CURRICULUM VITAE

George B. Crull, Ph.D.

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EDUCATION:

Spring 2003	Advance I Solid State NMR Training, Bruker Biospin, Billerica, MA
Fall 2000	Varian System Administration Training, Palo Alto, CA
Fall 2000	Varian New User Training, Palo Alto, CA
Spring 2000	Take the Mystery Out of HPLC, Training Masters, Princeton, NJ
Spring 1998	Advance II NMR Training Class, Bruker, Boston, MA
Fall 1996	Graduate Course in Structural Biology, Syracuse University, Syracuse, NY
Fall 1994	Intro to Molecular Modeling & NMR Data Processing, TRIPOS, St. Louis, MO
Fall 1993	Basic Training Course on Drug Development, PMA, Washington, DC

1987-1989 Post-Doctoral Research, Dept. of Chemistry, University of Iowa, Iowa City, IA
Supervisor: Dr. H.M. Goff

Research involved studying the interaction of halide and pseudo-halide ions with the heme iron of Lactoperoxidase by heteronuclear NMR and UV/Vis absorption spectroscopy. Research also included the development of 2D NMR methods for samples of high molecular weight and low concentration. The proton-carbon and proton-nitrogen connectivities of paramagnetic proteins explored through the scalar coupling by double quantum filtered reverse detection H-X correlated 2D NMR. Techniques applied to the structural analysis of diamagnetic natural products.

1987 Ph.D., Physical Chemistry, University of South Carolina, Columbia, SC

Dissertation: "Part I: An Investigation of the Substrate and Ligand Binding Sites of Cytochrome P-450-CAM Using Nuclear Magnetic Resonance. Part II: A Nuclear Magnetic Resonance Study of (1R)-(+)-Camphor and 25 Camphor Derivatives using One- and Two-Dimensional Methods."

Curriculum included courses in: spectroscopy (NMR, Solid State NMR, UV/VIS, CD, MCD, IR, AA, AE, and AF); separation methods (GC, LC, and HPLC); basic electronics; thermodynamics; kinetics; biophysical chemistry; bio-inorganic chemistry; biochemistry; physical-inorganic chemistry; group theory; and general inorganic chemistry.

1983-1987 Doctoral Research, Dept. of Chemistry, University of South Carolina, Columbia, SC
Supervisors: Dr. J.H. Dawson/Dr. P.D. Ellis

Research included determining the solution state heme iron to substrate distance of cytochrome P-450 using ^{19}F NMR through the application of the Solomon-Bloembergen equation. The interaction of fluoride ion with the active site of P-450-CAM was also probed by ^{1}H and ^{19}F NMR, EPR and UV/Vis absorption spectroscopy. The ^{13}C and ^{1}H NMR spectra of (1R)-(+)-Camphor and 20 derivatives assigned using high field one- and two-dimensional NMR.

1981 B.S., Chemistry, University of Southern Mississippi, Hattiesburg, MS

WORK EXPERIENCE:

2018-present Arts and Science NMR Center, Univ. of Iowa, Iowa City, IA 52242
2011- 2017 Leader, Solid State Spectroscopy
Material Science, Bristol-Myers Squibb Company, New Brunswick, NJ

As senior spectroscopist, coordinate and distribute projects for ssNMR in Pharmaceutical Development. The Solid State Spectroscopy group works closely with groups using varied types of spectroscopies in support of compounds in the BMS portfolio. As the solid state NMR spectroscopist, provide multi-nuclear 1-D and 2-D analysis of solid, amorphous dispersions and slurry samples using solid state NMR. Specify capital equipment related to ssNMR. As member of the Material Science Leadership team, review projects in Development and help set strategic objectives for Material Science.

2004-2011 Principal Scientist
Bristol-Myers Squibb Company, New Brunswick, NJ

As a Principal Scientist in Pharmaceutical Development, supported compounds from Discovery through Launch. As the solid state NMR spectroscopist, provided analysis of solid and slurry samples using solid state NMR from several different departments and locations. Summarized and presented these data to stake holders. Regularly contributed to the preparation and submission of regulatory documents and patents. Routinely utilized a broad background to address problems outside the area of NMR. Specified capital equipment related to ssNMR.

1999-2004 Senior Research Investigator II
Bristol-Myers Squibb Company, Princeton, NJ

As a Senior Research Investigator in the Analytical R&D department of Pharmaceutical Development supported compounds from late Discovery through Launch. As a Primary NMR spectroscopist, provided analysis of samples using solution state NMR, LC NMR and solid state NMR (CP-MAS) from several different departments and locations. Regularly contributed to the preparation and submission of regulatory documents, e.g. INDs, NDAs, sNDAs and BLAs. In a collaborative mode, routinely solved structure elucidation issues of process impurities, degradants and metabolites. Utilized a broad background to address problems outside the area of NMR. Specified capital equipment. As leader of a DMCT (Development Manufacturing Coordination Team) developing a novel biological therapeutic, fostered collaborations between several development areas (ARD, PRD, PhRD, DSE) to assure time lines were met. Also represented Pharmaceutical Development as a member of Project Working Groups.

1998-99 Senior Research Investigator I
Bristol-Myers Squibb Company, Syracuse, NY

Lead the Development Coordination Team developing a novel therapeutic. In this capacity, collaborations between several development areas were fostered to assure time lines were met. Assisted with the preparation and submission of INDs, NDAs and a BLA. Lead the Analytical Project teams developing novel biological chemotherapeutics. Represented AR&D throughout the development process and clinical testing of this compound.

Additional responsibilities included: preparing CMC and structural elucidation documents for filing with various regulatory agencies including the FDA; working as a member of development teams for both conventional and biologic products; developing and implementing analytical methods within GMP/GLP guide-lines for conventional and biological compounds using spectroscopic methods; supervision, operation and maintenance of NMR spectrometers; instruction and training of researchers in the hands-on operation of the NMR spectrometers; supervision of NMR staff; interdepartmental and inter-site collaborations on both specific compounds and infrastructure improvements; e.g. NMR spectra data base. Coordinated outsource testing of biological compounds in support of both stability and release testing.

1993-98 Research Investigator II, Analytical Research and Development
Bristol-Myers Squibb Company, Syracuse, NY

Responsibilities included: developing and implementing analytical methods within GMP/GLP guidelines for conventional and biological compounds using spectroscopic methods; supervision, operation and maintenance of NMR spectrometers; assistance with the application of spectroscopic methods, particularly 1- and 2-D NMR experiments, both within PRI and for other divisions; instruction and training of researchers in the hands-on operation of the NMR spectrometers; supervision of NMR staff.

1992-93 Research Investigator I, Analytical Research and Development
Bristol-Myers Squibb Company, Syracuse, NY

Responsibilities included: developing and implementing analytical methods within GMP/GLP guidelines for conventional and biological compounds using spectroscopic methods; supervision, operation and maintenance of NMR spectrometers; assistance with the application of spectroscopic methods, particularly 1- and 2-D NMR experiments, both within PRI and for other divisions; instruction and training of researchers in the hands-on operation of the NMR spectrometers.

1989-1992 NMR Coordinator, Stony Brook Regional NMR Center
Dept. of Chemistry, State University of New York, Stony Brook, NY
(Tenure-track non-teaching faculty position)

Coordinator's duties included: maintenance and repair of NMR instrumentation systems (Bruker AMX-600, MSL-400, AC-250, GE QE-300 and Nicolet NT-300 superconducting multinuclear spectrometers); consultation, collaboration and assistance for university as well as outside clients pertaining to areas of expertise and responsibility; instruction of

students and faculty in NMR operation; contribution to or preparation of pertinent research equipment grants; selection and installation of new spectrometers. Supervised a staff of two full-time employees and two students.

Taught classes in NMR theory and application at the graduate level both within the Chemistry Department and in the Biophysics Department. Lead a research laboratory studying the active sites of heme proteins and the role of Ca ion in the folding and regulation of the peroxidases, specifically HRP and LPO. Two students earned Thesis Masters of Science from these research activities. The lab received external funding for research activities.

1986-87 USC NMR Facilities Staff
Dept. of Chemistry, University of South Carolina, Columbia, SC

Duties included operation of all departmental NMR spectrometers and training, planning, performing and assisting in the analysis of 2-D NMR experiments for departmental users. Instruments operated included Varian EM-360 and EM-390 proton spectrometers, IBM NR-80 multinuclear FT spectrometer, and Bruker WP-200, WH-400, and AM-300 superconducting multinuclear FT spectrometers.

1981-83 UNM Research Chemist
Dept. of Chemistry, University of New Mexico, Albuquerque, NM

Research involved isolation of the hemoglobin from Glycerin dibranchiata. These monomeric hemoglobins were characterized using UV/Visible absorption spectroscopy.

TEACHING EXPERIENCE:

1995-2001 Adjunct Professor, Cell and Molecular Biology
State University of New York Health Science Center, Syracuse, NY

Lectured in graduate level classes as appropriate. Supervised one graduate student (Ph.D. candidate).

Spring 1997-99 Guest Lecturer
LeMoyne College, Dept. of Chemistry, Syracuse, NY

Part of a multi-discipline team-taught Instrumental Analysis class/lab (hands-on). Lectured on "Modern NMR Methods as Applied to Structure Elucidation". Implemented and taught hands-on 1-D and 2-D NMR to the students.

Spring 1990-92 Biophysical Chemistry, Graduate course
State University of New York at Stony Brook, Stony Brook, NY

Team-taught a class of 20 graduate students. Three sections devoted to spectroscopy of biopolymers covered in the class: X-ray Diffraction, Optical Methods, and NMR. Instructed NMR portion devoted to modern methods of structure elucidation by NMR and substrate-enzyme interactions.

Spring 1984 — Laboratory, Medical School Biochemistry
University of South Carolina, Columbia, SC

Responsible for instruction and supervision of 25 first-year medical students in biochemical laboratory procedures (4 hours per week). Procedures included both spectroscopic and chemical methods as well as basic sample handling techniques, (pH measurements, centrifugation, separation of blood products, etc.).

1981-83 — Laboratory and Recitation Instructor, General Chemistry
University of New Mexico, Albuquerque, NM

Responsible for instruction and grading of three (3) labs per semester of 20-25 students each for 3 hours per week.

PROFESSIONAL COMMUNITY OUTREACH:

2007-2008 — Chair, Princeton ACS Local Section
Hosted monthly meeting and speakers, lead executive board, prepared annual report.

2006-2007 — Chair-Elect, Princeton ACS Local Section
Assisted in meeting planning, served on executive board and became Local Section Chairman in 2007.

2004-2005 — Chair, NJ ACS NMR Topical Group
(2005) — Senior Chairman for the NMR Topical Group
Hosted monthly meetings featuring guest lectures on NMR topics.

2000-present — Science Enrichment Instructor for elementary education
Developed novel demonstrations in physical sciences. Demonstration topics include: magnetism, electricity, optics, drug formulation, and chromatography.

2000-present — NJACS NMR Topical Group (co-Chair 2003-2005)
This group has been meeting for more than 10 years to discuss applications and developments in NMR spectroscopy. Group comprised of scientists from both academics and industry. Chair responsible for scheduling meetings, arranging for speakers and facilities.

1995-99 — Science Horizons for Outstanding Junior High Students
Contributed as needed to this BMS-sponsored program, including demonstrations, conducting tours and acting as a mentor to students.

1997-99 — Invited Lecturer
LeMoyne College, Dept. of Chemistry, Syracuse, NY

1997 — Guest Lecturer
State University of New York Health Science Center, Syracuse, NY

1996 — Project Light, Bristol-Myers Squibb, Syracuse, NY
Mentor a student. Based on student's activities, manuscript prepared, submitted, accepted.

SELECTED HONORS:

1996 PRI President's Award for MMA of ZERIT
1986, 1988 Sigma XI Outstanding Student Paper Presentation

PROFESSIONAL ORGANIZATIONS:

1979-Present American Chemical Society, Physical Chemistry Division
2003-Present New York Academy of Sciences

REPRESENTATIVE BOOK REVIEWS:

1. Review of "Biological Magnetic Resonance, Volume 9, L. J. Berliner and J. Reuben eds." in The Quarterly Review of Biology, March **1991**.

2. Review of "NMR: Principles and Applications to Biomedical Research, Jay W. Pettegrew ed." in The Quarterly Review of Biology, December **1991**.

3. Review of "NMR of Paramagnetic Substances by I. Bertini and C. Luchinat in Bioinorganic Chemistry", in Journal of Inorganic Biochemistry, *69*, **1998**.

REPRESENTATIVE PUBLICATIONS:

1. Crull, G.B.; Garber, A.R.; Kennington, J.W.; Prosser, C.M.; Stone, P.W.; Fant, J.W.; Dawson, J.H. "Carbon-13 Spectra of Eighteen (1R)-(+)-Camphor Derivatives", Magn. Reson. Chem., **1986**, *24*, 737.

2. Crull, G.B.; Dawson, J.H. "Camphor Binding to Ferrous Cytochrome P-450- CAM: Initial Use of ^{19}F NMR to Determine the Distance Between the Substrate and the Heme Iron", Recueil des Travaux Chimiques des Pays Bas., **1987**, *106*, 269.

3. Crull, G.B.; Kennington, J.W.; Garber, A.R.; Ellis, P.D.; Dawson, J.H. "^{19}F Nuclear Magnetic Resonance as a Probe of the Spatial Relationship Between the Heme Iron of Cytochrome P-450 and Its Substrate", J. Biol. Chem., **1989**, *264*, 2649.

4. Dawson, J.H.; Crull, G.B; Alberta, J.A.; Sono, M. "Oxygen Activation by Heme Iron Mono-oxygenases: Cytochrome P-450 and Secondary Amine Mono-oxygenase", Cytochrome P-450: Biochemistry and Biophysics, Ed. I. Schuster, Taylor & Frances, Ltd, London, **1989**, pp. 77-84.

5. Crull, G.B.; Nardo, J.V.; Dawson, J.H. "Direct Observation of Substrate Binding to Ferrous-CO Cytochrome P-450-CAM Using ^{19}F NMR", FEBS Let., **1989**, *254*, 39-42.

6 Crull, G.B.; Goff, H.M. "NMR Studies of the Interaction Thiocyanate with Lactoperoxidase", J. Inorg. Biochem., **1989**, *36*, 268.

7. Bock, J.M.; Crull, G.B.; Wishina, A.; Springer, C.S. "^{25}Mg NMR Studies of Magnesium Binding to Erythrocyte Constituents", J. Inorg. Biochem., **1991**, *44*, 79.

8. Crull, G.B. "Spectral Simplification via Relaxation Editing", Proceedings of the 32nd GE NMR Instruments Users Meeting, April **1991**.

9. Crull, G.B.; Wong, H.C.; Sono, M. "Initial Investigations of the Active Site of Inodleamine 2,3-Dioxygenase (IDO); Evidence of Interaction of Water with the Active Site from Proton NMR", J. Inorg. Biochem., **1991**, *43*, 307.

10. Maryniak, D.M.; Kadkhodayan, S.; Crull, G.B.; Bryson, T.A.; Dawson, J.H. "The Synthesis of 1R- and 1S-5-methyllcamphor and Their Epoxsidation by Cytochrome P-450-CAM", Tetrahedron, October **1993**.

11. Eguchi, M.; Crull, G.B.; Dong, Q.; Ojima, I.; Coller, B.S. "Structure-activity relationship of small cyclic RGD peptides as inhibitors of platelet aggregation." Pept.: Chem., Struct. Biol., Proc. Am. Pept. Symp., 13th, **1994**, 780.

12. Ko, Y.; Bonner, F.T.; Crull, G.B.; Harbison, G.S. "Protonation Nitrogen Shielding and NOE in Aqueous Nitrite and Solid State ^{15}N NMR of $NOBF_4$ and NO_2BF_4", Inorganic Chemistry, **1993**, *32*, 3316.

13. Crull, G.B.; Goff, H.M. "NMR Relaxation Studies of the Interaction of Thiocyanate with Lactoperoxidase", J. Inorg. Biochem., **1993**, *50*, 181.

14. Wilson, A.; Myers, C.; Crull, G.B.; Curtis, M.S.; Pasciak, P.M. "A Mentorship: Analysis of Soft Drinks using Nuclear Magnetic Resonance Spectroscopy", Journal of Chemical Education, **1999**.

15. Ye, Qingmei; Xu, Zhongmin; Crull, George; Leshcninskaya, Vera; Huang, Yande; Palaniswamy, V. "Structural Determination of a Process Impurity and Control of Its Formation in Support of Development of Brivanib, An Oral Dual Inhibitor of VEGFR and FGFR Tyrosine Kinases." Abstracts, 40th Middle Atlantic Regional Meeting of the American Chemical Society, Queens, NY, United States, May 17-21, **2008**.

16. Pan, D.; Crull, G.; Yin, S.; Grosso, J. " Low Level Drug Product API Form Analysis – Avalide Tablet NIR Quantitative Method Development and Robustness Challenges", J. Pharm. Biomed. Sci., **2014**, *89*, 268.

17. Leane, M.M.; Gamble, J.F.; Tobyn, M.; Hughes, H.; Crull, G.; Bunker, M.; Rutherford, S.; Parker, A.; Roberts, C.J.; Brown, J. "Imaging dehydration kinetics of a channel hydrate form of the HIV-1 Attachment Inhibitor Prodrug BMS-663068", J. Pharm. Sci., **2013**, *102*, 3475.

18. Abraham, A.; Crull, G. "Understanding API-Polymer Proximities in Amorphous Stabilized Composite Drug products using Fluorine-Carbon 2D HETCOR Solid-state NMR"**,** J. Mol. Pharm., **2014**, *11*, 3754.

19. McNamara, Daniel; Yin, Shawn; Pan, Duohai; Crull, George; Timmins, Peter; Vig, Balvinder. "Characterization of Phase Separation Propensity for Amorphous Spray Dried Dispersions", Molecular Pharmaceutics, **2017,** *14***,** 377.

20. Schlam, Roxana; Crull, George; Pan, Duohai; Patel, Anisha; Ng, Alicia; Gao, Qi; Sandoval, Maria. "Understanding the Effect of Hydration-State Variability on the Solid-State Characterization of a Pharmaceutical Non-Stoichiometric Hydrate", Submitted.

21. Desai, Salil; Kundu, Ipsi[1]; Swamy, Narayana; Crull, George[3]; Pan, Duohai; Zhao, Junshu; Shah,

Ravi; Venkatesh, Chiranjeevi; Vig, Balvinder; A. Varia, Sailesh; Badawy, Sherif; Desikan, Sridhar; Bhutani, Hemant. "Mechanistic Investigation of poly (vinyl alcohol) based Opadry® II Films Insolubilization and Effect of Processing", Submitted.

INVITED LECTURES:

1. Crull, G.B., "Linear Prediction: When and When Not To" NJACS NMR Topical Group, Woodbridge, NJ, January **2002.**

2. Crull, G.B., "Applied Linear Prediction: Applications and Parameters", 10th Advances in NMR Applications Symposium, Monterey, CA, April **2002.**

3. Crull, G.B. "Linear Prediction: Getting the Maximum for the Minimum", SMASH, Breckenridge, CO, September **2002**.

4. Crull, G.B. "Can an NMR Method be Developed Consistent with ICH?", ACD Users Meeting, Princeton, NJ, August **2003**.

5. Crull, G.B. "Can an NMR Method be Developed Consistent with ICH?", ACD SMASH Users Meeting, Burlington, VT, September **2006.**

6. Crull, G.B. "Solid State NMR: an Essential Tool for Pharmaceutical Development", BMSIARC, New Brunswick, NJ, June **2012**.

7. Crull, G.B. "Solid State NMR: an Essential Tool for Pharmaceutical Development", SMASH, Province, RI, September **2012**.

8. Crull, G.B. "Solid State NMR: an Essential Tool for Pharmaceutical Development", Chemistry Department, Princeton University, Princeton, NJ, June **2011 and 2013.**

9. Crull, G.B. "Solid State NMR: an Essential Tool for Pharmaceutical Development", Bruker-Biospin Pre-ENC Symposium, Pacific Grove, CA, April **2013**.

10; Crull, G.B. "Solid State NMR: A Multi-Function Tool in Pharmaceutical Development, much more than a "Phase Meter", PANIC, Charlotte, NC, February **2014.**

11. Crull, G.B., "Solid State NMR: an Essential Tool for Pharmaceutical Development", University of South Carolina, Columbia, SC, **2015.**

12. Crull, G.B., "Expediting the Cures: The Role of Solid State NMR: Eastern Analytical Symposium, Bridgewater, NJ, September **2015.**

13. Crull, G.B., "I Do Drugs (Examples of Solid State NMR in Pharmaceuticals)", Cedar Crest College, Allentown, PA, October **2015.**

14. Crull, G.B., "Small Boxes and Huge Results, Initial Results from a MQC and MQR", Oxford Instruments Users Meeting, Concord, MA, May **2017.**

15 Crull, G.B., "I Do Drugs (Examples of Solid State NMR in Pharmaceuticals)", University of

Southern Mississippi, Hattiesburg, MS, October **2017.**

REPRESENTATIVE PRESENTATIONS:

1. Crull, G.B., Satterlee, J.D. "Comparative Studies of the Binding of the Azide Ion to Four Glycerin Monomeric Hemoglobins", 57th South Carolina Academy of Sciences Meeting, Charleston, SC, March **1984.** (Sigma Xi Outstanding Student Paper)

2. Crull, G.B., Dawson, J.H., Ellis, P.D. "The Use of Two-Dimensional (^{13}C-^{1}H Correlated) and ^{19}F NMR to Assign the Structure of Camphor Derivatives", 58th South Carolina Academy of Sciences Meeting, Columbia, SC, March **1985**.

3. Crull, G.B., Garber, A.R., Ellis, P.D., Dawson, J.H. "A Detailed Carbon and Proton Nuclear Magnetic Resonance Investigation of (1R)-(+)-Camphor", Joint Southeastern/Southwestern Regional American Chemical Society Meeting, Memphis, TN, October **1985**.

4. Crull, G.B., Garber, A.R., Benisi, A.J., Cohen, H.J., Dawson, J.H. "A Detailed Investigation of Homonuclear and Heteronuclear Scalar Coupling Constants of (1R)-(+)-Camphor Using One- and Two-Dimensional Nuclear Magnetic Resonance", 59th South Carolina Academy of Sciences Meeting, Clemson, SC, April **1986.** (Sigma Xi Outstanding Student Paper)

5. Crull, G.B., Garber, A.R., Ellis, P.D., Dawson, J.H. "^{19}F NMR as a Probe of the Spatial Relationship Between the Heme Iron of Cytochrome P-450 and its Substrate", 192nd National American Chemical Society Meeting, Anaheim, CA, September **1986**.

6. Crull, G.B., Garber, A.R., Ellis, P.D., Dawson, J.H. "^{19}F NMR as a Probe of the Spatial Relationship Between the Heme Iron of Cytochrome P-450 and its Substrate", Southeastern Magnetic Resonance Conference, Nashville, TN, October **1986**.

7. Crull, G.B., Garber, A.R., Dawson, J.H. " A ^{1}H and ^{13}C High Field NMR Library of Camphor and 20 Derivatives Compiled Using One- and Two- Dimensional Methods", Southeastern Regional American Chemical Society Meeting, Louisville, KY, November **1986**.

8. Crull, G.B., Dawson, J.H. "Camphor Binding to Ferrous Cytochrome P-450-CAM: Initial Use of ^{19}F NMR to Determine the Distance Between the Substrate and the Heme Iron", International Congress of Bio-Inorganic Chemistry, The Netherlands, July **1987**.

9. Crull, G. B., Goff, H. M. "Lactoperoxidase SCN^- Binding: An NMR Study", Iowa Section ACS Meeting, Grinnell, IA, April **1988**.

10. Crull, G.B., Garber, A.R., Dawson, J.H. "(1R)-(+)- Camphor as a Test Molecule for Two-Dimensional NMR", 3rd Chemical Congress of North America, Toronto, Ontario, Canada, June **1988**.

11. Crull, G.B., Dawson, J.H. "A Study of Fluoride Ion Binding To Cytochrome P-450-CAM", 3rd Chemical Congress of North America, Toronto, Ontario, Canada, June **1988**.

12. Crull, G.B., Goff, H.M. "Evidence for the Association of Thiocyanate with Lactoperoxidase by NMR Relaxation Studies", 13th International Conference on Magnetic Resonance in Biological Systems, Madison, WI, August **1988**.

13. Crull, G.B., Goff, H.M. "NMR Studies of the Interaction SCN^- with Lactoperoxidase: Solution State Distances and Association", Midwest Regional ACS Meeting, Iowa City, IA, November **1988**.

14. Crull, G.B., Garber, A.R., Dawson, J.H. "Two-Dimensional NMR Made Easy Using (1R)-(+)-Camphor", Midwest Regional ACS Meeting, Iowa City, IA, November **1988**.

15. Crull, G.B., Goff, H.M. "The Interaction of Water with the Active Site of Lactoperoxidase", International Congress of Bio-Inorganic Chemistry, Boston, MA, July **1989**.

16. Crull, G.B. "Water Suppression in 2-D NMR Using an AQ-300", GE NMR Instruments Users Meeting, Pebble Beach, CA, April **1990**.

17. Crull, G.B., Wong, H.C., Sono, M. "Initial Investigation of the Active Site of Inodleamine 2,3-Dioxygenase: Proton NMR Evidence of Facile Water Exchange Between the Active Site and Bulk Solution", 32nd Experimental Nuclear Magnetic Resonance Spectroscopy Conference, St. Louis, MO, April **1991**.

18. Crull, G.B., Harbison G.S. "^{15}N and ^{13}C Shielding Tensors of Thiocyanate Ion - The Diamagnetic Contribution to Relaxation", 32nd Experimental Nuclear Magnetic Resonance Spectroscopy Conference, St. Louis, MO, April **1991**.

19. Crull, G.B. "Spectral Simplification via Relaxation Editing", 32nd GE NMR Instruments Users Meeting, St. Louis, MO, April **1991**.

20. Crull, G.B, Wong, H.C., Sono, M. "Initial Investigations of the Active Site of Inodleamine 2,3-Dioxygenase (IDO): Evidence of Interaction of Water with the Active Site From Proton NMR", 5th International Conference on Bio-Inorganic Chemistry, Oxford, U.K., August **1991**.

21. Crull, G.B., Clark, B.A. "Active Site Conformation and Dynamics of Fluorinated Substrates Bound to Peroxidases", 33rd Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, March **1992**.

22. Crull, G.B., Equchi, M., Ed Ojima, I. "Solution Structure of Cyclic RFD Peptides Determined by NMR and MD Calculation", American Chemical Society Meeting, Washington D.C., August **1992**.

23. Curtis, M.S., Crull, G.B. "Empirical Optimization of Common Z-D NMR Experiments", 4th Annual Scientific Poster Session, Bristol-Myers Squibb PRI, Lawrenceville, NJ, November **1993**.

24. Curtis, M.S., Crull, G.B., Turner, C.E. "Solution State Characterization of the Novel LIM2 Domain of Paxillin", 37th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, March **1996**.

25. Crull, G.B., Curtis, M.S., Pelczer, I. "A Novel 3-D Sequence, Fast Enough for Routine Fingerprinting", 37th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, March **1996**.

26. Crull, G.B. "Getting a Handle on Bio-Molecular Shapes Using NMR Diffusion Measurements",

BMSIARC, Wallingford CT, June **1998**.

27. Kadima, W., Crull, G.B. "Characterization of the Binding of Biological Ligands to the Insulin Hexamer by Conventional and Pulsed-Field Gradient Nuclear Magnetic Resonance", 40th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Orlando, FL, March **1999**.

28. Crull, G.B. "Getting a Handle on Bio-Molecular Shapes Using NMR Diffusion Measurements", 40th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Orlando, FL, March **1999.**

29. Crull, G.B. "NMR Diffusion Measurements, a Stability Tool", BMSIARC, Stamford, CT, June **1999**.

30. Crull, G.B., Detefleson, D., Xu, F., Shi, Y., Khlor, S. "Leveraging Flow NMR in Pharmaceutical Research and Development", 42nd Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Orlando, FL, March **2001**.

31. Crull, G.B. "Applications of NMR to Structure Elucidation", BMSIARC, New Brunswick, NJ, June **2001.**

32. Crull, G.B.; Stone Wilkinson, P. "Linear Prediction: How to, When to, and When Not to", 43rd Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, April **2002**.

33. Crull, G.B., Francis, R.; Quiones, L.; Grosso J.; Gozo, S. "Quantification of Difficult Pharmaceutical Ingredients by NMR Spectroscopy", Rocky Mountain ACS, Denver CO, October **2003**.

34. Tattersall, P., Crull, G.B., Rinaldi, F. "Structural Determination of BMS-644950 Degradants", BMSIARC, Hopewell, NJ, September **2003.**

35. Crull, G.B., Francis, R., Quiones, L., Grosso J., Gozo, S. "Quantification of Difficult Pharmaceutical Ingredients by NMR Spectroscopy, Lysine in BMS-379224", BMSIARC, Hopewell, NJ, September **2003.**

36. Crull, G.B. "Can an NMR Method be Developed Consistent with ICH?", BMSIARC, Hopewell, NJ, September **2003.**

37. Crull, G.B., Francis, R., Gozo, S., Grosso J. "NMR Method Development: Can it be Consistent with ICH Q2B?", 45th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, April **2004.**

38. Crull, G.B., Grosso, J., Pommier, C.J., Sarsfeild, B., Shekunov, B., Yin, S. "Measuring Amorphous Content in Pharmaceutical Agents, Comparison of Two Methods", 50th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, March **2009**.

39. Crull, G., Scringe, R., Grosso, J. "Selective F-19 to C-13 Cross Polarization, a Novel Tool for Structure Elucidation in Pharmaceuticals", 51th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Daytona Beach, FL, April **2010**.

40. Crull, G., Cassidy, M., Grosso, J., Sinclair, W., Patel, A. "Quantitation of Crystallization in Amorphous Drugs by C-13 ssNMR Relaxation", 52th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, April **2011**.

41. Crull, G., Yin, S., Grosso, J., Pan, D. "Quantitative Determination of Low levels of Irbesartan Form B in Avalide Tablets by ssNMR Spectroscopy", 53th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Miami, FL, April **2012**.

42. Crull, G.B., Leane, M.M.,Gamble, J.F., Engstrom, J., Abraham, A. "Probing the dehydration behaviour of a channel hydrate, a multinuclear ssNMR study", 54th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, April **2013.**

43. Crull, G.B., Yin, S., Pan, D., McNamara, D.M., Timmins, P. "Importance of API: Polymer Interactions in Developing Robust ASD Formulations", 58th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pittsburgh, PA, April **2016.**

44. Crull, G.B., Chan, E. "Using Polarization Transfer from F-19 in the Solid State for Structure Elucidation", 58th Experimental Nuclear Magnetic Resonance Spectroscopy Conference, Pacific Grove, CA, March **2017.**