

# Questions and Answers with Nathan Cohen

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## *PART 2 October 2012--CLOAKING A MAN*



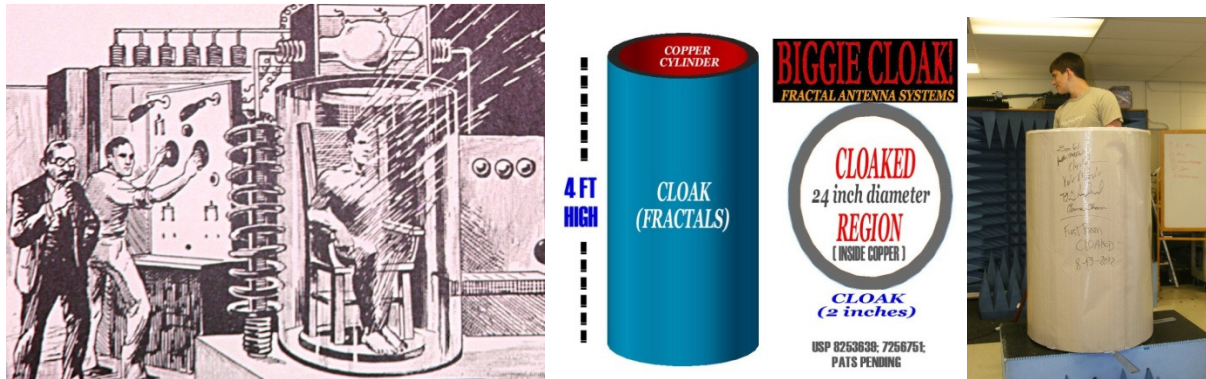
Nathan Cohen with patent plaque and an invisibility cloak

**Q: I'd like to start by revisiting the two images below.**

**A:** The sci-fi shot is a man who is disappearing, from the 1930's pulp magazine era. The second is an invisibility cloak (graphic) used to cloak a man in August 2012 , and subject 'Peter ' in the cloak.

**Q: Let me repeat-- you CLOAKED A MAN!**

**A:** Yes. We cloaked a man, at microwaves. First in August 2012. Here's a video link:



[http://www.youtube.com/watch?v=Z\\_bj5NTnd\\_0](http://www.youtube.com/watch?v=Z_bj5NTnd_0)

**Q: That's amazing.**

**A:** It's humbling and also burdensome There's been more to my life than that, but I am sure that will be a perceived punchline.

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## Seeing is believing

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**Q: How did it feel to cloak a man?**

**A:** You fight nature to give up her secrets. It's very sweet to win. Of course then you have to deal with a plethora of hassle from competitors and 'colleagues' who pretend you don't exist. They don't 'see' you. I took the trouble of understanding paradigm shifts many years ago. My family dubbed me the 'invisible ham' because of the hassles. Pretty funny☺!

**Q: Why ‘invisible ham’?**

A: It’s a takeoff of H.G. Wells’ book and the fact that ham radio had impact on getting me there. What it really means is that people perceive that I came out of nowhere. It’s a huge but often unintentional insult, so you laugh it off.

**Q: Why is that competitive hassle a problem?**

A: Because it sends the wrong message to young people, and we can deter future progress if the young are discouraged by some silly censoring, or pretending like it’s a clique with the popular people in high school. Right now it’s very difficult to persuade American students to get Ph.D.’s in engineering, for example. That’s a tragedy in the making.

**Q: Are they (colleagues) threatened?**

A: Why should they be funded to get at a target that’s already been hit? They should be concentrating in science first and funding second. I’ve already had people call me to get copies of the preprint article so they can charge more experimenting to their grants and get more grants. So much for the science.

**Q: Is there a symbolism that the first cloaked person is young?**

A: Absolutely; all progress is done for the young and future generations.

**Q: Can you tell us more about him?**

A: His name is Peter and he is a very bright young man with great promise as a future engineer. Beyond that you should let him decide for himself when he wants to discuss it. I confirm & support him when he brings it up.

**Q: Has Pandora’s Box been opened?**

A: All technology can be used for good or bad. If it only had a bad side I would have chosen not to do it. I do not assist nor enable the bad ones.

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# **The invisibility cloak is a Jetson technology on a Flintstone budget**

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**Q: Two big names in 'cloaking' are Ulf Leonhardt and John Pendry. Have you contacted them?**

A: Yes. Ulf is collegial but hasn't followed through to visit to date. He is into 'perfect' cloaks. This is not a 'perfect' cloak.

**Q: John Pendry?**

A: Has been invited twice to see the cloaks. No acknowledgement nor response.

**Q: What does that mean?**

A: From my end? Only that there won't be a third invitation. I put no additional conjectures on that.

**Q: Are such responses important?**

A: Well, no. Not scientifically. I was extending a courtesy.

**Q: What you have done is the very opposite of 'Big Science'. What's it like?**

A: It's like being on a desert island and building up your own technology such as 'Gilligan's Island', or the 'Flintstones'. You can't answer all the questions of nature this way, but damned if there isn't a lot that you can. This one was reduced to a simple approach. Working at simplicity is arduous and time consuming. Ultimately, the invisibility cloak is a Jetson technology on a Flintstone budget.

**Q: I want to get back to China...**

A: Enjoy the trip.

**Q: What is your opinion?**

A: PRC Chinese scientists are smart, hardworking, and motivated. These are American virtues, or used to be. We get lazy; they get going. Unfortunately it's under communism and 'state capitalism'. A basic tenet of state capitalism is the undercutting of intellectual property. If there was no patent system I would not invent. I cannot advocate the PRC communist system and its destruction of IP. People don't implement ideas when they get pirated or taken away. Atlas shrugs.

**Q: But you have no problem with PRC Chinese scientists?**

A: It's not a cultural issue. Certainly it's not a race issue. I would be appalled by that insinuation. IP destruction is the new 'Great Wall'. This is unfortunate, as I admire their positive qualities. They are trapped by a socialist cloak. I cannot work with them because of communism. Oddly, they are the only world group that 'gets' fractal antennas. I was told at a colloquium that I am viewed there with reverence for starting the fields of fractal antennas and fractal filters. Reverence! How's that! They are the only ones that cite the original fractal antenna article from 1995. I am thankful for their collegiality --but I can't work with them for the reasons just mentioned. Can we get off politics now 😊?

**Q: Is the 'biggie cloak' being published?**

A: Yes; soon. In a peer reviewed journal.



**Q: Some people are under the impression that visible light invisibility cloaks are already in use in war zones.**

A: Beyond narrowband and tiny, they do not exist. Projection cloaks exist.

**Q: How can you be sure?**

A: Look who you are asking☺! Projection cloaks have been around for at least 10 years. They are a form of camouflage with limited success and are power hungry.

**Q: Are you looking forward to visible light invisibility cloaks--ones big enough to wear?**

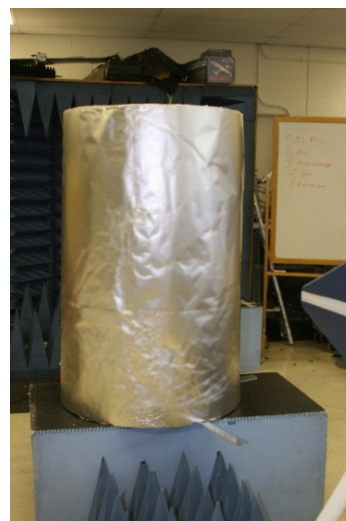
A: I don't have a great longing to hide. I think that psychologically I already blend into the scenery. I am a private person by nature. When I go to Starbucks in Belmont Center, I don't stand out. People can be interrupting Nobel Prize winners at the next table, discussing economics--that dismal science-- but I am fine sipping and reading Goethe or Godel. I could be selling vacuum cleaners.

**Q: Will you donate Biggie Cloak to the Smithsonian?**

A: Haven't been asked. But time flies; best to ask soon. Otherwise we will break it down and recycle the fractal metamaterials for other experiments.

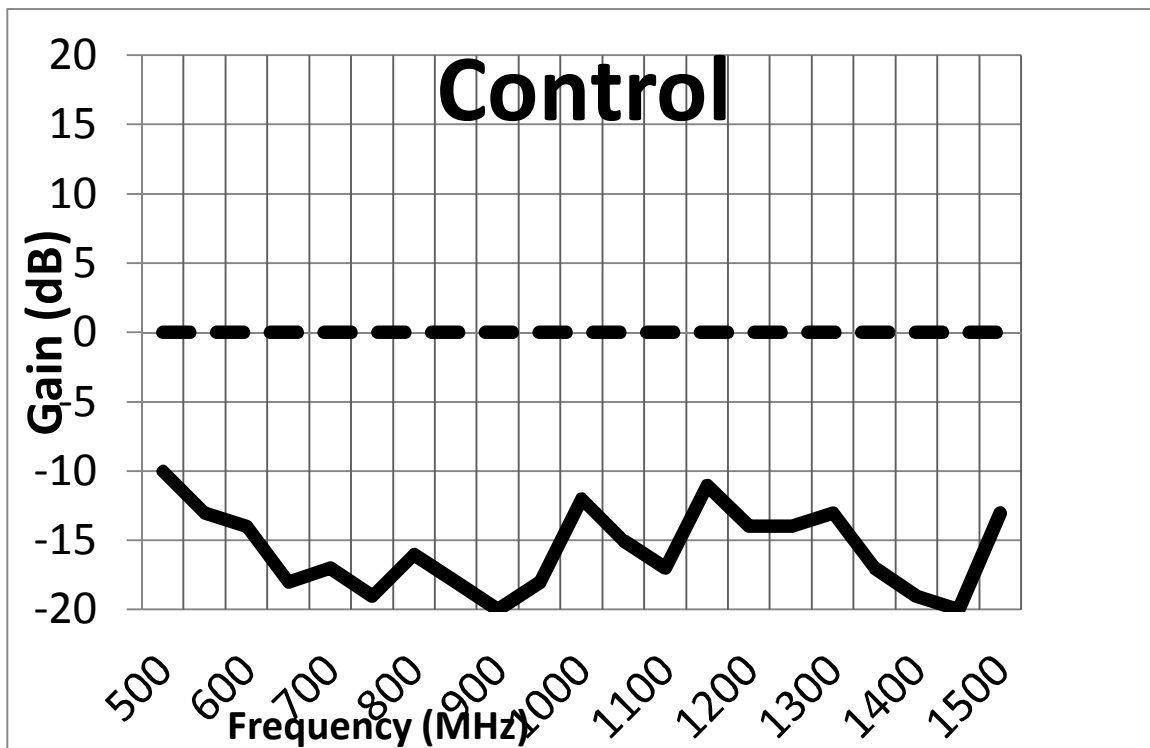
**Q: Can you show some more data on Biggie Cloak and subject Peter?**

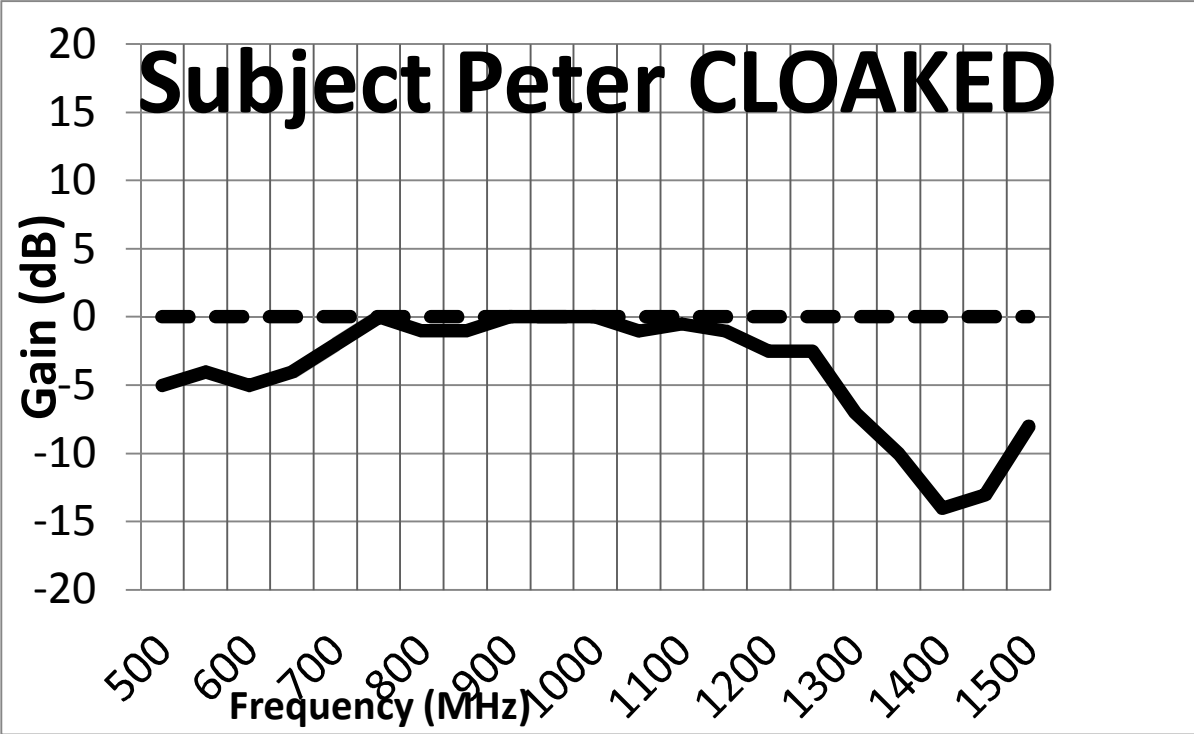
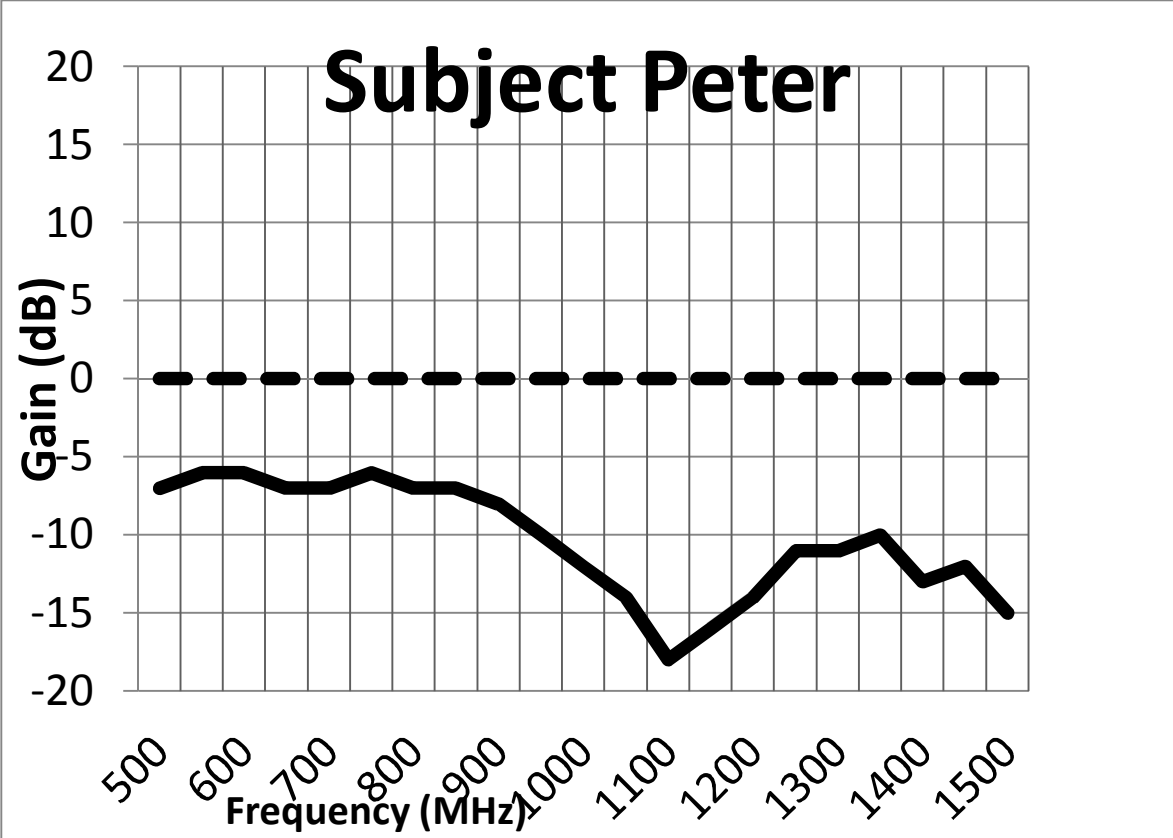
A: Well, there's the video. But some people like line graphs. There's a peer reviewed scientific paper in press. But here's some nice visuals: Here's Peter, in one of the cloaking sessions, having the cloak placed on him, and the 'control', which is empty and just a foil metal cylinder.



The key data is shown here as three spectral graphs where the intensity of the microwaves over frequency is compared to a direct, unobstructed path (dotted line), and the control.

The **control** shows that the geometry of that sized cylinder, when metallic, is a major obstruction and is not 'diffracting' the signal around to the other side; the '**Peter**' graph shows Peter makes a great door but lousy window (he is an obstruction); and the third shows that the **cloak (over Peter)** diverts the waves around to the other side and recovers the intensity of the direct path for a large bandwidth. Notice the cloaked intensity closely matches the direct path (dotted line) for most of the passband.







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## **You fight nature to give up her secrets**

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**Q: Going back to the original cloak approach in 2006 by a group led by David Smith at Duke, you mention that the experiment had a fatal flaw.**

A: First, it's important to separate a critique of an experiment from the criticism of a person. I have no such malice nor criticism of Smith, Pendry nor others. We are all scientists. But scientists are not science. An experiment is science. Now; the flaw you mention is that the experiment had no control. The control would be *the outer layer* of the cloaking (attempt) device replaced with a solid metal layer. That outer layer establishes whether diffraction is capable of producing the antipodal scattering seen--it's not. We were very careful to establish and measure the controls on our cloaks. Our control on Biggie Cloak had no measureable antipodal scatter (see graph)-- so diffraction was not causing the cloaking response. In other words, this was something new and novel. The 'Duke' effort had no such control and, IMO and that of the U.S. Patent Office, could not exclude diffraction effects as responsible for the (attenuated) signal seen at the antipodes in their experiment--which was interpreted a cloaking.

**Q: How do you get people to understand that you've made this major milestone?**

A: When the Wright Brothers flew at Kitty Hawk it was announced with a small press statement and essentially ignored. This was because Samuel Langley was trying to fly a man with a flawed steam powered contraption on the Potomac, which flopped and never flew. Langley had the press attention. So the Wright Brothers were the 'Wrong' Brothers--even though they did it and did it first. Of course, in the next few years, the Wright Brothers started flying over peoples' heads, and started the first flight school, training pilots. Seeing is believing. We are taking that approach here *and doing demonstrations* of an invisibility cloak at

public science and engineering forums. Also, the peer reviewed articles on the first invisibility cloak and the first human-sized invisibility cloak are both in press.

**Q: What about human cloaking demonstrations?**

A: The demo cloak is the one I am holding in the first photo. Biggie Cloak is big and rather fragile. Otherwise a robust version would weigh too much and be mega-expensive to make. This means we won't move it around much, and that limits where we can show it. After the publication of the paper, we'll have a 'V-Day'--vanishing day--when it can be seen by some of those who don't make it over to our lab. And there's the videos. That's why the videos were made.

**Q: Again, what about a visual light cloak?**

A: The nice thing about bootstrapping a new technology is it makes you razor sharp with the issue of 'who needs it'. When someone makes a case, then the resources will appear and the effort will proceed. But it's not my goal in life to be Griffin a la H.G. Wells.

**Q: What about stealth?**

A: The case there is stronger. But as a stealth mode-only it competes with other options already in use. Also, cloaking essentially ends the notion of 'Star Wars', as the impinging power ends up passing around, rather than being absorbed or reflected.

**Q: What appeals to you most about cloaking?**

A: I don't think you can underestimate the impact it has had on the young. It is a driving force for science for them. I imagine the same could be said for my generation with the space program, or robots. It points out unexpected opportunities and natural insights. Those are moments that make life worth living.

**Q: I discovered that you have a background in SETI and are essentially one of its pioneers.**

A: Yes.

**Q: Comments?**

A: My two major contributions in SETI are showing the signals have to be a high probability of intercept with a form of spread spectrum, and showing that galactic star clusters are where you look. Fill the beam, as they say. I've done several searches.

I went to Cornell to do SETI, to work with Sagan and Drake. I was the grad student doing SETI. I still get asked about CONTACT... 'Ellie Arroway' is a composite of several people Sagan knew. I was one. It creeps me out to see my youthful boldness as a grad student portrayed by a woman. I'm not saying women shouldn't be bold; I just thought it was bizarre to see myself in the book, later on the screen, with a sex change. I don't want a sex change. I am not Myra Breckenridge. I really felt that I was violated. I thought it was a cheap shot at disguising the character's true life origins. I still do. I told Sagan, when he was working on the book, I was extremely unhappy about it. We never spoke again and he died before the movie came out. Who knows? I released him from my thesis committee, with disgust. I actually like the movie but I have to have a beer beforehand to get past the Arroway person. Especially when she gets on the ham radio. As to SETI specifically, Frank Drake, on the other hand, is a wonderful person, and still very much alive.

**Q: Did Sagan know about ham radio?**

A: He knew I was a ham; we discussed it as a path to getting to SETI. I took him to the Cornell ham club station, twice. I showed him how it worked. The station was 30 seconds away from his office. Sagan was really a post-WWII guy in many of his views and memories. It was not what he thought it would be...too slick.

**Q: Another ham radio connection?**

A: Sure. Most older radio astronomers are hams. Sagan was itching to get a better flavor of how radio astronomers tick and how they got there, presumably for the book.

**Q: So Drake was your doctoral thesis advisor?**

A: Yes. Here's a shot of us in 2012 in Frank's backyard, amongst the orchids Frank raises. His wife, Amahl, is also a wonderful person. Great, great people. From Frank I learned many things, especially the resolve to push things through. Hence the cloak--a product of guts and sparse but calmly shepherded resources.



DRAKE AND COHEN, Fall 2012 (Amahl Drake photo)

**Q: The cloak is a great example of little science succeeding, but SETI, as Big Science, has not.**

A: IMO, 'projectitis' took over. The big 'new' telescope was and is essentially dead. The project manager was removed in 2006 and the key signals guy moved to New Zealand, then moved back and was institutionalized. There's a lot of projected hope and 'poster child' grandstanding, but the execution is disasterous, IMO. Very sad. Frank picked good people but they really, IMO, messed it up. Hence I steered away. If I was more active in SETI it might have worked out differently, but then you wouldn't have me creating the cloak.

**Q: Why is that?**

A: Because I would be out in California, where some people think magic and mystery already produces invisibility cloaks. Why bother? In cranky, cold Massachusetts, most presume you can't do it, indeed hope you fail, so its motivating, as a contrarian, to try. Hence the 'invisible ham'.

**Q: Do you think the invisibility cloak was a Big Science project that failed?**

A: My speculation is that others tried it and failed. As such they were not accountable. No one knows because it was not done in a public way, and failed projects seldom get reported.

**Q: Would you go back to SETI?**

A: I have my hands full; a growing company and a bead on the progress of fractal engineering. People look to me for leadership in the fractal fields. I'd like to get involved if the concentration could be on finding ET's with RF, rather than building big projects. Drake feels the same way these days. Unfortunately there is a vacuum of leadership in SETI, as Frank Drake is retired, the present gurus have failed, and we've lost a generation of SETI researchers.

Of course the scientists in PRC have the resources and the gung-ho spirit. So who knows?