Physics opportunities with forward detectors at the LHC

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Overview

Motivation

QCD description of hard exclusive processes

Study of SM and SUSY Higgs sector in exclusive channels

QCD measurements with forward detectors

Tests of the framework

Conclusions

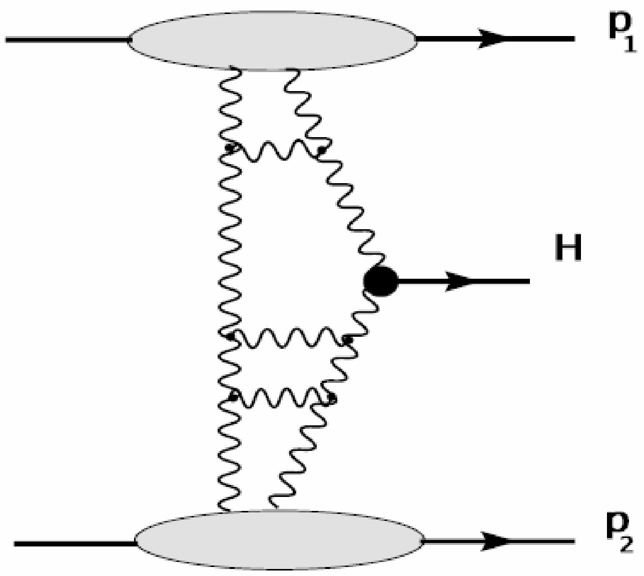
Main merits of forward detectors

$\longrightarrow$ All final state particles may be measured

$\longrightarrow$ Precise determination of kinematics and mass of the produced system, $\Delta M \sim 1$ GeV, $\Delta p_t \sim 100$ MeV

$\longrightarrow$ Extremely clean measurements, with backgrounds being substantially suppressed

$\longrightarrow$ Key process: The exclusive Higgs boson production in pp: $pp \rightarrow pHp$



$\longrightarrow$ Excellent energy resolution should be useful in determination of Higgs boson decay width and distinguishing almost degenerate Higgs boson states in some SUSY scenarios

$\longrightarrow$ Possibility to investigate quantum numbers of the produced state e.g. by observing angular correlations of the protons filtering the scalar from the pseudo-scalar: dominance of 0^{++} states

$\longrightarrow$ Very forward kinematics — detailed probe of multiple scattering at very high energies

Two Pomeron Fusion amplitude

Amplitudes to find gluon pair in the proton:

$\longrightarrow$ two-scale off-diagonal unintegrated gluon distributions are introduced:

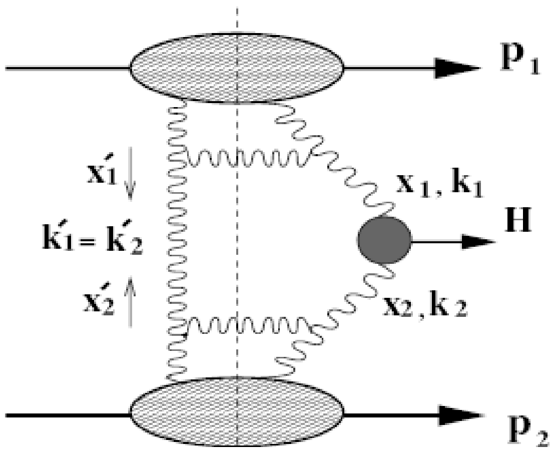
$$f_g(x, x', k, \mu), \qquad\qquad xg(x, Q^2) = \int^{Q^2} \frac{dk^2}{k^2} f_g(x, k^2, Q)$$

Sudakov form factor is naturally incorporated in f_g: [Kimber, Martin, Ryskin]

$$f_g(x, k^2; \mu) = Q^2 \frac{\partial}{\partial Q^2} \left[xg(x, Q^2) \cdot T_g(Q, \mu) \right]_{Q^2 = k^2}$$

$$f_g^{\rm off}(x, k^2; \mu) = R_\xi Q^2 \frac{\partial}{\partial Q^2} \left[xg(x, Q^2) \cdot \sqrt{T_g(Q, \mu)} \right]_{Q^2 = k^2}$$

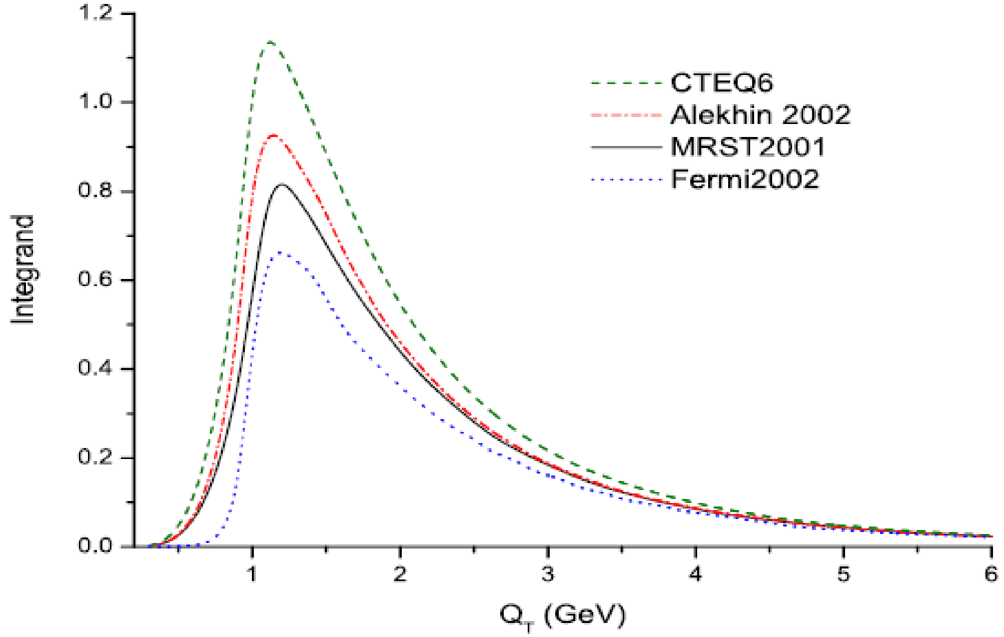
$$\mathrm{Im}\, M_0(y) \sim \int \frac{dk^2}{k^4} f_g^{\rm off}(x_1, k^2; \mu)\, f_g^{\rm off}(x_2, k^2; \mu)$$



Behaviour of the integrand:

$$\text{Im } M_0(y) \sim \int \frac{kdk}{k^4} f_g^{\text{off}}(x_1, k^2; \mu)\, f_g^{\text{off}}(x_2, k^2; \mu)$$

[J. Forshaw]



The integrand is dominated by momenta $Q_T \sim 1 - 2$ GeV

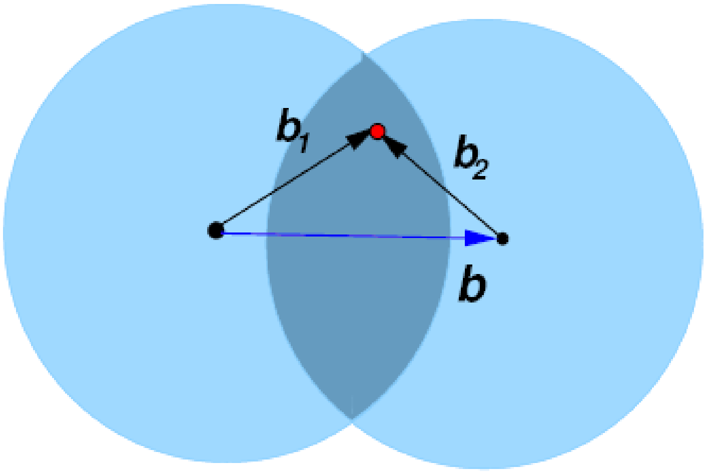
➔ **Exclusive hard diffractive production/inclusive hard production -1/100**

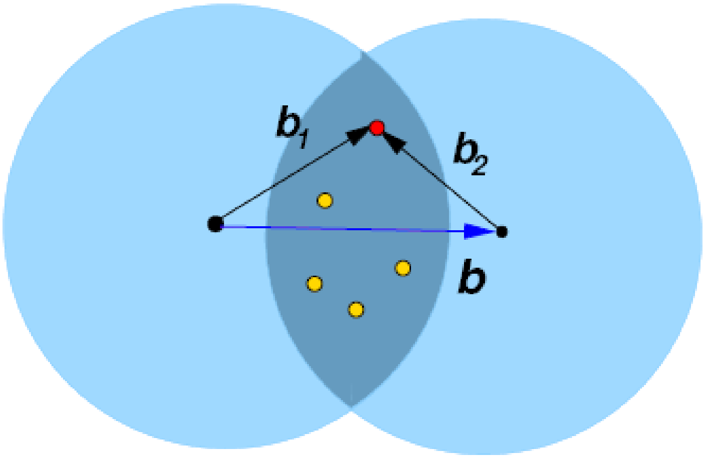
Soft gap survival

Soft rescattering corrections to a hard exclusive scattering process $\longrightarrow$ opacity $\Omega(b)$

Independence of hard production and rescattering is assumed

$$M_{corr}(b) = M_{hard}(b)[1-\Omega(b)/2+(\Omega(b)/2)^2/2!-(\Omega(b)/2)^2/3!+\ldots] \;=\; M_0(b)\ \exp(-\Omega(b)/2$$





Amplitude of matter distribution in the proton

$$S(b_1) \sim \exp(-b_1^2/R^2), \qquad R^2 \sim 8\ \mathrm{GeV}^{-2}$$

$$M_{\mathrm{hard}}(b) \;\sim\; M_0 \int d^2b_1\ S(\boldsymbol{b}_1)\, S(\boldsymbol{b}_1 - \boldsymbol{b})$$

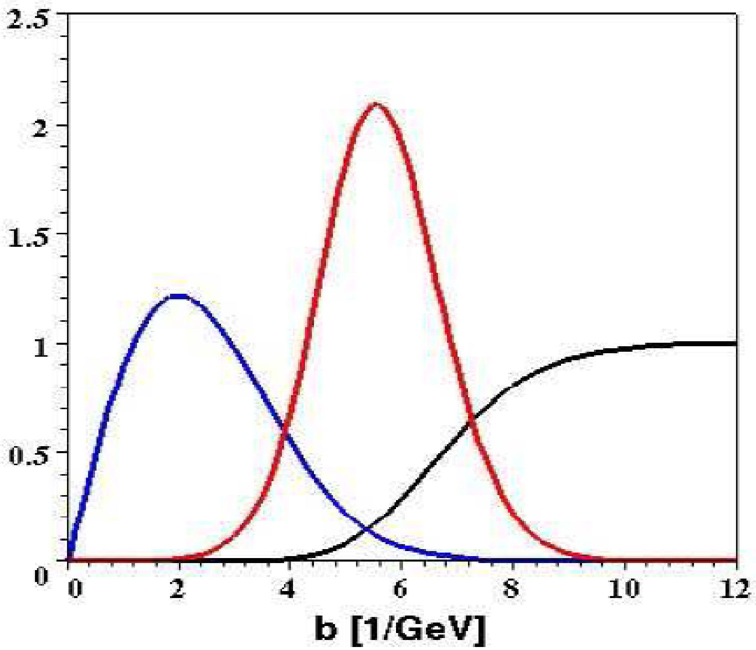
$$\sigma_{\mathrm{excl}} \;=\; \int d^2b \int d^2b_1\, |M_0\ S(\boldsymbol{b}_1)\ S(\boldsymbol{b}_1 - \boldsymbol{b})\ |^2\ \exp(-\Omega(b))$$

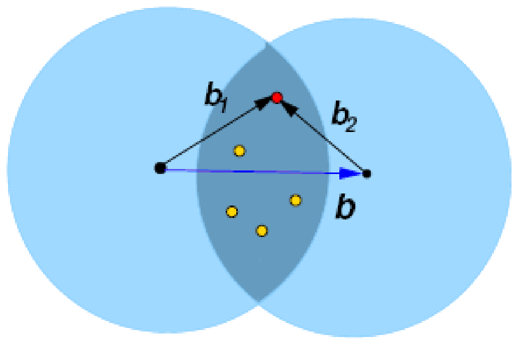
Impact parameter profile of exclusive process

Gap survival factor: $$S^2 = \frac{\int b\,db\;\exp(-\Omega(b))\,|M_{\rm hard}(b)|^2}{\int b\,db\;|M_{\rm hard}(b)|^2}$$

Exclusive Production = Hard matrix element $\times$ Amplitude of no rescattering

Production profile (red) for LHC is magnified by factor of 100



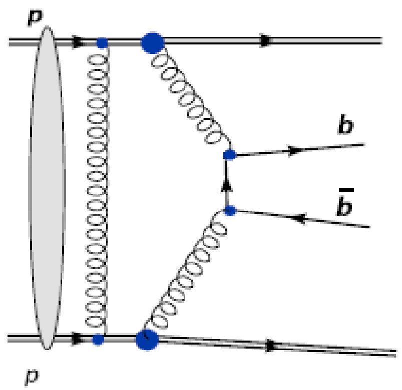


Production dominated by $b \simeq 1$ fm and $b_1 \simeq 0.5$ fm

Two-channel eikonal model of gap survival is used that incorporates low-mass diffractive intermediate states. Typically: $S^2 \simeq 0.03$ for exclusive processes at the LHC

Backgrounds

Main source irreducible of background for exclusive $H \longrightarrow bb$: direct exclusive $b\bar{b}$ production via $pp \longrightarrow ppb\bar{b}$



If both protons scatter in the forward direction — no J_z may be transfered to the produced state

The $J_z = 0$ rule: at the leading order and for massless quarks $\sigma(gg^{J_z=0} \rightarrow q\bar{q}) = 0$.

NLO, non-zero quark mass and p_t $\longrightarrow$ small cross sections: $\mathcal{O}(m_b^2/M_H^2)$ and $\mathcal{O}(p_t^2/k_t^2)$

Detailed calculation including experimental resolution $\longrightarrow$ signal to background ratio ~ 1

Tri-mixing CPX SUSY scenario

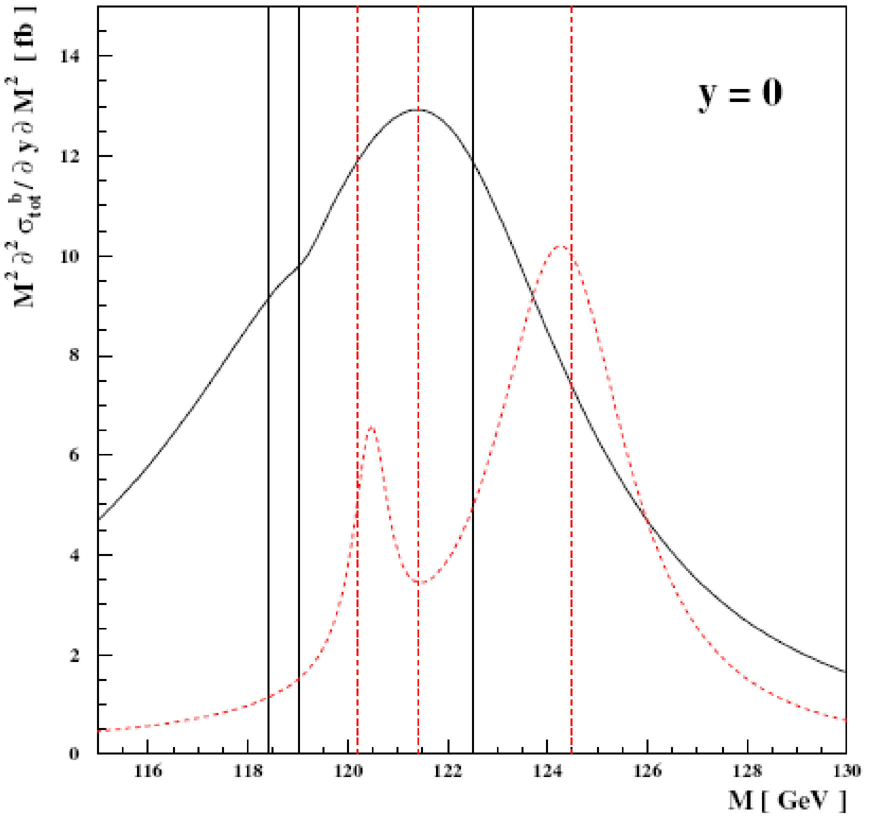
[Ellis, Lee, Pilaftsis]

Tri-mixing scenario: with $\tan\beta \simeq 50$, $M_{\rm SUSY} = 0.5$ TeV, $M_{H^\pm} \simeq 155$ GeV

H_i are nearly degenerate, $M_{H_i} \simeq 120$ GeV

CPX phase -90^o (-10^o)

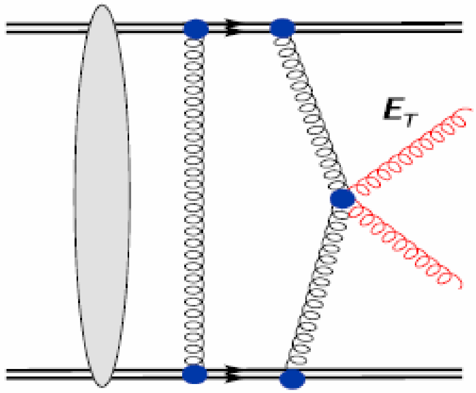
$$M^2 \frac{d\sigma}{dy\, dM^2}(pp \to pp + H \to pp + b\bar{b})$$

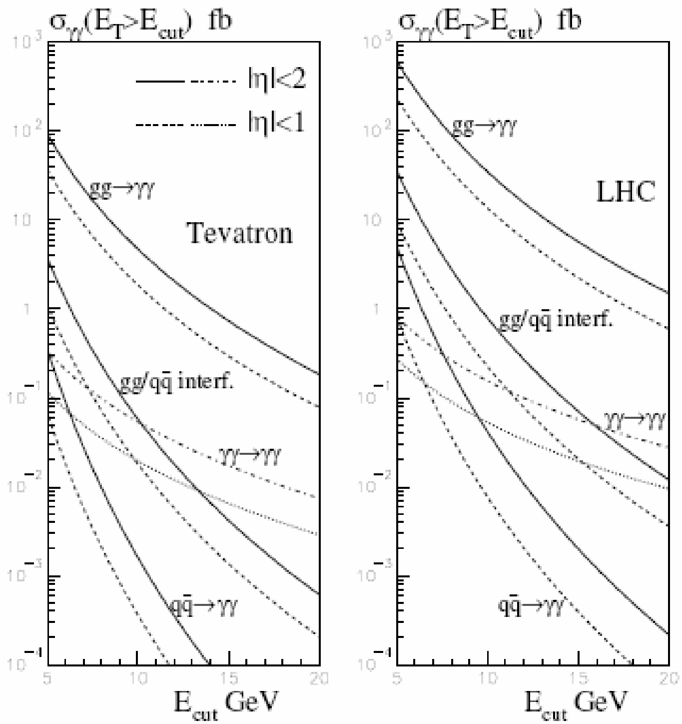


Explicit CP violation measurement should be possible in $\tau\bar{\tau}$ decay channels

Exclusive di-jets and di-photons at LHC

[Khoze, Martin, Ryskin]





Universality of the "scalar luminosity function" — calibration before exclusive Higgs measurement

Comfortably high rates, especially for di-jets:

$\sigma \sim 1$ nb for $E_T > 20$ GeV,

$\sigma \sim 0.5$ pb for $E_T > 60$ GeV, $|\eta| < 1$

For di-photons: $\sigma \sim 0.1$ pb for $E_T < 8$ GeV and $|\eta| < 2$

Precise measurements of protons' p_t $\longrightarrow$ possibility to study proton structure in the transverse plane

Excellent environment to study properties of gluonic jets

Transverse imaging of the proton

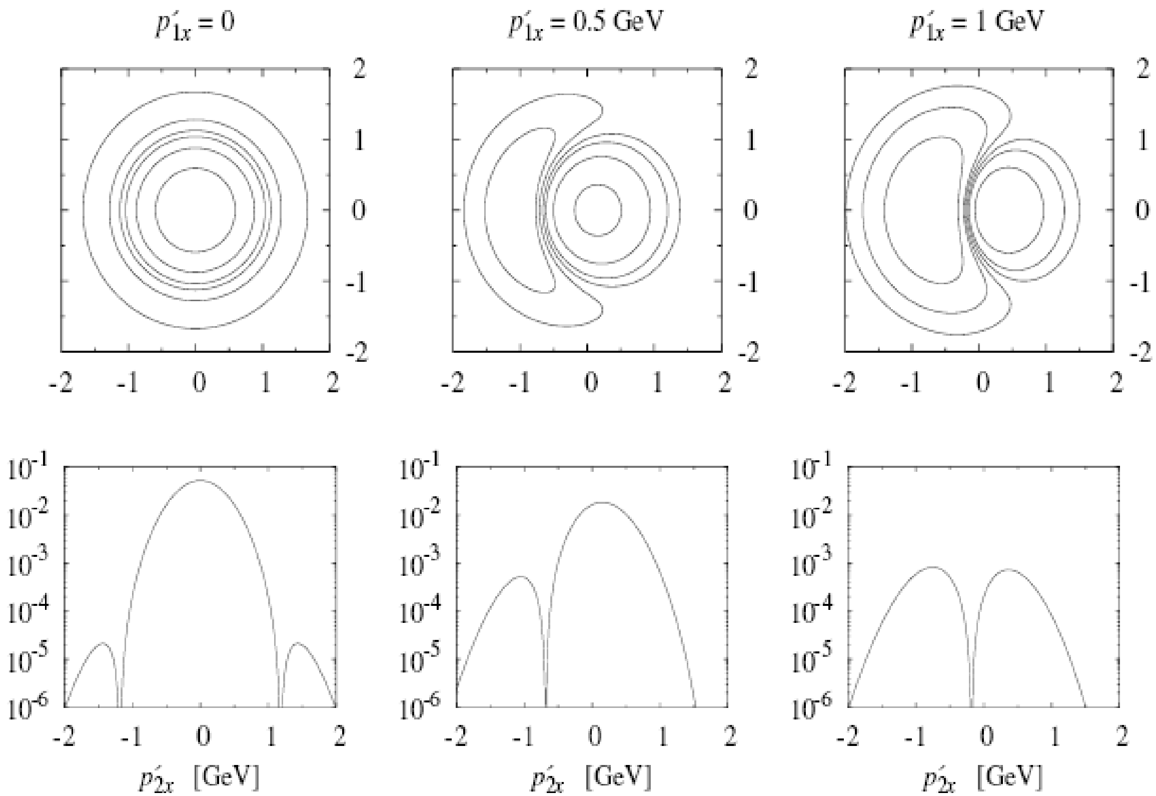
[Franfurt, Hyde-Wright, Strikman, Weiss]

Forward detectors may measure $\boldsymbol{p}_1$, $\boldsymbol{p}_2$ of scattered protons in hard exclusive production

$$\frac{d^4\sigma(pp \to ppA)}{d^2p_1\, d^2p_2}$$

Contour plots of $\boldsymbol{p}_2$ dependence and

distributions for parallel momenta $\boldsymbol{p}_1$ and $\boldsymbol{p}_2$



Differential $\boldsymbol{p}_i$ distributions may be used to probe

$\longrightarrow$ (in)dependence of production and rescattering mechanisms

$\longrightarrow$ (energy dependent) matter distribution in the proton in transverse space

$\longrightarrow$ Unique possibility to probe directly S-matrix instead of T-matrix

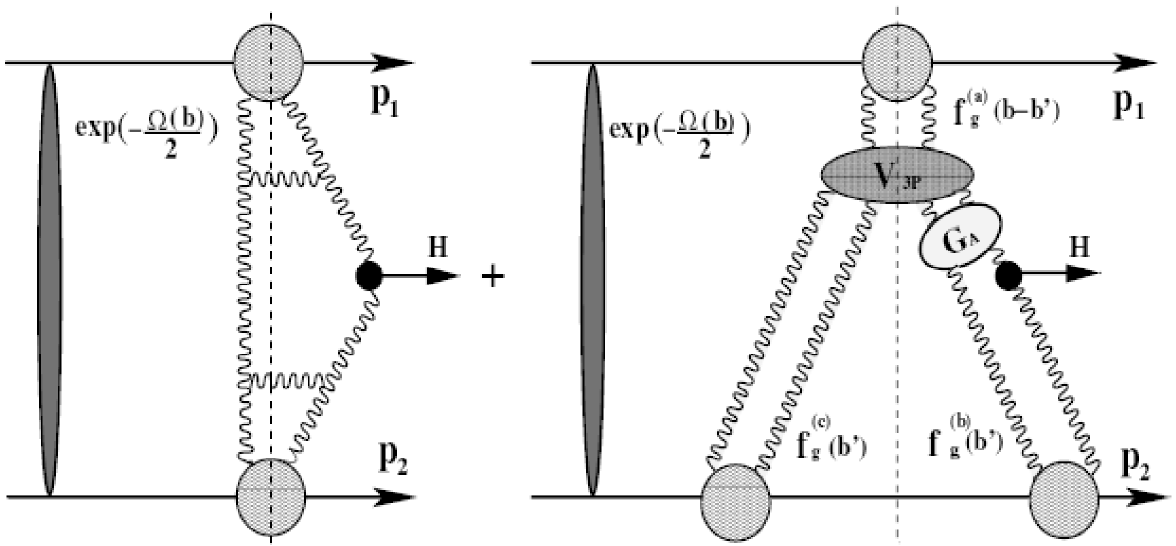
Uncertainties in hard exclusive production estimates

Basis of QCD calculations: hard production subprocess $\times$ soft rescattering

Hard production part — perturbative QCD — under good theoretical control

Soft rescattering — phenomenological, constrained by total, elastic and diffractive cross sections

$\longrightarrow$ Uncertainties: T vs S-matrix, extrapolations to the LHC energy, QCD rescattering within the hard part, possible breaking of factorisation between hard and soft part



[Bartels, Bondarenko, Kutak, LM]

$\longrightarrow$ Crude estimate of the gap survival uncertainty — factor of 2 – 4

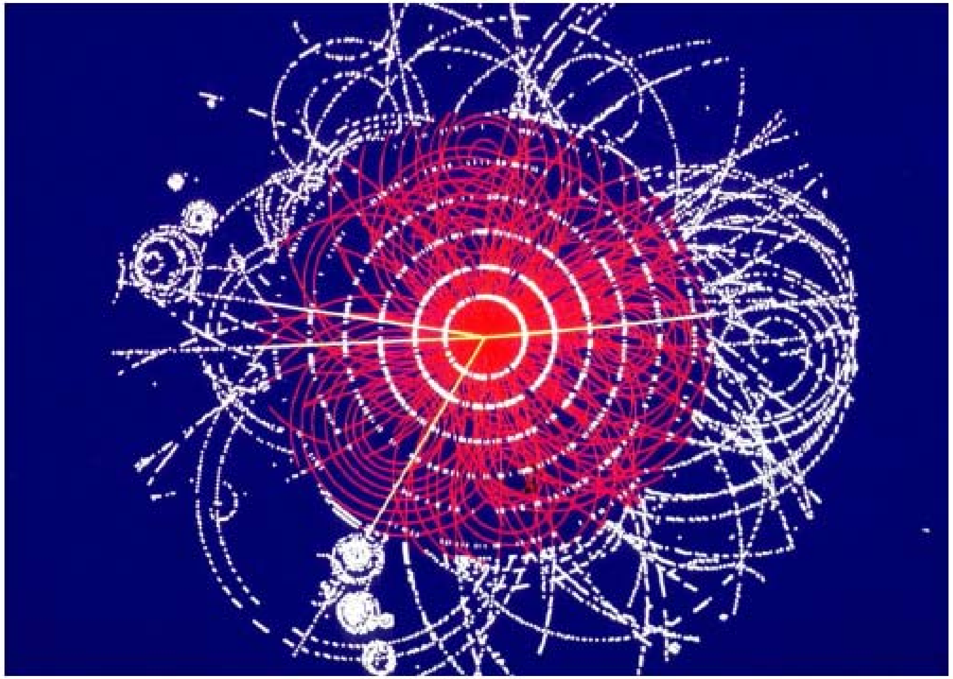
Higgs Physics at the LHC

Dieter Zeppenfeld

Universität Karlsruhe, Germany

ATLAS-DESY forward workshop, January 11, 2007

- Standard Search Channels
- Theoretical Precision
- Coupling Measurements
- CP properties
- Conclusions



Goals of Higgs Physics

Higgs Search = search for dynamics of $SU(2) \times U(1)$ breaking

- Discover the Higgs boson
- Measure its couplings and probe
  mass generation for gauge bosons and fermions

Fermion masses arise from Yukawa couplings via $\Phi^\dagger \to (0, \frac{v+H}{\sqrt{2}})$

$$\mathcal{L}_{\text{Yukawa}} = -\Gamma_d^{ij} \bar{Q}_L^{\prime i} \Phi d_R^{\prime j} - \Gamma_d^{ij*} \bar{d}_R^{\prime i} \Phi^\dagger Q_L^{\prime j} + \dots \qquad = -\Gamma_d^{ij} \frac{v+H}{\sqrt{2}} \bar{d}_L^{\prime i} d_R^{\prime j} + \dots$$

$$= -\sum_f m_f \bar{f} f \left(1 + \frac{H}{v}\right)$$

- Test SM prediction: $\bar{f} f H$ Higgs coupling strength $= m_f / v$
- Observation of $H f \bar{f}$ Yukawa coupling is no proof that v.e.v exists

Higgs coupling to gauge bosons

Kinetic energy term of Higgs doublet field:

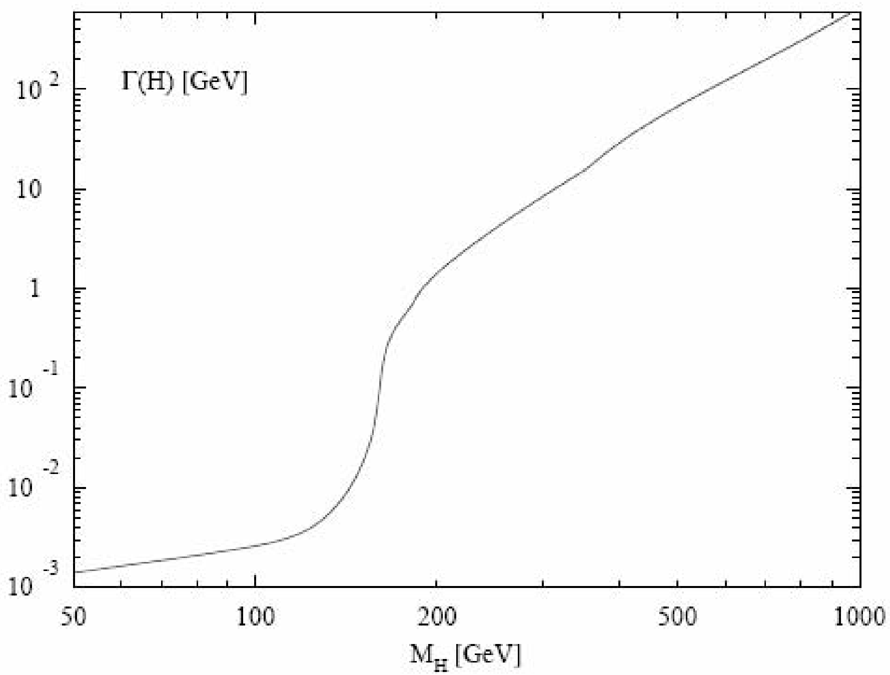
$$(D^\mu \Phi)^\dagger (D_\mu \Phi) = \frac{1}{2}\partial^\mu H \partial_\mu H + \left[\left(\frac{gv}{2}\right)^2 W^{\mu +} W^-_\mu + \frac{1}{2} \frac{(g^2 + g'^2)\, v^2}{4} Z^\mu Z_\mu \right] \left(1 + \frac{H}{v}\right)^2$$

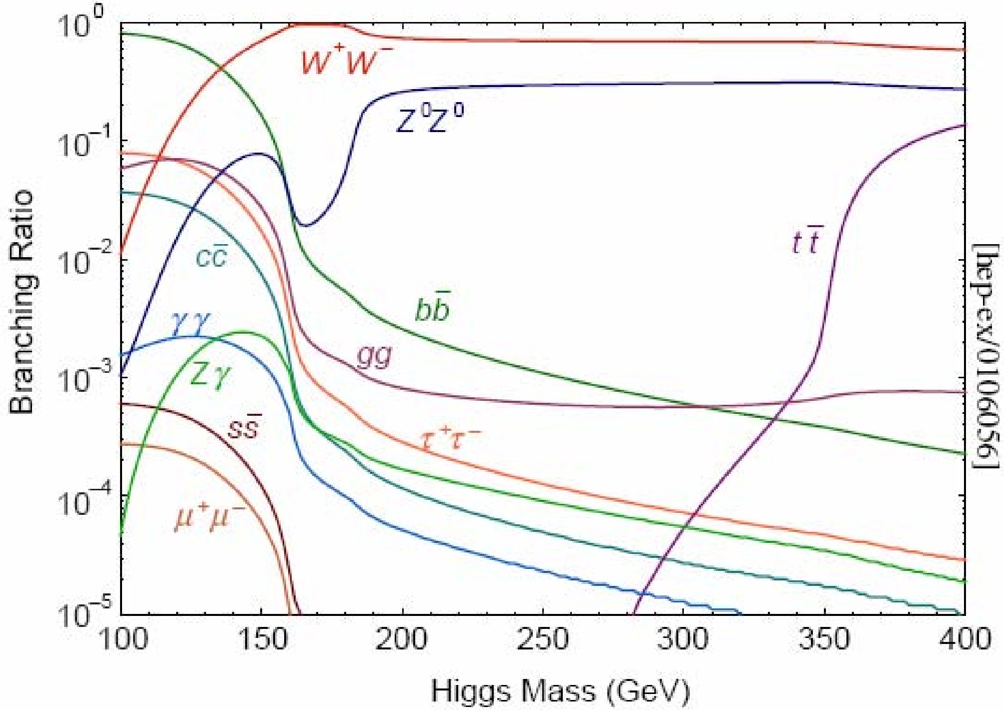
- W, Z mass generation: $m_W^2 = \left(\frac{gv}{2}\right)^2$, $m_Z^2 = \frac{(g^2+g'^2)v^2}{4}$
- WWH and ZZH couplings are generated
- Higgs couples propotional to mass: coupling strength $= 2\, m_V^2/v \sim g^2\, v$ within SM

Measurement of WWH and ZZH couplings is essential for identification of H as agent of symmetry breaking: Without a v.e.v. such a trilinear coupling is impossible at tree level

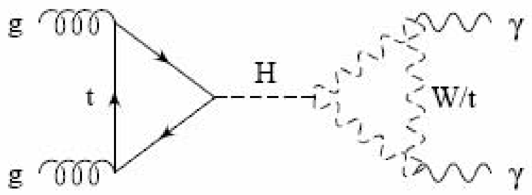
Decay of the SM Higgs

Higgs decay width and branching fractions within the SM

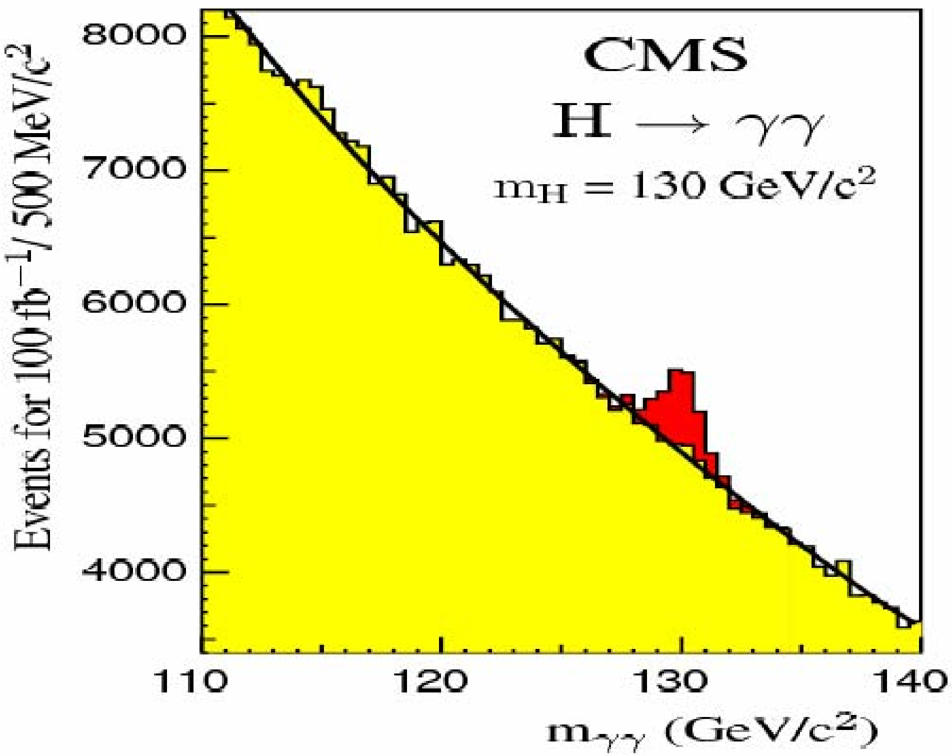




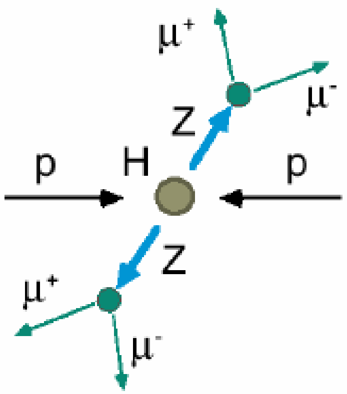
$H \to \gamma\gamma$

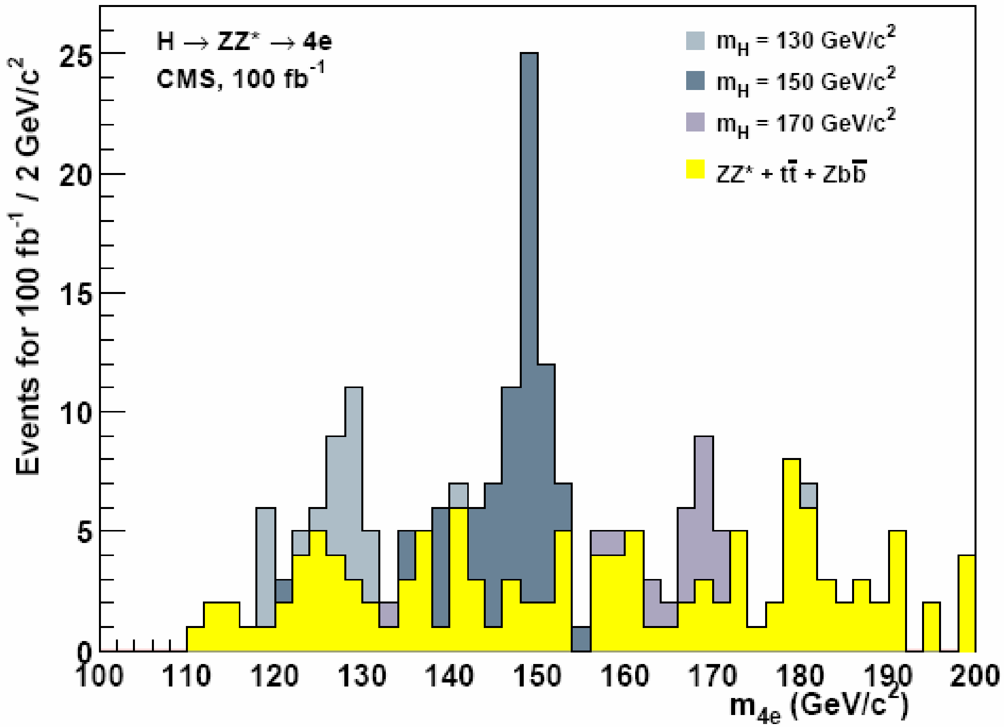


- ✗ $\mathrm{BR}(H \to \gamma\gamma) \approx 10^{-3}$
- ✗ large backgrounds from $q\bar{q} \to \gamma\gamma$ and $gg \to \gamma\gamma$
- ✓ but CMS and ATLAS will have excellent photon-energy resolution (order of 1%)
- ✓ Look for a narrow $\gamma\gamma$ invariant mass peak
- ✓ extrapolate background into the signal region from sidebands.



$H \to ZZ \to \ell^+\ell^-\ell^+\ell^-$





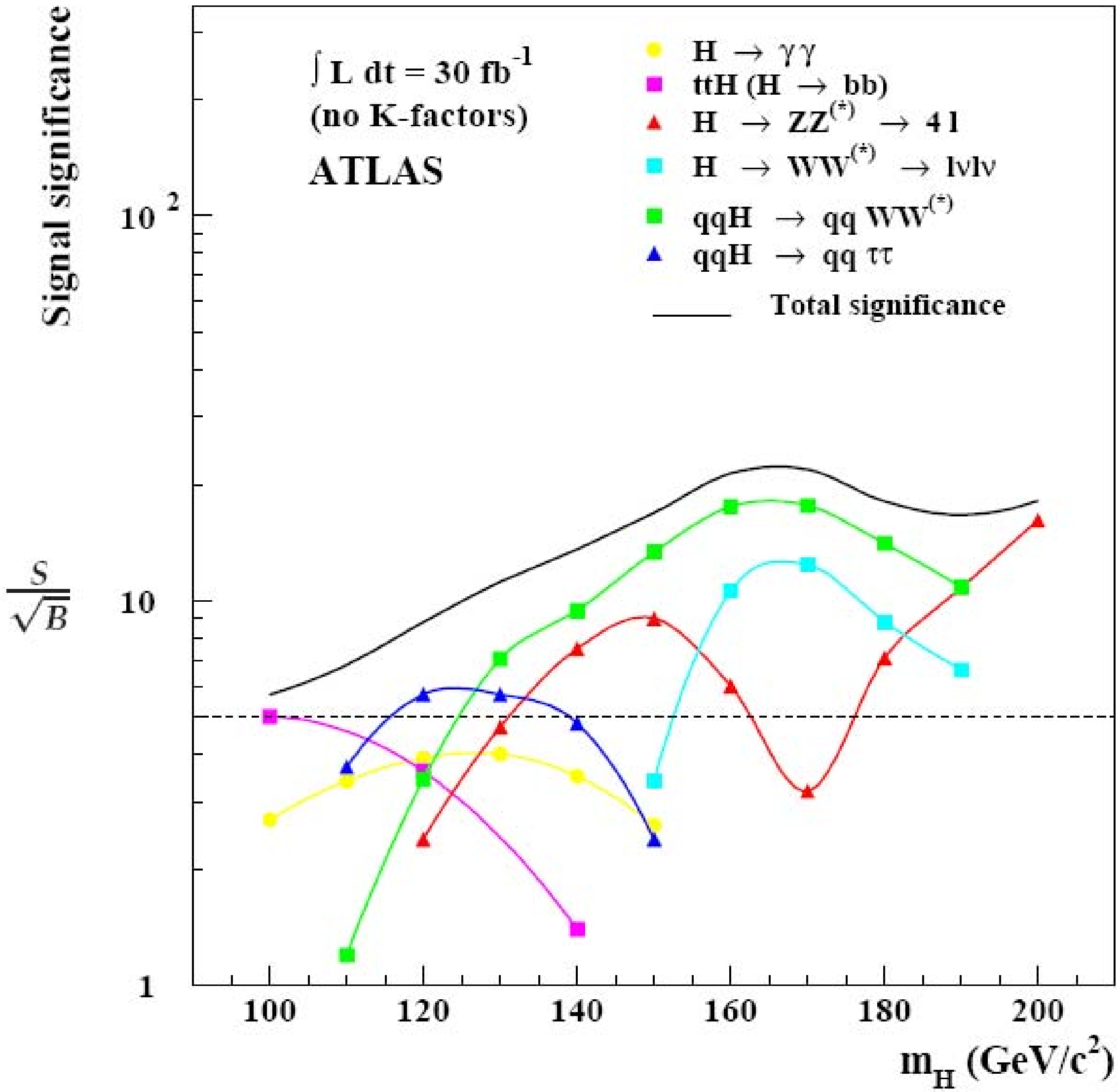
✓ invariant mass of the charged leptons fully reconstructed

For $m_H \approx 0.6$–1 TeV, use the "silver-plated" mode $H \to ZZ \to \nu\bar{\nu}\ell^+\ell^-$

✓ $\mathrm{BR}(H \to \nu\bar{\nu}\ell^+\ell^-) = 6\ \mathrm{BR}(H \to \ell^+\ell^-\ell^+\ell^-)$

✓ the large missing E_T allows a measurement of the transverse mass

Higgs discovery potential



Early measurements for Higgs physics

Discovery of Higgs boson may take 5–10 fb^{-1}, perhaps more …
It certainly requires a well understood and calibrated detector

- optimistic case: $m_H \approx 160\,\text{GeV}$, $H \to WW$
- challenging case: $m_H \approx 120\,\text{GeV}$, $H\tau\tau$ and Hbb couplings substantially enhanced by large $\tan\beta$ effects

$\Longrightarrow$ no visible $H \to \gamma\gamma$, $H \to ZZ$ or $H \to WW$ signals

$\Longrightarrow$ must search in VBF channel $qq \to qqH$, $H \to \tau\tau$ or in $t\bar{t}H$, $H \to b\bar{b}$

Measuring Higgs couplings at LHC

LHC rates for partonic process $pp \to H \to xx$ given by $\sigma(pp \to H) \cdot BR(H \to xx)$

$$\sigma(H) \times \mathrm{BR}(H \to xx) = \frac{\sigma(H)^{\mathrm{SM}}}{\Gamma_p^{\mathrm{SM}}} \cdot \frac{\Gamma_p \Gamma_x}{\Gamma} \,,$$

Measure products $\Gamma_p \Gamma_x / \Gamma$ for combination of processes ($\Gamma_p = \Gamma(H \to pp)$)

Problem: rescaling fit results by common factor f

$$\Gamma_i \to f \cdot \Gamma_i \,, \qquad \Gamma \to f^2 \Gamma = \sum_{obs} f \Gamma_i + \Gamma_{rest}$$

leaves observable rate invariant $\Longrightarrow$ no model independent results at LHC

Loose bounds on scaling factor:

$$f^2 \Gamma > \sum_{obs.} f \Gamma_x \qquad \Longrightarrow \qquad f > \sum_{obs.} \frac{\Gamma_x}{\Gamma} = \sum_{obs.} BR(H \to xx) (= \mathcal{O}(1))$$

Total width below experimental resolution of Higgs mass peak ($\Delta m = 1 \ldots 20$ GeV)

$$f^2 \Gamma < \Delta m \qquad \Longrightarrow \qquad f < \sqrt{\frac{\Delta m}{\Gamma}} < \mathcal{O}(10 - 40)$$

Absolute branching ratio measurement from $pp \to ppH$?

- Observe inclusive Higgs mass peak in recoil invariant mass spectrum
- For these events measure fraction with two b jets in central detector or other high branching ratio Higgs signal

Alternative if trigger on central event is required:

- Observe Higgs mass peak in recoil invariant mass spectrum for e.g. bb and WW signatures in central detector
- Ratio of rates gives ratio of partial widths, e.g. Γ_b/Γ_W

Obtain information on $\Gamma_b = \Gamma(H \to bb)$

$\Longrightarrow$ improved bound on

$$f > \sum_{obs.} \frac{\Gamma_x}{\Gamma} = \sum_{obs.} BR(H \to xx)$$

Note: need ≥ 100 events for competitive statistical errors

Conclusions

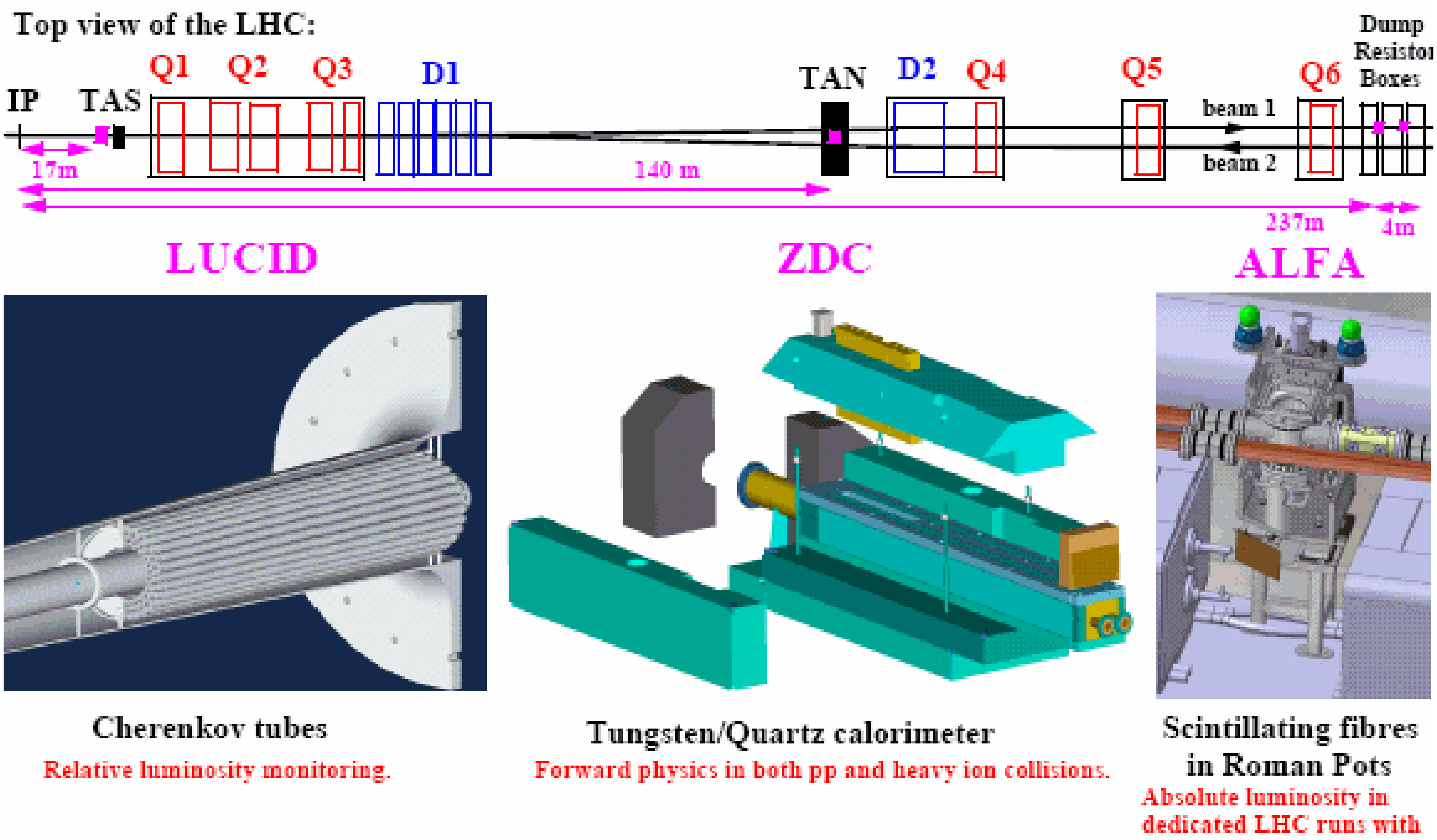
- LHC will observe a SM-like Higgs boson in multiple channels, with $5 \ldots 20\%$ statistical errors
  $\Longrightarrow$ great source of information on Higgs couplings
- Higgs boson CP properties and structure of the HVV and Hgg vertices can be obtained from jet-angular correlations in WBF and gluon fusion
- Obtaining direct information on $H \to bb$ is very difficult. Can $pp \to ppH$ help?

ATLAS Forward Detectors

DESY 11/1 /2007

Per Grafstrom

ATLAS Forward Detectors



Absolute luminosity measurements-why?

- Cross sections for “Standard “ processes
  - t-tbar production
  - W/Z production
  - …….

Theoretically known to better than 10% ……will improve in the future

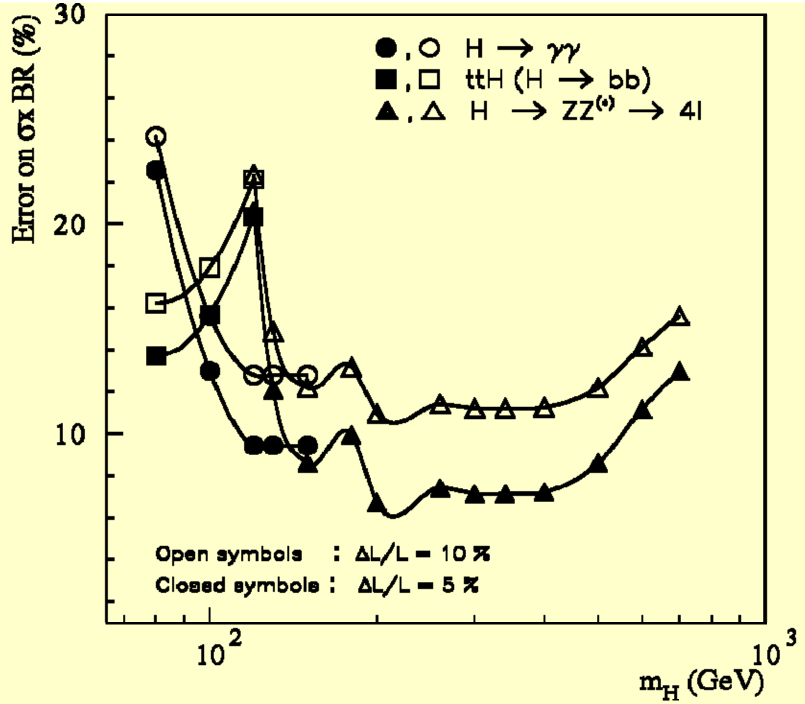
- New physics manifesting in deviation of σ x BR relative the Standard Model predictions

- Important precision measurements
  - Higgs production σ x BR
  - tanβ measurement for MSSM Higgs
  - …….

Absolute Luminosity Measurement (cont.)

Examples

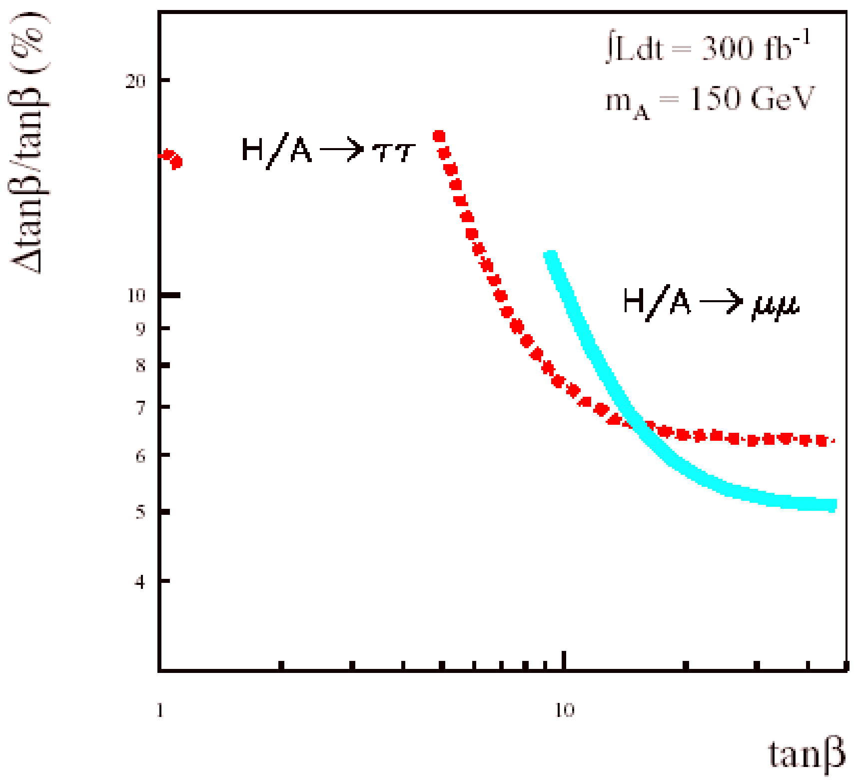
Higgs coupling



Relative precision on the measurement of $\sigma_H \times$BR for various channels, as function of m_H, at $\int Ldt$ = 300 fb^{-1}. The dominant uncertainty is from Luminosity: 10% (open symbols), 5% (solid symbols).

(ATLAS-TDR-15, May 1999)

tanβ measurement



Systematic error dominated by luminosity (ATLAS Physics TDR)

Absolute Luminosity Measurement (cont.)

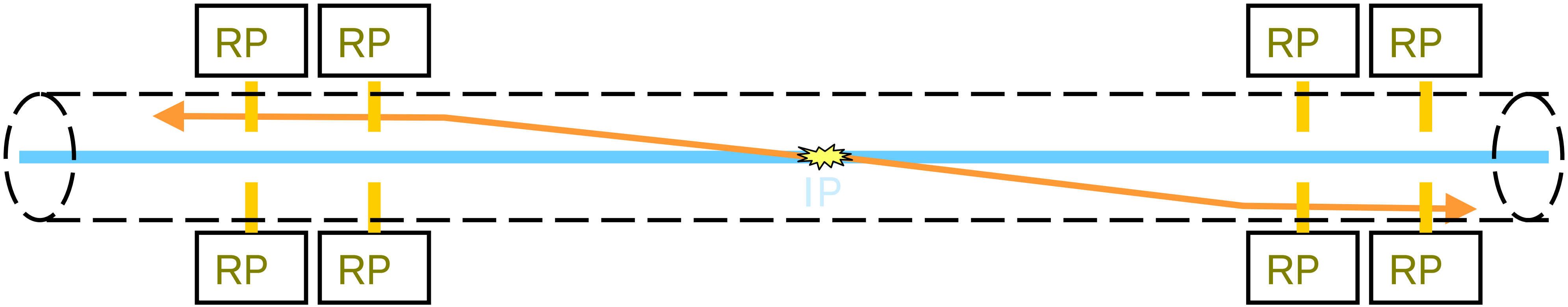
- Goal:
  - measure L with $\lesssim$ 2-3% accuracy
- How:
  - LHC Machine parameters
  - Use ZDC in heavy ion runs to understand machine parameters
  - rates of well-calculable processes:
    e.g. QED, QCD
  - optical theorem: forward elastic rate + total inelastic rate: **Use Roman Pots**
    - needs ~full |η| coverage-ATLAS coverage limited
    - Use σ_{tot} measured by others (TOTEM)
    - Combine machine luminosity with optical theorem
  - luminosity from Coulomb Scattering **Use Roman Pots**

ATLAS pursuing all options

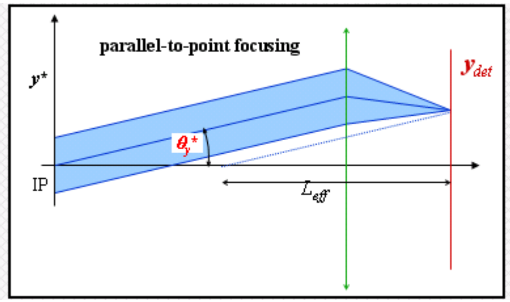
ATLAS Roman Pots

- Goal: Determine absolute luminosity at IP1 (2-3% precision)

- Measure elastic rate dN/dt in the Coulomb interference region (à la UA4). $|t|\sim0.00065\ GeV^2$ or $\Theta \sim 3.5$ microrad.



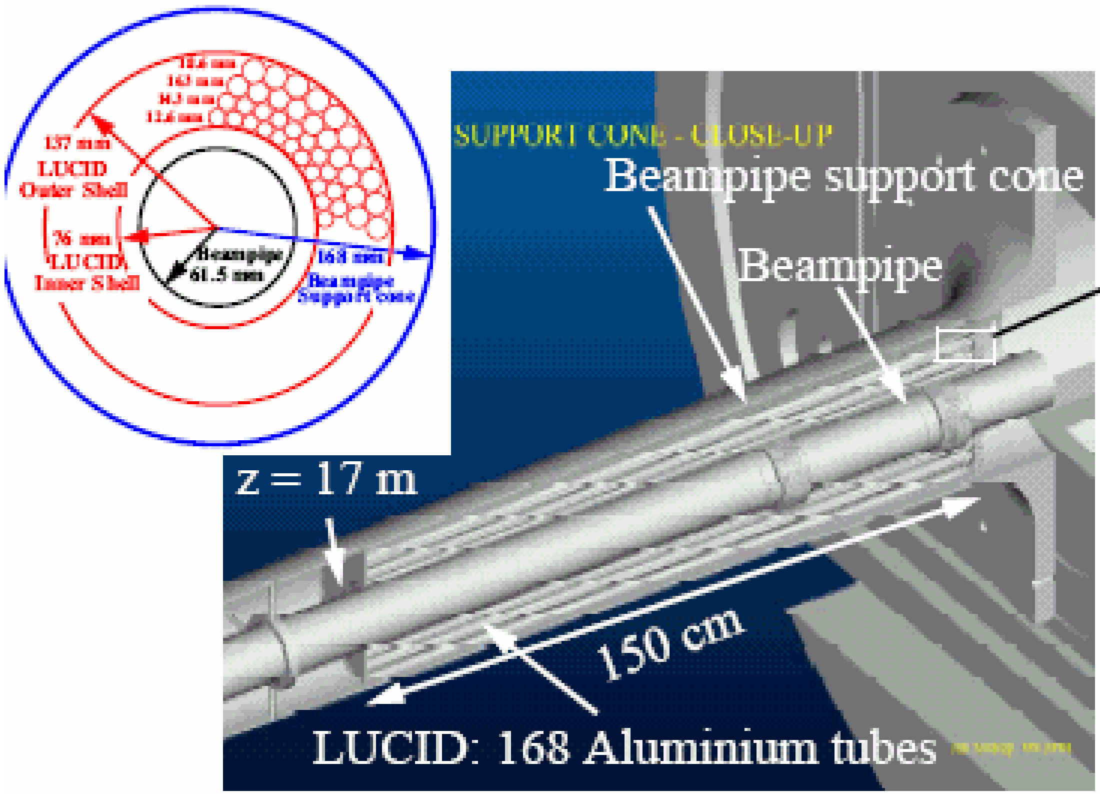
This requires (apart from special beam optics)
- to place detectors ~1.5 mm from LHC beam axis
- to operate detectors in the secondary vacuum of a Roman Pot
- spatial resolution $s_x = s_y$ well below 100 micron (goal 30 micron)
- no significant inactive edge (< 100 micron)

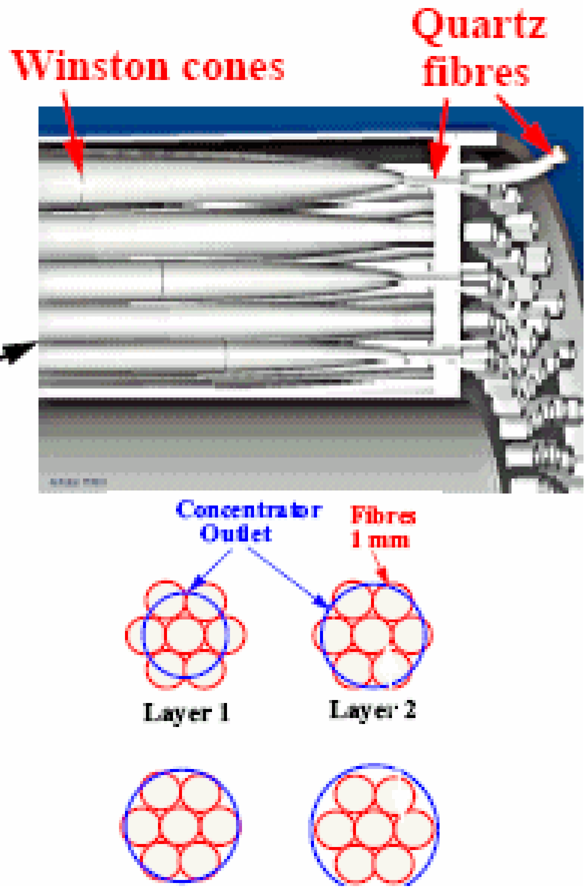


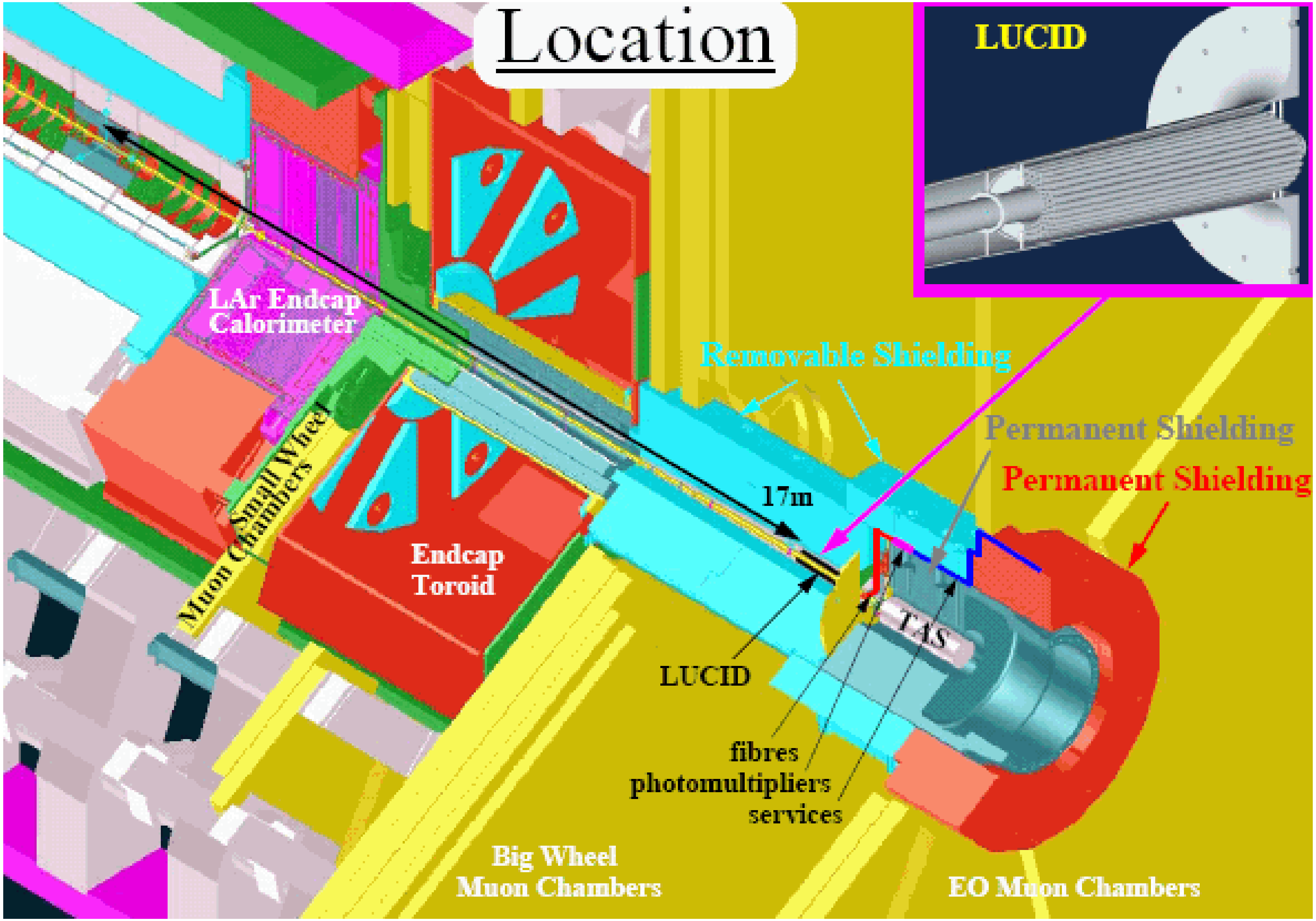
LUCID

LUCID: LUminosity measurement using a Cherenkov Integrating Detector

The two LUCID detectors consist each of 168 gasfilled (isobutane) aluminium tubes. The Cherenkov light in the tubes is read out by 1176 optical fibres that are connected to multianode photomultipliers.






Location
LUCID
LAr Endcap
Calorimeter
Removable Shielding
Permanent Shielding
Permanent Shielding
Small Wheel
Muon Chambers
17m
Endcap
Toroid
TAS
LUCID
fibres
photomultipliers
services
Big Wheel
Muon Chambers
EO Muon Chambers

Detector characteristic

The detector design is simple, robust and relatively cheap and it is based on an existing luminosity monitor at CDF.

The detector iself is very radiation hard which is important since it will see 60-70 kGray per year. The radiation hardness of the fibres needs, however, to be tested.

It is insensitive to soft background particles (the Cherenkov threshold is 2.7 GeV for pions and 9 MeV for electrons).

A good time resolution makes it possible to resolve individual beam crossings and to measure the luminosity of individual bunches in the LHC.

The pointing capability will help in reducing the background.

From pulseheight measurements it should be possible to measure if one or several particles have gone through a Cherenkov tube. This is important since at 10^{34} cm^{-2}s^{-1} there will be 25 inelastic interactions per bunch crossing and the basic principle of the detector is that the number of charged particles in the detector is proportional to the number of inelastic interactions.

Status and Plans

Testbeam studies at DESY in 2005 have verified the basic detector concept (efficiency and light yield of Kuraray SCSF-78 fibres, 4 photoelectrons, low optical cross talk, 36μm spatial resolution, sufficient edge sensitivity, 99% track reconstruction efficiency etc.).

A prototype of the read-out electronics was evaluated in a testbeam at CERN in October 2006. The basic design was shown to work but problems with cross talk and connectivity are still under study.

The design of the mechanics of the ATLAS Roman Pot unit is ready. A pre-production unit made by Vakuum Praha is at CERN for evaluation. The pot itself will be designed and manufactured by CERN.

The cabling of the detector in the LHC tunnel is finished.

Next step is to write a Technical Design Report.

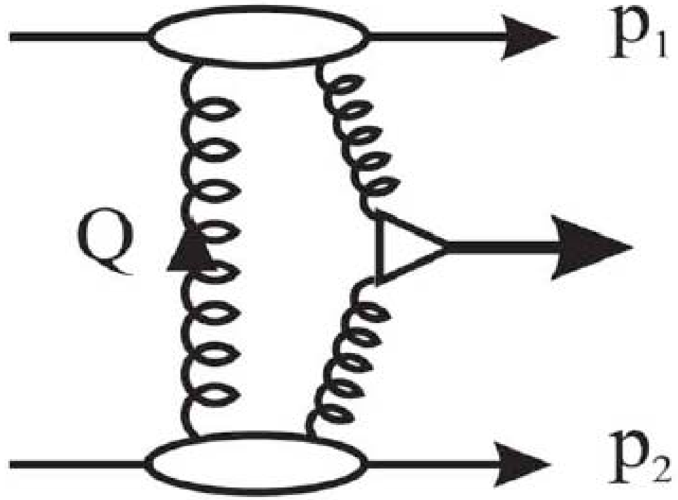
Schedule: Possible installation windows for the RP units are May 2007 or the 2007-2008 shutdown. Installation of the detectors at the earliest in the 2008-2009 shutdown.
The funding of the detector construction has still to be resolved.

Funding situation today

updated 4/10/06	Estimated cost	Already paid/funded	Possible further funds
Infrastructure (cables ,rp pedestal ,polarity inverter)	210	80 ATLAS TC/ISRAEL	ATLAS TC
RP mechanics (pot proper, rp-unit,instrumentation)	200	50 CERN /ATLAS TC	30 Prague
Electronics, PS, readout	415	20 Lund 55 Orsay 10 CERN	80 HV PS Dresden Lund CERN
Detector including prototype and tests	290	10 Prague 70 CERN	40 Lisbon 20 Humboldt 10 Prague ?? Giessen
PM's	300		ALL???
TOTAL	1415	300	180

MANCHESTER
1824

The FP420 R&D Project



1. Can we detect outgoing protons in interesting x_{IP} range ?
2. Can we use these protons to enhance the discovery potential of the LHC ?

"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)

R&D now fully funded : £500k from UK (Silicon, detector stations, beam pipe + LHC optics and cryostat design, DAQ), $100k from US (Fast Timing), €100k Belgium (+Italy / Finland) (mechanics, pocket design, detector stations, slow controls)

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The University of Manchester

FP420 R&D Collaboration

- Spokes : Brian Cox (Manchester, ATLAS) and Albert DeRoeck (CERN,CMS)
- Technical Co-ordinator : Cinzia DaVia (Manchester)
- Management Committee : Mike Albrow (FNAL), Michele Arneodo (Torino / INFN), Andrew Brandt (UTA), Krzysztof Piotrzkowski (Louvain), Risto Orava (Helsinki)
- Key FP420 personnel at CERN and Cockcroft Institute :

  Keith Potter (Manchester, ex-CERN)

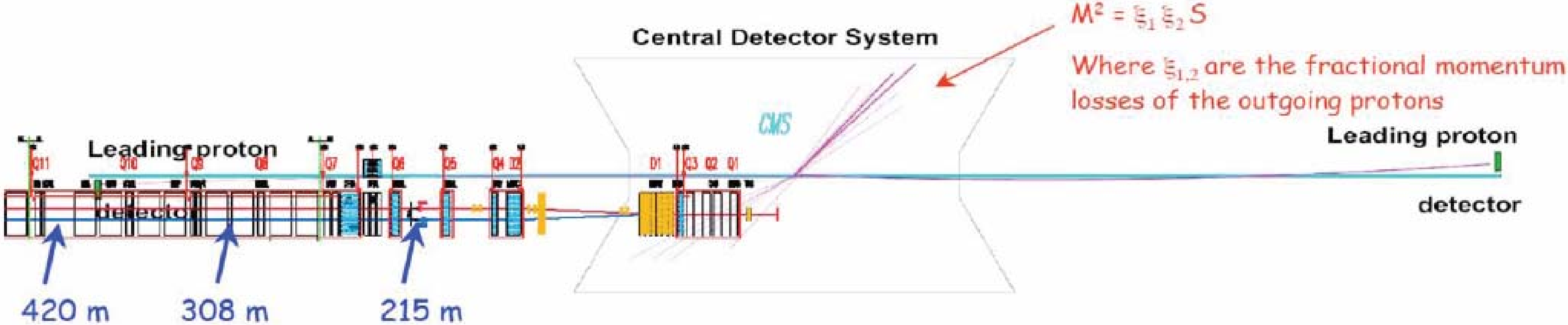
  Shrikant Pattalwar (ASTEC - cryogenics),

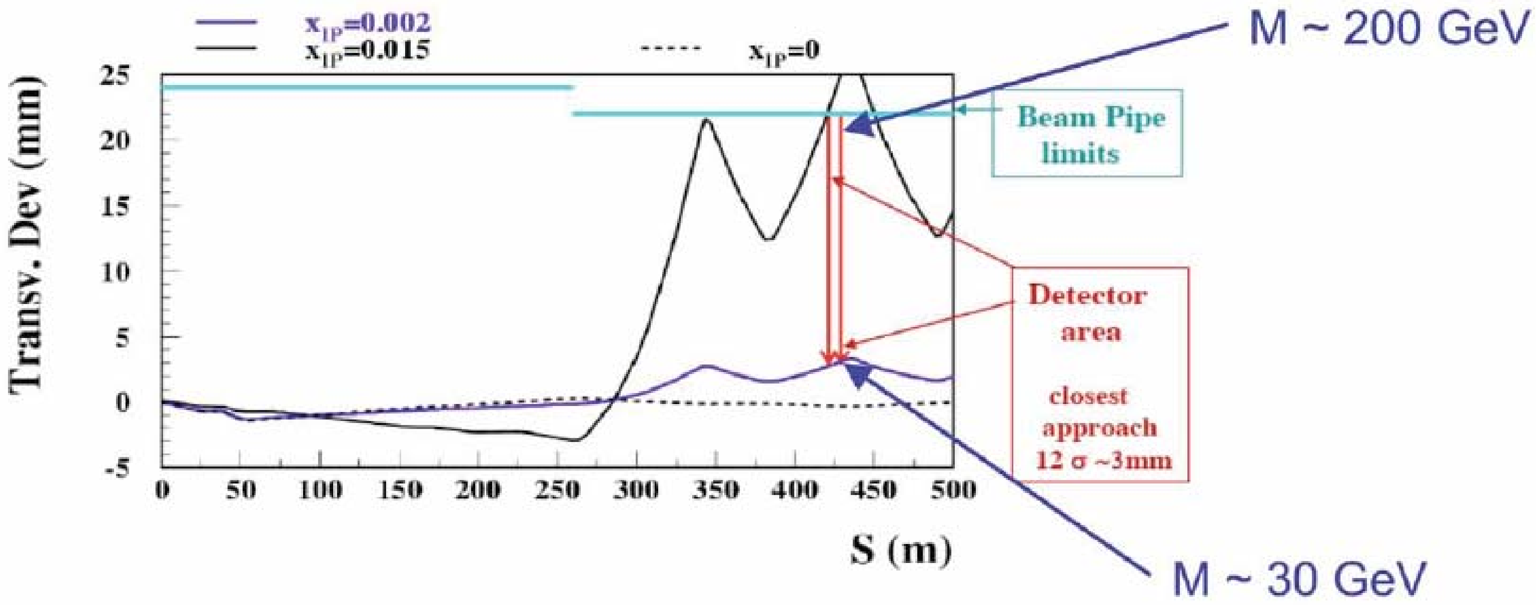
  Federico Roncarolo (Manchester, RF / Optics / Accelerator)

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

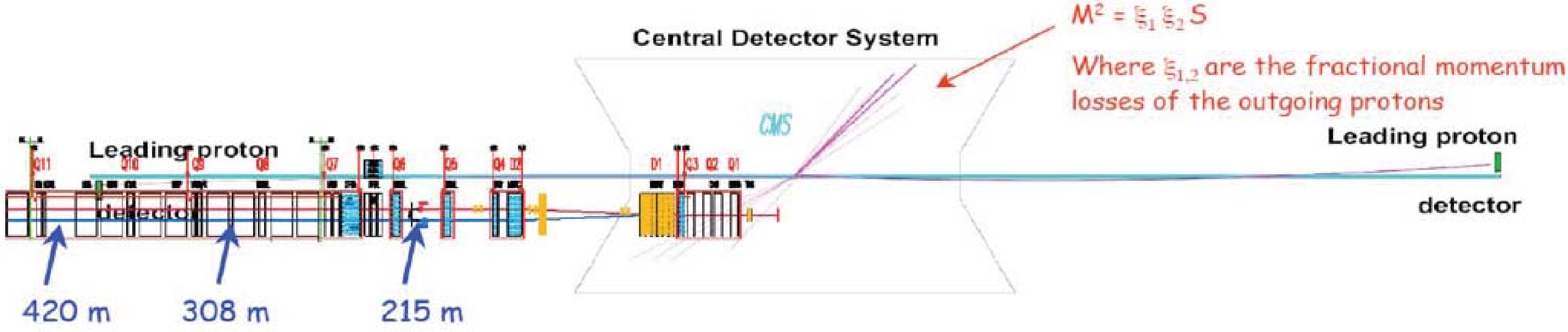
FP420 Schematic Outline

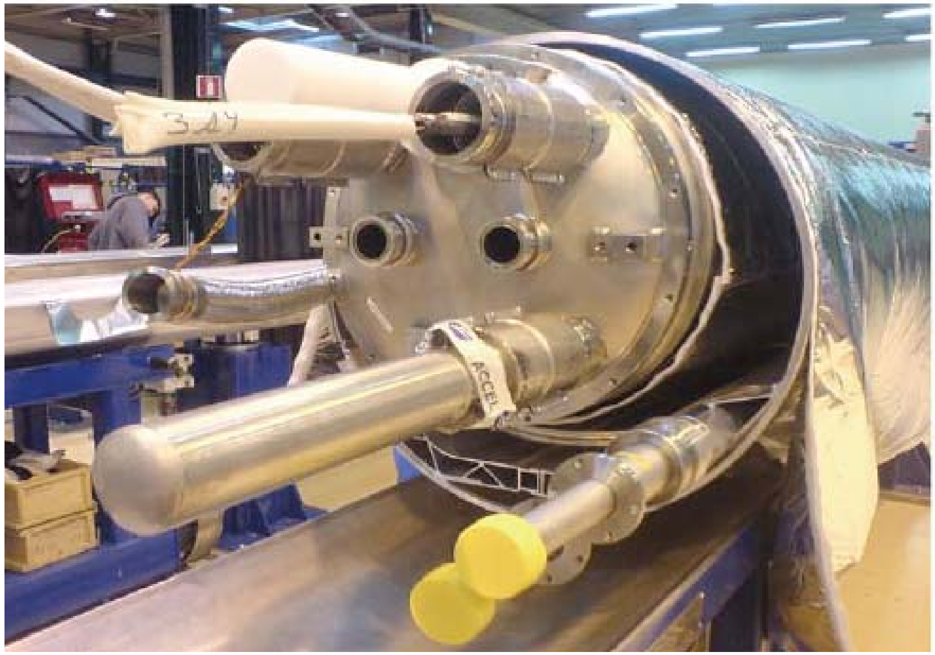
Spectrometer using LHC magnets to bend protons with small momentum loss out of the beam

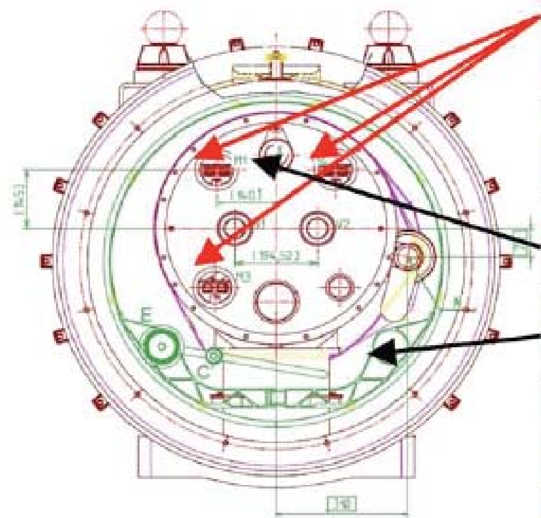




The 420m region at the LHC



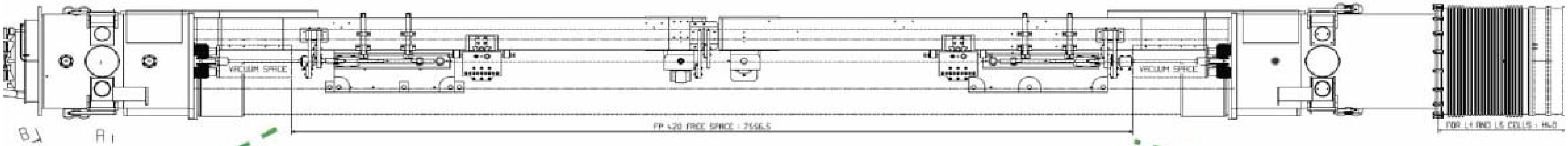


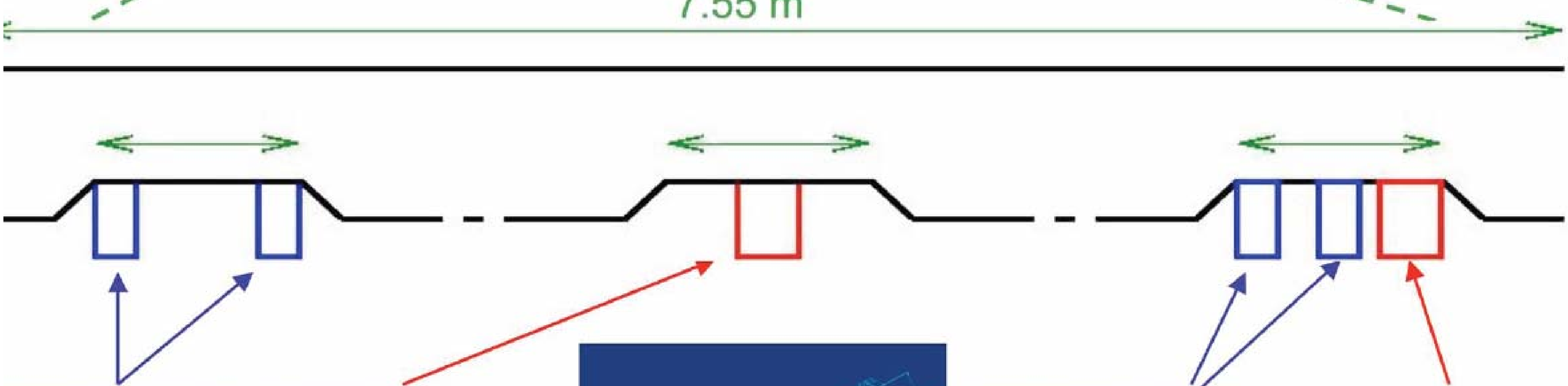


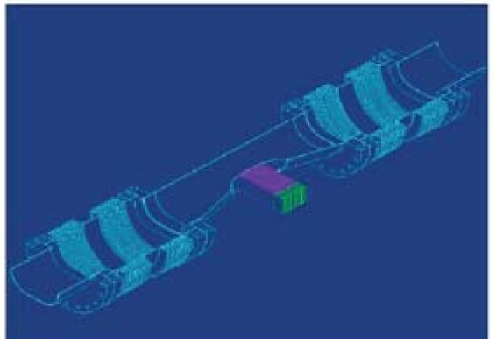
Line	T(K)	$\O_i$ - $\O_e$(m
M1,M2,M3 Bus-bars	1.9	80-84
N Auxiliary bus-bars	1.9	50-53
X Heat exchanger	1.8	54-58
E Thermal shield	50-65	79-86
C' Supports posts and beam screens	4.6	15-17.2
V1,V2 He jackets	1.9	50-53 66-70

Schematic baseline design

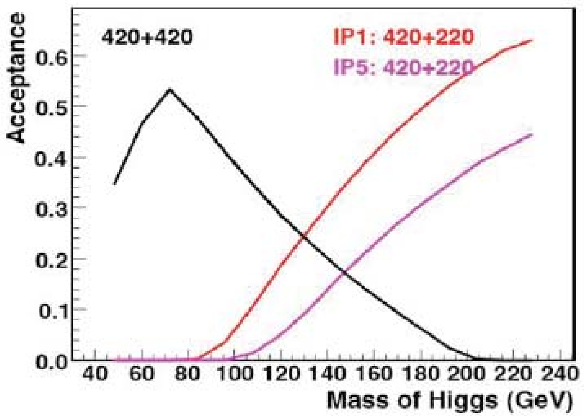
T. Renaglia, EDMS 771549



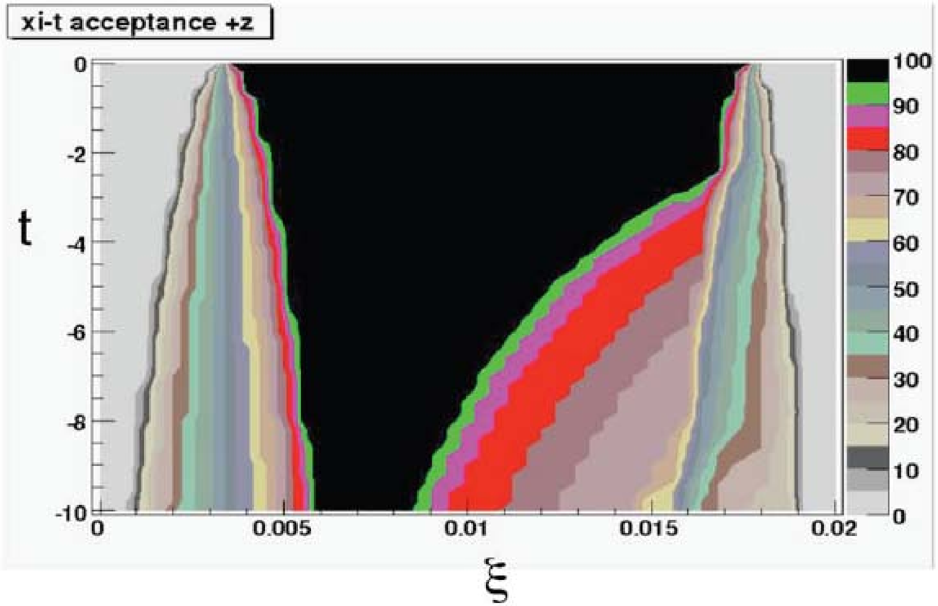


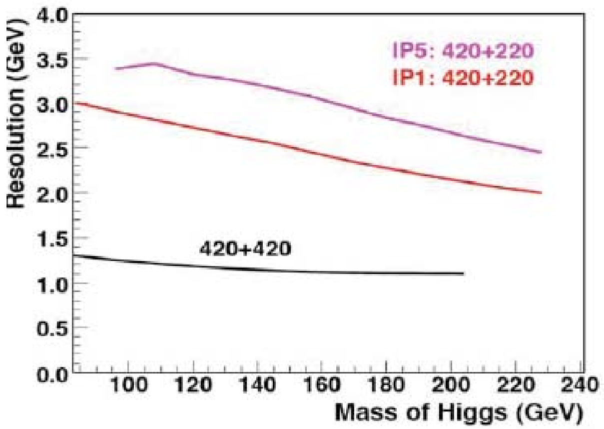


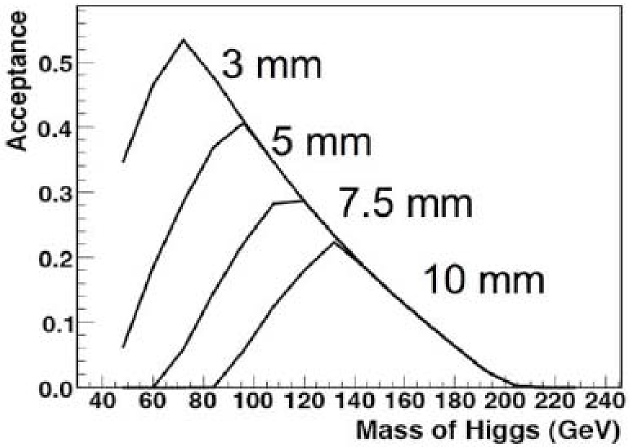
FP420 Acceptance and Resolution

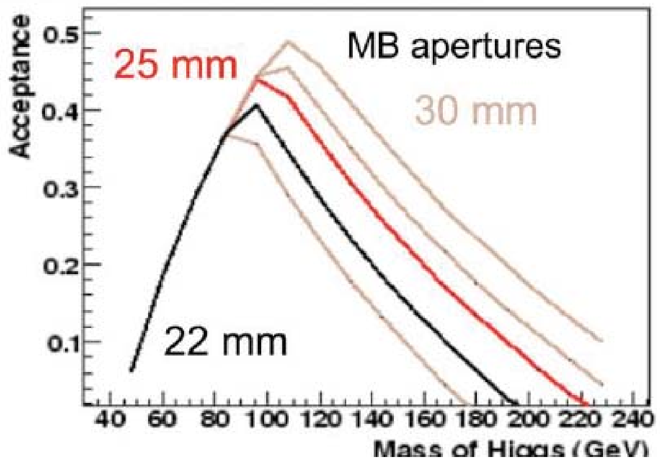


3 mm + 3 mm









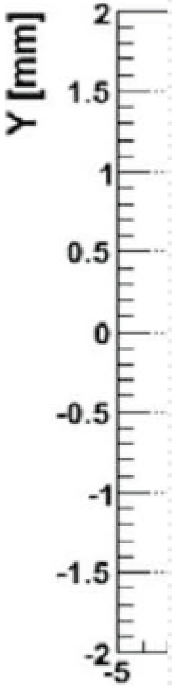
Machine Induced Backgrounds

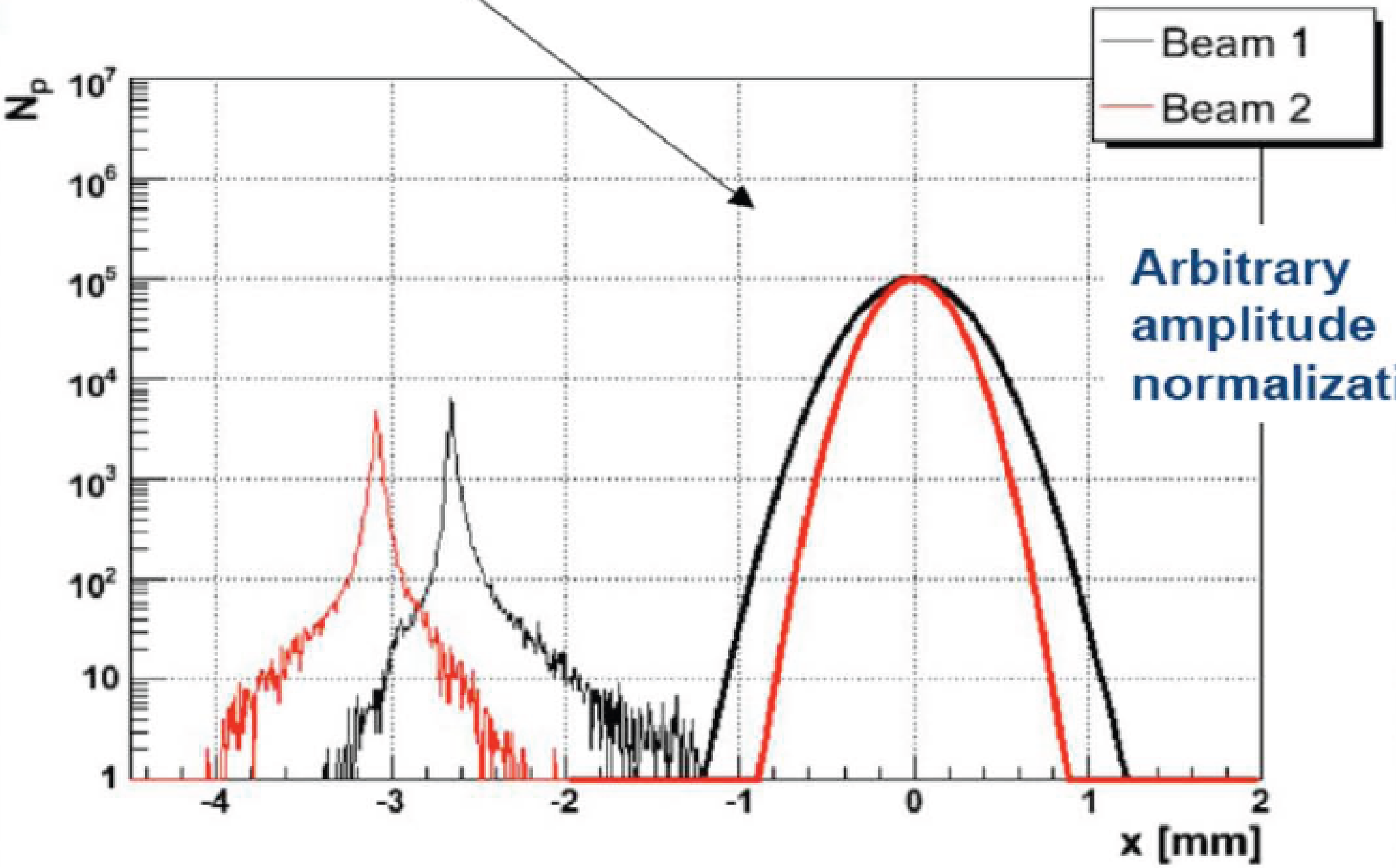
Hor beam profiles with nominal optics and momentum spread

Physical beam sizes:

Sigma1=250um

Sigma2=180





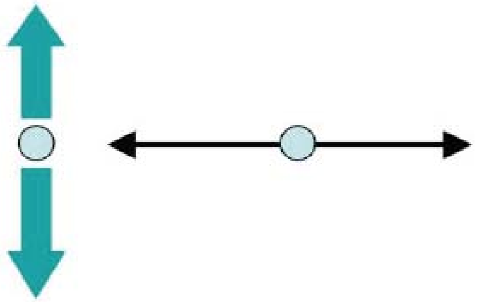
Arbitrary amplitude normalization

Fast Timing Detectors for FP420

UTA (**Brandt**), Alberta (Pinfold), Louvain (K.P.), FNAL (Albrow)

WHY? **Pileup Background Rejection**

E.g., Two protons from SD interactions, and two b-jets from another



How? **Compare z-vertex for SVX with TOF**

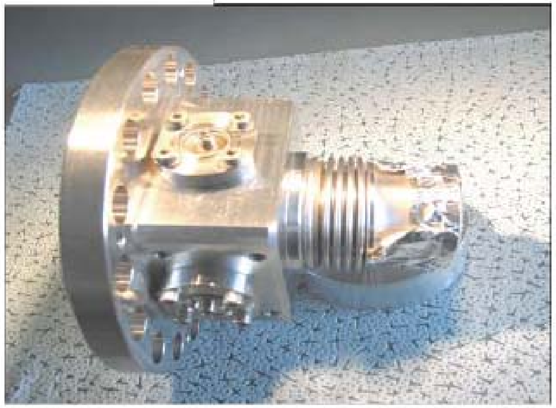
$z = c(TR-TL)/2$

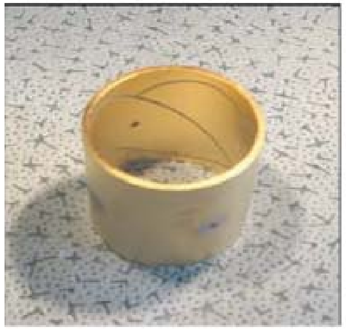
How Fast?

δz (mm) $= 0.21\ \delta t$ (psec)
(2.1 mm for $\delta t = 10$ psec)

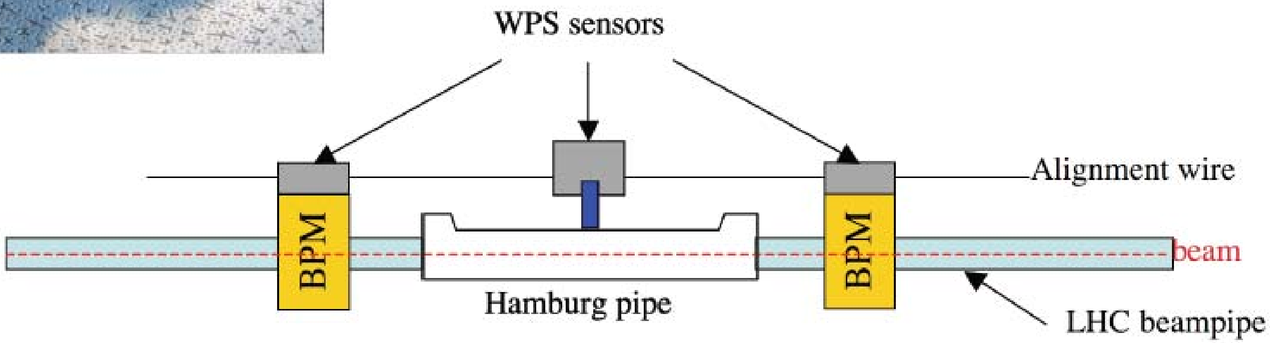
10 psec -> x40 to x30 rejection

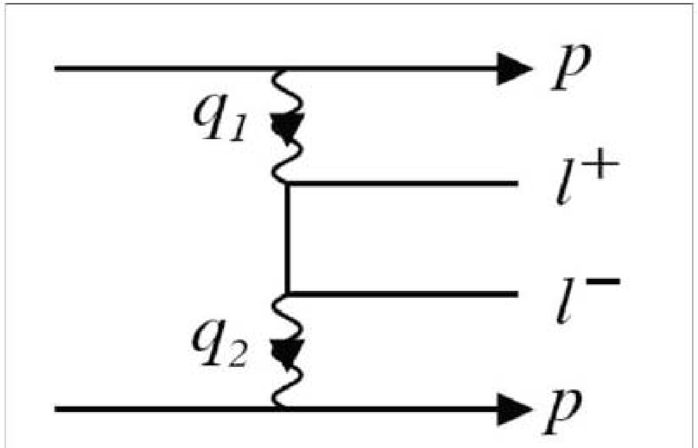
FP420 Alignment





CLIC BPMs + wire positioning system : aim for 10 microns relative to beam





@ 10^{33} cm^{-2}s^{-1} with standard ATLAS triggers, have ~ 30 di-muon events / fill in FP420 acceptance

Backgrounds 1: CEP

- Backgrounds are:
  - $pp \rightarrow p + bb + p$ and
  - $pp \rightarrow p + gg + p$ (where both gluons are mis-identified as b quarks).
- Quark production is suppressed by m_q^2 / M^2 . This means that bb production is suppressed, but also that light quark backgrounds are negligible.
- These are also produced by ExHuME.

Preliminary Results for full analysis (ATLFAST)

SM 120 GeV Higgs -> bb after all cuts and acceptances, but excluding trigger

Final Cross Section

Process	σ_{K_T} (fb)	σ_{cone} (fb)
H→bb (CEP)	0.058	0.054
bb (CEP)	0.12	0.10
gg (CEP)	0.18	0.08
bb (DPE)	0.14	0.08
jj (DPE)	0.002	0.0005
bb (OLAP)	0.032	0.03
jj (OLAP_	0.001	<0.001

27th September 2006 FP420 Collaboration meeting, CERN

How to keep those events

- Cannot use current jet triggers so…..
- Use low p_T muon triggers (as the b can decay to muon)
  - At ATLAS $p_T > 6GeV$
  - Retains 11% of events
- New Jet trigger?
  - Possible in principle to have large rate at level 1 and veto at level 2 using FP420. Level 2 rate of 20Hz (1%).
  - Veto on level 2 is 2 proton hits in FP420.
  - Additional veto on vertexing could be possible using QUARTIC TOF.
  - So choose $E_T > 40GeV$ and prescale to a fixed jet rate at level 1. i.e 1kHz, 5kHz or larger?

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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

Back up