

# LabVIEW Units— Better than Darren Thinks They Are

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STRAVARO LLC

NI CONNECT 2024

# #OurGiantsAreFemale

## Cole Brauer

Skipper of First Light

First US woman to sail solo around the world

Finished 2<sup>nd</sup> in Global Solo Challenge 2023-2024

- Unassisted, non-stop southern ocean race starting/ending in Spain
- Only woman and youngest of 16 competitors
- Finished in 130 days (40-ft class record)

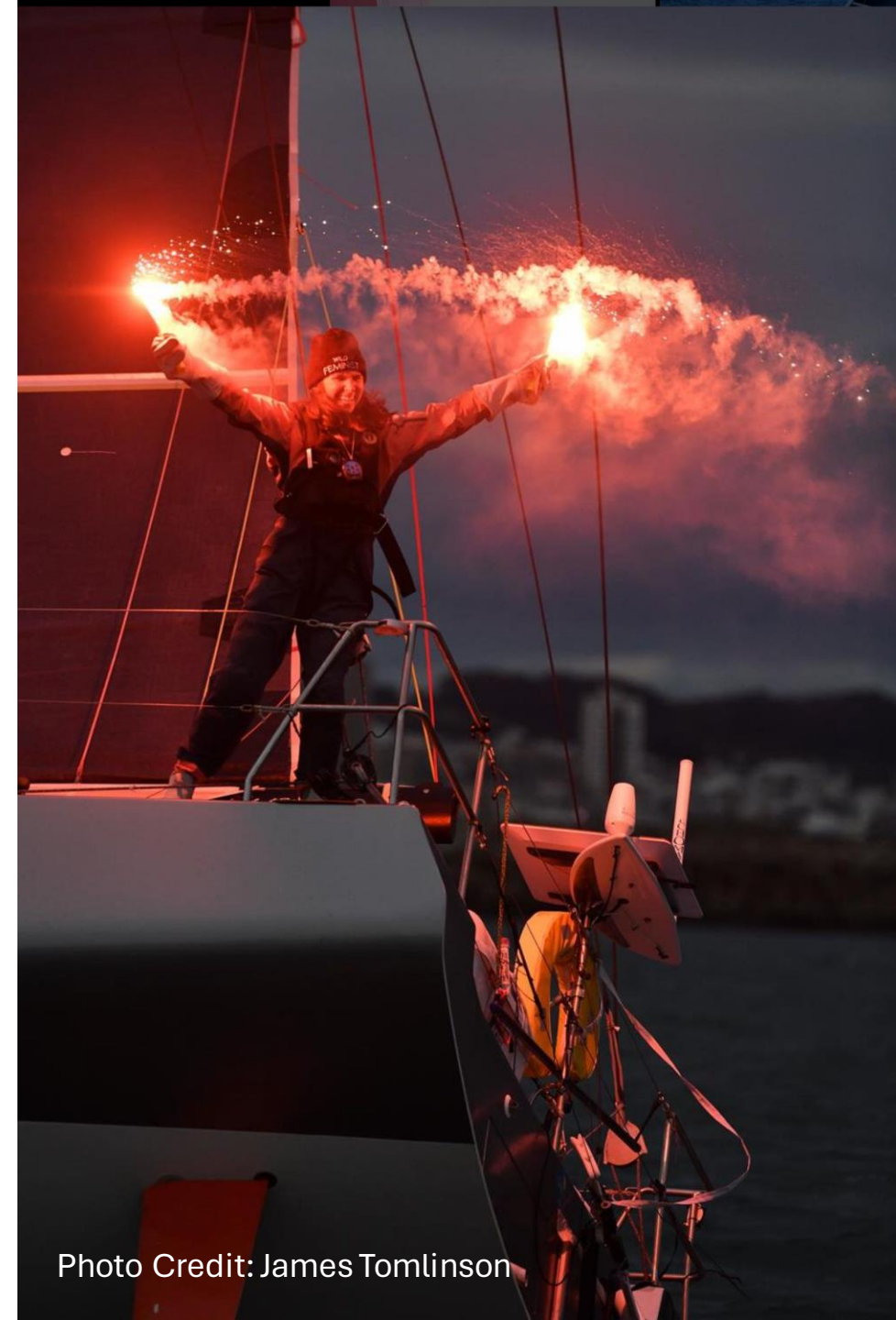
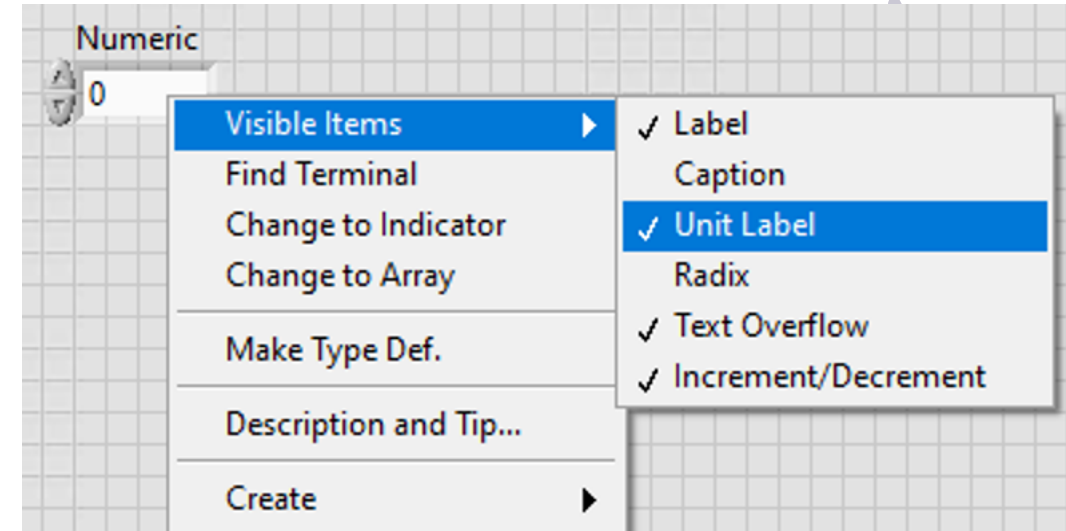


Photo Credit: James Tomlinson

# What are LabVIEW Units?

- A way to associate physical units with numeric data in LabVIEW
- Based on the seven SI Units

Can you name all seven?





# International System of Units (SI)

## Seven SI Units

- Length—meter (m)
- Time—seconds (s)
- Amount of substance—mole (mol)
- Electric current—ampere (A)
- Temperature—kelvin (K)
- Luminous intensity—candela (cd)
- Mass—kilogram (kg)



# Derived and Related Units

- Inch (in) = 2.54 cm
- Hertz (Hz) = 1/s
- Velocity = m/s (or mi/h or mm/ms, etc.)
- Volt (V) =  $\text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$
- Curie (Ci) = decay of one gram of radium per second =  $3.7 \times 10^{10}$  Hz

# Part of the data type (Type Descriptor)

Ci / V DBL



# SI prefixes

## Prefixes

yotta (Y)	$10^{24}$
zetta (Z)	$10^{21}$
exa (E)	$10^{18}$
peta (P)	$10^{15}$
tera (T)	$10^{12}$
giga (G)	$10^9$
mega (M)	$10^6$
kilo (k)	$10^3$
hecto (h)	$10^2$
deka (da)	$10^1$

## Prefixes

deci (d)	$10^{-1}$
centi (c)	$10^{-2}$
milli (m)	$10^{-3}$
micro (u)	$10^{-6}$
nano (n)	$10^{-9}$
pico (p)	$10^{-12}$
femto (f)	$10^{-15}$
atto (a)	$10^{-18}$
zepto (z)	$10^{-21}$
yocto (y)	$10^{-24}$

# Demo

- Simple m/s example
- Show that m+s doesn't work
- Show runtime compatible units
- Show SI notation and units





# When Do I Use Units?

I **consider** using them whenever I'm doing math on physical values

- Example: Computing velocity from distance and time
- Mixing imperial and metric systems
- Tip: Clearly define boundaries around where you will use units

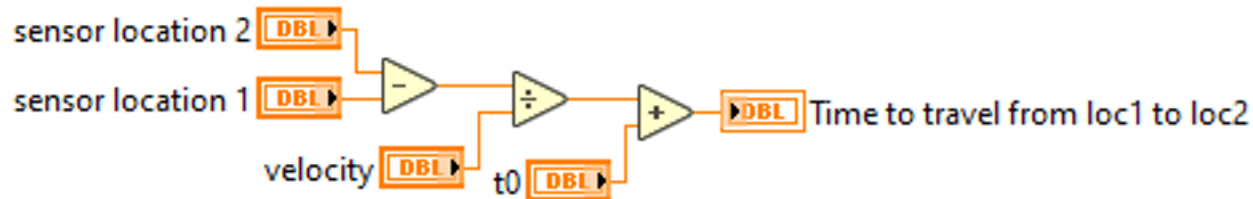
Use “convert units” at those boundaries.



# Examples: time to travel a distance

$$\text{result} = ((((\text{loc2} - \text{loc1}) * 25.4) / \text{velocity}) * 80) + \text{initialTicks};$$

*loc1 and loc2 in mm, velocity in inches/ $\mu$ s, 80 MHz ticks*



sensor location 2	3000 mm
sensor location 1	1000 mm
velocity	5 in/us
t0	0 s
Time to travel from loc1 to loc2	
15.748 us	

# Example: Depth of Field

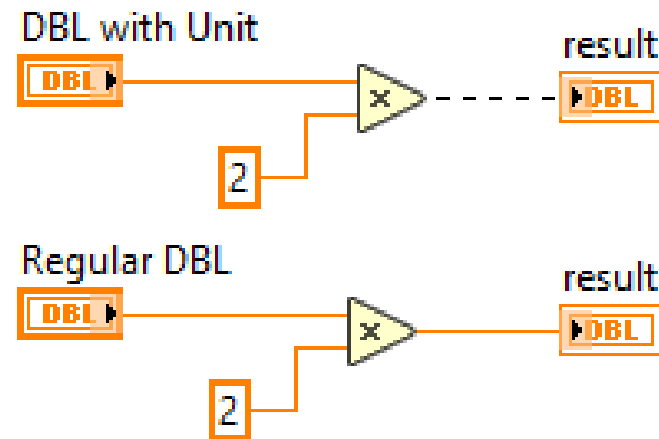


# Problems with Units



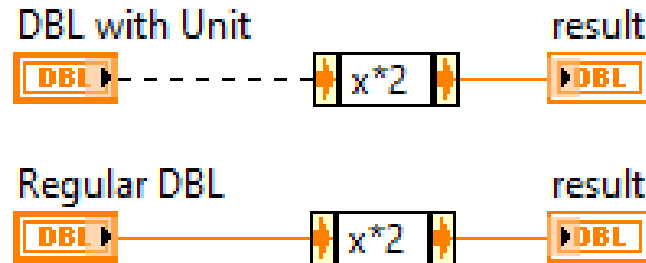
# Darren's Feedback About Units (1 of 3)

- **If you make one thing a unit, then everything has to be a unit** - I want to take my length in meters and multiply by 2? Better make sure that indicator is in meters too, or your wire will break:



# Darren's Feedback About Units (2 of 3)

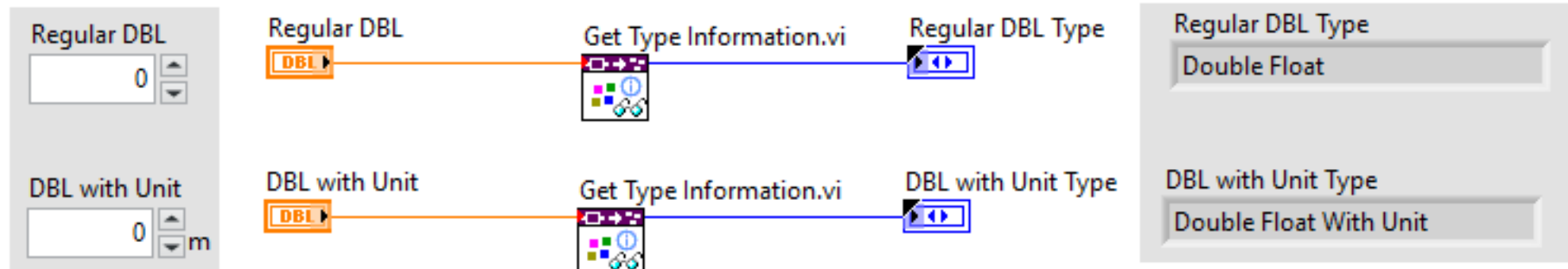
- **Some features just don't support units** - The Expression Node is the first one I thought of, but I know there are others:





# Darren's Feedback About Units (3 of 3)

- Many VI-based tools out there completely neglect unit-based data types, which means they likely function incorrectly whenever a unit-based type is encountered.



# Brian's Wishlist

- Allow for user-defined units. In particular, allow for non-SI-derived units. If someone wants to have a unit of “sheep”, then let them define it
- Allow for non-linear units, such as decibels
- Create a runtime Unit API. Almost everything is predetermined at compile time, with the one exception being that you can change the unit label to a compatible unit on the front panel while a VI is running. It'd be valuable to let users do richer and more flexible unit conversion if you could call the unit subsystem as an API from the diagram.



# Resources

- <https://stravaro.com/2021/07/labview-units-part-1/>
- <https://stravaro.com/2021/07/labview-units-part-2/>