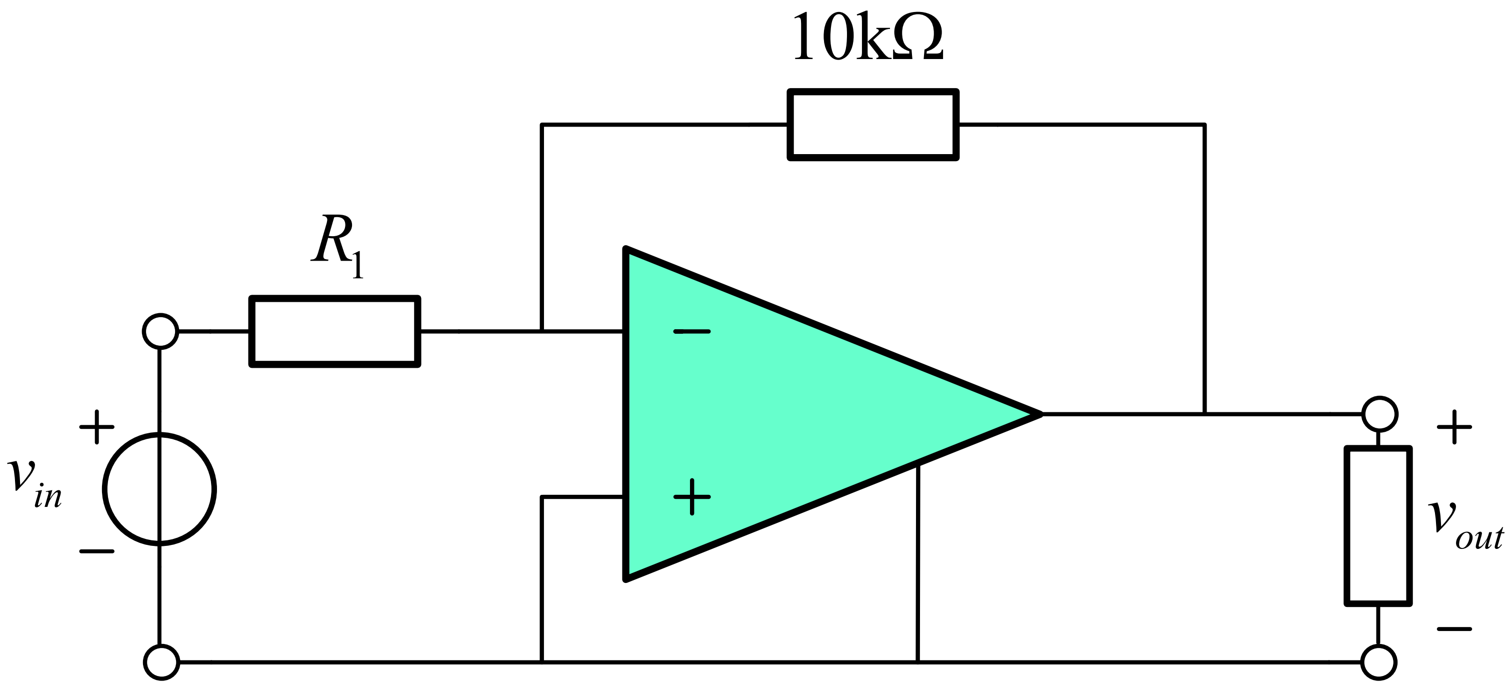
# Electronics Lecture 1

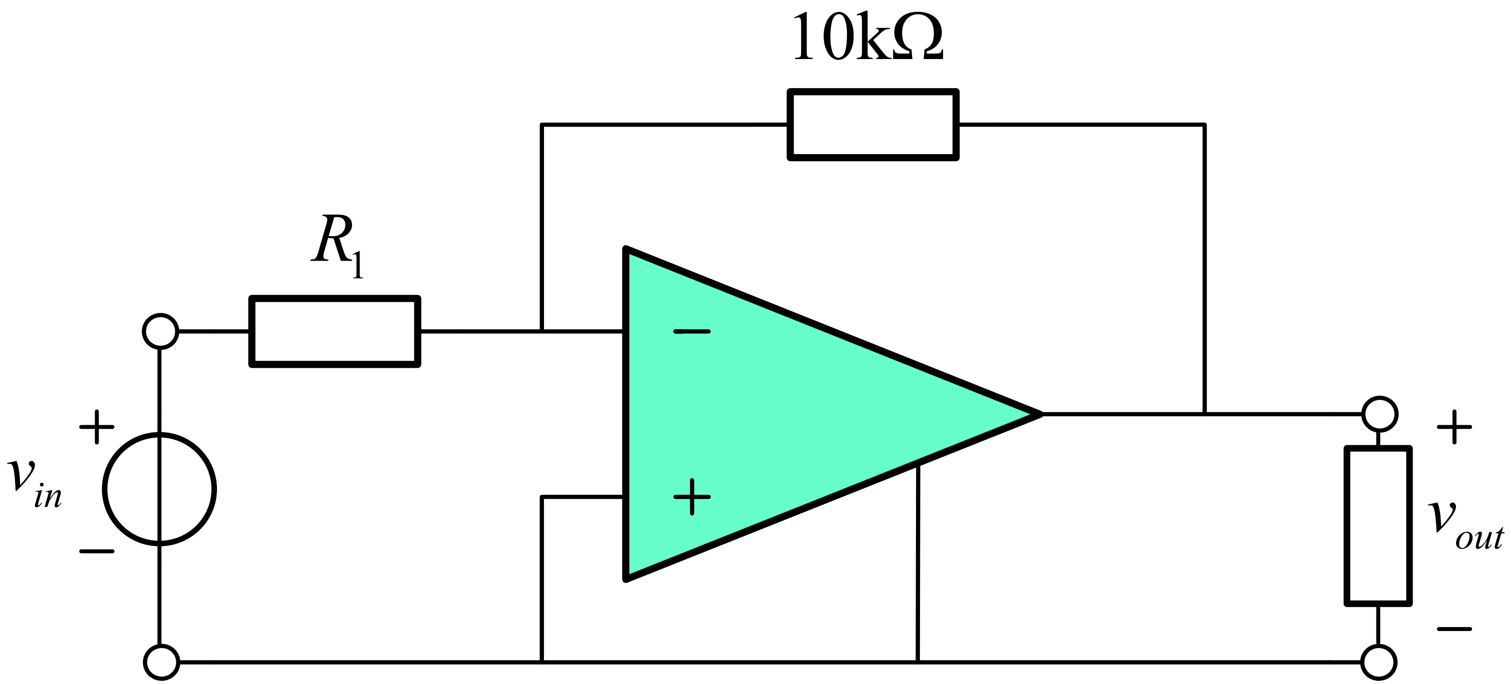
# An amplifier




What type of amplifier is this?

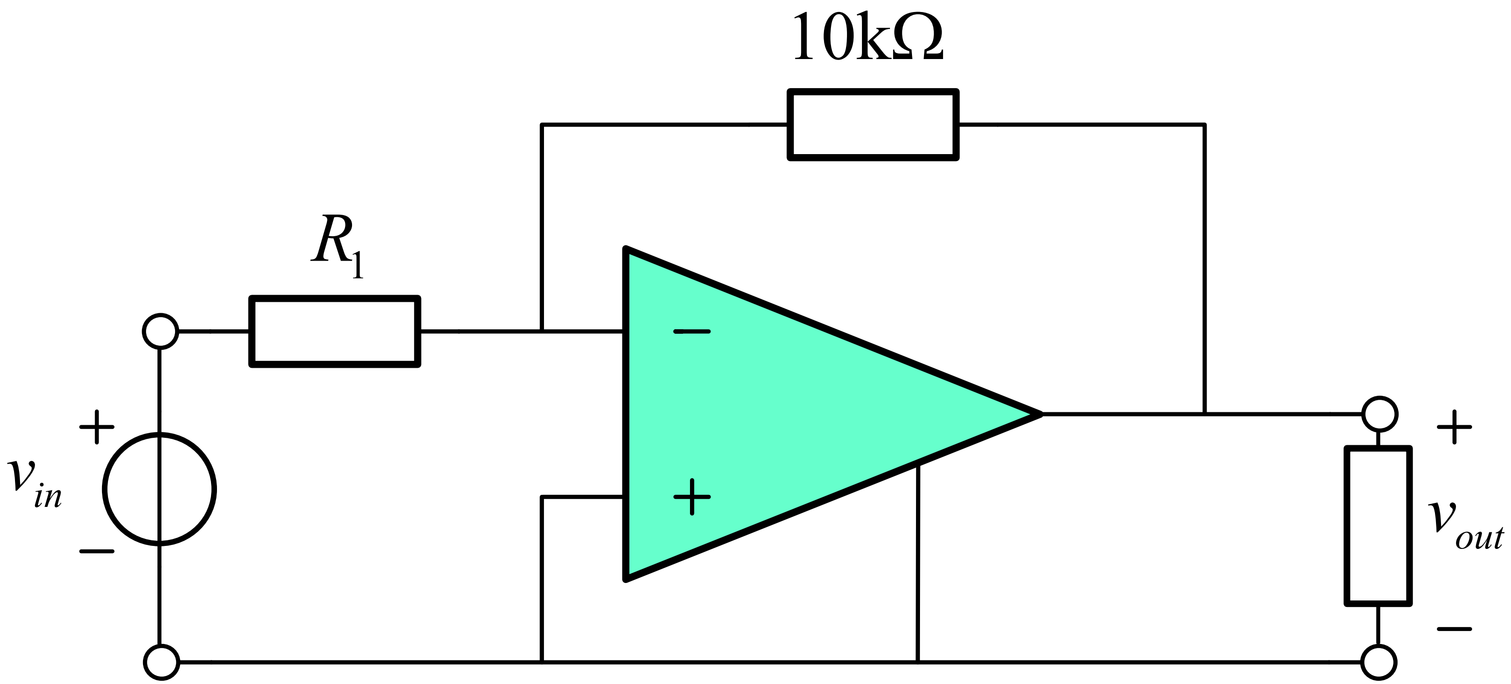
When the gain is -10, what is the value of $R_1$?

# Another amplifier



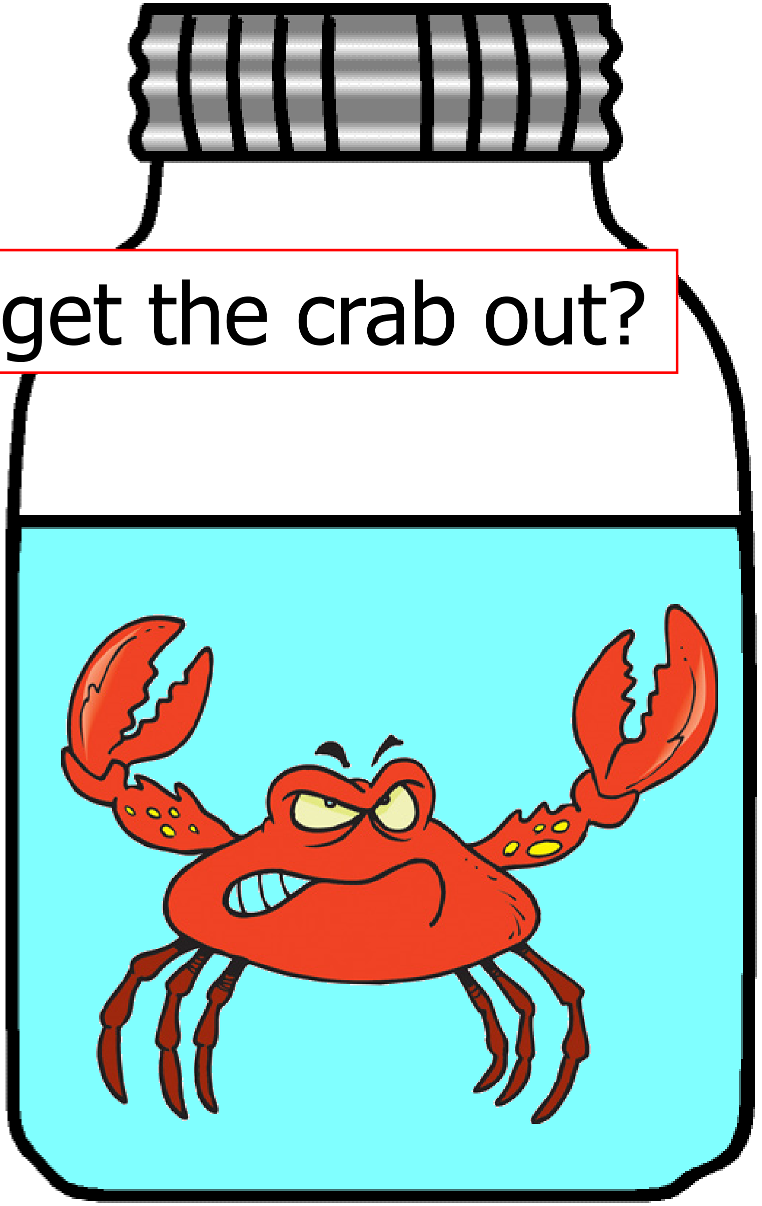

When the gain is -100, what is the value of $R_1$?

# And another amplifier



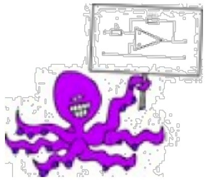

When the gain is -1, what is the value of $R_1$?

How do you get the crab out?

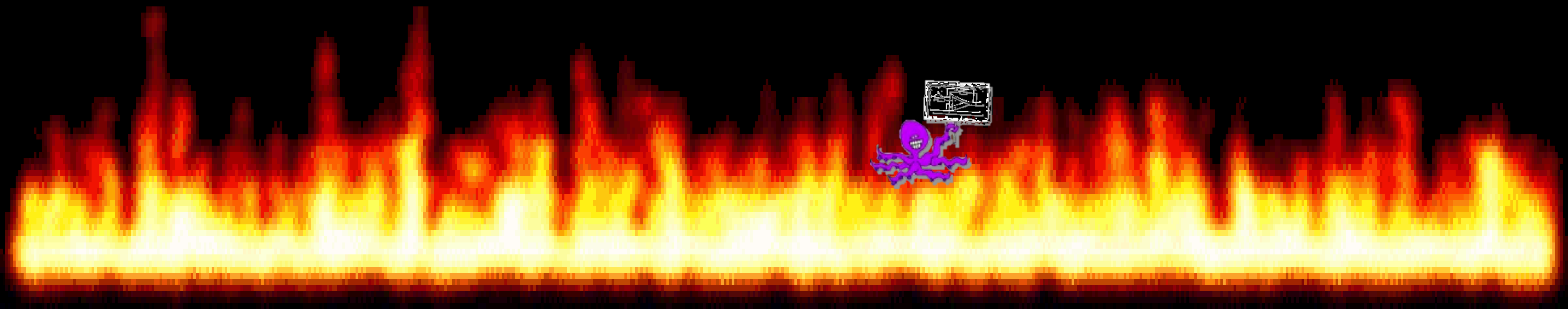


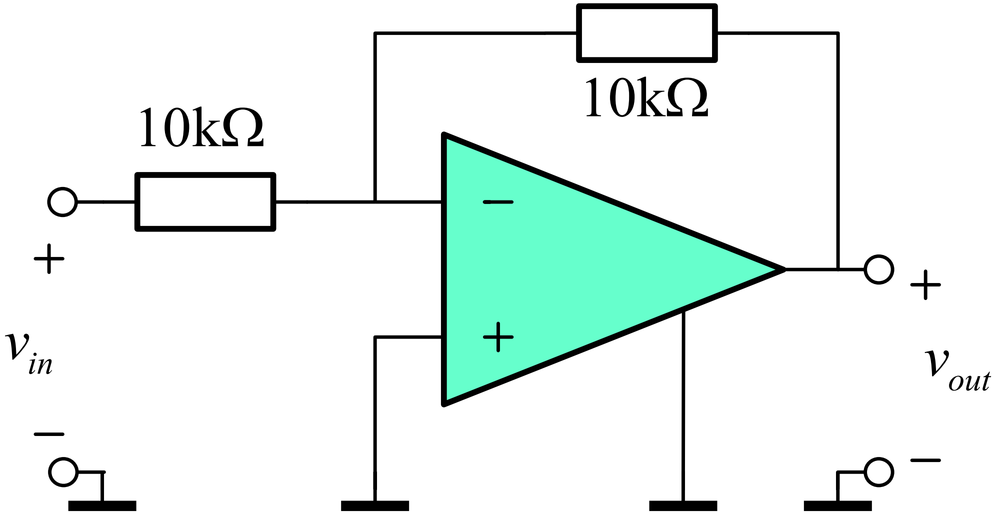
https://www.youtube.com/watch?v=V6mtZSzYeM0

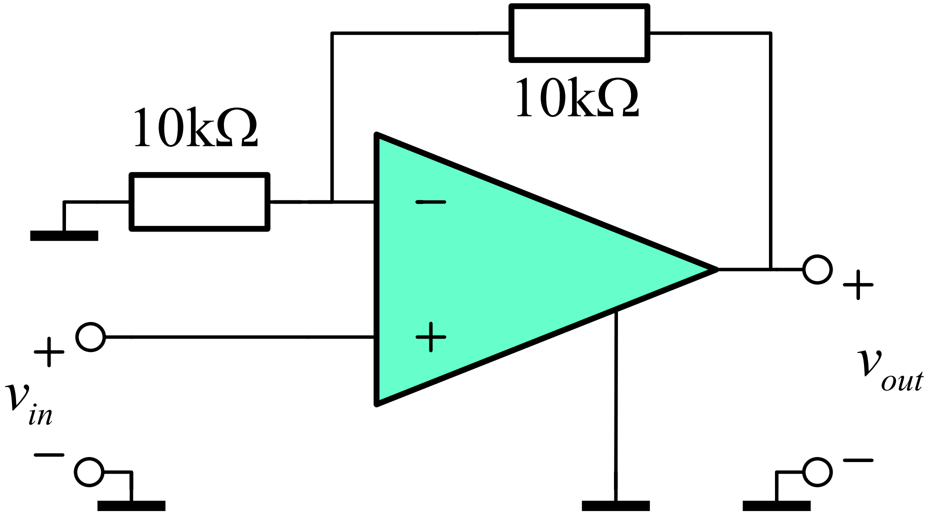
# Why?

How? 

# Why?






The gain is

# Design methodology

"There has never been a **better time** to be an **engineer** with **special skills** or the right education,

because these people can **use technology** to **create** and capture value."

"However,

there has never been a **worse time** to be an **engineer** with **only "ordinary" skills** and abilities.

Computers, virtual assistants and other **thinking machines are acquiring these skills** and abilities at an extraordinary rate."

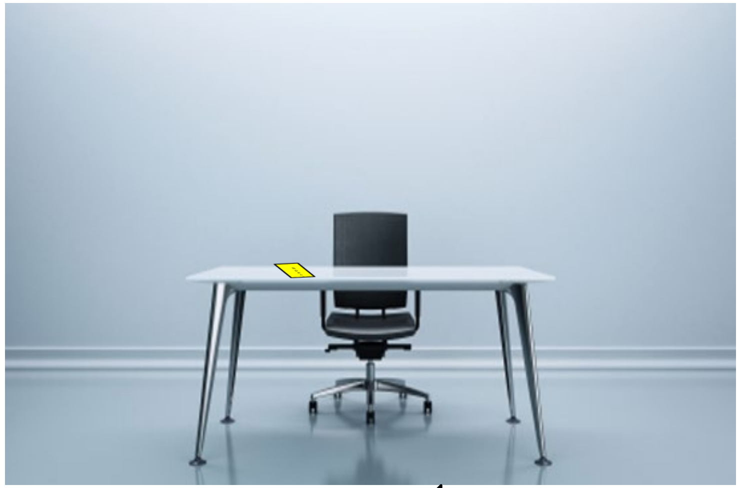
*Brynjolfsson and McAfee (2014)*

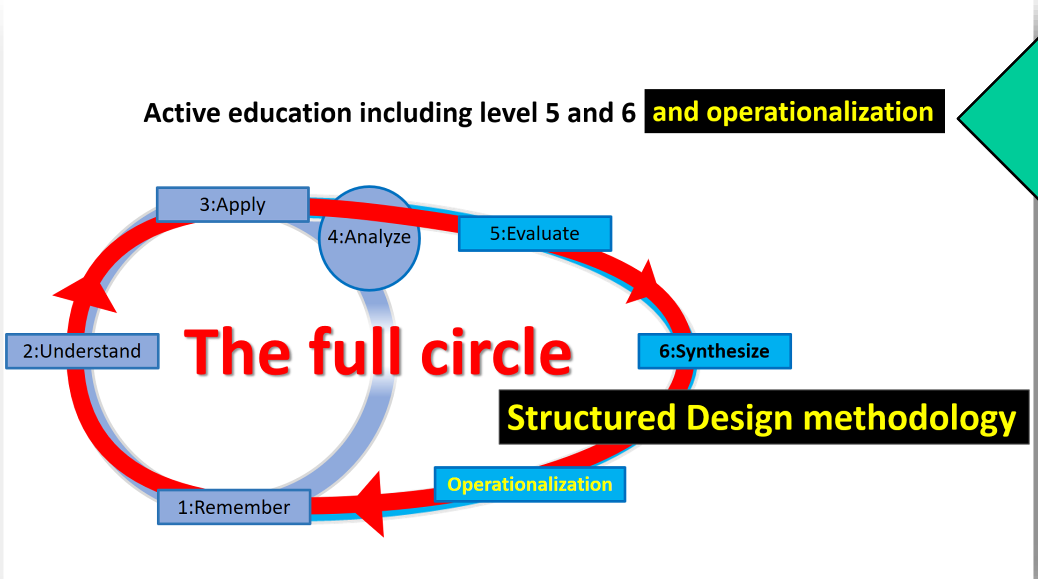
# There are specifications

There is **no** circuit, so:

**No** simulations to “optimize”

**No** “tweaking” of existing hardware

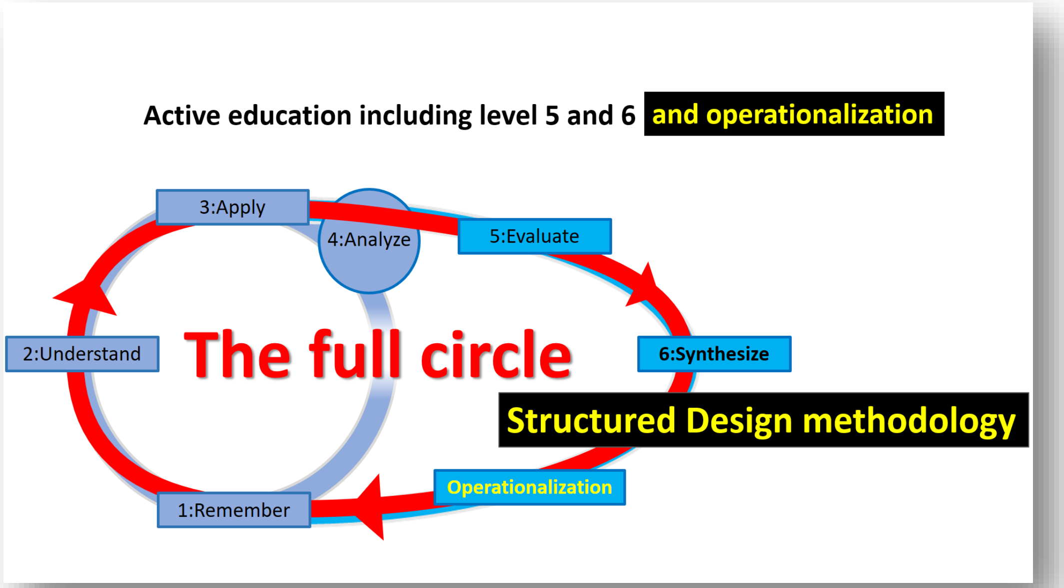




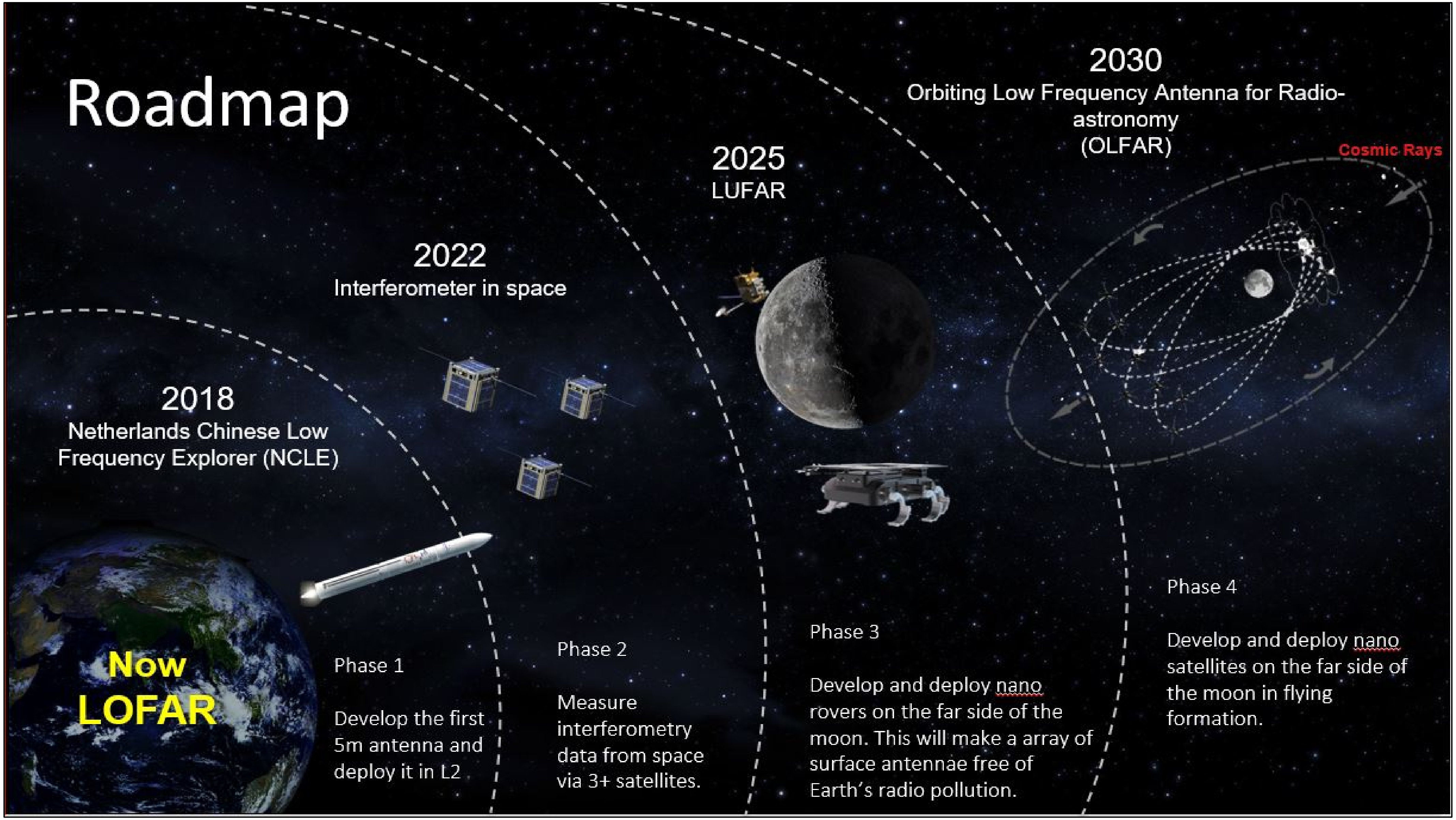

***Design Example***

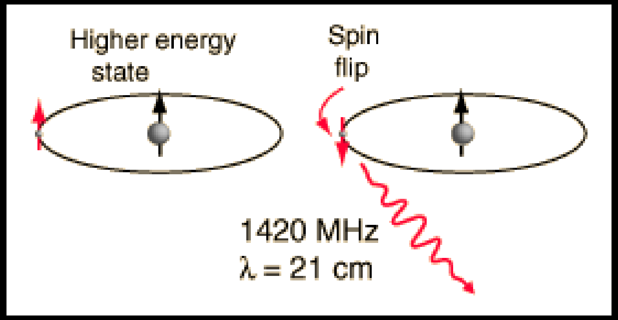
***Design Assignment***

# The design example



# Our Customer: Low Frequency Radio Astronomers

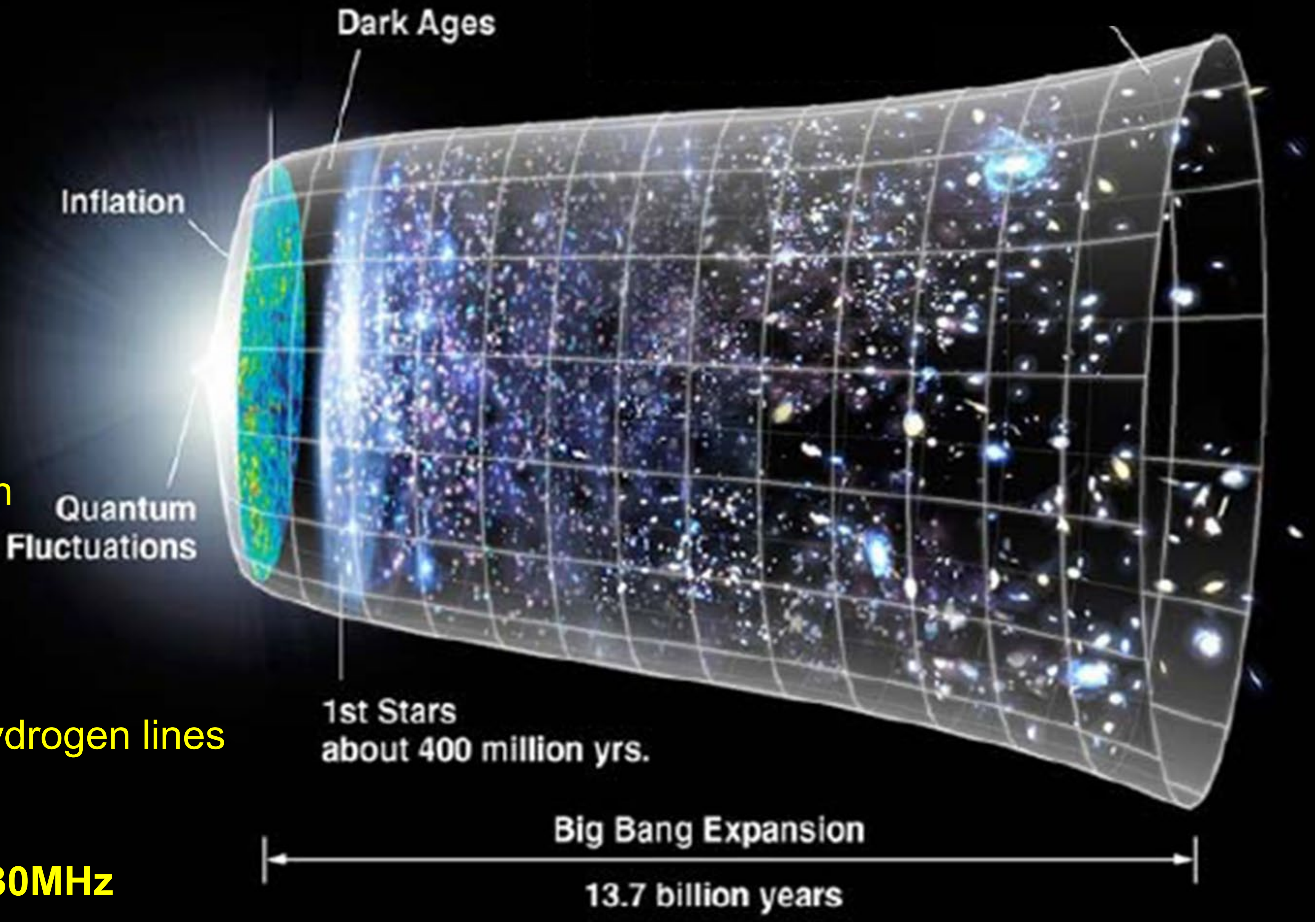




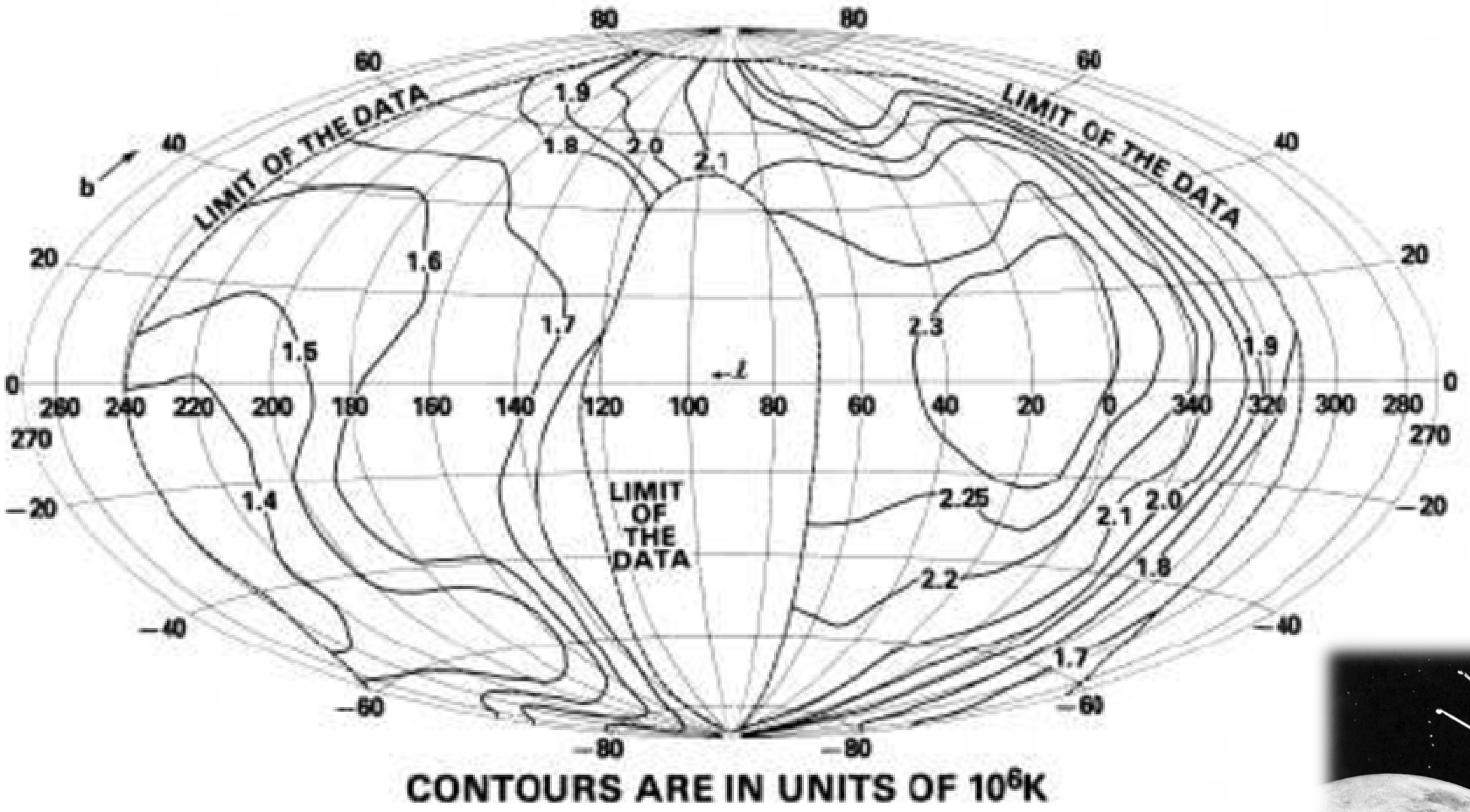

**“Hydrogen line” at 1420MHz**
Expanding universe:
Objects move away
**Red-shift**: frequency goes down

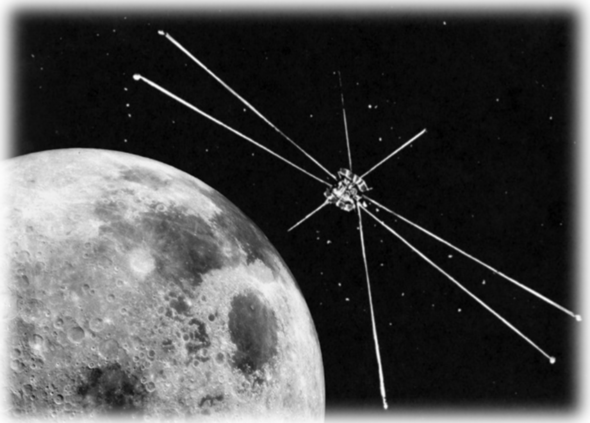
Looking deeper in space
and deeper into the past
means:
Looking for largely redshifted hydrogen lines

**OLFAR and LUFAR: 30kHz – 30MHz**



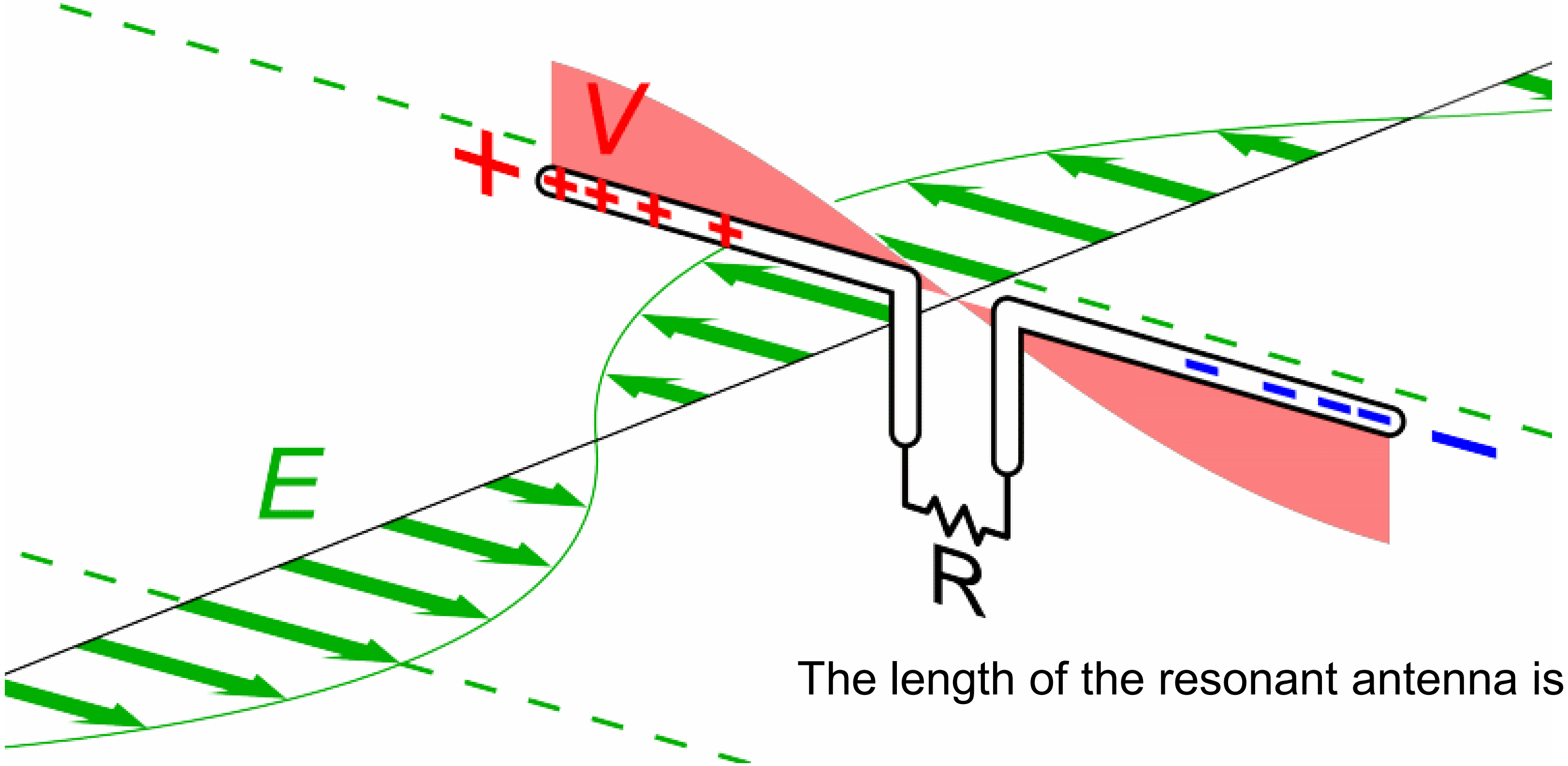
# Sky at **4.7MHz**



RAE-2 all-sky map of the galaxy at 4.70 MHz by J. C. Novaco & L. W. Brown (1978) [2]

# A resonant antenna




The length of the resonant antenna is ½λ (λ = wavelength)

OLFAR and LUFAR: 30kHz – 30MHz

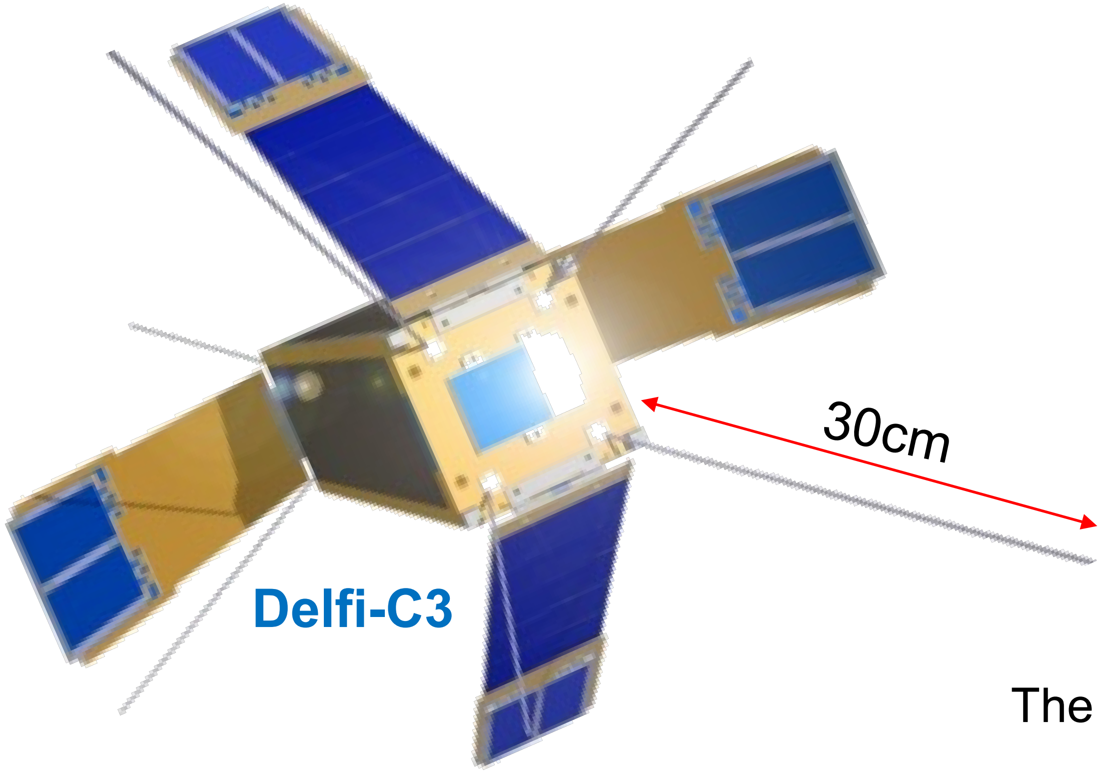
OLFAR and LUFAR: **λ≈10km** – λ≈10m

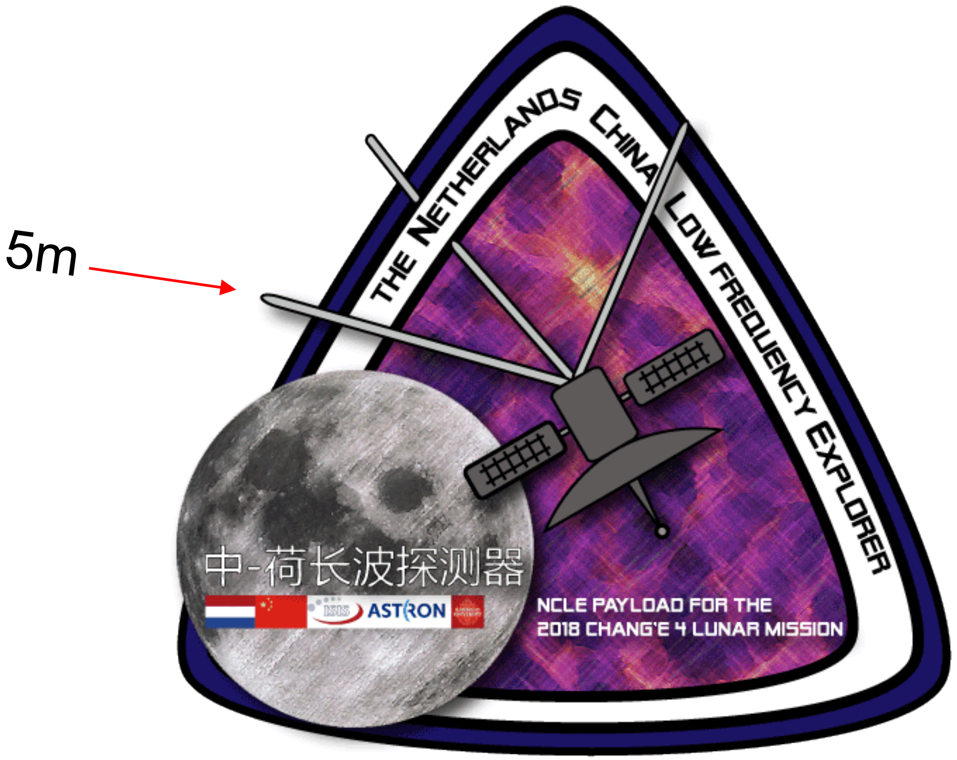
(RAE1, 4.7MHz: λ≈64m)



https://en.wikipedia.org/wiki/Antenna_(radio)

# A short antenna




The length of the resonant antenna is $\frac{1}{2}\lambda$ ($\lambda$ = wavelength)

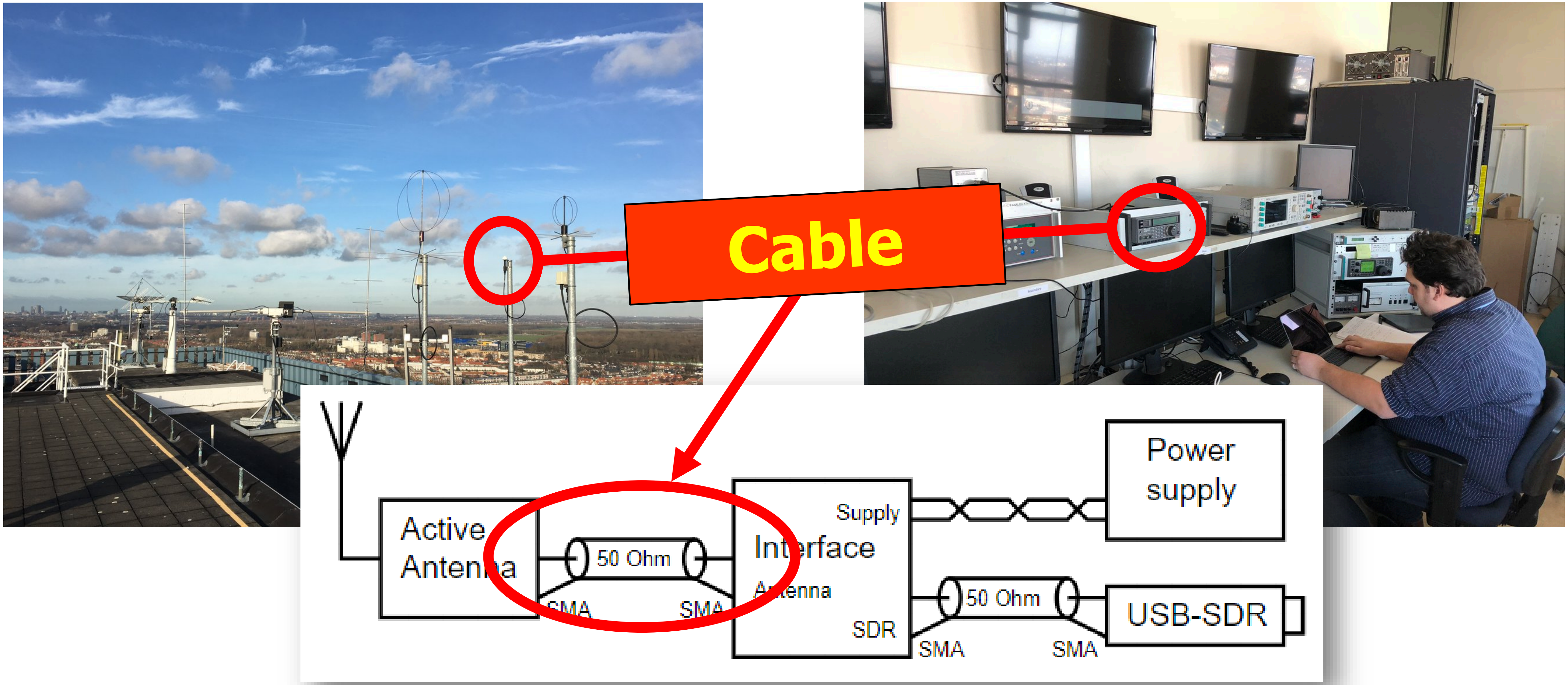
OLFAR and LUFAR: 30kHz – 30MHz

OLFAR and LUFAR: **$\lambda \approx$10km** – $\lambda \approx$10m
(RAE1, 4.7MHz: $\lambda \approx$64m)

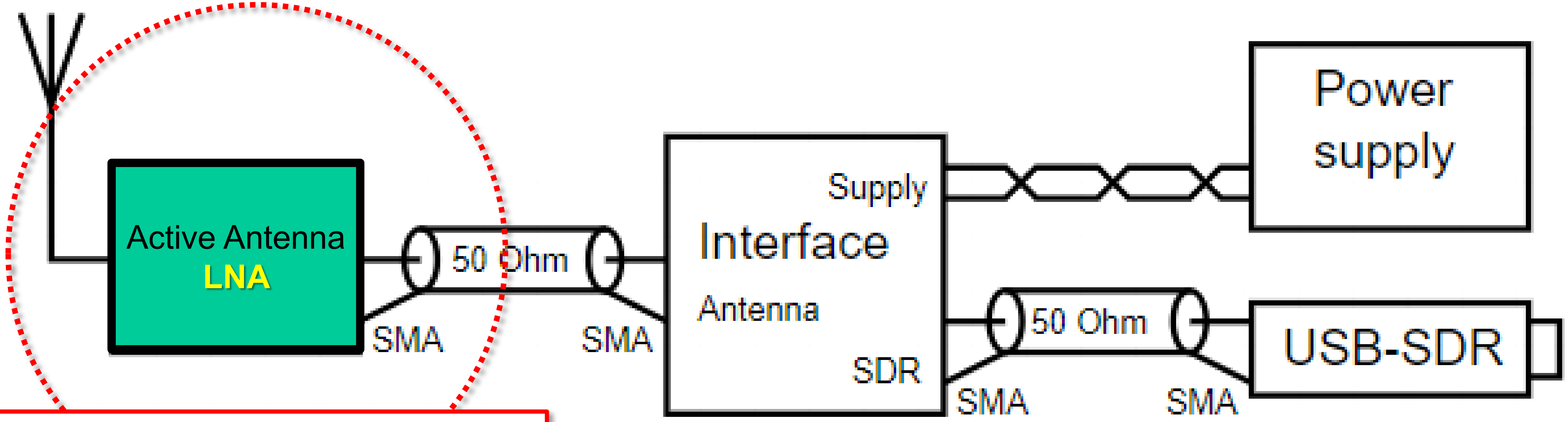


https://www.ru.nl/astrophysics/radboud-radio-lab/projects/netherlands-china-low-frequency-explorer-ncle/

# From antenna to radio



# The design example challenge in this course

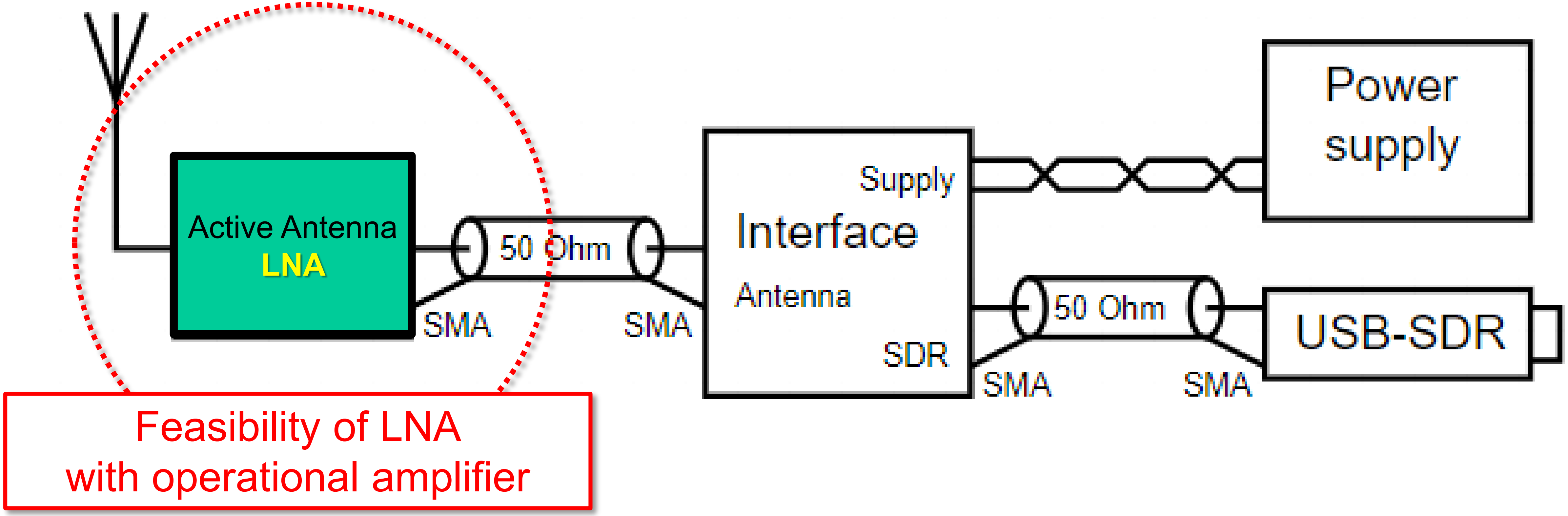



Feasibility of LNA
with operational amplifier

Application Description

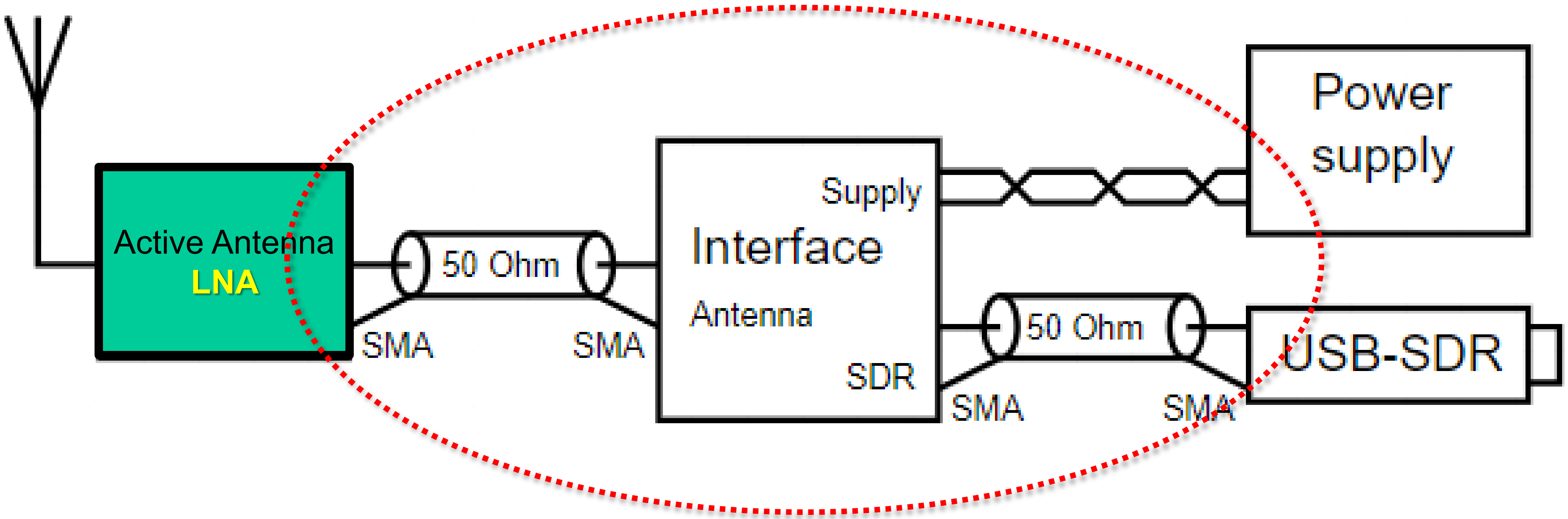
Understand the Application

# The design example challenge in this course




Understand the Application (The Antenna and the LNA)

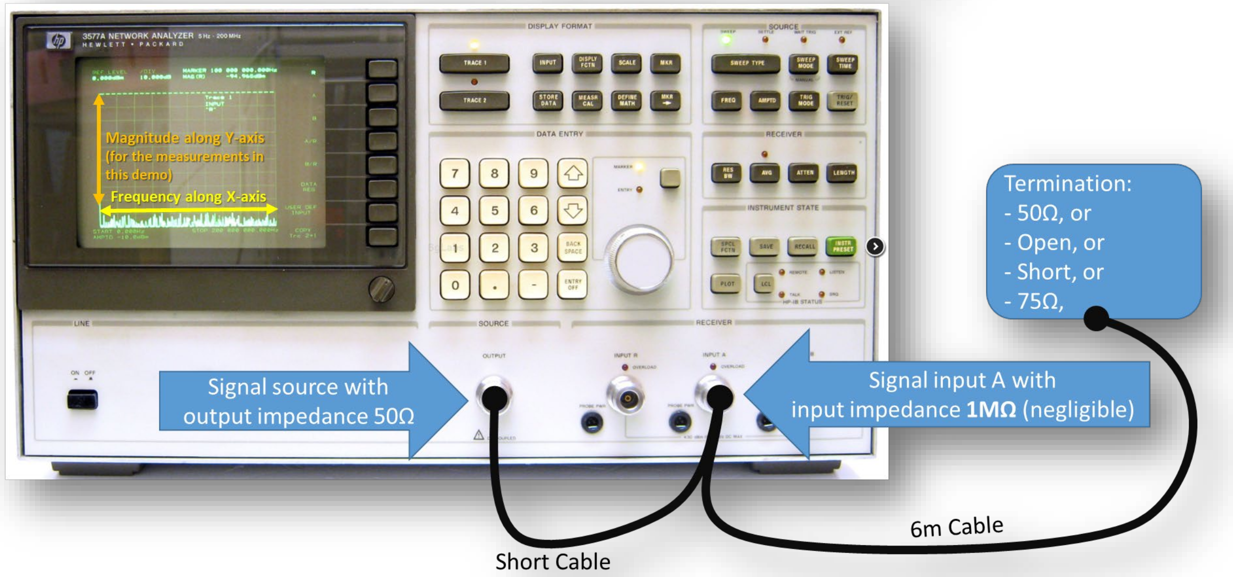
# The design example challenge in this course



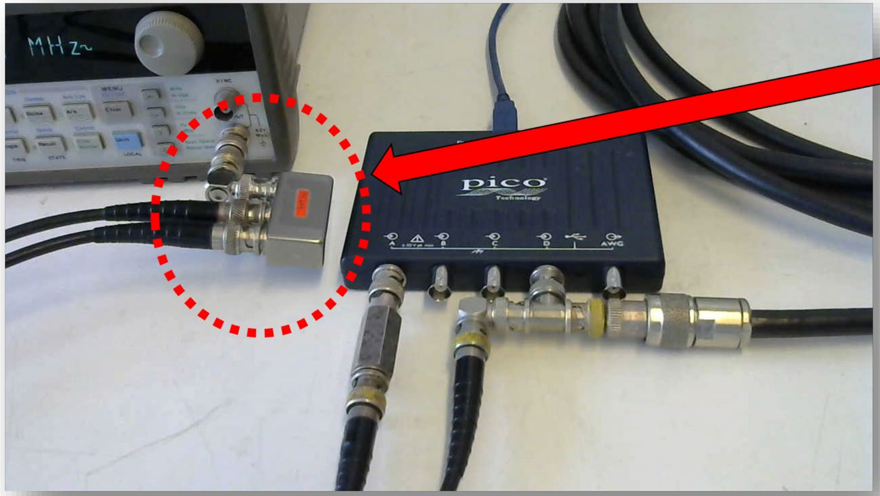

Understand the Application (The Interface)

# Demonstration. 50Ω coax cable, 6m length

## Measurements with Network Analyzer




## Measurements with oscilloscope




| | | |
|---|---|---|
| c | 299792458 | m/s |
| cable reduction of c | 0,666666667 | |
| c in cable | 199861638.7 | m/s |
| cable length | ≈6 | m |
| delay cable | 3.0021E-08 | s |
| delay cable [ns] | ≈30 | ns |
| return delay [ns] | ≈60 | ns |
| Lowest Resonant frequency at cable = 0.5 Wavelength | | |
| Lowest Resonant Frequency | 16655136 | Hz |
| Lowest Resonant Frequency [MHz] | ≈16.66 | MHz |

**Understand the Application (The Interface)**

# Structured Electronic Design