Oh the roGFPs you will see

Document setup options

```
knitr::opts_chunk$set(echo = TRUE)
library(knitr)
opts_chunk$set(tidy.opts=list(width.cutoff=55),tidy=TRUE)
shh <- suppressPackageStartupMessages
shh(require(sensorOverlord))
shh(require(ggplot2))
shh(require(cowplot))
shh(require(stringr))
shh(require(ggalt))
```

Initalize Sensors

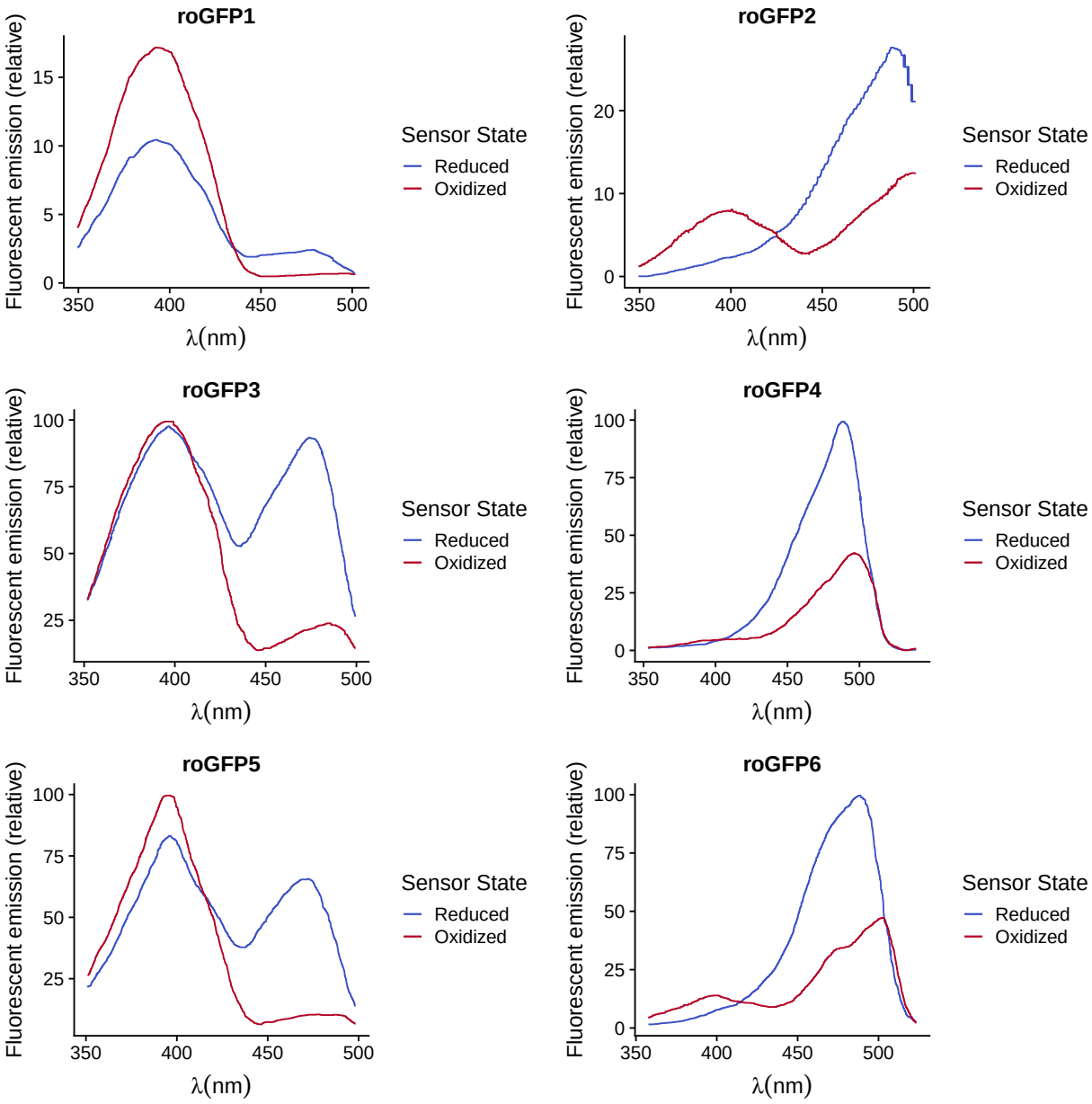
```
sensor_repo <- "../Raw_Spectra/"

# roGFP1
roGFP1_data <- read.csv(paste(sensor_repo, "rogfp1.csv", sep = ""), header = TRUE)
roGFP1_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP1_data$Lambda_Reduced,
    values_minimum = roGFP1_data$Values_Reduced,
    lambdas_maximum = roGFP1_data$Lambda_Oxidized,
    values_maximum = roGFP1_data$Values_Oxidized)
roGFP1_sensor <- new("redoxSensor", Rmin = 4.3, Rmax = 30.6, delta = 0.2, e0 = -281)

# roGFP1-R9
roGFP1_R9_data <- read.csv(paste(sensor_repo, "rogfp1_R9.csv", sep = ""), header = TRUE)
roGFP1_R9_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP1_R9_data$Lambda_reduced,
    values_minimum = roGFP1_R9_data$reduced,
    lambdas_maximum = roGFP1_R9_data$Lambda_oxidized,
    values_maximum = roGFP1_R9_data$oxidized)
roGFP1_R9_sensor <- new("redoxSensor", newSensorFromSpectra(roGFP1_R9_spectra,
                                    lambda_1 = c(380, 400), lambda_2 = c(460, 480)),
                        e0 = -278)

# roGFP1-R12 empirical
roGFP1_R12_empirical_sensor <- new("redoxSensor",
                                   Rmin = 0.667, Rmax = 5.207, delta = 0.171, e0 = -265)

# roGFP1-R12 from spectra
roGFP1_R12_data <- read.csv(paste(sensor_repo, "rogfp1_R12.csv", sep = ""),
                            header = FALSE)
roGFP1_R12_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP1_R12_data$V3,
    values_minimum = roGFP1_R12_data$V4,
    lambdas_maximum = roGFP1_R12_data$V1,
    values_maximum = roGFP1_R12_data$V2)
roGFP1_R12_sensor <- new("redoxSensor", newSensorFromSpectra(roGFP1_R12_spectra,
```

```
                                        lambda_1 = c(390, 410), lambda_2 = c(460, 480)),
                        e0 = -265)

# roGFP1_iE
roGFP1_iE_data <- read.csv(paste(sensor_repo, "rogfp1_iE.csv", sep = ""), header = FALSE, fileEncoding=
roGFP1_iE_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP1_iE_data$V3,
    values_minimum = roGFP1_iE_data$V4,
    lambdas_maximum = roGFP1_iE_data$V1,
    values_maximum = roGFP1_iE_data$V2)
roGFP1_iE_sensor <- new("redoxSensor", Rmin = 0.856, Rmax = 3.875, delta = 0.5, e0 = -236)

# roGFP2
roGFP2_data <- read.csv(paste(sensor_repo, "rogfp2.csv", sep = ""), header = FALSE, fileEncoding="UTF-8
roGFP2_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP2_data$V3,
    values_minimum = roGFP2_data$V4,
    lambdas_maximum = roGFP2_data$V1,
    values_maximum = roGFP2_data$V2)
roGFP2_sensor <- new("redoxSensor", Rmin = 0.09, Rmax = 1.7, delta = 0.3, e0 = -272)

# grx1_roGFP2
grx1_roGFP2_sensor <-  new("redoxSensor", Rmin = 0.3, Rmax = 2.0, delta = 0.5, e0 = -272)

# roGFP2_iL
roGFP2_iL_data <- read.csv(paste(sensor_repo, "rogfp2_iL.csv", sep = ""), header = FALSE, fileEncoding=
roGFP2_iL_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP2_iL_data$V3,
    values_minimum = roGFP2_iL_data$V4,
    lambdas_maximum = roGFP2_iL_data$V1,
    values_maximum = roGFP2_iL_data$V2)
roGFP2_iL_sensor <- new("redoxSensor", Rmin = 0.19, Rmax = 0.45, delta = 0.65, e0 = -229)

# roGFP3
roGFP3_data <- read.csv(paste(sensor_repo, "rogfp3.csv", sep = ""), header = TRUE)
roGFP3_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP3_data$Lambda_330,
    values_minimum = roGFP3_data$X.330.mv,
    lambdas_maximum = roGFP3_data$Lambda_240,
    values_maximum = roGFP3_data$X.240.mv)
roGFP3_sensor <- new("redoxSensor", newSensorFromSpectra(roGFP3_spectra,
                                        lambda_1 = c(380, 400), lambda_2 = c(460, 480)),
                    e0 = -299)


# roGFP4
roGFP4_data <- read.csv(paste(sensor_repo, "rogfp4.csv", sep = ""), header = TRUE)
roGFP4_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP4_data$Lambda_320,
    values_minimum = roGFP4_data$X.320.mv,
    lambdas_maximum = roGFP4_data$Lambda_230,
    values_maximum = roGFP4_data$X.230.mv)
roGFP4_sensor <- new("redoxSensor", newSensorFromSpectra(roGFP4_spectra,
```

```
                                        lambda_1 = c(380, 400), lambda_2 = c(460, 480)),
                    e0 = -286)

roGFP4_sensor <- new("redoxSensor", newSensorFromSpectra(roGFP4_spectra,
                                        lambda_1 = c(505, 515), lambda_2 = c(465, 475)),
                    e0 = -286)

# roGFP5
roGFP5_data <- read.csv(paste(sensor_repo, "rogfp5.csv", sep = ""), header = TRUE)
roGFP5_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP5_data$Lambda_330 ,
    values_minimum = roGFP5_data$X.330.mv,
    lambdas_maximum = roGFP5_data$Lambda_250,
    values_maximum = roGFP5_data$X.250.mv)
roGFP5_sensor <- new("redoxSensor", newSensorFromSpectra(roGFP5_spectra,
                                        lambda_1 = c(380, 400), lambda_2 = c(460, 480)),
                    e0 = -296)
# roGFP6
roGFP6_data <- read.csv(paste(sensor_repo, "rogfp6.csv", sep = ""), header = TRUE)
roGFP6_spectra <- spectraMatrixFromValues(
    lambdas_minimum = roGFP6_data$Lambda_310 ,
    values_minimum = roGFP6_data$X.310.mv,
    lambdas_maximum = roGFP6_data$Lambda_230,
    values_maximum = roGFP6_data$X.230.mv)
roGFP6_sensor <- new("redoxSensor", newSensorFromSpectra(roGFP6_spectra,
                                        lambda_1 = c(380, 400), lambda_2 = c(460, 480)),
                    e0 = -280)
```

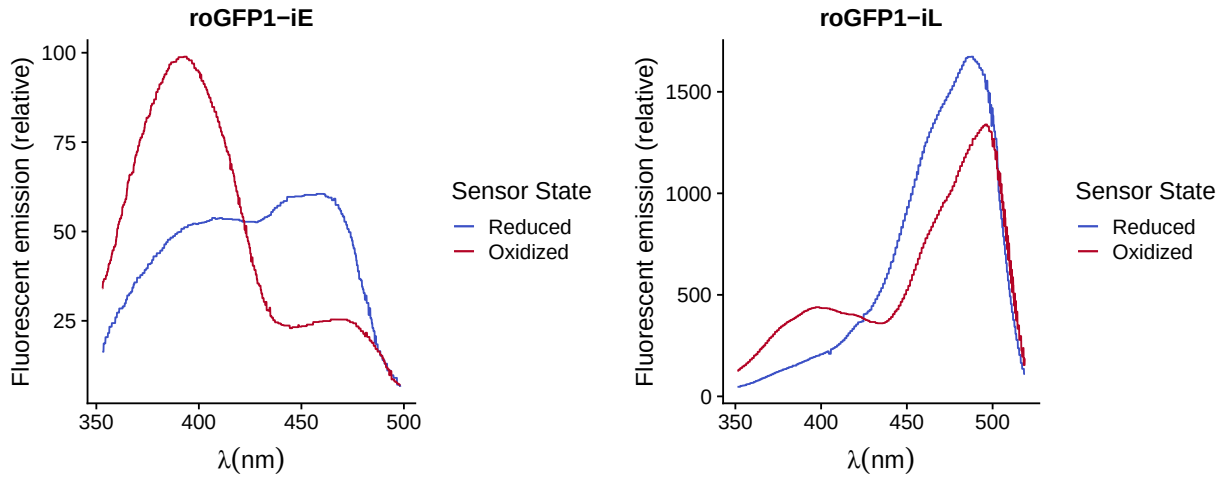
Original roGFP spectra

```
gfp1_spectraPlot <- plotSpectra(roGFP1_spectra, "Reduced", "Oxidized") + ggtitle("roGFP1")
gfp2_spectraPlot <- plotSpectra(roGFP2_spectra, "Reduced", "Oxidized") + ggtitle("roGFP2")
gfp3_spectraPlot <- plotSpectra(roGFP3_spectra, "Reduced", "Oxidized") + ggtitle("roGFP3")
gfp4_spectraPlot <- plotSpectra(roGFP4_spectra, "Reduced", "Oxidized") + ggtitle("roGFP4")
gfp5_spectraPlot <- plotSpectra(roGFP5_spectra, "Reduced", "Oxidized") + ggtitle("roGFP5")
gfp6_spectraPlot <- plotSpectra(roGFP6_spectra, "Reduced", "Oxidized") + ggtitle("roGFP6")

plot_grid(gfp1_spectraPlot, gfp2_spectraPlot, gfp3_spectraPlot, gfp4_spectraPlot, gfp5_spectraPlot, gfp
```



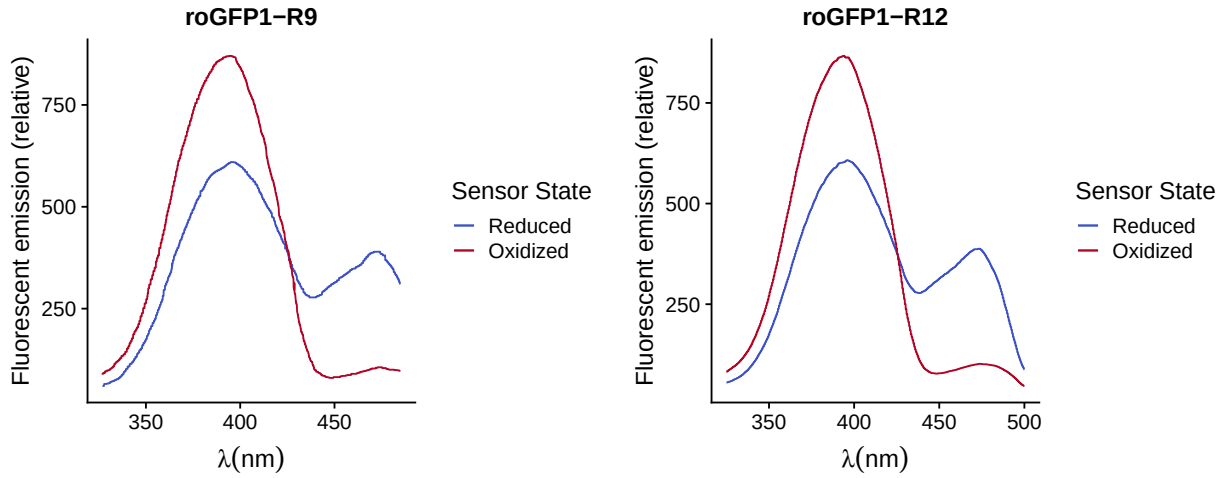
iL and iE spectra

```
gfp1_iE_spectraPlot <- plotSpectra(roGFP1_iE_spectra, "Reduced", "Oxidized") + ggtitle("roGFP1-iE")
gfp2_iL_spectraPlot <- plotSpectra(roGFP2_iL_spectra, "Reduced", "Oxidized") + ggtitle("roGFP1-iL")

plot_grid(gfp1_iE_spectraPlot, gfp2_iL_spectraPlot)
```



R12 and R9

```
gfp1_R12_spectraPlot <- plotSpectra(roGFP1_R12_spectra, "Reduced", "Oxidized") + ggtitle("roGFP1-R12")
gfp1_R9_spectraPlot <- plotSpectra(roGFP1_R9_spectra, "Reduced", "Oxidized") + ggtitle("roGFP1-R9")

plot_grid(gfp1_R9_spectraPlot, gfp1_R12_spectraPlot)
```



12 Total sensors created

- roGFP1 - roGFP6 (6)
- roGFP1-iE and roGFP2-iL (2)
- roGFP1-R9 and roGFP1-R12 and empirical roGFP1-R12 (3)
- grx1_roGFP2 (No spectra, 1)

```
q <- function(...) {
  sapply(match.call()[-1], deparse)
}

sensorList <- q(roGFP1_sensor, roGFP2_sensor, roGFP3_sensor, roGFP4_sensor,
                roGFP5_sensor, roGFP6_sensor, roGFP1_iE_sensor, roGFP2_iL_sensor,
                roGFP1_R9_sensor, roGFP1_R12_sensor, roGFP1_R12_empirical_sensor, grx1_roGFP2_sensor)
```

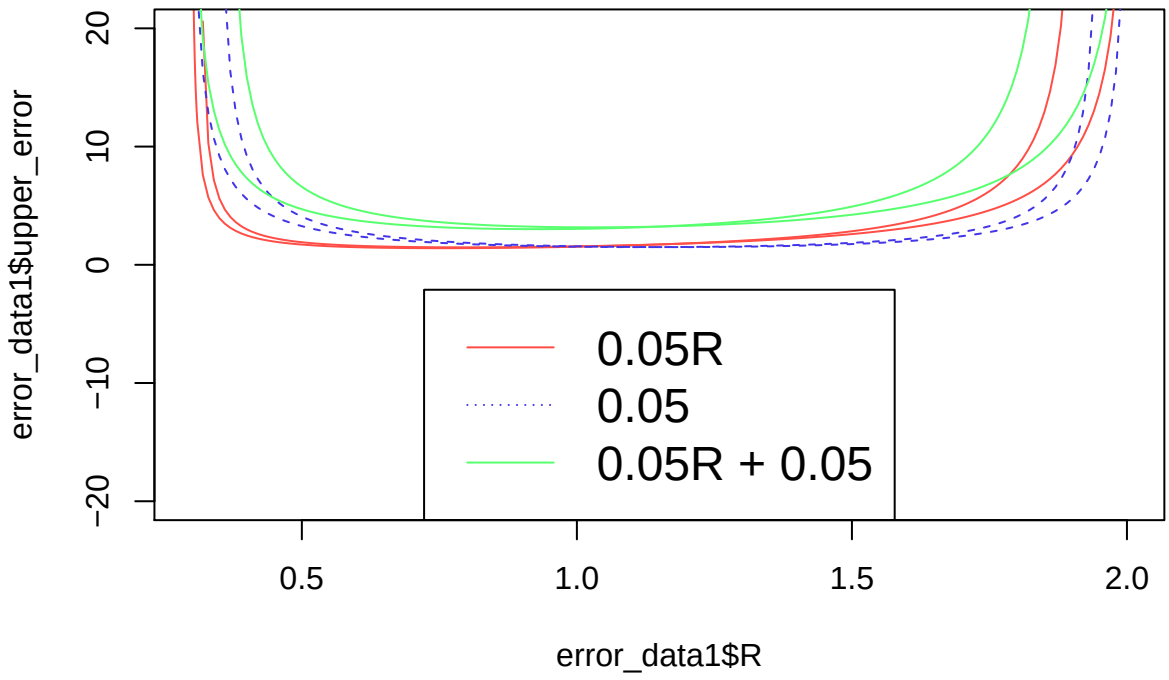
```
charsMatrix <- c()

for (sensorName in sensorList) {
    sensor <- get(sensorName)
    charsMatrix <- rbind(charsMatrix, c(sensorName, round(sensor@Rmin,2),
                                        round(sensor@Rmax,2), round(sensor@delta,2), round(sensor@e0,2)))
}

knitr::kable(data.frame(charsMatrix), col.names = c("Sensor", "Rmin", "Rmax", "Delta", "e0"), digits = 2)
```

Sensor	Rmin	Rmax	Delta	e0
roGFP1_sensor	4.3	30.6	0.2	-281
roGFP2_sensor	0.09	1.7	0.3	-272
roGFP3_sensor	1.04	4.69	0.23	-299
roGFP4_sensor	0.39	1.03	0.36	-286
roGFP5_sensor	1.19	9.34	0.16	-296
roGFP6_sensor	0.06	0.41	0.36	-280
roGFP1_iE_sensor	0.86	3.88	0.5	-236
roGFP2_iL_sensor	0.19	0.45	0.65	-229
roGFP1_R9_sensor	1.58	8.53	0.27	-278
roGFP1_R12_sensor	1.57	8.41	0.26	-265
roGFP1_R12_empirical_sensor	0.67	5.21	0.17	-265
grx1_roGFP2_sensor	0.3	2	0.5	-272

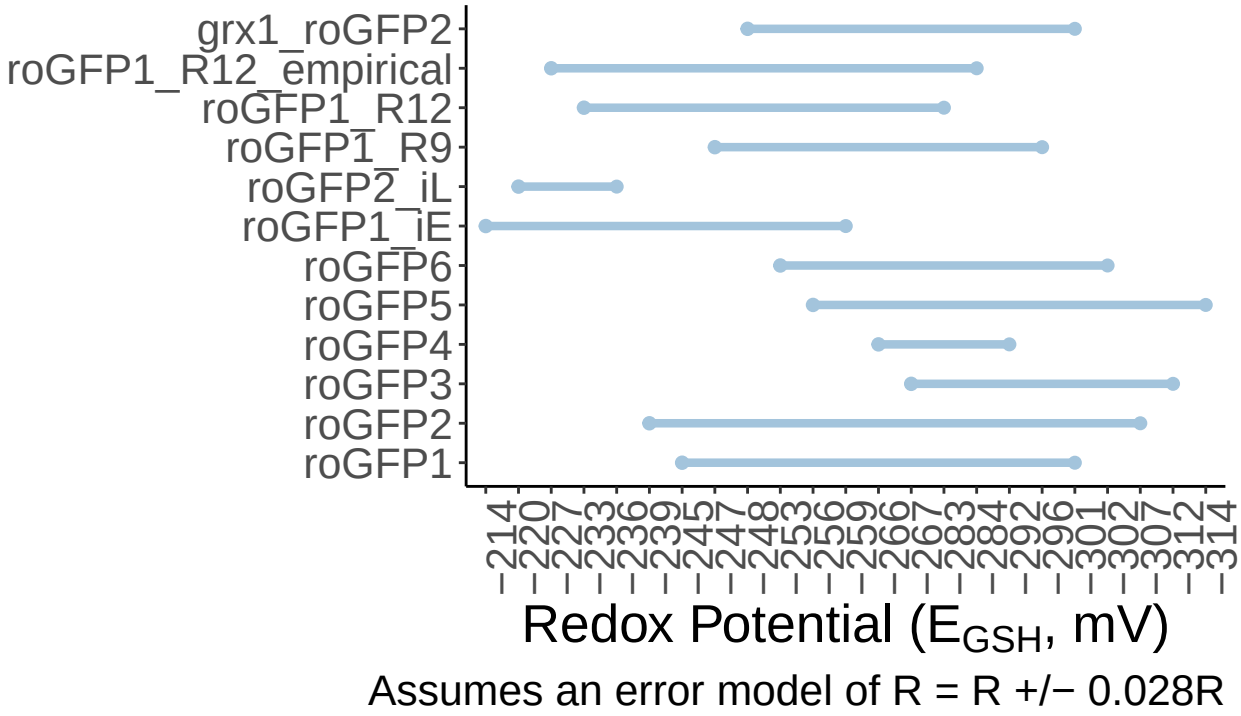
```
acceptable_error <- 2
error_model <- function(x) {return(0.028*x)}

minMaxMatrix <- c()

for (sensorName in sensorList) {
    sensor <- get(sensorName)
    sensorName <- str_replace(sensorName, "_sensor", "")
    error_data <- getErrorTable(sensor, R = getR(sensor),
                                FUN = getE, Error_Model = error_model)

    error_filter <- subset(error_data,
                           error_data$max_abs_error < acceptable_error)

    minimum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = min(error_filter$FUN_true))

    maximum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = max(error_filter$FUN_true))

    minMaxMatrix <- rbind(minMaxMatrix, c(sensorName, round(minimum, 0), round(maximum,0)))
}

ranges <- data.frame(minMaxMatrix)
colnames(ranges) <- c("Sensor_Name", "Minimum", "Maximum")
```

```
error_model <- function(x) {return(0.05*x)}
error_data1 <- getErrorTable(sensor, R = getR(sensor),
```

```
                                FUN = getE, Error_Model = error_model)

error_model <- function(x) {return(0.05)}
error_data2 <- getErrorTable(sensor, R = getR(sensor),
                                FUN = getE, Error_Model = error_model)

error_model <- function(x) {return(0.05 + 0.05*x)}
error_data3 <- getErrorTable(sensor, R = getR(sensor),
                                FUN = getE, Error_Model = error_model)


#plot(error_data1$FUN_true ~ error_data1$R, type = 'l', ylim = c(-280, -220))

redCol <- "#FF4E47"
blueCol <- "#4335E8"
greenCol <- "#58FF6E"

plot(error_data1$upper_error ~ error_data1$R, type = 'l',col = redCol, ylim = c(-20,20))
points(error_data1$lower_error ~ error_data1$R, type = 'l', col = redCol)
points(error_data2$upper_error ~ error_data2$R, type = 'l', lty = "dashed", col = blueCol)
points(error_data2$lower_error ~ error_data2$R, type = 'l',  lty = "dashed", col = blueCol)
points(error_data3$upper_error ~ error_data2$R, type = 'l',col = greenCol)
points(error_data3$lower_error ~ error_data2$R, type = 'l',  col = greenCol)

legend("bottom", legend = c("0.05R", "0.05", "0.05R + 0.05"),
       col = c(redCol, blueCol, greenCol),
       lty = c(1, 3, 1), cex = 1.5)
```

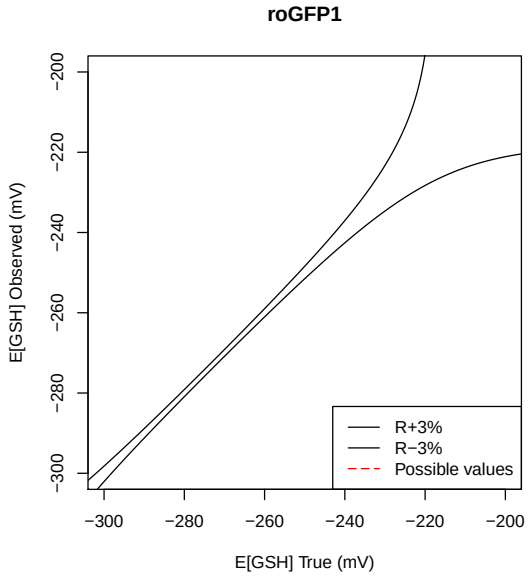


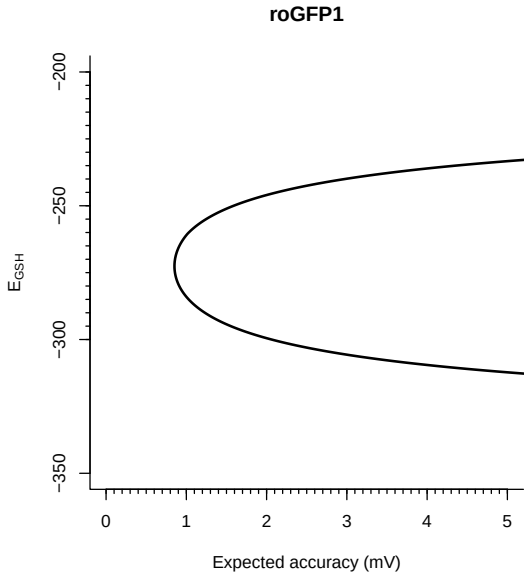

```
theme_set(theme_classic())

ranges$Sensor_Name <- factor(ranges$Sensor_Name,
                             levels=as.character(ranges$Sensor_Name))

gg <- ggplot(ranges, aes(x=Minimum, xend=Maximum,
                         y = Sensor_Name, group=Sensor_Name)) +
        geom_dumbbell(color="#a3c4dc",
                      size=1.5) +
           labs(x = expression("Redox Potential (" * E[GSH] * ", mV" * ")"),
             y=NULL,
             title="",
             caption="Assumes an error model of R = R +/- 0.028R",
             subtitle="") +
    theme(plot.title = element_text(hjust=0.5, face="bold"),
              #plot.background=element_rect(fill="#f7f7f7"),
              #panel.background=element_rect(fill="#f7f7f7"),
              panel.grid.minor=element_blank(),
              panel.grid.major.y=element_blank(),
              legend.position="top",
              panel.border=element_blank(),
          text = element_text(size = 20),
          axis.text.x = element_text(angle = 90, hjust = 1))
plot(gg)
```

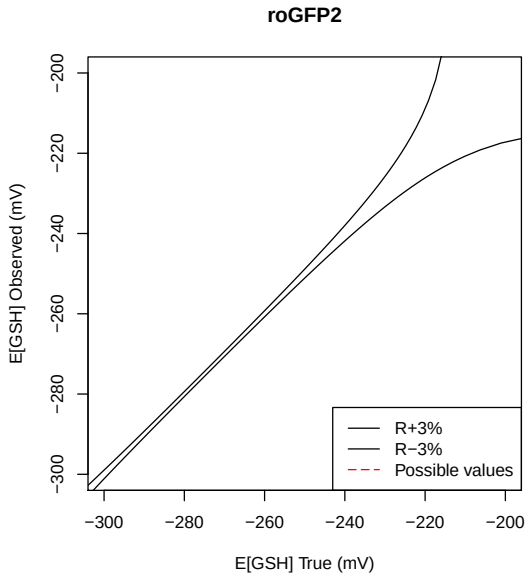


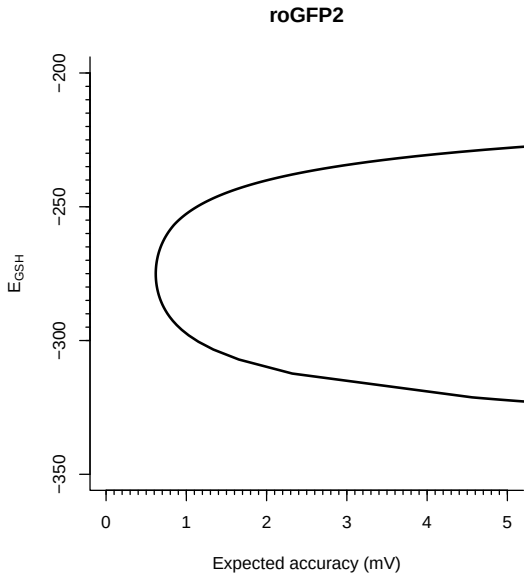

```
## [1] "roGFP1"
```

```
## [1] "roGFP2"
```



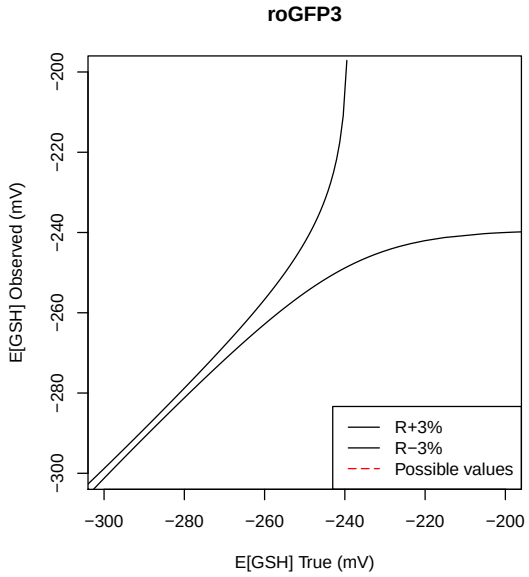


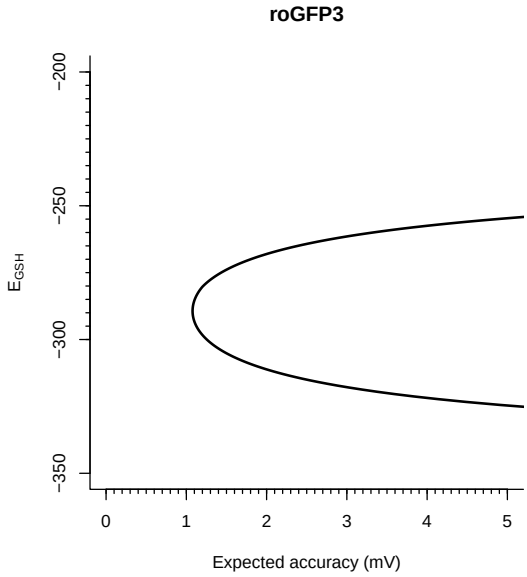


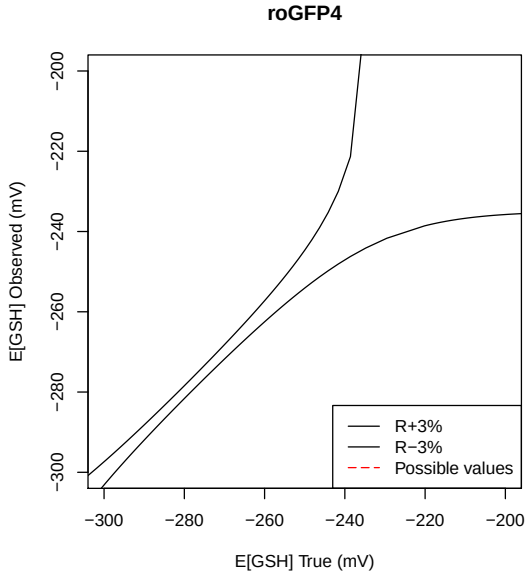


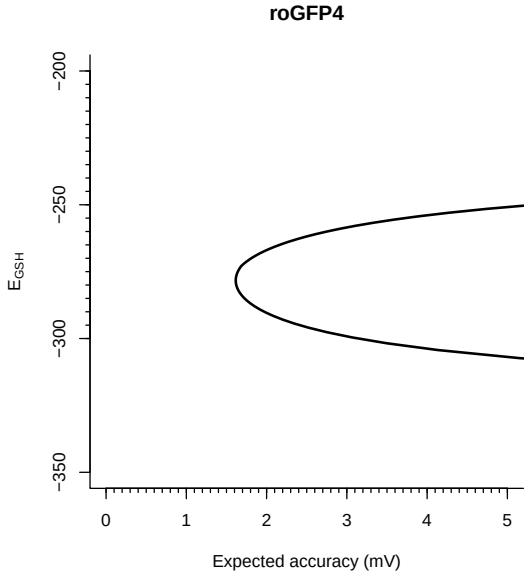

```
## [1] "roGFP3"
```

```
## [1] "roGFP4"
```



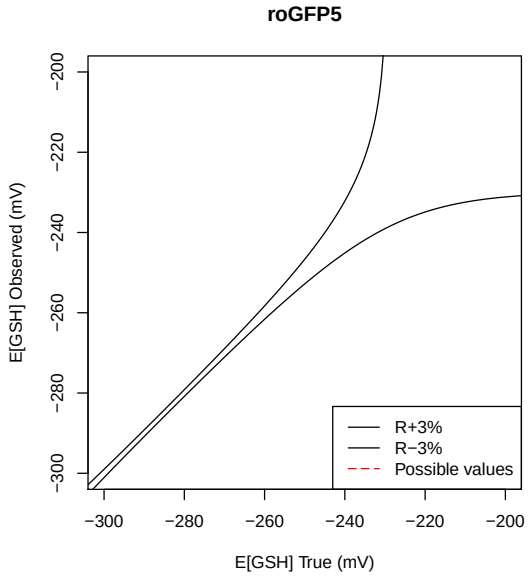


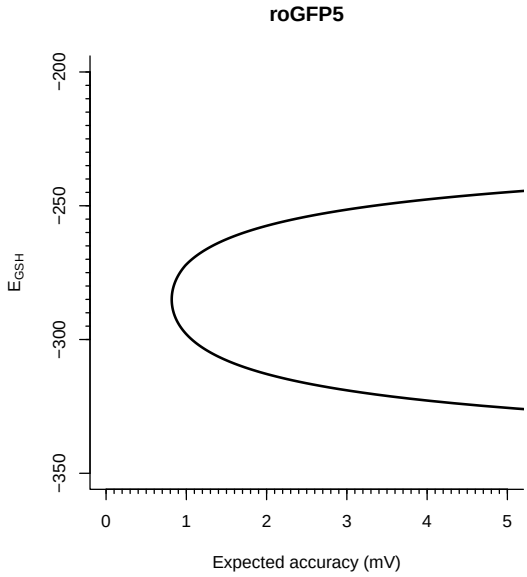


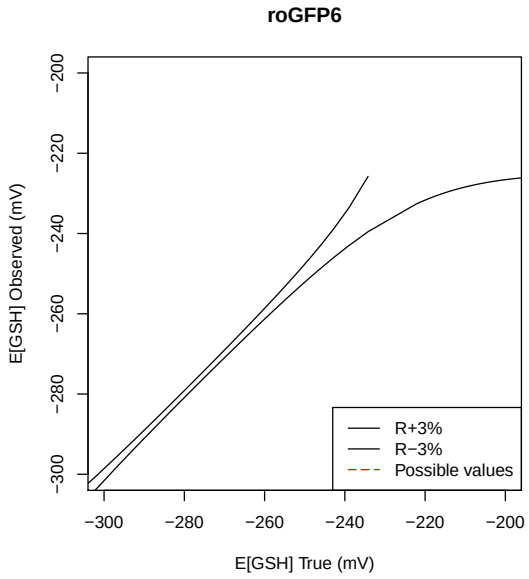


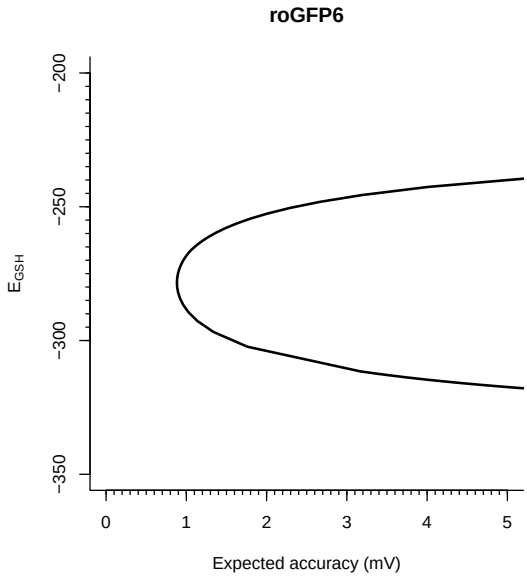

```
## [1] "roGFP5"
```

```
## [1] "roGFP6"
```



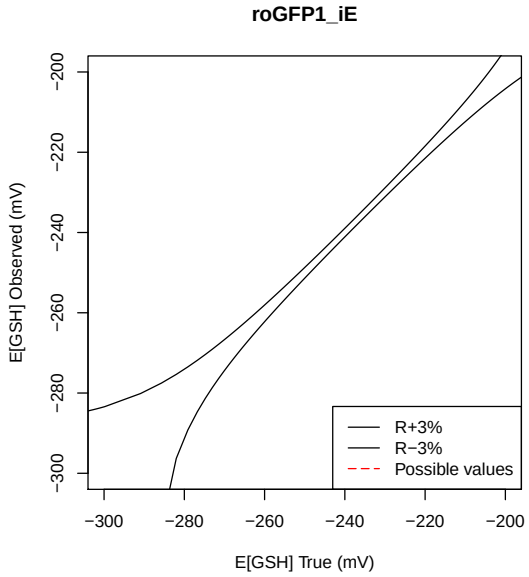


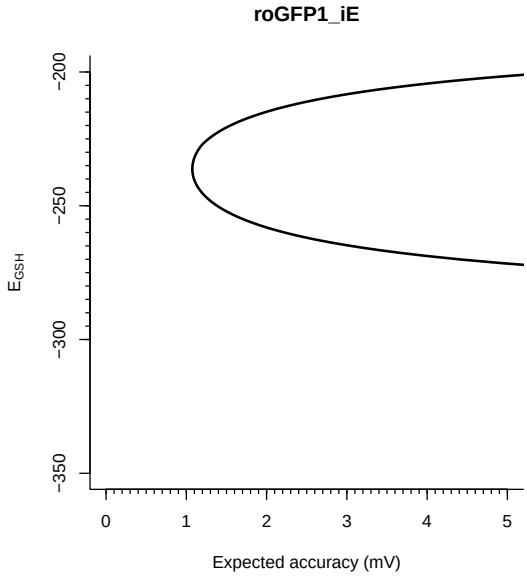


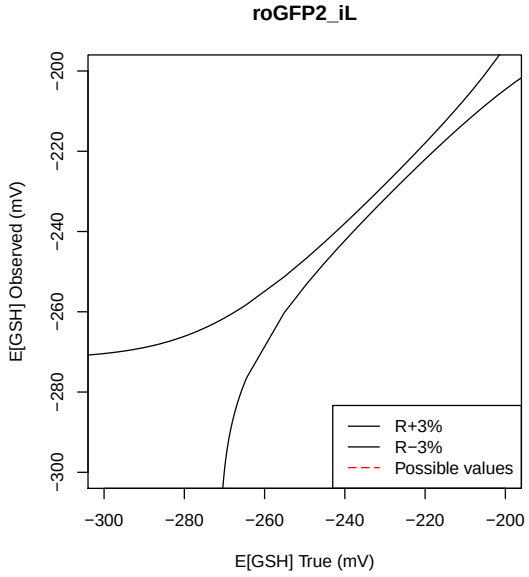


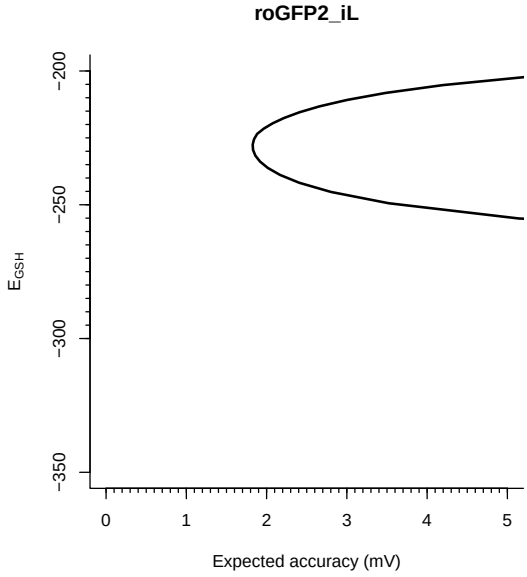

```
## [1] "roGFP1_iE"
```

```
## [1] "roGFP2_iL"
```



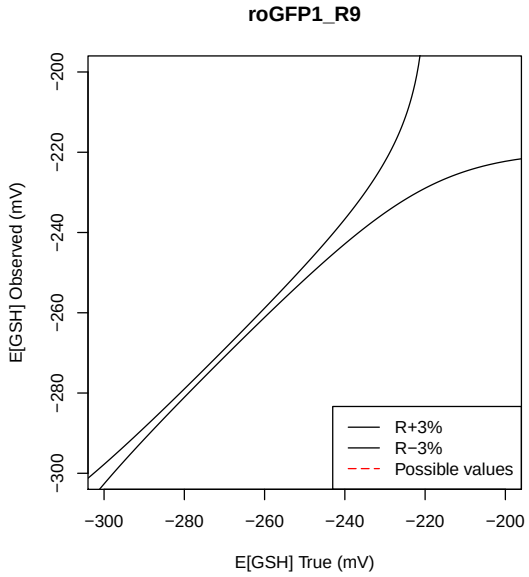


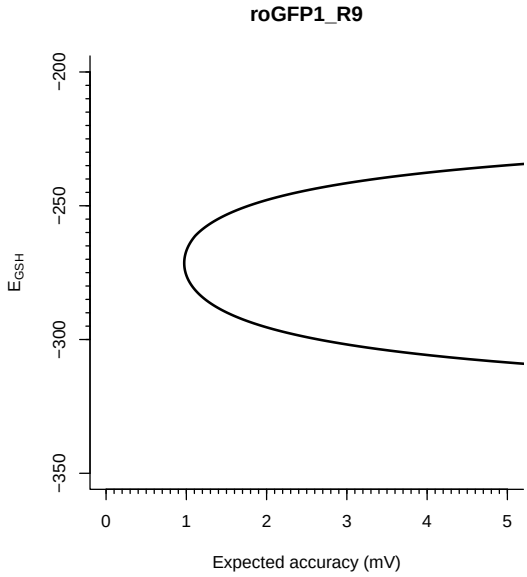


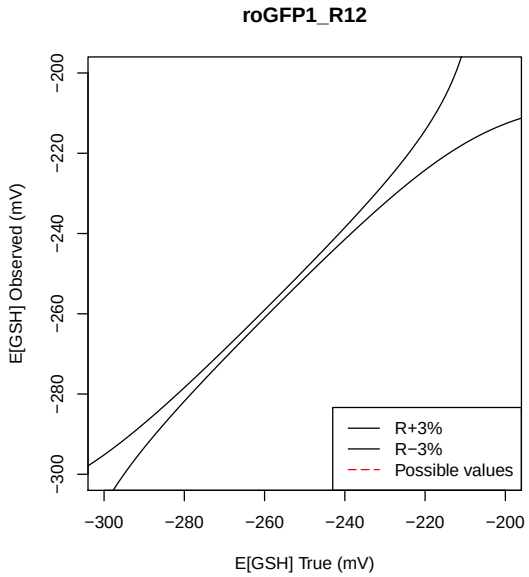


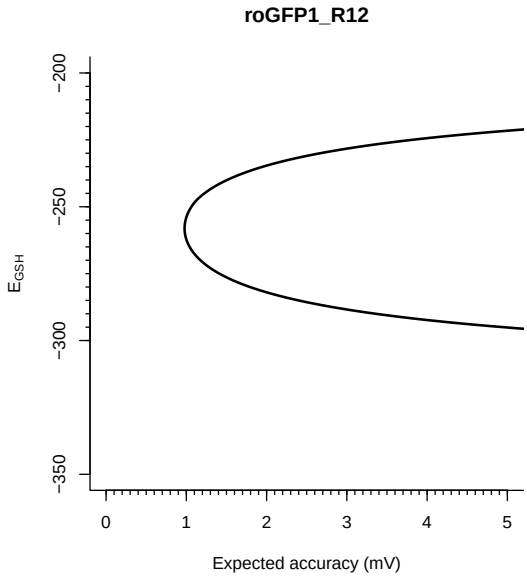

```
## [1] "roGFP1_R9"
```

```
## [1] "roGFP1_R12"
```

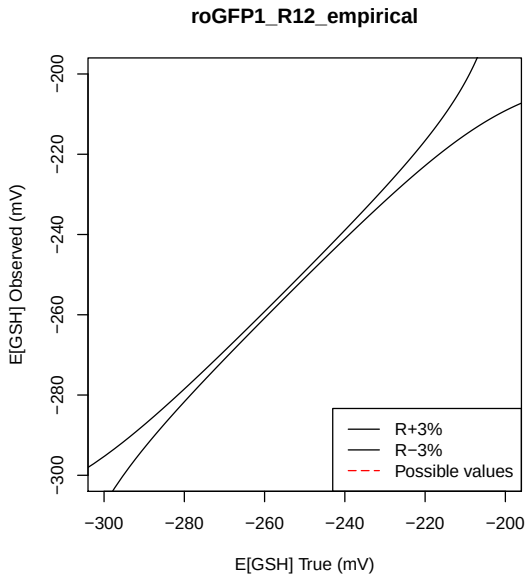


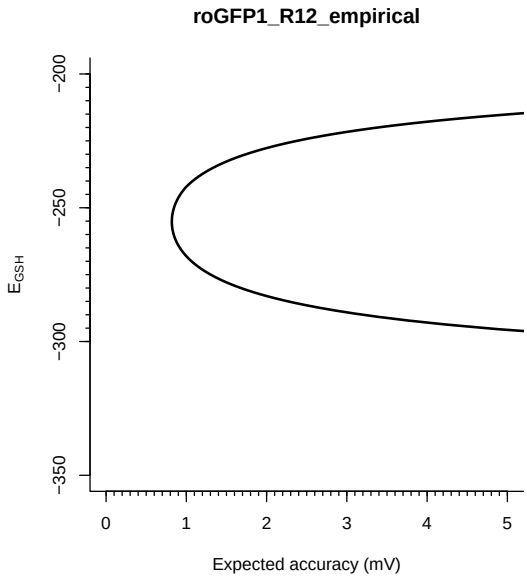


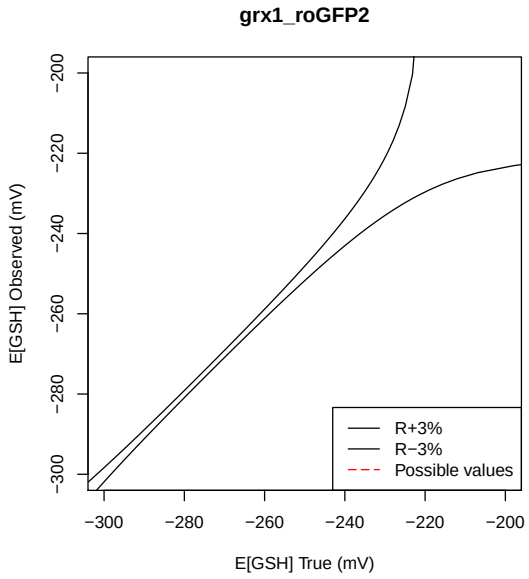


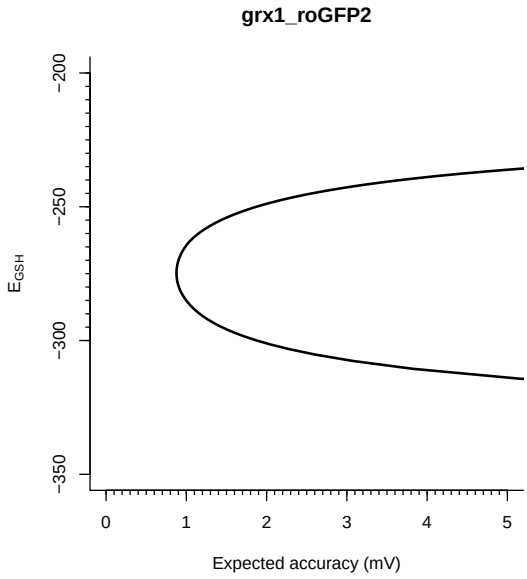



```
## [1] "roGFP1_R12_empirical"
## [1] "grx1_roGFP2"
```









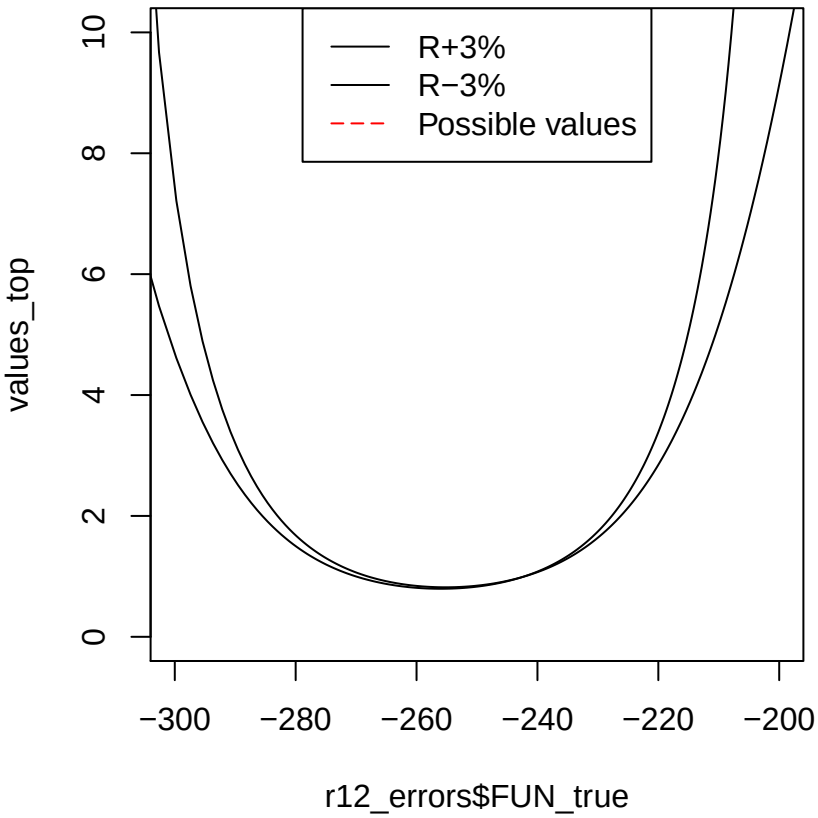
Extra

```
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M

r12_errors$lower_error_neg <- (r12_errors$lower_error * -1)

r12_errors$lower_value <- (r12_errors$FUN_true + r12_errors$lower_error_neg)
r12_errors$upper_value <- (r12_errors$FUN_true + r12_errors$upper_error)

r12_trunc <- data.frame(true = rep(r12_errors$FUN_true, 2),
                        observed = c(r12_errors$lower_value, r12_errors$upper_value),
                        error = c(r12_errors$lower_error_neg, r12_errors$upper_error),
                        absError = c(r12_errors$lower_error, r12_errors$upper_error),
```

```
                        maxAbsError = rep(r12_errors$max_abs_error, 2),
                        type = c(rep("lower", length(r12_errors$FUN_true)), rep("upper", length(r12_er
```

```
# par(pty = 's', mfrow = c(1,1), mai = c(0.8, 0.8, 0.4, 0.8))
# values_actual <- r12_errors$FUN_true
# values_top <- r12_errors$upper_error
# values_bottom <- r12_errors$lower_error_neg
#
# plot(values_top ~ r12_errors$FUN_true , type = 'l',
#      ylim = c(-20, 20), xlim = c(-300, -200), lwd = 1)
# points(values_bottom ~r12_errors$FUN_true, type = "l", lwd = 1)
# limits <- c(5, 435)
# polygon(c(values_actual[limits[1]:limits[2]], rev(values_actual[limits[1]:limits[2]])), y = c(values_
# legend("top", legend = c("R+3%", "R-3%", "Possible values"), col = c('black', 'black', rgb(1,0,0,alph
```

```
par(pty = 's', mfrow = c(1,1), mai = c(0.8, 0.8, 0.4, 0.8))
values_actual <- r12_errors$FUN_true
values_top <- r12_errors$upper_error
values_bottom <- r12_errors$lower_error
values_max = r12_errors$max_abs_error

plot(values_top ~ r12_errors$FUN_true , type = 'l',
     ylim = c(0, 10), xlim = c(-300, -200), lwd = 1)
points(values_bottom ~r12_errors$FUN_true, type = "l", lwd = 1)
limits <- c(5, 439)
# polygon(c(values_actual[limits[1]:limits[2]], rev(values_actual[limits[1]:limits[2]])), y = c(values_
legend("top", legend = c("R+3%", "R-3%", "Possible values"), col = c('black', 'black', rgb(1,0,0,alpha =
```

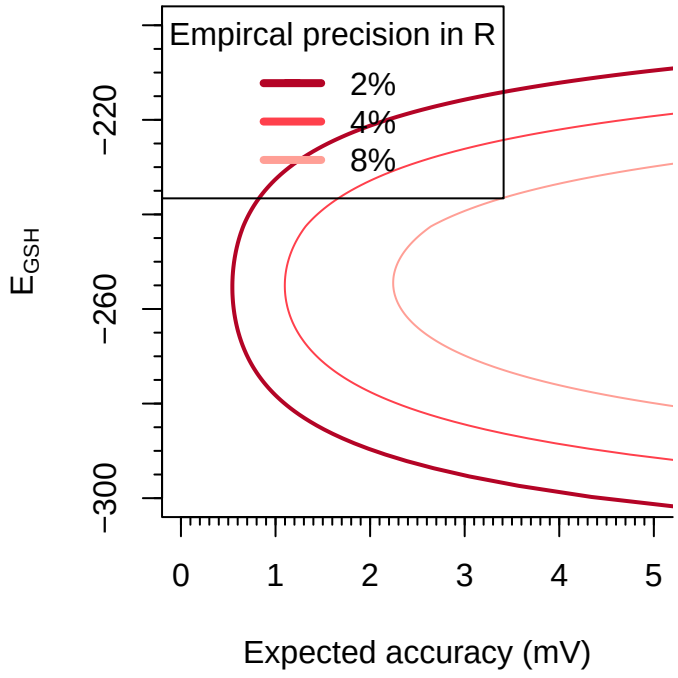



```
# Define coolwarm color gradient
coolwarm <- colorRampPalette(c(
  rgb( 60, 81,198, maxColorValue = 255),
  rgb( 61, 86,203, maxColorValue = 255),
  rgb( 63, 91,207, maxColorValue = 255),
  rgb( 65, 96,212, maxColorValue = 255),
  rgb( 67,101,216, maxColorValue = 255),
  rgb( 69,106,220, maxColorValue = 255),
  rgb( 71,111,224, maxColorValue = 255),
  rgb( 74,116,227, maxColorValue = 255),
  rgb( 76,121,231, maxColorValue = 255),
  rgb( 79,127,233, maxColorValue = 255),
  rgb( 83,132,236, maxColorValue = 255),
  rgb( 86,137,238, maxColorValue = 255),
  rgb( 90,143,240, maxColorValue = 255),
  rgb( 94,148,242, maxColorValue = 255),
  rgb( 99,153,243, maxColorValue = 255),
  rgb(103,159,244, maxColorValue = 255),
  rgb(109,164,244, maxColorValue = 255),
  rgb(114,169,245, maxColorValue = 255),
  rgb(120,174,245, maxColorValue = 255),
  rgb(126,179,245, maxColorValue = 255),
  rgb(132,184,244, maxColorValue = 255),
```

```
  rgb(139,188,243, maxColorValue = 255),
  rgb(146,193,242, maxColorValue = 255),
  rgb(153,197,241, maxColorValue = 255),
  rgb(161,201,239, maxColorValue = 255),
  rgb(169,205,238, maxColorValue = 255),
  rgb(177,209,236, maxColorValue = 255),
  rgb(186,212,233, maxColorValue = 255),
  rgb(195,215,231, maxColorValue = 255),
  rgb(204,218,229, maxColorValue = 255),
  rgb(214,221,226, maxColorValue = 255),
  rgb(223,223,223, maxColorValue = 255),
  rgb(235,218,215, maxColorValue = 255),
  rgb(245,213,207, maxColorValue = 255),
  rgb(255,206,198, maxColorValue = 255),
  rgb(255,192,184, maxColorValue = 255),
  rgb(255,180,170, maxColorValue = 255),
  rgb(255,168,159, maxColorValue = 255),
  rgb(255,157,148, maxColorValue = 255),
  rgb(255,147,139, maxColorValue = 255),
  rgb(255,138,130, maxColorValue = 255),
  rgb(255,129,122, maxColorValue = 255),
  rgb(255,121,115, maxColorValue = 255),
  rgb(255,113,109, maxColorValue = 255),
  rgb(255,105,103, maxColorValue = 255),
  rgb(255, 98, 98, maxColorValue = 255),
  rgb(255, 91, 93, maxColorValue = 255),
  rgb(255, 85, 89, maxColorValue = 255),
  rgb(255, 78, 85, maxColorValue = 255),
  rgb(255, 72, 81, maxColorValue = 255),
  rgb(255, 67, 78, maxColorValue = 255),
  rgb(255, 61, 75, maxColorValue = 255),
  rgb(255, 56, 72, maxColorValue = 255),
  rgb(255, 50, 70, maxColorValue = 255),
  rgb(255, 45, 67, maxColorValue = 255),
  rgb(255, 41, 65, maxColorValue = 255),
  rgb(252, 35, 62, maxColorValue = 255),
  rgb(242, 30, 58, maxColorValue = 255),
  rgb(233, 24, 55, maxColorValue = 255),
  rgb(223, 20, 51, maxColorValue = 255),
  rgb(212, 15, 48, maxColorValue = 255),
  rgb(202, 11, 44, maxColorValue = 255),
  rgb(191,  7, 41, maxColorValue = 255),
  rgb(180,  4, 38, maxColorValue = 255)))
```

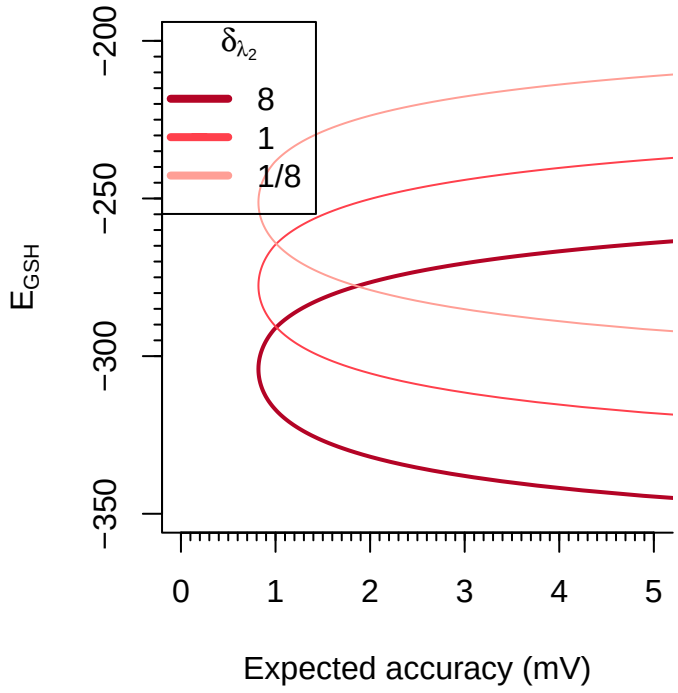
```
par(pty = 's', mfrow = c(1,1))
colors <- rev(coolwarm(6))

r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
plot(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', xlim = c(0, 5), ylim = c(-300, -200),
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
points(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', col = colors[2])
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
points(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', col = colors[3])
```

```
axis(side = 1, at = seq(0, 5, by = 0.1),
     labels = FALSE, tcl = -0.2)
axis(side = 2, at = seq(-300, -200, by = 5),
     labels = FALSE, tcl = -0.2)

legend("topleft", title = "Empircal precision in R", xpd=TRUE, c("2%", "4%", "8%"), pch = "-", lwd = 4,
```

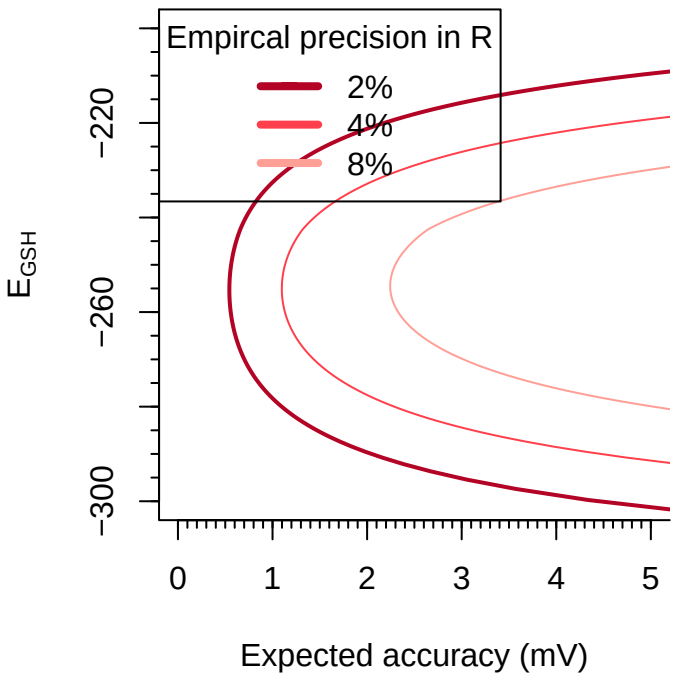



```
par(pty = 's', mfrow = c(1,1))
colors <- rev(coolwarm(6))

roGFP1_R12_empirical_sensor@delta = 8
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
plot(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', xlim = c(0, 5), ylim = c(-350, -200),
roGFP1_R12_empirical_sensor@delta = 1
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
points(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', col = colors[2])
roGFP1_R12_empirical_sensor@delta = 0.125
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
points(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', col = colors[3])
roGFP1_R12_empirical_sensor@delta = 0.171

axis(side = 1, at = seq(0, 5, by = 0.1),
     labels = FALSE, tcl = -0.2)
axis(side = 2, at = seq(-300, -200, by = 5),
     labels = FALSE, tcl = -0.2)
```

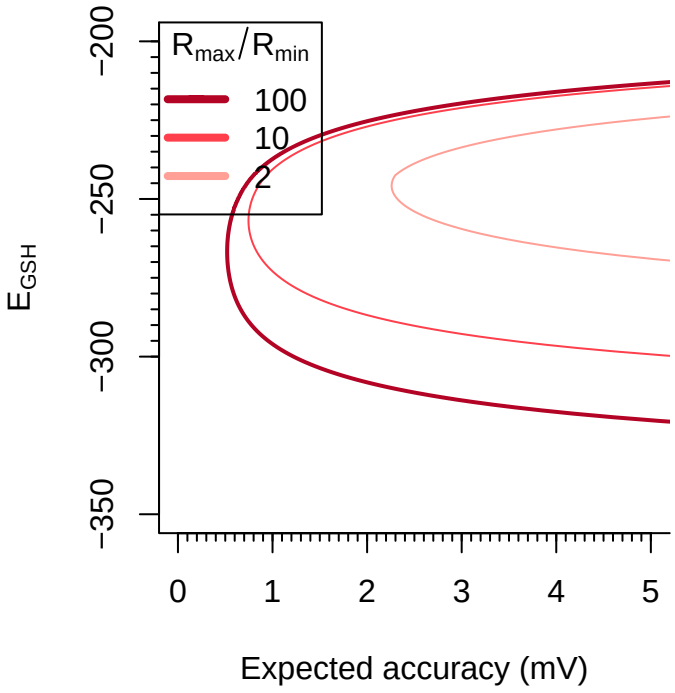
```
legend("topleft", title = expression(delta[lambda[2]]), xpd=TRUE, c("8", "1", "1/8"), pch = "-", lwd = 4
```




```
par(pty = 's', mfrow = c(1,1))
colors <- rev(coolwarm(6))

r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
plot(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', xlim = c(0, 5), ylim = c(-300, -200), 
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
points(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', col = colors[2])
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
points(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', col = colors[3])

axis(side = 1, at = seq(0, 5, by = 0.1),
     labels = FALSE, tcl = -0.2)
axis(side = 2, at = seq(-300, -200, by = 5),
     labels = FALSE, tcl = -0.2)

legend("topleft", title = "Empircal precision in R", xpd=TRUE, c("2%", "4%", "8%"), pch = "-", lwd = 4,
```




```
par(pty = 's', mfrow = c(1,1))
colors <- rev(coolwarm(6))

# Delta 1 of 8
roGFP1_R12_empirical_sensor@Rmax = 46.78
roGFP1_R12_empirical_sensor@Rmin = 1
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
plot(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', xlim = c(0, 5), ylim = c(-350, -200),

roGFP1_R12_empirical_sensor@Rmax = 10
roGFP1_R12_empirical_sensor@Rmin = 1
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
points(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', col = colors[2])
roGFP1_R12_empirical_sensor@Rmax = 2
roGFP1_R12_empirical_sensor@Rmin = 1
r12_errors <- getErrorTable(roGFP1_R12_empirical_sensor, R = getR(roGFP1_R12_empirical_sensor), Error_M
points(r12_errors$FUN_true ~ r12_errors$max_abs_error, type = 'l', col = colors[3])
roGFP1_R12_empirical_sensor@Rmax = 5.207
roGFP1_R12_empirical_sensor@Rmin = 0.667

axis(side = 1, at = seq(0, 5, by = 0.1),
     labels = FALSE, tcl = -0.2)
axis(side = 2, at = seq(-300, -200, by = 5),
     labels = FALSE, tcl = -0.2)

legend("topleft", title = expression(R[max]/R[min]), xpd=TRUE, c("100", "10", "2"), pch = "-", lwd = 4,
```

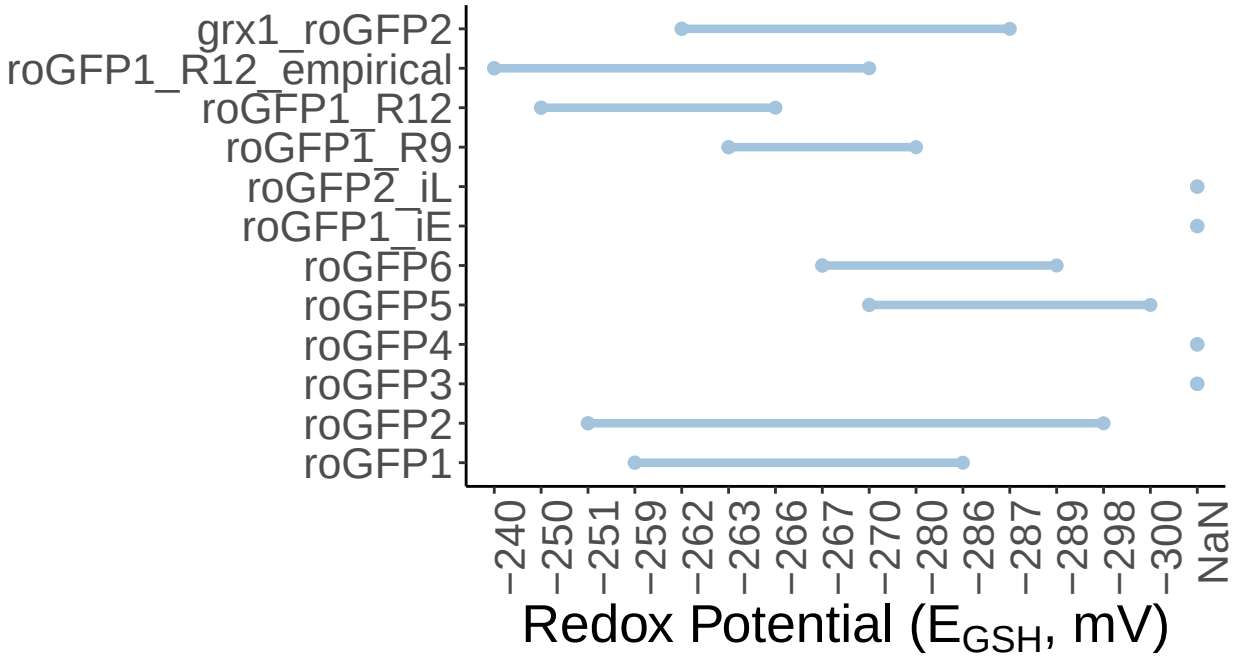



```
# error_model <- function(x) {return(0.025*x)}
# value <- -270
#
# plot(R12_error$FUN_true ~ R12_error$max_abs_error,
#      type = "l", ylim = c(value-1, value+1), xlim = c(0, 10))
#
# for (sensorName in sensorList) {
#     sensor <- get(sensorName)
#     sensorName <- str_replace(sensorName, "_sensor", "")
#     error_data <- getErrorTable(sensor, R = getR(sensor),
#                                 FUN = getE, Error_Model = error_model)
#
#     points(error_data$FUN_true ~ error_data$max_abs_error, type = "l")
#
#     print(sensorName)
#     print(subset(error_data, abs(error_data$FUN_true - value) < 0.1)$max_abs_error[1])
# }
```

For figures

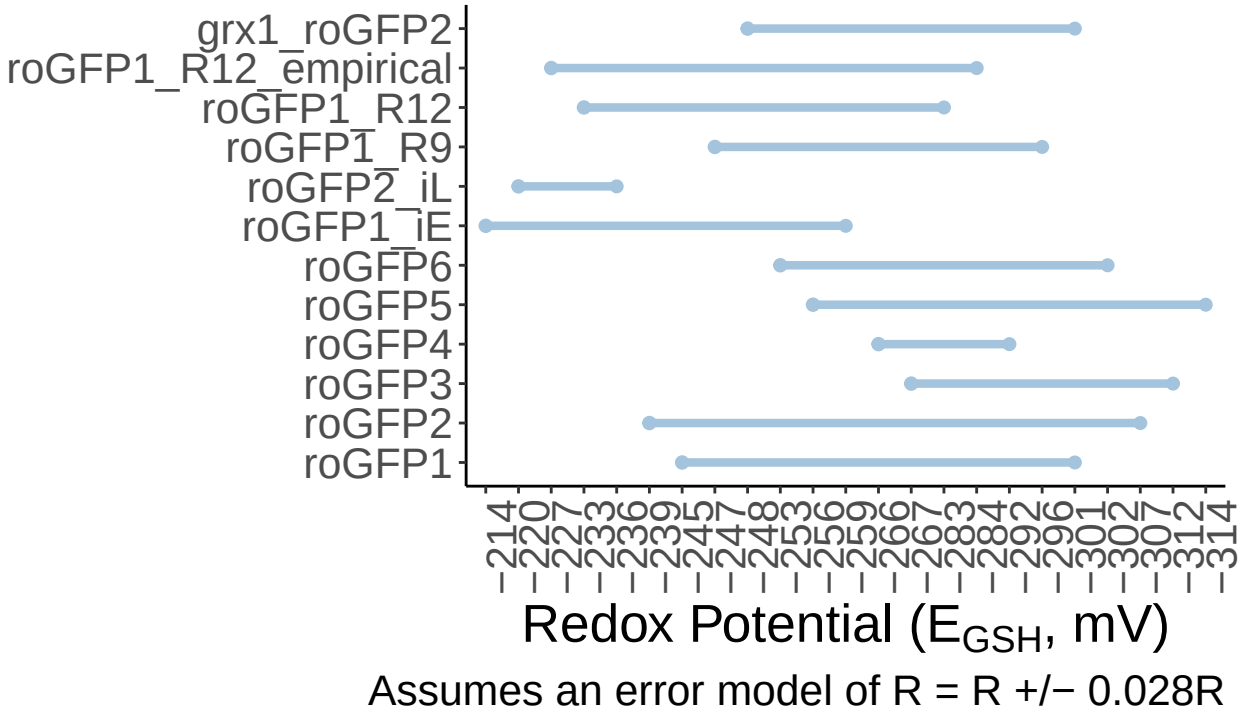
```
# For figures!
acceptable_error <- 1
error_model <- function(x) {return(0.028*x)}

minMaxMatrix <- c()
```

```
for (sensorName in sensorList) {
    sensor <- get(sensorName)
    sensorName <- str_replace(sensorName, "_sensor", "")
    error_data <- getErrorTable(sensor, R = getR(sensor),
                                FUN = getE, Error_Model = error_model)

    error_filter <- subset(error_data,
                           error_data$max_abs_error < acceptable_error)

    minimum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = min(error_filter$FUN_true))

    maximum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = max(error_filter$FUN_true))

    minMaxMatrix <- rbind(minMaxMatrix, c(sensorName, round(minimum, 0), round(maximum,0)))
}

ranges <- data.frame(minMaxMatrix)
colnames(ranges) <- c("Sensor_Name", "Minimum", "Maximum")

theme_set(theme_classic())

ranges$Sensor_Name <- factor(ranges$Sensor_Name,
                             levels=as.character(ranges$Sensor_Name))

gg <- ggplot(ranges, aes(x=Minimum, xend=Maximum,
                         y = Sensor_Name, group=Sensor_Name)) +
        geom_dumbbell(color="#a3c4dc",
                      size=1.5) +
           labs(x = expression("Redox Potential (" * E[GSH] * ", mV" * ")"),
             y=NULL,
             title="",
             caption="Assumes an error model of R = R +/- 0.028R",
             subtitle="") +
    theme(plot.title = element_text(hjust=0.5, face="bold"),
              #plot.background=element_rect(fill="#f7f7f7"),
              #panel.background=element_rect(fill="#f7f7f7"),
              panel.grid.minor=element_blank(),
              panel.grid.major.y=element_blank(),
              legend.position="top",
              panel.border=element_blank(),
          text = element_text(size = 20),
          axis.text.x = element_text(angle = 90, hjust = 1))
plot(gg)
```

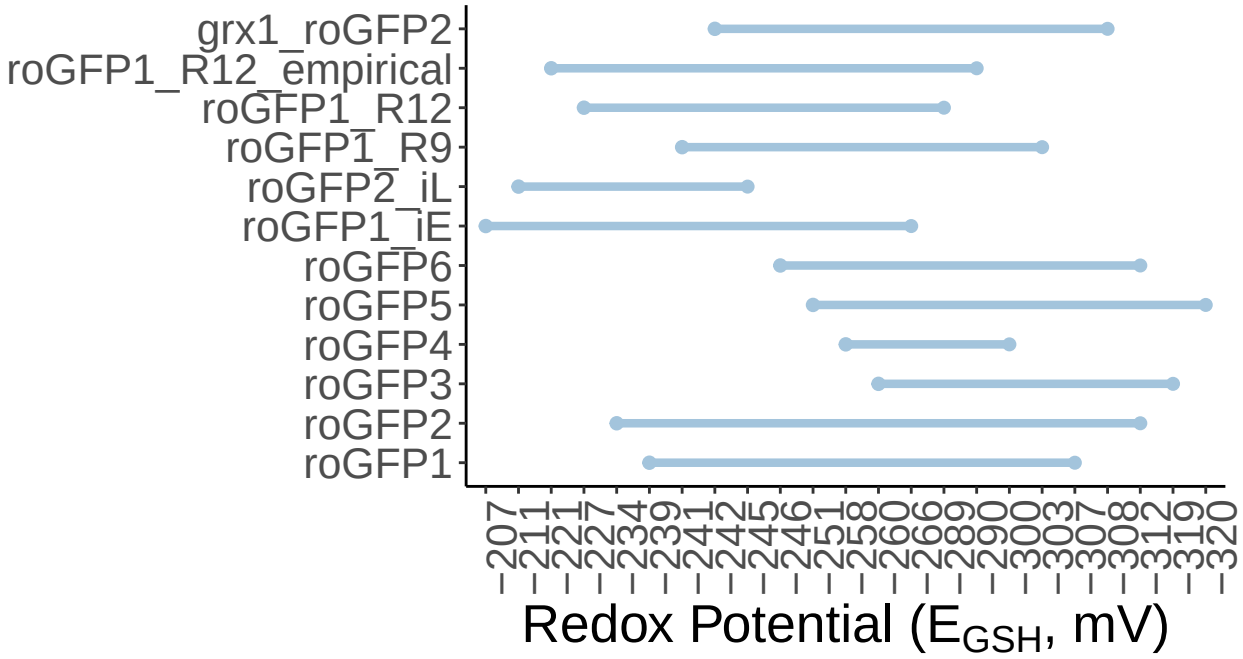



```
acceptable_error <- 2
error_model <- function(x) {return(0.028*x)}

minMaxMatrix <- c()

for (sensorName in sensorList) {
    sensor <- get(sensorName)
    sensorName <- str_replace(sensorName, "_sensor", "")
    error_data <- getErrorTable(sensor, R = getR(sensor),
                                FUN = getE, Error_Model = error_model)

    error_filter <- subset(error_data,
                           error_data$max_abs_error < acceptable_error)

    minimum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = min(error_filter$FUN_true))

    maximum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = max(error_filter$FUN_true))

    minMaxMatrix <- rbind(minMaxMatrix, c(sensorName, round(minimum, 0), round(maximum,0)))
}

ranges <- data.frame(minMaxMatrix)
colnames(ranges) <- c("Sensor_Name", "Minimum", "Maximum")
```

```r
theme_set(theme_classic())

ranges$Sensor_Name <- factor(ranges$Sensor_Name,
                             levels=as.character(ranges$Sensor_Name))

gg <- ggplot(ranges, aes(x=Minimum, xend=Maximum,
                         y = Sensor_Name, group=Sensor_Name)) +
        geom_dumbbell(color="#a3c4dc",
                      size=1.5) +
           labs(x = expression("Redox Potential (" * E[GSH] * ", mV" * ")"),
             y=NULL,
             title="",
             caption="Assumes an error model of R = R +/- 0.028R",
             subtitle="") +
    theme(plot.title = element_text(hjust=0.5, face="bold"),
              #plot.background=element_rect(fill="#f7f7f7"),
              #panel.background=element_rect(fill="#f7f7f7"),
              panel.grid.minor=element_blank(),
              panel.grid.major.y=element_blank(),
              legend.position="top",
              panel.border=element_blank(),
          text = element_text(size = 20),
          axis.text.x = element_text(angle = 90, hjust = 1))
plot(gg)
```



```r
acceptable_error <- 3
error_model <- function(x) {return(0.028*x)}

minMaxMatrix <- c()

for (sensorName in sensorList) {
    sensor <- get(sensorName)
    sensorName <- str_replace(sensorName, "_sensor", "")
    error_data <- getErrorTable(sensor, R = getR(sensor),
                                FUN = getE, Error_Model = error_model)

    error_filter <- subset(error_data,
                           error_data$max_abs_error < acceptable_error)

    minimum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = min(error_filter$FUN_true))

    maximum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = max(error_filter$FUN_true))

    minMaxMatrix <- rbind(minMaxMatrix, c(sensorName, round(minimum, 0), round(maximum,0)))
}

ranges <- data.frame(minMaxMatrix)
colnames(ranges) <- c("Sensor_Name", "Minimum", "Maximum")

theme_set(theme_classic())

ranges$Sensor_Name <- factor(ranges$Sensor_Name,
                             levels=as.character(ranges$Sensor_Name))

gg <- ggplot(ranges, aes(x=Minimum, xend=Maximum,
                         y = Sensor_Name, group=Sensor_Name)) +
        geom_dumbbell(color="#a3c4dc",
                      size=1.5) +
           labs(x = expression("Redox Potential (" * E[GSH] * ", mV" * ")"),
             y=NULL,
             title="",
             caption="Assumes an error model of R = R +/- 0.028R",
             subtitle="") +
    theme(plot.title = element_text(hjust=0.5, face="bold"),
              #plot.background=element_rect(fill="#f7f7f7"),
              #panel.background=element_rect(fill="#f7f7f7"),
              panel.grid.minor=element_blank(),
              panel.grid.major.y=element_blank(),
              legend.position="top",
              panel.border=element_blank(),
          text = element_text(size = 20),
          axis.text.x = element_text(angle = 90, hjust = 1))
plot(gg)
```



Assumes an error model of R = R +/− 0.028R

```
error_model <- function(x) {return(0.028*x)}

minMaxMatrix <- data.frame(Sensor_Name = c(),
                           Minimum = c(),
                           Maximum = c(),
                           acceptable_error = c())

for(acceptable_error in c(0.5, 1, 1.5, 2, 2.5)) {
    for (sensorName in sensorList) {
    sensor <- get(sensorName)
    sensorName <- str_replace(sensorName, "_sensor", "")
    error_data <- getErrorTable(sensor, R = getR(sensor),
                                FUN = getE, Error_Model = error_model)

    error_filter <- subset(error_data,
                           error_data$max_abs_error < acceptable_error)

    minimum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = min(error_filter$FUN_true))

    maximum <- ifelse(test = length(error_filter$FUN_true) == 0,
           yes = NaN, no = max(error_filter$FUN_true))

    minMaxMatrix <- rbind(minMaxMatrix, data.frame(Sensor_Name = sensorName,
                                          Minimum = round(minimum, 0),
                                          Maximum = round(maximum,0),
```

```
                                        acceptable_error =
                                            as.character(acceptable_error)))
    }
}

ranges <- minMaxMatrix
colnames(ranges) <- c("Sensor_Name", "Minimum", "Maximum", "acceptable_error")

ggplot() +
    geom_linerange(data = ranges, mapping=aes(x = Sensor_Name, ymin = Minimum, ymax = Maximum, lwd = 1,
                   position = position_dodge(width = 1)) +
    scale_y_continuous(c(-240, -300)) +
    coord_flip()
```

```
## Warning: Removed 18 rows containing missing values (geom_linerange).
```