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# How to Pleat a Shirt in the 15th Century

## Introduction

In the course of extensive renovation work in 2008 at Lengberg Castle, Nikolsdorf, East Tyrol, archaeological surveys became necessary in several parts of the building. These were carried out under the direction of Harald Stadler from the Institute of Archeology, Department of Medieval and Post-Medieval Archaeology, University of Innsbruck. In the south western room on the 2nd floor of the south wing of the castle, a vault filled with waste was located and documented. The filling consisted of dry material in different layers, including organic matter such as branches and straw but also processed wood, leather (especially shoes) and more than 2700 textile fragments, not counting yarns, cords and ropes. The architectural history of the castle (evidence of alterations can be found in the travel diary of Paolo Santonino), the architectural study of Martin Mittermaier and Walter Hauser, Office for the Preservation of Historical Monuments Tyrol, and the archaeological features date the finds to the 15th century. The material was probably dumped in the vault when a second storey was added to the building by order of Virgil von Graben who was a burggrave at Lengberg in the name of the Archbishops of Salzburg. According to Paolo Santonino, the castle chapel, then also situated in the south wing of the castle on the first floor, was consecrated on October 13th, 1485 by Pietro Carlo, Bishop of Caorle. Assuming the reconstruction was finished by the time the chapel was consecrated the finds from the vault predate the year 1485. Five radiocarbon dates from the textiles, analyzed at the ETH Zurich, now confirm the dating.

It is extremely rare to find this huge amount of organic objects, especially textiles, in an archaeological dig and this find can only be compared to the amount found in the Muehlberg Ensemble in Germany (Rast-Eicher and Tidow 2005, 83) and the Sittingbourne Cache

in England (Eastop 2007, 66). The textiles were only preserved thanks to the very dry conditions in the vault and now provide an almost unique opportunity to study 15th century sewing techniques in detail.

Seventeen textile fragments were identified as parts of linen shirts, fourteen of which feature either partially or totally pleated areas. Two sleeves with textile buttons and button holes (Fig. 1), two sleeves with button holes (Fig. 7 and 9), one sleeve with a textile button (Fig. 18), one neckline (Fig. 2) and five fragments being either sleeve or collar are pleated on their entire width. Two shirts are pleated partially on the front, one of them with a preserved textile button (Fig. 3). One sleeveless shirt is pleated at the shoulder (Fig. 4).

The analysis of the textiles, basically consisting of a visual analysis of the sewing techniques and reflected-light microscopy of the threads, yielded three different types of pleats and four methods to attach the trimming strips (narrow wrist- or neckbands).

## Pleat Type 1 and 2

These two pleat types are similar, the pleats are rounded and either folded to one side (Type 1) or straight (Type 2) (Fig. 6 bottom right), but there are variations in the sewing of the trimming strip (Type A, B and C – Fig. 6). The pleats of Type 1 can be either folded to the left or to the right side indicated on Table 2, column 5 “Trimming strip and pleat type” (l for left and r for right).

## Pleat Type 3

Among the shirt fragments from Lengberg Castle this pleat type was only observed once and was applied to a shirt made of slightly finer linen than the rest of the finds (find no. 121). It shows closely spaced, pointed, straight pleats that use a lot of fabric (see description of Trimming strip Type D below and Fig. 8 bottom left).

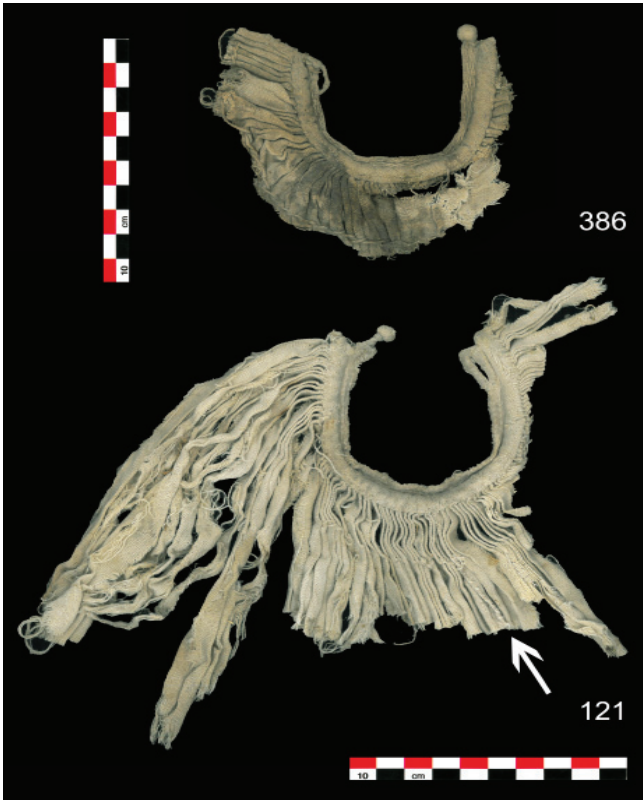


Fig. 1. (top left) Shirt sleeves with preserved textile button and button hole - inside. Find no. 386, Pleat Type C1r and Find no. 121, Pleat Type D (Photo: B. Nutz).

Fig. 2. (bottom left) Shirt collar / neckline. Find no. 01.24 - inside, Pleat Type B1r (Photo: B. Nutz).

Fig. 3. (top right) Fragment of a shirt or undergarment with partially pleated neckline in the front and preserved textile button - inside, Find no. 522.04. Pleat Type B1r (Photo: B. Nutz).



### Sewing the pleats

As the last few millimeters of most pleats are now covered by the wrist- or neckband it cannot be said for certain how the pleats themselves were made. A small fragment with missing trimming strip (find no. 273.14) suggests that the fabric was folded at regular intervals, maybe temporarily fixated with pins, and the pleats were then stitched down with stem stitches right at the edge of the cloth (Fig. 5). The pleats on find number 121 (Pleat Type 3, Fig. 1 and 8) were probably made in a very similar way, but having a sharp ridge they were most likely additionally treated with slick-stones and kept in place with some kind of starch. The sharp ridge also caused the cloth to break along the edges as the linen dried up over time.

### Trimming strip Type A

This type of trimming strip is found only once on a sleeve fragment with rounded, straight pleats (Fig. 6 and Tab. 2, find no. 430.02). The trimming strip is equally broad on both sides, first one edge is folded in, and then sewn onto the pleats with a running stitch, the fold fastened with whip stitches, then folded over the edge of the pleats and the border then folded in once more and sewn onto the other side of the pleats again with whip stitches.

### Trimming strip Type B

With seven textile fragments featuring the type B trimming strip it is the most common method of applying a strip of cloth to the pleats amongst the shirt finds from Lengberg. It is used for wrist- as well as neckbands and made similar to type A, but much



Fig. 4. Shirt fragment of a sleeveless shirt or blouse pleated at the shoulder - outside. Find no. 559. Right: Detail with pleats - inside). Pleat Type B11 (Photo: B. Nutz).

narrower on the outside. The strip is folded in at the edge, sewn onto the pleats, folded over the pleats, once more folded in and sewn onto the other side both with whip stitches. Above the whip stitches back stitches run through the front and back layer of the trimming strip with the fabric of the pleats in between.

Fig. 5. Pleated fragment of sleeve or neckline, trimming strip missing. Find no. 273.14. Pleat Type ?1r.

Right: Reconstruction of the pleating with possible pins and pleat fixation with stem stitches (Photo: B. Nutz).

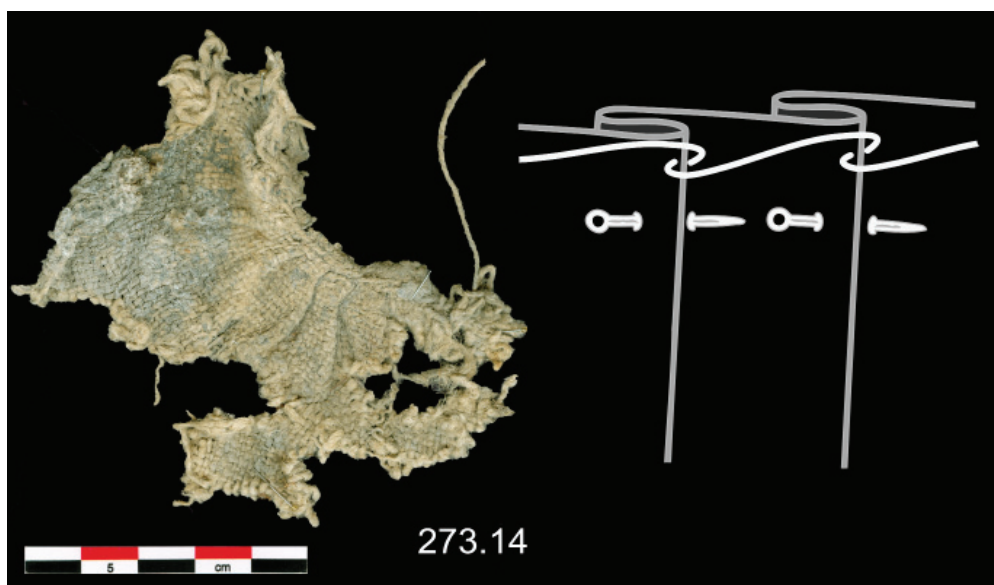




Fig. 6. Trimming strip and pleats Type A, B and C (Graphic: B. Nutz).

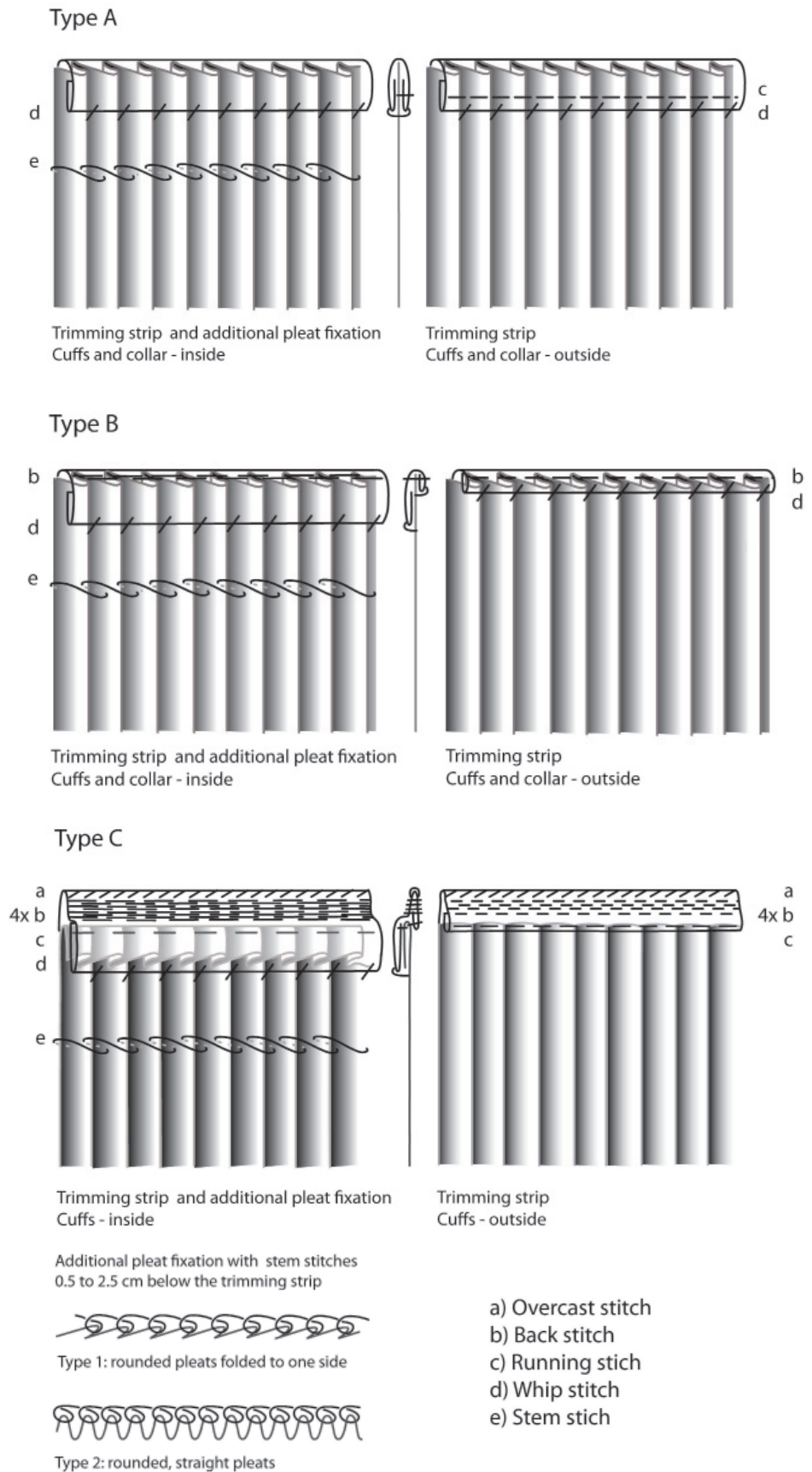
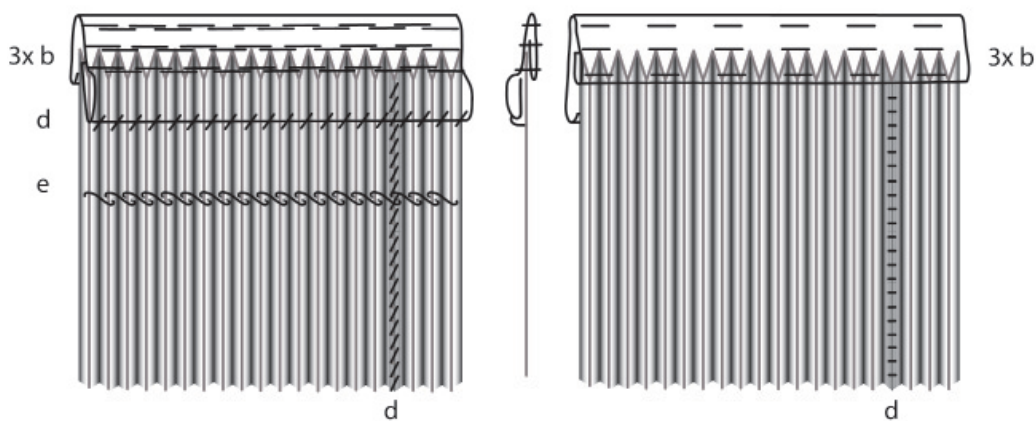




Fig. 7. Sleeve fragment with wristband (trimming strip) and button hole - inside. Find no. 430.02. Pleat Type A2 (Photo: B. Nutz).



Fig. 9. Sleeve fragment with wristband (trimming strip) and button hole - inside. Find no. 01.23. Pleat Type B1r. Dashed line indicating the run of the additional pleat fixation (Photo: B. Nutz).



Trimming strip and additional pleat fixation  
Cuffs - inside

Trimming strip  
Cuffs - outside

Additional pleat fixation with stem stitches  
2.0 cm below the trimming strip

- b) Back stitch
- d) Whip stitch
- e) Stem stitch

Fig. 8. Trimming strip and pleats Type D (Graphic: B. Nutz).



Type 3: closely spaced, pointed, straight pleats



Fig. 10. Neckband of linen shirt from Tyrol Castle, South-Tyrol – outside (above) and inside view (bottom). Pleats without additional pleat fixation (Photo: B. Nutz).

### Trimming strip Type C

Two sleeve fragments show a trimming strip of the type C. At first sight they appear to be from the same shirt but a closer examination shows them having been made from fabrics with different thread count suggesting two separate shirts: Find no. 386 is a sleeve fragment with a preserved textile button and button hole (Fig. 11) and a thread count of 17-21 threads/cm. Find no. 164.04 - also with a preserved button - is made from a coarser fabric of 12-14 threads/cm. Of course, one cannot rule out the possibility that more than one type of cloth was used in the tailoring of a single shirt. As can be seen at a slightly damaged area on find no. 386 which allows a look at the inside of the trimming strip, the fabric with the pleats was folded in after the pleating. The trimming strip was then sewn onto the pleats with a running stitch, folded in, the fold fixated with whip stitches, folded over the pleats, folded in

again and sewn onto the other side of the pleats with whip stitches. As the strip is not folded directly at the folded edge of the pleats but with some fabric to spare the two sides of the protruding strip were then sewn together with four rows of back stitches and the edge then fixed in place with an overcast stitch. This provides for an appearance resembling embroidery.

### Trimming strip Type D

The trimming strip type D only occurs once together with pleat type 3 on a sleeve fragment, find no. 121 (Fig. 1), with preserved textile button and button hole (Fig. 11). It is made of fine linen with a thread count of 18-19 threads/cm. Not all the pleats are preserved but with an average pleat count of 6.5 pleats/cm and a width of 19 cm it had approximately 123.5 pleats. With the average height of a pleat of 0.7 cm, leading to 1.4 cm of fabric per pleat, linen cloth with a width



of 172.9 cm was needed for the sleeve. To achieve that width two panels of cloth, one with a width of 91 cm, the other with 81.9 cm, were sewn together selvage to selvage with overcast stitch (Fig. 1, find no. 121, white arrow). The trimming strip was folded in, sewn onto the pleats with whip stitches, folded over the edge of the pleats with fabric to spare, folded in and sewn onto the other side with back stitches, the stitches piercing through all four layers of cloth (three layers of the trimming strip and one layer of pleats). The two sides of the protruding fabric then were sewn together with two additional rows of back stitches.

This shirt fragment was radiocarbon-dated at the Swiss Federal Institute of Technology (Table 1).

Based on the above mentioned presumption that the floorboards above the vault were in place by the time the chapel on the floor beneath was consecrated the shirt was in use sometime between 1440 and 1485.

### Additional pleat fixation or smocking

All pleats have an additional pleat fixation 0.5 to 2.5 cm below the trimming strip carried out in stem stitches. Whether the stem stitches used for pinning down the pleats were done before or after the application of the trimming strip cannot be determined. Neither can it be said for certain whether the stem stitches were visible on the outside or inside of the shirt. Traditional shirts of the Modern Era sometimes show additional pleat fixation on the outside which is carried out as smocking thus decorating the shirt. However, two factors speak against the pleat fixation on the Lengberg shirts showing on the outside. Firstly, the seams, most of which are half fell seams, would then show more prominently on the outside. Secondly, some of the stem stitch rows are fairly irregular in their distance to the trimming strip (Fig. 9) and are therefore not very 'decorative'.

As these shirt fragments from Lengberg Castle are the only ones so far from the 15th century in Tyrol, it cannot be said with certainty if this additional pleat fixation was common in the area. On a shirt dating to the 16th/17th century (Tomedi 1998, 159) from Tyrol Castle, South-Tyrol, this fixation is missing (Fig. 10). Similarly, fragments of two pleated shirt sleeves from Muehlberg, Kempten, Bavaria, dating to the end of the 15th to early 16th century, do not have the additional smocking or pleat fixation, according to the published catalogue, one of these is decorated with bobbin lace (Rast-Eicher and

Tidow 2011, 429-430). But it can be found on a shirt dating to 1567: on this shirt - once belonging to the Swedish diplomat Nils Svantesson Sture - the gathers or pleats of the sleeve-ends are held together on the inside above the wristband by a single line of stitching (Arnold 2008, 21).

### The stitches

With the exception of the stem stitches that were used for sewing the pleats and their additional fixation all stitches used in the sewing of the trimming strip and the sleeves can be encountered on other, contemporary, textile finds and are considered to be more or less common practice during the Middle Ages (Kania 2010, 86-101). All linen fabrics are woven with z-spun yarn and the sewing thread is invariably s-plyed 2-ply-yarn. Running stitch, whip stitch and back stitches were used to sew the trimming strips onto the pleats. In running stitch the sewing thread runs straight through the fabric, for whip stitches it passes over the fabric, in back stitch it doubles back on itself. The latter were also used for sewing together the protruding fabric of some of the trimming strips above the pleats. A distinction has been made between whip stitch and overcast stitch. Both stitches are basically sewn in the same way but the term overcast stitch is used to indicate whip stitches applied to the edge of a fabric, hem or trimming strip. The stem stitch consists of a long, slightly slanting, stitch forward on one side and a shorter one backward on the other side of the fabric.

Single threads were used for sewing all seams and hems as well as for most stem stitches. Only on two



Fig. 11. Textile buttons and button holes from shirt no. 121 and 386 (Photo: B. Nutz).

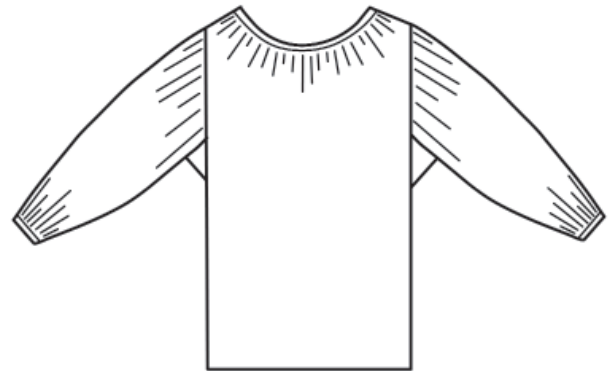


**Fig. 12. Self-portrait of Albrecht Dürer from 1493 wearing a pleated shirt with the neckline and front visible and the pleated sleeves peeking through slits in his gown (Photo: The Yorch Project: Gesellschaft für Bildarchivierung GmbH).**

sleeve fragments (finds no. 01.23 and 808.02) the stem stitches used for the additional pleat fixation were sewn with two ply-yarns. Both ply-yarns were either threaded through the eye of the needle at the same time, or a single thread was doubled by being hung equally long on both sides of the eye. This is indicated by both sewing threads passing between the same warp and weft threads or through the same holes caused by the needle in the fabric.

#### **Linen Shirts of the 15th and early 16th century**

Men and women of the period are often depicted wearing various types of pleated shirts, mostly beneath the outer garment, the pleated neckline and front visible and/or the sleeves peeking through



**Fig. 13. Sketch drawing of a shirt from Lengberg Castle (Graphic: B. Nutz).**

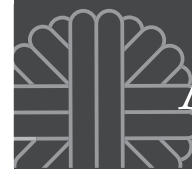
slits in the sleeves of the dress or gown (Fig. 12). That these shirts were not only worn by adults but also by children cannot only be seen on some of the contemporary images but is also confirmed by one of the sleeve fragments from Lengberg where the cuff has a girth of merely 14.5 cm (find no. 386, Fig. 1 - top) indicating the very slender wrist of its wearer.

Of course not all the shirts depicted in paintings were cut in the same manner than the shirts from Lengberg and none of the pictures are detailed enough to determine if one of them had an additional pleat fixation but they provide us with a good image of the appearance of shirts in general at the time.

An impression on how some of the shirts from Lengberg may have looked like is given with a sketch drawing (Fig. 13) where the neckline from find no. 01.24 (Fig. 2) and the sleeve fragments have been combined to reconstruct one shirt. Besides the sometimes elaborated pleats they were probably of a rather simple cut without many decorative elements such as embroidery or lace.

#### **Conclusion**

The excavation of a vault filled with waste dating to the 15th century yielded more than 2700 textile fragments, among them pieces of several pleated linen shirts. These finds now allow a detailed investigation and reconstruction of late medieval Tyrolean pleating methods. Three different pleat types (rounded straight, rounded folded to one side and closely spaced, pointed, straight pleats) and four wrist- or neckband-types could be determined. All pleats or gathers are additionally held together on the inside



by a line of stem stitches 0.5 to 2.5 cm above the band or trimming strip.

With fourteen fragments of pleated shirts this is probably the largest collection of 15th century linen shirts to be found from one find spot to date. The pleat and trimming strip varieties do not only offer insight into late medieval sewing and pleating techniques but also provide a rare opportunity to research the transition in fashion and textile techniques from medieval times to the Renaissance period. We must bear in mind that Lengberg Castle is situated close to today's Italian border and on modern day roads it is a mere 245 km from Lengberg to Venice. Therefore the influence of the Early Italian Renaissance on the textile production of Tyrol is not to be underestimated, especially as the silk fabrics also found in Lengberg were most likely imported from Italian silk production centers such as Venice or Florence.

As to the additional pleat fixation by means of stem stitches that are found on all pleated shirts from Lengberg further research and comparisons with other finds from surrounding areas, whether of an

earlier date, contemporary or of a later date, will be necessary. Hopefully this will help determine where this method of pleating was initially developed or if it was indigenous to the area and then spread from there. To assume that the shirts were not made by some local tailor but imported finished is unlikely. Contemporary account books from other Tyrolean noble families such as the Lords of Vilanders always mention the money spent on cloth and the tailor's payment but do not refer to the purchase of finished textile products (Goller 2007). Medieval dress used to be custom made, especially for the nobility.

That at least some of the shirts were once worn by the castle lords and the members of their family and not by some servant may be expected when looking at find no. 121. This heavily pleated shirt with its fine linen and the extensive use of cloth, probably being of the latest fashion, must have been quite expensive in the making. The still existing button-hole and textile button enables a measurement of the girth of the cuff of 17,5 cm. Whether this shirt was worn by a man or woman cannot be determined but the rather small

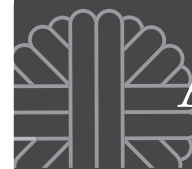
Lab Nr.	Sample Code and Description	Material	C14 age BP	DeltaC13 (‰)
ETH-45156	121 pleated shirt sleeve	linen	375 ± 25	-27,1 ± 1,1
<p><u>Calibrated C14 ages (Calendar time intervals) using OxCalv3.10</u>            INFORM : References - Atmospheric data from Reimer et al (2009);            OxCal v3.10 Bronk Ramsey (2005)</p> <p>ETH-45156 : 375±25BP            68.2% probability            1450AD (53.4%) 1520AD            1600AD (14.8%) 1620AD            95.4% probability            1440AD (62.4%) 1530AD            1550AD (33.0%) 1640AD</p>				

**Table 1.** 14C-dating, – results from the Swiss Federal Institute of Technology, Zurich.



Table 2. Types A, B, C and D = trimming strip type; Type 1, 2 and 3 pleat types; r = pleats folded to the right / l = pleats folded to the left.

Find No.	Yarn: warp/weft	Warp/weft identified	Threads/cm warp/weft	Trimming strip and pleat style	Garment	Graphic
430.02	z/z	no	12-14/10-11	A2	Sleeve fragment with wristband (trimming strip) and button hole.	Fig. 7
01.24	z/z	no	14/11	B1r	Shirt neckline with neckband (trimming strip).	Fig. 2
559	z/z	yes	18/18	B1l	Shirt fragment of a sleeveless shirt or blouse pleated at the shoulder. Front left side.	Fig. 4
522.04	z/z	no	10-11/7	B1r	Fragment of a shirt or undergarment with partially pleated neckline in the front and preserved textile button.	Fig. 3
01.23	z/z	no	18/15	B1r	Sleeve fragment with wristband (trimming strip) and button hole.	Fig. 9
343.23	z/z	no	18/14	B2	Fragment of a sleeve or neckline with wrist- or neckband (trimming strip).	Fig. 14
803.02	z/z	no	9/8	B2	Fragment of a sleeve or neckline with wrist- or neckband (trimming strip).	Fig. 15
343.02	z/z	no	9/8	B1l	Fragment of a sleeve or neckline with wrist- or neckband (trimming strip).	Fig. 16
624.02	z/z	no	8/7	B2 or C2	Fragment of a sleeve or neckline, wrist- or neckband (trimming strip) worn away.	Fig. 17



Find No.	Yarn: warp/weft	Warp/weft identified	Threads/cm warp/weft	Trimming strip and pleat style	Garment	Graphic
386	z/z	no	21/17	C1r	Sleeve fragment with wristband (trimming strip), textile button and button hole.	Fig. 1/ Fig. 11
164.04	z/z	no	14/14	C2	Sleeve fragment with wristband (trimming strip) and textile button.	Fig. 18
121	z/z	yes	18/19	D	Sleeve fragment with wristband (trimming strip), textile button and button hole.	Fig. 1/ Fig. 11
273.14	z/z	no	10/8	?1r	Pleated fragment of sleeve or neckline, trimming strip missing.	Fig. 5
01.11	z/z	yes	12/9-10	?1r	Fragment of a shirt with partially pleated neckline, trimming strip worn away.	Fig. 19

circumference suggests a female or juvenile wearer with a slender wrist, maybe the lady of the castle.

As some of the other shirts are made from coarser linen and have less pleats they may have belonged to lower ranking members of the household. Here too further investigation may help find connections between the type of textiles found in the castle and the social status of their former owner thus providing deeper insight into the structure of the society at the turning point from Late Medieval to Early Modern Times.

In the light of more than 2700 individual textile fragments from Lengberg much work is still left to be done but the now more or less completed research on the pleated linen shirts found in this castle offer an opportunity for future scholars to compare their finds and research results with the finds from Lengberg Castle.



Fig. 14. Find No. 343.23.



Fig. 15. Find No. 803.02.



Fig. 16. Find No. 343.02.



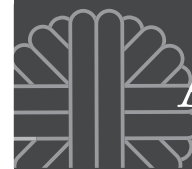
Fig. 17. Find No. 624.02.



Fig. 18. Find No. 164.04.



Fig. 19. Find No. 01.11.



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