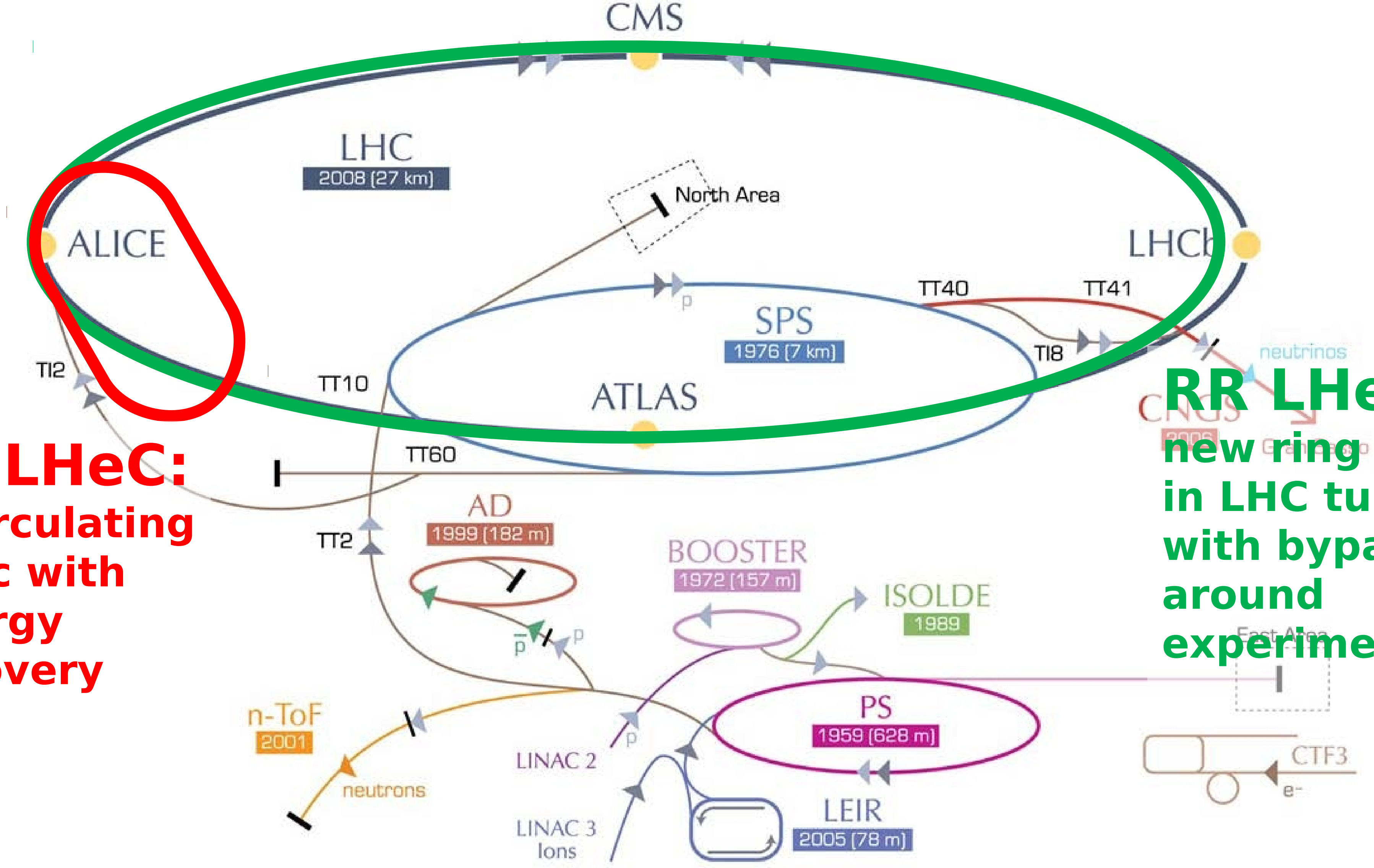
# LHeC interaction region

R. Tomas

Many thanks to J. Abelleira, N. Bernard, O. Bruning, M. Fitterer, B. Holzer, M. Klein, P. Kostka, D. Schulte, L. Thompson and F. Zimmermann

# LHeC Ring-Ring and Linac-Ring options




**LR LHeC:** recirculating linac with energy recovery

**RR LHeC:** new ring in LHC tunnel, with bypasses around experiments

# Draft LHeC CDR completed!

DRAFT 1.0
Geneva, September 3, 2011
CERN report
ECFA report
NuPECC report
LHeC-Note-2011-003 GEN

## A Large Hadron Electron Collider at CERN

Report on the Physics and Design
Concepts for Machine and Detector

LHeC Study Group
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http://cern.ch/lhec

### LHeC Study Group


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About 150 Experimentalists and Theorists from 50 Institutes
Tentative list

Thanks to all and to
CERN, ECFA, NuPECC

# LHeC targets

e- energy ≥60 GeV
luminosity ~1033 cm-2s-1
total electrical power for e-: ≤100 MW
e+p collisions with similar luminosity
simultaneous with LHC *pp* physics
e-/e+ polarization
detector acceptance down to 1 deg

# Machine options – Detector impacts

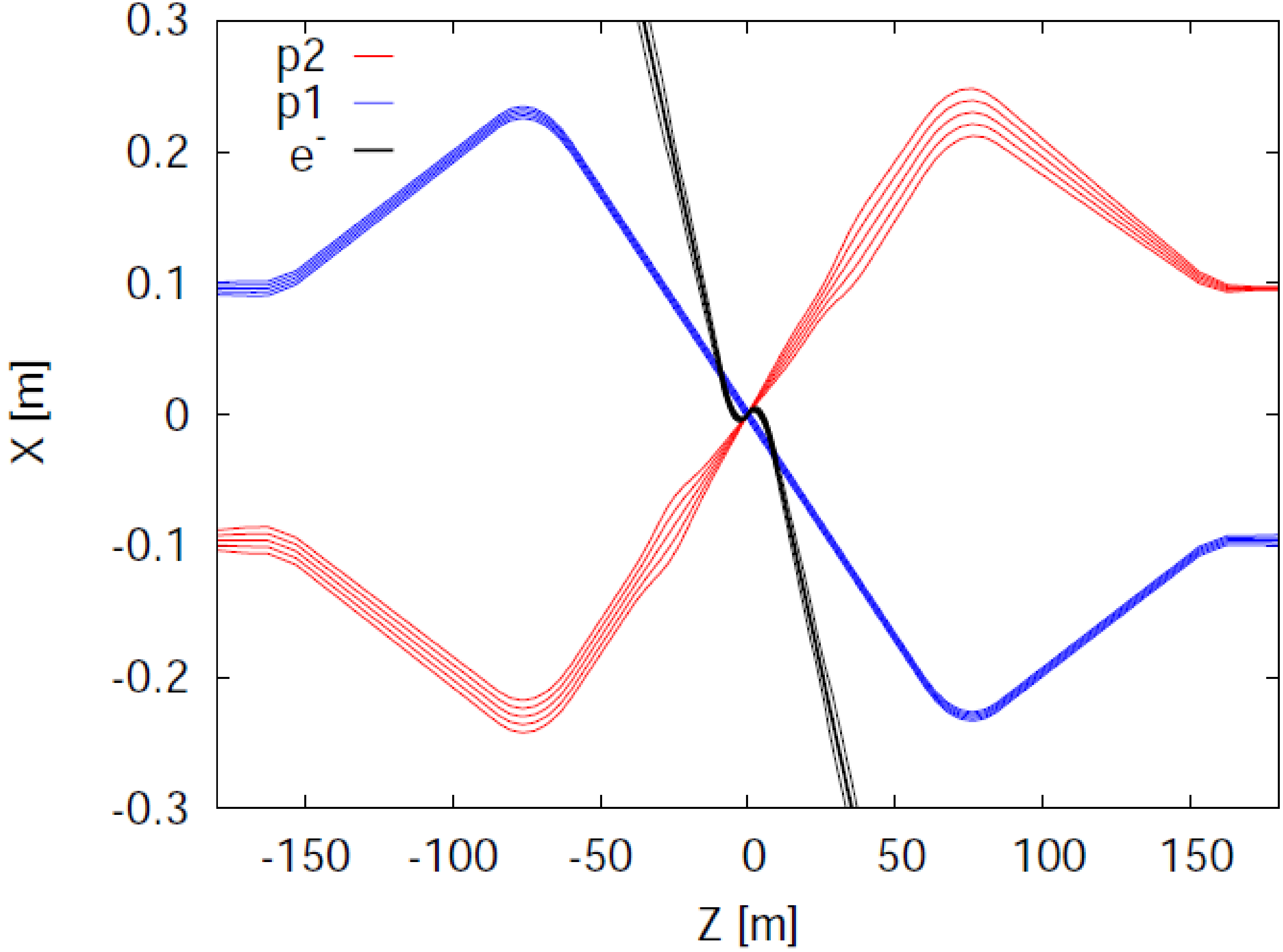
- Linac-Ring (LR)
  - 2 x 9m 0.3 T dipole over full detector length (and beyond)

- Ring-Ring (RR)
  - High Acceptance
    High Lumi option - low β-quadrupoles near to the Interaction Point
    → Detector modular / removable
    forward / backward tracker & calorimeter end-caps

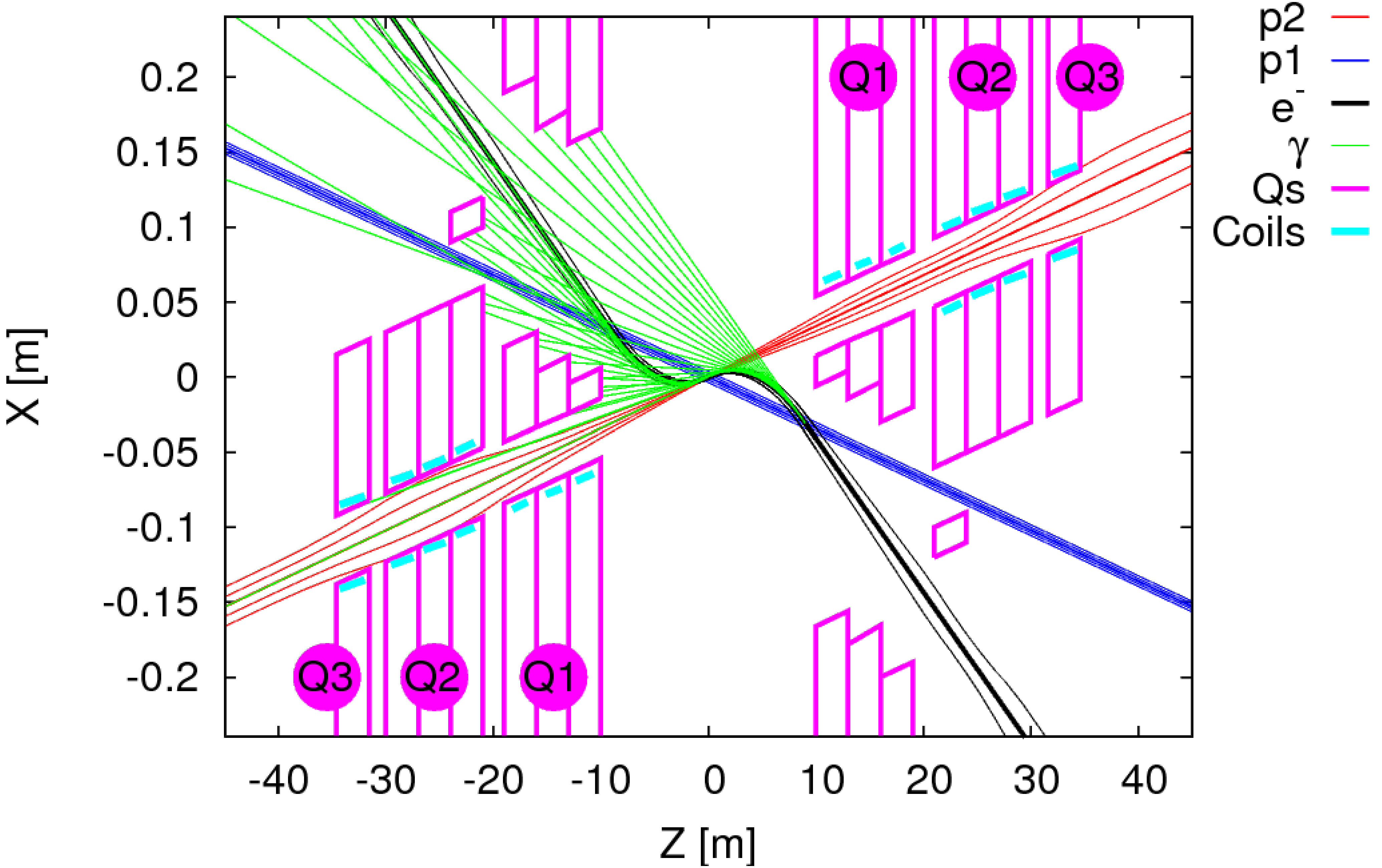
- Beam Optics / Synchrotron Radiation
  - beam pipe circular-elliptical - aperture φ-dependent
    → detector design - follow BP shape

| | RR HL/HA | LR |
|---|---|---|
| Luminosity [$10^{33}cm^{-2}s^{-1}$] | 1.3/0.7 | 0.4 |
| Detector acceptance [deg] | 10/1 | 1 |
| Polarization [%] | 40 | 90 |
| IP beam sizes [μm] | 30, 16 | 7 |
| Crossing angle [mrad] | 1 | 0 |
| e- L* [m] | 1.2/6.2 | 30 |
| Proton L* [m] | 23 | 10 |
| e- beta*$_{x,y}$ [m] | 0.2,0.1/0.4,0.2 | 0.12 |
| Proton beta*$_{x,y}$ [m] | 1.8, 0.5 | 0.1 |
| Synchrotron power [kW] | 33/51 | 50 |

# LHeC Linac-Ring IR layout

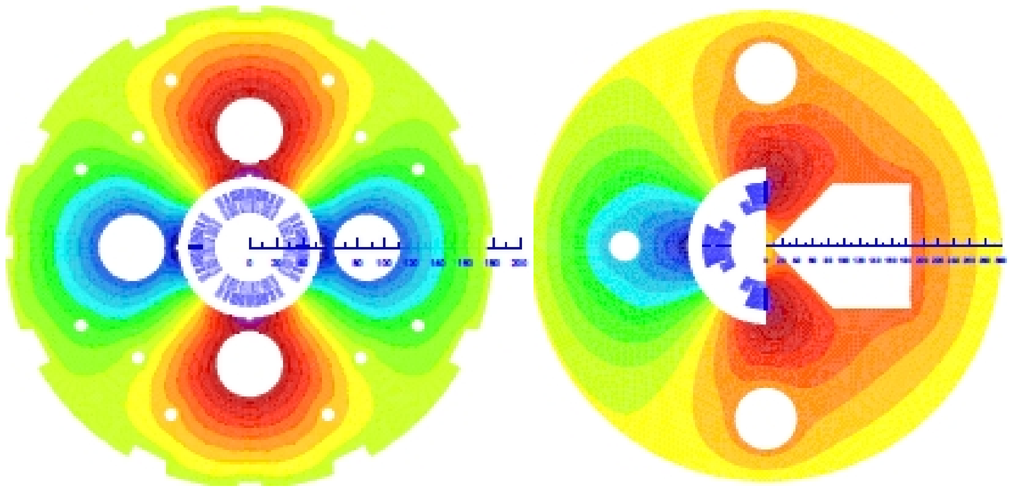


# Zooming around the IP



# Linac-Ring IR magnets

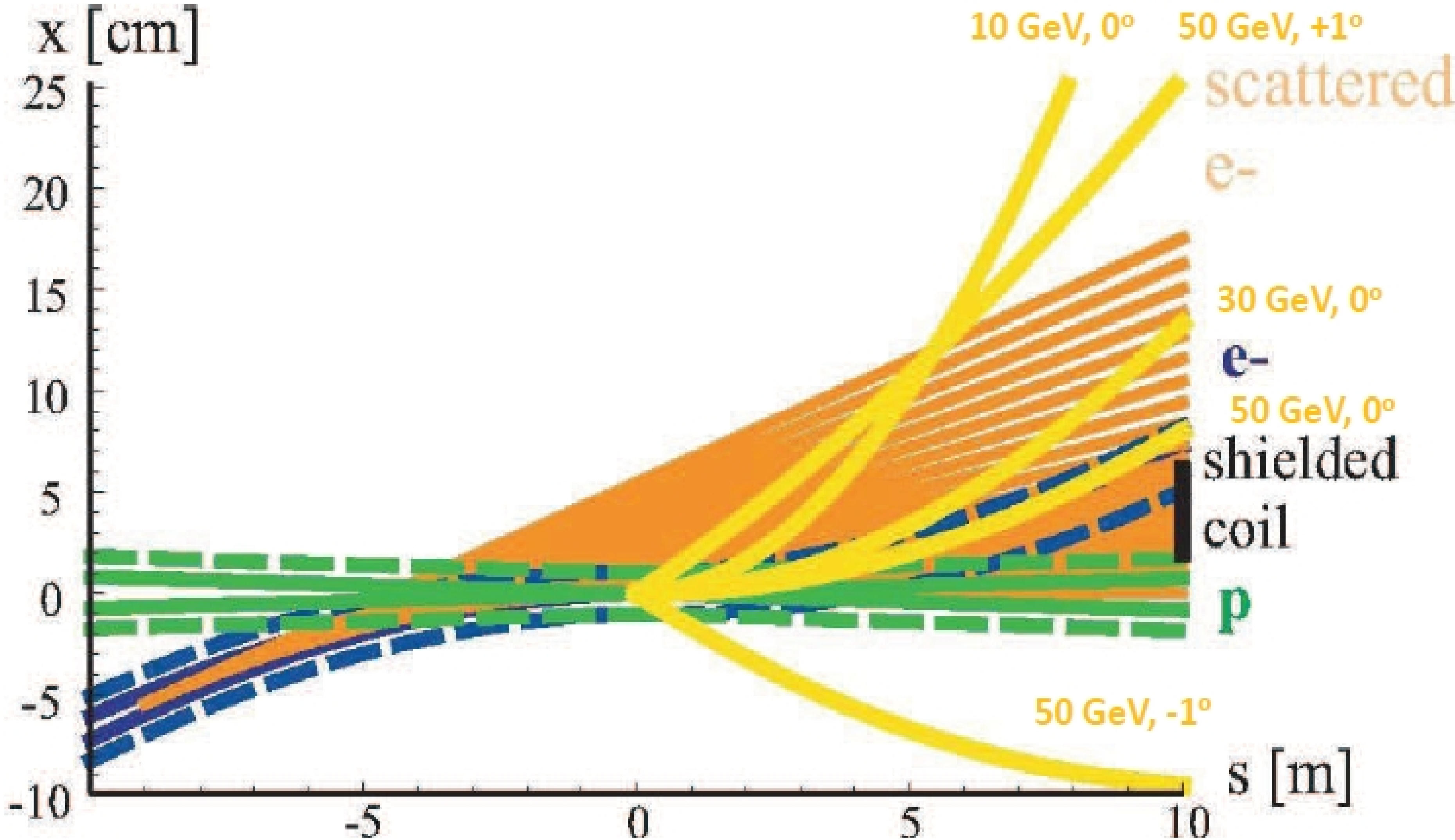
-High-gradient SC IR quadrupoles based on Nb3Sn for colliding proton beam with common low-field **exit hole for electron beam and non-colliding proton beam**



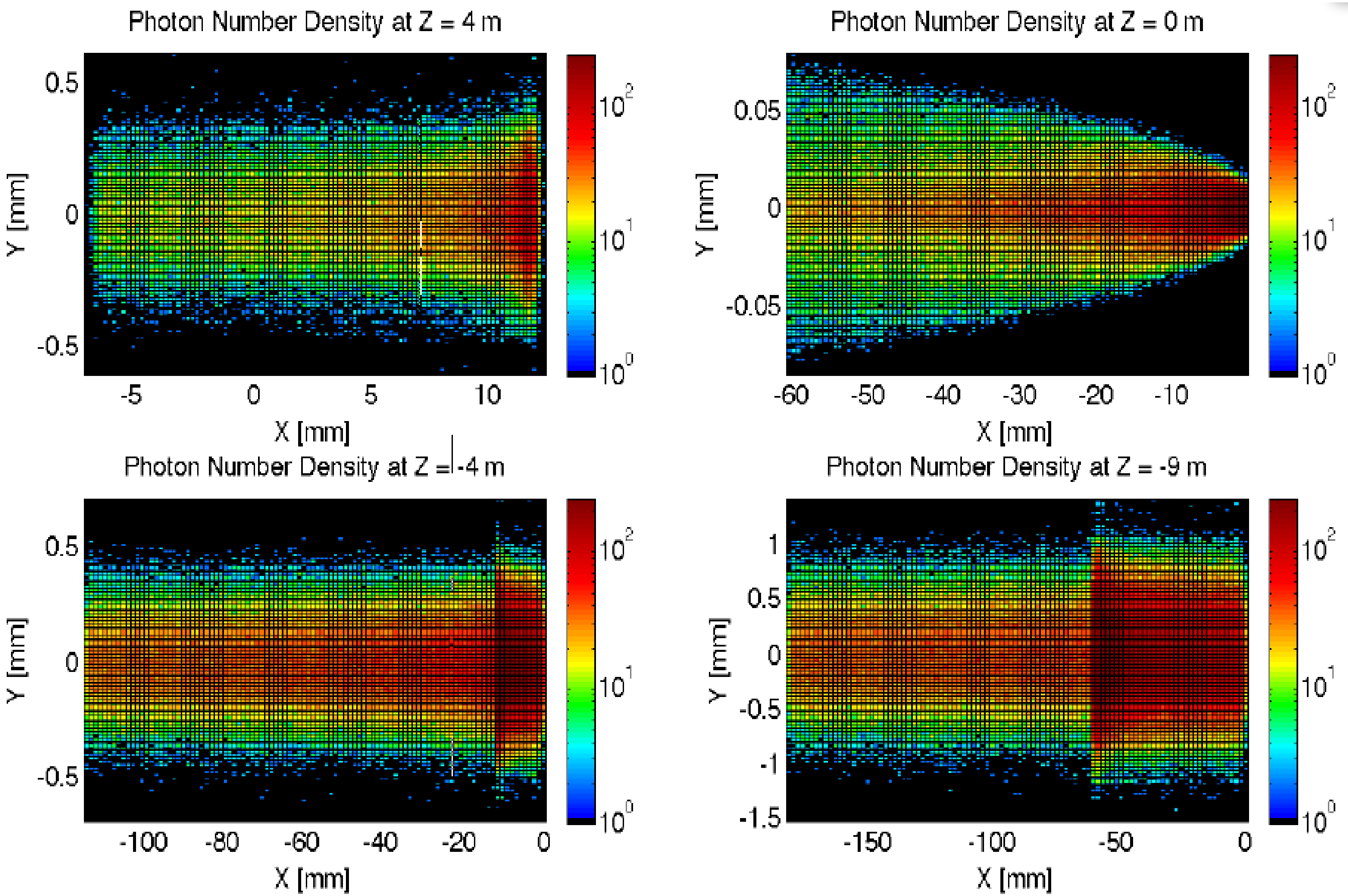
| | |
|---|---|
| Nb3Sn (HFM46): 5700 A, 175 T/m, 4.7 T at 82% on LL (4 layers), 4.2 K | Nb3Sn (HFM46): 8600 A, 311 T/m, at 83% LL, 4.2 K |
| 46 mm (half) ap., 63 mm beam sep. | 23 mm ap.. 87 mm beam sep. |
| 0.5 T, 25 T/m | 0.09 T, 9 T/m |

**-Detector integrated dipole**: 0.3 T over +/- 9 m

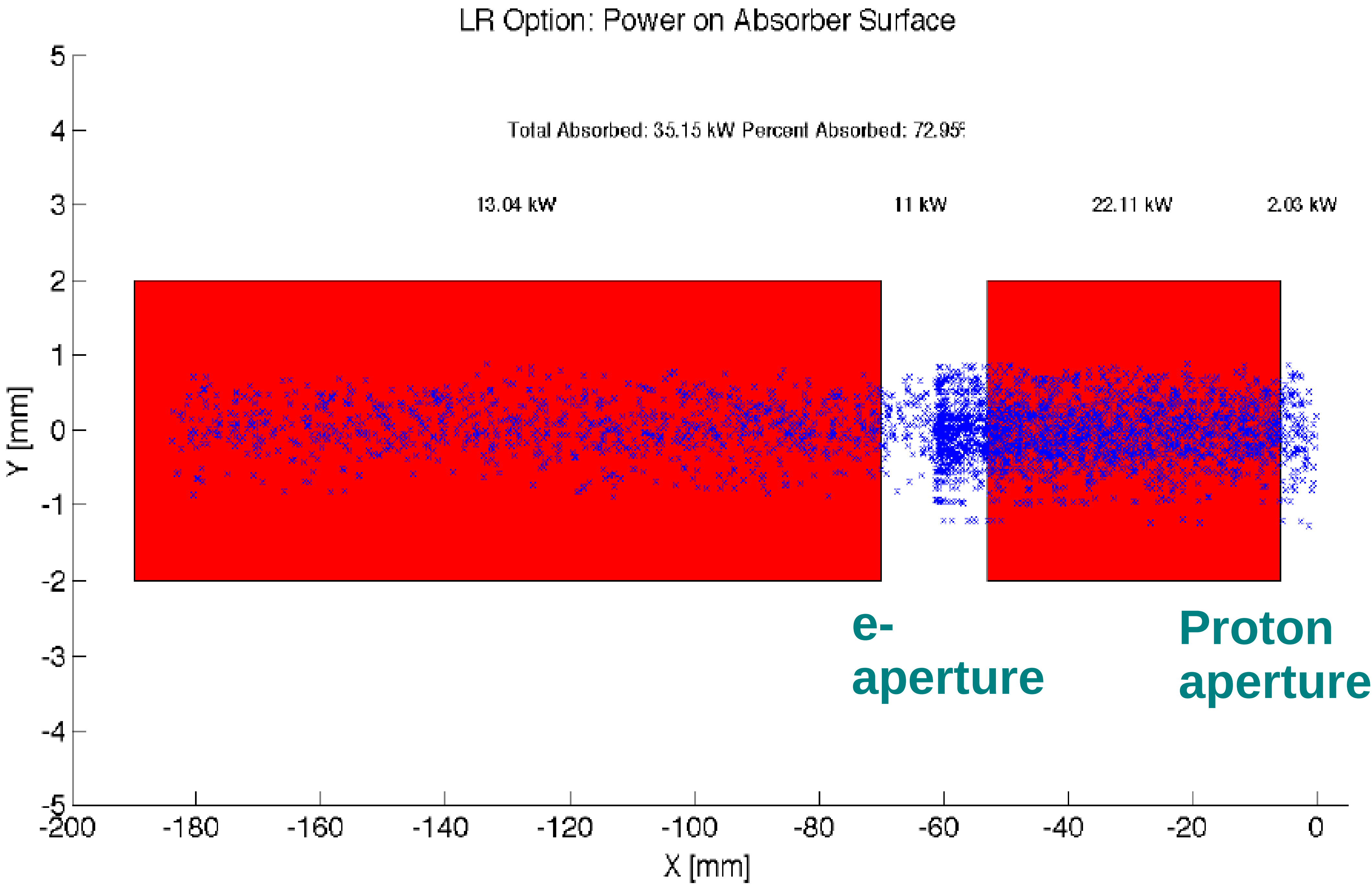
# Detector acceptance revisited



# SR photon density at different locations



# LR: Power on absorber surface

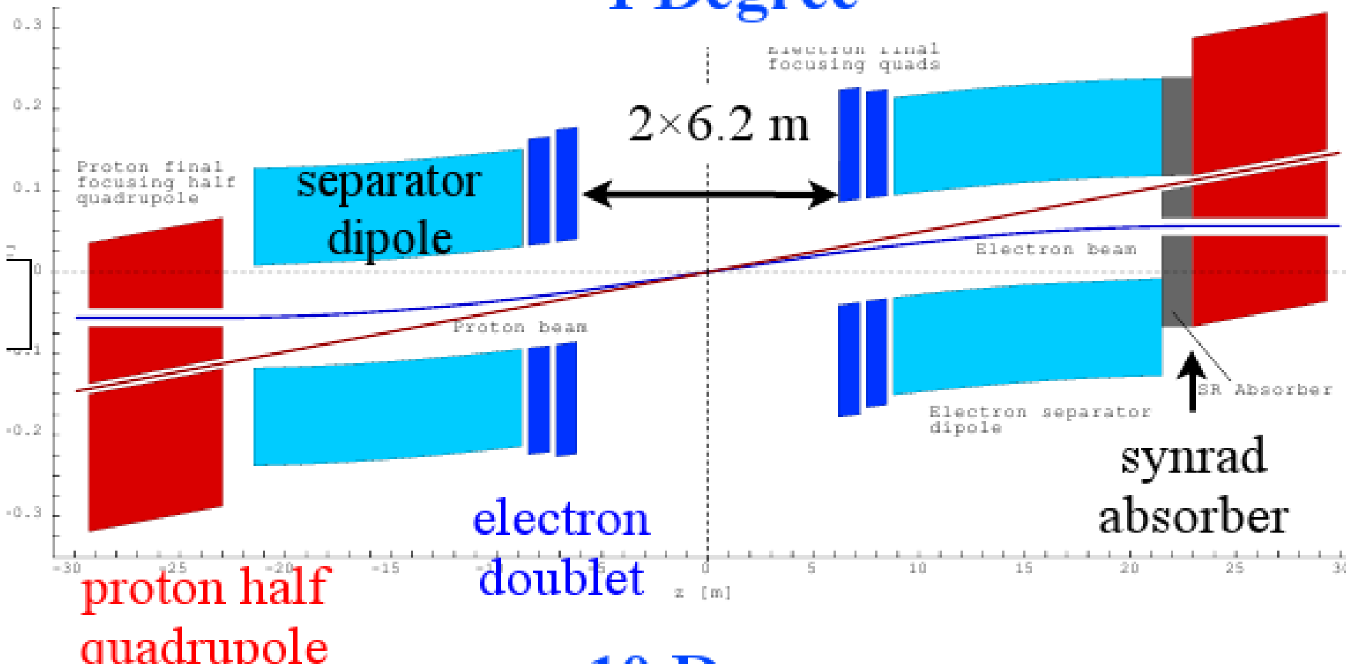


# Linac-Ring IP Beam pipe

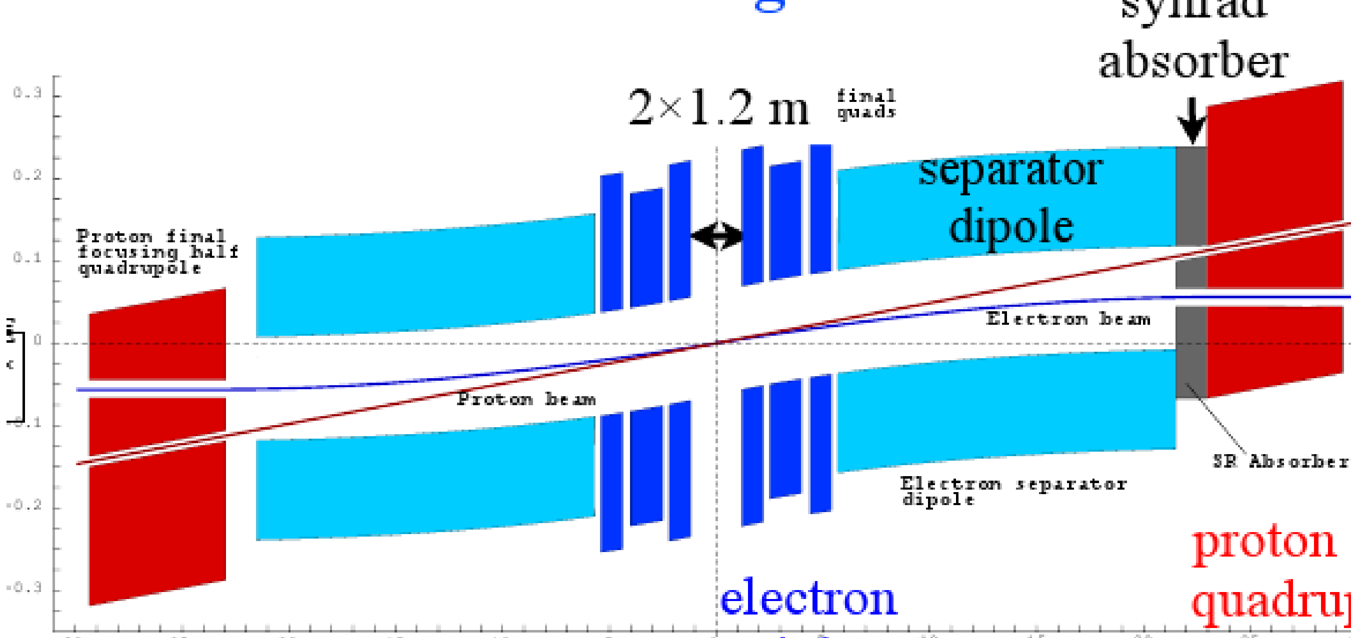
Inner Dimensions:
Circular(x)=2.2cm;   Elliptical(-x)=-10., y=2.2cm

# Linac-Ring HA & HL layouts

## 1 Degree

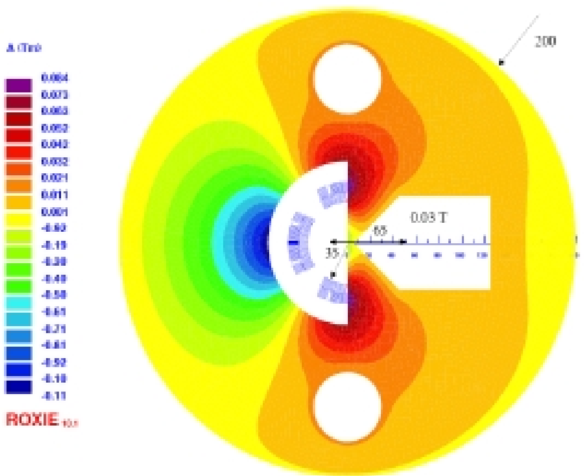



## 10 Degree

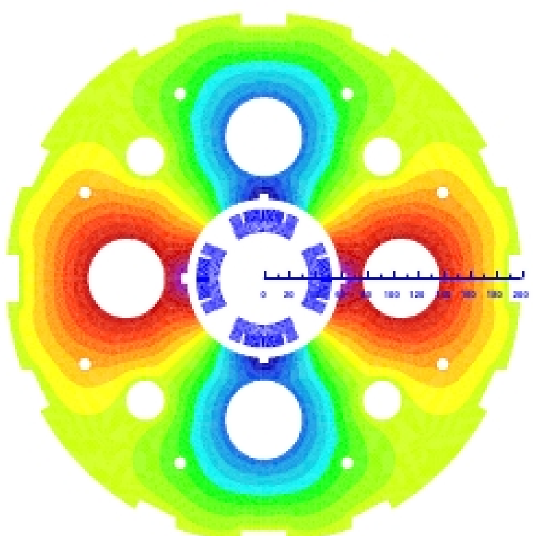


# Ring-Ring proton quadrupoles

**Q1: Half Quadrupole with field free regions for the e-beam**



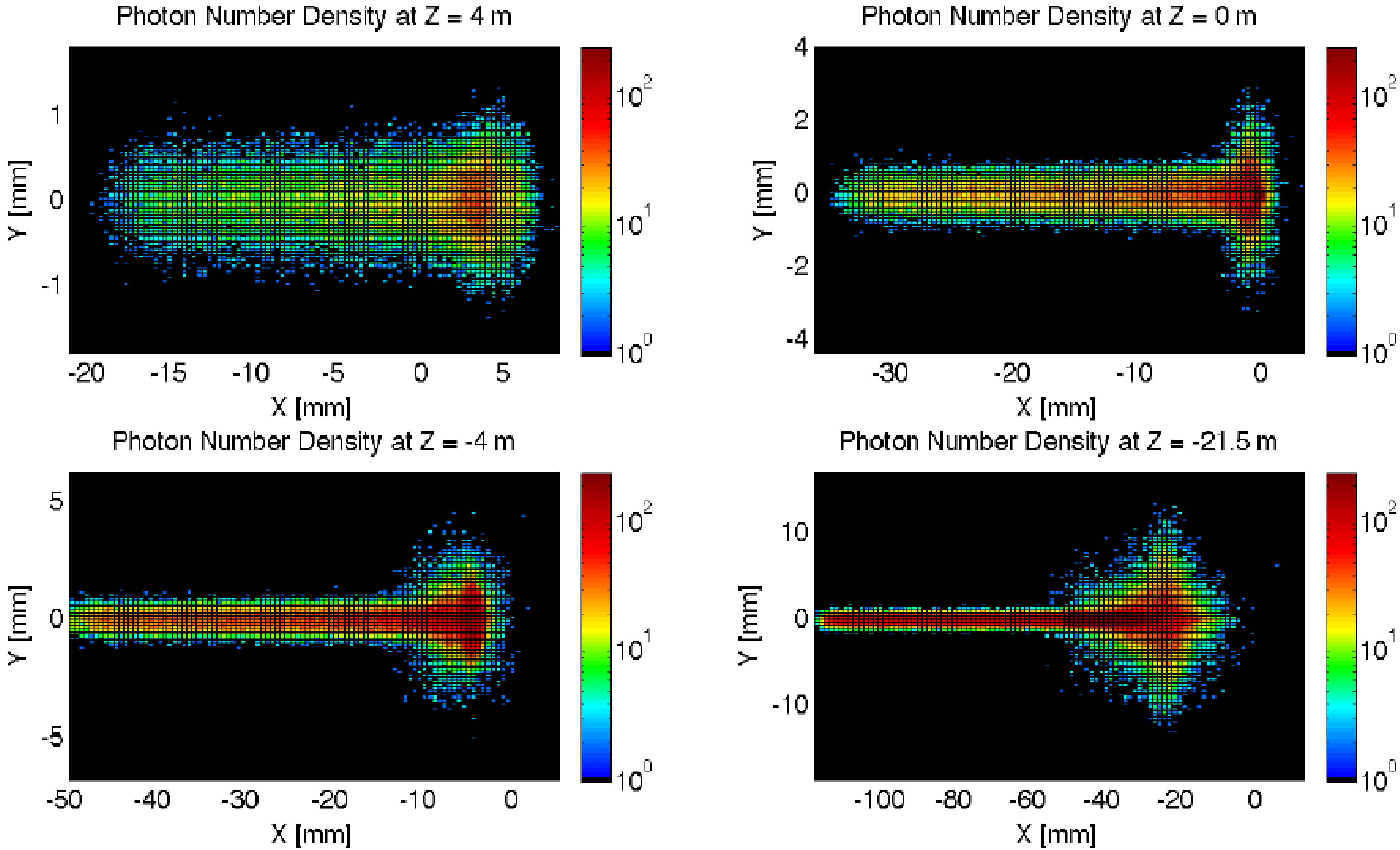

**Q2: Single aperture**



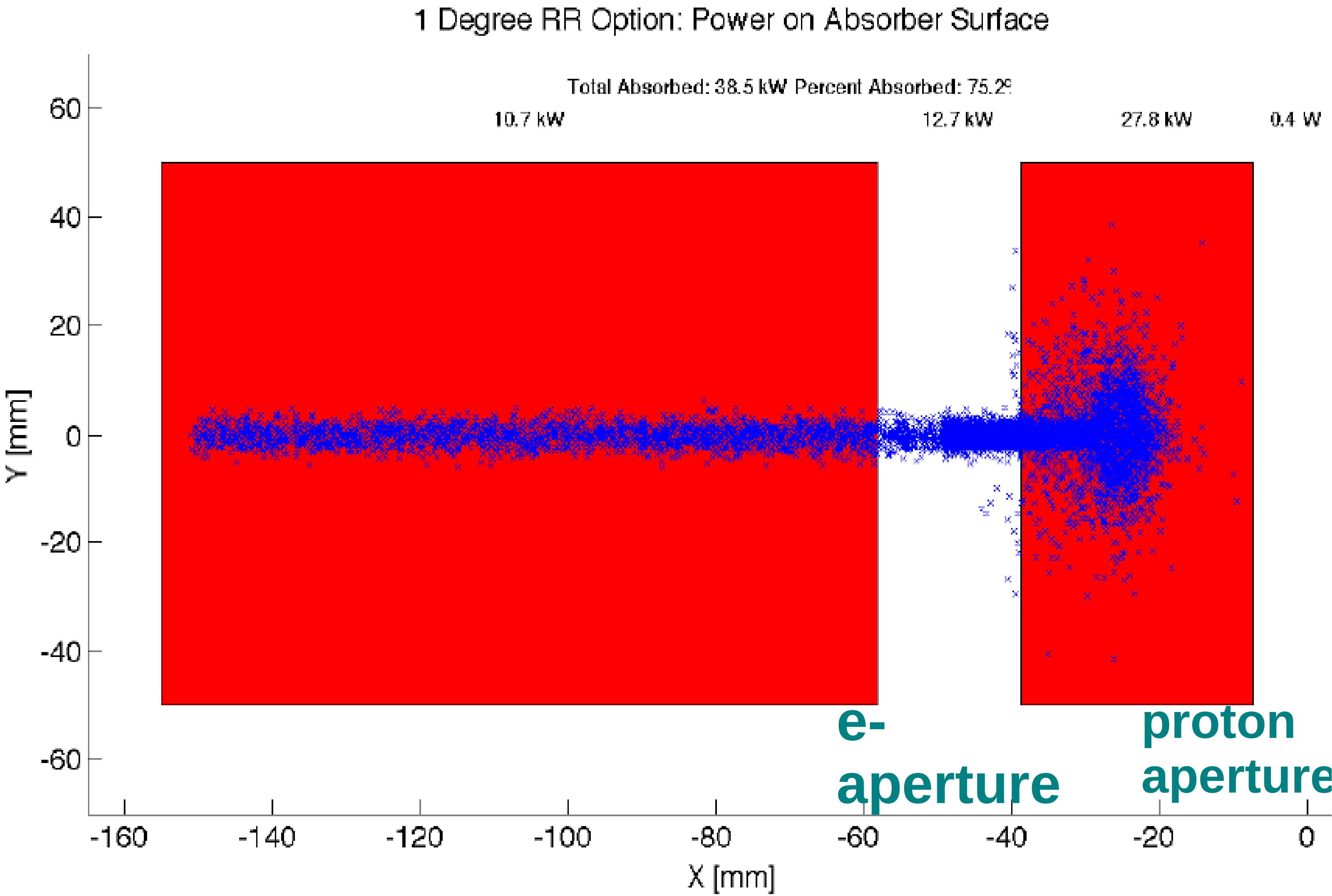
## Standard tech: NbTi

| | Q1 | Q2 |
|---|---|---|
| Radial aperture | 35 mm | 36 mm |
| $B_0$ | 137 T/m | 137 T/m |
| $g_0$ | 2.5 T | - |
| Beam separation | 65 mm | 107 mm |
| operation percentage on the load line of the sc | 77% | 73% |
| $B_{fringe}$ e-aperture | 0.03 T | 0.016 T |
| $g_{fringe}$ e-aperture | 0.8 T/m | 0.5 T/m |

# SR photon density at different locations

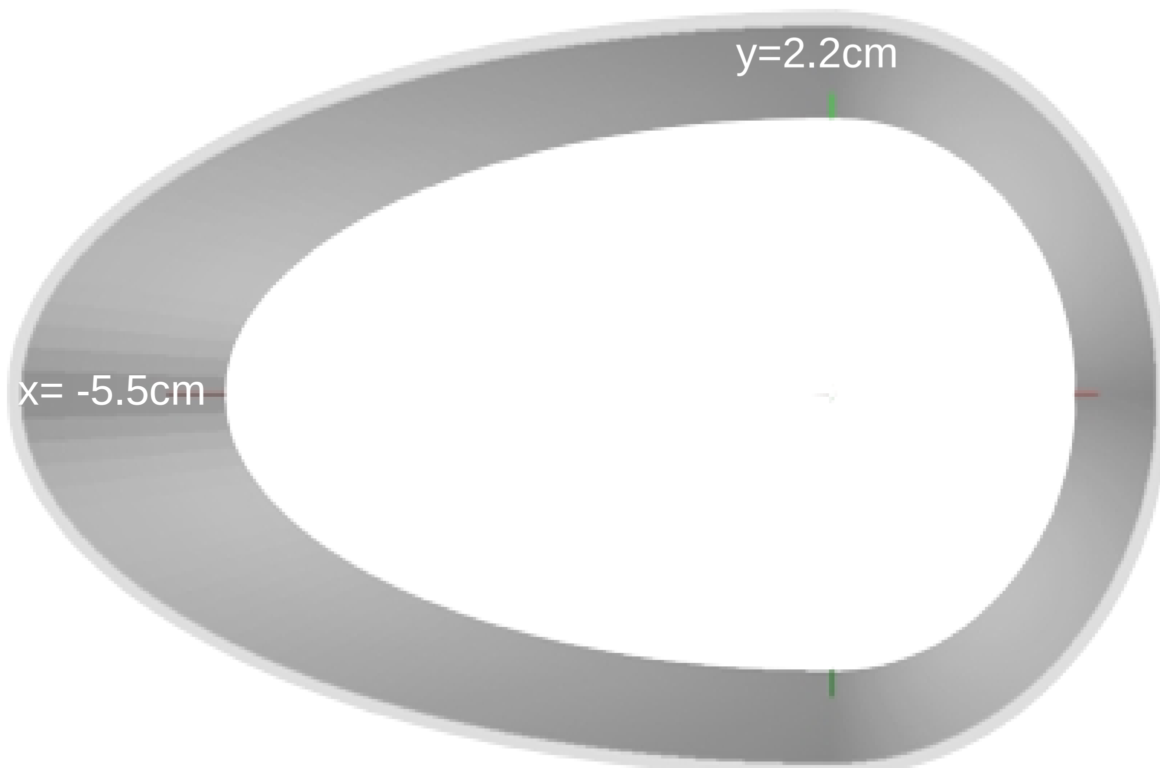


# RR HA SR Power on absorver surface



# Ring-Ring IP Beam pipe

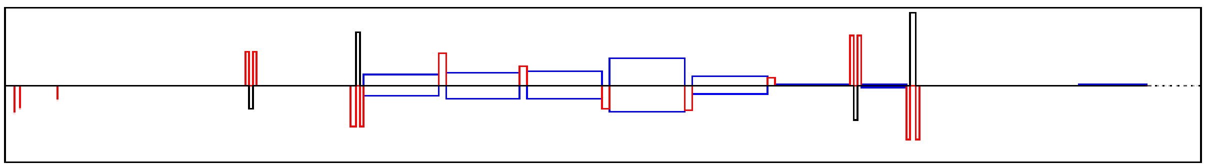
Inner dimensions (masks @ 6, 5, 4m; SR shield)
Circular(x)=2.2cm;    Elliptical(-x)=-5.5, y=2.2cm

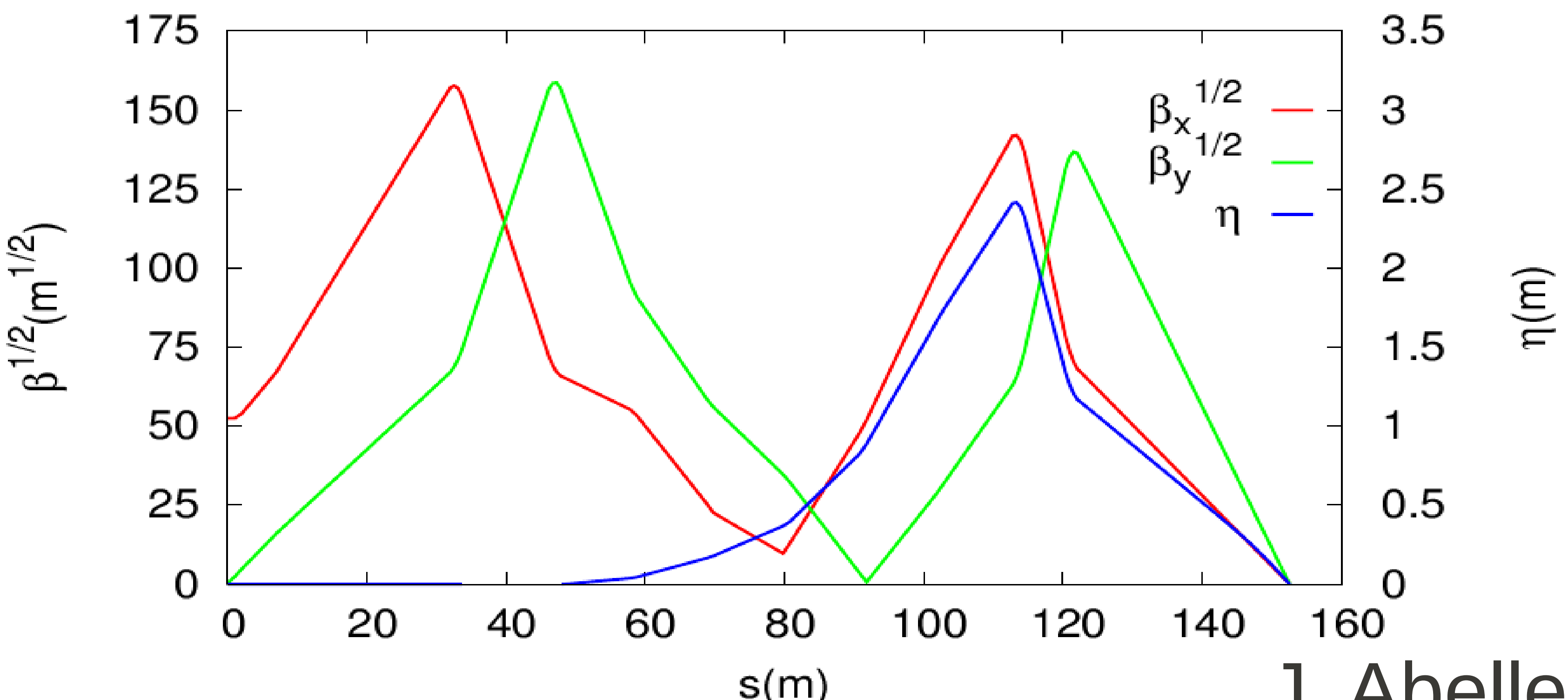


# News
# &
# Developments

# New Linac-Ring e- Final Focus with chromaticity correction

~20% more lumi and larger bandwidth but requires longer system and up to 100 kW of SR power

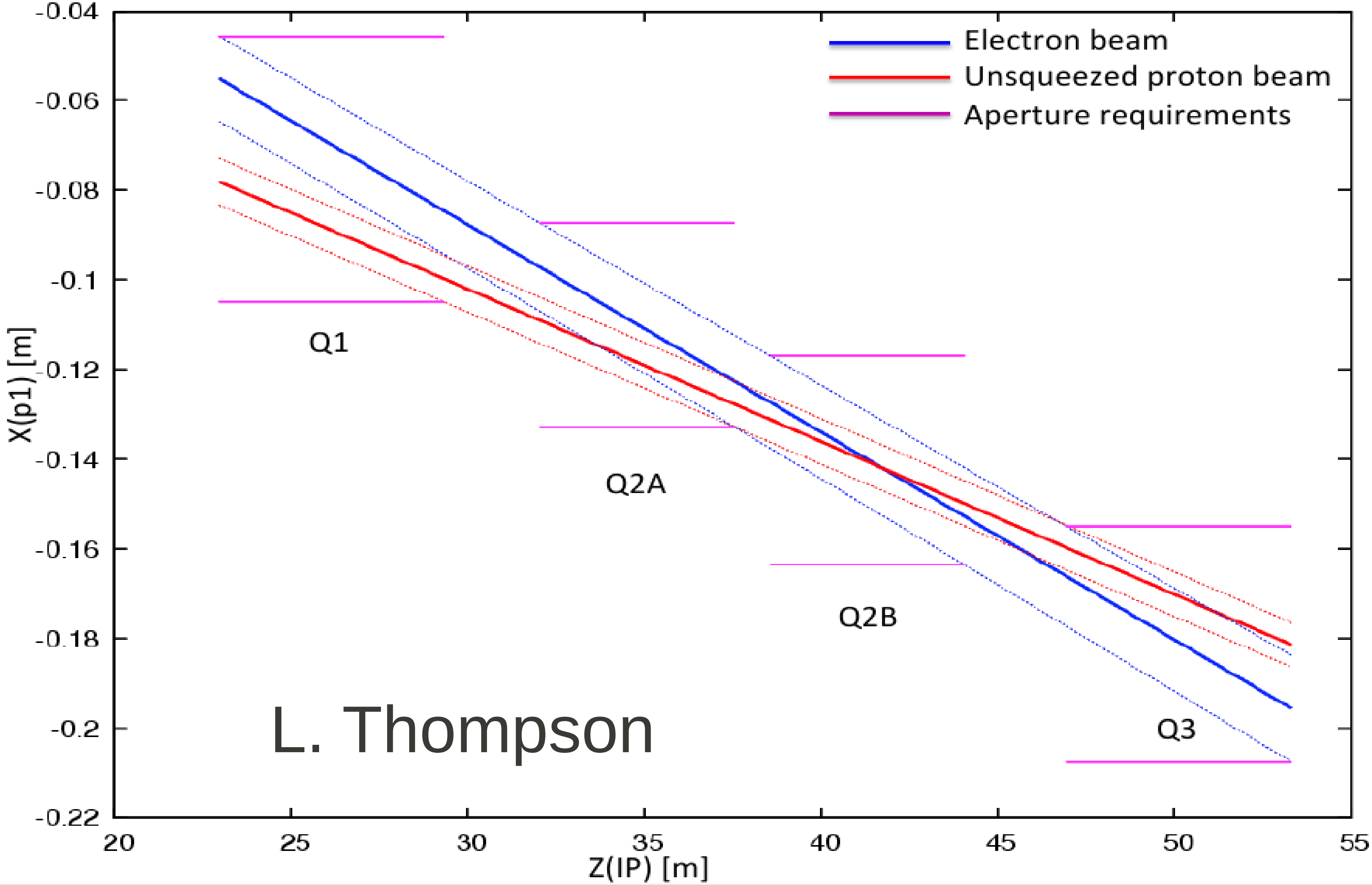





J. Abelleira

# RR full proton optics solution

Same concept as LR option, common apertures for e- and unsqueezed proton beams:



# Summary

- Exciting and challenging IR design
- CDR is out without major obstacles
- Looking forward the TDR phase:
  - Magnet design & tolerances
  - Optics developments, possibly in synergy with linear colliders
  - SR absorption and heat evacuation
  - Civil engineering