* **ESTABLISH A STORY (“Geschenkpapier” um die eigentliche Arbeit)**
* **Wichtige Dinge 3x erzählen (Anfang, Mitte, Ende)**
* **Also introduce more in the beginning of each section. Vincent wants to see context**
* **How much in detail need to describe KAP? Suggestion: keep it short as similar to DUCC, can also say, it was not part of your work and mechanical realization is therefore not discussed in detail.**
* **Need to discuss with Paul what the Main goals of the thesis should be**

Structure of outline:

**Chapter:**

* Stuff for introduction to chapter

Section:

* In introduction of section
* Information of section if no subsections
* **Subsection:**
  + Information in subsection

**Introduction: DEAL WITH INTRODUCTION AFTER EVERYTHING ELSE IS DONE**

* Add a paragraph discussing the basic ideas of types of x-ray emissions from plasma
  + Introduce each type of backlighter target, mentioning what the general advantages of each are
  + This is to allow for discussion later on about spectrometer, backlighter combinations
  + This could possibly be an extra, smaller section in the fundamentals section. Discuss with Philipp. If I remember correctly we discussed whether to mention the different types only when showing corresponding backlighter spectra.
* Extend the current sentences elaborating on the different methods for x-ray and WDM production. Also state the benefit of producing WDM at FAIR (i.e. with heavy ions)
  + Here can use experiments from MEC in America and HIBEF in Hamburg
  + Check the papers sent by Philipp for more info
  + Generation: laser-shocks, Z-machine, also intense X-rays (XFEL)
  + X-rays: synchtrotron, XFEL, laser-driven, …
  + MEC: XFEL for X-rays and featuring laser
  + HIBEF: XFEL for X-rays and featuring laser
  + ESRF (ID 24): Synchrotron for X-raysMEC, HIBEF and ESRF (ID 24) feature a laser to generate shocks. XFEL can also be used to generate WDM.
* Generally needs further elaboration on why we’re making new spectrometers, i.e. whats special about them. For this add extension onto current introduction, placed where the spectrometers are currently mentioned Generally for this bullet point: Do you want to have this in the introduction or later? Suggestion: Show XAFS spectrum from literature in XAFS chapter. Could also include XAFS from another WDM experiment. In Fundamentals of X-ray spectrometer chapter motivate why using flat and why using bent. Could also refer to the literature example of spectrometer. However, then also need to motivate why different choice than theirs. So you have something like   
  WDM in intro -> XAFS of WDM Al -> X-ray spectrometer.
* Of course in intro, mention that you built spectrometers etc., but not in as many details as later on
* Vincent would like to hear the word signal-to-noise ratio in the introduction, I suppose.
  + In this extension establish the main ideas and features of an x-ray spectrometer.
  + Then give example of use of a crystal X-ray spectrometer for XAFS of alu in an experiment, along with what quantities they were able to extract. Make sure to show a graph of this in spectrometer fundamentals section.
  + Finally, set up the overarching idea of comparing a simpler, two-channel flat crystal geometry with a more complex, spherically bent crystal geometry
  + This should give a why for the spectrometers we chose
* Another option is to give an example of a XAFS plasma experiment, then comparing our experiment and theirs. This would give context to our decisions and act as a primer for someone not in the field.

**XAFS**

* Describe XAFS in more detail, similar as in the proposal presentation. Can use the schematic graph from the presentation here as well
* Give an example of XAFS from a WDM experiment, describing how the quantities are extracted (show spectrum)
* Transition into fundamentals section by saying that we use x-ray spectrometers to perform XAFS
* Can cut down the XAFS section in the introduction

**Fundamentals of X-Ray Spectrometers:**

* Can elaborate a bit more in introduction to section. For example that x-ray spectrometers is nowadays a mature field, which many experiments of spectrometers with plasma backlighters conducted before. Compared to optics, the reflection efficiency is much lower -> spectrometer design is of great importance. Design restrictions as typically only one reflecting surface. Mention why bent crystals are becoming popular (lack of optics for x-rays, so everything in one device). Reiterate the overview of flat vs. bent and dual channel vs single channel spectrometer styles

Flat crystal:

* Much the same as in proposal section “Crystal spectrometers”, but without part with von hamos.
* Mention advantages of flat crystal, i.e. simpler and allows for more crystal materials etc. but has higher signal to noise ratio

Bent crystal:

* Introduce story of advent of johann geometry, and the main advantages that bent crystals offer (less background, higher intensity etc). Less background is kind of specific to us as the ion beam will generate a lot of background. Also mention possibility of improved resolution
* **Von Hamos:**
  + Explain von hamos geometry (like in proposal)
* **FSSR:**
  + Have FSSR subsection as is in proposal
* Here or later in Spectrometer Design Chapter: Quantify efficiency of bent crystals. Von-Hamos? FSSR? Imaging and more efficiency in spectral direction due to a larger distance on the crystal corresponding to the same Bragg angle interval? -> signal to noise ratio

Resolution:

* As in proposal
* Extend the explanation of the integrated reflectivity, as this plays a central role in the Auswertung. Write out the formula we used for the calculation

**Spectrometer Design:**

* Put spectrometer design in context by recalling the XAFS examples from the previous chapter
* Mention that spectrometer specs only appears at end of chapter in a comparison section
* Generally in this chapter need to pay attention to kind of apply the knowledge of fundamentals of X-ray spectrometers to XAFS -> then design should be conclusive
* I guess it is helpful if this chapter states clearly the planned layout to use the spectrometer for ion-heated warm dense Al. I think it is included in spectrometer considerations. But make sure you have the same line of arguments: WDM -> XAFS -> spectrometers, but not as general as in the chapters before but applied to our case using heavy ions for generating WMD and using laser-generated X-rays. Of course ,the idea should already be mentioned in the introduction. We can also discuss if it may be helpful to have it earlier in the thesis (not counting the introduction). Sarah had a scheme of experiment section quite in the beginning (I think it was a chapter on its own) and this may be helpful for you as well (so that the reader knows about the combination of laser and ion beam and the generation of WDM and X-rays from the beginning).
* Generally more motivation for the two designs

Spectrometer Considerations

* Keep the same as in proposal

Schemes (? not sure what to call it) Implemented spectrometer layouts?

* Add on that will briefly introduce KAP design for completeness, since is relevant for data analysis, but was not designed in the scope of this work (maybe say was already available?)
* **DUCC:**
  + describe geometry (as in proposal but without the parameters paragraph and table)
* **FSSR-1D:**
  + keep like in proposal, but without specs
* **KAP:**
  + Maybe compare to DUCC, since geometry is similar. Emphasis that is single channel spectrometer
  + Talk about extension capabilities? Probably you will not show spectra from the extended version, so you can skip this
  + I’d like to call it something other than KAP, since the other two spectrometers are referred to by their geometries, not the crystal type I absolutely agree

Specifications and Comparison:

* Explain choice of crystals. Do here because need it for the specifications
* Approximately describe simulations and source of numbers.
* Put shortened simulation and calculation section (from proposal) in appendix
* Combine the parameters into one table, bring over paragraphs about the parameters from proposal, then finish with paragraph comparing the spectrometers
* Only DUCC and FSSR-1D. Maybe put the KAP as well. It is kind of an overview spectrometer that covers a large spectral range for more extensive source characterization. You have to think about which absorption spectra you want to show later on. If you want to show KAP absorption spectra you somehow need to have the two KAP spectrometer here. I think it is ok to say that the older KAP spectrometer was actually only used because the FSSR showed issues (which in that case you have to explain later on in the results chapter). Then the two KAP spectrometers together allow for EXAFS even though not solely optimized for that purpose.

**Experimental Setup**

* Reiterate the overarching goal of setup (Al WDM with XAFS) and that this is a preparatory experiment

General Setup:

* Describe the setup, but not going into too much detail about the laser and backlighter setup, as will probably not be relevant for the discussion. More important is that the central parameters, i.e. laser energy, phase plate, backlighter type, placement of alu sample etc., are described. For the laser and backligther setup, maybe emphasis that Al close to backlighter as in combined experiment. You could also check if spectrometers fulfill sample size condition of spectrometer considerations for 5mm as was the geometry of the experiment and change from 3mm to 5mm as this number is kind of arbitrarily chosen.
* Show a scheme of the setup, as well as pictures from the experiment. How about Inventor scheme of the whole setup?
* Point out central aspects of the setup
  + focus diagnostics
  + phelix laser
  + future location of ion beam
  + spectrometer locations
  + TCC and target
* List main parameters of laser, phase plate, backlighters etc. This is to avoid having individual subsections for these, as would confuse the focus of the thesis

Mechanical Design of Spectrometers:

* Touch on how the CAD models were made and produced. Outline main goals for the design (like in presentation)
* **DUCC:**
  + Keep as in proposal, but shift some angles of CAD model to appendix, as well as the table with color code (maybe)
  + Move alignment procedure to this section
* **FSSR:**
  + Same as proposal, removing some pictures and table (maybe) and moving to appendix
  + move alignment procedure to appendix

Measurement procedure I am not sure if I understand what you mean by this. Is this about taking reference images and so on?

* Give simplified version of measurement procedure, so that main steps are present
* Mention switch from no phase plate to phase plate, as well as focusing and unfocusing of FSSR

**Data Analysis and Results**

* Briefly describe the work flow of the code and the main steps to go from raw image to spectrum (no details of code unless necessary), as well as the goals of the analysis. What should each quantity say about the spectrometers? You can emphasize the meaning of the code if you say it is also applicable for future experiments and allows for “online” analysis of the data. I think this is the right term to say it is possible to analyze data during experiment. (or say spectrum generation instead of data analysis)
* Use series of pictures to show processing steps
* State that will start with small section introducing x-ray emission from plasma, since needed for discussion

I generally think we need to discuss (with Paul) about the structure of this chapter. Need to connect the different sections. X-ray emission from plasma -> absorption spectra is kind of clear (because always need reference -> could use that as motivation why to look at X-rays from plasma first). Resolution and relative integrated reflectivity kind of is the spectrometer characterization. Could also summarize these as subsections under spectrometer characterization. The gold plasma temperature estimation does not really fit in here. Need to see how the results turn out. If this is only a sanity check, could be part of spectrometer characterization even though it seems to be something different to me.

Thinking about the gold plasma temperature estimation again, I think there is another way to frame this. Could estimate N\_total from thermal emission/Bremsstrahlungsformula and calculate R\_int from that. Then it could definitely be part of spectrometer characterization.

X-Ray Emission from Plasma

* Briefly describe three main types of emission. Show formula for Bremsstrahlung if use it to get plasma temperature
* Show source spectrum examples for each backlighter material, pointing out some main emission types Make clear why the backlighter is important for spectrometer considerations -> not every backlighter type can work with every spectrometer.

Absorption Spectra

* Describe how absorption coefficient spectra are created
* Show examples for each spectrometer, including the pretty one from KAP as proof of concept
* Point out some XAFS features. Actually here would be a good point to mention which combinations of spectrometer and backlgither apparently do not work.

Resolution

* For DUCC, present resolution extracted from peak, transmission edge, and absorption edge respectively, averaging over as many usable shots as possible
* For FSSR, get resolution from peak. Not sure if possible with transmission edge yet.
* In both cases, briefly compare to simulation values

Relative Integrated Reflectivity

* Most likely need to use Al for ADP, hence integrate over the He alpha peak and/or show the result from manually linearly correcting the background from left channel
* For FSSR, will have to just use He alpha line, since other areas likely to have higher order in it. Can check Teflon shots to see if useable

Gold Plasma Temperature Estimation

* Note that is not likely to be accurate, but just used as a “sanity check” that the data seems reasonable
* Use bremsstrahlung from gold. For this use the formula found in the plasma emission textbook. Requires N\_total, so use a literature value of R\_int

General Performance

* What stood out about the spectrometer performance? Examples:
  + Mica crystal showing many higher order reflections and maybe weaker k-edge This should be possible to mention with the source spectra already.
  + intensity of the DUCC very weak compared to KAP or FSSR. Compare using N\_ph after correcting out filters. Mention causes and if is expected should also be possible to mention with the source spectra.
  + Necessary filtering wasn’t as expected. What filters could we prepare for the next experiment? This could be part of the next chapter, the discussion.
  + Quality of crystals and influence of spectrometer design on the spectra. Could be mentioned in previous sections
* Typically, you would not present data without explanations. You need to grab the reader’s hand. If you really want to discuss the analysis only, this could be a separate chapter. In some papers it is also split into one chapter of data analysis and one chapter including discussion and results. Still, I think the following discussion chapter is something else because it combines all the previous results to inform the spectrometer design for next year and makes predictions on how to continue the work.

**Discussion (still very preliminary, need to discuss with Paul before moving forwards)**

* Here will summarize and discuss the consequences of the analysis, ending with some suggestions for the spectrometer setup of next experiment
* One could also argue that this is rather an outlook. -> should discuss with Paul

Summary

* Summarize results (compare to expected values) and list off advantages and disadvantages of each spectrometer by itself. The comparison to the expected values you could also do directly when presenting the results. Here I would rather bring everything together. If you think that is too much discussion of your results to call the chapter only Data analysis and results, we should really consider splitting into Data Analysis + Results and Discussion.

Backlighter and Spectrometer Combinations (first observations)

* Discuss backlighters in relation to spectrometers, i.e. rare earths good for intensity, but presence of lines at k-edge

Future Spectrometer Design I am not sure what you want to put in here.

* Then subsection discussing possibilities for design of spectrometer in next experiment and reasoning them

**Conclusion and outlook**

* Keep shorter than in proposal, maybe a page. Combining summary and outlook I would say 2 pages is fine as well
* Give very general outlook on the information gained by experiment. One sentence for each spectrometers performance.
* here you need to summarize the most important findings, not in discussion. And yes this is a lot of repetition. Probably need to mention the outcome of your discussion as well. Imagine someone only reading the introduction and the conclusion and outlook. They should get the most important take-aways.
* Touch on the overarching theme of flat vs bent and single vs dual channel. Discuss the implications of each in combination with the choice of backlighter. Discussion in the discussion chapter, here you need to summarize the most important statements. This is the final recommendation
* Give a final recommendation for the spectrometer design going forward
* Give an outlook: Future experiment. SIS-100. I guess, right now, the spectrometer recommendation for next year will be Teflon + KAP DUCC (at least this is what I tend to, we can discuss!). But still you can give an outlook about the possibilities with mica once the challenges are overcome...