Supporting Information

Two Flavors of PEPPSI-IPr: Activation and Diffusion Control in a Single NHC-Ligated Pd Catalyst?

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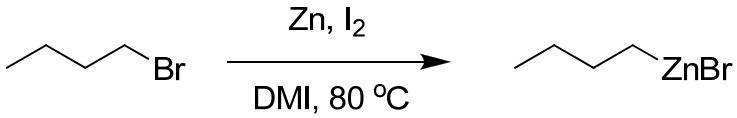
2. General Experimental Section

Unless otherwise stated, all reagents were purchased from commercial sources and used without further purification. All reactions were carried out under an atmosphere of nitrogen unless otherwise stated. Dry CH_2Cl_2 was obtained by passing the solvent through an activated alumina column on a PureSolv^{TM} solvent purification system (Innovative Technologies, Inc., MA). Petrol refers to the fraction of petroleum ether boiling in the range 40-60 °C.

Analytical TLC was performed on precoated silica gel plates (0.25 mm thick, 60F254, Merck, Germany) and observed under UV light. All ^{1}H and ^{13}C NMR spectra were recorded on a Bruker AV 400 instrument. Chemical shifts are reported in parts per million from low to high field and referenced to residual solvent. Coupling constants (*J*) are reported in Hz. Standard abbreviations indicating multiplicity were used as follows: m = multiplet, quint. = quintet, q = quartet, t = triplet, d = doublet, s = singlet, br = broad. All melting points were determined using a Sanyo Gallenkamp apparatus and are uncorrected.

3. Experimental Data

General Procedures



Preparation of *n*-BuZnBr:[1] A CEM microwave vial was charged with zinc powder (0.49 g, 7.5 mmol) and iodine (64 mg, 0.25 mmol), sealed, purged with N_2 and DMI (5 mL) was added. *N*-BuBr (0.5 mL, 5 mmol) was added to the suspension and the mixture heated to 80 ºC for 4 h. The mixture was allowed to cool to RT and the molarity of the *n*-BuZnBr solution produced determined (*vide infra*).

Titration of *n*-BuZnBr:[2] A CEM microwave vial was charged with iodine (0.127 g, 0.5 mmol), sealed, purged with N_2 and LiBr (0.5 M in THF, 4 mL, 2.0 mmol) was added. The resulting brown solution was cooled down to 0 ºC and *n*-BuZnBr was added dropwise until the solution became colourless which indicated consumption of one equivalent (0.5 mmol) of the zincate.

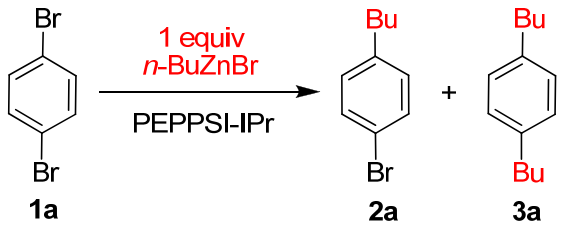
Preparation of *n*-heptyl-9BBN:[3] A vessel vial charged with 9-BBN dimer (0.684 g, 2.75 mmol) was sealed and purged with nitrogen. To this, anhydrous 1,4-dioxane (3.1 mL) and heptene (0.73 mL, 5.0 mmol) were added. This solution was stirred overnight at room temperature resulting in a clear, homogeneous solution 1.3 M in *n*-heptyl-9-BBN. Complete conversion was confirmed by ^{1}H NMR analysis.

General procedure for Negishi cross couplings:[4] To a stirred solution of LiBr (0.174 g, 2.0 mmol), 1,4 dibromobenzene (0.241 g, 1 mmol) and PEPPSI-IPr (13.9 mg, 0.02 mmol) in THF (3 mL) was added *n*-BuZnBr (0.66 M in DMI, 1.5 mL, 1.0 mmol) and the mixture stirred for 2 h at 25 ºC at which time mesitylene (1 M in $CDCl_3$, 1 mL, 1 mmol) was added.

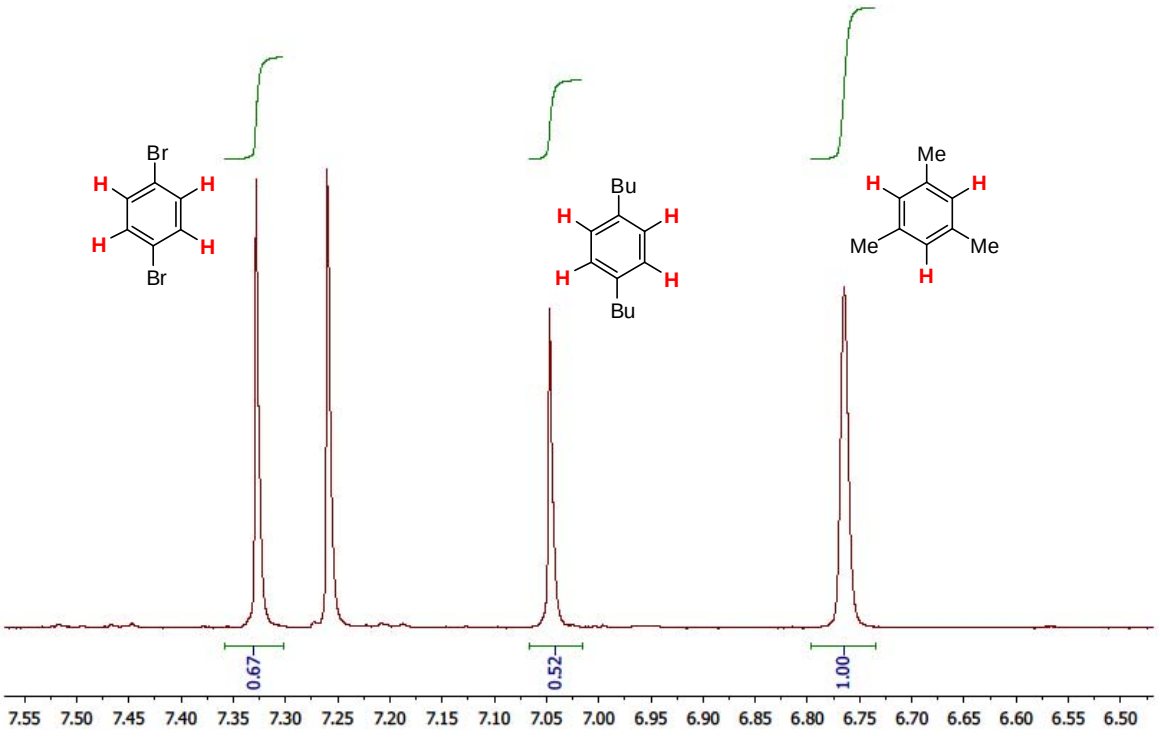
Procedure for Suzuki cross coupling with *n*-heptyl-9BBN:[3] To a mixture of K_3PO_4-H_2O (0.347 g, 1.6 mmol), 1,4 dibromobenzene (0.241 g, 1.0 mmol) and PEPPSI-IPr (27.7 mg, 0.04 mmol) was added *n*-heptyl-9BBN (1.3 M in dioxane, 0.77 mL, 1.0 mmol) and the mixture stirred for 16 h at 25 ºC at which time mesitylene (1 M in $CDCl_3$, 1 mL, 1 mmol) was added.

Procedure for Kumada cross coupling with PhMgBr:[5] To a stirred solution of 1,4 dibromobenzene (0.241 g, 1.0 mmol) and PEPPSI-IPr (13.9 mg, 0.02 mmol) in a mixture of THF (2 mL) and DMI (1.5 mL) was added PhMgBr (1.0 M in THF, 1.0 mL, 1.0 mmol) and the mixture stirred for 2 h at 50 ºC at which time mesitylene (1 M in $CDCl_3$, 1 mL, 1 mmol) was added.

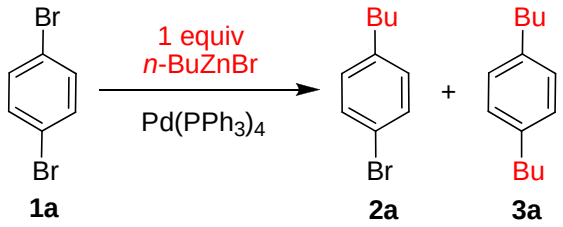
Negishi cross coupling of 1,4-dibromobenzene with PEPPSI-IPr (Scheme 1):



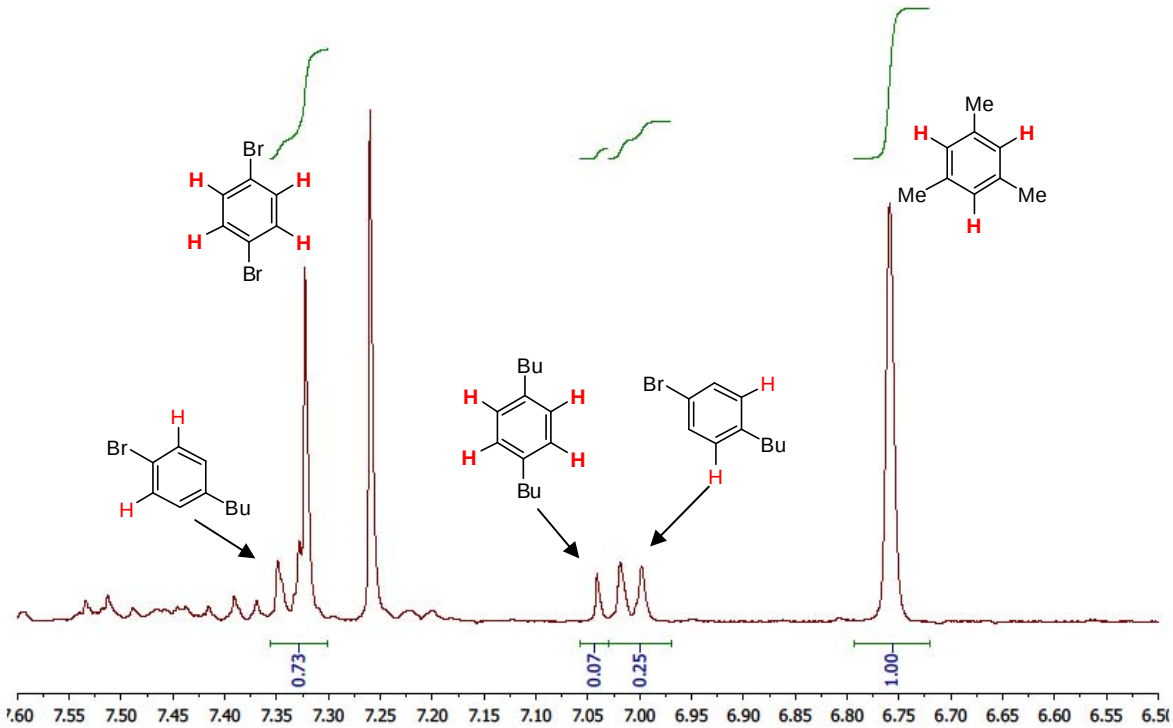
Using the general Negishi procedure a product mixture composed of 1,4-dibutylbenzene (**3a**) and 4-butylbromobenzene (**2a**) in a >99.5:0.5 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 79% yield of **3a** based on *n*-BuZnBr. **2a** was not observed by ^{1}H NMR.



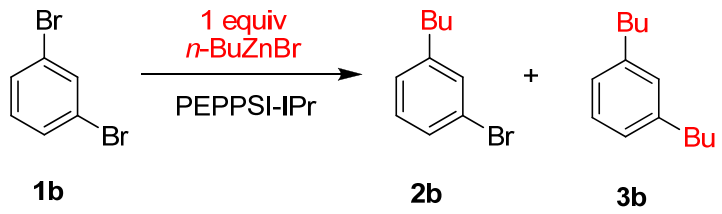
Negishi cross coupling of 1,4-dibromobenzene with $Pd(PPh_3)_4$ (Scheme 1):



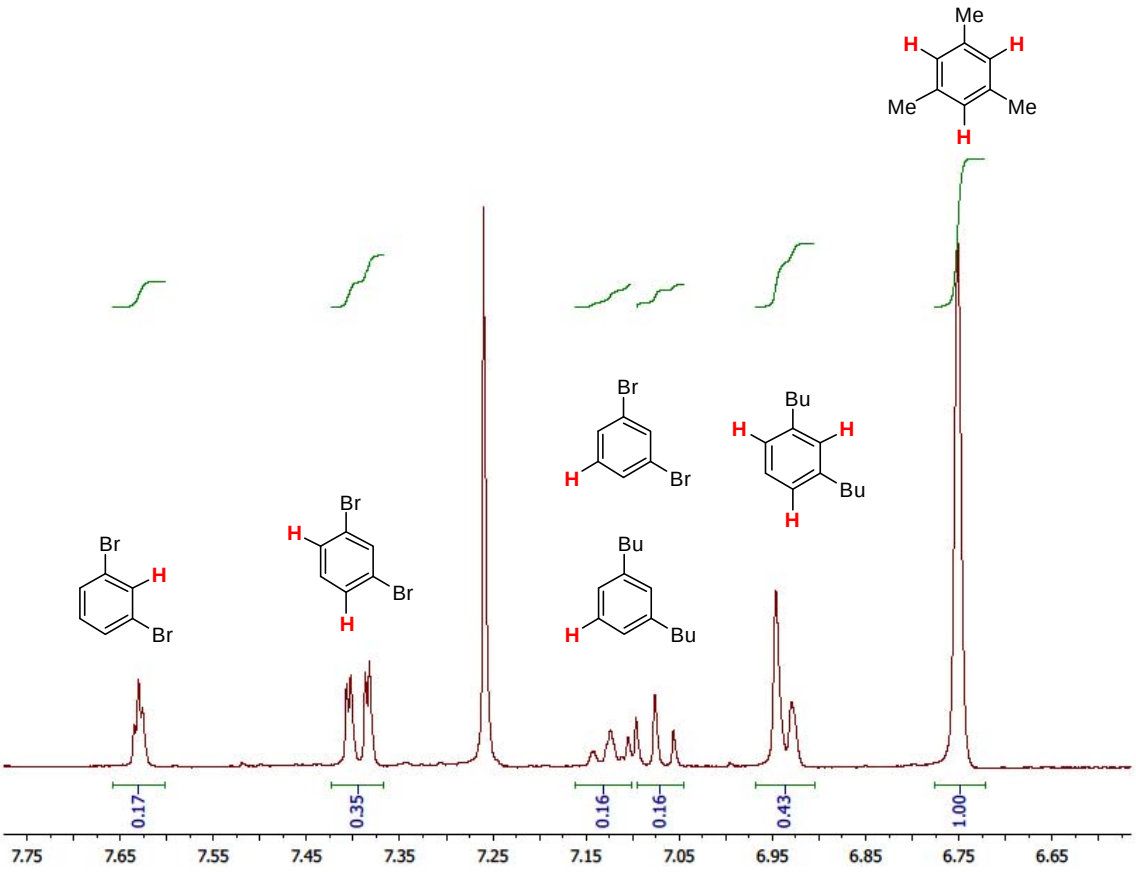
Using the general Negishi procedure but using 10 mol % of $Pd(PPh_3)_4$ in 24 h, a product mixture composed of 1,4-dibutylbenzene (**3a**) and 4-butylbromobenzene (**2a**) in a 12:88 ratio as determined by ^{1}H NMR analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 30% yield of **3a** based on *n*-BuZnBr. **2a** was not observed by ^{1}H NMR.



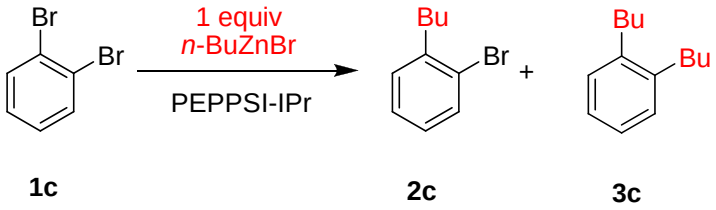
Negishi cross coupling of 1,3-dibromobenzene (Table 1, entry 1):



Using the general Negishi procedure a product mixture composed of 1,3-dibutylbenzene (**3b**) and 3-butylbromobenzene (**2b**) is obtained in a >99:1 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 86% yield of **3c** based on *n*-BuZnBr. **2b** was not observed by ^{1}H NMR.

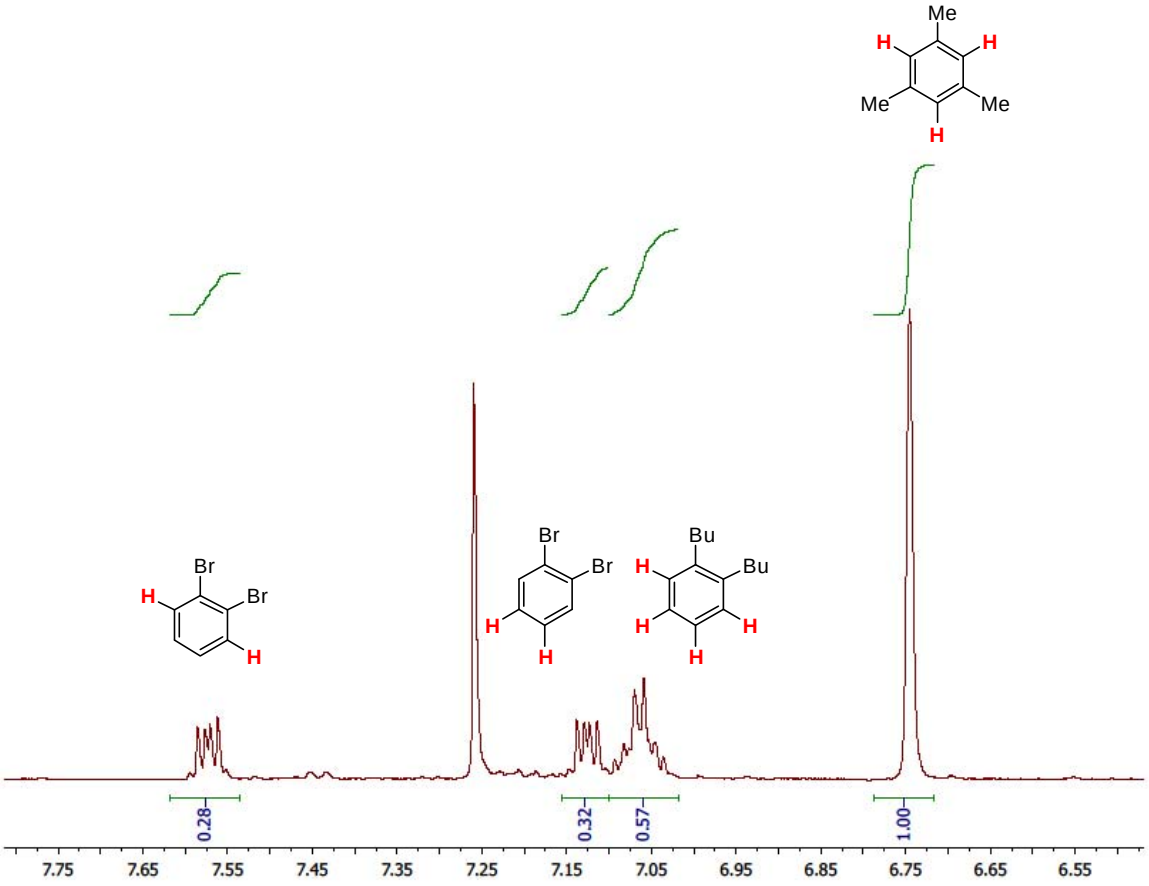


Negishi cross coupling of 1,2-dibromobenzene (Table 1, entry 2):

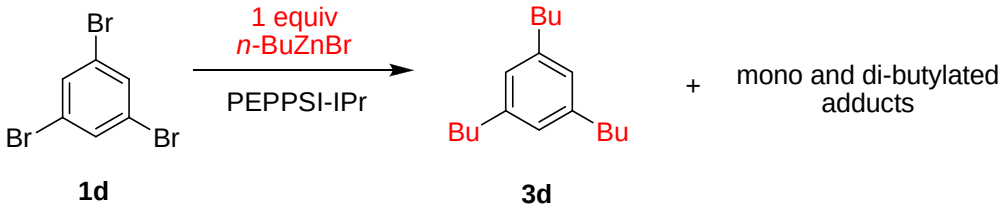


1c **2c** **3c**

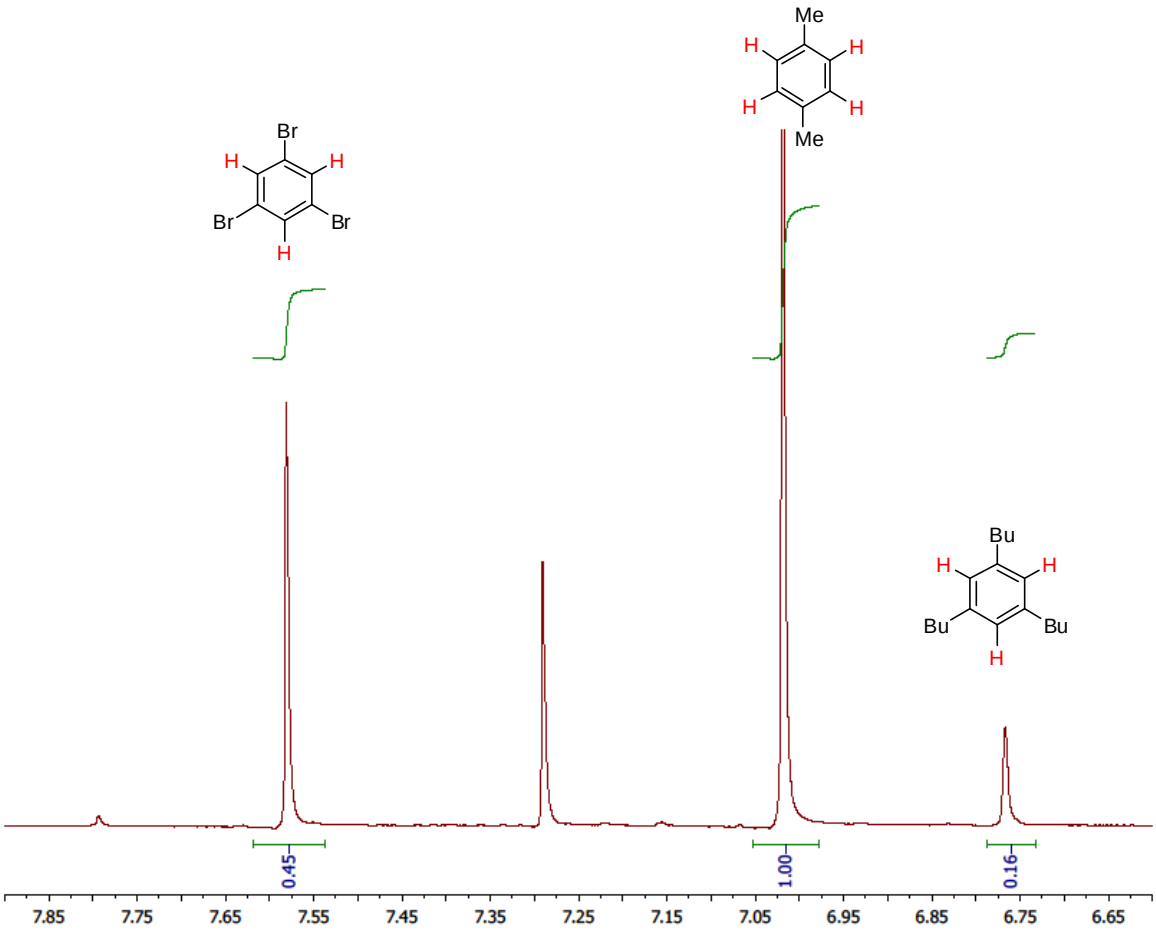
Using the general Negishi procedure a product mixture composed of 1,2-dibutylbenzene (**3c**) and 2-butylbromobenzene (**2c**) in a 97:3 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 86% yield of **3c** based on *n*-BuZnBr. **2c** was not observed by ^{1}H NMR.



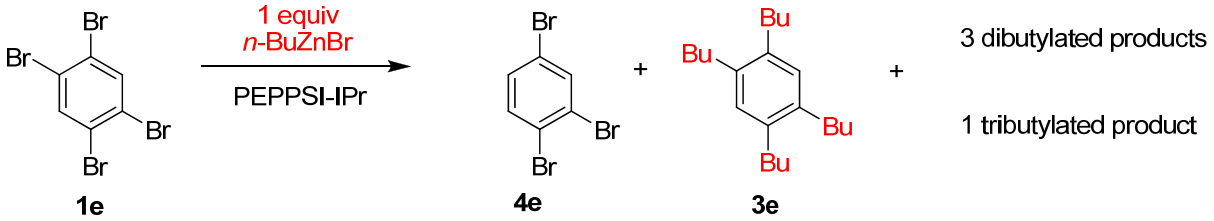
Negishi cross coupling of 1,3,5-tribromobenzene (Table 1, entry 3):



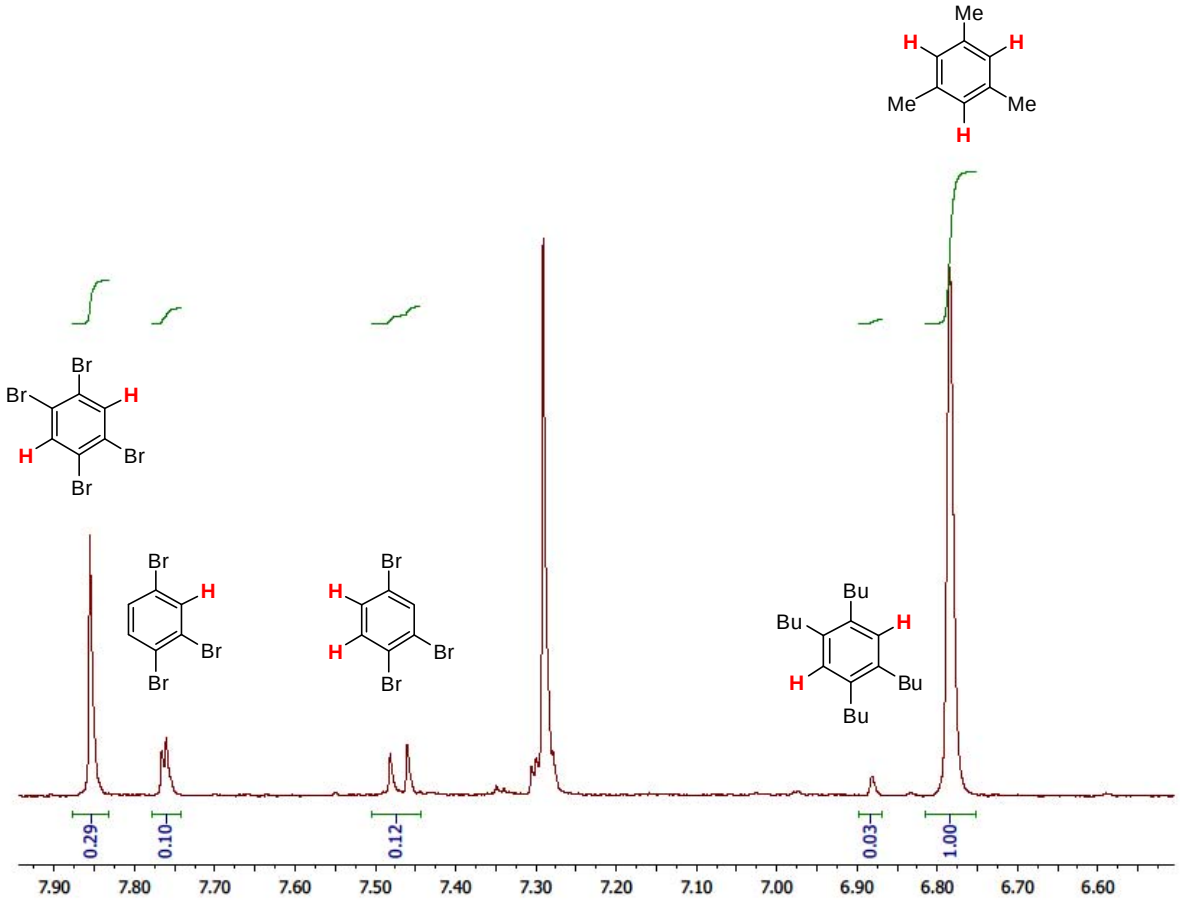
Using the general Negishi procedure a product mixture composed of 1,3,5-tributylbenzene (**3d**) and other butylated arenes, in a 99:1 ratio of **3d**:others as determined by GCMS analysis was obtained. ^{1}H NMR analysis using *p*-xylene (1 equiv) as internal standard indicates a 64% yield of **3d** based on *n*-BuZnBr.



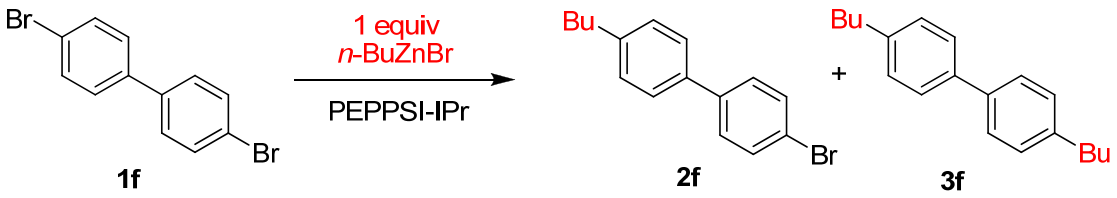
Negishi cross coupling of 1,2,4,5-tetrabromobenzene (Table 1, entry 4):



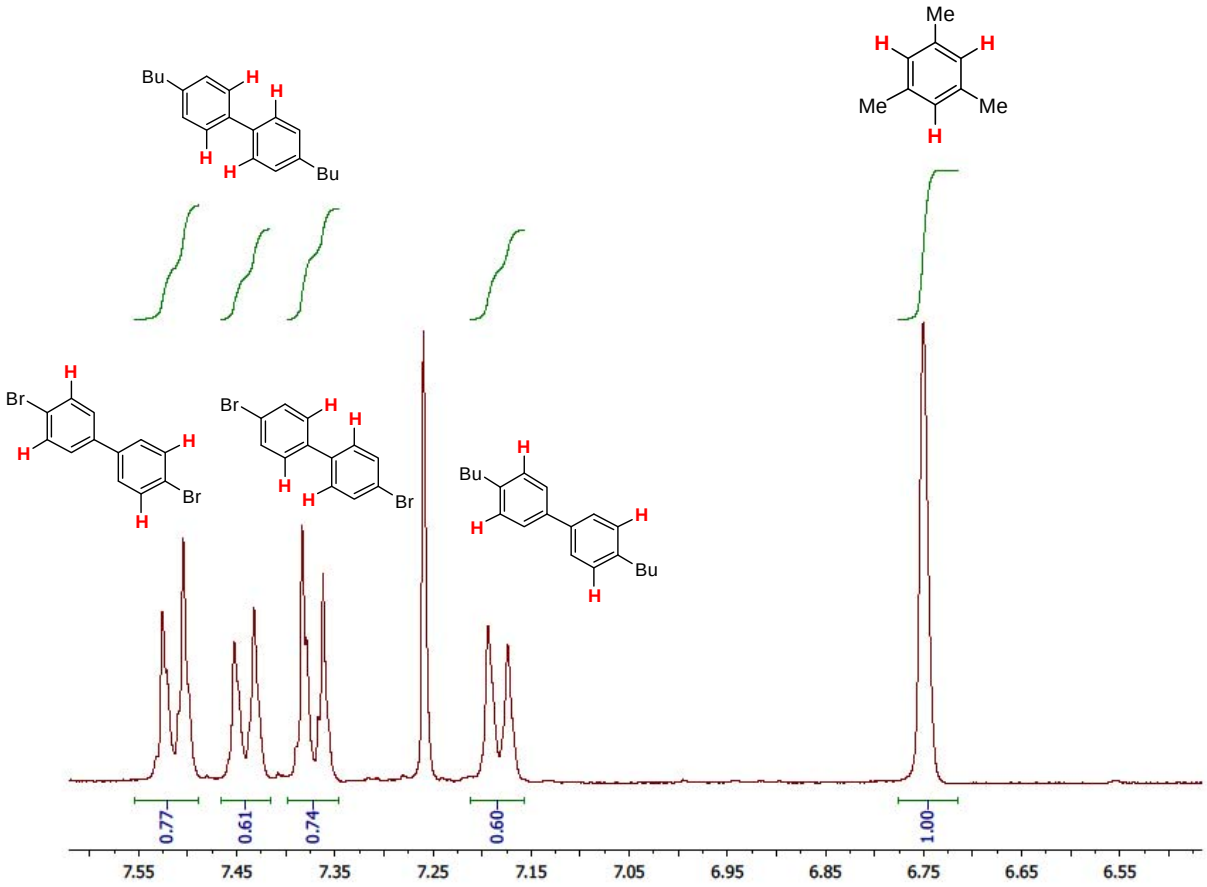
Using the general Negishi procedure a product mixture composed of 1,2,4,5-tetrabutylbenzene (**3e**) and polybutylated adducts in a 92:8 ratio as determined by GCMS analysis was obtained. In addition 1,2,4-tribromobenzene (**4e**) resulting from protodebromination was also obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 18% yield of **3e** based on *n*-BuZnBr and 27% conversion of starting material **1e** into the by-product **5e**.



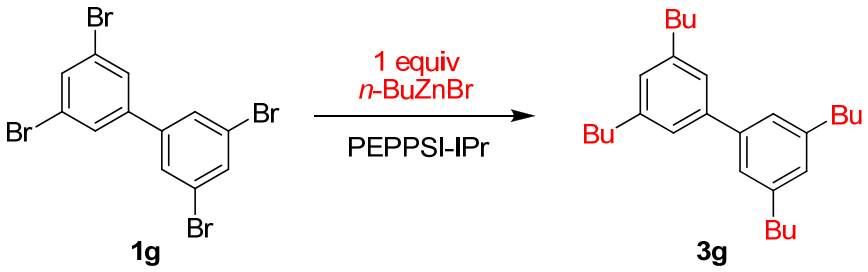
Negishi cross coupling of 4,4'-dibromobiphenyl (Table 1, entry 5):



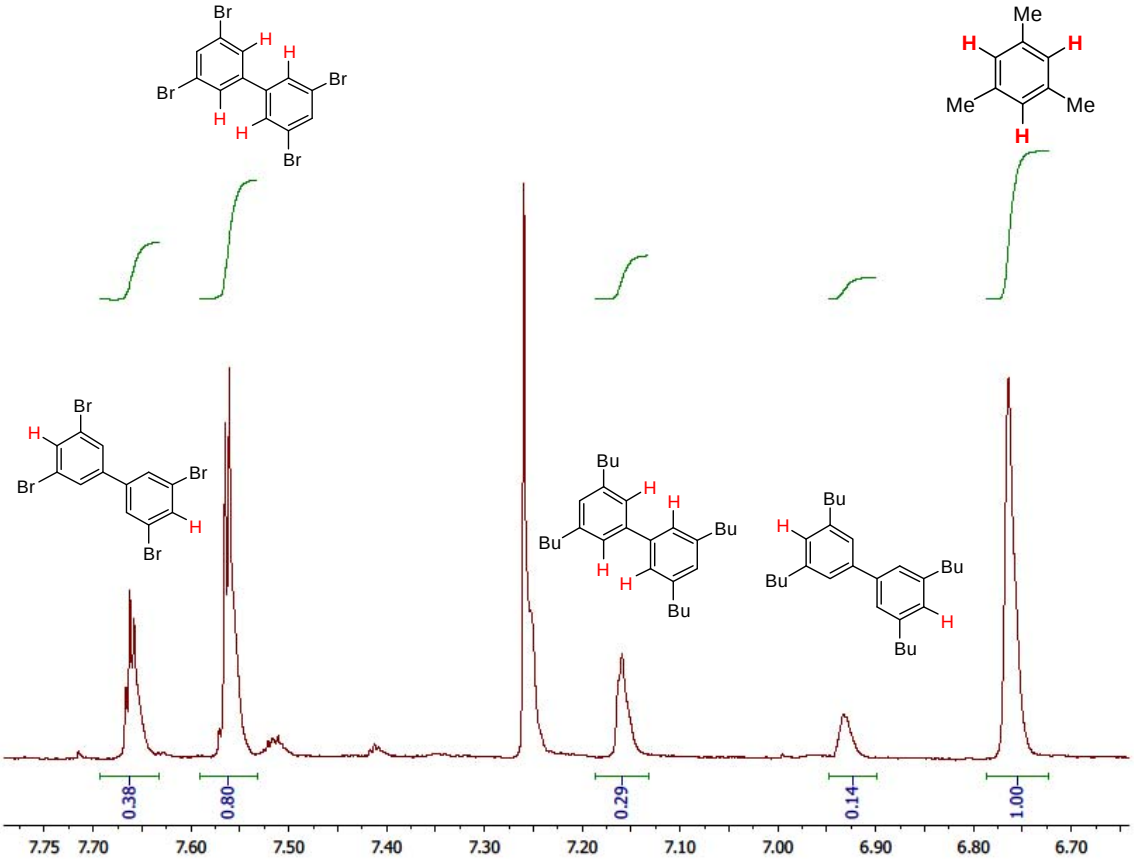
Using the general Negishi procedure a product mixture composed of 4,4'-dibutylbenzene (**3f**) and 4-bromo-4'-butylbenzene (**2f**) in a 97:3 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 90% yield of **3f** based on *n*-BuZnBr.



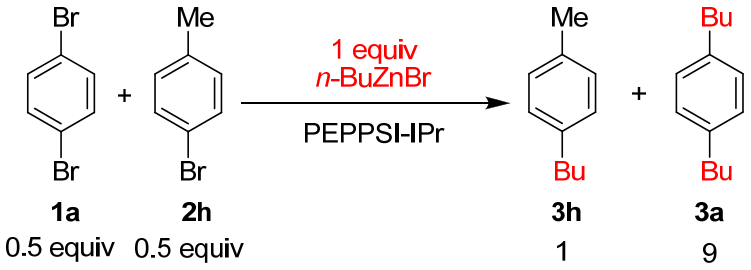
Negishi cross coupling of 3,3',5,5'-tetrabromobenzene (Table 1, entry 6):



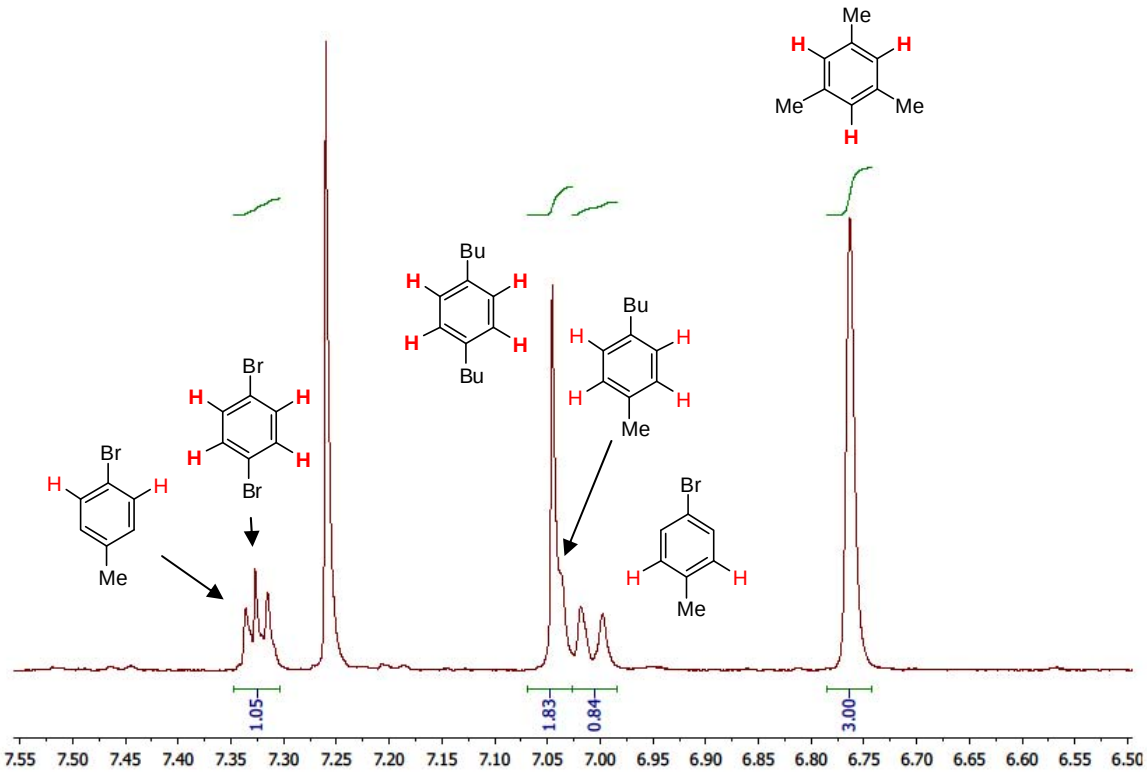
Using the general Negishi procedure a product mixture composed of 3,3',5,5'-tetrabutylbenzene (**3g**) and polybutylated adducts in a 99:1 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates an 86% yield of **3g** based on *n*-BuZnBr. The crude NMR shows some unidentified impurities as multiplets at 7.50 and 7.40 ppm which were also present in the starting material, **1g**.



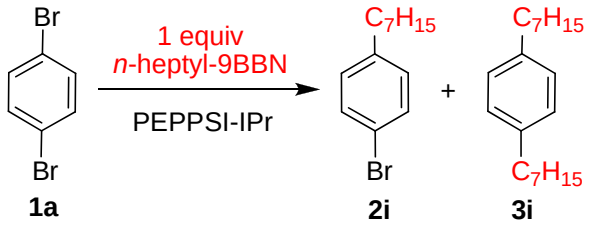
Competition experiment for Negishi cross coupling of 1,4-dibromobenzene and 4-bromotoluene (Scheme 2):



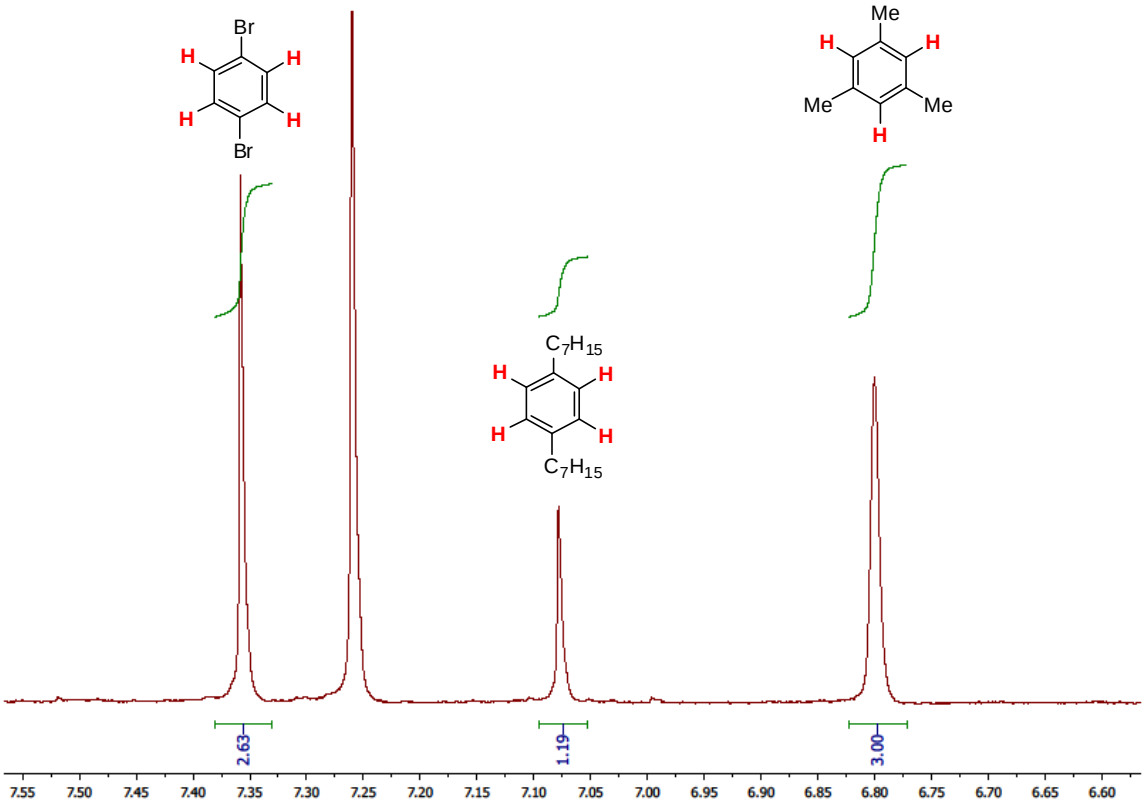
Using the general Negishi procedure a product mixture composed of 1,4-dibutylbenzene (**3a**) and 4-butyltoluene (**3h**) in a 9:1 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 91% yield of **3a**+**3h** based on *n*-BuZnBr.



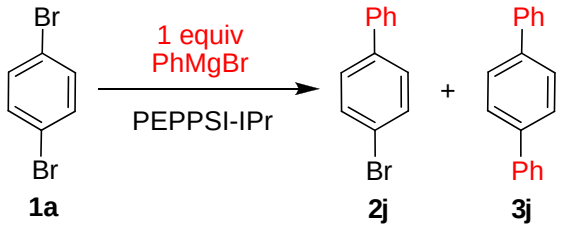
Suzuki cross coupling of 1,4-dibromobenzene (Scheme 4, eq 1):



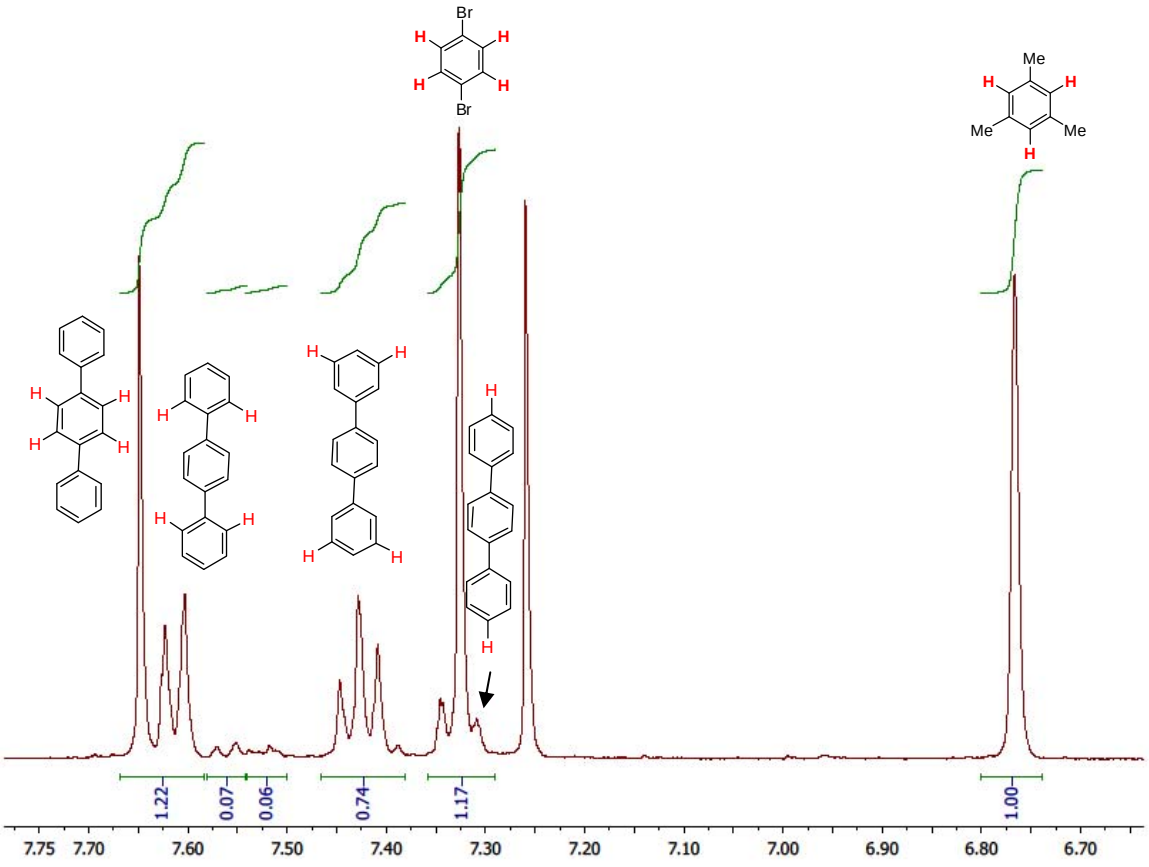
Using the general Suzuki procedure a product mixture composed of 1,4-diheptylbenzene (**3i**) and 4-butylbromobenzene (**2i**) in a 92:8 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 60% yield of **3i** based on *n*-heptyl-9BBN.



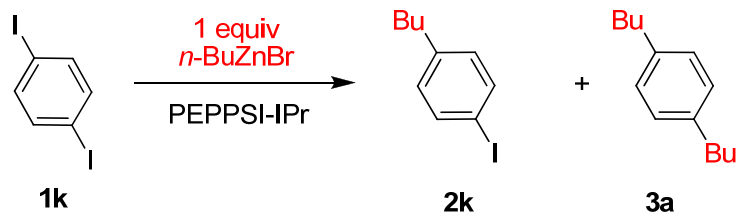
Kumada cross coupling of 1,4-dibromobenzene (Scheme 4, eq. 2):



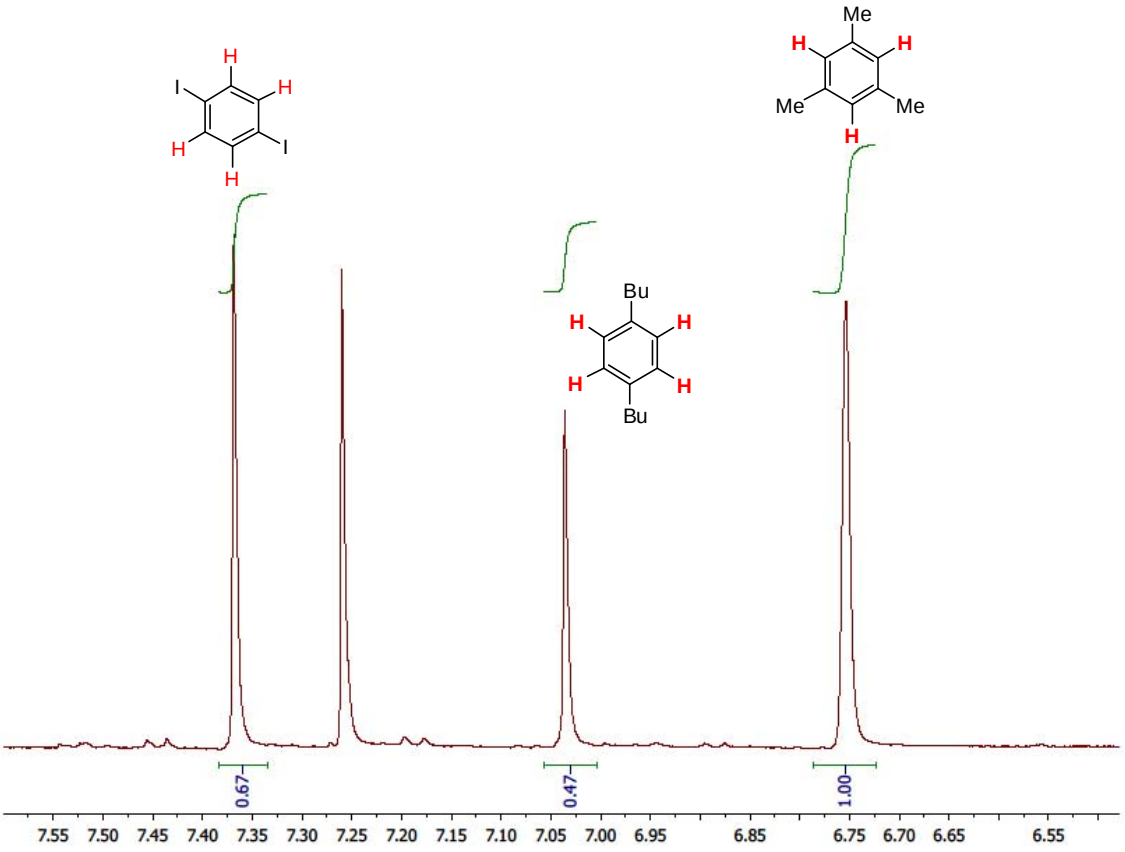
Using the general Kumada procedure a product mixture composed of 1,4-diphenylbenzene (**3j**) and 4-bromobiphenyl (**2j**) in a 91:9 ratio as determined by ^{1}H NMR analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 92% yield of **3j** based on PhMgBr.



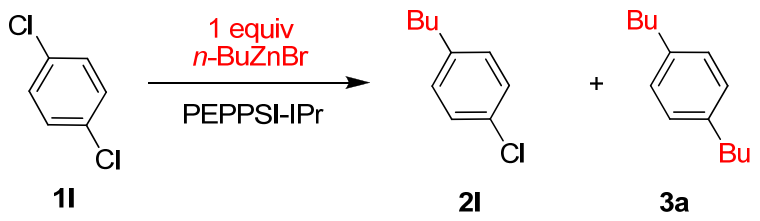
Negishi cross coupling of 1,4-diiodoobenzene (Table 2, entry 1):



Using the general Negishi procedure a product mixture composed of 1,4-dibutylbenzene (**3a**) and 4-butyliodobenzene (**2k**) in a >95:5 ratio as determined by ^{1}H NMR analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 71% yield of **3a** based on *n*-BuZnBr.

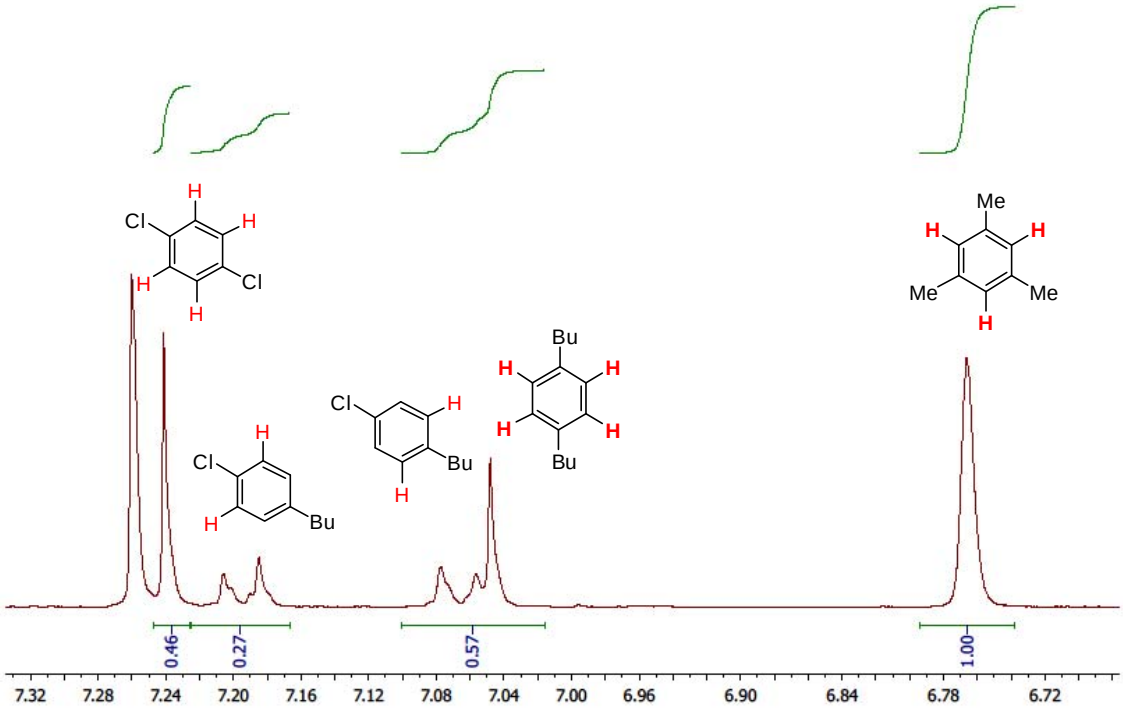


Negishi cross coupling of 1,4-dichlorobenzene (Table 2, entry 2):

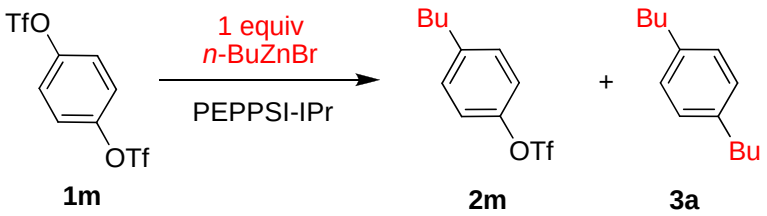


1l **2l** **3a**

Using the general Negishi procedure a product mixture composed of 1,4-dibutylbenzene (**3a**) and 4-butylchlorobenzene (**2l**) in a 35:65 ratio as determined by ^{1}H NMR analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 85% yield of **3a+2l** based on *n*-BuZnBr.

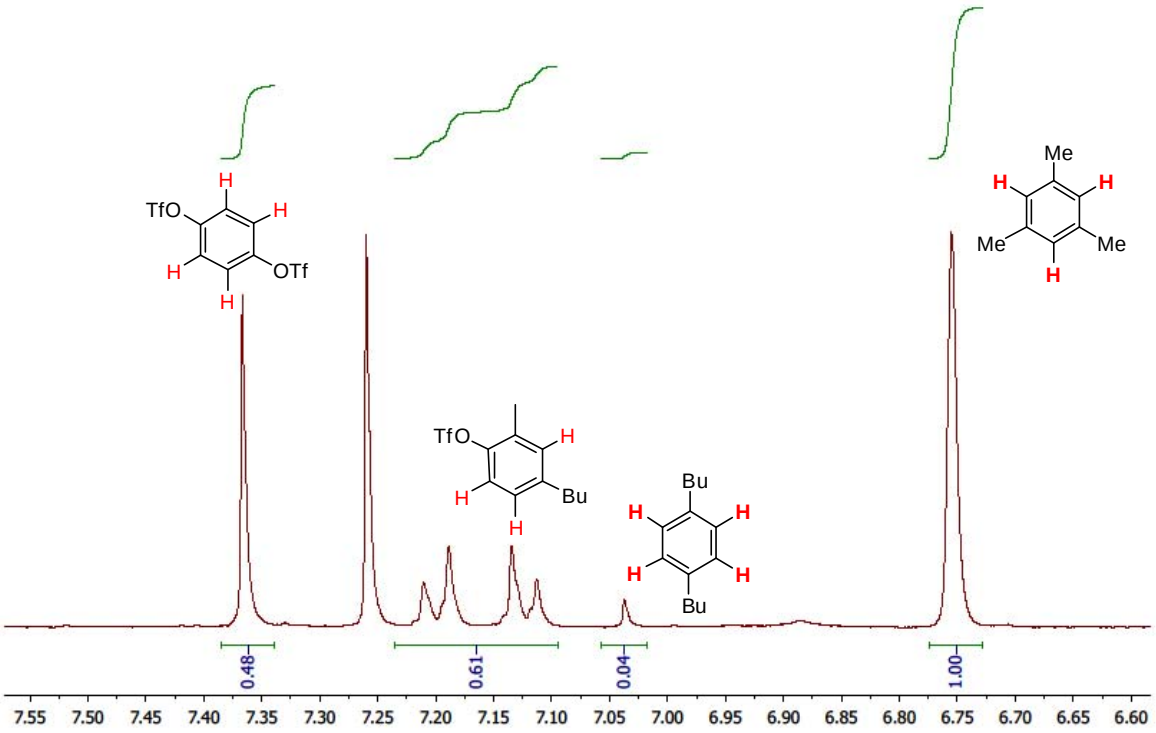


Negishi cross coupling of bistriflurometansulfonyl-1,4-dihydroxybenzene (Table 2, entry 3):

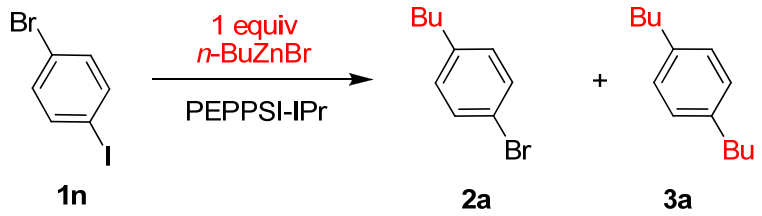


1m **2m** **3a**

Using the general Negishi procedure a product mixture composed of 1,4-dibutylbenzene (**3a**) and the monobutylated arene (**2m**) in a 6:94 ratio as determined by ^{1}H NMR analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 53% yield of **3a**+**2m** based on *n*-BuZnBr.

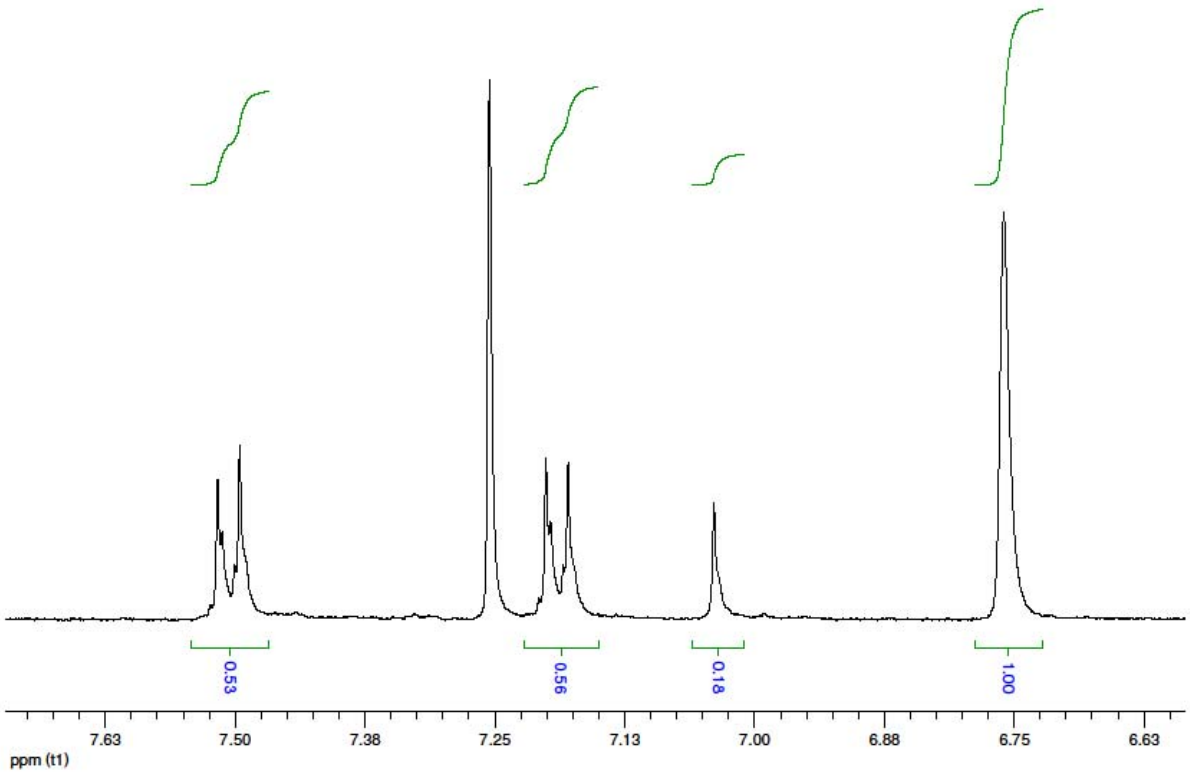


Negishi cross coupling of 4-bromoiodobenzene (Table 2, entry 4):

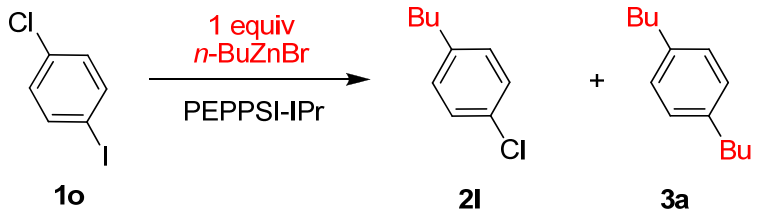


1n **2a** **3a**

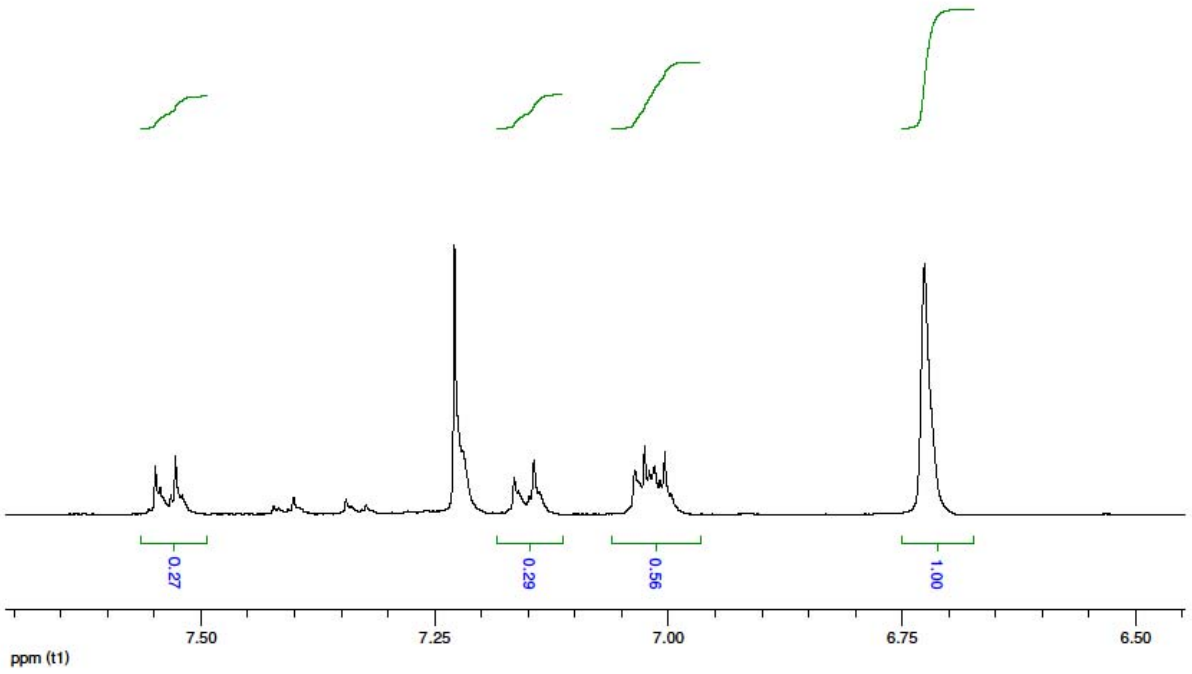
Using the general Negishi procedure a product mixture composed of 4-butylbromobenzene (**2a**) and 1,4-dibutylbenzene (**3a**) in a 7:93 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 27% yield of **3i** based on *n*-BuZnBr.



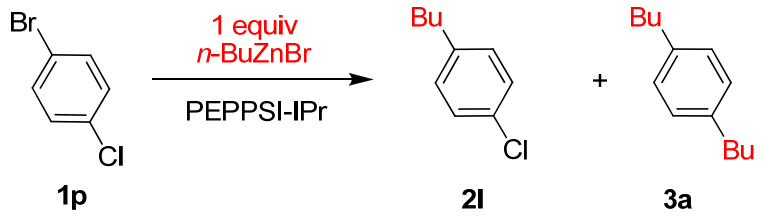
Negishi cross coupling of 4-chloroiodobenzene (Table 2, entry 5):



Using the general Negishi procedure a product mixture composed of 4-butylchlorobenzene (**2l**) and 1,4-dibutylbenzene (**3a**) in a 99:1 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 44% yield of **3i** based on *n*-BuZnBr.

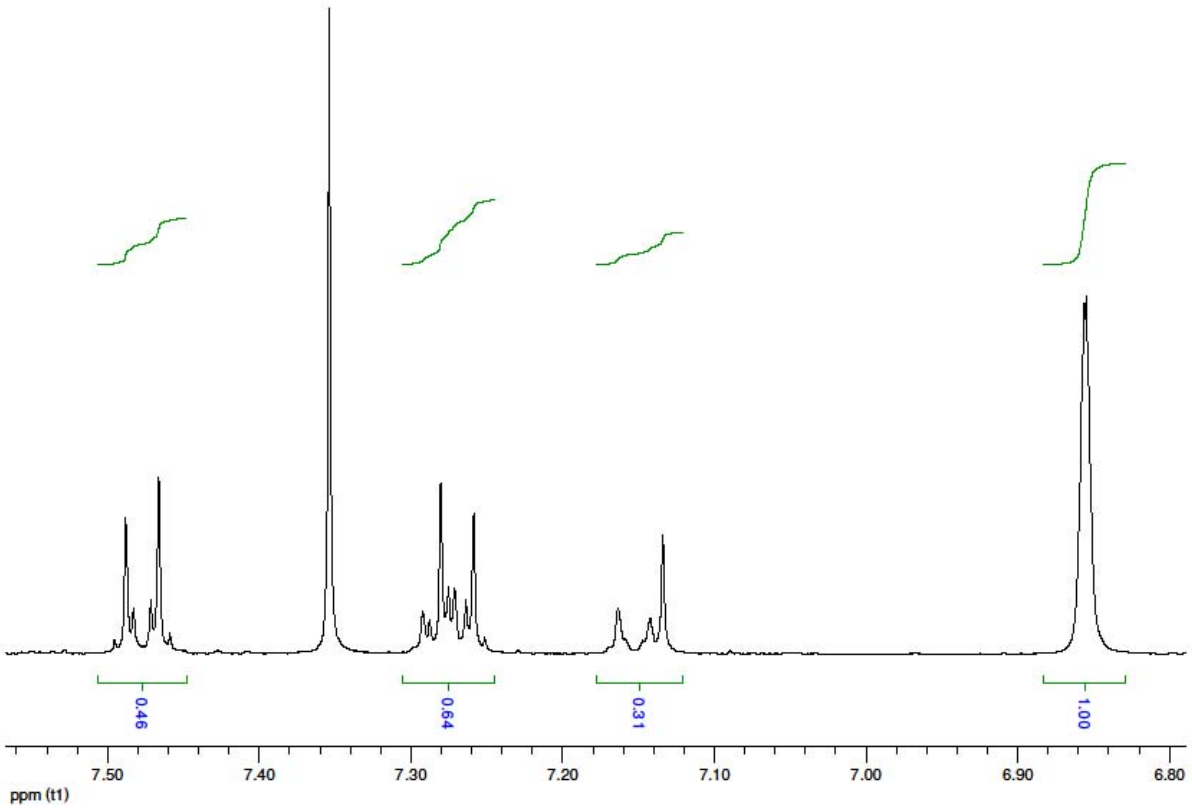


Negishi cross coupling of 4-chlorobromobenzene (Table 2, entry 6):



1p **2l** **3a**

Using the general Negishi procedure a product mixture composed of 4-butylchlorobenzene (**2l**) and 1,4-dibutylbenzene (**3a**) in a 73:27 ratio as determined by GCMS analysis was obtained. ^{1}H NMR analysis using mesitylene (1 equiv) as internal standard indicates a 47% yield of **3i** based on *n*-BuZnBr.



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[2] Krasovskiy, A.; Knochel, P. *Synthesis* **2006**, 890.

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