Jet Energy Loss at LHC

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In this work, the jet energy loss is analyzed using a monte carlo method. The data from LHC at $\sqrt{s_{\rm NN}} = 2.76$ TeV and 5.02 TeV is used to extract the perameters for specific energy loss of jets inside QGP. Our calculations give good discription of the nuclear modification factor and asymmetry measurements at LHC.

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I. INTRODUCTION

II. JET ENERGY LOSS

The Jet p_T distribution in pp collisions is measured by CMS and ATLAS experiments at LHC. We fit the jet p_T distribution with Hegedorn function.

$$f(p_T) = \frac{dn}{dy}(1+\frac{p_T}{p_0})^{-n} \tag{1}$$

The Jet p_T is generated from the fitted function. Now the QGP medium is assumed as a static sphere. The radius of the medium is related to the centrality of the collision as

$$R = R_A\sqrt{\frac{\rm N_{part}}{2A_m}} \tag{2}$$

here R_A and A_m are the radius and Atomic mass of the Pb nucleus. The $\rm N_{Part}$ is the number of participant in that particular collison class.

The cordinate r and ϕ are then generated randomly. The maximum value of the cordiante r is the radius R of the system formed. We assume that both partons move back to back before fragmenting to jets.

The pathlenghts d_1 and d_2 can be calculated as follows

$$\begin{aligned} d_1 &= \sqrt{R^2 - r^2\ sin(\phi)} - r\ cos(\phi) \\ d_2 &= \sqrt{R^2 - r^2\ sin(\pi+\phi)} - r\ cos(\pi+\phi) \end{aligned} \tag{3}$$

The specific energy loss (energy loss per unit length), dE/dx have following relation with the p_T of jet

$$\frac{dE}{dx} = Mp_T^{\alpha} \tag{4}$$

Here M and α are two parameters. We want to constrain these parameters with the help of LHC measurements and see their variations as a function of collision centrality and per nucleon energy.

The total energy loss for a jet then can be calculated as

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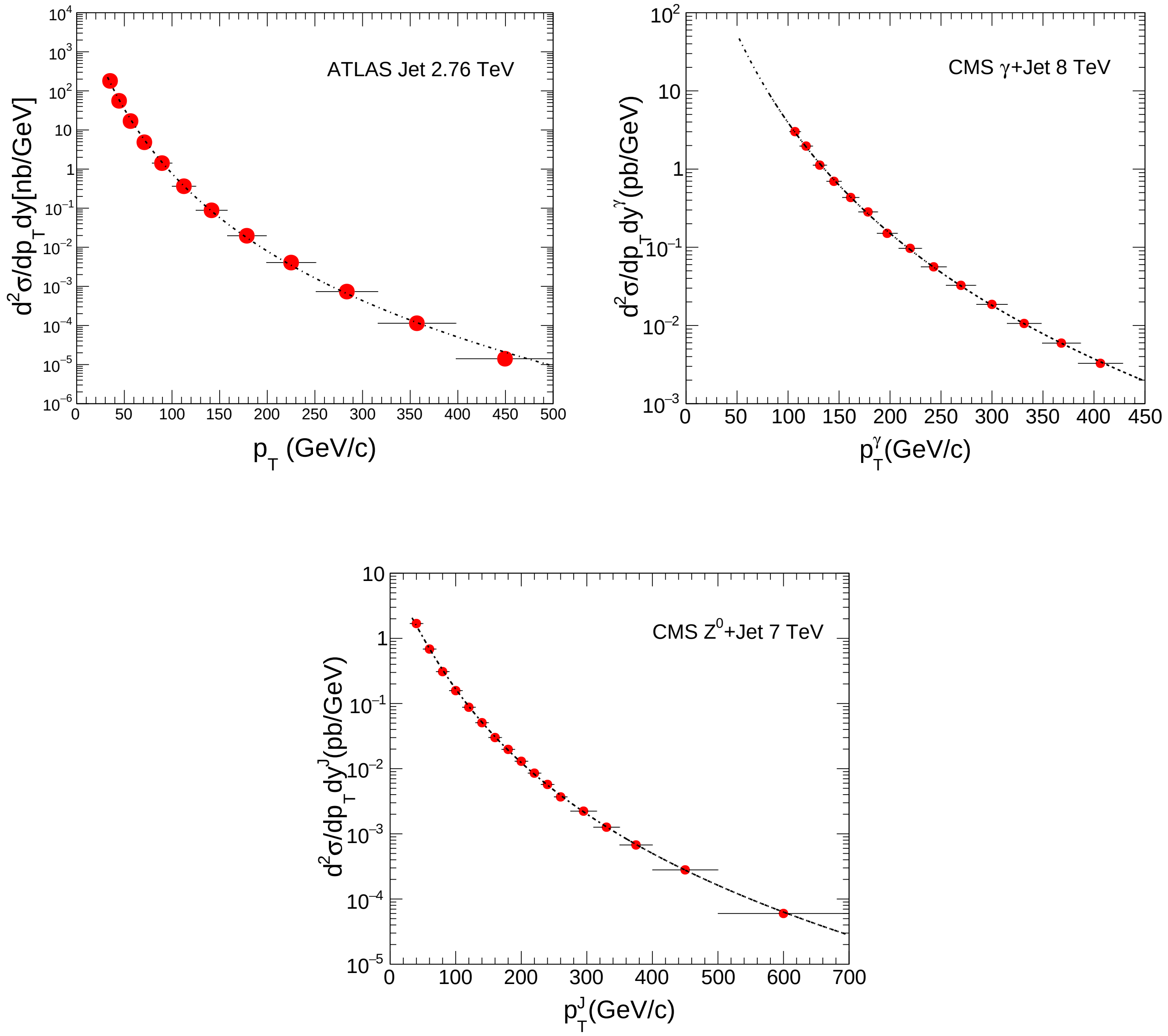

FIG. 1: (Color online) Jet yields as a function of jet p_T measured by ATLAS and CMS experiments. These yields are used in our calculations to generate the pp spectrum.

$$\Delta E = \frac{dE}{dx} \times d \tag{5}$$

where d is the pathlenght of the jet inside the medium. If ΔE_1 and ΔE_2 are the energy loss for both the jets respectively we can get the final jet energies as

$$\begin{aligned} p_{T1} &= p_T - \Delta E_1 \\ p_{T2} &= p_T - \Delta E_2 \end{aligned}$$

and the Jet asymmetry can finally be calculated as

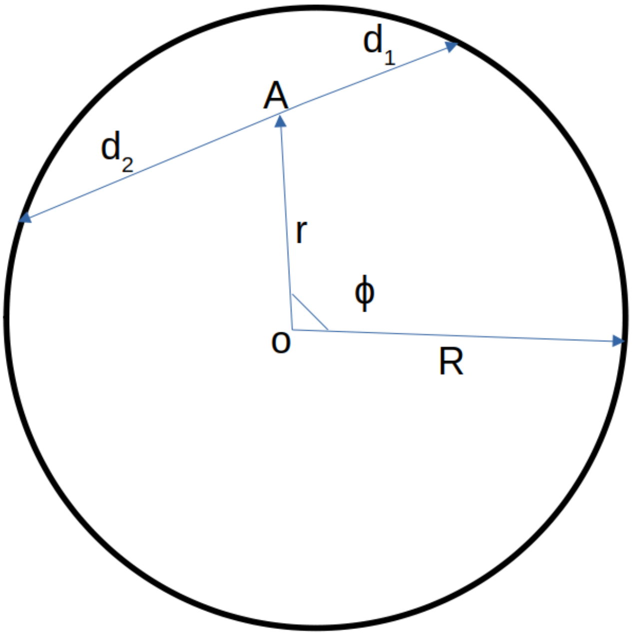

FIG. 2: (Color online) Figure showing the diagram of a diJet system.

$$A_J = \frac{p_{T1} - p_{T2}}{p_{T1} + p_{T2}} \tag{6}$$

We also calculate the nuclear modification factor R_{AA} for Jets. ATLAS and CMS experiments measured the R_{AA} for the jet at $\sqrt{s_{NN}}$ 2.76 TeV and 5.02 TeV respectively. To calculate the R_{AA} first jet p_T is generated randomly from the fitted function of the measurement of the p_T in pp collisions. Then two jets of this p_T (above the threshold) are filled in a histogram. This histogram works as denominator of the R_{AA} calculation. For the numerator energy loss is implemented as describe above and the ratio gives us the calculated R_{AA}.

III. RESULTS AND DISCUSSIONS

IV. SUMMARY

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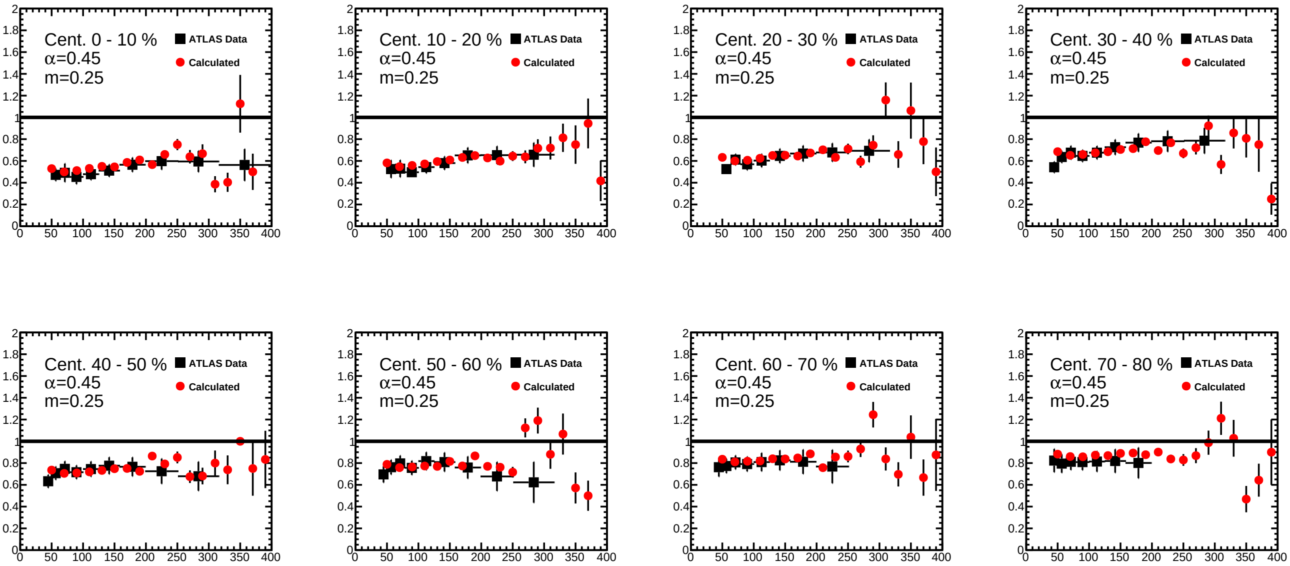

FIG. 3: (Color online) Jet R_{AA} as a function of jet p_T in several collision centrality bins measured by the ATLAS experiment. The measurement is compared with our model calculations.

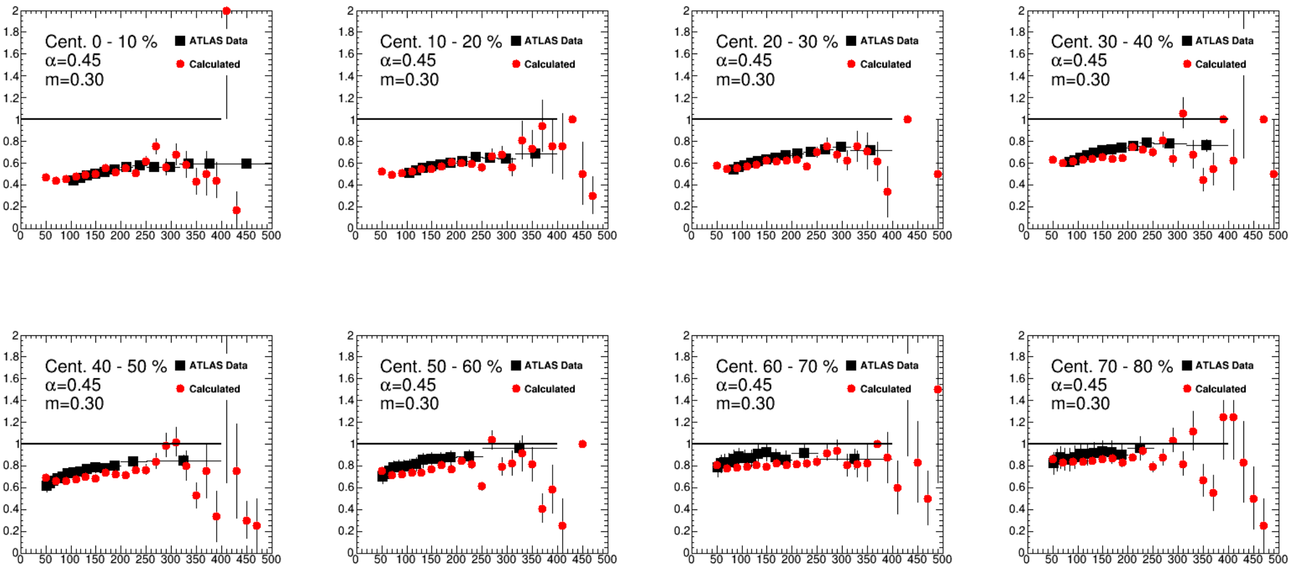

FIG. 4: (Color online) Jet R_{AA} as a function of jet p_T in several collision centrality bins measured by the CMS experiment at 5.02 TeV. The measurement is compared with our model calculations.

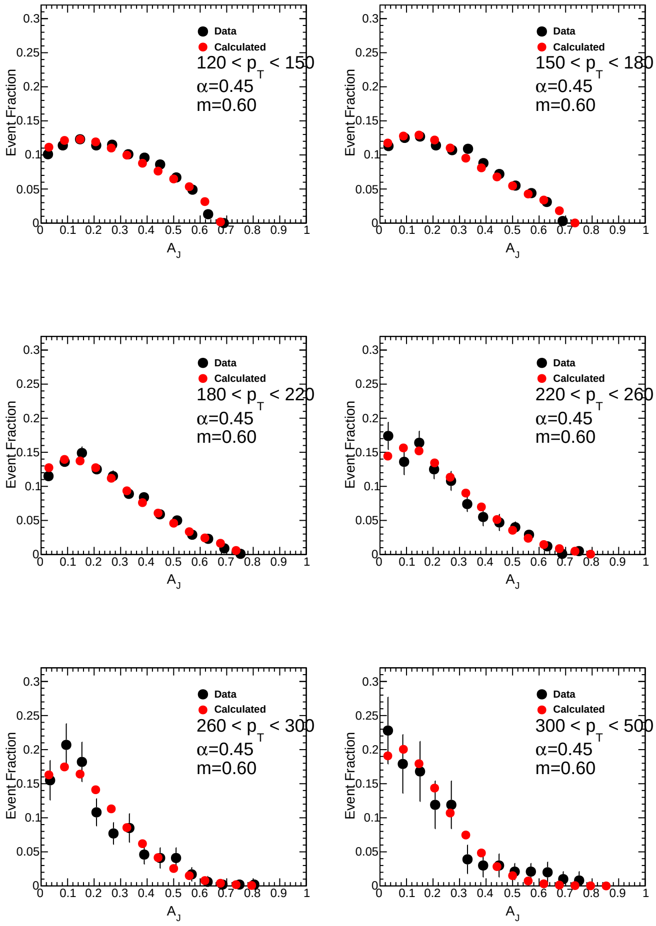

FIG. 5: (Color online) DiJet asymmatry as a function of jet p_T measured by CMS experiment compared with our calculations.

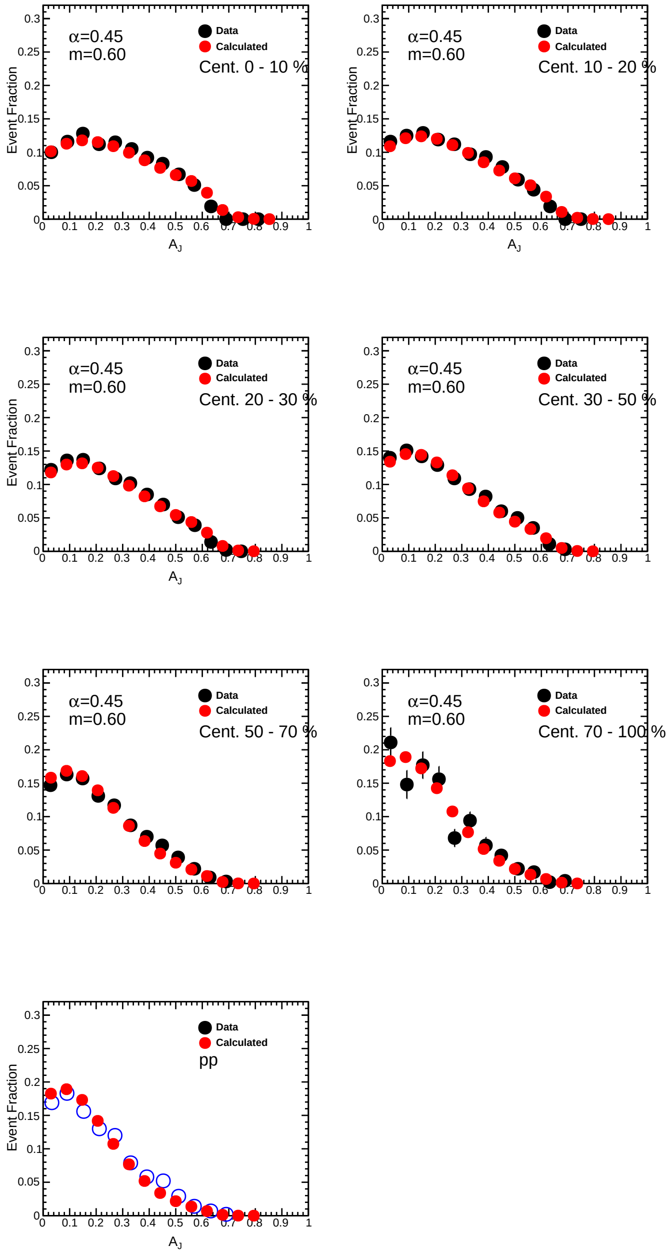

FIG. 6: (Color online) DiJet asymmetry as a function of collision centrality measured by CMS compared with our calculations.

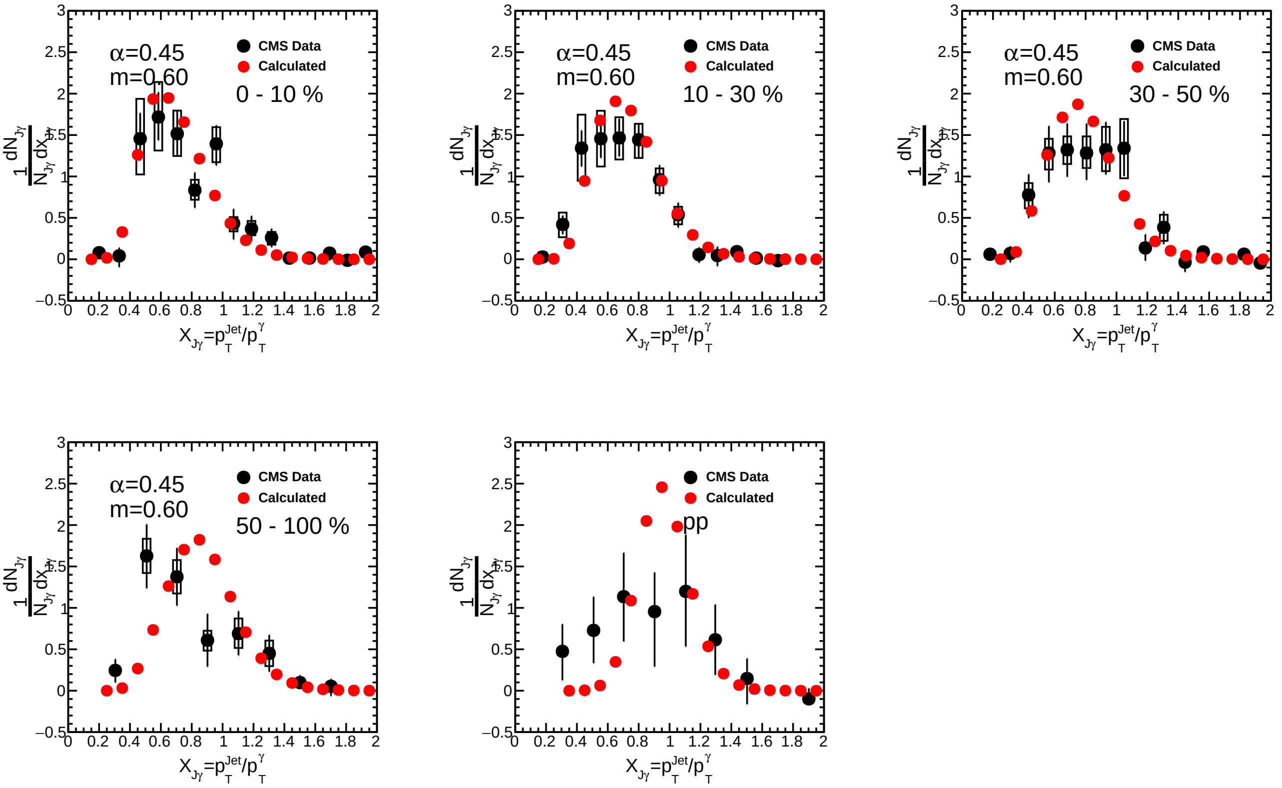

FIG. 7: (Color online) Jet asymmetry as a function of collision centrality in gamma + Jet events as measured by CMS experiment. The data is compared with our calculations.

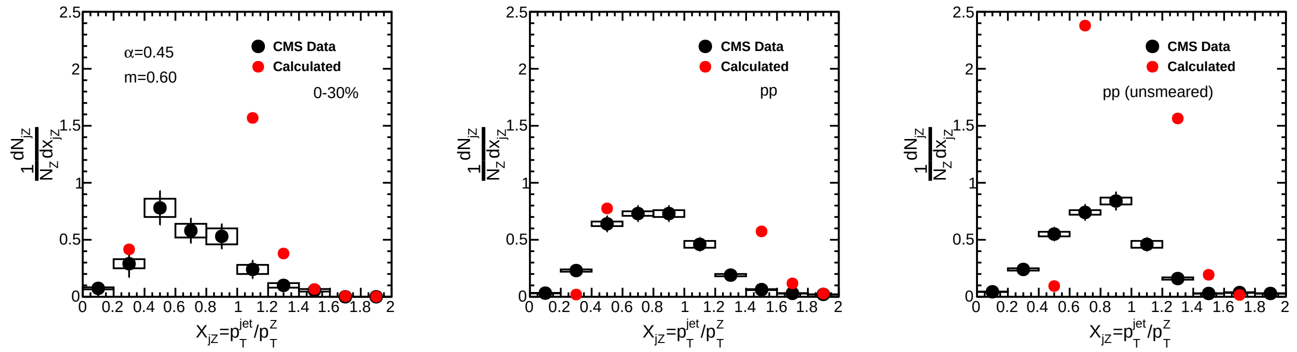

FIG. 8: (Color online) (Color online) Jet asymmetry as a function of collision centrality in Z^0 + Jet events as measured by CMS experiment. The data is compared with our calculations.