A1900 fragment separator and selected NSCL control applications

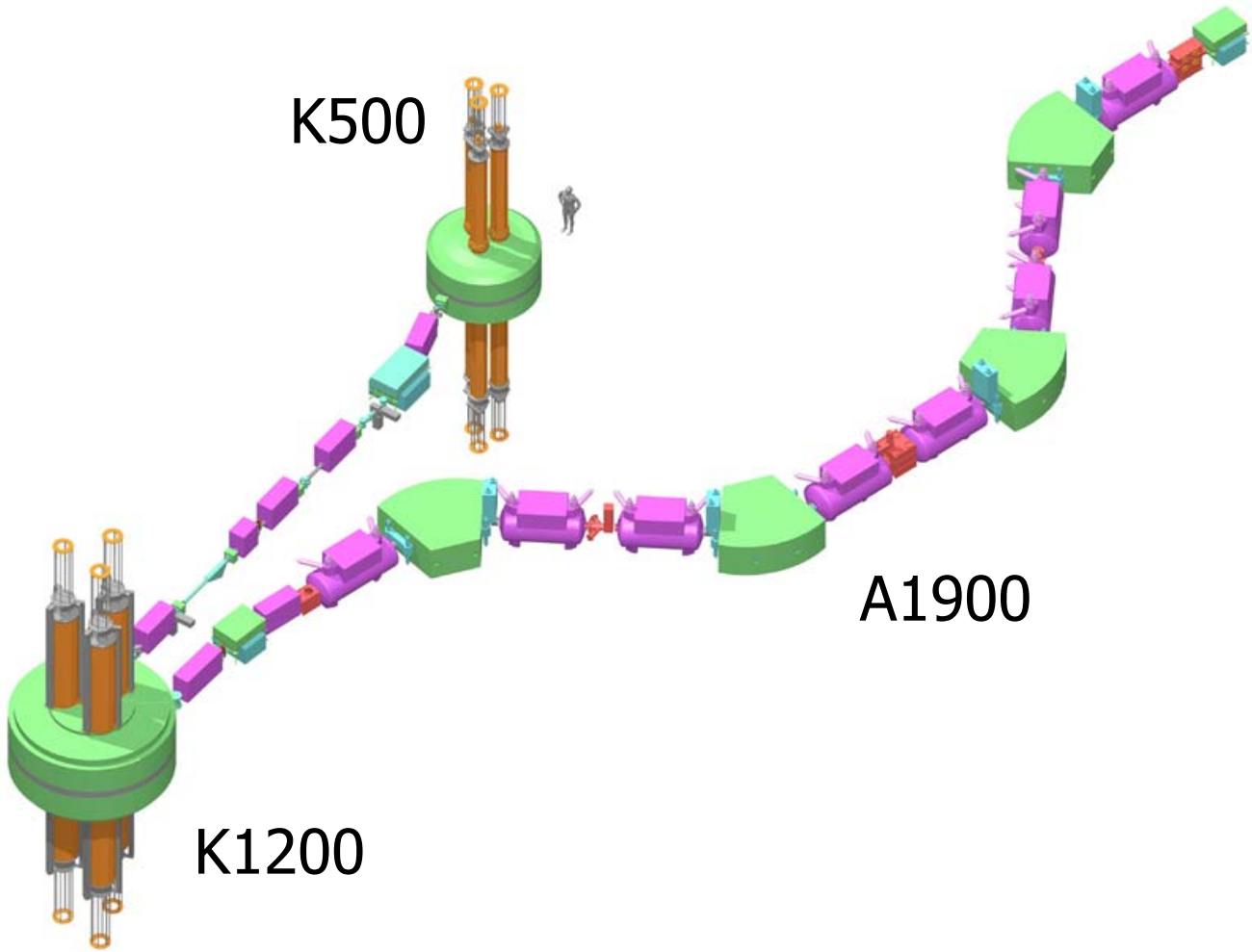
Mini-lecture series for HiRA group

By *Michal Mocko*

Part I

- A1900 overview (what it consists of…)
- A1900 detectors
- Particle identification in the A1900
- Method of separation using the A1900

Coupled Cyclotron Facility



Beam list:
^{40}Ca – 15pnA
^{48}Ca – 15pnA
^{58}Ni – 5pnA
^{64}Ni – 7pnA
^{86}Kr – 15pnA
etc.

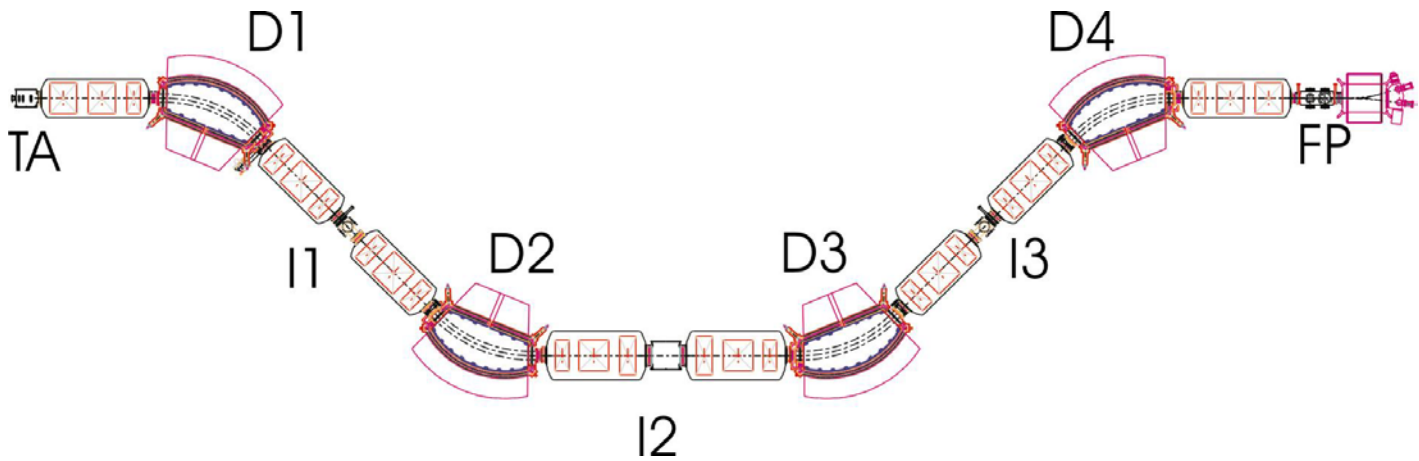
At 140MeV/u

A1900 – fragment separator

- Magnetic spectrometer
- Filter of projectile fragmentation products
- Five image planes
- Mirror symmetry about I2

- Selected properties:
  - Length 37m
  - 4x 45° dipoles
  - 24 quadrupoles
  - dp/p = 5%
  - δ = 59mm/%
  - $d\Omega$ = 8msr
  - $B\rho_{max}$ = 6Tm

A1900 - overview



- *Image 1:*
  - Wedge
  - Slit (remote)
- *Image 2:*
  - Slit
  - PPACs (2x)
  - Wedge (3x)
  - Scintillator (ToF)
- *Image 3:*
  - Slit system (remote)
- *Focal plane:*
  - PPACs (2x)
  - dE detector (PIN diode)
  - Scintillator (ToF)

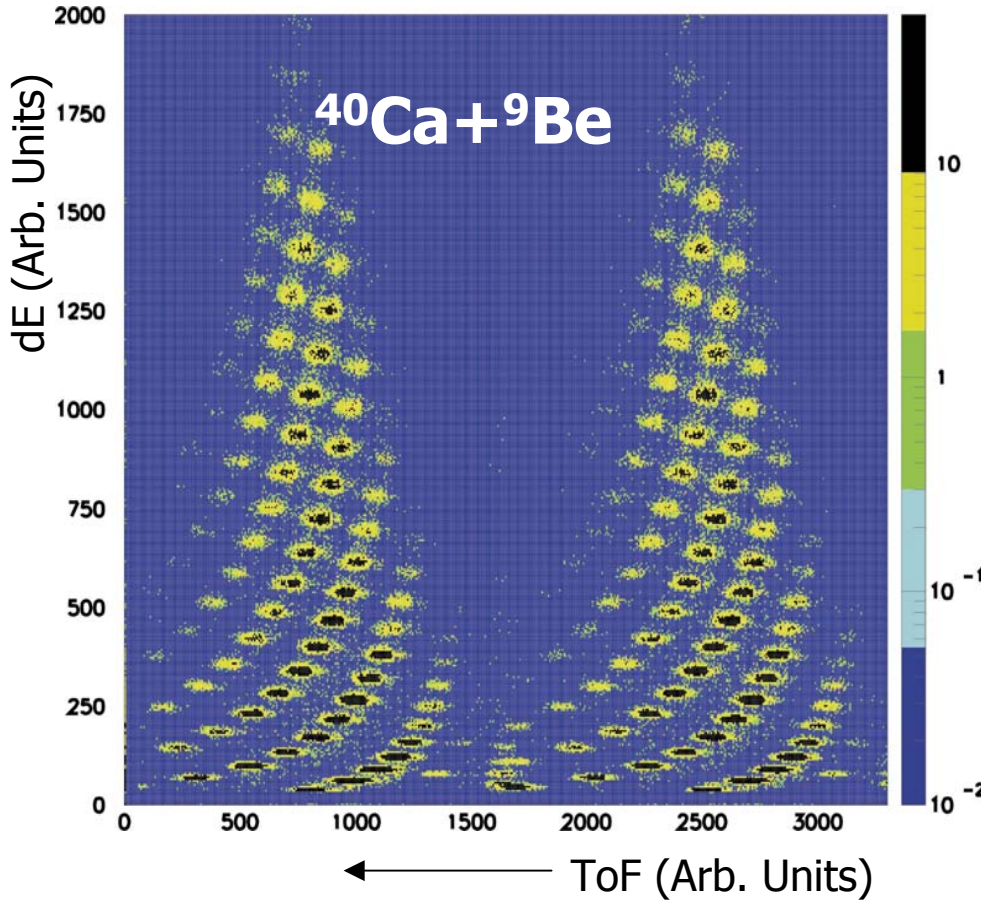
Particle identification (PID)

- Method: Bρ-ToF-dE

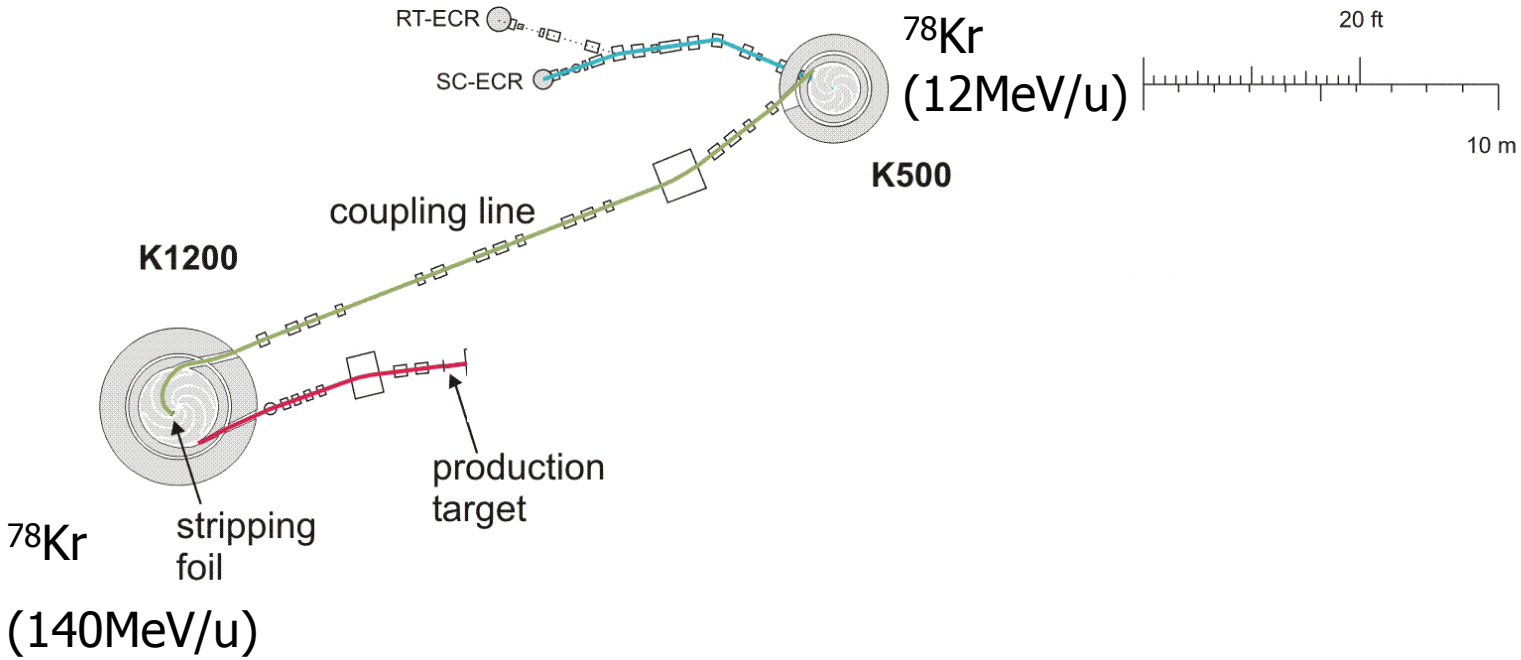
$$B\rho = \frac{p}{Q} \quad dE \approx \frac{z^2}{v^2}$$

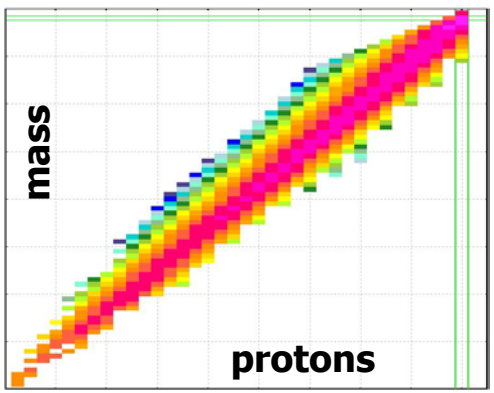
$$ToF \approx v$$

- Assuming Q=Z
- ➔dE versus ToF is a simple PID plot

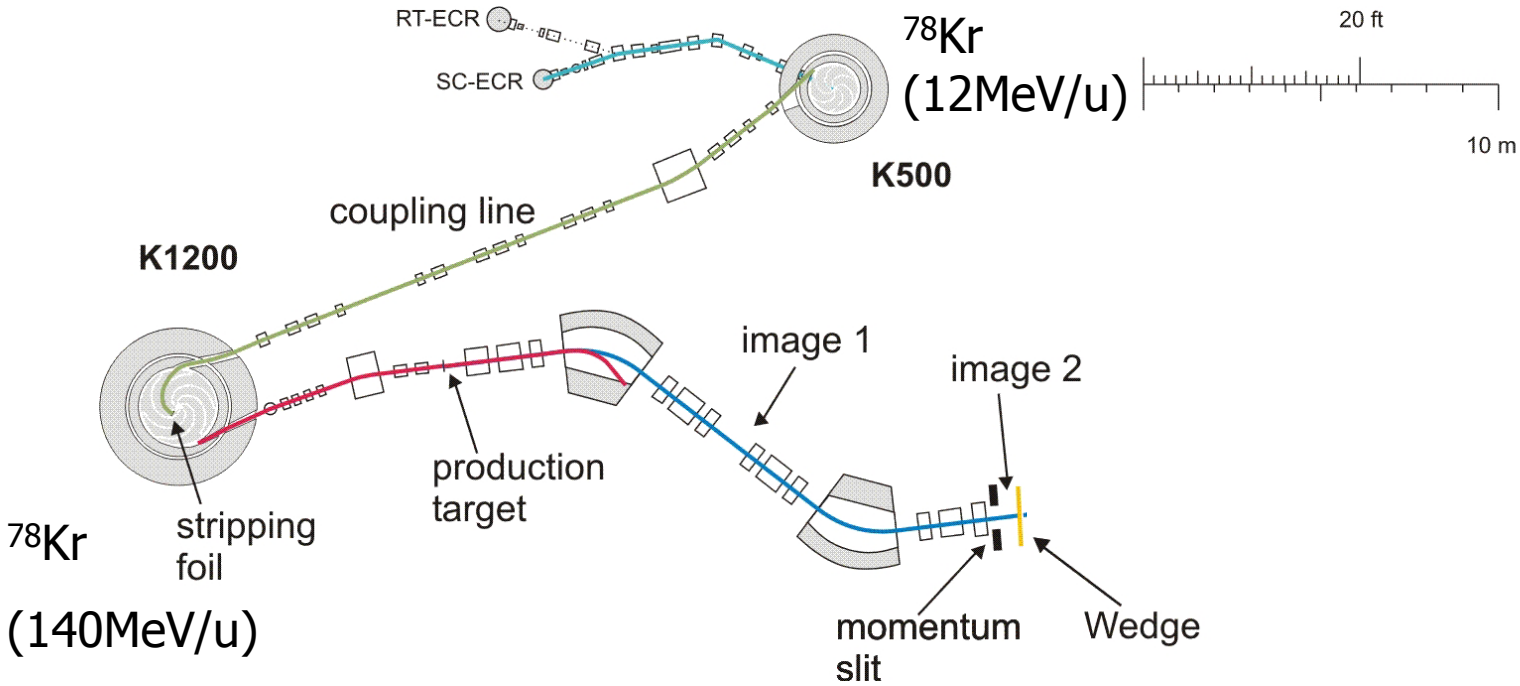


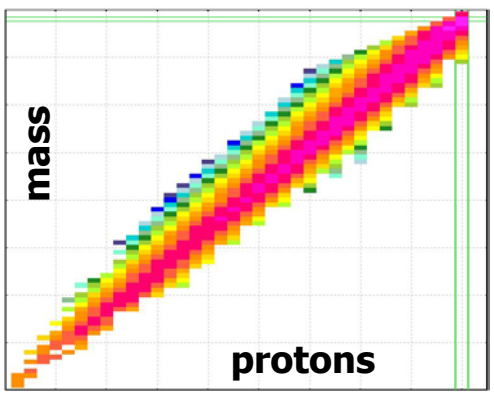
Fragment separation

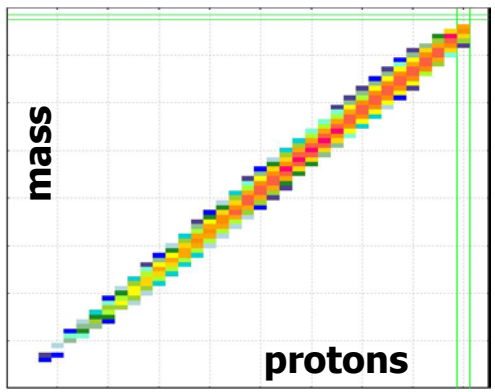




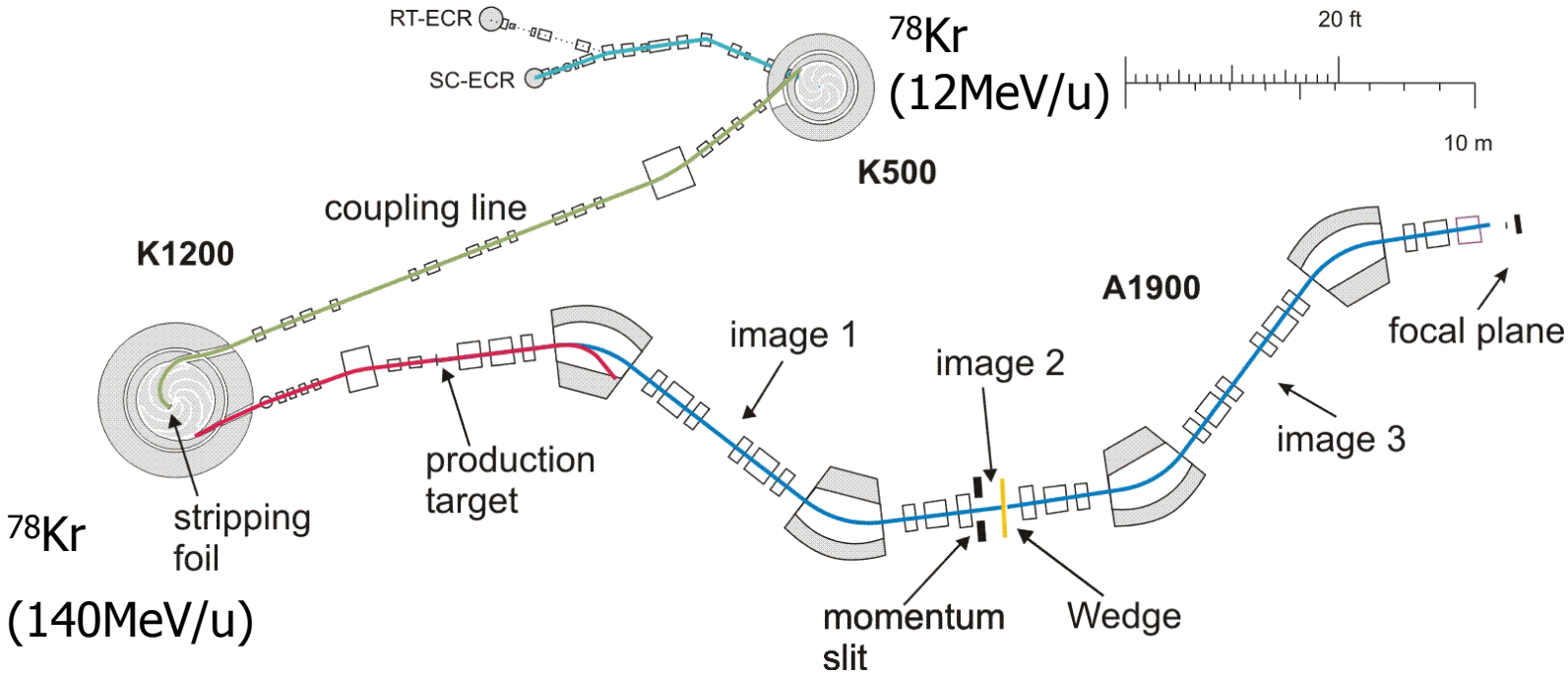
Fragment separation

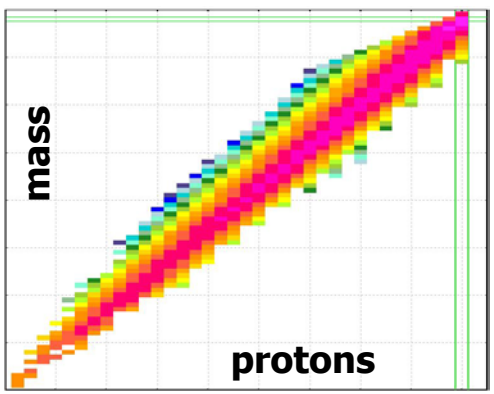


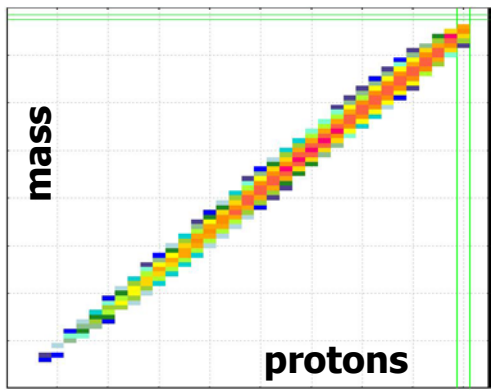


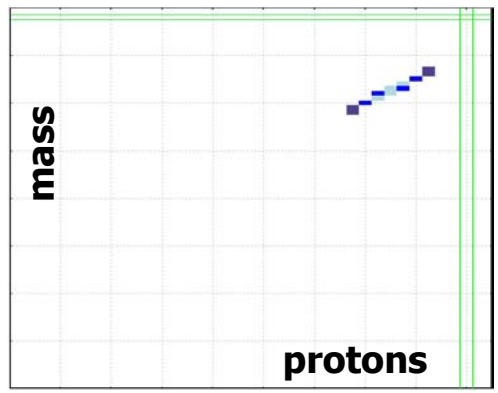


Fragment separation





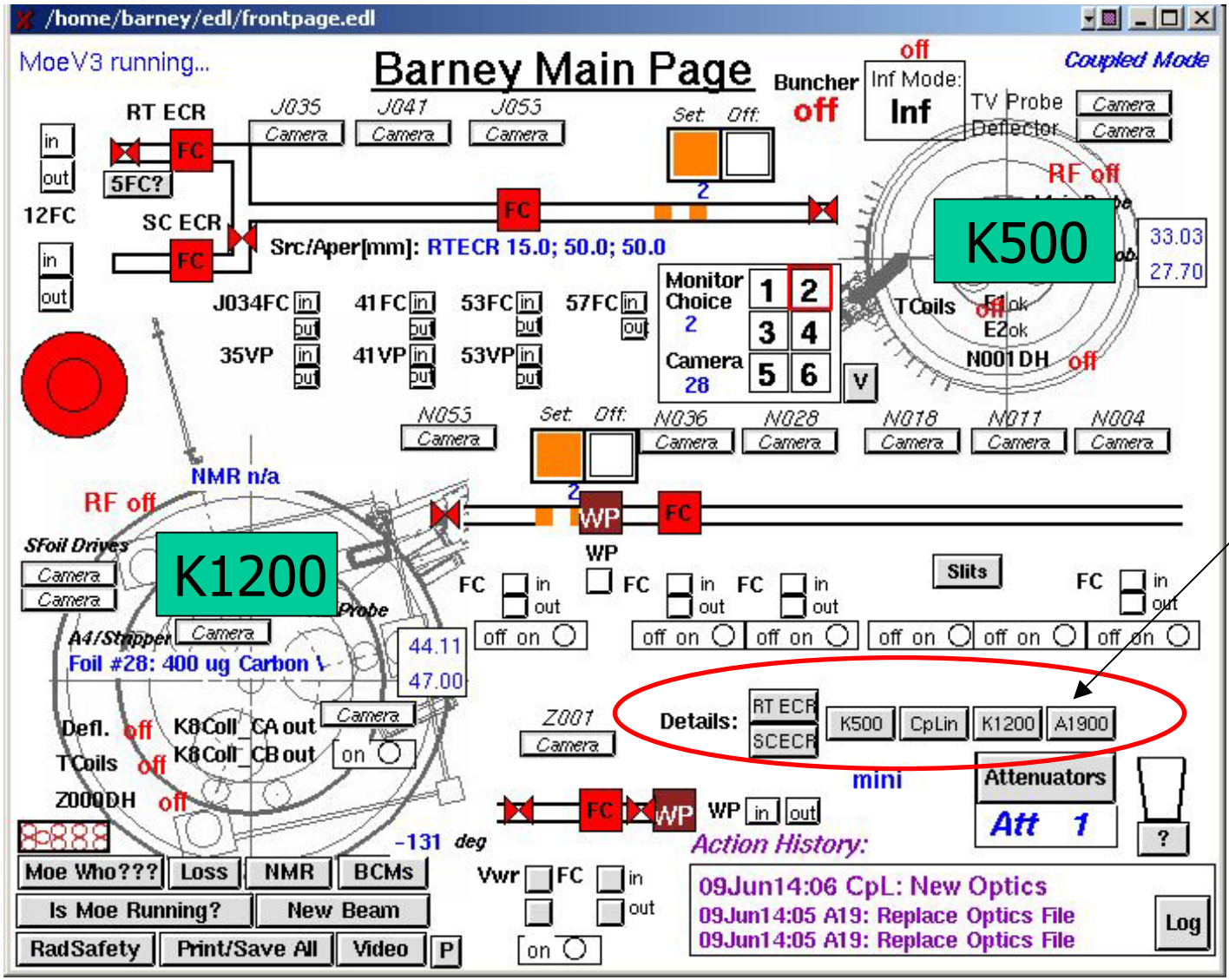




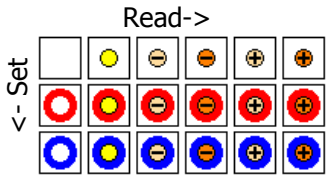
Part II

- Control system - Barney
- Controlling A1900
- Barney printout
- What to look for during an experiment

Barney main page

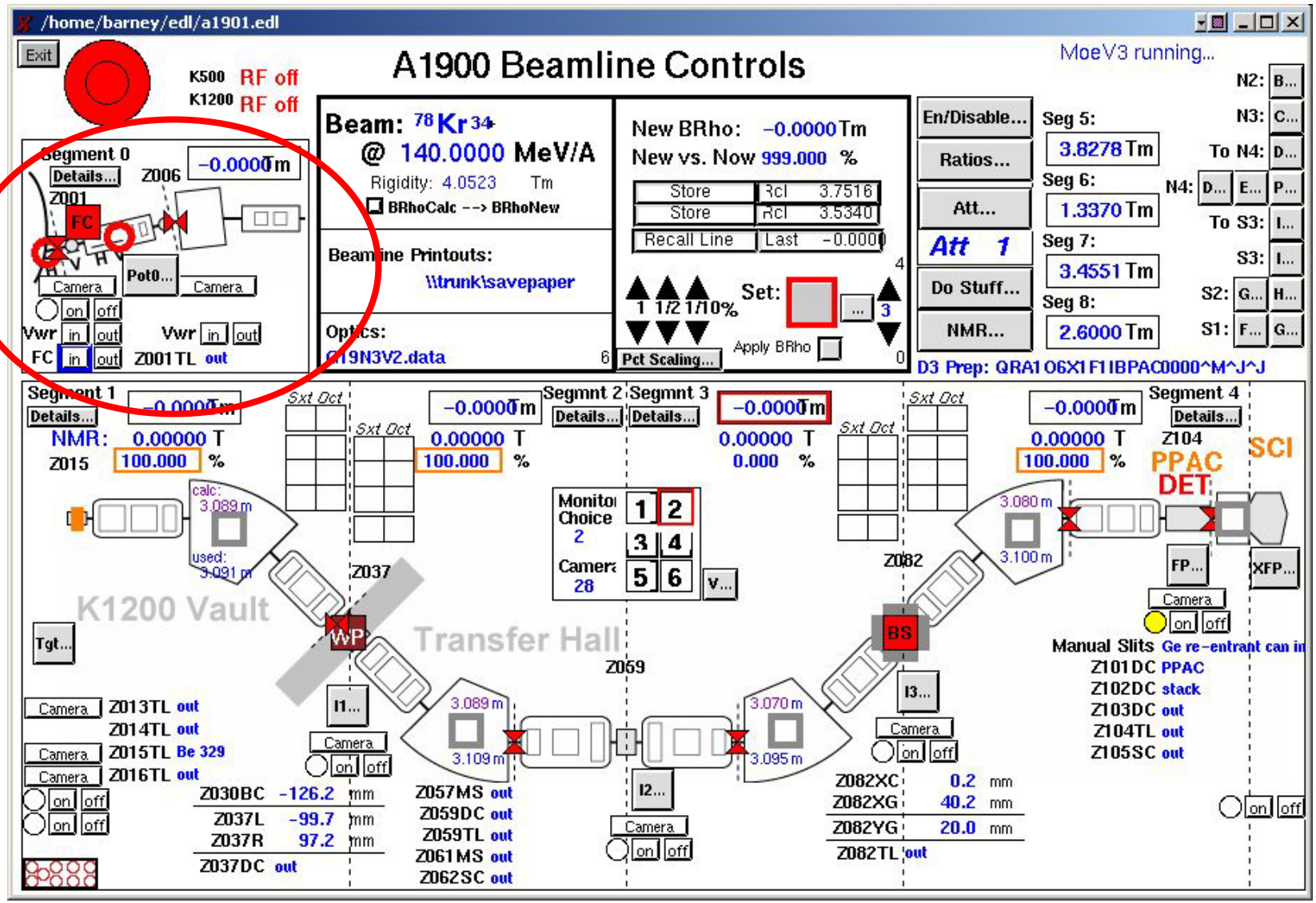


Summary of Barney states:

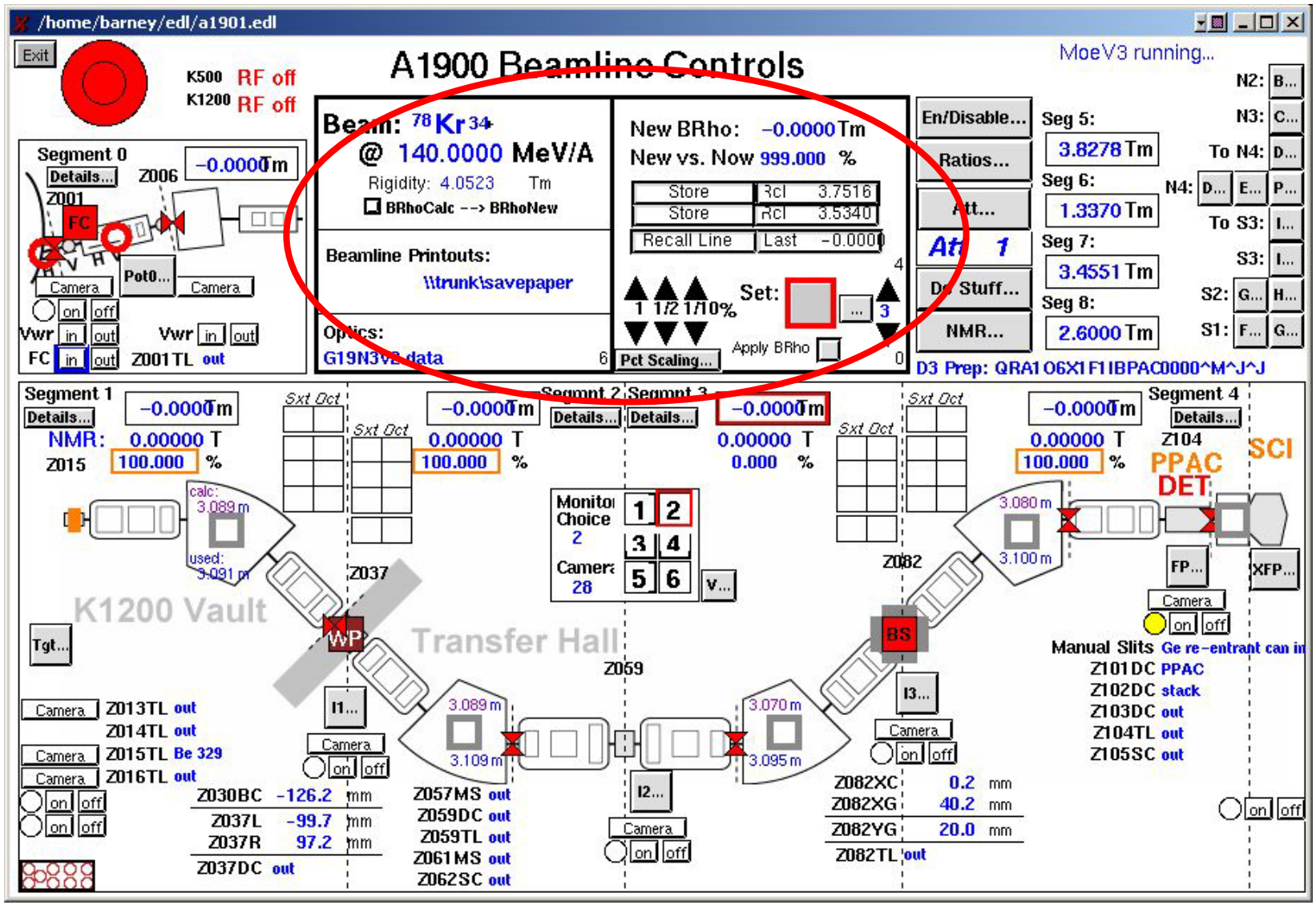


A1900

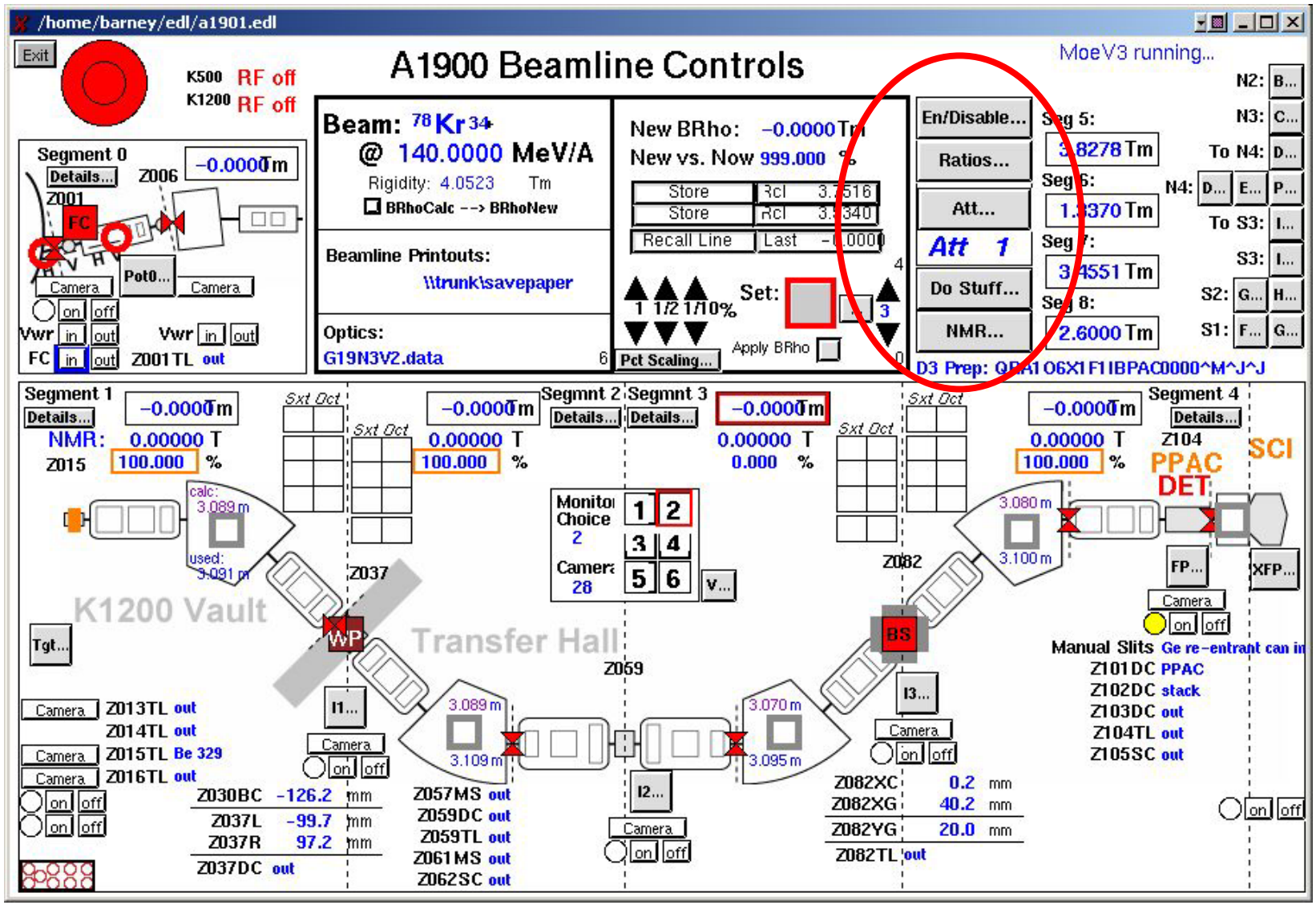
A1900 main page



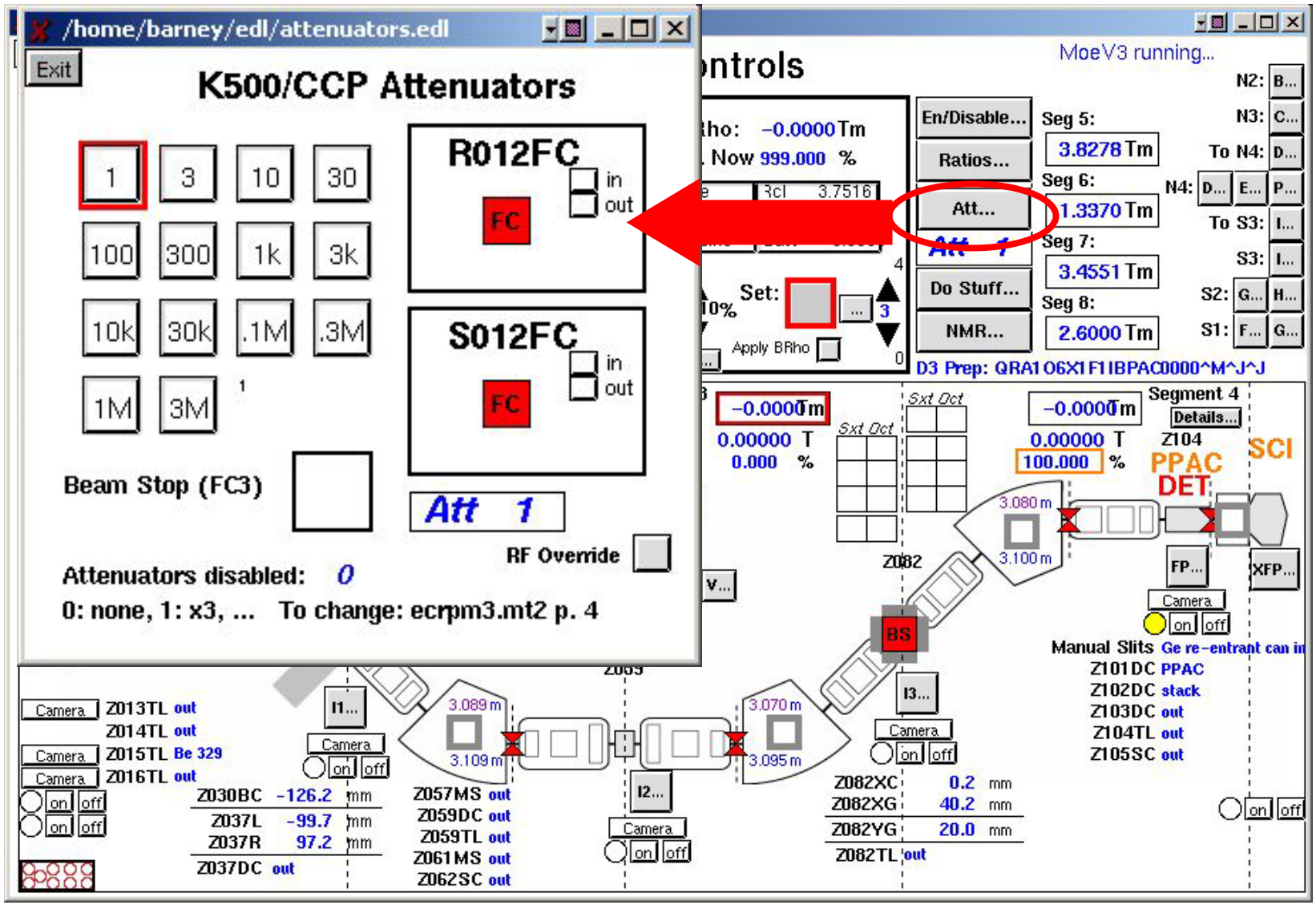
A1900 main page



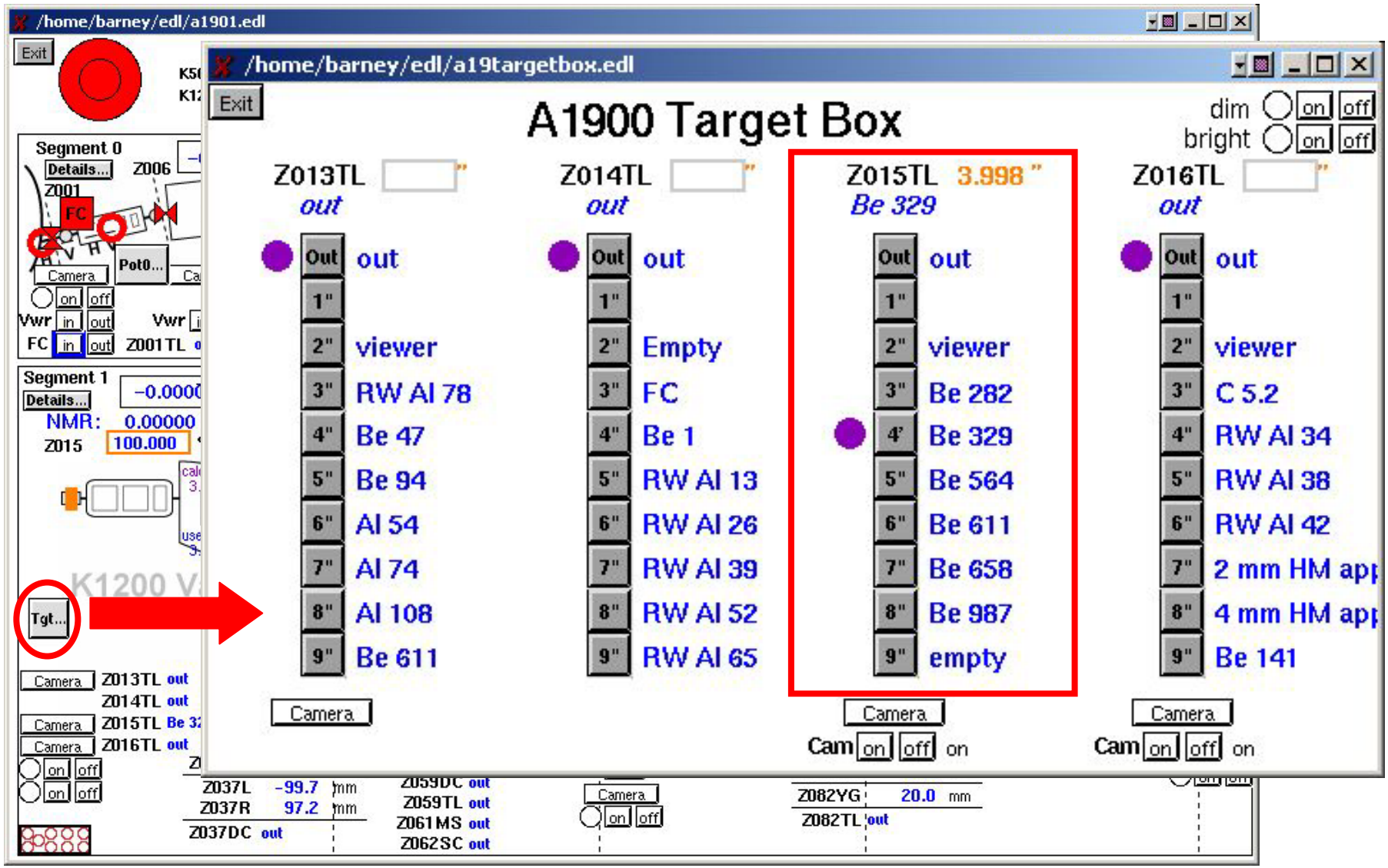
A1900 main page



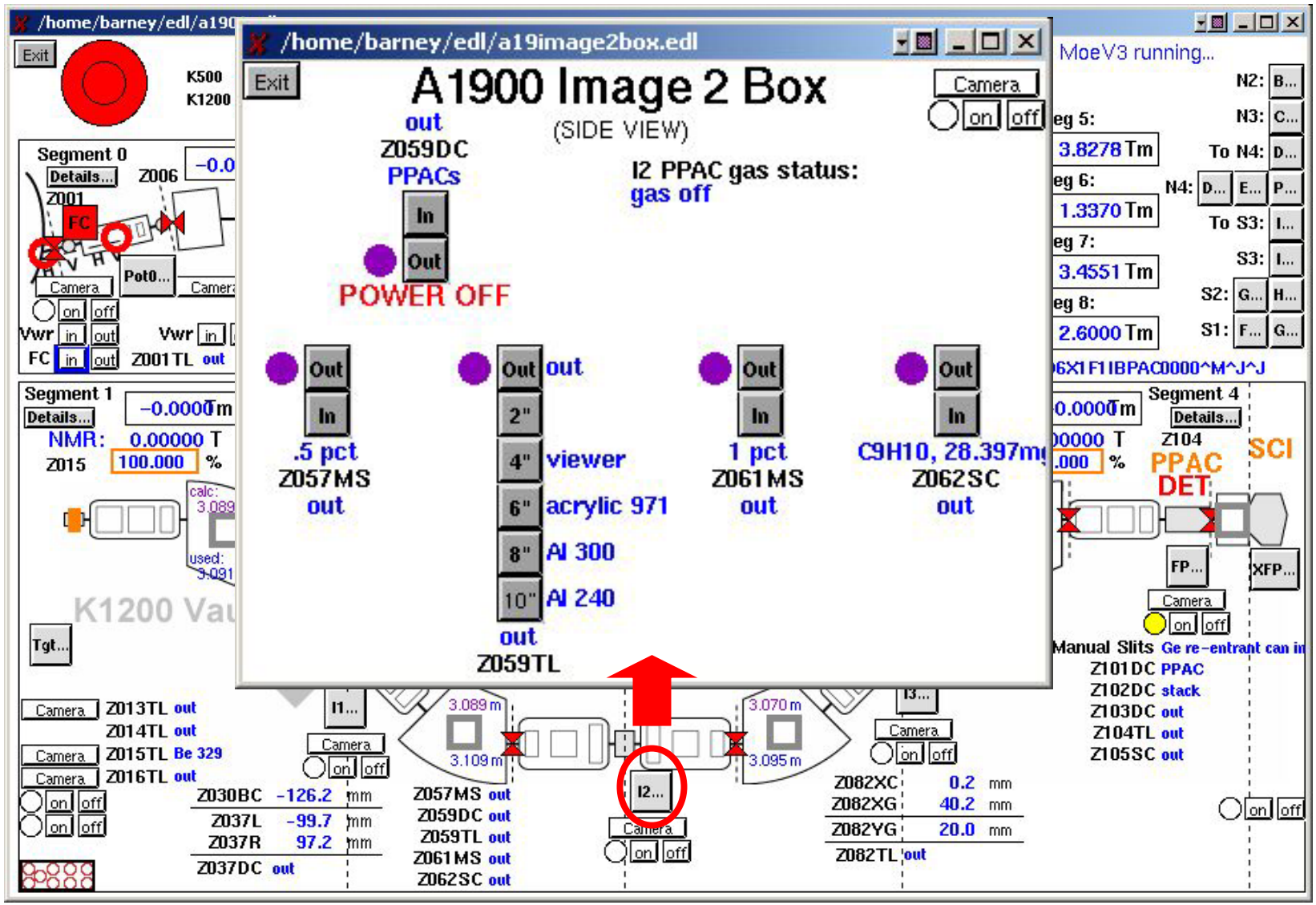
A1900 main page



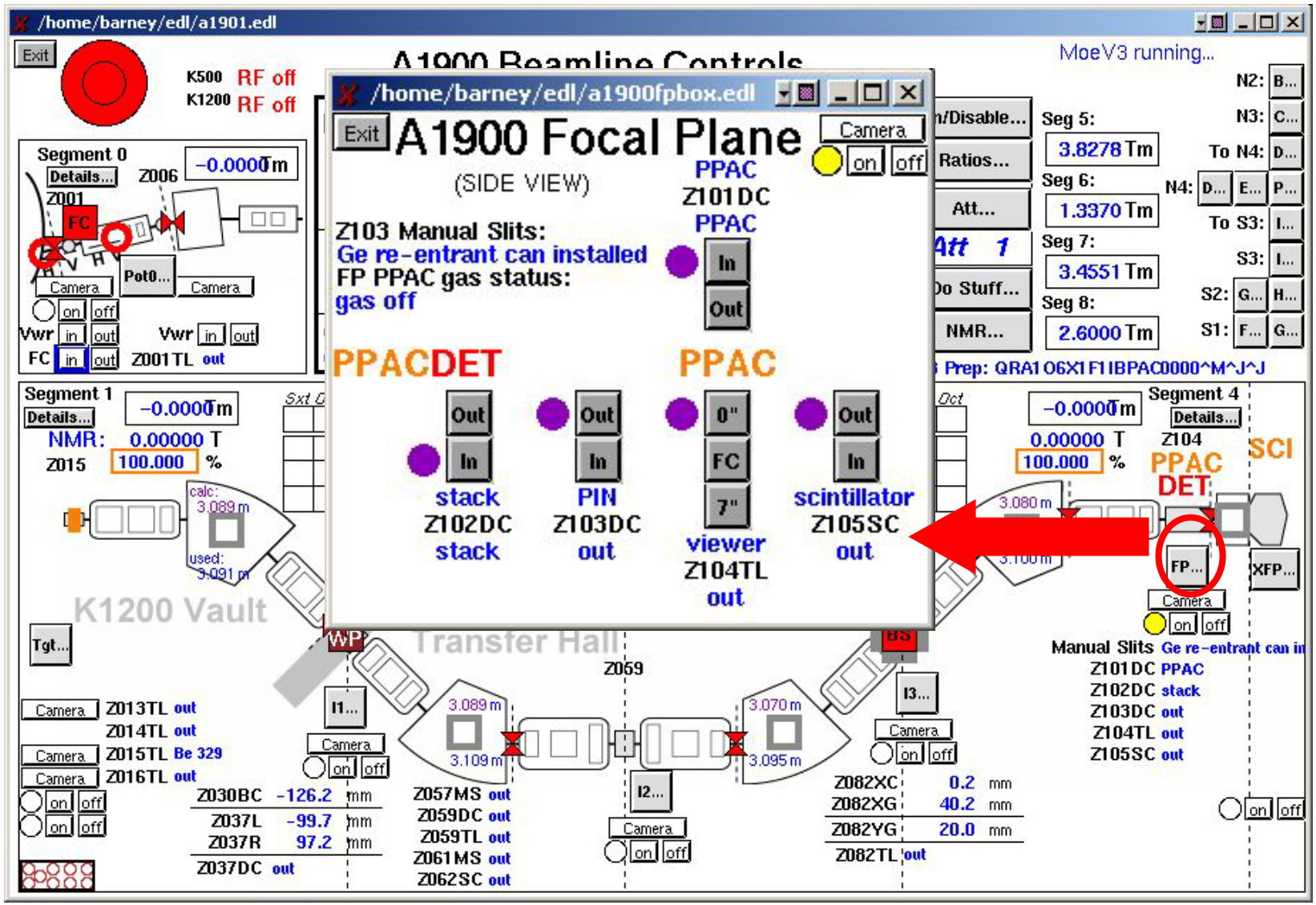
A1900 main page



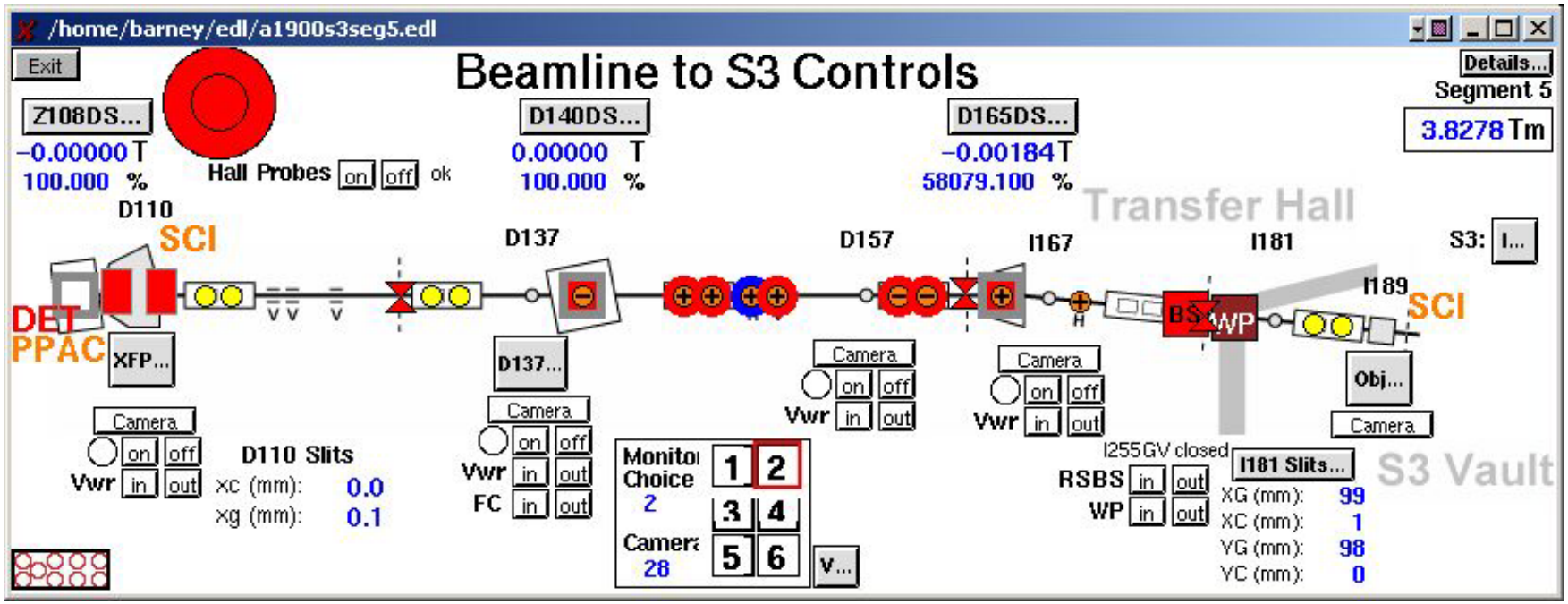
A1900 main page



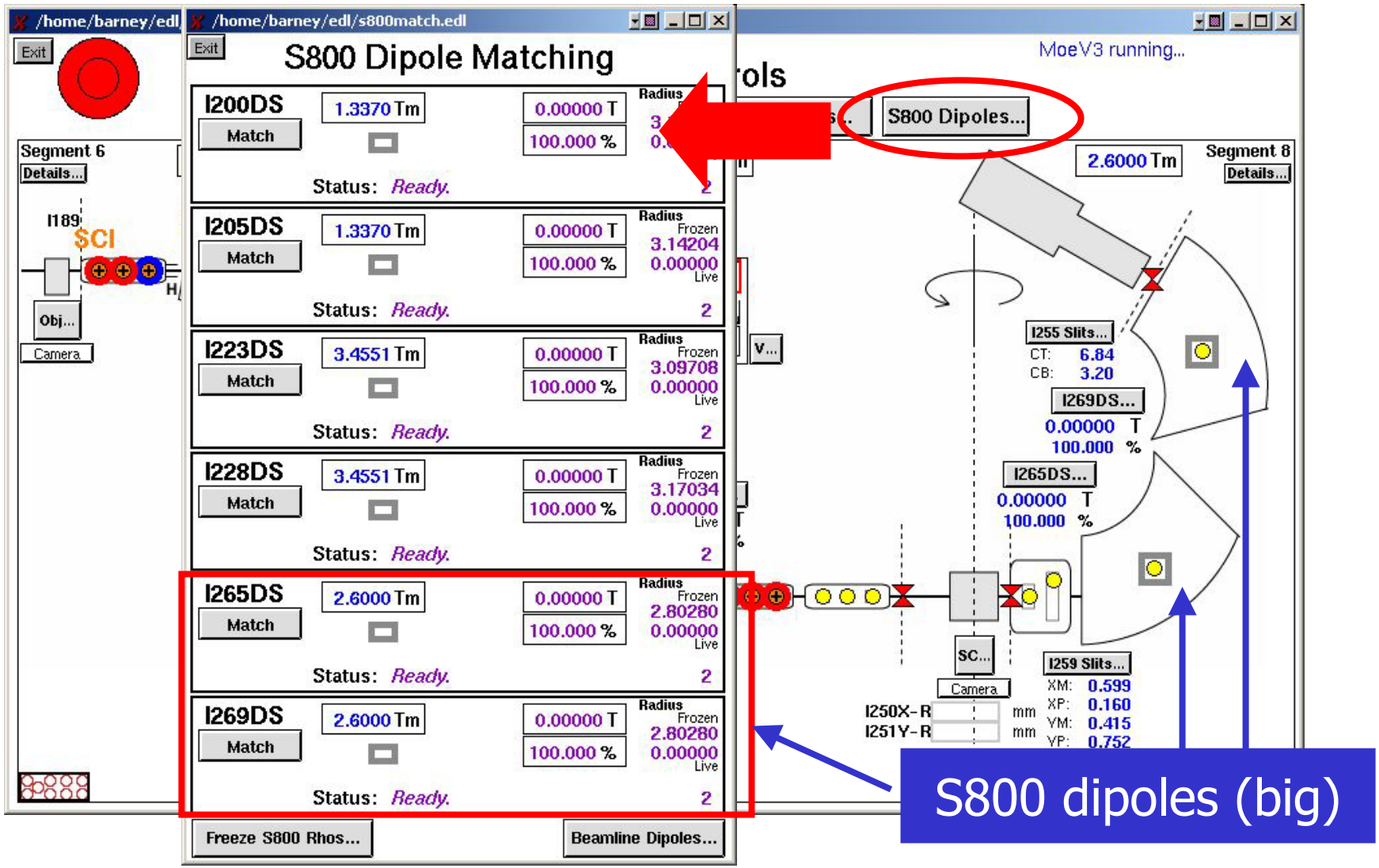
A1900 main page



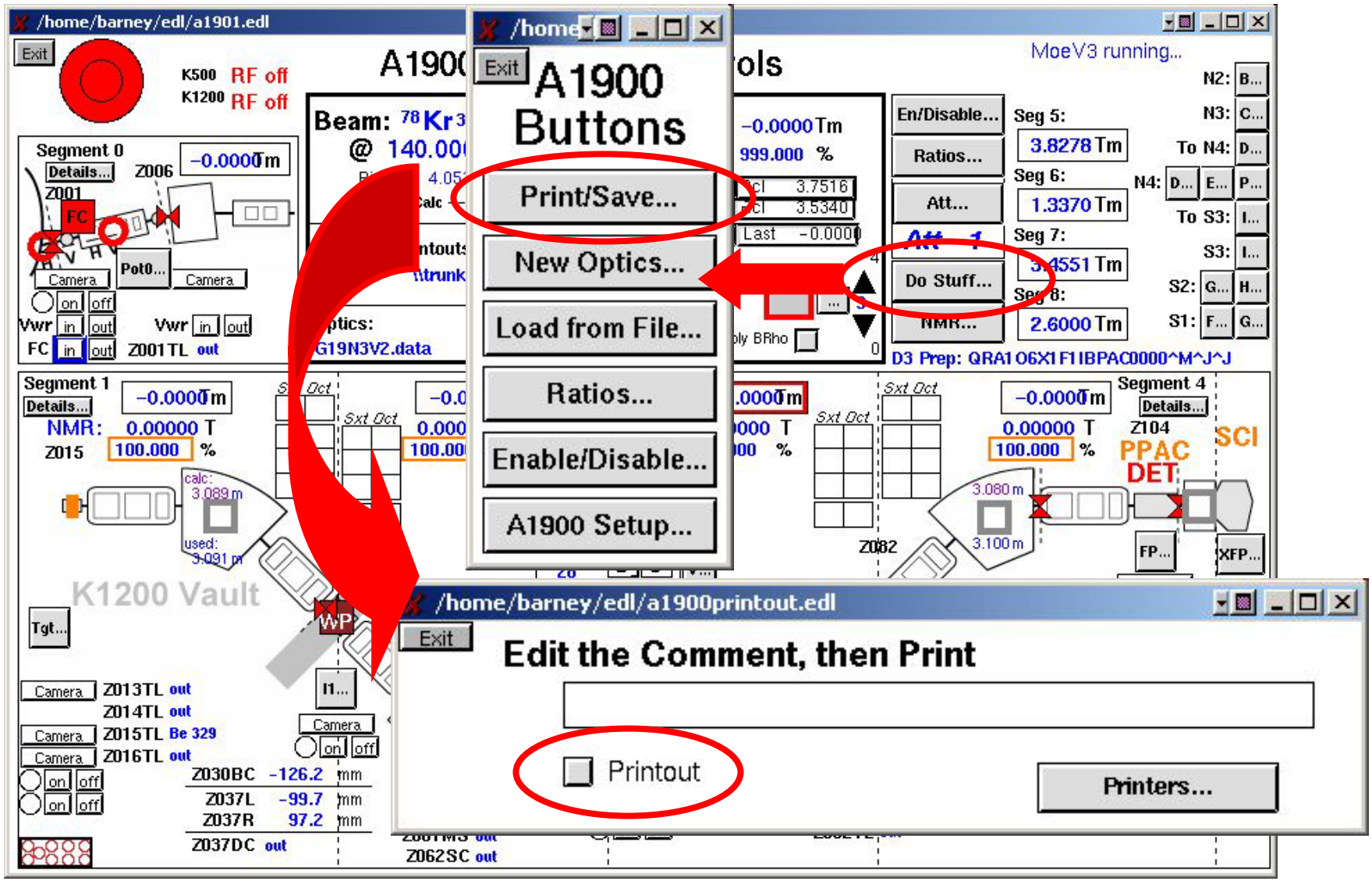
Beam Line to S800



S800 main page



Printout generation



Barney printout

```
A1900 "Print18May05_15h30.txt" Wednesday 15:30:58 2005-05-18  A1900
***                                  test ***
Expt: 03031 "Fragmentation of Ni-68" [Betty Tsang] Line: S800 [8]
Beam: 76 Ge 12+  11.59 MeV/nuc (K500) 30+ 130.00 MeV/nuc (K1200)
<Att    1>  ECR, Apertures: RTECR 50.0; 15.0; 50.0 mm RHVBI: 25.4900 kV
K500 a,b:      0 A,      0 A K1200:      0 A,      0 A RF:  22.49300 MHz
       A1900 Optics: G19S3V13_30x20Focus60x30.data
       Rigidity       Field     Radius       (live)  Difference (Field*Radius)
Seg 0:  4.32100 Tm
Seg 1:  3.83030 Tm  1.23568 T  3.09882 m    3.09974 m    0.02983 % (3.82916 Tm)
Seg 2:  3.83030 Tm  1.23520 T  3.10148 m    3.10095 m   -0.01712 % (3.83096 Tm)
Seg 3:  3.52600 Tm  1.13931 T  3.09502 m    3.09487 m   -0.00483 % (3.52617 Tm)
Seg 4:  3.52600 Tm  1.13852 T  3.09582 m    3.09700 m    0.03794 % (3.52466 Tm)
Seg 5:  3.50350 Tm
Seg 6:  3.46338 Tm
Seg 7:  3.45510 Tm
Seg 8:  2.60000 Tm
Z108DS              0.50040 T  7.04675 m    7.04918 m    0.03449 %
D140DS              0.00145 T  2282.62069 m 2416.20690 m    5.85232 %
D165DS              0.37016 T  9.46362 m    9.46477 m    0.01219 %
I200DS              1.10232 T  3.14194 m    3.14190 m   -0.00125 %
I205DS              1.10223 T  3.14204 m    3.14216 m    0.00373 %
I223DS              1.11579 T  3.09708 m    3.09655 m   -0.01710 %
I228DS              1.08990 T  3.17034 m    3.17011 m   -0.00734 %
I265DS              0.93431 T  2.80280 m    2.78280 m   -0.71349 %
I269DS              0.92819 T  2.80280 m    2.80115 m   -0.05885 %
Z001TL:  out, Z013TL: out; Z014TL OUT
Z015TL: OUT, Z016TL OUT
Z030BC Beam Stop: -126.22 mm
Z037L,R:   -4.70,   9.35 mm; Z037DC:  *out*
Z057MS:  out, Z061MS:  out
Z059DC:  out, Z062SC:  out, Z057TL:
Z082 XC,G,YG:    0.16, 203.50, 201.37 mm Z082Deg:  out
Z101DC:  in, Z102DC: out; Z103DC: out, Z105SC: out
B110 Cent,Gap:   -0.09,  -0.04 mm; D110   -3.01,  10.00 mm F110    0.15,    0.69 mm
B110DC:  out, D110DC:  out, D111DC: 5 mil BC-404, F110DC:  out
Slits: I181 XC,G,YC,G:    0.79,  98.98;  -0.00,  98.39
I187: [3"]Obj Scint, I188: [0"] out, I189: , I190: [0"] out
I213: [0"] out, i214: [0"] out, I215: [0"] out, I216: [0"] out
I214DC Detector Drive: _PPAC_
Extra Drive: Z059TL.VAL  = *out*
```

Run title

Barney printout

```
A1900 "Print18May05_13h30.txt" Wednesday 13:30:58 2005-05-18  A1900
***                                  test ***
Expt: 03031 "Fragmentation of Ni-68" [Betty Tsang] Line: S800 [8]
Beam: 76 Ge 12+  11.59 MeV/nuc (K500) 30+ 130.00 MeV/nuc (K1200)
<Att    1>  ECR; Apertures: RTECR 50.0; 15.0; 50.0 mm RHVBI: 25.4900 kV
K500 a,b:      0 A,      0 A K1200:      0 A,      0 A RF:  22.49300 MHz
       A1900 Optics: G19S3V13_30x20Focus60x30.data
       Rigidity       Field     Radius       (live)  Difference (Field*Radius)
Seg 0:  4.32100 Tm
Seg 1:  3.83030 Tm  1.23568 T  3.09882 m    3.09974 m    0.02983 % (3.82916 Tm)
Seg 2:  3.83030 Tm  1.23520 T  3.10148 m    3.10095 m   -0.01712 % (3.83096 Tm)
Seg 3:  3.52600 Tm  1.13931 T  3.09502 m    3.09487 m   -0.00483 % (3.52617 Tm)
Seg 4:  3.52600 Tm  1.13852 T  3.09582 m    3.09700 m    0.03794 % (3.52466 Tm)
Seg 5:  3.50350 Tm
Seg 6:  3.46338 Tm
Seg 7:  3.45510 Tm
Seg 8:  2.60000 Tm
Z108DS              0.50040 T  7.04675 m    7.04918 m    0.03449 %
D140DS              0.00145 T  2282.62069 m 2416.20690 m    5.85232 %
D165DS              0.37016 T  9.46362 m    9.46477 m    0.01219 %
I200DS              1.10232 T  3.14194 m    3.14190 m   -0.00125 %
I205DS              1.10223 T  3.14204 m    3.14216 m    0.00373 %
I223DS              1.11579 T  3.09708 m    3.09655 m   -0.01710 %
I228DS              1.08990 T  3.17034 m    3.17011 m   -0.00734 %
I265DS              0.93431 T  2.80280 m    2.78280 m   -0.71349 %
I269DS              0.92819 T  2.80280 m    2.80115 m   -0.05885 %
Z001TL:  out, Z013TL: out; Z014TL OUT
Z015TL: OUT, Z016TL OUT
Z030BC Beam Stop: -126.22 mm
Z037L,R:   -4.70,   9.35 mm; Z037DC:  *out*
Z057MS:  out, Z061MS:  out
Z059DC:  out, Z062SC:  out, Z057TL:
Z082 XC,G,YG:    0.16, 203.50, 201.37 mm Z082Deg:  out
Z101DC:  in, Z102DC: out; Z103DC: out, Z105SC: out
B110 Cent,Gap:   -0.09,  -0.04 mm; D110   -3.01,  10.00 mm F110    0.15,   0.69 mm
B110DC:  out, D110DC:  out, D111DC: 5 mil BC-404, F110DC:  out
Slits: I181 XC,G,YC,G:    0.79,  98.98;  -0.00,  98.39
I187: [3"]Obj Scint, I188: [0"] out, I189: , I190: [0"] out
I213: [0"] out, i214: [0"] out, I215: [0"] out, I216: [0"] out
I214DC Detector Drive: _PPAC_
Extra Drive: Z059TL.VAL  = *out*
```

Experiment name and beam

Barney printout

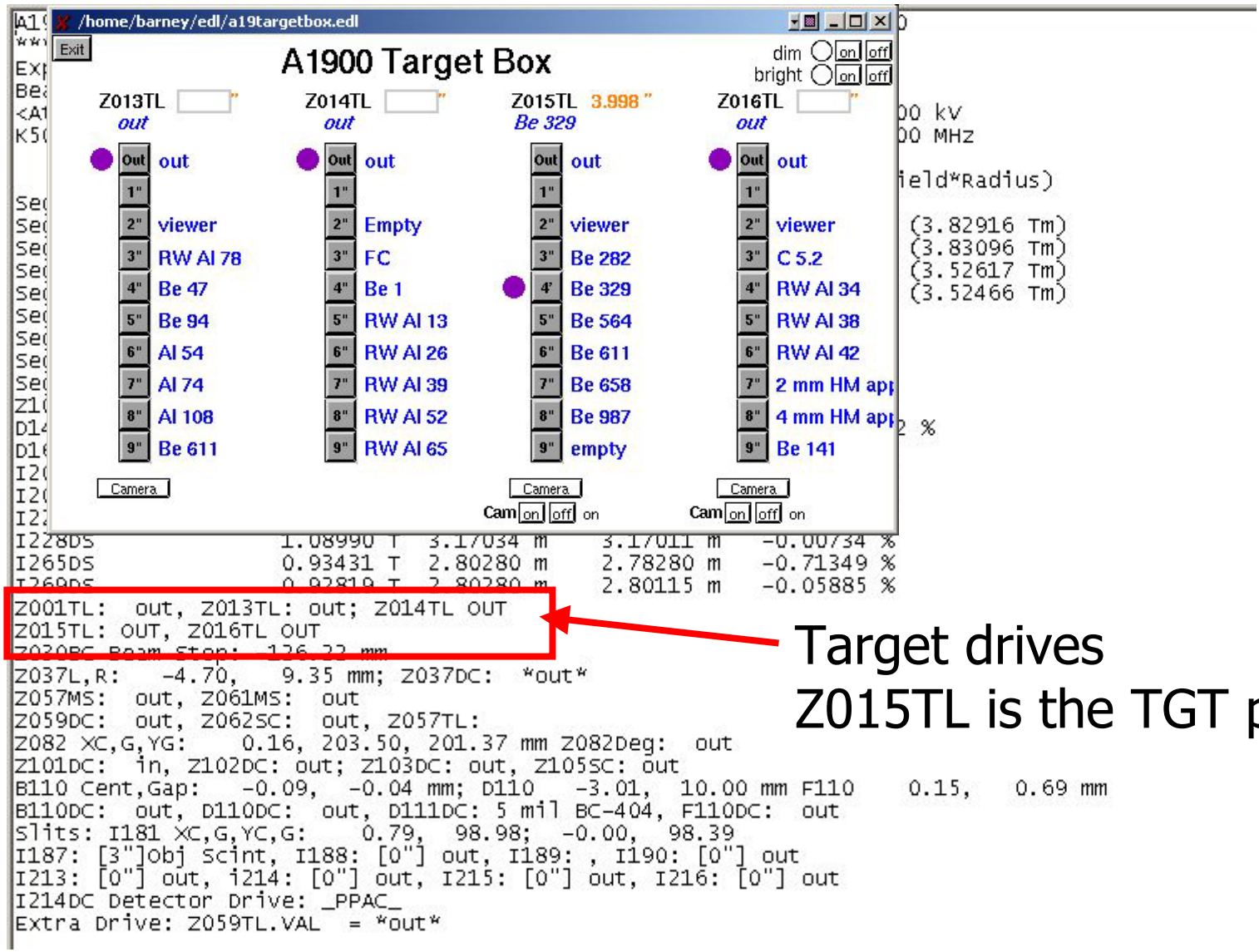
```
A1900 "Print18May05_13h30.txt" Wednesday 13:30:58 2005-05-18  A1900
***                                    test ***
Expt: 03031 "Fragmentation of Ni-68" [Betty Tsang] Line: S800 [8]
Beam: 76 Ge 12+  11.59 MeV/nuc (K500) 30+ 130.00 MeV/nuc (K1200)
<Att    1>  ECR, Apertures: RTECR 50.0; 15.0; 50.0 mm RHVBI: 25.4900 kV
K500 a,b:       0 A,       0 A K1200:      0 A,       0 A RF:  22.49300 MHz
      A1900 Optics: G19S3V13_30x20Focus60x30.data
      Rigidity          Field                              e (Field*Radius)
Seg 0:  4.32100 Tm
Seg 1:  3.83030 Tm   1.23568                               33 % (3.82916 Tm)
Seg 2:  3.83030 Tm   1.23520                               12 % (3.83096 Tm)
Seg 3:  3.52600 Tm   1.13931 T  3.09502 m    3.09487 m   -0.00483 % (3.52617 Tm)
Seg 4:  3.52600 Tm   1.13852 T  3.09582 m    3.09700 m    0.03794 % (3.52466 Tm)
Seg 5:  3.50350 Tm
Seg 6:  3.46338 Tm
Seg 7:  3.45510 Tm
Seg 8:  2.60000 Tm
Z108DS               0.50040 T  7.04675 m    7.04918 m    0.03449 %
D140DS               0.00145 T                               5232 %
D165DS               0.37016 T                                  9 %
I200DS               1.10232 T                                  5 %
I205DS               1.10223 T                                  3 %
I223DS               1.11579 T  3.09708 m    3.09655 m   -0.01710 %
I228DS               1.08990 T  3.17034 m    3.17011 m   -0.00734 %
I265DS               0.93431 T  2.80280 m    2.78280 m   -0.71349 %
I269DS               0.92819 T  2.80280 m    2.80115 m   -0.05885 %
Z001TL:  out, Z013TL: out; Z014TL OUT
Z015TL: OUT, Z016TL OUT
Z030BC Beam Stop: -126.22 mm
Z037L,R:   -4.70,   9.35 mm; Z037DC:  *out*
Z057MS:  out, Z061MS:  out
Z059DC:  out, Z062SC:  out, Z057TL:
Z082 XC,G,YG:    0.16, 203.50, 201.37 mm Z082Deg:  out
Z101DC:  in, Z102DC: out; Z103DC: out, Z105SC: out
B110 Cent,Gap:   -0.09,  -0.04 mm; D110   -3.01,  10.00 mm F110    0.15,   0.69 mm
B110DC:  out, D110DC:  out, D111DC: 5 mil BC-404, F110DC:  out
Slits: I181 XC,G,YC,G:    0.79,  98.98;  -0.00,  98.39
I187: [3"]Obj Scint, I188: [0"] out, I189: , I190: [0"] out
I213: [0"] out, i214: [0"] out, I215: [0"] out, I216: [0"] out
I214DC Detector Drive: _PPAC_
Extra Drive: Z059TL.VAL  = *out*
```

A1900 segments

S800 segments

Bρ settings of Segments
Very important!

Barney printout



Target drives
Z015TL is the TGT position

Barney printout

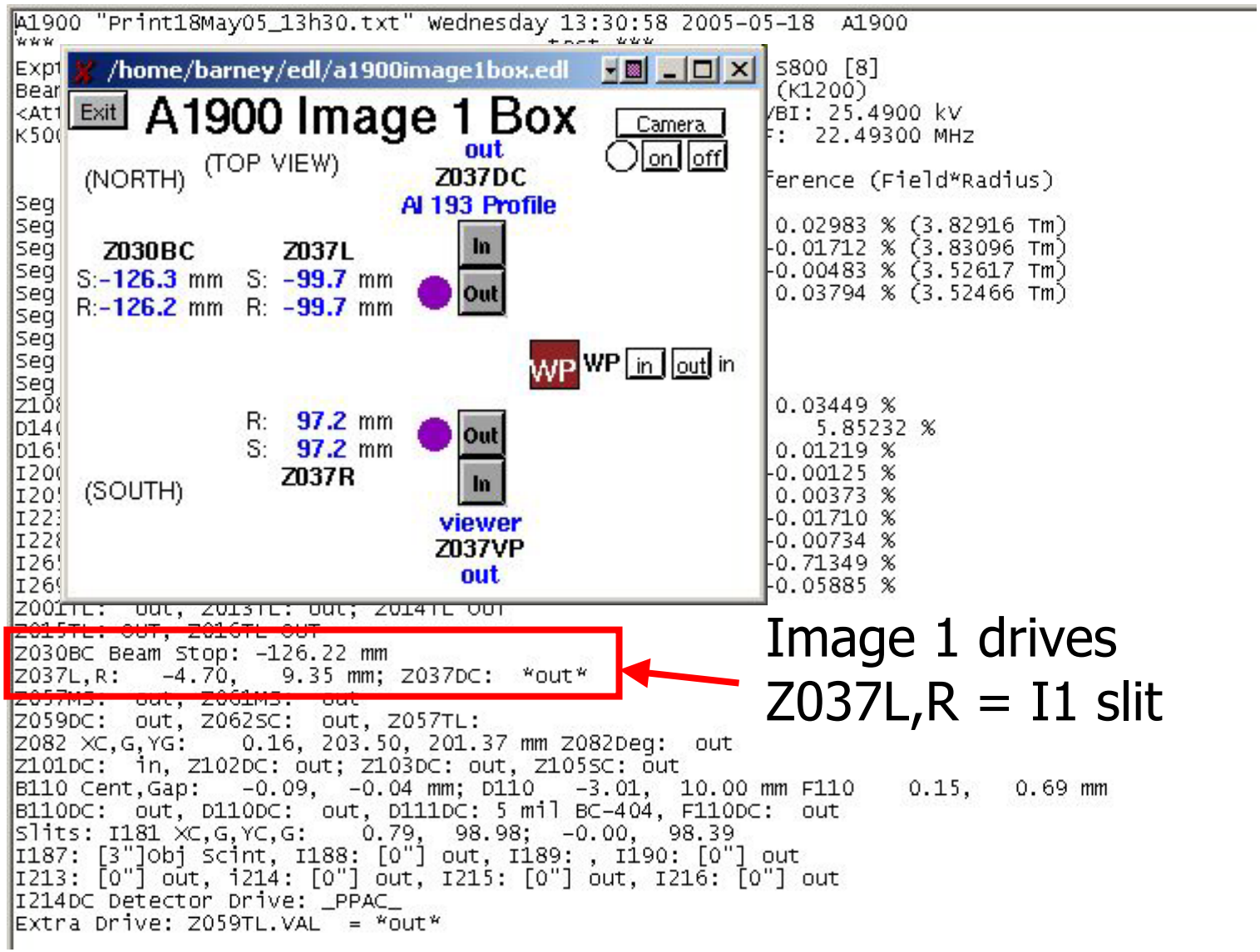


Image 1 drives
Z037L,R = I1 slit

Barney printout

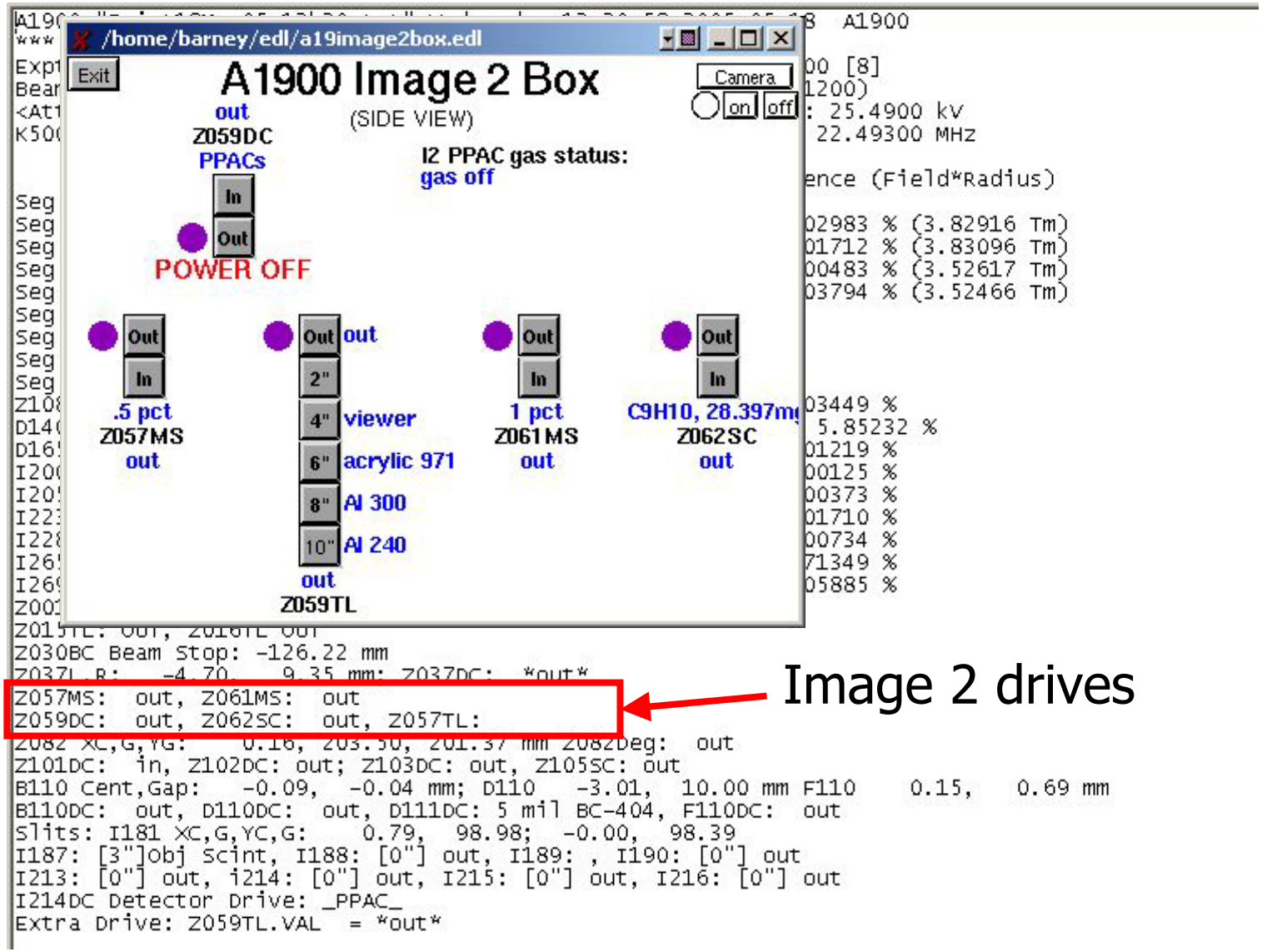


Image 2 drives

Barney printout

```
A1900 "Print18May05_13h30.txt" Wednesday 13:30:58 2005-05-18  A1900
***                                  test ***
Expt: 03031 "Fragmentation of Ni-68" [Betty Tsang] Line: S800 [8]
Beam: 76 Ge 12+  11.59 MeV/nuc (K500) 30+ 130.00 MeV/nuc (K1200)
<Att    1>  ECR, Apertures: RTECR 50.0; 15.0; 50.0 mm RHVBI: 25.4900 kV
K500 a,b:      0 A,      0 A K1200:      0 A,      0 A RF:  22.49300 MHz
       A1900 Optics: G19S3V13_30x20Focus60x30.data
       Rigidity       Field     Radius       (live)  Difference (Field*Radius)
Seg 0:  4.32100 Tm
Seg                                                  0.02983 % (3.82916 Tm)
Seg                                                  0.01712 % (3.83096 Tm)
Seg                                                  0.00483 % (3.52617 Tm)
Seg                                                  0.03794 % (3.52466 Tm)
Seg
Seg
Seg
Seg
Z10                                                  0.03449 %
D14                                                    5.85232 %
D16                                                  0.01219 %
I20                                                  0.00125 %
I20                                                  0.00373 %
I22                                                  0.01710 %
I22                                                  0.00734 %
I26                                                  0.71349 %
I26                                                  0.05885 %
Z00
Z01
Z030BC Beam Stop: -126.22 mm
Z037L,R:   -4.70,    9.35 mm; Z037DC:  *out*
Z057MS:  out, Z061MS:  out
Z059DC:  out, Z062DC:  out, Z057TL:
Z082 XC,G,YG:    0.16, 203.50, 201.37 mm Z082Deg:  out
Z101DC:  in, Z102DC:  out, Z103DC:  out, Z105DC:  out
B110 Cent,Gap:   -0.09,  -0.04 mm; D110   -3.01,  10.00 mm F110    0.15,    0.69 mm
B110DC:  out, D110DC:  out, D111DC: 5 mil BC-404, F110DC:  out
Slits: I181 XC,G,YC,G:    0.79,  98.98;  -0.00,  98.39
I187: [3"]Obj Scint, I188: [0"] out, I189: , I190: [0"] out
I213: [0"] out, i214: [0"] out, I215: [0"] out, I216: [0"] out
I214DC Detector Drive: _PPAC_
Extra Drive: Z059TL.VAL  = *out*
```

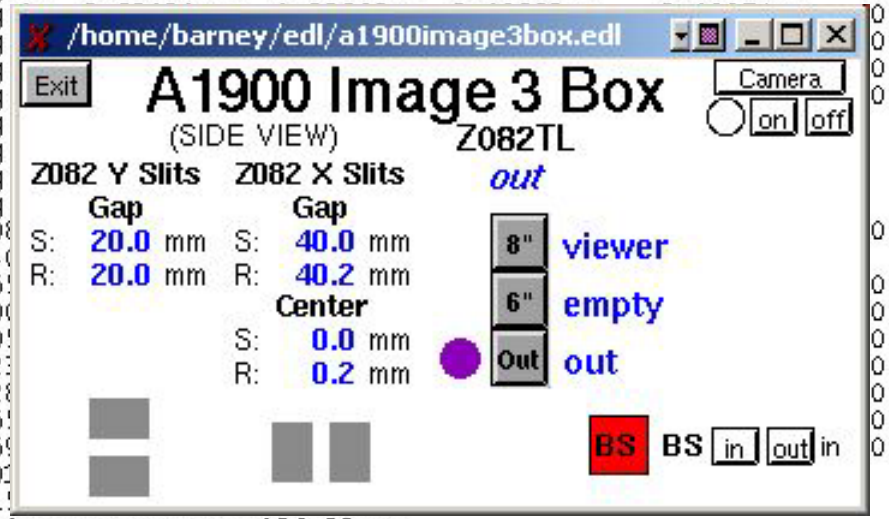
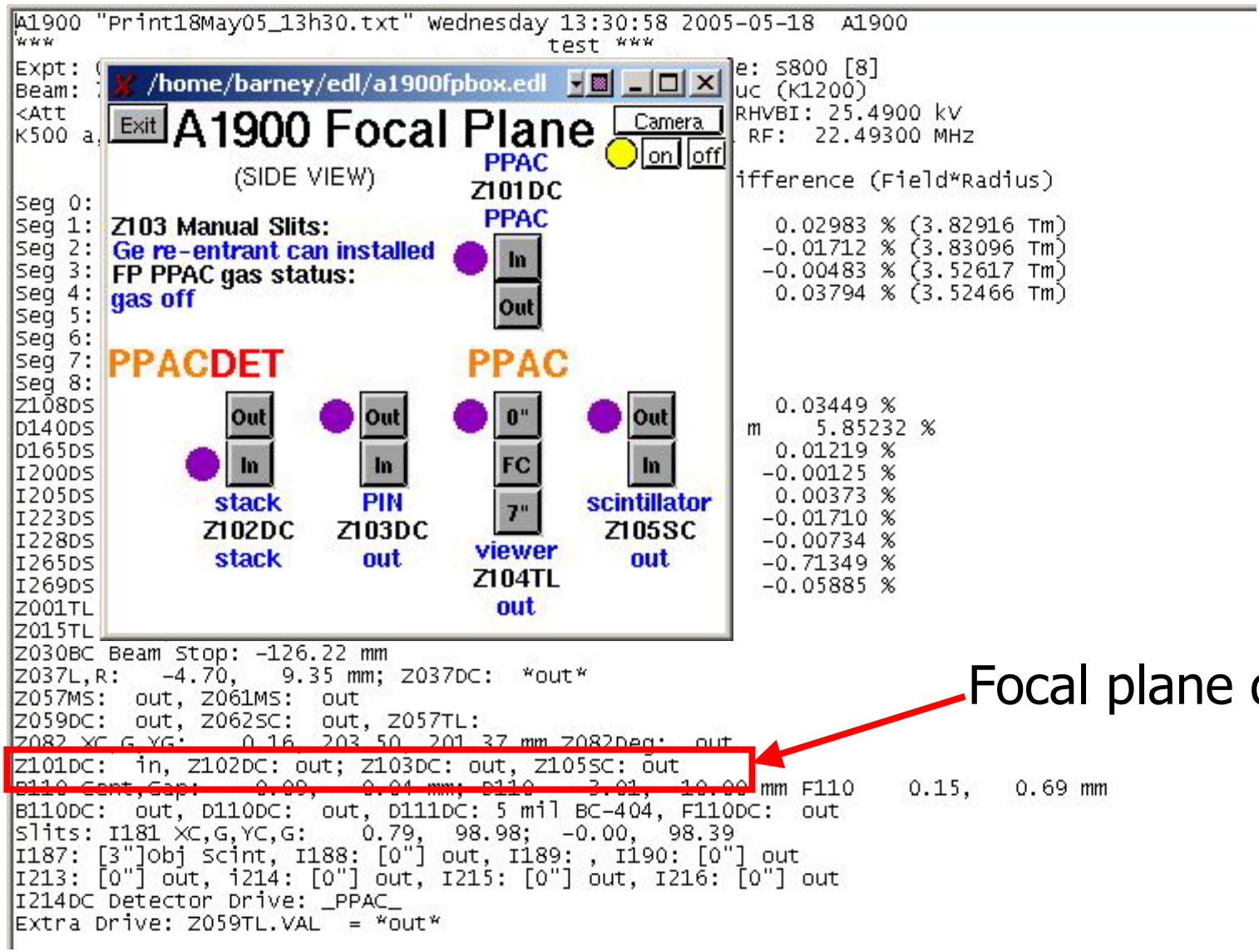


Image 3 drives

Barney printout



Focal plane drives

Conclusion

- Part I:
  - A1900 layout presented
  - Principle of particle identification
  - Separation of fragmentation products showed
- Part II
  - Control system (Barney) introduced
  - Control pages for A1900, S800 presented
  - Barney printout explained