

ISAC-RFQ Parameter Documentation

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TRIUMF

Abstract: This report documents the ISAC-RFQ's implementation in the envelope code `TRANSOPTR`, specifically acting as a record of the linac's vane parameters and the corresponding two-term focusing and accelerating efficiency parameters, A_{01} and A_{10} , along with the wavenumber k . A record is provided of the original `PARMTEQM` vane modulation, used to implement the RFQ in the envelope code. Additionally, use of `TRANSOPTR` via `python` to define a proxy for the ISAC-RFQ's longitudinal acceptance is demonstrated, revealing the characteristic golf club pattern. This is done using the two-term potential representation for the RFQ.

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1 sy.f and data.dat

sy.f[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13]:

```

SUBROUTINE TSYSTEM
COMMON /BLOC1/vane,rfp,ax,bxu,exu,ay,byu,eyu,az,bzu,ezu
COMMON/SCPARM/QSC,ISC,CMPS
COMMON/MOM/P,BRHO,pMASS,energk,gsq,ENERGKi,charge,current
COMMON/PRINT/IPRINT,IQ(8)
REAL axt,bxt,ayt,byt,emitVal,gzOptr,azi,bzi,bzOptr,azOptr
$,betaLocal,gamz,ezOptr,omega,newBz

iq(1)=6

CMPS=0.6
nscav=100
endDrift=15.825!cm
rmsDrift = 8.8814!cm: start of RMS in original PARMTEQ after drift

call cic3(ax,bxu,exu,ay,byu,eyu,az,bzu,ezu)
call vective(1)
call dr(rmsDrift, ".")
call rfq(71,298,vane,760.1275,35.435E+06,rfp,nscav)
call dr(endDrift, ".")
return
end

```

data.dat:

```

2.884e-2 0 0 13041.02 1 0.0 0 !Energy for mass 30 = 27944.83, mass 14= 13041.00, working Ein = 2.87003e-2
-1 5 0.1 1.e-4 ! iprint, 5=sp.charge, initial RK step, RK error tol.
0 0.00 1. 1. -3255.8 0.0 -1083.92 ! no Bz field; cyc centre coord for fort.3
1.0E-01 00.00E-03 1.00E-01 20.00E-03 28.0 0.01 ! bunch dim: x,x',y,y',z(bun. len.),dp/p
1. 1. 1. 1. 1. 1. 1. 1. ! 1 means x,y,z in cm, x',y',dp/p in rad (dimensionless)
0 !number of correl. params (GUI needs this line)
11 ! Number of parameters that will be passed into common block
0.0352 0.0 0.0704 0 ! Vane_voltage . MV
-25.0 -360.0 360.0 0 ! Phase . Deg
2.39 -10.0 20.0 0 ! Alpha_x axu 1
31.5 0.0 180.0 0 ! Beta_x bxu cm
3e-3 0.0 100.0 0 ! Emittance_x exu cm.rad
2.70 -10.0 20.0 0 ! Alpha_y ayu 1
33.6 0.0 180.0 0 ! Beta_y byu cm
3e-3 0.0 100.0 0 ! Emittance_y eyu cm.rad
2.0 -200. 300. 0 ! Alpha_z azu 1
47.27 0.0 200. 0 ! Beta_z bzu cm
4.9e-4 0.0 10.0 0 ! Emittance_z ezu cm.rad
1.E-4 900 !hack - 1e-4 is an epsilon convergence factor, 900 is max iterations
1 .0 0.9 20 ! hack - have to do with optimization routine - file parsed in main.f

```

2 298-line fort.71 Input Field File

0.000000E+00	1.068168E-02	0.000000E+00	3.539788E+00
9.654000E-02	6.454544E-02	0.000000E+00	3.539788E+00
1.930800E-01	1.163406E-01	0.000000E+00	3.539788E+00
2.896100E-01	1.679408E-01	0.000000E+00	3.539788E+00
3.861500E-01	2.193467E-01	0.000000E+00	3.539788E+00
4.826900E-01	2.705145E-01	0.000000E+00	3.539788E+00
5.792300E-01	3.213973E-01	0.000000E+00	3.539788E+00
6.757600E-01	3.719340E-01	0.000000E+00	3.539788E+00
7.723000E-01	4.220837E-01	0.000000E+00	3.539788E+00
8.688400E-01	4.717901E-01	0.000000E+00	3.539788E+00
9.653700E-01	5.209992E-01	0.000000E+00	3.539788E+00
1.061910E+00	5.696665E-01	0.000000E+00	3.539788E+00
1.158400E+00	6.177422E-01	0.000000E+00	3.539788E+00
1.255000E+00	6.651830E-01	0.000000E+00	3.539788E+00
1.351500E+00	7.119323E-01	0.000000E+00	3.539788E+00
1.448100E+00	7.579617E-01	0.000000E+00	3.539788E+00
1.544600E+00	8.032210E-01	0.000000E+00	3.539788E+00
1.641100E+00	8.476731E-01	0.000000E+00	3.539788E+00
1.737700E+00	8.912909E-01	0.000000E+00	3.539788E+00
1.834200E+00	9.340160E-01	0.000000E+00	3.539788E+00
1.930700E+00	9.758273E-01	0.000000E+00	3.539788E+00
2.027300E+00	1.016682E+00	0.000000E+00	3.539788E+00
2.123800E+00	1.056570E+00	0.000000E+00	3.539788E+00
2.220400E+00	1.095456E+00	0.000000E+00	3.539788E+00
2.316900E+00	1.133315E+00	0.000000E+00	3.539788E+00
2.413400E+00	1.170125E+00	0.000000E+00	3.539788E+00
2.510000E+00	1.205863E+00	0.000000E+00	3.539788E+00
2.606500E+00	1.240518E+00	0.000000E+00	3.539788E+00
2.703000E+00	1.274073E+00	0.000000E+00	3.539788E+00
2.799600E+00	1.306514E+00	0.000000E+00	3.539788E+00
2.896100E+00	1.337832E+00	0.000000E+00	3.539788E+00
2.992700E+00	1.368022E+00	0.000000E+00	3.539788E+00
3.089200E+00	1.397080E+00	0.000000E+00	3.539788E+00
3.185700E+00	1.424999E+00	0.000000E+00	3.539788E+00
3.282300E+00	1.451785E+00	0.000000E+00	3.539788E+00
3.378800E+00	1.477436E+00	0.000000E+00	3.539788E+00
3.475300E+00	1.501959E+00	0.000000E+00	3.539788E+00
3.571900E+00	1.525363E+00	0.000000E+00	3.539788E+00
3.668400E+00	1.547657E+00	0.000000E+00	3.539788E+00
3.764900E+00	1.568855E+00	0.000000E+00	3.539788E+00
3.861500E+00	1.588964E+00	0.000000E+00	3.539788E+00
3.958000E+00	1.608010E+00	0.000000E+00	3.539788E+00
4.054600E+00	1.626005E+00	0.000000E+00	3.539788E+00
4.151100E+00	1.642973E+00	0.000000E+00	3.539788E+00
4.247600E+00	1.658929E+00	0.000000E+00	3.539788E+00
4.344200E+00	1.673905E+00	0.000000E+00	3.539788E+00
4.440700E+00	1.687923E+00	0.000000E+00	3.539788E+00
4.537200E+00	1.701011E+00	0.000000E+00	3.539788E+00

4.633800E+00	1.713194E+00	0.000000E+00	3.539788E+00
4.730300E+00	1.724506E+00	0.000000E+00	3.539788E+00
4.826900E+00	1.734971E+00	0.000000E+00	3.539788E+00
4.923400E+00	1.744627E+00	0.000000E+00	3.539788E+00
5.019900E+00	1.753505E+00	0.000000E+00	3.539788E+00
5.116500E+00	1.761642E+00	0.000000E+00	3.539788E+00
5.213000E+00	1.769063E+00	0.000000E+00	3.539788E+00
5.309500E+00	1.775812E+00	0.000000E+00	3.539788E+00
5.406100E+00	1.781914E+00	0.000000E+00	3.539788E+00
5.502600E+00	1.787417E+00	0.000000E+00	3.539788E+00
5.599100E+00	1.792345E+00	0.000000E+00	3.539788E+00
5.695700E+00	1.796739E+00	0.000000E+00	3.539788E+00
5.792200E+00	1.800633E+00	0.000000E+00	3.539788E+00
5.888800E+00	1.804064E+00	0.000000E+00	3.539788E+00
5.985300E+00	1.807063E+00	0.000000E+00	3.539788E+00
6.081800E+00	1.809670E+00	0.000000E+00	3.539788E+00
6.178400E+00	1.811906E+00	0.000000E+00	3.539788E+00
6.274900E+00	1.813815E+00	0.000000E+00	3.539788E+00
6.371400E+00	1.815429E+00	0.000000E+00	3.539788E+00
6.468000E+00	1.816770E+00	0.000000E+00	3.539788E+00
6.564500E+00	1.817877E+00	0.000000E+00	3.539788E+00
6.661100E+00	1.818770E+00	0.000000E+00	3.539788E+00
6.757600E+00	1.819481E+00	0.000000E+00	3.539788E+00
6.854100E+00	1.820031E+00	0.000000E+00	3.539788E+00
6.950700E+00	1.820449E+00	0.000000E+00	3.539788E+00
7.047200E+00	1.820753E+00	0.000000E+00	3.539788E+00
7.143700E+00	1.820969E+00	0.000000E+00	3.539788E+00
7.240300E+00	1.821107E+00	0.000000E+00	3.539788E+00
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7.433400E+00	1.821240E+00	0.000000E+00	3.539788E+00
7.529900E+00	1.821254E+00	0.000000E+00	3.539788E+00
7.626400E+00	1.821254E+00	0.000000E+00	3.539788E+00
7.723000E+00	1.821245E+00	0.000000E+00	3.539788E+00
7.819500E+00	1.821235E+00	0.000000E+00	3.539788E+00
7.916000E+00	1.821225E+00	0.000000E+00	3.539788E+00
8.012600E+00	1.821225E+00	0.000000E+00	3.539788E+00
8.109100E+00	1.820805E+00	3.714819E-04	3.539788E+00
8.205600E+00	1.818425E+00	2.589445E-03	3.539788E+00
8.302200E+00	1.814741E+00	6.518352E-03	3.539788E+00
8.398700E+00	1.810995E+00	1.162388E-02	3.539788E+00
8.495300E+00	1.808263E+00	1.727213E-02	3.539788E+00
8.591800E+00	1.807073E+00	2.278790E-02	3.539788E+00
8.688300E+00	1.807255E+00	2.757016E-02	3.539788E+00
8.784900E+00	1.808135E+00	3.112309E-02	3.539788E+00
8.881400E+00	1.808896E+00	3.308218E-02	3.539788E+00
9.327744E+00	1.808923E+00	3.377031E-02	3.519250E+00
1.022668E+01	1.809046E+00	3.465181E-02	3.470649E+00
1.113817E+01	1.809164E+00	3.553721E-02	3.422989E+00
1.206236E+01	1.809274E+00	3.644880E-02	3.375976E+00
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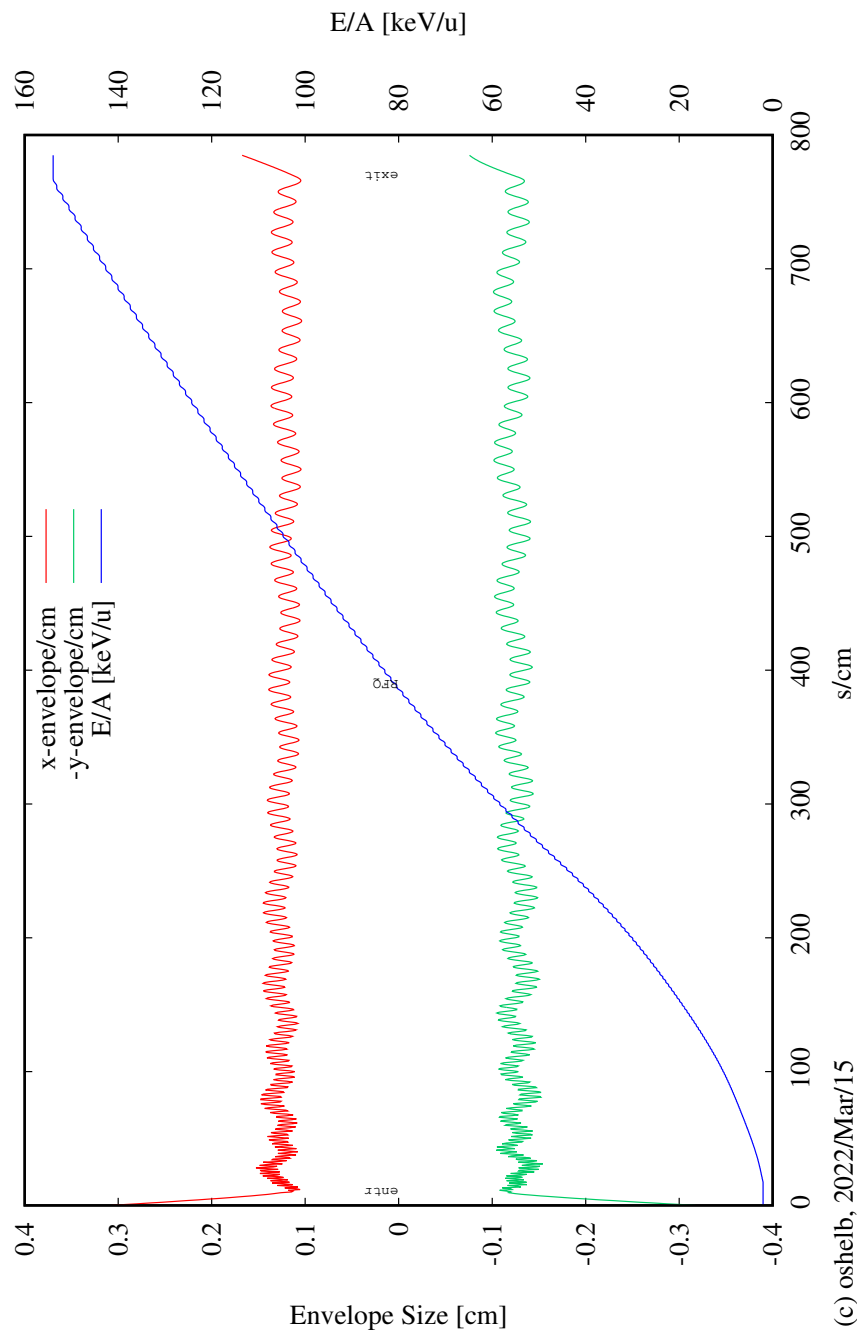
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1.588958E+01	1.809653E+00	4.036436E-02	3.194322E+00
1.687992E+01	1.809734E+00	4.141350E-02	3.150461E+00
1.788405E+01	1.809810E+00	4.249763E-02	3.107207E+00
1.890215E+01	1.809881E+00	4.361989E-02	3.064551E+00
1.993442E+01	1.809950E+00	4.475669E-02	3.022484E+00
2.098106E+01	1.810013E+00	4.594080E-02	2.981006E+00
2.204226E+01	1.810072E+00	4.717800E-02	2.940098E+00
2.311823E+01	1.810129E+00	4.843311E-02	2.899745E+00
2.420917E+01	1.810182E+00	4.972780E-02	2.859949E+00
2.531530E+01	1.810232E+00	5.106630E-02	2.820700E+00
2.643681E+01	1.810281E+00	5.242436E-02	2.781991E+00
2.757392E+01	1.810326E+00	5.383503E-02	2.743823E+00
2.872686E+01	1.810368E+00	5.530587E-02	2.706179E+00
2.989583E+01	1.810408E+00	5.679956E-02	2.669045E+00
3.108106E+01	1.810447E+00	5.834257E-02	2.632423E+00
3.228278E+01	1.810482E+00	5.994172E-02	2.596302E+00
3.350123E+01	1.810517E+00	6.156601E-02	2.560673E+00
3.473662E+01	1.810550E+00	6.324732E-02	2.525537E+00
3.598921E+01	1.810580E+00	6.499521E-02	2.490880E+00
3.725922E+01	1.810610E+00	6.677120E-02	2.456694E+00
3.854691E+01	1.810638E+00	6.859981E-02	2.422978E+00
3.985251E+01	1.810665E+00	7.048942E-02	2.389725E+00
4.117628E+01	1.810690E+00	7.240893E-02	2.356930E+00
4.251847E+01	1.810714E+00	7.439474E-02	2.324590E+00
4.387933E+01	1.810737E+00	7.646102E-02	2.292696E+00
4.525912E+01	1.810759E+00	7.856051E-02	2.261237E+00
4.665811E+01	1.810780E+00	8.073411E-02	2.230211E+00
4.807657E+01	1.810800E+00	8.300010E-02	2.199607E+00
4.951476E+01	1.810819E+00	8.530279E-02	2.169414E+00
5.097297E+01	1.810837E+00	8.766786E-02	2.139633E+00
5.245147E+01	1.810854E+00	9.010792E-02	2.110260E+00
5.395055E+01	1.810871E+00	9.258613E-02	2.081290E+00
5.547050E+01	1.810887E+00	9.514640E-02	2.052722E+00
5.701160E+01	1.810902E+00	9.781358E-02	2.024548E+00
5.857415E+01	1.810916E+00	1.005223E-01	1.996756E+00
6.015845E+01	1.810930E+00	1.033142E-01	1.969347E+00
6.176480E+01	1.810943E+00	1.062157E-01	1.942314E+00
6.339350E+01	1.810956E+00	1.091831E-01	1.915647E+00
6.504488E+01	1.810968E+00	1.122308E-01	1.889344E+00
6.671925E+01	1.810980E+00	1.153539E-01	1.863401E+00
6.841693E+01	1.810991E+00	1.185743E-01	1.837815E+00
7.013825E+01	1.811002E+00	1.218796E-01	1.812579E+00
7.188353E+01	1.811012E+00	1.252997E-01	1.787690E+00
7.365311E+01	1.811021E+00	1.287954E-01	1.763140E+00
7.544734E+01	1.811031E+00	1.323893E-01	1.738927E+00
7.726654E+01	1.811040E+00	1.360766E-01	1.715048E+00
7.911108E+01	1.811048E+00	1.398978E-01	1.691497E+00
8.098129E+01	1.811057E+00	1.438119E-01	1.668267E+00

8.287755E+01	1.811065E+00	1.478598E-01	1.645355E+00
8.480022E+01	1.811073E+00	1.519998E-01	1.622754E+00
8.674966E+01	1.811080E+00	1.562733E-01	1.600462E+00
8.872626E+01	1.811087E+00	1.606461E-01	1.578475E+00
9.073040E+01	1.811094E+00	1.651698E-01	1.556788E+00
9.276245E+01	1.811100E+00	1.697906E-01	1.535397E+00
9.482281E+01	1.811106E+00	1.745604E-01	1.514300E+00
9.691189E+01	1.811112E+00	1.794334E-01	1.493492E+00
9.903006E+01	1.811118E+00	1.844724E-01	1.472970E+00
1.011777E+02	1.811132E+00	1.896197E-01	1.452730E+00
1.033554E+02	1.811127E+00	1.949659E-01	1.432769E+00
1.055633E+02	1.811134E+00	2.004257E-01	1.413080E+00
1.078020E+02	1.811139E+00	2.060283E-01	1.393662E+00
1.100719E+02	1.811143E+00	2.118242E-01	1.374511E+00
1.123734E+02	1.811148E+00	2.177551E-01	1.355622E+00
1.147070E+02	1.811152E+00	2.238868E-01	1.336993E+00
1.170732E+02	1.811156E+00	2.301757E-01	1.318618E+00
1.194723E+02	1.811160E+00	2.366298E-01	1.300494E+00
1.219048E+02	1.811163E+00	2.432737E-01	1.282620E+00
1.243712E+02	1.811167E+00	2.500880E-01	1.264991E+00
1.268720E+02	1.811170E+00	2.571238E-01	1.247604E+00
1.294076E+02	1.811173E+00	2.643167E-01	1.230456E+00
1.319786E+02	1.811175E+00	2.717463E-01	1.213543E+00
1.345854E+02	1.811178E+00	2.793909E-01	1.196863E+00
1.372286E+02	1.811180E+00	2.872262E-01	1.180411E+00
1.399086E+02	1.811182E+00	2.953137E-01	1.164184E+00
1.426259E+02	1.811193E+00	3.036140E-01	1.148180E+00
1.453811E+02	1.811196E+00	3.121477E-01	1.132395E+00
1.481748E+02	1.811198E+00	3.208908E-01	1.116826E+00
1.510073E+02	1.811201E+00	3.299384E-01	1.101472E+00
1.538794E+02	1.811203E+00	3.392029E-01	1.086327E+00
1.567915E+02	1.811206E+00	3.487154E-01	1.071391E+00
1.597442E+02	1.811209E+00	3.585121E-01	1.056660E+00
1.627380E+02	1.811211E+00	3.686063E-01	1.042131E+00
1.657737E+02	1.811213E+00	3.789503E-01	1.027801E+00
1.688516E+02	1.811215E+00	3.896022E-01	1.013668E+00
1.719724E+02	1.811217E+00	4.005429E-01	9.997294E-01
1.751368E+02	1.811219E+00	4.117925E-01	9.859820E-01
1.783452E+02	1.811221E+00	4.233656E-01	9.724235E-01
1.815984E+02	1.811222E+00	4.352620E-01	9.590512E-01
1.848970E+02	1.811224E+00	4.474634E-01	9.458627E-01
1.882416E+02	1.811225E+00	4.600417E-01	9.328557E-01
1.916328E+02	1.811226E+00	4.729850E-01	9.200274E-01
1.950712E+02	1.811228E+00	4.862546E-01	9.073750E-01
1.985577E+02	1.811229E+00	4.999078E-01	8.948967E-01
2.020927E+02	1.811229E+00	5.139776E-01	8.825900E-01
2.056770E+02	1.811230E+00	5.284009E-01	8.704520E-01
2.093113E+02	1.811231E+00	5.432401E-01	8.584812E-01
2.129963E+02	1.811231E+00	5.585215E-01	8.466748E-01
2.167327E+02	1.811231E+00	5.742119E-01	8.350304E-01

2.205212E+02	1.811240E+00	5.903454E-01	8.235461E-01
2.243625E+02	1.811241E+00	6.069238E-01	8.122196E-01
2.282574E+02	1.811243E+00	6.239831E-01	8.010488E-01
2.322066E+02	1.811244E+00	6.415008E-01	7.900316E-01
2.362109E+02	1.811245E+00	6.595257E-01	7.791659E-01
2.402710E+02	1.811245E+00	6.793078E-01	7.684454E-01
2.443879E+02	1.811243E+00	7.149005E-01	7.577985E-01
2.485630E+02	1.811247E+00	7.153615E-01	7.472084E-01
2.527966E+02	1.811251E+00	7.157793E-01	7.369952E-01
2.570880E+02	1.811255E+00	7.161559E-01	7.271862E-01
2.614366E+02	1.811258E+00	7.165552E-01	7.177544E-01
2.658416E+02	1.811261E+00	7.169175E-01	7.086761E-01
2.703024E+02	1.811263E+00	7.172466E-01	6.999301E-01
2.748182E+02	1.811266E+00	7.175875E-01	6.914967E-01
2.793884E+02	1.811268E+00	7.178988E-01	6.833578E-01
2.840124E+02	1.811270E+00	7.181825E-01	6.754968E-01
2.886897E+02	1.811271E+00	7.184410E-01	6.678985E-01
2.934195E+02	1.811273E+00	7.187246E-01	6.605486E-01
2.982015E+02	1.811274E+00	7.189858E-01	6.534338E-01
3.030349E+02	1.811276E+00	7.192259E-01	6.465420E-01
3.079194E+02	1.811277E+00	7.194465E-01	6.398618E-01
3.128543E+02	1.811278E+00	7.196903E-01	6.333829E-01
3.178392E+02	1.811279E+00	7.199168E-01	6.270950E-01
3.228735E+02	1.811280E+00	7.201269E-01	6.209891E-01
3.279570E+02	1.811281E+00	7.203214E-01	6.150568E-01
3.330890E+02	1.811282E+00	7.205012E-01	6.092899E-01
3.382691E+02	1.811283E+00	7.207003E-01	6.036811E-01
3.434968E+02	1.811283E+00	7.208864E-01	5.982231E-01
3.487719E+02	1.811284E+00	7.210602E-01	5.929094E-01
3.540938E+02	1.811285E+00	7.212221E-01	5.877338E-01
3.594622E+02	1.811285E+00	7.213729E-01	5.826904E-01
3.648767E+02	1.811286E+00	7.215130E-01	5.777739E-01
3.703369E+02	1.811286E+00	7.216779E-01	5.729789E-01
3.758423E+02	1.811287E+00	7.218336E-01	5.683004E-01
3.813928E+02	1.811287E+00	7.219803E-01	5.637339E-01
3.869878E+02	1.811288E+00	7.221184E-01	5.592750E-01
3.926271E+02	1.811288E+00	7.222482E-01	5.549195E-01
3.983104E+02	1.811288E+00	7.223701E-01	5.506636E-01
4.040372E+02	1.811289E+00	7.224843E-01	5.465035E-01
4.098073E+02	1.811280E+00	7.226156E-01	5.424358E-01
4.156203E+02	1.811281E+00	7.227404E-01	5.384570E-01
4.214760E+02	1.811281E+00	7.228587E-01	5.345640E-01
4.273740E+02	1.811282E+00	7.229708E-01	5.307536E-01
4.333141E+02	1.811282E+00	7.230768E-01	5.270231E-01
4.392959E+02	1.811283E+00	7.231769E-01	5.233697E-01
4.453192E+02	1.811283E+00	7.232715E-01	5.197908E-01
4.513837E+02	1.811284E+00	7.233607E-01	5.162840E-01
4.574891E+02	1.811284E+00	7.234653E-01	5.128469E-01
4.636351E+02	1.811284E+00	7.235653E-01	5.094771E-01
4.698216E+02	1.811285E+00	7.236606E-01	5.061725E-01

4.760481E+02	1.811285E+00	7.237513E-01	5.029311E-01
4.823146E+02	1.811285E+00	7.238378E-01	4.997507E-01
4.886206E+02	1.811286E+00	7.239200E-01	4.966297E-01
4.949661E+02	1.811286E+00	7.239981E-01	4.935661E-01
5.013507E+02	1.811286E+00	7.240723E-01	4.905583E-01
5.077742E+02	1.811286E+00	7.241427E-01	4.876045E-01
5.142364E+02	1.811287E+00	7.242094E-01	4.847033E-01
5.207370E+02	1.811287E+00	7.242857E-01	4.818530E-01
5.272759E+02	1.811287E+00	7.243588E-01	4.790522E-01
5.338528E+02	1.811287E+00	7.243568E-01	4.762994E-01
5.404675E+02	1.811288E+00	7.244352E-01	4.735936E-01
5.471197E+02	1.811288E+00	7.245117E-01	4.709331E-01
5.538094E+02	1.811288E+00	7.245852E-01	4.683168E-01
5.605361E+02	1.811288E+00	7.246560E-01	4.657434E-01
5.672999E+02	1.811288E+00	7.247240E-01	4.632117E-01
5.741005E+02	1.811289E+00	7.247893E-01	4.607207E-01
5.809376E+02	1.811289E+00	7.248521E-01	4.582692E-01
5.878111E+02	1.811289E+00	7.249124E-01	4.558563E-01
5.947207E+02	1.811289E+00	7.249703E-01	4.534810E-01
6.016664E+02	1.811289E+00	7.250258E-01	4.511422E-01
6.086479E+02	1.811289E+00	7.250791E-01	4.488392E-01
6.156651E+02	1.811290E+00	7.251301E-01	4.465709E-01
6.227176E+02	1.811290E+00	7.251789E-01	4.443365E-01
6.298056E+02	1.811290E+00	7.252256E-01	4.421352E-01
6.369286E+02	1.811290E+00	7.252843E-01	4.399662E-01
6.440865E+02	1.811290E+00	7.253411E-01	4.378287E-01
6.512793E+02	1.811290E+00	7.253961E-01	4.357219E-01
6.585066E+02	1.811290E+00	7.254492E-01	4.336451E-01
6.657685E+02	1.811291E+00	7.255005E-01	4.315976E-01
6.730645E+02	1.811291E+00	7.255501E-01	4.295787E-01
6.803948E+02	1.811291E+00	7.255980E-01	4.275877E-01
6.877590E+02	1.811291E+00	7.256443E-01	4.256241E-01
6.951570E+02	1.811291E+00	7.256889E-01	4.236872E-01
7.025887E+02	1.811291E+00	7.257321E-01	4.217764E-01
7.100538E+02	1.811291E+00	7.257736E-01	4.198912E-01
7.175524E+02	1.811291E+00	7.258137E-01	4.180309E-01
7.250842E+02	1.811291E+00	7.258524E-01	4.161950E-01
7.326490E+02	1.811291E+00	7.258896E-01	4.143831E-01
7.402469E+02	1.811395E+00	7.258408E-01	4.125922E-01
7.478775E+02	1.810710E+00	7.258682E-01	4.108268E-01
7.517010E+02	1.810518E+00	7.259352E-01	4.090834E-01
7.526610E+02	1.759791E+00	7.145615E-01	4.090834E-01
7.536209E+02	1.648507E+00	6.785045E-01	4.090834E-01
7.545809E+02	1.554019E+00	6.122100E-01	4.090834E-01
7.555408E+02	1.527684E+00	5.082761E-01	4.090834E-01
7.565007E+02	1.579628E+00	3.642025E-01	4.090834E-01
7.574607E+02	1.682710E+00	1.972725E-01	4.090834E-01
7.584206E+02	1.781334E+00	5.601582E-02	4.090834E-01
7.593806E+02	1.821225E+00	0.000000E+00	4.090834E-01
7.601275E+02	1.821225E+00	0.000000E+00	4.090834E-01

3 TRANSOPTR Envelopes



(c) oshelb, 2022/Mar/15

4 Scanning TRANSOPTR in python

I've developed a few definitions in python to edit `data.dat` and `sy.f`, using routines from `accpy`. This then allows me to run the code in a loop over TRANSOPTR variables, as elaborated in reference [14] for rf cavities. Iterating through both rf phase (ϕ for the RFQ) and input energy (line 1, element 1 `data.dat` [15]) and running TRANSOPTR through python allows for the recording of the output energy, I obtain a two dimensional colormap which represents the characteristic RFQ golf club, shown in Figure 1.

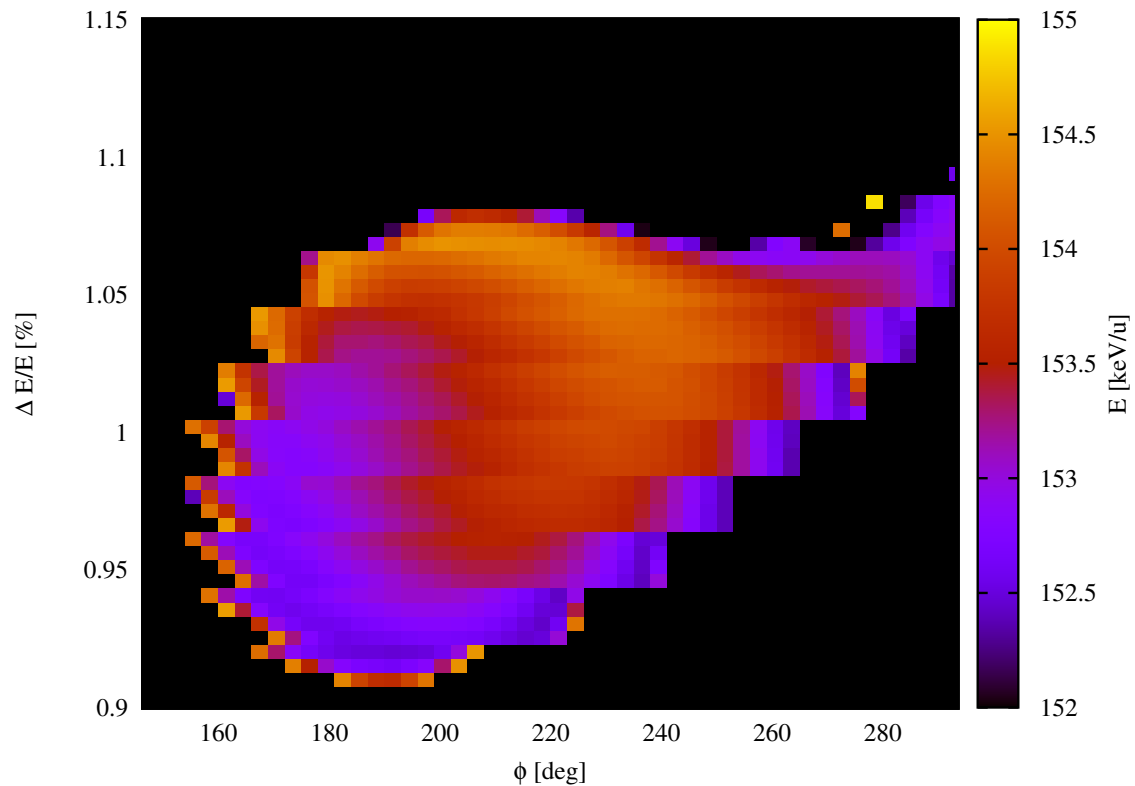


Figure 1: Output reference particle energy (color) shown against input RF phase and beam energy for a $12C^+$ beam, $V_0 = 31.0kV$. A 50x50 grid has been used.

5 PARMTEQM Input File RFQ.dat

```

RUN      1 1
TITLE
  8 M RFQ, N14 BEAM
LINAC 1 0.0287 35.435 14.0000
TANK
24 .741   RADIUS OF VANE TIPS
2  -193   LAST CELL BEFORE END CELLS
3  -25    SYNCHRONOUS PHASE
4  .0352  VANE VOLTAGE
11  1.0
RMATCH 0 8.8 -10.8 .1 .0250337831 .0250337831 .096536994
16.862665
.8875087
.89269
.90519
.91779
OUTPUT -1
OUTPUT -3
ZDATA -4  0.000  3.5000  -25.000  1.1242
          3.185  3.5000  -25.000  1.1242
          6.040  3.5000  -25.000  1.1246
          9.016  3.5000  -25.000  1.1257
         12.120  3.5000  -25.000  1.1273
         15.356  3.5000  -25.000  1.1296
         18.730  3.5000  -25.000  1.1324
         22.247  3.5000  -25.000  1.1359
         25.915  3.5000  -25.000  1.1400
         29.740  3.5000  -25.000  1.1448
         33.728  3.5000  -25.000  1.1502
         37.885  3.5000  -25.000  1.1564
         42.220  3.5000  -25.000  1.1635
         46.741  3.5000  -25.000  1.1713
         51.453  3.5000  -25.000  1.1801
         54.707  3.5000  -25.000  1.1866
         58.052  3.5000  -25.000  1.1935
         61.491  3.5000  -25.000  1.2009
         65.028  3.5000  -25.000  1.2089
         68.664  3.5000  -25.000  1.2174
         72.403  3.5000  -25.000  1.2266
         76.248  3.5000  -25.000  1.2365
         80.201  3.5000  -25.000  1.2471
         84.266  3.5000  -25.000  1.2585
         88.446  3.5000  -25.000  1.2707

```

92.744	3.5000	-25.000	1.2838
94.938	3.5000	-25.000	1.2908
97.163	3.5000	-25.000	1.2980
99.420	3.5000	-25.000	1.3054
101.707	3.5000	-25.000	1.3132
104.027	3.5000	-25.000	1.3212
106.380	3.5000	-25.000	1.3296
108.765	3.5000	-25.000	1.3383
111.184	3.5000	-25.000	1.3473
113.637	3.5000	-25.000	1.3567
116.124	3.5000	-25.000	1.3664
118.646	3.5000	-25.000	1.3766
121.204	3.5000	-25.000	1.3871
123.797	3.5000	-25.000	1.3981
126.427	3.5000	-25.000	1.4096
129.093	3.5000	-25.000	1.4215
131.797	3.5000	-25.000	1.4340
134.539	3.5000	-25.000	1.4470
137.319	3.5000	-25.000	1.4606
140.139	3.5000	-25.000	1.4747
142.998	3.5000	-25.000	1.4896
145.896	3.5000	-25.000	1.5051
148.836	3.5000	-25.000	1.5213
151.817	3.5000	-25.000	1.5383
154.839	3.5000	-25.000	1.5562
157.904	3.5000	-25.000	1.5749
161.012	3.5000	-25.000	1.5946
164.164	3.5000	-25.000	1.6153
167.360	3.5000	-25.000	1.6371
170.600	3.5000	-25.000	1.6601
173.886	3.5000	-25.000	1.6844
177.218	3.5000	-25.000	1.7100
180.597	3.5000	-25.000	1.7372
184.023	3.5000	-25.000	1.7661
187.497	3.5000	-25.000	1.7967
191.020	3.5000	-25.000	1.8293
194.592	3.5000	-25.000	1.8642
198.215	3.5000	-25.000	1.9014
201.888	3.5000	-25.000	1.9413
205.613	3.5000	-25.000	1.9843
209.390	3.5000	-25.000	2.0306
213.219	3.5000	-25.000	2.0807
217.103	3.5000	-25.000	2.1351
221.041	3.5000	-25.000	2.1945
225.034	3.5000	-25.000	2.2595
229.084	3.5000	-25.000	2.3312

233.190	3.5000	-25.000	2.4107	
237.353	3.5000	-25.000	2.5990	
250.190	3.5000	-25.000	2.5937	
263.532	3.5000	-25.000	2.5893	
282.078	3.5000	-25.000	2.5842	
301.454	3.5000	-25.000	2.5800	
326.791	3.5000	-25.000	2.5757	
358.759	3.5000	-25.000	2.5714	
398.105	3.5000	-25.000	2.5675	
445.636	3.5000	-25.000	2.5639	
508.682	3.5000	-25.000	2.5603	
521.756	3.5000	-25.000	2.5597	
528.350	3.5000	-25.000	2.5590	
624.503	3.5000	-25.000	2.5556	
750.409	3.5000	-25.000	2.5525	-1

```

RFQOUT 1
START 4
STOP
ELIMIT -1
INPUT 19 35.435 35.435 129.477 -25
EMATCH .037049998 .037049998 .1975639 .1
7.61428
7.647
7.67959
.74691
15.825
OUTPUT 0 0 198
OUTPUT -1
OUTPUT -5
BEGIN 1080
END
    
```

6 PARMTEQM input 8-term HARMDECK

1.	3.22568E-02	1.81131E+00	2.55500E-01	6.71191E-02	-2.94720E-07	1.43443E-04	-1.98397E-06	5.65861E-04	0.8927
2.	3.32976E-02	1.81080E+00	2.68379E-01	6.69854E-02	2.98153E-07	1.45686E-04	-1.08057E-06	6.05479E-04	0.9052
3.	3.42301E-02	1.81082E+00	2.81360E-01	6.71228E-02	1.17131E-07	1.53517E-04	-8.65547E-07	6.83617E-04	0.9178
4.	3.51811E-02	1.81082E+00	2.94339E-01	6.70329E-02	3.12626E-08	1.62916E-04	-9.75908E-07	7.29891E-04	0.9306
5.	3.61562E-02	1.81083E+00	3.07878E-01	6.69625E-02	-1.51453E-07	1.71190E-04	-1.19099E-06	7.57644E-04	0.9435
6.	3.71534E-02	1.81087E+00	3.22148E-01	6.68660E-02	-1.96887E-07	1.81734E-04	-1.22537E-06	8.14653E-04	0.9567
7.	3.81687E-02	1.81085E+00	3.36968E-01	6.67940E-02	-4.50796E-07	1.92123E-04	-1.57585E-06	8.49837E-04	0.9700
8.	3.92489E-02	1.81097E+00	3.54927E-01	6.71957E-02	7.07023E-07	2.27561E-04	7.17923E-06	1.72983E-03	0.9835
9.	4.03586E-02	1.81098E+00	3.71816E-01	6.71487E-02	4.95506E-07	2.42107E-04	7.78634E-06	1.87932E-03	0.9972

10.	4.14781E-02	1.81100E+00	3.89541E-01	6.70523E-02	8.54488E-07	2.55027E-04	9.45164E-06	2.05933E-03	1.0111
11.	4.26114E-02	1.81101E+00	4.07722E-01	6.70267E-02	2.46812E-07	2.71942E-04	9.60072E-06	2.21746E-03	1.0251
12.	4.37941E-02	1.81096E+00	4.27333E-01	6.69312E-02	6.67047E-07	2.86711E-04	1.15824E-05	2.43299E-03	1.0394
13.	4.49861E-02	1.81097E+00	4.47365E-01	6.69187E-02	-8.54263E-09	3.03419E-04	1.19849E-05	2.60655E-03	1.0539
14.	4.62436E-02	1.81100E+00	4.69046E-01	6.68395E-02	1.82767E-07	3.20443E-04	1.39094E-05	2.84351E-03	1.0685
15.	4.75228E-02	1.81102E+00	4.89806E-01	6.64989E-02	-1.82514E-07	3.38244E-04	1.21934E-05	2.76491E-03	1.0834
16.	4.88549E-02	1.81101E+00	5.13583E-01	6.64199E-02	-2.19680E-07	3.57926E-04	1.36565E-05	2.99292E-03	1.0985
17.	5.02105E-02	1.81099E+00	5.38415E-01	6.63529E-02	-4.43469E-07	3.79170E-04	1.49551E-05	3.22775E-03	1.1138
18.	5.15958E-02	1.81100E+00	5.64465E-01	6.62799E-02	-5.29919E-07	3.99421E-04	1.67710E-05	3.46781E-03	1.1293
19.	5.30129E-02	1.81103E+00	5.91757E-01	6.62119E-02	-8.79090E-07	4.23810E-04	1.80850E-05	3.74250E-03	1.1450
20.	5.44843E-02	1.81101E+00	6.20638E-01	6.61556E-02	-1.30286E-06	4.48350E-04	1.95559E-05	4.02640E-03	1.1609
21.	5.60003E-02	1.81102E+00	6.48349E-01	6.57095E-02	-5.02524E-07	4.67193E-04	5.96594E-06	3.57493E-03	1.1770
22.	5.75423E-02	1.81103E+00	6.79915E-01	6.56233E-02	-7.96370E-07	4.94666E-04	5.73192E-06	3.80025E-03	1.1934
23.	5.91393E-02	1.81102E+00	7.13229E-01	6.55458E-02	-1.24492E-06	5.22975E-04	5.28257E-06	4.01261E-03	1.2100
24.	6.07821E-02	1.81100E+00	7.48425E-01	6.54506E-02	-1.34415E-06	5.53730E-04	5.56851E-06	4.26618E-03	1.2269
25.	6.24625E-02	1.81098E+00	7.85280E-01	6.53764E-02	-1.77709E-06	5.84312E-04	5.23045E-06	4.48934E-03	1.2439
26.	6.42028E-02	1.81099E+00	8.24225E-01	6.52973E-02	-2.27131E-06	6.17075E-04	4.67480E-06	4.72073E-03	1.2612
27.	6.59900E-02	1.81099E+00	8.65315E-01	6.51960E-02	-2.42706E-06	6.53291E-04	4.80103E-06	4.98905E-03	1.2788
28.	6.78167E-02	1.81100E+00	9.08321E-01	6.51779E-02	-3.09725E-06	6.91301E-04	4.70170E-06	4.84116E-03	1.2966
29.	6.97009E-02	1.81102E+00	9.53723E-01	6.50864E-02	-3.62932E-06	7.32300E-04	3.78389E-06	5.06239E-03	1.3146
30.	7.16296E-02	1.81101E+00	1.00153E+00	6.49819E-02	-3.83878E-06	7.73298E-04	3.93856E-06	5.29849E-03	1.3329
31.	7.36032E-02	1.81103E+00	1.05158E+00	6.48937E-02	-4.52214E-06	8.16125E-04	2.70761E-06	5.47757E-03	1.3515
32.	7.56504E-02	1.81104E+00	1.10451E+00	6.48044E-02	-5.38331E-06	8.63472E-04	9.83901E-07	5.65512E-03	1.3703
33.	7.77489E-02	1.81097E+00	1.16053E+00	6.46788E-02	-5.41809E-06	9.17581E-04	6.34393E-07	5.91550E-03	1.3893
34.	7.99001E-02	1.81096E+00	1.21893E+00	6.46167E-02	-6.68287E-06	9.58645E-04	-1.09884E-06	5.91617E-03	1.4087
35.	8.21479E-02	1.81102E+00	1.28124E+00	6.45091E-02	-7.55505E-06	1.02025E-03	-4.07489E-06	6.05969E-03	1.4283
36.	8.44524E-02	1.81100E+00	1.34697E+00	6.43901E-02	-7.92900E-06	1.07853E-03	-5.03533E-06	6.16587E-03	1.4481
37.	8.68053E-02	1.81102E+00	1.41579E+00	6.42802E-02	-8.66796E-06	1.13653E-03	-6.64022E-06	6.16169E-03	1.4683
38.	8.92241E-02	1.81103E+00	1.48835E+00	6.41626E-02	-9.56639E-06	1.20464E-03	-9.80140E-06	6.14896E-03	1.4887
39.	9.17010E-02	1.81103E+00	1.56477E+00	6.40418E-02	-1.00573E-05	1.27085E-03	-1.15541E-05	6.02173E-03	1.5094
40.	9.42371E-02	1.81102E+00	1.64493E+00	6.39391E-02	-1.11430E-05	1.34606E-03	-1.61113E-05	5.54512E-03	1.5305
41.	9.68608E-02	1.81102E+00	1.72951E+00	6.38261E-02	-1.24642E-05	1.41797E-03	-2.05196E-05	5.15183E-03	1.5518
42.	9.95647E-02	1.81100E+00	1.82675E+00	6.32857E-02	-1.09666E-05	1.47600E-03	6.22141E-05	-2.32235E-03	1.5733
43.	1.02330E-01	1.81100E+00	1.92123E+00	6.31445E-02	-1.20111E-05	1.55832E-03	6.50427E-05	-3.85578E-03	1.5952
44.	1.05182E-01	1.81107E+00	2.01910E+00	6.30962E-02	-1.34953E-05	1.64677E-03	5.85557E-05	-4.12637E-03	1.6174
45.	1.08132E-01	1.81101E+00	2.14604E+00	6.19100E-02	-1.19178E-05	1.68466E-03	1.74491E-04	-2.54774E-02	1.6400
46.	1.11151E-01	1.81099E+00	2.25808E+00	6.17480E-02	-1.29669E-05	1.77966E-03	1.84652E-04	-2.97302E-02	1.6628
47.	1.14249E-01	1.81100E+00	2.37617E+00	6.15775E-02	-1.37572E-05	1.88179E-03	1.96248E-04	-3.46414E-02	1.6859
48.	1.17428E-01	1.81100E+00	2.50029E+00	6.14025E-02	-1.50065E-05	1.99072E-03	2.06478E-04	-4.02333E-02	1.7094
49.	1.20701E-01	1.81100E+00	2.63120E+00	6.12207E-02	-1.61107E-05	2.10403E-03	2.17620E-04	-4.67332E-02	1.7332
50.	1.24073E-01	1.81100E+00	2.76905E+00	6.10493E-02	-1.76378E-05	2.22720E-03	2.26521E-04	-5.43923E-02	1.7573
51.	1.27542E-01	1.81099E+00	2.91488E+00	6.08460E-02	-1.83489E-05	2.35412E-03	2.39605E-04	-6.31010E-02	1.7818
52.	1.31097E-01	1.81093E+00	3.09575E+00	5.94871E-02	-2.41034E-05	2.44092E-03	-2.33752E-07	-8.44923E-02	1.8066
53.	1.34741E-01	1.81097E+00	3.25838E+00	5.92602E-02	-2.55129E-05	2.58818E-03	-1.02214E-05	-9.68102E-02	1.8318
54.	1.38499E-01	1.81097E+00	3.42949E+00	5.90327E-02	-2.76483E-05	2.73728E-03	-2.34713E-05	-1.10844E-01	1.8573
55.	1.42371E-01	1.81098E+00	3.61049E+00	5.87812E-02	-2.86321E-05	2.89255E-03	-3.47172E-05	-1.27393E-01	1.8831
56.	1.46355E-01	1.81099E+00	3.80045E+00	5.85318E-02	-3.09031E-05	3.06253E-03	-5.40219E-05	-1.45732E-01	1.9094
57.	1.50458E-01	1.81100E+00	4.00159E+00	5.82553E-02	-3.18175E-05	3.23627E-03	-6.96848E-05	-1.67204E-01	1.9360
58.	1.54671E-01	1.81105E+00	4.20753E+00	5.73534E-02	-3.87543E-05	3.39409E-03	-1.16687E-05	-1.68485E-01	1.9629
59.	1.58996E-01	1.81100E+00	4.43514E+00	5.77703E-02	-3.42174E-05	3.62570E-03	-1.31663E-04	-2.22776E-01	1.9903

60.	1.63446E-01	1.81101E+00	4.66836E+00	5.74772E-02	-3.61559E-05	3.83719E-03	-1.67082E-04	-2.54826E-01	2.0180
61.	1.68013E-01	1.81088E+00	4.91453E+00	5.71629E-02	-3.65669E-05	4.08993E-03	-2.07143E-04	-2.91803E-01	2.0461
62.	1.72710E-01	1.81083E+00	5.17412E+00	5.67470E-02	-4.08393E-05	4.27470E-03	-2.30749E-04	-3.47331E-01	2.0746
63.	1.77542E-01	1.81090E+00	5.50683E+00	5.35278E-02	-6.07352E-05	4.74745E-03	-1.18250E-03	-3.77310E-01	2.1035
64.	1.82492E-01	1.81081E+00	5.79571E+00	5.30923E-02	-6.25790E-05	5.04871E-03	-1.31548E-03	-4.35180E-01	2.1328
65.	1.87585E-01	1.81078E+00	6.09792E+00	5.26648E-02	-6.46980E-05	5.28485E-03	-1.43582E-03	-5.06060E-01	2.1625
66.	1.92850E-01	1.81091E+00	6.40232E+00	5.10523E-02	-7.59281E-05	5.59608E-03	-1.44320E-03	-5.79284E-01	2.1927
67.	1.98245E-01	1.81087E+00	6.76288E+00	5.11932E-02	-6.36997E-05	5.93590E-03	-1.88010E-03	-6.75378E-01	2.2232
68.	2.03778E-01	1.81085E+00	7.11320E+00	5.06616E-02	-6.42332E-05	6.27082E-03	-2.07873E-03	-7.82221E-01	2.2542
69.	2.09485E-01	1.81076E+00	7.52768E+00	4.98987E-02	-5.54377E-05	6.47504E-03	-1.68134E-03	-9.44062E-01	2.2856
70.	2.15354E-01	1.81072E+00	7.96139E+00	4.90870E-02	-5.01431E-05	6.71273E-03	-1.62036E-03	-1.12423E+00	2.3175
71.	2.21369E-01	1.81081E+00	8.36270E+00	4.84755E-02	-5.19175E-05	7.10751E-03	-1.87150E-03	-1.28765E+00	2.3497
72.	2.27562E-01	1.81077E+00	8.75318E+00	4.64904E-02	-5.61837E-05	7.62405E-03	-2.09071E-03	-1.58734E+00	2.3825
73.	2.33902E-01	1.81049E+00	9.25115E+00	4.80405E-02	-4.71818E-05	7.93615E-03	-2.56434E-03	-1.57771E+00	2.4157
74.	2.40442E-01	1.81057E+00	9.69362E+00	4.74497E-02	-4.29865E-05	8.37575E-03	-2.68805E-03	-1.81050E+00	2.4494
75.	2.47177E-01	1.81043E+00	1.02599E+01	4.63333E-02	-5.74652E-05	8.84032E-03	-4.38973E-03	-2.11387E+00	2.4835
76.	2.54096E-01	1.81036E+00	1.07708E+01	4.36849E-02	-5.48154E-05	9.66253E-03	-4.84281E-03	-1.76167E+00	2.5181
77.	2.61203E-01	1.81042E+00	1.12849E+01	4.28631E-02	-5.17539E-05	1.02340E-02	-5.44306E-03	-2.07007E+00	2.5532
78.	2.68510E-01	1.81046E+00	1.17379E+01	4.04902E-02	-4.86464E-05	1.09027E-02	-6.40408E-03	-2.81921E+00	2.5888
79.	2.76016E-01	1.81027E+00	1.24933E+01	4.35527E-02	-4.88584E-05	1.12283E-02	-6.42277E-03	-2.14543E+00	2.6249
80.	2.83750E-01	1.81031E+00	1.30686E+01	4.20142E-02	-4.36638E-05	1.17974E-02	-7.24826E-03	-2.25456E+00	2.6614
81.	2.91716E-01	1.81015E+00	1.36481E+01	3.98810E-02	-6.02207E-05	1.29437E-02	-1.09089E-02	-3.18521E+00	2.6985
82.	2.99901E-01	1.81026E+00	1.41626E+01	3.80123E-02	-4.95859E-05	1.37460E-02	-1.27328E-02	-4.29113E+00	2.7361
83.	3.08307E-01	1.81027E+00	1.47517E+01	3.69096E-02	-4.24761E-05	1.44771E-02	-1.42486E-02	-5.02449E+00	2.7743
84.	3.16940E-01	1.81028E+00	1.53441E+01	3.57478E-02	-3.32975E-05	1.52177E-02	-1.59379E-02	-5.88008E+00	2.8130
85.	3.25852E-01	1.81017E+00	1.54282E+01	3.40893E-02	-1.31872E-05	1.56312E-02	-1.83873E-02	-7.37378E+00	2.8522
86.	3.34959E-01	1.81036E+00	1.55268E+01	3.44843E-02	-1.12384E-05	1.69024E-02	-2.29221E-02	-7.42404E+00	2.8919
87.	3.44379E-01	1.81016E+00	1.65304E+01	2.82022E-02	4.08629E-06	1.66386E-02	-1.76573E-02	-9.07067E+00	2.9323
88.	3.53998E-01	1.81014E+00	1.73137E+01	2.53608E-02	3.19388E-05	1.80048E-02	-2.06679E-02	-1.51583E+01	2.9731
89.	3.63958E-01	1.80994E+00	1.74728E+01	2.59818E-02	6.28094E-05	1.85597E-02	-2.64158E-02	-1.46334E+01	3.0146
90.	3.74151E-01	1.80990E+00	1.89330E+01	1.39975E-02	9.75703E-05	1.99682E-02	-2.98675E-02	-2.31315E+01	3.0566
91.	3.84663E-01	1.80970E+00	1.84366E+01	1.72088E-02	1.18571E-04	2.10098E-02	-2.89155E-02	-2.07349E+01	3.0992
92.	3.95446E-01	1.80972E+00	1.86855E+01	1.40771E-02	1.48697E-04	2.17980E-02	-3.37293E-02	-2.43353E+01	3.1424
93.	4.06533E-01	1.80953E+00	1.91367E+01	9.13482E-03	1.66798E-04	2.25717E-02	-4.30964E-02	-2.94518E+01	3.1863
94.	4.17937E-01	1.80976E+00	1.88218E+01	-3.97201E-03	1.73950E-04	2.33947E-02	-4.09462E-02	-3.83970E+01	3.2307
95.	4.29639E-01	1.80941E+00	1.88795E+01	2.85400E-03	2.41802E-04	2.38052E-02	-5.98453E-02	-3.84301E+01	3.2757
96.	4.41687E-01	1.80937E+00	1.87779E+01	-3.77779E-03	2.63572E-04	2.44762E-02	-7.90950E-02	-4.28939E+01	3.3214
97.	4.54076E-01	1.80963E+00	1.80234E+01	-1.03769E-02	3.12268E-04	2.47092E-02	-9.34382E-02	-4.44273E+01	3.3677
98.	4.66792E-01	1.80933E+00	1.69063E+01	-1.42740E-02	3.59315E-04	2.51637E-02	-1.07718E-01	-5.27462E+01	3.4147
99.	4.79864E-01	1.80941E+00	1.58900E+01	-3.25669E-02	3.80415E-04	2.36478E-02	-1.42427E-01	-3.43277E+01	3.4623
100.	4.93346E-01	1.80937E+00	1.15500E+01	-4.34690E-02	4.75779E-04	2.61721E-02	-1.55305E-01	-8.55249E+01	3.5106
101.	5.07153E-01	1.80955E+00	1.15788E+01	-3.52529E-02	5.04324E-04	2.31880E-02	-1.48948E-01	-2.64855E+01	3.5595
102.	5.21356E-01	1.80929E+00	7.82106E+00	-4.29733E-02	5.76969E-04	2.27823E-02	-1.78949E-01	-4.28632E+01	3.6092
103.	5.35945E-01	1.80928E+00	2.83635E+00	-5.64565E-02	6.25455E-04	2.05957E-02	-1.89592E-01	-3.85425E+01	3.6595
104.	5.51005E-01	1.80918E+00	-3.17012E+00	-5.95061E-02	7.10124E-04	1.75908E-02	-2.25300E-01	-3.01387E+01	3.7105
105.	5.66526E-01	1.80940E+00	-1.03797E+01	-7.40949E-02	7.89165E-04	1.46745E-02	-2.28620E-01	-7.01731E+01	3.7622
106.	5.82453E-01	1.80988E+00	-2.07589E+01	-1.02516E-01	8.32314E-04	1.23584E-02	-2.63323E-01	-1.81247E+02	3.8147
107.	5.98626E-01	1.80877E+00	-3.02604E+01	-1.50853E-01	1.02789E-03	3.24036E-03	-2.21002E-01	-3.60198E+02	3.8679
108.	6.15510E-01	1.80845E+00	-4.11284E+01	-3.01222E-01	1.14956E-03	-2.98779E-03	-4.37476E-01	-6.69789E+02	3.9218
109.	6.32784E-01	1.81080E+00	-7.05193E+01	-4.63437E-01	1.18634E-03	-9.71900E-03	-6.18916E-01	-9.15631E+02	3.9765

110.	6.50432E-01	1.80828E+00	-9.27877E+01	-3.35285E-01	1.38756E-03	-1.99163E-02	-6.81911E-01	-1.06915E+03	4.0320
111.	6.69381E-01	1.80928E+00	-1.46065E+02	-4.51216E-01	1.35707E-03	-2.74756E-02	-1.30781E+00	-1.26236E+03	4.0882
112.	6.96347E-01	1.80627E+00	-1.76873E+02	-5.61240E-01	8.47026E-04	-5.64539E-02	-1.68731E+00	-2.28951E+03	4.1457
113.	7.15701E-01	1.80981E+00	-2.06297E+02	-4.25099E-01	2.36910E-03	-5.78223E-02	-1.83866E+00	-2.45579E+03	4.2044
114.	7.16112E-01	1.80990E+00	-2.21182E+02	-4.25051E-01	2.37396E-03	-6.22922E-02	-1.95792E+00	-2.68017E+03	4.2627
115.	7.16483E-01	1.80999E+00	-2.36562E+02	-4.24830E-01	2.37976E-03	-6.67292E-02	-2.08095E+00	-2.91620E+03	4.3202
116.	7.16853E-01	1.80998E+00	-2.52649E+02	-4.25492E-01	2.38114E-03	-7.11199E-02	-2.21034E+00	-3.17322E+03	4.3770
117.	7.17214E-01	1.81002E+00	-2.68914E+02	-4.25114E-01	2.38989E-03	-7.57618E-02	-2.34004E+00	-3.43565E+03	4.4330
118.	7.17532E-01	1.81010E+00	-2.85893E+02	-4.25099E-01	2.39358E-03	-8.00949E-02	-2.47553E+00	-3.71682E+03	4.4884
119.	7.17845E-01	1.81013E+00	-3.03262E+02	-4.25167E-01	2.39896E-03	-8.46796E-02	-2.61430E+00	-4.01325E+03	4.5432
120.	7.18143E-01	1.81021E+00	-3.21221E+02	-4.25009E-01	2.40346E-03	-8.91521E-02	-2.75672E+00	-4.32298E+03	4.5973
121.	7.18434E-01	1.81025E+00	-3.39704E+02	-4.25135E-01	2.40852E-03	-9.36218E-02	-2.90387E+00	-4.65166E+03	4.6508
122.	7.18692E-01	1.81033E+00	-3.58369E+02	-4.24582E-01	2.41628E-03	-9.81819E-02	-3.05240E+00	-4.98815E+03	4.7037
123.	7.18934E-01	1.81040E+00	-3.77945E+02	-4.25021E-01	2.41804E-03	-1.02610E-01	-3.20813E+00	-5.35236E+03	4.7560
124.	7.19190E-01	1.81042E+00	-3.97800E+02	-4.24788E-01	2.42408E-03	-1.07100E-01	-3.36605E+00	-5.72894E+03	4.8078
125.	7.19429E-01	1.81044E+00	-4.18276E+02	-4.24703E-01	2.43044E-03	-1.11596E-01	-3.52830E+00	-6.12048E+03	4.8591
126.	7.19657E-01	1.81046E+00	-4.39112E+02	-4.24674E-01	2.43456E-03	-1.16106E-01	-3.69360E+00	-6.53328E+03	4.9098
127.	7.19878E-01	1.81055E+00	-4.60607E+02	-4.24591E-01	2.44046E-03	-1.20782E-01	-3.86366E+00	-6.96213E+03	4.9600
128.	7.20101E-01	1.81058E+00	-4.82676E+02	-4.24818E-01	2.44286E-03	-1.25089E-01	-4.03847E+00	-7.41236E+03	5.0098
129.	7.20319E-01	1.81053E+00	-5.05050E+02	-4.24471E-01	2.45044E-03	-1.29706E-01	-4.21563E+00	-7.87583E+03	5.0590
130.	7.20513E-01	1.81056E+00	-5.27836E+02	-4.24242E-01	2.45519E-03	-1.34231E-01	-4.39650E+00	-8.35905E+03	5.1078
131.	7.20695E-01	1.81061E+00	-5.51352E+02	-4.24258E-01	2.46203E-03	-1.38789E-01	-4.58118E+00	-8.86570E+03	5.1562
132.	7.20860E-01	1.81067E+00	-5.75141E+02	-4.23957E-01	2.46502E-03	-1.43279E-01	-4.76941E+00	-9.38671E+03	5.2041
133.	7.21042E-01	1.81070E+00	-5.99825E+02	-4.24298E-01	2.46741E-03	-1.47828E-01	-4.96474E+00	-9.94148E+03	5.2515
134.	7.21216E-01	1.81073E+00	-6.24453E+02	-4.23753E-01	2.47470E-03	-1.52365E-01	-5.15782E+00	-1.04967E+04	5.2986
135.	7.21364E-01	1.81076E+00	-6.50032E+02	-4.23815E-01	2.47953E-03	-1.56842E-01	-5.35985E+00	-1.10887E+04	5.3453
136.	7.21525E-01	1.81077E+00	-6.76004E+02	-4.23822E-01	2.48258E-03	-1.61435E-01	-5.56458E+00	-1.17021E+04	5.3915
137.	7.21666E-01	1.81079E+00	-7.02015E+02	-4.23112E-01	2.49000E-03	-1.65859E-01	-5.76866E+00	-1.23123E+04	5.4374
138.	7.21807E-01	1.81076E+00	-7.29385E+02	-4.23765E-01	2.49049E-03	-1.70355E-01	-5.98673E+00	-1.29864E+04	5.4829
139.	7.21973E-01	1.81074E+00	-7.56623E+02	-4.23517E-01	2.49667E-03	-1.74997E-01	-6.20064E+00	-1.36584E+04	5.5280
140.	7.22119E-01	1.81081E+00	-7.84683E+02	-4.23437E-01	2.50178E-03	-1.79670E-01	-6.42215E+00	-1.43620E+04	5.5728
141.	7.22256E-01	1.81083E+00	-8.13176E+02	-4.23224E-01	2.50588E-03	-1.84009E-01	-6.64420E+00	-1.50783E+04	5.6173
142.	7.22385E-01	1.81080E+00	-8.42051E+02	-4.23076E-01	2.50983E-03	-1.88631E-01	-6.87249E+00	-1.58225E+04	5.6613
143.	7.22495E-01	1.81087E+00	-8.71187E+02	-4.22712E-01	2.51572E-03	-1.93289E-01	-7.10121E+00	-1.65823E+04	5.7051
144.	7.22593E-01	1.81091E+00	-9.01193E+02	-4.22678E-01	2.51888E-03	-1.97593E-01	-7.33593E+00	-1.73818E+04	5.7485
145.	7.22708E-01	1.81088E+00	-9.31561E+02	-4.22731E-01	2.52088E-03	-2.02167E-01	-7.57529E+00	-1.82083E+04	5.7916
146.	7.22844E-01	1.81089E+00	-9.62842E+02	-4.22916E-01	2.52395E-03	-2.06829E-01	-7.82265E+00	-1.90679E+04	5.8344
147.	7.22967E-01	1.81093E+00	-9.94186E+02	-4.22359E-01	2.53098E-03	-2.11413E-01	-8.06627E+00	-1.99195E+04	5.8769
148.	7.23063E-01	1.81093E+00	-1.02609E+03	-4.22381E-01	2.53308E-03	-2.15753E-01	-8.31759E+00	-2.08178E+04	5.9191
149.	7.23168E-01	1.81089E+00	-1.05854E+03	-4.22327E-01	2.53879E-03	-2.20410E-01	-8.57295E+00	-2.17455E+04	5.9610
150.	7.23269E-01	1.81090E+00	-1.09145E+03	-4.22175E-01	2.54290E-03	-2.24933E-01	-8.83157E+00	-2.27008E+04	6.0026
151.	7.23361E-01	1.81093E+00	-1.12486E+03	-4.22059E-01	2.54647E-03	-2.29559E-01	-9.09315E+00	-2.36703E+04	6.0440
152.	7.23449E-01	1.81096E+00	-1.15877E+03	-4.21988E-01	2.55022E-03	-2.34000E-01	-9.35875E+00	-2.46832E+04	6.0850
153.	7.23554E-01	1.81093E+00	-1.19352E+03	-4.22185E-01	2.55128E-03	-2.38510E-01	-9.63309E+00	-2.57335E+04	6.1258
154.	7.23656E-01	1.81098E+00	-1.22803E+03	-4.21637E-01	2.55747E-03	-2.43441E-01	-9.90228E+00	-2.67759E+04	6.1663
155.	7.23749E-01	1.81100E+00	-1.26425E+03	-4.22028E-01	2.55795E-03	-2.47545E-01	-1.01859E+01	-2.78849E+04	6.2066
156.	7.23840E-01	1.81095E+00	-1.29968E+03	-4.21513E-01	2.56394E-03	-2.52417E-01	-1.04623E+01	-2.89743E+04	6.2466
157.	7.23911E-01	1.81100E+00	-1.33632E+03	-4.21458E-01	2.56694E-03	-2.56873E-01	-1.07509E+01	-3.01406E+04	6.2863
158.	7.24004E-01	1.81098E+00	-1.37346E+03	-4.21728E-01	2.56852E-03	-2.61386E-01	-1.10427E+01	-3.13394E+04	6.3258
159.	7.24096E-01	1.81097E+00	-1.41078E+03	-4.21410E-01	2.57456E-03	-2.66021E-01	-1.13333E+01	-3.25427E+04	6.3651

160.	7.24156E-01	1.81102E+00	-1.44813E+03	-4.20848E-01	2.57818E-03	-2.70712E-01	-1.16259E+01	-3.37539E+04	6.4041
161.	7.24211E-01	1.81105E+00	-1.48671E+03	-4.21072E-01	2.57993E-03	-2.74888E-01	-1.19280E+01	-3.50372E+04	6.4429
162.	7.24308E-01	1.81095E+00	-1.52658E+03	-4.21569E-01	2.58060E-03	-2.79470E-01	-1.22439E+01	-3.63964E+04	6.4815
163.	7.24394E-01	1.81095E+00	-1.56509E+03	-4.20647E-01	2.58965E-03	-2.84363E-01	-1.25409E+01	-3.76694E+04	6.5198
164.	7.24434E-01	1.81107E+00	-1.60508E+03	-4.20734E-01	2.59039E-03	-2.88918E-01	-1.28534E+01	-3.90483E+04	6.5579
165.	7.24460E-01	1.81112E+00	-1.64475E+03	-4.19893E-01	2.59559E-03	-2.93204E-01	-1.31586E+01	-4.03830E+04	6.5958
166.	7.24493E-01	1.81107E+00	-1.68588E+03	-4.20575E-01	2.59414E-03	-2.97400E-01	-1.34874E+01	-4.18827E+04	6.6335
167.	7.24577E-01	1.81101E+00	-1.72771E+03	-4.20816E-01	2.59639E-03	-3.02194E-01	-1.38168E+01	-4.33917E+04	6.6710
168.	7.24653E-01	1.81104E+00	-1.76912E+03	-4.20326E-01	2.60214E-03	-3.06866E-01	-1.41373E+01	-4.48443E+04	6.7083
169.	7.24724E-01	1.81106E+00	-1.81275E+03	-4.20878E-01	2.60239E-03	-3.11370E-01	-1.44804E+01	-4.64471E+04	6.7453
170.	7.24805E-01	1.81104E+00	-1.85533E+03	-4.20320E-01	2.60659E-03	-3.16005E-01	-1.48118E+01	-4.79764E+04	6.7822
171.	7.24868E-01	1.81102E+00	-1.89860E+03	-4.20108E-01	2.60955E-03	-3.20540E-01	-1.51513E+01	-4.95772E+04	6.8189
172.	7.24932E-01	1.81106E+00	-1.94306E+03	-4.20312E-01	2.61267E-03	-3.25319E-01	-1.54970E+01	-5.12471E+04	6.8553
173.	7.24980E-01	1.81113E+00	-1.98702E+03	-4.19858E-01	2.61722E-03	-3.29867E-01	-1.58387E+01	-5.28964E+04	6.8916
174.	7.25022E-01	1.81116E+00	-2.03258E+03	-4.20003E-01	2.61709E-03	-3.34354E-01	-1.61948E+01	-5.46096E+04	6.9277
175.	7.25078E-01	1.81116E+00	-2.07830E+03	-4.20186E-01	2.62082E-03	-3.38792E-01	-1.65503E+01	-5.63918E+04	6.9636
176.	7.25127E-01	1.81109E+00	-2.12322E+03	-4.19528E-01	2.62066E-03	-3.43128E-01	-1.69063E+01	-5.81082E+04	6.9994
177.	7.25179E-01	1.81108E+00	-2.16978E+03	-4.19739E-01	2.62576E-03	-3.48066E-01	-1.72708E+01	-5.99833E+04	7.0349
178.	7.25229E-01	1.81113E+00	-2.21719E+03	-4.19763E-01	2.62794E-03	-3.52488E-01	-1.76369E+01	-6.18421E+04	7.0703
179.	7.25285E-01	1.81108E+00	-2.26475E+03	-4.19620E-01	2.62834E-03	-3.56857E-01	-1.80124E+01	-6.37463E+04	7.1055
180.	7.25340E-01	1.81107E+00	-2.31229E+03	-4.19357E-01	2.63395E-03	-3.61802E-01	-1.83784E+01	-6.56551E+04	7.1405
181.	7.25381E-01	1.81112E+00	-2.36095E+03	-4.19524E-01	2.63365E-03	-3.66176E-01	-1.87627E+01	-6.76703E+04	7.1754
182.	7.25434E-01	1.81116E+00	-2.41305E+03	-4.19709E-01	2.67611E-03	-3.68616E-01	-1.63585E+01	-4.50980E+04	7.2101
183.	7.25515E-01	1.81113E+00	-2.45946E+03	-4.18944E-01	2.64183E-03	-3.75510E-01	-1.95259E+01	-7.16748E+04	7.2446
184.	7.25538E-01	1.81116E+00	-2.51010E+03	-4.19301E-01	2.64109E-03	-3.79999E-01	-1.99238E+01	-7.38536E+04	7.2790
185.	7.25588E-01	1.81118E+00	-2.56082E+03	-4.19276E-01	2.64414E-03	-3.84658E-01	-2.03171E+01	-7.59952E+04	7.3132
186.	7.25635E-01	1.81118E+00	-2.61196E+03	-4.19152E-01	2.64528E-03	-3.89163E-01	-2.07180E+01	-7.81649E+04	7.3472
187.	7.25702E-01	1.81115E+00	-2.66453E+03	-4.19613E-01	2.64704E-03	-3.93665E-01	-2.11302E+01	-8.04907E+04	7.3811
188.	7.25763E-01	1.81113E+00	-2.71577E+03	-4.18962E-01	2.65291E-03	-3.98399E-01	-2.15281E+01	-8.26638E+04	7.4149
189.	7.25785E-01	1.81114E+00	-2.76772E+03	-4.18774E-01	2.65479E-03	-4.02873E-01	-2.19304E+01	-8.49290E+04	7.4485
190.	7.25827E-01	1.81112E+00	-2.82181E+03	-4.19216E-01	2.65353E-03	-4.07381E-01	-2.23571E+01	-8.73904E+04	7.4819
191.	7.25872E-01	1.81114E+00	-2.87440E+03	-4.18532E-01	2.66124E-03	-4.12260E-01	-2.27605E+01	-8.96738E+04	7.5152
192.	7.25888E-01	1.81114E+00	-2.92823E+03	-4.18733E-01	2.65823E-03	-4.16283E-01	-2.31880E+01	-9.21106E+04	7.5484
193.	7.25924E-01	1.81110E+00	-2.98247E+03	-4.18601E-01	2.66131E-03	-4.21125E-01	-2.36063E+01	-9.45949E+04	7.5814

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