APPENDIX A Matlab Code

A.1 Flow Code

File: shockpos.m

```
function [] = shockpos(filename,arb1,arb2)
filenames = filename(1:8)
outputfilename = sprintf('sp%s',filenames)

% Read in the raw data; p1 and p2 have been reduced already
[bal,p1,p2,time,timer] = funprocesspress2(filename);
[m n] = size(p1);
figure
hold on
grid on
plot(p1(1:1000))
[x,y] = getpts(gcf);
shockstart = round(x(1));
shockend = round(x(2));
shock(1:shockstart-1,1) = 0;
shock(shockstart:shockend,1) = 1;
shock(shockend +1:m,1) = 0;
```

```
meany = mean(y);

[indexp1] = trigger(p1,meany);
[indexp2] = trigger(p2,meany);
dt = (indexp2-indexp1)/1e6;
vs = 0.626./dt %0.626 must never change because this is the distance between transducers
close
save(outputfilename)
```

File: funprocesspress2.m

```
function [bal,press1,press2,time,timer] = funprocesspress2(filename)
% For doing preprocessing pressure tests
% filename = 'name.asd'
[data,time,samplerate] = readasd(filename,3);
bal = data(:,1);
% press1 = data(:,2);
pressure1l(:,1)=((data(:,2))).*244760;
% press2 = data(:,3);
% pressure2l(:,1)=(zero100data(data(:,3))).*249450;
pressure2l(:,1)=((data(:,3))).*249450;
[press1] = sample10(pressure1l);
[press2] = sample10(pressure2l);
[timer] = sample10(time);
```

File: characterq4b.m

```
function [pts2lin,timelin] = characterq4b(ts1press,time,p0,t0,vs,shock)
% diss between ts1 and ts2 = 0.626m
diss = 0.599;
```

```
a0 = 20*(t0)^0.5;
rho0 = p0/(287*t0);
pressure1 = ts1press+p0;
[m n]=size(pressure1);
for i = 1:m
    a(i,1) = a0.*(pressure1(i,1)./p0)^0.14286;
    t(i,1) = t0.*(pressure1(i,1)./p0)^0.28571;
    v(i,1) = 5*a0*(((pressure1(i,1)./p0)^0.14286)-1);
    cplus(i,1) = 1/(a(i,1)+v(i,1));
    timets2c(i,1) = cplus(i,1)*diss+time(i);
end
joinc(1:m,1) = 1;
% figure
% plot(cplus)
% figure
% plot(gradient(cplus))
% work out the first intersection point
[minx(1),index] = intersection(cplus,time);
if minx(1) >= diss
    for i = 1:m
        timets2(i,1) = cplus(i,1)*diss+time(i);
    end
    [r s] =size(cplus);
    for i = 1:r
        pts2(i) = p0*((1/(a(1,1)*cplus(i,1))+5)*0.166667)^7;
    end
else
    step = 1;
    for i = 1:m
        timeminx(i,1) = cplus(i,1).*(minx(step)-0)+time(i);
    end
```

```
    [cplus,timeminx,joinc,shock] =
    cplusjoin6b(cplus(:,1),timeminx,joinc,index,p0,a0,t0,vs,shock);
    while minx(step) < diss
        minx(step)
        step = step + 1;
        cplusprev = cplus(:,1);
        timeminxprev = timeminx;
        [incrminx(step),index] = intersection(cplusprev,timeminxprev);
        minx(step) = incrminx(step) + minx(step-1);
        for i = 1:m-step+1
            timeminx(i,1) = cplusprev(i,1).*(minx(step)-minx(step-1))+timeminxprev(i,1);
        end
        [cplus,timeminx,joinc,shock] =
        cplusjoin6b(cplusprev,timeminx,joinc,index,p0,a0,t0,vs,shock);
    end
    % At this stage minx is greater than diss so values from the last step
    % must be used for the calculation
    final = step -1;
    timets2 = cplusprev(:,1).*(diss-minx(final))+timeminxprev(:,1);
    [r s] = size(cplusprev(:,1));
    for i = 1:r
        pts2(i) = p0*((1/(a(1,1)*cplusprev(i,1))+5)*0.166667)^7;
    end
end
timestart = (ceil(timets2(1,1).*1e6))./1e6;
timeend = (floor(timets2(r,1).*1e6))./1e6;
timelin = timestart:1e-6:timeend;
[p q] = size(timelin);
for i = 1:q
    pts2lin(i) = interp1(timets2,pts2,timelin(i));
end
```

```
% plot(cplus)
% plot(gradient(cplus))

% This code takes the final cplus data at ts2 and works out the pressure
% using the isentropic assumption
```

File: intersection.m

```
function [minx,index] = intersection(cplus,time)
% The sole purpose of this function is to take the time/characteristic
% information at a particular position and find the intersection positions
% and then to find the minimum intersection position and its index
% only valid for diss between ts1 and ts2 less than 1e3 (1km)
[m n] = size(cplus);
for i = 1:m-1
    den = (cplus(i,1)-cplus(i+1,1));
    if den > 0
        xint(i,1) = (time(i+1)-time(i,1))/den;
    else
        xint(i,1) = 1e3;
    end
end

% find the minimum
[minx,index] = min(xint);

% plot(xint,'.')
% for i =1:m-1
%   if and(xint(i,1) <= minx,xint(i,1) > 0)
%       minxlast = minx;
```

```
%       minx = xint(i,1);
%       index = i;
%       % index refers to the intersecting char with min index
%   end
% end
```

File: cplusjoin6b.m

```
function [cplusout,timeminxout,joincout,shock] =
cplusjoin6b(cplusin,timeminxin,joincin,index,p0,a0,t0,vs,shock)
% All this does is reduce the matrix - nothing else!
% This function takes a cplus/timeminx/joinc matrix where 2 characters
% have intersected at xmin/index
% and combines them giving a reduced matrix (1 less) with 1 stronger characteristic
[m n] = size(cplusin);
timeminxout(1:index-1,1) = timeminxin(1:index-1,1);
joincout(1:index-1,1) = joincin(1:index-1,1);
cplusout(1:index-1,1) = cplusin(1:index-1,1);
shock(1:index-1,1) = shock(1:index-1,1);

timeminxout(index,1) = timeminxin(index,1);

if and(cplusin(index,1) > 2.8e-3,cplusin(index+1,1) < 2.7w-3) ==1
if or(shock(index,1)==1,shock(index+1,1)==1) ==1
     shock(index,1) = 1;
     cplusout(index,1) = 1/vs;
else
    cplusout(index,1) = cplusin(index+1,1);
end
```

```
joincout(index,1) = joincin(index,1)+1;

timeminxout(index+1:m-1,1) = timeminxin(index+2:m,1);
joincout(index+1:m-1,1) = joincin(index+2:m,1);
cplusout(index+1:m-1,1) = cplusin(index+2:m,1);
shock(index+1:m-1,1) = shock(index+2:m,1);
```

File: flowprop.m

```
function [re,coefconv,cd_hoe,mach,timets2] = flowprop(pressure,p0,t0,eps)
% function [re,cd,coefconv,timets2] = flowprop(pressure,time,p0,t0)
% diss between ts1 and ts2 = 0.626m
% d = maximum diameter
d = 50e-3;
a0 = 20*((t0)^0.5);
rho0 = p0/(287*t0);
pressure1 = pressure+p0;
[m n] = size(pressure1)
for i = 1:m
    a(i,1) = a0.*(pressure(i,1)./p0)^0.14286;
    t(i,1) = t0.*(pressure(i,1)./p0)^0.28571;
    rho(i,1) = rho0.*(pressure(i,1)./p0)^0.71429;
    v(i,1) = 5*a0*(((pressure(i,1)./p0)^0.14286)-1);

    %   cplus(i,1) = 1/(a(i,1)+v(i,1));
    %   timets2(i,1) = cplus(i,1)*0.626+time(i);
    %   break
    coefconv(i,1) = pi*(d^2)*0.125*rho(i,1)*(v(i,1))^2;
    viscosity(i,1) = ((t(i,1)/273)^1.5)*((273+110.4)/(t(i,1)+110.4))*0.0000171;
    re(i,1) = (rho(i,1)*v(i,1)*d)/viscosity(i,1);
```

```
    mach(i,1) = 451.3338/sqrt(1.4*287*t(i,1));
    cd_hoe(i,1) = 2.1*(sin(eps)^2)+0.5*(sin(eps)/((mach(i,1)^2)-1)^(0.5));

end
```

A.2 SWDB Code

File: zero100data.m

```
function [zerod] = zero100data(data)
offset = mean(data(1:100));
zerod = data-offset;
```

File fullpolyfit2.m

```
function [smooth,diff] = fullpolyfit2(data,time,polyorder,sizepoly)
data = transpose(data);
[r,c] = size(data);
sizepoly = sizepoly;
a = 1;
b = sizepoly;
initpoly = polyfit(time(a:b),data(a:b),1);
for i = a:b
    zerotime(i,1) = -time(b-i+1+1);
    zerodata(i,1) = polyval(initpoly,zerotime(i));
end
timel(1:sizepoly,1) = zerotime;
timel(1+sizepoly:r+sizepoly,1) = time(1:r);
datal(1:sizepoly,1) = zerodata;
```

```
datal(1+sizepoly:r+sizepoly,1) = data;
for i = 1+sizepoly:r-sizepoly
    a = i-sizepoly;
    b = i+sizepoly;
    poly = polyfit(timel(a:b),datal(a:b),polyorder);
    smooth(i-sizepoly) = polyval(poly,timel(i));
    diffpoly = polyder(poly);
    diff(i-sizepoly) = polyval(diffpoly,timel(i));
end
```

File: sample10r.m

```
function [reduced] = sample10r(data)
% samples every 10th data point
[n m] = size(data);
m10 = m/10;
for i = 1:m10
   reduced(1,i) = data(1,i*10-9);
end
```

File: deconvolution.m

```
function [force,history] = deconvolution(diffc,data)
% data and diffc must be row vectors
% diffc is the unit impulse response of the system
[a,b] = size(diffc);
[e,f] = size(data);
p = [b f]
q = min(p);
% diffc = diffc./5e8;
```

```
r = q-10;
data = data-data(1,1);
force(1,1) = data(1,1)/diffc(1,1);
for i = 1:r
   for j = 1:i
      rdiffc(j,1) = diffc(1,i-j+2);
   end
   history(i) = force(1,1:i)*rdiffc;
   force(1,i+1) = (data(1,i)-history(i))/diffc(1,1);
end
```

A.3 Overall Code

File: readasd.m

```
function [data,time,samplerate] = readasd(filename,nochan)
% function for reading in data from asd file
[a1,samplerate] = textread(filename,'%s %f',1,'delimiter',',','headerlines',5);
[a1,blocksize] = textread(filename,'%s %f',1,'delimiter',',','headerlines',3);
if nochan == 1
   [ch1] = textread(filename,'%f','delimiter',',','headerlines',15);
   data = ch1;
elseif nochan == 2
   [ch1,ch2] = textread(filename,'%f %f','delimiter',',','headerlines',15);
   data(:,1) = ch1;
   data(:,2) = ch2;
elseif nochan == 3
   [ch1,ch2,ch3] = textread(filename,'%f %f %f','delimiter',',','headerlines',15);
   data(:,1) = ch1;
   data(:,2) = ch2;
```

```
    data(:,3) = ch3;
elseif nochan == 4
    [ch1,ch2,ch3,ch4] = textread(filename,'%f %f %f %f','delimiter',',','headerlines',15);
    data(:,1) = ch1;
    data(:,2) = ch2;
    data(:,3) = ch3;
    data(:,4) = ch4;
end

[m,n] = size(data);
if m ~= blocksize
    data = 0
elseif n ~= nochan
    data = 0
end
deltat = 1/samplerate;
totaltime = blocksize*deltat;
timet = 0:deltat:totaltime;
time(1:blocksize,1) = transpose(timet(1:blocksize));
```

File: trigger.m

```
function [index] = trigger(curve,triggerhigh)
% This function reads in a curve
% It compares the value to a predetermined trigger level
% It outputs the index where the curve exceeds the trigger level
% The data must be in a column vector

% Intended for determining the point of a step input i.e. a shock wave
```

```
curve = transpose(curve);
[m,n] = size(curve);
c = 1;
for i = 1:n
    if c == 1
        if curve(1,i) > triggerhigh
            c = 0;
            index = i;
        end
    end
end
```

File: dragb.m

```
function dragb(filename,p0,t0,cone)
filenames = filename(1:8)
outputfilename = sprintf('procb%s',filenames)
outputfilenameb = sprintf('proc%s',filenames)
shockfilename = sprintf('sp%s',filenames)

% eps = half vertex angle of cone (in radians)

if cone == 1
    load cone1;
    eps = 0.527;
else if cone == 2
        load cone2;
        eps = 0.438;
    else if cone == 3
            load cone3;
```

```
            eps = 0.352;
        else if cone == 4
                load cone4;
                eps = 0.263;
            end
        end
    end
end

% load(outputfilenameb)
% read in the raw data; p1 and p2 have been reduced already
[bal,p1,p2,time,timer] = funprocesspress2(filename);

% [indexp1] = trigger(p1,1e4);
% [indexp2] = trigger(p2,1e4);
% dt = (indexp2-indexp1)/1e6;
% vs = 0.626./dt

load(shockfilename,'shock','vs');

% Triggering was always done on p1 at 20%
% therefore we don't need to get the start at this stage
% figure
% plot(p2)
% [xstart,y] = getpts(gcf);
% xstart = round(xstart);
% xstart10 = xstart.*10;

% run characterstics code at this stage => character4q
% also as standard practice add 'e' data points to the start so as to avoid 'overrun'
e = 150;
```

```
clear p1char timechar
p1char(1:e,1) = p1(1);
p1char(e+1:e+2000,1) = p1(1:2000);
timechar = timer(1:e+2000);
shockchar(1:e,1) = shock(1);
shockchar(e+1:e+2000,1) = shock(1:2000);
[p1ts2,p1timets2] = characterq4b(p1char,timechar,p0,t0,vs,shockchar);
p1timets2r = p1timets2-timer(e+1);
p1timets2ms = p1timets2r.*1000;

% Plot resultant test section conditions and balance output

figure
hold on
grid on
p2abs = p2 + p0;

sizea = length(timerms);
sizeb = length(p2abs);
if (sizea > sizeb)
   p2abs(sizeb+1:sizea) = 0;
else if (sizeb > sizea)
      timerms(sizea+1:sizeb) = 0;
   end
end

plot(timerms,p2abs,'r')
plot(p1timets2ms,p1ts2,'k')

% Get relevant starting point
%%% [index] = trigger(p2abs,86000);
```

```
% Find the pressure index at trigger pt
[indexp1] = trigger(transpose(p1ts2),86000);
startp1 = indexp1-100;
% Convert it to a time
timestart = p1timets2ms(indexp1);
% Find the index in a normal large matrix
[index] = trigger(timerms,timestart);
% [startp1] = trigger(transpose(p1timets2ms),timestart);
start = index-100;
indexbal = start*10+530;

save(outputfilename)

% Process the relevant balance data
zbal = zero100data(bal(indexbal:indexbal+19000));
zbal = transpose(zbal);

sprintf('Fitting Polynomials')
[s] = fullpolyfit2(zbal,time,1,100);
s=sample10r(s);
sprintf('Deconvoluting')
force=deconvolution(ir,s);
forcex=ave10(transpose(force).*x);

% Don't worry about the truncated ir

figure
hold on
grid on
plot(timerms(1:1550),forcex(1:1550),'k')
xlabel('Time (ms)','Fontsize',14)
```

```
ylabel('Drag (N)','Fontsize',14)
figname = sprintf('figdragb%s',filenames)
hgsave(figname)
print(figname,'-deps')

% Calculate the relevant flow properties
% grab the right bits of data...
% timestart = timerms(start);
% [startp1] = trigger(transpose(p1timets2ms),timestart);

% re from p1 and p2 >> plot
% 0.5rho v^2 from p1
% actual cd
% theoretical cd from p1 and p2 >> plot including actual cd
% plot actual drag

p1ts2g = p1ts2 - p0;
[p q] =size(p1ts2);

[rep1,coefconvp1] = flowprop(transpose(p1ts2(startp1:q)),p0,t0,eps);
[rep2,coefconvp2] = flowprop(p2abs(start:start+1550),p0,t0,eps);

[rep3,coefconvp1] = flowprop(transpose(p1ts2g(startp1:q)),p0,t0,eps);
[rep4,coefconvp2] = flowprop(p2(start:start+1550),p0,t0,eps);

[rep5,coefconvp1,cd_hoe,mach] = flowprop(transpose(p1ts2g(startp1:q)),p0,t0,eps);
[rep6,coefconvp2,cd_hoe,mach] = flowprop(p2(start:start+1550),p0,t0,eps);

[length1 arb] = size(coefconvp1);
[length2 arb] = size(coefconvp2);
length = min([length1 length2]);
```

```
figure
hold on
grid on
plot(timerms(1:length,1),rep1(1:length,1),'b')
plot(timerms(1:length,1),rep2(1:length,1),'r.','linewidth',2)
xlabel('Time (ms)','Fontsize',14)
ylabel('Reynolds Number','Fontsize',14)
legend('Cone Front Calculated from Upstream Transducer','Cone Base Calculated from
Downstream Transducer',4)

figname = sprintf('figreb%s',filenames)
hgsave(figname)
print(figname, '-deps')

save(outputfilename)
```

APPENDIX B   Complete Experimental Results

B.1   Cone 1

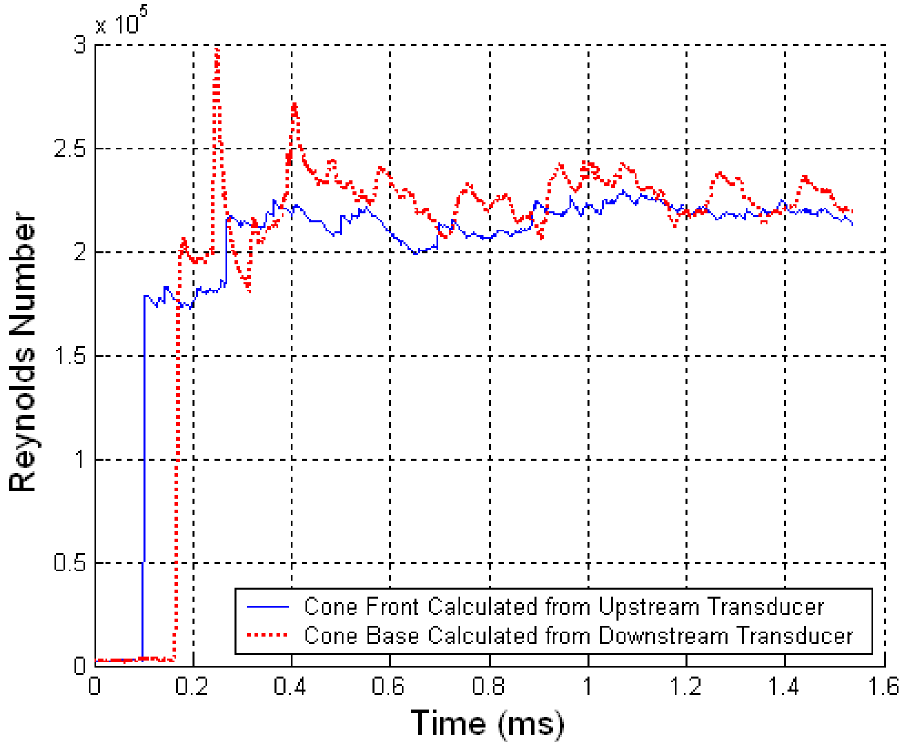

Figure B.1 Reynolds Number Plot ($M_s = 1.12$; $T_0 = 301K$; $P_0 = 82350Pa$)

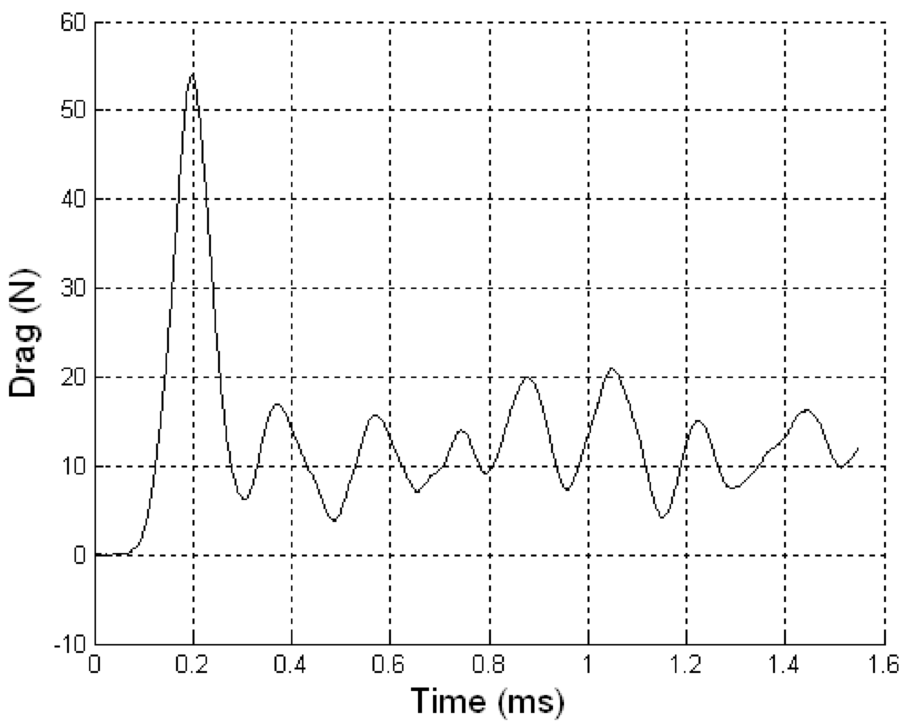

Figure B.2 Drag on Cone 1 ($M_s = 1.12$; $T_0 = 301K$; $P_0 = 82350Pa$)

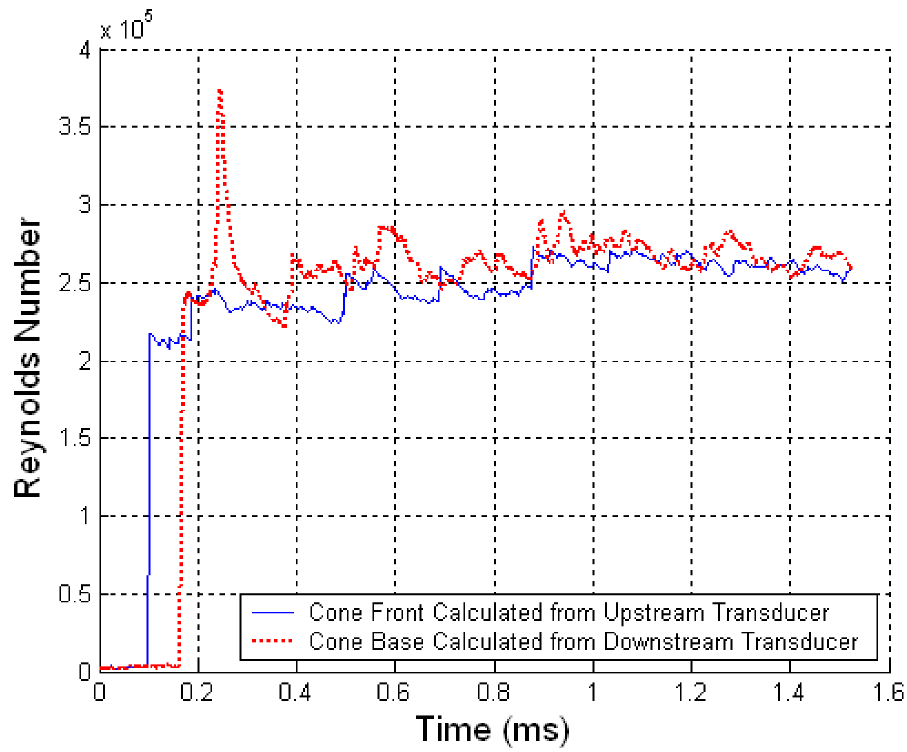

Figure B.3 Reynolds Number Plot ($M_s = 1.14$; $T_0 = 296K$; $P_0 = 82960Pa$)

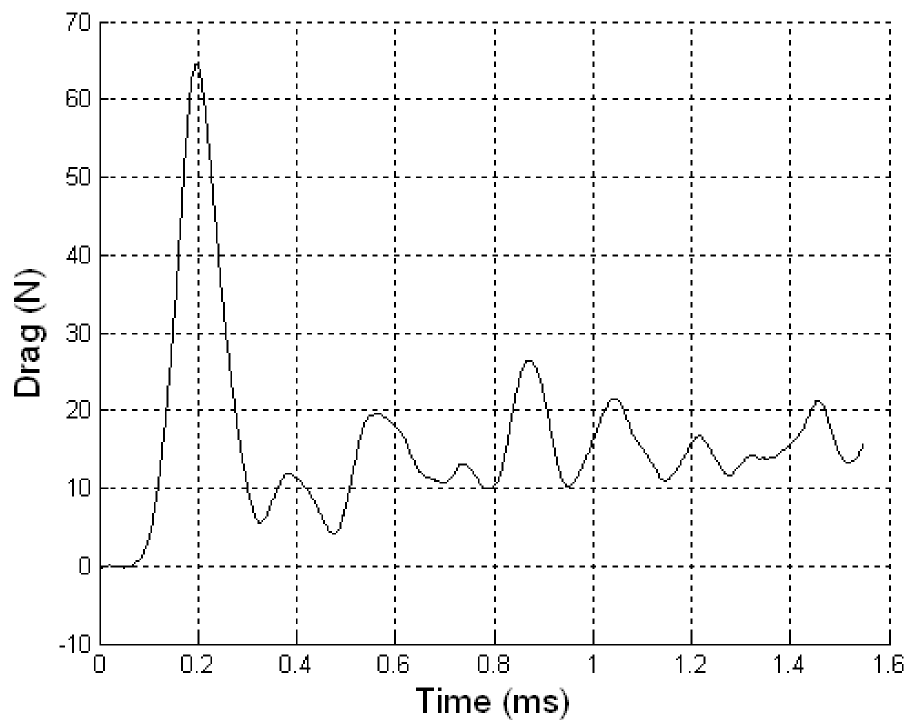

Figure B.4 Drag on Cone 1 ($M_s = 1.14$; $T_0 = 296K$; $P_0 = 82960Pa$)

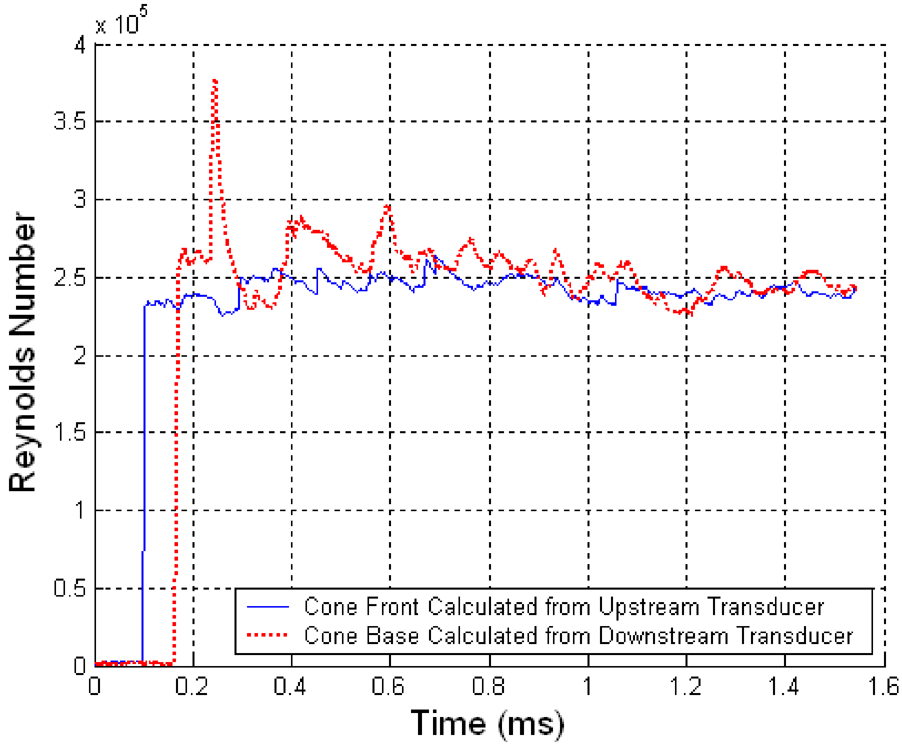

Figure B.5 Reynolds Number Plot ($M_s = 1.15$; $T_0 = 302K$; $P_0 = 82320Pa$)

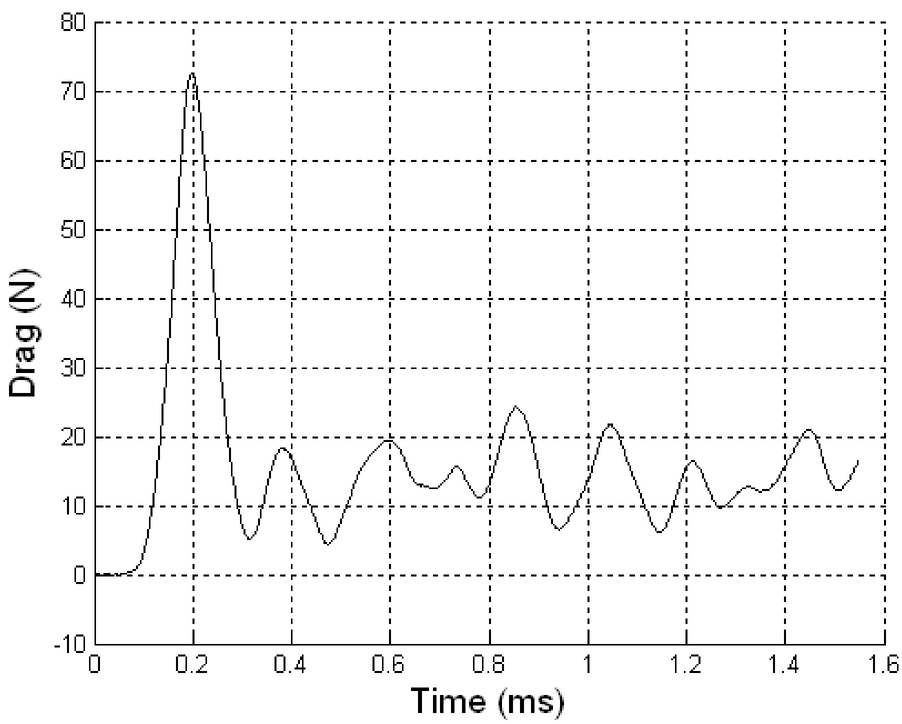

Figure B.6 Drag on Cone 1 ($M_s = 1.15$; $T_0 = 302K$; $P_0 = 82320Pa$)

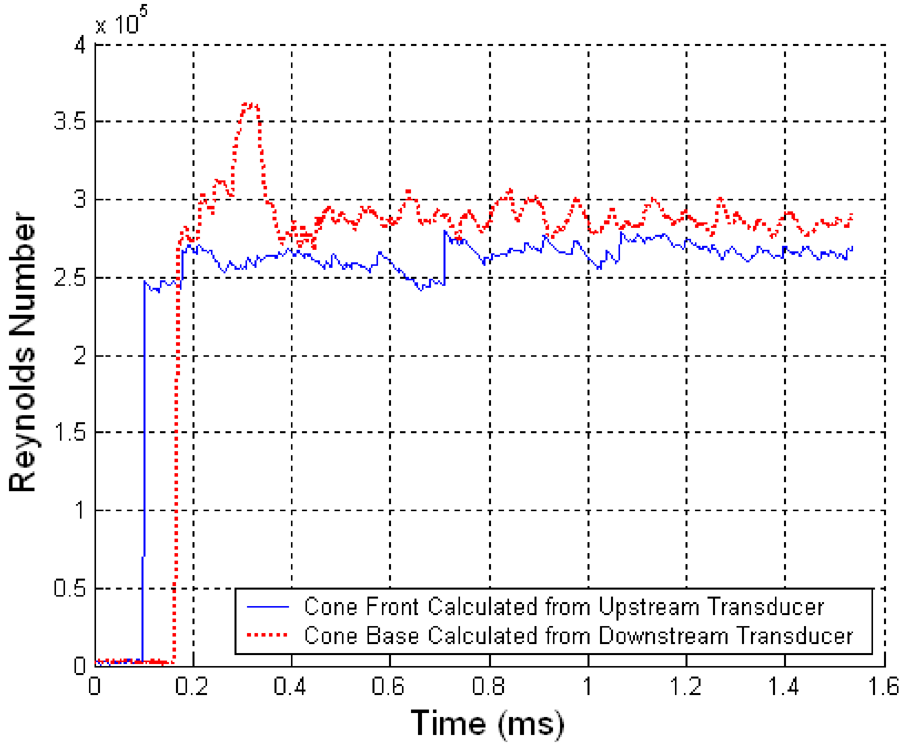

Figure B.7 Reynolds Number Plot ($M_s = 1.16$; $T_0 = 288K$; $P_0 = 83670Pa$)

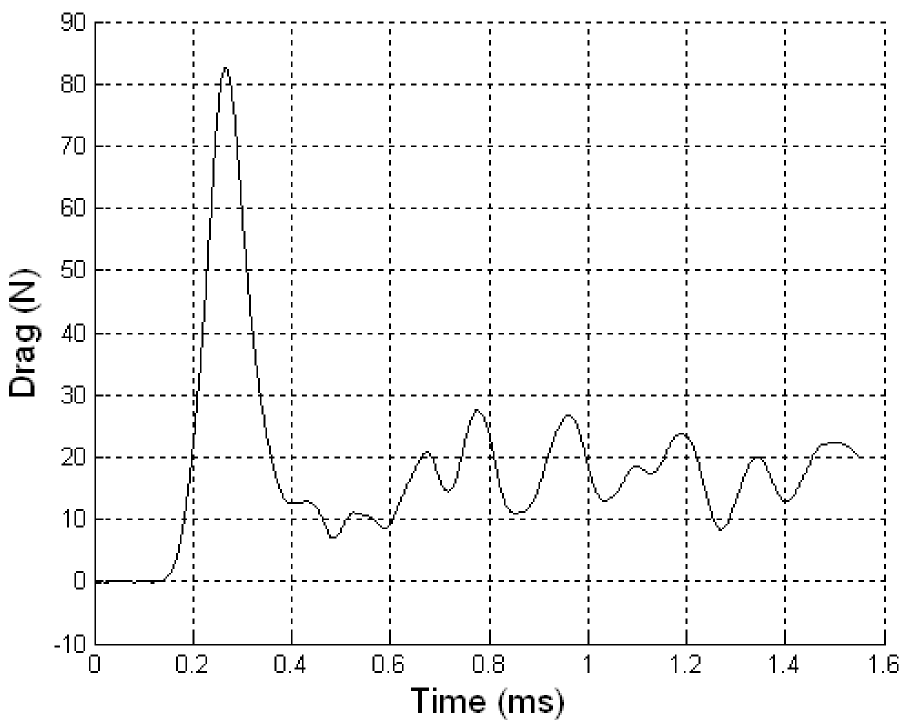

Figure B.8 Drag on Cone 1 ($M_s = 1.16$; $T_0 = 288K$; $P_0 = 83670Pa$)

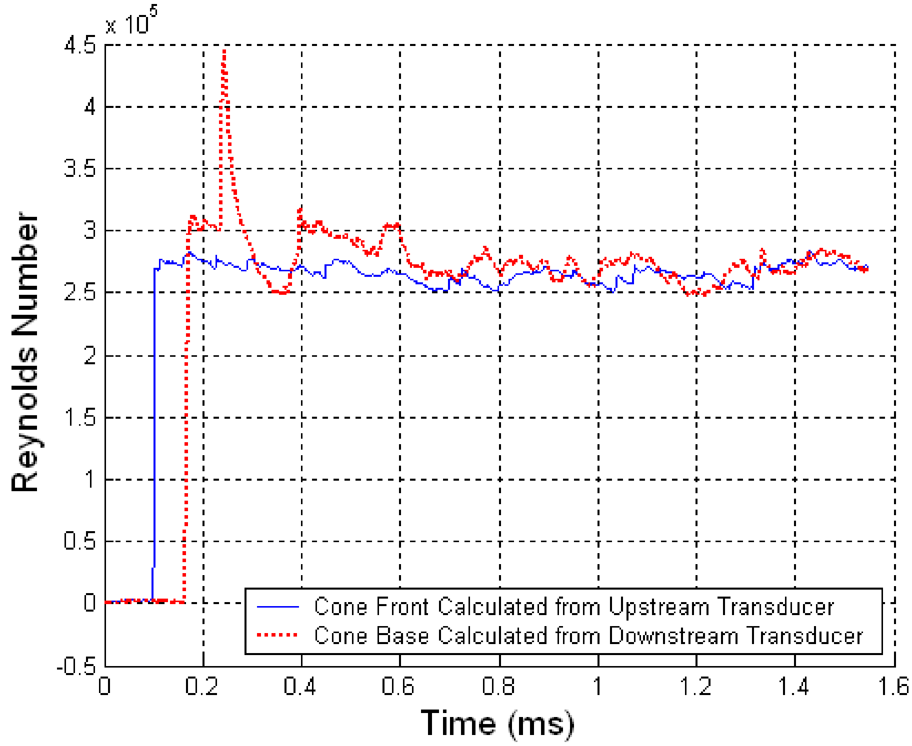

Figure B.9 Reynolds Number Plot ($M_s = 1.17$; $T_0 = 295K$; $P_0 = 83030Pa$)

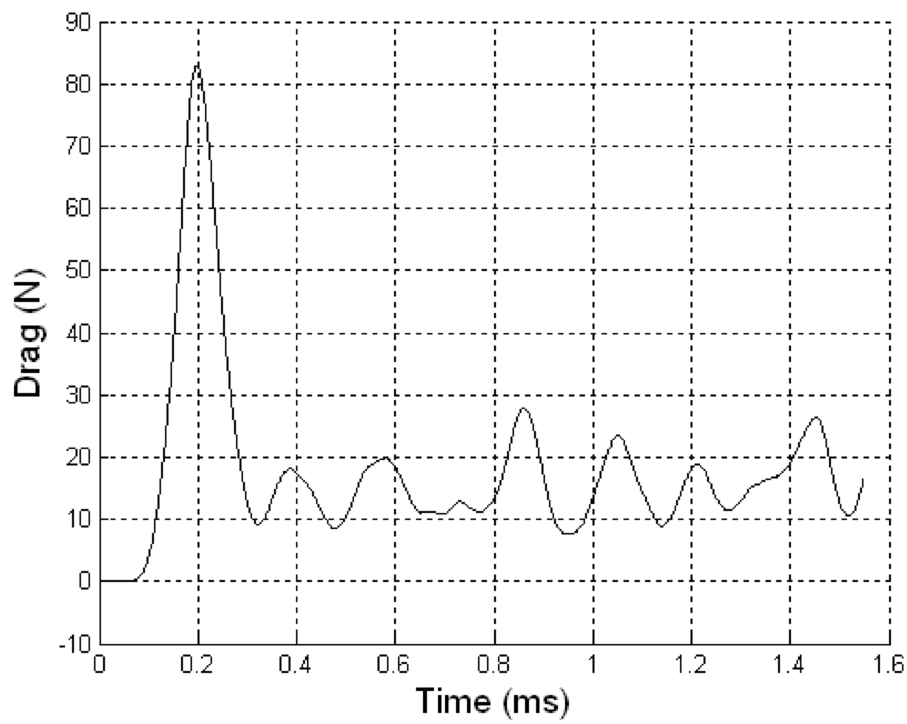

Figure B.10 Drag on Cone 1 ($M_s = 1.17$; $T_0 = 295K$; $P_0 = 83030Pa$)

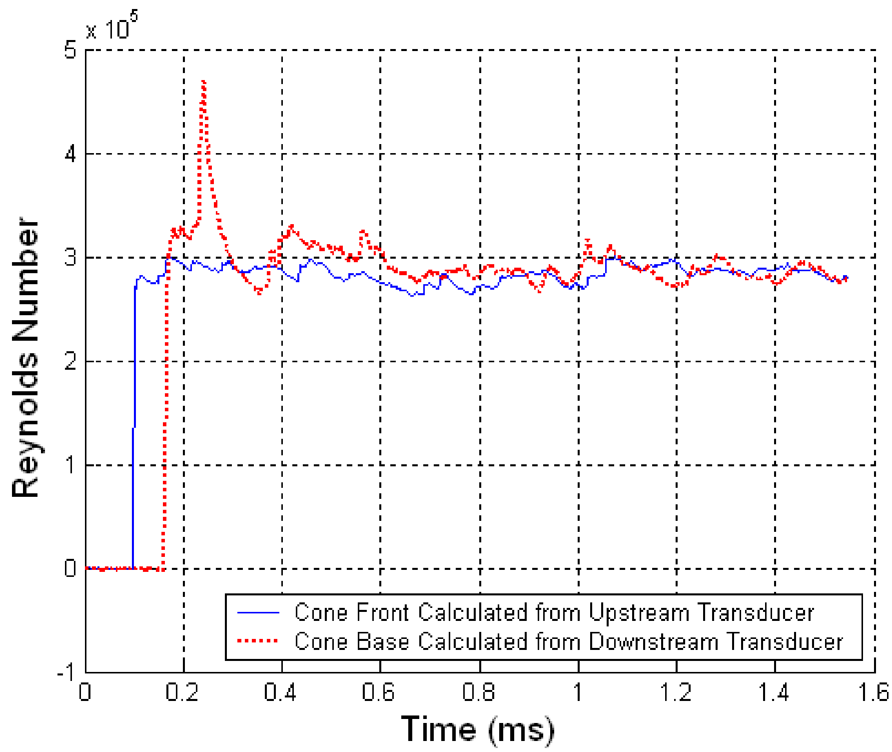

Figure B.11 Reynolds Number Plot ($M_s = 1.18$; $T_0 = 299K$; $P_0 = 83180Pa$)

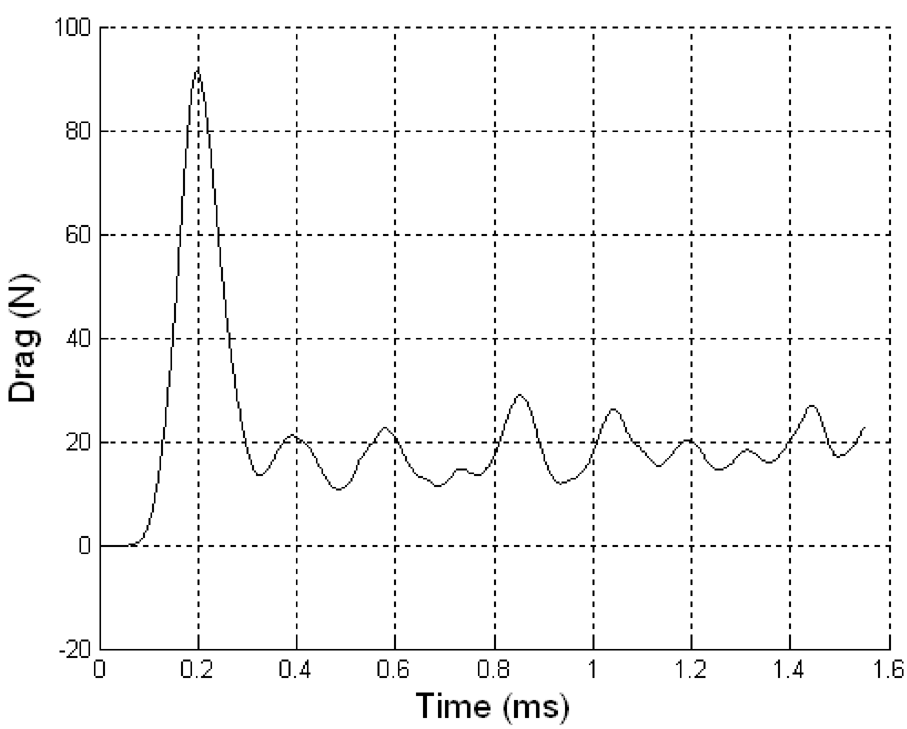

Figure B.12 Drag on Cone 1 ($M_s = 1.18$; $T_0 = 299K$; $P_0 = 83180Pa$)

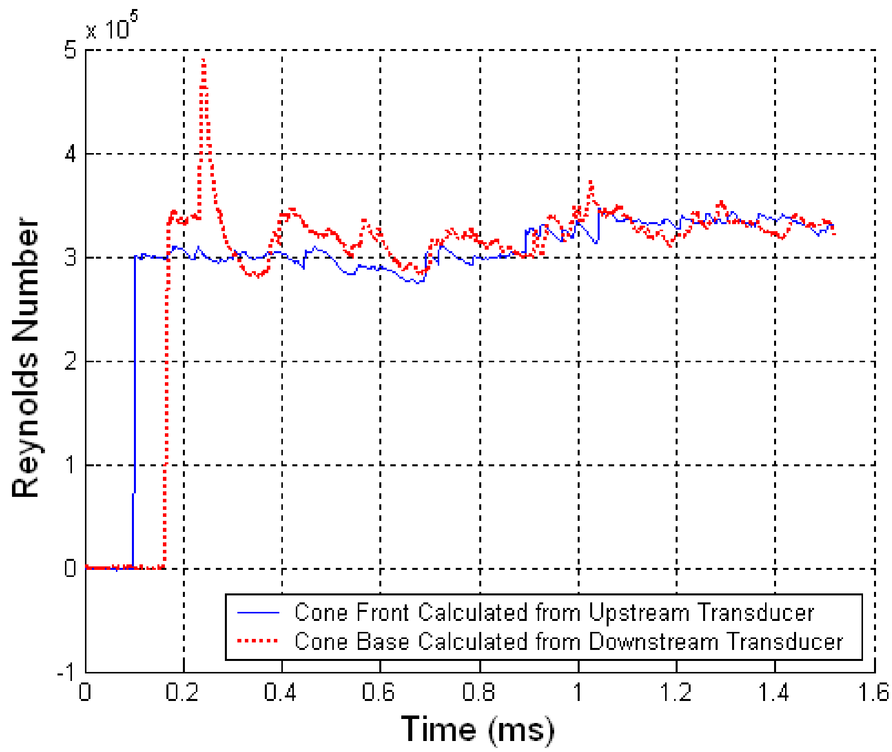

Figure B.13 Reynolds Number Plot ($M_s = 1.19$; $T_0 = 296K$; $P_0 = 82950Pa$)

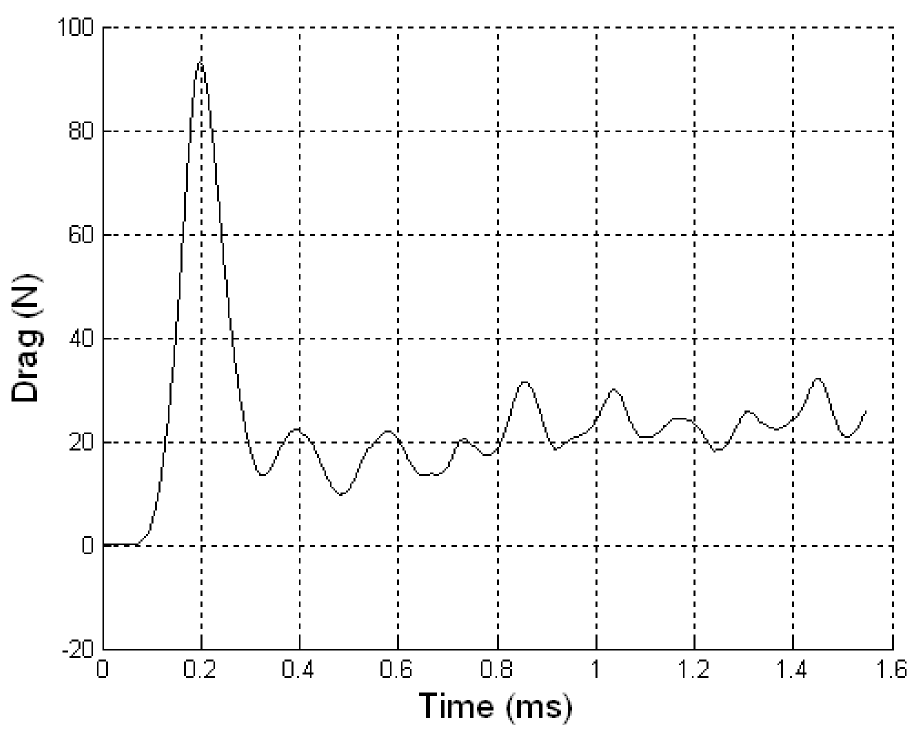

Figure B.14 Drag on Cone 1 ($M_s = 1.19$; $T_0 = 296K$; $P_0 = 82950Pa$)

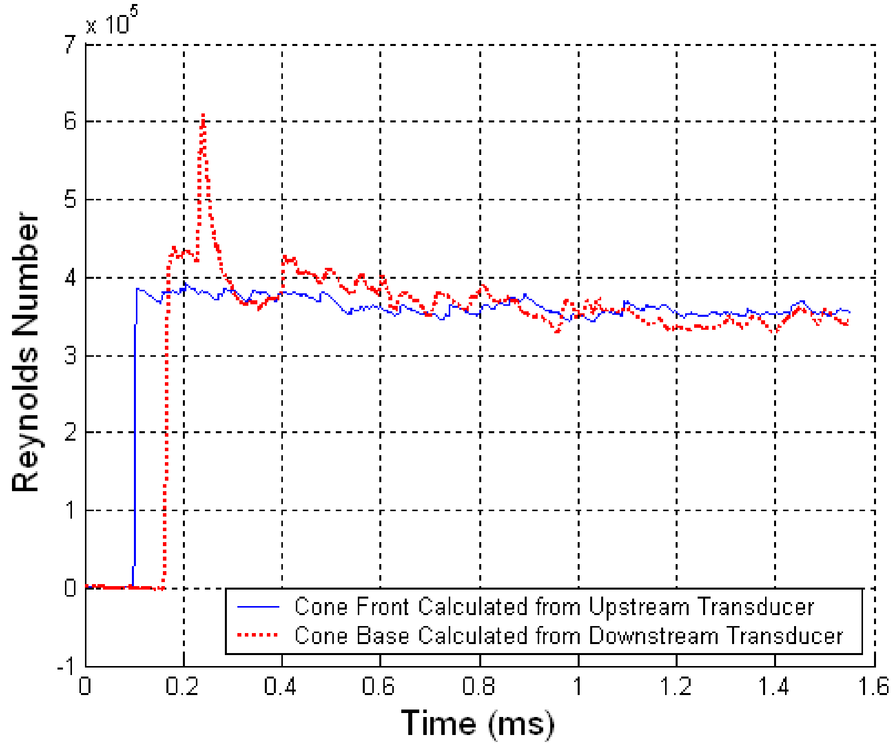

Figure B.15 Reynolds Number Plot ($M_s = 1.23$; $T_0 = 295K$; $P_0 = 83000Pa$)

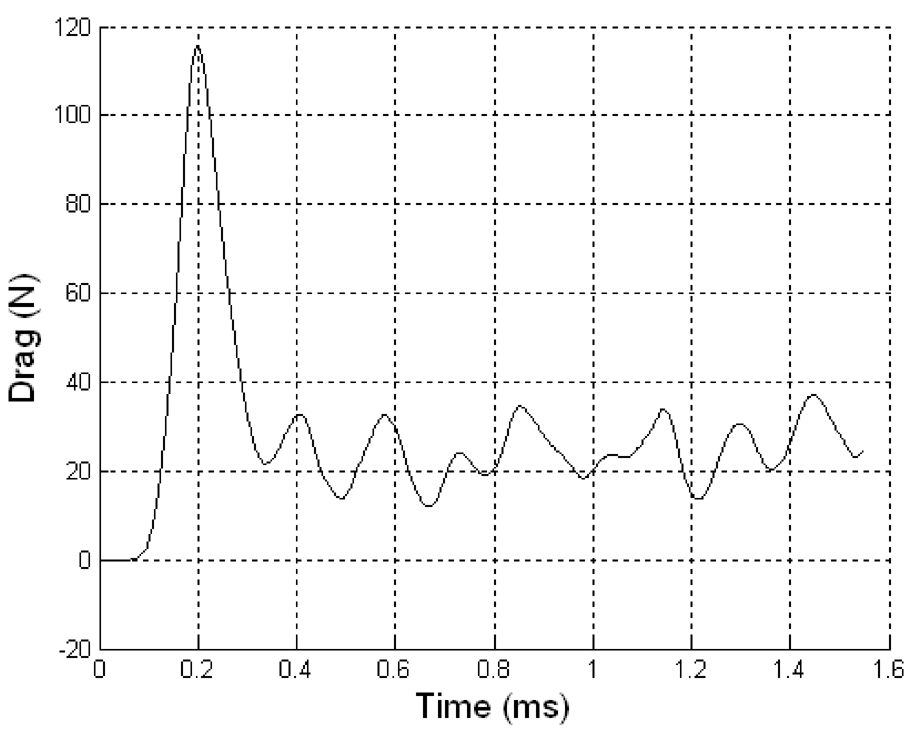

Figure B.16 Drag on Cone 1 ($M_s = 1.23$; $T_0 = 295K$; $P_0 = 83000Pa$)

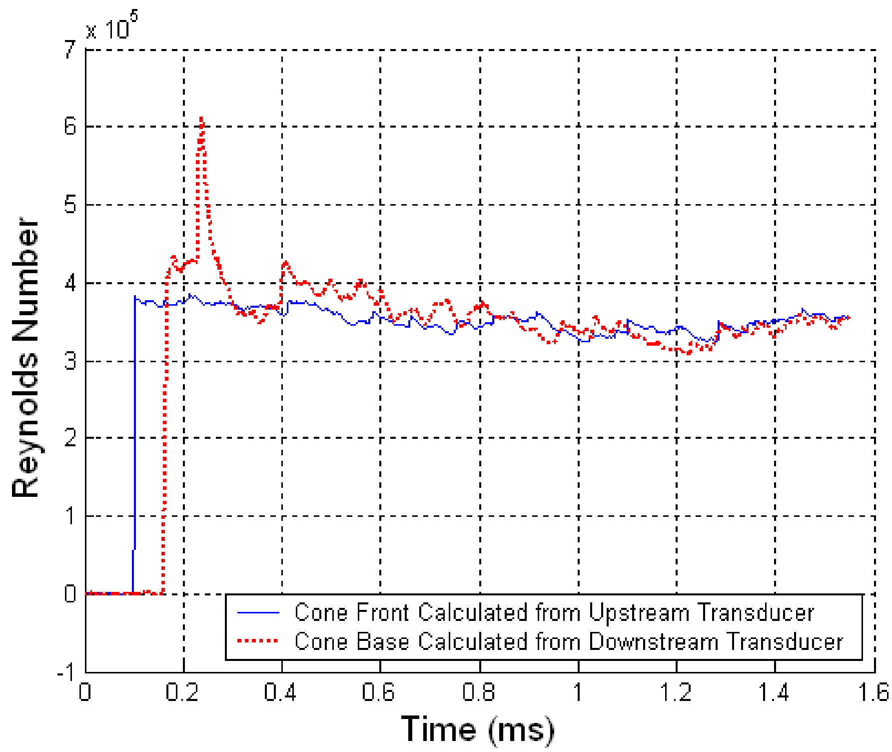

Figure B.17 Reynolds Number Plot ($M_s = 1.24$; $T_0 = 297K$; $P_0 = 82930Pa$)

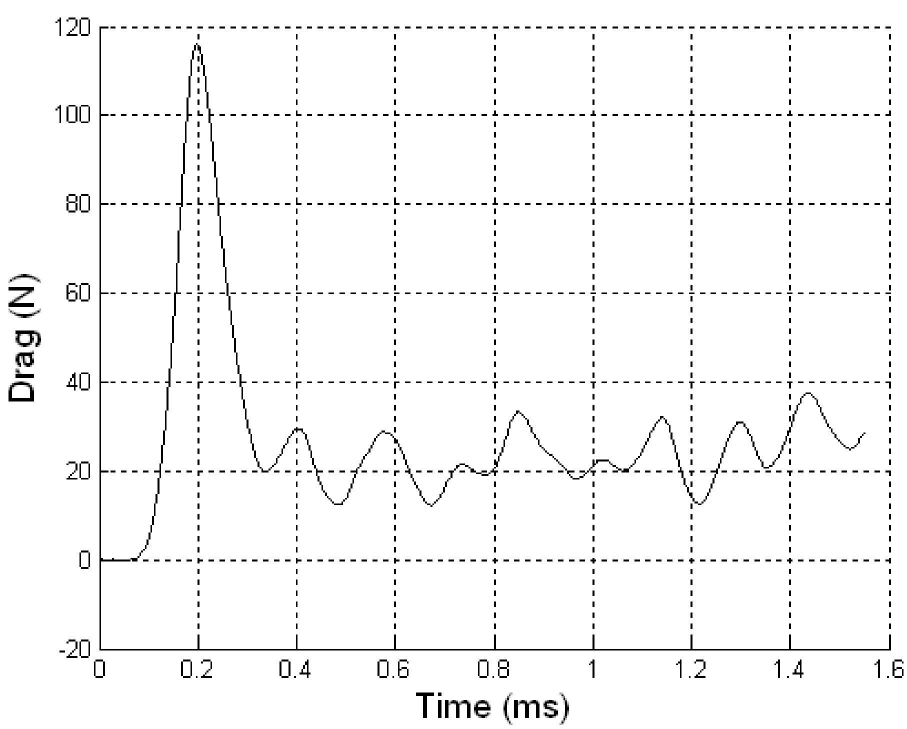

Figure B.18 Drag on Cone 1 ($M_s = 1.24$; $T_0 = 297K$; $P_0 = 82930Pa$)

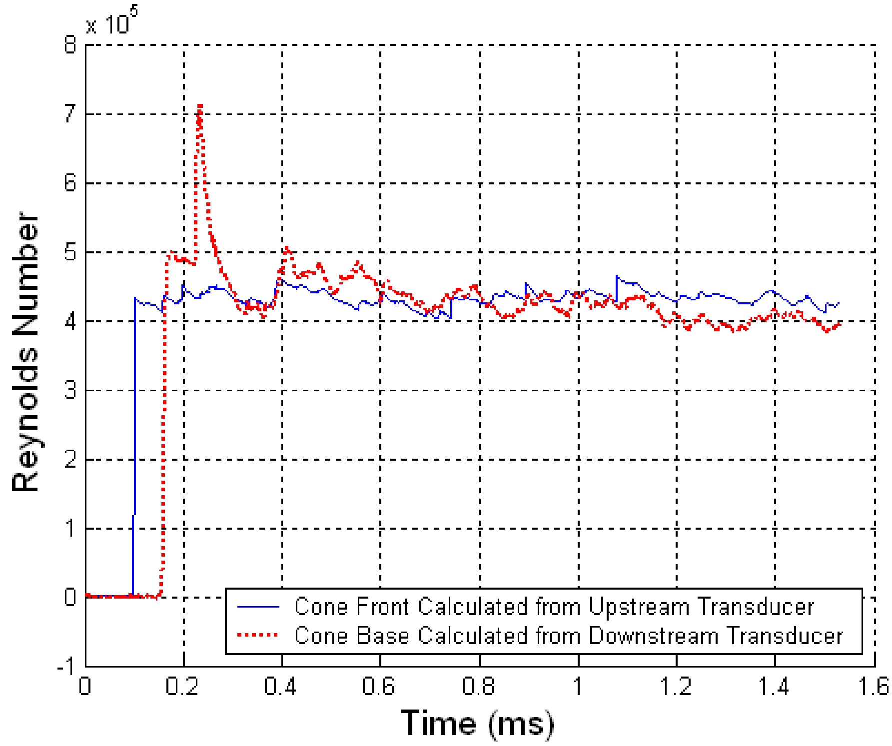

Figure B.19 Reynolds Number Plot ($M_s = 1.27$; $T_0 = 300K$; $P_0 = 83170Pa$)

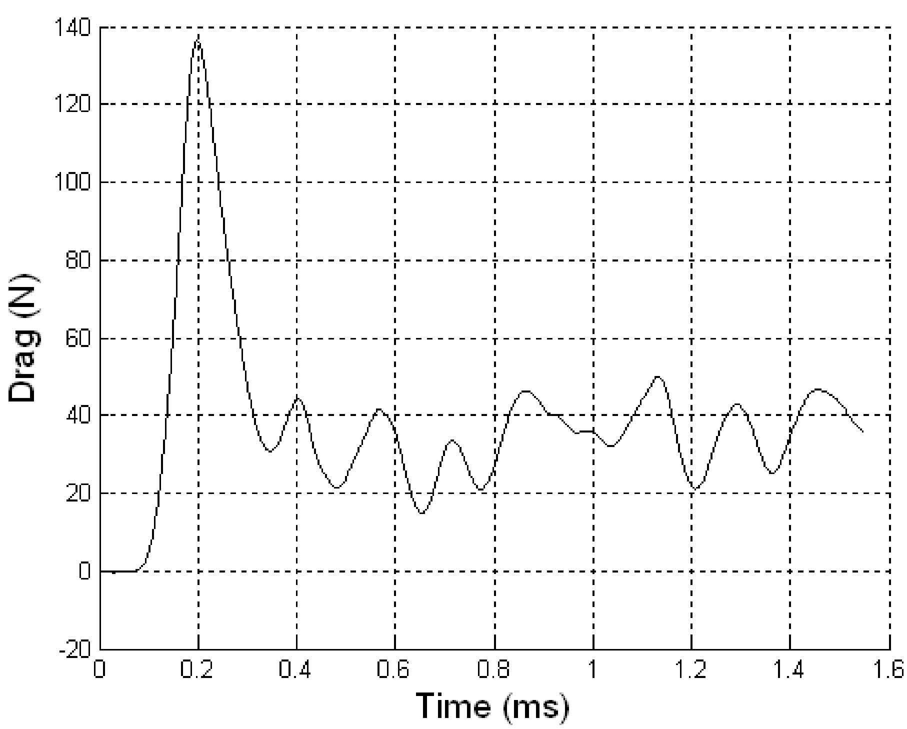

Figure B.20 Drag on Cone 1 ($M_s = 1.27$; $T_0 = 300K$; $P_0 = 83170Pa$)

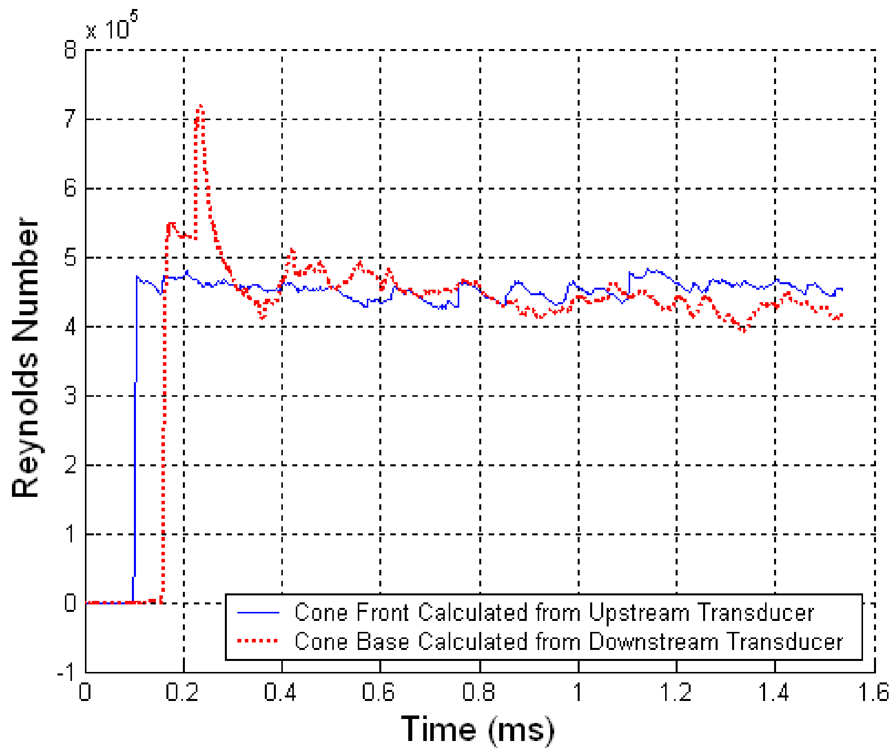

Figure B.21 Reynolds Number Plot ($M_s = 1.29$; $T_0 = 298K$; $P_0 = 83160Pa$)

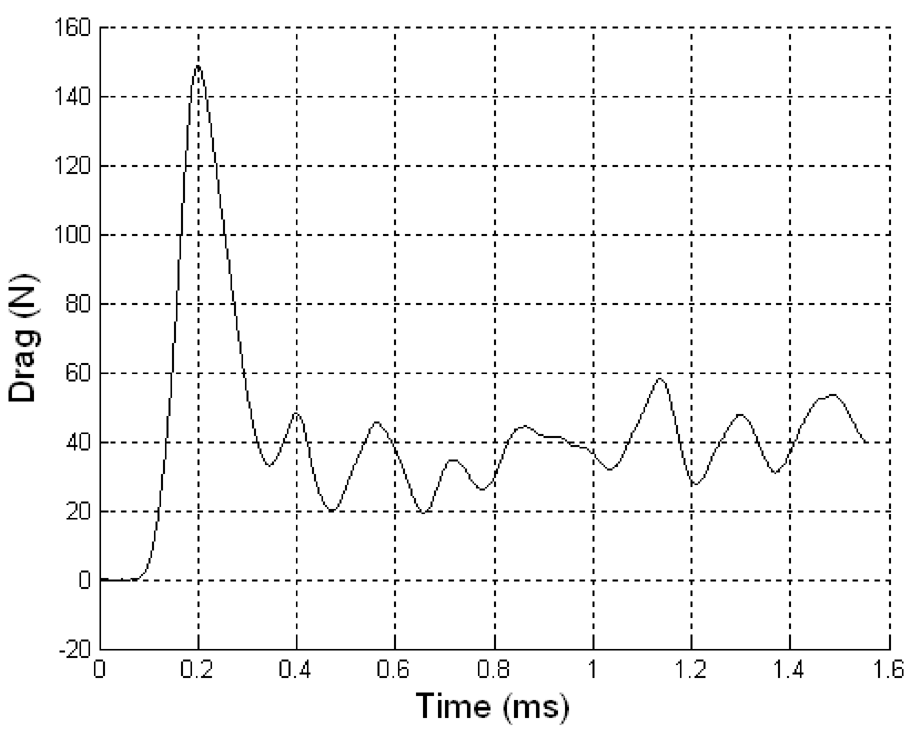

Figure B.22 Drag on Cone 1 ($M_s = 1.29$; $T_0 = 298K$; $P_0 = 83160Pa$)

B.2 Cone 2

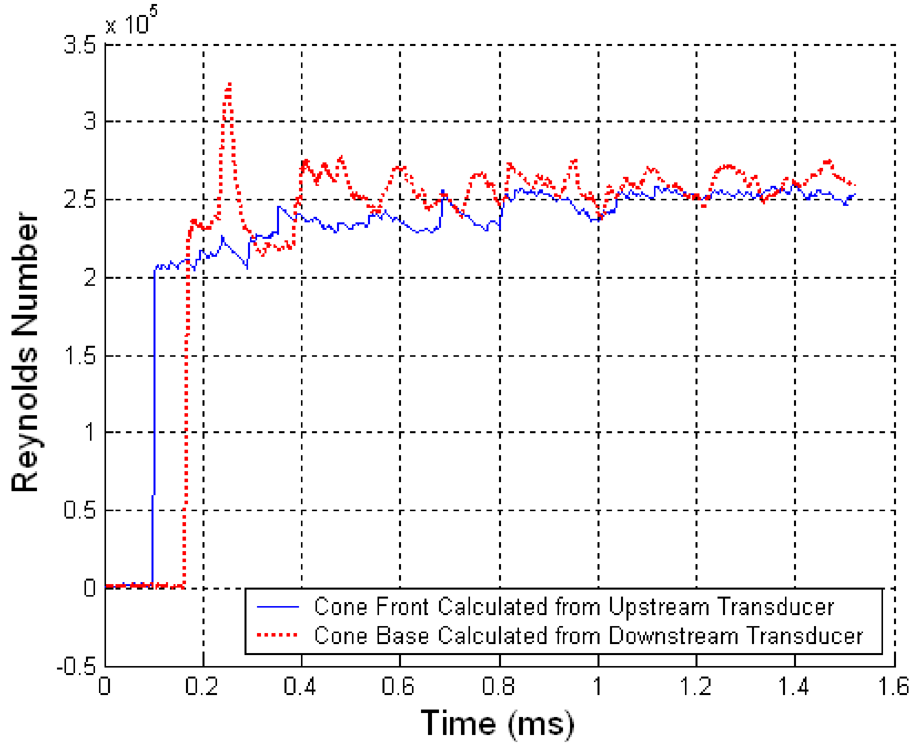

Figure B.23 Reynolds Number Plot ($M_s = 1.14$; $T_0 = 297K$; $P_0 = 82920Pa$)

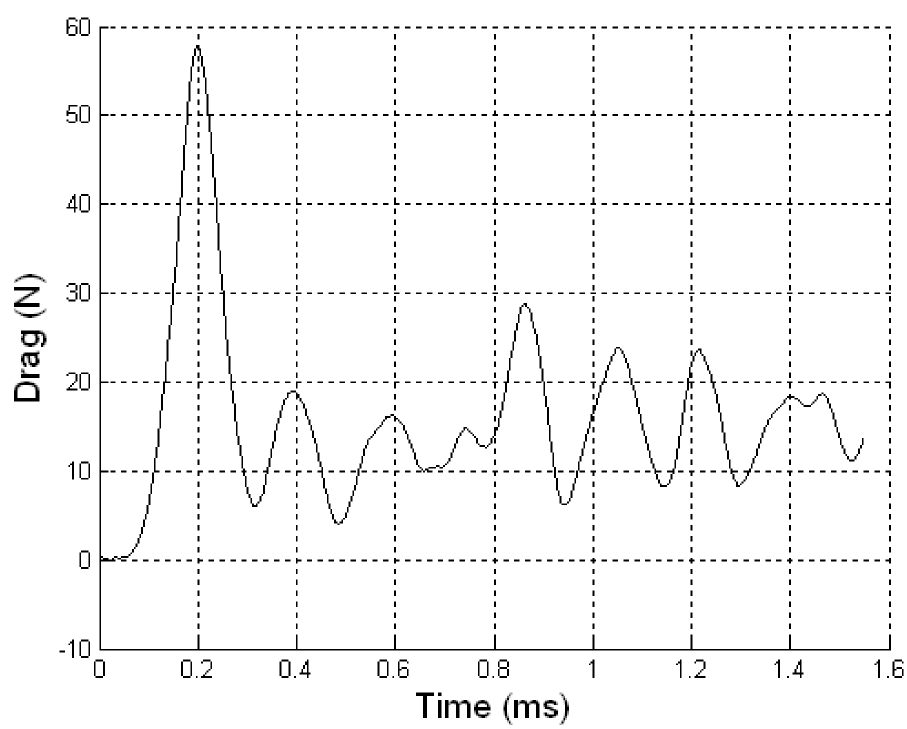

Figure B.24 Drag on Cone 2 ($M_s = 1.14$; $T_0 = 297K$; $P_0 = 82920Pa$)

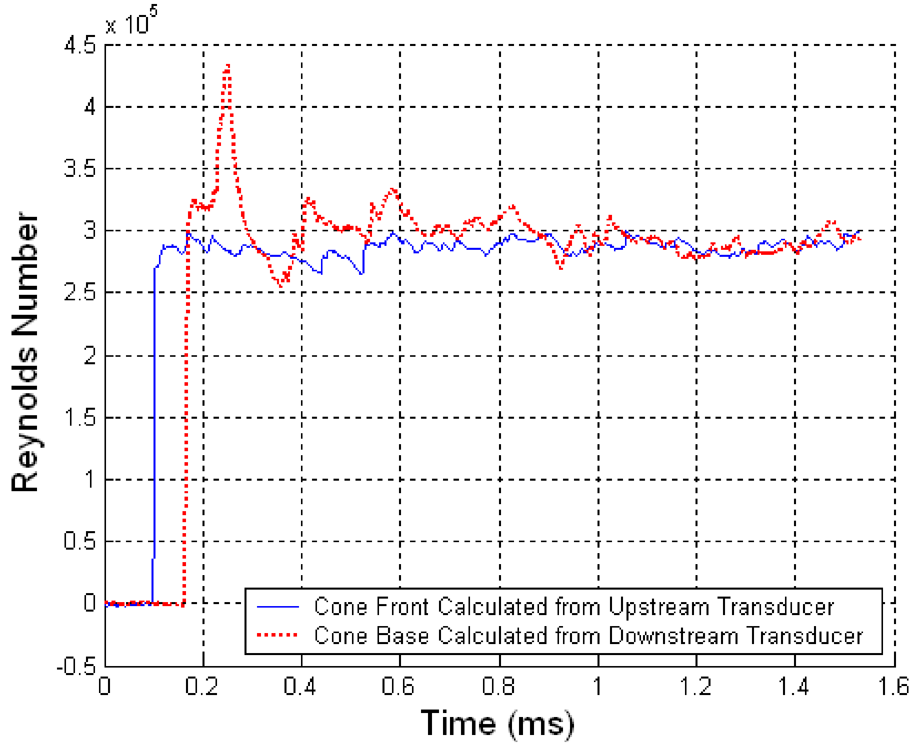

Figure B.25 Reynolds Number Plot ($M_s = 1.18$; $T_0 = 297K$; $P_0 = 82630Pa$)

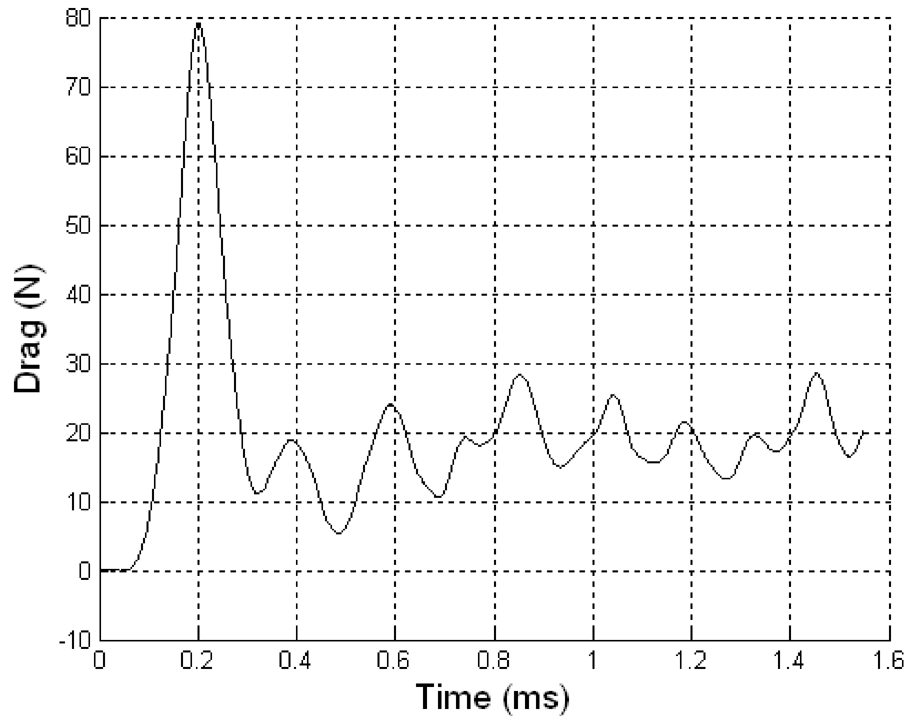

Figure B.26 Drag on Cone 2 ($M_s = 1.18$; $T_0 = 297K$; $P_0 = 82630Pa$)

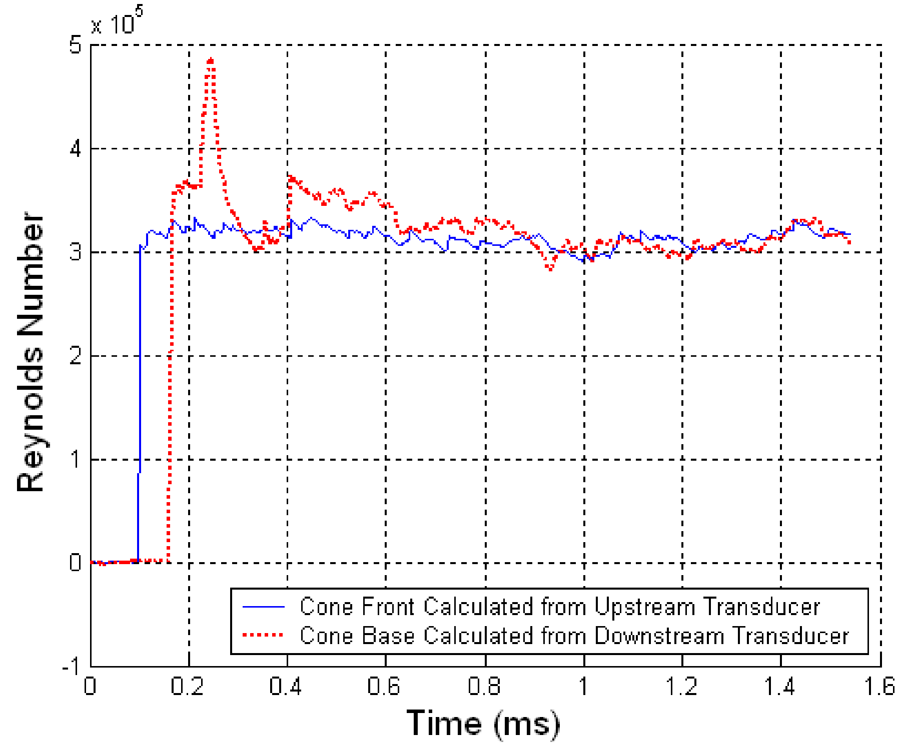

Figure B.27 Reynolds Number Plot ($M_s = 1.20$; $T_0 = 297K$; $P_0 = 82620Pa$)

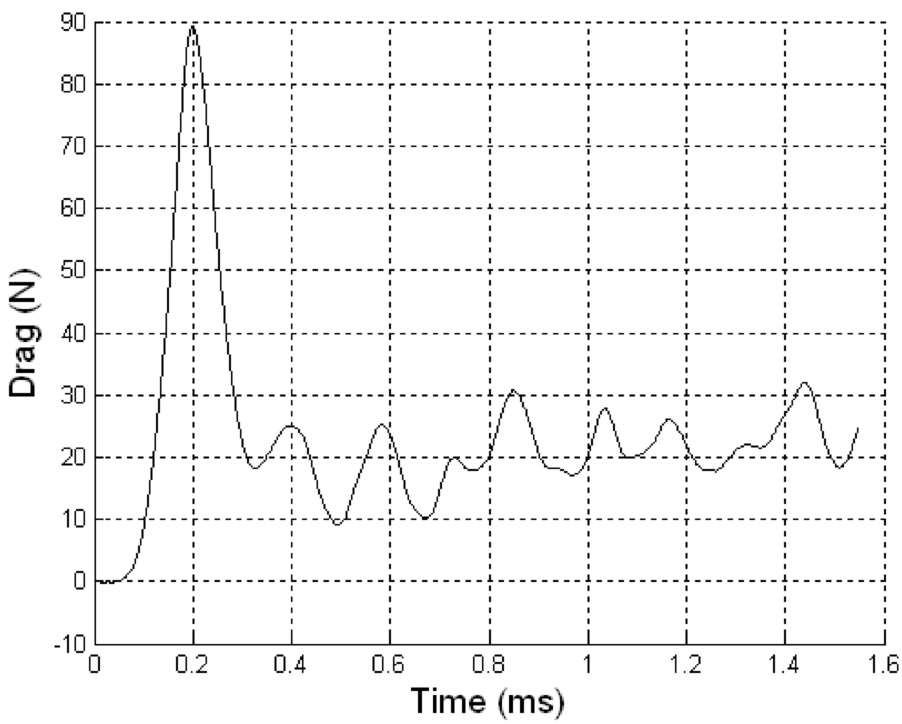

Figure B.28 Drag on Cone 2 ($M_s = 1.20$; $T_0 = 297K$; $P_0 = 82620Pa$)

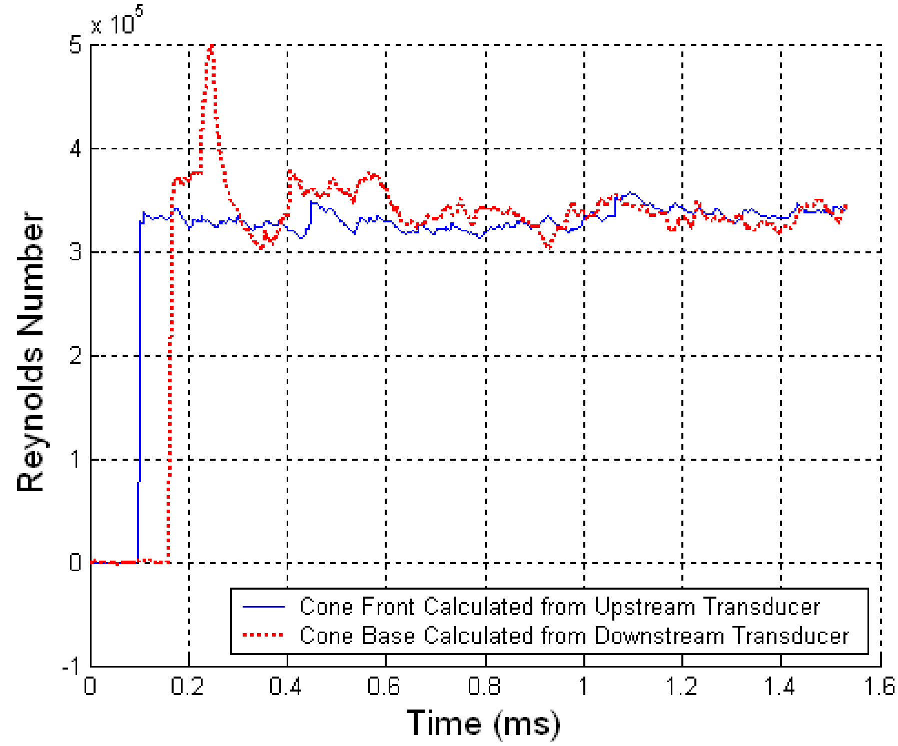

Figure B.29 Reynolds Number Plot ($M_s = 1.21$; $T_0 = 297K$; $P_0 = 82580Pa$)

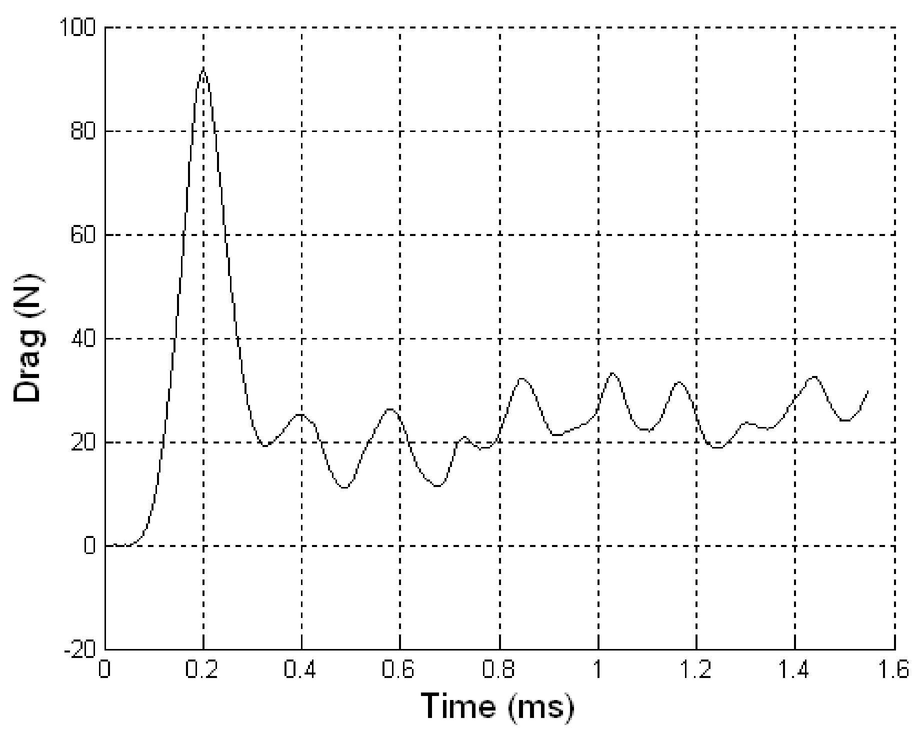

Figure B.30 Drag on Cone 2 ($M_s = 1.21$; $T_0 = 297K$; $P_0 = 82580Pa$)

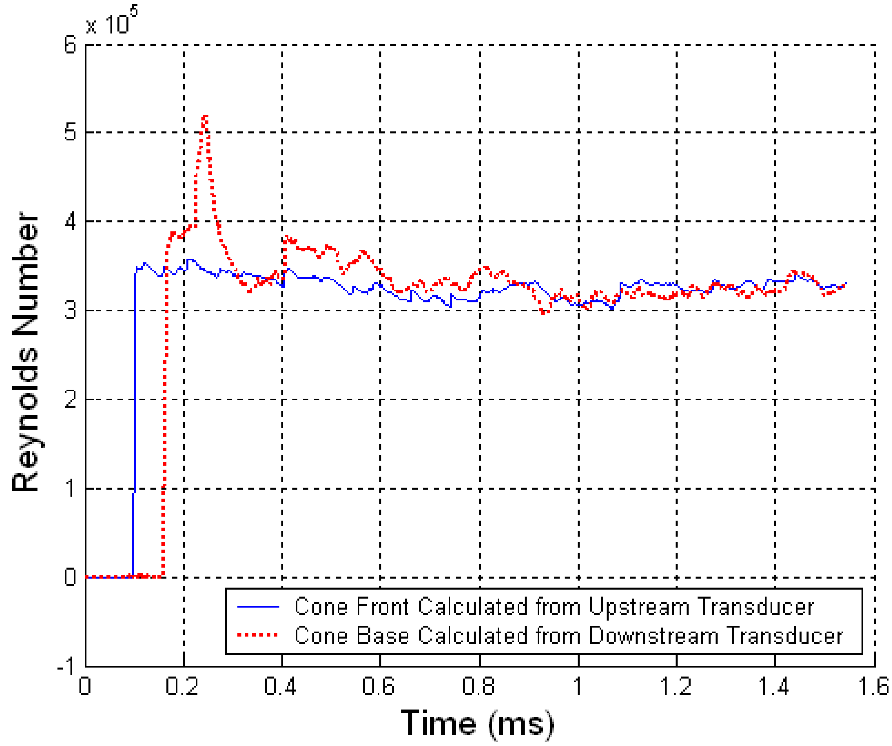

Figure B.31 Reynolds Number Plot ($M_s = 1.22$; $T_0 = 297K$; $P_0 = 82840Pa$)

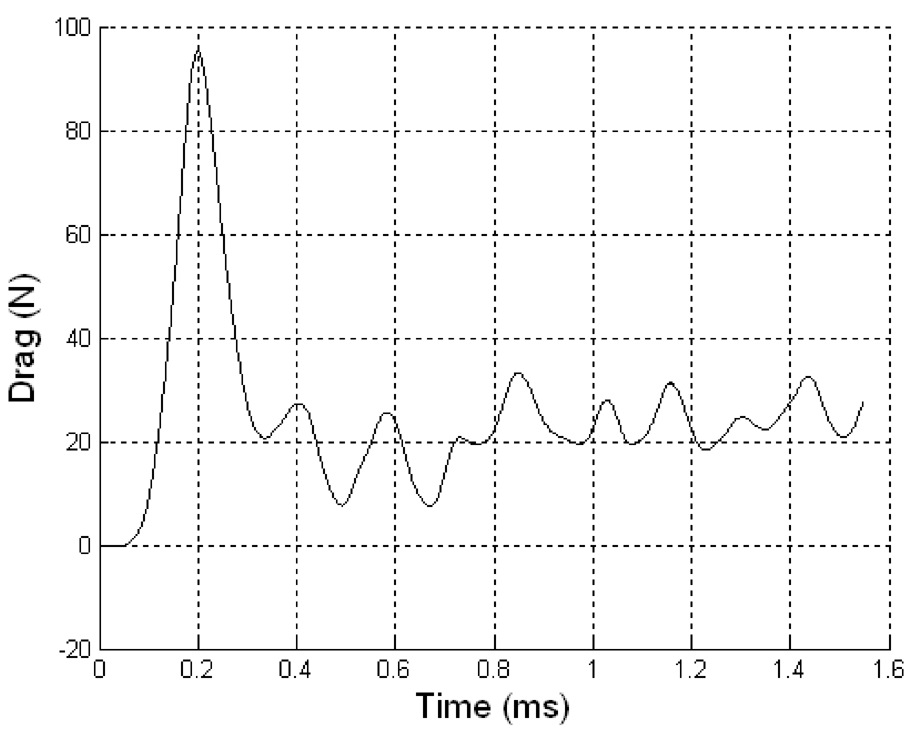

Figure B.32 Drag on Cone 2 ($M_s = 1.22$; $T_0 = 297K$; $P_0 = 82840Pa$)

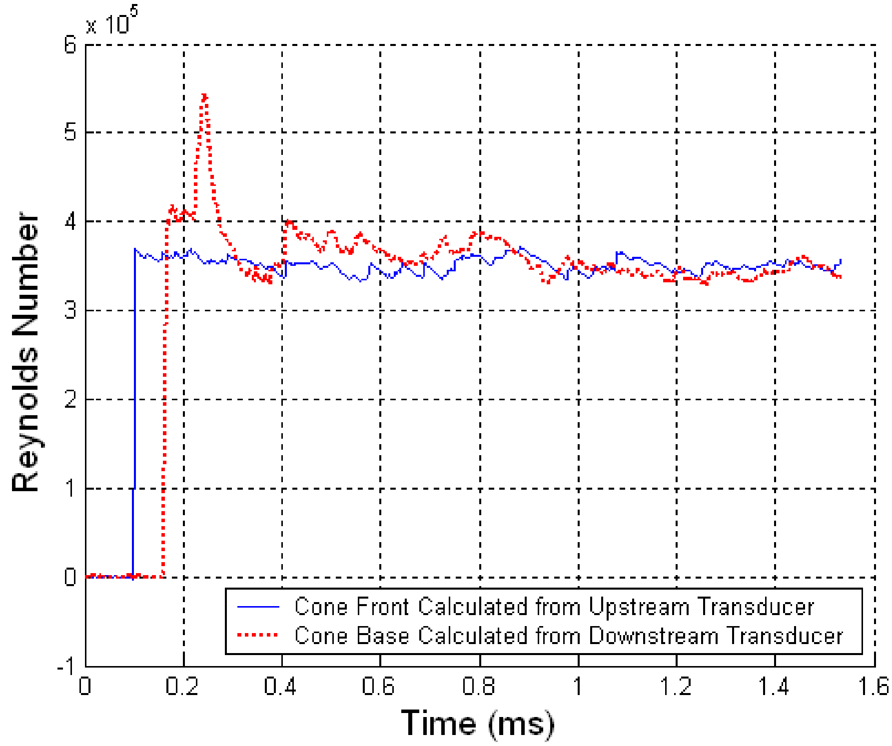

Figure B.33 Reynolds Number Plot ($M_s = 1.23$; $T_0 = 297K$; $P_0 = 82800Pa$)

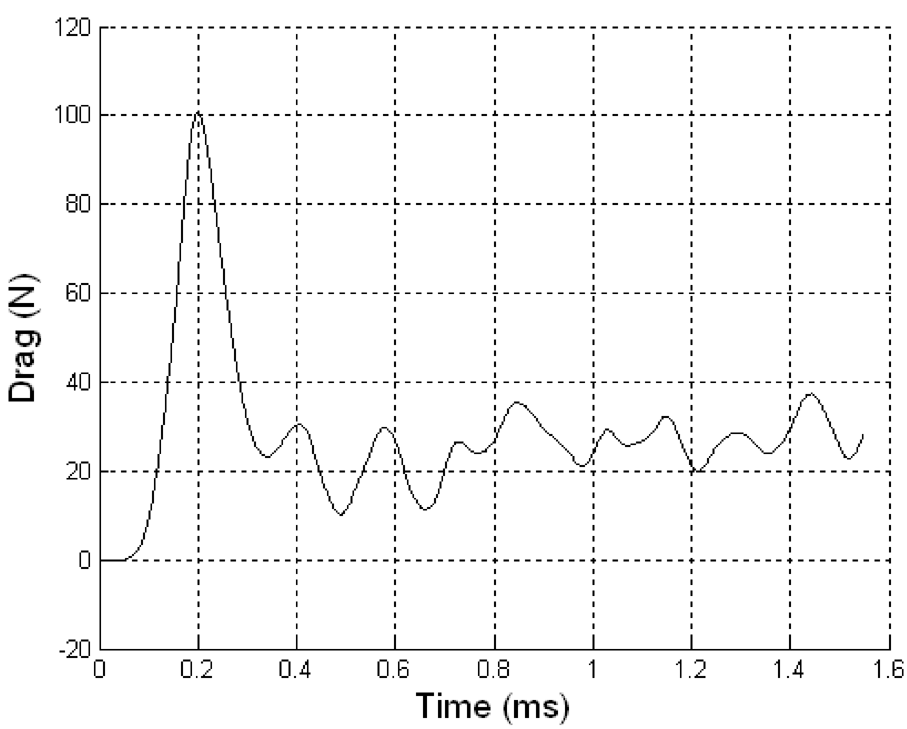

Figure B.34 Drag on Cone 2 ($M_s = 1.23$; $T_0 = 297K$; $P_0 = 82800Pa$)

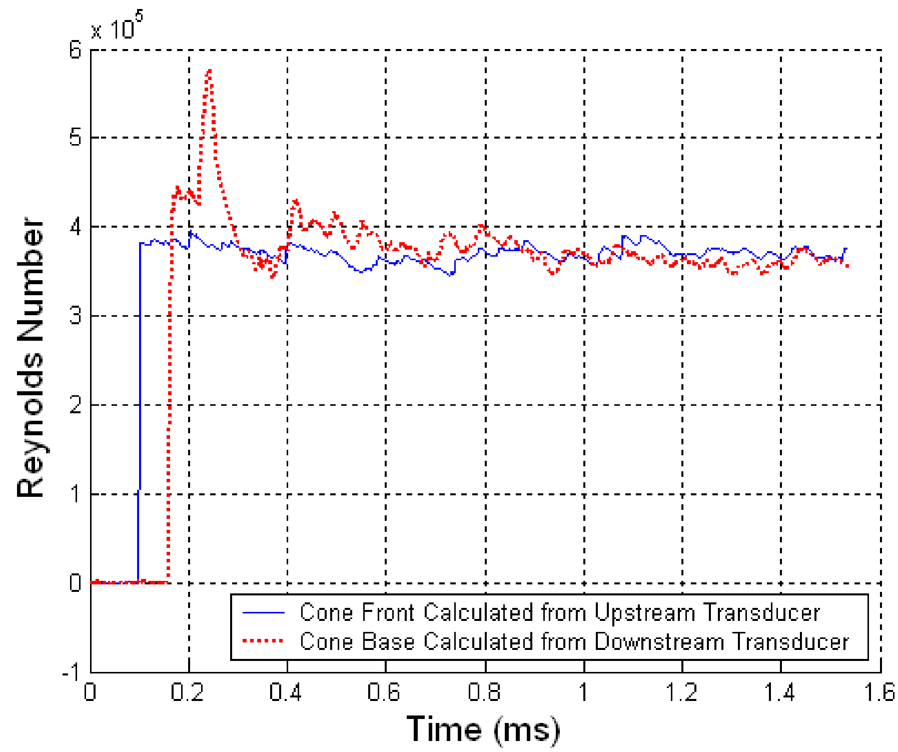

Figure B.35 Reynolds Number Plot ($M_s = 1.24$; $T_0 = 297K$; $P_0 = 82720Pa$)

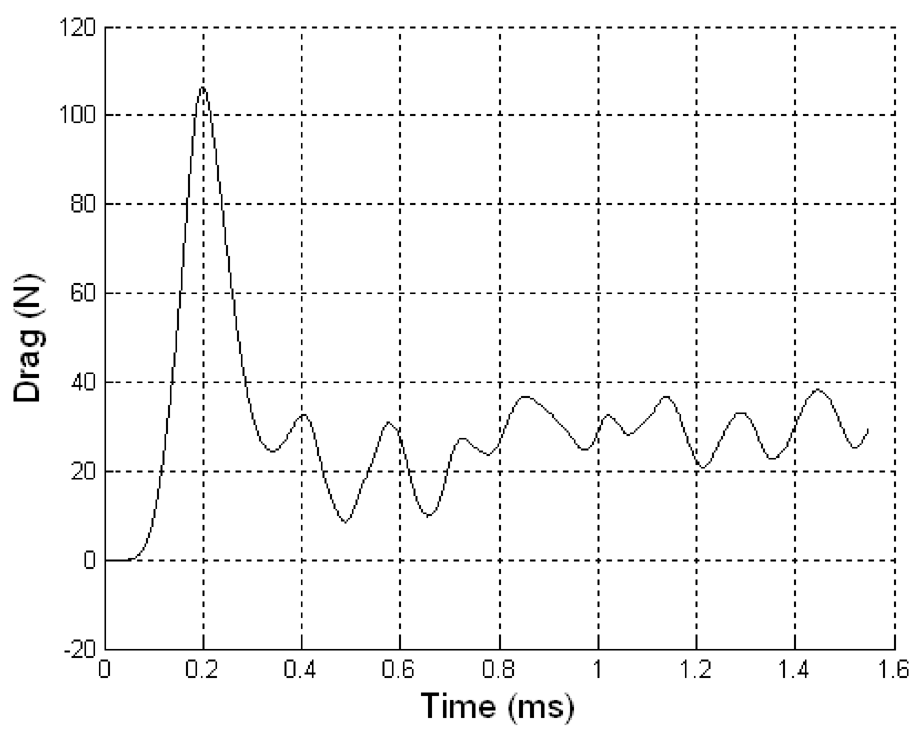

Figure B.36 Drag on Cone 2 ($M_s = 1.24$; $T_0 = 297K$; $P_0 = 82720Pa$)

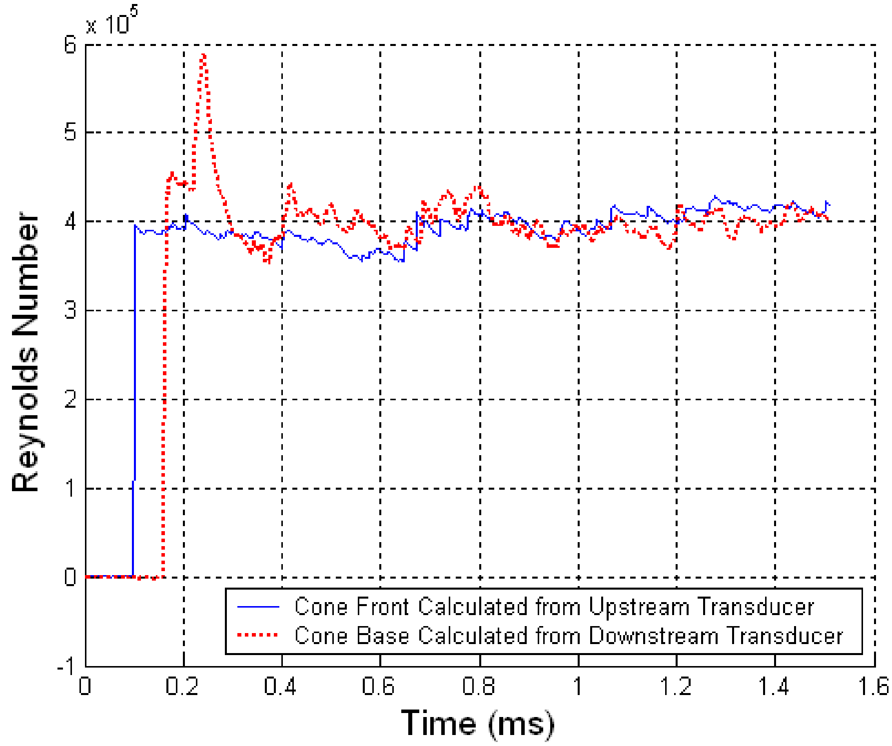

Figure B.37 Reynolds Number Plot ($M_s = 1.25$; $T_0 = 298K$; $P_0 = 82660Pa$)

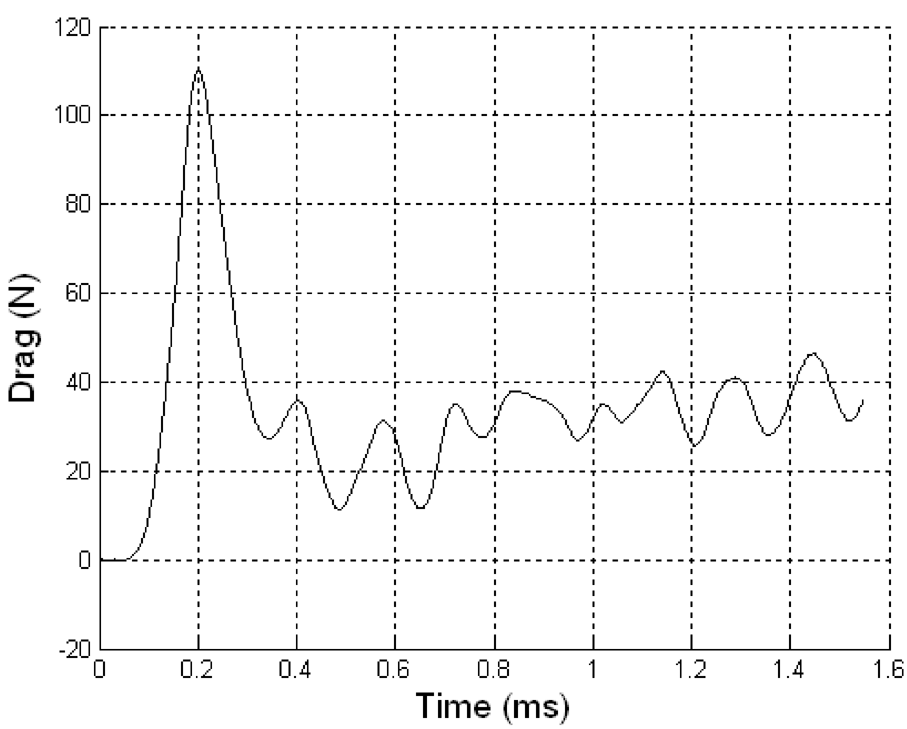

Figure B.38 Drag on Cone 2 ($M_s = 1.25$; $T_0 = 298K$; $P_0 = 82660Pa$)

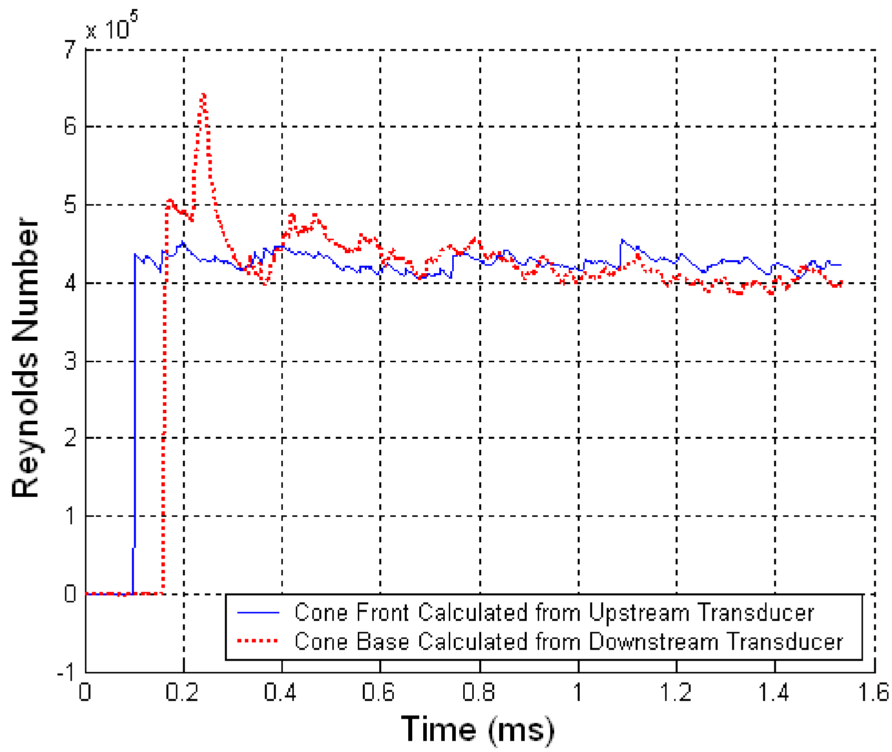

Figure B.39 Reynolds Number Plot ($M_s = 1.27$; $T_0 = 298K$; $P_0 = 82630Pa$)

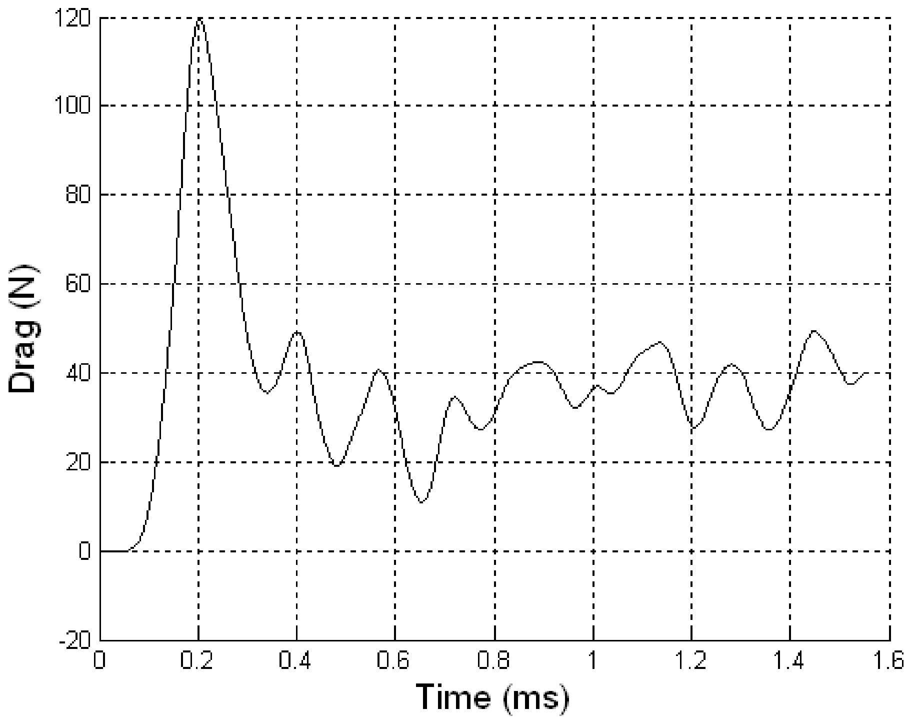

Figure B.40 Drag on Cone 2 ($M_s = 1.27$; $T_0 = 298K$; $P_0 = 82630Pa$)

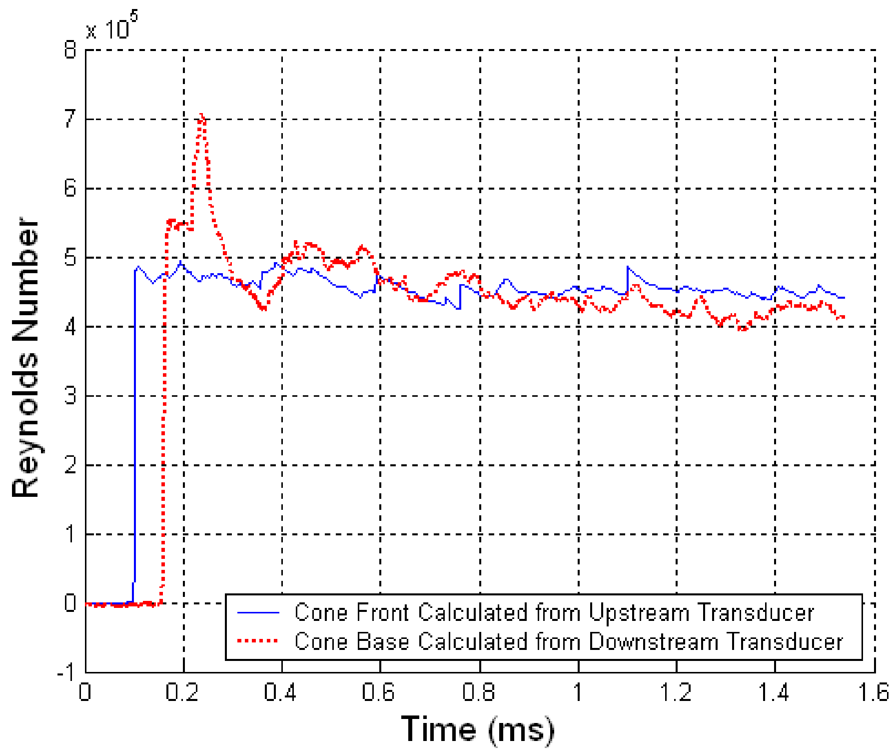

Figure B.41 Reynolds Number Plot ($M_s = 1.29$; $T_0 = 298K$; $P_0 = 82720Pa$)

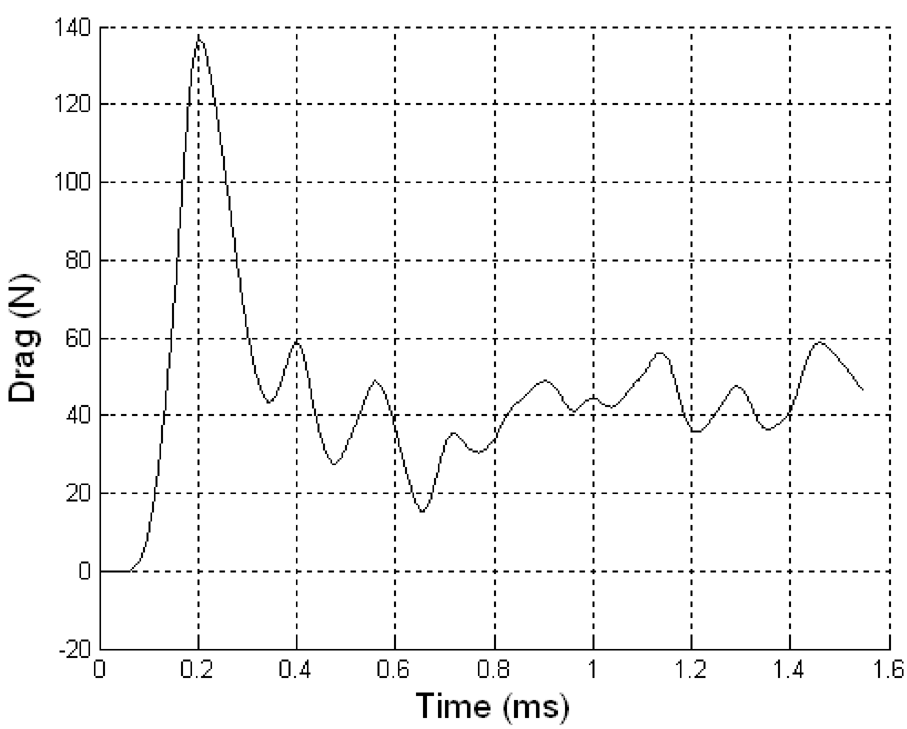

Figure B.42 Drag on Cone 2 ($M_s = 1.29$; $T_0 = 298K$; $P_0 = 82720Pa$)

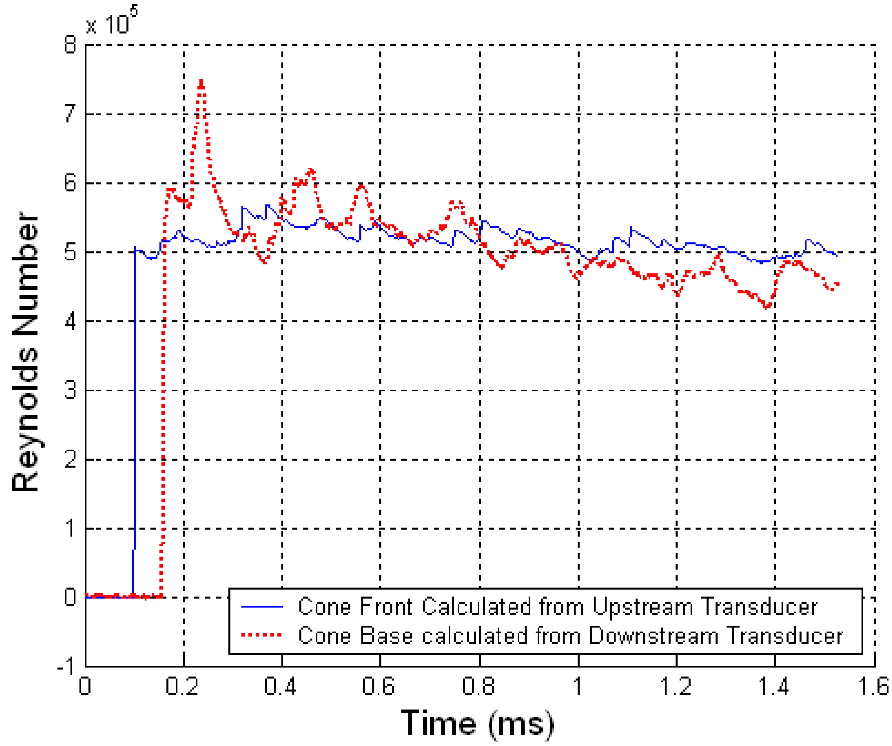

Figure B.43 Reynolds Number Plot ($M_s = 1.31$; $T_0 = 299K$; $P_0 = 83020Pa$)

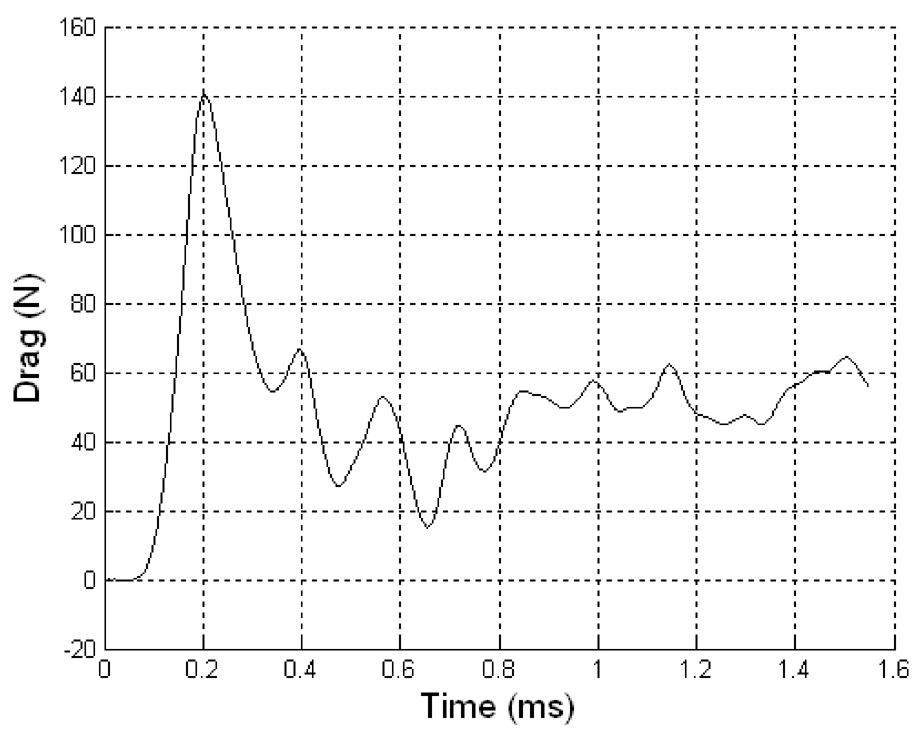

Figure B.44 Drag on Cone 2 ($M_s = 1.31$; $T_0 = 299K$; $P_0 = 83020Pa$)

B.3 Cone 3

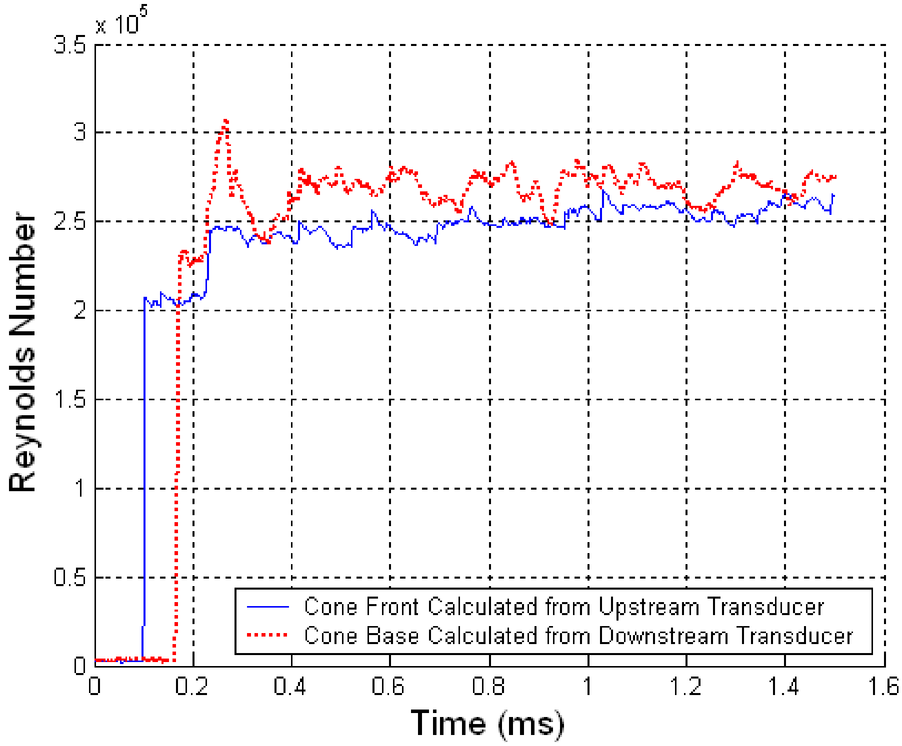

Figure B.45 Reynolds Number Plot ($M_s = 1.13$; $T_0 = 292K$; $P_0 = 83540Pa$)

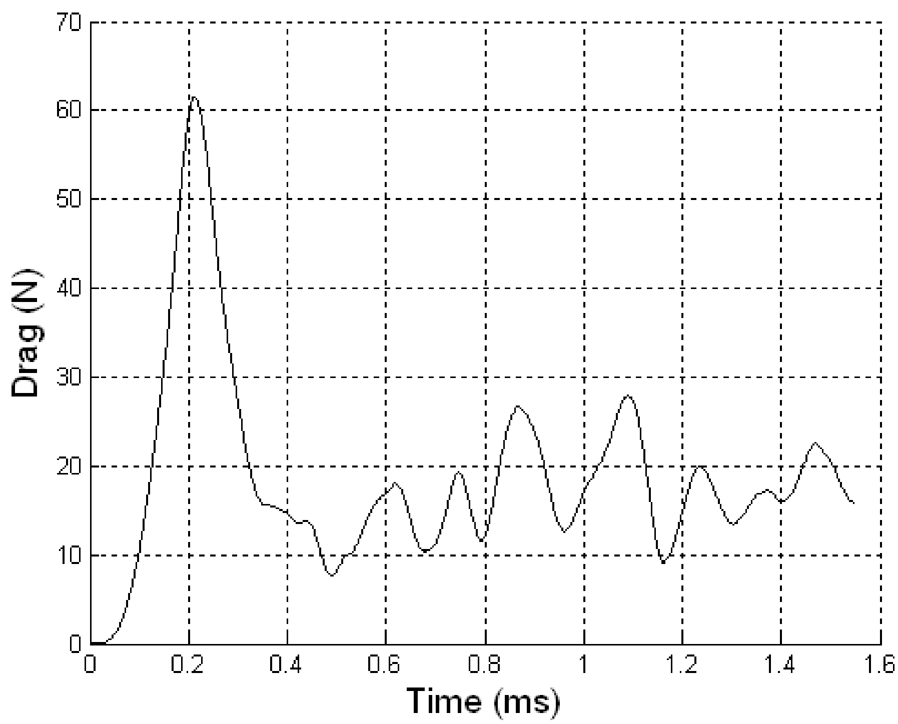

Figure B.46 Drag on Cone 3 ($M_s = 1.13$; $T_0 = 292K$; $P_0 = 83540Pa$)

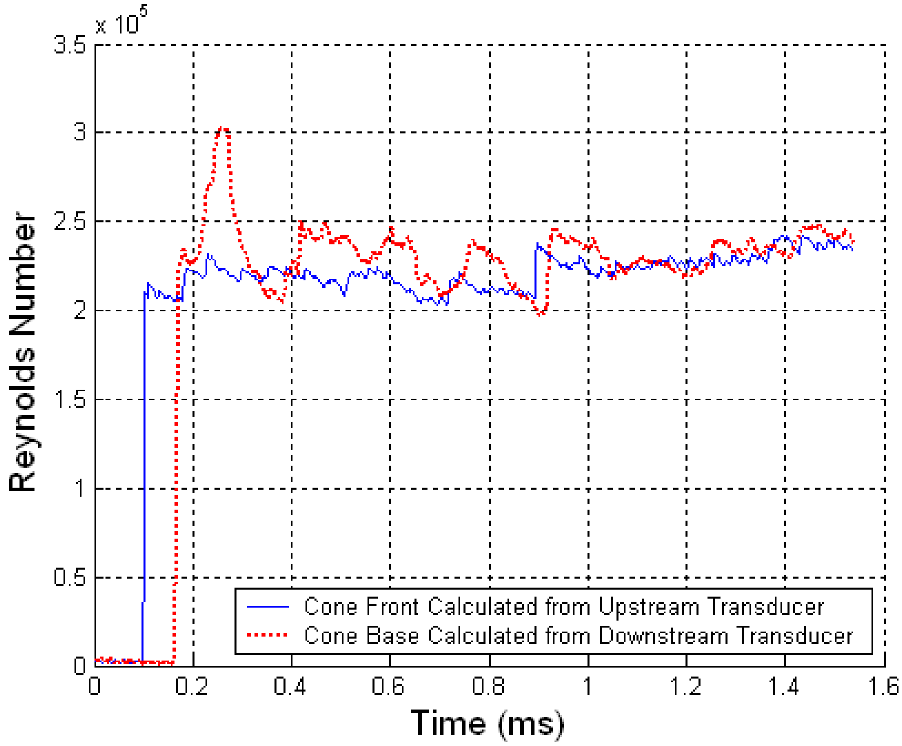

Figure B.47 Reynolds Number Plot ($M_s = 1.14$; $T_0 = 300K$; $P_0 = 83210Pa$)

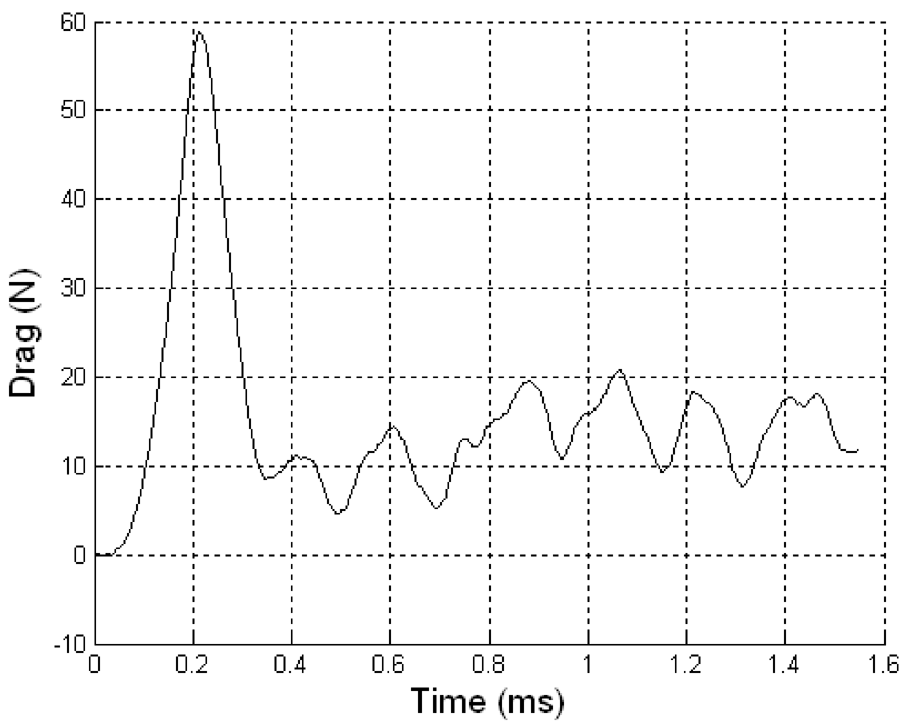

Figure B.48 Drag on Cone 3 ($M_s = 1.14$; $T_0 = 300K$; $P_0 = 83210Pa$)

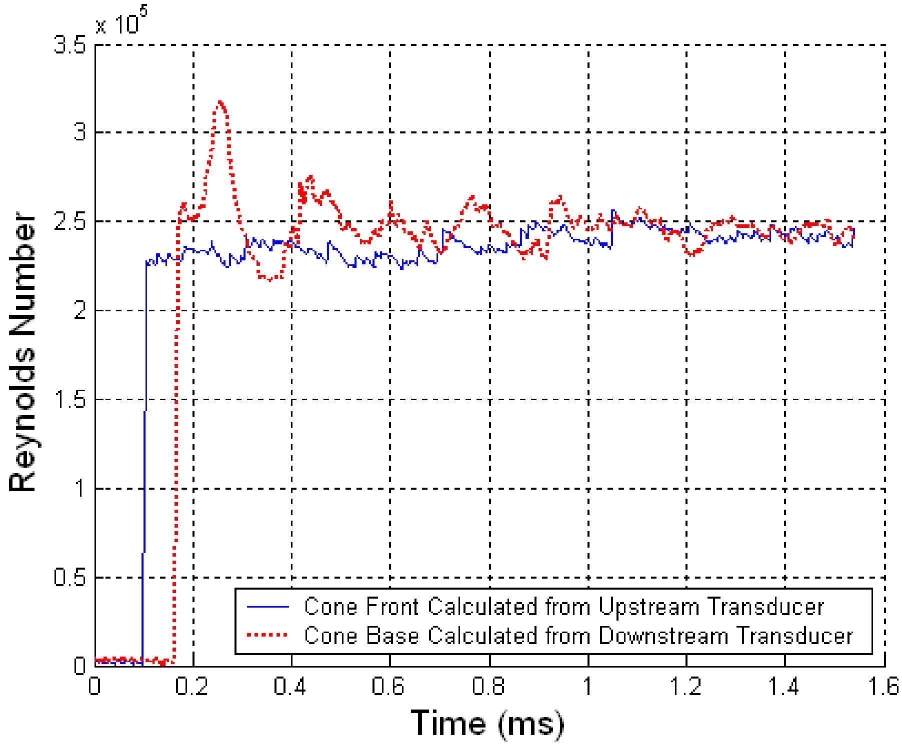

Figure B.49 Reynolds Number Plot ($M_s = 1.15$; $T_0 = 300K$; $P_0 = 83260Pa$)

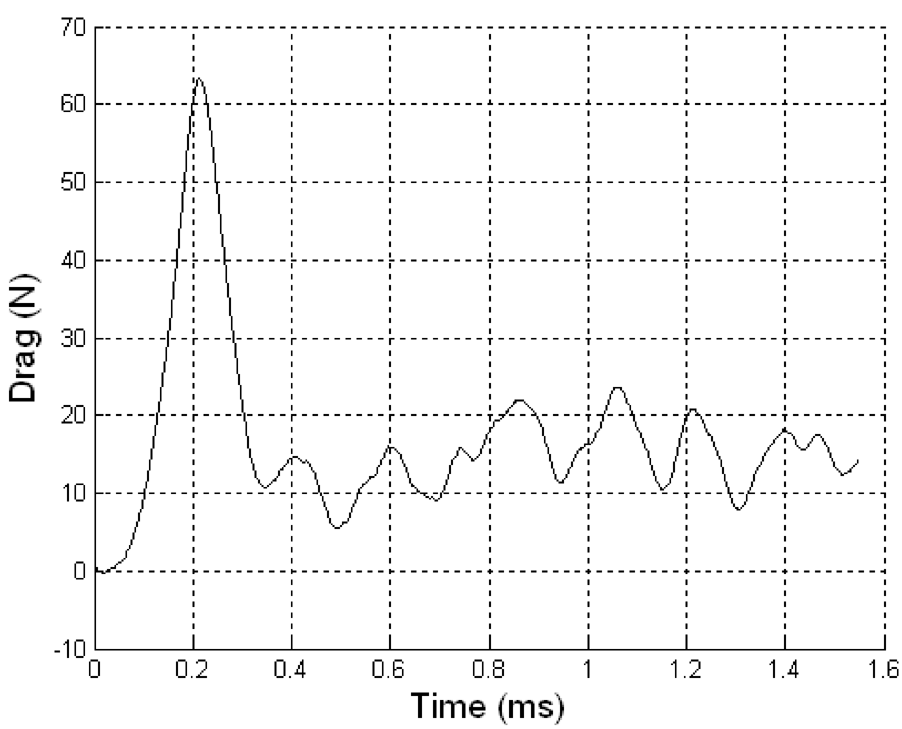

Figure B.50 Drag on Cone 3 ($M_s = 1.15$; $T_0 = 300K$; $P_0 = 83260Pa$)

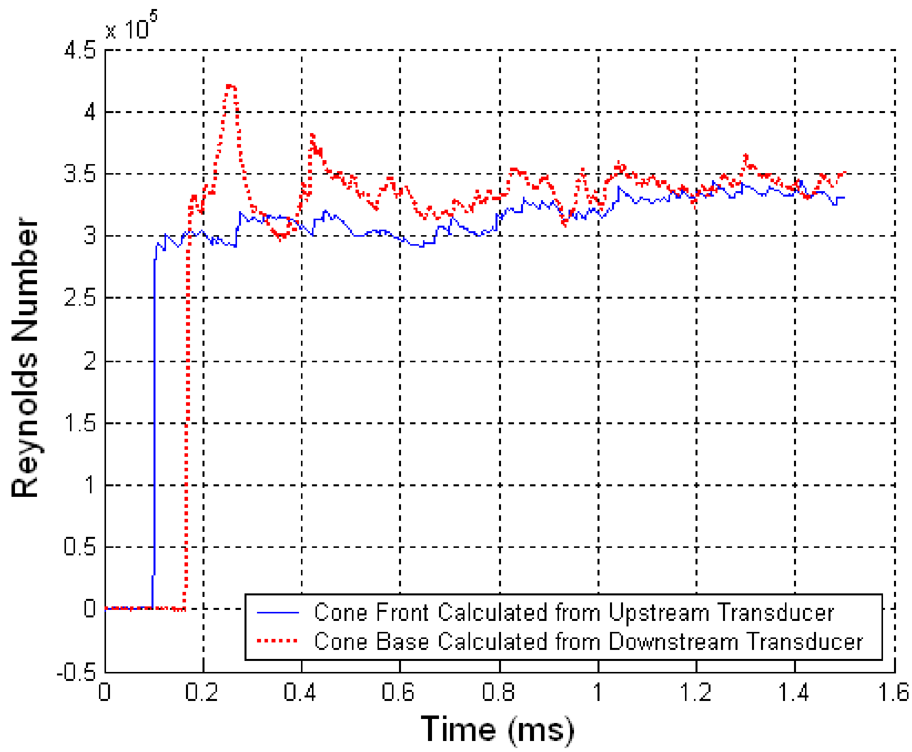

Figure B.51 Reynolds Number Plot ($M_s = 1.17$; $T_0 = 289K$; $P_0 = 83630Pa$)

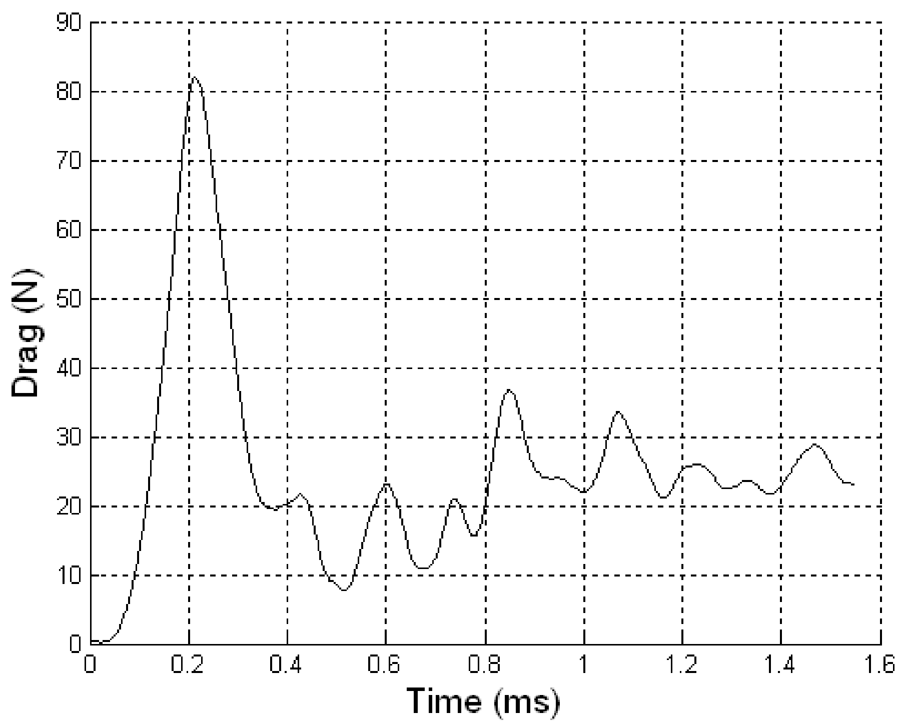

Figure B.52 Drag on Cone 3 ($M_s = 1.17$; $T_0 = 289K$; $P_0 = 83630Pa$)

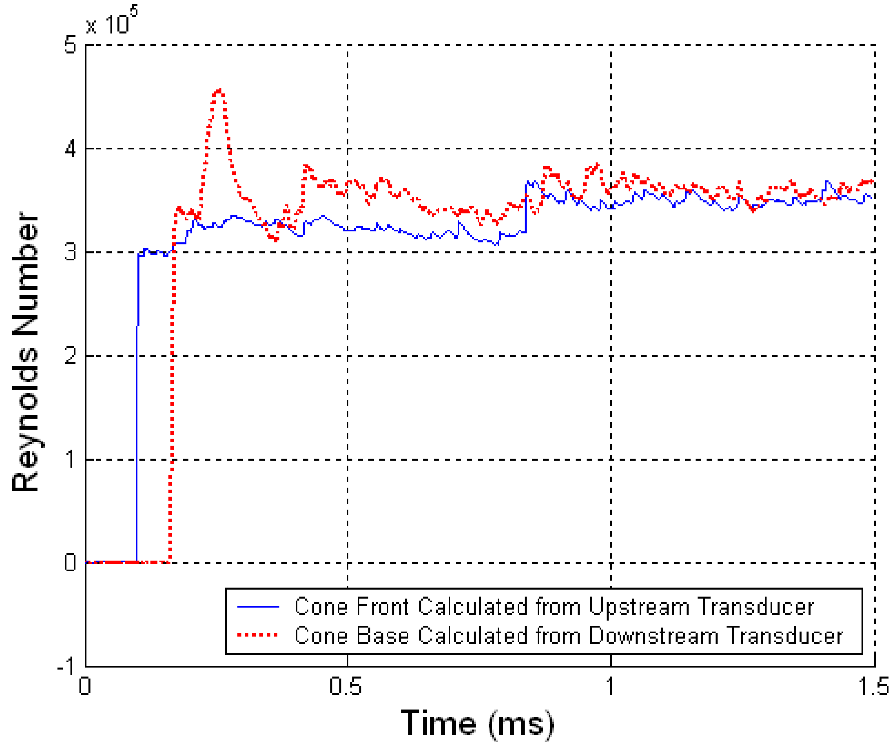

Figure B.53 Reynolds Number Plot ($M_s = 1.18$; $T_0 = 287K$; $P_0 = 83340Pa$)

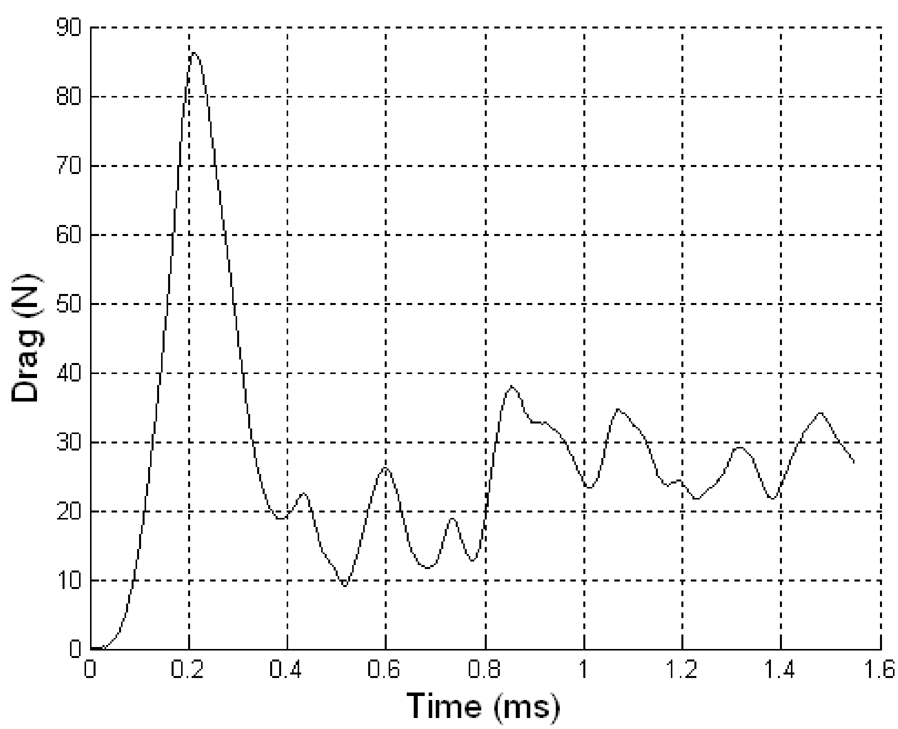

Figure B.54 Drag on Cone 3 ($M_s = 1.18$; $T_0 = 287K$; $P_0 = 83340Pa$)

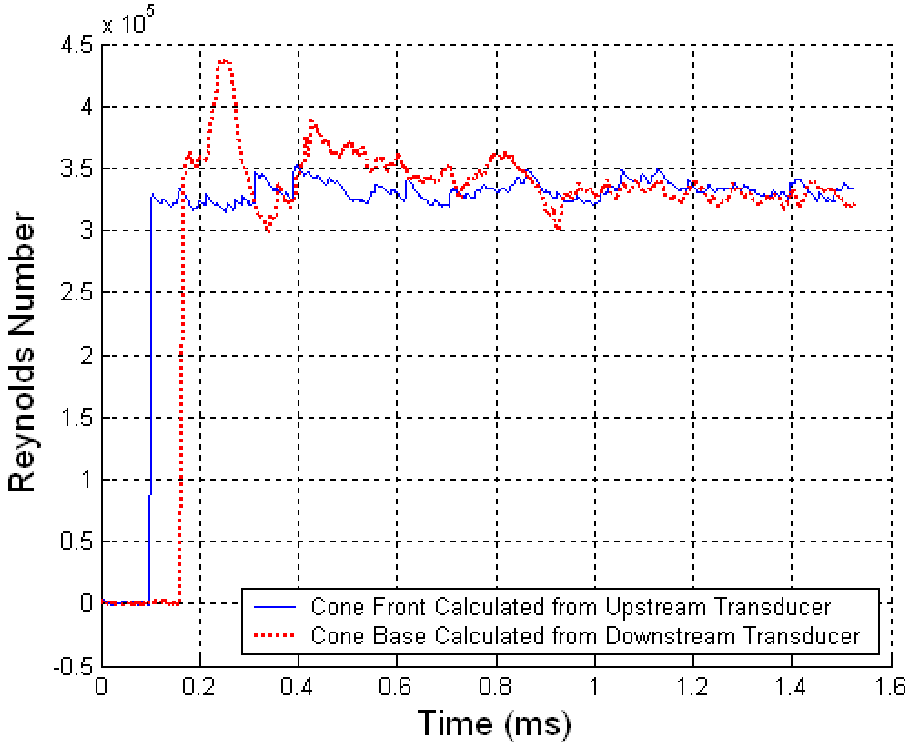

Figure B.55 Reynolds Number Plot ($M_s = 1.20$; $T_0 = 301K$; $P_0 = 82670Pa$)

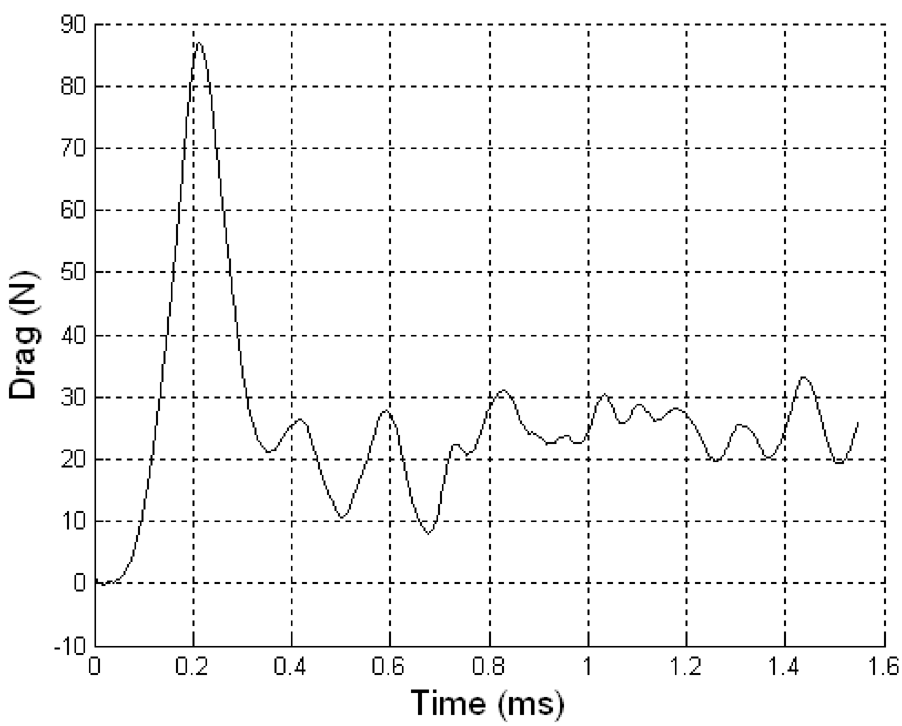

Figure B.56 Drag on Cone 3 ($M_s = 1.20$; $T_0 = 301K$; $P_0 = 82670Pa$)

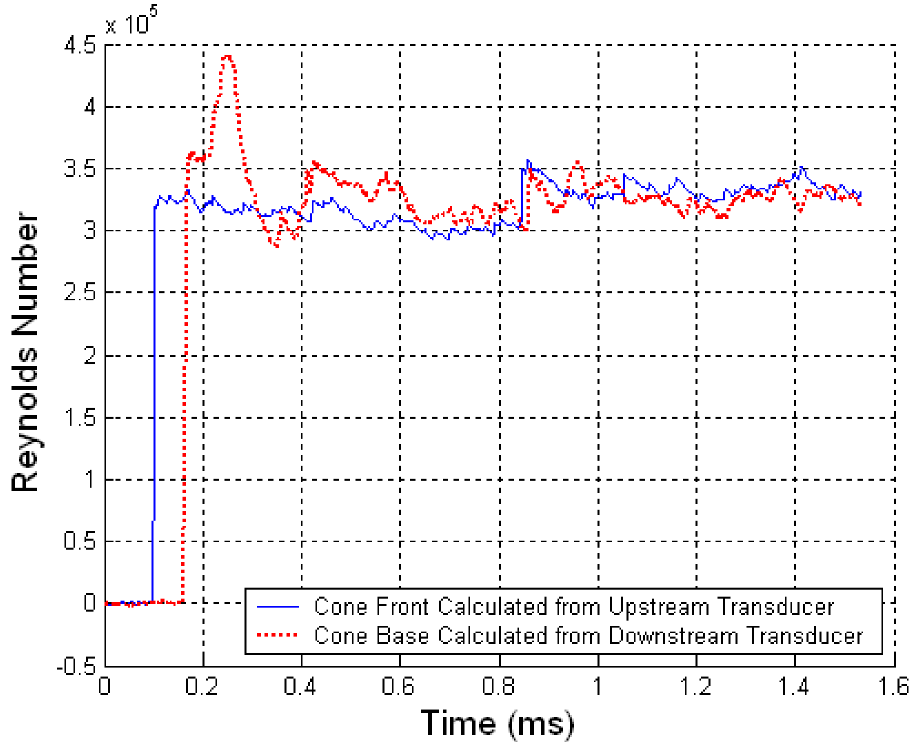

Figure B.57 Reynolds Number Plot ($M_s = 1.21$; $T_0 = 301K$; $P_0 = 83100Pa$)

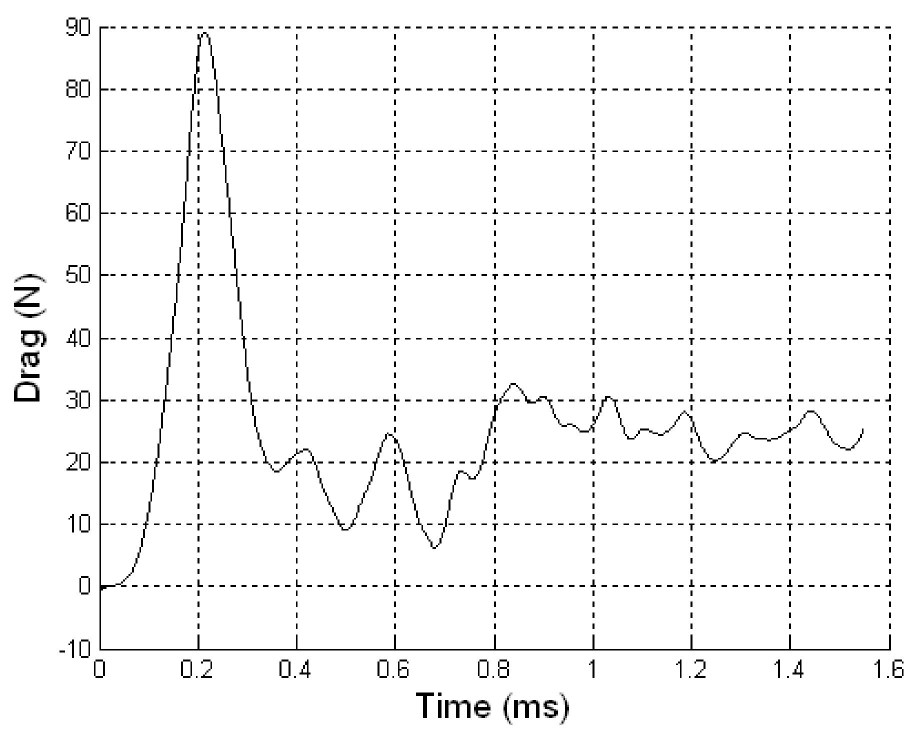

Figure B.58 Drag on Cone 3 ($M_s = 1.21$; $T_0 = 301K$; $P_0 = 83100Pa$)

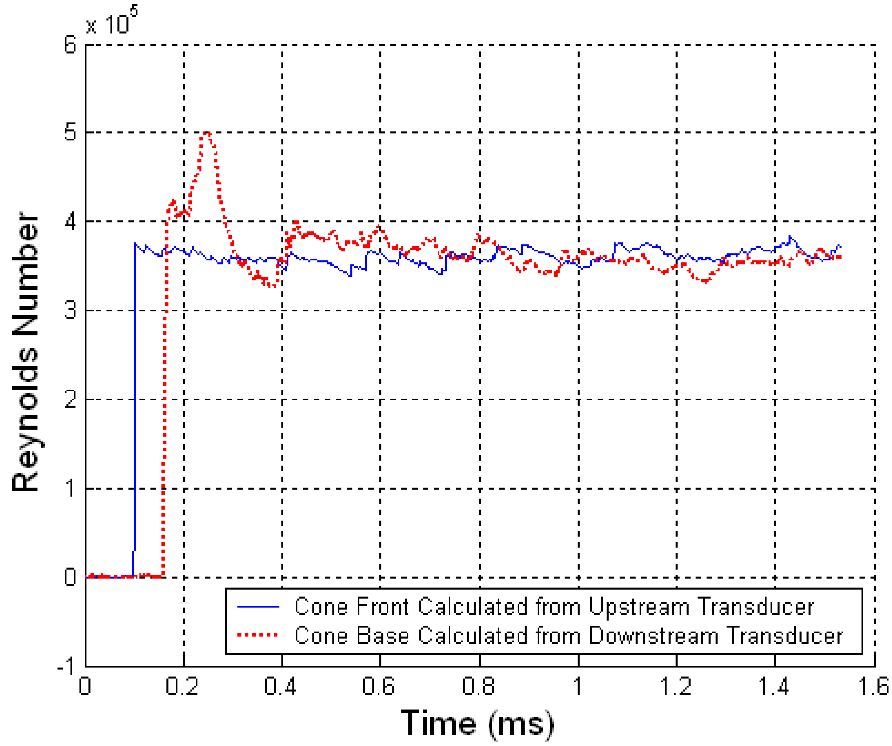

Figure B.59 Reynolds Number Plot ($M_s = 1.23$; $T_0 = 301K$; $P_0 = 83080Pa$)

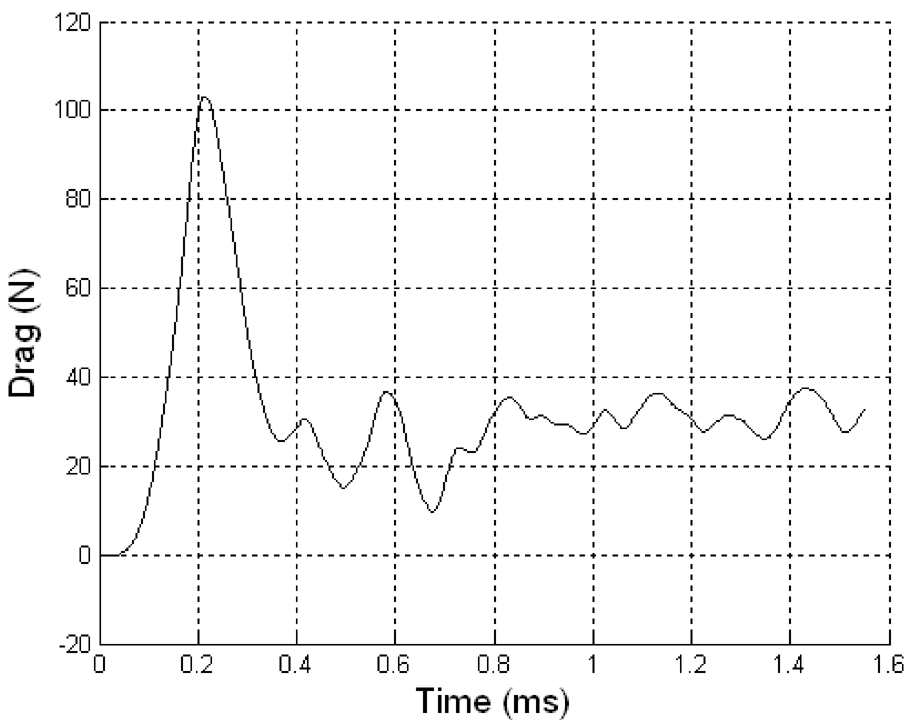

Figure B.60 Drag on Cone 3 ($M_s = 1.23$; $T_0 = 301K$; $P_0 = 83080Pa$)

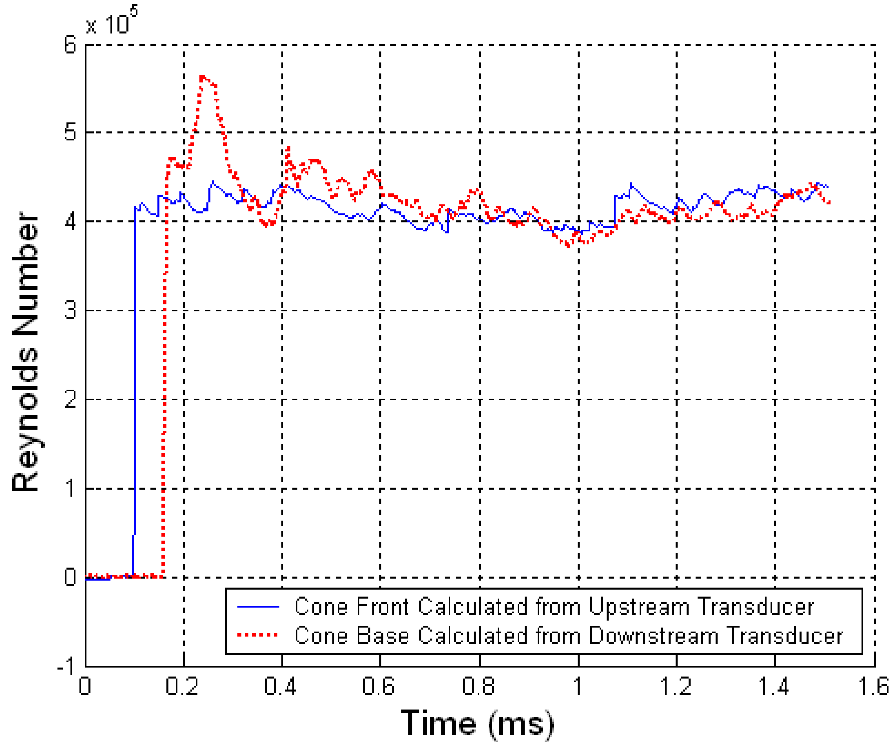

Figure B.61 Reynolds Number Plot ($M_s = 1.26$; $T_0 = 301K$; $P_0 = 82730Pa$)

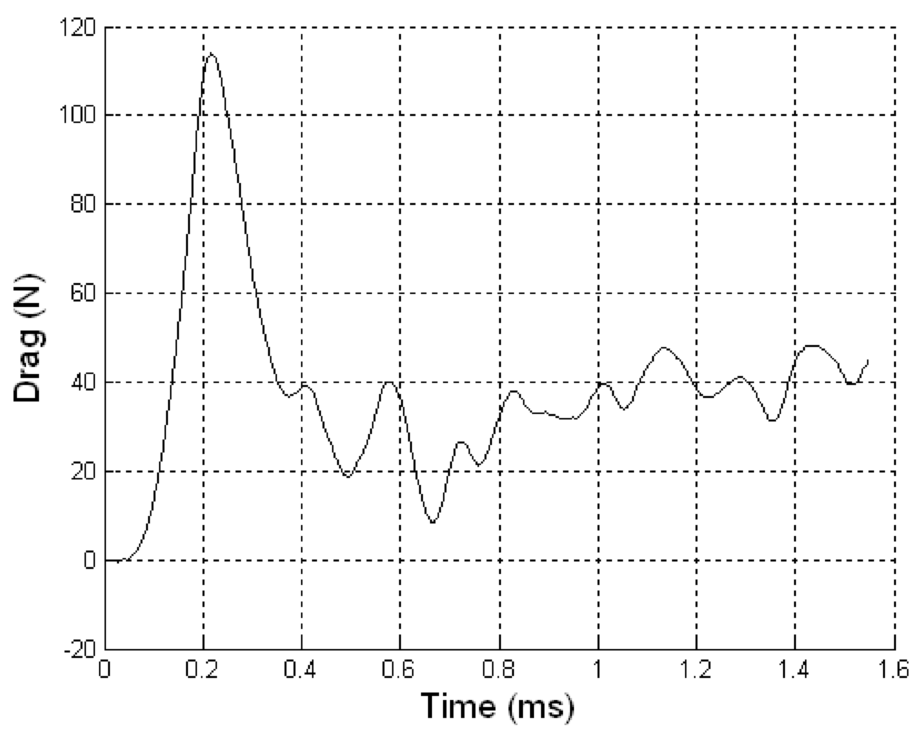

Figure B.62 Drag on Cone 3 ($M_s = 1.26$; $T_0 = 301K$; $P_0 = 82730Pa$)

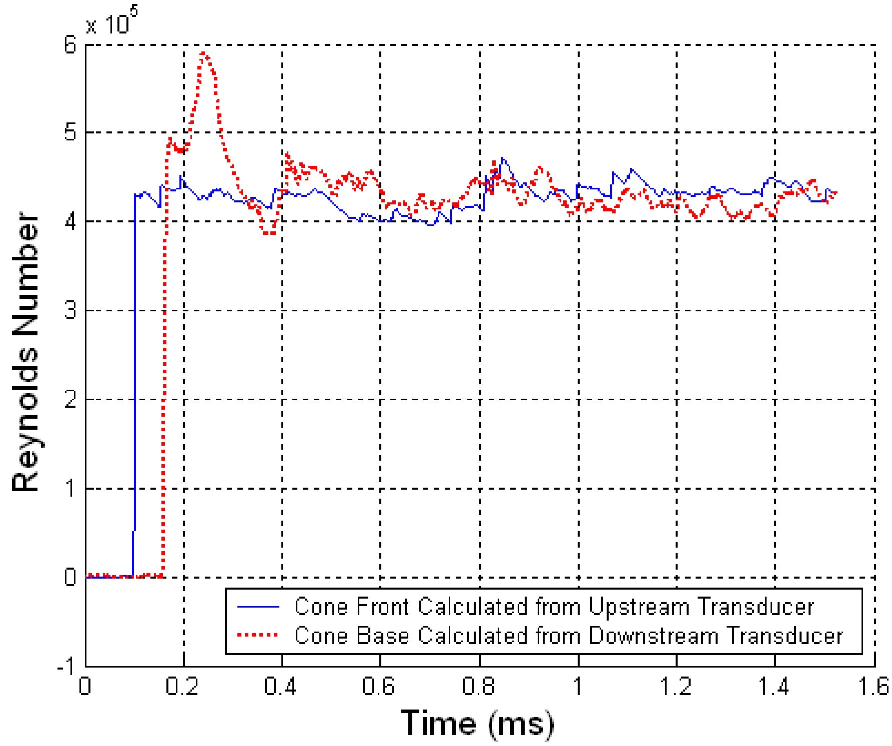

Figure B.63 Reynolds Number Plot ($M_s = 1.27$; $T_0 = 301K$; $P_0 = 82770Pa$)

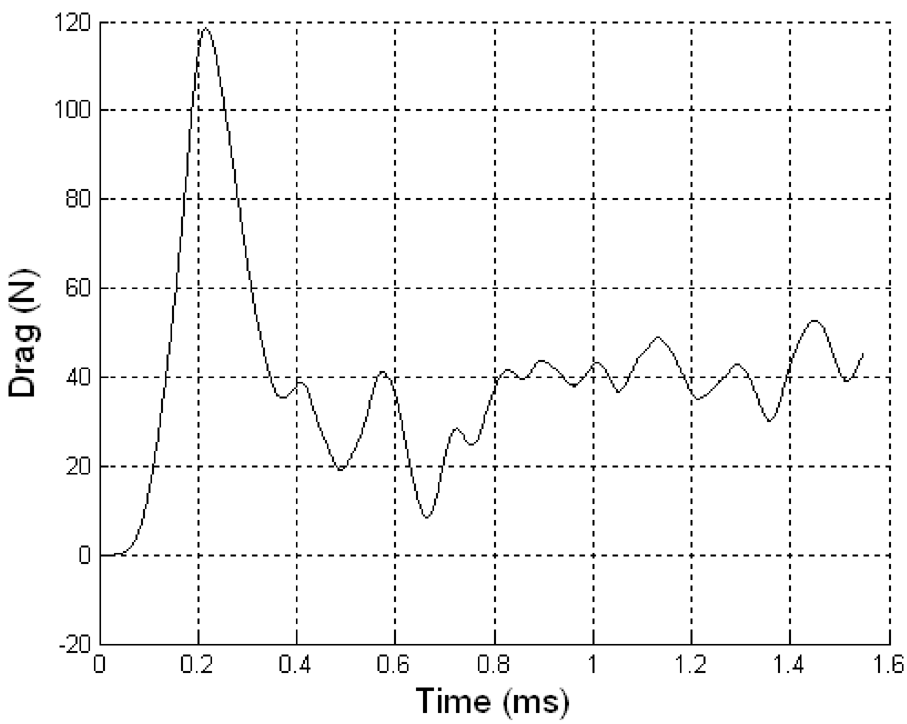

Figure B.64 Drag on Cone 3 ($M_s = 1.27$; $T_0 = 301K$; $P_0 = 82770Pa$)

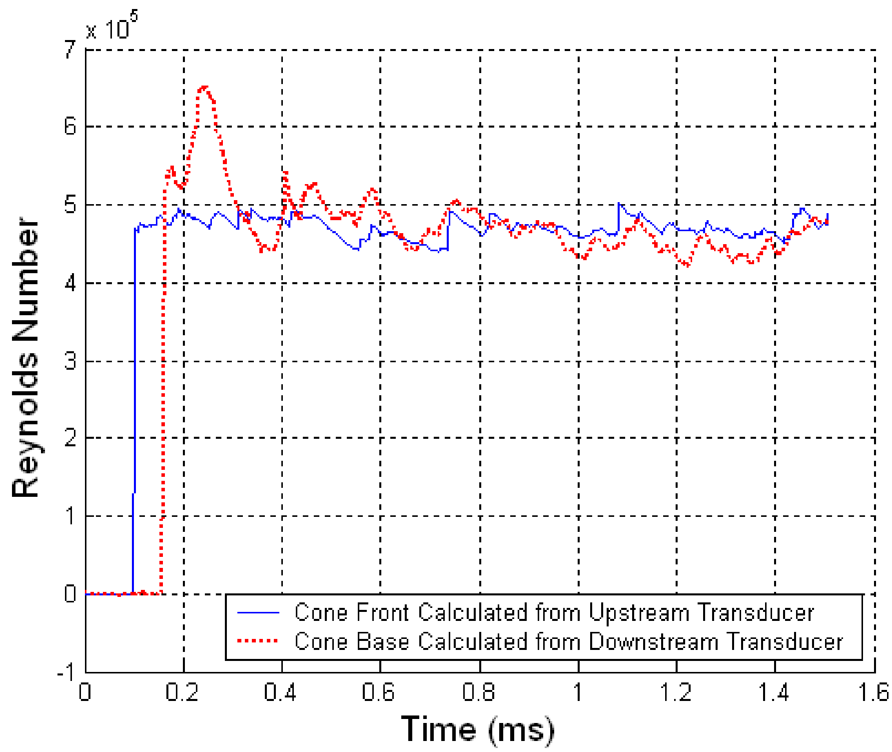

Figure B.65 Reynolds Number Plot ($M_s = 1.29$; $T_0 = 301K$; $P_0 = 82800Pa$)

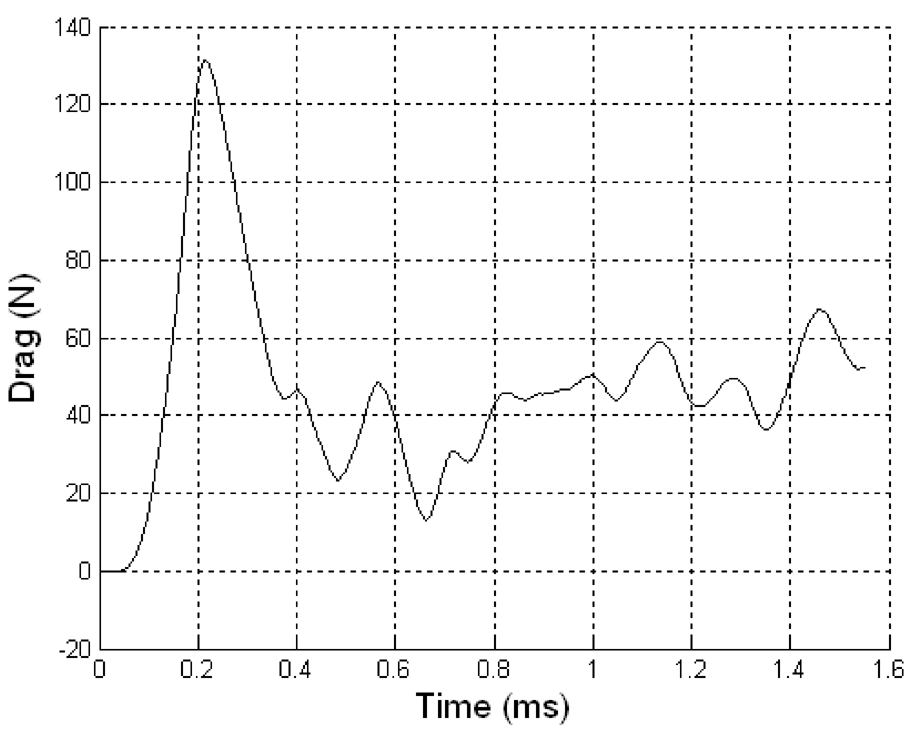

Figure B.66 Drag on Cone 3 ($M_s = 1.29$; $T_0 = 301K$; $P_0 = 82800Pa$)

B.4 Cone 4

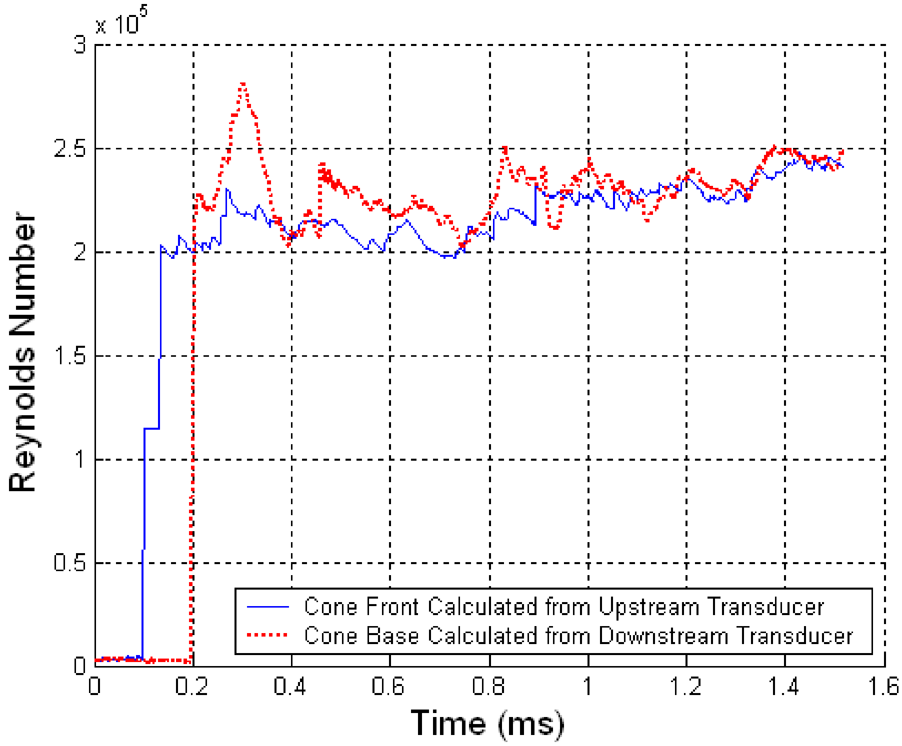

Figure B.67 Reynolds Number Plot ($M_s = 1.14$; $T_0 = 300K$; $P_0 = 83050Pa$)

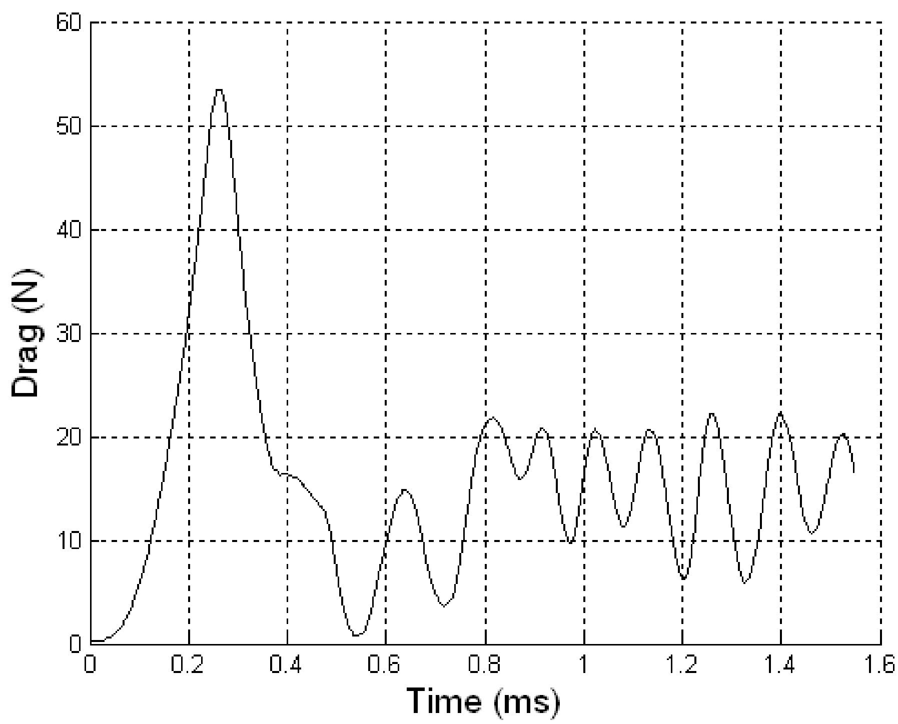

Figure B.68 Drag on Cone 4 ($M_s = 1.14$; $T_0 = 300K$; $P_0 = 83050Pa$)

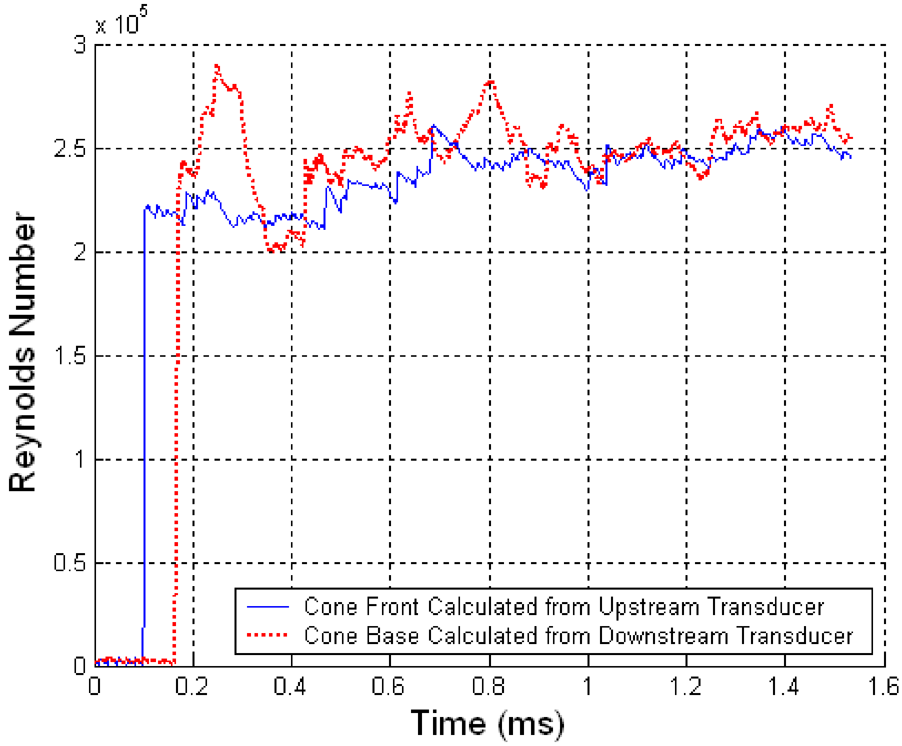

Figure B.69 Reynolds Number Plot ($M_s = 1.15$; $T_0 = 302K$; $P_0 = 82720Pa$)

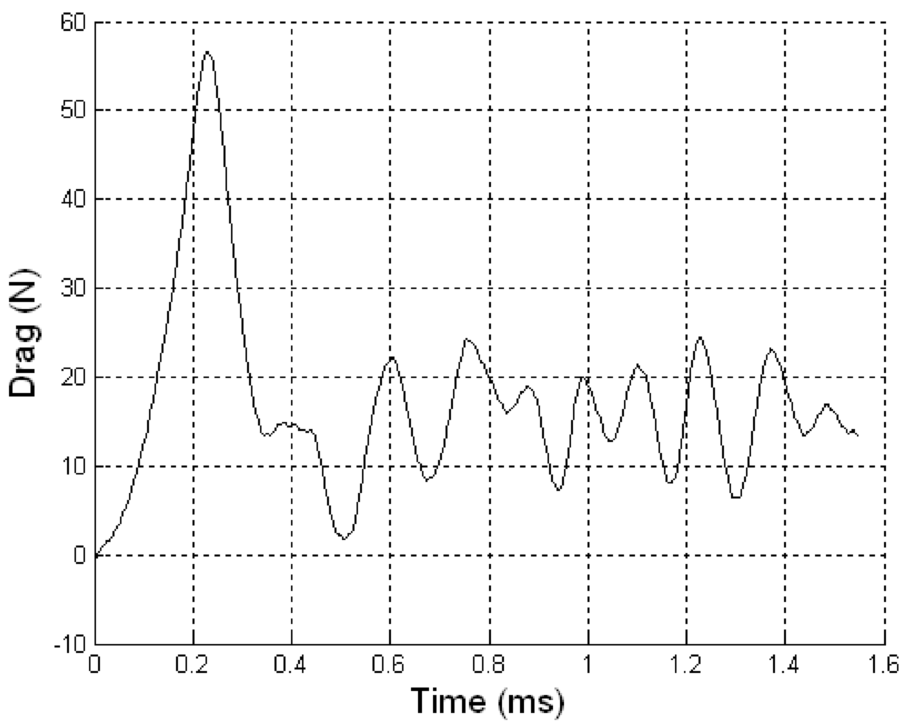

Figure B.70 Drag on Cone 4 ($M_s = 1.15$; $T_0 = 302K$; $P_0 = 82720Pa$)

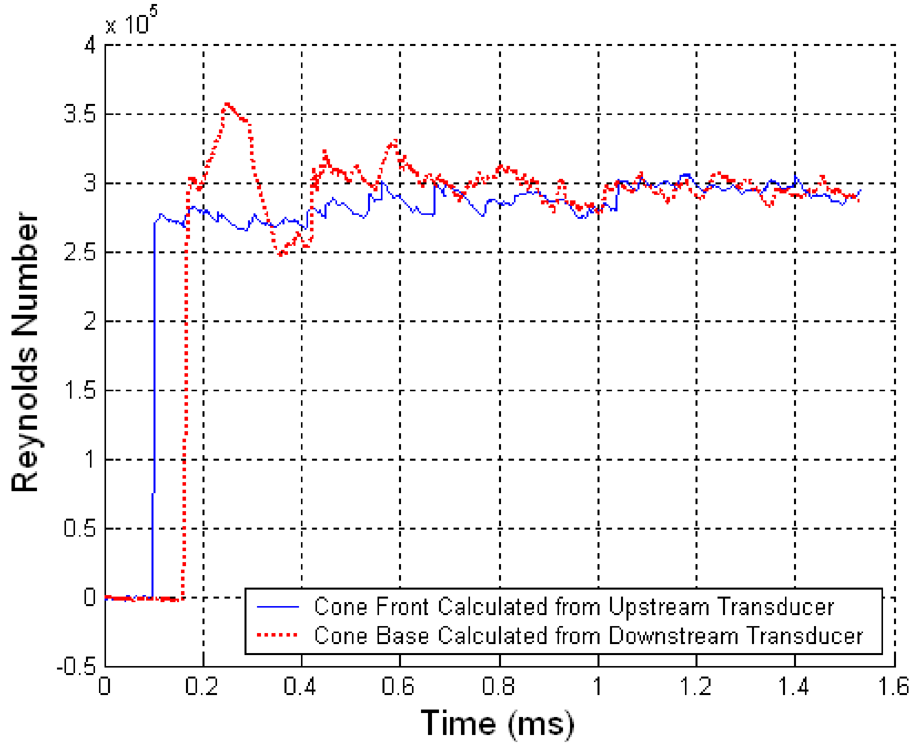

Figure B.71 Reynolds Number Plot ($M_s = 1.18$; $T_0 = 302K$; $P_0 = 82740Pa$)

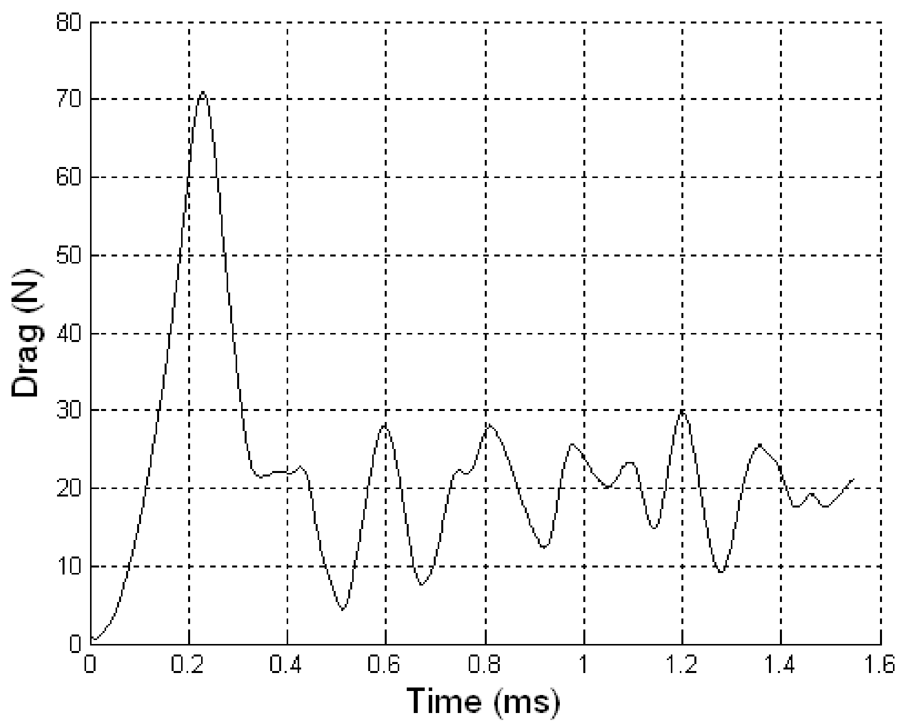

Figure B.72 Drag on Cone 4 ($M_s = 1.18$; $T_0 = 302K$; $P_0 = 82740Pa$)

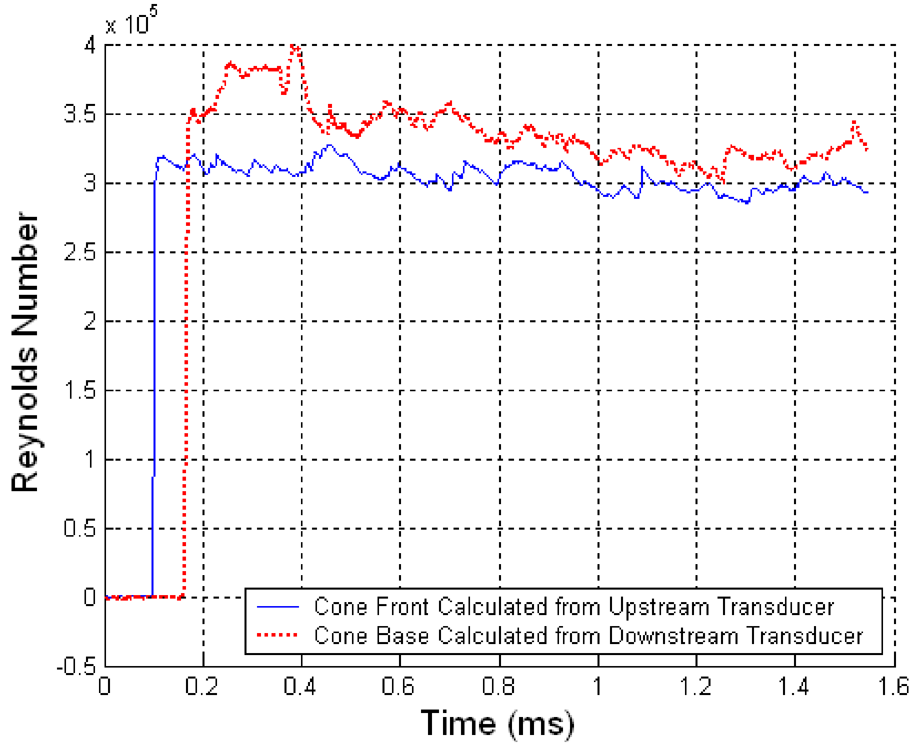

Figure B.73 Reynolds Number Plot ($M_s = 1.19$; $T_0 = 289K$; $P_0 = 82840Pa$)

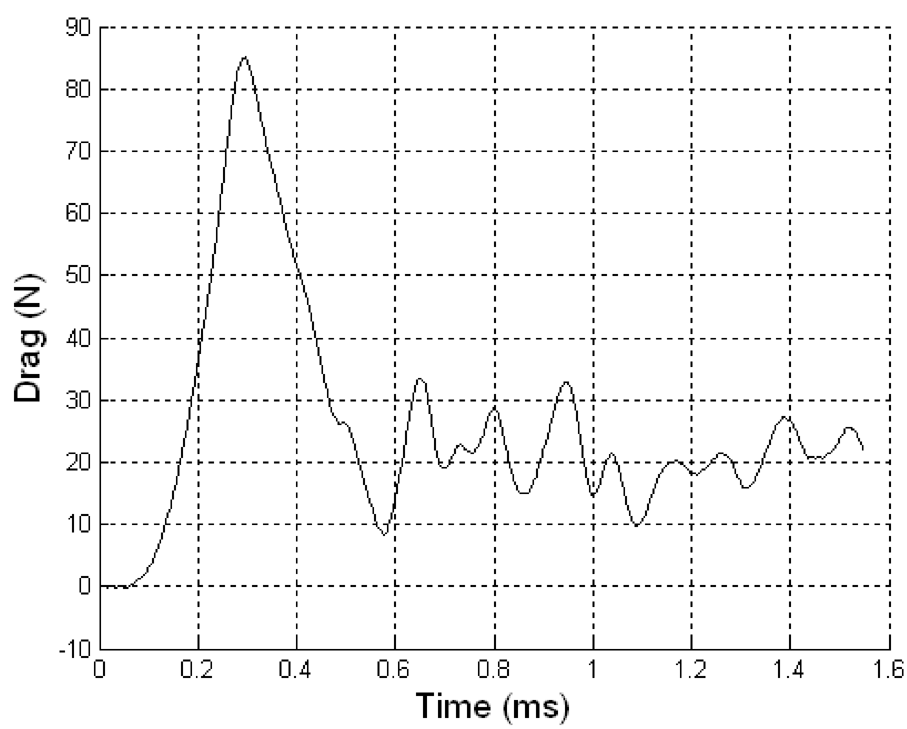

Figure B.74 Drag on Cone 4 ($M_s = 1.19$; $T_0 = 289K$; $P_0 = 82840Pa$)

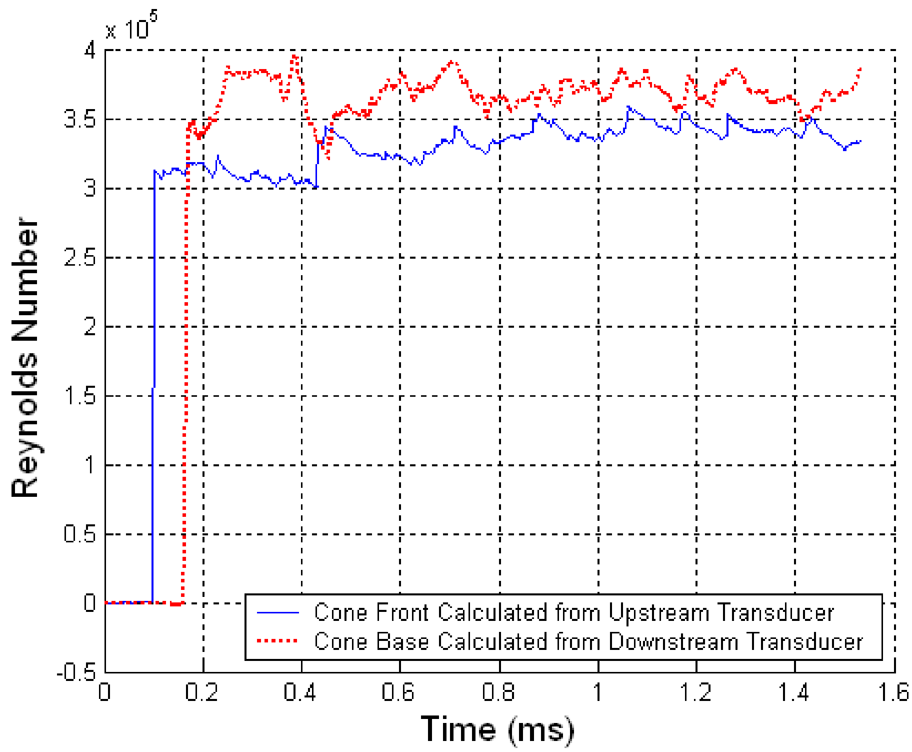

Figure B.75 Reynolds Number Plot ($M_s = 1.20$; $T_0 = 289K$; $P_0 = 82840Pa$)

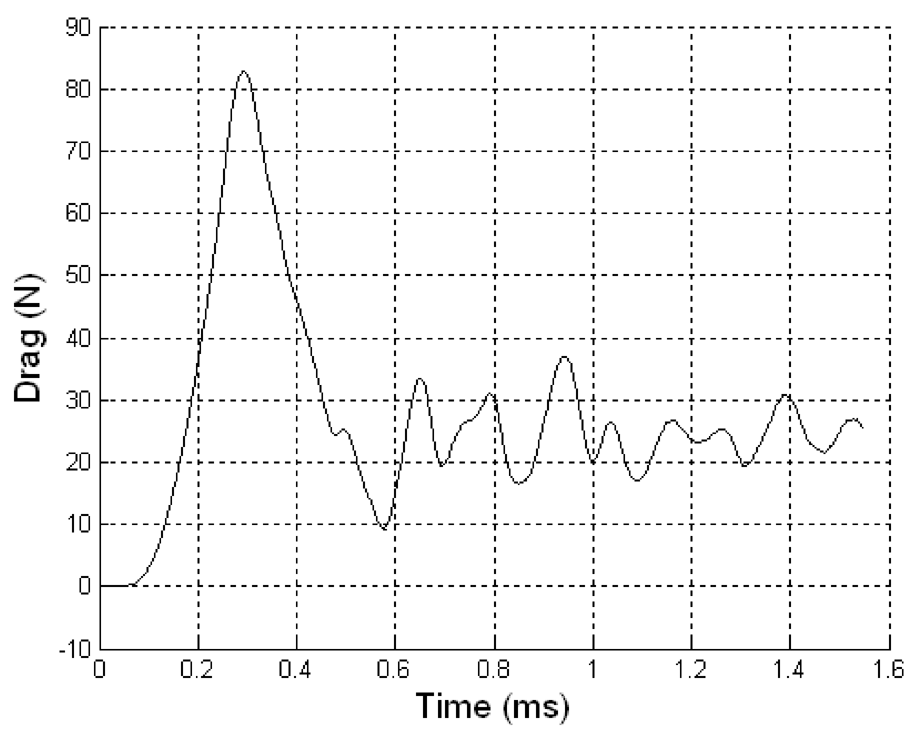

Figure B.76 Drag on Cone 4 ($M_s = 1.20$; $T_0 = 289K$; $P_0 = 82840Pa$)

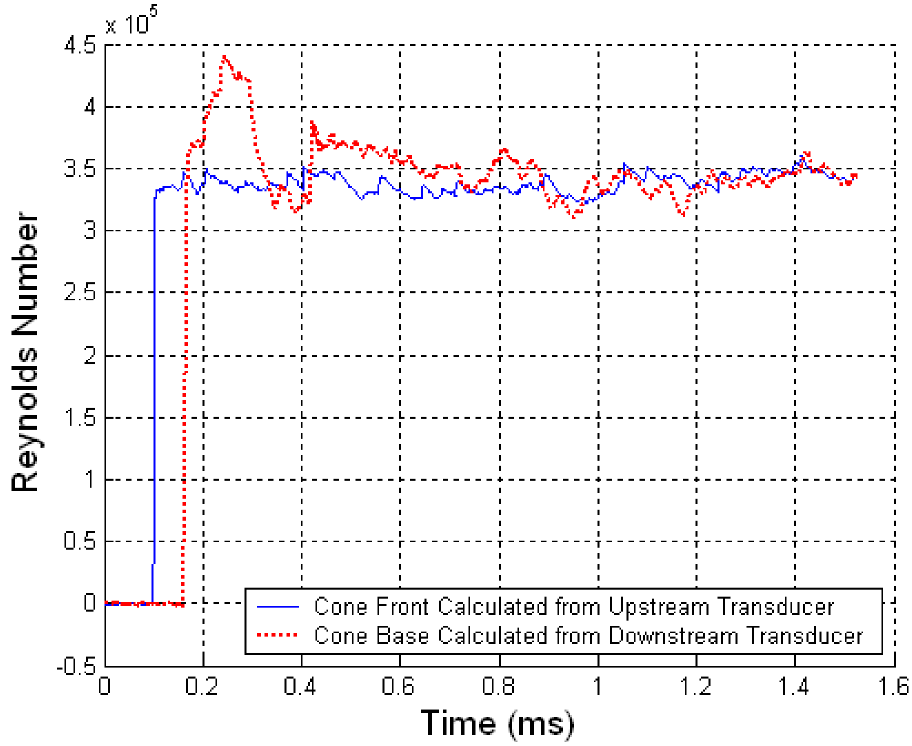

Figure B.77 Reynolds Number Plot ($M_s = 1.21$; $T_0 = 302K$; $P_0 = 82780Pa$)

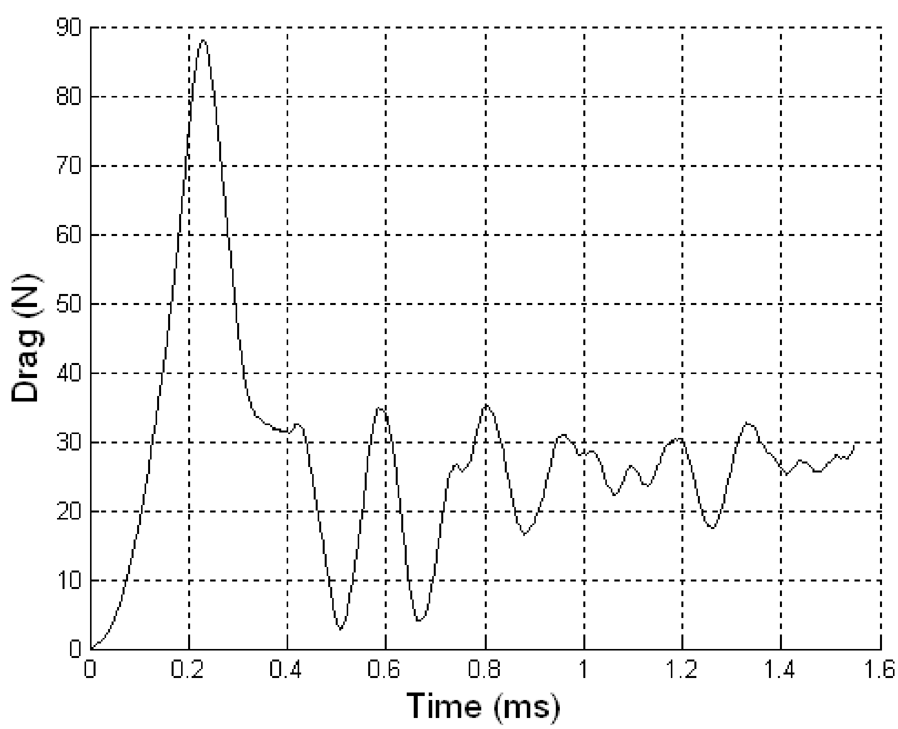

Figure B.78 Drag on Cone 4 ($M_s = 1.21$; $T_0 = 302K$; $P_0 = 82780Pa$)

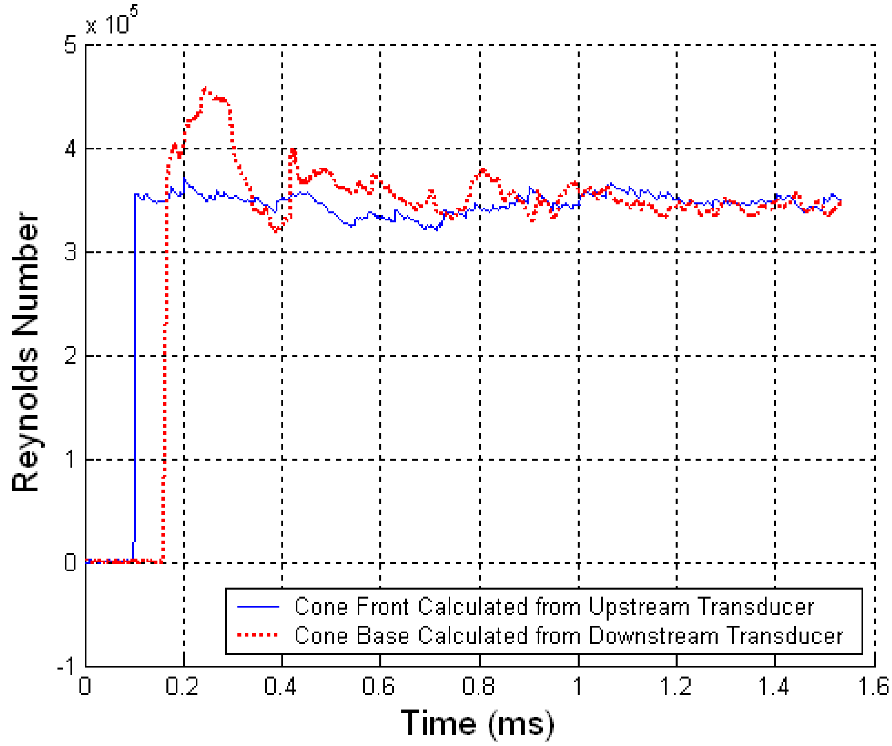

Figure B.79 Reynolds Number Plot ($M_s = 1.22$; $T_0 = 301K$; $P_0 = 82730Pa$)

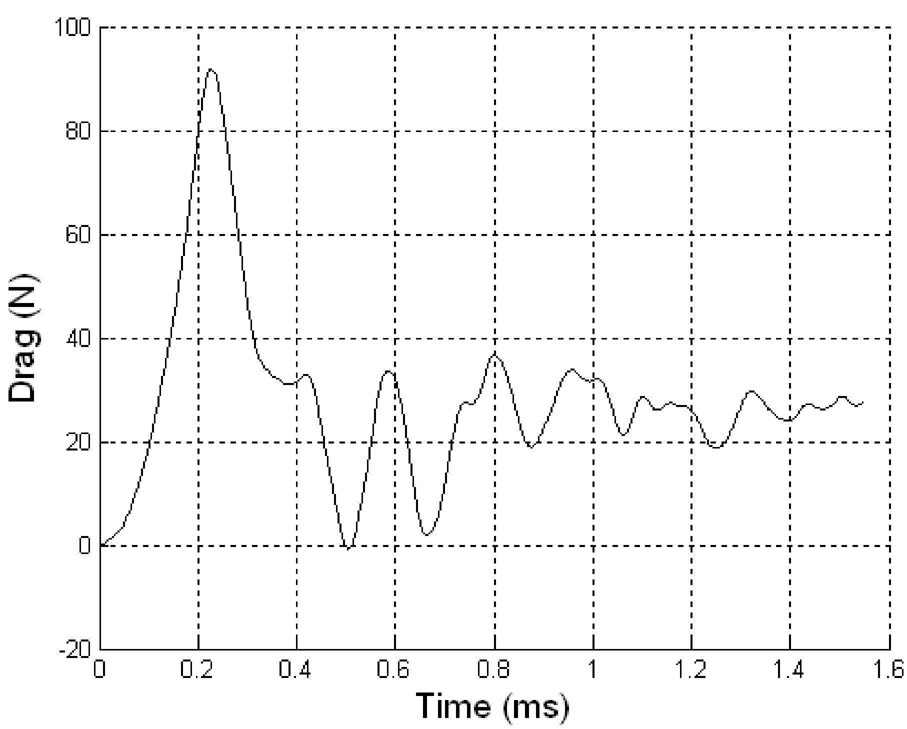

Figure B.80 Drag on Cone 4 ($M_s = 1.22$; $T_0 = 301K$; $P_0 = 82730Pa$)

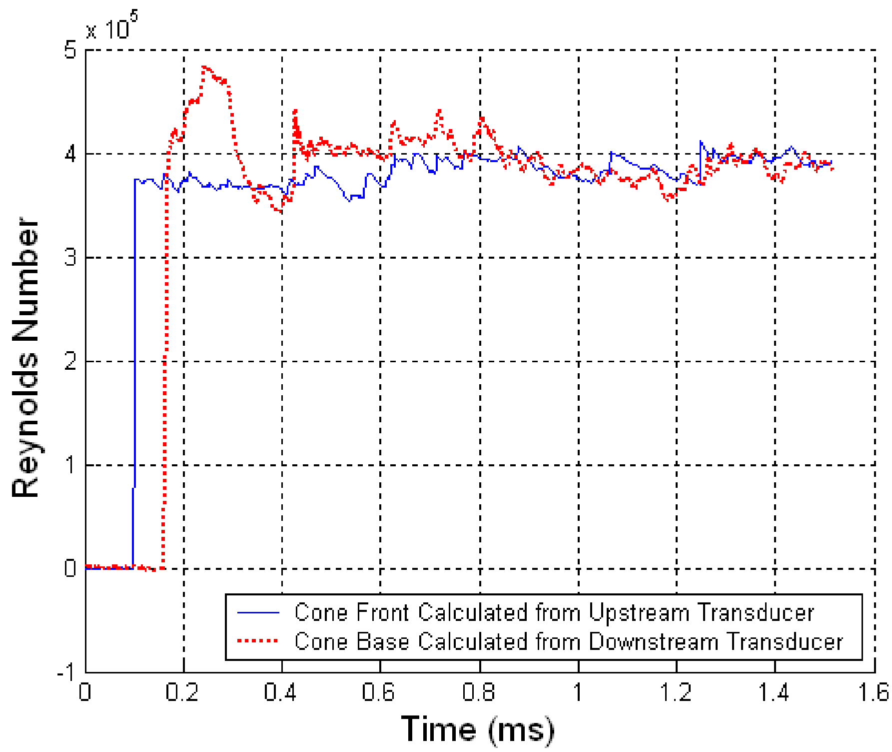

Figure B.81 Reynolds Number Plot ($M_s = 1.23$; $T_0 = 292K$; $P_0 = 83230Pa$)

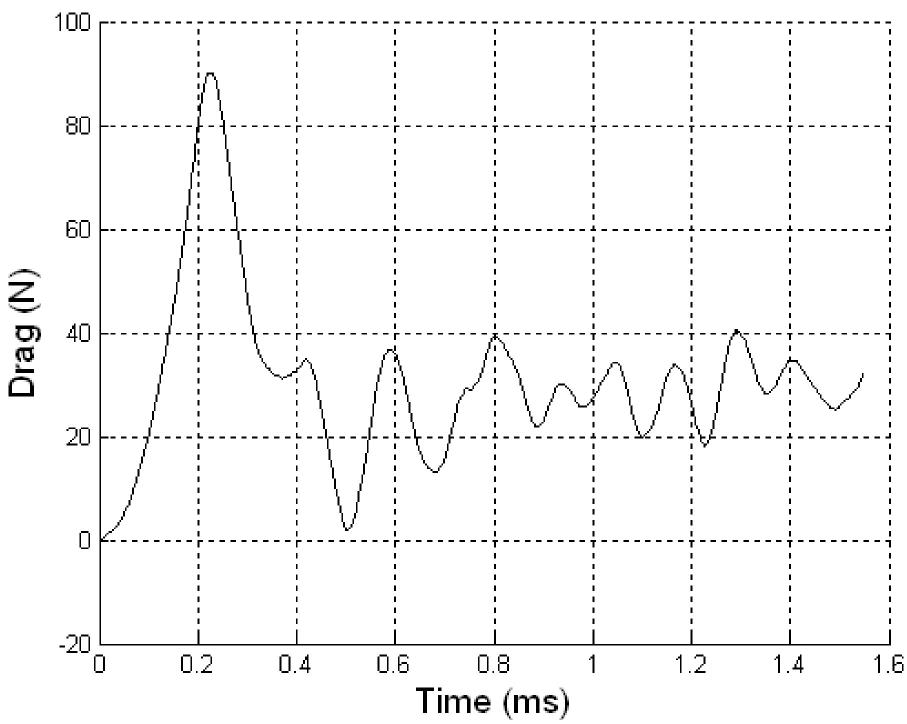

Figure B.82 Drag on Cone 4 ($M_s = 1.23$; $T_0 = 292K$; $P_0 = 83230Pa$)

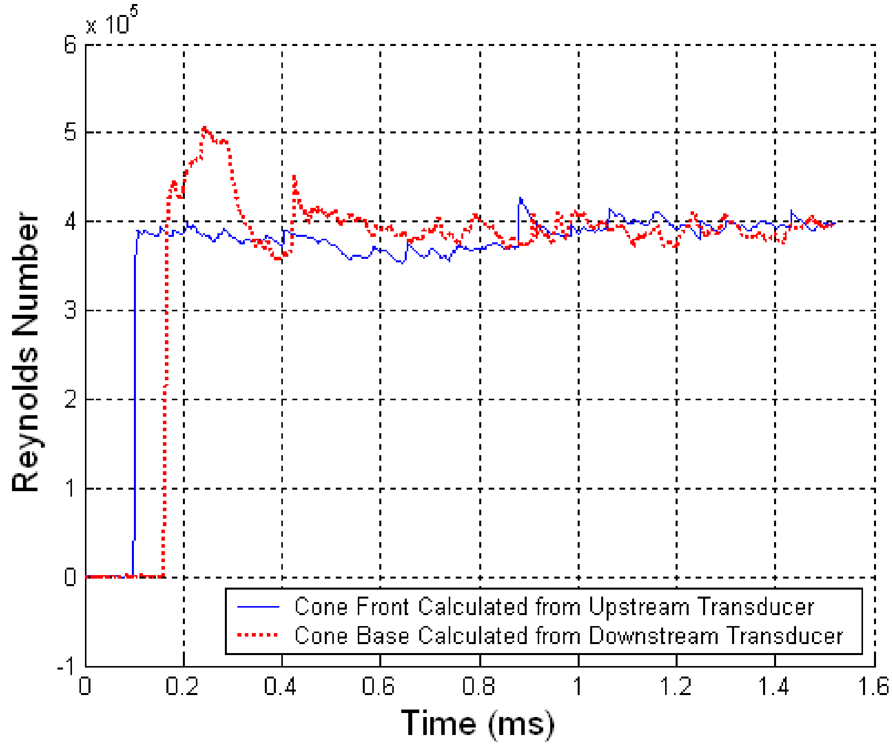

Figure B.83 Reynolds Number Plot ($M_s = 1.24$; $T_0 = 295K$; $P_0 = 83090Pa$)

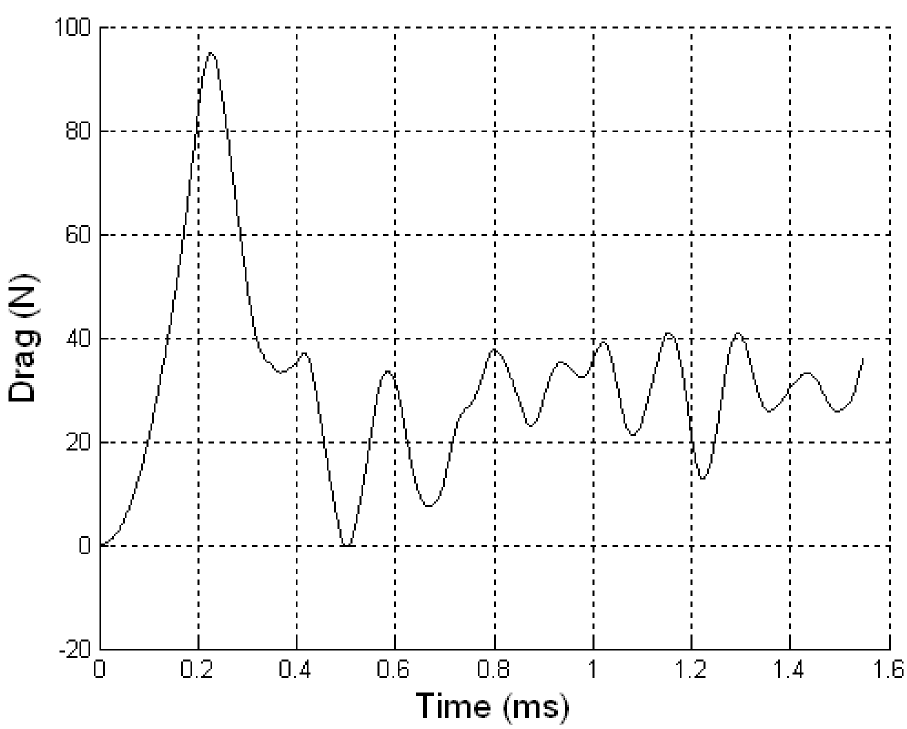

Figure B.84 Drag on Cone 4 ($M_s = 1.24$; $T_0 = 295K$; $P_0 = 83090Pa$)

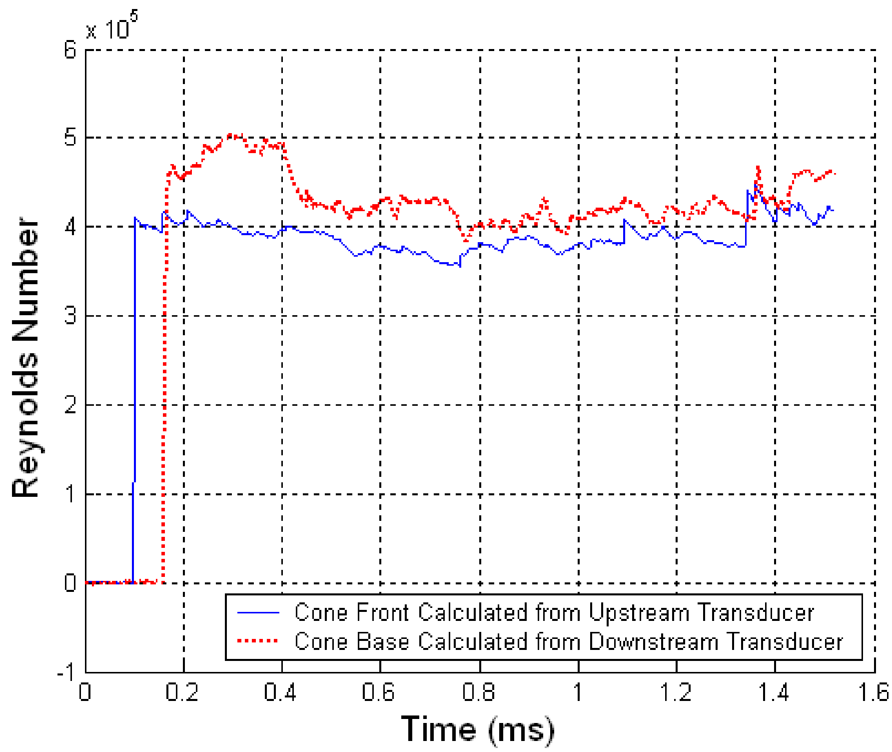

Figure B.85 Reynolds Number Plot ($M_s = 1.25$; $T_0 = 292K$; $P_0 = 82890Pa$)

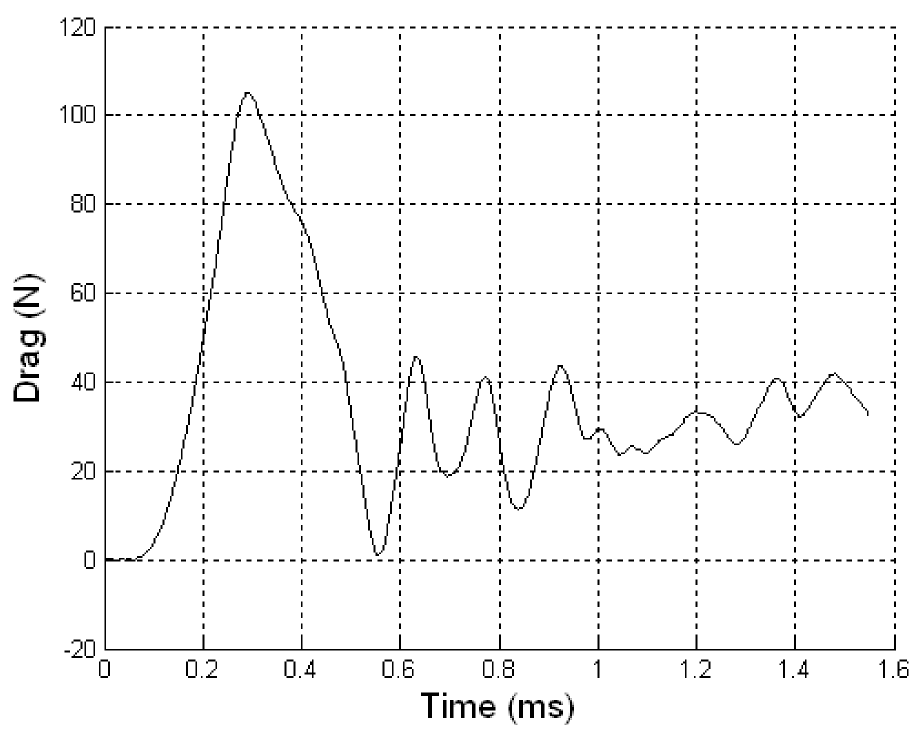

Figure B.86 Drag on Cone 4 ($M_s = 1.25$; $T_0 = 292K$; $P_0 = 82890Pa$)

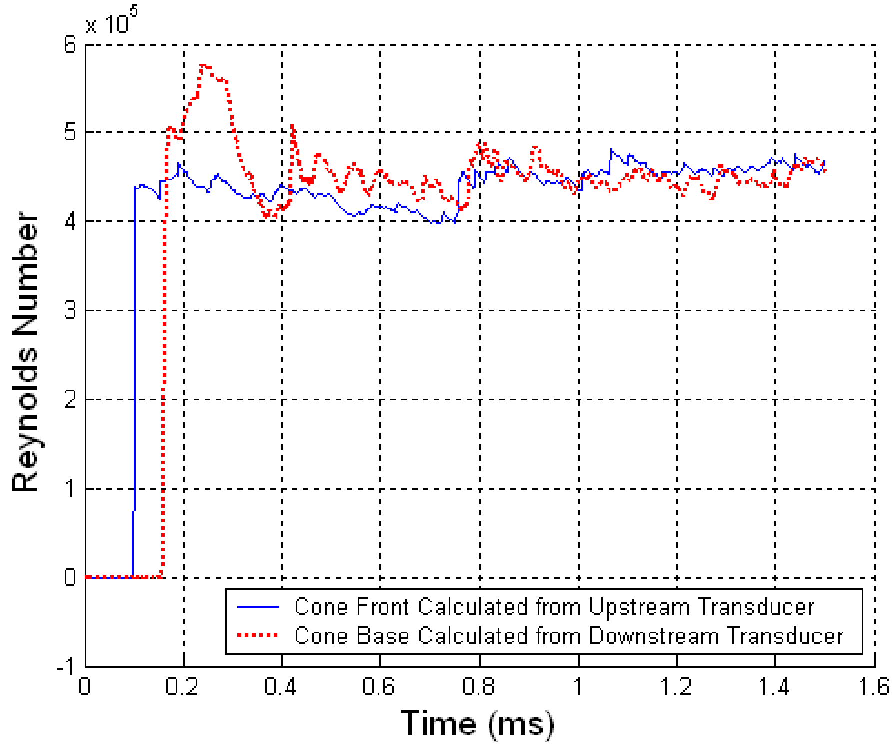

Figure B.87 Reynolds Number Plot ($M_s = 1.26$; $T_0 = 294K$; $P_0 = 83310Pa$)

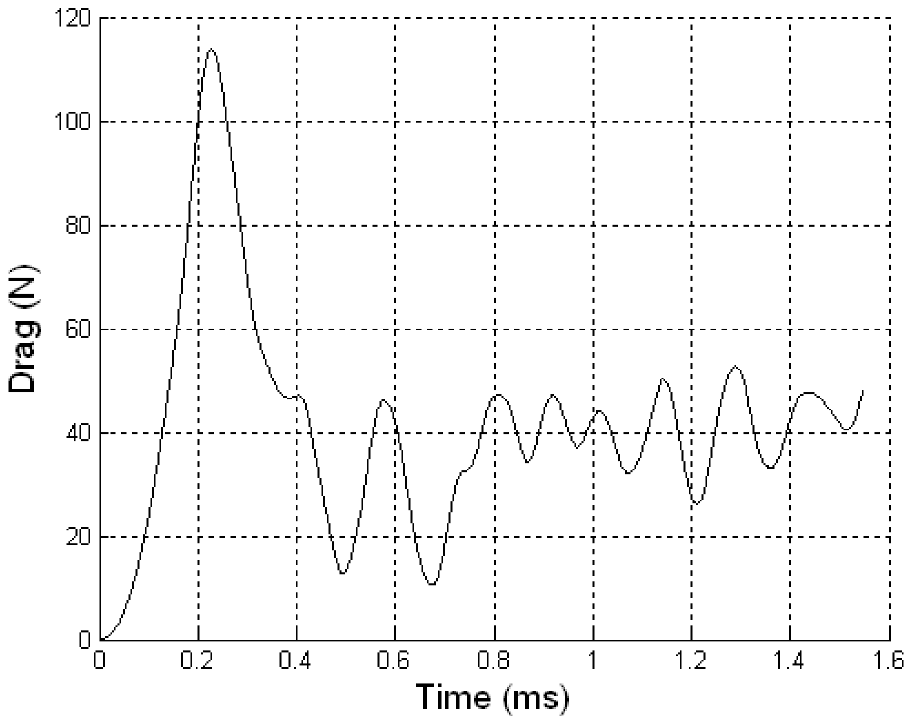

Figure B.88 Drag on Cone 4 ($M_s = 1.26$; $T_0 = 294K$; $P_0 = 83310Pa$)

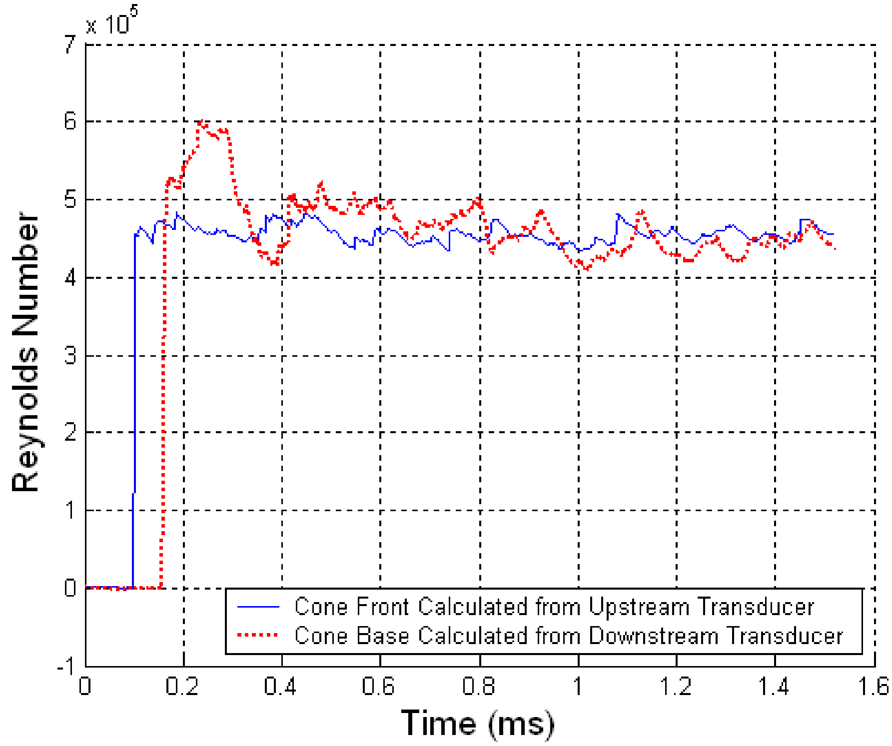

Figure B.89 Reynolds Number Plot ($M_s = 1.28$; $T_0 = 301K$; $P_0 = 82780Pa$)

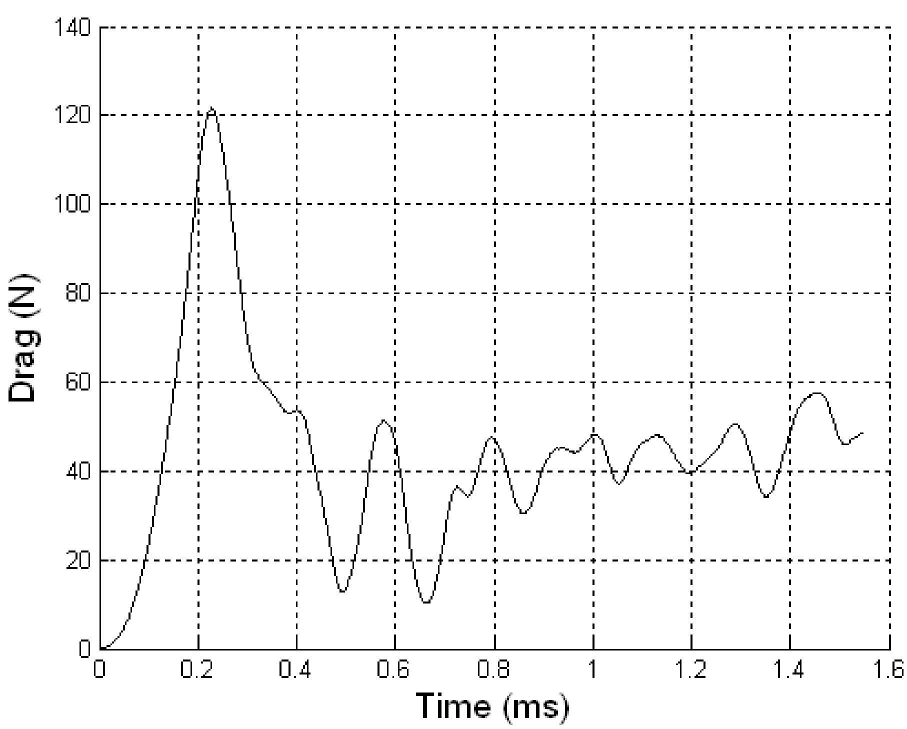

Figure B.90 Drag on Cone 4 ($M_s = 1.28$; $T_0 = 301K$; $P_0 = 82780Pa$)

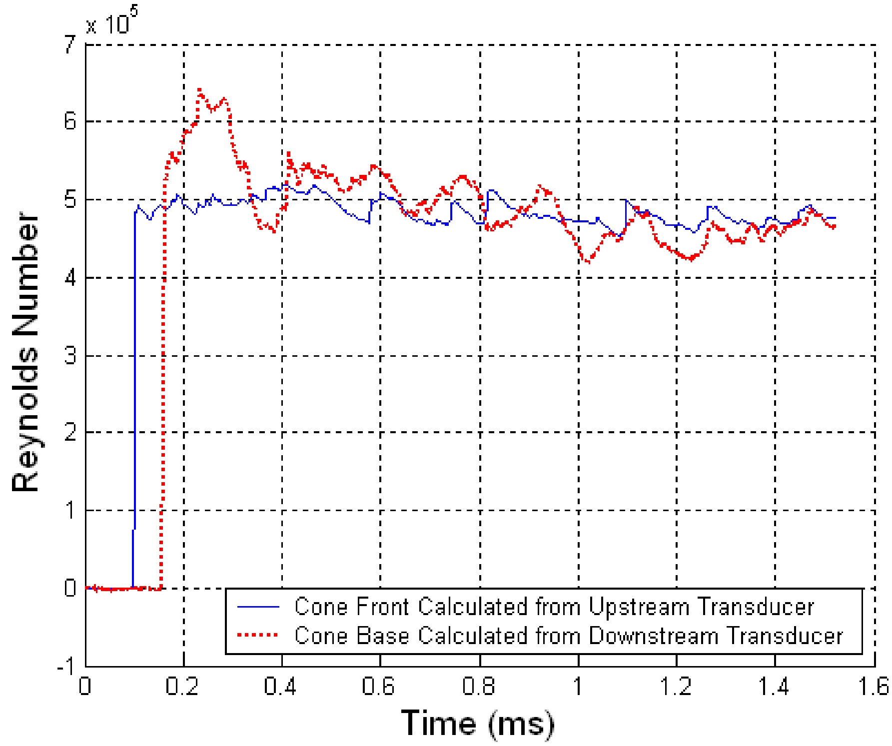

Figure B.91 Reynolds Number Plot ($M_s = 1.29$; $T_0 = 301K$; $P_0 = 82830Pa$)

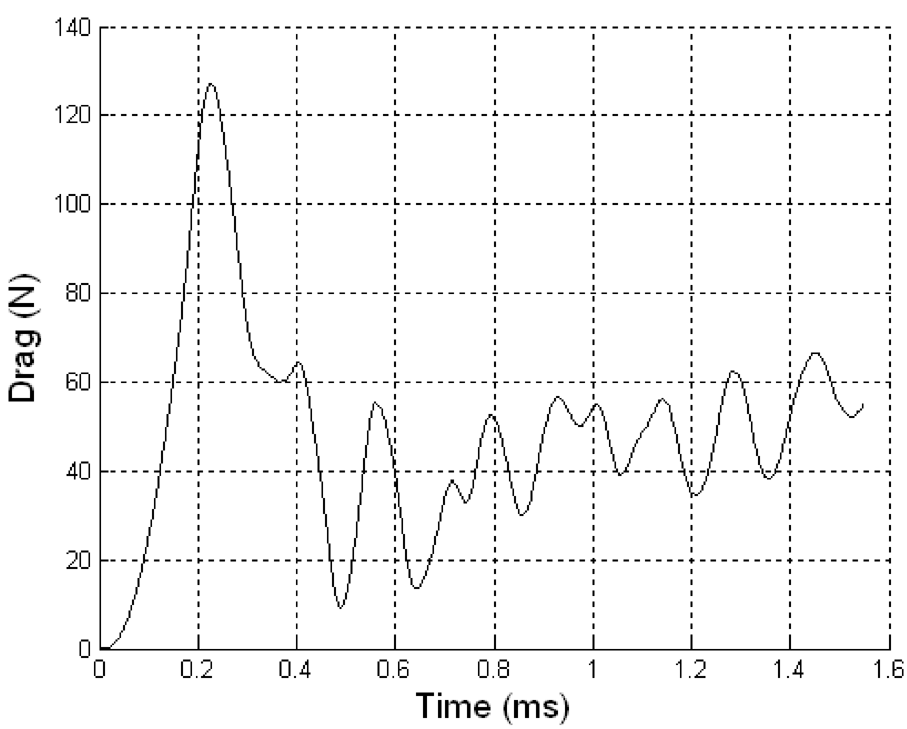

Figure B.92 Drag on Cone 4 ($M_s = 1.29$; $T_0 = 301K$; $P_0 = 82830Pa$)