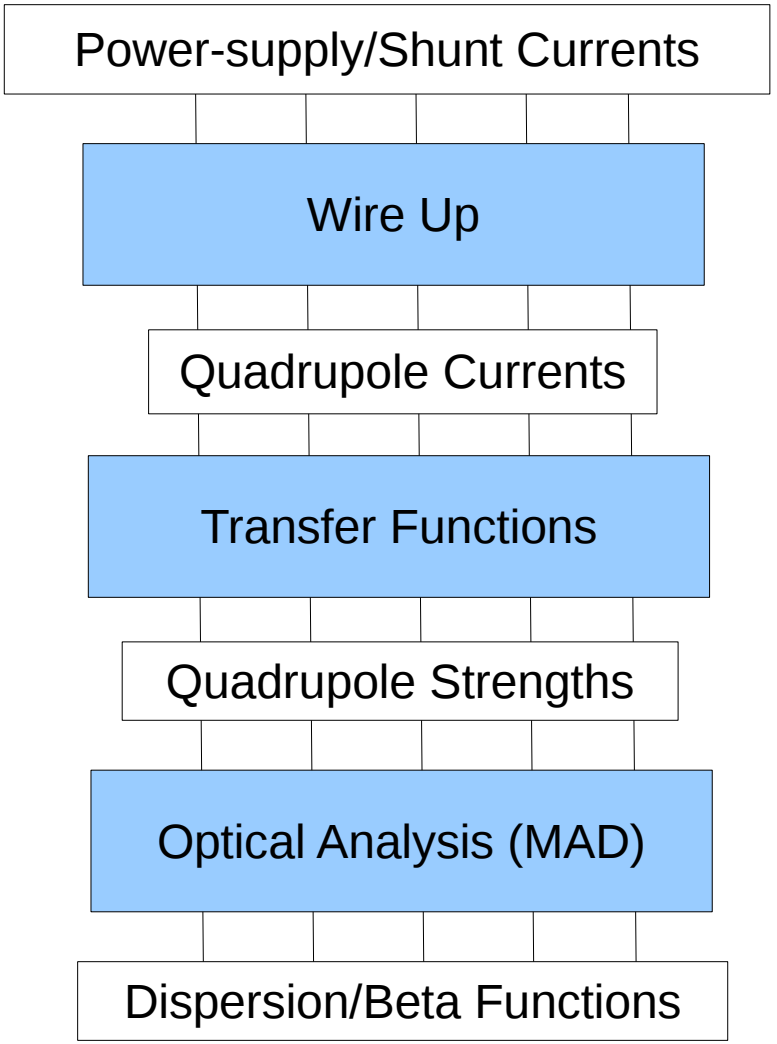
Optical and Chromatic Design

- Linear Model of RHIC
- Example transfer function
- Store optics for 250GeV protons in run-9
- Chromatic Correction
- Building the ramp
- Additional tools for ramps

Linear Model of RHIC

- Set the Power-supply/Shunt currents to get desired optics
  - Use an Optimizer to find the currents
  - Desired optics functions are the constraints
- Changing optics with beam (squeeze)
  - Requires smooth changes to the currents
- Weakest point: Magnet transfer functions



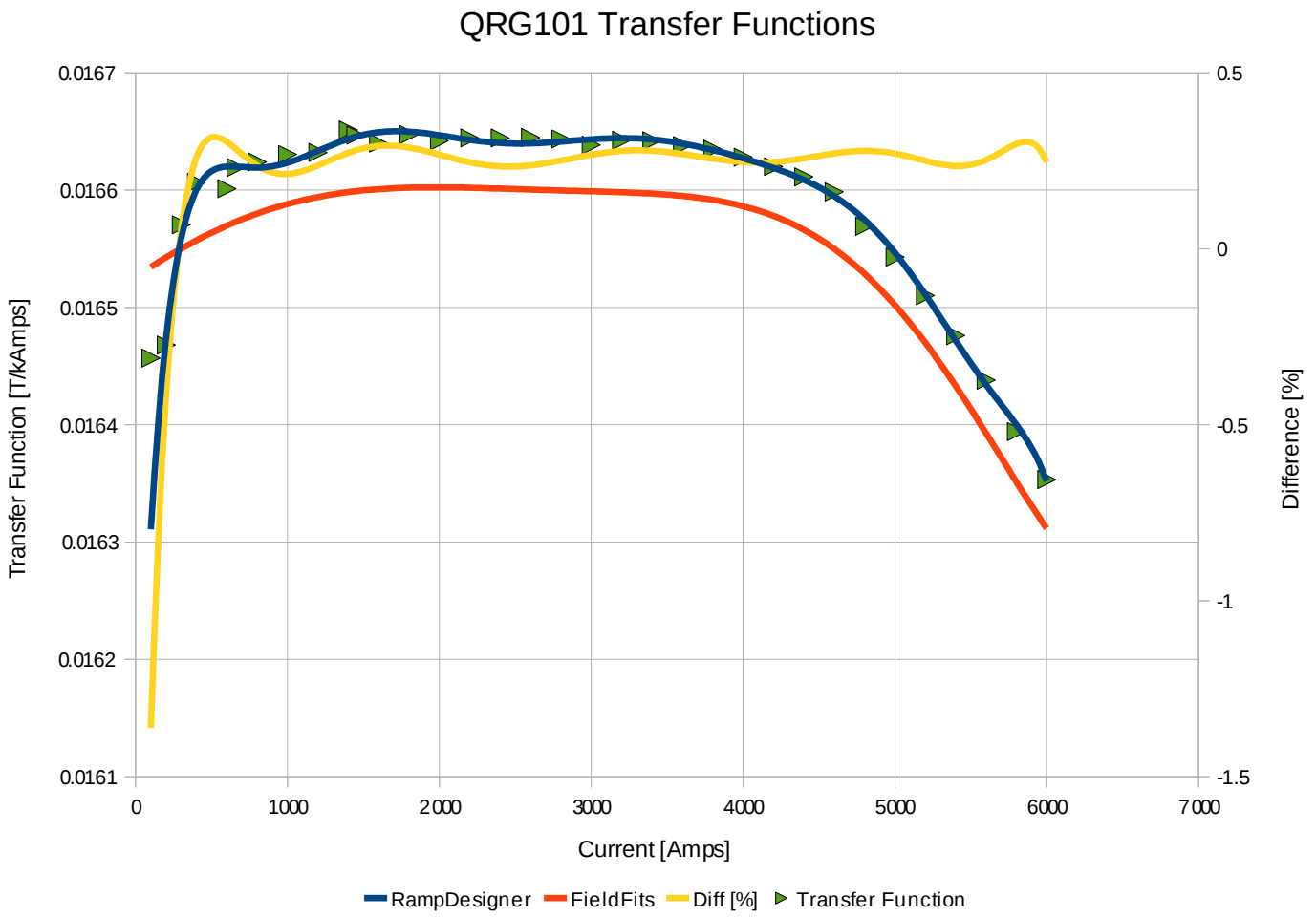
QRG101 Transfer Function

QRG101: an early magnet

Polynomial fit to measured transfer functions

Data points less certain at low current

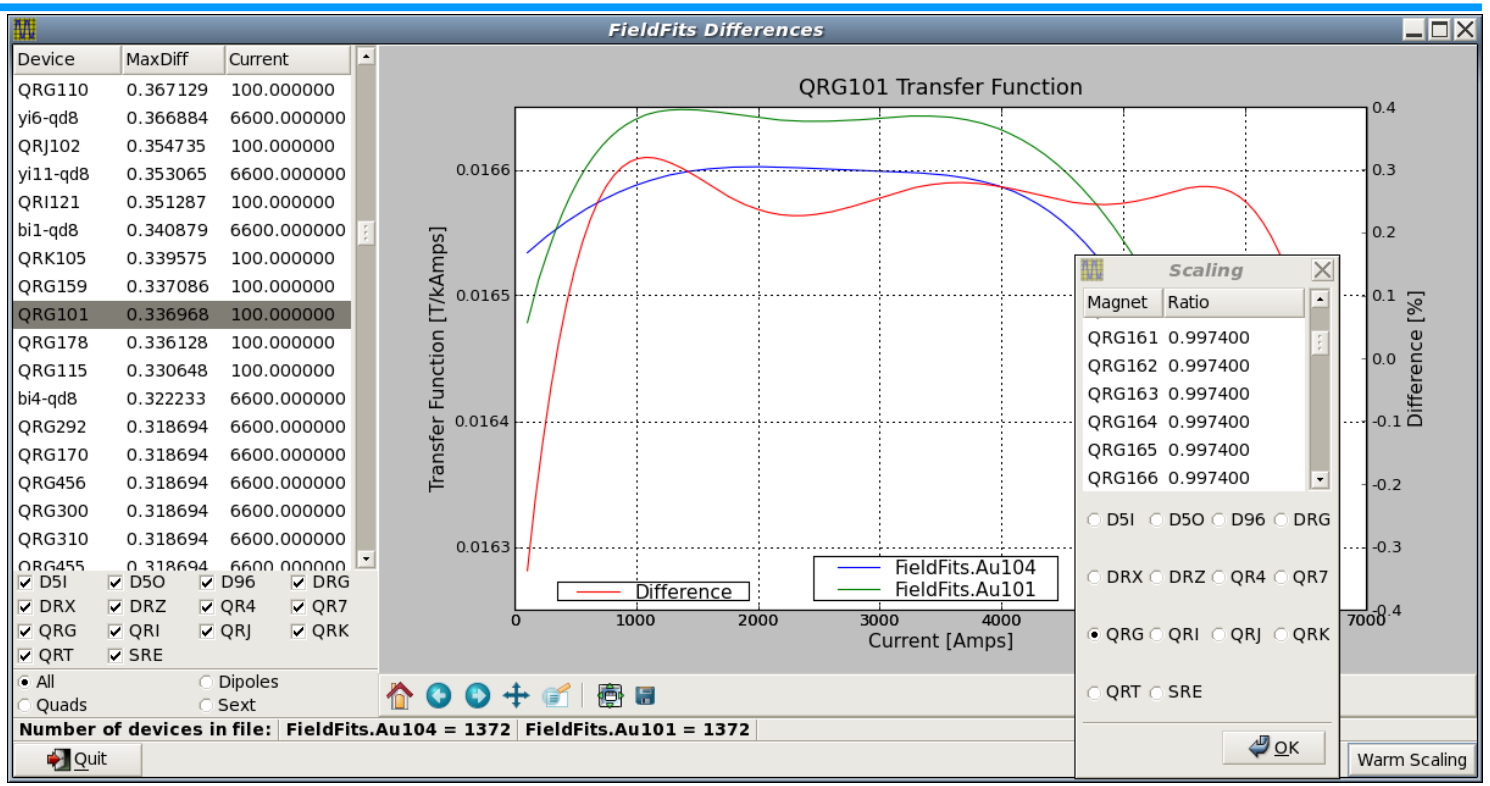
Use ORM for beam-based updates to the transfer function table?



QRG101 Transfer Function

Developing a fieldFitsDiff code to compare two FieldFits files (modeled after pscompare)

Difference between the FieldFits.Au104 and FieldFits.Au101



The FieldFits.Au101 was generated by dbFits.tcl

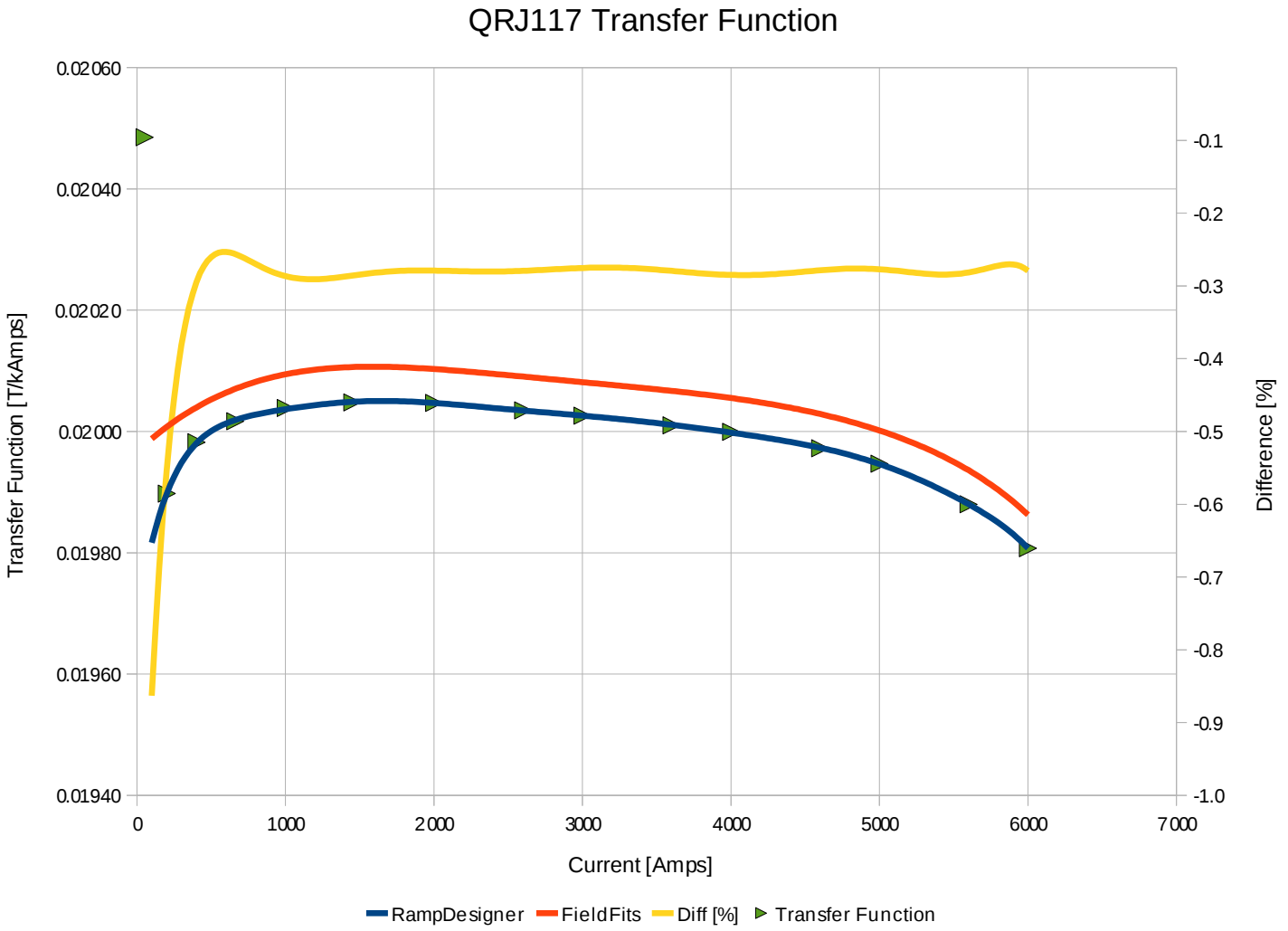
Factors found on measured transfer function:
Main quads, trim quads: 0.9974
Triplet quads: 1.0028

QRJ117 (bi5-qf3)

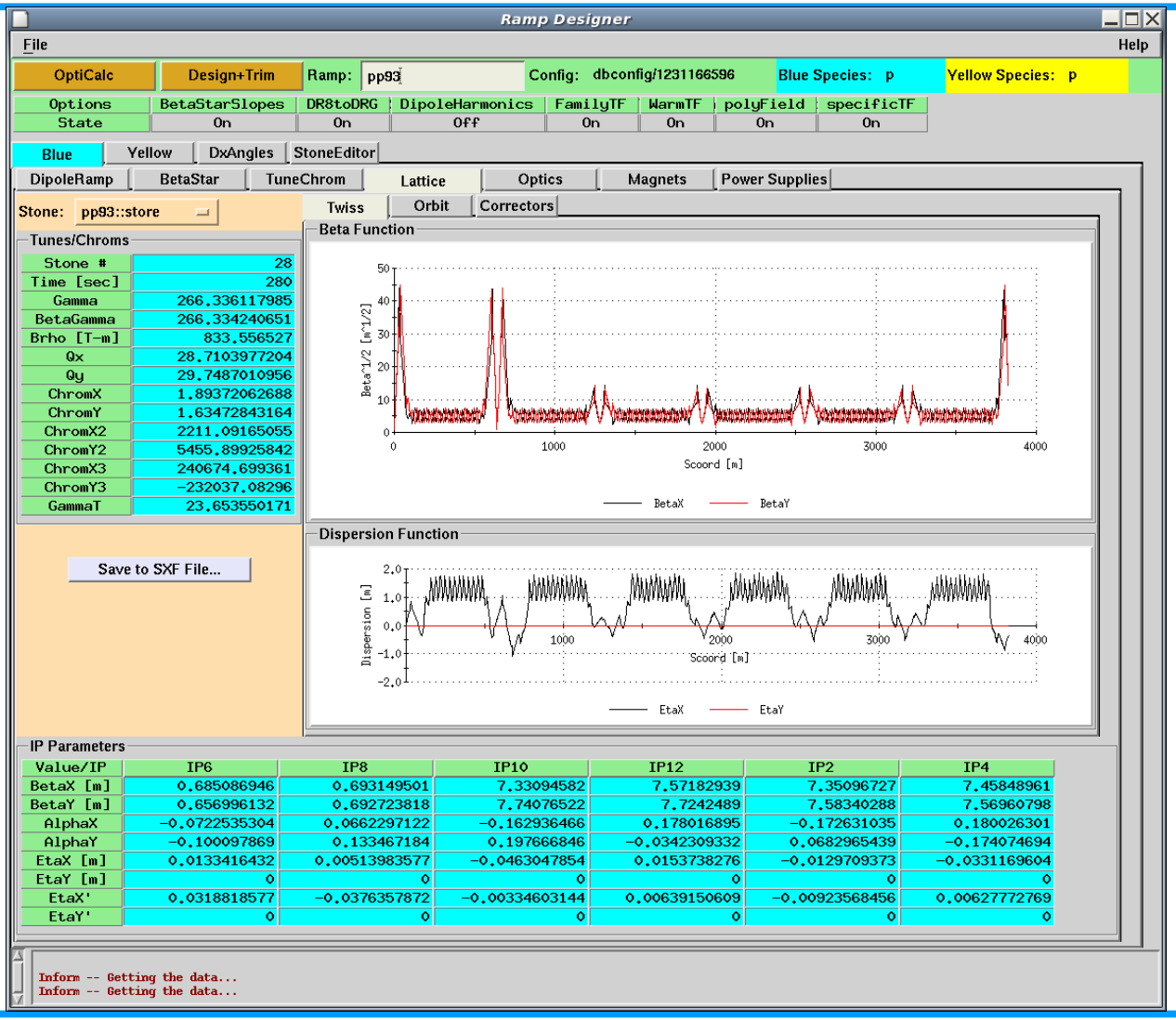
The Q3 triplet magnet at IP6

Large β functions make the IP6 and IP8 triplets more sensitive than other magnets

Improving the transfer function may help dynamic aperture



250GeV Proton Optics



Value/IP	IP6	IP8	IP10	IP12	IP2	IP4
BetaX [m]	0.685086946	0.693149501	7.33094582	7.57182939	7.35096727	7.45848961
BetaY [m]	0.656996132	0.692723818	7.74076522	7.7242489	7.58340288	7.56960798
AlphaX	-0.0722535304	0.0662297122	-0.162936466	0.178016895	-0.172631035	0.180026301
AlphaY	-0.100097869	0.133467184	0.197666846	-0.0342309332	0.0682965439	-0.174074694
EtaX [m]	0.0133416432	0.00513983577	-0.0463047854	0.0153738276	-0.0129709373	-0.0331169604
EtaY [m]	0	0	0	0	0	0
EtaX'	0.0318818577	-0.0376357872	-0.00334603144	0.00639150609	-0.00923568456	0.00627772769
EtaY'	0	0	0	0	0	0

Squeeze: Run-9 250GeV Protons

Must have smooth current changes during squeeze

Some power supplies hit their limits

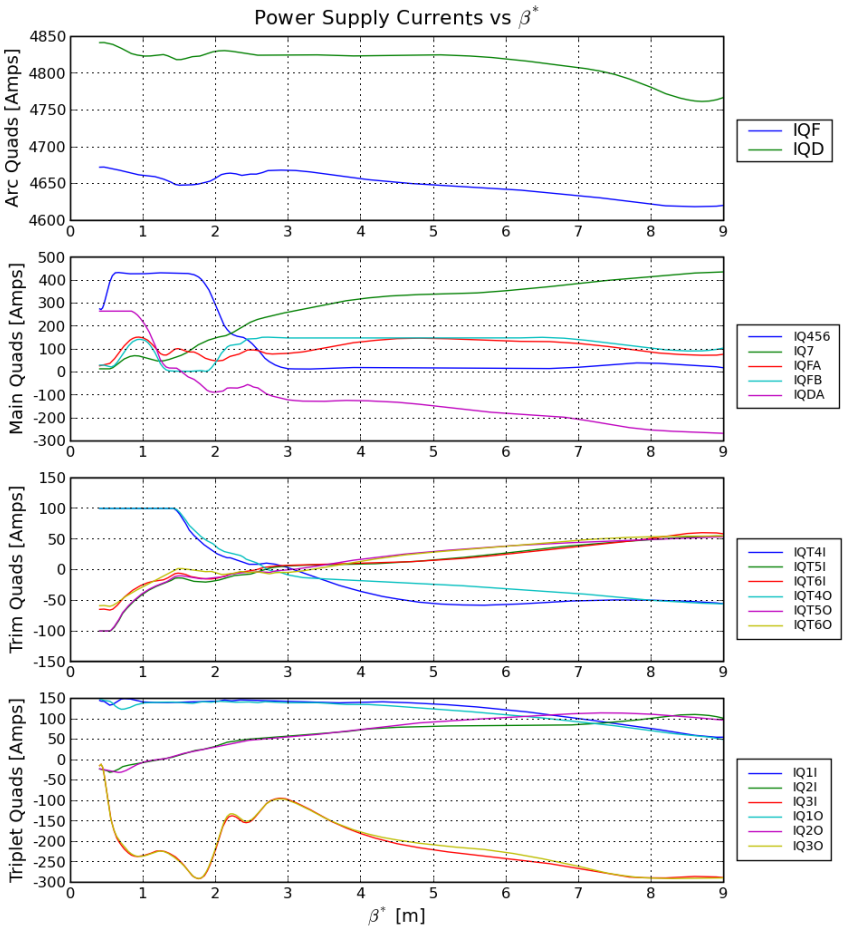
17 independent power supplies per IR and 2 independent arc power supplies. (less than this when anti-symmetric optics is imposed)

16 per IR + 2 constraints:

- 6 at IP per IR
- 6 to match to arcs per IR
- 4 β_{max} constraints per IR
- 2 for the machine tune

Result from Optimization + Smoothing

Convert this to the β* table file that will be used by the Ramping system



Chromatic Correction

Phase advance from IP6 to IP8

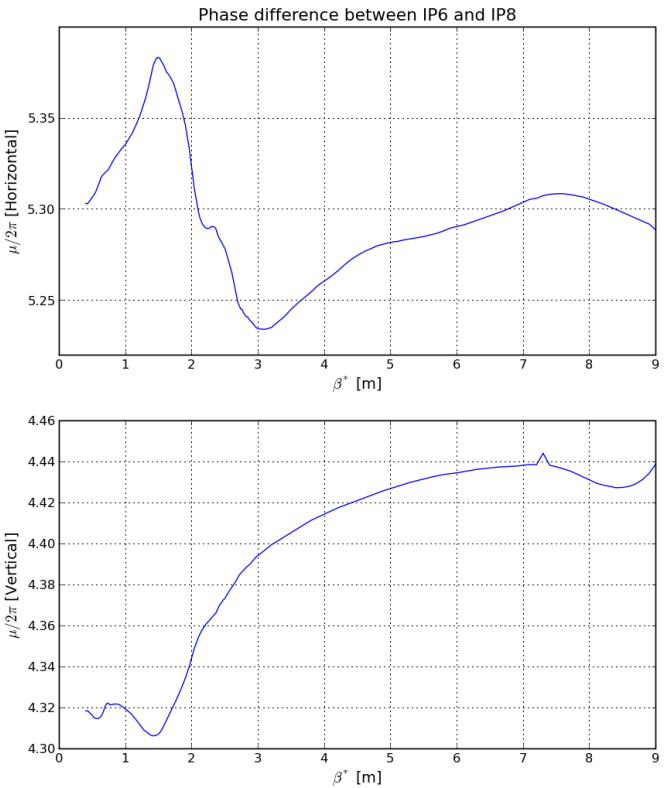
F. Pilat: Odd multiple of π/2 for chromatic cancellation

Will this improve radial aperture?

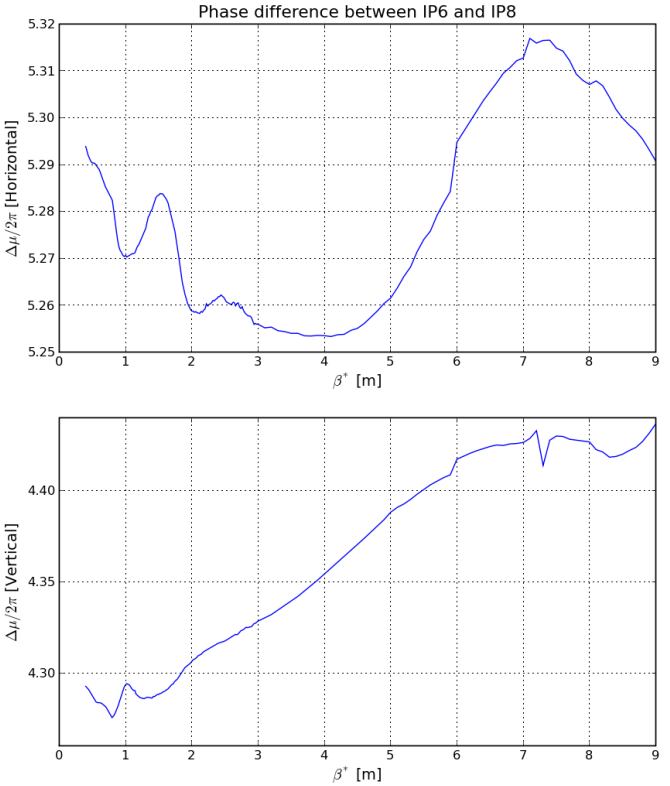
Tracking (after some further fitting)

Electron lens requirements?

Run-9



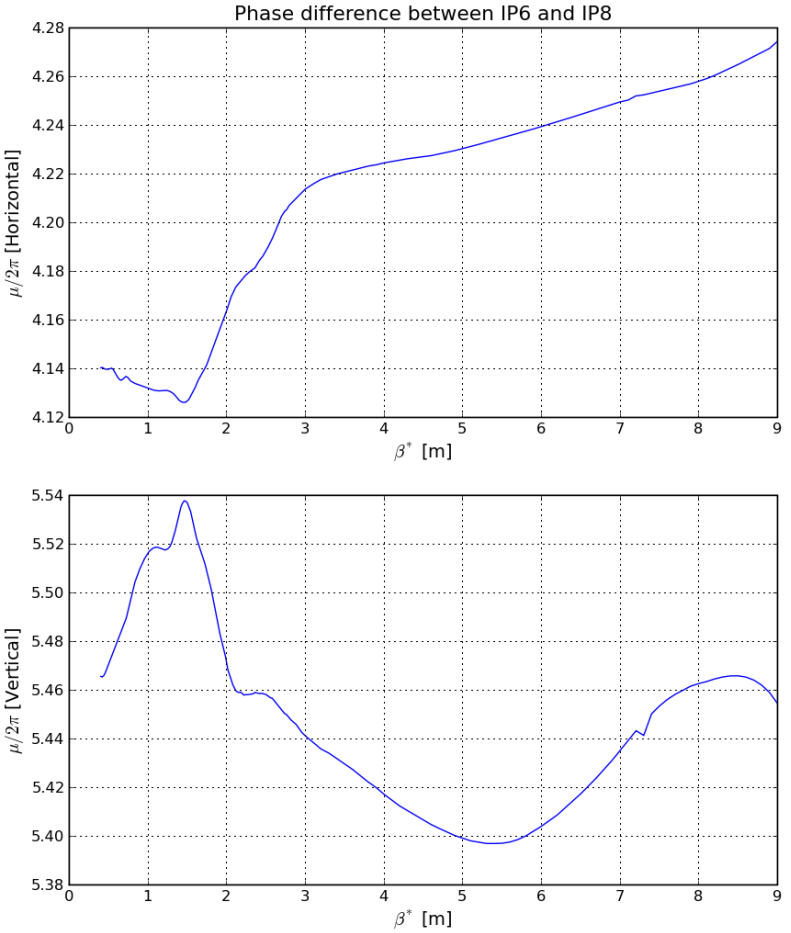
Next Run (Blue)?



Chromatic Correction

Yellow ring much further from ideal.

Will require extra work to achieve.



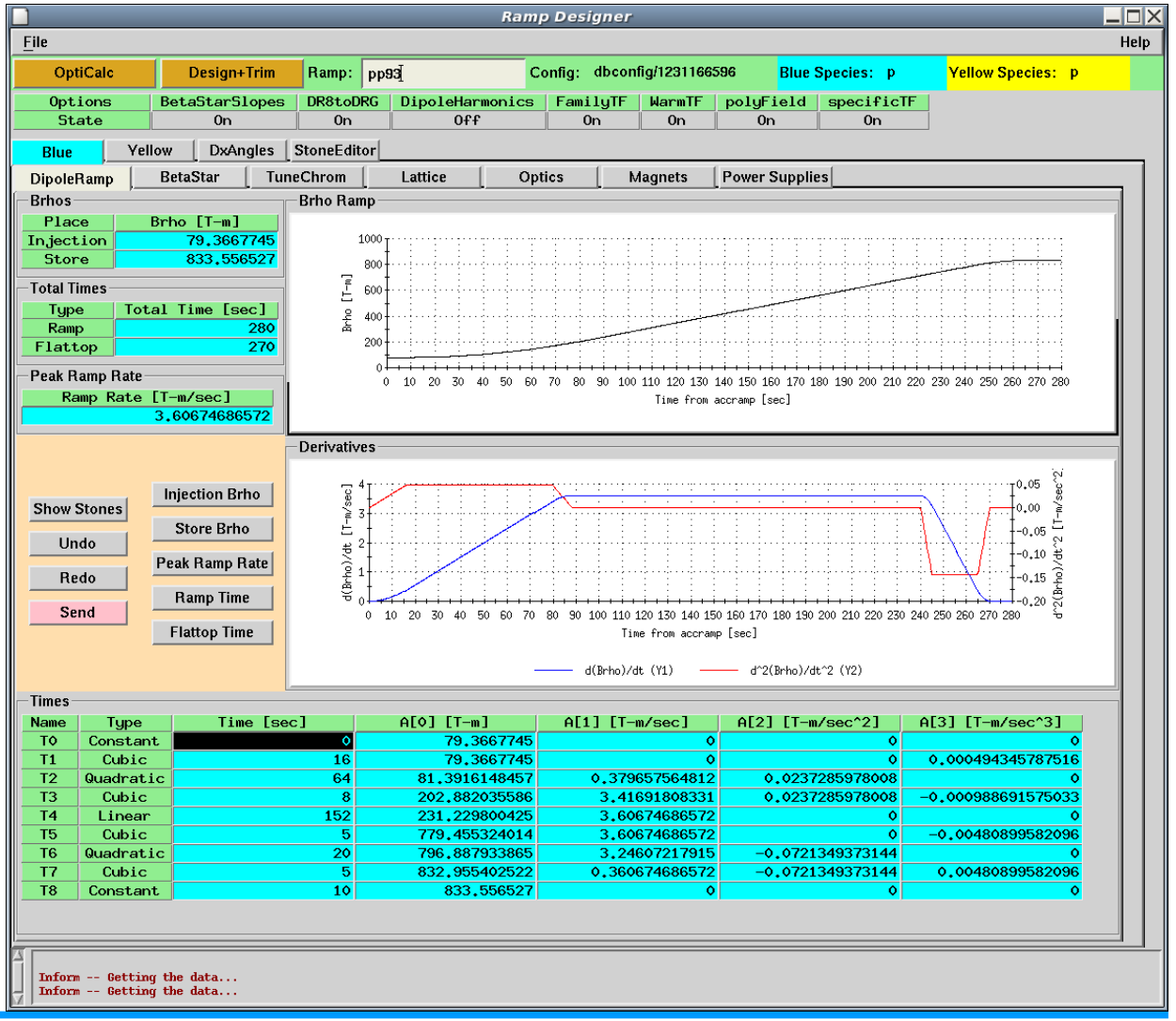
Building the Ramp

- Start with a close existing ramp
  - Create a new dbconfig directory if necessary
    - Updated optics database
    - Updated β* table
    - Changes to active devices: helix magnets, etc
- Modify the injection Bρ and store Bρ if necessary
  - Ensure the ramp rate isn't too large
  - May need to change the stones if the ramp length changes (and/or the flattop has changed)

Building the Ramp, cont

Note, the stepstone list is also updated, since, the Bρ per stepstone may have changed.

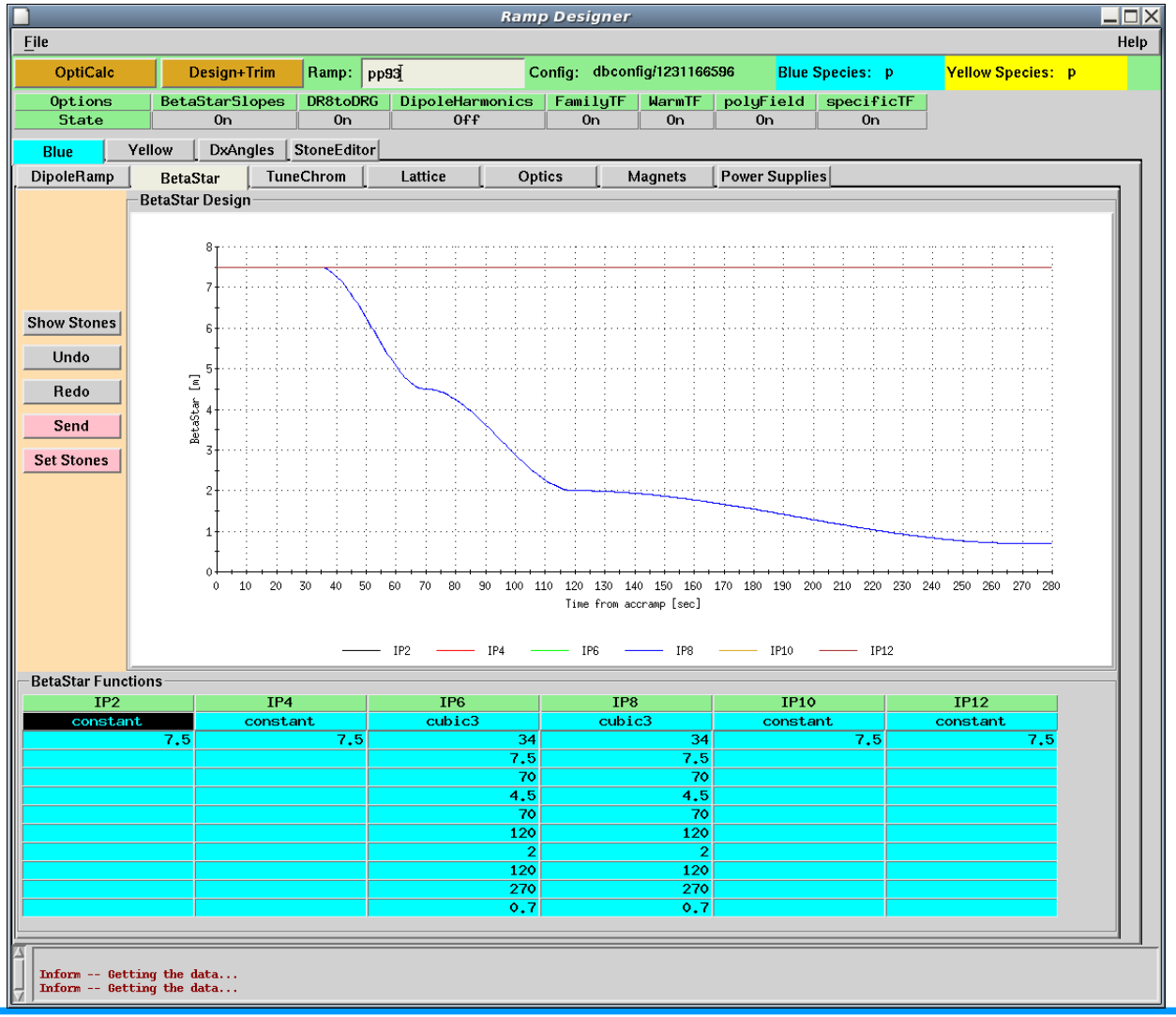
RampEditor and OptiCalc don't update when the stepstone list is changed.



Building the Ramp, cont

- Set up the design β* for each IR
  - Set the model of how the β*s change along the ramp
  - Set the IR quad strengths to reproduce the design using the β* table in dbconfig
- OptiCalc may need to be restarted after this, since, it gets confused when stone values become interpolated (unanchored)

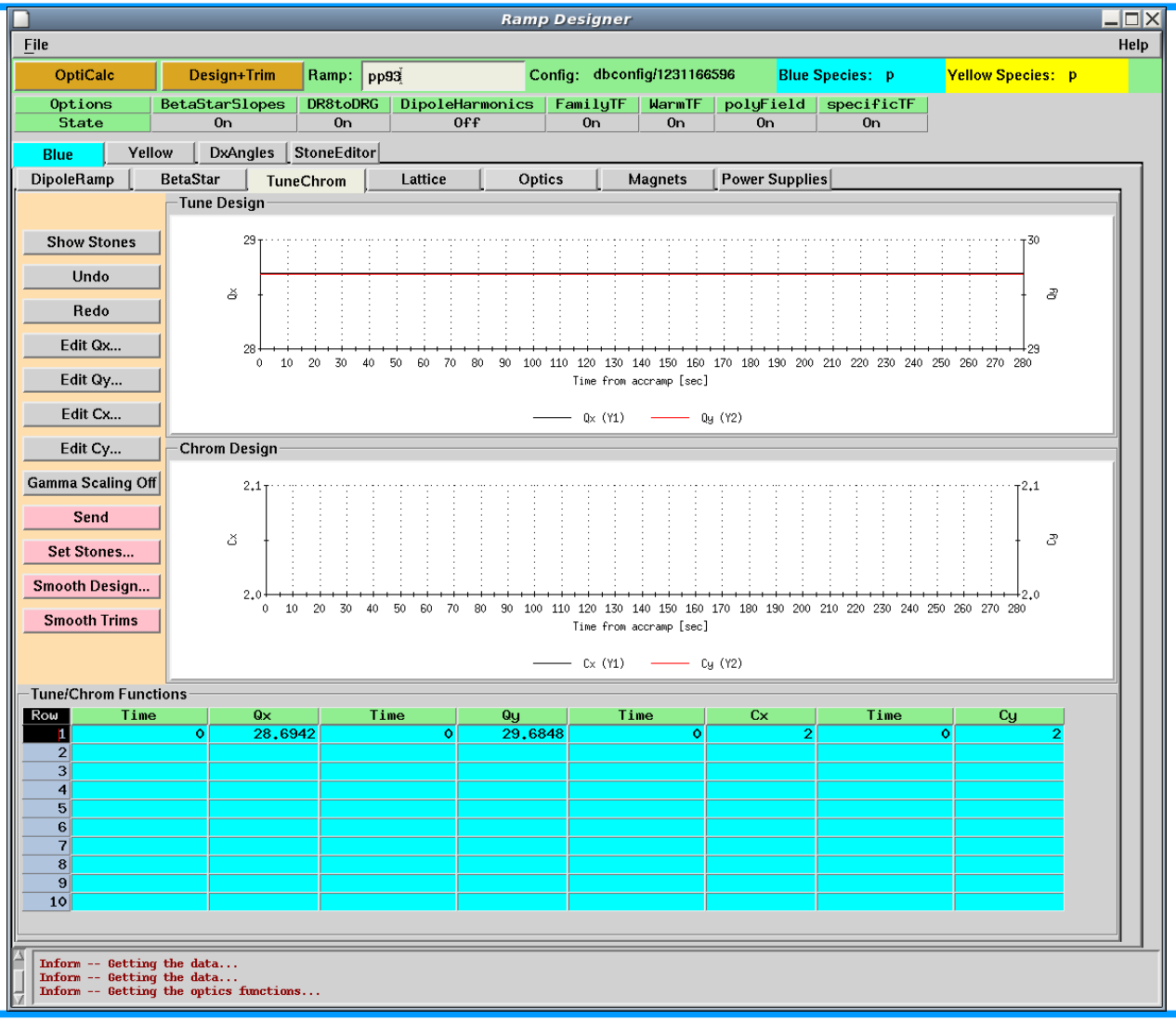
Building the Ramp, cont



Building the Ramp, cont

- Set up the design tunes and chromaticities
  - Include a shift to chromaticity if going through transition
  - Set each stone to their design tunes/chroms
    - May need to hand tweak some stones if the Model fails
  - Apply smoothing: repeat till this converges
- If needed, setup γ_T crossing
  - Some stones may be need to be shifted
  - Separated γ_Ts will need special attention

Build the Ramp, cont



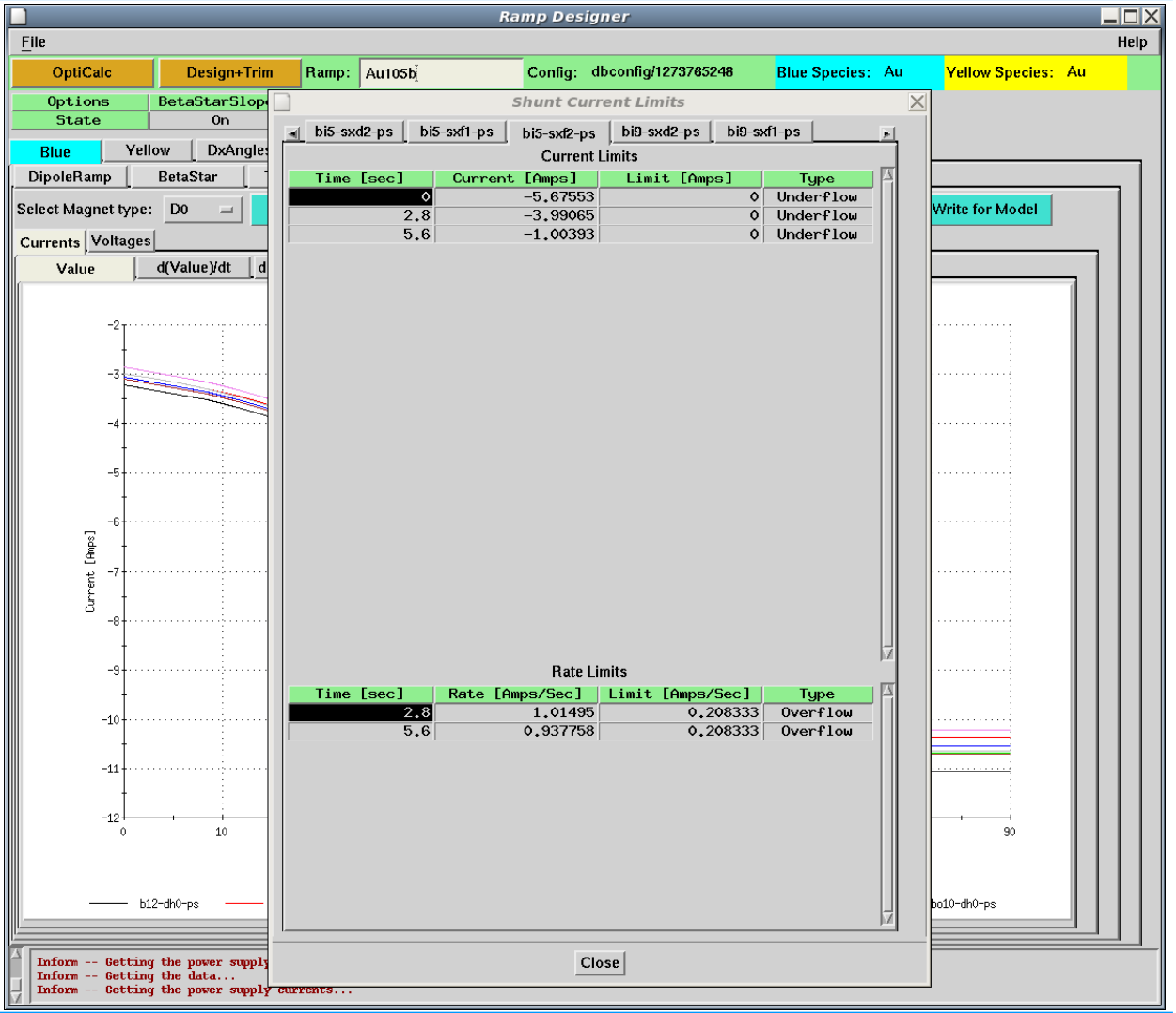
Build the Ramp, cont

Finally, check for current and/or rate limits

To fix rate limits, first try smoothing. If they are still exceeded, may have to increase the length of the ramp.

To fix current limits, tweak the design values. If the tweaks are small enough, the optics changes will be unnoticeable

If fixes are needed, you may have to reiterate previous steps

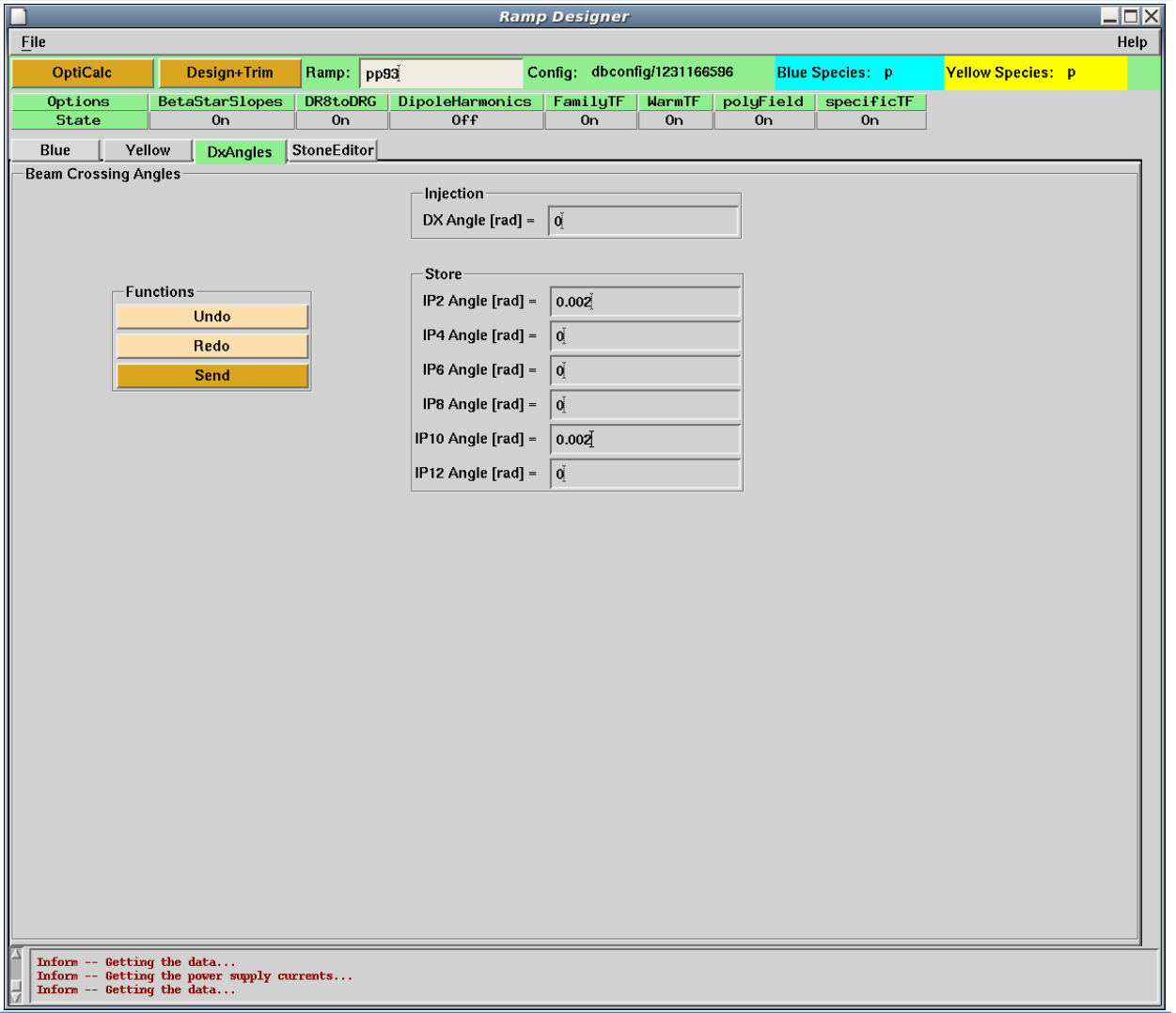


Setting crossing Angles

Changes the design values for the DX and D0 magnets

Any previous settings to the trims will be lost

RampEditor updates the changes to the interpolated values but OptiCalc responds with no changes



Stone Editor

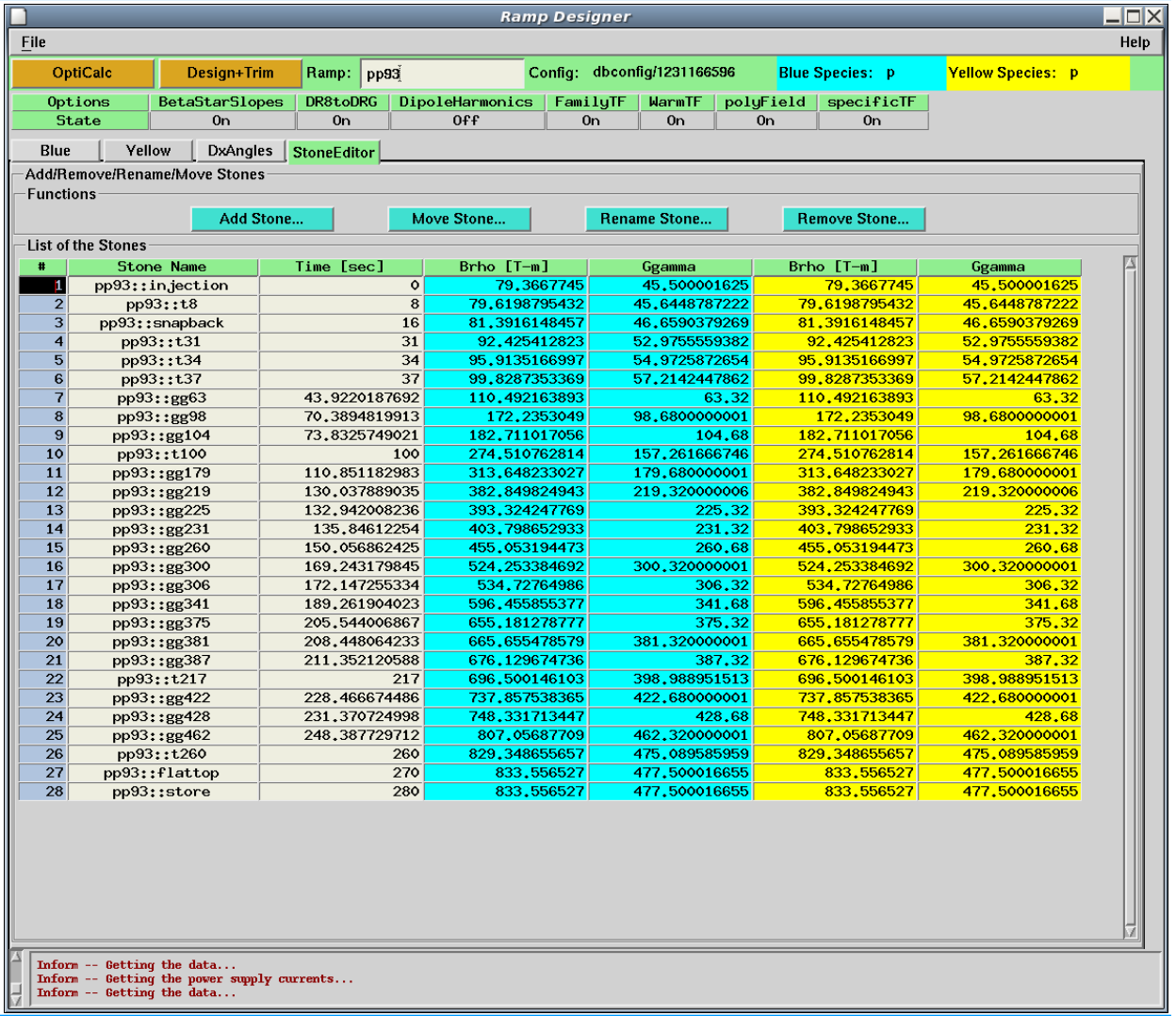
Provides:
- adding
- moving
- renaming
- removing

stones in a ramp

When a stone is removed, the original stepstone file remains

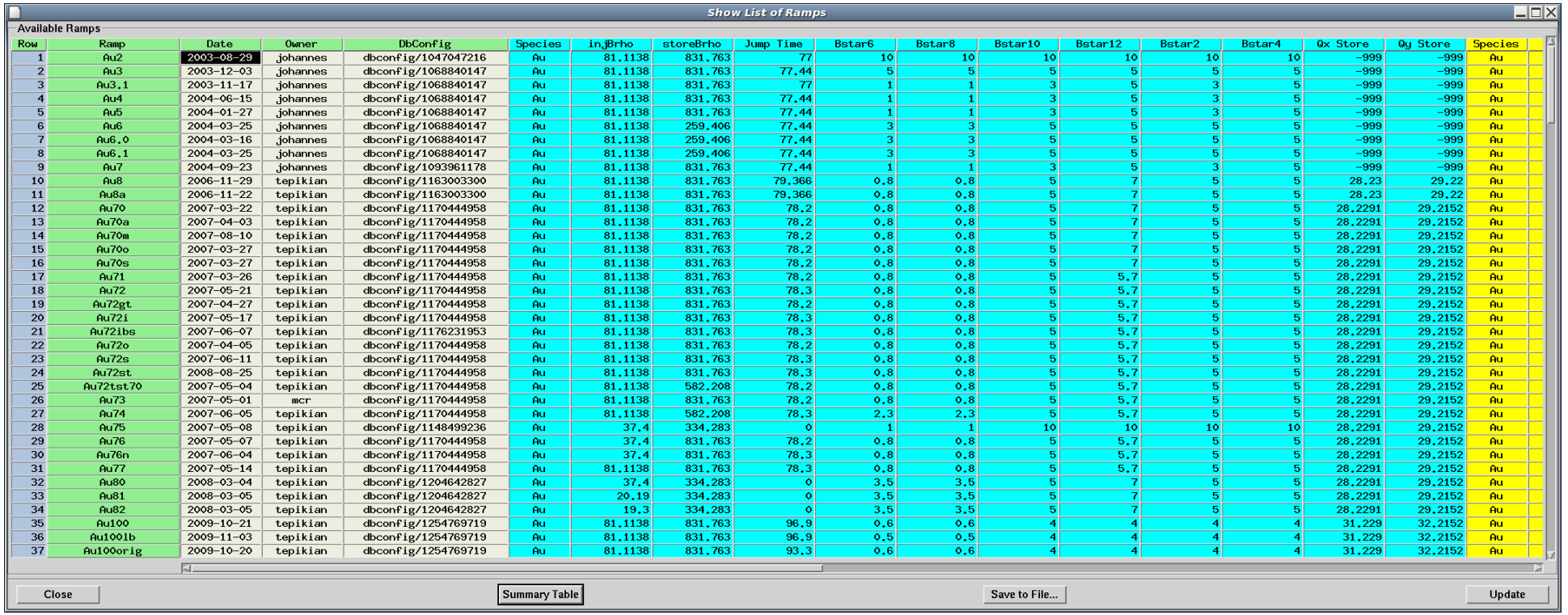
If a stepstone is added with the same name as an existing file, it uses that file instead of creating a new and empty file.

Neither RampEditor or OptiCalc updates when the stones are changed



#	Stone Name	Time [sec]	Brho [T-m]	Ggamma	Brho [T-m]	Ggamma
1	pp93::injection	0	79.3667745	45.500001625	79.3667745	45.500001625
2	pp93::t8	8	79.6198795432	45.6448787222	79.6198795432	45.6448787222
3	pp93::snapback	16	81.3916148457	46.6590379269	81.3916148457	46.6590379269
4	pp93::t31	31	92.425412823	52.9755559382	92.425412823	52.9755559382
5	pp93::t34	34	95.9135166997	54.9725872654	95.9135166997	54.9725872654
6	pp93::t37	37	99.8287353369	57.2142447862	99.8287353369	57.2142447862
7	pp93::gg63	43.9220187692	110.492163893	63.32	110.492163893	63.32
8	pp93::gg98	70.3894819913	172.2353049	98.6800000001	172.2353049	98.6800000001
9	pp93::gg104	73.8325749021	182.711017056	104.68	182.711017056	104.68
10	pp93::t100	100	274.510762814	157.261666746	274.510762814	157.261666746
11	pp93::gg179	110.851182983	313.648233027	179.680000001	313.648233027	179.680000001
12	pp93::gg219	130.037889035	382.849824943	219.320000006	382.849824943	219.320000006
13	pp93::gg225	132.942008236	393.324247769	225.32	393.324247769	225.32
14	pp93::gg231	135.84612254	403.798652933	231.32	403.798652933	231.32
15	pp93::gg260	150.056862425	455.053194473	260.68	455.053194473	260.68
16	pp93::gg300	169.243179845	524.253384692	300.320000001	524.253384692	300.320000001
17	pp93::gg306	172.147255334	534.72764986	306.32	534.72764986	306.32
18	pp93::gg341	189.261904023	596.455855377	341.68	596.455855377	341.68
19	pp93::gg375	205.544006867	655.181278777	375.32	655.181278777	375.32
20	pp93::gg381	208.448064233	665.655478579	381.320000001	665.655478579	381.320000001
21	pp93::gg387	211.352120588	676.129674736	387.32	676.129674736	387.32
22	pp93::t217	217	696.500146103	398.988951513	696.500146103	398.988951513
23	pp93::gg422	228.466674486	737.857538365	422.680000001	737.857538365	422.680000001
24	pp93::gg428	231.370724998	748.331713447	428.68	748.331713447	428.68
25	pp93::gg462	248.387729712	807.05687709	462.320000001	807.05687709	462.320000001
26	pp93::t260	260	829.348655657	475.089585959	829.348655657	475.089585959
27	pp93::flattop	270	833.556527	477.500016655	833.556527	477.500016655
28	pp93::store	280	833.556527	477.500016655	833.556527	477.500016655

Ramp Lists and Info



Show List of Ramps

Available Ramps

Row	Ramp	Date	Owner	DbConfig	Species	injBrho	storeBrho	Jump Time	Bstar6	Bstar8	Bstar10	Bstar12	Bstar2	Bstar4	Qx Store	Qy Store	Species
1	Au2	2003-08-29	johannes	dbconfig/1047047216	Au	81.1138	831.763	77	10	10	10	10	10	10	-999	-999	Au
2	Au3	2003-12-03	johannes	dbconfig/1068840147	Au	81.1138	831.763	77.44	5	5	5	5	5	5	-999	-999	Au
3	Au3.1	2003-11-17	johannes	dbconfig/1068840147	Au	81.1138	831.763	77	1	1	3	5	3	5	-999	-999	Au
4	Au4	2004-06-15	johannes	dbconfig/1068840147	Au	81.1138	831.763	77.44	1	1	3	5	3	5	-999	-999	Au
5	Au5	2004-01-27	johannes	dbconfig/1068840147	Au	81.1138	831.763	77.44	1	1	3	5	3	5	-999	-999	Au
6	Au6	2004-03-25	johannes	dbconfig/1068840147	Au	81.1138	259.406	77.44	3	3	5	5	5	5	-999	-999	Au
7	Au6.0	2004-03-16	johannes	dbconfig/1068840147	Au	81.1138	259.406	77.44	3	3	5	5	5	5	-999	-999	Au
8	Au6.1	2004-03-25	johannes	dbconfig/1068840147	Au	81.1138	259.406	77.44	3	3	5	5	5	5	-999	-999	Au
9	Au7	2004-09-23	johannes	dbconfig/1093961178	Au	81.1138	831.763	77.44	1	1	3	5	3	5	-999	-999	Au
10	Au8	2006-11-29	tepikian	dbconfig/1163003300	Au	81.1138	831.763	79.366	0.8	0.8	5	7	5	5	28.23	29.22	Au
11	Au8a	2006-11-22	tepikian	dbconfig/1163003300	Au	81.1138	831.763	79.366	0.8	0.8	5	7	5	5	28.23	29.22	Au
12	Au70	2007-03-22	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	7	5	5	28.2291	29.2152	Au
13	Au70a	2007-04-03	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	7	5	5	28.2291	29.2152	Au
14	Au70m	2007-08-10	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	7	5	5	28.2291	29.2152	Au
15	Au70o	2007-03-27	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	7	5	5	28.2291	29.2152	Au
16	Au70s	2007-03-27	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	7	5	5	28.2291	29.2152	Au
17	Au71	2007-03-26	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
18	Au72	2007-05-21	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.3	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
19	Au72gt	2007-04-27	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
20	Au72i	2007-05-17	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.3	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
21	Au72ibs	2007-06-07	tepikian	dbconfig/1176231953	Au	81.1138	831.763	78.3	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
22	Au72o	2007-04-05	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
23	Au72s	2007-06-11	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.3	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
24	Au72st	2008-08-25	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.3	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
25	Au72tst70	2007-05-04	tepikian	dbconfig/1170444958	Au	81.1138	582.208	78.2	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
26	Au73	2007-05-01	mcr	dbconfig/1170444958	Au	81.1138	831.763	78.2	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
27	Au74	2007-06-05	tepikian	dbconfig/1170444958	Au	81.1138	582.208	78.3	2.3	2.3	5	5.7	5	5	28.2291	29.2152	Au
28	Au75	2007-05-08	tepikian	dbconfig/1148499236	Au	37.4	334.283	0	1	1	10	10	10	10	28.2291	29.2152	Au
29	Au76	2007-05-07	tepikian	dbconfig/1170444958	Au	37.4	831.763	78.2	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
30	Au76n	2007-06-04	tepikian	dbconfig/1170444958	Au	37.4	831.763	78.3	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
31	Au77	2007-05-14	tepikian	dbconfig/1170444958	Au	81.1138	831.763	78.3	0.8	0.8	5	5.7	5	5	28.2291	29.2152	Au
32	Au80	2008-03-04	tepikian	dbconfig/1204642827	Au	37.4	334.283	0	3.5	3.5	5	7	5	5	28.2291	29.2152	Au
33	Au81	2008-03-05	tepikian	dbconfig/1204642827	Au	20.19	334.283	0	3.5	3.5	5	7	5	5	28.2291	29.2152	Au
34	Au82	2008-03-05	tepikian	dbconfig/1204642827	Au	19.3	334.283	0	3.5	3.5	5	7	5	5	28.2291	29.2152	Au
35	Au100	2009-10-21	tepikian	dbconfig/1254769719	Au	81.1138	831.763	96.9	0.6	0.6	4	4	4	4	31.229	32.2152	Au
36	Au100lb	2009-11-03	tepikian	dbconfig/1254769719	Au	81.1138	831.763	96.9	0.5	0.5	4	4	4	4	31.229	32.2152	Au
37	Au100orig	2009-10-20	tepikian	dbconfig/1254769719	Au	81.1138	831.763	93.3	0.6	0.6	4	4	4	4	31.229	32.2152	Au

Close | Summary Table | Save to File... | Update