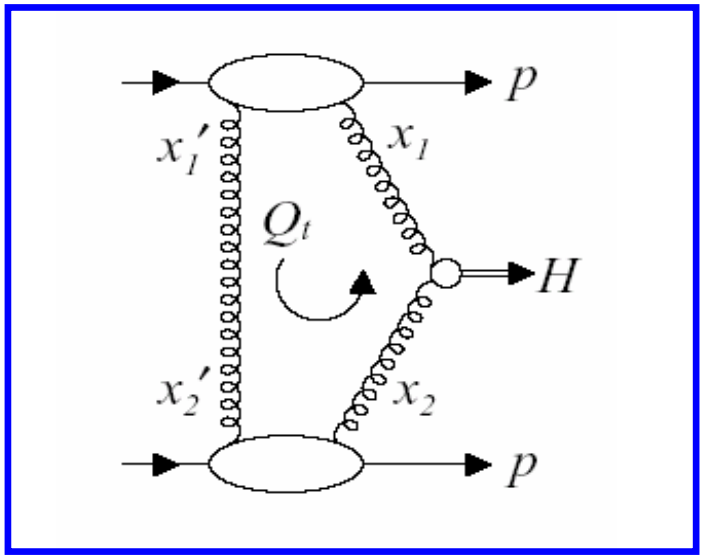
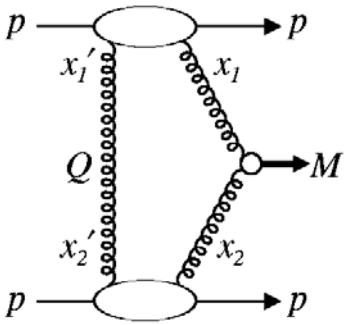
The FP420 project

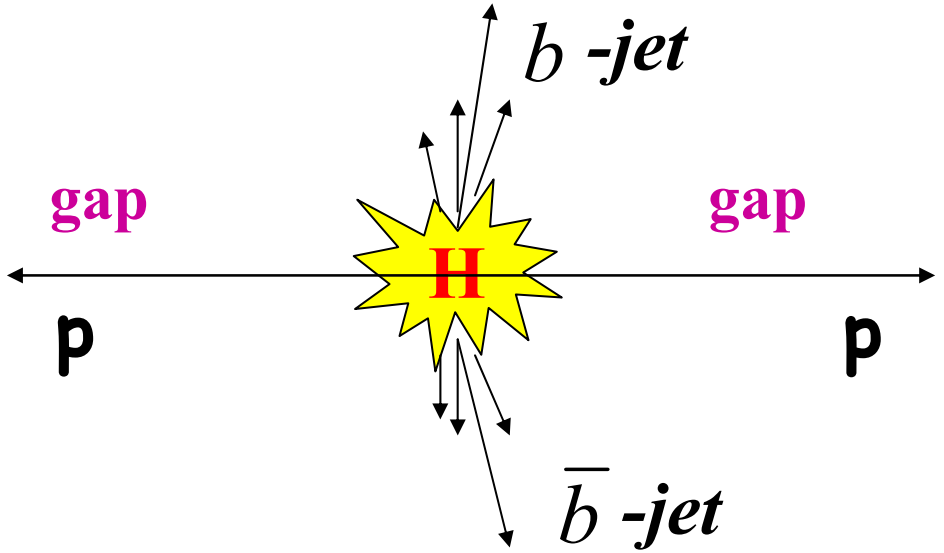
Albert De Roeck (CERN)



Diffractive Higgs Production

Exclusive diffractive Higgs production pp→ p H p : 3-10 fb
Inclusive diffractive Higgs production pp → p+X+H+Y+p : 50-200 fb

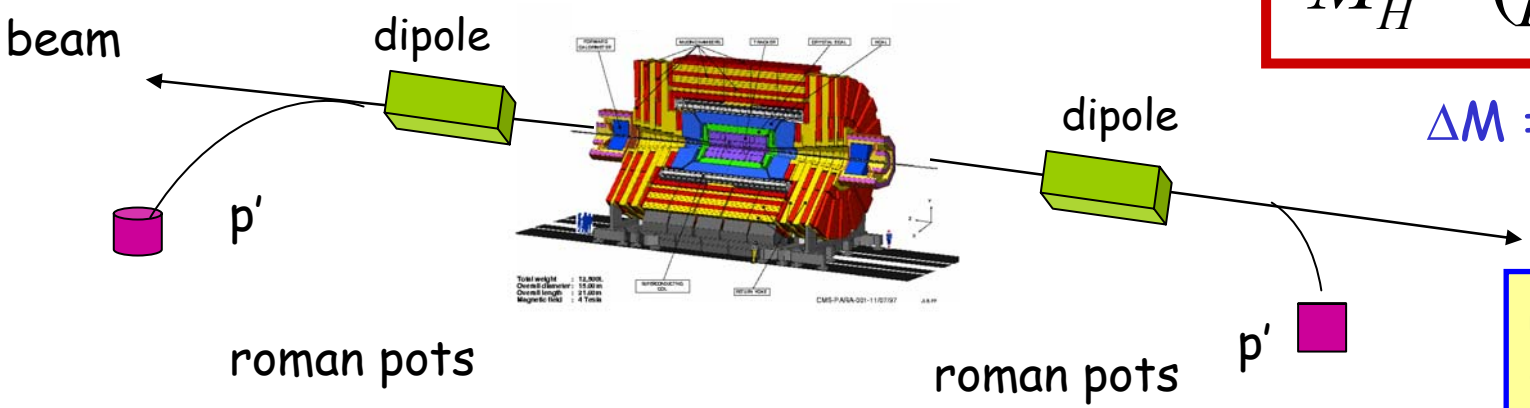




E.g. V. Khoze et al
M. Boonekamp et al.
B. Cox et al.
V. Petrov et al...

$$M_H^2 = (p + \bar{p} - p' - \bar{p}')^2$$

ΔM = O(1.0 - 2.0) GeV

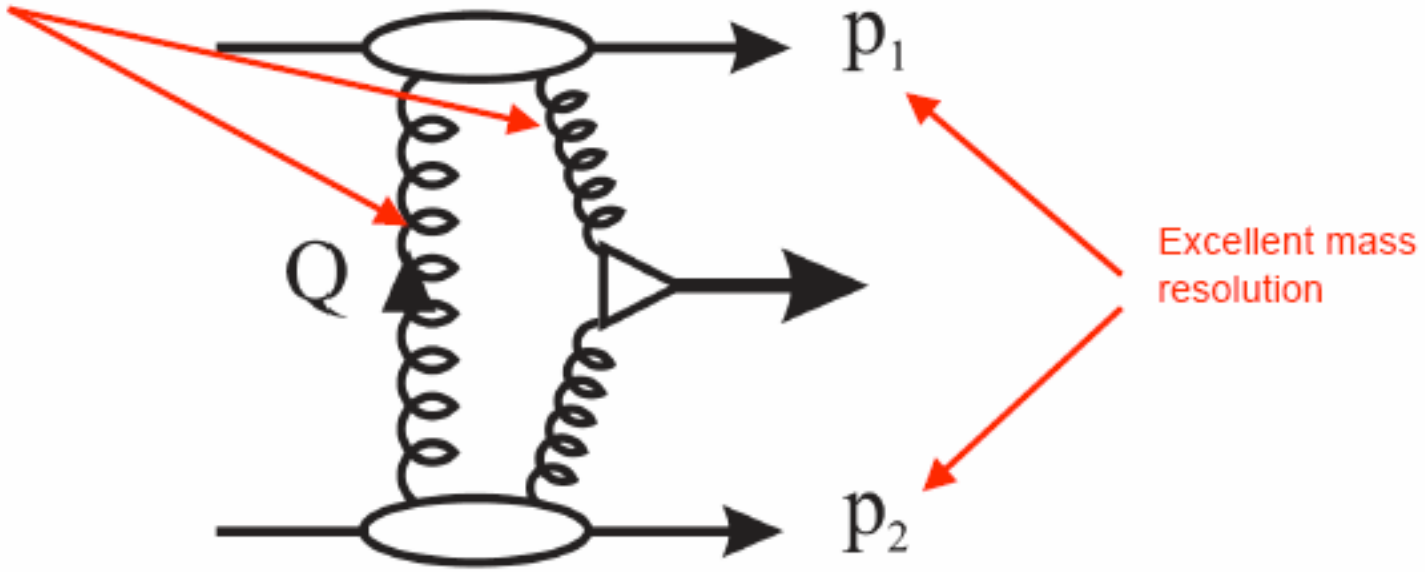


P. Landshoff not convinced that the cross sec. is small

Benefits from DPE Higgs

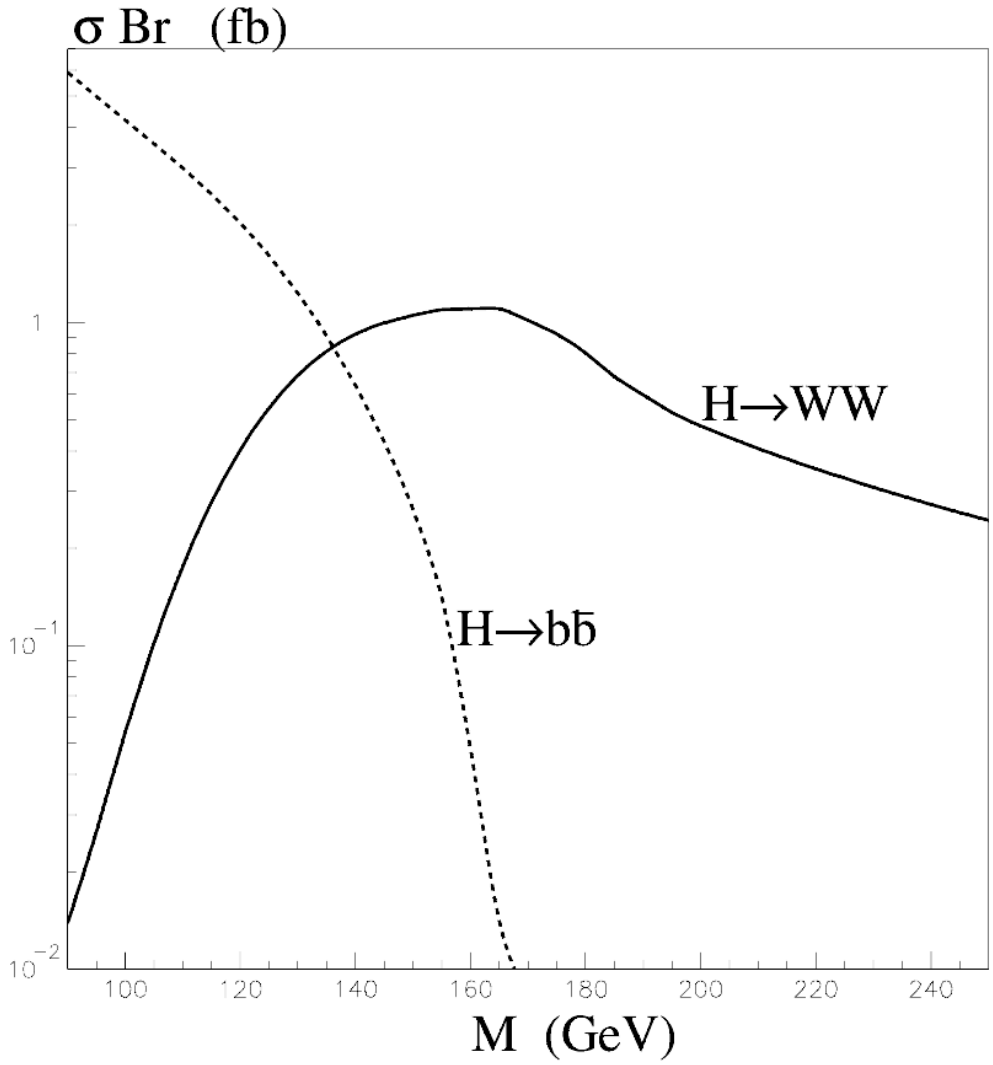
Only 0^{++} (or 2^{++}) systems produced

$b\bar{b}$ background strongly suppressed



Drawback: cross section is in fb region

Higgs cross section * BR



Cross sections ~ fb

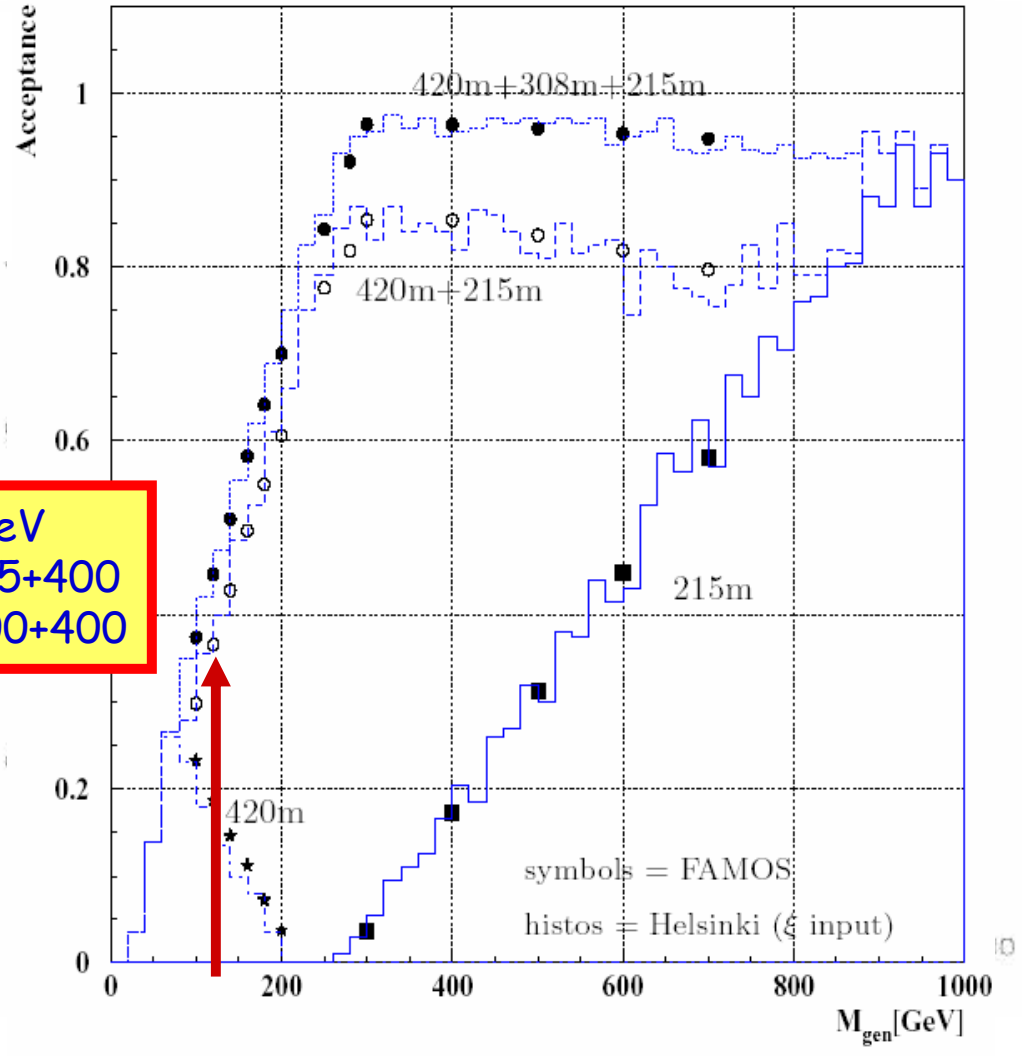
Diffractive Higgs mainly
Studied for H→bb
(Khoze et al.,
ADR et al.,
Boonekamp et al.,
Petrov et al…)

Recently study extended
for the decay into WW
Can reach higher masses
(Cox, Khoze, ADR, to appear)

Note H→bb (120 GeV) at tevatron ⇒ 0.13 fb

DPE Exclusive Higgs Production

Needs Roman Pots at new positions 320 and/or 420 m
Technical challenge: "cold" region of the machine, Trigger signals…



At 120 GeV
50% = 215+400
50% = 400+400

- Combined acceptance of
  - → All detectors
    - Dotted line
  - → 420 m + 215 m
    - Dashed line
  - → 215 m alone
    - Solid line
  - → 420 m alone
    - Dash-dotted line
- without 308 / 338 m location
  - → 10-15 % loss in acceptance

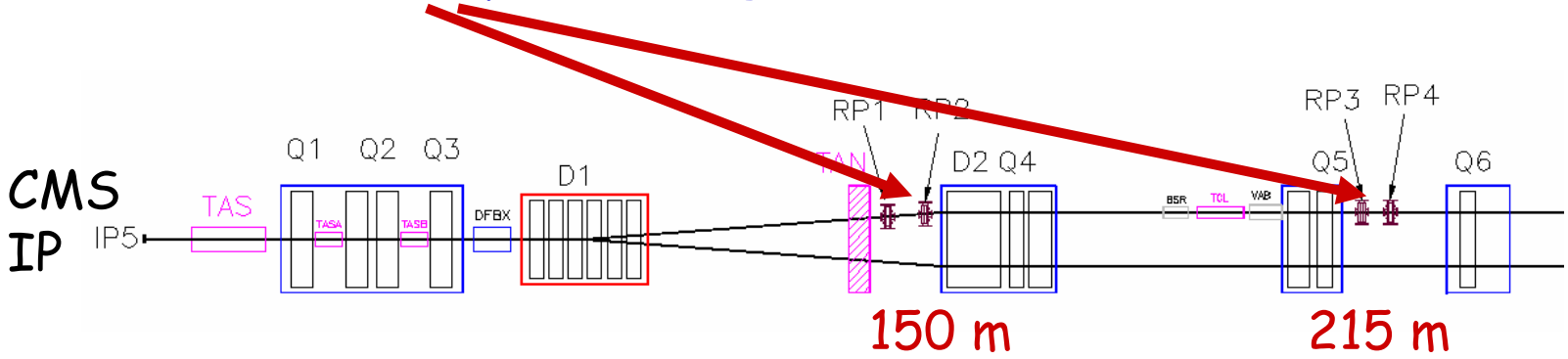
Curves: Helsinki Group

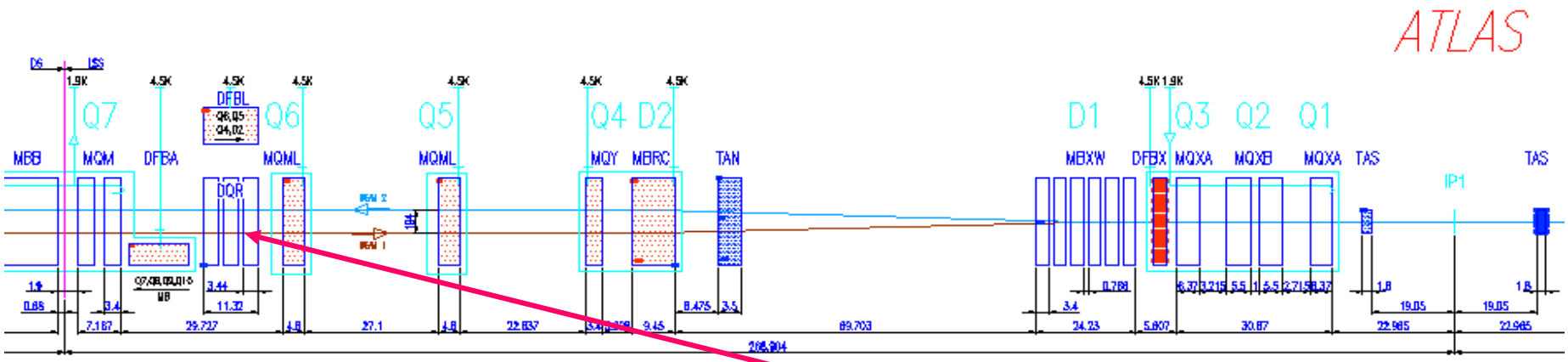
Dots CMS/FAMOS simulation

Calculations ⇒2 year ago
Need to recheck

Planned Roman Pot detectors@LHC

TOTEM physics program: total pp, elastic & diffractive cross sections
CMS+TOTEM Roman pots at high lumi

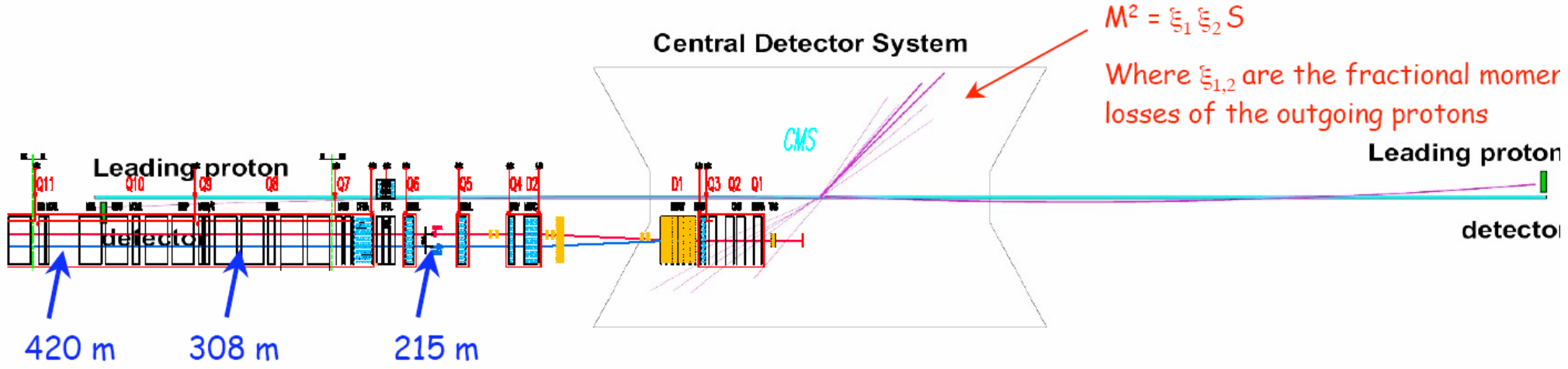




ATLAS Diffraction to be studied
Cannot use present RPs at high lumi

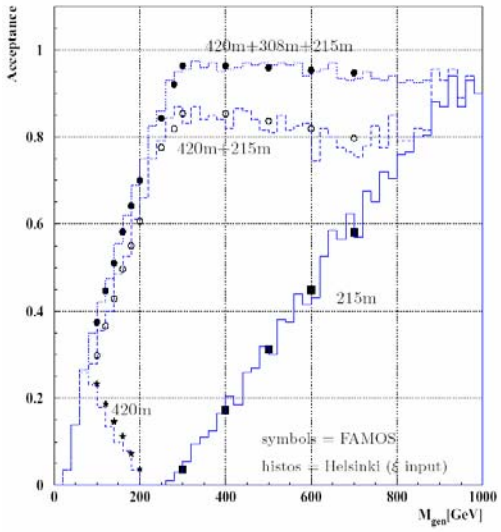
One **Roman Pot Station** per side on left and right from IP1

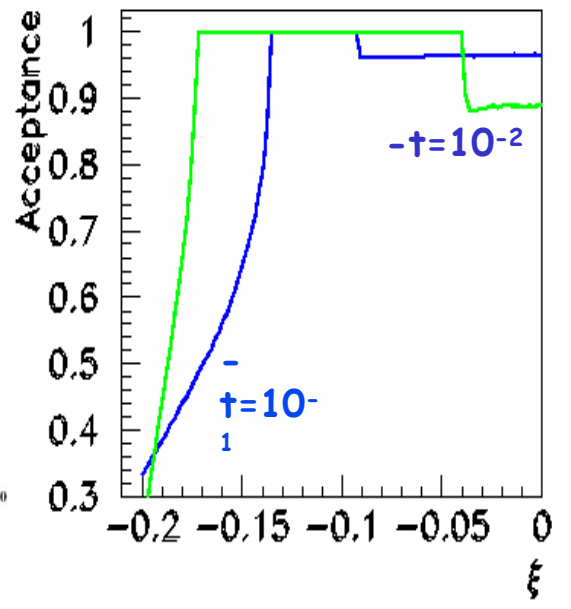
Roman pot acceptances



$M^2 = \xi_1 \xi_2 S$

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



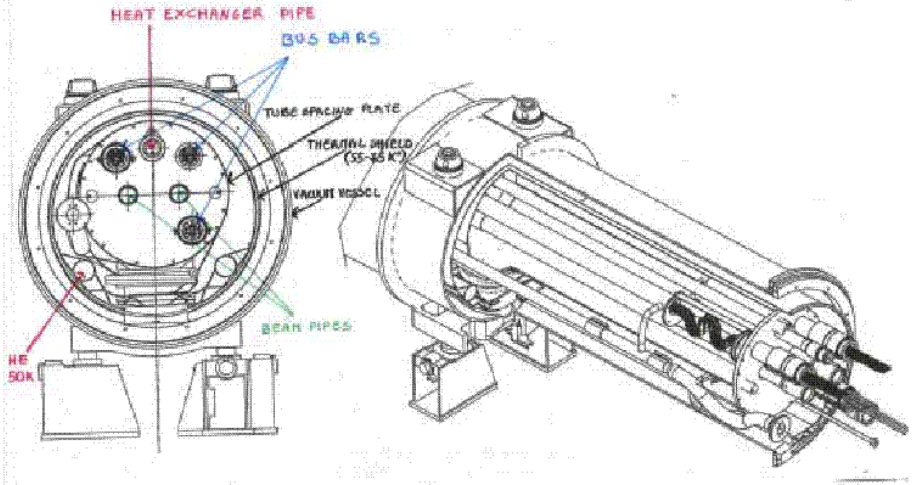


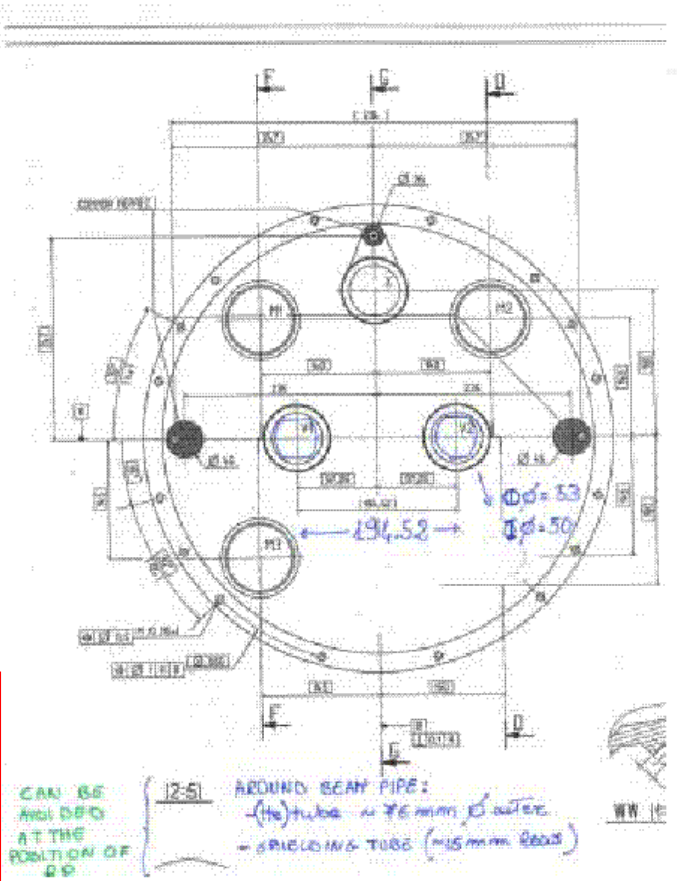
High β^* (1540m): Lumi 10^{28}-10^{31}cm^{-2}s^{-1}
>90% of all diffractive protons are seen in the Roman Pots.
Proton momentum measured with a resolution ~10^{-3}

Low β^*: (0.5m): Lumi 10^{33}-10^{34}cm^{-2}s^{-1}
220m: $0.02 < \xi < 0.2$
300/400m: $0.002 < \xi < 0.2$
(RPs in the cold region/
under discussion in CMS/ATLAS)

Detectors at 300/400m

- Initial discussions with the machine group (early 2002; D. Marcina)
- Cold section: Detectors have to be integrated with cryostat
  Is a bypass an option? 15m cold-warm transition… SC services…





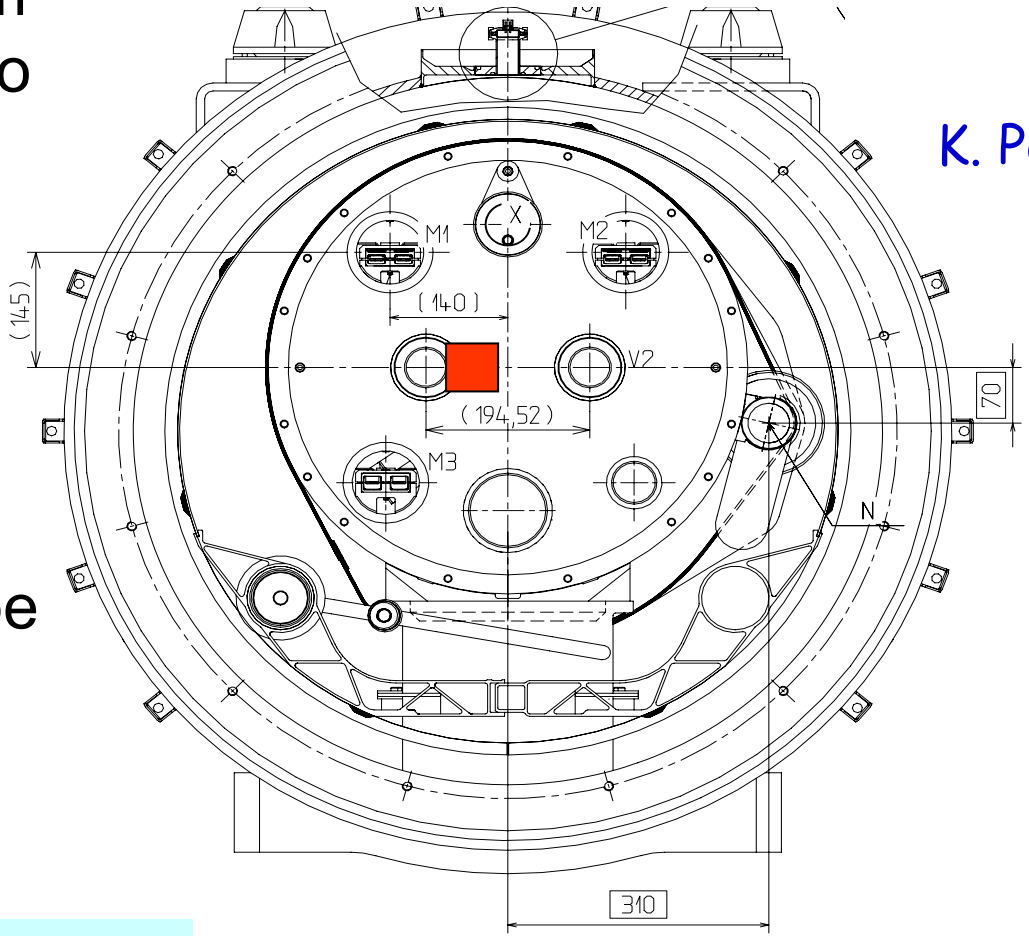
- Many machine components already ordered, some already delivered
- Machine wants "easy" start-up/no perturbation
  ⇒ Change means an "LHC upgrade" (phase II)

Detecting an off-momentum proton

At 420 m an off-momentum proton lies between the two beam pipes

D ≈ 2 m
Δp/p = 0.5 %
Δx = 10 mm

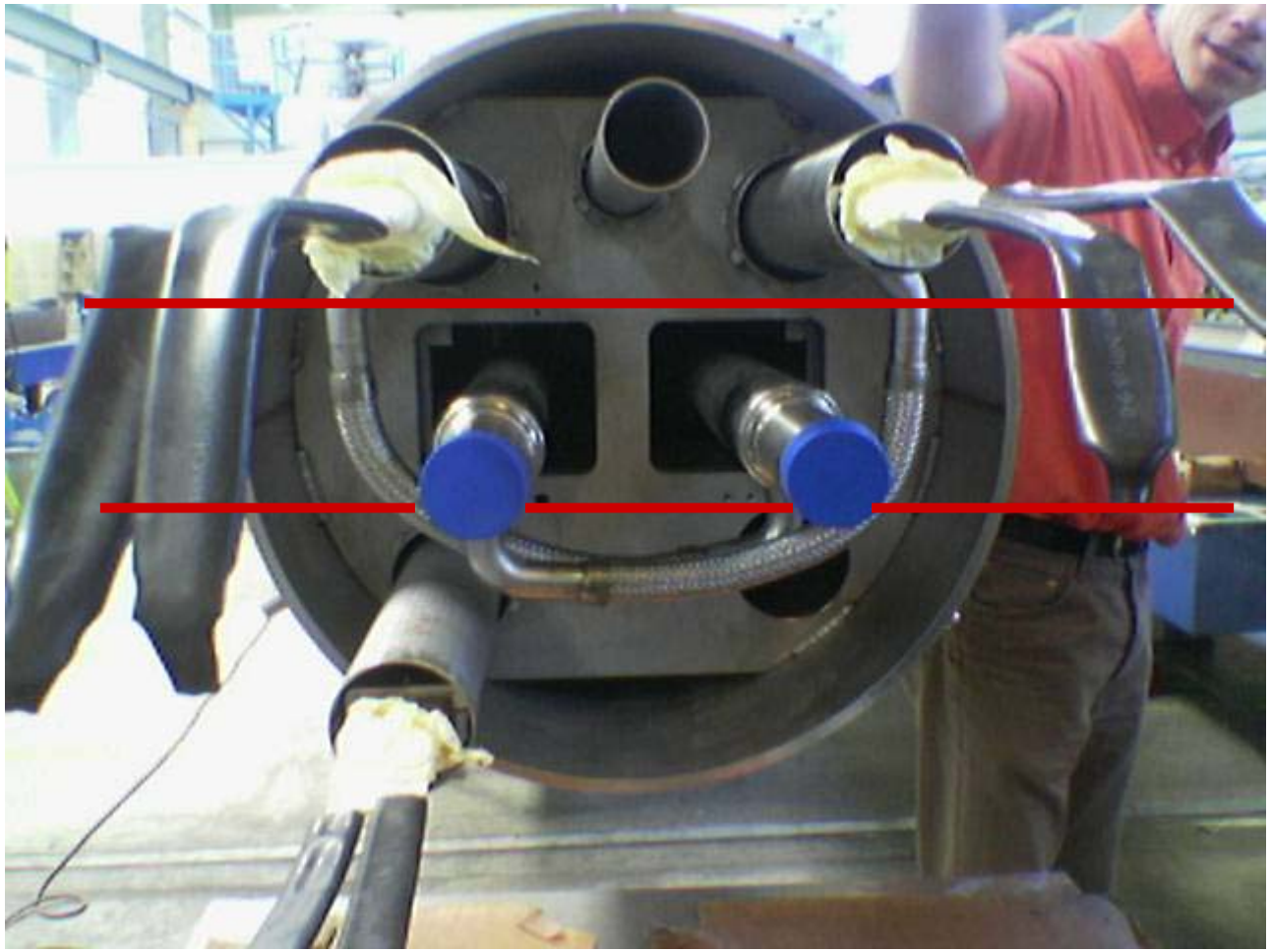
i.e. still inside the beampipe
But 10 beamσ ≈ 3mm



K. Potter

Detectors to measure the protons?
Mechanics, access etc.?
Alignment, calibration issues…

Cryostat upgrades



Very positive discussions with the machine group

Possible to modify the cryostat in future!

Two sections in cold but the detectors warm

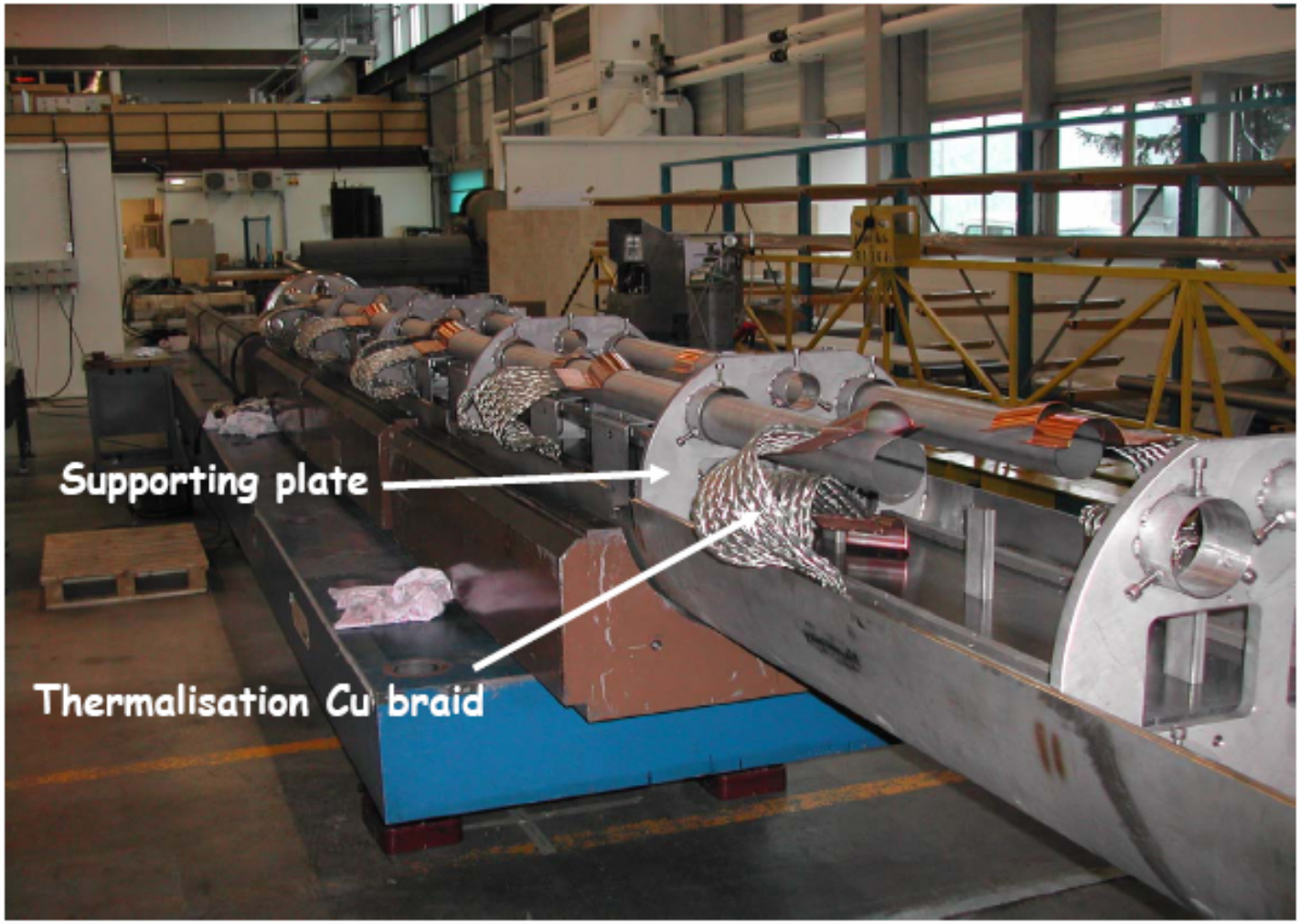
Could be exchanged during a shutdown Earliest autumn 2008

Connection cryostat

- All components located outside the "cold mass" are the same as for a cryodipole:
- jacks
- vacuum vessel ($P<10^{-4}$ Pa, max 10^{-2} Pa)
- alignment devices
- cold mass supports
- thermal shield

  (reduces the heat from T=293->1.9 K. It is made of MLI blankets wrapped around Al shells)
- thermalisation of cold support posts

Connection cryostat "cold mass"



The connection cryostat "cold mass"

CMS support for the Study

Dear Brian,

CMS has taken note of the UK project proposal to study the possibility of extending the physics reach of the LHC experiment central detectors by adding forward proton taggers 400m away from the interaction point. The physics topics that will be tackled with these detectors, namely the exclusive production of new particles such as the Higgs, and diffraction in general, are compatible with the intended CMS physics programme. CMS therefore looks forward to the outcome of such a study.

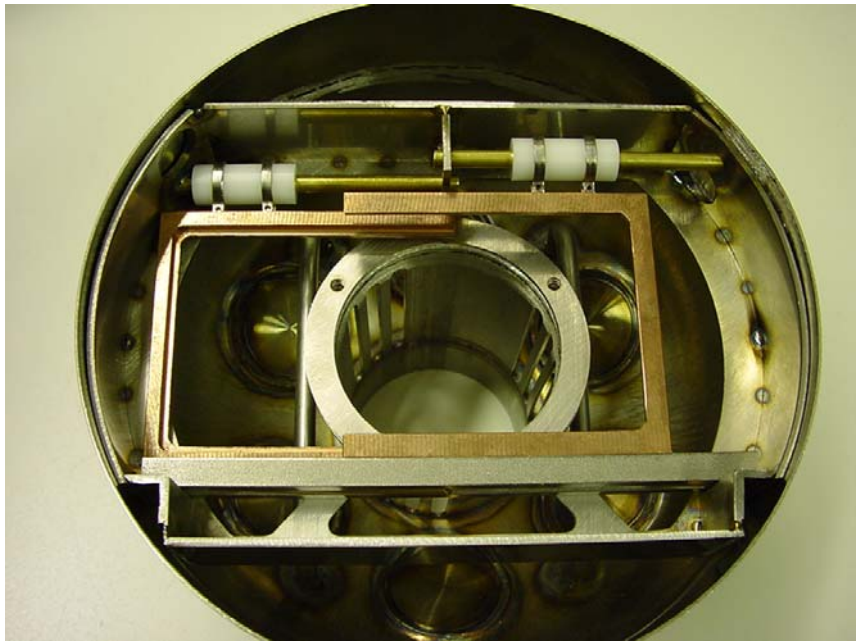
Best Regards,

Michel

Michel Della Negra CMS Spokesperson

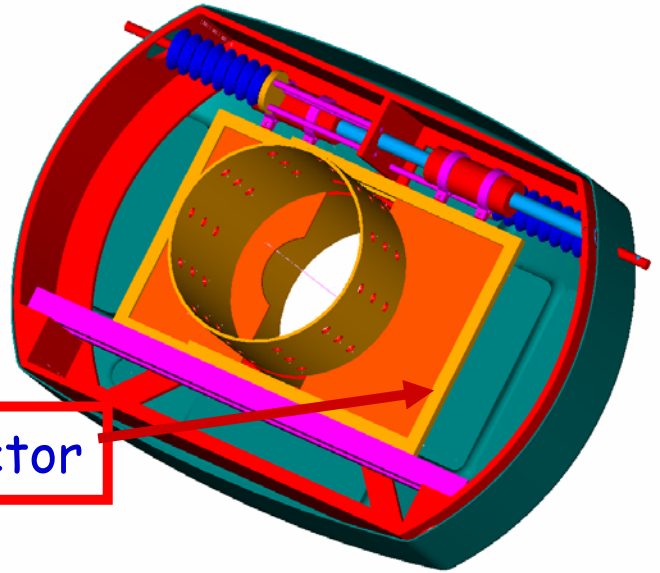
PH Department, CERN, CH1211 Geneva 23, Switzerland

Detectors: micro stations?



μ-station concept
(Helsinki proposal)

Silicon pixel or strip detectors in vacuum (shielded), 3D silicon…



Very compact!

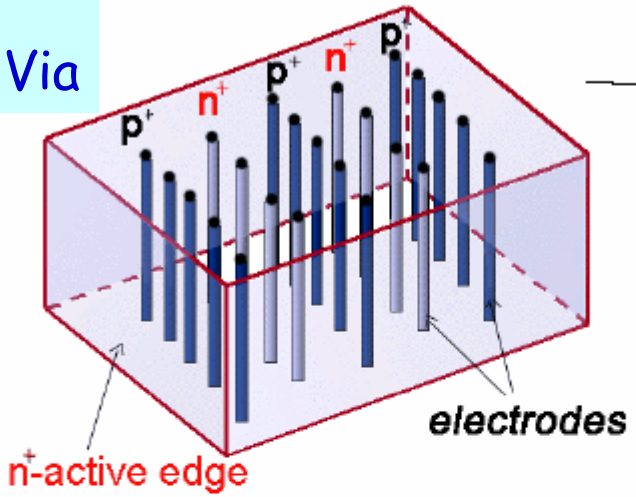
How close to mass shell are these detectors?
They have not been in any testbeam/real environment yet.
Which groups are interested to contribute to the developments?
It is the time for decisive R&D, test beam etc.

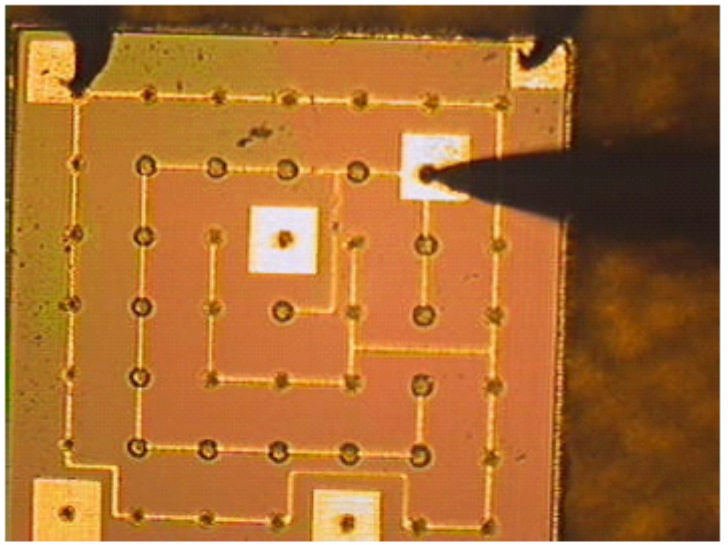
Detectors with Silicon: e.g.

3D DETECTORS AND ACTIVE EDGES

Brunel, Hawaii, Stanford

see:
C. Da Via



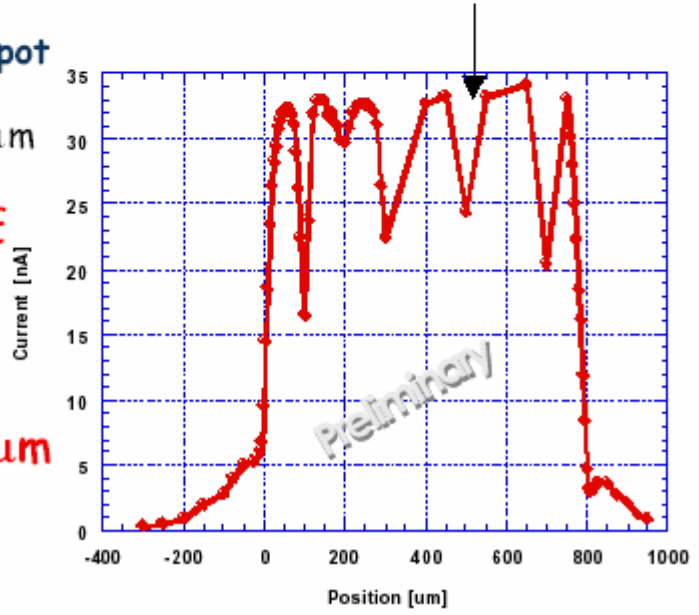


❖EDGE SENSITIVITY	<10 μm
❖COLLECTION PATHS	~50 μm
❖SPATIAL RESOLUTION	10-15 μm
❖DEPLETION VOLTAGES	< 10 V
❖DEPLETION VOLTAGES at 10^{15}n/cm^2	~105 V
❖SPEED AT RT	3.5 ns
❖AREA COVERAGE	3X3 cm^2
❖SIGNAL AMPLITUDE before Irradiation	24 000 e
❖SIGNAL AMPLITUDE at 10^{15}n/cm^2	15 000 e$^-$

❖15 μm InfraRed beam spot
❖FWHM = 772 μm
❖Edge Al strip width = 16 μm

INSENSITIVE EDGE (INCLUDING **16 μm Al** STRIP):

(813 - 772) / 2 = **21 μm**



❖*CERN Courier, Vol 43, Number 1, Jan 2003*

Projects developing

- UK seedcorn money bid to PPRP (B. Cox et al.)
  - Labs involved: Manchester Univ., Cockroft institute, University of Glasgow, Brunel university, IPPP Durham, Bristol, RAL
  - Initial support of the science committee last November
  - Bid in first stage for
    - A cryostat design post (@CERN): design and prototype cryostat region
    - A silicon detector desing post (@Brunel)
    - Working fund for design studies on physics, trigger, alignment studies..
- Belgian bid
  - Louvain: ~50 K Hamburg pipe prototype and 40% of postdoc
  - Antwerp: 3 postions + funds for electronics development
- Helsinki bid
  - Funds for manpower and detectors for leading protons (microstation and detector development)
- More groups interested
- Results of bids should be in by spring 2005

Rough timelines (preliminary)

- Spring 2005: Built R&D proto-collaboration spring 2005
- End of spring/Early summer 2005: LOI to the LHCC before summer
- Summer/fall 2005: start cryostat design and detector R&D (test beams?) optimizing of the detectors
- Summer/fall 2006: start construction of cryostat prototype/decide detector technology & details/test beams
- 2007: Technical proposal to LHCC (per experiment)
- Fall 2008: first possible time window to install the cryostats and detectors in the present schedule of the LHC
- First data in the 2009 run

- Spring 2005: CMS+TOTEM LOI for the LHCC on diffractive and forward physics: this will contain results of physics studies on DPE on Higgs and others, and show the interest in RP's at 420 m