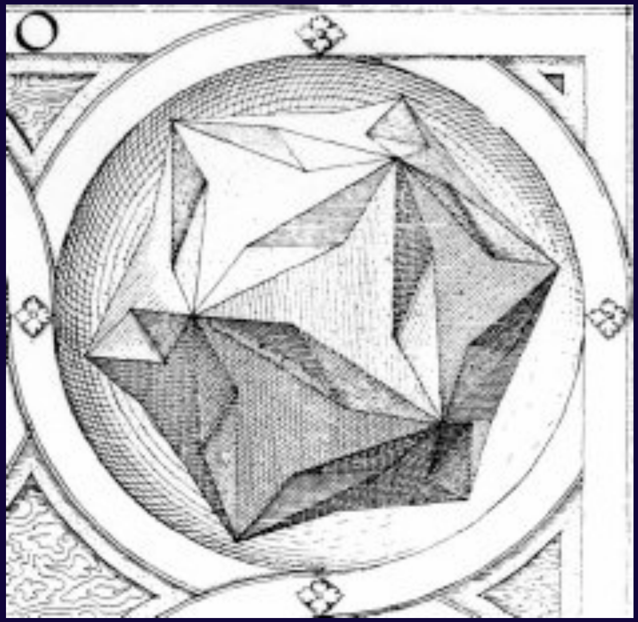
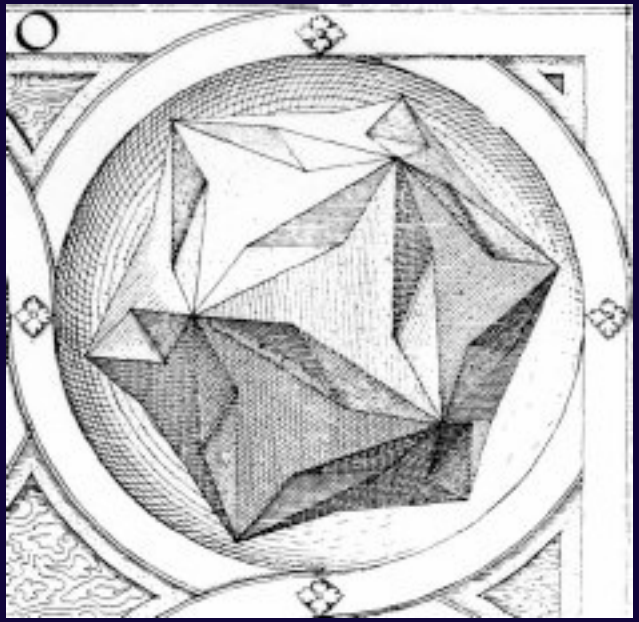


Machine Detector Interface

Interaction Region

backgrounds



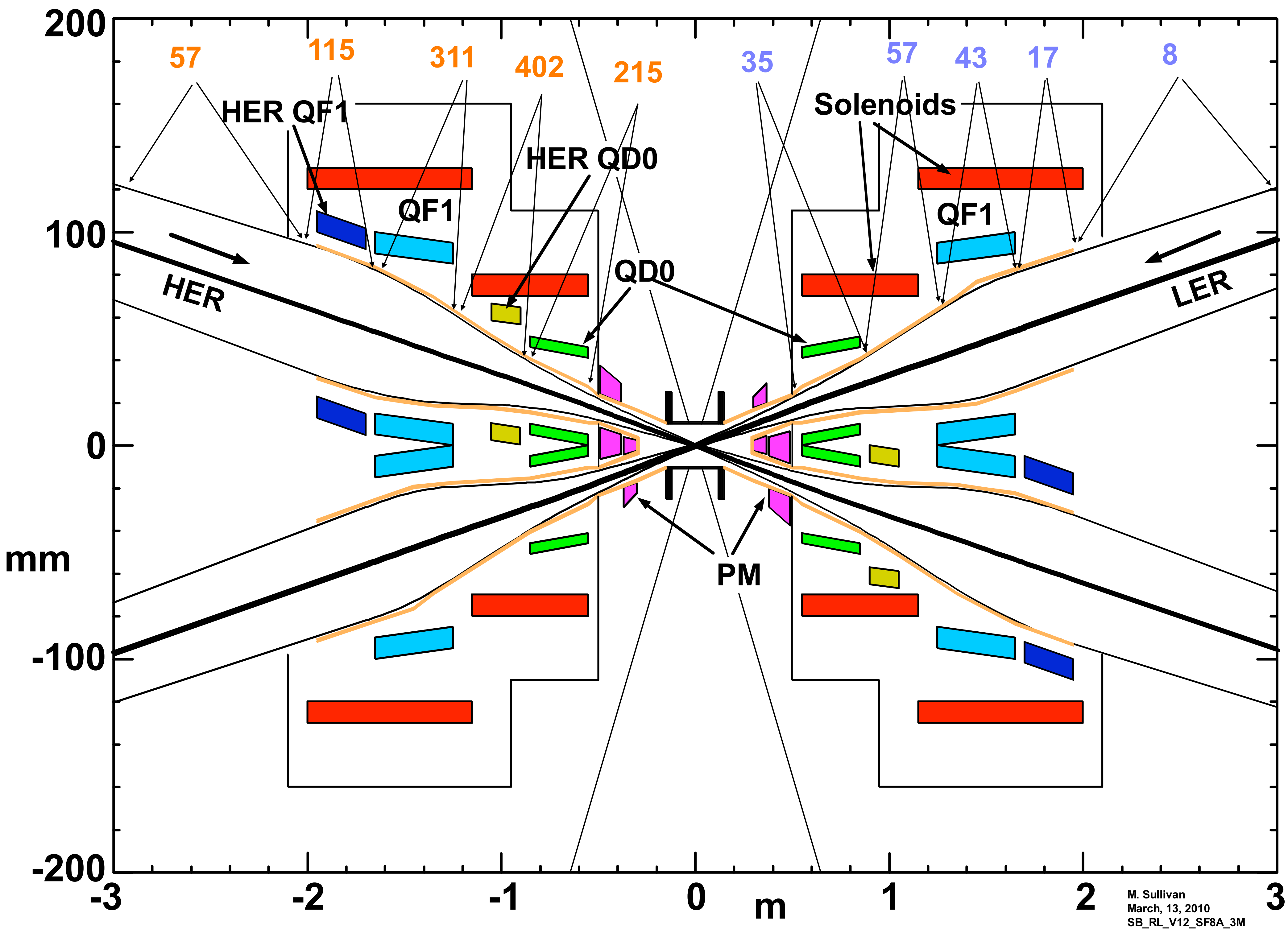
Talk Outline

- Interaction Region design progresses
  - Magnets
  - Radiation Monitors
  - Luminosity Monitors
- Background simulations
  - Multi turn radiative Bhabha
  - Shields optimizations
  - Latest simulations
- To Do list

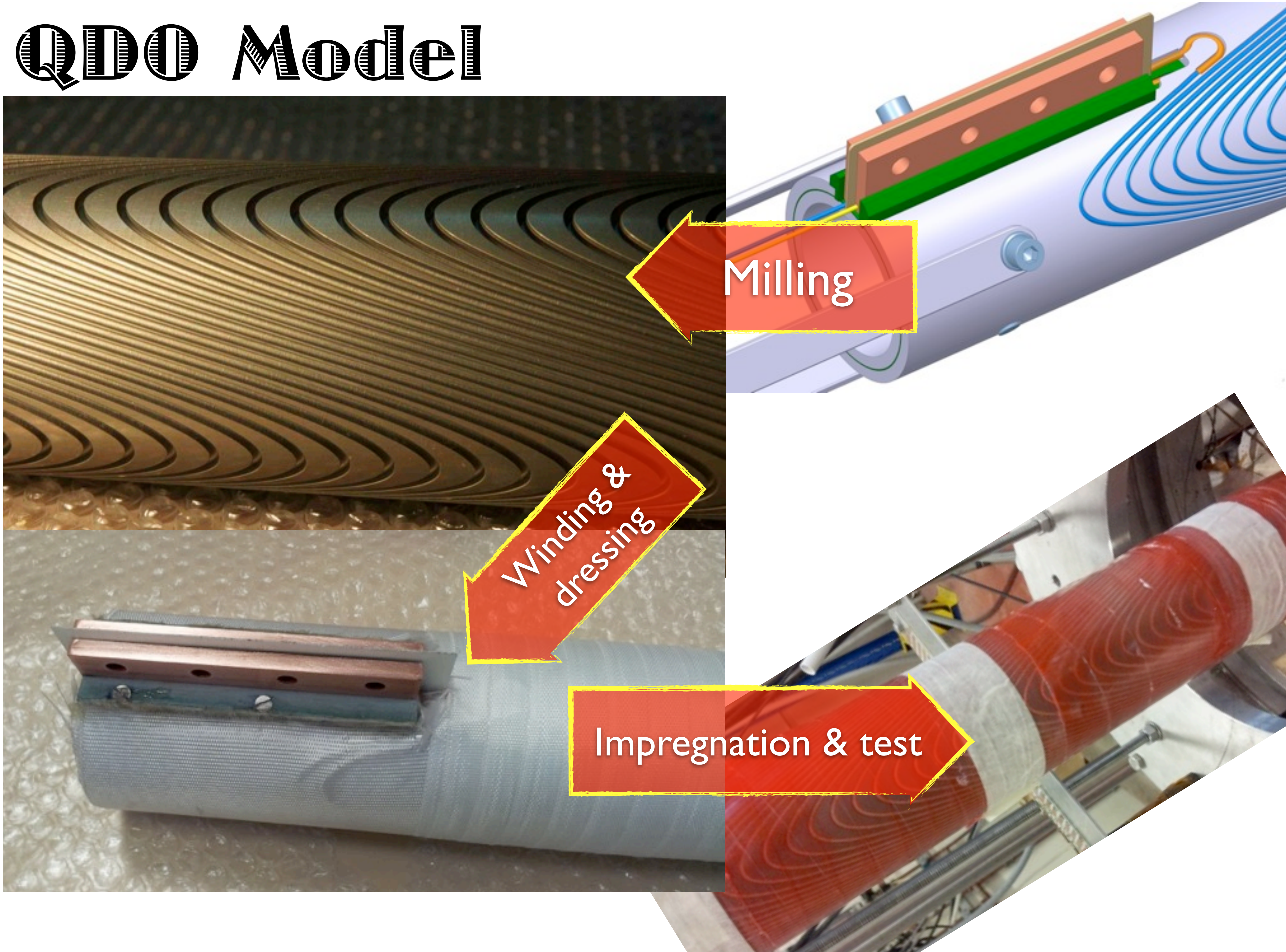
Parameters used in the IR designs

Parameter	HER	LER
Energy (GeV)	6.70	4.18
Current (A)	1.89	2.45
Beta X* (mm	26	32
Beta Y* (mm	0.253	0.205
Emittance X (nm-rad)	2.00	2.46
Emittance Y (pm-rad)	5.0	6.15
Sigma X (μm)	7.21	8.87
Sigma Y (nm)	36	36
Crossing angle (mrad)	+/- 30	

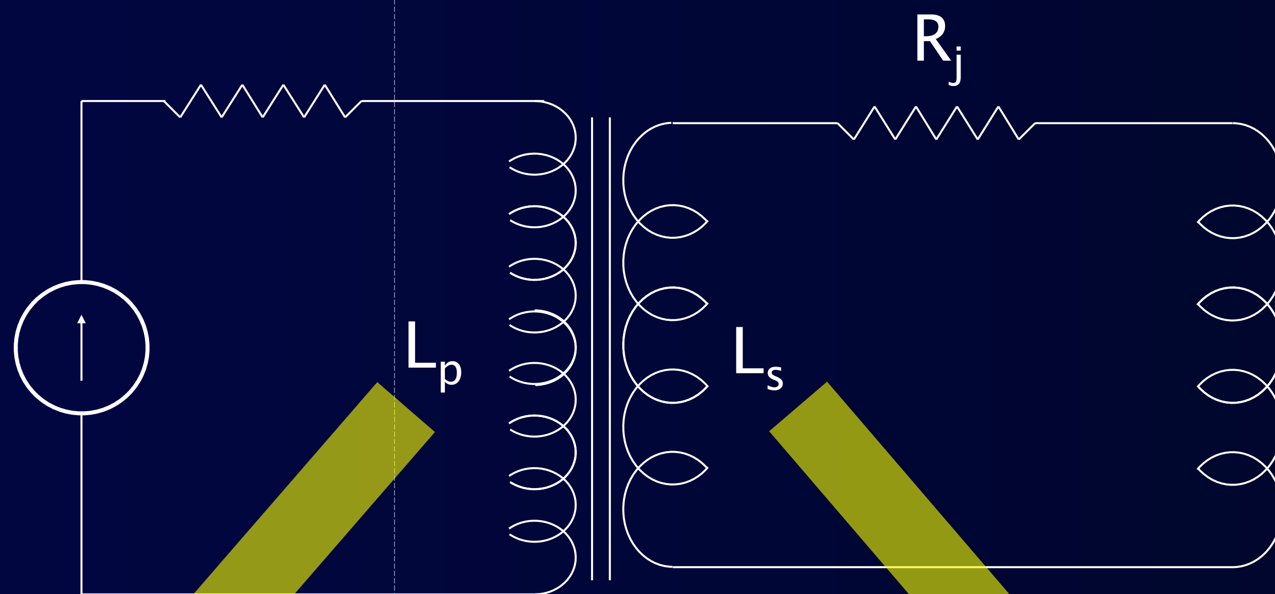
SR power (Watt)

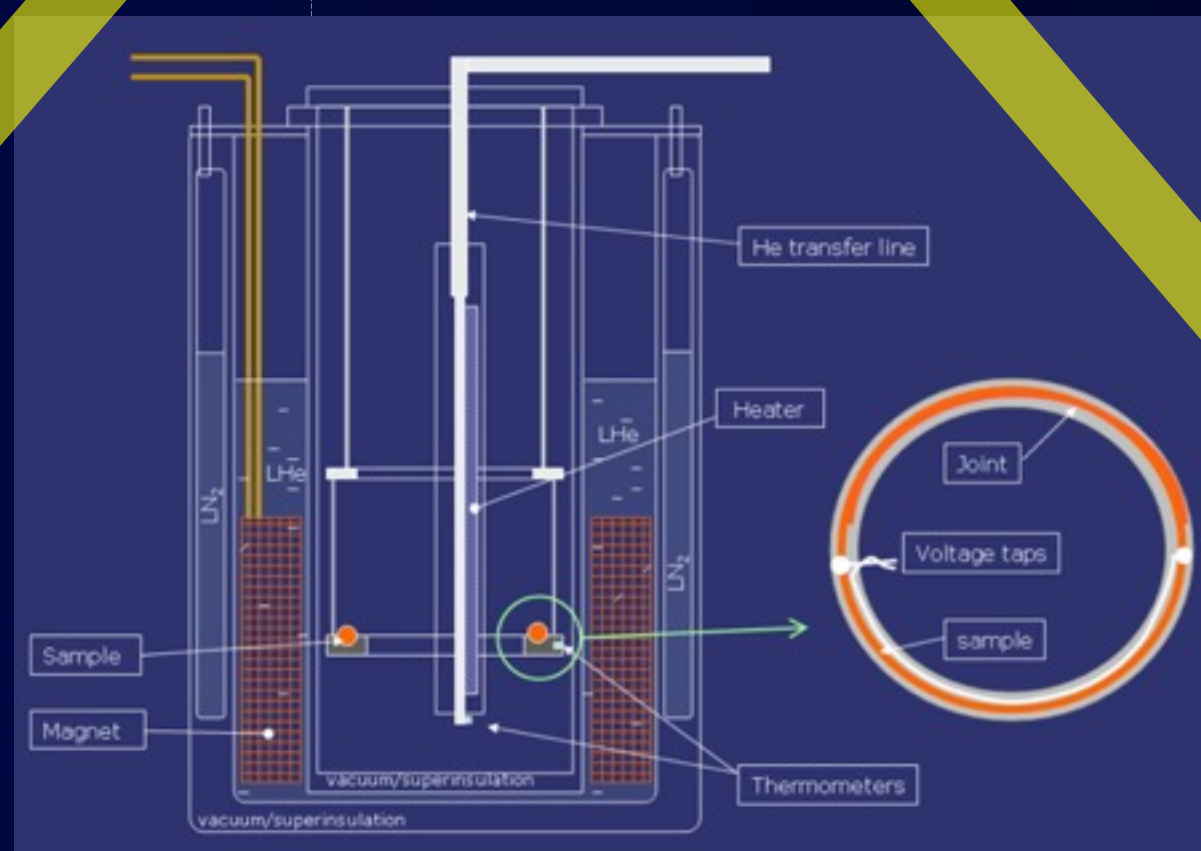


QDO Model



Test of the QDO in Genova



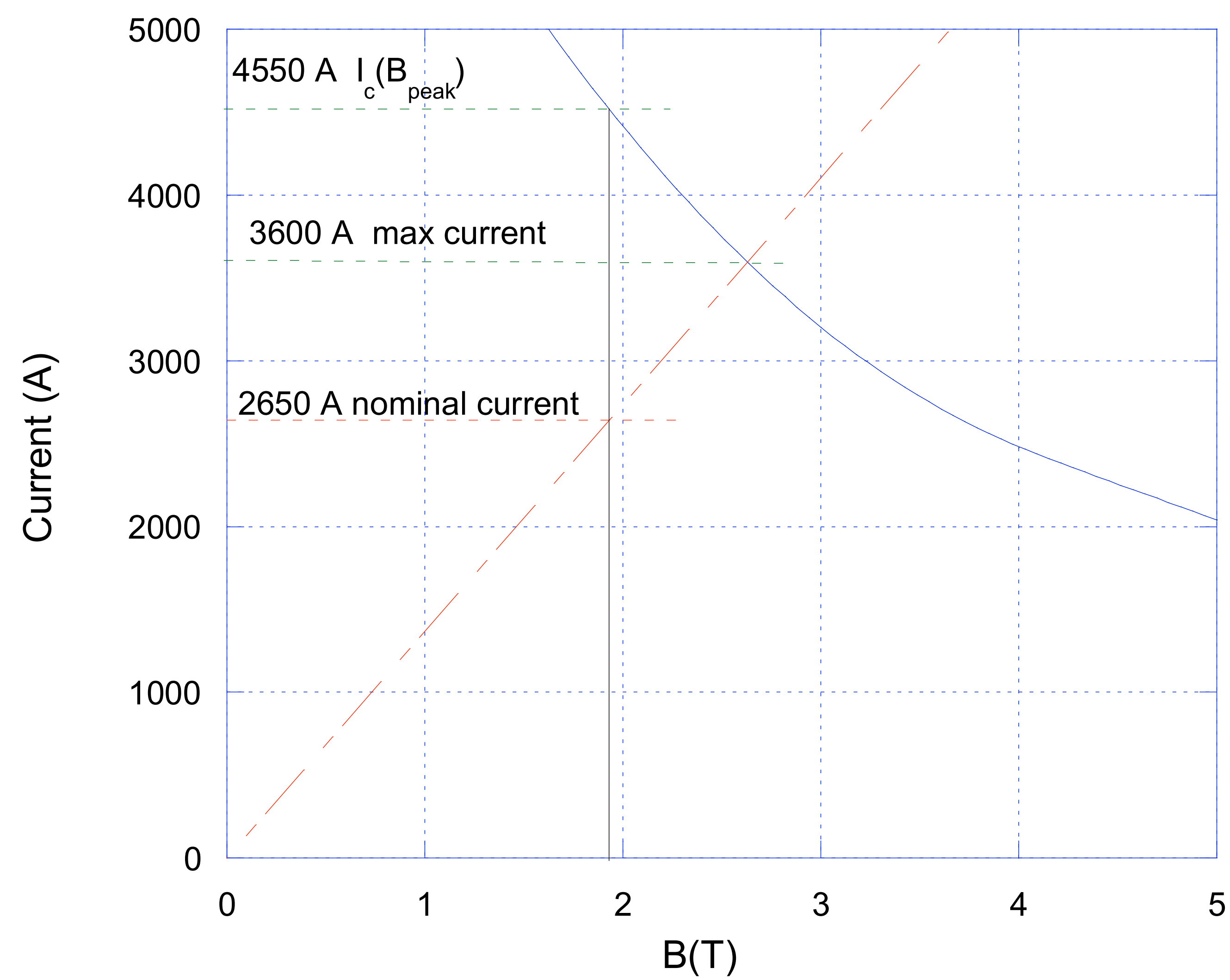


R. Musenich

L_p = 6.4 H; L_c = 340 μH; L_s = 90 μH

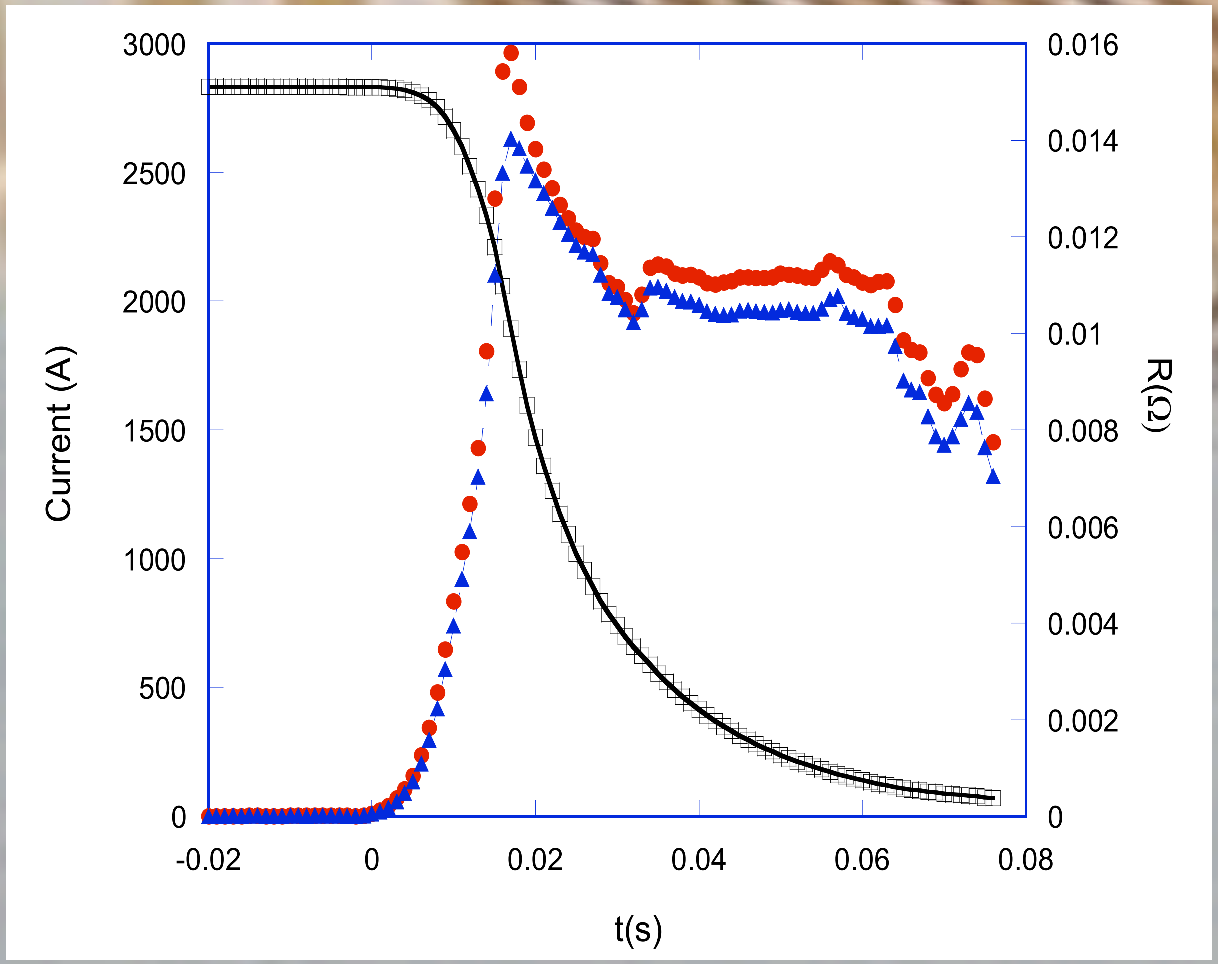
Cold Tests Completed

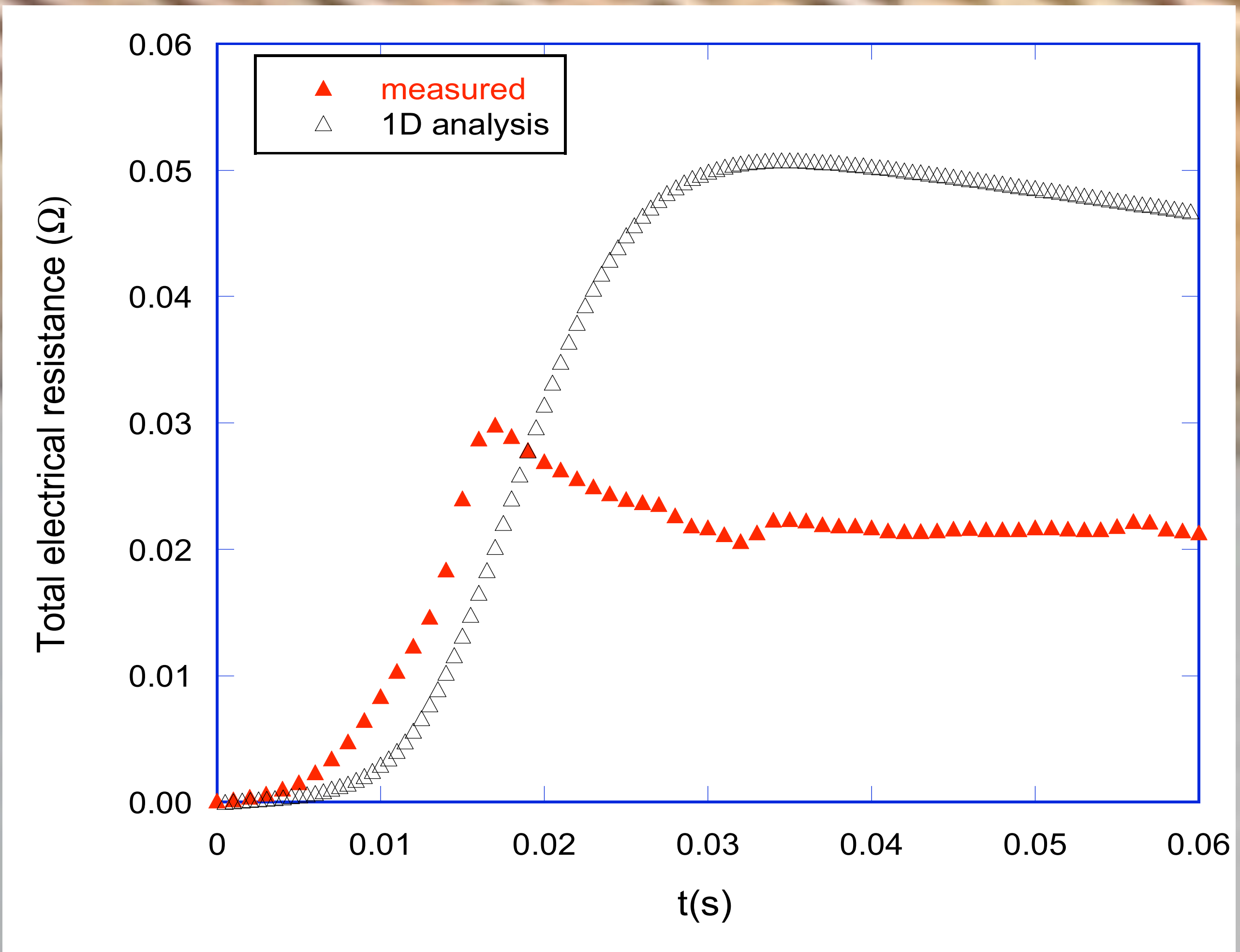
- 4 runs (each one cooling the coil from 300 K down to 4.2 K)
- The excellent results are confirmed. Max current 2830 A



Last meeting I stressed the question "Why the magnet does behave so well?". I remind that simple computations show that localized quench can damage the magnet.

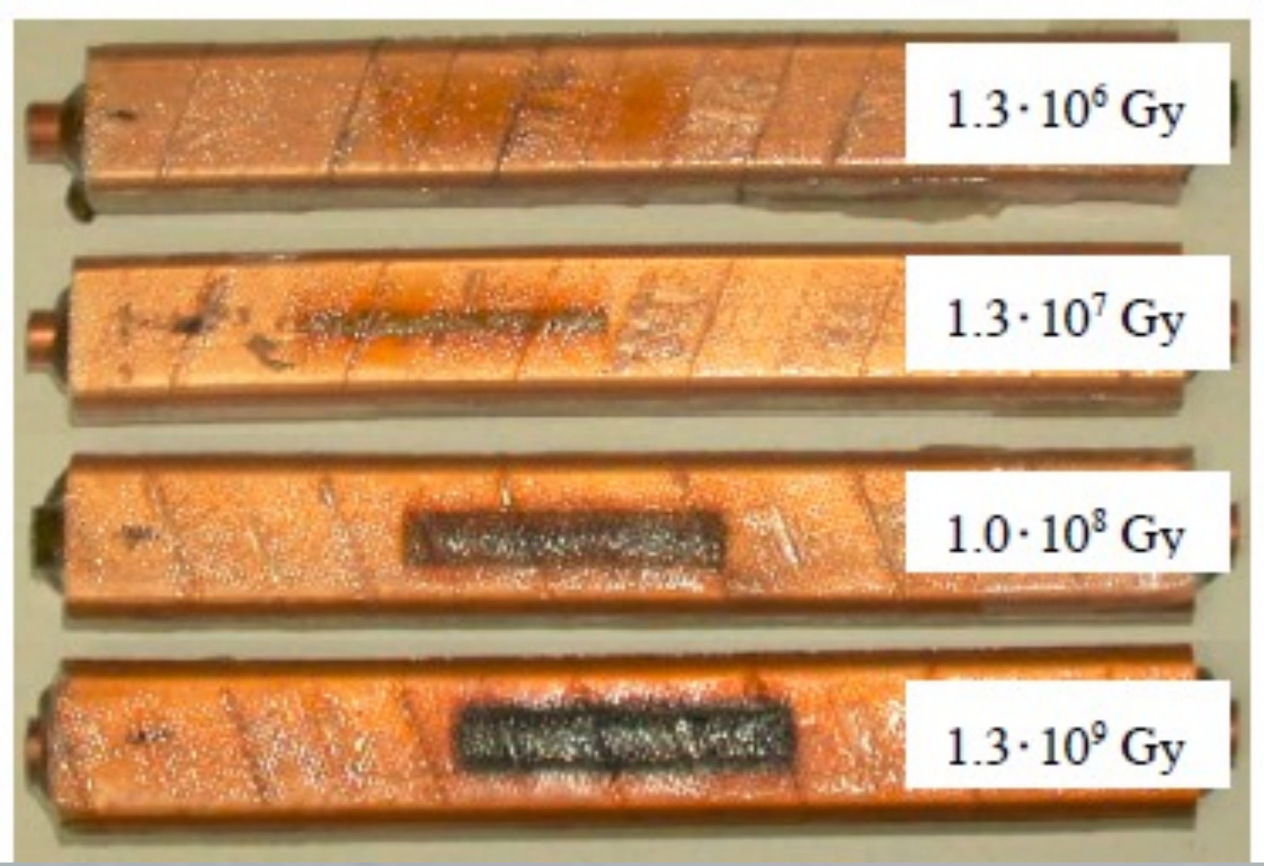
In last runs a fast quench acquisition (1 kHz) was implemented. The measured normal zone electrical resistance growth is compatible with a quench of the whole magnet.→ No localised quench

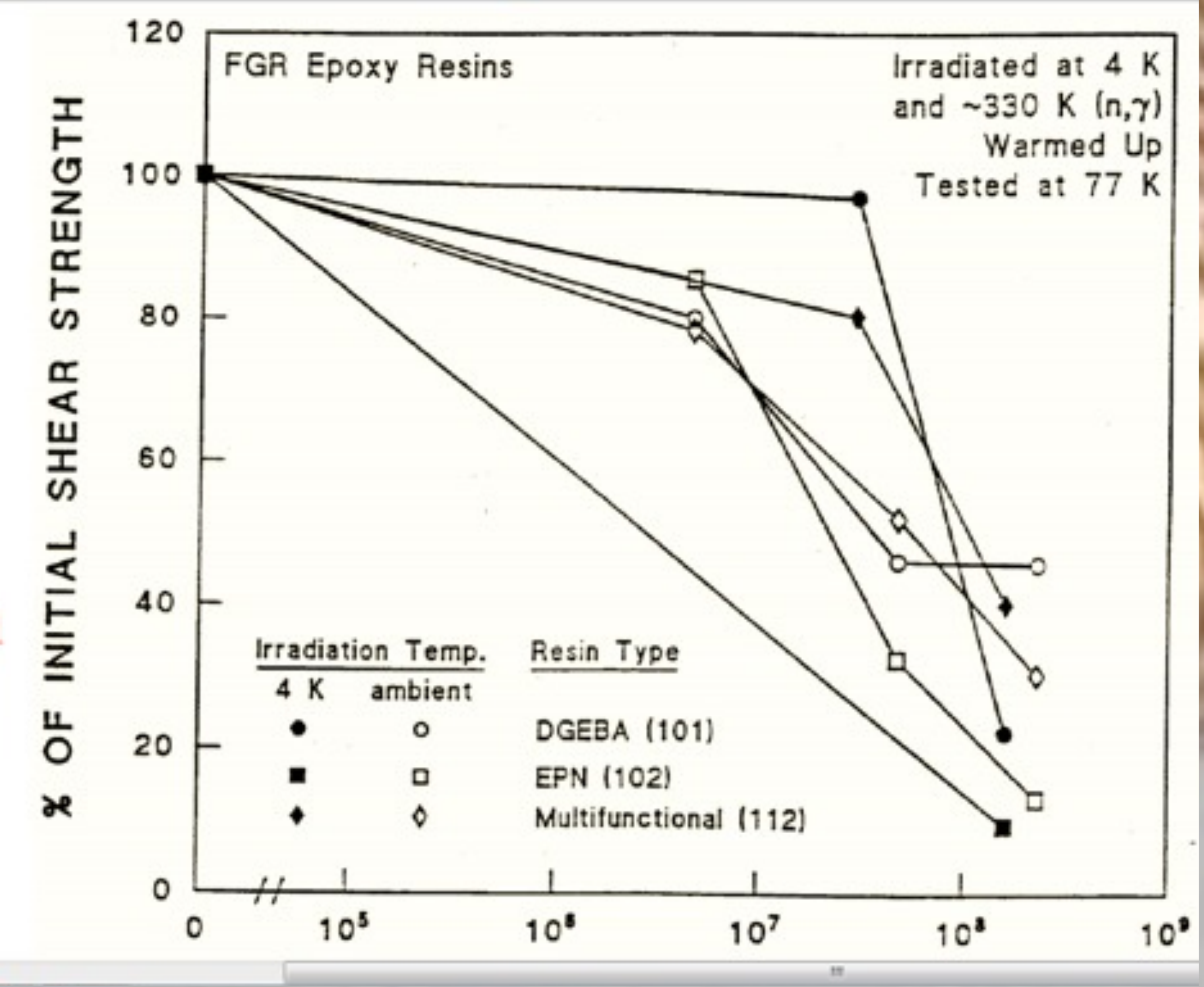




A problem to be addressed: radiation

According the simulation done by Alejandro some magnets of FF is exposed to high radiation. With 75 ab^{-1}, the dose is (at the best) 110 M Gy (safety factor 5 taken into account)

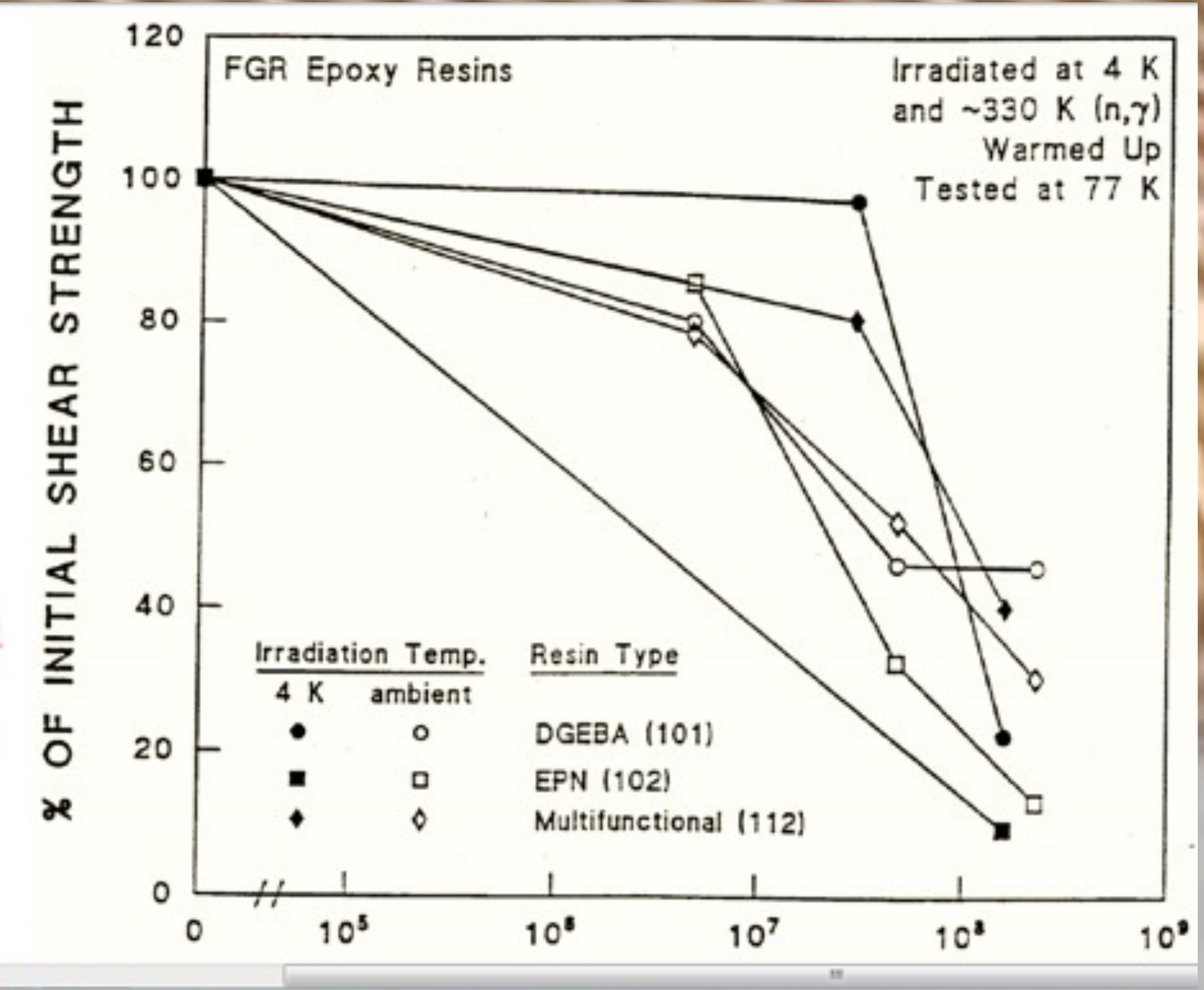




Literature data of insulation damage

A problem to be addressed: radiation

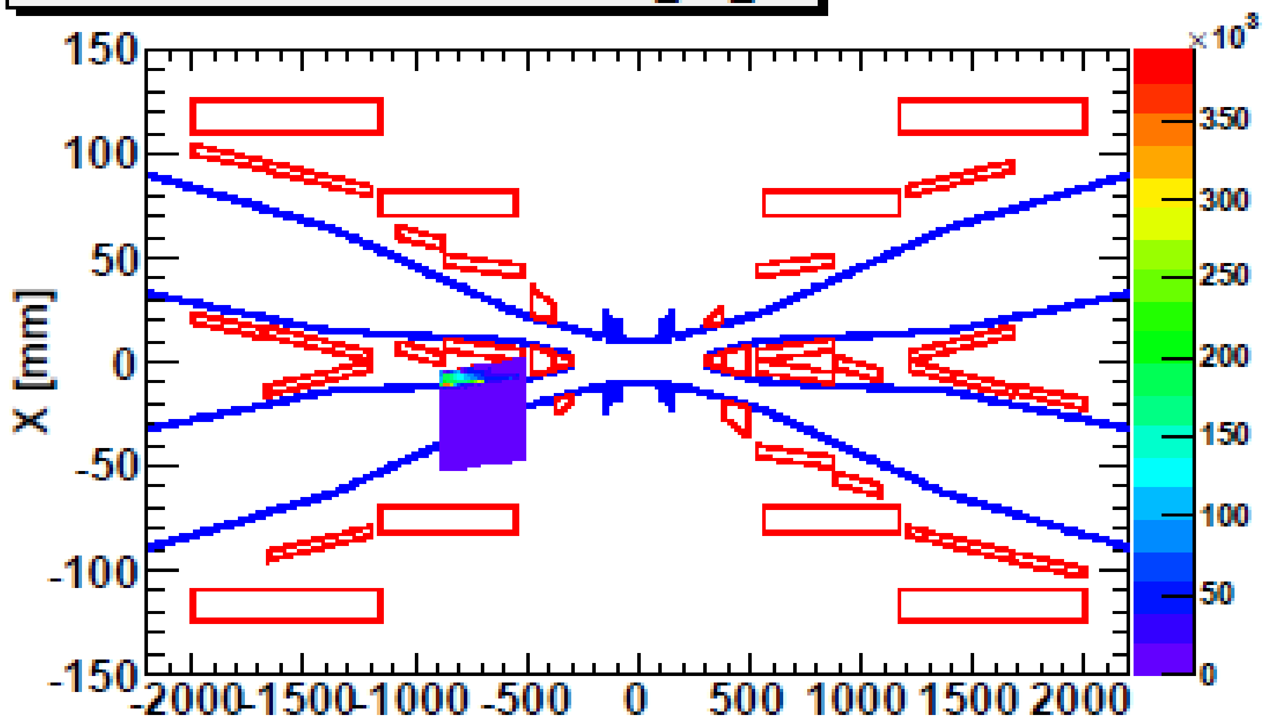
According the simulation done by Alejandro some magnets of FF is exposed to high radiation. With 75 ab^{-1}, the dose is (at the best) 110 M Gy (safety factor 5 taken into account)



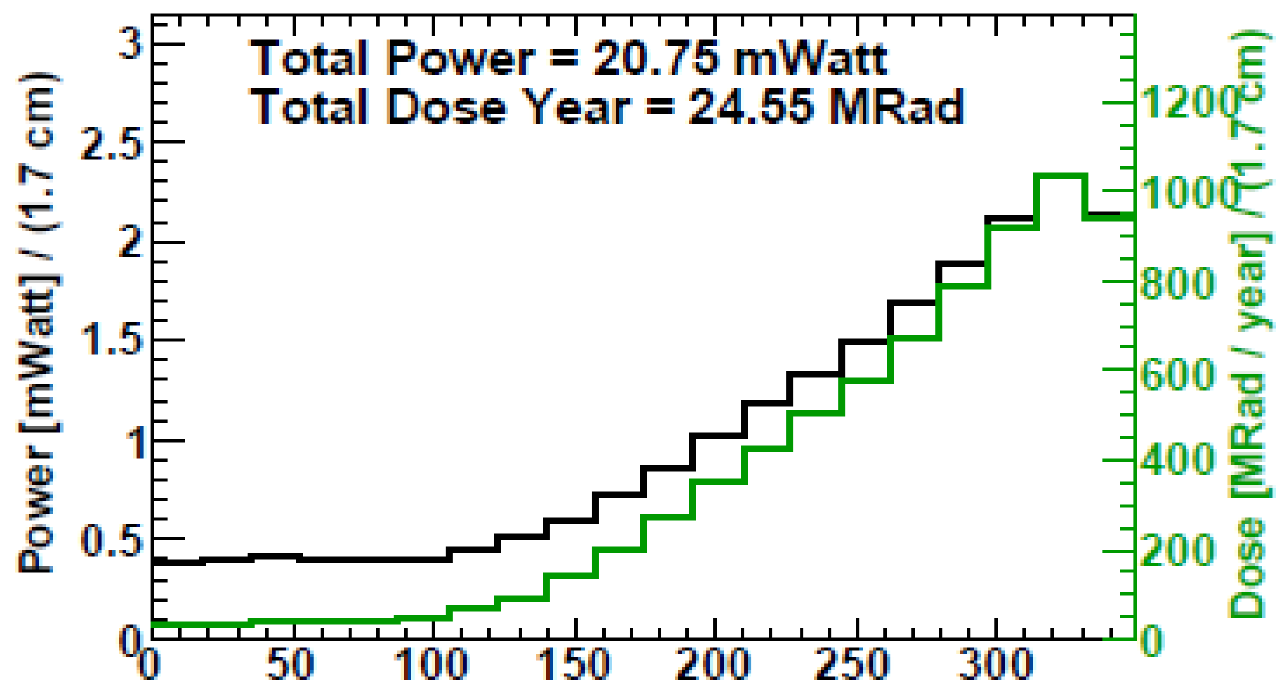
Literature data of insulation damage

Final Doublet Dose (Alejandro)

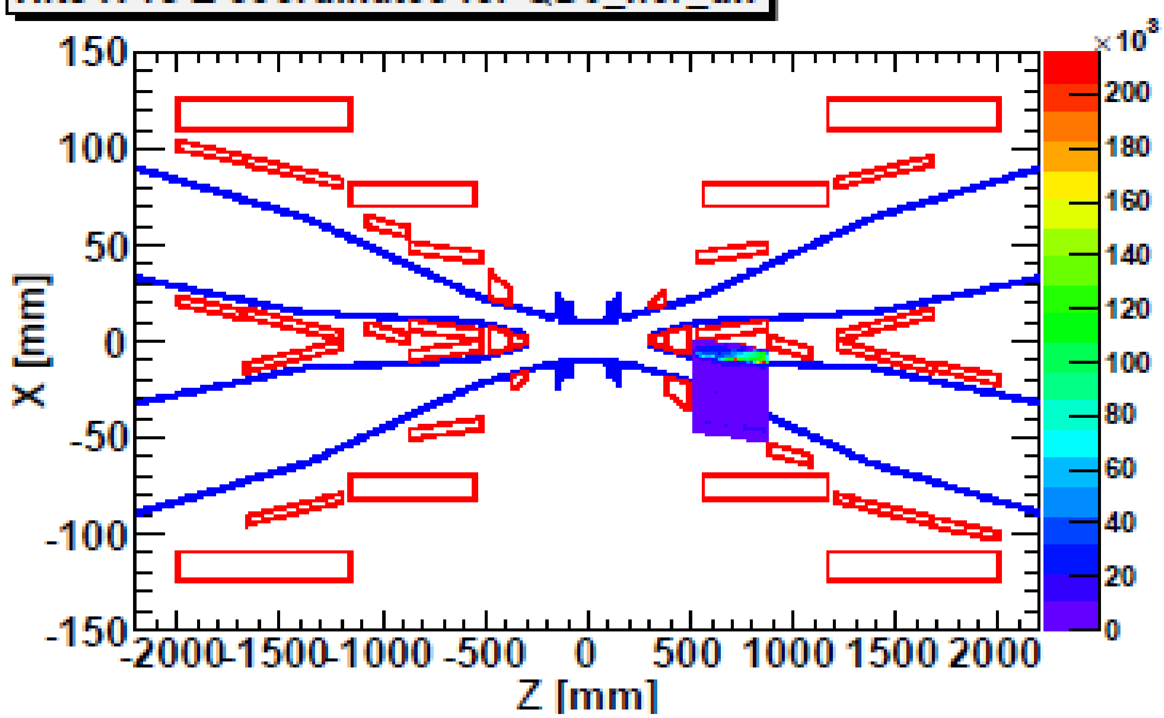
Hits X vs Z coordinates for QD0_ler_dn



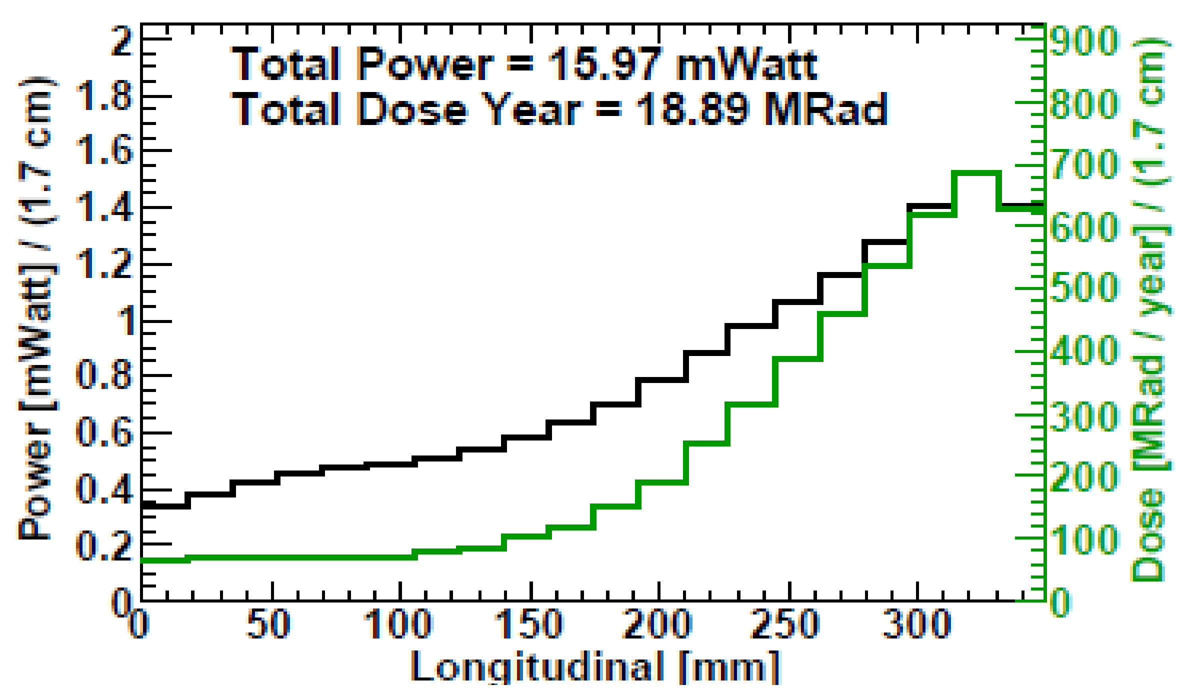
Absorbed power vs longitudinal coordinate for QD0_ler_dn



Hits X vs Z coordinates for QD0_her_dn

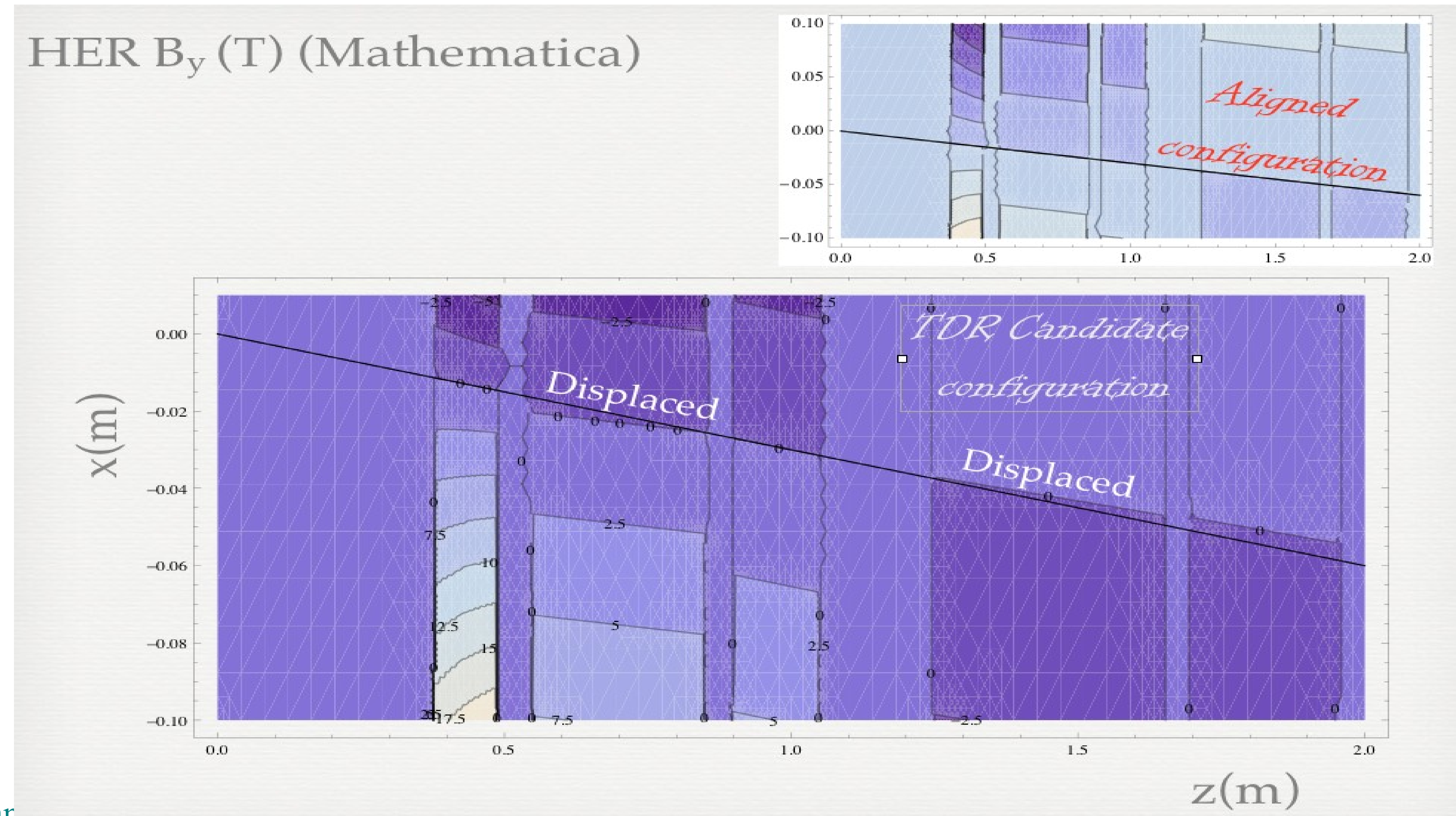


Absorbed power vs longitudinal coordinate for QD0_her_dn

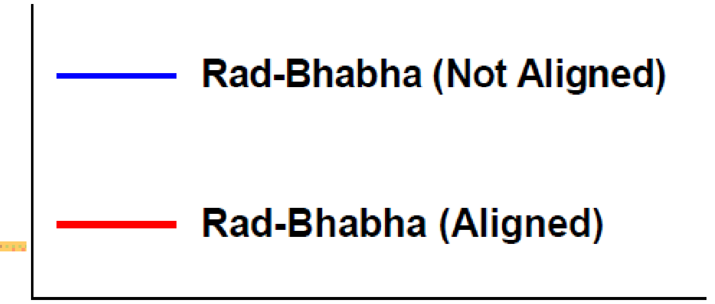


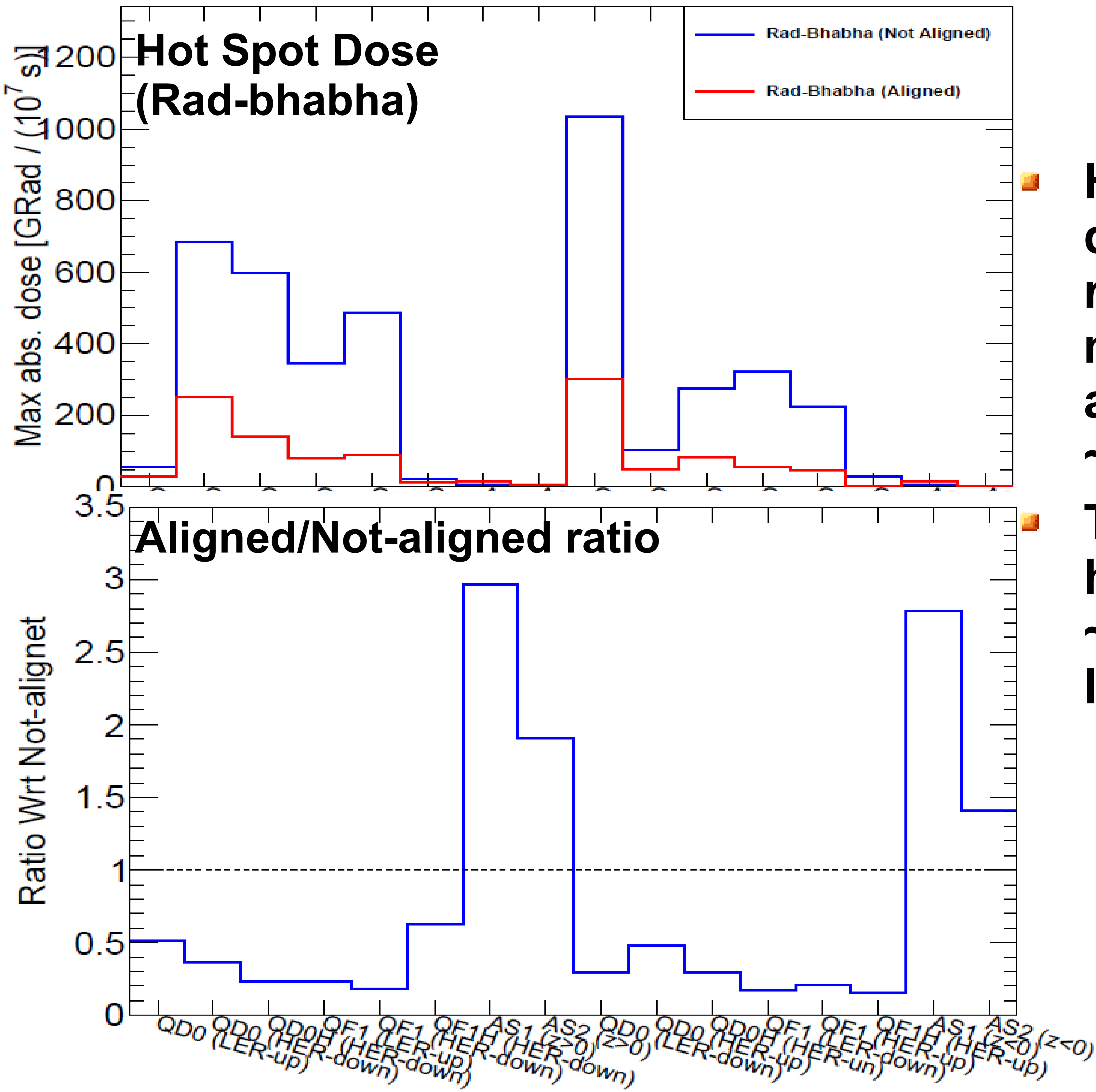
Aligned vs Not Aligned Magnetic elements

- **Current magnetic some elements (QD0, QD0H, QF1 and QF1H) are not aligned with nominal trajectory**
- **Try a model in which all magnetic elements are aligned ⇒ expect reduction on the doses**



Aligned vs Not Aligned: results





- Hot spots dose on the doublets are significantly reduced for the aligned model w.r.t. the Not-aligned one (a factor of ~2 reduction)
- The anti-solenoids have hot spot dose a factor of ~3 increase but still in the limits radiation hardness

Multi Turn Radiative Bhabha

Lifetime evaluation

$$\frac{1}{\tau_{rad}} = \frac{\dot{N}(Hz)}{N}$$ rate of losses due to radiative Bhabha for N(particles/bunch)

τ_{rad} is the calculated radiative Bhabha lifetime

- CDR2

Table 9.4: Radiative Bhabha beam lifetimes for several SuperB options.

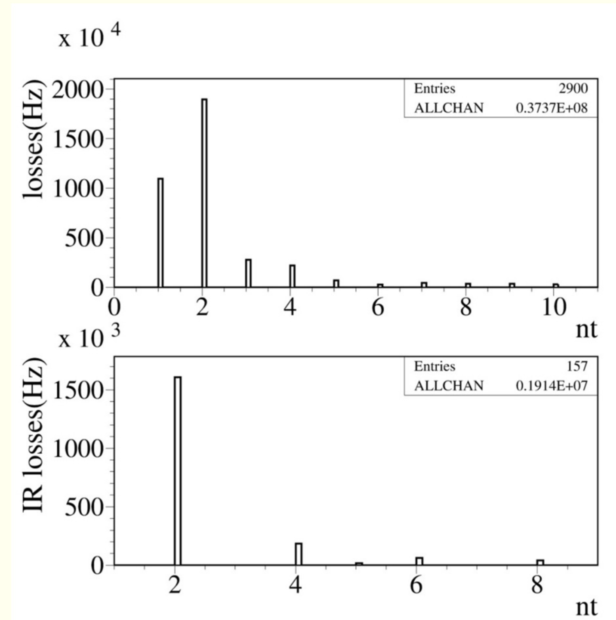
	Base Line		Low Emittance		High Current	
	HER	LER	HER	LER	HER	LER
τ (min)	4.87	6.29	3.76	4.85	7.96	10.3

- Monte Carlo:

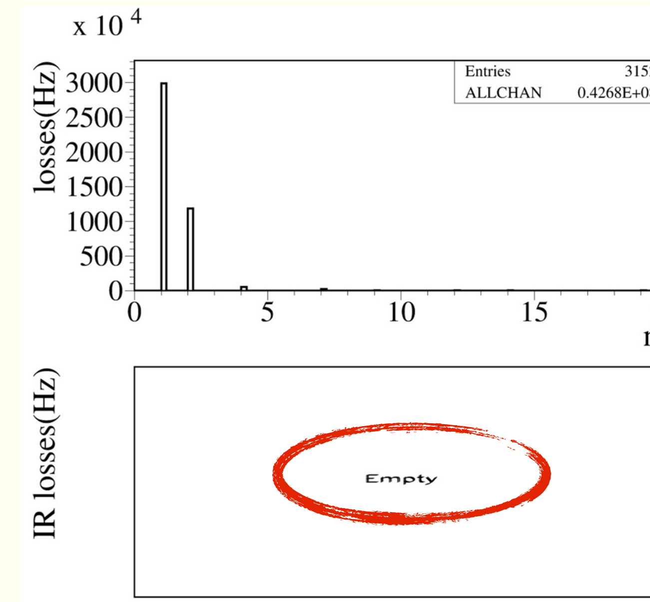
HER τ_{rad} = 4.7 min LER τ_{rad} = 7.0 min

LER Losses from Rad Bhabha process vs machine turns

LER no collimators



LER with collimators
(same set of Touschek &beam-gas)

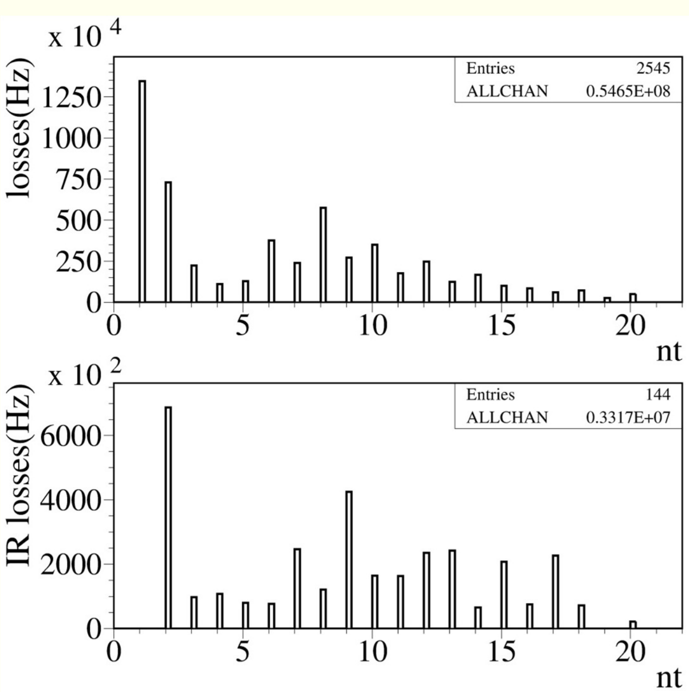


14

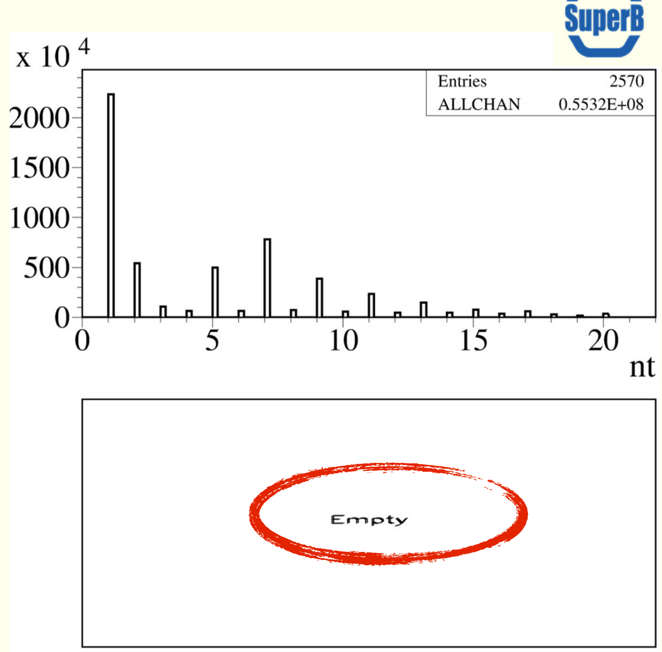
M. Boscolo, 4th SuperB Collaboration Meeting, June 2nd 2012

HER losses from rad Bhabha process

HER no collimators



HER no collimators



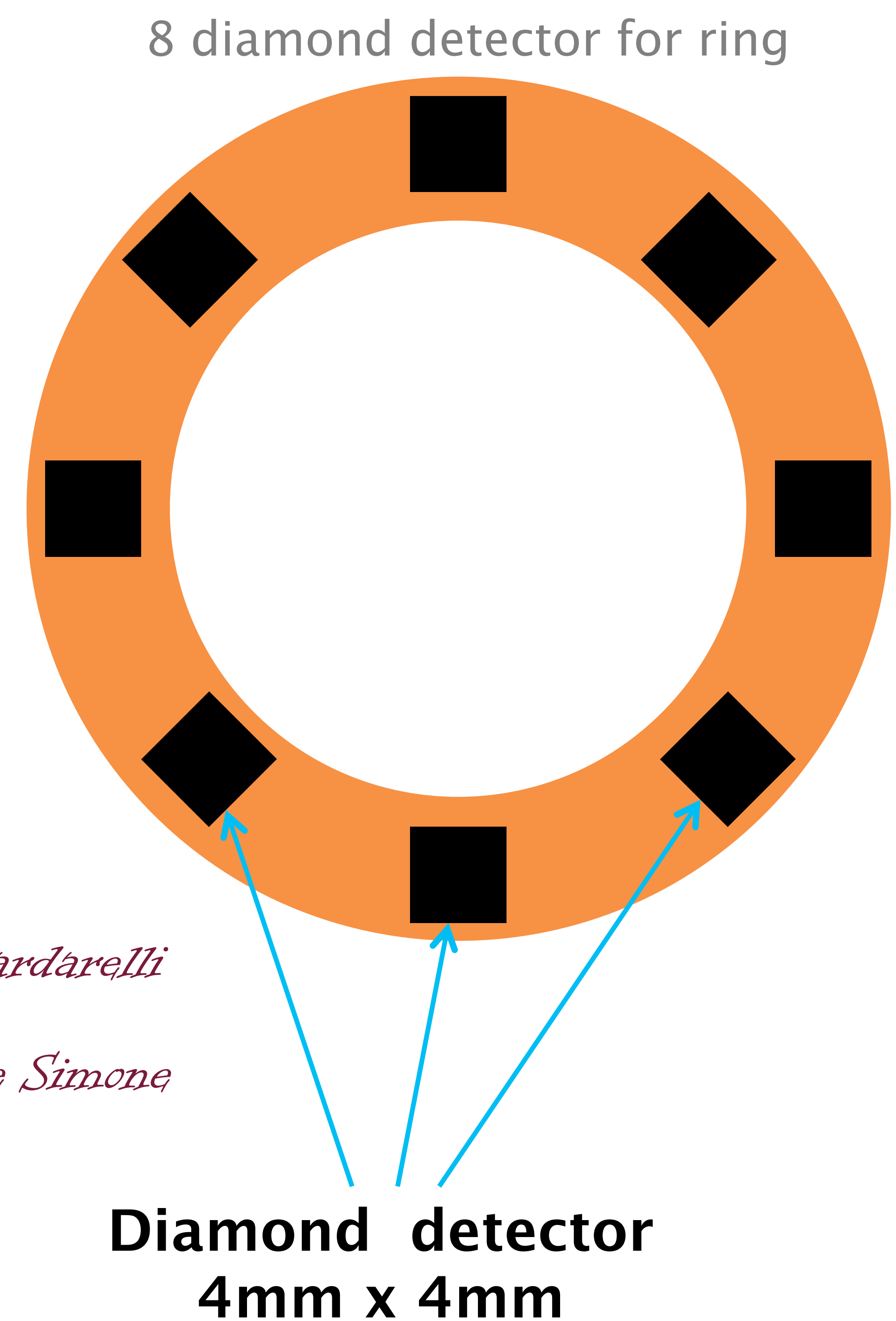
20

M. Boscolo, 4th SuperB Collaboration Meeting, June 2nd 2012

Manuela's preliminary simulations tell us that multi turn Radiative Bhabha are very effectively handled by her Touschek and beam gas scrapers

CABIBBO LAB
Laboratorio Nicola Cabibbo

Diamond Radiation Monitors



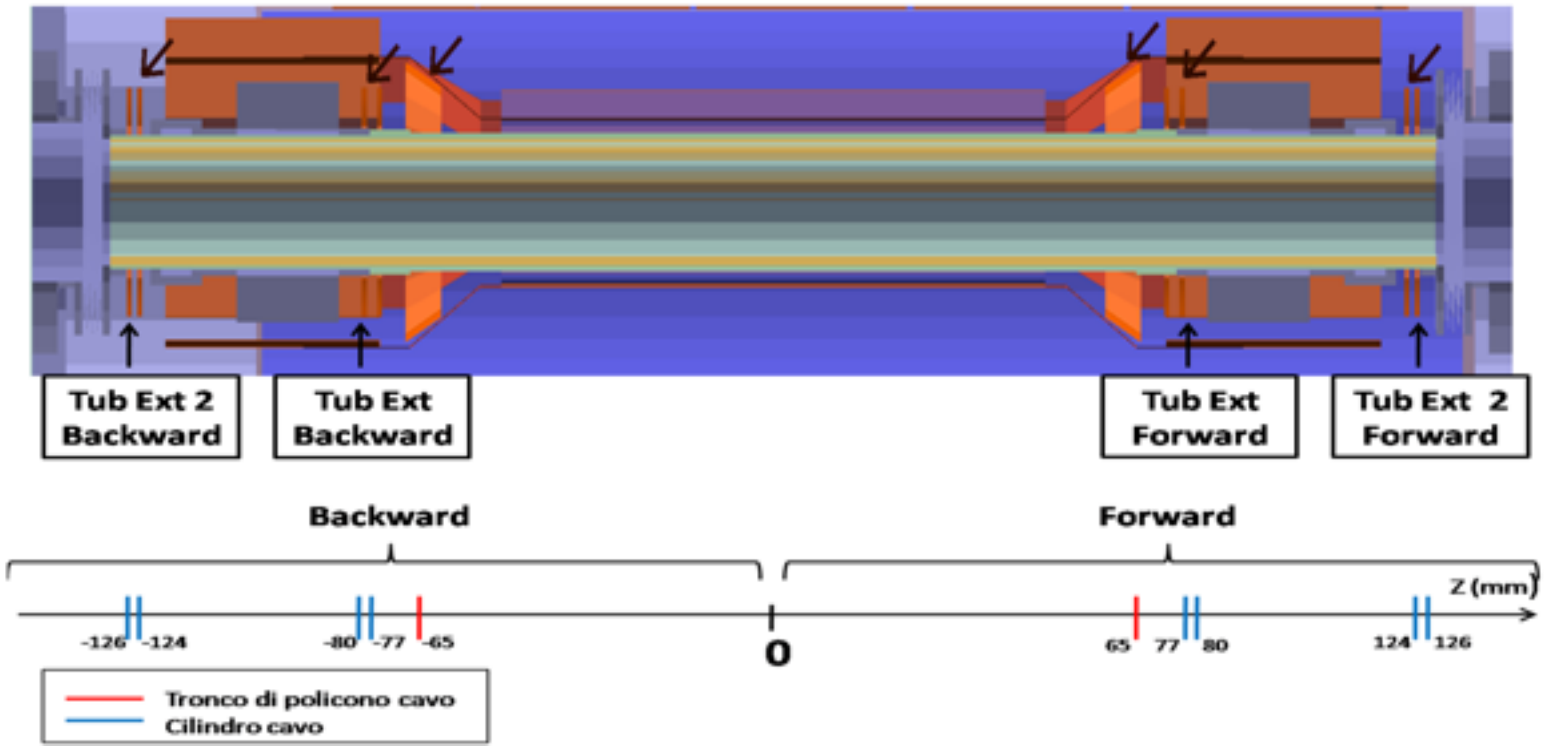
detector size	8 X16 mm^2
leakage current	8 nA
Ionization current (Rad Bhabha only)	0.67 nA
hits rate	130KHz
Detector Transit time	20 ns
Electronic Integration time	30 ns
Electric resistance	10^{11} Ωcm
Energy threshold	150KeV

Beam monitor characteristics L = 1 x 10^{36} cm^{-2} s^{-1}

Roberto Cardarelli

Andrea De Simone

Diamond Radiation Monitors



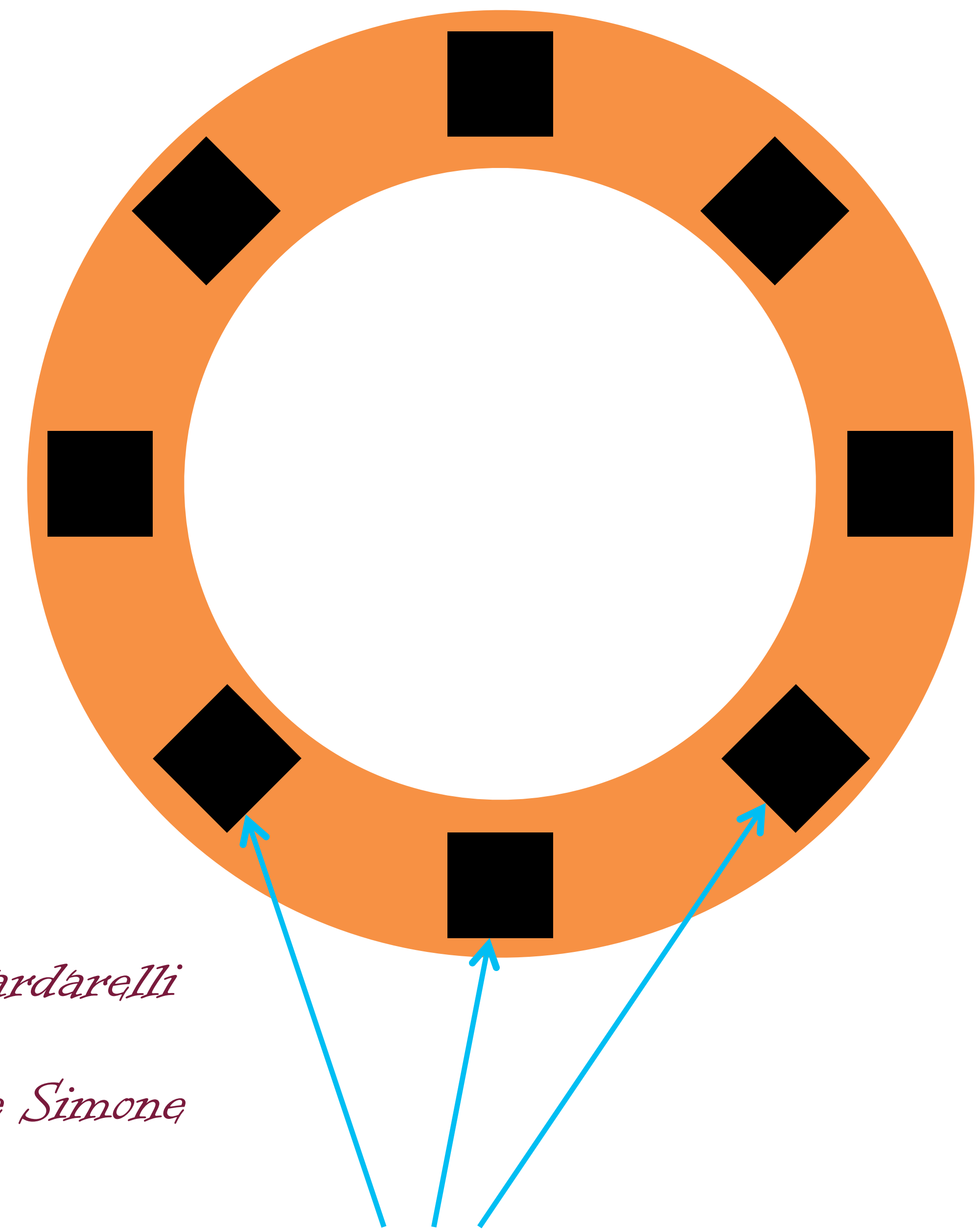
detector size	8 X16 mm^2
leakage current	8 nA
Ionization current (Rad Bhabha only)	0.67 nA
hits rate	130KHz
Detector Transit time	20 ns
Electronic Integration time	30 ns
Electric resistance	10^{11} Ωcm
Energy threshold	150KeV

Beam monitor characteristics L = 1 x 10^{36} cm^{-2} s^{-1}

Roberto Cardarelli

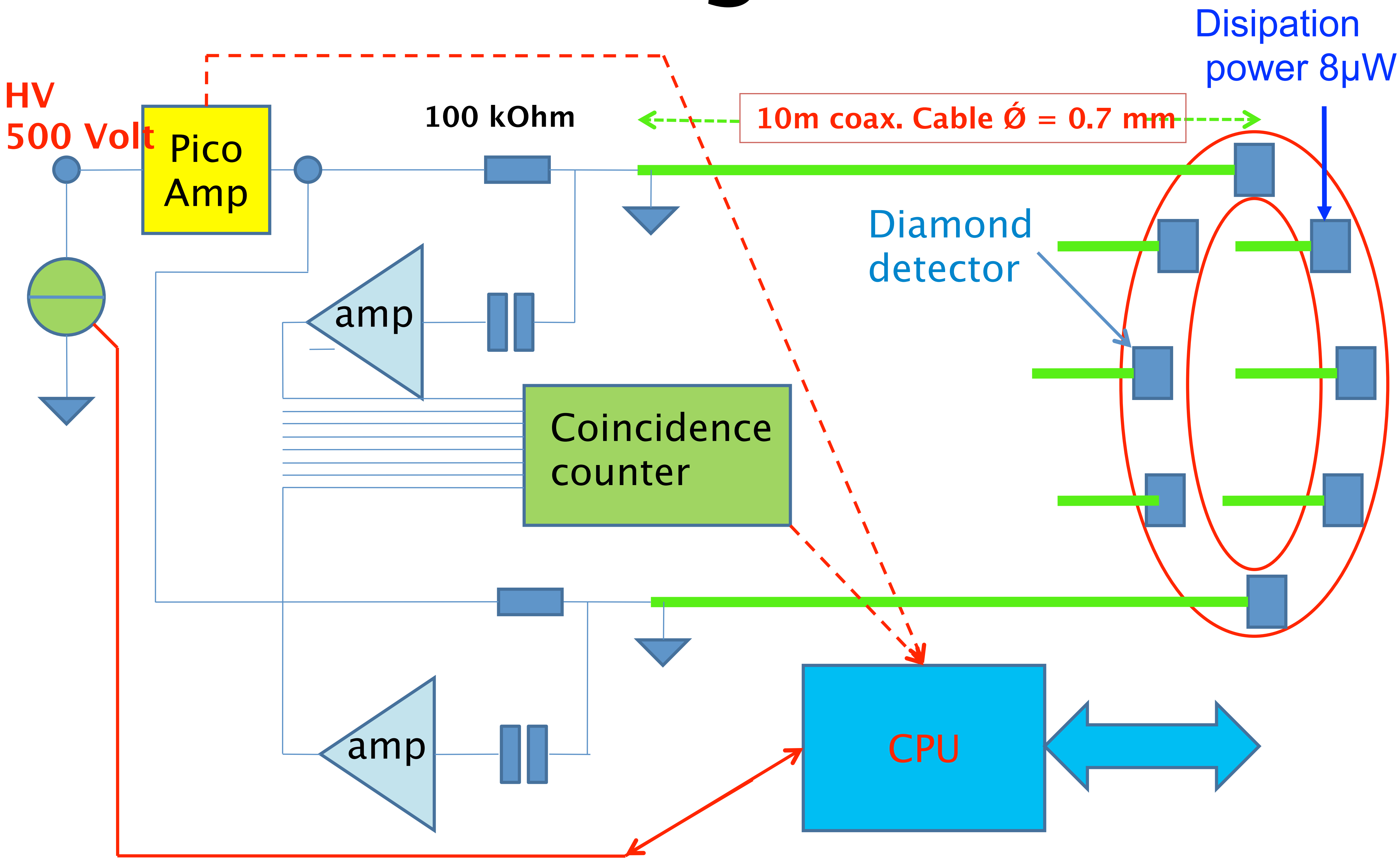
Andrea De Simone

8 diamond detector for ring



Diamond detector 4mm x 4mm

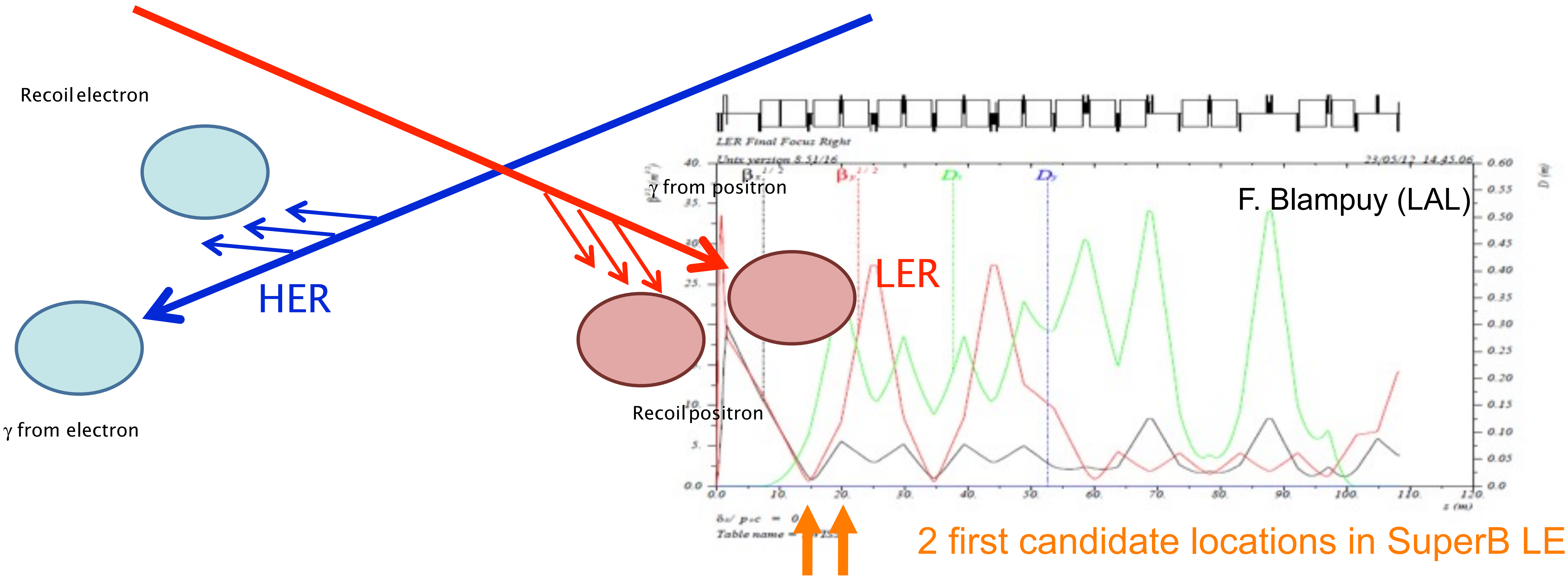
Tentative electronic diagram



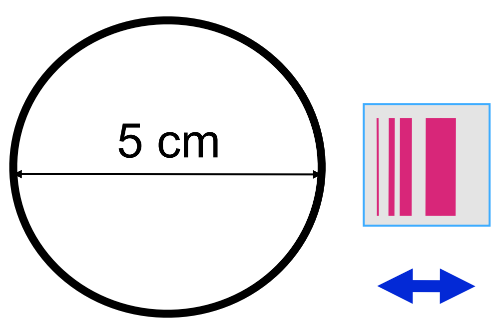
Rad Bhabha Luminosity Monitor

Philip

Where are the signals?



2 first candidate locations in SuperB LER



Estimated counting rate in 5×5 mm² **sensor** placed 3.5 cm from beam ~ 5 10^6 / 0.001 s

Estimated dose ~ up to 20 MGy / year of 10^7 s

sCVD diamond radiation resistant (up to ~ 10 MGy)

Mechanical adjustment and / or structured metallisation with variable size strips on one face to provide a suitable dynamic range

Work Plan at LAL (Philip)

Fast luminosity monitor(s) being investigated for **SuperB**

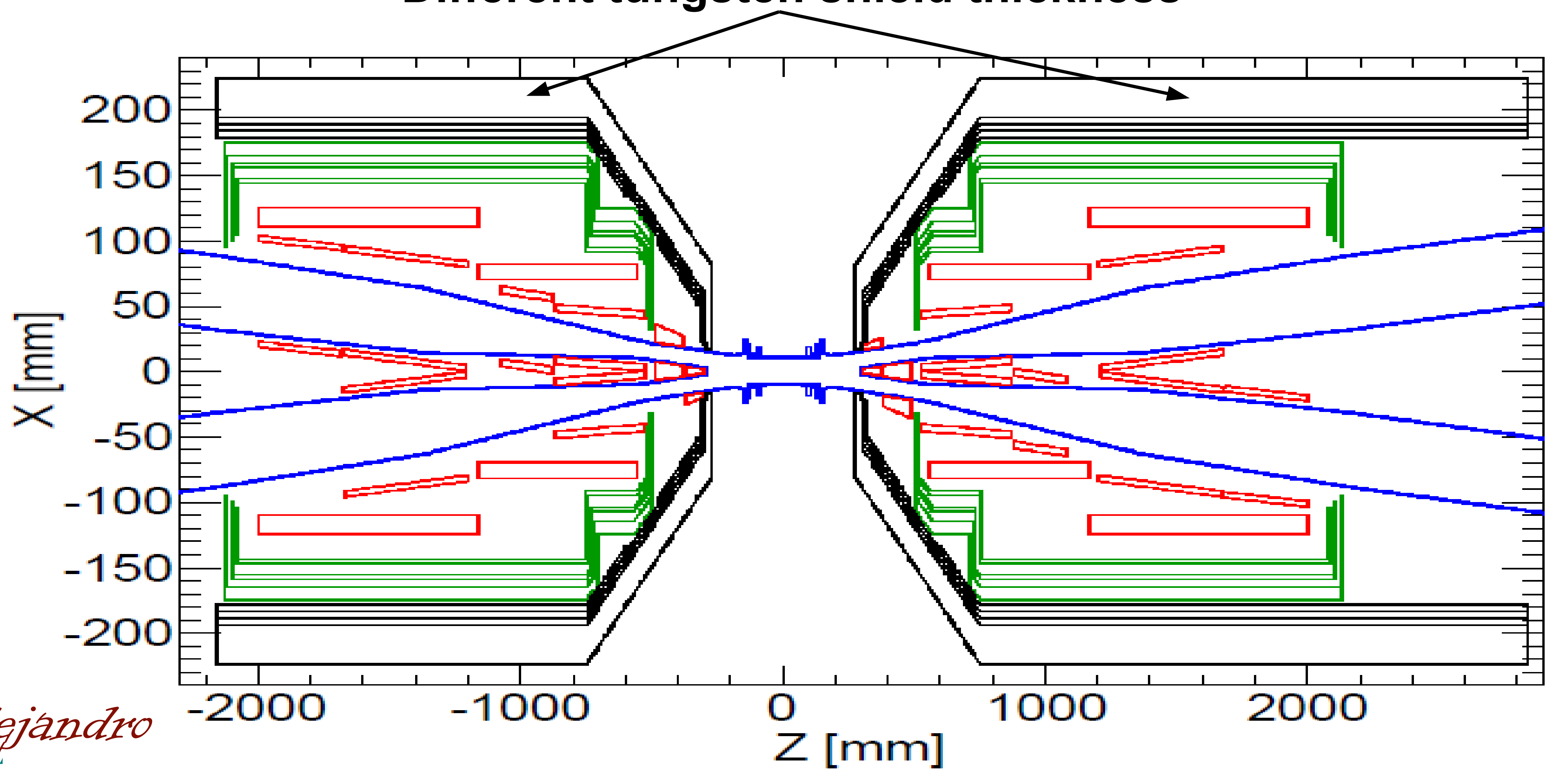
- Further checks / comparisons of cross-section and generator
- MAD tracking in lattice to define best locations in LER and HER
- GEANT4 for realistic signal computation (detector layout and position)
- Requirement on beam pipe shape from HOMs (for photon detection)
- Vacuum chamber design and magnet shapes, synchrotron radiation
- Background from non-Lumi scaling beam losses: Touschek, beam gas C.
- sCVD diamond sensor characterization and implementation (for ATF2)
- Readout: for ATF2, “Parisroc2” asic (remote) → OK also for SuperB ?
- Bunch by bunch luminosity monitoring (specifications, requirements)
- Useful to probe Touschek & beam gas C. losses with few add. sensors ?
- Prototype sensor test at Daphne for validation and training ?

• Workshop in autumn on luminosity monitoring and IP instrumentation ?

Shield studies: strategy

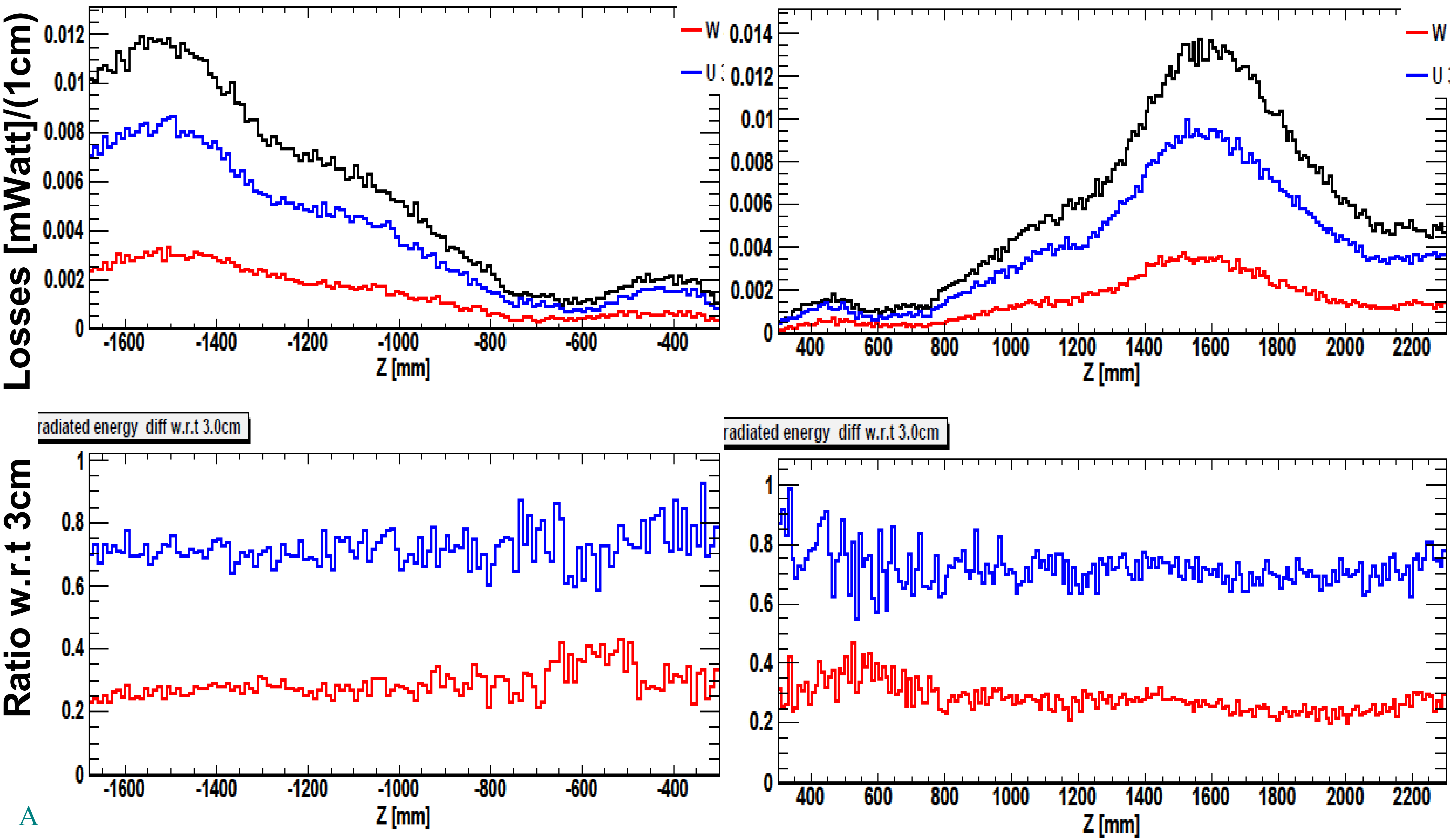
- Study reduction of Rad-bhabha flux of particles escaping the final focus:
  - Different W-shield thickness: 3.0 to 4.5 cm (step 0.5cm)
  - Different shield material: Depleted Uranium of 3cm thick (lower radiation length and higher density)

Different tungsten shield thickness

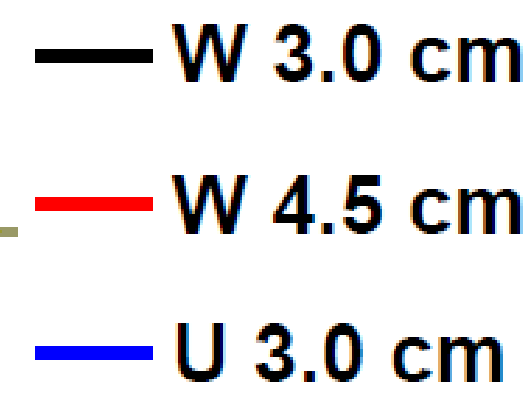


Shield studies: results

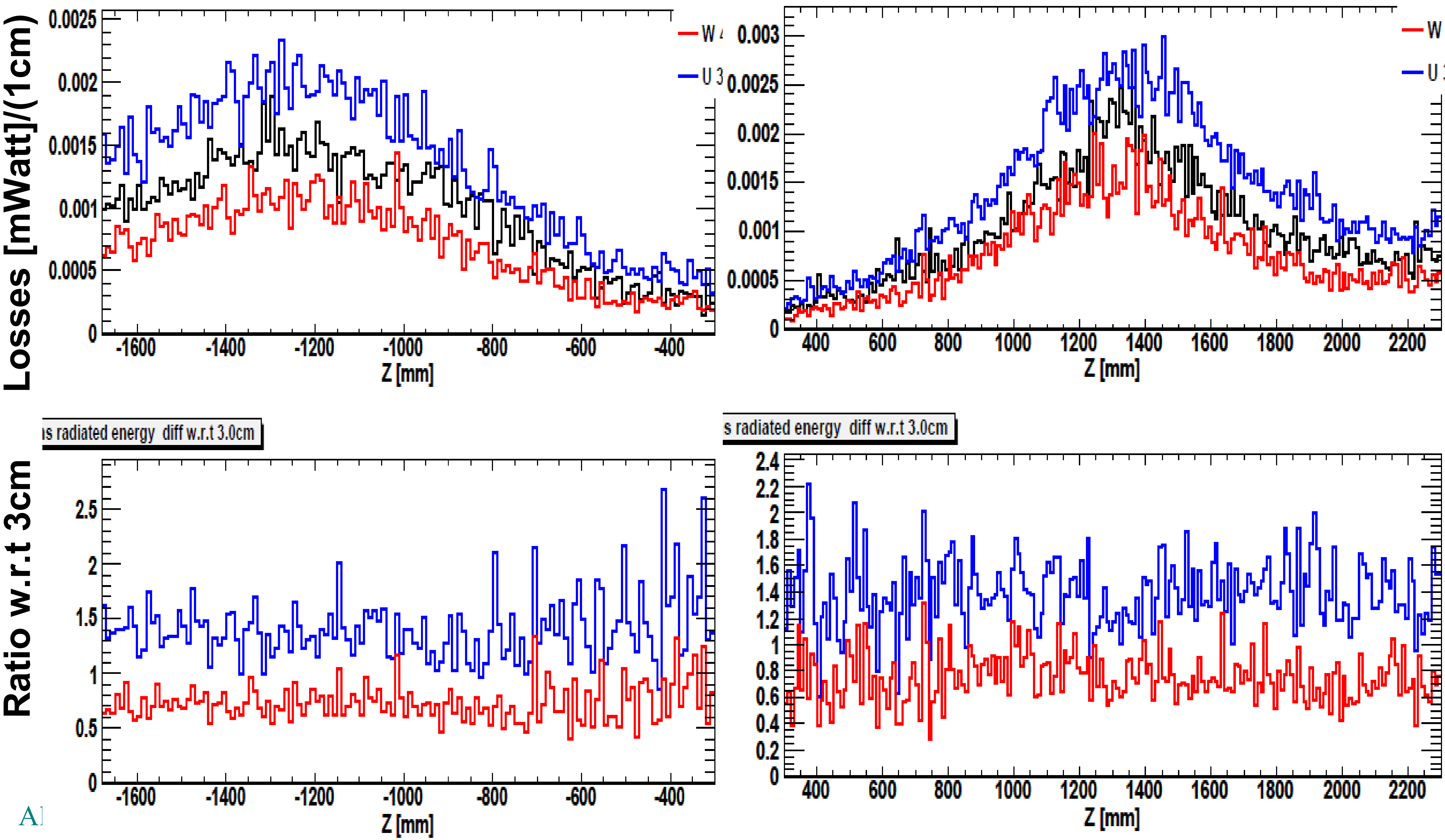
Photon energy flux comparisons



Shield studies: results

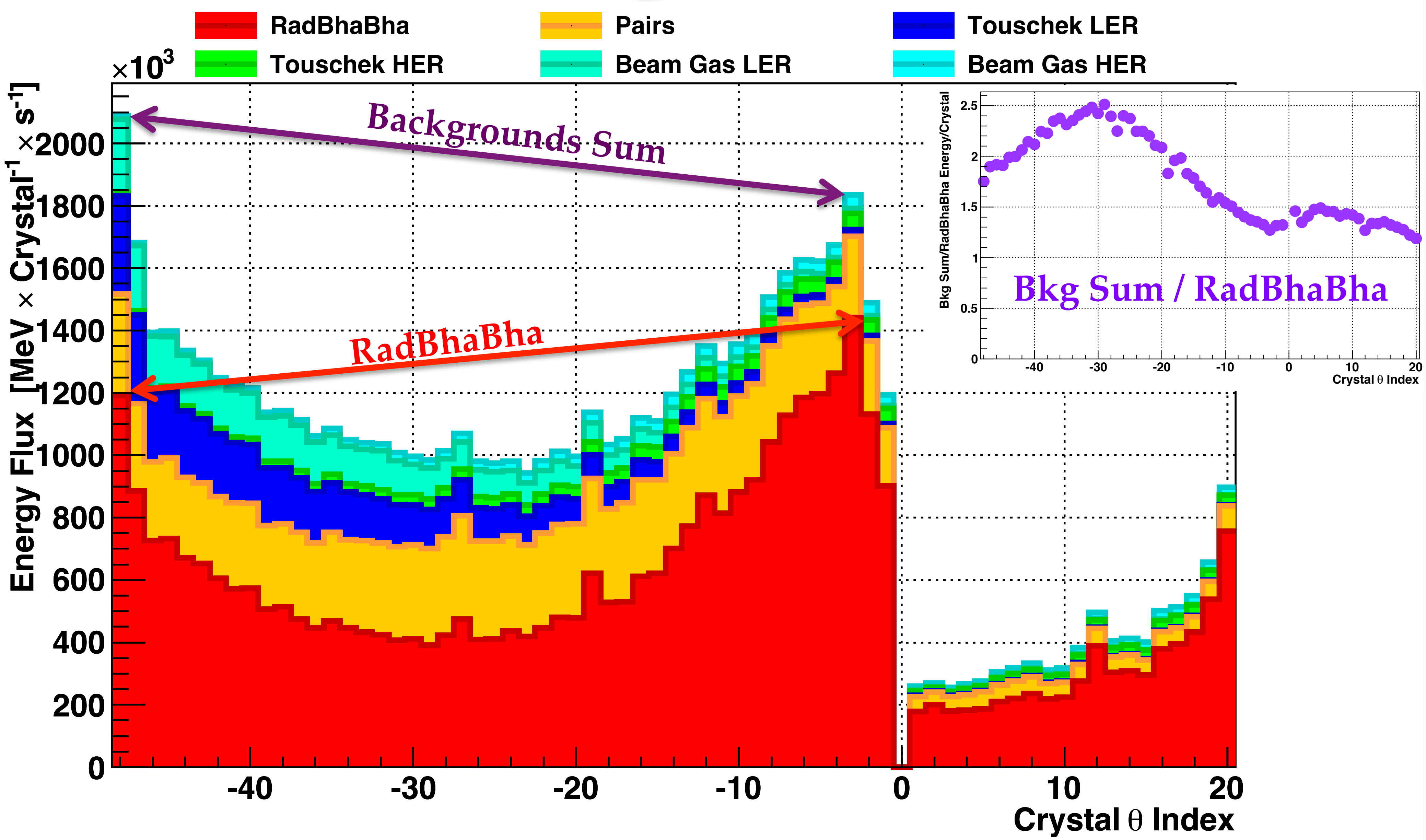


Neutron kinetic energy flux comparisons



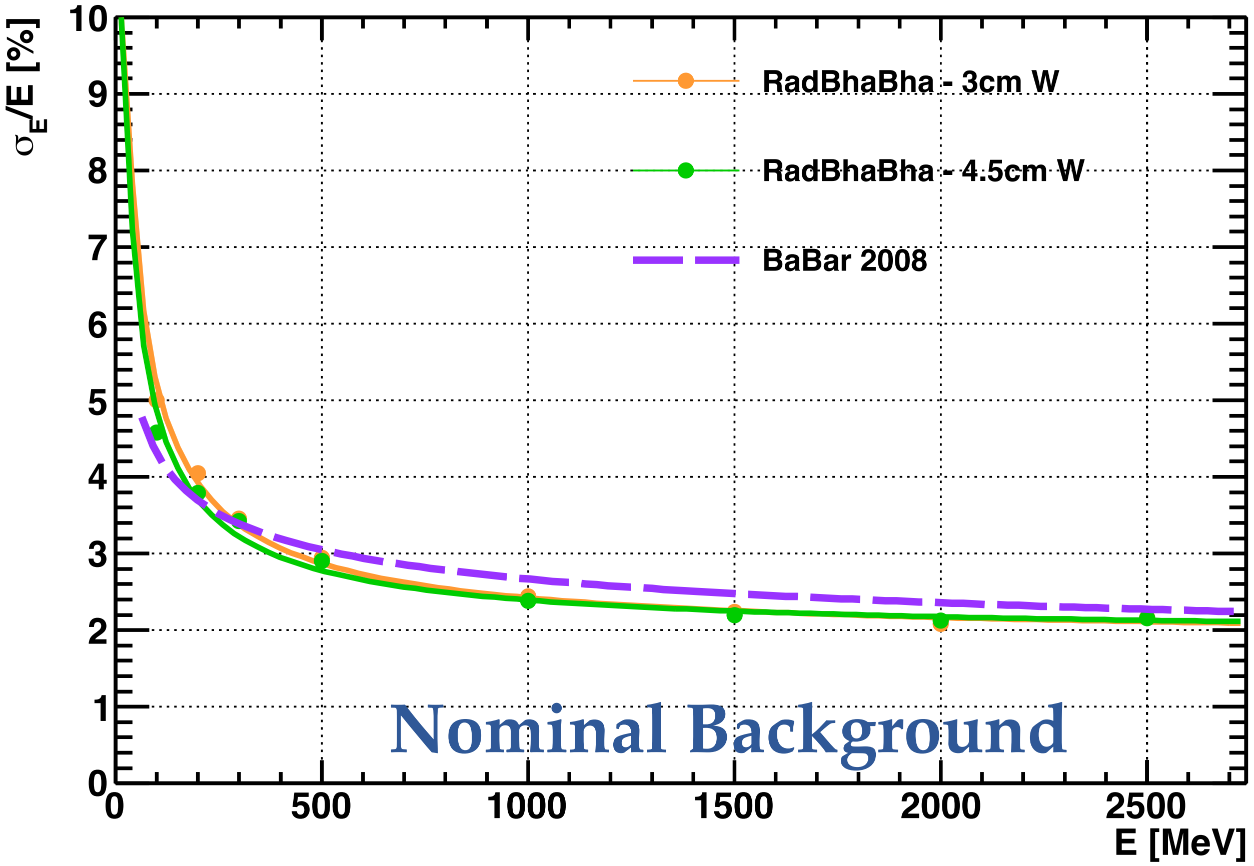
EMC studies (Stefano G.)

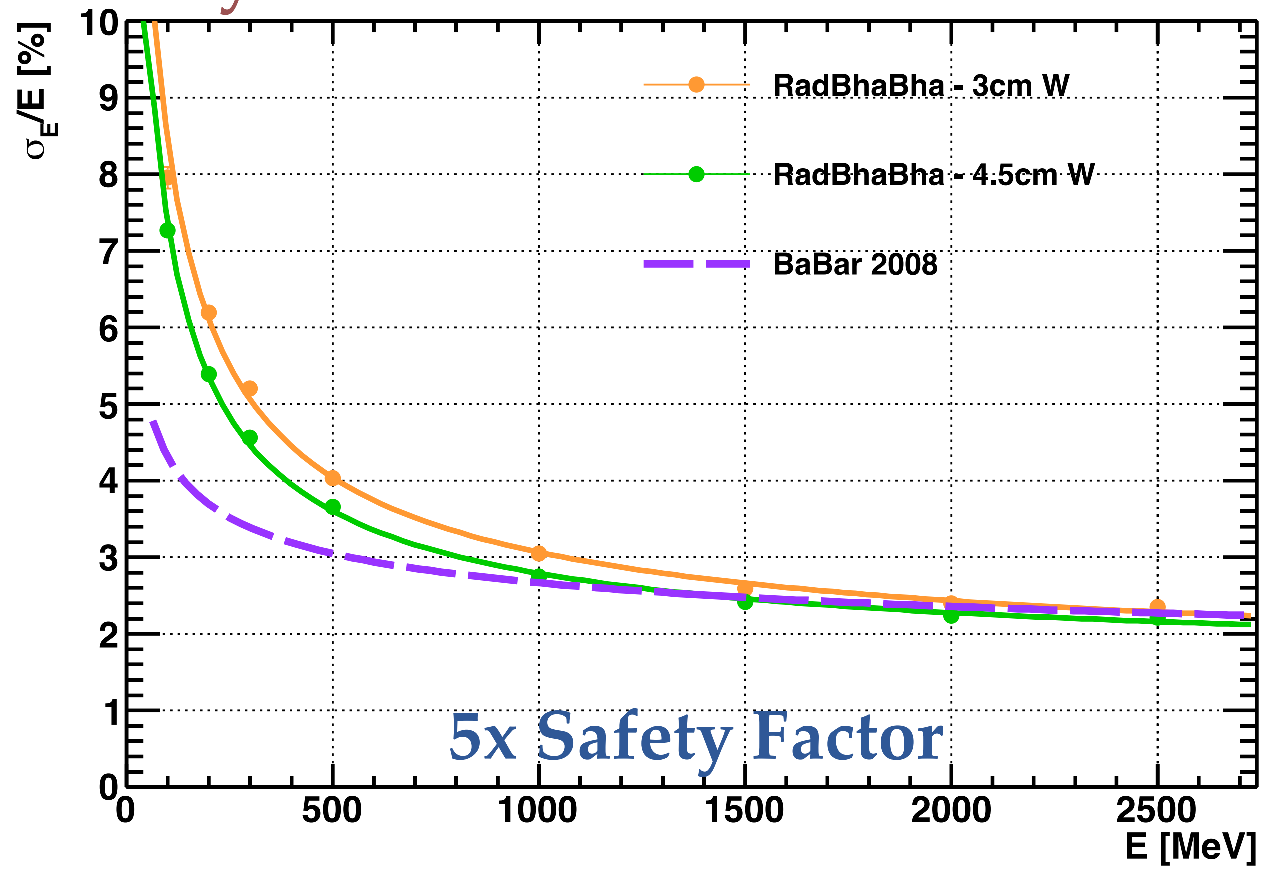
Sum of Bkgs - 45 mm W

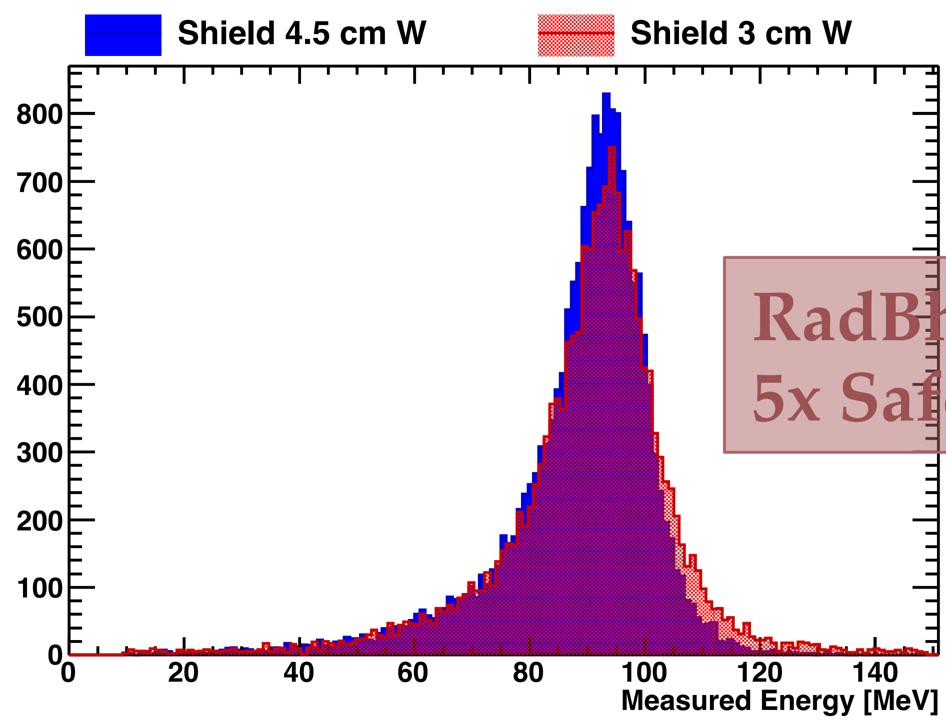


Barrel Resolution vs Shield

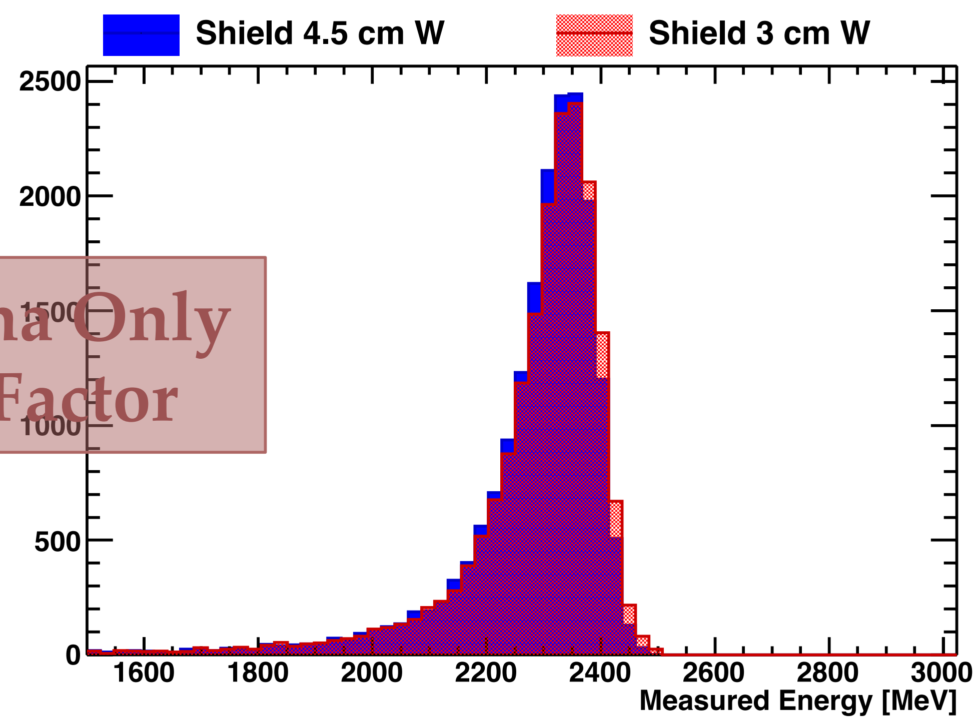
RadBhaBha Only





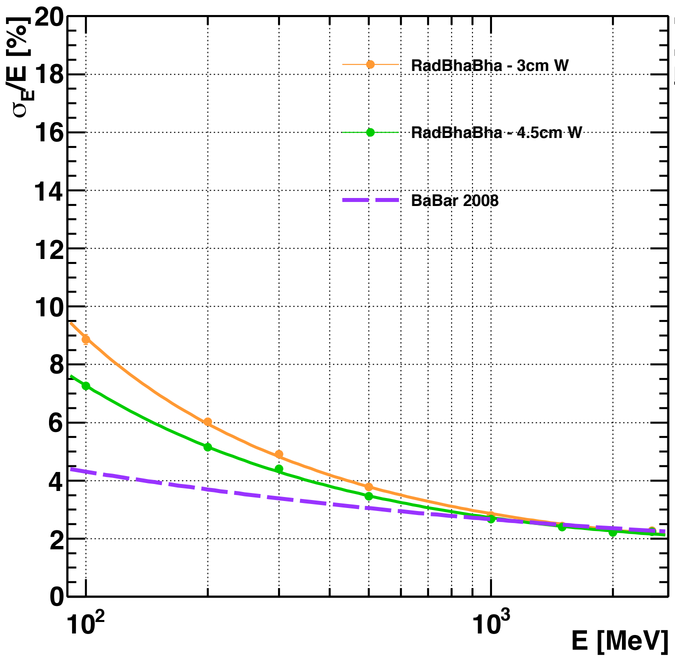


RadBhaBha Only
5x Safety Factor

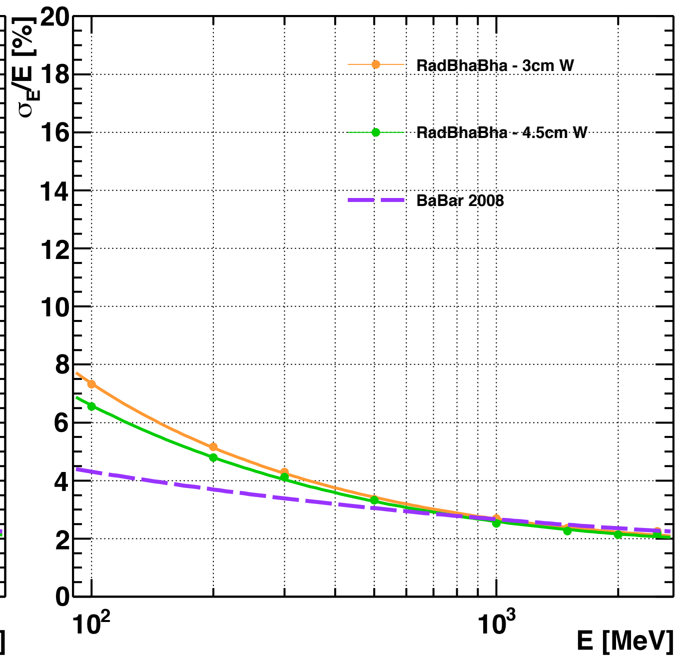


Shield Effect vs Theta (x5)

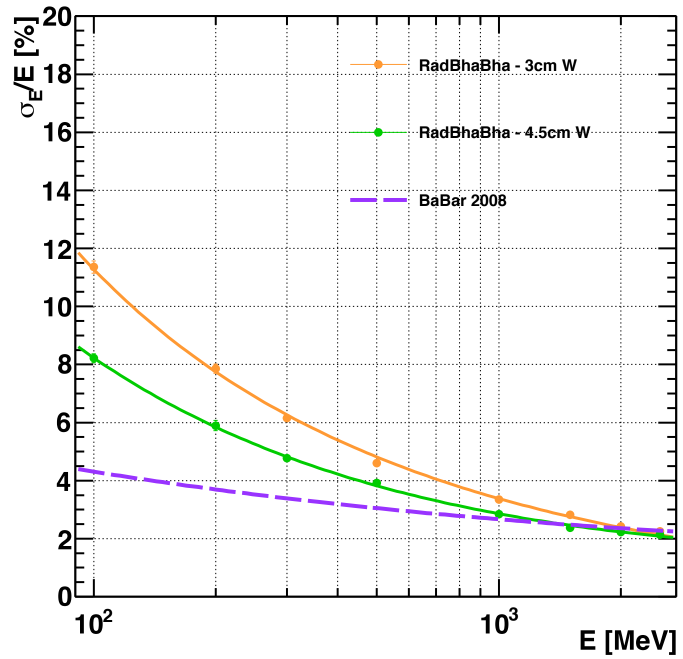
Theta 100-140



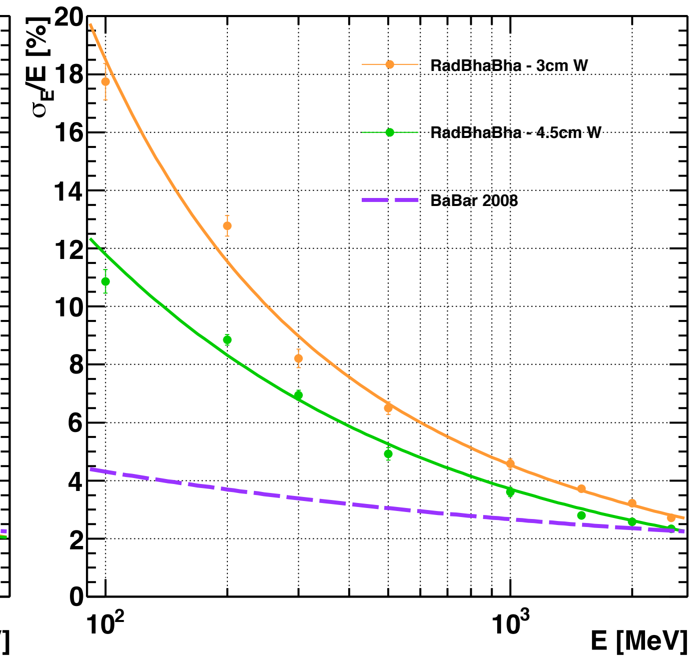
Theta 60-100



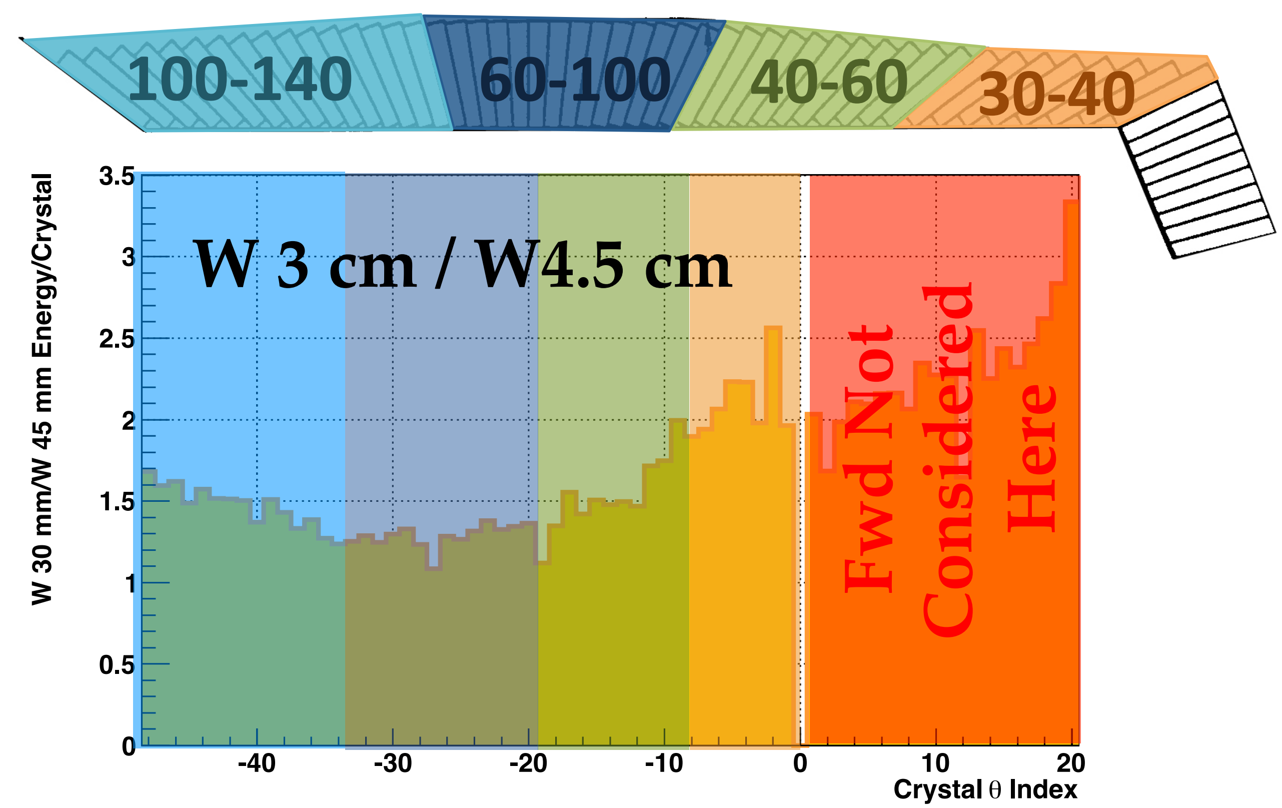
Theta 40-60



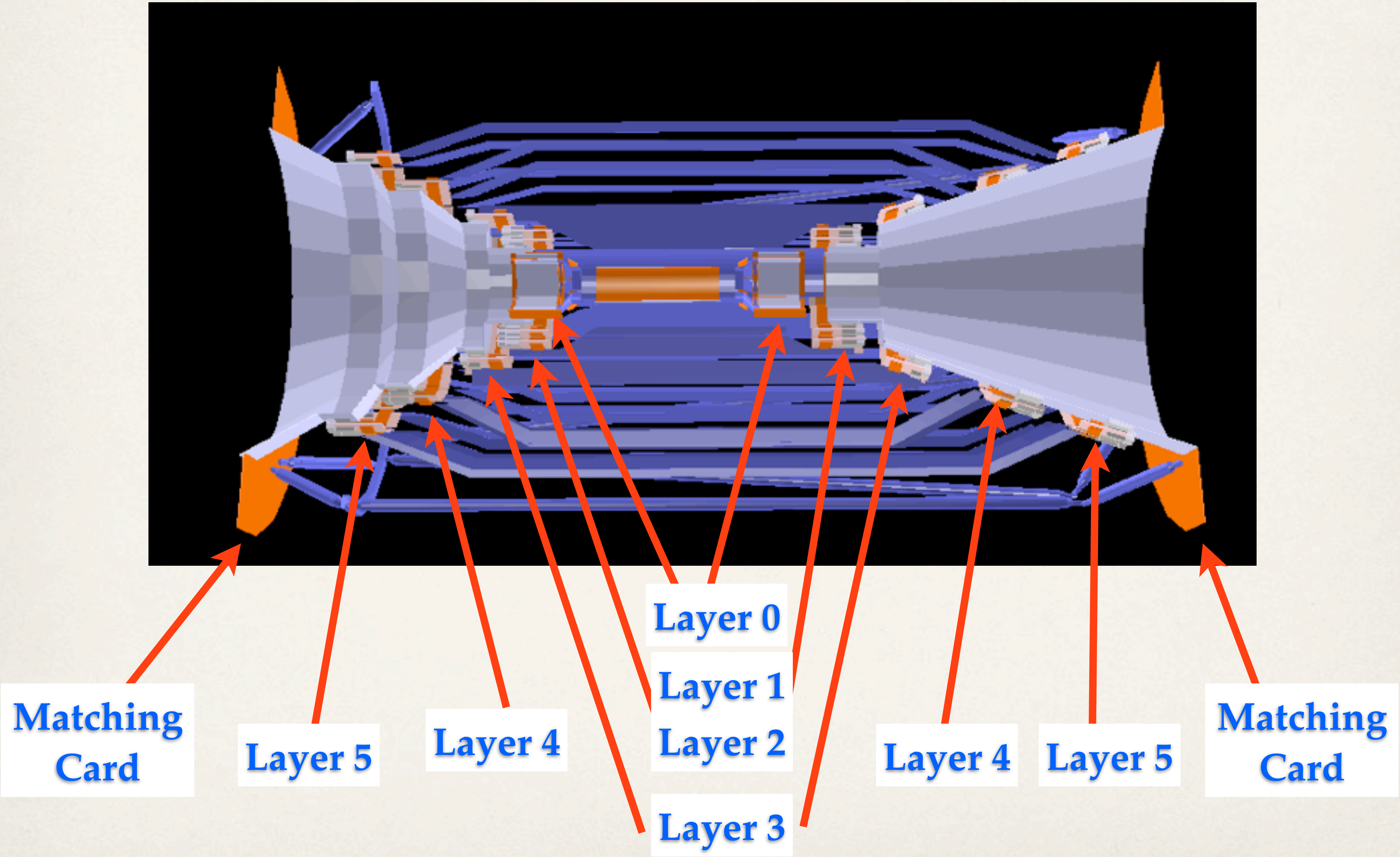
Theta 30-40



- ✓ Large performance improvement in fwd region
- ✓ Small effect in central barrel region
- ✓ More uniform Barrel performance across θ angles



Simulated radiation level

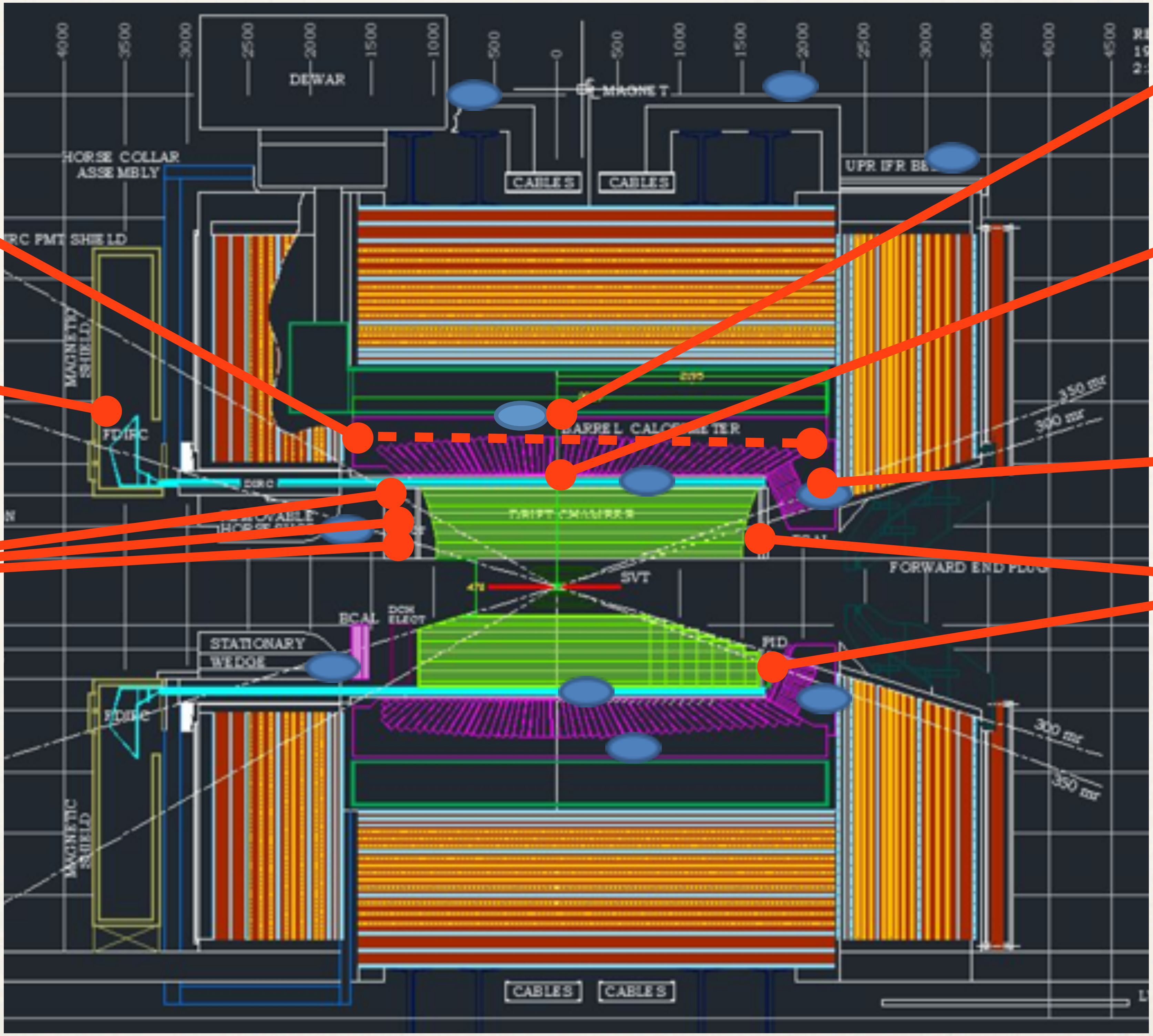


Simulated radiation level

EmcBrl

DrcFEE

DchFEE (3 zones)



EmcBrl Ctr

DrcCtr Bars

EmcFwd FEE

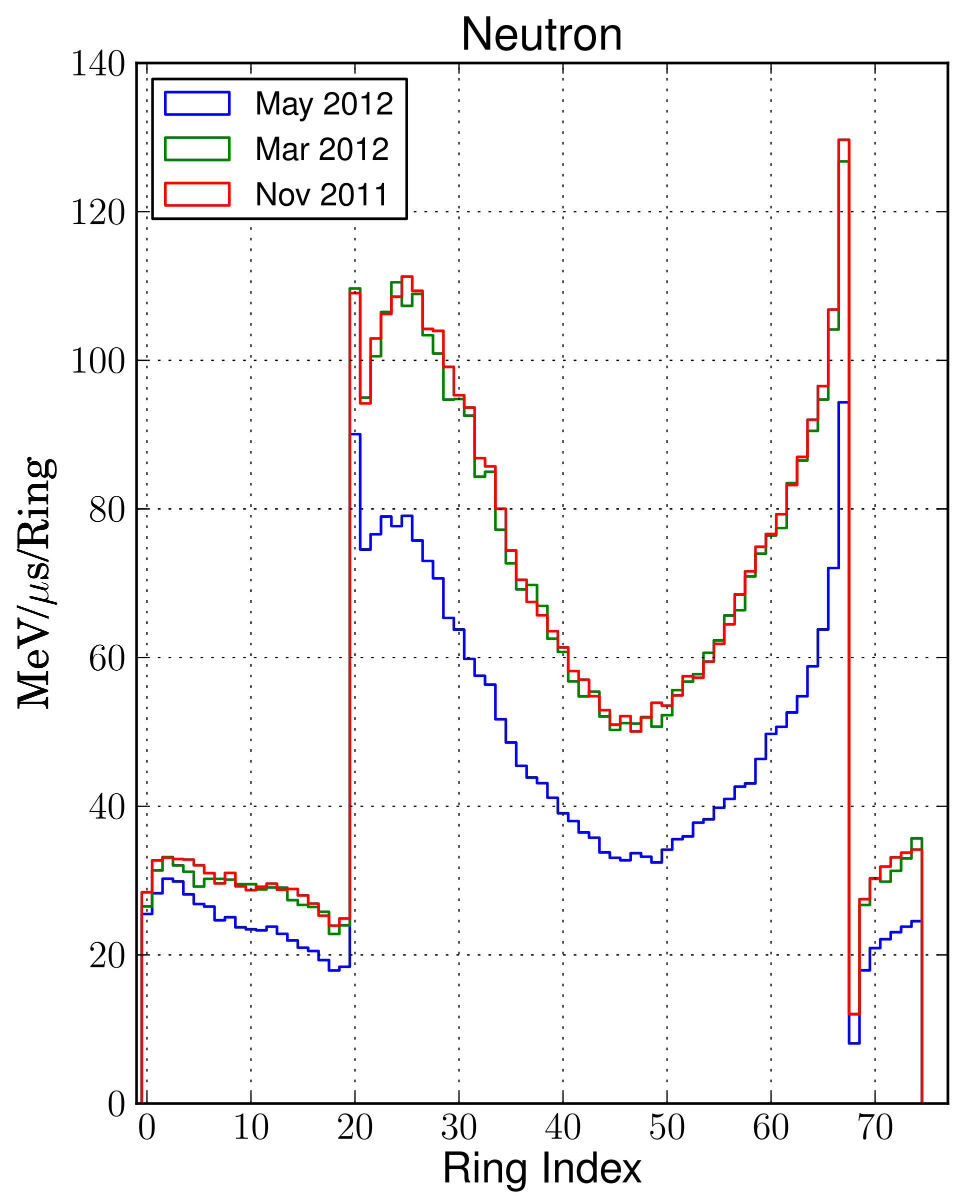
TofFEE

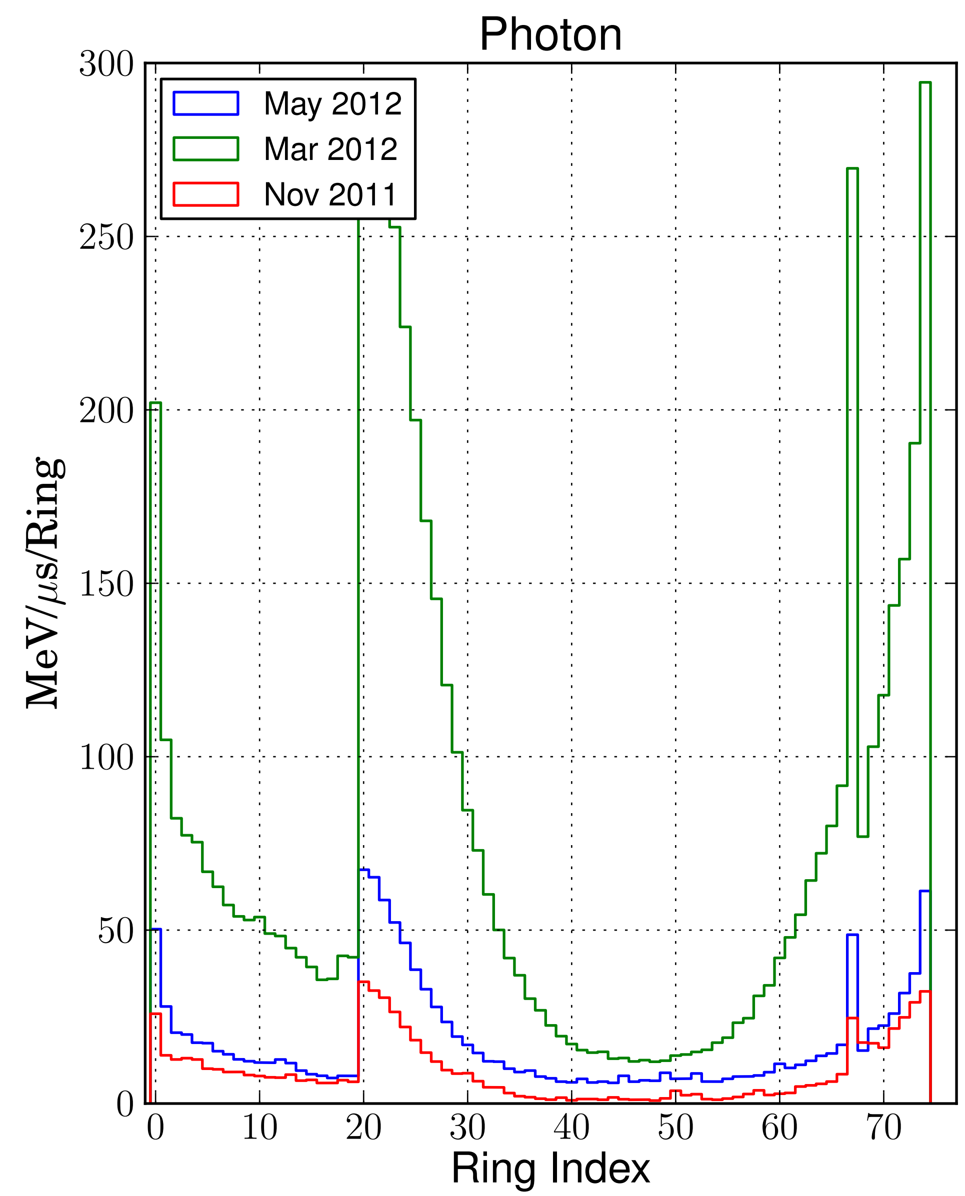
Simulated radiation level

- Nice big table, ***only*** for 2photons bkg : (

SubSystem	Location	rMin(cm)	rMax(cm)	zMin(cm)	zMax(cm)	TID(Gy)	NIEL(cm-2)	SEE(cm-2)
SVT	Layer0	1.292	1.292	-6	6	36059.5	1.20772e+13	0.0257399
SVT	Layer1	3.3	3.3	-10	10	1191.75	4.27953e+11	0.0189185
SVT	Layer2	4	4	-15	15	603.577	2.32608e+11	0.0388765
SVT	Layer3	5.9	5.9	-20	20	209.308	1.00633e+11	0.0454258
SVT	Layer4	12.2	12.2	-30	30	42.4517	5.1101e+10	0.0471571
SVT	Layer5	14.2	14.2	-30	35	25.257	4.36508e+10	0.0492751
SVT	FEELayer0	1.4	1.4	4.2	4.2	3359.8	1.14919e+12	0.157514
SVT	FEELayer1	3.3	3.3	1	1	548.919	2.0831e+11	0.29034
SVT	FEELayer2	4	4	1	1	546.259	2.18287e+11	0.539203
SVT	FEELayer3	5.9	5.9	1	1	236.526	1.20343e+11	0.609714
SVT	FEELayer4	12.2	12.2	1	1	70.0809	8.06467e+10	0.63149
SVT	FEELayer5	14.2	14.2	1	1	31.946	8.02268e+10	1.00651
SVT	MCard	30	30	0.2	0.2	8.2523	6.604e+10	0.471702
DCH	FEEZone0	23.6	40	-111.9	-111.9	0.847235	3.14484e+10	0.698707
DCH	FEEZone1	40	60	-111.9	-111.9	1.07063	2.45461e+10	0.506254
DCH	FEEZone2	60	81	-111.9	-111.9	0.946379	1.90069e+10	0.404555
TOF	FEE	55	92	200	200	0.423339	1.60694e+10	2.69903
DRC	BarCenter	81.7	89.3	-10	10	0.858083	2.19122e+10	3.12543
DRC	FEE	103	155	-377	-342	0.00749921	5.00567e+08	0.0553376
EMC	FwdFEE	70	110	216	236	0.0761059	1.22912e+10	1.40298
EMC	BrlFEE	120	120	-155	216	0.0223998	3.65836e+09	0.427492
EMC	BrlCtrFEE	120	120	-10	10	0	2.96564e+09	0.367001
IFR	FEEZone0Loc0	325.576	332.866	-281	-239	0.173197	2.35243e+08	0.0263963
IFR	FEEZone0Loc1	360.555	400.5	-281	-239	0.106209	3.88004e+08	0.0444569
IFR	FEEZone0Loc2	300	356.09	-281	-239	0.120344	2.58914e+08	0.0319534
IFR	FEEZone0Loc3	300.666	340.588	-281	-239	0.195358	2.8236e+08	0.0388998
IFR	FEEZone0Loc4	332.866	325.576	-281	-239	0.173152	4.05831e+08	0.0444569
IFR	FEEZone0Loc5	400.5	360.555	-281	-239	0.214878	3.12852e+08	0.0319534
IFR	FEEZone0Loc6	356.09	300	-281	-239	0.235287	2.66329e+08	0.0347319
IFR	FEEZone1Loc0	325.576	332.866	-21	21	0.0250389	1.82103e+08	0.0222284
IFR	FEEZone1Loc1	360.555	400.5	-21	21	0.0411469	1.70724e+08	0.0138928
IFR	FEEZone1Loc2	300	356.09	-21	21	0.0434939	1.71252e+08	0.0194499
IFR	FEEZone1Loc3	300.666	340.588	-21	21	0.10929	2.83561e+08	0.0305641
IFR	FEEZone1Loc4	332.866	325.576	-21	21	0.054466	2.33949e+08	0.0291748
IFR	FEEZone1Loc5	400.5	360.555	-21	21	0.0702368	2.79871e+08	0.0208392
IFR	FEEZone1Loc6	356.09	300	-21	21	0.0891178	2.51388e+08	0.0222284
IFR	FEEZone2Loc0	325.576	332.866	239	281	0.0743074	3.02512e+08	0.040289
IFR	FEEZone2Loc1	360.555	400.5	239	281	0.0854958	2.8198e+08	0.025007
IFR	FEEZone2Loc2	300	356.09	239	281	0.12929	2.41521e+08	0.0208392
IFR	FEEZone2Loc3	300.666	340.588	239	281	0.277088	4.19076e+08	0.0430676
IFR	FEEZone2Loc4	332.866	325.576	239	281	0.145233	2.38019e+08	0.0333426
IFR	FEEZone2Loc5	400.5	360.555	239	281	0.154433	2.47619e+08	0.0305641
IFR	FEEZone2Loc6	356.09	300	239	281	0.168629	2.67683e+08	0.0319534

Energy flux per ring





Neutron energy flux reduced by 20% –30% with new shielding

Photon energy flux reduced by ~4x with new shielding

Pending Issues

- Dose on the QD0
- Synchrotron Radiation simulation: Mike, we miss you!
- Shield thickness: how we will decide the best thickness?
- Shield support mechanical design, vibration budget: Kirk, we miss you!
- Neutron cloud effect mitigation

Conclusions

- The double helical quadrupoles behaves better than expected :)
- Multi turn radiative Bhabha are not an issue :)
- 45 mm tungsten shields are sufficient to significantly reduce the photon flux in the detector :)
- Promising technologies for both the Radiation and the Luminosity Monitor had been presented and studied :)
- Depleted Uranium shield does not work :)
- Background studies are progressing :)
- We have still big issues in front of us and we are working hard on that.

Thank You for your Attention