

SC6: Choking Currents on Guy Wires

CBC/Radio-Canada's Experimental Testings

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Presentation plan

Motivation

Theory & Simulations

Experimental Test Results

What have we learned / What will we monitor

Acknowledgements / Questions



Why did we do this?

Safety Code 6: Health Canada's Radiofrequency Exposure Guidelines (SC6)

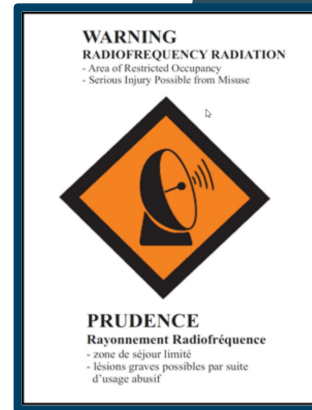
Public safeguard is the paramount responsibility for engineers.

Compliance with SC6 is **mandatory** for all RF operators

High Non Ionizing Radiation (**NIR**) levels often found in **proximity of guy anchors** at transmission sites. Typically requires fencing.

The Radio Advisory Board of Canada (**RABC**) SC6 sub-committee decided to try to gain better knowledge of the phenomenon and to find alternatives to fences (sometimes difficult / \$\$)

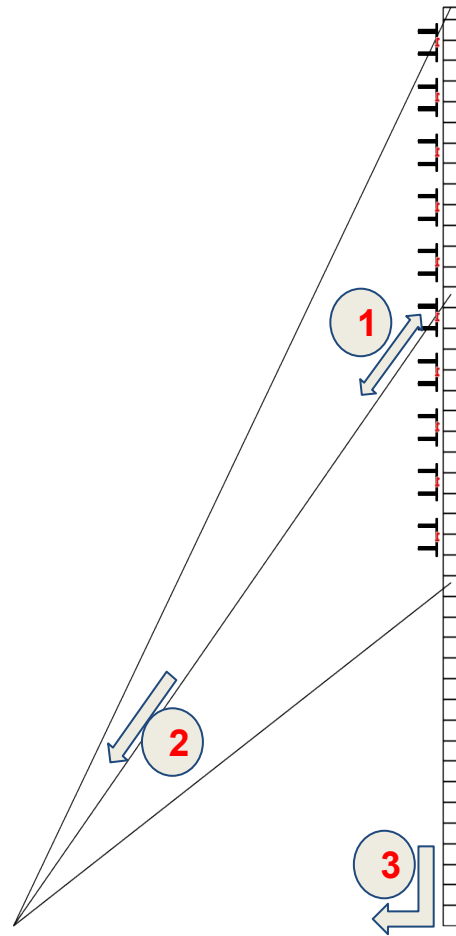
Max Larivière Birch: Suggestion to apply the Bazooka Balun principle on guy wires



Bazooka Balun Theory

Possible sources of guy-wire currents

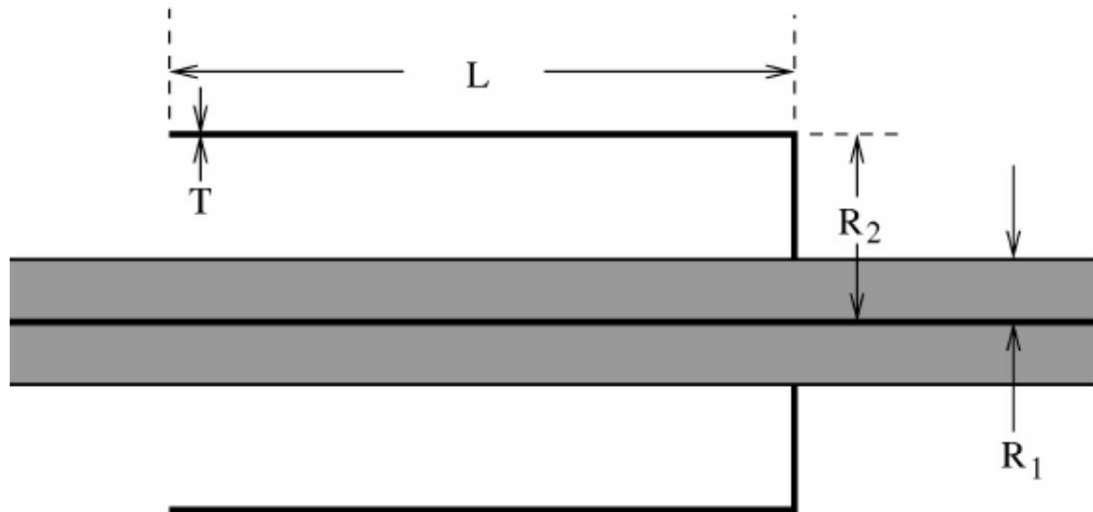
1. Induction by proximity of radiating element
2. Induction by side lobes on guy-wire
3. Induction through grounding system



Bazooka Balun Theory

Bazooka Sleeve Balun

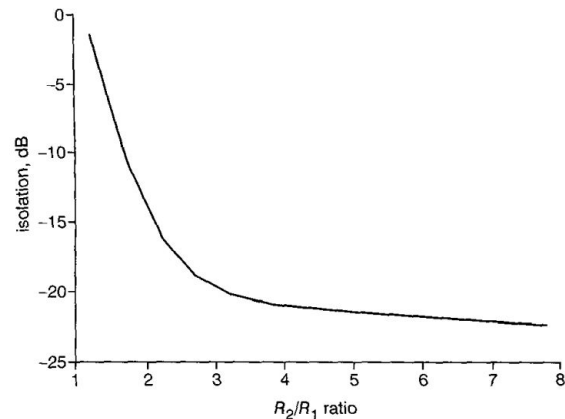
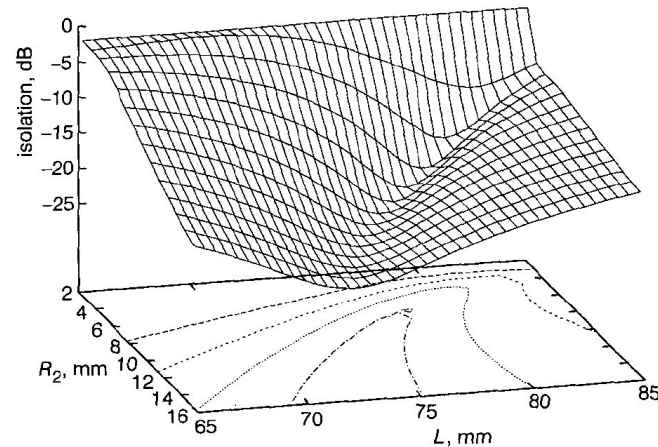
- Baluns are seen as an open circuit for currents traveling on the conductor's surface
- A technical paper¹ describes the performance of balun on coax cables at 900 MHz
- We transposed those characteristics for the FM band



Bazooka Balun Theory

Bazooka Sleeve Balun

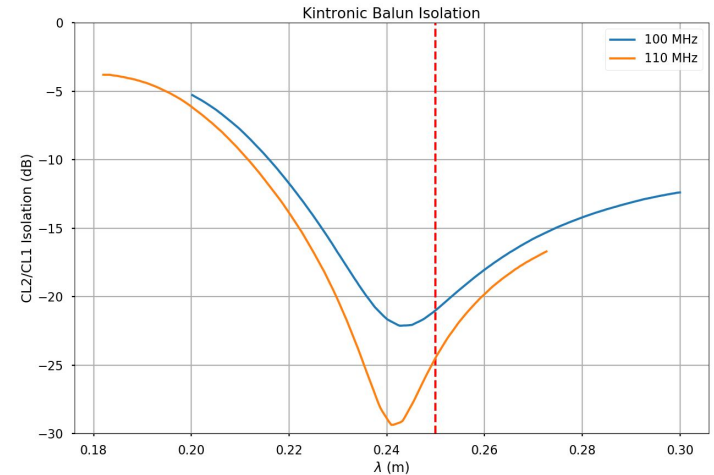
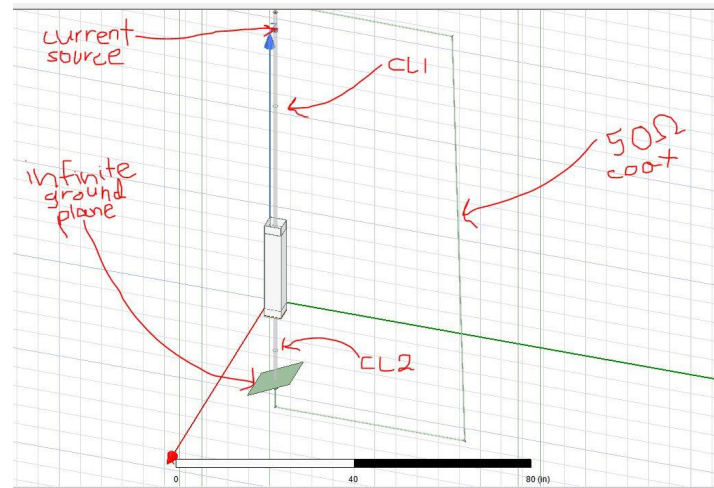
- Takeaways:
 - a. Balun length $\approx \lambda / 4$ or shorter
 - b. Bigger baluns have better isolation
 - c. Marginal improvements above $R_2/R_1 > 4$
 - d. Bigger baluns require shorter length



Simulations

Kintronic Lab's HFSS Simulation

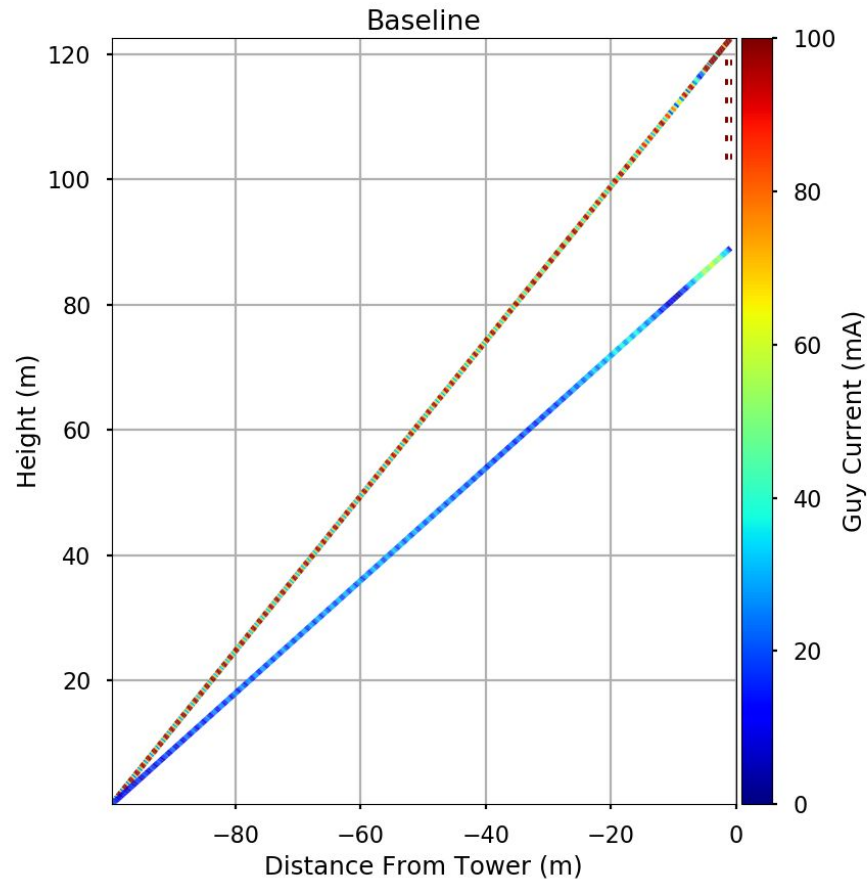
- Balun with 4:1 Radius Ratio
- Balun Length set to 0.25λ
- Optimal Isolation at less than 0.25λ
- Square Balun performs as well as Cylindrical Baluns

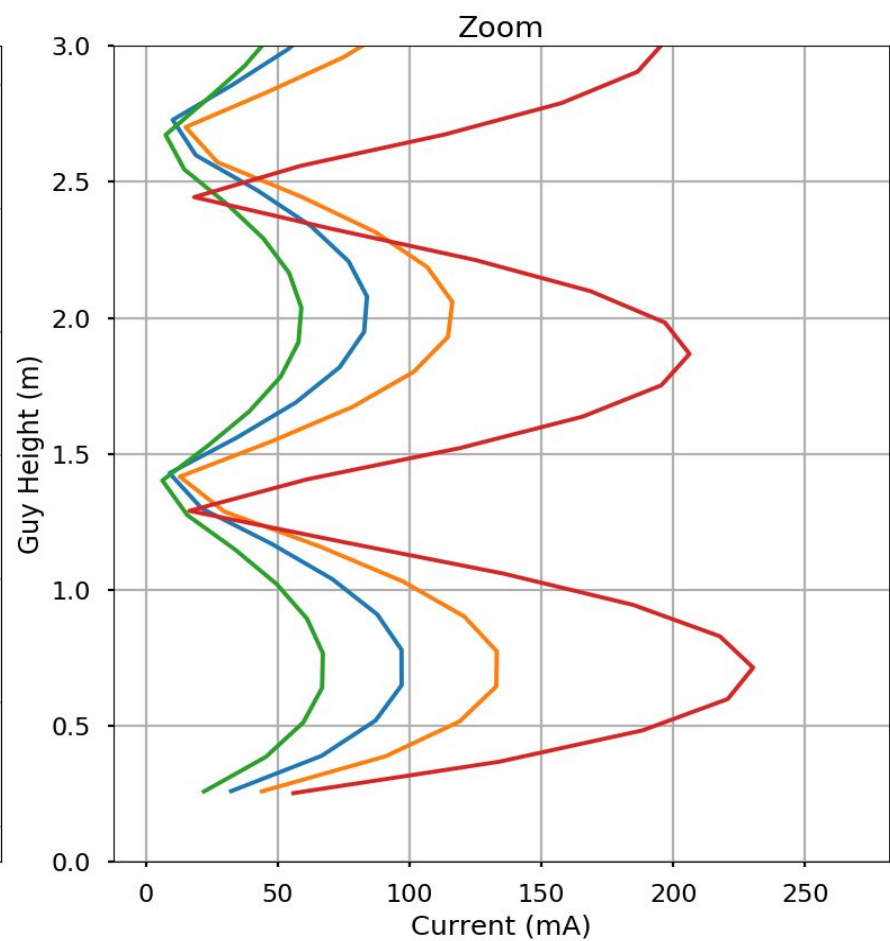
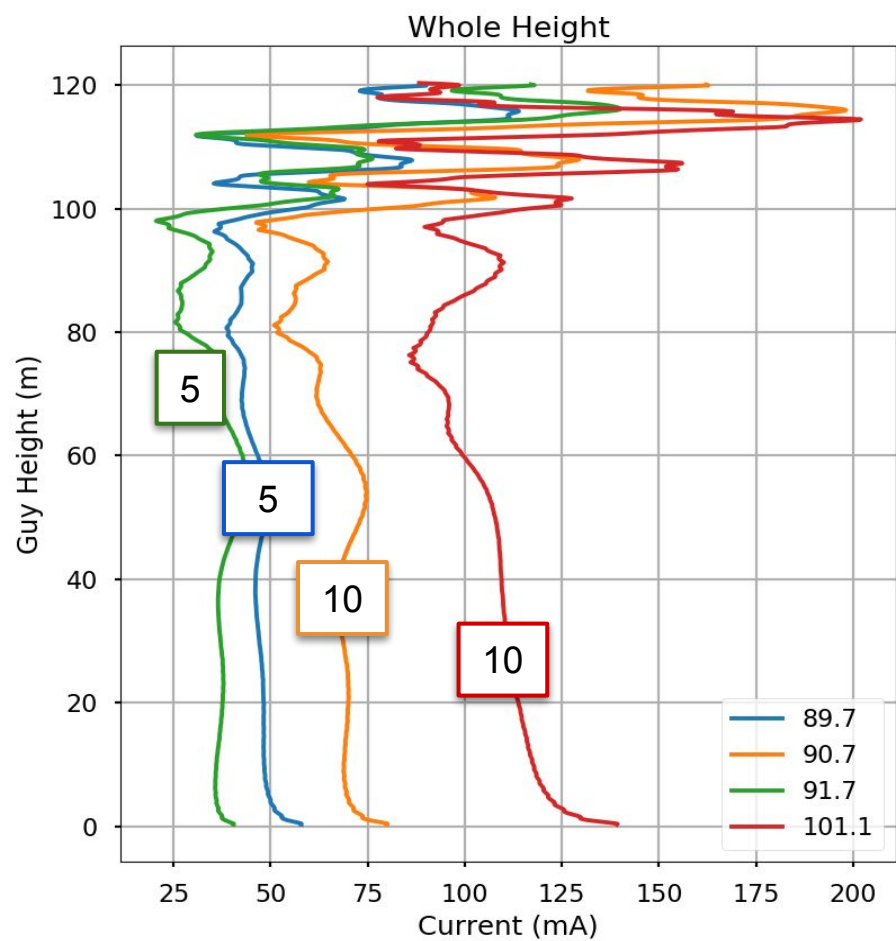


Simulations

CBC NEC Simulations

- Approximate Model Sherbrooke Tx Site Outer Anchors and Guy Heights
- Guy Wires 1" Ø
- Intensity of Induced Current varies with Frequency
 - Shown here for 101.1 MHz

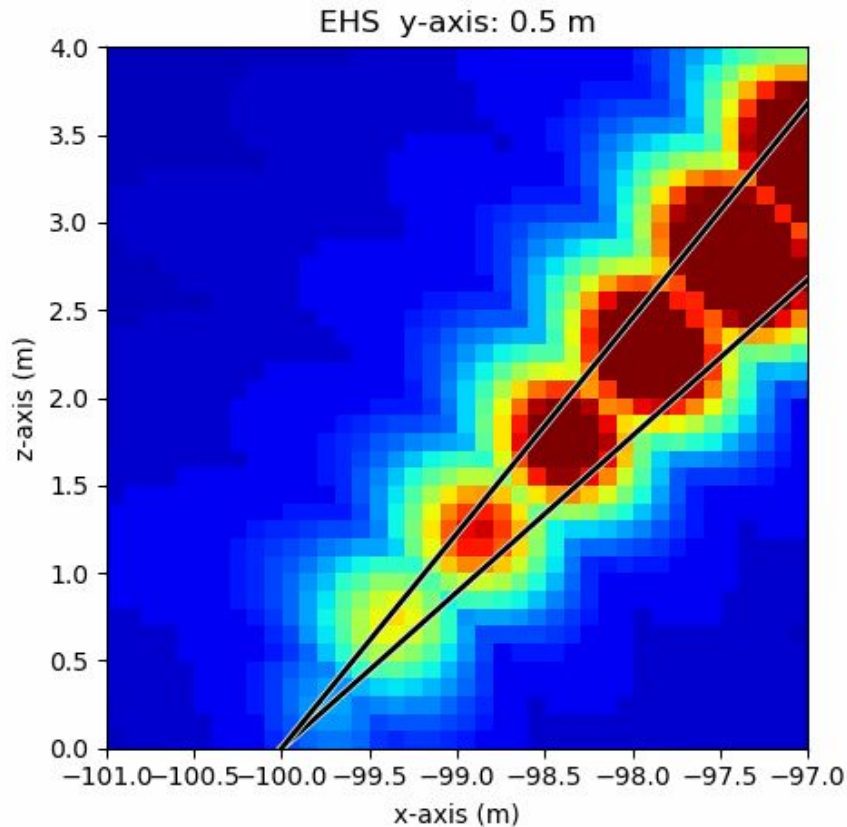




Simulations

CBC NEC Simulations

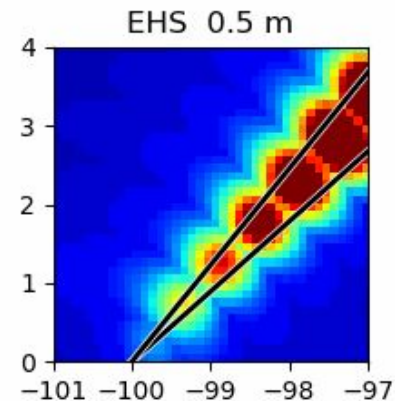
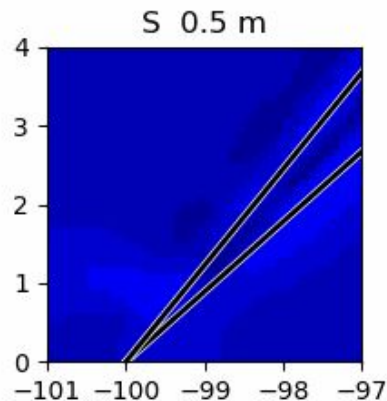
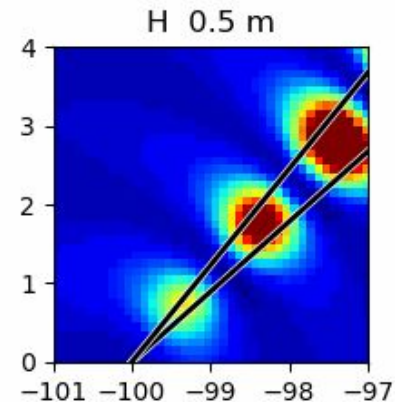
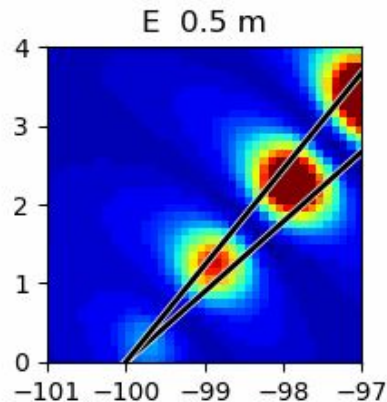
- RF Exposure without Bazooka
- SC6 Levels which include maximum of:
 - E-Field levels (E)
 - H-Field levels (H)
 - Power Density levels (S)



Simulations

CBC NEC Simulations

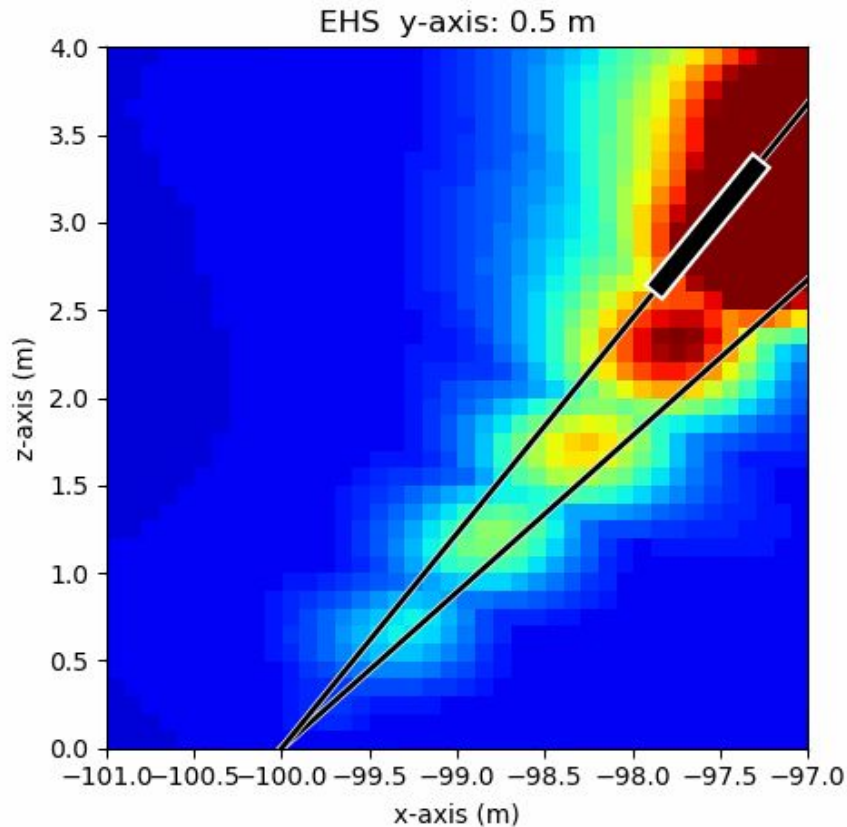
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Simulations

CBC NEC Simulations

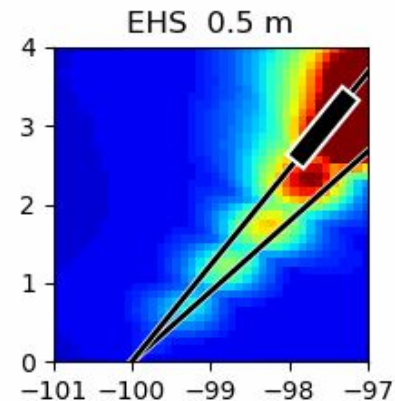
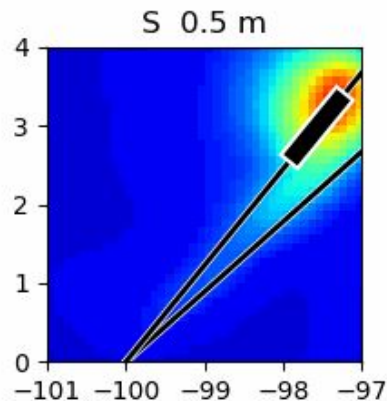
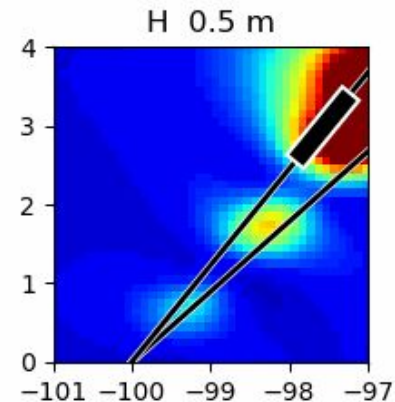
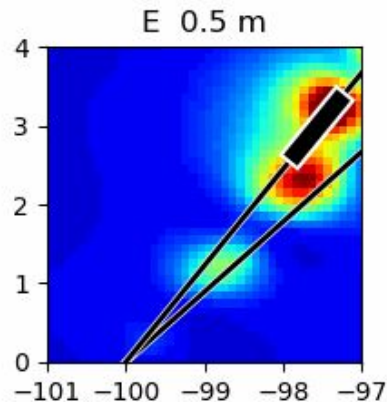
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Simulations

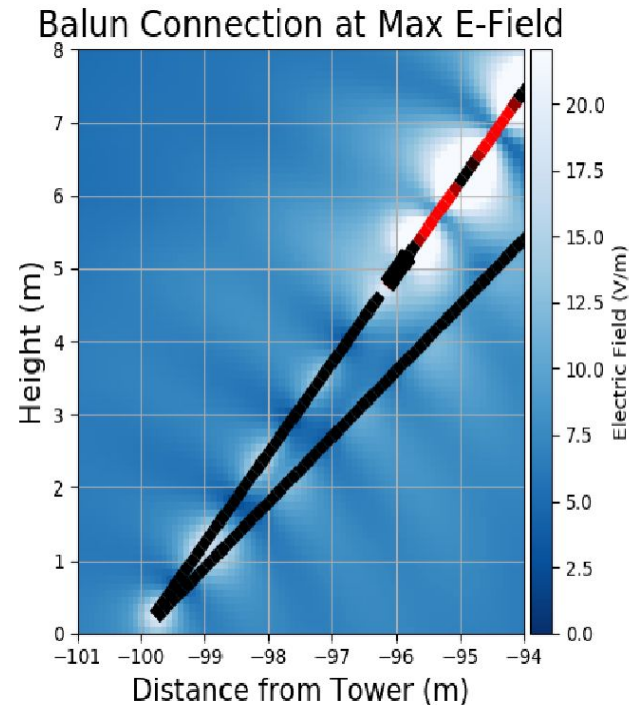
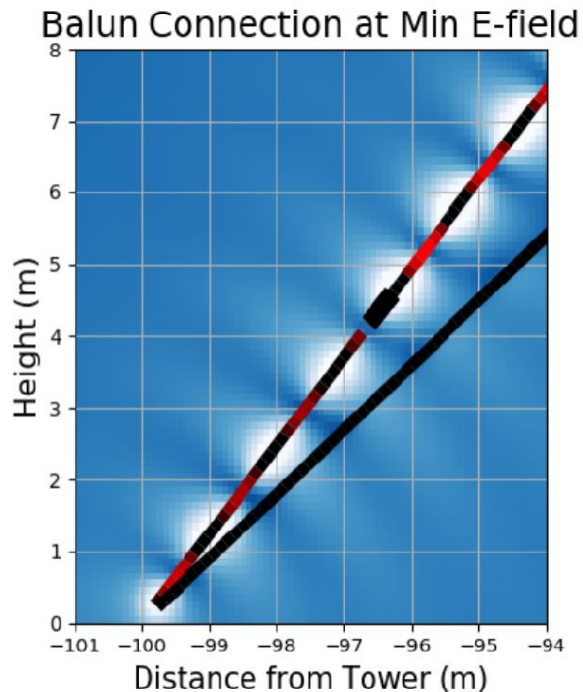
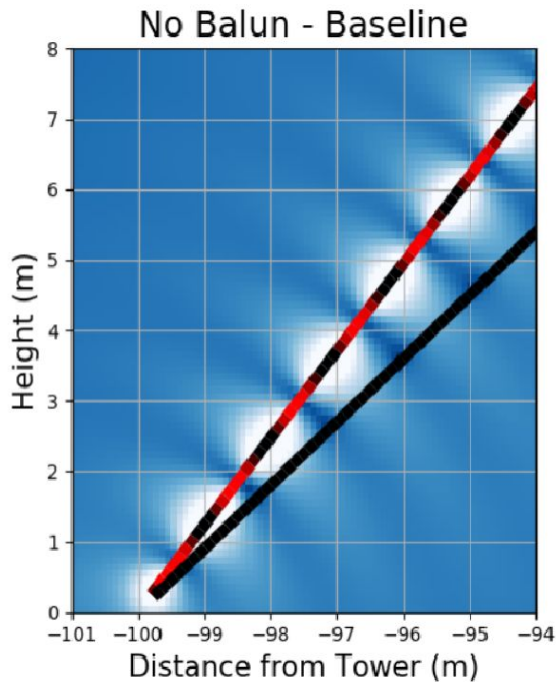
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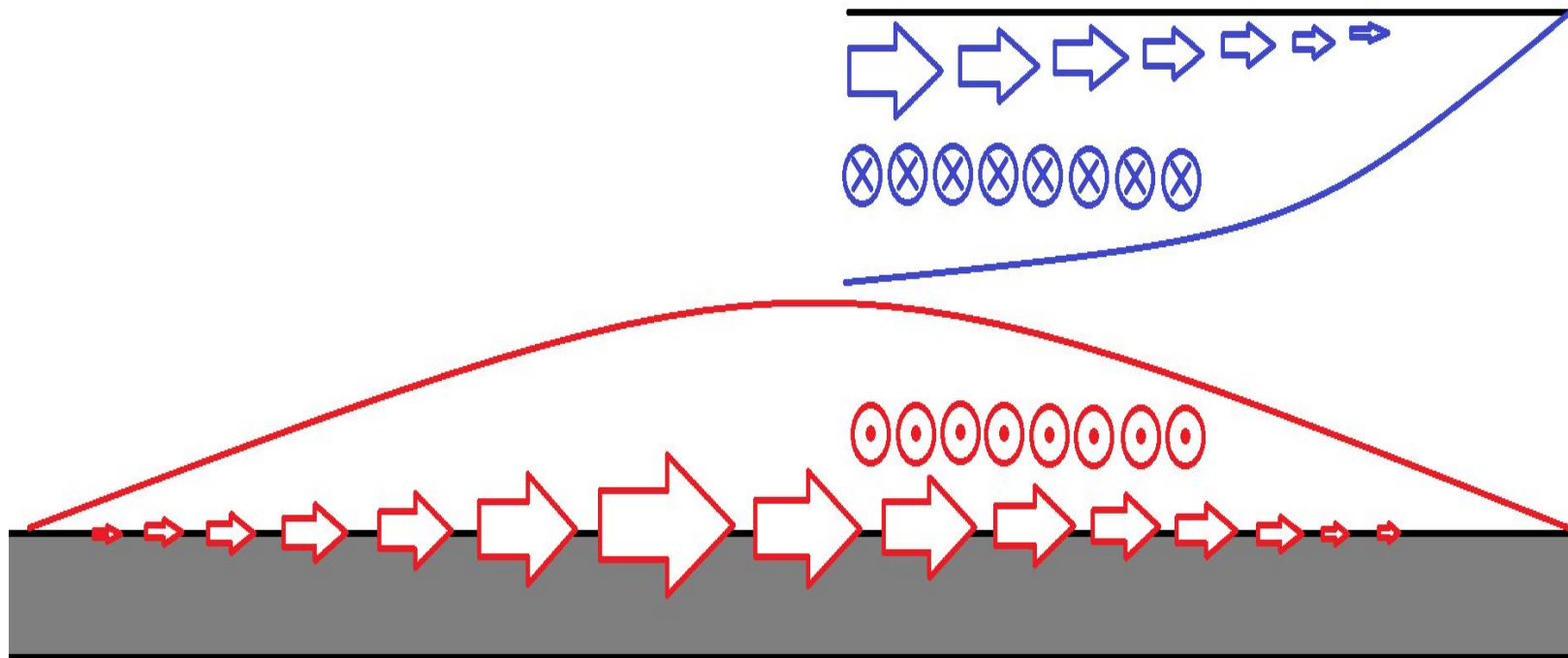
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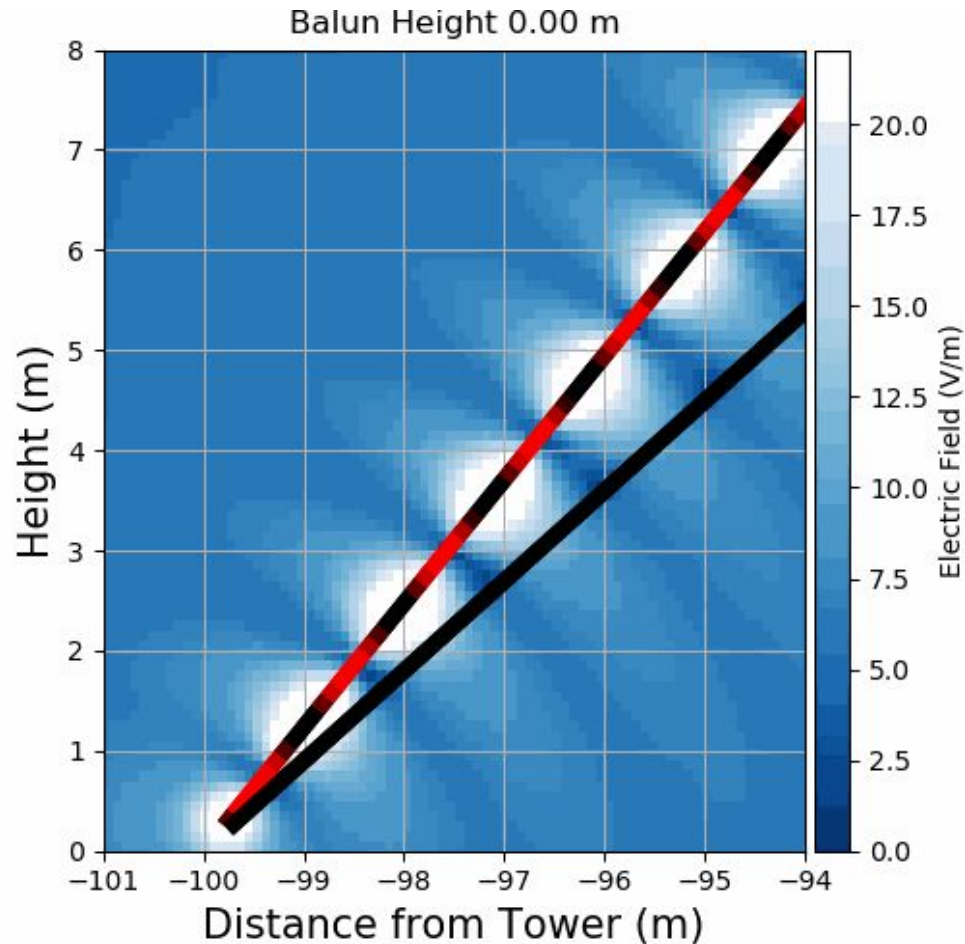




Simulations

CBC NEC Simulations

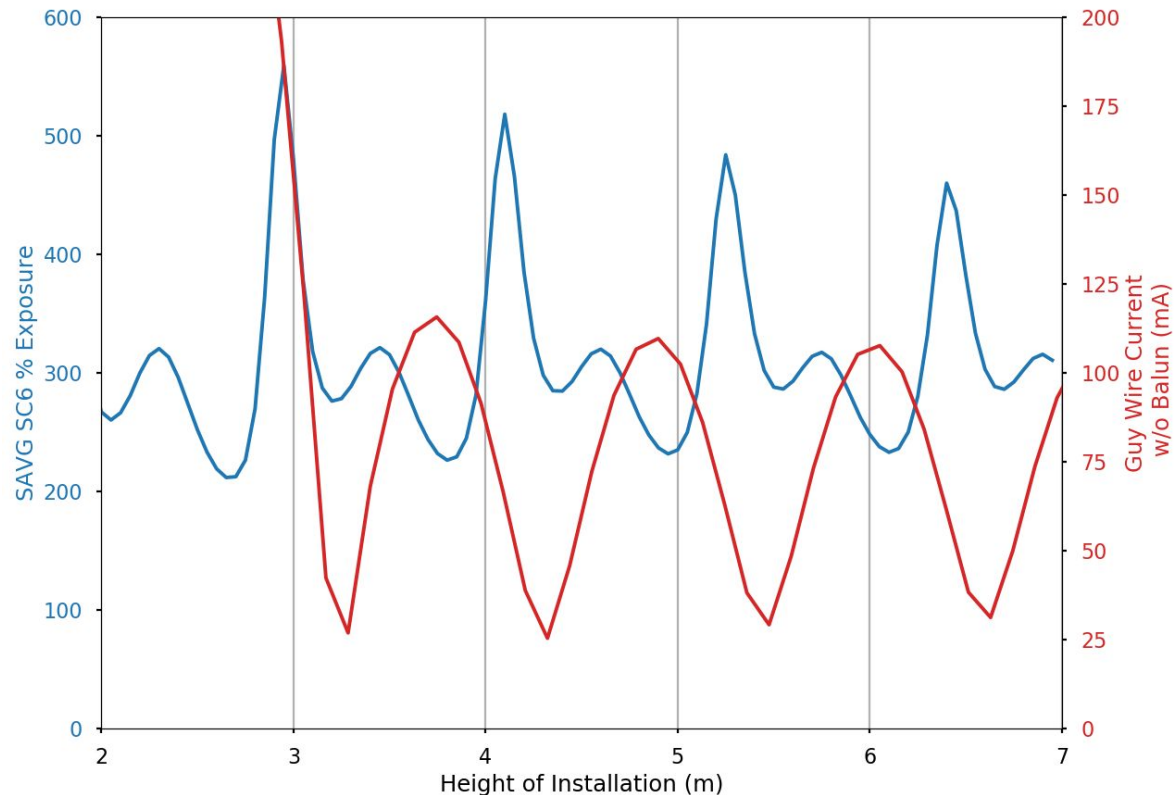
- Electric Field levels with Bazooka
- Balun height varies
 - Guy current varies
 - Electric field varies



Simulations

CBC NEC Simulations

- Standing wave-like current distribution on guy wire
- $\lambda/2$ periodicity
- Location of balun influences isolation performance



1st Prototypes

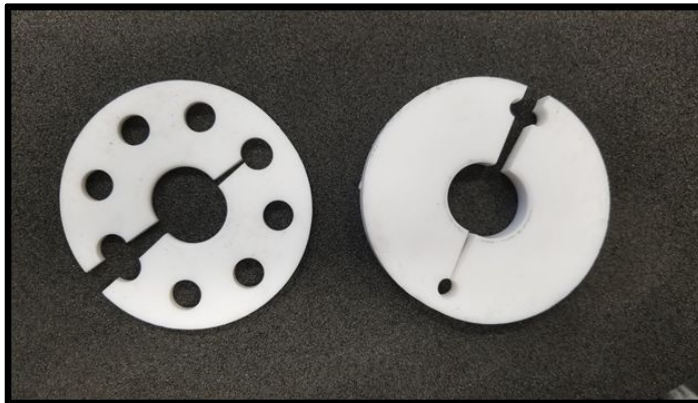
What happened in the field?

Homemade prototype (Recycle!)



3" 1/8 copper transmission line pieces
Teflon rings
Hose clamps
Copper grounding braids

We have installed baluns at 10 transmission sites



Test Setup

Optimise sleeve's position and length

- **Fixed E-field probe on tripod**
- **Current Clamp placed on guy wire**
- **Selective RF Meter**
determine main contributors
perform spatial averaging





Winnipeg, MB

Starbuck transmission site (before)

High power broadcast site (582 KW ERP)

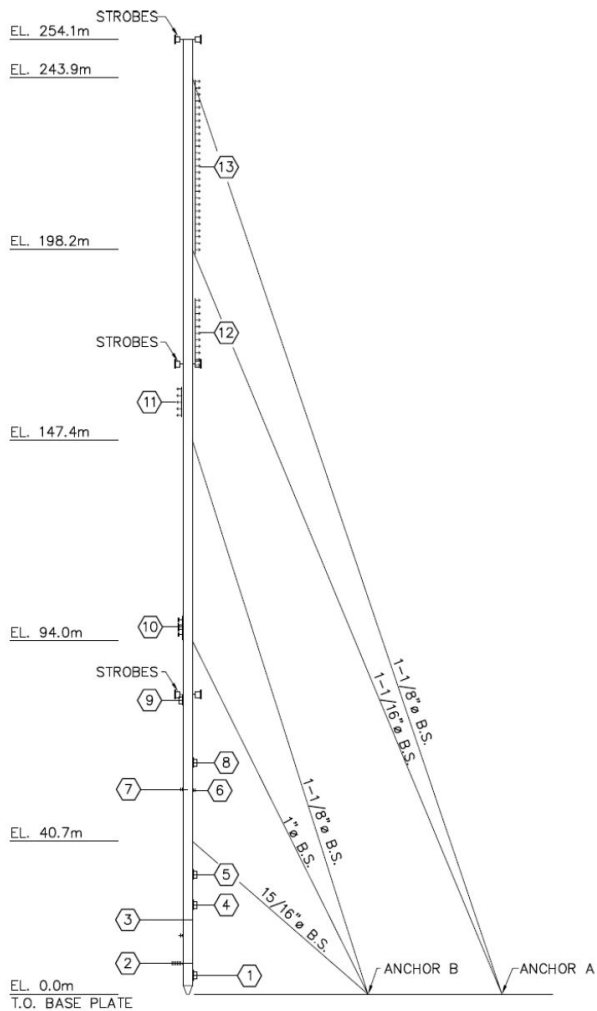
Hotspot \approx 2000% SC6

Multiple FM contributors

Very large cumbersome temporary fence
installed to prevent access

→ Permanent solution needed to ensure
compliance with SC6





Before - Without Bazooka Balun

Total : 1968.1 %

CKSB-10-FM	88.1 MHz	79.0 %
CKSB-FM	89.9 MHz	13.0 %
CKXL-FM	91.1 MHz	20.5 %
CHVN-FM	95.1 MHz	270.5 %
CBW-FM	98.3 MHz	1479.0 %
CKCL-FM	107.1 MHz	103.2 %
Others	inf MHz	3.0 %

73 After - With Bazooka Balun

Total : 49.8 %

CKSB-10-FM	88.1 MHz	9.5 %
CKSB-FM	89.9 MHz	1.9 %
CKXL-FM	91.1 MHz	0.3 %
CHVN-FM	95.1 MHz	11.0 %
CBW-FM	98.3 MHz	17.2 %
CKCL-FM	107.1 MHz	9.8 %
Others	inf MHz	0.1 %



Bazooka balun installations

Highest Spatial Average Measurement % SC6-2015 Uncontrolled Environment (with Uncertainties)		
Transmission site	Before - No Bazooka Balun	After - With Bazooka Balun
Belleville, ON	200%	22%
Kingston, ON	113%	58%
Campbell River, BC	> 2500%	92%
Little Current, ON	163%	93%
Fleurimont, QC	146%	41%
Winnipeg, MB	1968%	92%
Grande Vallée, QC	315%	42%
New Richmond, QC	115%	37%
La Sarre, QC	386%	63%

2nd Prototypes

Stainless Outfitters

Belleville, ON - September 25, 2019

Kintronic Labs

More simulations and prototypes to come



What have we learned in the field?

Conductive material used for sleeve: Aluminium /copper / steel

Optimal sleeve length: 0.24λ or slightly less

Sites with multiple frequencies and/or high power may require multiple baluns

Cylinder and rectangular shapes work

Positioning and length of the sleeve is crucial

Very high NIR levels measured near the sleeve

Significant impact of the ground wires on the guy wire



What to monitor?

Potential problems

Galvanic corrosion → next prototypes in stainless or galvanized steel

Displacement of ground wire connection

If the sleeve breaks / makes contact with the guy wire, it no longer works

How snow or ice could impact performances

Tower/guy wire loading, tension measurements

Monitor existing installations for long term effectiveness

Kingston & Belleville, ON

Installation: May 22

Validation: September 25 (4 months later) = ok!



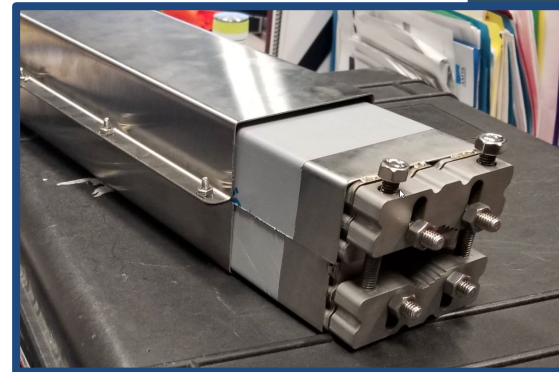
Next steps & Conclusion

Gain better knowledge (simulations and field tests)

Improve prototypes (effective, easy to manufacture, easy to install)

→ **The industry now has a new mean of solving SC6 issues near guy anchors!**

Fencing is not the only solution!



Acknowledgments

Max LaRiviere Birch, Alphawave Mobile Network Products (FieldSENSE) - For suggesting to use the bazooka balun principle on guy wires to solve SC6 issues

CBC/Radio-Canada Transmission Staff - For all the help, support and ideas to make it work in the field

RABC Radio Advisory Board of Canada - For the members contribution to the initiative



transmission



Acknowledgments

Yves R. Hamel & Associates Inc. (YRH) - For graciously providing a current clamp for the experimental testings

Stainless Outfitters Inc. - For manufacturing the firsts professionnel prototypes

Kintronic Labs - For the simulations and upcoming prototypes



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Questions ?



Thanks !



A 5¢ bazooka is better than a 3000\$ fence!
SC6 is no joke!