Institut für Luft- und Raumfahrt
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Titel der Arbeit

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von

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dd. monat jjjj

Eidesstattliche Erklärung

Hiermit erkläre ich, — , die vorliegende Arbeit selbständig und eigenständig sowie ohne unerlaubte fremde Hilfe und ausschließlich unter Verwendung der aufgeführten Quellen und Hilfsmittel angefertigt zu haben.

Berlin, den dd.mm.jjjj

Vorname Nachname

Inhaltsverzeichnis

Abbildungsverzeichnis

Tabellenverzeichnis

Abkürzungsverzeichnis

Abkürzungen

TU	Technische Universität	

Griechische Symbole

κ	Isentropenexponent	–

Lateinische Symbole

A	Fläche	m^2

Indizes

Z	Zylinder

1 Introduction

In order to structure the document in form and content, you can use several levels of headings. The only thing to do is to place one command before the actual text. Chapter, sections, subsections and so on then will be numbered and formatted automaticly in the right way. For example the heading of this chapter was generated by the command \chapter {Introduction}. The commands for the structuring are:

chapter:	\chapter[Option]{name of chapter}
section:	\section[Option]{name of section}
subsection:	\subsection[Option]{name of subsection}

Inside the square brackets of these commands you can write an alternative name of the heading, which will be inserted in the table of content. If this is not the case, just omit it.

1.1 Referencing

In order to be able to reference the heading, add the command \label {name of reference } below the heading-command. In another part of the document you will be able to reference the heading by using the command \ref {name of reference }.

For example, a reference of a heading could be realised in the following way:

```
\section{referencing}
\label{SECTION:referencing}
"In section \ref{SECTION:referencing} the referencing inside a document
is shown."
```

This text line would be compiled to:

"In section 1.1 the referencing inside a document is shown."

1.2 Formulas

There is an easy way to insert formulas in the text just by using specific commands. The fomular $\log \frac{a}{b} = \log a - \log b$ has been inserted in the text in the following way:

```
$ \log \frac {a}{b} = \log a - \log b $.
```

The easiest way to insert a formula in continuous text is to use $...$. Text inside the dollar sign will be interpreted in the math mode.

Formulas which should be placed after a paragraph in a proper line can be defined in their own environment (displaymath) to be separated from the text:

```
\begin{displaymath}
    \int_ a^b \frac{1}{1-x^2}dx =
    \left [ \ln \sqrt{ \frac{ 1 + x } {1 - x} } \right]_ a^b
\end{displaymath}
```

$$\int_a^b \frac{1}{1-x^2}dx = \left[\ln\sqrt{\frac{1+x}{1-x}}\right]_a^b$$

Usually it is necessary to give the formulas a number. In this case you should use the environment called equation.

```
\begin{equation}
\label{EQUATION:with-number}
    B(n; p; k) \approx \frac { \lambda ^k } {k!} e^{-\lambda}\
    quad (k = 0,1,2,3, \ldots)
\end{equation}
```

$$B(n;p;k) \approx \frac{\lambda^k}{k!}e^{-\lambda} \quad (k = 0,1,2,3,\ldots) \tag{1.1}$$

Similar to the referencing of headings, also equations can be referenced by adding the label-command and using e.g. \ref{EQUATION:with-number} to get the reference 1.1 to the upper formula.

In case you have not only one formula but an whole equation system, you should use the eqnarray-environment. While the environments described above are designed for single-line formulas, in this environment you can write formulas over several lines:

```
\begin{ eqnarray}
    \sigma_ e & = & n_ 0 \pi r^2\xi _ e \nonumber \\
    \sigma_ s & = & n_ 0 \pi r^2\xi _ s \\
    \sigma_ a & = & \sigma _e - \sigma _a
\end{ eqnarray}
```

$$\begin{aligned} \sigma_e &= n_0 \pi r^2 \xi_e \\ \sigma_s &= n_0 \pi r^2 \xi_s \qquad (1.2) \\ \sigma_a &= \sigma_e - \sigma_a \qquad (1.3) \end{aligned}$$

As you can see, the formulas are aligned by the sign which is embedded between the two & -signs. It mustn't be necessarily a "=". Normally every formula is numbered, but it can be avoided just by adding the command \nonumber at the end of a formula, as you see for example in the first line of the equation system.

Units should be written by means of the "'\unit"'-command in oder to keep the spacing according the DIN standard. Using for example the command \unit[2,0]{mm} produces $2,0\,\mathrm{mm}$. units should be written by use of the following command, in order to keep the spacing according to the DIN: \unit[2,0]{mm}. That leads to $2,0\,\mathrm{mm}$. Some other useful features for mathematics oferd by TeX are shown below:

\$\unit[1,17]{\unitfrac{\mathrm{kg}}{\mathrm{m}^ 3}}\$,

$$1,17\,\mathrm{kg}/\mathrm{m}^3$$

\$\nicefrac{1}{2}\$

$$1/2$$

2 Graphics

2.1 Include Graphics

First thing to consider is that using the driver LaTeX=¿DVI the graphics which are to insert to the document have to be of the .eps-format. In change, if you use LaTeX=¿PDF to compile your text, the graphics can be provided as .pdf, .jpeg or .png for example.

The command-structure for inserting a graphic - here: figure 2.1 - is easy and very similar to that of a formula. Just use the environment figure to include your graphic and to define its size and position on the page.

```
\begin{ figure}[position]
    \centering
    \includegraphics [options]{bilder/annulus}
    \caption{ EXAMPLE FOR A GRAPHIC }
    \label{GRAPHIC:expample}
\end{figure}
```

The graphic itself is inserted into the document by the command \includegraphics [options]{ }. By embedding this command into the figure-environment, the graphic will be able to float within the text, for example in case changes in the upper part of the document have been made. The consequence is that the float object won't be placed exactly where it is defined but near to this position.

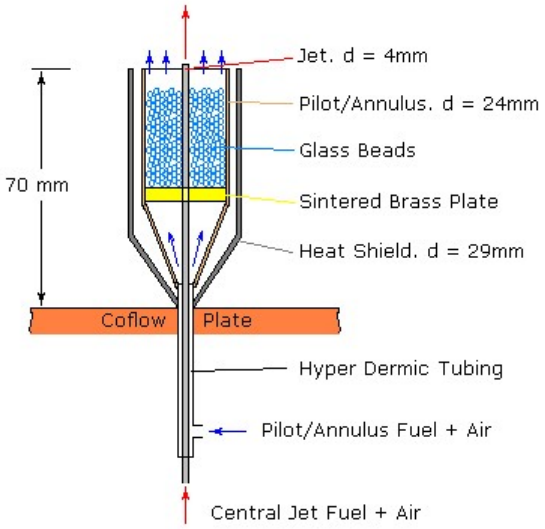


Figure 2.1: EXAMPLE FOR A GRAPHIC

The figure-environment allows to define the position of the graphic on the page filling out the square brackets with following parameters:

h It is tried to position the graphic at the point of the document where it is defined
H As the package float is included, by this parameter the graphic is not only tried but forced to be positioned at the point where it is defined
t The graphic should be placed at the top of the page
b The graphic should be placed at the bottom of the page
p The graphic should be placed on an own page only together with other floating objects

If the positioning of the figures shouldn't work out by the use of these parameters, the floating of the objects can be limited by the command "'\FloatBarrier"'. Apart from declaring the path of the graphic inside the braces, also the command \includegraphics contains options which allow to define some properties of the graphic. Some useful options are listed below. Several options are to separate in the common way: with a comma.

```
\includegraphics[keepaspectratio, draft,scale=0.5, width=4.5cm, height=5cm]
```

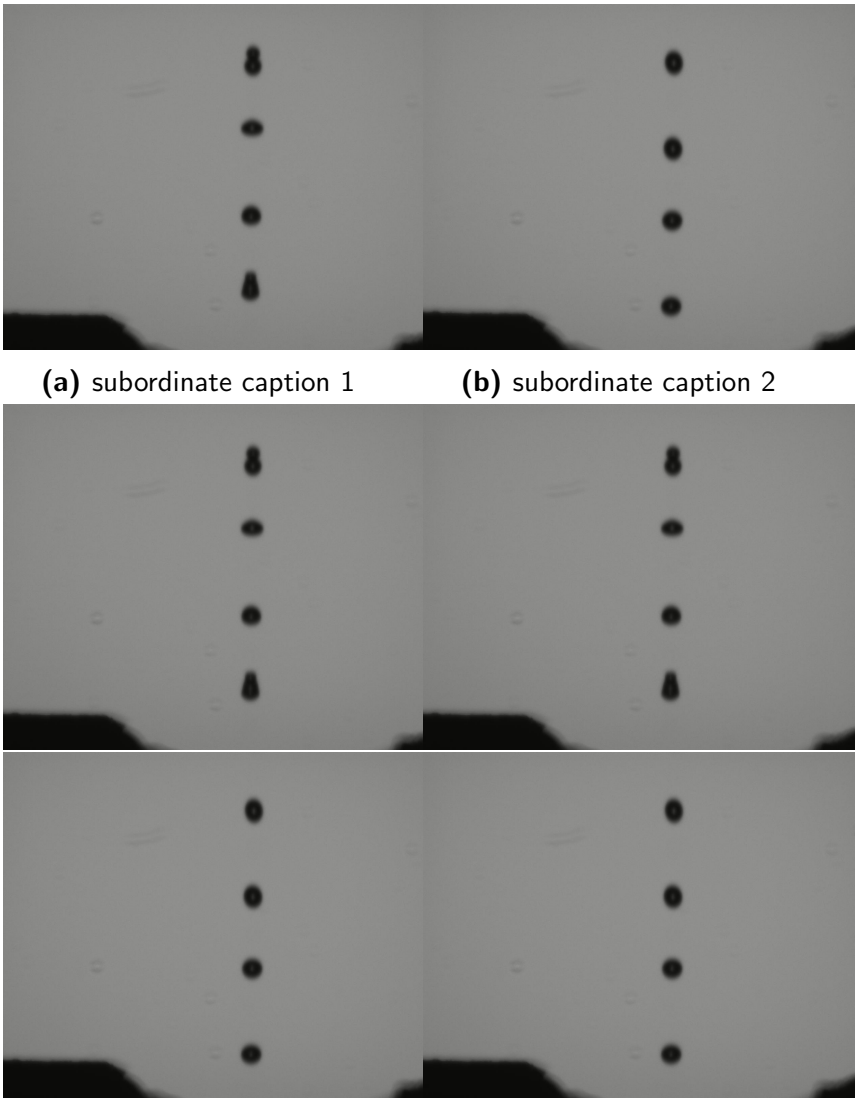
keepaspectratio	define only one length of the graphic and maintain the aspect ratio
draft	As the compiling of graphics cost time, by this parameter the graphic will be replaced by a simple white box in the size of the graphic. In that way the testing of a document with several graphics can be accelerated
scale	Scale your graphic to the according size
width	Define the width of your graphic
height	Define the height of your graphic

The command \caption contains the description and numbering of the graphic.

It is possible that you will have several graphics of the same measurement campaign which you would like to join as subfigures to one bigger picture. By the use of the command subfigure-environment inside of the figure-environment you will be able to - for example - to lable the subfigures with a), b), c), d),..., and the whole graphic with a common caption. See the following listing-example and list result on the next pages:

```
\begin { figure}[h]
\centering
\begin { subfigure} [b] { 0.35 \textwidth }     \includegraphics[width=5.7cm]{
Bilder/Bild_ 1_ von_ 2}
    \caption {subordinate caption 1}
    \label{SUBFIGURE:subordinate_ 1}
\end { subfigure}
~
\begin { subfigure} [b] { 0.35 \textwidth }     \includegraphics[width=5.7cm]{
Bilder/Bild_ 2_ von_ 2}
    \caption {subordinate caption 2}
    \label{SUBFIGURE:subordinate_ 2}
```

```
\end { subfigure}
~
\begin { subfigure} [b] { 0.35 \textwidth }      \includegraphics[width=5.7cm]{
Bilder/Bild_ 1_ von_ 2}
    \includegraphics[width=5.7cm]{ Bilder/Bild_ 2_ von_ 2}
    \caption {both graphics among each other;
caption 3}
    \label{SUBFIGURE:subordinate_ 3}
\end { subfigure}
~
\begin { subfigure} [b] { 0.35 \textwidth }      \includegraphics[width=5.7cm]{
Bilder/Bild_ 1_ von_ 2}
    \includegraphics[width=5.7cm]{ Bilder/Bild_ 2_ von_ 2}
    \caption {both graphics among each other;
caption 4}
    \label{SUBFIGURE:subordinate_ 4}
\end { subfigure}
\caption [SEVERAL GRAPHICS PLACED SIDE BY SIDE]
                        { SEVERAL GRAPHICS PLACED SIDE BY SIDE
                        AND AMONG EACH OTHER WITH SUBORDI-
NATE CAPTIONS }
\label{figure:_ several _graphics} \end { figure}
```



(a) subordinate caption 1

(b) subordinate caption 2

(c) both graphics among each other;
caption 3

(d) both graphics among each other;
caption 4

Figure 2.2: GRAPHICS PLACED SIDE BY SIDE AND AMONG EACH OTHER WITH SUBORDINATE CAPTIONS

In the following you will see some other examples about how to integrate a graphic in the document. The source-code could differ a little bit from the presented one above. To identify the small changes as made for figure 2.3 und figure 2.4. take a look at the source-code, opening the document with the "'TeXnic-Center"'-editor.

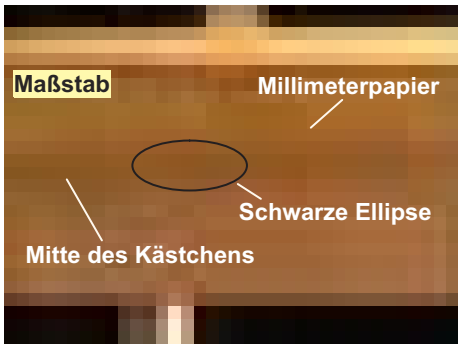


Figure 2.3: Foto, z.B. as a JPEG with caption. The size of the picture can be easily controled with a grafic software tool. The caption is generated separatly as an Encasulated Postscript and exported with an invisible frame of the same size as the picture.

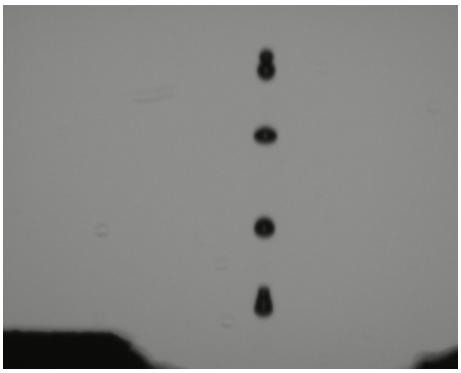


Figure 2.4: Generating a caption with a forced line-break.
Sometimes it is clearer to write certain informations regarding the figure in the second line of the caption.

2.2 Include Inkscape Vector Graphics

Use Inkscape to generate perfect vector graphics including text and equations (..). The *.svg-file is automatically checked by latex for up-to-dateness and, if necessary, updated

to PDF-latex. There is no need anymore saved the svg manually to pdf/jpg/png/.. All you need is the *.svg file. Please check the predefined Inkscape directory in the Main.tex.

how to use in latex:

```
\begin{figure}[htb]
     \centering
     \graphicspath{{./images/}}
     %required if image directory differ from tex directory

     \def\svgwidth{\columnwidth}
     \begin{small}%if wanted
         \includesvg{./images/file}%without ".svg"!
     \end{small}
     \caption[..]{..}
\end{figure}
```

2.3 Include TIKZ Vector Graphics

Smart way to include vector images from Matlab into Latex. Be careful with contour plot images, as they become very large and cannot be complicated by latex (latex error message). Scale down contour plot before using mat2tikz. The main advantage is that tikz images can be opened with the editor and can be freely modified afterwards (text colors, size, line widths, line markers...). The package tikzsuite is open available and also attached to this template.

Plot result in Matlab:

```
addpath('./tikzsuite/src');add Tikz package
```

```
..your matlab calculations..

%plot the results:
figure('name','figurename')
plot(x,y)
%save your plot as tikz:
matlab2tikz(name.tikz','floatFormat','%.5f','width',...
            '0.4\textwidth','height','0.4\textwidth');
            %selected options in tikz
```

How to use tikz in Latex:

```
\begin{figure}[h]
     \begin{minipage}[t]{.499\textwidth}
          \flushleft
          \begin{scriptsize}%if wanted
               \input{image1.tikz}
          \end{scriptsize}%
     \end{minipage}%
     \begin{minipage}[t]{.499\textwidth}
          \flushright
          \begin{scriptsize}%if wanted
          \input{image2.tikz}
          \end{scriptsize}
     \end{minipage}
     \caption[..]{...}
     \label{fig:fig_label}
\end{figure}
```

3 Tables

3.1 Insert Tables

The tabular-environment enables you to align text components and to define the spaces between the rows and the columns of the table, as seen already in figure 2.2. A description of definition of the tabular-environment and some of its useful parameters are given here.

```
\begin { table} [h]
\caption { UNIT-TABLE }
\centering
\begin {tabular} { | > {\ttfamily} l | p{ 2cm} @ { \hspace{ 0.5cm} } c | }
    \hline
    \textrm{ unit} & description & value\\
    \hline
    cm & Centimeter & 10 \\
    pt & Point & 1 \\
    bp & BigPoint & 4 \\
    \hline
\end { tabular }
\label{ example-for-table }
\end { table }
```

Table 3.1: UNIT-TABLE

unit	description	value
cm	Centimeter	10
pt	Point	1
bp	Big Point	4

The resulting table of the listing above is seen in table 3.1. At first the tabular-environment is embedded in the table-environment. This ensures, that the table will be defined as a float-object, similarly to the graphics, described in 2.1. By defining the positioning parameter inside the square brackets, the table can be placed on the page. The command \centering centers the following lines inside the environment.
The beginning line of the tabular-environment only serves to format the table and the columns. No content of the table will be written in this line. In this example posses in the beginning line of several features inside the brackets but not all of them are necessary to generate a table. These features will be described particularly in the following subsections.

3.1.1 Division of columns

The table consists of three columns. To divide the columns you can insert a vertical line "|"or define the type of separation by yourself using "@ {separation}". Between these signs the individual columns can be defined. As you see in the beginning line of the example, the division of the columns is:

| 1 .column | 2 .column @ {...} 3 .column |

In the upper example a horizontal spacing \hspace{ } was used as separation type defined by "@".

3.1.2 Alignment of columns

There are different parameters/letters to define the alignment of the text inside the column. The most important parameters are:

- c center the content of column
- l the content is placed left-aligned
- r the content is placed right-aligned

An additional useful parameter is to define the width of the column by the letter p:

- p{width} define the width of one column

3.1.3 Additional information for column

In case you want to format the content of the column, for example change the font, this can be controlled for each column by inserting the sign $<$ or $>$ followed by the command inside brackets. While with $>$ the command inside the brackets is written in front of the content of the following column, with $<$ the command will be written after the content of the prior column.
In the example above, the content of the first column is written in `typewriters` , inserting the command $>$ {\ttfamily} in front of the alignment parameter of the first column.

3.1.4 Fill out the table

After defining the number of columns by | or @{}, you can start to fill the table row after row. The content of each column is separated by the sign &. Each row finishes with the \\-sign, except the last one. By using the command "\hline"one row is filled out by a horizontal line. The heading "unit"is written in roman font.

4 Citations

4.1 How to cite

Literature and papers can be organized and sorted by means of the "JabRef"-software. This program enables you to generate a list of literature, which can be stored in a file and imported to the TeX-document by inserting the command \bibliography{path of file}. This command is already integrated in the file "'main.tex"' and the style of the bibliography is defined by the ITS-bibliographystyle.
As JabRef distributes to each literature reference a reference-key - similar to the labeling of float-objects - you can cite a certain literature by using the command "'cite{reference-key}"'. There are also some variations of the cite-command. A list of different examples how to cite and how the citation is then represented in the text is shown in the list above:

\cite{wittig92,wittig93}	⇔	Wittig et al. (1992, 1993)
\citep[s.a.][]{wittig92,wittig93}	⇔	(s.a. Wittig et al. 1992, 1993)
\citet{wittig92,wittig93}	⇔	Wittig et al. (1992, 1993)
\cite{winklhofer91,wittig93}	⇔	Winklhofer/Plimon (1991); Wittig et al. (1993)
\citep{winklhofer91,wittig93}	⇔	(Winklhofer/Plimon 1991; Wittig et al. 1993)
\citet{winklhofer91,wittig93}	⇔	Winklhofer/Plimon (1991); Wittig et al. (1993)
\cite{wittig93}	⇔	Wittig et al. (1993)
\citep{wittig93}	⇔	(Wittig et al. 1993)

\citet{wittig93}	⇔	Wittig et al. (1993)
\citet*{wittig93}	⇔	Wittig/Hallmann/Schmehl (1993)
\citeauthor{wittig93}	⇔	Wittig et al.
\citeauthor*{wittig93}	⇔	Wittig/Hallmann/Schmehl
\citeyear{wittig93}	⇔	1993
\citeyearpar{wittig93}	⇔	(1993)

\cite{winklhofer91}	⇔	Winklhofer/Plimon (1991)
\citep{winklhofer91}	⇔	(Winklhofer/Plimon 1991)
\citet{winklhofer91}	⇔	Winklhofer/Plimon (1991)
\citet*{winklhofer91}	⇔	Winklhofer/Plimon (1991)
\citeauthor{winklhofer91}	⇔	Winklhofer/Plimon
\citeauthor*{winklhofer91}	⇔	Winklhofer/Plimon
\citeyear{winklhofer91}	⇔	1991
\citeyearpar{winklhofer91}	⇔	(1991)

4.2 Some text

TeX does not mean only programing and using commands. Examining the source-code of the text below, you will realise that typing a bigger paragraph of text is relatively simple and does not require more effort for formatting than with other programs. In the text-section below, among other things, some examples for font formatting and referencing are given.

Fig. 2.4 shows selected results of the LDV measurements of the gaseous phase. In the upper diagram the phase averaged temporal variation of the vertical component (axial velocity) $u_{G,Y}(\phi) = \overline{u}_{G,Y} + u'_{G,Y}(\phi)$ is presented for a pulsating gaseous flow at a constant excitation frequency of $f_S = 250\,\mathrm{Hz}$, different mean velocities $\overline{u}_G$ and a constant bypass setting of the siren. Apparently, the instantaneous velocity $u_{G,Y}(\phi)$ is increasing with the mean velocity $\overline{u}_G$. However, the relation is not proportional. There is a loss of velocity due to the positioning of the LDV measuring volume in the

wake of the prefilming surface and the divergence of the open jet. Furthermore, the phase shift is moving towards an earlier time at higher mean velocities. This can be explained by the longer wavelength $\lambda \approx \overline{u}_G / f_S$ of the convected pulsation. It has to be noted that the signals are not perfectly sinusoidal as anticipated. The fundamental mode is superimposed by a first and second harmonic oscillations and additional noise. However, those perturbing components represent only a fraction of the designated signal.

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Anhang

A.1 Part 1

A.2 Part 2