Gmail **Gavin Weir <gavinmcweir@gmail.com>**

free boundary VMEC for Heliotron J

14 messages

Gavin Weir <gavin.mccabe.weir@gmail.com> Mon, Jan 15, 2018 at 1:40 AM
To: Samuel Lazerson <lazerson@pppl.gov>

Hi Sam,

I'm currently in Japan for experiments on Heliotron J. What do you think is necessary for getting a free boundary configuration for Heliotron J? We previously discussed this a little, but I am currently here and I have access to much more information now.
-Gavin

--
Gavin McCabe Weir, Ph.D.
Project Wendelstein 7-X, Max-Planck-Institut für Plasmaphysik - Greifswald
Cell: U.S.A: +001-612-616-3468 / Germany: +049-0151-5010-7538
gavin.mccabe.weir@gmail.com

Samuel Lazerson <lazerson@pppl.gov> Mon, Jan 15, 2018 at 8:06 AM
To: Gavin Weir <gavin.mccabe.weir@gmail.com>

Gavin,
So I dropped the ball on this a while back. You sent me a coils file which should be the only major thing we need. I'll make a Poincaré plot today and then send you MGRID parameters.

-Sam
[Quoted text hidden]

Gavin Weir <gavin.mccabe.weir@gmail.com> Mon, Jan 15, 2018 at 9:12 AM
To: Samuel Lazerson <lazerson@pppl.gov>

Sounds good, thanks!
[Quoted text hidden]

Samuel Lazerson <lazerson@pppl.gov> Mon, Jan 15, 2018 at 4:08 PM
To: Gavin Weir <gavin.mccabe.weir@gmail.com>

Gavin,
OK so I'm running into problems with setting the currents for the coils file. The file you has represents the helical coil with 24 windings. So for that one it appears I just need the current coming out of the power supply. All the other coils are represented by single filaments. So I need to multiply each power supply current by the number of windings in the coil. For the TA/TB coils this appears to be 20, but I'm not sure about the vertical coils. Can you send me the currents (as measured in a single turn) for each system? The pairs are wired in series so I can't specify them separately.

Thanks,
Sam
[Quoted text hidden]

Gavin Weir <gavin.mccabe.weir@gmail.com> Tue, Jan 16, 2018 at 8:33 AM
To: Samuel Lazerson <lazerson@pppl.gov>

Hi Sam,

Attached are the notes I was able to put together on the coil set.

Here is a summary:

Number of turn and maximum current of each coil are,
- Helical: 8 turns, 120kA each (= 960kAT) (3 parallel circuits of 8 turn windings, 40 kA/winding)
- Main Vertical (can be divided into three):
  OV1: 4 turns, 120kA (=480kAT)
  OV2: 2 turns, 120kA (=240kAT)
  OV3: 1 turn, 120kA (=120kAT)

TA: 5 turns, 120kA (=600kAT) (4 parallel circuits from 2x10 conductor pack: 30 kA/winding)
TB: 20 turns, 10.9kA (=218kAT) (1x20 conductor pack: 1 filament, 20 turns)
AV: 24 turns, 6kAT (=144kAT) (1 filamant, 24 turns)
IV: 80 turns, 6 kAT (=480kAT) (1 filament, 80 turns)

.... so now fitting it into the model we have:

24 filaments for the Helical coil

Example configuration (with naming convention): **HV89 TA74 TB81 AV46 IV76**

Current per turn for each coil in our filament model for this configuration:

Helical coil:	0.89*Imain / 24
OV1:	0.5*0.89*Imain / 4
OV2:	0.25*0.89*Imain / 2
OV3:	0.125*0.89*Imain / 1
TA:	0.74*Imain / 20
TB:	0.81*Imain / 20
AV:	0.46*Imain / 24
IV:	0.76*Imain / 80

Current per turn for each coil (generally in this filament model):

Helical coil:	HV / 24
OV1:	0.5*HV / 4

OV2: 0.25*HV / 2
OV3: 0.125*HV / 1

TA: TA / 20
TB: TB / 20
AV: AV / 24
IV: IV / 80

I think this is correct.
-Gavin

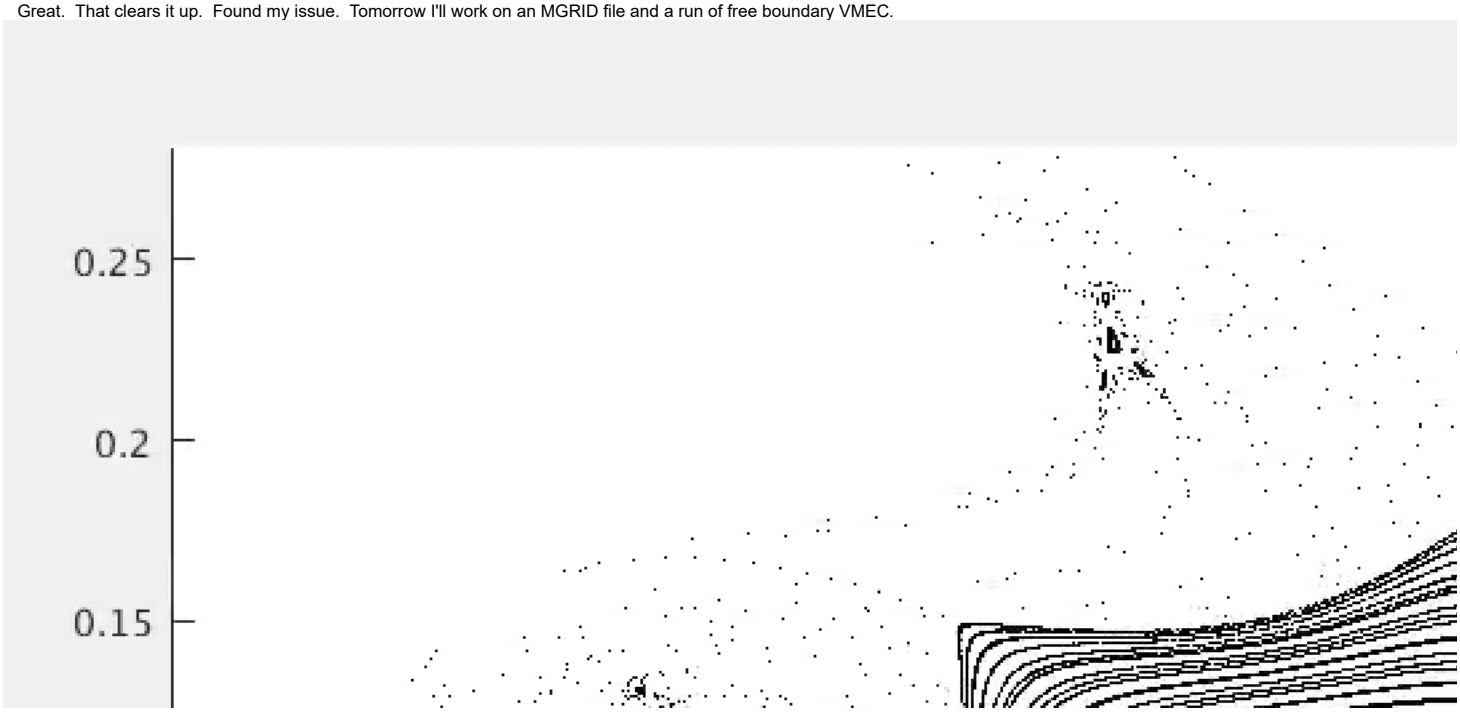
--
Gavin McCabe Weir, Ph.D.
Project Wendelstein 7-X, Max-Planck-Institut für Plasmaphysik - Greifswald
Cell: U.S.A: +001-612-616-3468 / Germany: +049-0151-5010-7538
gavin.mccabe.weir@gmail.com

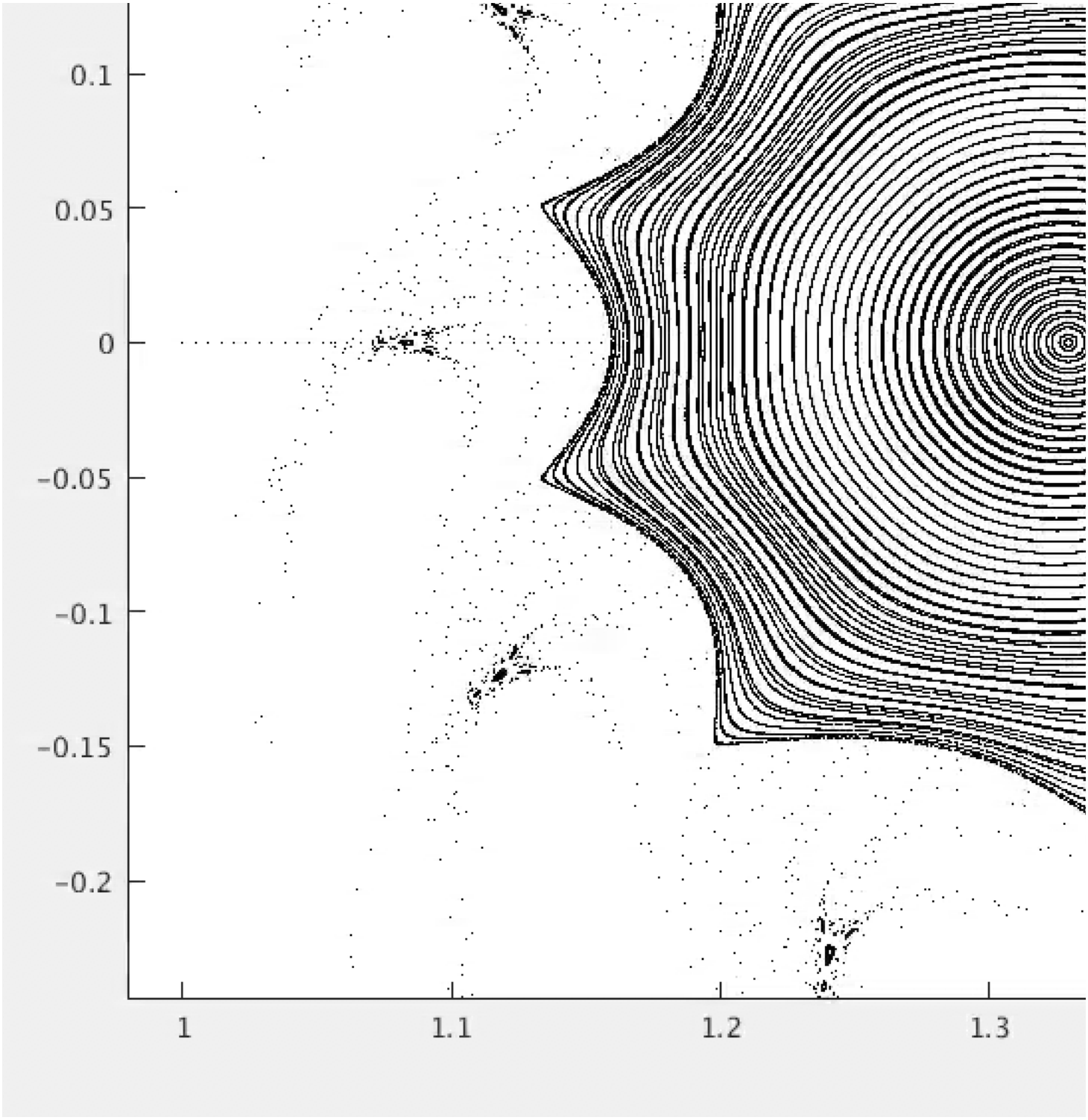
On Tue, Jan 16, 2018 at 12:08 AM, Samuel Lazerson <lazerson@pppl.gov> wrote:
> Gavin,
> OK so I'm running into problems with setting the currents for the coils file. The file you has represents the helical coil with 24 windings. So for that one it appears I just need the current coming out of the power supply. All the other coils are represented by single filaments. So I need to multiply each power supply current by the number of windings in the coil. For the TA/TB coils this appears to be 20, but I'm not sure about the vertical coils. Can you send me the currents (as measured in a single turn) for each system? The pairs are wired in series so I can't specify them separately.
>
> Thanks,
> Sam
>
> On Mon, Jan 15, 2018 at 9:12 AM, Gavin Weir <gavin.mccabe.weir@gmail.com> wrote:
> > Sounds good, thanks!
> >
> > On Jan 15, 2018 16:06, "Samuel Lazerson" <lazerson@pppl.gov> wrote:
> > > Gavin,
> > > So I dropped the ball on this a while back. You sent me a coils file which should be the only major thing we need. I'll make a Poincaré plot today and then send you MGRID parameters.
> > >
> > > -Sam
> > >
> > > On Mon, Jan 15, 2018 at 1:40 AM, Gavin Weir <gavin.mccabe.weir@gmail.com> wrote:
> > > > Hi Sam,
> > > >
> > > > I'm currently in Japan for experiments on Heliotron J. What do you think is necessary for getting a free boundary configuration for Heliotron J? We previously discussed this a little, but I am currently here and I have access to much more information now.
> > > > -Gavin
> > > >
> > > > --
> > > > Gavin McCabe Weir, Ph.D.
> > > > Project Wendelstein 7-X, Max-Planck-Institut für Plasmaphysik - Greifswald
> > > > Cell: U.S.A: +001-612-616-3468 / Germany: +049-0151-5010-7538
> > > > gavin.mccabe.weir@gmail.com

hj_vmec_freeboundary.docx
212K

Samuel Lazerson <lazerson@pppl.gov>
To: Gavin Weir <gavin.mccabe.weir@gmail.com>

Gavin,
Great. That clears it up. Found my issue. Tomorrow I'll work on an MGRID file and a run of free boundary VMEC.





-Sam
[Quoted text hidden]

Gavin Weir <gavin.mccabe.weir@gmail.com> Wed, Jan 17, 2018 at 1:09 AM
To: Samuel Lazerson <lazerson@pppl.gov>

Awesome, thanks for the update!
[Quoted text hidden]

Gavin Weir <gavin.mccabe.weir@gmail.com> Wed, Jan 17, 2018 at 3:14 AM
To: Samuel Lazerson <lazerson@pppl.gov>

Hi Sam,

Here is the output from a more complete coil model (one that uses method of moments to calculate the magnetic field using the full dimensions of the coil: KMAG is the code). The upper left-hand figure on page 3 looks very similar to what you sent me. That is a good check! An actual analytic comparison, or an overlay would be better, but the resolution from KMAG is not great.
-Gavin

--

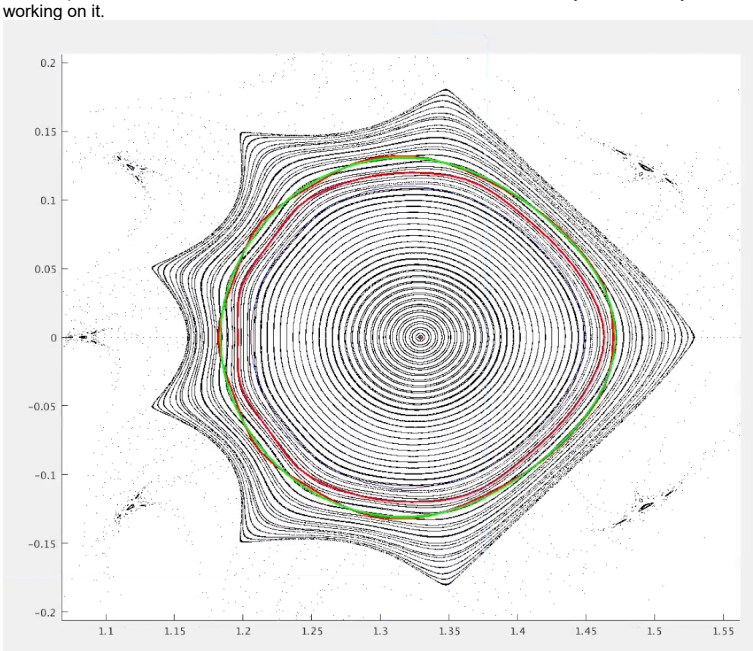
Gavin McCabe Weir, Ph.D.
Project Wendelstein 7-X, Max-Planck-Institut für Plasmaphysik - Greifswald
Cell: U.S.A: +001-612-616-3468 / Germany: +049-0151-5010-7538
gavin.mccabe.weir@gmail.com

[Quoted text hidden]

mg2_hj_HV89TA74TB81AV46IV76_c12w04_r128p128.pdf
1211K

Samuel Lazerson <lazerson@pppl.gov> Wed, Jan 17, 2018 at 10:23 AM
To: Gavin Weir <gavin.mccabe.weir@gmail.com>

Gavin,
OK so far I'm making progress. I've got an MGRID file, and initial guess file, and a more refined file. I'm working on refining the equilibrium so it's larger. However, I'm having trouble with the phase of the m=7 feature. The solid lines are VMEC free boundary runs. Clearly the smaller one seems a good fit. The larger ones are clearly missing the shape. I'll keep working on it.



-Sam
[Quoted text hidden]

Samuel Lazerson <lazerson@pppl.gov> Wed, Jan 17, 2018 at 11:33 AM
To: Gavin Weir <gavin.mccabe.weir@gmail.com>

Gavin,
Do you have a fixed boundary VMEC file for Heliotron-J?
-Sam
[Quoted text hidden]

Gavin Weir <gavin.mccabe.weir@gmail.com> Wed, Jan 17, 2018 at 12:12 PM
To: Samuel Lazerson <lazerson@pppl.gov>

Yes I do!

Here are some fixed-boundary VMEC input files.

The summary of the files is here:

1. input.vm8_hj_HV86TA60TB98AV19IV-15_x206m12n12s101bd00id+00 : low bumpy (mirror) configuration
2. input.vm8_hj_HV89TA74TB81AV46IV76_x384m12n12s101bd00id+00 : standard configuration
3. input.vm8_hj_HV92TA92TB50AV-05IV16_x537m12n12s101bd00id+00 : high bumpy configuration
4. input.vm8_hj_HV90TA90TB49AV-46IV-92_x707m12n12s101bd00id+00 : low toroidicity configuration

The file naming convention:
- vm8 : for vmec2000 ver. 8.0
- hj : device name
- HV92TA92TB50AV-05IV16 : each coil current,
HV: helical coil, TA: toroidal coil A, TB: toroidal coil B, AV: Auxiliary vertical coil (outer vertical), IV: Inner vertical coil in percentage.
- x537 : position of LCFS (Best fitting of LCFS)
- m12n12 : number of poloidal and toroidal Fourier harmonics (0<m<11, -12<n<12)
- s101 : number of magnetic surfaces
- bd00id+00 : zero beta and zero plasma current

-Gavin

--
Gavin McCabe Weir, Ph.D.
Project Wendelstein 7-X, Max-Planck-Institut für Plasmaphysik - Greifswald
Cell: U.S.A: +001-612-616-3468 / Germany: +049-0151-5010-7538
gavin.mccabe.weir@gmail.com

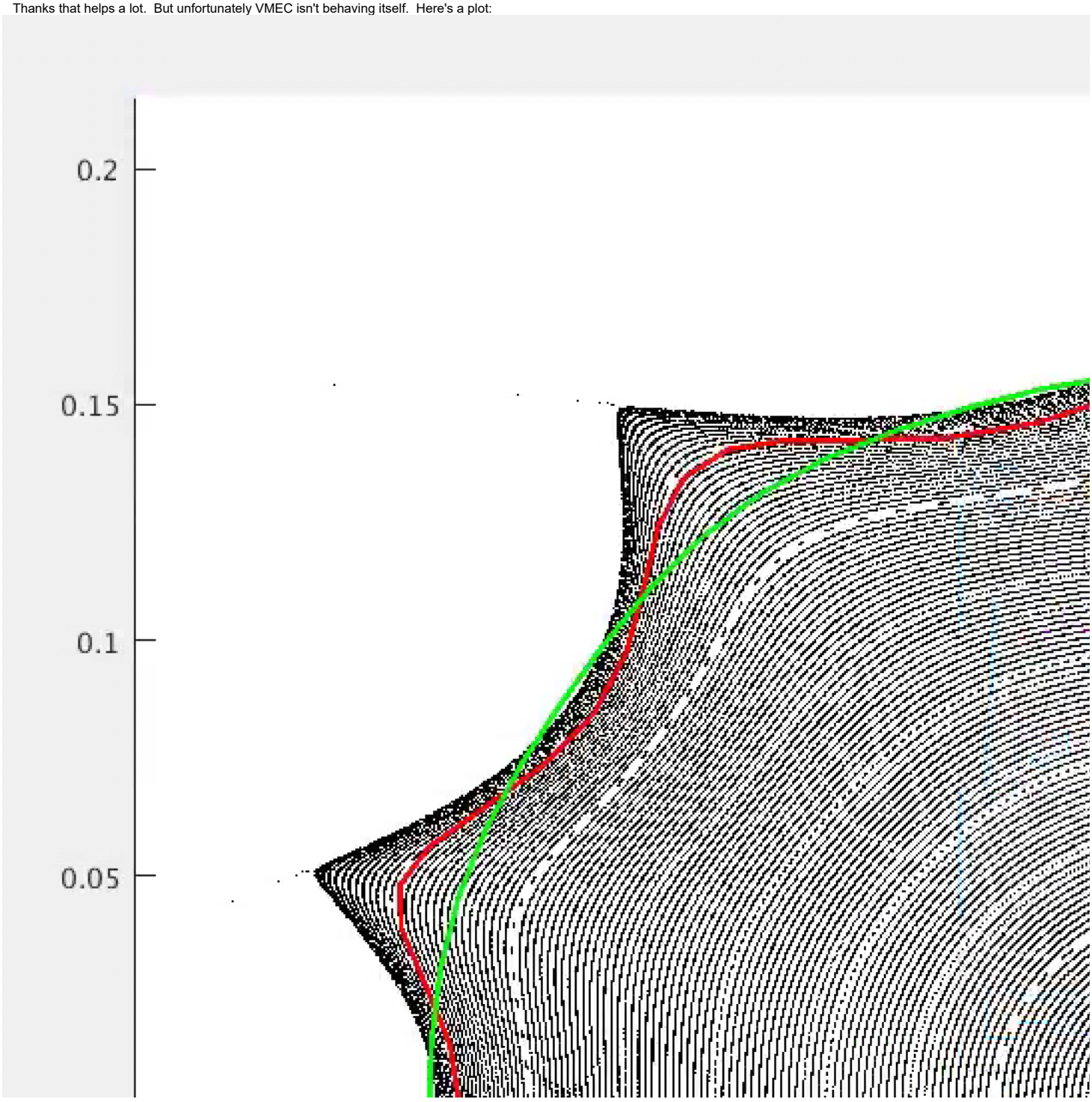
[Quoted text hidden]

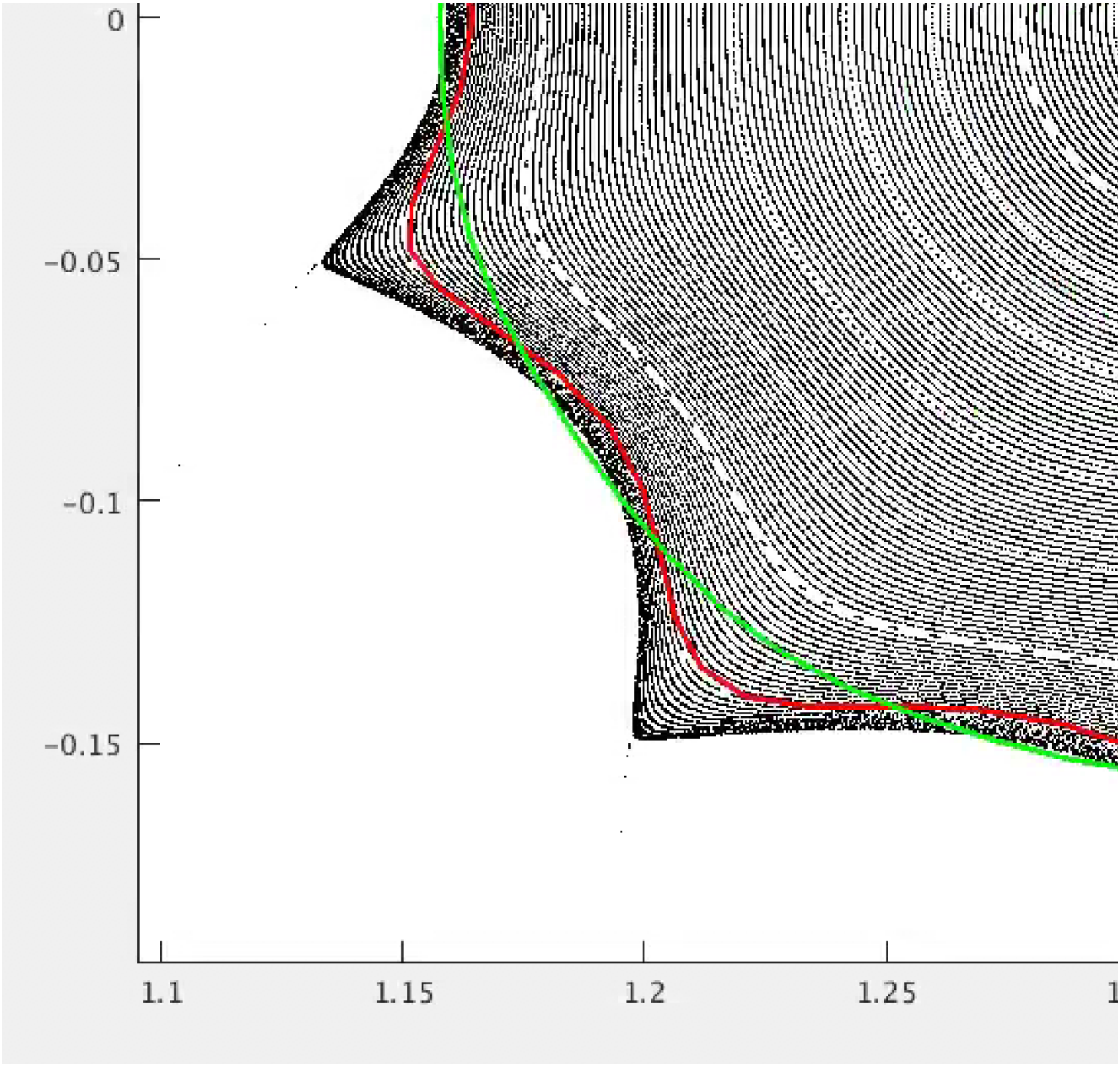
6 attachments

- **input.vm8_hj_HV86TA60TB98AV19IV-15_x206m12n12s101bd00id+00** 20K
- **input.vm8_hj_HV89TA74TB81AV46IV76_x384m12n12s101bd00id+00** 20K
- **input.vm8_hj_HV90TA90TB49AV-46IV-92_x707m12n12s101bd00id+00** 20K
- **input.vm8_hj_HV92TA92TB50AV-05IV16_x537m12n12s101bd00id+00** 20K
- **input.vm8_hjF_HV89TA74TB81AV46IV76_x384m12n12s101bd00id+00** 20K
- **input.vm85_hj_HV89TA74TB81AV46IV76_xfrm12n12s41bd00id+00** 20K

Samuel Lazerson <lazerson@pppl.gov>
To: Gavin Weir <gavin.mccabe.weir@gmail.com>

Gavin,
Thanks that helps a lot. But unfortunately VMEC isn't behaving itself. Here's a plot:





The only difference between the two runs in the turning on LFREEB from F to T. So even with an excellent guess the code is falling on it's face. I think that VMEC may have some intrinsic dif

-Sam
[Quoted text hidden]

Samuel Lazerson <lazerson@pppl.gov> Thu, Jan 18, 2018 at 8:01 AM
To: Gavin Weir <gavin.mccabe.weir@gmail.com>

Gavin,
Well I've tried a bunch of stuff and I'm no closer to a solution. It seems like VMEC is smoothing the surface as it iterates in free boundary. I've asked Steve Hirshman for help. Anyway, I'm not alone in this problem. It was documented a while back (see attached).

-Sam
[Quoted text hidden]

35074033.pdf
162K

Gavin Weir <gavin.mccabe.weir@gmail.com> Thu, Jan 18, 2018 at 8:47 AM
To: Samuel Lazerson <lazerson@pppl.gov>

Hi Sam,

Thank you for your help and for reaching out to Steve Hirshman. I spoke with Suzuki-san (co-author on that paper), and he said that they had the same problem on CHS. It sounds like if we truncate the surfaces (by decreasing the enclosed flux) and only look at the inner 75% of the plasma or so, we might be able to make progress. In your experience, will free boundary

runs still be representative of the equilibrium if we purposefully truncate the surfaces? Could we use that in a STELLOPT run, or would that be inappropriate?

I really only care about the core heat transport on Heliotron J, so I would be happy to let the edge do whatever it wants (or even shrink).
-Gavin

--
Gavin McCabe Weir, Ph.D.
Project Wendelstein 7-X, Max-Planck-Institut für Plasmaphysik - Greifswald
Cell: U.S.A: +001-612-616-3468 / Germany: +049-0151-5010-7538
gavin.mccabe.weir@gmail.com

[Quoted text hidden]