

# Yagi-Uda Antenna

## Theory, Design and Results

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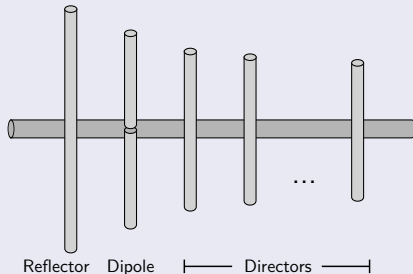
5 Results

# Theory

## History

- Invented by Shintaro Uda and Hidetsugu Yagi in 1926
- Relatively unknown until World War 2
- Now used for amateur radio, TV, satellite comm., ..

## Typical Yagi Antenna



# Theory

## Dipole

- Two conductors of length  $\approx \lambda/4$
- One connected to signal, the other to ground
- The only driven element in the system, no electrical connection to directors or reflector

## Directors

- Lengths smaller than dipole, continuously decreasing
- Excited by the field of the dipole
- Make antenna directional

## Reflector

- Larger than dipole
- Prevents antenna from sending backwards

# Antenna Design

## Fixed parameters

- Frequency: 2.45GHz  
≈ Channels 8 and 9
- 9 Directors

## Calculated parameters

- Element lengths
- Element positions
- Calculated with online JavaScript application

	Position [mm]	Length [mm]
Reflector	0	57.8
Dipole	24.47	54.68
D1	33.65	47.03
D2	55.68	45.98
D3	81.98	45.00
D4	112.58	44.13
D5	146.84	43.38
D6	183.55	42.74
D7	222.09	42.18
D8	262.47	41.7
D9	304.69	41.28

# Antenna Construction

## Requirements

- Low cost
- Non-metallic construction
- Adjustable element positions

## Materials Used

- 16mm $\varnothing$  wood rod
- Plastic pipe clamps to mount elements
- 2.5mm $\varnothing$  copper wire / 3mm $\varnothing$  aluminium sticks
- Plenty of hot glue

## Result

- Cost: about 20 CHF

# Test Set-up

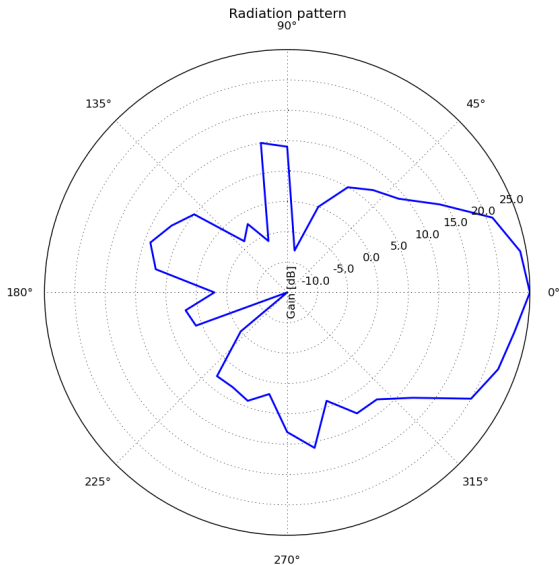
## Analysis with VNA

- Shows resonance frequency, input impedance, SWR
- Incredibly useful for tuning

## Analysis Signal Generator and Spectrum Analyzer

- Sender: signal generator (tuned to 2.43 GHz) + antenna
  - commercial 2.4 GHz dipole antenna (reference)
  - our Yagi antenna
- Receiver: spectrum analyzer + commercial 2.4 GHz dipole
- Sender antenna rotated in 10 degree steps

# Results – Radiation Pattern





# Results

## Key Parameters

- Gain: About 20 dBd
- Resonance frequency:  $\sim 2.43$  GHz
- Input impedance (after tuning):  
 $49 - i6\Omega$
- Found AP at 5.5 km distance :-)

## Lessons Learned

- Element lengths and spacings are critical
- Yagi has good directivity
- Professional equipment very helpful during construction

## Yagi in Action

