

新型K/π識別装置 Proximity focusing型 エアロジェルRICHの開発研究

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内容 イントロダクション
Proximity focusing型エアロジェルRICH
新しい光学系のアイデア
ビームテストとその結果
結論



エアロジェルRICH開発の目的

KEKBファクトリー実験:電子陽電子衝突型加速器でB中間子を大量生成 B中間子系でのCP対称性の破れを測定



コンパクトであること(Endcapの奥行きは28cm)





これまでのエアロジェルRICH開発研究

~ 検出光子数 ~

エアロジェルの透過長の改善 15mm → 45mm(@400nm) 光検出器の有効面積の向上 約89%

~ビームテストの結果~

•角度分解能 ~ 14 mrad •検出光子数 ~ 6個

2cmの薄いエアロジェルを使用

(チェレンコフ光発生点の不定性を抑える)

粒子識別能力 ~ 4σ

性能向上のための議論

エアロジェルを厚くして検出光子数の増加

角度分解能が悪化するのでトータルでの性能向上につながらない

デュアルラディエーター

デュアルラディエーターの原理を考案

(屈折率の異なる2種類のエアロジェルを輻射体として使用)

目的:角度分解能の悪化を抑えながら

検出光子数を増やして

検出器の性能を上げる。

■屈折率を自在に調節できるエアロジェルでのみ実現可能。



エアロジェルRICHのビームテスト





▶ 屈折率波長依存性、エアロジェルの表面散乱 等 ~6.0mrad



1トラック当りの角度分解能:4.6 mrad (従来型:5.3 mrad)

Defocusing型 デュアルラディエーターの結果









ビームテストのまとめ

デュアルラディエーターの原理を検証するためにビームテストを行った

■デュアルラディエーターの期待どうりの動作を確認

➢Focusing型 角度分解能を損なわずに検出光子数を増加 従来型 2cm : 6.9 Dual radiator 4cm : 9.6 ◇ (約40%増加)

▶Defocusing型 完全に分かれた2重のチェレンコフリングを観測

さらなる性能向上を狙い、マルチラディエーターの原理を導入した

■マルチラディエーターによって角度分解能も向上

➢Focusing型 角度分解能の悪化を強く抑え、且つ検出光子数を増やした

1光子当たりの角度分解能: 13.0 mrad、検出光子数: 8.5 従来型 2cm: 13.8mrad (3層型Focusingマルチラディエーター) 6.9個

▶Defocusing型 より角度分解能の良い2重のチェレンコフリングを観測 内側リング: 15.0mrad → 13.7mrad 外側リング: 14.6mrad → 13.0mrad



Proximity focusing型エアロジェルRICH の開発研究を行った。

Proximity focusing 型の問題である、厚い輻射体を使用できないという 原理的な問題を「デュアル、マルチラディエーター」というアイディアで解決した

高運動量領域(4GeV/c)におけるK/<u>π識別能力</u>

二識別能力~5.0σ(3層型Focusingマルチラディエーターの場合) 従来型~4.0 σ Dual radiator~4.6 σ

 $\bullet \theta_{\pi} - \theta_{\kappa} \sim 22 \text{ mrad}$

◆ σ_{θ} (1track) = σ_{θ} / √ Npe ~4.4 mrad ↓ (従来型 : 5.3 mrad Dual radiator : 4.6 mrad

Bファクトリー実験での高いK/π識別が期待できる

Back up

シリカエアロジェル

主成分は SiO_2 空隙部分が90%以上を占める。



構造

低密度、低屈折率

物質	屈折率	密度	
エアロジェル	1.007~1.07	0.0281~0.281	
空気	1.00028	0.001293	
水	1.3428	0.99984	
ガラス	1.48~2.00	2.4 ~ 2.6	

シリカ粒子の3次元ネットワーク構造





Focusing型デュアルラディエーター 運動量依存性











角度分解能の入射角依存性





各層のエアロジェルをそれぞれ 単一でチェレンコフリングを測定

layer	index	radius(mm
1st	1.046	63 ⁾ 76
2nd	1.051	64.52
3rd	1.056	62.84
4th	1.061	61.54

チェレンコフ角のずれ

5~10 mrad

屈折率波長依存性による誤差



エアロジェルの屈折率非一様

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フラウンフォーファー法による エアロジェル屈折率の測定



デュアルラディエーターRICHの開発研究

(屈折率を調節できるエアロジェルでのみ実現可能)

試作機を用いたビームテストで検証

角度分解能、検出光子数を評価

測定項目1. 従来型エアロジェルRICHの測定(2cmの輻射体)

- 2. 従来型エアロジェルRICHの測定(4cmの輻射体)
- 3. Focusing型デュアルラディエーターRICHの測定(計4cmの輻射体)
- 4. Defocusing型デュアルラディエーターRICHの測定(計4cmの輻射体)

