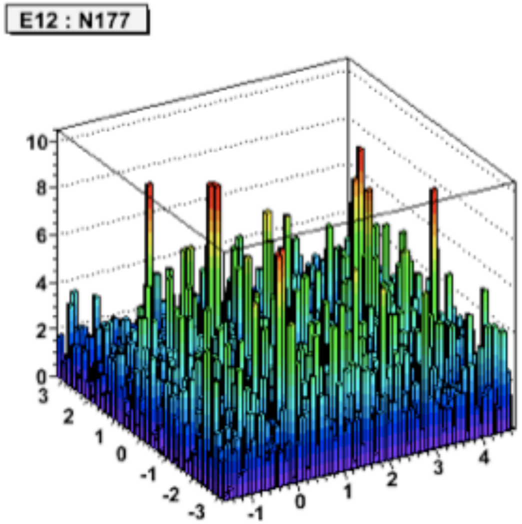
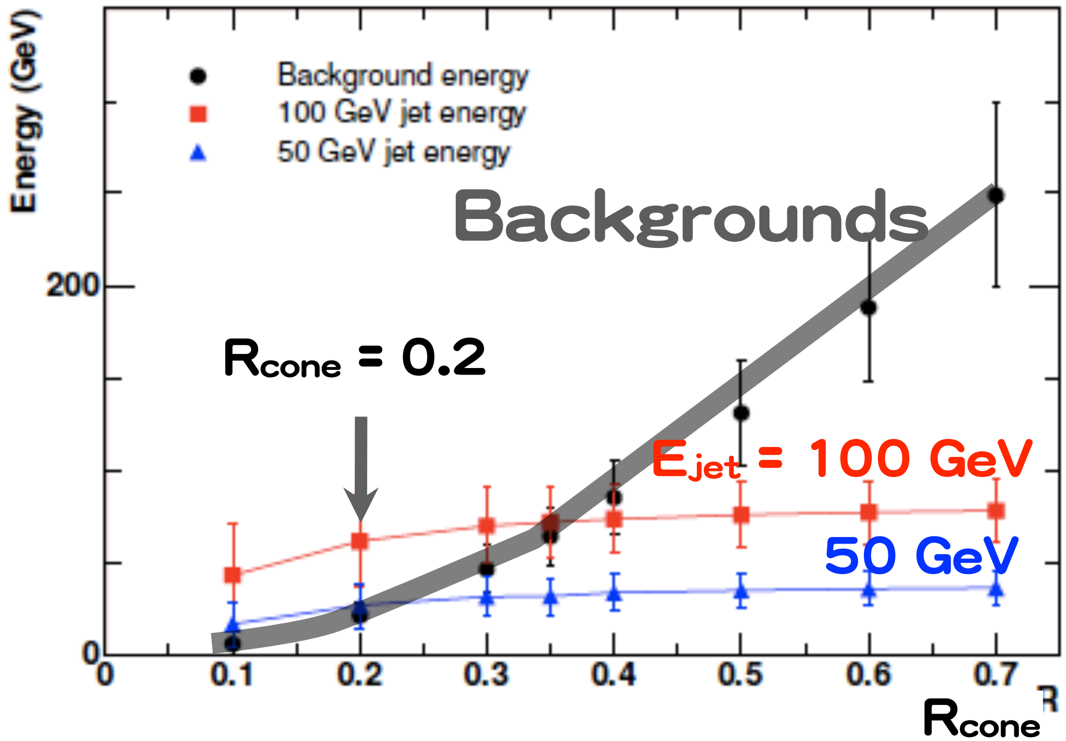
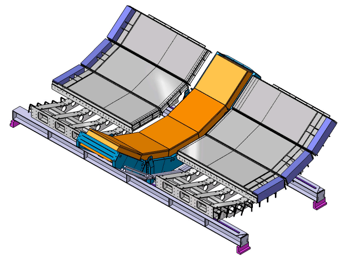


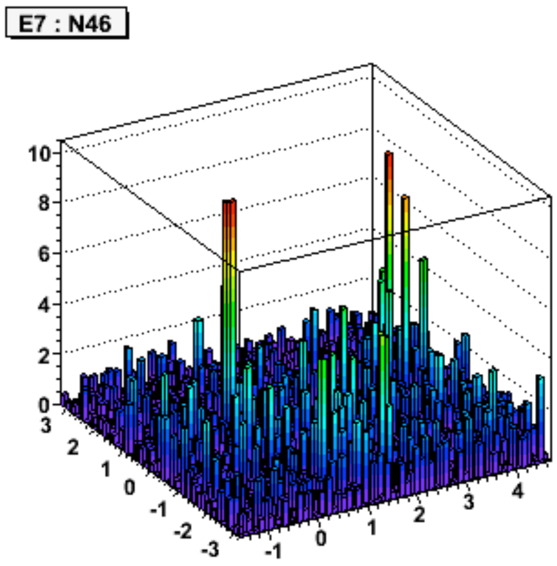
Fig.8.4 of TDR

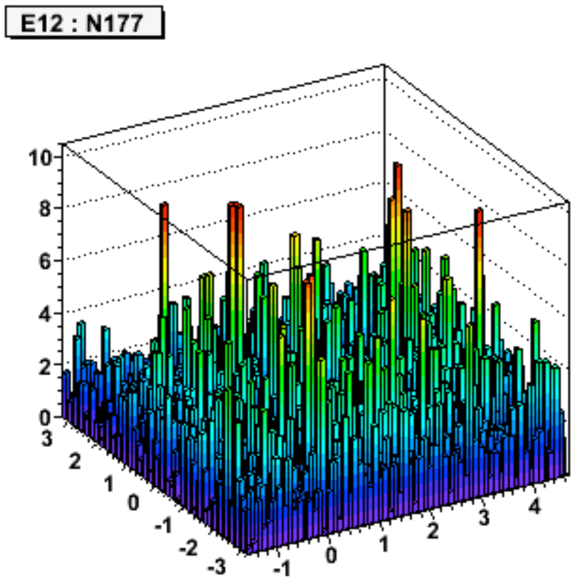


- ✓ With R_{cone} = 0.2, triggering jet of < 50 GeV becomes difficult.
- ✓ Back-to back in phi will improve trigger efficiency

Technical Challenge







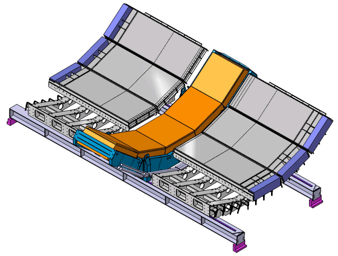
√Backgrounds !

- A lot of mini-jets may sweep away the jet structure.

√Keys are,

- higher the jet energy, S/N ratio improves
  ➡OK as a probe of QGP
- kinematical cleaness of di-jets structure improves the S/N
- But, higher the jet energy, the rate drops !
  ➡Need optimization !

FAQ

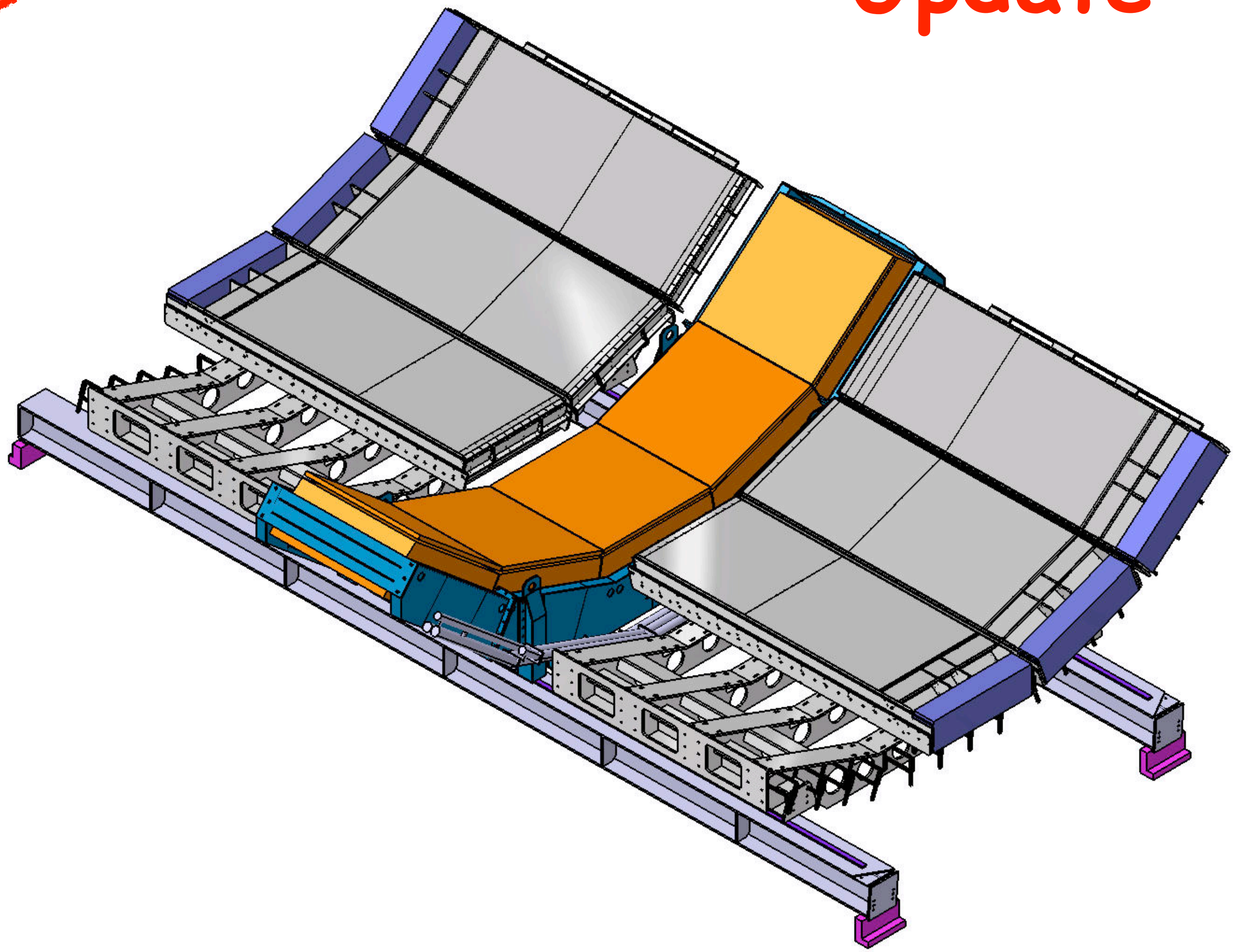


- ✓ Why not with PHOS?
  - For jets, eta coverage of PHOS is too narrow.
    - ➡Cone radius of >0.2 needed
    - ➡Dijet w. r_{cone} = 0.4 can be done with B6 config.
- ✓ Why you don't extend PHOS?
  - Too expensive
  - Prefer uniform coverage
- ✓ No γ/π^0 separation above ~10GeV w. EMcal. what you gonna do?
  - rates of γ/π^0 differ by ~10^3
  - Things are tough. Systematic meas. and PHOS helps to entangle these.

Details by T. Chujo, T. Horaguchi and H. Yokoyama

As a summary

JCal Progress and Status Update



T.M. Cormier for the JCal Collaboration

19-10-2009

JCal Collaboration

China
Huazhong Normal University

Finland
University of Jyvaskyla

France
LPSC Grenoble, Subatech Nantes, IPHC Strasbourg

Italy
INFN Catania, LNF Frascati,

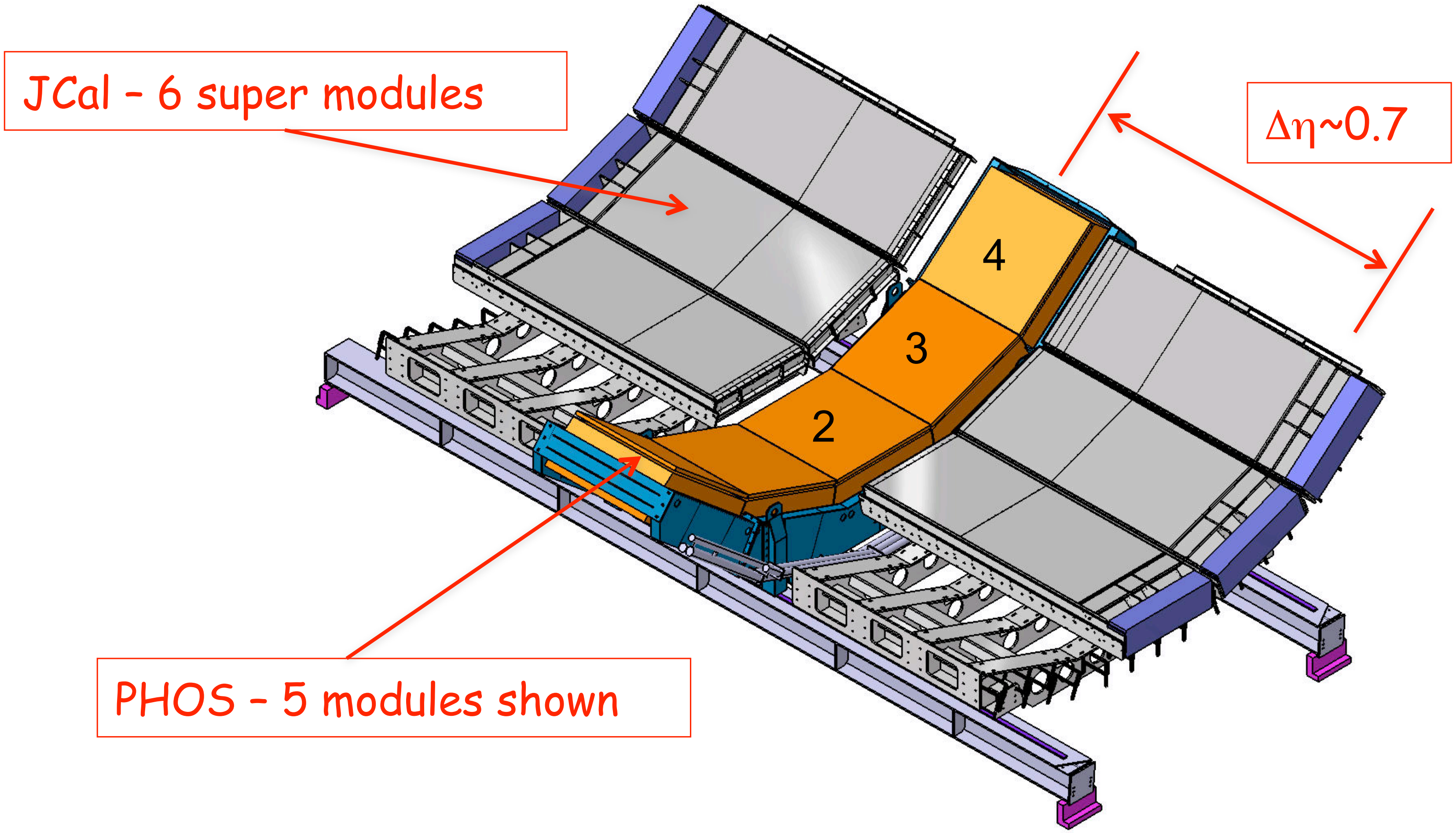
Japan
Hiroshima University, University of Tokyo, University of Tsukuba,

Switzerland
CERN

USA
Lawrence Berkeley National Laboratory, Wayne State University, University of Houston, University of Tennessee, Lawrence Livermore National Laboratory, Yale University, Oak Ridge National Laboratory, Creighton University, Cal Poly San Luis Obispo, Purdue University

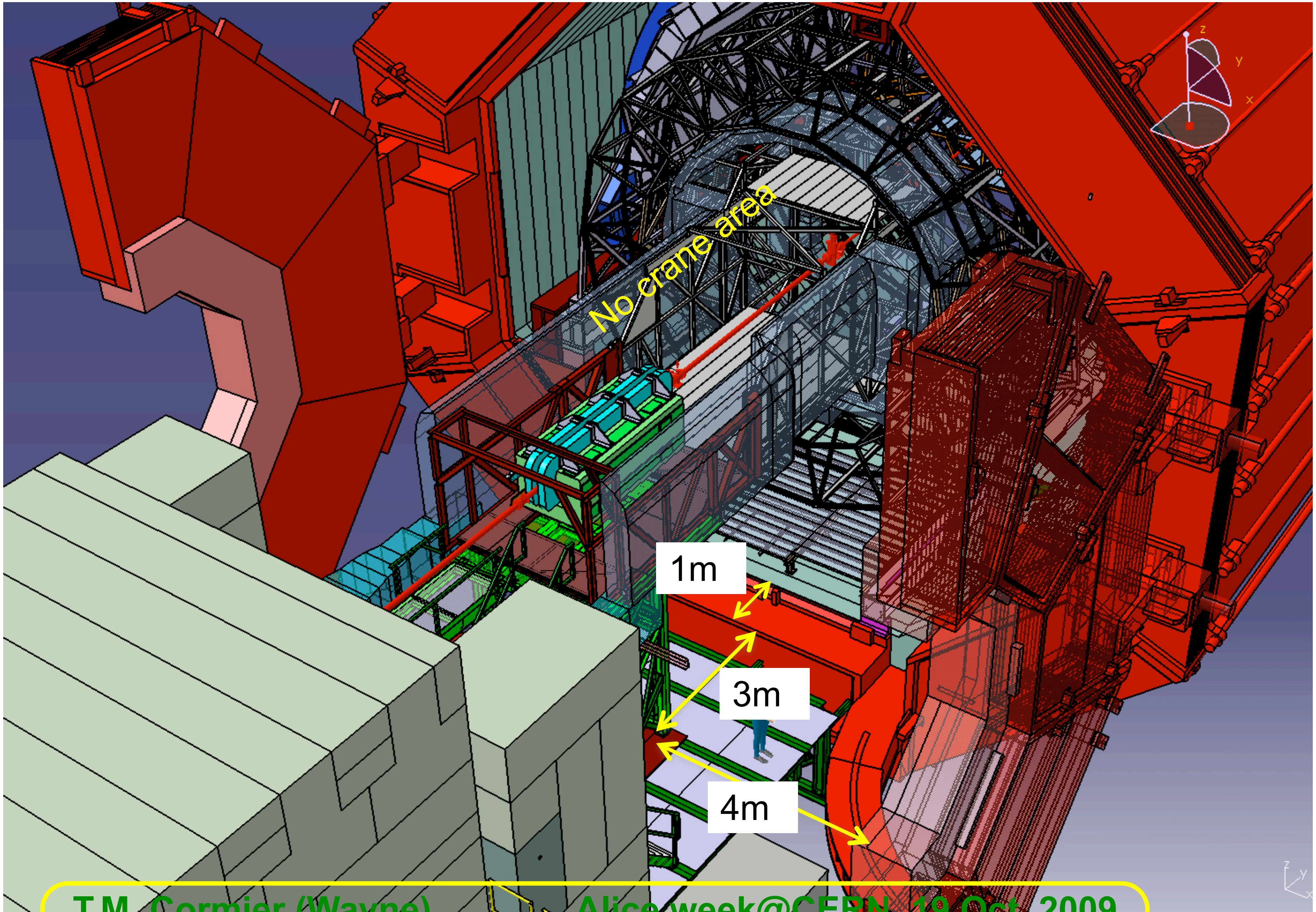
JCal Conceptual Design

1. B6 Configuration Now Selected

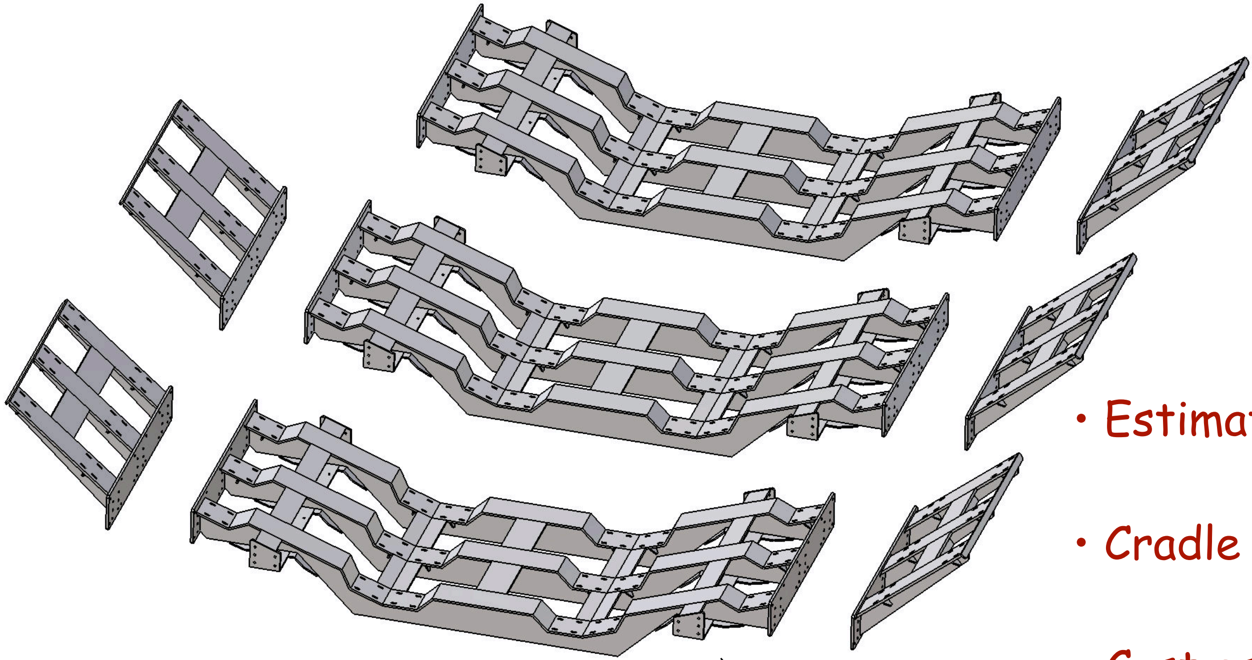


B6 Configuration allows largest possible jet radii in JCal

First Consequence:
Mini Frame Severely Limits Access

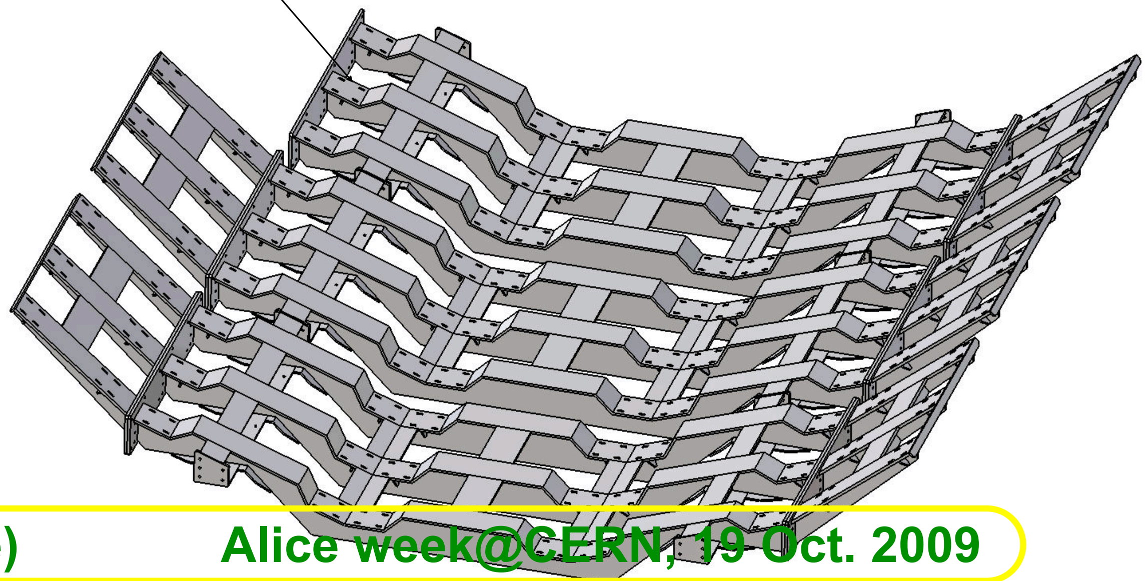


Common PHOS-JCal cradle



- Estimated weight of 1 transverse row 4.3 t
- Cradle total weight : 13 t
- Cost estimation (total support cradle) 150 – 180 k€
- Availbility : 6 months after order,

- The system features 3 transverse rows, each made of 3 elements, a central one, and 2 side ones.
- Raw material : SS 304 LN



Funding Status, Near term plans and schedule

Japan: Funding in place and preparations for module construction start well under way – critical path - scintillator delivery

China: Wuhan. Partial funding promised. Module construction start possible as soon as April. Critical path - A lot of preparatory work still needed, finalize funding

France: Subatech, Grenoble and Strasbourg. Funding discussions with IN2P3 November 13th. Construction and assembly facilities ready. Critical path - finalize funding

USA: Funding discussion with DOE November 30th. Construction and assembly facilities ready. Critical path - finalize funding

Funding Status, Near term plans and schedule

Schedule Objective: completion of full JCal in time for winter 2010 – 2011 shutdown

Schedule realities:

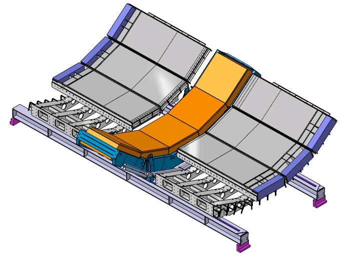
- completion of all detailed design and integration work including new PHOS rail and cradle is on schedule. No "show stoppers" foreseen in the remaining work. Procurement process of cradle and new PHOS rail must start very soon.

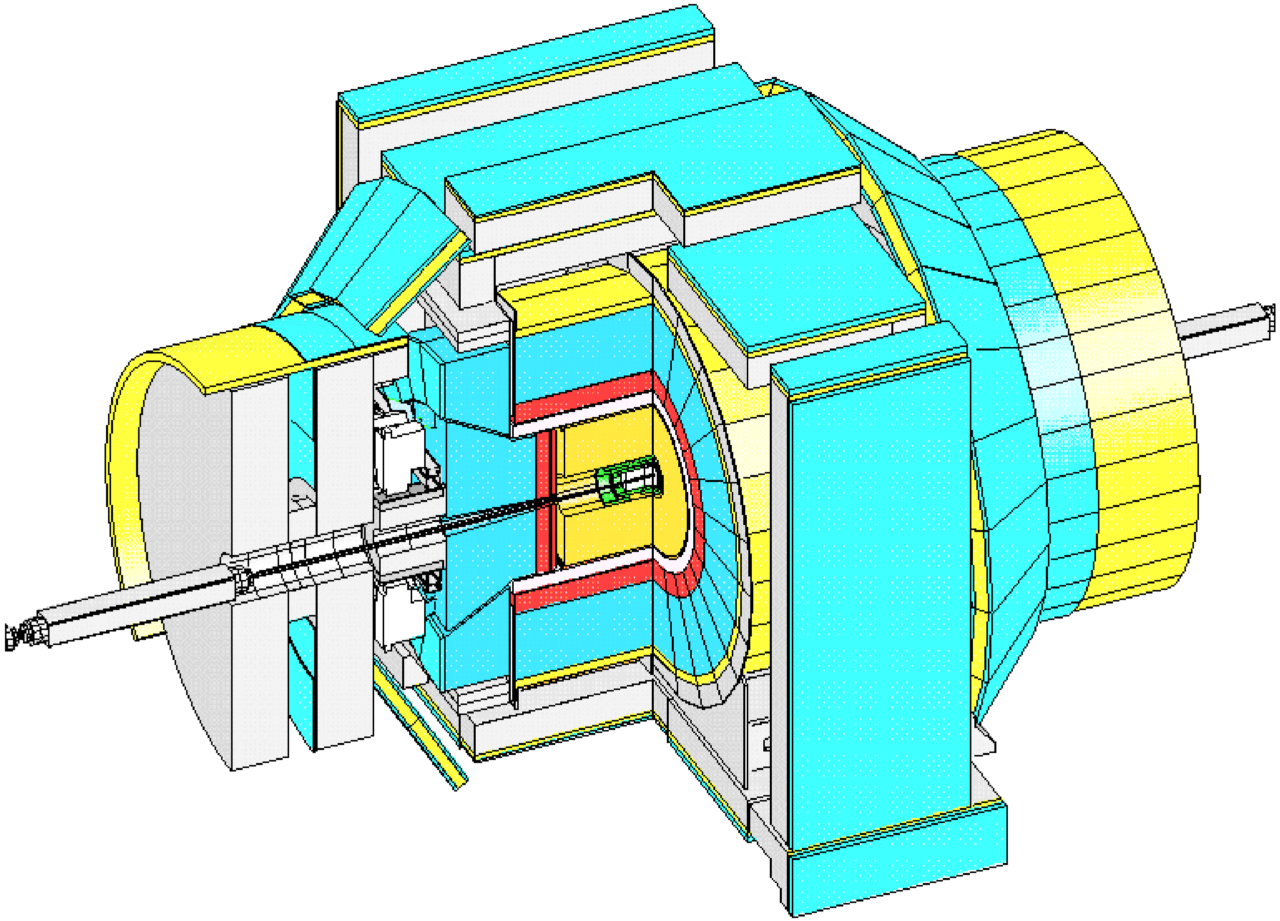
- Most of the required detector production capability is already in place. The balance can easily be added in time for a late summer 2010 completion

- Key requirement for success is funding in place by start of 2010

As an epilogue

ALICE like CDF



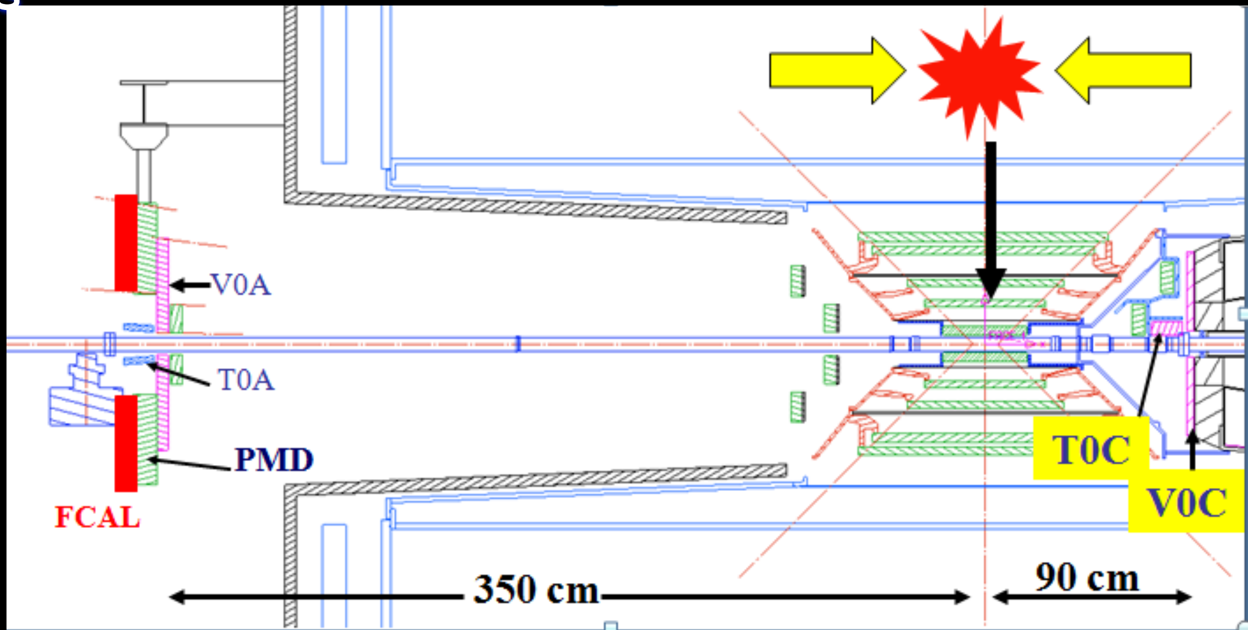


http://www-cdf.fnal.gov/events/detintro.html

- ✓ Full coverage
  - Plug
  - Central
- ✓ Azimuthally symmetric.

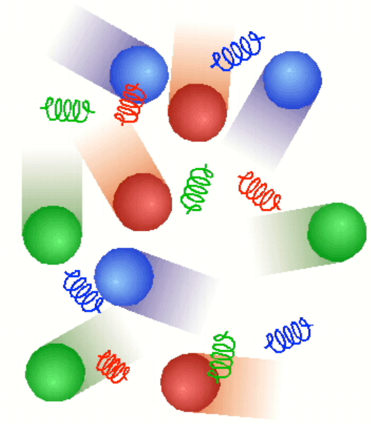
Forward calorimeter

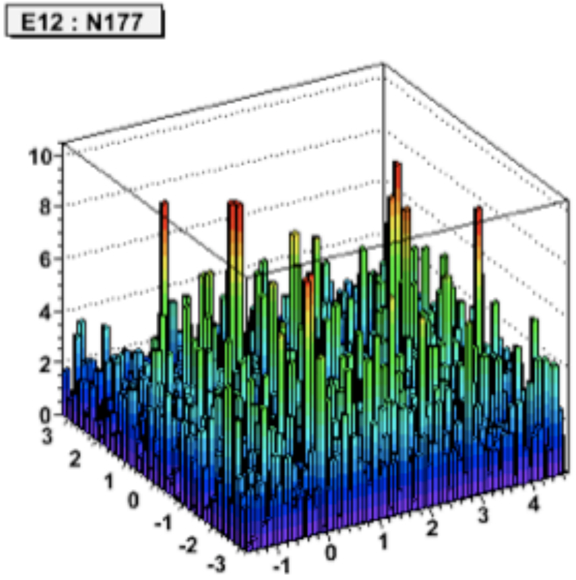
- rich physics menu
  - high gluon density physics
    - shadowing
    - CGC
  - event plane, centrality
  - limiting fragmentation
  - diffractive physics?
  - forward π^0 in pp



- Technology?
  - Si-W? (à la PHENIX Nosecone Calorimeter)
  - Pb-scint? (à la ALICE EMCal)

Backups

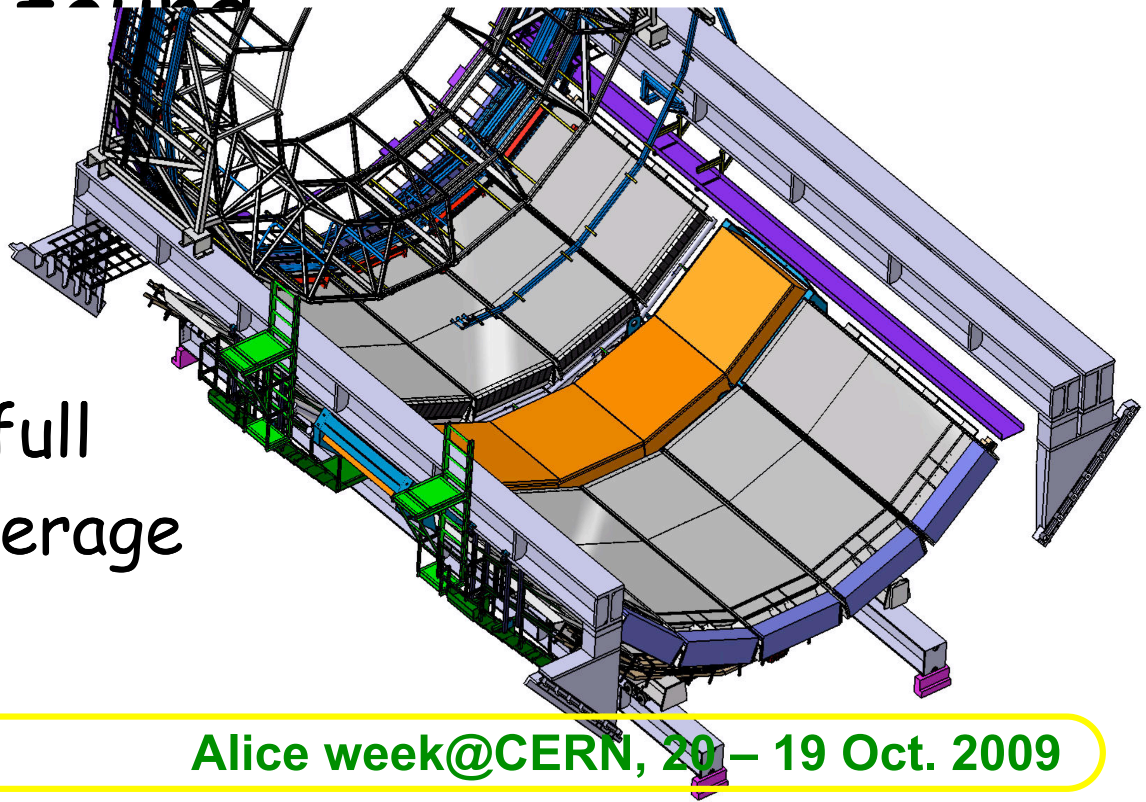


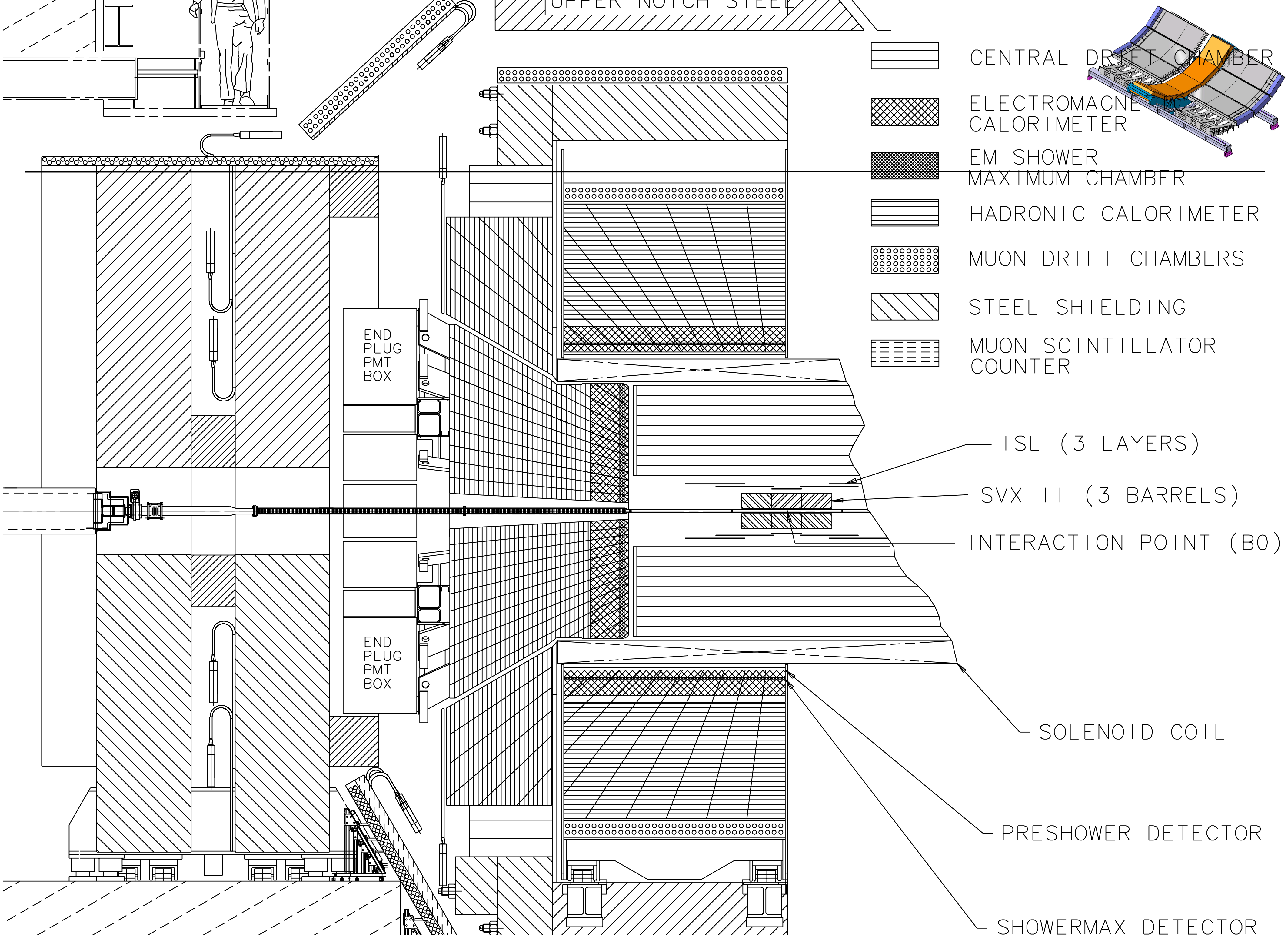


Note: The scope of the JCal project includes replacing only a single PHOS rail.

If Future addition of other HEAVY detectors is contemplated, then both rails should be replaced at this time providing funding can be found.

Example of HEAVY:
A first step toward full
Azimuthal EMCal coverage





UPPER NOTCH STEEL
CENTRAL DRIFT CHAMBER
ELECTROMAGNETIC CALORIMETER
EM SHOWER MAXIMUM CHAMBER
HADRONIC CALORIMETER
MUON DRIFT CHAMBERS
STEEL SHIELDING
MUON SCINTILLATOR COUNTER
END PLUG PMT BOX
END PLUG PMT BOX
ISL (3 LAYERS)
SVX II (3 BARRELS)
INTERACTION POINT (B0)
SOLENOID COIL
PRESHOWER DETECTOR
SHOWERMAX DETECTOR