Study of Impedance Variation Across the Lower Abdomen

in the Dorsal - Ventral Direction

as a function of Fullness of the Urinary Bladder

in the Adult Human

A Finite Element Model (FEA) using flexPDE

Craig E. Nelson - Consultant Engineer

Nelson Applied Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com

Goal for the Numerical Study

A steady state finite element model is to be developed that aids understanding of the variation of electrical impedance across the lower abdomen in the Dorsal-Ventral direction as a function of fullness of the urinary bladder.

The model is “electrostatic” in the sense that any time variation of electric current is considered to be slow compared with the propagation time of local electromagnetic waves that may be generated by the electric current generating source. Also, induced magnetic fields are considered to have negligible effect.

“Snap shot” plots show the bladder and related parameters at empty, medium and full levels of physical distension. In this way, the percent change in electrical impedance can be roughly estimated over the full range of bladder fullness.

The results show that the impedance variation is small but, with care, measurable.

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Solution Domain Geometry

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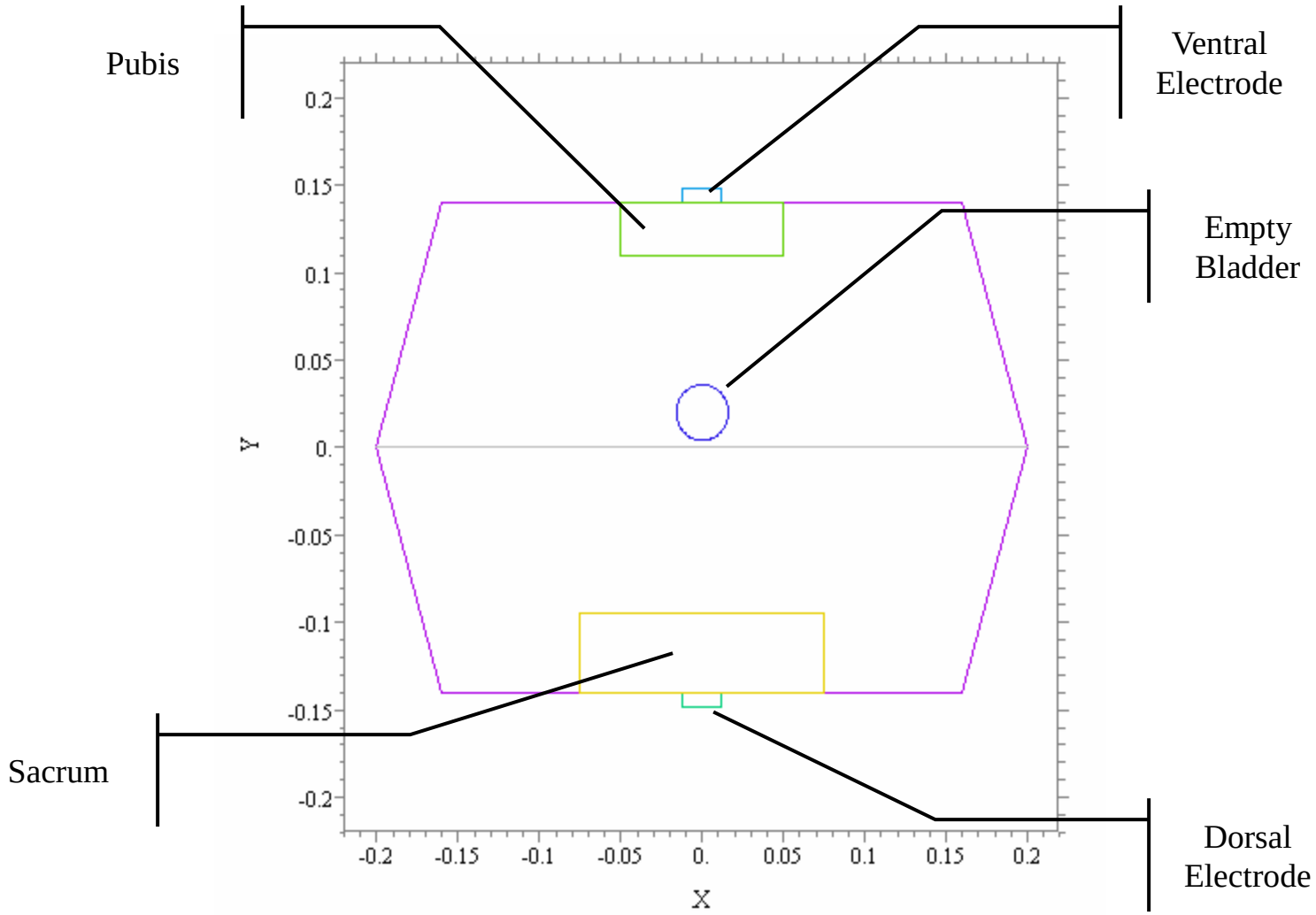

Cross Section of the Lower Abdomen

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Numerical Experiment Results

-- Potential --

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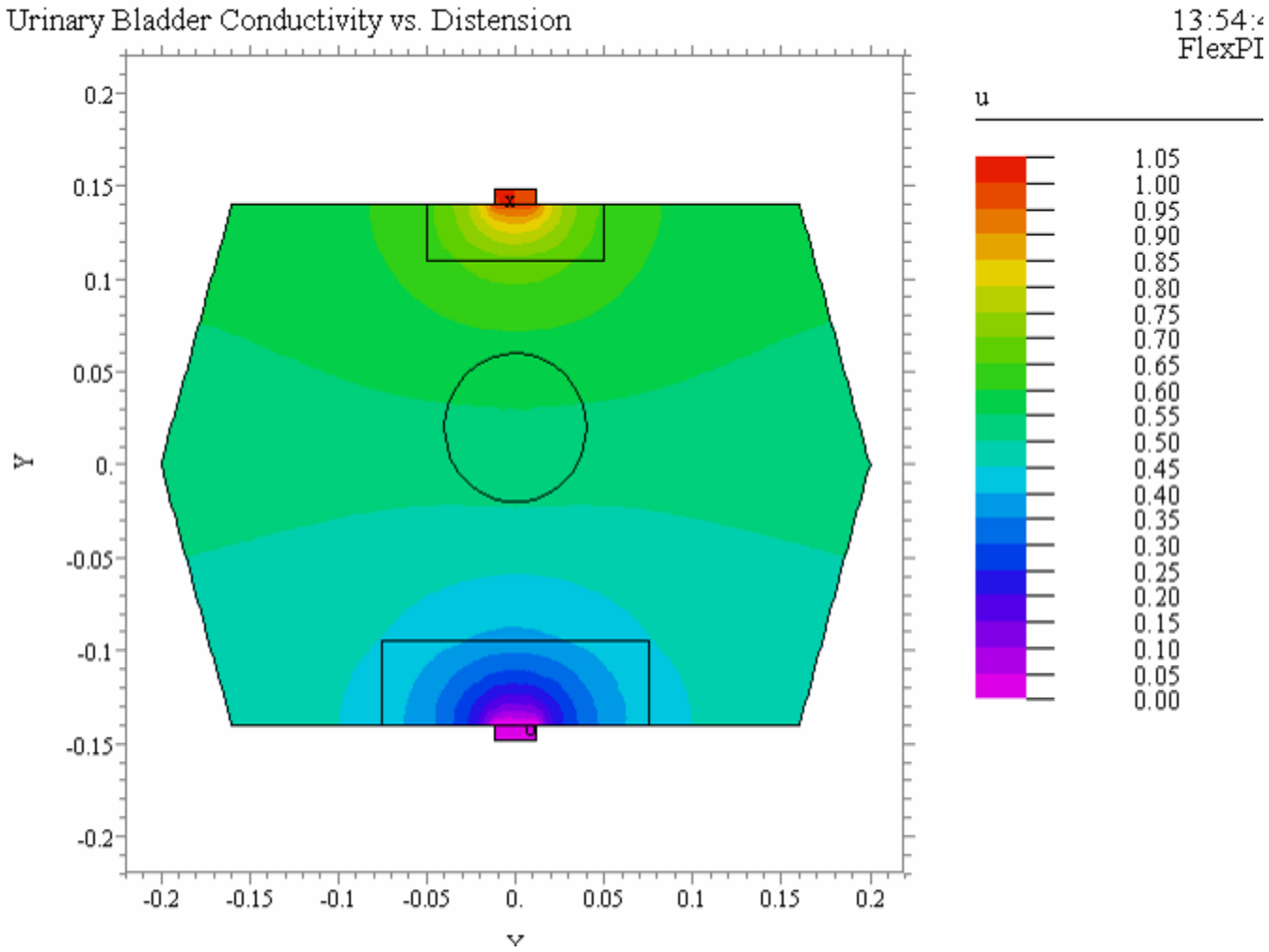

Potential – Half Full Bladder

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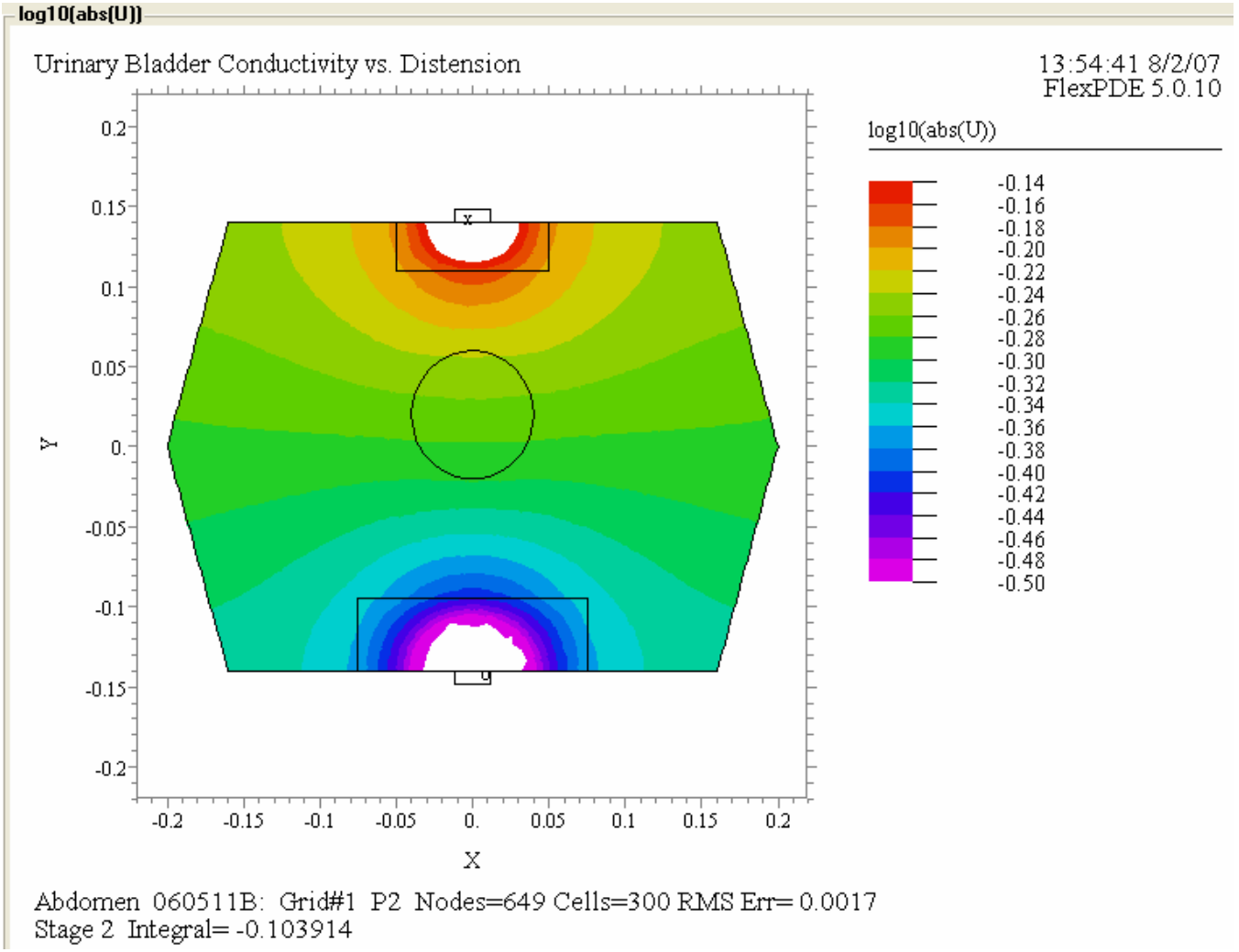

Potential – Half Full Bladder – Log10 Plot

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Numerical Experiment Results

-- Electric Field --

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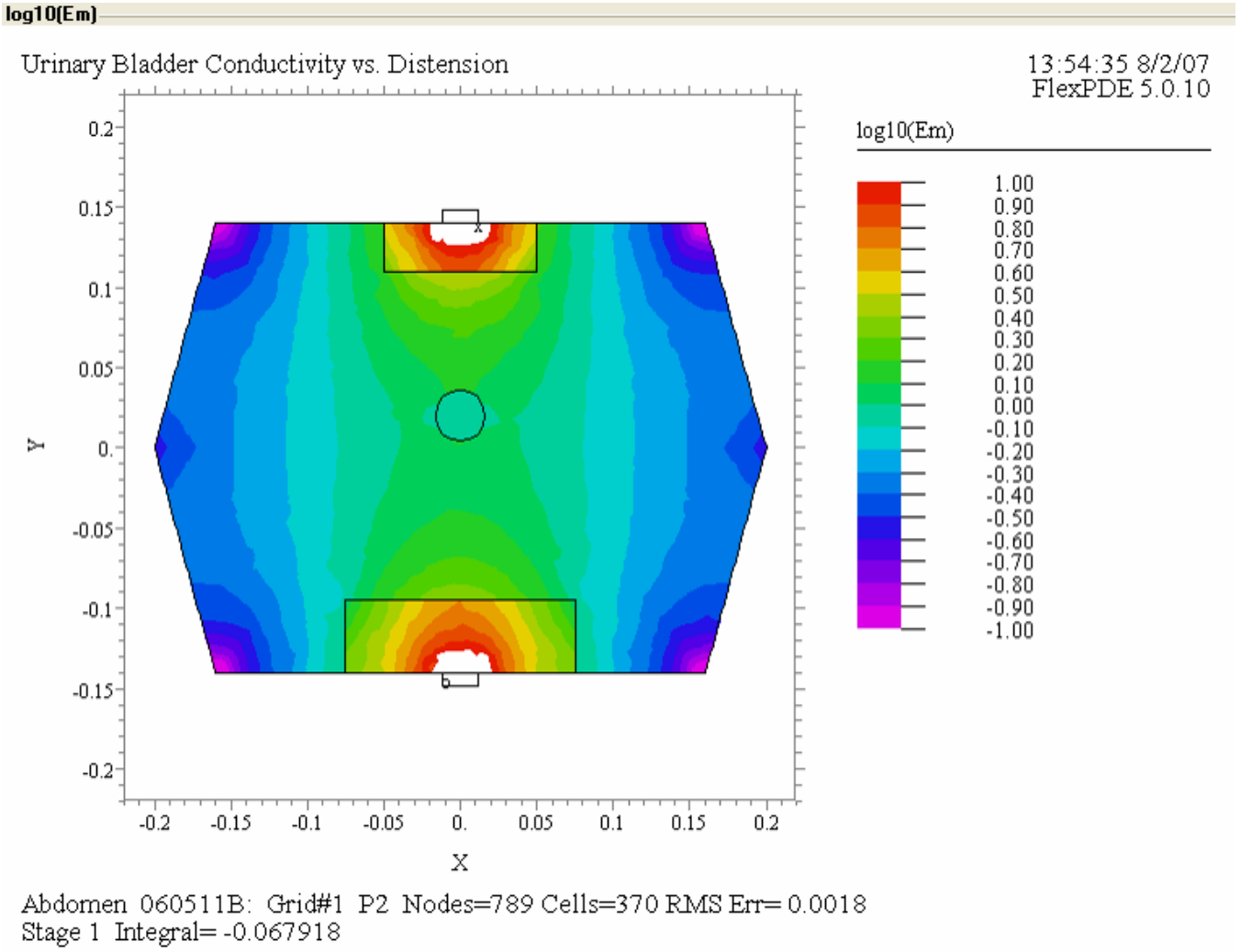

Electric Field – Empty Bladder – Log10 Plot

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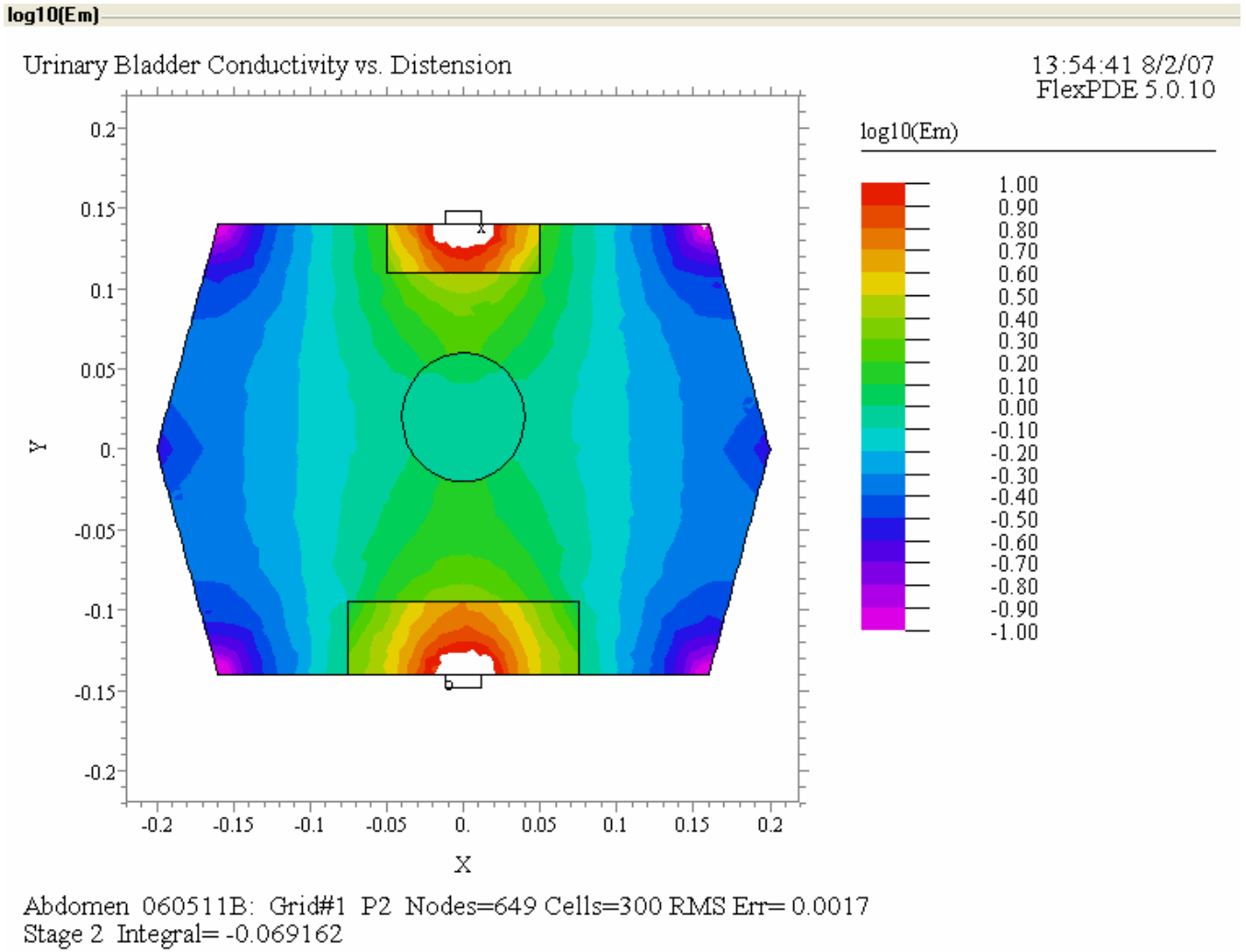

Electric Field – Half Full Bladder – Log10 Plot

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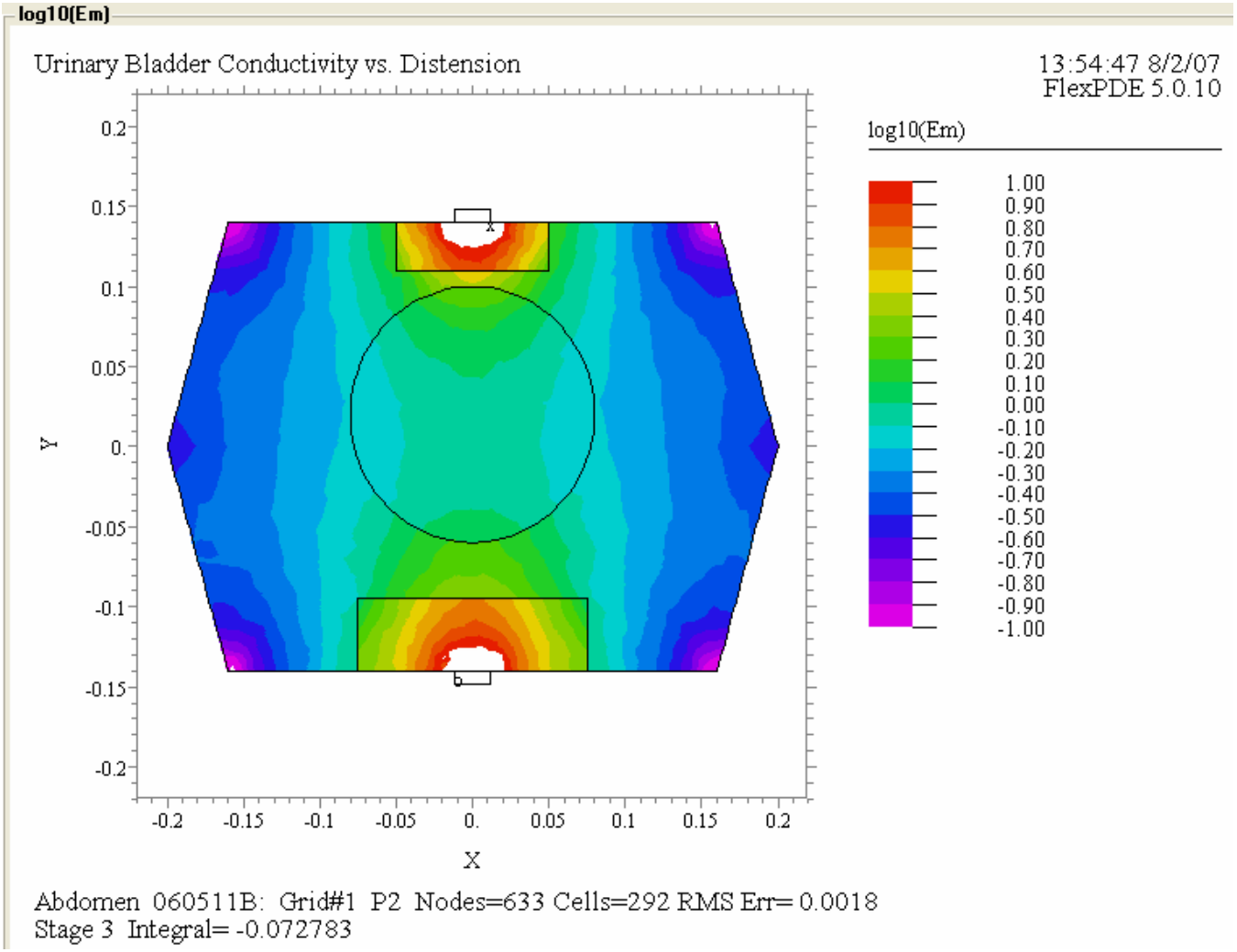

Electric Field – Full Bladder – Log10 Plot

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Numerical Experiment Results

-- Current Density --

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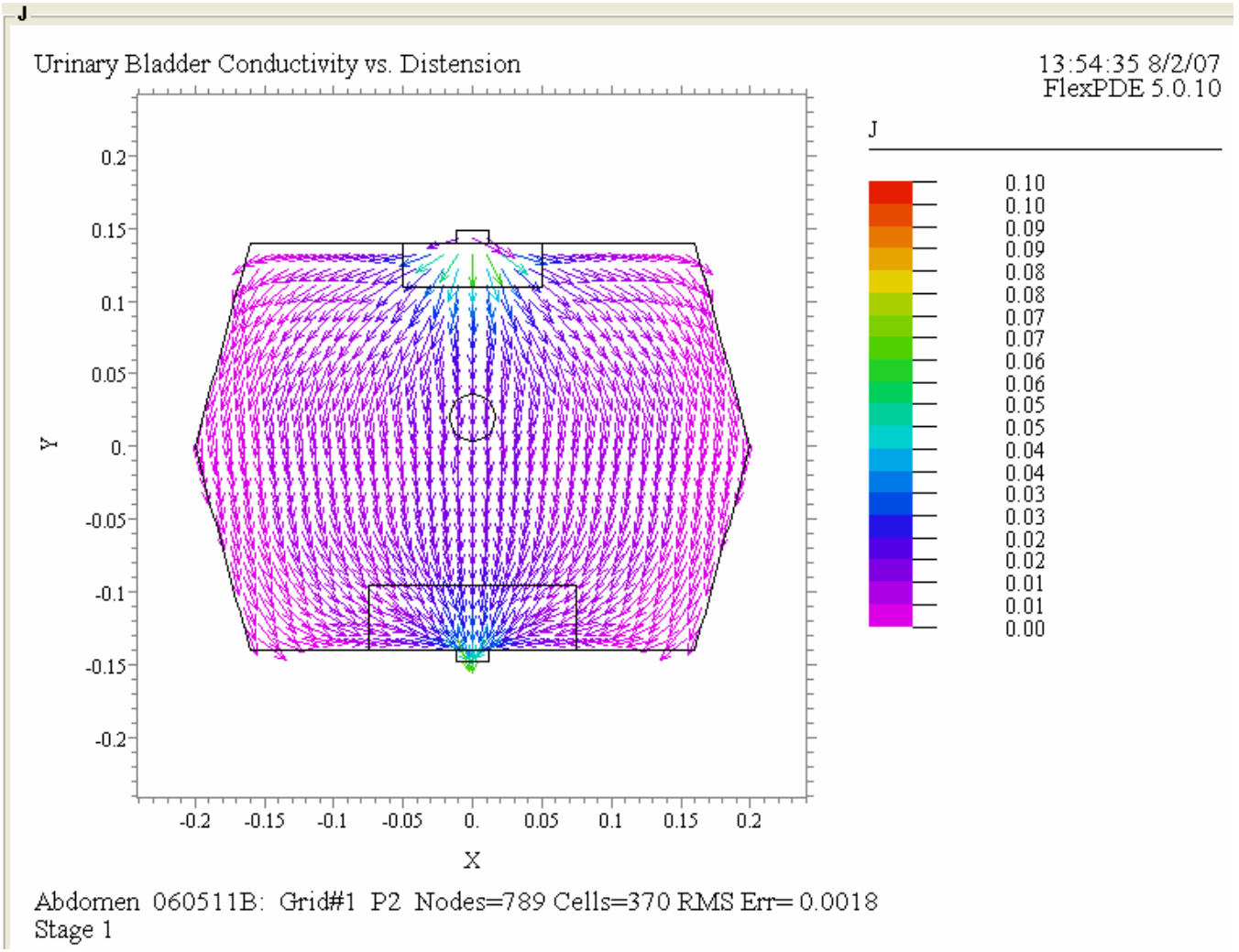

Current Density – Empty Bladder – Vector Plot

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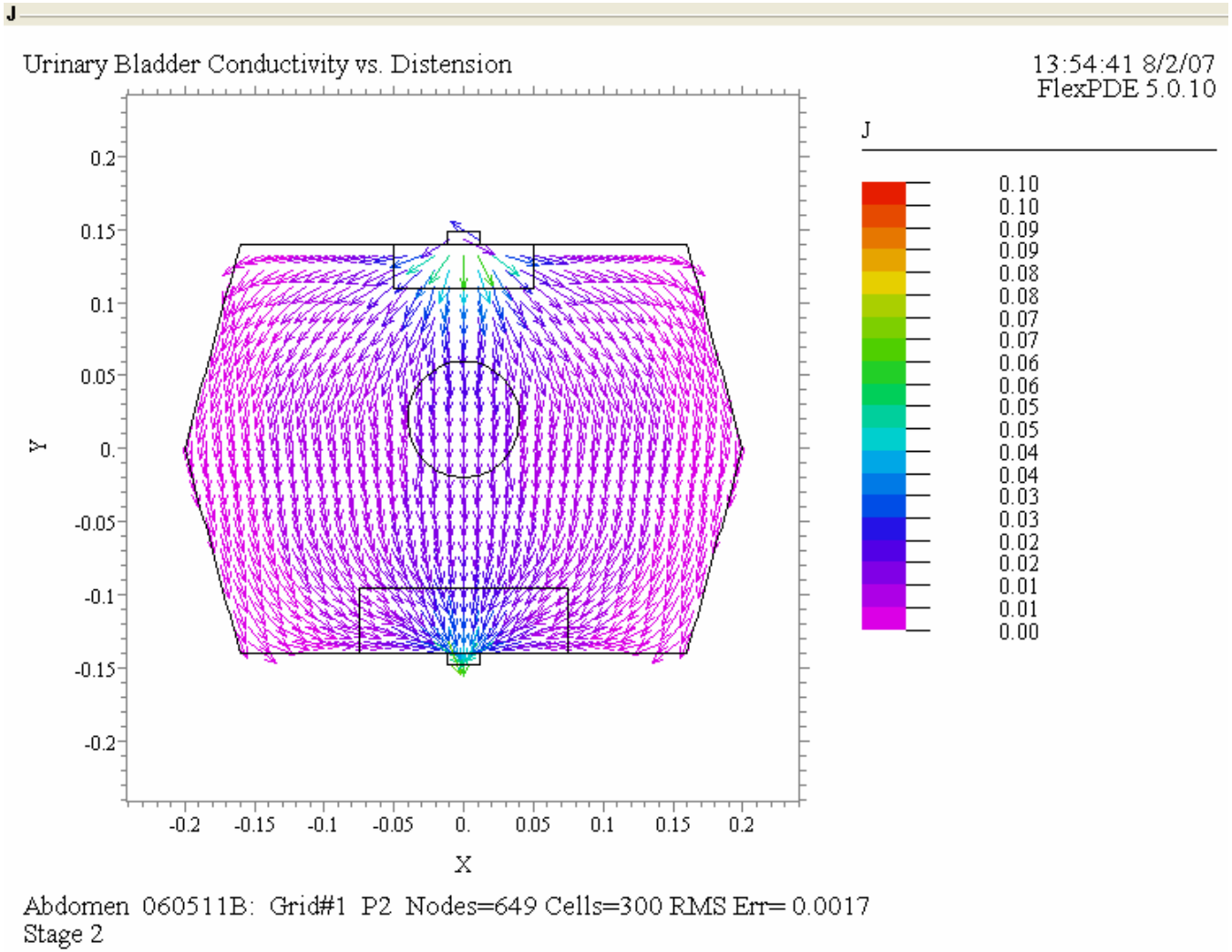

Current Density – Half Full Bladder – Vector Plot

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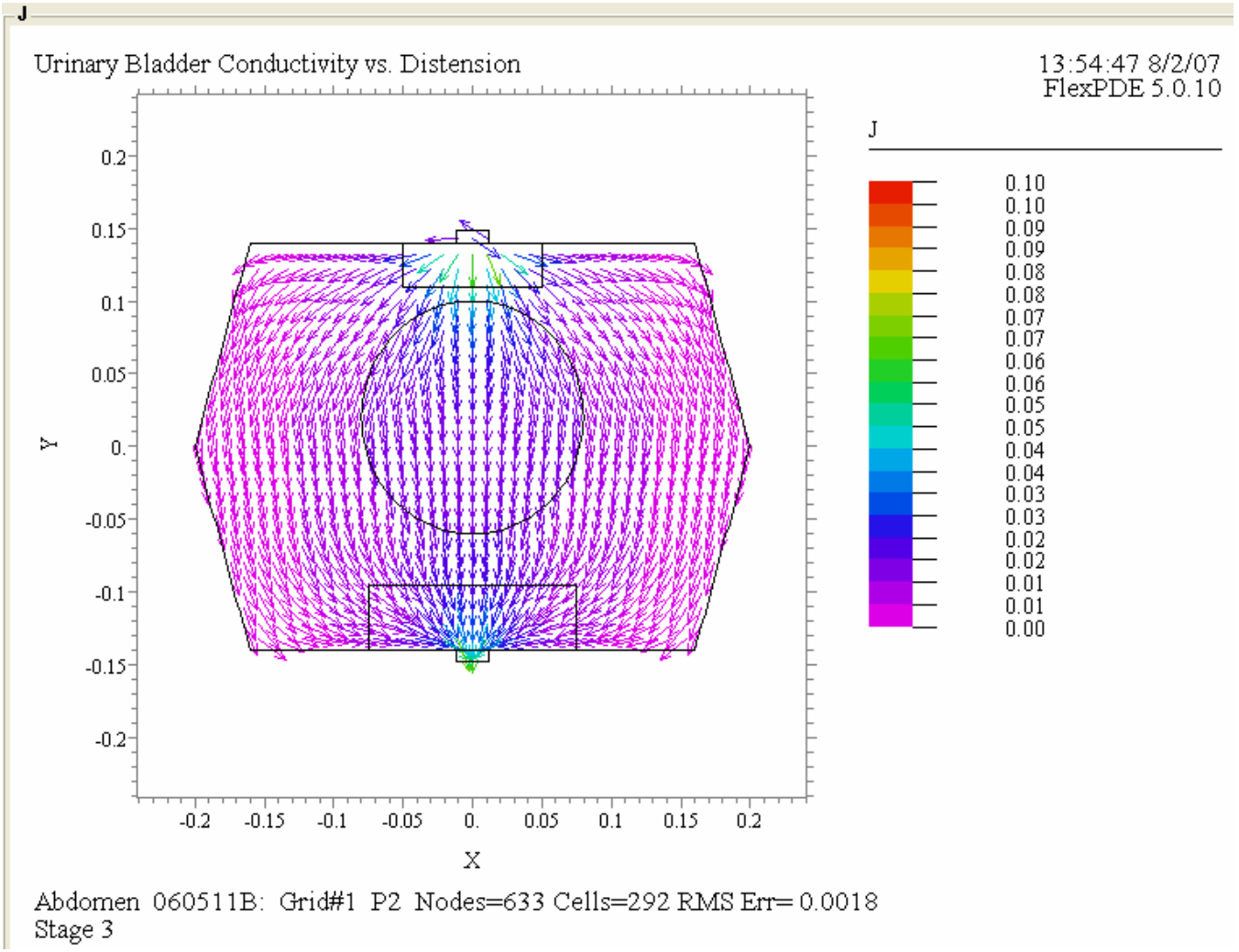

Current Density – Full Bladder – Vector Plot

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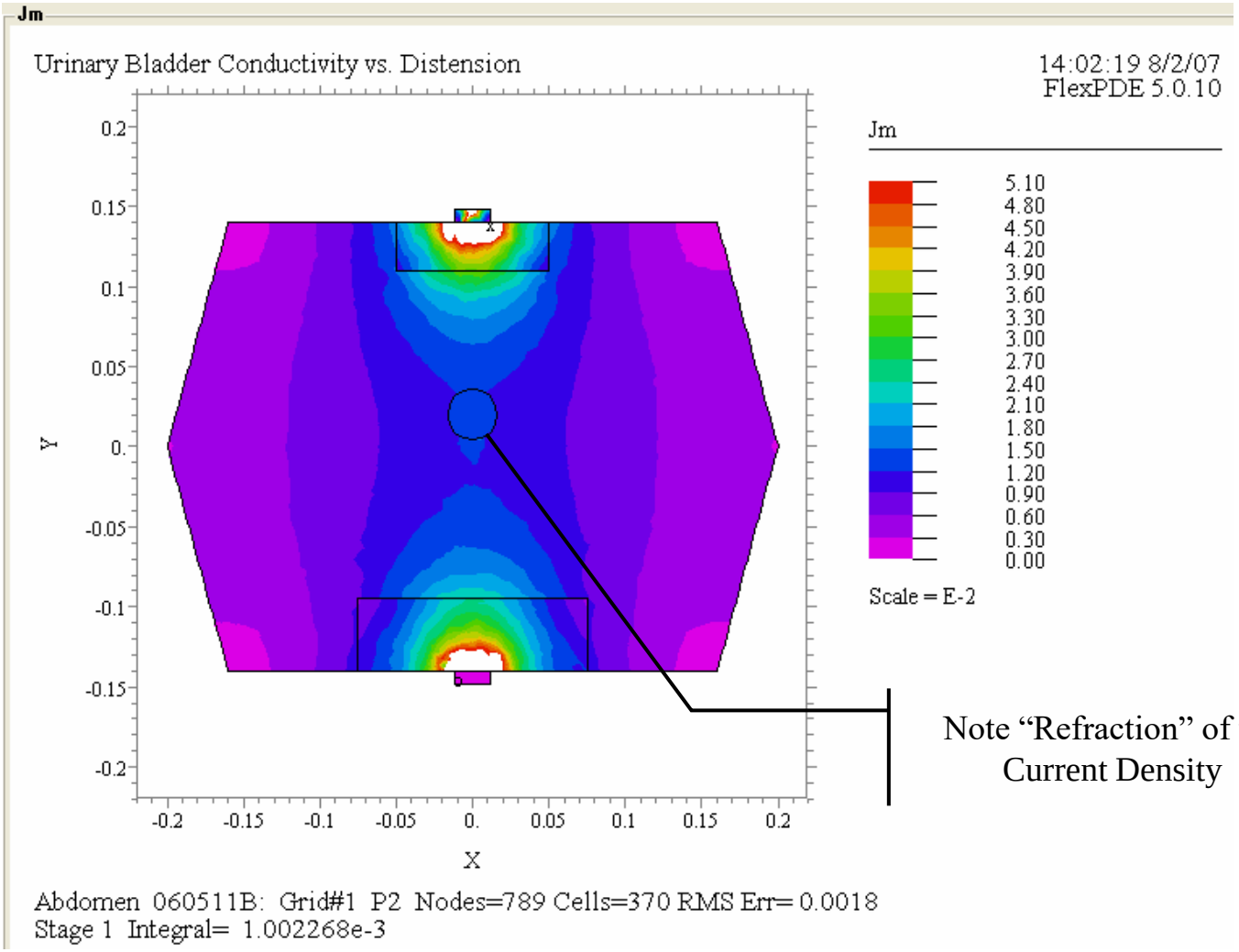

Note "Refraction" of the Current Density

Current Density – Empty Bladder – Contour Plot

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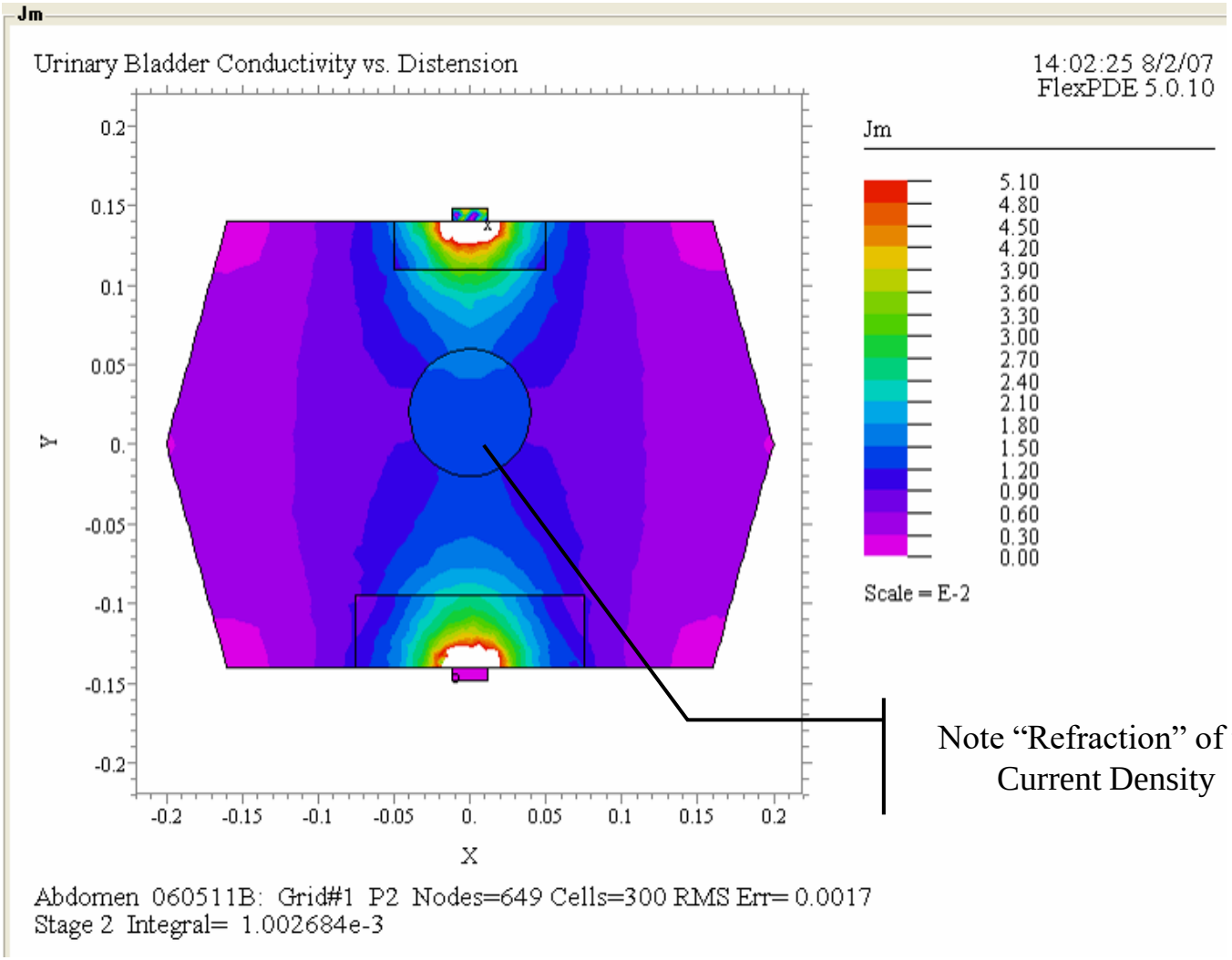

Current Density – Half Full Bladder – Contour Plot

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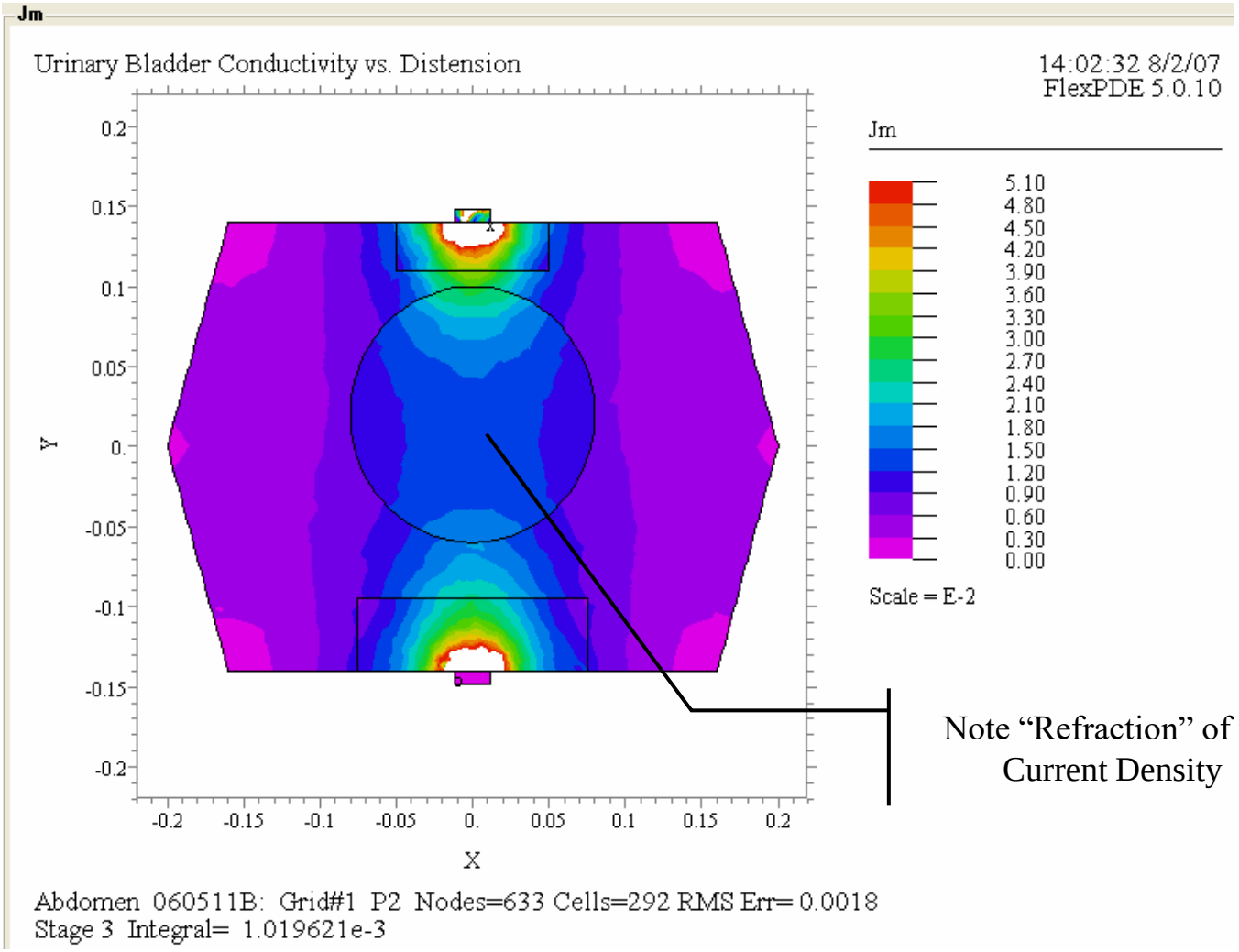

Note "Refraction" of the Current Density

Current Density – Full Bladder – Contour Plot

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Summary

A finite element model has been developed that aids understanding of the variation of electrical impedance across the lower abdomen in the Dorsal-Ventral direction as a function of fullness of the urinary bladder.

The model shows that as the bladder fills from empty to full, the impedance changes by about 3.4 percent. This is a small, but measurable variation, in a practical scenario.

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