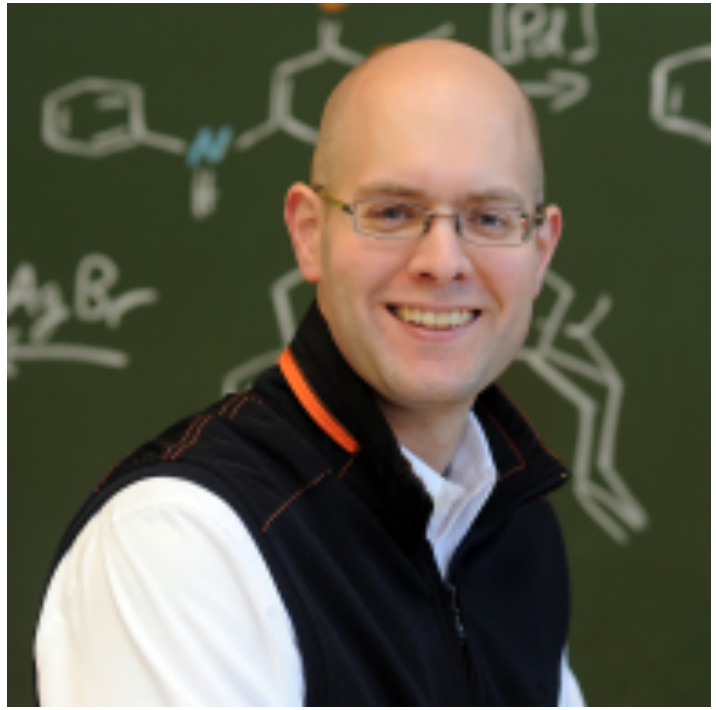
Dr. Frank Glorius at Westfälische Wilhelms-Universität Münster, Germany

By Eliseo Quiroz
BRG
5/12/2020

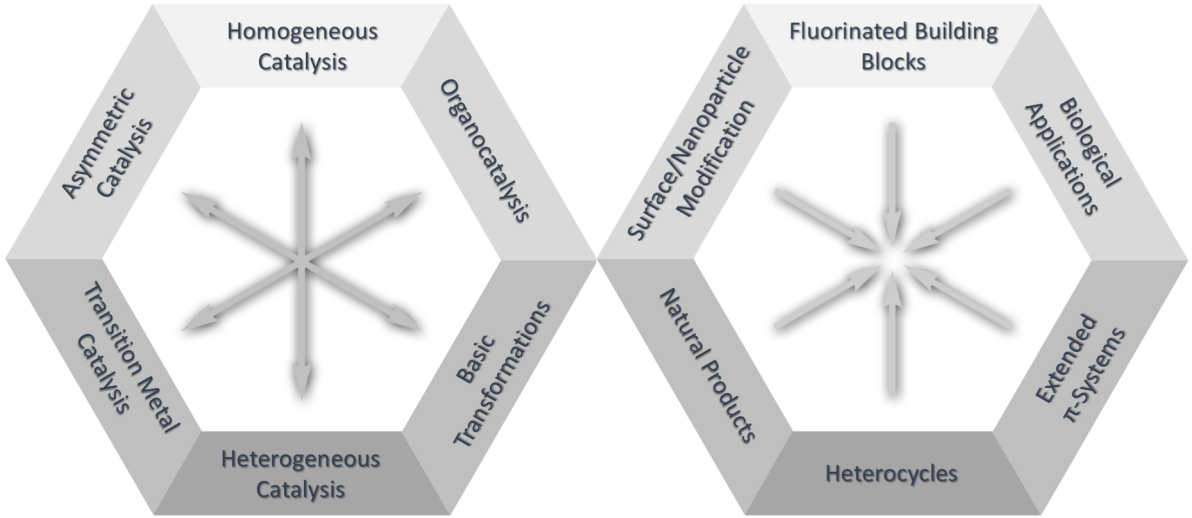
C.V.

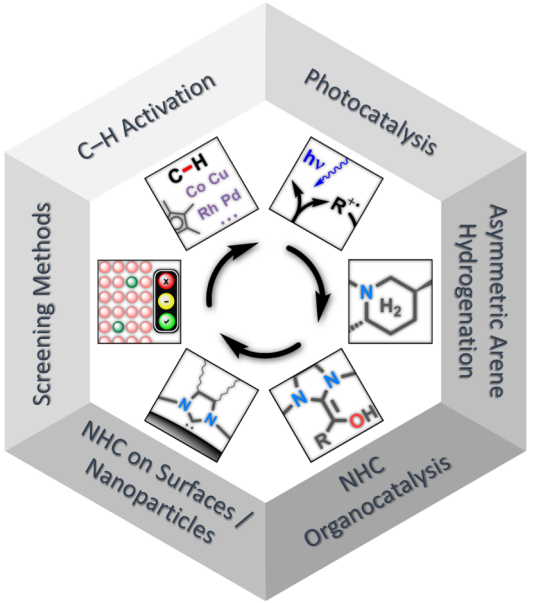
- Was born (1972) and raised in Walsrode, Germany.
- Received his Diploma thesis from **Leibniz University Hannover** in 1997.
- While completing his Diploma, he conducted research at **Stanford University** under **Paul Wender** for nine months.
- His Ph.D. was divided between the **Max-Planck-Institut für Kohlenforschung** (1997-1999) and **University of Basel** (1999-2000), where he ultimately receives his doctorate from. His Ph.D. thesis was on the work of "New chiral bis-oxazoline ligands for enantioselective catalysis" **with Andreas Pfaltz**.
- From 2000-2001, Glorius completed a Postdoc position at **Harvard University** working with **David Evans**. There, he worked on the total synthesis of Aflastatin A.
- After his Postdoc, Glorius conducted independent research back at **Max-Planck-Institut für Kohlenforschung** (2001-2004). He worked with **Alois Fürstner**.
- He was then awarded a position as a C3-Professor of Organic Chemistry at the **University of Marburg** (2004-2007).
- Glorius is currently a full professor (since 2007) at **Westfälische Wilhelms-Universität** in Münster.
- As of today, Glorius has 349 published papers



https://www.uni-muenster.de/Chemie.oc/glorius/glorius.html

Research Areas





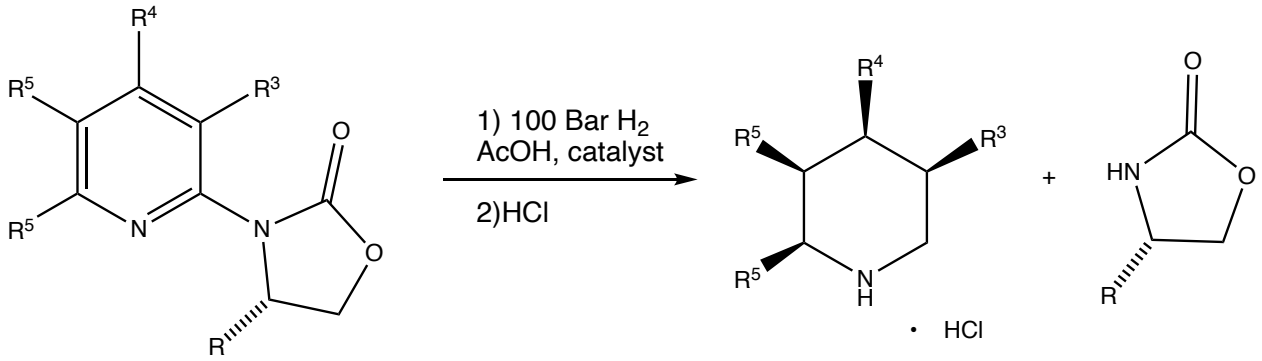
https://www.uni-muenster.de/Chemie.oc/glorius/research.html

Early Work

Copper Catalyzed Coupling for the Conversion of Primary Amides to Benzoxazoles

Gloruis, F. *Adv. Synth. Catal.* **2004**, 346, 1661–1664

Asymmetric hydrogenation of Heteroaromatic Compounds

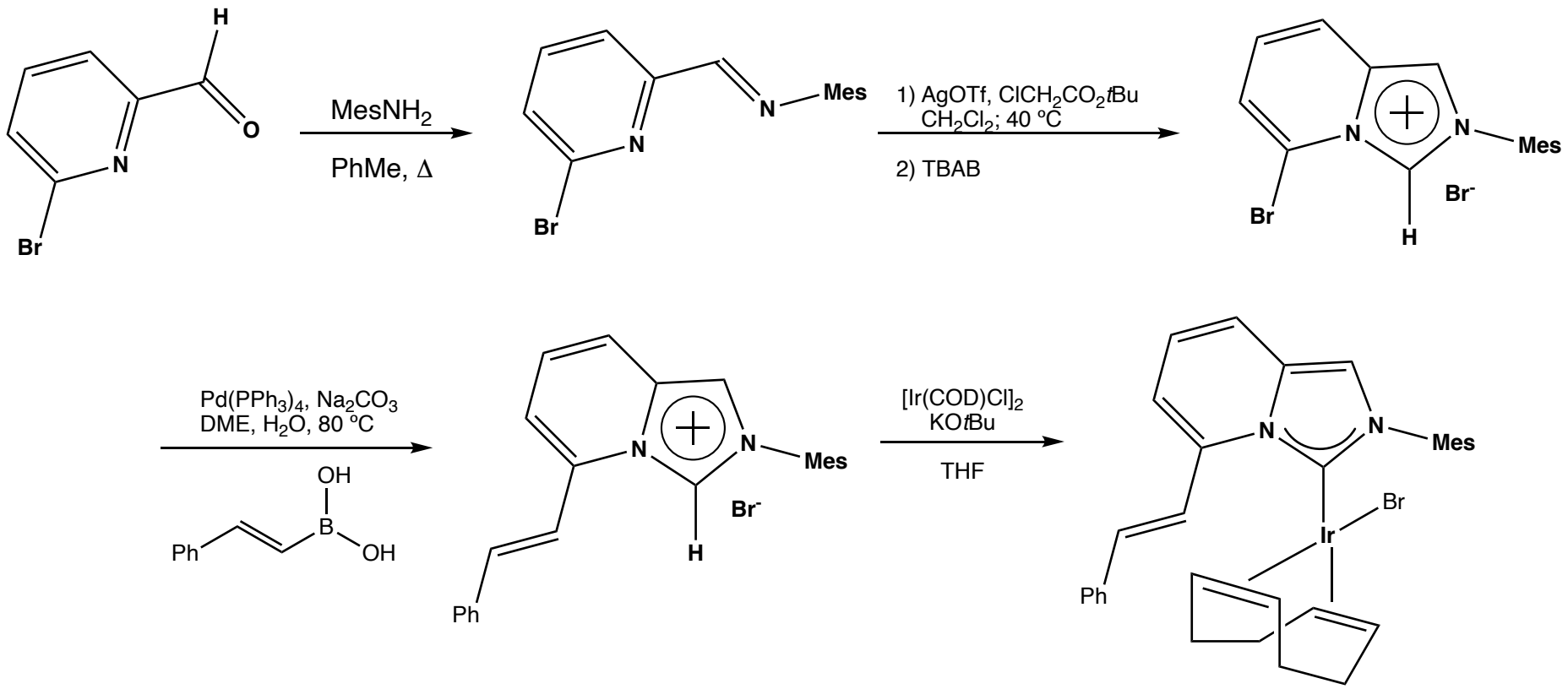


R = *i*Pr or *t*Bu

ee 88-98% (4% when R^3 = Me)

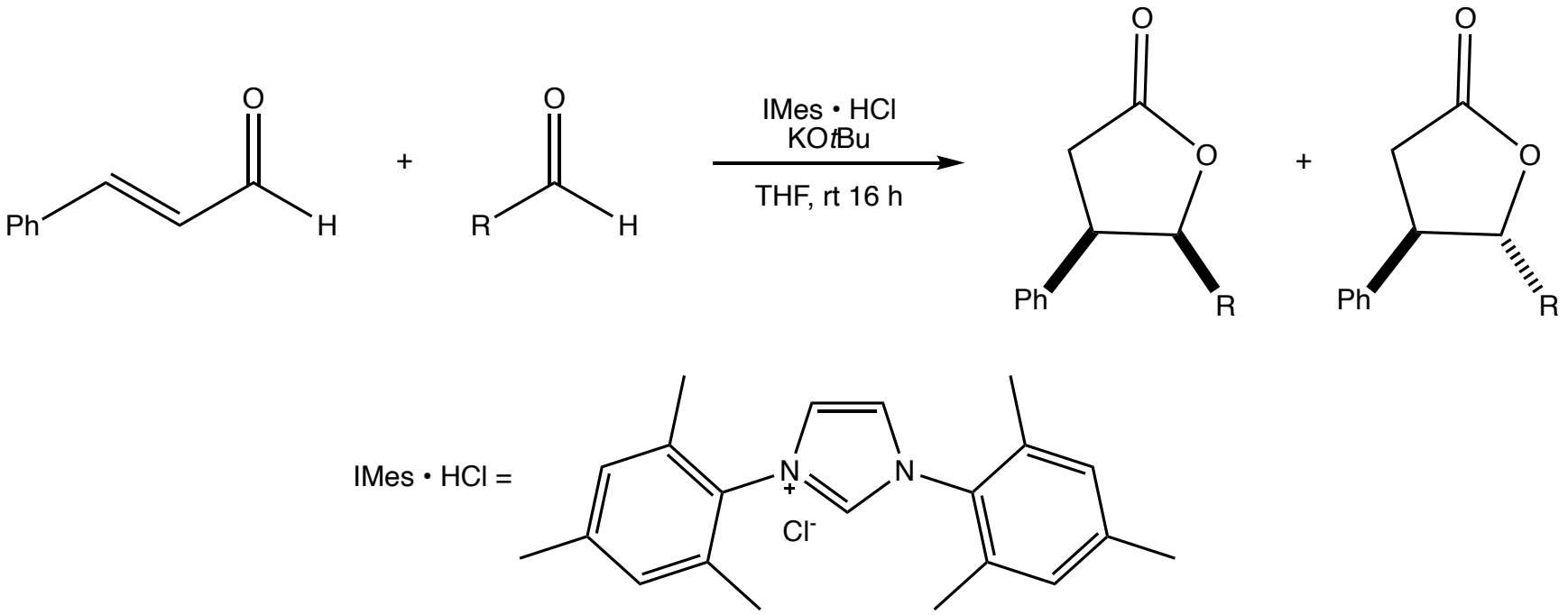
Gloruis, F. *Org. Biomol. Chem.* **2005**, 3, 4171–4175

Early N-Heterocyclic Carbenes



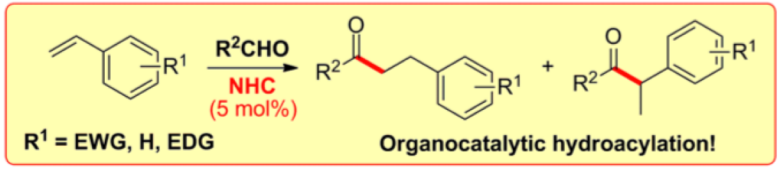
- Burstein, C., Lehmann, C.W., Glroius, F. *Tetrahedron,* **2005**, 61 6207–6217

Early N-Heterocyclic Carbenes

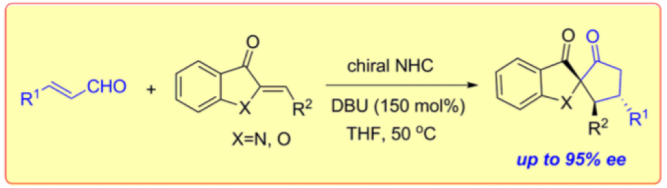


- Burstein, C., Tschan, S., Xie, X., Glroius, F. *Synthesis,* **2006**, 14 2418–2439

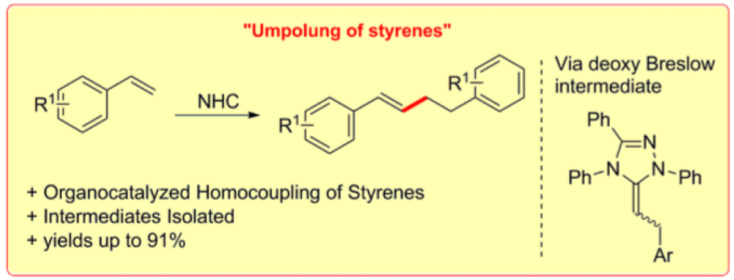
N-Heterocyclic Carbenes Organocatalysis



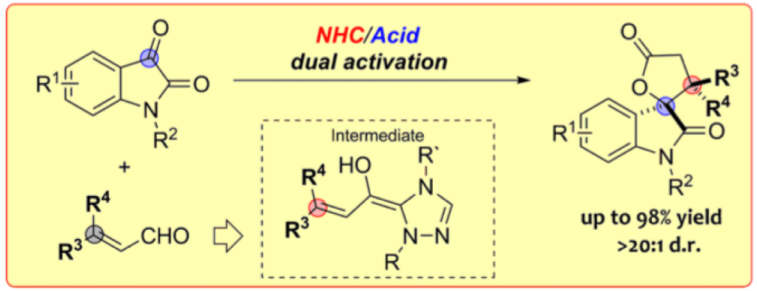
M. Schedler, D.-S. Wang, F. Glorius,
NHC-Catalyzed Hydroacylation of Styrenes,
Angew. Chem. Int. Ed. **2013**, *52*, 2585-2589; *Angew. Chem.* **2013**, *125*, 2645-2649.



C. Guo, M. Schedler, C. G. Daniliuc, F. Glorius,
N-Heterocyclic Carbene Catalyzed Formal [3+2] Annulation Reaction of Enals: An Efficient Enantioselective Access to Spiro-Heterocycles,
Angew. Chem. Int. Ed. **2014**, *53*, 10232-10236; *Angew. Chem.* **2014**, *126*, 10397-10401.
Highlighted in *Synfacts* **2014**, *10*, 1207.



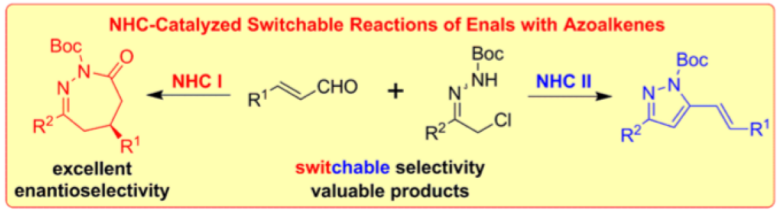
M. Schedler, N. E. Wurz, C. G. Daniliuc, F. Glorius,
N-Heterocyclic Carbene Catalyzed Umpolung of Styrenes: Mechanistic Elucidation and Selective Tail-to-Tail Dimerization,
Org. Lett. **2014**, *16*, 3134-3137.



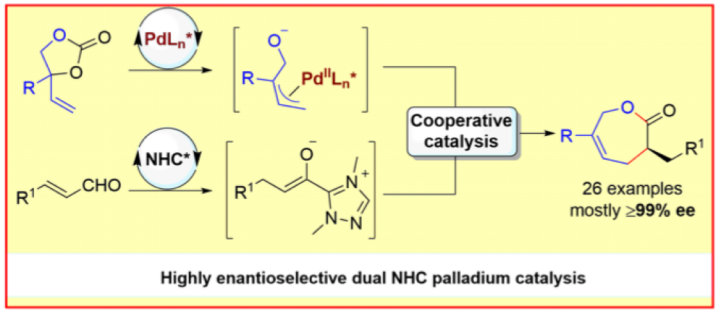
J.-L. Li, B. Sahoo, C.-G. Daniliuc, F. Glorius,
Conjugate Umpolung of β,β-Disubstituted Enals by Dual Catalysis with an N-Heterocyclic Carbene and a Brønsted Acid: Facile Construction of Contiguous Quaternary Stereocenters,
Angew. Chem. Int. Ed. **2014**, *53*, 10515-10519; *Angew. Chem.* **2014**, *126*, 10683-10687.

https://www.uni-muenster.de/Chemie.oc/glorius/glorius.html

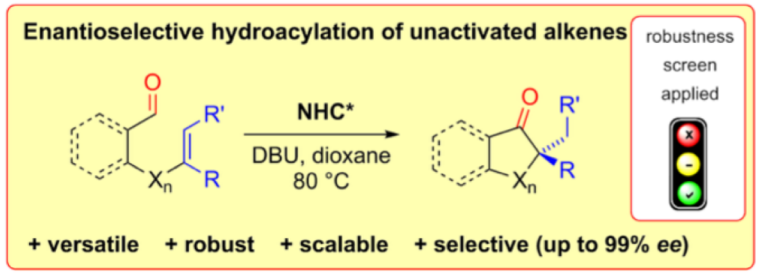
N-Heterocyclic Carbenes Organocatalysis



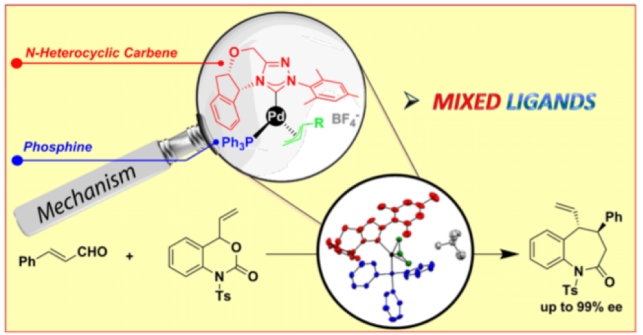
C. Guo, B. Sahoo, C. G. Daniliuc, F. Glorius,
N-Heterocyclic Carbene Catalyzed Switchable Reactions of Enals with Azoalkenes: Formal [4+3] and [4+1] Annulations for the Synthesis of 1,2-Diazepines and Pyrazoles,
J. Am. Chem. Soc. **2014**, *136*, 17402-17405.



S. Singha, T. Patra, C. G. Daniliuc, F. Glorius,
Highly Enantioselective [5+2] Annulations through Cooperative NHC Organocatalysis and Palladium Catalysis,
J. Am. Chem. Soc. **2018**, *140*, 3551-3554.



D. Janssen-Müller, M. Schedler, M. Fleige, C. G. Daniliuc, F. Glorius,
Enantioselective Intramolecular Hydroacylation of Unactivated Alkenes: An NHC-Catalyzed Robust and Versatile Formation of Cyclic Chiral Ketones,
Angew. Chem. Int. Ed. **2015**, *54*, 12492-12496; *Angew. Chem.* **2015**, *127*, 12671-12675.

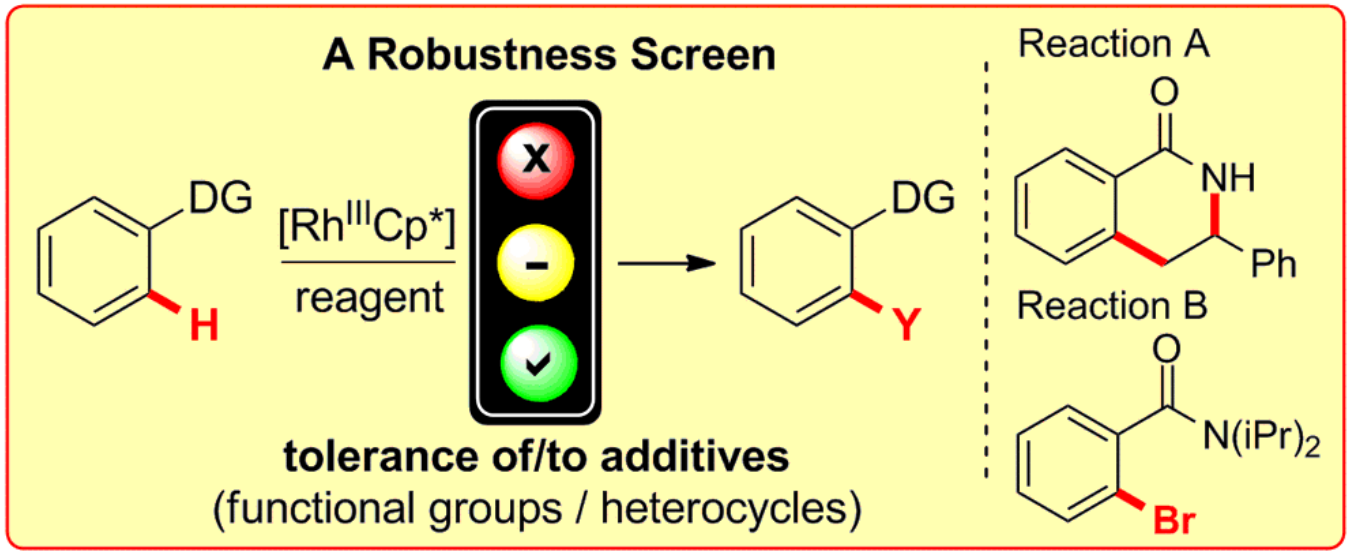


C. Guo,* D. Janssen-Müller, M. Fleige, A. Lerchen, C. G. Daniliuc, F. Glorius,*
Mechanistic Studies on a Cooperative NHC Organocatalysis/Palladium Catalysis System: Uncovering Significant Lessons for Mixed Chiral Pd(NHC)(PR_3) Catalyst Design,
J. Am. Chem. Soc. **2017**, *139*, 4443-4451.

https://www.uni-muenster.de/Chemie.oc/glorius/glorius.html

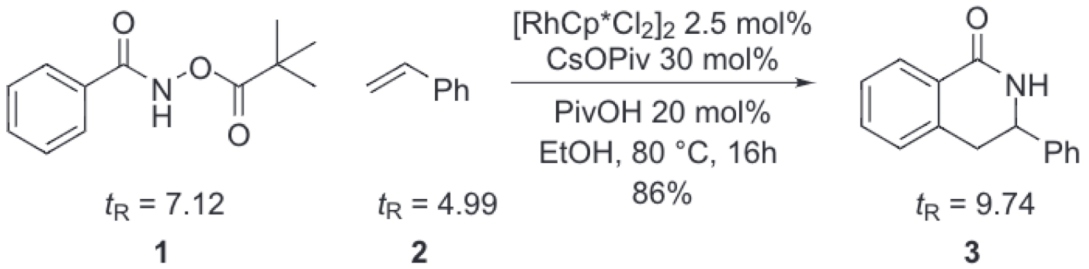
Robustness Screen

- Screening reaction conditions to evaluate its tolerance.
- Isolating a key step of a catalysis to enable the identification of new catalyst-substrate interactions in the absence of complicating factors.

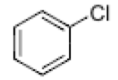
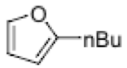
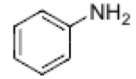
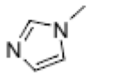
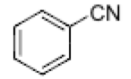
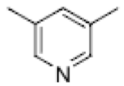
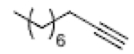
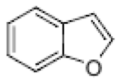
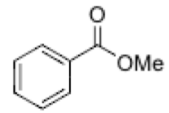
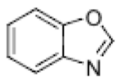
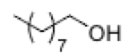
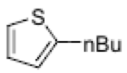
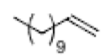
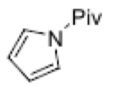
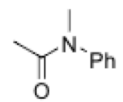
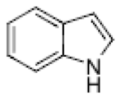
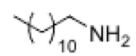
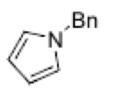
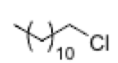
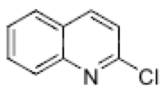


Collins, K.D.; Glorius, F. Tetrahedron, **2013**, 69 7817-7825
https://www.uni-muenster.de/Chemie.oc/glorius/glorius.html

Robustness Screen

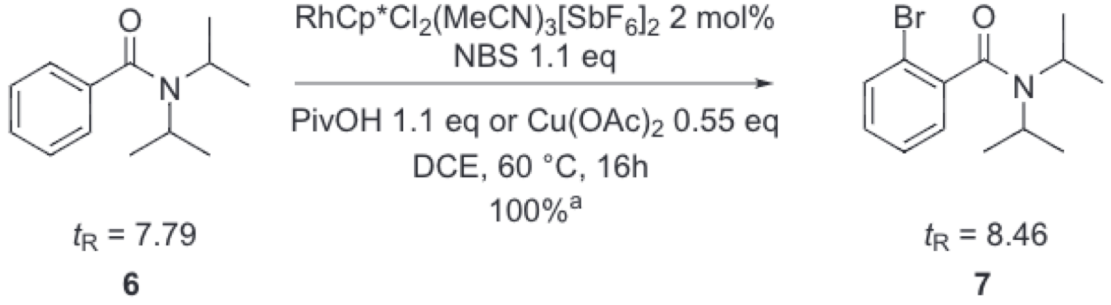


Reported by Fagnou

Group A - Functional Groups					Group B - Heterocycles				
Entry		Yield of **3** %	Additive remaining %	SM remaining %	Entry		Yield of **3** %	Additive remaining %	SM remaining %
A1		✓ 92	✓ >95	0	B1		– 45	nd[b]	0
A2		✓ 76	✓ >95	23	B2		X 10	✓ >95	0
A3		✓ 92	✓ >95	0	B3		X 16	– 59	0
A4		X 31	X 8	0	B4		– 54	✓ >95	0
A5		✓ >95	✓ >95	0	B5		– 37	✓ >95	0
A6		✓ 82	✓ 87	0	B6		✓ 70	✓ >95	0
A7		✓ 91	nd[a]	0	B7		✓ 68	✓ 81	0
A8		– 65	✓ >95	0	B8		✓ 69	✓ >95	0
A9		✓ 91	✓ >95	0	B9		– 63	✓ >95	0
A10		✓ >95	✓ >95	0	B10		– 52	✓ >95	0

Collins, K.D.; Glorius, F. Tetrahedron, **2013**, 69 7817-7825
https://www.uni-muenster.de/Chemie.oc/glorius/glorius.html

Robustness Screen



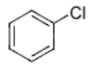
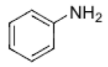
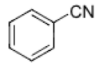
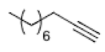
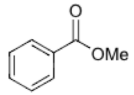
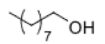
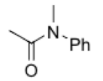
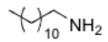
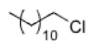
t_R = 7.79

6

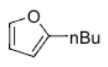
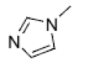
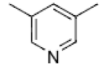
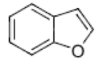
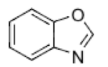
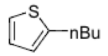
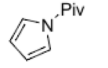
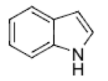
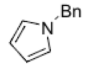
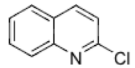
t_R = 8.46

7

Group A - Functional Groups

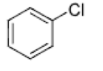
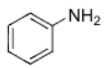
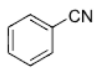
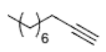
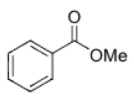
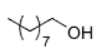
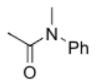
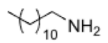
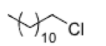
Entry		Yield of **7** %	Additive remaining %	SM remaining %
A1		✓ 81	✓ 71	<5
A2		✗ <5	✗ 12	88
A3		– 61	✓ >95	34
A4		✗ <5	– 55	73
A5		✓ 91	✓ >95	<5
A6		– 49	– 59	46
A7		✗ 19	✗ 28	80
A8		✓ 70	– 58	15
A9		✗ <5	✗ 0	86
A10		– 50	✓ >95	50

Group B - Heterocycles

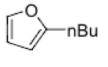
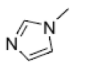
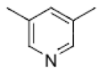
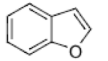
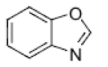
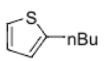
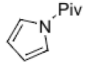
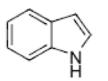
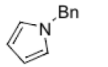
Entry		Yield of **7** %	Additive remaining %	SM remaining %
B1		✗ <5	✗ <5	90
B2		✗ <5	✗ <5	>95
B3		✗ <5	✓ 82	>95
B4		✓ 82	✓ 90	14
B5		✗ 15	✓ 94	85
B6		– 40	– 35	58
B7		✗ <5	– 34	90
B8		✗ <5	✗ <5	>95
B9		✗ <5	– 38	>95
B10		✗ <5	✓ >95	>95

Using PivOH to promote rxn

Group A - Functional Groups

Entry		Yield of **7** %	Additive remaining %	SM remaining %
A1		✓ >95	✓ 72	0
A2		✗ <5	✗ <5	>95
A3		✓ >95	✓ >95	<5
A4		✗ <5	✗ 11	>95
A5		✓ >95	✓ >95	<5
A6		– 39	✗ 22	64
A7		– 37	– 47	87
A8		✓ >95	✓ 81	<5
A9		✗ <5	✗ <5	>95
A10		✓ >95	✓ >95	<5

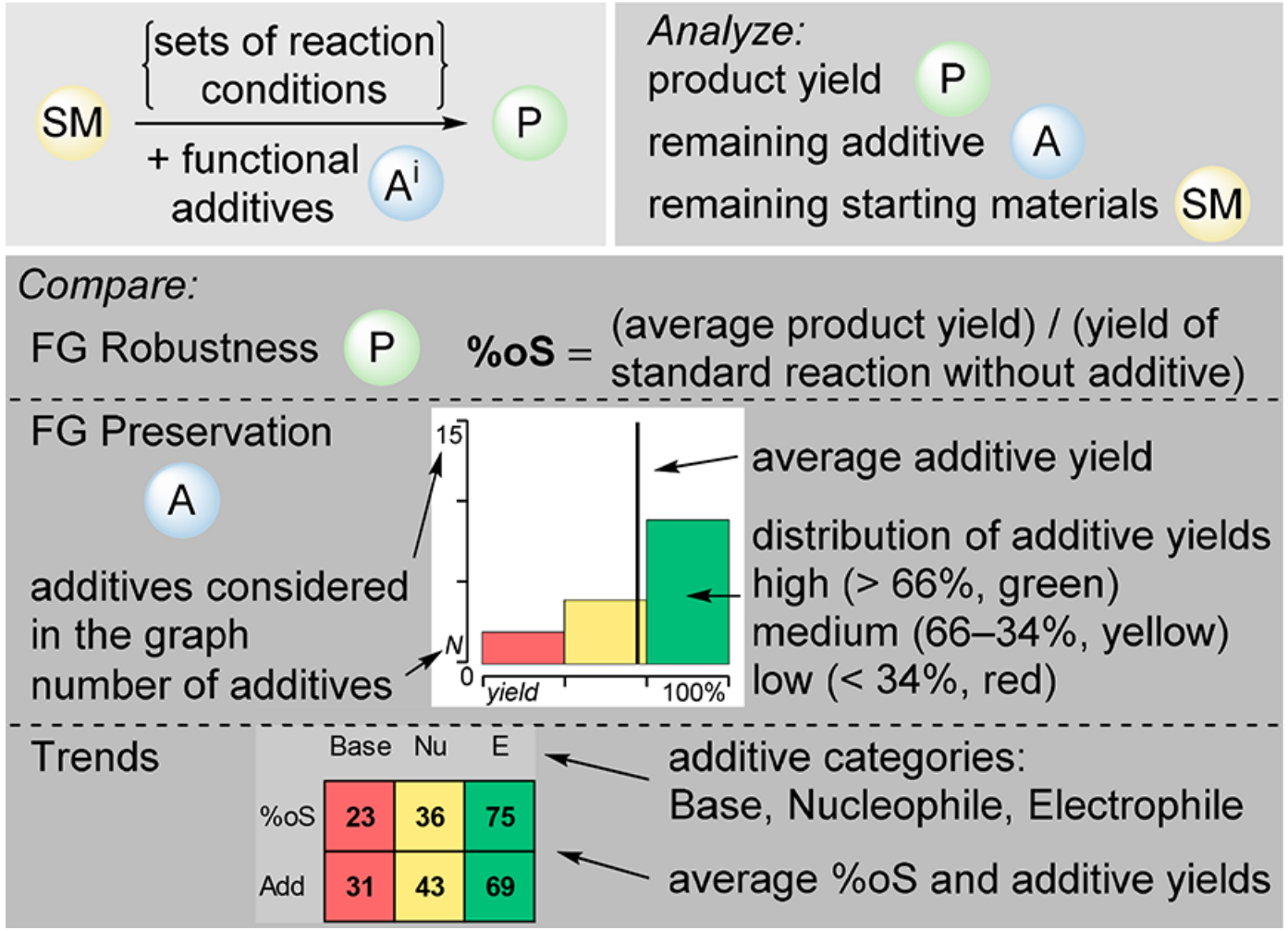
Group B - Heterocycles

Entry		Yield of **7** %	Additive remaining %	SM remaining %
B1		✗ <5	✗ <5	88
B2		✗ <5	– 34	>95
B3		✗ <5	– 56	94
B4		✓ >95	✓ 93	<5
B5		✗ 7	✓ >95	93
B6		✓ >95	✓ 90	<5
B7		✗ <5	– 30	>95
B8		✗ <5	✗ <5	>95
B9		✗ <5	– 38	>95
B10		✗ <5	✓ >95	94

Using $Cu(OAc)_2$ to promote rxn

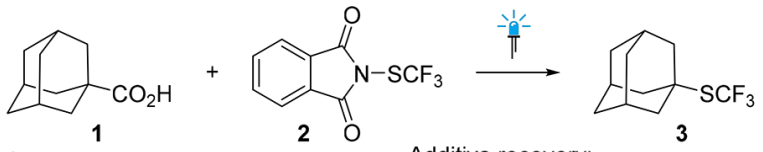
Collins, K.D.; Glorius, F. Tetrahedron, **2013**, 69 7817-7825

Robustness Screen



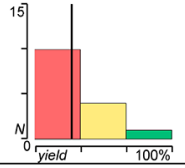
J. Org. Chem. **2017**, 82, 9154−9159

Robustness Screen



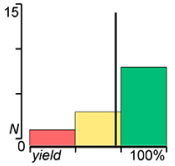
Conditions A
[Ir-F] (2.0 mol%), CsOBz (0.2 equiv.)
3-Me toluate, (2.0 equiv.), C_6H_5F
UV-A LED: 365 nm
Standard yield 89%
Average yield 63% = 71%oS

Additive recovery:



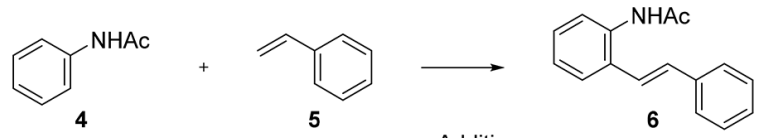
	Base	Nu	E
%oS	64	54	75
Add	44	24	54

Conditions B
[Ir-F] (2.0 mol%), CsOBz (0.2 equiv.)
3-Me toluate, (2.0 equiv.), C_6H_5F
blue LED: 455 nm
Standard yield 90%
Average yield 65% = 72%oS



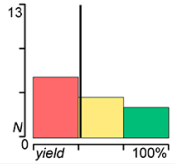
	Base	Nu	E
%oS	59	51	78
Add	82	56	83

Case Study 1: Decarboxylative Trifluoromethylthiolation



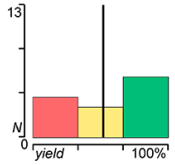
Conditions A
$(Cp^*RhCl_2)_2$ (0.5 mol%), $AgSbF_6$ (2 mol%)
$Cu(OAc)_2$ (2.1 equiv.), ^{t}AmOH, 120 °C
Standard yield 73%
Average yield 38% = 52%oS

Additive recovery:



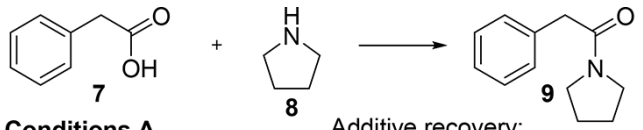
	Base	Nu	E
%oS	23	36	75
Add	31	43	69

Conditions B
$(Cp^ERhCl_2)_2$ (2.5 mol%), $AgSbF_6$ (10 mol%)
$Cu(OAc)_2 \cdot H_2O$ (20 mol%), air, acetone, rt
Standard yield 87%
Average yield 40% = 46%oS



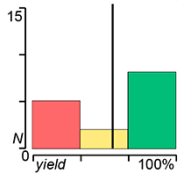
	Base	Nu	E
%oS	25	30	71
Add	55	44	80

Case Study 2: Rhodium-Catalyzed Oxidative C– H Olefination



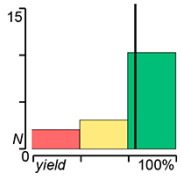
Conditions A
4 Å MS, neat, 150 °C
Standard yield 61%
Average yield 49% = 80%oS

Additive recovery:



	Base	Nu	E
%oS	85	84	77
Add	64	64	49

Conditions B
$PhSiH_3$ (3 equiv.), DMF, rt
Standard yield 62%
Average yield 53% = 85%oS



	Base	Nu	E
%oS	94	95	73
Add	80	71	73

Case Study 3: Amidation of Phenylacetic Acid

J. Org. Chem. **2017**, 82, 9154–9159

Thank You!