



STANFORD LINEAR ACCELERATOR CENTER

SPECIFICATION

STANFORD SYNCHROTRON RADIATION LABORATORY

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First Line:

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Second Line:

Magnet System

Title:

Quadrupole Magnet Core Production

Quadrupole

CORE

Specification

四极铁

铁芯

生产说明书

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SPEAR3 SPEC QUAD MAG CORE PROD



1. GENERAL / 概况

This document is presented in both English and Chinese text; in case of differences, the English version shall be used.

本说明书含中英文两种文字，如两种文字有不符之处，以英文为准。

1.1 Scope of the Specification / 说明书范围

This specification outlines the minimum requirements governing the acquisition of sheet steel, tooling, lamination punching and the assembly of the cores for the SPEAR3 production quadrupole magnets. It defines the required inspection, and provides the general outline for the documentation required in order to maintain a quality assurance program during the fabrication.

本说明书概况了SPEAR3工程四极铁钢材，工装、芯片冲制和铁芯组装的基本技术要求。规定了检验项目和在生产中实施质量检验和监督的文件要求。

1.1.1 Applicable Documents / 使用文件

Drawing PF 444-403-12	Lamination / 芯片图纸
Drawing SA 444-403-16	60Q Core Half Assembly/ 60Q铁芯组装
Drawing SA 444-403-14	50Q Core Half Assembly/ 50Q铁芯组装
Drawing SA 444-403-13	34Q Core Half Assembly/ 34Q铁芯组装
Drawing SA 444-403-15	15Q Core Half Assembly/ 15Q铁芯组装

1.1.2 Reference Documents / 参考文件

Drawing PF 444-403-11	Lamination Stamping Layout/ 芯片冲制排样
Engineering Note M320	Quadrupole Magnet Engineering Design Summary/ 四极铁工程设计总括
Engineering Note M325	Glued Core Fabrication Procedure/ 粘接铁芯制造工艺

1.2 Scope of Work / 工作范围

IHEP shall procure all required tooling including a die set. IHEP shall purchase all the steel sheet, plate and all fasteners and other commercial components required for core fabrication. IHEP shall stamp and sort all the laminations, fabricate all required parts and assemble the cores required for a prototype magnet, and production quantities of quadrupole magnets. IHEP shall provide all detail drawings required to fabricate the tooling and core parts, develop inspection documentation (travellers) for quality assurance and perform all Quality Assurance (QA) procedures.

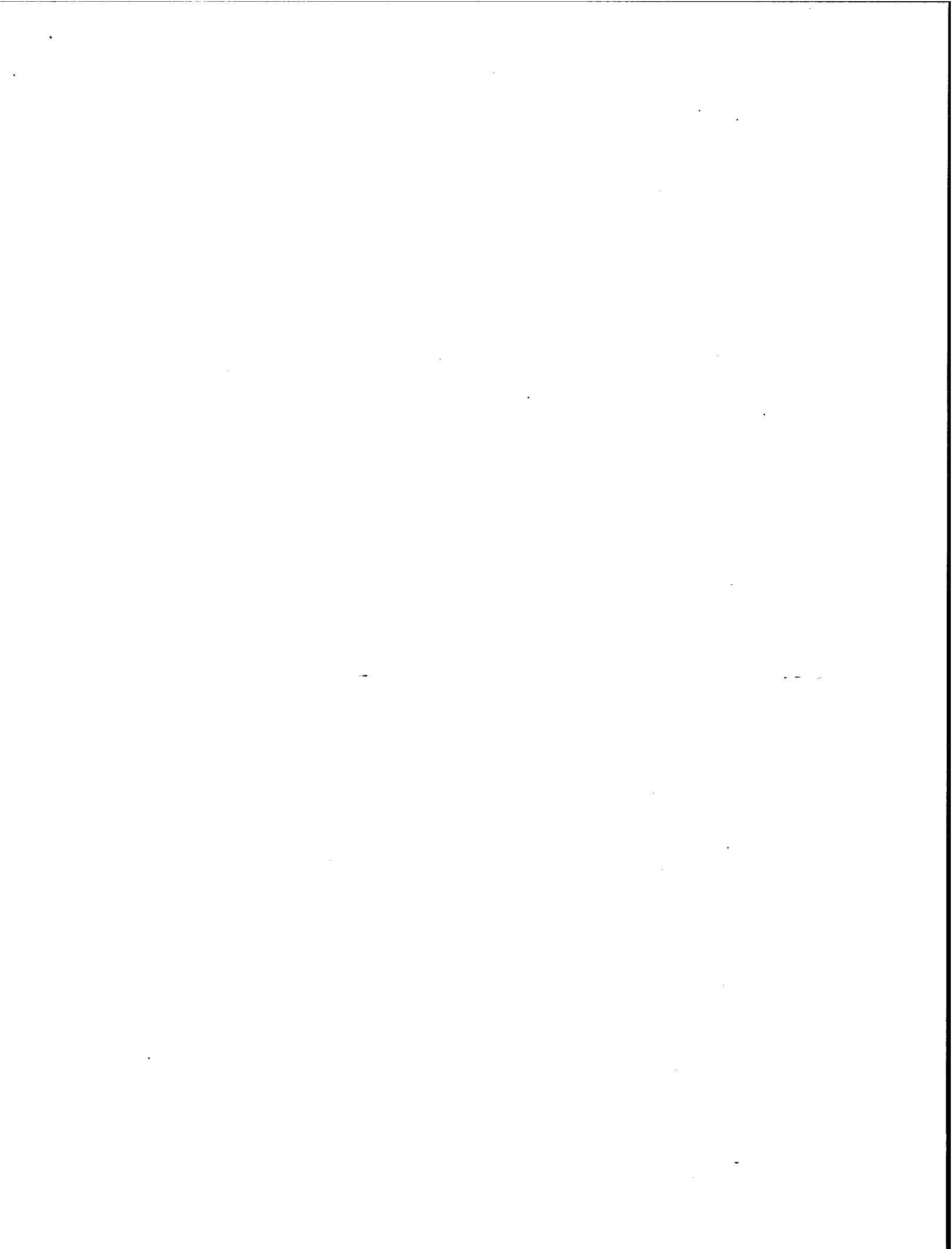
高能所应负责包括一套冲模在内的所有工装的制造以及铁芯制造所需钢材、板材和紧固件以及其他标准件的采购；负责所有样机和批量四极铁所需芯片的冲制和掺和；还应负责所有零部件的设计和和生产。制订质量管理的文件（跟踪卡）和实施质量检测及监督。

1.2.1 Quantities / 数量

The number of cores required for the production quantities of quadrupole, spares and prototype magnets are called out in Attachment 2 to the ICA.

样机和批量四极铁铁芯所需数量以合作协议附件2为准。

2. TOOLING / 工装



2.1 Die Set / 冲模

The die set shall be designed, fabricated and assembled in such a manner that its life will be sufficient to stamp at least 150% of production required laminations. The die and punch parts will have sufficient material for the number of times it will need to be sharpened.

冲模的设计寿命应1.5倍于批量生产所需芯片总量。凸凹模刃口的高度应考虑到留有足够的修模余量。

2.1.1 Die Set Inspection and Sample Laminations / 冲模和样片的检验

The die set will be thoroughly inspected in order to assure that all dimensions and die and punch clearances are consistent with producing the required laminations to the dimensions, tolerances and burr specifications outlined in lamination drawing. After inspection of the die set and approval of sample laminations at IHEP, a IHEP measurement report for at least three sample laminations shall be sent to SLAC. Those three sample laminations shall be kept by IHEP. Another three laminations shall be delivered to SLAC for verification of dimensions. Punching of laminations for the prototype or for the production quantity of magnets using the die set shall not proceed until SLAC inspection is completed and approval has been obtained.

冲模应经详细检验，确保其尺寸和凸凹模间隙满足冲制符合芯片图纸尺寸和毛刺公差要求的芯片的需要。高能所验模和通过样片检验之后，至少应向SLAC递交3张芯片的检验报告。高能所应妥善保存该3张芯片，另寄三张样片给SLAC核检。在SLAC核检报告出来之前，样机和批量铁芯片的冲制不得开始。

2.2 Core Compression Tooling / 叠片工装

IHEP shall design and fabricate all the tooling required to assemble and compress the core to the required tolerances defined in Core Half drawings. IHEP shall purchase all necessary components and devices required to compress the cores before assembly.

高能所应设计和制造叠片工装，工装应保证能加工出符合半铁芯图纸技术要求的铁芯。高能所应采购工装所需的一切元件和仪表。

2.3 Handling Equipment / 起吊工装

The weight and size of the core makes it difficult to handle, lift and turn. During the core assembly procedure, it will be necessary to lift and turn the core several times. IHEP shall design lifting devices and procedures so that the core can be lifted in a manner to safeguard both the core in various stages of manufacture and personnel working on the core assembly.

铁芯在安装过程中，需多次起吊和翻转。但是铁芯的重量和尺寸使操作十分困难。高能所应设计一套起吊工装和工艺，使铁芯在制造各阶段的起吊和翻转都能保证其本身和操作人员的安

3. MATERIAL / 材料

IHEP shall procure all material required for the fabrication of the quantity of cores specified in 1.2.1.

高能所应采购生产1.2.1款所规定铁芯数量需要的所有材料。

3.1 Steel Sheet for Laminations / 芯片钢板

3.1.1 Material Radioactivity Measurement / 材料放射性测量

No radioactivity above background level shall be present in steel sheet used for quadrupole lamination punching, i.e. the measurement should be within background + 2 standard deviations. Measurements of all material heats shall be recorded.

所有用于四极铁芯片冲制的钢板都应做放射剂量测量，任何一组钢板都不应测出高于本底剂量的放射物含量，也就是测得的剂量应为本底（环境）剂量+2个标准误差。测量结果应作记录。

3.1.2 Material Specification / 材料检验

The following section describing the requirements for the sheet steel had previously been negotiated with IHEP for the purchase of standard magnetic sheet steel for the PEP-II Low Energy Ring (LER) quadrupole and dipole core fabrication. It is understood that this same material is available from Chinese steel manufacturers. It is the intention of this specification to ensure that material with magnetic performance and ease of stamping and fabrication be used which is at least equal to the sheet steel used for the PEP-II LER magnet core fabrication. The sheet steel shall be standard IHEP coated magnet lamination steel, DW540G-50. IHEP shall purchase the sheet steel and define and carry out the acceptance tests for the sheet steel described in sections 3.1.2.1, 3.1.2.2, 3.1.2.3, 3.1.2.4 and 3.1.2.5 of this specification. IHEP will submit the final technical specification for the steel purchase to SLAC for approval prior to placing the order.

以下重复了PEP-II低能环磁铁工程时高能所使用钢材的技术要求，据悉这种材料目前仍能购得。固以PEP-II低能环磁铁工程钢板各项技术指标为本说明依据。SLAC所用钢板的磁性能和机械性能至少要等同于这些指标。钢板为DW540G50加涂高能所标准涂料。高能所应采购钢材和制订符合本说明3.1.2.1, 3.1.2.2, 3.1.2.3, 3.1.2.4和3.1.2.5各款的验收指标，并实施检验。

3.1.2.1 Chemical Analysis / 化学成分

The chemical analysis after all processing shall be (maximum):

经各处理过程后，钢板的化学成分应为：（表中指标为最大值）

C	Si	Mn	P	S	Al
0.007%	0.8%	0.3%	0.08%	0.007%	0.4%

A certified chemical analysis shall be furnished.

需附正式检验报告。

3.1.2.2 Magnetic Test Samples / 磁测样片

Total about 27 Epstein samples (50% parallel and 50% perpendicular to the rolling direction) shall be assembled from strips collected from every 20 packages from different heat of the material used for the quadrupole production. Magnetic permeability and coercive force measurements shall be made using these samples as outlined in sections 3.1.2.3. After testing, the samples shall be kept at IHEP for SLAC possible later re-testing to verify the measured properties.

四极铁生产所用钢板，每20包出自不同炉的钢板应从其中一包剪取三张Epstein样片（50%平行，50%垂直于轧制方向）。四极铁大约共取27张样片。用这些样片按3.1.2.3款要求测试磁通量和矫顽力。测量后，样片要保留在高能所，以备SLAC日后复检。

3.1.2.3 Magnetic Properties Test / 磁性能测试

The Epstein samples described in 3.1.1.2 shall be measured at an excitation of $H_m = 100$ oersted, the magnetic induction B shall be at least 17,900 gauss. After excitation to $H_m = 100$ oersted, the excitation shall be reduced to zero and the coercive force H_c shall be measured. The mean value of H_c for each heat shall not exceed 2.0 oersted. The variation of coercivity through the whole delivery of steel sheet must stay within ± 0.1 oersted.

在激磁强度 $H_m = 100$ 时测试 3.1.1.2 款所述 Epstein 样片的磁感应强度 B ，其值不应小于 17,900 高斯。在激磁强度达到 100 奥耳斯特后，回零，测量此时的矫顽力。其值不应超过 2.0 奥耳斯特。所有样片矫顽力的偏差不应大于正负 0.1 奥耳斯特。

3.1.2.4 Crown and Thickness / 同板度和厚度公差

Three 1 meter long x 20 mm wide strip will be cut from both ends and the center of a sheet from each steel sheet package used for the quadrupole production. The strips shall be cut so that the 1 meter dimension is cut from the 1 meter face of the 1 x 2 meter sheet. Measurements of the crown and thickness variation across the sheet width will be made for each of the nine samples. The thickness variation across the sheet shall not exceed 0.05 mm. The crown shall not exceed 0.03 mm.

四极铁生产所用的每包钢板都应取一张钢板裁样。样片应在沿钢板长度方向的两端和中间裁取，其宽度为 20 毫米。每张板三条 (1m x 0.2m) 样条，测同板差和厚度差。同板差不应大于 0.03 毫米，厚度差不应大于 0.05 毫米。

3.1.2.5 Hardness / 硬度

Material from the head, center and tail of each heat shall be tested for hardness. All material shall have hardness on the Rockwell scale of B 56 to 90 (HV 90 to 180).

每炉钢头、尾，中所轧材料都应测量硬度，所有材料的硬度值都应在洛氏 B56-90 (HV90-180) 的范围内。

3.1.2.6 Coating / 涂层

The sheet steel shall be supplied with 0.005 mm thick inorganic or semi-inorganic insulation.

钢板的表面应有 0.005 毫米无机或半无机涂料。

3.1.3 Quantity of Lamination Steel Required / 芯片钢板数量

IHEP shall purchase sufficient material to provide for loss, waste and other contingencies beyond the amount required for the specified number of required magnet cores. This amount should exceed the minimum amount required for the specified number of required magnet cores by no less than 10%.

高能所采购的板材数量应考虑丢失、损耗和其他意外情况。额外材料的数量应至少为铁芯生产最低总需量的 10%。

3.1.4 Sheet Size / 钢板规格

Each sheet will be 1 m x 2 meters, it will be flat and have a nominal thickness of 0.5 mm.

钢板规格为 1 米 x 2 米 x 0.5 毫米平板。

3.1.5 Packaging and Labeling / 包装和标记

All steel shall be packaged to protect the sheets against moisture during shipment and storage. The packages shall be properly labeled to indicate the heat number. The label shall be placed so that identification is possible when the packages are stacked. The packages shall be suitably stacked and braced to prevent bending or damage during handling, shipment and storage.

钢板的包装应能在运输和储存的过程中防潮。每包钢板应标明炉号、标号应位于码放储存时的易见位置。钢包的打包和码放应防止其在运输、储存和起吊过程中被压弯或损伤。

3.1.6 Documentation / 文件

IHEP shall keep original acceptance reports covering all tests required in 3.1.2.1 through 3.1.2.5, but will forward their copies to SLAC along with the steel sheet payment invoice.

高能所应保存条款3.1.2.1至3.1.2.5中所规定的各项检测的原始报告，将其复印件随钢材付款收据一并交SLAC。

4. LAMINATIONS / 芯片

4.1 Prototype Magnet Laminations / 样机芯片

The prototype magnet laminations may be punched from material DW540G-50 that is left over from SLAC PEP-II magnet project and already available at IHEP.

样机芯片可以用高能所现存SLAC PEP-II磁铁工程剩余DW540G-50钢板冲制。

4.2 Laminations Punching / 芯片冲制

Sufficient number of laminations shall be stamped for all quadrupole magnets to provide for damage, loss or other contingency.

冲制芯片的数量除保证四极磁铁生产的需要外，还应有足够的余量以补偿损坏、丢失和其他意外的额外需要。

4.3 Lamination Stamping and Inspection / 芯片冲制和检验

Prior to core fabrication, laminations for the entire required quantities of quadrupole cores of four lengths must be completed. The laminations must be periodically inspected in order to ensure adherence to both dimensional and burr tolerances.

铁芯叠装之前，所有四种长度的四极铁芯所需要的芯片都要冲制完毕。芯片冲制过程中要定期检验，确保尺寸和毛刺达到公差要求。

4.3.1 Burr Inspection / 毛刺检验

Stamped laminations shall adhere to the burr requirements outlined in lamination drawing. Burr inspections shall occur at frequencies determined by IHEP but not less than one lamination per steel package of 320 sheets. Should the burr exceed the drawing requirement, all laminations punched after last inspection shall either be rejected or deburred and the die and punch shall be re-sharpened. Deburring procedure shall be very carefully conducted, no coating damage shall be allowed.

芯片的毛刺要符合冲片图纸的要求。毛刺检验周期由高能所决定，但不得短于每320张一包钢板抽检一张芯片。如果毛刺超过标准，自前次检验以后所冲的芯片应予报废或去毛刺处理。

模具刃口要修磨。去毛刺过程要十分小心，不允许损伤钢板的涂层。

4.3.2 Inspection after Die Re-Sharpening / 修模后检验

Three (3) sample laminations shall be inspected after each die or punch re-sharpening. If IHEP determines that the sample laminations satisfy dimensional and burr tolerances, stamping may proceed without SLAC approval. All sample laminations and inspection records shall be forwarded to SLAC.

每次修模或修磨刃口后，高能所应全面检测三张芯片。如检测合格，高能所可自行决定开冲而不需获SLAC批准。所有样片和检测报告需送SLAC。

4.3.3 Lamination Gap Inspection / 芯片契隙检测

The gap between two poles is critical to the field quality and the reproducibility of the excitation from magnet to magnet. The gap size of the lamination may be affected by the release of rolling stress locked into the steel sheet material. This stress may vary between various batches of material used for stamping.

两极头间的契隙尺寸对场的质量和铁间励磁强度的一致性至关重要。芯片契隙尺寸可能会受到钢板内应力的影响。该内应力会因所用钢板的批量不同而各异。

4.3.3.1 Gap Inspection / 契隙检测

The first lamination stamped from the first sheet of a package shall be inspected to determine the gap size prior to stamping the laminations from that package. A package is chosen as the means for determining the inspection frequency since all the material in a package will share the same chemistry and mechanical properties. The minimum gap between two poles of the lamination must satisfy the tolerance given in lamination drawing. The measured data shall be recorded in the traveler.

每包钢板的第一张芯片都应检测契隙尺寸，检测结果合格之前，该包钢板不可开冲。以包为单位检验契隙是因为同包钢板的化学成分和机械性能应该是一致的。芯片两极头间契隙尺寸应符合芯片图纸要求。测量尺寸记入跟踪卡。

4.3.3.2 Pre-punching / 释放应力预冲

If the inspection described in 4.4.3.1 indicates that the gap tolerance is not met in the first lamination from a steel sheet package, the material in the package shall be set aside and pre-punched to remove some of the material from the throat region and release the stress prior to stamping the laminations from the material in the package.

如4.4.3.1款检测显示一包钢板的头一张芯片的契隙尺寸超差，此包钢板应搁置一旁，将该包内每一张板材芯片契隙部分的材料预冲开口，以释放材料的内应力。

4.3.4 Periodic Dimension Inspection / 尺寸定期检测

The total number of laminations required for the prototype and full production quantities of quadrupoles of four lengths will exceed 136,000 laminations. After punching 10,000 and 100,000 laminations, three laminations shall be fully inspected for burrs and measured by IHEP for adherence to the lamination drawing tolerance.

四极铁样机和四种长度生产铁所需芯片数量将超出十三万六千片。在冲制一万片和十万片芯片之后，高能所要各全面检测三张芯片。

4.3.4.1 Approval / 核准

If IHEP determines that sample lamination dimensional and burr tolerances are met, stamping may proceed without SLAC verification and approval. All sample laminations and inspection reports shall be delivered to SLAC for verification of dimensions.

如高能所认为检验结果证明芯片尺寸和毛刺均达到要求，可继续冲片，不必得到SLAC的首肯。所有样片和检测报告送SLAC复审。

4.3.4.2 Adjustments/Repairs / 调模或修模

If IHEP determines that the dimensional and/or burr tolerances of the sample laminations are not met, SLAC shall be informed and the stamping will be stopped until appropriate repairs or adjustments are made to the die set and a new set of sample laminations are inspected and approved.

如果检测结果表明尺寸和/或毛刺超标，应立即通知SLAC，并停冲进行调模或修模，直至新的一组样片检测获合格为止。

4.3.5 Inspection Record / 检验记录

Inspection sheets (travelers) shall be devised by IHEP and approved by SLAC. The information in these travelers shall include at minimum the following data:

- Steel sheet package number
- Lamination Punching Serial Number.
- Burr size(s) if exceed the tolerance, its (their) location on the lamination.
- Gap dimension.
- Names of inspector.
- Date of inspection.
- CMM report.

芯片检验跟踪卡应由高能所提供，交SLAC批准。芯片的跟踪卡至少应含以下内容：

- 钢包号
- 芯片冲制序号
- 毛刺尺寸，如超差，图示在芯片上的位置
- 契隙尺寸
- 检验员姓名
- 检验日期
- 三坐标检验报告

4.3.6 Handling and Storage / 操作和存放

Adequate care should be taken in order to avoid bending or otherwise damaging laminations during handling, sorting or storing. Laminations should not be stored on an uneven or soft surface. Bent, rusted or otherwise damaged laminations shall be discarded.

芯片的冲制、惨和及存放过程应十分小心。芯片绝不应堆放在不平或 松软的表面。弯折、锈蚀或有其他损伤的芯片应报废。

5. CORE FABRICATION / 铁芯组装

5.1 Prototype / 样机

5.1.1 Prototype Core Lamination Sorting / 样机铁芯芯片掺和

The lamination for prototype need not be sorted.

样机芯片不需掺和。

5.1.2 Prototype Core / 样机铁芯

The purpose for a prototype is to facilitate IHEP to develop an ideal procedure for the core assembly. The prototype will be a 34Q quadrupole. The pole contour is scaled from ALS quadrupole and detailed ANSYS calculations were made. It was anticipated that the pole contour would perform satisfactorily and that re-optimization of the chamfer on the pole edges would not be necessary.

样机的目的只是为了帮助高能所开发一套铁芯组装工艺。样机为34Q四极铁。极面尺寸是在ALS四极铁的基础上按比例放样，经二维程序计算得出。预计该设计应无问题，不需通过样机改进极面削斜。

5.2 Production Quadrupole / 批量四极铁

5.2.1 Core Lamination Sorting / 铁芯芯片掺和

The laminations for all required 60Q, 50Q, 34Q and 15Q quadrupole magnet cores must be sorted prior to start of assembly of the first quadrupole core. Prior to sorting, the pallets onto which the laminations are sorted shall be clearly marked with a sequential quadrupole core serial number. The package numbers of all steel sheet packages used to punch the laminations has to be recorded.

四极铁开始叠装第一块铁之前，用于制造所有60Q，50Q，34Q和15Q铁铁芯的芯片应都掺和完毕。在掺和开始之前，所有用于码放掺和后芯片的架子（箱子）应逐一按铁芯生产序号标明。所有冲制磁铁芯片的钢板包号应有记录。

5.2.2 Core Stacking, Compression and Assembly / 铁芯叠压和组装

A procedure developed at LBNL for ALS storage ring sextupole and quadrupole core fabrication is described in the SLAC Engineering Note M325 "Glued Core Fabrication Procedure".

LBNL现代光源的四、六极铁的铁芯制造工艺在SLAC工程设计书M325“粘接铁芯的制造工艺”中有详细介绍。

5.2.2.1 Gluing / 涂胶

The laminations for the core shall be carefully cleaned to remove any oil or grease, and coated using thermal setting epoxy before stacking. The glued cores shall be cured using IHEP suggested curing cycle for an IHEP selected epoxy formulation.

铁芯芯片粘接前应经彻底去油污清洗，热固化环氧涂膜处理，然后叠压。粘接好的铁芯应按高能所所选环氧制订的固化工艺进行固化处理。

5.2.2.2 Lamination Flipping / 芯片翻转

The core shall use the laminations presorted for that core. To achieve core symmetry, laminations shall be flipped about their centerline at an interval called for in the core assembly drawing. The laminations at the interfaces between flipped laminations shall be deburred to assure good compression at the interface where burrs face each other and cannot nest.

铁芯应使用为该铁芯预掺和好的芯片。为保证对称性，芯片应按铁芯组装图纸要求沿中心线按叠翻转。为保证叠压精度，翻转摺之间，面面相对的芯片应去毛刺，以避免毛刺相对难以压紧。

5.2.2.3 Compression / 叠装

The laminations shall be compressed in order to achieve certain goals.

芯片应被压紧，以达一定技术指标。

5.2.2.3.1 Length / 长度

The primary goal shall be to obtain the specified length between two ends as per core assembly drawing of each length quadrupole.

第一位应达到的技术指标是各长度四极铁铁芯总成图纸上规定的两端部间的长度尺寸。

5.2.2.3.2 Packing Factor / 叠装系数

The secondary goal shall be to reach a packing fraction $> 97.5\%$.

第二位重要的技术指标是铁芯叠装系数不小于97.5%。

5.2.2.3.3 Pressure / 叠装压力

The final goal shall be to have a compression pressure of no less than 3 atmospheres.

最後应达到的指标是叠装压力不小于3个大气压。

5.2.2.4 Bolting / 紧固铁芯

After stacking and compressing the laminations within the tolerance of the specified length and straightness, install bolts and torque at about 40–50 Nm.

叠压芯片并达到长度、直线度等指标后，加螺栓紧固。螺栓锁紧扭矩约为40-50牛顿米。

5.2.2.5 Welding / 融焊

After bolting, weld laminations. The purpose of this weld is to provide single ground point of core, the weld area and heat shall be very limited and shouldn't cause any thermal deformation of the core.

铁芯紧固后，融焊芯片。这一工艺的目的只是使铁芯整体接地，焊接面和焊接温度都应限制在最小范围，不应造成任何铁芯热变形。

5.2.2.6 End Chamfer Machining / 端部削斜加工

After core stacking, the end chamfer shall be carefully machined on both poles of two ends. The core should be carefully mounted on the machine tool in order to maintain left to right symmetry of the chamfer cut. The tool cutting depth and feed speed during the machining process shall be carefully determined to avoid excessive heating which can delaminate the glued core. IHEP shall develop a procedure to measure the chamfer

dimensions. Should the chamfer dimensions exceed the requirement, the core shall be re-machined or rejected in the worst case. The measured data shall be recorded in the traveler.

铁芯叠装好后，再对两端部的两个极头进行削斜机加工。铁芯在加工机床上的定位和固定十分重要，应确保左右极头削斜的对称性。要小心确定加工过程中的进刀深度和速度，以避免过热而造成粘接铁芯芯片剥离。高能所应设计测量削斜尺寸的方法。如削斜尺寸超差，铁芯应进行再加工。如难以修复，应作报废处理。检验数据应记入跟踪卡。

5.2.3 Notification / 情况通报

If the packing fraction goal is not met for a core, IHEP should notify SLAC immediately and core assembly should be suspended until agreement can be reached as to whether to accept a lower packing fraction or means of increasing the packing fraction can be mutually agreed upon.

如果叠装系数达不到要求，高能所应立即通知SLAC，并停止生产，直至双方就如何改进叠装方式提高叠装系数或接受低叠装系数达成协议。

5.2.4 Painting / 喷漆

All quadrupole core assemblies shall be painted. SLAC Drawing PF444-403-61 specifies all painted and non-painted surfaces. All painted surfaces shall be primed with Rustoleum or Chinese equivalent metal primer before application of the final colored coat. The color of all quadrupoles is BLUE. A sample shall be delivered to SLAC on a painted 6 x 6 (cm) piece of lamination steel for approval prior to painting of the production cores.

所有四极铁铁芯都需喷漆。SLAC图纸PF444-403-61规定了所有应喷和不应喷漆表面。所有喷漆表面在上色漆之前，应加涂Rustoleum 或中国等同成分的防锈底漆。四极铁漆色为蓝色。一块6X6喷漆样品应在批量铁芯正式喷漆开始之前交SLAC核准。

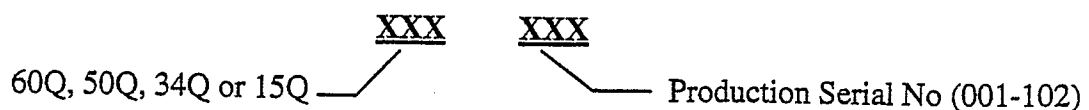
5.2.5 Unpainted Surfaces / 不喷漆表面

All specified non-painted surfaces shall be protected with rust preventative such as Lps-3 rust preventative oil or equivalent. For a Chinese equivalent rust preventative, IHEP shall submit a sample to SLAC for final approval.

所有不喷漆表面应喷涂Lps3防锈油或等同材料。如果选用中国产品，高能所应先提供样品交SLAC核准使用。

5.2.6 Identification / 身份号

Each quadrupole core shall be identified with a unique number. The number shall be marked on a location, which shall be visible after the magnet assembly. The identification number shall consist of two (2) components: Family of quadrupole and Production serial number. The 60Q, 50Q, 34Q and 15Q quadrupole core shall share the same production serial number.



每块四极铁芯应指定一归其独有的身份号。该身份号应打在磁铁总装后可见的位置。身份号应由两部分组成：四极铁类别和生产序号。60Q，50Q，34Q和15Q四极铁芯应采用统一生产序号。

6 QUALITY ASSURANCE, INSPECTION AND DOCUMENTATION / 质量保证、检验和文件

An inspection sheet (traveler) shall be devised by IHEP and approved by SLAC. This traveler shall include pertinent fabrication parameters and inspection data. The information in the traveler shall include at minimum the following data.

- Core Serial Number.
- Length between two end surfaces.
- Chamfer data.
- Number and weight of laminations.
- Computed packing fraction.
- Compression pressure.
- Gap dimension and pole tip flatness.
- Core squareness.
- Names of technicians assembling the core.
- Date of Core assembly.

高能所应设计铁芯总装质量检验跟踪卡，并交SLAC核准。跟踪卡应包括适当的生产数据和检验数据。其包括内容至少如下：

- 铁芯序号
- 两端面间长度
- 削斜尺寸
- 芯片数量和重量
- 计算叠装系数
- 最终叠装压力
- 裂隙尺寸和极面平直度
- 铁芯矩形度
- 操作人姓名
- 实施日期

6.1 Filling out the Traveler / 填写跟踪卡

The traveller shall be filled out, signed and dated by the technicians performing the assembly and/or inspection of the core and signed and dated by the technician supervisor signifying approval of the core for final magnet assembly.

跟踪卡应由生产和检验人员填写并签字，并经有关负责人签批转磁铁总装工序。

6.2 Traveler Original / 原始文件

The original of the completed, signed and approved traveller shall accompany the core until final magnet assembly. After magnet assembly, the completed original traveler should be filed at IHEP.

填写和签批完毕的原始跟踪卡应随铁芯周转，直至最后的总装工序。在磁铁总装完后，原始文件应保留在高能所。

6.3 Traveler Copies / 复印件

A copy of a traveler for each core shall be packaged with other completed travelers for each completed magnet and delivered to SLAC along with the magnet or mail to SLAC following the magnet being shipped out of IHEP.

每块铁芯的跟踪卡的复印件应与完工磁铁的其他跟踪卡的复印件一并汇总，随磁铁发往SLAC，或在该磁铁发出高能所之后寄往SLAC。



