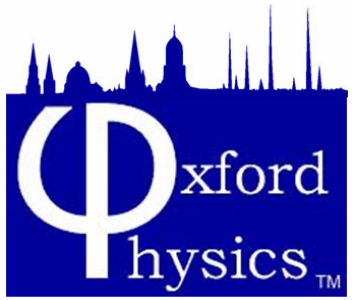
Large Projects
Present & Future



Overview

- Excuses
- What is large anyway?
- What is large in Oxford today?
  - A large present project: ATLAS
- What may be large in Oxford tomorrow?
  - Some large future possibilities: Linear Colliders

- England 2
  - 23rd min. Owen
  - 89th min. Wilkinson
- Brazil 1
  - 45th min. Rivaldo

- England 1
  - 23rd min. Owen
- Brazil 2
  - 45th min. Rivaldo
  - 50th min. Ronaldinho

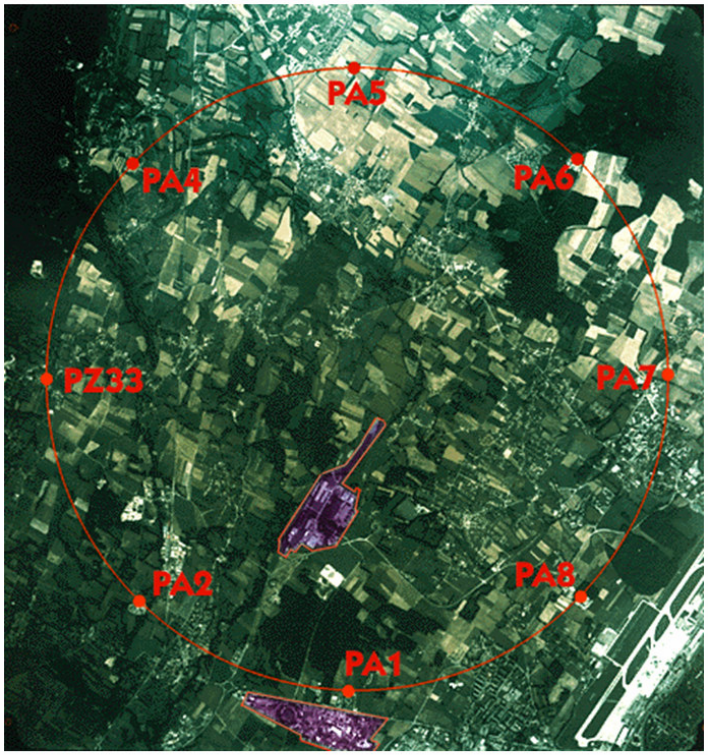
Excuses

- Don't talk about all the past, I am too young to do that.
- Don't talk about all the other projects (DELPHI, ZEUS, LHCb, CDF, SNO, MINOS, ADLER, VERITAS, HARP, SLD, LCFI, CRESST, ANTARES, Soudan2, Neutrino Factory, GRID) there are too many of them.
- Don't talk about all the science, that would take too long.
- Don't talk about all the people, you can talk to them directly (they are all here!)
- Don't talk about all the problems, we never do that!

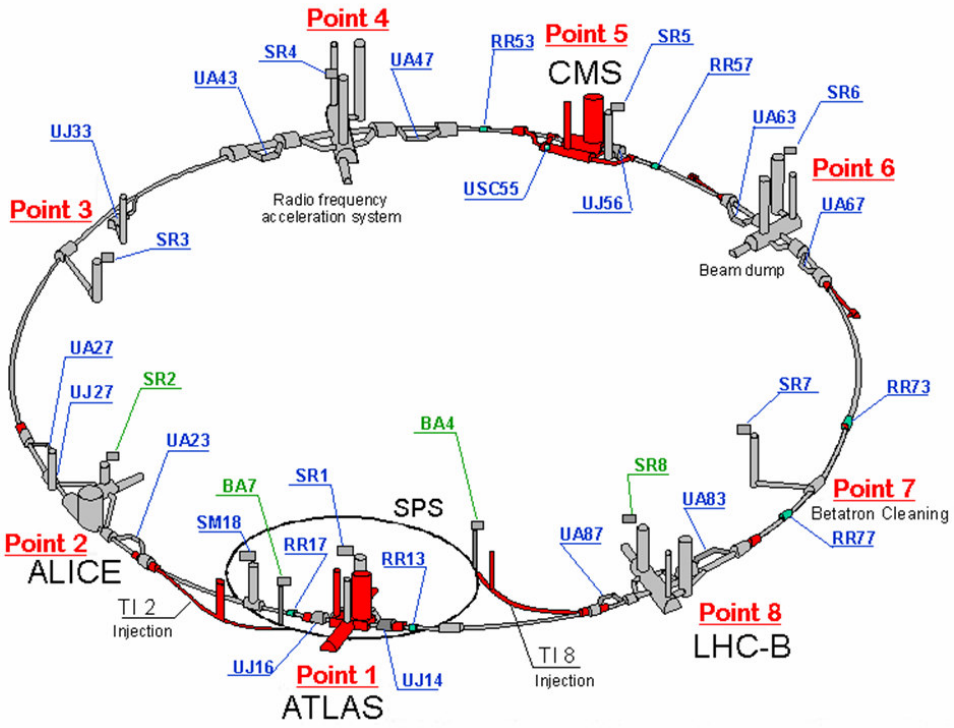
But do talk about something (said Susan)

- I will talk about some large projects from this laboratory because large is one of the things that we do best.

What is large anyway (LHC)

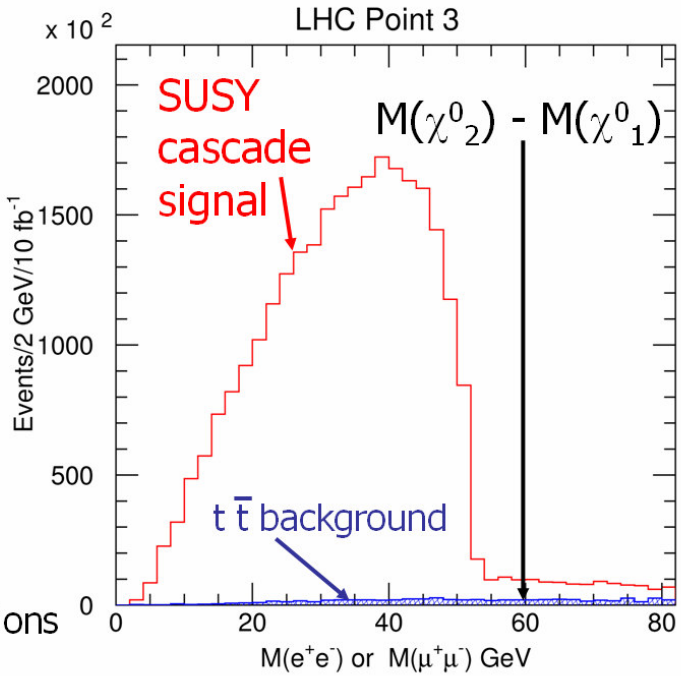


What is large anyway (LHC)



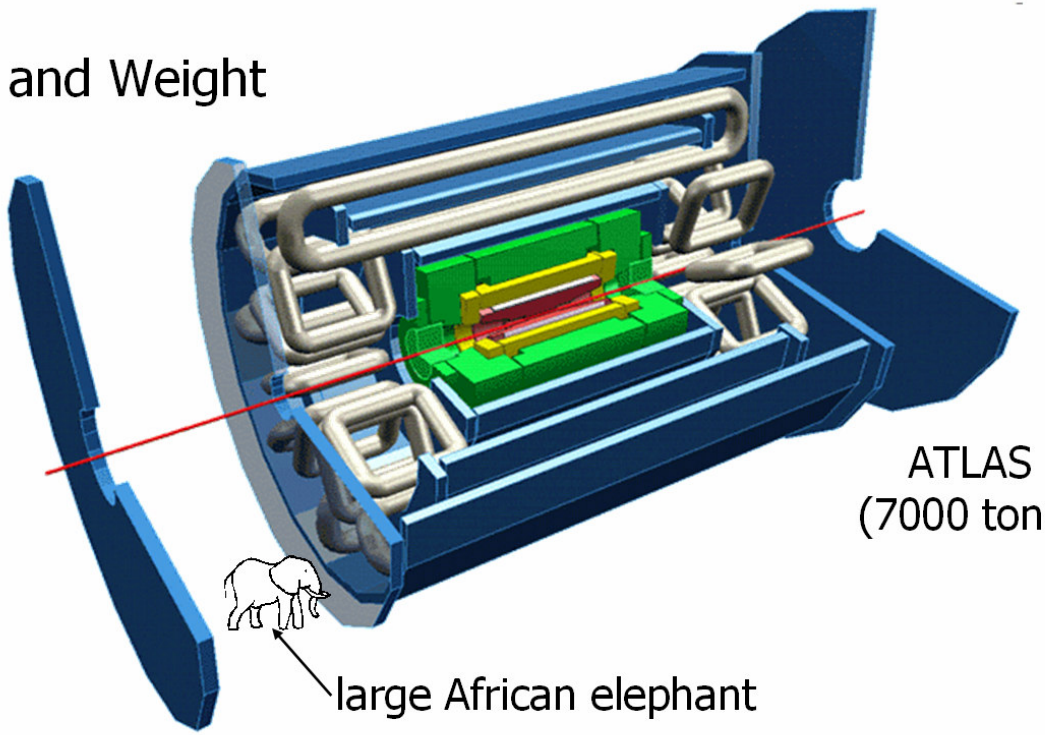
What is large anyway

- The physics potential:
- Beyond the SM
  - Higgs (also in SM)
  - SUSY
  - Compositeness
  - large extra dimensions
  - anything up to O(few TeV)
- In the SM
  - B-Physics
  - Top
  - Multi Gauge Boson Interactions



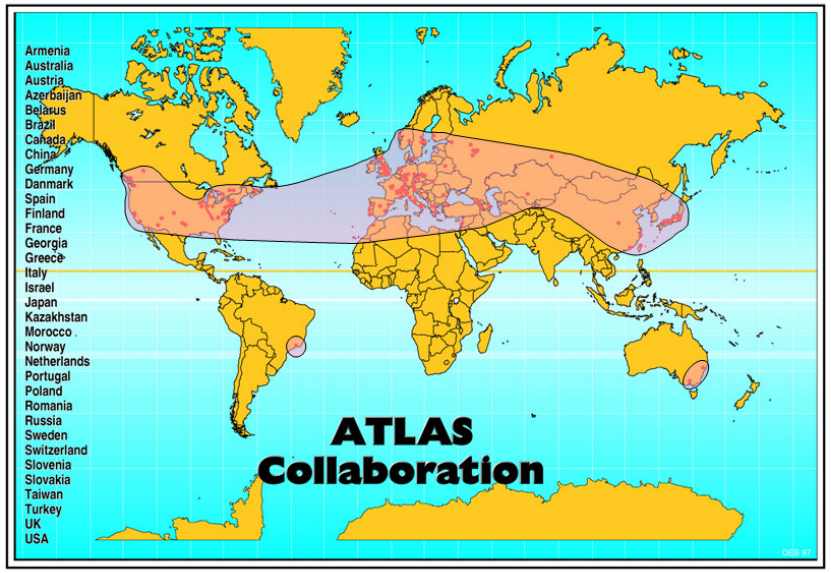
What is large anyway (ATLAS)

- Size and Weight



What is large anyway

- The Collaboration
  - 2400 users
  - 165 institutes
  - 34 countries

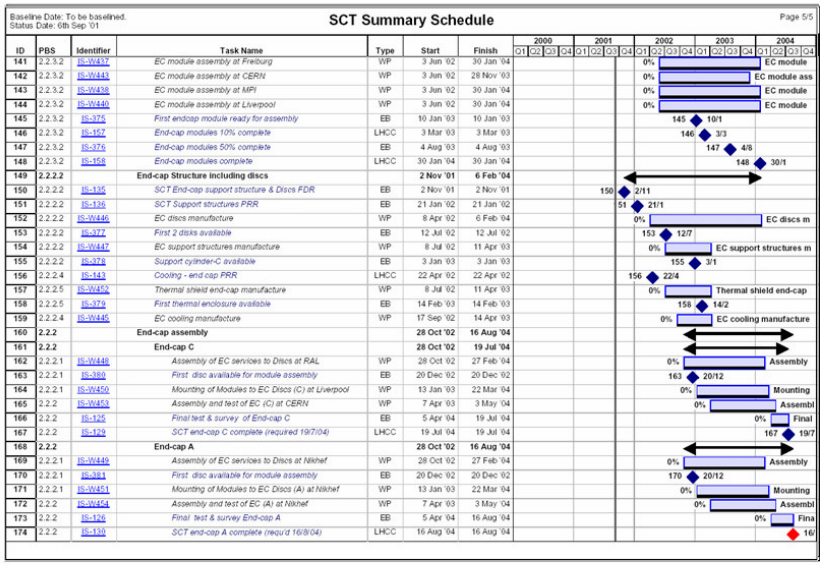


What is large anyway

- The Collaboration
  - 2400 users
  - 165 institutes
  - 34 countries
- The hole

What is large anyway

- The Collaboration
  - 2400 users
  - 165 institutes
  - 34 countries
- The hole
- The Timescale
  - even I have been working on it for 11 years
  - and we will still be going strong in 15 years from now



Baseline Date: To be baselined.
Status Date: 6th Sep '01

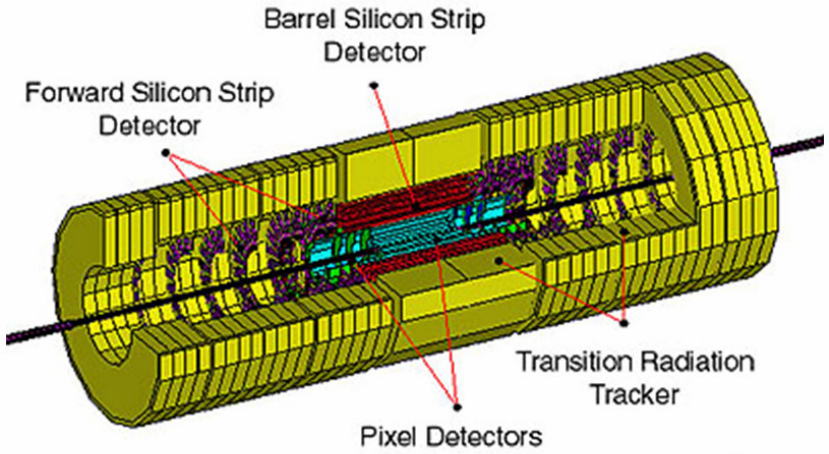
SCT Summary Schedule

Page 5/5

ID	PBS	Identifier	Task Name	Type	Start	Finish
141	2.2.3.2	IS-W437	*EC module assembly at Freiburg*	WP	3 Jun '02	30 Jan '04
142	2.2.3.2	IS-W443	*EC module assembly at CERN*	WP	3 Jun '02	28 Nov '03
143	2.2.3.2	IS-W438	*EC module assembly at MPI*	WP	3 Jun '02	30 Jan '04
144	2.2.3.2	IS-W440	*EC module assembly at Liverpool*	WP	3 Jun '02	30 Jan '04
145	2.2.3.2	IS-375	*First endcap module ready for assembly*	EB	10 Jan '03	10 Jan '03
146	2.2.3.2	IS-157	*End-cap modules 10% complete*	LHCC	3 Mar '03	3 Mar '03
147	2.2.3.2	IS-376	*End-cap modules 50% complete*	EB	4 Aug '03	4 Aug '03
148	2.2.3.2	IS-158	*End-cap modules complete*	LHCC	30 Jan '04	30 Jan '04
149	**2.2.2.2**		**End-cap Structure including discs**		**2 Nov '01**	**6 Feb '04**
150	2.2.2.2	IS-135	*SCT End-cap support structure & Discs FDR*	EB	2 Nov '01	2 Nov '01
151	2.2.2.2	IS-136	*SCT Support structures PRR*	EB	21 Jan '02	21 Jan '02
152	2.2.2.2	IS-W446	*EC discs manufacture*	WP	8 Apr '02	6 Feb '04
153	2.2.2.2	IS-377	*First 2 disks available*	EB	12 Jul '02	12 Jul '02
154	2.2.2.2	IS-W447	*EC support structures manufacture*	WP	8 Jul '02	11 Apr '03
155	2.2.2.2	IS-378	*Support cylinder-C available*	EB	3 Jan '03	3 Jan '03
156	2.2.2.4	IS-143	*Cooling - end cap PRR*	LHCC	22 Apr '02	22 Apr '02
157	2.2.2.5	IS-W452	*Thermal shield end-cap manufacture*	WP	8 Jul '02	11 Apr '03
158	2.2.2.5	IS-379	*First thermal enclosure available*	EB	14 Feb '03	14 Feb '03
159	2.2.2.4	IS-W445	*EC cooling manufacture*	WP	17 Sep '02	14 Apr '03
160	**2.2.2**		**End-cap assembly**		**28 Oct '02**	**16 Aug '04**
161	**2.2.2**		**End-cap C**		**28 Oct '02**	**19 Jul '04**
162	2.2.2.1	IS-W448	*Assembly of EC services to Discs at RAL*	WP	28 Oct '02	27 Feb '04
163	2.2.2.1	IS-380	*First disc available for module assembly*	EB	20 Dec '02	20 Dec '02
164	2.2.2.1	IS-W450	*Mounting of Modules to EC Discs (C) at Liverpool*	WP	13 Jan '03	22 Mar '04
165	2.2.2	IS-W453	*Assembly and test of EC (C) at CERN*	WP	7 Apr '03	3 May '04
166	2.2.2	IS-125	*Final test & survey of End-cap C*	EB	5 Apr '04	19 Jul '04
167	2.2.2	IS-129	*SCT end-cap C complete (required 19/7/04)*	LHCC	19 Jul '04	19 Jul '04
168	**2.2.2**		**End-cap A**		**28 Oct '02**	**16 Aug '04**
169	2.2.2.1	IS-W449	*Assembly of EC services to Discs at Nikhef*	WP	28 Oct '02	27 Feb '04
170	2.2.2.1	IS-381	*First disc available for module assembly*	EB	20 Dec '02	20 Dec '02
171	2.2.2.1	IS-W451	*Mounting of Modules to EC Discs (A) at Nikhef*	WP	13 Jan '03	22 Mar '04
172	2.2.2	IS-W454	*Assembly and test of EC (A) at Nikhef*	WP	7 Apr '03	3 May '04
173	2.2.2	IS-126	*Final test & survey End-cap A*	EB	5 Apr '04	16 Aug '04
174	2.2.2	IS-130	*SCT end-cap A complete (requ'd 16/8/04)*	LHCC	16 Aug '04	16 Aug '04

What is large in Oxford today

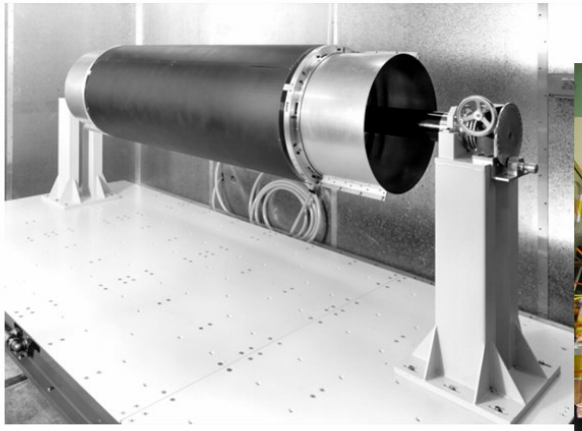
- ATLAS-Oxford task list

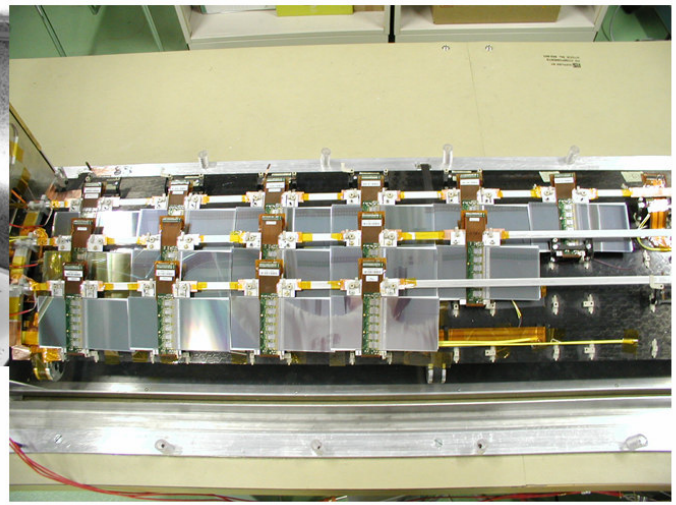


Inner Tracker

What is large in Oxford today

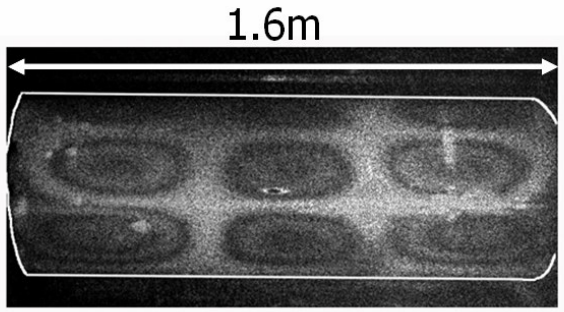
- ATLAS-Oxford task list



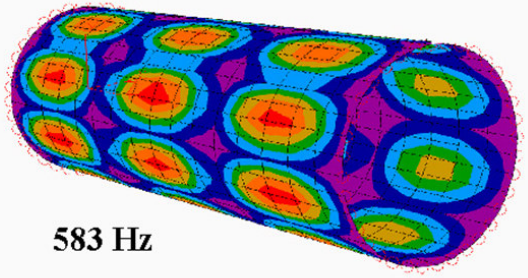


What is large in Oxford today

- ATLAS-Oxford task list
  - L-2 Trigger
  - Detector Layout
  - Read-out chip design
  - Mechanical Design
  - Optical data transmission & control
  - Services 'harness'
  - Alignment
  - Assembly
  - Software

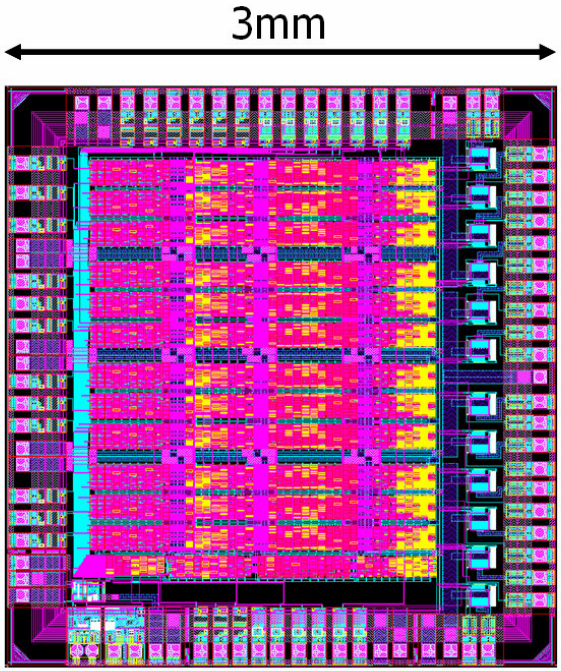


vibrational ESPI, resolution 1/3 μm



What is large in Oxford today

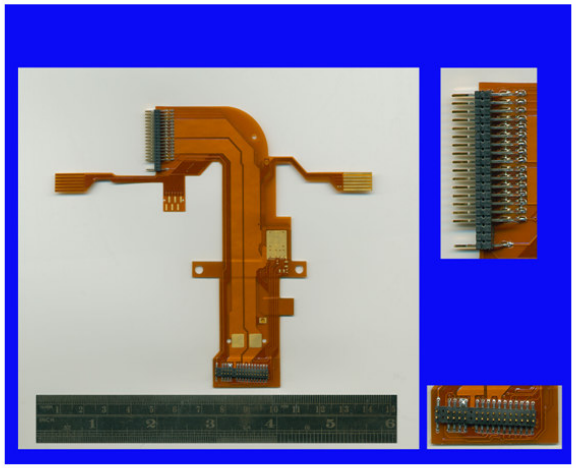
- ATLAS-Oxford task list
  - L-2 Trigger
  - Detector Layout
  - Read-out chip design
  - Mechanical Design
  - Optical data transmission & control
  - Services 'harness'
  - Alignment
  - Assembly
  - Software



Encodes 40 Mbits/s control data onto 40 MHz bunch crossing clock ➔TTC signal to SCT modules.

What is large in Oxford today

- ATLAS-Oxford task list
  - L-2 Trigger
  - Detector Layout
  - Read-out chip design
  - Mechanical Design
  - Optical data transmission & control
  - Services 'harness'
  - Alignment
  - Assembly
  - Software



Bertie Botts every (16) flavour "dog-leg" cable (4 layer Cu/kapton flex circuits)

What is large in Oxford today

- ATLAS-Oxford task list
  - L-2 Trigger
  - Detector Layout
  - Read-out chip design
  - Mechanical Design
  - Optical data transmission & control
  - Services 'harness'
  - Alignment
  - Assembly
  - Software

} past

} present, short term

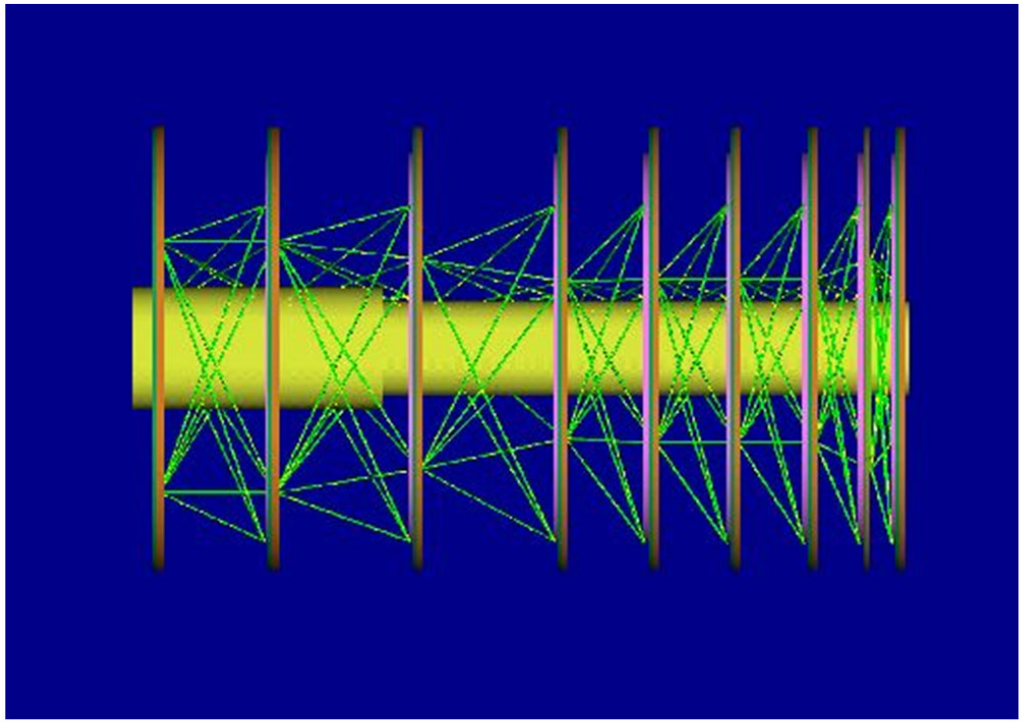
} present, long term

What is large in Oxford today

SCT – Alignment/Survey

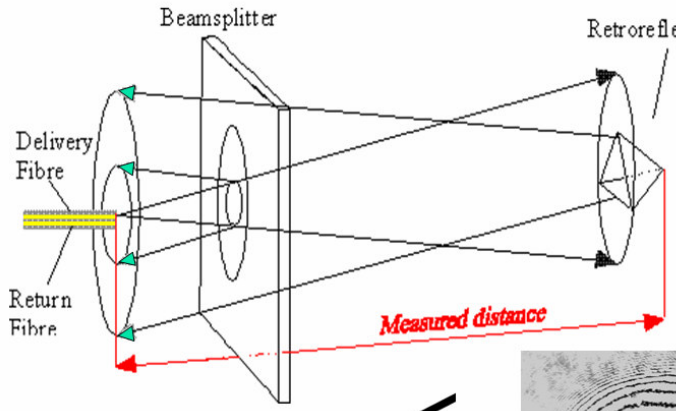
- Alignment Strategy
  - Excellent initial measurements
  - Continuous monitoring of primary support structures
  - Tracks
- X-ray Survey
  - Energetic enough to penetrate four layers
- FSI – Frequency Scan Interferometry
  - Over constrained grids of 800 1-D length measurements

ATLAS – FSI grid designs

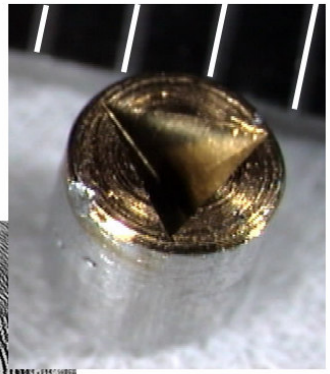


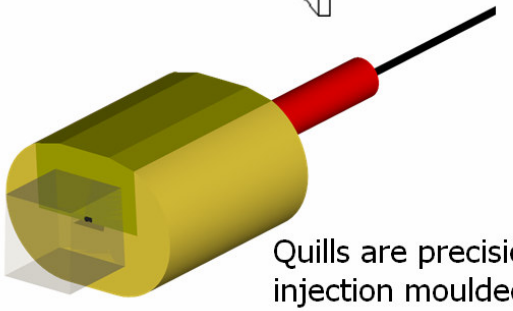
1μm per line
gives<5μm
in rϕ total

ATLAS – FSI on-detector

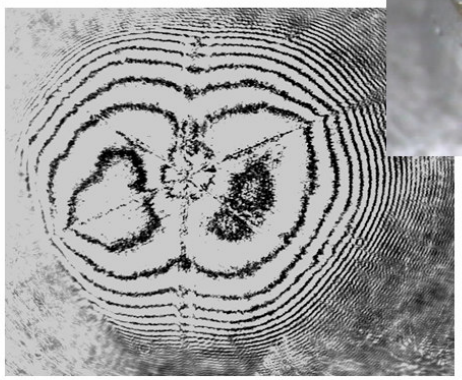


Retro-reflectors are punched in small Al pellets, gold coated, tested using WIPM

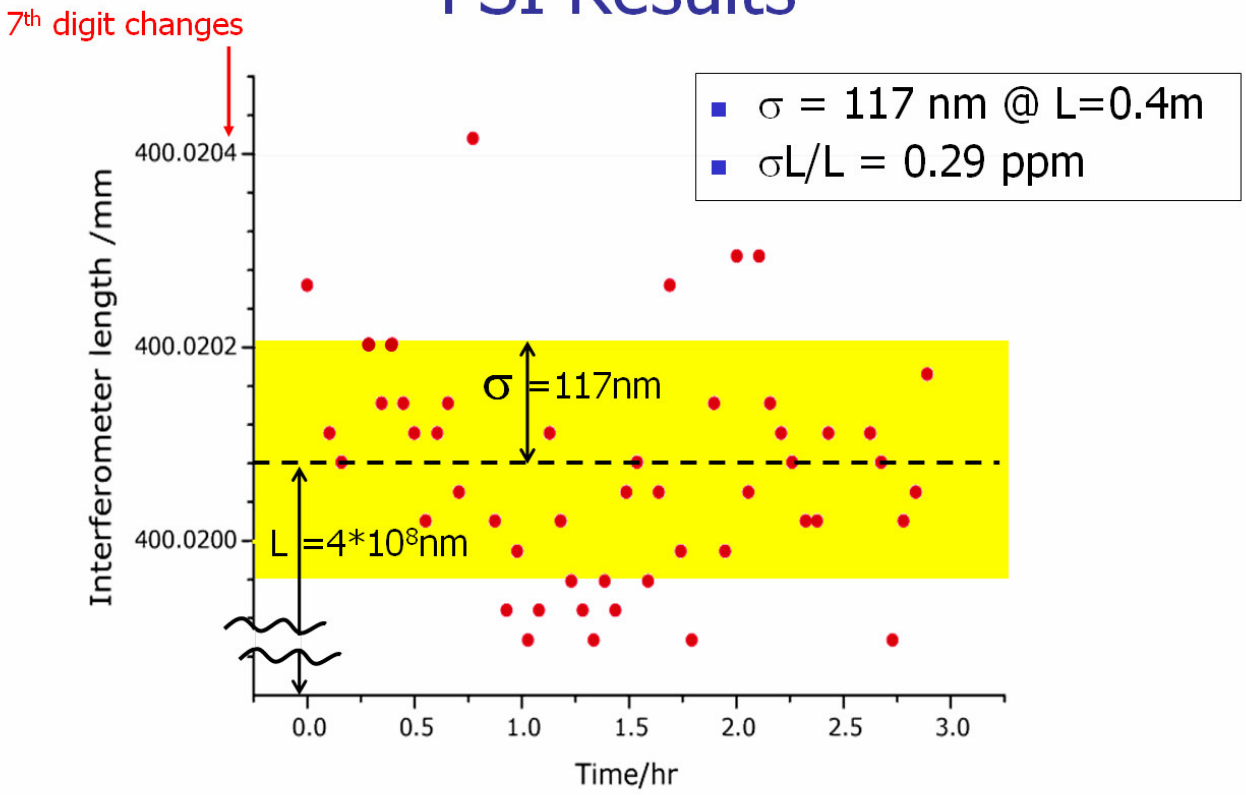




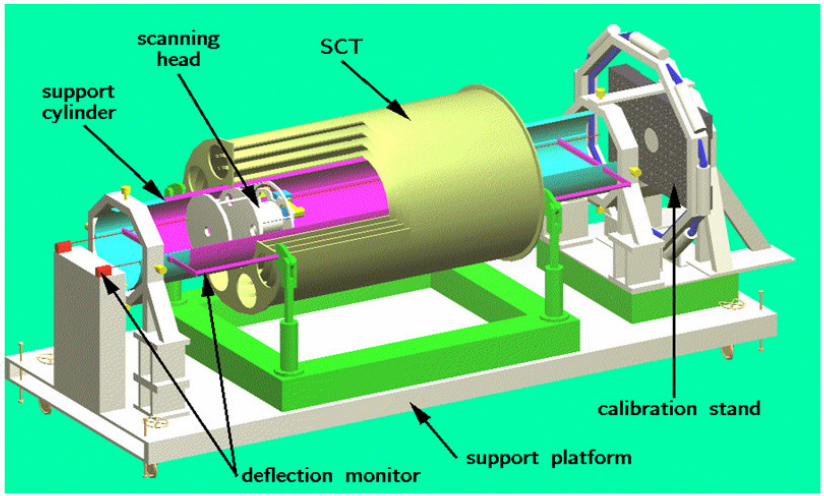
Quills are precision injection moulded parts



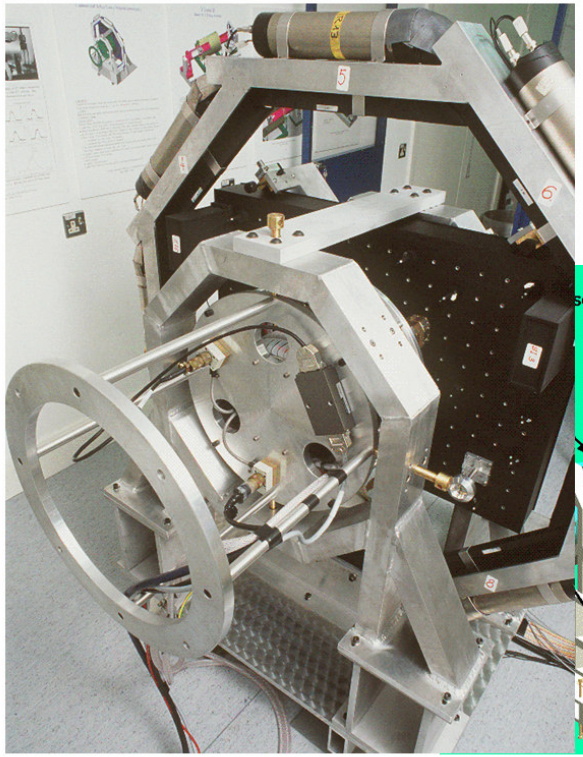
FSI Results


7th digit changes
σ = 117 nm @ L=0.4m
σL/L = 0.29 ppm
Interferometer length /mm
400.0204
400.0202
400.0200
σ =117nm
L =4*10^8nm
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time/hr

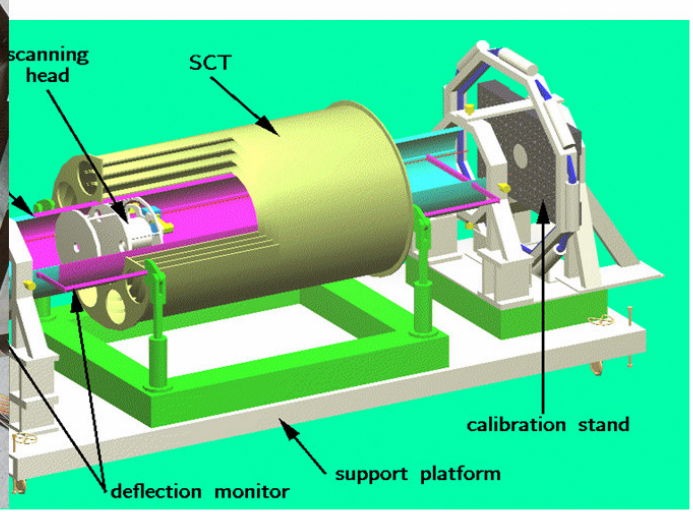
ATLAS – X-ray


scanning head
SCT
support cylinder
calibration stand
support platform
deflection monitor

ATLAS – X-ray

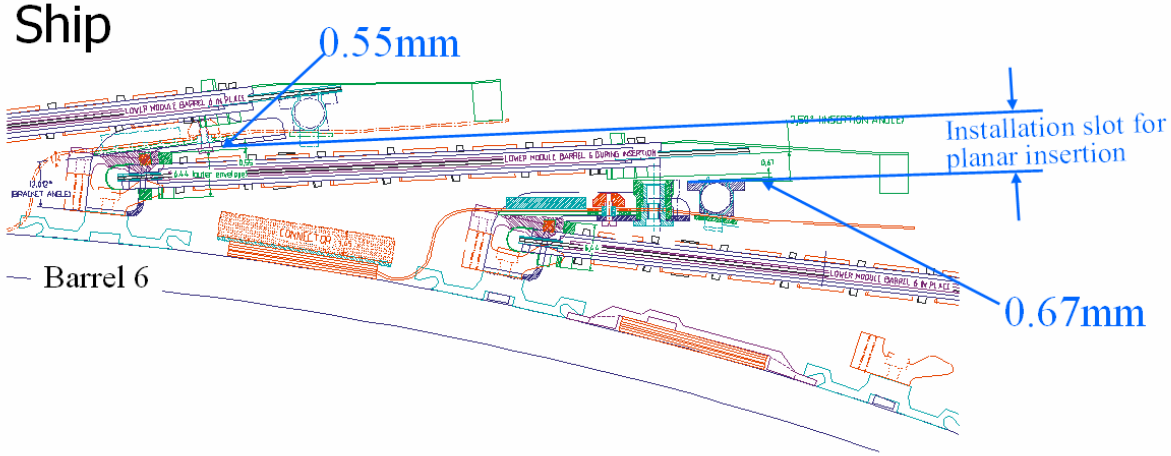


$\sigma(r\varphi) < 6\mu m$ (clocking)
$\sigma(r) < 30\mu m$ (radius)
$\sigma(z) < 50\mu m$ (length)



ATLAS -Assembly

- Attach 1500 Modules to 3 cylinders (£ 10k each)
- Debug (first time all components come together)
- Test
- Ship

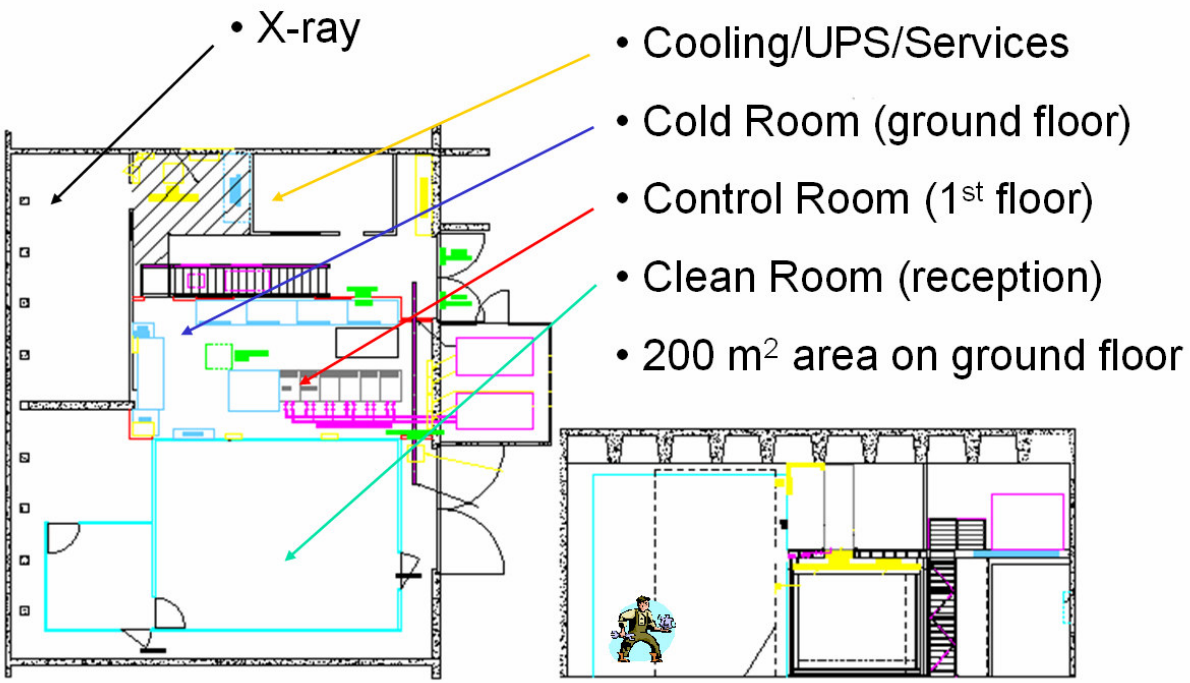


ATLAS - Assembly

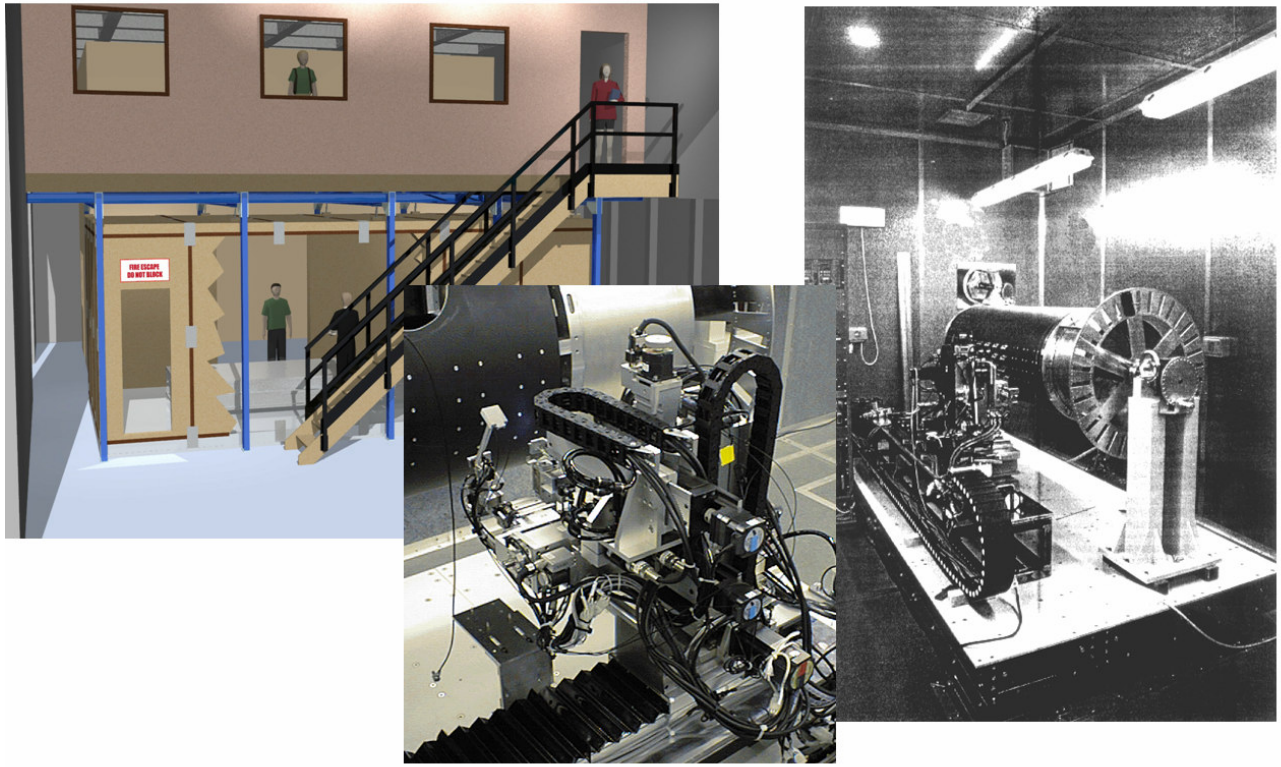
- Problems:
  - Clearances < 1mm
  - Grease layer 100 ± 10 μm
  - Insertion accuracy < 100 μm
  - Everything is VERY delicate (open wire bonds!)
- Infra structure:
  - 10kW evaporative cooling system
  - 700 cables, 2100 optical data links
  - 9 computer systems
  - Design and fabrication of assembly equipment
  - Test equipment, TI, WIPM, ToF, FSI
  - Design/manufacture shipping equipment

ATLAS – Assembly Facilities

(ex. Heavy Lab on Level-3)



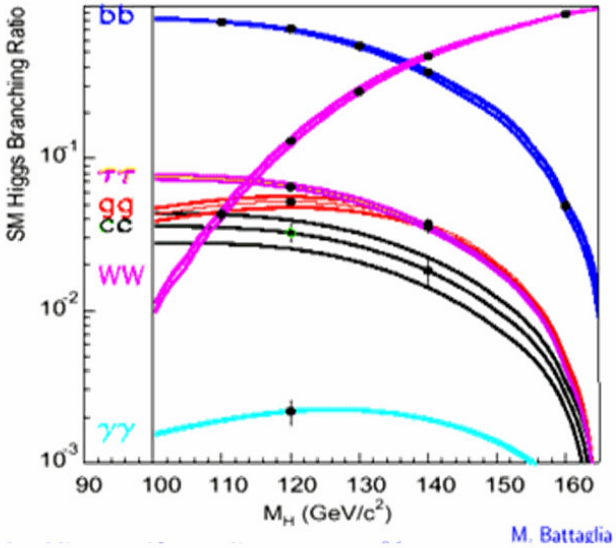
ATLAS – Assembly Facilities

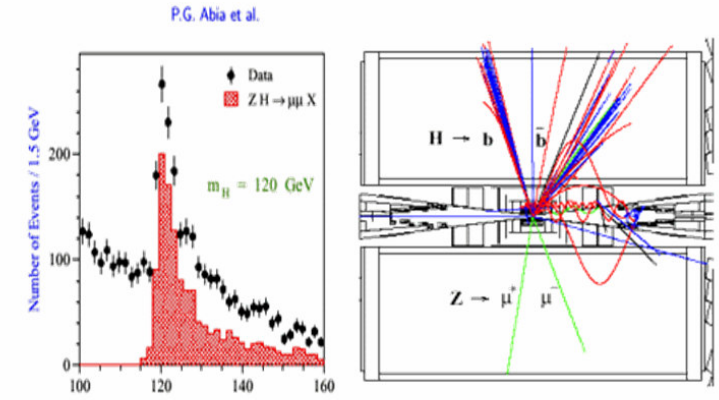


What may be large in Oxford tomorrow?

Why a Linear Collider?

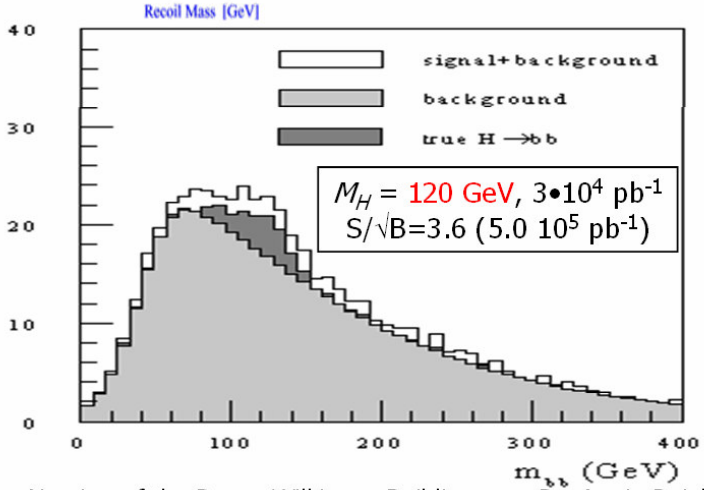
- Physics potential
  - Understand EW symmetry breaking mechanism
  - Do Higgs couplings generate masses?
  - Higgs self-coupling
  - Physics beyond the SM (SUSY)
- Collider even more challenging than detectors
- New initiatives on collider can use Oxford technology

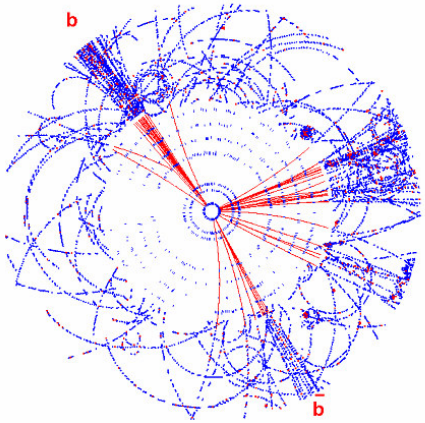




Why a LC ?

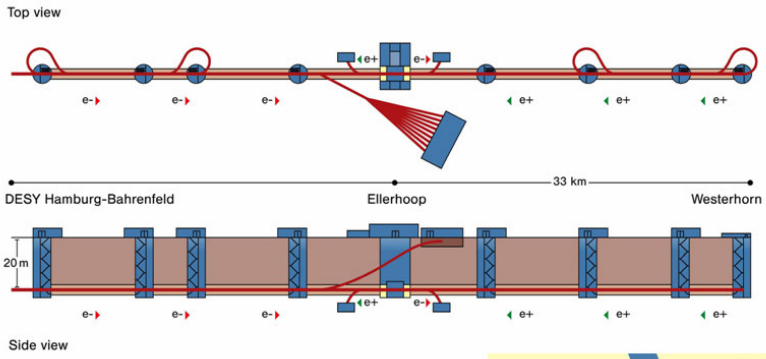
"Complementarity !"

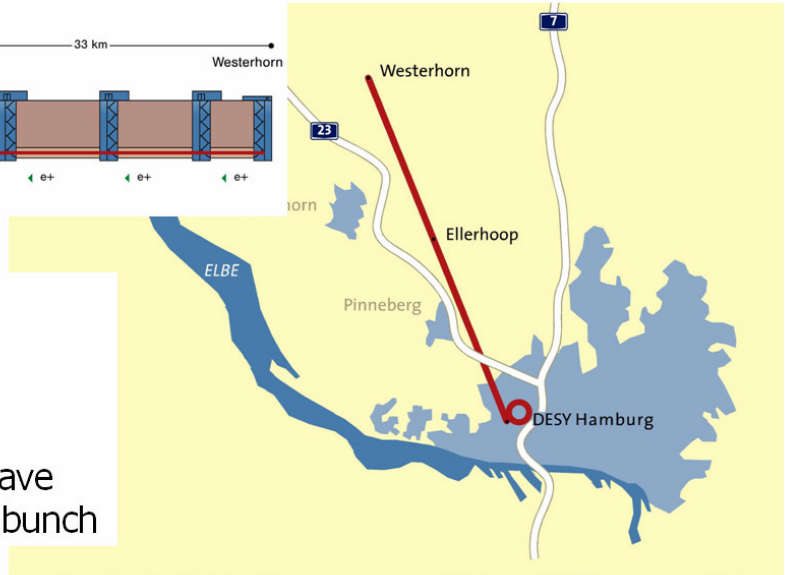




LCs are large (i.e. Tesla)

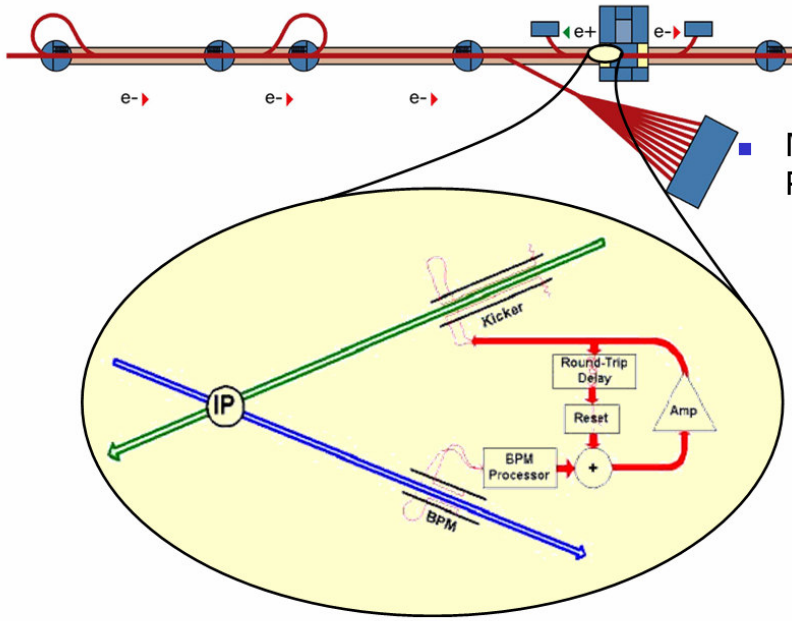
Large = 30km long





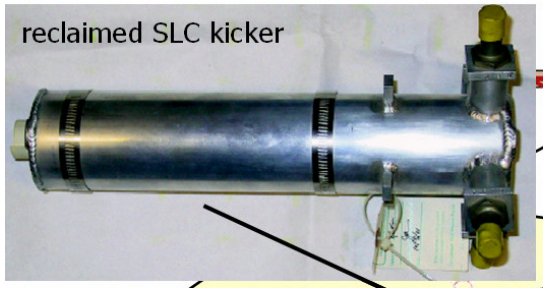
- Beam energy O(500GeV)
- Beams start at O(0.1μm)
- beams end up O(1nm) at interaction point
- no recirculation, you just have one shot to collide a given bunch

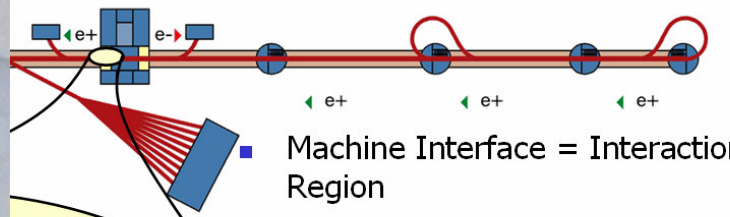
Interaction Region (FONT)

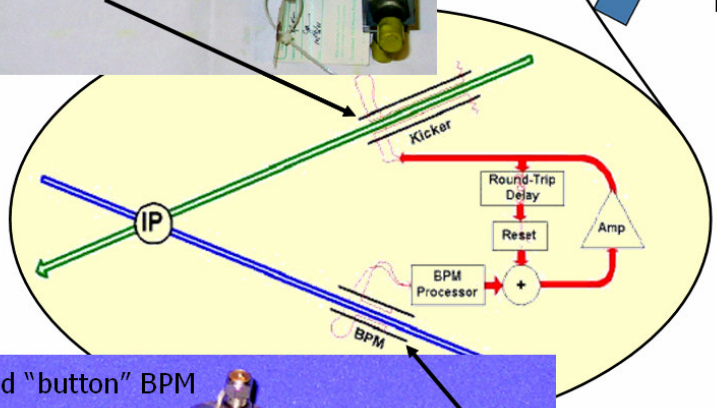


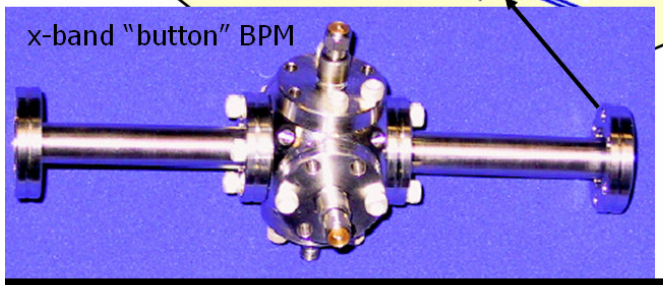
- Machine Interface = Interaction Region
  - FONT = Feedback On Nanosecond Timescales
  - Ground motion moves final doublet and beams stop colliding
  - Beam-beam interaction kicks beams
  - BPM measures kick of first few bunches in train
  - Kicker steers remaining ones back into collision
  - Need very fast feedback system
  - prototype @ SLAC since June

Interaction Region (FONT)







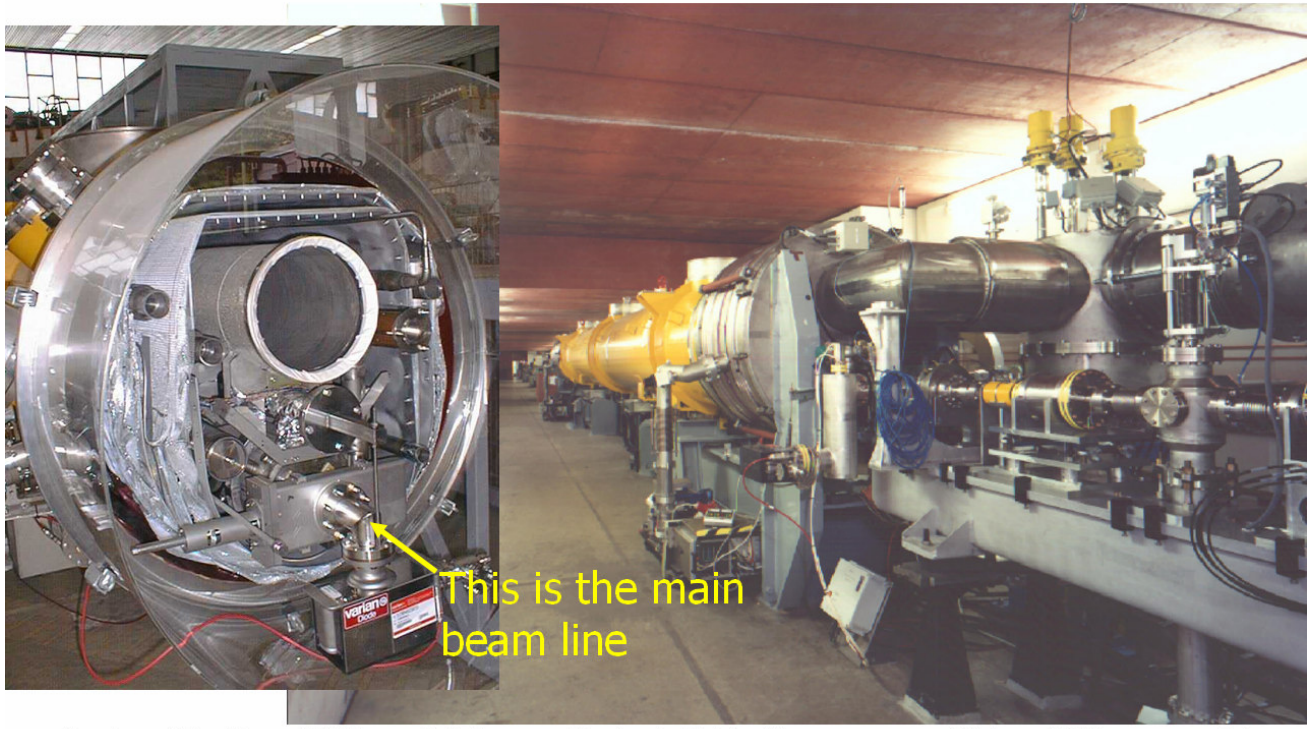


- Machine Interface = Interaction Region
  - FONT = Feedback On Nanosecond Timescales
  - Ground motion moves final doublet and beams stop colliding
  - Beam-beam interaction kicks beams
  - BPM measures kick of first few bunches in train
  - Kicker steers remaining ones back into collision
  - Need very fast feedback system
  - prototype @ SLAC since June

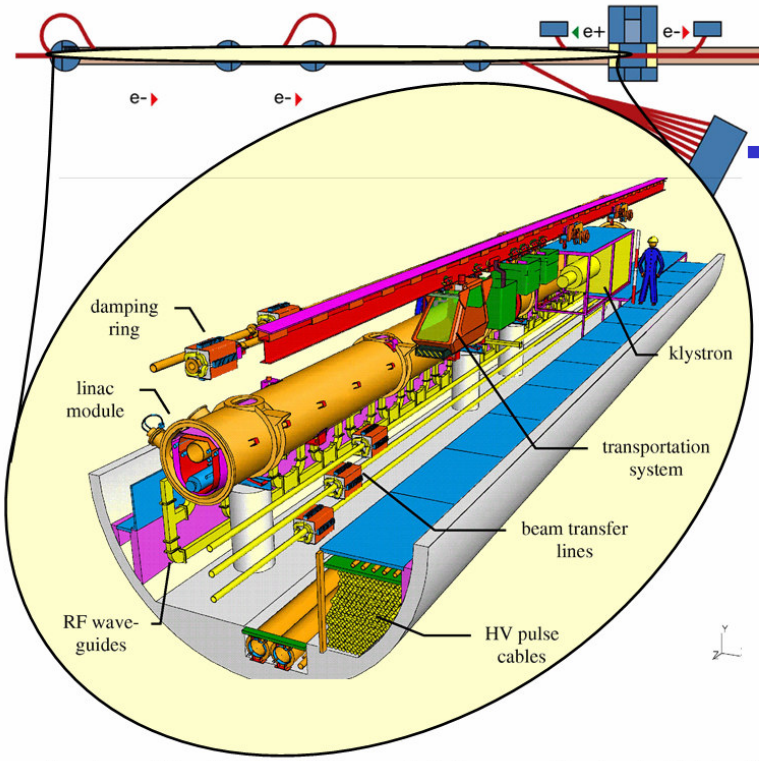
P. Burrows, G. White, S. Jolly, G. Nesom

LC alignment is important

(build accuracy: 200μm vertical over 600m for 30km total)



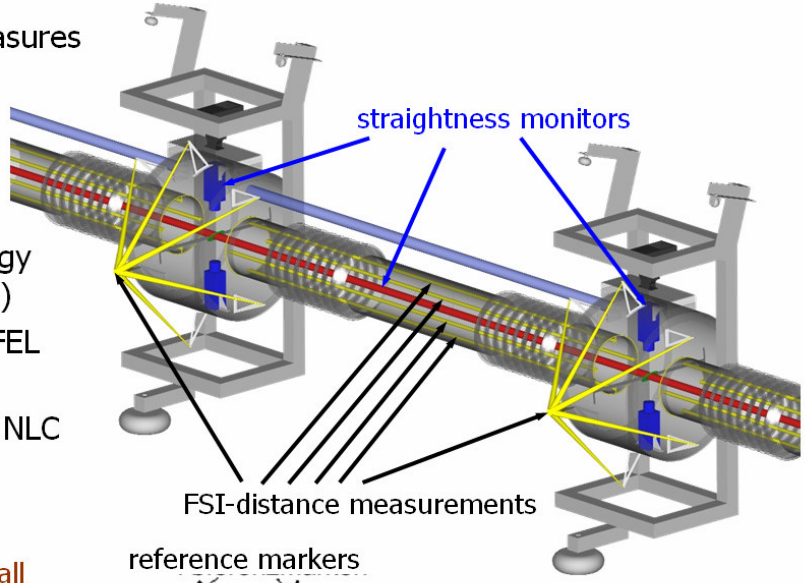
Collider & BDS (LiCAS)

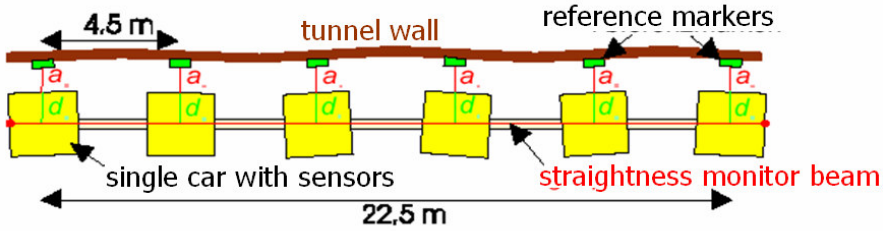


- Collider Alignment
  - LiCAS = Linear Collider Alignment & Survey
  - collider alignment at build time 200 μm over 600m
  - Today's open air survey technology fails
  - Build survey instrument that matches requirement
  - Use FSI (ATLAS) & Straightness monitors (ZEUS and ATLAS)
  - Extend technologies to new conditions

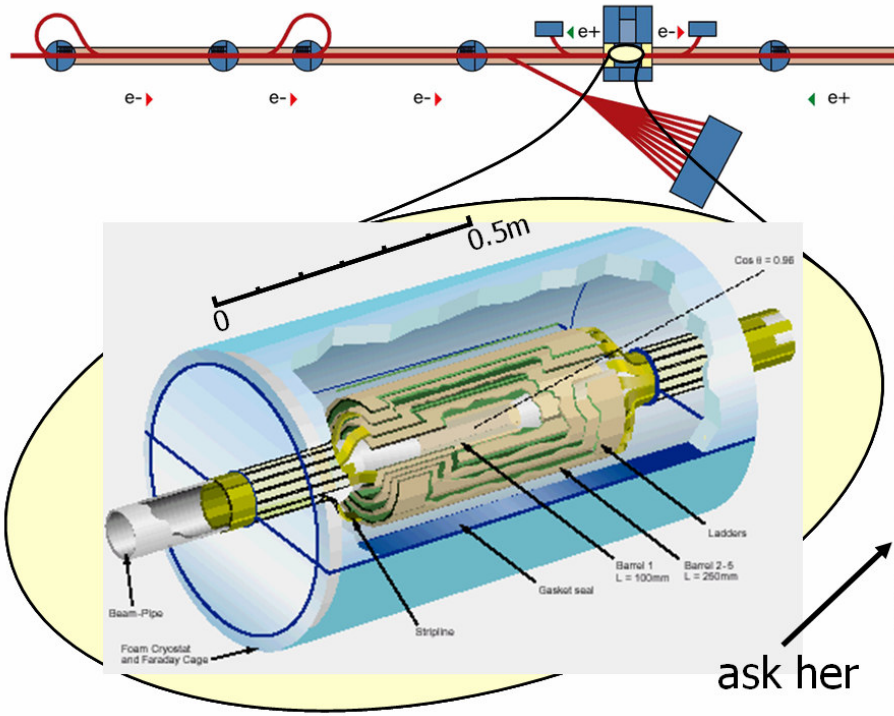
LiCAS Phase I

- Automatic survey train measures reference markers
- Later measure collider against reference
- Internal lines in vacuum
- Use scalable laser technology (not large monolithic lasers)
- Prototype @ DESY during FEL installation
- Same scheme for TESLA & NLC





Detector (LCFI)



ask her

Susan Cooper