2^{nd} SuperB Collaboration Meeting
MDI Parallel session Dec. 14^{th} 2011

Machine Background Report

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LNF SuperB Collaboration Meeting

Outline

- **New BRN developments:**
  - Fwd-EMC: New geometry
  - FDIRC: Cherenkov photons activated and instrumentation
- **New Final Focus model**
- **Nov. 2011 Full-Sim production**
  - Pairs
  - Touschek (LER/HER)
- **Machine background on the SuperB detector**
  - SVT
  - DCH
  - FDIRC
  - EMC
  - IFR
- **Summary and Outlook**

New BRN Developments

Fwd-EMC

- **Request from Stefano Germani to test different options for Fwd-EMC device**
  - Nominal configuration uses LYSO (Geometry_CIPE_V00-00-02)
  - New geometries being tested:
    - CSI: Csi with VPT readout (Geometry_CIPE_V00-00-02_CSI)
    - BGO: Bgo with PMT readout (Geometry_CIPE_V00-00-02_BGO)
    - PWO: Pwo with PMT readout (Geometry_CIPE_V00-00-02_PWO)

- **Nov. 2011 production:**
  - Geometry_CIPE_V00-00-02_PWO: Rad-Bhabha (~10k events)

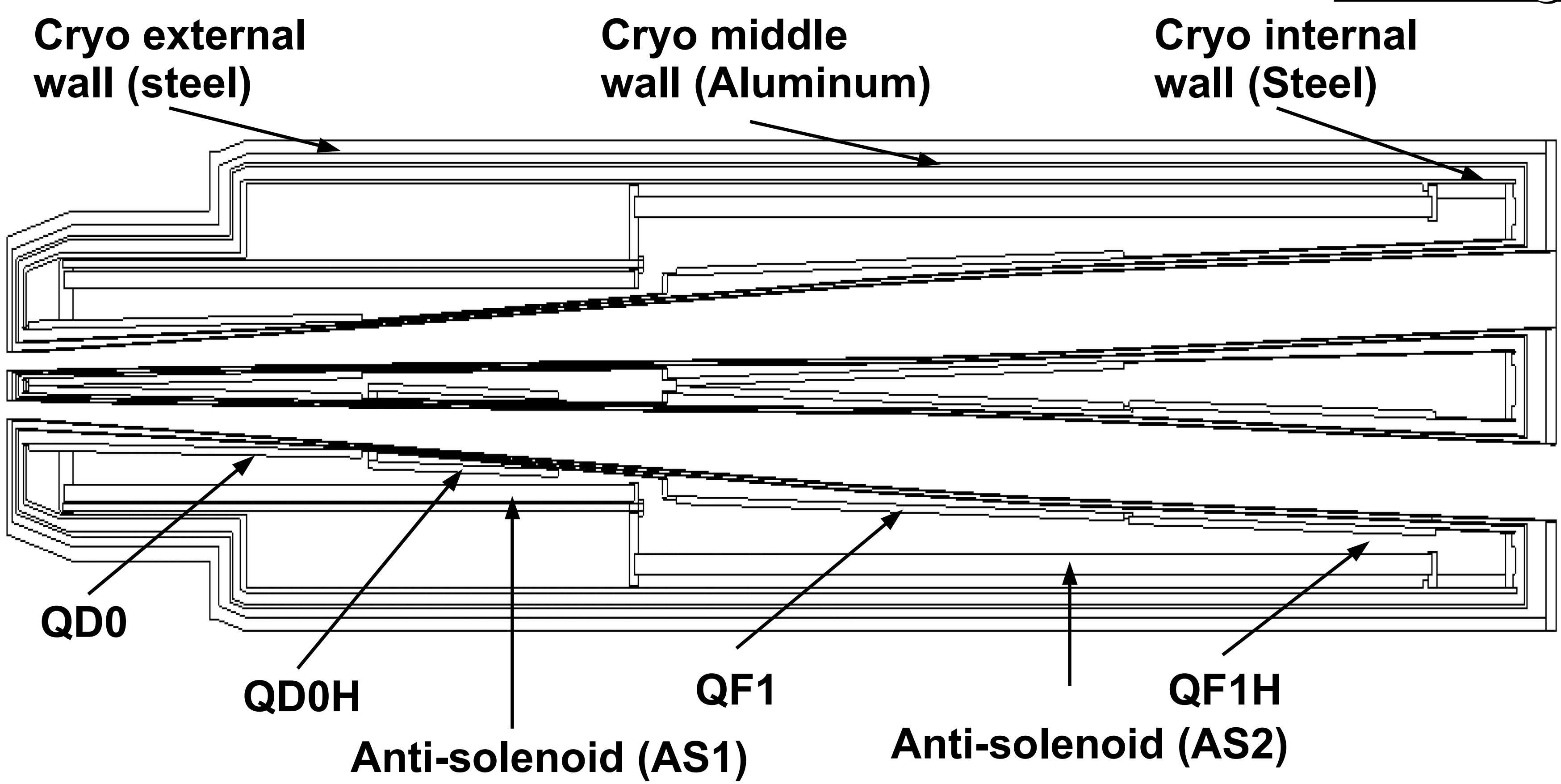
FDIRC

- **Previously:**
  - Stand Alone G4 simulation (Doug Roberts)
  - BRN: FDIRC geometrical model, no instrumentation
- **Currently:**
  - A lot of work to insert stand alone model in BRN (Andrea Di Simone and Doug Roberts)
  - Cherenkov photons in the bars can be activates/deactivated with an option on Bruno invovation (-O). No significant increase on computing-time/output-size
- **Nov. 2011 production:**
  - Cherenkov photons activated for all samples produced

New Final Focus Model

New FF model: Cryostat and Magnets (I)

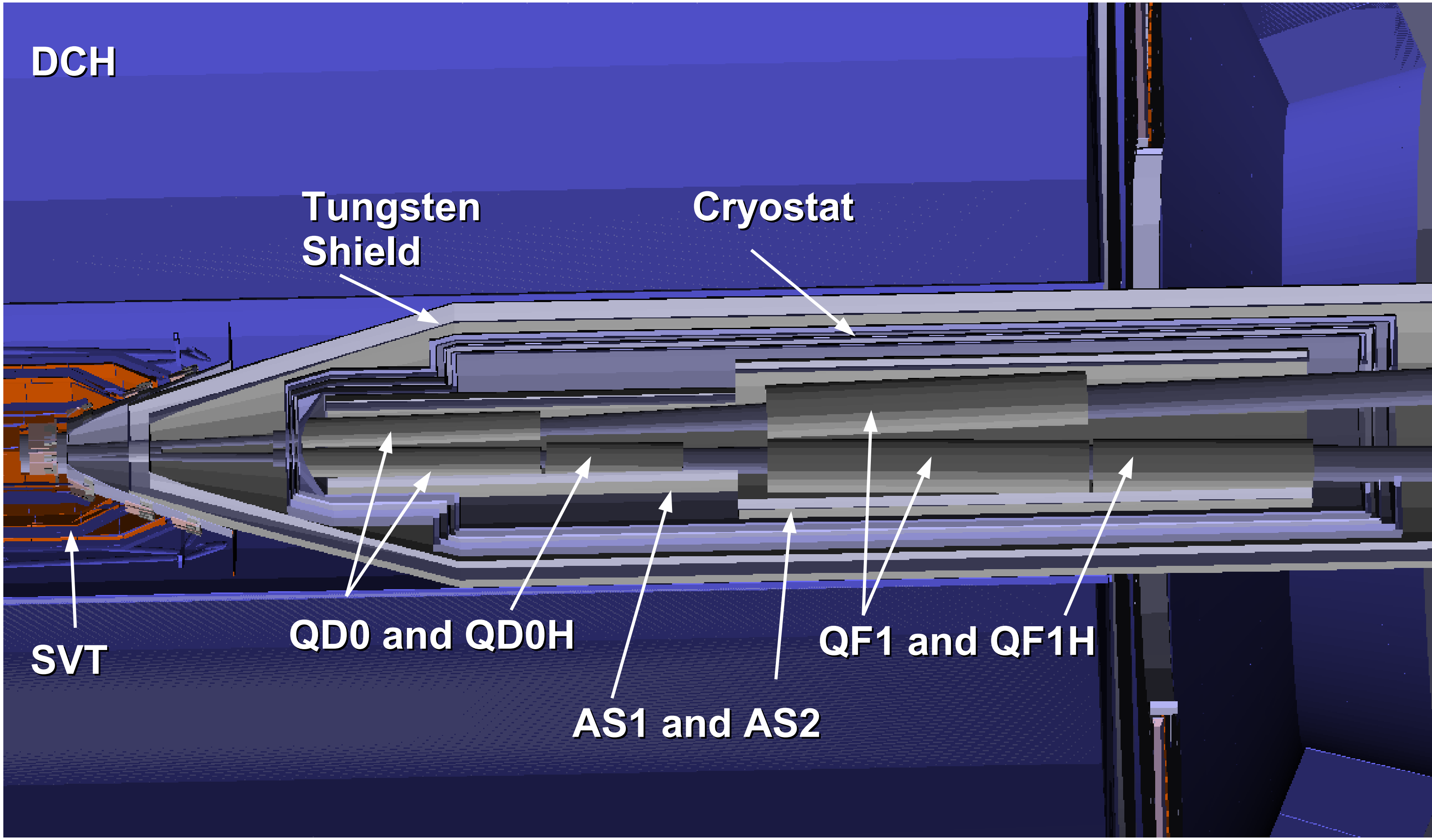
Filippo Bosi Drawings



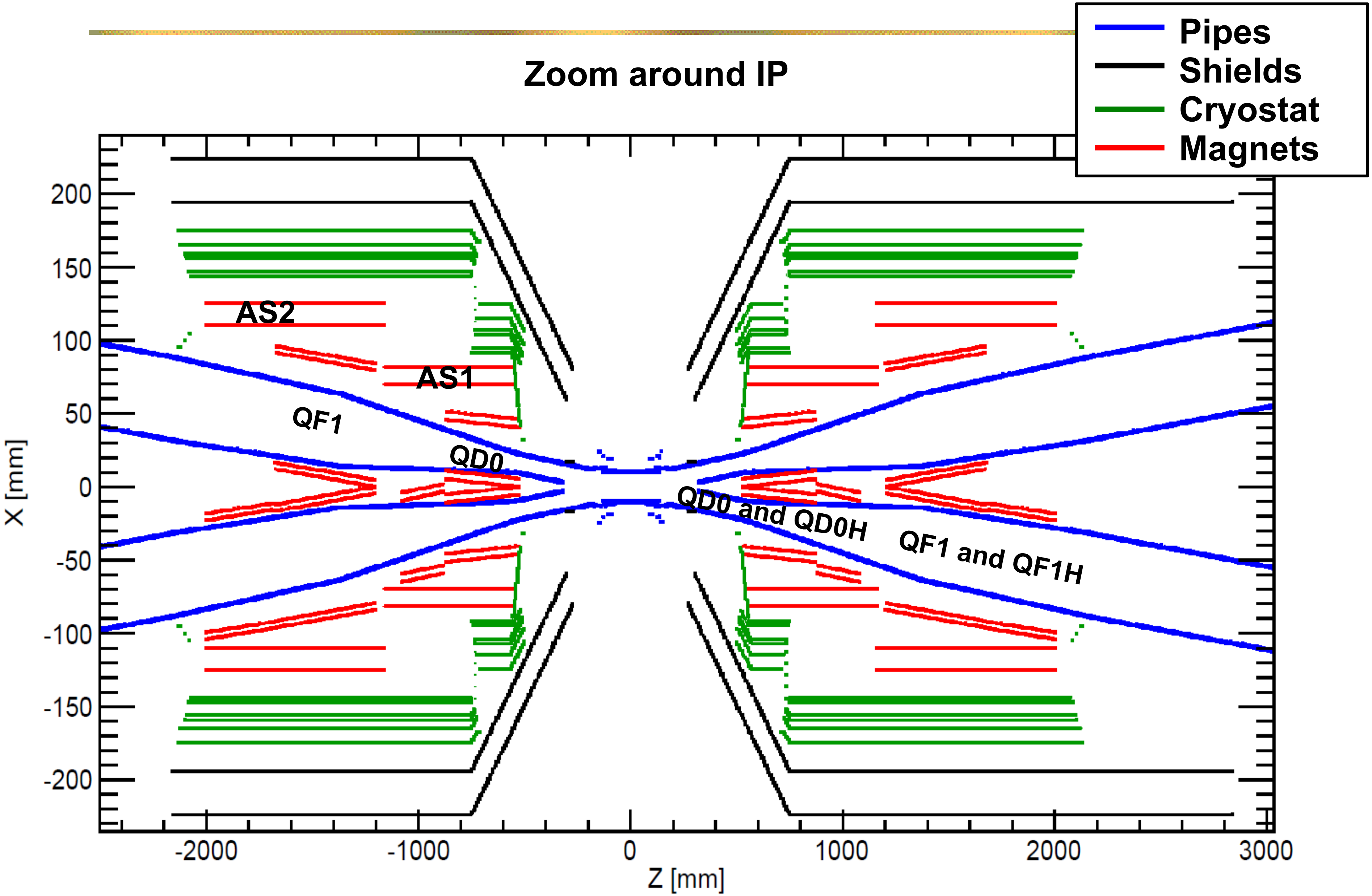
- **All magnetic elements are made of the same material (QD0_mixture):**
  - Density: 7.57 gr/cm^3
  - Composition: Niobium (0.106), Titanium (0.119), Cooper (0.347) and Iron (0.428)

New FF model: Cryostat and Magnets (II)

BRN implementation



New FF model: Cryostat and Magnets (III)



New FF model: Magnetic model

- **Previously:**
  - detector solenoidal field turned off in final focus magnetic model

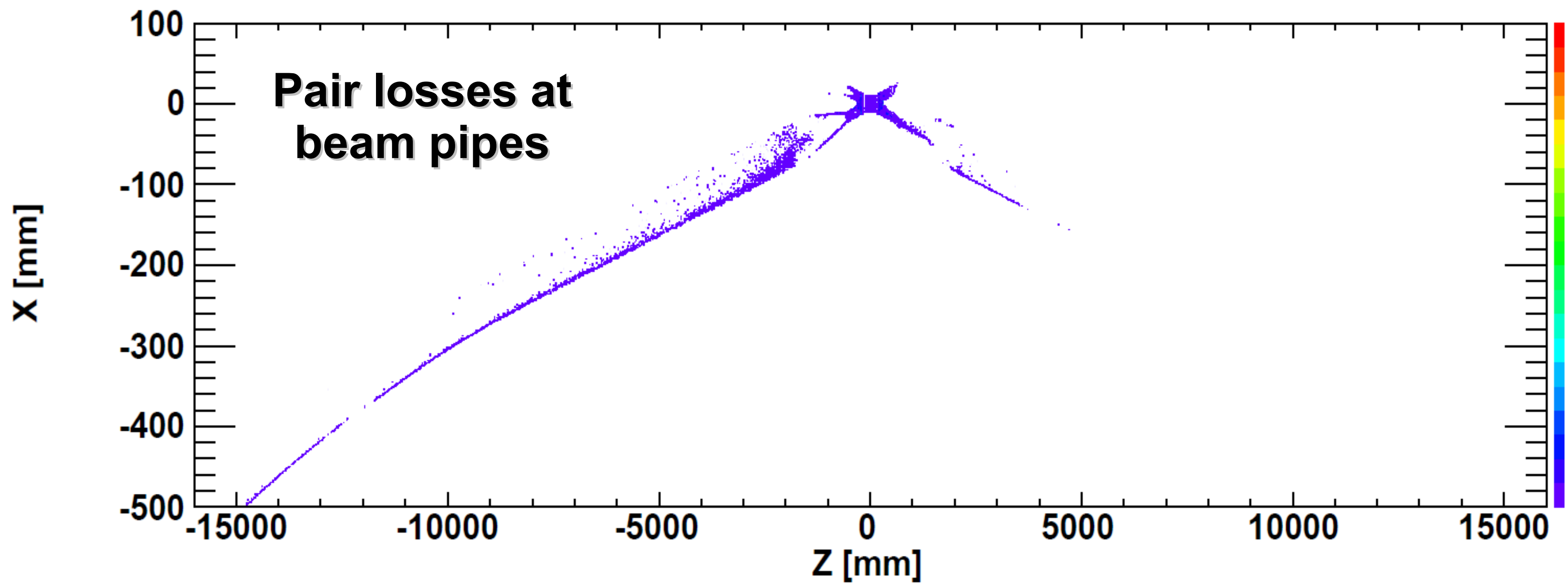
- **This field is important for an accurate model of two-photon (pairs) backgrounds on SVT. Less important for Rad-Bhaha and Touschek**

- **Implementation:**
  - Magnitude: 1.5 Tesla
  - Direction: Z>0 (0.0,0.0,1.0)
  - Volume: field different from zero only inside a cylinder of length 40cm and radius 40cm.

Nov. 2011
Full-Sim Production

Pairs background

- **Use diag36 (fastsim) generator to generate pairs (2-photon) primaries**
- **Kinematic cuts:**
  - Study the minimum Pt(CM) cut at generator level to not to bias the pairs sample and increase efficiency
  - Study the losses at the beam pipes from Pairs to set-up the Pt(CM) cut



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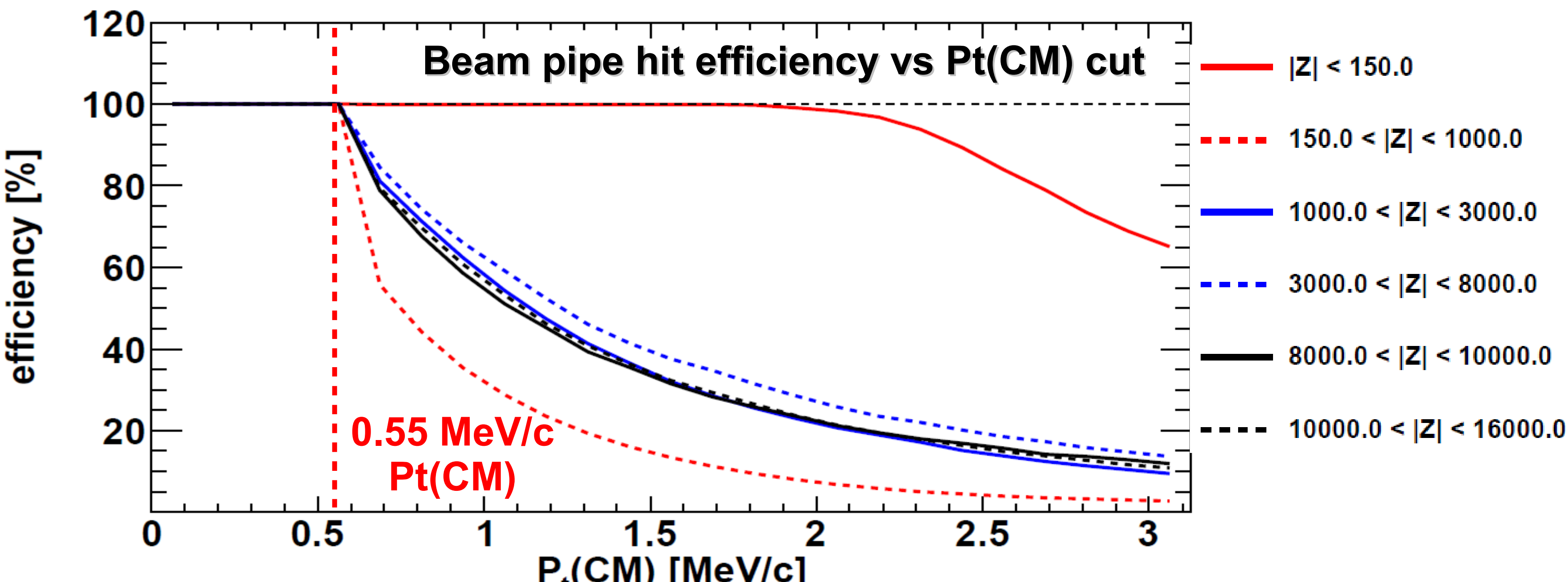
  - Selects Pt(CM) > 0.55 MeV/c
  - $\Rightarrow \sigma(Pt(CM) > 0.55\ MeV/c) = 4.47mb\ (\sigma(total) = 7.3mb)$



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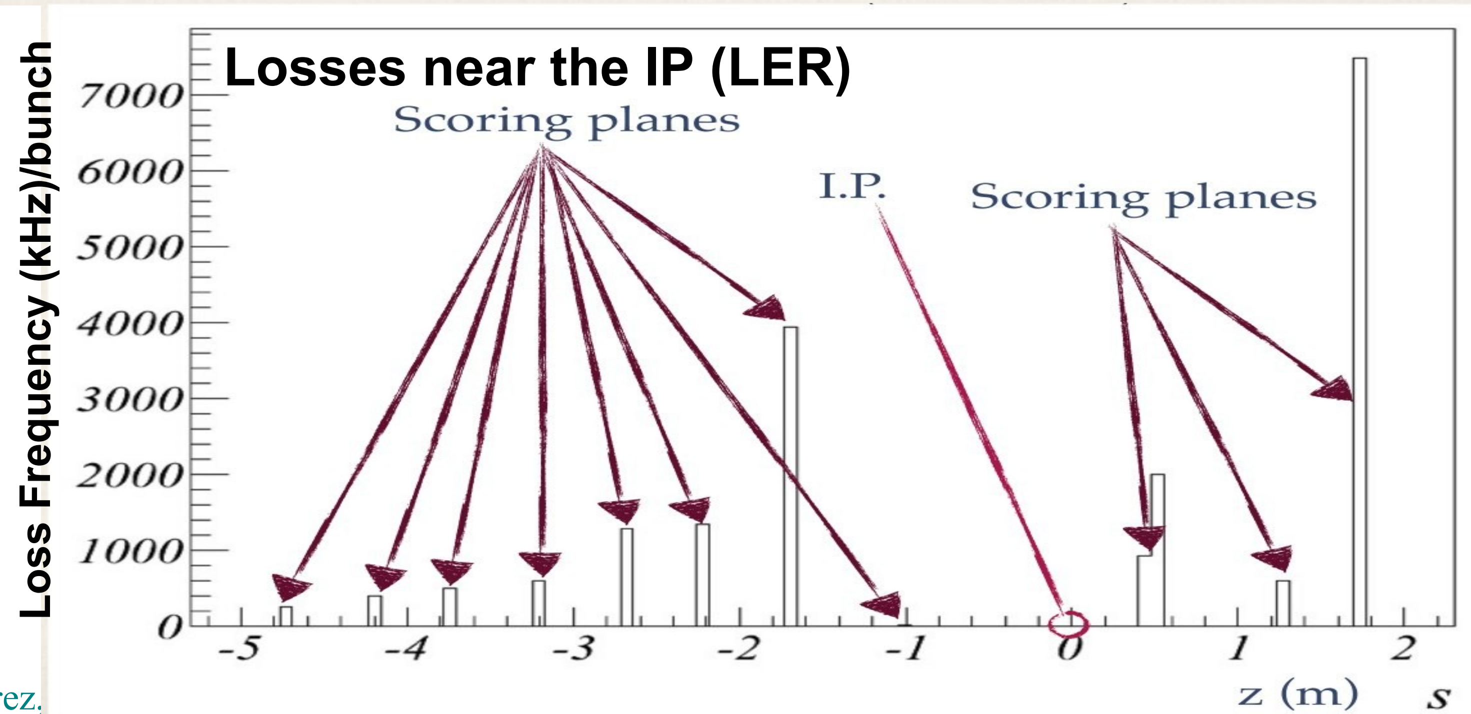
  - Selects Pt(CM) > 0.55 MeV/c
  - $\Rightarrow \sigma(Pt(CM) > 0.55\ MeV/c) = 4.47mb\ (\sigma(total) = 7.3mb)$
- **Use guinea pig generator to inject pairs primaries in BRN**
  - N-int-bunch = Lumi $\times\ \sigma(Pt(CM) > 0.55\ MeV/c)/f_c$ = 19.5 interactions
  - Each events has <N-int-bunch> interactions (4-primaries each)
  - N primaries per event ~ 78 (500 rad-bhabha) $\Rightarrow$ much faster than Rad-bhabha

Touschek background: strategy

- **Primaries for BRN: STAR code (Manuela Boscolo)**
  - Simulate both Touschek and the beam gas scattering along the beam line
  - Transport the scattered particles along the lattice
  - Detect the collisions of these particles with the beam pipes (scoring planes)
- **Typical output:**

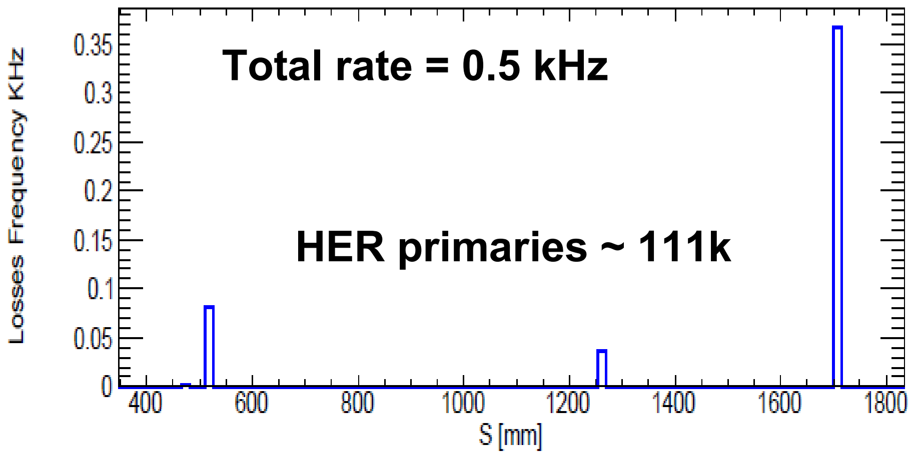
0.445558E-01	-0.550303E-02	-0.126830E-05	0.376408E-06	1.71000	-0.239831E-01	0.818628	1
0.456014E-01	-0.570537E-02	-0.280276E-04	0.113856E-04	1.71000	-0.252154E-01	0.755761	1
0.474620E-01	-0.592261E-02	-0.210435E-04	0.873927E-05	1.71000	-0.249482E-01	0.778852	1
0.432248E-01	-0.531700E-02	-0.179759E-04	0.663319E-05	1.71000	-0.236050E-01	0.997186	1
x (m)	$\frac{dx}{ds}$ (rad)	y (m)	$\frac{dy}{ds}$ (rad)	s (m)	$\frac{\Delta E}{E}$	f (KHz)	#turn

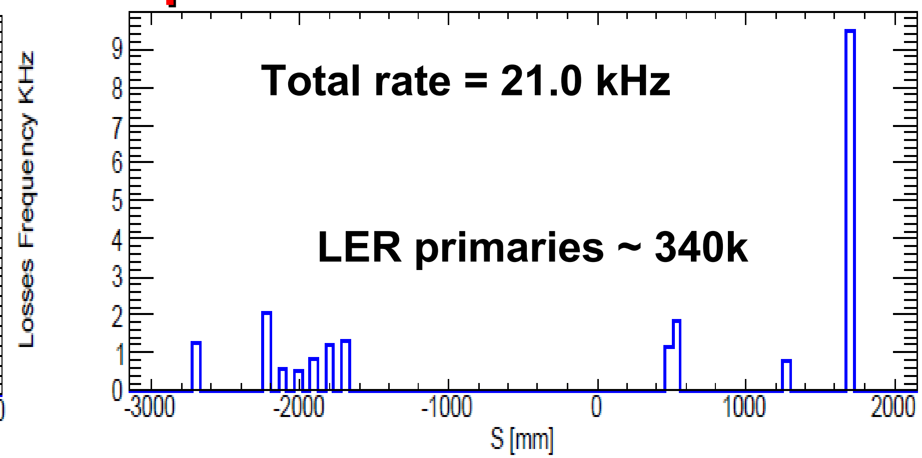


Touschek background: samples (I)

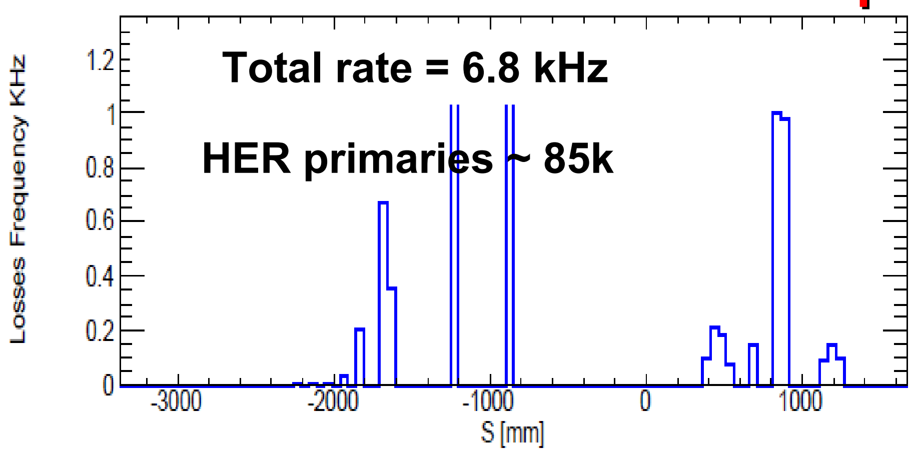
Losses near the IP

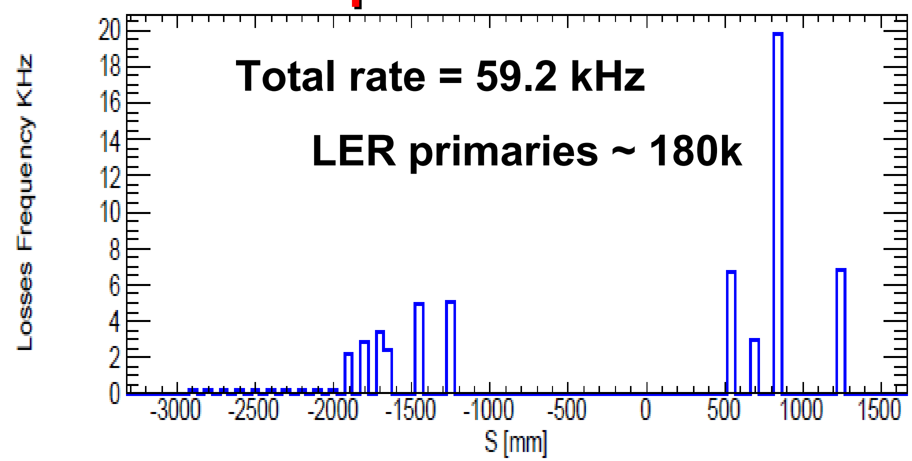
London samples





Nov. 2011 production samples





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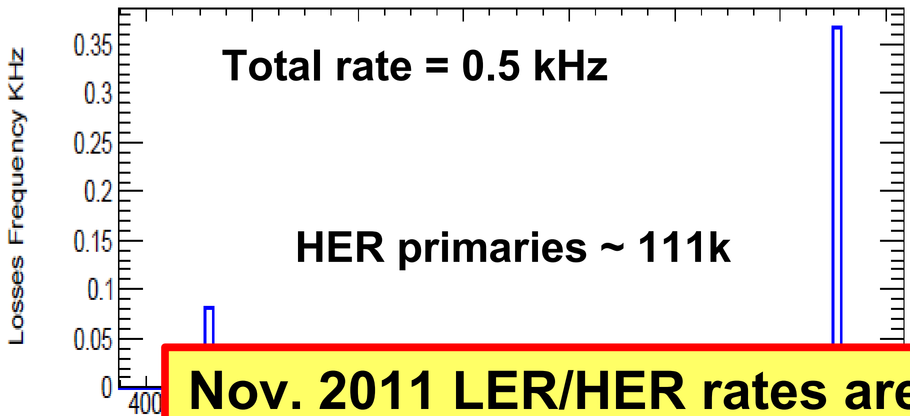
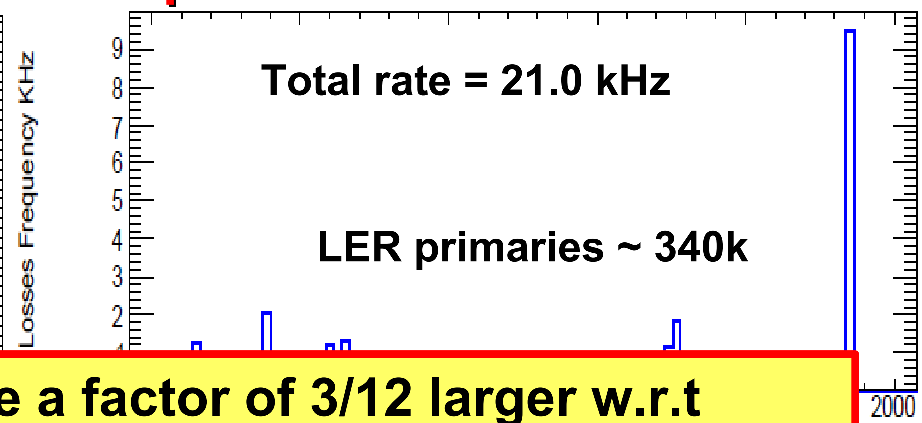
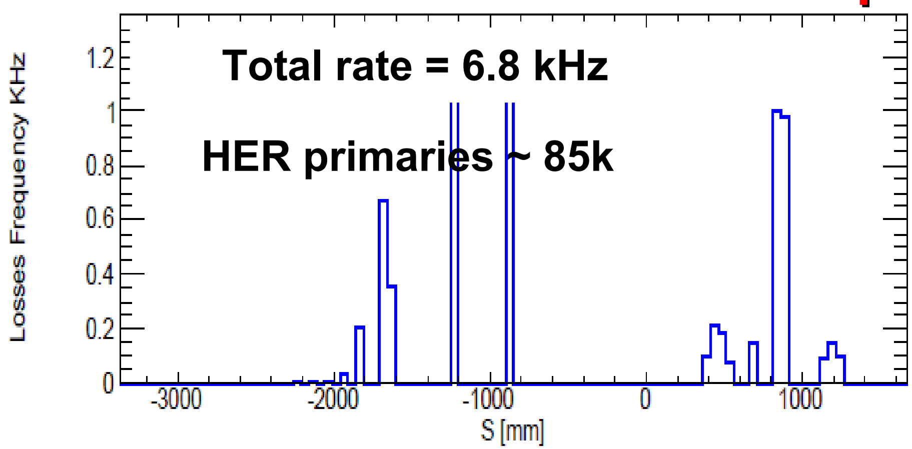
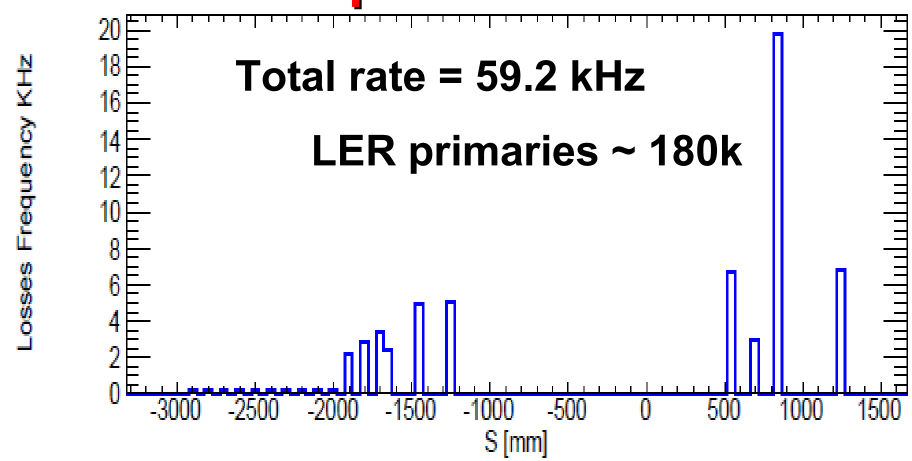


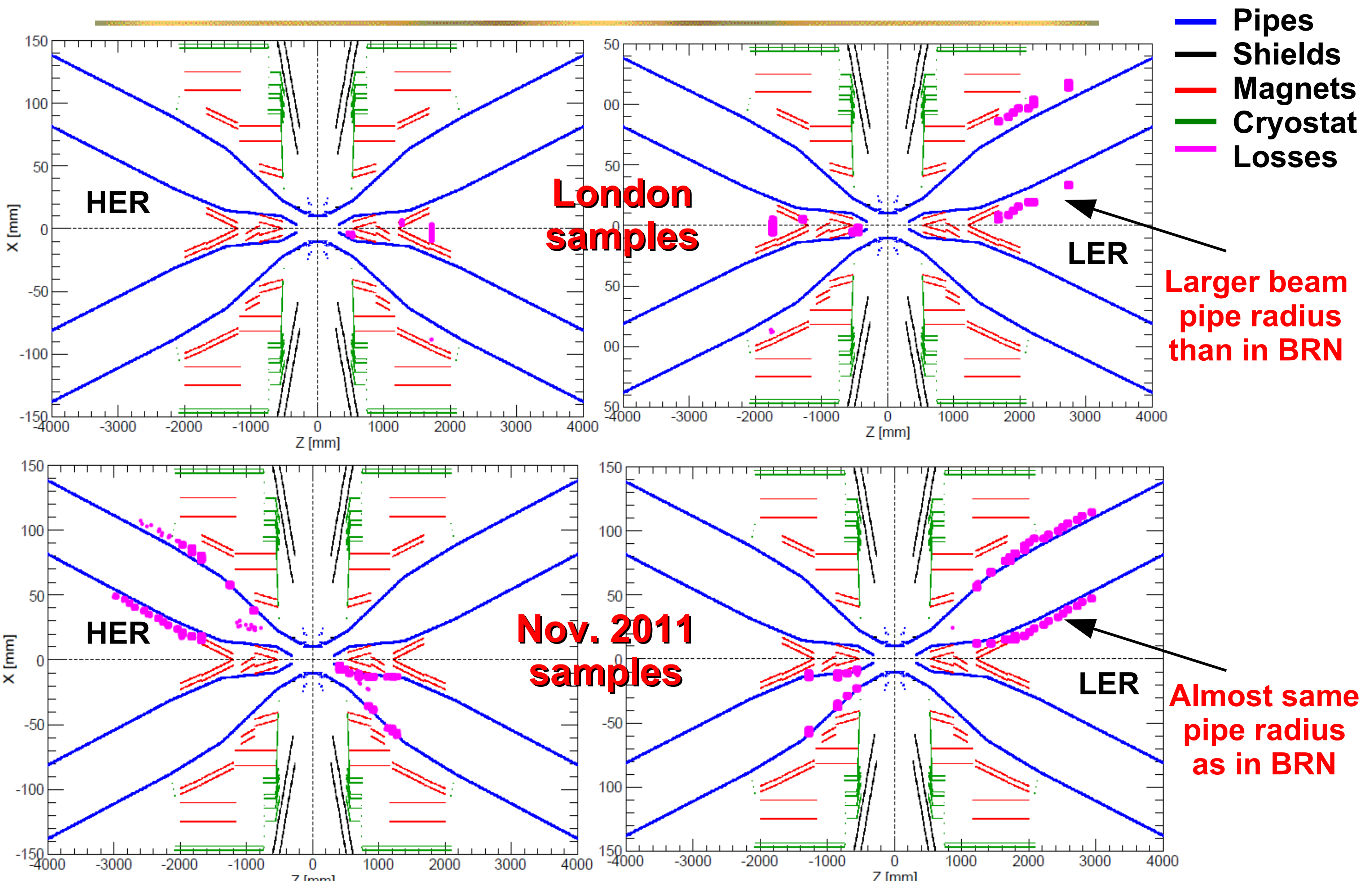


Nov. 2011 LER/HER rates are a factor of 3/12 larger w.r.t London samples. The London samples used a bigger physical (a factor of ~1.5) than the one implemented in BRN





Touschek background: samples (II)



Nov. 2011 production summary

- **Rad-Bhabha (fullsim):**
  - Jobs: 1099 (25 exited), ~10k events
  - Size: 1.4 TB
- **Pairs (fullsim):**
  - Jobs: 350 (22 exited), ~100k events
  - Size: 265 GB
- **Touschek HER/LER:**
  - Jobs: 1425 (65), ~180 (80k) primaries for LER (HER)
  - Size: 1.1TB
- **Rad-Bhabha (bg-frames):**
  - Jobs: 7324 (146 exited), ~900k events
  - Size: 39.4G

Machine Background on the SuperB Detector

SVT backgrounds

R. Cenci

- 2-photon background dominates
- Touschek-LER seems to have significant impact on outer layers

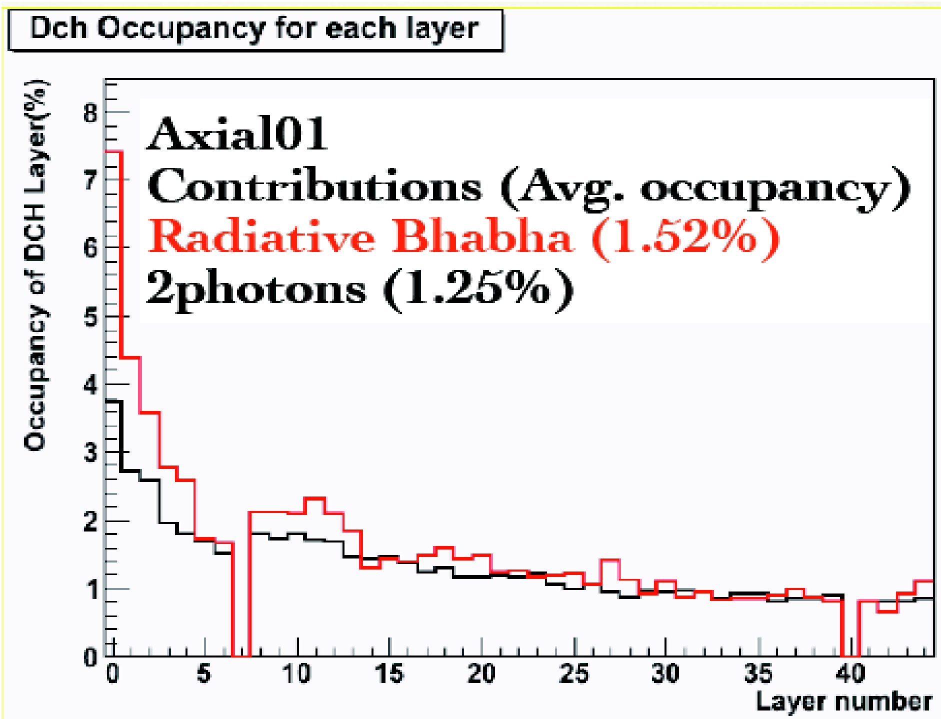
- Results from usual macros
- L0: +20-30% 2photons (see next slide), reduced RadBhabha
- Touschek became relevant for outer layers (+50%)

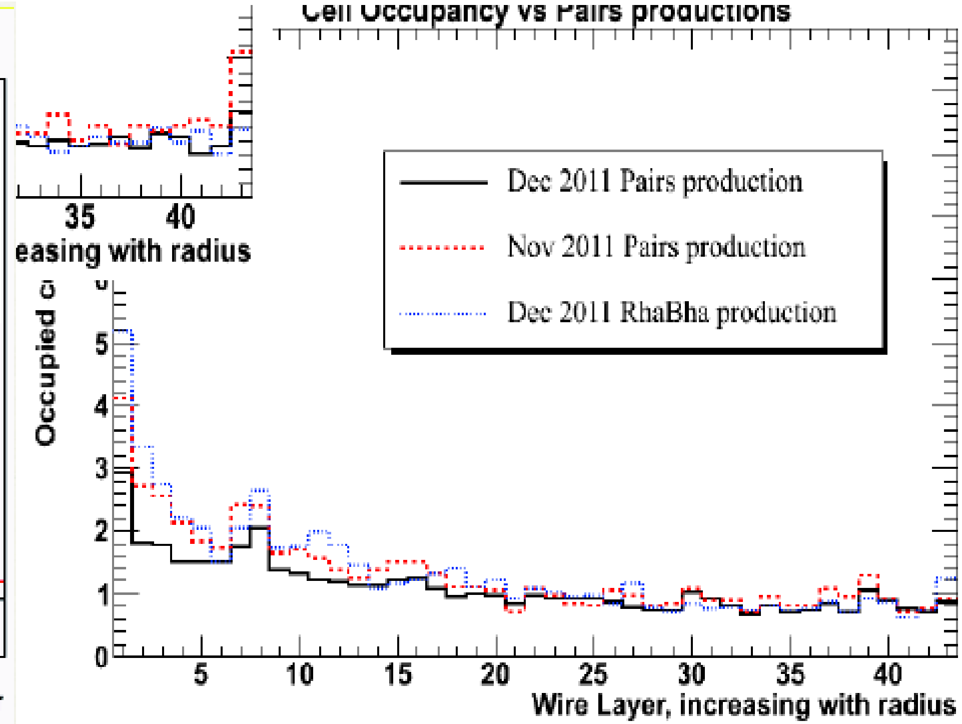
LAYERS	May2011 [MHz/cm2] 2phot. Pixels	May2011 [MHz/cm2] 2photons	Dec 2011 [MHz/cm2] 2photons	Dec 2011 [MHz/cm2] Rad Bhabha	Dec 2011 [MHz/cm2] Tousc-HER	Dec 2011 [MHz/cm2] Tousc-LER
L0 phi	55.5	23.3	32.2	0.96	0.52	1.73
L0 z		29.9	40.6	1.6	1.45	4.37
L1 phi	2.0	1.5	1.7	0.12	0.18	0.74
L1 z		0.7	0.85	0.083	0.19	0.77
L2 phi	0.96	0.72	0.88	0.086	0.12	0.56
L2 z		0.35	0.45	0.064	0.14	0.61
L3 phi	0.25	0.194	0.44	0.084	0.055	0.31
L3 z		0.097	0.27	0.056	0.055	0.29
L4 phi	0.014	0.012	0.05	0.014	0.004	0.019
L4 z		0.0076	0.03	0.008	0.003	0.013
L5 phi	0.007	0.006	0.019	0.006	0.002	0.009
L5 z		0.0041	0.014	0.004	0.0016	0.007

DCH backgrounds

R. Cenci
D. Lindemann

DCH occupancies for Rad-bhabha and Pairs



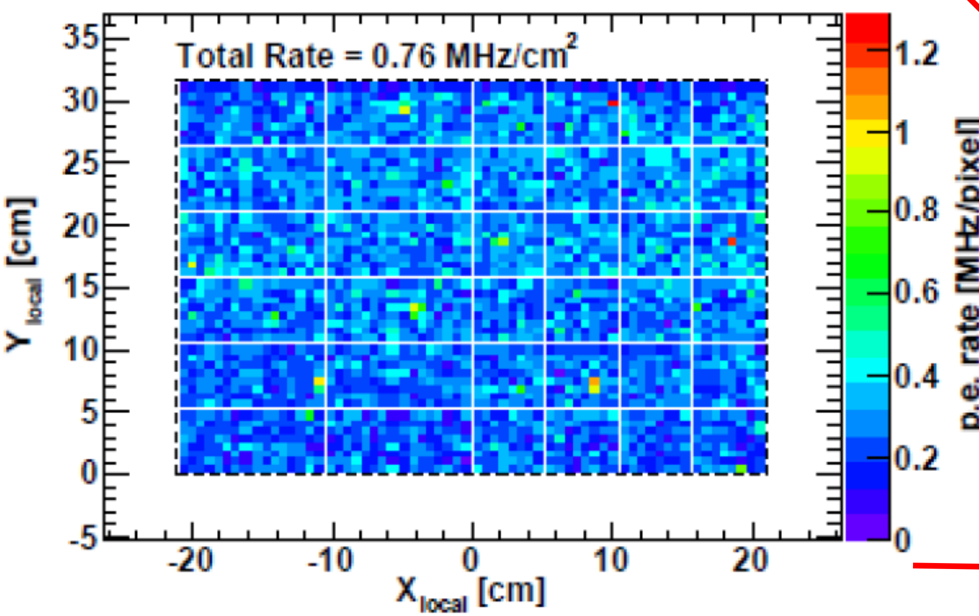


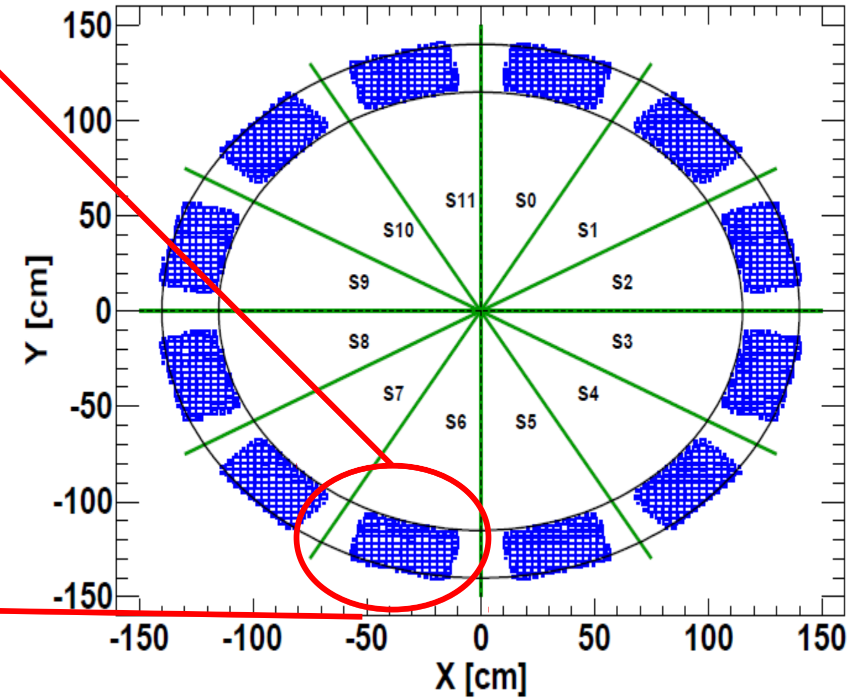
- Rad-bhabha and 2-photon background produce similar occupancies, both 1-2%. Total occupancy ~2-4%
- Touschek (both LER/HER) isn't a concern for DCH (around 1-2 order of magnitude smaller)

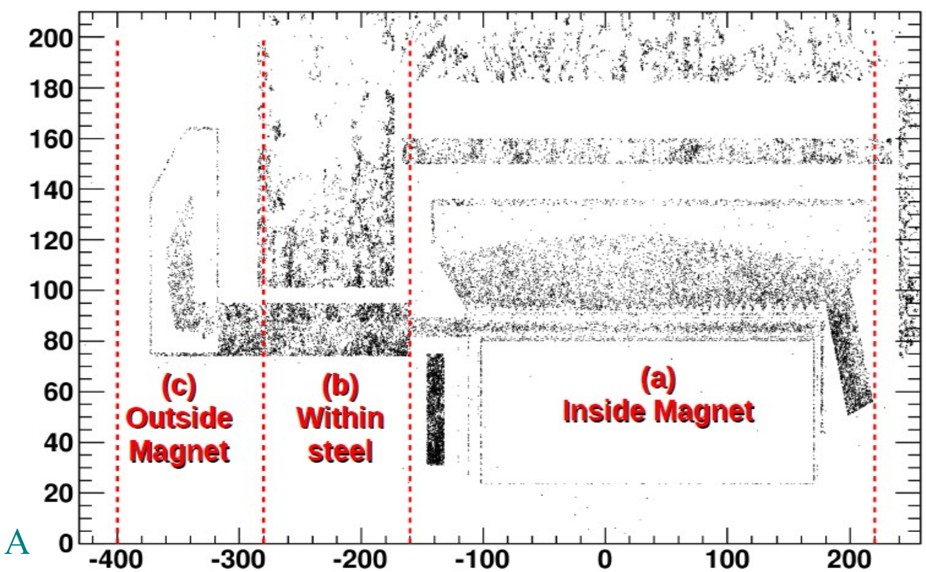
FDIRC background

A. Pérez

Rad-bhabha rates for Sector 6



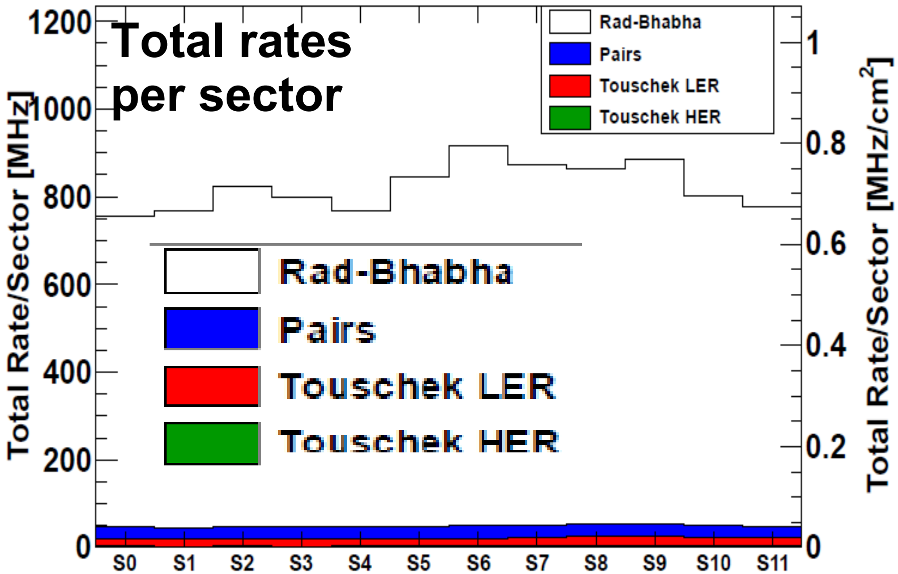




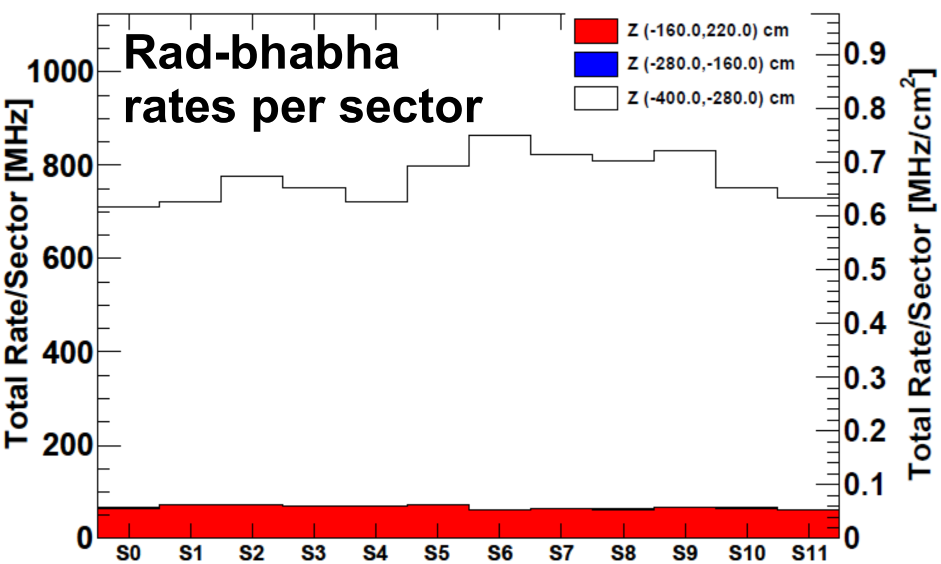
- **Evaluate the photo-electron (p.e.) rate per pixel for every sector and background source**
- **Study the rates for tracks hitting the quartz in different regions**

FDIRC background

A. Pérez



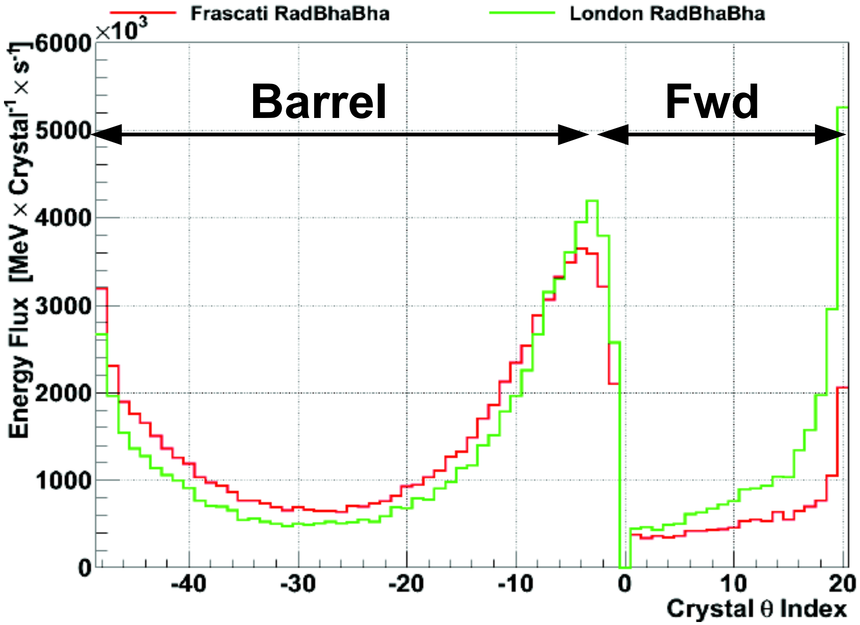
- Main background contribution is Rad-bhabha (other sources are 1-2 orders of magnitude lower)

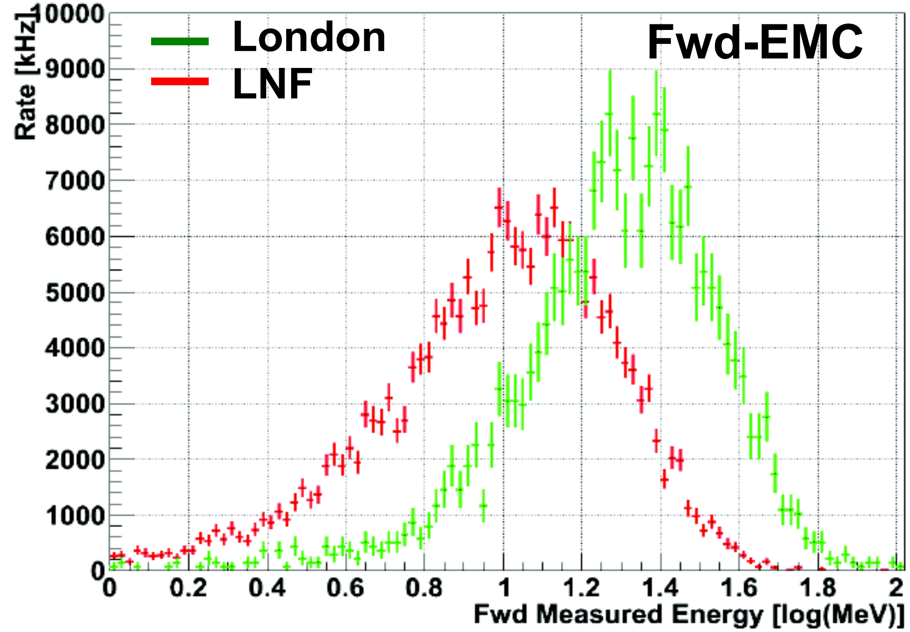


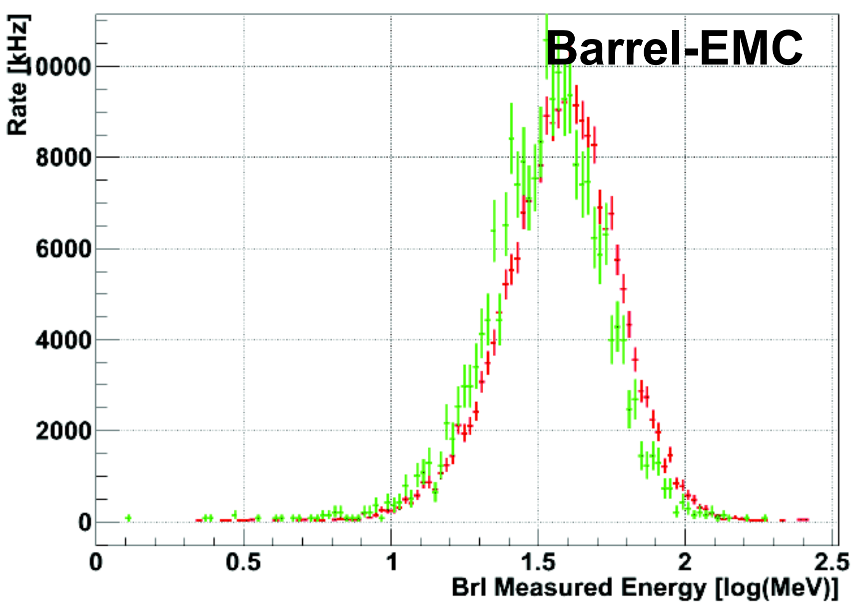
- For Rad-bhabha, the p.e. rates are mainly due to tracks hitting the quartz bar section outside magnetic field
- Will study additional shielding just below photon-camera to further reduce backgrounds

EMC backgrounds

S. Germani



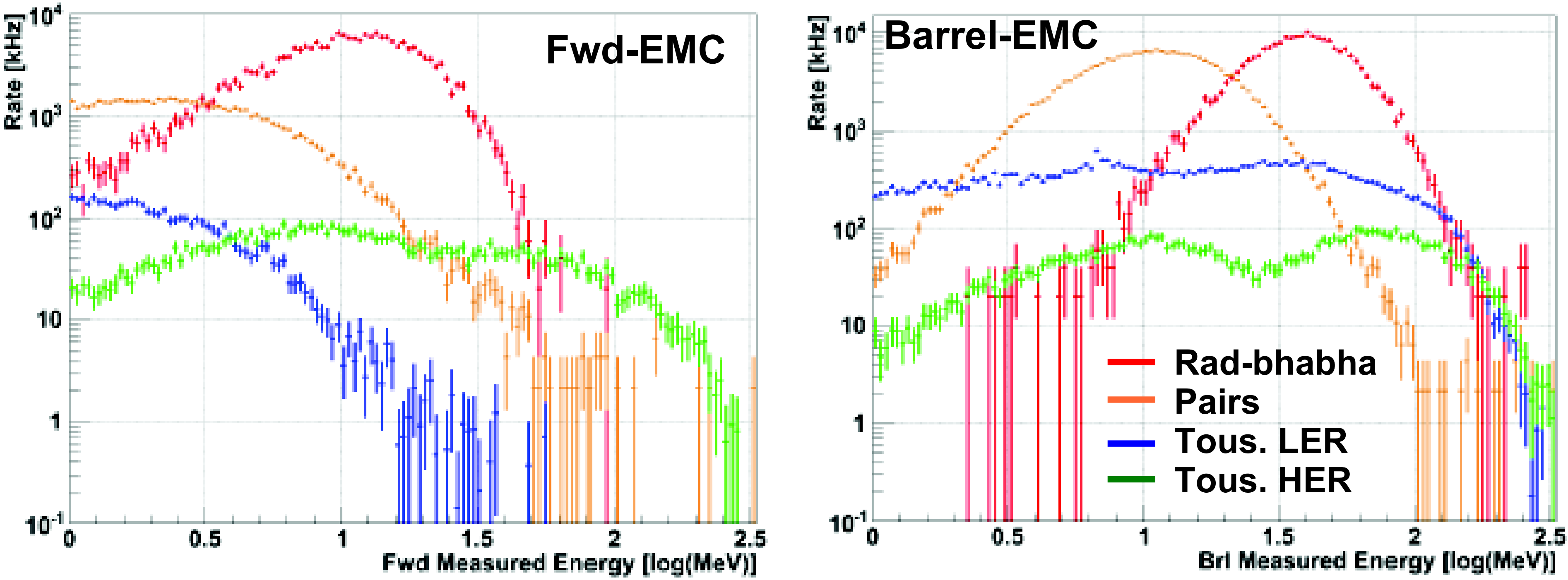




- Rad-bhabha samples for London (Oct. 2011) and LNF (Dec. 2011) productions
- LNF sample has a somewhat lower/higher energy spectrum for Fwd/Barrel w.r.t London
- Main differences are solenoidal field and cryostat model

EMC backgrounds

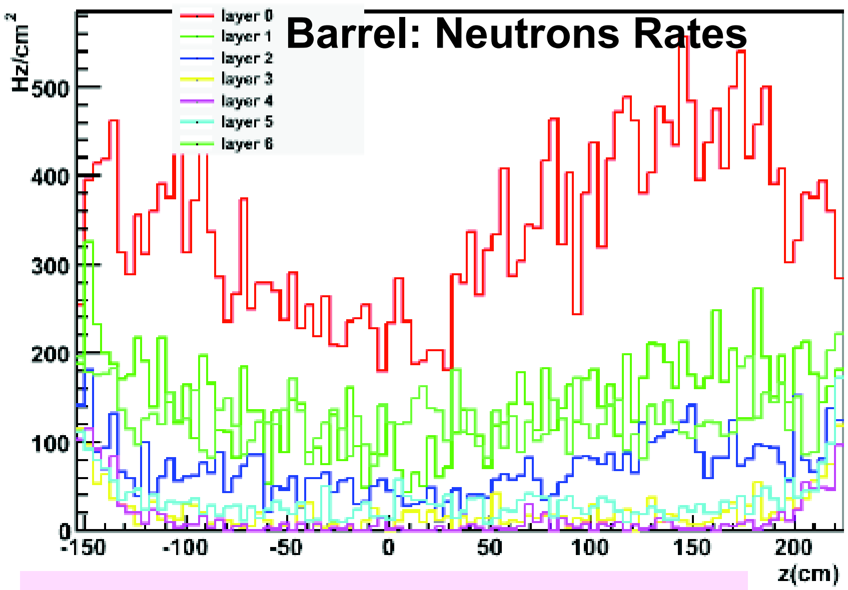
S. Germani

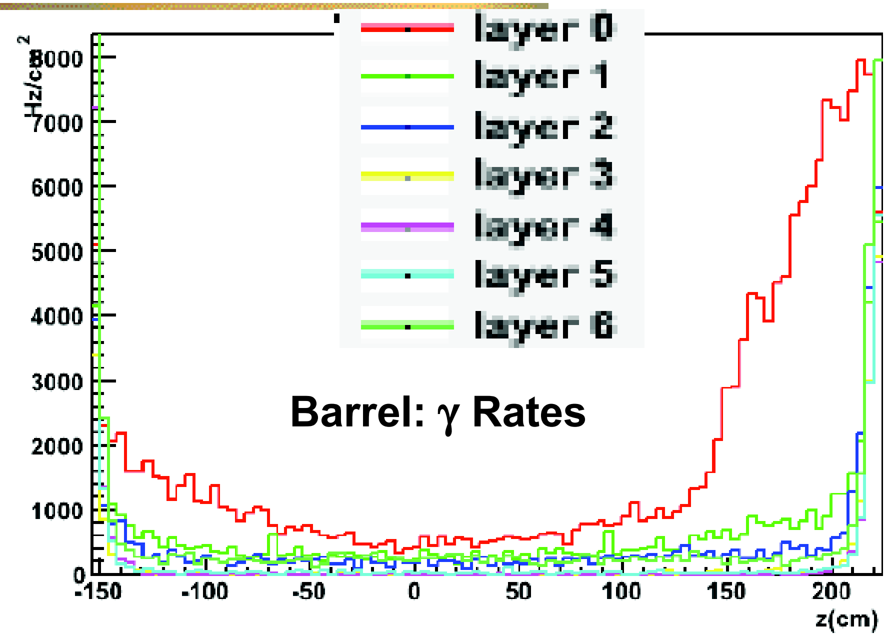


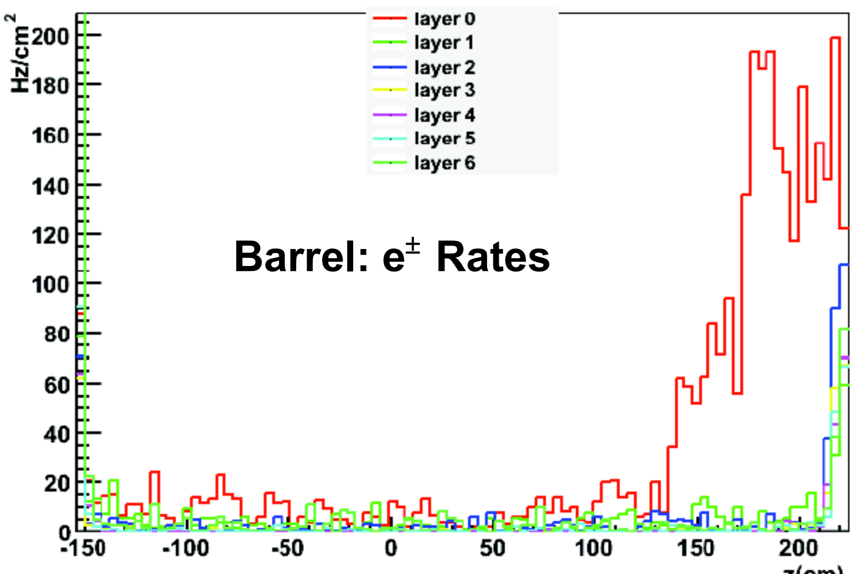
- **There is no absolute dominating background**
  - Energy and angular (Barrel/Fwd) dependence
  - Main background is Rad-bhabha, but
    - Pairs dominate at low energies (1<MeV) in central barrel
    - Touschek-LER at high energy (>10 MeV) in bwd-barrel

IFR backgrounds

V. Santoro







- **Rad-bhabha:**
  - Neutrons: rate is very high and dangerous for the Sipm
  - γ/e$^{\pm}$: rates are high but shouldn't be a problem
- **Other background sources (Pairs and Touschek) are small compared with Rad-bhabha**

Summary and Outlook

- **Several Changes in the BRN code since last SuperB meeting**
  - FDIRC: Cherenkov photons and intrumentation
  - Final Focus: Solenoidal field and Cryostat and super-conducting magnets
- **Several background sources produced: Rad-bhabha, Pairs, Touschek**
- **Backgrounds on the detector:**
  - SVT: Main background is Pairs
  - DCH: Rad-bhabha and Pairs produce similar amounts of backgrounds, 1-2% occupancy each.
  - FDICR: Main background is Rad-bhabha. Will increase shielding arounf photon-camera to reduce it.
  - EMC: No absolute dominant background. Main is Rad-bhabha, Pairs (Touschek-LER) dominates for low (high) energy regions
  - IFR: Rad-bhabha is main background. Neutron rate a little bit high

Backup

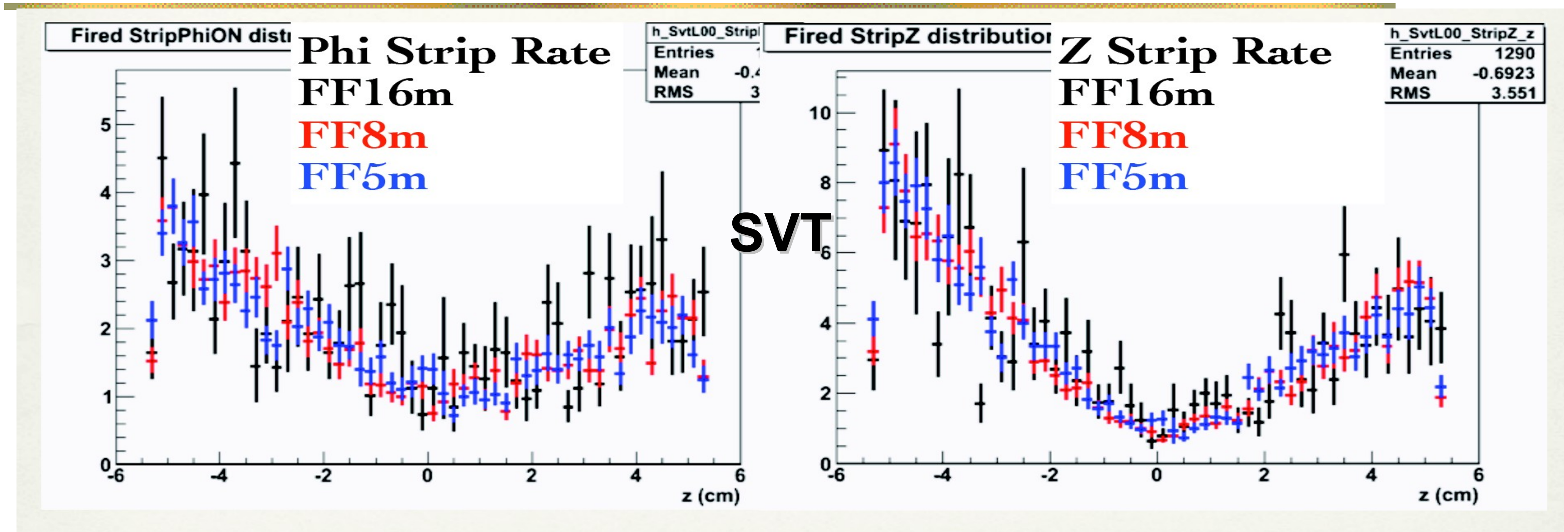
Rad-bhabha bg-frames production (I)

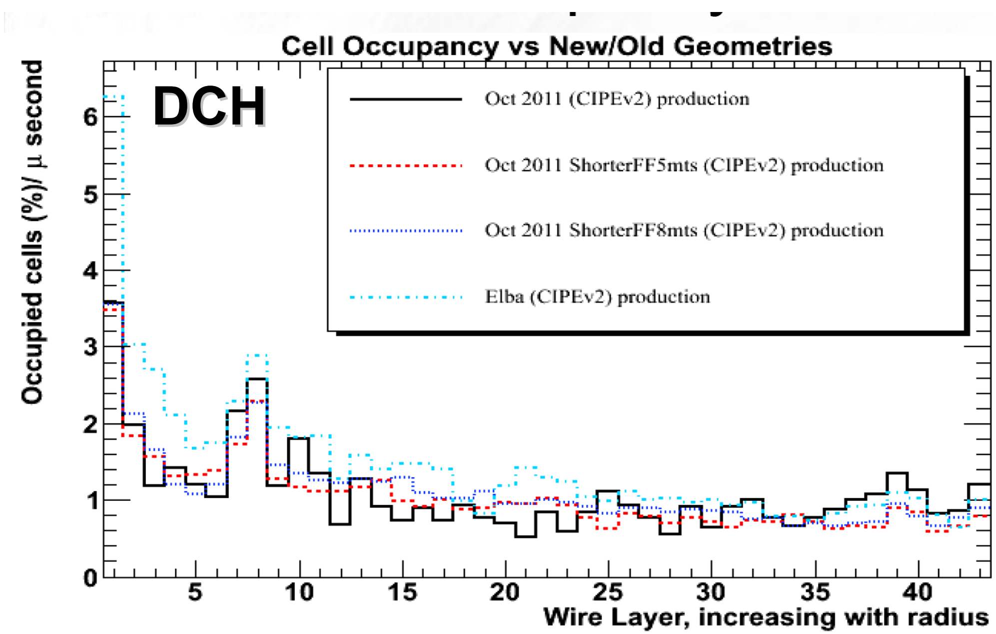
- **Current final focus (FF) model in FullSim is very complete, it covers from -16m to 16m**
  - Rad-bhabha simulation takes ~10min per event
  - Impossible to produce the rad-bhabha bg-frames request of 1M events in a reasonable time

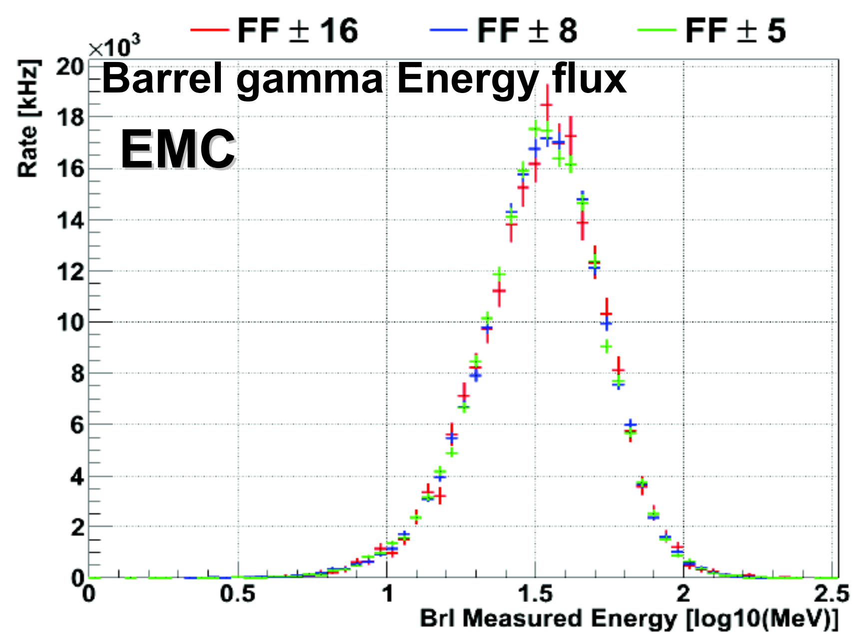
- **Approach to the problem:**
  - The reason of the long FF model is to have a realistic estimation of neutron rates on the subsystems (FDIRC, IFR, EMC)
  - FastSim doesn't have a good simulation for neutrons
  - Propose to build reduced version of the FF: ±8mts and ±5mts
  - Run a small fullsim production with the reduced versions of the FF
    - Compare background rates on different subsystems for the different FF models: nominal (±16mts) and reduced ones (±8mts and ±5mts)

If rates are similar ⇒ can use the reduced FF for the bg-frame production

Rad-bhabha bg-frames production (II)







Rad-bhabha bg-frames production (III)

- **Summary of comparison of FF models:**
  - Most of the subsystems see very similar rates for the different FF models
  - Only the IFR sees different rates. Can we leave with this? FastSim IFR experts yes
  - See link below for the reports full reports on this

- **The reduced FF model (±5mts) is the only approach that the FullSim group can offer to generate the requested 1M Rad-bhabha events in a reasonable time**

  ⇒ **The reduced FF model of ±5mts have a factor of 10 lower execution time per event w.r.t. the nominal FF model (±16mts)**

- **Nov. 2011 production:**
  - Use the ±5mts FF model (Geometry_CIPE_V00-00-02_ShorterFF5mts)