Gregory D. Lapin
1206 Somerset Avenue
Deerfield, IL 60015
(847) 710-0520
glapin@arrl.org

VIA ECFS

April 14, 2021

Marlene H. Dortch, Secretary
Federal Communications Commission
45 L Street NE
Washington, DC 20554

Re: ET Docket No. 19-226 Human Exposure to Radiofrequency Electromagnetic Fields and Reassessment of FCC Radiofrequency Exposure Limits and Policies
Notice of *Ex Parte* Discussion

Dear Ms. Dortch:

On April 12, 2021, members of the RF Safety Committee (RFSC) of ARRL, The National Association for Amateur Radio, and the Radio Society of Great Britain (RSGB) met by teleconference with serveral members of the FCC's Office of Engineering and Technology (OET). The RFSC members included Chairperson Gregory Lapin, Richard Tell and Kazimierz Siwiak and Peter Zollman from the RSGB. The OET staff that participated included Martin Doczkat, Kevin Graf, Chrysanthos Chrysanthou, Gulmira Mustapaeva, Robert Acacio, and Damian Ariza.

The purpose of this meeting was to clarify the responsibilities of radio amateurs under the modified rules that become effective on May 3, 2021, to discuss acceptable evaluation techniques that radio amateurs can use to conform to those rules and to discuss changes that will be necessary to the publications OET Bulletin 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, and Supplement B to OET Bulletin 65, *Additional Information for Amateur Radio Stations*.

New Rules

ARRL has three basic concerns about the ability of radio amateurs to conform to the new exposure regulations.

It was generally agreed that SAR testing, which is required in the rules under certain conditions, is beyond the means and abilities of most radio amateurs. As few previously manufactured handheld radios for amateur radio have been certified for SAR exposure, the first question was if these will still be usable after the rule change takes effect. We were informed that *Equipment* paragraph in Public Notice DA 21-363, which essentially "grandfathers" existing transmitting equipment that had been certified under the old rules would apply to existing amateur radios as well.

We were concerned that on frequency bands with longer wavelengths it is not unusual for people to be within the $\lambda/2\pi$ reactive near field distance from the antenna that might require SAR testing. For example, a dipole tuned to the 80M band mounted 40' above the ground would place people on the ground under the antenna in that near field zone. We were informed that a decision in a related 2013 proceeding in this docket permitted MPE analysis in lieu of SAR under such conditions. Under the current Report and Order, only exposure distances closer than 20 cm absolutely require SAR testing.

We questioned the MPE tables listed in the new regulations, at Table 1 to §1.1310(e)(1), as having a minimum frequency of 0.300 MHz. The amateur radio service has a frequency allocation at 0.137 MHz, which is not included in this table and we wanted to know how stations using that frequency would be able to comply with the exposure regulations. We were informed that KDB 680106 discusses exposure compliance testing for wireless charging systems whose frequencies are as low at 0.100 MHz and this would apply to the 0.137 MHz amateur radio band.

Evaluation Techniques

The concern over the inability of radio amateurs to perform SAR analysis on their personal equipment prompted us to look for alternative means to perform exposure analysis. Even after equipment manufacturers begin performing SAR analysis on the products that are meant for amateur radio use, we noted that amateurs often change the antennas on their commercially tested radios, nullifying the SAR testing that was done for that unit, and also that amateurs modify radios built for the commercial market so that they will also work on amateur radio frequencies, and there are some radio amateurs that design and build their own transmitters.

Peter Zollman presented antenna exposure software that he has developed for use with the newly enacted radio exposure rules in the United Kingdom. He showed how he uses the program, Mathematica, from Wolfram Research as the human interface and analysis automation tool that works with version 5.0 of the Numerical Electromagnetic Code (NEC5), from Lawrence Livermore National Laboratory. Mr. Zollman gave a presentation of his work, with slides that are attached to this document.

Richard Tell introduced a concept that he is currently researching, in which commercial handheld radios that have been SAR tested and operate on frequencies near amateur radio frequencies can have their testing results applied to similar amateur handheld radios. We were informed that different forms of testing were under the purview of the OET Laboratories and that in a future meeting personnel from the labs would attend and evaluate this proposal.

OET Bulletin 65

Discussion ensued about how the changes in the exposure rules would require modifications to OET Bulletin 65 and its Supplement B. The RFSC representatives offered to help to modify these documents to make it easier for radio amateurs to perform exposure analyses and remain in compliance with the FCC's exposure rules. As the time allotted for this meeting was expiring, it was agreed to continue discussing this topic at a future meeting.

Conclusion

We thank the Commission and OET staff for setting aside the time to meet with us to help make sure that radio amateurs are able to comply with the exposure rules that have been codified. We look forward to future collaborations in which we can further improve the processes of modeling and testing for compliance of exposure regulations.

This notice is being filed electronically pursuant to Section 1.1206 of the Commission's rules. Please contact me if you have any questions.

Respectfully submitted,

Gregory D. Lapin
Chairman, RF Safety Committee
ARRL, The National Association for Amateur Radio

cc: Martin Doczkat
Kevin Graf
Chrysanthos Chrysanthou
Gulmira Mustapaeva,
Robert Acacio
Damian Ariza
Sean Yun
Richard Tell
Kazimierz Siwiak
Peter Zollman
David Siddall

Using NEC in modelling HAM EMF compliance

Peter Zollman BSc. C.Eng. FIET SMIEE

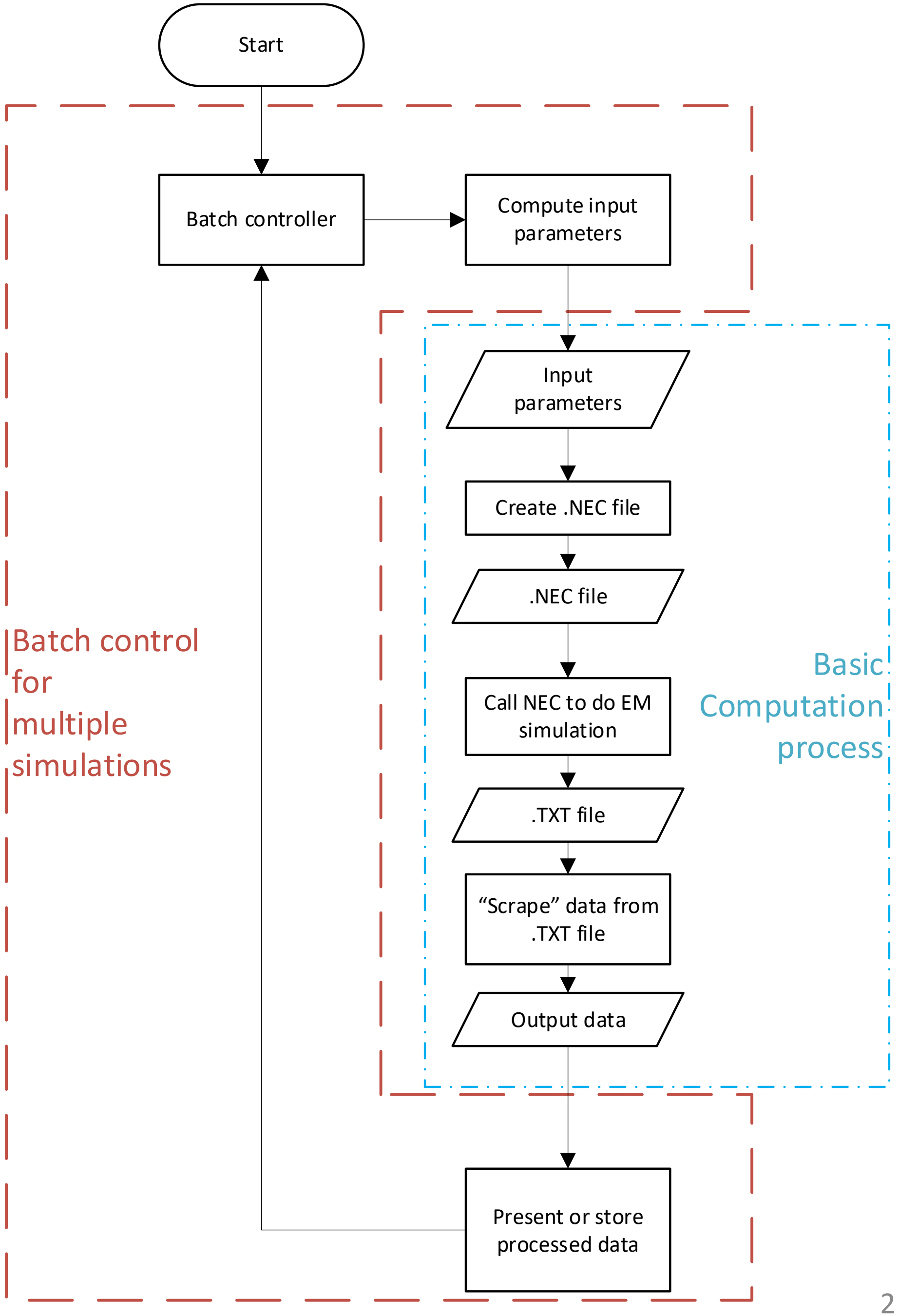
G4DSE

Modelling approach

- Use NEC as EM computation module integrated in bespoke driving software
- Lot of work but fully flexible
- Mathematica used for the main software to give powerful processing and presentation capabilities
- NEC 4.2 and NEC 5 capabilities
- Batch, including parallel computation
- Enables interpretation

NF field strength → Exposure WRT reference levels → Max compliant power

- Supports sensitivity investigation
  - Ground conditions
  - Segmentation v wire diameter…..



Example outputs

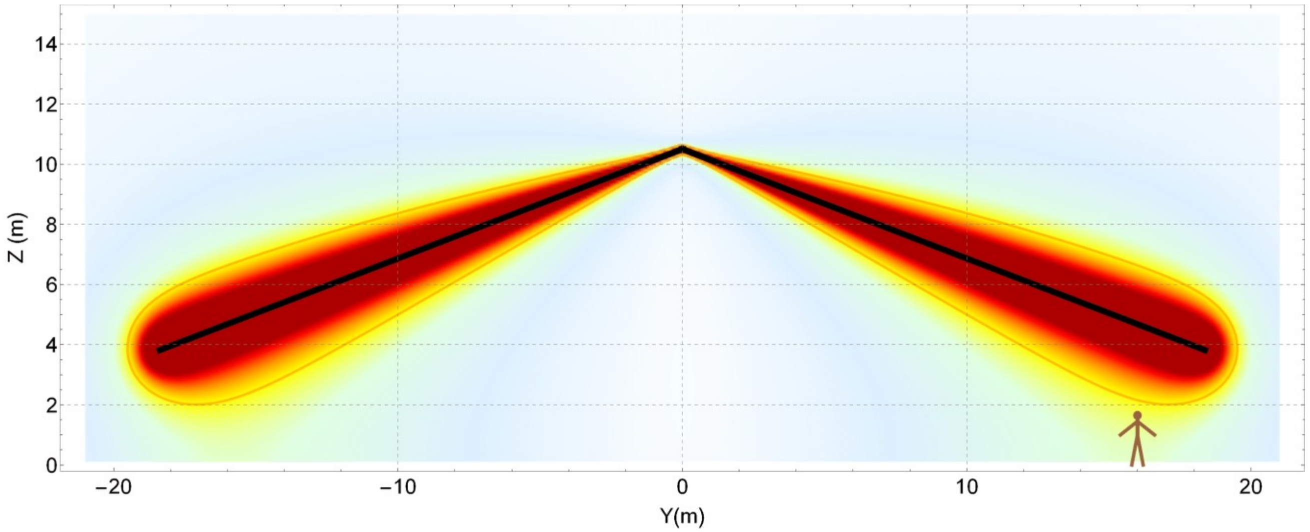
Conventional *E* & *H*

80m inverted V dipole electric and magnetic field strengths.

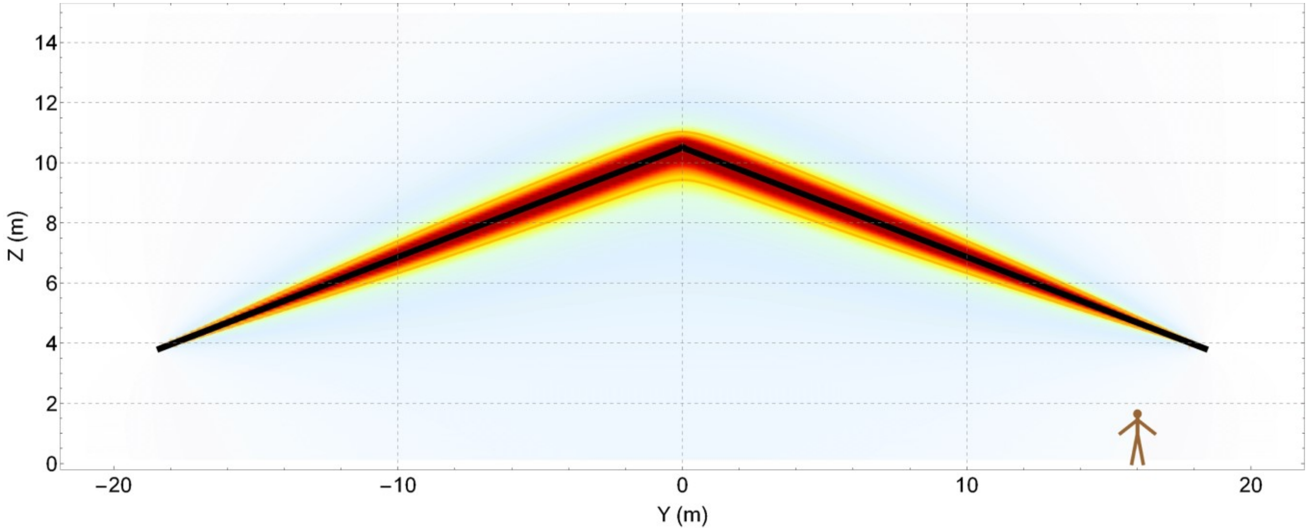
Fine for illustration but only provides information for one configuration and one output power level

Does not consider exposure limits with “spatial averaging” or “maximum field over body area” specifications

E



H



Example outputs

Exposure – compliant power

The top plot is derived from *E* and *H* near field data normalised to 1W radiated power

The data is "scanned" WRT the foot position based on a 1.8m person establishing the maximum spatial *E* and *H* and the RSS average.

The power that would just comply with each relevant limit is determined point-by-point.

The lowest compliant power is selected point-by-point.

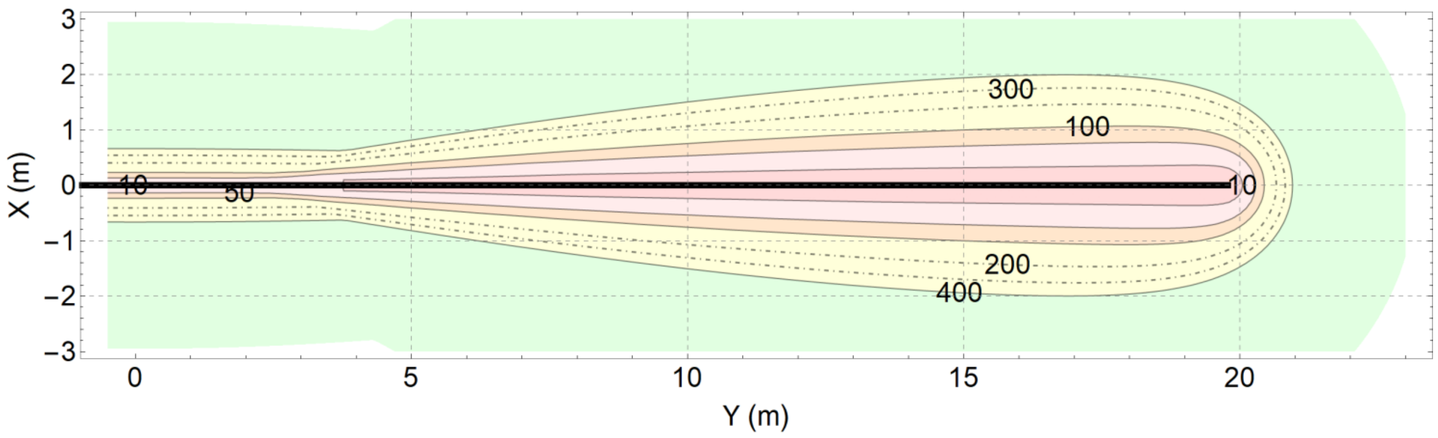
The array of powers is then interpolated using Mathematica contour plot

In one plot we now have a spatial presentation of the maximum compliant power for this antenna.

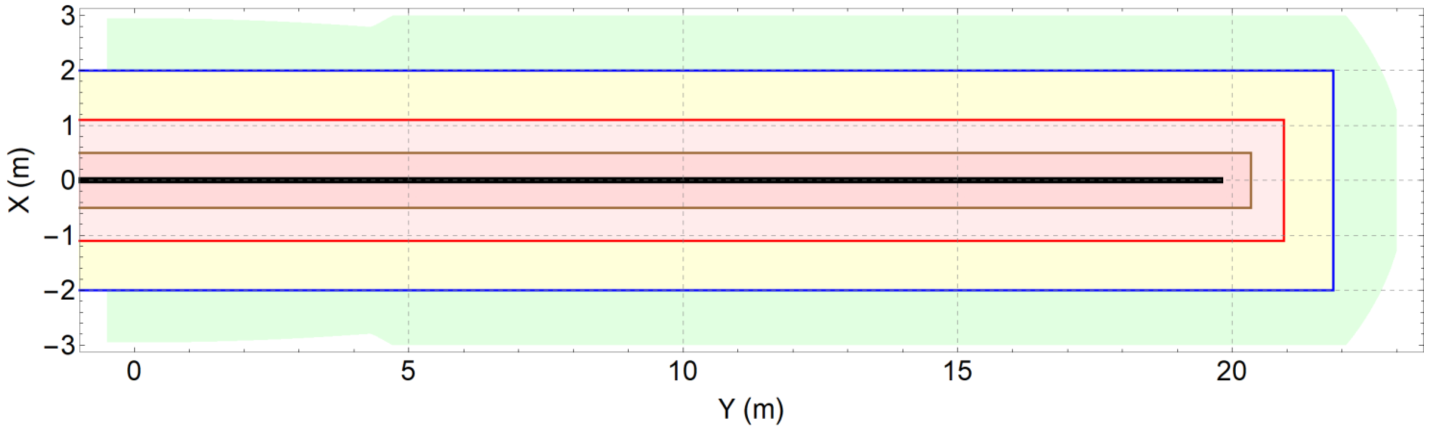
The upper plot can then be used to derive simple exclusion zones for different power levels

Looking down on 80m horizontal dipole

Compliant power contours



Simple exclusion zones



Example outputs

Minimum height guidance

Batch modelling of different V configuration 160m to 40m dipoles

Minimum compliant power determined for 1.8m person standing on ground under antenna an modelled at height intervals

Several hundred runs to cover 160m to 40m, several V configurations, different ground conditions

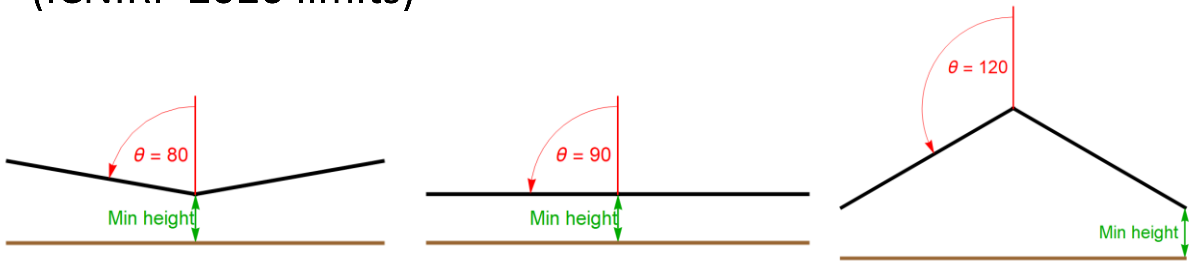
ICNIRP 2020 limits shown but can be done for OET65 or other limits

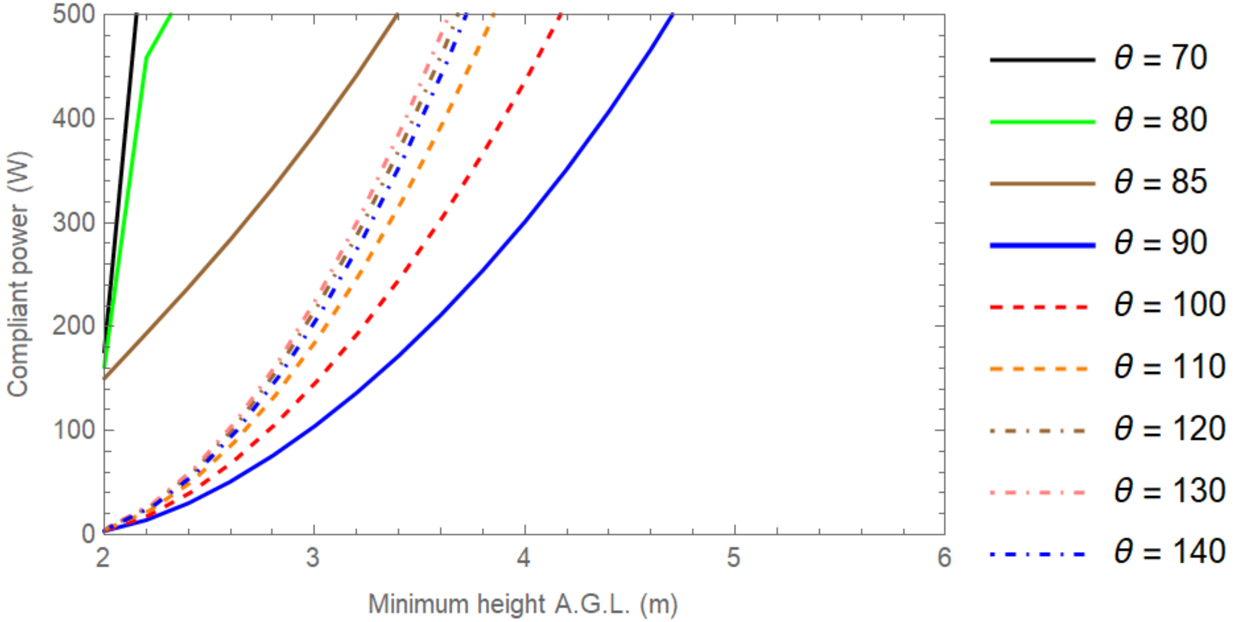
Plot enables determination:

a) For given V min height for target power

b) For given V max power for target height

80m dipole over Clay (OET65 “normal”) ground (ICNIRP 2020 limits)

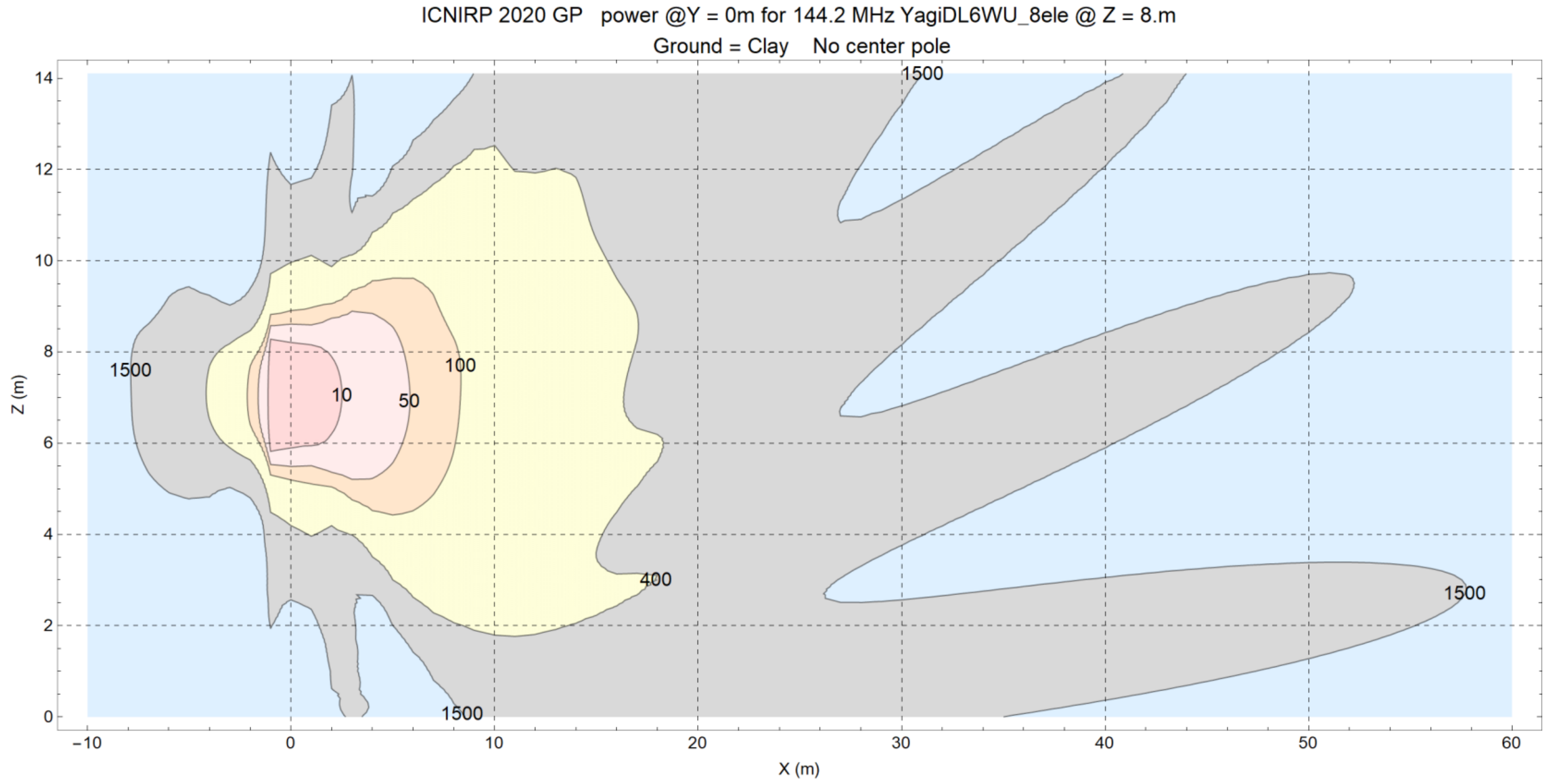




Example outputs
VHF Beam

Vertical slice showing compliant power for a VHF beam over ground.

Position refers to the foot location so a person on this diagram is represented by a point



NEC Segmentation study

NEC 4.2 and NEC 5 have different characteristics / limitations on segmentation.

NEC 4.2 uses sine wave current approximation whereas NEC 5 uses linear

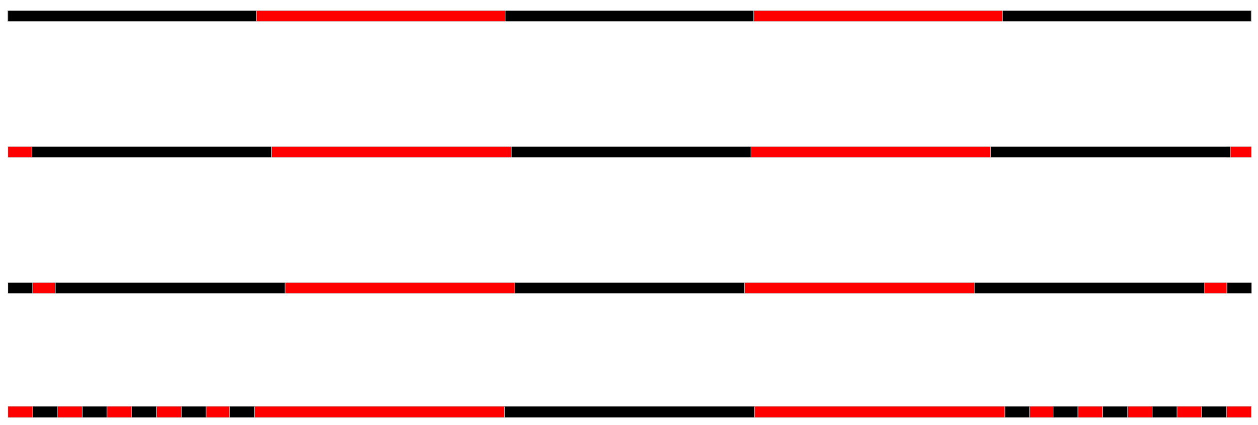
Different convergence characteristics

1 - Equal

2 – 1 short end

3 – 2 short end

4 – 10 short end



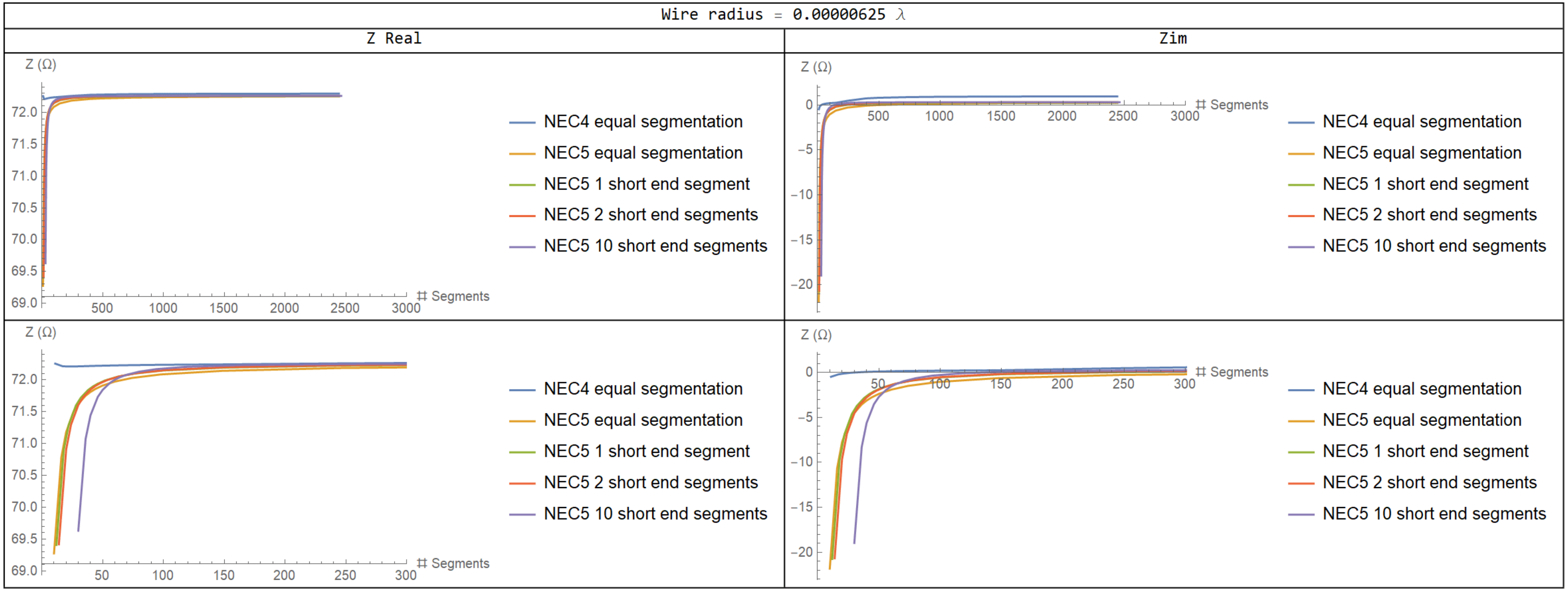
Model a half-wave dipole with different wire radius with respect to wavelength using different numbers of segments and for NEC 5 investigate use of short end segments to improve convergence with fewer segments.

Compare NEC4.2 equal segmentation with NEC 5 with 4 segmentation strategies by looking at the NEC-reported feed impedance.

NEC Segmentation study - equiv 1mm rad wire 1.8MHz

NEC 4.2 converges quickly to stable value and is stable with large number of segments

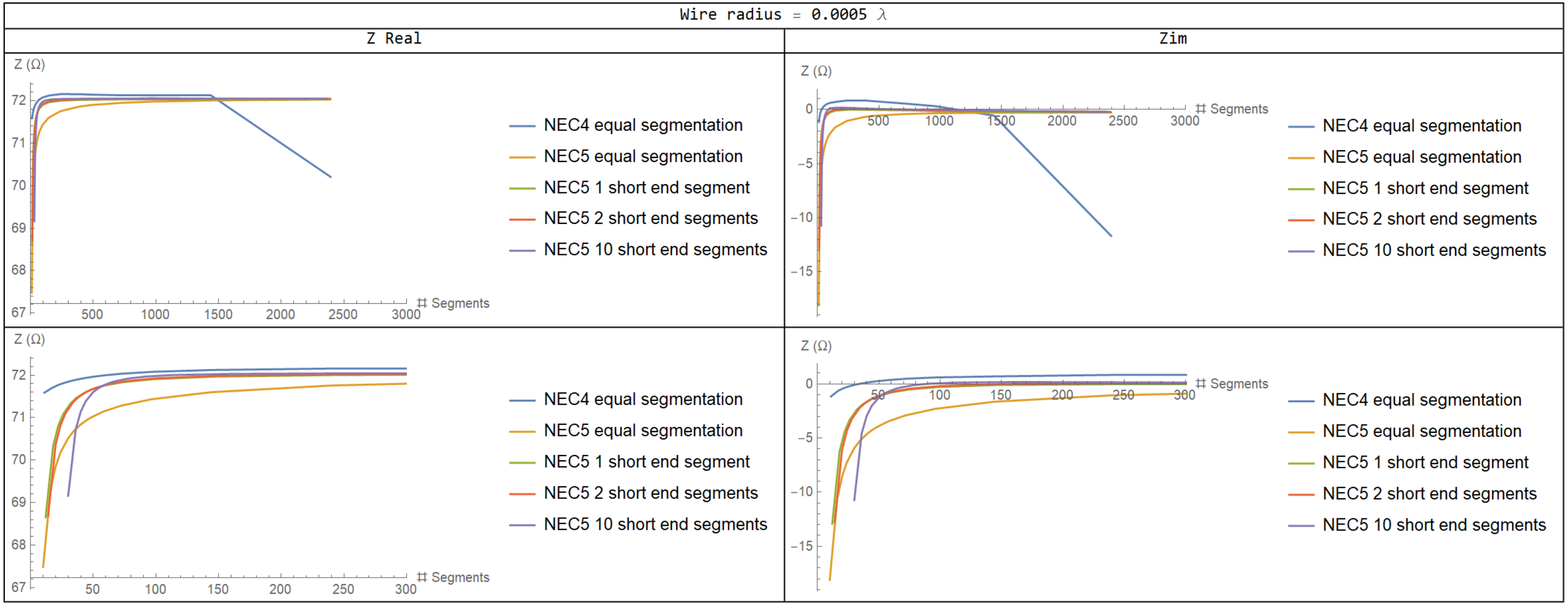
NEC 5 converges slowly to stable value and is stable with large number of segments. Very small advantage for using short end segment approach at about 200 segments per wavelength.



NEC Segmentation study - equiv 10mm rad wire 14 MHz

NEC 4.2 converges quickly to stable value and Zreal is stable, Zim has slight variation with number of segments. NEC 4.2 crashes at about 3000 segments per wavelength

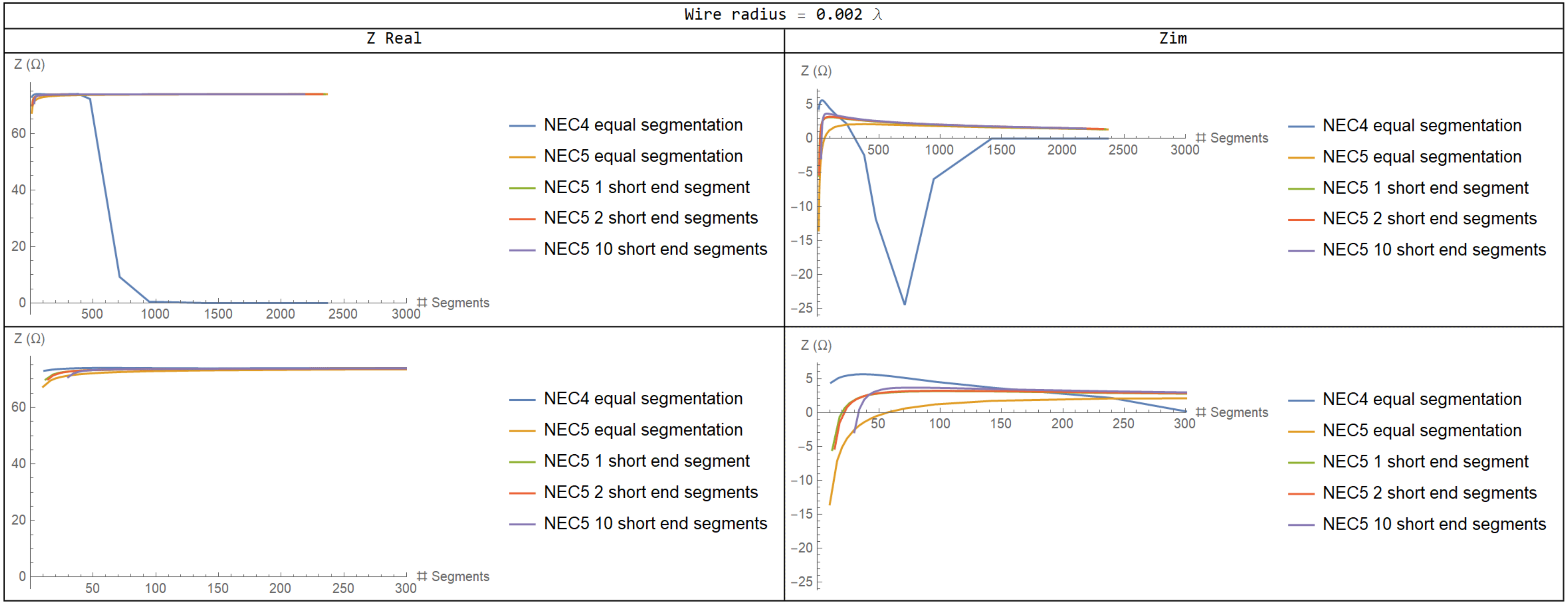
NEC 5 converges slowly to stable value and is stable with large number of segments. Notable advantage for using short end segment approach at about 200 segments per wavelength.



NEC Segmentation study - equiv 5mm rad wire 144 MHz

NEC 4.2 converges quickly to stable value and Zreal is stable, Zim has significant variation with number of segments.
NEC 4.2 crashes at about 1400 segments per wavelength

NEC 5 converges slowly to stable value and is stable with large number of segments. Notable advantage for using short end segment approach at about 100 segments per wavelength.



NEC Segmentation study - equiv 600mm rad wire 5 MHz

Using NEC as a tool for investigating limb current – “Salty man”

NEC 4.2 extremely unstable both for Zreal and Zim - crashes at about 100 segments per wavelength

NEC 5 converges slowly to stable Z real value and is stable with large number of segments. Zim subject to some variation with segmentation. Notable advantage for using short end segment approach at about 200 segments per wavelength.