CASP 13 internal ID: T0999/X0999

Cross-linking mass spectrometry data

**Protein information (as provided)**

CASP13 internal ID: regular target T0999, XL-MS assisted X0999.

Protein Name: Pentafunctional AROM polypeptide

Organism Name: Chaetomium thermophilum

**Amino acid sequence:**

10 20 30 40 50 60   
MATANVAGAG GSGSEPTRIA ILGKEDIIVD HGIWLNFVAH DLLQTLPSST YVLITDTNLY   
  
 70 80 90 100 110 120   
TTYVPPFQAV FEAAAPRDVR LLTYAIPPGE YSKSRETKAE IEDWMLSHAC TRDTVIIALG   
  
 130 140 150 160 170 180   
GGVIGDMIGY VAATFMRGVR FVQVPTTLLA MVDSSIGGKT AIDTPMGKNL IGAFWQPRRI   
  
 190 200 210 220 230 240   
YIDLAFLETL PVREFINGMA EVIKTAAIWN ETEFTALEEN AAAILEAVRS KASSPAARLA   
  
 250 260 270 280 290 300   
PIRHILKRIV LGSARVKAEV VSADEREGGL RNLLNFGHSI GHAYEAILAP QVLHGECVAI   
  
 310 320 330 340 350 360   
GMVKEAELAR YLGVLRPSAV ARLTKLIASY DLPTSVHDKR IAKLSAGKEC PVDVLLQKMA   
  
 370 380 390 400 410 420   
VDKKNEGRKK KIVLLSAIGK TYEKKATVVD DRAIRLVLSP SVRVTPGVPK GLSVTVTPPG   
  
 430 440 450 460 470 480   
SKSISNRALV LAALGEGTTR IHGLLHSDDV QYMLAAIEQL HGADFSWEDA GEILVVTGKG   
  
 490 500 510 520 530 540   
GKLQASKEPL YLGNAGTASR FLTSVVALCA PSAVSSTVLT GNARMKVRPI GALVDALRAN   
  
 550 560 570 580 590 600   
GVGVKYLEKE KSLPVEVDAA GGFAGGVIEL AATVSSQYVS SILMAAPYAH QPVTLRLVGG   
  
 610 620 630 640 650 660   
KPISQPYIDM TIAMMASFGI KVERSAEDPN TYLIPKGVYK NPPEYVVESD ASSATYPLAV   
  
 670 680 690 700 710 720   
AAITGTTCTI PNIGSESLQG DARFAVEVLR PMGCAVEQTA TSTTVTGPPI GTLKAIPHVD   
  
 730 740 750 760 770 780   
MEPMTDAFLT AAVLAAVADG TTQITGIANQ RVKECNRIAA MKDQLAKFGV QCNELEDGIE   
  
 790 800 810 820 830 840   
VIGKPYQELR NPVEGIYCYD DHRVAMSHSV LSTISPHPVL ILERECTAKT WPGWWDILSQ   
  
 850 860 870 880 890 900   
FFKVQLDGEE DPTKRTTQST QQVRKGTDRS IFIVGMRGAG KSTAGRWMSE LLKRPLVDLD   
  
 910 920 930 940 950 960   
AELERREGMT IPEIIRGERG WEGFRQAELE LLQDVIKNQS KGYIFSCGGG IVETEAARKL   
  
 970 980 990 1000 1010 1020   
LIDYHKNGGP VLLVHRDTDQ VVEYLMRDKT RPAYSENIRE VYERRKPWFY ECSNLQYHSP   
  
 1030 1040 1050 1060 1070 1080   
HEDGSEALLQ PPADFARFVK LIAGQSTHLE DVRAKKHSFF VSLTVPNVAD ALDIIPRVVV   
  
 1090 1100 1110 1120 1130 1140   
GSDAVELRVD LLESYEPEFV ARQVALLRAA AQVPIVYTVR TQSQGGKFPD EDYDLALRLY   
  
 1150 1160 1170 1180 1190 1200   
QTGLRSGVEY LDLEMTMPDH ILQAVTDAKG FTSIIASHHD PQCKLSWKSG SWIPFYNKAL   
  
 1210 1220 1230 1240 1250 1260   
QYGDVIKLVG VAREMADNFA LTNFKAKMLA AHDNKPMIAL NMGTAGKLSR VLNGFLTPVS   
  
 1270 1280 1290 1300 1310 1320   
HPALPSKAAP GQLSATEIRQ ALSLIGEIEP KSFYLFGKPI SASRSPALHN TLFYKTGLPH   
  
 1330 1340 1350 1360 1370 1380   
HYSRFETDEA SKALESLIRS PDFGGASVTI PLKLDIMPLL DSATDAARTI GAVNTIIPQT   
  
 1390 1400 1410 1420 1430 1440   
RDGSTTTLVG DNTDWRGMVH ALLHSSGSGS VVQRTAAPRG AAMVVGSGGT ARAAIYALHD   
  
 1450 1460 1470 1480 1490 1500   
LGFAPIWIVA RSEERVAELV RGFDGYDLRR MTSPHQGKDN MPSVVISTIP ATQPIDPSMR   
  
 1510 1520 1530 1540 1550 1560   
EVIVEVLKHG HPSAEGKVLL EMAYQPPRTP LMTLAEDQGW RTVGGLEVLA AQGWYQFQLW   
  
 1570 1580   
TGITPLYEEA RAAVMGEDSV ELEHHHHHH

**Methods**

**IMPORTANT NOTE: In contrast to all other cross-linking data provided by this laboratory, the AROM data was not acquired explicitly for CASP 13. Therefore, only one cross-linking chemistry (DSS) was used for the experiments. In addition, no information about modified lysine residues (other than those found in cross-links) is provided.**

The target protein or protein complex was cross-linked and analyzed by mass spectrometry as described here:

*Lysine-specific chemical cross-linking of protein complexes and identification of cross-linking sites using LC-MS/MS and the xQuest/xProphet software pipeline*. Leitner, Walzthoeni and Aebersold. *Nature Protocols*, 2014. DOI: 10.1038/nprot.2013.168

**Cross-links identified by mass spectrometry**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Intra-chain cross-links** | | | | | |
| **Protein1** | **Protein2** | **AbsPos1** | **AbsPos2** | **ld-Score\*** | **Chemistry\*\*** |
| AROM | AROM | 339 | 343 | 35.26 | DSS |
| AROM | AROM | 371 | 385 | 34.51 | DSS |
| AROM | AROM | 526 | 549 | 34.19 | DSS |
| AROM | AROM | 371 | 384 | 34.06 | DSS |
| AROM | AROM | 989 | 989 | 33.93 | DSS |
| AROM | AROM | 526 | 343 | 33.78 | DSS |
| AROM | AROM | 371 | 363 | 32.86 | DSS |
| AROM | AROM | 966 | 343 | 32.51 | DSS |
| AROM | AROM | 371 | 385 | 32.4 | DSS |
| AROM | AROM | 762 | 343 | 32.2 | DSS |
| AROM | AROM | 371 | 384 | 31.79 | DSS |
| AROM | AROM | 959 | 549 | 31.71 | DSS |
| AROM | AROM | 339 | 854 | 31.69 | DSS |
| AROM | AROM | 1040 | 881 | 31.58 | DSS |
| AROM | AROM | 526 | 753 | 31.45 | DSS |
| AROM | AROM | 854 | 343 | 31.23 | DSS |
| AROM | AROM | 526 | 482 | 31.06 | DSS |
| AROM | AROM | 487 | 231 | 30.94 | DSS |
| AROM | AROM | 1127 | 231 | 30.86 | DSS |
| AROM | AROM | 358 | 364 | 30.62 | DSS |
| AROM | AROM | 989 | 343 | 30.56 | DSS |
| AROM | AROM | 1235 | 343 | 30.48 | DSS |
| AROM | AROM | 343 | 959 | 30.31 | DSS |
| AROM | AROM | 989 | 549 | 30.25 | DSS |
| AROM | AROM | 1188 | 231 | 30.11 | DSS |
| AROM | AROM | 966 | 549 | 29.9 | DSS |
| AROM | AROM | 989 | 363 | 29.88 | DSS |
| AROM | AROM | 370 | 384 | 29.79 | DSS |
| AROM | AROM | 339 | 231 | 29.74 | DSS |
| AROM | AROM | 636 | 482 | 29.71 | DSS |
| AROM | AROM | 358 | 364 | 29.68 | DSS |
| AROM | AROM | 941 | 549 | 29.62 | DSS |
| AROM | AROM | 989 | 854 | 29.6 | DSS |
| AROM | AROM | 343 | 959 | 29.39 | DSS |
| AROM | AROM | 545 | 231 | 29.28 | DSS |
| AROM | AROM | 526 | 959 | 29.26 | DSS |
| AROM | AROM | 937 | 762 | 29.14 | DSS |
| AROM | AROM | 989 | 762 | 29.08 | DSS |
| AROM | AROM | 526 | 231 | 29.03 | DSS |
| AROM | AROM | 1040 | 865 | 28.71 | DSS |
| AROM | AROM | 371 | 364 | 28.68 | DSS |
| AROM | AROM | 937 | 343 | 28.62 | DSS |
| AROM | AROM | 966 | 231 | 28.46 | DSS |
| AROM | AROM | 339 | 526 | 28.31 | DSS |
| AROM | AROM | 937 | 549 | 28.31 | DSS |
| AROM | AROM | 937 | 959 | 27.99 | DSS |
| AROM | AROM | 966 | 231 | 27.7 | DSS |
| AROM | AROM | 410 | 343 | 27.62 | DSS |
| AROM | AROM | 545 | 959 | 27.61 | DSS |
| AROM | AROM | 231 | 959 | 27.48 | DSS |
| AROM | AROM | 1040 | 231 | 27.41 | DSS |
| AROM | AROM | 410 | 231 | 27.35 | DSS |
| AROM | AROM | 98 | 168 | 27.15 | DSS |
| AROM | AROM | 1127 | 1127 | 27.12 | DSS |
| AROM | AROM | 487 | 487 | 27.05 | DSS |
| AROM | AROM | 1235 | 1188 | 27 | DSS |
| AROM | AROM | 339 | 959 | 26.94 | DSS |
| AROM | AROM | 989 | 343 | 26.94 | DSS |
| AROM | AROM | 487 | 989 | 26.53 | DSS |
| AROM | AROM | 371 | 363 | 26.43 | DSS |
| AROM | AROM | 937 | 231 | 26.42 | DSS |
| AROM | AROM | 937 | 753 | 26.35 | DSS |
| AROM | AROM | 1040 | 343 | 26.28 | DSS |
| AROM | AROM | 1127 | 549 | 26.27 | DSS |
| AROM | AROM | 1235 | 231 | 26.14 | DSS |
| AROM | AROM | 168 | 98 | 26.09 | DSS |
| AROM | AROM | 410 | 385 | 26.08 | DSS |
| AROM | AROM | 1040 | 989 | 26.05 | DSS |
| AROM | AROM | 941 | 231 | 25.97 | DSS |
| AROM | AROM | 941 | 339 | 25.86 | DSS |
| AROM | AROM | 941 | 854 | 25.7 | DSS |
| AROM | AROM | 1127 | 989 | 25.7 | DSS |
| AROM | AROM | 1188 | 989 | 25.65 | DSS |
| AROM | AROM | 1184 | 881 | 25.39 | DSS |
| AROM | AROM | 339 | 989 | 25.39 | DSS |
| AROM | AROM | 1235 | 231 | 25.37 | DSS |
| AROM | AROM | 989 | 385 | 25.26 | DSS |
| AROM | AROM | 358 | 989 | 24.89 | DSS |
| AROM | AROM | 989 | 959 | 24.45 | DSS |
| AROM | AROM | 893 | 1040 | 24.11 | DSS |
| AROM | AROM | 1227 | 348 | 24 | DSS |
| AROM | AROM | 1235 | 358 | 23.93 | DSS |
| AROM | AROM | 893 | 865 | 23.78 | DSS |
| AROM | AROM | 1227 | 168 | 23.77 | DSS |
| AROM | AROM | 1227 | 1227 | 23.76 | DSS |
| AROM | AROM | 989 | 881 | 23.73 | DSS |
| AROM | AROM | 526 | 343 | 23.65 | DSS |
| AROM | AROM | 1235 | 343 | 23.6 | DSS |
| AROM | AROM | 1184 | 989 | 23.56 | DSS |
| AROM | AROM | 762 | 959 | 23.55 | DSS |
| AROM | AROM | 1198 | 231 | 23.52 | DSS |
| AROM | AROM | 966 | 339 | 23.41 | DSS |
| AROM | AROM | 1235 | 364 | 23.4 | DSS |
| AROM | AROM | 854 | 959 | 23.37 | DSS |
| AROM | AROM | 941 | 231 | 23.26 | DSS |
| AROM | AROM | 1184 | 231 | 22.81 | DSS |
| AROM | AROM | 1235 | 168 | 22.76 | DSS |
| AROM | AROM | 487 | 636 | 22.63 | DSS |
| AROM | AROM | 1184 | 343 | 22.45 | DSS |
| AROM | AROM | 1227 | 1188 | 22.26 | DSS |
| AROM | AROM | 487 | 636 | 22.21 | DSS |
| AROM | AROM | 168 | 371 | 22.2 | DSS |
| AROM | AROM | 784 | 410 | 22.09 | DSS |
| AROM | AROM | 1040 | 854 | 21.95 | DSS |
| AROM | AROM | 1225 | 1188 | 21.88 | DSS |
| AROM | AROM | 1267 | 1127 | 21.51 | DSS |
| AROM | AROM | 168 | 358 | 21.4 | DSS |
| AROM | AROM | 358 | 854 | 21.18 | DSS |
| AROM | AROM | 487 | 526 | 21.13 | DSS |
| AROM | AROM | 941 | 343 | 21.04 | DSS |
| AROM | AROM | 865 | 881 | 21.03 | DSS |
| AROM | AROM | 1184 | 1184 | 20.66 | DSS |
| AROM | AROM | 1188 | 1188 | 20.64 | DSS |
| AROM | AROM | 1235 | 1235 | 20.57 | DSS |
| AROM | AROM | 941 | 343 | 20.51 | DSS |
| AROM | AROM | 487 | 545 | 20.37 | DSS |
| AROM | AROM | 410 | 487 | 20.36 | DSS |
| AROM | AROM | 410 | 881 | 20.31 | DSS |
| AROM | AROM | 784 | 989 | 20.2 | DSS |
| AROM | AROM | 98 | 1188 | 19.32 | DSS |
| AROM | AROM | 1227 | 989 | 18.7 | DSS |
| AROM | AROM | 168 | 1188 | 18.54 | DSS |
| AROM | AROM | 1227 | 231 | 18.53 | DSS |
| AROM | AROM | 941 | 854 | 18.09 | DSS |
| AROM | AROM | 545 | 545 | 17.8 | DSS |
| AROM | AROM | 1184 | 1127 | 17.1 | DSS |
| AROM | AROM | 482 | 636 | 16.94 | DSS |
| AROM | AROM | 937 | 989 | 16.77 | DSS |
| AROM | AROM | 941 | 989 | 16.65 | DSS |

\* The score is a measure of confidence for the identification of the two connected peptides (i.e. computational assignment) that are identified by MS (the higher, the better). It is generally NOT correlated with the distance between the cross-linked residues. In addition, physicochemical properties of the peptides may affect the identification, so that some cross-linked peptides intrinsically have lower scores.

For the reported data, we expect a **false positive rate of identification of approximately 5%.** Cross-links reflecting different conformations may exist.

\*\*Cross-linking chemistries:

DSS: disuccinimidyl suberate – a lysine specific cross-linker.

For experimentally observed distance restraints, see the following plot (only DSS was used for this protein):



(taken from Leitner et al., PNAS, 2014)

**Sub-optimal sequence regions for conventional cross-linking mass spectrometry**

Red residues: Lysine residues. Can be cross-linked by DSS and are cleavage sites for trypsin (protease used in the experimental process).

Black residues: Arginine residues. Cleavage sites for trypsin.

Residues highlighted in yellow are sub-optimal regions for mass spectrometric analysis.

10 20 30 40 50 60   
MATANVAGAG GSGSEPT**R**IA ILG**K**EDIIVD HGIWLNFVAH DLLQTLPSST YVLITDTNLY   
  
 70 80 90 100 110 120   
TTYVPPFQAV FEAAAP**R**DV**R** LLTYAIPPGE YS**K**S**R**ET**K**AE IEDWMLSHAC T**R**DTVIIALG   
  
 130 140 150 160 170 180   
GGVIGDMIGY VAATFM**R**GV**R** FVQVPTTLLA MVDSSIGG**K**T AIDTPMG**K**NL IGAFWQP**RR**I   
  
 190 200 210 220 230 240   
YIDLAFLETL PV**R**EFINGMA EVI**K**TAAIWN ETEFTALEEN AAAILEAV**R**S **K**ASSPAA**R**LA   
  
 250 260 270 280 290 300   
PI**R**HIL**KR**IV LGSA**R**V**K**AEV VSADE**R**EGGL **R**NLLNFGHSI GHAYEAILAP QVLHGECVAI   
  
 310 320 330 340 350 360   
GMV**K**EAELA**R** YLGVL**R**PSAV A**R**LT**K**LIASY DLPTSVHD**KR** IA**K**LSAG**K**EC PVDVLLQ**K**MA   
  
 370 380 390 400 410 420   
VD**KK**NEG**RKK** **K**IVLLSAIG**K** TYE**KK**ATVVD D**R**AI**R**LVLSP SV**R**VTPGVP**K** GLSVTVTPPG   
  
 430 440 450 460 470 480   
S**K**SISN**R**ALV LAALGEGTT**R** IHGLLHSDDV QYMLAAIEQL HGADFSWEDA GEILVVTG**K**G   
  
 490 500 510 520 530 540   
G**K**LQAS**K**EPL YLGNAGTAS**R** FLTSVVALCA PSAVSSTVLT GNA**R**M**K**V**R**PI GALVDAL**R**AN   
  
 550 560 570 580 590 600   
GVGV**K**YLE**K**E **K**SLPVEVDAA GGFAGGVIEL AATVSSQYVS SILMAAPYAH QPVTL**R**LVGG   
  
 610 620 630 640 650 660   
**K**PISQPYIDM TIAMMASFGI **K**VE**R**SAEDPN TYLIP**K**GVY**K** NPPEYVVESD ASSATYPLAV   
  
 670 680 690 700 710 720   
AAITGTTCTI PNIGSESLQG DA**R**FAVEVL**R** PMGCAVEQTA TSTTVTGPPI GTL**K**AIPHVD   
  
 730 740 750 760 770 780   
MEPMTDAFLT AAVLAAVADG TTQITGIANQ **R**V**K**ECN**R**IAA M**K**DQLA**K**FGV QCNELEDGIE   
  
 790 800 810 820 830 840   
VIG**K**PYQEL**R** NPVEGIYCYD DH**R**VAMSHSV LSTISPHPVL ILE**R**ECTA**K**T WPGWWDILSQ   
  
 850 860 870 880 890 900   
FF**K**VQLDGEE DPT**KR**TTQST QQV**RK**GTD**R**S IFIVGM**R**GAG **K**STAG**R**WMSE LL**KR**PLVDLD   
  
 910 920 930 940 950 960   
AELE**RR**EGMT IPEII**R**GE**R**G WEGF**R**QAELE LLQDVI**K**NQS **K**GYIFSCGGG IVETEAA**RK**L   
  
 970 980 990 1000 1010 1020   
LIDYH**K**NGGP VLLVH**R**DTDQ VVEYLM**R**D**K**T **R**PAYSENI**R**E VYE**RRK**PWFY ECSNLQYHSP   
  
 1030 1040 1050 1060 1070 1080   
HEDGSEALLQ PPADFA**R**FV**K** LIAGQSTHLE DV**R**A**KK**HSFF VSLTVPNVAD ALDIIP**R**VVV   
  
 1090 1100 1110 1120 1130 1140   
GSDAVEL**R**VD LLESYEPEFV A**R**QVALL**R**AA AQVPIVYTV**R** TQSQGG**K**FPD EDYDLAL**R**LY   
  
 1150 1160 1170 1180 1190 1200   
QTGL**R**SGVEY LDLEMTMPDH ILQAVTDA**K**G FTSIIASHHD PQC**K**LSW**K**SG SWIPFYN**K**AL   
  
 1210 1220 1230 1240 1250 1260   
QYGDVI**K**LVG VA**R**EMADNFA LTNF**K**A**K**MLA AHDN**K**PMIAL NMGTAG**K**LS**R** VLNGFLTPVS   
  
 1270 1280 1290 1300 1310 1320   
HPALPS**K**AAP GQLSATEI**R**Q ALSLIGEIEP **K**SFYLFG**K**PI SAS**R**SPALHN TLFY**K**TGLPH   
  
 1330 1340 1350 1360 1370 1380   
HYS**R**FETDEA S**K**ALESLI**R**S PDFGGASVTI PL**K**LDIMPLL DSATDAA**R**TI GAVNTIIPQT   
  
 1390 1400 1410 1420 1430 1440   
**R**DGSTTTLVG DNTDW**R**GMVH ALLHSSGSGS VVQ**R**TAAP**R**G AAMVVGSGGT A**R**AAIYALHD   
  
 1450 1460 1470 1480 1490 1500   
LGFAPIWIVA **R**SEE**R**VAELV **R**GFDGYDL**RR** MTSPHQG**K**DN MPSVVISTIP ATQPIDPSM**R**   
  
 1510 1520 1530 1540 1550 1560   
EVIVEVL**K**HG HPSAEG**K**VLL EMAYQPP**R**TP LMTLAEDQGW **R**TVGGLEVLA AQGWYQFQLW   
  
 1570 1580   
TGITPLYEEA **R**AAVMGEDSV ELEHHHHHH