

# GAMMA Software

## **GAMMA Software References available on GAMMA homepage:**

There exist a number of technical reports, conference and journal papers that document a specific element or functionality of the GAMMA Software. Some of these documents are made available as pdf for download at <https://www.gamma-rs.ch/gamma/documents.html>.

- [1997-1 GAMMA Software.pdf: Wegmüller U. and C. L. Werner, GAMMA SAR processor and interferometry software, Proceedings 3rd ERS Scientific Symposium, Florence, Italy, 17-20 March 1997.](#)
- [1998-1 DINSAR.pdf: Wegmüller U., T. Strozzi, and C. Werner, SAR Interferometric and Differential Interferometric Processing Chain, Proceedings of IGARSS'98, 6-10 July, Seattle, WA, USA, 1998.](#)
- [1998-2 GAMMA Software.pdf: Wegmüller U., SAR Processing, Interferometry, Differential Interferometry and Geocoding Software, EUSAR'98, 25-27 May, Friedrichshafen, Germany, VDE-Verlag, ISBN 3-8007-2359-X, pp. 145-148, 1998.](#)
- [1999-1 Geocoding.pdf: Wegmüller U., Automated terrain corrected SAR geocoding, Proceedings of IGARSS'99, Hamburg, 28 June - 2 July 1999.](#)
- [1999-2 TR JERS Radcal.pdf: MSP JERS SAR processing: Absolute radiometric calibration, 1999.](#)
- [2000-1 GAMMA Software.pdf: Werner C., U. Wegmüller, T. Strozzi, and A. Wiesmann, „Gamma SAR and Interferometric Processing Software”, Proceedings of ERS-ENVISAT Symposium, Gothenburg, Sweden, 16-20 Oct. 2000.](#)
- [2000-2 Stacking1.pdf: Wegmüller U., T. Strozzi, and L. Tosi, „Differential SAR interferometry for land subsidence monitoring: methodology and examples”, Proceedings of SISOLS 2000, Ravenna, Italy, 25 -29 September 2000.](#)
- [2000-3 Stacking2.pdf: Strozzi T., U. Wegmüller, C. Werner, and A. Wiesmann, Measurement of slow uniform surface displacement with mm/year accuracy, Proc. of IGARSS'00, Honolulu, USA, 24-28 July 2000.](#)
- [2000-4 Stacking3.pdf: Wegmüller U., T. Strozzi, and L. Tosi, „ERS and ENVISAT differential SAR interferometry for subsidence monitoring”, Proceedings of ERS-ENVISAT Symposium, Gothenburg, Sweden, 16-20 Oct. 2000.](#)
- [2001-1 Tracking.pdf: Werner C., T. Strozzi, A. Wiesmann, U. Wegmüller, T. Murry, H. Pritchard, and A. Luckman, „Complementary measurement of geophysical deformation using repeat-pass SAR”, Proceedings of IGARSS 2001, Sidney, Australia, 9-13 July 2001.](#)
- [2002-1 Coregistration.pdf: Wegmüller U., C. Werner, T. Strozzi, and A. Wiesmann, „Automated and precise image registration procedures”, in Analysis of Multi-temporal remote sensing images, Bruzzone and Smits \(ed.\), Series in Remote Sensing, Vol. 2, World Scientific \(ISBN 981-02-4955-1\), pp. 37-49, 2002.](#)
- [2002-2 Geocoding.pdf: Werner C., T. Strozzi, U. Wegmüller, and A. Wiesmann, SAR geocoding and multi-sensor image registration, Proc. IGARSS 2002, Toronto, Canada, pp. 902-904, 24-28 June 2002.](#)
- [2002-3 InSAR.pdf: Wegmüller U., T. Strozzi, C. Werner, and A. Wiesmann, SAR interferometry for topographic mapping and surface deformation monitoring, Photogrammetric J. of Finland, Vol. 18, No. 1, pp. 24-32, 2002.](#)
- [2002-4 PhaseUnwrapping.pdf: Werner C., U. Wegmüller, and T. Strozzi, Processing strategies for phase unwrapping for INSAR applications, Procs. EUSAR Conf., Cologne, Germany, 4.-6. June, 2002.](#)
- [2002-5 TR PhaseUnwrapping.pdf: Phase Unwrapping with GAMMA ISP, 2002.](#)
- [2003-1 ASAR multiswath.pdf: Wiesmann A., U. Wegmüller, C. Werner, and T. Strozzi, „ASAR multi-swath techniques”, Proc. IGARSS 2003, Toulouse, France, 21-25 July 2003.](#)
- [2003-2 IPTA.pdf: Werner C., U. Wegmüller, T. Strozzi, and A. Wiesmann, „Interferometric point target analysis for deformation mapping”, Proc. IGARSS 2003, Toulouse, France, 21-25 July 2003.](#)
- [2003-3 IPTA JERS.pdf: Werner C., U. Wegmüller, A. Wiesmann, and T. Strozzi, „Interferometric point target analysis with JERS-1 L-band SAR data”, Proc. IGARSS 2003, Toulouse, France, 21-25 July 2003.](#)
- [2003-4 TR ASAR Processing.pdf: MSP ENVISAT ASAR DATA PROCESSING, 2003.](#)

- [2004-1 IPTA.pdf](#): Wegmüller U., C. Werner, T. Strozzi, and A. Wiesmann, „Multi-temporal interferometric point target analysis”, in Analysis of Multi-temporal remote sensing images, Smits and Bruzzone (ed.), Series in Remote Sensing, Vol. 3, World Scientific (ISBN 981-238-915-61), pp. 136-144, 2004.
- [2004-2 IPTA RSAT1.pdf](#): Rabus B., C. Werner, U. Wegmüller, and A. McCardle, „Interferometric point target analysis of RADARSAT-1 data for deformation monitoring at the Belridge/Lost Hills oil fields”, Proc. IGARSS 2004, Anchorage, USA, 20-24 Sep. 2004.
- [2004-3 PSI DINSAR combination.pdf](#): Wiesmann A., C. Werner, T. Strozzi, and U. Wegmüller, „Combination of point and extended target based interferometric techniques”, Proc. IGARSS 2004, Anchorage, USA, 20-24 Sep. 2004.
- [2005-1 IPTA ERS ASAR.pdf](#): Wegmüller U., C. Werner, T. Strozzi, and A. Wiesmann, „ERS ASAR Integration in the Interferometric Point Target Analysis”, Procs. FRINGE 2005 Workshop, Frascati, Italy, 28. Nov. - 2 Dec., 2005.
- [2005-2 OffsetEstimation.pdf](#): Werner C., U. Wegmüller, T. Strozzi, and A. Wiesmann, „Precision estimation of local offsets between SAR SLCs and detected SAR images”, Proc. IGARSS 2005, Seoul, Korea, 25-29 Jul. 2005.
- [2005-3 TR IPTA ERS ASAR Intergration.pdf](#): ERS – ASAR Integration in GAMMA IPTA Processing, 2005.
- [2005-4 TR IPTA Processing Example Luxemburg.pdf](#): IPTA Processing Example Luxemburg, 2005.
- [2006-1 ASAR ScanSAR Interferometry.pdf](#): Wiesmann A., C. Werner, M. Santoro, U. Wegmüller, and T. Strozzi, „ScanSAR Interferometry for land use applications and terrain deformation”, Proc. IGARSS 2006, Denver, Colorado, USA, 31- Jul. – 4. Aug. 2006.
- [2006-2 Ionosphere.pdf](#): Wegmüller U., C. Werner, T. Strozzi, and A. Wiesmann, „Ionospheric electron concentration effects on SAR and INSAR”, Proc. IGARSS 2006, Denver, Colorado, USA, 31- Jul. – 4. Aug. 2006.
- [2006-3 JERS DINSAR Tracking.pdf](#): Strozzi T., A. Wiesmann, A. Sharov, A. Kouraev, U. Wegmüller, and C. Werner, „Capabilities of L-band SAR data for arctic glacier motion estimation”, Proc. IGARSS 2006, Denver, Colorado, USA, 31- Jul. – 4. Aug. 2006.
- [2006-4 TR Palsar fine beam proc.pdf](#): Processing of Fine-Beam HH ALOS PALSAR Stripmap Data, 2006.
- [2006-5 TR PALSAR Processing.pdf](#): ALOS PALSAR data processing using GAMMA Software, 2006.
- [2007-1 ALOS FBS FBD Interferometry.pdf](#): Werner C., U. Wegmüller, T. Strozzi, A. Wiesmann, and M. Santoro, „PALSAR Multi-Mode Interferometric Processing”, Procs First joint PI Symposium of ALOS data nodes for ALOS Science Program, 19-23. Nov. 2007, Kyoto, Japan.
- [2007-2 CoherenceEstimation.pdf](#): Santoro M. , C. Werner, U. Wegmüller, and O. Cartus, „Improvement of interferometric SAR coherence estimates by slope-adaptive range common-band filtering“, Proc. IGARSS 2007, Barcelona, Spain, 23-27 Jul. 2007.
- [2008-1 TSX INSAR IPTA.pdf](#): Wegmüller U., D. Walter, V. Spreckels, and C. Werner, „Evaluation of TerraSAR-X DINSAR and IPTA for ground-motion monitoring“, Procs. 3. TerraSAR-X Science Team Meeting, 25/26 Nov. 2008, DLR, Oberpfaffenhofen, Germany.
- [2009-1 ERS-ENVISAT CInSAR CoherenceEstimation.pdf](#): Wegmüller U., M. Santoro, C. Werner, T. Strozzi and A. Wiesmann ERS-ENVISAT Tandem Cross - Interferometry Coherence estimation, Proc. IGARSS'09, Cape Town, South Africa, 13-17 Jul. 2009.
- [2009-2 ERS-ENVISAT CrossInSAR.pdf](#): Wegmüller U., M. Santoro, C. Werner, T. Strozzi, A. Wiesmann, and W. Lengert, „DEM generation using ERS–ENVISAT interferometry“, Journal of Applied Geophysics Vol. 69, pp 51–58, 2009, doi:10.1016/j.jappgeo.2009.04.002.
- [2009-3 PALSAR1 SBAS.pdf](#): Wegmüller U., C. Werner, and M. Santoro, Motion Monitoring for Etna using ALOS PALSAR time series, ALOS PI Symposium, Hawaii, USA, 9-13 Nov 2009.
- [2009-4 TSX SBAS.pdf](#): Wegmüller U., L. Petrat, K. Zimmermann, and I. Al Quseimi, „The potential of high resolution satellite interferometry for monitoring enhanced oil recovery”, Procs. 5<sup>th</sup>. European Symposium on Improved Oil Recovery, Paris, France, 27-29. Apr. 2009.
- [2010-1 TSX PSI nonuniform.pdf](#): Wegmüller U., D. Walter, V. Spreckels, and C. Werner, „Nonuniform ground motion monitoring with TerraSAR-X persistent scatterer interferometry,“ IEEE Trans. Geosci. Remote Sensing, Vol. 48, 2, pp. 895-904, 2010.
- [2011-1 PALSAR1 ScanSAR DInSAR.pdf](#): Werner C., U. Wegmüller, O. Frey, and M. Santoro, „Interferometric processing of PALSAR Wide-Beam ScanSAR data,“ Proc. Fringe'11, Frascati, Italy, 19. – 23. Sep. 2011.

- [2011-2\\_PixelArea.pdf](#): Frey, O., Santoro, M., Werner, C. L., Wegmüller, U., „DEM-based SAR pixel area estimation for enhanced geocoding refinement and radiometric normalization,“ In Proc. FRINGE 2011, Frascati, Italy, Sept. 2011.
- [2012-1\\_Multi-Baseline\\_Time-Series.pdf](#): Werner C., U. Wegmüller U, and T. Strozzi, „Deformation Time-Series of the Lost-Hills Oil Field using a Multi-Baseline Interferometric SAR Inversion Algorithm with Finite-Difference Smoothing Constraints”, AGU Fall Meeting, 2012.
- [2012-2\\_PointDensityReduction.pdf](#): Wegmüller U., O. Frey, and C. Werner, „Point Density Reduction in Persistent Scatterer Interferometry”, Procs. EUSAR 2012 Conf., 24-26. Apr. 2012.
- [2012-3\\_SBI\\_Ionosphere.pdf](#): Wegmüller U., T. Strozzi, and C. Werner, Ionospheric path delay estimation using split-beam interferometry, Procs. IGARSS'2012, Munich, Germany, 22-27 July 2012.
- [2013-1\\_Multi\\_Image\\_Filtering.pdf](#): Wegmüller, U., M. Santoro, and C. Werner, „Multi-temporal SAR data filtering for land applications,“ ESA Living Planet Symp., Edinburgh, UK, 9-13 Sep., SP-722, 2013.
- [2013-2\\_PixelArea.pdf](#): Frey O., M. Santoro, C.L. Werner, and U. Wegmüller, „DEM-based SAR pixel area estimation for enhanced geocoding refinement and radiometric normalization,“ IEEE Geosci. Remote Sens. Lett., 10(1):48-52, doi:10.1109/LGRS.2012.2192093, Jan. 2013.
- [2013-3\\_Offset\\_Tracking\\_Time-Series.pdf](#): Haemmig C., M. Huss, H. Keusen, J. Hess, U. Wegmüller, Z. Ao, and W. Kulubayi, „Hazard assessment of glacial lake outburst floods from Kyagar glacier, Karakoram mountains, China,“ Annals of Glaciology, 55(66), 66A001, 2013.
- [2013-4\\_IPTA\\_with\\_CornerReflectors.pdf](#): Strozzi, T., P. Teatini, L. Tosi, U. Wegmüller and C. Werner, „Land subsidence of natural transitional environments by satellite radar interferometry on artificial reflectors.” Journal of Geophysical Research: Earth Surface, Vol. 118, 1-15, doi: 10.1002/jgrf.20082, 2013.
- [2014-1\\_TR\\_IPTA\\_Thermal\\_Expansion\\_Phase.pdf](#): Considering thermal expansion component in IPTA, 2014.
- [2014-2\\_TR\\_KOMPSAT\\_Support\\_in\\_GAMMA.pdf](#): KOMPSAT-5 support within GAMMA Software, 2014.
- [2014-3\\_Multi-Temporal\\_Metrics.pdf](#): Santoro, M., Wegmüller, U., „Multi-temporal Synthetic Aperture Radar metrics applied to map open water bodies,“ IEEE JSTARS, vol. 7, 8, pp. 3225-3238, 2014.
- [2015-1\\_IPTA\\_ThermalExpansionPhase.pdf](#): Wegmüller U. and C. Werner, „Mitigation of Thermal Expansion Phase in Persistent Scatterer Interferometry in an Urban Environment“, Procs. Joint Urban Remote Sensing Event JURSE 2015, Lausanne, Switzerland, 30.3.-1.4. 2015.
- [2015-2\\_S1\\_coherence.pdf](#): Wegmüller U., M. Santoro, C. Werner and O. Cartus, „On the Estimation and Interpretation of Sentinel-1 TOPS InSAR Coherence“, Procs Fringe 2015 Conf., ESA ESRIN, Frascati, Italy, 23-27 Mar. 2015.
- [2015-3\\_S1\\_Support.pdf](#): Wegmüller U., C. Werner, T. Strozzi, A. Wiesmann, O. Frey, and M. Santoro, „Sentinel-1 support in the GAMMA Software“, Procs Fringe 2015 Conf., ESA ESRIN, Frascati, Italy, 23-27 Mar. 2015.
- [2015-4\\_TR\\_PALSAR2\\_Support\\_in\\_GAMMA.pdf](#): ALOS-2 PALSAR-2 support in GAMMA Software, 2015.
- [2015-5\\_TR\\_S1\\_GRD\\_geometry.pdf](#): Sentinel-1 GRD Geometry test, 2015.
- [2016-1\\_S1\\_IPTA.pdf](#): Wegmüller U., C. Werner, A. Wiesmann, T. Strozzi, P. Kourkouli, and O. Frey, „Time-Series Analysis of Sentinel-1 Interferometric Wide Swath Data: Techniques and Challenges”, Procs. IGARSS, 2016.
- [2016-2\\_S1\\_Support.pdf](#): Wegmüller U., C. Werner, T. Strozzi, A. Wiesmann, O. Frey and M. Santoro, „Sentinel-1 Support in the GAMMA Software”, Procedia Computer Science, 100: 1305-1312, 2016, doi:10.1016/j.procs.2016.09.246.
- [2017-1\\_TR\\_Offset\\_Estimation.pdf](#): Magnard C., C. Werner, and U. Wegmüller “GAMMA Technical Report: Offset estimation programs”, 2017.
- [2017-2\\_TR\\_Interpolation\\_and\\_resampling.pdf](#): Magnard C., C. Werner, and U. Wegmüller “GAMMA Technical Report: Interpolation and resampling”, 2017.
- [2017-3\\_GAMMA\\_big\\_data\\_use.pdf](#): Santoro M., O. Cartus, A. Wiesmann, U. Wegmüller, J. Kellndorfer, C. Schmullius, P. Defourny, O. Arino, M. Engdahl, and F.M. Seifert, "Exploitation of Envisat ASAR and Sentinel-1 SAR data in support of carbon and water cycle studies," Procs Big Data from Space (BiDS'17), Toulouse, 28-30 Nov., pp. 157-160, 2017.
- [2018-1\\_DINSAR\\_IonosphereMitigation](#): Wegmüller U., C. Werner, O. Frey, C. Magnard, and T. Strozzi, Reformulating the split-spectrum method to facilitate the estimation and compensation of the ionospheric phase in SAR interferograms, Procedia Computer Science, 138: 318-325, 2018, <https://doi.org/10.1016/j.procs.2018.10.045>.
- [2019-1\\_TR\\_ASNARO2\\_Support\\_in\\_GAMMA](#): Wegmüller U., C. Magnard, and C. Werner, ASNARO-2 support within GAMMA Software.

- [2019-2 3D Displacement Vector Retrieval: Wegmüller U., C. Werner, C. Magnard, and A. Manconi, Co-seismic displacement vector retrieval for the Iran-Iraq Earthquake using Sentinel-1, Poster at ESA Living Planet Meeting Milano, Italy, 2019.](#)
- [2020-1 Filtering in map geometry: C. Magnard, U. Wegmüller, and C. Werner, “Persistent Scatterer Interferometry in mountainous areas: advantages of working in map geometry,” SARWatch Workshop - Advances in the Science and Applications of SAR Interferometry, Vilamoura, Portugal, 2020.](#)
- [2020-2 Multi reference stack time series processing: U. Wegmüller, C. Magnard, C. Werner, T. Strozzi, R. Caduff, and A. Manconi, “Methods to avoid being affected by non-zero closure phase in InSAR time series analysis in a multi-reference stack,” SARWatch Workshop - Advances in the Science and Applications of SAR Interferometry, Vilamoura, Portugal, 2020.](#)
- [2021-1 TR S1 burst number: O. Cartus, U. Wegmüller, C. Magnard, and C. Werner, “How to generate S1 Burst IDs”, 2021.](#)