Introduction to Yagi-Uda Arrays: Analyzing a 5-Element Beam with a Folded Dipole Driver

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Learn the fundamentals of Yagi-Uda arrays with this introductory model. This simulation features a folded dipole driver with arced ends, illustrating how parasitic elements shape a highly directional 9.7 dBi beam and achieve a 15 dB Front-to-Back ratio. This baseline design provides the perfect foundation for mastering antenna feeding, tuning, and optimization using AN-SOF.

The Fundamentals of Parasitic Arrays

The Yagi-Uda antenna is the quintessential directional beam antenna. By placing “parasitic” (unfed) elements in the near field of a “driven” element, we can shape the radiation pattern through mutual coupling. In this introductory model, we explore a 5-element configuration at **100 MHz**, consisting of one reflector, one driven element, and three directors (**Fig. 1**).

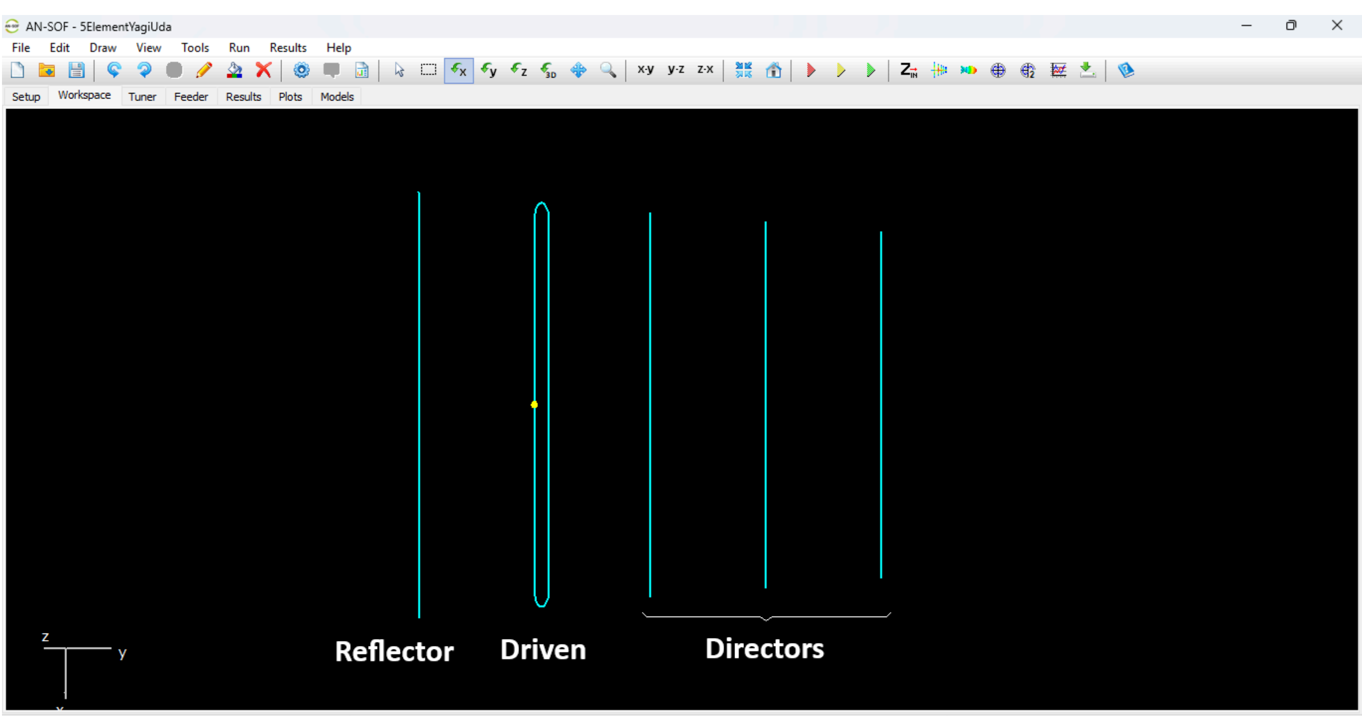

***Fig. 1**: Model of a 5-element Yagi-Uda antenna, featuring a folded dipole as the driven element, within the AN-SOF workspace.*

Geometric Modeling in AN-SOF

One unique feature of this model is the driven element: a **folded dipole** with arced wire ends. Unlike a standard dipole, the folded configuration provides a natural impedance step-up and increased bandwidth.

By using AN-SOF's **Conformal Method of Moments (CMoM)**, the arced ends of the folded dipole are modeled with exact geometric curvature. This ensures high numerical precision in the calculation of the surface currents where the wire bends, a critical area for determining the final input impedance.

Model Dimensions (at 100 MHz):

- **Reflector:** $1.5\ \mathrm{m}$
- **Driven Element (Folded):** $1.425\ \mathrm{m}$ (Length) x $0.12\ \mathrm{m}$ (Width)
- **1st Director:** $1.354\ \mathrm{m}$
- **2nd Director:** $1.286\ \mathrm{m}$
- **3rd Director:** $1.222\ \mathrm{m}$
- **Element Spacing:** A constant $0.45\ \mathrm{m}$ between all adjacent elements.

This article offers a step-by-step tutorial for constructing a Yagi-Uda antenna within the AN-SOF workspace:

- **Step-by-Step: Modeling Basic Yagi-Uda Arrays for Beginners**

Why use a Folded Dipole?

In a Yagi-Uda array, the proximity of parasitic elements typically causes the **radiation resistance** of the driven element to drop significantly, often well below $50\ \Omega$. By using a **folded dipole**, which has a self-impedance approximately **four times** that of a standard dipole, we can keep the final impedance in a range that is easier to match to standard transmission lines.

Simulation Results

Even without specific **optimization**, this 5-element array demonstrates the powerful directional characteristics of the Yagi-Uda design:

- **Forward Gain:** $9.7\ \mathrm{dBi}$
- **Front-to-Back (F/B) Ratio:** $15\ \mathrm{dB}$
- **Input Impedance:** $162 + j121\ \Omega$

Figure 2 presents a complete electromagnetic profile of the 5-element Yagi-Uda array. Note the symmetry in the current distribution and the significant forward directivity, which is achieved through the precise interaction of the parasitic elements as modeled in AN-SOF.

The complex impedance $(+j121\ \Omega)$ indicates that the antenna is currently inductive and not yet resonant at the design frequency. This provides a perfect starting point for users to learn the art of antenna "tuning."

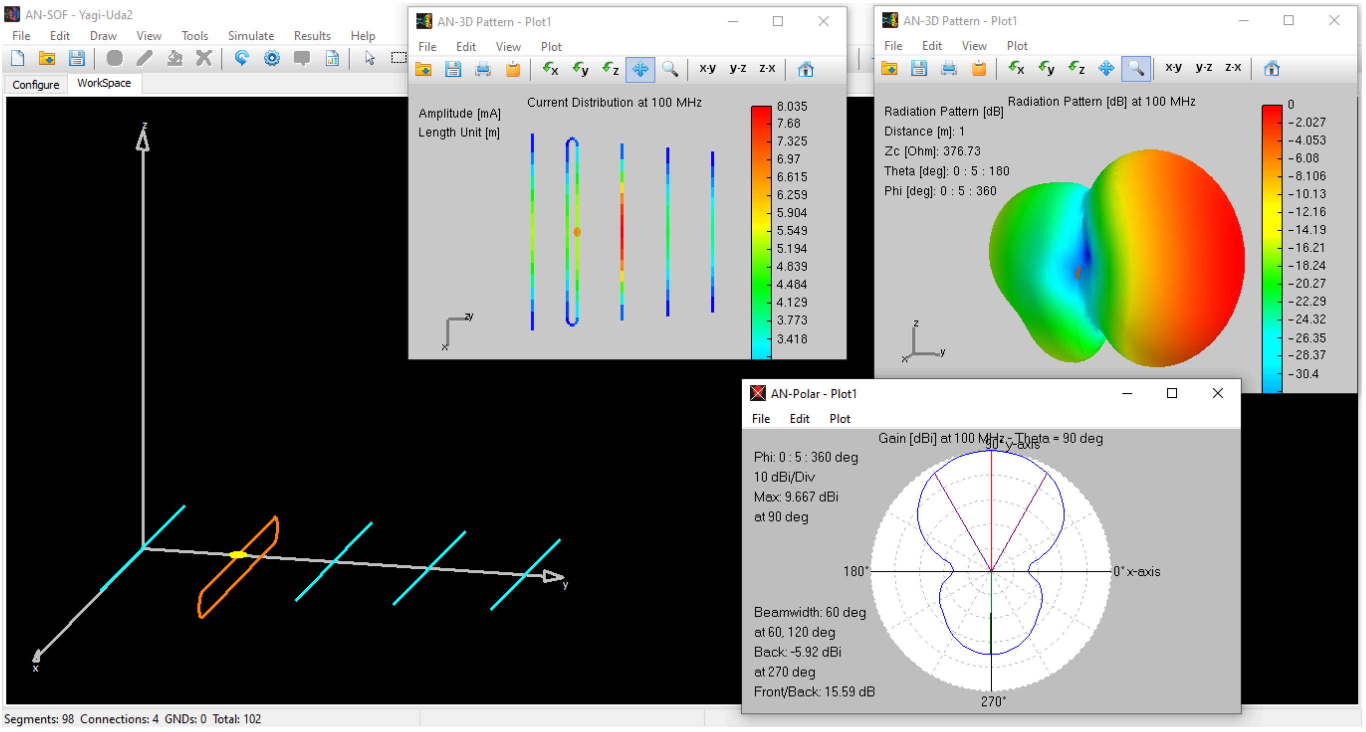

Fig. 2: *5-element Yagi-Uda antenna model showing the current distribution on the elements, the 3D radiation pattern, and a polar plot of the radiation pattern in the horizontal plane.*

Download Model

Next Steps: Feeding, Tuning, and Optimization

This model serves as a baseline. To transform this into a production-ready antenna, two distinct engineering steps are required:

1. **Feeding and Tuning:** To eliminate the reactive component (jX) and match the antenna to your feedline, refer to our comprehensive guide: **"Complete Workflow: Modeling, Feeding, and Tuning a 20m Band Dipole Antenna"**.
2. **Optimization:** The gain and F/B ratio can be significantly enhanced by varying the lengths and spacings of the directors. Advanced users can automate this process using our specialized scripts and methods:
   - **"Nelder-Mead Optimization for Antenna Design Using the AN-SOF Engine and Scilab"**
   - **"Element Spacing Simulation Script for Yagi-Uda Antennas"**

See Also:

- **Evolving Better Antennas: A Genetic Algorithm Optimizer Using AN-SOF and Scilab**
- **The Moxon-Yagi Dual-Band VHF/UHF Antenna for Superior Satellite Link Performance**

Technical Keywords: Yagi-Uda Array, Folded Dipole, Parasitic Elements, Conformal MoM, Antenna Gain, Front-to-Back Ratio, 100 MHz Beam.

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