# Data Processing Manual

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## 1 Ensight Profiles

1. Get Plot3D files from statistics.
2. Set max/min, white background, and linear/logrithmic.
3. **View** Uncheck everything in Axis triad visibility. Check Bound visibility. Uncheck Perspective.
4. **Viewports** Edit. Change the background to white. **Bounds** General is set to be 2D. Chang the color correspondingly. Change the Axis specific by adjusting the Axis origin and Width. For X, origin is 0.25, and width is 0.15. For Y, origin is 0.25, and width is 0.40.
5. Use Transformation Editor to adjust the viewports display.
6. Save two sets of figures. The first one is with Extent location BOTH and Gradation ON to record the dimensions. The second one is without Gradation.
7. When **Export** png files, watch out the resolution of the graphic card settings and the export image dimensions ($1166 * 755$).
8. **Export** Scenario for later use. However, query marks will not be able to display when reload the scenario file.
9. Use PowerPoint to do the post-processing. Create black frames with tics and figure out the tics. Be sure to add a white background for the final version, otherwise, component margins appear to be a black line in Latex for png files.

## 2 CEMA

1. Create mixture fraction iso-contours.
2. Create queries and be sure they are on nodes.
3. Choose up to ten quantities and save them to a file.
4. Save a png to keep track of query locations.
5. Combine data files to get *input.mat*. It should be a p by n matrix, where p is the number of sample points and n number of species plus temperature. The order of the column should be the same as the CHEMKIN chemical mechanism *chem.bin*.

6. Copy *input.mat* to a folder that includes both *chem.bin* and *CEMA_SD.m*. Be sure to run the MATLAB file on a WIN32 machine. Run the file by copying the first line of the function.

7. CEMA generates three solution files: *mat_r.mat*, *mat_s.mat*, and *em_mat*.

8. Run *generate_CEMA_out.m* within the folder that contains *List_s.mat* and *List_r.mat*.

9. The CEMA solution file *CEMA.out* is generated in the destination folder.

# 3 Lagrangian Flamelet Analysis

1. Create *CA.in* file.

   (a) Get profiles from Ensight, including the displacement velocity.

      i. Vector $\nabla\chi$. Create Grad(CHI), and name it GC.

      ii. Scalar $\|\nabla\chi\|$. Create SQRT(DOT(GC,GC)), and name it MGC.

      iii. Vector $\frac{\nabla\chi}{\|\nabla\chi\|}$. Create GC/MGC, and name it n.

      iv. Vector $\rho D\nabla\chi$. Create DIFF*GC, and name it I.

      v. Scalar $\nabla\cdot(\rho D\nabla\chi)$. Create Div(I), and name it DI.

      vi. Vector $-\frac{\nabla\cdot(\rho D\nabla\chi)}{\rho\|\nabla\chi\|}$. Create -DI/$\rho$/MGC*n, and name it VD.

      vii. Scalar $U+VD[x]$. Create U+VD[x], and name it RU.

      viii. Save the Scenerio file for later use.

   (b) On Zst iso-contour, sample CHI and RU, and save as chi_x_Zst and u_x_Zst, respectively.

   (c) Run *getCA_in.m* to get *CA.in*.

   (d) Extrapolate CHI to avoid the influence of ignition, which causes increasing CHI.

      i. Load *CA.in* into MATLAB.

      ii. Visualize plot(log(CA(:,1)),log(CA(:,6))), and pick the start and end (en) points to give a nice linear decreasing CHI v.s. time plot.

      iii. Use Tool -> Basic statistics to get linear fit coefficients, and save those coefficients as matrix for reference.

      iv. "y = exp(fit.coeff(1) * log(CA(en+1:end,1)) + fit.coeff(2));".

      v. "newCHI = [CA(1:en,6);y];".

      vi. Check the plot, and save newCHI.mat. "plot(CA(:,1),CA(:,6)); hold on; plot(CA(:,1),newCHI);".

      vii. Copy *CA.in* to *CA.fit*, and replace CHI with newCHI.
      For some cases, we need to run LFA longer to get the inhomogeneous autoignition response. To do that, we have to extrapolate time, distance, and CHI.

      viii. Load newCHI.mat and CA.

      ix. "I = find(CA(:,6)-newCHI);" take down the index as start.

      x. "plot(log(CA(start:end,1)),log(newCHI(start:end)));"

      xi. Save linear regression coefficients.

      xii. Create a new time array and extrapolate CHI:

      - "st = 2*CA(end,1) - CA(end-1,1);"
      - "dif = CA(end,1) - CA(end-1,1);"

- "ext_t = linspace(st,st+dif*4499,4500)';"

xiii. Save new t, x, and CHI as ext.mat:

- "ext_CHI = exp(fit.coeff(1) * log(ext_t) + fit.coeff(2));"
- "ext = [ext_t ext_t*3.2 ext_CHI];"

xiv. Create CA.ext file.

2. Create *TimeZero.FM* for initial conditions.

   (a) Clip x at ten times of the wall thickness (0.0004 m).

   (b) Sample Z(y), T(Z), species(Z). Be sure to use the same species names as the chemical mechanism.

   (c) Check Z file and clip extraneous zeros and ones. Take down the start and end indices.

   (d) Run *StartFile.m* to get *TimeZero.FM*.

3. Run LFM. Check I/O files. If *CA.in* has more than 5000 times, FM will stop at the 5000th line. Need to continue the calculation by providing the start file and pay attention to the time.

4. Process 1D LFM solution files.

   (a) Create a symbolic file *syms* with "time" in it.

   (b) "LT -s syms -l Z,<mixture fraction> -r <output file> <data file>".

   (c) Sort the output file. "sort -s -n -k 1,1 <output file> > <new file>".

5. Process 2D statistical files.

   (a) Sample U (RU), T, HO2, and H2O2 along mixture fraction iso-contours.

   (b) Run *int_time.m* to get the species time history files *species_time.out*.