Replies to the action items resulting from ECAL_EDR-04
held on 28 Nov 2000, for the EE detector.

Please note that, where possible, web links have been inserted for documents referred to in the text. A pdf version of this document is available at http://hepwww.rl.ac.uk/CMSecal/Workshops.htm

The replies are divided, as closely as possible, to follow the relevant chapter headings in the Committee finding.

Project Organisation

4-EE.1 Define what rate of crystal delivery is required to meet CMS schedule v30.

4-EE.2 Define milestones ML1 that can be met by EE, using the present crystal delivery schedule.

These actions have been superseded by events. The EE and EB planning has now been integrated and the latest version (ECAL week, July 2002) posted on EDMS. The rate of crystal delivery and related issues will be addressed at EDR-06. The V33 EE LHCC milestones are currently under approval. The planning and milestones are posted on EDMS.

4-EE.3 A contingency plan must be developed to mount one (or two) EE during a shutdown, with, if possible, the beam-pipe in position.

This is no longer a contingency but is now incorporated in the current EE design. It will be discussed in the installation session at EDR-06.

4-EE.4 A fully integrated schedule should be defined, including electronics, testing (VPTs), general quality control outlines and who is responsible for tooling, mounting and assembly.

The fully integrated schedule will be discussed at EDR-06. The responsibilities for EE tooling, mounting and assembly are currently being discussed and have not yet been confirmed.

4-EE.5 How manpower training will be implemented in the various centres must be defined.

In the UK, only the Rutherford laboratory is involved in the production assembly of Supercrystals. The other UK institutes have associated roles in the area of quality control, based on sample measurements (see EE.7). The SC regional centre at RAL will be supported by experienced staff from the Engineering and Particle Physics Departments. New or hired staff will be carefully selected for their skills and given on the job training. In due course, RAL staff will also train staff in the CERN and Rome EE regional centres, and will train staff in the Russian centre for assembly of partial supercrystals at CERN.

4-EE.6 Improve communication between EE collaborators, CERN/CMS and EB managers.

This has been much improved with the appointment of Mr A Lodge (RAL) to act as deputy to Dr W Lustermann in the electronics integration group, from March 2002, and with the increasing role of Dr K Bell (RAL), initially for EE Dee build, integration and installation questions. Dr Bell will spend a significant part of his time at CERN.

The EE project engineer, J Greenhalgh, has been in close contact with the ECAL PM and TC together with F Rondeaux (Saclay) for the integrated ECAL planning.

4-EE.7 Clarify relation and responsibilities between the four centres situated in the U.K. (RAL/Brunel/I.C./Bristol).

Bristol – Provision of jigs and tooling, as required. Provision of readout electronics for supercrystal testing.

Brunel – Sample verification of the gamma radiation tolerance of EE $PbWO_4$ crystals, in collaboration with I.C. Certification of gamma radiation hardness of VPT glass faceplate samples. Sample testing of mass production VPTs at 4T. Sample verification of the gamma radiation tolerance of production VPTs.

I.C. – Sample verification of the transmission, light-yield and radiation tolerance of production EE $PbWO_4$ crystals.

RAL – Acceptance testing of all production VPTs. The UK supercrystal assembly site. Provision of SC test equipment and test procedures. Provision of database infrastructure for the UK supercrystal assembly site.

4-EE.8 Draw up a flow chart of activities indicating the person responsible for each activity including general QA/QC aspects.

All aspects of SC build will be tracked by a Labview/database system with feedback from test and assembly, as shown in the figure set at the end of this document.

QA/QC Responsibilities:

SC assembly and overview of all related QA/QC aspects – B Smith (RAL)

SC database and Labview – J Williams (RAL)

VPT reception, test, appraisal and transfer to SC assembly lab – B Kennedy (RAL)

VPT to crystal gluing – P Flower (RAL), A Lintern (RAL)

SC electronics test – M Sproston (RAL), A Lintern (RAL)

4-EE.9 Nominate an independent Quality Control manager.

Supercrystal Quality Control manager – D Cockerill (RAL)

4-EE.10 Nominate one person for each ECAL sub-project (EB/EE/SE) to follow-up the progress of EE documents through EDMS.

For EE, M. Sproston (RAL) is undertaking this responsibility.

4-EE.11 Create an 'Integration and Parameter Group' in CDD, with representatives of neighbouring sub-detectors, with the Integration General Co-ordinator as approval leader.

After discussion with A Herve, CMS TC, it is agreed that the Integration General Co-ordinator (Gerard Faber) is the approval leader of the 'Integration and Parameter' drawings for EE (and also EB & SE).

4-EE.12 Open a dedicated 'QA & NC reports' section in the EE EDMS tree structure to log general quality assurance documents and the non-conformity reports, which may have an implication for the neighbouring systems.

A 'QA & NC reports' section in the CMS ECAL EDMS tree structure has been opened. The 3 boxes (and their documents) 'EB Major Non-conformities', 'EE Major Non-conformities', 'SE Major Non-conformities' appear inside the box 'ECAL Major Non-conformities' which itself appears inside the box 'CMS Major Non-conformities'.

Thus the EDMS structure appears now as follows:

ECAL GENERAL
    ECAL quality assurance documents
        ECAL Major Non-conformities

Barrel (EB)
    EB QA/QC Documents
        EB Major Non-conformities

Endcaps (EE)
    EE QA/QC Documents
        EE Major Non-conformities

Preshower endcaps (SE)
    SE QA/QC Documents
        SE Major Non-conformities

EE Crystals and Supercrystals

4-EE.13 An early plan for general maintenance and calibration of all automatic machines must be developed.

The VPT test rig at RAL is the major system with significant automation involved in SC production. General maintenance is the responsibility of staff in the Particle Physics Department at RAL and is carried out by them. As far as possible the system is modular and uses interfaces that are standard commercial products. Calibration is monitored through the use of reference VPTs and a Si PIN diode. Relevant parameters such as VPT bias voltage, magnetic field, temperature, and LED driver pulse height are automatically logged. The electrical equipment to verify the performance of assembled SCs will be based as much as possible on that of the VPT test rig. Calibration will be monitored through the use of a reference supercrystal.

As of 30.7.2002, 1800 mass production VPTs have been delivered to RAL. 1100 have been visually inspected and 1100 tested in the VPT test rig at RAL. This follows the delivery of 500 pre-production VPTs, which have all been inspected and tested.

4-EE.14 Shipping organisation must be reviewed taking into account customs formalities, insurance, documentation and tractability.

This is standard practice for the RAL import and export section who have many years of dealing with such matters, particularly for shipments/receipts to and from CERN. All shipping from the UK will be carried out through RAL.

Shipping between CERN and the Rome regional centre will use the procedures developed for the EB regional centre at Rome.

4-EE.15 In view of the non-maintainability of the Supercrystals, produce a detailed analysis of components and system failure modes, and assess the system tolerance to failures.

Detailed analysis of components and system failure modes, and the system tolerance to failures have been documented in the following papers:

Analysis of AC effects of faults in the EE HV system, M Torbet, 30.3.2002, EE262

Analysis of DC effects of faults in the EE HV system, M Torbet, 19.6.2001 ps
Appendix A, Component Failure Fault Analysis, Torbet-Connolly-Lodge, 29.3.2000 ps

4-EE.16 Improve axial compliance of Supercrystals inside the alveolar structure.

The crystals are fully constrained axially between the end stops, at the front, and the inserts, at the rear, of the Supercrystal. The end stops and inserts are bonded in place during the assembly procedure.

A jig holding the alveolar, 25 crystals and related parts is rotated to the vertical position so that all the crystals rest on the unglued, but jig constrained, rear inserts. In this position the 25 endstops, with reflective Tyvek on the crystal side, are inserted into each cell and pushed down to make physical contact with the crystals and are bonded in place. Differences in crystal lengths are dealt with by this procedure.

After the adhesive has cured on the endstops the jig is rotated by 180 degrees. In this position the rear inserts are glued in place, with the interface plate and housing aligned by the reference jig, as before.

4-EE.17 Consider effect of humidity variation on the carbon fibre structures.

Extract from report EE/240/RH, by R Head (Bristol):

An alveolar was stored for a period in excess of six weeks in an environment with a humidity range fluctuating between 23% and 45%. Upon removal from storage the alveolar was placed vertically on an engineers surface plate and using an engineers height gauge a transverse line was scribed across the alveolar at a height of 250.0mm. Thereupon the alveolar was placed in a chamber and evacuated. A vacuum pressure 10-3 torr was maintained for a period of 72 hours. Immediately upon release of the vacuum the alveolar was removed and rescribed using the original set-up, which had remained unaltered. No “second line” was discernable. The height gauge was then reset to 249.9 mm. At this setting a second line was produced. This indicates that a change of dimension in the order of 0.05% would have been detectable.

CONCLUSION.
The alveolars are not unduly susceptible to humidity.

4-EE.18 Assess the necessity to depolish faces of the crystals to achieve light yield uniformity.

The necessity to depolish the faces of the crystals to achieve light yield uniformity no longer appears to be necessary.

A quantitative assessment of light yield uniformity has been made on some of the 100 pre-production EE crystals produced in July 2001, by Dr. D. Britton at the Imperial College Crystal Laboratory. Two possible solutions have been found: to leave the chamfers of the EE crystals unpolished at production or to score part of the chamfer length with graphite using a pencil. Details of this work have been reported at several ECAL Detector Performance Group (F. Nessi) meetings. The general consensus is that there is a possible solution should one be necessary for crystals grown under mass production conditions.

4-EE.19 Produce a comprehensive full-scale model to study Supercrystal mounting scheme, including routing of fibres and umbilicals.

This has been initiated at RAL with a full scale E0’ (Ezero prime) model which is capable of taking up to 4 cantilevered SCs. At present the system comprises 2 cantilevered Supercrystals and their umbilical signal lines which are fed through the backplate and moderator to discrete component ‘Stephenson’ preamplifiers housed in a 50 channel readout box. Photographs of the E0’ model, including a photo set detailing the various stages of build, are shown below. Go to http://hepwww.rl.ac.uk/CMSecal/Photos.htm for direct access to the jpeg files or link to them from the pdf version of this file.

The E0’ model was undertaken to investigate integration issues for the 50-channel readout scheme, to study system noise and to provide an EE set-up for beam tests. Although the readout scheme has been superseded by the new ECAL electronics architecture, the work has nevertheless been extremely instructive and provides a useful basis for future work.

The E0’ model will be shipped to CERN so that issues relating to the integration of the new ECAL electronics architecture can be addressed.

The E0’ Integration model with capacity for up to four SCs

The model is an accurate section of a Dee, with the correct dimensions and placement of the backplate, moderator and service regions.

The current model comprises a full EE monitoring fibre harness (~211 fibres plus diffuser), of which 50 monitoring fibres have been fed through to two full sized SCs mounted on the backplate. It comprises anode and dynode high voltage distribution. The two SC umbilicals have been fed through the backplate and moderator to the electronics readout box. The model contains the precision cooling for the backplate, the power cooling for the electronics, the cooling plus moderator on the HE side and the low voltage services.

Front view of the E0' model

The E0' model has the capacity to take up to four cantilevered SCs. These can be mounted to represent any position on the Dee by the use of suitable positional spacers.

E0’ model, completing the build, 24.10.2001

Photos, from bottom to top, to the completion of the E0’ model.

2 SCs + R/O
E0' complete

Cooling plate for
moderator
HE side

Side view with studding
to take cooling +
moderator on HE side

Stephenson readout
electronics box attached

2 SCs with umbilicals
fed through backplate
and moderator

View of backplate with 2
SC umbilical Dee type
connectors
being located

Cooling for back of Dee
plate with umbilical
cutouts

Cooling for interim
layer

Interim cooling layer,
insulation, back of
Dee

E0’, preparing and mounting the 2 SCs, 23.10.2001

Photos, from top through to bottom.

SC 1 being prepared for E0’

Checking the fibre optic bundle (+diffuser) to SC connections

Mounting the first SC to E0’

Fibre bundle on back of Dee and SC umbilicals

Preparing for the second SC on E0’

Placing the monitoring fibres into the 2nd SC

2 SCs mounted, with umbilicals through the backplate

2 SCs mounted

2 SCs mounted

Cooling, interim cooling plane

Side view with interim cooling plane

Umbilicals through backplate and interim cooling plane

E0', preparing and mounting the 2 SCs, 23.10.2001 (contd)

High voltage distribution

8 cm thick polyethylene moderator in place

Umbilicals through moderator

Electronics cooling plane + low voltage

Preparing for the mounting of the readout box

Readout box cooling plane

Side view, waiting for readout box

Side view, waiting for readout box

4-EE.20 In view of the non-maintainability of the VPTs, review and (if possible) eliminate failure modes, including those from mechanical and chemical stresses during assembly and operation.

The VPT is glued to, and cantilevered from, the back of the $PbWO_4$ crystal. It receives no mechanical stress apart from its own weight and any small stresses brought about from the 3 service wires that exit the sockle at the rear of the device. It does not touch or receive any forces from any other surface.

The VPT wires that exit the VPT sockle are embedded in an insulating silicon compound that reduces the risk of cable stress transferring to the VPT pins, as shown in the photograph. The compound protects the area around the VPT pins from water vapour and reduces the risk of high voltage surface tracking between the pins.

A photograph of a mass production VPT showing the three service wires.

A possible serious chemical stress could be brought about by He ingress to the device. A study of He ingress was undertaken and is reported in **NIM A469 (2001) 29-46** pdf.

The study was undertaken with a VPT operating under a 70% Nitrogen/30% He atmosphere. No discernable effect was visible over approximately the first 5 days of helium operation. The leakage current increased by 10% over the next 5 days and in the following 20 days the current increased dramatically.

4-EE.21 Review the radiation damage for VPT's and assess the need of quartz windows for VPT's near the η 3 region.

ECAL has contracted to purchase 15,500 VPTs with UV glass windows for the 14,648 channels required on the EE. Sample faceplates are tested to 20kGy (10 years at η=2.6) and are required to show less than 10% loss of transmission, over the $PbWO_4$ emission spectrum, before they are approved for use in VPT mass production. Some faceplates have been taken higher (28kGy) and show very little additional loss.

The baseline is to use these VPTs to η = 3 (54 kGy), covering the whole EE detector, rather than to switch to quartz windowed devices for this region.

Quartz devices not only have graded seals, which may lead to failure through vacuum leaks, but also have higher susceptibility to He ingress.

A VPT INTAS programme is currently underway to investigate the possibility of alternative radiation tolerant faceplates. This could provide a fallback should one be necessary.

Electronics

4-EE.22 Schedule a system test with final electronics.

Prototype EE FPPAs are scheduled to be delivered in Spring 2003. It is intended that they be mounted onto the E0' model at CERN, with the new readout electronics, for test beam evaluation later in 2003.

4-EE.23 Review the grounding strategy with the Electronics Systems Co-ordinator.

This has been discussed at the pre-EDR meeting in May 2002 with the CMS Electronics Systems Co-ordinator. The baseline strategy is to have direct ground connections to the HE and not to attempt to isolate EE from HE. This strategy matches that of the Barrel ECAL.

Integration, Services and Maintenance

4-EE.25 Finalise integration of the two Dees.

This is taken to refer to the following text in the report:

‘The integration of the two Dees is to be finalised. In the present design the Dees must not risk coming into mutual contact under any foreseeable loading conditions, and it would be useful to assess the possibility of connecting mechanically the two Dees before axial movement’.

The mounting or dismounting of a Dee, in the presence of its neighbour will be considered at EDR-06.

4-EE.25 Assess the possibility of connecting mechanically the two Dees before axial movement.

This is not considered a necessary option now.

4-EE.26 Participate to a visit to assess a completed HE, and finalise the mechanical interface between EE and HE, in connection with HE and Integration groups.

This has been carried out. J Greenhalgh visited Minsk in 2001 to view a completed HE. The EE-HE mechanical interface has been defined and will be reported at EDR-06.

4-EE.27 Participate to the CMS Working Group that will define the η 3 region including thermal insulation and moderator for EE.

This was covered at the EE workshop in March 2002 and is now concluded.

See http://hepwww.rl.ac.uk/CMSecal/Workshops.htm

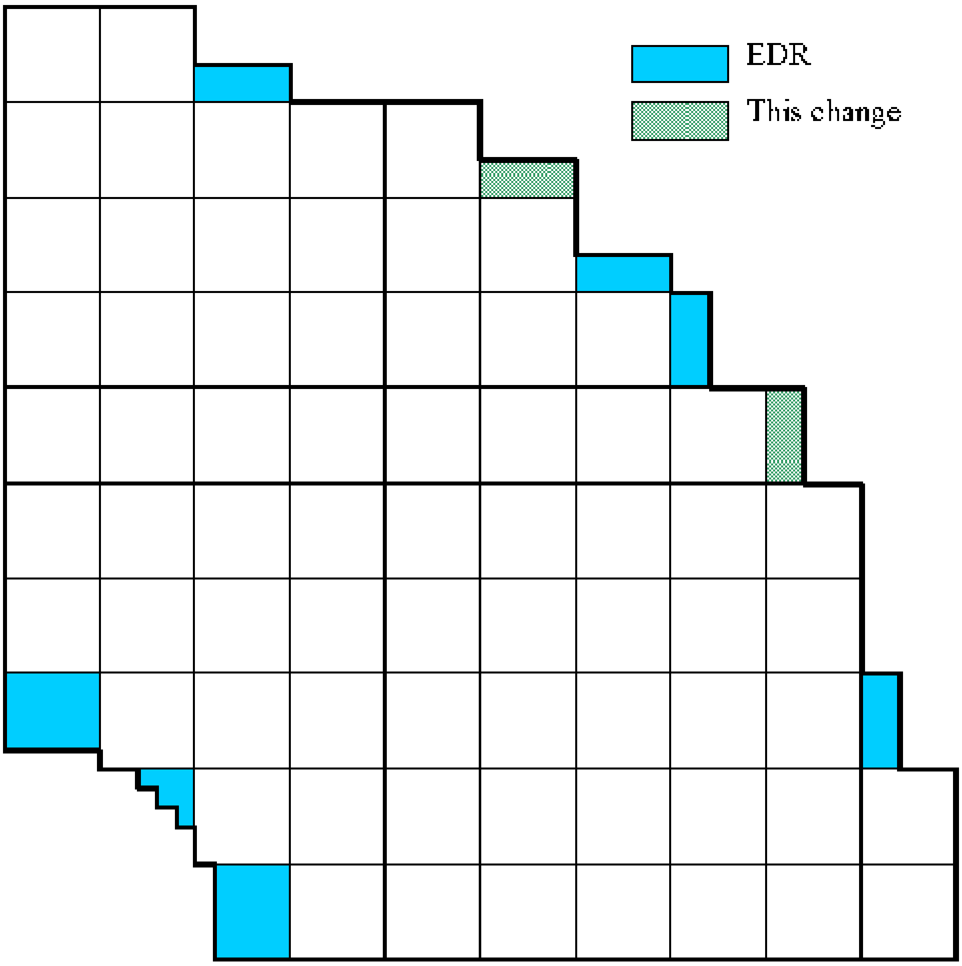
4-EE.28 Produce a design showing that the number of electronics boxes corresponds to the actual requirements (i.e. 69 Supercrystals), including those for the de-constructed Supercrystals.

Since EDR-04, where a scheme was subsequently presented for the readout of all channels, the ECAL readout scheme has completely changed. The integration of the new ECAL electronics into EE and EB is ongoing, though many unresolved and important electrical issues (such as the placement of the low voltage regulators on board or off detector) are delaying the detailed completion of this work.

4-EE.29 Produce quickly a statement on the possibility of increasing the number of de-constructed Supercrystals in the η 3 region.

This region is now defined:

The supercyrstal array on one quadrant. Change request number 005.



See also http://hepwww.rl.ac.uk/CMSecal/Mechanics.htm#SCposonDee

4-EE.30 Define nitrogen bleed/inertion system and sniffer tubes.

This work is ongoing with the electronics integration work.

4-EE.31 Foresee sufficient slack in the read-out optical fibres to avoid hindering ME1/1 chamber extraction.

A trial to lay the readout optical fibre cables into the cable trays in this region was successfully carried out in Spring 2002, using the CMS mockup in building 867.

4-EE.32 Do not use the HF riser system for the initial assembly; foresee a dedicated tooling.

We take this to refer to the following text in the committee report:

'The HF riser should only be used for EE installation in UX, and not for the initial assembly of the Dees on the surface'.

The current assembly schedule does not have any full Dee mounting to HE until installation in UX. Assembly of SCs onto Dees will be carried out with dedicated tooling, probably in building 867. This will be reported at EDR-06.

4-EE.33 Finalise cooling pipes layout, fixation, and insulation.

This will be reported at EDR-06.

General Safety

4-EE.34 Complete, in connection with GLIMOS, a 'materials table' indicating composition, product identification and quantities and showing compliance with TIS guides, notably IS41.

M Sproston (RAL) is responsible for the EE TIS materials list. He has had several communications with GLIMOS. The list of components is maintained and updated in an Excel file managed by him. The latest draft is located on the EE Web: pdf.

4-EE.35 Report details of any planned laser usage to the GLIMOS before the EDR and/or before any test beam usage.

Agreed. Any laser usage for EE will now take place under the general ECAL auspices of W. Lustermann's Integration team, or under the H4 area control, or at installation.

Lasers will also be needed at the mechanical assembly stage, when SCs are mounted onto Dees, for testing.

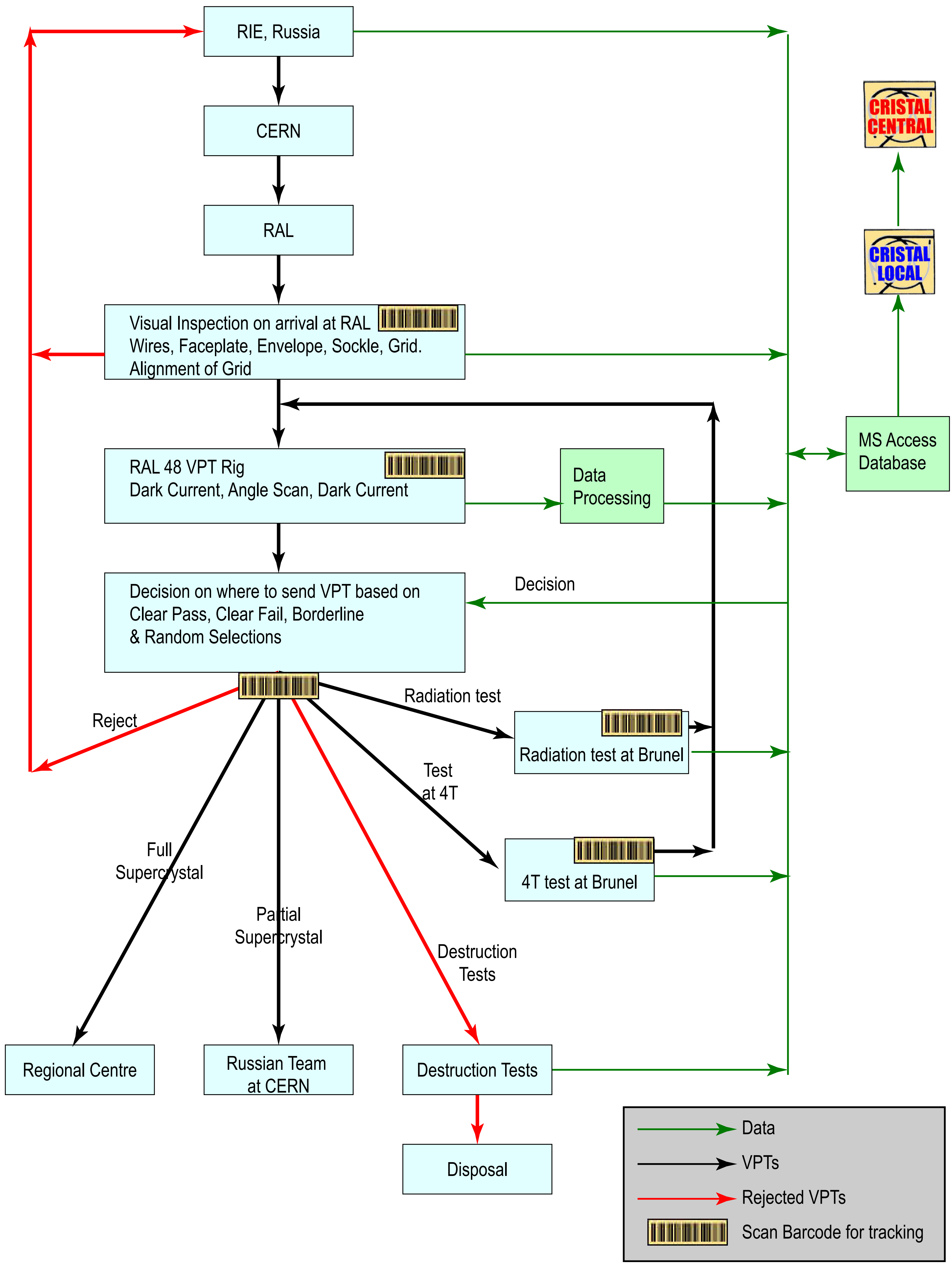
4-EE.36 Taking into account activation computations, devise possible protection schemes for most likely maintenance scenarios.

Under consideration. We note the option to remove a Dee entirely from the CMS cavern to allow work to be carried out in a dedicated laboratory on the surface. This would provide more flexibility for mounting appropriate and sufficient shielding.

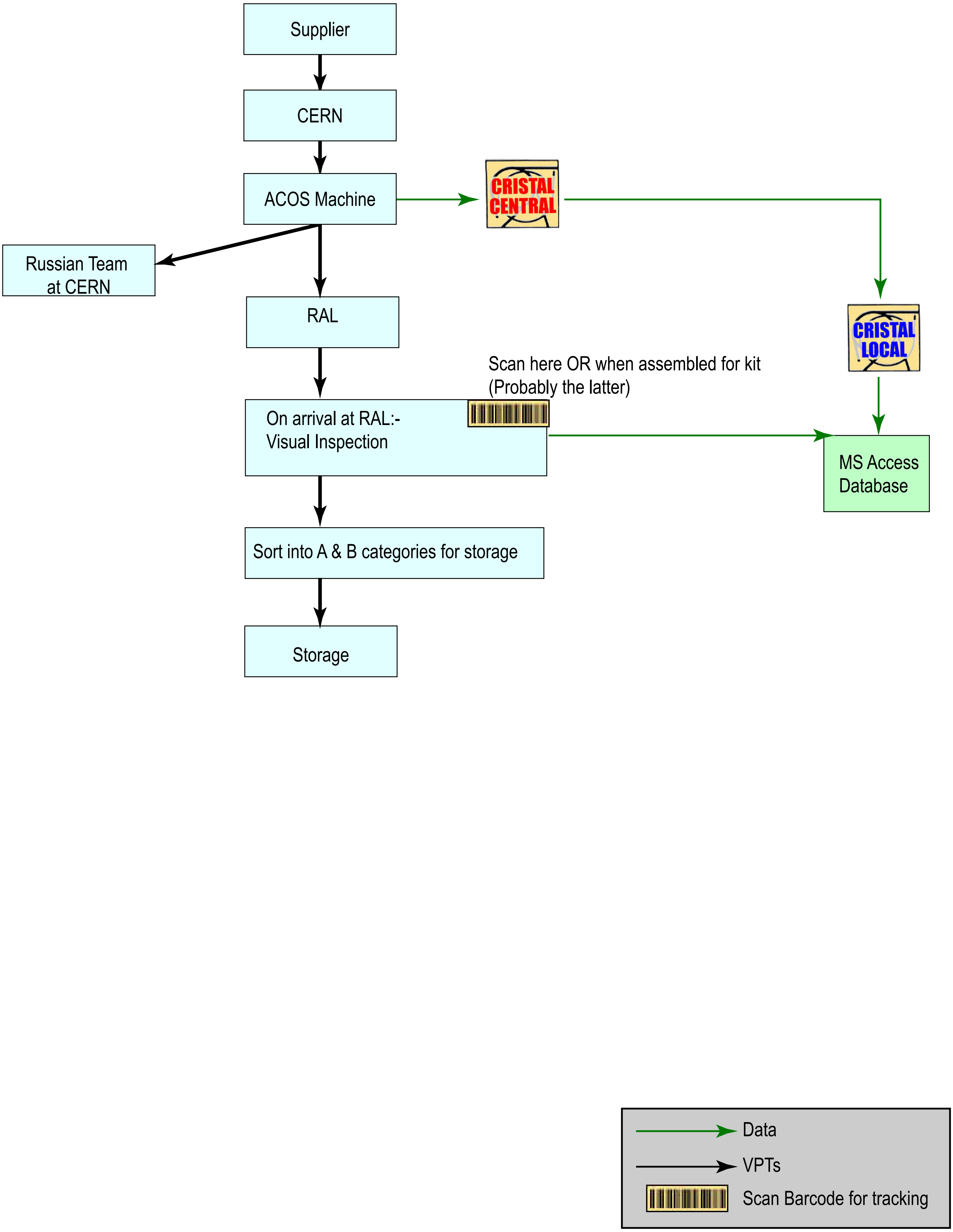
4-EE.37 Request and hold an Electronic Systems Review (ESR) in connection with EB with emphasis on grounding, shielding, L.V. distribution and control.

Agreed. Expected summer 2003, principally for EB but will have EE input. Final EE ESR expected in summer 2004.

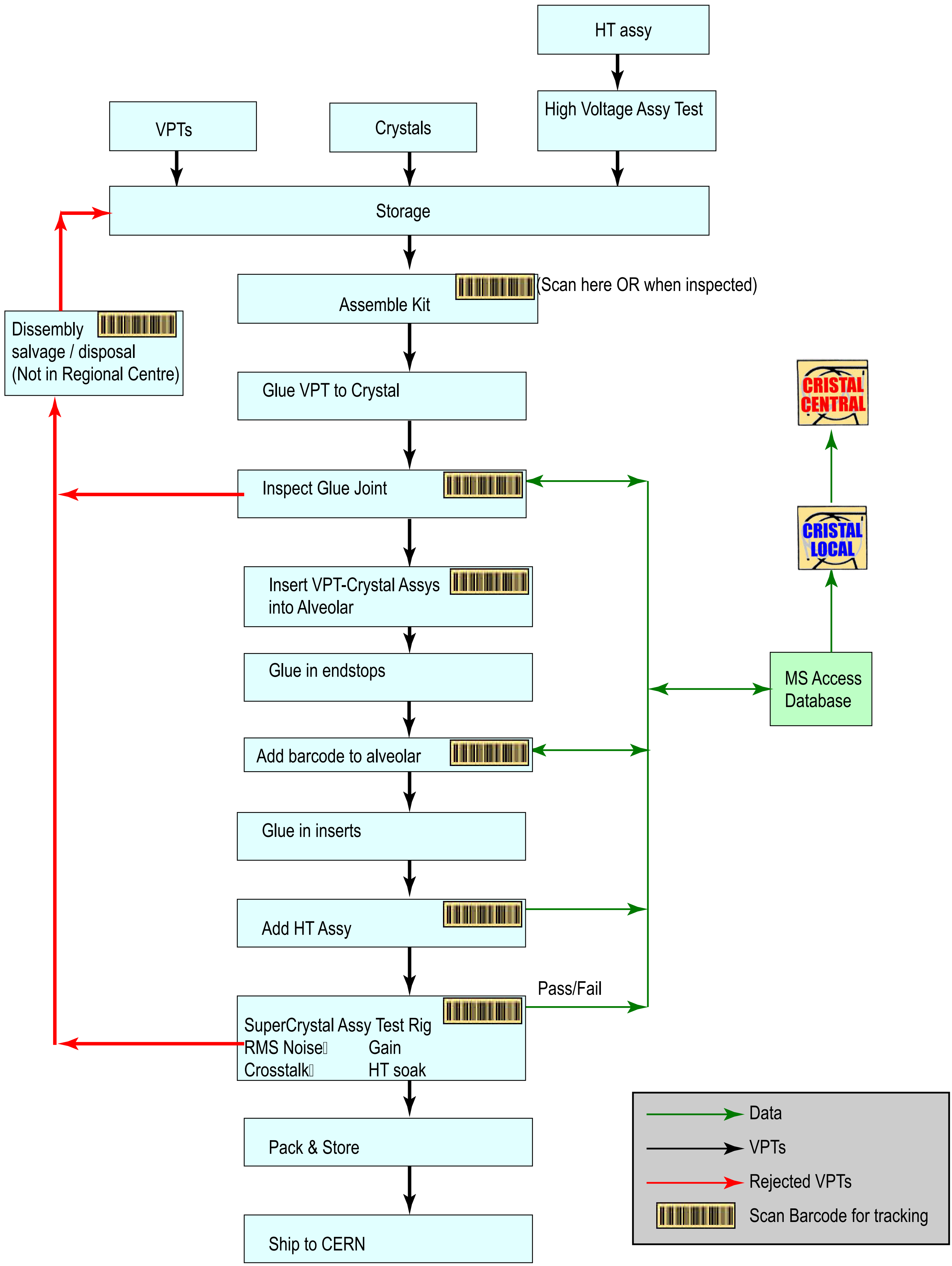
VPT procedures



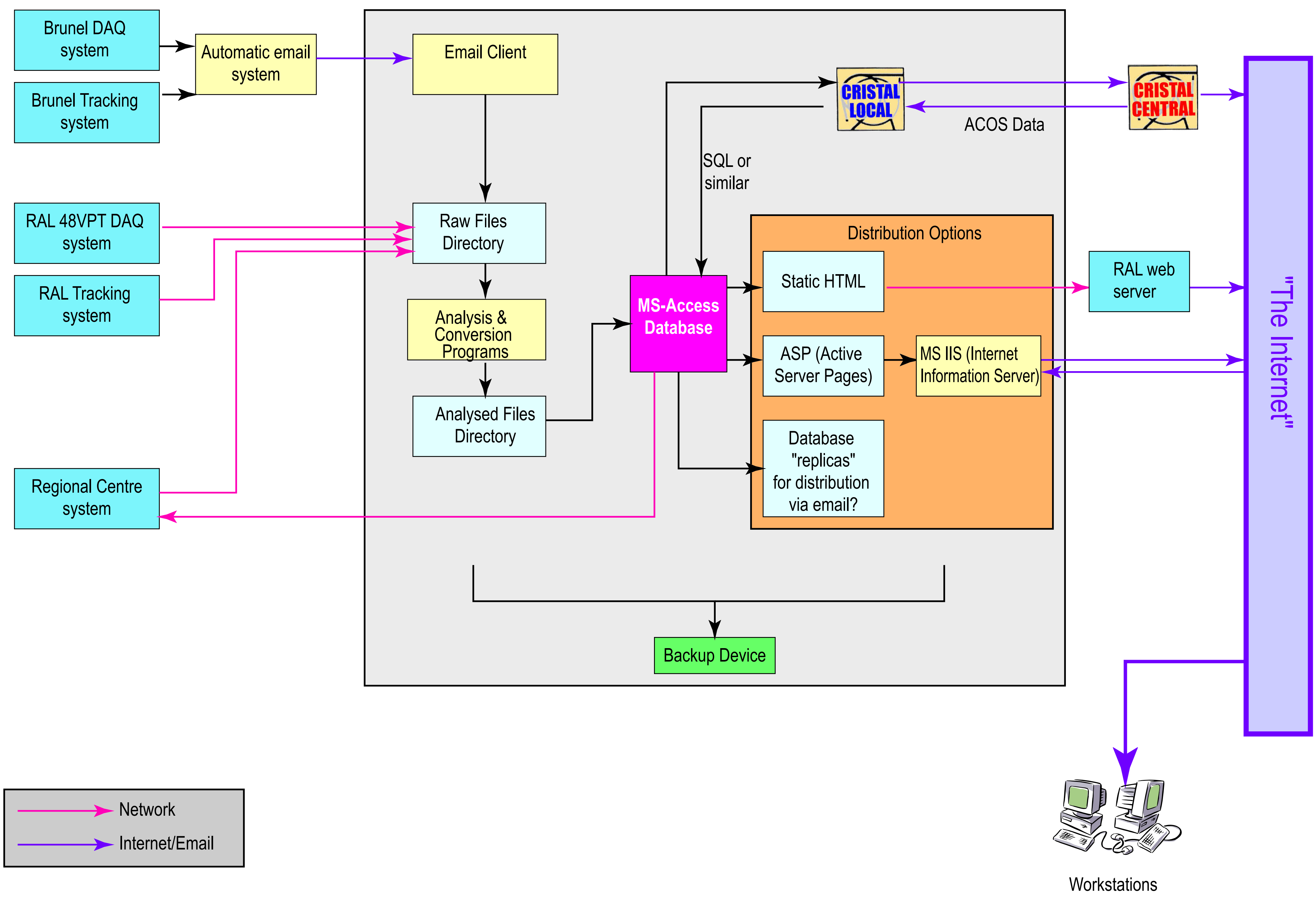
Crystal procedures



SuperCrystal procedures



Server Layout

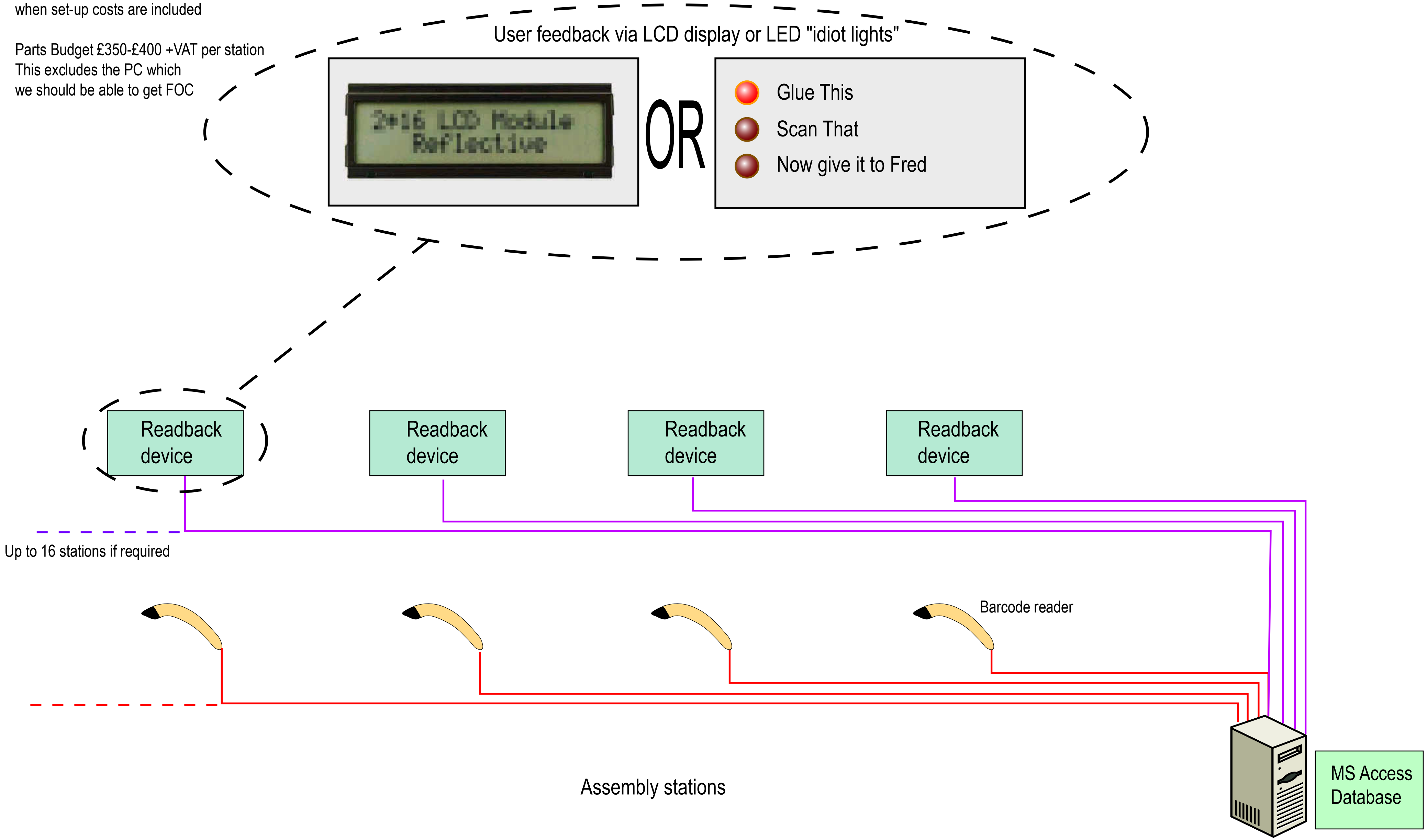


Regional Centre

Proposal for Assembly Procedure Tracking & Procedures

NB: It should be noted that this layout is proposed to save space - it will not necessarily be cheaper than having a PC at each assembly station, especially when set-up costs are included

Parts Budget £350-£400 +VAT per station
This excludes the PC which
we should be able to get FOC



Schematic of "Clara" database at RAL