UK Accelerator Design Base

Mike Poole

ASTeC Director

Accelerator Science and Technology (AST) in CCLRC

- **Core business importance recognised**
- **DL and RAL created as particle physics laboratories**
- **40+ years expertise in electron, proton and ion accelerators**
- **Design, build and operate Large User Facilities**
  - **latterly photon and neutron sources: SRS ISIS**
- **Develop next generation solutions**
  - **HELIOS DIAMOND ESS ERLP/4GLS (ILC, NF, IFMIF …..)**
- **Underpinning R&D programmes**

CCLRC AST Review - 2001

- **Major skill bases remained in ISIS and SR Departments**
- **Particle physics accelerator expertise (almost) lost**
- **Accelerator Science and Technology Centre (ASTeC) created in 2001, initially 20 staff - now 50 staff - restricted to accelerator specialists only - £8M pa programme by 2005**
- **Expansion funded by SR02 allocations to CCLRC + PPARC**
- **Major development activities continue in ISIS Department, partly funded by ASTeC**

ASTeC Strategic Objectives

- **Establish and consolidate UK core accelerator skills base**
  - **leadership and advice to stakeholders**
- **Ensure international competitiveness**
  - **(people + programme)**
- **Develop future LSF**
  - **(advice, design, prototype, construction)**
- **Promote suitable CCLRC activities (DL + RAL)**
- **Pursue underpinning technology**
  - **(inc. experiments)**
- **Encourage collaborations**
  - **(HEIs + international)**

Key Elements

- Recruit and retain skilled staff
- Underpinning design studies
- Beam dynamics simulations
- New technology developments
- Beam test facilities
- Major networking with HEIs and overseas laboratories
- Knowledge transfer

ASTeC Structure

- **Five Groups:**
  - **Accelerator Physics (Susan Smith)**
  - **RF and Diagnostics (Mike Dykes)***
  - **Magnetics and Radiation Sources (Jim Clarke)**
  - **Vacuum Science (Ron Reid)***
  - **Intense Beams (Chris Prior)**

* Imminent retirement

- **New style of Centre within CCLRC**
- **Income received also from DIAMOND, SRS, 4GLS, EU…**

and PPARC !

Principal ASTeC Sponsored Programmes

- **Novel light sources - 4GLS, FELs, ERLP**
- **Linear collider - ILC, CLIC**
- **Neutron sources - generic proton drivers, FETS**
- **Neutrino factory - MICE, design concepts, proton driver**

- **DIAMOND design/procurement role (now greatly reduced)**
- **SRS support/development (hands-on role and training until 2008)**
- **Laser based accelerators (laser-plasma project, HEIs)**
- **Underpinning technology (eg undulators, NEG pumps, RF systems etc)**

NB Sundry smaller scale projects/collaborations

EU Programmes

- **Previous FP5:** **EUFELE** **RF Cavity***
- **FP6 I3 contracts:** **HIPPI** **ELAN** **PHIN**
- **FP6 awards:** **EuroTeV** **EUROFEL**

* **Officially completed**

NB Major problem of overhead recovery for CCLRC

FP7 presents major challenges

Joint CCLRC/PPARC National Programme (2004-2007)

- **£11M PPARC sponsorship**
- **This covers both LC and NF activities**
- **PPARC award to CCLRC: £4.5M (75% LC, 25% NF)**
- **ASTeC adds £3M to this Joint Programme (inc MICE)**
- **ASTeC is largest partner but many HEIs involved now - and about 15-20 RA posts created**
- **Accelerator Institutes also created: CI and JAI**

The Accelerator Institutes

- **Formal ASTeC policy is to collaborate with both CI and JAI**
- **Search for synergies with broad range of ASTeC programmes**
- **ASTeC will fund posts in each Institute**
- **ASTeC is equal partner in CI, participates fully in management and policy issues and will share building at DL in mid-06 - CCLRC on CI Board.**
- **Many CI staff already housed with ASTeC on DL site**
- **Negotiations underway with JAI on joint programmes and appointments**
- **ASTeC is represented on JAI Executive Committee**

LC-ABD National Collaboration

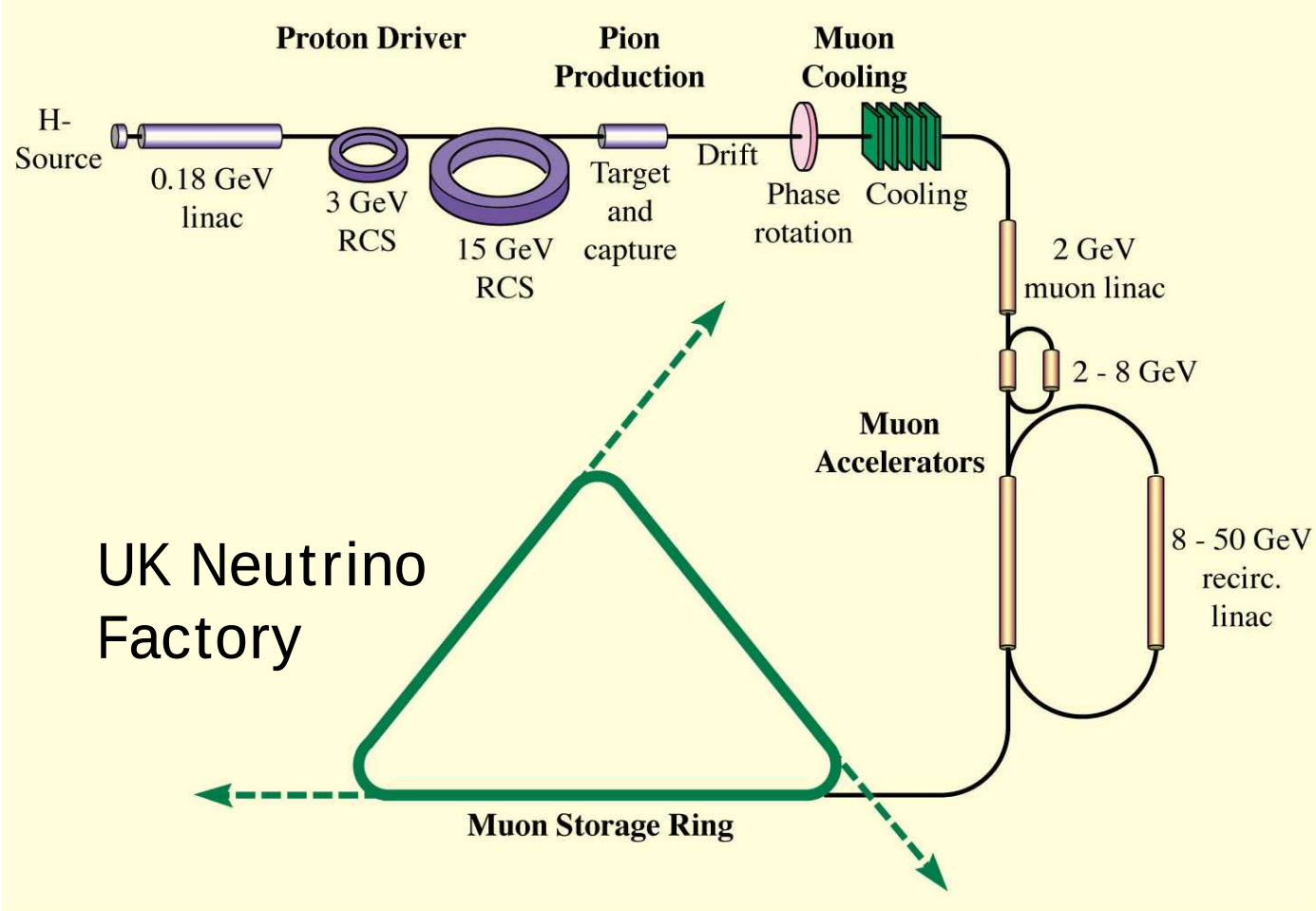
- **Linear Collider studies now organised in UK mainly through LC-ABD Collaboration with HEIs (2004-2007)**
- **Strategic decision to concentrate on Beam Delivery System**
- **Major funding initiatives (ca £10M over 3 years)**
- **ASTeC takes lead role in Beam Dynamics and in Magnet and RF Technologies**
- **Further major ASTeC role in Beam Diagnostics**

LC Technology at ASTeC

- **Polarised positron source (SCM)**
- **Crab RF system (SRF)**
- **Collimation and Wake Fields**
- **Diagnostics (nm + fs)**
- **Beam dump (just initiated)**

NB These are all HEI collaborations

Neutrino Factory Accelerator Concept



ASTeC Neutrino Factory Studies

- **PPARC funded programme with several HEIs**
- **ASTeC conceptual studies of proton driver, including high intensity synchrotrons, and muon accelerators**
- **Pre-FP7 Scoping Study (joint CCLRC/PPARC initiative)**
- **Direct financing of MICE Phase 1 (and RF activities for Phase 2)**
- **International collaborations, including FFAG development**

Intense beam transport relevant to FAIR

Linac Based Light Sources

- **Storage ring (10^{11} turns) fundamental limitations (σ, τ)**
- **Linacs can deliver very high quality electron beams**
- **Temporal pulse pattern flexibility**
- **High average flux requires Energy Recovery Linac (ERL)**
- **Superconducting RF technology can be exploited**
- **High average brightness gun is essential development**

ERL Prototype (ERLP) Project

Partnership:

DL (ASTeC + SRS)

RAL (CLF)

HEIs (Manchester/Liverpool/Strathclde)

Jefferson Lab

Rossendorf

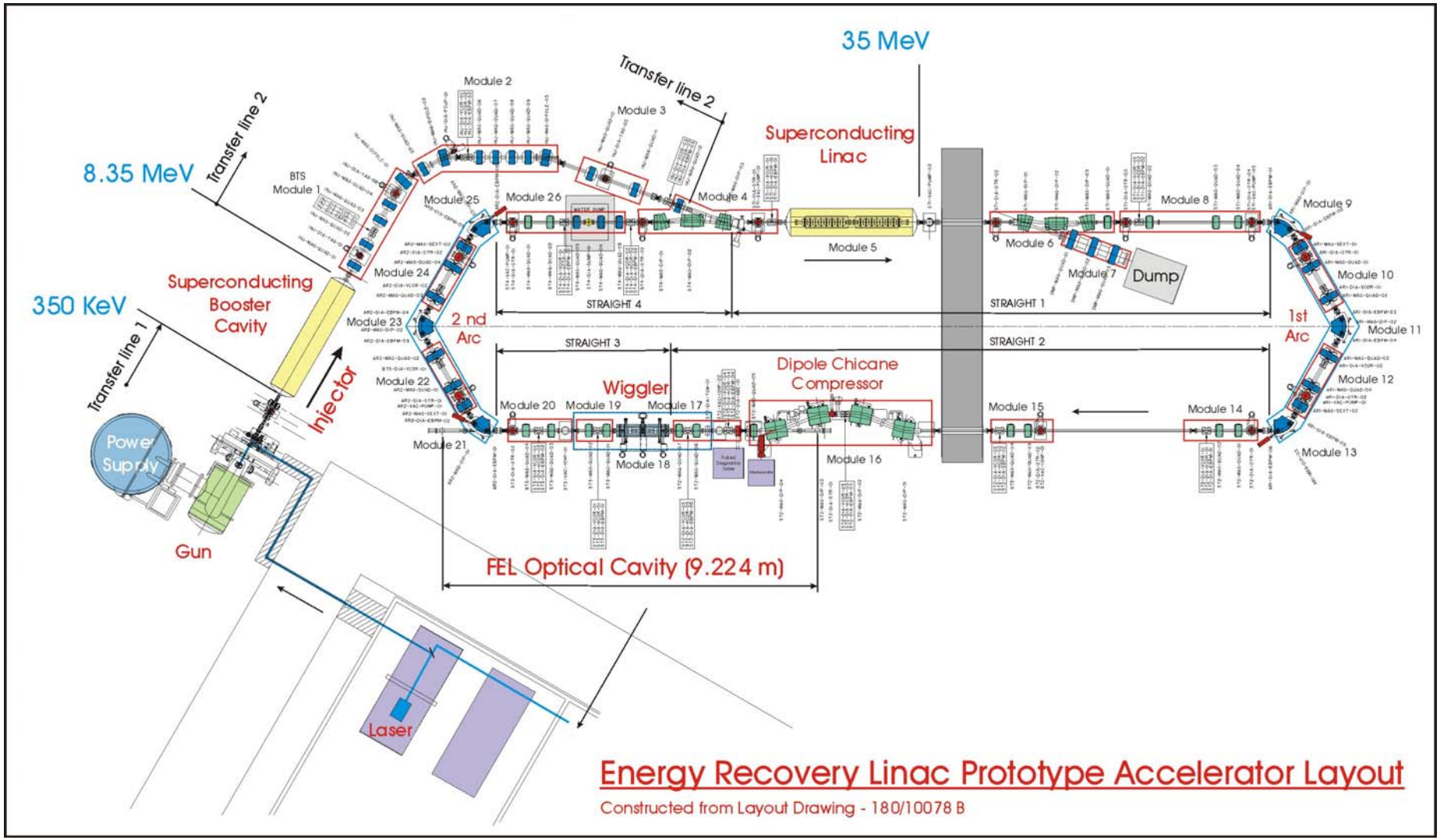
Principal challenges:

- High brightness and intensity gun
- High current superconducting linac
- Beam transport optics (bunch compression, CSR, wakes)
- Diagnostics

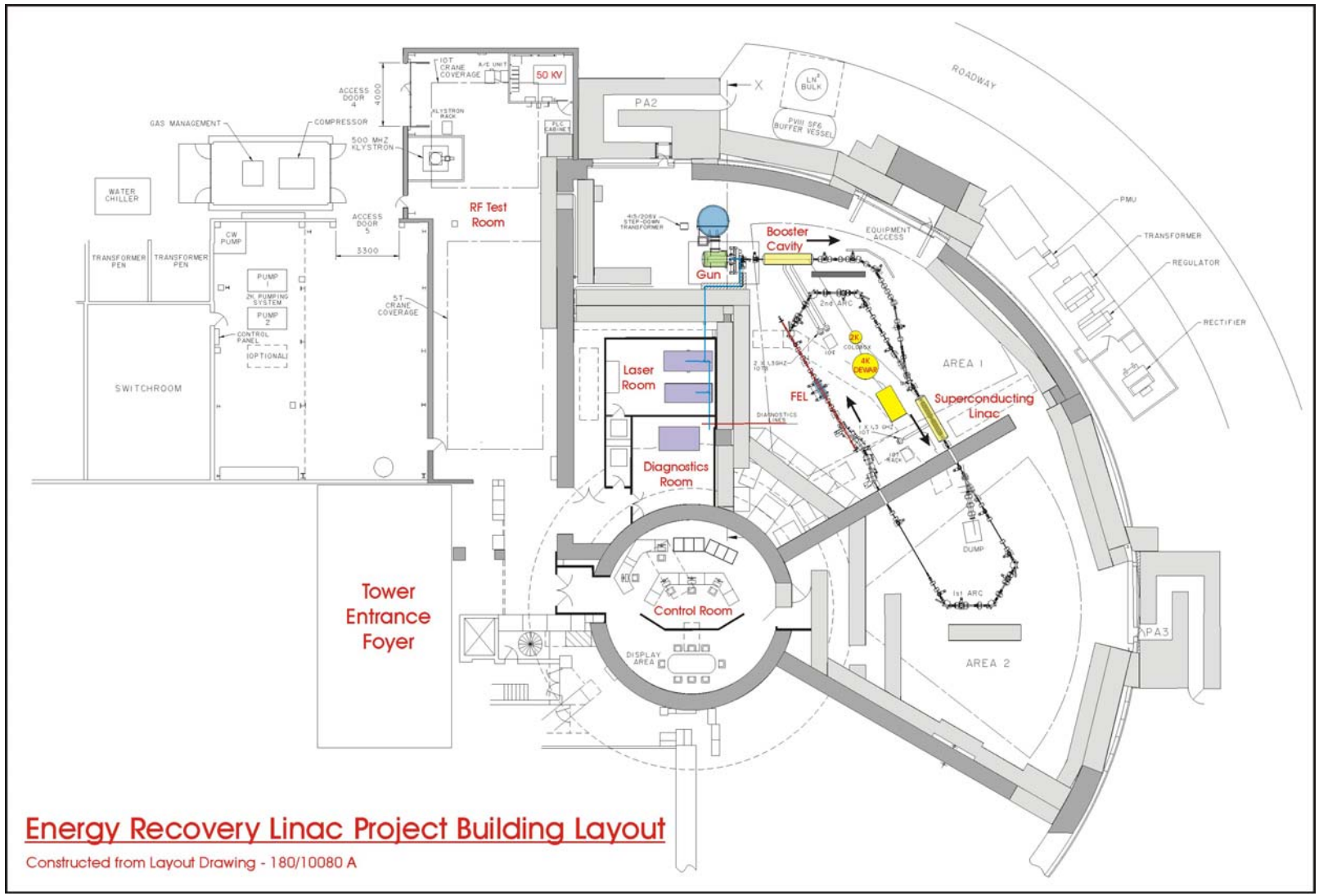
and:

- Lack of experience

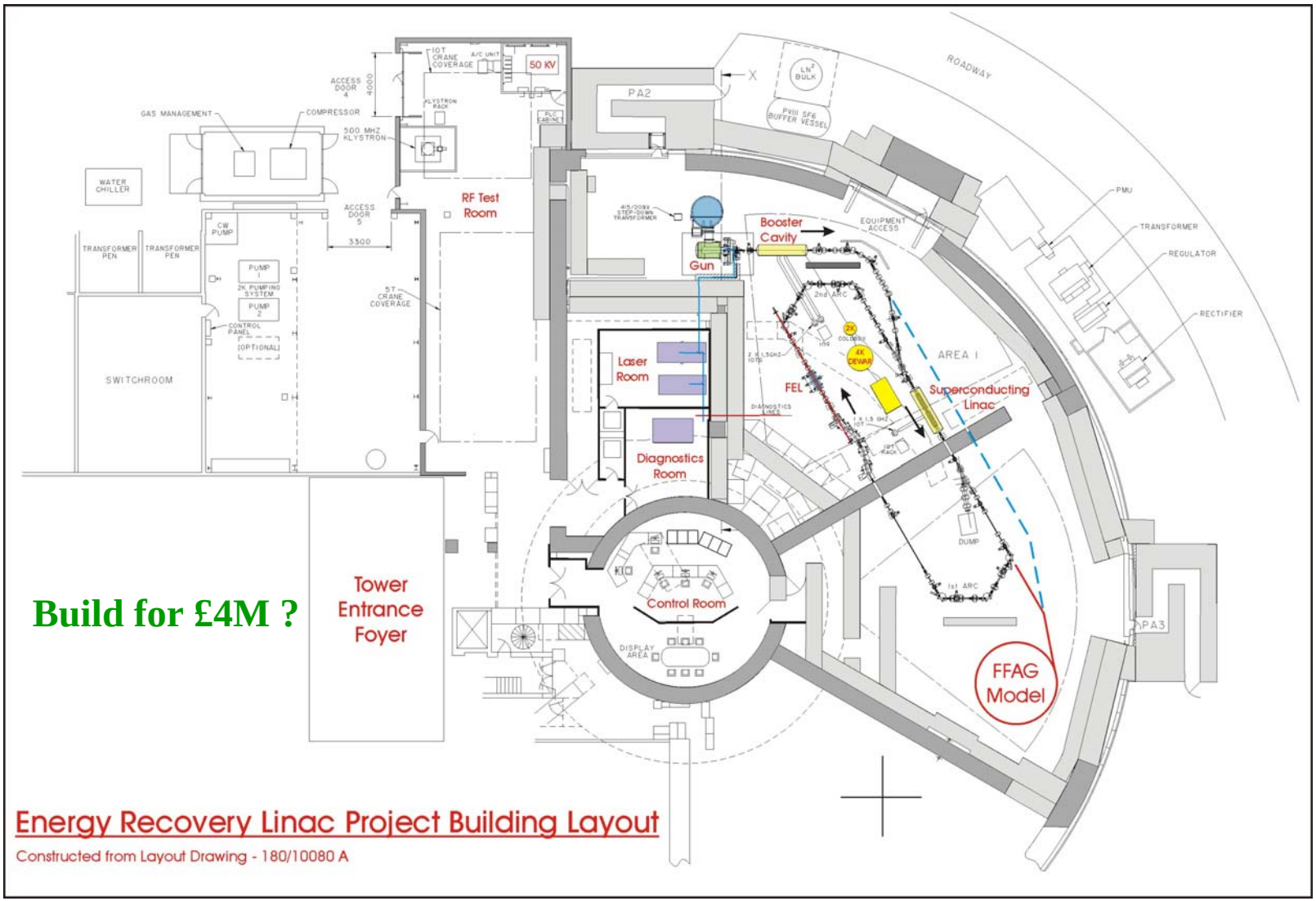
ERLP Detailed Layout



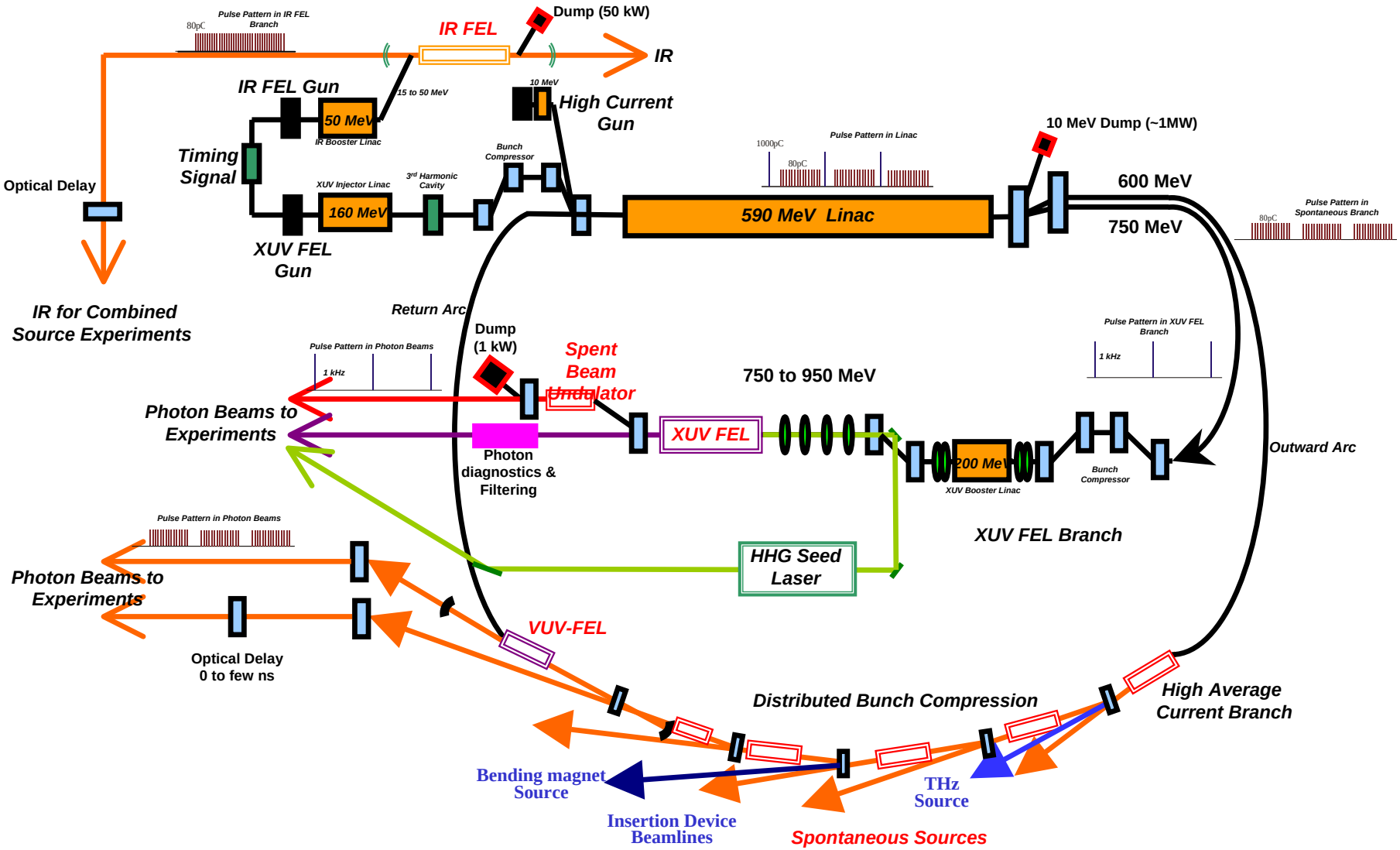
ERLP Layout in Tower Building



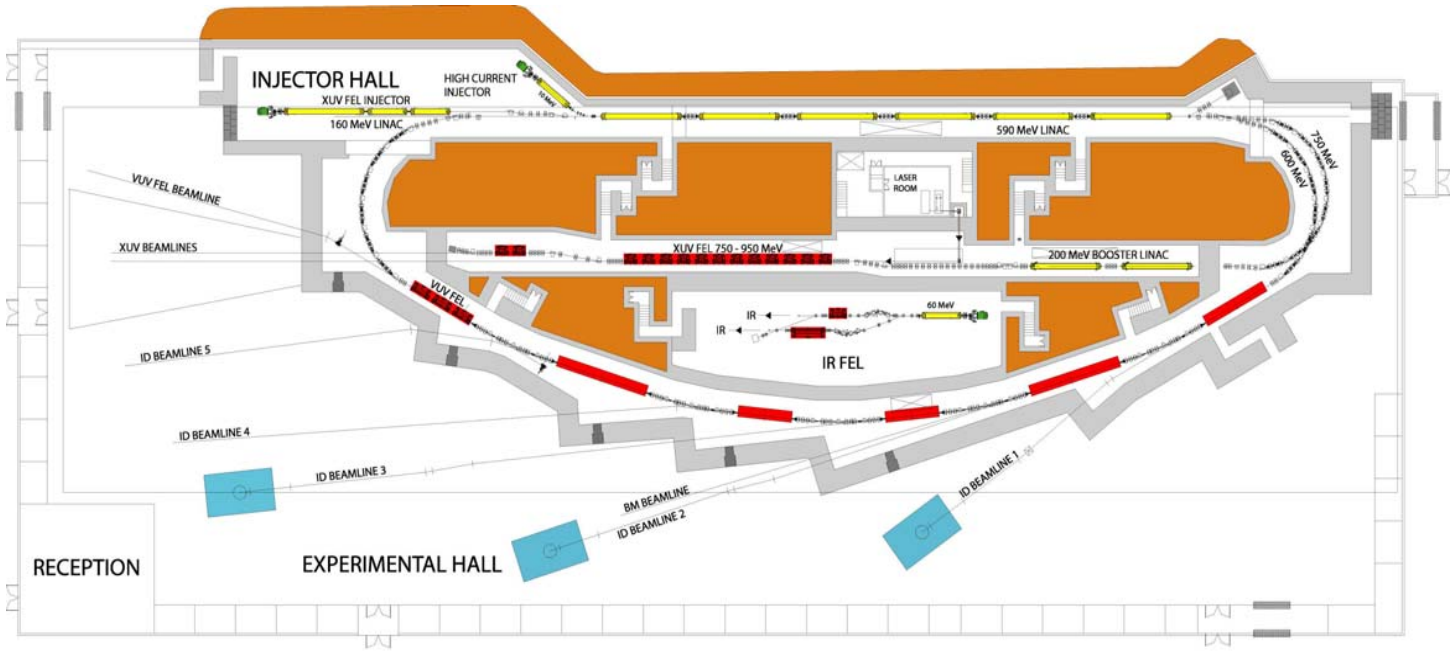
Proposed site for EMMA: e-FFAG Model

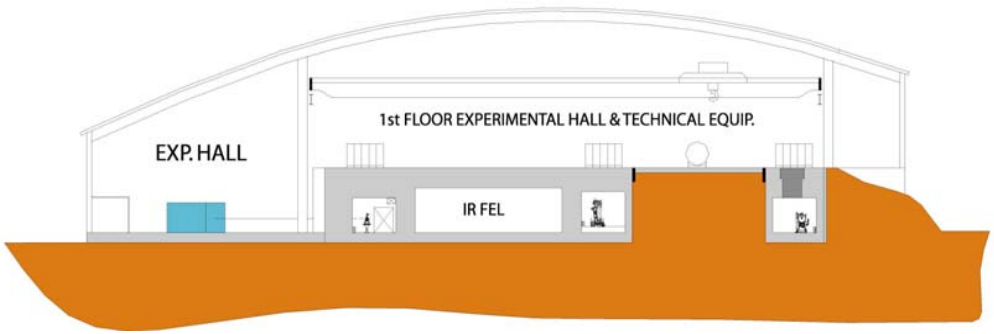


The 4GLS Multi-Source Concept



Practical 4GLS Layout (Preliminary)



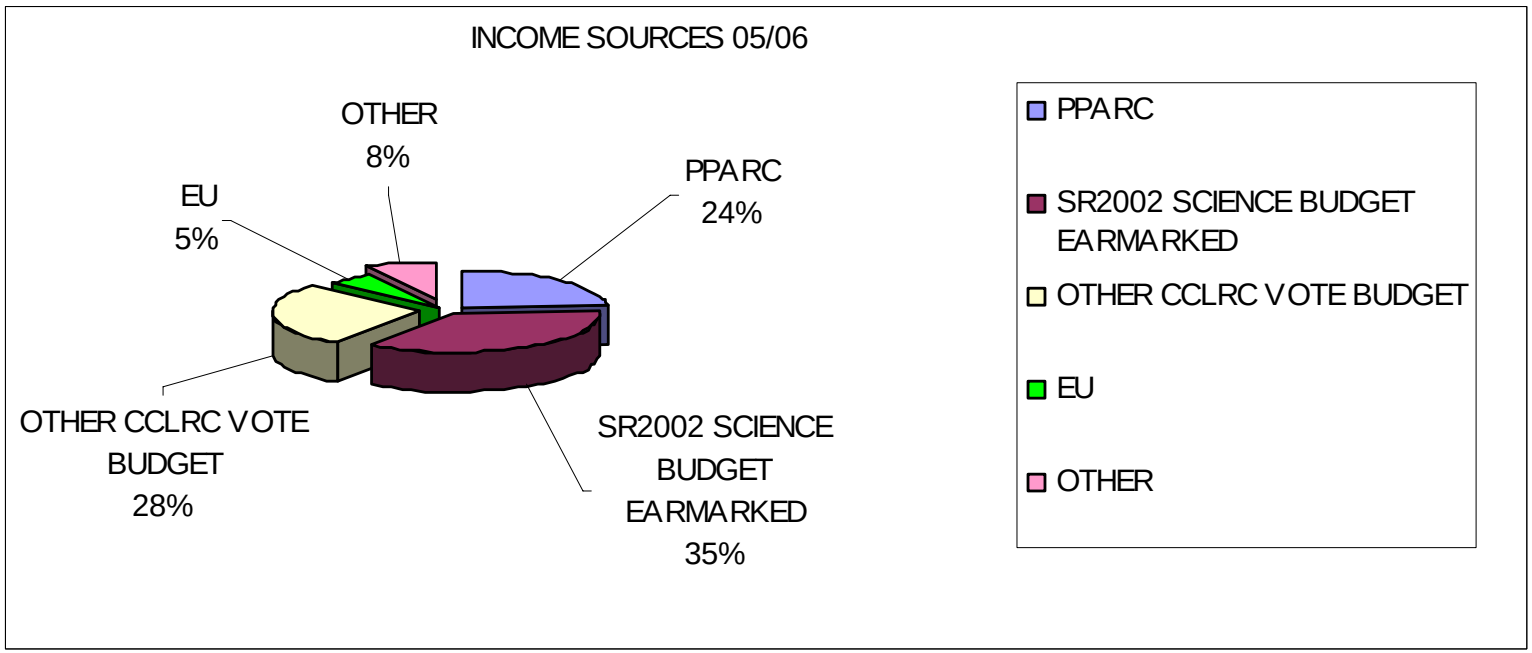


4GLS
LAYOUT

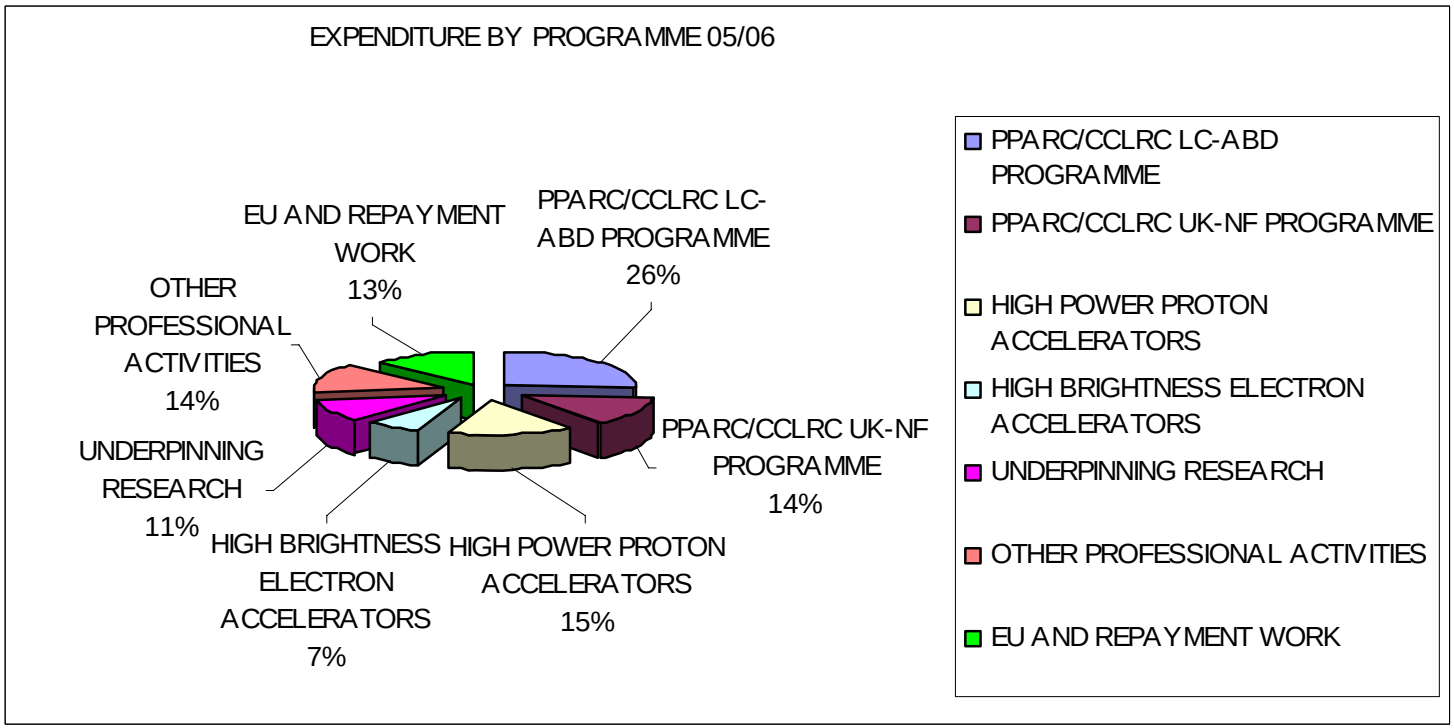
CONSTRUCTED FROM DRG. 205-10000C

Planned ASTeC Income 05/06

TOTAL ~ £8M



Planned ASTeC Expenditure 05/06



FAIR Contribution ?

- Accelerator physics discussions with GSI proposed Beam Transport Line design (space charge regime)
- BUT …..no significant ASTeC effort available (recruiting to IB Group now) so no progress yet
- AND …..this is not a major core role
- CCLRC has international class superconducting magnet expertise in its Project Engineering Group - much more promising role, and preliminary contacts established

Conclusions

- **Major investment in UK skill base in AST has occurred**
- **CCLRC (mainly through ASTeC) has given this priority and also has a major R&D collaboration with PPARC**
- **HEIs have seen large expansion (and not only Accelerator Institutes)**
- **Collaborations are now widespread**
- **Despite this CCLRC has small resources for AST support to FAIR, and also awaits EPSRC promotion ……..**