FP420 Detectors

F.Roncarolo - LOC meeting 29-01-2007

(following Brian Cox's presentation at the
Joint LHC Machine-Experiments Workshop on Very Forward Detectors)

What is FP420

- Forward Proton tagging detector in the 420m region at LHC

- Letter of Intent presented in 2005:

"By detecting protons that have lost less than 1% of their longitudinal momentum, a rich QCD, electroweak, Higgs and BSM program becomes accessible, with the potential to make measurements which are unique at LHC, and difficult even at a future linear collider."

"As the delivered luminosity reaches 10's of fb^{-1}, the double-tagged 'central exclusive' production process becomes a tool to search for new physics, delivering signal to background ratios greater than unity for Standard Model (SM) Higgs production, more than an order of magnitude larger for certain supersymmetric (MSSM) scenarios. It can provide a clear determination of the Higgs quantum numbers and excellent mass resolution, which may be necessary to resolve a nearly degenerate Higgs sector."

"The panel believed that this offers a unique opportunity to extend the potential of the LHC and has the potential to give a high scientific return." UK PPRP (PPARC)

FP420 R&D Collaboration

Spokes : Brian Cox (Manchester, ATLAS) and Albert DeRoeck (CERN,CMS)

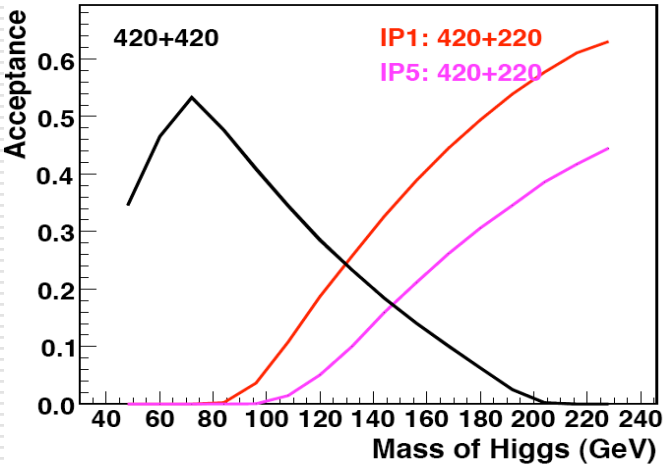
Technical Co-ordinator : Cinzia DaVia (Manchester)

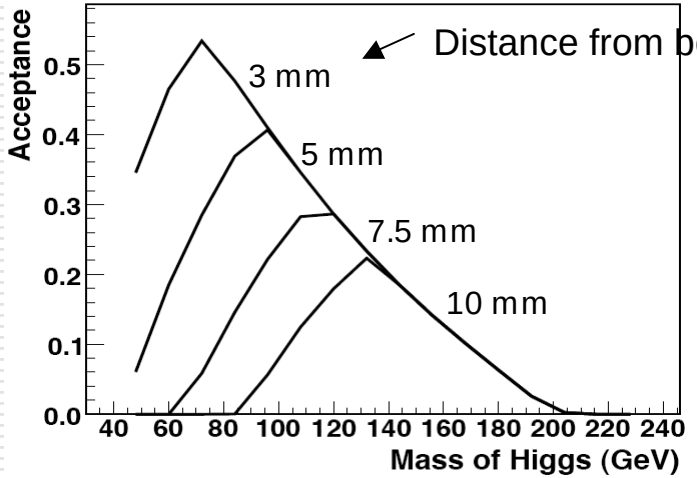
Collaboration : FNAL, The University of Manchester, University of Eastern Piedmont, Novara and INFN-Turin, The Cockcroft Institute, University of Antwerpen, University of Texas at Arlington, The University of Glasgow, University of Calabria and INFN-Cosenza, CERN, Lawrence Livermore National Laboratory, University of Turin and INFN-Turin, University of Lund, Rutherford Appleton Laboratory, Molecular Biology Consortium, Institute for Particle Physics Phenomenology, Durham University, DESY, Helsinki Institute of Physics and University of Helsinki, UC Louvain, University of Hawaii, LAL Orsay, University of Alberta, Stony Brook University, Boston University, University of Nebraska, Institute of Physics, Academy of Sciences of the Czech Republic, Brookhaven National Laboratory, University College London, Cambridge University

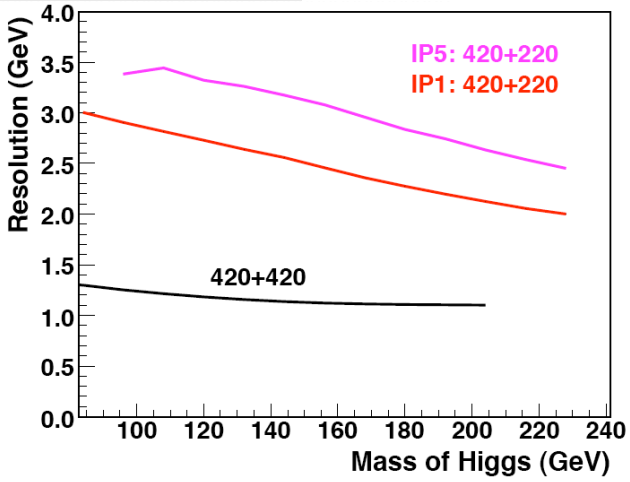
FP420 Timetable

- FP420 is an R&D collaboration between ATLAS, CMS and non-affiliated groups
- Aim is to build 420m proton taggers as upgrades to both experiments
- FP420 will produce a design report in Spring 2007
- If accepted by ATLAS and / or CMS, this will lead to TDR from experiments to LHCC in early summer 2007
- There will be no formal FP420 collaboration after this time, although we envisage creating some framework for continued co-operation in construction and installation phase
- The proton taggers will be operated and maintained like any other sub-detector component of ATLAS and CMS
- FP420 has the potential to add significantly to the discovery reach of ATLAS and CMS for modest cost, particularly in certain regions of MSSM parameter space
- There is a rich QCD and electroweak physics program in parallel with discovery physics
- FP420 is strongly supported by large physics groups with extensive experience in building and installing LHC detectors

FP420 Acceptance and Resolution

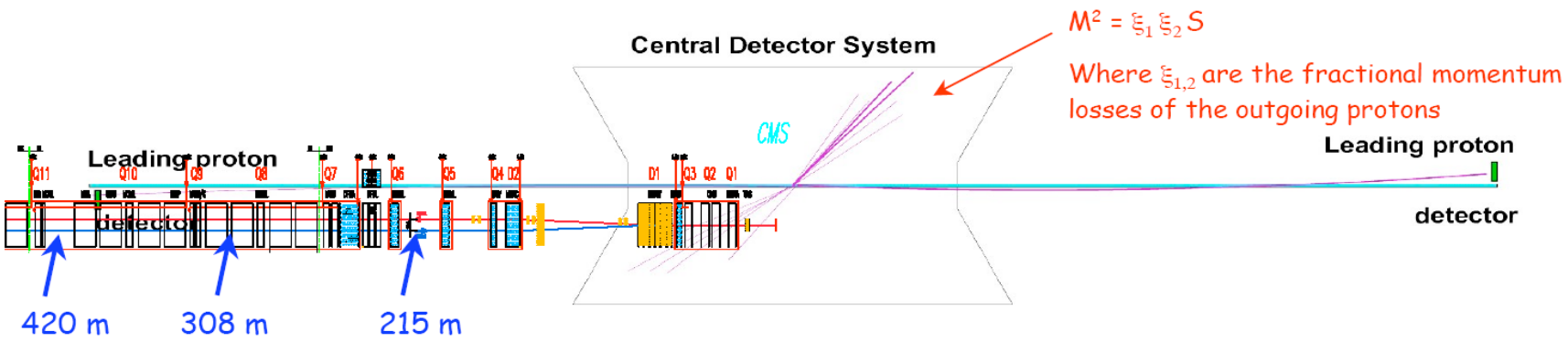






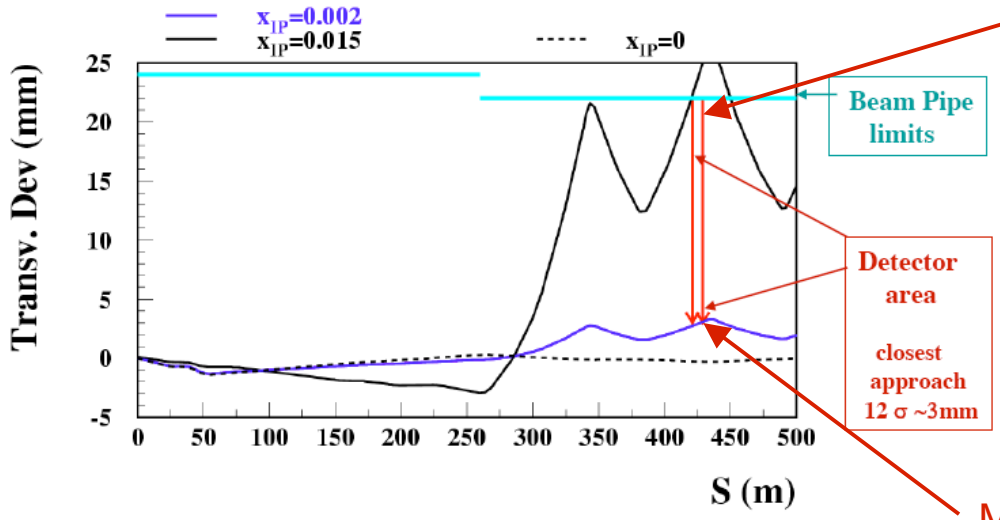
Plots : P. Bussey / W. Plano using ExHuME / FPTrack / FPTrack++

FP420 region at LHC



$M^2 = \xi_1 \xi_2 S$

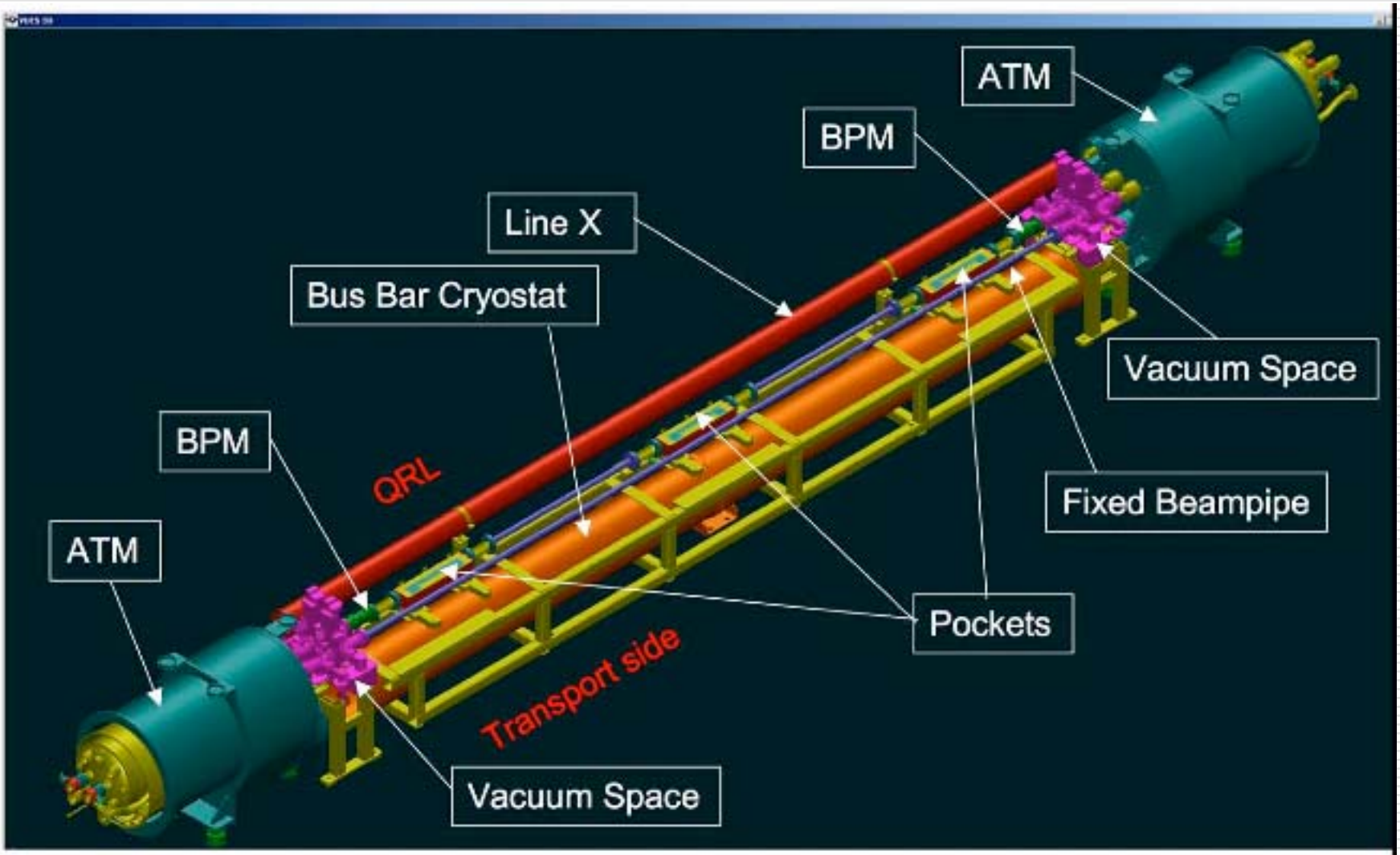
Where $\xi_{1,2}$ are the fractional momentum losses of the outgoing protons



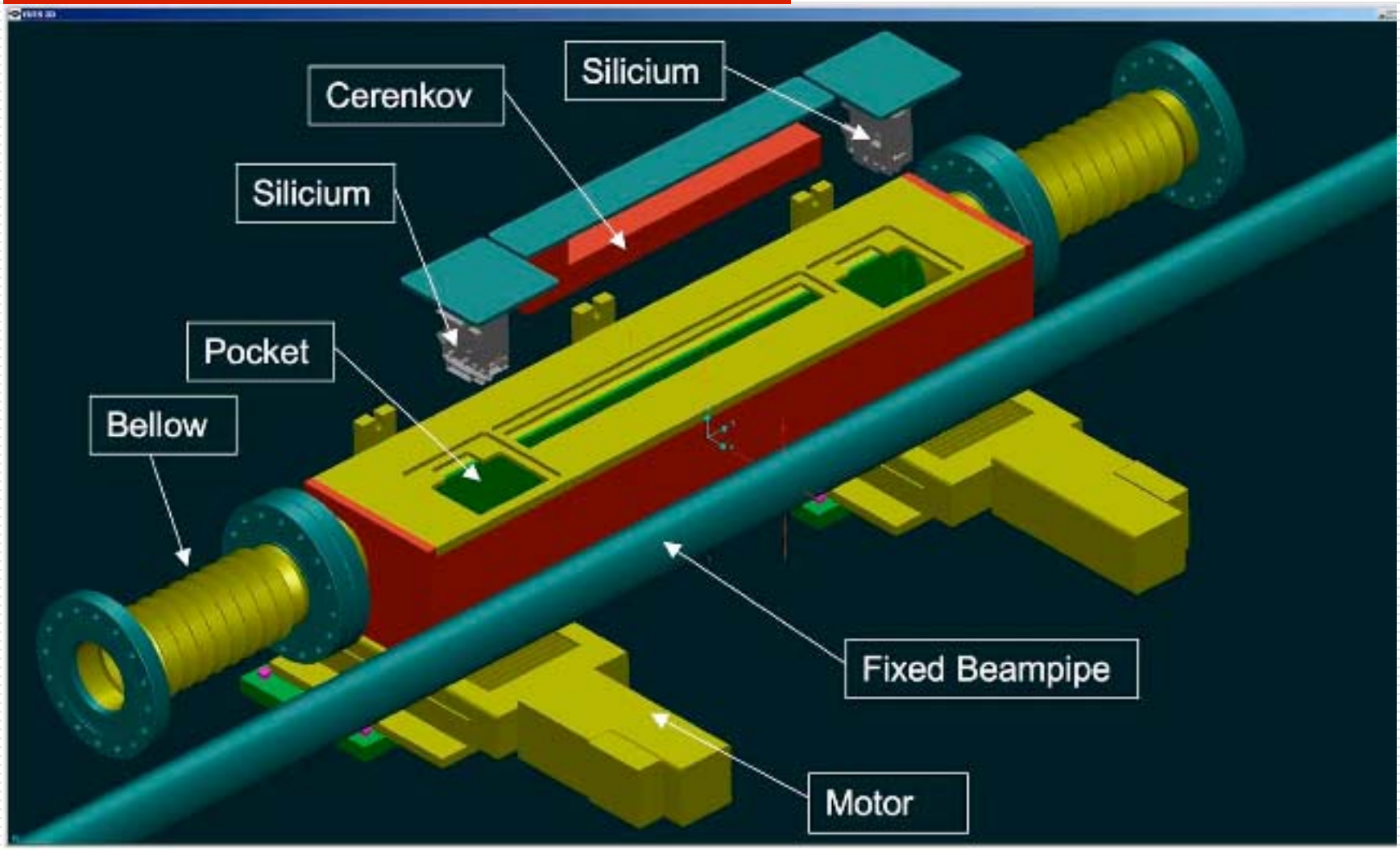
M ~ 200 GeV

M ~ 30 GeV

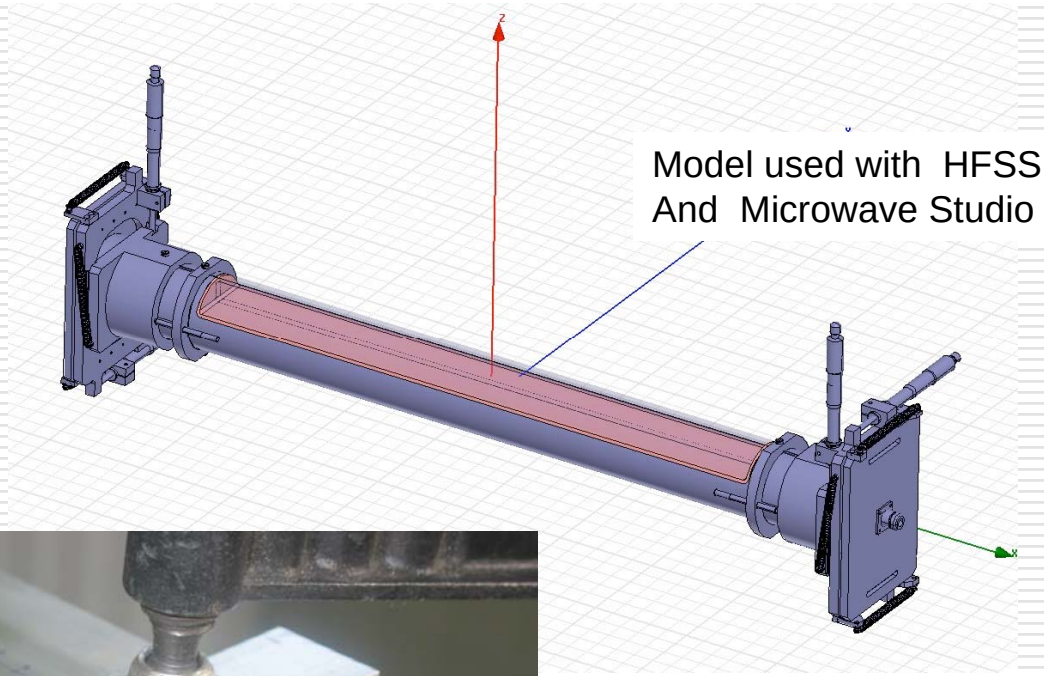
Integration in modified cryostat



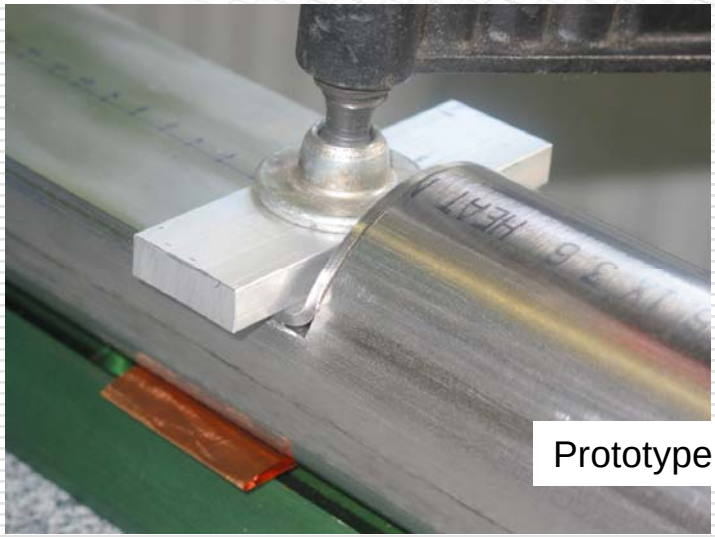
Moving pipe and detectors



Hamburg Pipe



Model used with HFSS
And Microwave Studio



Prototype shipped to Manchester

Machine Induced Background

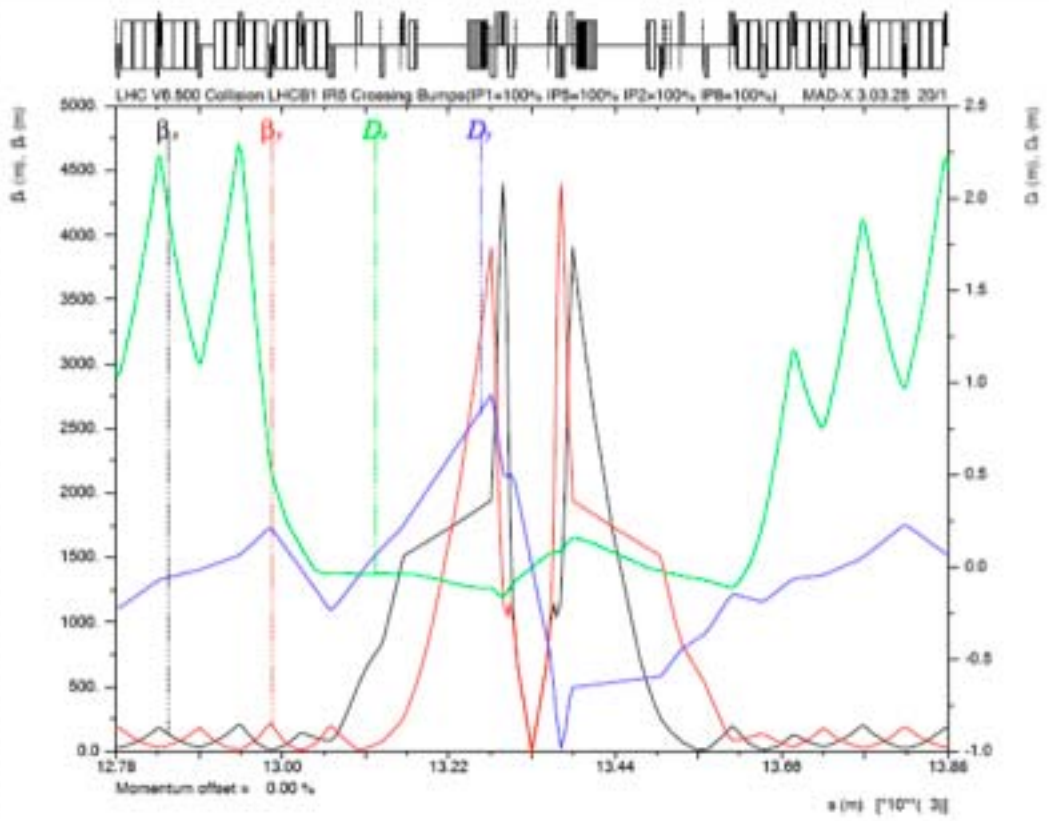
- Simulations of beam halo generated at Momentum cleaning collimators (I.Bahishev)
- Interpretation of results (K.Potter and me)
- I will show few slides I presented during the last collaboration meeting

Input

I.Baishev simulations:

- 20000 momentum cleaning events at IR3 collimators
- Track emerging off-momentum halo protons
- Count hits at FP420 location in x,x',y,y',dp/p until when all protons are absorbed at collimators or other aperture limits (NOT FP420)
- I'll show plots for FP420 IP5

Optics


LHC V6.500 Collision LHCB1 IR5 Crossing Bumps(IP1=100% IP5=100% IP2=100% IP8=100%) MAD-X 3.03.28 20/1
β_x
β_y
D_x
D_y
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
12.78
13.00
13.22
13.44
13.66
13.88
Momentum offset = 0.00 %
s (m) ["10**(3)]

Projection in X - Normalized

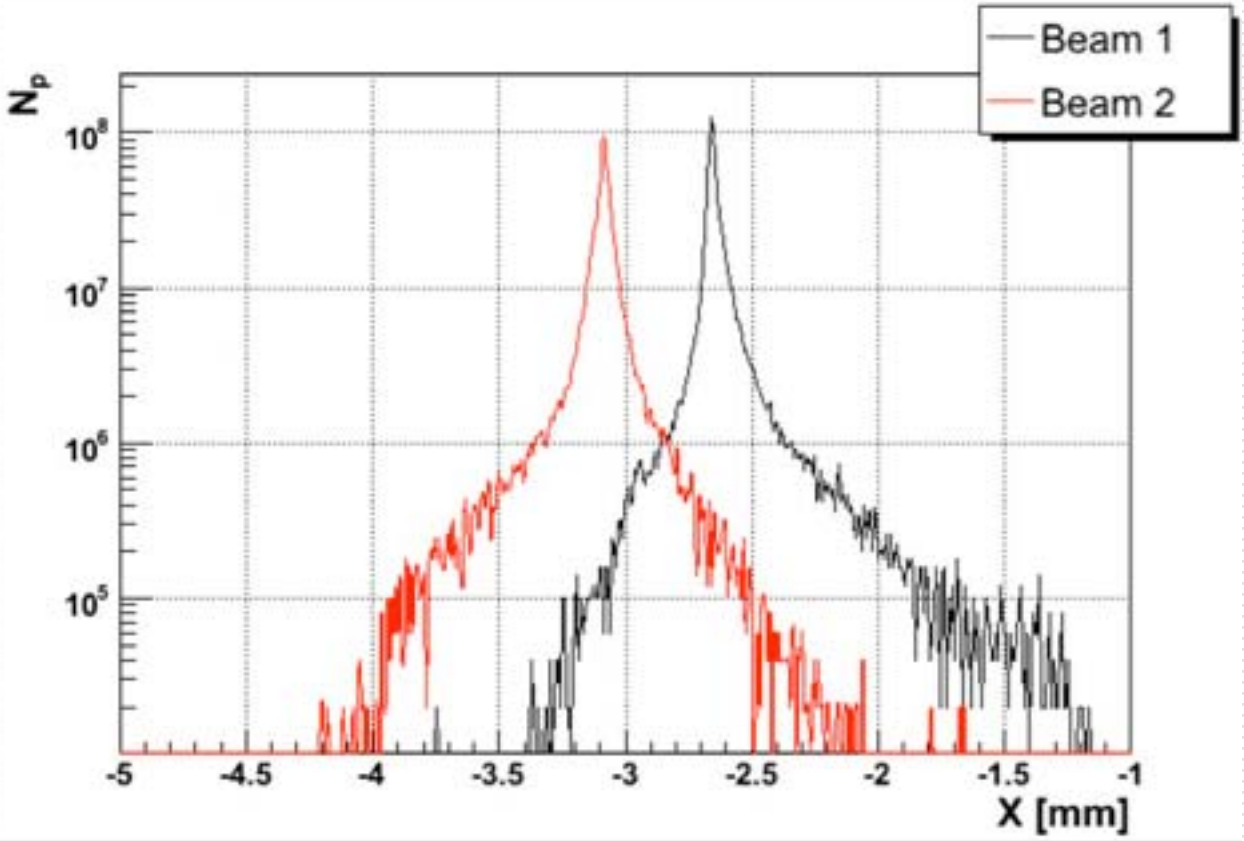
From beam Lifetime

Take:

Np/20000*LossRate

Simulation output

Simulation input



Physical beam sizes:

Sigma1=250um

Sigma2=180

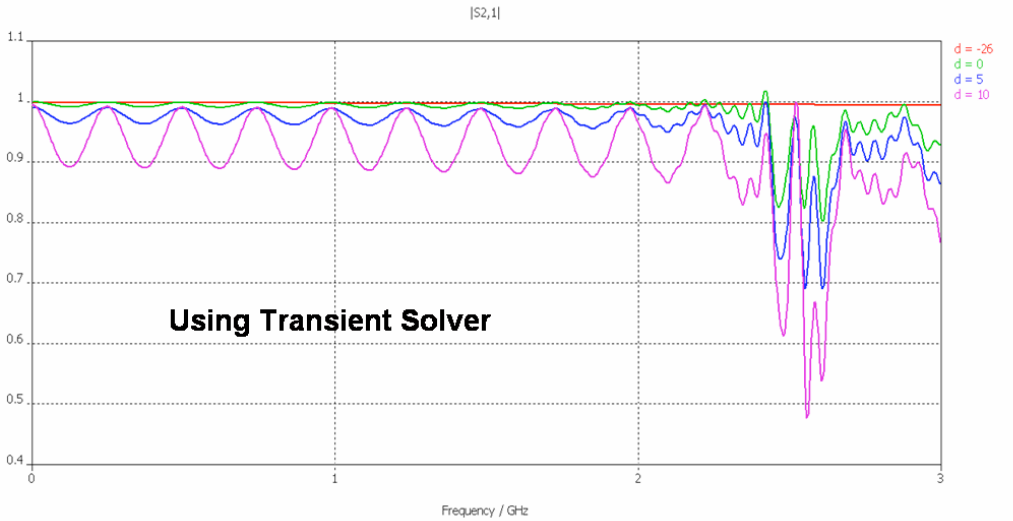
Impedance effects

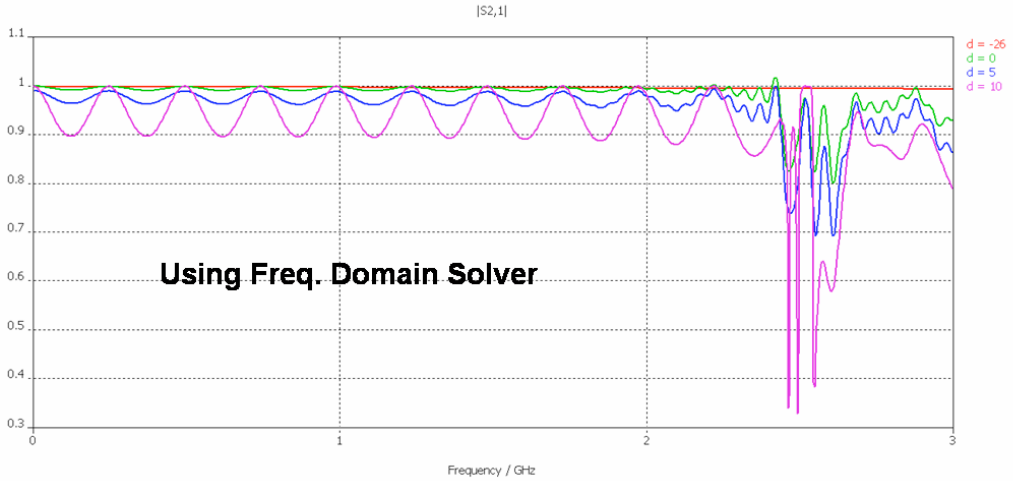
- RF simulations with HFSS and CST Microwave Studio are on going

- Stretched wire measurements are in preparation at Cockcroft Institute (Daresbury)

RF Simulations

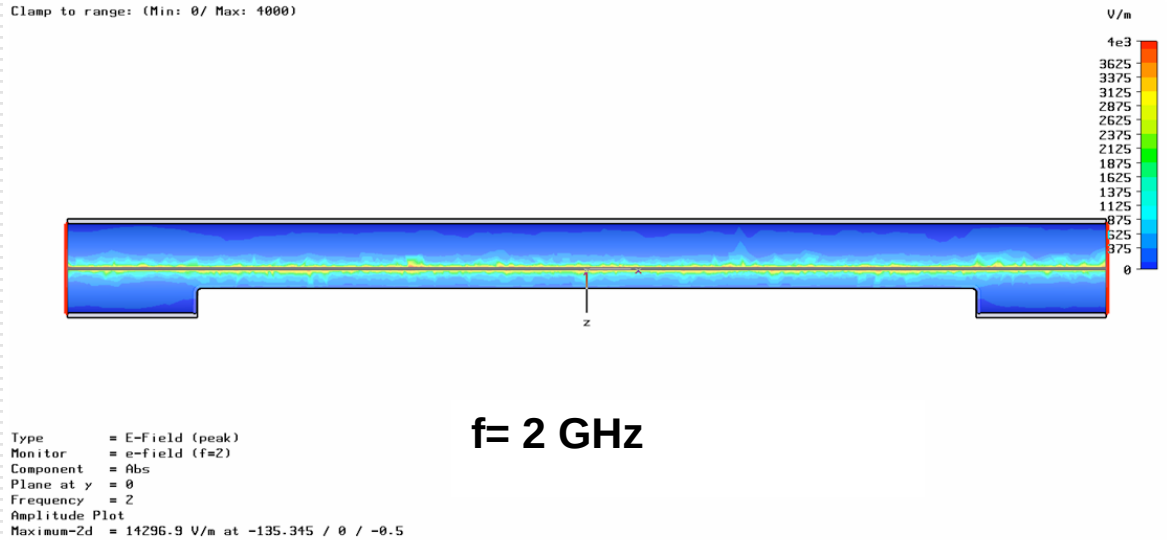
S21 parameter vs freq
--> Longitudinal impedance



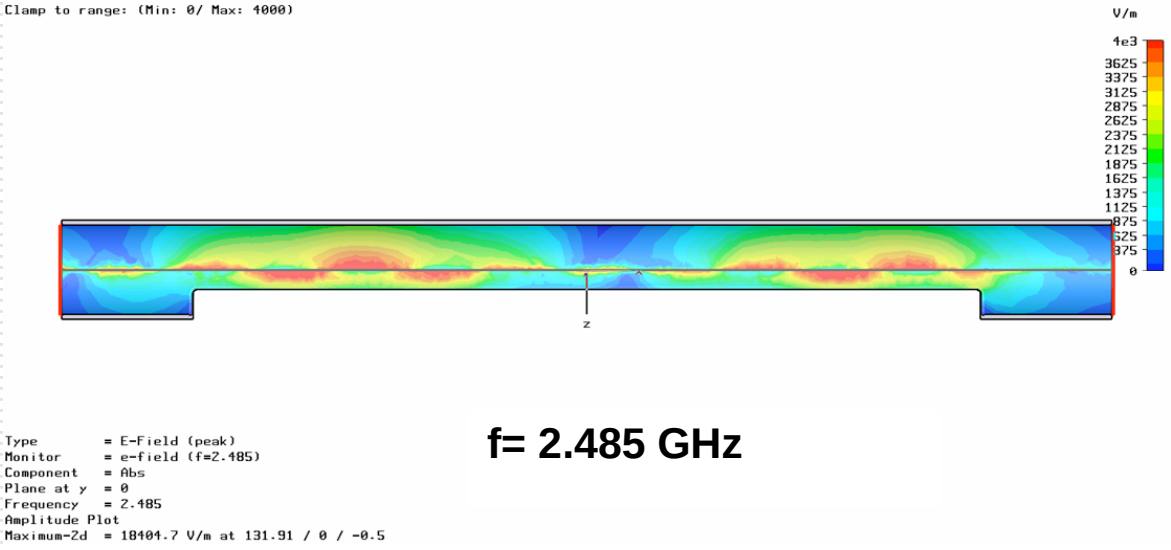


RF Simulations

E field distribution



f= 2 GHz



f= 2.485 GHz